ANALYTICAL EQUIPMENT FOR

VZOR

ECOLOGY AND POWER INDUSTRY

МАРК-409
DISSOLVED OXYGEN 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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1.1 Purpose

1.1.1 Product name and identification

Panel-mounted analyzer:
MAPK-409 dissolved oxygen analyzer
TU 4215-037-39232169-2010 Specifications

Wall-mounted analyzer:
MAPK-409/1 dissolved oxygen analyzer
TU 4215-037-39232169-2010 Specifications

1.1.2 The analyzer is used to measure mass concentration of dissolved oxygen and temperature in aquatic environment.

1.1.3 Applications include dissolved oxygen monitoring at heat power engineering facilities and other fields that require dissolved oxygen control (ecology, fish farming etc.).

Analyzer type:

- amperometric;
- with external poling voltage;
- with two measuring channels;
- with digital LCD display;
- continuous operation;
- with automatic temperature response correction;
- with flow-immersion type sensor;
- with automatic atmospheric pressure correction during calibration;
- with built-in atmospheric pressure sensor;
- with measurement readout via the analog current output and RS-485 port.

1.2 Basic parameters

1.2.1 By resistance to climatic effects the analyzer falls within Version Group B4 as per GOST R 52931-2008.

1.2.2 By resistance to mechanical effects the analyzer falls within Version Group L1 as per GOST R 52931-2008.

1.2.3 By protection against environmental exposure this analyzer version is subject to GOST 14254-96:

- with IP30 panel-mounted converting unit;
- with IP65 wall-mounted converting unit.

1.2.4 By resistance to atmospheric pressure this analyzer version falls within P1 Group as per GOST R 52931-2008.

1.2.5 Analyte medium parameters

1.2.5.1 Temperature, °C …… 0 to +70

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1.2.6.1 Dissolved ammonia concentration, ppm, max ..……40.0

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1.2.7 Operating conditions

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

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

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

1.2.8 The analyzer is calibrated for 100% air humidity.

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

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

1.2.10 Power consumption at rated supply voltage, VA, max…… 10

1.2.11 Warmup and heat balance time, h, max.……..... 0.5

1.2.12 After installation of spare parts from the kit and calibration the analyzer retains its characteristics within the norms established in the product requirement specifications.

1.2.13 Overall dimensions and weights of analyzer components are shown in Table 1.1.

Table 0.1

Analyzer version	Component name and identification	Overall dimensions, mm, max	Weight, kg, max
MAPK-409	Converting unit	252×146×100	2.60
	Oxygen probe (without cable)	∅30×135	0.10
MAPK-409/1	Converting unit	270×170×100	2.60
	Oxygen probe (without cable)	∅30×135	0.10

1.2.14 Conditions for transportation in shipping crates as per GOST R 52931-2008.

1.2.14.1 Temperature, °C ……..……. – 10 to + 50

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

1.2.14.3 Sinusoidal vibration at 5-35 Hz, shift amplitude of 0.35 mm in the direction shown by the "THIS SIDE UP" sign on a crate.

1.2.15 Reliability requirements

1.2.15.1 Average time between failures, h, min……..……... 20,000

1.2.15.2 Mean recovery time, h, max ……..……..…… 2

1.2.15.3 Average analyzer life, years, min ……..…….. 10

1.2.16 Electric insulation between the converting unit supply circuits and its frame withstands for 1 min (without failure or breakover) AC test voltage with a root-mean-square value of 1,500 V and frequency of (50 ± 1) Hz in normal conditions of use.

1.2.17 Electric resistance of the analyzer 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.

1.2.18 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 Measuring range for mass concentration of water dissolved oxygen (DOC) at analyte medium temperature of 20 °C, ppm…… 0 to 10.00.

The DOC measuring range upper limit depends on the analyte medium temperature and is shown in Table 1.2.

Table 0.2

t ,°C	0	10	20	30	40	50	60	70
DOC, ppm	17.45	13.48	10.00	8.98	7.69	6.59	5.63	4.63

1.3.2 The analyzer's margin of allowable basic absolute measuring error for DOC measurements at analyte medium temperature of (20.0±0.2)°C and ambient air temperature of (20±5)°C, ppm…….. ±(0.0027+0.035*C*), where *C* is measured DOC value, ppm.

