

M-192

AC/DC Resistance Load

Operation manual

MEATEST



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1. Use of the instrument

AC/DC Resistance Load M-192 is programmable resistance decade in range 15.000 Ohm to 300 kOhm. It is designed as power resistance decade (3000W) for testing AC/DC power sources, transformers or generally as resistance load. Set resistance value is created via appropriate combination of physical resistors. Actual set values are displayed on the front panel display. M-192 is sophisticated instrument with its own re-calibration procedure. The procedure enables to correct any deviation in resistance without any mechanical adjusting.

Instrument is especially suitable for automatic testing procedures. RS232 line (optionally IEEE488 bus) is used for connecting decade to the computer.

2. Contents of delivery

AC/DC Resistance Load M-192

User's manual

Power cable

Test leads 2 pcs

Test report

3. Preparation for use

The instrument should be powered by 100 ... 240 V – 50/60 Hz mains. Before powering on the instruments, place it on a level surface. Do not cover the vents at the bottom/top sides and the fan opening at the rear panel. Parameters of this instrument are guaranteed at 23 ± 5 °C.

3.1. Power-on

- 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 front panel. Display is lit.
- The resistance load performs internal hardware checks for 5 seconds. Configuration of the instrument is displayed in the end of this test (version M-192 or M-192A).



- After the tests conclude, instrument resets to its reference state, i.e. the following parameters are set:

Function	Resistance
Set value	100 Ω
Output terminals	OFF

3.2. Replacement of fuse

Resistance load includes a fuse located near the mains connector at the rear panel. Replace the fuse as follows:

- Switch off the instrument
- Remove the end of power cord from the mains connector at the rear panel.
- Release the fuse using flat screwdriver and pull out the fuse holder.
- Remove the fuse and replace it with new fuse of the same rating.

3.3. Safety precautions

The instrument has been designed in Safety Class I according to EN 61010-1. The design reflects the requirements of A2 amendment of the standard.

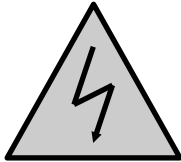
Safety is ensured by the design and by the use of specific component types.

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

Safety symbols used on the equipment



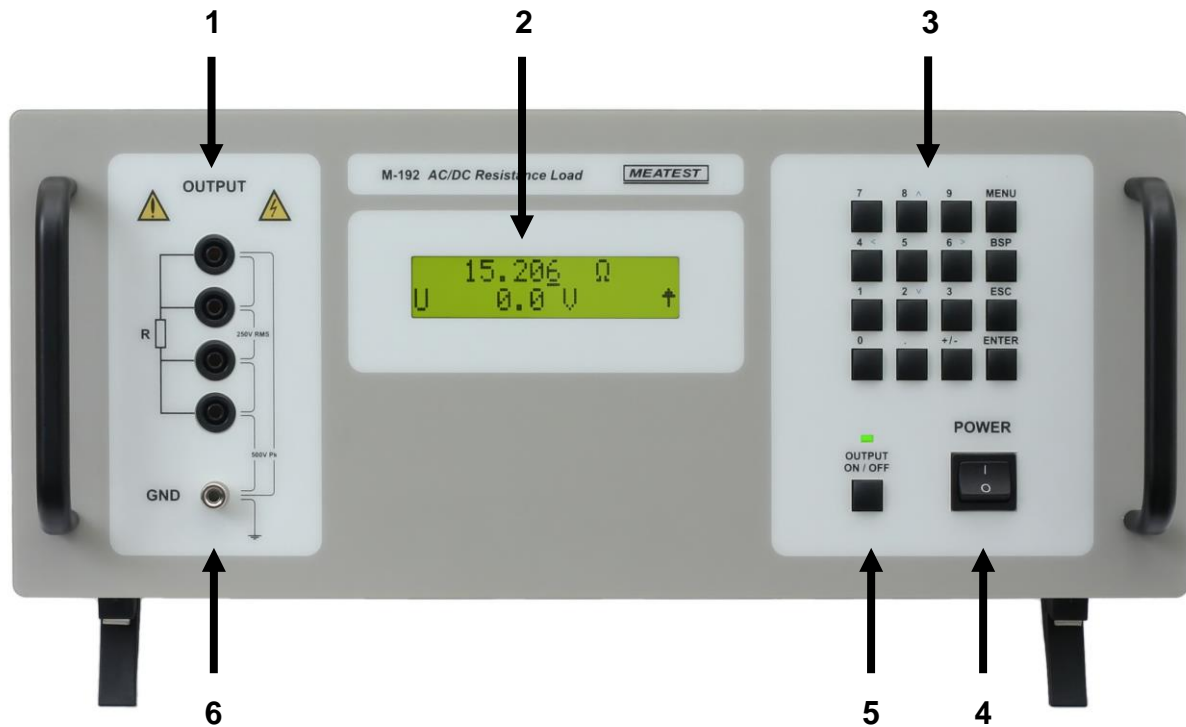
Warning, reference to the documentation



Warning - risk of electric shock

4. Description

4.1. Front panel



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

1. Output terminals

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

2. Display

Two-row alphanumeric display is used for displaying all information. Main value, i.e. simulated output resistance is displayed in upper row. In the lower row measured voltage connected to the output terminals (M-192A only) is displayed.

