

# M525

## Programmable Capacitance Box

Operation manual





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## 1. Basic information

Programmable decade M525 is designed for checking multimeters and simple RLC meter. It is suitable also for repair, adjustment and calibration of measuring instruments. Capacitance value is created via appropriate combination of physical capacitors. Capacitors are switched using special relays designed for high currents. Actual set values are displayed on high resolution TFT display. Comfortable user interface offers direct setting of capacity value, OPEN correction, grounding L terminal, user conversion curves setting and others. M525 is equipped with an internal calibration menu that allows correcting any deviation of capacity value without opening the instrument. M525 is sophisticated instrument with its own re-calibration procedure. The procedure enables to correct any deviation in capacitance without any mechanical adjusting.

Decade can be remotely controlled by a computer using standard RS232 interface. LAN, USB and GPIB interfaces are optional.

## 2. Preparation for use

### 2.1. *Inspecting package contents, selecting the installation location*

Basic package includes the following items:

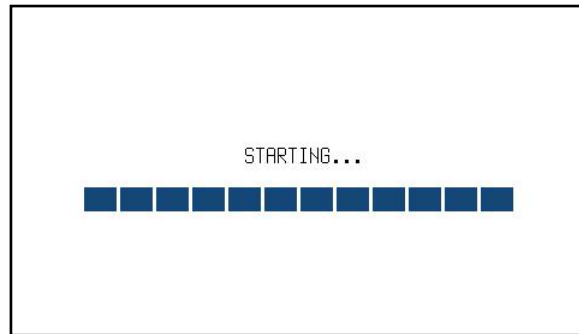
- Capacitance decade M525
- Power line cord
- CD with demo program
- User's manual
- Test report

The instrument must be powered by 85-260 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.



**Figure 1 Starting Screen**

- The instrument performs internal hardware checks for app. 5 seconds.
- After the tests conclude, the instrument is set to “Startup” preset. This preset is adjustable however, the instrument will always start with OPEN terminals.

### ***2.3. Warm-up time***

The instrument works after it is switched on and the initial checks complete. Specified parameters are only guaranteed after the instrument warms up for 10 minutes.

### ***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

## 3. Description

### 3.1. Front panel

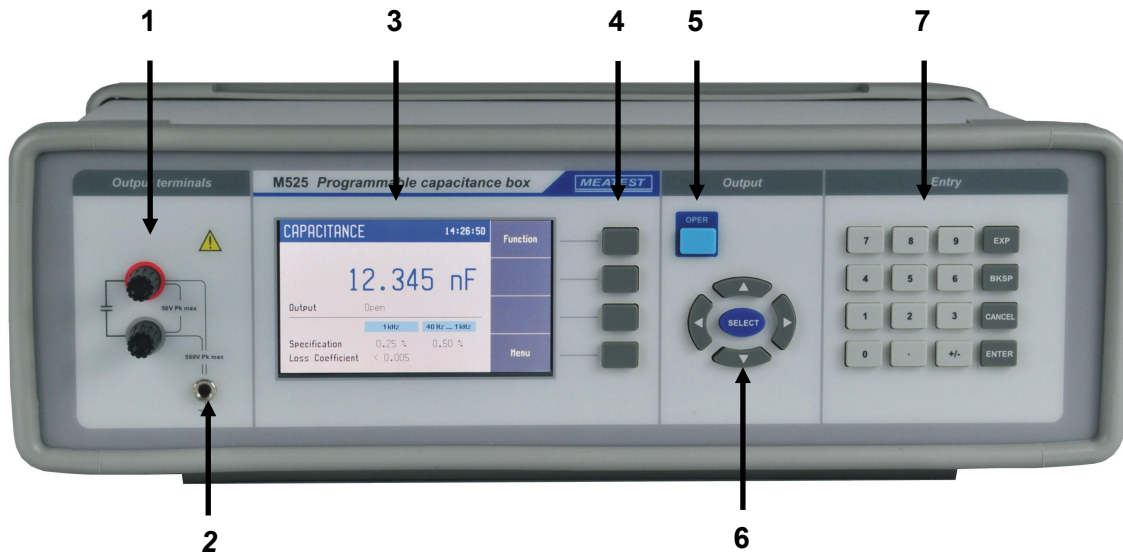


Figure 2 Front panel

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

#### 1 Output terminals

Two wire output terminals. Measuring (evaluation) circuit can be connected by 2 wires. Both sides (red and grey) are floating up to 500Vpk against the case (PE).

#### 2 Ground terminal

Central ground terminal (protective earth) connected to the metal case of the instrument. It is recommended to connect it to the “grey” output terminals if connected meter is not grounded.

#### 3 Display

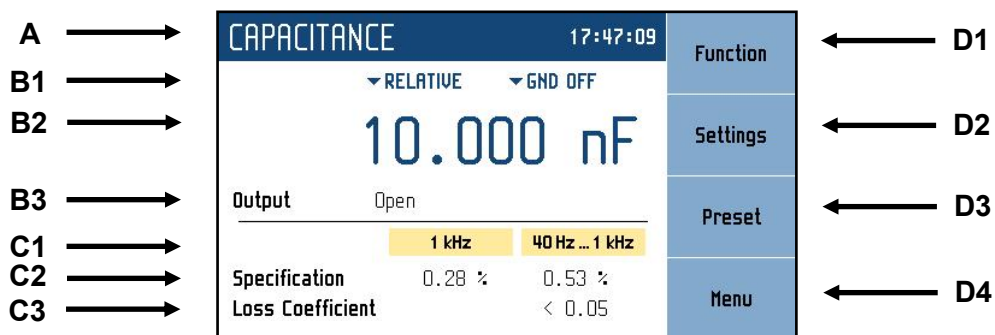


Figure 3 Display

The display is divided into four sections:

#### **A. Information line**

- Selected function (CAPACITANCE, USER FUNCTION, TIMING ...)
- Time

#### **B. Main area**

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

##### *1. Auxiliary parameters*

This section displays auxiliary parameters of actually selected function:

- Correction OPEN (RELATIVE, ABSOLUTE, ...)
- Grounding L terminal (GND ON, GND OFF, ...)

##### *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. Output state*

Output terminals (OPEN, ...)

#### **C. Specification**

This section displays specification and limits relating to the main value:

##### *1. Frequency*

This section displays frequency and frequency range for the corresponding specifications.

##### *2. Specification*

This section displays specification of the main value for the corresponding frequency.

##### *3. Loss coefficient*

This section displays specification of loss coefficient.

#### **D. Softkey labels**

The functions of these keys change during operation (depends on selected function and actual display mode).

#### **4 Softkeys**

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).

#### **5 OPER (Operate key)**

OPER key connects / disconnects selected value to the output terminals. Connected output terminals are indicated by the lit LED in the key.

#### **6 Cursor keys**



Using these keys, the cursor can be controlled within allowed limits on the display. The keyboard includes two buttons (◀, ▶) which allow the cursor to be moved to the left or right. When a list is displayed, (◀, ▶) buttons skip through pages. Buttons (▲, ▼) allow the user to increase or decrease the number at the cursor position or move across items in a list.

The central **SELECT** key is used to select value you want to change (like TAB key).

## 7 Numeric keyboard

The keyboard allows the entry of numeric values on the display. ENTER button is used to confirm the selection. CANCEL button can be used to cancel the entry.

### Colors on display

Common rules are used for applied color of labels and values.

- **Red color** is applied for fix capacitors and correction in calibration mode.
- **Blue color** is applied for parameters or values, which can be set-up or modified directly from front panel keyboard or via Main menu.
- **Black color** is used for fix values, labels, notes, parameters which cannot be modified and for other fix text with general information purpose.
- Meaning of softkeys is shown in the right part of display. If there is no description next to the softkey, the softkey is not active in selected function.

## 3.2 Rear panel

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



Figure 4 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.

Disconnected output terminals be used for OPEN correction.

### 4.2. Wires connection

Output capacitance is available on output terminals. Available is 2-wire connection. Both sides (red and grey) are floating up to 500Vpk against the case (PE).

Ground terminal is connected to the metal case and to the protective earth (PE) and can be in SETUP/DEVICE mode connected to terminal Lo ( GND ON, OFF ).

### 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 or „OK“ softkey.

Device supports following functions:

#### Capacitance

Offers direct setting of exact capacitance value.

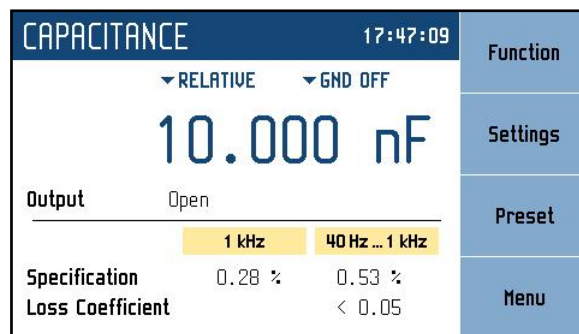


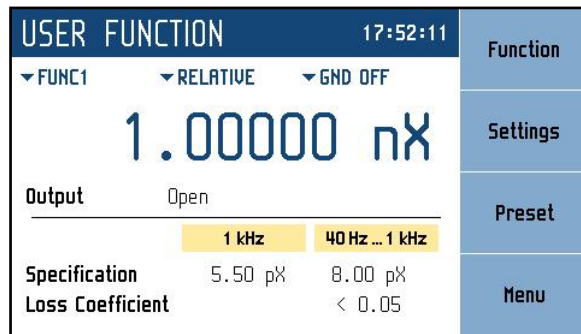
Figure 5 Capacitance screen

Editable parameters:

Capacitance value: 0.100 pF ... 100.00 uF  
 Open correction: RELATIVE, ABSOLUTE  
 Lo connection: GND ON, GND OFF

**User function**

Offers simulation of conversion curve defined by a table. User can define more conversion curves. Values between defined points are linearly interpolated.

