ANALYTICAL EQUIPMENT FOR

VZOR

ECOLOGY AND POWER INDUSTRY

MAPK-602 CONDUCTIVITY/ SALINITY METER

Operation Manual

АЯ74

Nizhny Novgorod 2010

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

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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

A panel-mounted conductivity meter with CP-025C and CP-2C flow-type conductivity probes.

MAPK-602 conductivity/salinity meter.
TU 4215-025-39232169-2006 Specifications.

A wall-mounted conductivity meter with CP-025C and CP-2C flow-type conductivity probes.

MAPK-602/1 conductivity/salinity meter.
TU 4215-025-39232169-2006 Specifications.

A panel-mounted conductivity meter with CP-003LD main/immersion conductivity probes.

MAPK-602LD conductivity/salinity meter.
TU 4215-025-39232169-2006 Specifications.

A wall-mounted conductivity meter with CP-003LD main/immersion conductivity probes.

MAPK-602LD/1 conductivity/salinity meter.
TU 4215-025-39232169-2006 Specifications.

1.1.2 Purpose

The MAPK-602 conductivity meter is designed to measure electric conductivity and electric conductivity (SEC) referred to 25 °C, and to calculate equivalent salinity referred to sodium chloride (NaCl) of water and aqueous solutions.

1.1.3 Applications – heat power engineering, pharmaceutical industry, fish farming and production processes.

1.1.4 Conductivity meter types:

- contact;
- low frequency;
- with passive sensors − CP-025C and CP-2C flow-type conductivity probes or CP-003LD line-dip conductivity probes;
- quick-response;
- with two measuring channels;
- with automatic temperature compensation;
- as a panel- or wall-mounted unit;
- measurement readouts via the current output and RS-485 port.

1.2 Basic parameters

1.2.1 By resistance to climatic effects this conductivity meter version falls within B4 group as per GOST 12997-84.

1.2.2 By resistance to mechanical action the conductivity meter version falls within L1 group as per GOST 12997-84.

1.2.3 By protection against environmental exposure the conductivity meter components, depending on the version, are made to GOST 14254-96, in accordance with Table 1.1.

Table1.1

Conductivity meter version	Component name and identification	Component version as per GOST 14254
MAPK-602, MAPK-602LD	Converting unit BP30.01.000(panel-mounted version)	IP30
MAPK-602/1, MAPK-602LD/1	Converting unit BP42.01.000 (wall-mounted version)	IP65
MAPK-602, MAPK-602/1	CP-025C conductivity probe BP30.02.000	IP62
	CP-2C conductivity probe BP30.02.000-01	IP62
MAPK-602LD, MAPK-602LD/1	CP-003LD conductivity probe BP30.10.000 (immersible section)	IP68

1.2.4 By resistance to atmospheric pressure the conductivity 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 temperature range, °C ..…… +5 to +50.

1.2.5.2 Analyte medium pressure, MPa, max:

– for MAPK-602 and MAPK-602/1 versions ……..……..…..…….. 0.1;

– for MAPK-602LD and MAPK-602LD/1 versions ……..……..…….. 1.

1.2.5.3 Aqueous solution flow rate for MAPK-602 and MAPK-602/1 versions, dm^3/h ..……..……..……..…….. 3 to 30.

1.2.5.4 Analyte medium velocity perpendicular to the probe axis for MAPK-602LD and MAPK-602LD/1 versions, cm/s, min ……... 5.

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 below without moisture condensation, %, max .....… 80.

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

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

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

1.2.7 Power consumption at the rated supply voltage, VA, max ……..…... 10.

1.2.8 Overall dimensions and weight of the conductivity meter components are as shown in Table 1.2 below.

Table 1.2

Conductivity meter version	Component name and identification	Overall dimensions, mm, max	Weight, kg, max
MAPK-602, MAPK-602LD	Converting unit BP30.01.000	252×146×100	2.60
MAPK-602/1, MAPK-602LD/1	Converting unit BP42.01.000	266×170×95	2.60
MAPK-602LD, MAPK-602LD/1	CP-025C conductivity probe BP30.02.000	115×145×30	0.27
	CP-2C conductivity probe BP30.02.000-01	115×145×30	0.27
	CP-003LD conductivity probe BP30.10.000	∅54×130	0.50

1.2.9 The conductivity meter must be transported in shipping crates as per GOST 12997-84.

1.2.9.1 Temperature, °C ……..... –20 to +50.

1.2.9.2 Relative humidity at 35 °C, % ……..……..…..... 95.

1.2.9.3 Sinusoidal vibration with a frequency of 5-35 Hz, shift amplitude of 0.35 mm in the direction shown by the "THIS END UP" mark on the crate.

1.2.10 Reliability requirements

1.2.10.1 Mean time to failure, h, min ……..……..…... 20.000.

1.2.10.2 Mean time to fix, h, max ..…….…. 2.

1.2.10.3 Conductivity meter's mean life, years, min ……..…... 10.

1.2.11 Resistance of electrical insulation of the conductivity meter's supply circuits between plug pins and case, MΩ, min:

– at ambient temperature of (20 ± 5) °C ……. 40;

– at ambient temperature of 50 °C ……..……. 10;

– at ambient temperature of 35 °C and relative humidity of 80 % ..……. 5.

1.2.12 Electrical insulation of the conductivity meter's supply circuits relative to the converting unit case handles a 1-minute 1.5 kV testing voltage of sinusoidal AC 50 Hz at an ambient temperature of (20 ± 5) °C relative humidity from 30 to 80 %.

1.2.13 Electrical insulation between the external terminal of the converting unit earthing and its case, Ω, max ……..……..... 0.1.

1.3 Specifications of each measuring channel

1.3.1 SEC and salinity measuring ranges are listed in Table 1.3.

Table 1.3

Conductivity meter version	Conductivity probe	Measuring range	
		SEC, µSm/cm	salinity in sodium chloride equivalent, ppm
MAPK-602, MAPK-602/1	CP-025C	0 to 2000	0 to 1.000
	CP-2C	0 to 20.000	0 to 10.000
MAPK-602LD, MAPK-602LD/1	CP-003LD	0 to 200	0 to 100

1.3.2 The conductivity meter's margin of allowable basic absolute measuring error at an analyte medium temperature of (25.0 ± 0.2) °C and ambient air temperature of (20 ± 5) °C is as shown in Table 1.4 below.

Table 1.4

Conductivity meter version	Conductivity probe	Conductivity meter's margin of allowable basic absolute measuring error	
		SEC, µSm/cm	salinity, ppm
MAPK-602, MAPK-602/1	CP-025C	± (0.004 + 0.02χ)	± (0.003 + 0.025C)
	CP-2C	± (0.03 + 0.02χ)	± (0.03 + 0.025C)
MAPK-602LD, MAPK-602LD/1	CP-003LD	± (0.001 + 0.02χ)	± (0.001 + 0.025C)
Note: χ – measured SEC value, µSm/cm; C – measured salinity value, ppm			

1.3.3 The conductivity meter's margin of allowable basic absolute measuring error caused by analyte medium temperature variations within a temperature compensation range from +5 to +50°C:

- SEC measurement, µSm/cm ……..……..... 0.02χ;
- salinity measurement, ppm ……..……..…….. 0.025C.

1.3.4 The conductivity meter's margin of allowable basic absolute measuring error, resulting from ambient temperature deviation from normal temperature (20 ± 5) °C per each ± 10 °C within an operating temperature range from +5 to +50 °C:

- SEC measurement, µSm/cm …..……..…..…… 0.01χ;
- salinity measurement, ppm ..……..……..…… 0.012C.

1.3.5 The conductivity meter's margin of allowable basic absolute measuring error resulting from the effect by the "conductivity probe – converting unit" connector length with a connecting cable length of up to 100 m:

- SEC measurement, µSm/cm ...……..……..…. 0.016χ;
- salinity measurement, ppm ……..…. 0.02C.

1.3.6 The function of converting the measured SEC or salinity value into the converting unit's output current at an ambient air temperature of (20 ± 5) °C is as follows:

– for 4-20 mA current output at a maximum load of 500 Ω:

$$I_{output} = 4 + 16\frac{X}{X_{range}};$$

– for 0-5 mA current output at a maximum load of 2 kΩ:

$$I_{output} = 5\frac{X}{X_{range}},$$

where X is measured SEC (salinity) value, μSm/cm (ppm);

X_{range} is upper limit of a programmable current output measuring subrange, corresponding to 5 mA for 0-5 mA current output and to 20 mA for 4-20 mA current output, μSm/cm (ppm).

1.3.7 Margins of allowable reduced error for converting the measured SEC or salinity value into the converting unit's output current at an ambient air temperature of (20 ± 5) °C, % of the current output range ……..……... ± 0.5.

1.3.8 Margins of allowable complementary error for converting the measured SEC or salinity value into the converting unit's output current, resulting from ambient temperature deviation from normal temperature (20 ± 5) °C per each ± 10 °C within an operating temperature range from +5 to +50 °C, % of the current output range ……..……..…… ± 0.25.

1.3.9 Margins of allowable fractional error for measuring the conductivity probe's electrolytic constant, % ……... ± 1.

1.3.10 Heat sensor resistance referred to 0 °C, Ω ……... 995 to 1,005.

1.3.11 Margins of allowable absolute error for measuring the heat sensor resistance referred to 0 °C, Ω ……..... ± 1.0.

1.3.12 The conductivity meter's transient period with stepwise SEC variations, s, max …… 30.

1.3.13 Step response time of the conductivity meter with conductivity probe, with stepwise variations in the analyte medium temperature, min, no more than…3.

1.3.14 The conductivity meter's indication stability for 8 h, at least:

– SEC measurement, μSm/cm ……..……..... 0.01χ;

– salinity measurement, ppm …… 0.0125C.

1.3.15 Operating mode setting time of the conductivity meter with conductivity probe, min, no more than ……... 15.

1.3.16 Any excess by the measured SEC or salinity value of the upper limit of the current output measuring subrange will cause the following actions to occur: the **OVERLOAD!** indicator will come on, the alarm will be sounded, the relay's dry contacts will close and the **OVERLOAD!** sign and flashing symbol "χ" or **"C"** will be displayed on the indicator screen.

1.3.17 Any excess by the measured SEC or salinity value of the lower or upper threshold will cause "▼" or "▲" to be displayed and the relay's dry contacts to close.

1.3.18 Analyte medium temperatures below 0 °C and above 50 °C enable the **OVERLOAD!** indicator and alarm and cause the relay's dry contacts to close and the **OVERLOAD!** sign and flashing symbol "**°C**" to be displayed.

