Instruction manual

VWR® pH/CONDUCTIVITY METER PH/CO-2500L

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I. INTRODUCTION

1. PACKAGE CONTENT

1. **PH/CO-2500L** pH/conductivity meter.
2. Glass combination pH electrode.
3. Stainless steel temperature sensor
4. pH 4,00 , pH 7,00, pH 10,00 buffer solution, 50 ml each.
5. Electrolyte – saturated KCl – 50 ml.
6. Plastic body, metal electrodes conductivity cell.
7. 12,90 mS/cm conductivity controlling solution – 50 ml.
8. 5V/1000mA power adapter.
9. Free standing electrode holder.
10. USB cable for connecting with a PC
11. Cartoon box for the meter with accessories.

2. DISCLAIMER

Dear User!

Wide range of 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 and cells of good quality and replacing them after a suitable time provides obtaining high measuring accuracy. It is worth remembering that electrodes have much shorter life time than the meter.

Clean membrane is the main condition of correct readings. After each measurement the membrane should be rinsed with distilled water. Oil, pastes, grease, etc., should be removed according to the instructions provided in the electrode's manual.

We wish a pleasant and trouble-free work with our meter.

3. CHARACTERISTICS OF THE METER

PH/CO-2500L waterproof pH/conductivity meter belongs to the newest generation of measuring devices. The meter provides high accuracy and repeatability of readings. The meter's memory is independent from power supply. The meter is equipped with a large backlit custom LCD, which can simultaneously display pH, conductivity and temperature readings. Thanks to its touchscreen keyboard the operation of the meter is very comfortable.
The most important features of **PH/CO-2500L** are:

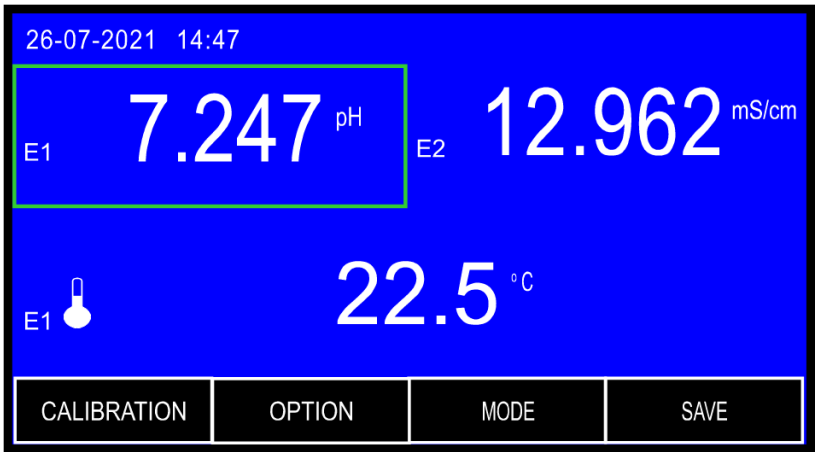
- automatic or manual temperature compensation;
- 1 - 3 point pH electrode calibration;
- automatic recognition of pH buffers and standards;
- default values of buffer solutions which may be changed by the user;
- automatic change of the stored pH value of the NIST standard solution with the temperature change (NIST norm);
- information about the pH electrode condition;
- storing of the calibration date and parameters of three electrodes (cells) in each function;
- wide range of conductivity measurement with six automatically switched subranges (autorange);
- converting conductivity to salinity in NaCl or KCl (g/l or %) according to actual dependence to conductivity;
- converting conductivity into TDS (g/l or %) with possibility of introducing the TDS coefficient;
- measurement of resistivity in Ω*cm;
- automatic introduction of temperature compensation coefficient α for measurements in natural, pure and ultra pure water;
- calibration of the conductivity cell by introducing the K constant or with use of 1 - 3 standard solutions;
- possibility of determining K constant of the conductivity cell;
- possibility of introducing the date of calibration validity termination and signalling its expiry;
- signalising of the reading stabilisation (READY);
- holding the reading on the display (HOLD);
- storing measurement results with time, date and temperature, taken as single or series of measurements with set time interval;
- possibility to create the last calibration report or reading of last 10 calibration data of each measuring function in the data transmission software;
- **USB** output for connecting with PC;
- graphic display with brightness control and touchscreen;
- real time clock with date;
- energy saving mode activated after time set by the user.

4. THE OUTSIDE VIEW

On the front wall of the meter there is a graphic LCD placed (Pic. 1), on which the following readings are displayed:

- pH or redox potential in mV units;
- conductivity or salinity, TDS, resistivity;
- temperature.

At the top of the LCD the current time and date are displayed.
Choosing particular functions is described in the chapter 23.1. Symbols of the units are displayed next to the readings.

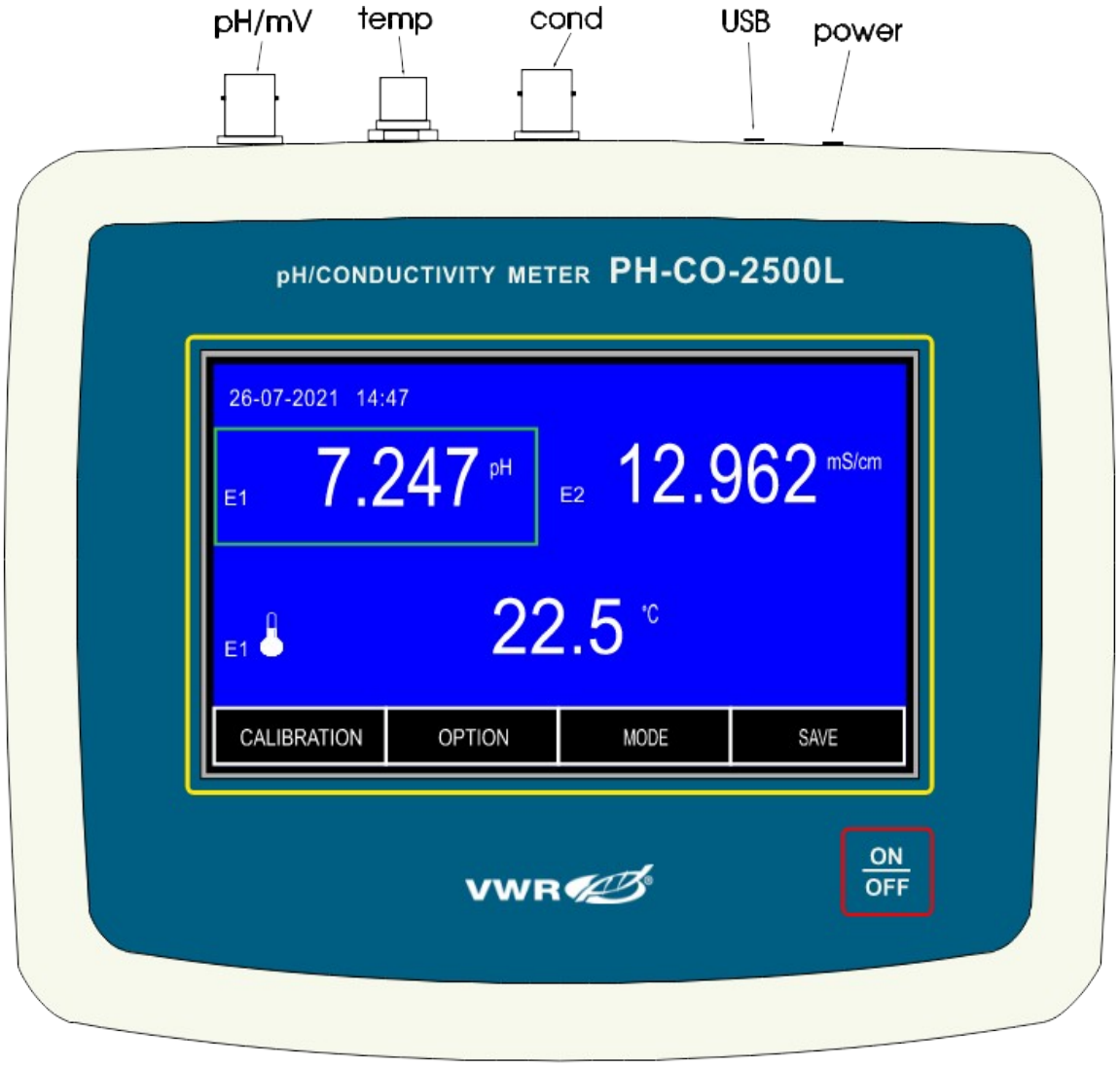


Pic. 1.

The automatic temperature compensation is signalised by the symbol, the manual compensation – by the symbol (next to the temperature reading). Number of the chosen electrode is displayed on the left (**E1**, **E2** or **E3**). It informs, which of the recorded characteristics will be taken into consideration during all calculations. Red colour of the electrode number informs about erased characteristic, yellow – calibration validity date expiry, or the electrode efficiency loss detected during the last calibration. The parameter screen of each function displays all parameters entered by the user.

The ON/OFF button (Pic. 2) placed below the display is used for switching the meter on and off.
In the back wall of the meter the sockets are placed with the symbols given below:

pH/mV - **BNC-50** socket for connecting the combination pH or redox electrode;
temp - **RCA** (Chinch) socket to connect the temperature probe;
cond - **BNC-50** socket for connecting the conductivity cell.
USB - **USB** socket for connecting with a PC;
power - **DC2.5** socket for connecting the power adapter;



Pic. 2.

All the sockets are connected in two groups isolated from each-other:

pH/mV and **temp.** sockets are connected with ground 1;
cond, USB and **power** sockets are connected with ground 2.

5. THE METER‘S MAINTENANCE

The meter is equipped with a graphic touchscreen. The maintenance consists in pressing particular keys and windows which appear on the screen. Grey captions in the windows and keys inform that these elements are not active in this particular operating mode. Particular keys, connected with the measurement function (i.e. CALIBRATION or MODE) become active after selecting the chosen function. To select, press the screen in a freely chosen spot of the chosen function. Around this spot a frame will be displayed. To deselect, press the spot again. If the chosen function has a possibility of calibration, the CALIBRATION key becomes active. If it has additional parameters, the MODE key also becomes active. The CALIBRATION key is the only key in the meter that responds exclusively to a long press (about 2 sec.). It prevents from accidental erase of the electrode (cell) calibration data.

Entering wrong value, attempt of calibration when the meter doesn‘t recognise the standard or attempt to turn the meter off when series collecting proceeds are signalised by a triple warning sound, irrespective of the chosen sound settings.

Turn the meter on and off with one mechanical ON/OFF button. When a measurement series is collected, the ON/OFF button is not active until the process of collecting ends or is stopped.

6. SWITCHING THE METER ON AND OFF

After switching the meter on with the ON/OFF button, the memory test proceeds. If the test ends successfully, the meter enters the measurement screen with settings entered before switching it off previously. In case of detecting the manufacturer‘s calibration data loss, the following information will appear:



Pressing the OK button accepts standard manufacturer‘s calibration parameters and enters the measurement screen. Such situation will be repeating each time the meter is switched on and requires sending the meter to the manufacturer for servicing.
In case of the user‘s data loss (i.e. the pH electrode characteristic), the following information will appear:



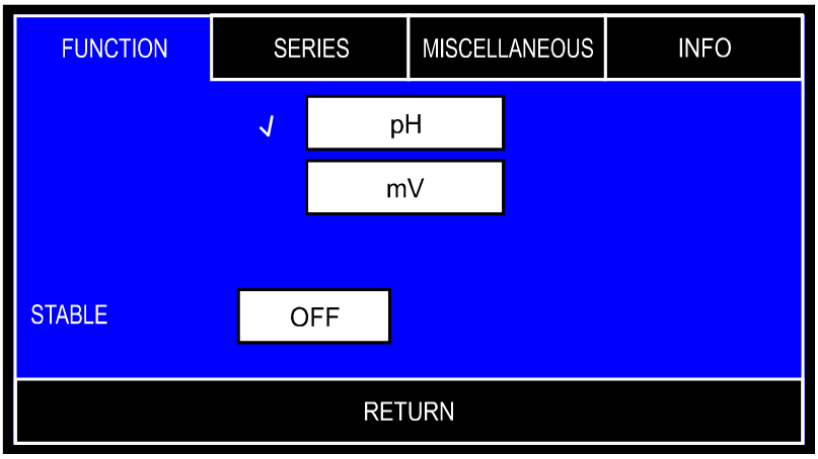
Pressing the OK button accepts and records in the memory standard pH electrode characteristic and enters the measurement screen. In such case, calibration of the pH electrode is necessary. Analogical situation occurs in case of other measuring functions. Repeating of the situation after switching the meter on again informs about the EEPROM memory malfunction and requires sending the meter to the manufacturer for servicing.

Switch the meter off by pressing the ON/OFF button. During the process of collecting series it is impossible to turn the meter off.

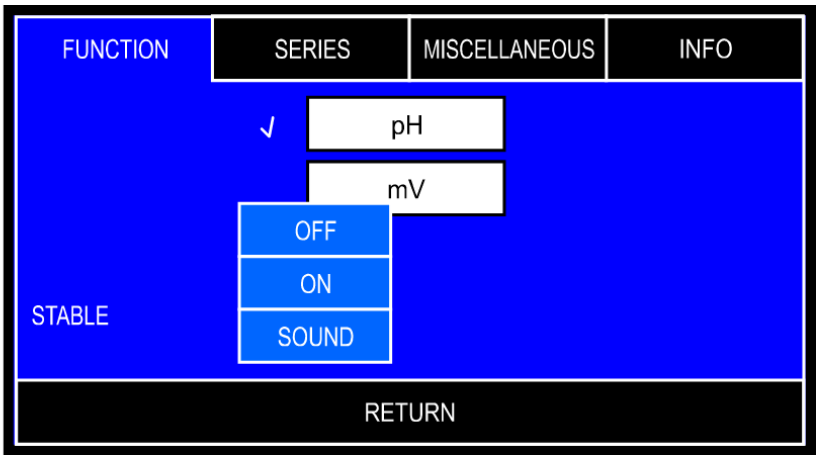
6.1. Choosing the measurement function

The user may choose the reading to be displayed on the upper left side of the measuring screen: pH or redox potential. To choose, on the measuring screen press the **OPTIONS** button, the option screen will display with the **FUNCTION** tab open containing the previously set configuration (Pic. 3A).

A



B



Pic. 3

After pressing the window with the chosen function, the confirmation mark will be displayed next to it.

The window for choosing the stabilised reading signalisation mode is placed below (Pic. 3B):

- **OFF** - the stabilised reading signalisation is off;
- **ON** - the stabilised reading signalised with changing the frame colour from white to green (only for reading marked with a frame);
- **SOUND** - the stabilised reading signalised by colour change and sound.

Return to the measurement screen by pressing the **RETURN** button.

6.2. Stabilised reading

The stabilised reading signalisation is active only for the reading marked with a frame. If the measured value meets the criterium of the stabilised reading, it is signalised by green colour of the frame and additionally with a sound if it has been activated. In this mode the meter does not record changes of the measured value in a certain range and does not display them. The meter exits the stabilised reading mode after exceeding this range, the frame changes colour to white and the meter displays the current measurement value. In practice, lowering accuracy in this mode is insignificant.

7. PREPARATION TO WORK

Before starting work:
- connect the power adapter to the **power** socket;
- connect prepared combination pH electrode or redox electrode to the **pH/mV** (BNC-50) socket;
- connect conductivity cell to the **cond** (BNC-50) socket;
- in case of using the temperature probe connect it to the **temp** (RCA) temperature socket;
- in case of working with a PC connect a suitable cable to the **USB** socket;
- switch the meter on by pressing the 

button.

The pH electrode is isolated from the conductivity cell, therefore during pH and conductivity measurements both electrode and cell may be immersed in the same solution simultaneously.

7.1. Choosing the kind of the temperature compensation

The meter switches to the automatic or manual temperature compensation mode itself. Connecting the temperature probe switches the automatic temperature compensation on. Next to the reading the symbol is displayed. After disconnecting the probe the meter enters the manual temperature compensation mode. Instead of the symbol the is displayed. In case of the manual temperature compensation the temperature value is set on the temperature measurement parameters screen (point 21.5).

