OCM-500B
Impedance Calibrator

Owner's Manual

ORBIT CONTROLS AG
Zürcherstrasse 137
CH - 8952 Schlieren

Tel.: +41 44 730 2753
Fax.: +41 44 730 2783

www.orbitcontrols.ch
info@orbitcontrols.ch

Table of contents

1. The Instrument

The impedance calibrator OCM 500B is designed for calibration of RLC measuring instruments. It contains 9 resistance Standards 100 mOhm to 10 MOhm in decade steps, 7 partial capacity standards 10 pF to 10uF in decade steps and 5 partial inductive standards 1 mH to 10 H in decade steps. For elimination of the connecting leads influence and the own background of the controlled meter, the calibrator is equipped with the SHORT and the OPEN positions of the output terminals. The basic connection between the impedance calibrator and the tested meter is with coaxial four-pair BNC terminals. The LCD display permits projection of the complete settings. New calibration data can be entered from the display during recalibration. The access to the calibration data is protected by a code. All functions of the calibrator except calibration procedures may be controlled by means of standard IEEE-488 bus.

2. Accessories

Mains supply cord	1 pc
Coaxial cables BNC-BNC	4 pcs
BNC adapter - banana plug	2 pcs
Operation manual	1 pc
Fuse	1 pc

3. Specifications

3.1 General data

Range of values:

Resistance	100 mΩ, 1 Ω, 10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ
Capacitance	10 pF, 100 pF, 1 nF, 10 nF, 100 nF, 1 μF, 10 μF
Inductance	1 mH, 10 mH, 100 mH (for frequencies 10 kHz and 20 kHz), 1 H (for frequencies 1 kHz, 2 kHz, 4 kHz) 10 H (for frequencies 100 Hz, 200 Hz, 400 Hz)

Referential position: SHORT and OPEN

Frequency range: 100 Hz - 20 kHz

Calibration data on
Firm frequencies: 100 (120), 200, 400, 1k, 2k, 4k, 10k, 20 kHz

Display functions:

A) Measuring mode MEANS

1) Projection of calibration data
   - main components (R, C, L)
   - Residual parameter (Q, D, Cs, Cp, Rs, Rp, Ls, Lp)

2) Projection of calibrator settings
   - Function
   - Frequency
   - Range
   - Data
   - Type of connection
   - External switch

3) Projection of additional data
   - Date of calibration
   - Maximum voltage
   - Maximum current
   - Calibration uncertainty of the main components
   - Calibration uncertainty of the residual Components

B) Calibration mode CAL

1) Projection of calibration data
   - main component
   - Residual parameter (Q, D, Cs, Cp, Rs, Rp, Ls, Lp)

2) Projection of calibrator settings
   - Function
   - Frequency
   - Range
   - Type of calibration
   - Type of connection

3) Projection of another data
   - Date of calibration
   - Calibration uncertainty of the main component
   - Calibration uncertainty of the residual component

C) System mode SYS
   - GPIB address
   - Code of calibration
   - Tests
   - Manufacturing number

Output terminals: 4 coaxial BNC terminals
H_{CUR} - current supply terminal Hi
H_{POT} - voltage sensing terminal Hu
L_{POT} - voltage sensing terminal Lu
L_{CUR} - current sensing terminal Li

Measuring voltage: $<$ 50 V depend on the impedance value by the specification

Measuring current: $<$ 0.5 A depend on the impedance value by the specification

Note: Maximum voltage between measuring terminals (H_{CUR}, H_{POT}, - L_{POT}, L_{CUR}, screen and the cabinet is 50 V.

3.2 Parameters

Resistance Standards - 4W

Nominal value	12 months stability	Accuracy*	Calibration uncertainty R*	Max. TempCo.	Q*	Calibration uncertainty Q*	I_{max}
Ohm	**ppm**	**%**	**%**	**ppm/°C**	**10^{-5}**	**10^{-5}**	**mA**
SHORT	50 μOhm	-	-	-	-	-	500
0.1	30	0.1	0.05	2	< 100	60	500
1.0	30	0.1	0.01	2	< 10	6	200
10	30	0.05	0.005	2	< 1	1	50
100	30	0.05	0.005	2	< 1	1	15
1 k	30	0.05	0.005	2	< 1	1	5
10 k	30	0.05	0.005	2	< 5	1	1.5
100 k	30	0.05	0.005	2	< 50	3	0.50
1.0 M	30	0.1	0.05	2	< 500	20	0.05
10 M	100	0.2	0.1	50	< 50	200	0.005

* For F = 1 kHz

Capacitance Standards - 4W

Nominal value	12 months stability	Accuracy*	Calibration uncertainty C*	Max. TempCo.	D* max.	Calibration uncertainty D*	U_{max}
F	**ppm**	**%**	**%**	**ppm/°C**	**10^{-4}**	**10^{-4}**	**V**
OPEN	5 fF	-	-	-	-	-	50
10 p	100	2.0	0.1	20	500	10	50
100 p	100	0.2	0.01	20	50	1	50
1 n	100	0.05	0.01	20	10	1	50
10 n	100	0.05	0.01	20	5	1	50
100 n	100	0.05	0.01	20	5	1	50
1 u	200	0.1	0.1	-150	10	2	15
10 u	200	0.1	0.1	-150	50	10	1.5

* For F = 1 kHz

Inductance Standards - 4W

Nominal value	12 months stability	Accuracy *	Calibration uncertainty L*	Max. TempCo.	Q* Min.	Calibration uncertainty Q*	I_{max}
H	**ppm**	**%**	**%**	**ppm/°C**	**-**	**-**	**mA**
1 m	200	0.5	0.1	100	10	0.1	100
10 m	200	0.5	0.1	100	10	0.1	100
100 m	100	0.5	0.1	20	-	-	-
1 H	100	0.5	0.1	100	2.5	0.1	80
10 H	100	0.5	0.1	100	-	-	-

* For F = 1 kHz (1 mH, 10 mH, 1 H)
For F = 10 kHz (100 mH)
For F = 100 Hz (10 H)

Resistance Standards - 2W (H_{CUR} - L_{CUR} terminals)

Nominal value	12 months stability	Accuracy *	Calibration uncertainty R*	Maximum TempCo.	I_{max}
Ohm	**ppm**	**%**	**%**	**ppm/°C**	**mA**
SHORT	50 mOhm	-	-	-	500
10	5000	0.5	0.1	2	50
100	500	0.05	0.05	2	15
1.0 k	50	0.05	0.01	2	5
10 k	30	0.05	0.01	2	1.5
100 k	30	0.5	0.05	2	0.50
1.0 M	30	5.0	0.3	2	0.05

* For F = 1 kHz

Capacity Standards - 2W (H_{CUR} - L_{CUR} terminals)

Nominal value	12 months stability	Accuracy*	Calibration uncertainty C*	Maximum TempCo.	U_{max}
F	**ppm**	**%**	**%**	**ppm/°C**	**V**
OPEN	fF	-	-	-	50
100 p	100	50	0.5	20	50
1 n	100	5.0	0.1	20	50
10 n	100	0.5	0.1	20	50
100 n	100	0.1	0.1	20	50
1 u	200	0.5	0.2	-150	15
10 u	200	5.0	0.5	-150	1.5

* For F = 1 kHz

Inductance Standards - 2W (H_{CUR} - L_{CUR} terminals)

Nominal value	12 months stability	Accuracy*	Calibration uncertainty L*	Maximum TempCo.	I_{max}
H	**ppm**	**%**	**%**	**ppm/°C**	**mA**
1 m	200	1.0	0.2	100	100
10 m	200	1.0	0.1	100	100

* For F = 1 kHz

The Accuracy are valid for the ambient temperature 23 $\pm$ 1 °C, relative humidity lower than 70% and 0.1 $U_{MAX.}$ or 0.1 $I_{MAX.}$.

Temperature Coefficient *TempCo* is valid for temperature range 20°C to 30°C.

3.3 Data Output and Remote Control

Interface:	IEEE-488
Remote controlled functions:	All Output Functions with exception of the own Calibration.
Interface function:	SH1, AH1, T5, L4

3.4 Working conditions

Operating temperature:	15°C to 30°C
Storing temperature:	-10°C to 55°C
Reference temperature:	23 ± 1 °C
Relative humidity:	70% as maximum
Outer magnetic field:	Negligible
Outer electric field:	Negligible
Power supply:	230 V ± 10%, 50/60 Hz, 65 VA
Protection:	Fuse 230 V - F 400 mA

3.5 General data

Protection class:	1 according EN1010
Degree of anti-jamming:	R 02
Weight:	12 kg
Dimensions:	450 x 135 x 480mm

4. Principle of Operation

Electric part of the Impedance Calibrator OCM-500B consists of analogue measuring path with Standards of resistors, capacitors, inductors and additional control circuits. Individual Standards are connected in four wire method and switched to the output terminals with relays. The impedance calibrator is equipped by reference positions OPEN and SHORT, which serve for residual wire effect elimination and for correction to the RLC meter under test. The SHORT circuits are created by coaxial relays.
Analogue measuring path is isolated from the control electronic. Analogue measuring ground is connected to the terminal L_{CUR} shielding. The control electronic circuits are based on the microcontroller board, which permits the operation with the control keys at the front panel, indication of the calibration data at the display, switching of the relays and the communication via the GPIB bus. The calibration data are stored in internal non volatile memory. Access to the calibration data is protected by a code.

