WATERPROOF pH-METER

CP-411

USER‘S MANUAL

ELMETRON

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WATERPROOF pH-METER

CP-411

Before starting work please read the instruction carefully.

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I. INTRODUCTION

1. Exploitation notices

Dear User!

We present you a device distinguished by accuracy according to the technical data and by a high stability of the displayed results. We believe that the measurements will not cause you any trouble and that the meter will operate without any inconvenience. **Wide range of additional functions requires careful reading of the manual, in other case some of the features may stay unused or using the meter may be troublesome.**
Employing of good-quality electrodes and replacing them after a suitable time ensures obtaining high measuring parameters. We want to call your attention to the fact, that this equipment has a much shorter working life than the meter. Typical symptoms of an improper operation of the electrode are: deterioration of final result stability and its flowing as well as significant measuring error. **Part of the users has problems arising from employing electrodes not being preconditioned before the measurement or making measurements without removing the shielding ring from the liquid junction or with a plugged junction.** To avoid such situations it is necessary to choose a proper kind of electrode for solutions which are going to be measured e.g. special electrodes for the sewage, liquids with deposits, meat cheese etc. Therefore, if you observe improper operation of the device, please take control measurements with another electrode or check the used electrode with another pH-meter. **Generally, the deterioration of the meter's work is caused by the electrode and not by the meter.**

The essential feature of our products is their low failure frequency. However, if your meter fails, our firm will immediately perform its warranty repair.

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

2. Characteristics of the meter

The **CP-411** pH meter belongs to the newest generation of measuring devices which offer wide range of additional functions. The meter ensures high accuracy and repeatability of the readings and is easy in use. Two kinds of power source: battery and power adapter enable work in the field and long-lasting measurements in the laboratory. Electronic elements of the newest generation used in the meter have made its memory independent from power supply and have ensured very low power consumption what greatly prolongs the operation time on 1 battery.
The meter is equipped with large custom LCD display, on which the pH, redox potential or temperature value is displayed. Waterproof housing makes working in difficult conditions possible. Small size and weight make the meter very handy especially during field work.

Main features of **CP-411** are:
- high accuracy and stability of readings;
- automatic temperature compensation;
- pH electrode calibration in 1 to 3 points;
- automatic recognition of pH buffers and standards;
- possibility of entering the standard solutions values;
- the electrode slope is stored in the memory independently from power supply;
- system protecting the meter against damages caused by connecting the battery inversely;
- information about the battery condition ();
- automatic switch off function.

3. What is the meter designed for

Waterproof pH meter **CP-411** is precise and easy-to-use meter designed for hydrogen ion concentration measurements in pH units and redox in mV units. The meter may be also used for accurate temperature measurement in solutions and air in ℃. The meter may be used both for work in the field and measurements in the laboratory.
Waterproof housing enables work in difficult weather conditions or in humid environment.
The **CP-411** pH meter is being used in food, chemical, pharmaceutical and power industries, in water treatment stations, laboratories, agriculture, universities, scientific laboratories etc.
The meter is prepared to work with all types of combination pH electrodes and redox electrodes equipped with BNC-50 connector. It is possible to connect the meter with two electrodes (pH measuring and reference) by special adapter offered as additional equipment. **CP-411** co-operates with Pt-1000 temperature probe with Chinch connector.

4. The outside view

On the front wall of the meter there is an LCD display (Pic. 1) which, depending on the chosen function, shows:
- the pH readout in pH units;
- the redox potential readout in mV.

Choosing functions is described in the chapter 6.1.

Simultaneously, below the readout, the temperature value in ^{0}C is displayed. Symbols of units are displayed next to the readout.
In case of disconnecting the temperature probe the meter switches to manual temperature compensation mode (the symbol disappears). The battery condition is signalised by the symbol. The keyboard placed below the display is used for switching the meter on and off, choosing the measuring function, calibration and entering the parameters.

The keyboard is equipped with the following keys:

- switching the meter on and off.

