meatest

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:
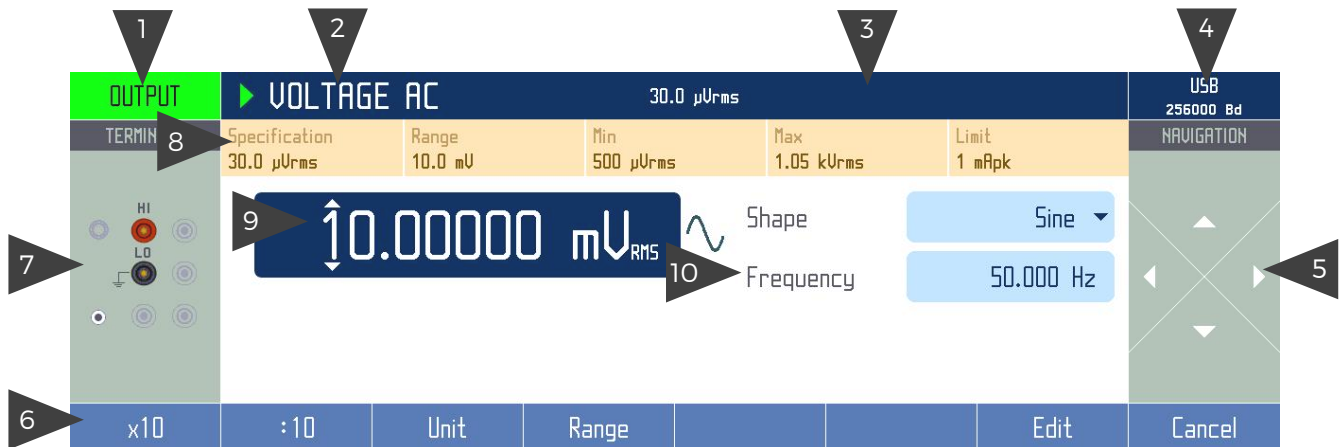
Figure 2 Display

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. ![warmup] Warm-up in progress. Calibrator is fully operational but it may be outside specifications.
    b. ![overheat] 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. ![error] 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.

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.
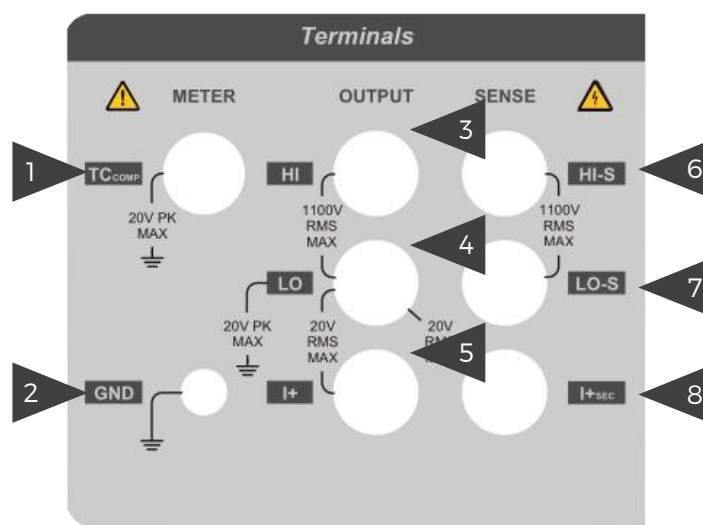
Figure 4 Input/output terminals

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.
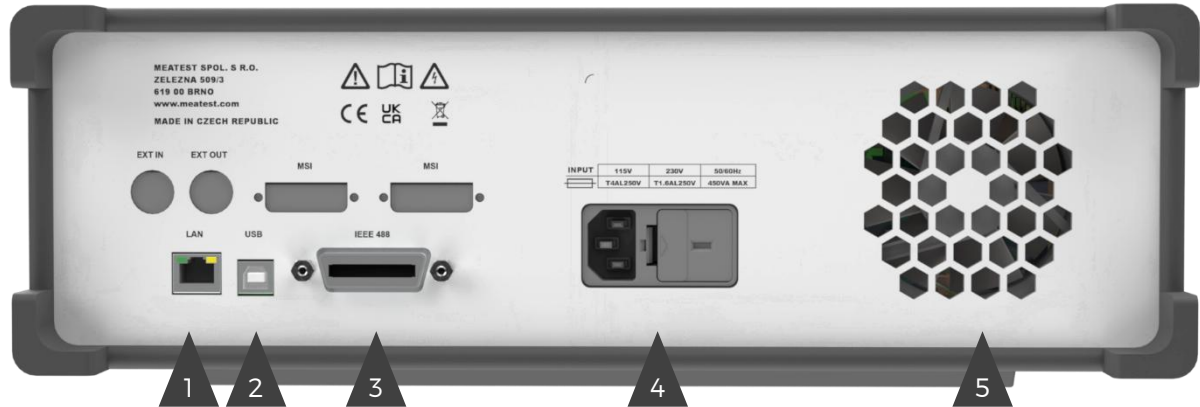
Figure 5 Rear panel

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_SNxxxxxx", 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.
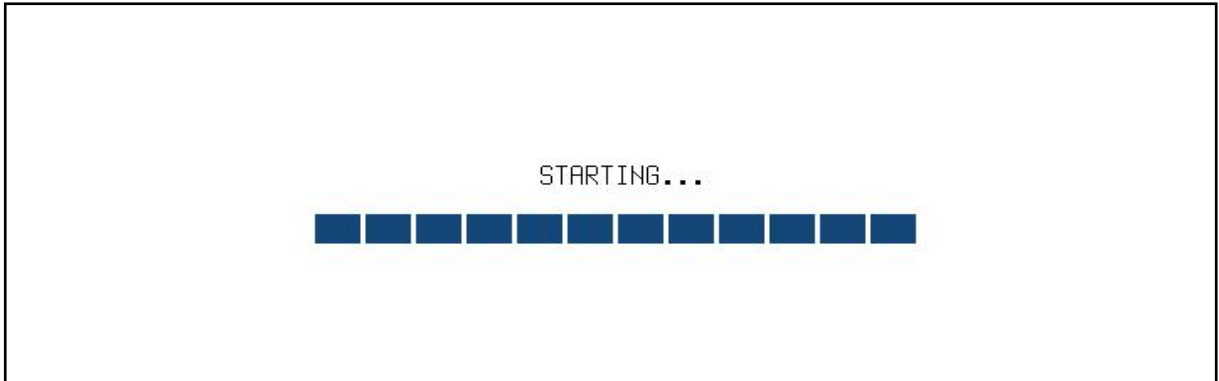
Figure 6 Starting Screen

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.
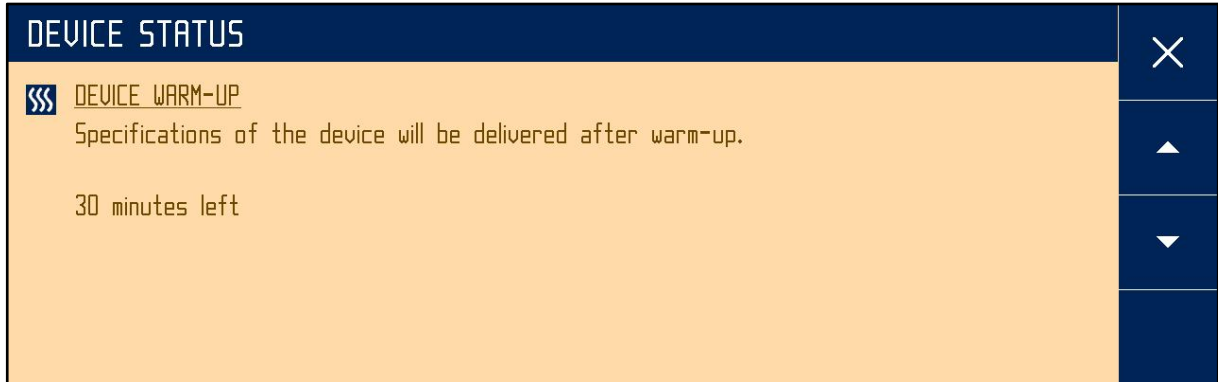
Figure 8 Warm-up screen

