M160

Precision DC calibrator

Operation manual

MEATEST

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1. Basic information

Precision DC calibrator M160 is an accurate source of DC voltage and DC current. It offers thermocouple and RTD simulation and some other features suitable for process calibrations. Calibrator is designed for use in production, but can be used also for development or in calibration laboratories.

Actual set values are displayed on high resolution TFT display. M160 is sophisticated instrument with its own re-calibration procedure. The procedure enables to correct any deviation without any mechanical adjusting.

Instrument is especially suitable for automatic testing procedures. RS232 line (optionally IEEE488, USB and Ethernet bus) is used for connecting calibrator to the computer.

2. Preparation for use

2.1. *Inspecting package contens, selecting the installation location*

Basic package includes the following items:

- Precision DC calibrator M160/M160i
- Power line cord
- User's manual
- Test report
- Spare fuse
- RS232 cable
- Option 15 – test lead (black)
- Option 16 – test lead (red)
- Option 160-60 frequency adapter
- Option 160-70 resistance adapter (M160 only)

The instrument must be powered by 230/115 V – 50/60 Hz mains. Before powering on the instruments, place it on a level surface. If the instrument was stored out of range of reference temperatures, let it stabilize for one hour.

2.2. *Power on*

- Before connecting the instrument to the mains, check the position of the mains voltage selector located at the rear panel.

- Plug one end of the power cord into the connector located at the rear panel and connect the other end of the power cord into a wall outlet.

- Switch on the mains switch located at the rear panel. Display is lit.
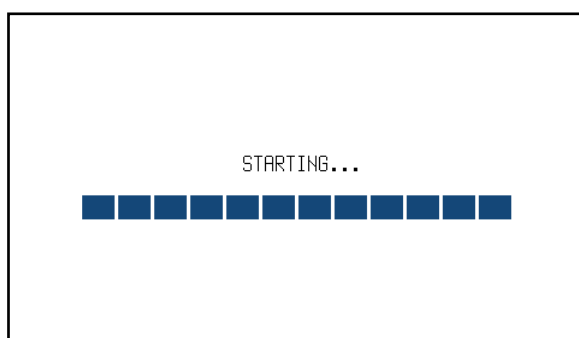
STARTING...

Figure 1 Starting Screen

- The instrument performs internal hardware checks for app. 5 seconds.

- After the tests conclude, the instrument resets to its Startup state (first item in Preset table). Startup state can be changed. Deafult setting is:

Function	Voltage DC
Set value	10.0000 V
Output terminals	OFF

2.3. Warm-up time

The instrument is ready after it is switched on and the initial checks complete. Specified parameters are guaranteed only when internal temperature reaches certain point.

Symbol [§§§] appears on display when internal temperature gets out of range (e.g. on startup, ambient temperature is too high or too low), specified parameters are not guaranteed in such state.

Figure 2 Warm-up

2.4. Safety precautions

The instrument has been designed according to EN 61010-1:2011. Safety is ensured by the design and by the use of specific component types.

The manufacturer is not liable for the damage caused by modification of the construction or replacement of parts with non-original ones.

Safety symbols used on the equipment

Warning, reference to the documentation
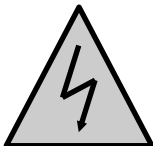
Warning - risk of electric shock.
Hazardous voltage. Voltage > 30 V
DC or AC peak might be present.

3. Description

3.1. Front panel
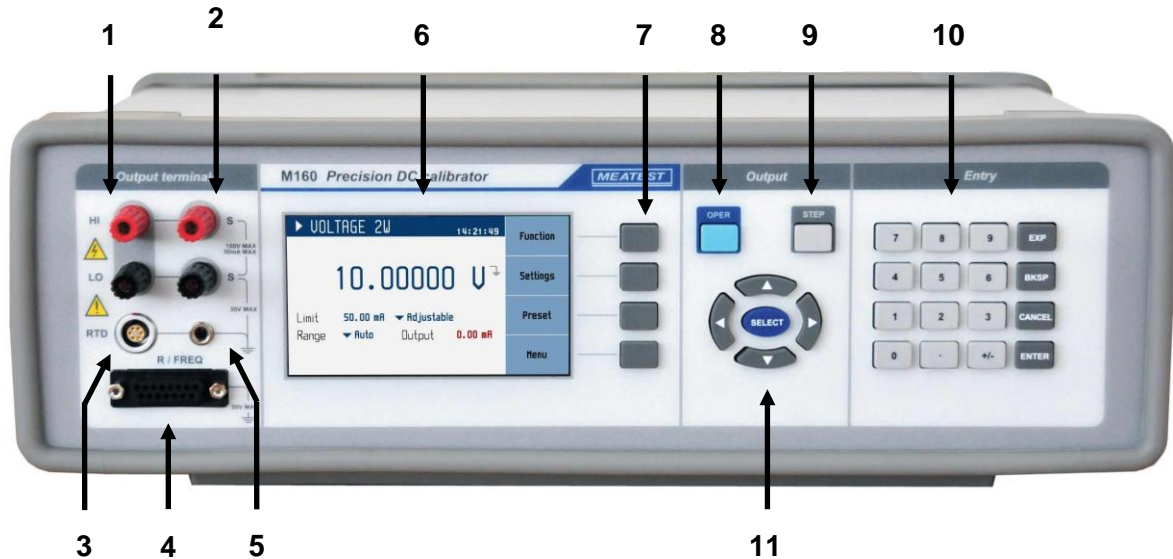
Figure 3 Front panel

On the front panel there are located all main control keys, display and output terminals.

1 Voltage/Current terminals

HI / LO are two wire output terminals. LO terminal is floating up to 50Vpk against the case (PE).

2 Voltage sense terminals

S / S are sense terminals for four wire voltage configuration.

3 RTD meter terminal

RTD connector is an input for thermocouple remote sense temperature measurement.

4 R/FREQ terminal

Auxiliary connector for RTD (resistance) simulation and frequency generation / measurement.

5 GND terminal

Central groud terminal (protective earth) connected to the metal case of the instrument. It is recommended to connect it to the LO voltage terminal if connected meter is not grounded.

6   Display
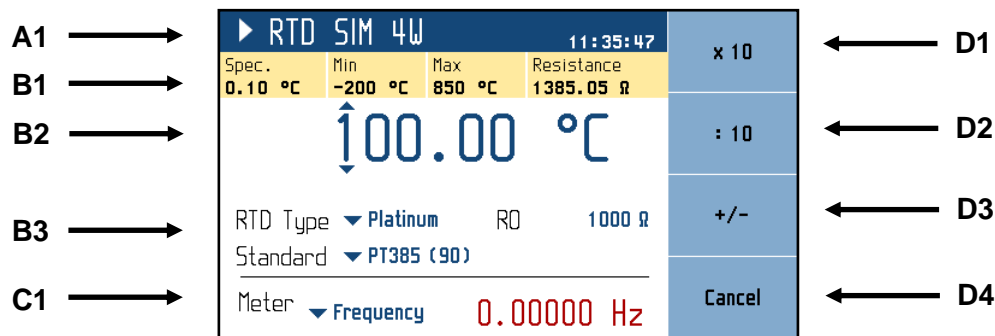
Figure 4 Display

The display is divided into four sections:

A. Information line

- Selected function (VOLTAGE 2W, CURRENT, …)
- Real time

B. Main area

This section displays the set-up values of generated signals and the data related to the device status. The section includes the following types of data:

1. *Tooltip line*
   This section displays additional information related to the selected item. It is displayed if any item on the screen is active (selected).

2. *Main value*
   There is displayed main value of selected function with the unit. There is displayed also actual position of cursor ▼▲ if the parameter is in edit mode. Position of cursor can be changed using keys ◄, ► and parameter can be changed using keys ▲,▼.

3. *Auxiliary parameters*
   This section displays auxiliary parameters of actually selected function:
   - Temperature standard (PT385, PT3916, …)
   - RTD type (Platinum, …)
   - R0 resistance

C. Meter

This section displays measured frequency or counter value. Meter can be displayed or hidden according to the switch (Meter show) in the Menu

D. Softkey labels

There are four keys next to the display with variable function. The functions of these keys change during operation (depends on selected function and actual display mode). These four softkeys appear in main function window by default:

Function – Setting the function. See chapter 4.3

Settings – Auxiliary parameter of selected function. See chapter 4.5

Preset – One click setup of all function parameters. See chapter 4.6

Menu – General settings and auxiliary parameters of all functions. See chapter 4.7

3.2. Rear panel

There are located power cord socket, power line fuse, power line voltage selector 115/230V, interface connectors RS232, SPS and optionaly LAN, USB and IEEE488 on the rear panel.

Figure 5 Rear panel

4. Operation

4.1.   *Connection and disconnection of output terminals*

Set value is connected (disconnected) to the output terminals after pressing OPER key. Connected output terminals are indicated by the lit LED in the key.

Disconected output terminals means:
- 0V in Voltage and TC functions
- 0mA in Current function
- LOW state with disconnected pull-up in Frequency function
- OPEN in RTD funcrion
- OPEN in resistance function

4.2.   *Front terminals*

Figure 6 Front terminals
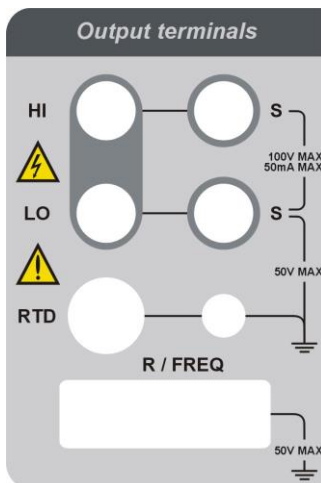
HI, LO
Main terminals for Voltage, Current and TC functions.

S, S
Sense terminals for Voltage 4W function.

RTD
Input connector for external Pt100 temperature sensor. Sensor is used for external RJ compensation in TC function.

GND
Ground terminal is connected to the metal case (PE protective earth).

R/FREQ
Auxiliary Output/Input connector. Output for Resistance 4W and RTD 4W functions. Output/Input for Frequency function. Suitable adapter to banana/BNC connectors is standard part of delivery.

4.3.   Setting the function

Function can be changed after pressing „Function" softkey. New function is selected using cursor keys ▲,▼ or display softkeys. Selection must be confirmed by pressing SELECT key, ENTER key or „OK" softkey.
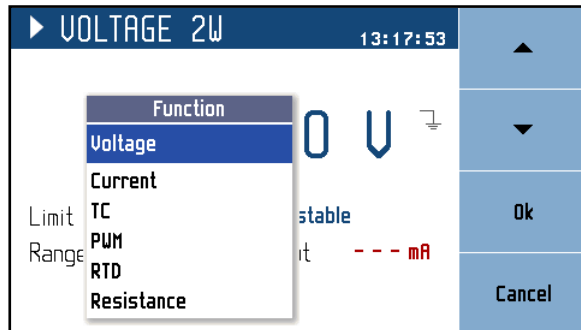
Figure 7 Function selection

Device supports following functions:

Voltage
Offers direct setting of DC voltage.

Figure 8 Voltage screen

Parameters:

Limit: 1.00 mA … 50.00 mA
                              Maximum output current without limiting the output voltage.
                              Parameter can be changed in the switch position "Adustable". In the switch
                                  position "Maximum" is set to maximum value.
Range: Auto, 100V, 30V, 3V, 300mV
                              Voltage range selection.
Output: Output current measured value.

Auxiliary parameters (Settings):

Terminal sense: Internal (2W), External (4W)
                              Two or four wire output configuration.
Terminal ground: On, Off
                              Connects LO terminal with the protective earth (PE) terminal in On state.
                              On state is indicated by the GND symbol ⏚ next to the main value.
Steps: Definition of 32 user programmable step sequences. Each sequence contains
                              up to 100 steps (amplitude/duration).

Current
Offers direct setting of DC current.

CURRENT   14:37:20
10.0000 mA
Limit   30.00 V ▼ Adjustable
Range   ▼ Auto   Output   0.12 V

Function / Settings / Preset / Menu
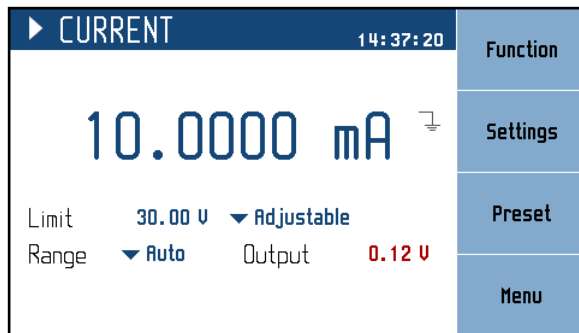
Figure 9 Current screen

Parameters:
Limit: 1.00 V … 100.00 V
                       Maximum output voltage without limiting the output current.
                       Parameter can be changed in the switch position "Adustable". In the switch
                          position "Maximum" is set to maximum value.
Range: Auto, 50mA, 25mA
                       Current range selection.
Output: Output voltage measured value.

Auxiliary parameters (Settings):
Terminal ground: On, Off
                       Connects LO terminal with the protective earth (PE) terminal in On state.
                       On state is indicated by the GND symbol ⊥ next to the main value.
Steps: Definition of 32 user programmable step sequencies. Each sequence contains
                       up to 100 steps (amplitude/duration).

TC
Offers direct setting of TC temperature.

TC SIM 2W   16:53:10
100.000 °C
TC type ▼ R
RJ mode ▼ Manual   RJ   000.000 °C

Function / Settings / Preset / Menu
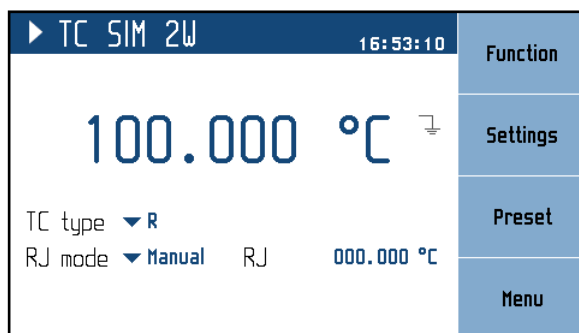
Figure 10 TC screen

Parameters:
TC type: R, S, B, J, T, E, K, N, M, C, D, G2
RJ mode: Manual, Extern
                       Reference junction compensation.
RJ: Reference junction temperature.
                       -   Red measured value for Extern RJ mode.
                       -   Blue editable value for Manual RJ mode.

Auxiliary parameters (Settings):

Terminal ground:	On, Off
	Connects LO terminal with the protective earth (PE) terminal in On state.
	On state is indicated by the GND symbol ⏚ next to the main value.
Temperature unit:	°C, °F, K
External RJ:	Folder with all RJ settings.
RJ type:	Platinum, Nickel – type of external RTD.
RJ R0:	100 Ω … 200 Ω, R0 value of external RTD.
Platinum standard:	Pt385 (68), Pt385 (90), Pt3916, Pt3926, Pt user
Platinum user coeff. A:	
Platinum user coeff. B:	
Platinum user coeff. C:	User coefficients for Pt user platinum standard.
Steps:	Definition of 32 user programmable step sequencies. Each sequence contains up to 100 steps (amplitude/duration).

Frequency

Offers direct setting of frequency (period) of generated pulses.
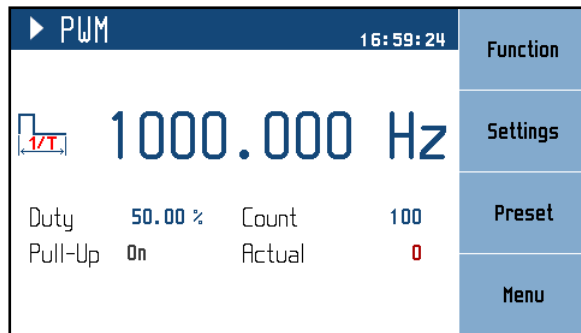
Figure 11 Frequency screen

Parameters:

Duty:	0.50% … 99.50%, duty cycle of generated signal
Count:	0 … 9999999, number of generated pulses
	Pulses generator must be set to On in Settings.
Pull-Up:	Off, On
Actual:	Actual number of generated pulses

Auxiliary parameters (Settings):

Expression:	Frequency, Period
Pulses generator:	Off, On
	Exact number of pulses generation.
Steps:	Definition of 32 user programmable step sequencies. Each sequence contains up to 100 steps (amplitude/duration).

RTD

Offers direct setting of temperature of simulated resistance thermometer.
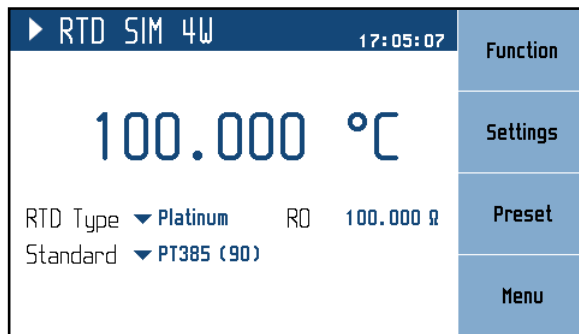
Figure 12 Platinum screen

Parameters:

RTD Type:	Platinum, Nickel
Standard:	PT385 (68), PT385 (90), PT3916, PT3926, PT User
R0:	100 Ω … 1000 Ω

Auxiliary parameters (Settings):

|	
Wire connection:	2W, 4W
	Two or four wire output configuration.
Terminal ground:	On, Off
	Connects Li and Lu terminals with the protective earth (PE) terminal in On state. On state is indicated by the GND symbol ⏚ next to the main value.
Temperature unit:	°C, °F, K
Platinum user coeff. A:	
Platinum user coeff. B:	
Platinum user coeff. C:	User coefficients for Pt user platinum standard.
Steps:	Definition of 32 user programmable step sequences. Each sequence contains up to 100 steps (amplitude/duration).