1.3.3 Margins of the analyzer's allowable complementary absolute error for DOC measurements, caused by deviation of analyte medium temperature from the normal one (20.0±0.2)°C per each ±5°C within operating temperature range from 0 to +70, ppm....……..... ± 0.013*C*.

1.3.4 Margins of the analyzer's allowable complementary absolute error for

DOC measurements, caused by deviation of ambient air temperature from the normal one (20±5)°C per each ±10°C within operating temperature range from +5 to +50 °C, ppm..... ± (0.0004 + 0.006*C*).

1.3.5 Analyte medium temperature measuring range, °C..... 0 to +70.

1.3.6 The analyzer's margin of allowable basic absolute measuring error for analyte medium temperature measurements at ambient temperature of (20 ± 5)°C, °C..... ± 0.3.

1.3.7 The analyzer's margin of allowable complementary absolute measuring error for analyte medium temperature measurements, caused by deviation of ambient air temperature from the normal one (20±5)°C per each ±10°C within operating temperature range from +5 to +50 °C, °C ..... ± 0.1.

1.3.8 The function of converting the measured DOC value, ppm, into the analyzer output current I_{output}, mA, corresponds to the following formulas:

$$I_{output} = 4 + 16\frac{C}{C_{range}} \quad (0.1)$$

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

$$I_{output} = 5\frac{C}{C_{range}} \quad (0.2)$$

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

where C_{range}, ppm is upper limit of the current output range corresponding to 5 mA for 0-5 mA current output and 20 mA for 4-20 mA current output (programmable measuring range).

1.3.9 Margins of the allowable basic reduced error in converting the measured DOC value into the analyzer output current at ambient air temperature of (20±5)°C, % of the current output range ..... ± 0.5.

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

1.3.11 Limit of allowable value of the analyzer's indication settling time at DOC measurements, $t_{0,9}$, min, maximum ..... 2.

1.3.12 Limit of allowable value of the analyzer's indication settling time at DOC measurements, t_y, min, maximum ..... 30.

1.3.13 Limit of allowable value of the analyzer's indication settling time at analyte medium temperature measurements, $t_{0,9}$, min, maximum ..... 7.

1.3.14 Limit of allowable value of the analyzer's indication settling time at

analyte medium temperature measurements, t_y, min, maximum ..... 20.

1.3.15 Analyzer reading instability for 8 h, ppm, max .....± (0.00135 + 0.0175 *C*).

1.3.16 If a measured DOC value exceeds the programmable measuring range upper limit, the ALARM indicator lights up, a warning signal is sounded, the relay dry contacts close and the flashing Overload! caption is displayed.

1.3.17 Any excess by a measured DOC value of the lower or upper threshold limit will cause the ▲ or ▼ symbol to be displayed and the relay dry contacts to close.

1.3.18 If a measured DOC value exceeds a temperature of 70°C, the ALARM indicator lights up, a warning signal is sounded, the relay dry contacts close and the flashing Overload! caption is displayed.

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

1.4 Product components

The analyzer is comprised of the following components:

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

– DOP-409 BP40.02.000 oxygen probe with a cable 5 m long;

– DOP-409 BP40.02.000-01 oxygen probe with a cable 5 m long and split inserted cable 5 to 95 m long;

– tool and accessory kit.

1.5 Design and operation

1.5.1 Analyzer general data

The dissolved oxygen analyzer is a microprocessor-based dual-channel measuring instrument designed for continuous DOC and temperature measurements via two measuring channels − A and B.

Measured DOC and temperature values are displayed on the screen of a digital LCD display (“the display”) that provides separate or simultaneous indication for two measuring channels.

Each channel has a programmable measuring range whose upper limit (from 10 to 20,000 ppb) corresponds to 5 mA for 0-5 mA current output and 20 mA for 4-20 mA current output. This enables convenient recording of measured values on the automatic recorder, using current outputs. A unified output signal (from 0 to 5 mA or from 4 to 20 mA) may be set separately for each channel.