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
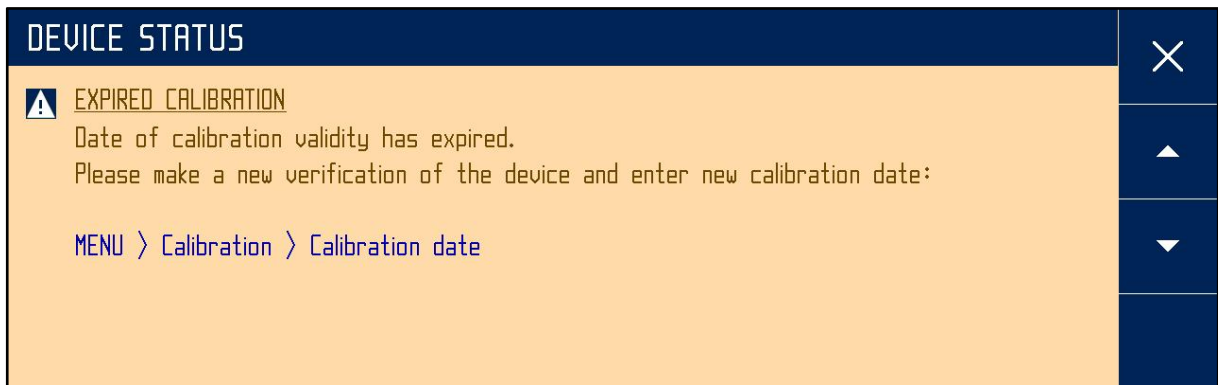
device.

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).
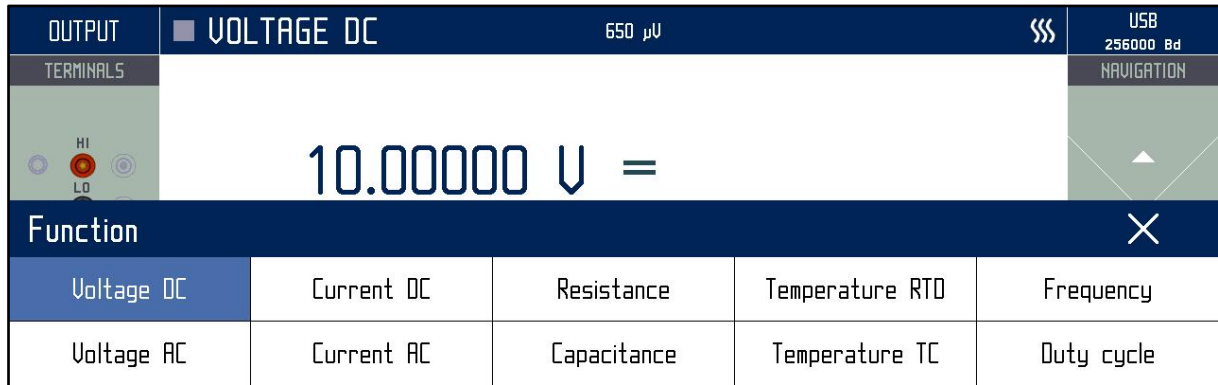
Figure 10 Function menu

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.
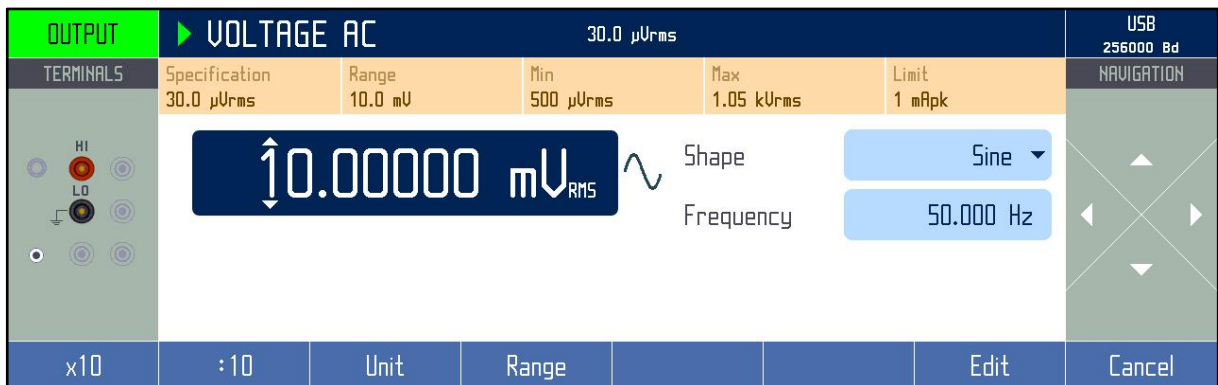
Figure 11 Main and auxiliary parameters

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.
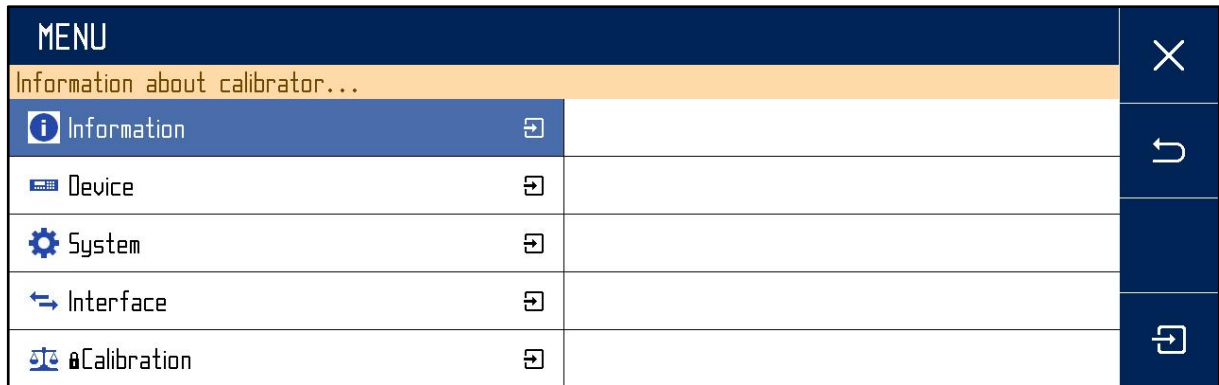
Figure 12 Main menu

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:

- Manufacturer - Model - Serial number	Device identification
- Software version - Hardware version - Internal options	Device configuration
- 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.
- Testing tools	Display and Touch screen diagnostics
- 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
    - o Time   System time in HH:MM:SS format
    - o Date   System date in selected format
    - o Format   Date format [M/D/Y, M-D-Y, D/M/Y, D.M.Y, D-M-Y, Y/M/D, Y.M.D]
    - o 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	
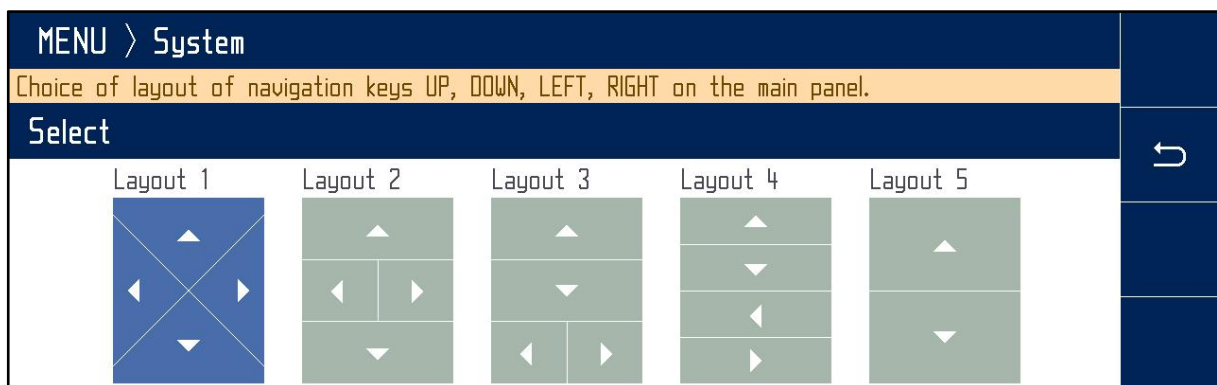
Figure 14 Keys layout

