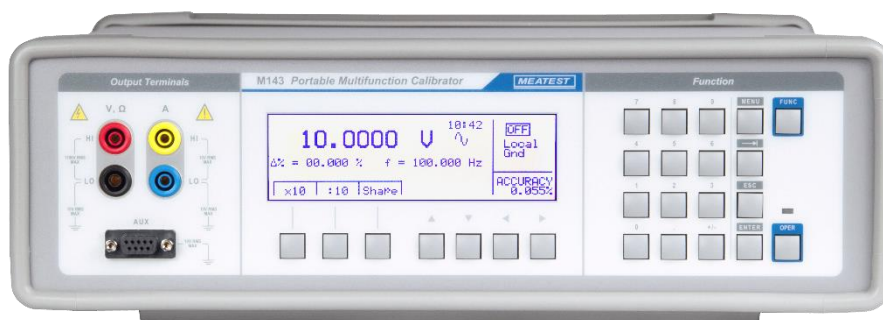


M143 Portable Multifunction Calibrator

remote control manual



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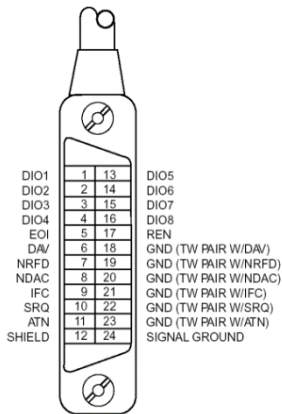
1. Connection Setup

The calibrator can be integrated into automated calibration systems (ATS) and generally controlled from remote computer via RS232 and GPIB (IEEE488) interface. When controlled remotely, maximum ratings of calibrator’s output signals as well as all other specifications are the same as in manual mode. Only one interface can be used for communication at any given time. To establish connection between the calibrator and computer, select preferred interface in MENU (RS232 is active by default) and follow instructions from relevant subchapter below.

1.1. IEEE488 bus properties

The instrument performs the following functions based on IEEE488 bus commands:

SHI, AH1, T5, L3, RL1, DC1, SRI



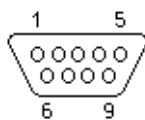
The instrument also recognizes the following general commands:

DCL	Device Clear	reset the calibrator
SDC	Selected Device Clear	reset the calibrator
EOI	End or Identify Message Terminator	close the message
GTL	Go To Local	close remote control mode
LLO	Local Lock Out	local control locked
SPD	Serial Poll Disable	close serial message status
SPE	Serial Poll Enable	release serial message status

1.2. RS232 serial line setting

To transfer the data using RS232 bus, 8N1 data format is used, i.e. each data word includes 8 bits, no parity and one stop bit. The communication speed can be set using the system menu. Available values: 150, 300, 600, 1200, 2400, 4800, 9600 and 19200 Bd. Software handshake (communication control) XON/XOFF can be set to control the transfer of the data through the bus.

RS-232 connector layout:



Pin	Name	Direction	Description
2	TXD	Output	Transmitter
3	RXD	Input	Receiver
5	GND	-	Ground

9-pin connector D-SUB FEMALE

Cable between the calibrator and PC (configuration 1:1)

PC	D-Sub 1	D-Sub 2	Calibrator
Receiver	2	2	Transmitter
Transmitter	3	3	Receiver
Ground	5	5	Ground

Note:

It is not possible to send or receive data over RS232 or Ethernet when the calibrator is not in remote mode.

You should use the command SYST:REM or SYST:RWL

2. Executing Commands

Most commands can be executed in Remote mode only. In Remote mode, device blocks manual entry interfaces (keyboard, touchscreen) to prevent unintended manipulation during remote control session. GPIB interface switches device into and out of Remote mode automatically. Other interfaces (RS232) need to use following commands:

- *REM Puts device into Remote mode and locks keyboard except Local button
- *LOC Returns device from Remote mode and unlocks keyboard

2.1. Command Syntax

All commands listed in this chapter are made of KEYWORDS and PARAMETERS.

One or more KEYWORDS divided by colons (:) make up name of a command. When typing a command, keywords in square brackets ([]) can be omitted as well as lowercase letters and leading colons. For example “:OUTPut:STATe ON”, “:OUTPut ON” and “OUTP 1” are considered the same.

