ANALYTICAL EQUIPMENT FOR

VZOR

ECOLOGY AND POWER INDUSTRY

МАРК-902
pH-METER

Operation Manual

АЯ 74

Nizhny Novgorod

2010

VZOR Ltd. will be grateful for any proposals and criticisms helping improve the product.

If you have any trouble using the instrument please contact us in writing or by phone.

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C O N T E N T S

1 DESCRIPTION AND OPERATION

1.1 Purpose

1.1.1 Product name and identification

pH-meter with a panel-mounted converting unit and the PU-902 probe unit:
MAPK-902 pH-meter. TU 4215-024-39232169-2006 Specifications.

pH-meter with a wall-mounted converting unit and the PU-902 probe unit:
MAPK-902/1 pH-meter. TU 4215-024-39232169-2006 Specifications.

pH-meter with a panel-mounted converting unit and the PU-902A probe unit:
MAPK-902A pH-meter. TU 4215-024-39232169-2006 Specifications.

pH-meter with a wall-mounted converting unit and the PU-902A probe unit:
MAPK-902A/1 pH-meter. TU 4215-024-39232169-2006 Specifications.

pH-meter with a panel-mounted converting unit and the PU-902LD probe unit:
MAPK-902LD pH-meter. TU 4215-024-39232169-2006 Specifications.
pH-meter with a wall-mounted converting unit and the PU-902LD probe unit:
MAPK-902LD/1 pH-meter. TU 4215-024-39232169-2006 Specifications.

1.1.2 The pH-meter is designed for continuous measuring of hydrogen ion activity index (pH) and aqueous solution temperature.

1.1.3 MAPK-902 and MAPK-902/1 pH-meters are intended to measure hydrogen ion activity index (pH) in thermal power industry and various industries.

MAPK-902A, MAPK-902A/1, MAPK-902LD, MAPK-902LD/1 pH-meters are intended to measure hydrogen ion activity index (pH) in wastewater and for environmental uses.

1.1.4 Converter type:

- operating with a sensitive element to measure hydrogen ion activity index (pH);
- with galvanic input/output separation;
- with indication device;
- with two measuring channels;
- as units for panel or wall installation;
- with current output and RS-485 port measuring data displayed.

1.1.5 Sensitive element type − in accordance with Table 1.1.

Table 1.1

pH-meter version	ЭС-10601/7 glass electrode	ЭСр-10106-3.0 reference electrode	ЭСК-10617/7 combined glass electrode	Sensitive element version
MAPK-902 MAPK -902/1	+	+	–	flow-through/dip
MAPK -902A MAPK -902A1	–	–	+	
MAPK -902MP MAPK-902MP/1	–	–	+	line-dip (LD)

1.1.6 This pH-meter version incorporates an electronic preamplifier galvanically isolated from the converter and located next to the electrodes to increase the allowable distance between the converter and the electrode system.

1.2 Basic parameters and dimensions

1.2.1 By resistance to climatic effects the pH-meter falls within Version Group B4 as per GOST 12997-84.

1.2.2 By resistance to mechanical effects the pH-meter falls within Version Group L1 as per GOST 12997-84.

1.2.3 By protection against environmental exposure, the pH-meter's components meet GOST 14254-96 in accordance with Table 1.2, depending on its version.

Table 1.2

pH-meter version	Description and identification of units	Unit versions as per GOST 14254
MAPK-902 MAPK-902A MAPK-902LD	Converting unit BP31.01.000 (panel-mounted version)	IP30
MAPK-902/1 MAPK-902A/1 MAPK-902LD/1	Converting unit BP43.01.000 (wall-mounted version)	IP65
MAPK-902 MAPK-902/1 MAPK-902A MAPK-902A/1	Amplifier unit BP31.02.100	IP62
MAPK-902LD MAPK-902LD/1	PU-902LD probe unit BP43.02.000	IP68

1.2.4 By resistance to atmospheric pressure this pH-meter version falls within P1 Group as per GOST 12997-84 (atmospheric pressure from 84 to 106.7 kPa).

1.2.5 Analyte medium parameters

1.2.5.1 Analyte medium (aqueous solutions) temperature, °C ….. + 5 to + 50.

1.2.5.2 Analyte medium pressure for MAPK-902A, MAPK-902A/1, MAPK-902LD, MAPK-902LD/1, MPa ……..... 0 to 0.025.

1.2.6 Operating conditions

1.2.6.1 Ambient air temperature, °C …….. + 5 to + 50.

1.2.6.2 Ambient air relative humidity at 35°C and lower temperatures without moisture condensation, %, max …..... 80.

1.2.6.3 Atmospheric pressure, kPa (mm Hg) ….... 84.0 to 106.7 (630 to 800).

1.2.7 The pH-meter is powered from single-phase 220 V AC (50 ± 1) Hz mains.

The supply voltage tolerance varies from –15 to +10 %.

Power consumption, V·A, max ……..……..... 10.

1.2.8 The pH-meter provides operation with electrode systems whose EMF corresponds to the following equation:

$$E = E_i + S_t(pH - pH_i), \quad (1.1)$$

where E – electrode system EMF, mV;

E_i, pH_i – coordinates of the electrode system isopotential point, mV, pH;

pH – hydrogen ion activity, pH;

S_t – electrode system transconductance, mV/pH.

The S_t value is defined with the following expression:

$$S_t = -0.1984 \cdot (273.16 + t) \cdot Cs, \quad (1.2)$$

where t – analyte medium temperature, °C;

Cs – coefficient taking values from 0.8 to 1.01 and used to allow for the deviation of electrode system transconductance from a theoretical value for which Cs=1.

1.2.9 The pH-meter electrode system may be set to the parameters shown in Table 1.3.

Table1.3

Slope of electrode system hydrogen curve in the linear part thereof, mV/pH, min	Coordinates of electrode system isopotential point	
	E_i, mV	pH_i, pH
− 57.0 (at 20 °C)	−14 ± 54	7.0 ± 0.3

1.2.10 Overall dimensions and weights of the main pH-meter components are shown in Table 1.4.

Table1.4

pH-meter version	Component name and identification	Overall dimensions, mm, max	Weight, kg, max
MAPK-902 MAPK-902A MAPK-902LD	Converting unit BP31.01.000	252×146×100	2.60
MAPK-902/1 MAPK-902A/1 MAPK-902LD/1	Converting unit BP43.01.000	266×170×95	2.60
MAPK-902 MAPK-902/1	PU-902 probe unit BP31.02.000: – BP31.02.100 amplifier unit; – BP31.02.200 temperature sensor; – ЭС-10601/7 glass electrode; – ЭСр-10106-3.0 reference electrode	 120×83×30 ∅11×128 ∅12×170 ∅10/26×230	 0.3 0.05 0.07 0.10
MAPK-902A MAPK-902A/1	PU-902A probe unit BP31.02.000-01: – BP31.02.100 amplifier unit; – BP31.02.200 temperature sensor; – ЭСК-10617/7 combination glass electrode.	 120×83×30 ∅11×128 ∅12×160	 0.3 0.05 0.10
MAPK-902LD MAPK-902LD/1	PU-902LD probe unit BP43.02.000	∅60×260	1.55

1.2.11 Conditions for the pH-meter transportation in shipping crates as per GOST 12997:

– temperature, °C ..... − 5 to + 55;
– relative humidity at 25 °C, %, max ……. 95;
– sinusoidal vibration at 5-35 Hz, shift amplitude of 0.35 mm in the direction shown by the "THIS WAY UP. HANDLE WITH CARE" sign on a crate.

1.2.12 Reliability requirements:

– average time between failures (except for electrodes), hours, min……..... 20.000;
– mean recovery time, hours, max …… 2;
– pH-meter average life (with electrodes replaced), years, min …… 10.

1.2.13 Electric resistance of the pH-meter supply circuit insulation between plug pins and frame, MΩ, min:

– at ambient air temperature of (20 ± 5) °C …….. 40;
– at ambient air temperature of 50 °C ……..…… 10;
– at ambient air temperature of 35 °C and relative humidity of 80 %..…... 5.

1.2.14 Electric insulation of the pH-meter power supply circuit relative to the converting unit case withstands for 1 min a 1.5 kV 50 Hz AC test sinusoidal voltage at an ambient air temperature of (20 ± 5) °C and relative humidity from 30 to 80 %.

1.2.15 Electric resistance between the external terminal (contact) of the converting unit protective earthing and frame, Ω, max …… 0.1.

1.3 Specifications

1.3.1 pH-meter's hydrogen-ion activity index measurements, pH ….. 1 to 12.

1.3.2 The pH-meter's margin of allowable basic absolute measuring error for pH measurements at an analyte medium temperature of (25.0 ± 0.2) °C and ambient air temperature of (20 ± 5) °C, pH:

– for MAPK-902 and MAPK-902/1 versions ……..……. ± 0.05;

– for MAPK-902A, MAPK-902A/1, MAPK-902MP and MAPK-902MP/1 versions ……..... ± 0.20.

1.3.3 The pH-meter's margin of allowable complementary absolute measuring error for pH caused by a change in the analyte medium temperature (temperature compensation error), pH:

– for MAPK-902 and MAPK-902/1 versions ……..…….. ± 0.1;

– for MAPK-902A, MAPK-902A/1, MAPK-902MP and MAPK-902MP/1 versions ……..... ± 0.20.

1.3.4 Margins of allowable complementary absolute error of the MAPK-902A, MAPK-902A/1, MAPK-902MP and MAPK-902MP/1 pH-meter versions in measuring pH caused by a change in the analyte medium pressure, ranging from 0 to 0.025 MPa, pH …..... ± 0.1.

1.3.5 Analyte medium temperature measuring range, °C ……...+ 5 to + 50.

1.3.6 Margins of the pH-meter's allowable basic absolute error in measuring the analyte medium temperature at an ambient air temperature of (20 ± 5) °C, °C…….. ± 0.3.

1.3.7 Converter measuring range:

– at pH measurements, pH …..……... 0 to 15.

– at U measurements (for MAPK-902, MAPK-902/1, MAPK-902A and MAPK-902A/1 versions), mV …… − 1.000 to + 1.000.

1.3.8 Margins of the converter's allowable basic absolute error at an analyte medium temperature of (25.0 ± 0.2) °C and ambient air temperature of (20 ± 5) °C:

– at pH measurements, pH ……. ± 0.02;

– at U measurements (for MAPK-902, MAPK-902/1, MAPK-902A and MAPK-902A/1 versions), mV ……..……. ±2.

1.3.9 Margins of the converter's allowable complementary absolute error caused by a change in the analyte medium temperature (temperature compensation error), pH …….. ± 0.03.

1.3.10 Temperature compensation range at pH measurements, °C……..……. from +5 to + 50.

1.3.11 Margins of the converter's allowable complementary absolute error caused by deviation of ambient air temperature from the normal one (20 ± 5) °C per each ± 10 °C within an operating temperature range from + 5 to +50°C:

– at pH measurements, pH ……... ± 0.01;

– at U measurements (for MAPK-902, MAPK-902/1, MAPK-902A and MAPK-902A/1 versions), mV ……..……..…… ± 1.

1.3.12 Margins of the allowable complementary absolute error caused by resistance effect in the measuring electrode circuit per each 500 MΩ within a measuring range from 0 to 1.000 MΩ:

– at pH measurements, pH …….…….…….. ± 0.005;

– at U measurements (for MAPK-902, MAPK-902/1, MAPK-902A and MAPK-902A/1 versions), mV ……..…….…..... ± 0.5.

1.3.13 The converter (for MAPK-902, MAPK-902/1, MAPK-902A and MAPK-902A/1 versions) withstands an input signal load for 2 h, mV …… ± 1.250.

1.3.14 Margins of the pH-meter's allowable complementary absolute error caused by deviation of ambient air temperature from the normal one (20 ± 5) °C per each ± 10 °C within an operating temperature range from +5 to +50 °C, °C…..……..... ± 0.1.

1.3.15 Converter reading stability at a minimum continuous operating time of 24 h, pH, at least ……..…… ± 0.02.

1.3.16 Measured pH value-to-output current conversion function at an ambient air temperature of (20 ± 5) °C is as follows:

– for 4-20 mA current output at load not exceeding 500 Ω:

$$I_{output}(mA) = 4 + 16 \cdot \frac{X - X_{init}}{X_{range}}, \qquad (1.3)$$

– for 0-5 mA current output at load not exceeding 2 kΩ:

$$I_{output}(mA) = 5 \cdot \frac{X - X_{init}}{X_{range}}, \qquad (1.4)$$

where X – measured pH value;

X_{init} – pH measuring subrange starting value (for current output);

X_{range} – pH measuring subrange width (for current output) defined as a difference between the pH measuring subrange minimum and maximum (for current output).

1.3.17 Margins of the allowable basic reduced error in converting the measured pH value into output current at an ambient air temperature of (20 ± 5) °C, % of the current output range:

– 0-5 mA……..... ± 0.5;

– 4-20 mA…… ± 0.5.

1.3.18 Margins of the allowable complementary reduced error in converting the measured pH value into output current, caused by caused by deviation of ambient air temperature from the normal one (20 ± 5) °C per each ± 10 °C within an operating temperature range from +5 to +50 °C, % of the current output range……..…… ± 0.25.

1.3.19 Converter's output signal (reading) settling time, s, maximum …… 10.

1.3.20 pH-meter's output signal (reading) settling time, min, maximum … 15.

1.3.21 Converter's warm-up and heat balance settling time, h, max ……. 0.5.

1.3.22 If the measured pH or U value (for MAPK-902 and MAPK-902/1 versions) or temperature goes beyond range limits, the audible alarm goes off and the OVERLOAD indicator lights up on the pH-meter face panel. The OVERLOAD! sign is displayed on the pH-meter screen.

1.3.23 Any excess by the measured pH or U value (for MAPK-902 and MAPK-902/1 versions) of the threshold limits will cause the ▼ or ▲ symbol to appear on the pH-meter indicator screen and the threshold relay to operate.

1.3.24 When connected to a personal computer (PC), the pH-meter exchanges information with PC through the RS-485 interface.

1.4 Product components

1.4.1 The product is comprised of the following components:

– panel- or wall-mounted converting unit depending on the pH-meter version;

– PU-902, PU-902A or PU-902LD probe unit depending on the pH-meter version (one or two depending on the delivery set);

– cable for connecting the probe unit to a converting unit (one or two depending on the delivery set);

– mounting parts kit.

1.5 Design and operation

1.5.1 pH-meter general data

The pH-meter is a dual-channel measuring instrument designed for continuous measuring:

– hydrogen ion activity (pH) within a range from 1 to 12 pH;

– temperature of aqueous solutions within a range from +5 to +50 °C;

– U (MAPK-902, MAPK-902/1, MAPK-902A and MAPK-902A/1 pH-meter versions) within a range from – 1.000 to +1.000 mV.

Measured pH and analyte medium temperature values are displayed on the screen of a digital LCD display (“the display”) with the least significant digit 0.001 pH (pH measurements), 1 mV (U measurements) and 0.1 °C (temperature measurements). It provides separate or simultaneous indication for two measuring channels.

For convenient recording of measured pH values on a recording unit using current outputs, the pH-meter’s user may set the pH measuring subrange start and end values (by current output).

