M-109R

High Resistance Decade

Operation Manual

meatest

CONTENT:

1. Use of the instrument

M-109R High resistance decade is designed for checking parameters of insulating resistance meters and megaohm-meters. High-voltage relays with high insulating resistance and steady high-voltage resistances steamed on ceramic substrate are used for the design.Advantages of M-109R are easy operation with indication of maximum voltage, which can be connected to the input terminals in the given configuration. as well as battery-operated supplying supplemented with power adapter and possibility of operating the decade through serial line RS-232.

2. Contents of delivery

High resistance decade M - 109R
Power adapter PSA18U-150
Cable RS 232
Demo program (CD)
Operation manual

3. Technical data

Resistance range	:	1 MΩ - 12.221 GΩ
Maximum voltage	:	5000 V DC – terminals H-L, H-⊥, L-⊥
Connection	:	two-terminal + ⊥ (GUARD)
Type of terminals	:	ERTALYTE terminals
Capacitance between terminals.	:	H – GUARD, L – GUARD < 150 pF
Remote control	:	RS-232 interface
Power supply	:	internal battery 12 V line adapter 100–240VAC/50-60Hz
Operating period	:	typically 3 hours from internal battery
Reference temperatures	:	23 °C ± 5 °C
Range of working temperatures	:	+5 °C to +40 °C
Range of storing temperatures	:	-10 °C to +55 °C
Relative humidity	:	10 - 50 %
Instrument case	:	metal
Dimensions	:	W 362 mm, H 111 mm, D 316 mm
Weight	:	4 kg

Range	Nominal value accuracy	Voltage coefficient	Temperature Coefficient +5 °C to +40 °C	Maximum voltage
	[%]	[± ppm/V]	[± ppm / °C]	[V DC/ RMS]
1 MΩ - 11 MΩ	**0.1/100 V**	**1**	**< 100**	**1000/700**
12 MΩ - 121MΩ	**0.2/1000 V**	**1**	**< 100**	**2500/1700**
122 MΩ - 1.221 GΩ	**0.5/1000 V**	**2**	**< 100**	**5000/3500**
1.222 GΩ - 12.221 GΩ	**1.0/1000 V**	**2**	**< 100**	**5000/3500**

Ref. temperature 23 °C +/- 5 °C
Note:

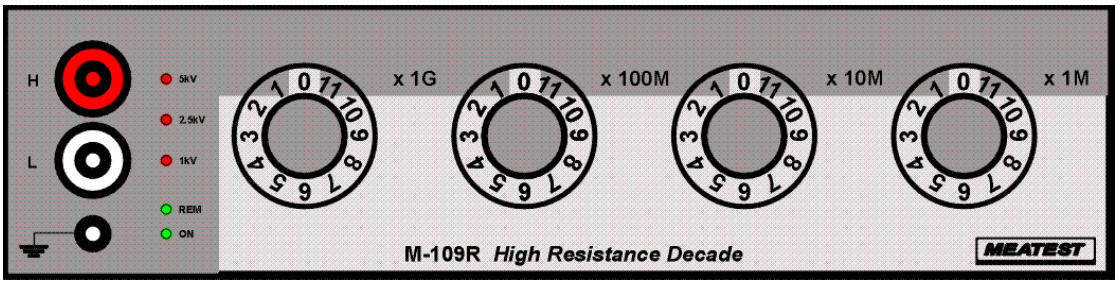
In voltage range 0-1kV and in temperature range 18-28°C is total accuracy given by basic accuracy of nominal value.
In voltage range 1-5kV and in temperature range without 18-28°C is total accuracy given by basic accuracy of nominal value + influence of voltage coefficient + influence of temperature coefficient

For example: (1GOhm, 5kV, 38°C)
*Total accuracy : 0,5% + (5000V-1000V)*2ppm/V + (38°C-28°C)*100ppm/°C =1,4%*

Insulation resistance of relays	$> 10^{15}$ Ω
Surface resistance of material ERTALYTE	$> 10^{16}$ Ω
Internal specific resistance of material ERTALYTE	$> 10^{16}$ Ω.cm

