

9814 Programmable D.C. Voltage Calibrator

Technical Manual



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

Section 1 - Introduction

The 9814 is a high performance programmable D.C. voltage calibrator. By combining the latest microprocessor and linear circuit technology exceptional long term stability has been achieved. Computer selection of the basic reference device combined with high performance precision resistors ensure a guaranteed 50 ppm/year stability.

The 9814 therefore maintains Time Electronics' high standard of stability and allows the customer complete confidence in the instruments long term performance. Construction is modular and is based on the standard Euro card frame. Each main section i.e. Microprocessor control, IEEE interface, D-A converter, Reference amplifier etc. are located on a separate plug in Euro board. All boards are easily accessible form the rear of the instrument.

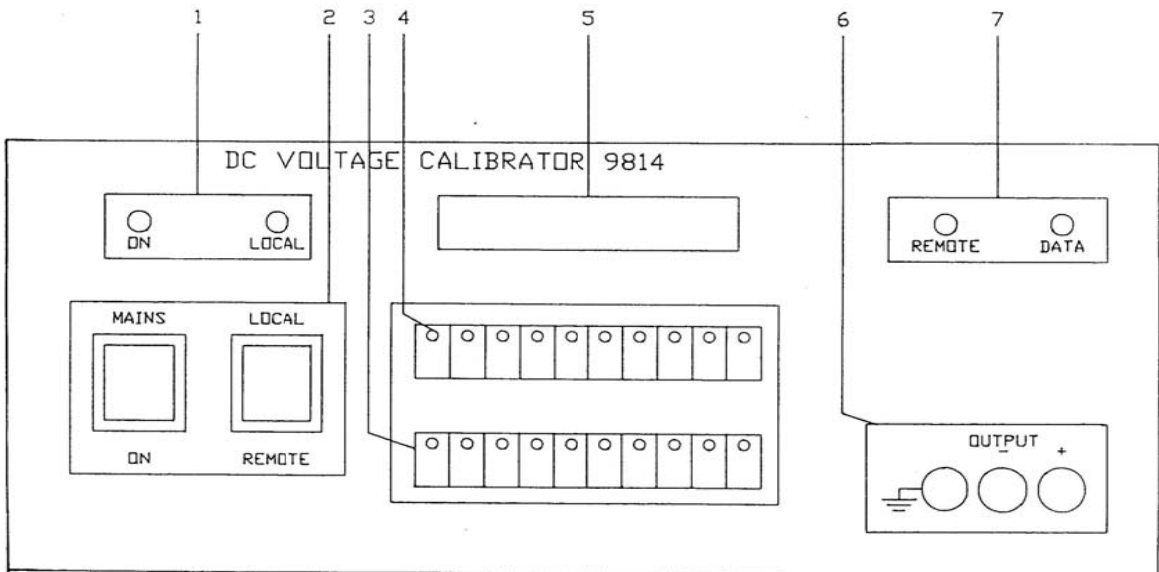
The 9814 can if required be operated in a manual mode with all controls located on the front panel.

Section 2 - Specifications

Output:	0 to 10V in 4 ranges
D.C. Accuracy:	
10V & 1V Ranges:	0.01% of setting, +/- 0.001% of range, +/-3uV
100mV & 10mV ranges:	0.02% of setting, +/- 0.005% of range, +/-2uV.
Output resistance:	10 mohms on 10V & 1V ranges. 10 ohms on 100mV and 10mV ranges.
Output current:	Internally adjustable between 200mA and 20mA on 1V and 10V ranges. On the 100mV and 10mV ranges the limit is the short circuit current, but loads of greater than 1 Kohm will cause errors of greater than 0.1% error in the output voltage.
Output Polarity:	True bi-polar output is provided. i.e. the 'Lo' output terminal can remain at earth for all output values and and polarities. This eliminates common mode errors or the need to reverse the input connections.
Temperature coefficient:	20ppm/°C on all ranges.
Noise:	4ppm of full scale.
Overload:	Continuous short circuit can be withstood on all ranges.
Settling time:	Less than 1ms between 0 and full scale. Less than 50ms with range change.
Power requirements:	220 - 240V A.C. 50 Hz OR 110 - 120V A.C. 60 Hz Switch selectable.
Interface:	IEEE-488.
Dimensions:	123 x 632 x 110mm. Weight 5Kg.

