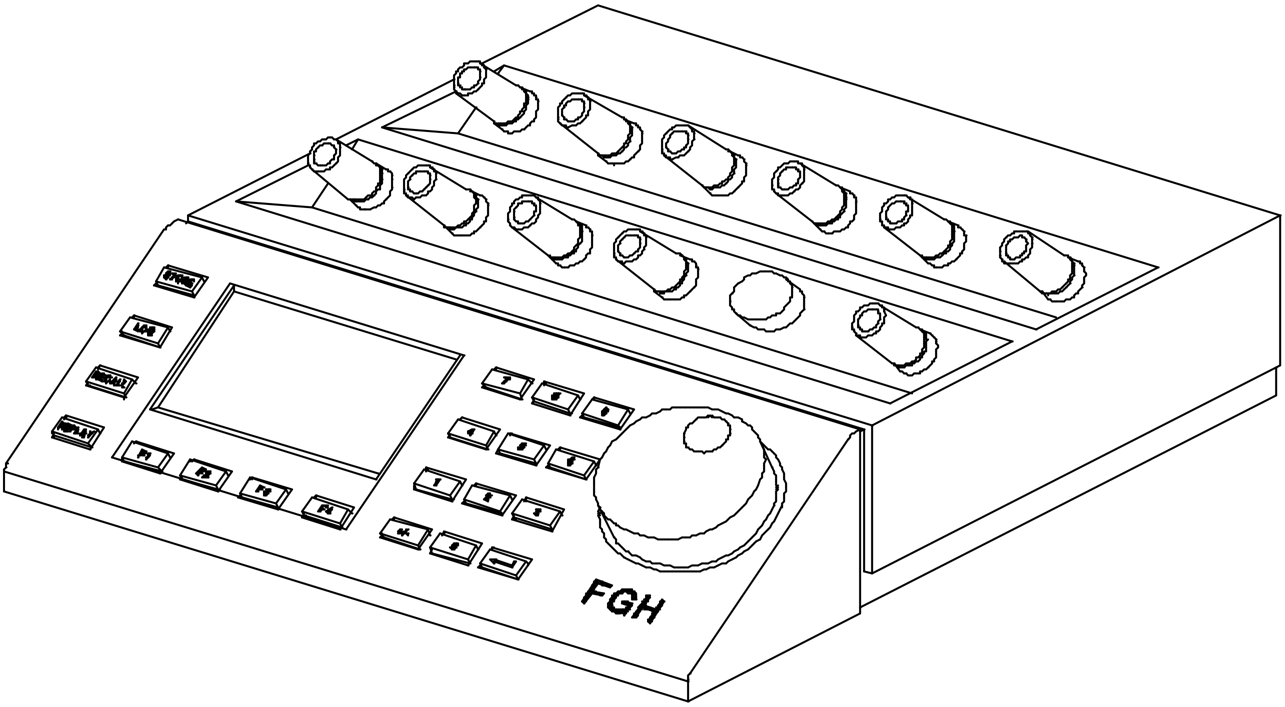
EZECAL 5

PRECISION PORTABLE PROCESS CALIBRATOR



CONTENTS.

SECTION 1 - INTRODUCTION

1.0 General.

The EZECAL 5 is a general purpose tool intended for the calibration of control equipment, instrumentation and transducers. It can both simulate and measure simultaneously and is also equipped with a power supply output to provide loop power for 2 wire transmitters.

The EZECAL 5 is a high precision instrument, and as such must be recalibrated regularly (at least once per year) to maintain optimum performance. For the users convenience, the date of the last calibration is shown on the display every time the unit is switched on.

The integral high capacity battery pack makes the instrument suitable for both field use (providing up to 10 hours continuous operation from one charge), and laboratory work using the mains power supply adapter.

In the field the EZECAL 5 can store around 200 calibration measurements or log 400 values for later retrieval back at the office, where the optional RS232 interface may be use to print calibration certificates or dump logged data into a PC spreadsheet for analysis.

1.1 Display and Keyboard.

When first switched on, the display shows the instrument serial number and the date of the last calibration.

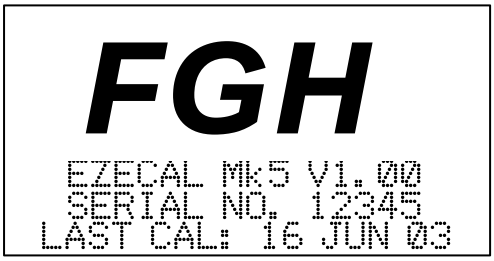


Fig 2

After 5 seconds this display is replaced by the primary working screen.

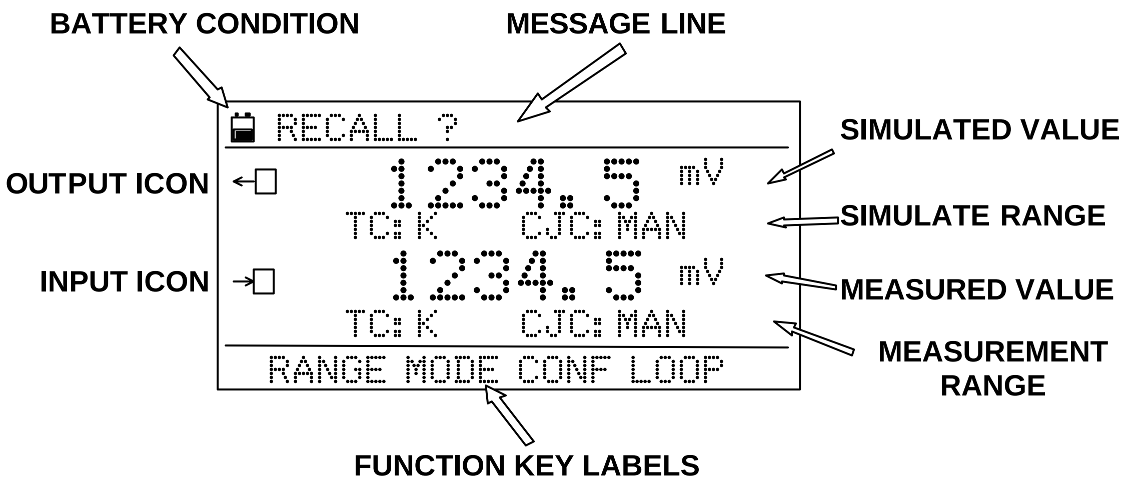


Fig 3

The primary display of the calibrator is divided into four main areas.

MESSAGE LINE
Shows prompt messages for the STORE and RECALL facilities.

FUNCTION KEY LABELS
The purpose of the four function buttons **F1** to **F4** change depending upon the screen mode. The function key labels tell the operator the purpose of the buttons for the current screen. For example, in the above illustration **F1** is used to change the measure or simulate range.

BATTERY CONDITION INDICATOR
This symbol shows the charge status of the battery pack. It is animated in six stages from fully charged (completely black) to low charge (all white) and critically low (all white and flashing).

Fig 2

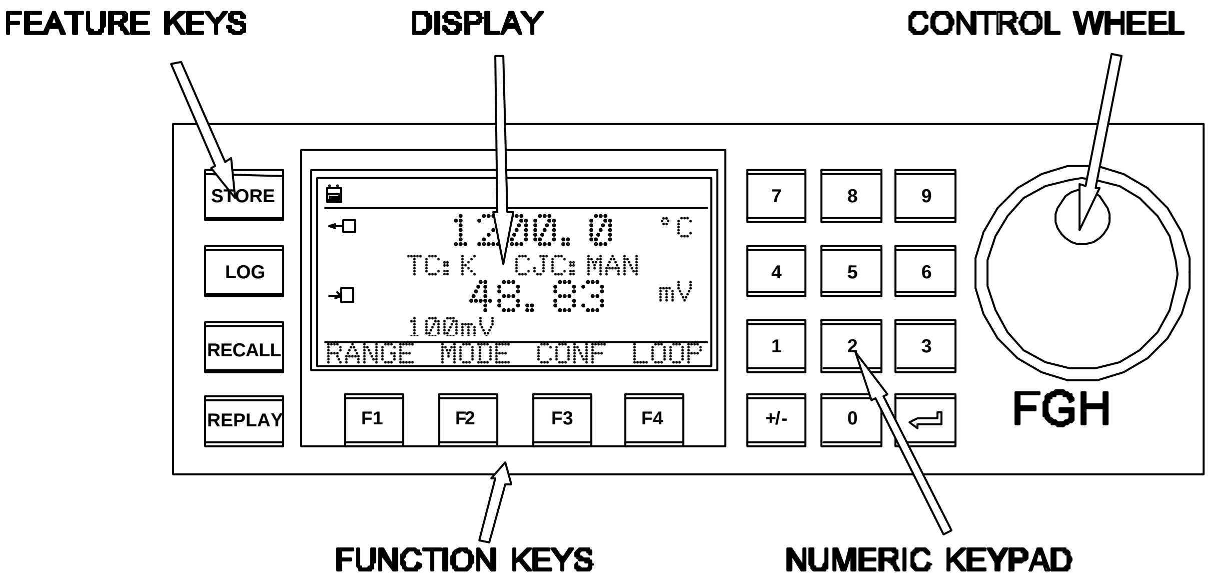


Fig 4

The keyboard is split into three areas:-

NUMERIC KEYPAD

The numeric keypad is used to enter numeric data in exactly the same way as a calculator.

Numbers are entered in exactly as written followed by the ENTER key. The decimal point position is taken care of automatically depending on the circumstances. Mistakes can be rectified simply by re-entering the correct value and pressing ENTER.

CONTROL WHEEL

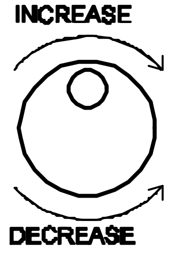


Fig 5

Alternatively, any number which can be entered via the numeric keypad, may be entered by turning the 'control wheel'. Turning the knob clockwise increases the displayed number and anticlockwise decreases the number. The rate at which the displayed number changes is dependent on the speed at which the pot is turned, so spinning the knob quickly will change the displayed number at several hundred digits per second.

The sensitivity of the control wheel is adjusted dynamically by the EZECAL 5 to suit the type of value actually being changed and the overall sensitivity (speed of response) may be adjusted as desired from the configuration menu (see 5.3).

FUNCTION KEYS

These four keys are used to select functions dependent upon the screen currently shown. Their function is indicated at all times by the function key labels on the bottom line of the display.

FEATURE KEYS

These four keys provide access from the primary display to the STORE, RECALL, LOG and REPLAY features described in later sections.

1.2 Batteries.

The EZECAL 5 has a fixed internal NiCad battery pack. This battery pack is inaccessible to the user and cannot be replaced by dry cells.

The useful life of the batteries depends on the use of calibrator. To obtain the longest use from one charge, the user should observe the following guidelines.

- Switch off the calibrator when not in use.
- Use the backlight only when necessary.
- Use the 24V transmitter supply only when power is unavailable elsewhere.

The internal battery pack must be recharged using the power supply adaptor provided. To charge the batteries simply plug the adaptor power lead into the power jack at the rear of the instrument.

With the instrument switched off, recharging will take approximately 14 hours. Do not charge for significantly longer than this as damage may be caused to the batteries.

The instrument may be used whilst the battery is recharging, however the charge rate will be reduced and the recharge time will be significantly lengthened.
For optimum battery performance, the batteries should be run down to their minimum operating level before recharging.

SECTION 2 - CONNECTIONS.

2.0 Terminals.

On the top of the EZECAL 5 are two rows of terminals. Each terminal can accept a 4mm banana type plug, or be used to clamp the bare end of a wire. The terminal function is indicated on the label and in the figure below.

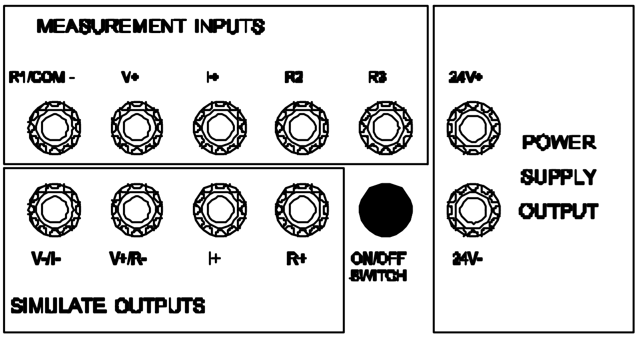
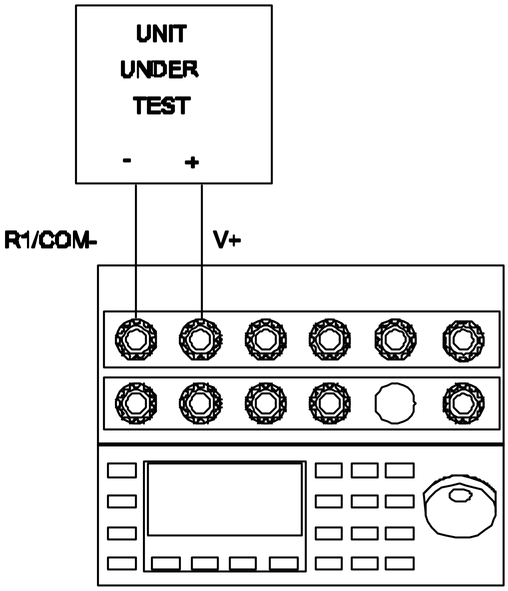


Fig 6

2.1 Voltage Measurement.

The unit under test is connected directly to the COM and V+ terminals shown.



For low level voltage measurements on the 100mV range see section 2.10 for hints on accuracy.

Fig 7

2.2 Current Measurement.

Devices which can source current (such as controller outputs and mains powered transmitters) may be measured by connecting them to the **I+** and **COM-** input terminals.

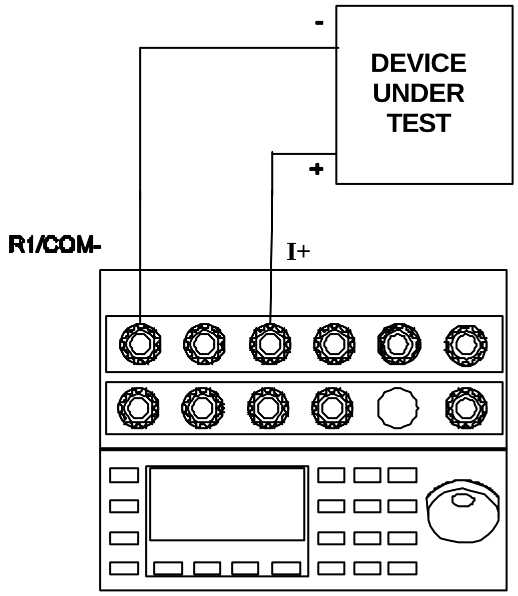


Fig.8

Other devices such as loop powered transmitters, are only capable of sinking current and hence require a power supply in order to work. For this type of device the integral power supply should be wired in series with the current loop.

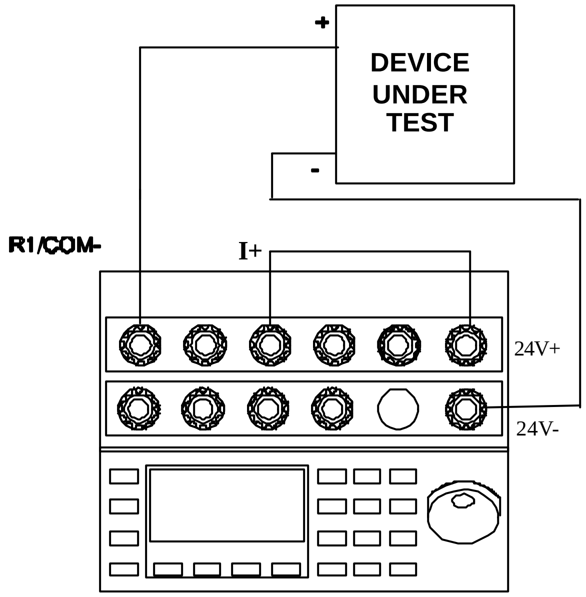


Fig.9

2.3 Resistance / RTD Measurement.

The resistor or resistance thermometer to be measured should be connected in 3 wire mode as shown. For the highest precision, the 3 wires used should be of the same gauge and length. This allows the measurement to compensate for the resistance of the lead wires.
A two wire measurement may be made by shorting together terminals **R2** and **R3** and connecting the resistor to be measured between terminals **R1** and **R2**. In this case however the displayed resistance will include the resistance of the lead wires.

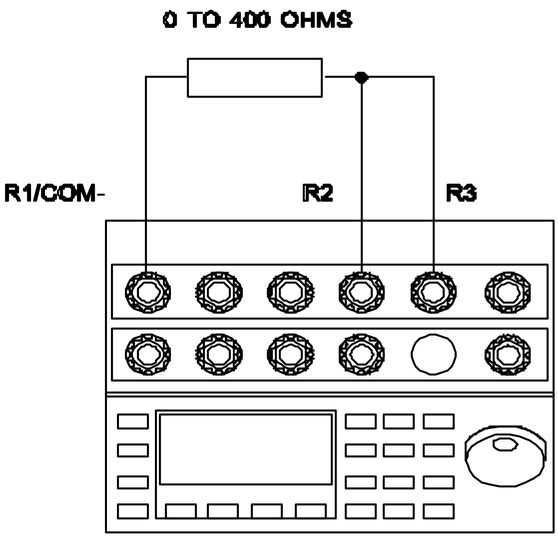


Fig.10

2.4 Thermocouple Measurement.

There are two modes of thermocouple measurement available depending on the location of the reference junction.

