

9000 Portable Multifunction Calibrator

user manual



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1. Introduction

9000 Portable Multifunction Calibrator is designed as universal calibration tool for electrical calibration laboratories and adjustment in manufacturing processes. Main source functions include voltage, current, frequency and thermocouple simulation. RC option adds resistance, capacitance and RTD simulation functions.

Advancing from M143 predecessor, the 9000 comes with much wider frequency ranges, capacitance function and stronger outputs to cover modern day handheld workload, including LoZ function calibration, panel meters, process meters and more.

8" touchscreen display provides full control of all functions, menu access, calibration and adjustment. Alternatively, the calibrator can be controlled remotely via USB, GPIB or Ethernet.

1.1. Front panel overview

Main control segments of the calibrator are:

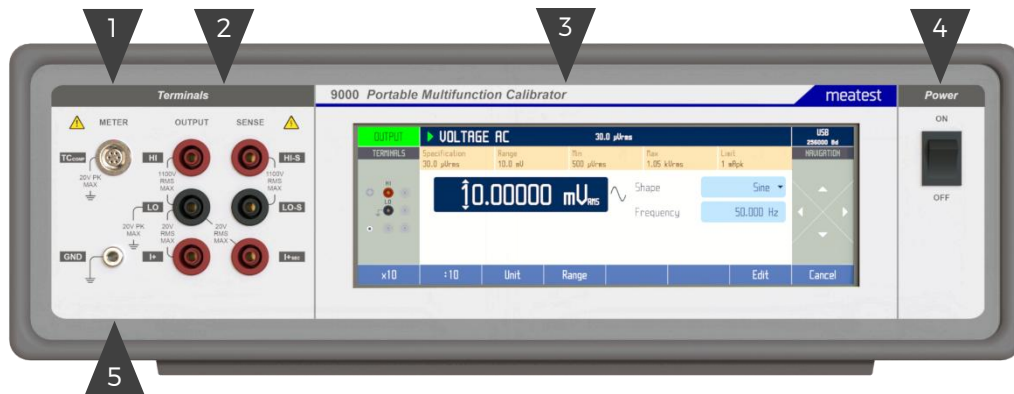


Figure 1 Front panel

1. Input terminal for cold junction temperature measurement (Adapter 91)
2. Output terminals
3. Touchscreen display
4. Power switch
5. Ground terminal

1.1.1. Touchscreen in detail

Display is divided into several sections with following meaning:

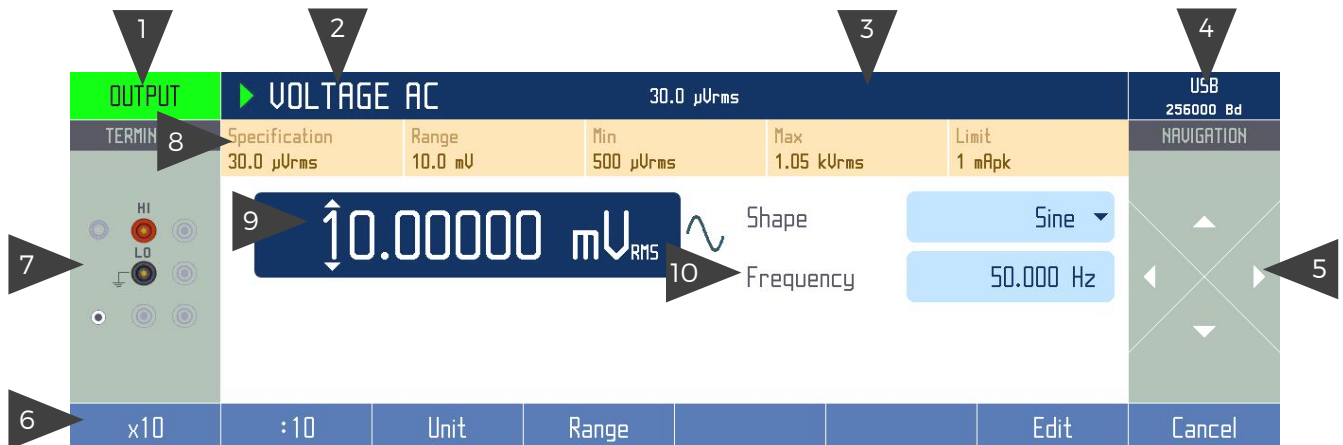


Figure 2 Display

1. Output button. Tap this area (or terminal diagram area) to switch output of selected function on/off. Green background indicates active output.
2. Function select button. Tap this area to select output function from a list of available functions. Symbol on the left indicates output status (■ standby, ◐ settling in, ► running). Text indicates selected output function. Symbols on the right (if any) indicate active warnings:

- a. Warm-up in progress. Calibrator is fully operational but it may be outside specifications.
- b. Overheated. Output terminals cannot be switched on until temperature falls below safe limit. Set function to Voltage DC, 10 V and keep the output off for a few minutes until the symbol disappears.
- c. Other error. Some functions may not be operational and/or outside specifications. Go to “MENU/Information/Device status” to get detailed information.

Taping an active warning icon will show its meaning.

3. Date and time. Read only. Can enabled/disabled in MENU > System > Date & Time.
4. Remote control button. “GO TO LOCAL” on orange background indicates active remote control mode. In this mode, the rest of the display is inactive and user may only click this area to switch to local (manual) control mode. Blue background indicates local control mode. In this mode, the button shows active interface and its main parameter (f.e. “USB” and “9600 Bd”). Clicking the button in local control mode will enter Interface menu.
5. Navigation keys. Inside MENU, these buttons are used to list through items (▲ and ▼ buttons). Outside menus, navigation buttons can be used to edit values of selected parameter – ◀ and ▶ buttons to shift through digits and ▲ and ▼ buttons to increment or decrement that digit. When no parameter is selected, tapping a navigation key will select function’s main parameter.
6. Softkey buttons. Softkeys change their texts and functions dynamically based on current workspace. Default softkey functions are as follows:
 - a. Function – Tap to change output function.
 - b. Settings – Tap to show and edit additional function-related settings.
 - c. Preset – Tap to show list of device presets.
 - d. Menu – Tap to enter main MENU.

| | | | | | | | |
|----------|----------|--|--|--|--|--------|------|
| Function | Settings | | | | | Preset | Menu |
|----------|----------|--|--|--|--|--------|------|

Figure 3 Softkeys

7. Terminal diagram. Shows active output terminals for selected function. Click this area to switch output of selected function on/off as you would with Output button.

8. Tooltip. Read only. Shows additional information about selected parameter or main value. Information may include uncertainty, range, description, limits (burden current, compliance voltage), etc. Tooltip is hidden when no parameter is selected.
9. Main parameter. Click this area to select main output value. Selected value can be edited by softkeys below, navigation keys on the right or via EDIT softkey that calls up numeric entry keyboard. Selecting any parameter will also show info relevant to the selected parameter in yellow tooltip line above.
10. Auxiliary parameters. Auxiliary parameters can be selected and edited in the same fashion as main output value. Auxiliary parameters differ in each function.

1.1.2. Terminals in detail

All input and output terminals are located on left side of front panel. Labels between terminals show overall maximum voltage ratings in standby. Maximum voltage ratings during operation are usually lower and exceeding them might cause damage to the calibrator! See Specifications for detailed ratings.

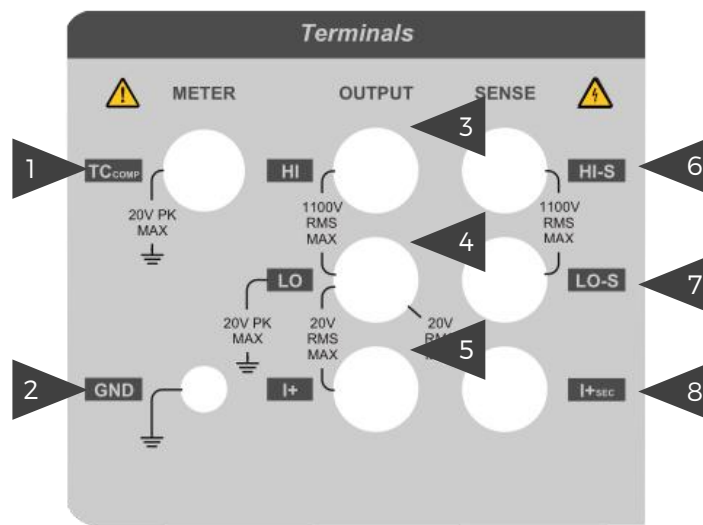


Figure 4 Input/output terminals

1. TCcomp – Measures cold junction temperature of Adapter 91 - Cold Junction Compensator. Do not connect any other cables to this terminal!
2. GND – Ground potential, galvanically connected with housing and mains PE wire.
3. HI – Outputs set voltage in VOLTAGE, set resistance in 2W mode of RESISTANCE and CAPACITANCE functions and force signal in 4W RESISTANCE mode. All signals are relative to LO.
4. LO – Acts as zero potential in VOLTAGE, CURRENT, 2W RESISTANCE, 2W CAPACITANCE. Also provides zero potential to force signal in 4W RESISTANCE mode.
5. I+ – Hi terminal of the current output
6. HI-S – Hi sense terminal for 4W resistors or 2W COMP resistors
7. LO-S – Lo sense terminal for 4W resistors or 2W COMP resistors
8. I+sec – Auxiliary Hi terminal of the current output. 9000 can be set to drive current below certain limit through I+sec instead of I+ and therefore eliminate the need to switch leads between low current and high current input terminals of meter under test (see MENU > Device > Current DC or Current AC).

2. Rear panel overview

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

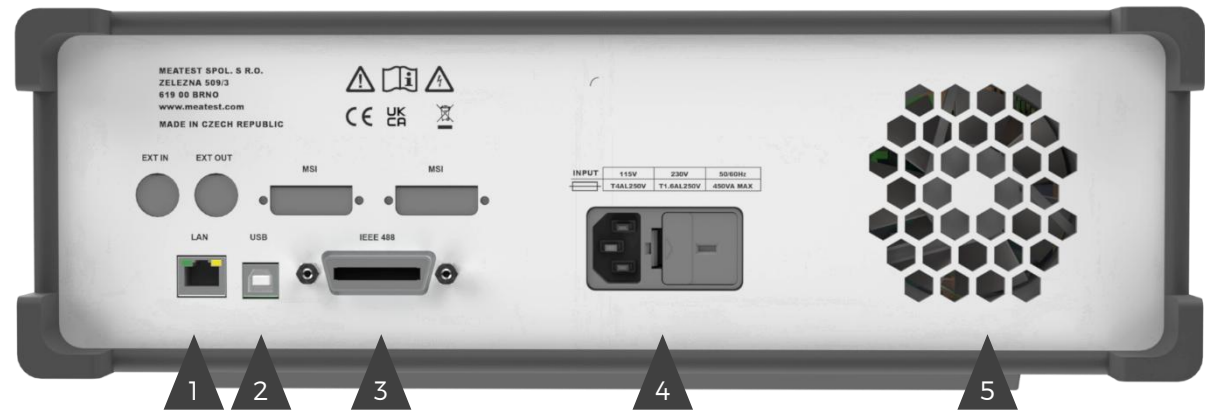


Figure 5 Rear panel

1. RJ-45 (Ethernet) connector for remote control
2. USB connector for remote control
3. GPIB IEEE-488 connector for remote control
4. Power cord module with power switch, fuse holder and 115/230 V voltage selector
5. Fan outlet cover

2.1. Options and accessories

9000 Portable Multifunction Calibrator delivery includes following items:

- | | |
|---|-------|
| - USB stick with user manual | 1 pc |
| - USB-B cable | 1 pc |
| - Factory calibration certificate | 1 pc |
| - Power cord (European E-type plug, feel free to ask for other types when ordering) | 1 pc |
| - Spare fuses (4A, 1.6A) | 2 pcs |
| - Test lead black | 1 pc |
| - Test lead red | 1 pc |

Following accessory is not part of standard delivery and can be extra ordered:

- Adapter 91 Pt100 Cold junction compensator
- 0950 Current Coil
- ISO17025 calibration certificate (replaces factory calibration certificate)

9000 Portable Multifunction calibrator can be ordered with integrated options as listed in Table 1. Integrated options can be fitted only by manufacturer and certified service providers. Additional accessories come automatically with given options.

| Option | Description |
|--------|---|
| GPIB | Adds IEEE488 (GPIB) and RJ45 (Ethernet) interfaces. |
| 20A | Extends current output range to 20.5 A. |
| RC | Adds Resistance, Capacitance and RTD functions. |

Table 1 Integrated options

2.2. Remote control

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

- USB
- GPIB (IEEE488)
- LAN

When controlled remotely, maximum ratings of calibrator's 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.

2.2.1. Connection setup

Only one interface can be used for communication at any given time. Default active interface is USB, other interfaces can be selected by tapping Remote Control Button on main display or in MENU->Interface->Active bus. To establish connection between the calibrator and computer, set interface settings in your computer accordingly:

USB connection settings

- COM port see available COM ports in Windows Device Manager
- Baudrate USB according to MENU > Interface > USB 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 hostname is "9000_SNxxxxxx23", where "xxxxxx" stands for serial number. Default ports are 23 for Telnet and 22 for both TCP and UDP protocols.

2.2.2. SCPI commands and protocol

See 9000 SCPI manual for complete SCPI reference, more details on communication setup and troubleshooting.

3. Getting started

Inspect package contents when unboxing the calibrator 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.

3.1. 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.
- Use test leads rated for at least 1050 V and 20.5 A in all core functions.
- 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.

3.2. Power on and warm-up

The calibrator must be powered by 230/115 V – 50/60 Hz mains. 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.

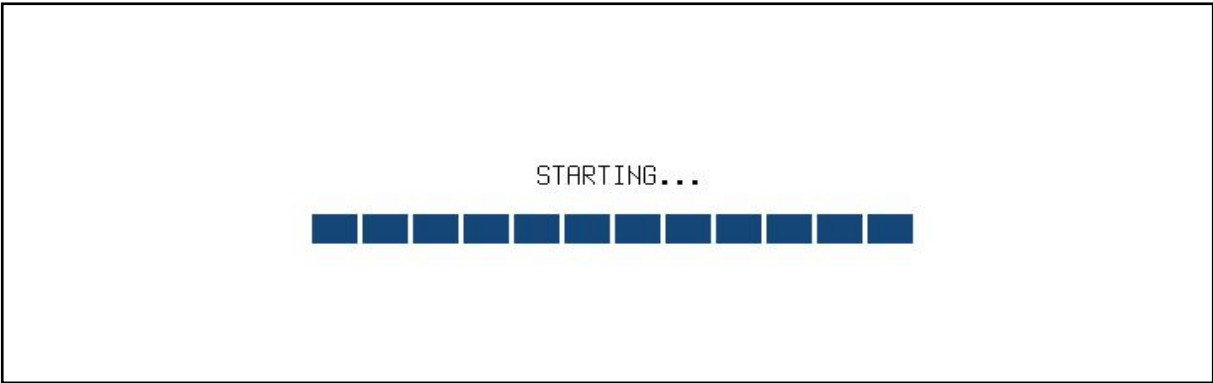


Figure 6 Starting Screen

Calibrator then performs internal hardware checks for app. 5 seconds and then starts in Startup state (called Preset). Startup preset can be customized and up to 99 other presets can be defined and recalled later at any time. By default the Startup preset is set to VDC function, 10 V with output switched off.



Figure 7 Factory default screen

Warm-up

Specified parameters are guaranteed 30 minutes after switching the calibrator on and stabilizing it in reference conditions.

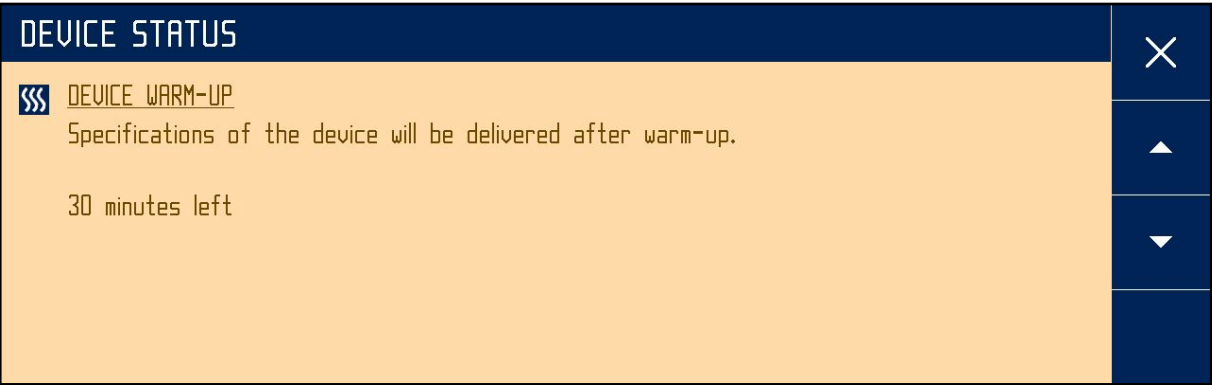


Figure 8 Warm-up screen

Expired Calibration

Specifications of this calibrator 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 this device.

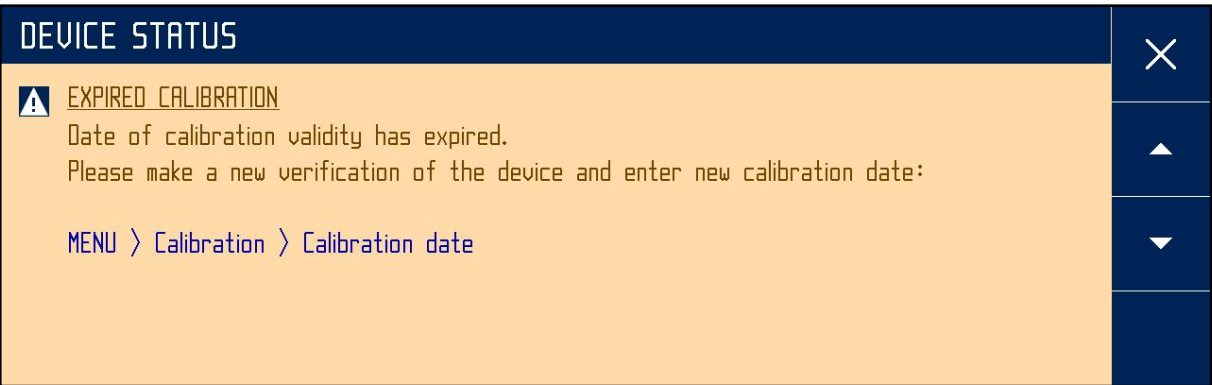


Figure 9 Expired Calibration

3.3. Function setup

Calibrator output (source) function can be set using FUNCTION button. Tap FUNCTION button to change function and select desired function (for example Voltage AC).