5. Start-Up

After the instrument has been received and taken out from the box, leave it at the ambient operation temperature for 12 hours. Apply 230VAC and energize the instrument by pressing the button POWER. All accessible metal parts are connected to the protective conductor and the GND terminal on the rear panel (except the measuring terminals H_{CUR}, H_{POT} L_{POT}, L_{CUR}).

Note: The analogue measuring ground is not galvanic connected with metal cabinet

6. Operation instructions

6.1 Description of the control elements

6.1.1 Front panel

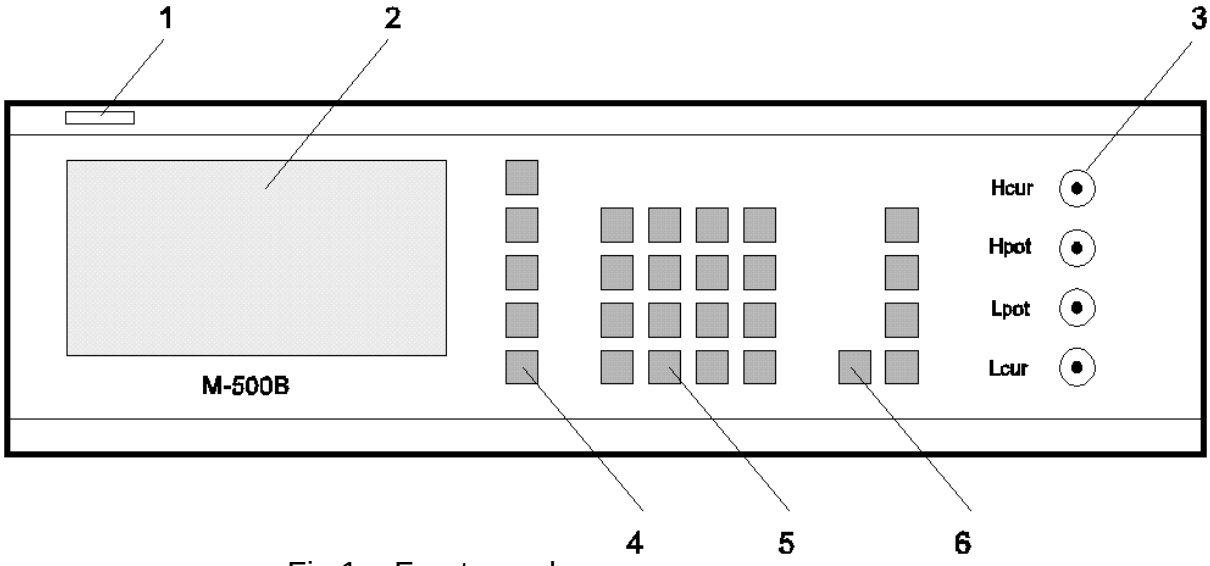
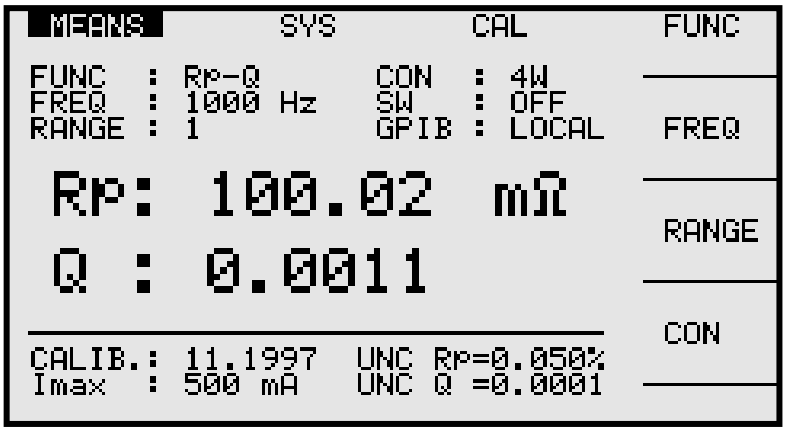


Fig.1. Front panel

1 Power supply switch

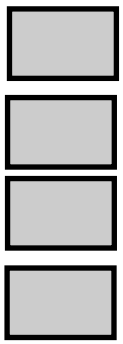
2 LCD display



3 Terminals for connection to the tested object

H_{CUR} - current supply terminal Hi
H_{POT} - voltage sensing terminal Hu
L_{POT} - voltage sensing terminal Lu
L_{CUR} - current sensing terminal Li

4 Push buttons



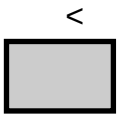
Four bush buttons for the access to the menu enable basic operation of the calibrator. The actual meaning of the individual keys corresponds to the legends on the left part of the LCD display.

CANCEL

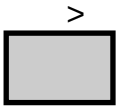
Control from the front panel or from the remote data port. Toggle operation of the key.

LOCAL

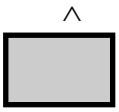
5 Numeric keyboard



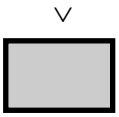
Key for cursor movement left.



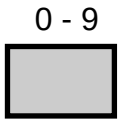
Key for cursor movement right.



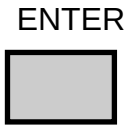
Key for cursor movement up.



Key for cursor movement down.

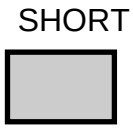


Keys 0 - 9 of the numeric keyboard.

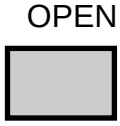


Key for confirmation.

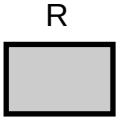
6 Function selection



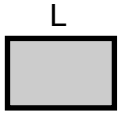
Push button SHORT closes the output terminals by coaxial relay. See also SHORT correction.



Push button OPEN connects the terminal pairs $H_{CUR,}$ $H_{POT,}$ $L_{POT,}$ L_{CUR}. See also OPEN correction.



Push button connects the internal resistance Standards to the output terminals. See also Function selection.



Push button connects the internal inductance Standards to the output terminals. See also Function selection.

C

Push button connects the internal capacitance Standards to the output terminals. See also Function selection.

6.1.2 Rear Panel

1 Connector for the control switch
2 Grounding terminal
3 GPIB bus plug
4 Power supply plug with fuse box
5 Fan

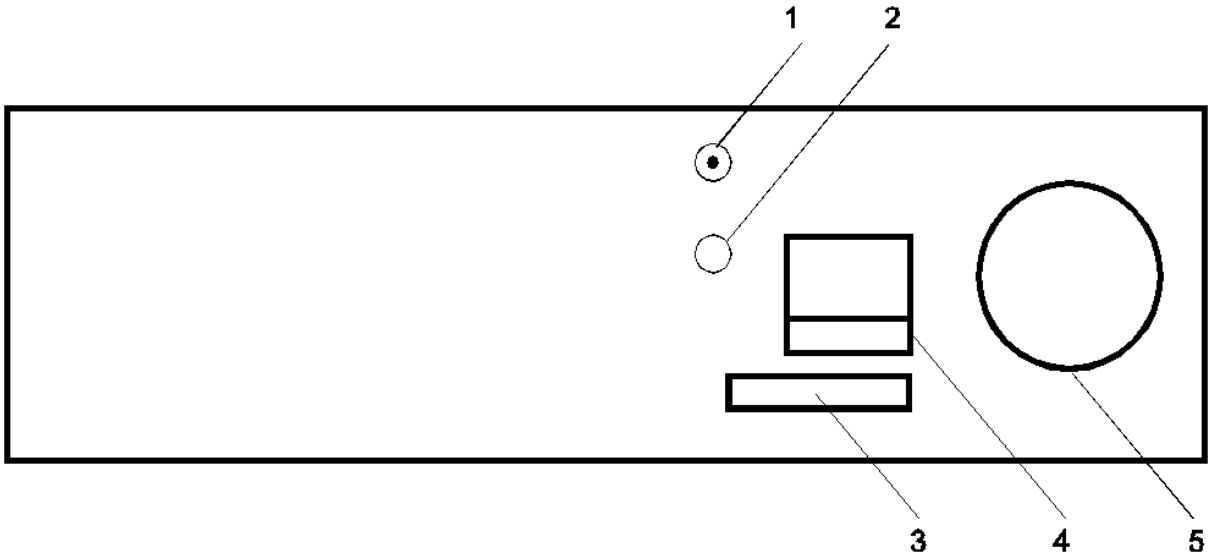
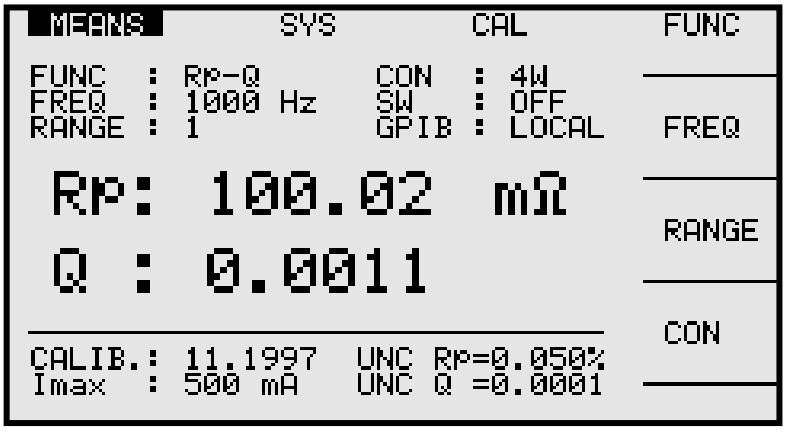


