

OCM141

MULTIFUNCTIONS

SERVICE CALIBRATOR

Owner's Guide

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Basic information

OCM-141 is a high precision instrument for use in calibrating laboratories, production lines and field applications for service purposes. It can be used for calibration of any measuring instrument for DC and AC voltage, current, resistance and frequency. It generates harmonic and non-harmonic signals with very accurate amplitude. The calibrator includes a function of simulation of thermocouple temperature sensors and RTD.

The basic function is the generation of precise DC and AC voltage in the range from 0 μ V to 750 V and DC and AC current in the range from 0 μ A to 2 A. The highest achieved precision is 0.01 % for DC voltage, 0.055 % for AC voltage, 0.018 % for DC current and 0.075 % for AC current. The frequency range is from 20 Hz to 1000 kHz. Firm resistance values can be set in decade steps from 10 Ω to 100 M Ω with accuracy of 0.01 %. In frequency mode the calibrator generates square wave signals from 0.1 Hz to 2 MHz

DIN Thermocouples R, S, B, J, T, E, K, N and RTD temperature sensors (option) Pt-100, Pt-200, Pt-1000 and Ni-100 can be simulated. The accuracy of the simulated temperature sensors ranges from 0.07 $^{\circ}$ C to 0.4 $^{\circ}$ C for RTD sensors and from 0.4 $^{\circ}$ C to 4 $^{\circ}$ C for thermocouples.

Internal multimeter with 20 mA, 20 mV, 200 mV and 10 V basic ranges and 0.01 % accuracy can be used to measure normalized signals from transducers, strain gauges, thermocouples or resistance sensors.

The instrument offers many other features for easy calibration, such as adjustment of the relative deviation from set value, uncertainty of the output signal displayed after each setting, calibration and testing procedures for individual applications any many others. The LCD display informs about the selected signal type and its magnitude, achieved accuracy, menu parameters, selection of the data port and the basic operation parameters. Frequently used functions are assigned to the keyboard keys. The basic instrument has RS232 serial data port. A GPIB data bus is optional available.

OCM141 supports the calibrating software MBASE/WinQbase for testing and calibrating of multimeters. A digital camera is available for scanning the seven segment LCD display of multimeters under test.

ATTENTION!

The calibrator generates dangerous high voltage.

The calibrator can only be used as described in this Manual.

First Steps

Input Inspection

The shipment includes:

- Multifunction calibrator
- Power cord
- Spare fuse
- Operation manual
- Test report
- Pair of test leads 1000V/20 A

Line voltage setting

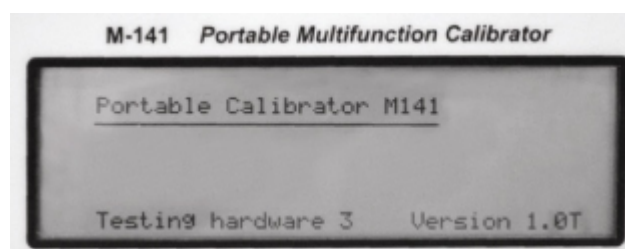
The calibrator is suitable for mains operation from 230/115 V-50/60 Hz. The stated parameters are valid for an ambient temperature 23 ± 5 °C.

Before applying the power, check the voltage selector at the rear for the mains voltage at your premises. If a change is necessary, follow steps below:

- Insert the flat end of a screwdriver into the slot of the power line socket at the rear panel. Pull-out the holder with the fuse and the selector contacts.
- Place the contacts in a position, such as the correct line voltage is readable in the small window.
- Push the holder back into the socket. The correct voltage has to appear in the window (115 or 230V).

Switching-on

- Plug one end of the power cord into the connector located at the rear panel. Plug the other end of the power cord into a wall outlet.
- Switch-on calibrator with the mains switch at the rear panel. The display will be illuminated.
- The calibrator performs internal hardware checks for 5 seconds.



- At the end of the test the display changes into the reference setting, which are:

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

Warm-up time

The calibrator can be used immediately after it has been switched-on and the internal tests have been completed. The specified parameters are guaranteed after the instrument warms up for 5 minutes. During this period, the instrument cannot be re-calibrated. The display shows “cannot access the calibration” while the calibration is attempted during this warm-up period.

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 power cord from the mains connector at the rear panel.
- Insert the blade of a screwdriver into the opening of the mains voltage selector and pull out the fuse holder.
- Remove the defective 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.

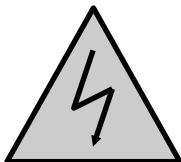
Safety is ensured by the design and by the use of specific component types.

The manufacturer is not responsible for a damage caused due to customer's modifications, repairs or usage of non-original components.

Safety symbols used on the instrument



Warning, see the documentation



Warning - risk of electric shock

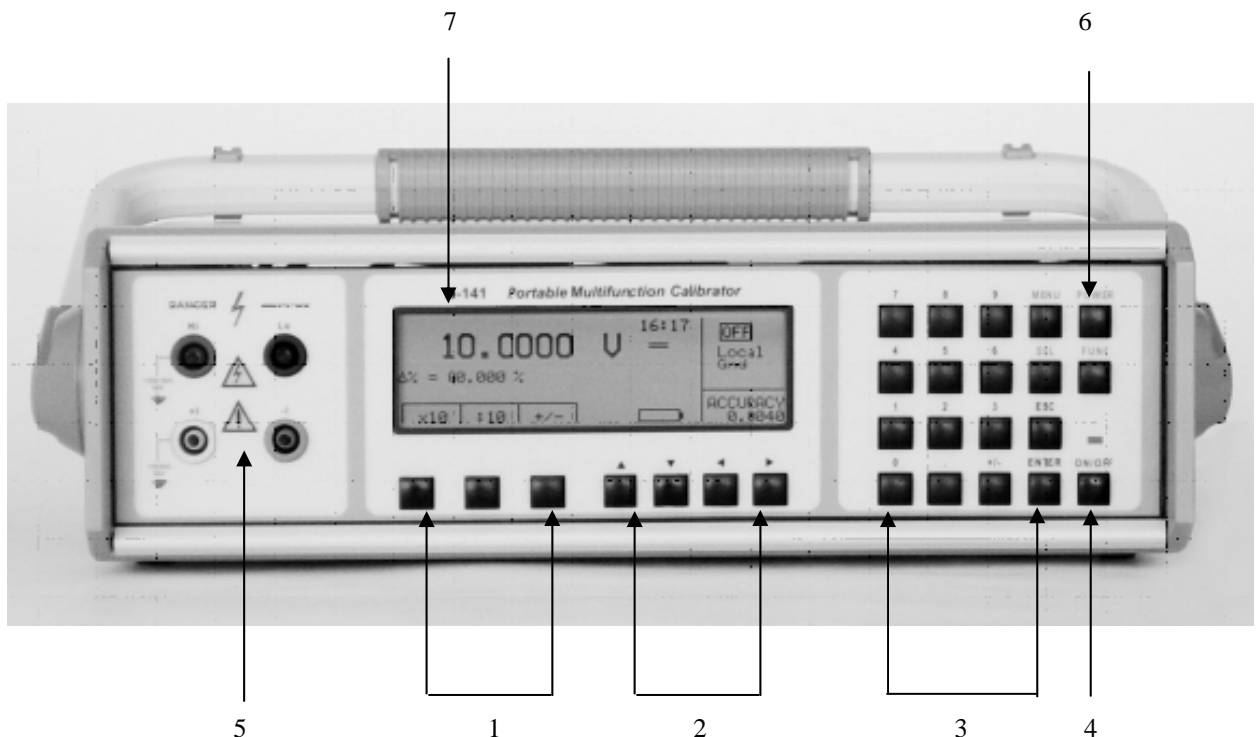


Danger - high voltage

Control Elements

Front panel

The front panel contains a LCD display, keyboard and output terminals.



1 Display keys

Three keys located under the display have alternative functions. Their momentary function is shown at the display. They are used for entering into the MENU, changing of the ranges and other frequently used functions.

2 Cursor keys

The cursor keys can be positioned across the numerical value and change it. Two keys set the required position of the cursor left or right (< >) inside one menu or can be used for switching between two menu, or setting the active position of the numerical value. With the keys (∧ ∨) the value can be incremented or decremented.

3 Numeric keys

The desired magnitude can be entered directly from the keyboard. The selected value has to be confirmed with ENTER or canceled with the key CANCEL.