II. pH MEASUREMENT

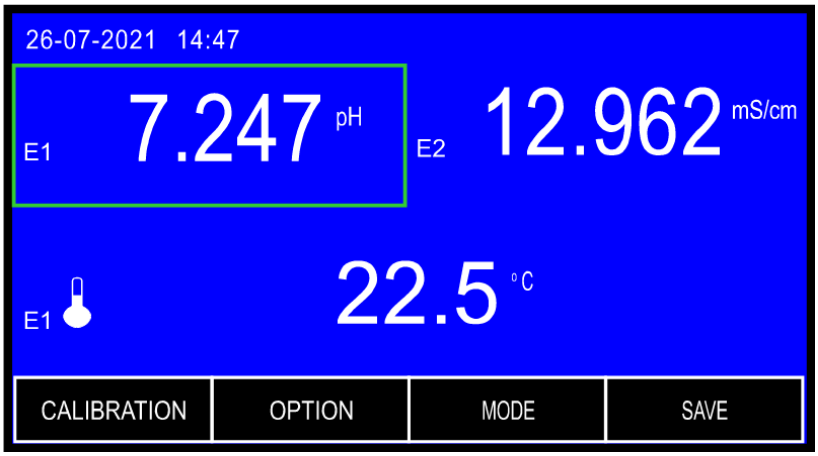
8. PREPARATION OF THE pH ELECTRODE

The electrode should be prepared to work according to the manufacturer's instructions. It is especially important to keep the membrane active and clean, rinse it accurately after each measurement and dry it gently with a tissue paper.

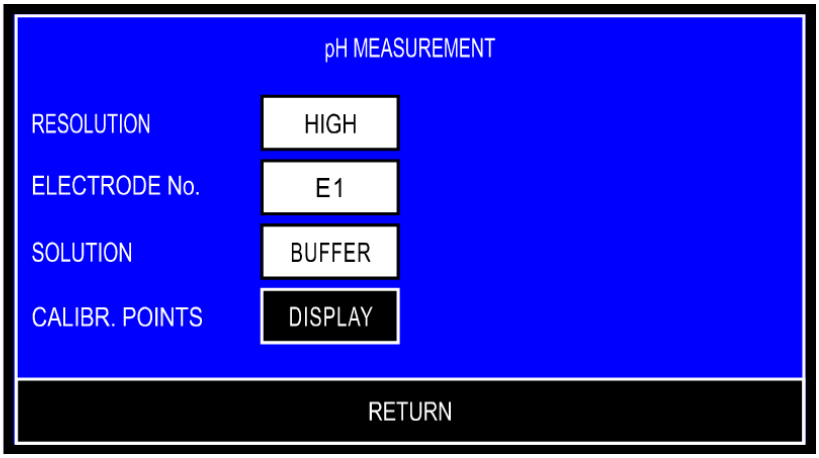
9. SETTING THE pH MEASUREMENT PARAMETERS

Enter the pH measurement parameters setting screen by pressing the pH measurement reading (a frame displays on it - Pic. 4A), and next the **MODE** button. The screen (Pic. 4B) enables choosing the resolution, electrode number, checking the solution type and - after pressing the **DISPLAY** button - (Pic. 4C) calibration points and validity time (these parameters are entered in the calibration mode only).

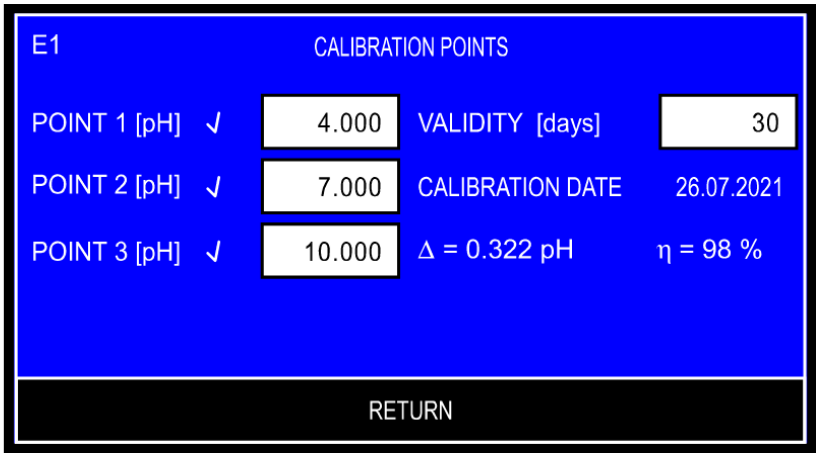
A



B



C



Pic. 4

When the parameters are set, return to the measurement screen by pressing the RETURN button.

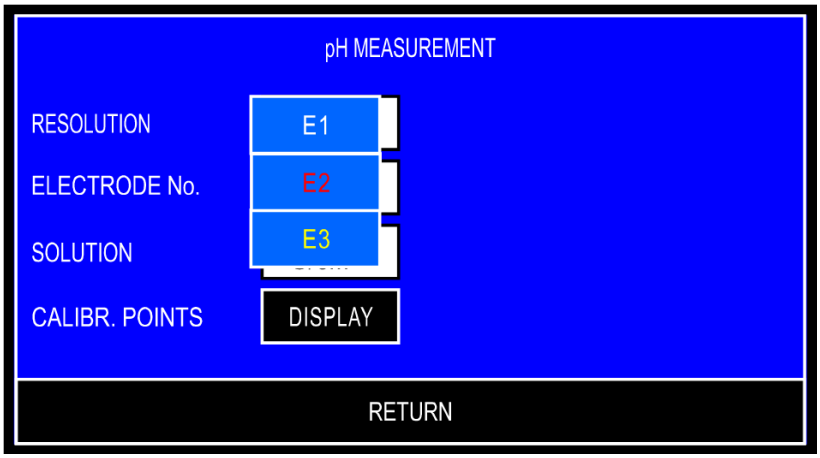
9.1. Resolution

The reading can be displayed with low or high resolution. By pressing the **RESOLUTION** window, choose:

LOW - 0.01 pH measurement resolution;
HIGH - 0.001 pH measurement resolution.

9.2. Electrode number

If the meter stores more than one electrode's characteristic, the electrodes may be replaced without calibration. This option is very useful for work with different types of samples. After pressing the **ELECTRODE No.** window the table with electrode numbers appears (Pic. 5). Choose one of the characteristics stored under **E1, E2 or E3** number.



Pic. 5

The number's colour informs about the electrode's condition:

white - electrode efficient, calibration valid;
yellow - electrode efficiency loss detected during the last calibration or the calibration validity date expired (see chapter 11);
red - characteristic erased, the electrode calibration necessary.

In the Pic. 5, the **E1** electrode is efficient, the **E2** electrode has the characteristic erased and the **E3** electrode lost its efficiency or the calibration validity date expired.

9.3. Calibration solution

Displays types of calibration solutions applied for the last calibration:

BUFFER - calibration with manually entered buffers‘ values;

STANDARD - calibration with automatic correction of the standards‘ values.

Calibration in buffers and standards is described in detail in the chapter 10. **The types of calibration solutions are stored for each of the three electrodes separately and may be changed only in the calibration mode (point 10.2).**

9.4. Calibration points and date

After pressing the DISPLAY button the following parameters are displayed (Pic. 4C): the electrode condition, calibration points, validity time and date of the last calibration. Markers next to the calibration points windows inform that the last calibration was performed in these particular solutions. All the pararmeters‘ values are stored separately for each of the three electrodes. **The calibration points may be changed only after entering the calibration mode (point 10.2).**

9.5. Calibration validity date

The meter stores the calibration validity time for each of the three electrodes separately. Expiry of this date is signalised with yellow electrode number. To set the calibration validity expiry date, press the **VALIDITY** window, the numerical keyboard will appear to enter the number of days and confirm with the OK button.

10. CALIBRATION

Before starting measurement with a new electrode or before making measurements which require high accuracy, the electrode connected to the meter should be calibrated. Results of measurements made without calibration will be burdened with a significant error. Calibration is performed in the buffer or standard solutions. It consists in comparing pH value of the standard solutions with the reading displayed by the meter and automatic correction which is taken into consideration during the 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 was used, temperature and value of the measured solutions.

PH/CO-2500L enables storing characteristics of three calibrated pH electrodes separately, recorded under different numbers (**E1**, **E2** or **E3**). This feature is very useful when it is necessary to change the electrode quickly or to replace a broken one.

The meter enables entering the calibration validity expiry date for each of the electrodes separately. If this option is active, the calibration should be performed when the applied electrode number (**E1**, **E2** or **E3**) turns yellow.

For obtaining optimal calibration results, the pH values of the applied solutions should be entered to the meter's memory by the user. During calibration, after putting the pH electrode and the temperature probe into solution, the meter detects its pH value automatically. When the highest accuracy is required, it is recommended to use certified standard solutions. However, the most often used are buffer solutions of total values i.e. 2.00 pH, 4.00 pH etc, with a composition specified by the manufacturer. They are also of quite high accuracy.

For accurate measurements it is necessary to use fresh solutions of good quality.

The temperature changes have a great influence on the pH value of standards and buffer solutions. The manufacturers usually specify the pH values of a solution in a specific temperature. During accurate calibration the stored solution value has to be the same as the value of this solution in the temperature in which the calibration is performed. If the electrode number turns yellow after the calibration is finished, it informs that the electrode lost its efficiency and will have to be replaced soon. An additional information is shown on the electrode calibration points screen (description in the chapter 11).

Calibration with use of 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 isn't very high and the measurements are made in the whole range, 1-point calibration should be performed with use of solution close to 7.00 pH. It enables to avoid an error resulting from so called zero offset of the electrode. In other points the meter adopts standard characteristic from the memory.
The solutions may be used randomly. In **PH/CO-2500L** the electrode characteristic is approximated linearly between the calibration points.
Entering the calibration mode erases the electrode's characteristic stored under the chosen number.
There is no possibility to calibrate the electrode only in one point with leaving the rest of the data from the previous calibration.
The characteristic erase is signalised by red colour of the electrode number.

10.1. Calibration in buffer or standard solutions

Before starting the calibration process, prepare the meter according to the chapter 6 and decide whether the calibration will be performed with use of buffer or standard solutions.

The calibration may be performed in two following methods:

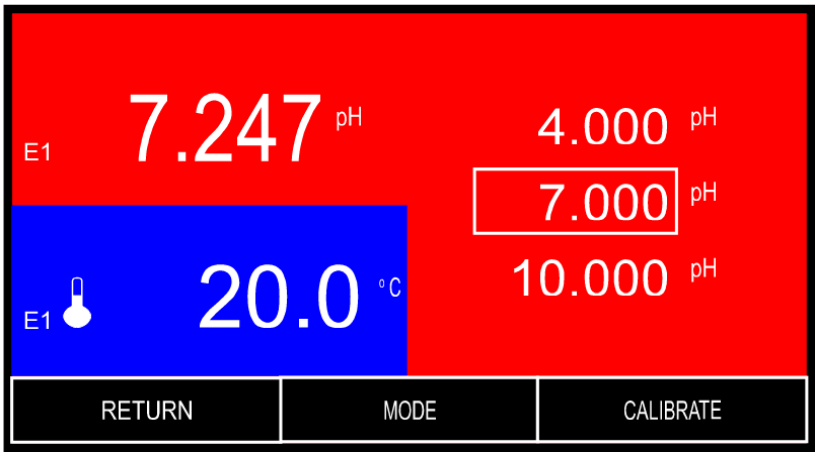
1. **Entering the values of currently used pH buffers to the meter's memory; calibration is performed in these buffers.**
2. **Using the pH standard solutions values entered to the memory by the manufacturer (NIST norm conformity). Choosing this type of calibration automatically enables correction connected with the temperature influence on the standard's value. As a result, there is no need to adjust the standard's temperature or to enter the standards' pH values corresponding with different temperature values.**

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

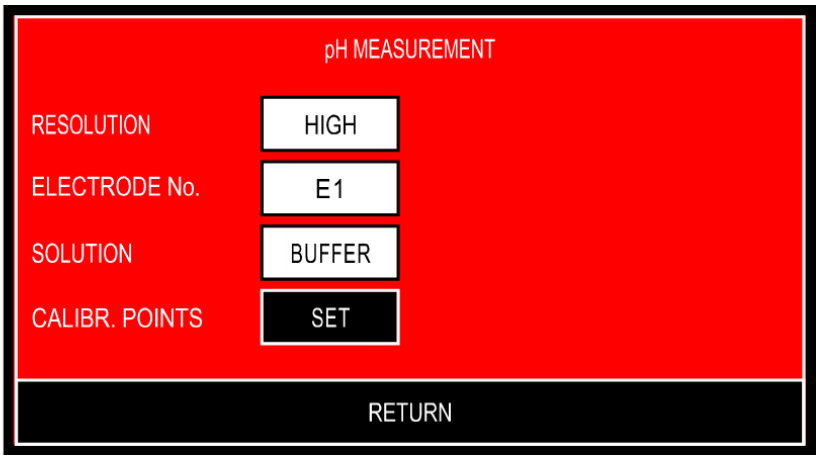
If the calibration with use of buffers has been chosen and the pH values set by the manufacturer are used, there is no need to change them. However, it should be verified whether the values correspond to those of applied buffers. Different buffers' values should be entered to the meter's memory before calibration.
To enter:

- according to the point 9.2 choose the number of electrode (**E1**, **E2** or **E3**), for which the points of calibration are to be changed;
- enter the calibration mode: select the pH measurement on the measurement screen, press and hold the **CALIBRATION** button until the background turns red (Pic. 6A). The previous characteristic is erased;
- press the **MODE** button, the pH measurement parameters screen will appear (Pic. 6B);
- press the **SOLUTION** window and choose **BUFFER**;
- press the **SET** button, the screen with calibration points will appear (Pic. 6C);
- select the window with a point to be changed, a numerical keyboard will appear to enter the value and confirm with the **OK** button.
- return to the measurement screen in calibration mode by double press of the **RETURN** button and calibrate the electrode in the chosen points or escape the calibration mode by pressing the **RETURN** button again;

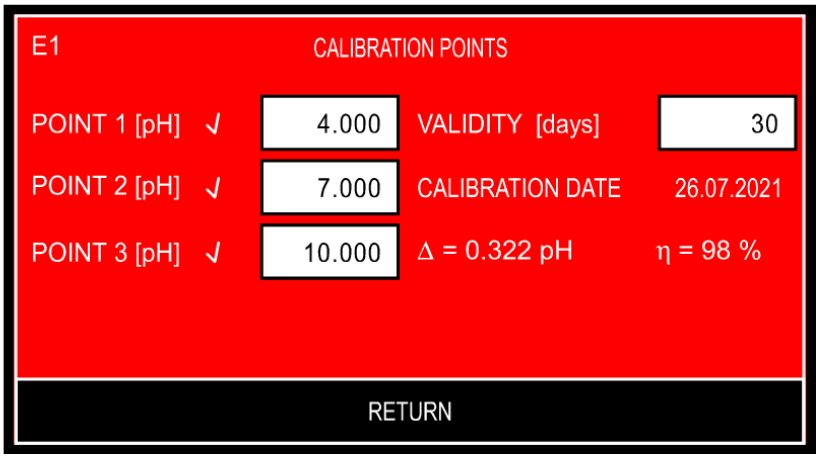
A



B



C



Pic. 6

Each of the calibration points has its own range of pH buffers values to enter. This limitation enables automatic detection of the buffer solutions by the meter. Table 1 contains the manufacturer's settings of the pH buffer solutions values used for calibration. They can be changed according to the ranges given in this table. The range for each of the calibration points is wide, what enables to use buffer solutions with values differing from those set by the manufacturer even to a large extent. In every case the introduced buffer solution will be automatically detected by the meter. There is a possibility to introduce values of buffer solutions with two or three decimal places, depending on the chosen resolution.

Table 1.

Calibration point	Manufacturer's value	Range
1	4,000	0,000 ÷ 6,000
2	7,000	6,800 ÷ 7,100
3	10,000	8,000÷ 14,000

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 previously used buffer solutions haven't been changed. The pH values introduced to the meter's memory by the user are stored in non-volatile memory.

The manufacturer gives an information about solutions values at different temperatures. This data may be useful for calibrating the electrode at temperature different than 20°C by entering the buffer value suitable at the current temperature to the meter's memory.