Figure 10 Function menu

Once a function is selected, you can change the main value as well as auxiliary output parameters like frequency in Voltage AC. Function parameters can be edited in three ways:

- Numeric keypad. Press the value on the touchscreen and press the Edit (softkey) and write a value directly with numeric keypad.
- Navigation keys. Tap the value on the touchscreen and change the value with navigation keys. ▲▼ buttons to increment/decrement selected digit by one. Move through parameter digits using ◀▶ buttons.
- Softkeys. Values of most parameters can be also changed by softkeys x10 and :10, which change value by order of magnitude and +/- softkeys which switches polarity.



Figure 11 Main and auxiliary parameters

Described methods change the main parameter by default. If there are any other parameters on display, you can edit them by pressing on them. Picture above shows AC voltage function with main value 10 V_{rms} and two auxiliary parameters: signal shape and frequency. You can click on both auxiliary parameters.

3.4. Signal output

Calibrator output can be turned on by pressing OUTPUT button on display. Pressing this button again turns output off. Output turns off automatically on calibrator startup and function switch. Output state is indicated by green rectangle next to Function label on the left side of the display. Diagram below terminals label shows which terminals are currently being used.

3.5. 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 calibrator 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 calibrator. 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 calibrator has hidden defect, when the rules for correct operation are not adhered to. 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)
- EMF interference spread through mains power or proximity to EMF source like current coils, high voltage, etc.
- strong electrostatic or electromagnetic field which can cause major instability during calibration using higher impedance.

4. Menu reference

To access main menu press menu softkey on the defaults screen.

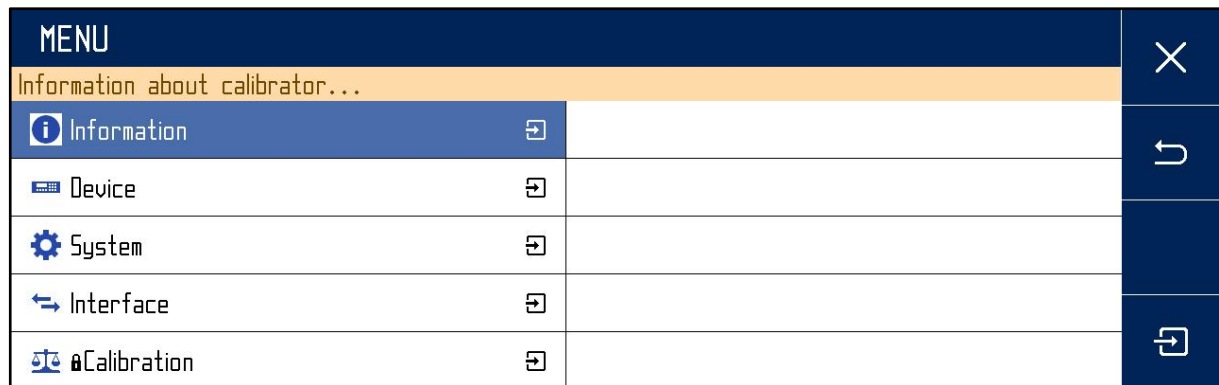


Figure 12 Main menu

Main menu is the most comprehensive setup tool of the calibrator, containing information like serial number, calibration date or display brightness as well as remote control interface setup or calibration constants. In menus bottom right icon is used as enter.

Short tooltip in yellow box shows basic description of selected item. Main menu items are described in detail in chapters 4.1 – 4.5.

4.1. Information menu

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

| | |
|---|---|
| <ul style="list-style-type: none">- Manufacturer- Model- Serial number | Device identification |
| <ul style="list-style-type: none">- Software version- Hardware version- Internal options | Device configuration |
| <ul style="list-style-type: none">- Device status- Expiration of Calibration validity- Current date | Device readiness info. Calibration expiration date is equal to last calibration date plus calibration interval, see menu item Calibration for more details. |
| <ul style="list-style-type: none">- Testing tools | Display and Touch screen diagnostics |
| <ul style="list-style-type: none">- Error logs | List of errors |

4.2. Device menu

Main part of device menu is divided according to calibrator functions that gives access to additional function related settings. Other settings like Hazardous voltage protection and Master limits allow you to set limits for given items. Tap “Terminals” will allow you to put output on/off just by pressing on terminals at main screen. Unlock code function will allow you to enable, disable or set some calibrator properties after entering a password.

Picture below shows Current AC section as an example of device menu.

| MENU > Device > Current AC | | | | ✕ |
|--|-------------------------|------------------------|----------|---|
| Connection between Lo-terminal and GND | | | | ↶ |
| Terminal ground | On | Signal synchronization | Internal | |
| Current range | Auto | Phase shift | 0.000 ° | ↶ |
| Current mode | ☐ | Ext Sync Output (BNC) | ☐ | |
| Output terminal | ☐ | | | |
| Current unit | Arms (Root Mean Square) | | | ↶ |

Figure 13 Device/Setup menu

4.3. System menu

System menu contains general, user-accessible device settings:

- Language Language version of user interface
- Display backlight [0 – 100 %]
- Beeper state On/Off
- Beeper volume [0 – 100 %]
- Touch screen beep [On/Off]
- Show tooltips on display Turns yellow menu tooltip On/Off
- Navigation keys' layout Allows to change keys layout
- Specification [Auto/Absolute/%/ppm]
- Date & Time Password protected submenu with following items
 - Time System time in HH:MM:SS format
 - Date System date in selected format
 - Format Date format [M/D/Y, M-D-Y, D/M/Y, D.M.Y, D-M-Y, Y/M/D, Y.M.D]
 - Show date & time on display [On/Off]
- Number format Allow to change decimal point and separator


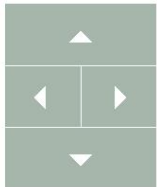
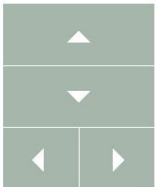
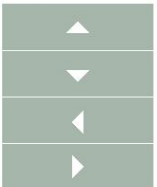
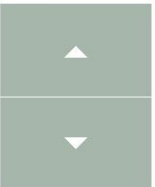
| MENU > System | | | | | ↶ |
|---|---|---|--|---|---|
| Choice of layout of navigation keys UP, DOWN, LEFT, RIGHT on the main panel. | | | | | |
| Select | | | | | ↶ |
| Layout 1 | Layout 2 | Layout 3 | Layout 4 | Layout 5 | |
|  |  |  |  |  | |

Figure 14 Keys layout

4.4. Interface menu

Interface menu contains remote control connection settings:

| Menu item | Range / format | Default value |
|-----------------------|--|-----------------|
| Active bus | GPIB/USB/LAN | USB |
| 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 | 9000_SN750011 |
| > Assigned IP address | IPv4 format; current IP address of the device | |

4.5. Calibration menu

Calibration menu contains internal calibration constants and other tools for device adjustment and is therefore password protected. See chapter 6 for more details on 9000 adjustments. Calibration menu has following items:

1. Data. Contains current calibration data. Structure of this menu is described in chapter 6.1.
2. Backup. Calibration data backup. See below for more details.
3. Password. Changes calibration password. Calibration password gives access to Calibration menu and Date/Time settings in Information menu.
4. Calibration date. Calibration date is updated automatically upon calibration data adjustment or just by manual confirmation (if calibration doesn't require adjustment).
5. Calibration interval. Recommended interval is 12 months.

Backup function allows you to save and recall entire sets of calibration data. Calibration data are also saved automatically when any calibration value gets changed, creating a record with "Auto" storage (or overwriting an existing one if the last change occurred within last 90 days). Use buttons on right side to back up / load previously stored calibration data sets:

1. Back up. Saves currently used calibration data, overwriting existing record on selected Location. Only empty records and records with Calibration access and Manual storage can be overwritten.
2. Try. Loads selected record temporarily, original calibration data will be restored on next calibrator startup.
3. Load. Loads selected record permanently.
4. Delete. Deletes record. Only records with Calibration access and Manual storage can be deleted.

4.6. Device preset menu

Device preset feature allows you to save and recall one of up to 100 calibrator configurations so that you can get to work quickly instead of setting up the calibrator every single time. Press PRESET softkey in default screen to show list of saved presets:

| DEVICE PRESETS | | | | ⏮ | ✕ |
|----------------|---------|----------------|------------|---|--------|
| Location | Preset | Function | Date | | |
| 00 | Startup | Voltage AC | 06/29/2023 | | |
| 01 | TC N | Temperature TC | 06/30/2023 | ⏮ | Delete |
| 02 | | | | | |
| 03 | | | | | |
| 04 | | | | ⏭ | Load |
| 05 | | | | | |
| 06 | | | | | |
| | | | | ⏭ | Save |

Figure 15 Preset function

To recall a predefined configuration, select its preset from the list and push Load button. Configuration will be loaded with output turned off for safety reasons.

Similarly you can save a configuration by choosing Location 0 – 99 from the list and pushing Save button. Preset includes configuration of:

- Function and mode (for example Voltage AC)
- Main value (for example 10 V)
- Auxiliary parameters (for example Sine, 1000 Hz)

While editing functions, parameters are stored in temporary RAM until another preset is selected or the device is restarted. Preset doesn't include harmonic distortion parameters nor main menu settings except those mentioned above. For harmonic preset feature see chapter 5.1.3.

5. Calibration examples

5.1. AC/DC Voltage

5.1.1. DC and SINE Voltage

1. Connect the voltmeter to the calibrator as shown on the figure below.
2. Select appropriate function and range on the voltmeter
3. Press VOLTAGE DC or VOLTAGE AC button in the function menu.

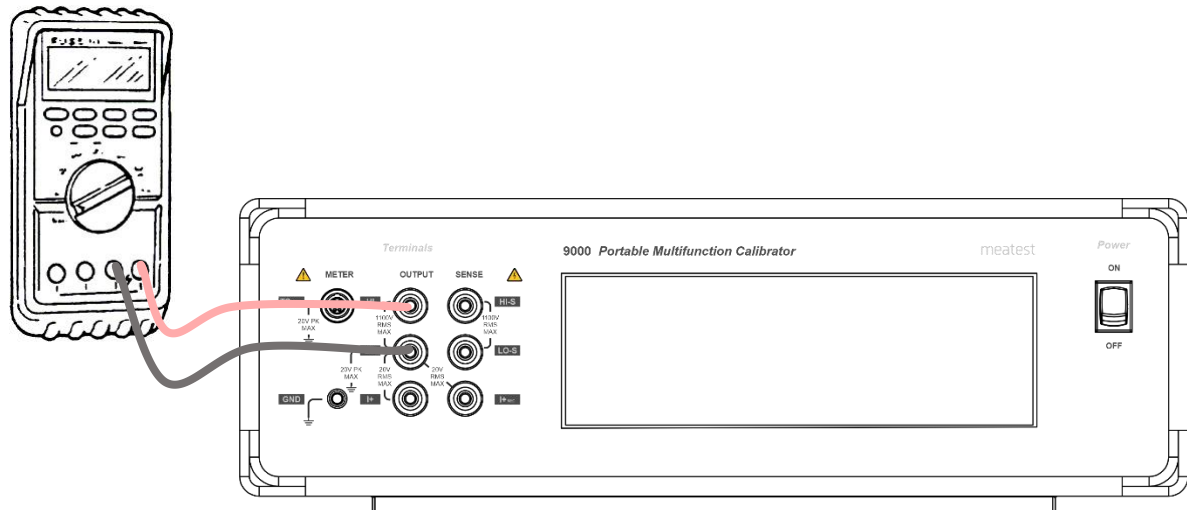


Figure 16 Voltmeter calibration

4. In AC mode press Frequency on touchscreen and set requested frequency.
5. Set output voltage value using navigation keys or numerical keyboard.
6. Switch output terminals on by pressing output button or terminals area on left. Output voltage is presented on the output terminals, green rectangle on the screen will indicate that output is on.
7. Press output button or terminal area to switch output off.

5.1.2. Non-sinusoidal Voltage

Calibrator can source non-sinusoidal waveforms with pre-defined shape. Output is limited to 10 V and 1 kHz. Following waveforms are implemented:

- Limit. Sine sinusoidal with defined distortion 13.22 %
- Square squarewave symmetrical
- Triangle symmetrical
- Ramp Up
- Ramp Down
- Harmonic adjustable harmonic products

To select requested waveform press Shape button. Select requested waveform with navigation keys or by pressing softkey with requested waveform.

5.1.3. Harmonic

Calibrator has unique feature of creation by customer defined output AC signal. Definition on the signal is based on setting of amplitude and phase shift of harmonic products related to basic, fundamental frequency. Number of harmonic products is limited to 50 but maximum frequency of harmonic product cannot exceed 5 kHz. Amplitude of individual harmonic products cannot be higher than 30 % of amplitude of fundament signal.

Harmonic product editing

1. Press Shape button and select Harmonic.
2. Press Harmonic then EDIT softkey. Table with list of harmonic products appears. Set amplitude and phase of requested harmonic product. Press either Amplitude or Phase to move active window between them.
3. When all harmonic products are set press cross [X] button on the right top to return back to basic screen. Distortion of sine wave signal has been adjusted.

| HARMONIC ADJUSTMENT > Voltage > TY | | | ⬆ | ✕ |
|------------------------------------|-----------|--------|---|-------|
| Harmonic | Amplitude | Phase | ⬆ | → * |
| 01 | 100.000 % | 0.00 ° | ⬆ | Edit |
| 02 | 0.000 % | 0.00 ° | ⬆ | Clear |
| 03 | 0.000 % | 0.00 ° | | |
| 04 | 0.000 % | 0.00 ° | | |
| 05 | 0.000 % | 0.00 ° | | |
| 06 | 0.000 % | 0.00 ° | | |
| 07 | 0.000 % | 0.00 ° | | |
| ▼ | | | | |

Figure 17 Harmonic products setting

To reset all harmonic products setting use CLEAR button in the Harmonic product menu. All higher harmonic products are set to zero except fundamental component.

To move between pages of harmonic products use ▲ and ▼ buttons.

Signal preview

The formed signal can be displayed either in frequency or time domain.

Press Bar button to display relative level of harmonic products setting in frequency domain. Fundamental component is displayed in red, higher harmonics in yellow colour.

Press Preview button to see the signal waveform in time domain.



Figure 18 Signal bar

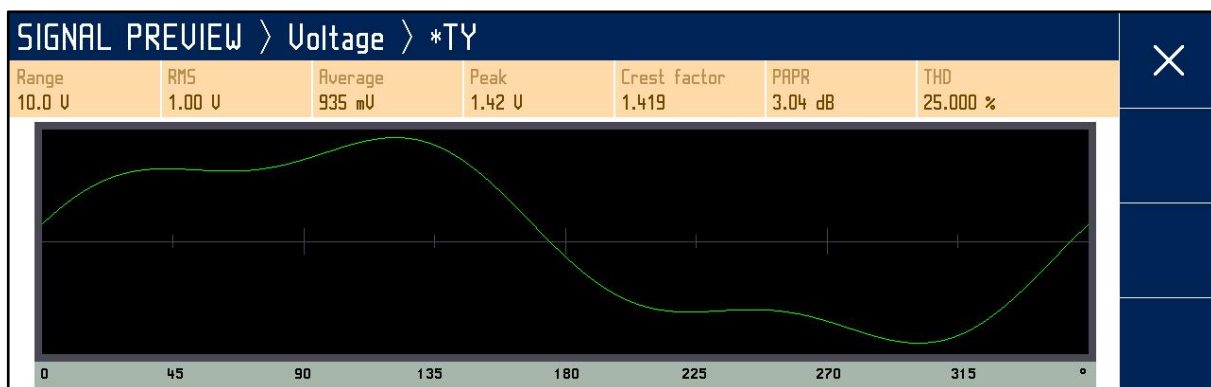


Figure 19 Signal preview

Preset feature

Harmonic preset feature works similarly as normal preset feature. Harmonic preset allows you to save and recall one of up to 22 configurations. First preset is Sine and it can't be changed or saved.

If the preset is being edited and not saved, an * appears in front of the name on the main panel.

Harmonic preset is selected from the main screen of the VAC, IAC functions from "Harmonic" auxiliary parameter.

| HARMONIC PRESETS | | | ⏮ | ✕ |
|------------------|----------|---------------|---|--------|
| Location | Preset | Date | | |
| 00 | Sine | 01/01/2020 | | |
| 01 | THD 5% | 06/30/2023 | ⏮ | Delete |
| 02 | Preset 3 | Not specified | | |
| 03 | Preset 4 | Not specified | | |
| 04 | Preset 5 | Not specified | ⏭ | Load |
| 05 | Preset 6 | Not specified | | |
| 06 | Preset 7 | Not specified | ⏭ | Save |
| | | | ⏭ | |

Figure 20 List of harmonic presets

5.1.4. Voltage SETUP

Voltage function MENU can be activated from default screen by pressing: MENU > Device > Voltage AC / DC. Alternatively, you can press the settings button on the default screen of the given function. Following screen will appear:

| MENU > Device > Voltage AC | | | ✕ |
|--|-------------------------|-----------------------|---|
| Connection between Lo-terminal and GND | | | |
| Terminal ground | On | Ext Sync Output (BNC) | ☑ |
| Voltage range | Auto | | ↶ |
| Voltage unit | Urms (Root Mean Square) | | |
| Signal synchronization | Internal | | |
| Phase shift | 0.000 ° | | ☑ |

Figure 21 Voltage SETUP screen

SETUP offers additional voltage function settings. Use ▲ ▼ navigation keys or touch screen to change following items:

| | | |
|------------------------------------|---|---|
| Terminal ground | On/Off | Voltage LO output terminal grounded/floating |
| Voltage range | Auto/10mV/100mV/1V/10V/100V/1050V | |
| [AC only] Voltage unit | Root Mean Square/Peak/Peak-Peak/Average | |
| [AC only] Signal synchronization | Internal | frequency and phase is given by internal oscillator |
| | Power Line | synchronized to power line voltage |
| | BNC | synchronized to rear panel EXT SYNC INPUT connector |
| | External Master | synchronized to Master unit via rear panel MSI connector |
| [AC only] Phase shift | x.xxx Degrees (°) | phase shift between voltage output and synchronization signal |
| [AC only] Ext Sync Output (BNC) | Mode | Switches function of rear panel Ext Sync Output BNC. Both outputs generate squarewave signal with rising edge phase-locked to internal AC reference. “Sync output” is phase and frequency reference of main output signal, used to synchronize with other devices. Sync output frequency is limited to 1200 Hz (2400 Hz if main signal frequency is 19200 Hz or more). Higher frequencies are divided by powers of two so that Sync output frequency is always kept below 1200 Hz (2400 Hz for main frequency of 19200 Hz or more). “Sample output” is meant to trigger an external voltmeter to synchronize sampling measurements with main output, useful for calibration of 9010. “Sample multiplier” set to “Auto” multiplies main signal frequency up to 850 Hz by factors 2048 – 64, keeping the sample output at around 30 – 65 kHz. Main signal frequency above 850 Hz gets multiplied by factors 32 – 8, rising sample output frequency up to its limit of 5 MHz. Fixed Sample multipliers multiply previously described Sync output instead of main signal frequency. |
| | Sample state | On/Off. Turning Sample state ON will cause sampling signal to start when reference signal passes through zero. |
| | Sample multiplier | Auto/16/32/64/128/256/512/1024/2048 |

5.2. AC/DC Current

5.2.1. DC and SINE Current

1. Connect the ammeter to the calibrator as shown on the figure below. You can connect both High current terminals (I_{+SEC} and I_{+}) at same time. Output of calibrator disconnect unused terminals. Current value that change output from primary to secondary connector is selectable by user.
2. Select appropriate function and range on the ammeter (multimeter)
3. Push CURRENT AC or DC function button in function menu.