Auxiliary information is displayed in lower row. Depending on status following symbols can be displayed in right low corner:

† keys 2, 4, 6 and 8 are switched to the cursor keys function (blue labels are valid)

☒ load is in remote control via RS232 (IEEE488 optionally)

3. *Keyboard*

Numerical values can be entered from the numerical part of keyboard. Keys with number 2, 4, 6, 8 have also next meaning as display cursor keys. Except numerical there are following keys in the keyboard:

<i>Key</i>	<i>Meaning</i>
MENU	enters to the SETUP/CALIBRATION MENU.
BSP	deletes last entered number.
ESC	Cancels last entered value, cancels cursor keys function or leaves last set mode
ENTER	confirms set value or confirms selected item in MENU or activates cursor keys function. Cursor key function is indicated with symbol (↑) in right low corner of the display.

4. *Power switch*

Turns instrument AC power ON and OFF.

5. *Output On/Off*

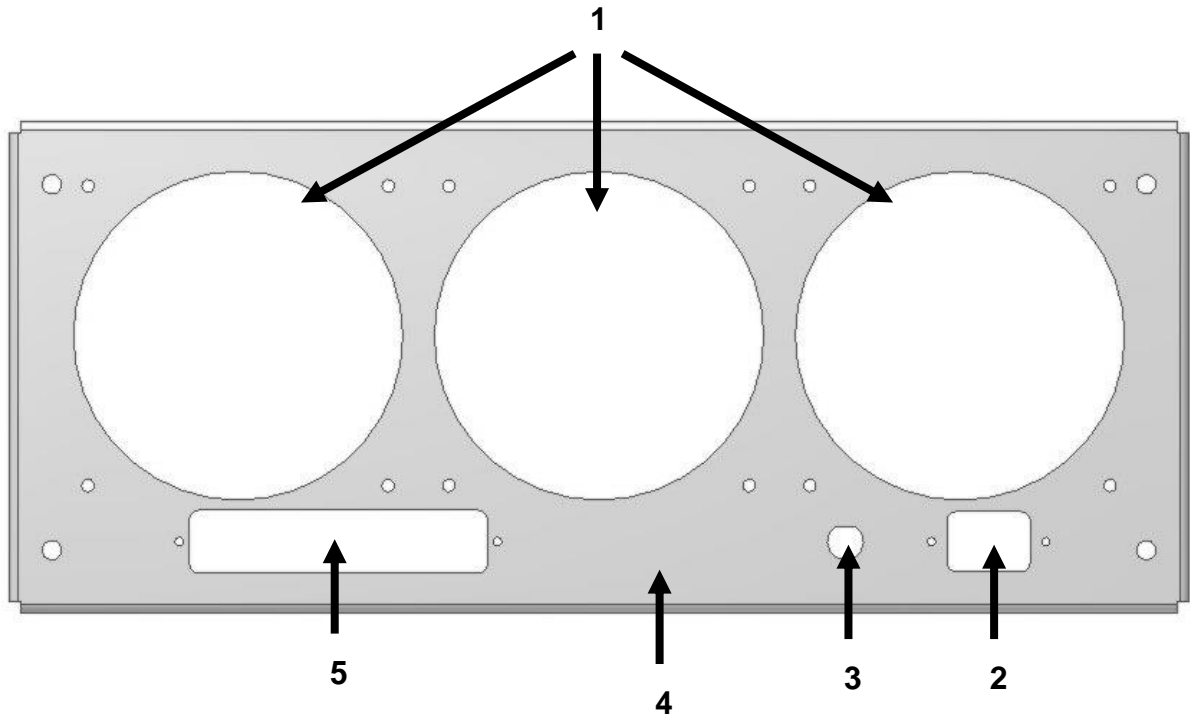
Connects (disconnects) selected resistance to the output terminals. Connected output is indicated with green LED.

6. *Central ground terminal*

Terminal with symbol “GND” is connected with the housing (PE).

4.2. Rear panel

On the rear panel there are located power supply connector, interface RS-232 connector (optionally IEEE488 connector) and serial number plate.