Different PARAMETER types describe what kind of data is expected. For more details on parameter types, see table below. In command reference parameters are indicated by sharp brackets (< >) and separated by commas (,). Square brackets ([]) indicate non-mandatory parameters, vertical lines (|) indicate parameter alternatives.

Multiple commands can be executed at once if separated by semicolon (;). In any case, command (or set of commands) has to end with line feed (LF) terminator in order to be executed. With exception of GPIB interface, the device will also accept carriage return (CR) and combination of both (CRLF) as terminators. Inversely, device will always terminate its reply with CRLF or just LF in case of GPIB. The communication may look like this:

1. Controller> „RES 100;OUTP ON“+LF (ASCII code 10)
2. Device> „1.000000E+02 OHM“+LF
3. Device> „1“+LF

Used parameter types

Type	Description
<DNPD>	Decimal Numeric Program Data, this format is used to express decimal number with or without the exponent.
<CPD>	Character Program Data. Usually, it represents a group of alternative character parameters. E.g. { GPIB}.
<SPD>	String Program Data (quoted string). This type of parameter is similar to CPD, but allows transmission of more ISO characters.
?	A flag indicating a request for the value of the parameter specified by the command. No other parameter than the question mark can be used.
(?)	A flag indicating a request for the parameter specified by the command. This command permits a value to be set as well as requested.

3. Status Reporting

3.1. Status Data Structure-Register Model

Device meets standard protocol according to the standard IEEE488.2. The protocol can be used for checking of error and status behavior of the device. It enables single-wire transmitting of SRQ command. The conditions on which SRQ signal (local control request) is sent can be set with commands *STB?, *SRE?, *SRE, *ESR?, *ESE?, *ESE a *CLS.