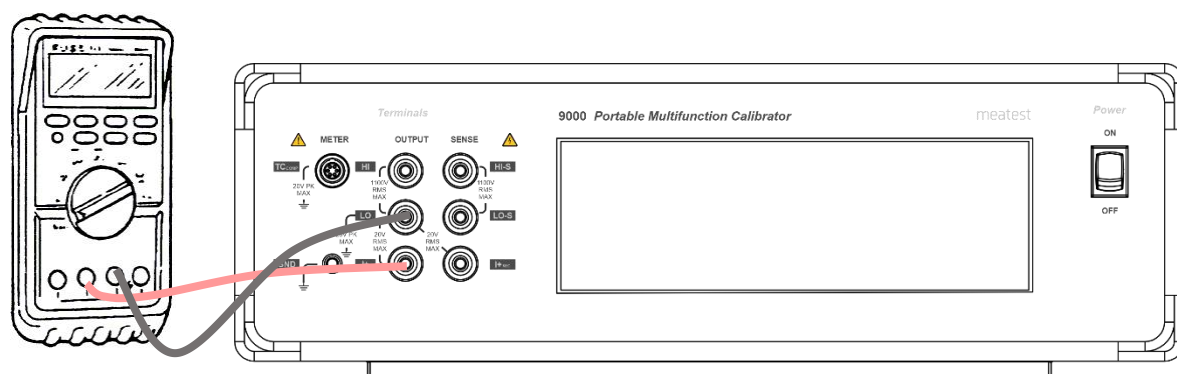


Figure 22 Ammeter calibration

4. Press Frequency auxiliary parameter and set requested frequency.
5. Set output current value using navigation key or numerical keyboard.
6. Switch output terminals on by pressing output button or terminals area on left. Output current is presented on the output terminals, green rectangle on the screen will indicate that output is on.
7. Press output button or terminal area to switch output off.

5.2.2. Non-sinusoidal Current

Calibrator can source non-sinusoidal waveforms with pre-defined shape. Output is limited to 100 μA – 2 A and 1 kHz. Following waveforms are implemented:

- Limit. Sine sinusoidal with defined distortion 13.22 %
- Square squarewave symmetrical
- Triangle symmetrical
- Ramp Up
- Ramp Down
- Harmonic adjustable harmonic products

To select requested waveform push the SHAPE button, highlight requested item using navigation \blacktriangle \blacktriangledown keys.

5.2.3. Harmonic

Calibrator has unique feature of sourcing by customer defined waveform signal. Definition on the signal is based on setting of amplitude and phase shift of harmonic products related to basic, fundamental frequency. Number of harmonic products is limited to 50 but maximum frequency of harmonic product cannot exceed 5 kHz. Amplitude of individual harmonic products cannot be higher than 30 % of amplitude of fundament signal.

See chapter 5.1.2. and 5.1.3. for setting waveform parameters.

5.2.4. Current SETUP

Current function MENU can be activated from default screen by pressing: MENU > Device > Current AC / DC. Alternatively, you can press the settings button on the default screen of the given function. Following screen will appear:

| MENU > Device > Current AC | | | | ✕ |
|--|-------------------------|------------------------|----------|---|
| Connection between Lo-terminal and GND | | | | ↶ |
| Terminal ground | On | Signal synchronization | Internal | |
| Current range | Auto | Phase shift | 0.000 ° | ↷ |
| Current mode | ☐ | Ext Sync Output (BNC) | ☐ | |
| Output terminal | ☐ | | | |
| Current unit | Arms (Root Mean Square) | | | ↻ |

Figure 23 Current SETUP screen

SETUP offers additional current function settings. Use ▲▼ navigation keys or touch screen to change following items:

| | | |
|----------------------------------|--|---|
| Terminal ground | On/Off | Current LO output terminal grounded/floating |
| Current range | Normal - Auto/200μA/2mA/20mA/200mA/2A/20.5A. | |
| Current mode | Current mode | Normal/Voltage from current/Coil |
| | Number of Coil turns | with current mode set to Coil, both display and remote control current values get multiplied by this number |
| | Coil uncertainty | with current mode set to Coil, both display and remote control uncertainty values get increased by this number |
| Output terminal | I+sec Terminal | Enabled/Disabled. Enabling I+sec terminal for low current up to defined limit. |
| | I+sec limit | 0 - 2 A |
| Current unit | Root Mean Square/Peak/Peak-Peak/Average | |
| [AC only] Signal synchronization | Internal | frequency and phase is given by internal oscillator |
| | Power Line | synchronized to power line voltage |
| | BNC | synchronized to rear panel EXT SYNC INPUT connector |
| | External Master | synchronized to Master unit via rear panel MSI connector |
| [AC only] Phase shift | x.xxx Degrees (°) | phase shift between current output and synchronization signal |
| [AC only] Ext Sync Output (BNC) | Mode | Switches function of rear panel Ext Sync Output BNC. Both outputs generate squarewave signal with rising edge phase-locked to internal AC reference. "Sync output" is phase and frequency reference of main output signal, used to synchronize with other devices. Sync output frequency is limited to 1200 Hz (2400 Hz if main signal frequency is 19200 Hz or more). Higher frequencies are divided by powers of two so that Sync output frequency is always kept below 1200 Hz (2400 Hz for main frequency of 19200 Hz or more). "Sample output" is meant to trigger an external meter to synchronize sampling measurements with main current output, useful for calibration of 9010. "Sample multiplier" set to "Auto" multiplies main signal frequency up to 850 Hz by factors 2048 - 64, keeping the sample output at around 30 - 65 kHz. Main signal frequency above 850 Hz gets multiplied by factors 32 - 8, rising sample output frequency up to its limit of 5 MHz. Fixed Sample multipliers multiply previously described Sync output instead of main signal frequency. |
| | Sample state | On/Off. Turning Sample state ON will cause sampling signal to start when reference signal passes through zero. |
| | Sample multiplier | Auto/16/32/64/128/256/512/1024/2048 |

5.3. Resistance

SIM version of the calibrator offers continuously adjustable resistance decade, based on resistance simulation using electronic circuits. The function is designed for calibration of standard resistance function of various multimeters which use low level signals. The mode is signed VARIABLE. FIXED mode offers set of fixed decadic resistors with higher accuracy.

Push RESISTANCE function button in function menu. Following screen will appear:



Figure 24 Resistance screen

5.3.1. VARIABLE mode

Resistance decade can be used in two-wire, two-wire compensated or four-wire connection. Two-wire connection uses output terminals labelled HI and LO. Four-wire connection uses terminals HI and LO and HI-S and LO-S as sense terminals.

Note: four-wire method of connection offers lower uncertainty of calibration especially for low resistance values due to by the principle excluded test lead resistance influence.

Resistance function is based on electronic simulator of resistance. It has limited working conditions. Maximum test voltage is displayed on tooltip. See specification for test voltage and test current limitations.

1. Select appropriate function and range on the ohmmeter (multimeter)
2. Set requested mode of connection either two-wire, four-wire or two-wire comp. Press Wire button on the touchscreen.
3. Switch output terminals on by pressing output button or terminals area on left.
4. Press output button or terminal area to switch output off.

5.3.1.1. Two-wire connection

The simplest connection, where lead resistance must be taken into account. Device can manually compensate lead resistance in Compensation field. Not suitable for small resistance measurement. Preferred method for measuring high resistance. To maintain good accuracy high quality preferably shielded cables with high isolation resistance (Teflon or similar) are needed for measuring high resistances.

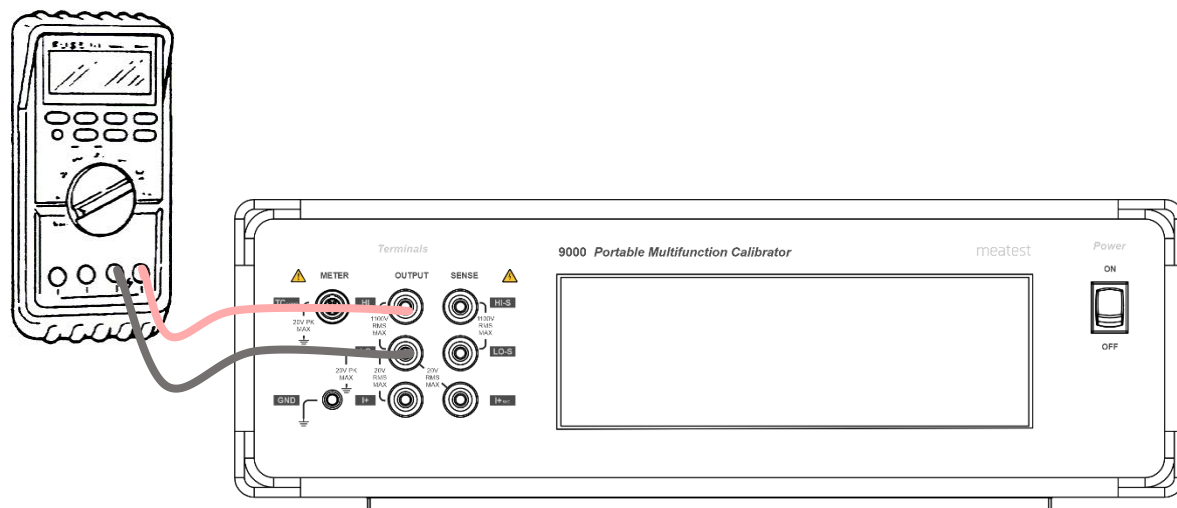


Figure 25 Two-wire resistance calibration

5.3.1.2. Two-wire compensated connection

Advance method for calibrating instrument that allow only two wire connection. Additional sense terminals connected directly to tested instrument allow automatic lead resistance compensation. This method is suitable even for low resistance measurement where lead resistance exceed simulated resistance.

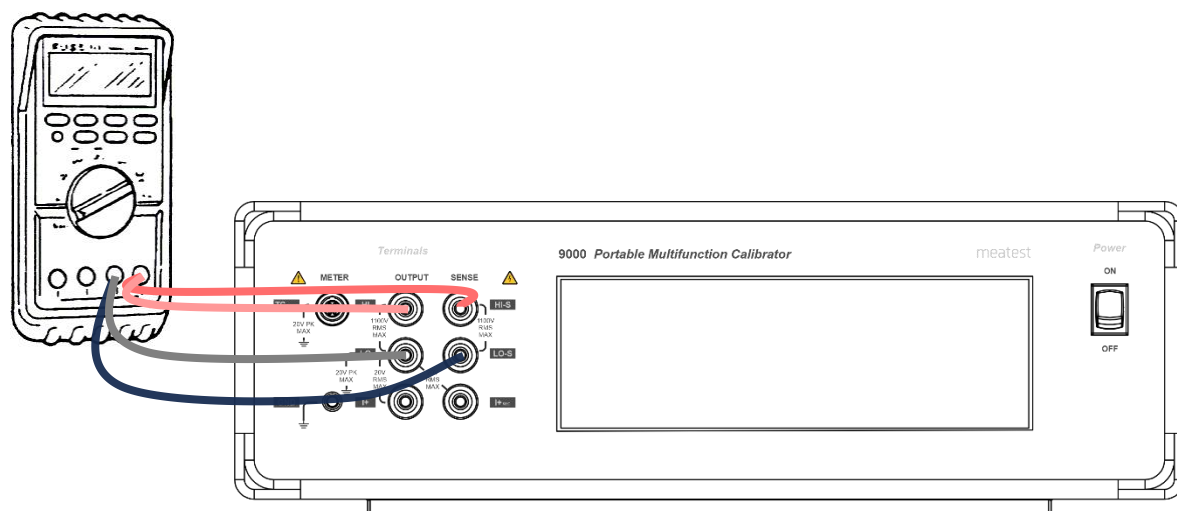


Figure 26 Two-wire compensated resistance calibration

5.3.1.3. Four-wire connection

Preferred connection method for instruments that support four wire connection with sense. Not recommended for values over 100 kΩ due to higher susceptibility to external noise. High quality preferably shielded cables with high isolation resistance (Teflon or similar) are needed for measuring high resistances.

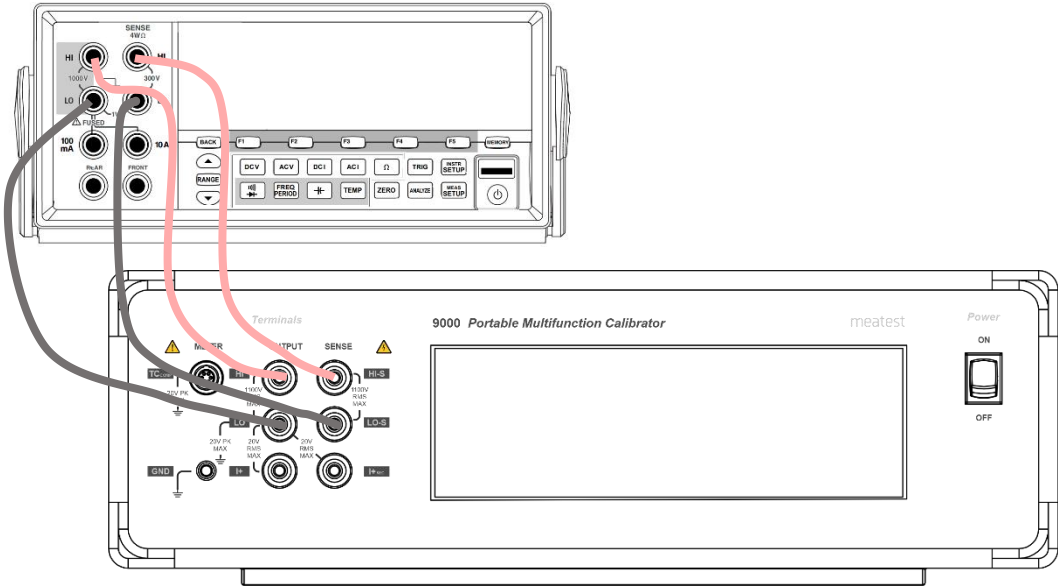


Figure 27 Four-wire resistance calibration

5.3.2. FIXED mode

Fixed mode offers high accuracy of sourced resistance however range of resistance is limited to fix decadic values. Exact calibration value is always displayed on the display. Push Mode button on touchscreen to display list of modes. Selection of individual fix value positions can be done using navigation buttons▲▼, or after pressing on the main value press list softkey to show list of fixed resistances. Numerical keypad is not active in this mode. Calibration value is displayed on the display.

5.4. Capacitance

Calibrator contains continuously adjustable decade, based on capacitance simulation using electronic circuits. The function is designed for calibration of standard capacitance function of various multimeters which use low level signals. The mode is signed VARIABLE. Except the VARIABLE mode the calibrator offers more accurate capacitance in FIXED mode. In this mode only fix nominal decadic values are available.



Figure 28 Capacitance screen

5.4.1. Capacitance Correction mode

Capacitance correction mode is available for both variable and fixed mode. It consists of relative and absolute mode.

In relative mode is output capacitance related to internal open position. When relative mode is used it allows to set OPEN position via softkeys and use appropriate NULL function on multimeter to correct background of calibrator and used measuring cables. Relative mode is more accurate and stable one.



Figure 29 Capacitance screen with OPEN position

In absolute mode background of calibrator is took in account and indicated value is set to output terminal. Connected cables are not taken in account and user must do NULL on multimeter without connected Hi terminal, but close to output terminal to maintain same position same position of cables.

5.4.2. Capacitance VARIABLE mode

Capacitance mode is available in two- terminal connection only with maximum test from 2 to 5 V depending on set value. See specification for test voltage and test current limitations.

Device is optimised and calibrated for devices that measure current in Hi terminal like common DMM. Do not connect Lo terminal to GND externally. In case of need connect it inside of device. Device uses GND connection status to compensate different small capacitance offsets.

Push MODE button to display list of modes. Select Variable.

1. Connect the multimeter to the calibrator as shown below.
2. Select appropriate function and range on the multimeter.
3. Push CAPACITANCE function button in function menu.
4. Switch output terminals on by pressing output button or terminals area on left.
5. Press output button or terminal area to switch output off.

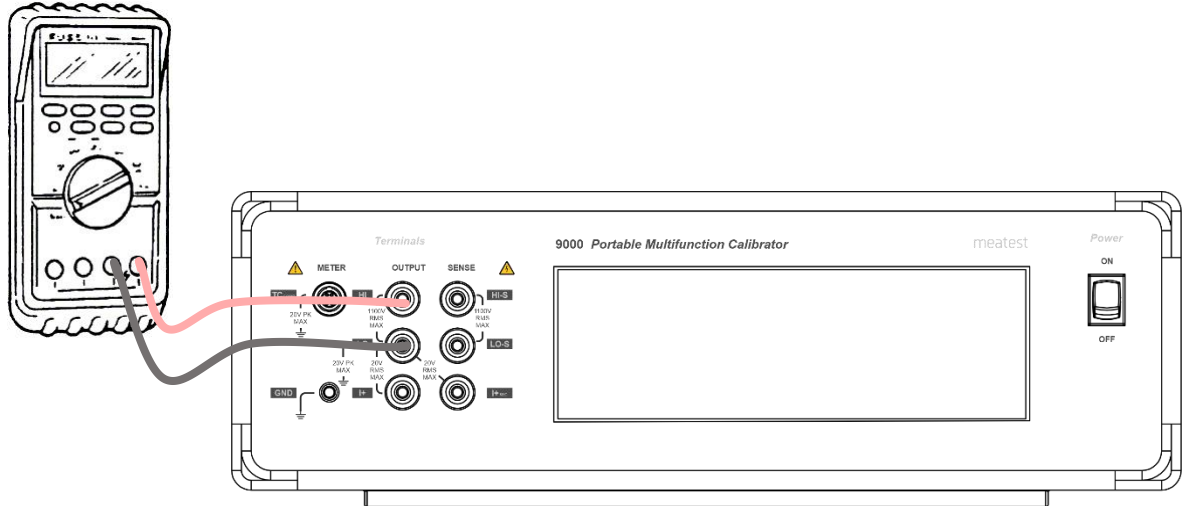


Figure 30 Capacitance calibration

Note: RC simulator used in 9000 series calibrators relies on test current flowing through its Hi terminal. For this reason, it's necessary to set calibrator terminal grounding to OFF and swap cable polarity (meter Hi to calibrator Lo and vice versa) when using grounded meters like **LCR bridges** to measure calibrator output in Capacitance VARIABLE and Resistance VARIABLE modes. Use of isolation transformer is not recommended as it compromises the RC simulator accuracy.