Resistance

Offers direct setting of Resistance.
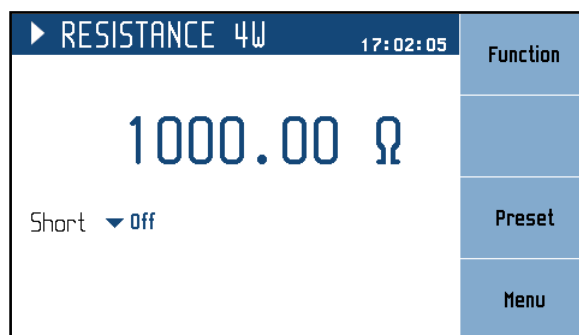
Figure 13 Resistance screen

Parameters:

Short:	Off, On
	Short circuit simulation. Also the short circuit must be connected to the output terminals by the OPER key.

Auxiliary parameters (Settings):

Wire connection:	2W, 4W

	Two or four wire output configuration.
Terminal ground:	On, Off
	Connects Li and Lu terminals with the protective earth (PE) terminal in On state. On state is indicated by the GND symbol ⏚ next to the main value.
Steps:	Definition of 32 user programmable step sequencies. Each sequence contains up to 100 steps (amplitude/duration).

4.4. Setting the step mode

Function can be changed after pressing „Step" key.
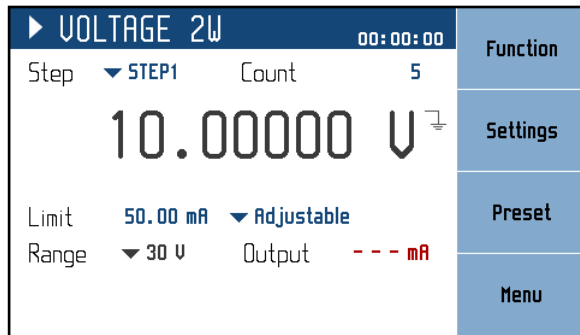
Figure 14 Step mode

New parameters:

Step – table defined by the user

Count – number of repetitions (N/A for resistance and RTD); set 0 for infinite loop

Sequence is defined by table of time intervals and corresponding function values, all of which can be edited. Maximum number of tables is 64 with each table having up to 100 time intervals. Sequence is started by pressing OPER button or sending OUTP ON command via remote control. Manual table setup can be done in *Settings → Steps*:
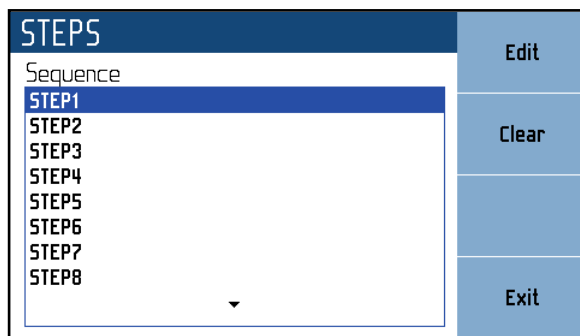
Figure 15 Step sequence list

Menu shows a list of all sequences. Softkeys on the right hand side of the panel have these functions:

Edit – edit selected sequence. Sequence can be selected using cursor keys where ◄, ► skip through pages.

Clear – clear all sequence data and set it to default (plain) state. Message prompt will appear before final clearance of the sequence.

Exit – close the sequence list and return previous menu.

Creating a new table

Pressing the *Edit* softkey upon plain sequence opens this submenu:
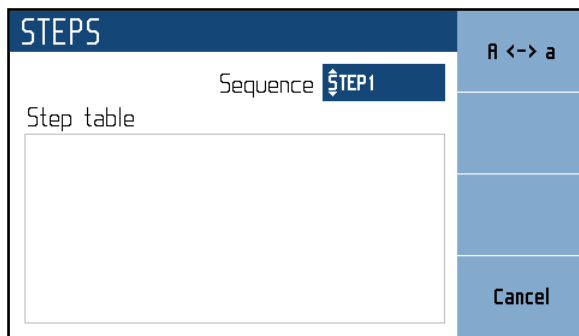
Figure 16 New sequence

Step table – table name is set using ▲,▼ (character selection) and ◄, ► (position) cursor keys. Name may be 8 characters long at most. Softkey „*A <-> a*" switches between uppercase and lowercase of selected character. Table name has to be set before proceeding to the next step using SELECT key.

Step table – a list of values and their durations in seconds. Browsing through the table is done by ▲,▼ cursor keys. Editing is done using these softkeys:

> **Add** – create a new point.
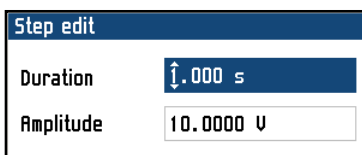
Figure 17 Timing sequence point editing

> > **Duration** – duration of selected resistance (from 10 ms to 600 s). Press the SELECT key to proceed.

> > **Amplitude** – corresponding function value. Range is selected automatically to fit all values in sequence.

> **Edit** – show the "Timing edit" panel for selected point to allow editing.

> **Delete** – delete selected point.

> **Cancel** – deactivate the Lookup Table and allow for curve saving.

Save – closes the table and saves current settings.

Cancel – closes the table and <u>does not</u> save current settings.

Editing an existing table

Existing table can be edited in the same way as it can be created. Editable entries (Sequence name, Timing table points) are selected using the SELECT key.
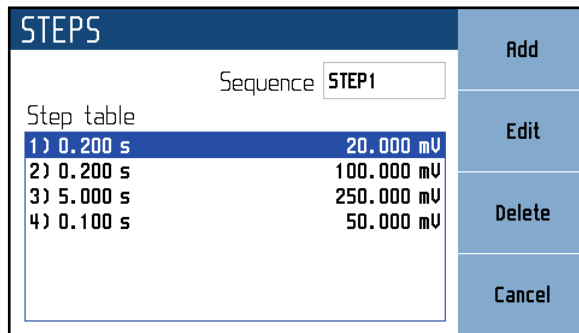
Figure 18 Step sequence edit

4.5. *Setting the value of output signal*

Edit mode

Parameters of output signal can be changed in Edit mode. Only parameters displayed in blue color can be changed. Display can be switched to edit mode in different ways:
- Pressing numeric button
- Pressing SELECT key
- Pressing cursor button

In edit mode is edited value highlighted by blue background. Exception is the main parameter, which is not highlighted. You can change among editable (blue) parameters pressing the SELECT key. Edit mode is finished by pressing CANCEL key.

Entry of the value using numeric keyboard
- Use the numeric keyboard to set the desired value. After the first digit is entered, input box is displayed. In the upper row of the input box is the name of edited parameter. Using softkeys you can enter the new value in different units.

Figure 19 Numeric value entry

- Enter desired value.

- After the entry is complete press softkey with requested unit or press ENTER key. ENTER key inputs the value in basic units (V, Ω, °C …).

- Instrument sets the new value.

- The value is copied to the appropriate field in the screen and the input box disappears.

Note:

- All parameters have limits (high and low). If the entered value is outside these limits warning message is displayed „Value too high (low)" and new value is not accepted.

Entry of the value using cursor keys

- Press ◄, ►, ▲ or ▼ key. The display now includes cursor marks which points to the active digit.

- ▲,▼ keys can be used to change the value. ◄, ► keys can be used to change the position of active digit.

- To get to the default screen, press CANCEL key.

4.6.   Auxiliary parameter settings (Settings menu)

Settings menu is displayed after pressing „Settings" softkey in main function window. It won't appear in editing mode so when in editing mode you have to press "Cancel" first.
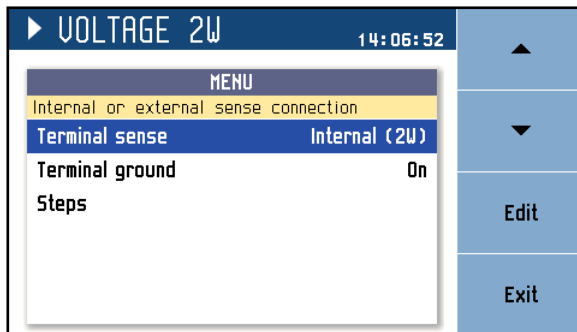
Figure 20 Settings menu

In settings menu you can edit all available auxiliary parameters of the current function. These settings are discarded on restart so if you'd like to save them for your next calibration session, use the "Preset" feature.

4.7.   Preset menu

Preset menu is displayed after pressing „Preset" softkey in the main function window. It won't appear in editing mode so when in editing mode you have to press "Cancel" first.

Figure 21 Preset menu

Presets contain all settings that normally disappear on restart. This includes auxiliary and main parameters for all functions (see previous chapter), selected function, main value and step state. Presets doesn't contain system, interface or calibration data as well as output state and step tables. Up to a 100 presets can be stored including a special "Startup" preset which is loaded on every device startup.

Startup (position 00) is reserved for the definition of device settings after power on. User can save any required Startup configuration.

Preset can be selected using cursor keys where ◄, ► skip through pages.

Save – Save current device settings to selected preset. Preset name can be edited before final saving.

Load – Load selected preset and return to function window defined by the preset.

Clear – Set selected preset to default factory setup.

Exit – Return to main function window.

4.8.   *Main Menu*

Main menu is displayed after pressing „Menu" softkey. Main Menu allows configuration and calibration of the device.
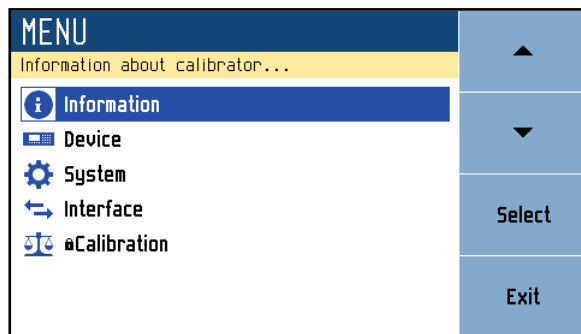
Figure 22 Setup menu

Required menu item is highlighted using cursor keys ▲,▼ or display softkeys. Highlighted menu is selected by pressing SELECT key or „Select" softkey. Only editable items can be selected.

Information
This menu displays information about the device. Items can't be changed by the user.

Manufacturer
Model
Serial number
Software version
Calibration validity

Device
This menu summarizes settings of auxiliary parameters for all functions. For description of individual items see chapter 4.3.

System
This menu permits setting system parameters of device.

Language
Language setting.

Backlight
Display backlight level setting.

Beeper
Beeper setting.

Show tooltips on display
Enables / Disables tooltips in the function windows (specification, ranges …).

Form of specification
Auto/Absolute/%/ppm way of showing specification in tooltips line.

Date&Time
Internal date/time setting.

Interface
This menu permits setting parameters of remote control interfaces.

Active bus
Active bus setting. Only active bus can be used for remote control.

RS232 Baudrate
RS232 communication baudrate setting. The same baudrate must be used in the controller.

GPIB Address
GPIB address setting. Each instrument connected to the GPIB bus must have a unique address.

LAN Settings
Ethernet parameters setting. Device use Telnet protocol. Default setting is:

DHCP	ON	
IP Address	192.168.001.100	only valid if DHCP is OFF
Subnet mask	255.255.255.000	only valid if DHCP is OFF
Default gateway	255.255.255.255	only valid if DHCP is OFF
Port number	23	
Host name	M160_SN710011	only valid if DHCP is ON

Calibraion
This menu permits adjusting of calibration constants. See chapter 5.

5. Calibration

Access to the calibration mode is from the setup Menu.

Correct password must be entered before calibration. Without correct password the access to the calibration mode is refused. Default factory set calibration code is "2". Return to standard mode is possible after pushing the CANCEL key.
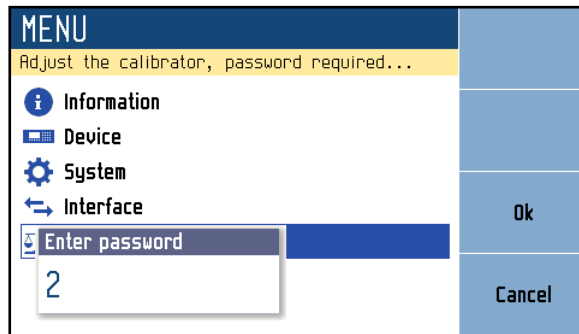
Figure 23 Password entry

Warning:
Calibration data cannot be changed during warm-up period. You can still browse previously saved data but all changes will be discarded.

5.1.   Calibration menu

Calibration menu appears after entering the correct password.
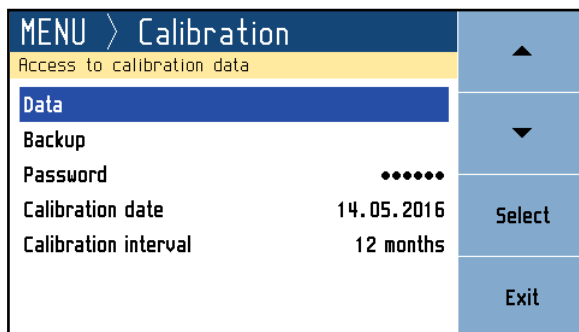
Figure 24 Password entry

Data
Direct access to all calibration data.

Backup
Backup is a tool for managing calibration backups.For example it allows recovery of older calibration data.

Password
Calibration Password editing.

Calibration date
Last calibration date.

Calibration interval
Recommended calibration interval for this unit.

5.2.   Adjustment

Following instruments are required for full adjustment:

- Keysight 3458A, Fluke 8508A or similar 8½ DMM with 10 ppm accuracy in DC voltage or better

- Keysight 53181A, Keysight 53131A or similar counter with 10 ppm accuracy or better

Go to "Calibration->Data" and using softkeys, select function and then range to be adjusted. All data points shall be adjusted in shown order in one go, see chapter "Adjustment points" for more details. Having selected the required calibration range, the following page is shown:
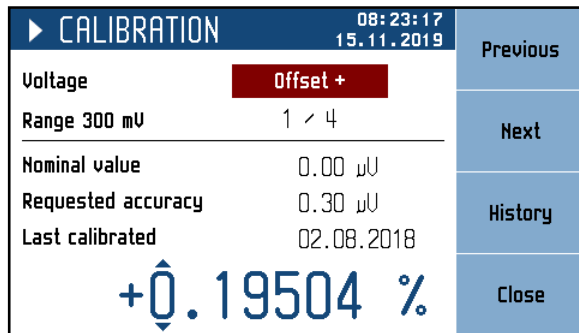
Figure 25 Calibration point

Here you can navigate through data points of selected range (300 mV in this case) using Previous and Next softkeys, check previous values of this data point with History softkey or change its value using cursor keys.

To adjust selected data point, connect standard device to output terminals and select its function accordingly (8½ digit DMM, Vdc function). Turn output on with OPER key. Adjust offset value with cursor keys so that nominal value and standard device readout are as close as possible.
Example: Let's say you selected the data point 1 (offset+) in 300 mV range as shown above. You turned output on and your standard multimeter reads 0.83 µV. Now you have to gradually decrease the offset value until the standard meter reads voltage around 0.00 µV. The closer you get, the better.

Once done, confirm the new value with Save softkey (output has to be switched on) and continue with next data point or leave the calibration menu with Close softkey.

Important note: With autocalibration enabled, changing 300 mV Offset+ data point will trigger a short sequence of internal measurements, showing this message:
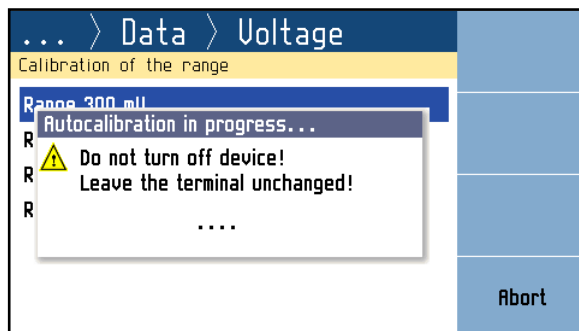
Figure 26 Autocalibration in progress

Do not interrupt this operation! All autocalibration offsets depend on this data point, aborting this measurement will invalidate all autocalibration offsets. The measurement can be re-initiated by adjusting the 300 mV Offset+ data point again.

5.3.   *Adjustment points*

The following is a list of all functions and their adjustment points. The instrument can be partially adjusted as well but in order to achieve best overall accuracy you should adjust all points in one go and in the same order as listed below.