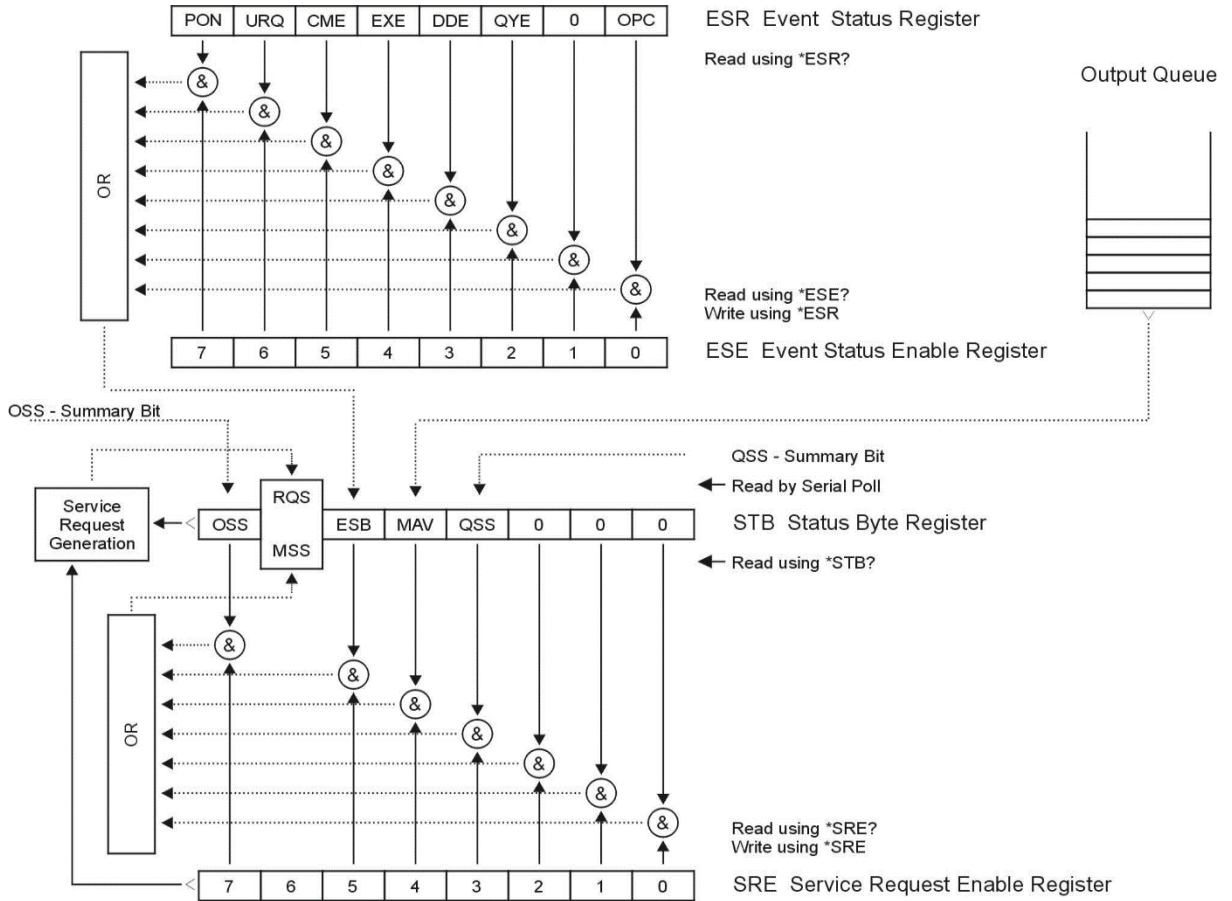


Figure 1 Status register overview

Status data structure contains following registers:

- STB – Status Byte Register
- SRE – Service Request Enable Register
- ESR – Event Status Register
- ESE – Event Status Enable Register
- Output Queue

3.2. Status Data Structure Registers

STB Status Byte Register

STB is main register where information from other status registers and from output queue is collected. Value of STB register is reset after switching on the device or after sending command *CLS. This command reset the STB register except bit MAV, which remains set if the output queue is not empty. STB register value can be read via serial message or through general query *STB?. Bit configuration of Status Byte Register is as follows:

- RQS Request Service, bit 6. The bit is read as a part of status byte only when serial message is sent.
- MSS Master Summary Status, bit 6. The MSS bit is set to 1 whenever bits ESB or MAV are 1 and enabled (1) in the SRE. This bit can be read using the *STB? command. His value is derived from STB and SRE status.
- ESB Event Summary Bit, bit 5. His value is derived from STB and SRE status. The ESB bit is set to 1 when one or more enabled ESR bits are set to 1.
- MAV Message Available, bit 4. The MAV bit is set to 1 whenever data is available in the M143/143i IEEE488 Output Queue (the response on query is ready).

SRE Service Request Enable Register

The Service Request Enable Register suppresses or allows the STB bits. “0” value of a SRE bit means, that the bit does not influence value of MSS bit. Value of any unmasked STB bit results in setting of the MSS bit to the level “1”. SRE bit 6 is not influenced and its value is “0”. The SRE register value can be set via the command *SRE followed by mask register value (0 – 191). The register can be read with the command *SRE?. The register is automatically resets after switching the device on. The register is not reset by the command *CLS.

ESR Event Status Register

Every bit of the EventStatusRegister corresponds to one event. Bit is set when the event is changed and it remains set also when the event passed. The ESR is cleared when the power is turned on (except bit PON which is set), and every time it is read via command *ESR? Or cleared with *CLS. Bit configuration of Event Status Register is as follows:

- PON Power On, bit 7. This event bit indicates that an off-to-on transition has occurred in the device’s power supply.
- URQ User Request, bit 6. Bit is not used and it is always “0”.
- CME Command Error, bit 5. This event bit indicates that an incorrectly formed command or query has been detected by the instrument.
- EXE Execution Error, bit 4. This event bit indicates that the received command cannot be executed, owing to the device state or the command parameter being out of limits.
- DDE Device Dependent Error, bit 3. This event bit indicates that an error has occurred which is neither a Command Error, a Query Error, nor an Execution Error. A Device-specific Error is any executed device operation that did not properly complete due to some condition, such as overload.
- QYE Query Error, bit 2. The bit is set if the device is addressed as talker and output queue is empty or if control unit did not pick up response before sending next query.
- OPC Operation Complete, bit 0. This event bit is generated in response to the *OPC command. It indicates that the device has completed all selected pending operations.

ESE Event Status Enable Register

The Event Status Enable Register allows one or more events in the Event Status Register to be reflected in the ESB summary-message bit. This register is defined for 8 bits, each corresponding to the bits in the Event Status Register. The Event Status Enable Register is read with the common query *ESE?. Data is returned as a binary-weighted value. The Event Status Enable Register is written to by the common command, *ESE. Sending the *ESE common command followed by a zero clears the ESE. The Event Status Enable Register is cleared upon power-on.

