9823
10ppm Programmable Multi Function Calibrator

Technical Manual

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Document Version: V2 (09/08/2002)

Contents

All Time Electronics' instruments are subject to continuous development and improvement and in consequence may incorporate minor detail changes from the information contained herein.

Chapter 1. Introduction

This calibrator provides, in one instrument, calibration facilities for AC/DC Volts, AC/DC Current and Resistance.

Simple controls and a clear, 8 digit LED display make operation straightforward. Remote operation via the IEEE (GPIB) bus is a standard feature and allows the instrument to be used for automatic calibration. All logic functions are controlled by a microprocessor, which also monitors the output. On overload, the output is automatically switched off and an error message is displayed. Safety features are incorporated for high voltage outputs. The instrument is constructed in a high quality Eurocard frame and is suitable for bench use or mounting in a 19" rack system.

Ranges:-

D.C. Voltages	20mV to 1kV (1.1kV in over-range)
A.C. Voltages (RMS)	20mV to 1kV
D.C. Current	200uA to 10A (11A in over-range)
A.C. Current	200uA to 10A
Resistance	10 Ohms to 10M Ohms (7 Decade values)

The D.C. Voltage and Current ranges allow a 4% over-range on the lower ranges, with 10% over-range on the 10 Amp and 1kV ranges.

The Deviation function allows the output to be adjusted by +/- 10%.

The Zero Offset allows the use of zero to be offset by a preset value.

The combination of Deviation and Zero Offset is particularly useful for linearity checking.

'User' function allows operating modes to be changed by the user.

See Chapter 4 for details on local operation.

A self-test program is available and can be run at any time to check that all digital functions are operating correctly.

A fully automated calibration system can be configured using the 9823 with Time Electronics' EasyCal calibration software running on a PC with a GPIB interface card fitted. See Chapter 8 for details on EasyCal

Re-calibration of the 9823 can be via the front panel or via the GPIB (IEEE bus). To prevent calibration by unauthorised personnel, this function can only be selected by insertion of a calibration key into the socket on the rear panel.

1.1 Safety

Emphasis has been placed on safety features. The 200V, 1kV and 10Amp ranges have separate output connections. EEC safety regulations require that an additional operation must be performed before voltages greater than 40V can be generated.

Additionally there is a 3 second delay and an audible warning before any voltage greater then 40V appears on the output. This important feature helps to prevent high voltages accidentally output. As a further warning, an indicator on the left side of the display flashes at all times when a high voltage is present at the output terminals.

1.2 Mains supply voltage selection

Situated at the rear of the instrument, on the power module, are the supply inlet socket, two fuses and the voltage selector. The mains supply voltage is displayed in a small window. Access to the fuses and supply voltage selector is via a lever down flap. To change the supply voltage, switch off the supply, remove the lead, open the flap and replace the selector with the required voltage in position and close the flap.

Chapter 2. Specifications

The specifications given below are relative to calibration standards and apply at a room temperature of 22°C, after a minimum warm-up period of 3 hours. They apply from 10% to 100% of range and are (± of output) + (± of range) unless otherwise stated and are stated for 24 hr, 90 day, 180 day and 1 year periods after calibration. In most cases improved stability performance can be expected as the 9823 ages, this will be observed from the year to year calibration results.

D.C. VOLTAGE

RANGE	ppm 24 HOUR	ppm 90 DAY	ppm 180 DAY	ppm 1 YEAR	Temp. Coef. ppm/ºC	OUTPUT RESISTANCE	MAX DRIVE CURRENT	RESOLUTION
20mV	4+2	5+2	7+2	10+2	4	10 Ohm	Short Circuit	20nV
200mV	3+2	5+2	7+2	10+2	3	10 Ohm	Short Circuit	200nV
2V	1+1	5+2	7+2	10+2	2	0.1 Ohm	100mA	2uV
20V	1+1	5+2	7+2	10+2	2	0.1 Ohm	100mA	20uV
200V	10+10	20+10	25+10	30+10	4	10 Ohm	10mA	200uV
1kV	10+10	20+15	25+15	30+15	4	10 Ohm	10mA	2mV

Noise (0.1Hz to 1Hz RMS): 0.3 ppm of range for 20mV to 20V, 5ppm of range for 200V to 1kV
For thermal e.m.f effects please allow ±3uV can be reduced using low thermal e.m.f leads and null of zero to- <1uV

A.C. VOLTAGE

RANGE	FREQUENCY	% 24 HOUR	% 90 DAY	% 180 DAY	% 1 YEAR	Temp. Coef. ppm/ºC	OUTPUT RESISTANCE	MAX DRIVE CURRENT
20mV							10 Ohm	Short Crct
200mV	40Hz -1kHz	0.008-0.005	0.02+0.005	0.025+0.005	0.03+0.005		10 Ohm	Short Crct
2V	1 - 2kHz	0.02+0.02	0.06+0.02	0.07+0.02	0.08+0.02	15	0.1 Ohm	100mA
20V	2 - 20kHz	0.05+0.03	0.25+0.05	0.35+0.05	0.4+0.05		0.1 Ohm	100mA
200V								
1kV	40-450Hz	0.02+0.005	0.035+0.01	0.04+0.01	0.05+0.01	15	10 Ohm	10mA

Frequency Accuracy ± 0.01%. Temp. Coef 20ppm/°C, Resolution 5Hz, range 15Hz to 20kHz.
Drive current shown is peak (not RMS) All A.C specifications ±30uV

D.C. CURRENT

RANGE	ppm 24 HOUR	ppm 90 DAY	ppm 180 DAY	ppm 1 YEAR	Temp. Coef. ppm/ºC	OUTPUT RESISTANCE	DRIVE VOLTAGE	RESOLUTION
200uA	10+5	30+10	40+10	50+10	8	10G Ohm	15V	200pA
2mA	10+5	30+10	40+10	50+10	8	1G Ohm	15V	2nA
20mA	10+5	30+10	40+10	50+10	8	100M Ohm	15V	20nA
200mA	10+5	30+10	40+10	50+10	8	10MOhm	15V	200nA
2A	25+20	60+30	70+30	100+30	15	1M Ohm	5V	2uA
10A	0.02%+0.02%	0.04%+0.03%	0.06%+0.03%	0.07%+0.03%	30	100k Ohm	1.2V	20uA

All D.C current specifications ±30nA

A.C CURRENT (20Hz to 1kHz)

RANGE	% 24 HOUR	% 90 DAY	% 180 DAY	% 1 YEAR	Temp. Coef. ppm/ºC	OUTPUT RESISTANCE	DRIVE VOLTAGE	RESOLUTION
200uA	0.01+0.003	0.03+0.01	0.035+0.01	0.04+0.01	20	10G Ohm	15V	200pA
2mA	0.01+0.003	0.03+0.01	0.035+0.01	0.04+0.01	20	1G Ohm	15V	2nA
20mA	0.01+0.003	0.03+0.01	0.035+0.01	0.04+0.01	20	100M Ohm	15V	20nA
200mA	0.01+0.005	0.03+0.01	0.035+0.01	0.04+0.01	20	10M Ohm	15V	200nA
2A	0.02+0.005	0.035+0.01	0.04+0.01	0.05+0.01	30	1M Ohm	5V	2uA
10A	0.04+0.02	0.07+0.03	0.08+0.03	0.10+0.03	50	100k Ohm	1.2V	20uA

All A.C. current specifications ± 50nA. 2A and 10A specifications to 500Hz

Specification notes :

1) A.C. Specifications include the effects of noise and distortion in the 10Hz to 20kHz frequency range.
2) 4% over-range available on all ranges.
3) Voltage and current limits are stated as peak values.
4) After a range change, thermal equilibrium may take some time to be restored, especially after the use of the 10 Amp range.
5) Voltages and current drive are peak values not RMS, unless otherwise stated.
6) Maximum Common Mode voltage, 60V D.C 40V A.C with respect to mains supply earth.
7) Warm-Up time of 3 Hours.

General specifications :

Mains Supply Operating Voltage : 220 - 240 V A.C.50/60 Hz
100 - 120 V A.C. 50/60 Hz

Mains Supply connector : I.E.C. Socket, 115/230V selector built-in.

Power consumption : 30 Watts plus output power.

GPIB (IEEE) Connector : 24 Pin Connector in accordance with IEEE STD. 488

GPIB (IEEE) Address selection : 8 Way DIL switch on rear panel.

Operating temperature range : 10°C to 30°C

Standard calibration temperature : 22°C +/- 1°C

Output Connectors :
20V to 1kV / 2A to 10A, 4 mm Safety shrouded sockets
20mV to 20V / 200uA to 2A / 10 Ohms to 10 M Ohms - Low thermal EMF terminals.

Dimensions : 520 mm x 160 mm x 320 mm including feet.
Standard 3U 19" Rack Mounting.

Weight : 15 Kilos, 10 Kilos (Rack mounted)

2.1 Specification interpretation

The following examples are given as an aid to interpretation of the specification and explain how to calculate uncertainty values

(1) D.C. Volts Measurement.

To determine the uncertainty in 0.5V D.C. output on the 2V range, 90 days after calibration at the same temperature as the initial calibration :

(a)	Of output term : + / - 5 ppm of 0.5V	+ / - 2.5 uV
(b)	Of range term : + / - 2 ppm of 2V range	+ / - 4.0 uV
(c)	Zero term : + / - 3 uV	+ / - 3.0 uV
	9823 Uncertainty	9.5 uV

(*2) A.C. Current Measurement.*

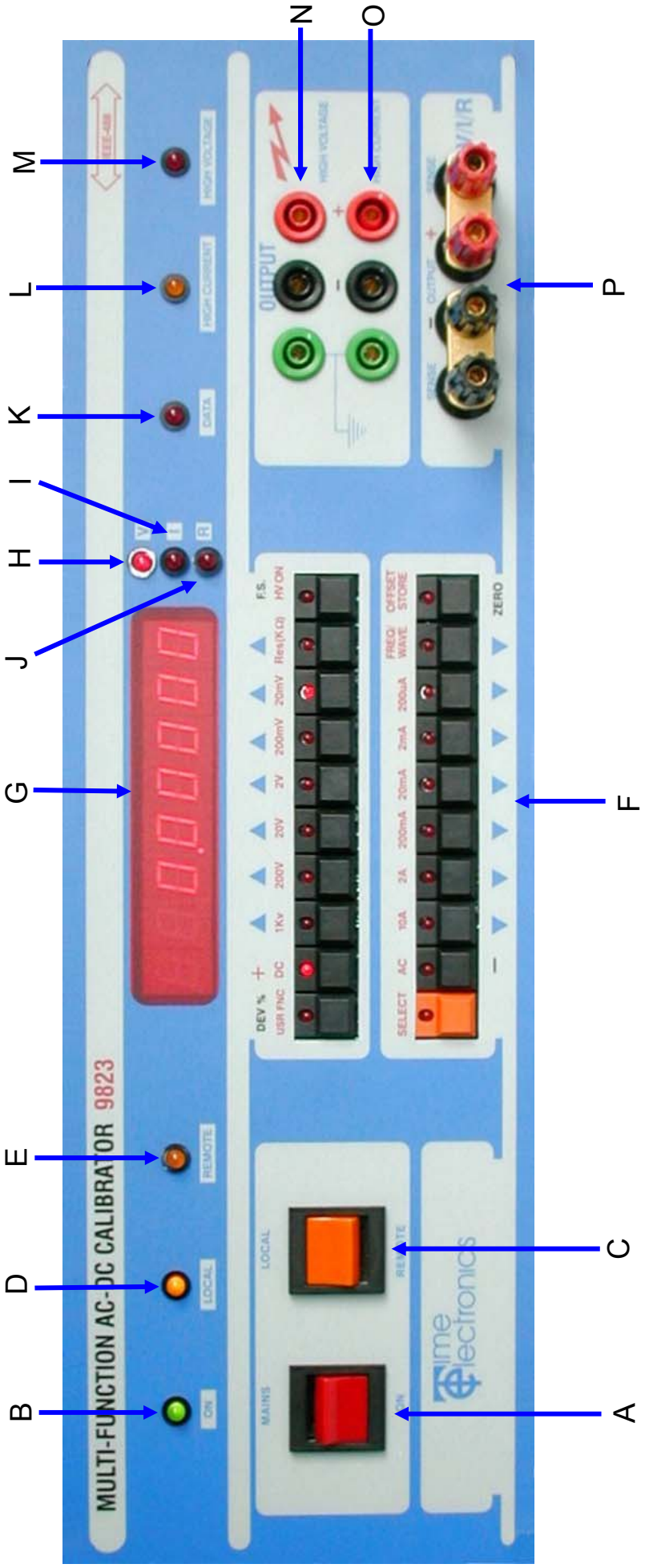
For a 200mA output on the 200mA range, 1 year after calibration at a temperature 5ºC different from the original calibration temperature.

(a)	Of output term : + / - 400 ppm of 200mA	+ / - 80 uA
(b)	Of range term : + / - 100 ppm 0f 200mA range	+ / - 20 uA
(c)	Temp. Coef. term : 20 ppm/deg * 5 = 100 ppm of 200mA	+ / - 20 uA
	9823 Uncertainty	120 uA

(Note : The ‘zero’ term is very small and has been omitted from this calculation)

It should also be noted that to determine the final calibration uncertainty the above figures need to be increased by the uncertainty of the calibrating standards used for the calibration of the 9823. Additional factoring may also be necessary depending on the requirements of your calibration laboratories certifying authority e.g. UKAS, PTB.