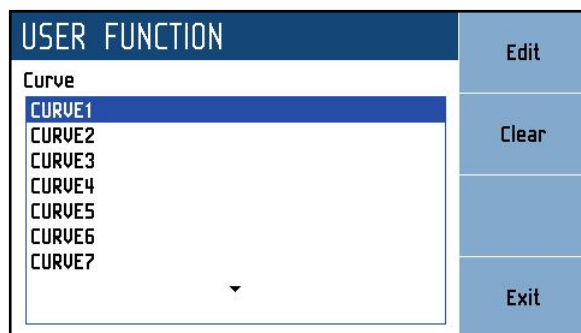


**Figure 6** User function screen

**Editable parameters:**

Main value: according to the function  
 User function: curves defined by the user  
 Open correction: RELATIVE, ABSOLUTE  
 Lo connection: GND ON, GND OFF

Function is defined by table of user values and corresponding capacitance values. This table is called „Curve“ and is editable. Maximum number of tables is 64 with each table having up to 100 values. Tables can be defined via remote control as well. Manual table setup can be done in *Menu* → *Device* → *User function curve*:



**Figure 7** User function list

Menu shows a list of all previously defined tables (curves). Curve names can be customized. Softkeys on the right hand side of the panel have these functions:

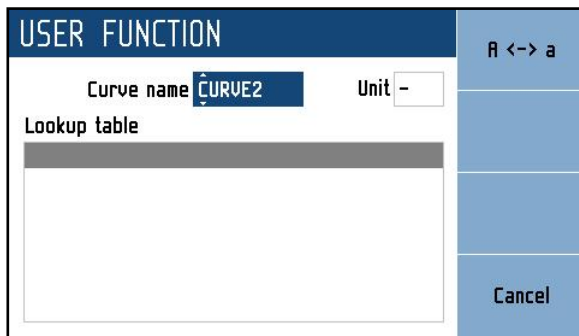
**Edit** – edit selected curve. Table can be selected using cursor keys where ◀, ▶ skip through pages.

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

**Exit** – close the curve list and return previous menu.

### Creating a new table

Pressing the *Edit* softkey upon plain curve opens this submenu:



**Figure 8** New user function

**Curve name** – 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.

**Unit** – user function unit abbreviation is set in the same way as table name only it can be just up to two characters long. Unit abbreviation has to be set before proceeding to the next step using the **SELECT** key.

**Lookup table** – a place where you define user function using values in farads. Table must contain at least two “user function value → farad value” points so that a slope of the function can be calculated. Range in user function mode is given by actual capacitance range of the decade. Browsing through the table is done by ▲, ▼ cursor keys. Editing is done using these contextual softkeys:

**Add** – create a new point.



**Figure 9** User function point editing

**Value** – user function value in user units. Press the **SELECT** key to proceed.

**Capacitance** – corresponding farad value. Range is restricted to actual capacitance range of the decade.

**Edit** – show the “Equation” panel for selected point to allow editing.

**Delete** – delete selected point.

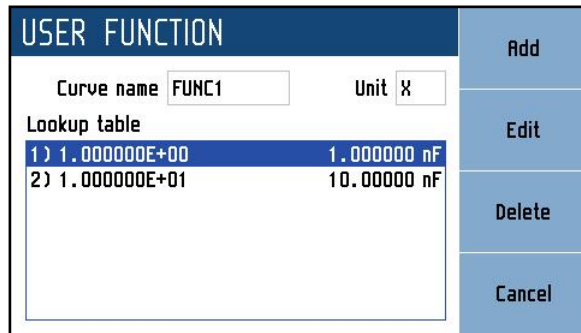
**Cancel** – deactivate the Lookup Table and allow for curve saving.

**Save** – closes the table and saves current settings.

**Cancel** – closes the table and does not save current settings.

*Editing an existing table*

Existing table can be edited in the same way as it can be created. Editable entries (Curve name, Unit, Lookup table points) are selected using the **SELECT** key.



**Figure 10** User function edit

*Timing*

Offers simulation of time-varying capacitance defined by a table. User can define more time curves.



**Figure 11** Timing screen

**Editable parameters:**

Timing table: table defined by the user  
 Open correction: RELATIVE, ABSOLUTE  
 Lo connection: GND ON, GND OFF

Sequence is defined by table of time intervals and corresponding resistance 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. Final state of every sequence is OPEN. Manual table setup can be done in *Menu* → *Device* → *Timings*:

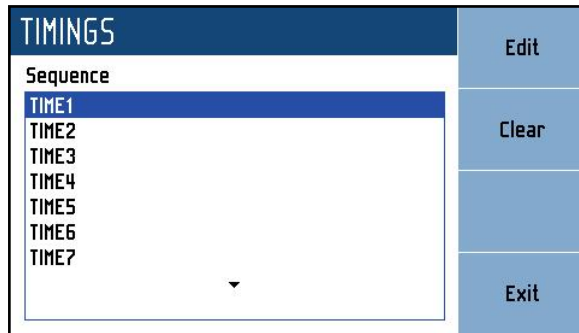


Figure 12 Time sequence list

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 *New* softkey opens this submenu:

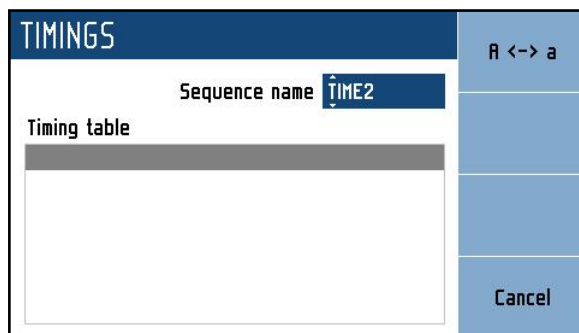


Figure 13 New sequence

**Timing 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.

**Preset name** – 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.

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

**Add** – create a new point.

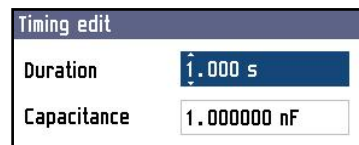


Figure 14 Timing sequence point editing

**Duration** – duration of selected resistance (from 2 ms to 60 s). Press the **SELECT** key to proceed.

**Capacitance** – corresponding farad value. Range is given by the actual resistance range of the decade.

**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 does not save current settings.

#### *Editing an existing table*

Existing table can be edited in the same way as it can be created. Editable entries (Preset name, Timing table points) are selected using the **SELECT** key.

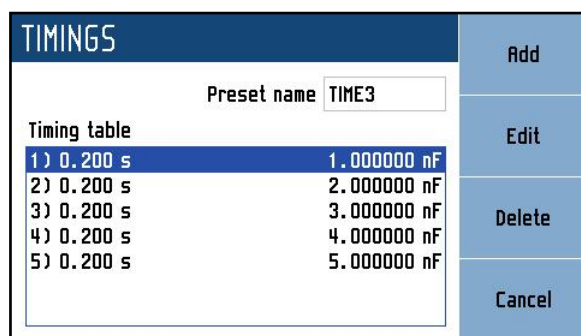


Figure 15 Timing sequence edit

#### 4.4. 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. Pressing the **SELECT** key you can change among editable (blue) parameters. 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.

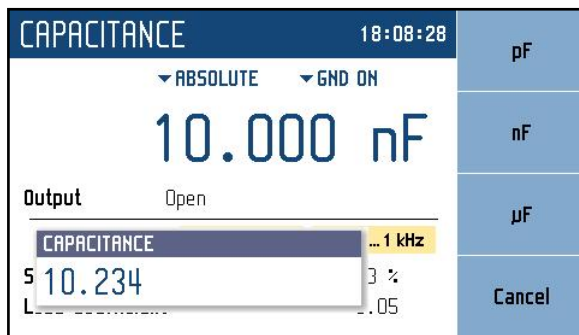


Figure 16 Numeric value entry

- Enter desired value.
- After the entry is complete press softkey with requested unit ( pF, nF, uF ) or press ENTER key. ENTER key inputs the value in basic units (F ...).
- Instrument sets the new value.
- The value is copied to the appropriate field in the screen and the input box disappears.

##### 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.

##### 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.



#### 4.5. 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 17 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.

#### 4.6. Preset menu

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

| PRESETS    |               |            | Save  |
|------------|---------------|------------|-------|
| Preset     | Function      | Date       |       |
| 00 Startup | Capacitance   | 01.01.2012 | Load  |
| 01 US      | User function | 12.10.2016 |       |
| 02 ---     | ---           | ---        | Clear |
| 03 ---     | ---           | ---        |       |
| 04 ---     | ---           | ---        |       |
| 05 ---     | ---           | ---        |       |
| 06 ---     | ---           | ---        |       |
| 07 ---     | ---           | ---        | Exit  |

Figure 18 Preset menu

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

## 4.7. Main menu

Main menu is displayed after pressing „Menu“ softkey. In main menu you can set all the parameters available.