The lower limit is always equal to DOC zero value. Range limit values are shown on the display screen.

Output currents are restricted by 5 mA for 0-5 mA current output and 20 mA for 4-20 mA current output.

Regardless of the set programmable range limit, the upper measuring range limit is used for display measurements in accordance with Table 1.2. If the values listed in Table 1.2 are exceeded, the measuring error is not normalized.

Oxygen probes are of flow-immersion type and may be taken away from the converting unit to a distance of up to 100 m.

Each sensor is fitted with a nonvolatile memory chip that has initially entered parameters of the heat sensor and records values of analyte water salinity and the inserted cable length, entered from the converting unit.

Automatic 2-point calibration is used for the analyzer:

– by oxygen-free (“zero”) solution;

– by oxygen of 100% humid air, allowing for atmospheric pressure.

Each of the analyzer channels has two freely programmable thresholds. If a measured DOC value falls outside the threshold limits the relay dry contacts will close and “▲”or “▼ ” symbol will be displayed for values in excess of the upper or lower limit, respectively.

If a measured DOC value falls outside the upper or lower limit of the programmable measuring range, the flashing ALARM indicator will come on and the flashing “Overload!” caption will appear on the display screen. Falling outside the range upper limit will trigger a sound signal and cause the relay dry contacts to close.

If a measured temperature value is beyond the range limits (0-70°C), ALARM indicator will come on, a sound signal will go off and the relay dry contacts will close. The “t°C overload!” indication will appear on the display screen.

In addition to unified output DC signals from 0 to 5 mA or from 4 to 20 mA, the analyzer menu may be used to set a unified output signal from 0 to 20 mA in each channel.

1.5.2 Oxygen measuring principle

The dissolved oxygen content in water is measured with an amperometric probe whose principle of operation is similar to that of a closed-type polarographic cell.

Electrodes are immersed into an electrolyte solution separated from the controlled medium by a membrane penetrable to oxygen, but impervious to liquid and water vapors. From the controlled medium, oxygen diffuses through the membrane into the thin layer of electrolyte between the cathode and membrane. It then enters into an electrochemical reaction on the cathode surface that is polarized by external voltage applied between the electrodes. When this happens, the sensor generates a

DC signal that is proportional to the dissolved oxygen concentration in the control medium at a fixed temperature.

The oxygen probe sensitivity (proportionality factor) increases sharply with a rise in the control medium temperature. To compensate for this dependency, the analyzer features automatic temperature correction using the heat sensor located in the same housing as the oxygen probe. A stable DC-powered transistor connected as a diode in the forward direction is used as a heat sensor. P-n junction voltage varies linearly as temperature changes and enters the temperature signal amplifier and the AD converter through the switchgear.

1.5.3 Analyzer components

1.5.3.1 Converting unit

The converting unit converts DOC and temperature signals from the sensor, measures atmospheric pressure, indicates DOC and temperature measuring results on the displayed screen, generates signals at current outputs, controls the relay dry contacts and transfers data to a PC.

The analyzer is powered from single-phase 220 V AC 50 Hz mains through a built-in power supply.

The layout of indicators and controls on the converting unit face panel is shown in Fig.1.1:

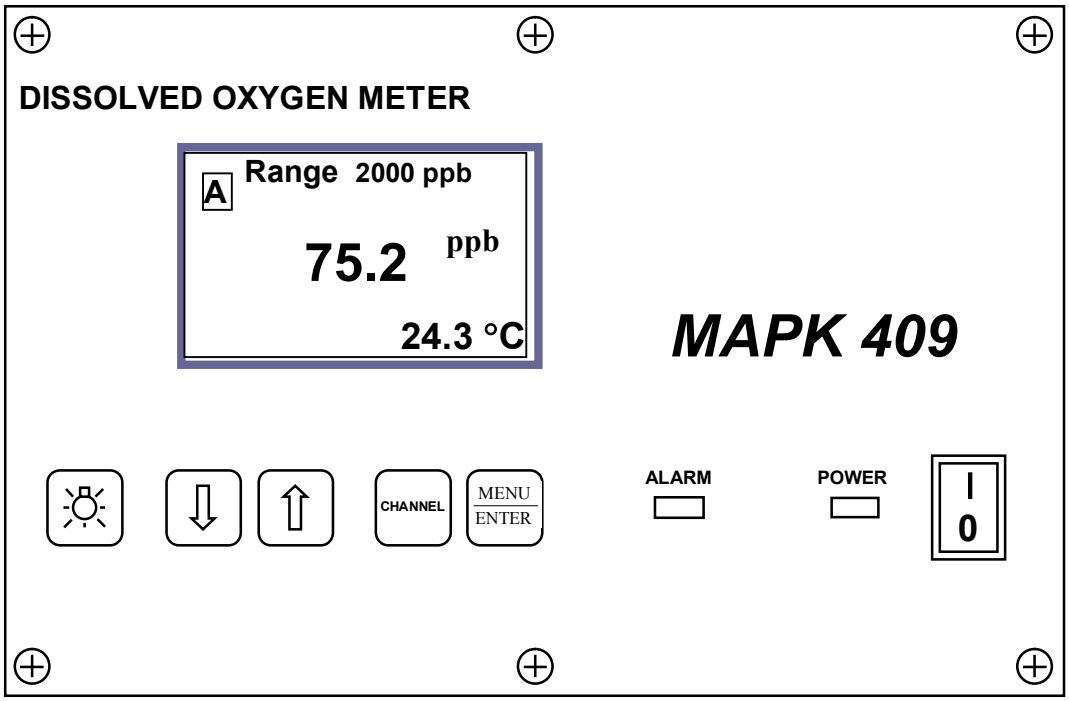


Fig.0.1 − *Layout of indicators and controls on the converting unit face panel*

– display screen designed to show measured DOC and temperature values and analyzer operating modes and to handle screen menus.

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

– The buttons **"⇓"** and **"⇑"** are used to move the cursor up and down the menu in the parameter checkout and changing mode and to change settings;

– The **"CHANNEL"** button is used to change channel indications (channel A, channel B or both) and to perform some operations in the **MENU** mode; ;

– The "$\frac{\text{MENU}}{\text{ENTER}}$" button is used to enter the menu (invoke the parameter checkout and changing mode) and confirm the values and operating modes selected in programming;

– The "**POWER**" button is used to switch the analyzer on and off;

– The "**POWER**" green LED is used to show that the indicator power is on;

– The "**ALARM**" red LED indicator is used to show an overloaded status of the programmable measuring range or a measured temperature value falling outside the range (from 0 to +70°C) and to indicate errors.

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 "**CHANNEL A**" and "**CHANNEL B**" connectors of the channel A and channel B respectively are used to connect oxygen probes to the converting unit;

– The "**CURRENT OUTPUT, SIGNALING, RS-485**" connector is used to hook up recording and actuating equipment and to hook up the analyzer to PC;

– The "⏚" terminal is used to connect protective earthing to the analyzer case.