Chapter 3. Front Panel Controls



3.1 Front Panel

Please refer to the picture of the 9823's front panel on the previous page when reading this section.

A) Power Switch
This rocker action switch controls the main power. The power on/off is manual operation only and cannot be controlled via the GPIB (IEEE).

B) On Indicator
Indicates the instrument is switched on.

C) Local/Remote Switch
This rocker action switch selects LOCAL operation, which allows manual operation, via the front panel and GPIB (IEEE bus) control is disabled. REMOTE operation allows control via the GPIB (IEEE bus), and the front panel controls are disabled.

D) Local Operation Indicator
Indicates the instrument is under manual operation via the front panel controls.

E) Remote Operation Indicator
Indicates the instrument is being controlled remotely via the GPIB (IEEE bus).

F) Control Buttons
There are 20 buttons arranged in two rows. These are located in the centre section of the front panel. Each button has an LED indicator. The buttons have a dual function which are shown in RED and BLUE. To obtain the RED function it is necessary to first press the SELECT button.

For the following descriptions the buttons are numbered, top row left to right (1 - 10) and bottom row left to right (11 - 20). The function of the LED indicators on each button is also explained.

BUTTON 1 :
DEV% (BLUE) - Operates in a toggle action to change between deviation display and normal output. See Chapter 4. for operation in deviation control mode.
USR FNC (RED) - Allows the user to select various operating modes. See Chapter 4 for details.
INDICATOR - ON : Deviation control is being used.
INDICATOR - OFF : Standard control mode.
INDICATOR - FLASHING : Nominal output displayed but terminal output has deviation applied.

BUTTON 2 :
'+' (BLUE) - Sets output polarity positive.
'DC' (RED) - To select DC ranges.
INDICATOR - ON : DC range in use.
INDICATOR - OFF : AC or resistance range in use.

BUTTONS 3 to 8
'^' (BLUE) - These four buttons increment the digit imdedaly above on the display.
1kV to 20mV (RED) - These 6 buttons select the voltage ranges.
INDICATOR - ON : Voltage range currently selected.
INDICATOR - OFF : Voltage range is not selected.

BUTTON 9
'^' (BLUE) - Increments the least significant digit on the display.
Res (K Ohm) (RED) - Selects the Resistance function.
INDICATOR - ON : Resistance function selected.
INDICATOR - OFF : Resistance function not selected.

BUTTON 10
'FS' (BLUE) - Full scale output for the range selected.
'HV ON' (RED) - Safety interlock button for the selection of outputs greater than 50V. See Chapter 4.
INDICATOR - Not used.

BUTTON 11
'SELECT'(RED) - This single function button selects the red identified functions on the other buttons see chapter XX for details. This button should be pressed and released before pressing another switch.
INDICATOR - ON : Indicates that the next button pressed will select a RED function.
INDICATOR - OFF : Indicates that the next button pressed will select a BLUE function.

BUTTON 12
'-' (BLUE) - Sets output polarity negative.
'A.C' (RED) - Selected Voltage and Current outputs will be AC
INDICATOR - ON : AC output is selected.
INDICATOR - OFF : DC or resistance output is selected.

BUTTONS 13 to 18
'v' (BLUE) - These four buttons decrement the digit immediately above on the display.
'10A' to '200uA' (RED) - These buttons select the Current ranges.
INDICATOR - ON : Current range selected.
INDICATOR - OFF : Voltage or resistance range selected.

BUTTON 19
'v' (BLUE) - Decrements the least significant digit on the display.
'FREQ/WAVE' (RED) - Allows frequency and waveform to be selected.
INDICATOR - ON : Frequency and waveform displayed.
INDICATOR - OFF : Voltage or Current output displayed.

BUTTON 20
'ZERO' (BLUE) - Immediately sets output to zero.
'OFFSET STORE' (RED) - Allows an offset to be applied to the output.
INDICATOR - Not used.

G) 8 Digit LED Display
Displays all functions and outputs of the 9823.

H) V Indicator
Indicates the output is 'VOLTAGE'

I) I Indicator
Indicates the output is 'CURRENT'

J) R Indicator
Indicates the output is 'RESISTANCE'.

K) Data Light
Flashes when data transfer is taking place on the GPIB (IEEE) bus when using remote operation mode. It also flashes once for every button press when in local (manual) operation mode.

L) 10 Amp Indicator
Indicates the 10 Amp output sockets are active.

M) H.V. Indicator
Indicates the H.V. (High Voltage) output sockets are active.

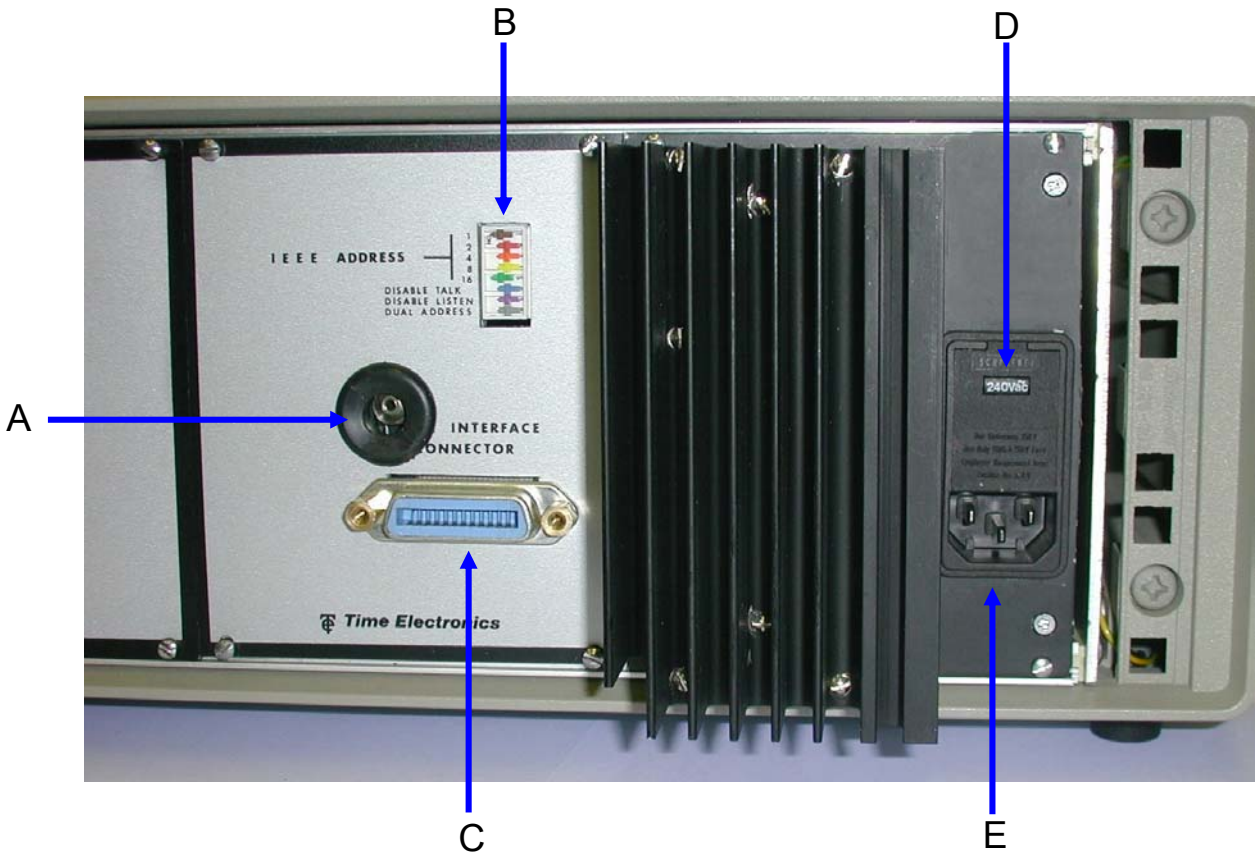
N) High voltage output sockets
3 x 4 mm (Red, Black, Green) sockets active when voltages from 21V - 1kV are selected.

O) 10 Amp Output Sockets
3 x 4 mm (Red, Black, Green) sockets active when currents from 2.1A - 10A are selected.

P) V / I / R Output Terminals
4 x 4 mm (Red, Red, Black, Black) low thermal terminals. Active when 20mV - 20V, 200uA - 2 A and Resistance are selected.

Note : 4 terminal operation is possible for voltage and resistance functions. See chapter 4.11.

3.2 Rear panel



A) Calibration key socket
Only used for 9823 recalibration adjustments, see chapter 9

B) GPIB (IEEE) address selection switch
8 miniature slide switches used to select GPIB (IEEE) address and functions, see chapter 5.6

C) GPIB (IEEE) Connector
Standard 24-Way GBIP (IEEE) socket, see chapter 5.3

D) Mains supply fuses and voltage selector
Open flap to replace fuses and select local supply voltage, see chapter 4.1

E) Mains supply inlet socket
IEC mains supply inlet, see chapter 4.1

Chapter 4. Local Operation

4.1 Switching On

At power on, the 9823 will initially display the software version number for approximately 1 second, then automatically switch to the 20mV D.C. range and select zero output.

If ‘ERROR 6’ is displayed at switch on, the 9823 will need a complete re-calibration. See chapter 9.

IMPORTANT NOTE : For all normal operations of the 9823 (manual or GPIB (IEEE)) the GPIB (IEEE) address should not be set to 0 or 16 and the calibration key should not be left plugged in. These conditions are reserved for re-calibrating the 9823, see chapter 9. Loss of all 9823 calibration data can result from inadvertent operation in this way.

4.2 Operation

Manual operation of the instrument is enabled by setting LOCAL mode front panel switch ‘C’ (chapter 3).

4.3 Selecting a D.C range and the output value

1.) See chapter 4.4 if a voltage of 21V or greater is required.

2.) See chapter 4.10 if four terminal operation is required.

3.) Press the SELECT button.

4.) Press the required VOLTAGE or CURRENT range button.

5.) Press the + or - button to select output polarity.

6.) Press buttons marked with ‘up’ or ‘down’ arrows to increment or decrement the output.

7.) Full scale or zero output can be selected directly by pressing the F.S. or Zero buttons.

8.) A) OFFSET - Set up the offset required as an output as described above. Then press SELECT followed by OFFSET STORE. This value will then be stored, and added to or subtracted from (if a negative offset was set) any output value subsequently selected.
During the period when the offset is in use, the left hand digit of the display will show a flashing horizontal bar.
To cancel offset, press SELECT and reselect a range.

If an offset needs to be added/subtracted to the subs an offset can be programmed in to an offset store location. To do this select an output normally as described above points 1—6 then press elect followed by offset store, This value will then be stored
B) Percentage Deviation - Press DEV%. The display will change to a 5 digit format indicating percentage deviation. This can be set in the range of -9.9999% to +9.9999% by pressing the arrowed increment or decrement buttons. To return to the normal output display, press DEV% again. When a deviation has been set, the LED on the DEV% button will flash as a reminder that a deviation is being applied to the output.
To exit deviation mode, zero the deviation by pressing the Zero button and then press the dev% button. The output and display returns to the original setting. Select next required output before re-entering deviation mode

4.4 Selecting a high voltage output

When using the 200V and 1kV ranges, use the high voltage output terminals. The H.V. OUTPUT LED will also light and a bleep will be heard every seven seconds.

EEC regulations require additional safety features to be incorporated when output voltages in excess of 40V can be selected. If the total value of the selected output plus and deviation and zero offset is greater than 40V, an operation additional to a normal selection is required to obtain the output. Note that this function can be modified by User Function 4. (See chapter 4.8)

1.) Select the required output on the display.

2.) Press SELECT followed by HV ON. The SELECT LED will flash.

3.) A buzzer will sound and within 3 seconds the output will ramp up to the selected value.

4.) When the output reaches the selected value, the SELECT LED will stop flashing, but the dot at the left hand end of the display will continually flash all the time a high voltage is present at the output terminal.

NOTES:
A) There will also be a delay in obtaining an output if the polarity of a high voltage is reversed. This is carried out as follows -

Select Polarity
Press SELECT
Press HV ON

B) When a high voltage range is selected, the instrument cannot be switched from A.C. to D.C. or vice versa. To do this, a low voltage range must first be selected.
C) Only D.C. and A.C. 40Hz - 1kHz Sine Wave outputs are allowed on the H.V. ranges.
D) See chapter 8.7 for earthing of the High Voltage output.

4.5 Selecting an AC frequency and waveform

By default, all AC ranges are Sine wave, 60Hz

Press SELECT
Press AC
Press SELECT
Press FREQ WAVE

The display will show :-

The left hand digit indicates the waveform type. The right hand 5 digits represent the frequency in Hz. The example above shows that a 60Hz sine wave has been selected.

DIGIT	WAVEFORM	CALIBRATED IN
1	SINE	RMS
2	SQUARE	PK/PKx2
3	RAMP UP	PK/PK
4	RAMP DOWN	PK/PK
5	TRIANGULAR	PK/PKx2
6	TRAPEZOIDAL	PK/PKx2
7	D.C.	

To change the waveform type, increment or decrement the waveform digit using the arrowed buttons beneath the waveform number. See table.

The frequency may be incremented or decremented by pressing the buttons below the displayed frequency value. Frequencies between 15 Hz and 20 kHz in 5Hz steps may be selected. A special very low frequency setting (0.025Hz) is available by pressing the ’ZERO’ button, all zeros will be displayed in this setting.