Section 3 - Front Panel Controls

- 1) 2 LEDS
 - A) ON Illuminates when unit is on
 - B) LOCAL Illuminates when unit is in LOCAL mode
- 2) 2 PRESS SWITCHES
 - A) MAINS / ON
 - B) LOCAL / REMOTE
- 3) 20 PRESS SWITCHES
 - Select range, output level and polarity
- 4) 20 LED STATUS
 - Indicates range and operating mode.
- 5) 8 DIGIT LED
 - Shows output and polarity
- 6) 3 TERMINALS
 - Output
- 7) 2 LEDS
 - A) REMOTE Illuminates when REMOTE is selected.
 - B) DATA Flashes once when a complete command has been received.



Section 4 - Local Operation

Mains Voltage Selection

Situated at the rear of the 9814 on the power module, are the mains inlet socket, two fuses and the voltage selector. The mains voltage is displayed in a small window. Access to the fuses and mains selector is via a lever down flap. To change the mains voltage, switch off the mains, open the flap and rotate the selector to the required value. Replace the selector and close the flap.

Switching On

At Power on, the 9814 will automatically switch to the 10mV D.C. range and select zero output.

If ERROR 6 is displayed, the calibration factors have been lost and the unit will need to be recalibrated. See section 8.

Important Note:-

The 9814 should not normally be operated with the IEEE address 0 or 16 set, or with the calibration key in. These addresses are reserved for autocal recalibration. Operation in this condition may result in the loss of the calibration factors.

Operation

Manual operation of the 9814 is always enabled by setting the instrument into LOCAL mode and selecting the required function.

Selecting a range and output value

- 1) Press SELECT
- 2) Press a RANGE key. (10V to 10mV).
- 3) Press + or—switch to select output polarity.
- 4) Press switches marked with upward or downward arrows to increment or decrement the output.
- 5) Full scale or zero output can be selected directly by pressing the F.S. or zero keys.

Zero Offset and Deviation

(a) Offset

Set up the offset required as an output as described above. Then press SELECT followed by ZERO. 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 the offset, press SELECT and re-select a range.

(b) Percentage deviation

This can be applied to the output as follows:-

Press the DEV key. The display will change to a 4-digit format indicating percentage deviation. This can be set in the range +9.999% to -9.999% by pressing the arrowed increment or decrement switches. To return to the normal output display, press the DEV key again. When a deviation has been set, the LED on the DEV key will flash as a reminder that a deviation is being applied to the output.

To cancel deviation mode, press SELECT and re-select a range, or zero the deviation and press the deviation key to return to the normal output display.

Selecting a user function

Operation of the SELECT key followed by DEV offers 2 user selectable functions. The user function display shows the functions on digits 2, 4, 6, 7 and 8 reading left to right. Only digits 6 and 8 are used on the 9814. The mode is incremented using the arrowed key beneath the function digit. The following paragraphs correspond to digit numbers and explain each of the functions and associated modes.

Default display:-

0 0 301

Digit 6 : Keyboard Operating Modes

This function allows 4 different modes of carry-over with or without auto-repeat as shown in Table 4.2. Selection of the carry-over function enables a 9 to 10 carry-over. Without it, the carry-over will be 9 to 0.

Table 4.2 Keyboard Operating Modes

<u>MODE</u>	<u>CARRY OVER</u>	<u>AUTO REPEAT</u>
0	N	N
1	Y	N
2	N	Y
3	Y	Y

The auto-repeat facility, available in modes 2 or 3, gives continuous repetition of the held down key.

Digit 8 : Output error modes

The 9814 will display 'OP ERROR' (output error) when it is unable to drive the load with the selected output.