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
> Port number	0 – 9999	23
> Host name	14 alphanumeric characters; locked with DHCP Off	9000_SN750011

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 💾	▲	Delete
01	TC N	Temperature TC	06/30/2023 💾		
02					
03				▼	Load
04					
05				⊻	Save
06					
		▼			

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.
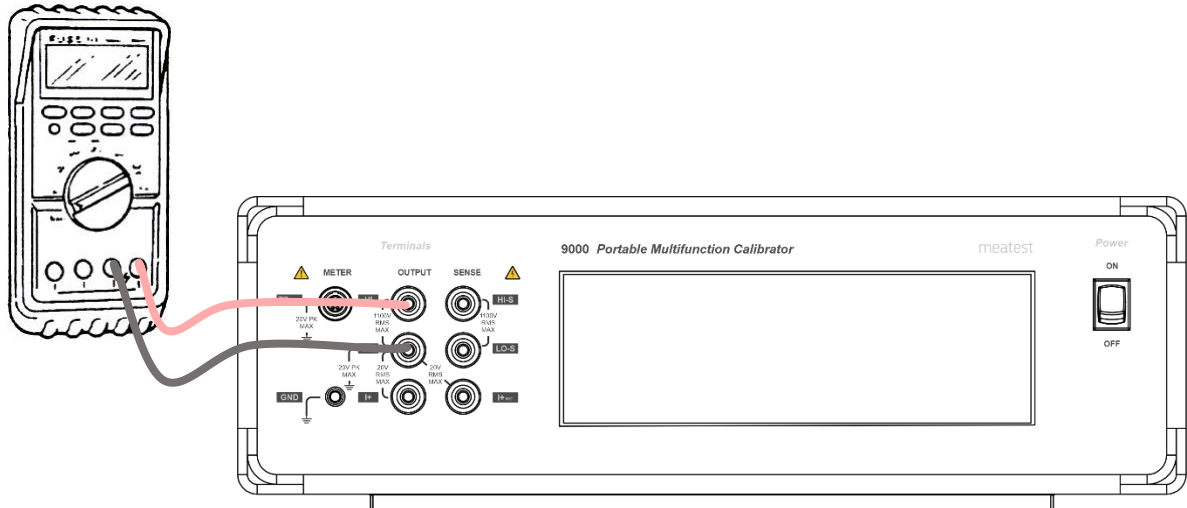
Figure 16 Voltmeter calibration

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.

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.
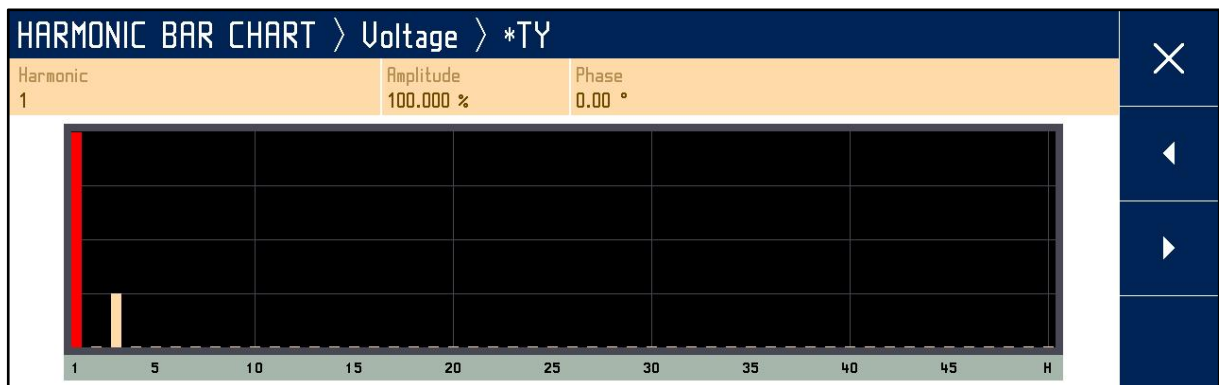
Figure 18 Signal bar
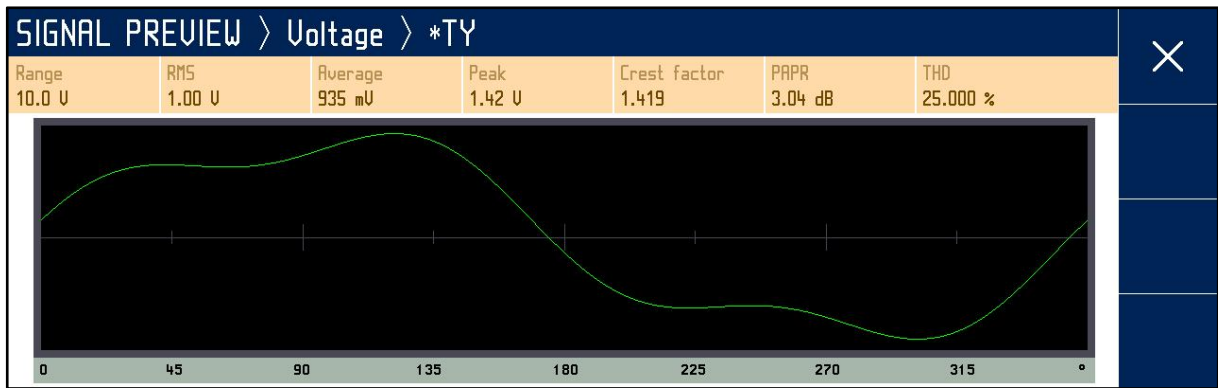
Figure 19 Signal preview

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.

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	Vrms (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.
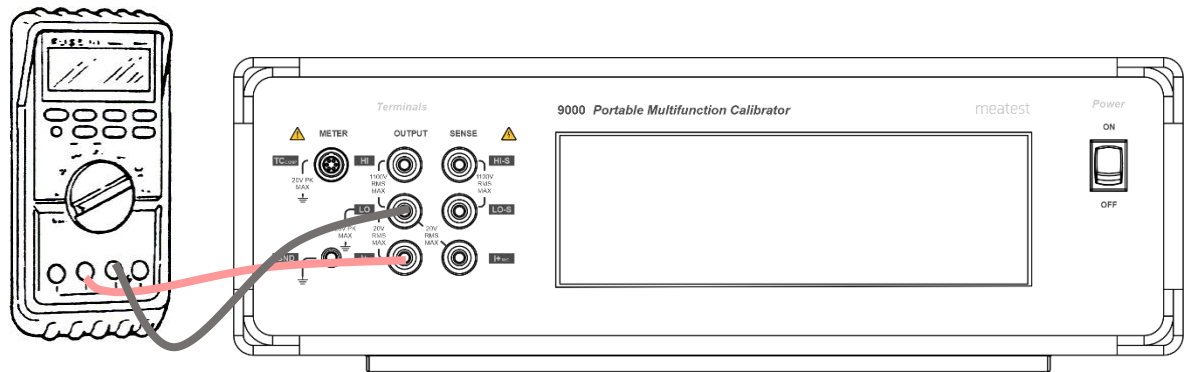
Figure 22 Ammeter calibration