To continue press SELECT then the required range and value. Please note it is possible to enter the AC freq/waveform setting mode, without loosing the output value previously set.

Full wave rectified outputs of waveform types 1,5 and 6 are available by pressing the negative polarity (-) button when in normal AC output mode. Note that the frequency of all the waveforms will double, however the R.M.S. values for sine wave will remain the same, see fig 4.1.

4.6 Selecting an AC range

1.) See chapter 4.11 if four terminal operation is required

2.) Press the SELECT button.

3.) Press the required VOLTAGE or CURRENT range button.

4.) Press buttons marked with ‘up’ or ‘down’ arrows to increment or decrement the output.

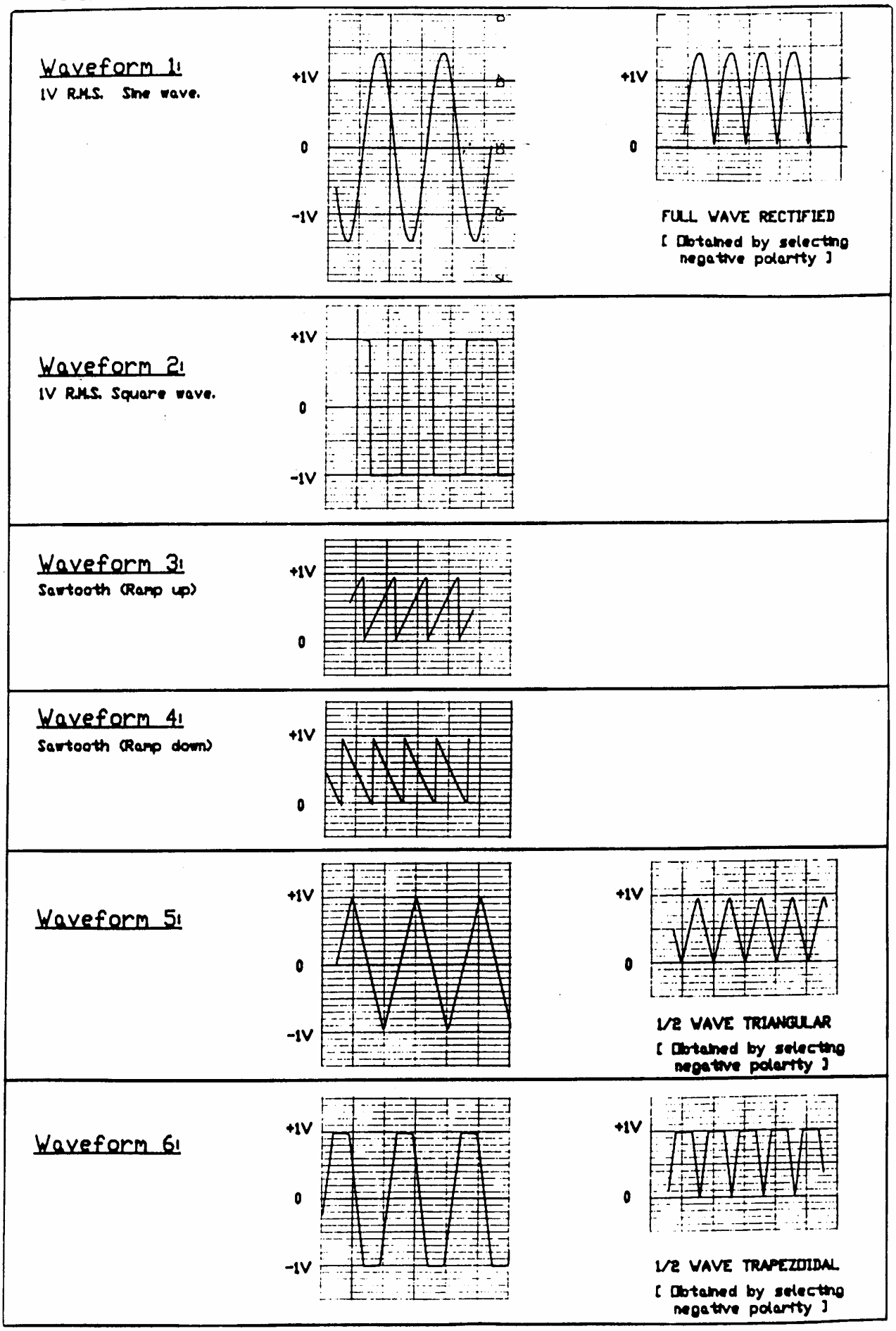
5.) Full scale or zero output can be selected directly by pressing the F.S. or Zero button

6.) To change the frequency response or waveform type, see chapter 4.5.

7.) Percentage deviation and AC offset is available in AC.

FIG 4.1 - A.C Waveforms

FIG.4.1 - A.C. WAVEFORMS



4.6 Selecting a resistance output

1.) See chapter 4.11 if four terminal operation is required.

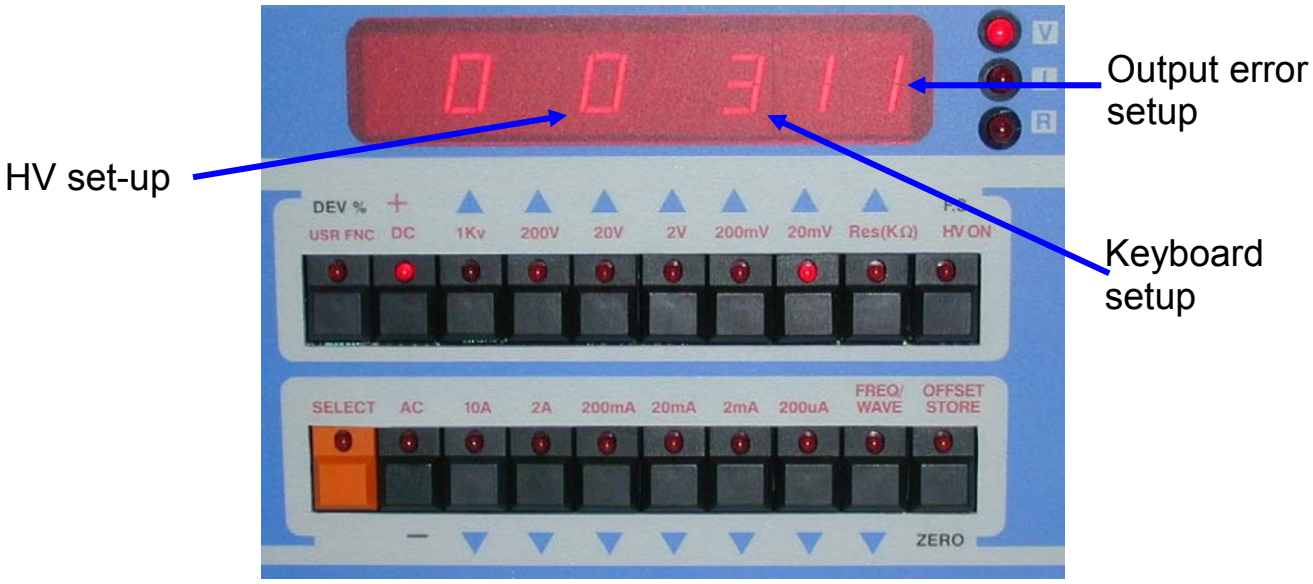
2.) Press SELECT and RES (kΩ). The display will show 0.01 (i.e. 10 Ohms).

3.) Press the top row of buttons to select a resistance value between 10 Ohms and 10M Ohms. Values can be set in decades only.

4.) Deviation and Offset are not available on the resistance ranges.

4.7 Selecting a user function

The user function mode displays information about the 9823 current operating characteristics. Three features can be user modified, the keyboard, the output error detection and the high voltage safety features.
User Functions can be displayed by pressing ‘SELECT’ followed by ‘USR FNC’.
The 3 user functions can be changed by pressing the keys immediately below the digit.



A.) HV setup

Increment and decrement this digit using the buttons below to change the high voltage operating mode. Refer to table 4.2 for mode numbers and their corresponding safety features.
NOTE: The HV ON button in this table is a feature incorporated to prevent the inadvertent application of dangerous voltages to the output terminals. Modes 4 - 7 disable this safety feature and users must be aware of the dangers especially in Mode 7 in which the voltage is applied to the terminals without warning.

MODE	ALARM	RAMP	HV-ON BUTTON
0	Y	Y	Y
1	N	Y	Y
2	Y	N	Y
3	N	N	Y
4	Y	Y	N
5	N	Y	N
6	Y	N	N
7	N	N	N

Table 4.2 High voltage set-up control

ALARM refers to the internal audible buzzer, RAMP refers to gradual increase/ decrease of the output during settling times (a few seconds) Ramp off means immediate application of high voltage to output sockets. HV-ON button on refers to safety interlock function of the HV ON button.

Time Electronics or their authorized agent take no legal responsibility for operation of the 9823 when the user has deselected the safety features

B) Keyboard setup

This function allows for four different modes of carry-over with or without auto-repeat as shown in table 4.3. Selection of the carry-over function enables a 9 to 10 carry-over. Without it, the carry-over will be 9 to 0. The auto-repeat facility, available in modes 2 or 3, gives continuous repetition of the held down key.

MODE	CARRY OVER	AUTO REPEAT
0	N	N
1	Y	N
2	N	Y
3	Y	Y

Table 4.3 Keyboard set-up

C) Output error setup

Output errors are detected when the calibrator is unable to drive the load with the selected output, e.g., a short circuit on a voltage range or an open circuit on the current range. Output errors are not detected on the 20 mV, 200mV and resistance ranges.

The user can select one of four ways in which the unit will respond to an output error.

Mode 1. The output will be set to zero immediately and ‘OP ERROR’ displayed. To continue using the instrument, the fault must be rectified and the output re-selected. The display will then show the re-selected value.

Mode 2. The output will be set to zero immediately and ‘OP ERROR’ displayed. The output will be reinstated if the overload disappears and the previous output value displayed.

Mode 3. Upon detection of an error, the instrument will wait for 0.5 seconds before setting the output to zero and displaying ‘OP ERROR’. The fault must be rectified and the output re-selected.

Mode 4. The instrument will continue to drive the output and after half a second, display ‘OP ERROR’.

4.8 Self test mode

To select self test mode, set all 8 GPIB (IEEE) switches on rear of unit to the ON position before switching on the instrument.

When switched on, the instrument will carry out an internal test sequence as follows.

Check internal circuitry
Each segment of the 8 digit display will light in turn
All front panel LEDs (with the exception of the ‘F.S’, ‘ZERO’, ‘+’ and ‘-’ LEDS)

If no errors are detected, the word ’PASS’ will appear on the display.

If an error is detected, the word ERROR followed with a error number from 1 to 6 will be displayed. The meaning of these error numbers is explained in table 4.4.

ERROR NUMBER	FAULT	REPLACE
1	RAM	Processor board
2	GPIA	IEEE board
4	PIA	Processor board. (IC1 6821)
5	PIA	Processor board. (IC2 6821)
6	CAL RAM	Calibration RAM (X2816)

Table 4.4 Types of waveforms

To exit from self test mode, turn the instrument off, set the unit address on the GPIB (IEEE) switches and switch on again.

Calibration RAM test is carried out every time the unit is switched on regardless of the IEEE address.
If the calibration factors stored in the RAM are corrupted, ‘ERROR 6’ will be displayed. To clear this condition, run the self test procedure described above with the calibration key plugged in. This will clear ALL stored calibration factor and a full re-calibration is required (see chapter 9). If ‘ERROR 6’ persists, then a fault is present in the calibration ram and will need replacing.

4.9 Ramp output for analogue meters - stiction test

This test enables the movement of an analogue meter needle to be checked if the user suspects that it is sticking at certain points. To carry out this test, proceed as follows.-

1.) Press SELECT.
2.) Press FREQ/WAVE.
3.) Select waveform 5.
4.) Press Zero key to select 0.025Hz frequency output. Display shows 5 00000.
5.) Select a full range suitable for the meter under test.
6.) The meter needle will move smoothly up and down if the scale is stiction free.

4.10 Four terminal operation

For resistance and voltage output, the 9823 can be used in four terminal mode for greater accuracy. 4 Terminal operation is not used for current outputs.

Voltage ranges, AC. or DC, can either take their output direct with the sense terminals connected to the output terminal, or for greater accuracy to remove errors that occur due to resistance of the calibration leads. This improves accuracy by sensing the voltage at the point of calibration and the 9823 then compensates for any lead losses or loading of the circuit. For resistance calibrations four terminal operation also improves accuracy.

Chapter 5. Remote GPIB (IEEE) Operation

5.1 Introduction

The IEEE-488 interface sometimes called GPIB (General Purpose Interface Bus) allows remote control of the instrument by a computer. Repetitive calibration work can be fully automated and fast, less skilled users can undertake complete calibration procedures. Additionally results are stored and certificates can be immediately printed out. See chapter 8

5.2 GPIB (IEEE) data transfer and addressing

Before a controller can send data it has to identify the recipient. Each device on the GPIB (IEEE) is given an address to which it will respond when called by the controller, in this way data can be transferred between selected devices in an orderly manner. The rate at which it is transferred is controlled by hand shake signals, the speed being governed by the slowest device active on the bus.

