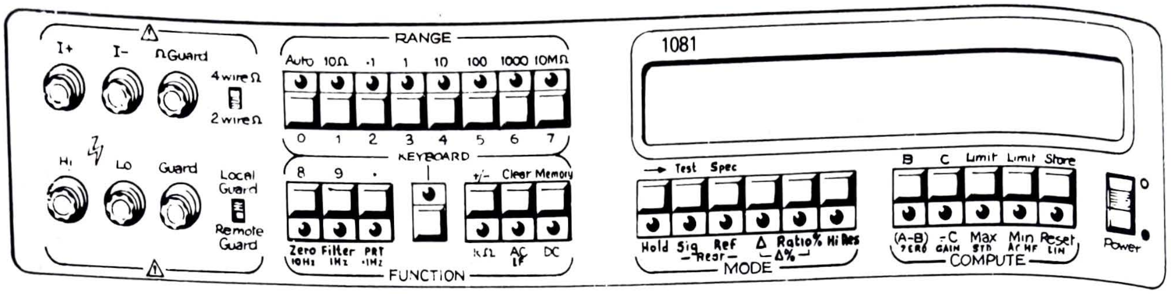
Hi Res mode measurements



Selection of 'Hi Res' with DC or kΩ functions extends the display to 7½ digits and with AC volts a display of 6½ digits is produced.

In this mode, the displayed reading up to the 15th measurement is the mean of all measurements since pressing the 'Hi Res' key. On the 16th and subsequent measurements the displayed reading is the mean of the 16 most recent measurements, and the resolution is increased to 7½ digits. The technique used to achieve this involves internally offsetting each reading from the next by approximately $\frac{1}{16}$ digit before the final displayed reading is obtained. In this way, and providing 'Filter' is selected, a useful increase in accuracy, of typically two times or greater, is achieved. An example of the method is shown diagrammatically in Fig. 3.3.

'Hi Res' deselects 'Auto' ranging. 'Auto' or 'Cal' deselects 'Hi Res'.

To deselect 'Hi Res' mode press the 'Hi Res' key again.

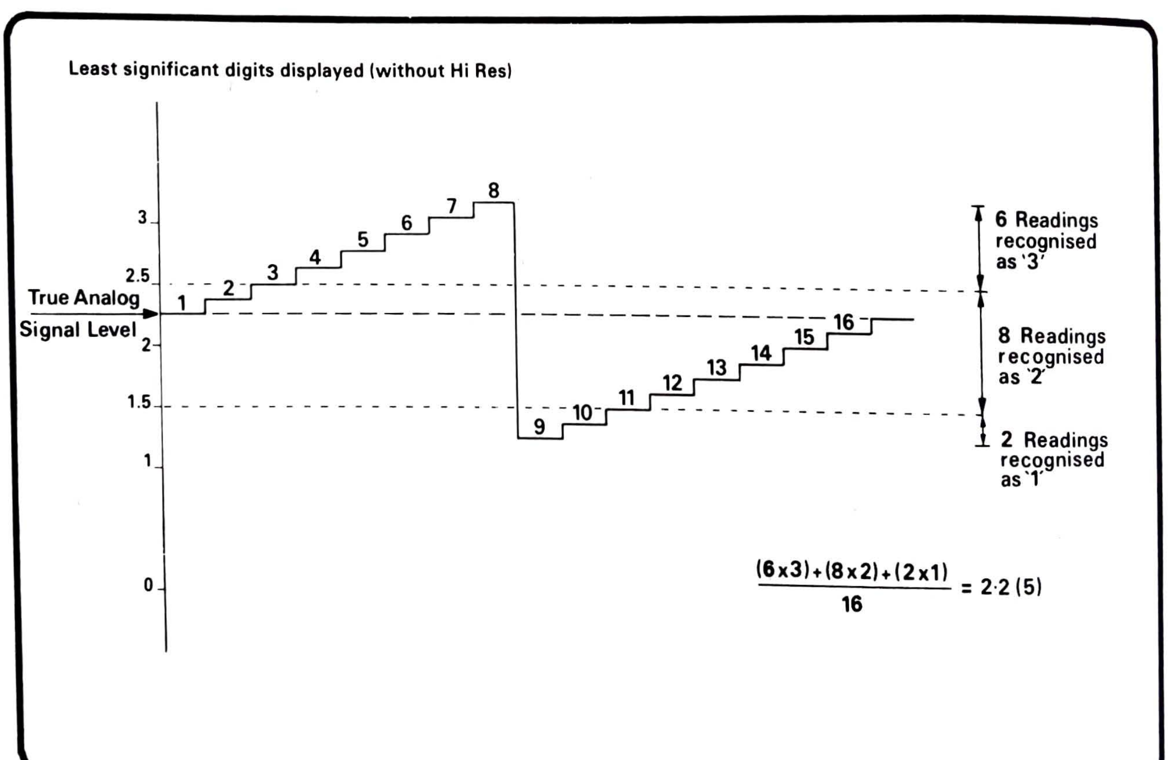


Fig. 3.3 DIAGRAM OF HI RES PROCESS

Other 'Hi Res' modes

In addition to the normal 'Hi Res' mode of averaging, two other methods are available called 'Cont' and 'Block'.

Cont – continuous averaging

This mode is selected by pressing 'Hi Res', then 'Keyboard', 'Ø', 'Store', 'Hi Res'.

The displayed reading is then the arithmetic mean of all the measurements taken since making this selection. An increase in resolution is provided by an extra digit, displayed after the first reading.

The average store has a capacity of 2^{22} measurements, leading to an overflow after approximately 24 days at 2 measurements per second. This store is reset whenever this mode is selected or a range or function change is made.

To deselect 'cont' mode, press the 'Hi Res' key again. Reselection of 'Hi Res' selects Normal 'Hi Res' mode.

Block mode

This mode is selected by pressing 'Hi Res', then 'Keyboard' then a number from 1 to 19,999, then pressing 'Store' 'Hi Res'. This sets the block size to the required number. A 'Block' is a preset number of measurements, taken at the maximum internal read rate, on receipt of a block trigger.

After completing a block of measurements, the 1081 displays and holds a single reading, which is the arithmetic mean of all measurements in the Block.

A 'single shot' block may be performed by using 'Hold' with an external trigger. Subsequent triggers during a block will be ignored. To deselect 'Block' mode press the 'Hi Res' key again. Reselection of 'Hi Res' selects Normal 'Hi Res' mode.

Computation facility

Four compute stores exist labelled B, C and Limits which can be loaded with any number from the display. This means that either a previous reading or a manually entered display using the 'Keyboard' feature can be used. These stores can then be used in a variety of ways to usefully extend the measurement capability of the instrument.

Entry of constants

The secondary use of the range and function keys as a keyboard is achieved by pressing the 'KEYBOARD' key. The display clears, apart from a '0' as the least significant digit. Digits and decimal points are then entered from the keyboard. The sign of the value keyed may be changed at any time by pressing the ' + / – ' key.

If an error is made, the entire display can be cleared by pressing the 'Clear' key.

Recall store

The number in any of the four computational stores may be displayed at any time by pressing the 'KEYBOARD' key, followed by the appropriate 'COMPUTE' key. Pressing 'KEYBOARD' again returns the instrument to the previous setting.

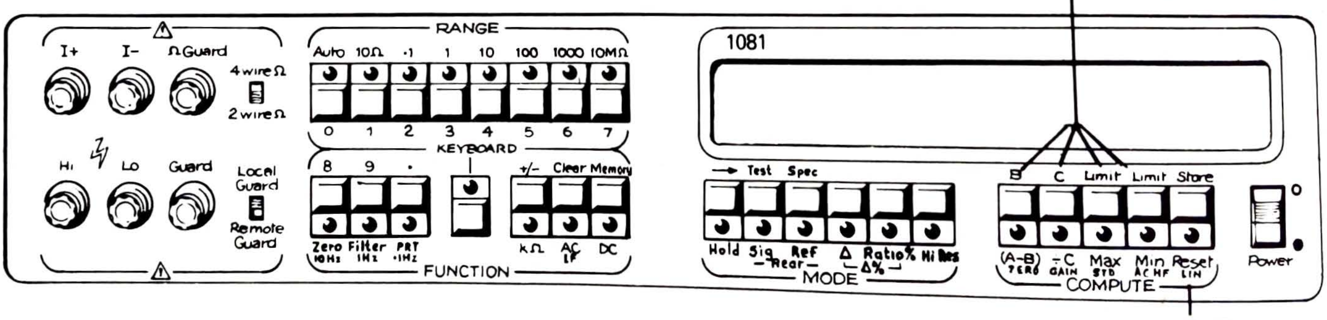
The units of the recalled number are dependent upon the function selected and legend displayed as shown below.

FUNCTION	LEGEND	UNITS
V	NONE	V
	m	mV
	k	kV
kΩ	NONE	kΩ
	m	Ω
	k	MΩ

e.g. with 'kΩ' selected 2.5 recalled indicates a stored value of 2.5kΩ and 2.5k recalled indicates a stored value of 2.5MΩ.

