OCM143
Multifunction Calibrator

Owner's Guide

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Basic information

OCM143/143i are precision instrument for use in calibrating laboratories, production lines and field applications for service purposes. They can be used for calibration of any measuring instrument for DC and AC voltage, current, resistance and frequency. The calibrator sources harmonic and non-harmonic signals with accurate amplitude. It includes function of simulation of thermocouple temperature sensors for testing of process meters and as an option function of RTD sensor simulation.

The calibrator covers DC and AC voltage in the range from 0 μV to 1000 V and DC and AC current in the range from 0 μA to 20 A (2A in OCM143i version). Best accuracy is 0.01 % for DC voltage, 0.055 % for AC voltage, 0.018 % for DC current and 0.075 % for AC current. Applicable frequency range is 20 Hz to 1000 kHz. The calibrator has built-in firm decade standard resistors in range from 10 Ω to 100 MΩ with accuracy 0.01 %. In frequency mode the calibrator can generate a square wave signals from 0.1 Hz to 2 MHz

Simulation of temperature sensors can be used for testing and calibration of evaluation parts of thermometers, panel meters, regulators, etc. The calibrator offers basic thermocouple sensor simulation of type R, S, B, J, T, E, K, N. Compensation of cold junction of thermocouple is achieved by entering of ambient temperature by using the front panel keyboard or by using external Pt1000 sensor from OCM143 accessory. The accuracy of simulated temperature sensors depends on the value, the sensor type and the simulated temperature and varies from 0.1 ^{o}C to 4.3 ^{o}C. Simulation of RTD temperature sensors is an option which offers simulation of Pt/Ni types.

The calibrator offers also other features which facilitate easy use such as relative deviation from the set value, currently displayed accuracy of the output signal, calibration and testing procedures and other.

The calibrators are delivered with RS-232 interface as a standard. GPIB can optionally be ordered. Software packages WinQbase/CALIBER can be run for automatic calibration of Multimeters. By using the digital camera full automatic calibration of Multimeters with LCD displays is possible.

The main difference between OCM143 full version and OCM143i light version is in the AC/DC current range. OCM143 can supply currents up to 20 A, OCM143i is limited to 2 A.

ATTENTION !

The calibrator generates dangerous high voltage.

Please pay attention to all instructions in this manual.

Preparation for operation

Content inspection

Basic package includes the following items:

- OCM143/143i Portable Multifunction Calibrator
- Power line Cord
- Spare fuse 1 pcs
- Operation manual
- Orbit Controls Test report
- Test cable 1000V/20 A 2 pcs
- Option 143-90 Pt1000 Temperature sensor
- Option 143-60 Cable Adapter (optionally)

Power line voltage setting

The calibrator is designed for operation from 115/230 V - 50/60 Hz line voltage. Before the first connecting to the mains, check the position of the mains voltage selector located at the rear panel and change if necessary, such described below:

- Insert flat end of a screwdriver to the slot in the power line socket on the rear panel. Wind with the screwdriver slightly to pull out the holder with the fuse and selector contacts.
- Place the contacts in such position, that correct power line voltage can be read in the rear window.
- Push the holder back to the power line socket. In the window correct voltage (115 or 230 V) must be seen. Use position 115V for nominal mains voltage 110 to 130 V. Use 230V position for mains voltage 220 to 240 V.

Power-On

- Plug one end of the power cord into the connector located at the rear panel and connect the other end of the power cord into a wall outlet.
- Switch on the main switch located at the rear panel. Front panel display illuminates.
- The calibrator performs internal hardware checks for 5 seconds.
- At the end of the test, the calibrator resets to the reference position with output parameters:

Function	DC voltage
Range	10 V
Set value	10 V
Output terminals	OFF

Note: The calibrator resets to its reference status always after switching off and switching on.

Note: After switching on the fan on the rear panel it blow for some time depending on the ambient temperature conditions.

Warm-up time

The calibrator works after it was switched-on and the initial checks completed. Specified parameters are guaranteed after the warmup time of 5 minutes. There is no approach to the calibration menu during the warmup time. The display will show “cannot access the calibration”.

Fuse replacement

The fuse is located in the mains connector at the rear panel. Replace the fuse as follows:

- Switch off the calibrator.
- Remove the cord from the mains connector at the rear panel.
- Insert the blade of a flat screwdriver into the opening in the mains voltage selector and pull out the fuse holder.
- Remove the fuse and replace it with a new of the same rating.

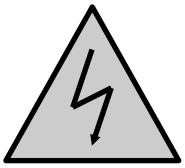
Safety precautions

The instrument has been designed in Safety Class I according to EN 61010-1. The design reflects the requirements of A2 amendment of the standard. Safety is ensured by the design and by the use of specific component types.

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

Safety symbols used on the instrument

Warning, reference to the documentation



Warning - risk of electric shock

Danger - high voltage

Description of controls

Front panel

The front panel of the calibrator includes an LCD display, control keys and output terminals.

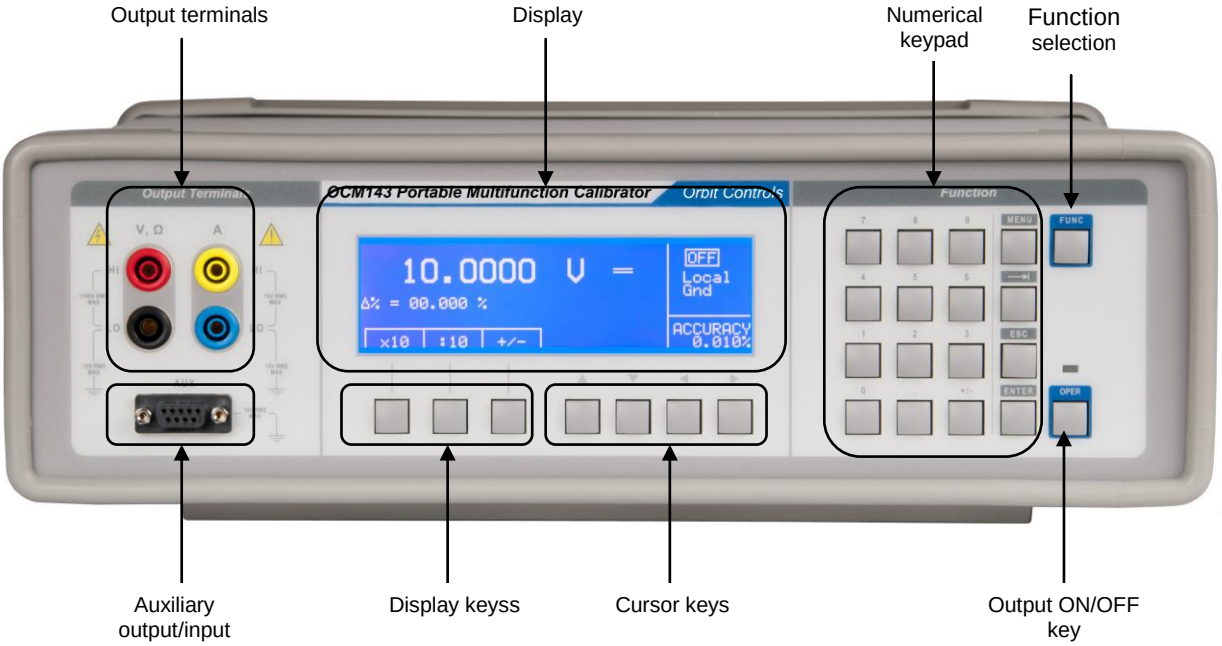


Fig. 1 OCM143/143i Front panel

Display keys

Three keys located under the display have more functions. Their momentary valid function is shown at the display. They are used for entering the MENU, changing the ranges, storing values and other.

Cursor keys

Two keys are used for setting the vertical position of the cursor (<, >). They are mostly used for moving inside the MENU, switching between two menus in different levels or setting active position of the numerical value. The next two keys (∧, ∨) will be used for setting the value.

Numerical keypad

The keys are used for entering the numerical value. The key ENTER confirms the selection, with CANCEL the value will not be accepted.

Output ON/OFF key

With the ON/OFF key the output terminals will be connected. Activated terminals are indicated with LED and a symbol ON or OFF at the display.

Output terminals

The selected signal is connected to the output terminals. Current ranges are **A +I / -I**, Voltage, Resistance, Thermocouples and frequency are at **V Hi / Lo** terminals.

AUX Connector

The auxiliary connector is intended for the option 143-90 (external Pt1000 temperature sensor) and for the option 143-60 (RTD temperature simulation).

Function selection keys

Main keys for function selection.

Display

Main field
Shows the selected output signal including the units. Symbols ▼▲ indicate the active digit. The value can be set with ∧ ∨ , the cursor position with > < .

Information field
Information related to the set function:
- OUTPUT ON or OUTPUT OFF output terminals.
- Local or remote control – LOCAL or REM
- Output current simulated by current coil Opt. 140-50 Setting in the SETUP MENU.
- Grounding of the Lo/-I terminals.
- Selected TC temperature sensor.

Time/Date field
Real time and Date of the Day

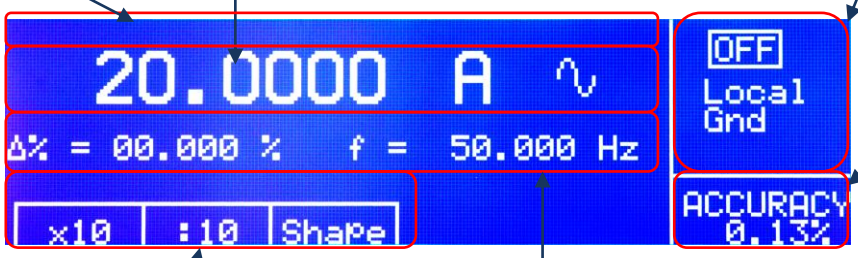


Fig. 2 OCM143/143i Display

Accuracy field
Currently valid accuracy of the set output signal.
It is calculated from full specification of the calibrator and displayed in %.

Auxiliary parameter field
Two lines auxiliary parameters related to the output signal:
- Set relative deviation in %
- Frequency of AC voltage/current
- Temperature of cold junction in TC temperature sensor simulation mode.

Display key field

Symbol	Key function	Note
x 10	10 x increasing the value	for functions U, I, R, F
: 10	10 x decreasing the value	For functions U, I, R, F
Shape	Waveform selection	U, I functions
+/-	Polarity of the output signal	For functions DC U, DC I
Calib	Enter to the calibration mode	Available in MENU
Type	TC sensor type setting	For temperature sensor simulation

Tab I Display keys

Rear panel

Power line socket with fuse, line voltage selector and power switch

RS-232 and GPIB (Option) sockets

Plate with serial number

GND Terminal connected to the metal cabinet

Fan air opening

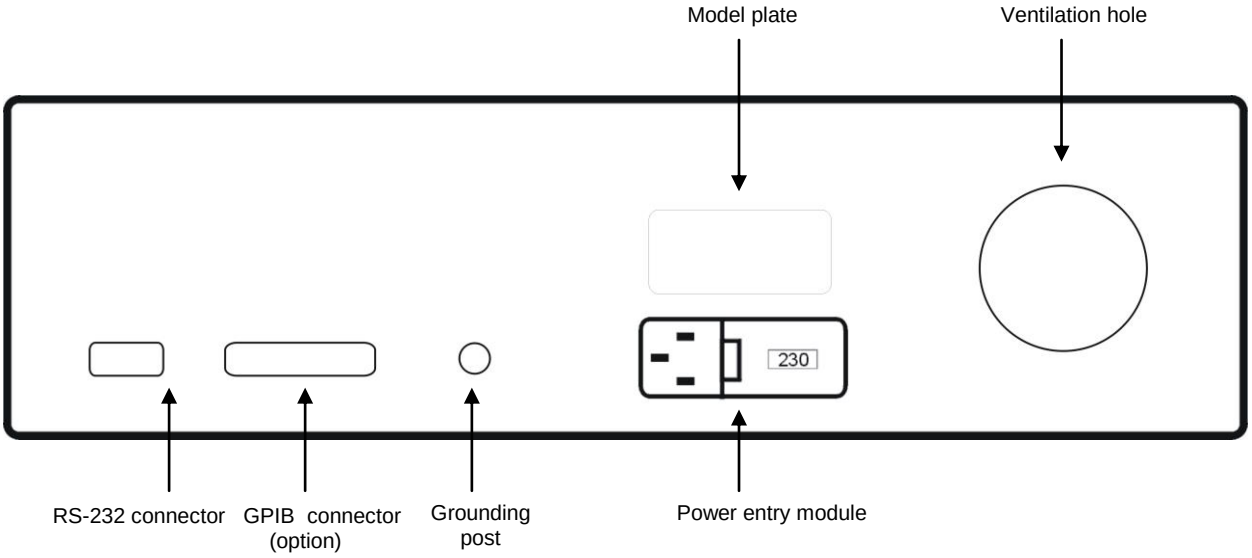


Fig. 3 OCM143/143i Rear panel

Between terminals following maximal voltages are allowed:

Hi - GND :	1100VRMS
+I - GND :	10VRMS
Lo - GND:	10VRMS
- I - GND :	10VRMS

Operation of the calibrator

Selection of the function

After the power has been applied and the initial checks completed, the calibrator resets to its reference status, i.e. DC voltage output 10 V and output terminals disconnected. The status of the calibrator can be changed with the keys located at the front panel in one of the following ways:

- ***Change of the function***

By repeated pushing the key FUNC the basic mode can be changed for DCV, ACV, DCI, ACI, Resistance, Frequency, T/C or RTD simulation (option).

- ***Connection /disconnection of output terminals***

The output terminals can be connected/disconnected with the ON/OFF key.

- ***Entry to the setup menu***

With the key SETUP the display changes into the SETUP MENU. The calibration mode can be opened. To return to the previous mode use the key ESC.

Output signal value

Entry of the value using the numeric keys

- use the numeric keyboard to select the desired value. After the first digit is entered, symbols of unit of measurements are displayed above the display keys.

  The monitor line displays [_ _ _ _ _ _ _ _].

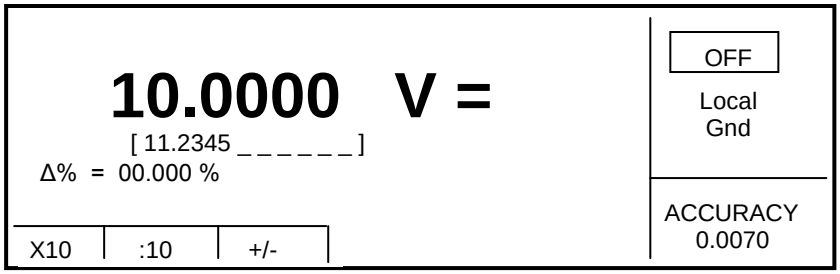


Fig. 4 10VDC Display

- Display keys select the units: V, mV or μV
- The value is copied into the main display and the monitor line will be closed.