Fig.2. Rear panel

6.2 Switching the Power Supply

After the power has been applied to the instrument, the display shows the main configuration:



6.3 Calibrator control

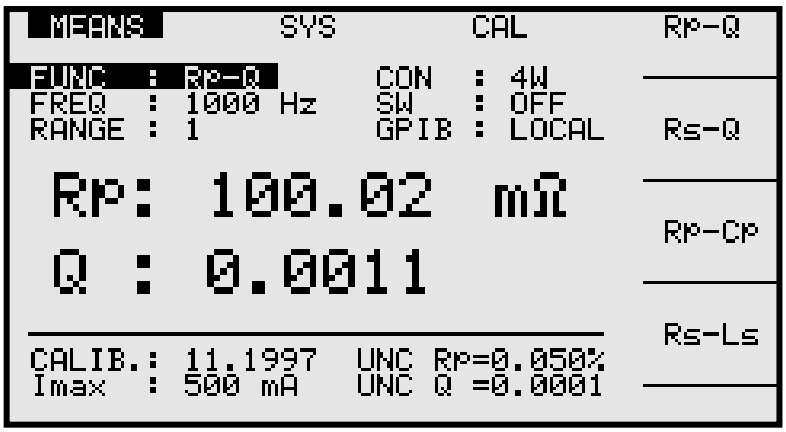
MEANS mode

6.3.1 Input value selection

Select the standard character with the R, C, L push buttons.

FUNCTION Selection

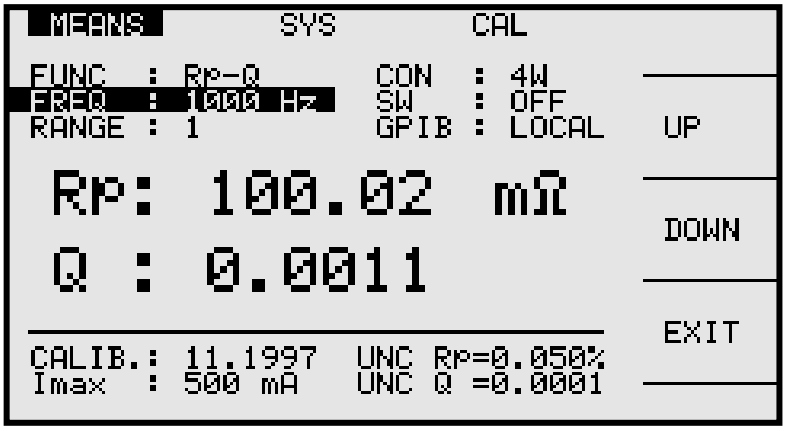
The MENU key with the function FUNC selects one of four possible types of the calibration data projection. The data marked with „s“ respond to the Serial equivalent circuit, the data marked „p“ respond to the Parallel equivalent circuit.



To return to the basic MENU use the UP cursor arrow „^„.

FREQUENCY Selection

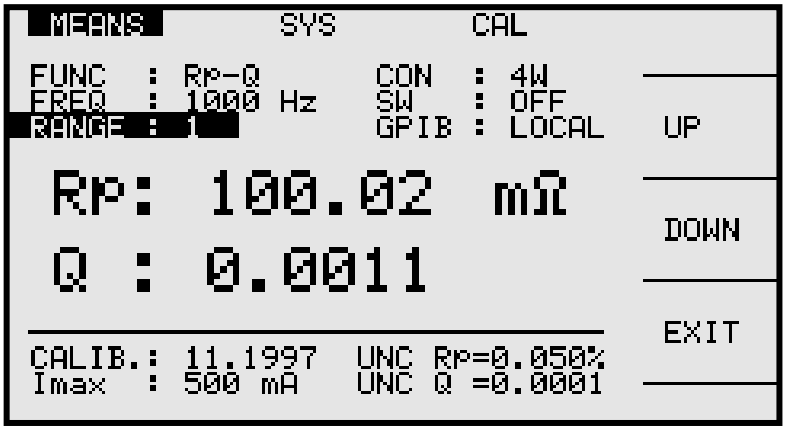
The key FREQ and the keys UP and DOWN at the display increment in discrete steps the frequencies at which the calibration data are shown.



To return to the basic MENU use the key EXIT.

RANGE Selection

Use the key RANGE and the display keys UP and DOWN to set the required value.



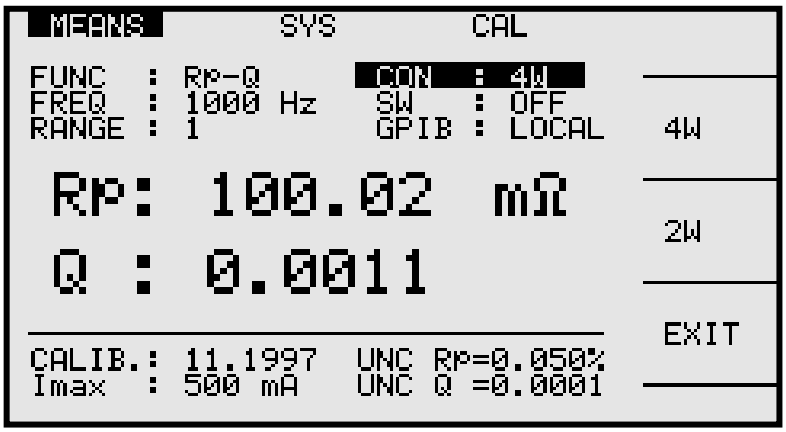
To return to the basic MENU use the key EXIT.

Note: In case of synthetic inductor standards (100 mH, 1 H and 10 H) selection the value has to be set by varying of the frequency. The value of synthetic inductor depends on the frequency range.

Note: All previous functions can be controlled with the MENU keys or with the cursor arrows.

Type of CONNECTIONS

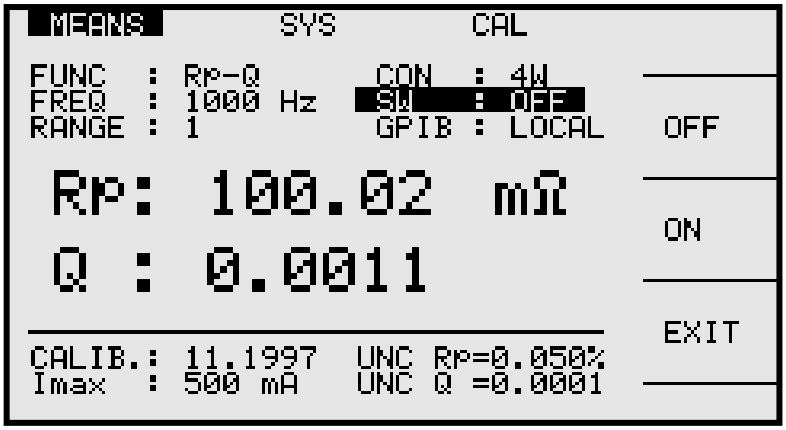
With the arrows the cursor will be set to CON. The display keys 4W and 2W select the type of connection to the external device under test.



To return to the basic MENU use the key EXIT.

EXTERNAL SWITCH Selection

With the arrows the cursor will be set to SW. The keys OFF and ON control the output of the external switch, e.g. OCM-510A from ON to OFF and vice versa.



To return to the basic MENU use the key EXIT.

6.3.2 SHORT Selection

The SHORT key operates the coaxial relay which shorts the output terminals H_{CUR}, H_{POT}, L_{POT}, L_{CUR}. The residual parameters have to be deducted from the measured value.

6.3.3 OPEN Selection

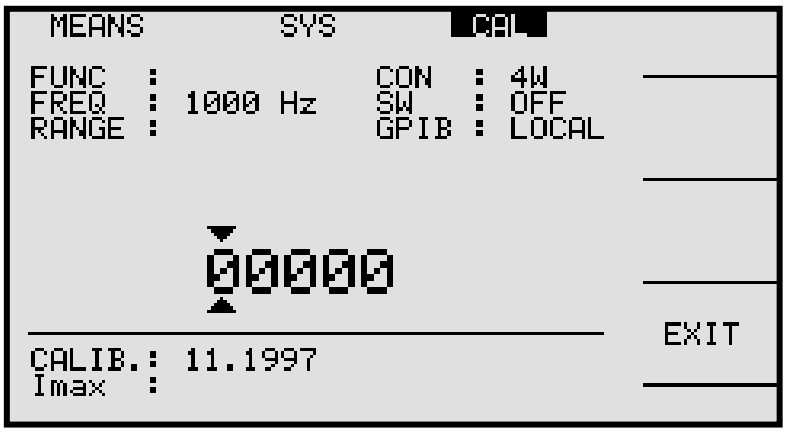
The key OPEN causes the terminal pairs H_{CUR}, H_{POT}, and L_{POT}, L_{CUR} connected. The residual parameters have to be deducted from the measured value.

ATTENTION
All calibration data relate to the reference positions SHORT and OPEN.