5.3 GPIB (IEEE) Cables and connectors

The IEEE-488 cable contains 24 wires terminated at both ends with identical plug/sockets which allow for daisy chaining of additional cables to extend the bus. See Table 5.2 for details of connections.
Cables used on GPIB (IEEE) systems are available in various lengths to suit different layouts. The following are recommended types :-

Manufacturer/Supplier	Part No	Length
Belden	9642	1m
Belden	9643	2m
Belden	9644	4m
Belden	9645	8m
Time Electronics	9596	1m
Time Electronics	9597	2m

Table 5.1 GPIB (IEEE bus) Cables part numbers

5.4 IEC Bus connections

A user requiring to connect the calibrator to a European standard bus (IEC), must be aware of the differences in connector pin assignments from the IEEE bus and provide a suitable interface. Table 5.2 compares the pin designations for each standard.

5.5 GPIB (IEEE) Connectors

The pin connections and dimensions of the IEEE connector are illustrated below and in table 5.2.

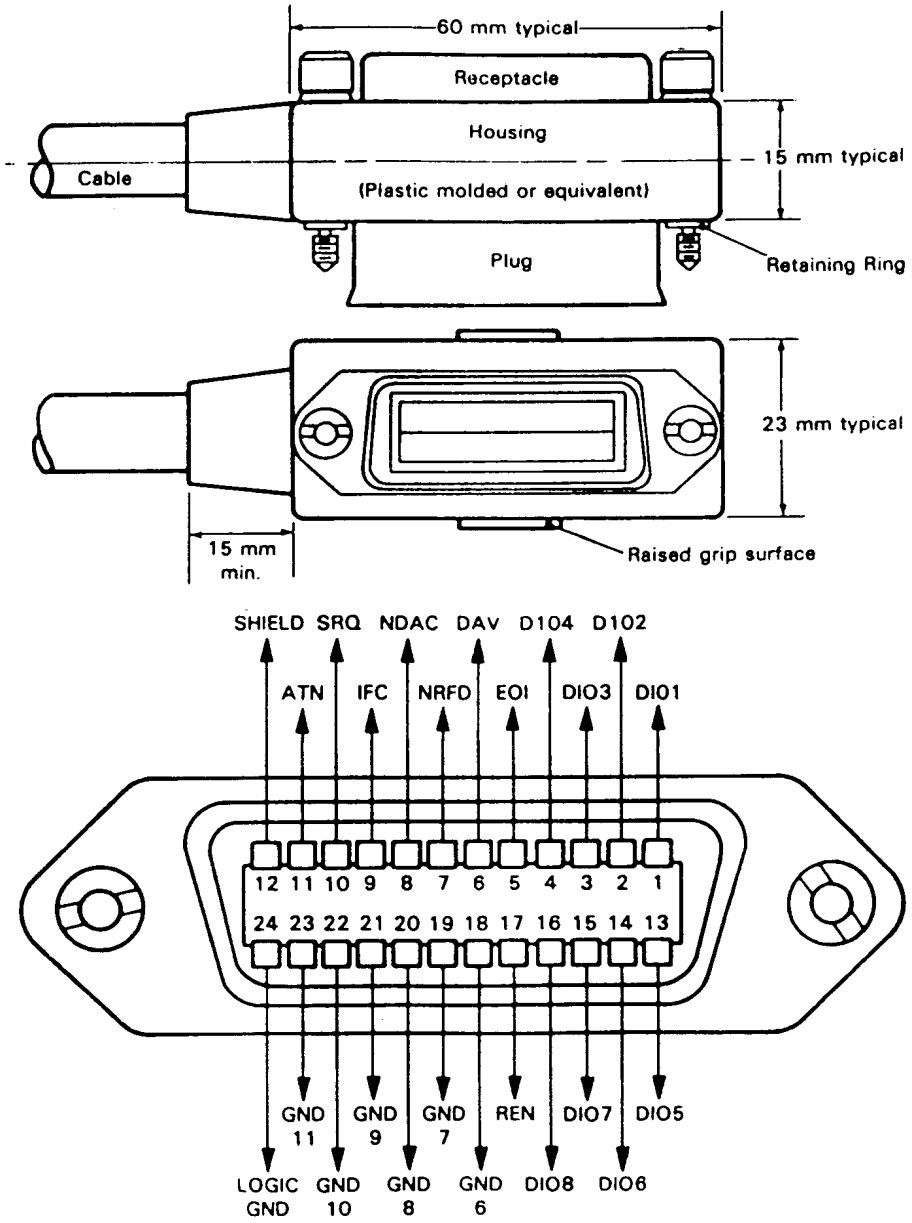


Fig. 5.1 I.E.E.E. CONNECTOR

IEEE STANDARD		IEC STANDARD	
PIN		PIN	
1	D101	1	D101
2	D102	2	D102
3	D103	3	D103
4	D104	4	D104
5	EOI	5	REN
6	DAV	6	EOI
7	NRFD	7	DAV
8	NDAC	8	NRFD
9	IFC	9	NDAC
10	SRQ	10	IFC
11	ATN	11	SRQ
12	SHIELD	12	ATN
13	D105	13	SHIELD
14	D106	14	D105
15	D107	15	D106
16	D108	16	D107
17	REN	17	D108
18	GND 6	18	GND 5
19	GND 7	19	GND 6
20	GND 8	20	GND 7
21	GND 9	21	GND 8
22	GND 10	22	GND 9
23	GND 11	23	GND 10
24	LOGIC GND	24	GND 11

Table 5.2 Pin designation comparison. IEEE and IEC

5.6 GPIB (IEEE) Address selection

Before operating the calibrator over the GPIB (IEEE bus), set the address on the rear of the unit to the required address and operating mode. The GPIB (IEEE) address is set on the top five positions of the DIP switch which is located on the rear panel. They are in binary format i.e. 1,2,4,8,16. The address is the addition of the switches selected in the ON position e.g. to select address 3 requires positions 1 and 2 ON, see example below.

GPIB (IEEE) Addresses 0 and 16 are reserved for recalibration mode and should not be used unless recalibrating the instrument. Address 31 is used to select self test mode.

Note : The eight switches are read only when the instrument is first switched ON. Therefore it is necessary to turn the unit OFF if a new GPIB (IEEE) address is required. See table 5.3

SWITCH SETTING	DECIMAL ADDRESS	SWITCH SETTING	DECIMAL ADDRESS
0 0 0 0 0	0	1 0 0 0 0	16
0 0 0 0 1	1	1 0 0 0 1	17
0 0 0 1 0	2	1 0 0 1 0	18
0 0 0 1 1	3	1 0 0 1 1	19
0 0 1 0 0	4	1 0 1 0 0	20
0 0 1 0 1	5	1 0 1 0 1	21
0 0 1 1 0	6	1 0 1 1 0	22
0 0 1 1 1	7	1 0 1 1 1	23
0 1 0 0 0	8	1 1 0 0 0	24
0 1 0 0 1	9	1 1 0 0 1	25
0 1 0 1 0	10	1 1 0 1 0	26
0 1 0 1 1	11	1 1 0 1 1	27
0 1 1 0 0	12	1 1 1 0 0	28
0 1 1 0 1	13	1 1 1 0 1	29
0 1 1 1 0	14	1 1 1 1 0	30
0 1 1 1 1	15		

Table 5.3 GPIB (IEEE) Address selection

A ‘1’ in the table corresponds to the ON position of the switch. Switch 1 (top) selects the least significant bit. The last three switches, which are normally set to the OFF position, are used to select the instruments operating modes as follows:

Switch 6 - GPIB (IEEE bus) talk (transmit) disable.

Switch 7 - GPIB (IEEE bus) listen (receive) disable.

Switch 8 - Dual Primary Addressing mode. In this mode, the unit will respond to two primary addresses differing only in the least significat bit. For example, if the unit address selection switches are set for an address of 8, the unit will also respond to address 9.

5.7 GPIB (IEEE) Commands

LOCAL LOCKOUT

The front LOCAL/REMOTE switch must be in the remote position for IEEE operation. The instrument will not respond to any IEEE commands when set to local.

INTERFACE CLEAR COMMAND IFC

This command initiates a complete reset of the unit, which is then unable to respond to any further IEEE commands for 1 second.

IEEE COMMAND FORMAT

IEEE commands are comprised of characters from the ASCII set. A series of commands can be used to simulate the manual operation of the unit.

The commands must be in one of the following formats:

1.) A single upper case character (A to Z).
2.) Upper case character followed by a number.
3.) A signed decimal number (8 digits maximum).

Commands may be sent individually or built into a string separated with a ‘slash character’ (/). For the command string to execute it must be terminated with either a line feed or carriage return character.

IEEE COMMAND EXECUTION

Before an GPIB (IEEE) command can be executed 4 conditions must be met.

1.) The unit must be switched to ‘remote’ on the front panel.
2.) GPIB (IEEE) cable and controller connected. The GPIB (IEEE) address and the talk/listen switches set correctly on the rear panel switch.
3.) The command must be a valid command (invalid commands are ignored).
4.) The command must be followed by a valid terminator.

Table 5.3 GPIB (IEEE) Command list

GPIB (IEEE) Command	Operation
D	Transmit display to bus controller
E1 to E4	Select unit action upon output error detection.
F15 to F20000	Select output frequency.
G1 or G2	Set / Cancel Group execute trigger response.
H	Set output to full scale.
I	Select serial poll operation.
K1 or K2	Enable/Disable Front panel controls.
L	Set output to zero.
O1 to O7	Output resistance between 10 Ohms and 10 M Ohms. O1 - 10 Ohms O2 - 100 Ohms O3 - 1k Ohms O4 - 10k Ohms O5 - 100k Ohms O6 - 1M Ohms O7 - 10M Ohms
Pn	Change output by ‘n’ percent.
R1 to R12	Select voltage or current range R1 - 20mV R3 - 200mV R3 - 2V R4 - 20V R5 - 200V R6 - 1kV R7 - 200uA R5 - 2mA R9 - 20mA R10 - 200mA R11 - 2A R12 - 10A
RA	AUTORANGE
T1 or T2	Set terminator character appended to a transmission.
W1 to W7	Select waveform. W1 - Sine W2 - Square W3 - Ramp up W4 - Ramp down W5 - Triangle W6 - Trapezoidal W7 - D.C.
Z	Take present output as offset.
/	Command separator.

5.8 Single letter commands

Command D

It is important to understand the sequence of operation on the IEEE bus when a data read-back command is executed. When the ‘D’ Command is sent it prepares the instrument to transmit (i.e. act as a talker). The controller program must then execute an ‘INPUT’ statement to actually initiate the data transfer. The data must be terminated with the correct character to complete the transfer.

Invalid terminating characters cause the GPIB (IEEE bus) to hang.

The terminator is controller dependent and the instrument allows either CR or LF to be used, as determined by the Command T1 or T2. Note that the T1 to T2 command (terminating setting) must be done before the ‘D’ command is executed.

When the unit is in the over-range condition the front panel display shows 1….. but this is not transmitted on read-back. The character string ‘OVERRNG’ is sent. In all other cases the read-back is exactly as seen on the display.

EXAMPLE (HP BASIC)

```
10 REMOTE 708
20 OUTPUT 708; “T2”          !SET TERMINATOR
30 OUTPUT 708; “D”           !TRANSMIT DISPLAY
40 ENTER 708; A$             !READ RETURNED VALUE IN
50 PRINT A$                  !PRINT IT
```

Command H

Sets output to full scale on the selected range. On the High Voltage ranges it will cause a three beep audio warning which lasts 3 seconds. The output will then appear on the terminals, this mode of operation is a safety feature.

EXAMPLE (BASIC)

```
10 OPEN 1,7                  :REM OPEN ADDRESS 7 TO INSTRUMENT
20 PRINT #1,‘H’              :REM SET OUTPUT TO FULL SCALE
30 END                       :REM END
```

Command 1

Sets the instrument to generate a serial poll request for service by the bus controller should an ‘OP ERROR’ arise.

EXAMPLE (HP BASIC)

```
10 REMOTE 708                    !OPEN IEEE ADDRESS 8
20 OUTPUT 708;“I”                !SETS UNIT TO GENERATE SERIAL POLL
                                  REQUEST ON OUTPUT ERROR
30 OUTPUT 708;“E4/R4/5”          !SET ERROR MODE, 20V RANGE WITH
                                  5 VOLTS OUTPUT
40 ON INTR 7 GOSUB 1000          !DEFINE ACTION ON SERIAL POLL
50 V1=0 @ X=0
60 X=X+1                         !WAIT FOR ERROR LOOP
70 GOTO 60
1000                             !SUBROUTINE TO PRINT POLL RESPONSE
1010 STATUS ,1;A 1020 P=SPOLL(708)
1030 PRINT P                     !DISPLAY SERIAL POLL RESULT
1040 ENABLE INTR 7;8
1050 RETURN                      !RETURN TO WAIT LOOP
```

Command L

Sets the output to zero.

Command Z

Takes the present output value as an offset. The display indicates zero with the top segment of the display flashing. When a new output value is sent it will be added to the offset stored. The offset is cleared by:

1.) A new range command
2.) Selecting a resistance output
3.) Setting the offset to zero

In remote AutoCal mode, indicated by a flashing ’C’ on the display, the offset is stored in the non volatile memory and is used as a calibration factor.

5.9 Letter & Number command

E1 To E4 Output Error Mode

Selects one of four possible error modes which determine the action taken by the unit on detection of an output error

E1 : (default) Displays ‘OP ERROR’ and turns off output immediately on detection of an output error, remains in this condition until reset by another command.