For thermocouples wired in compensating cable, the cables should be directly connected to the voltage measurement terminals and the EZECAL 5 should be set to REF:INTERNAL. For best results, the compensating wire tails should be bare wire and should be tightly clamped under the terminals.

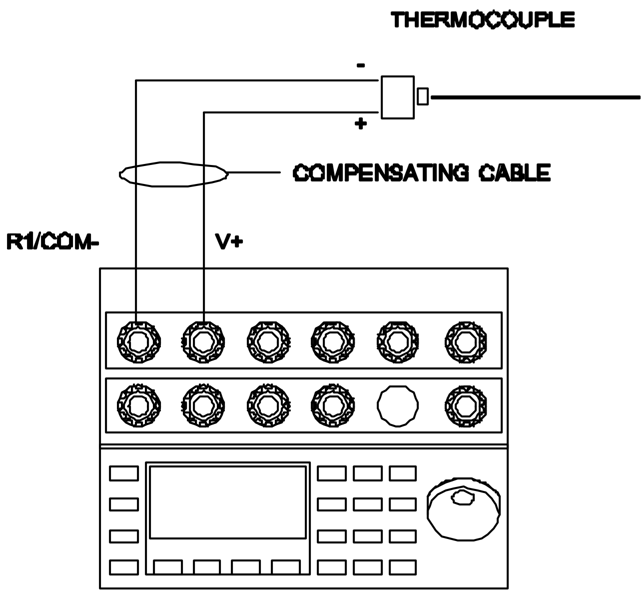


Fig.11

Alternatively an external reference junction may be used. In this case the cables from the reference junction should be connected as shown and the EZECAL 5 set to REF:MANUAL with the reference temperature Tref manually entered.

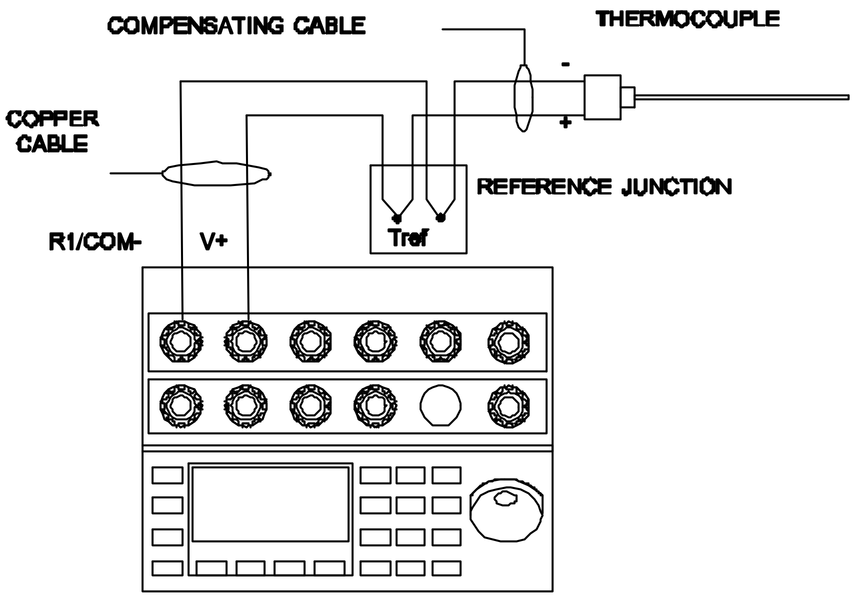


Fig 12

2.5 Voltage Simulation.

Connect up the unit under test to the **V-** and **V+** terminals as shown. For simulation on the 100mV range, pay particular attention to the guidelines given in section 2.10.

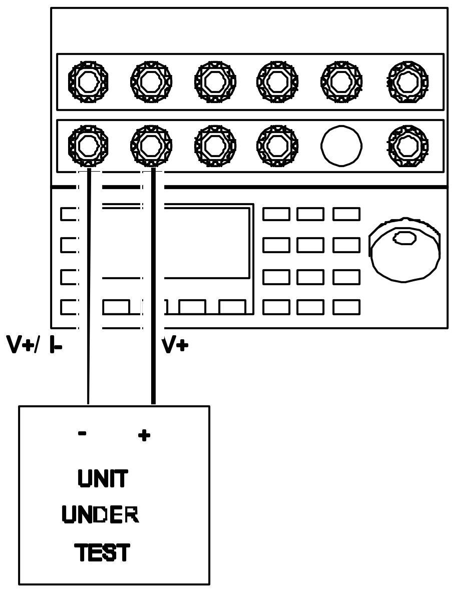


Fig 13

2.6 Current Simulation.

The current output terminals **I-** and **I+** do not source current and so the internal 24V power supply should be connected in series as shown to provide loop power. An existing supply may be used (as in a two wire transmitter loop). In this case connection need only to be made to the **I-** and **I+** terminals.

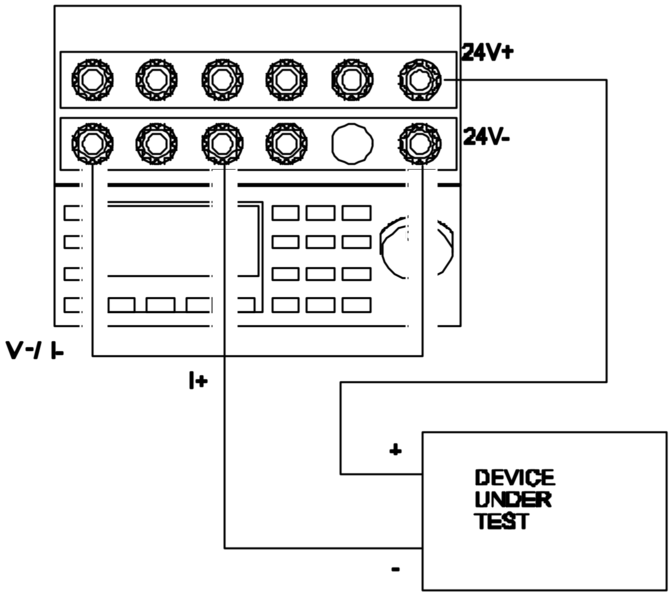


Fig 14

2.7 Resistance/RTD Simulation.

For the most accurate resistance simulation the unit under test should be connected using the four wire method shown below. This method cancels out the resistance of the wiring. Pay particular attention to the polarity of the measurement current sourced from the unit under test.

NOTE.
When calibrating instruments with scanning inputs (such as chart recorders), the scanning should be turned off such that the instrument under test is constantly measuring the input to which the EZECAL 5 is connected.

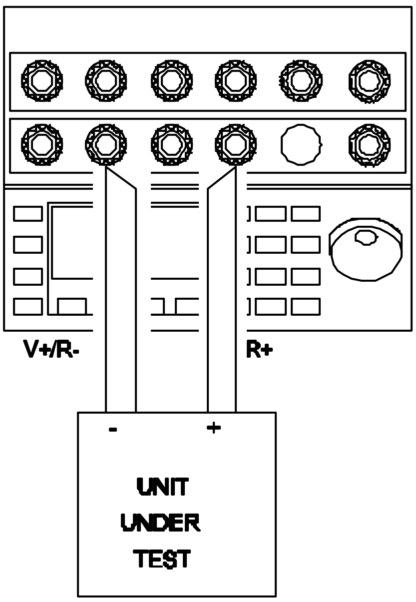


Fig 15

If the unit under test employs a three wire measurement technique, then connect the wires as shown below.

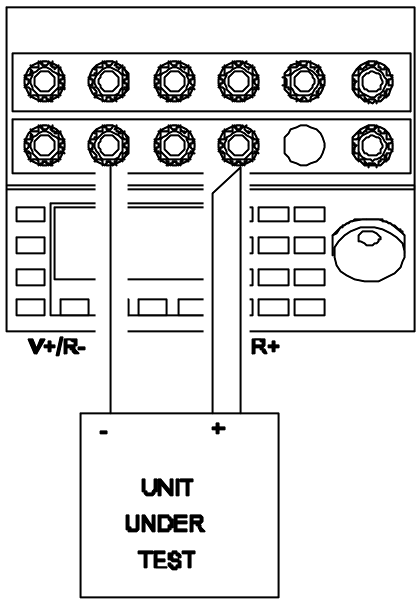


Fig 16

2.8 Thermocouple Simulation.

There are two modes of thermocouple simulation available depending on the location of the reference junction.

For connection in compensating cable to the unit under test, the cables should be directly connected to the voltage simulation terminals and the EZECAL 5 should be set to REF:INTERNAL. For best results, the compensating wire tails should be bare wire and should be tightly clamped under the terminals.

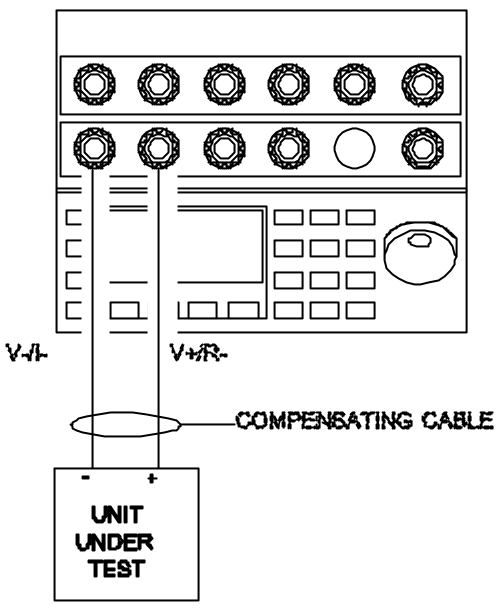


Fig 17

Alternatively an external reference junction may be used. In this case the cables from the reference junction should be connected as shown below and the EZECAL 5 set to REF:MANUAL with the reference temperature Tref manually entered.

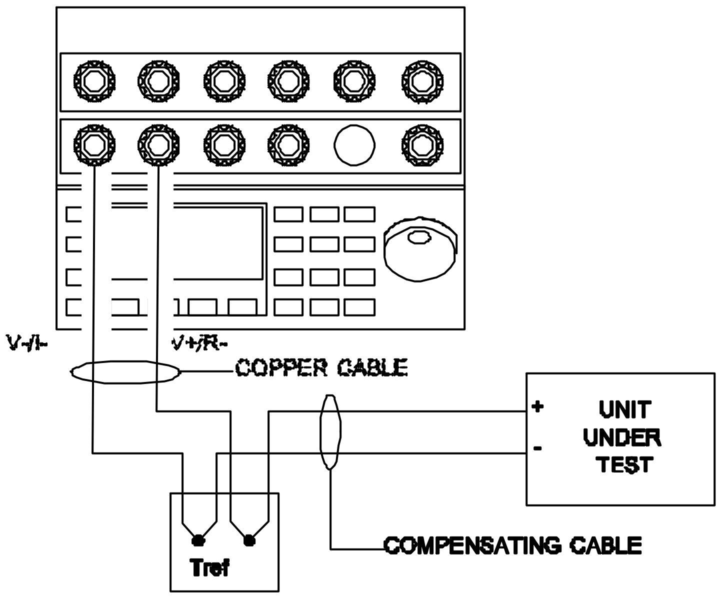


Fig 18

2.9 Transmitter power supply.

A 24V dc power supply is available to power two wire transmitters or any other current input/output device. The power supply is current limited to a nominal 25mA.

2.10 Hints for accurate low level voltage measurement and simulation.

When measuring or simulating low voltage levels such as thermocouple signals, the user can unwittingly introduce errors into the measurement. These errors are usually due to thermal emfs. Thermal emfs are small voltages which appear across joints of dissimilar metals. If two or more such joints are at differing temperatures then the resultant voltage will be added to the measurement/simulation voltage. Best results will be obtained by following the simple guidelines given below.

Always use the correct type of compensating cable for thermocouples that require it and pay particular attention to the polarity (red is not always positive). Some thermocouples (notably type B) do not require compensating cable.

When compensating leads are to be connected directly to the EZECAL 5, the bare wire ends should be firmly clamped under the terminals to allow the EZECAL 5 to make an accurate reference junction temperature measurement.

Avoid the use of banana plugs if possible, but if they are to be used, then handle them lightly by the plastic part to avoid warming them up.

Wait for several minutes after wiring to allow time for the temperature of the connections to equalise before making the measurement. This will reduce any thermal emf effects which do occur.

SECTION 3 - OPERATION.

3.0 Operating mode.

The EZECAL 5 has three primary operating modes. To change the mode, simply press F2 (MODE).

MEASURE ONLY MODE.

In this mode the display shows only the measured input. Although the simulated output is still functioning.

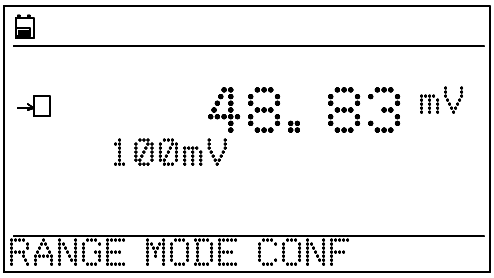


Fig 19

SIMULATE ONLY MODE.

In this mode the display shows only the simulate output value. To change the simulate output, enter the new value via the numeric keypad or rotate the control wheel as required.

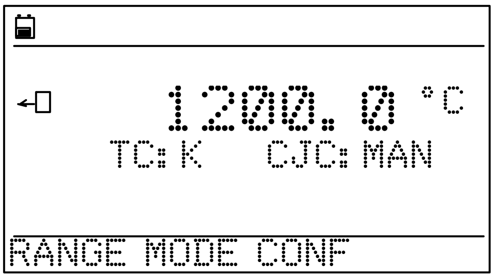


Fig 20

SIMULATE/MEASURE MODE.

In this mode both the simulated output and the measured inputs are shown. As in simulate only mode the simulated output may be entered at any time.

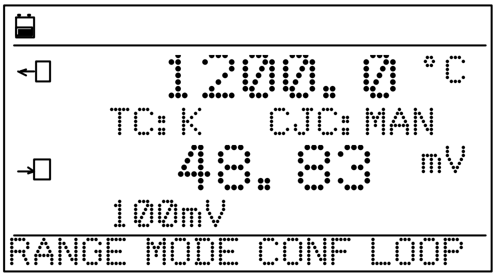


Fig 21

If F4 (LOOP) is pressed, then the simulate output value is forced to numerically equal the measured input value. This fact is indicated by the line now drawn between the input and the output icons.

This mode is useful when the ezecal is used as a conversion tool (eg to convert signals between different thermocouple types).

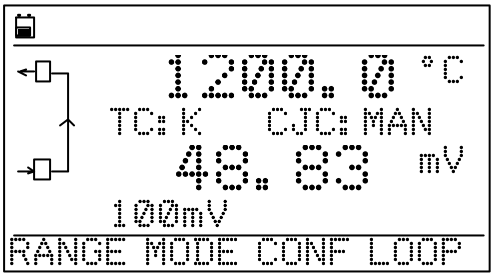


Fig 22

To exit from loop mode, simply press F4 (LOOP) again.

3.1 Changing range.

The EZECAL 5 is equipped with 20 standard ranges plus four user defined ranges. The range must be selected for both the simulation output and the measurement input and hence there is a range select screen for each.

To change range, from the primary screen press the **F1** (RANGE) key.

The current range name selected is shown on the top line of the display along with the associated range units, resolution and reference type. The parameter to be modified is indicated by means of the triangular pointer (cursor). This can be positioned by pressing the **F1** (DOWN ARROW) key.

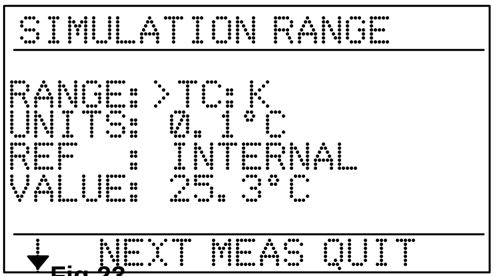


Fig 23

To change the range, press the **F2** (NEXT) key and the next range will be shown. Alternatively rotate the pot until the required range is shown. See appendix A for a list of available ranges.

To toggle between the simulation and measurement range screens press the **F3** key.

Finally, to return to the primary screen press **F4** (QUIT).

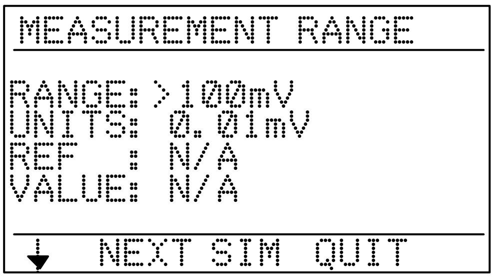


Fig 24

3.2 Changing temperature units.

On temperature ranges the user can select the display units and resolution. Temperatures may be displayed in degrees Celsius or Fahrenheit and in 1° or 0.1° resolution. On non temperature ranges, the UNITS line indicates units and resolution for information only.

From the range select screen, index down to the UNITS line using **F1**. Select the required units and resolution using **F2** (NEXT) or the control wheel.

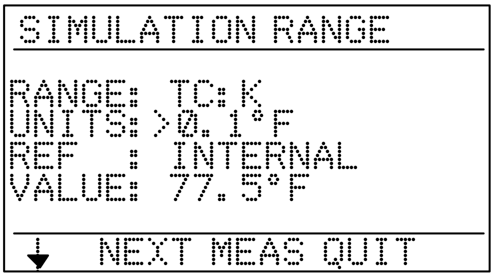


Fig 25

3.3 Changing cold junction mode.

For accurate measurement or simulation of thermocouples the EZECAL 5 must compensate for the temperature of the reference junction.