4 Output terminal keys

The selected signal will be connected or disconnected to the output terminals with the key ON/OFF. The control LED illuminates when the output is activated. The display shows a symbol ON or OFF.

5 Output terminals

The signal from the calibrator is available at the output terminals. The Current is at **+I / -I** terminals, all other functions are available at the **Hi / Lo** terminals.

GND terminal is located on the rear panel and is connected to the protective terminal of the mains plug. The GND Terminal can be preset in the SETUP MENU for grounded or floating. The grounding is performed internally by connecting Lo and GND terminals with an internal relay. Grounding is suitable for most calibration applications where the object (multimeter) being calibrated is floating.

The maximal voltage allowed between terminals:

Hi - GND protection terminal (housing): 1000VRMS

+I - GND protection terminal (housing): 10VRMS

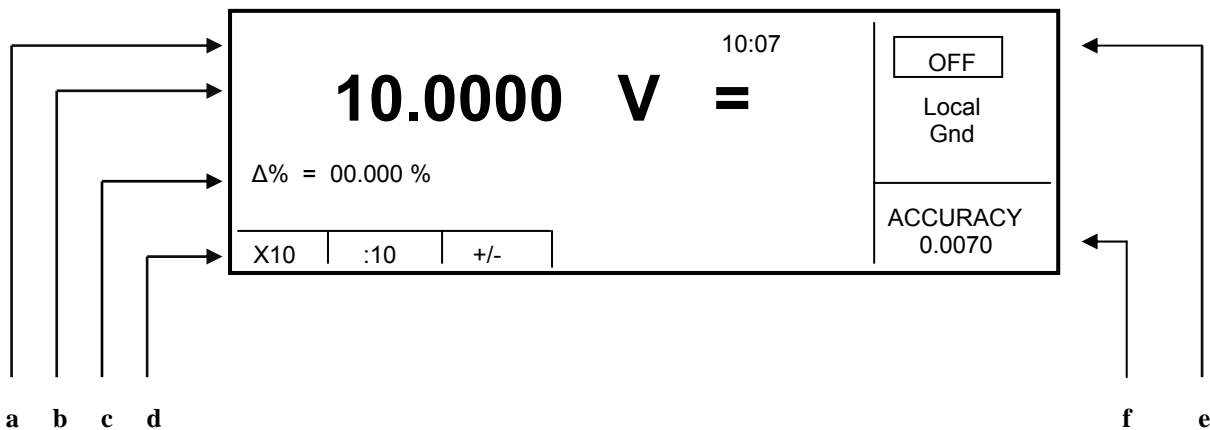
Lo - GND protection terminal (housing): 10VRMS

-I - GND protection terminal (housing): 10VRMS

6 POWER key

The calibrator can be switched-on by pushing the key POWER. The same key switches-off the power. This key has to be pushed twice to switch-off the calibrator.

7 Display



The Display has sections which give information about the parameters, settings, accuracy etc.:

a) *Information field*

It shows the real time. This can be disabled in the SERVICE MENU.

b) *Main field*

Large digits show the signal output value and the unit. Symbols ▼ ▲ indicate the active position of the cursor. The cursor position can be set with the cursor keys < >, the magnitude with keys ^ v. Symbols for active cursor are displayed after pushing of any of the cursor keys.

c) *Auxiliary field*

The auxiliary parameters of the output signal are displayed:

- Relative deviation in %
- Frequency of AC voltage/current output
- Temperature of the cold junction in TC simulation mode, type of TC sensor

d) *Display keys*

| 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 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 |

e) *Information field*

- Symbol of OUTPUT ON or OUTPUT OFF output terminals. An LED is turning on/off above the key ON/OFF.
- Local or Remote Control. REM is displayed in the remote control. LOCAL is displayed in the local control.
- Current Coil option 140-50 connected to the current output. The access to this function is in the SETUP MENU.
- Grounding of the Lo / -I terminals.
- Temperature sensor selected.

f) *Uncertainty field*

This field shows the currently valid uncertainty of the output signal. It is calculated from full specifications of the calibrator and displayed in %.

Rear panel

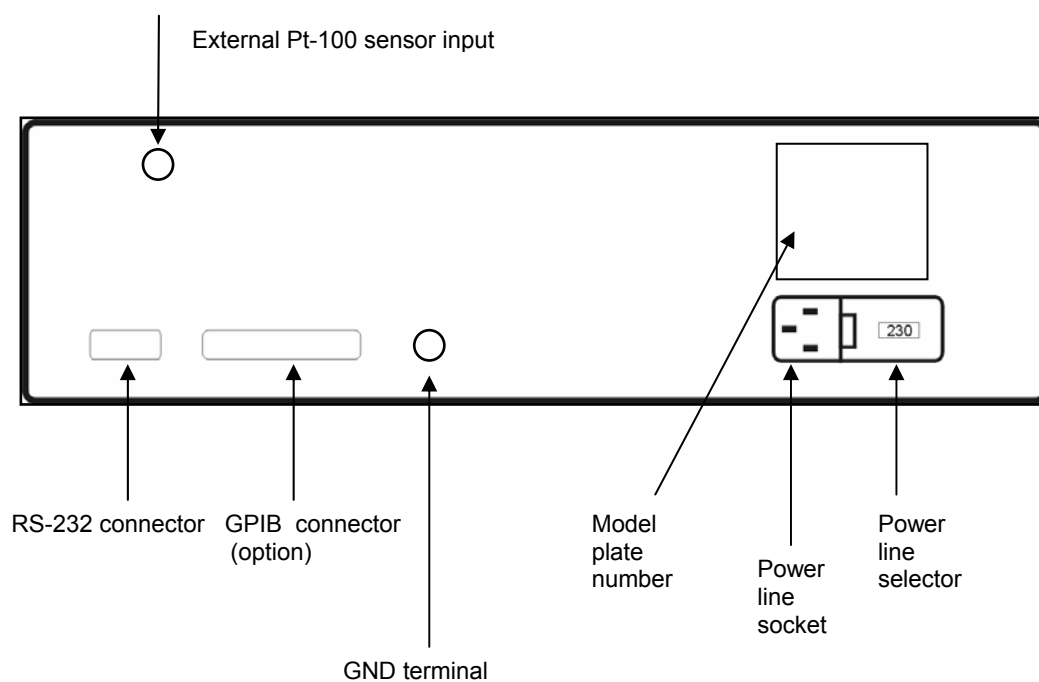
Power line socket with fuse and line voltage selector

RS-232 and GPIB (Option) sockets

Jack for external temperature sensor for cold junction compensation

Plate with serial number

GND Terminal



Operation of the Calibrator

Selection of the functions

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:

1. 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.

2. Activation or Deactivation of the output terminals

After pressing the ON/OFF key, the output terminals will be connected or disconnected.

3. Entry to the Setup Menu

After pressing the SETUP key the menu appears at the display and the display keys permit the entry into the calibration mode (CALIB). The previous mode can be restored by pressing the ESC display key.

Output Signal Magnitude

Entry by using the numerical keyboard

- Use the numerical 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 the symbol [_ _ _ _ _].

| | | | |
|---|-----|-----|---------------------|
| 10.0000 V = [11.2345 _ _ _ _ _] $\Delta\% = 00.000 \%$ | | | OFF Local Gnd |
| X10 | :10 | +/- | ACCURACY 0.0070 |

- Press the display key below the desired unit of measurement (V, mV or μV)
- The value is copied to the main display and the monitor line disappears.

Entry by using the cursor keys

- Press <, >, ^ or v key. The display will show the cursor pointing at the active digit.
- ^ and v keys can be used to change the active digit. <, > for changing the position of the cursor.
- To return to the default screen, press ESC or keep pressing the center cursor key until no value is in the help line [_ _ _ _ _]. The required magnitude can be set with the keys or with the digital potentiometer.

Reverse polarity

The polarity of the output DC voltage or DC current can be changed by pressing the +/- key. The „ - “ sign appears in front of the main value.

Relative Deviation

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

Setting of the Relative Deviation with the numerical keyboard

- keep pressing the center cursor key 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 output terminals is:

The value indicated by the main display + $\Delta\%$
The value indicated by the main display + $\Delta^\circ\text{C}$

for voltage, current, frequency mode .
for TC sensor simulation

| | | |
|---|--|---------------------------|
| 10.0000 V = | | OFF |
| $\Delta\%$ = 00.000 % [3.56 _ _ _ _ _] _ | | Local Gnd |
| % | | ACCURACY 0.0070 |

Maximum relative deviation can be set $\pm 30.000\%$.