Voltage

Range	Point	Nominal value	Requested Accuracy
300 mV	Offset +	0,00 µV	0,3 µV
300 mV	Offset -	0,00 µV	0,3 µV
300 mV	Full range +	285 mV	1,2 µV
300 mV	Full range -	-285 mV	1,2 µV
3 V	Offset +	0,00 µV	2 µV
3 V	Offset -	0,00 µV	2 µV
3 V	Full range +	2,85 V	11 µV
3 V	Full range -	-2,85 V	11 µV
30 V	Offset +	0,00 µV	20 µV
30 V	Offset -	0,00 µV	20 µV
30 V	Full range +	28,5 V	110 µV
30 V	Full range -	-28,5 V	110 µV
100 V	Offset +	0,00 µV	100 µV
100 V	Offset -	0,00 µV	100 µV
100 V	Full range +	95 V	400 µV
100 V	Full range -	-95 V	400 µV

Table 1 Calibration points – Voltage

Current

Range	Point	Nominal value	Requested Accuracy
25 mA	Offset +	0,00 µA	0,1 µA
25 mA	Offset -	0,00 µA	0,1 µA
25 mA	Full range +	23,75 mA	0,22 µA
25 mA	Full range -	-23,75 mA	0,22 µA
50 mA	Offset +	0,00 µA	0,1 µA
50 mA	Offset -	0,00 µA	0,1 µA
50 mA	Full range +	47,5 mA	0,34 µA
50 mA	Full range -	-47,5 mA	0,34 µA

Table 2 Calibration points – Current

Temperature (External RJ)

Range	Point	Nominal value	Requested Accuracy
-	Offset	23 °C	0,01 °C

Table 3 Calibration points – Temperature (External RJ)

Frequency

Range	Point	Nominal value	Requested Accuracy
15 kHz	100 Hz	100 Hz	0,01 µHz

Table 4 Calibration points – Frequency

Resistance (option)

Range	Point	Nominal value	Requested Accuracy
-	1	30 mΩ	1,00 mΩ
-	2	19,4 Ω	1,00 mΩ
-	3	38,2 Ω	1,00 mΩ
-	4	76,8 Ω	2,00 mΩ
-	5	150 Ω	3,00 mΩ
-	6	299 Ω	6,00 mΩ
-	7	589 Ω	15,00 mΩ
-	8	1,15 kΩ	30,00 mΩ
-	9	2,19 kΩ	100 mΩ
-	10	4,37 kΩ	250 mΩ
-	11	8,59 kΩ	500 mΩ
-	12	16,7 kΩ	1,00 Ω
-	13	33,0 kΩ	5,00 Ω
-	14	65,0 kΩ	10,0 Ω
-	15	129 kΩ	20,0 Ω
-	16	253 kΩ	40,0 Ω
-	17	503 kΩ	80,0 Ω
-	18	1,00 MΩ	200 Ω
-	19	2,00 MΩ	400 Ω
-	20	3,92 MΩ	1,00 kΩ
-	21	7,82 MΩ	5,00 kΩ
-	22	15,5 MΩ	50,0 kΩ
-	23	29,8 MΩ	200 kΩ
-	24	58,8 MΩ	500 kΩ
-	25	117 MΩ	1 MΩ

Table 5 Calibration points – Resistance (options)

5.4. Autocalibration

Autocalibration offsets are based on internal measurements of output terminals. This is to compensate for small daily drifts caused by material or temperature changes. Zero offsets can be measured in "Calibration->Data->Advanced->Source Autocalibration", 4W connection offset against 2W can be set in "Calibration->Data->Advanced->Source voltage terminal sense".
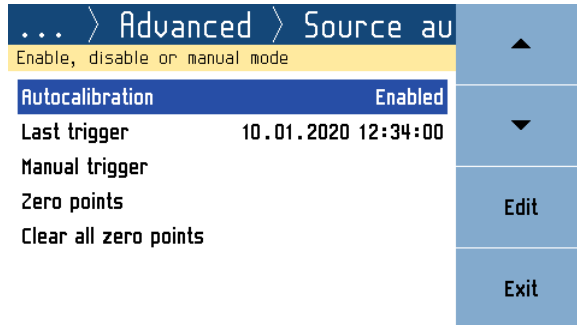
Figure 27 Source Autocalibration

For best results, all test leads shall be disconnected before triggering an autocalibration. If the calibrator cannot be disconnected (eg. as part of automated test system), make sure there is no active load at least. There are 3 autocalibration modes:

- **Enabled.** Autocalibration is triggered automatically every 24 hours. Measured offsets are added to output values.

- **Manual.** Autocalibration can be triggered on demand (via keybord or interface). Measured offsets are added to output values.

- **Disabled.** Measured offsets are not used. 24-hour stability applies in this mode only.

Running autocalibration is indicated by icon and can be interrupted by turning output on. Interrupted autocalibration will be resumed automatically when the calibrator is left idle again. Autocalibration will not start unless calibration conditions (minimum warm-up time, reference temperature,…) are met.

Last measured zero offsets can be found in "Zero points".

5.5. Performance verification test

Same instruments are required for performance verification test as for adjustment. See chapter "Adjustment" for more details.

Calibrator setup

Calibrator can be tested directly from the front panel terminals. To suppress influence of noise or interference with power line frequency in measuring circuit, it is recommended following setting of the calibrator (Settings menu):

Terminal ground   **On**

Procedure

Make sure the calibrator has been turned on in reference temperature conditions at least 1 hour before performing verification test. Verification procedure has following parts:

- 30 V voltage range test with linearity checking

- voltage interal ranges 300 mV, 3 V, 100 V

- 25 mA current range test with linearity checking

- current internal range 50 mA

- Frequency test at 1 kHz

- Resistance test in ponts 10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 300 kΩ (option)

Recommended testing points are the same as the points in table of allowed limits (see tables bellow).

30 V voltage range test with linearity test

Function	Range	Value	Max deviation (ppm of value)
Voltage	30 V	6 V	63,3
Voltage	30 V	12 V	46,7
Voltage	30 V	18 V	41,1
Voltage	30 V	24 V	38,3
Voltage	30 V	30 V	36,7
Voltage	30 V	-6 V	63,3
Voltage	30 V	-12 V	46,7
Voltage	30 V	-18 V	41,1
Voltage	30 V	-24 V	38,3
Voltage	30 V	-30 V	36,7

Table 6 Voltage range test 30 V

Voltage ranges verification test

Function	Range	Value	Max deviation (ppm of value)
Voltage	300 mV	150 mV	50,0
Voltage	300 mV	300 mV	40,0
Voltage	300 mV	-150 mV	50,0
Voltage	300 mV	-300 mV	40,0
Voltage	3 V	1,5 V	43,3
Voltage	3 V	3 V	36,7
Voltage	3 V	-1,5 V	43,3
Voltage	3 V	-3 V	36,7
Voltage	100 V	50 V	50,0
Voltage	100 V	100 V	40,0
Voltage	100 V	-50 V	50,0
Voltage	100 V	-100 V	40,0

Table 7 Voltage ranges verification test

25 mA current range test with linearity test

Function	Range	Value	Max deviation (ppm of value)
Current	25 mA	5 mA	250
Current	25 mA	10 mA	150
Current	25 mA	15 mA	117
Current	25 mA	20 mA	100
Current	25 mA	25 mA	90
Current	25 mA	-5 mA	250
Current	25 mA	-10 mA	150
Current	25 mA	-15 mA	117
Current	25 mA	-20 mA	100
Current	25 mA	-25 mA	90

Table 8 Current range test 25 mA

Current ranges verification test

Function	Range	Value	Max deviation (ppm of value)
Current	50 mA	30 mA	83,3
Current	50 mA	50 mA	70,0
Current	50 mA	-30 mA	83,3
Current	50 mA	-50 mA	70,0

Table 9 Current ranges verification test

Frequency

Function	Range	Value	Max deviation
Frequency	15 kHz	1 kHz	50,0 mHz

Table 10 Frequency verification test

Resistance (option)

Function	Range	Value	Max deviation (ppm of value)
Resistance	-	50 Ω	40,0 mΩ
Resistance	-	100 Ω	65,0 mΩ
Resistance	-	150 Ω	90,0 mΩ
Resistance	-	300 Ω	120 mΩ

Table 11 Resistance verification test (option)

6. Remote control

Device can be controled via RS232, GPIB, LAN and USB interface. Only one bus can be set as active for comunication. It is therefore necessary to select ans set-up one of the interfaces using the system menu. All interfaces shares the same commands except following commands, which are intended only for use with RS232, LAN and USB interface:

SYSTem:LOCal

This command places device in the "LOCAL" mode.

SYSTem:REMote

This command places device in the "REMOTE" mode.

SYSTem:RWLock

This command places the device in the "REMOTE" mode and locks all keys (including LOCAL key) on front panel.

NOTE: If device is not in REMOTE mode all other commands are ignored (for RS232, LAN and USB interface). With the exception of Compatible commands which are processed each time. GPIB interface places device in the "REMOTE" mode automatically by opening the GPIB interface and therefore these commands are not intended for this interface.

6.1.   *RS232 Interface*

Device can be controled via standard RS232 interface.

Following equipment is required:

- M160 precision DC calibrator
- Personal Computer (or other controling device) with RS232 port (USB-to-RS232 converter is also possible)
- 9-pin D-SUB, 3-wire direct (1:1) male/female RS232 cable

The RS232 interface must be selected from system menu to be in operation (*MENU->Interface->Active bus*). There is only one RS232 setting accesible from the system menu under *MENU->Interface* path:

RS232 Baudrate   1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200

Other RS232 parameters are fixed to the following settings:

Number of data bits   8
Number of stop bits   1
Parity   None
Handshake (XON/XOFF)   Off

RS232 connection
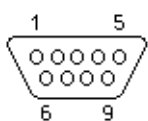
Pin	Label	I/O	Description
2	TXD	output	Transmitter
3	RXD	input	Receiver
5	GND	-	Ground

Figure 28 RS232 9 pin D-SUB MALE connector

RS232 cable wiring between device and computer (configuration 1:1)

Computer	D-Sub 1	D-Sub 2	Device
Receiver	2	2	Transmitter
Transmitter	3	3	Receiver
Ground	5	5	Ground

Table 12 RS232 cable connection

6.2.   GPIB Interface (option)

Device can be controled via GPIB (General Purpose Interface Bus) interface.

Following equipment is required:

- M160 precision DC calibrator with LAN, USB, IEEE488 bus option
- Personal Computer (or other controling device) with GPIB interface
- GPIB cable

The GPIB interface must be selected from system menu to be in operation (*MENU->Interface->Active bus*). There is only one GPIB setting accesible from the system menu under *MENU->Interface* path:

GPIB Address   1 to 31

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

SH1, AH1, T5, L3, RL1, DC1
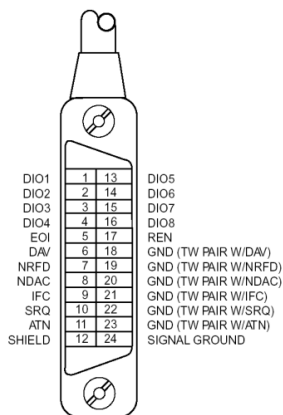
The instrument also recognizes the following general commands:
DCL Device Clear - resets the instrument to its basic state
SDC Selected Device Clear - resets the instrument to its basic state
GTL Go To Local - switches the remote control off
LLO Local Lock Out - switches the local control off, the instrument cannot be controlled from the front panel

Commands are identical to the commands for RS-232 interface. Detailed description is shown in chapter 8.2.

Figure 29 IEEE488 connector

6.3.   *LAN Interface (option)*

LAN Interface allows communication with device using Telnet protocol. A propper setting must be established.

Following equipment is required:

- M160 precision DC calibrator with LAN, USB, IEEE488 bus option
- Personal Computer (or other controling device) with LAN interface
- LAN cable

The LAN interface must be selected from system menu to be in operation (*MENU->Interface->Active bus*). There are folowing LAN settings accesible from system menu under *MENU->Interface->LAN Settings* path (values are default ones):

DHCP	ON	
IP Address	192.168.001.100	only valid if DHCP is OFF
Subnet mask	255.255.255.000	only valid if DHCP is OFF
Default gateway	255.255.255.255	only valid if DHCP is OFF
Port number	23	
Host name	M160_SN620031	only valid if DHCP is ON

If DHCP (Dynamic Host Configuration Protocol) is enabled, the IP Address and all necessary settings are done automatically and connection in Telnet protocol is done via "Host name" and "Port number". Otherwise the IP address, Subnest mask and Default gateway should be properly set. In this case connection is done via "IP Address" and "Port number".

Connection to thedevice using Microsoft Telnet terminal with DHCP option enabled:
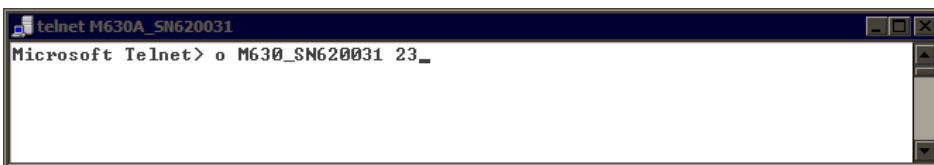
Figure 30 LAN connection 1

If connection is succesful following screen will appear:
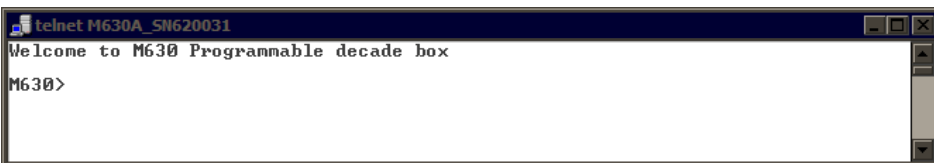
Figure 31 LAN connection 2

6.4. USB Interface (option)

Device can be controled via USB (Universal Serial Bus) interface.

Following equipment is required:

- M160 precision DC calibrator with LAN, USB, IEEE488 bus option
- Personal Computer (or other controling device) with USB interface (USB type A connector)
- Standard USB A-B cable

The USB interface must be selected from system menu to be in operation (*MENU->Interface->Active bus*). There is no USB setting in the device menu.

Device is equiped with USB type B connector.
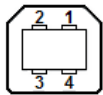
Pin	Label	Description
1	+5V	Power supply
2	DATA-	Data signal -
3	DATA+	Data signal +
4	GND	Ground

Figure 32 USB connector

Communication from user control program is performed via standard RS232 interface. Following settings must be set on your PC for propper operation:

Baudrate	9600 Bd
Data bits	8
Stop bits	1
Parity	None

Also proper COM port must be selected. After connecting device to your PC, virtual COM port should appear in System Control panel of Microsoft Windows OS. This COM port is labeled "USB Serial Port (COMxx)".

6.5.   Command syntax

The commands described in this chapter can be issued through all buses (RS232/GPIB/LAN/USB).

All commands listed in this chapter are explained in two columns:

KEYWORD and PARAMETERS.

KEYWORD column includes the name of the command. Each command includes one or more keywords. If a keyword is in brackets ([ ]), it is not mandatory. Non-mandatory commands are used only to achieve compatibility with language standard SCPI.

Capitals designate the abbreviated form of the commands; extended form is written in lowercase.

Command parameters are in brackets (<>); each parameter is separated using a comma. Parameters in brackets ([ ]) are not mandatory. Line (|) means "or" and is used to separate several alternative parameters.

Semicolon ';' is used to separate more commands written on one line.

E.g. :RES 100;:OUTP ON

Terminators:

For GPIB interface each command line must end with <lf>. Response from the device also returns <lf>. For non GPIB interfaces <cr>, <lf> or <crlf> can be used as terminator. The device returns <crlf> in this case. The device performs all commands written on one line of the program after it receives terminator. Without terminator, the program line is not executed.

Description of abbreviations

<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. {SERial|GPIB|USB|LAN}.

<SPD> =   String Program Data (quoted string). This type of parameter is similar to CPD, but allows transmission of more ISO characters.

<BOOL> = Boolean Program Data. This type of parameter has only two states 0 and 1. Parameter can take form of integer value (0 or 1), or character alias (ON or OFF). Device always returns integer value (0 or 1).

<UNIT> =   unit parameter works in conjunction with DNPD parameter and specifies unit of DNPD (numeric) value. Unit must be selected from predefined ones. If UNIT part is omitted, default one is used. Query always returns actual unit.

? =   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.

<cr> =   carriage return. ASCII code 13. This code executes the program line.

<lf> =line feed. ASCII code 10. This code executes the program line.