Load/reset store

2. Press B, C or Limit to enter displayed number into store



1. Press 'Reset (Store)'

In order to load a compute store with the displayed number, press the 'Reset (Store)' key followed by the required store location ('B', 'C' Limit (max)' or 'Limit (min)'). The number is then loaded, extinguishing the 'Reset (Store)' LED and returning the instrument to its original setting.

The stored number assumes the units displayed for the range being used i.e. 2.5 entered on the '10kΩ' range results in a stored value of 2.5kΩ and 2.5 entered on the '10MΩ' range results in a stored value of 2.5MΩ.

(A-B)

Pressing the (A-B) key gives measurements a constant offset, B, to be subtracted from the true reading, A. The offset must lie in the range.

$$10^{-7} \leqslant |B| < 2 \times 10^{+7}$$

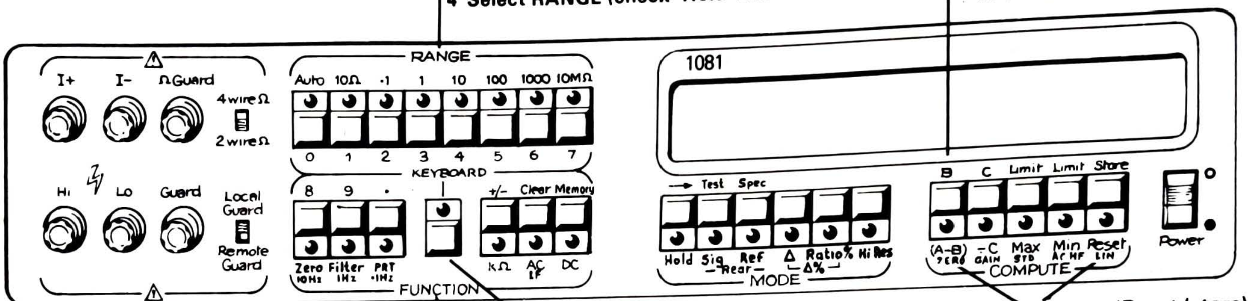
The (A-B) LED is lit to show that the instrument is operating in this mode. Repressing (A-B) returns the instrument to normal operation, with stored value in B for later use.

(A-B) may be used in conjunction with ÷ C, Ratio, and Hi Res mode.

(A-B) procedure: Subtracting an offset from each reading

4 Select RANGE (check 'Hold' LED is out)

5 Press 'B' to give offset to all readings taken



1 Press 'KEYBOARD' and enter required offset

2 Press 'Reset (store)' followed by 'B' to enter number into store B ('Keyboard' and 'Reset (store)' LEDs go out).

3 Select FUNCTION

÷ C

Selection of ÷ C allows measured readings to be divided by a constant C × 100%. The constant must lie in the range

$$10^{-7} \leqslant |C| < 2 \times 10^{+7}$$

(To multiply the measured reading by a constant, enter its reciprocal multiplied by 100 into Store C.)

The ÷ C key LED lit indicates that the instrument is operating in this mode. Repressing ÷ C returns the instrument to normal operation, with the stored value in C for later use.

÷ C may be used in conjunction with (A-B), Ratio and Hi Res mode.

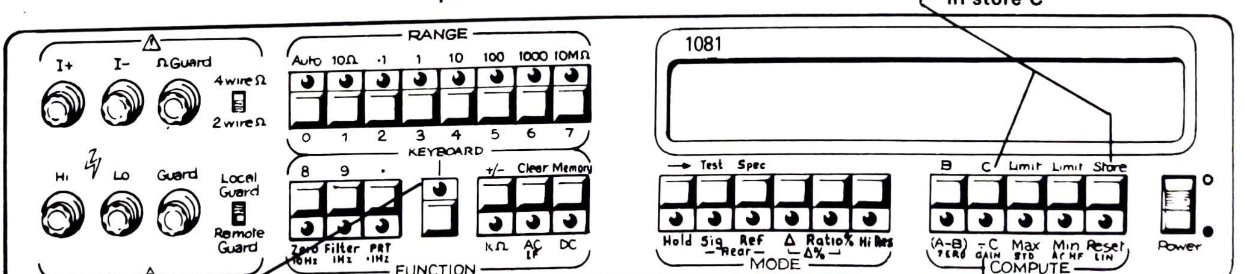
A display of:
Error 1 indicates an arithmetic overflow.
Error 9 indicates an arithmetic underflow.

In either case the value in the C store should be adjusted.

÷ C Procedure: Continuously halve all measurements

4. Select range (check 'Hold' LED is not lit)

2. Press 'Reset (store)' followed by 'C' to enter number 2 in store C



1. Press 'KEYBOARD' and enter number 2

3. Select FUNCTION

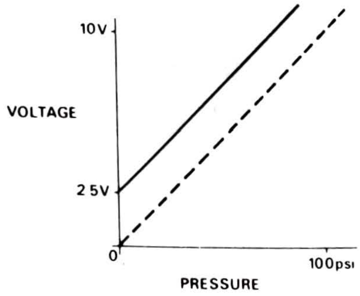
5 Press ÷ C to display halved value of readings

Note: Displayed reading is in %.

Examples of measurement using (A-B) and ÷ C

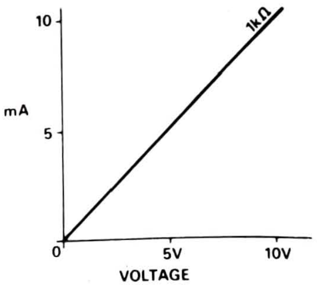
To remove the zero offset of a pressure transducer.

Most pressure transducers have a standard offset of a few volts at 'zero' pressure. This offset may be removed from subsequent readings by storing the constant in store 'B' and placing the instrument into '(A-B)' compute mode.



To compute the current flowing through a known resistance.

Using the simple formula I = V/R the value of I may be obtained by measuring the voltage developed across the resistance. The value of R, say 1kΩ, is placed into store 'C' and the instrument used in the ÷ C compute mode. The displayed reading then indicates the current in milliamps.

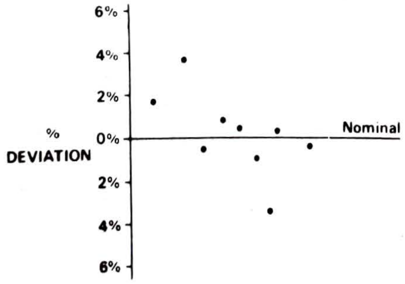


To check a particular component is within its stated tolerance.

Suppose we have a batch of 39kΩ ±5% resistors and we wish to know each resistor's percentage deviation from nominal. The equation

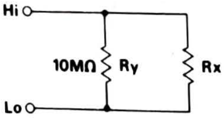
$$\frac{A-N}{N} \times 100$$

gives the percentage deviation from nominal, requiring the entry of the nominal value into both B and C stores. Selecting '(A – B)' and ÷ C compute modes gives a direct read-out of percentage deviation.



To measure a resistance greater than 20MΩ

By connecting a 10MΩ resistor in parallel with Rx and using the '(A – B)' and '÷ C' compute modes large resistances can be measured and displayed.



$$Rx = \frac{Ry\ Rz}{Ry - Rz}$$

Where Rz = Rx in parallel with Ry.

Measure Ry and store in store 'B'.
Select '(A – B)' and measure Rz (display reads Rz-Ry).
Store – 10 (Rz-Ry) in store 'C', using the 'Keyboard' mode and select '÷ C'.
The display now reads Rx in MΩ (% legend displayed) and the accuracy of the reading approximates to the accuracy of the DMM when measuring a value equal to

$$\frac{Rx}{Rz} \times \text{Acc. } Rz$$

Use short screened leads to reduce any errors due to noise.

Max and min

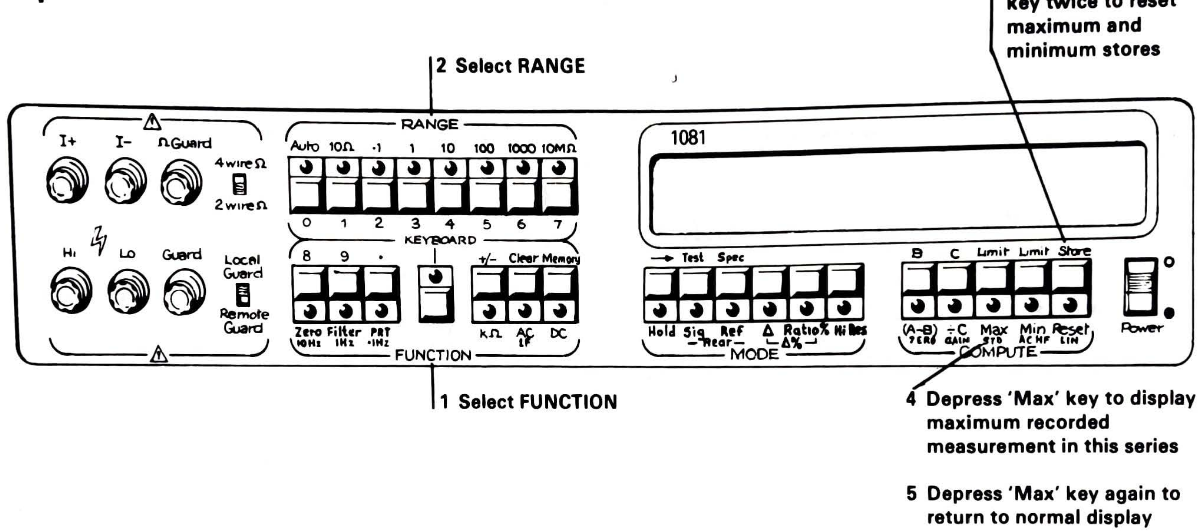
Selection of 'Max' or 'Min' causes the display to indicate the maximum or minimum reading since the stores were last reset. Each time the measured value is outside the current maximum or minimum, the appropriate store is updated.