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 ▲▼ 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.
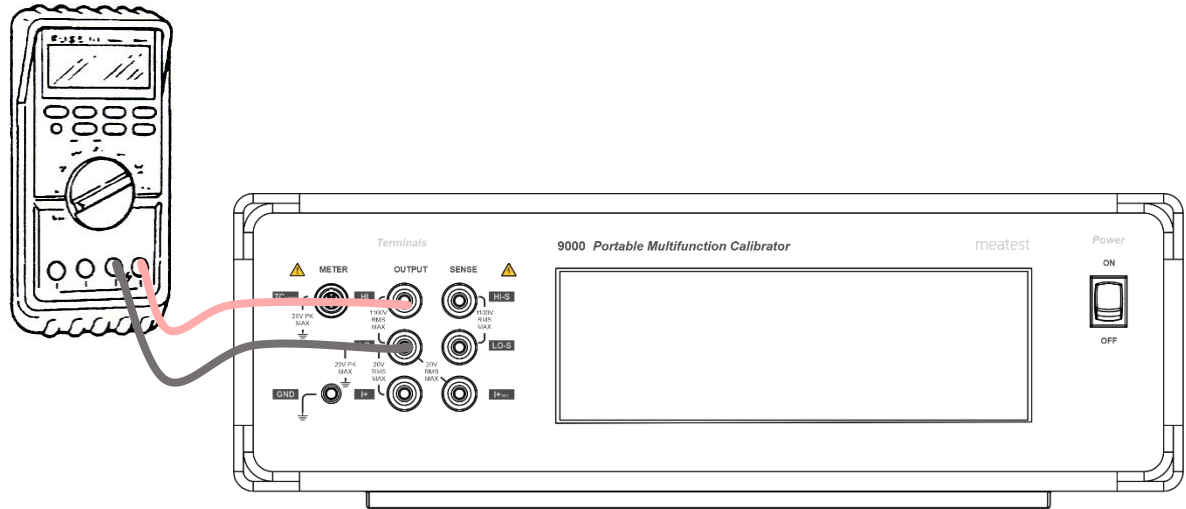
Figure 25 Two-wire resistance calibration

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.
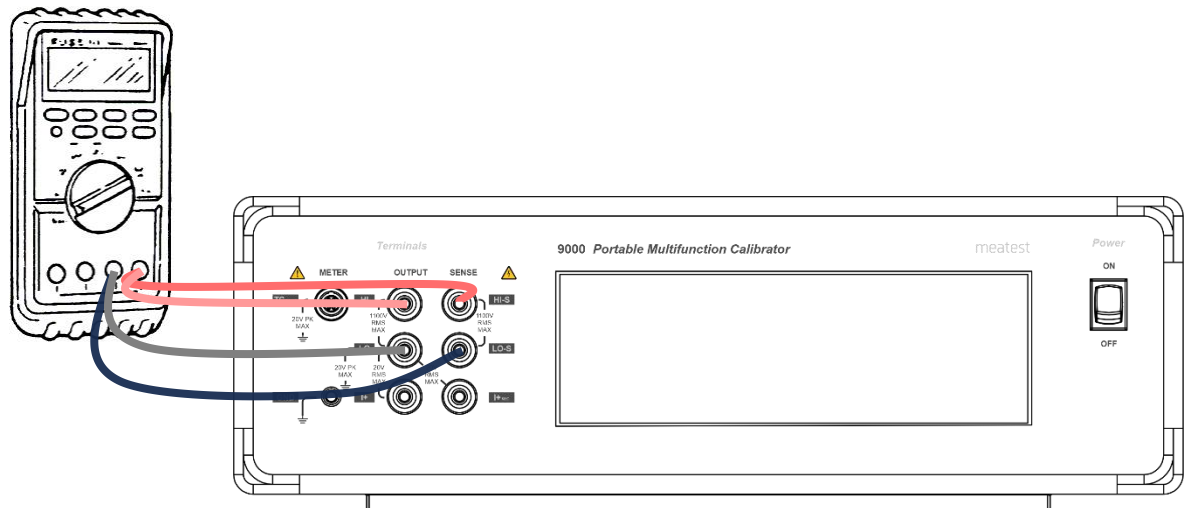
Figure 26 Two-wire compensated resistance calibration

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.
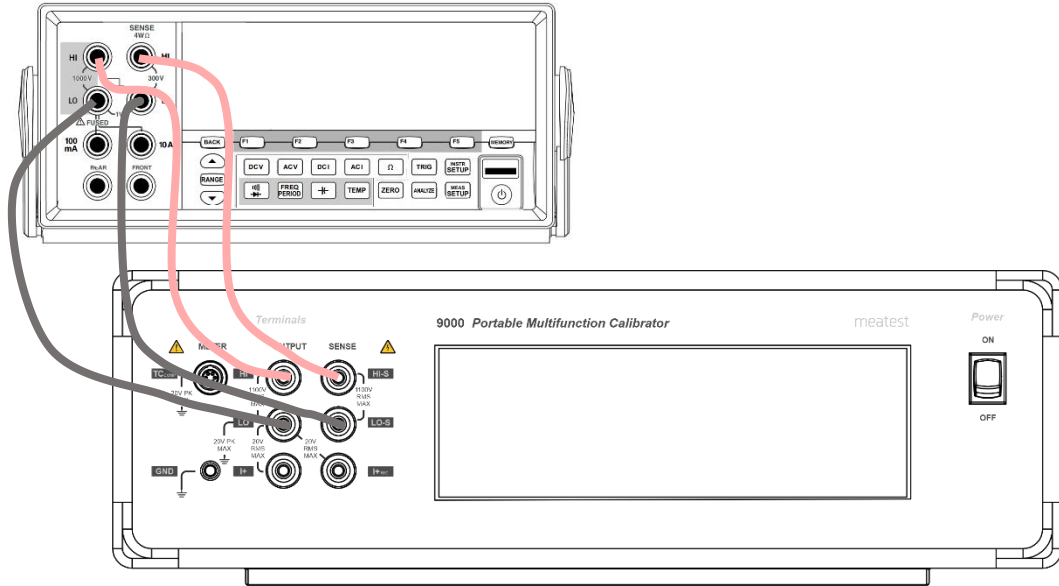
Figure 27 Four-wire resistance calibration

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.
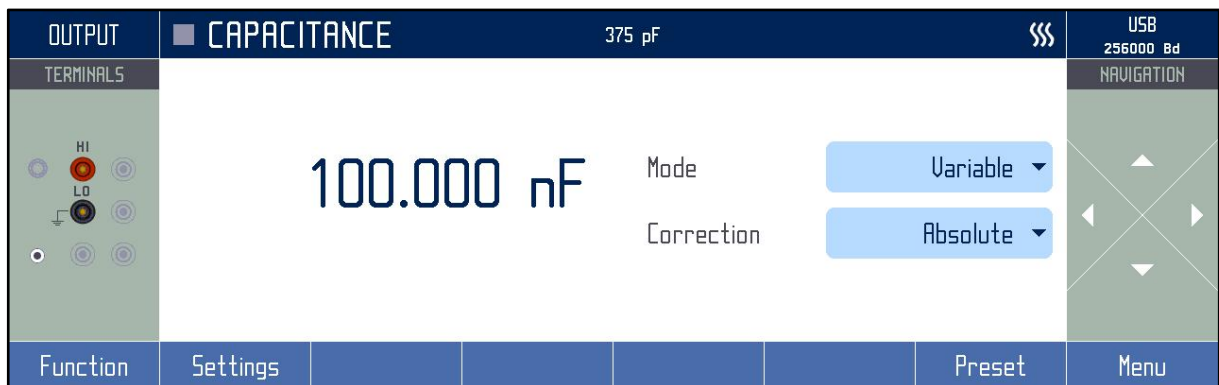
Figure 28 Capacitance screen

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.
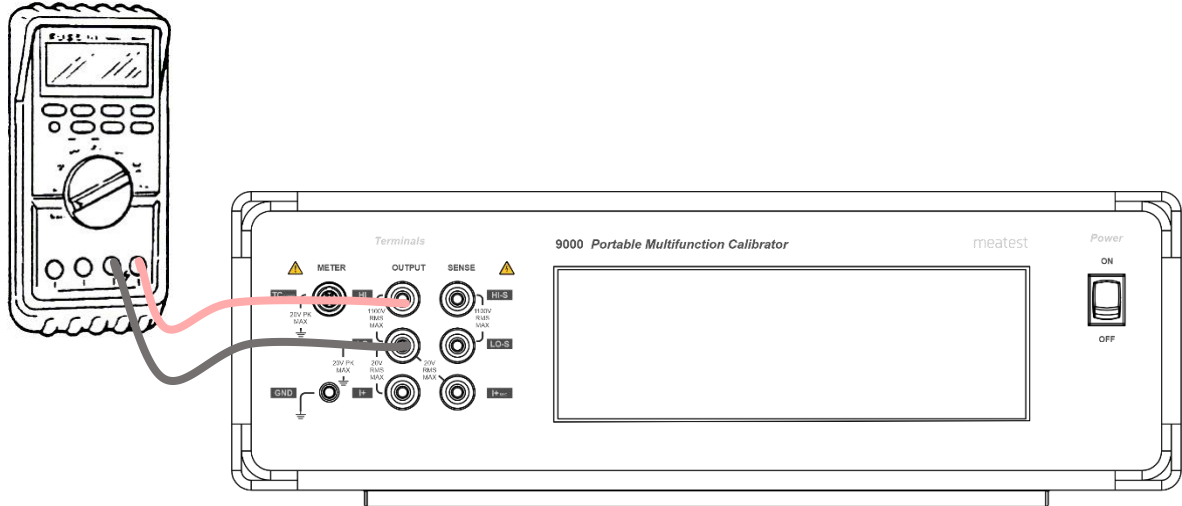
Figure 30 Capacitance calibration

