

# M600 Resistance Decade Boxes

user manual





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# 1. Introduction

Programmable Decade boxes M641, M642, M631 & M632 are suitable for automated simulation of different resistance sensors (temperature, pressure, position, force, etc). Internal design eliminates “zero resistance effect” which is typical for most resistance decades boxes.

Resistance value is created via appropriate combination of physical resistors. Decade boxes are equipped with built-in function of direct simulation of most frequent temperature Pt and Ni sensors. Low thermal voltage relays and stable resistors are used as main parts of the RTD simulators. Actual set values are displayed on high resolution TFT display. M641, M642, M631 & M632 are sophisticated instruments with its own re-calibration procedure. The procedure enables to correct any deviation in resistance without any mechanical adjustment.

These instruments are especially suitable for automatic testing procedures. RS232 line (optionally IEEE488, USB and Ethernet bus) is used for connecting decade boxes to the computer.

## 1.1. Front panel overview

Main control segments of the decade boxes are:

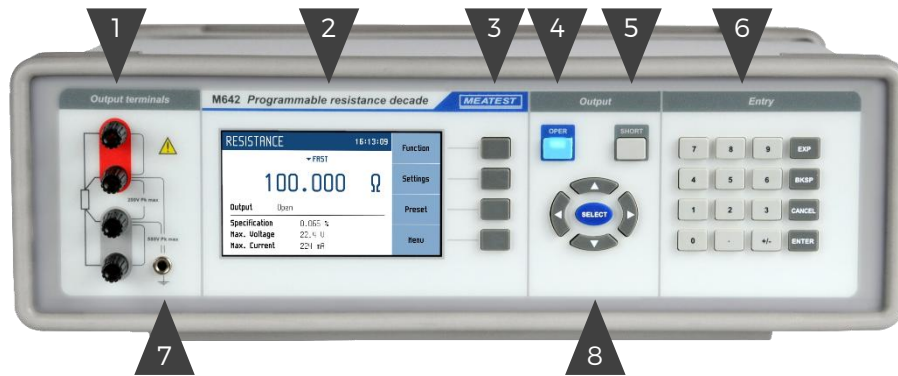


Figure 1 Front panel

1. Output terminals – Four wire output terminals. Measuring (evaluation) circuit can be connected by 2, 3 or 4 wires. Both sides (red and grey) are floating up to 500Vpk against the case (PE).
2. Display – More in chapter 1.1.1. Display in detail
3. 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).
4. 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.
5. SHORT (short key) – Active SHORT key (LED in the key is ON) replaces the main value with the short circuit. Also the short circuit must be connected to the output terminals by the OPER key.
6. 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. EXP button is for adding exponents to number (for example 1E3 – 1000). BSKP button is backspace.
7. 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.
8. 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.

### 1.1.1. Display in detail

Display is divided into several sections with following meaning:

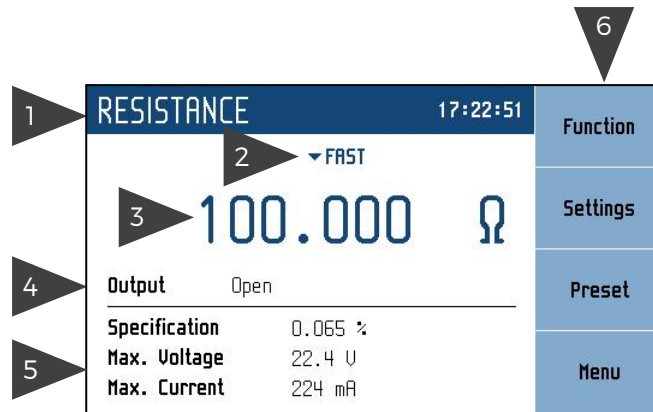


Figure 2 Display

1. Information line - Selected function and time
2. Auxiliary parameters - This section displays auxiliary parameters of actually selected function:  
Temperature standard (PT385, PT3916, ...)  
Switching mode (FAST, VIA OPEN, ...)  
R0 resistance
3. Main value - Main value of selected function with the unit.
4. Output state - Displays resistance value connected to the output terminals.
5. Additional information:  
Specification - Specification of the main value.  
Maximum voltage - Maximum allowed voltage for the main value.  
Maximum current - Maximum allowed current for the main value.
6. 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).

#### Colors on display

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

- **Blue color** - parameters or values, which can be set-up or modified directly from front panel keyboard or via Main menu.
- **Black color** - fix values, labels, notes, parameters which cannot be modified and for other fix text with general information purpose.

Meaning of softkeys is shown on the right side of display. If there is no description next to the softkey, the softkey is not active in selected function.

## 1.2. Rear panel overview

There is located power line entry module with power line fuse, power line voltage selector 115/230V and power line switch. On the bottom side interface connectors RS-232 and optionally LAN, USB and IEEE488 on the rear panel.

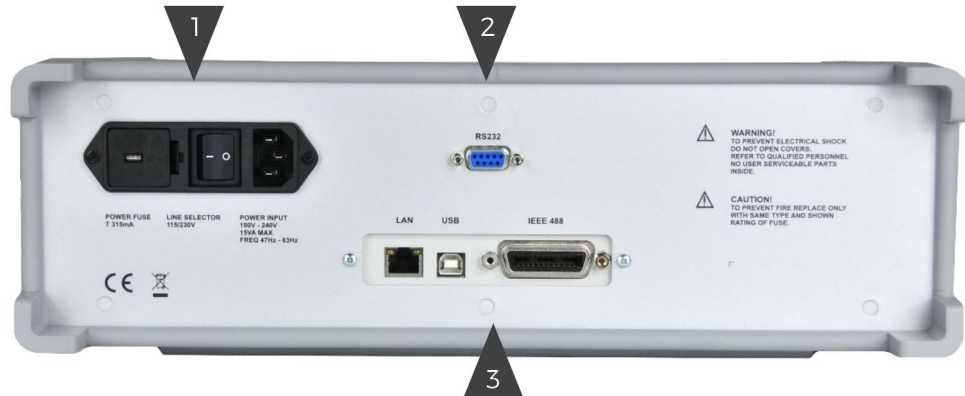


Figure 3 Rear panel

1. Power cord module with power switch, fuse holder and 115/230 V voltage selector
2. RS-232 connector
3. LAN, USB, GPIB IEEE-488 connector for remote control

## 1.3. Options and accessories

Every M600 series Decade box delivery includes following items:

- USB stick with user manual 1 pc
- Test report 1 pc
- Power cable 1 pc

Every Resistance Decade box can be ordered with integrated options – see ordering codes listed below. Integrated options can be fitted only by manufacturer and certified service providers.