1.3.19 When connected to a personal computer (PC), the conductivity meter exchanges information with PC via the RS-485 interface.

1.4 Product components

The conductivity meter is comprised of the following components:

– panel-mounted (for MAPK-602 and MAPK-602LD versions) or wall-mounted (for MAPK-602/1 and MAPK-602LD/1 versions) converting unit;

– CP-025C conductivity probe and/or CP-2C conductivity probe (for MAPK-602 and MAPK-602/1 versions);

– CP-003LD conductivity probe (for MAPK-602LD and MAPK-602LD/1 versions);

– connecting cables;

– mounting parts kit;

– tool and accessory kit.

1.5 Design and operation

1.5.1 Conductivity meter general data

The conductivity meter is a dual-channel measuring instrument designed for continuous measuring of SEC or SEC equivalent salinity referred to sodium chloride (NaCl) via two measuring channels A and B.

The measured SEC or equivalent analyte medium salinity value is displayed on a readout device − a digital LCD display ("the display"). It provides separate or simultaneous indication of parameters measured in channels A and B.

Each channel has a dedicated programmable subrange for current output measurement.

The lower limit of the programmable subrange for current output measurement is always 0 µSm/cm (0 ppm).

The upper limit may be set within a range from 0.1 µSm/cm (0.1 ppm) to the upper measuring range limit, depending on the connected type of probe. The preset upper limit of current output measurement is shown on the display.

The conductivity meter has two outputs with unified output DC signals from 0 to 5 mA or from 4 to 20 mA, corresponding to the two SEC or salinity measuring channels. The upper limit of the programmable subrange for current output measurement corresponds to a current of 5 or 20 mA. The required current output range (from 0 to 5 mA or from 4 to 20 mA) is chosen by the user separately for each channel through an option on the conductivity meter menu.

In addition to unified output DC signals from 0 to 5 mA or from 4 to 20 mA, the conductivity meter menu enables unified output signals from 0 to 20 mA to be set in each of the channels.

Independent of the set current output subrange, the conductivity meter display's measuring range is only determined by the type of probe employed. For SEC (salinity) measurement beyond the set measuring range the measuring error is not normalized.

SEC measuring range using:

- CP-025C conductivity probe − 0 to 2,000 µSm/cm;
- CP-2C conductivity probe − 0 to 20,000 µSm/cm;
- CP-003LD conductivity probe − 0 to 200 µSm/cm.

Salinity measuring range using:

- CP-025C conductivity probe − 0 to 1,000 ppm;
- CP-2C conductivity probe − 0 to 10,000 ppm;
- CP-003LD conductivity probe − 0 to 100 ppm.

The above instruments are contact-type conductivity probes with built-in heat sensors. They are passive devices (without electronic elements) and may be taken up to 100 m away from a converting unit.

The probe's constant value C_P, cm^{-1}, is shown in Table 3.1 of this Manual. A heat sensor (thermoresistor) resistance value referred to 0 °C, R_t, Ω, is shown in Para. 5.

Values C_p, cm^{-1}, and R_t, Ω, characterizing each particular conductivity probe must be entered (when using this probe) into the converting unit memory to allow sensor interchangeability. Values C_P, cm^{-1}, and R_t, Ω, are entered in the parameter monitoring and changing mode enabled by pressing the **menu / enter** button on the face panel and used to set all the conductivity meter's operating modes and parameters.

For easier SEC monitoring, provision is made in the conductivity meter for temperature compensation, i.e. reference of the SEC absolute value to SEC at 25 °C. Having a double algorithm, temperature compensation is provided for the absolutely clean water SEC component and for the component depending on the agents dissolved in water (temperature dependence approximated by a linear law – the so-called linear temperature compensation).

The linear temperature compensation factor depending on the composition of agents dissolved in water may be set by the user within a range from 0.0140 to 0.0200 $degrees^{-1}$.

The conductivity meter has a measuring mode for SEC not referred to 25 °C (with temperature compensation disabled).

Any excess by the measured SEC or salinity value of the upper limit of the current output measuring subrange will cause the **OVERLOAD!** indicator to come on, the **OVERLOAD!** sign and the flashing symbol of an overloaded parameter ("χ" or "**C**") to be displayed and the relay's dry contacts to close.

If the analyte medium temperature goes beyond the range from 0 to +50 °C, the **OVERLOAD!** indicator will come on, the alarm will be sounded and the relay's dry contacts will close. Also, the **OVERLOAD!** sign and the flashing symbol "**°C**" will be displayed.

Each of the conductivity meter's channels has two freely programmable thresholds setting the upper and lower monitoring limits for an SEC or salinity value being measured. If SEC or salinity values exceed the threshold limits, the relay's dry contacts close and a sign of the upper or lower threshold limit is displayed ("▼" or "▲").

The tool and accessory kit of MAPK-602LD (MAPK-602LD/1) conductivity meter includes a flow-through cell for flow-through measurements or a housing to install the probe in a main pipeline, supplied as agreed upon with the customer.

1.5.2 Conductivity meter's operating principle

1.5.2.1 SEC measuring principle

SEC measurement involves supply of constant AC voltage to a conductivity probe and measurement of current flowing through the probe. The current value, including the probe's electrolytic constant C_P, is transferred to the controlled medium SEC. To define SEC referred to 25 °C, use is made of the measured temperature value.

1.5.2.2 Temperature measuring principle

Temperature readings are determined by transferring the heat sensor's measured resistance value. Such transfer using the heat sensor's resistance value referred to 0 °C, R_t, Ω.

1.5.2.3 SEC temperature compensation principle (referring the measured SEC to 25 °C)

Temperature compensation comprises the following two stages:
– “pure” water SEC temperature compensation;
– salt solution temperature compensation.

1.5.2.4 Salinity measuring principle

Salinity is defined by transferring a temperature-compensated (referred to 25 °C) solution SEC to NaCl salt concentration using the known dependence.

1.5.3 Conductivity meter’s components

1.5.3.1 Converting unit

The converting unit (CU) is designed to convert conductivity probe signals, display measuring data, generate a signal at current outputs, control the relay’s dry contacts and data communication to PC.

CU is powered from 220 V DC 50 Hz mains through the built-in power supply.

The CU front panel features the following components (Fig.1.1):

– display screen designed to indicate measured or referred SEC values and temperatures, conductivity meter modes, and to work with screen menus;

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

– “⇓” and “⇑” buttons to move down and up the menu in the parameter monitoring and changing mode and to change the settings;

– “**CHANNEL**” button to change the indication mode (channel A, channel B or both channels) and perform some operations in the **MENU** mode;

– “**menu**/**enter**” button to enter the menu (invoke the parameter monitoring and changing mode) and confirm the values and operating modes selected in programming;

– “**POWER**” button to switch the conductivity meter on and off;

– “**POWER**” green light power on indicator;

– “**OVERLOAD**” red light indicator to show an overloaded programmable range for current output measurement or analyte medium temperature exceeding the range from 0 to +50 °C.

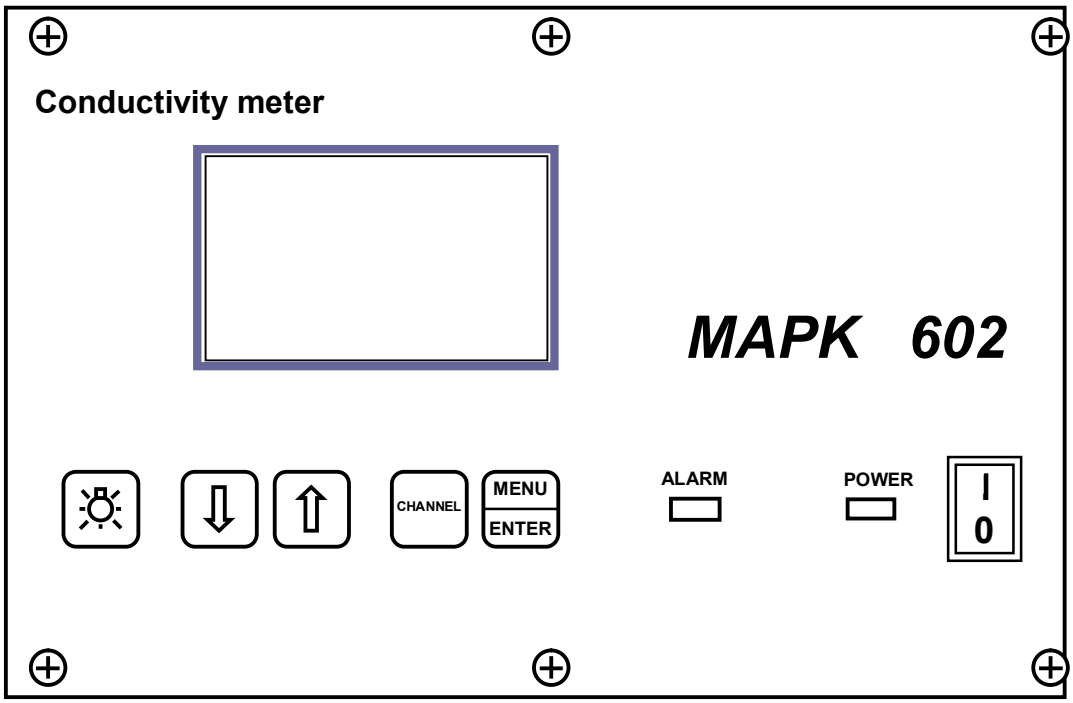


Figure 1.1 − Layout of controls and indicators on the converting unit face panel

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:

– two connectors “**CHANNEL A**” and “**CHANNEL B**” to hook up conductivity probes to the converting unit;

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

– terminal “⏚” to connect protective earthing to the conductivity 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 converting unit lower panel features the “**~220 V 50 Hz 10 V·A 1.0 A**” sealed mains cable entry.