4. Operation

4.1. Front panel



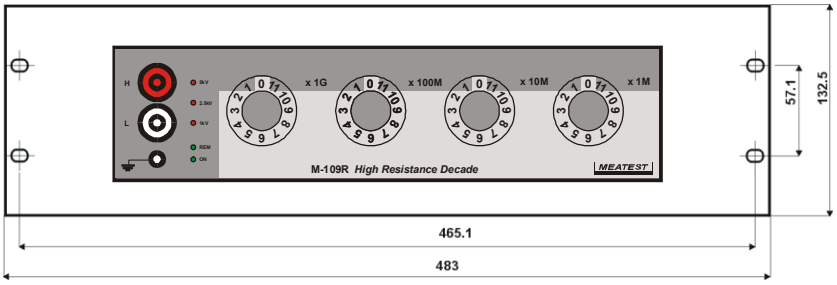
On the front panel, there are located all main operating and indicating elements and input terminals. Individual rotary buttons allow you to set a required electrical resistance value within the 1 MΩ through 12.221 GΩ. Red luminous LED diodes designated 5kV, 2,5kV and 1kV signalize maximum input direct voltage, which can be connected to the input terminals in the given setup configuration. A green LED diode designated REM indicates a mode of remote control. A green LED diode designated ON indicates switching the decade on. Successive dashed glare indicates switching the decade off.

4.2. Rear panel

On the rear panel is the ON/OFF button for switching the decade on and off, supplying connector and a connector for connecting RS-232.

4.3. 19“ rack version (extra ordered)

Resistance decade can be delivered in 3HE 19” rack module.



4.4. Supplying from an internal battery

The decade is equipped with an internal “non-service” 12V battery, as a standard. The decade is switched on and off by pressing the ON/OFF button. Switching the decade on is indicated by a green LED diode ON. If the decade is inactive for 9 minutes (no manipulation with the buttons), a repeated long acoustic signal is generated accompanied by a slowly flashing light of a green LED diode ON. After approx. one minute the decade is switched off automatically. If the battery is discharged when operating the decade, the operator is warned by a periodically repeated sequence of short and long acoustic signals accompanied by quick flashing of the green LED diode ON. After approx. one minute the decade is switched off. It is necessary to recharge the internal battery.

To operate resistance decade, connect measuring terminals to the resistance meter being checked with cables. Set required value with the front panel rotary buttons.

4.5. Supplying from a power adapter

When supplying from a power adapter, the decade is not switched off automatically and the internal non-maintenance battery is recharged simultaneously. A green LED diode permanently indicates the decade switching on. The decade is switched off automatically when you disconnect the power adapter, according to the procedure described in chapter 4.3.

4.6. Connecting the decade

Considering the presumed high measuring voltage, it is necessary to give relevant attention, when connecting the decade to the checked instrument. For safety

reasons, always connect the ⊥ terminal to the grounding terminal of the supplying system. Connections to the decade terminals must always be both mechanically as well as electrically reliable in order that the electric circuit cannot be interrupted or completely mechanically disconnected during the measuring procedure, and thus it could create a possibility of electric injury.

It is always necessary to accept the maximum allowed input voltage, which is in the given configuration indicated by red LED diodes. Setting of values is performed with a delay of approximately 1s.

Recommended connection

- Two-terminals measuring

Decade M109R		***Isolation meter***
terminal H	-	terminal H
terminal L	-	terminal L
ground terminal *		

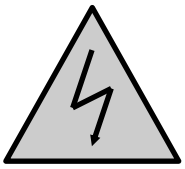
Note
If it is not excluded due to measuring method of tested isolation meter, it is recommended to connect ground terminal on resistance decade housing with ground terminal of power network or any other grounding point,

- Three-terminal measuring

Decade M109R		***Isolation meter***
terminal H	-	terminal H
terminal L	-	terminal L
ground terminal	-	shielding (GUARD)

WARNING:
When the decade is switched off, input terminals H and L are in state open.

When manipulating with resistance decade, realize that you are operating with device connected to dangerous high voltage.



!!! WARNING !!!