6.6. SCPI Command Tree

This chapter sumarizes all public SCPI commands supported by device in alphabetic order. Detailed description follows in next chapter.

```
:CALibration
      :DATE(?) <DNPD>,<DNPD>,<DNPD>
      :INTerval(?) <DNPD>
      :POINt
            :AMPLitude(?) <DNPD>
            :CONVerter? <DNPD>
            :DATE(?) <DNPD>,<DNPD>,<DNPD>
            :MEASure? <DNPD>
            :MODE(?) <DNPD>
            :SELect(?) <DNPD>
            :SAVE
      :SECure
            :EXIT
            :PASSword(?) <DNPD>
      :ACAL
            :ENAB(?) {OFF|ON|MANual}
            :CLR
            :TRIG
            :AMPLitude<IND_RANGE>? <DNPD>
:DISPlay
      :ANNotation
            :CLOCk
                  :DATE
                        :FORMat(?) {MDYS|MDYA|DMYS|DMYO|DMYA|YMDS|YMDO}
                  [:STATe](?) {ON|OFF|1|0}
            :TOOLtip
                  [:STATe](?) {ON|OFF|1|0}
      :METer
            [:STATe](?) {ON|OFF|1|0}
      :BRIGhtness(?) <DNPD>
      :LANGuage(?) {ENGLish}
:MEMory
      :COUNt? <DNPD>
      :PART<IND_MEMORY>
            :NAME? <CPD>
            :SIZE? <DNPD>
            :TRANsfer<IND_COUNTER>(?) <CPD>
:OUTPut
      [:STATe](?) {ON|OFF|1|0}
      :LOW(?) {FLOat|GROund}
      :COMPensation(?) {ON|OFF|1|0}
      :RESistance
            :SHORt(?) {ON|OFF|1|0}
            :COMPensation(?) {ON|OFF|1|0}
      :FREQuency
            :PULL(?) {ON|OFF|1|0}
```

[:SOURce]
    :VDC
        [:AMPLitude](?) <DNPD>[V]
        :RANGe(?) {AUTO|100V|30V|3V|300MV}
        :LIMiting
            [:AMPLitude](?) <DNPD>[A]
            :RESet(?) {ADJustable|MAXimum}
    :CDC
        [:AMPLitude](?) <DNPD>[A]
        :RANGe(?) {AUTO|50MA|25MA}
        :LIMiting
            [:AMPLitude](?) <DNPD>[V]
            :RESet(?) {ADJustable|MAXimum}
    :RTD
        [:AMPLitude](?) <DNPD>[{CEL|FAR|K}]
        :TYPE(?) {PLATinum|NICKel}
        :ZRESistance(?) <DNPD>[OHM]
        :STANdard(?) {PT385A|PT385B|PT3916|PT3926|USER}
        :COEFficient(?) <DNPD>,<DNPD>,<DNPD>
    :TCPL
        [:AMPLitude](?) <DNPD>[{CEL|FAR|K}]
        :TYPE(?) {R|S|B|J|T|E|K|N|M|C|D|G2}
        :RJMode(?) {MANual|EXTern}
        :RJAMplitude(?) <DNPD>
        :RJEXtern
            :TYPE (?) {PLATinum|NICKel}
            :RJMode (?) <DNPD>[OHM]
            :PTSTandard(?) { PT385A|PT385B |PT3916|PT3926|PTUSER}
            :COEFficient(?) <DNPD>,<DNPD>,<DNPD>
    :FREQuency
        [:AMPLitude](?) <DNPD>[HZ]
        :DUTY(?) <DNPD>
        :PULSes
            [:STATe](?) {ON|OFF|1|0}
            :COUNt(?) <DNPD>
            :ACTual? <DNPD>
    :RESistance
        [:AMPLitude](?) <DNPD>[OHM]
    :STEP
        [:STATe](?) {ON|OFF|1|0}
        :SELect<IND_STEP>(?) <DNPD>
        :COUNt<IND_STEP>(?) <DNPD>
        :PRESet
            :COUNt? <DNPD>
            :NAME(?) <SPD>
            :PCLear
            :RAPPend <SPD>
            :RCOunt? <DNPD>
            :ROW<IND_COUNTER
                :AMPLitude(?) <SPD>
                :RDELete
            :SAVE
:MEASure
    :VOLTage
        [:AMPLitude]? <DNPD>[V]
    :CURRent

```
                    [:AMPLitude]? <DNPD>[A]
            :CONFigure(?) {FREQ|COUN}
            :FREQuency
                    [:AMPLitude]? <DNPD>[HZ]
            :COUNter
                    [:AMPLitude]? <DNPD>
                    :CLEar
:TCPL
                    :RJAMplitude(?) <DNPD>
:STATus
        :OPERation
                    :CONDition(?) <DNPD>
                    :ENABle(?) <DNPD>
                    [:EVENt]? <DNPD>
                    :NTRansition(?) <DNPD>
                    :PTRansition(?) <DNPD>
        :QUEStionable
                    :CONDition(?) <DNPD>
                    :ENABle(?) <DNPD>
                    [:EVENt]? <DNPD>
                    :NTRansition(?) <DNPD>
                    :PTRansition(?) <DNPD>
:SYSTem
        :BEEPer
                    :STATe(?) {ON|OFF|1|0}
                    :VOLume(?) <DNPD>
                    :KEYBoard(?) {ON|OFF|1|0}
        :COMMunicate
                    :BUS(?) {SERial|GPIB|USB|LAN}
                    :GPIB
                            :ADDRess(?) <DNPD>
                    :LAN
                            :ADDRess(?) <CPD>
                            :MASK(?) <CPD>
                            :GATE(?) <CPD>
                            :PORT(?) <DNPD>
                            :HOST(?) <CPD>
                            :DHCP(?) {ON|OFF|1|0}
                    :RESTart
                    :SERial
                            :BAUD(?) {1200|2400|4800|9600|19200|38400|57600|115200}
                    :TBUS(?) {SERial|GPIB|USB|LAN}
        :DATE(?) <DNPD>,<DNPD>,<DNPD>
        :ERRor
                    [:NEXT]? <CPD>
        :KEY(?) <DNPD>
        :LOCal
        :MODel? <DNPD>
        :PRESet
        :REMote
        :RWLock
        :SERVice
                    :CFLash
                    :CRAM
        :TIME(?) <DNPD>,<DNPD>,<DNPD>
        :VERSion? <CPD>
```

:UNIT
    :TEMPerature(?) {CEL|FAR|K}
*CLS
*ESE(?)
*ESR?
*IDN?
*OPC(?)
*OPT?
*RST
*SRE(?)
*STB?
*TST?
*WAI

6.7.   Standard Status Data Structures

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 parameters *STB?, *SRE?, *SRE, *ESR?, *ESE?, *ESE a *CLS.
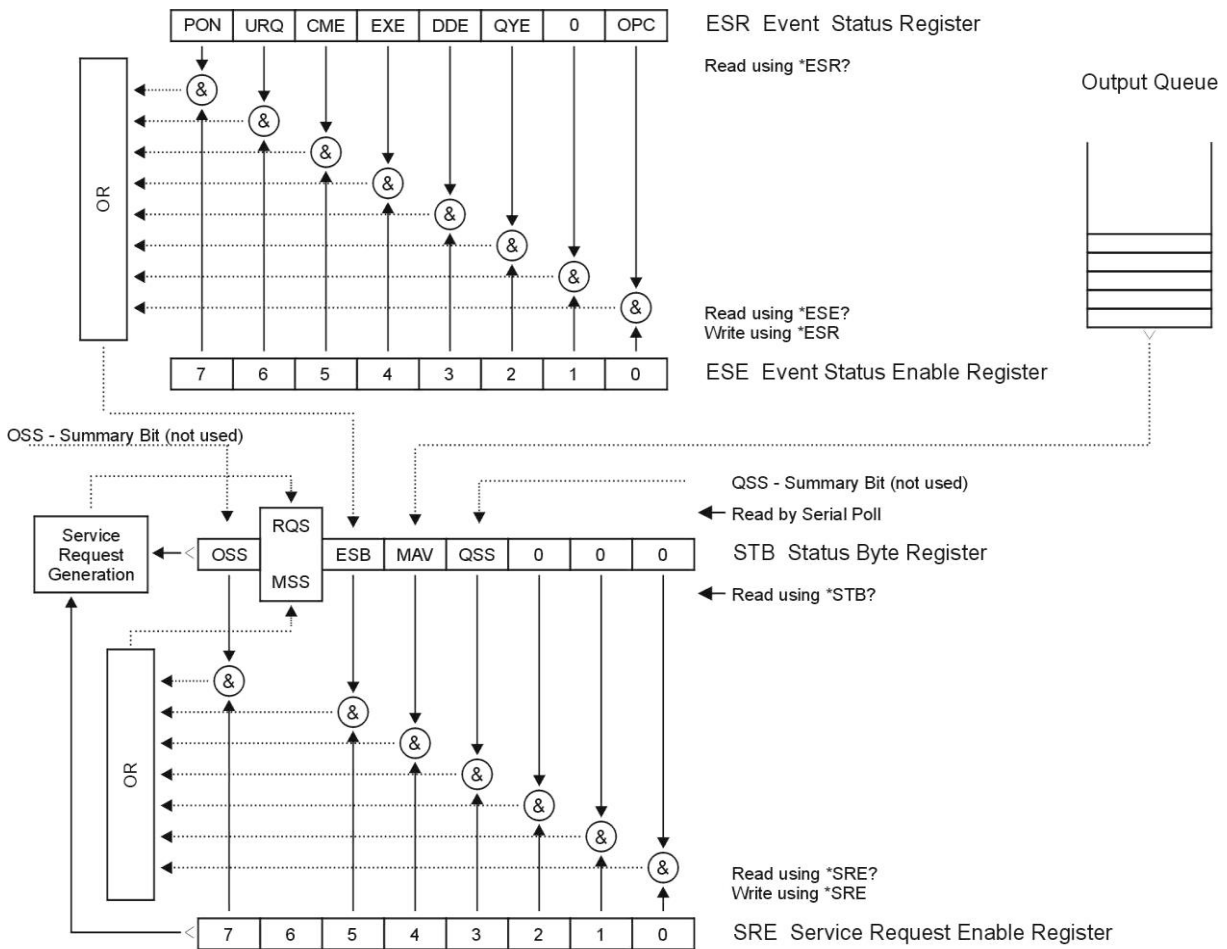
Figure 33 Status register overview

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

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:

OSS   Operation Summary Status, bit 7. SCPI-defined. The OSS bit is set to 1 when the data in the OSR (Operation Status Register) contains one or more enabled bits which are true.
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. Its 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 IEEE488 Output Queue (the response on query is ready).
QSS   Questionable Summary Status, bit 3. SCPI-defined. The QSS bit is set to 1 when the data in the QSR (Questionable Status Register) contains one or more enabled bits which are true.

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:

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.

Operation Status Register

Not used in this device.

Questionable Status Register

Not used in this device.

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.

Error Queue

The Error Queue stores error messages. They are placed in a "first in, first out" queue.

The queue is read destructively using the query command "SYSTem:ERRor?" to obtain a code number and errro message. The query "SYSTem:ERRor?" can be used to read errors in the queue until it is empty, when the message "0, No Error" will be returned.

6.8. SCPI Standard Commands

This chapter describes standard SCPI commands.

*IDN?
>   Syntax:
>>   *IDN?
>   Description:
>>   This command returns the identification of the manufacturer, model, serial number and
>>   firmware revision.
>   Parameters:
>>   <CPD>   manufacturer
>>   <CPD>   model
>>   <DNPD>   serial number
>>   <DNPD>   frimware version
>   Remarks:
>>   Overlapped command
>   Example:
>>   *IDN? Response: MEATEST,M160,712341,1.000

*OPC
>   Syntax:
>>   *OPC
>   Description:
>>   This command sets the OPC bit in the ESR (Event Status Register) when all pending
>>   operations are complete.
>   Parameters:
>>   None
>   Remarks:
>>   Overlapped command
>   Example:
>>   *OPC

*OPC?
>   Syntax:
>>   *OPC?
>   Description:
>>   This command returns "1" to the output queue after all pending operations inside device
>>   are complete.
>   Parameters:
>>   <DNPD>   always returns 1
>   Remarks:
>>   Sequential command
>   Example:
>>   *OPC? Response: 1

*OPT?
>   Syntax:
>>   *OPT?
>   Description:
>>   This command return the instrument's hardware fitment. The only parameter returns
>>   presence of GPIB/LAN/USB interface.
>   Parameters:
>>   <DNPD>   0 – extended interface not present, 1 – extended interface present
>   Remarks:
>>   Overlapped command

Example:
    *OPT? Response: 1

*WAI
    Syntax:
        *WAI
    Description:
        Prevents the instrument from executing any further commands or queries until all
        previous remote commands have been executed.
    Parameters:
        None
    Remarks:
        Sequential command
    Example:
        *WAI

*RST
    Syntax:
        *RST
    Description:
        This command resets the device to its initial status.
    Parameters:
        None
    Remarks:
        Sequential command
    Example:
        *RST

*TST?
    Syntax:
        *TST?
    Description:
        This command launches internal self-test and returns result.
    Parameters:
        <DNPD>   0 – test passed, 1 – test failed
    Remarks:
        Sequential command
    Example:
        *TST? Response: 0

*STB?
    Syntax:
        *STB?
    Description:
        This query returns content of register STB, which carries the MSS bit status.
    Parameters:
        <DNPD>   Status byte register, Range 0 … 255
    Remarks:
        Overlapped command
    Example:
        *STB? Response: 0
*SRE
    Syntax:
        *SRE
        *SRE?
    Description:

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

Parameters:

    <DNPD>   Service Request Enable register

Remarks:

    Overlapped command

Example:

    *SRE 2

    *SRE? Response: 2

*ESR?

Syntax:

    *ESR?

Description:

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

Parameters:

    <DNPD>   Event Status Register

Remarks:

    Overlapped command

Example:

    *ESR? Response: 0

*ESE

Syntax:

    *ESE

    *ESE?

Description:

    This command programs the Event Status Enable register bits.

Parameters:

    <DNPD>   Event Status Enable register, Range 0 … 255

Remarks:

    Overlapped command

Example:

    *ESE 2

    *ESE? Response: 2

*CLS

Syntax:

    *CLS

Description:

    This command clears all status data structures in the device i.e. Event Status Register, Status Byte Register except the MAV bit, Operation Status Register, Questionable Status Register. Also error queue is cleared. Output queue is unaffected.

Parameters:

    None

Remarks:

    Overlapped command

Example:

    *CLS

6.9. SCPI Commands

This chapters describes all public SCPI commands in detailed form. The commands here are in alphabetic order.

:CALibration:DATE

Syntax:

    :CALibration:DATE <DNPD>,<DNPD>,<DNPD>

:CALibration:DATE?

Description:

This command sets date of last calibration.

Parameters:

<DNPD>	Year, Range 2000 ... 2063
<DNPD>	Month, Range 1 ... 12
<DNPD>	Day, Range 1 ... 31

Remarks:

This command requires "Calibration" access

Overlapped command

Example:

CAL:DATE 2017,01,13

CAL:DATE? Response: 2017,01,13

:CALibration:INTerval

Syntax:

:CALibration:INTerval <DNPD>

:CALibration:INTerval?

Description:

This command sets recommended calibration interval for this unit.

Parameters:

<DNPD>	Month, Range 1 ... 240

Remarks:

This command requires "Calibration" access

Overlapped command

Example:

CAL:INT 12

CAL:INT? Response: 12

:CALibration:POINt:AMPLitude

Syntax:

:CALibration:POINt:AMPLitude <DNPD>

:CALibration:POINt:AMPLitude?

Description:

This command sets calibration value of particular point. Data will be saved to nonvolatile memory on CAL:POIN:SAVE command.

Parameters:

<DNPD>	Calibration point value. Ranges and default values varies in accordance to selected point (see "Calibration points").

Remarks:

The value is set to default after power on

The value is set to default on *RST command

Overlapped command

Example:

CAL:POIN:AMPL 1.944

CAL:POIN:AMPL? Response: 1.944000E+00

:CALibration:POINt:CONVerter?

Syntax:

:CALibration:POINt:CONVerter?

Description:

This command reads converter value of particular calibration point.

Parameters:

<DNPD>	Calibration converter value. Ranges and default values varies in accordance to selected point (see "Calibration points").

Remarks:

The value is set to default after power on
The value is set to default on *RST command
Overlapped command
Example:
CAL:POIN:CONV? Response: 1.944000E+00

:CALibration:POINt:DATE?

Syntax:
:CALibration:POINt:DATE?
Description:
This command reads date of last calibration of calibration point.
Parameters:
<DNPD>	Year, Range 2000 ... 2063
<DNPD>	Month, Range 1 ... 12
<DNPD>	Day, Range 1 ... 31

Remarks:
Overlapped command
Example:
CAL:POIN:DATE? Response: 2017,01,13

:CALibration:POINt:MEASure?

Syntax:
:CALibration:POINt:MEASure?
Description:
This command reads measured value of particular calibration point.
Parameters:
<DNPD>	Calibration measured value. Ranges and default values varies in accordance to selected point (see "Calibration points").

Remarks:
The value is set to default after power on
The value is set to default on *RST command
Overlapped command
Example:
CAL:POIN:MEAS? Response: 1.000000E+00

:CALibration:POINt:MODE

Syntax:
:CALibration:POINt:MODE <DNPD>
:CALibration:POINt:MODE?
Description:
This command enters calibration mode. Mode refers to a particular range.
Parameters:
<DNPD>	Ranges and default values varies in accordance to selected point (see "Calibration points").

Remarks:

This command requires "Calibration" access

The value is set to default after power on

The value is set to default on *RST command

Overlapped command

Example:

CAL:POIN:MODE 5

CAL:POIN:MODE? Response: 5

:CALibration:POINt:SELect

Syntax:

:CALibration:POINt:SELect <DNPD>

:CALibration:POINt:SELect?

Description:

This command selects calibration points of particular mode.

Parameters:

<DNPD>   Ranges and default values varies in accordance to selected point (see "Calibration points").

Remarks:

This command requires "Calibration" access

The value is set to default after power on

The value is set to default on *RST command

Overlapped command

Example:

CAL:POIN:SEL 1

CAL:POIN:SEL? Response: 1

:CALibration:POINt:SAVE

Syntax:

:CALibration:POINt:SAVE

Description:

This command saves current calibration point to non-volatile memory. Unsaved changes will disappear on restart, selection of another calibration point or close the calibration.

Parameters:

None

Remarks:

The value is set to default after power on

The value is set to default on *RST command

Overlapped command

Example:

CAL:POIN:SAVE

:CALibration:SECure:EXIT

Syntax:

:CALibration:SECure:EXIT

Description:

This command exits calibration mode and access.