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 v. The display now includes the cursor pointing to the active digit
- ^ and v 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 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 change

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

In resistance mode the 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 button to connect the output signal to the terminals. Red LED above the OUTPUT button 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

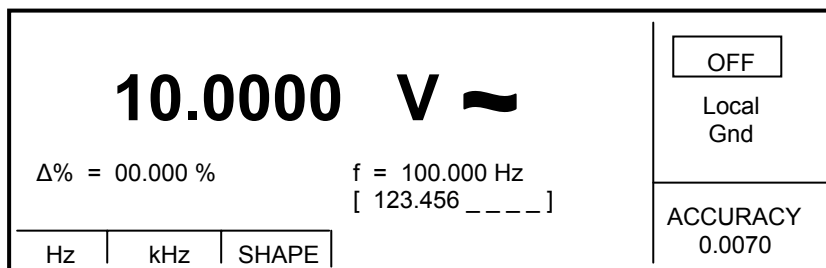
The frequency can be selected in AC voltage, AC current and frequency mode of operation. In each mode the frequency has a slightly different meaning and is therefore set in a different manner.

AC voltage (ACU), AC current (ACI)

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

Setting the Frequency

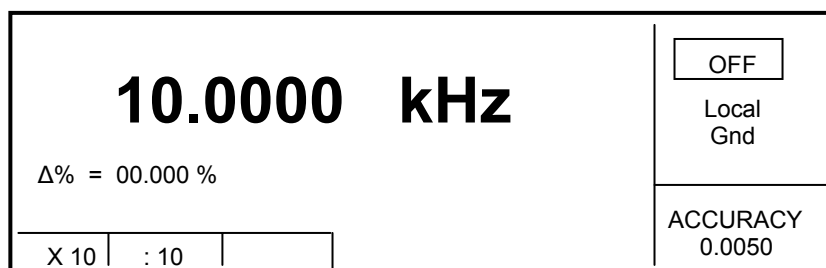
- Select the AC voltage or AC current by pressing the key FUNC. Frequency value „f = xxx.xx Hz“ appears in the Auxiliary field of the display.
- Press the button SEL until [_ _ _ _ _] appear below the frequency value. Numerical keyboard can be used to enter the desired value. Press “ Hz ” or “ kHz ”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



If too large or too small values are 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”.



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

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

Generation of the Calibrating Voltage

The calibrator OCM 141 generates high precision DC or AC voltages. The output terminals at the front panel for voltage ranges are labeled “Hi” and “Lo”. The maximum voltage at the output terminals can be set for 750 V.

DC voltage range: 0 to 750 V.

AC voltage range: 100 μ V to 750 V.

Output voltage up to 20 V is available also at AUXILIARY connector (pins 3, 4).

Setting the voltage

- Press FUNC to display DC or AC voltage mode. The display shows:
 - * Value of the voltage
 - * Relative deviation
 - * Uncertainty 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 lights up and the display shows the symbol ON.
- The set voltage is present at the output terminals.

Voltages 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.

Overloading the terminals

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

**ATTENTION DANGEROUS VOLTAGE**

When a voltage over 50 V is adjusted, rules for work with dangerous voltage must be observed.

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

**ATTENTION DANGEROUS VOLTAGE**

When the calibrator is controlled remotely, it is not possible to disconnect the output voltage by using the keys located at the front panel!

The calibrator must be first switched to local control mode by pressing the LOCAL button and then the output terminals can be disconnected or the mains switch switched off!

Generation of the Calibrating Current

The calibrator OCM 141 generates high precision DC or AC current. The output terminals at the front panel for voltage ranges are labeled “+I” and “-I”. The maximum current at the output terminals can be set for 2A.

DC current: 0 to 2 A

AC current: 1 μ A to 2 A

When 50-turn coil (option 140-50) is used, maximal simulated AC current is 100 A.

Setting the Current

- Press FUNC until AC or DC current mode will appear. The display shows:
 - * Value of the current
 - * Relative deviation
 - * Uncertainty of the output current
 - * 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.
- 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 set voltage 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 100 A.



CAUTION

***If GND terminal is connected to Lo, -I terminal, it is not allowed to connect external load to GND / Hi or GND / +I terminals.
Such connection can damage the calibrator.***

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.

Generation of Non-Harmonic Output Signals

The calibrator can generate non-harmonic periodic signals with predefined shape in ACV or ACI mode. The type of the output shape is displayed beside the main set value. To change the shape of the output signal, press the display key SHAPE.

Following shapes are available:

- SINE sine wave (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 sine wave with distortion $k=13.45\%$

Generation of non-harmonic signals has some limitations:

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

Setting in the non-harmonic mode

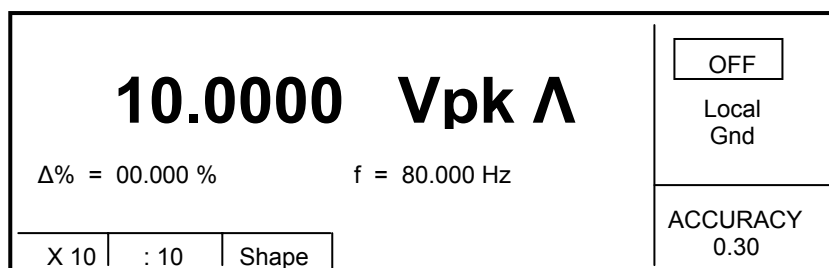
- Select AC voltage or AC current mode. The main display shows:
 - * Current or voltage and the measured units
 - * Relative deviation
 - * Frequency
 - * Selected SHAPE
- Press the SHAPE display key to select the desired shape of the output signal.

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

Information at the 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.

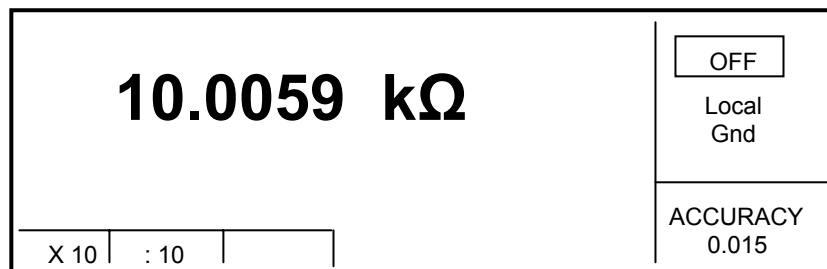


Resistance

OCM141 is equipped with high precision resistors of firm values 10 Ω , 100 Ω , 1k Ω , 10k Ω , 100k Ω , 1M Ω , 10M Ω and 100M Ω . They are connected to the Hi-Lo output terminals in two wire connection.

Resistor Selection

- Press FUNC to select the Resistor Mode. The display shows:
 - * Resistor value in Ω
 - * Uncertainty
- To increase or decay in 10 steps press the key x10 or :10.
- Press ON/OFF to connect the resistance to the output terminals.
- The red LED above the ON/OFF key is illuminated.



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

Frequency Generation

OCM141 can generate square wave TTL leveled signal 0.1Hz - 2MHz with 4 digit resolution. The signal is available at the terminals Hi – Lo.

Frequency Setting

- Press FUNC to select 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 button to activate the output. The red LED lights-up indicating the output terminals are activated.



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

Simulation of the Thermocouple Sensors

OCM141 can simulate thermocouple temperature sensors. The voltage corresponding to the selected temperature is available at the terminals Hi-Lo.

Temperature Range: -250 to +1820 °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 °C or K
- * Sensor type: K, N, R, S, B, J, T, E
- * Cold junction temperature of thermocouple sensors RJ
- * Relative deviation $\Delta T = \text{xxxx.x } ^\circ\text{C (K) in \%}$

The auxiliary display section shows:

- * Temperature scale
- * Uncertainty

- Set the temperature by using the numerical keyboard, cursor keys or digital potentiometer.
- 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.

| | | |
|---------------|----------------|-----------------------|
| 0450.0 °C | | OFF |
| Δ% = 00.000 % | RJ = 0000.0 °C | Local Gnd ITS90 |
| Type | TC type K | ACCURACY 0.3 °C |

Note: Current capability in TC simulation is 5 mA.

