LABORATORY
pH / CONDUCTIVITY / SALINITY
METER

CPC-505

USER’S MANUAL

ELMETRON

USER’S MANUAL

LABORATORY
PH / CONDUCTIVITY / SALINITY METER

CPC-505

Before use please read the instruction carefully.

CONTENTS

I. INTRODUCTION

1. EXPLOITATION NOTICES

Dear User!
We present you a device distinguished by accuracy according to the technical data and by a high stability of the displayed results. We believe that the measurements would not cause you any trouble and that the meter would operate without any inconvenience. **Wide range of additional functions requires careful reading of the manual, in other case some of the features may stay unused or using the meter may be troublesome.**
Using electrodes of good quality and replacing them after a suitable time ensures obtaining high measuring accuracy. It is worth remembering that electrodes have much shorter lifespan than the meter. Deterioration of the result stability and increase of the measuring error are typical symptoms of an improper work of the electrode. **Some problems users have may arise from using pH electrodes not being conditioned before the measurement, making measurements not having removed the shielding ring from the liquid junction, with contaminated membrane or plugged junction.** To avoid such situations it is necessary to choose a proper kind of electrode for solutions which are going to be measured, e.g., sewage, liquids with deposits, meat, cheese etc. Therefore, if you observe improper operation of the device, please take control measurements with another electrode. **In most cases deterioration of the meter's work is caused by the electrode and not by the meter itself.**
In case of conductivity measurements it is important to choose the cell with the K constant value suitable for the measuring range. Improper selection may cause larger error occurrence, what may also happen during measurements with automatic temperature compensation with an inappropriate α coefficient introduced.
The essential feature of our products is their low failure frequency. However, in case of the meter's failure, our firm provides its immediate repair under the warranty conditions.
We wish you a pleasant and trouble-free work with our meter.

2. CHARACTERISTICS OF THE METER

The pH / conductivity / salinity meter **CPC-505** belongs to the newest generation of measuring devices which offer wide range of additional functions. The meter ensures high accuracy and repeatability of readings. The electronic elements of the newest generation used in the meter made its memory independent from power supply. The internal clock is powered from battery which holds its charge for many years. The meter is equipped with a custom, backlit LCD display, which enables observing the measured function simultaneously with the temperature value. Additional graphic symbols make working easier.

Main features of **CPC-505** are:

- high accuracy and stability of readings;
- automatic and manual temperature compensation;
- electrode calibration in 1 to 5 points;
- automatic recognition of pH buffers and standards;
- provided values of standard solutions with possibility of changing their value;
- option of automatic introduction of temperature influence on the value of pH buffer solutions (NIST norm);
- information about condition of the electrode;
- remembering the date and parameters of last calibration of three sensors (electrodes) for each measuring function;
- wide range of conductivity measurement with 6 automatically switched subranges (autorange);
- counting conductivity to salinity in NaCl or KCl according to actual dependence to conductivity;
- possibility of introducing the TDS coefficient;
- calibration of the conductivity cell by introducing the K constant or in standard solutions;
- possibility of determining the K constant of the cell;
- remembering the measurements results with time, date, individually or in series with set time interval;
- USB port;
- real-time clock with date.

3. WHAT IS THE METER DESIGNED FOR

CPC-505 pH / conductivity / salinity meter is a precise and easy-to-use meter designed for measuring hydrogen ion concentration in pH units, redox potential (mV) and conductivity in µS/cm or mS/cm. The meter may be also used for accurate measurement of the solutions and air temperature in °C.

The conductivity measurement result may be also displayed in concentration units (g/l or %) counted to NaCl, KCl or TDS. The meter is used in food, chemical, pharmaceutical and power industries, in water treatment stations, laboratories, agriculture, universities, scientific laboratories etc.

CPC-505 is prepared to work with all types of combination pH electrodes and conductivity cells, with wide K constant range, equipped with BNC-50 connector. It co-operates with Pt-1000 temperature probe with Chinch connector.

The meter may collect measurements taken as single or in series with set time interval.

Built-in USB port enables sending the data to the PC. There is a possibility of sending current or collected results of measurements together with date and time they have been collected.

In case of necessity to collect series exceeding the memory capacity it is possible to use special PC software offered by our firm.

4. THE OUTSIDE VIEW

In the upper part of the meter there is an LCD display (Pic. 1), on which, depending on the chosen function, the following symbols are displayed:
- result of the conductivity or salinity measurement;
- result of the pH measurement in pH units;
- result of the mV measurement in mV;
- current time and date.

A particular function is chosen with specific button which is signalised by lighting LED diode placed on this button.
The temperature value in °C is displayed simultaneously with the result. Symbols of units are displayed next to the results.

Pic. 1.

Beside the temperature value there is a 🌡 symbol (automatic temperature compensation) or a ✋ symbol (manual temperature compensation) displayed. ***CAL*** symbol on the left side of the display informs that the meter is in the calibration mode. The number of the chosen electrode is displayed on the left side (E1, E2, E3). It informs which of the characteristics would be taken into consideration during all calculations. Flashing symbol of the number of electrode informs that the characteristic was deleted, the calibration validity has expired (point 6.5), or that the last calibration has shown that the electrode had lost its efficiency. The number of detected calibration point is displayed, during calibration, in the lower row of digits (P1, P2, P3, P4, P5).
After pressing the MODE button all parameters introduced by the user are displayed.

The keyboard (Pic. 2) placed under the display is used for switching the meter on and off, choosing the measuring function, calibration, entering parameters and memorising results.

ON/OFF - switches the meter on and off;

pH - chooses the pH measuring function;

mV - chooses the mV measuring function;

cond - chooses the conductivity and salinity measuring function;

time - displays current time and date;

CAL - holding this button enters the calibration mode (***CAL*** symbol displayed). Short press in this mode confirms the calibration result;

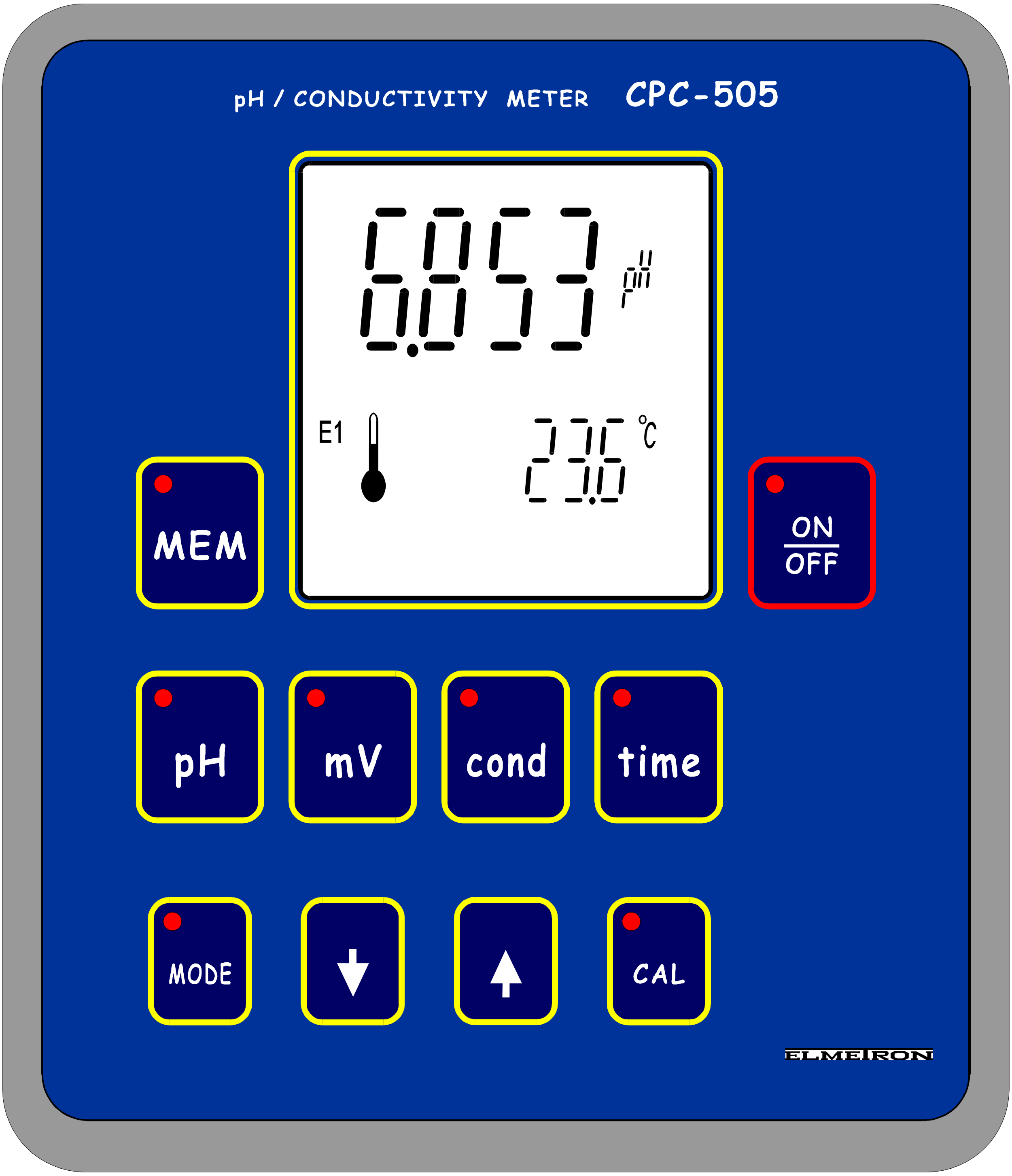
MEM - short press causes memorising single result or measuring series, holding enters the stored results readout mode;

MODE - chooses parameter for entering;

↓ , ↑ - buttons for entering parameters.

On the back wall of the meter there are inputs placed with the symbols given below:

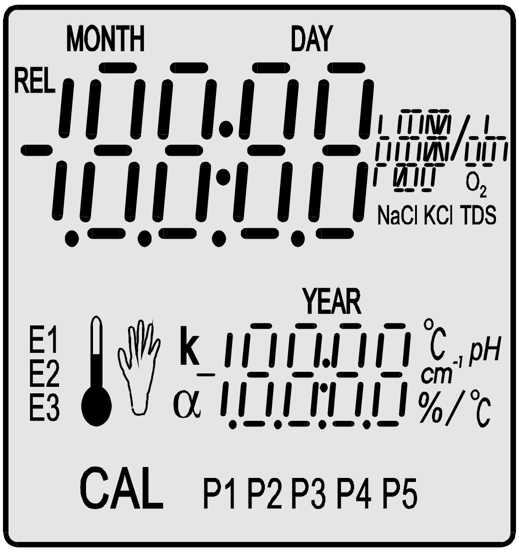
pH/mV - the **BNC-50** connector for combined or measuring pH electrode and redox or ion selective electrodes;
Gnd - connector for reference electrode;
cond - the **BNC-50** connector for conductivity cell;
temp - the **Chinch** connector for temperature probe;
USB - USB port for connecting the meter with the PC;
POWER - connector for power adapter.


pH / CONDUCTIVITY METER
CPC-505
6.853
pH
E1
23.6
°C
MEM
ON
OFF
pH
mV
cond
time
MODE
CAL
ELMETRON

Pic. 2.

5. SWITCHING THE METER ON AND OFF

After switching it on by pressing the ON OFF button the meter tests the memory and the display on which all symbols are being displayed (Pic. 3).



Pic. 3.

If the test ends successfully, after about 1.5 s the meter switches automatically to the measuring mode, in which it was switched off. Displaying of HELP sign informs that the meter has lost the factory settings and requires service repair. If after 1,5 s all symbols are continuously displayed, it informs that the calibration parameters of electrodes or cells are lost.

After pressing the CAL button the meter adopts standard characteristics:

- shift = 0 pH, characteristic slope = 100% for pH electrode;
- K constant = 1.000 cm^{-1} for conductivity cell;

and enters the measuring mode. It will be necessary to calibrate the conductivity cell and the pH electrode.

The meter is switched off by pressing the ON OFF button.

6. PREPARATION TO WORK

Before starting work:

- join the power adapter plug to the **Power** input;
- join the combination pH electrode, ion selective electrode or redox electrode to the **pH/mV** input (BNC-50);
- join the conductivity cell to the **cond** input (BNC-50);
- in case of using the temperature probe it should be connected with the chinch temperature input - **temp**;
- in case of work with the PC join the cable with the USB port;
- switch the meter on by pressing the ON/OFF button.

The pH electrode is isolated from the conductivity sensor, therefore during the pH and conductivity measurements the pH electrode and conductivity sensor may be plunged together into the same solution.