- 1 forced ventilation holes
- 2 power line entry
- 3 power line fuse
- 4 model plate
- 5 RS-232 (IEEE488) connectors

5. Operation

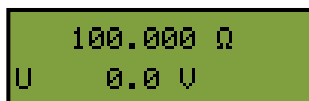
5.1. Standard mode

After switching on load comes to standard mode. Following information is shown on the display:



99.982 Ω

M-192 version



100.000 Ω
U 0.0 V

M-192A version

In the upper row generated resistance in [Ω] is displayed. In the lower row measured voltage connected to the output terminals (M-192A only) is displayed.

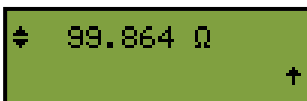
New resistance value can be set using cursor keys or direct via numeric keyboard. Cursor keys are active after pressing ENTER key. Numeric keyboard is active after pressing ESC key.

Use of cursor keys

Cursor keys are active after pressing ENTER key.

Function of cursor keys depends on the version of the load:

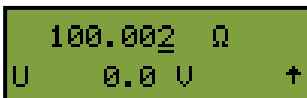
M-192 (basic version)



⊕ 99.864 Ω ⊕

There is certain number of different resistance values (64) in range 15.000 to 4700 Ω . Cursor keys \uparrow \downarrow switch between these discrete values and increase or decrease resistance value. Cursor keys \leftarrow \rightarrow are not used.

M-192A (full version)



100.002 Ω
U 0.0 V ⊕

Any value in range 15.000 Ω to 300 k Ω can be set. Cursor keys \uparrow \downarrow increase or decrease resistance value. Cursor keys \leftarrow \rightarrow change the cursor position.

Numerical keyboard

Numeric keys are active after pressing ESC key.

New resistance value can be entered directly using numeric keys. New value is settled after pushing ENTER key. BSP key deletes last entered number.

M-192 (basic version)

```
<100.2 > Ω
```

M-192A (full version)

```
<100.2 > Ω
U 0.0 U
```

5.2. Setup mode - Basic rules

In the Setup mode can be changed parameters of the resistance load. Parameters are stored in EEPROM memory.

Setup menu is organized as tree type structure. Meaning of keys is:

- „↑“, „↓“ - parameter selection
- „ENTER“ - confirmation of selected parameter
- „ESC“ - return one level back

Parameter's value is displayed in square brackets – [50.652] Ω. In this mode is not possible to change displayed value. Parameter should be switched to the edit mode. Edit mode is entered after pressing „ENTER“ key. The parameter in edit mode is displayed between marks „<” and „>” - < 50.652> Ω. In case parameter can't be switched to edit mode you should use password with higher access level – vide infra.

5.3. Setup mode

Access to the Setup mode is enabled after pushing the “ENTER” key from the Standard mode.

```
SETUP MENU
+Instrument +
```

6.3.1. Load configuration (Instrument)

Item serves for configuration of instrument's output. After pushing “↓” key next item (“General”) is selected. After pushing “ENTER” key following menu is displayed:

6.3.1.1. Simulated function (Function)

This item is available only in M-192A (full version). Load can simulate:

- a) Resistance – constant resistance mode. Load simulates required resistance in [Ω].
- b) Current – constant current mode. Load measures voltage connected to the R terminals and sets output resistance according to the formula $R = \text{Measured voltage} / \text{Required current}$. This resistance can be automatically refreshed (recalculated) according to the state of “C/P refresh” parameter.

- c) Power – constant power mode. Load measures voltage connected to the R terminals and sets output resistance according to the formula $R = (\text{Measured voltage})^2 / \text{Required power}$. This resistance can be automatically refreshed (recalculated) according to the state of “C/P refresh” parameter.

6.3.1.2. Refresh cycle for Current and Power function (C/P refresh)

This item is available only in M-192A (full version). Item defines method of regulation the output in Current and Power function. One of following modes can be selected:

- a) Off –calculated resistance is not changed.
- b) One time – calculated resistance is changed one time.
- c) 5 s – calculated resistance is changed (stabilized) 5 seconds after switching output On.
- d) 10 s – calculated resistance is changed (stabilized) 10 seconds after switching output On.
- e) 30 s – calculated resistance is changed (stabilized) 30 seconds after switching output On.
- f) Continually – calculated resistance is changed (stabilized) if measured value (current or power) differs from required more than “C/P – dev.” %. Allowed deviation is defined in “C/P dev.” parameter.

6.3.1.3. Deviation limit for Current and Power function (C/P dev.)

This item is available only in M-192A (full version). Item defines maximal deviation for Current or Power in “Continually” refresh mode. Output value is refreshed if measured deviation is higher. Any value in range 0.1 % to 10.0% can be entered.