Switching between the sensor types

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

Cold Junction Compensation RJ

The temperature of the cold junction can be compensated manually or automatically. In the manual mode the temperature is entered from the keyboard. In the automatic mode the external temperature is measured with a Pt sensor plugged onto the jack at the rear panel. Switching between automatic and manual mode is in the service menu.

Manual Compensation

- The key MENU opens the service menu. With keys \vee , \wedge select RJ Temp. With the display keys select FIXED.
- By repeated pushing the key FUNC select the TC simulation.
- Push the button 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).

| | | |
|-----------------------|----------------|-----------------------|
| 0450.0 °C | | OFF |
| $\Delta\%$ = 00.000 % | RJ = 0023.0 °C | Local Gnd ITS90 |
| [_ _ _ _ _] | | ACCURACY 0.3 °C |
| °C | TC type K | |

Automatic Compensation

- The key MENU opens the service menu. With keys \vee , \wedge select RJ Temp. With the display keys select MEAS.
- By repeated pushing the button FUNC select TC simulation.
- The temperature is measured with the Pt Sensor plugged into the socket at the rear panel. The generated simulated voltage is compensated to the measured temperature.

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 | | |

Use \wedge or \vee cursor keys to select one of the menu options. The display keys are assigned to the displayed functions. After selection press ESC button 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 this parameter to ON. If the calibrated unit has the Lo terminal grounded, it is better to unground the outputs of the calibrator to prevent building of ground loops.

Note:

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

3. Temp.scale xx ITS90/PTS68

This parameter allows selecting the temperature scale for platinum resistance temperature sensors. The display keys permits 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. Interface xx GPIB/RS232

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

6. GPIB address xx UP/DOWN

The GPIB Address can be selected with the UP or DOWN display buttons. Factory setting is 02.

7. RS232 baud rate xx UP/DOWN

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

8. Handshake xx OFF/Xon-Xoff

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

9. 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.

10. Beep.volume xx HIGH/LOW

The sound level can be set in two intensity steps.

11. Display xx UP/DOWN

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

12. Contrast xx UP/DOWN

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

13. Cal.code 00000

Calibration code is a five-digit number, which must be entered to access the calibration mode. Factory setting is "00000" 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.

| | | |
|------------|-----------|---------|
| Contrast | | OFF |
| Cal. code. | | 000000 |
| Cal. date | | 01.2003 |
| Serial No | | xxxxxx |
| Time | | 16:54 |
| Calib | | |

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.

14. 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.

15. Serial No xxxxxx

Serial number if the instrument entered during the production. This parameter can not be changed.

16. Time xx:yy

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

17. Date xx.yy.zzzz

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

18. 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 id ON.

Calibration Mode

The calibrator OCM141 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.

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.

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 measuring and new starting of the values of the internal resistors.

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.

Access to the calibration procedure

To access the calibration procedure, a calibration code has to be entered.

- Press MENU button to open the setup menu.
- Press CALIB display button.
- When an attempt to the calibration mode is made within 60 minutes after the calibrator has been switched on, the display refuses to open the calibration menu. Following message appears:

Err 21 Time warm up!

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

| | | | |
|---|--|--|---|
| Set Calibration code [0 0 0 0] | | | <div>OFF</div> <div>Local Gnd</div> |
| | | | |

- Enter the correct calibration code using numeric keyboard and press ENTER.
- If incorrect calibration code is entered, an error message appears for 3 sec. on the display:

Err 20
Bad calib. code!

- If correct calibration code is entered correctly, the calibration menu will open:

| | | | |
|---|--|--|---|
| Voltage DC Voltage AC Current DC Current AC Resistance | | | <div>OFF</div> <div>Local Gnd</div> |
| Sel. | | | |

- Use \wedge and \vee 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 the calibration type

After the calibration menu is displayed, any of partial calibrations can be selected. Use \wedge and \vee cursor keys to roll through the list. Select the required function and press the key SEL. The example bellow shows the VOLTAGE DC range:

| | | | |
|---|--|---|---|
| Voltage DC Range 10 mV | | +0mV - 0mV +10 mV - 10 mV + 0 mV | <div>OFF</div> <div>Local Gnd</div> |
| Sel. | | | |

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

| | | | |
|---------------------------|------|-----------------------------|---------------------|
| Voltage DC Range 10 mV | | Range 10mV Value + 10 mV | OFF Local Gnd |
| ▲ 10146350 ▼ | | | |
| Write | Skip | | |

The Display keys have following functions:

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

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

New Calibration Data Entry

Use ^, v, <, > 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 button has been pressed.

Press ESC display button 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 firm 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 by using the keyboard. For the calibration of RESISTANCE the values of the firm resistances must be entered. The temperature 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 [V] | Tolerance [V] | Range [V] | Note |
|--------------------------|----------------------|------------------|-------------------|
| +0.0 | 2 μ | 10 m | zero calibration |
| - 0.0 | 2 μ | -10 m | zero calibration |
| +10 m | 4 μ | 10 m | slope calibration |
| - 10 m | 4 μ | -10 m | slope calibration |
| + 0.0 | 2 μ | 100 m | zero calibration |
| - 0.0 | 2 μ | -100m | zero calibration |
| +100 m | 6 μ | 100 m | slope calibration |
| - 100 m | 6 μ | -100m | slope calibration |
| + 0.0 | 5 μ | 1 | zero calibration |
| - 0.0 | 5 μ | -1 | zero calibration |
| +1.0 | 12 μ | 1 | slope calibration |
| -1.0 | 12 μ | -1 | slope calibration |
| + 0.0 | 20 v | 10 | zero calibration |
| - 0.0 | 20 μ | -10 | zero calibration |
| +10 | 100 μ | 10 | slope calibration |
| - 10 | 100 μ | -10 | slope calibration |
| +10 | 200 μ | 100 | slope calibration |
| - 10 | 200 μ | -100 | slope calibration |
| +100 | 600 μ | 100 | slope calibration |
| - 100 | 600 μ | -100 | slope calibration |
| +750 | 20 m | 750 | slope calibration |
| - 750 | 20 m | -7500 | slope calibration |

DCV

VOLTAGE AC

| Nominal value [V] | Tolerance [V] | Range [V] | Frequency[Hz] |
|--------------------------|----------------------|------------------|----------------------|
| 1 m | 5 μ | 10 m | 100 |
| 10 m | 10 μ | 10 m | 100 |
| 10 m | 15 μ | 100 m | 100 |
| 100 m | 40 μ | 100 m | 100 |
| 100 m | 30 μ | 1 | 100 |
| 1.0 | 100 μ | 1 | 100 |
| 1.0 | 200 μ | 10 | 100 |
| 10 | 1 m | 10 | 100 |
| 10 | 5 m | 100 | 100 |
| 100 | 10 m | 100 | 100 |
| 100 | 50 m | 750 | 100 |
| 750 | 50 m | 750 | 100 |

ACV

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 [A] | Tolerance [A] | Range [A] | Note |
|--------------------------|----------------------|------------------|-------------------|
| +0.0 | 3 n | 200 μ | zero calibration |
| - 0.0 | 3 n | -200 μ | zero calibration |
| +190 μ | 5 n | 200 μ | slope calibration |
| - 190 μ | 5 n | -200 μ | slope calibration |
| +200 μ | 20 n | 2 m | zero calibration |
| - 200 μ | 20 n | -2 m | zero calibration |
| +1.9 m | 50 n | 2 m | slope calibration |
| - 1.9 m | 50 n | -2 m | slope calibration |
| +2 m | 100 n | 20 m | zero calibration |
| - 2 m | 100 n | -20 m | zero calibration |
| +19 m | 200 n | 20 m | slope calibration |
| - 19m | 200 n | -20 m | slope calibration |
| +20 | 1 μ | 200 m | zero calibration |
| - 20 | 1 μ | -200 m | zero calibration |
| +190 m | 2 μ | 200 m | slope calibration |
| - 190 m | 2 μ | -200 m | slope calibration |
| +200 | 20 μ | 2 | zero calibration |
| - 200 | 20 μ | -2 | zero calibration |
| +1.9 | 50 μ | 2 | slope calibration |
| - 1.9 | 50 μ | -2 | slope calibration |