Warning: If you are using RCL meter with 4TP connection or grounded equipment, proceed with caution. Due to using simulation principle (it needs measuring current at Hi terminal) it is necessary to swap Hi and Lo terminal. High terminal of RCL must be inserted into Lo terminal of calibrator and Lo terminal of RCL must be inserted into Hi terminal of calibrator. Do not try to solve this issue with isolation transformer otherwise accuracy of calibrator will be disturbed.

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:
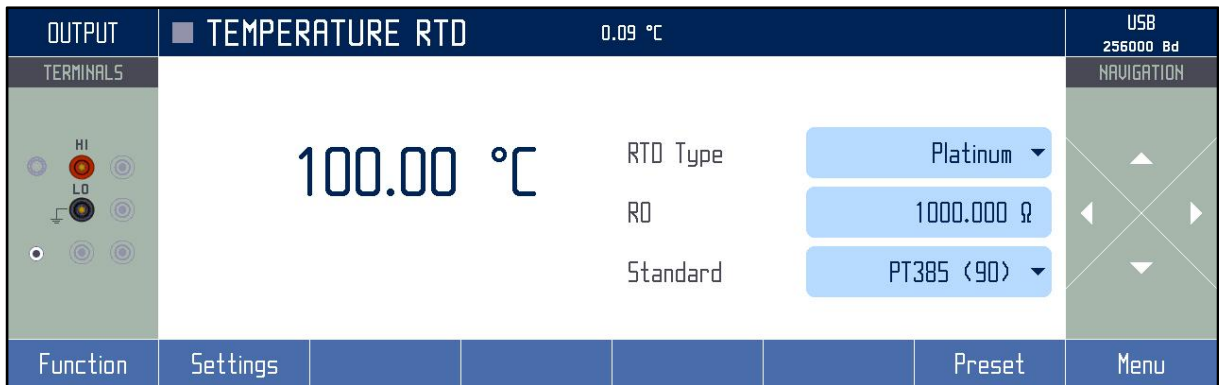
Figure 31 RTD temperature sensor simulation

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

$$R_{sim} = R0 * (1 + T*(A + T*(B + T*C(T\text{-}100.0))))$$

, 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:
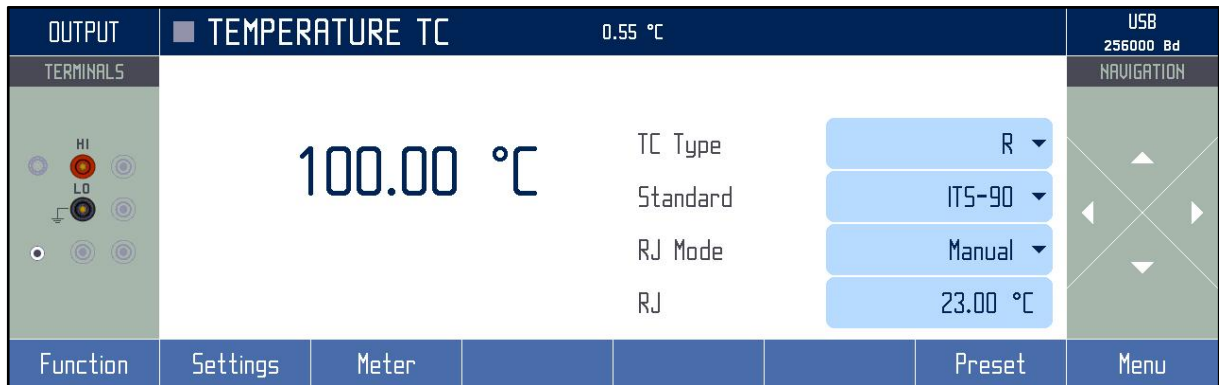
Figure 32 TC temperature sensor simulation

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:
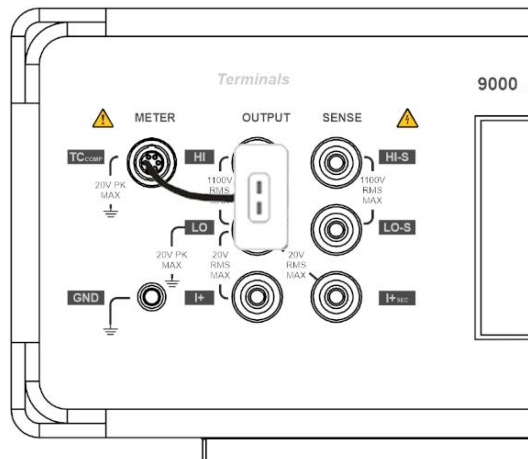
Figure 33 Thermocouple simulation using Adapter 91

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.
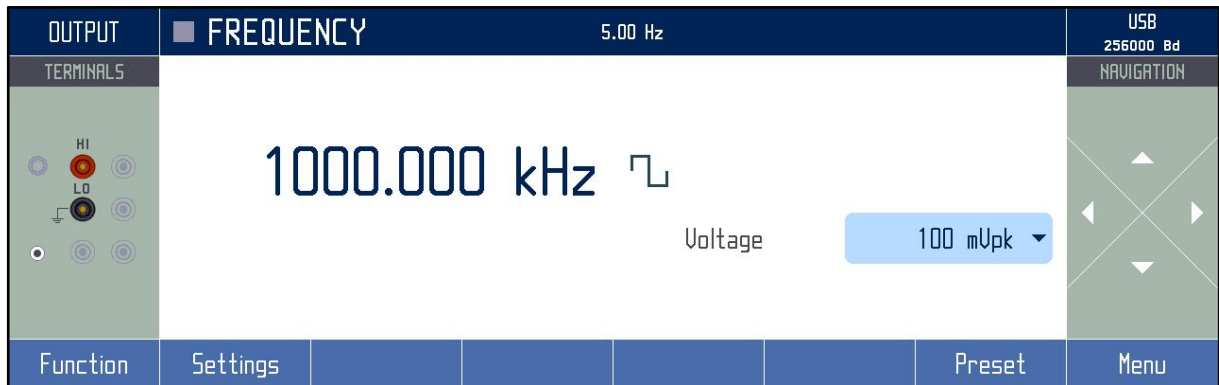
Figure 34 Frequency mode display

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.
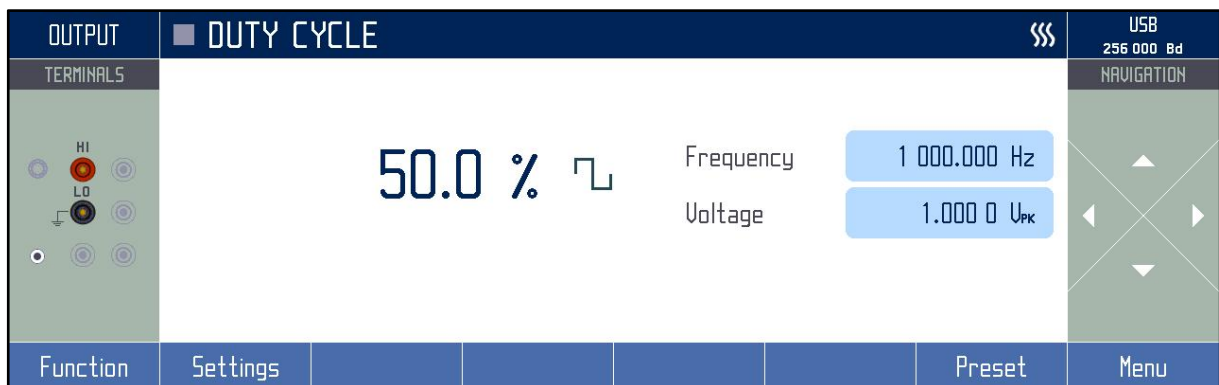
Figure 35 Duty cycle mode display