6.1. Choosing the kind of temperature compensation

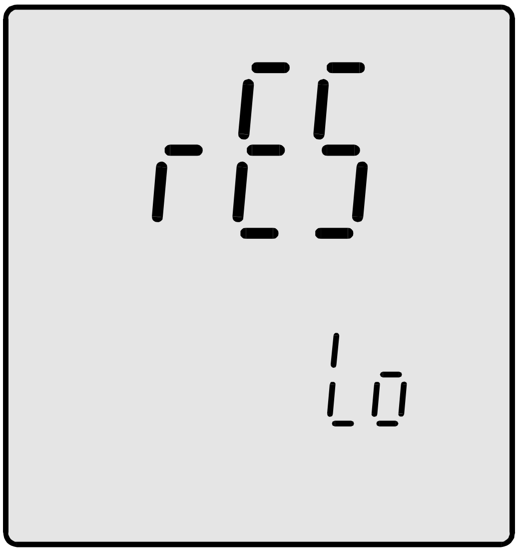
The meter switches to the automatic temperature compensation mode automatically after connecting the temperature probe, after disconnecting it the meter enters the manual temperature compensation mode. In the ATC mode, next to the displayed temperature 🌡 symbol appears. Manual temperature compensation is indicated by ✋ symbol next to the value entered by the user, its value may be changed with use of the ↓ , ↑ keys.

6.2. Changing resolution of measurements

The measurement results may be displayed with a chosen resolution. In order to change it:

- in the measuring mode press the MODE button, a rES (resolution) sign will be displayed. (Pic. 4);
- using the ↓ , ↑ keys, choose:

    Lo - low resolution of the measurement;
    Hi - high resolution of the measurement.



Pic. 4.

For the pH measurement:
    Lo - resolution of the measurement 0.01 pH;
    Hi - resolution of the measurement 0.001 pH.

For the conductivity measurement:
    Lo - resolution of the measurement 3½ digits;
    Hi - resolution of the measurement 4½ digits.

There is no possibility of changing resolution in the mV measuring mode.

Return to the measuring mode by pressing the chosen function button.

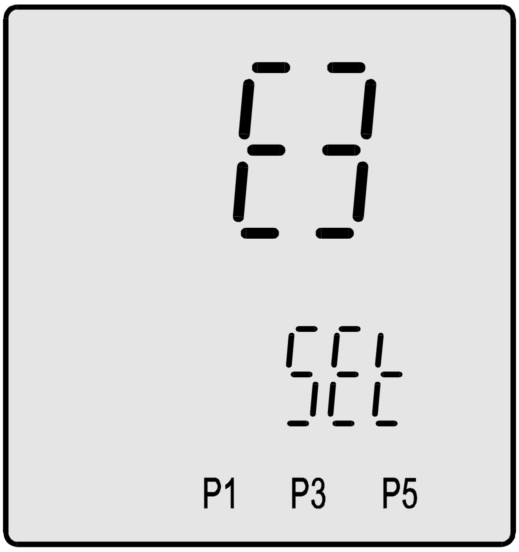
6.3. Changing the electrode number

If there is more than one electrode's characteristic stored in the meter's memory, it is possible to replace the electrode without the need of calibration. This option is quite useful in case of working with different kinds of electrodes, e.g. for sewage, clear water, etc. It is necessary to connect the electrode calibrated earlier, marked with the number which corresponds to the number stored in the memory and choose this number.
In order to do so, in the measuring mode:

- press the MODE button till the moment of displaying E 1, E2 or E3 symbol in the upper row of the display, than using the ↓ , ↑ buttons choose the electrode number. The calibration results will be stored under this number (pic 5). Below the electrode number one of the following signs will be displayed:

CLr - under this number there is no characteristic stored and the producer's values are provided. In the measuring mode the electrode number will be flashing.
SEt - under this number there are values of the last calibration stored.
bAd - the last calibration has shown that the electrode has been loosing it's efficiency and in a short time its calibration may not be possible. In the measuring mode the electrode number will be flashing.

Additionally, the points in which the electrode is calibrated are shown under the electrode number.



Pic. 5.

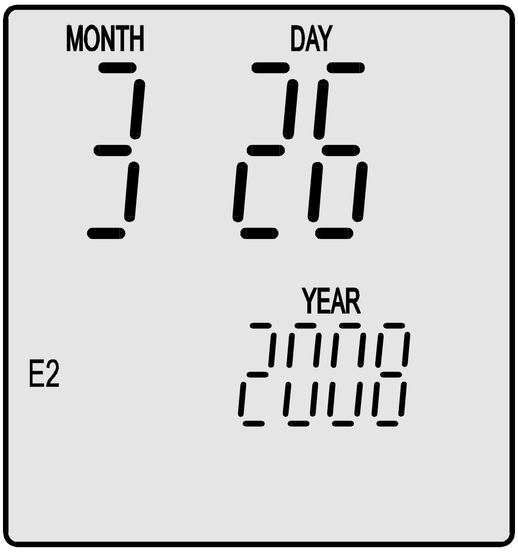
- return to the measuring mode by pressing the chosen function button.

6.4. Readout of the last calibration date

The meter remembers dates of calibration of all electrodes and sensors in every measuring function. Before starting work it is possible to check the last calibration date.
In order to do so, in the measuring mode:

- press the MODE button till the moment of displaying the electrode number (E1, E2 or E3 symbol) in the upper row of the display;
- using the ↓, ↑ buttons choose the electrode number of which calibration date we want to check and press the CAL button shortly. The last calibration date will be displayed in the following format: month – day year (below), Pic. 6. On the left the electrode number is displayed.

Flashing date informs about expiration of the electrode's calibration validity. Introducing the calibration time is described in the section 6.5.



Pic. 6.

The meter memorises the date during calibration. If the date in the meter‘s clock is changed after calibration, the date of calibration validity expiration will be faulty signalised. It is important to set the current date before calibration.

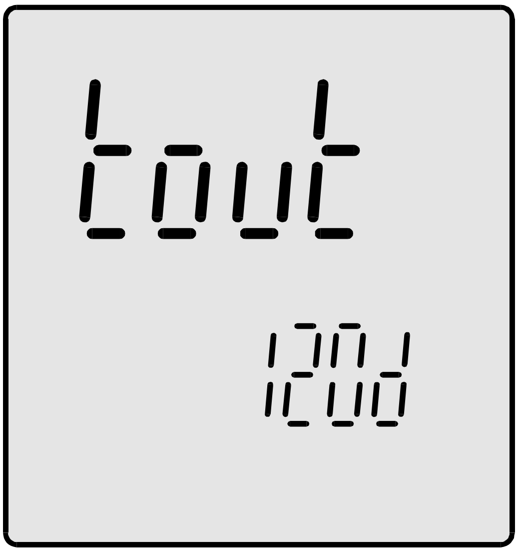
Return to the readout of the electrode number by pressing the MODE button, or to the measuring mode by pressing any of the function buttons.

6.5. Setting the calibration validity time

The meter remembers the time of calibration validity separately for three electrodes or sensors. After this time has been exceeded, the meter signals with flashing number of the electrode (E1, E2 or E3 symbol) that it is necessary to calibrate this electrode.

In order to set the time validity of calibration, in the measuring mode of the chosen function:

- press the MODE button till the moment of displaying tout (time out) symbol in the upper row. The number of days to the next calibration will be displayed below (Pic. 7);
- with the ↓, ↑ buttons enter the requested number of days to the next calibration. After choosing time of one day and pressing the ↓ button instead of digital values the --- symbol appears and the function of reminding about the next calibration is blocked.



Pic. 7.

Return to the measuring mode by pressing any of the function buttons.

II. pH MEASUREMENT

7. PREPARATION OF THE pH ELECTRODE

The electrode should be prepared to work according to the producer's instructions. If the instructions weren't given please act accordingly to the following steps:

- new electrode should be put into saturated KCl solution for about 5 hours;
- before starting measurements, the protecting rings (if used in this kind of electrode) should be removed. The ring placed on the junction - the lower part of the electrode - should be removed upward the electrode's body and the upper, which protects the KCl refilling hole, downward the body. **Removing the lower ring is essential, in other case the electrode would not measure.** Upper ring should be removed during measurements of high temperature solutions or to protect the junction during measurements in solutions with deposits or oils. Sometimes instead of a ring a cork is used;
- during measurements in laboratory it is advisable to use an electrode holder;
- after every measurement the electrode should be washed in distilled water;
- excess liquid on the electrode should be removed by gentle touching the glass with a tissue paper;
- after work the electrode should be stored in the saturated KCl solution. The protecting rings should be put on the junction and upper hole;
- in case of long breaks between measurements the electrode should be stored dry in the packaging;
- after taking the electrode out of the package the eventual deposit should be removed with use of water;
- before using it after a long break, the electrode should be placed in saturated KCl solution for about 1 hour;
- if construction of the electrode enables refilling the electrolyte, it should be controlled and refilled periodically by the upper hole in the electrode's body (usually as the electrolyte KCl solution is used).
- If the electrode is equipped with a small container (bottle) put on its end, the bottle should be taken off before measurements by unscrewing the nut gently and taking the bottle down the electrode's body. After the measurements the bottle should be put on again. Such electrodes are not equipped with the protective ring on the junction. It is necessary to control the level of the saturated KCl solution in the bottle and fill it up if necessary.

CAUTION: storing the electrode in distilled water shortens its lifetime and may increase measurement error.

8. CALIBRATION

Before starting measurement with new electrode or before making measurements which require high accuracy, the electrode connected to the meter should be calibrated.

Calibration is performed in buffer or standard solutions with accurately determined value and consists in comparing pH value of the standard with the value displayed by the meter and automatic introduction of the correction into the meter’s memory. The correction is calculated during next measurements. Calibration should be periodically repeated because the parameters of the electrode in use are changing what influences the accuracy. The frequency of this procedure depends on the required accuracy, number of the measurements carried out, conditions in which the electrode is used, temperature and pH value of the measured solutions.

CPC-505 enables storing characteristics of 3 calibrated pH electrodes marked by different symbols (E1, E2 or E3). This feature is especially useful when it is necessary to change the electrode quickly or replace a broken one.

The meter enables entering the calibration validity expiry date. In case of using this option, calibration should be performed when the symbol of the electrode in use (E1, E2 or E3) is blinking.

For accurate calibration, enter the pH values of the applied solutions to the meter’s memory. During calibration, after immersing the pH electrode and the temperature probe, the meter will detect the value of the buffer automatically.

When the highest accuracy is required, it is recommended to use certified standard solutions. The most frequently used are buffer solutions having total values i.e. 2.00 pH, 4.00 pH etc, with a composition specified by the manufacturer. Usually, they are also of high accuracy.

For accurate measurements it is necessary to use fresh solutions of good quality. The pH value of standard and buffer solutions is influenced by temperature changes.

The solutions contain the manufacturer’s specifications of the pH values corresponding to the particular temperature.

In case of an accurate calibration the value of the solution recorded in the memory has to be the same as the value of this solution at the temperature in which the calibration is performed. Blinking of the electrode’s symbol when the calibration process is finished informs that the electrode is no longer efficient and should be replaced in a short time (description in the chapter 9).

Calibration performed in one solution does not guarantee high accuracy. If only one solution is used, its value should be close to the anticipated value of the measured solution. If the required accuracy is not very high and the measurements will be made in the whole pH range, 1 point calibration should be performed with use of standard or buffer solution of value close to 7.00 pH. Thanks to this, the zero offset of the electrode will be eliminated and in other points a standard characteristic slope will be adopted.

If measurements are made both in acids and alkalis and not at the extremes of pH range, it is enough to calibrate the electrodes in 3 buffer solutions with values in range given in the table 2 – calibration points 2, 3 and 4. In case of performing accurate measurements in the whole measuring range it is recommended to calibrate the electrode in all 5 points, additionally taking into consideration the solutions' pH values given in points 1 and 5 in the table. In **CPC-505** the characteristics of the electrodes are approximated linearly between the calibration points. **Entering the calibration mode irreparably erases the electrode's characteristic stored under the chosen electrode number. There is no possibility to perform calibration only in one point without changing the rest of the data from the last calibration.**

Blinking of the electrode's number informs about its characteristic erase, its calibration validity expiry or that it is no longer efficient. In the calibration mode the number of the recognised calibration point is displayed between the upper and the lower row (P1, P2, P3, P4, P5).

8.1. Calibration in buffer or standard solutions

The user may choose between two independent ways of action:

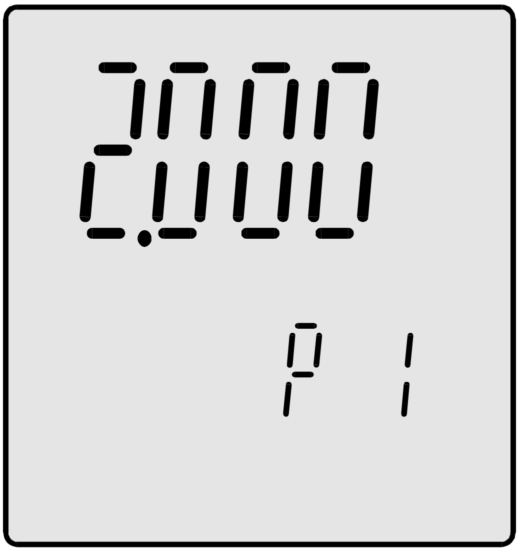
1. **Enter the value of pH buffer solutions depending on the actually used buffers, in the range given for each point of calibration.**

2. **Use the values of pH standard solutions entered to the memory by the manufacturer. Those values are in conformity with the NIST norm. This type of calibration switches on the automatic correction introduction connected with the change of standard solution along with temperature changes. It eliminates the necessity of warming up or cooling down the standard solutions to the temperature given by the manufacturer or introducing the values of standard solutions responding to their real temperature**.