Parameters:

None

Remarks:

The value is set to default after power on

The value is set to default on *RST command

Overlapped command

Example:

CAL:SEC:EXIT

:CALibration:SECure:PASSword

Syntax:

:CALibration:SECure:PASSword <DNPD>

:CALibration:SECure:PASSword?

Description:

This command validates entered password and enables calibration access if verification is successful. Access is invalidated after reset or if CAL:SEC:EXIT command is issued. Calibration password can be changed from decade system menu *MENU->Calibration->Password.*

Parameters:

Range 0 ... 4294967295 (default 0)

Remarks:

The value is set to default after power on

The value is set to default on *RST command

Overlapped command

Example:

CAL:SEC:PASS 0

:CALibration:ACAL:ENAB

Syntax:

:CALibration:ACAL:ENAB < CPD >

:CALibration:ACAL:ENAB?

Description:

This command enables/disables autocalibration (see Autocalibration chapter).

Parameters:

< CPD >   {ON|OFF|MANual} (default ON)

·ON   autocalibration is enabled

·OFF   autocalibration is disabled

·MAN   autocalibration on user request

Remarks:

Overlapped command

Example:

CAL:ACAL:ENAB ON

CAL:ACAL:ENAB? Response: ON

:CALibration:ACAL:CLR

Syntax:

:CALibration:ACAL:CLR

Description:

This command clears all autocalibration offsets.

Parameters:

None

Remarks:

Overlapped command

Example:

:CALibration:ACAL:CLR

:CALibration:ACAL:TRIG

Syntax:

:CALibration:ACAL:TRIG

Description:

This command triggers autocalibration procedure.

Parameters:

None

Remarks:

Overlapped command

Example:

        CAL:ACAL:TRIG

:CALibration:ACAL:AMPLitude<IND_RANGE>? <DNPD>

    Syntax:

        :CALibration:ACAL:**AMPLitude<IND_RANGE>?**

    Description:

        This command reads autocalibration offset of selected calibration point.

    Parameters:

        <IND_RANGE>   Range 1 ... 12 (1 - if omitted):

                                1 – voltage +300 mV range

                                2 – voltage -300 mV range

                                3 – voltage +3 V range

                                4 – voltage -3 V range

                                5 – voltage +30 V range

                                6 – voltage -30 V range

                                7 – voltage +100 V range

                                8 – voltage -100 V range

                                9 – current +25 mA range

                                10 – current -25 mA range

                                11 – current +50 mA range

                                12 – current -50 mA range

    Remarks:

        Overlapped command

    Example:

        CAL:ACAL:AMPL1? Response: 1.944000E-07

:DISPlay:ANNotation:CLOCk:DATE:FORMat

    Syntax:

        :DISPlay:ANNotation:CLOCk:DATE:FORMat <CPD>

        :DISPlay:ANNotation:CLOCk:DATE:FORMat?

    Description:

        This command selects format of date displayed on device screen.

    Parameters:

        <CPD>   {MDYS|MDYA|DMYS|DMYO|DMYA|YMDS|YMDO} (default MDYS)

            ·MDYS M/D/Y format (M-month, D-day, Y-year)

            ·MDYA M-D-Y format

            ·DMYS D/M/Y format

            ·DMYO D.M.Y format

            ·DMYA D-M-Y format

            ·YMDS Y/M/D format

            ·YMDO Y.M.D format

    Remarks:

        Overlapped command

    Example:

        DISP:ANN:CLOC:DATE:FORM MDYS

        DISP:ANN:CLOC:DATE:FORM? Response: MDYS

:DISPlay:ANNotation:CLOCk[:STATe]
    Syntax:
        :DISPlay:ANNotation:CLOCk[:STATe] <BOOL>
        :DISPlay:ANNotation:CLOCk[:STATe]?
    Description:
        This command enables/disables showing actual time in title on device screen.
    Parameters:

<BOOL>	{ON|OFF|1|0} (default 1)
·ON	actual time is shown
·OFF	actual time is hidden
·1	same as ON
·0	same as OFF

    Remarks:
        Overlapped command
    Example:
        DISP:ANN:CLOC ON
        DISP:ANN:CLOC? Response: 1

:DISPlay:ANNotation:TOOLtip[:STATe]
    Syntax:
        :DISPlay:ANNotation:TOOLtip[:STATe] <BOOL>
        :DISPlay:ANNotation:TOOLtip[:STATe]?
    Description:
        This command enables/disables showing tooltip in top on device screen.
    Parameters:

<BOOL>	{ON|OFF|1|0} (default 1)
·ON	tooltip is shown
·OFF	tooltip is hidden
·1	same as ON
·0	same as OFF

    Remarks:
        Overlapped command
    Example:
        DISP:ANN:TOOL ON
        DISP:ANN:TOOL? Response: 1

:DISPlay:METer[:STATe]
    Syntax:
        :DISPlay:METer[:STATe] <BOOL>
        :DISPlay:METer[:STATe]?
    Description:
        This command enables/disables showing meter in bottom on device screen.
    Parameters:

<BOOL>	{ON|OFF|1|0} (default 0)
·ON	meter is shown
·OFF	meter is hidden
·1	same as ON
·0	same as OFF

    Remarks:
        The value is stored in each preset
        The value is set according to "Startup" preset after power on
        The value is set to default on *RST command
        Overlapped command
    Example:
        DISP:MET ON
        DISP:MET? Response: 1

:DISPlay:BRIGhtness
    Syntax:

        :DISPlay:BRIGhtness <DNPD>

        :DISPlay:BRIGhtness?

Description:

        This command sets brightness of device display.

Parameters:

        <DNPD>   Range 0.0 ... 1.0 (default 1.0), 0.0 – Min, 1.0 – Max brightness

Remarks:

        Overlapped command

Example:

        DISP:BRIG 1.0

        DISP:BRIG? Response: 1.000000E+00

:DISPlay:LANGuage

    Syntax:

        :DISPlay:LANGuage <CPD>

        :DISPlay:LANGuage?

    Description:

        This command selects language that is used on device display.

    Parameters:

        <CPD>   {ENGLish} (default ENGL)

          ·ENGLish   english version

    Remarks:

        Overlapped command

    Example:

        DISP:LANG ENGL

        DISP:LANG? Response: ENGL

:OUTPut[:STATe]

    Syntax:

        :OUTPut[:STATe] <BOOL>

        :OUTPut[:STATe]?

    Description:

        This command switches ON/OFF output terminals.

    Parameters:

        <BOOL>   {ON|OFF|1|0} (default 0)

          ·ON   output terminals are switched on

          ·OFF   output terminals are switched off

          ·1   same as ON

          ·0   same as OFF

    Remarks:

        The value is set to default after power on

        The value is set to default on *RST command

        Overlapped command

    Example:

        OUTP ON

        OUTP? Response: 1

:OUTPut:LOW

    Syntax:

        :OUTPut:LOW <CPD>

        :OUTPut:LOW?

    Description:

        This command connects or disconnects the Lo terminals of voltage and current outputs to/from GND terminal.

    Parameters:

        <CPD>   {FLOat|GROund} (default GRO)

          ·FLOat

          ·GROund

    Remarks:

The value is stored in each preset
The value is set according to "Startup" preset after power on
The value is set to default on *RST command
Overlapped command
Example:
OUTP:LOW FLO
OUTP:LOW? Response: FLO

:OUTPut:COMPensation
Syntax:
:OUTPut:COMPensation <BOOL>
:OUTPut:COMPensation?
Description:
This command select 4-wire voltage outputs connection (remote sense).
Parameters:
<BOOL>   {ON|OFF|1|0} (default 0)
·ON   selsects 4-wire connection
·OFF   selsects 2-wire connection
·1   same as ON
·0   same as OFF
Remarks:
The value is stored in each preset
The value is set according to "Startup" preset after power on
The value is set to default on *RST command
Overlapped command
Example:
OUTP:COMP ON
OUTP:COMP? Response: 1

:OUTPut:RESistance:SHORt
Syntax:
:OUTPut:RESistance:SHORt <BOOL>
:OUTPut:RESistance:SHORt?
Description:
This command turns on short function. "Short" is activated only if output terminals are switched on (see OUTP:STAT command).
Parameters:
<BOOL>   {ON|OFF|1|0} (default 0)
·ON   short is set if output is on
·OFF   resistance is set if output is on
·1   same as ON
·0   same as OFF
Remarks:
The value is stored in each preset
The value is set according to "Startup" preset after power on
The value is set to default on *RST command
Overlapped command
Example:
OUTP:RES:SHOR ON
OUTP:RES:SHOR? Response: 1

:OUTPut:RESistance:COMPensation
Syntax:
:OUTPut:RESistance:COMPensation <BOOL>
:OUTPut:RESistance:COMPensation?
Description:
This command select 4-wire resistance outputs connection (remote sense).

Parameters:
> <BOOL>   {ON|OFF|1|0} (default 1)
>> ·ON   selsects 4-wire connection
>> ·OFF   selsects 2-wire connection
>> ·1   same as ON
>> ·0   same as OFF

Remarks:
> The value is stored in each preset
> The value is set according to "Startup" preset after power on
> The value is set to default on *RST command
> Overlapped command

Example:
> OUTP:RES:COMP ON
> OUTP:RES:COMP? Response: 1

:OUTPut:FREQuency:PULL

Syntax:
> :OUTPut:FREQuency:PULL <BOOL>
> :OUTPut:FREQuency:PULL?

Description:
> This command connects the internal pull-up resistor (50 Ω) to the Frequency output.

Parameters:
> <BOOL>   {ON|OFF|1|0} (default 0)
>> ·ON   connects pull-up resistor
>> ·OFF   disconnects pull-up resistor
>> ·1   same as ON
>> ·0   same as OFF

Remarks:
> The value is stored in each preset
> The value is set according to "Startup" preset after power on
> The value is set to default on *RST command
> Overlapped command

Example:
> OUTP:FREQ:PULL ON
> OUTP:FREQ:PULL? Response: 1

[:SOURce]:VDC[:AMPLitude]

Syntax:
> [:SOURce]:VDC[:AMPLitude] <DNPD>[<UNIT>]
> [:SOURce]:VDC[:AMPLitude]?

Description:
> This command sets voltage amplitude in Voltage function. Node SOUR:VDC also selects
> Voltage function if not already selected.

Parameters:
> <DNPD>   Range -100.0 ... 100.0 (default 10.0)
> <UNIT>   {V}
>> ·V   Volt

Remarks:
> The value is stored in each preset
> The value is set according to "Startup" preset after power on
> The value is set to default on *RST command
> Overlapped command

Example:
> VDC 10.0
> VDC? Response: 1.000000E+01 V

[:SOURce]:VDC:RANGe
>   Syntax:
>>   [:SOURce]:VDC:RANGe <CPD>
>>   [:SOURce]:VDC:RANGe?
>   Description:
>>   This command selects range in Voltage function. Node SOUR:VDC also selects Voltage
>>   function if not already selected.
>   Parameters:
>>   <CPD>   {AUTO|100V|30V|3V|300MV} (default AUTO)
>>>   ·AUTO   auto-range mode
>>>   ·100Vfixed 100 V range
>>>   ·30V   fixed 30 V range
>>>   ·3V   fixed 3 V range
>>>   ·300MV   fixed 300 mV range
>   Remarks:
>>   The value is stored in each preset
>>   The value is set according to "Startup" preset after power on
>>   The value is set to default on *RST command
>>   Overlapped command
>   Example:
>>   VDC:RANG AUTO
>>   VDC:RANG? Response: AUTO

[:SOURce]:VDC:LIMiting[:AMPLitude]
>   Syntax:
>>   [:SOURce]:VDC:LIMiting[:AMPLitude] <DNPD>[<UNIT>]
>>   [:SOURce]:VDC:LIMiting[:AMPLitude]?
>   Description:
>>   This command sets output current limiting in Voltage function. This command operates
>>   in conjunction with VDC:LIM:RES command. Node SOUR:VDC also selects Voltage
>>   function if not already selected.
>   Parameters:
>>   <DNPD>   Voltage amplitude 0-30 V: Range 0.0 ... 0.05 (default 0.05)
>>   <DNPD>   Voltage amplitude 30.0001-100 V: Range 0.0 ... 0.05 (default 0.05)
>>   <UNIT>   {A}
>>>   ·A   Amper
>   Remarks:
>>   The value is stored in each preset
>>   The value is set according to "Startup" preset after power on
>>   The value is set to default on *RST command
>>   Overlapped command
>   Example:
>>   VDC:LIM 0.05
>>   VDC:LIM? Response: 5.000000E-02 A

[:SOURce]:VDC:LIMiting:RESet

   Syntax:

   [:SOURce]:VDC:LIMiting:RESet <CPD>

   [:SOURce]:VDC:LIMiting:RESet?

   Description:

   This command selects output current limitigne behavior, if was voltage amplitude changed. Node SOUR:VDC also selects Voltage function if not already selected.

   Parameters:

   <CPD>   {ADJustable|MAXimum} (default ADJ)

   ·ADJustable   output current limiting is adjustable (see VDC:LIM:AMPL)

   ·MAXimum   output current limiting is always maximum

   Remarks:

   The value is stored in each preset

   The value is set according to "Startup" preset after power on

   The value is set to default on *RST command

   Overlapped command

   Example:

   VDC:LIM:RES ADJ

   VDC:LIM:RES? Response: ADJ

[:SOURce]:CDC[:AMPLitude]

   Syntax:

   [:SOURce]:CDC[:AMPLitude] <DNPD>[<UNIT>]

   [:SOURce]:CDC[:AMPLitude]?

   Description:

   This command sets current amplitude in Current function. Node SOUR:CDC also selects Current function if not already selected.

   Parameters:

   <DNPD>   Range -0.05 ... 0.05 (default 0.01)

   <UNIT>   {A}

   ·A   Amper

   Remarks:

   The value is set to default after power on

   The value is set to default on *RST command

   Overlapped command

   Example:

   CDC 0.01

   CDC? Response: 1.000000E-02 A

[:SOURce]:CDC:RANGe

   Syntax:

   [:SOURce]:CDC:RANGe <CPD>

   [:SOURce]:CDC:RANGe?

   Description:

   This command selects range in Current function. Node SOUR:CDC also selects Current function if not already selected.

   Parameters:

   <CPD>   {AUTO|50MA|25MA} (default AUTO)

   ·AUTO   auto-range mode

   ·50MA   fixed 50 mA range

   ·25MA   fixed 25 mA range

   Remarks:

   The value is stored in each preset

   The value is set according to "Startup" preset after power on

   The value is set to default on *RST command

   Overlapped command

Example:
> CDC:RANG AUTO
> CDC:RANG? Response: AUTO

[:SOURce]:CDC:LIMiting[:AMPLitude]

Syntax:
> [:SOURce]:CDC:LIMiting[:AMPLitude] <DNPD>[<UNIT>]
> [:SOURce]:CDC:LIMiting[:AMPLitude]?

Description:
> This command sets output voltage limiting in Current function. This command operates in conjunction with CDC:LIM:RES command. Node SOUR:CDC also selects Current function if not already selected.

Parameters:

<DNPD>	Current amplitude 0-25 mA: Range 0.0 ... 100.0 (default 30.0)
<DNPD>	Current amplitude 25.0001-50 mA: Range 0.0 ... 30.0 (default 30.0)
<UNIT>	{V}
·V	Voltage

Remarks:
> The value is stored in each preset
> The value is set according to "Startup" preset after power on
> The value is set to default on *RST command
> Overlapped command

Example:
> CDC:LIM 30.0
> CDC:LIM? Response: 3.000000E+01 V

[:SOURce]:CDC:LIMiting:RESet

Syntax:
> [:SOURce]:CDC:LIMiting:RESet <CPD>
> [:SOURce]:CDC:LIMiting:RESet?

Description:
> This command selects output voltage limitigne behavior, if was current amplitude changed. Node SOUR:CDC also selects Current function if not already selected.

Parameters:

<CPD>	{ADJustable|MAXimum} (default ADJ)
·ADJustable	output current limiting is adjustable (see CDC:LIM:AMPL)
·MAXimum	output voltage limiting is always maximum

Remarks:
> The value is stored in each preset
> The value is set according to "Startup" preset after power on
> The value is set to default on *RST command
> Overlapped command

Example:
> CDC:LIM:RES ADJ
> CDC:LIM:RES? Response: ADJ

[:SOURce]:RTD[:AMPLitude]

Syntax:
> [:SOURce]:RTD[:AMPLitude] <DNPD>[<UNIT>]
> [:SOURce]:RTD[:AMPLitude]?

Description:
> This command sets temperature in RTD function. Node SOUR:RTD also selects RTD function if not already selected. If unit parameter is part of temperature, new unit is set.

