

OCM-520 CAPACITANCE DECADE

Owner's Manual

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The purpose of the instrument

OCM-520 is 5-decade capacitance box designed for calibration of capacitance ranges of multimeters and RCL meters. The RS-232 data bus permits calibration and testing in automated production lines. Special capacitors with polypropylene dielectricum are internally switched with precision relays. OCM-520 is supplied from internal battery. A mains power adapter is used as an external power source and a battery charger.

1. Content of delivery

Capacitance decade OCM-520
 Mains adapter
 Cable RS 232
 Supporting Software at 2 diskettes
 Operation manual
 Calibration certificate

2. Specifications

Capacitance range	:	100 pF - 12.2221 uF
Residual capacitance Co	:	typ. < 2 pF floating terminal L and 00000 setting typ. < 10 pF grounded terminal L and 00000 setting
Number of decades	:	5
Accuracy	:	2.5 % \pm 1pF for decade x 100 pF 0.25 % for all others
Temperature coefficient	:	< 250 ppm/ °C (polypropylene dielectricum)
Maximal allowed voltage	:	50 V DC (Imax 1.5 A), 35 V AC (Imax 1 Aeff)
Test voltage	:	500 V DC between GND and L/H terminals in floating connection
Connection	:	Two-terminal type of connection
Type of terminals	:	Gold plated terminals, diameter 4mm
Remote control	:	RS-232, isolated
Power supply	:	Internal battery 12 V type LONG B-WP 1.9-12 Mains adapter 15 V/1A (100 - 240 V)
Operating period	:	6 hours from internal battery Continuously from the mains adapter
Reference temperatures	:	+23 °C \pm 2°C
Working temperature	:	+5 °C ...+40 °C
Storing temperature	:	-10 °C ...+50 °C
Cabinet	:	Metal
Dimensions	:	325 x 111 x 316 mm (W x H x D)
Weight	:	4 kg

Notes:

- The data shown with the tolerance or with the band of limits are tested. All other values have an informative character only.
- During switching the output circuit might be opened for up to 250 ms.

Accuracy

Specified accuracy is valid after 10 minutes warm-up at the ambient temperature of 23 ± 2 °C. Uncertainties include long-term stability, temperature coefficient, linearity, load and line regulation and traceability to the National calibration standards. Accuracies assigned in % are related to the set value. The specified accuracy is valid for one year, when the instrument is supplied from the internal battery.

OCM-520 Ranges	Accuracy f = 1 kHz	Loss coefficient f = 1 kHz	Temperature coefficient	Maximal Voltage*
	[%]		[\pm ppm / °C]	[V DC/ RMS]
100 pF – 1100 pF	2.5 ± 1 pF	< 0.05	< 250	50/35
1 nF – 11 nF	0.25	< 0.005	< 250	50/35
10 nF – 110 nF	0.25	< 0.005	< 250	50/35
100 nF – 1.1 uF	0.25	< 0.005	< 250	50/35
1 uF – 11 uF	0.25	< 0.05	< 250	50/35

* At max I < 1,5 ADC / 1 Aeff

Note:

Parameter of accuracy is related to series equivalent schematic. The capacitance is defined relatively to residual capacitance C_0 in 00000 dial position.

3. Before use

OCM-520 Capacitance Decade is supplied from the internal battery or from the external mains adapter, ranging from 100 V to 240 V 50/60 Hz. The Capacitance Decade OCM-520 is a laboratory device and its accuracy is guaranteed for the ambient temperature range 23 ± 5 °C. The instrument can be used in a horizontal or a slope position. Angle of the slope is determined by holder.

After unpacking put the instrument on flat surface and have it stabilized to the ambient temperature for at least one hour.