8.2. Entering the buffers' values into the meter's memory

If the calibration in buffer solutions has been chosen and the pH values set by the producer are used, there is no necessity of changing them. However, it should be verified whether the values correspond to those of applied buffers. Different buffers' values should be introduced to the meter's memory before calibration.
In order to do so:

- in the pH measuring mode press the MODE button few times until a P.CAL symbol (points of calibration) displays in the upper row of the display. Using the ↓ , ↑ buttons choose buFF in the lower row (entering values of applied buffer solutions);
- press the CAL button a P 1 symbol (point one of calibration) displays in the lower row and the value of the buffer displays in the upper row (Pic. 8.) In case of using a buffer solution with a value different than this displayed one, bring the displayed value to the value of your buffer solution with use of the ↓ , ↑ buttons;



Pic. 8.

- in order to pass to the second point of calibration again press CAL button, in the lower row a P2 symbol (point 2) will display. The upper row displays the value of the buffer solution stored for this point. For the next steps of checking or changing the values please follow the instructions given above.

Having the pH values of buffer solutions introduced, enter the pH measuring mode by pressing the pH button.

Each of the calibration points has a different range for entering the pH buffers' values. Such a limitation is essential for the meter's ability to detect the buffer solutions automatically.

Table 1 contains the producer's settings of the values of pH buffer solutions used for calibration. They can be changed according to the ranges given in this table. The range of introducing these changes is quite wide for each of the calibration points, what enables to use buffer solutions with values differing from those set by the producer even to a large extent.

The meter doesn't allow for introducing pH values in ranges other than those given in the table 1. In every case the introduced buffer solution will be automatically detected by the meter.

Calibration point	Factory value	Range of changes
1	2,000	0,800 ÷ 2,100
2	4,000	3,900 ÷ 4,100
3	7,000	6,800 ÷ 7,100
4	9,000	8,900 ÷ 10,200
5	12,000	11,800÷ 14,000

Table 1.

The meter takes into account only the values detected during calibration. The pH values stored in unused calibration points do not affect the calibration results.

During next calibrations there is no need to perform the actions described above provided that the buffer solutions applied for calibration are the same. The pH values introduced to the meter's memory by the user are stored until they would be changed to another buffers.

The manufacturer provides the values of the solutions in different temperatures. This data may be useful for calibrating the electrode in temperature other than 20 ^{o}C by introducing the value of the buffer corresponding to its value in this temperature to the meter's memory. In such a case there is no need to heat up or cool down the solutions.

8.3. Calibration in buffer solutions

After preparing the pH electrode and after the pH buffers' values have been introduced or verified, calibration can be started. The buffers can be applied in any order.

It is necessary to:

a. choose the resolution with which the pH standard solution value will be introduced, section 6.2;

b. choose the electrode number (E1, E2, E3), under which the results of calibration will be stored, section 6.3 and mark the electrode with this number;

c. in the pH measuring mode press MODE button until P.CAL symbol displays in the upper row of the display; using ↓ , ↑ in the lower row choose buFF (calibration in buffers);

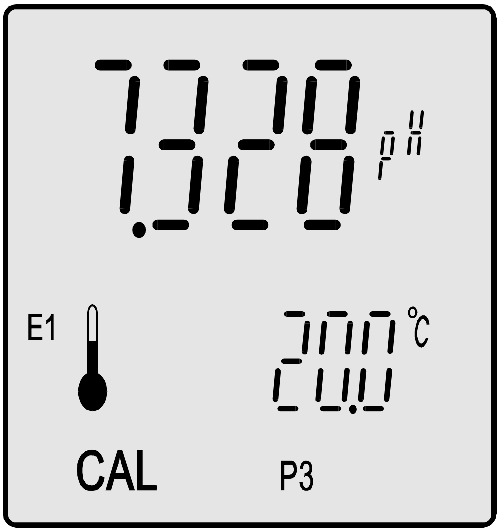
d. connect the combination pH electrode and the temperature probe to the meter, use the **pH/mV** and **temp** connectors respectively;

e. put the electrode and the temperature probe into the buffer, do not touch the walls or bottom of the vessel – it is advisable to use an electrode holder;

f. bring the temperature of the buffers to the temperature corresponding to the buffers' values stored by the meter;

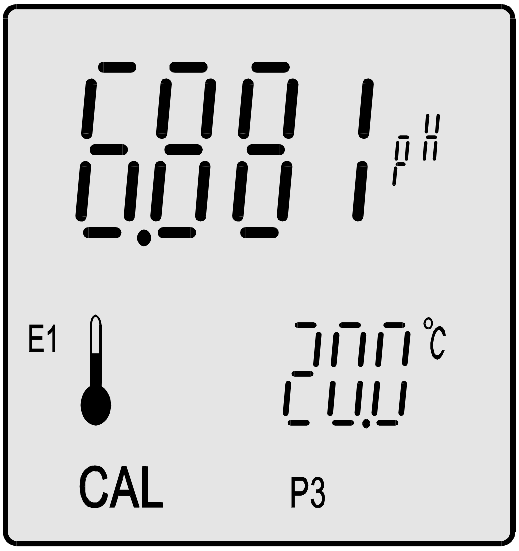
g. press and hold CAL until the **CAL** symbol appears on the display**.** The meter is now in the calibration mode. **Previously stored parameters of calibration are deleted,** the P symbol a with a number of calibration point is displayed (Pic. 9);

h. wait till the result stabilises on the display (in most cases the result slightly differs from the standard's value)



Pic. 9

After the result stabilisation press the CAL button shortly. The result will blink and the value equal to the standard's value will be displayed. The correction is now stored in the meter's memory. If the result is still different than this of the standard, wait until it stabilises and shortly press the CAL button again.



Pic. 10

In case of using a buffer solution different than these given in the set and the meter is unable to detect this value, Err sign will be displayed. In this case it is necessary to check the value of the buffer solution or the electrode which may be broken.
The meter takes into account only the values detected during calibration. Values entered earlier do not affect the results.
After finishing calibration in the first buffer wash the electrode and the temperature probe with distilled water and start calibrating in the next buffers, acting according to the procedure given above (points e ÷h) after calibration in the last point exit the calibration mode pressing the pH button.
When one electrode has been calibrated, it is possible to calibrate two other electrodes, assigning remaining numbers to them in accordance with the section 6.3.

In case of choosing the electrode number, entering and escaping the calibration mode not having calibrated the meter, previously stored characteristics would be deleted and a standard characteristic will be adapted.

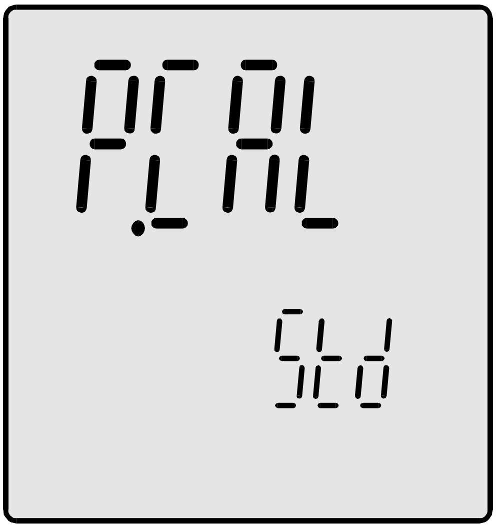
8.4. Calibration with use of NIST standard solutions

In this mode 5 constant standard solutions values, according to NIST, are used. **The meter's memory stores a table with a dependence between the temperature and pH values for these 5 standard solutions.** This dependence is shown in the table 2. Some standard solutions' values may differ from the values given in the table 2 in the third decimal place. In case of very accurate measurements it is possible to make a correction of the factory settings and introduce the value given by the standard's manufacturer.
After immersing the temperature sensor in the pH standard solution it's temperature is measured and the pH value responding to this temperature is given. The user doesn't have to warm up or cool down the standard solution.

To start the calibration in NIST standards it is necessary to:

a. according to the chapter 6.2 choose the resolution for the calibration process;
b. choose the electrode number (E1, E2, E3), under which the calibration results will be stored (chapter 6.3) and mark the electrode with the number;
c. in the pH measuring mode press the MODE button a few times until the P.CAL symbol (points of calibration) is displayed and using the ▼ , ▲ buttons choose Std (calibration in standard solution);
d. connect the combination pH electrode and the temperature probe to the meter, use the **pH/mV** and **temp** connectors respectively;
e. put the electrode and the temperature probe into the buffer, do not touch the walls or bottom of the vessel, it is advisable to use an electrode holder;
f. press and hold the CAL button until the **CAL** symbol appears on the display**.** The meter is now in the calibration mode. **The parameters of calibration stored previously are deleted;** a **P** symbol with a number of calibration point is displayed;
g. wait till the result stabilises on the display (in most cases the result slightly differs from the standard's value) and press the CAL button shortly. The result will flash and the value equal to the standard's value will be displayed. The correction is now stored in the meter's memory. If the result is still different than the standard value, wait until it stabilises and press the CAL button again.

At this point calibration may be finished by pressing the pH button or continued in other standard solutions. Wash the electrode and the temperature probe in distilled water after each immersing in the standard and dry them with a tissue paper. Act accordingly to the points e ÷ g.



Pic. 11

The meter takes into account only the values recognised during calibration. Another pH values stored in the memory do not influence the result of the calibration.
The range of the temperatures taken into consideration while introducing correction is 0 to 60 ^{O}C and can’t be exceeded during calibration.

Table 2.

Temp. ^{0}C	Kind of buffer solution				
	1 oxalate	2 phthalate	3 phosphate	4 di-sodium tetraborate	5 calcium hydroxide
0	1.666	4.003	6.984	9.464	13.423
5	1.668	3.999	6.951	9.395	13.207
10	1.670	3.998	6.923	9.332	13.003
15	1.672	3.999	6.900	9.276	12.810
20	**1.675**	**4.002**	**6.881**	**9.225**	**12.627**
25	1.679	4.008	6.865	9.180	12.454
30	1.683	4.015	6.853	9.139	12.289
35	1.688	4.024	6.844	9.102	12.133
40	1.694	4.030	6.838	9.063	11.984
45	1.700	4.047	6.834	9.038	11.841
50	1.707	4.060	6.833	9.011	11.705
55	1.715	4.075	6.834	8.985	11.574
60	1.723	4.091	6.836	8.962	11.449

The values between the points given in the table are approximated linearly by the meter.
The values of standard solutions prepared according to the norm may differ from its values at the third decimal place. In case of very accurate measurements it is possible to make a correction of the factory settings and introduce the value given by the standard's producer. The meter enables changing the standard value differing in range of ±0.010 pH from the table values for 20 ^{0}C. The procedure of introducing changes in standard values is the same as for entering the buffers' values. In case of differences greater than ±0.010 pH it is recommended to perform calibration in buffers which enables entering a freely chosen solution value to the meter's memory.

When the electrode is calibrated, it is possible to calibrate two another electrodes, choosing the remaining electrode numbers.

After choosing the electrode number, entering the calibration mode and escaping it without performing calibration, the stored characteristic will be erased and the standard characteristic will be adopted.

8.4.1. Calibration with manual temperature compensation

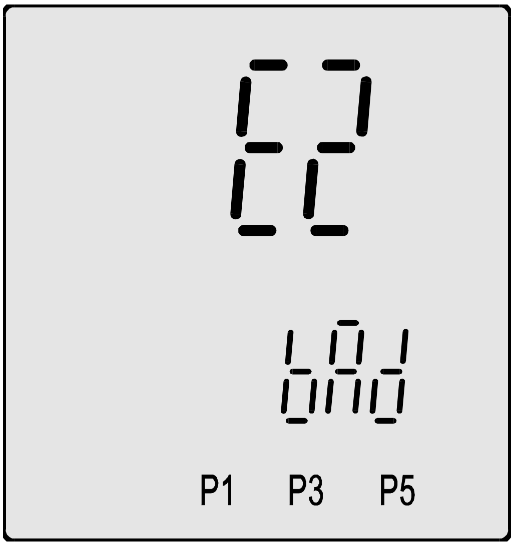
In order to start calibration with manual temperature compensation, disconnect the temperature probe. It switches the meter to manual temperature compensation. In this mode the display shows the temperature value introduced by the user, not the one measured with the probe. The ⬇ , ⬆ buttons are being unlocked and entering the value of the solution temperature with their use is possible. This value is displayed in the lower row of numbers on the display. Next, connect the pH electrode to the meter and act accordingly to the previously given description of calibration.