Each pH measuring channel of the pH-meter has a current output with unified output DC signals from 0 to 5 mA or from 4 to 20 mA. A unified output DC sig-

nal (from 0 to 5 mA or from 4 to 20 mA) may be set separately for each channel. The lower (0 or 4 mA) and upper (5 or 20 mA) limits of a current output range correspond to the programmed pH measuring subrange start and end values (by current output).

Apart from unified output DC signals from 0 to 5 mA or from 4 to 20 mA, the pH-meter's user may set a unified output DC signal from 0 to 20 mA for each channel, using the pH-meter menu.

pH measuring subranges in each channel may be selected independently. Values of selected subranges limits are also displayed. In case any of the subranges is overloaded the **OVERLOAD!** indication will appear on the display screen.

The probe unit is connected to the converting unit with a cable 5 to 100 m long.

Each of the pH-meter channels has two freely programmable thresholds setting the upper and lower limits for monitoring the measured pH value. If pH values go beyond the threshold limits the relay's dry contacts will close and the character of the upper or lower threshold limit will be displayed.

In accordance with MU 34-70-114-85 Guidelines, the pH-meter may reduce the measured pH_t value to pH_{25}.

pH values are reduced to pH_{25} within a range from +5 to +50 °C. A reduced pH_{25} value may be shown on the display.

The pH-meter's function showing the dependence of the pH value of highly diluted acid and alkali solutions on the analyte medium temperature is charted in Appendix B.

1.5.2 pH-meter operating principle

The pH-meter operation is based on the potentiometric method for analyte solution pH measurement.

The electrode system immersed in an analyte solution generates U linearly dependent on the pH value.

Signals (U) from the electrode system and temperature sensor are supplied to the converter comprised of the amplifier and converting units. Once amplified and digitized in the amplifier unit, signals are then fed to the converting unit input via cable.

The measured U of the pH-meter electrode system is translated into the pH value, allowing for the analyte solution temperature, i.e. temperature compensation occurs automatically and only relates to the electrode system U variations.

1.5.3 pH-meter components

1.5.3.1 Converting unit

The converting unit is a microprocessor instrument designed to display measuring results (pH, pH_{25}, U and temperature), generate a current output signal, control the threshold relay and exchange with a PC. The unit is powered from single-phase 220 V AC 50 Hz mains. The converting unit may be panel- or wall-mounted.

The layout of indicators and controls on the converting unit face panel (panel- and wall-mounted versions) is shown in Fig.1.1:

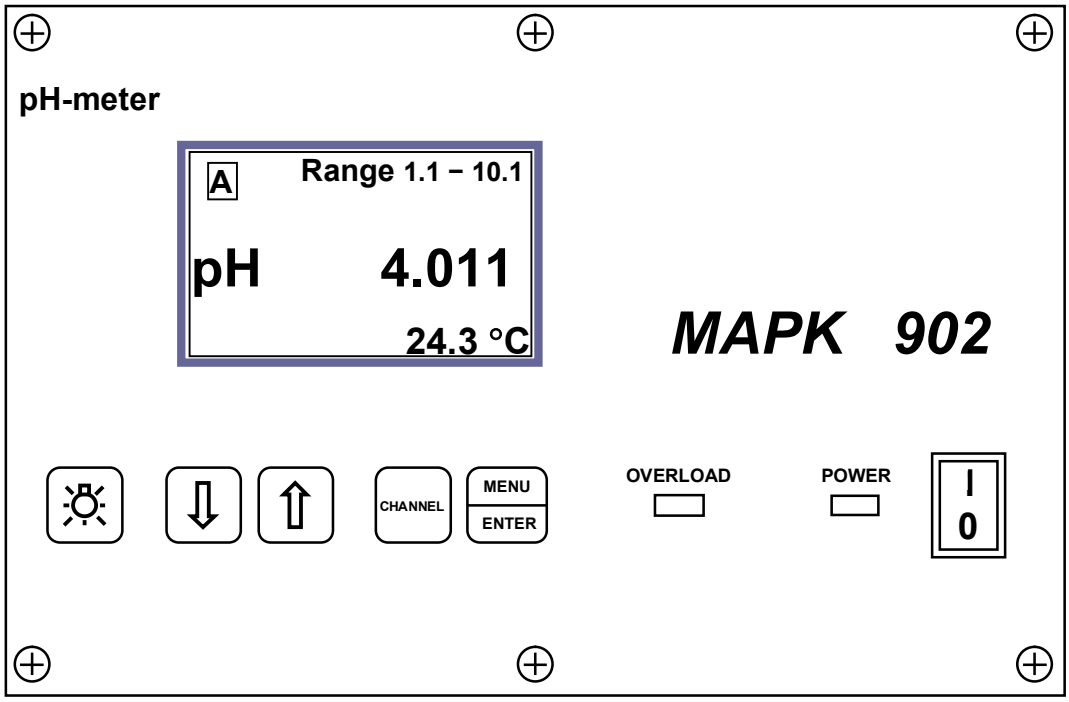


Figure 1.1 − Layout of indicators and controls on the converting unit face panel

– display screen designed to show measured pH, pH_{25}, U and temperature values and pH-meter operating modes;

– "**POWER**" button to switch the pH-meter on and off;

– "⇓" and "⇑" buttons to move the cursor up and down the menu when selecting the operating mode and changing measuring subranges (by current output) and threshold values;

– "**CHANNEL**" button to change channel indications and menus;

– "$\frac{\textbf{menu}}{\textbf{enter}}$" to enter the menu and confirm the values and operating modes selected in programming;

– button "☼" to switch on and off the display screen illumination;

– "**OVERLOAD**" red LED indicator to show an overloaded range for current output, temperature and U;

– "**POWER**" green LED power on indicator.

The panel-mounted CU rear panel (see Fig.1.2) and the wall-mounted CU lower panel (see Fig.1.3) feature the following components:

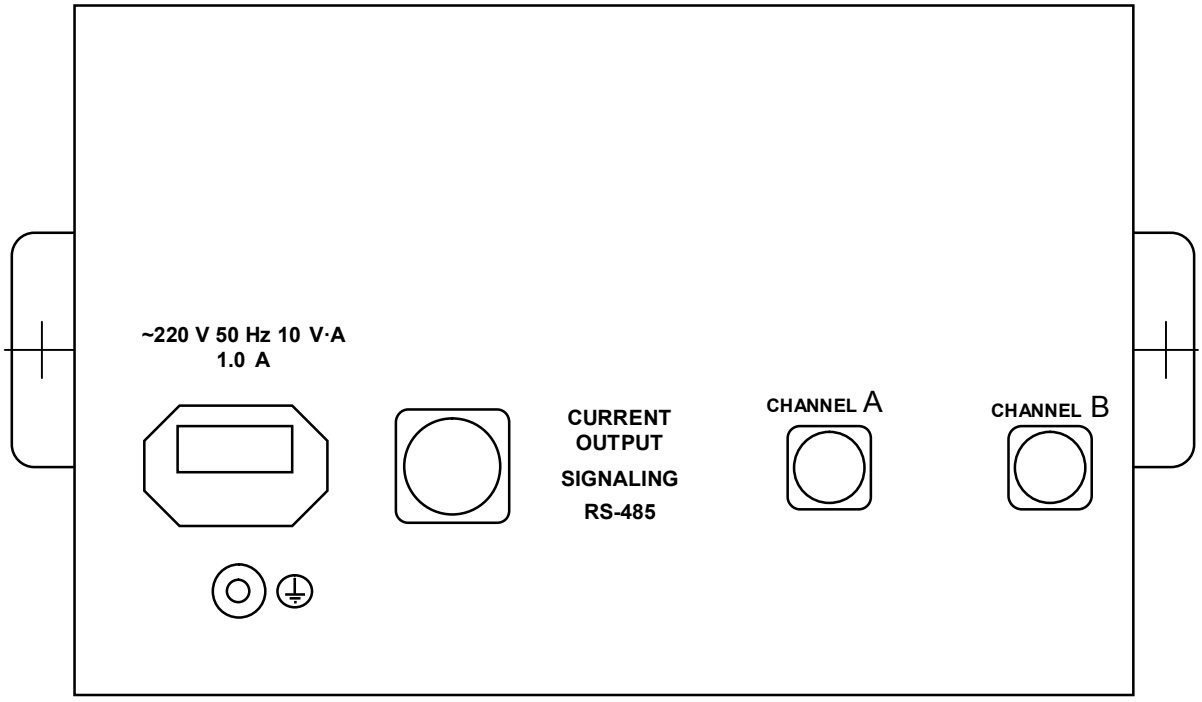


Figure 1.2 − Layout of connectors on the panel-mounted converting unit rear panel

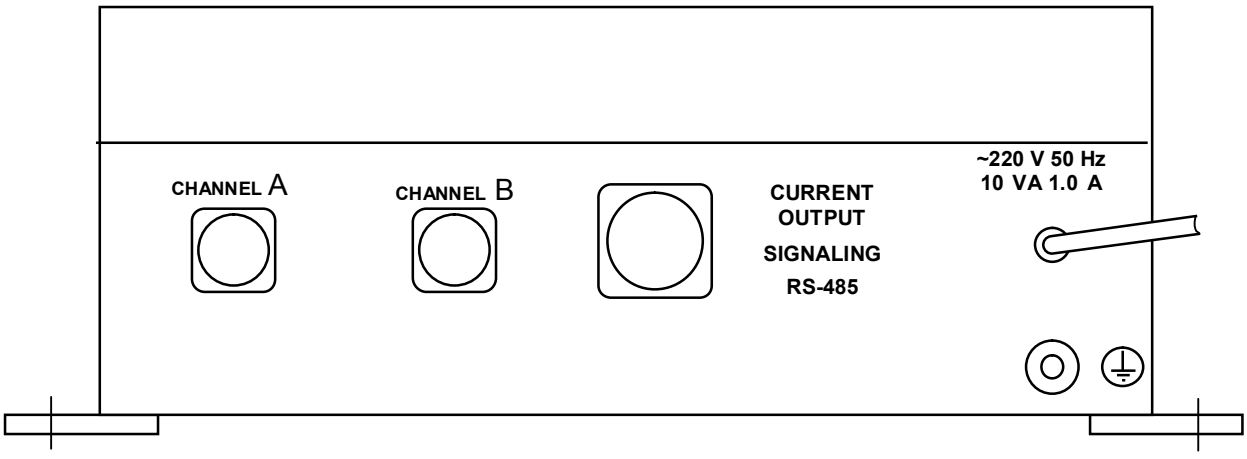


Figure 1.3 − *Layout of connectors on the wall-mounted converting unit lower panel*

– two connectors “**CHANNEL A**” and “**CHANNEL A**” for cables connecting probe units and the converting unit;

– “**CURRENT OUTPUT**, **SIGNALING**, **RS-485**” connector to hook up recording and actuating equipment and to hook up the pH-meter to PC;

– terminal“ ⏚ ” to connect protective earthing to the pH-meter frame.

The panel-mounted CU rear panel features the “**~220 V 50 Hz 10 V·A 1.0 A**” mains connector.

The wall-mounted CU lower panel features the “**~220 V 50 Hz 10 V·A 1.0 A**” sealed mains cable entry.

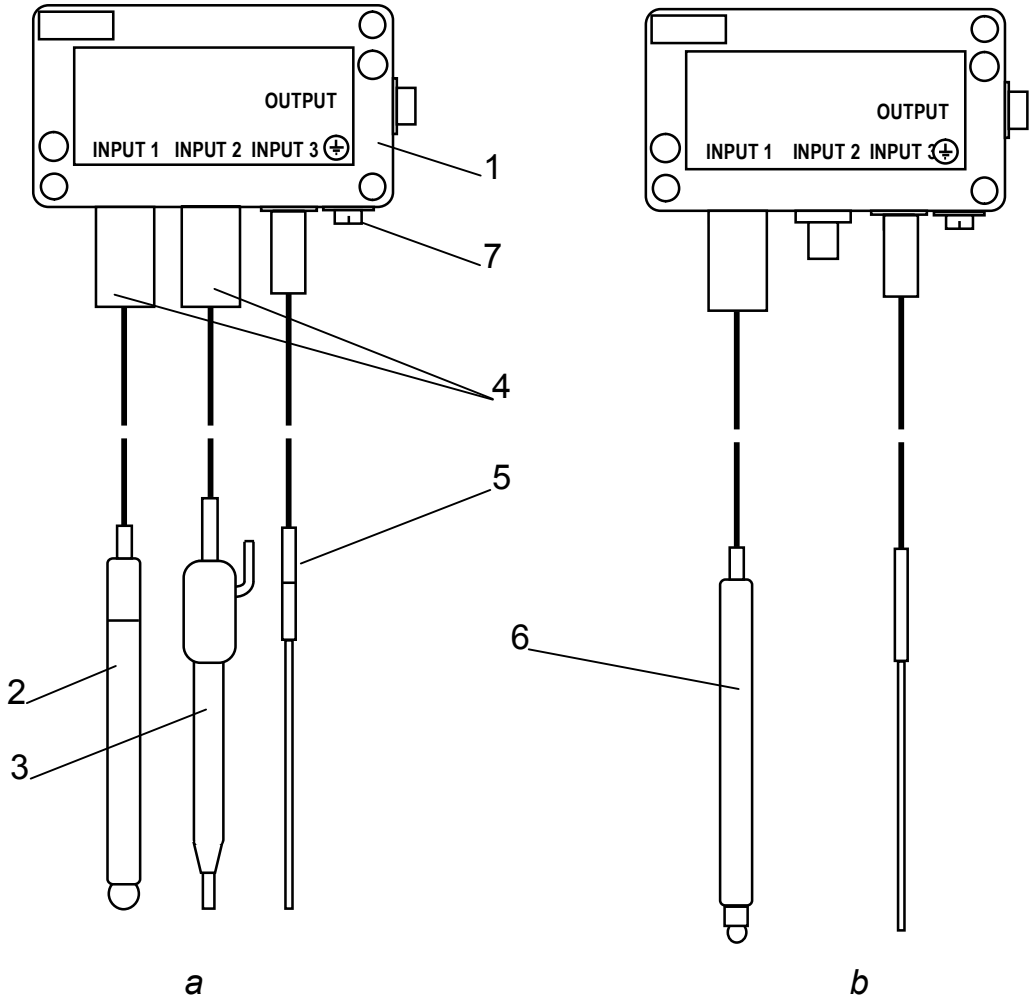
1.5.3.2 Probe unit

1.5.3.2.1 *PU-902 probe unit* (Fig.1.4 *a*) and *PU-902A probe unit* (Fig.1.4 *b*) are comprised of:

– amplifier unit;

– temperature sensor;

– electrode system.



a *b*

Figure 1.4 – PU-902 and PU-902A probe units

Amplifier unit 1 has a sealed aluminum housing that features the connectors as shown in Fig.1.4.

In the PU-902 probe unit the electrode system comprising measuring electrode 2 (pH-electrode) and reference electrode 3 is connected to the "**INPUT 1**" and "**INPUT 2**" connectors.

In the PU-902A probe unit, combination electrode 6 подключается к разъему "**INPUT 1**".

Protective collars 4 are intended for water splash protection of electrode connectors.

Connected to the "**INPUT 3**" connector is temperature sensor 5, a thermoresistor enclosed in a metal case.

Connected to the "**OUTPUT**" connector is a shielded cable hooking up the probe unit to the converting unit.