Order example: M632-V2000 – M632 with RS232, LAN, USB, IEEE488

Ordering codes	
Bus	M6xx-V1xxx – RS232 M6xx-V2xxx – RS232, USB, LAN, GPIB
Range (M642 only)	M642-Vx0xx – default range M642-Vx2xx – extended 22MΩ range

Table 1 Ordering codes

M600 series Decade boxes can be fitted with RACK M adapter (3HE). Rack adapter is detachable providing extra flexibility.



Figure 4 RACK M adapter

Note: M600 series used to be available in -Vxx1x rack panel version. This version is no longer available as the rack panel was non-detachable (unlike the rack adapter above).

## 1.4. Remote control

Decade boxes can be integrated into automated calibration systems (ATS) and generally controlled from remote computer via following remote control interfaces:

- RS232
- USB
- GPIB (IEEE488)
- LAN

When controlled remotely, maximum ratings of decade's boxes output signals as well as all other specifications are the same as in manual mode.

Meatest software package WinQbase + Caliber is recommended for best automation results. This system is designed for automated and semi automated calibrations of digital and analogue meters including uncertainty calculation, result evaluation and certificate printing according to ISO 17025 standard.

### 1.4.1. Connection setup

Only one interface can be used for communication at any given time. Default active interface is RS232, other interfaces can be selected in MENU->Interface->Active bus. To establish connection between the decade boxes and computer, set interface settings in your computer accordingly:

#### RS232 and USB connection settings

- COM port see available COM ports in Windows Device Manager
- Baudrate USB according to MENU > Interface > USB Baudrate (9600 by default)
- Baudrate RS232 according to MENU->Interface->RS232 Baudrate (9600 by default)
- Data bits 8
- Stop bits 1
- Parity None
- Handshake (XON/XOFF) Off

#### GPIB connection settings

- GPIB Address according to MENU->Interface->GPIB Address (2 by default)

#### LAN connection 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 "M631 / M632 / M641 / M642\_SNxxxxxx 23", where "xxxxxx" stands for serial number and 23 is default communication port (22 for TCP and UDP protocol).

### 1.4.2. SCPI commands and protocol

See M63x and M64x SCPI manual for complete SCPI reference, more details on communication setup and troubleshooting.



## 2. Getting started

Inspect package contents when unboxing the decade box for the first time. See chapter 1.3 for complete list of accessories.

Place the instrument on a level surface before powering on and let it stabilize for at least one hour if the instrument has been stored outside of reference temperatures beforehand.

### 2.1. Safety precautions

The instrument has been designed according to IEC 61010-1:2011 + A1. Safety is ensured by design and by use of specific components. 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, risk of danger.



Warning - risk of electric shock. Hazardous voltage above 50 V DC or AC might be present.



See User Manual.



Protective earth.



Fuse.

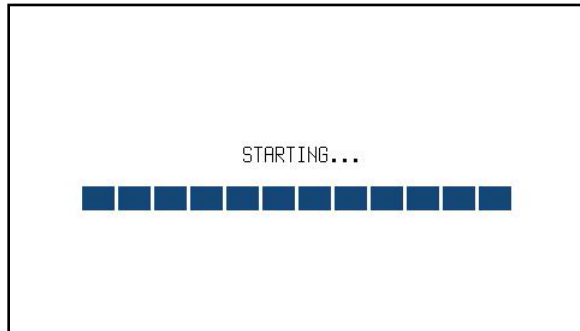
To prevent possible electrical shock or personal injury:

- Read carefully safety information before you use the Product.
- Do not alter the Product and use only as specified, or the protection supplied by the Product can be compromised.
- Do not use the Product if it is altered or damaged.
- Use this Product indoors only.
- Use power cord approved for local mains voltage and plug configuration and rated for the Product.
- Keep hands away from all Product terminals and exposed metal cable parts during operation. High voltage on those may be cause death or serious injury.

## 2.2. Power on and warm-up

Every decade box must be powered by 230/115 V. Before connecting the instrument to the mains, check the position of the mains voltage selector located on the rear panel. Set appropriate voltage selector position either 115 V or 230 V.

Plug one end of the power cord into connector on the rear panel and connect the other end of the power cord into a wall outlet. Turn the calibrator on with mains switch right next to it. You should see following splash screen on display.



**Figure 5 Starting Screen**

Decade box then performs internal hardware checks for app. 5 seconds and then starts in Startup state (called Preset). Startup preset can be customized however, the instrument will always start with OPEN terminals.

### **Warm-up**

Specified parameters are guaranteed 10 minutes after switching on and stabilizing it in reference conditions for all decade boxes.

## 2.3. Signal output

Decade box output can be turned on by pushing OPER button. Pressing OPER button again turns output off. Output turns off automatically on decade box startup and function switch. Output state is indicated by LED light in OPER button.

### Short circuit

Short circuit" is simulated after pressing SHORT key. Active SHORT key (LED in the key is ON) replaces the main value with the short circuit. Also the short circuit must be connected to the output terminals by the OPER key.

## 2.4. What to do in case of failure

If an obvious failure occurs during the operation (e.g. the display is not lit, the fan is not turning), the decade box must be switched off immediately. First, check the fuse located in the power cord receptacle. Procedure is following:

- 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 pry out the fuse holder.
- Remove the fuse. Replace it with new fuse of the same rating if the fuse was broken.
- Replace the fuse holder, reconnect the power cord and switch on the decade box. If the problem persists, contact the manufacturer.

If an obvious fault is evidenced, e.g. a measurement range or an operating mode is not functional, the user cannot correct the fault. Contact the manufacturer.

Hidden faults can cause different symptoms and be caused by different causes. Usually, they cause instability of some parameter. Hidden defects can be caused by unacceptable distortion, degraded insulation etc. In this case contact the manufacturer.