The 'Max' and 'Min' stores are reset by pressing 'Reset' twice, changing function or passing into or out of 'Ratio' 'Δ' or 'Δ%' mode, after which the maximum and minimum displayed values are again retained and updated.

Simultaneous selection of 'Max' and 'Min' gives a maximum-minimum indication, i.e. a peak to peak indication of the readings since the stores were last reset.

NOTE: 'Limit' operation is also cancelled when the stores are reset.

Max and Min procedure: Displaying the maximum value of a series of inputs



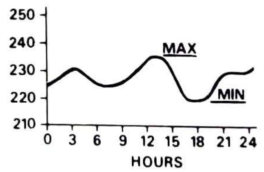
Example of Max and Min measurement

To find the maximum and minimum line supply voltage over 24 hours.

The instrument automatically keeps a record of maximum and minimum readings. Therefore once the DMM voltage has been set to monitor the input voltage (i.e. AC Volts, 1000V range, filter in), the run may be started by clearing the stores (press 'Reset' twice).

During the run the instrument can be set to display individual readings, the maximum or the minimum without store corruption.

On completion of the run, selecting 'Max' or 'Min' causes the instrument to display the maximum or minimum readings respectively.



Limits

High and low limit values are placed into the 'Limit' stores so that when these values are transgressed a display message is shown. Limit operation is cancelled (and the limit values lost) by pressing 'Reset' twice, changing function or passing into or out of 'Ratio %' 'Δ' or 'Δ%'.

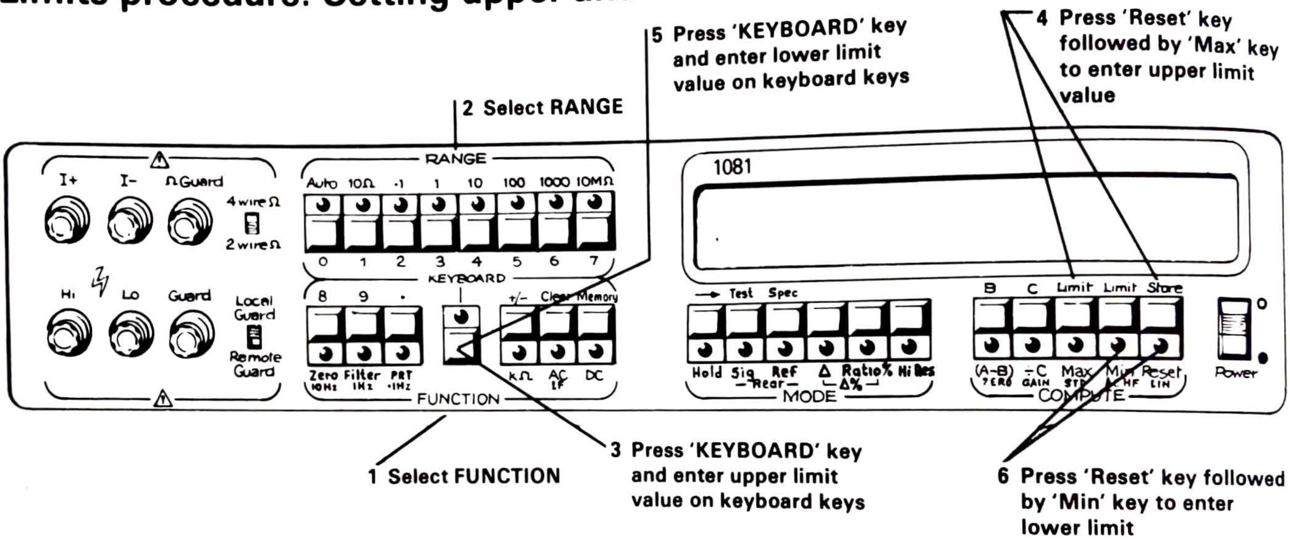
NOTE: 'Max' and 'Min' stores are also reset when cancelling the 'Limit' operation.

The value of a limit can be entered independently of the range selected, i.e. 100.000V limit can be entered with 0.1V range selected.

The display of an out of limit reading is as follows:

Hi Lt – indicates Hi Limit transgressed.
Lo Lt – indicates Lo Limit transgressed.
Err Lt – Lo Limit has been set higher than Hi Limit.

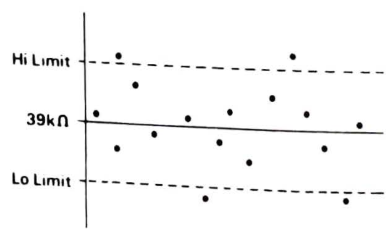
Limits procedure: Setting upper and lower limits



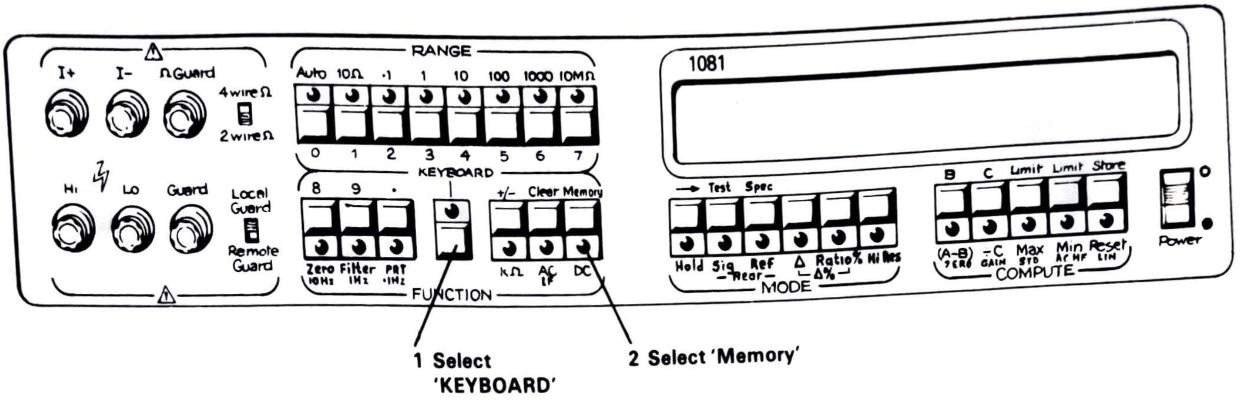
Example of Limit measurement

To use the limit mode for 'in specification' selection.

Consider the fabrication of 39kΩ±5% resistors. To meet the tolerance specification the resistor value must lie in the range 37.05kΩ to 40.95kΩ. The first step is to set the DMM to monitor the resistor value (kΩ, 100kΩ range, 2-wire Ω) then using the keyboard mode, place 37.05 in the min limit and 40.95 in the max limit ('Keyboard' 37.05, 'Reset', 'Min' limit, etc.). The samples may then be measured, the display messages Hi Lt and Lo Lt showing out of tolerance samples.



Recall memory



The 'Memory' store available to the user to retain information such as the last date of calibration, serial number, etc. can be displayed. By selecting 'KEYBOARD' followed by 'Memory' the contents of the eight character store will be shown on the display, e.g. 02.03.82. Normal operation can be restored by pressing 'KEYBOARD' again.

This store can only be loaded with new data when the instrument is in the calibration mode – refer to the Calibration and Servicing Handbook.

SECTION 4 SYSTEMS APPLICATION VIA THE IEEE INTERFACE

The IEEE interface option allows the instrument to form part of a system, outputting measurement data to other parts of that system. In addition, the DMM can be instructed via the interface so that the instrument's facilities can be selected remotely.

In order that instruments from differing manufacturers can be built into the same system, it is necessary that all interfaces are compatible. To ensure this, the interfaces conform to a standard specification as detailed in the publication ANSI/IEEE Std 488-1978 called 'IEEE Standard Digital Interface for Programmable Instrumentation'.

A typical system is shown in Fig. 4.1. The system is driven by a controlling device able to issue commands (controller), receive data (listener) and output data (talker). The DMM is able to receive programming information (listener) and to output data (talker). A device such as a printer or VDU will simply input data (listener), its output not being into the system, but onto paper or the screen. The signal scanner is also a listener only, receiving only commands. Neither its signal input or output are directly connected to the interface bus.

If a system comprises several instruments, the controller is able to communicate with the instruments individually through the assignment to each of a different 'address'. The controller adds information to the address to define either talk or listen.