Caution: pressing both ⬇ , ⬆ buttons simultaneously sets the temperature to 20 ^{0}C.

9. CHECKING THE ELECTRODE CONDITION

Flashing of the electrode’s symbol (E 1, E2, E3) after calibration informs that the electrode has lost its efficiency and that in a short time its calibration would not be possible. After entering the mode of the electrode’s number changing, under the number of the electrode a bAd symbol is displayed (Pic. 12).

It is necessary to prepare a new electrode.

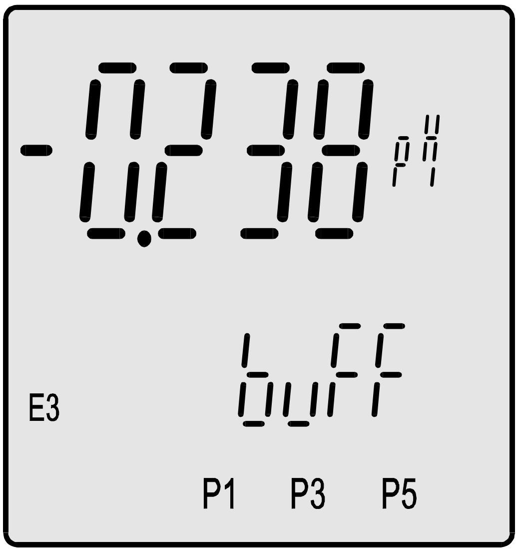


Pic. 12

9.1. Readout of the electrode‘s parameters after calibration

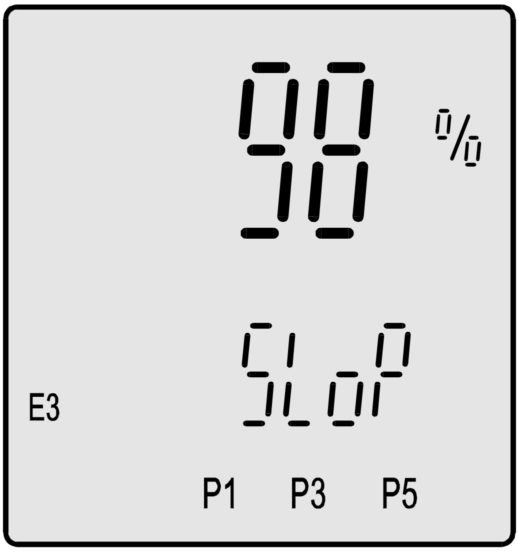
When the pH electrode has been calibrated, it is possible to check its parameters: zero offset and slope. In the pH measurement mode:

- press the MODE button until the electrode number shows at the upper part of the display (E 1, E2 or E3 symbol);
- with the ↓ , ↑ buttons choose the number of the electrode that is to be checked and press the CAL button shortly. The last calibration date will be displayed in the following format: month – day – year (below);
- press the CAL button again, a buFF symbol will be displayed in the lower row, the zero offset will be visible in the upper row of the display (Pic. 13);



Pic. 13

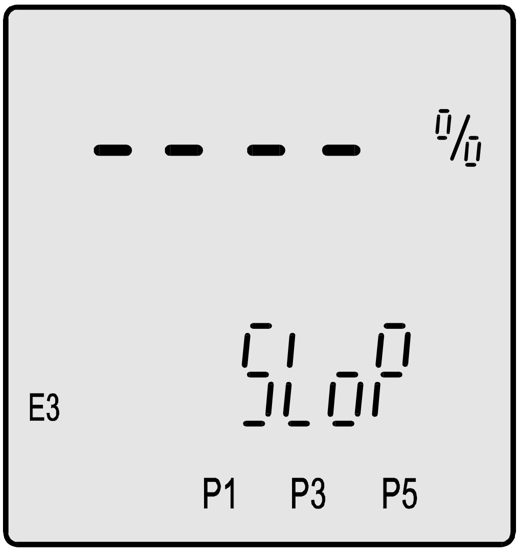
- press the CAL button once again, the lower row will display the SLoP aymbol, and the upper row – the percentage value of the electrode‘s condition (Pic. 14);



Pic. 14

The electrode‘s calibration points are displayed between the upper and the lower row.

After the electrode‘s characeristic has been deleted (entering the calibration mode and leaving it not calibrating in any point) the meter takes into consideration an ideal electrode‘s characteristics and its actual parameters are unknown. In such case, in the electrode parameters readout mode instead of numbers lines are displayed. One-point calibration enables to indicate only the zero offset of the electrode. Instead of the slope value lines are displayed (Pic. 15).



Pic. 15

Back to the electrode number readout by pressing the MODE button, and to the measuring mode by pressing pH.

10. pH MEASUREMENT

Before starting measurement the meter and the pH electrode have to be prepared for work (chapters 6 and 7 respectively). Good condition of the electrode is essential for obtaining valid result. If the electrode is calibrated and connected to the meter, it is advisable to check whether the number of the electrode is the same as the number of the characteristic chosen from the memory. If not, the number should be changed according to the section 6.3 and the resolution of measurement should be chosen according to the section 6.2.

10.1. Measurement with automatic temperature compensation

During measurements with automatic temperature compensation, the meter co-operates with the temperature probe and measures the temperature of the solution simultaneously with the pH measurement and takes it into consideration during compensation.
In case of measurement with automatic temperature compensation:

- turn the meter on by pressing the ON/OFF button;
- using the pH button choose the pH measurement function;
- join the temperature probe and the combination pH electrode to the connectors **temp** and **pH/mV** respectively, the 🌡 symbol will be displayed;
- if the electrode wasn't calibrated or has already been in use for a quite long period of time, it is advisable to calibrate it (chapter 8);
- insert the electrode and the temperature probe to the measured solution. During measurements in vessels don't touch the bottom and the walls with the electrode. It is advisable to use an electrode stand;
- after stabilisation read the result.

Accurate laboratory measurements require using an electromagnetic stirrer.

NOTICE: exceeding of the measuring range is indicated by flashing digits on the display.
Exceeding the automatic temperature compensation range is signalised by flashing digits and the 🌡 symbol.

10.2. Measurement with manual temperature compensation

Disconnecting the temperature probe from the meter switches the meter to the manual temperature compensation mode (the ✋symbol is displayed). Measurement with manual temperature compensation proceeds similarly to the measurement with ATC, the difference is that the buffer's temperature is measured with a thermometer and entered by the ↓ , ↑ buttons. This value is displayed under the pH value and is taken into consideration during compensation.
Manual compensation may be used in stable conditions, e.g. during pH measurements in the laboratory, especially when a thermostat is used, or when the temperature probe has been damaged.
In case of measurement with manual temperature compensation:

- turn the meter on by pressing the ON/OFF button;
- using the pH button choose the pH measurement function;
- insert the pH electrode to the vessel with the measured solution; if the electrode wasn't calibrated or has already been in use for a quite long period of time, it is advisable to calibrate it (chapter 8). During measurements in a vessel don't touch the bottom and the walls with the electrode. It is advisable to use an electrode stand;
- using a laboratory thermometer, measure the temperature of the solution;
- with the ↓ , ↑ buttons enter the value of measured temperature;
- wait till the value stabilises and read the result.

Caution: pressing both ↓ , ↑ buttons simultaneously sets the temperature to 20 ^{0}C.

11. NOTICES ABOUT THE TEMPERATURE COMPENSATION AND INTERPRETATION OF THE pH MEASUREMENTS RESULTS

The **CPC-505** meter has a possibility of manual and automatic temperature compensation, what enables eliminating errors which result from affecting the electrode characteristics by the temperature changes. The pH meter is a mV meter which displays voltage counted to pH units. In a constant temperature there is a constant mV value per one pH unit. In 20 ^{0}C it is 58,168 mV. The value of mV per one pH unit **changes together with the temperature,** what is taken into consideration in the formula for the "k coefficient" of the pH electrode:

$$\mathbf{k = 0.198423\ T}$$

Calculating this change into measurement result is called temperature compensation. It is connected with a change of the electrode efficiency and not with a change of the pH value of the measured solution caused by temperature change.

Changes of the pH values with the temperature in the majority of solutions are rather slight, however in e.g. pure water they tend to be significant.

Comparing values of solutions which tend to be affected by the temperature change should be done in the same temperature. Sometimes the results of measurements in the same solution in stable temperature are different. These are possible reasons of such situations:

- differences occur because of poor quality of the electrode;
- the result is treated as stabilised too soon (medium class electrode needs about 40 seconds to full stabilisation);
- the measured solution is not homogeneous and lack of magnetic stirrer doesn't allow for obtaining similar results;
- during measurements in sewage some chemical reactions, which change the result, may occur.

The final measurement error is dependent mainly on the electrode's quality, the temperature measurement error, quality of the buffers applied for calibration and accuracy while performing procedures connected with a calibration as well as measurements. Minor differences may be caused by the meter. Accuracy of the meter totals to ±0.002 pH, ±1 digit, what practically means that in extreme situations the difference between results of measurements made by 2 meters in the same sample may come to 0.005 pH. Such error is acceptable because one measurement will be made with -0.002 pH error and the second with +0.002 pH error. ±1 digit information explains the difference caused by rounding up of the result on the last visible place on the LCD (discretisation error).

When the meter is calibrated in two points, in buffers 7.00 pH and 4.00 pH (acidic solutions), and the measurement accuracy is checked in 9.00 pH (alkali solution), in some cases the result may amount to 8.90 pH or 9.10 pH. This may occur when the electrode has unsymmetrical characteristic. Making a three-point calibration with alkaline, neutral and acidic buffers may prevent from such errors. Sometimes the measurement readings are unstable and in such cases the quality of the electrode has crucial meaning. **Slow drifting of the result, its unstability or prolonging time of stabilisation in most cases result from clogged junction, broken electrode or contaminated membrane.** It happens as a result of irrelevant kind of electrode chosen for the kind of measured solution.

Storing the electrode in the distilled water for several hours or placing it in water with detergent may eliminate such problems, especially if the measurements were done in solutions with deposits, fats or oils. The electrode which hasn’t been in use for a long time may have the junction clogged by KCl crystals, what can be removed by placing the electrode in distilled water. If it does not take effect, the thiourea solution in saline acid can be used. Heavily contaminated electrode should be cleaned in chloroform and deposits of iron in 2N HCl. The electrode life can be prolonged by storing it in KCl solution. Depending on the kind of measured solution or substance, proper kind of electrode should be chosen. They differ one from another in shape, membrane’s look, kind of junction and body. Using unsuitable electrodes may cause their damage and make measurements impossible.

III. CONDUCTIVITY AND SALINITY MEASUREMENT

12. BASIC INFORMATION ABOUT THE CONDUSTIVITY MEASUREMENT

The conductivity measurement is based on applying electric current with a proper voltage and frequency to the measured solution. In **CPC-505** the voltage comes to several dozens of mV and the frequency depends on the measuring range and may vary from 100 Hz up to 10 kHz. The electric current value is dependent on the kind of the measured liquid, its concentration and temperature. The conductivity result indirectly informs about the salt concentration in the measured liquid – when it increases, the conductivity rises (KCl, NaCl). However, this dependence doesn't concern all of the solutions. In some of them, after overdrawing certain salinity value the conductivity starts decreasing. The value of a conductivity measurement also increases together with the temperature. Measured conductivity can be displayed as salinity in g/l of NaCl or KCl assuming that the measured liquid includes homogeneous salt. There is a possibility to define approximately the concentration of salt dissolved in water on the basis of the TDS coefficient. The electrodes' surface and the distance between them are decisive factors for the cell's K constant value. This value has a great influence on the accuracy of the measurement. Depending on the measured conductivity value, cells with K constant = 0,1 $cm^{-.1}$ up to 10 $cm^{-.1}$ are used. During measurement the meter multiplies the measured value by the K constant introduced to the meter's memory and displays the result in units of **conductivity** (µS/cm or mS/cm). The unit symbol in abbreviated form (µS or mS) is displayed next to the result. Conductivity changes along with temperature and salts concentration. In order to enable comparison of the results, the measured value is counted by the meter to the value which corresponds to measurement in reference temperature (it is usually the temperature 25℃). Measurement in reference tempera ture is the most accurate. In other temperatures the temperature compensation is used, which means that the meter calculates the influence of the temperature and α coefficient (this value should be entered by the user before making measurement, section 13.3). on the result. This coefficient describes how much (in %) the result changes with 1^{0}C of the temperature change. The α coefficient may be introduced into the meter in 0 ÷ 10.00% / ^{o}C range. For NaCl in temperatures close to 25 ^{0}C it amounts to 2%/ ^{0}C, e.g., in case of measurements in 30 ^{0}C the result change totals to 5x2%=10%.