NOTE

Output errors are not detected on the 10mV and 100mV ranges.

The user can select one of 4 ways in which the 9814 will respond to an output error detailed below.

Mode 1. The output will be set to zero immediately and 'OP ERROR' displayed. To continue using the 9814, 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 9814 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 9814 will continue to drive the output circuits and 'OP ERROR' will be displayed after 0.5 seconds.

Self Test Mode

To select self test mode, set all 8 IEEE switches (on rear of 9814) to the ON position before switching on the instrument.

When switched on, the 9814 will carry out an internal test sequence as follows. Each segment of the 8 digit display will light in turn, followed by all the front panel LED's (with the exception of the F.S., ZERO, + & - LEDS which are not tested). If no errors are detected, the word PASS will appear on the display.

If an error is detected, the word ERROR followed with a number from 1 to 6 will be displayed. The meaning of these numbers is explained in Table 4.3

Table 4.3. Fault displays

<u>NUMBER</u>	<u>FAULT</u>	<u>REPLACE</u>
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)

See section 7 for details of board replacement.

*** Error 6**

This test is carried out every time the 9814 is switched on regardless of the IEEE address. If the calibration factors are corrupted ERROR 6 will be displayed. To clear this condition, run the self test with the calibration key plugged in. This exercise leaves the cal ram empty so re-calibration is required. (see section 8).

If ERROR 6 persists, then change the non-volatile RAM.

NOTE: Running self test with the calibration key plugged in will result in the loss of calibration data.

To exit from self test mode, turn the 9814 off, set the unit address on the IEEE switches and switch on again.

Section 5 - Remote Operation

Introduction

The IEEE-488 interface sometimes called GPIB (General Purpose Interface Bus) or HPIB (Hewlett Packard Interface Bus) allows remote control of the 9814 by a suitable computer. Repetitive calibration work can be speedily and accurately carried out giving printed results if required.

The IEEE-488 defines a complete interface system for the interconnecting of instruments and computers using a bit parallel, byte serial bi-direction bus.

Protocols, connections and cables are also defined, enabling computer controlled systems to be quickly realised.

The main limitations of the IEEE are:-

- 1). A maximum of 15 devices on the bus.
- 2). The maximum bus length should not be greater than 20m or number of devices x2, which ever is the shorter.

Data Transfer and Device Addressing

Before a controller can send data it has to identify the recipient. Each device on the 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. Set baud rates are unnecessary with the system.

Further information on the IEEE-488 can be found in the condensed description of the Hewlett Packard Interface Bus.

IEEE Cables/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 5.1 for details of connections.

Cables used on IEEE systems are available in various lengths to suit different layouts.

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

IEC Bus Connections

A user requiring to connect the 9814 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 5.1 compares the pin designations for each standard.

IEEE Connector

The pin connections and dimensions of the IEEE connector are illustrated in Table 5.1 and Fig. 5.1