5.4.3. Capacitance FIXED mode

Fixed mode offers high accuracy of sourced capacitors with fix nominal values.

Press MODE button on touchscreen to display list of modes. Select Fixed item. Selection of individual fix value positions can be done using navigation buttons ▲▼. Numerical keypad is not active in this mode.

5.4.4. Capacitance SETUP

Capacitance Setting can be activated using Setting softkey. Following parameters are available:

- Terminal ground
LO output terminals are internally connected to PE wire when parameter is set to ON.

5.5. Temperature sensor simulation

Calibrator can simulate various, most frequently used temperature sensors, both resistance RTD type and thermocouple TC type. These functions are accessible through function menu.

5.5.1. Temperature RTD

In TEMPERATURE RTD function calibrator simulates resistance temperature sensor by connecting such resistance to the output terminals which corresponds set temperature. Following screen appears after the function selection:

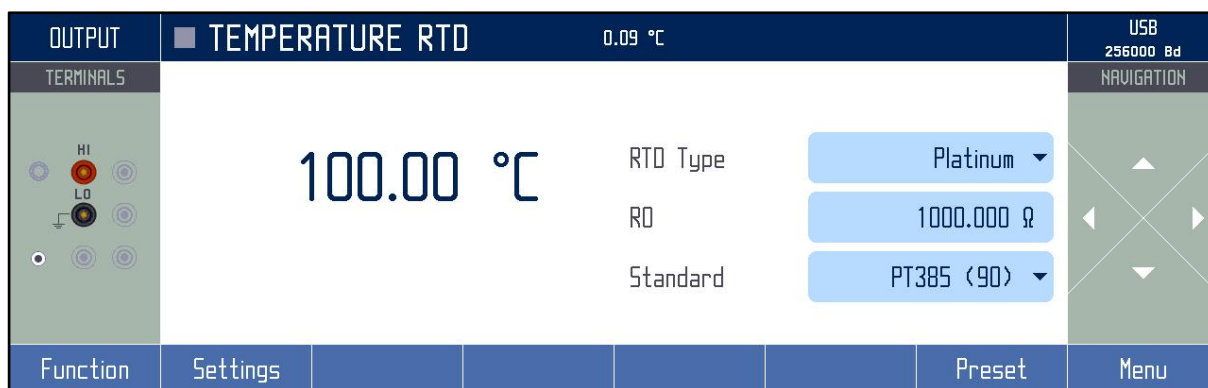


Figure 31 RTD temperature sensor simulation

To simulate an RTD temperature sensor:

1. Connect thermometer input to HI – LO, HI-S – LO-S terminals.
2. Select RTD type sensor using RTD Type soft button, either Platinum or Nickel.
3. Set nominal resistance of the sensor at 0. °C R0. For Pt 100 sensor the value is 100.000 Ω.
4. Select a predefined temperature scale or create a custom scale and select „PT user“ to access it.
5. Enter requested temperature value into main field on the display to simulate temperature sensor.
6. Push the Output button or Terminals area. Calculated resistance corresponding to the set temperature is connected to the output terminals. Real resistance value is displayed in yellow information line in upper part of the display.

Resistance is connected to HI – LO and HI-S – LO-S terminals in 4W configuration. HI – LO terminals are “power” terminals, HI-S – LO-S terminals are “sense” terminals.

RTD Simulation SETUP

TEMPERATURE RTD function has related Setting function. The Setting can be opened by pressing Settings softkey. It contains following items:

- Temperature unit selection, °C, °F or K
- Terminal ground, enables internally LO output terminal grounding

Coefficients of „PT User“ scale. RTD calculation formula is

$$R_{sim} = R_0 * (1 + T*(A + T*(B + T*C(T-100.0))))$$

, where T is temperature in °C and R0 is nominal resistance of temperature sensor at 0 °C.

5.5.2. Temperature TC

In TEMPERATURE TC function calibrator simulates thermocouple temperature sensor by sourcing such DC voltage to the output terminals which corresponds set temperature and selected type of sensor. Following screen appears after the function selection:

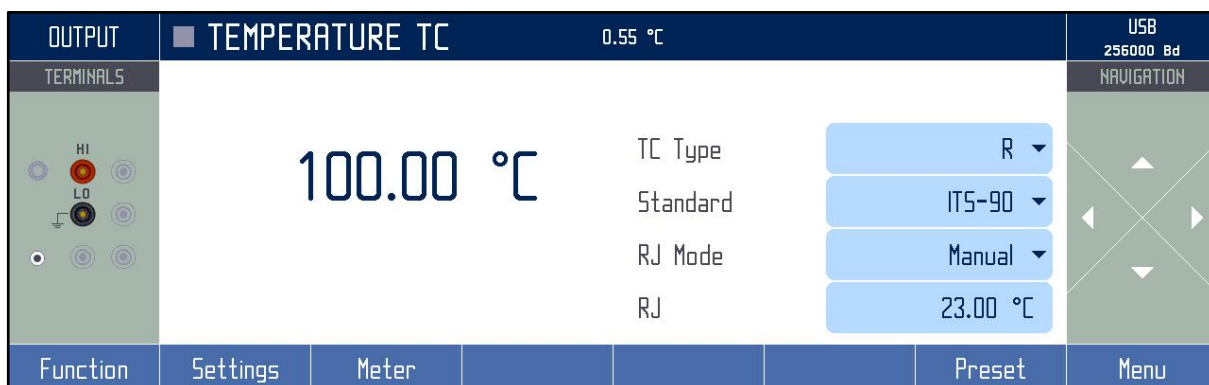


Figure 32 TC temperature sensor simulation

To simulate a TC temperature sensor:

1. Connect thermometer input to HI – LO output terminals.
2. Select TC Type sensor, one of following R, S, B, J, T, E, K, N, M, C, D, G2
3. Select requested temperature standard PTS-68 or ITS-90
4. Select Manual RJ mode and enter cold junction temperature into RJ field. With Adapter 91 connected as in picture below you can also use Auto compensation mode:

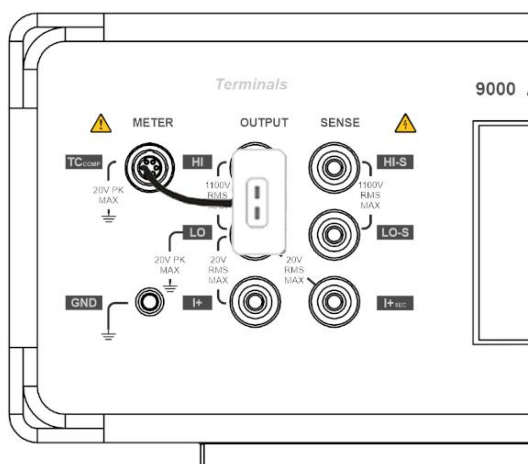


Figure 33 Thermocouple simulation using Adapter 91

5. Enter requested temperature value into main field on the display to simulate temperature sensor.
6. Press the Output button or Terminals area to activate output. Real DC voltage level is displayed in yellow information line in upper part of the display.

TC temperature sensor simulation SETUP

TEMPERATURE TC function has related Settings function. The Setting can be opened by pushing the Settings softkey. It contains following items:

- Temperature unit selection, °C, °F or K
- Terminal ground, enables internally LO output terminal grounding

5.6. Frequency

Multifunction calibrator can generate square wave TTL leveled signal with 6 ½ digit resolution frequency. The signal is available in frequency mode on output terminals Hi – Lo. Frequency range is from 100 mHz to 20 MHz.

Output waveform in frequency mode is always positive square wave with selectable amplitude 0.1 V, 1 V, 5 V.

Frequency mode

1. Push Frequency function button in function menu.
2. Set the frequency using navigation buttons or numeric keyboard by pressing main value then pressing Edit softkey.
3. Connect the object of calibration to left Hi and Lo terminal.
4. Switch output terminals on by pressing output button or terminals area on left.

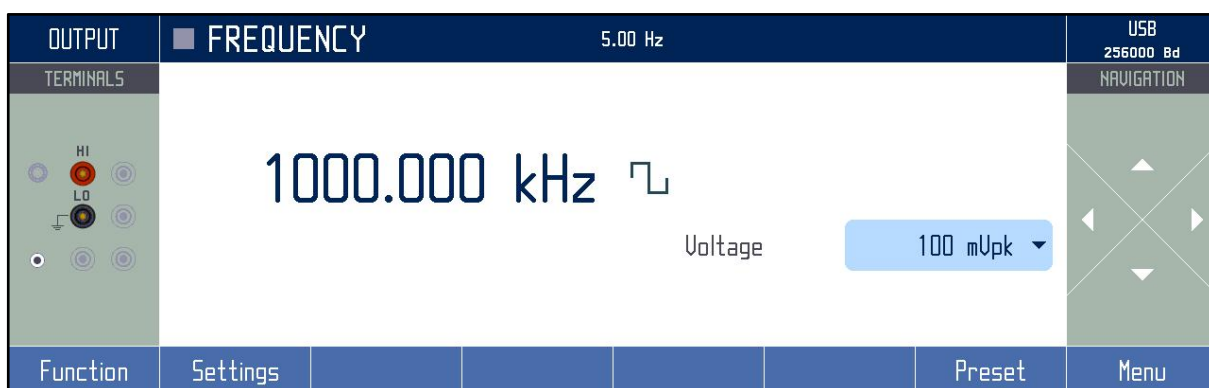


Figure 34 Frequency mode display

5.7. Duty cycle

The period signal in Duty cycle uses Hi and Lo terminal. Fraction of one period is set by percentage with available ranges from 0.1% to 99.9%. Frequency range is from 100 mHz to 1 kHz.

Output waveform in duty cycle mode is always symmetrical square with selectable amplitude range from 1 mV to 14.1 V.

Duty cycle mode

1. Push Duty cycle function button in function menu.
2. Set the percentage using navigation buttons or numeric keyboard by pressing main value then pressing Edit softkey.
3. Connect the object of calibration to left Hi and Lo terminal.
4. Switch output terminals on by pressing output button or terminals area on left.

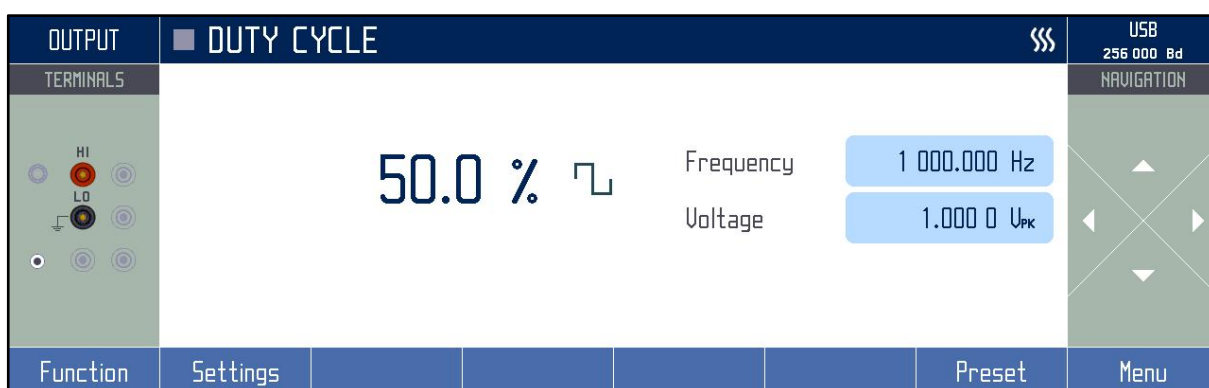


Figure 35 Duty cycle mode display

6. Performance verification

Specifications of this calibrator 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 this device.

6.1. Required equipment

Following instruments are required for performance verification test:

- 8½ digit multimeter Fluke 8588A or similar with uncertainty 10 ppm or better on DC voltage, 100 ppm on AC voltage and capacitance measurement function
- Counter Keysight 53181A or similar with uncertainty 1 ppm or better.
- LCR meter type Keysight U4980A or similar with uncertainty 0.1 % at 1 kHz or better
- 1kΩ standard with uncertainty 20 mΩ or better and Meatest 9000-60 Adapter for RJ temperature meter verification

6.2. Verification procedure

1. Place the calibrator to the standard condition and let it switched on for at least one hour in a laboratory in reference conditions 21 °C to 25 °C.
2. Set Terminal ground ON in 9000's Function Setting menu in order to suppress mains noise during measurement.
3. Connect output/input terminals of the calibrator to the input voltage terminals of the standard device. Set parameters which enables the most accurate measurement in standard device.
4. Use table in chapter 6.3 (and 6.4 if RC option is installed) to verify all recommended test points. Measured deviation should not exceed the limits in tables.
 - a. DC voltage test
 - b. AC SINE voltage test
 - c. Non-sinusoidal voltage test
 - d. DC current test
 - e. AC current SINE test
 - f. Non-sinusoidal current test
 - g. AC voltage frequency test
 - h. Frequency test
 - i. Test of reference junction temperature meter in thermocouple function
 - j. Fixed resistance test (with RC option installed)
 - k. Variable resistance test (with RC option installed)
 - l. Fixed capacitance test (with RC option installed)
 - m. Variable capacitance test (with RC option installed)

6.3. Test points

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|------------|-------|---------|-----------|-----------|------|---------------|-----------------|
| DC Voltage | 10 | -10 | -10.008 | -9.992 | mV | 8½ digit DMM | DC |
| | | -5 | -5.007 | -4.993 | mV | | |
| | | -1 | -1.0062 | -0.9938 | mV | | |
| | | 1 | 0.9938 | 1.0062 | mV | | |
| | | 5 | 4.993 | 5.007 | mV | | |
| | | 10 | 9.992 | 10.008 | mV | | |
| | 100 | -100 | -100.016 | -99.984 | mV | | |
| | | -50 | -50.011 | -49.989 | mV | | |
| | | -11 | -11.0071 | -10.9929 | mV | | |
| | | 11 | 10.9929 | 11.0071 | mV | | |
| | | 50 | 49.989 | 50.011 | mV | | |
| | | 100 | 99.984 | 100.016 | mV | | |
| | 1 | -1 | -1.00007 | -0.99993 | V | | |
| | | -0.5 | -0.50004 | -0.49996 | V | | |
| | | -0.11 | -0.110017 | -0.109983 | V | | |
| | | 0.11 | 0.109983 | 0.110017 | V | | |
| | | 0.5 | 0.49996 | 0.50004 | V | | |
| | | 1 | 0.99993 | 1.00007 | V | | |
| | 10 | -10 | -10.00065 | -9.99935 | V | | |
| | | -5 | -5.00035 | -4.99965 | V | | |
| | | -1.1 | -1.100116 | -1.099884 | V | | |
| | | 1.1 | 1.099884 | 1.100116 | V | | |
| | | 2 | 1.99983 | 2.00017 | V | | |
| | | 3 | 2.99977 | 3.00023 | V | | |
| | | 4 | 3.99971 | 4.00029 | V | | |
| | | 5 | 4.99965 | 5.00035 | V | | |
| | | 6 | 5.99959 | 6.00041 | V | | |
| | | 7 | 6.99953 | 7.00047 | V | | |
| | | 8 | 7.99947 | 8.00053 | V | | |
| | | 9 | 8.99941 | 9.00059 | V | | |
| | | 10 | 9.99935 | 10.00065 | V | | |
| | 100 | -100 | -100.007 | -99.993 | V | | |
| | | -50 | -50.004 | -49.996 | V | | |
| | | -11 | -11.00166 | -10.99834 | V | | |
| | | 11 | 10.99834 | 11.00166 | V | | |
| | | 50 | 49.996 | 50.004 | V | | |
| | | 100 | 99.993 | 100.007 | V | | |
| | 1000 | -950 | -950.1005 | 949.8995 | V | | |
| | | -500 | -500.06 | -499.94 | V | | |
| | | -110 | -110.0249 | -109.9751 | V | | |
| | | 110 | 109.9751 | 110.0249 | V | | |
| | | 500 | 499.94 | 500.06 | V | | |
| | | 950 | 949.8995 | 950.1005 | V | | |

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|--------------------|-------|---------|-----------|-----------|------|---------------|-----------------|
| AC Voltage SINE | 10 | 2 | 1.978 | 2.022 | mV | 8½ digit DMM | 55 Hz |
| | | | 1.978 | 2.022 | mV | | 1 kHz |
| | | | 1.966 | 2.034 | mV | | 5 kHz |
| | | | 1.966 | 2.034 | mV | | 10 kHz |
| | | | 1.93 | 2.07 | mV | | 50 kHz |
| | | | 1.93 | 2.07 | mV | | 100 kHz |
| | | 5 | 4.975 | 5.025 | mV | | 55 Hz |
| | | | 4.975 | 5.025 | mV | | 1 kHz |
| | | | 4.96 | 5.04 | mV | | 5 kHz |
| | | | 4.96 | 5.04 | mV | | 10 kHz |
| | | | 4.915 | 5.085 | mV | | 50 kHz |
| | | | 4.915 | 5.085 | mV | | 100 kHz |
| | | 10 | 9.97 | 10.03 | mV | | 55 Hz |
| | | | 9.97 | 10.03 | mV | | 1 kHz |
| | | | 9.95 | 10.05 | mV | | 5 kHz |
| | | | 9.95 | 10.05 | mV | | 10 kHz |
| | | | 9.89 | 10.11 | mV | | 50 kHz |
| | | | 9.89 | 10.11 | mV | | 100 kHz |
| | 100 | 11 | 10.939 | 11.061 | mV | | 55 Hz |
| | | | 10.939 | 11.061 | mV | | 1 kHz |
| | | | 10.9135 | 11.0865 | mV | | 5 kHz |
| | | | 10.9135 | 11.0865 | mV | | 10 kHz |
| | | | 10.745 | 11.255 | mV | | 50 kHz |
| | | | 10.745 | 11.255 | mV | | 100 kHz |
| | | 50 | 49.9 | 50.1 | mV | | 55 Hz |
| | | | 49.9 | 50.1 | mV | | 1 kHz |
| | | | 49.855 | 50.145 | mV | | 5 kHz |
| | | | 49.855 | 50.145 | mV | | 10 kHz |
| | | | 49.55 | 50.45 | mV | | 50 kHz |
| | | | 49.55 | 50.45 | mV | | 100 kHz |
| | | 100 | 99.85 | 100.15 | mV | | 55 Hz |
| | | | 99.85 | 100.15 | mV | | 1 kHz |
| | | | 99.78 | 100.22 | mV | | 5 kHz |
| | | | 99.78 | 100.22 | mV | | 10 kHz |
| | | | 99.3 | 100.7 | mV | | 50 kHz |
| | | | 99.3 | 100.7 | mV | | 100 kHz |
| | 1 | 0.11 | 0.109895 | 0.110105 | V | | 55 Hz |
| | | | 0.109895 | 0.110105 | V | | 1 kHz |
| | | | 0.109823 | 0.110177 | V | | 5 kHz |
| | | | 0.109823 | 0.110177 | V | | 10 kHz |
| | | | 0.10845 | 0.11155 | V | | 50 kHz |
| | | | 0.10845 | 0.11155 | V | | 100 kHz |
| | | 0.5 | 0.4997 | 0.5003 | V | | 55 Hz |
| | | | 0.4997 | 0.5003 | V | | 1 kHz |
| | | | 0.49955 | 0.50045 | V | | 5 kHz |
| | | | 0.49955 | 0.50045 | V | | 10 kHz |
| | | | 0.4965 | 0.5035 | V | | 50 kHz |
| | | | 0.4965 | 0.5035 | V | | 100 kHz |