Entry by using the cursor keys

- With the keys < > or ∧ ∨ the display will show the cursor pointing at the active digit.
- ∧ and ∨ can be used to set the active digit. < or > to change the cursor position.
- ESC key return the display to the default screen.

Reverse polarity

In DC voltage and DC current modes, the polarity of the output can be reversed with +/- display key The display shows the symbol „ - “.

Relative deviation

In all functions - except frequency - the relative deviation of the output value can be set and displayed in the “auxiliary field” as „ Δ%= 00.0000 % “. The relative deviation can be entered by using one of the methods described below.

Setting of the Relative Deviation with the numerical keyboard

* keep pressing SEL until [_ _ _ _ _ _ _] appears under the relative deviation of the display
* enter the desired deviation value and confirm by pressing “ % “ display key or by pressing ENTER of the numerical keyboard
* the auxiliary line below the main data on the display shows the total value of output signal including the unit of measurement

The value of the signal at the output terminals is:

The value indicated by the main display + Δ % for voltage, current, frequency mode .
The value indicated by the main display + Δ °C for TC sensor simulation

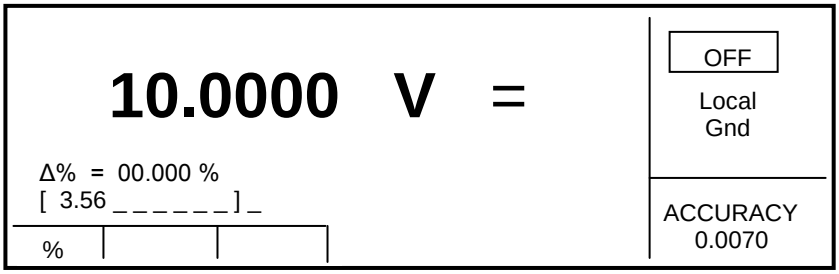


Fig. 5 Relative deviation setting

Maximum relative deviation can be set ± 30.000 %.
The deviation can be positive or negative. For negative deviation the display key +/- has to be pressed. The polarity can also be reversed using the cursor keys or the digital potentiometer.

Setting the Relative Deviation with the cursor keys

- Press the key SEL until [_ _ _ _ _ _ _] appears under the relative deviation
- Press <, >, ∧ or ∨. The display now includes the cursor pointing to the active digit
- ∧ and ∨ keys can be used to change the active digit. The keys <, > position of the cursor
- To return to the default mode press the key SEL until [_ _ _ _ _ _ _] disappears from the display, or press the key ESC.

Changing the value by factor of ten (10)

All functions except the temperature simulation allow the increase or reduction of the output value by 10. Error messages:

Value too large!	The resulting value is too large
Value too small!	The resulting value is too small

Range changing

- Press the display key " x10 " for increasing, " :10 " for decreasing.

In the Resistance Function firm values are connected to the output terminals.

Connection / Disconnection of the output terminals

After the power has been applied, the output terminals are disconnected. Press the ON/OFF key to connect the output signal to the terminals. Red LED above the OUTPUT key will illuminate and the symbol ON appears at the display .

To disconnect the output terminals, press ON/OFF again. The red LED will switch-off and the the display will show OF.

During the mode of operation is being changed, the output terminals are always disconnected.

Voltage over 100 V is indicated with an acoustic signal.

Frequency Setting

Frequency can only be selected in AC voltage, AC current and Frequency mode. In each mode the frequency has a slightly different meaning and the is therefore set in a different ways.

AC voltage (ACU), AC current (ACI)

The frequency is shown in the Auxiliary field of the display.

Setting the Frequency

- Select the AC voltage or AC current by pressing the key FUNC. Frequency value „f = xxx.xx Hz“ appears in the Auxiliary field of the display.
- Press the key SEL until [_ _ _ _ _ _ _] appear below the frequency value. Numerical keyboard can be used to enter the desired value. Press “ Hz “ or “ kHz “ to confirm.

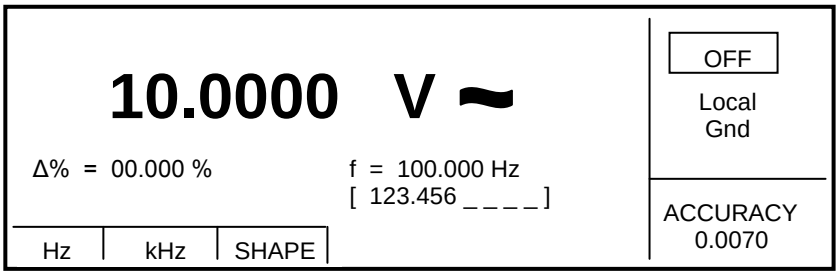


Fig. 6 Frequency change

If too large or too small value is entered, the calibrator displays the maximum (minimum) value which is allowed for the selected function.

Frequency (F)

The main display shows the frequency value. The frequency can be set by direct from the keyboard, with the potentiometer or by changing the digit at the cursor position. The setting procedure is described in the “Setting the value of output signal”.

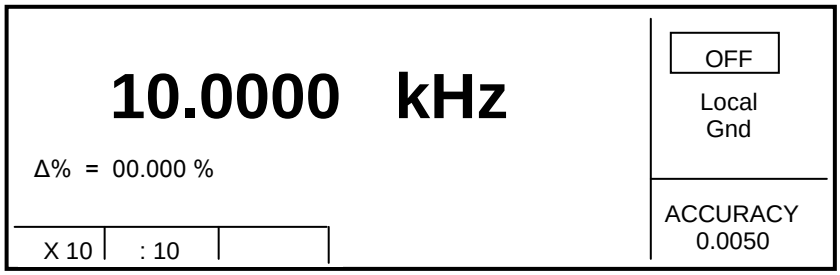


Fig. 7 Frequency function

If frequency larger or smaller than the calibrator’s range, the calibrator displays an error message: „Value is too large (small)“.

Output waveform in frequency mode is always square wave with TTL amplitude 0 – 5 V.

AC/DC Voltage Function

The multifunction calibrator provides calibrated DC and AC voltage. Output terminals for voltage ranges are " **Hi** " and " **Lo** ". Depending on the setting of the calibrator, voltage up to 1000 V_{rms} can be present at the terminals.

DC voltage range	0 to 1000 V.
AC voltage range	100 µV to 1000 V

Control in the voltage mode

- Use the FUNC key until DC or AC voltage mode will be displayed:

  Voltage Value
  Relative Deviation
  Accuracy of the output voltage
  Frequency (for AC only)

- Set the desired value, including polarity, frequency and relative deviation. Until now the signal is not connected to the output terminals and the display shows OFF.
- Press the key OUTPUT.
- Red LED above the OUTPUT terminals is on, the display shows the symbol ON.
- The selected voltage is present at the output terminals.

Output voltage over 100 V

The display informs about a dangerous voltage with a symbol .
If the output terminals are activated, they will be automatically disconnected as soon as the selection is larger than 100V. The terminals have to be activated with the key ON/OFF. The sound informs about the dangerous voltage at the terminals.
Voltage, polarity, frequency, absolute and relative deviations can be set without the outputs being disconnected. The output terminals are automatically disconnected while changing between AC and DC or changing into another operation mode.

Output terminals overloading

If the output terminals are overloaded or short-circuit in the voltage mode, the calibrator disconnects the signal from the output terminals and reports „Overload U output“.

ATTENTION DANGEROUS VOLTAGE

When working with voltages over 50 V, rules for work with dangerous voltage must be respected!

Never touch the measurement circuit when the voltage at the output terminals exceeds 50V!

ATTENTION DANGEROUS VOLTAGE

It is not possible to disconnect the output voltage using the keys located at the front panel when the calibrator is in remote mode !

The calibrator must be first switched to local control mode by pressing the LOCAL key and then the output terminals can be disconnected !

AC/DC current

The multifunction calibrator provides calibrated DC and AC current. Output terminals at the front panel for current ranges are “ +I “ and “ -I “. The terminals can carry high current up to 20 A_{rms}.

DC current range	0 to 20 A in OCM143	0 to 2 A in model OCM143i
AC current range	1μA to 20 A in OCM143	1μA to 2 A in model OCM143i

When Current coil 50/25 (option 140-50) is used, maximal simulated AC current is 1000 A (100 A in OCM143i).

Control in the current mode

- The key FUNC permits selection of AC or DC current mode. The display shows:

  main value of the current
  relative deviation
  accuracy of the output current
  frequency (when AC current is selected)

- Set the desired value, including polarity, frequency and relative deviation. Until now the signal is not connected to the output terminals and the display shows OFF.
- Connect the load or short the output terminals **+I, -I**.
- Press the key OUTPUT.
- Red LED lights up and the display shows the symbol ON.
- The selected current is present at the output terminals.
- If COILx50 function is activated in the SETUP menu, the optional 50-turn coil can be connected to the output terminals. Clamp Amperemeters can be calibrated up to 1000 A.

Note: OCM143 current power stage is cooled by fan with variable speed. A noise is produced by the fan, especially when the range 20A is selected.

Note: OCM143 can supply the current in range 10A to 20A for a limited period. Default period is 5 minutes at 20 A and 15 minutes at 10 A. It can vary depending on previous load conditions. Full recovery to starting condition takes about 5 minutes.

Overloading the terminals

When external circuit connected to current output terminals is disconnected or a higher voltage generated across the load, the calibrator disconnects the output terminals and displays „Overload I output“ message. The same message can be displayed when 50-turn coil is used for AC current output at frequencies higher than 80 Hz.

Non-harmonic mode

The multifunction calibrator can generate non-harmonic periodic signals with predefined shape. To allow the setting of a non-harmonic output shape, the calibrator must be switched to ACV or ACI mode. In both cases, an indication of the type of output shape is displayed beside the main set value. Press the display key SHAPE to change the shape of the output signal.

The calibrator can generate the following shapes:

- SINE — sinus (harmonic)
- PWM SYM — square wave - symmetrical, with adjustable duty cycle
- RAMP A — ramp, symmetrical positive
- RAMP B — ramp, symmetrical negative
- TRIANGLE — triangular, symmetrical
- LIM SINE — sinewave with amplitude distortion k=13.45%

Generation of non-harmonic signals has some limitations:

- non-harmonic signals can be generated in frequency range 20 Hz to 80 Hz
- maximal non-harmonic current is 2A, maximal voltage is 10V

Setting in the non-harmonic mode

- Select AC voltage or AC current mode. The main display shows:

  * Current or voltage and the measured units
  * Relative deviation
  * Frequency
  * Selected SHAPE

- Press the SHAPE display key to select the desired shape of the output signal.

The output terminals are automatically disconnected during the shape of the output signal is changing.

Information on display

When non-harmonic output shape is selected, the display shows additional information:

- „pk“ index shows that the value is peak-to-peak.
- Symbol showing the shape.

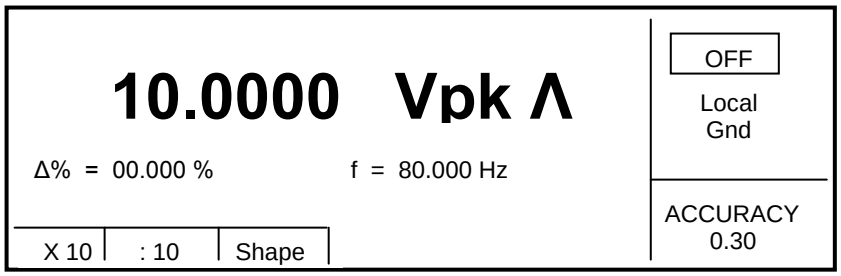


Fig.8 Non-harmonic mode display

Resistance

OCM143/143i is equipped with high precision resistors of firm values 10Ω, 100Ω, 1kΩ, 10kΩ, 100kΩ, 1MΩ, 10MΩ and 100MΩ. They are connected to the Hi-Lo output terminals in two wire connection.

Resistor Selection

The key FUNC selects the Resistor Mode. The display shows the value in Ω and the uncertainty.

- Use the key x10 or :10 to increase or decay in 10 steps.
- Use the key ON/OFF (with LED) to connect the resistance to the output terminals. T

Resistance mode is suitable for use in DC applications and AC applications up to 10 kHz.

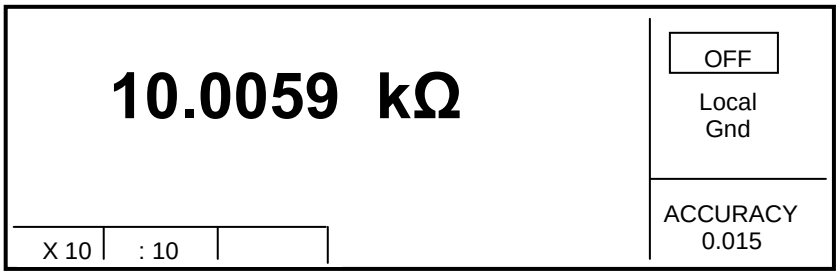


Fig.9 Resistance display

Frequency Generation

OCM143/143i can generate square wave TTL level signal 0.1Hz - 2MHz with 4 digit resolution. The signal is available at the terminals Hi – Lo.

Frequency Setting

- The key FUNC selects the frequency mode. The display shows:

  * Frequency value
  * Relative deviation
  * Uncertainty

- Set the frequency with the numerical keyboard, cursor keys or digital potentiometer.

- Connect the object to be calibrated to the FREQ terminals.

Press ON/OFF key to activate the output. The red LED lights-up indicating the output terminals are activated.

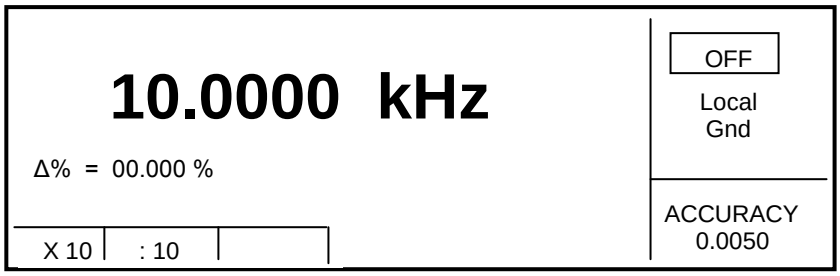


Fig.10 Frequency mode display

***Note**:* The output impedance of the Hi-Lo terminals is 50 Ohm.

Simulation of RTD temperature sensors (Option RTD)

OCM143/143i can optionally simulate resistance temperature sensors.

When the RTD sensors are simulated, the appropriate resistance corresponding to the temperature is available at the output terminals on rear panel terminals. The connection is four-wire type. A mating connector is enclosed to the shipment.