- pressing shortly enters the mode of choosing the measurement function (pH or redox potential); holding returns the meter to the measurement mode;

- holding this button in the pH measurement function enters the calibration mode (**CAL** symbol displayed). Pressing shortly in this mode records the calibration result in the calibration point;

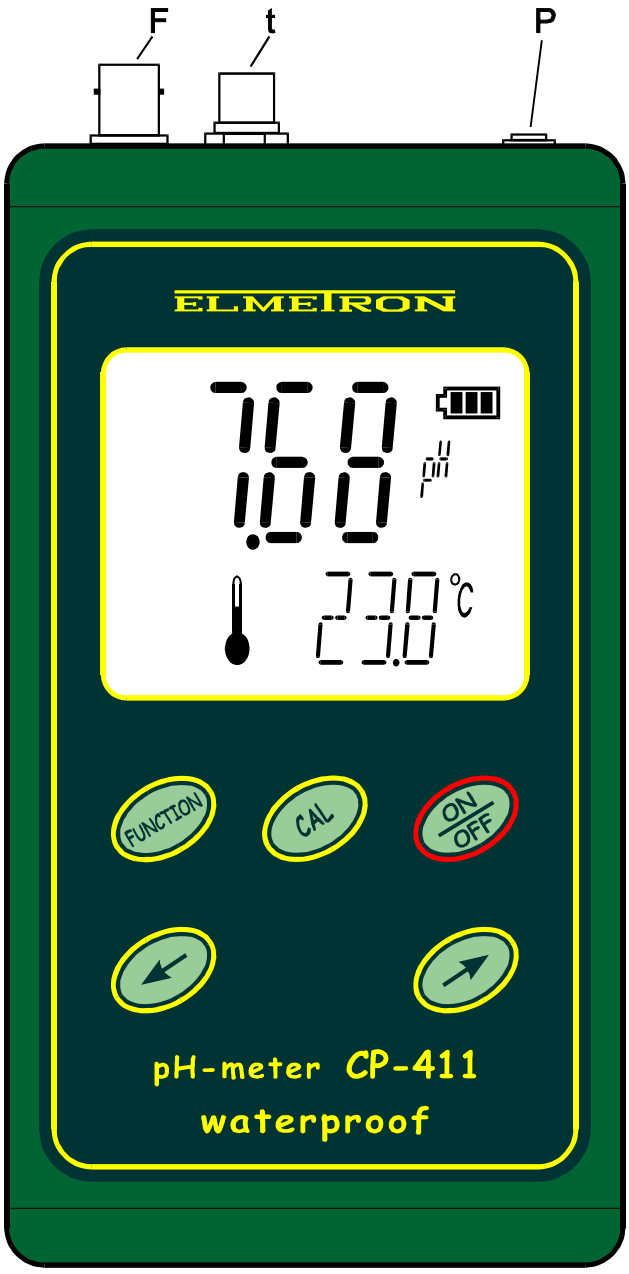

, 
- buttons used for entering parameters.

In the upper wall of the meter there are inputs placed with the symbols given below:

F - BNC-50 for connecting combination pH electrode**,** measuring pH electrode or redox electrode;

t - **Chinch** input for connecting the temperature probe;

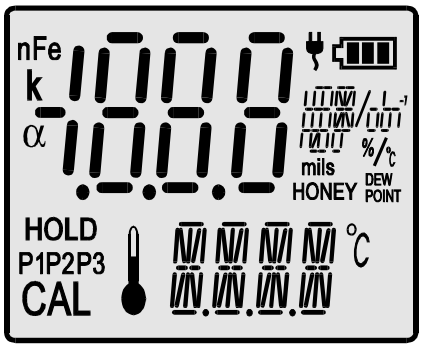
P - power adapter input.


F
t
P
ELMETRON
7.68
pH
23.0 °C
FUNCTION
CAL
ON
OFF
pH-meter CP-411
waterproof

Pic. 1.

5. Switching the meter on and off

After switching it on with the ON/OFF button, the meter tests the memory and the display on which all symbols are displayed (pic. 2).



Pic. 2.

If the test ends successfully, after about 1.5 s the meter switches automatically to the measuring mode, in which it was switched off. If the HLP sign is displayed, it means that the meter has lost the factory settings and requires service. If after 1,5 s all symbols are continuously displayed, it informs that the calibration parameters of the electrode have been lost.

After pressing the CAL button the meter adopts standard parameters:
- drift 0 pH, slope 100%

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

The meter is switched off by pressing the ON/OFF button. To save the battery, the meter switches automatically off after 10 minutes of non-use. This function is automatically deactivated when working with power adapter or during calibration.