There is earthing screw 7 in the amplifier unit lower wall.

1.5.3.2.2 *The PU-902LD probe unit* is composed of:

- amplifier unit;
- combined electrode;
- temperature sensor.

The PU-902LD probe unit is shown in Fig.1.5*a*.

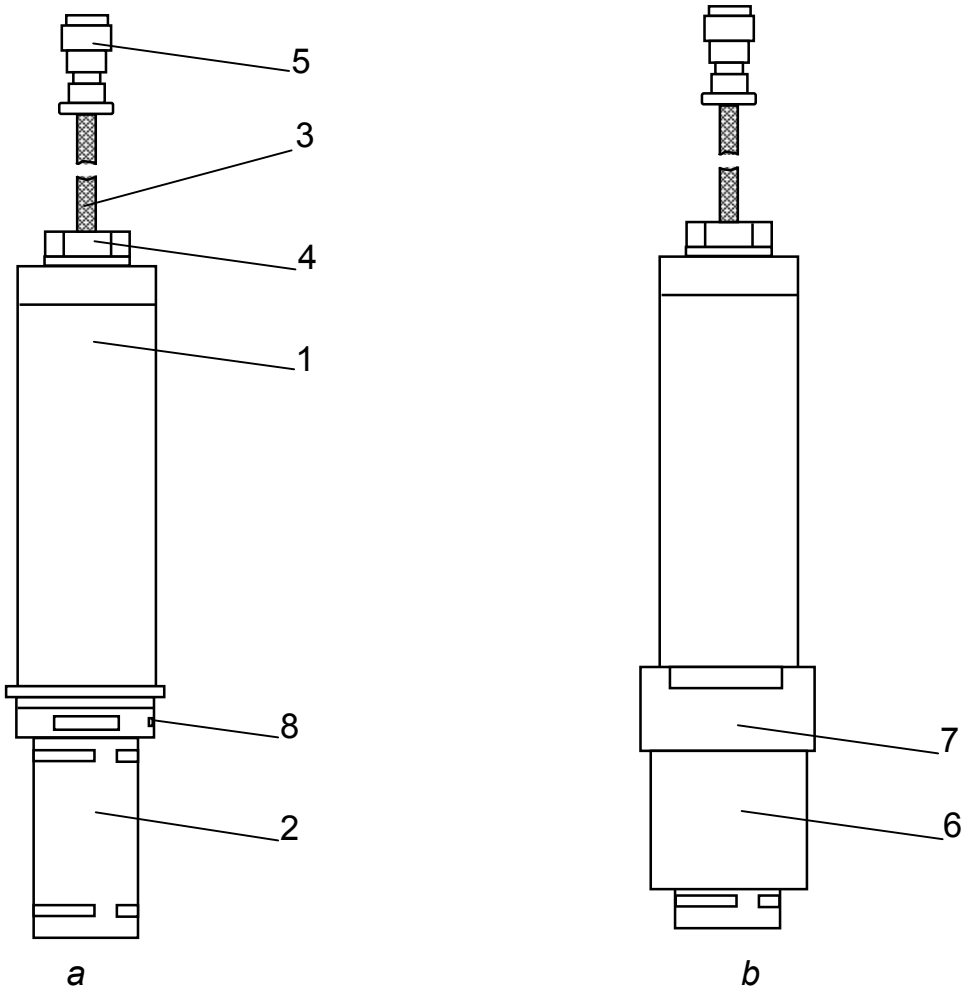


Figure1.5

Housing 1 provides sealed protection for the amplifier unit board and contact joints. The probe unit electrode section (working parts of the combined electrode and temperature sensor) is protected by housing 2 representing a steel pipe holed to provide free circulation of analyzed water in the electrode area. Retention screw 8 prevents inadvertent unscrewing of housing 2. Cable 3 sealing is achieved by the tightening of nut 4. Connector 5 is for the cable hooking up the probe unit to the converting unit.

As approved by the customer, the probe unit may come complete with pipe 6 and coupling nut 7 for main pipeline measurements, as shown in Fig.1.2*b.*

1.5.4 Measurement screens

1.5.4.1 Types of measurement screens

The pH-meter has the following measurement screens:

- single channel (A or B) measurement screen as shown in Fig.1.6 and 1.7;
- double channel (A and B) measurement screen as shown in Fig.1.8.

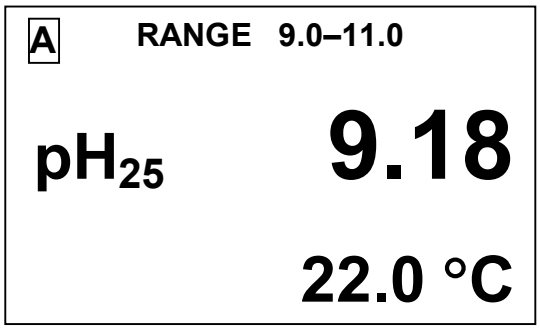


Figure1.6

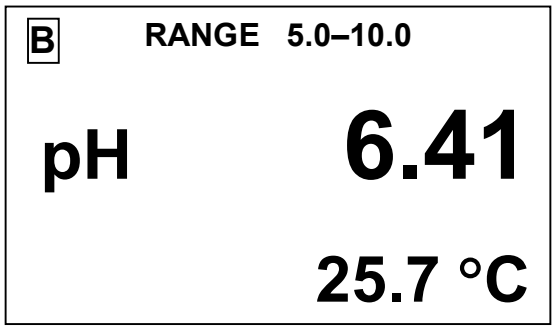


Figure 1.7

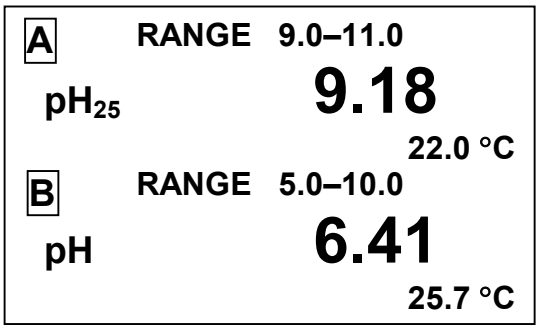


Figure 1.8

Toggling between channel A and B measurement screens and A/B measurement screen is by pressing the "**CHANNEL**" button.

Indicated on the screens are channel names (A or B), upper and lower limits of programmable measuring subrange values (by current output) and measured electrode system pH, pH_{25}, U and temperature values.

Toggling among measuring channel indication modes is by successively pressing the "**CHANNEL**" button, with channel A or B readings or both channel A and B readings displayed.

If the probe unit is only connected to one channel, measurements may be performed for this channel only.

1.5.5 Types of setting monitoring and changing mode screens (MENU mode)

1.5.5.1 General information on handling the **MENU**

The pH-meter's parameters are monitored and changed using the screen menus.

The **MENU** mode is entered from the measuring mode by pressing the "**menu**/**enter**" button.

The pH-meter has three screen menus:

- **MENU [A]**;
- **MENU [B]**;
- **MENU [A] [B]**.

Toggling among screen menus is by successively pressing the "**CHANNEL**" button.

MENU [A] and **MENU [B]** screens reflect the status of individual channel parameters and are shown in Fig.1.9.

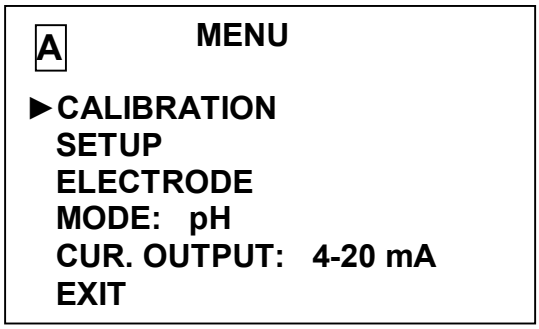


Figure 1.9

MENU [A] [B] screen reflects the pH-meter's parameters common for both measuring channels and is shown in Fig.1.10.

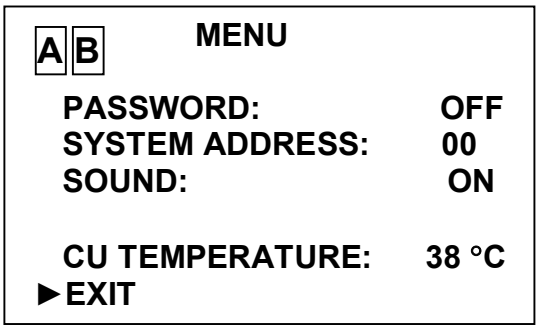


Figure 1.10

The required menu item is highlighted with the "►" marker moved up and down the screen with the "⇓"/"⇑" buttons.

After the "►" marker is set at the required menu item, press the "**menu / enter**" button.

To exit **MENU** screens, set the marker at **EXIT** and press the "**menu / enter**" button.

1.5.5.2 Entry of numerical values in **MENU [A], MENU [B]** and **MENU [A] [B]**

As required, the pH-meter allows the user to change numerical values in menu lines or enter new ones. This concerns, for example, selection of a programmable current output measuring subrange, entry of threshold values etc.

Left scrolling is by the "**CHANNEL**" button.

Right scrolling is by the "**menu / enter**" button.

Number increasing or decreasing is by "⇓"/"⇑" buttons.

Proceed as follows to enter or change a numerical value:

- set the "►" marker at this line;
- press the "**menu / enter**" button; the first digit will be flashing;
- use the "⇓"/"⇑" buttons to set the first digit value;
- press the "**menu / enter**" button; the second digit will be flashing;
- use the "⇓"/"⇑" buttons to set the second digit value;
- press the "**menu / enter**" button; set the other digits.

Once all the digits and units of measurements are set (no number is flashing), use the "⇓"/"⇑" buttons to set the "►" marker at another line and enter another

value, if necessary.

Once all the digits and units of measurements are set (no number is flashing), use the "⇓"/"⇑" buttons to set the "►" marker at **EXIT** and press the "**menu**/**enter**" button.

1.5.5.3 Using **MENU [A]** and **MENU [B]** screens (Fig. 1.11)

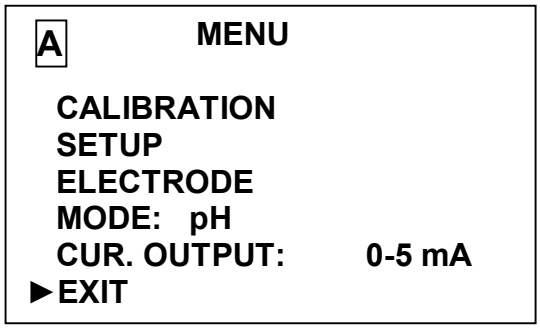


Figure 1.11

► **CALIBRATION** – a menu item used to select the pH-meter's pH calibration mode (see 2.3.8).

► **SETUP** – a menu item used to view and change a pH measuring subrange (by current output) and to view and change minimum and maximum pH threshold values.

The screen is as shown in Fig. 1.12.

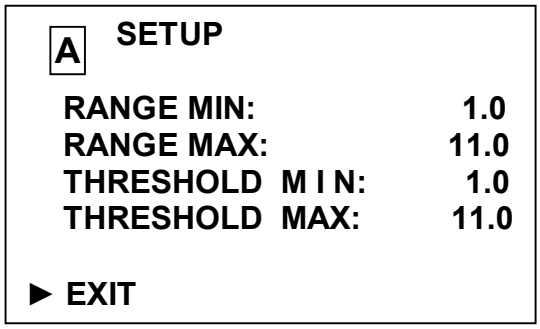


Figure 1.12

The user may set values ranging between 0.0 and 14.9 pH (with interval of 0.1 pH) in the RANGE MIN line and those ranging between 0.1 and 15.0 pH (with interval of 0.1 pH) in the RANGE MAX line.

The difference between pH values in RANGE MAX and RANGE MIN lines is 1 pH, as a minimum.

pH values from 0.0 and 14.9 pH (with interval of 0.1 pH) may be set in the THRESHOLD MIN line and pH values from 0.1 and 15.0 pH (with interval of 0.1 pH) in the THRESHOLD MAX line.

Once all the required values are set, press the "**menu / enter**" button.

This action will cause the pH-meter confirmation screen as shown in Fig. 1.13 to be displayed.

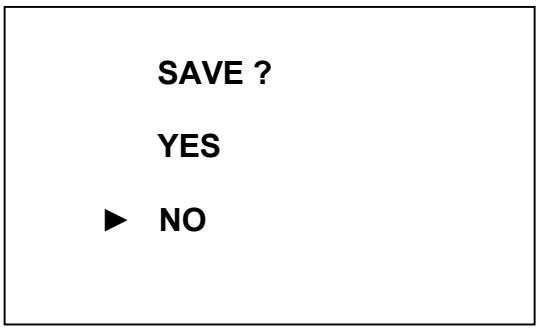


Figure 1.13

Use "⇓"/"⇑" buttons to set the "►" marker at **YES** and press the "**menu / enter**" button.

The pH-meter will change over to the **MENU** mode, saving the pH measuring subrange minimum and maximum values (by current output) and new threshold values.

► **ELECTRODE** – a menu item meant to view the electrode system parameters.

Set the "►" marker at this item and press the "**menu / enter**" button.

This action will cause the pH-meter information screen as shown in Fig. 1.14 to be displayed.

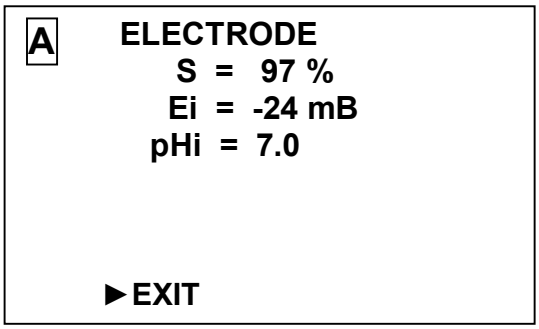


Figure 1.14

The display shows the sensor's parameter values defined by the last calibration:

S – electrode system transconductance in % of the rated value;
pHi and **Ei** – coordinates of the electrode system isopotential point.

To exit this screen, press the "**menu / enter**" button.

The pH-meter will change over to the **MENU** mode.

► **MODE: pH** – a menu item meant to select the channel indication mode (pH, pH_{25}, U).

To change the indication mode, set the "►" marker at this menu item. Each depression of the "**menu / enter**" button will cause the pH-meter to successively change over to pH, pH_{25} and U measuring modes.

Once the required indication mode is chosen, use the "⇓"/"⇑" buttons to set the "►" marker at **EXIT** and press the "**menu / enter**" button.

The pH-meter will change over to the selected parameter measuring mode.

► **CUR.OUTPUT: 0-5 mA** – a menu item intended to select the current output range (0-5 mA, 4-20 mA or 0-20 mA).

To change the current output range, set the "►" marker at this menu item and press the "**menu / enter**" button to select the desired current output range.

1.5.5.4 Using the **MENU [A] [B]** screen

The **MENU [A] [B]** screen (Fig. 1.15) enables the user to change the pH-meter's parameters common for both channels.