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|--------------------|-------|---------|-----------|-----------|------|---------------|-----------------|
| AC Voltage SINE | 1 | 1 | 0.99945 | 1.00055 | V | 8½ digit DMM | 55 Hz |
| | | | 0.99945 | 1.00055 | V | | 1 kHz |
| | | | 0.9992 | 1.0008 | V | | 5 kHz |
| | | | 0.9992 | 1.0008 | V | | 10 kHz |
| | | | 0.994 | 1.006 | V | | 50 kHz |
| | | | 0.994 | 1.006 | V | | 100 kHz |
| | 10 | 1.1 | 1.09895 | 1.10105 | V | | 55 Hz |
| | | | 1.09895 | 1.10105 | V | | 1 kHz |
| | | | 1.09623 | 1.10377 | V | | 5 kHz |
| | | | 1.09623 | 1.10377 | V | | 10 kHz |
| | | | 1.0745 | 1.1255 | V | | 50 kHz |
| | | | 1.0745 | 1.1255 | V | | 100 kHz |
| | | 2.5 | 2.49825 | 2.50175 | V | | 55 Hz |
| | | | 2.49825 | 2.50175 | V | | 1 kHz |
| | | | 2.49525 | 2.50475 | V | | 5 kHz |
| | | | 2.49525 | 2.50475 | V | | 10 kHz |
| | | | 2.4675 | 2.5325 | V | | 50 kHz |
| | | | 2.4675 | 2.5325 | V | | 100 kHz |
| | | 5 | 4.997 | 5.003 | V | | 55 Hz |
| | | | 4.997 | 5.003 | V | | 1 kHz |
| | | | 4.9935 | 5.0065 | V | | 5 kHz |
| | | | 4.9935 | 5.0065 | V | | 10 kHz |
| | | | 4.955 | 5.045 | V | | 50 kHz |
| | | | 4.955 | 5.045 | V | | 100 kHz |
| | | 7.5 | 7.49575 | 7.50425 | V | | 55 Hz |
| | | | 7.49575 | 7.50425 | V | | 1 kHz |
| | | | 7.49175 | 7.50825 | V | | 5 kHz |
| | | | 7.49175 | 7.50825 | V | | 10 kHz |
| | | | 7.4425 | 7.5575 | V | | 50 kHz |
| | | | 7.4425 | 7.5575 | V | | 100 kHz |
| | | 10 | 9.9945 | 10.0055 | V | | 55 Hz |
| | | | 9.9945 | 10.0055 | V | | 1 kHz |
| | | | 9.99 | 10.01 | V | | 5 kHz |
| | | | 9.99 | 10.01 | V | | 10 kHz |
| | | | 9.93 | 10.07 | V | | 50 kHz |
| | | | 9.93 | 10.07 | V | | 100 kHz |
| | 100 | 11 | 10.9845 | 11.0155 | V | | 55 Hz |
| | | | 10.9845 | 11.0155 | V | | 1 kHz |
| | | | 10.9535 | 11.0465 | V | | 1.1 kHz |
| | | | 10.9535 | 11.0465 | V | | 5 kHz |
| | | | 10.9535 | 11.0465 | V | | 10 kHz |
| | | | 10.9535 | 11.0465 | V | | 10 kHz |
| | | 50 | 49.965 | 50.035 | V | | 55 Hz |
| | | | 49.965 | 50.035 | V | | 1 kHz |
| | | | 49.895 | 50.105 | V | | 1.1 kHz |
| | | | 49.895 | 50.105 | V | | 5 kHz |
| | | | 49.895 | 50.105 | V | | 10 kHz |
| | | | 49.895 | 50.105 | V | | 10 kHz |

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|----------------------------|-------|---------|-----------|-----------|------|---------------|-----------------|
| AC Voltage SINE | 100 | 100 | 99.94 | 100.06 | V | 8½ digit DMM | 55 Hz |
| | | | 99.94 | 100.06 | V | | 1 kHz |
| | | | 99.82 | 100.18 | V | | 1.1 kHz |
| | | | 99.82 | 100.18 | V | | 5 kHz |
| | | | 99.82 | 100.18 | V | | 10 kHz |
| | 1000 | 150 | 149.695 | 150.305 | V | | 55 Hz |
| | | | 149.695 | 150.305 | V | | 1 kHz |
| | | | 149.1 | 150.9 | V | | 1.1 kHz |
| | | | 149.1 | 150.9 | V | | 5 kHz |
| | | 500 | 499.45 | 500.55 | V | | 55 Hz |
| | | | 499.45 | 500.55 | V | | 1 kHz |
| | | | 498.4 | 501.6 | V | | 1.1 kHz |
| | | | 498.4 | 501.6 | V | | 5 kHz |
| | | 950 | 949.135 | 950.865 | V | | 55 Hz |
| | | | 949.135 | 950.865 | V | | 1 kHz |
| | | | 947.5 | 952.5 | V | | 1.1 kHz |
| | | | 947.5 | 952.5 | V | | 2.5 kHz |
| AC Voltage Square Shape | 10 | 10 | 9.949 | 10.051 | mV | 8½ digit DMM | 120 Hz |
| | 100 | 100 | 99.67 | 100.3 | mV | | 120 Hz |
| | 1 | 1 | 0.997 | 1.003 | V | | 120 Hz |
| | 10 | 10 | 9.97 | 10.03 | V | | 120 Hz |
| DC Current | 200 | -190 | -190.096 | -189.904 | μA | 8½ digit DMM | DC |
| | | -100 | -100.06 | -99.94 | μA | | |
| | | -10 | -10.024 | -9.976 | μA | | |
| | | 10 | 9.976 | 10.024 | μA | | |
| | | 100 | 99.94 | 100.06 | μA | | |
| | | 190 | 189.904 | 190.096 | μA | | |
| | 2 | -1.9 | -1.90048 | -1.89952 | mA | | |
| | | -1 | -1.0003 | -0.9997 | mA | | |
| | | -0.21 | -0.210142 | -0.209858 | mA | | |
| | | 0.21 | 0.209858 | 0.210142 | mA | | |
| | | 1 | 0.9997 | 1.0003 | mA | | |
| | | 1.9 | 1.89952 | 1.90048 | mA | | |
| | 20 | -19 | -19.00345 | -18.99655 | mA | | |
| | | -10 | -10.0021 | -9.9979 | mA | | |
| | | -2.1 | -2.100915 | -2.099085 | mA | | |
| | | 2.1 | 2.099085 | 2.100915 | mA | | |
| | | 10 | 9.9979 | 10.0021 | mA | | |
| | | 19 | 18.99655 | 19.00345 | mA | | |
| | 200 | -190 | -190.0345 | -189.9655 | mA | | |
| | | -100 | -100.021 | -99.979 | mA | | |
| | | -21 | -21.00915 | -20.99085 | mA | | |
| | | 21 | 20.99085 | 21.00915 | mA | | |
| | | 100 | 99.979 | 100.021 | mA | | |
| | | 190 | 189.9655 | 190.0345 | mA | | |

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|--------------------|-------|---------|-----------|-----------|------|---------------|-----------------|
| DC Current | 2 | -1.9 | -1.900385 | -1.899615 | A | 8½ digit DMM | DC |
| | | -1 | -1.00025 | -0.99975 | A | | |
| | | -0.21 | -0.210132 | -0.209869 | A | | |
| | | 0.21 | 0.209869 | 0.210132 | A | | |
| | | 1 | 0.99975 | 1.00025 | A | | |
| | | 1.9 | 1.899615 | 1.900385 | A | | |
| | 20.5 | -19 | -19.01155 | -18.98845 | A | | |
| | | -10 | -10.00705 | -9.99295 | A | | |
| | | -2.1 | -2.1031 | -2.0969 | A | | |
| | | 2.1 | 2.0969 | 2.1031 | A | | |
| | | 10 | 9.99295 | 10.00705 | A | | |
| | | 19 | 18.98845 | 19.01155 | A | | |
| AC Current SINE | 200 | 10 | 9.885 | 10.115 | μA | 8½ digit DMM | 55 Hz |
| | | | 9.885 | 10.115 | μA | | 1 kHz |
| | | | 9.78 | 10.22 | μA | | 5 kHz |
| | | | 9.77 | 10.23 | μA | | 10 kHz |
| | | | 9.55 | 10.45 | μA | | 20 kHz |
| | | 100 | 99.75 | 100.25 | μA | | 55 Hz |
| | | | 99.75 | 100.25 | μA | | 1 kHz |
| | | | 99.6 | 100.4 | μA | | 5 kHz |
| | | | 99.5 | 100.5 | μA | | 10 kHz |
| | | | 99.1 | 100.9 | μA | | 20 kHz |
| | | 190 | 189.615 | 190.385 | μA | | 55 Hz |
| | | | 189.615 | 190.385 | μA | | 1 kHz |
| | | | 189.42 | 190.58 | μA | | 5 kHz |
| | | | 189.23 | 190.77 | μA | | 10 kHz |
| | | | 188.65 | 191.35 | μA | | 20 kHz |
| | 2 | 0.21 | 0.20959 | 0.21041 | mA | | 55 Hz |
| | | | 0.20959 | 0.21041 | mA | | 1 kHz |
| | | | 0.20939 | 0.21061 | mA | | 5 kHz |
| | | | 0.209285 | 0.210715 | mA | | 10 kHz |
| | | | 0.20837 | 0.21163 | mA | | 20 kHz |
| | | 1 | 0.9988 | 1.0012 | mA | | 55 Hz |
| | | | 0.9988 | 1.0012 | mA | | 1 kHz |
| | | | 0.9986 | 1.0014 | mA | | 5 kHz |
| | | | 0.9981 | 1.0019 | mA | | 10 kHz |
| | | | 0.996 | 1.004 | mA | | 20 kHz |
| | | 1.9 | 1.8979 | 1.9021 | mA | | 55 Hz |
| | | | 1.8979 | 1.9021 | mA | | 1 kHz |
| | | | 1.8977 | 1.9023 | mA | | 5 kHz |
| | | | 1.89675 | 1.90325 | mA | | 10 kHz |
| | | | 1.8933 | 1.9067 | mA | | 20 kHz |

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|--------------------|-------|---------|-----------|-----------|------|---------------|-----------------|
| AC Current SINE | 20 | 2.1 | 2.09753 | 2.10247 | mA | 8½ digit DMM | 55 Hz |
| | | | 2.09753 | 2.10247 | mA | | 1 kHz |
| | | | 2.0939 | 2.1061 | mA | | 5 kHz |
| | | | 2.09285 | 2.10715 | mA | | 10 kHz |
| | | | 2.0837 | 2.1163 | mA | | 20 kHz |
| | | 10 | 9.992 | 10.008 | mA | | 55 Hz |
| | | | 9.992 | 10.008 | mA | | 1 kHz |
| | | | 9.986 | 10.014 | mA | | 5 kHz |
| | | | 9.981 | 10.019 | mA | | 10 kHz |
| | | | 9.96 | 10.04 | mA | | 20 kHz |
| | | 19 | 18.9857 | 19.0143 | mA | | 55 Hz |
| | | | 18.9857 | 19.0143 | mA | | 1 kHz |
| | | | 18.977 | 19.023 | mA | | 5 kHz |
| | | | 18.9675 | 19.0325 | mA | | 10 kHz |
| | | | 18.933 | 19.067 | mA | | 20 kHz |
| | 200 | 21 | 20.9753 | 21.0247 | mA | | 55 Hz |
| | | | 20.9753 | 21.0247 | mA | | 1 kHz |
| | | | 20.939 | 21.061 | mA | | 5 kHz |
| | | | 20.9285 | 21.0715 | mA | | 10 kHz |
| | | | 20.837 | 21.163 | mA | | 20 kHz |
| | | 100 | 99.92 | 100.08 | mA | | 55 Hz |
| | | | 99.92 | 100.08 | mA | | 1 kHz |
| | | | 99.86 | 100.14 | mA | | 5 kHz |
| | | | 99.81 | 100.19 | mA | | 10 kHz |
| | | | 99.6 | 100.4 | mA | | 20 kHz |
| | | 190 | 189.857 | 190.143 | mA | | 55 Hz |
| | | | 189.857 | 190.143 | mA | | 1 kHz |
| | | | 189.77 | 190.23 | mA | | 5 kHz |
| | | | 189.675 | 190.325 | mA | | 10 kHz |
| | | | 189.33 | 190.67 | mA | | 20 kHz |
| | 2 | 0.21 | 0.20969 | 0.21031 | A | | 55 Hz |
| | | | 0.20969 | 0.21031 | A | | 1 kHz |
| | | | 0.208685 | 0.211315 | A | | 5 kHz |
| | | | 0.20837 | 0.21163 | A | | 10 kHz |
| | | 1 | 0.9989 | 1.0011 | A | | 55 Hz |
| | | | 0.9989 | 1.0011 | A | | 1 kHz |
| | | | 0.9975 | 1.0025 | A | | 5 kHz |
| | | | 0.996 | 1.004 | A | | 10 kHz |
| | | 1.9 | 1.898 | 1.902 | A | | 55 Hz |
| | | | 1.898 | 1.902 | A | | 1 kHz |
| | | | 1.89615 | 1.90385 | A | | 5 kHz |
| | | | 1.8933 | 1.9067 | A | | 10 kHz |

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|----------------------------|-------|---------|-----------|-----------|------|-------------------|-----------------------|
| AC Current SINE | 20.5 | 2.1 | 2.0928 | 2.1072 | A | 8½ digit DMM | 55 Hz |
| | | | 2.0928 | 2.1072 | A | | 120 Hz |
| | | | 2.0928 | 2.1072 | A | | 1 kHz |
| | | 10 | 9.977 | 10.023 | A | | 55 Hz |
| | | | 9.977 | 10.023 | A | | 120 Hz |
| | | | 9.977 | 10.023 | A | | 1 kHz |
| | | 19 | 18.959 | 19.041 | A | | 55 Hz |
| | | | 18.959 | 19.041 | A | | 120 Hz |
| | | | 18.959 | 19.041 | A | | 1 kHz |
| AC Current Square Shape | 200 | 190 | 188.9 | 191.1 | µA | 8½ digit DMM | 120 Hz |
| | 2 | 1.9 | 1.894 | 1.906 | mA | | 120 Hz |
| | 20 | 19 | 18.94 | 19.06 | mA | | 120 Hz |
| | 200 | 190 | 189.4 | 190.6 | mA | | 120 Hz |
| | 2 | 1.9 | 1.894 | 1.906 | A | | 120 Hz |
| Frequency in AC Voltage | 100 | 100 | 99.999 | 100.001 | kHz | Frequency counter | 1 V |
| Frequency | 2 | 1 | 0.999995 | 1.000005 | MHz | | 1 V |
| RJ Meter in Temperature TC | - | 0.00 | -0.05 | +0.05 | °C | 1kΩ standard | 2kΩ range; see below |
| | - | 0.0 | -0.5 | +0.5 | °C | | 20kΩ range; see below |

Table 2 List of main test points

Verification of RJ Meter in Temperature TC function

1kΩ standard resistor and 9000-60 Adapter are required for RJ meter verification. See Application Note AN108 from <https://www.meatest.com/application-notes> for additional information.

1. Go to "Temperature TC" function
2. Set RJ Mode to External
3. Push "Meter" softkey, then go to RTD submenu and set R0 equal to nominal value of the 1kΩ standard resistor. Note down the original R0 value as you will need to revert this change at the end of the verification procedure.