6.3.1.4. Output On/Off switching mode (Output switch.)

Parameter defines how is the output of the load connected and disconnected. One of following modes can be selected:

- a) Random-Fire –load is connected or disconnected immediately after pushing OUTPUT ON/OFF key. This type of output switching is fastest.
- b) Zero-Crossing – load waits after pushing OUTPUT ON/OFF key for zero cross of connected voltage (100ms timeout). This type of output switching reduces produced electromagnetic noise.

6.3.2. General settings (General)

General instrument’s settings are in this item. After pushing “↑” key previous item (“Load“) is selected. After pushing “↓” key next item (“Protected“) is selected. After pushing “ENTER” key following menu is displayed:

6.3.2.1. Beeper setting (Beeps)

Configuration of generating sounds is in this item.

6.3.2.1.1. Keyboard beep (Keyboard)

One of following items can be selected:

- a) Off – no sound is generated after pushing the key.

b) On – short beep is generated after pushing the key.

6.3.2.1.2. Other beeps (Others)

Sounds produced by the instrument (except of keyboard) can be switched:

a) Off – no sound is generated

b) On – sound is generated

6.3.2.2. Display setting (Display)

Configuration of display is in this item.

6.3.2.2.1. Display backlight (Backlight)

Item enables to set the backlight of the display. One of following items can be selected: (Low , High).

6.3.2.2.2. Message display time (Message time)

Item enables to set the message display time. One of following items can be selected: (Normal, Long).

6.3.2.3. Passwords setting (User access)

Item enables to set user passwords.

6.3.2.3.1. Calibration access password (Cal. password)

Item enables to set five digits password for access level “Calibration”.

6.3.2.3.2. Service access password (Srv. password)

Item enables to set five digits password for access level “Service”.

6.3.2.4. Language (LANGUAGE)

Item enables to set the language. You can select one of following items: (English, Cesky, Deutsch).

6.3.2.5. Device information (INFO)

Item enables to read out device internal information.

6.3.2.5.1. Serial number (Serial number)

Function displays instrument’s serial number as ‘xxxxxx’ (six digits).

6.3.2.5.2. Firmware version (FW version)

Function displays internal firmware version.

6.3.2.6. Interface setting (Interface)

6.3.2.6.1. RS232 parameters (RS232 Baud Rate)

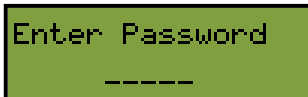
Item is available only for RS232 version. Item enables to set the baudrate. You can select one of following baud rates: 1200, 2400, 4800, 9600 and 19200.

6.3.2.6.2. IEEE488 address (IEEE488)

Item is available only for IEEE488 version. Item enables to set the IEEE488 address. You can select any integer value in range 1...30.

6.3.3. Protected area (Protected)

Protected settings (calibration constants and service settings) are in this item. Correct password should be written before entering protected area. M-192 has two access levels for protected



parameter's setting:

- **Calibration (calibration laboratory)**, default password is "00000" and can be changed by the user
- **Service (only for authorized service)**

Access level is defined by used password.

After pushing "↑" key previous item ("General ") is selected. After pushing "ENTER" key following menu is displayed:

6.3.3.1. Calibration constants (Calibration)

All calibration constants are store in internal eeprom.

6.3.3.1.1. Resistance values (R constant)

In this menu resistance elements of the load can be recalibrated. Complete recalibration procedure consists of measuring of 24 resistance values and entering their actually measured values. Detailed description of calibration procedure is in chapter "Calibration".

6.3.3.1.2. Internal voltmeter (Voltage)

In this menu internal voltmeter can be recalibrated. Complete recalibration procedure consists of adjusting of 4 calibration points. Detailed description of calibration procedure is in chapter "Calibration".

6.3.3.2. Service setting (Service)

Item is available only for service department after entering service password.

6.3.3.2.1. [Internal state reading \(View\)](#)

In this item can be displayed following information:

Fan speed: speed of fans.

Temp. heat sink: temperature of internal heat sinks.

Temp. others: temperature of frame and temperature of internal air.

CPU firmware: version of main CPU FW.

RE firmware: version of auxiliary CPU FW.

6.3.3.2.2. [Temperature sensors calibration \(Temp. calibr.\)](#)

In this item can be adjusted offset of all internal temperature sensors (Real temp 1, Real temp 2, Real temp 3, Real temp 4, Real temp 5, Real temp 6, Real temp 7).

6. Calibration

In this mode resistance elements of the decade and voltmeter (M-192A only) can be recalibrated. Access to the calibration mode is enabled after entering correct password. Please see chapter “Protected area” how to enter (modify) calibration password. Calibration parameters are stored in EEPROM memory.

6.1. Resistance calibration

In Resistance calibration mode can be changed parameters of the resistance load. For calibration is required ohmmeter with ranges 10 Ω ... 200 M Ω and required accuracy.