E2 : Displays ’OP ERROR’ and turns off output immediately on detection of OP ERROR, will automatically restore output and display if the error is removed.

E3 : Waits for an error condition to last for 0.5 seconds before turning off output and displaying ‘OP ERROR’.

E4 : Waits for an error condition to last for 0.5 seconds before displaying ‘OP ERROR’ and leaves output ON.

F15 to F20000 frequency setting commands

Commands F15 to F20000 select output frequency. Enter ’F’ followed by the required frequency. Any frequency between 15Hz and 20KHz (in 5Hz steps) may be selected. F0 selects 0.025Hz for stiction tests.

G1/G2 enable/disable group execute trigger

G1 - Enables Group Execute Trigger response.
G2 - Disables Group Execute Trigger response.

Group Execute Trigger (GET) is a command issued by the bus controller to make several devices respond simultaneously, the devices having been previously told how to respond when the GET command is received.

EXAMPLE (HP BASIC)

```
10 REMOTE 708          !OPEN IEEE ADDRESS 8
20 OUTPUT 708;“G1”     !SETS UNIT TO RESPOND TO GET
30 OUTPUT 708;“R2”     !COMMAND TO EXECUTE
40 TRIGGER 708         !EXECUTE COMMAND
50 OUTPUT 708;“G2”     !COMMAND TO EXECUTE
60 TRIGGER 708         !EXECUTE COMMAND TO EXIT GET MODE
```

K1/K2 enable/disable front panel control

K1 - Sets instrument to respond to front panel control.
K2 - Disables front panel controls.

P(n) set percentage deviation

Set deviation '**n**' on present output where '**n**' is in the range of + 9.99 and -9.99.

EXAMPLE (BASIC)

10 PRINT #1,"P3.45" *REM SET output 3.45% high*
20 PRINT #1,"P-0.02" *REM SET output 0.02% low*

R1 To R12 Range Setting Commands

Selects a voltage or current range from IEEE command table.

COMMAND SELECTED	RANGE	PROGRAM IN
R1	20 mV	mV
R2	200 mV	mV
R3	2 V	Volts
R4	20 V	Volts
R5	200 V	Volts
R6	1 KV	Volts
R7	200 uA	uA
R8	2 mA	mA
R9	20 mA	mA
R10	200 mA	mA
R11	2 A	Amps
R12	10 A	Amps

RA : Automatically selects the range for the output required. Default : R1.

T1/T2 select transmission terminator

Sets the last character appended to a transmission from the instrument.

T1 : (default) carriage return.
T2 : line feed.

W1 to W7 waveform setting commands

Select waveform or D.C. see IEEE command table in Table 5.3.
NOTE : On the high voltage ranges (R5 & R6) only Sine Wave and DC (W1 & W7) are permitted. It is not possible to change the Waveform without first going to a lower range.
Default is W7 (DC).

5.10 Setting an output value

Transmit the voltage or current required a an ASCII string.

EXAMPLES (HP BASIC) on the 2 Volt range (R3)

OUTPUT 708;"-0.3765" *!SETS OUTPUT TO -0.3765 VOLTS*

OUTPUT 708;"2.9" *!SETS OUTPUT TO OVER-RANGE DISPLAY SHOWS '1…' , OUTPUT IS APPROX 2.08V*

OUTPUT 708;"0.00000007" *!SETS OUTPUT TO ZERO, TOO MANY DECIMAL PLACES*

NOTE :
1.) The 5th digit is always rounded to 0, 2, 4, 6, or 8.
2.) On D.C. (W7) or sine wave A.C (W1) the output limit of any range is 20800 or 1100v on the 1 KV ranges.
3.) On the 10 Amp ranges, output limit is 11 Amps.

5.11 Setting voltage above 40V

When a voltage above 40V is selected, (except when using certain output error modes), an alarm sounds 3 times before the voltage is applied to the output terminals. To avoid damaging circuitry by applying large rates of voltage change, the output ramps up to the set value. It takes about approx. 5 seconds to reach 1kV output.

On the 200V and 1kV ranges, only Sine wave and D.C. are permitted. Changing the waveform on these ranges is disabled by the software in the instrument. Frequencies above 1kHz will give large amplitude errors.

Changing range to the 200V or 1kV range where the output would be set to more than 40V causes the output to be set to zero.

The left hand decimal point on the display flashes when an output of 40V or greater is on the terminals.

Chapter 6. Fault Diagnosis

This section gives details of fault conditions, and how to identify and correct them. Faulty items may be returned for repair or replacement boards obtained (See Chapter 10. Spare Parts List) please ensure you always quote serial number, and give details of the fault.

Time Electronics and their authorised agent offer an exchange service for all boards and the power module.

6.1 Fault check list

1) If the unit is completely dead with no front panel lights, check the following:

A) Mains supply.
B) Mains supply fuse in plug.
C) Mains supply fuse in instrument inlet IEC connector (see chapter 3.2)
D) Internal fuses in power module (see fuse replacement).

2) If instrument responds to manual control but not to GPIB (IEEE) control and the data light does not flash in remote mode, check the following:

A) Faulty or incorrectly connected GPIB (IEEE) cable.
B) GPIB (IEEE) address set incorrectly.
C) Incorrect terminating characters.
D) Processor board not correctly plugged in.

3) If unit responds to manual control but not to GPIB (IEEE) control and the data light flashes, the probable fault is an incorrect command in the user software.

4) Unit powers up but not working correctly.

A) Run Self Test. See chapter 4.8.

5) Unit displays ERROR 6.

A) Calibration factors corrupted, unit required a complete re-calibration see chapter 9.

6) Unit occasionally resets to power on (20mV range) condition and makes a short bleep.

A) Mains interference is causing the microprocessor to reset. Additional mains filtering required. A propiortary stabilised UPS is recommended where the mains supply voltage is unreliable and/or noisy.

6.2 Fuse replacement

Four types of fuses are used in this instrument.

1.) Mains supply : 800mA for 240 V, 20mm, anti surge.
1.6A for 110 V, 20mm, anti surge.
2.) Power module 18V supply : 2.5A, 20mm, anti surge.
3.) Power module 5V supply : 2A, 20mm, quick blow.
4.) V/I/R output terminals : 250mA, 5/8 inch, quick blow.

Replacement fuses are available from Time Electronics or their authorised agent. See Chapter 10. Spare Parts for order details.

Fuse replacement procedures :

1.) Mains fuse : This fuse is located in the mains inlet filter. To replace, disconnect equipment from mains and lever down hinged cover to reveal fuse holders. This fuse should be 800 mA for 240 V operation, or 1.6 Amp for 110 V operation.
2.) +/- 18 V fuses : These fuses are mounted on the right hand printed circuit board of the power module.
3.) 5V supply : The 5V supply fuse is mounted on the left-hand printed circuit board of the power module.
4.) V/I/R fuse : This fuse is mounted on the reference board underneath the module.

6.3 Mainframe

The calibrator is constructed on a 19 inch Eurocard frame. Cards and modules plug into the frame from the rear of the unit. All modules and printed circuit boards connect to the 64-way data bus via a DIN 41612 type connector.
The front panel is removed by unscrewing the four captive screws at each corner. Then lift away from the frame.

6.4 Fan replacement

The fan is situated at the left hand side of the instrument, behind the front panel and it cools the 10 Amp board. Should the fan fail, it is replaced as follows :

1.) ENSURE MAINS SUPPLY IS DISCONNECTED BEFORE ATTEMPTING TO DISMANTLE THIS INSTRUMENT.
2.) Remove the instrument from the free standing case.
3.) Remove the two cross head screws situated at each end of the top front cross member.
4.) Release the cross member and lay it back on top of the unit.
5.) Take off the four fan retaining nuts and washers.
6.) Remove the fan supply plug from the power module.
7.) The fan can now be lifted out of the mainframe.
8.) Fit replacement fan using reverse procedure.

6.5 10 Amp board replacement

Should the 10 Amp board fail, it is replaced as follows :

1.) ENSURE MAINS SUPPLY IS DISCONNECTED BEFORE ATTEMPTING TO DISMANTLE INSTRUMENT.
2.) Remove the unit from the free standing case.
3.) Remove the front panel and the cross member (screws at each end).
4.) Remove the plug connecting the 10 Amp board to the power module.
5.) Remove the plug connecting the 10 Amp board to the current module.
6.) Disconnect the wires to the output terminals.
7.) The 10 Amp board can now be removed from the mainframe.
8.) Fit replacement board using the reverse procedure.

6.6 Power module replacement

To remove the power unit module which is located on the right hand side of the frame viewed from the rear, first unscrew the four captive screws in the corners of the power unit rear panel. The power unit can then be pushed out of the rear of the frame. DO NOT PULL ON THE MAINS LEAD.

Replacement is in the reverse order.

6.7 Processor / GPIB board replacement

The IEEE and processor boards are located behind the IEEE rear panel. Remove the panel by unscrewing the four captive screws at each of its corners.
Disconnect the multipin plug that connects the rear panel to the IEEE panel. Before the boards can be removed, the black retaining clips located at the bottom of the frame must be depressed.
NOTE : The IEEE multipin connector is NOT polarized and can be accidentally reversed during replacement. To avoid this, ensure that the embossed arrow heads on the plug and socket are aligned. Care must also be taken to ensure the correct alignment of the IEEE address switch in the rear panel cut out.

6.8 Analogue board replacement

All analogue boards are located behind the rear panel on the left of the frame when viewed from the rear. To replace a board, remove this panel locate the board to replace, depress card retaining clip and pull board back. On all boards additional connectors need to be disconnected as the board is removed.

NOTE : To remove the H.V. board it is also necessary to remove the IEEE panel.

Chapter 7. Calibration Techniques

This section indicates some of the common errors made when using the calibrator.

7.1 Output resistance

Output resistance causes a drop in output voltage when a load is applied. The percentage error depends on the ratio of load resistance to output resistance

Ratio of load to output Resistance	Error in output Voltage
100,000 : 1	0.001%
10,000 : 1	0.01%
1,000 : 1	0.1%
100 : 1	1.0%
10 : 1	9.0%
1 : 1	50.0%

This table applies to D.C. and A.C. For A.C, capacitive loading must also be added to resistive load. The table below gives reactance of capacitors (in ohms).

CAPACITOR	REACTANCE @ 50Hz	REACTANCE @ 10kHz
100pF	32M Ohms	160k Ohms
1000pF	3.2M Ohms	16k Ohms
0.1uF	32k Ohms	160 Ohms

For most application the ratio is very high and the error can be ignored. One important exception is the Thermal Transfer where the ratio can be 1000 : 1 or less. This will give errors in excess of 0.1% unless compensated for.

Another exception is the calibration of a 60mV analogue meter. It is often better to use the 2 Volt range as the output resistance is much lower than the 200 m V range and the accuracy at 1/20 full is still sufficiently high for analogue meters.

7.2 Using shunts

Using a shunt and a digital voltmeter (DVM) to measure the 2mA and 200uA ranges gives rise to two possible errors :-

1.) Low Shunt Value.

Low value shunts give a very small voltages which are very difficult to measure on DVM's, the non-linear A.C. to D.C. conversion techniques used, often give large zero errors which cannot be corrected by simply taking off the zero reading.

2.) 1k Ohm shunts and above.

The input impedance on most high performance DVM's is usually 1M Ohm. This causes a 0.1% error when reading across a 1k Ohm. It is therefore necessary to correct this or use a buffer amplifier to isolate the DVM from loading the shunt.

7.3 Output current limitation on voltage ranges

The instrument warns when the maximum output current is exceeded for more than 10 milliseconds by displaying 'OP ERROR' (O.P Mode 1).

Two important exceptions to output error detection should be noted.

1.) No error is detected on the 200mV and 20mV ranges as the output current is limited by the output resistance of 10 Ohms.

2.) As output errors lasting less than 10mS are not detected a slightly clipped peak of an A.C. waveform may not cause an output error.

7.4 Output voltage limitation on current ranges

Output errors are generated when there is insufficient terminal voltage to drive the set current through the load. Error condition must last for more than 10 mS to be detected. Note that some meters and transducers have a large inductance and may need 20 or 30 Volts A.C. to drive them although their D.C. resistance is very low.

7.5 Interference rejection

As none of the output terminals has a path to mains earth at voltages less than 80 Volts, it is good practice to earth the instrument by taking one of the terminals to earth or by ensuring that the instrument being calibrated is properly earthed. However, care should be taken that an earth loop is not created by inadvertently earthing the calibrators terminal when it is already earthed via the instrument under calibration.
On current ranges with very high output impedance, series mode noise can be induced onto the output but may be suppressed by the use of screened leads.

In addition to inherent electrical noise from internal circuitry, the output can contain fluctuations which originate externally and often cover a wide spectrum of frequencies. The most effective solution is to locate the source and provide suitable filtering e.g. capacitor suppression on arcing contacts.

7.6 Earthing the High Voltage output

The V/I/R and 10 Amp terminals are true bipolar outputs, but the H.V. output terminals are not. Therefore, when using a positive H.V. output the negative terminal should be earthed as normal, but when a negative H.V. output is required, it is recommended that the earth be transferred from the negative terminal to the positive terminal. Alternatively the low voltage negative terminal may be earthed, this automatically earths the correct side of the H.V. output.