DCI

CURRENT AC

| Nominal value [A] | Tolerance [A] | Range [A] | Frequency [Hz] |
|--------------------------|----------------------|------------------|-----------------------|
| 10 μ | 5 n | 200 μ | 100 |
| 190 μ | 50 n | 200 μ | 100 |
| 200 μ | 40 n | 2 m | 100 |
| 1.9 m | 200 n | 2 m | 100 |
| 2.0 m | 200 n | 20 m | 100 |
| 19 m | 2 μ | 20 m | 100 |
| 20 m | 2 μ | 200 m | 100 |
| 190 m | 20 μ | 200 m | 100 |
| 200 m | 20 μ | 2 | 100 |
| 1.9 | 200 μ | 2 | 100 |

ACI

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] | Range [Ω] |
|--|--|------------------------------------|
| 10 | 0.01 | 10 – 50 |
| 100 | 0.005 | 10 – 50 |
| 1 k | 0.005 | 10 – 50 |
| 10 k | 0.005 | 50 - 100 |
| 100 k | 0.005 | 50 - 100 |
| 1 M | 0.01 | 50 - 100 |
| 10 M | 0.01 | 100 – 400 |
| 100 M | 0.01 | 100 – 400 |

R

The standard multimeter has to be connected with four terminals to the output terminals Hi-Lo.

Full calibration

Following pages describe the calibration in all ranges and points.

Required instruments:

- 8 1/2 digit multimeter type HP3458A or Wavetek 1281 or Fluke 8508A or other type with accuracy 0.002 % or better on DC voltage
- 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 analyzer 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 °C.
2. Press MENU display button to recall the setup menu. Press the CALIB display button 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**.

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 ! | Not allowed range in the 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. |

Maintenance

The multifunction calibrator OCM-141 is an electronic instrument, which does not require any special kind of maintenance.

Rules for correct operation

- *The calibrator has to be switched ON and OFF only by pressing the POWER key on the front.*
- *Do not connect the calibrator to other supply voltage than the one set by the voltage selector.*
- *Do not cover the openings located at the rear and bottom of the cabinet.*
- *Do not operate the calibrator in dusty environment.*
- *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 the correct output terminals. The calibrator is not protected against damage caused by improper connections.*
- *Do not damage the output terminals by inserting thicker bananas.*
- *Whenever possible, use the Lo output 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 on 2 A current range, 1200V and 750 V volt ranges.*
- *If the instrument to be calibrated is not connected to the calibrator's output terminals by using the original cables, ensure that the cables are suitable for the voltage and the current used. The maximum output voltage is 750 V AC and the maximum output current is 2 A AC.*

Regular maintenance

The calibrator does not require any special maintenance of electrical or mechanical parts. The housing and the display may be cleaned with a wool cloth moistened with alcohol.

Recommended re-calibration period is 12-month intervals.

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 can be caused by different symptoms. Usually, they cause instability of some parameters. Contact the manufacturer.

Sometimes the “hidden defects” are caused by the operator, such as:

- mains voltage out of tolerances or is unstable
- wrong grounding of the measurement circuit (bad connection of the ground terminal of the mains outlet, or several ground connection, forming grounding loops)
- close proximity to sources of intensive interferences such as electromagnetic field.
- strong electrostatic or electromagnetic field which can cause major instability during calibration using higher impedance.

Verification test

Required equipment

Following instruments are required for performing of the verification test:

- 8 1/2 digit multimeter type HP3458A or Wavetek 1281, or other type with accuracy 0.001 % on DC voltage
- 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 analyzer and scope with bandwidth min. 20 MHz are recommended for THD measuring of AC signals.

Configuration of the calibrator

The calibrator can be tested directly from the front panel terminals. To suppress influence of noise or interferences 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 standard meter are grounded, higher level can occur on the output terminals.

Settings 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, 750 V test
- **10 V AC** voltage range test with linearity checking
- **AC V** voltage internal ranges 10 mV, 100 mV, 1 V, 100 V, 750 V test
- **200 mA DC** current range test with linearity checking
- **DC I** current internal ranges 200 uA, 2 mA, 20 mA, 2A test
- **AC I** current internal ranges 200 uA, 2 mA, 20 mA, 200 mA, 2A test
- **Resistance** test in points 10, 100, 1k, 10k, 100k, 1M, 10M, 100M Ohm
- **Frequency** test at 1 kHz nominal value

Verification procedure

1. Place the calibrator in the laboratory conditions at 23 ± 1 °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%.

A new calibration (adjusting) should be performed only if one or more ranges are out of tolerances. In most cases a partial calibration helps. Information about calibration procedure in more details is described under "Calibration Mode".

Verification Test - Tables of Limits**20 V DC basic voltage range with linearity testing**

| Function | Range | Value (V) | Frequency (Hz) | Max. deviation (% of value) |
|----------|--------|-----------|----------------|-----------------------------|
| V-DC | 10.0 V | 2.0 | | 0.008 |
| V-DC | 10.0 V | 4.0 | | 0.006 |
| V-DC | 10.0 V | 6.0 | | 0.005 |
| V-DC | 10.0 V | 8.0 | | 0.004 |
| V-DC | 10.0 V | 10.0 | | 0.004 |
| V-DC | 10.0 V | -2.0 | | 0.008 |
| V-DC | 10.0 V | -4.0 | | 0.006 |
| V-DC | 10.0 V | -6.0 | | 0.005 |
| V-DC | 10.0 V | -8.0 | | 0.004 |
| V-DC | 10.0 V | -10.0 | | 0.004 |

Table I

DC voltage ranges

| Function | Range | Value (V) | Frequency (Hz) | Max. deviation (% of value) |
|----------|---------|-----------|----------------|-----------------------------|
| V-DC | 10 mV | 5 m | | 0.004 |
| V-DC | 10 mV | 9 m | | 0.004 |
| V-DC | 10 mV | -5 m | | 0.004 |
| V-DC | 10 mV | -9 m | | 0.004 |
| V-DC | 100 mV | 50 m | | 0.004 |
| V-DC | 100 mV | 90 m | | 0.004 |
| V-DC | 100 mV | -50 m | | 0.004 |
| V-DC | 100 mV | -90 m | | 0.004 |
| V-DC | 1.0 V | -0.5 | | 0.004 |
| V-DC | 1.0 V | 1.0 | | 0.004 |
| V-DC | 1.0 V | -0.5 | | 0.004 |
| V-DC | 1.0 V | -1.0 | | 0.004 |
| V-DC | 100.0 V | 50.0 | | 0.004 |
| V-DC | 100.0 V | 100.0 | | 0.003 |
| V-DC | 100.0 V | -50.0 | | 0.004 |
| V-DC | 100.0 V | -100.0 | | 0.003 |
| V-DC | 750.0 V | 300.0 | | 0.010 |
| V-DC | 750.0 V | 700.0 | | 0.010 |

Table II

20 V AC voltage basic range with linearity testing

| Function | Range | Value (V) | Frequency (Hz) | Max. deviation (% of value) |
|----------|--------|-----------|----------------|-----------------------------|
| V-AC | 20.0 V | 2.0 | 100 | 0.075 |
| V-AC | 20.0 V | 4.0 | 100 | 0.050 |
| V-AC | 20.0 V | 6.0 | 100 | 0.042 |
| V-AC | 20.0 V | 8.0 | 100 | 0.037 |
| V-AC | 20.0 V | 10.0 | 100 | 0.035 |

Table III

AC voltage ranges

| Function | Range | Value (V) | Frequency (Hz) | Max. deviation (% of value) |
|----------|---------|-----------|----------------|-----------------------------|
| V-AC | 10 mV | 0.010 | 1000 | 0.358 |
| V-AC | 100 mV | 0.100 | 1000 | 0.142 |
| V-AC | 1.0 V | 1.0 | 1000 | 0.030 |
| V-AC | 10.0 V | 10.0 | 50 | 0.030 |
| V-AC | 10.0 V | 10.0 | 300 | 0.030 |
| V-AC | 100.0 V | 100.0 | 1000 | 0.030 |
| V-AC | 750.0 V | 750.0 | 1000 | 0.036 |