In the system example (Fig. 4.1), the sequence of events for the task of selection of one of the input signals, measuring it with the DMM and printing the result is as follows:

1. The controller requires to select a signal and therefore must send instructions to the scanner. The instruction must not be received by the DMM or the printer and so the controller sends the general bus message 'unlisten'.

2. To enable the scanner to receive its instructions the controller sends the listen address which has been assigned uniquely to this device. It follows this with the instructions required to select a channel. The instructions are passed along the IEEE bus data lines as coded messages (bytes). The code most normally used is ASCII (American Standard Code for Information Interchange).

3. Since the scanner will take a period of time to change channels it sends a message back to the controller via one of the IEEE bus management lines (SRQ) upon completion. Note that the scanner does not have to be addressed as a talker to return information to the controller via the management lines. This is only necessary if the data lines are to be used.

4. The controller does not know which of the devices generated a message on this management line, since all devices are connected to the same line. To determine the originator, the controller will, by sending messages via the interface, ask or 'poll' all the devices either one by one (serial poll) or together (parallel poll).

5. The controller will determine that the scanner is the source and must send instructions to the DMM so that the correct range and function is selected before the measurement is made. Firstly it must ensure the scanner is not listening since any coded messages sent to the DMM (known as 'device dependent') could be misinterpreted by the scanner.

   Sending 'unlisten' followed by the listen address of the DMM and the required programming instructions achieves the desired result.

6. The DMM requires a period of time to take a measurement and prepare data. It generates a message via the same management line (SRQ) to the controller when it is ready.

7. The controller must again determine which of the devices sent the message (service request SRQ) by conducting a poll.

8. With the reading available, the controller activates the printer with its listen address only, and the DMM with its talk address.

9. When the controller signals the beginning of the transfer, using another of the bus management lines, the DMM will send the data byte

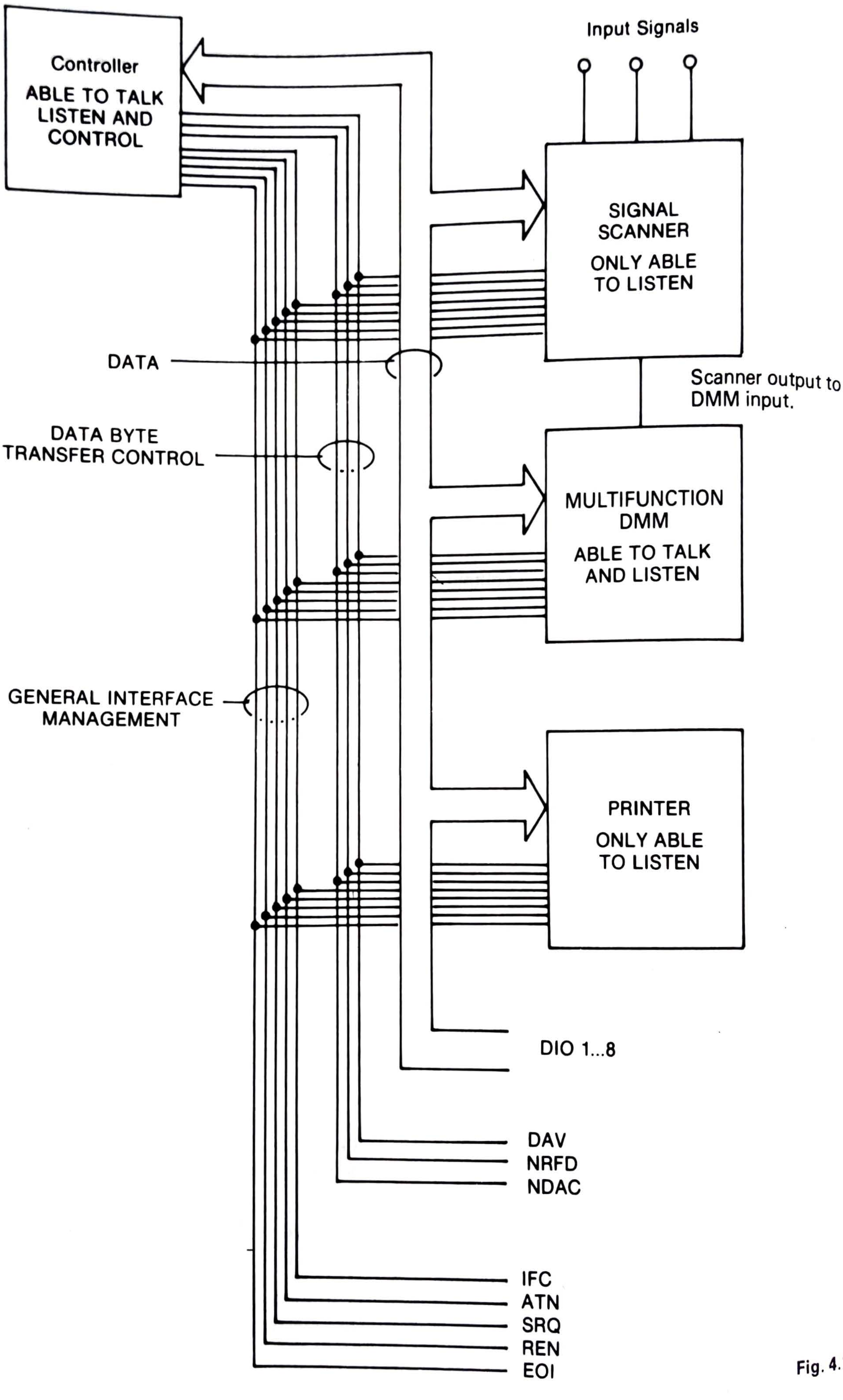

Controller
ABLE TO TALK
LISTEN AND
CONTROL
Input Signals
SIGNAL
SCANNER
ONLY ABLE
TO LISTEN
DATA
Scanner output to
DMM input.
DATA BYTE
TRANSFER CONTROL
MULTIFUNCTION
DMM
ABLE TO TALK
AND LISTEN
GENERAL INTERFACE
MANAGEMENT
PRINTER
ONLY ABLE
TO LISTEN
DIO 1...8
DAV
NRFD
NDAC
IFC
ATN
SRQ
REN
EOI

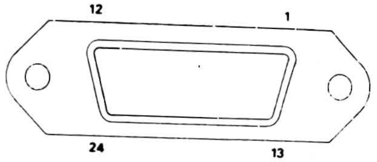
Fig. 4.1

by byte to the printer using the three data byte transfer control lines (handshake lines) to ensure orderly transfer of data between the instruments.

10. Usually the controller is also listening to this data transfer to determine when it is complete. As an aid to the controller and printer, the DMM will send with the last byte to be transferred another message (EOI end or identify) using another of the bus management lines.

11. The sequence is complete and the controller is able to start again using another input signal.

Connecting the 1081 into a system



24 - PIN SOCKET
IEEE 488/1978 INTERFACE
INPUT/OUTPUT

Fig. 4.2

J27 Pin No.	Name	Description
1	DIO 1	Data Input Output Line 1
2	DIO 2	Data Input Output Line 2
3	DIO 3	Data Input Output Line 3
4	DIO 4	Data Input Output Line 4
5	EOI	End of Identify
6	DAV	Data Valid
7	NRFD	Not ready for Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Screening on cable - connected to DMM Safety Ground
13	DIO 5	Data Input Output Line 5
14	DIO 6	Data Input Output Line 6
15	DIO 7	Data Input Output Line 7
16	DIO 8	Data Input Output Line 8
17	REN	Remote Enable
18	GND 6	Gnd wire of twisted pair with DAV
19	GND 7	Gnd wire of twisted pair with NRFD
20	GND 8	Gnd wire of twisted pair with NDAC
21	GND 9	Gnd wire of twisted pair with IFC
22	GND 10	Gnd wire of twisted pair with SRQ
23	GND 11	Gnd wire of twisted pair with ATN
24	GND	DMM logic ground

Table 4.1 IEEE 488/1978 Connector - Pin Designations

Interconnections

Instruments fitted with an IEEE interface are connected together to form a system by using an interconnecting cable as specified in the IEEE Standard 488-1978 document. The connector and pin designations are also standardised and shown in Fig. 4.2 and Table 4.1.

Although the interface specification is called a standard, variations in implementation within the specification are permitted. These variations determine the capabilities of the particular interface and a list of abbreviations are defined in the standard document to indicate to a user which interface capabilities have been designed in. These abbreviations appear on the rear of the instrument beneath the interface connector and are shown in the table below. A fuller description of each code appears in appendix C of the IEEE standard.