3.1. Switching on

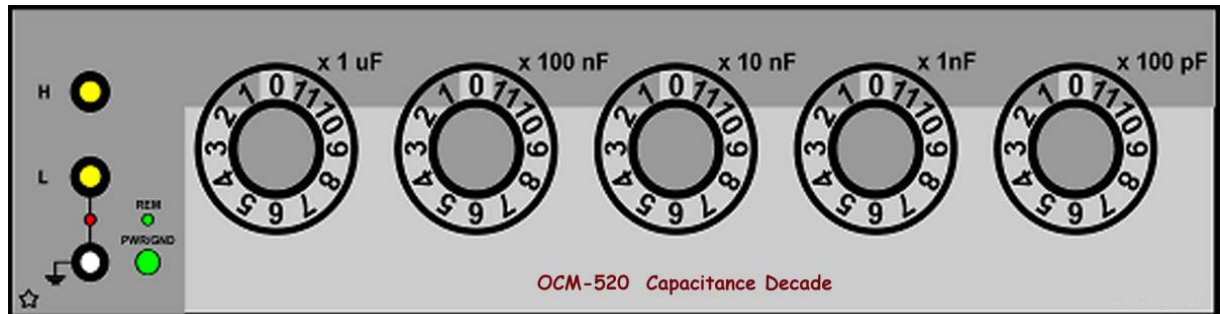
When you decide to run the instrument from the internal battery, push the button POWER. When the mains adapter is connected, OCM-520 switches automatically. After the power is applied to the instrument, the microcontroller performs internal tests for approx. 3 sec. After that the capacitance at the output terminals is defined by the position of the dials at the front panel. The sign PWR at the front panel illuminates.

3.2. Warm-up time

Capacitance decade can operate immediately after switching on. After 10 min. warm-up period it meets specified accuracy. During warm-up period it is not recommended to perform recalibration.

4. Description

4.1. Front panel



Dials

The dials are used for manual settings of capacitances from 100 pF to 12.2221 μ F.

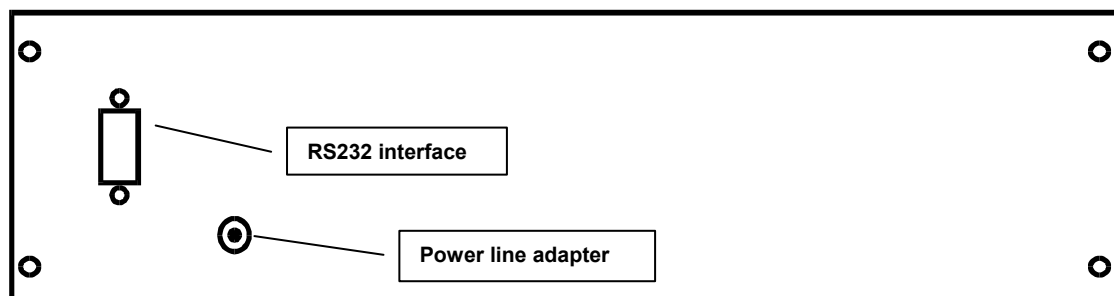
Buttons and indicators

The green REM indicates the remote control mode via the serial data port. The red LED located between the Ground and the L terminal indicates whether the terminal L is galvanically connected to the ground or if it is floating. The green PWR lights-up when the power is switched-on.