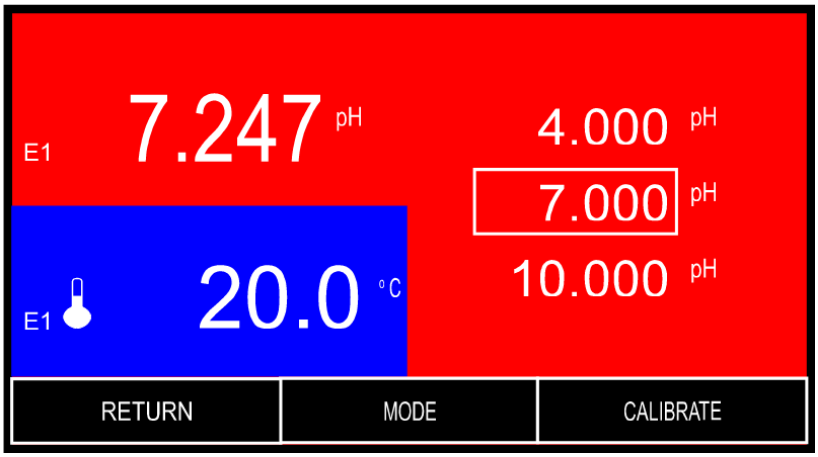
10.3. Calibration in buffer solutions

When the electrode is prepared for measurement, start calibration in buffer solutions. The buffers may be applied randomly.
To start calibration:

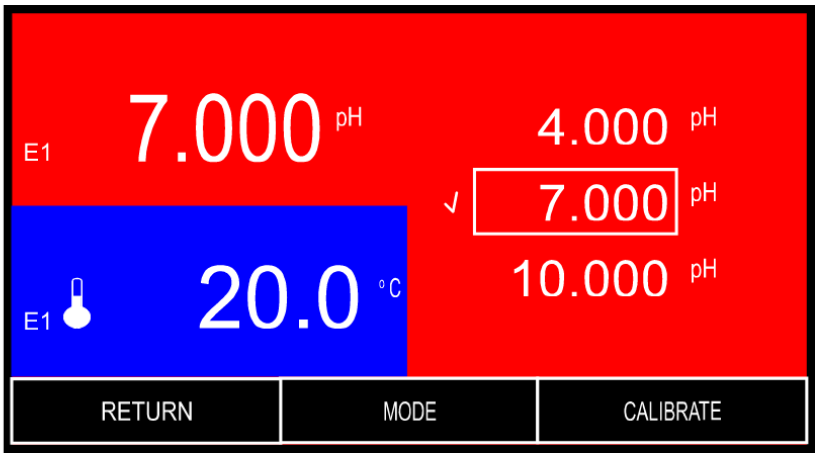
- choose the electrode number (**E1**, **E2** or **E3)** according to the point 9.2 and mark the electrode with this number;
- connect the pH electrode and temperature probe to the **pH/mV** and **t** sockets respectively (Pic. 2);
- enter the calibration mode: on the measurement screen mark pH result with a frame, press and hold the **CALIBRATION** button until the background turns red (Pic. 7.A). The previous electrode characteristic is erased;
- press the **MODE** button, the pH measurement parameters screen will appear;
- press the **SOLUTION** window and choose **BUFFER**;
- check and, if necessary, enter the calibration points values according to the point 10.2;
- put the pH electrode and temperature probe into the solution; do not touch the vessel's walls and bottom. It is advisable to use an electrode holder. The meter will mark the detected buffer's value with frame;
- wait until the reading stabilises (it will be probably slightly different than the calibration point value).

When the reading stabilises, press the **CALIBRATE** button. Next to the detected buffer value the marking will appear, what informs that the calibration value has been recorded. Simultaneously, the measurement value will be adjusted to the detected buffer value (Pic. 7.B). If the reading is still different than the solution value, wait until the reading stabilises and press the **CALIBRATE** button again.

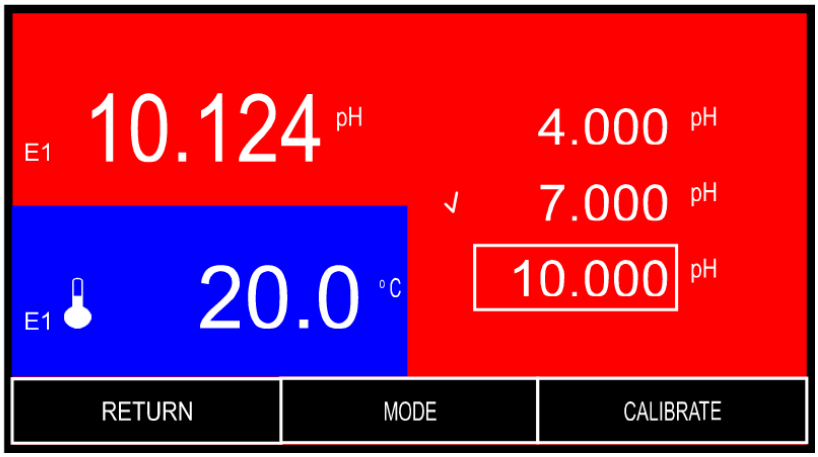
A



B



C



Pic. 7.

If the meter is unable to detect the buffer‘s value, it will signalise the error after pressing the **CALIBRATE** button with a tripple warning sound. In such case check the solution value or the electrode which may be broken.
Only the pH buffers values detected during calibration are calculated, any other values recorded earlier do not influence the reading.

After finishing calibration in the first buffer rinse the electrode and temperature probe in distilled water and dry them with tissue paper and start calibration in next buffers (Pic. 7.C) by repeating the last point of the activities described above.
When the electrode is calibrated, two other electrodes may be calibrated and marked with the other electrode numbers.

10.4. Calibration with use of standard solutions

In this mode the standard solutions values, compliant with the NIST norm, are used. **The meter's memory stores a table with a dependence between the temperature and pH values for these standard solutions.**
If the standard solution's value differs from the entered standard value in the 3rd decimal place, the factory values may be adjusted in the range ±0.010 pH (description below). After inserting the temperature probe into the pH standard its temperature is measured and the pH value corresponding to this temperature is suggested automatically. There is no need to adjust the standard solutions temperature.

To perform calibration in standards:
- choose the electrode number (**E1**, **E2** or **E3)** according to the point 9.2 and mark the electrode with this number;
- connect the pH electrode and temperature probe to the **pH/mV** and **t** sockets respectively (Pic. 2);
- enter the calibration mode: on the measurement screen mark pH, press and hold the **CALIBRATION** button until the background turns red (Pic. 7.A). The previous electrode characteristic is erased;
- press the **MODE** button, the pH measurement parameters screen will appear;
- press the **SOLUTION** window, choose **STANDARD**;
- check and, if necessary, enter the calibration points values according to the point 10.2;
- put the pH electrode and temperature probe into the solution; do not touch the vessel's walls and bottom. It is advisable to use an electrode holder. The meter will mark the detected buffer's value with frame;
- wait until the reading stabilises (it will be probably slightly different than the calibration point value).

When the reading stabilises, press the CALIBRATE button. Next to the detected buffer value the marking will appear, what informs that the calibration value has been recorded. Simultaneously, the measurement value will be adjusted to the detected buffer value. If the reading is still different than the solution value, wait until the reading stabilises and press the CALIBRATE button again.
If the meter is unable to detect the buffer‘s value, it will signalise the error after pressing the CALIBRATE button with a triple warning sound.
At this point the calibration may be finished by pressing the RETURN button or continued in other standards. After finishing measurement in each standard rinse the electrode and temperature probe with distilled water and dry them with tissue paper.
Only the pH buffers values detected during calibration are calculated, the other values recorded earlier do not influence the reading.

After calibrating the electrode, two other electrodes may be calibrated after choosing the other electrode numbers.

In case of choosing the electrode number, entering the calibration mode and exiting it without performing calibration, the stored characteristic will be erased and the standard characteristic will be adopted. The characteristic erasing is signalised with red colour of the electrode number on the measurement screen.

10.5. Calibration with manual temperature compensation

In case of the temperature probe breakdown, calibration with manual temperature compensation may be proceeded. To start this calibration, disconnect the temperature probe. It switches the meter to manual compensation. Next to the entered (not measured) temperature value instead of the symbol the symbol will appear. Entering the temperature value for the manual compensation is described in the point 21.5. Than act identically as in case of calibration with automatic temperature compensation, excluding the temperature probe connection.

11. CHECKING THE ELECTRODE CONDITION

After pH electrode calibration the meter calculates its parameters: offset in pH units and slope defined also as efficiency in percents.

The electrode offset may be defined in pH or mV units.
An ideal electrode immersed in the 7.00 pH buffer before calibration should indicate 7.00 pH which equals 0.00 mV. If the reading is different, it informs that the electrode has an offset, which may be reduced by calibration. The information about the offset in mV may be obtained by converting the reading in pH. At 20 °C each pH unit corresponds to 58.168 mV. If the electrode has 0.2 pH offset, multiply it by 58.168 mV to obtain the electrode potential value in mV (SEM – Standard Error of Measurement). In the given example it will be equal 11.634 mV.
The SEM parameter may be also checked by immersing the electrode in 7.00 pH buffer and switching the meter to measurement in mV.

When the electrode is calibrated, its condition may be checked. To check, enter the calibration points screen according to description in the point 9.4. The top left of the screen (Pic. 4C) displays the electrode number and below the calibration date two parameters, determined during the last calibration are displayed: Δ (zero offset in pH) and η (condition in %).
Yellow colour of the electrode number signalises:

- electrode condition loss, if the zero and condition parameter are displayed in yellow;
- calibration validity date expiry if the last calibration date is also displayed in yellow.

In case of 1 point calibration, only the zero offset parameter is displayed.

12. pH MEASUREMENT

Before starting measurement the meter and the pH electrode have to be prepared for work (chapters 7 and 8 respectively). Good condition of the electrode is crucial for correct readings. If the electrode is calibrated, choose its number according to the section 9.2 and the measurement resolution according to the section 9.1.

12.1. Measurement with automatic temperature compensation

During measurements with automatic temperature compensation the meter cooperates with the temperature probe and measures the temperature of the solution simultaneously with pH and calculates its influence to the pH reading. In case of measurement with automatic temperature compensation:

- turn the meter on by pressing the ON/OFF button;
- connect the temperature probe and the combination pH electrode to the **pH/mV** and **t** sockets respectively (Pic. 2), the symbol will be displayed;
- immerse the electrode and the temperature probe in 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.

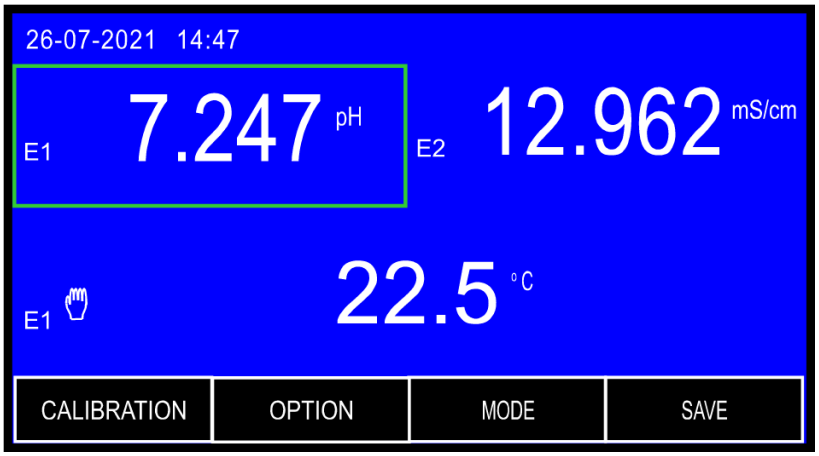
Accurate laboratory measurements require using of a magnetic stirrer.

NOTE: exceeding the measurement range is signalised with red colour of the displayed pH value; exceeding the temperature compensation range is signalised with yellow colour.

12.2. Measurement with manual temperature compensation

Disconnecting the temperature probe from the meter switches the meter to the manual temperature compensation mode. Next to the entered (not measured) temperature value, instead of the symbol, the symbol is displayed (Pic. 8). The procedure of measurement with manual temperature compensation is similar to that of measurement with ATC. The difference is in entering the solution temperature value (description – point 21.5). This value is displayed in place of the measured temperature and is used for compensation.
Manual compensation may be used in stable conditions, i.e. during laboratory pH measurements, especially with use of thermostat, or in case of the temperature probe breakage.
In case of measurement with manual temperature compensation:

- turn the meter on with the ON/OFF button;
- insert the pH electrode into the vessel with the measured solution; if the electrode is not calibrated or has already been in use for a long period of time, perform a calibration (chapter 10). During measurements in a vessel don't touch its bottom and walls with the electrode. It is advisable to use an electrode stand;
- measure the temperature of the solution with use of a laboratory thermometer and enter the value according to the point 21.5;
- wait till the value stabilises and read the result.



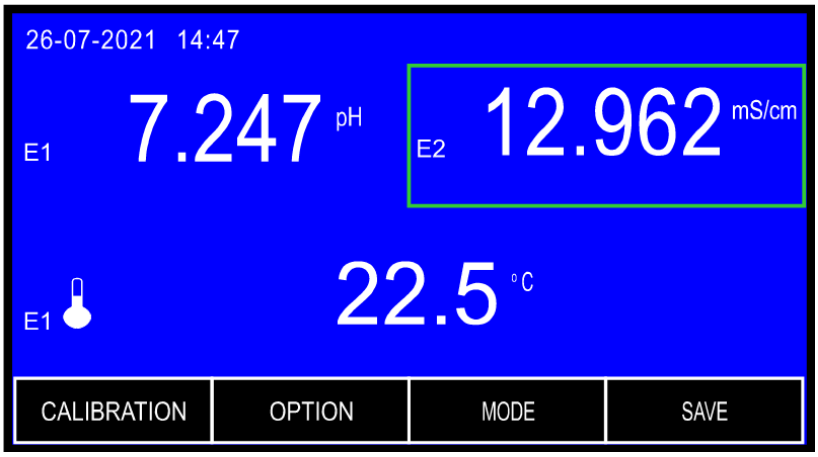
Pic. 8

III. CONDUCTIVITY AND SALINITY MEASUREMENT

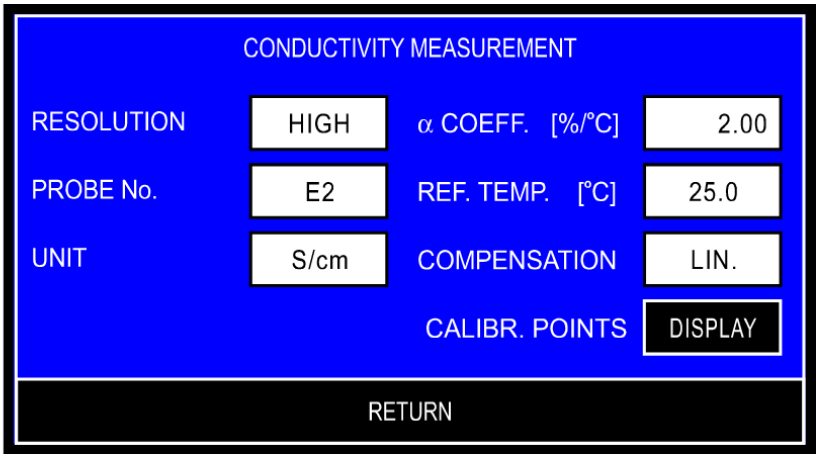
13. ENTERING THE CONDUCTIVITY PARAMETERS

Before starting calibration and measurements it is necessary to perform all activities described in the chapter 7. Additionally, according to the chapter below, it is necessary to choose the unit in which the calibration and measurement are going to be made.
The parameters screen is entered by pressing the conductivity reading (a frame will display around it Pic. 9A), and next pressing the MODE button. This screen (Pic. 9B) enables choosing resolution, the cell number, unit, checking the calibration point and date, entering the calibration validity time, a coefficient, reference temperature and TDS coefficient.

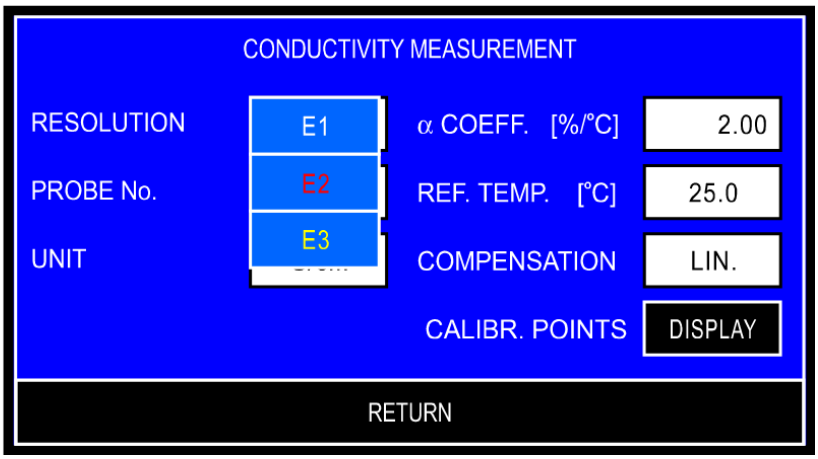
A



B



C



Pic. 9

When the parameters are entered, return to the measurement screen by pressing the RETURN button.

