9823
10ppm Programmable Multi Function Calibrator

GPIB Command Manual

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Chapter 5. Remote GPIB (IEEE) Operation

1.1 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.

1.2 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.

1.3 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

GPIB (IEEE bus) Cables part numbers

1.4 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.

1.5 GPIB (IEEE) Connectors

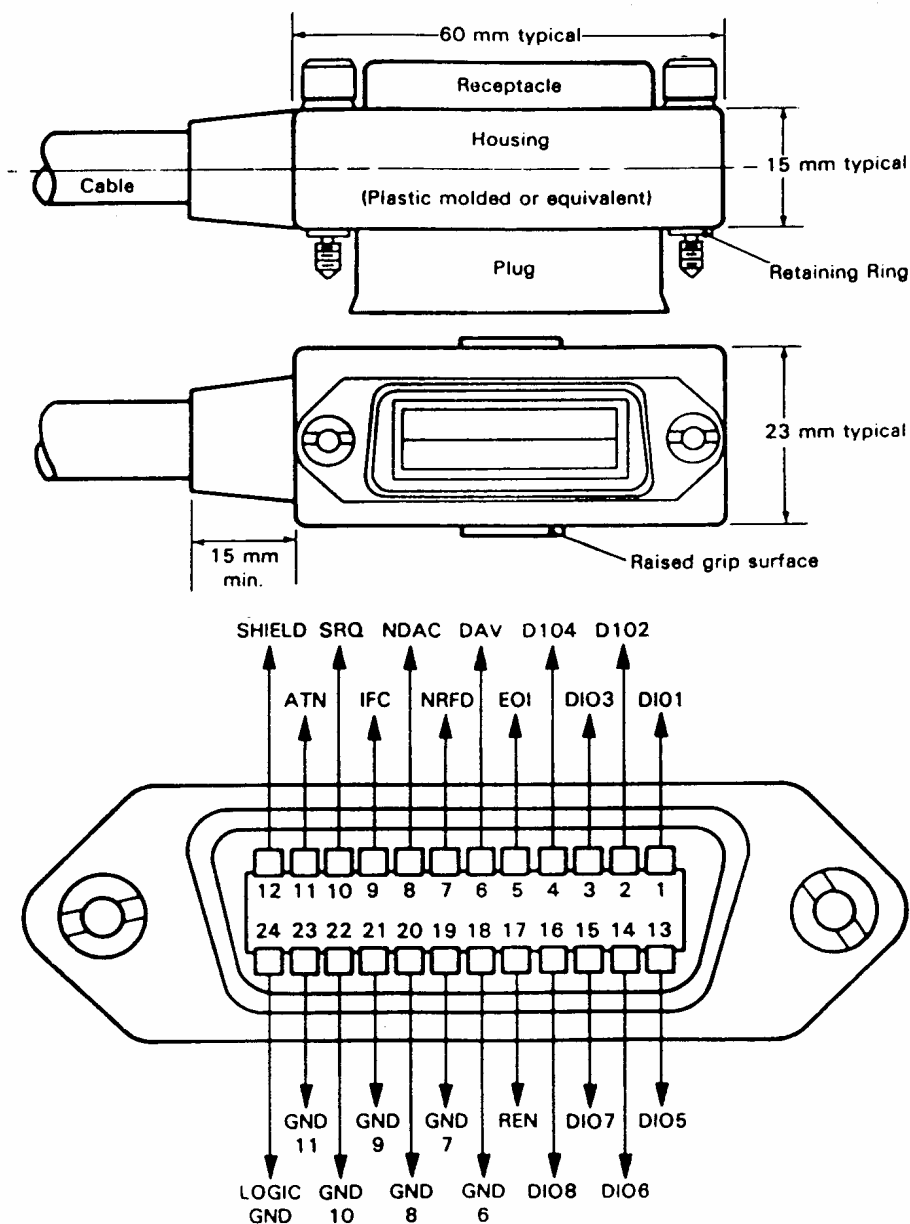The pin connections and dimensions of the IEEE connector are illustrated below and in table 5.2.

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

1.6 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.
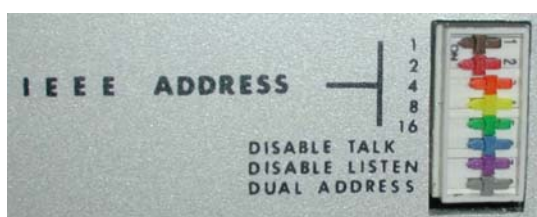
GPIB (IEEE) Addresses 0 and 16 are reserved for recalibration mode and should not be used unless recalibrating the instrument. Address 31 is used to select self test mode.

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.

1.7 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 O5 - 100k Ohms O2 - 100 Ohms O6 - 1M Ohms O3 - 1k Ohms O7 - 10M Ohms O4 - 10k Ohms
Pn	Change output by 'n' percent.
R1 to R12	Select voltage or current range R1 - 20mV R7 - 200uA R3 - 200mV R5 - 2mA R3 - 2V R9 - 20mA R4 - 20V R10 - 200mA R5 - 200V R11 - 2A R6 - 1kV R12 - 10A
RA	AUTORANGE
T1 or T2	Set terminator character appended to a transmission.
W1 to W7	Select waveform. W1 - Sine W5 - Triangle W2 - Square W6 - Trapezoidal W3 - Ramp up W7 - D.C. W4 - Ramp down
Z	Take present output as offset.
/	Command separator.

1.8 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.

1.9 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).

1.10 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.

1.11 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.

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