Output terminals

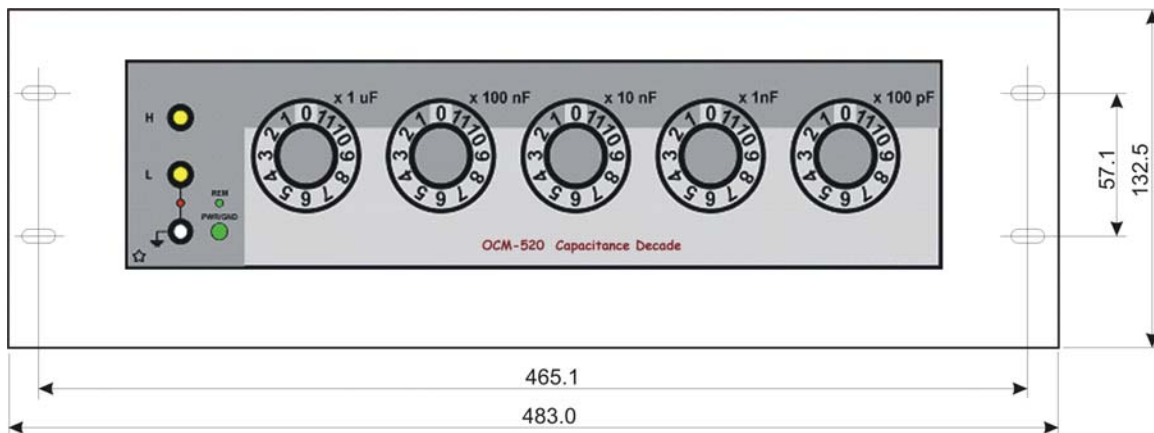
The selected capacitance is available at the terminals L and H. The Ground terminal is galvanically connected with metal cabinet. This terminal can be connected to the L terminal via internal relay, as indicated in 6.2.1.

4.2. Rear panel



4.3. 19" Rack Version (Option)

OCM-520 Capacitance Decade can be delivered in 3HE 19" rack module.



5. Operation

5.1. Switch On and Off

6.1.1 Operation from internal battery

OCM-520 has build-in maintenance free 12V Battery which permits an uninterrupted operation for approx. 6 hours. When the mains adapter is not plugged-in, the instrument can be switched-on with the button at the front, pressed for aprox. 2 sec. When the dials are not attended for longer than 9 minutes, an acoustic signal and the flashing button LPWR informs that the power will automatically be removed within next one minute. When the battery is discharged, a beep tone and the flashing PWR button indicate that the instrument will switch-off within the next one minute. The mains adapter has to be connected and the battery charged.

6.1.2 Operation from mains adapter

When the mains adapter is connected, the OCM-520 switches automatically and the battery is being charged. The green LED indicates the mains operation. The instrument can not be switched-off with the front button. The mains adapter has to be unplugged - see 6.1.1.

5.2. Terminals

The capacitance at the output is determined by the dials settings plus the residual C_0 capacitance.

The output terminals can be selected for:

- Floating mode, L terminal is not connected to the grounding terminal
- Grounded mode, L terminal is connected to grounding potential

The method used depends on the application.

The floating or the grounded mode can be selected with the button PWR. The grounded mode is indicated with the red LED between the two terminals.

Note: To limit the current pulses after setting the dials and changing the capacitance, an internal serial resistor is being used for a short time period in order to prevent damage of the external circuit under test.

Note: During the dials are set, the output terminals H and L are disconnected for up to 250ms.

Note: When the instrument is switched off, the terminals H and L are disconnected.

5.3. Calibration mode

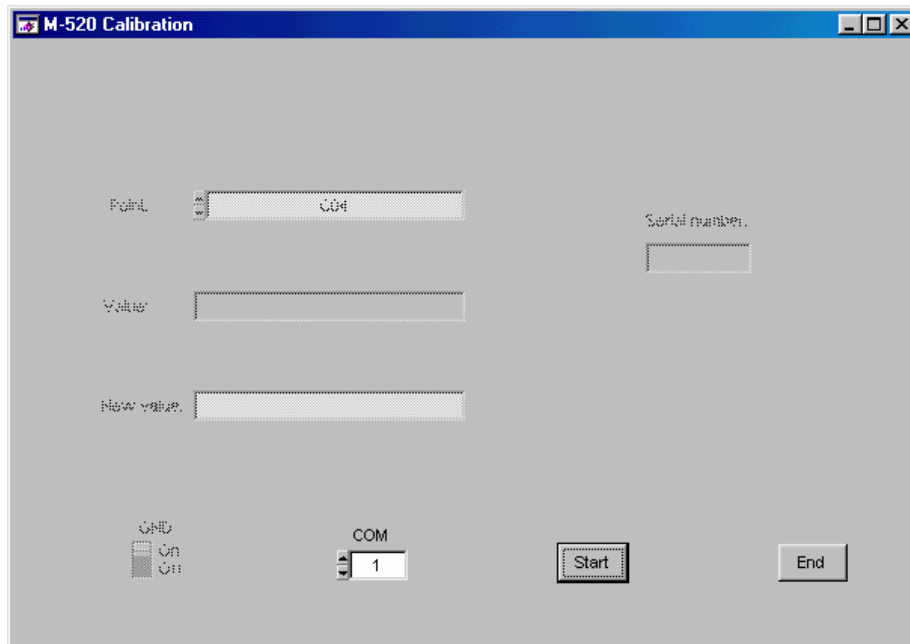
OCM-520 Capacitance Decade contains a calibration mode which permits the calibration of the individual capacitors inside the instrument. The recalibration can be accessed via RS-232 only by using the software at the diskettes. The nominal values of capacitors and their accuracies are shown in the table bellow. The instrument can be calibrated in the grounded or in the floating mode. Both modes are equal.