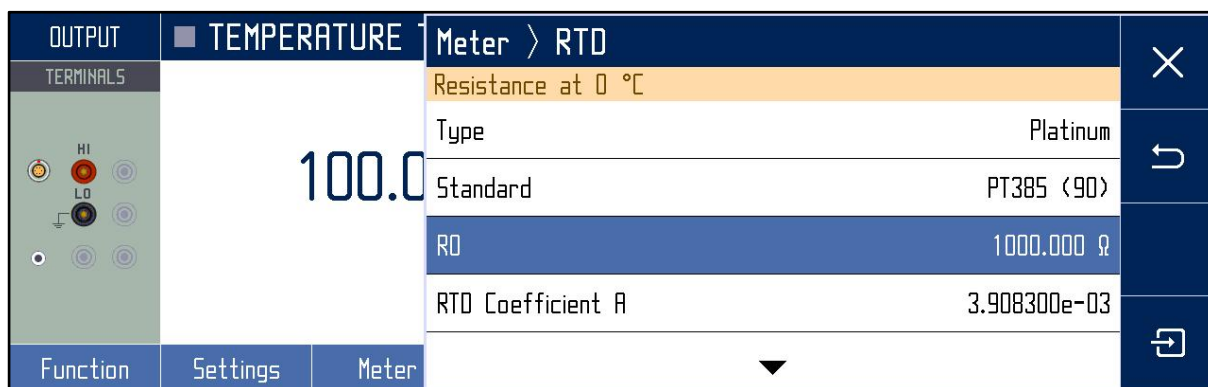


Figure 36 Temperature TC - RTD R0

- Go back to Meter menu and set Range to 2 k Ω

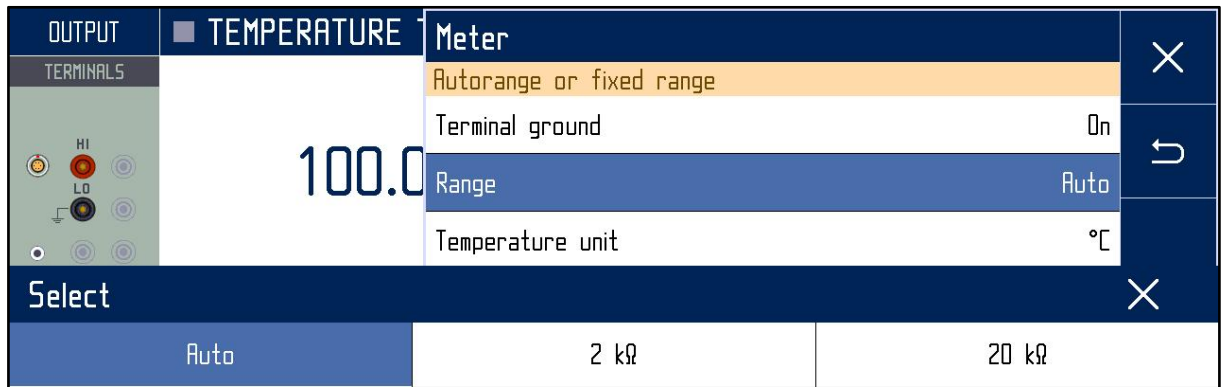


Figure 37 Temperature TC - RTD range

- Connect the 1k Ω standard resistor to TCcomp terminal of the 9000 calibrator using the 9000-60 Adapter
- Exit the Meter menu and read the first temperature reading from “RJ” field

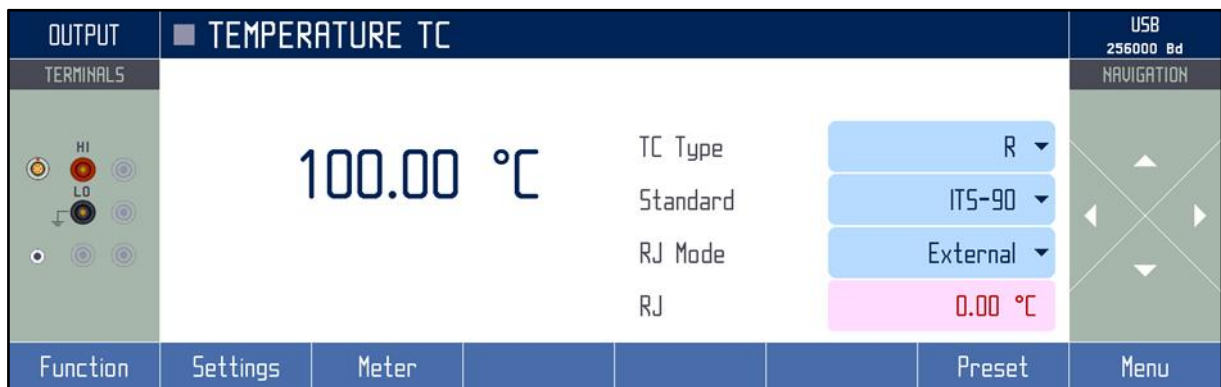


Figure 38 Temperature TC - RJ mode

- Push “Meter” softkey again, set Range to 20 k Ω , exit the Meter menu and read the second temperature reading from “RJ” field
- Finish the procedure by reverting R0 to its original value (typically 1000 Ω)

6.4. RC option test points

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|---------------------|-------|---------|-----------|-----------|------------|---------------|-----------------|
| Variable Resistance | 10 | 0 | -0.01 | 0.01 | Ω | 8½ digit DMM | 4W |
| | | 9 | 8.9855 | 9.0145 | Ω | | |
| | 100 | 15 | 14.98625 | 15.01375 | Ω | | |
| | | 30 | 29.9825 | 30.0175 | Ω | | |
| | | 40 | 39.98 | 40.02 | Ω | | |
| | | 90 | 89.9675 | 90.0325 | Ω | | |
| | 1000 | 150 | 149.9375 | 150.0625 | Ω | | |
| | | 300 | 299.9 | 300.1 | Ω | | |
| | | 400 | 399.875 | 400.125 | Ω | | |
| | | 900 | 899.75 | 900.25 | Ω | | |
| | 10 | 1.5 | 1.449775 | 1.550225 | k Ω | | |
| | | 3 | 2.94955 | 3.05045 | k Ω | | |
| | | 4 | 3.9494 | 4.0506 | k Ω | | |
| | | 9 | 8.94865 | 9.05135 | k Ω | | |
| | 100 | 15 | 14.49775 | 15.50225 | k Ω | | |
| | | 30 | 29.4955 | 30.5045 | k Ω | | |
| | | 40 | 39.494 | 40.506 | k Ω | | |
| | | 90 | 89.4865 | 90.5135 | k Ω | | |
| | 10 | 9 | 8.886 | 9.114 | Ω | | 2W |
| | 1000 | 150 | 149.965 | 150.035 | k Ω | | |
| | | 300 | 299.935 | 300.065 | k Ω | | |
| | | 400 | 399.915 | 400.085 | k Ω | | |
| | | 900 | 899.815 | 900.185 | k Ω | | |
| | 10 | 1.5 | 1.4993 | 1.5007 | M Ω | | |
| | | 3 | 2.9981 | 3.0019 | M Ω | | |
| | | 4 | 3.9975 | 4.0025 | M Ω | | |
| | | 9 | 8.9945 | 9.0055 | M Ω | | |
| | 120 | 15 | 14.915 | 15.085 | M Ω | | |
| | | 30 | 29.84 | 30.16 | M Ω | | |
| | | 40 | 39.79 | 40.21 | M Ω | | |
| | | 90 | 89.54 | 90.46 | M Ω | | |
| | 600 | 150 | 146.95 | 153.05 | M Ω | | |
| | | 300 | 293.95 | 306.05 | M Ω | | |
| | | 400 | 391.95 | 408.05 | M Ω | | |
| | | 600 | 587.95 | 612.05 | M Ω | | |

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|--|-------|---------|-----------|-----------|------------|---------------|----------------------|
| Fixed Resistance (min and max relative to calibration values) | 0 | 0 | -0.001 | +0.001 | Ω | 8½ digit DMM | 4W |
| | 10 | 10 | -0.01 | +0.01 | Ω | | |
| | 33 | 33 | -0.01 | +0.01 | Ω | | |
| | 100 | 100 | -0.015 | +0.015 | Ω | | |
| | 330 | 330 | -0.015 | +0.015 | Ω | | |
| | 1 | 1 | -0.0001 | +0.0001 | k Ω | | |
| | 3.3 | 3.3 | -0.00033 | +0.00033 | k Ω | | |
| | 10 | 10 | -0.0005 | +0.0005 | k Ω | | |
| | 33 | 33 | -0.00165 | +0.00165 | k Ω | | |
| | 100 | 100 | -0.005 | +0.005 | k Ω | | |
| | 330 | 330 | -0.02475 | +0.02475 | k Ω | | |
| | 0 | 0 | -0.1 | +0.1 | Ω | | 2W, low voltage mode |
| | 1 | 1 | -0.0001 | +0.0001 | M Ω | | |
| | 3.3 | 3.3 | -0.000825 | +0.00825 | M Ω | | |
| | 10 | 10 | -0.005 | +0.005 | M Ω | | |
| | 33 | 33 | -0.033 | +0.033 | M Ω | | |
| | 100 | 100 | -0.25 | +0.25 | M Ω | | |
| | 330 | 330 | -1.65 | +1.65 | M Ω | | |

| Function | Range | Nominal | Min value | Max value | Unit | Standard unit | Test parameters |
|---|-------|---------|-----------|-----------|------|--|-----------------|
| Variable Capacitance | 10 | 2 | 1.979 | 2.021 | nF | LCR meter (see note on page 30 for proper connection setup) | 1 kHz |
| | | 5.5 | 5.479 | 5.521 | nF | | |
| | | 6.5 | 6.479 | 6.521 | nF | | |
| | | 9 | 8.979 | 9.021 | nF | | |
| | 100 | 15 | 14.955 | 15.045 | nF | | 100 Hz |
| | | 55 | 54.835 | 55.165 | nF | | |
| | | 65 | 64.805 | 65.195 | nF | | |
| | | 90 | 89.73 | 90.27 | nF | | |
| | 1000 | 150 | 149.55 | 150.45 | nF | | |
| | | 550 | 548.35 | 551.65 | nF | | |
| | | 650 | 648.05 | 651.95 | nF | | |
| | | 900 | 897.3 | 902.7 | nF | | |
| | 10 | 1.5 | 1.4955 | 1.5045 | μF | | |
| | | 5.5 | 5.4835 | 5.5165 | μF | | |
| | | 6.5 | 6.4805 | 6.5195 | μF | | |
| | | 9 | 8.973 | 9.027 | μF | | |
| | 100 | 15 | 14.955 | 15.045 | μF | | |
| | | 55 | 54.835 | 55.165 | μF | | |
| | | 65 | 64.805 | 65.195 | μF | | |
| | | 90 | 89.73 | 90.27 | μF | | |
| | 1000 | 150 | 149.55 | 150.45 | μF | 8½ digit DMM | Ramp method |
| | | 550 | 548.35 | 551.65 | μF | | |
| | | 650 | 648.05 | 651.95 | μF | | |
| | | 900 | 897.3 | 902.7 | μF | | |
| | 10 | 1.5 | 1.4955 | 1.5045 | mF | | |
| | | 5.5 | 5.4835 | 5.5165 | mF | | |
| | | 6.5 | 6.4805 | 6.5195 | mF | | |
| | | 9 | 8.973 | 9.027 | mF | | |
| | 120 | 15 | 14.925 | 15.075 | mF | | |
| | | 55 | 54.725 | 55.275 | mF | | |
| | | 65 | 64.675 | 65.325 | mF | | |
| | | 100 | 99.5 | 100.5 | mF | | |
| Fixed Capacitance (min and max relative to calibration values) | 1 | 1 | -0.0125 | +0.0125 | nF | LCR meter (see note on page 30 for proper connection setup) | 1 kHz |
| | 3.3 | 3.3 | -0.02475 | +0.02475 | nF | | |
| | 10 | 10 | -0.035 | +0.035 | nF | | |
| | 33 | 33 | -0.1155 | +0.1155 | nF | | 100 Hz |
| | 100 | 100 | -0.25 | +0.25 | nF | | |
| | 330 | 330 | -0.825 | +0.825 | nF | | |
| | 1 | 1 | -0.0025 | +0.0025 | μF | | |
| | 3.3 | 3.3 | -0.00825 | +0.00825 | μF | | |
| | 10 | 10 | -0.025 | +0.025 | μF | | |

Table 3 List of RC option test points

7. Adjustment

Adjustment is done through MENU > Calibration > Data. This menu item is password protected, default factory set calibration code is “9000”.

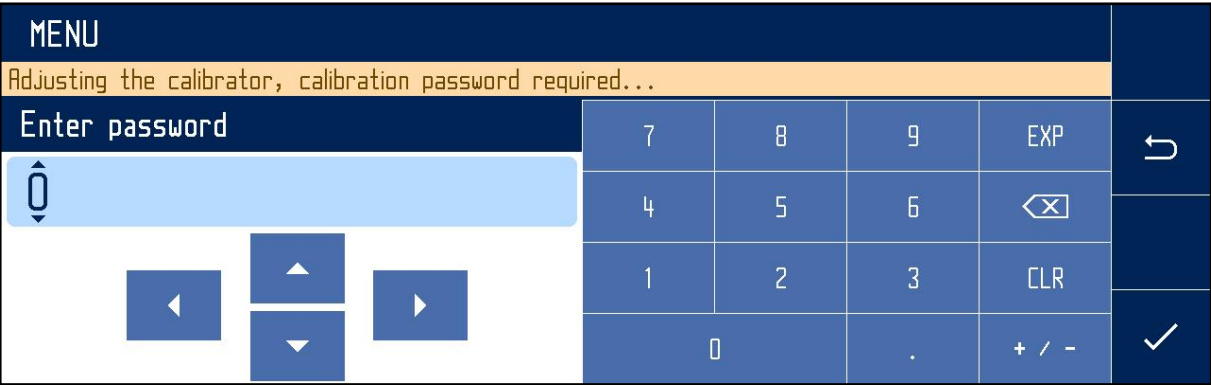


Figure 39 Password entry

7.1. Calibration menu structure

Calibration data are sorted in a tree structure with following hierarchy:

1. Function groups (source and measurement)
2. Functions (f.e. Voltage DC)
3. Ranges (f.e. 10 V)
4. Calibration points (f.e. zero offset)

As with any other menu you can navigate through the tree structure using navigation buttons or pressing directly on the screen.

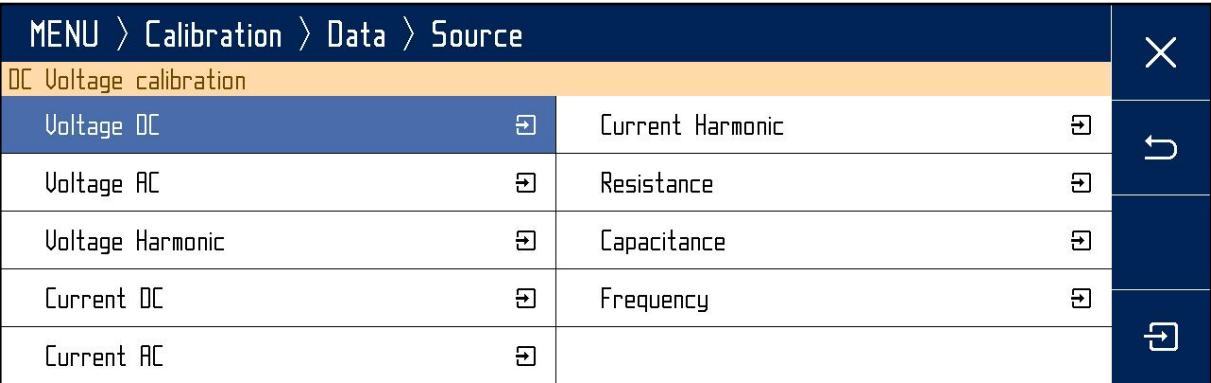


Figure 40 Calibration menu

Once range level of the tree structure is reached, calibration points are displayed in following format:



Figure 41 Calibration point adjustment – direct

Upper part shows selected function and range on the left, selected calibration point on the left and remote control command used to access this specific point in tooltip bar on top. Lower part of the display shows:

- Nominal value
- Requested accuracy of used calibration standard
- Last calibration date of this point
- Calibration value (only this can be modified)

History of each calibration point can be recalled using History button. History shows all previously saved values in a table, including date and relative drift from the first value ever recorded.

7.2. Calibration point adjustment

Two different approaches to calibration value adjustment are applied in 9000:

- Values denoted in % or without any unit (mostly used in source functions with continuous ranges like V_{dc} function in fig. above) show relative position within selected range. Such points can be adjusted by changing the value so that the standard readout gets as close to nominal value as possible.
- Values with other units (mostly used in meter functions or fixed source standards) can be calibrated indirectly by typing in meter readout. Figure below shows an example of 3.3 k Ω point of fixed resistance function.

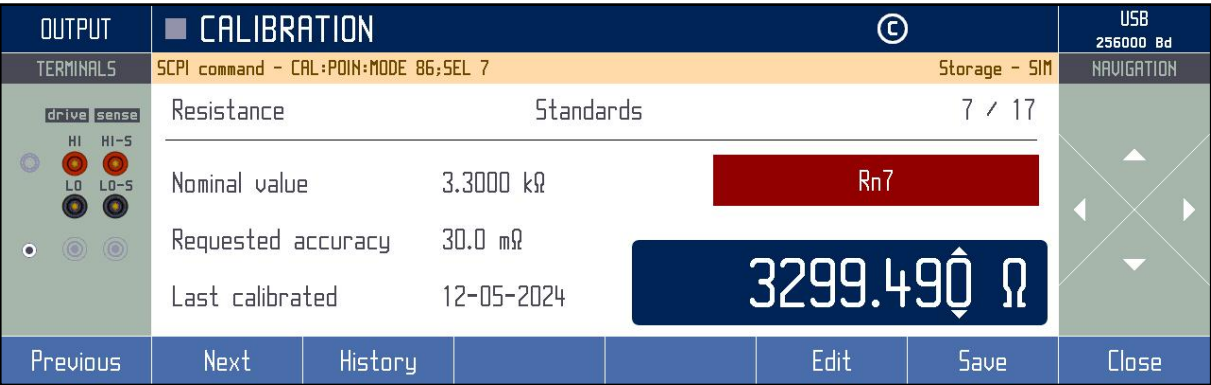


Figure 42 Calibration point adjustment - indirect

In both cases the procedure starts by connecting required standard to relevant terminals as shown on the right side of display. Meter functions measure all the time, source functions have to be switched on first using OUTPUT button. Then adjust the main value accordingly and confirm with SAVE button.

HISTORY button allows you to check all previous values of this specific calibration point, PREVIOUS and NEXT button navigate through other calibration points in selected range.

It is strongly recommended to periodically adjust all calibration points at once and in order as described in chapter 6.3 in order to maintain instrument specifications. That said, the instrument can be also adjusted partially, i.e. in particular functions or ranges only. If adjustment of next calibration point is not possible (f.e. when required standard is not available), the point can be skipped and old calibration data can be confirmed. However, specification can no longer be guaranteed in that range or function.

7.3. List of calibration points

Process of adjustment mostly involves changing offsets and slopes of individual ranges and other factors.