If the thermocouple is wired to the EZECAL 5 in compensating cable then this reference junction exists at the terminals of the calibrator and the cold junction mode should be set to INTERNAL.

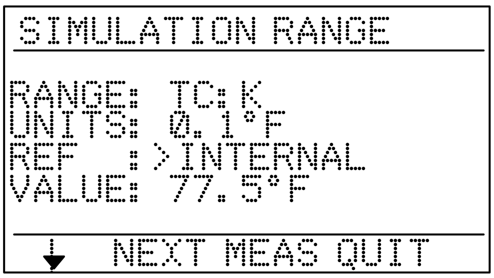


Fig 26

Alternatively, if an external reference junction is used then the reference type should be set to MANUAL and the reference temperature entered under VALUE.

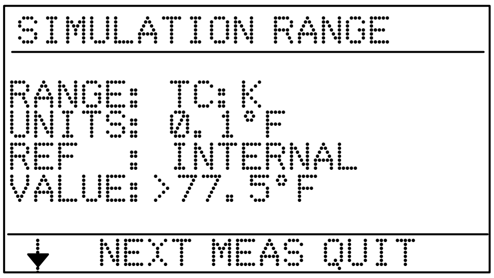


Fig 27

3.4 Saving frequently used values.

The EZECAL 5 has ten memories in which simulate values can be stored. These may be used to store frequently used output values (such as 0 and 1000) or be used together to form an output profile which may be replayed in sequence automatically.

To store a value in memory, first of all enter a valid simulate value (for example 100.0). Then press the **STORE** button. The display will indicate on the top line that a store cycle is in progress.

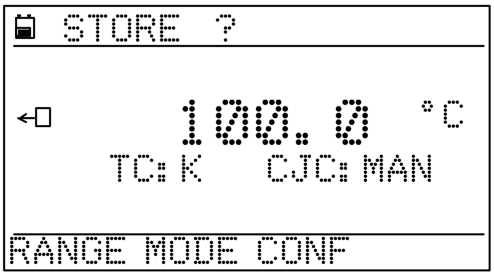


Fig 28

Now press the numeric key appropriate to the memory in which ou wish to store the value (or rotate the control wheel).

The top line of the display will show the current contents of the memory. Press **ENT** to store the value in the selected memory or press **STORE** to abort without saving.

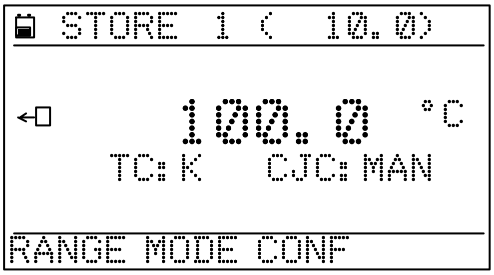


Fig 29

To recover a value from memory press the **RECALL** key. The top line of the display will indicate that a recall cycle is in progress.

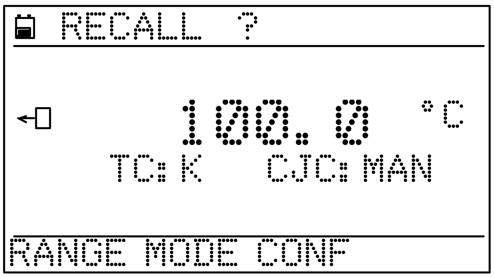


Fig 30

Using the numeric keypad, press the number of the memory that you wish to recall and the stored value will immediately appear as the simulate output value. Press another number key and a different stored value will appear.
Finally, exit from RECALL mode, press the **RECALL** key again.

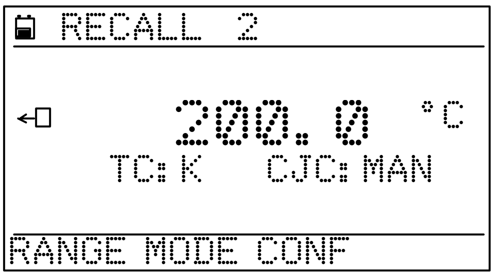


Fig 31

SECTION 4 - ADVANCED FEATURES.

4.0 Logging.

The EZECAL 5 logger can operate in one of two modes.

MEASUREMENT v TIME — The logger will log the value of the measured input at fixed time intervals.

CALIBRATION POINTS — The logger will store calibration data files.

The logger function is set up under the configuration menu see 5.1.

4.1 Measurement versus time logging.

In this mode the logger will record the value of the measured input at preset time intervals. 400 such logs can be made and the data obtained can be replayed in graphical form, output from the simulate output or down loaded via the serial communications option into a personal computer for later analysis. Once started the logging continues to operate in the background until 400 logs have been made or is manually stopped. While the logger is running the calibrator may continue to be used in the normal way.

Before the logger can be started, the log interval must be entered. From the primary display press the **LOG** key and the logger control display will appear.

The STATUS line shows the current logger status, either STOPPED or RUNNING. The next line shows the programmed log interval in minutes and seconds, in this case 1 minute is set.

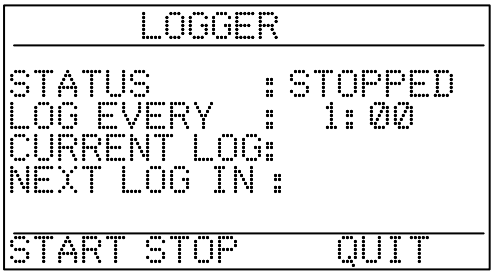


Fig. 32

This value may be set as required using the numeric keypad or the control wheel between one second and ten minutes.

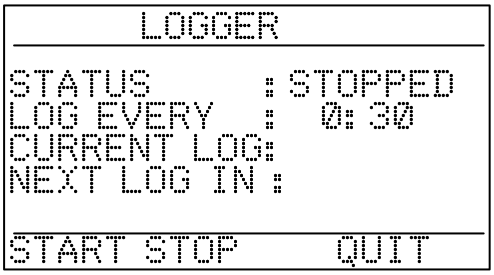


Fig. 33

The logger can now be started by pressing **F1** (START). The display will now show two additional pieces of information. The number of logs made and the time remaining before the next log is made. Use **F2** (STOP) to stop the logger if required.

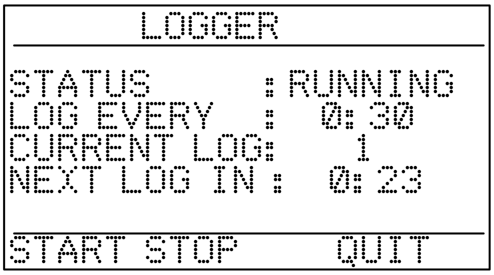


Fig. 34

To return to the primary screen press the **F4** (QUIT) key. The primary display will now indicate that the logger is running by showing a small **LG** symbol underneath the measure icon.

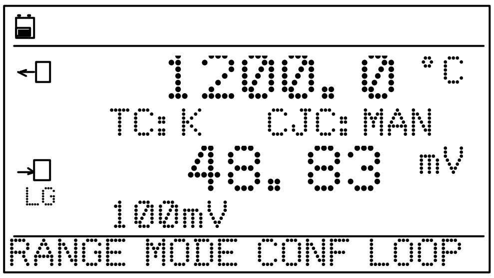


Fig.35

4.2 Retrieving logged data.

Logged data may be retrieved in one of three ways. It may be shown on the display as a graph. It may be replayed in real time from the simulate output or may be down loaded to a personal computer via the serial communications option.

The replay option required is selected by pressing **REPLAY** from the primary screen.

4.2.1 Display log graph.

From the replay options screen move the cursor to **SHOW LOG GRAPH** using the **F1** key and press **F2** (SELect) to select the log graph display.

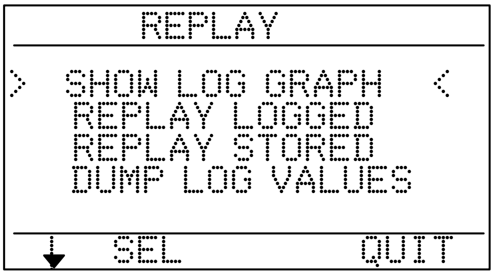


Fig.36

The graph y axis is automatically scaled to accommodate the range of the logged values and the first one hundred logs are shown across the display. If the logger is actually running while the graph is shown, then the graph will automatically be updated with any new values as they are logged.

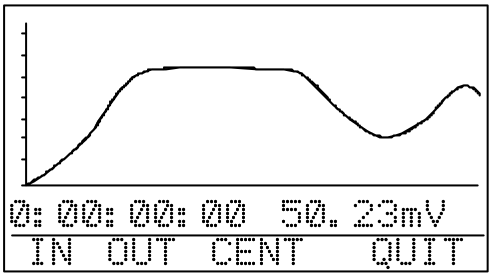


Fig.37

A vertical cursor line is provided in order to read off the time and value at the point where the cursor intersects the graph. The cursor is positioned using the control wheel and the associated elapsed time in days, hours, minutes and seconds is shown below the graph along with the actual input value at that time. If the cursor is moved to the far right of the graph then the next page of logged points will be displayed.

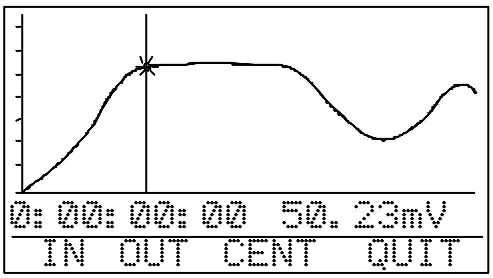


Fig.38

To show more detail, the user may zoom in on the graph using **F1** (IN). This will cause the y axis to expanded by a factor of 2 and the graph to be centred on the currently selected (flashing) point. Repeated presses of **F1** will cause greater magnification up to the maximum limit of ten digits on the y axis. To zoom out again use **F2** (OUT), or to centre the flashing point use **F3** (CENT).

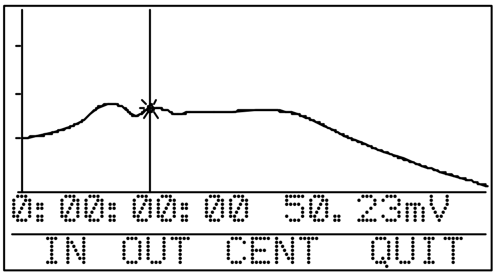


Fig. 39

To exit from the graph display and return to the replay options screen press **F4** (QUIT).

4.2.2 Replay logged data.

The data recorded by the logger can be replayed via the simulate output. Once started the replay will continue automatically at the programmed rate until all of the logged points have been replayed or the replay is manually stopped.

From the replay options screen, move the cursor to REPLAY LOGGED using **F1** and select using **F2** (SELect). The replay control screen will appear.

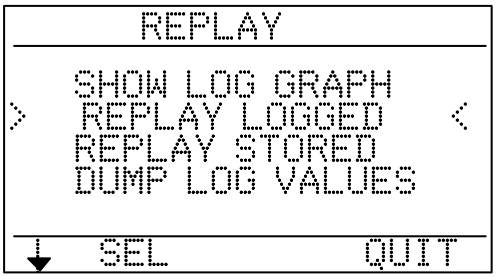


Fig. 40

The STATUS line shows the current replay status, either STOPPED or RUNNING. The next line shows the programmed replay interval in minutes and seconds, in this case 1 minute is set.
The replay interval may be set as required between 1 second and 10 minutes per step using the numeric keypad or control wheel.

Fig.41

The replay mode may be toggled between STEP and RAMP using **F3** (MODE). In STEP mode the calibrator will step change the simulate output between the logged data values. In RAMP mode the calibrator will ramp the simulate output by interpolating between the logged points every one second. This option may be changed while the replay is running.

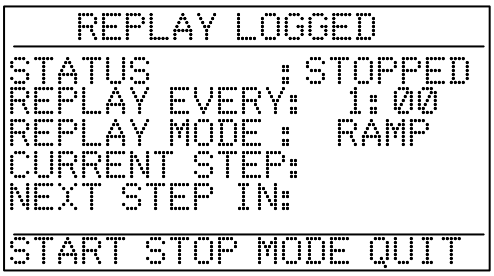


Fig 42

The replay may be started using **F1** (START) or stopped by using **F2** (STOP). While the replay is running both the current step number and the time remaining until the next step is shown on the display.

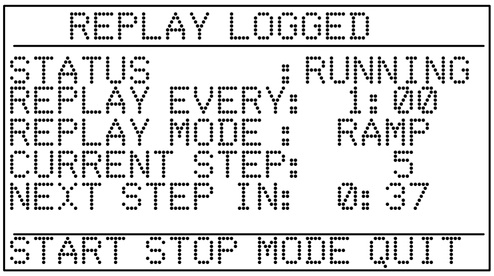


Fig 43

To return to the primary screen press the **F4** (QUIT) key. The primary display will now indicate that the replay is running by showing a small **RP** symbol underneath the simulate icon. While this is present the simulate output value may not be changed manually.

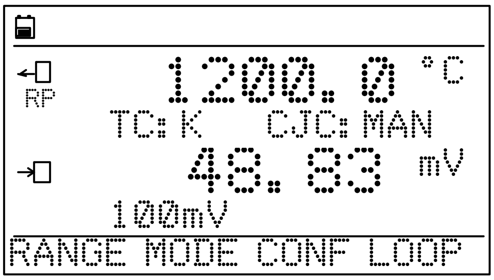


Fig 44

4.2.3 Replay stored data.

This option is identical to the REPLAY LOGGED option except that the values replayed will be the ten values saved in memory using the STORE key. Linking the ten STORED values in this manner enables the user to create a 'test profile'. Unlike the REPLAY LOGGED option, the test profile will be repeated over and over until the replay is manually stopped.

This 'test profile' can be useful, for example when checking the calibration of an instrument mounted in a control panel. In this case the calibrator would be connected inside the panel to the instrument and the test profile entered as described in 3.4. The EZECAL 5 would then be set to replay the stored profile at say 1 minute per step. The operator need now only to observe the instrument readings from the front of the panel and record them if necessary.

4.2.4 Dump log values.

Data collected by the logger may be down loaded to a computer for analysis or printing. This is only available if the serial communications option is fitted. The data is transmitted using standard ASCII characters in a format suitable for most popular spreadsheet programmes.

From the replay options screen, move the cursor to DUMP LOG VALUES using **F1** and select using **F2** (SELect).

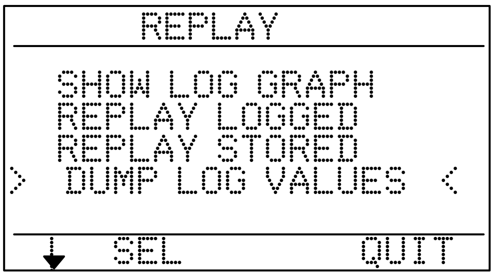


Fig 45

The log dump confirmation screen will now appear. Ensure that the computer to be used is both connected and ready to receive data, then press **F3** to transmit the data.

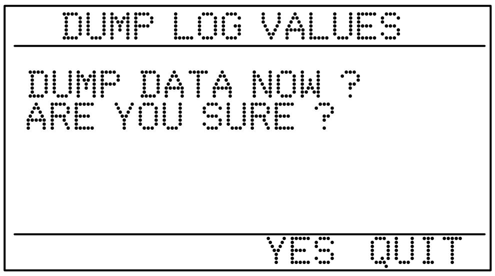


Fig 46

While the data is being transmitted the display will show the word DUMPING. This may take some time for slow baud rates and large amounts of logged data. When complete the replay options menu will re appear.

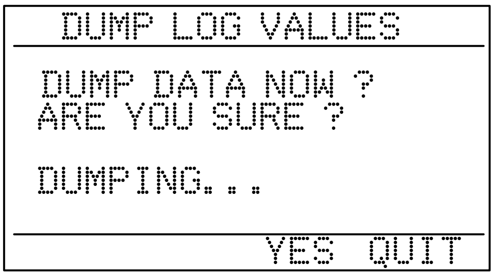


Fig 47

4.2 Storing calibration records.

The alternative use for the logger is to store calibration records. This mode of operation is set up from the configuration menu under LOGGER FUNCTION see 5.1.

A calibration record is a file stored within the calibrator which records the before and after calibration performance of an instrument or transmitter. The EZECAL 5 can store many such files depending on the number of calibration points used within each file.

Once a calibration file is stored, it can be examined, dumped to a computer or printed out as a calibration certificate on a suitable serial printer.

This powerful feature allows many instruments to be calibrated during a day in the field and the results stored within the calibrator. Then, upon return to the office or car, the calibration certificates printed out and signed.

A typical calibration sequence would consist of the following steps:-

1. Set up the simulate output and measure input to suit the unit under test.

   For display only devices (such as a panel meter), set the EZECAL to simulate only mode.

   For devices which have a measurable output (such as a transmitter), set the EZECAL to simulate/measure mode.
2. Open a new calibration record file.
3. Record the uncalibrated performance of the unit under test at several points within its range.
4. Close the calibration record file.
5. Calibrate the unit under test.
6. Record the calibrated performance of the unit under test.

7. Repeat steps 1 to 6 on other units.

8. Print out and sign calibration certificates.

4.2.1 Opening a calibration record file.

Before any records can be stored, the calibration file must be opened. This merely consists of giving the file a name. The file name is a string of up to seven characters and would normally be the tag name or serial number of the instrument to be calibrated. File names need not be unique, but in this case it is up to the user to distinguish between identically named files. Files are stored in memory and each file occupies 24 bytes plus 6 bytes per record.