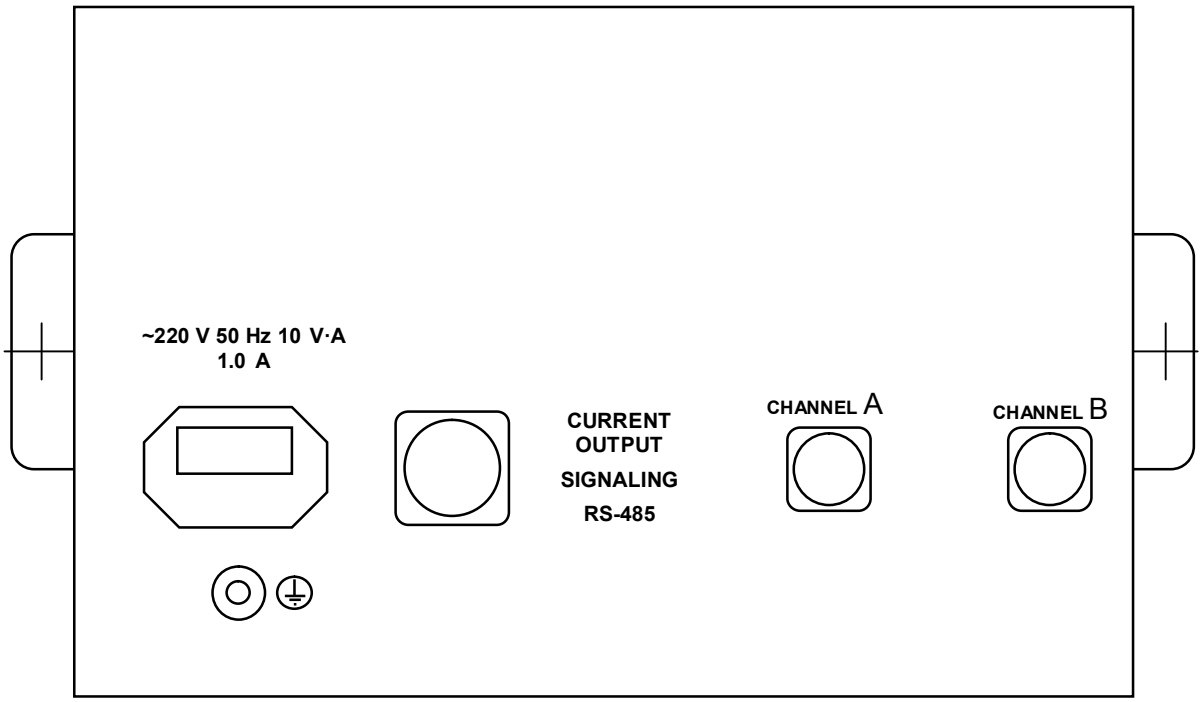


Figure 1.2 − Layout of connectors on the panel-mounted converting unit rear panel

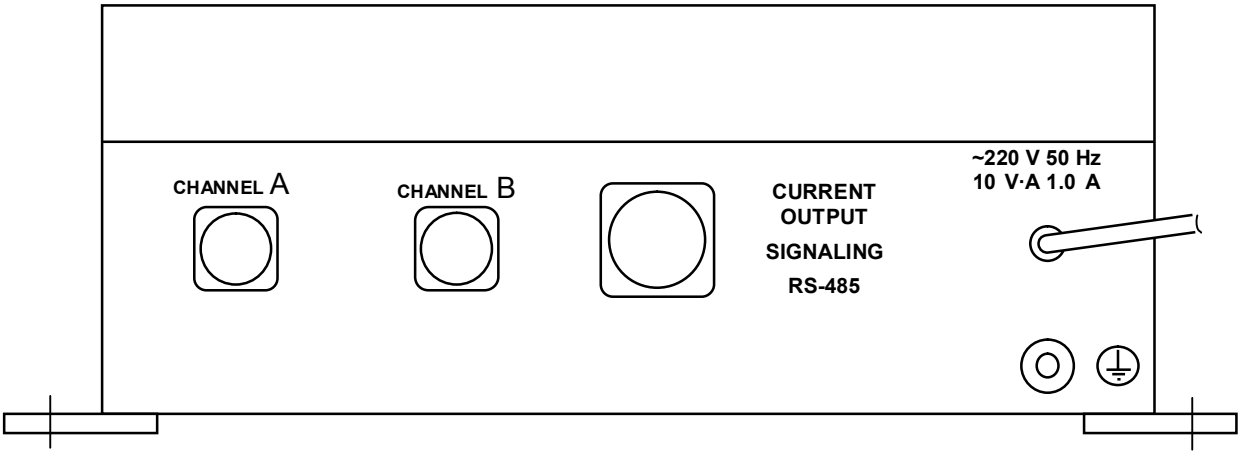


Figure 1.3 − Layout of connectors the wall-mounted converting unit lower panel

1.5.3.2 Conductivity probes

CP-025C and CP-2C are flow-type conductivity probes with electrodes of stainless steel.

The CP-025C (CP-2C) conductivity probe is shown in Fig.1.4.

The probes have a sealed aluminum housing that accommodates electrode assembly 1, heat sensor 2 based on platinum thermoresistor with connector 3, connector 4 for shielded connecting cable, and two metal pipe connections − inlet connection 5 for supply of controllable solution and outlet connection 6. The conductivity probe is secured to the vertical surface with M4×8 screws using holes 7. Conductivity probe cover 8 providing a sealed enclosure for the probe electrode section is secured with screws 9.

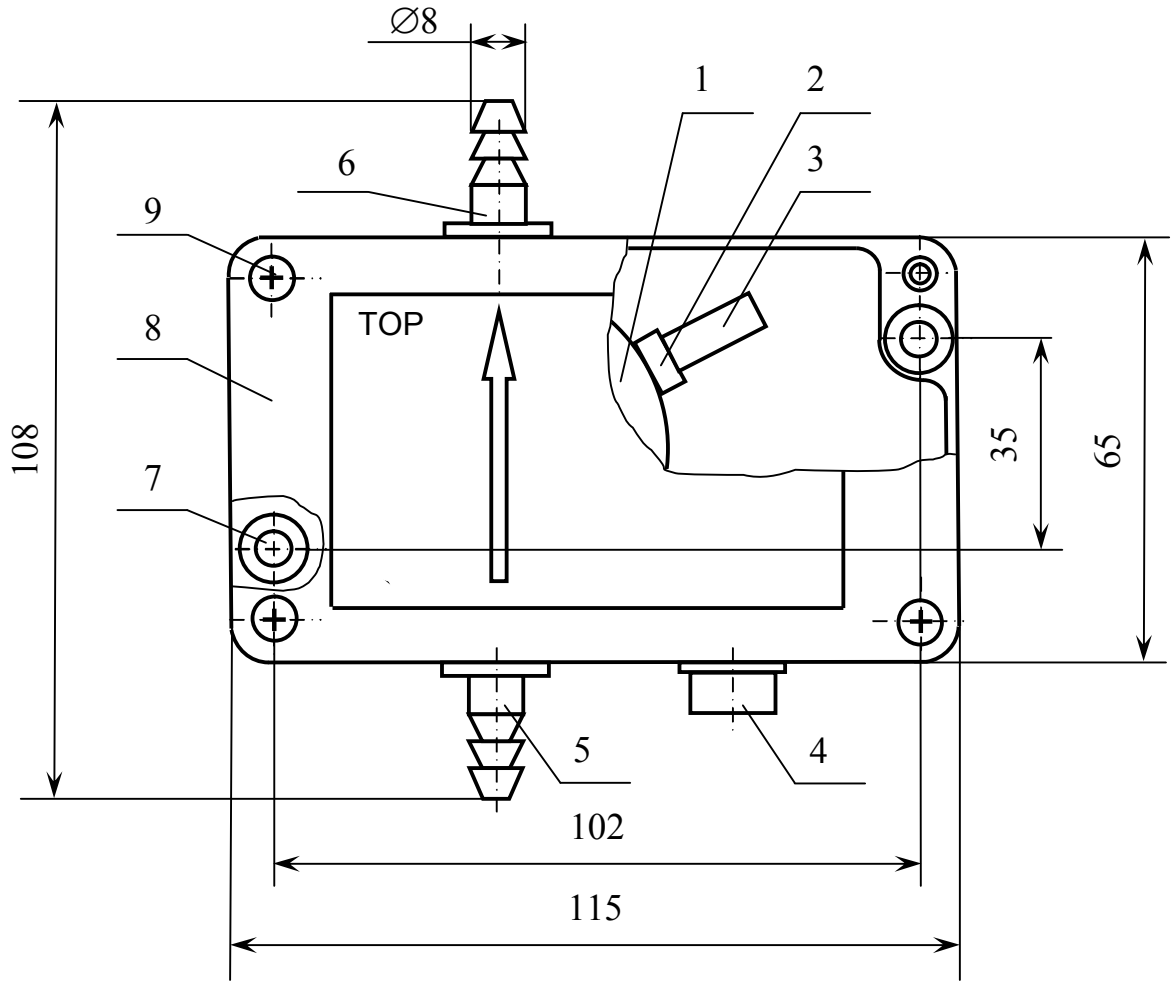


Figure 1.4 – CP-025C (CP-2C) conductivity probe

CP-003LD is a line-dip conductivity probe with electrodes of stainless steel. The CP-003LD conductivity probe is shown in Fig.1.5.