It suppresses or allows bits in ESR register. Value „0“ of a bit of ESE register suppresses influence of appropriate bit of ESR register on value of sum bit of ESB status register. Setting of any unmask bit of ESR register results in setting of ESB status register. ESE register value can be modified by command *ESE followed by value of mask register (integer in range 0 –255). Reading of the register can be performed with command *ESE?. The register is automatically reset after switching on. The register is not reset with *CLS command.

Output Queue

The Output Queue stores response messages until they are read from control unit. If there is at minimum one sign in the output queue, MAV register (message available) is set. The Output Queue is cleared upon power-on and after reading all signs from output queue.

3.3. Error messages

Code	Error message	Description
01	Overload 1V!	Voltage terminals are shorted and/or external voltage has been detected. Voltage output has been disconnected. Increase load impedance to specified limits and/or disconnect external source of current from output terminals.
02	Overload 10V!	
04	Overload I output!	Current terminals are open and/or external voltage has been detected. Current output has been disconnected. Decrease load impedance to specified limits and/or disconnect external source of current from output terminals.
10	Interface error!	Remote connection error. Enter correct data.
11	Bad command!	Unknown remote command. Use defined commands.
13	Over range!	Value is out of range. Enter correct value.
14	Communication error	Communication error in remote control.
15	Check sum error!	Data failed to load into internal memory.
16	Interrupted!	Interrupted IEEE488.2 command. Enter full data format.
17	Unterminated!	Wrong syntax IEEE488.2 Enter correct data format.
18	Deadlocked!	Wrong syntax IEEE488.2 Enter correct data format.
20	Bad calib. code!	Enter correct calibration code.
21	Time warm up!	Attempt to start calibration before 60 minutes warm up period. Let the calibrator warm up on for at least 60 minutes.
40	Value too large!	Value is too high. Enter value within limits.
41	Value too small!	Value is too low. Enter value within limits.
42	Deviation too large!	Deviation is out of limit. Enter correct value.
44	Unable +/-!	Polarity change is not allowed for selected mode.
45	Unable - polarity!	Negative polarity is not allowed for selected mode.
51	High temperature!	20 A amplifier overheated. Output stage is overloaded. Do not use 20 A range for at least 10 minutes. Check if the ventilation holes are free.

4. M143 SCPI Command Reference

OUTPut subsystem

This subsystem enables to activate or deactivate the M143/143i output and switch on/off current coil function.

Keyword	Parameters
OUTPut	
[:STATe](?)	<CPD> { ON OFF 0 1 }
:ISELction(?)	<CPD> { HIGHi HI50turn }

OUTP [:STAT](?) <CPD> { ON | OFF | 0 | 1 }

This command activates or deactivates output terminals.

- ON or 1 - activates the output
- OFF or 0 - deactivates the output

If query is sent, M143/143i returns ON if the output is active or OFF if it is inactive

Example: OUTP 1 <cr> - activates the output
 OUTP ? <cr> - the calibrator returns ON or OFF

OUTP :ISEL(?) <CPD> { HIGH | HI50 }

This command activates or deactivates setting using a 50-turn coil.

- HIGH - deactivates the 50-turn coil
- HI50 - activates the 50-turn coil (up to 100A range)

If query is sent, M143/143i returns HIGH if the 50-turn coil is deactivated or HI50 if it is activated.

Example: OUTP :ISEL HI50 <lf> activates the 50-turn coil
 OUTP :ISEL ? <lf> the calibrator returns HIGH or HI50

SOURce subsystem

This subsystem allows to control the individual functions of M143/143i calibrator.