Table IV

200 mA DC current basic range with linearity testing

| Function | Range | Value (A) | Frequency (Hz) | Max. deviation (% of value) |
|----------|----------|-----------|----------------|-----------------------------|
| A-DC | 200.0 mA | 0.04 | | 0.025 |
| A-DC | 200.0 mA | 0.08 | | 0.018 |
| A-DC | 200.0 mA | 0.12 | | 0.015 |
| A-DC | 200.0 mA | 0.16 | | 0.014 |
| A-DC | 200.0 mA | 0.18 | | 0.013 |
| A-DC | 200.0 mA | -0.04 | | 0.025 |
| A-DC | 200.0 mA | -0.08 | | 0.018 |
| A-DC | 200.0 mA | -0.12 | | 0.015 |
| A-DC | 200.0 mA | -0.16 | | 0.014 |
| A-DC | 200.0 mA | -0.18 | | 0.013 |

Table V

DC current ranges

| Function | Range | Value (A) | Frequency (Hz) | Max. deviation (% of value) |
|----------|---------------|-----------|----------------|-----------------------------|
| A-DC | 200.0 μ A | 0.00018 | | 0.061 |
| A-DC | 200.0 μ A | -0.00018 | | 0.061 |
| A-DC | 2.0 mA | 0.0018 | | 0.025 |
| A-DC | 2.0 mA | -0.0018 | | 0.025 |
| A-DC | 20.0 mA | 0.018 | | 0.013 |
| A-DC | 20.0 mA | -0.018 | | 0.013 |

Table VI

AC current ranges

| Function | Range | Value (A) | Frequency (Hz) | Max. deviation (% of value) |
|----------|---------------|-----------|----------------|-----------------------------|
| A-AC | 200.0 μ A | 0.00018 | 100 | 0.161 |
| A-AC | 2.0 mA | 0.0018 | 100 | 0.081 |
| A-AC | 20.0 mA | 0.018 | 100 | 0.055 |
| A-AC | 20.0 mA | 0.018 | 300 | 0.055 |
| A-AC | 20.0 mA | 0.018 | 100 | 0.055 |
| A-AC | 20.0 mA | 0.018 | 100 | 0.055 |
| A-AC | 200.0 mA | 0.18 | 100 | 0.055 |
| A-AC | 2.0 A | 1.8 | 100 | 0.055 |

Table VII

Resistance

| Function | Range | Value (Ohm) | Frequency (Hz) | Max. deviation (% of value) |
|----------|-----------|-------------|----------------|-----------------------------|
| O-4W | 10.0 Ohm | 10.0 | DC | 0.130 |
| O-4W | 100.0 Ohm | 10.0 | DC | 0.130 |
| O-4W | 100.0 Ohm | 100.0 | DC | 0.015 |
| O-4W | 1000 Ohm | 1000.0 | DC | 0.015 |
| O-4W | 10k Ohm | 10000.0000 | DC | 0.015 |
| O-4W | 100k Ohm | 100000.0000 | DC | 0.015 |
| O-4W | 1M Ohm | 1.000000e+6 | DC | 0.050 |
| O-4W | 10M Ohm | 1.000000e+7 | DC | 0.200 |
| O-4W | 100M Ohm | 1.000000e+8 | DC | 0.500 |

Table VIII

Frequency

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

Table IX

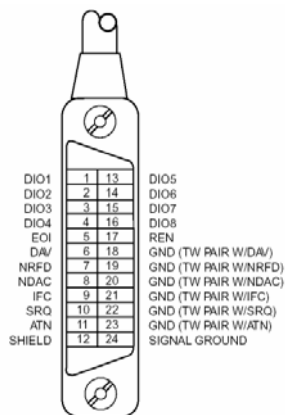
Interface

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 from 150 to 19200, the software handshake XON/XOFF. The address for the IEEE-488 bus can be set from 0 to 30. 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.

IEEE-488 bus

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

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



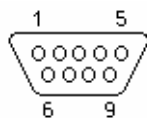
The instrument also recognizes the following general commands:

| | | |
|-----|------------------------------------|-------------------------------|
| 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 |

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 |

9-pin connector D-SUB MALE

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

| PC | D-Sub 1 | D-Sub 2 | M-141 |
|-------------|---------|---------|-------------|
| Transmitter | 2 | 2 | Transmitter |
| Receiver | 3 | 3 | Receiver |
| Ground | 5 | 5 | Ground |

Command Syntax

The commands described in this chapter can be issued by the 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 OCM141 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, OCM141 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 the 100A current range (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, OCM141 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 OCM141 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> |

[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, OCM141 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, OCM141 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, OCM141 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 Ohms. "Technical Data" chapter lists the acceptable ranges.

If query is sent, OCM141 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 ungrounds the voltage output

If query is sent, OCM141 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, OCM141 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, OCM141 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, OCM141 returns the set temperature scale { TS68 | TS90 }.

[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, OCM141 returns the set 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, OCM141 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, OCM141 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, OCM141 returns the set temperature using standard exponential format. Example: 20.5°C is returned as 2.050000e+001.

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, OCM141 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, OCM141 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-141,412341,4.6

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 button.

Local control***LOC**

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

Local control lock***LLO**

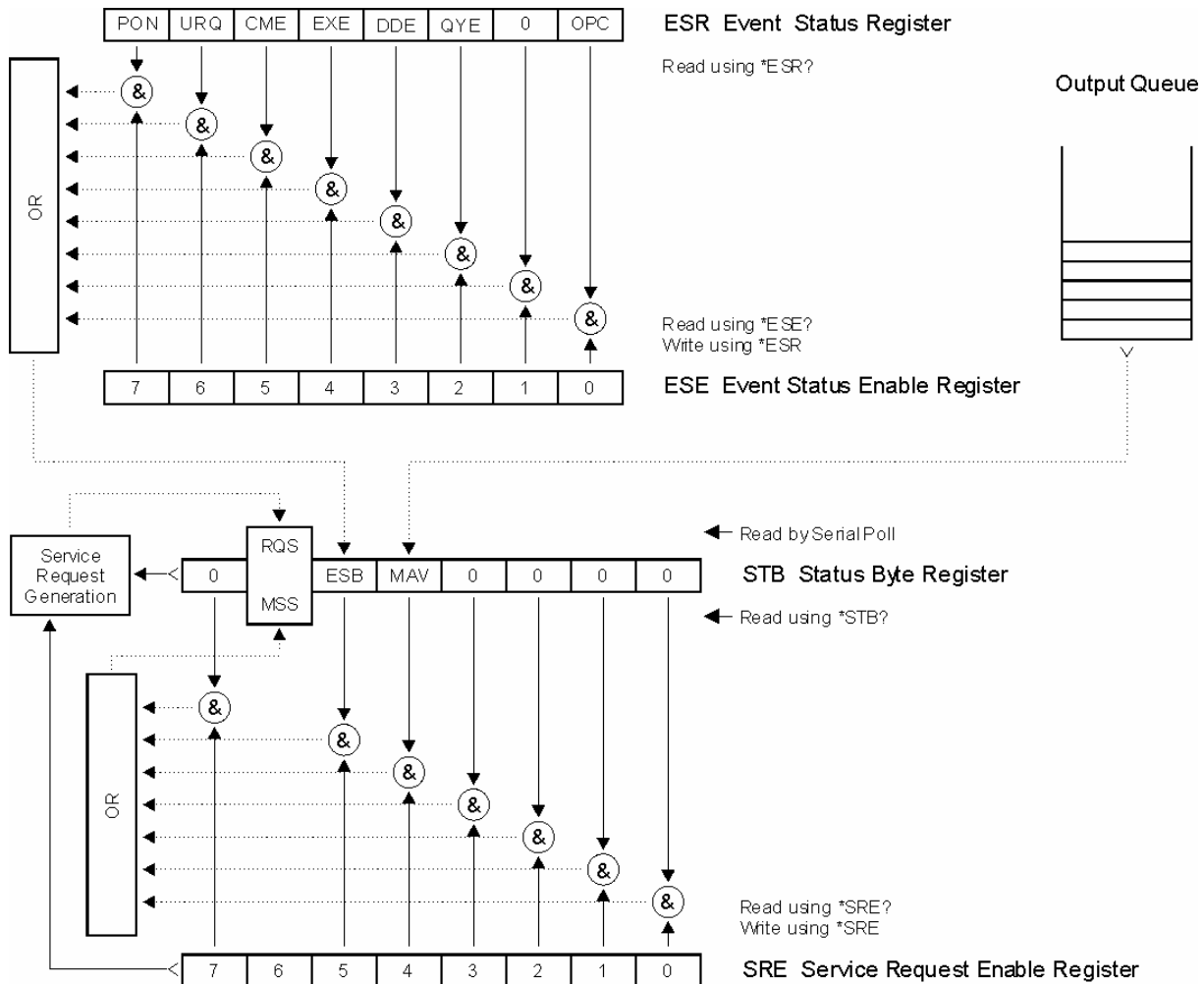
This command locks out the local control; the calibrator cannot be returned to local control by pressing LOCAL button. Return to local control can only be performed by a command sent through the bus, or by switching the calibrator off and on.