Before using the resistance decade, follow these instructions:

1. **Check the quality of a connection between terminals H, L.**
2. **Check the pre-defined resistance value relative to the value of applied voltage.**
3. **When measuring and manipulating rotary buttons, work with maximum caution – you are working with high voltage.**
4. **Connect measuring voltage only for the necessary time.**
5. **It is not allowable to leave the resistance decade unsupervised when measuring voltage is connected.**
6. **Before manipulation with measuring cables, check switching off of test voltage source.**

If you are not absolutely sure about the safety of the connection, do not touch operating elements or the instrument shield.

4.7. Calibration

Individual resistance elements are switched in binary code. Information about calibration data in positions 1, 2, 4, 8 of each individual decade is stored in an internal memory EEPROM. The internal software provides optimal organization of individual resistance elements with resolution of 1MΩ.

When calibrating a resistance decade, it is necessary to test all resistance points and with accuracy bellow described:

Calibrating points	Decade	Nominal value accuracy
1	x 1 MΩ	0.1% at 100 V
2	x 1 MΩ	0.1% at 100 V
4	x 1 MΩ	0.1% at 100 V
8	x 1 MΩ	0.1% at 100 V

Calibrating points	Decade	Nominal value accuracy
1	x 10 MΩ	0.2% at 1000 V
2	x 10 MΩ	0.2% at 1000 V
4	x 10 MΩ	0.2% at 1000 V
8	x 10 MΩ	0.2% at 1000 V

Calibrating points	Decade	Nominal value accuracy
1	x 100 MΩ	0.5% at 1000 V
2	x 100 MΩ	0.5% at 1000 V
4	x 100 MΩ	0.5% at 1000 V
8	x 100 MΩ	0.5% at 1000 V

Calibrating points	Decade	Nominal value accuracy
1	x 1 GΩ	1.0% at 1000 V
2	x 1 GΩ	1.0% at 1000 V
4	x 1 GΩ	1.0% at 1000 V
8	x 1 GΩ	1.0% at 1000 V

Ref. temperature 23 °C

If any of the checking points does not match the specification, contact the manufacturer.

4.8. Performace verification test

Parametr verication procedure is described in the chapter. Verification procedure is based on measuring resistance in recommended points.

Required equippment

Calibrator voltage 100V –1000V DC accuracy 0.01% (type M140, M142), multimetr with range of DC current 100nA – 100uA accuracy 0.01%-0.1% depends on range (type HP3458).

Procedure

Use following procedure to perform parametr verification test.

1. Disconnect the power supply adapter from the decade. Use the internal battery.
2. Connect the H terminal of the decade to the H terminal of the calibrator. Connect the L terminal of the decade to the H terminal of the multimeter. Connect the L terminal of the multimeter to the L terminal of the calibrator. Set the multimeter to the current DC mesurement.
3. Case of decade schould be grounded or connected to the L terminal of multimeter.
4. Switch both instruments on and let them for 1 hour stabilise in the laboratory with ambient temperature 23±1 ^{o}C.
5. Repeat the test for all points in the table below. The resistance value is calculated as:
   $R = (U_K – U_A) / I_A$
   Where:
   U_K is voltage set on the calibrator
   U_A is drop of voltage on the multimetr (not important for most measured points)
   I_A is current measured with multimetr

Maximal deviations M-109R

Nominal value [MΩ]	Max.deviation [Ω]	Voltage [V]
1	1 k	100
2	2 k	100
4	4 k	100
8	8 k	100
10	20 k	1000
20	40 k	1000
40	80 k	1000
80	160 k	1000
100	500 k	1000
200	1 M	1000
400	2 M	1000
800	4 M	1000
1000	10 M	1000
2000	20 M	1000
4000	40 M	1000
8000	80 M	1000

4.9. Remote control

Parameters of serial link are fixed as follow:

transmission speed 1200 Bd
number of data bits 8
number of stop bites 1
parity not used

For data flow operation neither hardware handshake (RTS/CTS) nor program handshake (XON/XOFF) is used, however the presence of operating signals is necessary for correct voltage levels on the TXD data signal leading from the decade. Communication between the computer (PC) and the instrument runs in a periodic exchange of the command-response type. A command is always an upper case letter followed by an alternative parameter without a space and ended by the CR symbol, again without a space. The instrument response is always ended by the operating symbol CR (\r). The serial interface of the instrument requires signals RXD, TXD, RTS (static on level -3 through -12V), DTR (static on level +3 through +12V) and GND.
Serial line cable connects pins of relevant numbers of both connectors (connection 1:1).