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
- 1 kΩ standard with uncertainty 20 mΩ

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 22 °C to 24 °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 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. Meter RTD in TC function test
    j. Fixed resistance test
    k. Variable resistance test
    l. Fixed capacitance test
    m. Variable capacitance test

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		
AC Voltage	10	2	1.978	2.022	mV	8½ digit DMM	60 Hz

Function	Range	Nominal	Min value	Max value	Unit	Standard unit	Test parameters
SINE			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		60 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		60 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		60 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		60 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		60 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		60 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		60 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
AC Voltage		1	0.99945	1.00055	V	8½ digit DMM	60 Hz

Function	Range	Nominal	Min value	Max value	Unit	Standard unit	Test parameters
SINE			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		60 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		60 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		60 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		60 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		60 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		60 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
		50	49.965	50.035	V		60 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
		100	99.94	100.06	V		60 Hz
			99.94	100.06	V		1 kHz
			99.82	100.18	V		1.1 kHz

Function	Range	Nominal	Min value	Max value	Unit	Standard unit	Test parameters
			99.82	100.18	V		5 kHz
			99.82	100.18	V		10 kHz
AC Voltage SINE	1000	150	149.695	150.305	V	8½ digit DMM	60 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		60 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		60 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 Harmonic Sine	10	10	9.92	10.08	mV	8½ digit DMM	120 Hz
	100	100	99,65	100,35	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		
	2	-1.9	-1.900385	-1.899615	A		
		-1	-1.00025	-0.99975	A		
		-0.21	-0.210132	-0.209869	A		
		0.21	0.209869	0.210132	A		

Function	Range	Nominal	Min value	Max value	Unit	Standard unit	Test parameters
		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		
	200	10	9.885	10.115	µA		60 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		60 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		60 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
AC Current SINE	2	0.21	0.20959	0.21041	mA	8½ digit DMM	60 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		60 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		60 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
	20	2.1	2.09753	2.10247	mA		60 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		60 Hz
			9.992	10.008	mA		1 kHz

Function	Range	Nominal	Min value	Max value	Unit	Standard unit	Test parameters
			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		60 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		60 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		60 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		60 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
AC Current SINE	2	0.21	0.20969	0.21031	A	8½ digit DMM	60 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		60 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		60 Hz
			1.898	1.902	A		1 kHz
			1.89615	1.90385	A		5 kHz
			1.8933	1.9067	A		10 kHz
	20.5	2.1	2.0928	2.1072	A		60 Hz
			2.0928	2.1072	A		120 Hz
			2.0928	2.1072	A		1 kHz
		10	9.977	10.023	A		60 Hz
			9.977	10.023	A		120 Hz
			9.977	10.023	A		1 kHz
		19	18.959	19.041	A		60 Hz
			18.959	19.041	A		120 Hz
			18.959	19.041	A		1 kHz

Function	Range	Nominal	Min value	Max value	Unit	Standard unit	Test parameters
AC Current Square Shape Harmonic Sine	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 AC Voltage	100	100	99,999	100,001	kHz	8½ digit DMM	1 V
Frequency	2	1	0,999995	1,000005	MHz	8½ digit DMM	1 V
Temperature TC (meter ˚C) (see below)	2 kΩ	0.00˚C	-0.05˚C	+0.05˚C		Standard 1kΩ	Apply to Meter 1 kΩ with Option 9000-60, read measure in red box in ˚C for more information see AN108
	20 kΩ	0.00˚C	-0.5˚C	+0.5˚C		Standard 1kΩ	

Table 2 List of main test points

Temperature TC (meter ˚C)

For right verification of RTD meter in function TC you have to connect to TCcomp terminal Option 9000-60. 4mm banana side of this Option 9000-60 connect to 1 kΩ standard.

Device 9000 set to function "Temperature TC". In main screen set RJ Mode to External. RJ is now red box with continues measurement of temperature. Now you have to set RTD meter push softkey
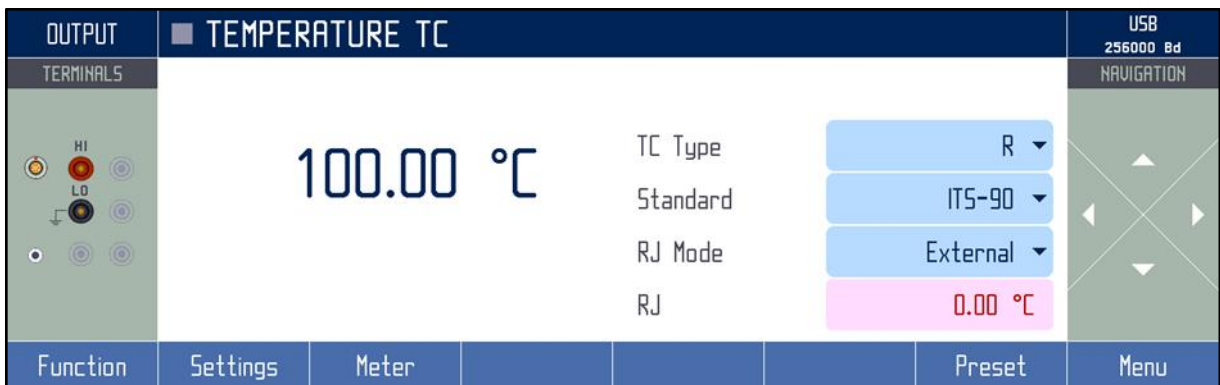
"Meter" and set range to 2 kΩ or 20 kΩ and go to RTD and set R0=1 kΩ.

Figure 36 Temperature TC - RJ mode

RJ Mode is set to External and RJ goes to red box with continues measurement.

Set range 2 kΩ or 20 kΩ, you need to verify both ranges. See table list 2.
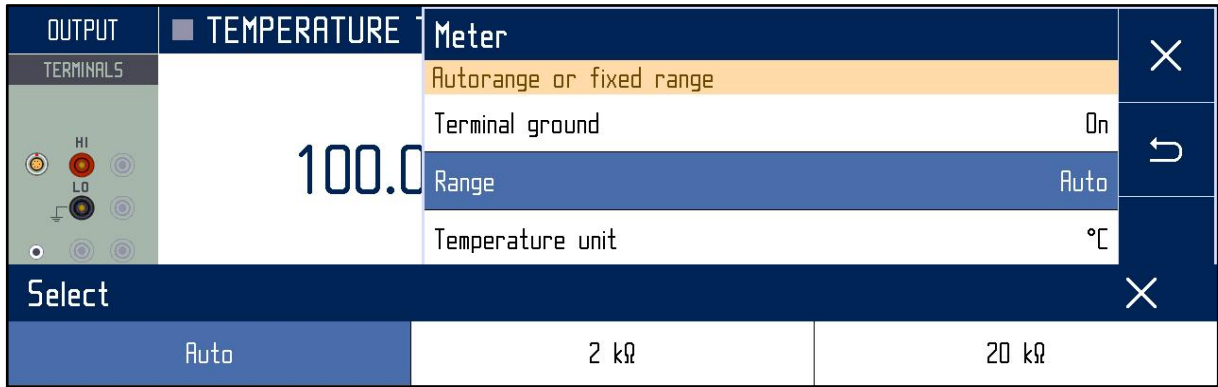
Figure 37 Temperature TC - RTD range
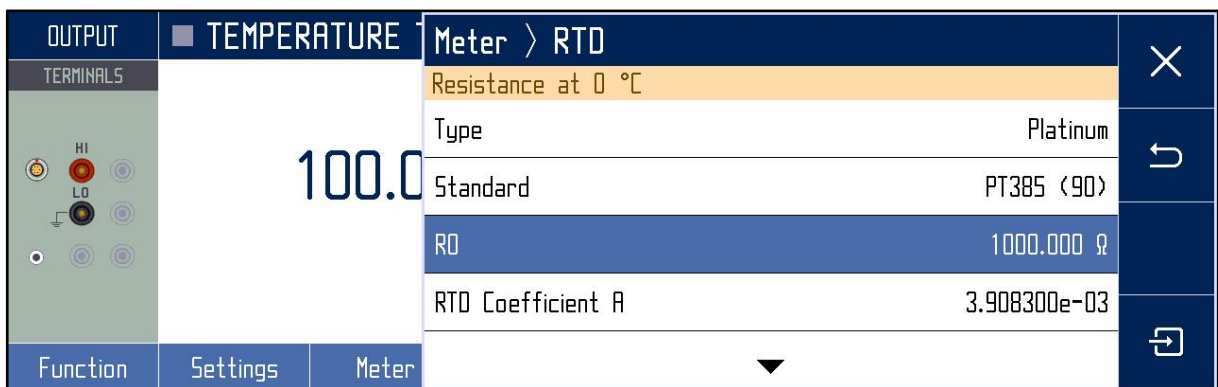
Figure 38 Temperature TC - RTD R0