6. Preparation to work

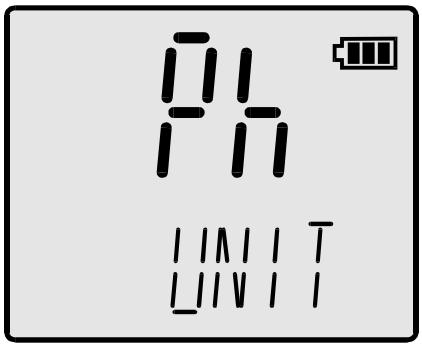
Before starting work:

- connect the power adapter plug to the **P** input, if work with the power adapter is planned;
- in case of pH measurements join the combination pH electrode to BNC-50 input **F**;
- in case of using a measuring and reference electrode connect them the adapter, available optionally;
- connect the temperature probe to the Chinch temperature input (**t**);
- switch the meter on by pressing the ON/OFF button.

6.1. Choosing the measuring function

The CP-411 pH meter may work in the pH or redox potential measurement mode.
In order to switch the measuring function:

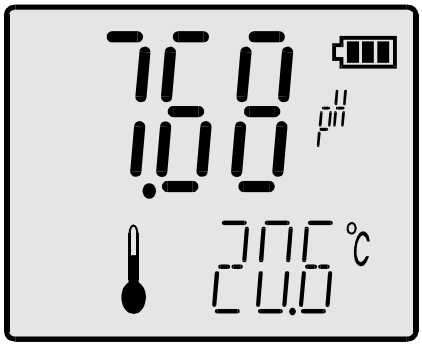
- press the FUNCTION button, until the lower row of the display shows the LIMIT symbol and the upper row – currently active measurement function;
- with the button choose:
  - pH - pH measurement
  - U - redox measurement
- by pressing and holding the FUNCTION button return to the measurement mode.



Pic. 3

6.2. Choosing the kind of temperature compensation

The meter switches to the automatic temperature compensation mode after connecting the temperature probe. Next to the reading the symbol is displayed (pic. 4). The measurement will be compensated to the value of temperature measured by the probe.
Disconnecting the temperature probe switches the meter to the manual temperature compensation mode (the symbol disappears) and the value of the temperature introduced by the user in the way described below is displayed in the place of the temperature reading. This value will be adopted for compensation.



Pic. 4

6.2.1. Entering the temperature value for manual temperature compensation

To introduce the temperature value for manual temperature compensation:

- disconnect the temperature probe (the symbol disappears);
- with the , buttons enter the chosen temperature value.

II. pH MEASUREMENT

7. Preparation of the pH electrode

The electrode should be prepared to work according to the manufacturer's instructions. If the instructions weren't given please follow the steps:

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

Caution: storing the electrode in distilled water shortens its life span and may heighten the measurement error.

8. Calibration

Before starting measurement with new electrode, after long-lasting use or before making measurements which require high accuracy the electrode connected with the meter should be calibrated. Results of measurements made without calibration will be burdened with a significant error. Calibration is made in buffer solutions. It consists in comparing pH value of buffer solutions with the value displayed by the meter and next in automatic introduction of correction which is taken into consideration during next measurements. Calibration should be periodically repeated because the parameters of the electrode are changing while working, what influences accuracy. The frequency of this procedure depends on the demanded accuracy, number of the measurements carried out, conditions in which the electrode was used, temperature and value of the measured solutions. When the highest accuracy is required, it is recommended to use fresh buffer solutions with certificates.

CP-411 enables calibration in **buffer solutions with values determined by the manufacturer,** which are: 4.00; 7.00 and 10.00 pH, and are automatically detected.

There is a possibility of calibration minimum in 1 point and maximum in 3 points. The more calibration points are used, the higher accuracy in the whole range is ensured.

Calibration at 1 point does not ensure high accuracy. If the accuracy requirements are not very high and the measurement is made in the whole measuring range one-point calibration should be made with use of 7.00 pH buffer solution. Thanks to this the error connected with so called “zero offset” of the electrode will be eliminated.

At the rest of the points standard electrode’s slope parameters from the meter’s memory will be adopted. This slope corresponds to the theoretical efficiency of pH electrode. In case of accurate measurements in the whole range we recommend three-point calibration. In case of measurements in acids calibration in 2 buffer solutions: 4.00 and 7.00 pH is recommended, in case of alkali measurements calibration in 7.00 and 10.00 pH buffers is advisable.