Temperature setting range: -250 to +850 ^{o}C for Pt Temperature Sensors
-60 to +300 ^{o}C for Ni Temperature Sensors
Temperature scale: ITS 90, PTS 68

Rear panel RTD connector connection: Pin 1 - Li, Pin 2 - Lu, Pin 3 - Hi, Pin 6 - Hu

Temperature setting

With the key FUNC the RTD simulation can be selected.

The display shows:

Temperature in ^{o}C or K
Sensor type: Pt or Ni with nominal value in 0 ^{o}C
Set value of absolute deviation in %, labeled ΔT = xxxx.x °C (K)

The auxiliary display section shows:

Temperature scale type
Accuracy of the simulated temperature value

The temperature can be set from the numeric keyboard or cursor keys. The information display section shows the symbol OFF and the terminals are disconnected.

Connect the object to be calibrated to RTD connector

Press the ON/OFF key for connecting the terminals. The display shows ON.

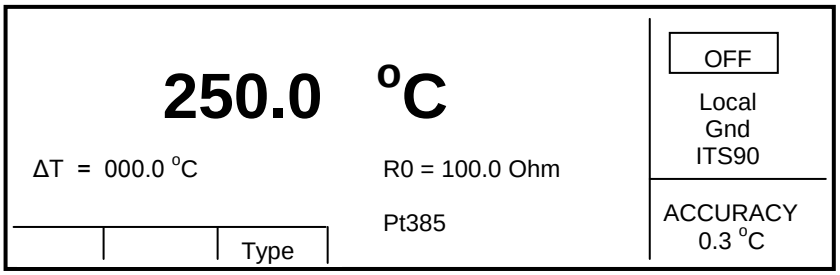


Fig.11 RTD simulation display

Note: Maximal power dissipation is 0.2 W.

Switching between temperature sensor types

With the display key ***Type*** the resistance norms can be selected and displayed: Pt1.385, Pt1.392 or Ni.

Entry of R0 – the Zero Resistance

The Zero Resistance R0 can be set within the range 100 to 1000 Ohms.

- Select the resistance sensor mode and press the cursor key until [_ _ _ _ _ _ _] appears below R0 (R0 = xxxx Ω).
- Set the value by using the keyboard and confirm by " Ω" display key or by pressing ENTER.

***Note**: For temperature scale selection ITS90 / PTS68 use the SETUP menu.*

Simulation of Thermocouple Sensors

OCM143 can simulate thermocouple temperature sensors. The voltage corresponding to the selected temperature is available at the terminals Hi-Lo.

Temperature Range:	-250 to +1820 ^{o}C depending on simulated sensor type
Sensor Type:	K, N, R, S, B, J, T, E
Temperature Scale:	ITS 90, PTS 68

Temperature Setting

- Press FUNC to activate the TC simulation. The display shows:

  * Temperature in ^{o}C or K
  * Sensor type: K, N, R, S, B, J, T, E
  * Cold junction temperature of thermocouple sensors RJ
  * Relative deviation ΔT = xxxx.x °C (K) in %

  The auxiliary display section shows the Temperature and the Uncertainty:

- Set the temperature by using the numerical keyboard or cursor keys.
- Connect the object to be calibrated to Hi - Lo terminals.
- Press ON/OFF. The red LED above the OUTPUT terminal lights-up indicating that the output terminals are activated. The display shows ON.

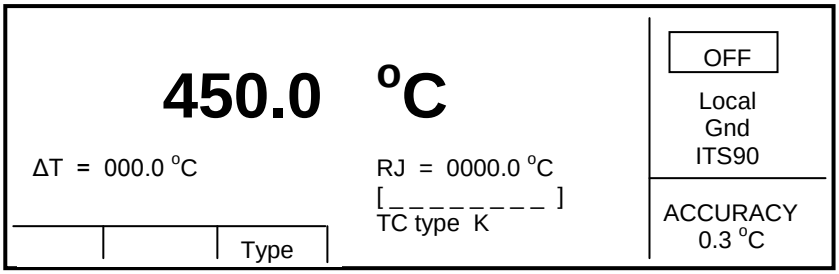


Fig.12 TC sensor simulation

Switching between temperature sensor types

- Press the key **Type**.
- Select the desired thermocouple K, N, R, S, B, J, T, E. The selected type is displayed as TC TYPE x..

Cold junction temperature compensation RJ

Temperature of cold junction can be compensated manually or automatically. The selection is in the Setup Menu. In the manual mode the temperature is entered from the keyboard. In the automatic mode is the temperature of the terminals internally measured and automatically compensated.

Manual Compensation

* The key MENU opens the Setup Menu. With keys ∨, ∧ select RJ Temp. With the display keys select FIXED.
* By repeated pushing the key FUNC select the TC simulation.
* Push the key SEL until symbol [_ _ _ _ _ _ _ _] appears under the RJ value which is in a form RJ = xxxx.x °C.
* Insert the required temperature with the numerical keys. Confirm with the key °C (K).

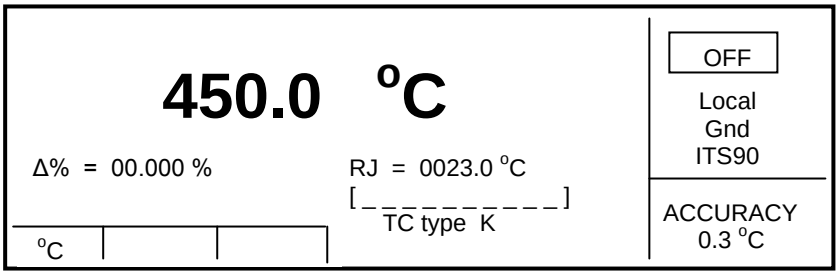


Fig.13 Manual RJ compensation display

Automatic compensation

- Connect Option 143-90 External temperature sensor to the AUX connector.
- The key MENU opens the service menu. With keys ∨, ∧ select RJ Temp. With the display keys select MEAS.
- By repeated pushing the key FUNC select TC simulation.

  The temperature is measured with internal Pt Sensor. The simulated voltage is compensated to the measured temperature.

Note: Use the Setup Menu for the Temperature scale selection ITS90 / PTS68.

Note: The current through the TC sensor is 2 mA.

Setup menu

Not frequently used parameters can be set in the Setup Menu. The menu can be opened with MENU. The display shows:

```
Coil x50   . . . . . . OFF
Gnd  . . . . . . . . . ON
Temp. scale   . . .  ITS90
Temp. unit . . . . . . °C
RJ Temp.  . . . . .  FIXED
Calib
```

Fig.14 Setup menu display

Use ∧ or ∨ cursor keys to select one of the menu options. The display keys are assigned to the displayed functions. After selection press ESC key twice to save the parameter. The new setting is stored also when the calibrator is switched off. The Setup Menu offers following options:

1. ***Coil x50 .... xx ON/OFF***

This parameter can be set on when 50-turn current coil is used for clamp Amperemeters calibration. The coil multiplies the current flow by 50. Default is OFF.

2. ***GND .... xx ON/OFF***

This parameter connects **Lo** terminal to the **GND** (housing). By using the display keys the terminal can be grounded or ungrounded. Default is ON.

It is recommended to set the parameter to ON. If the calibrated UUT has Lo terminal grounded, it is better to unground the outputs of the calibrator, GND OFF to exclude ground loops.

Note: *If neither the calibrator's output nor the meter's inputs are grounded, signal/noise ratio can arise at the calibrator's output.*

3. ***Temp.scale .... xx ITS90/PTS68***

This parameter allows selecting of the temperature scale. The display keys permit switching between ITS90 and PTS68 temperature scales. Factory setting is ITS90.

4. ***Temp.unit .... xx °C/K***

This parameter allows selection of the temperature unit between °C and K. Factory setting is °C.

5. ***RJTemp. .... xx FIXED/MEAS.***

Setting the cold junction temperature compensation with the display keys FIXED or MEAS. In FIX mode the cold junction temperature will be entered manually from the keyboard. In the MEAS mode the temperature of output terminals is measured by internal thermometer.

6. ***Interface .... xx GPIB/RS232***

Selection of the data port GPIB or RS232 with the display keys. The GPIB data port is option.

7. ***GPIB address .... xx UP/DOWN***

The GPIB Address can be selected from 00 to 30 with the UP or DOWN display keys. Default is 02.

8. ***RS232 baud rate .... xx UP/DOWN***

The communication speed of RS232 can be selected with the UP/DOWN display keys for 150, 300, 600, 1200, 2400, 4800, 9600 or 19200.

9. ***Handshake .... xx OFF/Xon-Xoff***

The communication handshake can be select for OFF or Xon/Xoff.

10. ***Keyb.beep .... xx ON/OFF***

Acoustic sound when the keys are pressed. The sound can be switched OFF or ON. Factory setting is ON. Voltages over 100 V are indicated by beep also when this parameter is switched off.

11. ***Beep.volume .... xx HIGH/LOW***

The sound level can be set in two intensity steps.

12. ***Display .... xx UP/DOWN***

The back light of the display can be set for OFF, OFF 30s, OFF 300s or ON.

13. ***Contrast .... xx UP/DOWN***

The display contrast can be set in 32 levels from 00 to 31.

14. ***Cal.code 000000***

Calibration code is a five-digit number, which must be entered to access the calibration mode. Factory setting is “000000” and is displayed in the Setup Menu. The Calibration Code can be changed upon demand with the numeric keyboard and confirmed by ENTER. If non-zero calibration code is set, the correct calibration code must be entered to access the calibration mode. Non-zero calibration code is not displayed on the display.

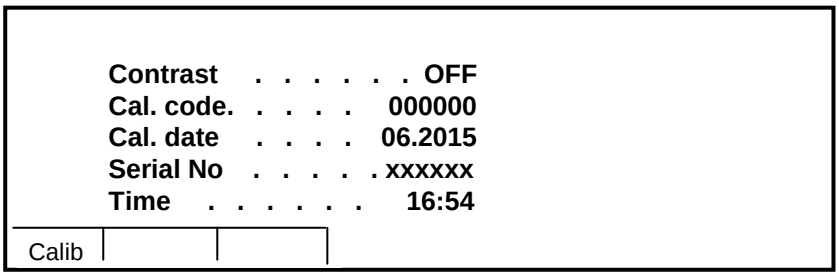


Fig.15 Calibration password change

The calibration code has to be used to prevent unauthorized access to the calibration menu.

Note: It is advisable to note the calibration code. If forgotten, the instrument has to be returned to the manufacturer.

15. ***Cal.date .... xx.yyyy***

Date of the last calibration (month/year). The parameter cannot be changed as it is automatically recorded at the end of the calibration procedure.

16. ***Serial No .... xxxxxx***

Displays the serial number of the calibrator. The parameter cannot be changed.

17. ***Time .... xx:yy***

Real Time Clock. The parameter can be changed by using HOUR, MIN +, MIN - display keys.

18. ***Date .... xx.yy.zzzz***

Date of the Day. The parameter can be changed by using DAY, MONTH, and YEAR display keys.

19. ***Time on display .... xx ON/OFF***

The Time and the Date are displayed at the upper part of the display when this parameter is set ON. Factory setting is ON.

Calibration mode

OCM143/143i is equipped with internal calibration procedure, which allows very precise re-calibration of all output signals. The calibration contains the Zero Point and the Slope of the selected Function and the Range. The calibration is controlled from the keyboard and the internal calibration menu steps.

Principle of Calibration

- Complete calibration in recommended points
- Partial calibration of selected points
- Partial calibration of selected functions and selected points

Complete calibration contains all functions and points. If an item of the calibration menu, e.g. “VOLTAGE DC” is selected, it is not necessary to calibrate all ranges defined by the calibration algorithm. When the new calibration of all ranges is not possible (e.g. the required standard is not available), old calibration data can be confirmed and the rest can be skipped.

Full calibration contains:

DC voltage calibration is performed by setting the zero and slope of the scale in all ranges and in both signal polarities (+ and -) (except the 750 V range, where zero correction is not necessary).

AC voltage calibration is performed by setting the zero and slope of the scale in all ranges at 100 Hz.

DC current calibration is performed by setting the zero and slope of the scale in all ranges and in both signal polarities (+ and -).

AC current calibration is performed by setting the zero and slope of the scale in all ranges at 100 Hz.

Resistance calibration is based on writing and saving new calibration values of the fixed resistors.

RTD temperature sensor simulation calibration. The procedure is based on measuring and saving into calibration memory of partial resistors in range from 20 Ω to 120 MΩ.

Frequency function does not require any adjustment. Also **TC temperature sensor simulation** function need no other adjustment as it is calculated from DC voltage ranges 10 and 100 mV.

Note: TC sensor simulation does not require recalibration. It is derived from DC voltage scale by using arithmetic formulas.

The Calibration can be interrupted at any point of the calibration procedure. The calibrated point however will influence the calibrator’s overall performance.

The accuracy of the calibrator is guaranteed when full calibration has been performed.

Access to the calibration procedure

Calibration code is required to access the calibration procedure.

- Press MENU key to open the setup menu.
- Press CALIB display key.
- If an attempt is made to access the calibration procedure within 60 minutes after the calibrator was switched on, the calibrator refuses to open the calibration menu and displays following message:

  Err 21 Time warm up !

After the warm-up time of 60 minutes the calibrator is ready for calibration. The display shows:

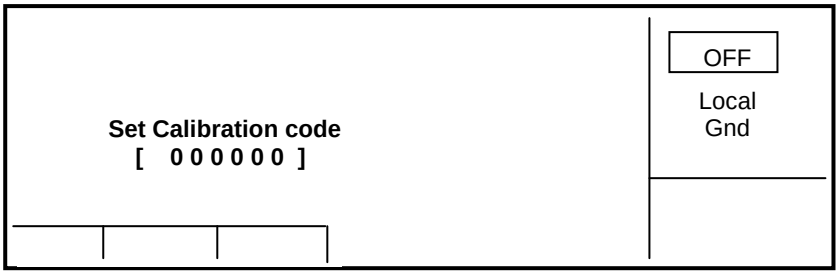


Fig.16 Calibration password entering

- Enter correct calibration code from the numeric keyboard and confirm with ENTER.
- With an incorrect code an error message appears on the display for approximately 3 seconds:

  Err 20 Bad calib. code!