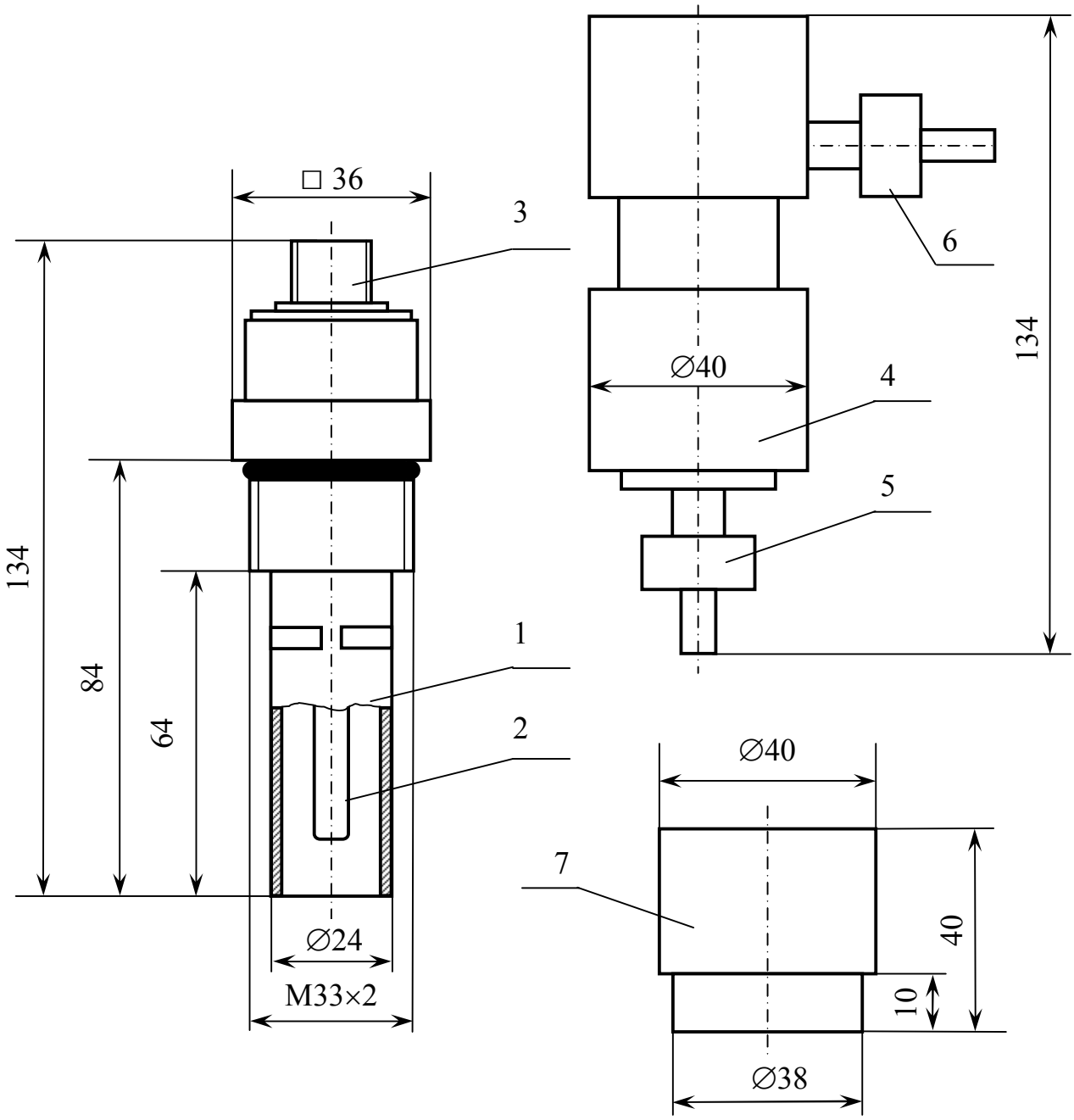


Figure 1.5 – CP-003LD conductivity probe

The conductivity probe electrode section consists of case 1 and inside electrode 2 fitted with a heat sensor based on platinum thermoresistor. Connector 3 is intended for shielded connecting cable. The probe has M33×2 thread.

For flow-through measurements the conductivity probe is set in flow-through cell 4.

The flow-through cell has two nipples (ball-cone) − inlet 5 and outlet 6, with a pipe connection outside diameter of 9 mm. The flow-through cell is connected to the process pipeline with a metal pipe (by welding).

Designed to install the conductivity probe for main pipeline measurements, housing 7 is welded into the pipeline.

The flow-through cell and housing are included in the tool and accessory kit and supplied as agreed upon with the customer.

1.5.4 Measuring screens

1.5.4.1 Types of measuring mode screens

The conductivity meter has the following measuring mode screens:

– single-channel (A or B) measuring mode screen according to Fig.1.6 and 1.7;

– double-channel (A and B) measuring mode screen according to Fig.1.8.

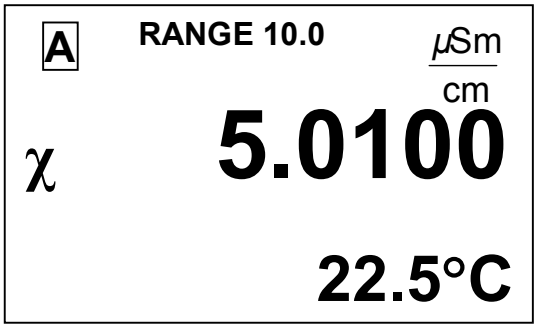


Figure 1.6

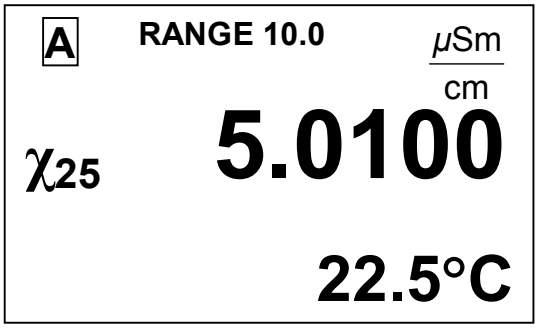


Figure 1.7

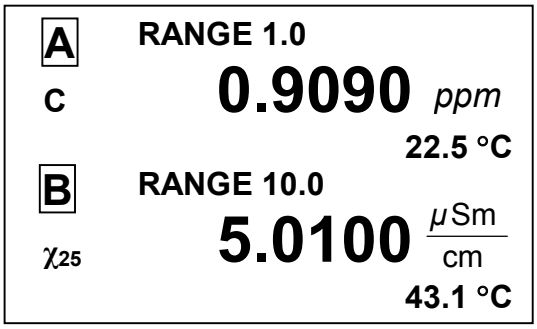


Figure 1.8

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.

Indicated on the screens are channel names (A or B), current output measuring subrange values for each channel and measured values of SEC or SEC referred to 25 °C or salinity as well as temperature.

If the conductivity probe 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 conductivity 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 conductivity 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 is shown in Fig.1.9.

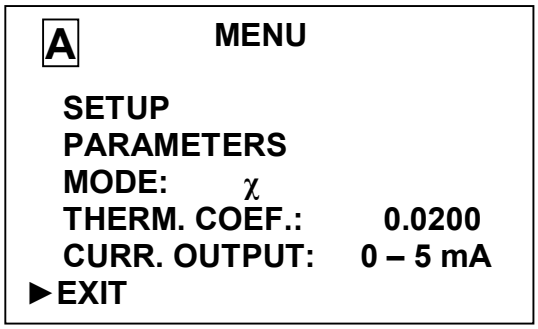


Figure 1.9

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

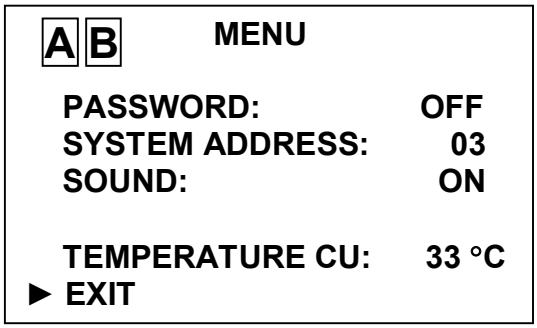


Figure 1.10

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 the **EXIT** line 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 conductivity 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 the **EXIT** line and press the "**menu / enter**" button.

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

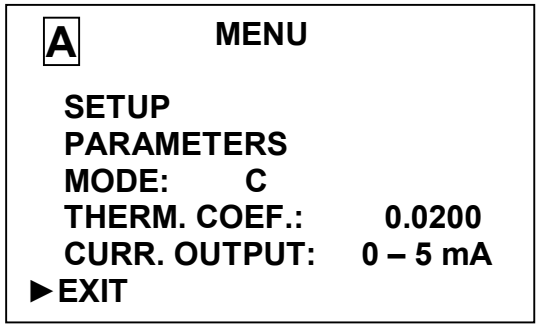


Figure 1.11

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 the **EXIT** line and press the "**menu / enter**" button.

► **SETUP** − this menu item is intended to set the upper limit of the current output measuring subrange and for changing or viewing minimum and maximum threshold values.

The screen is shown in Fig.1.12 below.

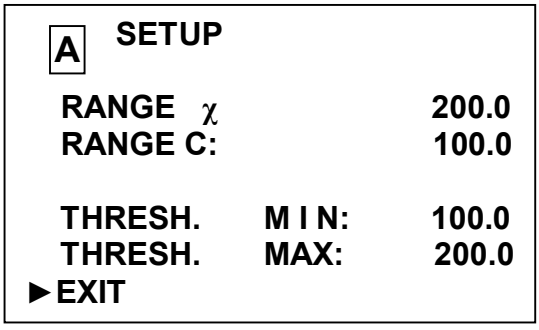


Figure 1.12

A value of the programmable current output measuring subrange should be set within a range from 0.1 to the values as listed in Table 1.3. A measuring range is set in the units of measurement of the mode selected (μSm/cm or ppm).

The **M I N** threshold value should be set within a range from 0.0 to 19.999.

The **MAX** threshold value should be set within a range from 0.1 to 20.000.

Once all the digit values are selected, set the "►" marker at the **EXIT** line and press the "**menu / enter**" button. This action will cause the screen as shown in Fig.1.13 to appear.

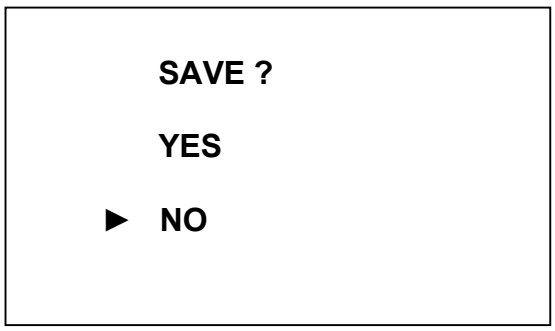


Figure 1.13

Use "⇓"/"⇑" buttons to set the "►" marker at the **YES** line, and press the "**menu**/**enter**" button. The conductivity meter will change over to the **MENU** mode, saving the set measuring range value and changed threshold values.

► **PARAMETERS** − this menu item is intended to change or view the conductivity meter's parameters:

- connected conductivity probe's electrolytic constant (**PROBE CONST.**);
- heat sensor's resistance referred to 0 °C (**THERMORESISTOR**).

The screen is shown in Fig.1.14 below.

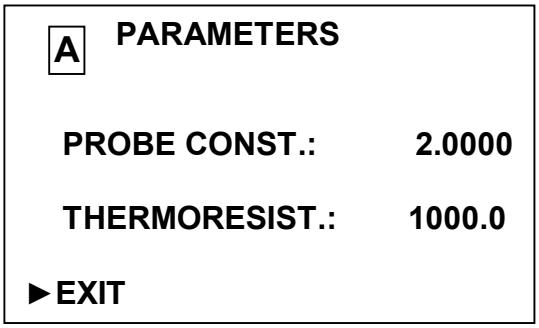


Figure 1.14

Once all the digit values are selected, set the marker at the **EXIT** line and press the "**menu**/**enter**" button. This action will cause the screen as shown in Fig.1.13 to appear.

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

The conductivity meter will change over to the **MENU** mode, saving the conductivity probe's new parameters.

► **MODE** − this menu item is meant to select a channel's measuring mode.

Set the marker at the ► **MODE** line. Press successively the "**menu/enter**" button to select a measuring mode. This action will cause one of the following characters corresponding to the selected measuring mode to appear in the **MODE** line:

«**χ**» − measurement of SEC not referred to 25 °C;
«χ_{25}» − measurement of SEC referred to 25 °C;
«**C**» − salinity measurement.
Having set the required mode, move to another **MENU** line or exit **MENU**.