From the primary display press the **LOG** key and the cal' record menu screen will appear. The amount of free memory is displayed in bytes at the bottom of the screen. Point to OPEN NEW FILE using **F1** and press **F2** to select.

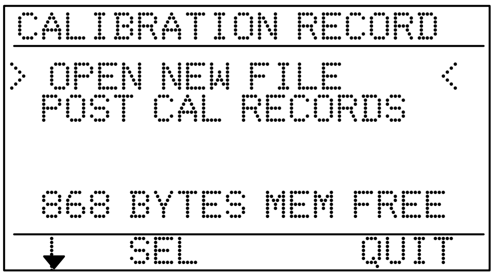


Fig 48

The EZECAL 5 will invite you to enter the name of the new file. Initially the file name will be set to 'UNNAMED' and this may be overwritten as required. The file name is entered one character at a time using the numeric keys, control wheel or **F2** (NEXT). All alphanumeric characters and punctuation may be used in the file name. The character being entered is indicated by the flashing underline cursor. When the correct character is displayed, press the ENTER key to advance to the next character position or **F3** (CLeaR) to blank the character. When complete press **F1** (OPEN) to open the file or **F4** (QUIT) to abort.

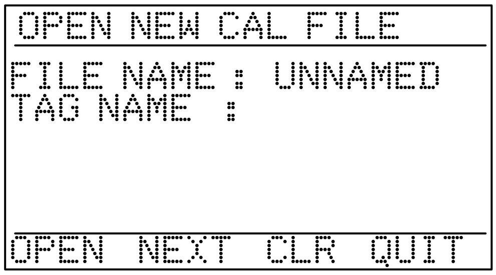


Fig 49

If the file is opened the user may then enter the tag name or serial number of the device being calibrated. This is done in the same manner as the file name. Press **F1** (DONE) when complete or **F4** (QUIT) to abort.

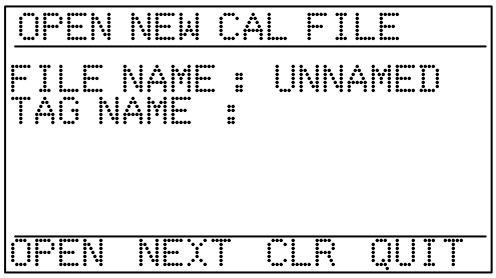


Fig 50

The primary display will show the LG symbol to indicate that a calibration file is open and that the EZECAL 5 is now ready to store the pre calibration values.

4.2.2 Saving a pre calibration point.

After setting the simulate output to the required pre calibration point on the primary display, press the **LOG** key. The PRE CAL RECORD screen will appear.

The current simulate output value is displayed as the INPUT value on the display (because it is the input to the unit under test). If the unit under test has a measurable output, then this output value is displayed as the PRE CAL value. Alternatively for display only devices, the PRE CAL value is displayed as zero and the engineer should enter the current display reading of the unit under test. In either case the values should be saved by pressing **F3** (SAVE) at which point the screen will revert to the primary display.

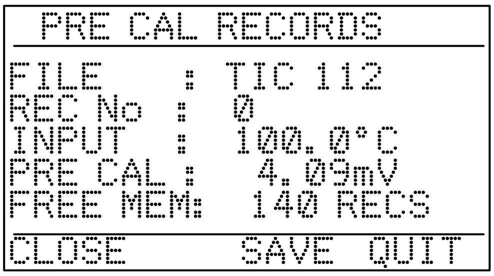


Fig 51

The bottom line on the display shows the available memory space in records. Up to forty such records can be entered into one calibration file.

4.2.3 Closing the pre calibration record file.

When all necessary calibration points have been recorded, the calibration file should be closed to save away all the pre calibration data.

Once the file is closed it may not be re-opened and the pre calibration points may not be edited.

From the primary display press the **LOG** key to access the pre calibration record screen. The display will show the number of records which have been saved.

Press **F1** (CLOSE) to close the file or **F4** (QUIT) to return to the primary display.

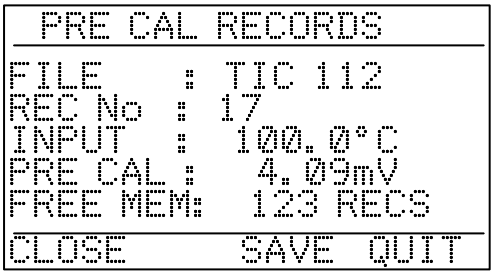


Fig 52

4.2.4 Recording post calibration data.

Once the unit under test has been calibrated, the calibrated performance should be recorded.

From the primary display, press the **LOG** key and point to 'POST CAL RECORDS' using **F1** and select using **F2** (SELect).

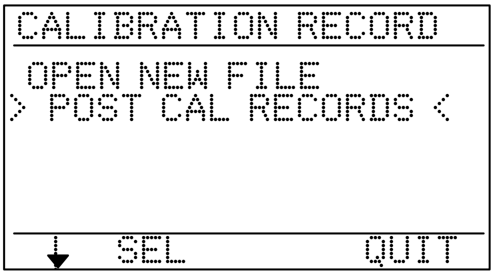


Fig 53

Point to the required file from the menu by using **F1** and then press **F2** (SELect) to select the indicated file. If more than six files are stored then press **F3** (MORE) to display the next page.

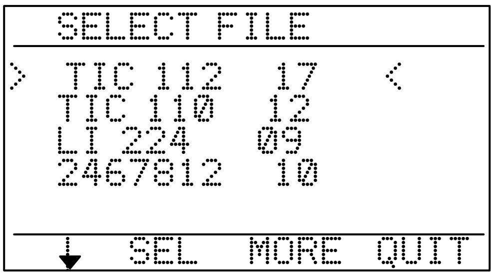


Fig 54

When the file has been selected the post calibration record screen will appear. The EZECAL 5 will automatically set the simulate and measure ranges to those set at the time when the pre cal records were stored and the simulate output will be set to source the INPUT value shown.

For devices with a measurable output, the POST CAL value will show the current output from the unit under test. When this value has settled, press the **F3** (SAVE) key to store the post calibration value for that calibration point.

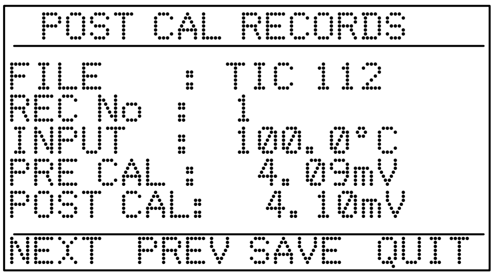


Fig 55

For display only devices the POST CAL value will appear blank and the value displayed on the unit under test should be entered manually using the keypad or control wheel. Press **F3** (SAVE) to store the value in memory. POST CAL values which have been saved are indicated by a star appearing before the displayed value.

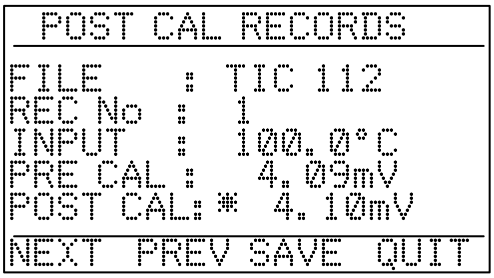


Fig 56

Press **F1** (NEXT) to advance to the next calibration point. Again the EZECAL 5 will automatically set the simulate output to the correct value ready for the operator to enter or save the post calibration reading as before.

Continue using **F1** (NEXT) or **F2** (PREVious) until all post calibration points have been done. Press **F4** (QUIT) to return to the primary display.

4.3 Retrieving calibration records.

There are three ways in which stored calibration files can be retrieved.

1. The calibration data can be shown one point at a time on the EZECAL 5 display.
2. The calibration data can be down loaded to a personal computer via the serial communications option if fitted.
3. The EZECAL 5 can be connected to a suitable serial printer and a calibration certificate can be printed out.

To perform any of these three options, from the primary display press the REPLAY key and the CAL RECORD REPLAY screen will appear.

Select the option required using **F1** to move the cursor and **F2** (SELect) to select the indicated option.

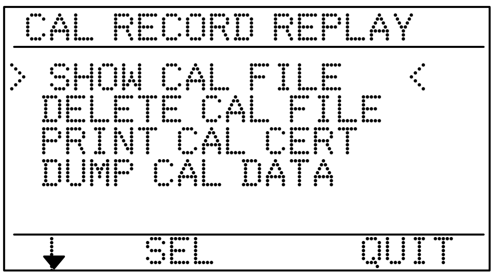


Fig 57

4.3.1 Show calibration file.

When this option is selected the file selector menu will appear. The file selector shows all the files currently stored within the calibrator in the order that they were created. The number of records contained within the file is shown next to the file name. To select the file of interest, move the triangular pointer with the **F1** key and press **F2** (SELect) to select the indicated file. If the file required is not shown on the display then press **F3** (MORE) to show the next page of files.

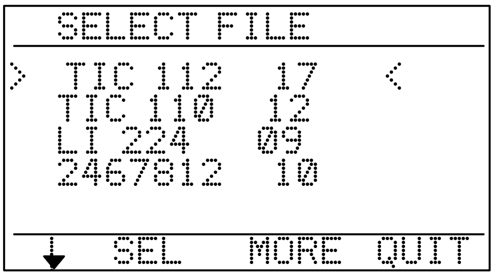


Fig 58

The calibration records are shown one point at a time. The user can scan through the records by pressing **F1** (NEXT) to show the next point, or **F2** (PREVious) to show the previous point. The record number shown will end around to 1 at the end of the list. If the POST CAL value is shown blank then the post cal figure was not saved for that calibration point. Press **F4** (QUIT) to return to the cal record replay screen.

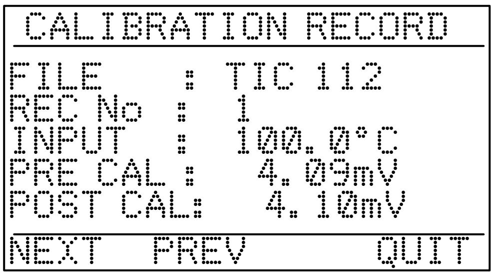


Fig 59

4.3.2 Print calibration certificate.

When this option is selected the file selector menu will appear. The file selector shows all the files currently stored within the calibrator in the order that they were created. The number of records contained within the file is shown next to the file name. To select the file of interest, move the triangular pointer with the **F1** key and press **F2** (SELect) to select the indicated file. If the file required is not shown on the display then press **F3** (MORE) to show the next page of files.

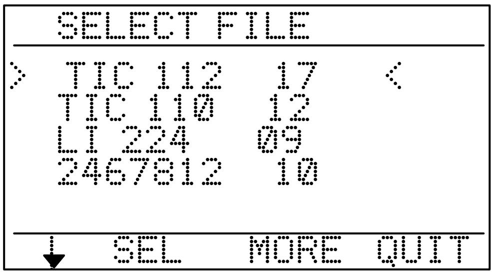


Fig 60

Ensure that the printer is connected, on line and that the paper is correctly aligned. Finally press **F3** (YES) if everything is ready for printing or **F4** (QUIT) to abort.

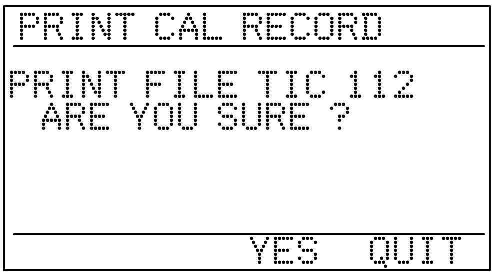


Fig 61

The print screen will remain until the print out has finished.

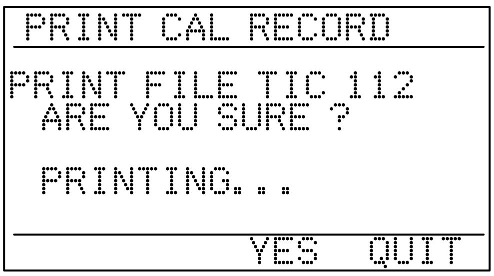


Fig 62

An example of a typical calibration certificate is shown below. All that now needs to be done is to sign and date it.

```
CALIBRATION CERTIFICATE

TEST EQUIPMENT.

FGH EZECAL Mk5 SERIAL : 11111
EZECAL S/W VERSION    : V1.00
LAST CAL. DATE        : 05/10/93
CALIBRATION FILE      : TIC 112
DEVICE UNDER TEST     : 1865241

             TEST RESULTS

                    OUTPUT/READING
   INPUT         PRE CAL      POST CAL
    degC          degC          degC

     0.0          -0.1           0.0
   250.0         250.1         250.0
   500.0         499.8         500.0
   750.0         749.9         750.1
  1000.0         999.8        1000.1


SIGNED                          DATE
```

4.3.3 Dump calibration data.

The calibration data may be down loaded to a personal computer if the serial communications option is fitted. The data is transmitted in serial form using ASCII characters only and is in a format suitable for most popular spreadsheet programmes.

When this option is selected the file selector menu will appear. The file selector shows all the files currently stored within the calibrator in the order that they were created. The number of records contained within the file is shown next to the file name. To select the file of interest, move the triangular pointer with the **F1** key and press **F2** (SELect) to select the indicated file. If the file required is not shown on the display then press **F3** (MORE) to show the next page of files.

```
   SELECT FILE
> TIC 112   17    <
  TIC 110   12
  LI 224    09
  2467812   10

 ↓   SEL   MORE  QUIT
```

Fig 63

Ensure that the computer is connected and ready to receive data. Finally press **F3** (YES) if everything is ready and the calibration point data will be transmitted to the computer or press **F4** (QUIT) to abort.

```
   DUMP CAL RECORD
DUMP FILE TIC 112
  ARE YOU SURE ?



             YES  QUIT
```

Fig 64

This display will remain until the file has been transmitted. At which point the screen will return to the file selector menu in order that another file may be down loaded if required.

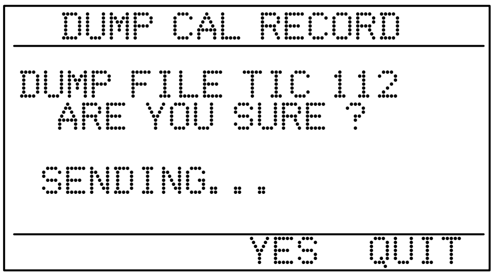


Fig 65

4.4 Deleting a calibration file.

After the calibration file has been printed or down loaded as necessary the calibration file may be deleted from memory.

From the cal record replay menu, select the delete file option using **F1** to move the cursor and **F2** (SELect) to select.

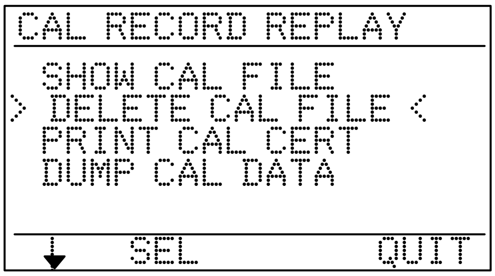


Fig 66

Select the file name to be deleted from the file selector menu and press **F2** (SELect) to select the chosen file. If the file required is not shown on the display then press **F3** (MORE) to show the next page of files.

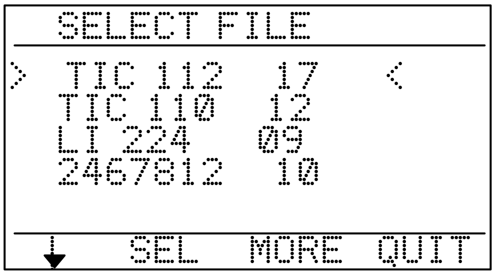


Fig 67

On the confirmation screen press **F3** (YES) if you are certain that you want to delete the chosen file. Remember calibration files cannot be recovered once they have been deleted.

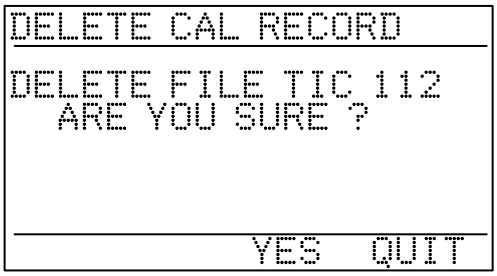


Fig 68

4.5 Custom ranges.

The EZECAL 5 is capable of storing up to four user defined ranges known as custom ranges. These are used when a standard EZECAL range is not appropriate for the specific non standard simulation or measurement required.

Once a custom range is defined it remains resident within the calibrator ready to be called up by name the next occasion it is needed. The same custom range may be used for both input and output ranges, depending on whether it is called up as a simulation or measurement range.

Example of a custom range.

Consider a head mounted thermocouple transmitter which accepts as its input a type K thermocouple, and outputs a non linearised 4-20mA signal over the range 200°C to 800°C
Checking the calibration of such a transmitter over its range would normally involve a lot of tedious calculations using look up tables.

EZECAL 5 makes this task simple by the use of a custom range.

Programming the range.

Custom ranges are defined under the CUSTOM RANGE option on the configuration menu. To illustrate the setting up procedure we take the above thermocouple transmitter as our example.

From the primary display, press **F3** (CONFigure) and then select CUSTOM RANGES.

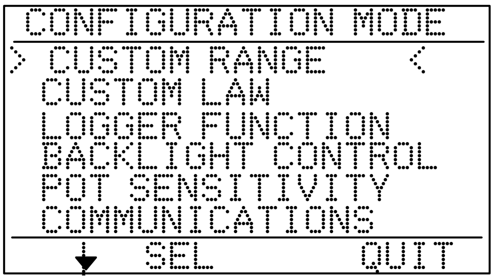


Fig 69

Select a spare range number or pick an existing range to be overwritten using **F2** (NEXT) or the control wheel.