In **CP-411** the slope of the electrode is approximated in segments between the calibration points.

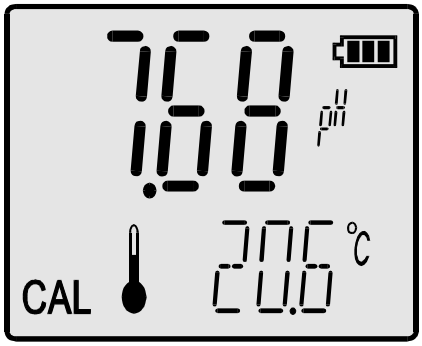
Starting the calibration process irreversibly erases the calibration data stored in the memory.

The buffer solutions may be used in a freely chosen order.

8.1. Calibration with automatic temperature compensation

After preparing the meter to calibration according to the chapter 6, in the pH measurement function:

a. press and hold the CAL button till the moment of appearance of the **CAL** symbol on the display (Pic. 5), **the previous parameters of calibration are now deleted;**
b. put the electrode and the temperature probe to the standard solution, the meter will recognise the pH value of the standard and the **P1** (calibration point) symbol will appear. The reading may be different than the actual pH value of the standard. After stabilisation of the reading press the CAL button. Blinking of the reading informs about recording the calibration value. At the same time the measured value will be adjusted to the value of the applied buffer solution.
   If the value of the applied solution (buffer) is different then the recorded one and cannot be recognised by the meter or the electrode connected to the meter is broken, the Err symbol will appear.
c. the calibration may be finished at this moment by pressing the FUNCTION button or continued in next standard solutions accordingly to the point b. The electrode and the temperature probe should be washed before each immersion in the buffer.

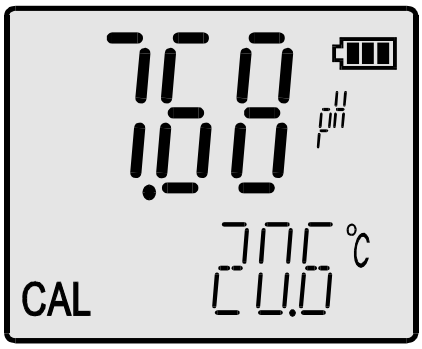


Pic. 5.

In case of entering the calibration mode and escaping it not having made calibration at least in one point, previously stored calibration data will be deleted and standard parameters will be adopted.

8.2. Calibration with manual temperature compensation

Disconnecting the temperature probe switches the meter to manual compensation (the symbol next to the temperature reading disappears). The value of the temperature introduced by the user will be adopted for compensation.
Next, connect the pH electrode to the meter, introduce the actual temperature of the applied buffer solutions according to the point 6.2.1 and act accordingly to the points a ÷ c of the previous chapter.

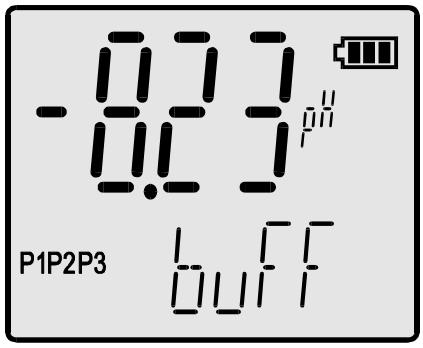


Pic. 6

9. The electrode parameters readout

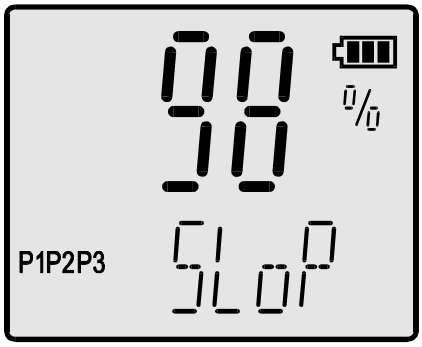
After the pH electrode has been calibrated, it is possible to check its condition: zero offset and slope.
To check, in the pH measurement mode:

- press the FUNCTION button two times, in the lower display row the buFF symbol willl apear, the upper row will show the electrode's zero offset (Pic. 7);