OCM-520	Nominal value in floating mode *	Nominal value in grounded mode L *	Required accuracy at f = 1kHz
C04	30 pF	60 pF	0.5%
C05	35 pF	65 pF	0.5%
C07	45 pF	75 pF	0.5%
C08	48 pF	78 pF	0.5%
C09	70 pF	100 pF	0.5%
C10	120 pF	150 pF	0.5%
C11	135 pF	165 pF	0.5%
C12	245 pF	275 pF	0.5%
C13	465 pF	500 pF	0.5%
C14	520 pF	575 pF	0.5%
C15	1 nF	1 nF	0.05%
C16	2 nF	2 nF	0.05%
C17	2.35 nF	2.35 nF	0.05%
C18	4.7 nF	4.7 nF	0.05%
C19	9.4 nF	9.4 nF	0.05%
C20	11 nF	11 nF	0.05%
C21	22 nF	22 nF	0.05%
C22	44 nF	44 nF	0.05%
C23	50 nF	50 nF	0.05%
C24	100 nF	100 nF	0.05%
C25	200 nF	200 nF	0.05%
C26	235 nF	235 nF	0.05%
C27	470 nF	470 nF	0.05%
C28	940 nF	940 nF	0.05%
C29	1.1 uF	1.1 uF	0.05%
C30	2.2 uF	2.2 uF	0.05%
C31	4.4 uF	4.4 uF	0.05%
C32	4.4 uF	4.4 uF	0.05%

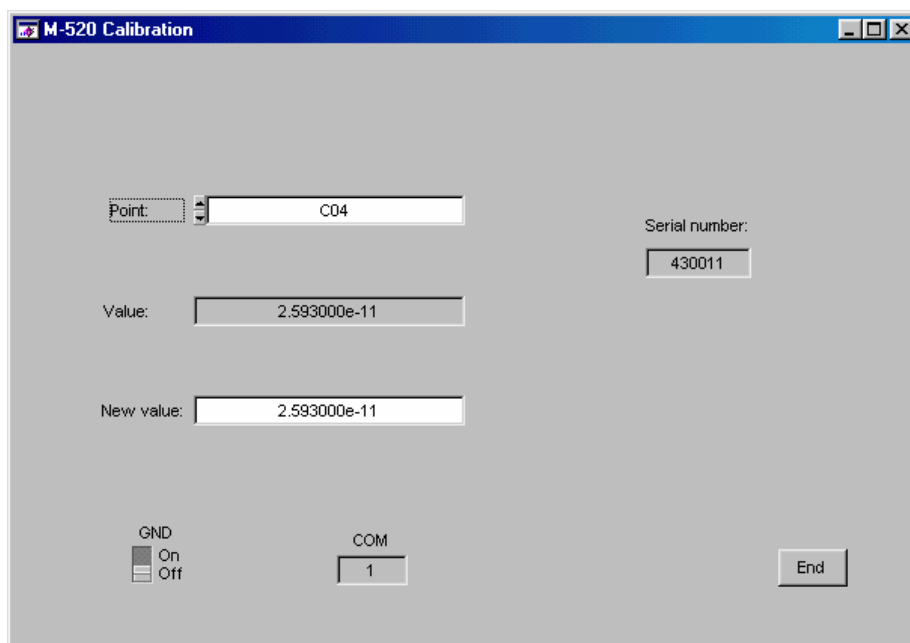
* Nominal values in the table are informative.