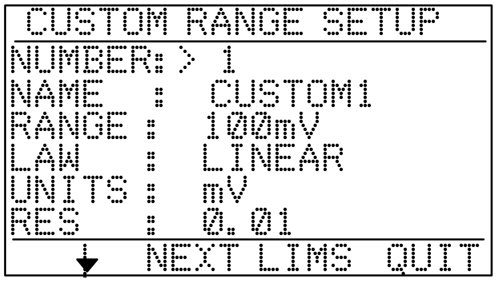


Fig 70

Press **F1** (DOWN ARROW) to advance down to the range name. Enter the required name for the range. The name is entered one character at a time. The current character is indicated by the flashing underline cursor and may be moved by pressing the ENTER key. To change the character above the cursor, use the numeric keypad or spin the control wheel.

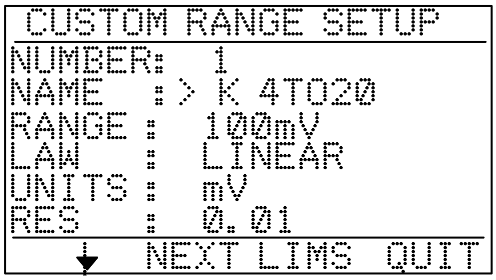


Fig 71

Use **F1** again to advance the triangular cursor. Press **F2** or spin the pot to select the range. The range selected is the physical range required. In our case we require the 20mA range in order to measure the output from the transmitter.

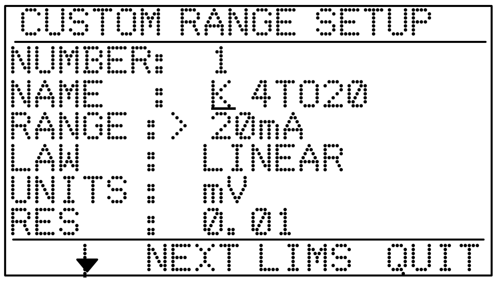


Fig 72

Advance down again and enter the law required. In our case the transmitter output is not linear and follows the type K thermocouple law. To provide a linear display on the EZECAL 5 we must linearise according to the law 'TC:K'.

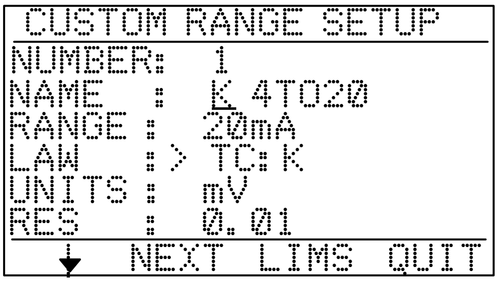


Fig 73

Advance down again to select the units that we wish on the EZECAL 5 display using **F2** or the control wheel. In our case we require degrees Celsius.

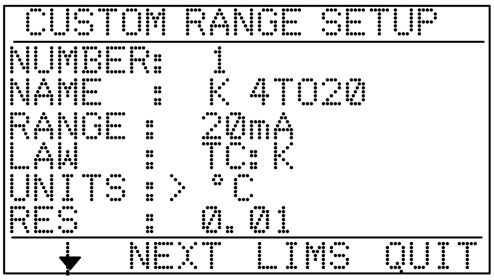


Fig 74

The display resolution parameter merely defines the decimal point position on the display. It does not increase the resolution of the calibrator (except on TC or RTD ranges). In our example we wish to display in tenths degree Celsius. So we set the display decimal point position to 0.1.

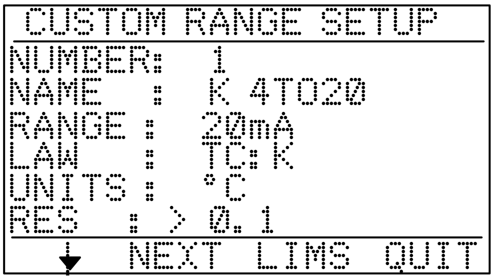


Fig 75

Now it is necessary to specify the limits over which the custom range is to work.

Press **F3** (LIMS) to enter the custom limit set up screen, and select again the range number chosen.

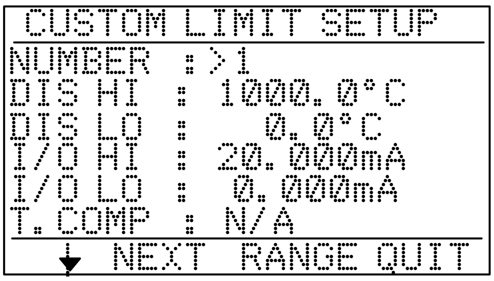


Fig 76

Use **F1** to point to the DISPLAY HI LIMIT. This is the maximum number which can appear on the display. In our case this is 800.0°C which corresponds to an input signal of 20mA. For a simulate range, this number should be the highest allowable output value which can be set on the display.

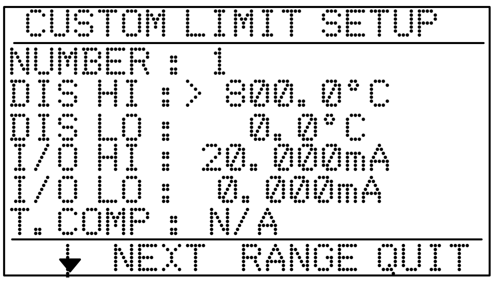


Fig 77

Use **F1** again to point to the DISPLAY LO LIMIT. This is the minimum number which can appear on the display. In our case this is 200.0°C which corresponds to an input signal of 4mA. For a simulate range, this number should be the lowest allowable output value which can be set on the display.

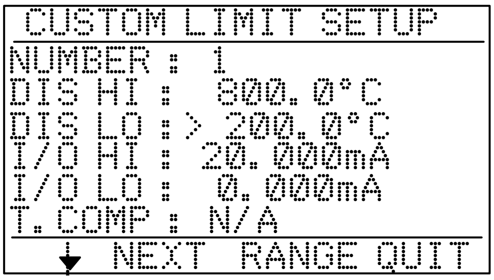


Fig 78

Now point to the INPUT/OUTPUT HI LIMIT. This is the maximum physical input or output value which will appear at the instruments terminals. In our case this is 20.000mA which corresponds to the DIS HI value of 800°C. For a simulate range, this number should be the maximum physical output value to be sourced.

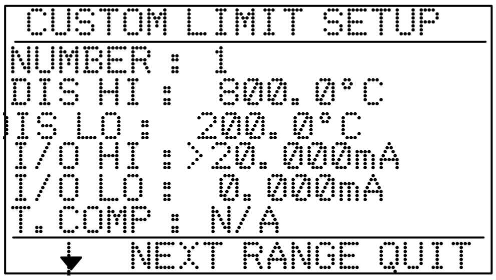


Fig 79

Now point to the INPUT/OUTPUT LO LIMIT. This is the minimum physical input or output value which will appear at the instruments terminals. In our case this is 4.000mA which corresponds to the DIS LO value of 200°C. For a simulate range, this number should be the minimum physical output value to be sourced.

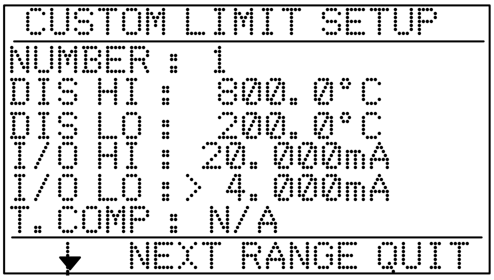


Fig 80

Next we have the temperature compensation parameter. This is only applicable to non standard thermocouple inputs or outputs and should be set to the appropriate cold junction compensation rate in millivolts per degree Celsius. For example a type K thermocouple would require a temperature compensation rate of approximately 0.040 mV/°C.

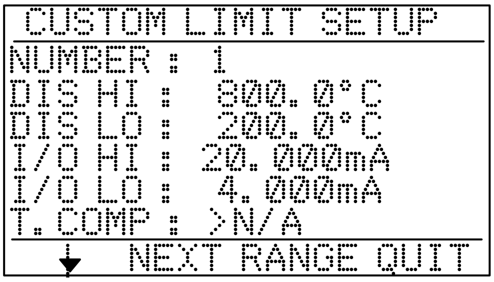


Fig 81

The custom range configuration is now complete and this new range is now available for selection by name from the simulate or measure range selection screens.

To complete our example of calibrating the thermocouple transmitter the following steps are required.

Connect the transmitter to the EZECAL 5 as shown below.

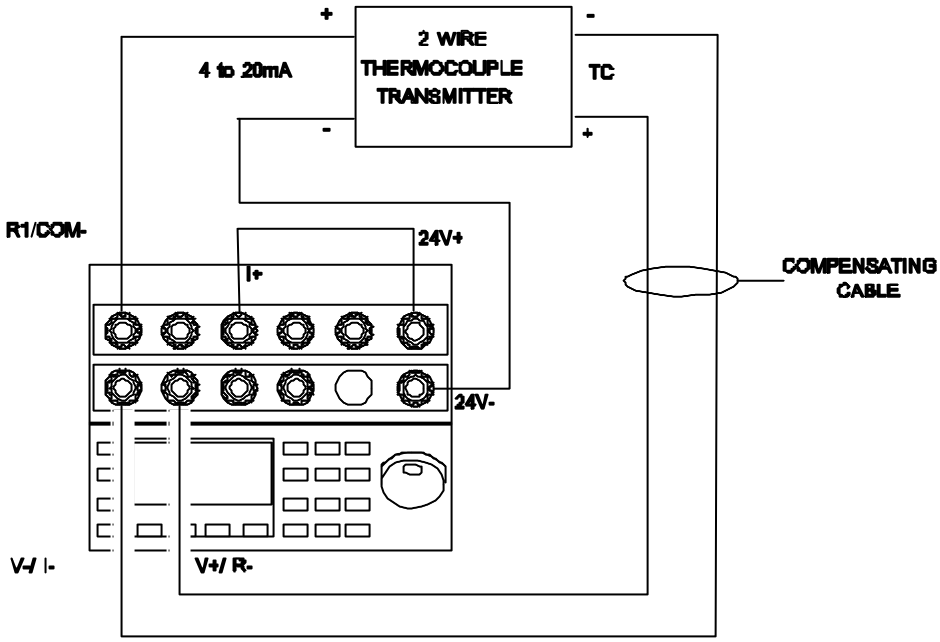


Fig 82

Select 'K 4TO20' as the measurement range and 'TC;K' as the simulate range.

Set 200.0°C as the simulate output value and adjust the zero control on the transmitter until the measured input reads 200.0°C.

Set 800.0°C as the simulate output value and adjust the span control on the transmitter until the measured input reads 800.0°C.

Check the transmitter output at any mid points required.

4.6 Programming custom laws.

Another powerful feature of the EZECAL 5 is ability to accept custom laws. A custom law defines how the calibrator is to linearise an input signal or to characterise an output signal. Up to four custom law definitions can be stored at any one time, and any law may be used in association with any custom range.

A custom law is implemented inside the EZECAL 5 as set of straight line segments which approximate to the shape of the curve required. Up to 15 such line segments may be used within one law. The junction of two adjacent line segments is called a 'breakpoint' and these breakpoints may be positioned anywhere in the range of the instrument.

There are a few important points to consider before attempting to program a custom law.

- The function curve to be programmed must be strictly increasing. ie the output from the lineariser should increase as the input increases.
- The function curve should have no discontinuities and no regions where the curve is perfectly flat.

To allow a custom law to be applied to any input or output range, the law is always programmed as an output law. For example if an exponential type law is programmed for an output, then this law will automatically be used in reverse when applied to linearise an input. ie it will perform a natural logarithm type law.

Consider the following example.

The user wishes to measure and simulate an Iron-Gold/Chromel cryogenic thermocouple. This is not a standard thermocouple in the EZECAL 5 and so must be programmed as a custom range with a custom law.

The thermocouple has the following characteristic.

Temp' (Input)	EMF (Output)	Temp (Input)	EMF (Output)
-270°C	-4.714mV	-235°C	-4.181mV
-267°C	-4.666mV	-230°C	-4.111mV
-265°C	-4.634mV	-225°C	-4.041mV
-260°C	-4.555mV	-220°C	-3.973mV
-255°C	-4.478mV	-215°C	-3.906mV
-250°C	-4.402mV	-210°C	-3.839mV
-245°C	-4.327mV	-205°C	-3.774mV
-240°C	-4.254mV	-200°C	-3.709mV

The custom law should therefore convert a linear temperature input to a shaped millivolt output. Further, so that this law may be applied to *any* input or output range (for example to measure the output of a two wire transmitter for this couple), the input and output values must be converted to percentages.

From the table above we take four parameters A, B, C, D.

Where
A is the minimum input value (-270)
B is the maximum input value (-200)
C is the minimum output value (-4.714)
D is the maximum output value (-3.709)

We then calculate for each input value I.

$$\frac{(I\text{-}A)}{(B\text{-}A)} \times 100$$

And for each output value O.

$$\frac{(O\text{-}C)}{(D\text{-}C)} \times 100$$

After calculating each value we get the table below.

Breakpoint	Temperature	Input %	EMF	Output%
0	-270	0.00	-4.714	0.00
1	-267	4.29	-4.666	4.78
2	-265	7.14	-4.634	7.96
3	-260	14.29	-4.555	15.82
4	-255	21.42	-4.478	23.48
5	-250	28.58	-4.402	31.04
6	-245	35.71	-4.327	38.51
7	-240	42.86	-4.254	45.77
8	-235	50.00	-4.181	53.03
9	-230	57.14	-4.111	60.00
10	-225	64.29	-4.041	66.97
11	-220	71.42	-3.973	73.73
12	-215	78.58	-3.906	80.40
13	-210	85.71	-3.839	87.06
14	-205	92.86	-3.774	93.53
15	-200	100.00	-3.709	100.00

The custom law is now ready to load into the EZECAL 5.

From the primary display, press **F3** (CONFigure) to access the configuration menu. Then select CUSTOM LAW.

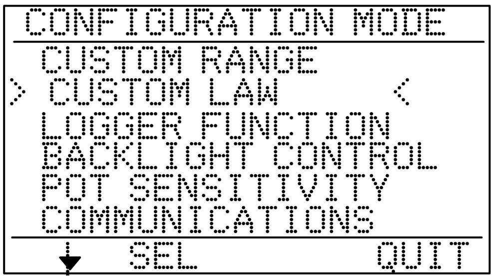


Fig 83

Select the law number required by pressing **F3** (LAW). The law editing screen shows four breakpoints at a time and displays the input and output values as percentages. The triangular pointer shows the currently selected parameter. Use **F1** to move the pointer to the next value as required. The default law table shown contains evenly spaced breakpoints and describes a perfectly linear relationship between input and output. Breakpoints 0 and 15 are fixed and cannot be modified.

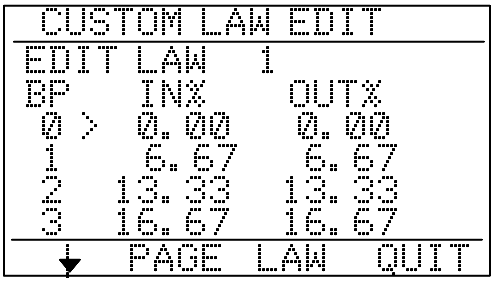


Fig 84

To enter the calculated values for the new law, advance to breakpoint 1 input using **F1** and enter the required value on the numeric key pad or control wheel.

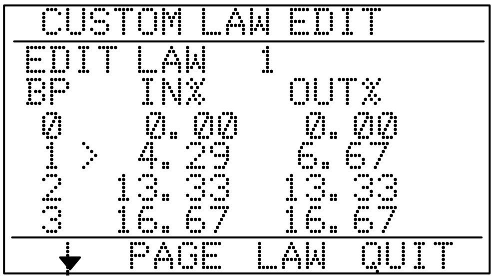


Fig 85

Then press **F1** again and enter the output value for breakpoint 1.

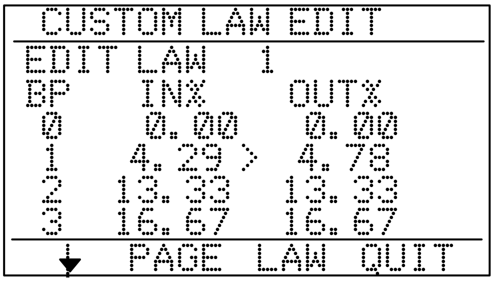


Fig 86

Continue in the same way and enter the values for all the breakpoints. When the pointer reaches the last parameter on the display, the display will automatically advance to the next page. Alternatively the display may be manually paged by pressing **F2** (PAGE).

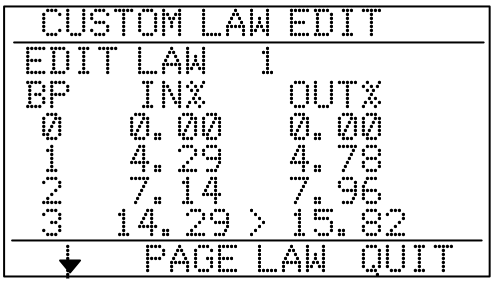


Fig 87

Continue to enter the values until all four pages have been completed.

```
CUSTOM LAW EDIT
EDIT LAW   1
BP    IN%     OUT%
 4   21.42   23.48
 5   28.58   31.04
 6   35.71   38.51
 7   42.86 > 45.77
  ↓   PAGE  LAW  QUIT
```

Fig 88

If a value is entered in error and this error breaks the custom law rules as described earlier then an asterisk is shown next to the value. The asterisk will disappear when the error is corrected.

```
CUSTOM LAW EDIT
EDIT LAW   1
BP    IN%     OUT%
 4    21.42   23.48
 5  >21.42*   31.04
 6   35.71    38.51
 7   42.86    45.77
  ↓   PAGE  LAW  QUIT
```

Fig 89

Now that the new law has been entered, it may be called up from the custom range set up screen.