7.7 Thermal EMFs

Thermal EMF's are significant when low level D.C. Voltage measurements are being made. Thermal EMF errors are unpredictable and arise when dissimilar metal junctions are at different temperatures. To minimise them, the same metal should be used throughout the measuring circuit, avoiding the use of steel probes, nickel plated terminals and tinned copper wire where possible. If the use of dissimilar metal junctions in the measuring circuit is unavoidable, it should be ensured that they are offset by other junctions of the same metals at the same temperature. Allowance for Thermal EMF's should then be made by making a measurement twice with reversed polarities. Time Electronics can supply Low Thermal EMF leads, (see Chapter 10. Spare Parts).

7.8 Resistance measurements

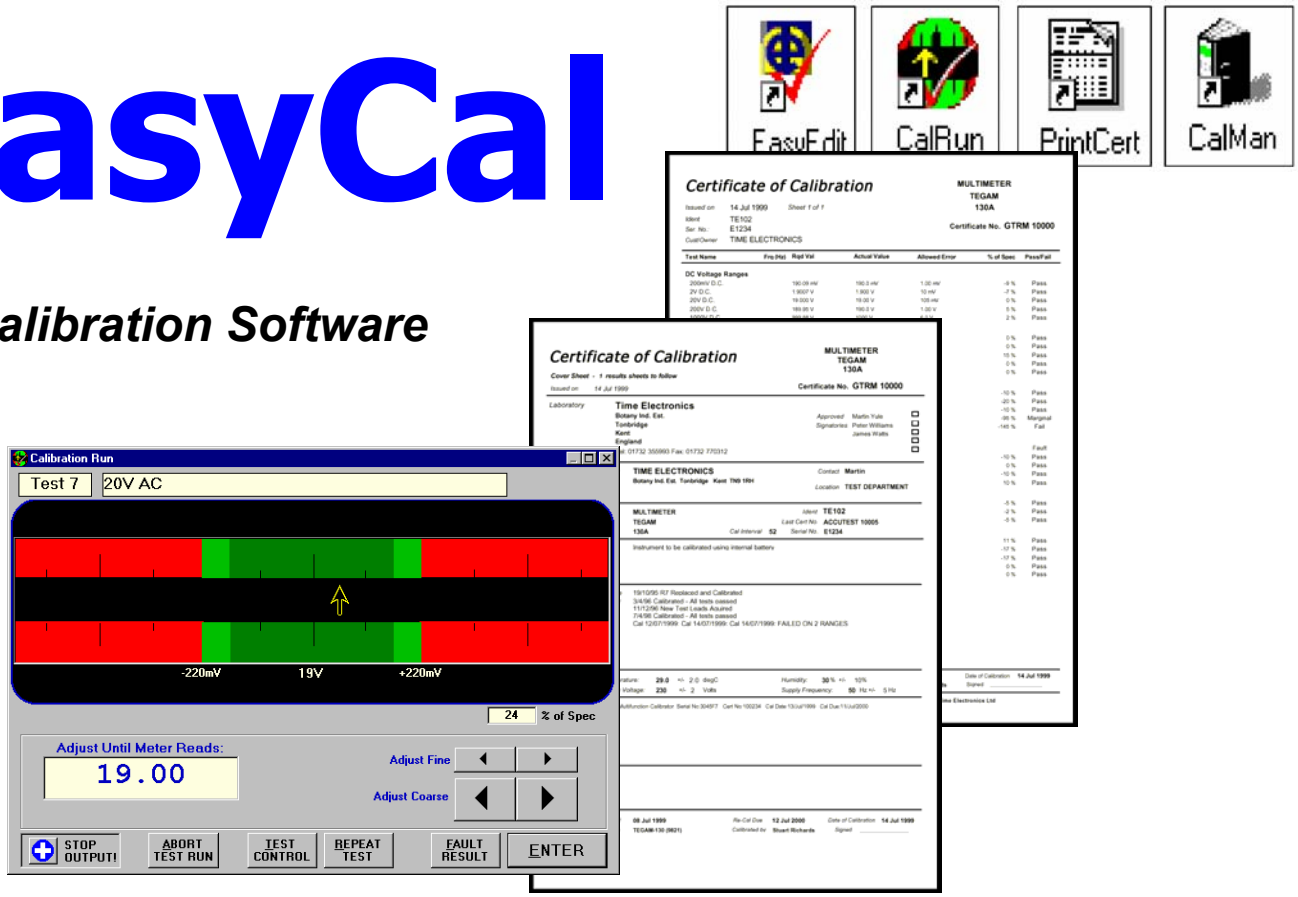
There are three types of errors in resistance measurement :

1) Thermal EMF's can effect the accuracy of resistance measurement if not zeroed out properly.
2) Self heating of the resistor being measured. Use of a lower current will minimize this but the resulting lower voltage is more difficult to measure.
3) Noise and pick-up on the higher value resistors. The use of screened leads may help but may not remove noise completely.

Errors caused from 1 and 2 can usually be completely removed, but errors from noise pick-up on high value resistances will always be present.

EasyCal

Calibration Software

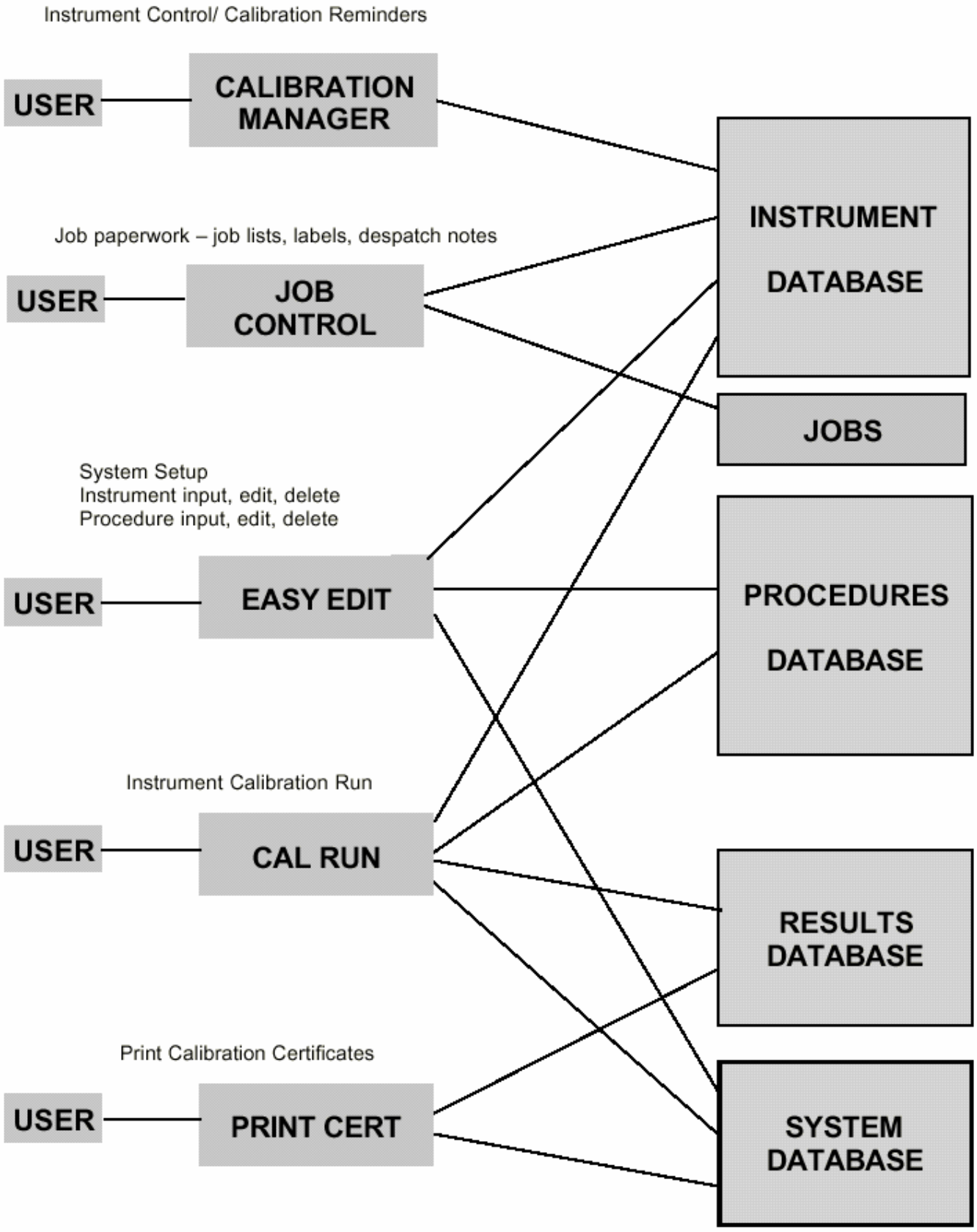


- ***Closed Loop Calibration - Universal Read-Back***
- ***Uncertainty calculator - to the new ISO 17025 standard***
- ***Electronic signatures for full traceability of stored results***
- ***Conditional Tests for closed loop calibration***
- ***Repeat cal points - max, min, mean, rms or std dev results***
- ***Calibration Manager - reminder letters, pre-cal sheets***
- ***User definable conversion tables***
- ***More than 800 standard procedures***

The new **Universal Read-Back** function now allows you to automate calibration using a wide range of third party equipment.

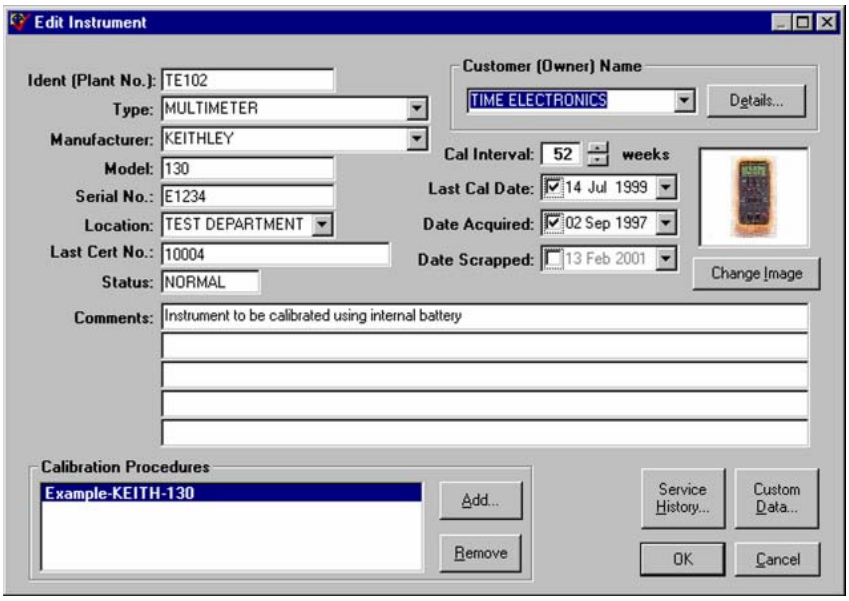
You can connect your existing calibration equipment (GPIB or RS232 interface) to an EasyCal system and be up and running in no time using the straightforward, user friendly, procedure generation, followed by the well known CalRun for the actual calibration.