13.1. Resolution

The reading may be displayed with low or high resolution.
After pressing the **RESOLUTION** window, choose:

LOW - 3½ digit measurement resolution;
HIGH - 4½ digit measurement resolution.

13.2. Cell number

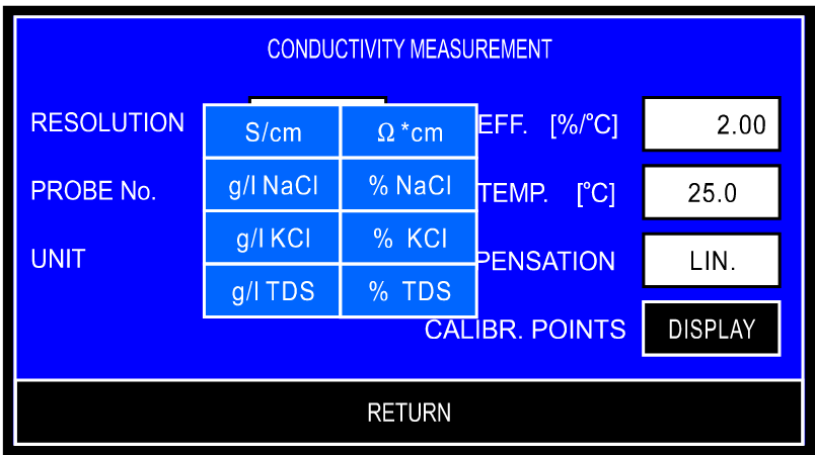
If the meter stores more than one cell characteristic, the cell may be replaced without calibration. This option is very useful in case of using different types of cells, i.e. for sewage, clear water etc. After pressing the **PROBE NO** window the table appears (Pic. 9C), from which its possible to choose one of the characteristics stored under **E1**, **E2** or **E3** number. The number's colour informs about the cell's condition:

white - cell calibrated;
yellow - the calibration validity date expired;
red - calibration data erased (default value K = 1.000 cm^{-1}), the cell calibration necessary.

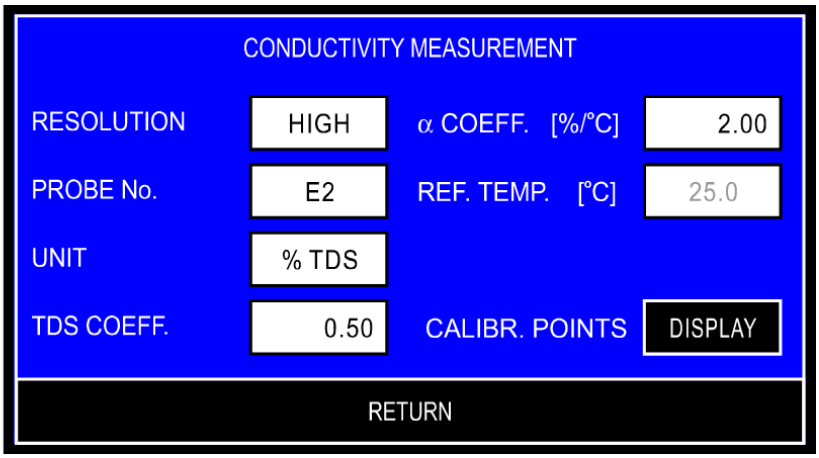
13.3. Choosing the unit

The reading may be displayed in units of conductivity, resistivity 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, press the **UNIT** window. The screen for choosing the unit will appear (Pic. 10A).

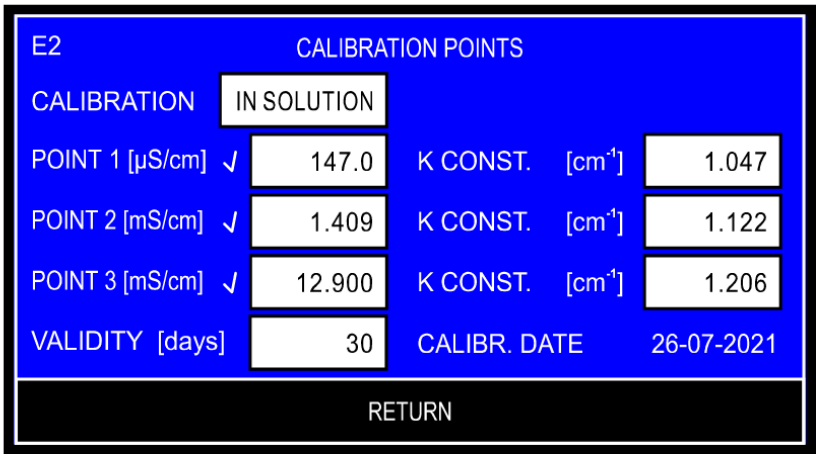
A



B



C



Pic. 10

Choose the unit by pressing the relevant window.
In case of choosing **S/cm** and **Ω*cm** unit, at the bottom of the screen the **COMPENSATION** position and the window with the chosen compensation mode with appear. In case of measurements in **g/l NACL**, **% NACL**, **g/l KCL**, **% KCL, g/l TDS, % TDS** units, the **COMPENSATION** position does not appear. Only the linear compensation is possible.

In case of the salinity measurement in **g/l TDS or % TDS** units in the place of the **COMPENSATION** position the **TDS COEF** position will appear for entering the TDS coefficient (Pic. 10B).

The reading in w % of the weight concentration can be counted to the value in **ppm** according to the following proportion:
1% of the weight concentration (C) = 10 000 ppm = 10 ppt.
The measurement resolution in % of the weight concentration is equal 0.01% or 100 ppm.

13.4. Calibration points and date

Pressing the **DISPLAY** button opens a screen (Pic. 10C) which displays calibration modes, calibration points, K constant in these points, calibration validity time and the last calibration date. In the **MANUAL** calibration mode only P1 point is active. The marker next to the window with K constant value in this mode informs about entering the K constant. Lack of the marker informs about deleted characteristic. In the **IN SOLUTION** calibration mode it is possible to check values of three calibration solutions by pressing the window with the point number. The marker next to the window with the calibration point value informs that calibration was made in this point. The K constant value determined for this point is displayed next to it. All parameters are stored separately for each of three cells. The calibration point and K constant may be changed in the calibration mode only.

13.5. Calibration validity time

Below the window with the calibration point value there is a **VALIDITY [days]** position and a window with the number of days entered earlier. The meter stores the calibration validity time separately for each of the three cells. Exceeding this time is signalised with yellow cell number. To enter the calibration validity time, press the **VALIDITY [days]** window, numerical keyboard will appear to enter the number of days and confirm it with the **OK** button.

13.6. Choosing the type of temperature compensation

In case of measurements in **S/cm** and **Ω∗cm** unit, depending on the type of measured solutions, it is possible to choose the most suitable way of compensating the conductivity changes with the temperature measurement function.
To choose, on the conductivity measurement parameters screen press the **COMPENSATION** window, a table with the following positions will appear:

- **LIN.** - linear compensation with calculation of the entered α coefficient value;
- **NLIN.** - non-linear compensation for natural water;
- **UPW** - non-linear compensation for ultra pure water;
- **NACL** - non-linear compensation for ultra pure water with traces of neutral salt;
- **HCL** - non-linear compensation for ultra pure water with traces of acid;
- **NAOH** - non-linear compensation for ultra pure water with traces of alkaline.

Choose the type of compensation by pressing the relevant window in the table.

13.7. Entering the α coefficient

The α coefficient range in **PH/CO2500L** is 0 ÷ 10.00 % / ^{0}C with accuracy 0.01 % / ^{0}C. Generally for measurements, the most frequently applied temperature compensation coefficient is equal α = 2 % / ^{0}C. In case of higher accuracy requirements the kind of solution should be determined and the relevant coefficient value entered.
To enter the α coefficient press the „**α COEF.**“ window, numerical keyboard will appear to enter the value and confirm with the **OK** button (available only for units: S/cm and Ωcm and LIN and UPW compensation).

The measurement result will be calculated with use of the entered α temperature coefficient.

Note: changing the unit in the temperature measurement function will automatically convert the α coefficient into this unit.

For certain types of the temperature compensation the option of changing the α coefficient may be unavailable.

13.8. Entering the reference temperature

It is possible to choose calculation to 20.0 °C or to 25.0 °C.
To enter the reference temperature value, press the „**REF. TEMP.**“ window, table will appear with values 20.0 °C and 25.0 °C. Choose the right value by pressing the relevant window in the table.

The measurement result will be calculated with use of the entered reference temperature.

Note: changing the unit in the temperature measurement function will automatically convert the reference temperature into this unit.

13.9. Entering the W_{TDS} coefficient

In case of choosing salinity measurement with conversion to TDS content the **TDS COEF.** window will appear (Pic. 10B). Enter the W_{TDS} coefficient value in it. To enter, press the **TDS COEF.** window, numerical keyboard will appear to enter the value and confirm with the **OK** button.

14. MAINTENANCE OF THE CONDUCTIVITY CELL

The delivered in the set conductivity cell with a range 0 ÷ 400 mS/cm is sufficient for measurements in almost every type of liquids with maximal concentration. Metal electrodes are easy to clean and plastic body provides higher durability.

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. In case of measurements in water, maintenance of the cell consists in accurate rinsing the measuring cell with distilled water. In case of liquids with oils sediment or fat content, cleaning should be made in water with detergent or proceeded according to the instructions from the cell's manual.

In case of using platinum cells the electrodes **must not be cleaned mechanically**, because it results in rubbing off the platinum layer, what can cause decreasing of accuracy, lowering of stability and changing of the K constant. Measurements may cause platinum contamination, make the measurement impossible and irreparably damage the electrodes.

To obtain stable readings it is advisable to soak the cell for an hour before the measurements. It is especially important in case of measurements in distilled water.

Broken glass cell cannot be used due to significant K constant change, unstable readings and increase of the dependence of the result on the position of the cell in the measuring vessel. To obtain correct measurement results, the cell should be immersed in such a way for the solution to fill it up and not to include any air bubbles. 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 are difficult to remove, it is advisable to immerse the cell in a water – washing up liquid mixture, what lowers the surface tension and disables air bubbles to stick to the surface of the cell walls or electrodes. Next, wash the cell accurately with distilled water and proceed with the measurements.

15. CALIBRATION

A characteristic feature of every conductivity cell is its K constant. Before the result is displayed, the measured value is multiplied by the K constant value.

In practice, the K constant is determined by calibration in standard solution. The user may calibrate in two ways: by entering known K constant value (given by the cell's manufacturer) or by determining it with use of a standard solution. The manufacturer of the cell provides information about the K constant, precisely determined by calibration in a particular standard solution (usually it is 12.90 mS/cm). Before the first measurement or in case of replacing the cell it is necessary to enter this value into the meter's memory, as it is crucial condition for obtaining accurate results.
The solution may be considered as a standard solution when it is a KCl solution with conductivity 7.4 mS/m (0.0005 mol/l solution) to 2480 mS/m (0.2 mol/l solution), which means respectively 740 mS/cm to 24.8 mS/cm at 25 ^{0}C. In case of conductivity measurements in liquid with parameters which significantly differ from the standard solution used for calibration, the error may be greater. In case of measurements in solutions with conductivity above 200 mS/cm or higher it is advisable to calibrate in solution with known conductivity value close to the measured value. In such case it is possible to prepare KCl solution according to the given table.

mS/cm at 25 ^{0}C	C (g/dm^3)	%	M (mol/dm^3)
111.80	74.555	7.1135	1.0
156.5	106.18	10	1.424
230.9	164.34	15	2.204
303.4	226.16	20	3.033

Weight accurately the KCl amount and dissolve it in 700 ml of the distilled water and next filled up to 1000 ml.

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

Entering the calibration mode irreversibly erases the cell's K constant stored under the chosen cell number.

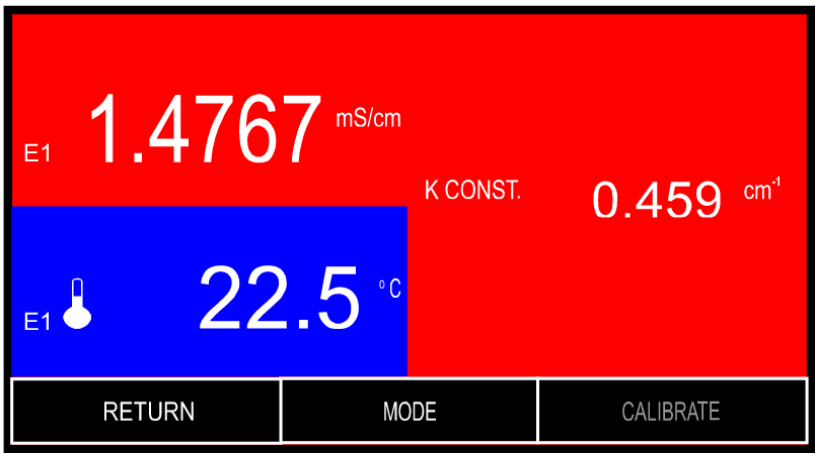
In case of choosing the cell number, entering and escaping the calibration mode not having made calibration, the previously stored K constant will be deleted and K = 1 cm^{-1} constant will be adopted.
The characteristics erasing is signalised with red colour of the cell number on the measuring screen.

15.1. Calibration without standard solution

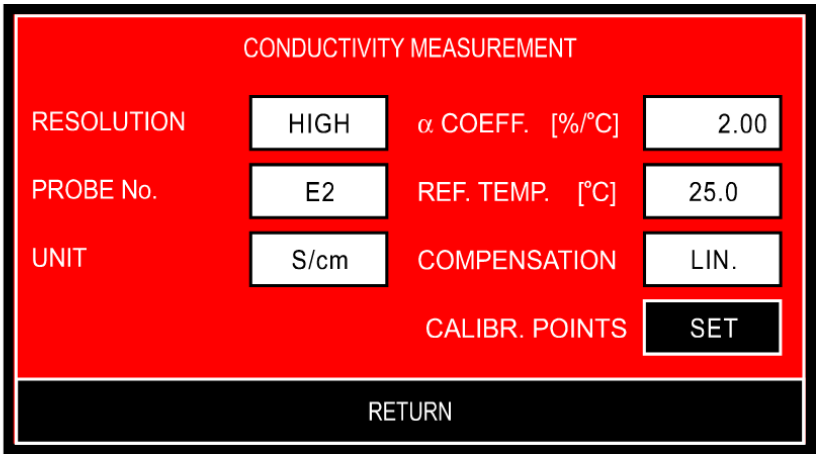
The meter has a possibility of calibration without use of standard solution. In case of such calibration it is necessary to know the K constant of the conductivity cell. This value may be given by the cell manufacturer or may be determined with use of **PH/CO-2500L** meter. The meter has to be calibrated in the standard solution.
To calibrate:

- choose the cell number (**E1**, **E2** or **E3)** according to the point 13.2;
- enter the calibration mode: on the measurement screen select the conductivity measurement by pressing the result, it will be marked with a frame, press and hold the **CALIBRATION** button until the background changes colour to red, the meter will automatically change the unit to S/cm (Pic. 11.A). Adopted K constant is equal 1.000cm^{-1};
- press the **MODE** button, the conductivity measurement screen will display (Pic. 11.B);
- press the **SET** button, the screen with K constant will display;
- press the window of the **CALIBRATION** position and choose **MANUAL**;
- press the **K CONST.** window, numerical keyboard will appear to enter the value and confirm it with the **OK** button. In the window the entered K constant will appear and a marker next to it (Pic. 11.C);
- return to the measurement screen by double pressing the **RETURN** button.

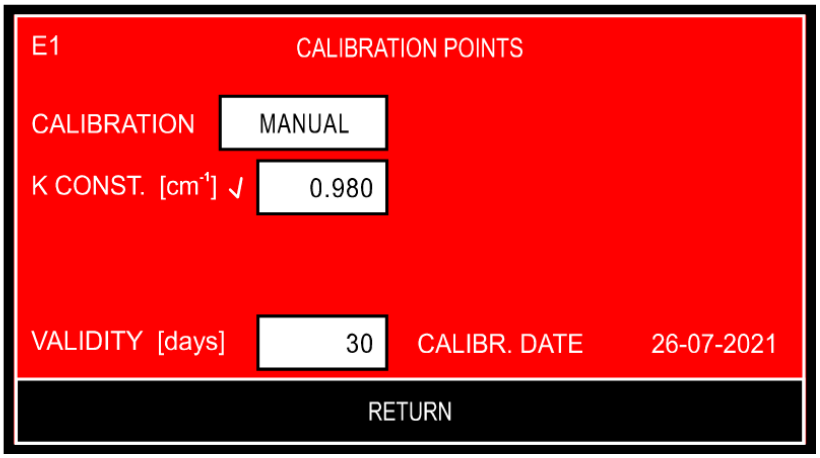
A



B



C



Pic. 11.