Figure 19 Main 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*

*Seial number*

*Software version*

*Hardware version*

### **Device**

This menu permits setting operational parameters of device.

#### *Open Correctiont*

Item defines how is the value of capacity determined.

RELATIVE - output value of the capacity is defined relatively to the correction OPEN

ABSOLUTE - output value of the capacity is defined absolutely to the level of output terminals

#### *Timings*

This menu permits definition of different time dependent capacitance curves. Each curve is defined by the Timing table. Each row in the table contains information about capacitance value and duration for which is this value applied. If the timing function is activated all rows are sequentially executed. User can define more timing tables with different names. Number of sequences is limited to 64.

#### *User function curve*

This menu permits definition of different conversion curves. Each curve is defined by the Lookup table. Each row in the table contains information about value of simulated function and appropriate resistance value. User can define more lookup tables with different names. Number of conversion curves is limited to 64.

*Lo terminal ground*

Item defines connection terminal Lo to the ground terminal.

OFF Lo terminal disconnected ( floating connection ).

ON Lo terminal connected to the ground terminal ( grounding connection )

**System**

This menu permits setting system parameters of device.

*Language*

Language setting.

*Backlight*

Display backlight level setting.

*Beeper volume*

Beeper volume level setting.

*Keyboard beep*

Enables / Disables keyboard beep.

*Time*

Internal time setting.

*Date*

Internal date 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*

DHCP service discovery is active by default and is recommended for easiest connection. If you prefer to use fixed IP address or change any other default settings, go to MENU->Interface->LAN Settings.

LAN communication uses Telnet/TCP/UDP protocol. Default log-in for client is “9010\_SNxxxxxx 23”, where “xxxxxx” stands for serial number and 23 is default communication port (22 for TCP and UDP protocol).

#### 4.8. Calibration mode

In this mode capacitance elements of the decade can be recalibrated. 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 key ESC.

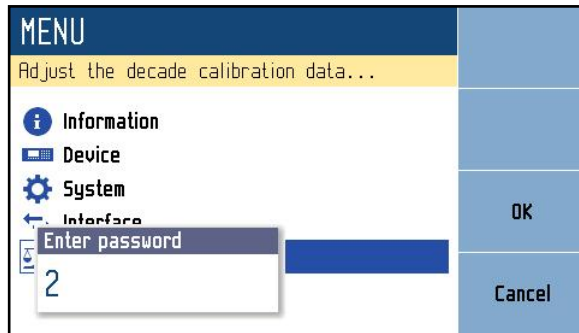


Figure 20 Password entry

#### Capacitance Standards

Recalibration procedure consists of measuring of 35 basic capacitance values and 6 open correction values and entering their actually measured data. Calibration point can be changes using display softkeys “Previous” and “Next”. Calibration value of selected capacitance can be change using cursor keys ▲, ▼, ◀, ▶.

Following table describes nominal values of calibration points and requested recalibration accuracy:

#### Calibration points M525

| Standard | Nominal value | Requested Accuracy |
|----------|---------------|--------------------|
| C1       | 0,5 pF        | 0,2 pF             |
| C2       | 1.0 pF        | 0,2 pF             |
| C3       | 2,2 pF        | 0,2 pF             |
| C4       | 5,0 pF        | 0,2 pF             |
| C5       | 10,0 pF       | 0,2 pF             |
| C6       | 20,0 pF       | 0,2 pF             |
| C7       | 23,5 pF       | 0,2 pF             |
| C8       | 47,0 pF       | 0,2 pF             |
| C9       | 94,0 pF       | 0,5 pF             |
| C10      | 110 pF        | 0,5 pF             |
| C11      | 220 pF        | 1,0 pF             |
| C12      | 440 pF        | 1,0 pF             |
| C13      | 500 pF        | 1,0 pF             |
| C14      | 870 pF        | 1,0 pF             |
| C15      | 2,00 nF       | 1,0 pF             |

|     |          |         |
|-----|----------|---------|
| C16 | 2,35 nF  | 1,2 pF  |
| C17 | 4,70 nF  | 2,4 pF  |
| C18 | 9,40 nF  | 4,7 pF  |
| C19 | 11,0 nF  | 5,5 pF  |
| C20 | 22,0 nF  | 11 pF   |
| C21 | 44,0 nF  | 22 pF   |
| C22 | 50,0 nF  | 25 pF   |
| C23 | 100 nF   | 50 pF   |
| C24 | 200 nF   | 0,10 nF |
| C25 | 235 nF   | 0,12 nF |
| C26 | 470 nF   | 0,24 nF |
| C27 | 940 nF   | 0,47 nF |
| C28 | 1,10 uF  | 0,55 nF |
| C29 | 2,20 uF  | 1,1 nF  |
| C30 | 4,40 uF  | 2,2 nF  |
| C31 | 4,40 uF  | 2,2 nF  |
| C32 | 10,0 uF* | 5,0 nF* |
| C33 | 20,0 uF* | 10 nF*  |
| C34 | 20,0 uF* | 10 nF*  |
| C35 | 50,0 uF* | 25 nF*  |

**Table 1 M525 Calibration points**

Note:

Nominal values in the table are informative.

Measuring frequency 1 kHz

\* Measuring frequency 100 Hz

### *Corrections*

#### *Open correction points M525*

| Standard | Nominal value | Requested Accuracy |
|----------|---------------|--------------------|
| C0       | 1,0 pF        | 0,5 pF             |
| C00      | 8,4 pF        | 0,5 pF             |
| C000     | 53,0 pF       | 2,0 pF             |
| C0G      | 12,0 pF       | 0,5 pF             |
| C00G     | 50,0 pF       | 0,5 pF             |
| C000G    | 130,0 pF      | 2,0 pF             |

**Table 2 M525 Open calibration points**

Note:

Measuring frequency 1 kHz

Process of calibration consists of measuring partial capacitors and open correction points and writing their actual values into the decade:

Capacitance standards

- Set Lo terminal ground OFF ( from “SETUP” → “Device” → “Lo terminal ground” menu )
- Set configuration on standard RCL meter:

frequency 1 kHz ( 100 Hz )  
 test voltage 1-2 V  
 serial parameters  
 four-pair-terminal or four-terminal connection

- Make correction SHORT on RCL meter to exclude residual parameters (with connected cables to RLC meter, since M525 the cables are disconnected).
- Connect RLC meter to the M525 box in 4-wire mode.
- Set the first calibration point (capacitance element) named “C1” from “Setup” → “Calibration” → “Capacitance standards” menu. Use display softkeys “Previous” and “Next” to select the appropriate element.
- Use “OPER” button to perform Open correction ( OPEN ) of the RLC meter (The “OPER” LED is not lit in this case).
- Use the same button to activate standard capacity C1.....C35 (the “OPER” LED should lights).
- Measure capacitance of the selected element. Use C-meter with appropriate accuracy in 4-wire connection mode.

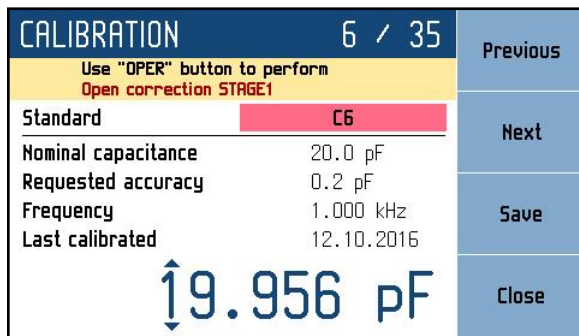


Figure 21 Calibration point screen – capacitance standards

- Using cursor keys ▲, ▼, ◀, ▶ adjust capacitance value in M525 according to the C-meter.
- Confirm new calibration value by pressing “Save” softkey.
- Repeat above described procedure for all capacitance elements. In every step make open correction.
- Measuring frequency is 1 kHz and 100 Hz in dependence on the nominal value - See table 1 (frequency is also shown on display in calibration menu).
- Close calibration of capacitance standards by pressing “Close” context button.

Corrections

- Set the following configuration on RCL standard meter:

frequency 1 kHz  
 test voltage 1-2 V  
 serial parameters  
 four-pair-terminal or four-terminal connection

- Disconnect terminals and perform Open correction on the RLC meter.
- Set the first correction point labeled “C0” from “Setup” → “Calibration” → “Corrections” menu. Use display softkeys “Previous” and “Next” to select the appropriate element.
- Connect terminals to the M525 box.
- Measure capacitance at the output terminals.