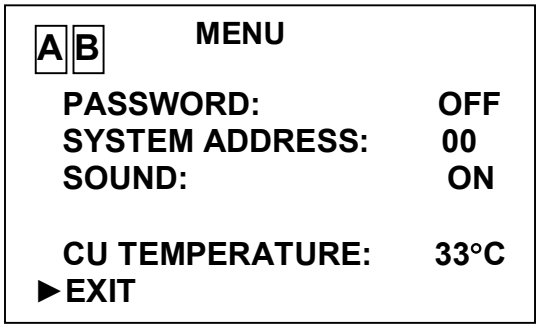


Figure 1.15

This screen menu is handled similarly to the **MENU [A]** and **MENU [B]** screens.

► **PASSWORD: ON** – a menu item intended to restrict access to changing the pH- meter's parameters.

If the password feature is off ("**PASSWORD: OFF**"), no password is requested for changeover from the measuring mode to the **MENU** mode.

If the password feature is on ("**PASSWORD: ON**"), the pH-meter will request to enter the password (**12**) for changeover from the measuring mode to the **MENU** mode.

The screen as shown in Fig. 1.16 below will appear.

Figure 1.16

The first digit to be entered will be flashing on the screen.

Use the "⇓"/"⇑" buttons to set the value of the first password value (**1**) and press the "**menu**/**enter**" button. As the second digit starts flashing on the screen, set the password value (**2**) and press the "**menu**/**enter**" button.

If the correct password is entered the **MENU** screen will drop into view. If a wrong password is entered the pH-meter will switch over to the measuring mode.

► **SYSTEM ADDRESS: 00** – a **MENU [A] [B]** item intended to set the pH-meter's system address for network operation of several instruments via the RS-485 interface. The system address is used to identify a specific pH-meter in the network and may take values from **00 to 99**. In out-of-network operation the system address does not matter.

► **SOUND:** − a **MENU [A] [B]** item is intended to disable the pH-meter's alarm signal, if necessary.

► **CU TEMPERATURE:** − a **MENU [A] [B]** item intended to indicate the CU case inside temperature.

1.5.5.5 Warning and failure screens

The warning screen as shown in Fig. 1.17 will appear if the probe unit cable is not connected **CHANNEL A** or **B**, as appropriate.

Figure 1.17

The warning screen as shown in Fig. 1.18 will appear in the case of a failure. Refer to Section 2.5 of this Operation Manual (Troubleshooting, Table 2.5).

Figure 1.18

The warning screen as shown in Fig. 1.19 will appear in case of a calibration failure. Whenever this screen comes on, refer to Section 2.5 of this Operation Manual (Troubleshooting, Table 2.5).

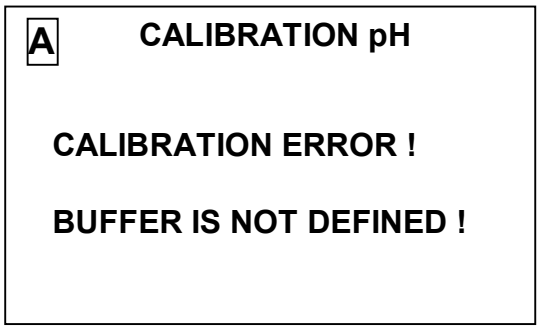


Figure 1.19

On the warning screens as shown in Fig. 1.20 to 1.25 the blinking captions will disappear after the overload on the indicated parameter (pH, pH_{25} or U) is corrected.

The warning screen as shown in Fig. 1.20 will appear, if the measured pH value falls outside the set pH measuring subrange (by current output). Set the correct pH measuring range (by current output).

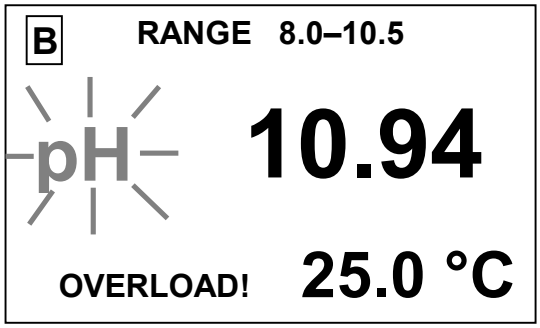


Figure 1.20

The warning screen as shown in Fig. 1.21 will appear, if the analyte solution temperature falls outside the range (+5 to +50 °C).

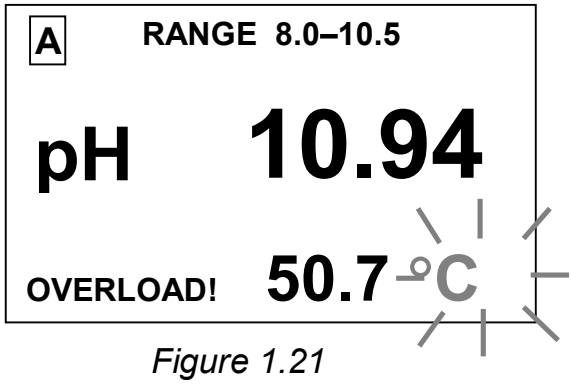


Figure 1.21

The warning screen as shown in Fig. 1.22 will appear, if the analyte solution temperature falls outside the range (+5 to +50 °C) and the measured pH value goes beyond the set pH measuring subrange (by current output).

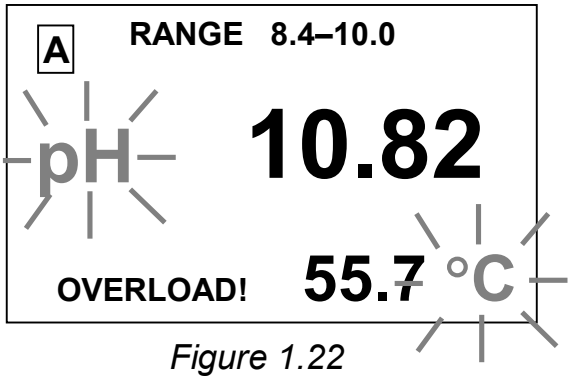


Figure 1.22

The warning screen as shown in Fig. 1.23 will appear, if the measured U value falls outside the range (–1.000 to +1.000 mV).

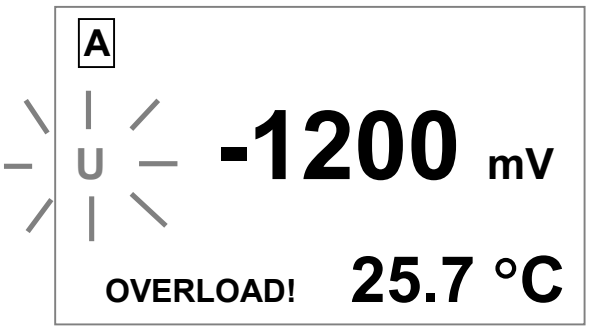


Figure 1.23

The warning screen as shown in Fig. 1.24 will appear, if the measured pH value goes beyond the lower threshold limit.

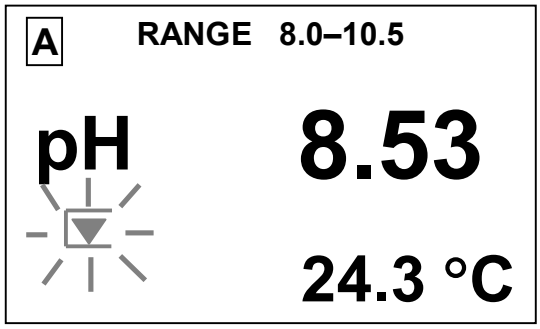


Figure 1.24

The warning screen as shown in Fig. 1.25 will appear, if the measured pH value goes beyond:

– the lower threshold limit – in channel A;

– the upper threshold limit – in channel B.

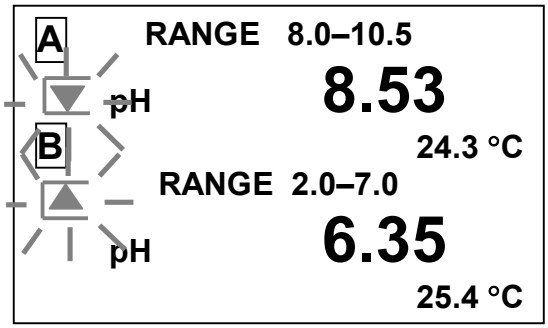


Figure 1.25

1.6 Measuring instruments, tools and accessories

The pH-meter maintenance shall additionally require the following tools and accessories not included in the delivery set:

- K-2-1000-50 flask;
- B-1-250 beaker;
- KCl solution of 3 mol/dm^3 concentration;
- HCl solution of 0.1 mol/dm^3 concentration;
- buffer solutions − grade 2 pH industry standards as per GOST 8.120.

2 INTENDED USE

2.1 Operating limitations

2.1.1 If a pH-meter set includes a panel-mounted converting unit, install it so as to prevent ingress of water as its housing has IP30 protection.

2.1.2 When using the pH-meter protect its electrodes and converting unit against impacts as they comprise glass components.

2.1.3 When using MAPK-902 and MAPK-902/1 versions for pH immersion measurement, ensure that electrodes are dipped in an analyte solution at least 16 mm deep, but no higher than the electrolyte level in the reference electrode.

2.1.4 When using MAPK-902A and MAPK-902A/1 versions for pH immersion measurement, ensure that electrodes are dipped in an analyte solution at least 16 mm deep, but no higher than the limit of the combination electrode glass envelope. (The electrode withstands a maximum excess pressure of 0.025 MPa).

2.1.5 When using MAPK-902MP and MAPK-902MP/1 versions for pH immersion measurement, ensure that electrodes are dipped in a solution 5 cm to 2.5 m deep and the excess pressure does not exceed 0.025 MPa).

When using MAPK-902MP and MAPK-902MP/1 pH-meter versions for main pipeline measurements, ensure that the excess pressure in analyzed water does not exceed 0.025 MPa.

2.1.6 pH, U and temperature must not be measured in solutions containing fluorhydric acid or fluorides and agents forming deposits and films on electrode surfaces. Nor must electrodes not filled with electrolyte be used and stored.

2.2 Safety precautions

2.2.1 The pH-meter must be operated by personnel familiar with this Manual and chemical solution handling rules.

2.2.2 The pH-meter must be used in compliance with the Rules for Operation of Customers' Electrical Installations, the Safety Rules for Operation of Customers' Electrical Installations and GOST 12.2.007.0.

2.2.3 The converting unit must be installed so as not to hinder the de-energizing of the pH-meter.

2.2.4 The pH-meter must not be used with the CU case covers removed or CU and the amplifier unit unearthed.

2.2.5 Electric circuits providing connection to the **CURRENT OUTPUT**, **SIGNALING**, **RS-485** connector must use a shielded cable or wires laid in cable troughs or conduits.

2.3 pH-meter setting-up procedures

2.3.1 Receipt of pH-meter

Before use, unpack the pH-meter, check the set for completeness and make sure the components are intact.

If the pH-meter has stayed in cold environment, keep it at room temperature for at least 1 h before starting setting-up procedures.

2.3.2 Probe unit preparation

2.3.2.1 PU-902 probe unit preparation

Prepare electrodes in accordance with their certificates. Prepared electrodes are to be connected to the amplifier unit (Fig. 1.4):

- connect the measuring electrode to the "**INPUT 1**" connector;
- connect the reference electrode to the "**INPUT 2**" connector;
- connect the temperature sensor to the "**INPUT 3**" connector.

IMPORTANT: ID numbers of the temperature sensor and the amplifier unit must coincide!

Use the same procedure to prepare the second electrode set and connect it to the second amplifier unit, if the delivery set contains two probe units.

Install the probe unit next to the sampling point. The layout of attachment holes for PU-902 probe unit's amplifier unit is as shown in Fig. 2.1.

Earth the amplifier unit housing with at least 0.35 mm^2 copper wire connected to the earthing screw.

The electrode dipping depth in immersion measurements is as specified in 2.1.3.

It is recommended to use the BP31.04.000 hydraulic control panel (optional) for flow-through measurements.

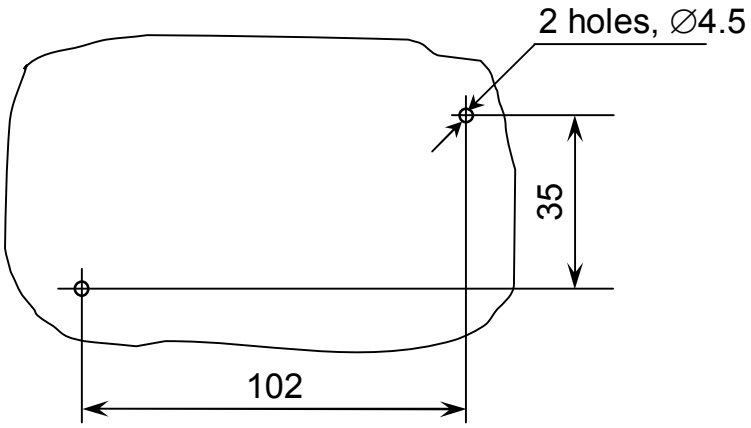


Figure 2.1 – Layout of attachment holes for PU-902/PU-902A probe unit's amplifier unit

2.3.2.2 PU-902LD probe unit preparation

The PU-902LD probe unit comes complete with a combination electrode installed therein. The electrode is protected with a cap. Before removing the cap, undo retention screw 8 (Fig.1.5 *a*) and unscrew protective housing 2. Once the cap is removed, rescrew protective housing 2 and replace retention screw 8.

Prepare the combination electrode in accordance with its certificate.

To perform calibration against buffer solutions, ensure that the probe unit electrode section is immersed into a buffer solution at least 5 cm deep.

To perform measurements at a depth of up to 2.5 m, install the probe unit in a way ruling out any mechanical load on the cable, for example, in a steel pipe as shown in Fig.2.2*a.*

Main pipeline measurements are performed using the pipe and coupling nut supplied optionally.

The pipe should be welded into a pipeline vertically as shown in Fig.2.2b.

Before installing the probe unit electrode section into the pipe apply a thin coating of petroleum jelly to the packing ring on the probe unit housing to prevent the ring from "biting".

Insert the probe unit electrode section into the pipe against the stop and tighten with the coupling nut.