Counting is made automatically and takes into consideration the value of the α coefficient introduced by the user. This value can be found in appropriate resources or approximated by the user (chapter 18). The conductivity measurement should always be treated as burdened with a certain error, which depends on the conductivity cell (its linearity) and temperature. When measurements are not made in the reference temperature, the error is dependent mainly on the α coefficient, which is affected by the temperature and concentration changes.

13. ENTERING THE CONDUCTIVITY METER PARAMETERS

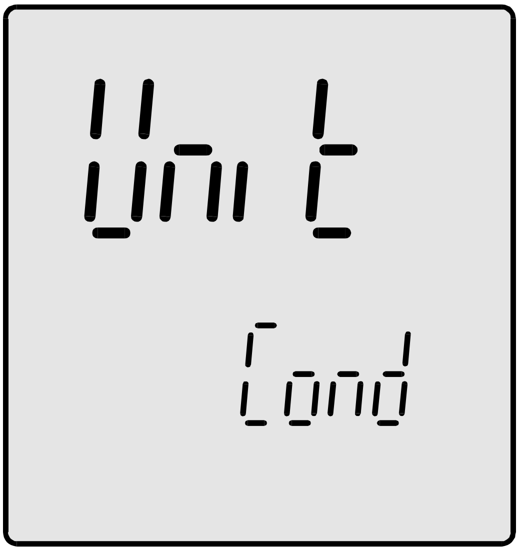
Before starting calibration and measurements it is necessary to perform all activities described in the chapter 6. Additionally, according to the chapter below, it is necessary to choose the unit in which the calibration and measurement are going to be made.

13.1. Choosing the unit

The measurement result is displayed in units of conductivity or salinity. Salinity can be counted to NaCl, KCl or TDS content. The result can be displayed in **% of weight concentration** or in **g/l**. To choose the unit:

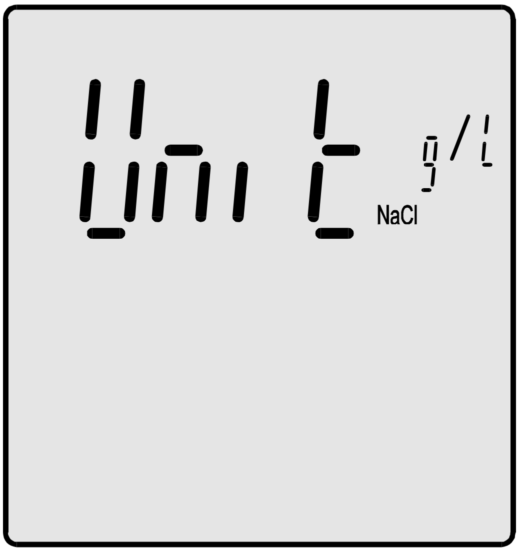
- in the conductivity measuring mode press the MODE button till the Unit (unit) symbol displays in the upper row on the LCD;
- with the ↓ , ↑ buttons choose from the lower row on LCD:

Cond - measurement in units of conductivity (Pic.16);



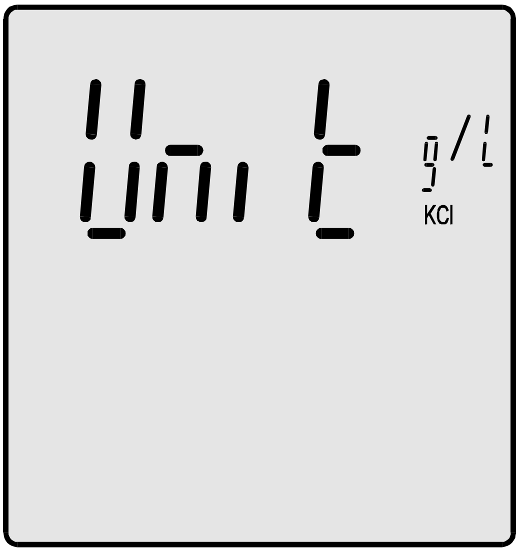
Pic.16.

nACL - measurement result calculated to NaCl in **g/l** (Pic.17);



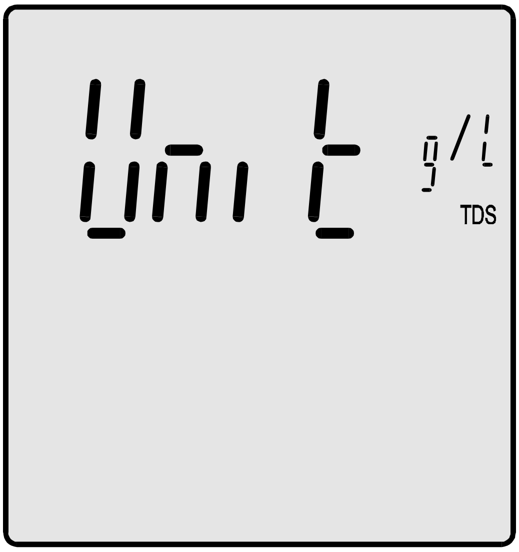
Pic.17.

KCL - measurement result calculated to KCl in **g/l** (Pic.18);



Pic.18.

tdS - measurement result calculated to TDS in **g/l** (Pic.19).



Pic.19.

In case of the salinity measurement (nACL, KCL or tdS) short press of the CAL button displays the result in % of weight concentration or in g/l. Next to the Unit a **%** or **g/l** symbol will be displayed.

- enter the measuring mode by pressing the cond button.

The result of measurement in % of weight concentration may be counted to value in **ppm** according to the dependence:

1% of weight concentration (C) = 10 000 ppm = 10 ppt

Resolution of measurement in % of weight concentration is 0.001% or 10 ppm.

13.2. Entering the W_{TDS} coefficient

In case of measurement of salinity with conversion to TDS it is necessary to introduce the W_{TDS} coefficient:

- in the conductivity measuring mode press the MODE button till c.tdS symbol (TDS coefficient) displays in the upper row on the LCD (Pic. 20);
- with the ↓ , ↑ buttons enter the appropriate value of the TDS coefficient;
- enter the measuring mode by pressing the cond button.

Pic. 20.

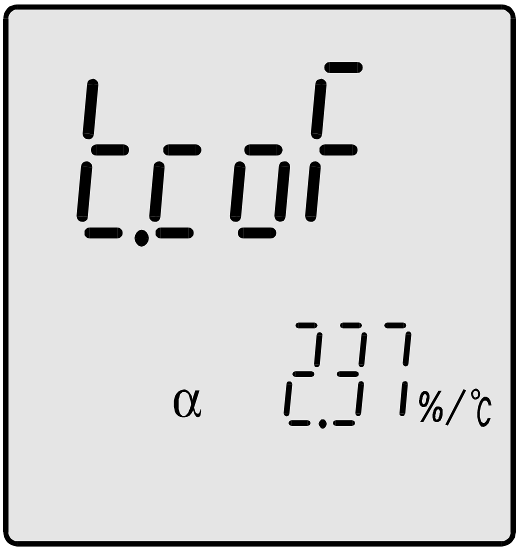
The way of determining the W_{TDS} coefficient has been described in the section 17.3.

13.3. Entering the α coefficient value

The α coefficient entering range in **CPC-505** is 0.00 ÷ 10.00 % / ^{o}C, every 0.01 % / ^{o}C. It is possible to adopt the most often used temperature coefficient α = 2 % / ^{o}C or, in case of higher accuracy requirements, to determine the kind of measured solution and choose the appropriate value of this coefficient.

In order to introduce the α coefficient:

- in the conductivity measuring mode press the MODE button till there is a screen with a value of the α coefficient with t.coF (temperature coefficient α) symbol displayed (pic. 21);
- with the ↓ , ↑ buttons enter the value of the coefficient;
- return to the measuring mode by pressing the cond button.



Pic. 21.

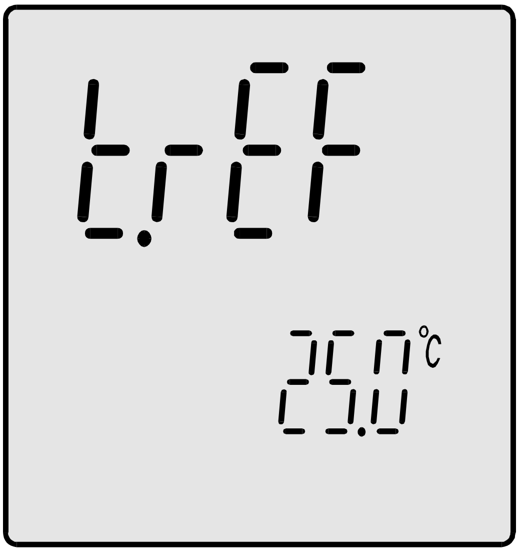
The measurement result will be counted with use of the introduced temperature coefficient α.

Simplified way of determining the α coefficient is described in the chapter 18.

13.4. Entering the reference temperature value

The range of introducing the reference temperature values is 10.0 ÷ 40.0 °C, every 0.1 °C. The most often used value is 25 °C.
In order to introduce the reference temperature:

- in the conductivity measuring mode press and hold the MODE button till the screen with a value of the reference temperature and a t.rEF sign (temperature reference) displays (pic. 22);
- with the ↓ , ↑ buttons introduce the temperature value;
- return to the measuring mode by pressing the cond button.



Pic. 22.

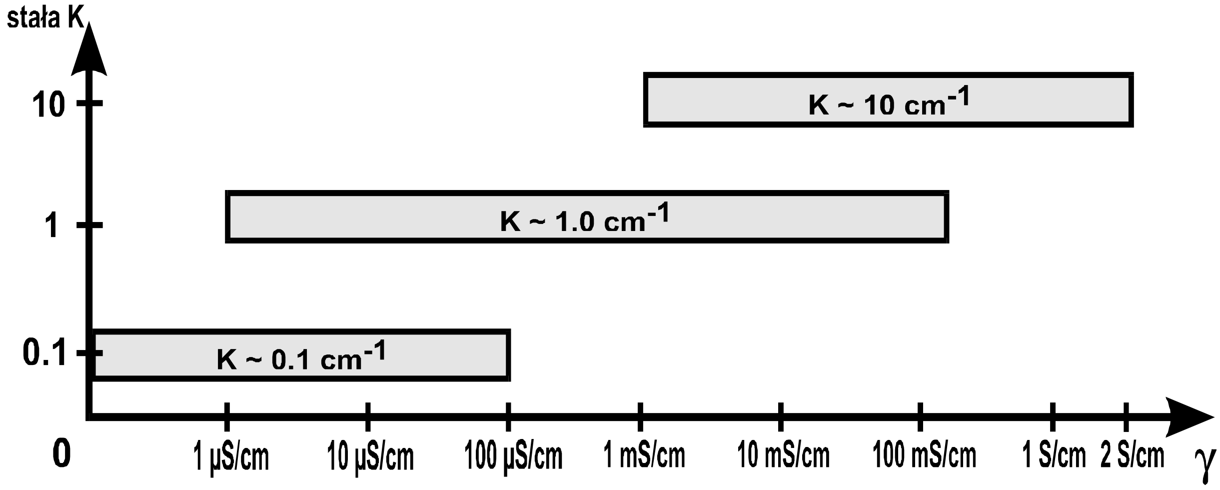
The measurement result will be calculated to introduced reference temperature.

Caution: pressing both ↓ , ↑ buttons simultaneously sets the temperature to 25 ^{0}C.

14. CHOOSING AND MAINTAINING THE CONDUCTIVITY CELL

14.1. Choosing the cell

The **CPC-505** meter measures conductivity in the range 0 – 1999.9 mS/cm. The meter co-operates with conductivity cells with K constant=0.010 ÷ 19.99 cm^{-1} and BNC-50 connector. Depending on the required measuring range it is necessary to choose the cell with a K constant which enables receiving valid results. **Beyond its range the cell looses its linearity and the results are burdened with an increasing error.** Accurate measurements in the whole range are possible when using 3 different conductivity cells.
Depending on the expected measuring range the proper cell may be chosen with use of the chart below.



Pic.23. The dependence between the measuring range and K constant of applied conductivity cells.

The cell with a K constant ≈ 0,1 cm^{-1} should be used for measurements of ultra pure and distilled water, which changes conductivity after contact with air very quickly, therefore pouring it into vessels for measurement with a submersible cell may cause errors. For accurate measurements of such low concentration it is necessary to use flow-through cell with built-in temperature probe, what enables measurement of water which flows directly from the container.

14.2. Maintenance of the conductivity cell

In order to receive stable results it is advisable to soak the cell for a few hours before measurement, especially in case of measurements in distilled water.

Maintenance of the conductivity cell consists mainly in washing the inside of the measuring cell accurately with distilled water. The platinum electrodes **must not be cleaned mechanically**, because this results in rubbing off the platinum layer, what can cause decreasing of accuracy, lowering of stability and changing of the K constant.