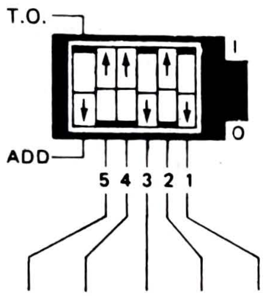
Code	Interface Function
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T5	Talker (basic talker, serial poll, talk only mode, unaddressed to talk if addressed to listen)
TEØ	No Address Extension Talker Mode
L4	Listener (basic listener, unaddressed to listen if addressed to talk).
LEØ	No Address Extension Listener Mode
SR1	Service Request Capability
RL2	Remote/Local Capability (without Local Lockout)
PP1	Parallel Poll Capability (configured by the controller)
DC1	Device Clear Capability
DT1	Device Trigger Capability
CØ	No Controller Capability

Table 4.2 IEEE Interface capability

Address selection

The instrument address is set manually using a six way miniature switch near the interface connector on the rear panel. Five of the switches are used to set the address, and using a binary code, this enables any address in the range 00 to 30 to be used. e.g. 11010 is address 26.

e.g. Switch setting – ADD 11010 = ADDRESS 26



A5	A4	A3	A2	A1	Decimal Code
0	0	0	0	0	00
0	0	0	0	1	01
0	0	0	1	0	02
0	0	0	1	1	03
0	0	1	0	0	04
0	0	1	0	1	05
0	0	1	1	0	06
0	0	1	1	1	07
0	1	0	0	0	08
0	1	0	0	1	09
0	1	0	1	0	10
0	1	0	1	1	11
0	1	1	0	0	12
0	1	1	0	1	13
0	1	1	1	0	14
0	1	1	1	1	15
1	0	0	0	0	16
1	0	0	0	1	17
1	0	0	1	0	18
1	0	0	1	1	19
1	0	1	0	0	20
1	0	1	0	1	21
1	0	1	1	0	22
1	0	1	1	1	23
1	1	0	0	0	24
1	1	0	0	1	25
1	1	0	1	0	**26** (e.g. above)
1	1	0	1	1	27
1	1	1	0	0	28
1	1	1	0	1	29
1	1	1	1	0	30

Table 4.3 Address Selection

'Talker only' ('T.O.')

The sixth switch, when set to a '1', causes the DMM to become a 'talker only', meaning it can only output data and not be programmed over the interface. This is particularly useful if, for example, the system consists of only a DMM (the talker) and a printer (the listener), in which case a controller is not required.

Address 31 (Illegal bus address)

If the interface option is fitted, the address selected affects the manner in which the DMM powers up.

With address 31 selected, the DMM assumes the role of bench instrument and powers up to DC, 1000V range and reading at the internally controlled read rate. In addition, a manual calibration is only enabled with Address 31 selected, as explained in the Calibration and Servicing Handbook.

With an address selected in the range of 0 to 30, the instrument powers up as a systems instrument in DC, 1000V range but in 'Hold'. Each time power-up occurs in this condition, a message is sent to the system controller to indicate that an instrument power-up has taken place.

Using the 1081 in a system

The DMM can be operated under remote control, when ASCII coded programming instructions are received from a controller, or in local control when the DMM is operated from its front/rear controls. In both cases output of results or parameters is available at both DMM display and via the interface.

When operating in remote the legend 'rem' is displayed and all front panel controls are disabled except 'Power', '2/4-wire Ω', 'Local/Remote Guard'.

All the front panel controls (except 'Power', 2/4-wire Ω' and 'Local/Remote Guard') are programmable via the interface, in addition to 'Run/Calibration Enable' on the rear panel.

Furthermore, other 1081 features exist which are only programmable and therefore can only be used if the IEEE interface is fitted. These are known as Double trigger ratio, Double Trigger Δ, Double Trigger Δ% and Delay. These are explained in this section of the handbook under 'Programming Instructions'.

From the example given earlier in this section it may be seen that the DMM requires an address command followed by a series of device dependent messages or commands to change the various range, function and operating modes.

A series of these commands can be sent together as a 'program string'. e.g. R4F3T3 =

programming instructions

string terminator

Each string will contain at least one programming instruction, details of which are given later, but before the instrument can take any action on the instructions, it must receive a terminate signal at the end of any string.

The required terminators are:

i) The ASCII character '='

or ii) EOI (end or identify) with the last byte of the string.

To assist in obtaining a correct set of programming instructions, the DMM checks for errors in the string, and generates a service request (SRQ) if a syntax error occurs or if an option was called for but not fitted.

The full range of commands for programming the DMM is given in Table 4.4. The precise programming details for each command are given in the next section under PROGRAMMING INSTRUCTIONS.

Programming instructions

Control of DMM inputs

Range. R1 through to R7 configure the instrument to a specific range, while RØ places the instrument in auto-range. Programming R1 or R7 when Ohms is not selected causes the DMM to set itself to R2 and R6 respectively.

Function. F1 through to F7 configure the instrument to the required function. Programming a function which is not fitted will generate an option select error.

Filter. Programming C1 introduces an additional filter into the analog circuitry in DC, Ω or PRT; and selects 10Hz in AC.

Programming C2, C3, selects 1Hz, 0.1Hz respectively in AC, in all other functions sets C1.

Programming CØ selects normal mode.

Front/Rear Input Selection.
Selection of front or rear can be accomplished by programming IØ—Front, I1—Signal rear, or I2—Reference rear.

Triggers. A reading may be triggered from one of three sources, (1) internally generated, (2) external (see section 3), (3) a GET (group execute trigger) via the interface. A group execute trigger is a standard bus message which is recognised by the DMM when it has been addressed as a listener. Programming the appropriate trigger code allows one or more of these sources to initiate a measurement cycle. When the DMM is programmed to accept GET, sending the ASCII character @ as part of the program string will also trigger the instrument.

The GET command will initiate a measurement cycle if one is not already in progress or will be stored until the current measurement cycle is complete in order to initiate a second cycle. This permits the second cycle to overlap the processing of data from the previous measurement cycle to increase overall instrument read rate.

In the same way, an external trigger received during the processing of data from an earlier measurement cycle will initiate another measurement cycle. External triggers received during the measurement cycle will be ignored.

CONTROL	CODE	DESCRIPTION
HIGH RESOLUTION	A∅ A1 A2 A3 A4	Normal mode Continuous Average Hi Res (16 reading average) Block Average Hi Res (4 reading average)
FILTER	C∅ C1 C2 C3	Normal mode Filter or 10Hz 1Hz 0.1Hz
DELAY	DX D***	Internal delay Programmed delay (*** 0 to 254)
SPEC	E∅ E1	Normal mode SPEC readout mode
FUNCTION	F1 F2 F3 F4 F5 F6	kΩ ACV DCV PRT (°C readout) PRT (Ω readout) DC + ACV
CALIBRATE	G∅ G1 G2 G3 G4	Zero Gain STD AcHf Lin
INPUT SELECTION	I∅ I1 I2	Front Signal (Rear) Reference (Rear)
KEYBOARD	K	Calls Keyboard mode
STORE	L∅ L1 L2 L3 L4 L5	Clears Limits, Max and Min stores Store B Store C High Limit Low Limit Block Size (A3)
MESSAGE STRING	L6	K* Character String
MATHS	M∅ M1 M2 M3	Normal Mode A-B A/C (A-B)/C
MAX/MIN	N∅ N1 N2 N3	Normal Mode Max Min Max-Min
OUTPUT NOTATION	O∅ O1 O2 O3	Scientific and range and function Scientific and full status Four byte binary As O2 without EOI
RATIO	P∅ P1 P2 P3 P4 P5 P6 P7	Normal Mode Ratio % (single trigger) Ratio % (double trigger) Ratio % (double trigger) Δ (single trigger) Δ% (single trigger) Δ (double trigger) Δ% (double trigger)
SERVICE REQUEST	Q∅ Q1 Q2 Q3 Q4	No SRQ generated SRQ when data ready for output SRQ if out of limit or new max/min As Q1 with triggers inhibited until data output As Q2 with triggers inhibited until data output
RANGE	R∅ R1 R2 R3 R4 R5 R6 R7	Autorange 10Ω otherwise 100mV, 100mV, Ω 1V, kΩ 10V, kΩ 100mV, kΩ 1000V, kΩ 10MΩ, otherwise 1000V,
TRIGGER	T∅ T1 T2 T3	Internal External GET or @ GET, @ or external
	@ J	} Immediate trigger
RECALL STORES	V1 V2 V3 V4 V5 V6	Store B Store C High Limit Low Limit Block Size Message String
ENABLE CALL	W∅ W1	Normal mode Cal mode
SELF TEST	Y	
ZERO	Z	

Table 4.4 IEEE Programming Instructions

Delay. DX inserts the standard internal delay into the digital circuitry to allow for the settling of analog signals and is dependent upon the function/range/filter combination selected.

D*** (D followed by a number in the range 0-254) inserts a programmable delay.

Delay = (***N) mS
where *** is in the range 0-254
and N = 10mS

Control of DMM output

Output notation. O∅ configures the data to be output as an ASCII character string in scientific notation, with range and function data in the following format:

```
                        V    (EOI is also
 ±1.8888(8)(8)(8)E±88   O CrLf  available on
 ~                      A    the last byte)
 #
```

±DC — 5½ digit - AC normal — V = volts
~AC — 6½ digit - AC hi. res. / - kΩ-PRT / - DC/Ω normal — O = ohms
\# DC coupled AC — 7½ digit - DC/Ω averaging

Programming O1 includes in the output string full instrument status information having the format:

```
±                V
~ 1.8888(8)(8)E±88O,R4F3M∅N∅P∅Q1T3C∅A∅DXW∅CrLf
#
```

(EOI is also available on last byte.)