Sometimes it seems that the decade box has hidden defect, when the rules for correct operation are not adhered to. In this case, the fault is caused by the operator. Most frequent cases of false "hidden defects":

- mains voltage out of tolerance limits or unstable
- wrong grounding of the measurement circuit (bad connection of the ground terminal of the mains outlet, or several ground connections when grounding loops are formed)
- proximity to sources of intensive influence, whose products are spread through the mains or propagated by the electromagnetic field
- strong electrostatic or electromagnetic field which can cause major instability during calibration using higher impedance.

### 3. Menu reference

#### 3.1. Main menu

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



Figure 6 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.

#### 3.1.1. Information

Information submenu contains general device data which cannot be modified by the user:

<ul style="list-style-type: none"> <li>- Manufacturer</li> <li>- Model</li> <li>- Serial number</li> </ul>	Device identification
<ul style="list-style-type: none"> <li>- Software version</li> <li>- Hardware version</li> </ul>	Device configuration

#### 3.1.2. Device

Device submenu is divided according to calibrator functions that gives access to additional function related settings:

Temperature unit - Temperature functions can be expressed in different units. Available units are °C (Celsius), °F (Fahrenheit) and K (Kelvin).	
Switching	Item defines the way how resistance value is changed. R1 is changed to value R2 in the time interval T.  Resistance connected to the output terminals can have different values during the time interval T.  FAST - Fastest possible switching method. T is typically 400us. Resistance during T is undefined. It can be higher or lower than R1 (R2).
	SMOOTH - 2 steps switching method with smallest possible resistance change. T is typically 1ms.
	VIA OPEN - 2 steps switching method. R1 is switched to OPEN and then to R2. T is typically 1ms.
	VIA SHORT - 2 steps switching method. R1 is switched to SHORT and then to R2. T is typically 1ms. SHORT value is lower than min (R1, R2).

Platinum standard	Platinum thermometers simulations.  PT385 (68) - DIN, standard EN60751, temperature scale IPTS68 (A=3.90802e-3, B=-5.80195e-7, C=-4.2735e-12)  PT385 (90) - DIN, standard EN60751, temperature scale ITS90 (A=3.9083e-3, B=-5.775e-7, C=-4.18301e-12)  PT3916 - Pt3916 temperature curve (A=3.9692e-3, B=-5.8495e-7, C=-4.2325e-12)  PT3926 - Pt3926 temperature curve (A=3.9848e-3, B=-5.870e-7, C=-4.0e-12)  PT User - custom temperature curve, see “Platinum user coefficients” item below
Platinum user coefficients - This menu permits A, B and C coefficients definition of the PT User platinum standard (see above).	
Timings – See chapter 4.2.1.	
User function curve – See chapter 4.2.2.	

### 3.1.3. System

System submenu contains basic parameters of display and keyboard.

- Language Language version of user interface
- Backlight [0 – 100]
- Beeper volume [0 – 100]
- Keyboard beep [On/Off]
- Time System time in HH:MM:SS format
  - o Show on display [On/Off]
- Date System date in selected format
  - o Format Date format [M/D/Y, M-D-Y, D/M/Y, D.M.Y, D-M-Y, Y/M/D, Y.M.D]

### 3.1.4. Interface

Interface submenu contains remote control parameters:

Menu item	Range / format	Default value
Active bus	RS232/GPIB/USB/LAN	RS232
RS232 Baudrate	1200 – 115200	9600
GPIB Address	0 – 31	2
USB Baudrate	1200 – 115200	9600
LAN Settings		
> 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	M642_SN686921
> Assigned IP address	IPv4 format; current IP address of the device	

### 3.1.5. Calibration

See chapter 6. for detailed information.

### 3.2. 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.

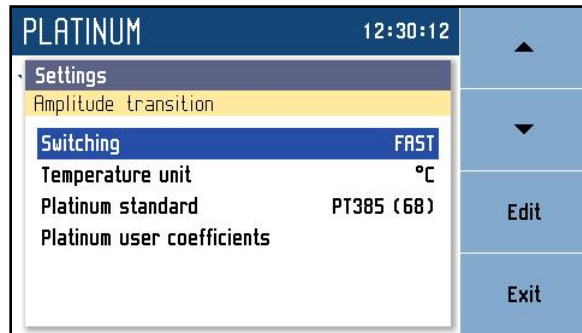


Figure 7 Settings menu

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.

### 3.3. 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.

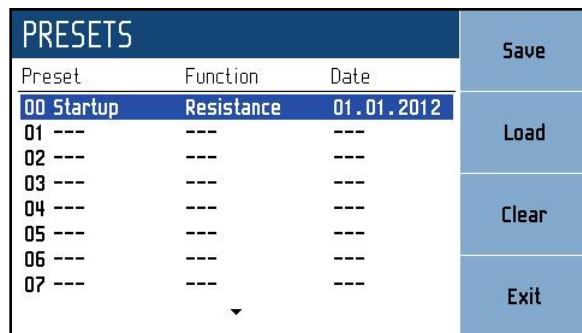


Figure 8 Preset menu

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 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. Calibration examples

### 4.1. Wires connection

Output resistance is available on R output terminals. Available is 2, 3 and 4-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).

### 4.2. 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: Resistance, Platinum, Nickel, User function and Timing.

Platinum and Nickle is for setting temperature of simulated thermometer.

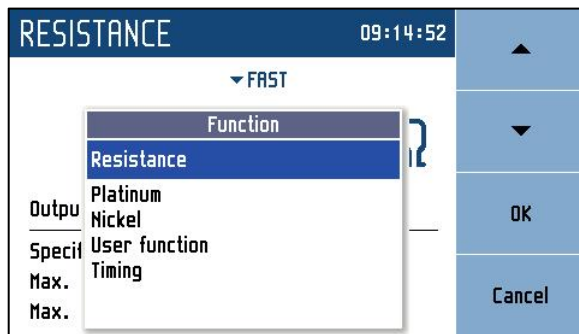


Figure 9 Functions

#### 4.2.1. User function

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

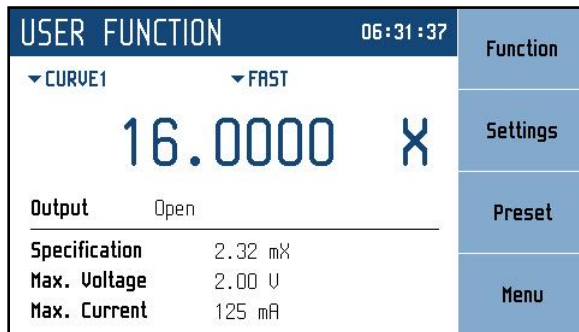


Figure 10 User function screen

Function is defined by table of user values and corresponding resistance 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:

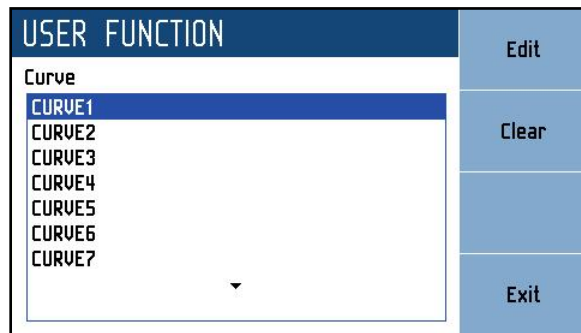


Figure 11 User function list

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:

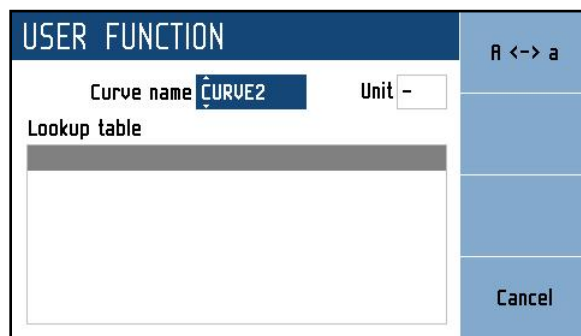


Figure 12 New user function

**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  $\Omega$ . Table must contain at least two “user function value →  $\Omega$  value” points so that a slope of the function can be calculated. Range in user function mode is given by actual resistance range of the simulator. Browsing through the table is done by ▲, ▼ cursor keys. Editing is done using these contextual softkeys:



**Add** – create a new point.



The screenshot shows a panel titled "Equation". It contains two input fields: "Value" with the text "1.000000E+00" and "Resistance" with the text "1.000000 Ω".

**Figure 13 User function point editing**

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

**Resistance** – corresponding  $\Omega$  value. Range is given by the actual resistance range of the simulator.

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

**Delete** – delete selected point.

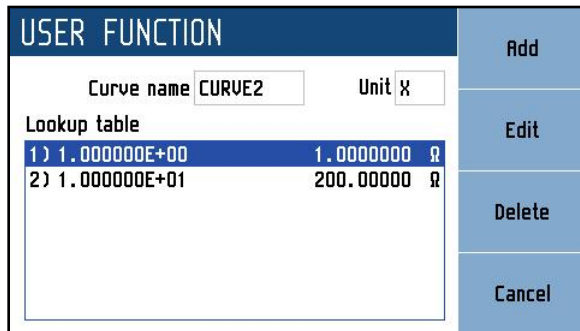
**Cancel** – deactivate the Lookup Table and allow for curve saving.

**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.



The screenshot shows a panel titled "USER FUNCTION". It has input fields for "Curve name" (CURVE2) and "Unit" (X). Below these is a "Lookup table" with two entries:

	Value	Resistance
1)	1.000000E+00	1.000000 $\Omega$
2)	1.000000E+01	200.00000 $\Omega$

On the right side of the panel are four buttons: "Add", "Edit", "Delete", and "Cancel".

**Figure 14 User function edit**

## 4.2.2. Timing

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



Figure 15 Timing screen

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:

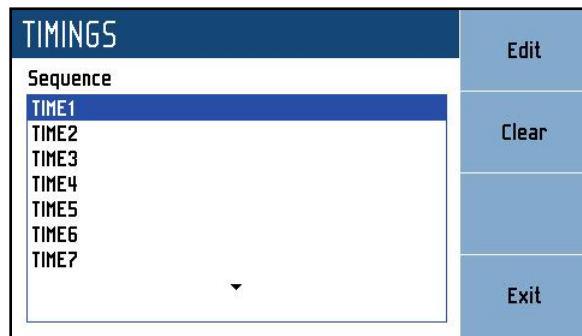


Figure 16 Time sequence list

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 *Edit* softkey upon plain sequence opens this submenu:

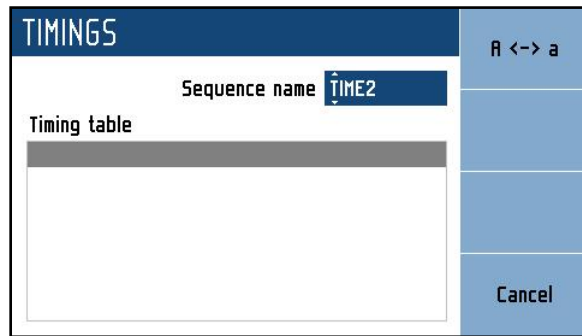


Figure 17 New sequence

**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  $\Omega$  and their durations in seconds. Browsing through the table is done by ▲, ▼ cursor keys. Editing is done using these softkeys:

**Add** – create a new point.

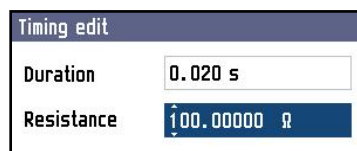


Figure 18 Timing sequence point editing

**Duration** – duration of selected resistance (from 2 ms to 10 000 s). Press the **SELECT** key to proceed.

**Resistance** – corresponding  $\Omega$  value. Range is given by the actual resistance range of the simulator.

**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.

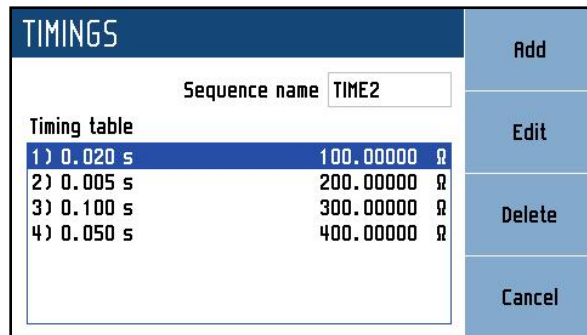


Figure 19 Timing sequence edit

## 4.3. 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.

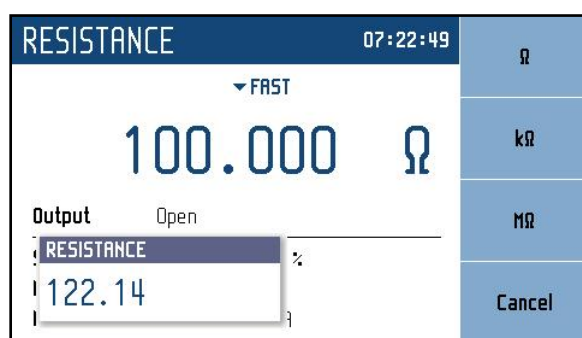


Figure 20 Numeric value entry

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

## 5. Performance verification

Specifications of these Decade boxes are defined for 1 year period so it should be periodically tested (and adjusted if necessary) within the same period of time. If you don't have the necessary equipment or can't do the calibration on your own, please ask local Meatest representative to help you calibrate these devices.

Parameter verification procedure is described in the chapter 5.3. Verification procedure is based on measuring resistance on the simulator output terminals with standard multimeter in recommended points.

### 5.1. Required equipment

Ohmmeter nominal accuracy 0.001% in range 1  $\Omega$  to 1.2 M $\Omega$  (type Fluke 8508A or similar)

### 5.2. RTD simulator setting

Switch RTD simulator to the resistance function. Connect standard multimeter to the simulator output terminals. Use four-wire connection technique.

### 5.3. Verification procedure

Use following procedure to perform parameter verification test:

1. Switch both instruments on and let them for 1 hour stabilize in the laboratory with ambient temperature  $23 \pm 3$  °C. Connect simulator terminals 4W to the standard ohm-meter (multimeter).
2. Case of the simulator should be grounded or connected to the Lo terminal of multimeter.
3. Check resistance value in points according to your Decade box version.

**Maximum absolute deviations M631**

Nominal value	Deviation
16 $\Omega$	2.2 m $\Omega$
20 $\Omega$	2.4 m $\Omega$
50 $\Omega$	3.0 m $\Omega$
100 $\Omega$	4.0 m $\Omega$
200 $\Omega$	6.0 m $\Omega$
500 $\Omega$	15 m $\Omega$
1 k $\Omega$	30 m $\Omega$
2 k $\Omega$	100 m $\Omega$
5 k $\Omega$	750 m $\Omega$
10 k $\Omega$	1.5 $\Omega$
20 k $\Omega$	6.0 $\Omega$
50 k $\Omega$	50 $\Omega$
100 k $\Omega$	100 $\Omega$
200 k $\Omega$	800 $\Omega$
400 k $\Omega$	1.6 k $\Omega$

**Table 2 M631 test points**

**Maximum absolute deviations M641**

Nominal value	Deviation
19 $\Omega$	25 m $\Omega$
36 $\Omega$	33 m $\Omega$
70 $\Omega$	50 m $\Omega$
140 $\Omega$	85 m $\Omega$
250 $\Omega$	50 m $\Omega$
500 $\Omega$	100 m $\Omega$
1 k $\Omega$	200 m $\Omega$
2 k $\Omega$	400 m $\Omega$
4 k $\Omega$	800 m $\Omega$
8 k $\Omega$	1.6 $\Omega$
16 k $\Omega$	8 $\Omega$
30 k $\Omega$	15 $\Omega$
60 k $\Omega$	60 $\Omega$
120 k $\Omega$	600 $\Omega$
250 k $\Omega$	1250 $\Omega$

**Table 3 M641 test points**

**Maximum absolute deviations M632**

Nominal value	Deviation
1 Ω	2.0 mΩ
2 Ω	2.0 mΩ
5 Ω	2.1 mΩ
10 Ω	2.2 mΩ
16 Ω	2.2 mΩ
20 Ω	2.4 mΩ
50 Ω	3.0 mΩ
100 Ω	4.0 mΩ
200 Ω	6.0 mΩ
500 Ω	15 mΩ
1 kΩ	30 mΩ
2 kΩ	60 mΩ
5 kΩ	150 mΩ
10 kΩ	300 mΩ
20 kΩ	600 mΩ
50 kΩ	1.5 Ω
100 kΩ	3.0 Ω
200 kΩ	6.0 Ω
400 kΩ	20 Ω
500 kΩ	25 Ω
1 MΩ	50 Ω
1.2 MΩ	60 Ω

**Table 4 M632 test points**

**Maximum absolute deviations M642**

Nominal value	Deviation
180 mΩ	15 mΩ
300 mΩ	15 mΩ
700 mΩ	15 mΩ
1.3 Ω	16 mΩ
2.5 Ω	16 mΩ
5.0 Ω	18 mΩ
9.5 Ω	20 mΩ
19 Ω	25 mΩ
36 Ω	33 mΩ
70 Ω	50 mΩ
140 Ω	85 mΩ
250 Ω	50 mΩ
500 Ω	100 mΩ
1 kΩ	200 mΩ
2 kΩ	400 mΩ
4 kΩ	800 mΩ
8 kΩ	1.6 Ω
16 kΩ	3.2 Ω
40 kΩ	8 Ω
80 kΩ	16 Ω
150 kΩ	30 Ω
300 kΩ	60 Ω
700 kΩ	140 Ω
1.5 MΩ	300 Ω
3 MΩ	1.5 kΩ
6 MΩ	3 kΩ

**Table 5 M642 test points**

## 6. Adjustment

Adjustment is done through MENU > Calibration > Resistance standards. This menu item is password protected, default factory set calibration code is “2”.

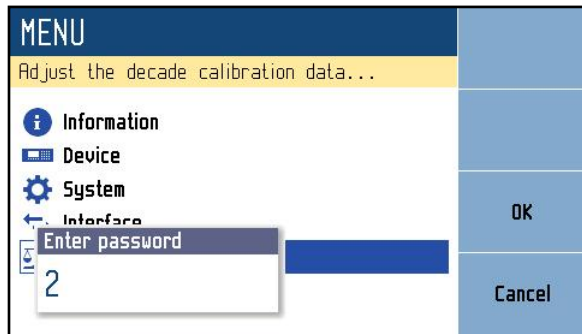


Figure 21 Password entry

In this mode resistance elements of the RTD simulators can be recalibrated. Return to standard mode is possible after pushing the key ESC

### Change password

MENU > Calibration > Change password. In this menu you can change the password of the calibration mode.