Pic. 7

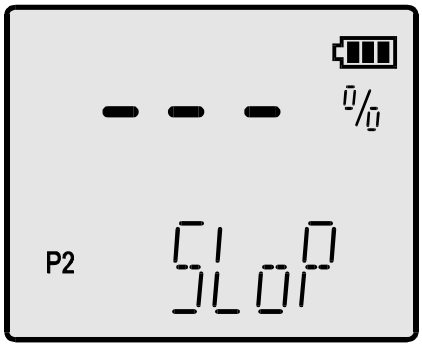
- press the FUNCTION button once again, in the lower row the SLoP symbol will be displayed and the percentage value of the electrode condition - in the upper row. (Pic. 8);



Pic. 8

In the lower left corner of the display the points of the electrode calibration are shown.

After deleting the electrode characteristics (entering the calibration mode and escaping it without calibrating at any point) the meter adopts the ideal electrode characteristics for its calculations and the actual electrode's parameters are unknown. In this case, after entering in the electrode parameters readout mode, in the place of the digital values, lines are displayed.
One-point calibration enables to indicate only the zero offset of the electrode. Instead of the slope value lines are displayed (Pic. 9).



Pic. 9

Escape the electrode parameters readout by pressing and holding the FUNCTION button until the meter returns to the measurement mode.

10. pH measurement

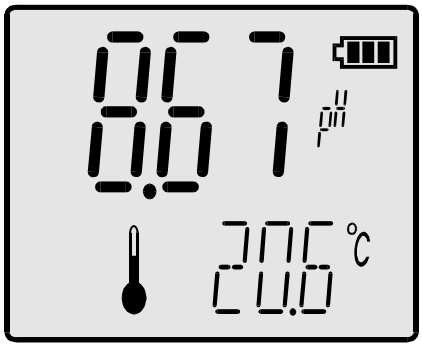
Before starting measurement, prepare the meter (chapter 6) and the pH electrode (chapter 7) to work. Good condition of the electrode is the most important condition for accurate measurements.

10.1. Measurement with automatic temperature compensation

During measurements with automatic temperature compensation the meter co-operates with the temperature probe and measures the temperature of the solution simultaneously with pH. The measured temperature is taken into consideration during compensation.
In case of measurement with automatic temperature compensation:

- join the temperature probe and the combination pH electrode to the appropriate connectors on the meter (pic.1);
- if the electrode is not calibrated or has been already used for some time it is advisable to calibrate it (chapter 8);
- insert the electrode and the temperature probe to the measured solution. During measurements in vessels do not touch the bottom and the walls with the electrode. It is to advisable to use an electrode stand;
- turn the meter on by pressing the ON/OFF button;
- choose the pH measurement mode according to the chapter 6.1;
- after stabilisation read the result (pic.10)

Accurate laboratory measurements require using of electromagnetic stirrers.



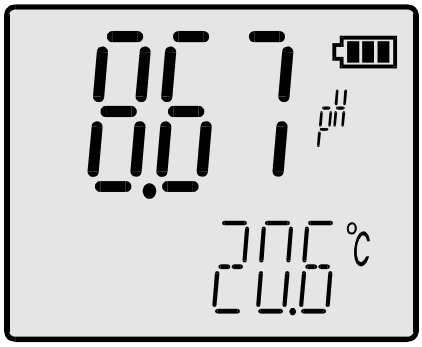
Pic. 10.

NOTE: exceeding of the range of temperature compensation is indicated by blinking of the pH readout and the symbol.

10.2. Measurements with manual temperature compensation

Disconnecting the temperature probe switches the meter to the manual temperature compensation mode (the symbol next to the temperature reading disappears).
Measurement with manual temperature compensation is similar to measurement with ATC, the difference is that in manual compensation the meter takes into consideration the value of the temperature introduced by the user instead of the temperature measured with the temperature probe.
Manual compensation may be used during work in stable conditions e.g. during pH measurements in the laboratory, especially with use of a thermostat, or when the temperature probe is broken.
During measurement with manual temperature compensation:

- switch the meter on using the ON/OFF button;
- insert the pH electrode to the vessel with the measured solution, if the electrode is not calibrated or has been already used for some time it is advisable to calibrate it (chapter 8). During measurements in a vessel do not touch the bottom and the walls with the electrode. It is advisable to use an electrode stand;
- measure a temperature of measured solutions using laboratory thermometer
- enter the temperature value of measured solution for manual compensation according to the point 6.2.1;
- choose the pH measuring function according to the chapter 6.1;
- wait till the value stabilises and read the result (Pic. 8)



Pic. 11

11. Notices about the temperature compensation and interpretation of the measurement results

The **CP-411** pH meter has an automatic temperature compensation, which enables eliminating errors resulting from affecting the electrode characteristics by temperature changes. To explain the role of the temperature compensation it is important to remind that pH meter is an mV meter which displays redox counted to pH. In constant temperature one pH unit corresponds to constant mV value. In 20 ^{0}C it is 58.17 mV. The value of mV for one pH unit **is affected by the temperature,** what is taken into consideration in the formula for "k coefficient" of the pH electrode:

k=0.198423 T

This coefficient is connected with the electrode's slope and not with the measured solution. Temperature compensation doesn't consider changes of the pH value of the solution caused by the temperature. Usually these are slight changes, however in e.g. pure water they tend to be significant. Values of solutions, which tend to be affected by the temperature changes, should be compared in the same temperature. Sometimes the results are unstable, which is connected with the quality of the electrode. **Unstable measurement results, slow drifting of the result or very long time of stabilisation are usually caused by clogged junction, contaminated or broken electrode.** It often happens in case of choosing inappropriate kind of electrode for the measured solution.
Putting the electrode into distilled water for a few hours or placing it in water with detergent may eliminate this symptoms, especially if measurements were made in solutions with deposits, fats or oils. The electrode which hasn't been used for a long time, may have the junction clogged by KCl crystals, what may be removed by placing the electrode in distilled water. Heavily contaminated electrode may be cleaned in chloroform and deposits of iron in 2N HCl.

Depending on the kind of measured solution or substance, appropriate kind of electrode should be chosen. They differ one from another with shape, membrane's look, kind of junction and body. Electrode for heavily polluted sewage is different than this for clean water or for meat or soil. Using unsuitable electrode for measurements may cause its damage and make next measurements impossible.

Results of multiple pH measurements of the same solution with stabile temperature may differ one from another. When analysing this situation, the factors given below should be taken into consideration:

- the differences may occur because of using electrode of not very good quality;
- the result was treated as stabilised too soon (the time of stabilisation of an average-quality electrode is about 40 s.);
- the measured solution may not be homogeneous and without using the electromagnetic stirrer the results won't be equal;
- during measurements of sewage the result may be changed by chemical reactions.

Slight differences of the results are connected with the accuracy of the meter. The accuracy of **CP-411** is ±0,01 pH, ±1 digit, what practically means that in extreme conditions results of two measurements of the same solution may differ in ±0,05 pH. This is an acceptable error, because one result has error equal – 0.02 and the second one + 0,02 pH. Expression ±1 digit in the technical data takes into consideration another possible difference which arises because of so called discretisation error – number of digits displayed on the LCD.

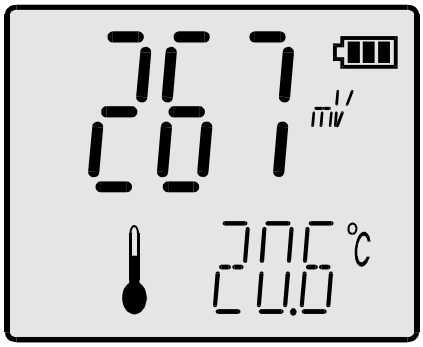
Sometimes the accuracy of calibration is checked in another buffer solution. In case of performing two-point calibration in 7,00 pH and 4,00 pH buffer solutions and the accuracy of such calibration is checked in 10,00 pH buffer in some cases the result may be 9,90 pH or 10,10 pH. Such difference is possible when the slope of the electrode isn't symmetrical to 7 pH.

Using three-point calibration in neutral, alkali and acidic buffer solutions may prevent such a situation.

III. REDOX AND TEMPERATURE MEASUREMENT

12. Redox potential measurement

CP-411 enables redox potential measurement. The measurement may be made with use of special redox electrode or during titration. The readout is possible after choosing the redox measurement mode (chapter 6.1).