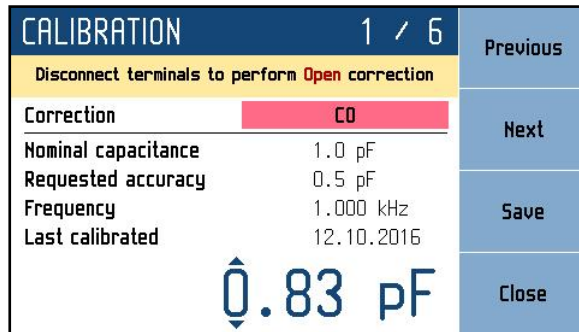


Figure 22 Calibration point screen - corrections

- Using cursor keys ▲, ▼, ◀, ▶ adjust capacitance value in M525 according to the C-meter.
- Confirm new calibration value by pressing “Save” softkey.
- Select correction point labeled “C00” by pressing “Next” button.
- Use “OPER” button to perform Open correction ( OPEN - STAGE 1 ) on the RLC meter (the “OPER” LED is not lit). Terminals between the RLC meter and the M525 box are connected in this case.
- Use “OPER” button to activate correction point “C00” (the “OPER” LED is lit).
- Measure capacitance of the selected correction.
- Using cursor keys ▲, ▼, ◀, ▶ adjust capacitance value in M525 according to the C-meter.
- Confirm new calibration value by pressing “Save” softkey.
- Select the next correction point “C000”.
- Use “OPER” button to perform Open correction ( OPEN - STAGE 2 ) on the RLC meter (the “OPER” LED is not lit).
- Use “OPER” button to activate correction point “C000” (the “OPER” LED is lit).
- Measure capacitance of the selected correction.
- Using cursor keys ▲, ▼, ◀, ▶ adjust capacitance value in M525 according to the C-meter.
- Confirm new calibration value by pressing “Save” softkey.
- Select the next correction point “C0G”. Keep in mind, that Lo terminal of the M525 box is grounded from this correction point, which may affect measuring.
- Disconnect terminals and perform Open correction on the RLC meter.
- Use “OPER” button to activate correction point “C0G” (the “OPER” LED is lit).
- Measure capacitance of the selected correction.
- Using cursor keys ▲, ▼, ◀, ▶ adjust capacitance value in M525 according to the C-meter.
- Confirm new calibration value by pressing “Save” softkey.
- Select the next correction point “C00G”. Use display softkeys “Previous” and “Next” to select the element.
- Use “OPER” button to perform Open correction ( OPEN - STAGE 3 ) on the RLC meter (the “OPER” LED is not lit). Terminals remain connected from this correction point.
- Use “OPER” button to activate correction point “C00G” (the “OPER” LED is lit).
- Measure capacitance of the selected correction.
- Using cursor keys ▲, ▼, ◀, ▶ adjust capacitance value in M525 according to the C-meter.
- Confirm new calibration value by pressing “Save” softkey.

- Select the next correction point “C000G”.
- Use “OPER” button to perform Open correction ( OPEN - STAGE 4 ) on the RLC meter (the “OPER” LED is not lit).
- Use “OPER” button to activate correction point “C000G” (the “OPER” LED is lit).
- Measure capacitance of the selected correction.
- Using cursor keys ▲, ▼, ◀, ▶ adjust capacitance value in M525 according to the C-meter.
- Confirm new calibration value by pressing “Save” softkey.
- Close calibration of correction by pressing “Close” button.
- Press “Quit” context button to return to the SETUP menu.
- Press “Quit” context button to return to the CAPACITANCE menu.

### *Change password*

This menu permits changing password. The unit is shipped with a default password 2.



## 5. Performance verification test

Parameter verification procedure is described in the chapter. Verification procedure is based on measuring capacitance on the decade output terminals with standard RLC - meter in recommended points.

### Required equipment

- RLC-meter nominal accuracy 0.05% in range (type Agilent E4980A or similar)

### Decade setting

Switch decade to the capacitance function. Connect standard RLC-meter to the decade output terminals.

- Set the following configuration on RCL standard meter:

frequency 1 kHz ( 100 Hz )  
 test voltage 1-2 V  
 serial parameters  
 four-pair-terminal or four-terminal connection

### Procedure

Use following procedure to perform parameter verification test:

1. Switch both instruments on and let them for 1 hour stabilise in the laboratory with ambient temperature  $23 \pm 2$  °C. Connect capacitance decade terminals to the standard RLC-meter.
2. Make correction SHORT and OPEN on RCL meter to exclude residual parameters (with connected cables to RLC meter, since M525 the cables are disconnected).
3. Set Lo terminal ground OFF ( "SETUP" → "Device" → "Lo terminal ground" ).
4. Set Open correction to ABSOLUTE ( "SETUP" → "Device" → "Open correction" ).
5. Check capacitance value in points according to Table 3.

### Maximal absolute deviations M525

| Nom. value [pF] | Max.deviation [pF] | Nom. value [nF] | Max.deviation [nF] |
|-----------------|--------------------|-----------------|--------------------|
| 100             | 3.2                | 8.0             | 0.023              |
| 110             | 3,2                | 10              | 0.028              |
| 120             | 3.3                | 20              | 0.050              |
| 130             | 3.3                | 40              | 0.10               |
| 140             | 3.3                | 80              | 0.20               |
| 150             | 3.3                | 100             | 0.25               |
| 160             | 3.4                | 200             | 0.50               |
| 170             | 3.4                | 400             | 1.0                |
| 180             | 3.4                | 800             | 2.0                |
| 190             | 3.4                | 1 000           | 2.5                |
| 200             | 3.5                | 2 000           | 5                  |

|       |     |         |     |
|-------|-----|---------|-----|
| 400   | 4.0 | 4 000   | 10  |
| 800   | 5.0 | 8 000   | 20  |
| 1 000 | 5.5 | 10 000  | 25  |
| 2 000 | 8.0 | 20 000  | 50  |
| 4 000 | 13  | 100 000 | 250 |

**Table 3 Verification - allowed deviations**

## 6. Remote control

Decade box can be controlled via RS232, GPIB, LAN and USB interface. The decade can be only controlled by one of interfaces at a time. It is therefore necessary to select and set-up one of the interfaces using the system menu. All interfaces share the same commands except following commands, which are intended only for use with RS232, LAN and USB interface:

### **SYSTEM:LOCAL**

This command places decade in the “LOCAL” mode.

### **SYSTEM:REMOte**

This command places decade in the “REMOTE” mode.

### **SYSTEM:RWLock**

This command places the decade 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 by decade (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

The capacitance box can be controlled via standard RS232 interface.

Following equipment is required:

- \* M525 capacitance box
- \* Personal Computer (or other controlling device) with RS232 port (USB-to-RS232 converter is also possible)
- \* 9-pin D-SUB, 3-wire direct (1:1) male/female RS232 cable

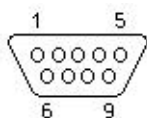
The RS232 interface must be selected from decade system menu to be in operation (*SETUP->Interface->Active bus*). There is only one RS232 setting accessible from the decade system menu under *SETUP->Interface* path:

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 23 RS232 9 pin D-SUB MALE connector

Cable between decade and computer description (configuration 1:1)

| Computer    | D-Sub 1 | D-Sub 2 | M630        |
|-------------|---------|---------|-------------|
| Receiver    | 2       | 2       | Transmitter |
| Transmitter | 3       | 3       | Receiver    |
| Ground      | 5       | 5       | Ground      |

Table 4 RS232 cable connection

## 6.2. GPIB Interface (option)

The capacitance box can be controlled via GPIB (General Purpose Interface Bus) interface.

Following equipment is required:

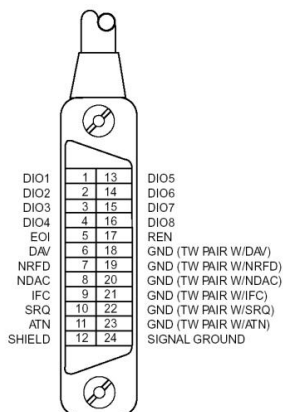
- \* M525 capacitance box with LAN, USB, IEEE488 bus option
- \* Personal Computer (or other controlling device) with GPIB interface
- \* GPIB cable

The GPIB interface must be selected from decade system menu to be in operation (*SETUP->Interface->Active bus*). There is only one GPIB setting accessible from the decade system menu under *SETUP->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 24 IEEE488 connector

### 6.3. LAN Interface (option)

LAN Interface allows communication with decade box using TCP or UDP protocols. A proper setting must be established.

Following equipment is required:

- \* M525 decade box with LAN, USB, IEEE488 bus option
- \* Personal Computer (or other controlling device) with LAN interface
- \* LAN cable

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

| Menu item             | Range / format                                   | Default value   |
|-----------------------|--|-----------------|
| > DHCP                | On/Off   | On              |
| > IP Address          | IPv4 format; locked with DHCP On                 | 192.168.001.100 |
| > Subnet mask         | IPv4 format; locked with DHCP On                 | 255.255.255.000 |
| > Default gateway     | IPv4 format; locked with DHCP On                 | 255.255.255.255 |
| > Telnet port number  | 0 - 9999   | 23              |
| > TCP port number     | 0 - 9999   | 22              |
| > UDP port number     | 0 - 9999   | 22              |
| > Host name           | 14 alphanumeric characters; locked with DHCP Off | M525_SN620031   |
| > Assigned IP address | IPv4 format; current IP address of the device    |                 |

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, Subnet mask and Default gateway should be properly set. In this case connection is done via “IP Address” and “Port number”.

Connection to decade box using Microsoft Telnet terminal with DHCP option enabled:



Figure 25 LAN connection 1

If connection is successful following screen will appear:



Figure 26 LAN connection 2

## 6.4. USB Interface (option)

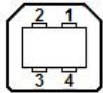
The decade box can be controlled via USB (Universal Serial Bus) interface.