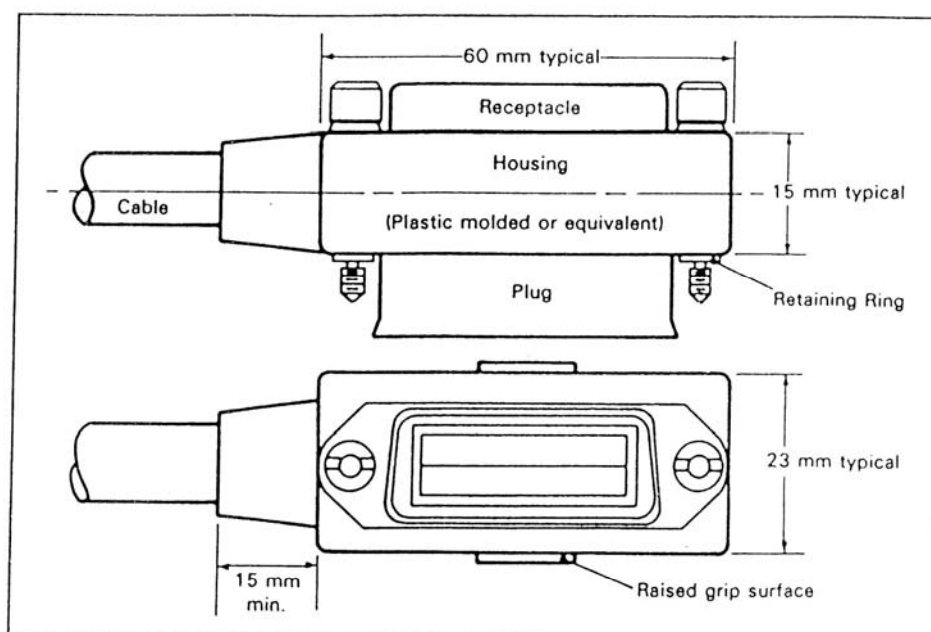


Fig. 5.1 I.E.E.E. CONNECTOR

Table 5.1 Comparison of pin designations IEEE/IEC

<u>IEEE Standard</u>		<u>IEC Standard</u>	
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 END	24	GND 11

IEEE Address selection

Before operating the 9814 over the IEEE, set the address on the rear of the unit to the required address and operating mode.

Addresses 0 and 16 are reserved for recalibration in AUTO-CAL mode and should not be used unless recalibrating the instrument. Address 31 is used to select self test mode.

The eight switches are read only when the 9814 is first switched 'ON'. Therefore it is necessary to turn the 9814 'OFF' if a new IEEE address is required.

Table 5.2 IEEE Address selection

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		

A '1' in the table corresponds to the left (on) position of the switch. Switch 1 (top) selects the least significant bit. The lower three switches, which are normally set to the off position, are used to select the 9814 operating modes as follows:

Switch 6 - IEEE talk (transmit) mode.

Switch 7 - IEEE listen (receive) mode.

Switch 8 - Dual Primary Addressing mode In this mode, the 9814 will respond to two primary addresses differing only in the least significant bit. For example, if the unit address selection switches are set for an address of 8, the unit will also respond to address 9.

NOTE: The 9814 only looks at the address switch at power up.

IEEE Commands

Local lockout

The front LOCAL/REMOTE switch must be in the remote position for IEEE operation. The 9814 will not respond to any IEEE commands when sent to local.

Interface clear command IFC

This command initiates a complete reset of the 9814, 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 9814.

The commands must be in one of the following formats:

1. A single uppercase 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 IEEE command can be executed 4 conditions must be met.

1. The 9814 must be switched to 'remote' on the front panel.
2. IEEE cable and controller connected. The 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.

IEEE command list

D	Transmit display to bus controller bus controller.
E1 to E4	Select 9814 action upon output error detection.
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.
Pn	Change output by 'n' percent.
R1 to R4	Select range from 10mV to 10 V R1 - 10mV R2 - 100mV R3 - 1V R4 - 10V
T1 or T2	Set terminator character appended to a transmission.
Z	Take present output as Zero Offset.
/	Command separator.

Description of commands

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 9814 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 IEEE bus to hang.

The terminator is controller dependent and the 9814 allows either CR or LF to be used, as determined by the 9814 Command T1 or T2. Note that the T1 or T2 command (terminating setting) must be done before the 'D' command is executed.

When the 9814 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.