NOTE: DX will be replaced by D? when using non-standard delays.

Programming O2 or O3, changes the output to four byte binary where the reading is represented as a fraction of full range. Various formats exist to cope with the variable scale lengths and the following equations are provided for translation to decimal numbers assuming the four bytes in order are A B C & D.

Positive readings (A = $\emptyset_{10}$ or 1_{10})

$$\text{Reading} = +\left(A + \frac{B}{256} + \frac{C}{65536} + \frac{D}{16777216}\right) \times \text{Full range}$$

Negative readings (A = 255_{10} or 254_{10})

$$\text{Reading} = -\left((255\text{-A}) + \frac{(255\text{-B})}{256} + \frac{(255\text{-C})}{65536} + \frac{(255\text{-D})}{16777216}\right) \times \text{Full Range}$$

When output has been read no further output is available until the data from another measurement cycle has been obtained and processed. If an error occurs during a measurement cycle the normal output is replaced by a message, e.g.:

In O∅ and O1 an overload would produce 'ERR OL'.

In O2 and O3 any error will produce 255_{10}, i.e. all 1's, in all four bytes.

Service request

A wide variation can occur in the time taken for a measurement cycle, dependent on factors such as the magnitude of the signal. Therefore, when the result is available, a service request (SRQ) is generated by the DMM via the interface. This can act as a flag (or interrupt) to a controller, which is processing other data, signalling that the DMM requires service.

Q1 and Q3 allow an SRQ to be generated on completion of any reading while Q2 and Q4 allow generation of SRQ only when a reading is 'out of limits', or when a new maximum or minimum occurs. Programming Q3 or Q4 inhibits further triggers until the DMM has been serviced. An SRQ will always be generated on power up and when a syntax or option error occurs. Q∅ however, will suppress other SRQ's normally generated.

Serial Poll and Status Byte

In a system with various devices, many of them could request service and to determine which of these devices had initiated a request, either a serial poll or a parallel poll would be undertaken by the controller. During a serial poll each device sends its status byte on command, and the controller checks the request bit, thus determining a requesting device.

The DMM has many reasons for requesting service and with the additional bits available in the status byte this information is transferred at a serial poll.

Parallel poll

The parallel poll capability provided for in the DMM allows a controller with similar capability to more quickly determine which device is requesting service. The controller can at any time conduct a parallel poll, when all devices which have been configured to respond will place on separate bus data lines: a positive poll response if the device was requesting service or a negative poll response if the device does not require service. With eight data lines available the controller can simultaneously check eight responses.

Having determined the requesting devices from the parallel poll the controller would normally conduct a serial poll of these devices to determine the reason for the request.

The configuration of a device to respond to a parallel poll consists of determining the DIO line on which the response will occur, and the sense (∅ or 1) of the positive poll response. The negative poll response gives the opposite sense. The DMM can only be configured for this response by the controller. The configuration sequence is given later in this section.

The DMM **must** be serviced by either reading the output or by reprogramming to allow the generation of subsequent service requests.

To aid the user in servicing the instrument by reading, a character string is always available for output on generation of an SRQ even if a measurement is not available. This string in O∅ and O1 modes is '!CrLf' and in O2 and O3 modes all four bytes contain 255_{10} (all 1's). These 'null' strings occur with syntax or option programming errors if no measurement is available.

1 = True 0 = False x = 1 or 0

bits	b8	b7	b6	b5	b4	b3	b2	b1		
	x	0	x	x	x	x	x	x	Invalid Status byte	
	x	1	x	x	x	x	x	x	RQS Request-for-service bit	
	x	1	1	x	x	x	x	x	Syntax error	
	x	1	x	1	x	x	x	x	Option error	
Valid measurement messages										
	0	1	x	x	x	x	x	1	'Hi' limit transgressed	
	0	1	x	x	x	x	1	x	'Lo' limit transgressed	
	0	1	x	x	x	1	x	x	New maximum	
	0	1	x	x	1	x	x	x	New minimum	
	0	1	x	x	0	0	0	0	Normal reading	
Invalid measurement messages										
	1	1	x	x	0	0	0	0	Error OL	Overload/valid recall
	1	1	x	x	0	0	0	1	Error 1	Arithmetic overflow
	1	1	x	x	0	0	1	0	Error 2	Invalid data entry/invalid recall
	1	1	x	x	0	0	1	1	Error 3	Spec readout invalid
	1	1	x	x	0	1	0	0	IP·O	Input zero or calibration failure
	1	1	x	x	0	1	0	1	Error 5	DC self test failure
	1	1	x	x	0	1	1	0	Error 6	Ohms self test failure
	1	1	x	x	0	1	1	1	Error 7	AC self test failure
	1	1	x	x	1	0	0	1	Error 9	Arithmetic underflow
	1	1	x	x	1	0	1	1		Reference finished (see code P2)
	1	1	x	x	1	1	0	0	Fail	Self test finished memory fail
	1	1	x	x	1	1	0	1	Pass	Self test finished memory pass
	1	1	x	x	1	1	1	0		Power-up/memory fail
	1	1	x	x	1	1	1	1		Power-up/memory pass

Table 4.5 Status Byte Coding

Control and computing functions

Keyboard. The DMM will place itself into keyboard mode on receipt of a K, enabling the entry of math, limit and calibration constants via the bus. The constant may be expressed in numeric or scientific notation as ±1.999999(9) E±∅9. If a two digit exponent is used the first must be zero. To exit keyboard mode the constant entered must be placed in an appropriate store or used in calibration.

NOTE: The constant entered in not shown on the front panel display.

Store. L1 through to L4 inform the instrument of the store location for the entered constant or alternatively, if used without keyboard mode, the location for the previous valid reading.

L∅ deselects limit operations and resets max/min stores. A new max/min value will be stored on completion of the next valid reading.

Store L5 is only accessible after A3 is programmed
i.e.: A3, L5, N1----19,999
sets new block size on 1----19,999

Store L6 is only accessible in calibrate mode and after selecting keyboard.
i.e. K* character string L6

This store can be used to store a message using 0–9 and decimal point to a maximum of 8 digits.
e.g. Date of next calibration 01.02.84.

Recall stores. The current contents of the stores can be displayed on the front panel and output via the bus with the commands V1 through to V4 having the format:

±1.999999(9)E±99L2CrLf.
store location

NOTE:
1. The output of the stores is not available in binary output modes.
2. It is recommended that after the recall of a store value the trigger mode is reprogrammed.
3. Recall of empty limit stores will result in ERR 2 being output.

Recall store V5 recalls block size but does not display block size unless preceded by A3. i.e. A3V5.

Recall store V6 recalls message String.

Maths mode. Programming M1 to M3 causes the reading to be offset, divided by or both offset and divided by the contents of stores B and C respectively. M∅ places the instrument back to its normal operating mode.

Max/min. The maximum or minimum reading since the stores were last reset is output in place of the current reading when N1 or N2 are programmed. N3 computes the difference between maximum and minimum. N∅ places the instrument back to its normal operating mode. Reset of stores occurs automatically on changing function and entry or exit from ratio and programming L∅ mode.

Ratio. Programming rear input with P1 or P2 configures the DMM into the ratio mode. P1 when next triggered initiates two readings, the first from the reference input and the second from the rear signal input. P2, P3, P6 and P7 require two triggers, the first to take a reading from the reference input (an SRQ being generated on completion) and the second, a reading from the rear signal input. The ratio is then calculated and made available for output as a 'per unit' (p.u.) quantity, the format being:

±1.999999(9)E±99PUCrLf

High resolution

Programming A∅–A4 selects one of the following modes:

A∅ - Normal mode
A1 - Continuous average
A2 - High resolution mode
A3 - Block average
A4 - Filter average (Block of 4)

If no block size has been inserted a block size of 1 is recorded.

If block size of ∅ is inserted in manual a block size of 1 is recorded.

Calibration via the bus

The DMM can be calibrated remotely using the programming instructions provided. For full details of procedure see the Calibration and Servicing Handbook.

Invalid use of these instructions will cause the generation of an option error SRQ.

Spec readout, test and input zero

Spec. The programming and execution of code E1 causes the instrument to compute the measurement uncertainty of the previous reading. An SRQ is generated (if allowed) with the status byte indicating a normal valid measurement. The output format is:

1.888E±PUCrLf (where PU = per unit)

The DMM will be held until E∅ is programmed or until a GET, J, or @ is received, assuming the correct trigger mode has been programmed.

Spec readout is not available for maths modes.

Self test. When the DMM receives a Y command the internal test routine is initiated. The front panel displays are not exercised in this test and only option and calibration memory checks are included. Any error will be reported with the generation of an SRQ together with the appropriate status and an error message made available for output. An @ or J (regardless of trigger mode programmed) will continue the test after an error situation. Upon completion an appropriate pass or fail status will be generated with an SRQ, and the DMM will return to the previously programmed range and function. Maths modes, max/min, Hi Res and Spec readout will all be cleared on completion.