7.3.1. Voltage and current DC functions

| Function | Range | Nominal value | | | |
|------------|--------|---------------|-------------|--------------|--------------|
| | | Offset + | Offset - | Full range + | Full range - |
| Voltage DC | 10 mV | 0.000 mV | 0.000 mV | +10.000 mV | -10.000 mV |
| | 100 mV | 0.000 mV | 0.000 mV | +100.000 mV | -100.000 mV |
| | 1 V | 0.000 000 V | 0.000 000 V | +1.000 000 V | -1.000 000 V |
| | 10 V | 0.000 00 V | 0.000 00 V | +10.000 00 V | -10.000 00 V |
| | 100 V | 0.000 0 V | 0.000 0 V | +100.000 0 V | -100.000 0 V |
| | 1050 V | 0.000 0 V | 0.000 0 V | +750.000 0 V | -750.000 0 V |
| Current DC | 200 µA | 0.000 µA | 0.000 µA | +190.000 µA | -190.000 µA |
| | 2 mA | 0.000 00 mA | 0.000 00 mA | +1.900 00 mA | -1.900 00 mA |
| | 20 mA | 0.000 0 mA | 0.000 0 mA | +19.000 0 mA | -19.000 0 mA |
| | 200 mA | 0.000 mA | 0.000 mA | +190.000 mA | -190.000 mA |
| | 2 A | 0.000 00 A | 0.000 00 A | +1.900 00 A | -1.900 00 A |
| | 20.5 A | 0.000 0 A | 0.000 0 A | +19.000 0 A | -19.000 0 A |

Table 4 Calibration points – DC voltage and current

7.3.2. Voltage and current AC functions

| Function | Range | Nominal value | |
|---------------------|--------|---------------|------------------|
| | | Offset 1 kHz | Full range 1 kHz |
| Voltage AC sine | 10 mV | 3.000 mV | 10.000 mV |
| | 100 mV | 10.000 mV | 100.000 mV |
| | 1 V | 0.100 00 V | 1.000 00 V |
| | 10 V | 1.000 0 V | 10.000 0 V |
| | 100 V | 10.000 V | 100.000 V |
| | 1050 V | 100.000 V | 750.000 V |
| Voltage AC non-sine | 10 mV | 1.0 mV | 10.0 mV |
| | 100 mV | 10.0 mV | 100 mV |
| | 1 V | 100 mV | 1.00 V |
| | 10 V | 1.00 V | 10.0 V |
| | 100 V | 10.0 V | 100 V |
| | 1050 V | 100 V | 750 V |
| Current AC sine | 200 µA | 19.000 µA | 190.000 µA |
| | 2 mA | 0.190 00 mA | 1.900 00 mA |
| | 20 mA | 1.900 0 mA | 19.000 0 mA |
| | 200 mA | 190.00 mA | 190.000 mA |
| | 2 A | 0.190 00 A | 1.900 00 A |
| | 20.5 A | 1.900 0 A | 19.000 0 A |
| Current AC non-sine | 200 µA | 19.0 µA | 190 µA |
| | 2 mA | 190 µA | 1.9 mA |
| | 20 mA | 1.9 mA | 19 mA |
| | 200 mA | 19 mA | 190 mA |
| | 2 A | 190 mA | 1.9 A |
| | 20.5 A | 1.9 A | 19 A |

Table 5 Calibration points – AC voltage and current

7.3.3. Frequency function

Single point adjustment of internal oscillator at 5 V @ 1 MHz adjusts frequency of Voltage AC, Current AC, Frequency and Duty Cycle functions.

7.3.4. Resistance function

Background Offsets rarely change over time but can be affected by hardware damage. As such, they shall be used mostly as an indication of hardware damage and not adjusted frequently.

| Subsection | Adjustment point | Nominal value | Method |
|--------------------|--------------------|----------------|--|
| Standards | Rn1 | 0 Ω | 4W resistance measurement |
| | Rn2 | 10 Ω | |
| | Rn3 | 33 Ω | |
| | Rn4 | 100 Ω | |
| | Rn5 | 330 Ω | |
| | Rn6 | 1 k Ω | |
| | Rn7 | 3.3 k Ω | |
| | Rn8 | 10 k Ω | |
| | Rn9 | 33 k Ω | |
| | Rn10 | 100 k Ω | |
| | Rn11 | 330 k Ω | |
| | Rn12 | 1 M Ω | 2W resistance measurement |
| | Rn13 | 3.3 M Ω | |
| | Rn14 | 10 M Ω | |
| | Rn15 | 33 M Ω | |
| | Rn16 | 100 M Ω | |
| | Rn17 | 330 M Ω | |
| Simulator Gain | Gain Lo | 400 Ω | 4W resistance measurement |
| | Gain Mid | 1.6 k Ω | |
| | Gain Hi | 3.5 k Ω | |
| Background Offsets | 2W Fixed Short | 0 Ω | 2W resistance measurement |
| | 2W Variable Short | 0 Ω | |
| | 2W Variable Hi Res | 100 M Ω | |
| | Voltage 2W Lo | 0 V | DC voltage measurement / zero monitoring |
| | Voltage 2W Hi | 0 V | |
| | Voltage 2W0 Lo | 0 V | |
| | Voltage 4W Lo | 0 V | |
| | Voltage 2W COMP Lo | 0 V | |

Table 6 Calibration points – Resistance

7.3.5. Capacitance function

Background Offsets rarely change over time but can be affected by hardware damage. As such, they shall be used mostly as an indication of hardware damage and not adjusted frequently.

Capacitance simulator shares gain amplifier with resistance function. See Resistance > Simulator Gain subsection in order to adjust gain of capacitance function.

| Subsection | Adjustment point | Nominal value | Method |
|--------------------|------------------|---------------|--|
| Standards | Cn1 | 1 nF | DC capacitance measurement (using multimeter) |
| | Cn2 | 3.3 nF | |
| | Cn3 | 10 nF | |
| | Cn4 | 33 nF | |
| | Cn5 | 100 nF | |
| | Cn6 | 330 nF | |
| | Cn7 | 1 μ F | |
| | Cn8 | 3.3 μ F | |
| | Cn9 | 10 μ F | |
| | x10 | 100 μ F | |
| | x100 | 1 mF | |
| | x1k | 10 mF | |
| | x10k | 100 mF | |
| Background Offsets | DC Absolute | 0 F | DC capacitance measurement (using multimeter). See note below the table. |
| | DC Relative Lo | 0 F | |
| | DC Relative Hi | 0 F | |
| | AC Absolute | 0 F | AC capacitance measurement (using LCR bridge). See note below the table. |
| | AC Relative Lo | 0 F | |
| | AC Relative Hi | 0 F | |

Note: Background Offsets adjustment requires cable compensation to be done before each point. Procedure is as follows: 1) Press Open softkey and turn calibrator OUTPUT on, 2) connect the meter as shown on calibrator display, 3) null the multimeter (or do open correction when using LCR bridge), 4) Press Open softkey again to disable correction mode, 5) connect the meter as shown on calibrator display, 6) enter meter reading into the calibrator and press Save softkey to confirm the change.

Table 7 Calibration points – Capacitance

7.3.6. Meter function

This function is used for calibration resistance meter of temperature sensors used for cold junction compensation.

| Function | Range | Nominal value | |
|------------|---------------|---------------------|----------------------------------|
| | | Offset | Full range + |
| Resistance | 2 k Ω | 0.000 00 k Ω | 1.000 00 k Ω ¹ |
| | 20 k Ω | 0.000 0 k Ω | 10.000 0 k Ω |

1. Note: To get more accurate temperature readings with the Opt 91, it's recommended to adjust the calibrator's measurement range at 100 Ohms instead of 1 kOhm. Keep in mind that this might push the upper end of the range (typically 2 kOhm) outside specified limits.

Table 7 Calibration points – Meter

7.3.7. Cold junction compensator calibration

For calibration of cold junction compensator look up: [AN108 Option 91 Verification and Calibration manual](#).

8. Maintenance

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

8.1. Fuse replacement

9000 calibrator has user-replaceable fuse located on rear panel. Replace the fuse as follows:

1. Switch the calibrator off and disconnect power cord from it
2. Locate the fuse to be replaced: Main 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.

8.2. External surface cleaning

To keep the device in mint condition, clean the case using a soft cloth slightly dampened with either water or a non-abrasive mild cleaning solution that is not harmful to plastics.

8.3. Firmware update

Internal firmware can be updated by user. It is recommended check for firmware updates every 6 months or so to get the latest UI improvements, new features and bug fixes. To do this:

1. Go to www.meatest.com/drivers-updates and find firmware update file (.upl) for your device. If your device is not listed, contact Meatest support and ask for firmware update file for your device.
2. Check if the update file version is greater than yours, installed FW version can be found in MENU > Information > Software version. If the installed version is the same, stop the update process.
3. Download Uploader program from the same website and install it if you haven't already.
4. Connect the instrument to your PC using USB cable and use Uploader to update your instrument's firmware. The calibrator will be restarted once the update is finished.
5. Check installed FW version.

8.4. Error messages

The following table lists an overview of error codes that you might come across when operating the calibrator manually. Complete list of errors is available in SCPI manual.

| Error code groups | Description and most notable error codes |
|-------------------|--|
| -1000 - 999 | SCPI errors. Check SCPI command in separate manual. |
| 1000-5999 | Internal errors are detected by internal processors. Try updating internal firmware to the latest version as described in chapter 8.3 and if the error persists, please report this error to the Service Center. |
| 6000-6999 | User interface errors prevent the user from entering incorrect values from keyboard and accessing unavailable features. |
| | <u>6009</u> : Access denied. Entered calibration password is invalid. To reset password contact us. |
| | <u>6032</u> : Device is locked in remote control mode. Press "Go to Local" button to exit. |
| | <u>6043</u> : Value exceeded user global limit. Check global limits and change them in case of need. |
| 7000-7099 | Errors caused by missing or damaged hardware. Restart the instrument and if the error persists, please report this error to the Service Center. |
| | <u>7006</u> : Internal fan stopped!. Check if fan is rotating, otherwise turn off the device to prevent overheating. |
| | <u>7023</u> : Current amplifier overheating protection. Check inlet and outlet perforation and remove items that can block air flow. |
| 7100-7999 | Protective element has been triggered and output/input has been shut off in order to prevent calibrator damage. Check for excessive load and/or external voltage at terminals. If the error persists, please report this error to the Service Center. |
| | <u>7100</u> : 1V Amplifier overload! It's used for 1V range and lower ranges. Disconnect cables from output terminals and turn on output to verify proper function. Check connected load if it exceeds maximal output current limits. |
| | <u>7101</u> : 10V Amplifier overload! It's used for 10V range and higher ranges. Disconnect cables from output terminals and turn on output to verify proper function. Check connected load if it exceeds maximal output current limits. |
| | <u>7102</u> : Hi-Current amplifier overload! It is used for 20 A range. Short output terminals and turn on output to verify proper function. Check connected load if it exceeds maximal output voltage limits. |
| | <u>7103</u> : Lo-Current amplifier overload! It is used for 2 A range and lower ranges. Short output terminals and turn on output to verify proper function. Check connected load if it exceeds maximal output voltage limits. |
| | <u>7104</u> : Simulator current overload! Check if source doesn't exceed maximal limits. |
| | <u>7105</u> : Simulator voltage overload! Check if source doesn't exceed maximal limits. |
| | <u>7106</u> : The current terminals are open! Short output terminals and turn on output to verify proper function. Check connected load if it exceeds maximal output voltage limits. |
| 8000-8999 | Calibration data errors can occur when working with calibration data. They also diagnose calibration backup errors. |
| 9000-10999 | Preset errors usually come up when trying to create, modify or delete a device or harmonic setup preset in a way which would corrupt preset data like reusing existing names, deleting actively used presets or exceeding memory capacity. See chapter 3.6 for more details. |
| 11000-11999 | Exceeding the limits of internal meters: The instrument contains a number of internal meters that monitor voltage and current limits at the terminals, the temperatures of some important parts of the device, and other meters. Some of these errors may disconnect the output terminals. |
| | <u>11004</u> , <u>11005</u> , <u>11006</u> : The Hi-Current amplifier temperature is too high. Check inlet and outlet perforation and remove items that can block air flow. Check fan functionality. |
| | <u>11007</u> : The current terminals are open! Short output terminals and turn on output to verify proper function. Check connected load if it exceeds maximal output voltage limits. |
| | <u>11008</u> : Power supply temperature is too high. Check inlet and outlet perforation and remove items that can block air flow. |

Table 6 Error code list

9. Specifications

All absolute uncertainty specifications in this document are defined at a confidence interval of 95%, extension coefficient $k = 2$. Uncertainties include 12 months long-term stability, temperature coefficient, linearity, load and line regulation and the traceability of factory and National calibration standards. Recommended recalibration interval is 1 year.

Ambient conditions

| | |
|--------------------------|--|
| Reference conditions: | +21 – +25 °C, max. 70% relative humidity |
| Operating conditions: | +13 – +33 °C, max. 70% relative humidity, max. altitude 3 km |
| Storage conditions: | -10 – +55 °C, max. altitude 12 km |
| Temperature coefficient: | 10 % of specifications per °C outside T_{ref} |

General

| | |
|-------------------------|--|
| Warm-up time: | 30 minutes |
| Power supply: | 115/230 V \pm 10 % – 50/60 Hz, 450 VA max. |
| EMC compliance: | Safety class I according to IEC 61010 ed. 2 ESD class I according to EN 61326 Overvoltage CAT II Pollution Degree 2 |
| Dimensions (W x H x D): | 390 x 128 x 430 mm |
| Weight: | 11 kg (basic version) |

9.1. Voltage

| | |
|------------------------|---|
| DCV range summary: | 0.00000 mV – 1050.000 V |
| ACV range summary: | 1.00000 mV _{rms} – 1050.000 V _{rms} |
| Voltage ranges: | auto, 10 mV, 100 mV, 1 V, 10 V, 100 V, 1050 V |
| Range limits: | 150 – 1050 V for 1050V range, 5 – 100 % of range otherwise |
| Available AC units: | RMS, peak, peak-peak, average |
| Frequency range: | 10.000 Hz – 100.00 kHz below 10 V 40.000 Hz – 10.000 kHz up to 100 V 40.000 Hz – 5.000 kHz up to 500 V 40.000 Hz – 2.500 kHz above 500 V |
| Frequency uncertainty: | 5 ppm |
| Voltage output modes: | passive 50 Ω output up to 100 mV active output above 100 mV |

DCV Absolute Uncertainty [% of value + % of range]

| Range | Uncertainty |
|------------------------|----------------|
| 0.0000 mV – 10.0000 mV | 0.020 + 0.060 |
| 10.000 mV – 100.000 mV | 0.010 + 0.0060 |
| 0.10000 V – 1.00000 V | 0.006 + 0.0010 |
| 1.0000 V – 10.0000 V | 0.006 + 0.0005 |
| 10.000 V – 100.000 V | 0.006 + 0.0010 |
| 100.00 V – 1050.00 V | 0.009 + 0.0015 |

ACV Absolute Uncertainty [% of value + % of range]

| Range | 10 Hz – 1 kHz ¹ | 1 kHz – 10 kHz ² | 10 kHz – 20 kHz | 20 kHz – 100 kHz |
|-----------------------------------|----------------------------|-----------------------------|-----------------|------------------|
| 1.0000 mV – 10.0000 mV | 0.10 + 0.20 | 0.20 + 0.30 | 0.35 + 0.40 | 0.50 + 0.60 |
| 10.000 mV – 100.000 mV | 0.10 + 0.05 | 0.15 + 0.07 | 0.30 + 0.15 | 0.50 + 0.20 |
| 0.10000 V – 1.00000 V | 0.05 + 0.005 | 0.07 + 0.01 | 0.15 + 0.04 | 0.50 + 0.10 |
| 1.0000 V – 10.0000 V | 0.05 + 0.005 | 0.07 + 0.03 | 0.15 + 0.08 | 0.50 + 0.20 |
| 10.000 V – 100.000 V | 0.05 + 0.010 | 0.15 + 0.03 | N/A | N/A |
| 100.00 V – 1050.00 V ² | 0.07 + 0.020 | 0.2 + 0.06 | N/A | N/A |

2. Minimum frequency is 40 Hz above 10 V.

3. Limited to 5 kHz between 100 V and 500 V and 2.5 kHz above 500 V.

Distortion and Load Characteristics

| Parameter | Range | 10 mV | 100 mV | 1 V | 10 V | 100 V | 1050 V |
|--------------------------|----------------|---------------------|---------------------|----------------------|----------------------|----------------------|---------------------|
| THD + noise ³ | 10 – 20 Hz | 0.2 % + 100 μ V | 0.1 % + 100 μ V | 0.15 % + 200 μ V | 0.15 % + 400 μ V | 0.15 % + 4 mV | 0.15 % + 40 mV |
| | 20 – 1000 Hz | 0.2 % + 100 μ V | 0.1 % + 100 μ V | 0.06 % + 200 μ V | 0.06 % + 400 μ V | 0.06 % + 4 mV | 0.06 % + 40 mV |
| | 1 – 10 kHz | 0.2 % + 100 μ V | 0.1 % + 100 μ V | 0.06 % + 200 μ V | 0.06 % + 400 μ V | 0.1 % + 4 mV | 0.15 % + 40 mV |
| | 10 – 20 kHz | 0.2 % + 100 μ V | 0.1 % + 100 μ V | 0.15 % + 200 μ V | 0.15 % + 400 μ V | N/A | N/A |
| | 20 – 100 kHz | 0.4 % + 100 μ V | 0.2 % + 100 μ V | 0.25 % + 200 μ V | 0.5 % + 400 μ V | N/A | N/A |
| Burden current | DC | 50 Ω output | 50 Ω output | 30 mA | 50 mA | 20 mA | 4 mA |
| | 10 – 10 000 Hz | 50 Ω output | 50 Ω output | 10 mA _{rms} | 50 mA _{rms} | 20 mA _{rms} | 4 mA _{rms} |
| | 10 – 100 kHz | 50 Ω output | 50 Ω output | | | N/A | N/A |

4. Includes non-linear distortion and non-harmonic noise up to 500 kHz.

Non-sinusoidal waveforms

Waveforms: symmetrical square, ramp up, ramp down, triangle, truncated sinus with THD 13.45 %, harmonics

Voltage range: 1.00000 mV_{pk} – 14.1 V_{pk}

Frequency range: 10.000 – 1000.00 Hz

Peak value uncertainty: 0.21 % of value + 0.1% of range + 20 μ V_{pk}

9.2. Current

DCI range summary: 0.0000 μ A – 20.50000 A^{*4}

ACI range summary: 10.0000 μ A_{rms} – 20.50000 A_{rms}^{*4}

Current ranges: auto, 200 μ A, 2 mA, 20 mA, 200 mA, 2 A, 20.5 A^{*4}

Range limits: 5 – 100 % of range

Available AC units: RMS, peak, peak-peak, average

Frequency range: 10.000 Hz – 20.0000 kHz below 200 mA
10.000 Hz – 5.0000 kHz for 200 mA – 2 A
10.000 Hz – 1000.00 Hz above 2 A

Frequency uncertainty: 5 ppm

DCI Absolute Uncertainty [% of value + % of range]

| Range | Uncertainty |
|--------------------------------------|---------------|
| 0.000 μ A – 200.000 μ A | 0.040 + 0.010 |
| 0.20000 mA – 2.00000 mA | 0.020 + 0.005 |
| 2.0000 mA – 20.0000 mA | 0.015 + 0.003 |
| 20.000 mA – 200.000 mA | 0.015 + 0.003 |
| 0.2000 A – 2.0000 A | 0.015 + 0.005 |
| 2.0000 A – 20.500 A ^{*4 *5} | 0.05 + 0.01 |

5. 20.5A range is optional.

6. 30 min – 5 min maximum continuous output time. Depleted time regenerates 2x slower.