EasyCal's Program and Database Interaction

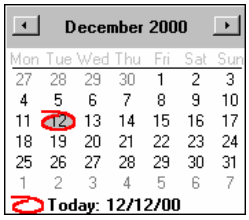


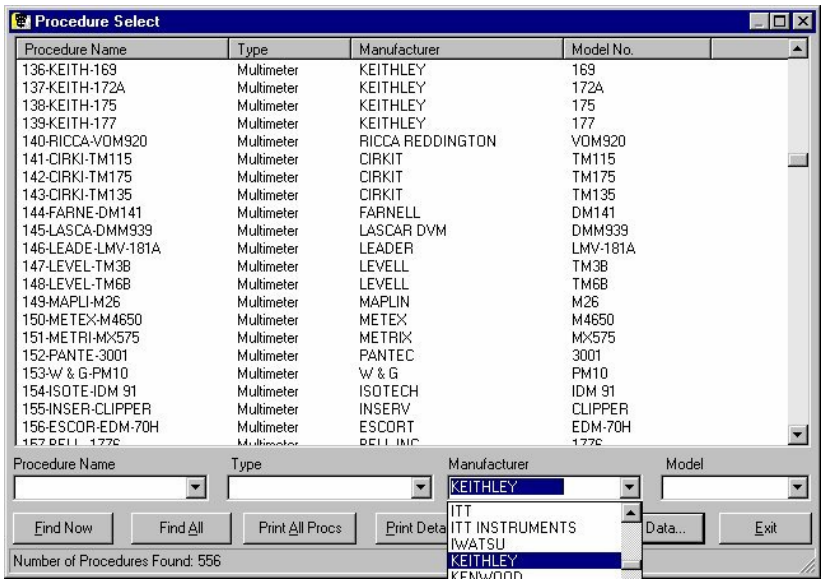
EasyEdit

Details of instruments are held in the EasyCal Instrument Database



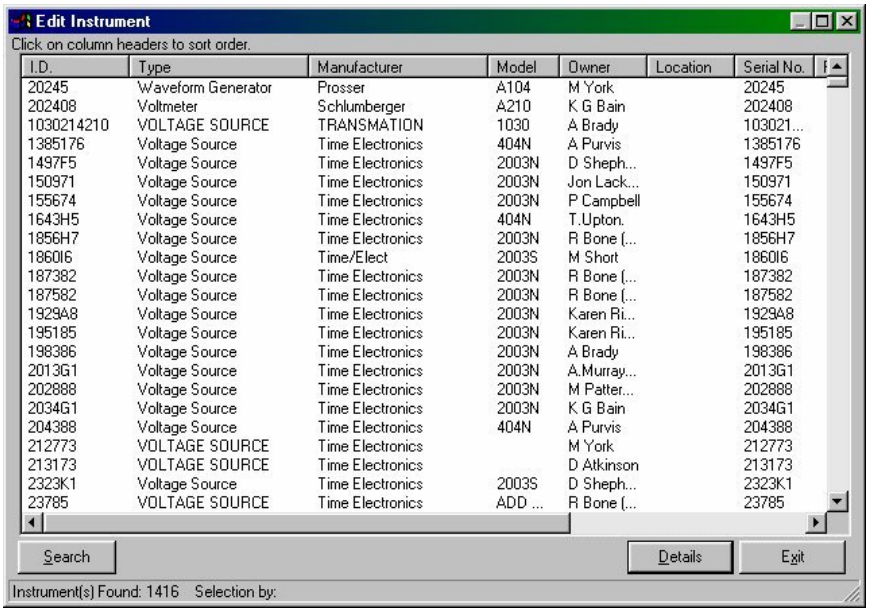
A pop-up calendar aids entry





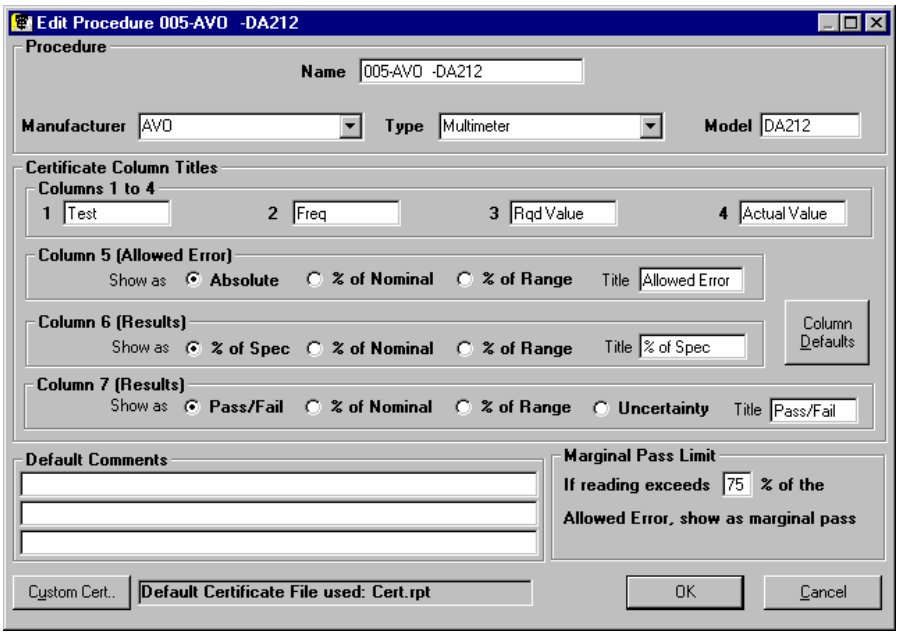
Select calibration procedures from the large EasyCal library, or enter one yourself

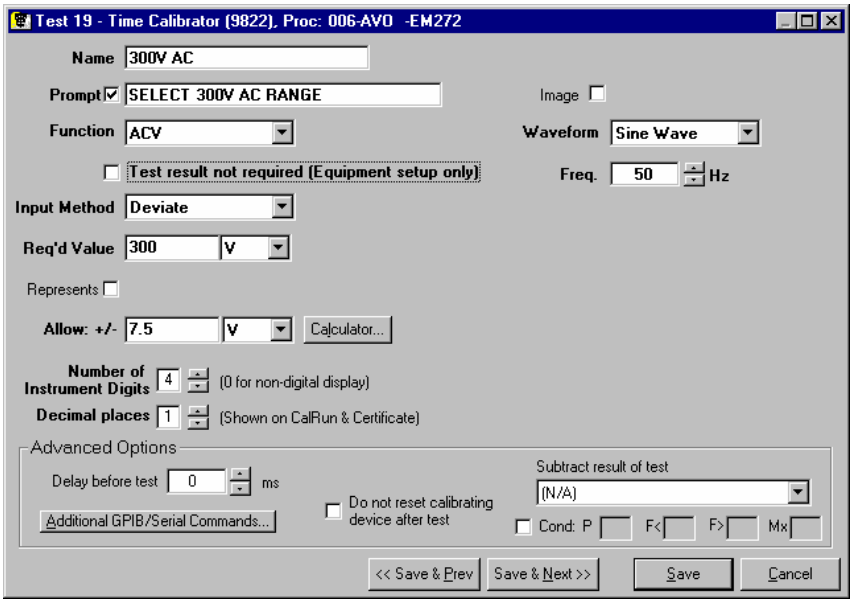
EasyEdit has full search facilities for locating any instrument or procedure...fast



Entering your own calibration procedures is easy.

First enter the header information...

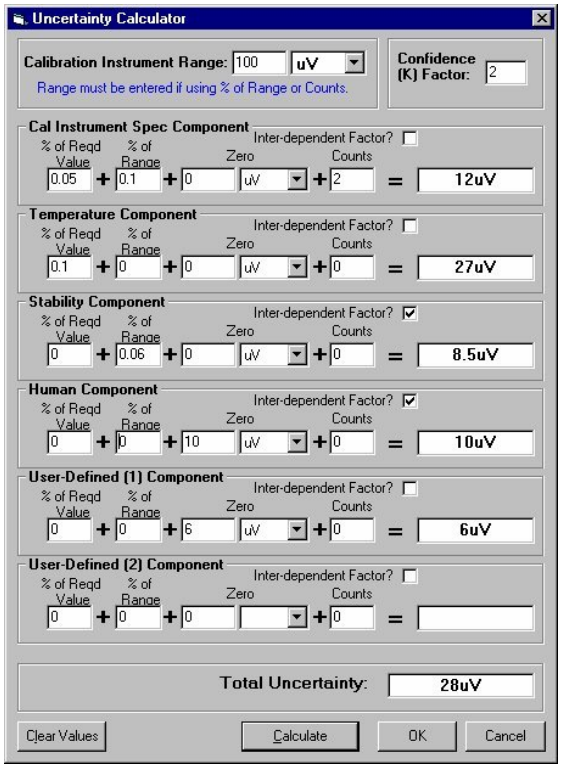


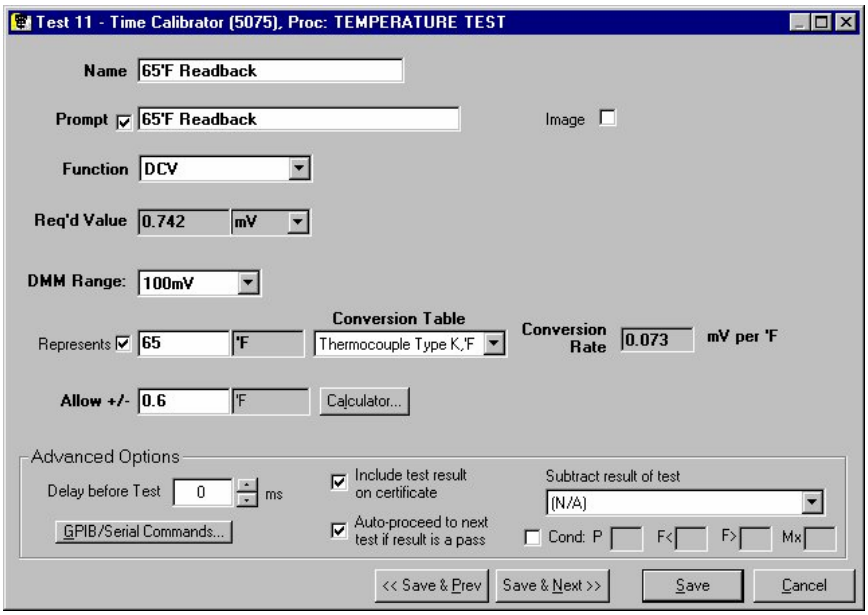


...Now enter the details of each test.

Intuitive screens make test entry a breeze...

...and the EasyCal Uncertainties Calculator makes manual computation a thing of the past!

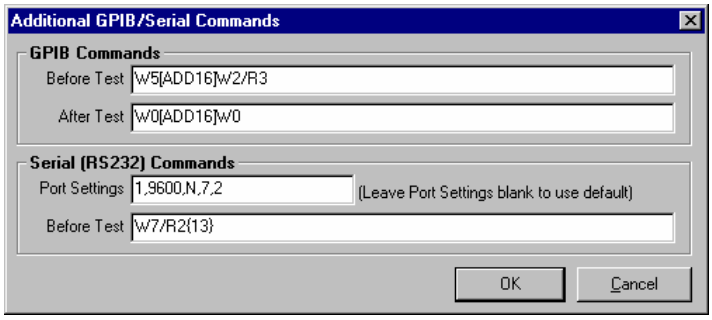


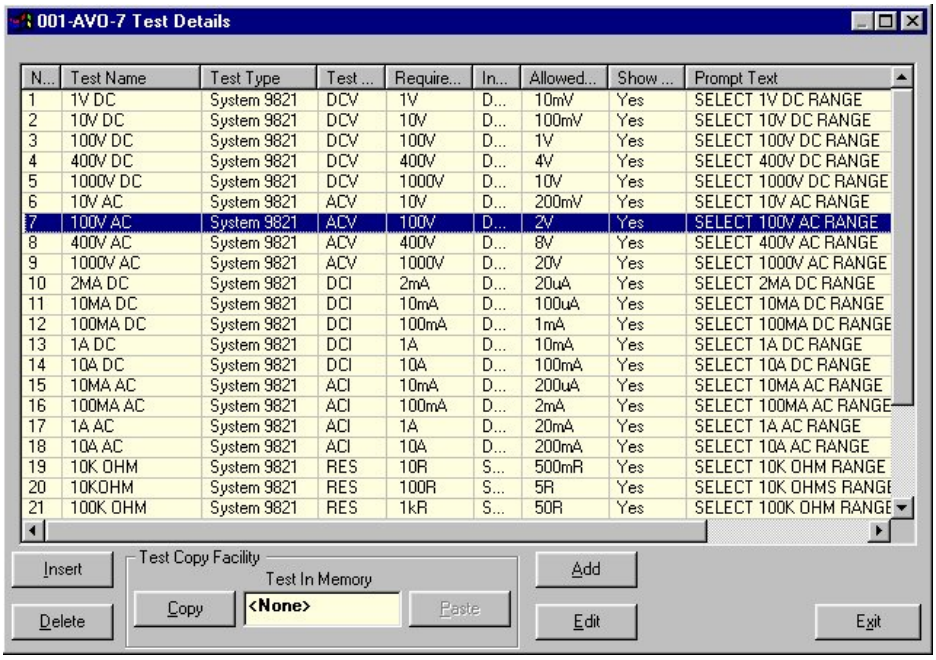


Advanced options such as readback make closed loop calibration possible.

While conversion tables allow you to calibrate in any units you require!

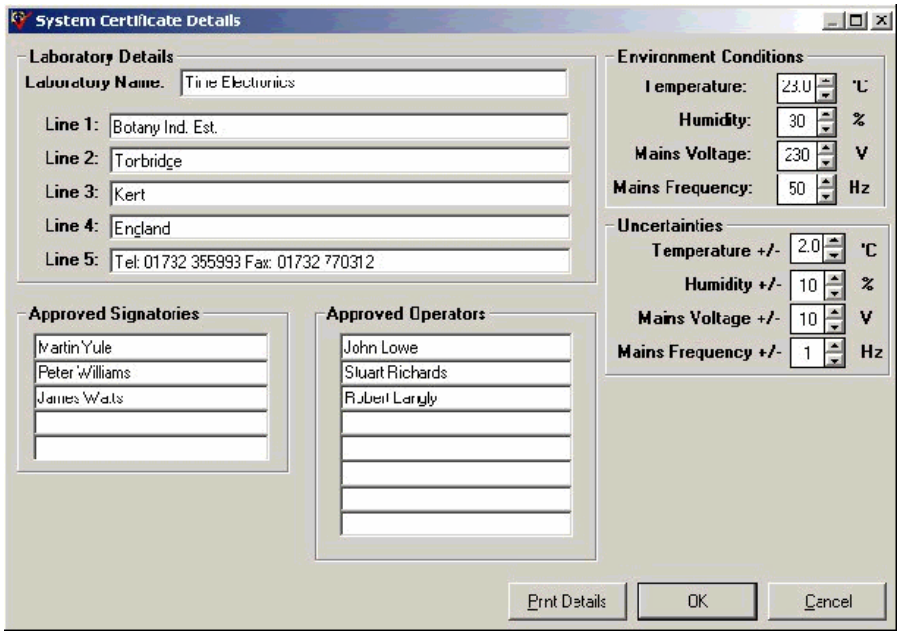
Control any instrument that is equipped with either a GPIB or RS232 interface