The following two screens show how the custom range would be set up to measure or simulate the special thermocouple in the example.

```
CUSTOM RANGE SETUP
NUMBER:  1
NAME   :  FE/AU
RANGE :  100mV
LAW    :  CUSLAW1
UNITS :  °C
RES    :  1
  ↓   NEXT  LIMS  QUIT
```

Fig 90

```
CUSTOM LIMIT SETUP
NUMBER : 1
DIS HI :  -200°C
DIS LO :  -270°C
I/O HI :  -3.71mV
I/O LO :  -4.71mV
T.COMP :  0.021mV/°C
  ↓   NEXT RANGE QUIT
```

Fig 91

SECTION 5 - CONFIGURATION.

5.1 Logger function.

As described in earlier sections the logger memory may be used for one of two purposes. To store a log record of measured input versus time, or to hold calibration record files. The selection of this function is made from the configuration menu. Because the same internal memory area is used for both functions, changing the function will result in any stored data being lost. So make sure that any logged data is no longer required before selecting the alternate function.

Select LOGGER FUNCTION from the configuration menu. The cursor will indicate the current logger mode. Press **F2** (LOG) to use the log memory for time v input logging. Press **F3** (CALibration record) to use the logger memory to store calibration files. Press **F4** (QUIT) to abort without changing function.

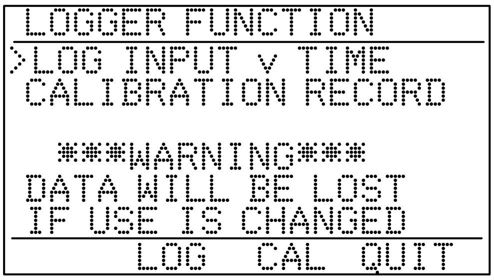


Fig 92

5.2 Backlight control.

The EZECAL 5 is equipped with a backlight to illuminate the display under bad lighting conditions. Unfortunately the backlight can require a lot of power from the batteries. To help increase battery life the backlight can operate in one of three modes.

ALWAYS OFF The backlight is always off.
(recommended for portable use in good light conditions)

TIMED The backlight comes on whenever a key is pressed or the control wheel is used and remains on for 15 seconds.
(recommended for portable use in bad light conditions)

ALWAYS ON The backlight is permanently on.
(recommended for bench top use with the supply adaptor fitted)

To select the mode of operation, select BACKLIGHT CONTROL from the configuration menu. Use **F3** (NEXT) to select the backlight mode required.

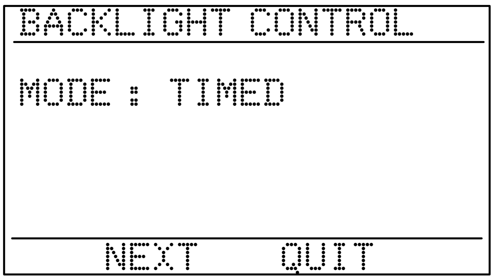


Fig 93

5.3 Control wheel sensitivity.

The sensitivity (speed of response) of the control wheel can be set to one of five levels to suit the taste of the operator.

From the configuration menu, select POT SENSITIVITY. The response speed may now be increased using **F2** (FASTer), or decreased using **F1** (SLOWer). The current setting may be tested on the TEST VAL number displayed on the screen.

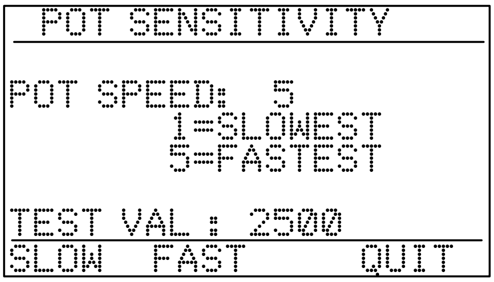


Fig 94

5.4 Communications.

If the serial communications option is fitted, this must be set up to suit the computer or printer to be used. There are two parameters which must be set.

BAUD RATE	Communications speed. OFF, 300, 600, 1200, 2400, 4800 or 9600 Baud.	
PARITY	Odd	7 bit data + 1 odd parity bit.
	Even	7 bit data + 1 even parity bit.
	None	8 bit data (bit 7 always false).

From the configuration menu select COMMUNICATIONS. Use **F1** to move the cursor to either BAUD RATE or PARITY and press **F2** (NEXT) or spin the control wheel to modify the indicated parameter.

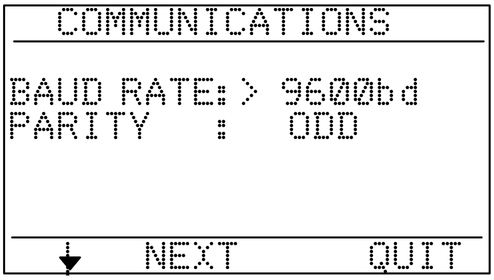


Fig 95

SECTION 6 - SERIAL COMMUNICATIONS.

6.0 General.

The EZECAL 5 may be fitted with a serial communications option. This option provides an RS232 serial interface for connection to a computer, terminal or serial printer. When connected to a computer it is possible to control the EZECAL 5 remotely, enabling it to be used in an automatic test/calibration system. This section describes the protocol necessary for remote control.

6.1 Connections.

The RS232 interface connector is situated at the rear of the instrument. Connections should be made using a suitable 3 pin DIN plug wired as shown.

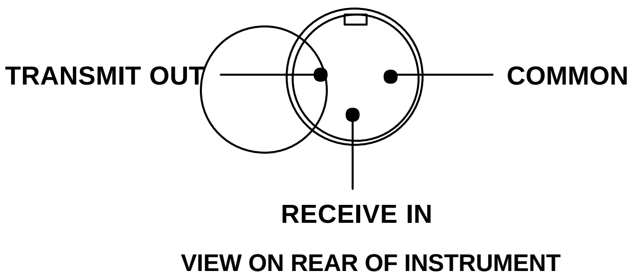


Fig 96

6.2 Protocol.

The EZECAL 5 command protocol is based on short subcommand mnemonics which can be strung together according to the command tree given in section 6.2.2. Each basic subcommand consists of a colon (:) followed by a four character mnemonic to signify the parameter of interest. One or more subcommands strung together in a precisely defined way form a command. The complete command is terminated in a carriage return character (ASCII code 13 decimal), at which point the command will be executed by the calibrator.

There are three basic types of command.

READ COMMAND.
The command string is followed by a query (?) symbol. for example:-

:MEAS:VALU? <CR> would be sent to read the current measured input value.

WRITE COMMAND.
The command string is followed the an equals (=) symbol and the required value. for example.

:SIMU:VALU=1000 <CR> would be sent to write the value of 1000 to the simulate output.

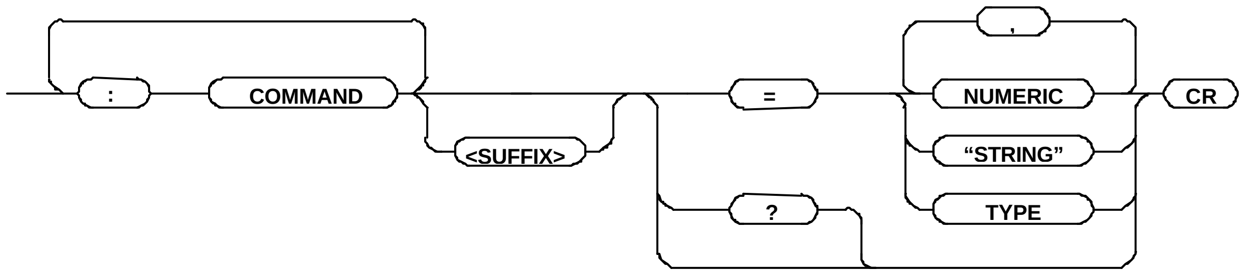
SET COMMAND.
The command string is simply terminated in carriage return. for example:-

:KEYB:DISB <CR> would be sent to disable the front panel of the calibrator.

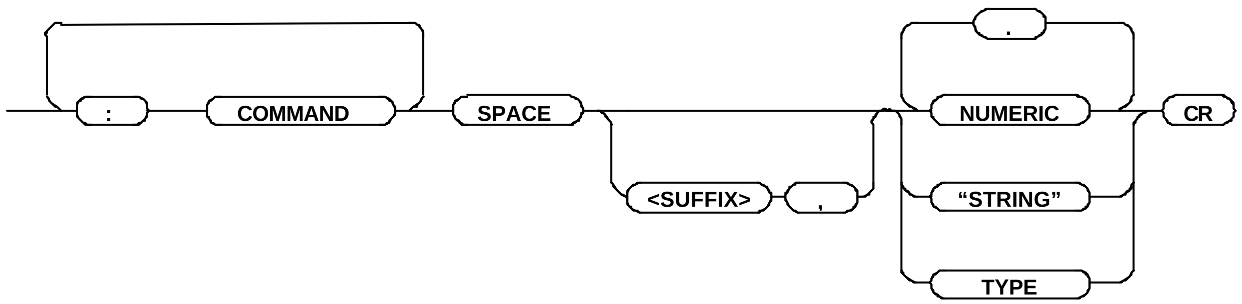
In each case the EZECAL 5 will respond with the command string followed by the read or write data. The response message will always be terminated with carriage return (ASCII code 13 decimal).

6.2.1 Command syntax.

The charts below show the syntax paths for both commands sent to the EZECAL 5 and responses. All commands and type data should be sent in uppercase characters and the user may insert spaces anywhere in the message if required. These will be ignored by the EZECAL 5.



COMMAND SYNTAX



RESPONSE SYNTAX

The response message from the EZECAL 5 will be exactly of the form shown. Numeric values will be returned in the same format as they are shown on the calibrator display.

Some subcommands require a suffix number to be sent after the subcommand string. This is used to uniquely identify one of many similar parameters.

For example the command

:MEMY7=500 <CR>

Uses a suffix value to store the value 500 in memory 7.

Giving the response

:MEMY 7,500<CR>

6.2.2 Command tree.

The following diagram shows the complete command tree for the EZECAL 5 along with the meanings and associated data types for each command. Commands shown in square boxes have no data associated with them. Values shown in angle brackets <> indicate the maximum value of the associated suffix number required.

Command	Sub-command	Sub-sub-command	Meaning
:SIMU	:VALU		(NUMERIC) SIMULATE VALUE
	:RNGE		(RANGE TYPE) SIMULATE RANGE
	:UNIT		(UNIT TYPE) SIMULATE UNITS
	:RESN		(RES TYPE) SIMULATE RESOLUTION
	:REFR	:VALU	(NUMERIC) REFERENCE VALUE
		:MODE	(REF MODE TYPE) REFERENCE MODE
:MEAS	:VALU?		(NUMERIC) MEASURED VALUE
	:RNGE		(RANGE TYPE) MEASURE RANGE
	:UNIT		(UNIT TYPE) MEASURE UNITS
	:RESN		(RES TYPE) MEASURE RESOLUTION
	:REFR	:VALU	(NUMERIC) REFERENCE VALUE
		:MODE	(REF MODE TYPE) REFERENCE MODE
:SENS			(NUMERIC) CONTROL WHEEL SENSITIVITY
:STAT?			CALIBRATOR STATUS
:LOOP			(LOOP TYPE) SIMULATE/MEASURE LOOP SWITCH
:MODE			(MODE TYPE) OPERATING MODE
:VERS?			SOFTWARE VERSION NUMBER
:BLGT			(BL MODE TYPE) BACKLIGHT MODE
:KEYB	:ENBL		ENABLE FRONT PANEL OPERATION
	:DISB		DISABLE FRONT PANEL OPERATION
:MEMY<9>			(NUMERIC) MEMORY STORAGE
:RECL<9>			(NUMERIC) MEMORY RECALL
:SERL?			INSTRUMENT SERIAL NUMBER
:CUSL	:NUMB		(NUMERIC) CUSTOM LAW NUMBER
	:BKPT<15>		(NUMERIC) CUSTOM BREAKPOINT DATA
:CUSR	:NUMB		(NUMERIC) CUSTOM RANGE NUMBER
	:NAME		(STRING) CUSTOM RANGE NAME
	:RNGE		(PRIMARY TYPE) CUSTOM RANGE
	:LINR		(LAW TYPE) CUSTOM RANGE LAW
	:UNIT		(UNIT TYPE) CUSTOM RANGE UNITS
	:DIHI		(NUMERIC) CUSTOM RANGE DISPLAY HIGH LIMIT
	:DILO		(NUMERIC) CUSTOM RANGE DISPLAY LOW LIMIT
	:IOHI		(NUMERIC) CUSTOM RANGE I/O HIGH LIMIT
	:IOLO		(NUMERIC) CUSTOM RANGE I/O LOW LIMIT
	:TCMP		(NUMERIC) TEMPERATURE COMPENSATION RATE

:LOGR	:BASE	(NUMERIC) LOGGER TIMEBASE
	:STEP?	(NUMERIC) LOGGER STEP NUMBER
	:STRT	START LOGGER
	:STOP	STOP LOGGER
	:STAT?	LOGGER STATUS
	:DUMP	DUMP LOGGED DATA
:LOGF	:CALR	SET CAL RECORD MODE
	:LOGR	SET LOGGING MODE
:CALN	:DATE?	(NUMERIC) DATE OF LAST CAL
	:MNTH?	(NUMERIC) MONTH OF LAST CAL
	:YEAR?	(NUMERIC) YEAR OF LAST CAL

6.2.3 Variable types.

NUMERIC.

A numeric value is a string of characters which represent a numerical value.
All of the following examples are valid ways of representing the number five.

5 5.0 5. 05 +5 +005.0 5.000

and any of these forms will be accepted by the instrument (assuming 5 is a valid setting for the parameter being written).

In certain circumstances the instrument will truncate the number received if it exceeds the resolution of the parameter being written. For example on the 100mV range, a received simulate value of 5.0001mV will be truncated to 5.00 (the maximum resolution in the 100mV range).

In all cases the response from the calibrator will show the exact value used.

STRING.

A string value is just a sequence of alphanumeric characters enclosed in inverted commas ("). The received string will be converted to uppercase characters and either padded out or truncated to the required length for the particular parameter being written.

String values sent in responses will always be padded out with spaces to the correct length.

Example

:CUSR:NAME="fred"<CR>	Would result in the current custom range name being set to 'FRED'.
:CUSR:NAME FRED <CR>	Would be returned from the EZECAL 5.

RANGE TYPE.

Any command which uses a RANGE TYPE parameter implies the use of one of the following range mnemonics to indicate a simulation or measurement range.

TC:S	Thermocouple type S	**TC:R**	Thermocouple type R
TC:J	Thermocouple type J	**TC:K**	Thermocouple type K
TC:T	Thermocouple type T	**TC:E**	Thermocouple type E
TC:B	Thermocouple type B	**TC:N**	Thermocouple type N
TC:W	Thermocouple type W	**TC:W3**	Thermocouple type W3
TC:W5	Thermocouple type W5	**TC:L**	Thermocouple type L
TC:NIMO	Thermocouple type NiMo	**PT100**	Platinum 100R RTD
NI100	Nickel 100R RTD	**100MV**	Linear voltage 100mV
1V	Linear voltage 1V	**10V**	Linear voltage 10V
20MA	Linear current 20mA	**400OHM**	Linear resistance 400R
CUSTOM1	Custom range 1	**CUSTOM2**	Custom range 2
CUSTOM3	Custom range 3	**CUSTOM4**	Custom range 4

Example

:MEAS:RNGE=TC:K<CR> Would set the current measure range to thermocouple type K.

:MEAS:RNGE TC:K<CR> Would be returned from the EZECAL 5.

RES TYPE.

This type of parameter is used to set the measurement or simulation resolution and must be one of the following.

1 0.1 0.01 0.001 0.0001

Example. If the current simulation range is one of the thermocouple ranges.

:SIMU:RESN=0.1<CR> Would set the simulate resolution to 0.1 degrees.

:SIMU:RESN 0.1<CR> Would be returned from the EZECAL 5.

REF MODE TYPE.

This parameter type is used to set the reference junction (cold junction) operating mode.

MANUAL Manual mode (junction temperature must be manually entered).

INTERNAL Internal mode (reference junction temperature in internally measured).

Example

:MEAS:REFR:MODE=INTERNAL<CR> Would cause the measurement to use the internally measured reference ju

MODE TYPE.

This parameter type is used to select the basic operating mode.

SIM The EZECAL 5 displays only the simulation value.

MEAS The EZECAL 5 displays only the measured value.

BOTH The EZECAL 5 displays both simulate and measured values.

Example

:MODE=MEAS<CR> Would cause the instrument to display only the measured value.

:MODE MEAS<CR> Would be returned from the EZECAL 5.

PRIMARY TYPE.

This parameter type is used to select one of the primary (linear) input or output ranges.

100MV	100mV linear voltage range.
1V	1V linear voltage range.
10V	10V linear voltage range.
20MA	20mA linear current range.
400OHM	400R linear resistance range.

Example

:CUSR:RNGE=20MA<CR> Would set a custom range to measure or simulate linear current.

:CUSR:RNGE 20MA<CR> Would be returned from the EZECAL 5.