- With a correct calibration code the calibration menu opens:

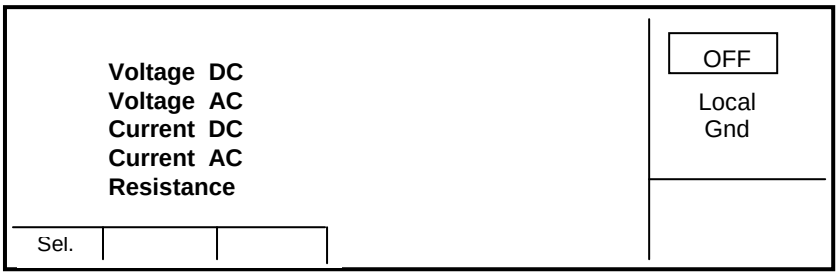


Fig.17 Calibration menu

- Use ∧ and ∨ cursor keys to move the cursor through the list:

1.	VOLTAGE DC	All DC voltage ranges calibration
2.	VOLTAGE AC	All AC voltage ranges calibration
3.	CURRENT DC	All DC current ranges calibration
4.	CURRENT AC	All AC current ranges calibration
5.	RESISTANCE	Resistance calibration

Selection of calibration type

After the calibration menu is displayed, any of partial calibrations can be selected. Use ∧ and ∨ cursor keys to move the cursor through the list. Having selected the required function to be calibrated, press SEL display key. Following data are shown (the example below is valid for VOLTAGE DC range):

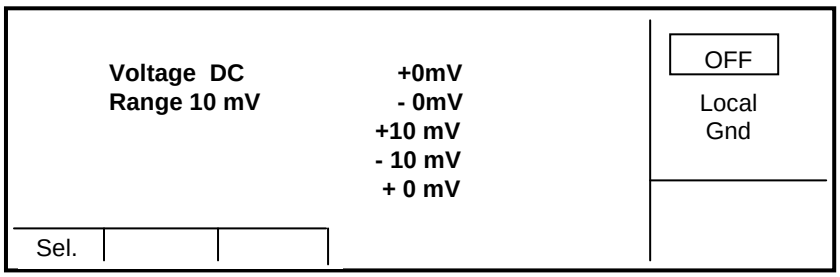


Fig.18 10 mV DC calibration points

The list of calibration points will be presented. Select the required function and press the key SEL.

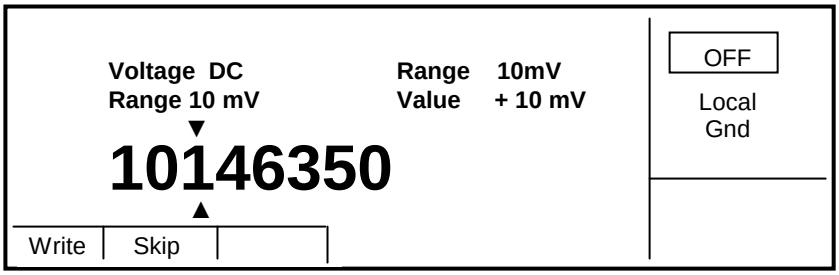


Fig.19 New calibration value entering

The Display keys have following meaning:

WRITE	new calibration value is entered into the memory, old value is irreversibly lost
SKIP	current calibration step is skipped, old value is retained in the memory

The display shows also the range (RANGE) and the value (VALUE) to be set at the external multimeter.

Next Calibration Point selection

Use ∧, ∨, <, > cursor keys to set such value on the display that the output signal corresponds to the required value of the calibrated point measured with the external standard instrument. Press “WRITE” to store the new setting. If “SKIP” is pressed the calibrated point remains unchanged. The menu increments to next calibration point.

Repeat the steps for all points selected. When ESC is pressed before completing the calibration, the calibrator returns to the basic calibration menu.

Termination of calibration

The calibration can be terminated after:

* the complete calibration has been performed, new calibration data have been saved, the program is returned to the calibration menu,
* the calibration of selected function and selected ranges has been performed, new calibration data have been saved, the program is returned to the calibration menu,
* the calibration has been started but no calibration data have been entered, the program is returned to the calibration menu after ESC display key has been pressed.

Press ESC display key to terminate the calibration. The calibrator’s function returns into the state it was in before the calibration has been started.

Calibration points

Each function contains fixed calibration points which have to be set during the calibration. For VOLTAGE DC, VOLTAGE AC, CURRENT DC, CURRENT AC the output signal value is set using the keyboard. For RESISTANCE function calibration data of the fixed resistances must be entered. T function does not require any calibration, as the output voltage or resistance is based on arithmetic interpolation using standard tables of temperature sensor values.

VOLTAGE DC

Nominal value	*Tolerance*	*Range*	*Note*
+0.0 mV	2 µV	10 mV	zero calibration
- 0.0 mV	2 µV	-10 mV	zero calibration
+10 mV	4 µV	10 mV	slope calibration
- 10 mV	4 µV	-10 mV	slope calibration
+ 0.0 mV	2 µV	100 mV	zero calibration
- 0.0 mV	2 µV	-100 mV	zero calibration
+100 mV	6 µV	100 mV	slope calibration
- 100 mV	6 µV	-100 mV	slope calibration
+ 0.0 V	5 µV	1 V	zero calibration
- 0.0 V	5 µV	-1 V	zero calibration
+1.0 V	12 µV	1 V	slope calibration
-1.0 V	12 µV	-1 V	slope calibration
+ 0.0 V	20 µV	10 V	zero calibration
- 0.0 V	20 µV	-10 V	zero calibration
+10 V	100 µV	10 V	slope calibration
- 10 V	100 µV	-10 V	slope calibration
+10 V	200 µV	100 V	slope calibration
- 10 V	200 µV	-100 V	slope calibration
+100 V	600 µV	100 V	slope calibration
- 100 V	600 µV	-100 V	slope calibration
+750 V	20 mV	1000 V	slope calibration
- 750 V	20 mV	-1000 V	slope calibration

Table II DC voltage calibration points

VOLTAGE AC

Nominal value	*Tolerance*	*Range*	*Frequency*
1 mV	5 µV	10 mV	100 Hz
10 mV	10 µV	10 mV	100 Hz
10 mV	15 µV	100 mV	100 Hz
100 mV	40 µV	100 mV	100 Hz
100 mV	30 µV	1 V	100 Hz
1.0 V	100 µV	1 V	100 Hz
1.0 V	200 µV	10 V	100 Hz
10 V	1 mV	10 V	100 Hz
10 V	5 mV	100 V	100 Hz
100 V	10 mV	100 V	100 Hz
100 V	50 mV	1000 V	100 Hz
750 V	50 mV	1000 V	100 Hz

Table III AC voltage calibration points

The ACV function can also be calibrated for another frequency than 100 Hz. The calibrator's specifications within the entire frequency range are however guaranteed when the recommended frequency is used.

CURRENT DC

Nominal value	*Tolerance*	*Range*	*Note*
+0.0 µA	3 nA	200 uA	zero calibration
- 0.0 µA	3 nA	-200 uA	zero calibration
+190 µA	5 nA	200 uA	slope calibration
- 190 µA	5 nA	-200 uA	slope calibration
+200 µA	20 nA	2 mA	zero calibration
- 200 µA	20 nA	-2 mA	zero calibration
+1.9 mA	50 nA	2 mA	slope calibration
- 1.9 mA	50 nA	-2 mA	slope calibration
+2 mA	100 nA	20 mA	zero calibration
- 2 mA	100 nA	-20 mA	zero calibration
+19 mA	200 nA	20 mA	slope calibration
- 19mA	200 nA	-20 mA	slope calibration
+20 mA	1 µA	200 mA	zero calibration
- 20 mA	1 µA	-200 mA	zero calibration
+190 mA	2 µA	200 mA	slope calibration
- 190 mA	2 µA	-200 mA	slope calibration
+200 mA	20 µA	2 A	zero calibration
- 200 mA	20 µA	-2 A	zero calibration
+1.9 A	50 µA	2 A	slope calibration
- 1.9 A	50 µA	-2 A	slope calibration
+2.0 A	1 mA	20 A	zero calibration
-2.0 A	1 mA	-20 A	zero calibration
+10.0 A *	2 mA	20 A	slope calibration
-10.0 A *	2 mA	-20 A	slope calibration

Table IV DC current calibration points

* model OCM143 only

CURRENT AC

Nominal value	*Tolerance*	*Range*	*Frequency*
10 µA	5 nA	200 µA	100 Hz
190 µA	50 nA	200 µA	100 Hz
200uA	40 nA	2 mA	100 Hz
1.9 mA	200 nA	2 mA	100 Hz
2.0 mA	200 nA	20 mA	100 Hz
19 mA	2 µA	20 mA	100 Hz
20 mA	2 µA	200 mA	100 Hz
190 mA	20 µA	200 mA	100 Hz
200 mA	20 µA	2 A	100 Hz
1.9 A	200 µA	2 A	100 Hz
2.0 A	1 mA	20 A	100 Hz
10 A	3 mA	20 A	100 Hz

Table V AC current calibration points

The ACI function can also be calibrated for another frequency than 100 Hz. The calibrator's specifications within the entire frequency range are however guaranteed when the recommended frequency is used.

RESISTANCE

Nominal value [Ω]	*Tolerance [Ω]*
10 Ω	0.010 Ω
100 Ω	0.010 Ω
1 kΩ	0.05 Ω
10 kΩ	0.2 Ω
100 kΩ	2 Ω
1 MΩ	50 Ω
10 MΩ	1 kΩ
100 MΩ	50 kΩ

Table VI Resistance calibration points

Use the Standard Multimeter connected with four terminals to the output terminals V, Ω Hi-Lo.

RTD TEMPERATURE SENSOR SIMULATION

Nominal calibration point	*Nominal resistance value*	*Tolerance of calibration value [%]*	*Type of measurement*
SHORT	0-0.2 Ω	10 mΩ	4W
20 Ω	20 Ω	0.05	4W
40 Ω	40 Ω	0.02	4W
80 Ω	75 Ω	0.01	4W
150 Ω	150 Ω	0.01	4W
300 Ω	300 Ω	0.01	4W
600 Ω	590 Ω	0.01	4W
1k1 Ω	1.15 kΩ	0.01	4W
2k2 Ω	2.19 kΩ	0.01	4W
4k4 Ω	4.37 kΩ	0.01	4W
8k8 Ω	8.6 kΩ	0.01	4W
16 kΩ	16.7 kΩ	0.01	2W
33 kΩ	33 kΩ	0.02	2W
66 kΩ	65 k Ω	0.02	2W
125 kΩ	129 kΩ	0.05	2W
250 kΩ	253 kΩ	0.05	2W
500 kΩ	503 kΩ	0.1	2W
1 MΩ	1 MΩ	0.2	2W
2 MΩ	2 MΩ	0.2	2W
4 MΩ	4 MΩ	0.5	2W
8 MΩ	7.8 MΩ	0.5	2W
16 MΩ	15.6 MΩ	1	2W
30 MΩ	30 MΩ	2	2W
60 MΩ	59.7 MΩ	5	2W
120 MΩ	118 MΩ	5	2W

Table VII RTD simulator calibration points

In column Tolerance requested accuracy of measurement of the resistance segment is shown. Standard multimeter has to be connected in four terminal connection (4W) to the output terminals Hi-Lo for values below 10 kΩ and in two terminal connection (2W) for values above 10 kΩ.

Full calibration

Following pages describe the calibration in all ranges and points.

Required instruments:

- 81/2 digit multimeter type HP3458A or Fluke 8508A or other type with accuracy 0.002 % or better on DC voltage.
- Resistance shunt 10 mΩ and 100 mΩ Burster 1280, or other type with accuracy 0.01%
- Counter HP 53181A, HO 53130 or other with accuracy 0,001 %

HP8903A Distortion Analyser and Scope with bandwidth min. 20 MHz are recommended for THD measuring of AC signals.

Calibration procedure

1. Switch-on the calibrator and the standard multimeter for at least three hours at 23±1 ^{o}C.
2. Press MENU display key to recall the setup menu. Press the CALIB display key to recall the calibration menu.
3. Enter the calibration code and press ENTER (default calibration code is “00000”).
4. **DC voltage ranges calibration**
   a) Connect the voltage input terminals of the multimeter to the **Hi - Lo** calibrator output terminals.
   b) Select VOLTAGE DC from the calibration menu and confirm by pressing the SEL key.
   c) Switch-ON the output terminals.
   d) Follow the instructions at the display. Refer to the DCV table in the “Calibration points” and adjust the output level of the calibrator to the nominal value displayed on the standard multimeter. Use predefined calibration points.
   e) Set the output level with <, >, ∨, ∧ cursor keys. Confirm the settings by pressing the display key WRITE. To skip the calibration point, the display key SKIP has to be pressed.
   f) Switch-OFF the output terminals.
5. **AC voltage ranges calibration**
   a) Select VOLTAGE AC in the Menu and confirm with the SEL key.
   b) Switch-ON the output terminals.
   c) Follow the instructions at the display. Refer to the ACV table and adjust the calibrator output in the calibration points.
   d) Set the output level in the calibration points with <, >, ∨, ∧ cursor keys. Confirm the setting by pressing the display key WRITE. To skip the calibration point, the display key SKIP has to be pressed.
   e) Switch-OFF the output terminals. Disconnect the multimeter and the calibrator.

6. **DC current ranges calibration**

   a) Connect current input terminals of the Multimeter to the **+I** and **-I** output terminals of the calibrator. Select CURRENT DC from the calibration menu.

   b) Select DC current range on the standard Multimeter. Switch-ON the output terminals.

   c) Follow the instructions at the display and the DCI table to adjust the calibrator output in the calibration points.

   d) To adjust the output level in the calibration points the cursor keys <, >, ∨, ∧ have to be used. Confirm the settings with the display key WRITE. To skip the calibration point, the display key SKIP has to be pressed.

   e) A resistance shunt 100 mOhm should be used on 2A range, when the standard multimeter does not cover this range with required accuracy.

   f) Switch-OFF the output terminals.

7. **AC current ranges calibration**

   a) Select CURRENT AC from the calibration menu. Set the same function on the external Multimeter.

   b) Follow the instructions provided on the display and the ACI table to adjust the calibrator output in the calibration points.

   c) To adjust the output level the cursor keys <, >, ∨, ∧ have to be used. Confirm the settings with the display key WRITE. To skip the calibration point, the display key SKIP has to be pressed.

   d) A resistance shunt 100 mOhm should be used on 2A range, when the standard multimeter does not cover this range with required accuracy.

   e) Switch-OFF the output terminals and disconnect the Multimeter and the calibrator.

8. **Resistance ranges calibration**

   a) Select RESISTANCE function in the calibration menu by pressing the key SEL.

   b) Set Resistance function on the standard Multimeter, select the 4W method. Short on the standard Multimeter terminals to correct zero if necessary.

   c) Select fixed resistance values on the calibrator from 10 Ohm to 100 MOhm and measure them by standard Multimeter. Enter the measured values into the calibrator by using the numeric keyboard. Confirm the new calibration values with the key WRITE.

9. **RTD temperature sensor simulation**

   a) Select RTD temperature sensor function in calibration menu by pressing the key SEL.

   b) Set Resistance function on the standard Multimeter, select 4W method for values below 10kOhm. Short the input terminals of the Multimeter to correct zero if necessary.

   c) Select partial resistance segments in the calibrator from 20 Ohm to 120 MOhm and measure them by the Multimeter. Write the measured values from the numerical keyboard into the calibrator. Confirm the new calibration value by pressing WRITE.