Keyword	Parameters
[SOURce]	
:FUNCTion	
[:SHAPe](?)	<CPD> { DC SINusoid RMPA RMPB TRIangle LIMS SQUARE }
:VOLTage	
[:LEVEl]	
[:IMMediate]	
[:AMPLitude](?)	<DNPd>
:CURRent	
[:LEVEl]	
[:IMMediate]	
[:AMPLitude](?)	<DNPd>
:RESistance	
[:LEVEl]	
[:IMMediate]	
[:AMPLitude](?)	<DNPd>
:EARTH(?)	<CPD> { ON OFF 0 1 }
:FREQuency	
[:CW](?)	<DNPd>
:TEMPerature	
:UNITs(?)	<CPD> { C CEL F FAR }

```

:SCALe(?) <CPD> { TS68 | TS90 }
:THERmocouple
  [:LEVEl]
    [:IMMediate]
      [:AMPLitude](?) <DNPd>
:TYPE(?) <CPD> { B | E | J | K | N | R | S | T }
:RJUN
  :RSElect(?) <CPD> { REAL | SIMulated }
  :SIMulated(?) <DNPd>
  :REAL(?) <DNPd>
:PRT
  [: LEVEl]
    [: IMMEDIATE]
      [: AMPLitude] (?) <DNPd>
  : TYPE (?) <CPD> { PT385 | PT392 | NI }
  : NRESistance (?) <DNPd>

```

[SOUR] :FUNC [:SHAP](?) <CPD> { DC | SIN | RMPA | RMPB | TRI | LIMS | SQU }

This command sets the shape of the output signal. At the same time, the respective function must be set. E.g. for :VOLT or :CURR function, FUNC DC, FUNC SIN, or other signal shape must be set. Some functions (:RES) do not require any other settings.

- DC sets a DC output signal for voltage, current or power modes.
- SINusoid sets AC output signal for voltage, current or power modes.
- RMPA sets AC output signal - ramp shape A- for voltage or current modes. The amplitude can be set. -The output switches between -amplitude a +amplitude.
- RMPB sets AC output signal - ramp shape B - for voltage or current modes. The amplitude can be set. -The output switches between -amplitude a +amplitude.
- TRIangel sets AC output signal - triangular shape - for voltage or current modes. The amplitude can be set. -The output switches between -amplitude a +amplitude.
- LIMSinusoid sets AC output signal - sinus shape with limitation of amplitude- for voltage or current modes. The amplitude can be set. -The output switches between -amplitude a +amplitude.
- SQUare sets digital frequency output.

If query is sent, M143/143i returns a string containing { DC | SIN | RMPA | RMPB | TRI | LIMS | SQU } depending on the current setting. If resistance or temperature sensor simulation is set, NONE is returned.

[SOUR] :VOLT [:LEVE] [:IMM] [:AMPL] (?) <DNPd>

This command activates the generation of DC or AC voltage (depending on the DC or SIN parameter of the FUNC command).

<DNPd>

The command represents the value of DC or AC voltage expressed in Volts. Negative value is accepted for DC voltage. “Technical Data” chapter lists the acceptable ranges.

If query is sent, M143/143i returns the set value of current using standard exponential format.

Example: 20.547mV is returned as -2.054700e-002. Positive numbers are sent without “+” sign.

Examples:

DC voltage 5V:

```
FUNC DC::VOLT 5<lf>
```

AC voltage 5V, 100Hz:

```
FUNC SIN::VOLT 5::FREQ 100<lf>
```

[SOUR] :CURR [:LEVE] [:IMM] [:AMPL] (?) <DNPd>

This command activates the generation of DC or AC current (depending on the DC or SIN parameter of the FUNC command).

<DNPD>

The command represents the value of DC or AC current expressed in Amperes. Negative value is accepted for DC current. "Technical Data" chapter lists the acceptable ranges.

If query is sent, M143/143i returns the set value of current using standard exponential format.

Example: 20.547mA is returned as -2.054700e-002. Positive numbers are not preceded with "+" sign.

Examples::

DC current 18mA:

```
FUNC DC;;CURR 0.018<lf>
```

AC current 18mA, 100Hz:

```
FUNC SIN;;CURR 0.018;;FREQ 100<lf>
```

[SOUR] :RES [:LEVE] [:IMM] [:AMPL] (?) <DNPD>

This command activates the generation of a resistance.

<DNPD>

The command represents the value of the resistance in Ω . "Technical Data" chapter lists the acceptable ranges.

If query is sent, M143/143i returns the calibration value of resistance using standard exponential format. Example: 100.5 Ω is returned as 1.005000e+002.

Example :

Resistance 1k Ω setting:

```
RES 1000<lf>
```

[SOUR] :EART(?) <CPD> { ON | OFF | 0 | 1 }

This command connects or disconnects the voltage Lo terminal to/from GND terminal.

- ON or 1 grounds the voltage output
- OFF or 0 unground the voltage output

If query is sent, M143/143i returns ON when the output is grounded or OFF when ungrounded.