ACI Absolute Uncertainty [% of value + % of range]

| Range | 10 Hz – 1 kHz | 1 kHz – 5 kHz | 5 kHz – 10 kHz | 10 kHz – 20 kHz |
|--------------------------------------|---------------|---------------|----------------|-----------------|
| 1.000 μ A – 200.000 μ A | 0.15 + 0.05 | 0.20 + 0.10 | 0.30 + 0.10 | 0.50 + 0.20 |
| 0.20000 mA – 2.00000 mA | 0.10 + 0.010 | 0.10 + 0.02 | 0.15 + 0.02 | 0.30 + 0.05 |
| 2.0000 mA – 20.0000 mA | 0.07 + 0.005 | 0.10 + 0.02 | 0.15 + 0.02 | 0.30 + 0.05 |
| 20.000 mA – 200.000 mA | 0.07 + 0.005 | 0.10 + 0.02 | 0.15 + 0.02 | 0.30 + 0.05 |
| 0.2000 A – 2.0000 A | 0.10 + 0.005 | 0.15 + 0.05 | 0.30 + 0.05 | N/A |
| 2.0000 A – 20.500 A ^{*6 *7} | 0.20 + 0.015 | N/A | N/A | N/A |

7. 20.5A range is optional.

8. 30 min – 5 min maximum continuous output time. Depleted time regenerates 2x slower.

Distortion and Load Characteristics

| Parameter | Range | 200 μ A | 2 mA | 20 mA | 200 mA | 2 A | 20.5 A |
|---------------------------|-----------------|--------------------|--------------------|--------------------|---------------------|--------------------|--------------------|
| Max. inductive load | 10 Hz – 20 kHz | 1 H | 100 mH | 100 mH | 10 mH | 1 mH | 500 μ H |
| THD + noise ^{*8} | 10 Hz – 1 kHz | 0.1 % + 1 μ A | 0.1 % + 2 μ A | 0.1 % + 10 μ A | 0.1 % + 100 μ A | 0.2 % + 4 mA | 0.3 % + 8 mA |
| | 1 kHz – 5 kHz | 0.2 % + 1 μ A | 0.2 % + 2 μ A | 0.2 % + 10 μ A | 0.2 % + 100 μ A | 0.5 % + 4 mA | N/A |
| | 5 kHz – 10 kHz | 0.2 % + 1 μ A | 0.2 % + 2 μ A | 0.2 % + 10 μ A | 0.2 % + 100 μ A | 0.6 % + 4 mA | N/A |
| | 10 kHz – 20 kHz | 0.5 % + 1 μ A | 0.5 % + 2 μ A | 0.5 % + 10 μ A | 0.5 % + 100 μ A | N/A | N/A |
| Compliance voltage | DC | 5 V | 5 V | 8 V | 5V | 5 V | 2 V |
| | 10 Hz – 1 kHz | 4 V _{rms} | 4 V _{rms} | 4 V _{rms} | 4 V _{rms} | 4 V _{rms} | 2 V _{rms} |
| | 1 kHz – 10 kHz | 3 V _{rms} | 3 V _{rms} | 3 V _{rms} | 3 V _{rms} | 2 V _{rms} | N/A |
| | 10 kHz – 20 kHz | 2 V _{rms} | 2 V _{rms} | 2 V _{rms} | 2 V _{rms} | N/A | N/A |
| Load adder ^{*9} | DC | 100 nA/V | 150 nA/V | 250 nA/V | 2 μ A/V | 100 μ A/V | 500 μ A/V |
| | 10 Hz – 1 kHz | 100 nA/V | 150 nA/V | 250 nA/V | 2 μ A/V | 100 μ A/V | N/A |
| | 1 kHz – 10 kHz | 2 μ A/V | 2 μ A/V | 2 μ A/V | 5 μ A/V | 200 μ A/V | N/A |
| | 10 kHz – 20 kHz | 5 μ A/V | 5 μ A/V | 5 μ A/V | 10 μ A/V | N/A | N/A |

9. THD in bandwidth up to 500 kHz

10. Additional uncertainty for compliance voltage above 0.5 V_{rms}

Non-sinusoidal waveforms

Waveforms: symmetrical square, ramp up, ramp down, triangle, truncated sinus with THD 13.45 %, harmonics

Current range: 100.0000 μ A_{rms} – 2.000000 A_{rms} (2.83 A_{pk} max.)

Frequency range: 10.000 – 1000.00 Hz

Peak value uncertainty: 0.21 % of value + 0.1% of range + 700 nA_{pk}

9.3. Frequency Output

| | |
|---------------------|---|
| Waveform type: | positive 100 mVpk, 1 Vpk, 5 Vpk |
| Amplitude accuracy: | 20 % |
| Frequency range: | 0.100 00 Hz to 2.000 00 MHz (unspecified to 20 MHz) |
| Frequency accuracy: | 5 ppm |

9.4. Duty cycle

| | |
|----------------------|---------------------------|
| Duty cycle range: | 0.1 % to 99.9 % |
| Duty cycle accuracy: | 0.05 % |
| Waveform type: | symmetrical square |
| Voltage range: | 1 mVpk to 14.1 Vpk |
| Amplitude accuracy: | 0.5 % + 100 μ V |
| Frequency range: | 0.100 0 Hz to 1.000 0 kHz |
| Frequency accuracy: | 5 ppm |

9.5. Thermocouple Temperature Sensor Simulation

| | |
|----------------------------|---------------------------------------|
| Temperature range summary: | -250.00 – 2315.00 °C (by sensor type) |
| Thermocouple types: | B, C, D, E, G2, J, K, M, N, R, S, T |
| Cold junction comp. modes: | off, manual, automatic |

Ranges and uncertainties of TC sensor simulation [°C]

| | | | | | |
|----------------------|-------------|-------------|------------|-------------|-------------|
| R | range | -50 – 100 | 100 – 400 | 400 – 1000 | 1000 – 1767 |
| | uncertainty | 0.96 | 0.55 | 0.44 | 0.39 |
| S | range | -50 – 100 | 100 – 250 | 250 – 1400 | 1400 – 1767 |
| | uncertainty | 0.90 | 0.56 | 0.49 | 0.40 |
| B | range | 400 – 800 | 800 – 1000 | 1000 – 1500 | 1500 – 1820 |
| | uncertainty | 0.90 | 0.54 | 0.48 | 0.41 |
| J | range | -210 – -100 | -100 – 150 | 150 – 700 | 700 – 1200 |
| | uncertainty | 0.30 | 0.25 | 0.18 | 0.18 |
| T | range | -200 – -100 | -100 – 0 | 0 – 100 | 100 – 400 |
| | uncertainty | 0.30 | 0.26 | 0.21 | 0.18 |
| E | range | -250 – -100 | -100 – 280 | 280 – 600 | 600 – 1000 |
| | uncertainty | 0.45 | 0.23 | 0.19 | 0.19 |
| K | range | -200 – -100 | -100 – 480 | 480 – 1000 | 1000 – 1372 |
| | uncertainty | 0.35 | 0.25 | 0.23 | 0.24 |
| N | range | -200 – -100 | -100 – 0 | 0 – 580 | 580 – 1300 |
| | uncertainty | 0.45 | 0.30 | 0.26 | 0.23 |
| M | range | -50 – 50 | 50 – 100 | 100 – 470 | 470 – 1410 |
| | uncertainty | 0.25 | 0.22 | 0.21 | 0.20 |
| C | range | 0 – 100 | 100 – 280 | 280 – 1370 | 1370 – 2315 |
| | uncertainty | 0.37 | 0.34 | 0.34 | 0.47 |
| D | range | 0 – 100 | 100 – 280 | 280 – 1830 | 1830 – 2315 |
| | uncertainty | 0.45 | 0.37 | 0.34 | 0.47 |
| G₂ | range | 100 – 200 | 200 – 430 | 430 – 2080 | 2080 – 2315 |
| | uncertainty | 0.72 | 0.49 | 0.35 | 0.39 |

Automatic cold junction compensation (Adapter 91)

| | |
|---------------------------|--|
| Sensor type: | Pt100 |
| Temperature uncertainty: | 0.1 °C with calibration constants saved in 9000, 0.3 °C otherwise |
| Typical sensor stability: | < 0.05 °C/year |

9.6. Harmonics

Harmonic products may be added in all AC functions of the calibrator (voltage, current) with limitation of amplitude in voltage up to 14 Vpk and current up to 2.8 Apk.

Fundamental signal specifications

| | |
|-------------------------------|-------------------------------------|
| Max. peak amplitude of single | |
| fundamental harmonic: | $\sqrt{2} \times \text{full range}$ |
| Amplitude uncertainty: | 0.2 % of fundamental harmonic range |
| Max. frequency: | 1 kHz |
| Min. frequency uncertainty: | 5 ppm |

Harmonic product specifications

| | |
|--------------------------|--|
| Number of products: | 50 |
| Amplitude range: | 0.00 – 30.00 % of full range of fundamental harmonic |
| Amplitude uncertainty: | 0.4 % of fundamental harmonic range |
| Max. frequency: | 5 kHz |
| Phase shift range: | 0.00 – 360.00 ° |
| Phase shift uncertainty: | 10 µs (typical) |

Amplitude limitation of complex distorted signal

| | |
|---------------------|---|
| Max peak amplitude: | $\sqrt{2} \times \text{full range of fundamental harmonic}$ |
|---------------------|---|

9.7. RC option (Resistance, Capacitance and RTD functions)

Measurement modes: 4W, 2W, 2W COMP; capacitance is 2W only

9.7.1. Continuous resistance mode

Resistance range summary: 0.0000 Ω – 600.0 M Ω in both 4W and 2W modes

Continuous resistance ranges, uncertainty [ppm] and limits

| Nominal value | Uncertainty ¹⁰ | Applicable test current ¹¹ | Typical bandwidth |
|------------------------------|---------------------------|---------------------------------------|-------------------|
| 0.0000 – 10.0000 Ω | 500 + 10 m Ω | 0.4 – 100 mA | 1 500 Hz |
| 10.001 – 100.000 Ω | 250 + 10 m Ω | 0.4 – 50 mA | 1 500 Hz |
| 100.01 – 1000.00 Ω | 250 + 25 m Ω | 0.4 – 30 mA | 1 500 Hz |
| 1.0001 – 10.0000 k Ω | 150 + 50 m Ω | 20 – 2000 μ A | 100 Hz |
| 10.001 – 100.000 k Ω | 150 + 500 m Ω | 4 – 1000 μ A | 10 Hz |
| 100.01 – 1000.00 k Ω | 200 + 5 Ω | 1 – 100 μ A | 1 Hz |
| 1.00001 – 3.30000 M Ω | 600 + 100 Ω | 0.04 – 6 μ A | 1 Hz |
| 3.3001 – 10.0000 M Ω | 600 + 100 Ω | 10 – 2000 nA | 0.5 Hz |
| 10.001 – 33.000 M Ω | 5000 + 10 k Ω | 10 – 600 nA | 0.5 Hz |
| 33.01 – 120.00 M Ω | 5000 + 10 k Ω | 10 – 180 nA | 0.1 Hz |
| 120.1 – 600.0 M Ω | 20000 + 50 k Ω | 4 – 20 nA | 0.1 Hz |

11. Add 100 m Ω in 2W mode.

12. Absolute uncertainty is valid for test currents which give min 100 mV across set resistance. For example, min test current is 10 mA at 10 Ω resistance to meet uncertainty specification. Floor adder increases by multiplication factor k = (Current at 100 mV / Actual Current) below 100 mV. For example, the floor adder for 1 mA test current across 10 Ω resistance is: 10 m Ω x 10mA/1mA = 100 m Ω instead of 10 m Ω .

9.7.2. Fixed resistance mode

Resistance range summary: 0 Ω – 330 k Ω in both 4W and 2W modes, up to 330 M Ω in 2W mode

Fixed resistance uncertainties

| Nominal value | Calibration value uncertainty | | Tolerance from nominal | | Maximum load |
|---------------------|-------------------------------|------------------|------------------------|------------------|----------------------|
| | 4W | 2W ¹² | 4W | 2W | |
| 0.0000 Ω | 1 m Ω | 100 m Ω | ± 1 m Ω | ± 1 Ω | 100 mA _{pk} |
| 10.0000 Ω | 10 m Ω | 110 m Ω | ± 2 % | ± 1 Ω | 100 mA _{pk} |
| 33.0000 Ω | 10 m Ω | 110 m Ω | ± 2 % | ± 1 Ω | 50 mA _{pk} |
| 100.0000 Ω | 15 m Ω | 115 m Ω | ± 2 % | ± 2 % | 50 mA _{pk} |
| 330.0000 Ω | 15 m Ω | 115 m Ω | ± 2 % | ± 2 % | 50 mA _{pk} |
| 1000.000 Ω | 100 ppm | 200 ppm | ± 2 % | ± 2 % | 20 V _{pk} |
| 3300.000 Ω | 100 ppm | 200 ppm | ± 2 % | ± 2 % | 20 V _{pk} |
| 10.00000 k Ω | 50 ppm | 60 ppm | ± 2 % | ± 2 % | 20 V _{pk} |
| 33.00000 k Ω | 50 ppm | 60 ppm | ± 2 % | ± 2 % | 20 V _{pk} |
| 100.0000 k Ω | 50 ppm | 50 ppm | ± 2 % | ± 2 % | 100 V _{pk} |
| 330.0000 k Ω | 75 ppm | 75 ppm | ± 2 % | ± 2 % | 100 V _{pk} |
| 1000.000 k Ω | - | 100 ppm | - | ± 2 % | 100 V _{pk} |
| 3300.000 k Ω | - | 250 ppm | - | ± 2 % | 100 V _{pk} |
| 10.00000 M Ω | - | 500 ppm | - | ± 5 % | 100 V _{pk} |
| 33.00000 M Ω | - | 0.10 % | - | ± 5 % | 100 V _{pk} |
| 100.0000 M Ω | - | 0.25 % | - | ± 10 % | 100 V _{pk} |
| 330.0000 M Ω | - | 0.50 % | - | ± 10 % | 100 V _{pk} |

13. Specification applies to "True Ohm" (bipolar) measurement method. Add 15 μ V divided by test current when measuring with pure DC signal to account for thermoelectric voltage at output terminals. For example, 10 mA test current adds 15 μ V / 10 mA = 1.5 m Ω additional floor.

9.7.3. Continuous capacitance mode

Range summary: 2.0000 nF – 120.00 mF

Maximum load: 5 V_{pk} or 150 mA_{pk}, whichever comes first

Capacitance ranges, loads and uncertainties

| Range | Uncertainty ¹³ | | Max. test frequency | Maximum load |
|----------------------|---------------------------|----------------|---------------------|------------------------|
| | 90 days | 1 year | | |
| 2.0000 – 10.0000 nF | 0.3 % + 15 pF | 0.35 % + 15 pF | 1000 Hz | 2 – 5 V _{rms} |
| 10.001 – 100.000 nF | 0.3 % | 0.35 % | 500 Hz | 2 – 5 V _{rms} |
| 0.10001 – 1.00000 µF | 0.3 % | 0.35 % | 300 Hz | 2 – 5 V _{rms} |
| 1.0001 – 10.0000 µF | 0.3 % | 0.35 % | 300 Hz | 100 mA _{rms} |
| 10.001 – 100.000 µF | 0.3 % | 0.35 % | 25 Hz | 100 mA _{rms} |
| 0.10001 – 1.00000 mF | 0.3 % | 0.35 % | 20 Hz | 100 mA _{rms} |
| 1.0001 – 10.0000 mF | 0.3 % | 0.35 % | 10 Hz | 100 mA _{rms} |
| 10.01 – 120.00 mF | 0.5 % | 0.60 % | 2 Hz | 100 mA _{rms} |

14. Specification applies to Relative mode of capacitance, for Absolute mode add additional floor 25 pF.

9.7.4. Fixed capacitance mode

Range summary: 1.0000 nF – 10.0000 µF

Maximum load: 25 V_{pk} or 150 mA_{pk}, whichever comes first

Tolerance from nominal: ± 10 %

Capacitance uncertainties

| Nominal value | Calibration value uncertainty ¹⁴ | Max. test frequency |
|---------------|---|---------------------|
| 1.0000 nF | 1.25 % | 1000 Hz |
| 3.3000 nF | 0.75 % | 1000 Hz |
| 10.0000 nF | 0.35 % | 1000 Hz |
| 33.0000 nF | 0.35 % | 1000 Hz |
| 100.000 nF | 0.25 % | 500 Hz |
| 330.000 nF | 0.25 % | 500 Hz |
| 1.00000 µF | 0.25 % | 300 Hz |
| 3.30000 µF | 0.25 % | 300 Hz |
| 10.0000 µF | 0.25 % | 300 Hz |

15. Specification applies to Relative mode of capacitance, for Absolute mode add additional floor 25 pF.

9.7.5. RTD resistance temperature sensor simulation

Temperature scales: Pt 3850 IPTS68, Pt 3851 ITS90, Pt 3916, Pt 3926, Ni 120, custom

Range of R0 setting: 20 – 2000 Ω

| Thermometer type | Temperature range | Uncertainty |
|------------------|----------------------|-------------|
| Pt100 – 1000 | -200.000 – 0.000 °C | 0.15 °C |
| | -0.001 – 850.000 °C | 0.2 °C |
| Ni100 – 1000 | -60.000 – 300.000 °C | 0.1 °C |

10. Revisions

10.1. Change 1 (28. 05. 2024)

- Added Duty Cycle function chapter (Chapter 5.7)
- Added additional information in menu section (Chapter 4.)

10.2. Change 2 (26. 06. 2024)

- New sub-chapters: Two-wire connection, Two-wire compensated connection, Four-wire connection (Chapters 5.3.1.1-3)

10.3. Change 3 (25. 10. 2024)

- Additional information for verification (Chapter 6.1-2.)
- Added new test points for:
 - o ACV (Square Shape) (Chapter 6.3.)
 - o ACI (Square Shape) (Chapter 6.3.)
 - o Temperature TC (meter °C) (Chapter 6.3.)
 - o Frequency (Chapter 6.3.)
 - o Variable resistance and Fixed resistance (Chapter 6.4.)
- New sub-chapter Temperature TC (meter °C) (Chapter 6.3)

10.4. Change 3 (22. 04. 2025)

- Added TCP/UDP protocol feature for LAN communication in chapter 2.2.1. and 4.4.
- Updated Required equipment in chapter 6.1.
- Additional information in chapter 6.2.
- More detailed subchapter Verification of RJ Meter in Temperature TC function in chapter 6.3.
- Updated adjustment sub-chapters: Voltage and current AC functions, Resistance function, Capacitance function, Frequency function (Chapters 7.3.2 -7.3.5)
- New chapter with specifications about Harmonics (Chapter 9.6.)

10.5. Change 4 (14.08. 2025)

- Updated test points – all test parameters with 60 Hz were reduced to 55 Hz (Chapter 6.3)

Declaration of conformity

According to EN ISO/IEC 17050-1:2010 standard as well as European Parliament and European Council directives 2011/65/EU + amendment 2015/863, 2012/19/EU, 2014/30/EU and 2014/35/EU, MEATEST, spol. s r. o., manufacturer of 9000 Portable Multifunction Calibrator, 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 26th, 2025



Place

Date

Signature