Parameters:

<DNPD>	Temperature at Nickel function. Default value is 100.0 °C.
<UNIT>	{CEL|FAR|K}
·CEL	degrees of Celsius

·FAR   degrees of Fahrenheit
·K   Kelvin

Remarks:
    The value is set to default after power on
    The value is set to default on *RST command
    Overlapped command
Example:
    RTD 100.0
    RTD? Response: 1.000000E+02 CEL

[:SOURce]:RTD:TYPE

Syntax:
    [:SOURce]:RTD:TYPE <CPD>
    [:SOURce]:RTD:TYPE?
Description:
    This command selects RTD type in RTD function. Node SOUR:RTD also selects RTD function if not already selected.
Parameters:
    <CPD>   {PLATinum|NICKel} (default PLAT)
        ·PLATinum
        ·NICKel
Remarks:
    The value is stored in each preset
    The value is set according to "Startup" preset after power on
    The value is set to default on *RST command
    Overlapped command
Example:
    RTD:TYPE PLAT
    RTD:TYPE? Response: PLAT

[:SOURce]:RTD:ZRESistance

Syntax:
    [:SOURce]:RTD:ZRESistance <DNPD>[<UNIT>]
    [:SOURce]:RTD:ZRESistance?
Description:
    This command sets resistance at 0 °C for Platinum function. Node SOUR:RTD also selects RTD function if not already selected.
Parameters:
    <DNPD>   Range 100.0 ... 1000.0 (default 100.0)
    <UNIT>   {OHM}
        ·OHM
Remarks:
    The value is stored in each preset
    The value is set according to "Startup" preset after power on
    The value is set to default on *RST command
    Overlapped command
Example:
    RTD:ZRES 100.0
    RTD:ZRES? Response: 1.000000E+02 OHM

[:SOURce]:RTD:STANdard
>   Syntax:
>>   [:SOURce]:RTD:STANdard <CPD>
>>   [:SOURce]:RTD:STANdard?
>   Description:
>>   This command selects Platinum temperature standard. Node SOUR:RTD also selects
>>   RTD function if not already selected.
>   Parameters:
>>   <CPD>   {PT385A|PT385B|PT3916|PT3926|USER} (default PT385A)
>>>   ·PT385A   Pt385 (68) standard
>>>   ·PT385B   Pt385 (90) standard
>>>   ·PT3916   Pt3916 standard
>>>   ·PT3926   Pt3926 standard
>>>   ·USER   User (see RTD:COEF command)
>   Remarks:
>>   The value is stored in each preset
>>   The value is set according to "Startup" preset after power on
>>   The value is set to default on *RST command
>>   Overlapped command
>   Example:
>>   RTD:STAN PT385A
>>   RTD:STAN? Response: PT385A

[:SOURce]:RTD:COEFficient
>   Syntax:
>>   [:SOURce]:RTD:COEFficient <DNPD>,<DNPD>,<DNPD>
>>   [:SOURce]:RTD:COEFficient?
>   Description:
>>   This command allows to define Coefficients (A, B, C) used for "User" Platinum standard
>>   scale. Node SOUR:RTD also selects RTD function if not already selected.
>   Parameters:
>>   <DNPD>   Range 3e-3 ... 5e-3 (default 3.9083E-3)
>>   <DNPD>   Range -7e-7 ... -5e-7 (default -5.775E-7)
>>   <DNPD>   Range -5e-12 ... -3e-12 (default -4.18301E-12)
>   Remarks:
>>   The value is stored in each preset
>>   The value is set according to "Startup" preset after power on
>>   The value is set to default on *RST command
>>   Overlapped command
>   Example:
>>   RTD:COEF 3.9083E-3,-5.775E-7,-4.18301E-12
>>   RTD:COEF? Response: 3.908300E-03,-5.775000E-07,-4.183010E-12

[:SOURce]:TCPL[:AMPLitude]
>   Syntax:
>>   [:SOURce]:TCPL[:AMPLitude] <DNPD>[<UNIT>]
>>   [:SOURce]:TCPL[:AMPLitude]?
>   Description:
>>   This command sets temperature in TC function. Node SOUR:TCPL also selects TC
>>   function if not already selected. If unit parameter is part of temperature, new unit is set.
>   Parameters:
>>   <DNPD>   TC function. Default value is 100.0 °C.
>>   <UNIT>   {CEL|FAR|K}
>>>   ·CEL   degrees of Celsius
>>>   ·FAR   degrees of Fahrenheit
>>>   ·K   Kelvin

Remarks:
   The value is set to default after power on
   The value is set to default on *RST command
   Overlapped command
Example:
   TCPL 100.0
   TCPL? Response: 1.000000E+02 CEL

[:SOURce]:TCPL:TYPE

Syntax:
   [:SOURce]:TCPL:TYPE <CPD>
   [:SOURce]:TCPL:TYPE?
Description:
   This command selects thermocouple type. Node SOUR:TCPL also selects TC function if not already selected.
Parameters:
   <CPD>   {R|S|B|J|T|E|K|N|M|C|D|G2} (default R)
         ·R
         ·S
         ·B
         ·J
         ·T
         ·E
         ·K
         ·N
         ·M
         ·C
         ·D
         ·G2
Remarks:
   The value is stored in each preset
   The value is set according to "Startup" preset after power on
   The value is set to default on *RST command
   Overlapped command
Example:
   TCPL:TYPE R
   TCPL:TYPE? Response: R

[:SOURce]:TCPL:RJMode

Syntax:
   [:SOURce]:TCPL:RJMode <CPD>
   [:SOURce]:TCPL:RJMode?
Description:
   This command selects manual or external reference junction compensation. Node SOUR:TCPL also selects TC function if not already selected.
Parameters:
   <CPD>   {MANual|EXTern} (default MAN)
         ·MANual   manual reference junction is set (see TCPL:RJAM)
         ·EXTern   external reference junction is set
Remarks:
   The value is stored in each preset
   The value is set according to "Startup" preset after power on
   The value is set to default on *RST command
   Overlapped command
Example:
   TCPL:RJM MAN

TCPL:RJM? Response: MAN

[:SOURce]:TCPL:RJAMplitude

Syntax:
    [:SOURce]:TCPL:RJAMplitude <DNPD>
    [:SOURce]:TCPL:RJAMplitude?

Description:
    This command sets/reads reference junction temperature. Node SOUR:TCPL also selects
    TC function if not already selected.

Parameters:
    <DNPD>   Range -50.0 ... 150.0 (default 23.0)

Remarks:
    The value is set to default after power on
    The value is set to default on *RST command
    Overlapped command

Example:
    TCPL:RJAM 23.0
    TCPL:RJAM? Response: 2.300000E+01

[:SOURce]:TCPL:RJEXtern:TYPE

Syntax:
    [:SOURce]:TCPL:RJEXtern:TYPE <CPD>
    [:SOURce]:TCPL:RJEXtern:TYPE?

Description:
    This command selects reference junction type. Node SOUR:TCPL also selects TC
    function if not already selected.

Parameters:
    <CPD>   {PLATinum|NICKel} (default PLAT)
        ·PLATinum
        ·NICKel

Remarks:
    The value is stored in each preset
    The value is set according to "Startup" preset after power on
    The value is set to default on *RST command
    Overlapped command

Example:
    TCPL:RJEX:TYPE PLAT
    TCPL:RJEX:TYPE? Response: PLAT

[:SOURce]:TCPL:RJEXtern:ZRESistance

Syntax:
    [:SOURce]:TCPL:RJEXtern:ZRESistance <DNPD>[<UNIT>]
    [:SOURce]:TCPL:RJEXtern:ZRESistance?

Description:
    This command sets resistance at 0 °C for Platinum reference junction. Node SOUR:TCPL
    also selects TC function if not already selected.

Parameters:
    <DNPD>   Range 100.0 ... 200.0 (default 100.0)
    <UNIT>   {OHM}
        ·OHM

Remarks:
    The value is stored in each preset
    The value is set according to "Startup" preset after power on
    The value is set to default on *RST command
    Overlapped command

Example:

TCPL:RJEX:ZRES 100.0
TCPL:RJEX:ZRES? Response: 1.000000E+02 OHM

[:SOURce]:TCPL:RJEXtern:PTSTandard

Syntax:

[:SOURce]:TCPL:RJEXtern:PTSTandard <CPD>
[:SOURce]:TCPL:RJEXtern:PTSTandard?

Description:

This command selects Platinum temperature standard for reference junction. Node SOUR:TCPL also selects TC function if not already selected.

Parameters:

<CPD>   {PT385A|PT385B|PT3916|PT3926|USER} (default PT385A)
    ·PT385A   Pt385 (68) standard
    ·PT385B   Pt385 (90) standard
    ·PT3916   Pt3916 standard
    ·PT3926   Pt3926 standard
    ·USER   User (see RTD:COEF command)

Remarks:

The value is stored in each preset
The value is set according to "Startup" preset after power on
The value is set to default on *RST command
Overlapped command

Example:

TCPL:RJEX:PTST PT385A
TCPL:RJEX:PTST? Response: PT385A

[:SOURce]:TCPL:RJEXtern:COEFficient

Syntax:

[:SOURce]:TCPL:RJEXtern:COEFficient <DNPD>,<DNPD>,<DNPD>
[:SOURce]:TCPL:RJEXtern:COEFficient?

Description:

This command allows to define Coefficients (A, B, C) used for "User" Platinum standard reference junction scale. Node SOUR:TCPL also selects TC function if not already selected.

Parameters:

<DNPD>   Range 3e-3 ... 5e-3 (default 3.9083E-3)
<DNPD>   Range -7e-7 ... -5e-7 (default -5.775E-7)
<DNPD>   Range -5e-12 ... -3e-12 (default -4.18301E-12)

Remarks:

The value is stored in each preset
The value is set according to "Startup" preset after power on
The value is set to default on *RST command
Overlapped command

Example:

TCPL:RJEX:COEF 3.9083E-3,-5.775E-7,-4.18301E-12
TCPL:RJEX:COEF? Response: 3.908300E-03,-5.775000E-07,-4.183010E-12

[:SOURce]:FREQuency[:AMPLitude]

Syntax:

[:SOURce]:FREQuency[:AMPLitude] <DNPD>[<UNIT>]
[:SOURce]:FREQuency[:AMPLitude]?

Description:

This command sets frequency (period) amplitude in Frequency function. Node SOUR:FREQ also selects Frequency function if not already selected.

Parameters:

         <DNPD>   Range 1E-2 ... 15E3 (default 1000.0)
         <UNIT>   {HZ}
            ·HZ   Hertz

Remarks:
         The value is stored in each preset
         The value is set according to "Startup" preset after power on
         The value is set to default on *RST command
         Overlapped command

Example:
         FREQ 1000.0
         FREQ? Response: 1.000000E+03 HZ

[:SOURce]:FREQuency:DUTY

Syntax:
         [:SOURce]:FREQuency:DUTY <DNPD>
         [:SOURce]:FREQuency:DUTY?

Description:
         This command sets duty cycle of generated signal in Frequency function. Node
         SOUR:FREQ also selects Frequency function if not already selected.

Parameters:
         <DNPD>   Range 0.005 ... 0.995 (default 0.5)

Remarks:
         The value is stored in each preset
         The value is set according to "Startup" preset after power on
         The value is set to default on *RST command
         Overlapped command

Example:
         FREQ:DUTY 0.5
         FREQ:DUTY? Response: 5.000000E-01

[:SOURce]:FREQuency:PULSes[:STATe]

Syntax:
         [:SOURce]:FREQuency:PULSes[:STATe] <BOOL>
         [:SOURce]:FREQuency:PULSes[:STATe]?

Description:
         This commnad switch on pulses generator. Node SOUR:FREQ also selects Frequency
         function if not already selected.

Parameters:
         <BOOL>   {ON|OFF|1|0} (default 0)
            ·ON   pulses generator activate (see FREQ:PULS:COUN)
            ·OFF   pulses generator deactivate
            ·1   same as ON
            ·0   same as OFF

Remarks:
         The value is stored in each preset
         The value is set according to "Startup" preset after power on
         The value is set to default on *RST command
         Overlapped command

Example:
         FREQ:PULS ON
         FREQ:PULS? Response: 1

[:SOURce]:FREQuency:PULSes:COUNt

Syntax:
         [:SOURce]:FREQuency:PULSes:COUNt <DNPD>

[:SOURce]:FREQuency:PULSes:COUNt?

Description:

This command sets number of generated pulses. Pulses generator must be set to On (see FREQ:PULS). Node SOUR:FREQ also selects Frequency function if not already selected.

Parameters:

<DNPD>   Range 1 ... 9999999 (default 100)

Remarks:

The value is stored in each preset

The value is set according to "Startup" preset after power on

The value is set to default on *RST command

Overlapped command

Example:

FREQ:PULS:COUN 100

FREQ:PULS:COUN? Response: 100

[:SOURce]:FREQuency:PULSes:ACTual?

Syntax:

[:SOURce]:FREQuency:PULSes:ACTual?

Description:

This command reads actual number of generated pulses.

Parameters:

<DNPD>   Actual number of generated pulses (range 1 ... 9999999)

Remarks:

The value is stored in each preset

The value is set according to "Startup" preset after power on

The value is set to default on *RST command

Overlapped command

Example:

FREQ:PULS:ACT? Response: 0

[:SOURce]:RESistance[:AMPLitude]

Syntax:

[:SOURce]:RESistance[:AMPLitude] <DNPD>[<UNIT>]

[:SOURce]:RESistance[:AMPLitude]?

Description:

This command sets resistance amplitude in Resistance function. Node SOUR:RES also selects Resistance function if not already selected.

Parameters:

<DNPD>   Range 10 ... 3e5 (default 1000.0)

<UNIT>   {OHM}

          ·OHM

Remarks:

The value is set to default after power on

The value is set to default on *RST command

Overlapped command

Example:

RES 1000.0

RES? Response: 1.000000E+03 OHM

[:SOURce]:STEP[:STATe]

Syntax:

[:SOURce]:STEP[:STATe] <BOOL>

[:SOURce]:STEP[:STATe]?

Description:

This command turns on Step mode for the appropriate function. Step mode defines of 32 user programmable step sequencies for each function. Each sequence contains up to 100 steps (amplitude/duration).

Parameters:

    <BOOL>   {ON|OFF|1|0} (default 0)

        ·ON   step mode activate

        ·OFF   step mode deactivate

        ·1   same as ON

        ·0   same as OFF

Remarks:

    The value is stored in each preset

    The value is set according to "Startup" preset after power on

    The value is set to default on *RST command

    Overlapped command

Example:

    STEP ON

    STEP? Response: 1

[:SOURce]:STEP:SELect<IND_STEP>

Syntax:

    [:SOURce]:STEP:SELect<IND_STEP> <DNPD>

    [:SOURce]:STEP:SELect<IND_STEP>?

Description:

    This command selects step sequence. Selected sequence is shown on device display, can be executed using OUTP ON command and can be edited using SOUR:STEP:PRES group of commands. Sequence is defined by function and by number of step sequence for this function.

Parameters:

    <IND_STEP>   Range 1 ... 6 (1 - if omitted):

                           1 – Voltage function

                           2 – Current function

                           3 – TC function

                           4 – Frequency function

                           5 – RTD function

                           6 - Resistance function

    <DNPD>   Range 1 ... maximum sequence count (32), one based index of sequence

Remarks:

    The value is stored in each preset

    The value is set according to "Startup" preset after power on

    The value is set to default on *RST command

    Overlapped command

Example:

    STEP:SEL1 0

    STEP:SEL1? Response: 0

[:SOURce]:STEP:COUNt<IND_STEP>
Syntax:
[:SOURce]:STEP:COUNt<IND_STEP> <DNPD>
[:SOURce]:STEP:COUNt<IND_STEP>?
Description:
This command selects step sequence. Selected sequence is shown on device display, can be executed using OUTP ON command and can be edited using SOUR:STEP:PRES group of commands. Sequence is defined by function and repetition count.
Parameters:
<IND_STEP>   Range 1 ... 4 (1 - if omitted):
                     1 – Voltage function
                     2 – Current function
                     3 – TC function
                     4 – Frequency function
<DNPD>   Range 0 ... 999999 (0 – infinite loop)
Remarks:
The value is stored in each preset
The value is set according to "Startup" preset after power on
The value is set to default on *RST command
Overlapped command
Example:
STEP:COUN1 0
STEP:COUN1? Response: 0

[:SOURce]:STEP:PRESet:COUNt?
Syntax:
[:SOURce]:STEP:PRESet:COUNt?
Description:
This command retrieves maximum number of step sequences. This number represents maximum index used in sequence commands.
Parameters:
<DNPD>   Integer value representing maximum sequence count.
Remarks:
Overlapped command
Example:
STEP:PRES:COUN? Response: 64

[:SOURce]:STEP:PRESet:NAME
Syntax:
[:SOURce]:STEP:PRESet:NAME <SPD>
[:SOURce]:STEP:PRESet:NAME?
Description:
This command allows reading and changing sequence name. Data will be saved to non-volatile memory on STEP:PRES:SAVE command.
Parameters:
<SPD>   Quoted sequence name. Upper alpha, lower alpha, digits and spaces are allowed. Maximum string size is 8 characters.
Remarks:
Overlapped command
Example:
STEP:PRES:NAME "STEP 1s"
STEP:PRES:NAME? Response: "STEP 1s"

[:SOURce]:STEP:PRESet:PCLear

    Syntax:

        [:SOURce]:STEP:PRESet:PCLear

    Description:

        This command clears existing sequence data including its step table. Data will be saved to non-volatile memory on STEP:PRES:SAVE command.

    Parameters:

        None

    Remarks:

        Overlapped command

    Example:

        STEP:PRES:PCL

[:SOURce]:STEP:PRESet:RAPPend

    Syntax:

        [:SOURce]:STEP:PRESet:RAPPend <SPD>

    Description:

        This command appends new record at the end of step table. Data will be saved to non-volatile memory on STEP:PRES:SAVE command.

    Parameters:

        <SPD>   Quoted string representing amplitude. The amplitude consists of two float numeric fields separated by comma. The first one represents timing interval in seconds and the second one amplitude.