Example of initialization of a serial line COM1 and setup of operating signals for operating the M-109 decade in the BASIC language is shown:

```
10 OPEN "COM1:1200,N,8,1,RS,CD,DS,CD" FOR RANDOM AS #1
```

List of commands

I - instrument identification - reading the serial number xxx (response of the instrument is for example „65xxx1\r“)

K - reading the controllers status, it is set for example 110 MOhm – the response is a five-digit integer number corresponding to the set value in MOhm, e.g. „00110\r“

Lx - L0 - remote control - the resistance value is determined by the last Rx command on the serial line RS232
- L1 - local control - the resistance value is given by the position of rotary controllers (switches) on the front panel of the instrument

M - reading the maximum allowed voltage [V] for the given setup, the response is a four-digit integer, e.g. „5000\r”

Px - P0 - disconnection of the battery (if external supplying is not connected, the instrument is switched of by this command)

Rx - setting the resistance value x on the instrument (x is a whole non-negative number within the range 0 to 15000 without a space, corresponding to the required resistance value in MOhm, e.g. „R10000\r”

V - reading the set decade resistance, the instrument response is a 5-digit integer number corresponding to the resistance value in MOhm, e.g. „12000\r”

S - version of internal SW

The response of M-109 when received an unknown command is the string "?\r“. A correctly executed command is confirmed by "ok\r. Commands must be ended by the CR symbol (\r,\0x0d). The program is case sensitive.

Demo program

A simple operating program is supplied with the decade in order to provide easy operation of the decade from the computer, and to check the RS-232 line of the instrument. The installation CD ROM contains a program (for WIN95/98/NT/ME/2000/XP/Vista only), you can communicate with the instrument through standard serial line with. For example, you can read a value pre-defined on switches from the decade and, conversely, from the computer you can set any value (within range of the instrument).

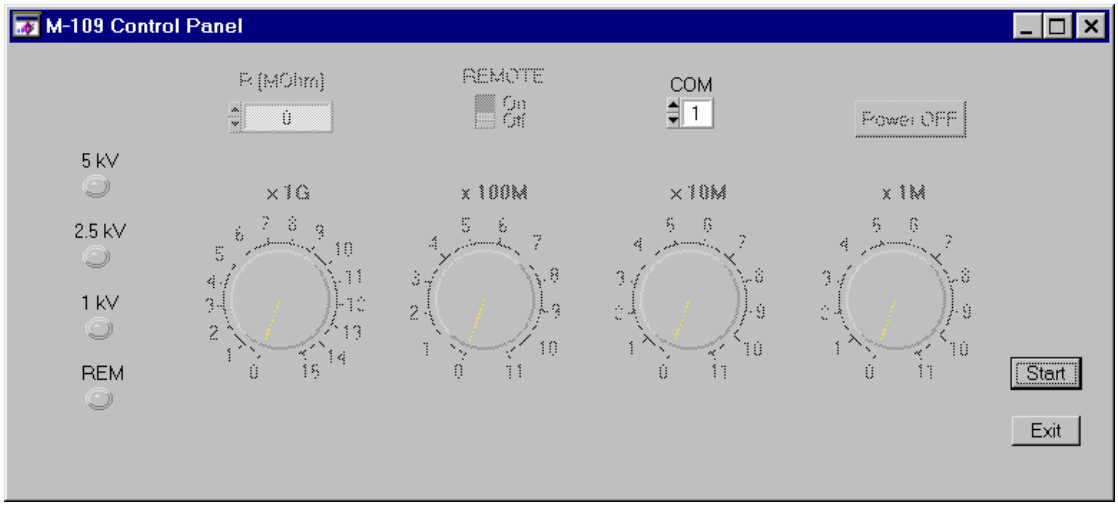
When using remote control, the value set on individual switches does not correspond to the actual decade resistance value – the resistance value is corresponding to the value setup through the RS-232.