Table contains nominal values of calibration points and required recalibration accuracy:

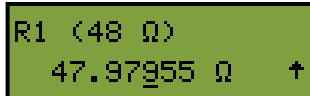
Standard	Nominal value	Required Accuracy
R1	48 Ω	10 m Ω
R2	50 Ω	10 m Ω
R3	75 Ω	15 m Ω
R4	150 Ω	20 m Ω
R5	300 Ω	40 m Ω
R6	600 Ω	80 m Ω
R7	1200 Ω	150 m Ω
R8	2400 Ω	300 m Ω
R9	4700 Ω	600 m Ω
R10	9220 Ω	1 Ω
R11	18.2 k Ω	2 Ω
R12	35.2 k Ω	5 Ω
R13	69.3 k Ω	10 Ω
R14	136 k Ω	20 Ω
R15	267 k Ω	40 Ω
R16	522 k Ω	100 Ω
R17	1030 k Ω	500 Ω
R18	2020 k Ω	1 k Ω
R19	3990 k Ω	2 k Ω
R20	7900 k Ω	10 k Ω
R21	15.7 M Ω	50 k Ω
R22	30 M Ω	200 k Ω
R23	60 M Ω	500 k Ω
R24	120 M Ω	2 M Ω

Note: **M-192** (basic version) contains resistance values R1...R9 only. **M-192A** (full version) contains all resistances (R1...R24).

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

- Set the first calibration point (resistance element). Use keys \uparrow \downarrow to select the element.

- Press ENTER key to confirm selected resistance.
- Press OUTPUT ON key to connect selected resistance to the output terminals.
- Measure resistance of the selected element. Use ohm-meter with appropriate accuracy in 4-wire connection.
- Change mode of keyboard to cursor mode by pushing the ENTER key.
- Change calibration value of selected resistance if needed.



R1 (48 Ω)
47.97955 Ω †

- Confirm new calibration data by pushing ENTER key or leave without changes by ESC key.
- Repeat above described procedure for all resistance elements.

6.2. Voltmeter calibration (M-192A version only)

In Voltmeter calibration mode can be changed parameters of internal AC/DC voltmeter. For calibration is required voltage calibrator with ranges up to 250V and required accuracy. Alternatively can be used voltage source and accurate voltmeter.

Table contains nominal values of calibration points and required recalibration accuracy:

Calibr. point	Nominal value	Required Accuracy
<i>U DC pos</i>	<i>100 V</i>	<i>10 mV</i>
<i>U DC neg</i>	<i>-100 V</i>	<i>10 mV</i>
<i>U AC low</i>	<i>50 V</i>	<i>25 mV</i>
<i>U AC high</i>	<i>250 V</i>	<i>100 mV</i>

Calibration procedure:

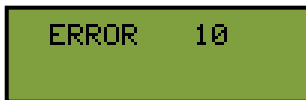
- Set the first calibration point (U DC pos).
- Press ENTER key to confirm selected point.
- Connect the voltage calibrator to the load (R terminals) and set the output value +100V dc.
- Change mode of keyboard to cursor mode by pushing the ENTER key.
- Change exact value of connected DC voltage. It should be close to the nominal value (+/- 10%).
- Confirm new calibration data by pushing ENTER key or leave without changes by ESC key.
- Repeat above described procedure for all calibration points.

7. Error messages

If an error occurs during the loads's operation or control, error message is displayed on the display. Errors can be caused by:

- Incorrect control using the front panel, i.e. attempts to force a prohibited mode, e.g. setting an out-of-range value, overloading of output terminals etc.,
- Calibrator's fault.

Sample error message which appears is shown bellow.



The following table lists all error messages, their meaning and simple troubleshooting.

<i>Error message</i>	<i>Description</i>
WARNING: Temperature over	Load overheated. Disconnect external source. Ambient temperature is too high or forced ventilation holes are blocked.
WARNING: Fanner blocked	Fan does not work. Forced ventilation is blocked.
ERROR xx	Internal error. Turn the load off and after 5 s turn on. If the error will appear again, contact manufacturer.

8. Performance verification test

This chapter describes how to verify parameters of the instrument. Verification procedure is based on measuring resistance on the load output terminals with standard multimeter in recommended points.

Required equipment

- Ohm-meter nominal accuracy 0.01% in range 10 Ω to 300 k Ω (type Agilent 34401A or similar)

Load setting

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

Range of the test

- output resistance on terminals R4W checking

Procedure

Use following procedure to perform parameters verification test.