UNIT TYPE.

This parameter type is used to select display units.

CEL	°C	**FAR**	°F
K	°K	**R**	°R
MV	mV	**V**	V
MA	mA	**OHM**	0
KOHM	k0	**NONE**	blank
PCT	%	**PSI**	psi
KPA	kPa	**BAR**	Bar
TORR	Tor	**RPM**	RPM
HZ	Hz	**KHZ**	kHz
W	W	**KW**	kW
VA	VA	**KVA**	kVA

Example

:MEAS:UNIT?<CR> Would read the current measurement units.

:MEAS:UNIT OHM<CR> Returned would indicate current measurement units are Ohms.

LAW TYPE.

Used to select the type of lineariser to be used on a custom range.

LINEAR	Linear law	**SQUARE**	Square law
TC:S	TC type S law	**TC:R**	TC type R law
TC:J	TC type J law	**TC:K**	TC type K law
TC:T	TC type T law	**TC:E**	TC type E law
TC:B	TC type B law	**TC:N**	TC type N law
TC:W	TC type W law	**TC:W3**	TC type W3 law
TC:W5	TC type W5 law	**TC:L**	TC type L law
TC:NIMO	TC type NiMo law	**PT100**	Pt100 RTD law
NI100	Ni100 RTD law	**ROOT**	Square root law
CUSLAW1	Custom law 1	**CUSLAW2**	Custom law 2
CUSLAW3	Custom law 3	**CUSLAW4**	Custom law 4

Example

:CUSR:LINR=ROOT<CR> Would set the current custom range to use a square root law.

:CUSR:LINR ROOT<CR> Would be returned from the EZECAL 5.

BL MODE TYPE.

This parameter type is used to select the mode operation for the display backlight.

OFF	Backlight always off.
TIMED	Backlight comes on for 15 seconds.
ON	Backlight is permanently on.

Example.

:BLGT?<CR>	Would read the current backlight mode.
:BLGT TIMED<CR>	Would be returned to indicate that the backlight was in timed mode.

LOGGER STATUS TYPE.

This parameter type is used to return the status of the logger.

STOPPED	The logger is not running.
RUNNING	The logger is running.

Example.

:LOGR:STAT?<CR>	Would read the current logger status.
:LOGR:STAT RUNNING<CR>	Might be returned to indicate that the logger is currently running.

6.2.4 Error codes.

If for any reason the EZECAL 5 cannot process the received message, an error message will be returned.

The error message is of the form :-

ERROR NNNN<CR> where NNNN is a hexadecimal error code.

The binary weighting of the error code is as follows.

Bit	0	The selected parameter may not be written to.
	1	An illegal suffix number was received.
	2	The command string was too long for the EZECAL 5.
	3	The received command was not recognised.
	4	An illegal numeric character was received.
	5	The selected parameter may not be read.
	6	The numeric value received was out of range
	7	There was a parity error in the received message

Example.

The command

:MEMY12=0<CR>	will generate the error message
ERROR 0002<CR>	indicating that 12 is an illegal suffix for that parameter.

6.2.5 Status Codes.

The :STAT? command is returns a four digit hexadecimal number containing status information about the calibrator.

The binary weighting of the status code is as follows

Bit 0	Simulate value out of range.
1	not used.
2	Simulate reference junction temperature out of range.
3	Simulate lineariser error.
Bits 4 to 7	not used.
8	Measurement over range.
9	Measurement under range.
10	Measure reference junction temperature out of range.
12	Measure lineariser error.

6.3 Notes.

The following notes should be considered when configuring the EZECAL 5 via the serial communications.

- To avoid the possibility of interaction, the front panel should be disabled using the **:KEYB:DISB** command before configuration starts.

- When setting up custom ranges, ensure that the instrument display is not showing the "CUSTOM RANGE SETUP" or "CUSTOM LIMIT SETUP" screens else the range data may not be stored. Again use the keyboard disable command to avoid this.

- When reading or writing custom range or custom law data, the range or law number required should first be written using **:CUSR:NUMB** or :**CUSL:NUMB** commands respectively. New custom range values will not take effect until the modified range is next selected as the current measure or simulate range.

- When setting the logger function using the **:LOGF** command, any existing logged data will be lost.

- The logger control commands (**:LOGR**) will return an illegal command error code if they are used while the logger is configured to store calibration data.

SECTION 7 - CALIBRATION.

7.0 General.

The EZECAL 5 is a high precision instrument and as such should be calibrated at least once per year to maintain optimum performance.

Calibration should only be performed by trained and competent personnel and under standardised conditions using suitable equipment with calibration traceable to national standards.

To prevent unauthorised tampering with the calibration, the calibration parameters are protected by a two level security system. The CAL MODE switch and one case screw are fitted with a tamper evident label. If either of these labels are missing or damaged then the instrument should not be used until the calibration has been verified by a reputable source and the labels have been replaced.

The calibration parameters are also protected by a PIN number which must be correctly entered by the operator before any adjustments can be made.

7.1 Calibration mode.

IMPORTANT.
The instrument and calibration equipment should be left switched on under standard reference conditions for at least two hours before calibration.

To gain access to the calibration mode, remove the security label from the baseplate of the calibrator to reveal a small hole. With the instrument switched on, press the button at the bottom of the hole by means of slim blunt object.

The EZECAL 5 will then enter CALIBRATION MODE. Enter the correct PIN number and press ENTER to gain access to the calibration menu.

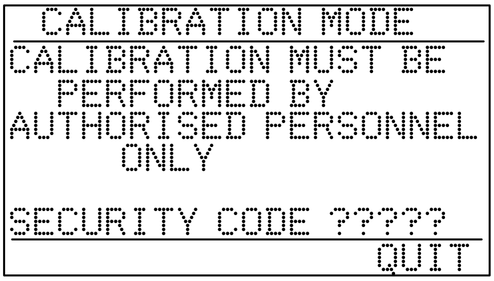


Fig 100

Use **F1** to move the cursor and **F2** (SELect) to select input or output calibration as required.

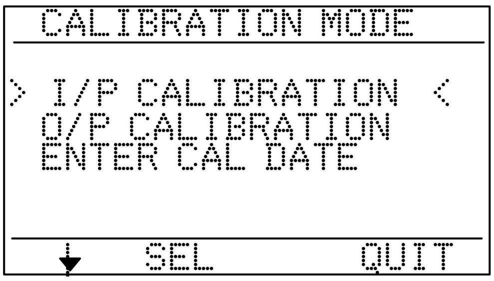


Fig 101

7.2 Input calibration.

There are individual calibration adjustments for each of the five basic input ranges, and an additional adjustment for the input cold junction temperature sensor. The calibration of the input ranges may be performed in any order.

Each range has a ZERO and SPAN parameter which should be adjusted individually via the control wheel.

Calibration should be performed at the points given in table 7.2.

Table 7.2 Input calibration points

RANGE	ADJUST ZERO AT	ADJUST SPAN AT	CHECK AT	CHECK AT	TOLERANCE
100mV	0.000mV	100.000mV	-10.000mV	+50.000mV	±2µV
1V	0.000mV	1.00000V	-100.000mV	+500.00mV	±20µV
10V	0.000mV	10.0000V	-1.0000V	+5.0000V	±200µV
20mA	0.000mA	20.0000mA	8.0000mA	12.0000mA	±0.4µA
4000	0.0000	400.0000	150.0000	250.0000	±8m0

Connect the reference input source to the appropriate terminals (see section 2). Low thermal emf cable should be used if possible.

Point to the required range using **F1** and press **F2** (SELect).

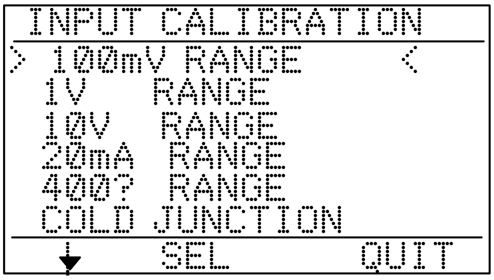


Fig 102

Set the reference source to the ZERO value in table 7.2 and allow at least 30 seconds for the measurement to settle before making any adjustments.

The input value is displayed to its maximum resolution during input calibration and because of this the least significant digit shown may change by more than one digit at a time. Point to the ZERO parameter using **F1** and rotate the control wheel until the measured input is as close as possible to the correct value.

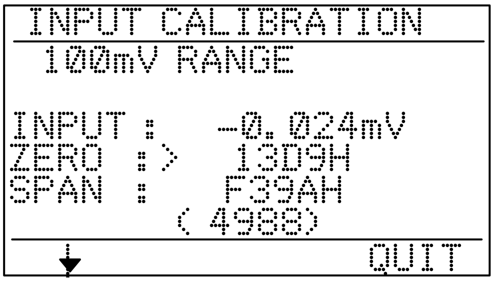


Fig 103

Set the reference source to the SPAN value in table 7.2, again allowing time for the measurement to settle.

Point to the SPAN parameter using **F1** and rotate the control wheel until the measured input is as close as possible to the correct value.

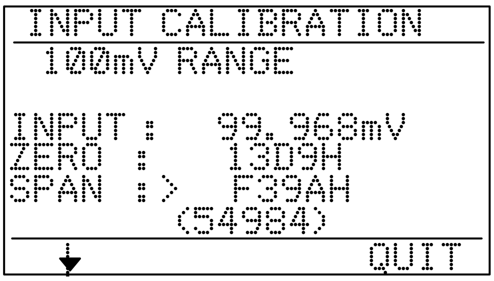


Fig 104

Repeat the ZERO and SPAN adjustments until no further adjustment is necessary.
Check linearity by setting the reference source to the CHECK values given in table 7.2 and checking that the displayed measurement is within the stated tolerance.

Repeat the above procedure for each input range.

7.3 Output calibration.

There are individual calibration adjustments for each of the five basic output ranges, and an additional adjustment for the output cold junction temperature sensor. The calibration of the output ranges may be performed in any order.

Select O/P CALIBRATION from the calibration mode menu.

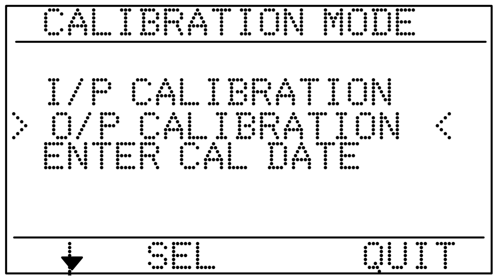


Fig 105

Each range has a ZERO and SPAN parameter which should be adjusted individually via the control wheel. Calibration should be performed at the points given in table 7.3.

Table 7.3 Output calibration points.

RANGE	ADJUST ZERO AT	ADJUST SPAN AT	CHECK AT	CHECK AT	TOLERANCE
100mV	0.000mV	100.000mV	-10.000mV	+50.000mV	±2μV
1V	0.000mV	1.00000V	-100.000mV	+500.00mV	±20μV
10V	0.000mV	10.0000V	-1.0000V	+5.0000V	±200μV
20mA	0.000mA	20.0000mA	8.0000mA	12.0000mA	±0.4μA
4000	1.0000	400.0000	150.0000	250.0000	±8m0

Connect the precision measuring equipment to the appropriate terminals (see section 2). Low thermal emf cable should be used if possible.

Point to the required range using **F1** and press **F2** (SELect).

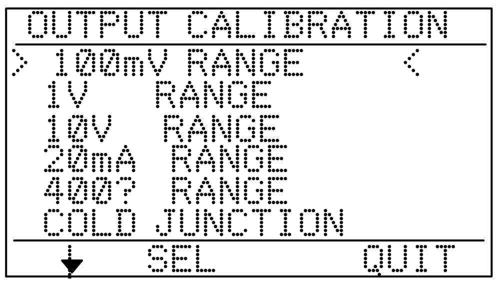


Fig 106

Set the precision measuring equipment to the appropriate range and resolution.

The current desired output value is displayed as OUTPUT on the display. Press **F2** (MINimum) to force the minimum output value. Point to the ZERO parameter using **F1**. When the output has settled rotate the control wheel until the actual output is as close as possible to the correct value.

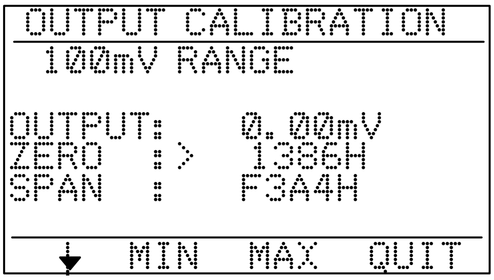


Fig 107

Point to the SPAN parameter using **F1** and press **F3** (MAXimum) to source the maximum output. Allow time for the output to settle then rotate the control wheel until the measured output is as close as possible to the correct value.

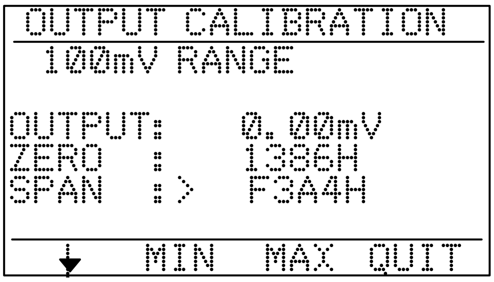


Fig 108

Repeat the ZERO and SPAN adjustments until no further adjustment is necessary.
Check linearity by setting the output to source the CHECK values given in table 7.3 and check that the actual output is within the stated tolerance.

Repeat the above procedure for each output range.

7.4 Reference junction temperature calibration.

The EZECAL 5 has two reference junction temperature sensors fitted into the R1/COM- (measurement reference) and V-/I- (output reference) terminals. The calibration for these sensors should not usually require adjustment, but their calibration may be periodically checked as follows.

Measurement reference junction sensor.

Clamp a precision temperature measurement probe under the R1/COM- terminal and leave to stabilise for at least 10 minutes.

From the INPUT CALIBRATION MENU, point to COLD JUNCTION using **F1** and select by pressing **F2** (SELect).

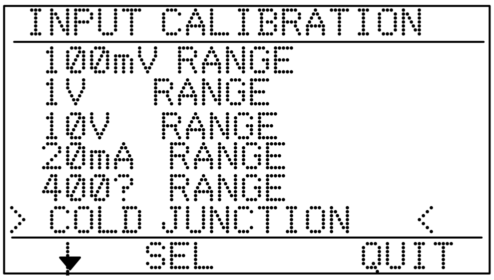


Fig 109

The C.J temperature shown should match that of the precision temperature probe ±0.2°C. If not then point to the ZERO parameter using **F1** and adjust using the control wheel if absolutely necessary.

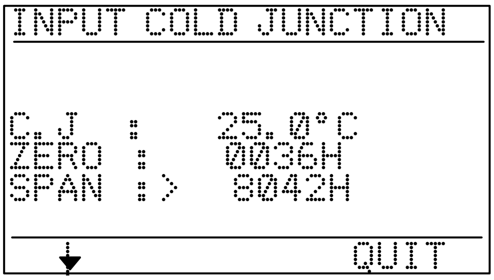


Fig 110

Repeat the above at an elevated temperature of 45°C using an environmental chamber and adjust the SPAN parameter if necessary.

Simulation reference junction sensor.

Clamp a precision temperature measurement probe under the V-/I- terminal and leave to stabilise for at least 10 minutes.

From the OUTPUT CALIBRATION MENU, point to COLD JUNCTION using **F1** and select by pressing **F2** (SELect).

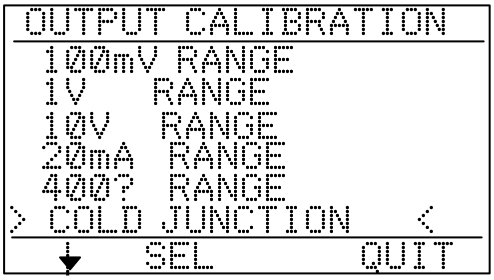


Fig 111

The C.J temperature shown should match that of the precision temperature probe ±0.2°C. If not then point to the ZERO parameter using **F1** and adjust using the control wheel if absolutely necessary.

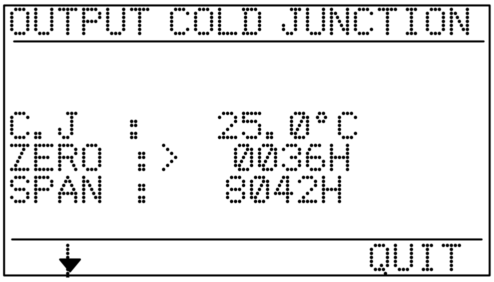


Fig 112

Repeat the above at an elevated temperature of 45°C using an environmental chamber and adjust the SPAN parameter if necessary.

7.5 Calibration date.

After calibration is complete it is important to enter in the date on which the calibration was performed. This date will be displayed on the screen every time the unit is switched on.

From the calibration menu, point to ENTER CAL DATE using **F1** and press **F2** (SELect) to select.

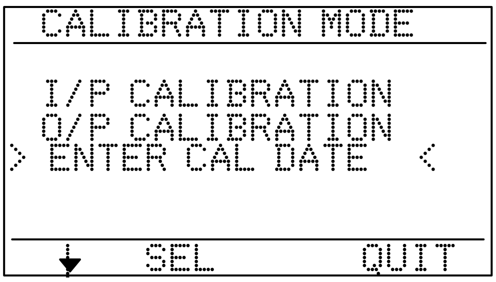


Fig 113

Enter the day, month and year of calibration by using **F1** to point to the parameter and **F2** (NEXT) to increment (or use the control wheel). Finally press **F4** (QUIT) to return to the calibration menu.