Local control unlock***UNL**

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

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.



Status Register Overview

Status data structure of M140 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 OCM141 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 OCM141.
- 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 Connections

Calibration of measuring instruments

The calibrator can be used for direct calibration of various instruments for measuring of electrical values. It is also suitable for field applications.

Multimeters

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

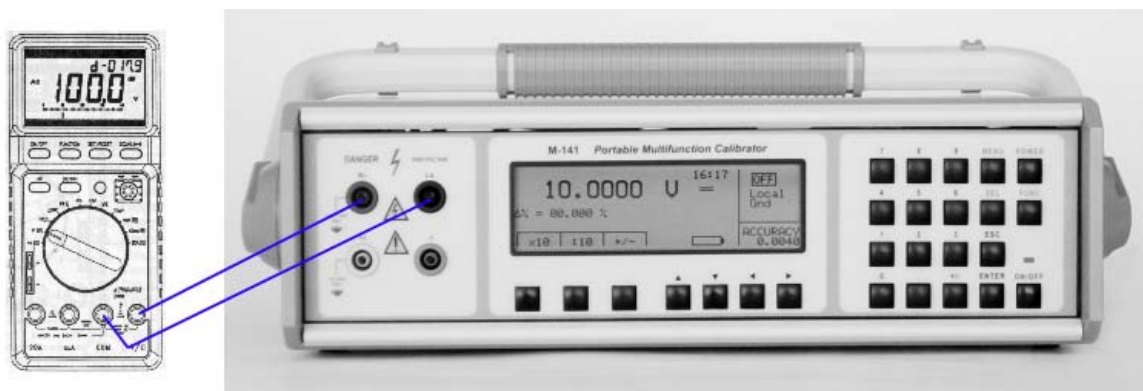
Voltage ranges

The low output impedance and high output current permit the calibration of analogue voltmeters with low input impedance. The voltage output is connected to Hi/Lo terminals. The calibrator does not allow the four-wire connection of the instrument to be calibrated.

It is not recommended to connect non-standard load to the voltage output. The calibrator is 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 filters and protected against oscillations, high capacitance or inductance loads can damage the output amplifiers.

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

Connecting the voltage input of the multimeter to the OCM141 voltage output:



Current ranges

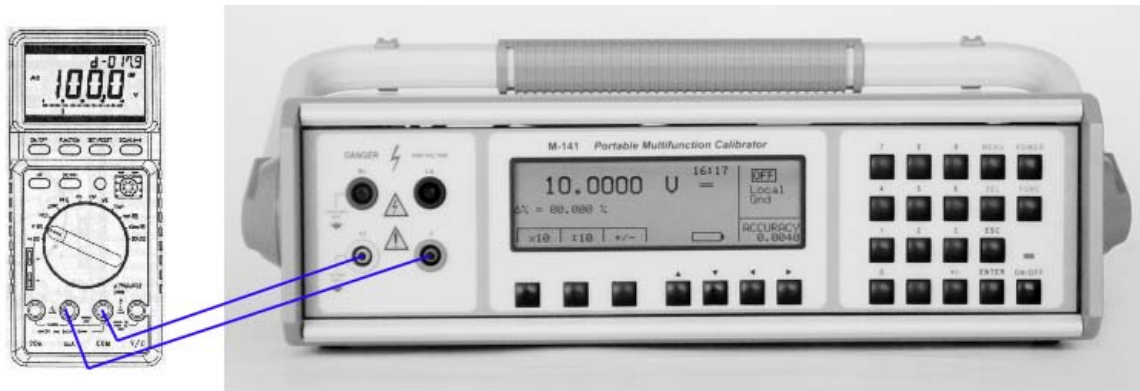
All DC and AC current ranges are connected to calibrator's **+I -I** terminals.

When using higher current output than 1A, check if the bananas are fully inserted in the output terminals in order to limit the contact resistance which can result in distortion and errors.

It is not recommended to connect non-standard load to the current output. The output terminals should be loaded with low and real impedance. The excitation voltage is around 2V RMS. Even the output is secured with fast electronic and microprocessor protection, high capacitance or inductance can cause oscillations of the output amplifiers which might result in their damage.

When the **L** terminal of the instrument to be calibrated is not grounded, the **Lo** terminal of the calibrator has to be grounded GND ON, see „Setup menu“.

Connecting the ammeter to the current terminals:



Optional current coil can extend the calibrator's current range up to 100 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 large calibration error.

ATTENTION

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

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:

- Frequency calibration up to 2 MHz using a square wave signal. The function is activated with repetitive pressing the FUNC key and selecting the Frequency mode. Only the frequency value can be set.
- Calibration of vertical sensitivity from 1 mV to 10 V in the frequency range up to 1 kHz. In the ACV function the square wave output form can be selected. The frequency value and amplitude can be set.

The instrument to be calibrated is connected to the **Hi – Lo** output terminals.

Thermometers (except sensor)

The calibrator can be used for calibration of thermometers and transmitters for thermocouple sensors. The thermometer mode can be activated by repeated pressing FUNC key until TC function is selected. The simulation is available for sensor types K, N, R, S, B, J, T, E. The thermometer under test is connected to the Hi – Lo output terminals of the calibrator.

Specification

The uncertainties shown below are valid after the calibrator has been switched-on for the specified warm-up time in a room with $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$. The uncertainties include long-term stability, temperature coefficient, linearity, load and line regulation and the traceability of factory with the National Calibration Standards. Specified uncertainties are valid for one year after the last calibration. Specified uncertainties „of range“ are related to the maximal value which can be set on the range. All uncertainties are calculated for coefficient probability 95% in normal distribution.

Technical data

Voltage

| | |
|------------------------|--|
| Voltage range: | 0 μV – 750 V DC, 1 mV – 750 V AC |
| Sub-Ranges: | 100 mV, 1 V, 10 V, 100 V, 750 V |
| Frequency range: | 1 mV – 10 V 20 Hz to 2 kHz, 10 V – 100 V 40 Hz to 2 kHz 100 V – 750 V 40 Hz to 1 kHz |
| Frequency resolution: | 0.001 Hz to 1 kHz 0.01 Hz to 2 kHz |
| Accuracy of frequency: | 0.01% |
| Output waveform: | harmonic: sinus non-harmonic: triangle symmetrical, triangle A/ B, square, limited sin (with defined distortion $k=13.45\%$) |

DC voltage

| Range | % of value + % of range |
|-------------------------|---|
| 0 μV – 10 mV | $0.05 + 0.005 + 10\text{ } \mu\text{V}$ |
| 10 mV – 100 mV | $0.01 + 0.001 + 10\text{ } \mu\text{V}$ |
| 100 mV – 1 V | $0.008 + 0.002$ |
| 1 V – 10 V | $0.008 + 0.002$ |
| 10 V – 100 V | $0.015 + 0.004$ |
| 100 V – 750 V | $0.018 + 0.004$ |

AC voltage

| Range | % of value + % of range | % of value + % of range |
|-----------------------------|--|--|
| | 20 Hz - 200 Hz | 200 Hz -2000 Hz |
| 1 mV – 10 mV | $0.20 + 0.05 + 20\text{ } \mu\text{V}$ | $0.20 + 0.10 + 20\text{ } \mu\text{V}$ |
| 10 mV – 100 mV | $0.10 + 0.03 + 20\text{ } \mu\text{V}$ | $0.15 + 0.05 + 20\text{ } \mu\text{V}$ |
| 100 mV – 1 V | $0.05 + 0.005$ | $0.07 + 0.01$ |
| 1 V – 10 V | $0.05 + 0.005$ | $0.07 + 0.03$ |
| 10 V – 100 V ^{*1} | $0.05 + 0.010$ | $0.07 + 0.03$ |
| 100 V – 750 V ^{*2} | $0.07 + 0.02$ | $0.1 + 0.03$ |