1. Switch both instruments on and let them for 1 hour stabilise in the laboratory with ambient temperature 23 ± 2 °C. Connect resistance decade terminals R4W to the standard ohm-meter (multimeter).
2. Check resistance value in points according to Table I, for M-192A (full version) also according to Table II

Table I. M-192 (all versions) maximal deviations

Nominal value [Ω]	Max. deviation [$m\Omega$]
15.000	45
50.000	80
100.000	100
600.00	600
1200.0	1200
4700.0	4700

Table II. M-192A (full version) maximal deviations

Nominal value [k Ω]	Max. deviation [Ω]
10.00	10
30.00	30
100	200
300	1500

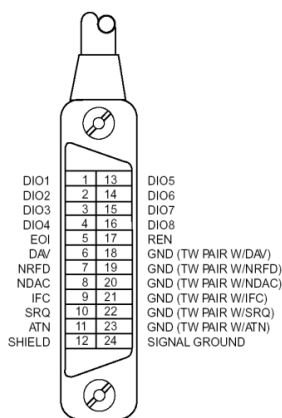
9. System control

The load is equipped with RS232 serial line as standard. IEEE-488 bus is optional. System connectors are located at the rear panel. For the remote control to work properly, interface parameters must be set in the system menu. For RS232 line communication speed can be set (1200 to 19200 Bd). For IEEE-488 bus, an address from range 0 to 30 is allowed. The calibrator can be only controlled by one of interfaces at a time. It is therefore necessary to select one of the interfaces (RS232/IEEE488) using the system menu.

9.1. IEEE-488 bus properties

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

SH1, AH1, T5, L3, RL1, DC1, SRI



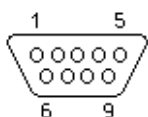
The instrument also recognizes the following general commands:

- DCL Device Clear reset the calibrator
- SDC Selected Device Clear reset the calibrator
- EOI End or Identify Message Terminator close the message
- GTL Go To Local close remote control mode
- LLO Local Lock Out local control locked

9.2. RS232 serial line setting

To transfer the data using RS232 bus, 8N1 data format is used, i.e. each data word includes 8 bits, no parity and one stop bit. The communication speed can be set using the system menu. Available values: 1200, 2400, 4800, 9600 and 19200 Bd.

RS-232 connector layout



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

9-pin connector D-SUB FEMALE

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

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

Note:

It is not possible to send or receive data over RS232 when the calibrator is not in remote mode. You should use the command `SYST:REM` or `SYST:RWL`.

9.3. Command syntax

The commands described in this chapter can be issued through all buses (RS232/IEEE488).

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. `:SAF:LR 100.5;;OUTP ON`

Note (only for RS232): Each command must end in <cr> or <lf>. Both codes <cr> can be used at the same time. The instrument performs all commands written on one line of the program after it receives <cr>, <lf> or <cr><lf> code. Without this code, the program line is ignored.

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. {ON | OFF | 0 | 1}.
- <SPD> = String Program Data. String value consisting from more parts. It is used for date/time setting.
- ? = 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.

OUTPut subsystem

This subsystem enables to activate or deactivate the instrument output.

Keyword	Parameters
OUTPut	
[:STATe](?)	<CPD> { ON OFF }
:SYNChronization(?)	<CPD> { ON OFF }

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

This command activates or deactivates output terminals.

- ON - activates the output
- OFF - deactivates the output

If query is sent, calibrator returns ON if the output is active or OFF if it is inactive.

Example: OUTP ON - activates the output
OUTP? - the instrument returns ON or OFF

OUTP:SYNC(?) <CPD> { ON | OFF }

This command how is the output of the load connected and disconnected.

- OFF – without synchronization to the input signal
- ON – synchronized zero crossing output connection/disconnection

If query is sent, instrument returns ON or OFF according to selected synchronization mode.

Example: OUTP:SYNC OFF selects output switching without synchronization to the input signal
OUTP:SYNC? Calibrator returns ON or OFF

FUNCTION subsystem (M-192A only)

This subsystem sets function of the load.

Keyword	Parameters
FUNCTION?	<CPD> { RES POW CURR }

[FUNCTION]	
:RESistance (?)	<DNPd>
:POWer (?)	<DNPd>
:CURRent (?)	<DNPd>

FUNC(?) <CPD> { RES | POW | CURR }

This command sets the output function of the load.

- RES - constant resistance output function. Load simulates required resistance in [Ω].
- POW – power output function.
- CURR – current output function.

If query is sent, calibrator returns active output function.

Example: FUNC RES – sets resistance output function
FUNC? - the instrument returns RES, POW or CURR

[FUNC:]RES(?) <DNPd>

This command sets the output resistance value.

<DNPd>

Parameter represents the value of the output resistance expressed in Ω .

If query is sent, calibrator returns the value of output resistance using standard exponential format. Example: 110.1 Ω is returned as 1.101000e+002.