Following equipment is required:

- \* M525 capacitance box with LAN, USB, IEEE488 bus option
- \* Personal Computer (or other controlling device) with USB interface (USB type A connector)
- \* Standard USB A-B cable

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

Decade box is equipped with USB type B connector.



| Pin | Label | Description   |
|-----|-------|---------------|
| 1   | +5V   | Power supply  |
| 2   | DATA- | Data signal - |
| 3   | DATA+ | Data signal + |
| 4   | GND   | Ground        |

**Figure 27 USB connector**

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

|           |         |
|-----------|---------|
| Baudrate  | 9600 Bd |
| Data bits | 8       |
| Stop bits | 1       |
| Parity    | None    |

Also proper COM port must be selected. After connecting decade 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 summarizes all public SCPI commands supported by device in alphabetic order. Detailed description follows in next chapter.

```

:CALibration
  :CAPacitance
    :AMPLitude(?) <DNPd>
    :SElect(?) <DNPd>
  :SECure
    :PASSword(?) <DNPd>
    :EXIT
:DISPlay
  :ANNotation
    :CLOCK
      :DATE
        :FORMat(?) {MDYS|MDYA|DMYS|DMYO|DMYA|YMDS|YMDO}
        [:STATe](?) {ON|OFF|1|0}
  :BRIGHtness(?) <DNPd>
  :LANGUage(?) {ENGLish|DEUTsch|FRENch|RUSSian|SPANish|CZECh}
:OUTPut
  :CORRection(?) {ABSolute|RELative}
  :GROund(?) {ON|OFF|1|0}
  [:STATe](?) {ON|OFF|1|0}
[::SOURce]
  :CAPacitance
    [:AMPLitude](?) <DNPd>[F]
  :TIMing
    :PCOunt? <DNPd>
    :PRESet
      :NAME(?) <SPD>
      :PCLear
      :RAPPend <SPD>
      :RCOunt? <DNPd>
      :ROW<IND_ROW>
        :AMPLitude(?) <SPD>
      :RDElete
      :SAVE
      :SElect(?) <DNPd>
  :UFUNction
    [:AMPLitude](?) <DNPd>
    :CURVe
      :SElect(?) <DNPd>
      :PCOunt? <DNPd>
      :PRESet
        :NAME(?) <SPD>
        :PCLear
        :RAPPend <SPD>
        :RCOunt? <DNPd>
        :ROW<IND_ROW>
          :AMPLitude(?) <SPD>
        :RDElete
        :SAVE
        :UNIT(?) <SPD>
:STATus
  :OPERation

```

```

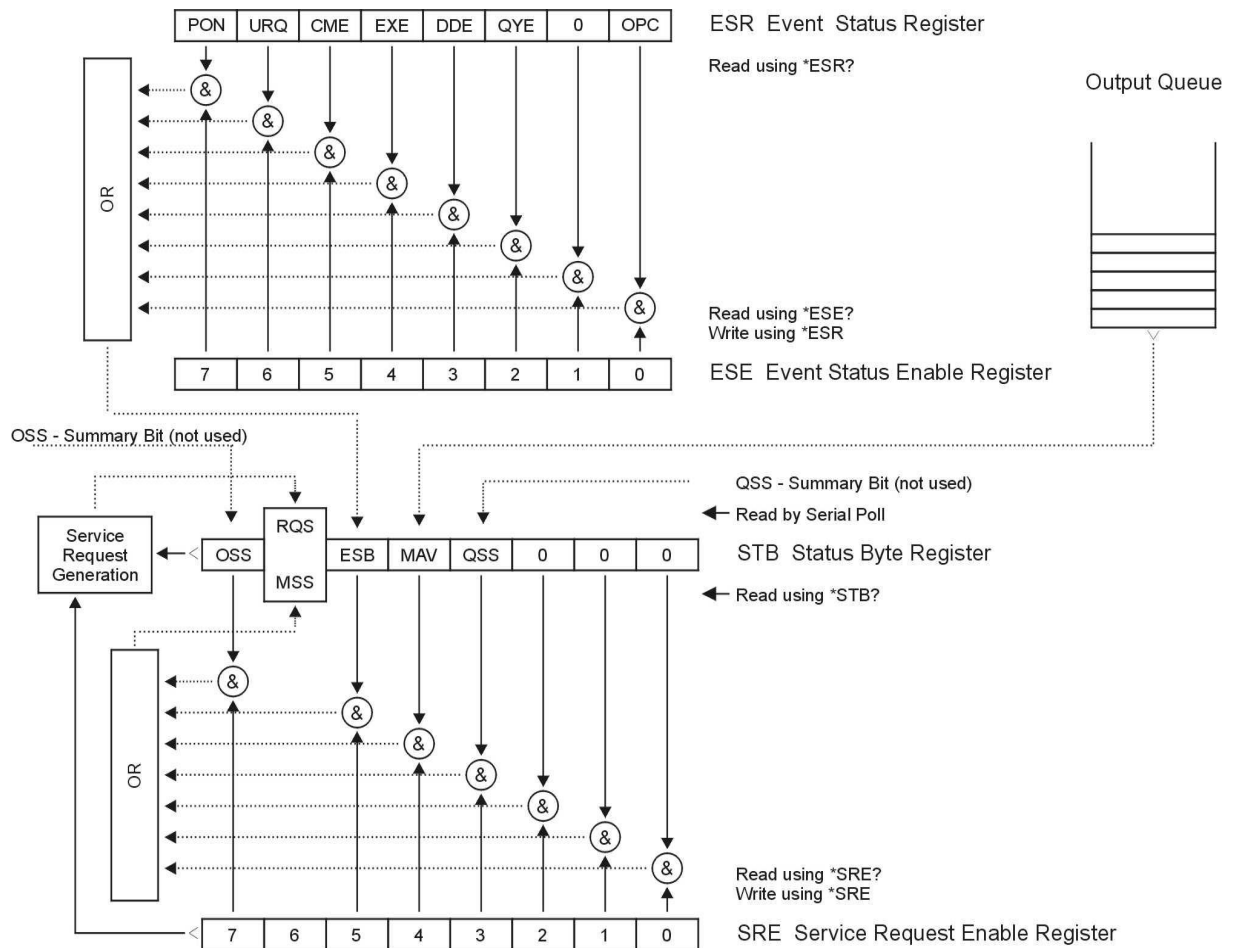
:CONDition(?) <DNPd>
:ENABle(?) <DNPd>
[:EVENT]? <DNPd>
:NTRansition(?) <DNPd>
:PTRansition(?) <DNPd>
:QUEStionable
:CONDition(?) <DNPd>
:ENABle(?) <DNPd>
[:EVENT]? <DNPd>
:NTRansition(?) <DNPd>
:PTRansition(?) <DNPd>
:SYSTem
:BEEPer
:STATe(?) {ON|OFF|1|0}
:VOLume(?) <DNPd>
:COMMunicate
:BUS(?) {SERial|GPIB|USB|LAN}
: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}
:DATE(?) <DNPd>,<DNPd>,<DNPd>
:ERRor
[:NEXT]? <CPD>
:KEY(?) <DNPd>
:LOCal
:PRESet
:REMote
:RWLock
:TIME(?) <DNPd>,<DNPd>,<DNPd>
:VERSiOn? <CPD>
*CLS
*ESE(?)
*ESR?
*IDN?
*OPC(?)
*OPT?
*RST
*SRE(?)
*STB?
*TST?
*WAI

```

## 6.7. Standard Status Data Structures



Decade box 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.



Status Register Overview

Figure 28 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 decade box 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 decade box 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 the decade box.

### ***Questionable Status Register***

Not used in the decade box.

### ***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 error 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>    firmware version

Remarks:

Overlapped command

Example:

\*IDN? Response: MEATEST,M520,640531,1.00

**\*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 decade box are complete.

Parameters:

&lt;DNPD&gt; 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:

&lt;DNPD&gt; 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:CAPacitance:AMPLitude**

Syntax:

```
:CALibration:CAPacitance:AMPLitude <DNPD>
:CALibration:CAPacitance:AMPLitude?
```

Description:

This command sets calibration value of particular internal capacitance standard at output terminals. Open correction must be performed for every standard (using OUTP OFF/OUTP ON command).

Parameters:

<DNPD> Standard capacitance value in Farads. Ranges and default values varies in accordance to selected capacitance etalon (see table "Calibration points M525").

Remarks:

This command requires "Calibration" access  
Overlapped command  
Value is not affected by reset

Example:

```
CAL:CAP:AMPL 220.651e-12
CAL:CAP:AMPL? Response: 2.220651E-10
```

### **:CALibration:CAPacitance:SElect**

Syntax:

```
:CALibration:CAPacitance:SElect <DNPD>
:CALibration:CAPacitance:SElect?
```

Description:

This command enters calibration mode and selects internal capacitance standard for calibration.

Parameters:

<DNPD> Range 1 ... Max. Capacitance Count, one based index of capacitance standard

Remarks:

This command requires "Calibration" access  
Overlapped command

Example:

```
CAL:CAP:SEL 1
CAL:CAP:SEL? Response: 1
```

### **:CALibration:SECure:PASSword**

Syntax:

```
:CALibration:SECure:PASSword <DNPD>
```

Description:

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

Parameters:

<DNPD> Range 0 ... 4294967295 (default 0)

Remarks:

Overlapped command

Example:

CAL:SEC:PASS 0

### **:CALibration:SECure:EXIT**

Syntax:

:CALibration:SECure:EXIT

Description:

This command exits calibration mode and access.