Measurements of liquids with oils and heavy sediment content may cause platinum contamination, make the measurement impossible and irreparably damage the electrodes. In case of fat content in the measured liquids it is possible to clean the electrodes by immersing the cell in acetone, chloroform, 4-hydrofuran or detergent.

Certain norms propose universal liquid for cleaning the cells. This is a mixture of equal parts of isopropyl alcohol, ethyl ether and hydrochloric acid diluted with water in 1:1 ratio.

Broken measuring cell hinders any further measurements due to significant change of the K constant, unstable results and increase of the dependence of the result on the position of the cell in the measuring vessel.

The cell should be immersed in such a way for the solution to fill it up and not to include any air bubbles (single bubbles or silver coating). It is essential for obtaining accurate results of measurements. The best way is to immerse the cell, make a few vertical moves and thus to remove air bubbles through holes in the upper part of the cell. If the air bubbles appear each time after the cell has been immersed and they are difficult to remove, it is advisable to immerse the cell in a water – washing up liquid mixture, what will lower the surface tension and disable air bubbles to stick to the surface of the cell walls or electrodes. Next, wash the cell accurately with distilled water.

15. CALIBRATION

A characteristic feature of every conductivity cell is its K constant. Before the result is shown on the display, the value is multiplied by the K constant value. The value of the K constant depends on the size of the electrodes' surface and the distance between them. **If the user keeps the cell clean, the K constant is not changing. However, it is likely to change in case of contamination of the surface of the electrodes**.

Calibration consists in introducing the K constant value into the meter's memory and is essential for obtaining accurate results. The meter may be calibrated without the standard solution, by entering the value of the K constant of the cell given by the manufacturer (recommended) or with use of standard solution with known conductivity – in order to determine the K constant.

The K constant is precisely determined by the cell manufacturer and using this value will be the most reliable.

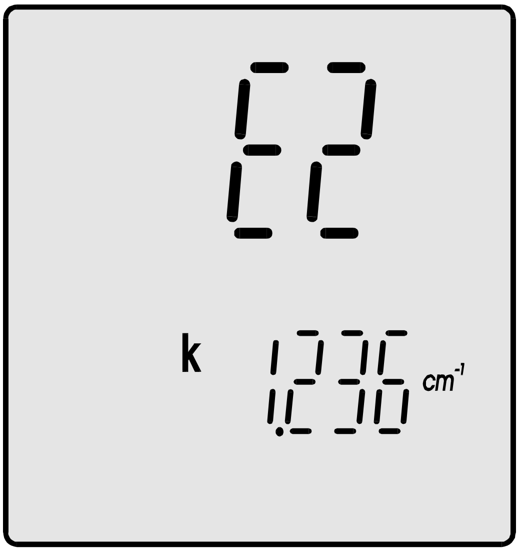
In case of the user's calibration it is necessary to apply fresh, accurately prepared standard solution. Additionally it has to be accurately thermostatic to the temperature 25^0C. When these conditions are not kept, the calibration will be burdened with error.

When using three cells, it is possible to store their characteristics under E1, E2 or E3 symbol.

15.1. Calibration without standard solution

The meter has a possibility of calibration without the use of standard solution. In case of such calibration it is necessary to know the K constant of the conductivity cell. This value may be given by the cell manufacturer or may be determined using the **CPC-505** meter after having calibrated it in the standard solution.
In order to calibrate without the standard:

- in the measuring mode press the MODE button till the screen with the value of K constant displays (pic. 24);
- with the ↓ , ↑ buttons choose the cell number; (E1, E2, E3 symbols);
- press and hold the CAL button, till the ***CAL*** symbol appears on the display;
- with the ↓ , ↑ buttons enter the value of the K constant;
- press the MODE button and return to the mode of choosing the number of cell or enter the measuring mode by pressing cond button.



Pic. 24.

15.2. Calibration with use of standard solution

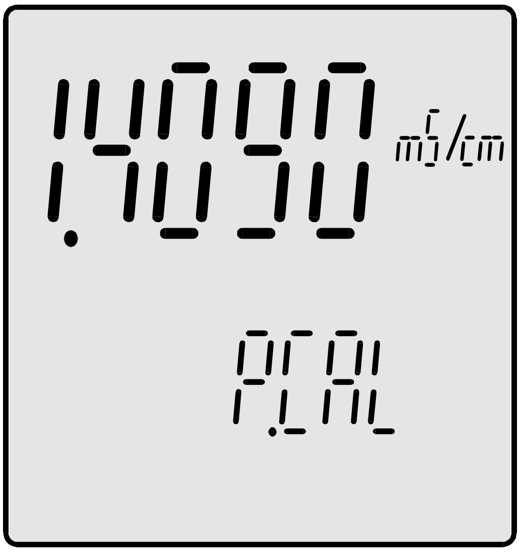
The purpose of such calibration is to determine the K constant. The meter enables one-point calibration in a freely chosen standard solution. To decrease the error it is recommended to use solutions with a value close to the estimated value of measurement. It is required to use standard solutions of high quality. Calibration is made in the chosen unit (section 13.1).
It is necessary to comply to the principles given below to obtain the exact results of calibration:

1. The temperature of the standard solution should be equal to the reference temperature (most often it is 25 °C).
2. New, unused standard solution should be applied.
3. The cell and its electrodes should be clean and devoid of air bubbles.
4. The electrode holder should be used.

15.2.1. Entering the standard solution value

In order to enter the value of the standard solution:

- choose the unit according to the section 13.1;
- in the conductivity measuring mode press the MODE button till the P.CAL symbol appears in the lower row (pic. 25);
- with the ↓ , ↑ buttons enter the value of the standard solution into the upper row;
- enter the measuring mode by pressing the cond button.

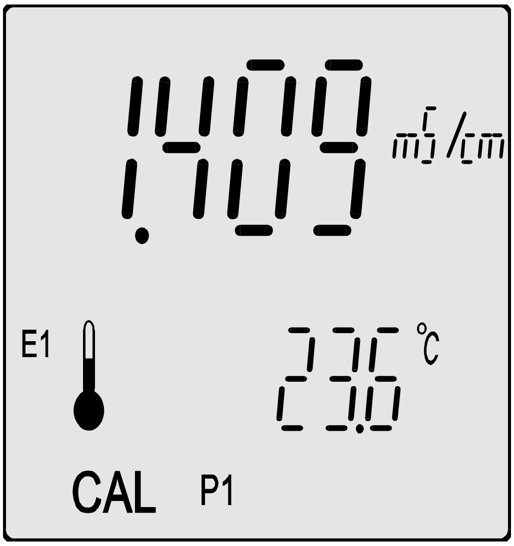


Pic. 25.

15.2.2. *Calibration with automatic temperature compensation*

It is necessary to:

- enter the value of standard solution (point 15.2.1);
- connect the conductivity cell and the temperature probe;
- immerse both of them in the standard solution, hold the conductivity cell at least 1 cm away from the bottom and walls of the vessel. The measuring cell should be filled up with the measured solution, there shouldn't be any air bubbles and the electrodes should be evenly moistened*;
- measure the temperature of solution and bring it to the introduced value of reference temperature;
- press and hold the CAL button until the ***CAL*** symbol appears on the display (pic. 26).
- wait till the value stabilises and press CAL. Flashing result informs about storing it in the memory. If the Err symbol displays, it is necessary to check the introduced value of the standard solution;
- exit the calibration mode by pressing cond.



Pic. 26.

The meter is calibrated and ready to work.

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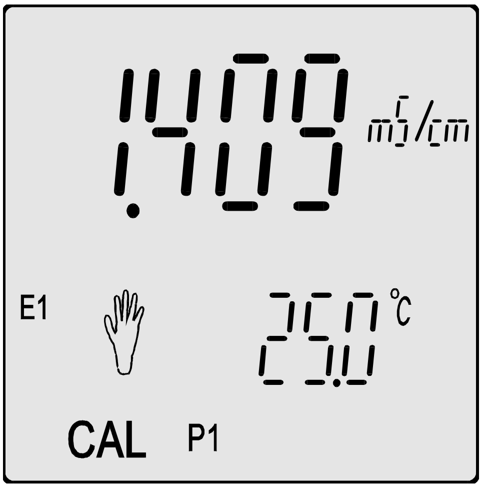
* - air bubbles may be removed by moving the immersed cell. In order to make moistening of the electrodes easier, it is recommended to immerse the cell in distilled water with washing-up liquid, and than wash it in distilled water.

15.2.3. Calibration with manual temperature compensation

In order to calibrate the meter it is necessary to:

- turn the meter on with ON/OFF;
- choose the conductivity measuring modewith the cond button;
- disconnect the temperature probe and press the ↓ , ↑ buttons simultaneously. Introduced reference temperature value will appear In the lower row;
- introduce the value of the standard solution (point 15.2.1);
- immerse the conductivity cell in the standard solution and hold it at least 1cm away from the bottom and walls of the vessel. The measuring cell should be filled up with the standard solution completely and shouldn't include any air bubbles, the electrode's surface should be evenly moistened*;
- measure the temperature of the standard solution with a lab thermometer and bring it to the introduced reference temperature;
- press and hold CAL till the ***CAL*** symbol (pic. 27) appears on the display.
- wait till the result stabilises and press CAL. Flashing result informs about storing it in the memory. If Err symbol displays it is necessary to check the introduced value of the standard solution.
- exit the calibration mode by pressing cond.

The meter is calibrated and ready to work.



Pic. 27.

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* - air bubbles may be removed by moving the immersed cell. In order to make moistening of the electrodes easier, it is recommended to immerse the cell in distilled water with washing-up liquid, and than wash it in distilled water.

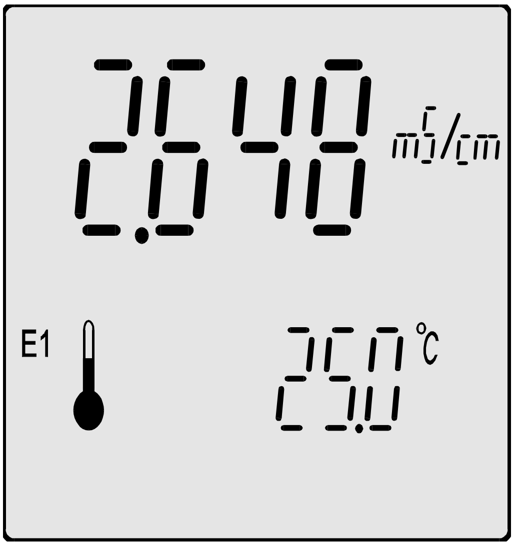
16. THE CONDUCTIVITY MEASUREMENT

16.1. Measurement without the temperature compensation

An accurate conductivity measurement should be made without the temperature compensation. The measured solution should be brought to the reference temperature value introduced earlier. When controlling, it is possible to use the temperature probe. In case of work without the temperature probe it is necessary to introduce the temperature value with the ↓ , ↑ buttons.

In order to make a measurement without the temperature compensation:

- connect the conductivity cell and the temperature probe to the connectors **F1** and **t** respectively;
- turn the meter on with ON/OFF.
- choose the conductivity measuring mode and the unit (section 13.1);
- if the conductivity cell wasn't calibrated, calibrate it according to the chapter 15;
- place both probes in the measured solution, the conductivity cell can't touch the walls and the bottom. The measuring cell should be filled up with the standard solution and shouldn't include any air bubbles, the electrode's surface should be evenly moistened*;
- bring the temperature of the measured solution to the value of the reference temperature.
- read the result after it has stabilised (pic. 28).



Pic. 28.

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* - air bubbles may be removed by moving the immersed cell. In order to make moistening of the electrodes easier, it is recommended to immerse the cell in distilled water with washing-up liquid, and than wash it in distilled water.

16.2. Measurement with automatic temperature compensation

In order to make measurement with automatic temperature compensation:

- connect the conductivity cell and the temperature probe to the connectors **cond** and **temp** respectively;
- turn the meter on with the ON OFF button.
- choose the conductivity measuring mode (the cond button) and the unit (section 13.1);
- if the conductivity cell is not calibrated, calibrate it according to the chapter 15;
- check or change the value of the reference temperature and the
- α coefficient;
- place both probes in the measured solution, the conductivity cell can't touch the walls and the bottom. The measuring cell should be filled up with the standard solution and shouldn't include any air bubbles, the electrode's surface should be evenly moistened*;
- wait till the result stabilises and read it (pic. 29).

Pic. 29.

Notice: in case of exceeding the range of temperature compensation the result starts flashing even though the conductivity measuring range has not been exceeded.

Displaying of the ✋ symbol instead of 🌡 next to the value informs that the temperature probe is broken.

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* - air bubbles may be removed by moving the immersed cell. In order to make moistening of the electrodes easier, it is recommended to immerse the cell in distilled water with washing-up liquid, and than wash it in distilled water.