Example:

Resistance 230.5 Ω :

 FUNC:RES 230.5

Note:

Command selects resistance output function.

[FUNC:]POW(?) <DNPD>

This command sets the output power value.

<DNPD>

Parameter represents the value of the output power expressed in W.

If query is sent, calibrator returns the value of output power using standard exponential format. Example: 1101 W is returned as 1.101000e+003.

Example:

Power 230W:

 FUNC:POW 230

Note:

Command selects power output function.

[FUNC:]CURR(?) <DNPD>

This command sets the output current value.

<DNPD>

Parameter represents the value of the output current expressed in A.

If query is sent, calibrator returns the value of output current using standard exponential format. Example: 2 A is returned as 2.000000e+000.

Example:

Current 2.5A:

 FUNC:CURR 2.5

Note:

Command selects current output function.

MEASure subsystem

This subsystem allows controlling the internal multimeter.

Keyword

Parameters

MEASure

 :VOLTage?

 :CURRent?

 :POWer?

MEAS:VOLT?

This query returns value measured by the voltmeter.

Example: MEAS:VOLT? Instrument returns measured value

MEAS:CURR?

This query returns value measured by the voltmeter and converted to current.

Example: MEAS:CURR? Instrument returns measured value

MEAS:POW?

This query returns value measured by the voltmeter and converted to apparent power.

Example: MEAS:POW? Instrument returns measured value

CONFigure subsystem

This subsystem allows setting instrument's basic parameters.

Keyword

Parameters

CONFigure

:REFResh(?)	<CPD> { OFF 1x 5x 10x 30x CONT }
:DEViation (?)	<DNPD>

CONF:REFR(?) <CPD> { OFF | 1x | 5x | 10x | 30x | CONT }

This command defines method of regulation the output in Current and Power function. One of following modes can be selected:

- OFF –calculated resistance is not changed.
- 1x – calculated resistance is changed one time.
- 5s – calculated resistance is changed (stabilized) 5 seconds after switching output On.
- 10s – calculated resistance is changed (stabilized) 10 seconds after switching output On.
- 30s – calculated resistance is changed (stabilized) 30 seconds after switching output On.
- CONT – calculated resistance is changed (stabilized) if measured value (current or power) differs from required more than “C/P – dev.” %. Allowed deviation is defined in “C/P dev.” Parameter (command CONF:REFR:DEV)

If query is sent, instrument returns OFF, 1x, 5s, 10s, 30s or CONT according to selected multimeter method.

Example: CONF:VOLT OFF without refresh the output in current and power mode

CONF: DEV(?) <DNPD>

This command defines maximal allowed deviation for continual regulation in functions CURR (current) and POW (power).

<DNPD>

Parameter represents allowed deviation expressed in %.

If query is sent, calibrator returns the value of deviation using standard exponential format.

Example: 1 % is returned as 1.000000e+000.

Example:

Deviation 2%:

CONF:DEV 2

SYSTem subsystem

The subsystem enables to control various functions from the MENU.

SYSTem

:ERRor?
:REMote
:RWLock
:LOCal

SYST:ERR?

Query the instrument's error queue. Detected errors are placed in the queue. This query returns the first error from the queue. The queue is type “first in, first out”. The error is deleted after reading.

The response is in the form of 'String Program Data', and consists of two elements: a code number and error message.

If all errors are read calibrator returns message 0,"No Error".

In case of overflow the error queue the last error in the queue is -350,"Queue overflow". Also the earliest errors remain in the queue, and the most recent error is discarded.

Example:

SYST:ERR?

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.

SYST:REM

This command places the instrument in the remote mode for RS232 operation. All keys on the front panel, except the ESC (LOCAL) key, are disabled.

Note:

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

SYST:RWL

This command places the instrument in the remote mode for RS232 operation. All keys on the front panel are disabled.

SYST:LOC

This command returns the instrument in the local mode. This command is for RS232 interface only.

I/D (instrument identification)

***IDN?**

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

The reply is formatted as follows:

MEATEST,M-192,100002,1.22

Clear status

***CLS**

This command clears the Error Queue.

10. Electric function

Resistance elements are switched to the output terminals through relays in binary code system. The resistors are very stable power resistors with low temperature coefficient. Resistors are mounted on the heat sink. Metal housing is connected to the ground terminal (PE) only.

CPU unit with one-chip micro-controller generates all necessary internal control signals. Calibration data and set-up parameters are saved in EEPROM memory.

11. Specification

Only values, functions, ranges with signed accuracy in relative or absolute expression or where limits are specified, are guaranteed.