Set R0 to 1000.000 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	kΩ		
		3	2.94955	3.05045	kΩ		
		4	3.9494	4.0506	kΩ		
		9	8.94865	9.05135	kΩ		
	100	15	14.49775	15.50225	kΩ		
		30	29.4955	30.5045	kΩ		
		40	39.494	40.506	kΩ		
		90	89.4865	90.5135	kΩ		
	10	9	8,886	9,114	Ω		2W
	1000	150	149.965	150.035	kΩ		
		300	299.935	300.065	kΩ		
		400	399.915	400.085	kΩ		
		900	899.815	900.185	kΩ		
	10	1.5	1.4993	1.5007	MΩ		
		3	2.9981	3.0019	MΩ		
		4	3.9975	4.0025	MΩ		
		9	8.9945	9.0055	MΩ		
	120	15	14.915	15.085	MΩ		
		30	29.84	30.16	MΩ		
		40	39.79	40.21	MΩ		
		90	89.54	90.46	MΩ		
	600	150	146.95	153.05	MΩ		
		300	293.95	306.05	MΩ		
		400	391.95	408.05	MΩ		
		600	587.95	612.05	MΩ		
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	kΩ		
	3.3	3.3	-0.00033	+0.00033	kΩ		
	10	10	-0.0005	+0.0005	kΩ		
	33	33	-0.00165	+0.00165	kΩ		
	100	100	-0.005	+0.005	kΩ		
	330	330	-0.02475	+0.02475	kΩ		
	0	0	-0,1	+0,1	Ω		2W

Function	Range	Nominal	Min value	Max value	Unit	Standard unit	Test parameters
	1	1	-0.0001	+0.0001	MΩ		
	3.3	3.3	-0.000825	+0.00825	MΩ		
	10	10	-0.005	+0.005	MΩ		2W, low voltage mode
	33	33	-0.033	+0.033	MΩ		
	100	100	-0.25	+0.25	MΩ		
	330	330	-1.65	+1.65	MΩ		
	10	2	1.979	2.021	nF		
		5.5	5.479	5.521	nF		
		6.5	6.479	6.521	nF		
		9	8.979	9.021	nF		1 kHz
	100	15	14.955	15.045	nF		
		55	54.835	55.165	nF		
		65	64.805	65.195	nF		
		90	89.73	90.27	nF	LCR meter (see correct connection of meter)	
	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		100 Hz
Variable Capacitance		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		
		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	8½ digit DMM	Ramp method
		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		
	1	1	-0.0125	+0.0125	nF		
	3.3	3.3	-0.02475	+0.02475	nF		
	10	10	-0.035	+0.035	nF		1 kHz
	33	33	-0.1155	+0.1155	nF		
Fixed Capacitance (min and max relative to calibration values)	100	100	-0.25	+0.25	nF	LCR meter	
	330	330	-0.825	+0.825	nF		
	1	1	-0.0025	+0.0025	µF		
	3.3	3.3	-0.00825	+0.00825	µF		100 Hz
	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.
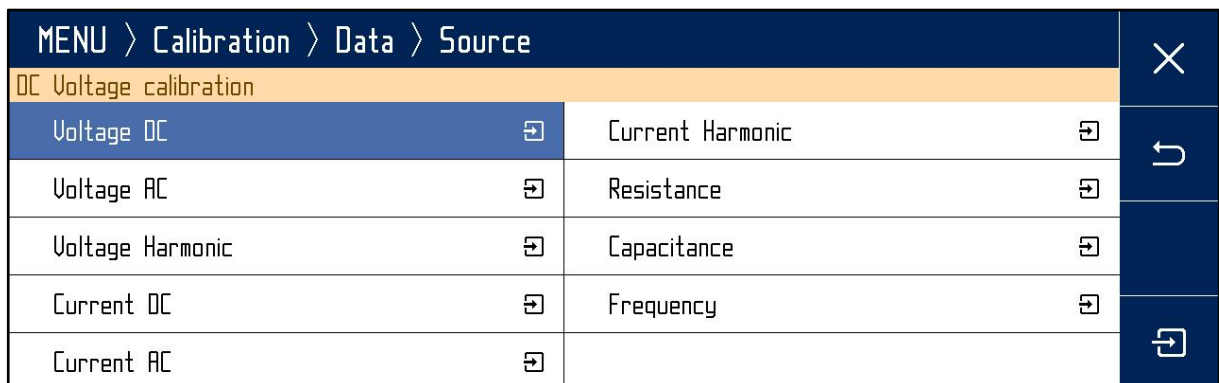

Figure 40 Calibration menu

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 kΩ point of fixed resistance function.
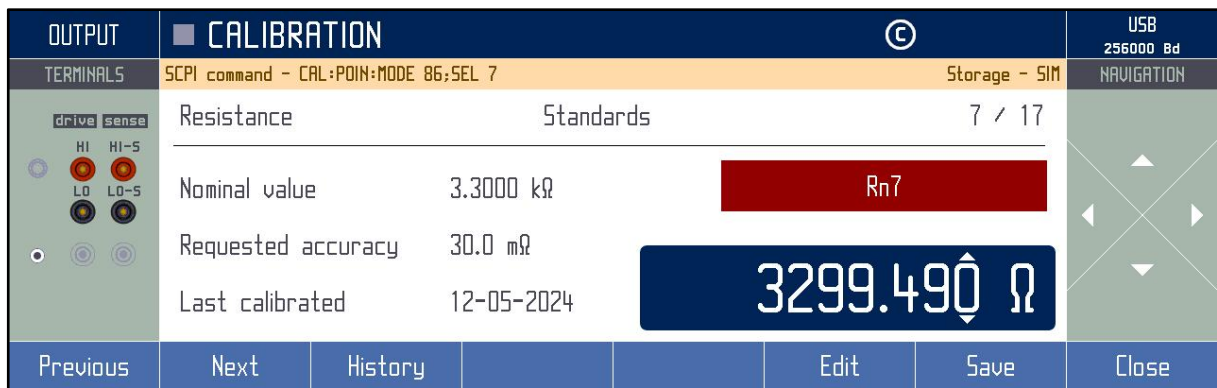
Figure 42 Calibration point adjustment – indirect

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	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 Harmonic	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	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 Harmonic	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.   Resistance function

Fixed resistance nominals:

        4W: 10 Ω, 33 Ω, 100 Ω, 330 Ω, 1 kΩ, 3.3 k Ω, 10 kΩ, 33 kΩ, 100 kΩ, 330 kΩ

        2W: 1 MΩ, 3.3 MΩ, 10 MΩ, 33 MΩ, 100 MΩ, 330M Ω

Variable offset correction: 2W Lo, 2W Hi, 2W0 Lo, 4W Lo, 2W COMP Lo

Variable Gain: Lower, Upper, High

Variable High resistance correction

2W offset: Fixed, Variable

7.3.4.   Capacitance function

Fixed capacitance nominals:

        2W: 1 nF, 3.3 nF, 10 nF, 33 nF, 100 nF, 330 nF, 1 µF, 3.3 µF, 10 µF

Offset: Absolute, Relative (6 values)

Capacitance multiplier: x10, x100, x1k, x10k

Note: Gain for Capacitance function is shared with resistance function.