16.3. Measurement with manual temperature compensation

Measurement with manual temperature compensation may be made in stable work conditions, e.g., during measurements in laboratory, especially with use of thermostat, or in case of the temperature probe damage. Disconnecting of the temperature probe switches the meter to manual temperature compensation.

In case of measurement with manual temperature compensation:

- connect the conductivity cell to the **cond** connector;
- turn the meter on with the ON/OFF button.
- choose the conductivity measurement and the unit (section 13.1);
- if the conductivity cell has not been calibrated earlier, calibrate it according to the chapter 15;
- check or change the value of the reference temperature and the coefficient α;
- place the probe in the measured solution, the conductivity cell can't touch the walls and bottom. The measuring cell should be filled up with the standard solution and shouldn't include any air bubbles, the electrode's surface should be evenly moistened*;
- measure the temperature of the solution and introduce its value with the ↓ , ↑ buttons.
- after stabilisation read the result (pic. 30).

Notice: pressing of the ↓ , ↑ buttons simultaneously sets the compensation temperature to the reference temperature value that has been entered earlier.

Pic. 30.

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* - air bubbles may be removed by moving the immersed cell. In order to make moistening of the electrodes easier, it is recommended to immerse the cell in distilled water with washing-up liquid, and than wash it in distilled water.

17. SALINITY AND TOTAL DISSOLVED SOLIDS MEASUREMENT

Salts and minerals dissolved in natural water influence the conductivity, which in principle is proportional to the quantity of dissolved substances. This dependence enables to determine, after certain calculations, salinity of the measured solution in concentration units (g/l or %), or TDS (Total Dissolved Solids). Received values are always approximate and total accuracy depends on the way of making calculations, concentration of the measured solution and its temperature. In most salinity meters a simplification is used, that dependence between conductivity and salinity in the solution is linear in the whole measuring range. Usually a 0.5 coefficient is used, the conductivity result in mS/cm is multiplied by this coefficient and the result of salinity is received in g/l, e.g., if the conductivity value is 2 mS/cm, salinity amounts to 1g/l. In practice the dependence between conductivity and salinity isn't linear and the conversion coefficient is changing together with the concentration and temperature. Table 3 shows the dependence between conductivity and actual salinity of NaCl solution in temperature 25 ^{0}C and values of salinity counted for constant coefficient 0.5. This comparison shows that using a constant coefficient for greater concentrations introduces significant error.

Table 1.

Conductivity (mS/cm)	Real salinity (g/l)	Salinity (g/l) Counted for coefficient = 0.5	Error (%) by using the coefficient = 0.5
1.00	0.495	0.500	0.01
2.00	1.006	1.000	0.60
4.00	1.976	2.000	1.21
10.00	5.400	5.000	7.40
30.00	18.174	15.000	17.46

In CPC-505 microcontroller takes into consideration actual dependence between conductivity and salinity what greatly reduces the error. There is a possibility of counting the salinity in NaCl or KCl, because the dependence for these salts is slightly different.

The results are more accurate for homogeneous solutions (NaCl, KCl). Concentration of salts mixture with unknown composition in most cases is counted to NaCl. The usefulness of water for home or industry is usually checked by determining of TDS.

In order to use the conductivity readout for determining the TDS it is necessary to specify the W_{TDS} coefficient, which enables automatic conversion after having introduced it to the meter's memory. To determine the W_{TDS} coefficient it is necessary to specify the weight of dissolved substances. Laboratory method of determining the dissolved solids content consists in taking a given volume of water, evaporating the filtered sample, drying it to constant weight in temperature $103 \div 105^0$C, weighting and counting in volume ratio (mg/dm^3). The received weight is lower than total dry mass in water because apart from the dissolved solids the latter contains also undissolved substances which are removed by filtering before evaporating. It is possible to determine the approximate Total Dissolved Solids content using the conductivity readout on the assumption that the salt's composition in the taken samples has not been changing significantly.

17.1. Salinity measurement with conversion to NaCl or KCl content

The measurement of salinity with conversion to NaCl or KCl content is made in the following way:

- choose the salinity measurement with conversion to NaCl or KCl content according to the section 13.1;
- choose the unit (g/l or %);
- then act as during the conductivity measurement (chapter 16);
- after stabilisation read the result.

17.2. Salinity measurement with conversion to TDS content

The measurement of salinity with conversion to TDS should be made in the following way:

- according to the section 17.3 determine the W_{TDS} coefficient;
- according to section 13.2 introduce the W_{TDS} coefficient;
- choose the measurement of salinity with conversion to TDS and the unit (g/l);
- then act as during conductivity measurement;
- after stabilisation read the result in the chosen units (g/l or %).

17.3. Determining the W_{TDS} coefficient

In case of the salinity measurement with conversion to TDS content it is necessary to determine the W_{TDS} coefficient and enter it to the meter's memory. In order to do so it is necessary to make the measurement of the tested water conductivity with exactly given volume or weight, determine the Total Dissolved Solids in traditional way and than count the coefficient according to the formulas given below.

1. If the result is to be displayed in g/l:

$$W_{TDS} = \frac{TDS}{\gamma}$$

where:

W_{TDS} - TDS coefficient
TDS- Total Dissolved Solids in g/l;
γ - conductivity of the sample in mS/cm;

Caution: the TDS value should be counted to volume of sample equal to 1l.

2. If the result is to be displayed in % of weight concentration:

$$W_{TDS} = \frac{TDS}{\gamma}$$

where:

W_{TDS} - TDS coefficient
TDS- Total Dissolved Solids in g/kg;
γ - conductivity of the sample in mS/cm;

Caution: the TDS value should be counted to weight of the sample equal to 1kg.

18. SIMPLIFIED WAY OF DETERMINING THE α COEFFICIENT

The knowledge of α coefficient has a crucial significance during measurements in temperatures different than the reference temperature.
This coefficient is changing together with the temperature and concentration.
Table 4 contains values of α coefficient in 25 ^{O}C for a few compounds with determined weight concentration.

Table 2.

substance	**Weight Concentr.**	**α coefficient**
HCl	10 %	1.56
KCl	10 %	1.88
H_2SO_4	50 %	1.93
NaCl	10%	2.14
HF	1.5 %	7.20
HNO_3	31 %	1.39

In the table 5 there are given rough values of α coefficient for KCl and NaCl depending on the temperature and concentration of the measured liquid.

Table 5.

temp. `^{0}C	**α coefficient**			
	KCl solution			**Saturated NaCl**
	0,01M	**0,1M**	1,0M	
5	2,68	2,68	2,39	2,77
10	2,45	2,36	2,20	2,53
15	2,27	2,19	2,04	2,38
20	2,11	2,06	1,89	2,21
25	1,91	1,86	1,75	2,03
30	1,80	1,77	-	1,91

Use the value of the α coefficient determined for the reference temperature to which the meter calculates the result**.**

It may be assumed that the α coefficient is constant in the range ±5 ^{O}C from the reference temperature.

For more significant differences between the measurement and the reference temperatures the value of the α coefficient may be determined according to the description below:

1. Bring the measured solution to the reference temperature $\mathbf{T_R}$ and measure its conductivity ($\mathbf{G_{TR}}$).
2. Change the solution temperature $\mathbf{T_X}$ to the value in which the measurement will be made.
3. Turn the meter to manual temperature compensation by disconnecting the temperature probe.
4. Enter the value of reference temperature $\mathbf{T_R}$ with the keyboard.
5. Measure the conductivity of the solution again. This value will be different than in $\mathbf{T_R}$ temperature ($\mathbf{G_{Tx}}$).

Determine the α coefficient using the formula:

$$\alpha = \frac{G_{TR} - G_{TX}}{G_{TR}\,(T_R - T_X)} \times 100\ (\%/^0C)$$

where:

$\mathbf{T_R}$ - reference temperature value in ^{0}C
$\mathbf{T_x}$ - value of the changed temperature in ^{0}C
$\mathbf{G_{TR}}$ - conductivity measured in ref. Temperature $\mathbf{T_R}$.
$\mathbf{G_{Tx}}$ - conductivity measured in temperature $\mathbf{T_x}$

Now, the α coefficient is determined for the reference temperature T_R and the measurement temperature T_x.

During measurements in temperatures different than the reference temperature it is necessary to introduce the calculated α coefficient value for the measurement temperature.

Caution: in case when the T_R reference temperature is equal to 25℃, the formula mentioned above is:

$$\alpha = \frac{G_{25} - G_{Tx}}{G_{25}\,(25 - T_X)} \times 100\ (\%/^0C)$$

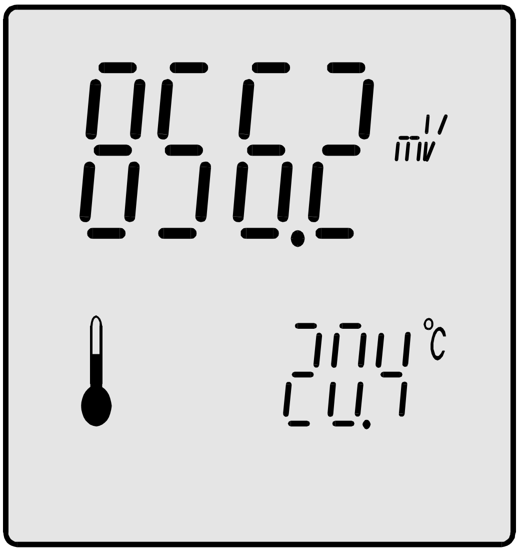
where:

$\mathbf{T_x}$ - value of the changed temperature in ^{0}C
$\mathbf{G_{25}}$ - conductivity measured in **25 ^{0}C**.
$\mathbf{G_{Tx}}$ - conductivity measured in temperature $\mathbf{T_x}$

IV. REDOX POTENTIAL (mV) AND TEMPERATURE MEASUREMENT

19. REDOX POTENTIAL (mV) MEASUREMENT

pH / conductivity / salinity meter **CPC-505** is an accurate mV meter (redox potential). The measurement can be made with a special redox electrode or during titration. The result is checked after choosing the mV mode with the mV button (pic. 31).



Pic. 31.

20. TEMPERATURE MEASUREMENT

The temperature measurement is made as follows:

- switch the meter on by pressing the ON/OFF button;
- connect the temperature probe to the Chinch connector, the 🌡 symbol will be displayed;
- put the temperature probe to the measured solution;
- wait till the value stabilises and read the result from the lower row.

The meter cooperates with the Pt-1000 probe. Depending on its class the accuracy of the measurement changes.

CAUTION: break in the circuit of the temperature probe switches the meter to the manual temperature compensation mode. It is signalised by change of the 🌡 symbol to the ✋ symbol. The display shows the value of the temperature entered by the user.
Flashing -50℃ value while making measurement in positive temperature informs about short circuit in the temperature probe.

V. OTHER

21. CLOCK WITH DATE

After choosing the **time** mode with the time button the meter displays current time. Pressing of MODE displays interchangeably: date, backlight mode and number of the software version.

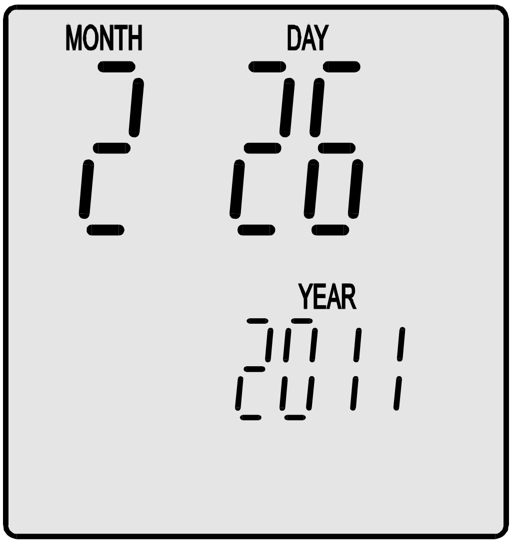
21.1. Clock

Current time is displayed in two rows (pic. 32). Hours and minutes are displayed in the upper one and the lower one displays seconds. The way of changing hours is described in the section 0.

Pic. 32.

21.2. Date

The date is displayed as follows: Month – Day – Year (pic. 33). In the upper row month and day are displayed and in the lower row - current year.



Pic. 33.

21.3. Setting time and date

The mode of setting currently displayed parameter (hour or date) is entered by pressing and holding CAL. The position which we are going to change starts flashing, the value can be changed with the ↓ , ↑ buttons. Pulsating position is chosen by pressing the CAL button shortly. Seconds are not set, they reset after the mode has been left. Press the time button to leave the setting mode.

The clock is powered with a lithium battery which lasts for 10 years. Flashing of the clock readings after the meter has been connected to the power supply informs about loss of the clock settings. It is necessary to introduce new settings. If such situation occurs each time the meter is being switched on, it has to be sent to us in order to have the battery replaced.

21.4. The LCD backlight mode

In the **time** mode press MODE till a LEd sign displays in the upper row of the LCD (pic. 34). In the lower row the oFF, Auto or on parameter will be displayed.