### 6.1. Calibration mode

Recalibration procedure consists of measuring of 24 basic resistance values and entering their actually measured data. Calibration point can be changes using display softkeys “Previous” and “Next”. Calibration value of selected resistance can be change using cursor keys ▲, ▼, ◀, ▶.

Process of calibration consists of measuring partial resistances and writing their actual values into the RTD simulator:

- Set the first calibration point (resistance element). Use display softkeys “Previous” and “Next” to select the element.
- Measure resistance of the selected element. Use ohm-meter with appropriate accuracy in 4-wire connection mode.



Figure 22 Calibration point screen

- Using cursor keys ▲, ▼, ◀, ▶ adjust resistance value in M631 / M632 / M641 / M642 according to the ohm meter.
- Confirm new calibration value by pressing “Save” softkey.
- Repeat above described procedure for all resistance elements.



## 6.2. List of calibration points

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

### 6.2.1. Calibration points M631

Standard	Nominal value	Requested Accuracy
R1	30.5 $\Omega$	1 m $\Omega$
R2	60.4 $\Omega$	1 m $\Omega$
R3	120 $\Omega$	2 m $\Omega$
R4	237 $\Omega$	3 m $\Omega$
R5	464 $\Omega$	6 m $\Omega$
R6	909 $\Omega$	15 m $\Omega$
R7	1.78 k $\Omega$	30 m $\Omega$
R8	3.48 k $\Omega$	100 m $\Omega$
R9	6.87 k $\Omega$	250 m $\Omega$
R10	13.5 k $\Omega$	500 m $\Omega$
R11	26.6 k $\Omega$	1 $\Omega$
R12	52.2 k $\Omega$	5 $\Omega$
R13	103 k $\Omega$	10 $\Omega$
R14	202 k $\Omega$	20 $\Omega$
R15	396 k $\Omega$	40 $\Omega$
R16	778 k $\Omega$	80 $\Omega$
R17	1.54 M $\Omega$	200 $\Omega$
R18	3.03 M $\Omega$	400 $\Omega$
R19	6.0 M $\Omega$	1 k $\Omega$
R20	12 M $\Omega$	5 k $\Omega$
R21	23 M $\Omega$	50 k $\Omega$
R22	48 M $\Omega$	200 k $\Omega$
R23	100 M $\Omega$	500 k $\Omega$
R24	200 M $\Omega$	1 M $\Omega$

Table 6 M631 calibration points

### 6.2.2. Calibration points M641

Standard	Nominal value	Requested Accuracy
R1	20 $\Omega$	1 m $\Omega$
R2	38.8 $\Omega$	1 m $\Omega$
R3	75.6 $\Omega$	2 m $\Omega$
R4	148 $\Omega$	3 m $\Omega$
R5	287 $\Omega$	6 m $\Omega$
R6	570 $\Omega$	15 m $\Omega$
R7	1.13 k $\Omega$	30 m $\Omega$
R8	2.23 k $\Omega$	100 m $\Omega$
R9	4.4 $\Omega$	250 m $\Omega$
R10	8.7 k $\Omega$	500 m $\Omega$
R11	17 k $\Omega$	1 $\Omega$
R12	33.3 k $\Omega$	5 $\Omega$
R13	66 k $\Omega$	10 $\Omega$
R14	130 k $\Omega$	20 $\Omega$
R15	258 k $\Omega$	40 $\Omega$
R16	506 k $\Omega$	80 $\Omega$
R17	1 M $\Omega$	200 $\Omega$
R18	2 M $\Omega$	400 $\Omega$
R19	3.99 M $\Omega$	1 k $\Omega$
R20	7.8 M $\Omega$	5 k $\Omega$
R21	15 M $\Omega$	50 k $\Omega$
R22	30 M $\Omega$	200 k $\Omega$
R23	60 M $\Omega$	500 k $\Omega$
R24	120 M $\Omega$	1 M $\Omega$

Table 7 M641 calibration points

### 6.2.3. Calibration points M632

Standard	Nominal value	Requested Accuracy
R1	1.95 Ω	1 mΩ
R2	3.88 Ω	1 mΩ
R3	7.73 Ω	1 mΩ
R4	15.4 Ω	1 mΩ
R5	30.5 Ω	1 mΩ
R6	60.4 Ω	1 mΩ
R7	120 Ω	2 mΩ
R8	237 Ω	3 mΩ
R9	464 Ω	6 mΩ
R10	909 Ω	15 mΩ
R11	1.78 kΩ	30 mΩ
R12	3.48 kΩ	100 mΩ
R13	6.87 kΩ	250 mΩ
R14	13.5 kΩ	500 mΩ
R15	26.6 kΩ	1 Ω
R16	52.2 kΩ	5 Ω
R17	103 kΩ	10 Ω
R18	202 kΩ	20 Ω
R19	396 kΩ	40 Ω
R20	778 kΩ	80 Ω
R21	1.54 MΩ	200 Ω
R22	3.03 MΩ	400 Ω
R23	6.0 MΩ	1 kΩ
R24	12 MΩ	5 kΩ
R25	23 MΩ	50 kΩ
R26	48 MΩ	200 kΩ
R27	100 MΩ	500 kΩ
R28	200 MΩ	1 MΩ
R29	2.09 kΩ	40 mΩ
R30	4.14 kΩ	80 mΩ
R31	8.18 kΩ	100 mΩ
R32	16.1 kΩ	200 mΩ
R33	34.3 kΩ	500 mΩ
R34	75.3 kΩ	1 Ω
R35	150 kΩ	4 Ω
R36	301 kΩ	10 Ω
R37	602 kΩ	20 Ω