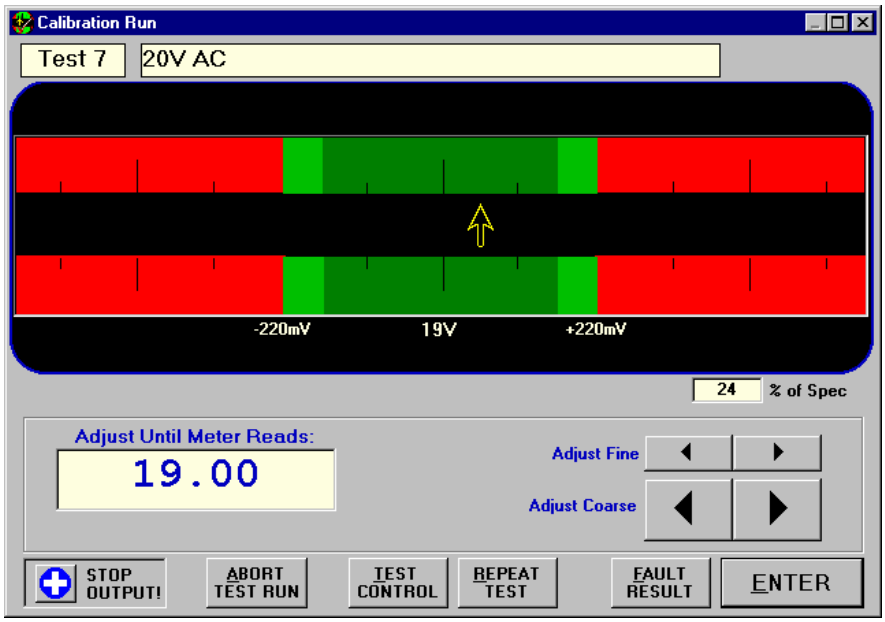




Once entered, your tests can be reviewed, edited and printed with ease

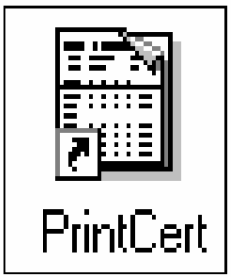
Configure the Calibration Certificates to your requirements





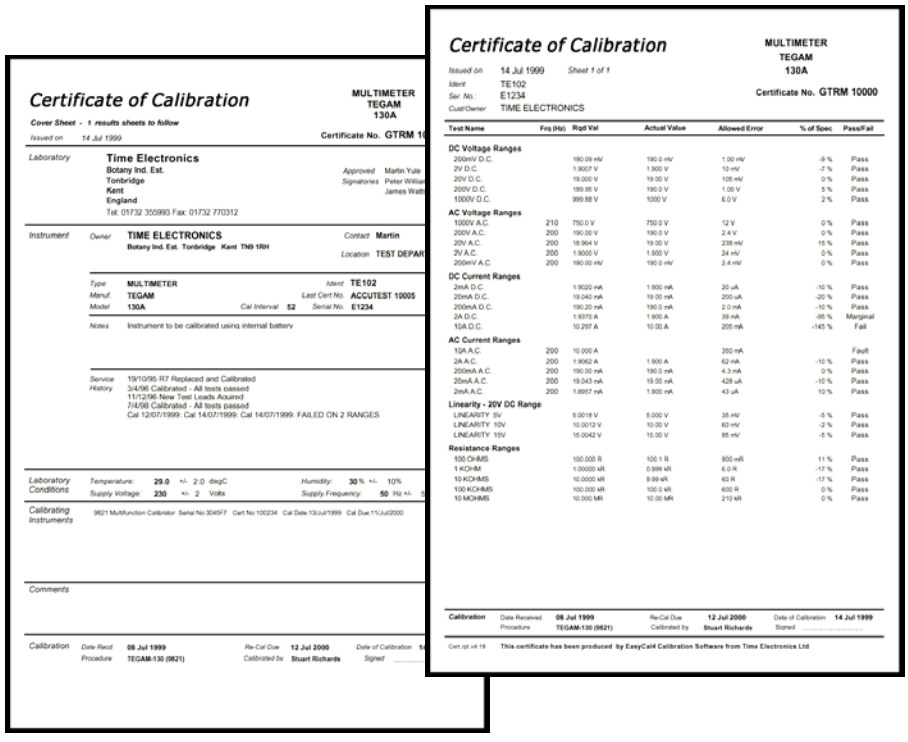
Calibration runs are quick and painless with EasyCal's CalRun

The deviation screen opposite shows nominal value and upper and lower limits. Marginal pass area is clearly identified in another colour.



Now print your certificate and store the results.

Certificate layout is user-customiseable thanks to industry-standard software Crystal Reports



CalMan — EasyCal's Calibration Manager

A range of instrument search functions are provided to speed up identification of any instrument on the database.

Searches can be performed by dates, amongst other parameters. The selection of instruments due for calibration is also done via this function, the user inputs the number of weeks notice required.

A list of instruments due for calibration is then shown. The reminder list/ letters are printed out using the final icon shown below.

New Instrument.
A window will appear allowing a new instrument to be created in the data base.

Edit Instrument.
A window will appear allowing the selected instrument's details to be edited.

Print Instrument Details.
This prints the details for an individual instrument.

Print Instrument List.
A full listing of all the instruments in the list will be printed.

Print Calibration Label.
If the instrument has been calibrated using the EasyCal 4 system a calibration label can be produced.

Ident Label.
An instrument identification label will be printed. This includes a barcode.

Address Label.
An address label using the customer details will be printed.

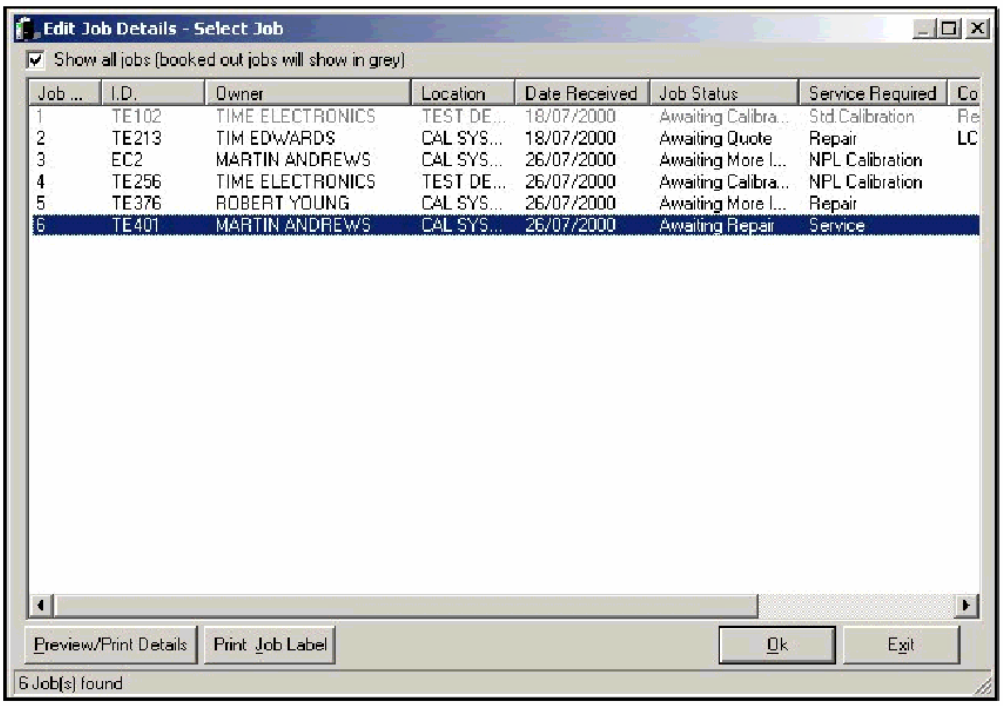
Site Cal.
SiteCal is a program suitable for users who have to undertake calibration work on site ie the calibrating equipment to be taken to the place where the instruments are located. The program not only produces a list of the equipment to be taken but also provides pre-cal sheets which are suitable for recording the results of the various calibrations to be done.

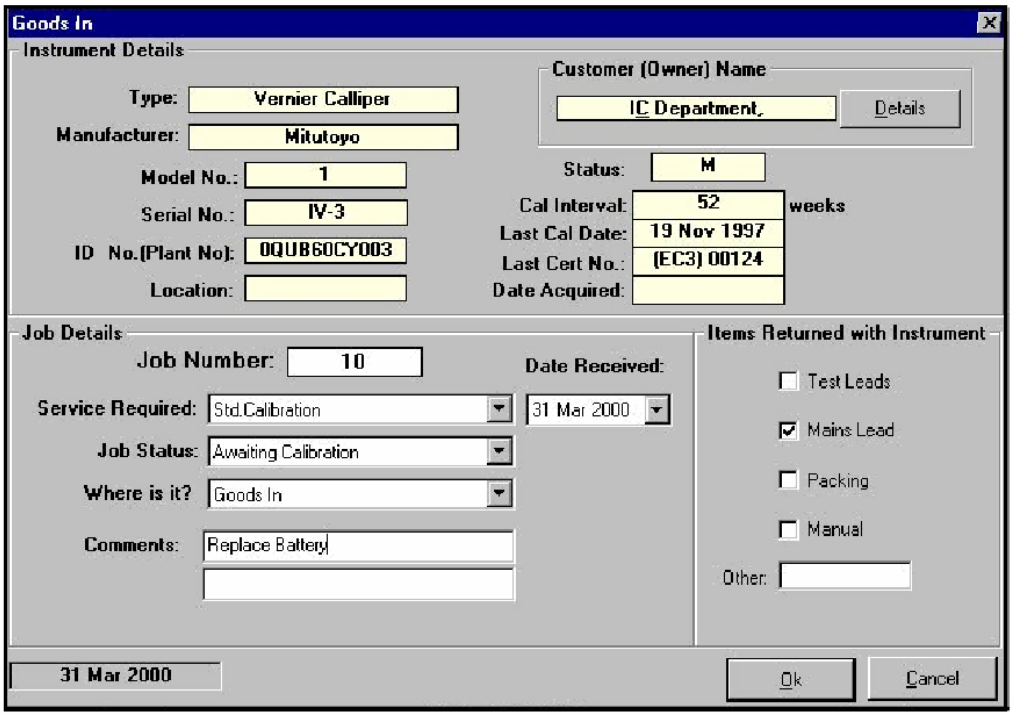
Print PreCal Sheet.
The PreCal sheet allows hand written results to be taken for a calibration. When available the results from the previous calibration of the instrument will also be printed.

Print Reminder List/Letters.
When a list of 'calibrations due' is produced this option made is available. From here either reminder letters or a list can be produced. The letters or lists can be grouped in 4 different ways.

Calibration/Repair Job Control

Keep track of your calibration/ repair work with CalMan's Job database





Instrument status and location are recorded via screens such as "Goods In"

Chapter 9. Calibration Adjustment

If the 9823 needs a adjustment during a recommended yearly calibration procedure, or the calibration factors have because corrupted, the calibration adjustment procedure should be performed to store a new set of calibration factors.

The calibration adjustment procedure will need suitable calibrating instruments and standards. The calibration key supplied with 9823 is also required to enable changes in the calibration memory.

Please refer to the ‘9823 Calibration adjustment procedure’ manual for detailed notes and instruction on performing this operation.

Chapter 10. Spare Parts

Spare parts for the 9823 can be ordered, the table below indicates each items ordering code. When ordering spare parts it is necessary to state the serial number of the instrument.
Please note that in some cases if a design has been superseded, the latest version will be supplied.

ITEM	ORDER CODE
12 V Relay (S2)	6314
12 V Relay (S4)	6312
8 way D.I.L. switch	6306
IEEE Connector	6420
Mains Fuse 800 mA	6128
Mains Fuse 1.6 A	6130
Fuse 5/8” 250 mA	6102
Fuse 20 mm 2 A	6111
Fuse 20 mm 2.5 A	6122
IEEE Driver (3448)	4555
IEEE Interface (68488)	4556
Crystal (3.2768 MHz)	4559
Microprocessor (6802)	4583
PIA (68A21)	4585
12 Bit timer (14040)	4590
Press switch with LED	6452
7 Seg LED	4631
Display Driver ICM7218A	4592
LED Driver 74LS273	4594
K/B Encoder 74C923	4595
Non Volatile RAM	4566
Terminal Red	6224
Terminal Black	6225
Fan	7504
A.C. Converter Board	9418
Current Converter Board	9421
D to A Converter Board	9403
H.V. Board	9415
IEEE Board	9573
uP Board	9574
Power Module	9429
Reference Board	9404
Resistance Board	9414
10 Amp Board	9428

Chapter 11. Guarantee and service facilities

The unit is guaranteed for a period of two years from its delivery to the purchaser.

We maintain comprehensive after sales facilities and the unit can, if necessary, be returned to us (or our authorised dealer) for servicing. The type and serial number should always be quoted, together with details of any fault, and the service required.

Time Electronics can re-calibrate your instrument and issue a 5 page calibration certificate, traceable to N.P.L. or alternatively obtain a B.C.S. certificate.

If a fault can be traced to board level, Time Electronics offer an exchange service for all Printed Circuit Boards in this instrument. (See Chapter 10. Spare Parts).

Equipment returned to us for servicing must be adequately packed, preferably in the special box supplied, and shipped with transportation charges prepaid. WE CAN ACCEPT NO RESPONSIBILITY FOR INSTRUMENTS ARRIVING DAMAGED. Should the cause of failure during the guarantee period be due to misuse or abuse of the unit, or if the guarantee period has expired, the repair will be put in hand without delay, and charged unless other instructions are received.

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Website: www.TimeElectronics.co.uk