Parameters:

None

Remarks:

Overlapped command

Example:

CAL:SEC:EXIT

### **:DISPlay:ANNotation:CLOCK:DATE:FORMat**

Syntax:

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

:DISPlay:ANNotation:CLOCK:DATE:FORMat?

Description:

This command sets 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

Value is not affected by reset

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

Value is not affected by reset

Example:

DISP:ANN:CLOC ON

DISP:ANN:CLOC? Response: 1

### **:DISPlay:BRIGhtness**



## Syntax:

:DISPlay:BRIGhtness &lt;DNPD&gt;

:DISPlay:BRIGhtness?

## Description:

This command sets brightness of device display.

## Parameters:

&lt;DNPD&gt;                    Range 0.0 ... 1.0 (default 1.0), 0.0 – Min, 1.0 – Max brightness

## Remarks:

Overlapped command

Value is not affected by reset

## Example:

DISP:BRIG 1.0

DISP:BRIG? Response: 1.000000E+00

**:DISPlay:LANGuage**

## Syntax:

:DISPlay:LANGuage &lt;CPD&gt;

:DISPlay:LANGuage?

## Description:

This command sets language that is used on device display.

## Parameters:

<CPD>                    {ENGLish|DEUTsch|FRENch|RUSSian|SPANish|CZECch}  
(default ENGL)

|          |                 |
|----------|-----------------|
| ·ENGLish | english version |
| ·DEUTsch | deutsch version |
| ·FRENch  | french version  |
| ·RUSSian | russian version |
| ·SPANish | spanish version |
| ·CZECch  | czech version   |

## Remarks:

Overlapped command

Value is not affected by reset

## Example:

DISP:LANG ENGL

DISP:LANG? Response: ENGL

**:OUTPut:CORRection**

## Syntax:

:OUTPut:CORRection &lt;CPD&gt;

:OUTPut:CORRection?

## Description:

This command turns on open function. “Open” is activated only if output terminals are switched on (see OUTP:STAT command).

## Parameters:

|           |   |
|-----------|---|
| <CPD>     | {ABSolute RELative} (default REL)                     |
| ·ABSolute | capacitance shown on display is the same as on output |
| ·RELative | capacitance is relative to open state                 |

## Remarks:

Overlapped command

Value is set to default after reset

## Example:

OUTP:CORR ABS

OUTP:CORR? Response: ABS

**:OUTPut:GROund**

## Syntax:

:OUTPut:GROund <CPD>  
 :OUTPut:GROund?

**Description:**

This setting affects Lo-terminal grounding

**Parameters:**

|        |                                   |
|--------|-----------------------------------|
| <BOOL> | {ON OFF 1 0} (default 0)          |
| ·ON    | Lo-terminal is switched to ground |
| ·OFF   | Lo-terminal is floating           |
| ·1     | same as ON                        |
| ·0     | same as OFF                       |

**Remarks:**

Overlapped command  
 Value is not affected by reset

**Example:**

OUTP:GRO ON  
 OUTP:GRO? Response: 1

**:OUTPut[:STATe]****Syntax:**

:OUTPut[:STATe] <BOOL>  
 :OUTPut[:STATe]?

**Description:**

This command switches ON/OFF output terminals. The OFF state can be used for OPEN compensation, if “OUTP:CORR REL” command is issued.

**Parameters:**

|        |  |
|--------|--|
| <BOOL> | {ON OFF 1 0} (default 0)                       |
| ·ON    | output terminals are switched on               |
| ·OFF   | output terminals are switched off (OPEN state) |
| ·1     | same as ON                                     |
| ·0     | same as OFF                                    |

**Remarks:**

Overlapped command  
 Value is set to default after reset

**Example:**

OUTP ON  
 OUTP? Response: 1

**[:SOURce]:CAPacitance [:AMPLitude]****Syntax:**

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

**Description:**

This command sets amplitude in Capacitance mode. Node SOUR:CAP also selects “CAPACITANCE” function if not already selected. Optionally unit can be enclosed.

**Parameters:**

|        |  |
|--------|--|
| <DNPD> | Range 99.0E-12 ... 101.0E-6, default 10.0E-9 |
| <UNIT> | {F}  |
| ·F     | Farad  |

**Remarks:**

Overlapped command  
 Value is set to default after reset

**Example:**

CAP 68.5e-9  
 CAP? Response: 6.850000E-10 F

**[:SOURce]:TIMing:PCOunt?**

## Syntax:

[:SOURce]:TIMing:PCOunt?

## Description:

This command retrieves maximum number of timing sequences. This number represents maximum index used in sequence commands.

## Parameters:

<DNPD> Integer value representing maximum sequence count

## Remarks:

Overlapped command

## Example:

TIM:PCO? Response: 64

**[:SOURce]:TIMing:PRESet:NAME**

## Syntax:

[:SOURce]:TIMing:PRESet:NAME &lt;SPD&gt;

[:SOURce]:TIMing:PRESet:NAME?

## Description:

This command allows reading and changing sequence name. Data will be saved to non-volatile memory on TIM: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:

TIM:PRES:NAME "TIME 1s"

TIM:PRES:NAME? Response: "TIME 1s"

**[:SOURce]:TIMing:PRESet:PClear**

## Syntax:

[:SOURce]:TIMing:PRESet:PClear

## Description:

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

## Parameters:

None

## Remarks:

Overlapped command

## Example:

TIM:PRES:PCL

**[[:SOURce]:TIMing:PRESet:RAPPend**

Syntax:

[:SOURce]:TIMing:PRESet:RAPPend &lt;SPD&gt;

Description:

This command appends new record at the end of timing table. Data will be saved to non-volatile memory on TIM: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 in Ohms.

Remarks:

Overlapped command

Example:

TIM:PRES:RAPP "0.5,220.0"

**[[:SOURce]:TIMing:PRESet:RCOunt?**

Syntax:

[:SOURce]:TIMing:PRESet:RCOunt?

Description:

This commands returns actual number of records in timing table.

Parameters:

<DNPD>                      Integer value representing number of records

Remarks:

Overlapped command

Example:

TIM:PRES:RCO? Response: 6

**[[:SOURce]:TIMing:PRESet:ROW<IND\_ROW>:AMPLitude**

Syntax:

[:SOURce]:TIMing:PRESet:ROW&lt;IND\_ROW&gt;:AMPLitude &lt;SPD&gt;

[:SOURce]:TIMing:PRESet:ROW&lt;IND\_ROW&gt;:AMPLitude?

Description:

This command sets / retrieves selected row in timing table. Data will be saved to non-volatile memory on TIM: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 in Ohms.

Remarks:

Overlapped command

Example:

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

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

**[[:SOURce]:TIMing:PRESet:ROW<IND\_ROW>:RDELete**

Syntax:

[:SOURce]:TIMing:PRESet:ROW&lt;IND\_ROW&gt;:RDELete

Description:

This command deletes row from timing table. Data will be saved to non-volatile memory on TIM:PRES:SAVE command.

Parameters:

<IND\_ROW>                      Range 1 ... Row count (1 - if omitted)

Remarks:

Overlapped command

Example:

TIM:PRES:ROW1:RDEL

**[[:SOURce]:TIMing:PRESet:SAVE**

Syntax:

[:SOURce]:TIMing: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:

TIM:PRES:SAVE

**[[:SOURce]:TIMing:SElect**

Syntax:

[:SOURce]:TIMing:SElect &lt;DNPD&gt;

[:SOURce]:TIMing:SElect?

Description:

This command selects timing sequence. Selected sequence is shown on device display, can be executed using OUTP ON command and can be edited using SOUR:TIM:PRES group of commands.

Parameters:

<DNPD>                      Range 1 ... 64 – maximum sequence count (default 1), one based index of sequence

Remarks:

Overlapped command

Value is set according to “Startup” preset on restart and to default on \*RST command

Example:

TIM:SEL 1

TIM:SEL? Response: 1

**[:SOURce]:UFUNction[:AMPLitude]**

Syntax:

```
[:SOURce]:UFUNction[:AMPLitude] <DNPD>
[:SOURce]:UFUNction[:AMPLitude]?
```

Description:

This command sets amplitude in USER FUNCTION mode. Node SOUR:UFUN also selects “USER FUNCTION” function if not already selected.

Parameters:

<DNPD>                    Range depends on translation curve, default value is 1.0 or minimal value that can be set

Remarks:

Overlapped command

Value is set according to “Startup” preset on restart and to default on \*RST command

Example:

```
UFUN 1.0
UFUN? Response: 1.000000E+00
```

**[:SOURce]:UFUNction:CURVe:SElect**

Syntax:

```
[:SOURce]:UFUNction:CURVe:SElect <DNPD>
[:SOURce]:UFUNction:CURVe:SElect?
```

Description:

This command selects conversion curve. Selected curve is activated on device display and can be edited using SOUR:UFUN:CURV:PRES group of commands.

Parameters:

<DNPD>                    Range 1 ... 64 – Maximum curve count (default 1), one based index of curve

Remarks:

Overlapped command

Value is set according to “Startup” preset on restart and to default on \*RST command

Example:

```
UFUN:CURV:SEL 1
UFUN:CURV:SEL? Response: 1
```

**[:SOURce]:UFUNction:CURVe:PCOunt?**

Syntax:

```
[:SOURce]:UFUNction:CURVe:PCOunt?
```

Description:

This command retrieves maximum number of user function presets. This number represents maximum index used in preset commands.