Pic. 12

13. Temperature measurement

The temperature measurement is made as follows:
- connect the temperature probe to the Chinch connector;
- by pressing the ON/OFF button switch the meter on;
- put the temperature probe to the measured solution;
- wait till the value stabilises and read the result.

The meter co-operates with the PT-1000 platinum resistor sensor and the final accuracy of the temperature measurement depends on its class.

NOTE: lack of the symbol on the display signalises disconnecting the temperature probe or break in its circuit. In such case the meter shows the temperature value introduced by the user for manual temperature compensation. Blinking -50°C value during measurement in positive temperatures informs about short-circuit in the temperature probe.

IV. OTHER

14. Readout of the software version number

In order to check the software version number turn the meter off and next, holding the FUNCTION button, turn the meter on by pressing the ON/OFF button. Instead of the display test, the screen as in the picture below will appear (Pic. 13). In the upper row the software version will appear and in the lower row a type of internal power supply, to which the meter has been adjusted:

Accu - internally powered by two rechargeable R6/AA batteries;;

bAtt - internally powered by two standard R6/AA batteries.

Pic. 13

After about 1.5 s. the meter enters the measurement mode.

15. Power source and changing the battery

The meter is powered by 9V battery or 12V stabilised power adapter. The adapter should be joined with the **P** connector (Pic.1). Connecting the power adapter disconnects the battery and is signalised by the symbol.
The symbol informs about the battery condition. Flashing of the symbol informs that the battery should be changed. In order to do so, it is necessary to undo two screws in the lower wall of the meter, pull out the whole wall and replace the battery.
The next thing is to put the new battery into the meter and mount the wall.
The wall has a sealing ring at the edge. While closing the meter, it is very important to pay attention if the ring is put inside the housing in the whole perimeter. Next, do the screws till the moment of resistance (not too hard). Leaving the wall improperly screwed may cause the meter's inundation, which is not repaired under the warranty conditions.

16. Technical data

pH MEASUREMENT:

Range	Resolution	Accuracy (±1 digit)
0.00 ÷ 14.00 pH	0.01 pH	±0.01 pH

INPUT IMPEDANCE: $>10^{12}\ \Omega$
TEMPERATURE COMPENSATION: automatic
RANGE OF COMPENSATION: -5.0 ÷ 110.0 °C
pH ELECTRODE CALIBRATION: automatic, in 1 ÷ 3 points
THERMAL STABILITY OF ZERO : 0.001pH/^{0}C

REDOX POTENTIAL MEASUREMENT:

Range	Resolution	Accuracy (±1 digit)
-1999 ÷ 1999 mV	1 mV	±1 mV

TEMPERATURE MEASUREMENT:

Range	Resolution	Rccuracy* (±1 digit)
- 50.0 ÷ 199.9 °C	0.1 °C	±0.1 °C

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

TEMPERATURE PROBE: platinum resistor Pt-1000

ACCURACY OF THE PROBE IN RANGE 0 ÷ 100 ^{0}C:
for Pt-1000b resistor: ±0.8 ^{0}C
for Pt-1000$^1/_3$b resistor: ±0.3 ^{0}C

OTHER:

OPERATING TEMPERATURE:	-5 ÷ 45 oC
POWER:	1. 9V battery type 6F22 2. 12V power adapter
POWER CONSUMPTION:	27 mW
DISPLAY:	LCD 55 x 45 mm
DIMENSIONS:	149 x 82 x 22 mm
WEIGHT:	220 g

17. Equipment

Standard set includes:
1. Glass combination pH electrode;
2. Pt-1000B temperature sensor (standard);
3. Plastic container for the meter, electrode and temperature probe;
4. Warranty with manual;

Additional equipment includes:
1. 12V/100mA stabilised power adapter;
2. Pt-1000 1/3B temperature probe of higher accuracy.

W A R R A N T Y

The “ELMETRON” company gives 24 months of warranty for the **CP-411** pH-meter number

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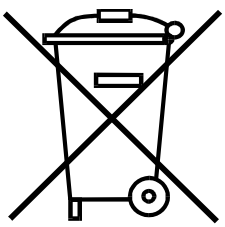
The electrode has a 12-month warranty.

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

NOTICE: Before sending the meter to us please contact the firm by phone.

When sending the meter, please include the electrode, temperature probe and the power adapter.
We also provide after-warranty repair service.

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



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