Installing the program

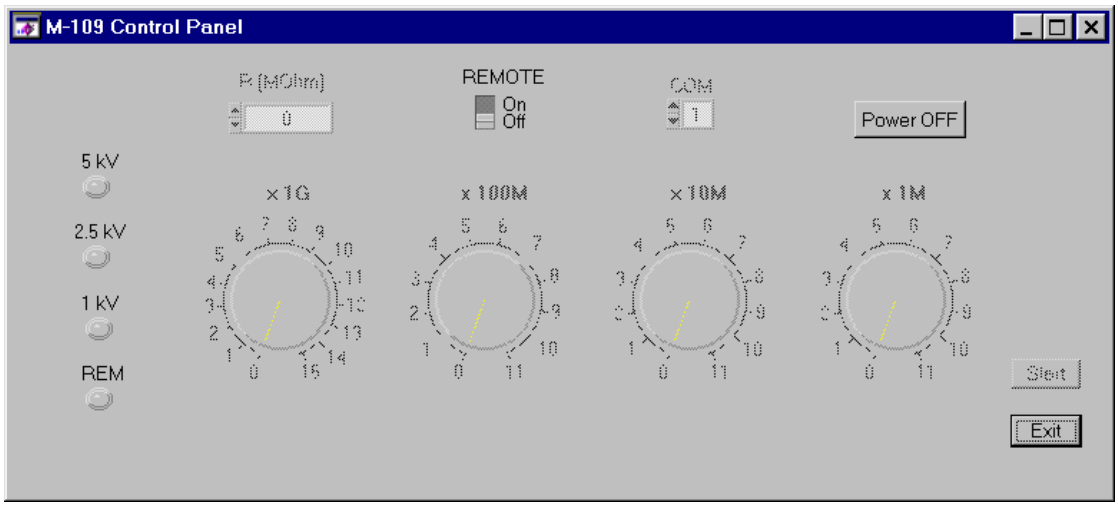
Insert the software CD into your CD ROM drive. Wait for autorun and select "Software installation" and "M109" or start direct „install\freeware\M109\en\setup.exe". When you launch SETUP.EXE, the installation program asks for the destination directory and executes the actual installation. The UNINST.EXE program is also copied into the selected directory for alternative delete of the directory from the system.

Program description

When you launch M190 program, following control panel is displayed on the screen.



First use the operating element COM to select a serial port number to which the instrument is connected. Check if slide button REMOTE is in position OFF and confirm this selection using the START button. If the instrument is found on the serial line, actual instrument setup is read periodically and the setup of rotary buttons on the screen correspond to the setup on the instrument.