Input zero. Z initiates a series of 17 readings at an internal read rate, the first 16 being averaged and the result used as a zero offset. The 17th reading is available for output. If autorange is selected each range is zeroed in turn (lowest to highest). Should the offset be too large, the store is not updated and an SRQ and error status is generated together with an error message for output.

Program string characteristics

If more than 25 bytes have been programmed before receipt of any terminator the execution of the string will commence sequentially until sufficient space is available for further input data.

If an invalid command is sent an SRQ will be generated, the associated status byte containing a syntax or option error. In this case the output available is '!CrLf'.

-

NOTE:

1. For program instruction requiring only one numeral after an alpha character, the last numeral is operated on and a syntax error reported.
   e.g. F123 results in F3 (DCV).
2. For all program strings a finite time is required for execution, e.g. the string 'R4F3Q1T7=' will be processed and triggers enabled after approx 15mS from receipt of string terminator.

Bus messages

Remote. The DMM will go into remote when remote enable line (REN) is true and the device receives its listen address. It is possible to send a program string to the DMM when in local which will be acted upon immediately when the DMM goes to remote.

Local. The GTL message returns the DMM to front panel control in the condition in which it was last programmed remotely with the exception of the trigger mode which is forced to L T3 except T∅ which remains at T∅.

Clear. When the instrument receives a clear message (SDC or DCL) it will revert to a predetermined state of DC volts 1000V range and hold.

i.e. A∅C∅DXE∅F3M∅N∅P∅Q∅R6S∅T1

Operational sequence guidelines

Most interface communication tasks require sequences of coded messages to be sent over the interface. Many controllers assign a single programming instruction to a complete sequence, so it is advisable to study the available controller capabilities carefully before attempting to program a system. Because the IEEE Std 488 (1978) allows a certain latitude in bus protocol, considerable differences may be found between programming instructions and operating sequences from one make of controller to another.

Consequently, the following sequences are recommendations only.

Untalk

It is highly recommended that a sequence which causes the DMM to be addressed as a talker should be terminated with an untalk command.

Data transfer

UNL	Inhibits all current listeners
LAD_1	Each address sent enables a specific device to receive future data bytes.
LAD_n	More than one address may be sent if multiple listeners desired.
TAD	The address sent enables a specific device to send data.
DAB_1	Data bytes sent by currently enabled talker to all currently enabled listeners.
DAB_n	
UNT	Disables the talker on receipt of last character.

UNL =	unlisten
LAD =	listen address of specific device
TAD =	talk address of specific device
DAB =	data bytes
UNT =	untalk

Serial poll

UNL	Prevents other devices listening to status sent.
SPE	Puts interface into serial poll mode during which all devices send status instead of data when addressed.
TAD_n	Enable a specific device to send status. Within this loop devices should be sequentially enabled.
SBN or SBA	Status byte sent by enabled device. If SBN sent, loop should be repeated. If SBA sent, the enabled device is identified as having sent SRQ and will automatically remove it.
or	
SPD	Disables serial poll mode
UNT	Disable last talker.

SPE =	serial poll enable
SPD =	serial poll disable
SBN =	status byte negative where bit 7 = Ø
SBA =	status byte affirmative where bit 7 = 1.

Parallel poll Configure

LAD	Addresses a particular device for which a parallel response coding is to be assigned.
PPC	Enables the listener to be configured.
PPE	Bit 4 specifies the sense of the poll response. Bits 1 to 3 specify, in binary code, the data line (DIO) on which the poll response is to be given.
UNL	End of configuration routine.

PPC =	parallel poll configure
PPE =	parallel poll enable

NOTE: The PPE command can be disabled by substitution of PPD.
All devices can be unconfigured by use of the PPU command.

PPD =	parallel poll disable
PPU =	parallel poll unconfigure

Parallel poll response

To obtain the parallel poll response, the controller must place the management lines ATN and EOI (attention and identify) true when the predetermined devices will each place their request on a specified data line.

SECTION 5 INSTALLATION

This section contains information and instructions for unpacking and installing the Datron 1081 Autocal Multimeter.

Unpacking and inspection

Every care is taken in the choice of packing material to ensure that your equipment will reach you in perfect condition.

If the equipment has been subject to excessive mishandling in transit, the fact will probably be visible as external damage to the shipping carton. In the event of damage, the shipping container and cushioning material should be kept for the carrier's inspection or until the instrument has passed the Specification Verification Tests.

Unpack the equipment and check for external damage to the case, terminals, keys, etc. If damage is found notify the carrier and your sales agent immediately.

Standard accessories supplied with the instrument are as described in Section 1. If input and/or output options are fitted the appropriate plug or socket is attached in its respective place on the rear panel of the instrument.

The rack mounting kit option is packed separately and should be fitted as instructed in 'mounting'.

Preparation for operation

Power cable

A detachable supply cable, comprising two metres of 3-core PVC sheath cable permanently moulded to a fully-shrouded 3-pin cable socket, fits at the rear of the instrument and should be pushed firmly home. The supply lead should be connected to grounded outlet ensuring that the ground lead is connected. Connect Brown lead to Live, Blue lead to Neutral and Green/Yellow lead to Ground.

Line voltage

The instrument is packed ready for use with 205V to 255V 50Hz supplies unless Option 80, 81 or 82 is specified at the time of ordering. To change the supplies and/or line frequency, it is essential to alter links in the instrument. (Refer to Calibration and Servicing Handbook.)

Fuses

Power Fuse:
The power fuse is located on the left-hand side of the back panel adjacent to the power input. The power fuse rating is 160mA for 205V—255V and 500mA for 105V—127V supply voltages. It should be of the anti-surge type.

MAKE SURE THAT ONLY FUSES WITH THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE ARE USED FOR REPLACEMENT. THE USE OF MENDED FUSES AND THE SHORT-CIRCUITING OF FUSE-HOLDERS SHALL BE AVOIDED, AND RENDERS THE WARRANTY VOID.

Mounting

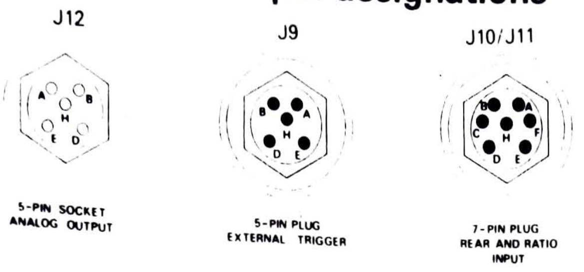
Bench Use:
The instrument is fitted with rubber covered plastic feet and tilt stand. Thus it may be placed flat on the bench or tilted for ease of viewing.

Rack Mounting:
Option 90 permits the instrument to be mounted in a standard 19 inch rack.

The method of fitting this option is described below but on no account should the covers be removed. The handles should be removed, if fitted, by loosening the hexagonal screws of the handle assembly and sliding the assembly to the rear of the instrument until free.

The rack mounting 'ears' may now be fitted by slotting the 'ears' into the guides at each side of the instrument, from the rear. Draw the 'ears' forward until positioned correctly and tighten the hexagonal screws, using the hexagonal key provided. It is recommended that the rear of the instrument is supported in the rack.

Connectors and pin designations



Pin No.	Signal
A	Output Hi
B	Output Lo
D	)
E	) Not Used
H	)

Table 5.3 Analog Output - pin designations

Rear input and ratio input (option 40)

J10 and J11 are 7-pin connectors accepting input signals as defined for the front panel terminals. See Tables 2.1 to 2.3 for maximum inputs, Table 5.1 for pin descriptions and Fig. 5.1 for pin layout.

Pin No.	Signal
A	Ω GUARD
B	Not Used
C	I+
D	Input Hi
E	Input Lo
F	I−
H	GUARD

Table 5.1 Ratio & Rear Inputs - pin designations

NOTE: For local guarding, connect pins A and H.

External trigger input (option 52)

J9 is a 5-pin connector used to accept an external trigger source to initiate a DMM measurement cycle. See Table 5.2 for pin descriptions and Fig. 5.1 for pin layout.

Pin No.	Signal
A	Trigger (High to Lo edge ⌊)
B	Logic Ground
D	Not Used
E	Not Used
H	Not Used

Table 5.2 External Trigger Input - pin designations

Analog output (option 70)

J12 is a 5-pin connector providing a 1V full-range output for any nominal full-range input, with over-range capability to 2V. See Table 5.3 for pin designations and Fig. 5.1 for pin layout.

IEEE input/output (option 50)

The IEEE input/output is a 24-way connector that is directly compatible with the IEEE defined system.

Fig. 5.2 gives the pin designations and Table 5.4 the pin layout.