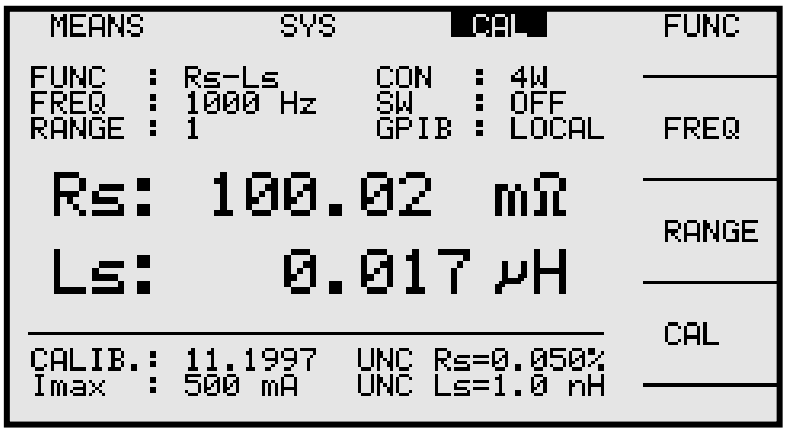
6.3.4 Setting the Calibration Values

CAL mode

Select the CAL mode with the Cursors.



Enter the calibration code from the numeric keyboard and confirm with ENTER.
Repeat the steps when a wrong calibration code was entered.



CALIBRATION Selection

The impedance calibrator can be calibrated in following ways:

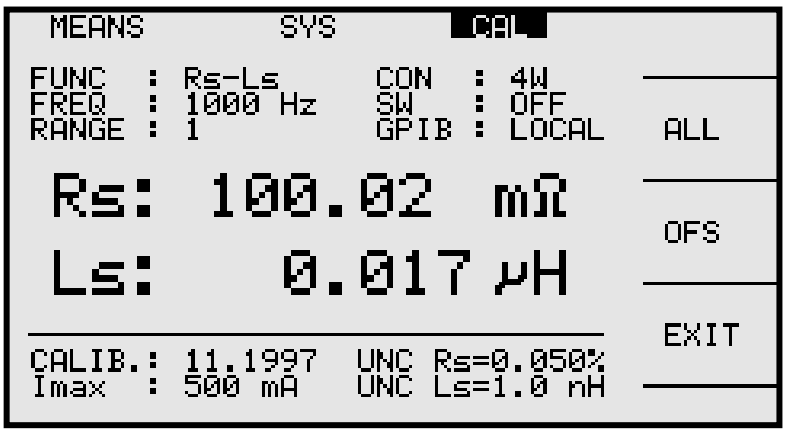
ALL mode
This mode will be used for the calibration of impedance components (real and imaginary parts) in the entire frequency band. This mode has to be selected always during the first calibration or when one of the standards has been replaced.

OFS mode
This Offset method will be used at the reference frequency of 1000 Hz at the main components. Calibration data at other frequencies will automatically shift by the same offset amount.

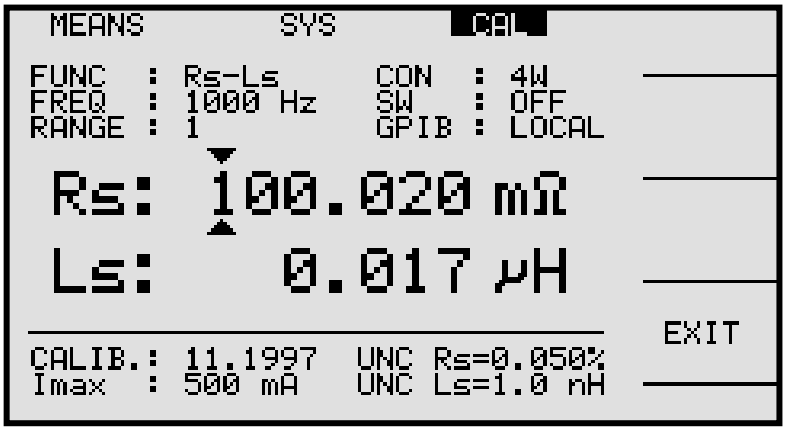
These two ways of calibration may be independently combined.

ALL Calibration Mode

Set the calibrator into the calibration mode: FUNC, FREQ, RANGE, CON.
Push the key CAL in the basic MENU.



Select ALL type of calibration.

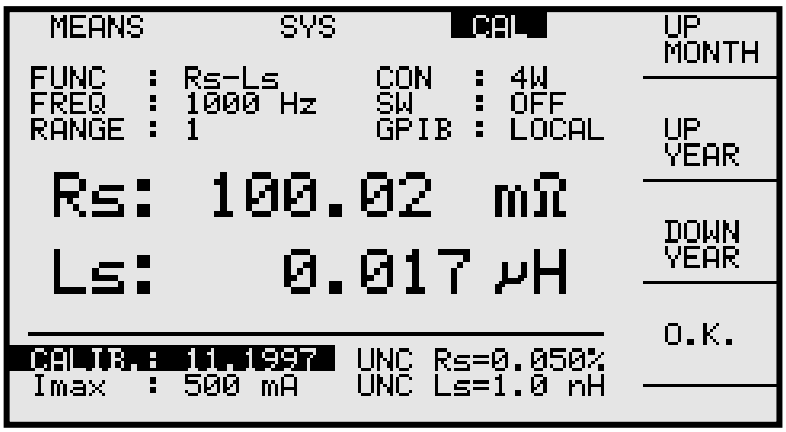


By using the Cursor arrows and the numeric keys enter the new calibration value of the main component and confirm with ENTER. Move the flashing cursor to the next digit and enter the new value. Precede the same for all digits.

Note: In case of negative residual component entry use the minus sign of the cursor „down". For changing from minus to plus, use the cursor „up".

Press ENTER to store the settings. Use the same way for all calibrated components.

To exit the calibration mode use the cursor right or left into SYS or MEANS mode.

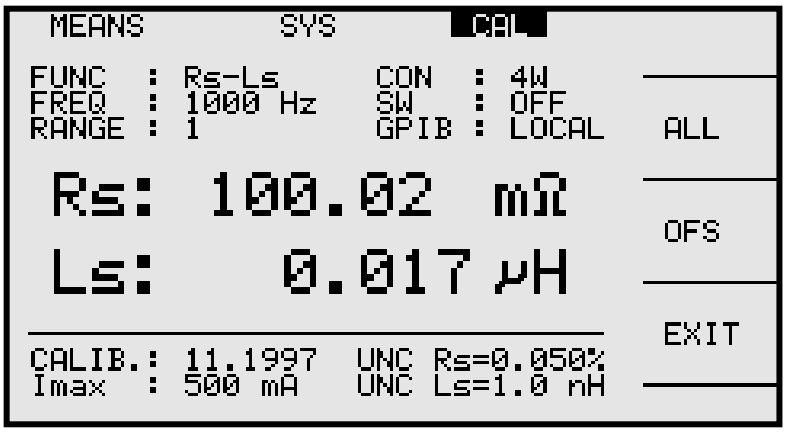


With the keys UP MONTH, UP YEAR and DOWN YEAR the calibration date will be entered and stored with OK.

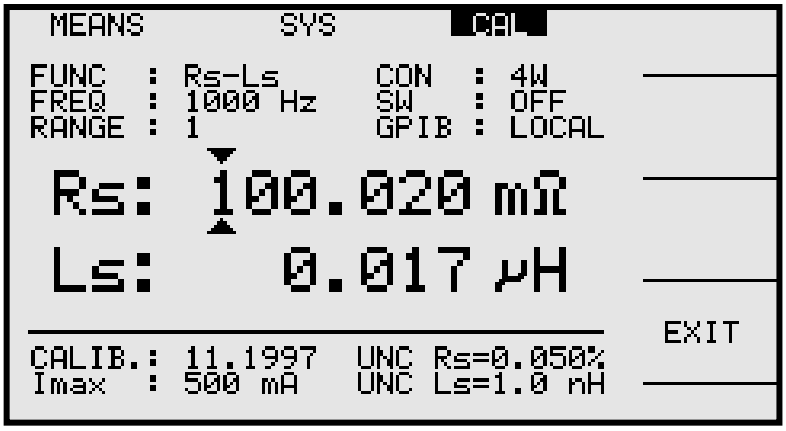
Note: Wrong entry can be corrected with cursors and numeric keys. The key EXIT permits always interruption of the calibration without storing the values.

OFS Calibration Mode

Set the calibrator into the calibration mode: FUNC, FREQ, RANGE, CON.
Push the key CAL in the basic MENU.



Select OFS.



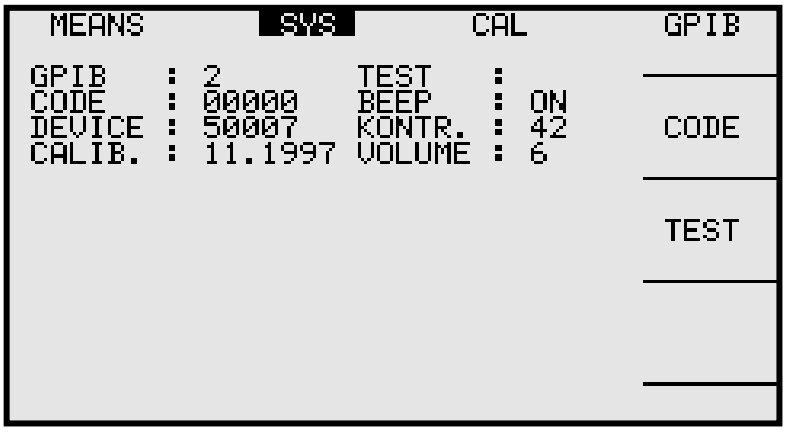
From the numeric keyboard or by using the cursor arrows a new calibration value of the main component will be entered and confirmed with ENTER. Select the next calibration point (FUNC, FREQ, RANGE, CON), the calibration mode (ALL, OFS) and continue the calibration as before. Exit from the calibration mode is with the cursor arrows left or right into the SYS or MEANS mode and entry of the calibration date UP MONTH, UP YEAR and DOWN YEAR. Store the settings with OK.