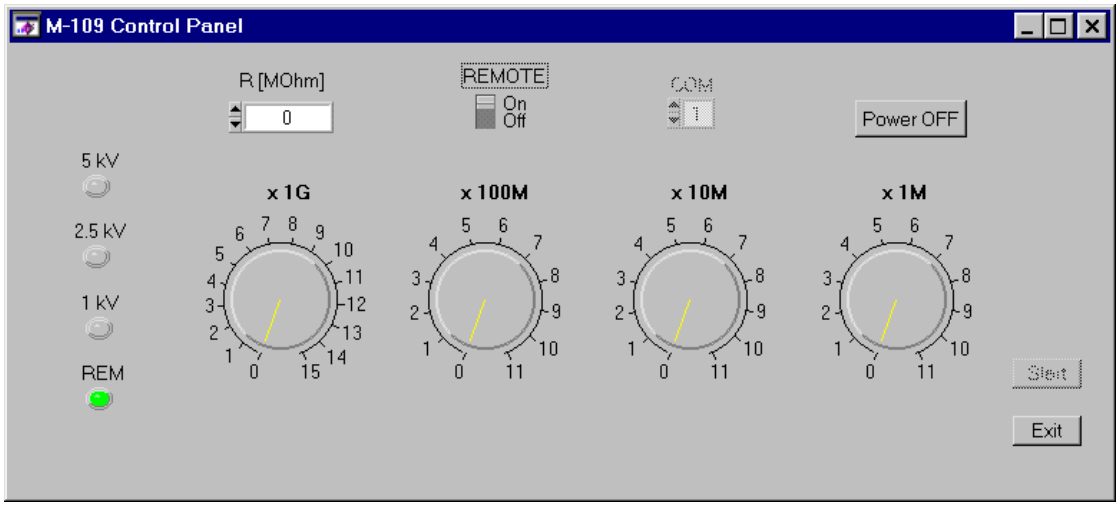


The light of indicating elements on the left-hand part of the screen is corresponding to LED diodes on the instrument panel. Rotary buttons on the control panel are displayed like “enable”. They are only indicators of the real switches setup position on the front panel of the instrument now.
If the instrument is not switched on or connection is incorrect or the instrument is connected on a different port, the program is terminated after sending error message.

When you switch the operating element REMOTE to the ON position, the signal diodes REM on both the instrument as well as on the control panel are switched on, and the setup resistance value can be set from the control panel on the computer screen. It is possible in several ways:

Using the mouse:
- Place the mouse cursor on any rotary button now fully displayed on the screen and press and hold the left mouse-button to rotate the button
- Place the mouse cursor on a small black up arrow (or down arrow) located to the left from the numeric resistance value, press and hold the left mouse-button to increase or decrease the setup resistance value.

From the keyboard:
- Select a field containing a numeric resistance value (using the mouse or the TAB or SHIFT TAB keys). Enter a resistance value directly and confirm this value using the ENTER key
- Select a field containing a numeric resistance value (using the mouse or the TAB or SHIFT TAB keys) and press the up (down) arrow keys to increase (decrease) the resistance value by steps of 1 MOhm
- Select appropriate rotary button (using the mouse or the TAB or SHIFT TAB keys) and press the up (down) arrow keys to increase (decrease) the resistance value in steps corresponding to the given button (only within the limits of each decade).



When supplying from a battery, you can switch off the instrument from the control panel by pressing the OFF button. This will break communication between the computer and the instrument.

You can end the program at any time by pressing the QUIT button.

4.10. Maintenance

Although the decade contains mechanical switches, it does not require any special cleaning. Keep output terminals and ERTALYTE grommets absolutely clean. Recharge the internal battery if necessary. Frequency of recharging depends on the proportion of operating the decade in the mode when it is supplied from the internal battery or from a power adapter. If the battery is discharged and the decade was switched off automatically, it is recommended to recharge battery for approx. 10 hours. If the battery is recharged properly, you can operate the decade without a power adapter for 3-8 hours depending on the set resistance value and the number of switching on high-voltage relays. The current consumption of the decade is lowest when the resistance value is set to 0 MOhm.

5. Description of electrical construction

Individual resistors are connected in a binary code using high-voltage relays. Relay board with individual resistors which are placed on Teflon grommets, forms a separate construction unit. Resistors are submitted to temperature cycles and strict selection of accuracy of both the nominal value as well as temperature coefficient. The value of the setup resistance is defined between output terminals. The metal-enclosed case is connected only to the GND terminal.

The CPU unit with a one-chip computer control decade operation and communication through the RS-232.

6. Mechanical construction

High resistance decade M - 109R is placed in a standardized metal case made from aluminum alloys. Rotary buttons and input terminals are placed on the front panel. The end position of switches is locked. PCB with high-voltage relays and resistors is placed in a separate build-in metal case, which is connected to the ⊥ terminal. The CPU board is mechanically connected to the relay board, and thus they form a joint assembly unit. On the rear panel you is situated ON/OFF button, supplying connector for power adapter connecting and RS 232 connector. Internal battery is also mechanically attached to this panel.

6.1. Exchanging the battery

When exchanging the battery, you must disconnect the power supply and the RS 232 cable. Unscrew the 4 screws in the corners of the rear panel and tip the panel out together with the battery. Then disconnect connectors of the battery and release the lug that secures the battery mechanically. Exchange the battery and execute its mechanical and electrical installation following a reverse procedure.

Manufacturer

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CE Certificate of conformity

MEATEST, spol. s r. o., manufacturer of M-109R High Resistance Decade, based in Železná 3, 619 00 Brno, Czech Republic, declares that its product conforms to following specifications:

Safety requirements

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

Electromagnetic compatibility

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

Brno	September 25th, 2020	
Place	Date	Signature