Parameters:

<DNPD>                    Integer value representing maximum number of curves

Remarks:

Overlapped command

Example:

```
UFUN:CURV:PCO? Response: 64
```

**[[:SOURce]:UFUNction:CURVe:PRESet:NAME**

Syntax:

```
[[:SOURce]:UFUNction:CURVe:PRESet:NAME <SPD>
[:SOURce]:UFUNction:CURVe:PRESet:NAME?
```

Description:

This command allows reading and changing selected curve name. Data will be saved to non-volatile memory on UFUN:CURV:PRES:SAVE command.

Parameters:

<SPD>                    Quoted curve name. Upper alpha, lower alpha, digits and spaces are allowable. Maximum string size is 8 characters.

Remarks:

Overlapped command

Example:

```
UFUN:CURV:PRES:NAME "CURVE 2"
UFUN:CURV:PRES:NAME? Response: "CURVE 2"
```

**[[:SOURce]:UFUNction:CURVe:PRESet:PClear**

Syntax:

```
[[:SOURce]:UFUNction:CURVe:PRESet:PClear
```

Description:

This command deletes existing curve including its lookup table. Data will be saved to non-volatile memory on UFUN:CURV:PRES:SAVE command.

Parameters:

None

Remarks:

Overlapped command

Example:

```
UFUN:CURV:PRES:PCL
```

**[[:SOURce]:UFUNction:CURVe:PRESet:RAPPend**

Syntax:

```
[[:SOURce]:UFUNction:CURVe:PRESet:RAPPend <SPD>
```

Description:

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

Parameters:

<SPD>                    Quoted string representing amplitude. The amplitude consists of two float numeric fields separated by comma. The first one represents amplitude in "User Function" units and the second one amplitude in Ohms.

Remarks:

Overlapped command

Example:

```
UFUN:CURV:PRES:RAPP "10.6,220.0"
```

**[[:SOURce]:UFUNction:CURVe:PRESet:RCOunt?**

Syntax:

[:SOURce]:UFUNction:CURVe:PRESet:RCOunt?

Description:

This command returns actual number of records in curve table.

Parameters:

&lt;DNPD&gt; Integer value representing number of records for particular curve table

Remarks:

Overlapped command

Example:

UFUN:CURV:PRES:RCO? Response: 2

**[[:SOURce]:UFUNction:CURVe:PRESet:ROW<IND\_ROW>:AMPLitude**

Syntax:

[:SOURce]:UFUNction:CURVe:PRESet:ROW&lt;IND\_ROW&gt;:AMPLitude &lt;SPD&gt;

[:SOURce]:UFUNction:CURVe:PRESet:ROW&lt;IND\_ROW&gt;:AMPLitude?

Description:

This command sets / retrieves selected row in curve table. Data will be saved to non-volatile memory on UFUN:CURV:PRES:SAVE command.

Parameters:

&lt;IND\_ROW&gt; Range 1 ... Row count (1 - if omitted)

&lt;SPD&gt; Quoted string representing amplitude. The amplitude consists of two float numeric fields separated by comma. The first one represents amplitude in "User Function" units and the second one amplitude in Ohms.

Remarks:

Overlapped command

Example:

UFUN:CURV:PRES:ROW1:AMPL "10.6,220.0"

UFUN:CURV:PRES:ROW1:AMPL? Response: "1.060000E+01,2.200000E+2"

**[[:SOURce]:UFUNction:CURVe:PRESet:ROW<IND\_ROW>:RDELe**

Syntax:

[:SOURce]:UFUNction:CURVe:PRESet:ROW&lt;IND\_ROW&gt;:RDELe

Description:

This command deletes row from curve table. Data will be saved to non-volatile memory on UFUN:CURV:PRES:SAVE command.

Parameters:

&lt;IND\_ROW&gt; Range 1 ... Row count (1 - if omitted)

Remarks:

Overlapped command

Example:

UFUN:CURV:PRES:ROW1:RDEL



**[[:SOURce]:UFUNction:CURVe:PRESet:SAVE**

Syntax:

[:SOURce]:UFUNction:CURVe:PRESet:SAVE

Description:

This command saves current curve to non-volatile memory. Unsaved changes will disappear on restart, function change or selection of another curve.

Parameters:

None

Remarks:

Overlapped command

Example:

UFUN:CURV:PRES:SAVE

**[[:SOURce]:UFUNction:CURVe:PRESet:UNIT**

Syntax:

[:SOURce]:UFUNction:CURVe:PRESet:UNIT &lt;SPD&gt;

[:SOURce]:UFUNction:CURVe:PRESet:UNIT?

Description:

This command sets / retrieves unit of selected curve. Data will be saved to non-volatile memory on UFUN:CURV:PRES:SAVE command.

Parameters:

<SPD>                      Quoted user function unit. Upper alpha, lower alpha, digits and spaces are allowable. Maximum string size is 2 characters.

Remarks:

Overlapped command

Example:

UFUN:CURV:PRES:UNIT "N"

UFUN:CURV:PRES:UNIT? Response: "N"

**: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:

&lt;DNPD&gt;                      Operational Condition register

Remarks:

Overlapped command

Example:

STAT:OPER:COND? Response: 2

**:STATus:OPERation:ENABLE**

Syntax:

:STATus:OPERation:ENABLE &lt;DNPD&gt;

: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:

&lt;DNPD&gt;                      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 command 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 command 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 command 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 command 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: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 M525_SNXXXXXX
SYST:COMM:LAN:HOST? Response: M525_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 | 12   |
| KEY 1 | 11   |
| KEY 2 | 15   |
| KEY 3 | 19   |
| KEY 4 | 10   |
| KEY 5 | 14   |
| KEY 6 | 18   |
| KEY 7 | 9    |
| KEY 8 | 13   |



|               |    |
|---------------|----|
| KEY 9         | 17 |
| KEY SELECT    | 25 |
| KEY ENTER     | 24 |
| KEY CANCEL    | 23 |
| KEY UP        | 2  |
| KEY DOWN      | 1  |
| KEY LEFT      | 3  |
| KEY RIGHT     | 4  |
| KEY EXPONENT  | 21 |
| KEY BACKSPACE | 22 |
| KEY POINT     | 16 |
| KEY USER 1    | 5  |
| KEY USER 2    | 6  |
| KEY USER 3    | 7  |
| KEY USER 4    | 8  |
| KEY SIGN      | 20 |
| KEY OPER      | 26 |

Table 5 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 &lt;DNPD&gt;,&lt;DNPD&gt;,&lt;DNPD&gt;

:SYSTem:TIME?

Description:

This commands allows set system device time (RTC).

Parameters:

&lt;DNPD&gt; Hours, Range 0 ... 23

&lt;DNPD&gt; Minutes, Range 0 ... 59

&lt;DNPD&gt; 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 retrieves version of implemented SCPI language

Parameters:

&lt;CPD&gt; SCPI language version

Remarks:

Overlapped command

Example:

SYST:VERS? Response: 1999.0

### 6.10. SCPI Error codes

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

| <b>Error</b> | <b>Message</b>                                 |
|--------------|--|
| -100         | "Command error"                                |
| -101         | "Invalid character"                            |
| -102         | "Syntax error"                                 |
| -103         | "Invalid separator"                            |
| -104         | "Data type error"                              |
| -105         | "GET not allowed"                              |
| -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 6 SCPI error codes**

### 6.11. Compatible Commands

Decade box also responds to “Old style” command syntax to provide compatibility with previous decade box models.

#### *Value setting / reading*

##### **A (?) <DNPD>**

The command sets capacitance value (if capacitance function is selected) or “User function” value (if User function is selected).

<DNPD>

It represents capacitance value in Farads or “user defined units” (if User function is selected). Capacitance range is from 99 pf to 101 uF. Limit of User defined function is recalculated according to capacitance range.

In case of control, the decade confirms correct setting with string „Ok<cr><lf>”.

In case of query, M525 returns set capacitance or value of User function as floating number in exponential format. For example value 10 nF is returned as 1.000000E-08<cr><lf>. Positive numbers are sent without polarity sign.

#### **Example :**

Command „A120.0e-9 <cr>” sets capacitance 120 nF if decade is in Capacitance function and 120.0e-9 X if decade is in User function (X – represents user defined unit).

If query „A?<cr>” is sent, decade returns response in format „1.200000E-07<cr><lf>”.

#### *Decade function setting*

##### **F (?) <CPD> { 0 | 7 | 8 }**

Following function can be set:

- 0      Capacitance function
- 7      User function
- 8      Timing function

M525 confirms execution with string „Ok<cr><lf>”.

#### **Example :**

„F7<cr>” sets User function.

After query „F?<cr>” decade returns string „7<cr><lf>”.

#### *Lo-terminal grounding*

##### **G (?) <CPD> { 0 | 1 }**

Following modes can be set:

- 0      Lo-terminal is floating
- 1      Lo-terminal is switched-on to ground

M525 confirms execution with string „Ok<cr><lf>”.

#### **Example :**

„G1<cr>” switches-on Lo-terminal to ground.