Error messages

If an error occurs during the operation of the calibrator, an error message is displayed. The errors can be caused by:

* incorrect control using the front panel, i.e. an attempts to set a not allowed mode, setting an out-of-range value, overloading the output terminals etc.,
* fault of the calibrator, e.g. internal communication error during the communication between individual functional blocks,
* incorrect control using the GPIB or RS-232 bus.

Lists of error messages.

Error No	*Error message*	*Meaning*	*Solution*
01	Overload 1V !	Overloading of voltage output on range 1V	Output current is too high. Increase load resistance.
02	Overload 10V !	Overloading of voltage output on range 10V/100V/750V	Output current is too high. Increase load resistance.
04	Overload I output !	Overloading of current output	Voltage across external load is too high. Decrease load resistance.
10	Interface error !	Remote connection error	Enter correct data format on GPIB/RS-232.
11	Bad command !	Unknown command GPIB/RS-232	Use only defined commands..
13	Over range !	Over crossed range in remote control mode	In remote control mode value out of allowed limits was send to the calibrator. Enter correct value.
14	Communication error	Communication error on GPIB/RS-232	General communication error in remote control mode.
15	Check sum error !	Fail data loading into internal memory	For service purpose only.
16	Interrupted !	Interrupted command IEEE488.2	Enter full data format.
17	Unterminated !	Wrong syntax IEEE488.2	Enter correct data format.
18	Deadlocked !	Wrong syntax IEEE488.2	Enter correct data format.
20	Bad calib. code !	Wrong calibration code	Wrong calibration code was entered, calibration cannot start. Enter correct calibration code
21	Time warm up !	Attempt to start calibration before warm up	Attempt to start calibration before 60 minutes warm up period. Let the calibrator turned on for at least 60 minutes.
40	Value too large !	Maximum value is out of limit	Maximum value is out of limit
41	Value too small !	Minimum value is out of limit	Attempt to set value under possible range. Set correct value.
42	Deviation too large !	Deviation is too high	Set deviation is out of limit –30% to +30%. Set correct value.
44	Unable +/- !	Change of polarity is not allowed	Attempt to change polarity, where it is not allowed. For functions ACV, ACI only.
45	Unable – polarity !	Negative polarity is not allowed.	Attempt to set negative polarity, where it is not allowed.. For functions ACV, ACI only.
51	High temperature!	20 A amplifier overheated	Output stage is overloaded. Do not use 20 A range for at least 10 minutes. Check if the ventilation holes are free.

Table VIII Error messages

Maintenance

OCM143/143i Multifunction Calibrator is an electronic instrument, which does not require any special kind of maintenance. It is equipped with electronic protection circuits against overloading.

Rules for correct operation

Especially the following rules should be adhered to guarantee correct operation of the calibrator:

- *The calibrator has to be switched ON and OFF only with the POWER switch at the front panel.*
- *Do not connect the calibrator to other voltage than set by the voltage selector.*
- *Do not cover the ventilation openings located at the rear and the bottom panel.*
- *Do not operate the calibrator in dusty environments.*
- *Prevent liquids or small objects to enter into the ventilating openings.*
- *Do not use the calibrator outside its operating temperature range.*
- *Connect the instruments to be calibrated to correct output terminals. The Calibrator is not protected against damage caused by improper connections.*
- *Do not damage the output terminals by inserting thicker banana plugs.*
- *Whenever possible, use the Lo terminal grounded in the setup menu (GND ON).*
- *Do not overload the power stages by leaving the calibrator switched on with the load connected for a long time, especially at 20 A current and 1000 V voltage ranges.*
- *If the instruments to be calibrated are not connected to calibrator's output terminals by using the original cables, ensure that cables are suitable for the voltage and current used. Maximum output voltage is 1000 V AC and the maximum output current 20 A AC*

Regular maintenance

The calibrator does not require any special maintenance of electrical or mechanical parts. If it gets dirty, the housing and the display may be cleaned by a wool rag moistened with alcohol.

Recommended re-calibration period is 12 month.

What to do in case of failure

If a simple failure occurs during the operation (e.g. the display is not illuminated), switched off the calibrator. Check the fuse located in the power socket at the rear panel. Proceed as follows:

- Remove the power cord from the mains connector at the rear panel.
- Insert the blade of a flat screwdriver into the opening in the mains voltage selector and pull out the fuse holder.
- Remove the fuse. Replace the broken fuse with a new one of the same rating.
- Replace the fuse holder, reconnect the power cord and switch on the calibrator. If the problem continues, contact the manufacturer.

If e.g. a measurement range or an operating mode is not functional, the calibrator has to be send to the manufacturer. Do not attempt the repair!

Hidden faults usually 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 respected. They might be caused by the operator. They are mostly:

- 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 connection when grounding loops are formed)
- proximity to sources of intensive influence, such as electromagnetic field.
- strong electrostatic or electromagnetic field which can cause major instability during calibration using higher impedance.

Verification test

Required equipment

- 81/2 digit multimeter type HP3458A or Wavetek 1281, or other with DCV accuracy 0.001 %
- resistance shunt 100 mΩ Burster 1280, or other type with accuracy 0.01%
- counter HP 53181A, HO 53130, BM 642 or other with accuracy 0,001 %

HP8903A Distortion Analyser and Scope with bandwidth min. 20 MHz are recommended for THD measuring of AC signals.

Configuration of the calibrator

Calibrator can be tested directly from the front panel terminals. To suppress influence of noise or interference with power line frequency in measuring circuit it is recommended to select the parameters in the Setup Menu:

Coil x50	***OFF***
GND U	***ON***

Note: When neither the calibrator nor the standard meter are grounded, higher level can occur on the output terminals.

It is recommended to provide calibration and verification tests with ***GND U ON***

Setting of the other parameters do not influence accuracy of the calibrator. Accuracy of AC voltage and AC current is defined for sinusoidal output signal.

Verification test should be provided after placing the calibrator to the temperature stabilized condition for at minimum 4 hours before verification test is started.

Basic steps of the performance verification test

Verification procedure consists of following steps:

- **10 V DC** voltage range test with linearity checking
- **DCV** voltage internal ranges 10 mV, 100 mV, 1 V, 100 V, 1000 V test
- **AC V** voltage internal ranges 10 mV, 100 mV, 1 V, 100 V, 1000 V test
- **200 mA DC** current range test with linearity checking
- **DC I** current internal ranges 200 µA, 2 mA, 20 mA, 2A, 20A test
- **AC I** current internal ranges 200 µA, 2 mA, 20 mA, 200 mA, 2A, 20A test
- **Resistance** test in points 10 Ω, 100 Ω, 1k, 10k, 100k, 1M, 10M, 100MΩ
- **Frequency** test at 1 kHz nominal value
- **RTD simulator** test (for models with RTD option)

Verification procedure

Following part describes the procedure of performance verification test. Recommended testing points are the same as the points in tables of allowed limits (see tables below).

1. Place the calibrator in the laboratory conditions at 23±1 ^{o}C let it switched-on for at least one hour.
2. Connect voltage output of the calibrator (**Hi** – **Lo**) to the input voltage terminals of the standard multimeter. Set the multimeter parameters for the most accurate measurement.
3. Perform linearity test on the voltage range 10VDC, test the other DC voltage ranges. Perform the linearity test on 10 VAC, test on all other AC voltage ranges according to the tables I, II, III, IV. The measured deviation should not exceed the limits in tables.
4. Connect current output of the calibrator (**+I** and **-I**) to the input current terminals of the standard multimeter. Set the multimeter parameters for the most accurate measurement.
5. Perform linearity test on the range 100 mA DC, tests the other DC current ranges. Test the AC current according to the tables V, VI, VII. The measured deviation should not exceed the limits in tables.
6. Select the resistance measurement on the standard multimeter, 4 wire terminals. Measure the values of the firm resistances according to the table VIII. The measured deviation should not exceed the limits in tables.
7. Select the AC voltage, output 1V, frequency 1 kHz. Connect a frequency counter to the output terminals **Hi** – **Lo**.
8. Test the output frequency of the calibrator according to the table IX. The measured deviation should not exceed the limits in tables.
9. Measure harmonic distortion of the signal on **Hi** – **Lo** terminals. Use the same setting on the calibrator as in the previous step. The measured deviation should not exceed value 0.05%.
10. Perform test of RTD simulator. Connect standard multimeter to the Opt 143-60 RTD Simulator Cable Adapter using four-terminal connection. Set multimeter to four terminal resistance function.
11. Set parameter type of temperature sensor simulation to o Pt385 in OCM143/143i and parameter R0 to 100 Ω. Switch output terminals to ON and measure resistance at Opt. 143-60. Measured deviation should not exceed the limits in tables.

New calibration (adjusting) should be performed if in any of previous steps deviation out of limits is found. Partial calibration of the out of limit function/range is usually enough. Information about calibration procedure in more details are described in the chapter Calibration mode.

Verification test - tables of limits

10 V DC basic voltage range with linearity test

Function	Range	Value	Max. deviation (% of value)
V-DC	10 V	2.0000 V	0.00850
V-DC	10 V	4.0000 V	0.00725
V-DC	10 V	6.0000 V	0.00683
V-DC	10 V	8.0000 V	0.00463
V-DC	10 V	10.0000 V	0.00650
V-DC	10 V	-2.0000 V	0.00850
V-DC	10 V	-4.0000 V	0.00725
V-DC	10 V	-6.0000 V	0.00683
V-DC	10 V	-8.0000 V	0.00463
V-DC	10 V	-10.0000 V	0.00650

Table IX 10 VDC verification test

DC voltage ranges

Function	Range	Value	Max. deviation (% of value)
V-DC	10 mV	5.0000 mV	0.190
V-DC	10 mV	9.0000 mV	0.128
V-DC	10 mV	-5.0000 mV	0.190
V-DC	10 mV	-9.0000 mV	0.128
V-DC	100 mV	50.000 mV	0.024
V-DC	100 mV	90.000 mV	0.018
V-DC	100 mV	-50.000 mV	0.024
V-DC	100 mV	-90.000 mV	0.018
V-DC	1 V	-0.50000 V	0.008
V-DC	1 V	1.00000 V	0.007
V-DC	1 V	-0.50000 V	0.008
V-DC	1 V	-1.00000 V	0.007
V-DC	100 V	50.000 V	0.008
V-DC	100 V	100.000 V	0.007
V-DC	100 V	-50.000 V	0.008
V-DC	100 V	-100.000 V	0.007
V-DC	1000 V	300.00 V	0.0107
V-DC	1000 V	950.00 V	0.0102

Table X DC voltage verification test

AC voltage ranges

Function	Range	Value	Frequency	Max. deviation (% of value)
V-AC	10 mV	10.0000 mV	120 Hz	0.450
V-AC	100 mV	100.000 mV	120 Hz	0.150
V-AC	1 V	1.00000 V	120 Hz	0.055
V-AC	10 V	2.0000 V	120 Hz	0.075
V-AC	10 V	6.0000 V	120 Hz	0.058
V-AC	10 V	10.0000 V	120 Hz	0.055
V-AC	10 V	10.0000 V	1000 Hz	0.100
V-AC	100 V	100.000 V	120 Hz	0.060
V-AC	1000 V	950.00 V	120 Hz	0.091

Table XI AC voltage verification test

200 mA DC current basic range with linearity test

Function	Range	Value	Max. deviation (% of value)
A-DC	200 mA	40.000 mA	0.0300
A-DC	200 mA	80.000 mA	0.0225
A-DC	200 mA	120.000 mA	0.0200
A-DC	200 mA	160.000 mA	0.0187
A-DC	200 mA	180.000 mA	0.0183
A-DC	200 mA	-40.000 mA	0.0300
A-DC	200 mA	-80.000 mA	0.0225
A-DC	200 mA	-120.000 mA	0.0200
A-DC	200 mA	-160.000 mA	0.0187
A-DC	200 mA	-180.000 mA	0.0183

Table XII 200 mADC verification test

DC current ranges

Function	Range	Value	Max. deviation (% of value)
A-DC	200 µA	180.000 µA	0.061
A-DC	200 µA	-180.000 µA	0.061
A-DC	2 mA	1.80000 mA	0.0306
A-DC	2 mA	-1.80000 mA	0.0306
A-DC	20 mA	18.0000 mA	0.0183
A-DC	20 mA	-18.0000 mA	0.0183
A-DC	200 mA	180.000 mA	0.0183
A-DC	200 mA	-180.000 mA	0.0183
A-DC	2 A	1.8000 A	0.0206
A-DC	2 A	-1.8000 A	0.0206
A-DC	20 A	18.000 A	0.101
ADC	20 A	-18.000 A	0.101

Table XIII DC current verification test

AC current ranges

Function	Range	Value	Frequency	Max. deviation (% of value)
A-AC	200 µA	180.000 µA	120 Hz	0.261
A-AC	2 mA	1.80000 mA	120 Hz	0.111
A-AC	20 mA	4.0000 mA	120 Hz	0.095
A-AC	20 mA	10.0000 mA	300 Hz	0.140
A-AC	20 mA	18.0000 mA	120 Hz	0.076
A-AC	200 mA	180.000 mA	120 Hz	0.076
A-AC	2 A	1.80000 A	120 Hz	0.106
A-AC	20 A	18.0000 A	120 Hz	0.217

Table XIV AC current verification test

Resistance

Function	Range	Value	Frequency	Max. deviation (% of value)
O-4W	10.0 Ω	10.0 Ω	DC	0.550
O-4W	100.0 Ω	10.0 Ω	DC	0.050
O-4W	100.0 Ω	100.0 Ω	DC	0.020
O-4W	1000 Ω	1000.0 Ω	DC	0.020
O-4W	10k Ω	10 000 Ω	DC	0.020
O-4W	100k Ω	100 000 Ω	DC	0.020
O-4W	1M Ω	1 000 000 Ω	DC	0.050
O-4W	10M Ω	10 000 000 Ω	DC	0.050
O-4W	100M Ω	100 000 000 Ω	DC	0.500

Table XV Resistance verification test

Frequency

Function	Range	Value (Hz)	Max. deviation (% of value)
FREQ	1 MHz	1 000 000	0.005

Table XVI Frequency verification test

RTD simulator (option)

Function	Value (°C)	Limits of measured resistance (Ω)
RTD Pt385/100Ω	-50.0	80.31 ± 0.030
RTD Pt385/100Ω	0.0	100.00 ± 0.035
RTD Pt385/100Ω	100.0	138.50 ± 0.048
RTD Pt385/100Ω	600.0	313.71 ± 0.110

Table XVII RTD simulator verification test

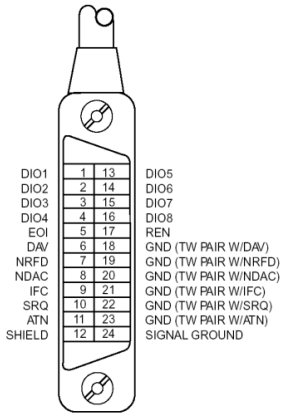
Interface

The calibrator is equipped with RS232 serial data port. Optionally the standardized IEEE-488 bus can be ordered. The connectors are located at the rear panel. The interface parameters have to be set in the system menu. The Baud Rate for RS232 can be set from150 to 19200, the software handshake XON/XOFF. The address for the IEEE-488 bus can be set from 0 to30. The calibrator can be controlled by only one of the data ports at a time. The data port (GPIB/RS232) can be selected in the system menu.