    Remarks:

        Overlapped command

    Example:

        STEP:PRES:RAPP "0.5,220.0"

[:SOURce]:STEP:PRESet:RCOunt?

    Syntax:

        [:SOURce]:STEP:PRESet:RCOunt?

    Description:

        This commands returns actual number of records in step table.

    Parameters:

        <DNPD>   Integer value representing number of records.

    Remarks:

        Overlapped command

    Example:

        STEP:PRES:RCO? Response: 6

[:SOURce]:STEP:PRESet:ROW<IND_ROW>:AMPLitude

    Syntax:

        [:SOURce]:STEP:PRESet:ROW<IND_ROW>:AMPLitude <SPD>

        [:SOURce]:STEP:PRESet:ROW<IND_ROW>:AMPLitude?

    Description:

        This command sets / retrieves selected row in step table. Data will be saved to nonvolatile memory on STEP:PRES:SAVE command.

    Parameters:

        <IND_ROW>   Range 1 ... Row count (1 - if omitted)

        <SPD>   Quoted string representing amplitude. The amplitude consists of two float numeric fields separated by comma. The first one represents timing interval in seconds and the second one amplitude.

    Remarks:

        Overlapped command

    Example:

        STEP:PRES:ROW1:AMPL "0.5,220.0"

STEP:PRES:ROW1:AMPL? Response: "5.000000E-01,2.200000E+02"

[:SOURce]:STEP:PRESet:ROW<IND_ROW>:RDELete
    Syntax:
        [:SOURce]:STEP:PRESet:ROW<IND_ROW>:RDELete
    Description:
        This command deletes row from step table. Data will be saved to non-volatile memory on
        STEP:PRES:SAVE command.
    Parameters:
        <IND_ROW>   Range 1 ... Row count (1 - if omitted)
    Remarks:
        Overlapped command
    Example:
        STEP:PRES:ROW1:RDEL

[:SOURce]:STEP:PRESet:SAVE
    Syntax:
        [:SOURce]:STEP:PRESet:SAVE
    Description:
        This command saves current sequence to non-volatile memory. Unsaved changes will
        disappear on restart, function change or selection of another sequence.
    Parameters:
        None
    Remarks:
        Overlapped command
    Example:
        STEP:PRES:SAVE

:MEASure:VOLTage[:AMPLitude]?
    Syntax:
        :MEASure:VOLTage[:AMPLitude]?
    Description:
        This query returns value of output voltage in Current function.
    Parameters:
        <DNPD>   Range -100.0 ... 100.0
        <UNIT>   {V}
            ·V   Voltage
    Remarks:
        The value is set to default after power on
        The value is set to default on *RST command
        Overlapped command
    Example:
        MEAS:VOLT? Response: 1.000000E+02 V

:MEASure:CURRent[:AMPLitude]?
    Syntax:
        :MEASure:CURRent[:AMPLitude]?
    Description:
        This query returns value of output current in Voltage function.
    Parameters:
        <DNPD>   Range -5e-2 ... 5e-2
        <UNIT>   {A}
            ·A   Amper

Remarks:
    The value is set to default after power on
    The value is set to default on *RST command
    Overlapped command
Example:
    MEAS:CURR? Response: 5.000000E-02 A

:MEASure:CONFigure

Syntax:
    :MEASure:CONFigure <CPD>
    :MEASure:CONFigure?
Description:
    This command sets the function of internal multimeter.
Parameters:
    <CPD>   {FREQ|COUN} (default FREQ)
        ·FREQ   Frequency
        ·COUN   Counter
Remarks:
    The value is stored in each preset
    The value is set according to "Startup" preset after power on
    The value is set to default on *RST command
    Overlapped command
Example:
    MEAS:CONF FREQ
    MEAS:CONF? Response: FREQ

:MEASure:FREQuency[:AMPLitude]?

Syntax:
    :MEASure:FREQuency[:AMPLitude]?
Description:
    This query returns value of frequency meter.
Parameters:
    <DNPD>   Measured value
    <UNIT>   {HZ}
        ·HZ   Hertz
Remarks:
    The value is set to default after power on
    The value is set to default on *RST command
    Overlapped command
Example:
    MEAS:FREQ? Response: 5.000000E+01 HZ

:MEASure:COUNter[:AMPLitude]?

Syntax:
    :MEASure:COUNter[:AMPLitude]?
Description:
    This query returns value of counter.
Parameters:
    <DNPD>   Measured value
Remarks:
    The value is set to default after power on
    The value is set to default on *RST command
    Overlapped command
Example:
    MEAS:COUN? Response: 1.0E+006

:MEASure:TCPL:RJAMplitude

Syntax:

      :MEASure:TCPL:RJAMplitude?

Description:

      This query returns external reference junction temperature.

Parameters:

      <DNPD>   Measured value

Remarks:

      The value is set to default after power on

      The value is set to default on *RST command

      Overlapped command

Example:

      MEAS:TCPL:RJAM? Response: 2.300000E+01

:STATus:OPERation:CONDition

Syntax:

      :STATus:OPERation:CONDition?

Description:

      This query returns the content of Operational Condition register. It is a decimal value which corresponds to the binary-weighted sum of all bits in the register. Register is not cleared after this query. The response to the query therefore represents an instantaneous 'Snapshot' of the register state, at the time that the query was accepted.

Parameters:

      <DNPD>   Operational Condition register

Remarks:

      Overlapped command

Example:

      STAT:OPER:COND? Response: 2

:STATus:OPERation:ENABle

Syntax:

      :STATus:OPERation:ENABle <DNPD>

      :STATus:OPERation:ENABle?

Description:

      This command enables bits in the Operational Data Enable register. Selected bits are summarized at bit 7 (OSS) of the IEEE488.2 Status Byte register.

Parameters:

      <DNPD>   Operational Data Enable register

Remarks:

      Overlapped command

Example:

      STAT:OPER:ENAB 2

      STAT:OPER:ENAB? Response: 2

:STATus:OPERation[:EVENt]?

Syntax:

      :STATus:OPERation[:EVENt]?

Description:

      This query returns the content of Operational Data Event register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Register is cleared after this query.

Parameters:

      <DNPD>   Operational Data Event register

Remarks:

      Overlapped command

Example:

      STAT:OPER? Response: 0

:STATus:OPERation:NTRansition

Syntax:

:STATus:OPERation:NTRansition <DNPD>

:STATus:OPERation:NTRansition?

Description:

This comman allows set Operation Negative Transition Register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Setting a bit in the negative transition filter shall cause a 1 to 0 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

Parameters:

<DNPD>   Operation Negative Transition Register, Range 0… 32767

Remarks:

Overlapped command

Example:

STAT:OPER:NTR 2

STAT:OPER:NTR? Response: 2

:STATus:OPERation:PTRansition

Syntax:

:STATus:OPERation:PTRansition <DNPD>

:STATus:OPERation:PTRansition?

Description:

This comman allows set Operation Positive Transition Register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Setting a bit in the positive transition filter shall cause a 0 to 1 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

Parameters:

<DNPD>   Operation Positive Transition Register, Range 0 … 32767

Remarks:

Overlapped command

Example:

STAT:OPER:PTR 1.0

STAT:OPER:PTR? Response: 1.000000E+00

:STATus:QUEStionable:CONDition

Syntax:

:STATus:QUEStionable:CONDition?

Description:

This query returns the content of Questionable Condition register. It is a decimal value which corresponds to the binary-weighted sum of all bits in the register. Register is not cleared after this query. The response to the query therefore represents an instantaneous 'Snapshot' of the register state, at the time that the query was accepted.

Parameters:

<DNPD>   Questionable Condition register

Remarks:

Overlapped command

Example:

STAT:QUES:COND? Response: 2

:STATus:QUEStionable:ENABle

Syntax:

:STATus:QUEStionable:ENABle <DNPD>

:STATus:QUEStionable:ENABle?

Description:

This command enables bits in the Questionable Data Enable register. Selected bits are summarized at bit 3 (QSS) of the IEEE488.2 Status Byte register.

Parameters:

          \<DNPD>   Questionable Data Enable register

Remarks:

          Overlapped command

Example:

          STAT:QUES:ENAB 2

          STAT:QUES:ENAB? Response: 2

:STATus:QUEStionable[:EVENt]?

Syntax:

          :STATus:QUEStionable[:EVENt]?

Description:

          This query returns the content of Questionable Data Event register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Register is cleared after this query.

Parameters:

          \<DNPD>   Questionable Data Event register

Remarks:

          Overlapped command

Example:

          STAT:QUES? Response: 0

:STATus:QUEStionable:NTRansition

Syntax:

          :STATus:QUEStionable:NTRansition \<DNPD>

          :STATus:QUEStionable:NTRansition?

Description:

          This comman allows set Questionable Negative Transition Register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Setting a bit in the negative transition filter shall cause a 1 to 0 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

Parameters:

          \<DNPD>   Questionable Negative Transition Register, Range 0… 32767

Remarks:

          Overlapped command

Example:

          STAT:QUES:NTR 2

          STAT:QUES:NTR? Response: 2

:STATus:QUEStionable:PTRansition

Syntax:

          :STATus:QUEStionable:PTRansition \<DNPD>

          :STATus:QUEStionable:PTRansition?

Description:

          This comman allows set Questionable Positive Transition Register. It is a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Setting a bit in the positive transition filter shall cause a 0 to 1 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

Parameters:

          \<DNPD>   Questionable Positive Transition Register, Range 0… 32767

Remarks:

          Overlapped command

Example:
        STAT:QUES:PTR 2
        STAT:QUES:PTR? Response: 2

:SYSTem:BEEPer:STATe
        Syntax:
                :SYSTem:BEEPer:STATe <BOOL>
                :SYSTem:BEEPer:STATe?
        Description:
                This command sets state of device beeper.
        Parameters:
                <BOOL>   {ON|OFF|1|0} (default 1)
                        ·ON   device system beeper is enabled
                        ·OFF   device system beeper is disabled
                        ·1   same as ON
                        ·0   same as OFF
        Remarks:
                Overlapped command
                Value is not affected by reset
        Example:
                SYST:BEEP:STAT ON
                SYST:BEEP:STAT? Response: 1

:SYSTem:BEEPer:VOLume
        Syntax:
                :SYSTem:BEEPer:VOLume <DNPD>
                :SYSTem:BEEPer:VOLume?
        Description:
                This command sets the system device beeper volume.
        Parameters:
                <DNPD>   Range 0.0 ... 1.0 (Max. volume) (default 0.2)
        Remarks:
                Overlapped command
                Value is not affected by reset
        Example:
                SYST:BEEP:VOL 0.2
                SYST:BEEP:VOL? Response: 2.000000E-01

:SYSTem:BEEPer:KEYBoard
        Syntax:
                :SYSTem:BEEPer:KEYBoard <BOOL>
                :SYSTem:BEEPer:KEYBoard?
        Description:
                This command sets state of keyboard beeper.
        Parameters:
                <BOOL>   {ON|OFF|1|0} (default 1)
                        ·ON   device system beeper is enabled
                        ·OFF   device system beeper is disabled
                        ·1   same as ON
                        ·0   same as OFF
        Remarks:
                Overlapped command
        Example:
                SYST:BEEP:KEYB ON
                SYST:BEEP:KEYB? Response: 1

:SYSTem:COMMunicate:BUS

Syntax:

    :SYSTem:COMMunicate:BUS <CPD>

    :SYSTem:COMMunicate:BUS?

Description:

    This command selects communication interface.

Parameters:

    <CPD>   {SERial|GPIB|USB|LAN} (default SER)

        ·SERial   RS232 interface

        ·GPIB   GPIB interface

        ·USB   USB interface

        ·LAN   LAN interface

Remarks:

    Sequential command

    Value is not affected by reset

Example:

    SYST:COMM:BUS SER

    SYST:COMM:BUS? Response: SER

:SYSTem:COMMunicate:GPIB:ADDRess

Syntax:

    :SYSTem:COMMunicate:GPIB:ADDRess <DNPD>

    :SYSTem:COMMunicate:GPIB:ADDRess?

Description:

    This commands allows set communication GPIB address

Parameters:

    <DNPD>   Range 1 ... 31 (default 2)

Remarks:

    Overlapped command

    Value is not affected by reset

Example:

    SYST:COMM:GPIB:ADDR 2

    SYST:COMM:GPIB:ADDR? Response: 2

:SYSTem:COMMunicate:LAN:ADDRess

Syntax:

    :SYSTem:COMMunicate:LAN:ADDRess <CPD>

    :SYSTem:COMMunicate:LAN:ADDRess?

Description:

    This command allows to change IP address if DHCP is switched off. Interface must be restarted to take effect (see SYST:COMM:REST command).

Parameters:

    <CPD>   Range 000.000.000.000 ... 255.255.255.255 (default 192.168.001.100)

Remarks:

    Overlapped command

    Value is not affected by reset

Example:

    SYST:COMM:LAN:ADDR 192.168.001.100

    SYST:COMM:LAN:ADDR? Response: 192.168.001.100

:SYSTem:COMMunicate:LAN:MASK

Syntax:

    :SYSTem:COMMunicate:LAN:MASK <CPD>

    :SYSTem:COMMunicate:LAN:MASK?

Description:

    This command allows to change subnet mask if DHCP is switched off. Interface must be restarted to take effect (see SYST:COMM:REST command).

Parameters:

    <CPD>   Range 000.000.000.000 ... 255.255.255.255 (default 255.255.255.000)

Remarks:
    Overlapped command
    Value is not affected by reset
Example:
    SYST:COMM:LAN:MASK 255.255.255.000
    SYST:COMM:LAN:MASK? Response: 255.255.255.000

:SYSTem:COMMunicate:LAN:GATE
Syntax:
    :SYSTem:COMMunicate:LAN:GATE <CPD>
    :SYSTem:COMMunicate:LAN:GATE?
Description:
    This command allows to change default gateway if DHCP is switched off. Interface must
    be restarted to take effect (see SYST:COMM:REST command).
Parameters:
    <CPD>   Range 000.000.000.000 ... 255.255.255.255 (default 255.255.255.255)
Remarks:
    Overlapped command
    Value is not affected by reset
Example:
    SYST:COMM:LAN:GATE 255.255.255.255
    SYST:COMM:LAN:GATE? Response: 255.255.255.255

:SYSTem:COMMunicate:LAN:PORT
Syntax:
    :SYSTem:COMMunicate:LAN:PORT <DNPD>
    :SYSTem:COMMunicate:LAN:PORT?
Description:
    This command allows to change port number. Interface must be restarted to take effect
    (see SYST:COMM:REST command).
Parameters:
    <DNPD>   Range 0 ... 9999 (default 23)
Remarks:
    Overlapped command
    Value is not affected by reset
Example:
    SYST:COMM:LAN:PORT 23
    SYST:COMM:LAN:PORT? Response: 23

:SYSTem:COMMunicate:LAN:HOST
    Syntax:
        :SYSTem:COMMunicate:LAN:HOST <CPD>
        :SYSTem:COMMunicate:LAN:HOST?
    Description:
        This command allows to change host name if DHCP is switched on. Interface must be
        restarted to take effect (see SYST:COMM:REST command).
    Parameters:
        <CPD>   Upper alpha, lower alpha, digits, underscores and spaces are
                             allowable. Maximum string size is 14 characters.
    Remarks:
        Overlapped command
        Value is not affected by reset
    Example:
        SYST:COMM:LAN:HOST M160_SNXXXXXX
        SYST:COMM:LAN:HOST? Response: M160_SNXXXXXX

:SYSTem:COMMunicate:LAN:DHCP
    Syntax:
        :SYSTem:COMMunicate:LAN:DHCP <BOOL>
        :SYSTem:COMMunicate:LAN:DHCP?
    Description:
        This command allows switch On/Off DHCP.
    Parameters:
        <BOOL>   {ON|OFF|1|0} (default 1)
            ·ON   DHCP is On
            ·OFF   DHCP is Off
            ·1   same as ON
            ·0   same as OFF
    Remarks:
        Overlapped command
        Value is not affected by reset
    Example:
        SYST:COMM:LAN:DHCP ON
        SYST:COMM:LAN:DHCP? Response: 1

:SYSTem:COMMunicate:RESTart
    Syntax:
        :SYSTem:COMMunicate:RESTart
    Description:
        This command will restart communication interface. It will take several seconds. During
        this period device will not respond to any commands. Restart is needed for all LAN
        setting changes.
    Parameters:
        None
    Remarks:
        Overlapped command
    Example:
        SYST:COMM:REST

:SYSTem:COMMunicate:SERial:BAUD
    Syntax:
        :SYSTem:COMMunicate:SERial:BAUD <CPD>
        :SYSTem:COMMunicate:SERial:BAUD?
    Description:
        This command allows changing RS232 transfer rate.
    Parameters:
        <CPD>   {1200|2400|4800|9600|19200|38400|57600|115200} (default 9600)

·1200	1200 Bd
·2400	2400 Bd
·4800	4800 Bd
·9600	9600 Bd
·19200	19200 Bd
·38400	38400 Bd
·57600	57600 Bd
·115200	115200 Bd

    Remarks:
        Overlapped command
        Value is not affected by reset
    Example:
        SYST:COMM:SER:BAUD 9600
        SYST:COMM:SER:BAUD? Response: 9600

:SYSTem:DATE
    Syntax:
        :SYSTem:DATE <DNPD>,<DNPD>,<DNPD>
        :SYSTem:DATE?
    Description:
        This commands allows to change system device date.
    Parameters:
        <DNPD>   Year, Range 2000 ... 2063
        <DNPD>   Month, Range 1 ... 12
        <DNPD>   Day, Range 1 ... 31
    Remarks:
        Overlapped command
    Example:
        SYST:DATE 2012,12,31
        SYST:DATE? Response: 2012,12,31

:SYSTem:ERRor[:NEXT]?
    Syntax:
        :SYSTem:ERRor[:NEXT]?
    Description:
        This command reads SCPI error (maximum 32) that occurred at first. If number of SCPI errors exceed 32, error -350 "Queue overflow" is returned. For all available error codes and messages see "SCPI Error codes" table. Error queue is cleared by reading all errors or by issuing *CLS command.
    Parameters:
        <DNPD>   Error code
        <SPD>   Quoted error message
    Remarks:
        Overlapped command
    Example:
        SYST:ERR? Response: -300,"Device error"

:SYSTem:KEY
 Syntax:
  :SYSTem:KEY <DNPD>
  :SYSTem:KEY?
 Description:
  This command allows send key code to the device the same way the user can press keys on front panel. Query returns last pressed key.