► **THERM. COEF.** − this menu item is meant to change or view the linear temperature compensation coefficient.

Set the market at this line, press the "**menu/enter**" button and enter, digit-by-digit, a new value within a range from 0.0140 to 0.0200 degree^{-1} (similarly to the setting of the current output measuring subrange).

Only the second, third or fourth digit after the point may be edited.

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

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

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

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

Use of this screen menu is similar to that of **MENU [A]**, **MENU [B]** screens.

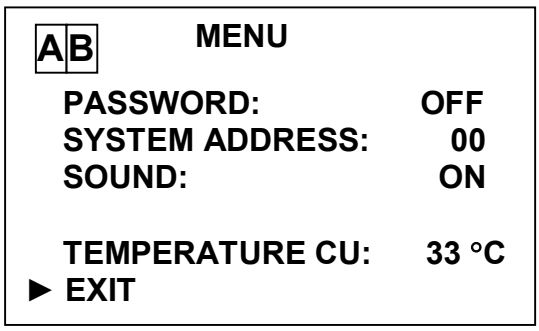


Figure 1.15

► **PASSWORD: ON** – this menu item is intended to restrict access to changing the conductivity meter's parameters.

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

If the password feature is enabled (**PASSWORD: ON**) the conductivity meter will request the password (**12**) to be entered to change over from the measuring mode to the **MENU** mode.

The screen as shown in Fig.1.16 will appear.

Flashing on the screen will be the first digit to be entered.

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.

Figure 1.16

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

► **SYSTEM ADDRESS: 00** – this **MENU [A] [B]** item is intended to set the conductivity meter's system address in case a few networked instruments operate on the RS-485 interface. The system address identifies a specific conductivity meter in the network and may take values from **00** to **32**. In out-of-network operation the system address does not matter.

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

► **TEMPERATURE CU: −** this **MENU [A] [B]** item is 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 measured SEC value exceeds that of the current output measuring subrange. Set the appropriate current output subrange for SEC measurement.

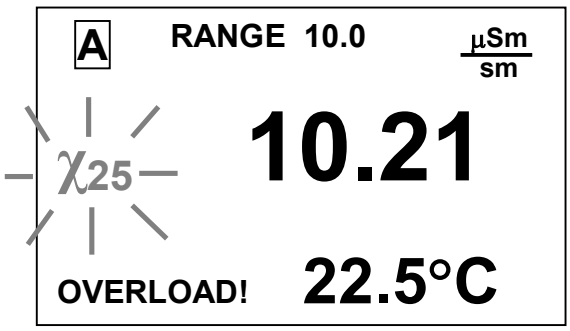


Figure 1.17

The warning screen as shown in Fig.1.18 will appear if the measured salinity value exceeds that of the current output measuring subrange. Set the appropriate current output subrange for salinity measurement.

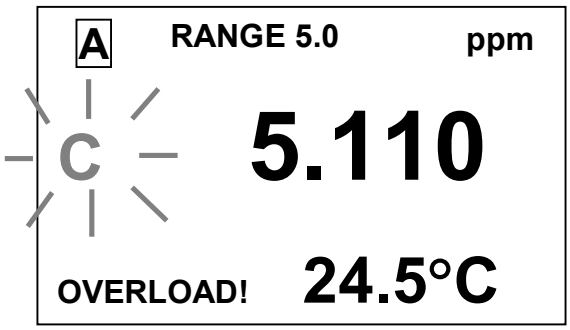


Figure 1.18

The warning screen as shown in Fig.1.19 will appear if the salinity value being measured in channel A and the measured SEC value in channel B are higher than that of the current output measuring subrange.

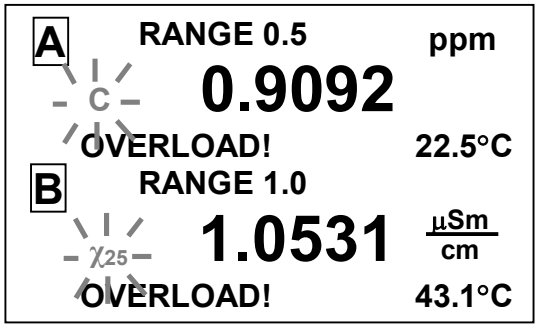


Figure 1.19

The warning screen as shown in Fig.1.20 will appear if the analyte solution temperature is below 0 °C and above 50 °C.

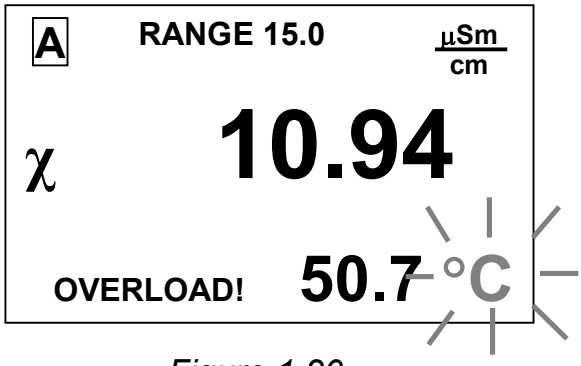


Figure 1.20

The warning screen as shown in Fig.1.21 will appear if the analyte solution temperature is below 0 °C and above 50 °C and the measured SEC value exceeds that of the current output measuring subrange.

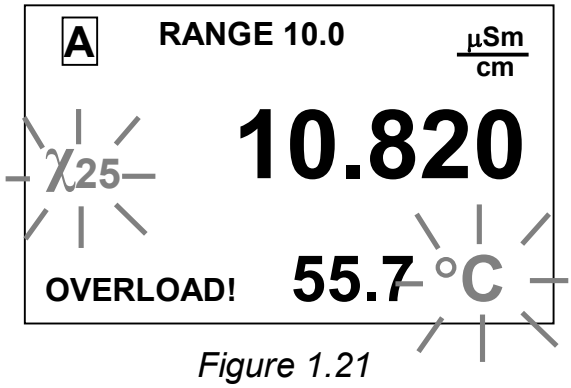


Figure 1.21

The warning screen as shown in Fig.1.22 will appear if the measured SEC value is lower than the **MIN** threshold.

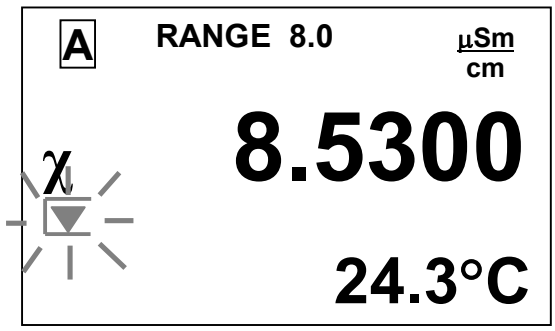


Figure 1.22

The warning screen as shown in Fig.1.23 will appear if the measured SEC value:

– in channel A – lower than **MIN** threshold;

– in channel B – higher than **MAX** threshold.

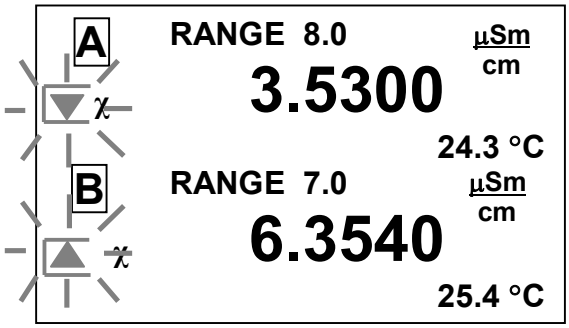


Figure 1.23

The warning screen as shown in Fig.1.24 will appear if the measured SEC value is higher than **MAX** threshold and exceeds the current output measuring subrange value and the analyte solution temperature is above 50 °C.

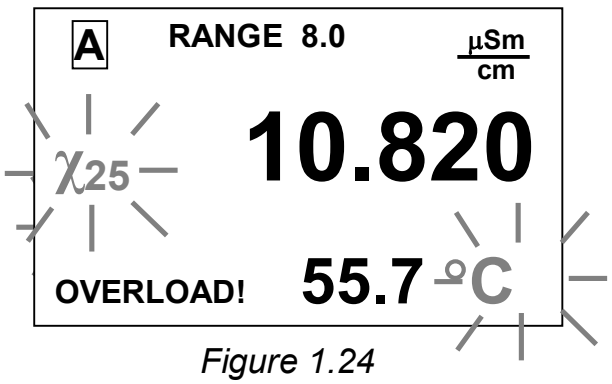


Figure 1.24

2 INTENDED USE

2.1 Operating limitations

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

2.1.2 Protect CU against impacts as it comprises glass components.

2.1.3 Protect CP-025C and CP-2C conductivity probes against impacts as they are made of fragile materials. Never use CP-025C and CP-2C conductivity probes for measurements in solutions containing chemical solvents and alcohols that may damage a probe, because it incorporates parts of acrylic plastic (methacrylate resin).

2.1.4 When making immersion measurements, dip the CP-003LD conductivity probe 60 to 100 mm into an analyte solution. In main pipeline measurements the analyte medium pressure should not exceed 1.0 MPa.

2.2 Safety precautions

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

2.2.2 The conductivity 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 12.2.007.0-75 requirements.

2.2.3 CU must be installed so that the de-energizing of the conductivity meter is not hindered.

2.2.4 The conductivity meter must not be used with the CU case cover removed and CU 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.

2.2.6 Conductivity probe and the converting unit are connected by a shielded cable.

2.3 Conductivity meter setting-up procedures

2.3.1 Before use, unpack the conductivity meter, check the set for completeness and make sure the components are intact. If the conductivity meter has stayed in cold environment, keep it at room temperature for at least 2 h before starting setting-up procedures.

2.3.2 Converting unit Installation and connection

Install CU 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 CU is shown in Fig.2.1.

A panel-mounted CU is installed on the panel inside. The plate included in the panel-mounted conductivity meter delivery set is installed on the panel face.