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

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

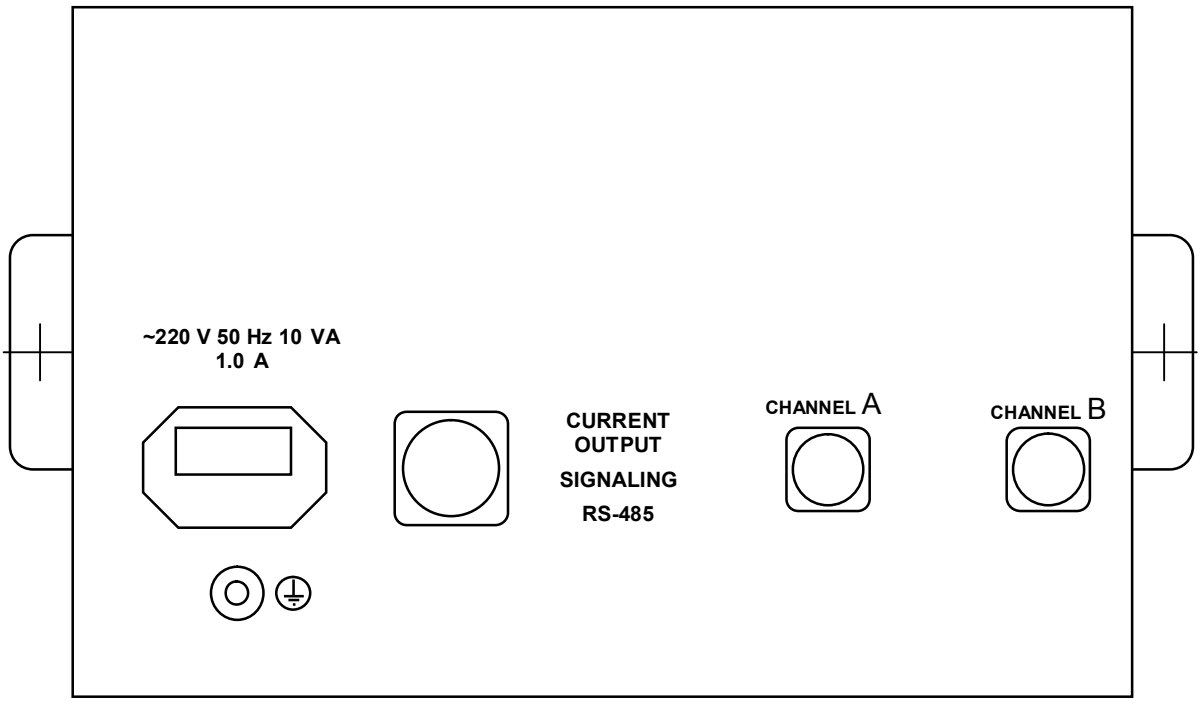


Figure 1.2 − Layout of connectors on the panel-mounted converting unit rear panel

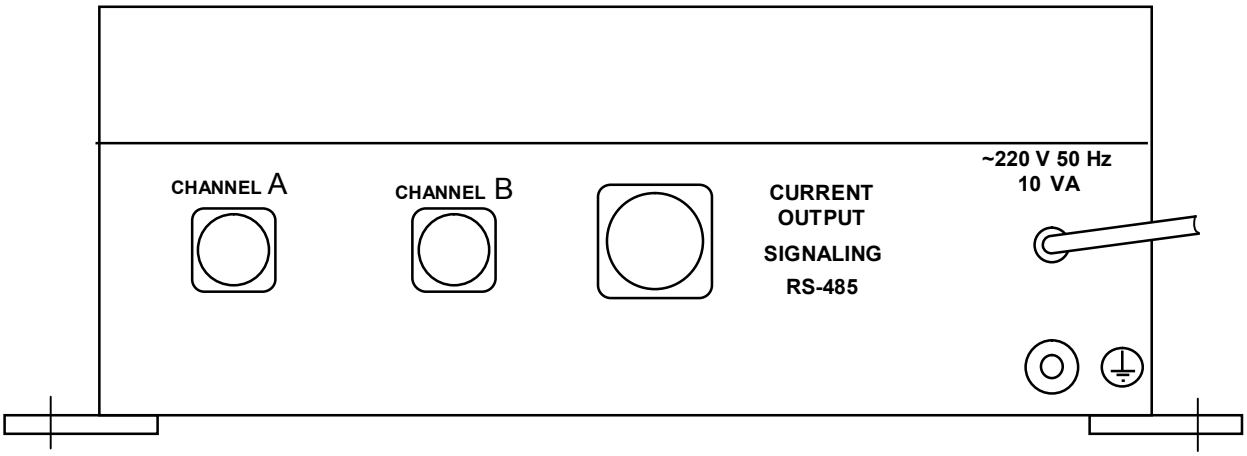


Figure 1.3 − *Layout of connectors the wall-mounted converting unit lower panel*

1.5.3.2 Dissolved oxygen probe

Fig.1.4 shows the basic parts of the oxygen probe whose case is made of acrylic plastic.