^{*1} Voltage range 100 V from 40 Hz to 2000 Hz

^{*2} Voltage range 750 V from 40 Hz to 1000 Hz

Auxiliary parameters

| Range | 10mV | 100mV | 1V | 10V | 100V | 750V |
|--|------------------------------------|------------------------------------|-----------------------|-----------------------|------------------------|------------------------|
| THD ^{*3} | $0.05\% + 200\text{ } \mu\text{V}$ | $0.05\% + 300\text{ } \mu\text{V}$ | 0.05% | 0.05% | 0.05% | 0.2% |
| Maximum output current | 5 mA | 5 mA | 10 mA | 30 mA | 10 mA | 2 mA |
| Output impedance | $< 10\text{ m}\Omega$ | $< 10\text{ m}\Omega$ | $< 10\text{ m}\Omega$ | $< 10\text{ m}\Omega$ | $< 100\text{ m}\Omega$ | $< 100\text{ m}\Omega$ |
| Maximum capacitance load | 500 pF | 500 pF | 500 pF | 500 pF | 300 pF | 150 pF |
| Amplitude accuracy in non-harmonic mode (peak value) | 0.3% | 0.3% | 0.3% | 0.3% | -- | -- |

^{*3} Parameter includes harmonic distortion and non-harmonic noise in range to 1 MHz

Current

Current range: 0 μ A – 2 A DC, 1 μ A – 2 A AC
 Sub-Ranges: 200 μ A, 2 mA, 20 mA, 200 mA, 2A
 Frequency range: 20 Hz to 1 kHz, accuracy of frequency 0.01%
 Frequency resolution: 0.001 Hz
 Output wave form: harmonic: sinus
 Non-harmonic: triangle symmetric, triangle A/ B, square, limited sinus

DC current

| Range | % of value + % of range |
|-------------------------|-------------------------|
| 0 μ A – 200 μ A | 0.05 + 0.0 + 20 nA |
| 200 μ A – 2 mA | 0.025 + 0.005 |
| 2 mA – 22 mA | 0.015 + 0.003 |
| 22 mA – 200 mA | 0.015 + 0.003 |
| 200 mA – 2 A | 0.015 + 0.005 |

AC current

| Range | % of value + % of range | % of value + % of range |
|-------------------------|-------------------------|-------------------------|
| | 20 Hz – 200 Hz | 200 Hz – 1000 Hz |
| 1 μ A – 200 μ A | 0.25 + 0.0 + 20 nA | 0.30 + 0.10 + 20 nA |
| 200 μ A – 2 mA | 0.10 + 0.01 | 0.20 + 0.05 |
| 2 mA – 20 mA | 0.07 + 0.005 | 0.20 + 0.05 |
| 20 mA – 200 mA | 0.07 + 0.005 | 0.20 + 0.05 |
| 200 mA – 2 A | 0.1 + 0.005 | 0.25 + 0.05 |

Auxiliary parameters

| Range | 200 μ A | 2 mA | 20 mA | 200 mA | 2 A |
|--|-------------|-------------|--------------|-------------|-------------|
| Maximum inductive load | 400 μ H | 400 μ H | 400 μ H | 400 μ H | 200 μ H |
| Maximum voltage on the load (pk) | 2 V | 2 V | 2 VAC, 7 VDC | 2 V | 2 V |
| THD ⁴ | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% |
| Amplitude accuracy in non-harmonic mode (peak value) | 0.3% | 0.3% | 0.3% | 0.3% | 0.3% |

⁴ Parameter includes harmonic distortion and non-harmonic noise in range to 1 MHz

Resistance

Range: 10 Ω to 100 M Ω in firm decade steps.
 Maximum voltage/dissipation power: 50 V_{eff} / 0.1 W.

| Range | Calibration uncertainty[%] | Tolerance [%] |
|----------------|----------------------------|---------------------|
| 10 Ω | 0.03 + 10 m Ω | 0.2 + 100m Ω |
| 100 Ω | 0.05 | 0.2 + 100m Ω |
| 1 k Ω | 0.02 | 0.2 |
| 10 k Ω | 0.02 | 0.2 |
| 100 k Ω | 0.02 | 0.2 |
| 1 M Ω | 0.05 | 0.2 |
| 10 M Ω | 0.05 | 1 |
| 100 M Ω | 0.5 | 2 |

Thermocouple Sensor Simulation

Type : R, S, B, J, T, E, K, N
 Temperature scale : ITS90, IPTS68

| | | | | | |
|---|---------------|-------------|------------|-------------|-------------|
| R | range [°C] | -50 – 0 | 0 – 400 | 400 – 1000 | 1000 – 1767 |
| | accuracy [°C] | 2.5 | 2.0 | 1.2 | 1.2 |
| S | range [°C] | -50 – 0 | 0 – 250 | 250 – 1400 | 1400 – 1767 |
| | accuracy [°C] | 2.2 | 2.1 | 1.5 | 1.5 |
| B | range [°C] | 400 – 800 | 800 – 1000 | 1000 – 1500 | 1500 – 1820 |
| | accuracy [°C] | 2.7 | 1.5 | 1.4 | 1.3 |
| J | range [°C] | -210 – -100 | -100 – 150 | 150 – 700 | 700 – 1200 |
| | accuracy [°C] | 0.9 | 0.4 | 0.3 | 0.4 |
| T | range [°C] | -200 – -100 | -100 – 0 | 0 – 100 | 100 – 400 |
| | accuracy [°C] | 0.9 | 0.5 | 0.3 | 0.3 |
| E | range [°C] | -250 – -100 | -100 – 280 | 280 – 600 | 600 – 1000 |
| | accuracy [°C] | 1.7 | 0.3 | 0.2 | 0.3 |
| K | range [°C] | -200 – -100 | -100 – 480 | 480 – 1000 | 1000 – 1372 |
| | accuracy [°C] | 0.8 | 0.4 | 0.4 | 0.5 |
| N | range [°C] | -200 – -100 | -100 – 0 | 0 – 580 | 580 – 1300 |
| | accuracy [°C] | 1.3 | 0.6 | 0.6 | 0.5 |

Uncertainties in the table are maximal uncertainties of TC sensor simulation. Actual uncertainty for each set value of simulated temperature is determined by uncertainty of the relevant resistance. Actual temperature uncertainty is displayed on the calibrator display. Actual uncertainties are always lower than those shown in the table above.

Frequency

Waveform: square with fix amplitude 5Vpk-pk / 50 Ohm
 Frequency range: 0.1 Hz to 2 MHz
 Frequency resolution: 5 ½ digit
 Uncertainty: 0.005%

General

| | |
|------------------------|---|
| Reference temperature: | 23 °C ± 2 °C (for specified uncertainties) Within the temperature range of 23 °C ± 5 ° are the uncertainties twice as large. |
| Warm-up time: | 5 min |
| Working temperatures: | +5 °C ... +40 °C |
| Storing temperatures: | 0 to 40 °C at the relative humidity up to 80 % |
| Ambient: | 86000 to 106000 Pa |
| Power supply voltage: | 115/230V - 50/60 Hz |
| Power consumption: | 40 VA max |
| Dimensions: | 325mm x 111mm x 316mm |
| Weight: | 6 kg |
| Interface: | RS232, (IEEE488 Option) |
| Fuses: | T1L250 – 230 V, T2L250 – 115 V |

Models

| | |
|-------------|---|
| OCM-141 | basic model with RS-232 |
| OCM-141GPIB | model with both RS-232 and GPIB interface |

Accessory (included in basic delivery)

| | |
|--------------------|--------|
| • Power line cord | 1 pc |
| • Operation manual | 1 pc |
| • Test report | 1 pc |
| • Spare fuse | 1 pc |
| • Test cable | 1 pair |

Options (extra ordered)

| | |
|--------------------|--|
| • Option 140-50 | Current coil 25/50 turns |
| • Option 10 | Test cable 20A/1000V (red) |
| • Option 11 | Test cable 20A/1000V (black) |
| • Option RS-232 | Cable RS-232, 2m |
| • Option GPIB | Cable GPIB IEEE488/IEEE488, 2m |
| • WinQbase/CALIBER | Application SW for automatic calibration of meters |