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

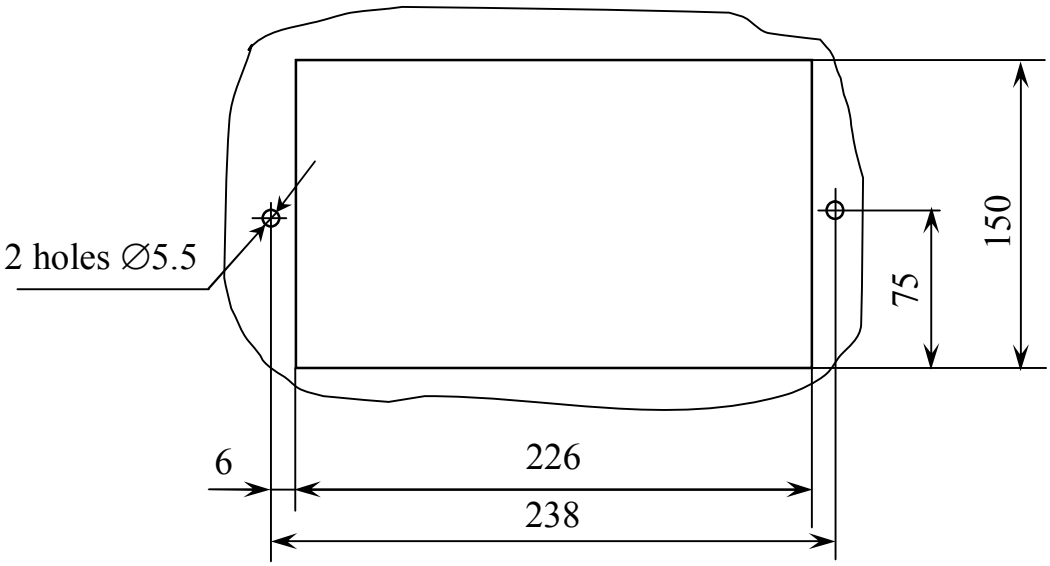


Figure 2.1 − *Layout of attachment holes for a panel-mounted converting unit*

The layout of holes for vertical attachment of a wall-mounted CU is shown in Fig.2.2.

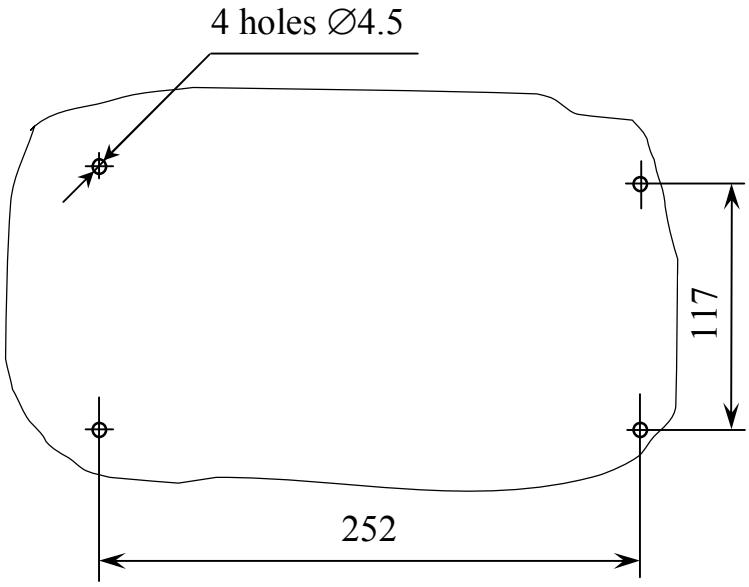


Figure 2.2 − Layout of holes for vertical attachment of a wall-mounted converting unit

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

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.

2.3.3 Conductivity meter's parameter monitoring and changing

Proceed as follows:

– press the "**menu / enter**" button, the conductivity meter will switch over to the parameter monitoring and changing mode;

– check the probe connectors for correct connection to the appropriate measuring channel;

– by pressing the **CHANNEL** button, check parameters specified in **MENU [A]**, **MENU [B]** and **MENU [A.B]** and adjust them, if necessary, according to 1.5.5.1 and 1.5.5.2.

Notes

1 The probe constant *Cp* is shown in Table 3.1 and the heat sensor resistance R_t is shown in Para.5.

2 When replacing or relocating the probes, readjust each channel for the parameters of a specific probe.

3 In case of any doubts as to the conductivity meter's correctness and prior to calibration, check the instrument in accordance with 3.3 and adjust the probe constant C_P, if required.

De-energize CU; the **POWER** light indicator will go out.

2.3.4 Transducer unit's external connections

External connections of 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.2.3.

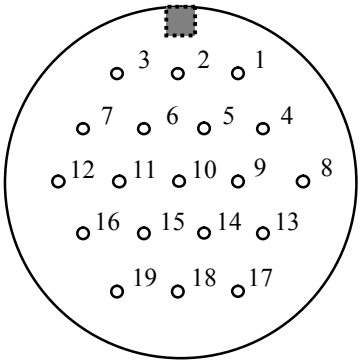


Figure 2.3

2.3.5 Connection of external recording unit

The external recording unit is connected to the transducer 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.

2.3.6 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
11	SG (signal ground)
14	DAT+ (Data +)
15	DAT– (Data –)

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

Rate of exchange – 19.200 bps.

2.3.7 Connection of external actuating and warning equipment

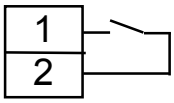
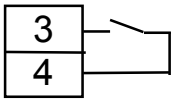
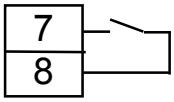
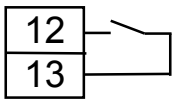
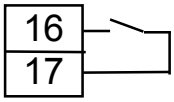
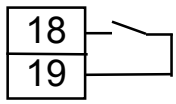
Connection of external actuating and warning equipment to the transducer unit is through the **CURRENT OUTPUT**, **SIGNALING**, **RS-485** connector contacts.

If the measured dissolved oxygen concentration values and analyte medium temperature exceed the specified limits, the relay's dry contacts close the circuits between the connector contacts, as per Table 2.3.

Threshold parameters are changed in accordance with 1.5.5.

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

Table 2.3

Controlled parameter	Channel	Controlled parameter value	No. of contacts, between which circuit is closed
Measured SEC value, µSm/cm Measured salinity value, ppm	A	above upper limit and below lower limit of the current output measuring subrange	
Measured temperature value, °C		above 50 °C	
Measured SEC value, µSm/cm Measured salinity value, ppm	B	above upper limit and below lower limit of the current output measuring subrange	
Measured temperature value, °C		above 50 °C	
Measured SEC value, µSm/cm Measured salinity value, ppm	A	below MIN threshold value	
		above MAX threshold value	
Measured SEC value, µSm/cm Measured salinity value, ppm	B	below MIN threshold value	
		above MAX threshold value	

2.3.8 Installation of CP-025C and CP-2C CP-003LD conductivity probes

Overall and mounting dimensions of the CP-025C (CP-2C) probe are shown in Fig.1.4.

Perform the following steps to install the probes:

– undo cover 8 attachment screws 9 (Fig.1.4);

– remove probe cover 8;

– secure the conductivity probe so as to ensure that the analyte medium flows via the probe from the bottom upwards (according to the arrow on the probe cover); vertical deviation of the arrow must not exceed 15°;

– reinstall cover 8 and tighten up screws 9;

– connect the probe to the sampler;

– let flow pass through the probe until air bubbles are removed and the probe is washed; if the proposed SEC value is below 1 μSm/cm, the probe washing time may reach 2 h at the maximum flow rate;

– once the probe is washed, set the flow rate within a range from 3 to 30 dm^3/h; the higher the proposed SEC value, the higher the flow rate to be set; with SEC of less than 5 μSm/cm the water flow rate must exceed 10 dm^3/h;

– repeat the same procedure to set the second probe, if it is included in the delivery set.

2.3.9 Installation of CP-003LD conductivity probe

Overall and mounting dimensions of the CP-003LD conductivity probe and the housing for probe installation in a main pipeline are shown in Fig.1.5.

An example of the CP-003LD conductivity probe installed in a main pipeline is provided in Fig.2.4. The housing should be welded into the pipeline at an angle of (45 ± 5)°.

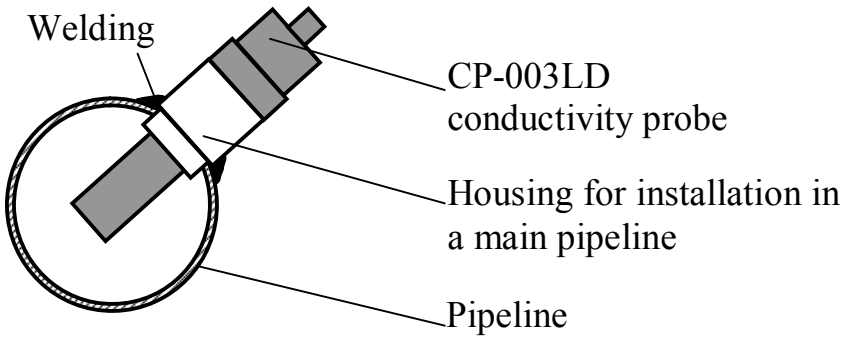


Figure 2.4 − Example of installation of the CP-003LD conductivity probe for main pipeline measurements

Installation of the CP-003LD conductivity probe for flow-through cell measurements is as shown in Fig.2.5.

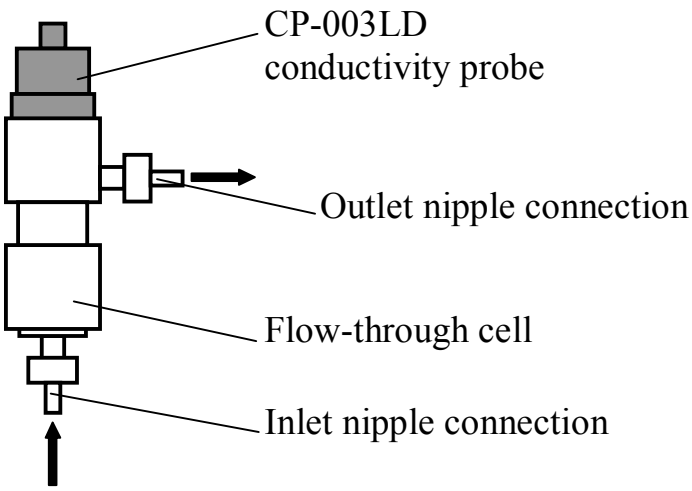


Figure 2.5 − Installation of the CP-003LD conductivity probe in a flow-through cell

Connection to a process line is by means of a metal pipe (by welding). The outer diameter of connections is 9 mm.

The conductivity probe's position in immersion measurements is as shown in Fig.2.6. The analyte solution level in the container must range between 60 and 100 mm.