Resistance range *	:	15 Ω - 4700 Ω (basic version) 15 Ω - 300 k Ω (version M-192A)
Resolution	:	0.1 Ω to 1 Ω for M-192 version 0.001 Ω to 1 k Ω for M-192A version
Temperature coefficient	:	< 10 ppm/ $^{\circ}\text{C}$ (1 Ω - 10 k Ω) < 25 ppm/ $^{\circ}\text{C}$ (> 10 k Ω)
Maximal dissipation power	:	3000 W
Maximal voltage	:	250 Vrms
Connection of output terminals	:	2, 4 wire
Frequency range	:	0 (DC) to 10 kHz
Working mode	:	constant Resistance constant Power (simulation) constant Current (simulation)
Reaction time **	:	30 ... 100 ms
Terminals	:	instrument terminals diameter 4mm, gold plated
Interface	:	RS232 as standard (IEEE488 optionally)
Reference temperature	:	+18 $^{\circ}\text{C}$... +28 $^{\circ}\text{C}$
Working temperature	:	+5 $^{\circ}\text{C}$... +45 $^{\circ}\text{C}$
Storing temperature	:	-10 $^{\circ}\text{C}$... +60 $^{\circ}\text{C}$
Housing	:	metal
Dimensions	:	W 430 mm, H 190 mm, D 500 mm
Weight	:	15 kg

Isolation resistance between output terminals and housing : > 2 G Ω (at 500V DC)

* Basic version M-192 allows to select between 64 fixed resistance values. Nominal values of resistancis are 15.0, 15.5, 16.0, 16.5, 17.0, 17.5, 18.0, 18.5, 19.0, 19.5, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 180, 200, 220, 240, 270, 300, 340, 400, 480, 600, 680, 800, 960, 1200, 1590, 2400 and 4700 Ω

** 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.
- During over-switching, resistance circuit is opened for a period about 40 ms.

12. Accuracy

Specified accuracy is valid after 10 minutes warm up in temperature range 23 ± 5 °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.

Resistance accuracy (M-192A only up to 4700 Ω)

Range	Accuracy
15.000 Ω - 99.999 Ω	0.1 % + 30 mΩ
100.000 Ω - 3.000 kΩ	0.1 %
3.001 kΩ - 30.00 kΩ	0.1 %
30.1 kΩ - 100.0 kΩ	0.2 %
101 kΩ - 300 kΩ	0.5 %

Internal voltmeter (M-192A only)

Range	Accuracy	
	DC	AC
1.0 - 299.9 V	0.1 % + 0.2 V	0.2 % + 0.2 V

Frequency response (M-192A)

R	Max. AC/DC difference		
	100 Hz	1 kHz	10 kHz
15 Ω	0,01 %	0,01 %	0,05 %
100 Ω	0,01 %	0,04 %	0,40 %
1000 Ω	0,04 %	0,40 %	4,00 %
10 kΩ	0,40 %	4,00 %	
100 kΩ	4,00 %		

13. Ordering information – options

- M-192-Vxxxx** - basic version (15Ω - 4700Ω)
M-192A-Vxxxx - extended version (15Ω - 300kΩ)

Remote control

- M-192-V0xxx** - RS232
M-192-V2xxx - IEEE488

Housing

- M-192-Vxx0x** - table version
M-192-Vxx1x - module 19", 4HE

Example of the order:

- M-192A-V2000 - resistance load 15Ω - 300kΩ, IEEE488 bus, table version

14. Appendix A M-192 Menu structure

Setup menu has following folders:

- Load
- General
- Protected

M-192 has two access levels for protected parameter's setting:

- *Calibration (calibration laboratory)*
- *Service (service organization)*

Access level is defined by used password.

Load	Function	Resistance	
		Current	
		Power	
	C/P -refresh	Off	
		One time	
		5 s	
		10 s	
		30 s	
		Continually	
	C/P -dev.	0.1 – 10 %	
	Ourput switch.	Random-Fire	
		Zero-Crossing	
	Meter	Voltage	
		Current	
		Power	
General	Beeps	Keyboard	Off
			On
		Others	Off
			On
	Display	Backlight	Low
			High
		Message time	Normal
			Long
	User access	Cal. password	
		Srv. password	
	Language	English	
		Cesky	
		Deutsch	
	Info	Serial number	
		FW version	
	Interface	Active	RS232/IEE488
		RS232 BaudRate	
		IEEE488 addr.	
Protected	Calibration	R constant	R1...Rxx
		Voltage	U DC pos
			U DC neg
			U AC low
			U AC high
	Service	View	Fan speed
			Temp. heat sink
			Temp. others
			CPU firmware
			RE firmware

		Temp. calibr.	Real temp:A
			Real temp:B
			Real temp:C
			Real temp:D
			Real temp:Air
			Real temp:Case

Manufacturer

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