EXAMPLE: (CBM BASIC)

```
10  OPEN 1,7                  :REM OPEN 9814 ADDRESS 7
20  PRINT # 1,'H'             :REM SET OUTPUT TO F. SCALE
30  END                        :REM END
```

Command I

Sets the 9814 to generate a serial poll request for service by the bus controller should an 'OP ERROR' arise. (Auto-cal units only)

EXAMPLE (HP BASIC)

```

10  REMOTE 708           !OPEN IEEE ADDRESS 8
20  OUTPUT 708 ; "I"    !SET 9814 TO GENERATE SERIAL POLL REQUEST ON
                        !OUTPUT ERROR
30  OUTPUT 708 ; "E4/R4/2" !SET ERROR MODE, 10V RANGE WITH 2 VOLTS
                        !OUTPUT
40  ON INTR 7 GOSUB 100  !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' on the present range.

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 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.

Letter and number command**E1 to E4 output error mode**

Selects one of 4 possible error modes which determine the action taken by the 9814 on detection of an output error.

E1: (default). Display 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.

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"     !SET 9814 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 - Set the 9814 to respond to front panel control
 K2 - Disables front panel controls

P (n) set percentage deviation

Set deviation on present output in range +9.999 and -9.999.

EXAMPLE (CBM BASIC)