GPIB (IEEE-488) bus description

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

SH1, AH1, T5, L3, RL1, DC1, SR1



The instrument also recognizes the following general commands:

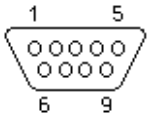
DCL	Device Clear	reset the calibrator
SDC	Selected Device Clear	reset the calibrator
EOI	End or Identify Message Terminator	close the message
GTL	Go To Local	close remote control mode
LLO	Local Lock Out	local control locked
SPD	Serial Poll Disable	close serial message status
SPE	Serial Poll Enable	release serial message status

Fig. 20 GPIB connector

RS232 serial line setting

To transfer the data by using the RS232 bus, the format of 8 bits, no parity and one stop has to be used. The communication speed can be set for 150, 300, 600, 1200, 2400, 4800, 9600 and 19200 bd. Software handshake (communication control) XON/XOFF can be set to control the transfer of the data through the bus.

RS-232 connector layout



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

Fig. 21 9-pin connector D-SUB FEMALE

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

PC	D-Sub 1	D-Sub 2	OCM143/143i
Receiver	2	2	Transmitter
Transmitter	3	3	Receiver
Ground	5	5	Ground

Command syntax

The commands described in this chapter can be issued through both buses (IEEE-488 and RS232).

All commands listed in this chapter are explained in two columns:
KEYWORD and PARAMETERS.

KEYWORD column includes the name of the command. Each command includes one or more keywords. If a keyword is in brackets ([ ]), it is not mandatory. Non-mandatory commands are used only to achieve compatibility with language standard SCPI.

Capitals designate the abbreviated form of the commands; extended form is written in lowercase.

Command parameters are in brackets (<>); each parameter is separated using a comma. Parameters in brackets ([ ]) are not mandatory. Line (|) means “or” and is used to separate several alternative parameters.

Semicolon ‘;’ is used to separate more commands written on one line.
E.g. VOLT 2.5 ; OUTP ON

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

Description of abbreviations

<DNPD> = Decimal Numeric Program Data, this format is used to express decimal number with or without the exponent.

<CPD> = Character Program Data. Usually, it represents a group of alternative character parameters. E.g. {ON | OFF | 0 | 1}.

<SPD> = String Program Data. String value consisting from more parts. It is used for date/time setting.

? = A flag indicating a request for the value of the parameter specified by the command. No other parameter than the question mark can be used.

(?) = A flag indicating a request for the parameter specified by the command. This command permits a value to be set as well as requested.

<cr> = carriage return. ASCII code 13. This code executes the program line.

<lf> = line feed. ASCII code 10. This code executes the program line.

OUTPut subsystem

This subsystem enables to activate or deactivate the OCM143/143i output and switch on/off current coil function.

Keyword	**Parameters**
OUTPut	
[:STATe](?)	<CPD> { ON | OFF | 0 | 1 }
: ISELection(?)	<CPD> { HIGHi | HI50turn }

OUTP [:STAT](?) <CPD> { ON | OFF | 0 | 1 }

This command activates or deactivates output terminals.
- ON or 1 - activates the output
- OFF or 0 - deactivates the output

If query is sent, OCM143/143i returns ON if the output is active or OFF if it is inactive

Example: OUTP 1 <cr> - activates the output
OUTP ? <cr> - the calibrator returns ON or OFF

OUTP :ISEL(?) <CPD> { HIGH | HI50 }

This command activates or deactivates setting using a 50-turn coil.
- HIGH - deactivates the 50-turn coil
- HI50 - activates the 50-turn coil (up to 100A range)

If query is sent, OCM143/143i returns HIGH if the 50-turn coil is deactivated or HI50 if it is activated.

Example: OUTP :ISEL HI50 <lf> activates the 50-turn coil
OUTP :ISEL ? <lf> the calibrator returns HIGH or HI50

SOURce subsystem

This subsystem allows to control the individual functions of OCM143/143i calibrator.

Keyword	**Parameters**
[SOURce]	
:FUNCtion	
[:SHAPe](?)	<CPD> { DC | SINusoid | RMPA | RMPB | TRIangle | LIMS | SQUare }
:VOLTage	
[:LEVEl]	
[:IMMediate]	
[:AMPLitude](?)	<DNPD >
:CURRent	
[:LEVEl]	
[:IMMediate]	
[:AMPLitude](?)	<DNPD>
:RESistance	
[:LEVEl]	
[:IMMediate]	
[:AMPLitude](?)	<DNPD>
:EARTh(?)	<CPD> { ON | OFF | 0 | 1 }
:FREQuency	
[:CW](?)	<DNPD>
:TEMPerature	
:UNITs(?)	<CPD> { C | CEL | F | FAR }
:SCALe(?)	<CPD> { TS68 | TS90 }
:THERmocouple	
[:LEVEl]	
[:IMMediate]	
[:AMPLitude](?)	<DNPD>
:TYPE(?)	<CPD> { B | E | J | K | N | R | S | T }
:RJUN	
:RSELect(?)	<CPD> { REAL | SIMulated }
:SIMulated(?)	<DNPD>
: PRT	

```
[: LEVEl]
    [: IMMediate]
        [: AMPLitude]  (?)          <DNPD>
: TYPE (?)                          <CPD> { PT385 | PT392 | NI }
: NRESistance (?)                   <DNPD>
```

[SOUR] :FUNC [:SHAP](?) <CPD> { DC | SIN | RMPA | RMPB | TRI | LIMS | SQU }

This command sets the shape of the output signal. At the same time, the respective function must be set. E.g. for :VOLT or :CURR function, FUNC DC, FUNC SIN, or other signal shape must be set. Some functions (:RES) do not require any other settings.

- DC sets a DC output signal for voltage, current or power modes.
- SINusoid sets AC output signal for voltage, current or power modes.
- RMPA sets AC output signal - ramp shape A- for voltage or current modes. The amplitude can be set. - The output switches between -amplitude a +amplitude.
- RMPB sets AC output signal - ramp shape B - for voltage or current modes. The amplitude can be set. - The output switches between -amplitude a +amplitude.
- TRIangel sets AC output signal - triangular shape - for voltage or current modes. The amplitude can be set. -The output switches between -amplitude a +amplitude.
- LIMSinusoid sets AC output signal - sinus shape with limitation of amplitude- for voltage or current modes. The amplitude can be set. -The output switches between -amplitude a +amplitude.
- SQUare sets digital frequency output.

If query is sent, OCM143/143i returns a string containing { DC | SIN | RMPA | RMPB | TRI | LIMS | SQU } depending on the current setting. If resistance or temperature sensor simulation is set, NONE is returned.

[SOUR] :VOLT [:LEVE] [:IMM] [:AMPL] (?) <DNPD>

This command activates the generation of DC or AC voltage (depending on the DC or SIN parameter of the FUNC command).

<DNPD>
The command represents the value of DC or AC voltage expressed in Volts. Negative value is accepted for DC voltage. “Technical Data” chapter lists the acceptable ranges.

If query is sent, OCM143/143i returns the set value of current using standard exponential format. Example: 20.547mV is returned as -2.054700e-002. Positive numbers are sent without “+” sign.

Examples:
DC voltage 5V:
```
FUNC DC;:VOLT 5<lf>
```

AC voltage 5V, 100Hz:
```
FUNC SIN;:VOLT 5;:FREQ 100<lf>
```

[SOUR] :CURR [:LEVE] [:IMM] [:AMPL] (?) <DNPD>

This command activates the generation of DC or AC current (depending on the DC or SIN parameter of the FUNC command).

<DNPD>
The command represents the value of DC or AC current expressed in Amperes. Negative value is accepted for DC current. “Technical Data” chapter lists the acceptable ranges.

If query is sent, OCM143/143i returns the set value of current using standard exponential format. Example: 20.547mA is returned as -2.054700e-002. Positive numbers are not preceded with “+” sign.

Examples::
DC current 18mA:
```
FUNC DC;:CURR 0.018<lf>
```

AC current 18mA, 100Hz:
```
FUNC SIN;:CURR 0.018;:FREQ 100<lf>
```

[SOUR] :RES [:LEVE] [:IMM] [:AMPL] (?) <DNPD>

This command activates the generation of a resistance.

<DNPD>
The command represents the value of the resistance in Ω. “Technical Data” chapter lists the acceptable ranges.

If query is sent, OCM143/143i returns the calibration value of resistance using standard exponential format. Example: 100.5Ω is returned as 1.005000e+002.

Example :
Resistance 1kΩ setting:
RES 1000<lf>

[SOUR] :EART(?) <CPD> { ON | OFF | 0 | 1 }

This command connects or disconnects the voltage Lo terminal to/from GND terminal.

- ON or 1 grounds the voltage output
- OFF or 0 unground the voltage output

If query is sent, OCM143/143i returns ON when the output is grounded or OFF when ungrounded.

Example:
Grounding of the voltage output terminal Lo
EART : VOLT 1 <lf>

[SOUR] :FREQ [:CW] (?) <DNPD>

This command sets the frequency being generated.

Examples:
AC voltage frequency :
FUNC :SIN ; :VOLT <DNPD>; **:FREQ <DNPD>** <lf>

AC current frequency :
FUNC :SIN ; :CURR <DNPD>; **:FREQ <DNPD>** <lf>

Digital frequency :
FUNC :SQU ; **:FREQ <DNPD>** <lf>

<DNPD>
It represents the frequency in Hz. . “Technical Data” chapter lists the acceptable ranges which depend on the selected function mode.

If query is sent, OCM143/143i returns the set value of the current using standard exponential format. Example: 200.5Hz is returned as 2.005000e+002.

[SOUR] :TEMP :UNIT(?) <CPD> { C | CEL | F | FAR }

This command sets the unit of measurement of temperature.

- C or CEL sets „Centigrade“
- F or FAR sets „Kelvin“

The unit of measurement remains valid after the calibrator is switched off.

If query is sent, OCM143/143i returns the set unit of measurement{ C | K }.

[SOUR] :TEMP :SCAL (?) <CPD> { TS68 | TS90 }

This command sets one of temperature scales. The setting influences the simulation of resistance temperature sensors and thermocouples.

- TS68 sets IPTS-68 temperature scale
- TS90 sets ITS-90 temperature scale

The temperature scale remains valid after the calibrator is switched off.

If query is sent, OCM143/143i returns the set temperature scale { TS68 | TS90 }.

[SOUR] :TEMP :THER :RJUN :REAL? <DNPD>

This command send the temperature of external temperature sensor Pt1000.

<DNPD>
Represents the temperature expressed in the units set by the 'UNIT' command. "Technical Data" chapter lists the acceptable ranges.

Example: to read the temperature of temperature sensor:
:TEMP :THER :RJUN :REAL?<lf>

OCM143/143i returns the temperature using standard exponential format. Example: 20.5°C is returned as 2.050000e+001.

[SOUR] :TEMP :THER :TYPE (?) <CPD> { B | E | J | K | N | R | S | T }

This command sets the type of thermocouple to be simulated.

If query is sent, OCM143/143i returns the set type thermocouple { B | E | J | K | N | R | S | T }.

Examples:
TC type K setting, temperature 200°C, ITS-90 temperature scale:
:TEMP:UNIT C;:TEMP:SCAL TS90;:TEMP:THER:TYPE K;:TEMP:THER 200 <lf>

[SOUR] :TEMP :THER :RJUN :RSEL(?) <CPD> { REAL | SIM }

This command sets type of getting the cold end of thermocouple RJ temperature. The RJ temperature can be either measured by internal thermometer or simulated.

- REAL sets measured RJ temperature
- SIM sets simulated RJ temperature

If query is sent, OCM143/143i returns the set type of RJ temperature { REAL | SIM }.

[SOUR] :TEMP :THER :RJUN :SIM(?) <DNPD>

This command sets the temperature of cold end of thermocouple RJ.

<DNPD>
Represents the temperature expressed in the units set by the 'UNIT' command. "Technical Data" chapter lists the acceptable ranges.

Example: to set the temperature of cold end of thermocouple to 25°C:
:TEMP :THER :RJUN :SIM 25 <lf>

If query is sent, OCM143/143i returns the set temperature using standard exponential format. Example: 20.5°C is returned as 2.050000e+001.

[SOUR] :TEMP :PRT [:LEVE] [:IMM] [:AMPL] (?) <DNPD>

This command activates the simulation of resistance temperature sensors (resistance generation).

<DNPD>
Represents the temperature expressed in the units set by the 'UNIT' command. "Technical Data" chapter lists the acceptable ranges.

If query is sent, OCM143/143i returns the set temperature using standard exponential format. Example: 20.5°C is returned as 2.050000e+001.

[SOUR] :TEMP :PRT :TYPE (?) <CPD> { PT385 | PT392 | NI }

This command sets the type of resistance temperature sensor to be simulated.

Example: to activate the simulation of platinum resistance temperature sensor at 350°C approximated using PT385 table (Europe):

:TEMP :PRT 350; :TEMP :PRT :TYPE PT385 <cr>

If query is sent, OCM143/143i returns the set type of approximation table { PT385 | PT392 | NI }.

[SOUR] :TEMP :PRT :NRESistance (?) <DNPD>

This command sets the nominal resistance of the resistance temperature sensor at 0°C. 100Ω to 1kΩ can be set.

<DNPD>
Represents the nominal resistance in Ω.

If query is sent, OCM143/143i returns the set value of nominal resistance using standard exponential format. Example: 100Ω is returned as 1.000000e+002.

SYSTem subsystem

The subsystem enables to control various functions from the MENU.

SYSTem	
:DATE(?)	<DNPD>,<DNPD>,<DNPD>
:TIME(?)	<DNPD>,<DNPD>,<DNPD>

SYST :DATE(?) <DNPD>,<DNPD>,<DNPD>

This command sets system date of the calibrator.

<DNPD>,<DNPD>,<DNPD>
Represents date in format YYYY, MM, DD.

If query is sent, OCM143/143i returns current value of system date in format YYYY,MM,DD.

where YYYY = year (2000..2099)
MM = month (01..12)
DD = day (01..31)

SYST :TIME(?) <DNPD>,<DNPD>,<DNPD>

This command sets time of the calibrator.

<DNPD>,<DNPD>,<DNPD>
Represents time in format HH,MM,SS.