Note: Wrong entry can be corrected with cursors and numeric keys. The key EXIT permits always interruption of the calibration without storing the values.

6.3.5 Setting from the Data Port

SYS Mode

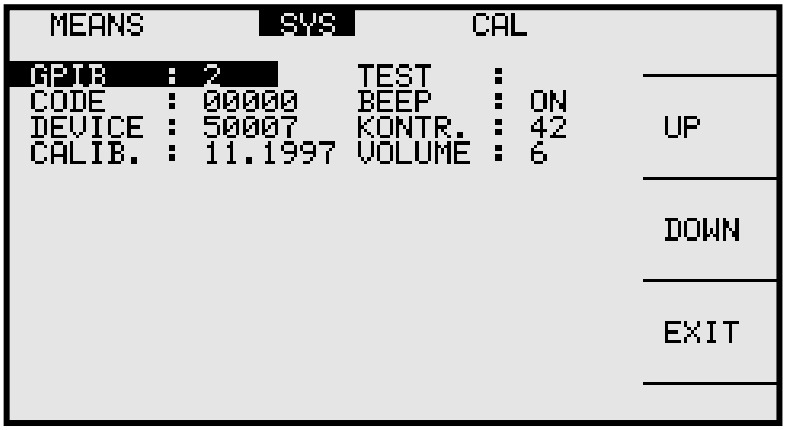
In the **SYS** Mode the **GPIB** address, the calibrator coding and the test procedures will be set.



Additional information
Manufacturing No.: DEVICE
Date of calibration: CALIB.

Setting of the GPIB Address

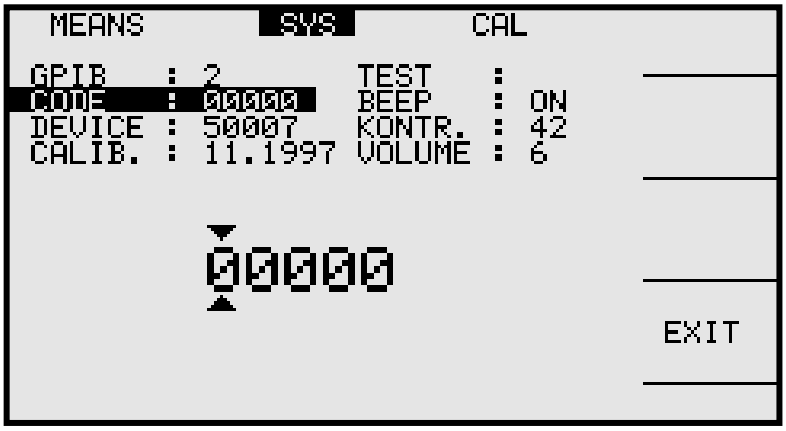
In the **SYS** mode press the key **GPIB**.



Set the required GPIB address 0 - 30 with UP or DOWN.

CODE Setting

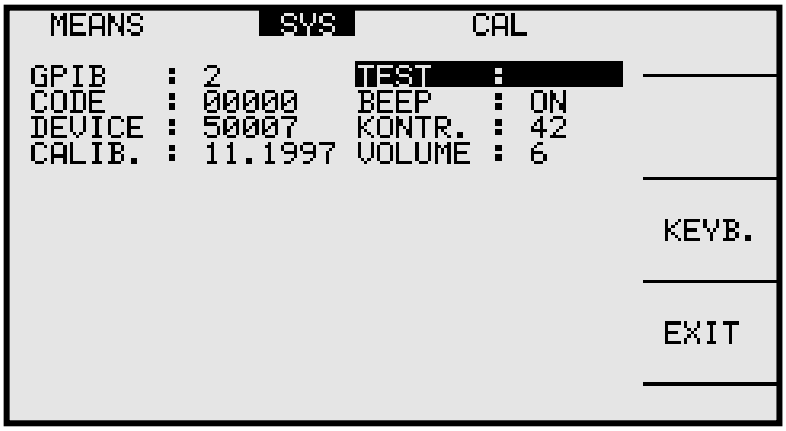
In the **SYS** mode press the key **CODE**.



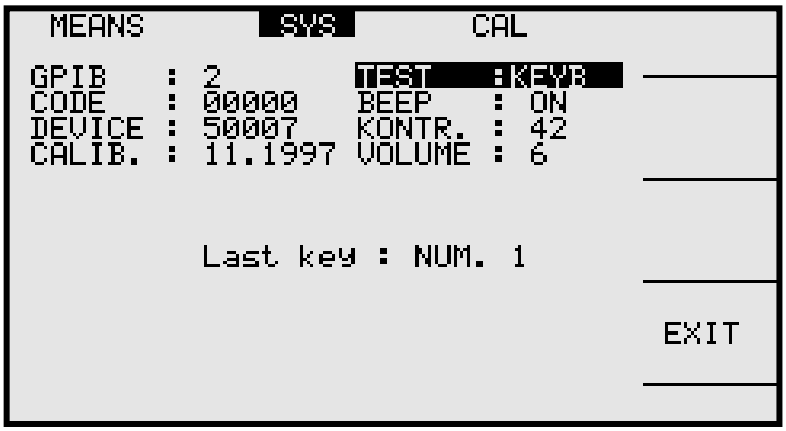
The code required for the entry into the calibration mode will be set with the numerical keys. Please record it for future calibration! Confirm the code with ENTER. The coding is indicated in the Menu SYS with CODE : SECRET. When the code is not used and not entered, the factory setting 00000 is valid and can be used by the key ENTER all the time.

TESTS Setting Test

In the **SYS** MENU press the key **TEST**.



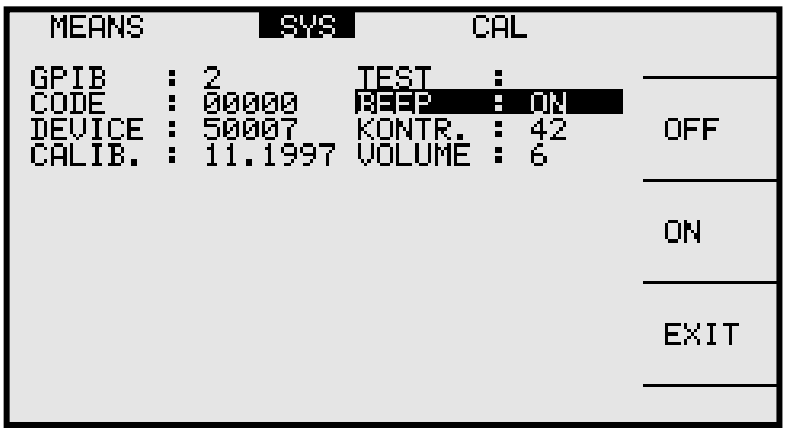
The key **KEYB**. permits the check of all keyboards keys. When applied, the last used key will be indicated at the display.



To exit the keyboard test use the key EXIT.

BEEP Setting

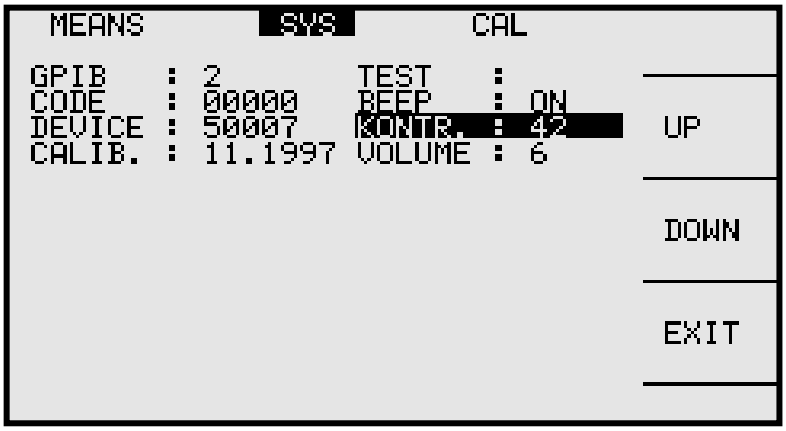
In the **SYS** mode select the **BEEP** function.



The beep can be switched-on or off with ON or OFF.

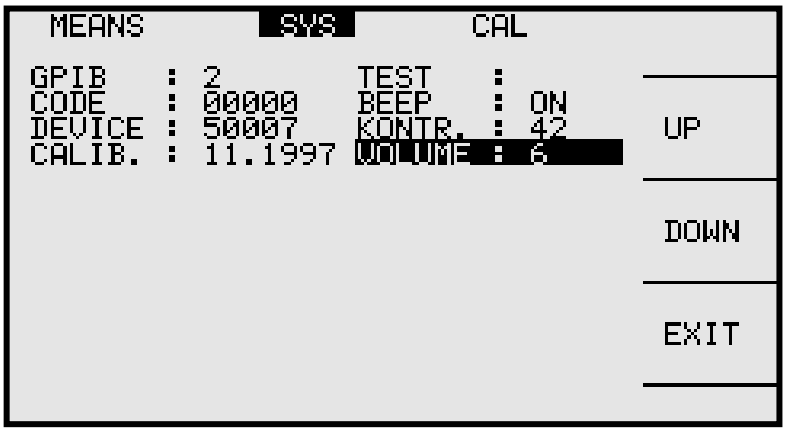
Function KONTR

In the **SYS** mode the contrast of the display will be activated with **KONTR.** and adjusted with **UP** and **DOWN**.