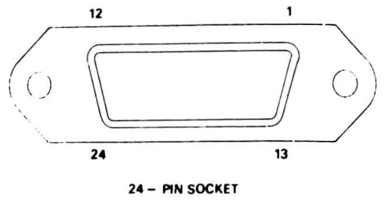


Fig. 5.2 IEEE 488 connector - pin layout

J27 Pin No.	Name	Description
1	DIO 1	Data Input Output Line 1
2	DIO 2	Data Input Output Line 2
3	DIO 3	Data Input Output Line 3
4	DIO 4	Data Input Output Line 4
5	EOI	End or Identify
6	DAV	Data Valid
7	NRFD	Not ready for Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Screening on cable - connected to DMM Safety Ground
13	DIO 5	Data Input Output Line 5
14	DIO 6	Data Input Output Line 6
15	DIO 7	Data Input Output Line 7
16	DIO 8	Data Input Output Line 8
17	REN	Remote Enable
18	GND 6	Gnd wire of twisted pair with DAV
19	GND 7	Gnd wire of twisted pair with NRFD
20	GND 8	Gnd wire of twisted pair with NDAC
21	GND 9	Gnd wire of twisted pair with IFC
22	GND 10	Gnd wire of twisted pair with SRQ
23	GND 11	Gnd wire of twisted pair with ATN
24	GND	DMM logic ground

Table 5.4 IEEE 488 connector - pin designations

SECTION 6 SPECIFICATIONS

General

POWER SUPPLY

Voltage	:	105-127 or 205-255 Volts
Line Frequency	:	50Hz±2%, 60Hz±2%, or 400Hz±2%
Consumption	:	Approximately 20 Watts
Fuses	:	160mA or 500mA anti-surge (depends on voltage)

MECHANICAL

Dimensions	:	Height = 89mm (3.5ins) Width = 455mm (17.9ins) Depth = 420mm (16.5ins)
Weight	:	10 kg (22lbs)

AUTORANGE

Range Up	:	200% of nominal range
Range Down	:	18.8% of nominal range

SAFETY

The 1081 has been designed to meet BSI 4743, IEC 348, and UL 1244 specifications.

Read rate	:	with full scale input 2/second

CLIMATIC CONDITIONS

Operating Temperature	:	0°C to +50°C (except where specified)
Storage Temperature[1]	:	−40°C to +70°C
Maximum Relative Humidity	:	75% @ 40°C
Warm-up Time	:	Two hours to meet all specifications

OPERATING INDICATIONS

Scale length	:	7½ digits maximum, i.e. 19,999,999
Overload	:	Error 0L displayed
indication	:	Symbols lit on display and illuminated keys

DIGITAL ERROR

Computation	:	±1 digit (assumes no error in stored value)
Spec read-out	:	< 1% of displayed SPEC

MAXIMUM INPUTS

See Tables 2.1 and 2.2 on page 2.1

ANALOG OUTPUT (0 to ±2 Volts)

1 Volt output for full range signal input

Accuracy	:	±1% of Reading ±2mV
Output Resistance	:	Approximately 200Ω

[1] Excessive temperature stress may affect calibration stability.

DC Voltage

Stability and Accuracy

RANGES	STABILITY [2] ±(ppm Reading + ppm FS) [4]		ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(ppm Reading + ppm FS) [4][8] 23°C±1°C			ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(ppm Reading + ppm FS) [4][8] 23°C±5°C		
	1 Minute	24 Hours	24 Hours	90 Days	1 Year	24 Hours	90 Days	1 Year
100.0000(0)mV	0.25 + 0.25μV	2.0 + 1.50	3 + 2.0	8 + 2.0	11 + 2.0	8 + 2.0	11 + 2.0	14 + 2.5
1.000000(0)V	0.25 + 0.5μV	1.5 + 0.25	2 + 1.0	5 + 1.5	8 + 1.5	5 + 1.5	8 + 1.5	11 + 1.5
10.00000(0)V	0.25 + 2.5μV	1.5 + 0.25	2 + 0.5	5 + 1.0	8 + 1.0	5 + 1.0	8 + 1.0	11 + 1.5
100.0000(0)V	0.25 + 50μV	2.0 + 0.25	3 + 1.0	8 + 1.5	11 + 1.5	8 + 1.5	11 + 1.5	14 + 1.5
1000.000(0)V	0.25 + 250μV	2.0 + 0.25	3 + 1.0	8 + 1.5	11 + 1.5	8 + 1.5	11 + 1.5	14 + 1.5

NOTES:

( ) – Hi Res selected gives 7½ digits on DCV and Resistance; 6½ digits on ACV.
[1] – signals $<2\times10^7$ Volt-Hertz $>$ 1% FS: DC coupled below 100Hz.
[2] – For same conditions with Hi Res selected between 18°C and 28°C.
[3] – Datron Instruments traceability to National Standards.
[4] – FS = 2 × Full Range.
[5] – At same amplitude, frequency etc., errors tend to zero.
[6] – Add 0.01% per 100V above 500V.
[7] – At full range ± 2%.
[8] – Figures assume prior Input Zero.

CALIBRATION UNCERTAINTY ±ppm |3|	TEMPERATURE COEFFICIENT ±ppm Reading per °C 13°C – 18°C 28°C – 33°C	NOISE Filter (Hi-Res) selected and after 'Zero' Peak over 1 min. ±ppm Reading	INPUT IMPEDANCE
5	1.5	0.15 + 0.2μV	.1 to 10V ranges, (<20V): >10,000MΩ
3	1.0	0.15 + 0.3μV	
3	1.0	0.15 + 2.0μV	
5	1.5	0.15 + 30μV	100&1000V ranges: 10MΩ±0.1%
5	1.5	0.15 + 200μV	

Other Specifications

Type:	Multi-slope A-D Converter.
Read Rate:	2 Readings per second.
Full Scale Count:	1,999,999(9) on all ranges except 1000V.
Normal Mode Rejection Ratio	
Filter Out:	66dB at 50/60Hz±0.15%.
Filter In:	120dB at 50Hz increasing at 18dB per octave.
Common Mode Rejection Ratio (1kΩ Source Unbalance)	
DC:	>140dB.
1Hz – 60Hz:	80dB plus Normal Mode Rejection.
Settling Time: (to within 10ppm of step size)	
Filter Out:	<50ms.
Filter In:	<1s (<3s in LOCAL operation).
Input Current:	<50pA drifting at <1pA per °C.
Input Protection:	Withstands 1000V RMS on any range.
Zero Temperature Coefficient:	1/10 of 'FS' part of 90-day specification, per°C.
Zero Stability:	(±(0.2 digits±0.1μV) per month).
Ratio Accuracy |5|:	±net signal accuracy±net reference accuracy.

AC Voltage

True RMS |1|

Stability and Accuracy

Resolution	RANGE Frequencies	Ranges	STABILITY |2| ±(ppm Reading + ppm FS) |4| 1 Minute	24 Hours	ACCURACY RELATIVE TO CALIBRATION STANDARDS ±(% Reading + % FS) |4| 23°C±1°C 24 Hours	90 Days	1 Year
100.000(0)mV 1.00000(0)V 10.0000(0)V 100.000(0)V 1000.00(0)V	10Hz-2kHz	100mV 1V-100V 1kV	10 + 5.0 10 + 2.5 20 + 2.5	40 + 15 30 + 8 50 + 8	0.02 + 0.007 0.01 + 0.005 0.02 + 0.007	0.025 + 0.007 0.015 + 0.005 0.025 + 0.007	0.03 + 0.007 0.02 + 0.005 0.03 + 0.007
	2kHz-20kHz	100mV 1V-100V 1kV |6|	10 + 5.0 10 + 2.5 20 + 2.5	60 + 20 50 + 12 70 + 12	0.04 + 0.012 0.02 + 0.010 0.04 + 0.012	0.060 + 0.012 0.030 + 0.010 0.060 + 0.012	0.08 + 0.012 0.04 + 0.010 0.08 + 0.012
	20kHz-100kHz	100mV 1V-100V 1kV |6|	10 + 5.0 10 + 2.5 20 + 2.5	70 + 30 60 + 25 80 + 25	0.08 + 0.022 0.04 + 0.020 0.08 + 0.022	0.120 + 0.022 0.070 + 0.020 0.120 + 0.022	0.16 + 0.022 0.10 + 0.020 0.16 + 0.022

AC Voltage Transfer

(6½ digits) Frequencies	Ranges	TRANSFER STABILITY (±% Reading) |2||7| AC/DC 24 Hours 23°C±1°C	AC/DC 90 Days 23°C±5°C	AC/AC 24 Hours 23°C±1°C	ACV/DCV TRANSFER ACCURACY (±% add to Transfer Stability)
10Hz-2kHz	100mV 1V-100V 1kV	0.005 0.003 0.005	0.010 0.005 0.010	0.004 0.003 0.005	0.02 0.01 0.02
2kHz-20kHz	100mV 1V-100V 1kV |6|	0.010 0.005 0.010	0.040 0.015 0.040	0.006 0.005 0.007	0.06 0.03 0.06 |6|

NOTES:

( ) – Hi Res selected gives 7½ digits on DCV and Resistance; 6½ digits on ACV.
|1| – Signals $<2\times10^7$ Volt-Hertz $>$ 1% FS: DC coupled below 100Hz.
|2| – For same conditions with Hi Res selected between 18°C and 28°C.
|3| – Datron Instruments traceability to National Standards.
|4| – FS = 2 × Full Range.
|5| – At same amplitude, frequency etc., errors tend to zero.
|6| – Add 0.01% per 100V above 500V.
|7| – At Full Range ± 2%.