If query is sent, OCM143/143i returns current value of system time in format HH,MM,SS.

where HH = hour (00..23)
MM = minute (00..59)
SS = second (00..59)

I/D (instrument identification)

***IDN?**

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

The reply is formatted as follows:
ORBIT,M-143/143i ,670011,1.000

Operation complete

***OPC**

This command sets the OPC bit in the ESR (Event Status Register) when all pending operations are complete.

Operation complete?

***OPC?**

This command returns “1” to the output queue after all pending operations are complete.

Wait-to-Continue command

***WAI**

Prevents the instrument from executing any further commands or queries until all previous remote commands have been executed.

Reset

***RST**

This command resets the calibrator to its initial status.

Test operation

***TST?**

This command launches an internal self-test. Return the self-test result (“0” for pass or “1” for fail).

Status byte reading (IEEE488 only)

***STB?**

This query returns number in range 0 to 255 with information about content of register STB, which carries the MSS bit status.

Service Request Enable reading (IEEE488 only)

***SRE <value>**

This command sets condition of the Service Request Enable register. Since bit 6 is not used, the maximum value is 191.

Service Request Enable reading (IEEE488 only)

***SRE?**

This query returns the Service Request Enable Register number.

Event Status Register reading (IEEE488 only)

***ESR?**

This query returns the contents of the Event Status Register and clears the register.

Event Status Enable setting (IEEE488 only)

***ESE <value>**

This command programs the Event Status Enable register bits. Parameter “value” is number in range 0 – 255.

Event Status Enable reading (IEEE488 only)

***ESE?**

This query returns the Event Status Enable register.

Clear status (IEEE488 only)

***CLS**

This command clears the Event Status Register and the Status Byte Register except the MAV bit and output queue. Output line is not reset.

Remote control

***REM**

This command activates the remote control. When the calibrator is controlled by GPIB bus, it goes to the remote control mode automatically. When remote control is active, the calibrator ignores all controls from the front panel, except LOCAL key.

Local control

***LOC**

This command activates the local control (using front panel keys). When the calibrator is controlled by GPIB bus, it goes to the local control mode automatically.

Local control lock

***LLO**

This command locks out the local control; the calibrator cannot be returned to local control by pressing LOCAL key. Return to local control can only be performed by a command sent through the bus, or by switching the calibrator off and on.

Local control unlock

***UNL**

This command cancels the „*LLO“ command. Unlocked calibrator can be returned to local control mode by pressing LOCAL key.

Standard Status Data Structures

Calibrator meets standard protocol according to the standard IEEE488.2. The protocol can be used for checking of error and status behavior of the calibrator. It enables single-wire transmitting of SRQ command. The conditions on which SRQ signal (local control request) is sent can be set with parameters *STB?, *SRE?, *SRE, *ESR?, *ESE?, *ESE a *CLS.

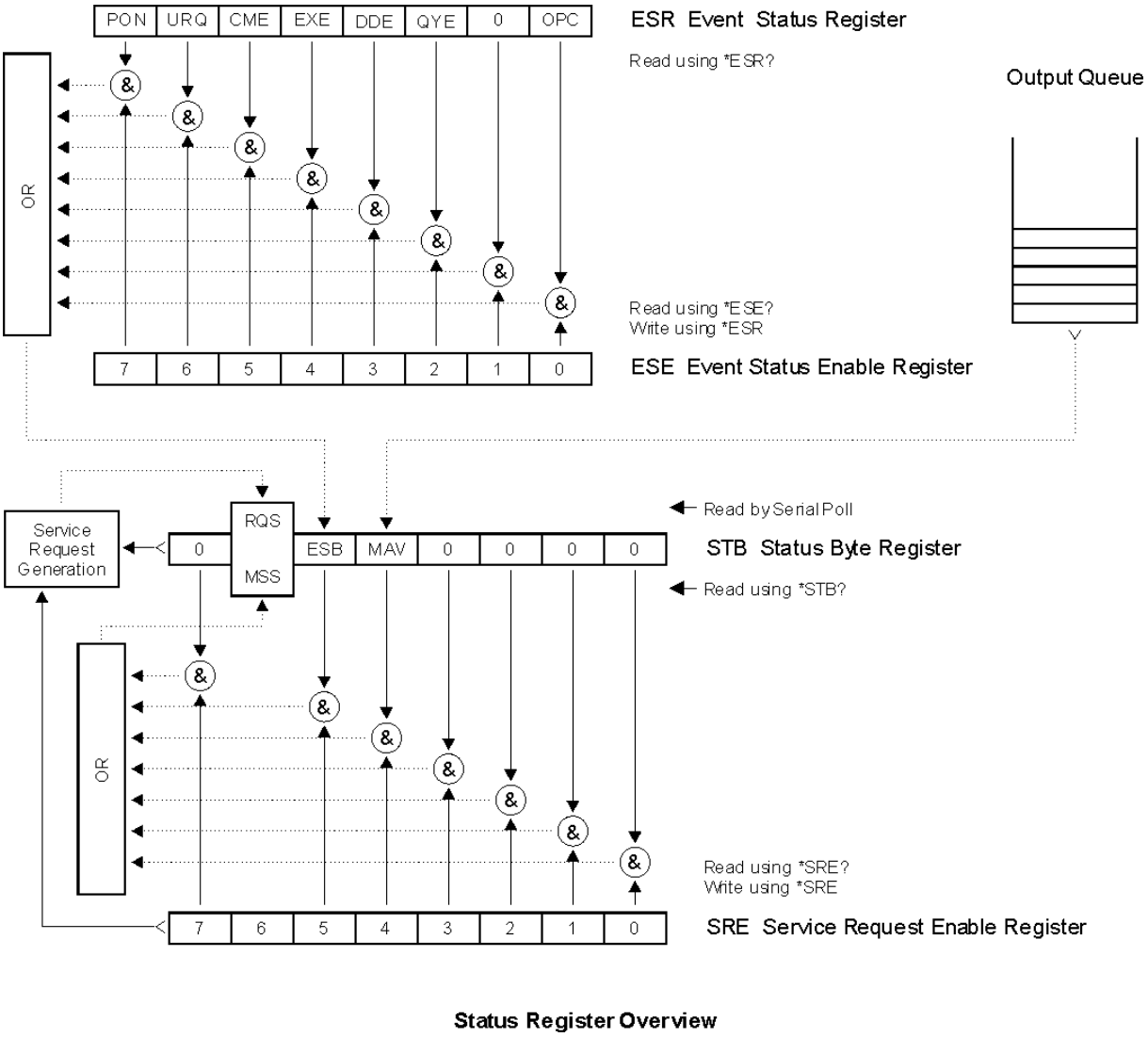


Fig. 22 Status data structure of OCM143

Calibrator contains following registers:

STB – Status Byte Register
SRE – Service Request Enable Register
ESR – Event Status Register
ESE – Event Status Enable Register
Output Queue

STB Status Byte Register

STB is main register where information from other status registers and from output queue is collected. Value of STB register is reset after switching on the calibrator or after sending command *CLS. This command reset the STB register except bit MAV, which remains set if the output queue is not empty. STB register value can be read via serial message or through general query *STB? .

Bit configuration of Status Byte Register :

RQS Request Service, bit 6. The bit is read as a part of status byte only when serial message is sent.

MSS Master Summary Status, bit 6. The MSS bit is set to 1 whenever bits ESB or MAV are 1 and enabled (1) in the SRE. This bit can be read using the *STB? command. His value is derived from STB and SRE status.

ESB Event Summary Bit, bit 5. His value is derived from STB and SRE status. The ESB bit is set to 1 when one or more enabled ESR bits are set to 1.

MAV Message Available, bit 4. The MAV bit is set to 1 whenever data is available in the OCM143/143i IEEE488 Output Queue (the response on query is ready).

SRE Service Request Enable Register

The Service Request Enable Register suppresses or allows the STB bits. “0” value of a SRE bit means, that the bit does not influence value of MSS bit. Value of any unmask STB bit results in setting of the MSS bit to the level “1” . SRE bit 6 is not influenced and its value is “0”. The SRE register value can be set via the command *SRE followed by mask register value (0 – 191). The register can be read with the command *SRE?. The register is automatically resets after switching the calibrator on. The register is not reset by the command *CLS.

ESR Event Status Register

Every bit of the Event Status Register corresponds to one event. Bit is set when the event is changed and it remains set also when the event passed. The ESR is cleared when the power is turned on (except bit PON which is set), and every time it is read via command *ESR? Or cleared with *CLS.

Bit configuration of Event Status Register :

PON Power On, bit 7. This event bit indicates that an off-to-on transition has occurred in the device’s power supply.

URQ User Request, bit 6. Bit is not used and it is always “0”.

CME Command Error, bit 5. This event bit indicates that an incorrectly formed command or query has been detected by the OCM143/143i.

EXE Execution Error, bit 4. This event bit indicates that the received command cannot be executed, owing to the device state or the command parameter being out of limits.

DDE Device Dependent Error, bit 3. This event bit indicates that an error has occurred which is neither a Command Error, a Query Error, nor an Execution Error. A Device-specific Error is any executed device operation that did not properly complete due to some condition, such as overload.

QYE Query Error, bit 2. The bit is set if the calibrator is addressed as talker and output queue is empty or if control unit did not pick up response before sending next query.

OPC Operation Complete, bit 0. This event bit is generated in response to the *OPC command. It indicates that the device has completed all selected pending operations.

ESE Event Status Enable Register

The Event Status Enable Register allows one or more events in the Event Status Register to be reflected in the ESB summary-message bit. This register is defined for 8 bits, each corresponding to the bits in the Event Status Register. The Event Status Enable Register is read with the common query *ESE?. Data is returned as a binary-weighted value. The Event Status Enable Register is written to by the common command, *ESE. Sending the *ESE common command followed by a zero clears the ESE. The Event Status Enable Register is cleared upon power-on.

It suppresses or allows bits in ESR register. Value „0“ of a bit of ESE register suppresses influence of appropriate bit of ESR register on value of sum bit of ESB status register. Setting of any unmask bit of ESR register results in setting of ESB status register. ESE register value can be modified by command *ESE followed by value of mask register (integer in range 0 –255). Reading of the register can be performed with command *ESE?. The register is automatically reset after switching on. The register is not reset with *CLS command.

Output Queue

The Output Queue stores response messages until they are read from control unit. If there is at minimum one sign in the output queue, MAV register (message available) is set. The Output Queue is cleared upon power-on and after reading all signs from output queue.

Examples of applications

The calibrator can be used for direct calibration of various instruments, which measure electrical values. Thanks its low weight and small dimensions it is suitable also for field applications.

Multimeters

The calibrator can be used for calibration of digital and analogue multimeters (DCV, ACV, DCI, ACI, resistance, temperature sensors, frequency.

Voltage ranges

Thanks to low output impedance and high output current, the calibrator can be used for calibration of analogue voltmeters and millivoltmeters having low input impedance. Voltage output is connected to Hi/Lo terminals. The calibrator does not allow the four-terminal connection of the instrument to be calibrated.

It is not recommended to connect non-standard load to the voltage output. The calibrator is designed as a source of precise voltage for calibration of voltmeters. Output terminals should be loaded with high and real impedance. Although the output is fitted with fast electronic and microprocessor protection, high capacitance or inductance loads can lead to oscillations of output amplifiers and result in damage.

The instrument to be calibrated can be connected directly to the front panel terminals with test cables, which are a part of basic delivery. If L terminal of device under test is not grounded it is recommended to ground Lo terminal on the calibrator GND ON, see chapter SETUP MENU.

Connect voltage input of the multimeter to the OCM143/143i voltage output:

Fig. 23 Voltmeter calibration

Current ranges

All DC and AC current ranges are connected to calibrator's +I/-I terminals.
When using the current output under heavy load (10 to 20 A), the runtime is limited to 0 to 60 s. The runtime depends on the set current and it is controlled by the microprocessor. The user cannot extend the runtime; if longer runtime is required, the output terminals must be unloaded, some time must elapse (for example1 min.) and the load can then be connected again.

When feeding 0.2 to 2 A current to the output terminals, the output voltage must not exceed approx. 2 Vef. If the current causes higher voltage on the load, the calibrator disconnects the output terminals and displays an error message.

When ammeters are being calibrated using currents over 1 A, it is important to connect the terminals properly, paying attention both to the calibrator's output terminals and the instrument's input terminals. Excessive contact resistance can heat up the terminals and cause calibration errors. Excessive and unstable contact resistance has non-linear characteristic and can distort the output AC current.

It is not recommended to connect non-standard load to the current output. The calibrator is designed for use in calibration of ammeters. Output terminals should be loaded with low and real impedance. Although the output is fitted with fast electronic and microprocessor protection, high capacitance or inductance can lead to oscillations of output amplifiers and result in damage.

If L terminal of the instrument to be calibrated is not grounded, the Lo terminal should be grounded GND ON, see „Setup menu" chapter.

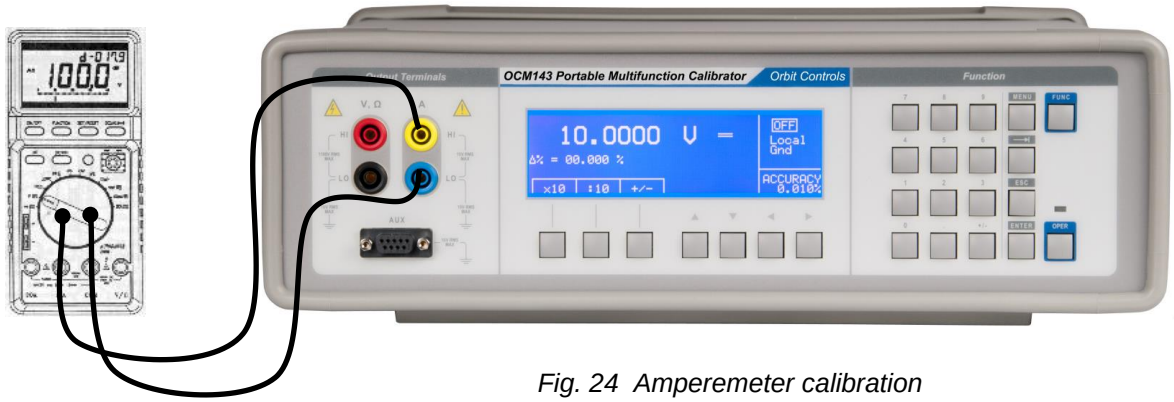


Fig. 24 Amperemeter calibration

Optional current coil can extend the calibrator's current range to 1000 A. The coil can be used for calibration of both DC and AC ammeters. The clamps of the ammeter must be positioned in angle 90° to the coil. When using the current coil, no steel or other magnetic objects must be present in the vicinity (50 cm) of the current coil, as they would deform the magnetic field and cause big calibration error.