Calibration procedure:

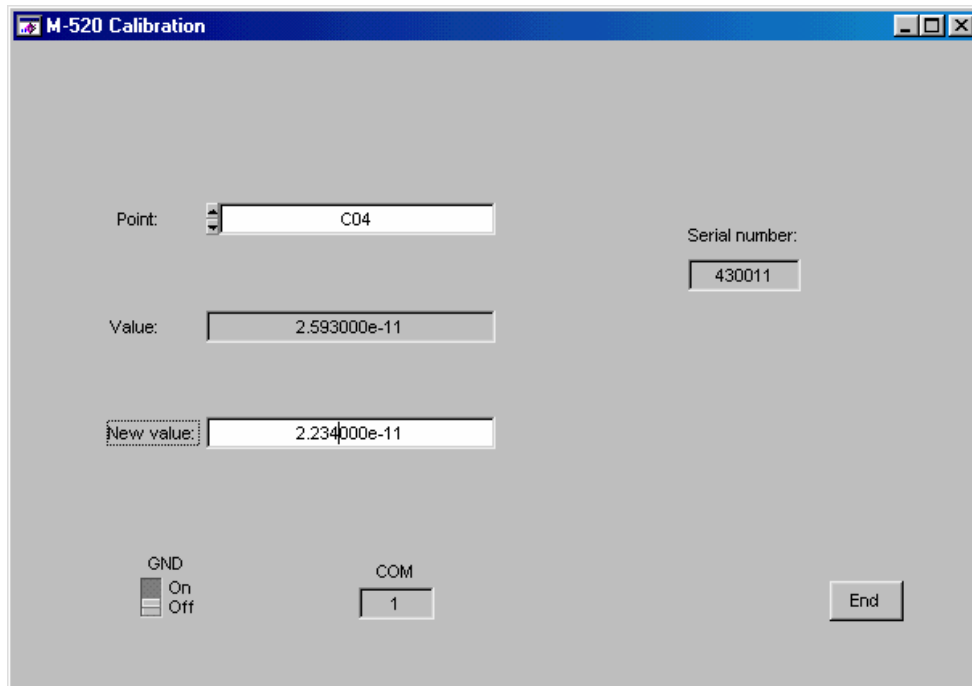
1. The instrument has to be recalibrated with the disconnected mains adapter.
2. Use the ambient temperature $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and have the instrument warm-up for 2 hours.
3. Set configuration on standard RCL meter:
 - Frequency 1 kHz
 - Test voltage 1-2 V
 - Serial parameters
 - Four-pair-terminal or four-terminal connection
4. Make correction OPEN and SHORT on RCL meter to exclude residual parameters (with connected cables)
5. Connect the RLC meter to the capacitance decade and start the calibration program. The software installation is described under 9.



6. Set the serial port (COM 1, 2, 3) and push the button **Start**. Test serial number of the instrument is displayed.



7. Set the required mode of connection (grounded or floating).



8. Start the measurement of the partial capacitances, C04 at first. The old calibration value is shown in the field "Value". Type the new measured value into the field "New value" and press ENTER. Calibrate all partial capacitors C04 to C32.
9. Close the program with "End".

6. Accuracy verification

For the recalibration following has to be considered:

Requirements for RCL meter

- RCL meter with accuracy 0.05%, ranging from 100 pF to 10 μ F (HP 4284A, Wayne Kerr WK 6425, etc.)