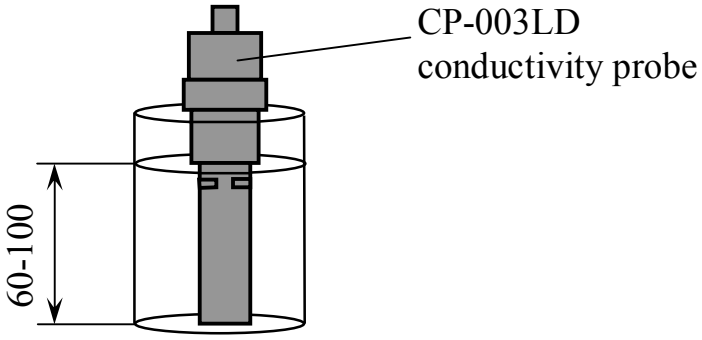


Figure 2.6 − Immersion measurements

2.3.10 Preparation for measurements using a hydraulic panel − in accordance with ВР30.08.000РЭ

2.4 Measurements

To perform measurements, proceed as follows:

– push on the **POWER** switch on the front panel, the display screen will come up;

– check correct setting of the conductivity meter's parameters and operating modes;

– use the **CHANNEL** button to select indication of channel A, channel B or both channels.

The screen indication updating time may reach 30 s.

2.5 Troubleshooting

Typical failures of the conductivity meter and remedial actions are provided in Table 2.4.

If any troubles listed in Table 2.4 occur, perform the steps recommended in the "Remedy" column.

Table 2.4

Trouble	Probable cause	Remedy
1 Conductivity meter does not turn on.	Blown fuses	For panel-mounted conductivity meter – replace fuses (2.6). For wall-mounted conductivity meter − factory repair.
2 Unstable conductivity meter readings	Open cable or loose contact in electrode cable connector	Check and provide reliable contact or remedy the cable fault.
3 Conductivity meter overreads when measuring low SEC values	Contaminated conductivity probe	Wash the conductivity probe (3.1).
		When changing over from high to lower SEC values, increase time of washing the conductivity probe with analyte water.
	Inadequate flow rate in the conductivity probe	Increase flow rate through the probe.

Table 2.4 continue

Trouble	Probable cause	Remedy
4 Measured SEC or salinity value markedly different from the actual value	Conductivity probe parameters are inconsistent with the set parameters of measuring channel probes	Check correct connection of probes to measuring channel connectors.
	Wrongly set value of probe constant C_P	Check the set probe constant value, compare it with C_P value given in Table 3.1; in case of discrepancy, enter the correct probe constant value.
	Open connecting cable	Check contact joints at connectors and restore connection, if necessary.
	Contaminated conductivity probe	Wash the conductivity probe (3.1).
	Ingress of moisture into CU connector and cardboards, and into conductivity probe connector contacts	Dry the converting unit or conductivity probe connector.
5 Measured value of SEC referred to 25 °C or salinity markedly different from the actual value	Probe parameters are inconsistent with the set parameters of measuring channel probes	Check correct connection of probes to measuring channel connectors.
	Wrongly set heat sensor resistance R_t	Invoke the parameter monitoring and changing mode and check the heat sensor resistance set. Compare it with the R_t value marked in Para. 5 and adjust it, if required.
	Open connecting cable	Check wire connections at the conductivity probe connector, temperature sensor connector and restore connection.
	Faulty temperature sensor	Factory repair
	Ingress of moisture into CU connector and cardboards, and into conductivity probe connector	Dry the converting unit and probe connector.

Table 2.4 continue

Trouble	Probable cause	Remedy
6 When measuring low SEC values with CP-025C and CP-2C conductivity probes, the conductivity meter underreads	Wrong probe installation (vertical deviation angle exceeding 15°)	Install the probe so as to ensure that analyte water flows from bottom upwards with vertical deviation of 15° max.
7 Channel temperature and zeros in all digits and ranges are not indicated on the display	Conductivity probe is off	Connect the conductivity probe.
	Temperature sensor break	Eliminate temperature sensor circuit fault.
8 Channel temperature and zeros in all digits and ranges are indicated on the display	Conductivity probe break	Eliminate the conductivity probe circuit fault.

2.6 Supply line fuses

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

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

3 MAINTENANCE

3.1 Washing of conductivity probes and temperature sensor

For washing, use a washing solution that does not destroy acrylic plastic parts stainless steel electrodes of the CP-025C (CP-2C) conductivity probe. A 1:2 ethyl alcohol-water solution is recommended. If no cleaning of oily deposits is required, it is recommended to wash the probe with distilled water. Gasoline should not be used for the purpose.

Do the washing by pumping distilled water or washing solution through the CP-025C (CP-2C) conductivity probe or by multiple immersion of the CP-003LD conductivity probe into distilled water or washing solution. A brush of appropriate size may be used for the purpose.

IMPORTANT: PREVENT washing and analyte solutions from getting on connectors!

3.2 Converting unit maintenance

The converting unit requires no maintenance.
Use mild detergents to clean the CU outer surface.

IMPORTANT: The transducer unit SHALL NOT be opened during the guarantee period!

3.3 Checking the conductivity meter and adjusting the probe constant

3.3.1 Checking the transducer unit's relative error

To check the transducer unit's relative error, establish a set-up as depicted in Fig.3.1 below.

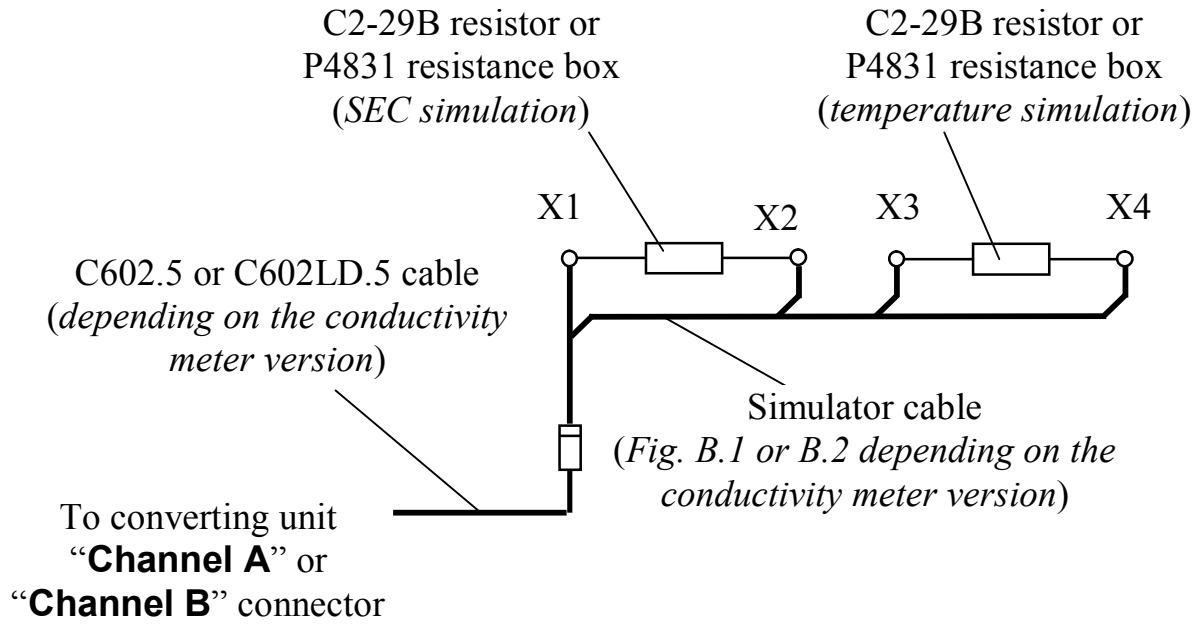


Figure 3.1 − Set-up for checking the converting unit's relative error

Invoke the measuring mode for SEC not referred to 25 °C («**χ**»).

Connect the C2-29B resistor with deviation not exceeding ± 0.1 % or the P4831 resistance box to terminals X1 and X2 of the simulator cable. The value of resistor connected to terminals X1 and X2 must vary between 0.25 and 0.3 kΩ.

Connect a 1 kΩ C2-29B resistor to terminals X3 and X4 of the simulator cable.

Record the readings of the converting unit indicator χ_R, μSm/cm.

The rated value of the converting unit indicator readings in the SEC measuring mode χ_{rated}, μSm/cm, is defined with the following formula:

$$\chi_{rated} = \frac{C_P \cdot 10^3}{R}, \qquad (3.1)$$

where C_P – value of the conductivity probe's electrolytic constant saved to the conductivity meter memory, cm^{-1};

R − value of the connected resistor simulating SEC, kΩ.

The converting unit channel A (channel B) relative error δ_{CU}^{χ}, %, is defined with the following formula:

$$\delta_{CU}^{\chi} = \frac{\chi_R - \chi_{table}}{\chi_R} \cdot 100\,\%. \qquad (3.2)$$

If δ_{CU}^{χ}, %, is within: $-0.5 \le \delta_{CU}^{\chi} \le 0.5$; proceed to 3.3.2.

3.3.2 Probe constant check

3.3.3 To check the probe constant, establish a set-up as shown in Fig.3.2 for checking the CP-025C or CP-2C conductivity probe and as shown in Fig.3.3 for checking the CP-003LD conductivity probe.

To this end, perform the following steps:

– pour 0.007M KCl solution into a 3 dm^3 container for CP-025C or CP-2C conductivity probe (SEC at 25 °C is 995.7 μSm/cm) and 0.0007M KCl solution for CP-003LD conductivity probe (SEC at 25 °C is 102.6 μSm/cm);

– place the container on the magnetic stirrer;

– put the reference temperature meter into the container;

– install the CP-025C or CP-2C conductivity probe as shown in Fig.3.2 with a vertical deviation not exceeding 15° so as to ensure that the KCl solution flows via the CP-025C or CP-2C probe from the bottom upwards; dip the CP-003LD into the container with KCl solution as shown in Fig.3.3;

– let the KCl solution flow through the reference conductivity meter's electrolytic cell;

– place the conductivity probe, electrolytic cell and container with KCl solution in the same temperature conditions (t = (20 ± 5) °C);

– switch on the conductivity meter under check and enter the probe constant C_P, cm^{-1}, shown in Table 3.1;

– set the value (20,000 μSm/cm) of the programmable current output measuring subrange;

– invoke the measuring mode for SEC not referred to 25 °C («**χ**»);

– select threshold values equal to 0 μSm/cm (**MIN**) and 20,000 μSm/cm (**MAX**);

– switch on the reference conductivity meter and set the desired range;

– disable temperature compensation of the reference conductivity meter;

– switch on the pump.

Define the solution SEC value χ_{ref}, μSm/cm, by the reference conductivity meter and χ, μSm/cm, by the conductivity meter and conductivity probe under check.