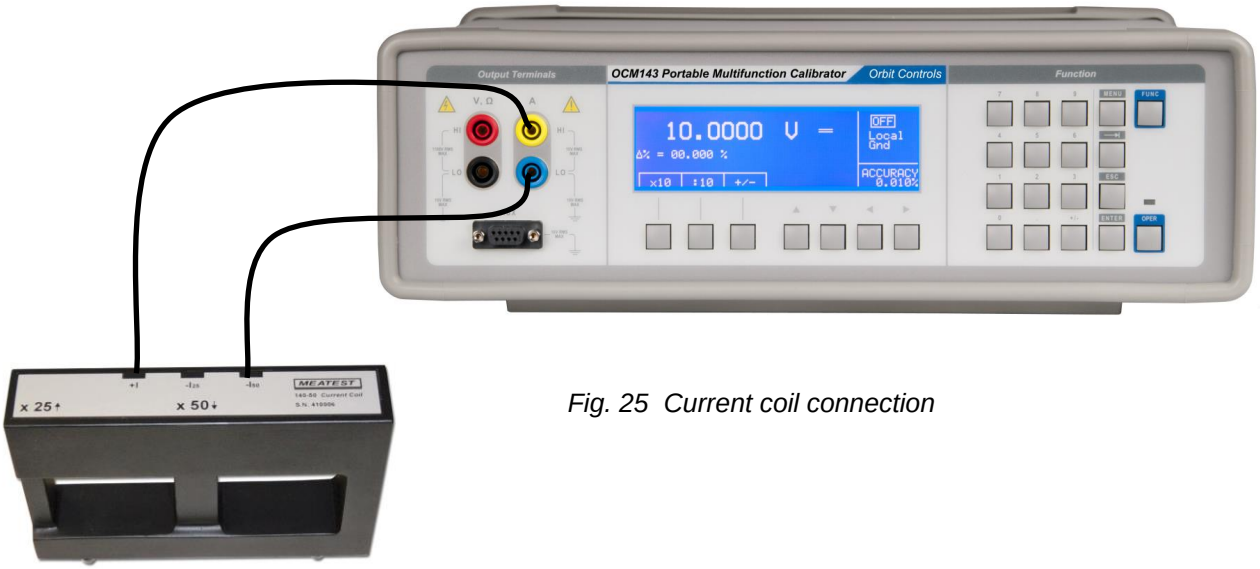


Fig. 25 Current coil connection

Counters and Oscilloscopes

The calibrator can be used for basic calibration of the frequency ranges of multimeters and simple counters. The calibrator provides the following functions:

- calibration of frequency functions up to 2 MHz using square wave signal. The function is activated with repetitive pressing the FUNC key and selecting the Frequency mode. Only value of frequency can be set.
- calibration of vertical sensitivity from 1 mV to 10 V in the frequency range 1 kHz. ACV function is used with square wave output form. Frequency and amplitude can be set.
  The instrument to be calibrated is connected to the Hi – Lo output terminals.

Thermometers (without sensor)

The calibrator can be used for calibration of transducers used in thermometers and heat meters, which use thermocouple sensors. The block connected to the sensor is checked, as it is disconnected from the transducer and the calibrator's output is connected to the transducer's input instead. Simulation of thermal sensor is activated by repeated pressing FUNC key until TC function is selected. Temperature sensors type K, N, R, S, B, J, T, E can be simulated. Unit under test is connected to the Hi – Lo output terminals.

ATTENTION

The voltage between calibrator's –I and Lo outputs must not exceed 10 V.

Specification

The below stated accuracies are valid after specified warm-up time in a temperature range 23 ± 2 °C. The accuracy includes long-term stability, temperature coefficient, linearity, load and line regulation and the traceability of factory and National calibration standards. Specified accuracy is valid for one year after the last calibration. Specified accuracy „of range“ are related to the maximal value which can be set on the range.

DC / AC Sine Wave Voltage

Voltage range summary :	0.0000 mV – 1000.00 V DC, 1.0000 mV – 1000.00 V AC
Internal ranges :	100 mV, 1 V, 10 V, 100 V, 1000 V
Resolution of voltage setting:	5½ digit
Frequency range in AC mode :	1 mV - 10 V from 20 Hz to 2 kHz, 10 V – 1000 V from 40 Hz to 1 kHz
Accuracy of frequency:	0.01%
Resolution of frequency setting :	5½ digit

Voltage accuracy

DC Voltage		***AC Voltage***		
Range	***% of value + % of range***	***Range***	***% of value + % of range***	***% of value + % of range***
---	---	---	***20.000 Hz-400.000 Hz*[*1]**	***400.000 Hz-2000.00 Hz*[*1]**
0.0000-10.0000 mV	0.050 + 0.070	1.0000mV-10.0000 mV	0.20 + 0.25	0.20 + 0.30
10.000-100.000 mV	0.010 + 0.0070	10.00 mV-100.000 mV	0.10 + 0.05	0.15 + 0.07
0.10000V-1.00000 V	0.006 + 0.0010	0.10000 V-1.00000 V	0.05 + 0.005	0.07 + 0.01
1.0000 V-10.0000 V	0.006 + 0.0005	1.0000 V-10.0000 V	0.05 + 0.005	0.07 + 0.03
10.000 V-100.000 V	0.006 + 0.0010	10.000 V-100.000 V	0.05 + 0.010	0.07 + 0.03
100.00 V-1000.00 V	0.010 + 0.0020	100.00 V-1000.00 V	0.07 + 0.020	0.10 + 0.03

[*1] Voltage ranges 100 and 1000V from 40 Hz to 1kHz.

Auxiliary parameters

Range	***10mV***	***100mV***	***1V***	***10V***	***100V***	***1000V***
THD[*2]	0.05 % + 200 µV	0.05 % + 300 µV	0.05 %	0.05 %	0.05 %	0.10 %
Maximal output current [*3]	3 mADC 3 mAAC	5 mADC 5 mAAC	20 mADC 10 mAAC	50 mADC 50 mAAC	20 mADC 10 mAAC	2 mADC 1.5 mAAC
Output impedance	< 10 mΩ	< 10 mΩ	< 10 mΩ	< 10 mΩ	< 100 mΩ	< 100 mΩ
Maximal capacitance load	3 nF	3 nF	3 nF	10 nF	10 nF	3 nF
Overload protection H against L terminal (pk)	60 V	60 V	60 V	60 V	250 V	1500 V

[*2] The parameter includes non-linear distortion and non-harmonic noise in frequency range to 100 kHz.
[*3] The parameter shows maximal output current while output voltage in specification.

NON-Sine Wave Voltage

Voltage range :	1.0000 mV_{pk} – 10.0000 V_{pk}
Waveform type :	saw, triangle, square symmetric, truncated sinewave
Frequency range :	20.000 to 80.000 Hz
Accuracy of amplitude (peak value):	0.3 %
Frequency accuracy:	0.01 %

DC / AC SINE Wave Current

Current range summary :	OCM143:	0.000 μA – 20.000 A DC, 1.000 μA – 20.000 A AC
	OCM143i:	0.000 μA – 2.0000 A DC, 1.000 μA – 2.0000 A AC
Internal ranges :	200 uA, 2 mA, 20 mA, 200 mA, 2 A (20 A in model OCM143)	
Resolution of current setting:	5½ digit	
Frequency range in AC mode :	OCM143/143i:	1 μA - 2A range 20 Hz to 1 kHz
	OCM143:	2 A - 20 A range 20 Hz to 500 Hz
Frequency accuracy:	0.01%	
Resolution of frequency setting :	5½ digit	

Current accuracy

DC Current		***AC Current***		
Range	***% of value + % of range***	***Range***	***% of value + % of range***	***% of value + % of range***
			20 Hz – 200 Hz	***200 Hz -1000 Hz***
0.000 μA-200.000 μA	0.050 + 0.010	1.000 μA-200.000 μA	0.25 + 0.010	0.20 + 0.10
0.20000 mA-2.00000 mA	0.025 + 0.005	0.20000 mA-2.00000 mA	0.10 + 0.010	0.10 + 0.02
2.0000 mA-20.0000 mA	0.015 + 0.003	2.0000 mA-20.0000 mA	0.07 + 0.005	0.10 + 0.02
20.000 mA-200.000 mA	0.015 + 0.003	20.000 mA-200.000 mA	0.07 + 0.005	0.10 + 0.02
0.2000 mA-2.0000 A	0.015 + 0.005	0.2000 mA-2.0000 A	0.10 + 0.005	0.15 + 0.05
2.0000 A-20.000 A [*7]	0.1 + 0.01	2.0000 A-20.000 A	0.20 + 0.015	0.25 + 0.05

Auxiliary parameters

Range	***200 μA***	***2 mA***	***20 mA***	***200 mA***	***2 A***	***20 A*** [*6 *7]
Maximal inductive load	400 μH	400 μH	400 μH	400 μH	200 μH	200 μH
Maximal compliance voltage (pk)	2 V	2 V	2 VAC, 7 VDC	2 V	2 V	1.5 V
THD[*4]	0.15 %	0.10 %	0.10 %	0.10 %	0.20 %	0.40 % [*5]
Overload protection +I against – I terminals (pk)	15 V	15 V	15 V	15 V	15 V	15 V

[*4] Parameter includes non-linear distortion and non-harmonic noise in frequency range to 100 kHz.
[*5] Frequency range 30 Hz to 500 Hz. Distortion in frequency range 20 Hz to 30 Hz and 500 Hz to 1000 Hz is max. 0.6%.
[*6] Limited period is in range 10 A to 20 A for which can OCM143 supply continuously external load. The period is 5 minutes at 20 A and 15 minutes at 10 A. It can vary depending on previous load conditions. Full recovery to starting conditions takes about 5 minutes.
[*7] 20A range in model OCM143 only.

NON-Sine Wave Current

Current range :	100.000 μA_{pk} – 2.000 00 A_{pk}
Waveform type :	saw, triangle, square symmetrical, truncated sin wave
Frequency range :	20.000 to 80.000 Hz
Amplitude accuracy (peak value) :	0.3 %
Frequency accuracy :	0.01 %

Resistance

Number of resistances: 8
Range : 10 Ω to 100 MΩ
Calibration value resolution : 5 dig
Maximal test voltage : 50 V_{rms} or 0.1W, what is lower
Type of connection : two-terminal

Resistance accuracy

Nominal value (Ω)	10 Ω	100 Ω	1 kΩ	10 kΩ	100 kΩ	1 MΩ	10 MΩ	100 MΩ
Max. calibration difference to nominal value (%)	5	1	0.5	0.5	0.5	0.5	1	5
Accuracy of calibration value (%)	0.05+50 mΩ	0.05	0.02	0.02	0.02	0.05	0.05	0.5

TC / RTD[*8] Temperature Sensor Simulation

TC sensor types : R, S, B, J, T, E, K, N
TC temperature simulation range : -250.0 °C to +1820.0 °C depending on type
TC cold junction compensation : fixed in range -5.0 °C to 50.0 °C
automatic using external temperature sensor
TC compensation accuracy: 0.2 °C

RTD sensor types : Pt 1.385, Pt 1.392, Ni
RTD temperature simulation range : -50.0 °C to +850.0 °C depending on sensor type
Range of R0 coefficient : 100 Ω to 1000 Ω
Type of connection: four-terminal

Temperature scale : IPTS68, ITS90
Temperature units : °C, °F
Resolution of temperature setting : 0.1 °C/°F

TC/RTD sensor simulation accuracy [*10]

TC sensor simulation			*RTD sensor simulation*		
Thermocouple	*Temperature range (°C)*	*Accuracy (°C)*	*Temperature sensor type*	*Temperature range (°C)*	*Accuracy (°C)* [*9]
R	-50.0 to +1767.0	1.2 to 2.5	Pt100 - Pt200	-200.0 … 0.0	0.2
S	-50.0 to +1767.0	1.5 to 2.2	Pt100 - Pt200	0.0 … 850.0	0.1
B	400.0 to +1820.0	1.3 to 2.7	Pt200 - Pt1000	-200.0 … 0.0	0.1
J	-210.0 to +1200.0	0.3 to 0.9	Pt200 - Pt1000	0.0 … 850.0	0.1
T	-200.0 to +400.0	0.3 to 0.9	Ni100 - Ni200	-60.0 … 0.0	0.2
E	-250.0 to +1000.0	0.2 to 1.7	Ni100 - Ni200	0.0 … 300.0	0.1
K	-200.0 to +1372.0	0.4 to 0.8	Ni200 - Ni1000	-60.0 … 0.0	0.1
N	-200.0 to +1300.0	0.5 to 1.3	Ni200 - Ni1000	0.0 … 300.0	0.1

[*9] Specification is valid for four-terminal connection.
[*10] Specified accuracy relates to specified temperature simulation range. Exact value of accuracy for set temperature is shown on the OCM143/143i display.

Frequency Output

Waveform type :	positive $5V_{pk}$
Amplitude accuracy :	10 %
Output resistance:	50 Ω ± 5 %
Frequency range :	0.100 0 Hz to 2.000 00 MHz
Frequency accuracy :	0.005 %

Content of Delivery

OCM143/143i Multifunction Calibrator	1 pc	Opt 143-60 RTD Simulator Adapter (option)	1 pc
Test Lead 1000V/20 A length 1m,	2 pcs	RS232 Cable	1 pc
Power Line Cord	1 pc	Operation Manual	1 pc
Calibration Certificate	1 pc	Spare fuse	1 pc

General Data

Reference temperature range :	23 °C ± 2 °C (for above stated accuracies)
Relative humidity :	< 80 % @ 30 °C, < 70 % 2 40 °C, < 40 % @ 50 °C
Temperature coefficient : accuracy	In extended temperature range +5 °C to +40 °C multiply parameters 0.15x / °C
Absolute accuracy definition : coefficient, linearity, standards	OCM143/143i specifications include stability, temperature line and load regulation, and the traceability of the external used for calibration.
Protection fuses:	T4L250 for 115V, T3.15L250 for 230V
Safety standard compliance :	EN/IEC 61010-2:2011
EMC standard compliance:	EN 61326-1 ed. 2:2013 EN 61000 part 3-2 ed. 3:2006 +A1:2010+A2:2010 EN 61000 part 3-3 ed. 2:2009 EN 61000 part 4-2 ed. 2:2009 EN 61000 part 4-3 ed. 3:2006 +A1:2008+A2:2011 EN 61000 part 4-4 ed. 3:2013 EN 61000 part 4-5 ed. 2:2007 EN 61000 part 4-6 ed. 3:2009 EN 61000 part 4-11 ed.2:2005
Range of working temperatures :	+10 °C … +40 °C
Range of storing temperatures :	- 10 °C … +55 °C
Power supply :	115/230V - 50/60 Hz
Power consumption :	250 VA max
Dimensions (W x H x D) :	325 x 111 x 316 mm
Weight :	9 kg
Interface :	RS232, (IEEE488 as option)