```

10  PRINT #1,"P3.456"    REM SET output 3.456% high
20  PRINT #1,"P-0.02"   REM SET output 0.02% low
  
```

R1 to R4 range setting commands

Selects a voltage range from IEEE command table.

<u>COMMAND SELECTED</u>	<u>RANGE</u>	<u>PROGRAM IN</u>
R1	10mV	mVolts
R2	100Mv	mVolts
R3	1V	Volts
R4	10V	Volts

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 9814

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

Setting an output value

Transmit the voltage or current required as an ASCII string.

EXAMPLES (HP BASIC) on the 1 volt range (R3)

OUTPUT 708;2-0.3765"

!SET OUTPUT TO -0.3765 VOLTS

OUTPUT 708;"1.9"

*!SETS OUTPUT TO OVER-RANGE DISPLAY SHOWS
! 1....., OUTPUT SET TO APPROX 1.3 VOLTS.*

OUTPUT 708;"0.0000007"

*!SETS OUTPUT TO ZERO, TO MANY DECIMAL
PLACES*

Notes:

1. The 7th digit is always rounded to 0 or 5.
2. The output limit of any range is 1250000

Section 6 - Fault Diagnosis

Introduction

This section gives details of some possible problems, and how to correct them. Spares parts are available from Time Electronics and are listed in Section 9. If the fault is not listed or if parts required are not listed, please enquire quoting type and serial number, and giving details of the fault where possible.

Fault check list

- 1) If the 9814 is completely dead with no front panel lights, check the following:
 - a) Mains supply.
 - b) Mains fuse blown in plug.
 - c) Mains fuse blown in combination appliance inlet.
 - d) Internal fuses blown (see fuse replacement).

- 2) If unit responds to manual control but not to IEEE control and the data light does not flash, check the following:
 - a) Defective IEEE cable.
 - b) 9814 incorrectly addressed.
 - c) Incorrect terminating characters.
 - d) Processor board not correctly plugged in.

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

- 4) Unit powers up but not working correctly.
 - a) Run Self Test. See table 4.3 for error codes.

- 5) Unit displays ERROR 6.
 - a) Cal RAM corrupted.

- 6) Unit occasionally resets to power on (10mV range) condition and makes a short bleep.
 - a) Mains interference is causing the microprocessor to stop, tripping the watchdog circuitry to give an automatic restart. Additional mains filtering required.

Fuse replacement

Three types of fuse are used in the 9814

- 1) 2 AMP 20mm quick blow - 5V supply
- 2) 2 AMP 20mm anti surge - Mains input
- 3) 2.5 AMP 20mm anti surge - 18V supply

Replacement fuses are available from Time Electronics and R.S. Components. See SECTION 9 (Spare Parts) for order details.

Fuse location and replacement procedure

- 1) The 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.
- 2) 5V supply:- The 5V supply fuse is mounted on the left hand printed circuit board of the power unit.
- 3) +/- 18V fuses:- These fuses are mounted on the right hand printed circuit board of the power unit.

Main Frame

The 9814 is constructed on a 19 inch Euro-card 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.

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.

Replacement of IEEE and Processor Boards

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.

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.

Section 7 - Technical Description

Introduction

This section contains a brief technical description of the 9814, starting with the mainframe and associated modules, followed by the plug-in boards.

The technical description is divided into the following parts:

1. The Mainframe
2. The Front Panel Electronics Board
3. The Power Module
4. The IEEE Interface Board
5. Microprocessor Board
6. Reference Board
7. Digital to Analogue Board and Module

Mainframe

A 19" Eurocard frame houses all boards and modules which plug into a 64 way bus via DIN 41612 type connectors.

The Front Panel Electronics Board

The microprocessor reads the keypad and drives the display through a 74C923 keypad encoder and an ICN 7218 8 digit display driver respectively. Two 8 bit latches on the data bus drive the L.E.D's above the switches.

Address decoding for these I.C's is performed by a 74LS138 and a 7400 also on the P.C.B.

Power Module

The power module contains a 100VA rated mains transformer, DC regulated supplies and select circuitry for the LOCAL/REMOTE switch and indicators.

The mains transformer has two 120V RMS primary windings and 9V, 11V and two 22V RMS secondary windings.

The 9V winding connects, via a 2A fuse, to a full wave bridge rectifier and smoothing capacitor. It supplies a regulated 5V DC at 1A for the microprocessor board, the IEEE board and front panel display.

The 11V supply is full wave rectified to supply an unregulated 14V DC at 1A. An unregulated 5V DC supply derived from this 14V DC drives the circuit relays and can be pulled up to 14V on command for latching the relays.

The 18V supply is rectified and regulated at +/- 18V DC for the analogue circuitry.

The Microprocessor Board

Mounted on the microprocessor board are the microprocessor, its clock, a PROM, the power-on-reset circuitry, address decoding and 32 lines of parallel input/output (I/O).

The microprocessor used in the 9814 is the Motorola MC 6802. A 3.2768MHz crystal, divided down internally by the 6802, supplies the 8192 kHz clock.

Parallel I/O lines is provided with a pull-up resistor.

An on board link provides for the installation of either a 16K (2516), 32K (2532) or 64K (2764) PROM.

The power-on circuitry is a low frequency oscillator held off by the microprocessor stop, the oscillator does not receive a pulse and automatically resets.

Auto-cal models are fitted with a non-volatile RAM (type X2816).

The IEEE Interface Board

The IEEE interface board is constructed around the Motorola MC68488 general purpose interface adaptor (GPIA). The I/O lines of the 68488 are driven through MC3448 drivers. The address select switches are mounted directly on the board and their condition is gated onto the 6802 bus via 74LS244 tristate buffer.

The Reference Board

The encapsulated reference circuitry consists of two precision, aged zener diodes running at their optimum current. The output from these diodes is averaged and amplified supply the master reference voltage of + 13.1072V. This voltage is inverted by a precision inverter to give -13.1072V. Either the positive or negative reference voltage is applied to the output by a low thermal FET switch controlled by a logic input.