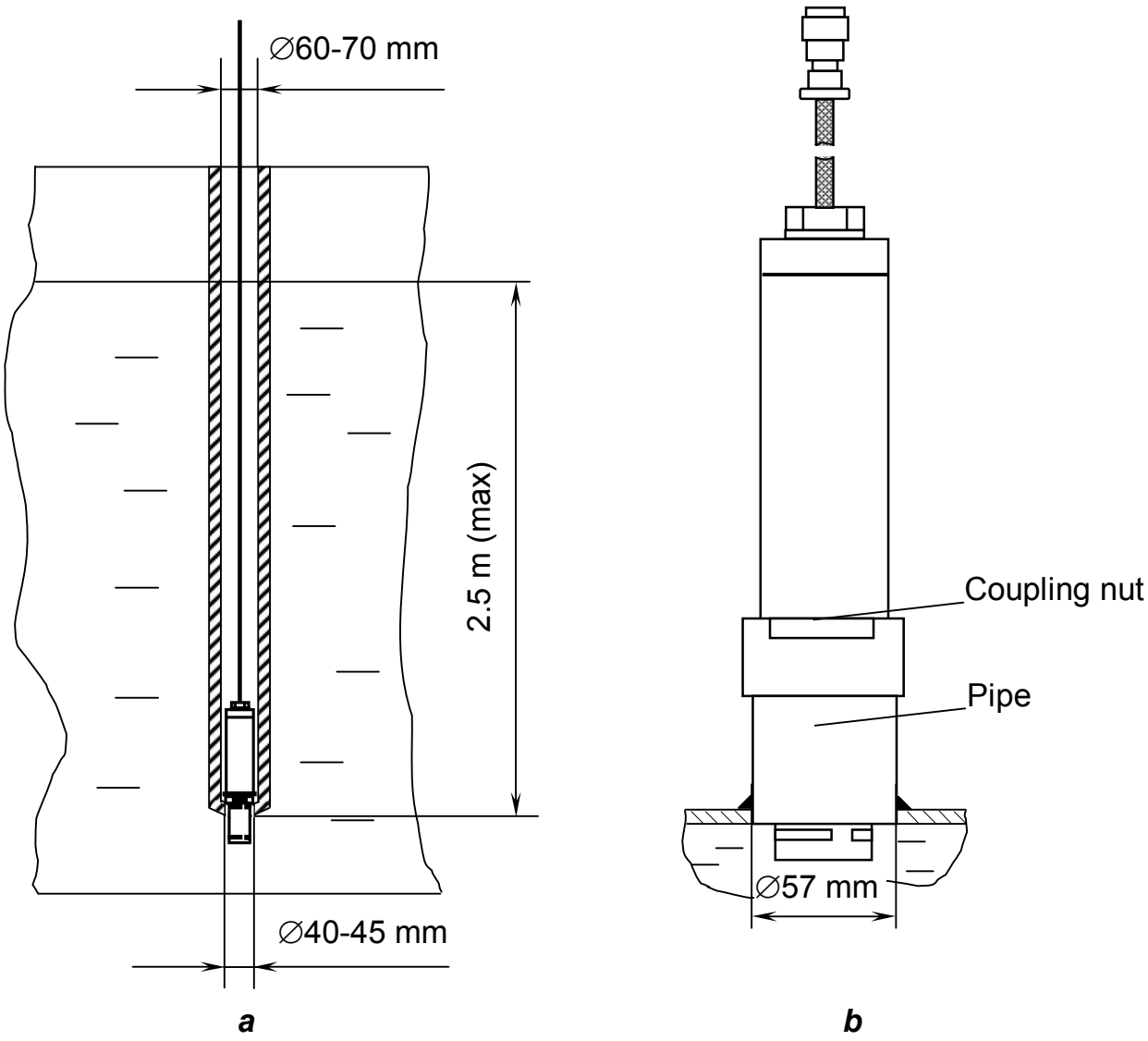


Figure 2.2

2.3.3 Converting unit setting-up procedures

2.3.3.1 Converting unit installation

Install the pH-meter so that the de-energizing of the conductivity meter is not hindered.

The layout of attachment holes provided in the panel for a panel-mounted converting unit is shown in Fig.2.3.

The pH-meter's panel-mounted converting unit is installed on the panel inside. The plate included in the panel-mounted pH-meter delivery set is installed on the panel face.

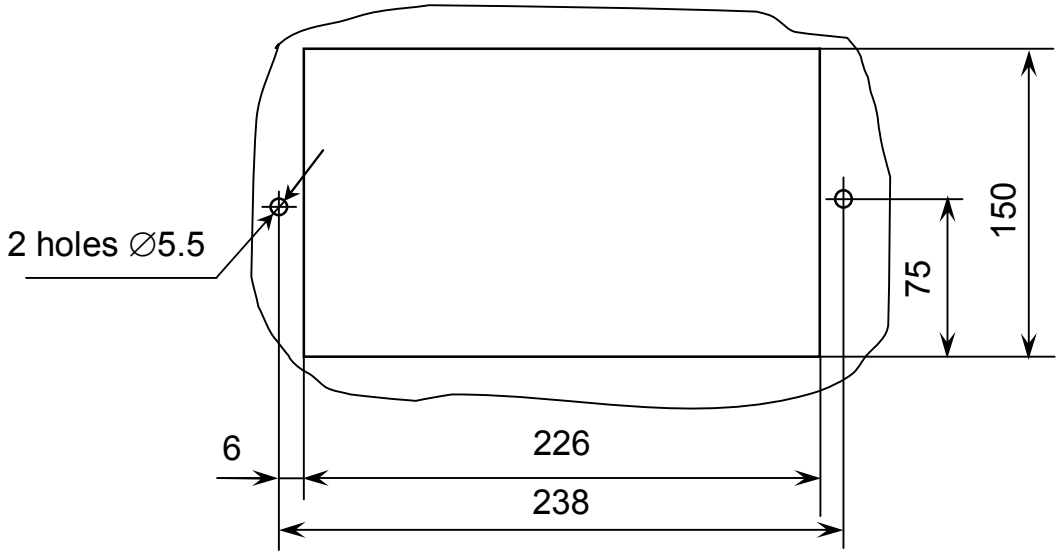


Figure 2.3 − Layout of attachment holes for a panel-mounted converting unit

M5 screws with nuts included in the delivery set are used for attachment.

The layout of holes for vertical attachment of a wall-mounted converting unit is shown in Fig.2.4.

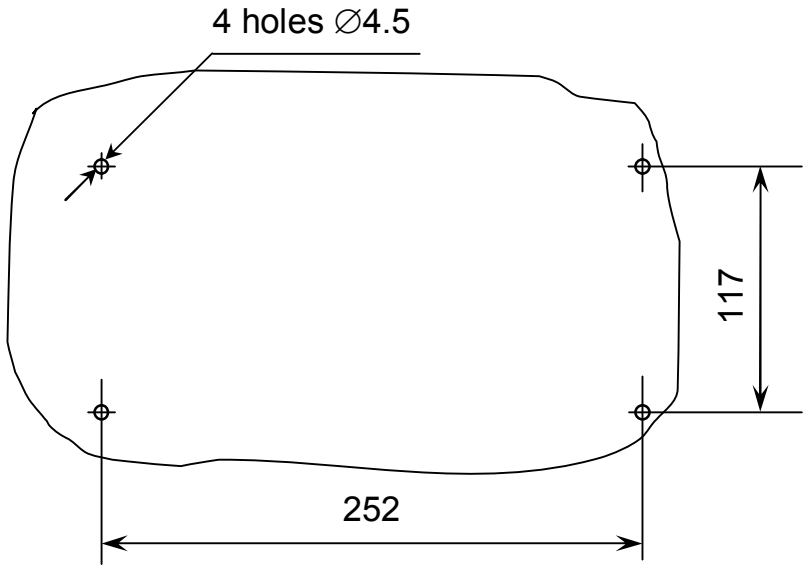


Figure 2.4 − Layout of holes for vertical attachment of a wall-mounted converting unit

Attachment is with M4 screws included in the delivery set.

Provide 220 V 50 Hz mains supply.

Earth the CU case by connecting a copper wire with a section of at least 0.35 mm^2 to the unit earth terminal.

Use the shielded cable from the delivery set to connect the PU-902/PU-902A probe unit and the converting unit "**CHANNEL A**" or "**CHANNEL B**" connector.

Use the shielded cable from the delivery set to connect the PU-902LD probe unit and the converting unit "**CHANNEL A**" or "**CHANNEL B**" connector. This cable set includes a terminal block.

Install the terminal block as appropriate. Attachment holes are shown in Fig.2.5.

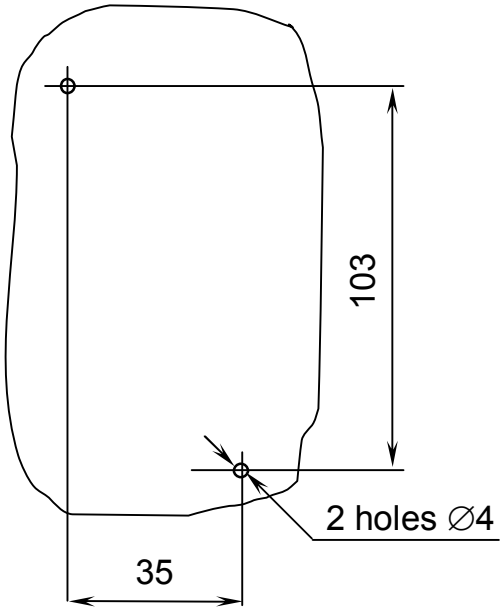


Figure 2.5

If connection requires that the cable is disconnected from the terminal block, proceed as follows after cabling:

– pass the cable through the sealed entry in the terminal block case;

– connect the cable to the shoe inside the terminal block according to the table set inside plate;

– close the terminal block with a cover.

Connect the PU-902LD probe unit connector to one on the terminal block bottom surface.

Push on the **POWER** switch; the green light indicator on the front panel will come on. A sound signal is produced to indicate that the conductivity meter is on. After a few seconds the pH-meter will change over to the measuring mode.

2.3.4 Converting unit external connections

External connections to the converting unit are made to the "**CURRENT OUTPUT**, **SIGNALING**, **RS-485**" connector on the rear panel of a panel-mounted converting unit or on the lower panel of a wall-mounted converting unit, as shown in Fig.1.2 and 1.3, using the PC19TB receptacle included in the mounting parts kit.

The PC19TB receptacle contact layout (view as seen from the soldered contact side) is shown in Fig.2.6.

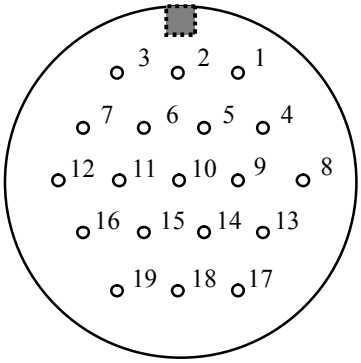


Figure 2.6

2.3.4.1 Connection of external recording unit

The external recording unit is connected to the converting unit through the "**CURRENT OUTPUT**, **SIGNALING**, **RS-485**" connector contacts, as per Table 2.1.

Table 2.1

Contact No.	5	6	9	10
Circuit	Channel A (+)	Channel A (–)	Channel B (+)	Channel B (−)

Contacts 6 and 10 are interconnected.
The 4-20 mA range load must not exceed 500 Ω.
The 0-5 mA range load must not exceed 2 kΩ.

2.3.4.2 RS-485 interface connection

Connection of the PC's RS-485 port to the transducer unit is through the "**CURRENT OUTPUT**, **SIGNALING**, **RS-485**" connector contacts, according to Table 2.2.

Table 2.2

Contact	Circuit
1	SG (signal ground)
14	DAT+ (Data +)
15	DAT– (Data –)

IMPORTANT: De-energize your PC and converting unit before connecting them!

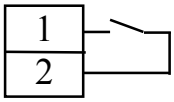
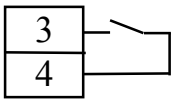
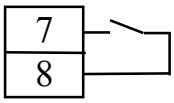
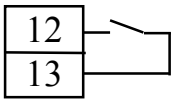
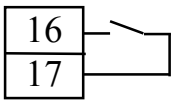
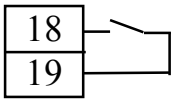
Rate of exchange – 19.200 bit/s.
Data communications protocol – as per Attachment C.

2.3.4.3 Connection of external actuating and warning equipment

Connection of external actuating and warning equipment to the converting unit is through the "**CURRENT OUTPUT**, **SIGNALING**, **RS-485**" connector contacts.

If measured pH, pH_{25}, U and analyte medium temperature values exceed the specified limits, the relay's dry contacts close the circuits between the PC19TB receptacle contacts, as per Table 2.3.

Table 2.3

Controlled parameter	Channel	Controlled parameter value	No. of contacts, between which circuit is closed
Measured pH and pH_{25} values	A	above upper limit and below lower limit of the measuring subrange (by current output)	
Measured U value, mV		Overrange (–1.000 mV to +1.000 mV)	
Measured temperature value, °C		over 70 °C	
Measured pH and pH_{25} values	B	above upper limit and below lower limit of the measuring subrange (by current output)	
Measured U value, mV		Overrange (–1.000 mV to +1.000 mV)	
Measured temperature value, °C		over 70 °C	
Measured pH and pH_{25} values	A	below MIN threshold value	
		above MAX threshold value	
	B	below MIN threshold value	
		above MAX threshold value	

Threshold parameters are changed in accordance with 1.5.5.

The maximum switching current is 150 mA at 36 V AC.

2.3.5 pH-meter parameter checkout and changing

Proceed as follows:

– press the "**menu / enter**" button, the pH-meter will switch over to the parameter checkout and changing mode (**MENU [A]** screen as shown in Fig. 1.2 will appear);

– check (or set) channel A parameters in accordance with 1.5.5;

– press the "**CHANNEL**" button, the pH-meter will switch to the parameter checkout mode (**MENU [B]** screen as shown in Fig. 1.3 will appear);

– check (or set) channel B parameters in accordance with 1.5.5;

– press the "**CHANNEL**" button, the pH-meter will switch to the common parameter checkout mode (**MENU [A] [B]** screen as shown in Fig. 1.4 will appear);

– check (or set) parameters common for channels A and B, in accordance with 1.5.5.

2.3.6 pH-meter calibration

2.3.6.1 General guidelines

When operating the pH-meter, periodically calibrate it with connected electrodes.

Calibration against buffer solutions should be carried out:

– when placing the pH-meter into service;

– whenever any doubts arise as to correct operation of the pH-meter;

– when receiving the pH-meter that has been in repair or long storage;

– when replacing electrodes;

– once every three months.

Calibration should be carried out against buffer solutions meeting TU 2642-002-42218836-96 Specification. pH values of standard buffer solutions are listed in Attachment B.

Two types of calibration are provided for the pH-meter.

Automatic calibration is carried out against one or two buffer solutions exhibiting 1.65 and 9.18 pH values at a solution temperature of (25.0 ± 0.2) °C.

The pH-meter should be calibrated at a buffer solution temperature of (20 ± 5) °C, with a temperature difference between the two calibration solutions not exceeding 0.5 °C.

Manual calibration is performed against any solution with a known pH value. The pH value of the solution against which calibration has been performed is entered manually.

Prior to calibration, check the temperature sensor of MAPK-902, MAPK-902A and MAPK-902/1 pH-meters for correct connection: ID numbers of the amplifier unit and temperature sensor must coincide.

The reference electrode or combination electrode filling hole must be opened.

Wash pH-electrodes and the PU-902/PU-902A probe unit temperature sensor or the PU-902LD probe unit operating section first in distilled water (in two vessels in succession) and then in the calibration buffer solution exhibiting pH = 1.65 at a solution temperature of (25.0 ± 0.2) °C.

Place pH-electrodes and the PU-902/PU-902A probe unit temperature sensor or the PU-902LD probe unit operating section (Fig. 2.7) in a fresh buffer solution and switch the pH-meter on. Wait for the pH-meter readings to settle down.