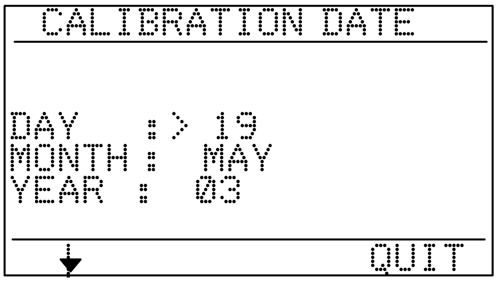


Fig 114

APPENDIX A - SPECIFICATIONS.

A.1 General.

OPERATING TEMPERATURE	-10°C to +45°C.
STORAGE TEMPERATURE	-20°C to +45°C.
HUMIDITY	0 to 95%RH (non condensing).
WEIGHT	2.5kg without carrying case.
BATTERY LIFE	Typically 12 hours continuous depending on use.

A.2 Measurement Inputs.

ISOLATION	All measurement terminals are galvanically isolated from all other terminal to 250V ac.
OVERLOAD PROTECTION	All inputs are overvoltage protected to 250V ac.
RESOLUTION	1 part in 55000 of range.
SERIES MODE VOLTAGE	25% of range voltage RMS at 50 or 60Hz.
SERIES MODE NOISE REJECTION	Better than 70dB at 50 or 60Hz.
BASIC LINEAR ACCURACY	(90 day) ±0.02% of range at reference conditions.
REFERENCE CONDITIONS	20°C ±2°C and 40% RH.
COLD JUNCTION ACCURACY	±0.25°C (in INTERNAL mode).
INPUT IMPEDANCE	Voltage ranges. > 10M0. Current range. 900 approx.
RESISTANCE MEASUREMENT CURRENT	0.25mA.
TEMPERATURE COEFFICIENT (100mV range)	Typically 30ppm of reading +1µV per °C 50ppm of reading +1µV per °C maximum.

A.2 Simulation outputs.

ISOLATION	All measurement terminals are galvanically isolated from all other terminal to 250V ac.
OVERLOAD PROTECTION	All outputs are overvoltage protected to 250V ac Resistance output is fuse protected at ±24V dc.
RESOLUTION	1 part in 55000 of range.
BASIC LINEAR ACCURACY	(90 day) ±0.02% of range at reference conditions.
REFERENCE CONDITIONS	20°C ±2°C and 40% RH.
COLD JUNCTION ACCURACY	±0.25°C (in INTERNAL mode).

OUTPUT IMPEDANCE	Voltage ranges. < 0.10. Current range. > 10M0.
RESISTANCE SIMULATION CURRENT RANGE	+0.1mA to +5.0mA for stated accuracy.
TEMPERATURE COEFFICIENT	Typically 30ppm of reading +1μV per °C 50ppm of reading +1μV per °C maximum.

A.3 Ranges and standards.

Thermocouples to BS4937

TC:S	Thermocouple type S (Pt10%Rh/Pt)	-50 to 1768°C
TC:R	Thermocouple type R (Pt13%Rh/Pt)	-50 to 1768°C
TC:J	Thermocouple type J (Fe/CuNi)	-210 to 1200°C
TC:K	Thermocouple type K (NiCr/NiAl)	-270 to 1372°C
TC:T	Thermocouple type T (Cu/CuNi)	-270 to 400°C
TC:E	Thermocouple type E (NiCr/CuNi)	-270 to 1000°C
TC:B	Thermocouple type B (Pt30%Rh/Pt6%Rh)	0 to 1820°C
TC:N	Thermocouple type N (NiCrSi/NiSi)	-270 to 1300°C

Thermocouples to Engelhard published data

TC:W	Thermocouple type W (W/W26%Re)	0 to 2320°C
TC:W3	Thermocouple type W3 (W3%Re/W25%Re)	0 to 2320°C
TC:W5	Thermocouple type W5 (W5%Re/W26%Re)	0 to 2320°C

Thermocouples to DIN 43710

TC:L	Thermocouple type L (Fe/CuNi)	-200 to 900°C
TC:NiMo	Thermocouple type NM (Ni/Ni18%Mo)	0 to 1310°C

Resistance thermometers to BS1904

Pt100	Platinum resistance thermometer 1000 @ 0°C	-200 to 850°C

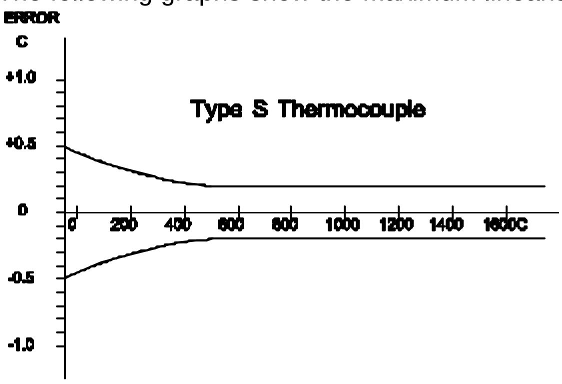
Resistance thermometer to DIN 43760

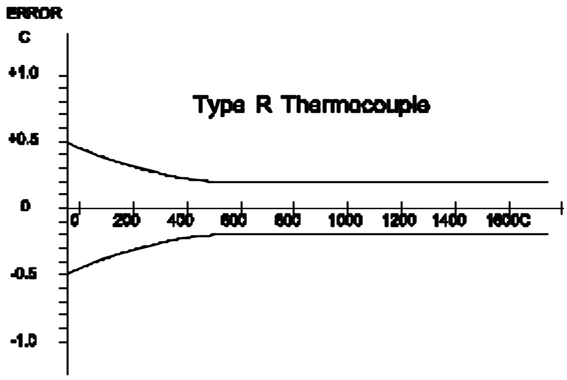
Ni100	Nickel resistance thermometer 1000 @ 0°C	-60 to 180°C

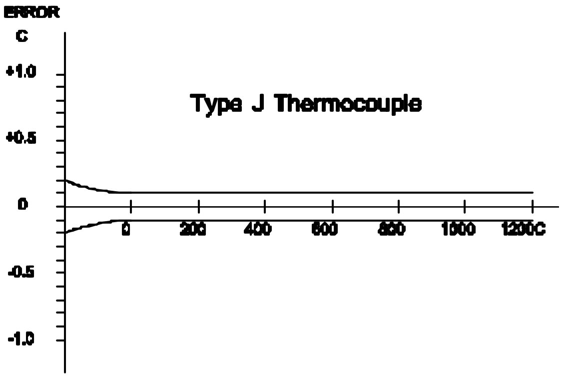
100mV	DC Voltage	-10mV to +100mV
1V	DC Voltage	-0.1V to +1V
10V	DC Voltage	-1V to +10V
20mA	DC Current	0mA to 20mA
4000	Resistance	00 to 4000

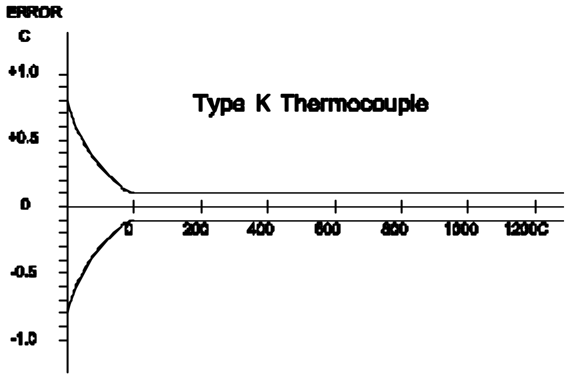
A.4 Conformity.

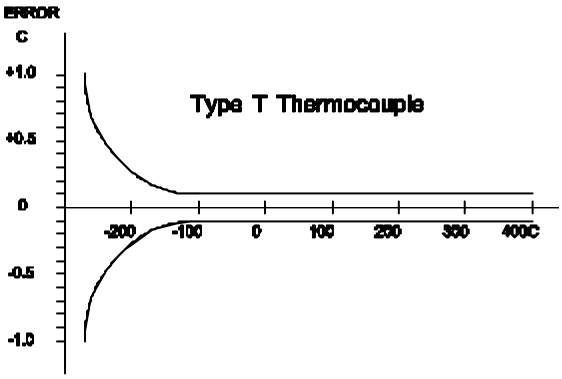
The following graphs show the maximum linearisation errors in °C.

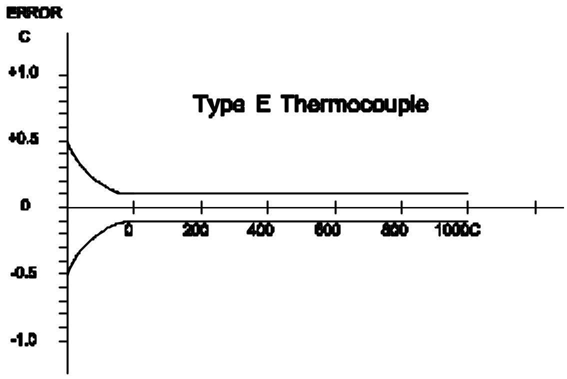


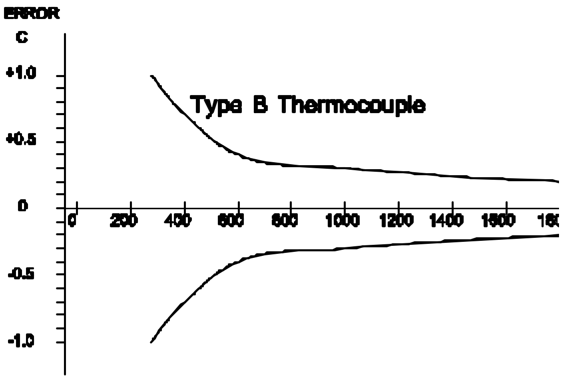


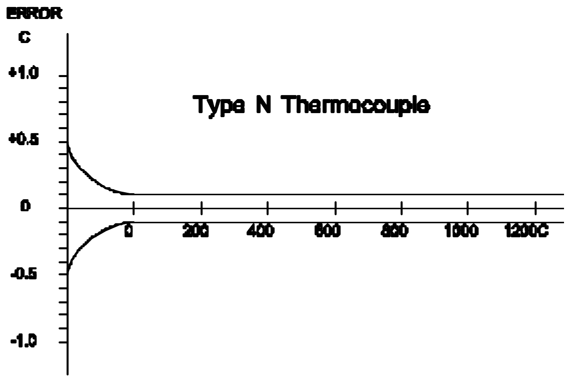


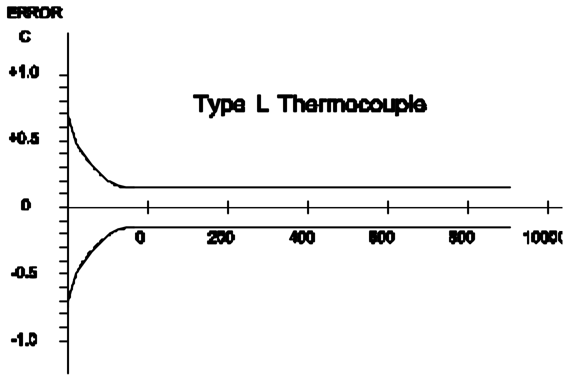


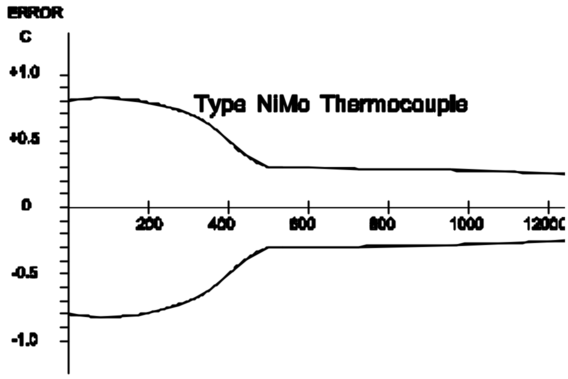


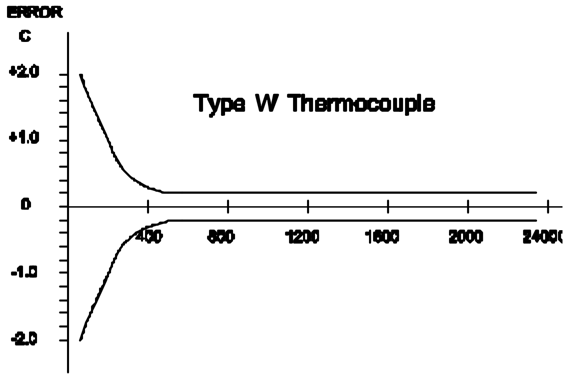


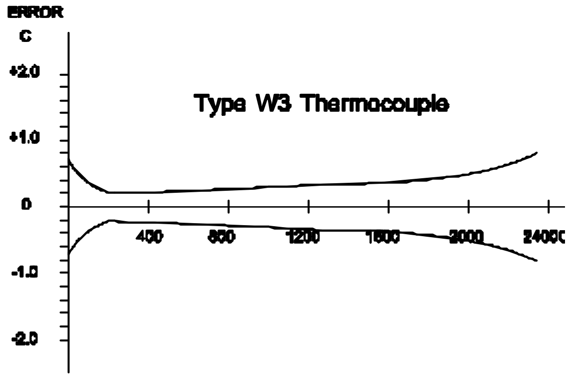


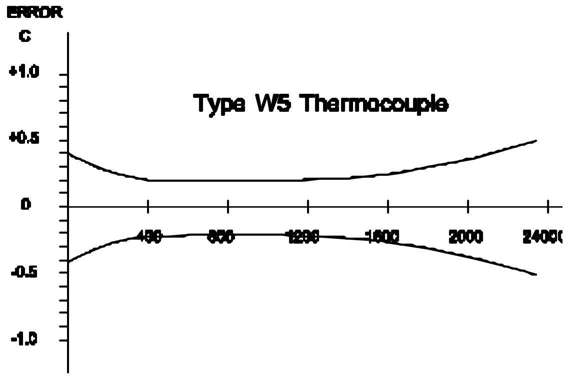


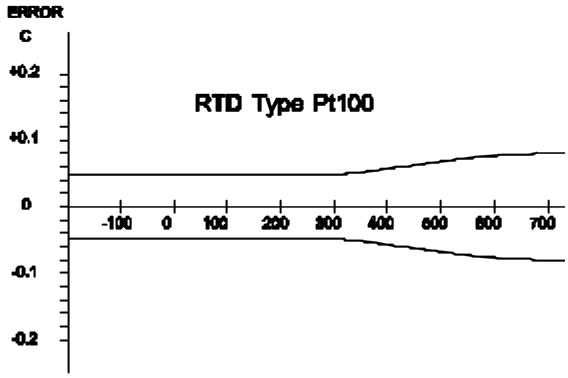

ERROR
C
+1.0
+0.5
0
-0.5
-1.0
Type L Thermocouple
0
200
400
600
800


ERROR
C
+1.0
+0.5
0
-0.5
-1.0
Type NiMo Thermocouple
200
400
600
800
1000


ERROR
C
+2.0
+1.0
0
-1.0
-2.0
Type W Thermocouple
400
800
1200
1600
2000


ERROR
C
+2.0
+1.0
0
-1.0
-2.0
Type W3 Thermocouple
400
800
1200
1600
2000


ERROR
C
+1.0
+0.5
0
-0.5
-1.0
Type W5 Thermocouple
400
800
1200
1600
2000


ERROR
C
+0.2
+0.1
0
-0.1
-0.2
RTD Type Pt100
-100
0
100
200
300
400
500
600
700

B.1 Custom law programming sheet.

EZECAL 5 CUSTOM LAW PROGRAMMING SHEET				
PURPOSE				
WRITTEN BY			DATE	
	Install Equation Editor and double-click here to view equation. 1		Install Equation Editor and double-click here to view equation. 2	
	LINEARISER INPUT		LINEARISER OUTPUT	
Breakpoint	ACTUAL INPUT	% INPUT	ACTUAL OUTPUT	% OUTPUT
0	A=	0.00	C=	0.00
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15	B=	100.00	D=	100.00

B.2 Custom range programming sheet.

EZECAL 5 CUSTOM RANGE PROGRAMMING SHEET.						
PURPOSE						
WRITTEN BY				DATE		
RANGE NUMBER			NAME			
PRIMARY I/O RANGE [	100mV	1V	10V	20mA	4000	
LAW			UNITS			
RESOLUTION [	1	0.1	0.01	0.001	0.0001	
DISPLAY HIGH LIMIT		≡	I/O HIGH LIMIT			
DISPLAY LOW LIMIT		≡	I/O LOW LIMIT			
TEMPERATURE COMPENSATION					mV/°C	
PURPOSE						
WRITTEN BY				DATE		
RANGE NUMBER			NAME			
PRIMARY I/O RANGE [	100mV	1V	10V	20mA	4000	
LAW			UNITS			
RESOLUTION [	1	0.1	0.01	0.001	0.0001	
DISPLAY HIGH LIMIT		≡	I/O HIGH LIMIT			
DISPLAY LOW LIMIT		≡	I/O LOW LIMIT			
TEMPERATURE COMPENSATION					mV/°C	
PURPOSE						
WRITTEN BY				DATE		
RANGE NUMBER			NAME			
PRIMARY I/O RANGE [	100mV	1V	10V	20mA	4000	
LAW			UNITS			
RESOLUTION [	1	0.1	0.01	0.001	0.0001	
DISPLAY HIGH LIMIT		≡	I/O HIGH LIMIT			
DISPLAY LOW LIMIT		≡	I/O LOW LIMIT			
TEMPERATURE COMPENSATION					mV/°C	