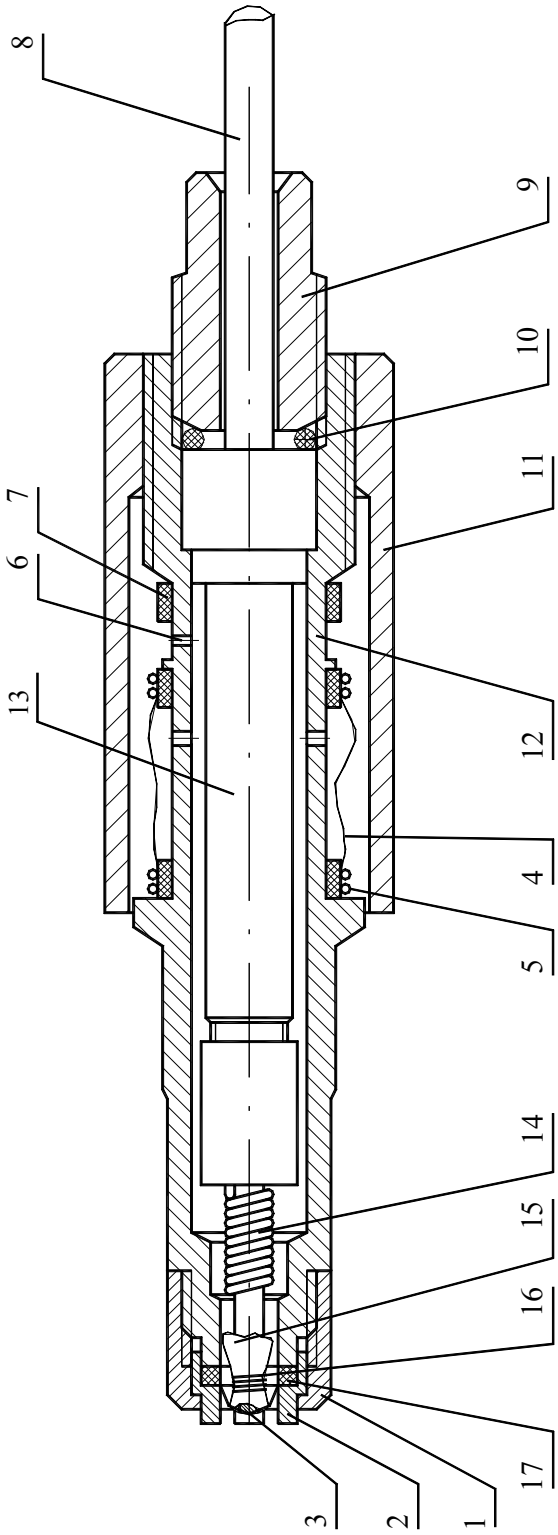
Platinum cathode 3 is soldered into the end of a glass electrode holder tube and the silver anode 14 is wound on the tube. The holder tube and shielded cable 8 are hermetically mounted into the internal case 13 that is inserted into basic case 12 and secured by nut 9 with sealing ring 10.

Secured to the holder tube with caprone thread 16 is teflon film 15 providing fixed clearance between the cathode and membrane.

The membrane unit is comprised of crown bush 2 and membrane with glued rubber ring 17 inserted into it. The membrane unit is installed on the basic case and secured with coupling nut 1.

The basic case also features diaphragm 4 designed to equalize pressure outside and inside the probe. Bands of line 5 secure the diaphragm to the basic case and seal the sensor inside the space filled with electrolyte. Electrolyte is filled through ports 6 in the basic case, closed by rubber ring 7 in the operating position.

Protective cap 11 is intended to protect the diaphragm against damage and also has decorative use.



1 – coupling nut, 2 – crown bush, 3 – platinum cathode, 4 – diaphragm, 5 – diaphragm coupling, 6 – electrolyte filling ports, 7 – rubber ring, 8 – cable, 9 – nut, 10 – rubber ring, 11 – protective cap, 12 – basic case, 13 – internal case, 14 – silver anode, 15 – teflon film, 16 – caprone thread, 17 – rubber ring and membrane assembly.