Procedure

1. Charge the internal battery from the mains adapter for 8 hours.
2. Place the instrument into laboratory environment $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and have it stabilize for 2 hours in switch off status.
3. Disconnect power supply adapter and switch-on the instrument.
4. Set configuration on standard RCL meter:
 - frequency 1 kHz
 - test voltage 1-2 V
 - serial parameters
 - four-pair-terminal or four-terminal connection
5. Make correction OPEN and SHORT on RCL meter to exclude residual parameters (with connected cables).
6. Set nominal value on the decade according to test points shown in the table below. Measure the capacitance with the RCL meter. Deviations should not exceed limits below:

Test Points

Nom. value [nF]	Max.deviation [pF]	Nom. value [nF]	Max.deviation [pF]
0.1	3.5	10.2	25.5
0.2	6.0	13.0	32.5
0.3	8.5	26.0	65
0.4	11	47.1	118
0.5	13.5	60.0	150
0.6	16	120.0	300
0.7	18.5	217.2	543
0.8	21	280.0	700
0.9	23.5	550.0	1375
1.0	26	1019.0	2548
1.2	3	1300.0	3250
2.2	5.5	2600.0	6500
3.0	7.5	5100.0	12750
5.5	13.8	10200.0	25500

7. Remote control

7.1. Description

OCM-520 is equipped with an isolated RS-232 serial interface with firm parameters:

Baud rate 1200 Bd

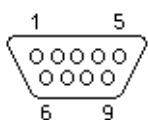
Data bits 8

Stop bit 1

Parity none

The hardware (RTS/CTS) and the program handshake (XON/XOFF) are not used.

RS-232 terminals



Pin	Name	Direction	Description
2	TXD	Output	Transmitter
3	RXD	Input	Receiver
4	DTR	Input	Power supply RS232 +
5	GND	-	Ground
7	RTS	Input	Power supply RS232 -

9-pin connector D-SUB MALE

Cable between the OCM-520 and the PC (configuration 1:1)

PC	D-Sub 1	D-Sub 2	M-520
Receiver	2	2	Transmitter
Transmitter	3	3	Receiver
DTR (+3 ... +12V) static level	4	4	Power supply RS232 +
Ground	5	5	Ground
RTS (-3 ... -12V) static level	7	7	Power supply RS232 -

Demo program

The communication software for WINDOWS 95/98/ME/NT/2000 is at the diskette enclosed to the instrument.

8.2. Syntax

The communication between the PC and the decade is based of periodic alternating of command types command - query. Commands are presented by a letter, followed by <cr> or <lf>. The response is always ended with <cr> <lf>.

Abbreviation description

<DNPD>	Decimal Numeric Program Data. It is used for setting of the value in form with the decimal point or as an exponential number.
<CPD>	Character Program Data. It represents mostly group of alternative sign parameters, for example {0 1}.
?	Query character related to a parameter determined by the command. Except question mark no other sign is permitted.
(?)	Query character related to a parameter determined by the command. It enables both the query and the setting.
<cr>	Carriage return. It is ASCII character 13, used as executive character for command execution.
<lf> =	Line feed. It is ASCII character 10, used as executive character for line with command execution.

8.3. List of commands

Setting / reading value

A (?) <DNPD>

Setting capacitance value.

<DNPD>

It represents capacitance value in F. Limit values are shown in chapter "Technical data". Set value on OCM-520 is confirmed with string „Ok <cr><lf>“. In case of query OCM-520 returns set value in exponential format. E.g. value 150 nF is returned as 1.500000e-007.

Example :

„A1.1e-6 <cr>“ set capacitance 1.1 uF.

After query „A?<cr>“ OCM-520 returns response in form „1.100000e-006<cr><lf>“.

I/D (device identification)

*IDN?

Response to the query is name of manufacturer, model, SN and firmware version.