After query „G?<cr>” decade returns string „1<cr><lf>”.

**Status reading**

**V?**

M525 returns device status in form „GxL0<cr><lf>“. On positions of signs „x“ there are values corresponding to the actual status of decade. Gx means grounding, L0 means remote mode – decade is always controlled remotely.

**Example :**

After query „V?<cr>” decade returns for example string „G1L0<cr><lf>”, which means Pt (90), °C actual setting.

**I/D (device identification)**

**\*IDN?**

Response contains name of manufacturer, model type number, serial number, firmware version

**Example :**

If query „\*IDN?<cr>” is sent, decade returns response:  
„MEATEST,M525,642351,1.2 <cr><lf>“.

Correctly executed command is confirmed with string "Ok<cr><lf>. When correct query is received M525 returns response in above described format. All commands must contain sign <cr> or <lf> at the end. Both small and large letters can be used.

## 6.12. Demo program

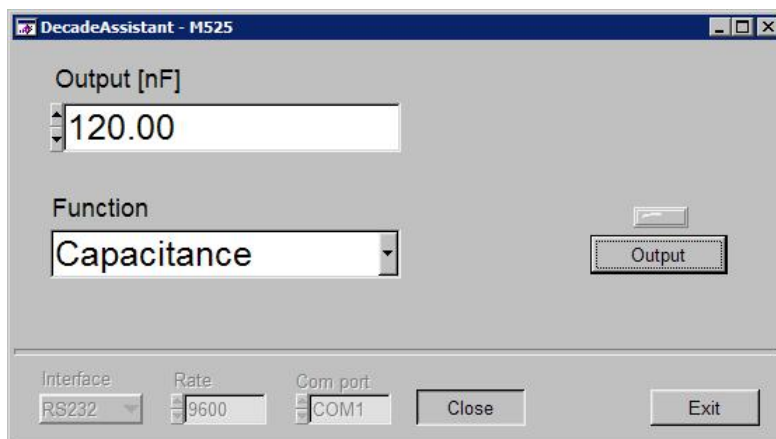
A simple operating program is supplied with the decade in order to provide easy operation of the instrument from the computer, and to check the RS-232 line (GPIB, USB bus) of the instrument. The installation CD ROM contains a program (for XP/Vista/W7), you can communicate with the instrument. For example, you can set value or function on the decade. For GPIB connection this Demo program requires properly configured National Instruments IEEE488 card.

### Installing the program

Insert the software CD into your CD ROM drive. Wait for autorun and select “Software installation” and “DecadeAssistant” or start direct „install\freeware\DecadeAssistant\en\setup.exe“. When you launch SETUP.EXE, the installation program asks for the destination directory (pre-defined is DecadeAssistant) and executes the actual installation. The UNINST.EXE program is also copied into the selected directory for alternative delete of the directory from the system.

### Program description

When you launch “R decade” program, following control panel is displayed on the screen.



**Figure 29** Capacitance decade application software

All communication parameters (Interface, Rate, Com port or GPIB address) have to be set before pressing Open (Close) key. For RS232 you have to set the serial port number (Com port) to which the instrument is connected and the baud rate. For GPIB you have to set GPIB address only. After pressing “Open” button the program checks if the instrument is connected. If the instrument is found, appropriate control windows are activated. Output value can be set by typing requested value to window “Output” or with mouse by activating arrows up or down.

You can end the program at any time by pressing the “Exit” button.

## **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 decade box
- \* 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. Rack adapter

Decade can be ordered with RACK M adapter (3HE). Rack adapter is detachable providing extra flexibility. Module height is 3HE.



Figure 30 RACK M adapter



## 9. Technical data

|                               |   |  |
|-------------------------------|---|--|
| Capacitance range             | : | 100 pF ... 100 $\mu$ F<br>OPEN terminals   |
| Accuracy                      | : | 0.25 % $\pm$ 3 pF for values to 10 000 pF<br>0.25 % for all others                   |
| Temperature coefficient       | : | < 270 ppm/ $^{\circ}$ C ( polypropylen dielectricum )                                |
| Maximal allowed voltage       | : | 50 V DC ( I <sub>max</sub> 1.5 A ) , 35 V AC ( I <sub>max</sub> 1 A <sub>eff</sub> ) |
| Test voltage                  | : | 500 V DC between GND and L/H terminals in floating connection                        |
| Frequency range               | : | 40 Hz to 1 kHz   |
| Connection                    | : | two-terminal   |
| Typ of terminals              | : | instrument gold plated terminals, diameter 4mm                                       |
| Reference temperatures        | : | +23 $^{\circ}$ C $\pm$ 2 $^{\circ}$ C  |
| Range of working temperatures | : | +5 $^{\circ}$ C to 40 $^{\circ}$ C   |
| Range of storing temperatures | : | -10 $^{\circ}$ C to +50 $^{\circ}$ C   |
| Reaction time *               | : | < 200 ms   |
| Interface                     | : | RS232 (optionally IEEE488, USB, Ethernet)  |
| Power supply                  | : | 85-260 Vac, 45...65 Hz   |
| Housing                       | : | full metal   |
| Dimensions                    | : | W 390 mm, H 128 mm, D 310 mm   |
| Weight                        | : | 4 kg   |
| Languages                     | : | English, German, French, Spanish, Russian, Czech                                     |

\* Reaction time means time interval between setting up value from front panel or receiving command from remote control bus and settling set-up value on output terminals.

Notes:

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

### Accuracy

Specified accuracy is valid after 10 minutes warm up in temperature range  $23 \pm 2^{\circ}$  C. Uncertainties include long-term stability, temperature coefficient, linearity, load and line regulation and traceability of factory to National calibration standards. Accuracies assigned in % are related to the set value. Specified accuracy is one-year accuracy.

### M525 Capacitance accuracy

| <i>Range / Resolution</i>                                  | <i>Accuracy</i><br><i>1 kHz</i> | <i>Loss coefficient</i><br><i>1kHz</i> | <i>Accuracy</i><br><i>40 Hz-1 kHz</i> | <i>Loss coefficient</i><br><i>10 Hz- 1 kHz</i> | <i>Temperature coefficient</i> |
|--|---------------------------------|--|---------------------------------------|--|--------------------------------|
|  | [ % ]                           | [ - ]                                  | [ % ]                                 | [ - ]  | [ ppm / $^{\circ}$ C ]         |
| <b>0.100 nF – 10.000 nF</b>                                | <b>0.25<math>\pm</math> 3pF</b> | <b>&lt; 0.05</b>                       | <b>0.5 <math>\pm</math> 3pF</b>       | <b>&lt; 0.05</b>                               | <b>&lt; 270</b>                |
| <b>10.001 nF – 100.00 nF</b>                               | <b>0.25</b>                     | <b>&lt; 0.005</b>                      | <b>0.5</b>                            | <b>&lt; 0.005</b>                              | <b>&lt; 270</b>                |
| <b>100.01 nF – 1.0000 <math>\mu</math>F</b>                | <b>0.25</b>                     | <b>&lt; 0.005</b>                      | <b>0.5</b>                            | <b>&lt; 0.005</b>                              | <b>&lt; 270</b>                |
| <b>1.0001 <math>\mu</math>F – 10.000 <math>\mu</math>F</b> | <b>0.25</b>                     | <b>&lt; 0.05</b>                       | <b>0.5</b>                            | <b>&lt; 0.05</b>                               | <b>&lt; 270</b>                |
| <b>10.001 <math>\mu</math>F – 100.00 <math>\mu</math>F</b> | <b>0.25*</b>                    | <b>&lt; 0.2 *</b>                      | <b>0.5</b>                            | <b>&lt; 0.2 **</b>                             | <b>&lt; 270</b>                |

Note:

\* For frequency 100 Hz

\*\* For frequency range 40 -100 Hz

Capacity value is defined in the output terminals level.

Correction Open OFF – capacity value is defined relative to the OPEN value.

Correction Open ON – capacity value is defined absolutely.

Specification is defined for grounded and floating Lo terminal ( Lo grounding ON/OFF )

In temperature range 21 °C - 25 °C the total accuracy is given by basic accuracy of nominal value.

Outside the 21 °C - 25 °C temperature range the total accuracy is given by basic accuracy of nominal value + influence of temperature coefficient.

For example: ( 100 nF, 38°C )

Total accuracy :  $0,25\% + (38^{\circ}\text{C} - 25^{\circ}\text{C}) * 270\text{ppm}/^{\circ}\text{C} = 0,60\%$

## 10. Ordering information – options

Bus M525-V1xxx - RS232  
M525-V2xxx - RS232, USB, LAN, IEEE-488

Housing M525-Vxx0x - table version  
Alternatively, the benchtop version can be fitted with RACK M adapter (3HE). Rack adapter is detachable providing extra flexibility.

Example of order:

M525-V2010

- programmable capacitance box, RS232, USB, LAN, IEEE488

### Manufacturer

MEATEST, s.r.o.

Železná 509/3, 619 00 Brno

Czech Republic

www.meatest.com

tel: +420 543 250 886

fax: +420 543 250 890

meatest@meatest.cz



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 M525 Programmable Capacitance Box 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. 3:2020

Brno

March 25<sup>th</sup>, 2024

A handwritten signature in blue ink, appearing to be 'J. Šimůnek', is written over a faint, illegible stamp.

Place

Date

Signature