Function VOLUME

In the **SYS** mode the volume of the sound will be activated with **VOLUME.** and adjusted with **UP** and **DOWN**.



All functions set are stored also when the instrument is switched-off from the mains.

6.4 Connections

By connecting analogue or digital RLC meters it is necessary to keep some precautions in order to receive the best calibration accuracy.

Correct shielding and grounding of the calibrated instruments suppresses the influence of ambient electric fields. Suitable cables eliminate possible magnetic induction into the measuring loop. Please observe following rules:

1. Connect the power line cord of the calibrator and checked RLC meter into the same distribution plug.

2. Do not connect the cabinets of the calibrator and the tested meter. This will avoid the current ground loops.

3. Place the calibrator and tested meter on a conductive surface (metal plate, semi-conducting sheet) and ground it to the mains power ground.

4. For interconnections between the calibrator and the tested meter use coaxial cables from the calibrator accessories.

6.4.1 Four Pair Connection

For wire connection between the calibrator and the tested meter eliminates interfering since the return measuring current flows through the outer skin of the coaxial cables. The magnetic field generated by the measuring current flowing through the inner cable leads will thus be suppressed. This method is suitable for most applications.

Example of RLC meters with four wire connection:

HEWLETT-PACKARD HP 4275A, 4274A, 4284A, 4276A, 4277A
ESI 2150, 2160
WAYNE-KERR 6425
TESLA BK 134, BK 136, BM 595

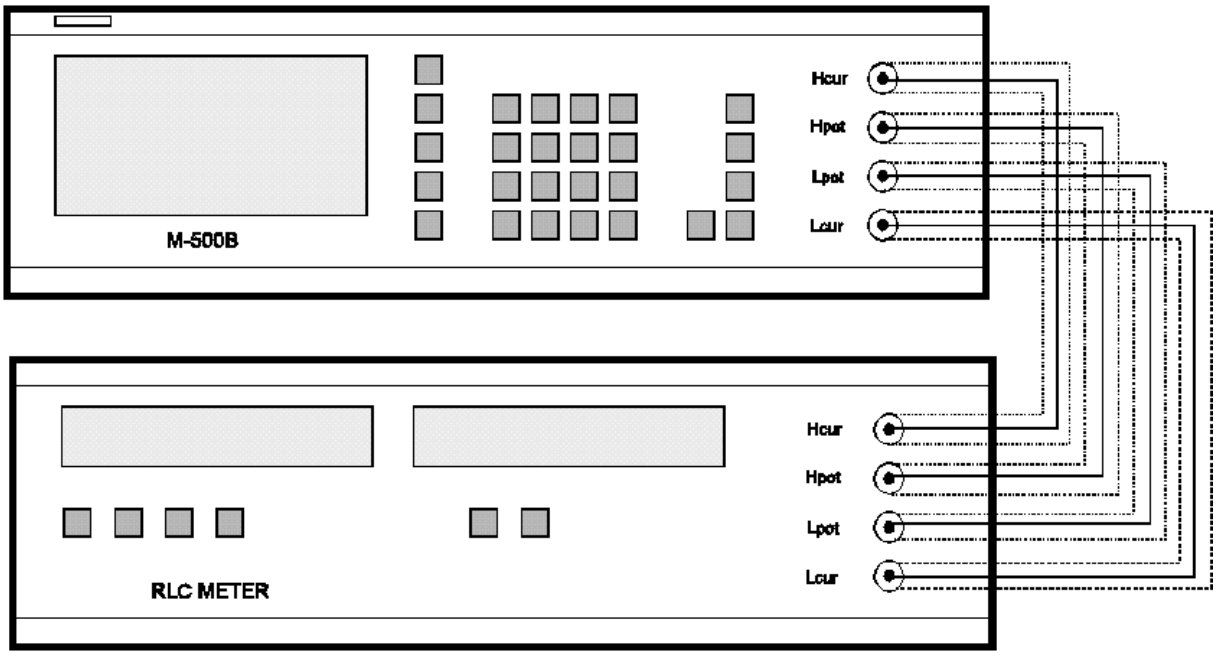


Fig.3. Four Wire connection

6.4.2 Four Terminal Connection

The four terminal connection substantially reduces the influence of measuring cables between the calibrator and checked RLC meter. The current supply circuit and sensing voltage loop are separated and independent. The four terminal connection is commonly used, especially at older RLC meters and at very precise calibration applications such as bridges and AC impedance compensators. The four terminal connection is suitable to be used for impedances from about 1Ω. By measuring of lower impedances the results might be distorted by the feedback between the current and the voltage conductors, especially when higher measuring current is used. For the four terminal connection up to 1kHz regular standard cables are used. For lower values than 100 Ohm it is advisable to twist the both current and the both voltage wires. For values larger than 100 Ohms twist L_{POT}-L_{CUR} and H_{POT}-H_{CUR}.

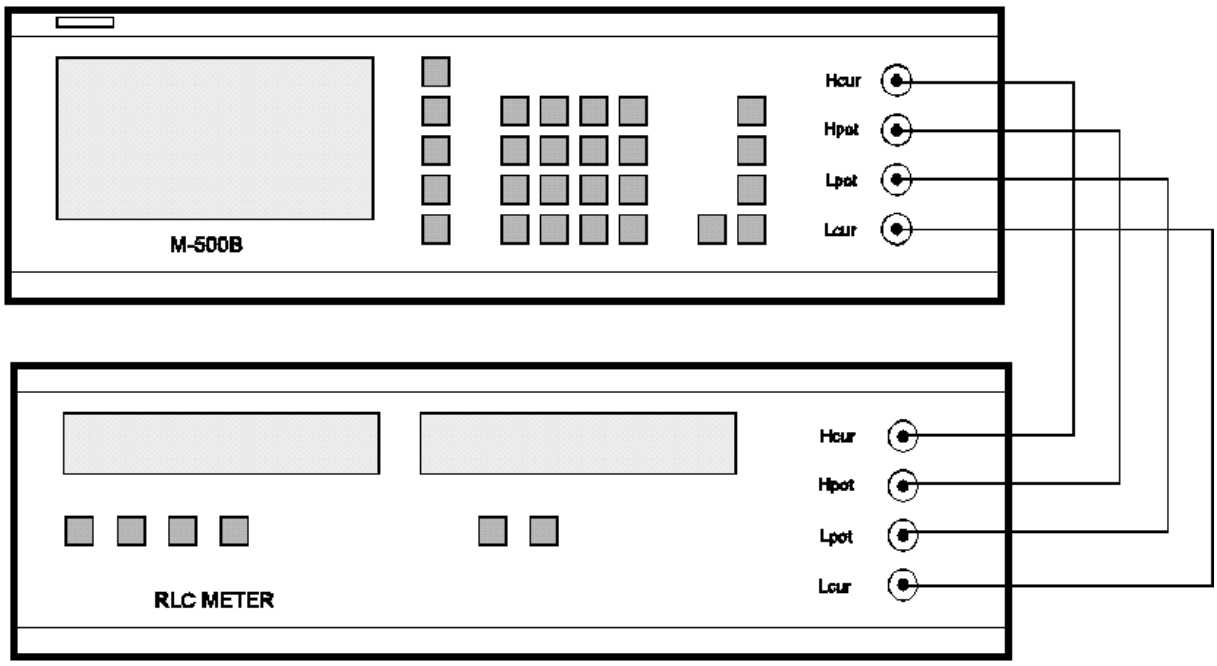


Fig.4. Four Terminal Connection

6.4.3 Three Terminal Connection

Three Terminal Connection enables to eliminate the influence of residual parallel capacity and conductivity. The outside conductor (shielding) of the coaxial cable is connected to the L_{CUR} terminal of the calibrator and to the cabinet (chassis) of the meter under test. The connection is suitable for higher impedance values. At lower impedance values the influence of residual inductance and resistance of cables is high. Regarding the different impedance definition, the calibration data of residual components are not valid. The Three Terminal Connection is suitable for checking of service and other less accurate RLC meters.