Calculate a new value of the probe constant C_P^n, cm^{-1}, using the following formula:

$$C_P^n = C_P \cdot \frac{\chi_{ref}}{\chi} \cdot \frac{\chi_R}{\chi_{rated}} \qquad (3.3)$$

where C_P – previous value of conductivity probe's electrolytic constant saved to the conductivity meter memory, cm^{-1};

χ_{ref} – solution SEC value defined by the reference conductivity meter, μSm/cm;

χ – solution SEC value defined by the conductivity meter under check, μSm/cm;

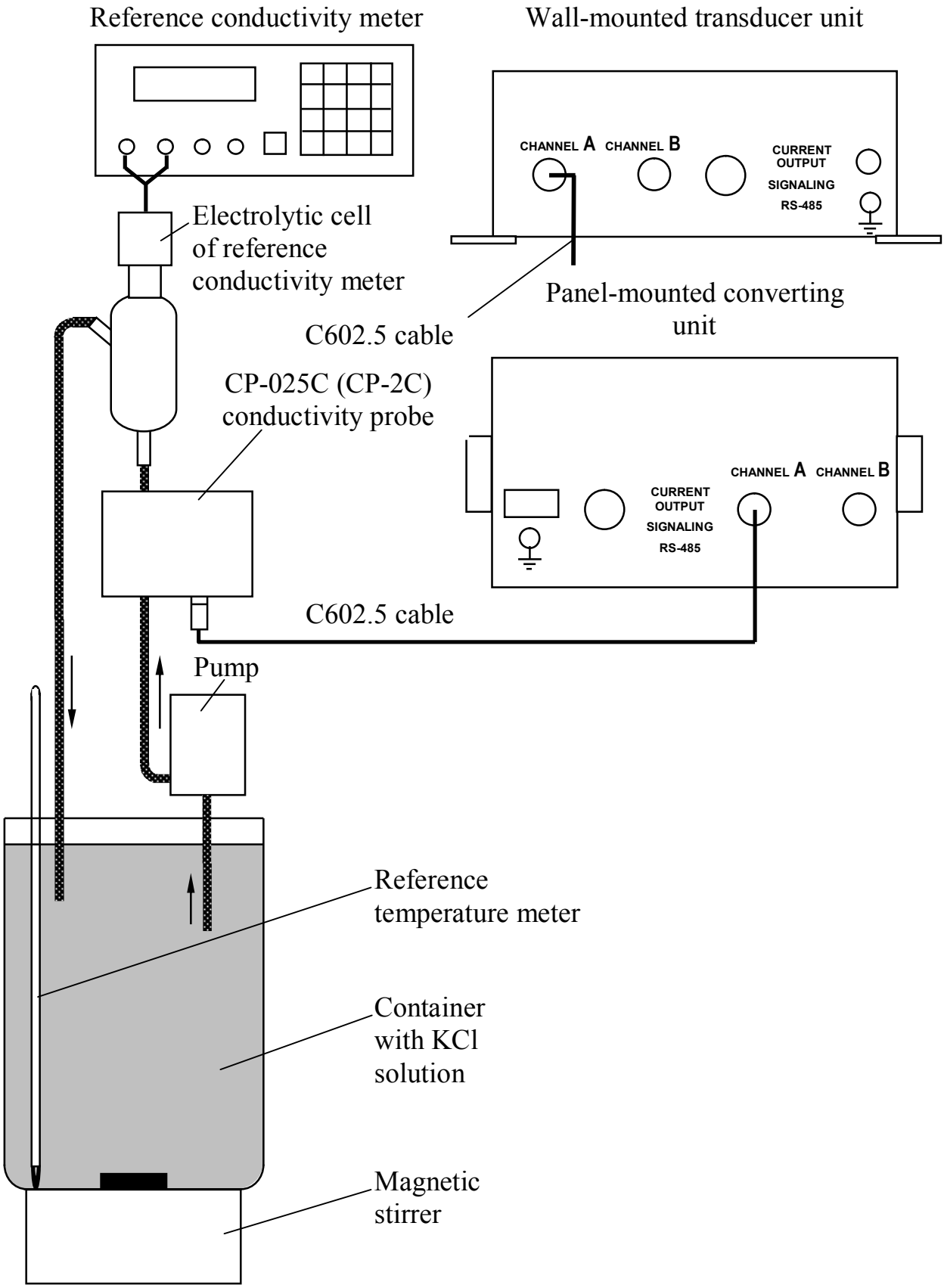


Figure 3.2 − Set-up for checking the CP-025C or CP-2C probe constant

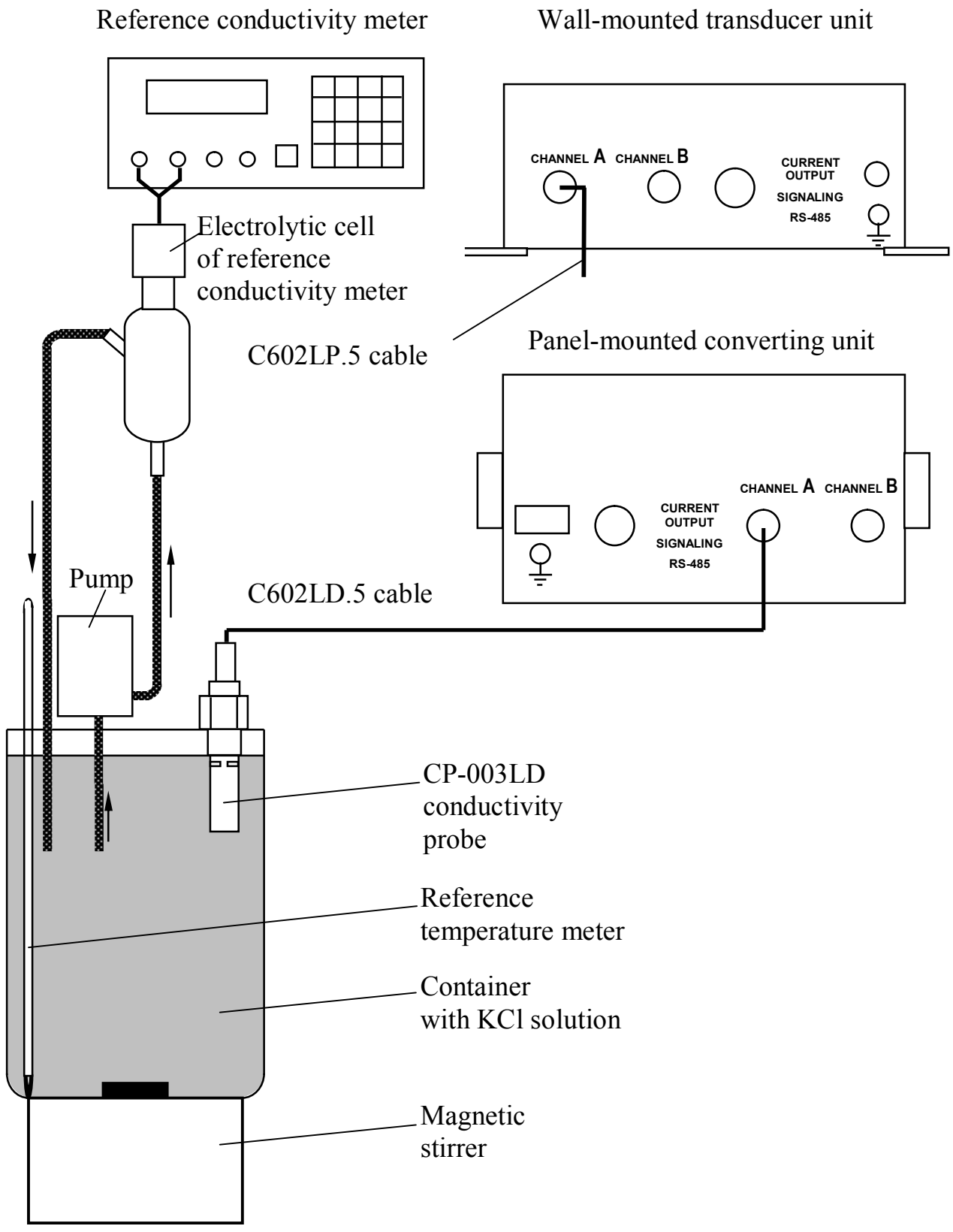


Figure 3.3 − Set-up for checking the CP-003LD probe constant

χ_R – readings of the indicator of CU of the conductivity meter under check, when measuring SEC with resistance simulator, μSm/cm (3.3.1);

χ_{rated} – rated readings of the indicator of CU of the conductivity meter under check with resistance simulator, μSm/cm (3.3.1).

Put the obtained value in Table 3.1 below and enter it in the conductivity meter memory each time before measurement.

Table 3.1

Type of conductivity probe	Probe No.	Probe constant C_P, cm^{-1}	Date	Position, name and signature of the person checking the probe constant

4 DELIVERY SET

The delivery set is as shown in Table 4.1.

Table 4.1

Description	Code	Quantity per version MAPK-			
		602	602/1	602LD	602LD/1
1 Converting unit	BP30.01.000	1	–	1	–
	BP42.01.000	–	1	–	1
2 Conductivity probe:					
– CP-025C	BP30.02.000	1*	1*	–	–
– CP-2C	BP30.02.000-01	1*	1*	–	–
– CP-003LD	BP30.10.000	–	–	1*	1*
3 Connecting cable:					
– C602.5	BP42.03.000	1**	1**	–	–
– C602.LD.5	BP42.03.000-02	–	–	1**	1**
4 Mounting parts kit: – PC19TB receptacle with housing	BP30.03.100	1	1	1	1
5 Tool and accessory kit: – HP-602 hydraulic panel	BP30.04.000 BP30.08.000	1*	1*	–	–
6 Tool and accessory kit: – C602.L connecting cable ***	BP30.07.000 BP42.03.000-01	1*	1*	–	–
7 Tool and accessory kit: – C602.LD.L connecting cable ***	BP30.11.000 BP42.03.000-03	–	–	1*	1*
8 Mounting parts kit	BP30.14.000	1	–	1	–
9 Operation Manual	BP30.00.000	1	1	1	1

*Quantity as approved by the customer.
** Quantity corresponds to that of conductivity probes.
*** Length L as approved by the customer (5 to 100 m).

5 ACCEPTANCE CERTIFICATE

Conductivity meter MAPK-602, MAPK-602/1, MAPK-602LD, MAPK-602LD/1 (underline as appropriate) № _____

conductivity probe CP-_____ № _____

R_t=_____Ω;

Conductivity probe CP-_____ № _____

R_t=_____Ω.

Password – **12**
is produced and accepted in accordance with government standards requirements, valid production forms and record, and considered exploitable.

QC department Chief

stamp here _____ _____
personal signature full name

“_____”_____ 20_____.