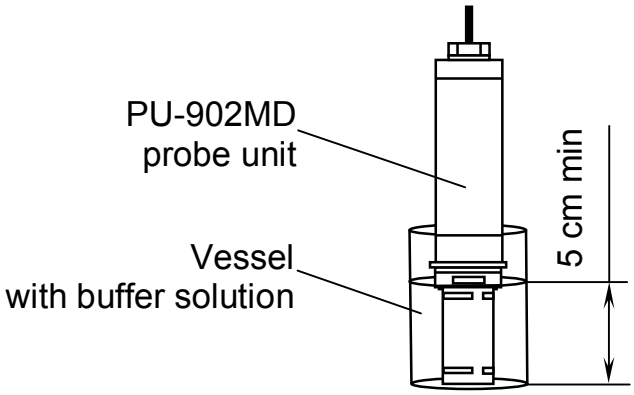


Figure 2.7

2.3.6.2 Procedure for pH-meter automatic calibration against buffer solutions

1 Press the "**CHANNEL**" button to set the indication mode for the channel to be calibrated, for example, channel A.

2 Press the "**menu / enter**" button, the screen as shown in Fig.2.8 will appear.

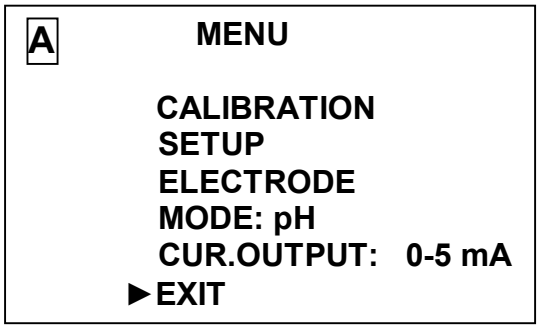


Figure 2.8

3 Use the "⇓"/"⇑" buttons to set the "►" marker at **CALIBRATION**.

4 Press the "**menu**/**enter**" button, the screen as shown in Fig.2.9 will appear.

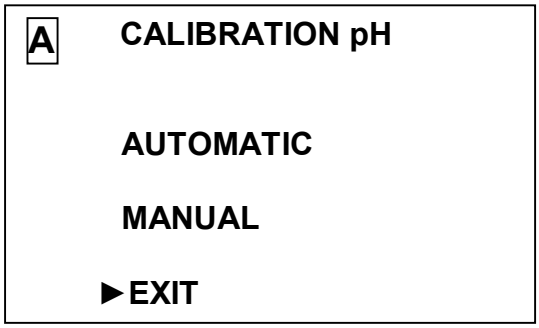


Figure 2.9

5 Set the "►" marker at **AUTOMATIC** and press the "**menu**/**enter**" button, the screen as shown in Fig.2.10 will be displayed showing the buffer solution pH value measured before calibration.

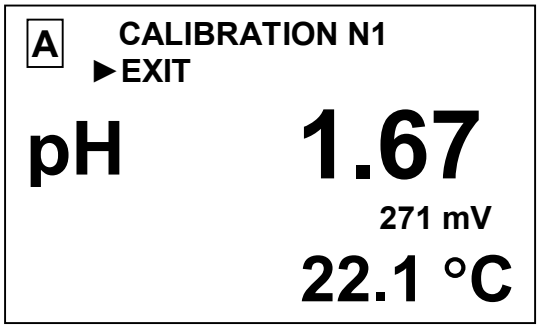


Figure 2.10

If, with the marker set at **EXIT**, the "**menu**/**enter**" button is pushed the pH-meter will quit the calibration mode.

6 Use the "⇓"/"⇑" buttons to set the "►" marker at **CALIBRATION N1**.

7 Press the "**menu**/**enter**" button to put the pH-meter into the calibration mode against the first buffer solution. This action will cause the screen as shown in Fig.2.11 to be displayed.

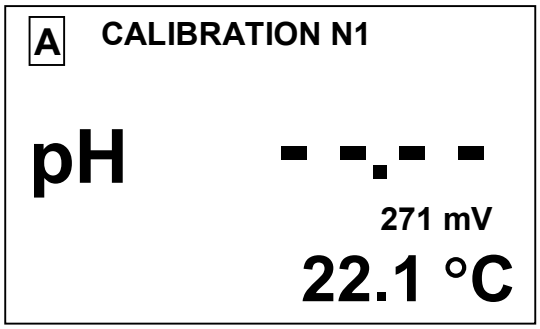


Figure 2.11

8 If the buffer solution pH value is not defined automatically, the screen as shown in Fig.2.12 will be displayed. In this case refer to Section 2.5 of this Operation Manual (Troubleshooting. Table 2.5).

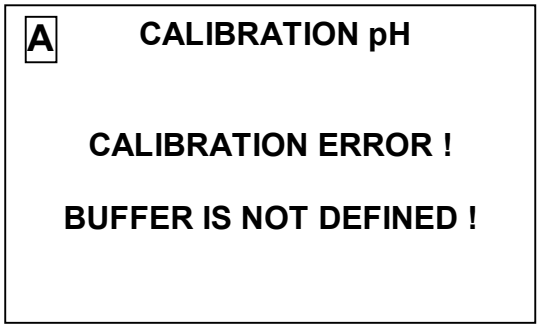


Figure 2.12

9 If the buffer solution pH value is defined automatically, it will be displayed and the progress meter will be pasted.

Once the progress meter is fully pasted, the screen as shown in Fig.2.13 will come on.

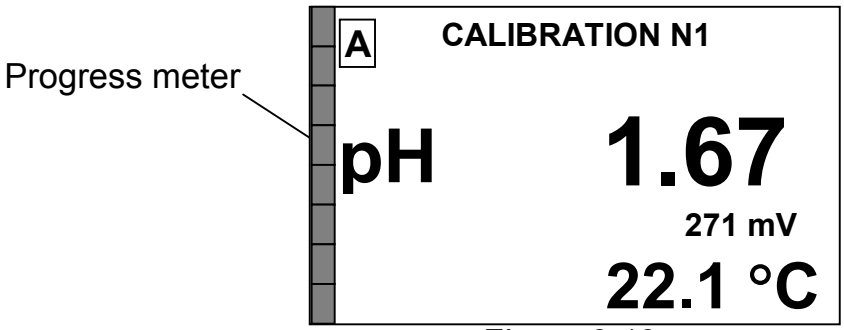


Figure 2.13

10 Press the "**menu / enter**" button to complete the calibration against the first buffer solution. The screen as shown in Fig.2.14 will be displayed.

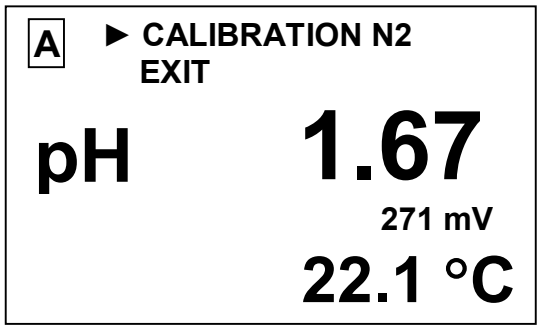


Figure 2.14

11 If calibration against the second buffer solution is not needed, set the cursor at **EXIT** and move on to step 17.

12 If calibration against the second buffer solution is required, exhibiting pH = 9.18 at a solution temperature of (25 ± 0.2) °C, remove the pH-electrodes and

the PU-902/PU-902A probe unit temperature sensor or the PU-902LD probe unit operating section from the first buffer solution. Wash them in distilled water (in two vessels in succession) and then in a volume of the second buffer solution and place in the fresh second buffer solutions. Wait for the pH-meter readings to settle down.

13 Use the "⇓"/"⇑" buttons to set the "►" marker at **CALIBRATION N2**.

14 Press the "**menu**/**enter**" button to put the pH-meter into the calibration mode against the second buffer solution. The screen as shown in Fig.2.15 will be displayed.

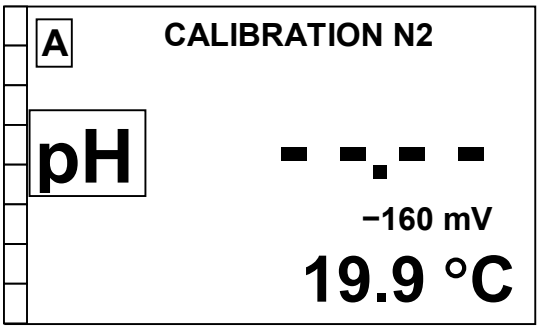


Figure 2.15

15 If the second buffer solution pH value is not defined automatically, the screen as shown in Fig.2.12 will be displayed. In this case refer to Section 2.5 of this Operation Manual (Troubleshooting. Table 2.5).

16 If the second buffer solution pH value is defined automatically, the progress meter will start being pasted.

Once the progress meter is fully pasted, the screen as shown in Fig.2.16 will come on.

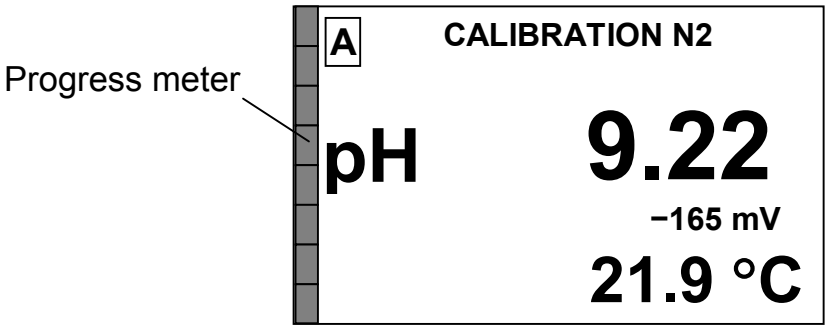


Figure 2.16

17 Press the "**menu**/**enter**" button to complete the calibration against the second buffer solution. The screen as shown in Fig.2.17 will be displayed.

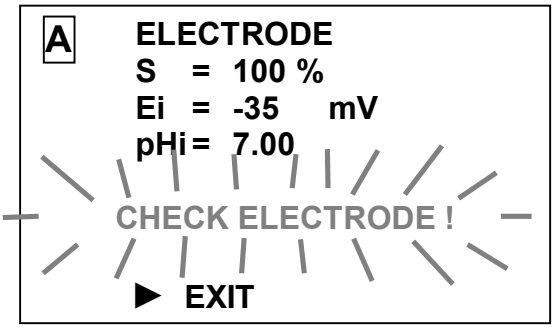


Figure 2.17

If indicated values fall outside the permissible limits the blinking "**CHECK ELECTRODE !**" caption will come on in the display bottom line. Switch the pH-meter off and check the electrodes (integrity of electrodes and electrolyte level in the reference electrode). Check the buffer solution and recalibrate the pH-meter.

If no blinking "**CHECK ELECTRODE !**" caption appears, press the "**menu / enter**" button. The screen as shown in Fig.2.18 will be displayed.

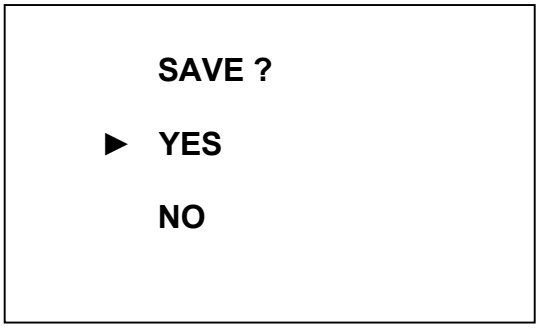


Figure 2.18

18 Use the "⇓"/"⇑" buttons to set the "►" marker at **YES** and press the "**menu / enter**" button. The pH-meter will go into the **MENU** mode, having saved the current calibration results. The screen as shown in Fig.2.19 will be displayed.

If the "►" marker is set at **NO** and the "**menu / enter**" button is pressed, the pH-meter will go into the **MENU** mode, having saved the previous calibration values.

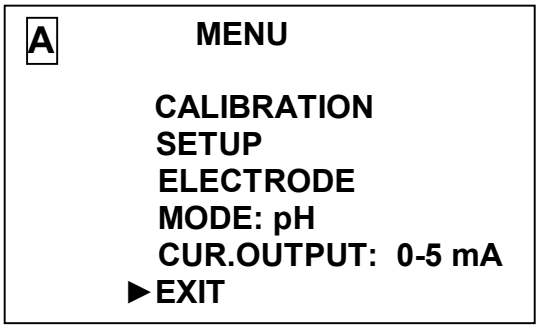


Figure 2.19

19 Use the "⇓"/"⇑" buttons to set the "►" marker at **EXIT**. Press the "**menu** / **enter**" button to put the pH-meter into the measuring mode as shown, for example, in Fig.2.20.

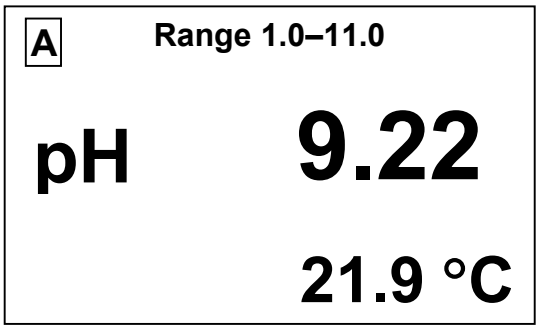


Figure 2.20

Calibration is over.
Use the same procedure to calibrate the second measuring channel.

2.3.6.3 Procedure for pH-meter manual calibration against buffer solutions

General calibration guidelines are as per 2.3.6.1.

1 By pressing the "**CHANNEL**" button, set the indication mode for the channel to be calibrated, for example, channel A.

2 Press the "**menu** / **enter**" button, the screen as shown in Fig.2.9 will be displayed.

3 Set the "►" marker at **MANUAL** and press the "**menu** / **enter**" button. The screen as shown in Fig.2.21 will be displayed showing the buffer solution pH value measured before calibration.

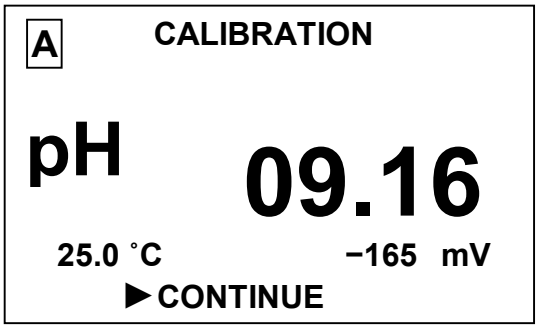


Figure 2.21

4 After the display settles down, press the "**menu / enter**" button. The screen as shown in Fig.2.22 will appear, with the initial digit flashing.

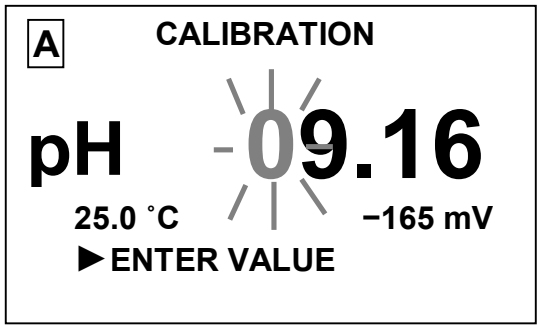


Figure 2.22

5 Enter the pH-value of the calibration buffer solution, in accordance with 1.5.5.2. After the value is entered (no digit is flashing), press the "**menu / enter**" button. The screen as shown in Fig.2.23 will appear.