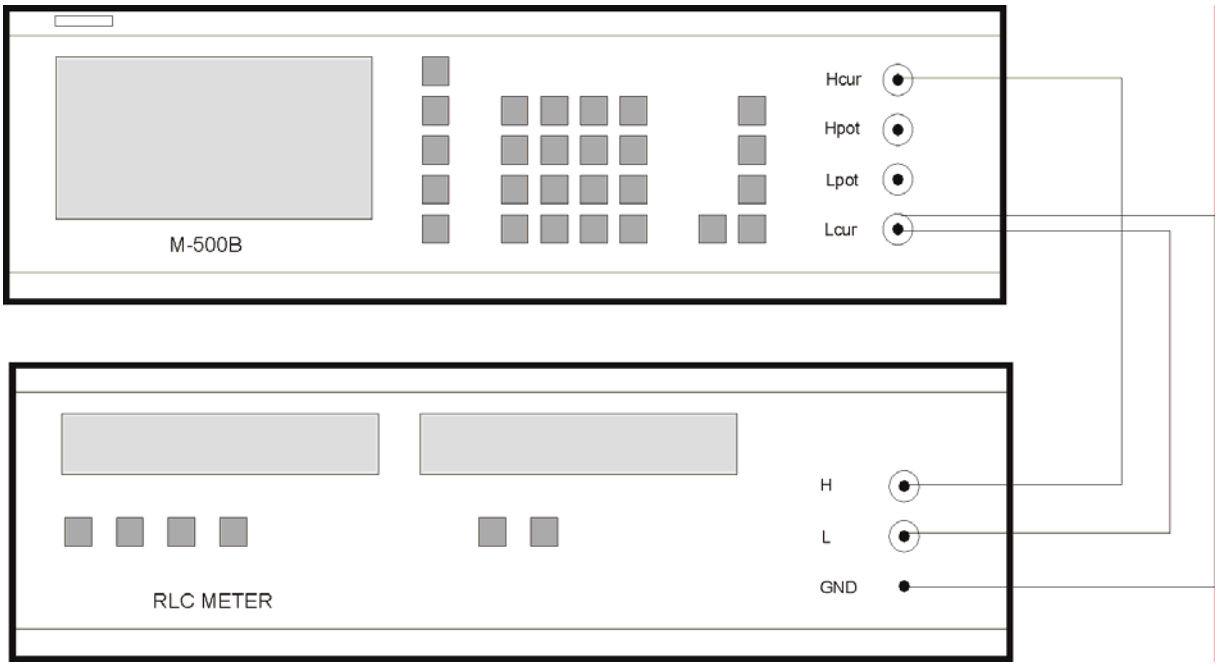


Fig.5. Three Terminal Connection

6.4.4 Two Terminal Connection

Two Terminal Connection of the calibrator and the tested meter is very simple, however less accurate. The measurement results are loaded with errors due to the resistance and the inductance of connecting cables, parallel capacity and conductance of the H_{POT} and L_{POT} terminals. At the individual Standards is in the 2W connection mode the residual impedance not defined. The internal Standards are suitable for frequencies up to 1kHz.

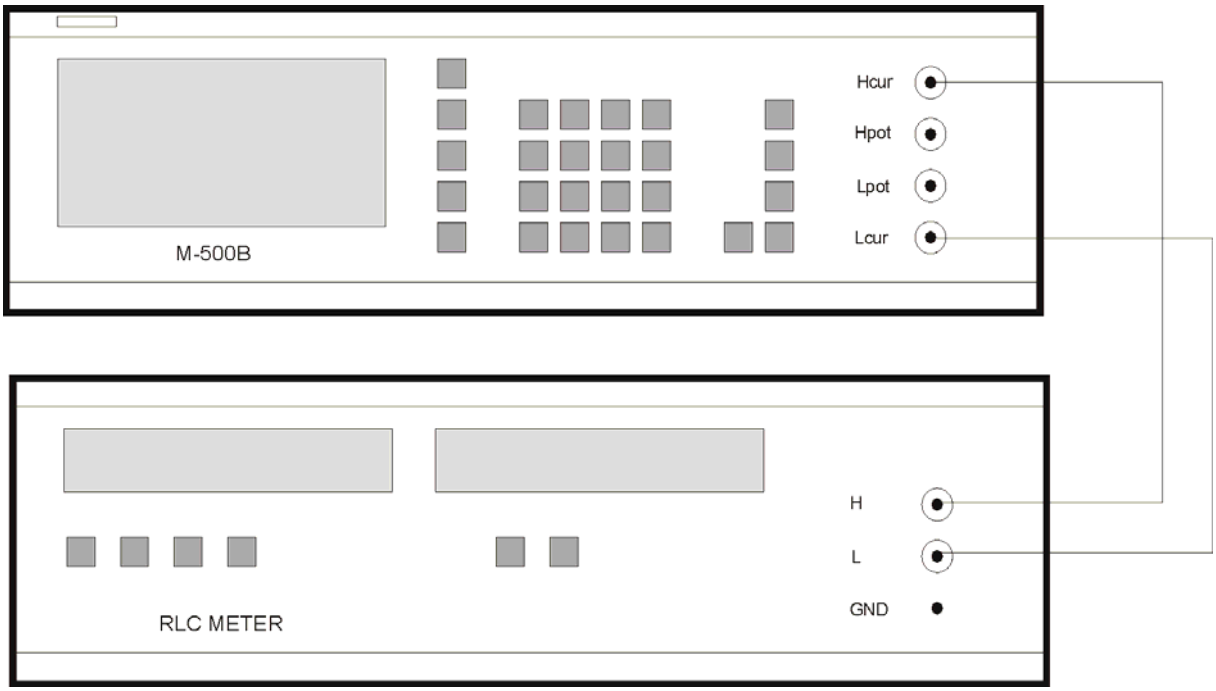


Fig.6. Two Terminal Connection

6.5 Remote control of the calibrator

Format of commands: AXAXAX...
A .... code of controlled function (character)
X .... Code of this function state (number)

Permitted commands:

Function	Function code	State code	Meaning
Equivalent connection	A	1 2 3 4	Rp-Q Lp-D Cp-D Rs-Q Ls-D Cs-D Rp-Cp Lp-Rp Cp-Rp Rs-Ls Ls-Rs Cs-Rs
Keyboard beep	B	0 1	switched off switched on
Frequency	F	1 2 3 4 5 6 7 8 9	100 Hz 120 Hz 200 Hz 400 Hz 1000 Hz 2000 Hz 4000 Hz 10000 Hz 20000 Hz
Capacity	C	1 2 3 4 5 6 7	10 pF 100 pF 1 nF 10 nF 100 nF 1 μF 10 μF
Inductance	L	1 2 3	1 mH 10 mH 10 H [100 Hz - 400 Hz] 1 H [1 kHz - 4 kHz] 100 mH [10 kHz - 20 kHz]
Resistance	R	1 2 3 4 5 6 7 8 9	100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ

Function	Function code	State code	Meaning
Terminals	T	0 1	OPEN SHORT
Connection	S	0 1	4W (four-terminals) 2W (two-terminals)
Operation	O	5 6	coaxial switch ON coaxial switch OFF
Verification	V	0 1 2 3 4 5	value of standard state of device manufacturing No. date of calibration standard uncertainty maximum load

Format of the Data read:
At V0 Function used:

FN X.XXXXX[X]EZXX FN X.XXXXX[X]EZXX CR LF

F - Variable
R - Resistance
C - Capacity
L - Inductance
Q - Quality number
D - Loss number

N - Equivalent diagram
S - Serial
P - Parallel

When V1 function is used:
State of the device
AxBxCxFxLxRxSxTxOx CR LF

When V2 function is used:
Number of device
NXXXXX CR LF

When V3 function is used:
Number of device
D MM.RRRR CR LF
MM - month
RRRR - year

When V4 function is used:
FN X.XXX% FN {X.XXX%/X.XXXXX} CR LF

F - Variable
R - Resistance
C - Capacity
L - Inductance
Q - Quality number
D - Loss number

N – Equivalent diagram
S - Serial
P - Parallel

When V5 function is used:
Maximum load
Umax: X[XX] [m]V CR LF
(or Imax: X[XX] [m]A CR LF)

7. Functional Blocks

The basic description is in the Chapter 4. Following paragraphs relate to the schematic diagrams, which are part of the user's documentation.

7.1 Microcontroller Unit

The unit consists of three blocks:
- Microcomputer, Watch-Dog, Memory Blocks
- GPIB Communication Bus
- Supporting Circuits

7.2 Display

The display has adjustable contrast and background illumination.

7.3 Keyboard

The Keyboard contains 26 keys in a 5x7 matrix.

7.4 Power Supply and Relays

This functional block contains all necessary power sources and relays for switching the selected Standards

7.5 Standards

7.5.1 Low Impedance Box

The Low Impedance Box contains the Resistance Standards from 100 mΩ to 100 Ω, Capacity Standards 100 nF to 10 μF, synthetic Inductance Standards 100 mH to 10 H, SHORT circuits and corresponding switches.
All Standards are artificially aged and selected for a minimal thermal coefficient. The Standards are encapsulated in a metal box with outputs (H_{CUR}, L_{CUR}, H_{POT}, L_{POT}). The components are arranged in a pseudo-coaxial arrangement in order to achieve a maximum protection against the external magnetic field. The high impedance voltage conductors create a minimum loop size which permits a minimum noise injection. Very low time constant of the individual Standards is thus achieved.

7.5.2 High Impedance Box

The High Impedance Box contains Resistance Standards 1 kΩ to 10 MΩ, Capacity Standards 10 pF to 10 nF, Inductance Standards 1 mH and 10 mH and OPEN circuits. The resistance standard 10 MΩ is created by T network. Low Time Constant and low frequency dependence is achieved.
All Standards are artificially aged and selected for a minimal thermal coefficient. The Standards are encapsulated in a metal box with outputs H_{CUR}, L_{CUR}, H_{POT}, L_{POT}.

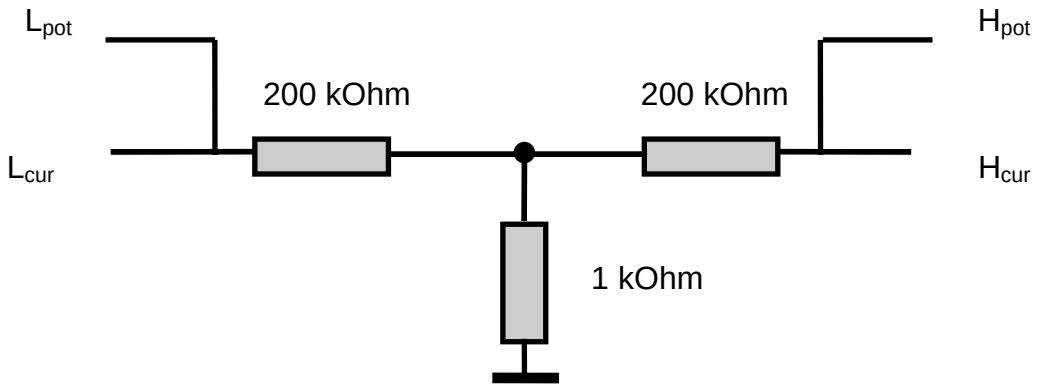


Fig.7. Resistance 10 MΩ network.