The reference voltage is split to drive two D/A convertors:

- a) The 12 bit monolithic convertor (MPS 7623) mounted on this board via a buffer, an inverter and a calibrator. This convertor makes up the least significant bits and hence is termed the LS bits D/A. A trimmer (LS bits gain) adjusts the magnitude of reference fed to this convertor, while another trimmer (balance) adjusts any offset between the positive and negative reference voltages.
- b) The precision 6-bit D/A convertor on the D/A board.

D/A Convertor Board

This board consists of an encapsulated module and a R-2R resistor ladder network.

This encapsulated module contains logic, buffer amplifiers and switching.

The R-2R resistor ladder consists of high quality low temperature coefficient resistors which have been carefully chosen, both in value and type, to give optimum stability. The value of each resistor can be adjusted by a multi-turn trimmer to give very high linearity. The output from the ladder is buffered and returned to the reference board.

Section 8 - Calibration

Introduction

The automatic calibration (auto-cal) feature of the 9814 enables independent calibration of the zero, positive and negative outputs of all DC ranges either from the front panel or via the IEEE bus. The calibration factors are stored twice in memory and when the 9814 is switched on the factors are compared to check for any corruption. Should an error be found the message ERROR 6 will be displayed on the front panel.

When using auto-cal, all calibration factors may be zeroed and the operation of the calibration memory verified by inserting the CAL key and selecting self test (i.e. all IEEE address switches to the left and switch on). Self test can be run without inserting the CAL key which leaves the calibration factors unchanged.

If the CAL key is inserted when the 9814 is not addressed for auto-cal, the display will flash ERROR 7.

Setting the 9814 into auto-cal mode.

The 9814 is set into auto-cal mode as follows:

1. Switch off and select IEEE address 0 or 16
2. Switch on and insert CAL key. The front panel display will show a flashing C.

Recalibrating from the front panel

All ranges can be calibrated independently or in any sequence, it is necessary to set the zero before adjusting full scales.

1. Select the range to be calibrated.
2. For ZERO calibration, (DC only) set a value on the display which makes the output of the 9814 zero, then press SELECT followed by ZERO which will set the output to zero. Press ZERO again and the display will zero.
3. For FULL SCALE calibration, set the display to full scale or to the value required as the point to check against a standard (e.g. checking the 1V range against a standard cell). Press DEV, adjust the output to the correct value and press DEV again. This saves the calibration factor. The negative full scales are adjusted in the same way

Recalibrating over the IEEE bus

1. Select the range to be calibrated.
2. Set the output to zero by setting a value to cancel the zero error then send command 'Z' to store this value.
3. Set the output to full scale and select deviation required to adjust output to correct value with command 'PX.XXX'. When another command is received the value is saved.

After calibration, carry out the following operations STRICTLY in the order given:

- (a) remove the CAL key
- (b) switch off
- (c) reselect the unit address

Notes:

1. Addresses 0 and 16 only should be used for calibration.
2. If the 9814 is operated in auto-cal mode with the CAL key not inserted, the deviation and offset functions will not work.
3. The IEEE address is only read when the 9814 is first switched on.

Section 9 - Spare Parts

<u>ITEM</u>	<u>ORDER CODE</u>
12v Relay	6314
Key Switch	6362
8 way D.I.L. switch	6306
D/A module	9516
Reference module	9599
IEEE connector	6420
Mains fuse 20mm (1A)	6110
Fuse 20mm (2A)	6111
IEEE driver (3448)	4555
IEEE interface (68488)	4556
Crystal (3.2768 MHz)	4559
Microprocessor (6802)	4583
PIA (6821)	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

Section 10 - Guarantee and Servicing

Guarantee Period

The 9814 is guaranteed against defects in materials and workmanship for a period of one year from its delivery to the customer.

We maintain comprehensive after sales Facilities and the unit can, if necessary be returned to us for servicing.

During this period, we will at our discretion repair or replace the defective item.

For servicing under guarantee, the instrument type and serial number must always be quoted, together with details of any fault and the service required. The purchaser of the instrument must pay all shipping charges to manufacturer. We will pay return shipping charges.

This guarantee is void if servicing has been attempted by an unauthorised person or agent.

If during the guarantee period, failure is due to misuse or abuse of the unit, the repair will be put in hand without delay and charged unless other instructions are received.

We guarantee that the software and firmware for this instrument will execute its programmed function. We do not guarantee that the operation will be uninterrupted or error free.

Please note that if you require a new UKAS Certificate during the warranty period, this will be charged at the current rate on our price list.

Service After Guarantee Period

Even after the guarantee period has expired, we can still recalibrate and service your instrument.

As the manufacturer, we have the specialised knowledge needed to keep your instrument in peak condition and we also maintain a comprehensive spare parts service.

Please enclose details of the service required and your full company details including a contact name.

Returning Instruments

When returning instruments, please ensure that they have been adequately packed, preferably in the original packing supplied. **We will not accept responsibility for units returned damaged.**

Please ensure that all units have details of the service required and all relevant paperwork including contact name, address and telephone number.

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