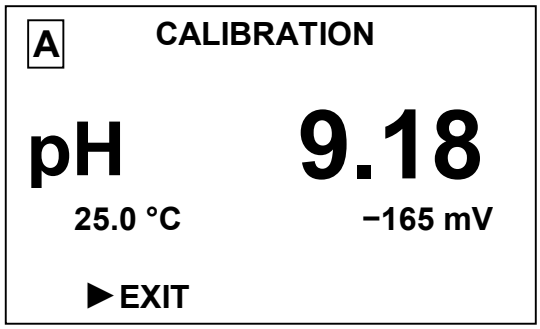


Figure 2.23

6 Press the "**menu / enter**" button. The screen as shown in Fig.2.17 will appear.

If indicated values fall outside the permissible limits the blinking "**CHECK ELECTRODE !**" caption will come on in the display bottom line. Switch the pH-meter off and check the electrodes (integrity of electrodes and electrolyte level in the reference electrode). Check the buffer solution and recalibrate the pH-meter.

If no blinking "**CHECK ELECTRODE !**" caption appears, press the "**menu / enter**" button. The screen as shown in Fig.2.18 will be displayed.

7 Use the "⇓"/"⇑" buttons to set the "►" marker at **YES** and press the "**menu / enter**" button. The pH-meter will go into the **MENU** mode, having saved the current calibration results. The screen as shown in Fig.2.19 will be displayed.

If the "►" marker is set at **NO** and the "**menu / enter**" button is pressed, the pH-

meter will go into the **MENU** mode, having saved the previous calibration values.

8 Use the "⇓"/"⇑" buttons to set the "►" marker at **EXIT**. Press the "**menu**/**enter**" button to put the pH-meter into the measuring mode as shown, for example, in Fig.2.24.

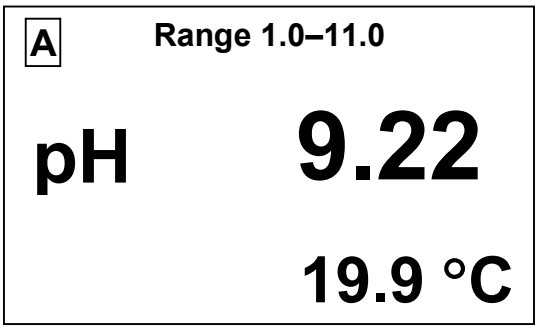


Figure 2.24

Calibration is over.
Use the same procedure to calibrate the second measuring channel.

2.4 Measurements

2.4.1 Pre-measurement procedures

The pH-meter components must be prepared for operation in accordance with 2.3.

Pre-measurement procedures using a hydraulic control panel are subject to HP-902 operation manual.

2.4.2 Measurements

Switch on the pH-meter and check that its parameters and operating modes are correctly set for each channel according to 2.3.5.

Set minimum and maximum values of the current output range for each channel, depending on the expected pH value.

Using the "**CHANNEL**", set indication for both channels if both probe units are connected. Measured pH values will be shown on the pH-meter display.

Note: Storage of electrodes between measurements is as specified in relevant electrode certificates.

2.5 Troubleshooting

Typical pH-meter failures and remedial actions are provided in Table 2.4.

Table 2.4

Trouble	Probable cause	Remedy
1 pH-meter does not turn on	Blown fuses	Factory repair
2 Unstable pH-meter readings	Open cable or loose contact in electrode cable connector	Check and provide reliable contact or remedy cable fault.
3 During pH-meter calibration against buffer solutions its readings remain virtually the same when pH electrodes are transferred from one buffer solution to the other	Faulty electrode	Replace the electrode
4 Measured temperature value (in normal operating conditions) differs from the actual one by more than 0.3°C	Faulty temperature sensor	Factory repair
5 When the pH-meter is powered up or analyte fluid is measured **WARNING! PROBE IS NOT CONNECTED!** caption is displayed	Probe unit cable is not connected to the converting unit **CHANNEL A** or **B** connector	Connect the probe unit cable to the converting unit **CHANNEL A** or **B** connector
6 During calibration, **WARNING! CALIBRATION ERROR!** caption is displayed	Buffer solution pH value is not identified	Turn off the pH-meter. Check that buffer solution has one of the pH values: 1.65 or 9.18.
		Check electrodes
7 When the pH-meter is powered up or analyte fluid is measured **WARNING! NO COMMUNICATION WITH PROBE!** caption is displayed	Cable (between converting and amplifier units) is not connected to the amplifier unit connector	Connect cable to the amplifier unit
	Damaged connecting cable	Connecting cable to be repaired
	Broken contact in connectors connected either to the amplifier unit or converting unit	Connecting cable to be repaired

Note – Warning screens are shown in 1.5.5.3.

2.5.1 Replacement of fuses

Supply line fuses of a panel-mounted pH-meter may be replaced by the user.

Supply line fuses of a wall-mounted pH-meter are to be replace on a **factory basis** after the faults which have destroyed fuses are cleared.

Two ВП2Б-1В (0.5 A/250 V) fuses are installed in the supply transformer primary winding.

Four ВП4-3 (1 A/250 V) are installed in the supply transformer secondary windings.

3 MAINTENANCE

3.1 pH-meter scheduled maintenance

3.1.1 Periodic inspection of the converting unit, probe units and connecting cables for mechanical damage.

3.1.2 Periodic inspection of the flow reference electrode for a sufficient amount of KCl solution with a 3.0 M concentration.

3.1.3 Cleaning of dirty exterior CU surfaces with soft detergents.

IMPORTANT: When cleaning a panel-mounted converting unit, make sure to PREVENT ingress of moisture into the instrument!

3.1.4 pH-meter calibration against buffer solutions is subject to 2.3.6.

pH-meter calibration against buffer solutions should be carried out:

- once every three months;
- if there are doubts as to a pH-meter's correct operation;
- after receiving a pH-meter that has been in repair or long storage;
- in case of electrode replacement.

3.2 Replacement of PU-902LD probe unit combination electrode

Prior to electrode replacement, wash carefully the probe unit exterior surface and dry it up.

To replace an electrode according to Fig. 3.1, perform the following steps:

- undo the cable seal nut and move it along the cable (Fig. 3.1 *a*);
- remove the washer by turning the probe unit with cable down and waggling the cable;
- unscrew the housing (right-hand thread) off the probe unit electrode section, preventing the cable from turning;
- move the housing about 20 cm along the cable, then move it slightly back and remove the sealing ring;
- move the nut, washer, sealing ring and housing along the cable;
- disconnect the combination electrode from the board contacts (Fig.3.1 *b*); unscrew the combination electrode retaining nut and remove, while turning, the electrode with nut from the probe unit electrode section (Fig.3.1 *c*);
- remove the nut, washer and sealing ring from the electrode (Fig.3.1 *d*).

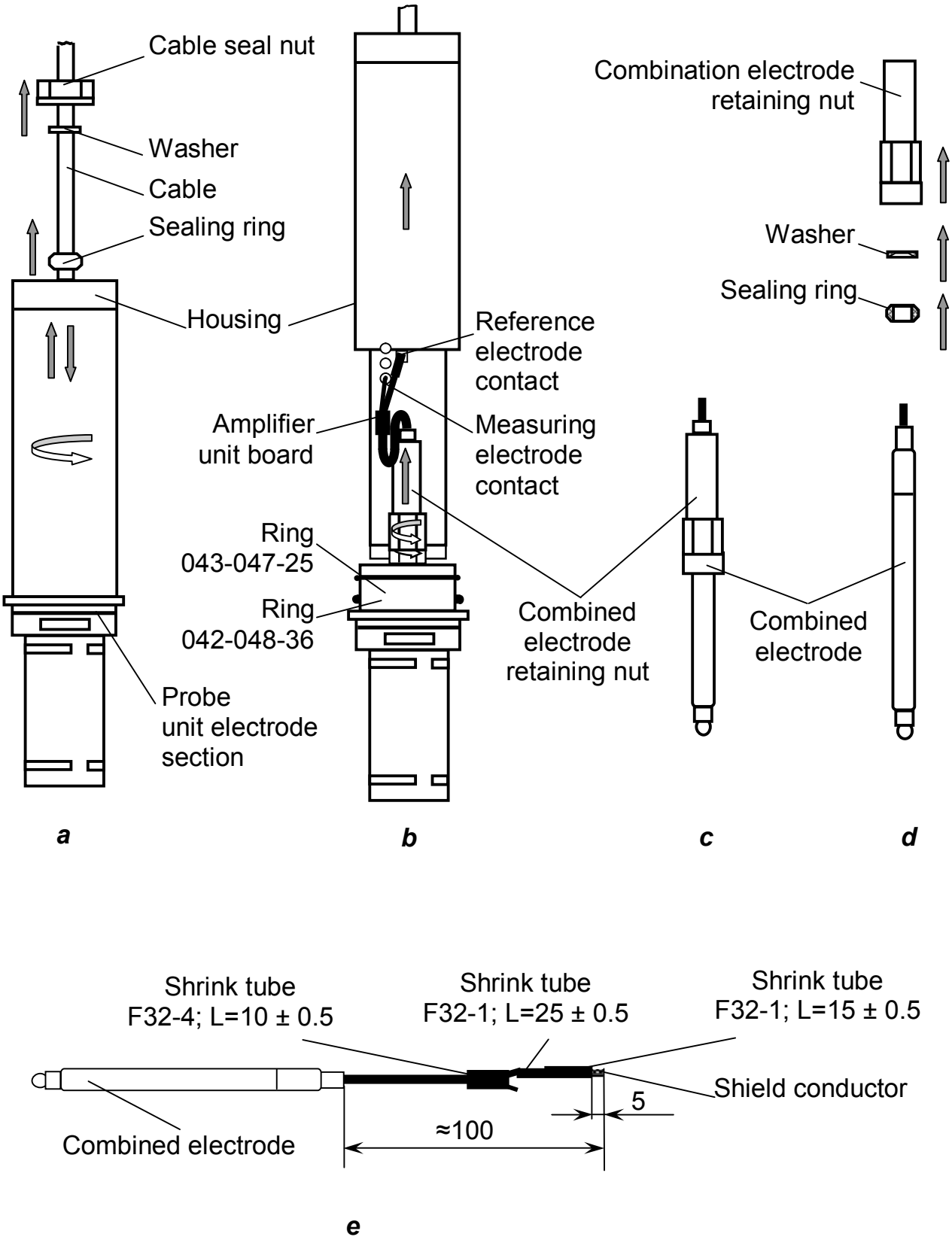

Cable seal nut
Washer
Cable
Sealing ring
Housing
Amplifier
unit board
Ring
043-047-25
Ring
042-048-36
Probe
unit electrode
section
Reference
electrode
contact
Measuring
electrode
contact
Combined
electrode
retaining nut
Combination electrode
retaining nut
Washer
Sealing ring
Combined
electrode
a
b
c
d
Shrink tube
F32-4; L=10 ± 0.5
Shrink tube
F32-1; L=25 ± 0.5
Shrink tube
F32-1; L=15 ± 0.5
Shield conductor
5
≈100
Combined electrode
e

Figure 3.1

Prepare the cable of a replacement combination electrode according to Fig.3.1 *e*. To this end, proceeds as follows:

- cut a length of cable of about 100 mm;
- desheath the cable over a length of 30 mm;
- put the shrink tube F32-1, L=25 ± 0.5 from the spare part kit onto the shield conductor running from the reference electrode and heat shrink it;
- put the shrink tube F32-4, L=10 ± 0.5 onto the cable and heat shrink it.

Once the cable of the replacement combined electrode is prepared, install it in the probe unit.

To this end, perform the following steps:

- insert the electrode into the combination electrode retaining nut as far as it will go;
- place the washer onto the electrode with its inside chamfer toward the sealing ring;
- install the sealing ring;
- install the nut with electrode into the probe unit, ensuring sealing tightness; avoid applying too much force to the nut as it is made of acrylic plastic;
- solder the combination electrode to the corresponding contacts on the amplifier unit board (Fig.3.1 *b*), having put the shrink tube F32-1, L=25 ± 0.5 onto the shield conductor running from the reference electrode; move the shrink tube over the shield conductor soldering joint and heat shrink it;
- screw the housing on, ensuring tight connection; if necessary, install a new ring (043-047-25) from the spare part kit;
- move the nut, washer and sealing ring over toward the housing and screw in the cable seal nut, ensuring sealing tightness.

If the probe unit is mounted in a main pipeline a new ring (042-048-36) from the spare part kit may be installed, if required.

4 DELIVERY SET

4.1 The delivery set is as shown in Table 4.1.

Table 4.1

Description	Code	Quantity per version MAPK-					
		902	902/1	902A	902A/1	902MP	902MP/1
1 Converting unit	BP31.01.000	1	–	1	–	1	–
	BP43.01.000	–	1	–	1	–	1
2 Probe unit:							
– PU-902	BP31.02.000	1*	1*	–	–	–	–
– PU-902A	BP31.02.000-01	–	–	1*	1*	–	–
– PU-902LD	BP43.02.000	–	–	–	–	1*	1*
3 Connecting cable:							
– C902.5	BP43.03.000	1**	1**	1**	1**	–	–
– C902.L***	BP43.03.000-01	1****	1****	1****	1****	–	–
– C902.LD.2	BP43.05.000	–	–	–	–	1**	1**
– C902.LD.L***	BP43.04.000	–	–	–	–	1**	1**
4 Mounting parts kit	BP31.10.000	1	1	1	1	1	1
5 Mounting parts kit	BP31.12.000	1	–	1	–	1	–
6 Operation Manual	BP31.00.000РЭ	1	1	1	1	1	1

* Quantity (1 or 2) as approved by the customer.
** Quantity corresponding to that of probe units.
*** Length as approved by the customer (5 to 100 m).
**** Supplied as an option.