- oFF the backlight is switched off;
- Auto mode of automatic switch on of the backlight for 60 seconds after each press of any button;
- on the backlight is always on.

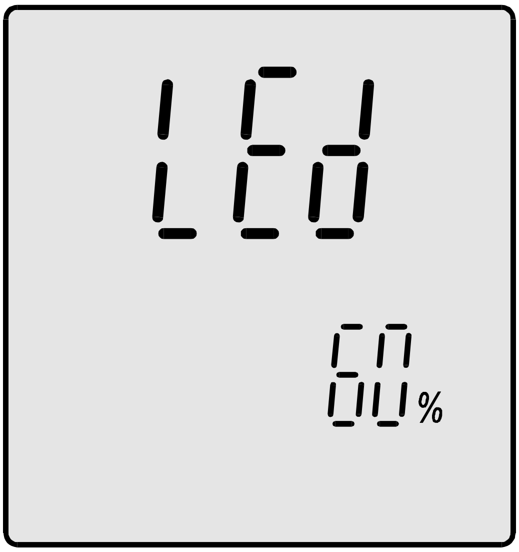
Pic. 34.

With the ↓ , ↑ buttons choose the backlight mode.

Return to the **time** mode after pressing the time button.

21.5. The brightness control

Controling brightness of the backlight is especially important in case of working in various lighting conditions. While choosing the backlight mode (section 21.4) it is possible to control brightness by pressing the CAL button shortly. Instead of oFF, Auto or on parameter the value of brightness in % displays. With the ▼, ▲ buttons it is possible to set the brightness value from 10 ÷ 100%, every 10%.



Pic. 35.

Return to the backlight mode by pressing the MODE button, and to the measuring mode by pressing any function button.

21.6. Readout of the software version number

In the **time** function press the MODE button till the software version number displays (pic. 36).

Pic. 36.

Return to the **time** mode by pressing the time button.

22. STORING AND READOUT OF THE RESULTS

The meter enables storing of 4000 results of the currently measured function. The results are stored in EEPROM memory, which is non-volatile, therefore the data isn't lost even after complete lack of power. Before starting work it is necessary to choose the parameters of storing or readout of the stored results.

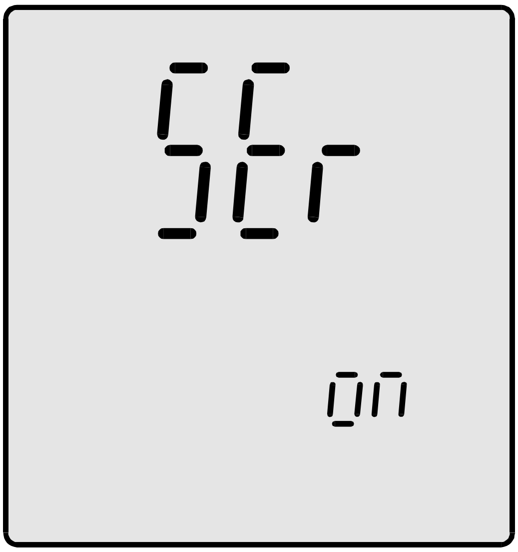
22.1. Parameters of storage and readout from the memory

The parameters are changed in the readout mode, which is entered from every measuring function by pressing and holding the MEM button, until the number of last stored result shows. This number is displayed on turns with the stored result.

Before storing, choose the way of collecting results: on request or automatically in series, and also the way of displaying the result.

Next presses of the MODE button show screens with following parameters which may be changed:

a. SEr - taking or printing series or single results.



Pic. 37.

With the ↓ , ↑ buttons choose in the lower row the on or oFF symbol (pic. 37). Choosing on activates automatic storage of the results and oFF - single storage, after every pressing of the MEM button.

b. Int - time interval during series taking (pic. 38).

Pic. 38.

Length of the time interval is displayed in the lower row of digits, and the informative symbol Int in the upper row.

The ▼ , ▲ buttons are used for setting time in minutes and seconds. The shortest interval is 1 second and the longest - 60 minutes. Holding the button increases change rate (repetition).
In case of setting the SEr parameter to oFF, the position Int is not displayed.

c. ALL - the way of displaying stored results;
on - successively: number of the sample, result, time and date of memorising the result.
oFF - successively: number of the sample and the result.

Changing with the ▼ , ▲ buttons.

Return to the results readout display after pressing the MEM button.
Exit from the readout mode after pressing the chosen function button.

22.2. Memorising single redouts

If storing of single results has been chosen according to previous section, every press of the MEM button memorises the result. The results are stored as the next ones after the latest stored. In case of checking the results stored earlier and not returning to the last one, the results won't be deleted and the value will be stored under the first empty position. In case of storing the result beginning with the chosen number, first delete the results starting from this particular number (as described in the section 22.5) and next start memorising the results by pressing the MEM button.
While memorising the result, its number is being displayed for a moment.

If after having pressed the MEM button instead of a number an End sign is displayed, it informs that the maximal number of results to store has been reached.

22.3. Storing the measuring series

There is a possibility to store series of measurements in the meter's memory. It is necessary to:

- choose the way of collecting the results serially (point 22.1.a);
- enter the time interval (point 22.1.b);
- delete stored results starting from the chosen one (section 22.5);
- with the appropriate button choose the function of which results are going to be stored;
- with the MEM button start taking series. The measurement results will be collected starting from the first free number.

Collecting series is signalised by flashing diode in placed in the MEM button**.**
Before each time the result is memorised, the number of the measurement is displayed for a moment. Collecting series may be stopped by pressing the MEM button, any function button or by filling up all the memory capacity. The next series can be started unless the memory capacity has been filled up.

22.4. Reviewing the results

Reviewing stored results is started in the measuring mode, by pressing and holding the MEM button until the number of the last stored result displays on turns with its value.

Every press of the ↓ or the ↑ button shows the next or the previous number and the result with time and date **depending on which parameter of the ALL function has been chosen** (point 22.1.c).

In this mode the ↓ , ↑ buttons function with repetition which means that after holding them the numbers are changing with increasing rate till they stop at the highest or the lowest number.
The reviewing mode is left by pressing any function button.

22.5. Deleting stored results

In order to delete stored results:

- press and hold the MEM button;
- with the ↓ , ↑ buttons set the number of the measurement from which we want to start deleting results from the memory;
- press and hold the CAL button until there is a --- sign displayed instead of the results; all the results from the chosen one up to the last one remembered are now deleted;
- press any function button to exit the reviewing mode.

Deleting all the results from the memory should be started beginning with the first number.

23. CO-OPERATION WITH A PC

Connecting the meter with a PC enables storing the data directly on the computer, what makes a possible number of results to store unlimited. The PC should be equipped with a USB connector. For transmission a special software prepared by our firm should be used. The software is delivered on a CD. After inserting the CD to a drive the installation program starts automatically. During installation it is necessary to follow the given instructions.

In the back wall of the meter there is a USB connector placed, which enables connecting with a PC using a cable. After connecting, turn on the meter and the PC and launch the transmission software. We have two options available:

- “Collect series” is used for collecting results of a current measurement. After choosing this option a window with the result of a current measurement displays. Only the elements which are marked in the field “Send” will be collected and stored. It is necessary to set the number of measurements which are to be stored and storage intervals. On the basis of this data the software will count the time of collecting the whole series. The series are stored in temporary file. In case of lack of power the collected data will be stored in a file “NoNamexx”. Collecting is started by pressing the “Collect” button.

- “Download data from memory” enables sending the chosen part or whole of the data stored in the meter’s memory to a file. In option “Collect” we mark the data we want to be sent. The transfer is started by pressing the button “Download”.

Caution: the meter and the PC should be switched on **after** connecting the cable.

24. TECHNICAL DATA

pH MEASUREMENT:

Range	Resolution	Accuracy (±1 digit)
-2.000 ÷ 16.000 pH	0.001 / 0.01 pH	±0.002 pH

INPUT IMPEDANCE: >10^{12} Ω
TEMPERATURE COMPENSATION: manual/automatic
COMPENSATION RANGE: -5.0 ÷ 110.0 °C
pH ELECTRODE CALIBRATION: automatic,
in 1 ÷ 5 points

RANGE OF RECOGNITION AND ENTERING OF THE pH BUFFER SOLUTIONS

Calibration point	Range
1	0,800 ÷ 2,100
2	3,900 ÷ 4,100
3	6,800 ÷ 7,100
4	8,900 ÷ 10,200
5	11,500÷ 14,000

AUTOMATIC CHANGE OF THE pH BUFFER VALUE WITH THE TEMPERATURE CHANGE, FOR STANDARDS CONSISTENT WITH NIST (table page 19) IN RANGE: 0 ÷ 60 °C
THERMAL STABILITY OF ZERO: 0.0005 pH/ °C

mV MEASUREMENT:

Ranges	Resolution	Accuracy (±1 digit)
-1999.9 ÷ 1999.9 mV	0.1 mV	±0.1 mV

INPUT IMPEDANCE: >10^{12} Ω

CONDUCTIVITY MEASUREMENT:

Ranges	Resolution	Accuracy (±1 digit)	Frequency
0.000 ÷ 19.999 μS/cm	0.001 / 0.01 μS/cm	±0.1 %	100 Hz
20.00 ÷ 199.99 μS/cm	0.01 / 0.1 μS/cm	±0.1 %	1 kHz
200.0 ÷ 1999.9 μS/cm	0.1 / 1 μS/cm	±0.1 %	2 kHz
2.000 ÷ 19.999 mS/cm	0.001 / 0.01 mS/cm	±0.1 %	5 kHz
20.00 ÷ 199.99 mS/cm	0.01 / 0.1 mS/cm	±0.25 %	10 kHz
200.0 ÷ 1999.9 mS/cm	0.1 / 1 mS/cm	±0.25 %	10 kHz

* Accuracy given for the end value of the range.

Ranges of frequency changes were given for constant K = 1. For other values of the K constant the values will be changing proportionally to changes of this constant.

TEMPERATURE COMPENSATION: manual/automatic
COMPENSATION RANGE: -5.0 ÷ 70.0 ^{O}C
K CONSTANT RANGE: 0.010 ÷ 19.999 cm^{-1}
α COEFFICIENT RANGE: 0.00 ÷ 10.00 %/ ^{O}C
TDS COEFFICIENT RANGE: 0.20 ÷ 1.00
MEASURING RANGE KCl: 0 ÷ 200 g/l
MEASURING RANGE NaCl: 0 ÷ 250 g/l
PROBE CALIBRATION: one-point

1. by entering the K constant of the probe
2. using the calibration solution

TEMPERATURE MEASUREMENT:

Range	Resolution	Accuracy* (±1 digit)
- 50.0 ÷ 199.9 ^{O}C	0.1 ^{O}C	±0.1 ^{O}C

* accuracy of the meter. Final accuracy of the measurement depends on the accuracy of applied Pt-1000 probe

TEMPERATURE PROBE: platinum resistor Pt-1000

ACCURACY OF THE PROBE IN RANGE 0 ÷ 100 ^{0}C:

for Pt-1000b resistor: ±0.8 ^{0}C
for Pt-1000$^{1}/_{3}$b resistor: ±0.27 ^{0}C

OTHER:

MEMORY CAPACITY:	4000 results
OPERATING TEMPERATURE:	0 ÷ 40 ºC
POWER SUPPLY:	12V/100mA power adapter.
POWER CONSUMPTION:	60 mW
DISPLAY:	LCD 70 x 55 mm
DIMENSIONS:	200 x 180 x 50 mm
WEIGHT:	660g

25. EQUIPMENT

Standard set:

1. EPS-1 combination glass electrode;
2. ECF-1 conductivity cell (K constant=0.45);
3. Pt-1000B temperature probe (standard);
4. 12V/100mA power adapter;
5. Software for collecting data on the PC;
6. USB cable;
7. User's manual with warranty.

Additional equipment:

1. pH electrodes for special purposes (sewage, wastes, meet etc.);
2. Additional conductivity cells chosen according to the measuring range;
3. Pt-1000 1/3B temperature probe with higher accuracy;
4. Redox measuring electrodes;

WARRANTY

The ELMETRON company ensures a 24-month warranty for the pH / conductivity / salinity meter **CPC-505** number:

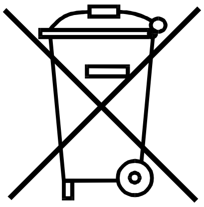
....

In case of damage the producer will repair the meter within 14 days from the day of delivery.
The warranty doesn’t cover the damages caused by usage not in conformity with the user’s manual, using wrong power adapter, mechanical damages and damages caused by repairs made by unauthorised persons.

The pH electrode and the conductivity cell have a one-year warranty of the producer.

NOTICE: Before sending the meter to us please contact the firm by phone or email.
When sending the meter, the electrode, the conductivity cell, the temperature probe and the power adapter should be also included.

Date of production..
Date of sale..
Date of warranty expiry.................................



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