Format :

1 2 3 4 5 6 7 8	
O R B I T,	- manufacturer
9 10 11 12 13	
M 5 2 0,	- model
14 15 16 17 18 19	
X X X X X ,	- SN
20 21 22 23	
X . X	- firmware version

Example:

After query „*IDN?<cr>“ OCM-520 returns:

„ORBIT, OCM520, 52000, 1.0 <cr><lf>“.

Output grounding

G <CPD> { 0 | 1 }

Grounding or floating L terminal.

Parameter:

- 1 L is grounded
- 0 L is not grounded

Example :

„G1<cr>” internal connection between GND and L.

Set value reading

K?

OCM-520 returns setting of the dials in hex code (signs 0, 1, ... 9, A, B relates to setting 0 ... 11).

Example :

After query „K?<cr>” OCM-520 returns for example:

„0000B <cr><lf>” 1100 pF value is set

Local control

L <CPD> { 0 | 1 }

Command switches decade to local/remote control.

Parameter:

- 1 The decade is switched to the remote control. The output capacitance is determined by the actual setting of the dials.
- 0 The decade is switched to the manual control. The output capacitance equals to the last setting via the RS-232 before switching to manual mode.

Example:

„L0<cr>” switches the decade to the remote control.

Switching OFF

P0

This command switches-off the decade. The command is executed only when the decade is supplied from the internal battery. When the mains adapter is connected, the command is ignored.

The execution is confirmed by sending a string „Ok <cr><lf>”.

Example:

„P0<cr>” switches-off the decade.

Device status

V?

OCM-520 returns the status in form „GxLx <cr><lf>”, where „x” the set parameters.

Example:

After query „V?<cr>” OCM-520 returns for example:

„G1L0 <cr><lf>” L terminal is grounded, device in remote mode.

9. Application software

9.1. Installation

The installation described is valid for PCs with MS Windows operation system. After starting SETUP.EXE from the diskette, the directory is requested. Preset name is **Cdecade**. Start the installation. In the menu Start\Program\CDecade files M520demo.exe, M520cal.exe and Uninstall CDecade are stored.

9.2. Features

After starting OCM520demo.exe OCM-520 front panel is displayed on the PC screen.



Enter the correct number of the used **COM** port. Confirm it by pressing the button **START**. When the device is found on the RS-232, the actual setting of the dials is displayed as well as the LEDs status.

Switch to **REMOTE**. The REM illuminates at the screen as well as on the front panel of the decade. The capacitance can be set in two ways:



With the mouse:

- Place the mouse cursor on the dial and keep pressed the left key. The dial can be rotated.
- The value can be changed by placing the mouse cursor on the small black arrow left from the field C (nF).

With the keyboard:

- Enter the numerical value into the field C (nF) in nF and confirming with ENTER.
- Activate C (nF) field with the cursor buttons UP or DOWN and set the value step 100 pF steps.
- Activate the dials with the cursor buttons UP or DOWN and change within the limits of the dial.

The decade can be switched off after pressing the button “**Off**”. The program can be closed by pressing button “**End**”.

Note: In the remote mode, the real decade value setting via the RS-232 does not correspond to the physical position of the dials at the decade's front.

9. Electric circuits

The partial capacitors are switched in parallel in binary code via reed relays. The PC-Board with relays, capacitors and dials forms one mechanical unit. The metal case is galvanically connected with the terminal GND at the front panel. The functionality of the OC M-520 as well as the RS232 communication is controlled by the microcontroller. The calibration data are saved in an EEPROM.

The capacitors are artificially aged and selected for best performance and specifications.

10. Mechanical construction

10.1. Description

The decade is built in standardized aluminum housing. The dials and the output terminals are mounted on the front panel. The dials have end stops. The analog board is located in the middle of the cabinet together with the CPU.

The rear panel contains the power supply, the RS-232 connector and the power jack.

10.2. Battery replacement

The battery requires 40 hours for full charge. When the instrument is not used for longer than 3 month, charge the battery before use!

To replace the internal battery, take off the top and the bottom cover. Disconnect the battery wires and take off the battery holder. Insert the new battery and close the cabinet.

Manufacturer

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