APPENDIX A

(*reference*)

pH of standard buffer solutions versus temperature

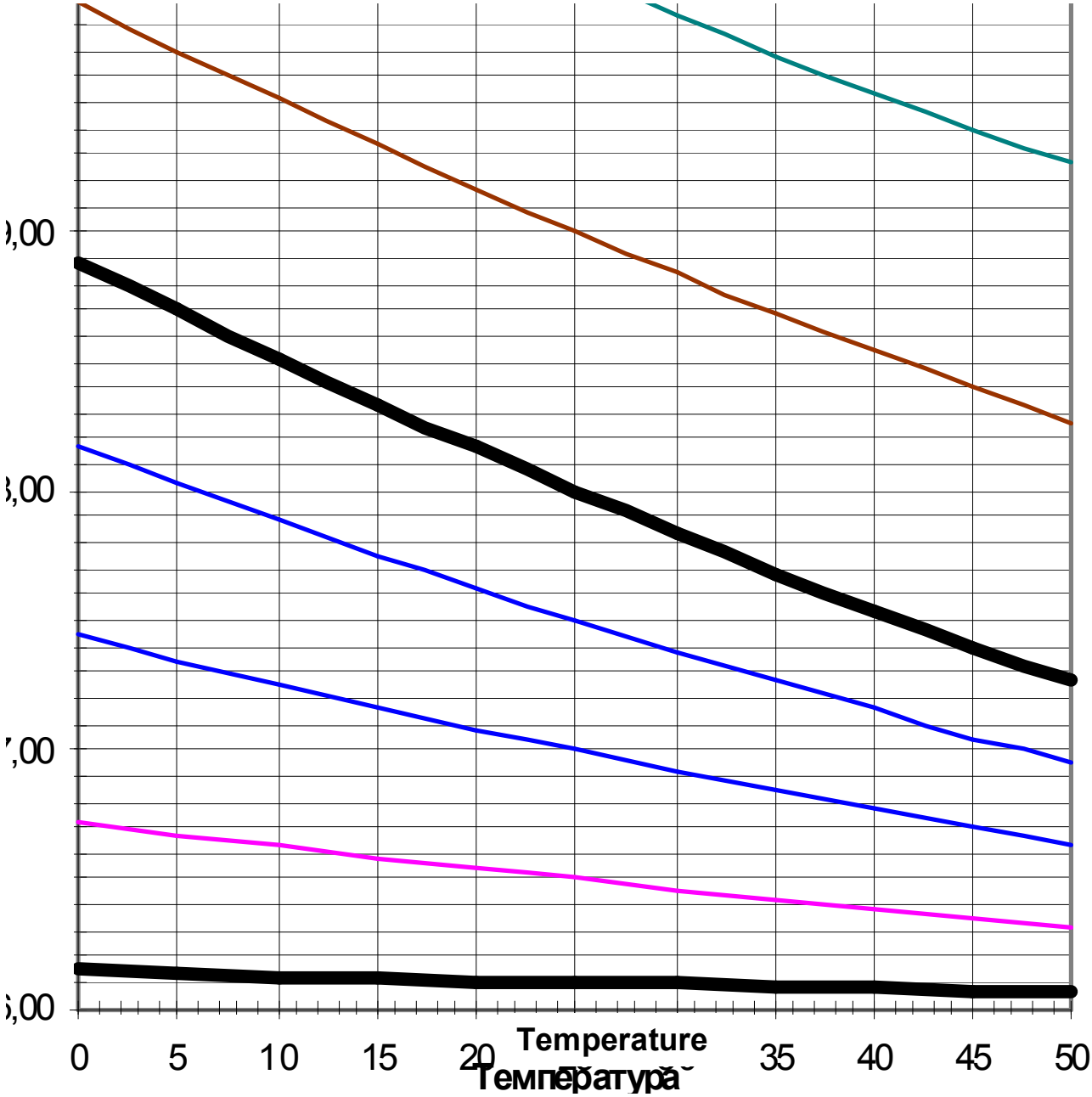
Table A.1

Temperature, °C	Chemistry of buffer solutions					
	$KH_3(C2O_4)_2 \times 2H_2O$ tetraoxalate, 2-aqueous, (25.219 ppt)	$KHC_4H_4C_5$ potassium hydrotartrate, saturated at 25 °C, (7.868 ppt)	$KC_8H_5O_4$ potassium hydrophthalate (10.120 ppt)	$KH_2PO_4 + Na_2HPO_4$ potassium dihydrophosphate (3.3880 ppt) +sodium monohydrophosphate (3.5330 ppt)	$Na_2B_4O_7 \times 10H_2O$ sodium tetraborate, 10-aqueous (3.8064 ppt)	$Na_2CO_3 + NaHCO_3$ sodium carbonate (2.6428 ppt) + sodium carbonate, acidic (2.0947 ppt)
	1.65	3.56	4.01	6.86	9.18	10.00
0	-	-	4.000	6.961	9.475	10.273
5	-	-	3.998	6.935	9.409	10.212
10	1.638	-	3.997	6.912	9.347	10.154
15	1.642	-	3.998	6.891	9.288	10.098
20	1.644	-	4.001	6.873	9.233	10.045
25	1.646	3.556	4.005	6.857	9.182	9.995
30	1.648	3.549	4.011	6.843	9.134	9.948
37	1.649	3.544	4.022	6.828	9.074	9.889
40	1.650	3.542	4.027	6.823	9.051	9.866
50	1.653	3.544	4.050	6.814	8.983	9.800
60	1.660	3.553	4.080	6.817	8.932	9.753
70	1.67	3.57	4.12	6.83	8.90	9.730
80	1.69	3.60	4.16	6.85	8.88	9.73
90	1.72	3.63	4.21	6.90	8.84	9.75
95	1.73	3.65	4.24	6.92	8.89	-

APPENDIX B

(reference)

pH of highly dilute alkaline and acid solutions as a function of the analyte medium temperature, computed using the data from MU 34-70-114-85 Guidelines



APPENDIX C

(reference)

Protocol of data communications with PC

C.1 Physical format of one byte communication

- 1 go bit;
- 8 data bit;
- 1 stop bit;
- no even-odd check is used;
- rate – 19.200 bit/s.

C.2 PC-communicated data frame format

Communication format – 7 bytes:
1 – preamble (255);
2 – system address (0-255);
3 – channel (0 – converting unit, 1 – channel A, 2 – channel B);
4 – operation code (high bit: 1 – Write, 0 – Read);
5 – lead data byte;
6 – trail data byte;
7 – cyclic redundancy checksum (CRC).

Table C.1 − Channel 0

Pream-ble	System address	Chan-nel	Operation code	Lead data byte	Trail data byte	CRC	Comment
255	DEV	0	1	0	0	CRC	Test
255	DEV	0	2	0	0	CRC	Read the type of net-work device
255	DEV	0	3	0	0	CRC	Read RegIndChannel
255	DEV	0	4	0	0	CRC	Read OfficialMaster
255	DEV	0	5	0	0	CRC	Read OfficialMaster1
255	DEV	0	6	0	0	CRC	Read OfficialSlave
255	DEV	0	7	0	KeyKod	CRC	KeyKod depression simutation
255	DEV	0	131	0	RegIndChannel	CRC	Write RegIndChannel

Type of network device:
1 – MAPK-302;
2 – MAPK-902;
3 – MAPK-408.

Table C.2 − Channel 1

Preamble	System address	Channel	Operation code	Lead data byte	Trail data byte	CRC	Comment
255	DEV	1	1	0	0	CRC	Channel A test
255	DEV	1	2	0	0	CRC	Read FirstWord_A and SecondWord_A
255	DEV	1	3	0	0	CRC	Read U_A
255	DEV	1	4	0	0	CRC	Read T_A
255	DEV	1	5	0	0	CRC	Read pH_A
255	DEV	1	6	0	0	CRC	Read pH25_A
255	DEV	1	7	0	0	CRC	Read S_A
255	DEV	1	8	0	0	CRC	Read Ei_A
255	DEV	1	9	0	0	CRC	Read StartDiapA
255	DEV	1	10	0	0	CRC	Read WidthDiapA
255	DEV	1	11	0	0	CRC	Read MAX_A
255	DEV	1	12	0	0	CRC	Read MIN_A
255	DEV	1	13	0	0	CRC	Read RegIndA
255	DEV	1	137	0	StartDiapA	CRC	Write StartDiapA
255	DEV	1	138	0	WidthDiapA	CRC	Write WidthDiapA
255	DEV	1	139	0	MAX_A	CRC	Write MAX_A
255	DEV	1	140	0	MIN_A	CRC	Write MIN_A
255	DEV	1	141	0	RegIndA	CRC	Write RegIndA

Table C.3 − Channel 2

Preamble	System address	Channel	Operation code	Lead data byte	Trail data byte	CRC	Comment
255	DEV	2	1	0	0	CRC	Channel B test
255	DEV	2	2	0	0	CRC	Read FirstWord_B and SecondWord_B
255	DEV	2	3	0	0	CRC	Read U_B
255	DEV	2	4	0	0	CRC	Read T_B
255	DEV	2	5	0	0	CRC	Read pH_B
255	DEV	2	6	0	0	CRC	Read pH25_B
255	DEV	2	7	0	0	CRC	Read S_B
255	DEV	2	8	0	0	CRC	Read Ei_B
255	DEV	2	9	0	0	CRC	Read StartDiapB
255	DEV	2	10	0	0	CRC	Read WidthDiapB
255	DEV	2	11	0	0	CRC	Read MAX_B
255	DEV	2	12	0	0	CRC	Read MIN_B
255	DEV	2	13	0	0	CRC	Read RegIndB
255	DEV	2	137	0	StartDiapB	CRC	Write StartDiapB
255	DEV	2	138	0	WidthDiapB	CRC	Write WidthDiapB
255	DEV	2	139	0	MAX_B	CRC	Write MAX_B
255	DEV	2	140	0	MIN_B	CRC	Write MIN_B
255	DEV	2	141	0	RegIndA	CRC	Write RegIndB

C.3 CU to PC-communicated data frame format

Communication format – 7 bytes:
1 – preamble (255);
2 – system address (0-255);
3 – channel (0 – converting unit, 1 – channel A, 2 – channel B);
4 – operation code (high bit: 1 – Write, 0 – Read);
5 – lead data byte;
6 – trail data byte;
7 – cyclic redundancy checksum (CRC).

Table C.4 − Channel 0

Preamble	System address	Channel	Operation code	Lead data byte	Trail data byte	CRC	Comment
255	DEV	0	1	0	0	CRC	Response to test
255	DEV	0	130	0	TYPE	CRC	Write the type of network device
255	DEV	0	131	0	RegIndChannel	CRC	Write RegIndChannel
255	DEV	0	132	0	OfficialMaster	CRC	Write OfficialMaster
255	DEV	0	133	0	OfficialMaster	CRC	Write OfficialMaster1
255	DEV	0	134	0	OfficialSlave	CRC	Write OfficialSlave

Type of network device:
1 – MAPK-302;
2 – MAPK-902;
3 – MAPK-408.

Table C.5 − Channel 1

Preamble	System address	Channel	Operation code	Lead data byte	Trail data byte	CRC	Comment
255	DEV	1	1	0	0	CRC	Response to channel A test
255	DEV	1	130	FirstWord_A	SecondWord_A	CRC	Write FirstWord_A and SecondWord_A
255	DEV	1	131	U_A_Hi	U_A_Lo	CRC	Write U_A
255	DEV	1	132	T_A_Hi	T_A_Lo	CRC	Write T_A
255	DEV	1	133	pH_A_Hi	pH_A_Lo	CRC	Write pH_A
255	DEV	1	134	pH25_A_Hi	pH25_A_Lo	CRC	Write pH25_A
255	DEV	1	135	0	S_A	CRC	Write S_A
255	DEV	1	136	0	Ei_A	CRC	Write Ei_A
255	DEV	1	137	0	StartDiapA	CRC	Write StartDiapA
255	DEV	1	138	0	WidthDiapA	CRC	Write WidthDiapA
255	DEV	1	139	0	MAX_A	CRC	Write MAX_A
255	DEV	1	140	0	MIN_A	CRC	Write MIN_A
255	DEV	1	141	0	RegIndA	CRC	Write RegIndA

Table C.6 − Channel 2

Preamble	System address	Channel	Operation code	Lead data byte	Trail data byte	CRC	Comment
255	DEV	2	1	0	0	CRC	Response to channel B test
255	DEV	2	130	FirstWord_B	SecondWord_B	CRC	Write FirstWord_B and SecondWord_B
255	DEV	2	131	U_B_Hi	U_B_Lo	CRC	Write U_B
255	DEV	2	132	T_B_Hi	T_B_Lo	CRC	Write T_B
255	DEV	2	133	pH_B_Hi	pH_B_Lo	CRC	Write pH_B
255	DEV	2	134	pH25_B_Hi	pH25_B_Lo	CRC	Write pH25_B
255	DEV	2	135	0	S_B	CRC	Write S_B
255	DEV	2	136	0	Ei_B	CRC	Write Ei_B
255	DEV	2	137	0	StartDiapB	CRC	Write StartDiapB
255	DEV	2	138	0	WidthDiapB	CRC	Write WidthDiapB
255	DEV	2	139	0	MAX_B	CRC	Write MAX_B
255	DEV	2	140	0	MIN_B	CRC	Write MIN_B
255	DEV	2	141	0	RegIndB	CRC	Write RegIndB

Where:
FirstWord – first status word;
SecondWord – second status word;
OfficialSlave – official slave processor;
StartDiapA – channel A range start;
StartDiapB – channel B range start;
WidthDiapA – channel A range width;
WidthDiapB – channel B range width;
RegIndA – channel A indication mode:
0 – pH indication;
1 – pH_{25} indication;
2 – U (voltage) indication;
RegIndB – channel B indication mode:
0 – pH indication;
1 – pH_{25} indication;
2 – U (voltage) indication;
OfficialMaster – first byte of official master processor;
OfficialMaster1 – second byte of official master processor;
RegIndChannel – channel indication mode:
0 – channel A indication;
1 – channel B indication;
2 – channel A+B indication;
MAX_A – channel A maximum threshold;
MAX_B – channel B maximum threshold;
MIN_A – channel A minimum threshold;
MIN_B – channel B minimum threshold;

OfficialMaster – master processor status word

7	6	5	4	3	2	1	0
0	0	GlobalErr_B	GlobalErr_A	Cal_B	Cal_A	Port	Iout

Iout (current output) – current output value:
at 0 – 0-5 mA;
at 1 – 4-20 mA;
Port – port type:
at 0 – RS-232C;
at 1 – RS-485;
Cal_A – channel A calibration:
at 0 – normal operating mode (measuring);
at 1 – channel A calibration;
Cal_B – channel B calibration:
at 0 – normal operating mode (measuring);
at 1 – channel B calibration;
GlobalErr_A – global error in channel A (probe not responding);
in 0 – normal operation;
in 1 – global error (probe not responding);
GlobalErr_B – global error in channel B (probe not responding):
at 0 – normal operation;
at 1 – global error (probe not responding);
OfficialSlave – slave processor status word

7	6	5	4	3	2	1	0
0	0	0	0	ErrEEPROM	Iout	BEn	AEn

AEn (Channel A Enabled) – channel A availability:
at 0 – channel A unavailable;
at 1 – channel A available;
BEn (Channel B Enabled) – channel B availability:
at 0 – channel B unavailable;
at 1 – channel B available;
IOut (current output) – current output value:
at 0 – 0-5 mA,
at и 1 – 4-20 mA;
ErrEEPROM – error of writing into internal EEPROM:
at 0 – no error;
at 1 – error.

First status word format (FirstWord):

7	6	5	4	3	2	1	0
BufNotDef	ErrSensor	ErrBuf	LowPower	InCom	RegWork2	RegWork1	RegWork0

RegWork – operating mode:
0 – pre-measurement normal operation;
1 – normal operation;
2 – status: pH calibration;
3 – status: temperature calibration;
4 – data package contains electrode parameter info;
InCom – incorrect command:
at 0 – command taken correctly;
at 1 – command taken incorrectly;
LowPower – low supply voltage indication:
at 0 – normal supply voltage;
at 1 – low supply voltage;
ErrBuf – buffer definition error:
at 0 – buffer defined correctly;
at 1 – buffer defined incorrectly;
ErrSensor – electrode parameter identification error:
at 0 – electrode parameters identified correctly;
at 1 – electrode parameters identified incorrectly;
BufNotDef – buffer not defined
at 0 – buffer defined correctly;
at 1 – buffer not defined;

Second status word format (SecondWord)

7	6	5	4	3	2	1	0
0	0	0	0	U_Locked	Err_U1	Err_U	Err_T

Err_T – temperature overload:
at 0 – no temperature overload;
at 1 – temperature overload (negative temperature value or temperature value over 50 °C);
Err_U – voltage overload:
at 0 – no voltage overload;
at 1 – voltage overload (voltage module varying between 1,001 and 1,250 mV);
Err_U1 – voltage overload:
at 0 – no voltage overload;
at 1 – voltage overload (voltage module in excess of 1,250 mV);
U_Locked – U_{input} and T recorded for calibration point:
at 0 – not recorded;
at 1 – recorded.