Table 8 M632 calibration points

### 6.2.4. Calibration points M642

Standard	Nominal value	Requested Accuracy
R1	0.17 Ω	1 mΩ
R2	0.35 Ω	1 mΩ
R3	0.7 Ω	1 mΩ
R4	1.37 Ω	1 mΩ
R5	2.66 Ω	1 mΩ
R6	5.15 Ω	1 mΩ
R7	10.2 Ω	1 mΩ
R8	20 Ω	1 mΩ
R9	38.8 Ω	1 mΩ
R10	75.6 Ω	2 mΩ
R11	148 Ω	3 mΩ
R12	287 Ω	6 mΩ
R13	570 Ω	15 mΩ
R14	1.13 kΩ	30 mΩ
R15	2.23 kΩ	100 mΩ
R16	4.4 kΩ	250 mΩ
R17	8.7 kΩ	500 mΩ
R18	17 kΩ	1 Ω
R19	33.3 kΩ	5 Ω
R20	66 kΩ	10 Ω
R21	130 kΩ	20 Ω
R22	258 kΩ	40 Ω
R23	506 kΩ	80 Ω
R24	1 MΩ	200 Ω
R25	2 MΩ	400 Ω
R26	3.99 MΩ	1 kΩ
R27	7.8 MΩ	5 kΩ
R28	15 MΩ	50 kΩ
R29	30 MΩ	200 kΩ
R30	60 MΩ	500 kΩ
R31	120 MΩ	1 MΩ
R32	3.55 kΩ	80 mΩ
R33	7.39 kΩ	100 mΩ
R34	16.4 kΩ	200 mΩ
R35	33.8 kΩ	500 mΩ
R36	72.2 kΩ	1 Ω
R37	147 kΩ	4 Ω
R38	300 kΩ	10 Ω
R39	600 kΩ	20 Ω
R40	1.23 MΩ	40 Ω
R41	2.48 MΩ	80 Ω
R42	5 MΩ	160 Ω
R43	10 MΩ	320 Ω

Table 9 M632 calibration points

## **7. Maintenance**

This chapter explains how to perform the routine maintenance to keep your device in optimal operating conditions.

### **7.1. Fuse replacement**

M600 decade boxes have user-replaceable fuse, located on rear panel. Replace the fuses as follows:

1. Switch the calibrator off and disconnect power cord from it
2. Locate the fuse to be replaced: Mains fuse is in fuse/voltage selector case next to mains connector.
3. Use flat screwdriver to open voltage selector cover to get to the fuse holder.
4. Remove the fuse, check if it's blown and replace it with new fuse of the same rating if needed.

### **7.2. External surface cleaning**

To keep the device in mint condition, 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.

### 7.3. Error messages

The following table lists an overview of error codes that you might come across.

Error	Message
-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 10 Error code overview**

## 8. Specifications

Specified accuracy is valid after 10 minutes warm up in temperature range  $23 \pm 3^\circ\text{C}$ . 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.

Pt sensor temperature simulation:	-200.000 °C - 850.000 °C (-328 °F - 1562 °F)
Ni sensor temperature simulation:	-60.000 °C - 300.000 °C (-76 °F - 572 °F)
Type of temperature sensors:	Pt100 - Pt1000, Ni100 - Ni1000
Pt temperature standards:	IEC 751 (1,3850 for IPTS68) (A=3.90802e-3, B=-5.80195e-7, C=-4.2735e-12) IEC 751 (1,3851 for ITS90) (A=3.9083e-3, B=-5.775e-7, C=-4.18301e-12) 1,3916 (A=3.9692e-3, B=-5.8495e-7, C=-4.2325e-12) 1,3926 (A=3.9848e-3, B=-5.870e-7, C=-4.0e-12)
Ni temperature standards:	DIN 43760 (6180) (A=5.485e-3, B=6.65e-6, C=2.805e-11, D=-2e-17)
Maximal power	0.25 W (M631 & M632) 5 W (M641 & M642)
Maximum current:	0.5 A
Maximum voltage:	200 Vpk
Reaction time *:	6 ms
Terminals:	instrument terminals diameter 4mm, gold plated
Interface:	RS232 (optionally IEEE488, USB, Ethernet)
Power supply:	115/230 Vac, 45 - 65 Hz
Maximum power consumption:	15 VA
Power coefficient:	above 1W is 50 % of the stated specification per W (only M641 & M642)
Reference temperature:	20 °C - 26 °C
Working temperature:	5 °C - 40 °C
Storing temperature:	-10 °C - 50 °C
Temperature coefficient:	10 % of specifications per °C outside $T_{\text{ref}}$
Relative humidity:	< 80 %
Dimensions:	W 390 mm, H 128 mm, D 310 mm
Weight:	4 kg
Languages:	English, German, French, Spanish, Russian, Czech

Isolation resistance between output terminals and housing:  $> 2 \text{ G}\Omega$  (at 500V DC)

\*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. Value is valid for FAST switching mode.

### M631 Resistance accuracy

Range & resolution	Accuracy
16.000 0 Ω – 20.000 0 Ω	0.002 % + 2 mΩ
20.001 Ω – 200.000 Ω	0.002 % + 2 mΩ
200.01 Ω – 1000.00 Ω	0.003 %
1000.1 Ω – 3000.0 Ω	0.005 %
3001 Ω – 10000 Ω	0.015 %
10.01 kΩ – 30.00 kΩ	0.03 %
30.1 kΩ – 100.0 kΩ	0.1 %
101 kΩ – 400 kΩ	0.4%

### M632 Resistance accuracy

Range & resolution	Accuracy
1.000 00 Ω – 2.000 00 Ω	0.002 % + 2 mΩ
2.000 1 Ω – 20.000 0 Ω	0.002 % + 2 mΩ
20.001 Ω – 200.000 Ω	0.002 % + 2 mΩ
200.01 Ω – 2000.00 Ω	0.003 %
2.000 1 kΩ – 20.000 0 kΩ	0.003 %
20.001 kΩ – 200.000 kΩ	0.003 %
200.01 kΩ – 1200.00 kΩ	0.005 %

### M641 Resistance accuracy

Range & resolution	Accuracy
10.000 0 Ω – 20.000 0 Ω	0.05 % + 15 mΩ
20.001 Ω – 200.000 Ω	0.05 % + 15 mΩ
200.01 Ω – 1000.00 Ω	0.02 %
1.000 1 kΩ – 3.000 0 kΩ	0.02 %
3.001 kΩ – 10.000 kΩ	0.02 %
10.01 kΩ – 30.00 kΩ	0.05 %
30.1 kΩ – 100.0 kΩ	0.1 %
101 kΩ – 300 kΩ	0.5 %