15.2. Calibration with use of standard solution

The K constant of the conductivity cell changes with the conductivity value of the measured solution. The purpose of multi-point calibration is to suppress this effect. The meter enables 3-point calibration in freely chosen standard solutions. For each of the standard solutions the meter determines the K constant and during measurement automatically provides the K constant value appropriate for the measured range. 1-point calibration in standard enables to determine one K constant of the cell. In case of 1-point calibration, to decrease the possible error, it is recommended to use solution with a value close to the expected conductivity value of the measured solution. In the majority of cases, 1-point calibration is sufficient.
It is required to use standards of high quality for calibration.

To obtain accurate results of calibration, comply to the following principles:

1. For multi-point calibration start with the standard solution of the lowest conductivity value and end with one of the highest.
2. The temperature of the standards should be equal to the reference temperature (the most frequently it is 25 ^{0}C).
3. New, unused standards should be applied.
4. The calibrated cell and its electrodes should be clean and without air bubbles.
5. The electrode holder should be used.

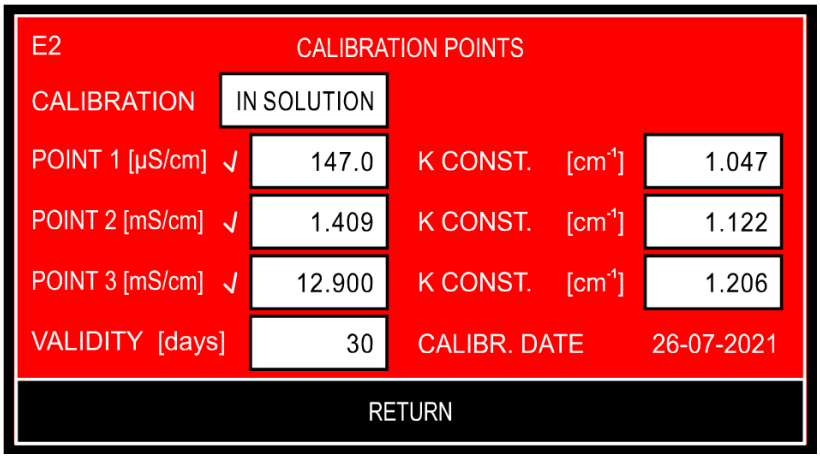
15.2.1. Entering the standard solution value

To enter the standard solution value:

- choose the cell number (**E1**, **E2** or **E3)**, according to the point 13.2;
- enter the calibration mode: on the measurement screen select the conductivity measurement by pressing the conductivity result, it will be marked with a frame, press and hold the **CALIBRATION** button until the background changes colour to red, the meter will automatically change the unit to S/cm (Pic. 11.A). Adopted K constant is equal 1.000cm^{-1};
- press the **MODE** button, the conductivity measurement parameters screen will be displayed (Pic. 11.B);
- press the **SET** button, the screen with a previous calibration point will be displayed (Pic. 12.);
- press the window of the **CALIBRATION** position and choose **IN SOLUTION**;
- press the window of the **POINT No.** position and choose the point which is to be set;
- press the window with the point value, a window for choosing the unit will appear;
- choose the unit, a numerical keyboard will appear to enter the value and confirm with the **OK** button.
- choose successive points by pressing the **POINT No.** window;

or

- enter the measurement screen in the calibration mode by pressing the **RETURN** button, or quit the calibration mode by pressing the **RETURN** button once again .



Pic. 12.

15.2.2. Calibration with automatic temperature compensation

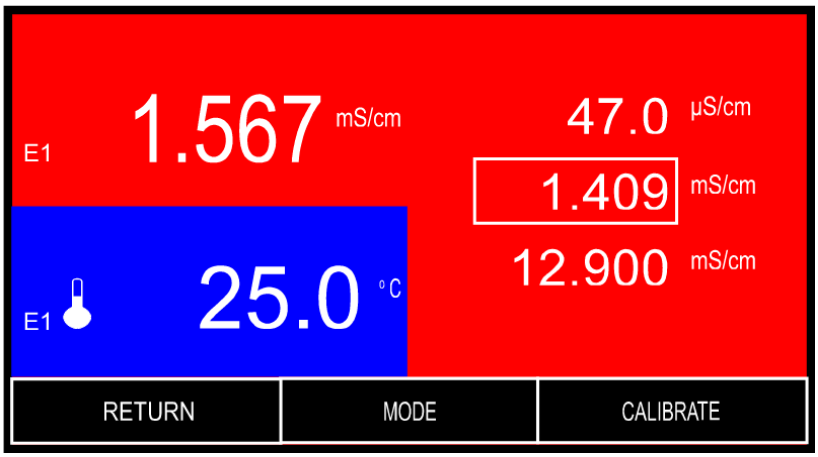
Follow the instructions:

- choose the cell number (**E1**, **E2** or **E3)**, according to the point 13.2;
- connect the conductivity cell and the temperature probe;
- enter the calibration mode: on the measurement screen select the conductivity measurement, press and hold the **CALIBRATION** button until the background changes colour to red, the meter will automatically change the unit to S/cm (Pic. 13.A). Adopted K constant is equal 1.000cm^{-1}. Next to the reading the calibration point values will be displayed. The currently calibrated point is always displayed in a frame
- check and, if necessary, adjust the standard solution values (point 15.2.1);
- immerse the conductivity cell and the temperature probe in the first standard, hold the conductivity cell at least 1 cm away from the bottom and walls of the vessel. Make sure, that the measuring cell is filled up with the sample solution and does not include any air bubbles, and the electrode's surface is evenly moistened. Around the calibration point displays a frame, which informs about recognising of the standard solution by the meter;
- when the reading stabilises, press the **CALIBRATE** button. Next to the calibration point a mark appears, what informs about recording the calibration value. At the same time, the reading will be adjusted to the recognised standard value and the frame indicating the calibration point will switch to the next position (Pic. 13.B);
- continue calibration in the following standards, rinsing the cell and the temperature probe with distilled water after each calibration in solution,

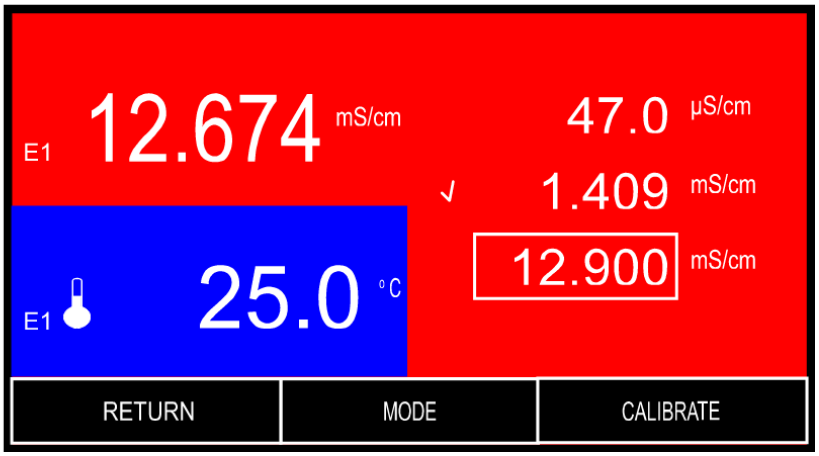
or

- quit the calibration mode by pressing the **RETURN** button.

A



B



Pic. 13.

Blinking frame around the calibration point informs, that the difference between the reading and the standard is significant, the meter will signalise the error with a triple warning sound after pressing the **CALIBRATE** button.

When the calibration process is finished, the meter is ready for the measurement.

Calibration in standard solutions may be done in 1, 2 or 3 points. After finishing calibration in 1 point, if no other points will be calibrated, to finish the calibration it is necessary to press the **RETURN** button. After calibrating all 3 points the meter will automatically, after 2 seconds, leave the calibration mode.

To check the calibration result, value of the determined constant K, one should exit the calibration mode by pressing the **RETURN** button, on the measuring screen press the conductivity result and mark it with a frame. Next press the **MODE** button and Calibr. Points **DISPLAY**. The displayed screen will show the calibration details. The points used in calibration will be marked with a sign and constant K for that point will be displayed.

15.2.3. Calibration with manual temperature compensation

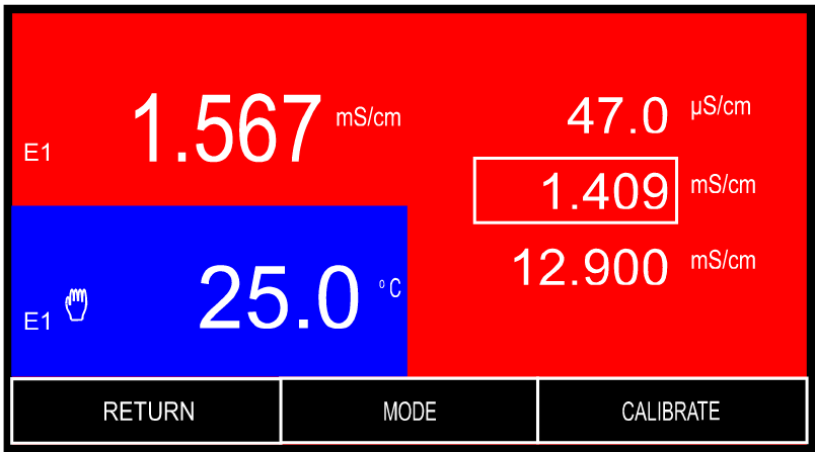
To calibrate the meter:

- disconnect the temperature probe;
- measure the temperature of the solution with a laboratory thermometer and enter its value according to section 21.5;
- enter the calibration mode: select the conductivity measurement on the measurement screen, press and hold the **CALIBRATION** button until the background changes colour into red, the meter will automatically change the unit into S/cm (Pic. 14A). Adopted K constant is equal 1.000cm^{-1}. Next to the reading the calibration point values will be displayed. The currently calibrated point is always framed;
- check and, if necessary, adjust the standard solution values (point 15.2.1);
- immerse the conductivity cell in the first standard solution and hold it at least 1cm away from the bottom and walls of the vessel. Make sure, that the measuring cell is filled up with the sample solution and does not include any air bubbles, and the electrode's surface is evenly moistened. Around the calibration point displays a frame, which informs, which informs about recognising the standard by the meter;
- when the reading stabilises, press the **CALIBRATE** button. Next to the calibration point a mark appears, what informs about recording the calibration value. At the same time, the reading will be adjusted to the recognised standard value and the frame indicating the calibration point will switch to the next position (Pic. 14B);
- continue calibration in the following standards, rinsing the cell and the temperature probe with distilled water after each calibration in solution,

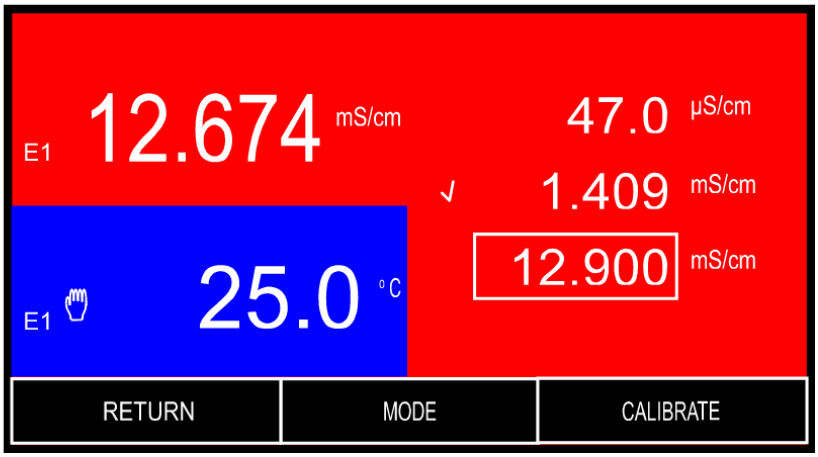
or

- quit the calibration mode by pressing the **RETURN** button.

A



B



Pic. 14

Blinking frame around the calibration point informs, that the difference between the reading and the standard is significant, the meter will signalise the error with a tripple warning sound after pressing the **CALIBRATE** button.

When the calibration process is finished, the meter is ready for the measurement.

Calibration in standard solutions may be done in 1, 2 or 3 points. After finishing calibration in 1 point, if no other points will be calibrated, to finish the calibration it is necessary to press the **RETURN** button. After calibrating all 3 points the meter will automatically, after 2 seconds, leave the calibration mode.

To check the calibration result, value of the determined constant K, one should exit the calibration mode by pressing the **RETURN** button, on the measuring screen press the conductivity result and mark it with a frame. Next press the **MODE** button and Calibr. Points **DISPLAY**. The displayed screen will show the calibration details. The points used in calibration will be marked with a sign and constant K for that point will be displayed.

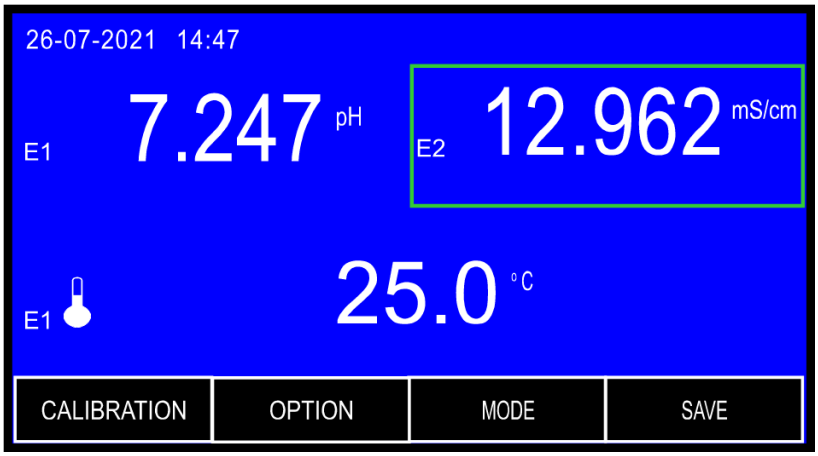
16. CONDUCTIVITY MEASUREMENT

16.1. Measurement without temperature compensation

An accurate conductivity measurement should be performed without the temperature compensation. The measured solution should be adjusted to the reference temperature chosen earlier (25 °C or 20 °C), with use of the temperature measurement provided by the meter. In case of work without the temperature probe it is necessary to enter the temperature value according to the point 21.5.

Follow the instructions:

- connect the conductivity cell and the temperature probe to the **Con** and **t** sockets respectively (Pic. 2);
- turn the meter on with ON/OFF;
- choose the conductivity measurement mode (section 13.3);
- if the conductivity cell is not calibrated, calibrate it (chapter 15);
- immerse the conductivity cell and the temperature probe in the solution, hold the conductivity cell at least 1 cm away from the bottom and walls of the vessel. Make sure, that the measuring cell is filled up with the sample solution and does not include any air bubbles, and the electrode's surface is evenly moistened*;
- adjust the solution temperature to the reference temperature;
- check the reading when it stabilises (Pic. 15).



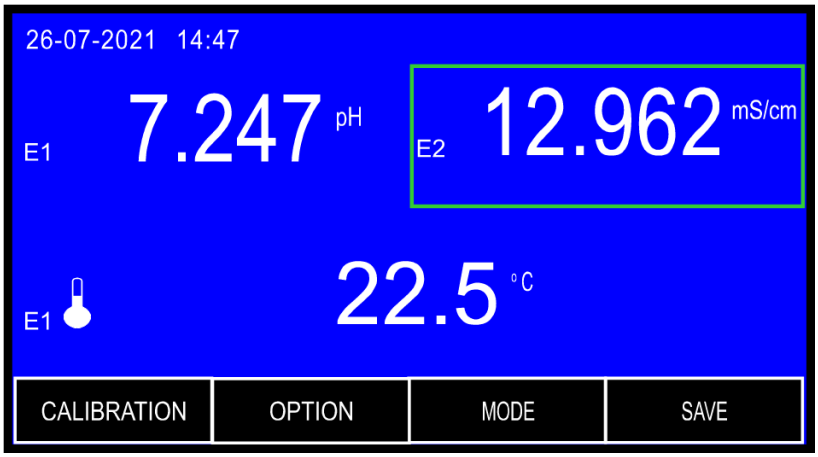
Pic. 15.