Example:

Grounding of the voltage output terminal Lo

```
EART : VOLT 1 <lf>
```

[SOUR] :FREQ [:CW] (?) <DNPD>

This command sets the frequency being generated.

Examples:

AC voltage frequency :

```
FUNC :SIN ; :VOLT <DNPD>; :FREQ <DNPD> <lf>
```

AC current frequency :

```
FUNC :SIN ; :CURR <DNPD>; :FREQ <DNPD> <lf>
```

Digital frequency :

```
FUNC :SQU ; :FREQ <DNPD> <lf>
```

<DNPD>

It represents the frequency in Hz. . "Technical Data" chapter lists the acceptable ranges which depend on the selected function mode.

If query is sent, M143/143i returns the set value of the current using standard exponential format.

Example: 200.5Hz is returned as 2.005000e+002.

[SOUR] :TEMP :UNIT(?) <CPD> { C | CEL | F | FAR }

This command sets the unit of measurement of temperature.

- C or CEL sets „Centigrade“
- K or FAR sets „Kelvin“

The unit of measurement remains valid after the calibrator is switched off.

If query is sent, M143/143i returns the set unit of measurement { C | K }.

[SOUR]:TEMP:SCAL(?) <CPD> { TS68 | TS90 }

This command sets one of temperature scales. The setting influences the simulation of resistance temperature sensors and thermocouples.

- TS68 sets IPTS-68 temperature scale
- TS90 sets ITS-90 temperature scale

The temperature scale remains valid after the calibrator is switched off.

If query is sent, M143/143i returns the set temperature scale { TS68 | TS90 }.

[SOUR]:TEMP:THER:RJUN:REAL? <DNPD>

This command send the temperature of external temperature sensor Pt1000.

<DNPD>

Represents the temperature expressed in the units set by the 'UNIT' command. "Technical Data" chapter lists the acceptable ranges.

Example: to read the temperature of temperature sensor:

:TEMP:THER:RJUN:REAL?<lf>

M143/143i returns the temperature using standard exponential format. Example: 20.5°C is returned as 2.050000e+001.

[SOUR]:TEMP:THER:TYPE(?) <CPD> { B | E | J | K | N | R | S | T }

This command sets the type of thermocouple to be simulated.

If query is sent, M143/143i returns the set type thermocouple { B | E | J | K | N | R | S | T }.

Examples:

TC type K setting, temperature 200°C, ITS-90 temperature scale:

:TEMP:UNIT C::TEMP:SCAL TS90::TEMP:THER:TYPE K::TEMP:THER 200 <lf>

[SOUR]:TEMP:THER:RJUN:RSEL(?) <CPD> { REAL | SIM }

This command sets type of getting the cold end of thermocouple RJ temperature. The RJ temperature can be either measured by internal thermometer or simulated.

- REAL sets measured RJ temperature
- SIM sets simulated RJ temperature

If query is sent, M143/143i returns the set type of RJ temperature { REAL | SIM }.

[SOUR]:TEMP:THER:RJUN:SIM(?) <DNPD>

This command sets the temperature of cold end of thermocouple RJ.

<DNPD>

Represents the temperature expressed in the units set by the 'UNIT' command. "Technical Data" chapter lists the acceptable ranges.

Example: to set the temperature of cold end of thermocouple to 25°C:

:TEMP:THER:RJUN:SIM 25 <lf>

If query is sent, M143/143i returns the set temperature using standard exponential format. Example: 20.5°C is returned as 2.050000e+001.

[SOUR]:TEMP:THER:RJUN:REAL? <DNPD>

This command read actual temperature of cold end of thermocouple RJ from external temperature sensor.

<DNPD>

Represents the temperature expressed in the units set by the 'UNIT' command. "Technical Data" chapter lists the acceptable ranges.

Example: to read the temperature of cold end of thermocouple from external temperature sensor:

:TEMP:THER:RJUN:REAL? <lf>

If query is sent, M143/143i returns the real temperature using standard exponential format. Example: 20.5°C is returned as 2.050000e+001.

[SOUR] :TEMP :PRT [:LEVE] [:IMM] [:AMPL] (?) <DNPD>

This command activates the simulation of resistance temperature sensors (resistance generation).
<DNPD>

Represents the temperature expressed in the units set by the 'UNIT' command. "Technical Data" chapter lists the acceptable ranges.