### M642 Resistance accuracy

Range & resolution	Accuracy
100.000 mΩ – 200.000 mΩ	0.05 % + 15 mΩ
0.200 01 Ω – 2.00000 Ω	0.05 % + 15 mΩ
2.000 1 Ω – 20.0000 Ω	0.05 % + 15 mΩ
20.001 Ω – 200.000 Ω	0.05 % + 15 mΩ
200.01 Ω – 2 000.00 Ω	0.02 %
2.0001 kΩ – 20.0000 kΩ	0.02 %
20.001 kΩ – 200.000 kΩ	0.02 %
0.20001 MΩ – 2.00000 MΩ	0.02 %
2.0001 MΩ – 20.0000 MΩ	0.05 %
20.01 MΩ – 21.00 MΩ <sup>1</sup>	0.1 %
21.01 MΩ – 22.00 MΩ <sup>1</sup>	0.2 %

1. Extended 22 MΩ range available only in -Vx2xx versio

### M63x Typical frequency response

AC/DC difference	M632						M631				
	1 Ω	10 Ω	100 Ω	1 kΩ	10 kΩ	100 kΩ	16 Ω	100 Ω	1 kΩ	10 kΩ	100 kΩ
100 Hz	0.01 %	0.01 %	0.01 %	0.05 %	0.50 %	5.00 %	0.01 %	0.01 %	0.03 %	0.30 %	3.00 %
1 kHz	0.02 %	0.01 %	0.05 %	0.50 %	5.00 %	-	0.01 %	0.03 %	0.30 %	3.00 %	-
10 kHz	0.20 %	0.04 %	0.50 %	5.00 %	-	-	0.04 %	0.30 %	3.00 %	-	-

### M64x Typical frequency response

AC/DC difference	M642							M641				
	100 mΩ	1 Ω	10 Ω	100 Ω	1 kΩ	10 kΩ	100 kΩ	16 Ω	100 Ω	1 kΩ	10 kΩ	100 kΩ
100 Hz	0.05 %	0.02 %	0.01 %	0.01 %	0.06 %	0.60 %	6.00 %	0.01 %	0.01 %	0.04 %	0.40 %	4.00 %
1 kHz	0.20 %	0.10 %	0.02 %	0.01 %	0.60 %	6.00 %	-	0.01 %	0.05 %	0.40 %	4.00 %	-
10 kHz	5.00 %	0.50 %	0.10 %	0.60 %	6.00 %	-	-	0.05 %	0.50 %	4.00 %	-	-

### M631 Typical thermal emf

Range & resolution	Thermal emf
16.000 0 Ω- 2000.0 Ω	<1 μV
2.000 1 kΩ - 30.00 kΩ	<10 μV

### M632 Typical thermal emf

Range & resolution	Thermal emf
1.000 00 Ω- 50.000 kΩ	<1 μV

### M63x Pt simulation accuracy

Temperature Range & resolution	M632		M631	
	Pt10 – Pt99	Pt100 – Pt20000	Pt100 – Pt500	Pt501 – Pt1000
-200.000 – 0.000 °C	0.05 °C	0.01 °C	0.01 °C	0.01 °C
0.001 – 200.000 °C	0.06 °C	0.015 °C	0.015 °C	0.02 °C
200.001 – 500.000 °C	0.08 °C	0.03 °C	0.03 °C	0.04 °C
500.001 – 850.000 °C	0.1 °C	0.04 °C	0.04 °C	0.1 °C

### M63x Ni simulation accuracy

Temperature Range & resolution	M632		M631	
	Ni10 – Ni99	Ni100 – Ni20000	Ni100 – Ni500	Ni10 – Ni1000
-60.000 – 0.000 °C	0.05 °C	0.01 °C	0.01 °C	0.01 °C
0.001 – 300.000 °C	0.05 °C	0.01 °C	0.01 °C	0.02 °C

### M64x Pt simulation accuracy

Temperature Range & resolution	M642		M641
	Pt10 – Pt99	Pt100 – Pt20000	Pt100 – Pt1000
-200.000 – 0.000 °C	0.5 °C	0.15 °C	0.15 °C
-0.001 – 850.000 °C	1.0 °C	0.2 °C	

### M64x Ni simulation accuracy

Temperature Range & resolution	M642		M641
	Ni10 – Ni99	Ni100 – Ni20000	Ni10 – Ni1000
-60.000 – 300.000 °C	0.4 °C	0.1 °C	0.1 °C

### Short and Open simulation

For M641 & M642

„SHORT“ resistance is lower than 40 mΩ. Maximum allowed current is 500 mA.

„OPEN“ resistance is higher than 10 GΩ. Maximum allowed voltage is 200 Vpk.

For M631 & M632

„SHORT“ resistance is lower than 60 mΩ. Maximum allowed current is 500 mA.

„OPEN“ resistance is higher than 1 GΩ. Maximum allowed voltage is 200 Vpk.

Note: All resistance values are absolute, ie. not relative to SHORT position. Short and Open positions are intended for functional checking of tested instrument only.

## **9. Revisions**

### **9.1. Change 1 (10. 05. 2023)**

- New detachable RACK M adapter in chapter 1.3.

### **9.2. Change 2 (02. 08. 2023)**

- Specifications changes in chapter 8.

### **9.3. Change 3 (16. 05. 2023)**

- Added chapter about Typical thermal emf in chapter 8.



# Declaration of conformity

According to EN ISO/IEC 17050-1:2010 standard as well as 2014/30/EU and 2014/35/EU directives of European Parliament and European Council, MEATEST, spol. s r. o., manufacturer of Programmable Decade boxes M641, M642, M631 & M632, based in Železná 3, 619 00 Brno, Czech Republic, declares that its product conforms to following specifications:

## **LVD**

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

## **EMC**

- 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
- EN 55011 ed. 4:2015 + A1:2016 + A11:2020

## **RoHS**

- EN IEC 63000:2018

## **WEEE**

- EN 50419:2022

Brno

February 26<sup>th</sup>, 2025



Place

Date

Signature