* - 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

Follow the instructions:

- connect the conductivity cell and the temperature probe to the **Con** and **t** sockets respectively (Pic. 2);
- turn the meter on with ON/OFF;
- choose the conductivity measurement mode (section 13.3);
- if the conductivity cell is not calibrated, calibrate it (chapter 15);
- check or change the α coefficient and the reference temperature;
- immerse the conductivity cell and the temperature probe in the solution, hold the conductivity cell at least 1 cm away from the bottom and walls of the vessel. Make sure, that the measuring cell is filled up with the sample solution and does not include any air bubbles, and the electrode's surface is evenly moistened*;
- check the reading when it stabilises (Pic. 16).



Pic. 16.

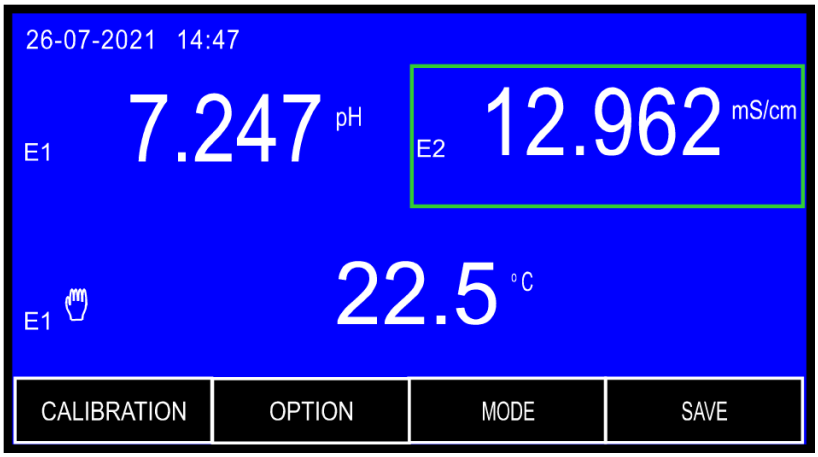
Note: in case of exceeding the range of temperature compensation the reading changes colour to yellow. The symbol next to the reading instead of informs that the temperature probe is broken or disconnected.

* - 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 performed in stable working conditions, i.e., measurements in laboratory, especially with use of thermostat, or in case of the temperature probe breakdown. Disconnecting the temperature probe switches the meter to manual temperature compensation.
To make measurement with manual temperature compensation:

- connect the conductivity cell to the **Con** socket (Pic. 2);
- disconnect the temperature probe;
- turn the meter on with ON/OFF;
- choose the conductivity measurement mode (section 13.3);
- if the conductivity cell is not calibrated, calibrate it (chapter 15);
- check or change the α coefficient and the reference temperature;
- immerse the conductivity cell and the temperature probe in the solution, hold the conductivity cell at least 1 cm away from the bottom and walls of the vessel. Make sure, that the measuring cell is filled up with the sample solution and does not include any air bubbles, and the electrode's surface is evenly moistened*;
- measure the temperature of the solution and enter its value according to the point 21.5;
- check the reading when it stabilises (Pic. 17.).



Pic. 17.

* - 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 to determine the TDS (Total Dissolved Solids). The received values are always approximated and the 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 the salinity is 1g/l. In practice, the dependence between conductivity and salinity isn't linear and the conversion coefficient is changing with the concentration and temperature. Table 3 shows the dependence between conductivity and real 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 results in significant error.

Table 3.

Conductivity (mS/cm)	Real salinity (g/l)	Salinity (g/l) calculated for coefficient = 0.5	Error (%) for 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

The microcontroller in PH/CO-2500L calculates actual dependence between conductivity and salinity according to the real characteristic, what greatly reduces the error. There is a possibility of calculating the salinity in conversion to NaCl or KCl, because the dependence for this two 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. It is possible to determine the approximate Total Dissolved Solids content using the conductivity reading 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

To make the salinity measurement with conversion to NaCl or KCl content, follow the instructions:

- choose the salinity measurement with conversion to NaCl or KCl content according to section 13.3;
- act as during the conductivity measurement (chapter 16);
- check the reading when it stabilises.

18. NOTICES ABOUT TEMPERATURE COMPENSATION

18.1. Natural water

The meter enables reduction of the temperature compensation error in case of measurements in natural water with conductivity in range 60 µS/cm ÷ 1 mS/cm. Natural water is the surface water and the ground water. Compensation may be applied in the temperature range 0 ÷ 37 ºC. The coefficient values for natural water have been entered to the meter's memory and are calculated in counting process. After choosing non-linear compensation (**NLIN**) from the menu the meter will calculate the relevant parameters using the α coefficient which changes with the temperature.

18.2. Ultra pure water

The most accurate conductivity readings will be obtained in the reference temperature without temperature compensation. In case of measurements in ultra pure water with conductivity up to 10 µS/cm proceeded with automatic temperature compensation, the measurement accuracy has been improved. A special function, in the meter, which enables automatic detection of the most suitable α coefficient depending on the temperature of the measured solution is used.

A distinction has been made among four types of ultra pure water (UPW):

UPW - ultra pure water without contamination (C=0.055µS/cm at 25.0ºC).
UPW $_{NaCl}$ - ultra pure water with traces of neutral ions (e.g. NaCl);
UPW $_{HCl}$ - ultra pure water with traces of acidic ions (e.g. HCl);
UPW $_{NaOH}$ - ultra pure water with traces of alkaline ions (e.g. NaoH).

Trace contamination usually appears as a result of water filtration and depends on types of applied filters.
Temperature changes cause the α coefficient changes. The most significant change appears in case of water without trace contamination.
The table below describes the changes.

In case of water with conductivity C=0.5µS/cm at 25 °C the α coefficient values at other temperature are as follows:

	T=26.0ºC		T=50.0ºC		T=69.9ºC	
	conductivity	α coef.	conductivity	α coef.	conductivity	α coef.
UPW	0.532µS/cm	5.81%	1.50µS/cm	8.55%	3.20µS/cm	11.96%
UPW NaCl	0.512µS/cm	2.07%	0.77µS/cm	2.15%	1.00µS/cm	2.20%
UPW HCl	0.508µS/cm	1.47%	0.67µS/cm	1.41%	0.81µS/cm	1.36%
UPW NaOH	0.512µS/cm	1.83%	0.72µS/cm	1.72%	0.88µS/cm	1.68%

In case of ultra pure water without trace contamination it is possible to compensate to the chosen reference temperature. For water with trace contamination compensation is calculated for 25 ºC.
The user has to determine the type of contamination in the measured water and choose the relevant option which will enable to calculate conductivity for the reference temperature.
In case of measurements in ideally clear water, the **UPW** compensation has to be chosen from the menu.
If water contains trace contamination (it is the most frequent case), knowing the type of contamination (acidic, alkaline or neutral) enables to choose relevant compensation option. If we know that water is not ideally clear but we do not know the type of contamination, the best solution is to choose compensation for contamination with neutral salts - **NaCl**.

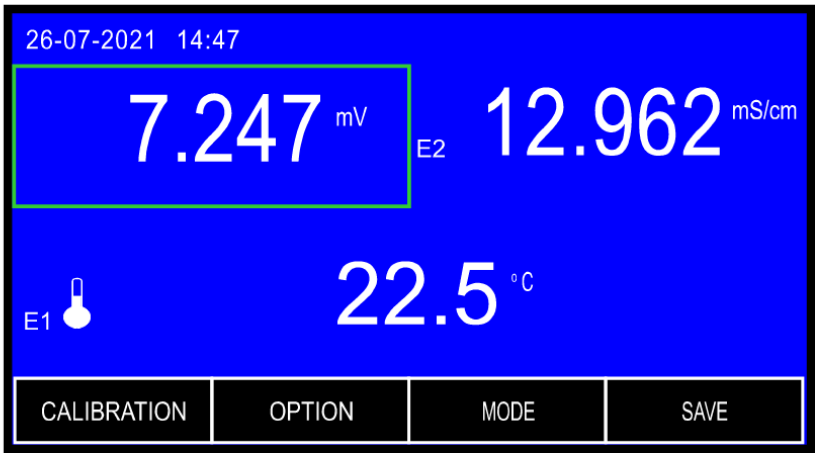
Ultra pure water is a strong solvent. When it is exposed to air even for a short time, its conductivity changes to about 2 ÷ 3µS/cm as a result of dissolution of CO_2 in it. Therefore, measurements in open vessels may result in additional error.
Using the same cell for measurements in both salty and ultra pure water may also cause erroneous readings. It is crucial to carefully and accurately rinse the cell. Systematically rising measurement values may signalise that the cell was not cleaned sufficiently and the remains of chemical compounds from the cell infiltrate into the measured water. It is advisable to use a separate cell for measurements in ultra pure water.
In order to improve accuracy, it is advisable to use a flow cell connected in the by-pass outflow of the ultra pure water. The materials used in the supply circuit should not be soluble in water. In case of making pH measurements in the same circuit, the pH electrode should be placed as the second one, behind the conductivity cell.
The cell has to be accurately rinsed, especially before first measurements. It may last even 24h to rinse the cell with flowing ultra pure water until the cell is clean.

IV. REDOX POTENTIAL AND TEMPERATURE MEASUREMENT

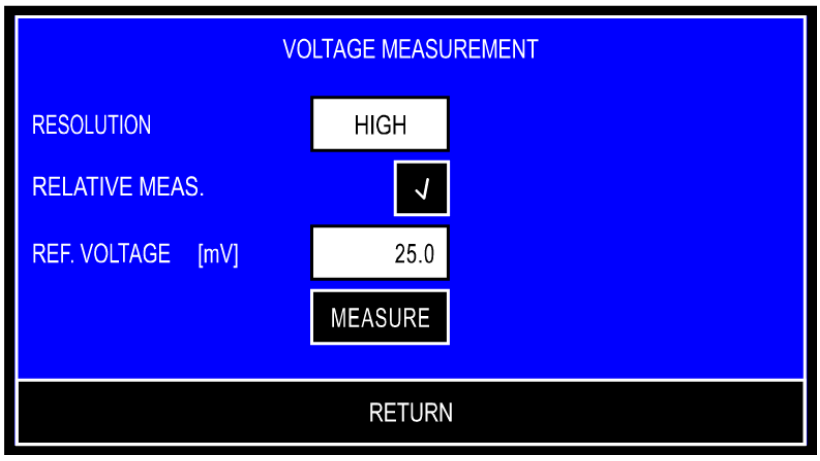
19. SETTING THE REDOX POTENTIAL PARAMETERS

The redox potential (ORP) parameters window is entered by selecting the redox potential reading (a frame will be displayed around it – Pic. 18A) and the **MODE** button. The screen (Pic. 18B) enables choosing the resolution, the reference temperature and setting the zero offset for the relative measurement.

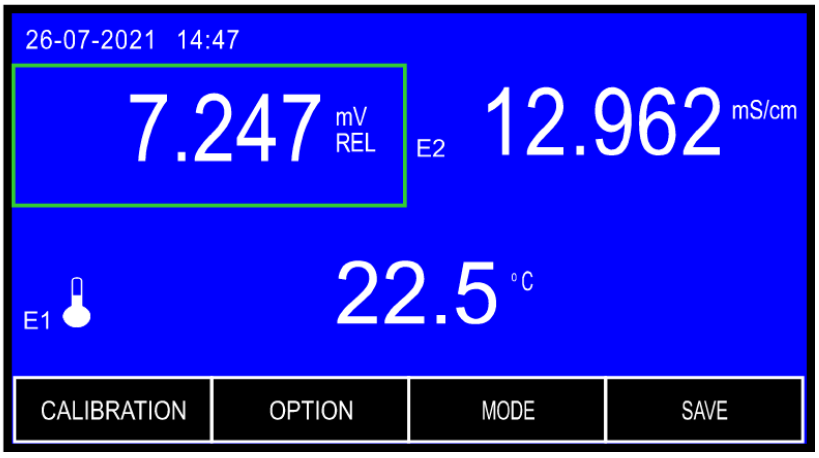
A



B



C



Pic. 18

After setting the parameters return to the measurement screen by pressing the RETURN button.

If the relative measurement has been chosen, next to the redox value the Rel symbol (Relative) will appear (Pic. 18C). The difference between the redox potential value and the reference value is displayed.

19.1. Resolution

The reading can be displayed with low or high resolution. By pressing the **RESOLUTION** window, choose:

LOW - 0.1 mV measurement resolution;

HIGH - 1 mV measurement resolution.

19.2. Relative measurement

The meter enables relative measurement of the redox potential. To make measurement, on the redox potential parameters screen (Pic. 18B) select the **RELATIVE MEAS** window. Pressing the window again turns the relative measurement off.

In case of choosing the relative measurement the **REL** symbol will be displayed on the right side of reading. The displayed reading is a difference between the measured and the reference voltage value.

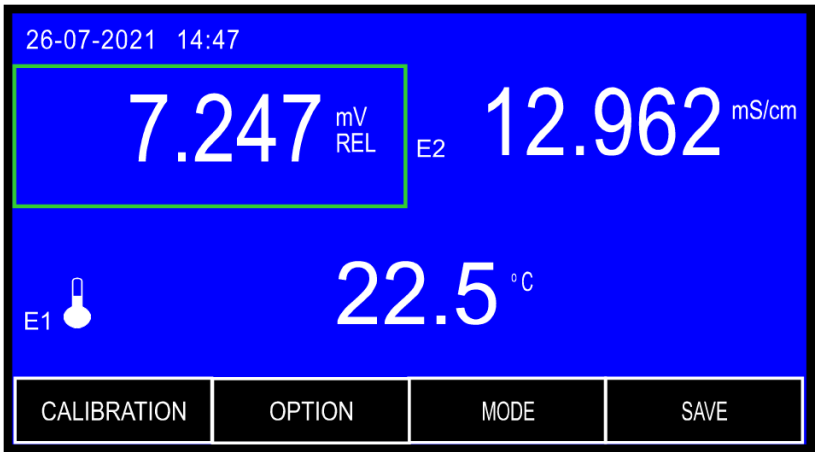
19.3. Reference voltage

After choosing the relative measurement the **REF. VOLTAGE** window appears to enter the reference voltage value. To enter, press the **REF. VOLTAGE** window, the numerical keyboard will appear to enter the reference voltage value and confirm with the OK button. To enter the current measurement result as a reference voltage value, press the MEASURE button during the measurement process, the currently measured reference voltage value will be entered into the **REF. VOLTAGE** window automatically.

20. REDOX POTENTIAL MEASUREMENT

PH/CO-2500L is an accurate voltmeter. The measurement may be made with redox electrode or during titration. To make measurement:

- turn the meter on by pressing the ON/OFF button;
- choose the redox potential measurement to be displayed on the measuring screen according to the point 23.1;
- enter the measurement parameters according to the point 19;
- return to the measurement screen by pressing the RETURN button and check the reading (Pic. 19).

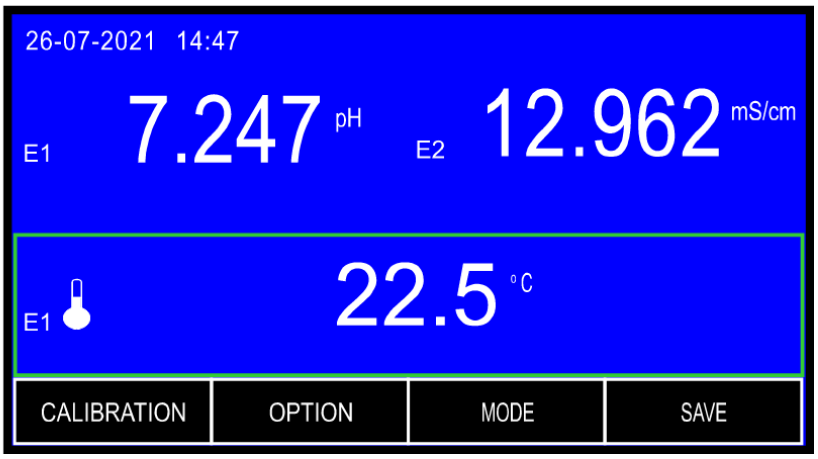


Pic. 19.