Key	Code
KEY_0	16
KEY_1	15
KEY_2	21
KEY_3	27
KEY_4	14
KEY_5	20
KEY_6	26
KEY_7	13
KEY_8	19
KEY_9	25
KEY_SELECT	2
KEY_ENTER	34
KEY_CANCEL	33
KEY_UP	5
KEY_DOWN	1
KEY_LEFT	3
KEY_RIGHT	4
KEY_EXPONENT	31
KEY_BACKSPACE	32
KEY_POINT	22
KEY_USER_1	7
KEY_USER_2	8
KEY_USER_3	9
KEY_USER_4	10
KEY_SIGN	28
KEY_OPER	11
KEY_STEP	17

Table 13 Keyboard codes

 Parameters:
  <DNPD>   Key code. For particular key codes see table above.
 Remarks:
  Overlapped command
 Example:
  SYST:KEY 12
  SYST:KEY? Response: 12

:SYSTem:LOCal
    Syntax:
        :SYSTem:LOCal
    Description:
        This command places device in the LOCAL mode and unlocks all keys on front panel of the device. The Command is valid only for RS232, LAN and USB interfaces. The device will not respond to commands in LOCAL mode.
    Parameters:
        None
    Remarks:
        Overlapped command
    Example:
        SYST:LOC

:SYSTem:PRESet
    Syntax:
        :SYSTem:PRESet
    Description:
        This command will preset all device settings. These settings are the same as the RESET ones.
    Parameters:
        None
    Remarks:
        Overlapped command
    Example:
        SYST:PRES

:SYSTem:REMote
    Syntax:
        :SYSTem:REMote
    Description:
        This command places device in the REMOTE mode and locks all keys but LOCAL key. The Command is valid only for RS232, LAN and USB interfaces. The device will not respond to any other command until is in REMOTE mode.
    Parameters:
        None
    Remarks:
        Overlapped command
    Example:
        SYST:REM

:SYSTem:RWLock
    Syntax:
        :SYSTem:RWLock
    Description:
        This command places device in the REMOTE mode and locks all keys including LOCAL key. The Command is valid only for RS232, LAN, USB interfaces. The device will not respond to any other command until is in REMOTE mode.
    Parameters:
        None
    Remarks:
        Overlapped command
    Example:
        SYST:RWL

:SYSTem:TIME

Syntax:
>   :SYSTem:TIME <DNPD>,<DNPD>,<DNPD>
>   :SYSTem:TIME?

Description:
>   This commands allows set system device time (RTC).

Parameters:
>   <DNPD>   Hours, Range 0 ... 23
>   <DNPD>   Minutes, Range 0 ... 59
>   <DNPD>   Seconds, Range 0 ... 59

Remarks:
>   Overlapped command

Example:
>   SYST:TIME 10,45,15
>   SYST:TIME? Response: 10,45,15

:SYSTem:VERSion?

Syntax:
>   :SYSTem:VERSion?

Description:
>   This query retreives version of implemented SCPI language

Parameters:
>   <CPD>   SCPI language version

Remarks:
>   Overlapped command

Example:
>   SYST:VERS? Response: 1999.0

:UNIT:TEMPerature

Syntax:
>   :UNIT:TEMPerature <CPD>
>   :UNIT:TEMPerature?

Description:
>   This function allows to set unit for all temperature functions (Platinum, Nickel).

Parameters:
>   <CPD>   {CEL|FAR|K} (default CEL)
>   ·CEL   degrees of Celsius
>   ·FAR   degrees of Fahrenheit
>   ·K   Kelvin

Remarks:
>   Overlapped command
>   Value is not affected by reset

Example:
>   UNIT:TEMP CEL
>   UNIT:TEMP? Response: CEL

6.10. SCPI Error codes

Device distinguishes following SCPI error codes. These codes are reported on device display screen or can be read by SYST:ERR? Command.

Error	Message
-100	"Command error"
-101	"Invalid character"
-102	"Syntax error"
-103	"Invalid separator"
-104	"Data type error"
-105	"Event GET received during command proccessing"
-108	"Parameter not allowed"
-109	"Missing parameter"
-112	"Program mnemonic too long"
-113	"Undefined header"
-114	"Header suffix out of range"
-120	"Numeric data error"
-121	"Invalid character in number"
-130	"Suffix error"
-141	"Invalid character data"
-144	"Character data too long"
-151	"Invalid string data"
-161	"Invalid block data"
-203	"Command protected"
-220	"Parameter error"
-222	"Data out of range"
-283	"Illegal variable name"
-350	"Queue overflow"
-400	"Query error"
-410	"Query INTERRUPTED"
-420	"Query UNTERMINATED"
-430	"Query DEADLOCKED"
-440	"Query UNTERMINATED after indefinite response"
514	"Command not allowed with GPIB"

Table 14 SCPI error codes

7. Maintenance

This chapter explains how to perform the routine maintenance to keep your device in optimal operating condition. The tasks covered in this chapter include the following:

- Fuse replacing
- External surface cleaning

7.1. Fuse replacing

The instrument includes a fuse located in the mains connector at the rear panel. Replace the fuse as follows:

- Switch off the device.
- Remove the end of power cord from the mains connector at the rear panel.
- Insert the blade of a flat screwdriver into the opening cut in the mains voltage selector and pull out the fuse holder.
- Remove the fuse and replace it with new fuse of the same rating.

7.2. External surface cleaning

To keep the device looking like new, clean the case and front panel keys using a soft cloth slightly dampened with either water or a non-abrasive mild cleaning solution that is not harmful to plastics.

8. Module 19" (version M160-Vxx1x)

Calibrator can be ordered as 19" module for easy assembling into a 19" rack. Module height is 3HE.

Figure 34 Module 19'' rack, front panel

9. Specification

Uncertainties include long-term stability, temperature coefficient, linearity, line regulation and the traceability of factory and National calibration standards. Specified accuracy is valid after one hour warm up in temperature range 23°C ± 10 °C. Specified accuracy is one year accuracy.

DC voltage

Summary range:	0 to 100 Vdc
Voltage resolution:	6½ digits
Typical linearity:	2 ppm
4W sense compensation limit	0.2 V

Autocalibration enabled

Range +/-	Resolution	Max. current	± (ppm of output + V)	
			1 year	
300 mV	100 nV	50 mA	15	2.5 µV
3 V	1 µV	50 mA	15	10 µV
30 V	10 µV	50 mA	15	100 µV
100 V	100 µV	25 mA	15	500 µV

Autocalibration disabled

Range +/-	Resolution	Max. current	± (ppm of output + V)							
			Stability 24 hours [1]		**90 days**		**180 days**		**1 year**	
300 mV	100 nV	50 mA	3	1.5 µV	15	2.5 µV	18	3 µV	20	3 µV
3 V	1 µV	50 mA	3	5 µV	15	10 µV	18	15 µV	20	20 µV
30 V	10 µV	50 mA	3	50 µV	15	100 µV	18	150 µV	20	200 µV
100 V	100 µV	25 mA	3	200 µV	15	500 µV	18	750 µV	20	1 mV

1)   24 hour stability applies at a constant temperature (± 1°C)

DC current

Summary range:	0 to 50 mAdc
Current resolution:	6 digits
Typical linearity:	15 ppm

Autocalibration enabled

Range +/-	Resolution	Max. voltage	± (ppm of output + A)	
			1 year	
25 mA	100 nA	100 V	35	1 µA
50 mA	100 nA	30 V	35	1 µA

Autocalibration disabled

Range +/-	Resolution	Max. voltage	± (ppm of output + A)					
			90 days		180 days		1 year	
25 mA	100 nA	100 V	35	1 µA	40	1 µA	50	1 µA
50 mA	100 nA	30 V	35	1 µA	40	1 µA	50	1 µA

Frequency source
Summary range: 10 mHz to 15 kHz
Open collector: max. 30 V/50 mA
                               or internal pull up 100R to +5V (±10 %)

Range	+/- (ppm of output)	Resolution
200 mHz	50	100 nHz
2000 mHz	50	1 µHz
20 Hz	50	10 µHz
200 Hz	50	100 µHz
2000 Hz	50	10 mHz
4 kHz	100	100 mHz
10 kHz	600	1 Hz
15 kHz	1500	10 Hz

Frequency meter
Summary range: 10 mHz to 100 kHz
Frequency resolution: 5½ digits
Accuracy: ±50 ppm

Current meter (in voltage function)
Ranges: 5 mA, 25 mA, 50 mA (based on current limit setting)
Resolution: 10 µA
Accuracy: ± 0.1 % of range

Voltage meter (in current function)
Ranges: 100 V
Resolution: 10 mV
Accuracy: ± 0.1 % of range

Current limit setting (in voltage function)
Ranges: 50 mA
Resolution: 10 µA
Accuracy: ± 0.2 % of range

Voltage limit setting (in current function)
Ranges: 100 V
Resolution: 10 mV
Accuracy: ± 0.2 % of range

TC
Resolution: 0.01 °C

Type	Range	± °C
R (EN60584-1/ITS90)	-50 … -10 °C	0.8 °C
	-10 … 100 °C	0.6 °C
	100 … 400 °C	0.4 °C
	400 … 1768 °C	0.3 °C
S (EN60584-1/ITS90)	-50 … -20 °C	0.7 °C
	-20 … 100 °C	0.6 °C
	100 … 1768 °C	0.4 °C
B (EN60584-1/ITS90)	400 … 500 °C	0.8 °C
	500 … 800 °C	0.6 °C
	800 … 1820 °C	0.4 °C
J (EN60584-1/ITS90)	-210 … -180 °C	0.15 °C
	-180 … 1200 °C	0.1 °C
T (EN60584-1/ITS90)	-200 … -100 °C	0.2 °C
	-100 … 400 °C	0.1 °C
E (EN60584-1/ITS90)	-250 … -200 °C	0.25 °C
	-200 … 1000 °C	0.1 °C
K (EN60584-1/ITS90)	-200 … -100 °C	0.2 °C
	-100 … 900 °C	0.1 °C
	900 … 1372 °C	0.15 °C
N (EN60584-1/ITS90)	-200 … -100 °C	0.3 °C
	-100 … 100 °C	0.15 °C
	100 … 900 °C	0.1 °C
	900 … 1300 °C	0.15 °C
M (General Electric IPTS 68)	-50 … 1410 °C	0.1 °C
C (Hoskins ITS 90)	0 … 100 °C	0.3 °C
	100 … 900 °C	0.2 °C
	900 … 2315 °C	0.3 °C

D (Hoskins ITS 90)	0 … 300 °C	0.3 °C
	300 … 1100 °C	0.2 °C
	1100 … 2315 °C	0.3 °C
G2 (Hoskins ITS 90)	0 … 300 °C	0.5 °C
	300 … 2100 °C	0.2 °C
	2100 … 2315 °C	0.3 °C

Pt100 meter for RJ
Summary range: -50 to 150 °C
Resolution: 0.01 °C

Range	± °C [2]
-50 … 150 °C	0.02 °C

2) Reference temperature range 23 °C ± 2°C

Option 91
External reference junction for thermocouples.

RTD 4W (full version only)
Pt summary range: -200 °C to +850 °C
Ni summary range: -60 °C to +300 °C
Resolution: 0.01 °C

Type	Range	± °C [3]
Pt100 … Pt1000	-200 … 0 °C	0.15 °C
Pt100 … Pt1000	0 … 850 °C	0.2 °C
Ni100 … Ni1000	-60 … 300 °C	0.1 °C

3) Reference temperature range 23 °C ± 2°C

RTD 2W (full version only)
Pt summary range: -200 °C to +850 °C
Ni summary range: -60 °C to +300 °C
Resolution: 0.01 °C

Type	Range	± °C [4]
Pt100 … Pt1000	-200 … 850 °C	0.2 °C
Ni100 … Ni1000	-60 … 300 °C	0.15 °C

4) Reference temperature range 23 °C ± 2°C

Resistance 4W (full version only)
Summary range: 10 Ω to 300 kΩ
Short resistance: < 50 mΩ

Range	±(% of output + Ω) [5]		Resolution
20 Ω	0.05	15 mΩ	0.0001 Ω
200 Ω	0.05	15 mΩ	0.001 Ω
1000 Ω	0.02	0	0.01 Ω
3000 Ω	0.02	0	0.1 Ω
10000 Ω	0.02	0	1 Ω
30 kΩ	0.05	0	0.01 kΩ
100 kΩ	0.1	0	0.1 kΩ
300 kΩ	0.5	0	1 kΩ

5) Reference temperature range 23 °C ± 2°C

Resistance 2W (full version only)
Terminals: Hi, Li (adapter)
Summary range: 10 Ω to 300 kΩ
Specification: add 10 mΩ to the 4W specification
Short resistance: < 200 mΩ

RTD, Resistance limits
Maximum dissipation power: 0.3 W
Maximum current: 0.2 A
Maximum voltage: 50 Vpk

Interface : RS232 (optionally IEEE488, USB, Ethernet)
Power supply : 115/230 Vac, 47…63 Hz
Maximal power consumption : 60 VA
Reference temperature : +13 °C … +33 °C (Voltage, Current, TC, Frequency)
                          : +20 °C … +26 °C (RTD, Resistance)
Working temperature : +5 °C … +45 °C
Storing temperature : -10 °C … +55 °C
Temperature coefficient : <1ppm/°C   (frequency in+out)
                          <10ppm/°C (RTD in; for TC compensation)
                          <25ppm/°C (resistance, RTD out)
                          10 % of specification /°C (voltage, current, TC out)
Housing : metal sheet
Dimensions : W 390 mm, H 128 mm, D 310 mm
Weight : 5.5 kg
Protection fuses : T315mAL250 for 230 V
                     T630mAL250 for 115 V

Note:
Only data shown with tolerance or with band of limits are tested. All other values have informative character.

10. Ordering information – options

Bus
M160-V1xxx   - RS232
M160-V2xxx   - RS232, LAN, USB, IEEE488

Functions
M160i-Vxxxx   - economy version (U, I, TC, Frequency)
M160-Vxxxx   - full version (U, I, TC, Frequency, RTD, R)

Housing
M160-Vxx0x   - table version
M160-Vxx1x   - module 19", 3HE

Example of order:
M160-V2010
- Precision DC calibrator
  RS232, LAN, USB, IEEE488 / full version / 19" rack

11. Accesories

M160 Basic accessories (included in delivery)

- Power line cord   1 pc
- User's manual   1 pc
- Test report   1 pc
- Spare fuse   1 pc
- RS232 cable   1 pc
- Option 15 – test lead (black)   1 pc
- Option 16 – test lead (red)   1 pc
- Option 160-60 frequency adapter   1 pc
- Option 160-70 resistance adapter (M160 only) 1 pc

Options (extra ordered)

- Option 91   External Reference Junction for thermocouples

Manufacturer

MEATEST, s.r.o.   *tel: +420 543 250 886*
Železná 509/3, 619 00 Brno   *fax: +420 543 250 890*
Czech Republic   *meatest@meatest.cz*
www.meatest.com

$C\,E$ Certificate of conformity

According to EN ISO/IEC 17050-1:2010 standard as well as 2014/30/EU and 2014/35/EU directives of European Parliament and European Council, MEATEST, spol. s r. o., manufacturer of M-160 Precision DC calibrator based in Železná 3, 619 00 Brno, Czech Republic, declares that its product conforms to following specifications:

Safety requirements

-   EN 61010-1 ed. 2:2010 + A1:2016 + COR1:2019-03

Electromagnetic compatibility

-   EN 61000 part 3-2 ed. 5:2019
-   EN 61000 part 3-3 ed. 3:2014
-   EN 61000 part 4-2 ed. 2:2009
-   EN 61000 part 4-3 ed. 3:2006 +A1:2008+A2:2011+Z1:2010
-   EN 61000 part 4-4 ed. 3:2013
-   EN 61000 part 4-5 ed. 3:2015 + A1:2018
-   EN 61000 part 4-6 ed. 4:2014
-   EN 61000 part 4-11 ed. 2:2005
-   EN 61326-1 ed. 2:2013
-   EN 55011 ed. 4:2015 + A1:2016 + A11:2020

Brno   September 25th, 2020

Place   Date   Signature