If query is sent, M143/143i returns the set temperature using standard exponential format. Example: 20.5°C is returned as 2.050000e+001.

[SOUR] :TEMP :PRT :TYPE (?) <CPD> { PT385 | PT392 | NI }

This command sets the type of resistance temperature sensor to be simulated.

Example: to activate the simulation of platinum resistance temperature sensor at 350°C approximated using PT385 table (Europe):

:TEMP :PRT 350; :TEMP :PRT :TYPE PT385 <cr>

If query is sent, M143/143i returns the set type of approximation table { PT385 | PT392 | NI }.

[SOUR] :TEMP :PRT :NRESistance (?) <DNPD>

This command sets the nominal resistance of the resistance temperature sensor at 0°C. 100Ω to 1kΩ can be set.

<DNPD>

Represents the nominal resistance in Ω.

If query is sent, M143/143i returns the set value of nominal resistance using standard exponential format. Example: 100Ω is returned as 1.000000e+002.

SYSTem subsystem

The subsystem enables to control various functions from the MENU.

SYSTem

:DATE(?) <DNPD>,<DNPD>,<DNPD>

:TIME(?) <DNPD>,<DNPD>,<DNPD>

SYST :DATE(?) <DNPD>,<DNPD>,<DNPD>

This command sets system date of the calibrator.

<DNPD>,<DNPD>,<DNPD>

Represents date in format YYYY, MM, DD.

If query is sent, M143/143i returns current value of system date in format YYYY,MM,DD.

where YYYY = year (2000..2099)

MM = month (01..12)

DD = day (01..31)

SYST :TIME(?) <DNPD>,<DNPD>,<DNPD>

This command sets time of the calibrator.

<DNPD>,<DNPD>,<DNPD>

Represents time in format HH,MM,SS.

If query is sent, M143/143i returns current value of system time in format HH,MM,SS.

where HH = hour (00..23)

MM = minute (00..59)

SS = second (00..59)

I/D (instrument identification)

***IDN?**

This command returns the identification of the manufacturer, model, serial number and firmware revision.

The reply is formatted as follows:

MEATEST,M-143/143i ,670011,1.000

Operation complete

***OPC**

This command sets the OPC bit in the ESR (Event Status Register) when all pending operations are complete.

Operation complete?

***OPC?**

This command returns “1” to the output queue after all pending operations are complete.

Wait-to-Continue command

***WAI**

Prevents the instrument from executing any further commands or queries until all previous remote commands have been executed.

Reset

***RST**

This command resets the calibrator to its initial status.

Test operation

***TST?**

This command launches an internal self-test. Return the self-test result (“0” for pass or “1” for fail).

Status byte reading (IEEE488 only)

***STB?**

This query returns number in range 0 to 255 with information about content of register STB, which carries the MSS bit status.

Service Request Enable reading (IEEE488 only)

***SRE <value>**

This command sets condition of the Service Request Enable register. Since bit 6 is not used, the maximum value is 191.

Service Request Enable reading (IEEE488 only)

***SRE?**

This query returns the Service Request Enable Register number.

Event Status Register reading (IEEE488 only)

***ESR?**

This query returns the contents of the Event Status Register and clears the register.

Event Status Enable setting (IEEE488 only)

***ESE <value>**

This command programs the Event Status Enable register bits. Parameter “value” is number in range 0 – 255.

Event Status Enable reading (IEEE488 only)

***ESE?**

This query returns the Event Status Enable register.

Clear status (IEEE488 only)

***CLS**

This command clears the Event Status Register and the Status Byte Register except the MAV bit and output queue. Output line is not reset.

Remote control

***REM**

This command activates the remote control. When the calibrator is controlled by GPIB bus, it goes to the remote control mode automatically. When remote control is active, the calibrator ignores all controls from the front panel, except LOCAL button.

Local control

***LOC**

This command activates the local control (using front panel buttons). When the calibrator is controlled by GPIB bus, it goes to the local control mode automatically.

Local control lock

***LLO**

This command locks out the local control; the calibrator cannot be returned to local control by pressing LOCAL button. Return to local control can only be performed by a command sent through the bus, or by switching the calibrator off and on.

Local control unlock

***UNL**

This command cancels the „*LLO“ command. Unlocked calibrator can be returned to local control mode by pressing LOCAL button.