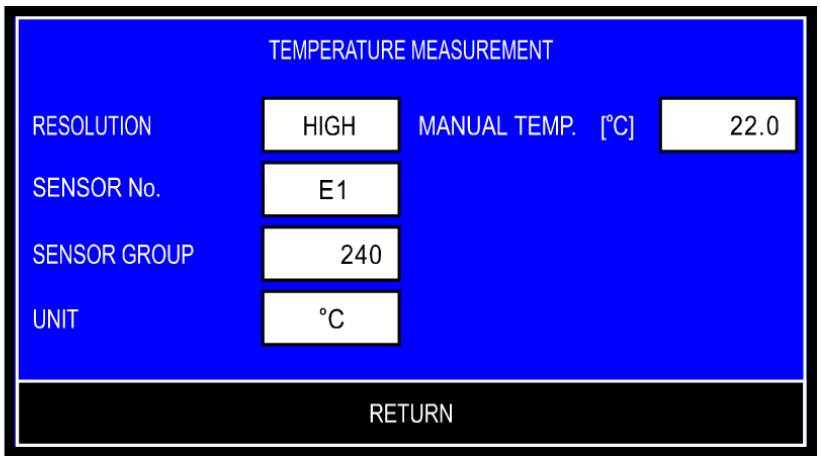
21. SETTING THE TEMPERATURE MEASUREMENT PARAMETERS

The temperature measurement parameters window is entered by selecting the temperature reading (Pic. 20A) and next the **MODE** button (Pic. 20B). The screen enables choosing resolution, probe group, unit and entering the manual temperature compensation value.

A



B



Pic. 20

After setting the parameters return to the measurement screen by pressing the **RETURN** button.

21.1. Resolution

The reading can be displayed with low or high resolution. By pressing the **RESOLUTION** window, choose:

- **LOW** - 1 ^{0}C measurement resolution;
- **HIGH** - 0.1 ^{0}C measurement resolution.

21.2. Probe number

The meter may store parameters of three probes, which may be replaced without the need of entering the group again, only the number which symbolises the sensor group has to be selected. By pressing the **PROBE NO.** window choose one of the three groups recorded under **E1**, **E2** or **E3** number.

21.3. Sensor group

The meter may cooperate with Pt1000B standard temperature sensor or with Pt-1000S selected sensor of higher accuracy. Before starting measurement, the probe data have to be entered.
To enter, press the **SENSOR GROUP** window, the numerical keyboard will appear to insert the value given on the probe‘s plug (the number following the G letter) and confirm with the OK button.
The meter is calibrated and ready for the measurement.

To adjust the meter for cooperation with Pt-1000B standard sensor, into the **SENSOR GROUP** window insert the **nn00** number, where nn – cable lenght in meters in range 1 - 19m. For the Pt1000B sensor on 1 meter cable the number will be 100 (the zero at the frontal position is not displayed) and for the same sensor on 15 meter cable the number will be 1500.

As standard the meter is set for co-operation with standard PT-1000B sensor.

21.4. Unit

The reading may be displayed in ^{0}C, K or ^{0}F.
By pressing the **UNIT** window choose the measurement unit.

21.5. Temperature of the manual compensation

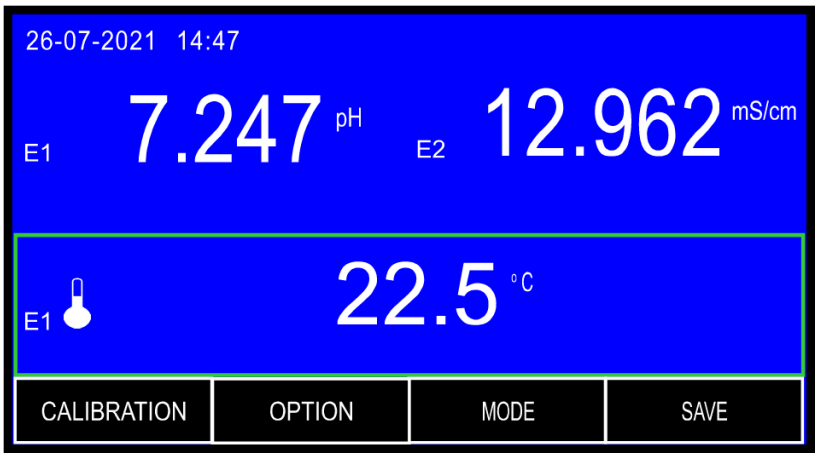
After disconnecting the temperature probe the meter switches to manual compensation automatically and calculates in the entered temperature value. To enter this value, press the **MANUAL TEMP.** window, the numerical keyboard will appear to enter the value and confirm with the OK button.

22. TEMPERATURE MEASUREMENT

Follow the instructions:

- turn the meter on by pressing the ON/OFF button
- connect the temperature probe to the **RCA (Chinch)** socket, the symbol will appear on the screen;
- immerse the temperature probe into the solution;
- wait till the value stabilises and read the result.

The meter cooperates with Pt-1000 platinum resistor sensor and the final accuracy of the temperature measurement is dependent on the sensor‘s class.



Pic. 21

NOTE: break in the temperature probe’s circuit switches the meter to the manual temperature compensation mode. It is signalised by change of the symbol to the symbol. Instead of the measured temperature value, the value inserted by the user is displayed.
Displaying of -50°C value in red while making measurement at positive temperature informs about short circuit in the temperature probe.

V. OPTIONS

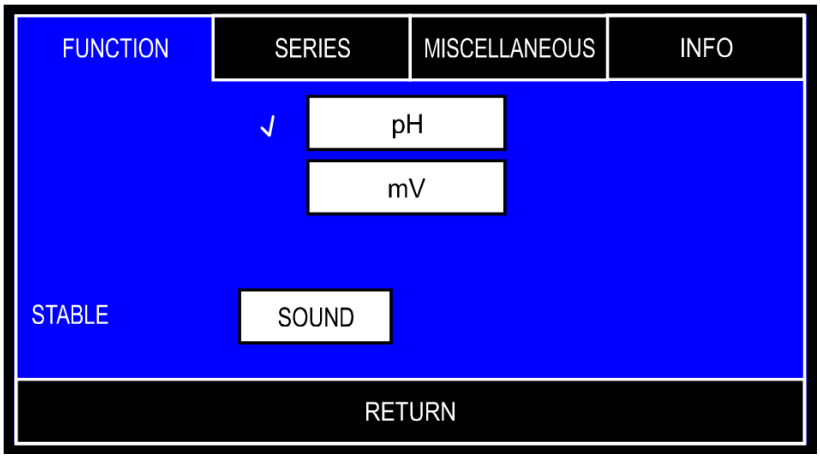
23. OPTION SCREEN

Enter the **OPTION** screen by pressing the **OPTION** button in the measurement screen. The **OPTION** screen contains the following tabs:

FUNCTION - choose the measurement functions to be displayed on the measurement screen;
SERIES - parameters for collecting measurement series;
MISCELLANEOUS - choose the language, set the economical mode, time and date;
INFO - information about the software version, the serial number and the factory calibration date.

23.1. Function

This tab enables choosing the measurement functions to be displayed on the measurement screen. After entering this screen the recently chosen configuration is displayed.



Pic. 22

After pressing the window with the chosen function, the confirmation mark will be displayed next to it.

Return to the measurement screen by pressing the **RETURN** button.

23.2. Series

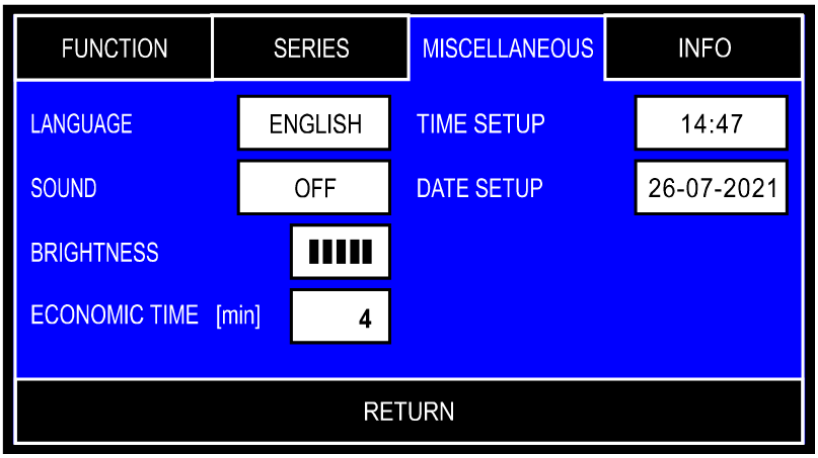
For the description of the **SERIES** tab, see the chapter 24.

23.3. Miscellaneous

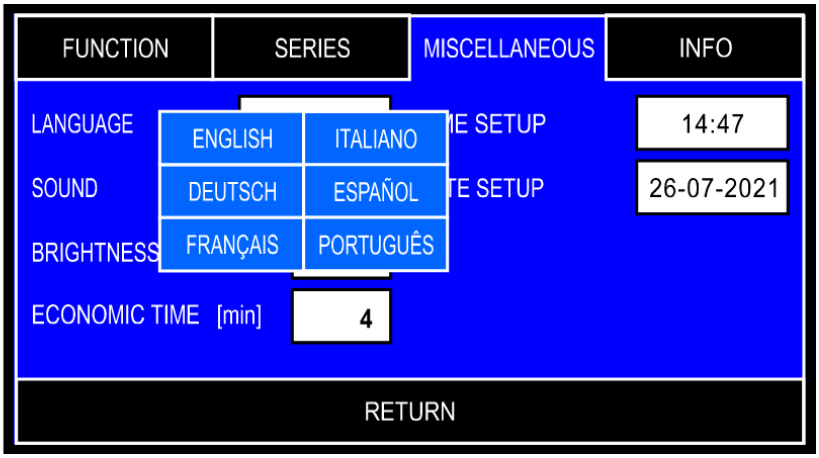
On this screen (Pic. 23A) the following parameters may be entered:

LANGUAGE	- choosing the language: English, German, French, Spanish, Italian, Portugese (Pic. 23B);
SOUND	- turning the buttons sound on / off;
BRIGHTNESS	- setting the display‘s brightness;
ECONOMIC MODE	- the time of non-use (the last press of any button), until the meter switches to the economical mode, reducing the brightness to the minimum;
TIME SETUP	- after pressing the **TIME SETUP** window the screen will appear (Pic. 23C) to turn the time displaying on / off, chose the 12 / 24 clock mode and set the current time;
DATE SETUP	- after pressing the **DATE SETUP** a screen will appear (Pic. 23D), where the date display may be turned on/off and the current date may be set;

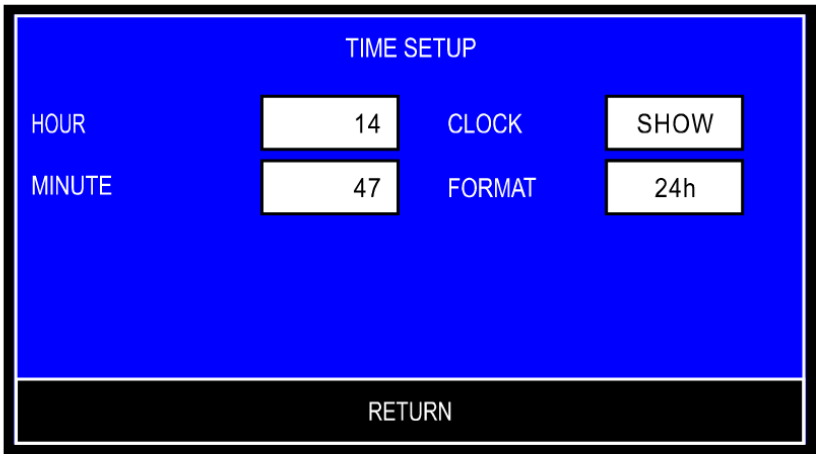
A


FUNCTION
SERIES
MISCELLANEOUS
INFO
LANGUAGE
ENGLISH
TIME SETUP
14:47
SOUND
OFF
DATE SETUP
26-07-2021
BRIGHTNESS
ECONOMIC TIME [min]
4
RETURN

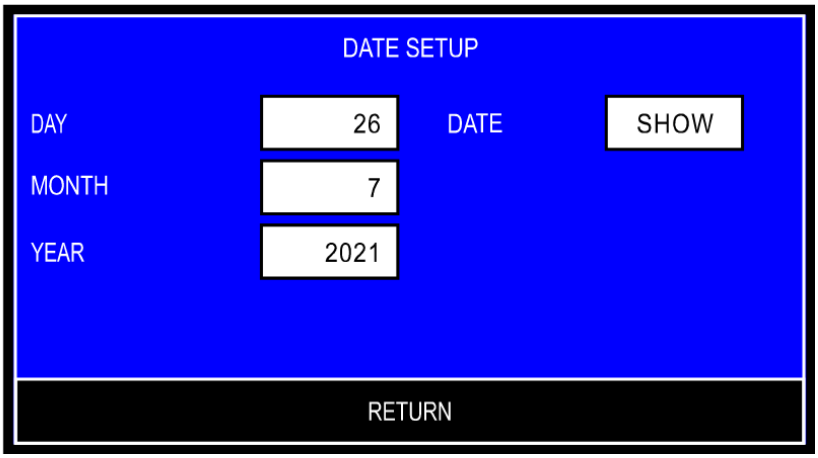
B


FUNCTION
SERIES
MISCELLANEOUS
INFO
LANGUAGE
ENGLISH
ITALIANO
DEUTSCH
ESPAÑOL
FRANÇAIS
PORTUGUÊS
SOUND
BRIGHTNESS
14:47
26-07-2021
ECONOMIC TIME [min]
4
RETURN

C


TIME SETUP
HOUR
14
CLOCK
SHOW
MINUTE
47
FORMAT
24h
RETURN

D


DATE SETUP
DAY
26
DATE
SHOW
MONTH
7
YEAR
2021
RETURN

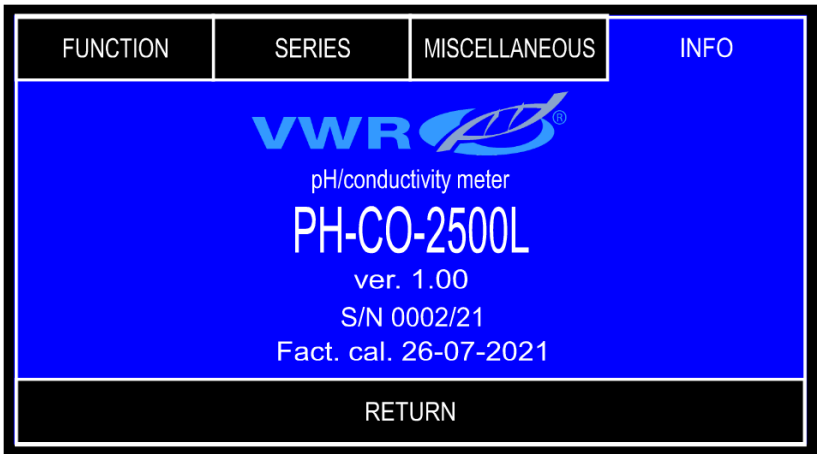
Pic. 23

To enter a logical value (language, sound, brightness), press the chosen window, a table will appear to choose the value.

To enter a numerical value, press the chosen window, a numerical keyboard will appear to enter the value and confirm with the **OK** button.

23.4. Info

The INFO tab contains the software version, the serial number and the factory calibration date (Pic. 24).



Pic. 24.

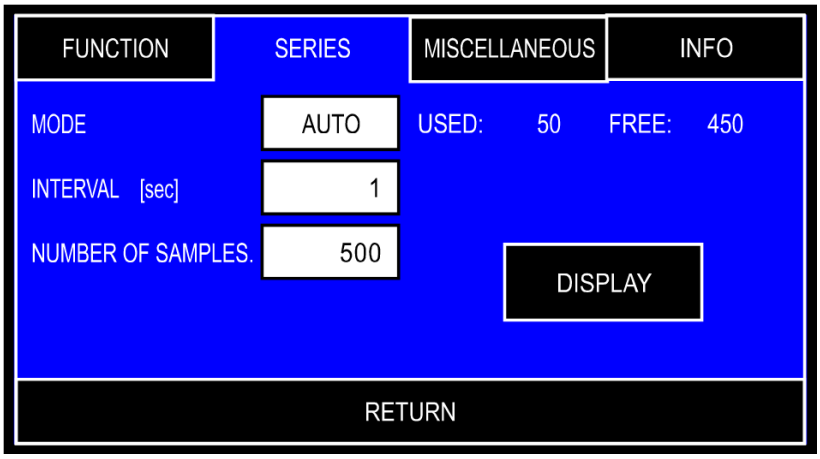
Return to the measurement mode by pressing the **RETURN** button.

24. RECORDING THE READINGS, MEMORY READOUT

The meter enables recording 500 readings of the displayed measurement functions. The readings are stored in memory independently from power supply. Before the measurement set the storage parameters for the readings.