7.3.5.   Frequency function

Calibration constant 5 V/1 MHz for frequency correction of internal oscillator.

It affects frequency of AC voltage, AC current and frequency function.

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 kΩ	0.000 00 kΩ	1.000 00 kΩ
	20 kΩ	0.000 0 kΩ	10.000 0 kΩ

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.
	6009: Access denied. Entered calibration password is invalid. To reset password contact us.
	6032: Device is locked in remote control mode. Press "Go to Local" button to exit.
	6043: 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.
	7006: Internal fan stopped!. Check if fan is rotating, otherwise turn off the device to prevent overheating.
	7023: 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.
	7100: 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.
	7101: 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.
	7102: 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.
	7103: 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.
	7104: Simulator current overload! Check if source doesn't exceed maximal limits.
	7105: Simulator voltage overload! Check if source doesn't exceed maximal limits.
	7106: 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.
	11004, 11005, 11006: The Hi-Current amplifier temperature is too high. Check inlet and outlet perforation and remove items that can block air flow. Check fan functionality.
	11007: 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.
	11008: 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 ± 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 50Ω 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

1. Minimum frequency is 40 Hz above 10 V.
2. 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 µV	0.1 % + 100 µV	0.15 % + 200 µV	0.15 % + 400 µV	0.15 % + 4 mV	0.15 % + 40 mV
	20 – 1000 Hz	0.2 % + 100 µV	0.1 % + 100 µV	0.06 % + 200 µV	0.06 % + 400 µV	0.06 % + 4 mV	0.06 % + 40 mV
	1 – 10 kHz	0.2 % + 100 µV	0.1 % + 100 µV	0.06 % + 200 µV	0.06 % + 400 µV	0.1 % + 4 mV	0.15 % + 40 mV
	10 – 20 kHz	0.2 % + 100 µV	0.1 % + 100 µV	0.15 % + 200 µV	0.15 % + 400 µV	N/A	N/A
	20 – 100 kHz	0.4 % + 100 µV	0.2 % + 100 µV	0.25 % + 200 µV	0.5 % + 400 µV	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					N/A	N/A

3. 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 µV$_{pk}$

9.2. Current

DCI range summary:	0.0000 µA – 20.50000 A [4]
ACI range summary:	10.0000 µA$_{rms}$ – 20.50000 A$_{rms}$ [4]
Current ranges:	auto, 200 µA, 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 µA – 200.000 µA	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

4. 20.5A range is optional.
5. 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 µA – 200.000 µA	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

6. 20.5A range is optional.
7. 30 min – 5 min maximum continuous output time. Depleted time regenerates 2x slower.

Distortion and Load Characteristics

Parameter	Range	200 µA	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 µH
THD + noise [8]	10 Hz – 1 kHz	0.1 % + 1 µA	0.1 % + 2 µA	0.1 % + 10 µA	0.1 % + 100 µA	0.2 % + 4 mA	0.3 % + 8 mA
	1 kHz – 5 kHz	0.2 % + 1 µA	0.2 % + 2 µA	0.2 % + 10 µA	0.2 % + 100 µA	0.5 % + 4 mA	N/A
	5 kHz – 10 kHz	0.2 % + 1 µA	0.2 % + 2 µA	0.2 % + 10 µA	0.2 % + 100 µA	0.6 % + 4 mA	N/A
	10 kHz – 20 kHz	0.5 % + 1 µA	0.5 % + 2 µA	0.5 % + 10 µA	0.5 % + 100 µA	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 µA/V	100 µA/V	500 µA/V
	10 Hz – 1 kHz	100 nA/V	150 nA/V	250 nA/V	2 µA/V	100 µA/V	N/A
	1 kHz – 10 kHz	2 µA/V	2 µA/V	2 µA/V	5 µA/V	200 µA/V	N/A
	10 kHz – 20 kHz	5 µA/V	5 µA/V	5 µA/V	10 µA/V	N/A	N/A

8. THD in bandwidth up to 500 kHz
9. 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 µA$_{rms}$ – 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 μV
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. RC option (Resistance, Capacitance and RTD functions)

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

9.6.1. Continuous resistance mode

Resistance range summary: 0.0000 Ω – 600.0 MΩ 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 mΩ	0.4 – 100 mA	1 500 Hz
10.001 – 100.000 Ω	250 + 10 mΩ	0.4 – 50 mA	1 500 Hz
100.01 – 1000.00 Ω	250 + 25 mΩ	0.4 – 30 mA	1 500 Hz
1.0001 – 10.0000 kΩ	150 + 50 mΩ	20 – 2000 µA	100 Hz
10.001 – 100.000 kΩ	150 + 500 mΩ	4 – 1000 µA	10 Hz
100.01 – 1000.00 kΩ	200 + 5 Ω	1 – 100 µA	1 Hz
1.00001 – 3.30000 MΩ	600 + 100 Ω	0.04 – 6 µA	1 Hz
3.3001 – 10.0000 MΩ	600 + 100 Ω	10 – 2000 nA	0.5 Hz
10.001 – 33.000 MΩ	5000 + 10 kΩ	10 – 600 nA	0.5 Hz
33.01 – 120.00 MΩ	5000 + 10 kΩ	10 – 180 nA	0.1 Hz
120.1 – 600.0 MΩ	20000 + 50 kΩ	4 – 20 nA	0.1 Hz

10. Add 100 mΩ in 2W mode.
11. 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 mΩ x 10mA/1mA = 100 mΩ instead of 10 mΩ.

9.6.2. Fixed resistance mode

Resistance range summary: 0 Ω – 330 kΩ in both 4W and 2W modes, up to 330 MΩ 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 mΩ	100 mΩ	±1 mΩ	± 1 Ω	100 mA_pk
10.0000 Ω	10 mΩ	110 mΩ	± 2 %	± 1 Ω	100 mA_pk
33.0000 Ω	10 mΩ	110 mΩ	± 2 %	± 1 Ω	50 mA_pk
100.0000 Ω	15 mΩ	115 mΩ	± 2 %	± 2 %	50 mA_pk
330.0000 Ω	15 mΩ	115 mΩ	± 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 kΩ	50 ppm	60 ppm	± 2 %	± 2 %	20 V_pk
33.00000 kΩ	50 ppm	60 ppm	± 2 %	± 2 %	20 V_pk
100.0000 kΩ	50 ppm	50 ppm	± 2 %	± 2 %	100 V_pk
330.0000 kΩ	75 ppm	75 ppm	± 2 %	± 2 %	100 V_pk
1000.000 kΩ	-	100 ppm	-	± 2 %	100 V_pk
3300.000 kΩ	-	250 ppm	-	± 2 %	100 V_pk
10.00000 MΩ	-	500 ppm	-	± 5 %	100 V_pk
33.00000 MΩ	-	0.10 %	-	± 5 %	100 V_pk
100.0000 MΩ	-	0.25 %	-	± 10 %	100 V_pk
330.0000 MΩ	-	0.50 %	-	± 10 %	100 V_pk

12. Specification applies to "True Ohm" (bipolar) measurement method. Add 15 µV 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 µV / 10 mA = 1.5 mΩ additional floor.

9.6.3. 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}

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

9.6.4. 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

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

9.6.5. 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:
  - ACV (Square Shape Harmonic Sine) (Chapter 6.3.)
  - ACI (Square Shape Harmonic Sine) (Chapter 6.3.)
  - Temperature TC (meter °C) (Chapter 6.3.)
  - Frequency (Chapter 6.3.)
  - Variable resistance and Fixed resistance (Chapter 6.4.)
- New sub-chapter Temperature TC (meter °C) (Chapter 6.3)

$C\epsilon$ **Declaration of conformity**

According to EN ISO/IEC 17050-1:2010 standard as well as 2014/30/EU and 2014/35/EU directives of European Parliament and European Council, MEATEST, spol. s r. o., manufacturer of 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