8. Mechanical Construction

The functional blocks are placed in the standard metal housing. They can be accessed from the top or from the bottom after removing the cover plates. The display and keyboard are at the front panel.

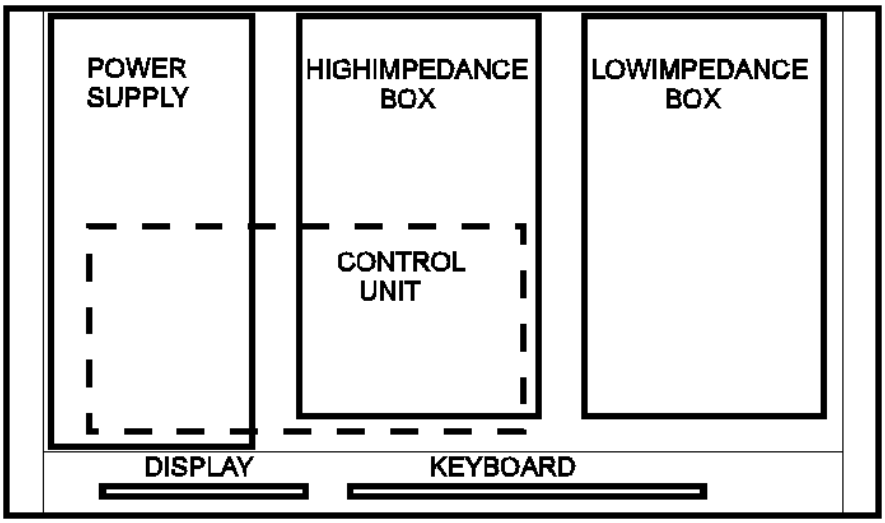


Fig.8. Mechanical construction

9. Maintenance

9.1 Mechanical

With exception of the push buttons, power supply switch and fan the device does not contain movable parts and therefore it is not necessary to make any mechanical maintenance.

10. Calibration

OCM-500B calibrator requires periodical calibration. Recommended recalibration interval is 12 month. The calibration is focused on setting new calibration values within the entire range of operation.

10.1 Required Equipment for Calibration

1. Set of the impedance standards verified in a frequency range up to 20 kHz with accuracy better than 0.005% (1 kHz), e.g. HP 16380A, HP 16380C, HP 16074A.
2. RLC meter used as a comparator, e.g. HP 4284A, WK 6425, ESI 2150 or similar.
3. Connecting coaxial cables.

In addition for an automatic calibration:
4. Coaxial switch OCM-510A.
5. PC
6. Calibration Software Package.

10.2 Process of calibration

1. Assure the ambient temperature of $23^oC \pm 1^oC$. Switch-on for 2 hours. Do not stuck instruments one on the other.

2. Connect the calibrator according to Fig 9. Select the desired type of Impedance (R, C, L), Range and Frequency.

3. Set the parameters (integration time, range, results averaging) for the highest specified accuracy at the given frequency.

4. Set the value of the calibrated Standard. Record the measured values of the main A_{DUT} and the residual components B_{DUT}.

5. Connect the corresponding Standard to the RLC-meter as shown at Fig 10. Record the measured values of the main A_{STD} and the residual components B_{STD}.

6. Calculate the new calibration value of the partial Standard of the calibrator A_X , B_X

$$A_X = (A_{STD} - A_{DUT}) + A_{CAL}$$
$$B_X = (B_{STD} - B_{DUT}) + B_{CAL}$$

where A_{CAL} calibration value of standard main component.
B_{CAL} calibration value of standard residual component

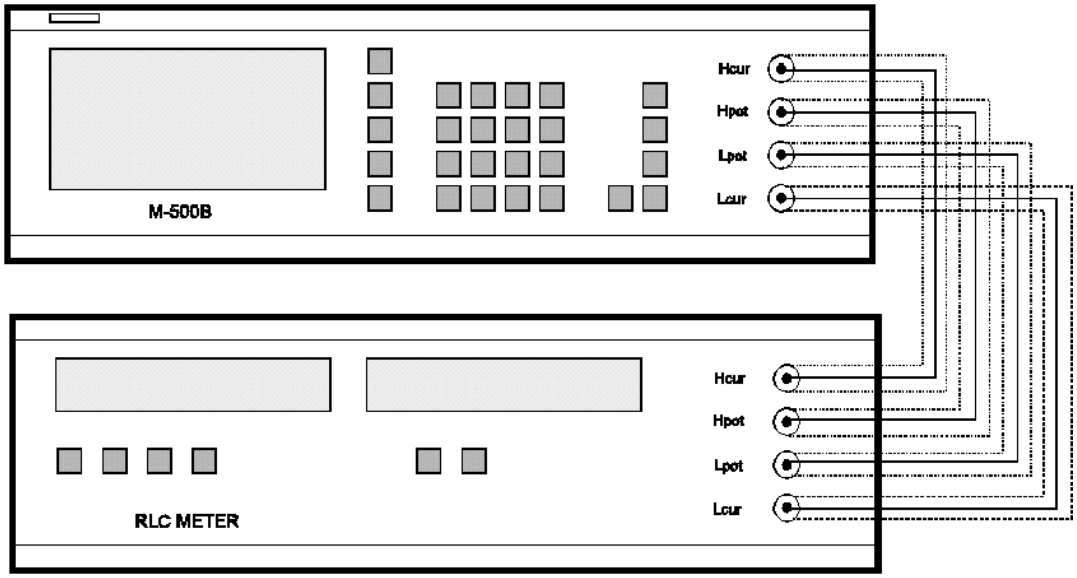


Fig. 9. Calibrator connected to RLC-meter

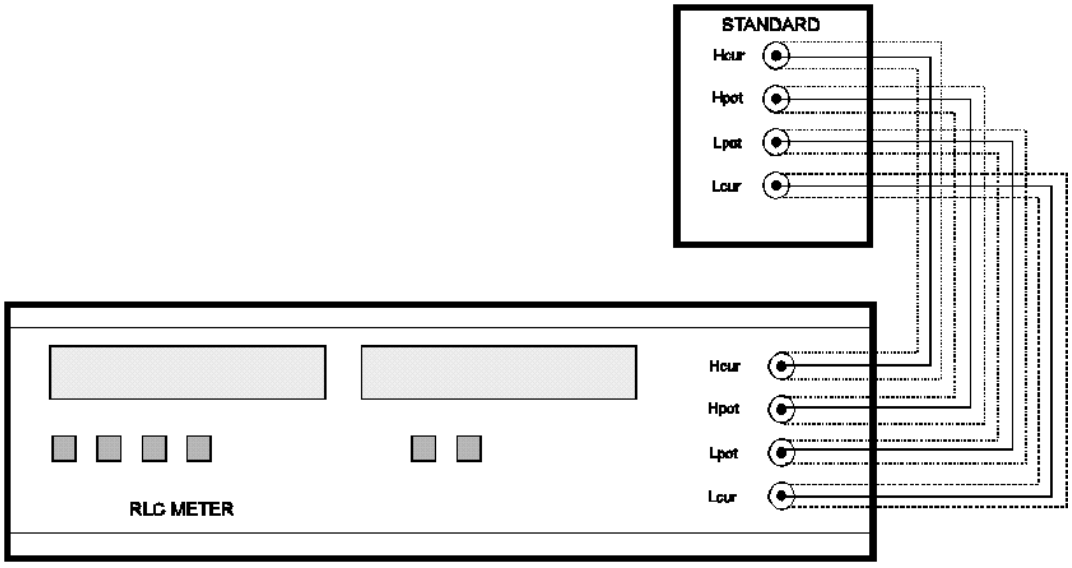


Fig.10. Standard connected to RLC-meter

5. Repeat the measurement in all partial frequencies at the same impedance value.

6. Select the next impedance value and repeat steps 5 - 7.

7. Subtract the rest parameters SHORT and OPEN from all measurements. (They have been determined by direct measurements). By doing the measurements and the calculation, the set of calibration data is created.

8. Store the calibration data in the memory as described in 6.3.4.

10.3 Control Steps

1. Place the devices in the reference temperature; connect as shown by 6.4, switch on the power for 2 hours before approaching the calibration.

2. Set the required frequency and impedance ranges at the calibrated meter or switch the calibrated meter into the Autoranging mode.

3. Set SHORT and OPEN at the calibrator. Store both values measured by the tested meter (if the meter permits it. If not, record both and subtract from the later measurements).

4. Set the required impedance at the calibrator.

5. Read the measured values A_x and B_x at the tested meter

6. Calculate the error of the RLC meter:

   $t_A = (A_x/A_N - 1) . 100$ [%] for the main component
   $t_B = B_X - B_N$ for residual component in form D, Q

7. Repeat steps 2 - 6 for the remaining impedance and frequency values.

****