24.1. Storage parameters

Parameters may be changed in the **SERIES** tab - the **OPTION** screen. Enter the screen from the measurement screen, by pressing the **OPTIONS** screen.



Pic. 25.

The screen enables setting the following parameters:

MODE - choosing the collecting series mode: **MANUAL**, **AUTO** and **STOP**. Each press of the window changes the mode;

INTERVAL - the interval between recorded readings in the automatic mode;

NUMBER OF SAMPLES - number of measurements to be recorded in the automatic mode.

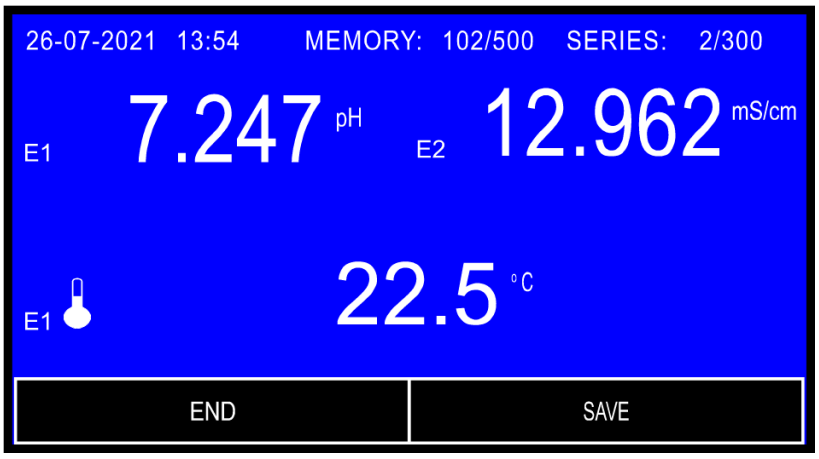
Next to the collecting series mode window the information is given about the recorded samples number (**USED**) and how many samples are yet to be recorded (**FREE**).

To enter the interval or number of samples, press the chosen window, a numerical keyboard will appear to enter the value and confirm with the OK button.

If in the **MODE** position is set to **STOP**, the **INTERVAL** and **NUMBER OF SAMPLES** positions are unavailable.

24.2. Entering single readings into the memory

If, according to the previous section, collecting single readings has been chosen (**MANUAL**), than pressing the START button starts up manual readings collecting (the SAVE and END button will show at the bottom of the measurement screen). If the memory already contains any readings, a table will appear to choose among: **DELETE, ADD** and **RETURN**. At the bottom part of the measuring screen the SAVE and END buttons will appear. Every press of the SAVE button records the reading. Press the END button if you want to quit the reading collecting mode. If pressing the SAVE button results in filling the last free space in the memory, the meter quits the reading collecting mode automatically.



Pic. 26

Note: pressing the ON/OFF button while collecting series manually results in signalising an error with a triple warning sound. Collecting series will be continued until the END button is pressed.

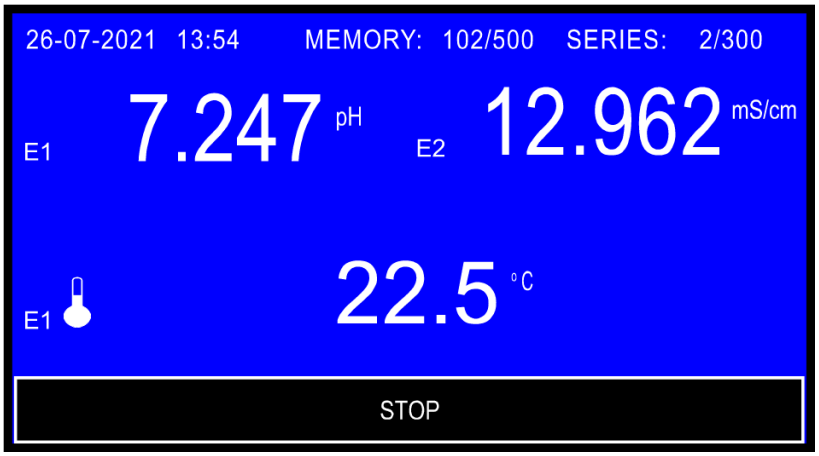
24.3. Collecting measurement series

There is a possibility to automatically store series of measurements in the meter's memory. Follow the instructions:

- choose automatic collection of readings (point 24.1);
- enter the time interval and number of samples (point 24.1);
- return to the measurement screen with the RETURN button;
- start collecting series with the START button. If the memory already contains any readings, the meter asks whether they should be deleted or the new readings placed after the earlier recorded ones.

The buttons at the screen bottom will be replaced with the STOP button and the meter will start collecting measurement series. At the top of the screen, below the clock and date displays the recorded sample number and the declared number of samples.

Collecting series is finished when the declared number of samples has been collected, the STOP button pressed or the memory filled up.

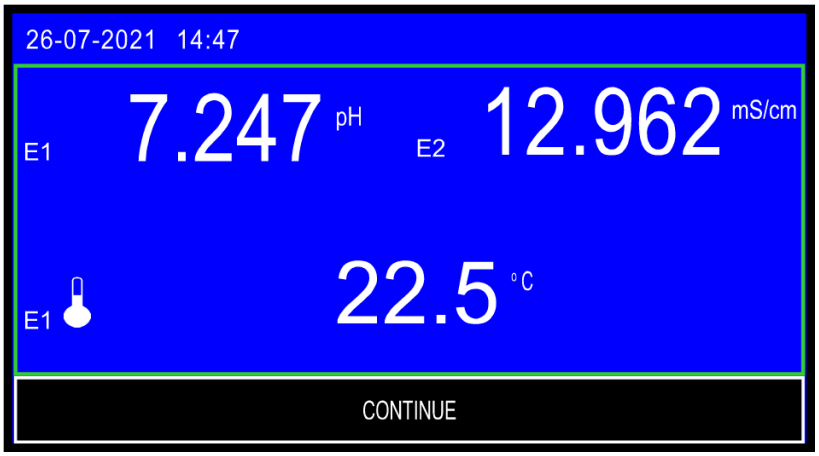


Pic. 27

Note: pressing the ON/OFF button while collecting series automatically results in signalising an error with a triple warning sound. Collecting series will be continued until the STOP button is pressed.

24.4. Mode of holding readings (HOLD)

If in the **MODE** position **STOP** option has been chosen, than on the measuring screen in the place of the START button the HOLD button will appear. Pressing this button holds all the readings, the green frame displays around them and the CONTINUE button appears at the bottom of the screen (Pic. 28). Pressing this button returns the meter to the measurement function.



Pic. 28

24.5. Viewing the readings

The stored readings may be viewed on the meter‘s screen. Follow the instructions:

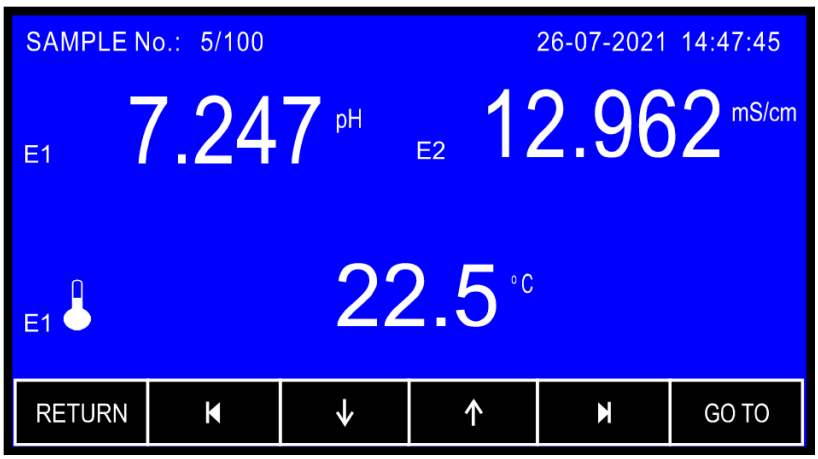
- on the measurement screen press the **OPTIONS** button and choose the **MEMORY** tab on the option screen;
- press the **DISPLAY** button. A screen with the readings collected in the memory will display (Pic. 29);
- change the displayed sample number with the ↓ , ↑ buttons;

or

- display the first or the last sample with use of the |◄ , ►| buttons;

or

- press the **GO TO** button, a numerical keyboard will display to enter the number of the chosen sample and confirm with the **OK** button.



Pic. 29

Return from the memory review mode by pressing the **RETURN** button.

25. CALIBRATION REPORT

During calibration process in each of the measurement functions the meter creates a calibration report, which includes information about calibration points, measurement results in these points and calculated parameters as: efficiency and offset of the pH electrode and K constant of the conductivity cell. The calibration time and date is also recorded in the memory. Apart from the last calibration report the meter stores data of 10 last calibrations in each of the measurement functions. The reports may be transmitted to a PC with use of the data transmission software and there they may be reviewed, edited or recorded on a hard drive. There is no possibility to read the report in the meter. All the process is described below.

26. COMMUNICATION WITH A PC

Connecting the meter with a PC enables storing the data directly on the computer, what practically creates no limits to the number of stored data. It is also possible to review collected series stored in the meter‘s memory and the user‘s calibration reports. A PC should be equipped with USB connector. For data transmission, use a special software of our production. It may be downloaded from the web site. After downloading start the installation. It is necessary to follow the given instructions.

In the back wall of the meter the **USB** connector is placed for connecting it with the PC.
After connecting, turn on the meter and the PC and launch the transmission software. In the SETUP / PORT menu choose USB. Next, choose the mode of cooperation with the meter. Choose among the following options:

- **“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 intervals between the storage processes. 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”. The 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. Pressing the „Download” button starts the transfer.

- "**Download calibration data**" enables downloading the calibration data from the meter. Choose the measuring function in the meter to collect its report.

  In this option choose:

  „Name“ - the meter's name will be given to each report. At least one of the other following options needs to be selected with this one;

  "**Factory data**" - downloads the meter‘s data: name, serial number calibration date;

  "**Last calibration**" - downloads only the last calibration in a chosen measuring function;

  "**History of calibration**"- downloads all the stored calibrations in a chosen measurement function. The first downloaded calibration will be the most recent one.

  "**Signatures**" - space for a handwritten signature.

The data will be downloaded after choosing an option and pressing the **"START"** button.

Note: before downloading the last calibration or the history of calibrations, mark the pH or the conductivity value with the green frame.

27. TECHNICAL DATA

pH MEASUREMENT:

range	resolution	accuracy (±1 digit)
-6.000 ÷ 20.000 pH	0.001 / 0.01 pH	±0.002 pH

Input impedance: $>10^{12}\ \Omega$
Temperature compensation: manual/automatic
Compensation range: -5.0 ÷ 110.0 ^{0}C
pH electrode calibration: automatic, in 1 ÷ 3 points
pH electrode calibration range:
Offset: ±0.7 pH
Efficiency: 85 % ÷ 105 %
Thermal stability of zero: 0.001 pH/ ^{0}C

mV MEASUREMENT:

range	resolution	accuracy (±1 digit)
-2000.0 ÷ 2000.0 mV	0.1 mV	±0.1 mV

Input impedance: $>10^{12}\ \Omega$
Relative measurement range: ±3999.9mV

CONDUCTIVITY MEASUREMENT:

ranges	resolution	accuracy[1] (±1 digit)	frequency[2]
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 ÷ 1000.0 mS/cm	0.1 / 1 mS/cm	±0.25 %	10 kHz

[1] - accuracy corresponds to the end value of the range.
[2] - frequency changes range corresponds to the K constant = 1. For other K constant values the range will change proportionally to the changes of this constant.

Temperature compensation:	manual/automatic
Compensation range:	-5.0 ÷ 70.0 ^{0}C
K constant range:	0.010 ÷ 20.000 cm^{-1}
α coefficient range:	0.00 ÷ 10.00 %/ ^{0}C
TDS coefficient range:	0.20 ÷ 1.00

Measuring range for conversion to KCl:	0 ÷ 239 g/l (0 ÷ 21.00 %)
Measuring range for conversion to NaCl:	0 ÷ 296 g/l (0 ÷ 25.00 %)
Measuring range for conversion to TDS:	0 ÷ 1000 g/l (0 ÷ 100.00 %)
Measuring accuracy for conversion to TDS:	1.0 %*
Measuring accuracy for conversion to KCl:	2.0 %
Measuring accuracy for conversion to NaCl:	2.0 %
Resistivity measuring range:	1.000 Ωcm ÷ 200 MΩcm
Resistivity measuring accuracy:	2.0 %

Cell calibration:

1. by entering the K constant of the cell
2. with use of max. 3 calibration solutions

* - for correct TDS coefficient value

TEMPERATURE MEASUREMENT:

range	resolution	accuracy* (±1 digit)
- 50.0 ÷ 200.0 ^{0}C	0.1 ^{0}C	±0.1 ^{0}C

* Accuracy given for the meter. The final accuracy depends on the type of Pt-1000 probe.

Temperature probe: Pt-1000 platinum resistor

The probe‘s accuracy in range 0 ÷ 100 ^{0}C:

for Pt1000B resistor	±0.8 ^{0}C
for Pt1000S resistor	±0.27 ^{0}C

OTHER:

MEMORY CAPACITY:	500 results
OPERATING TEMPERATURE:	-5 ÷ 45 ºC
POWER SUPPLY:	5V/1000mA power adapter
POWER CONSUMPTION:	max. 1.5 W
DISPLAY	LCD 5.0‘‘ 480 x 272
DIMENSIONS:	175 x 140 x 52 mm
WEIGHT:	260 g

28. ORDERING INFORMATION

EPH-1	standard glass pH electrode & 1 meter cable	**662-2381**
REG-1	glass ORP (redox) electrode 1 meter cable	**662-2357**
TS-2B	stainless steel temperature sensor 1meter cable	**442-1264**
ECS-1	conductivity cell constant K-0.45 0 – 400 mS/cm	**663-0373**

Buffer solutions, 20 °C AVS TITRINORM:

pH 4	100 ml plastic bottles	**32095.184**
	500 ml plastic bottles	**32095.264**
pH 7	100 ml plastic bottles	**32096.187**
	500 ml plastic bottles	**32096.267**
pH 10	100 ml plastic bottles	**32040.185**
	500 ml plastic bottles	**32040.260**

Storage solution Potassium chloride 3 mol/l (3 N) in
Aqueous solution AVS TITRINORM 100 ml Plastic bottle **83605.180**

Conductivity standard solution (25 °C), 100ml plastic bottle
12,9mS/cm (12,880 uS/cm) **84136.180**

EH-10 Electrode holder **662-2352**

29. TECHNICAL SERVICE

Web Resources
Visit the VWR website at **www.vwr.com** for:
• Complete technical service contact information
• Access to the VWR Online Catalogue, and information about accessories and related products
• Additional product information and special offers
Contact us For information or technical assistance contact your local VWR representative or visit. www.vwr.com.

30. WARRANTY

VWR warrants that this product will be free from defects in material and workmanship for a period of two (2) years from date of delivery. If a defect is present, VWR will, at its option and cost, repair, replace, or refund the purchase price of this product to the customer, provided it is returned during the warranty period. This warranty does not apply if the product has been damaged by accident, abuse, misuse, or misapplication, or from ordinary wear and tear. If the required maintenance and inspection services are not performed according to the manuals and any local regulations, such warranty turns invalid, except to the extent, the defect of the product is not due to such non-performance.

Items being returned must be insured by the customer against possible damage or loss. This warranty shall be limited to the aforementioned remedies. IT IS EXPRESSLY AGREED THAT THIS WARRANTY WILL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND IN LIEU OF THE WARRANTY OF MERCHANTABILITY.

Compliance with local laws and regulations
The customer is responsible for applying for and obtaining the necessary regulatory approvals or other authorisations necessary to run or use the Product in its local environment. VWR will not be held liable for any related omission or for not obtaining the required approval or authorisation, unless any refusal is due to a defect of the product.

31. EQUIPMENT DISPOSAL



This equipment is marked with the crossed out wheeled bin symbol to indicate that this equipment must not be disposed of with unsorted waste.
Instead it's your responsibility to correctly dispose of your equipment at lifecycle -end by handling it over to an authorized facility for separate collection and recycling. It's also your responsibility to decontaminate the equipment in case of biological, chemical and/or radiological contamination, so as to protect from health hazards the persons involved in the disposal and recycling of the equipment.
For more information about where you can drop off your waste of equipment, please contact your local dealer from whom you originally purchased this equipment.

By doing so, you will help to conserve natural and environmental resources and you will ensure that your equipment is recycled in a manner that protects human health.

Thank you

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