Fig.0.4 – Probe design

1.5.4 Measurement screens

1.5.4.1 Types of measurement screens

The analyzer has the following measurement screens:
- single channel (A or B) measurement screen as shown in Fig.1.5;
- double channel (A and B) measurement screen as shown in Fig.1.6.

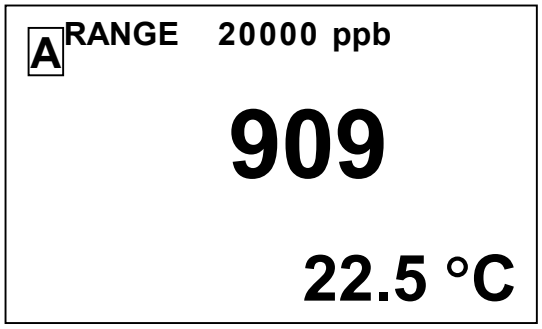


Fig.0.5

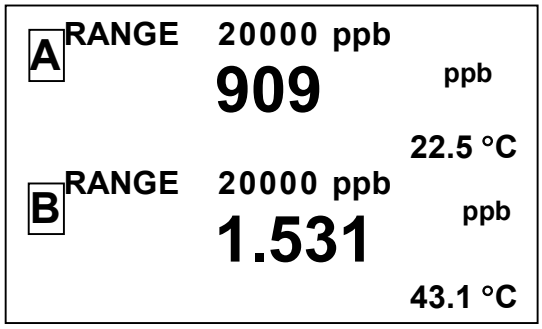


Fig.0.6

Toggling between channel A and B measurement screens is by pressing the "**CHANNEL**" button, this will display A or B measurement screen, or both A and B screens simultaneously .

Indicated on the screens are channel names (A or B), upper and lower limits of programmable measuring ranges and measured DOC and temperature values.

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

1.5.5 Types of setting checkout and changing mode screens (**MENU** mode)

1.5.5.1 General information on handling the **MENU**

The analyzer's parameters are checked and changed using the screen menus.

The **MENU** mode is entered from the measuring mode by pressing the "$\frac{\text{MENU}}{\text{ENTER}}$" button.

The analyzer 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 show the status of individual channel parameters and are shown in Fig.1.7.

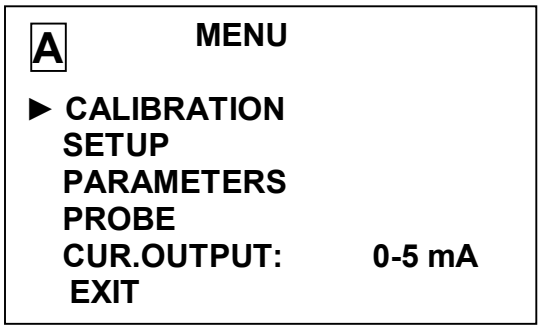


Fig.0.7

MENU [A] [B] screen shows the analyzer's parameters common for both measuring channels and is shown in Fig.1.8.

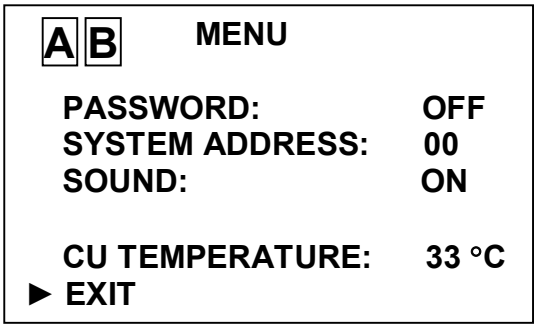


Fig.0.8

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 "$\frac{\text{MENU}}{\text{ENTER}}$" button.

To exit **MENU** screens, set the marker at **EXIT** and press the "$\frac{\text{MENU}}{\text{ENTER}}$" button.

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

As required, the analyzer allows the user to change numerical values in menu lines or enter new ones. This concerns, for example, selection of a programmable measuring range, entry of threshold values etc.

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

Right scrolling is by the "$\frac{\text{MENU}}{\text{ENTER}}$" 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 digit 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 digit 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.1.9)

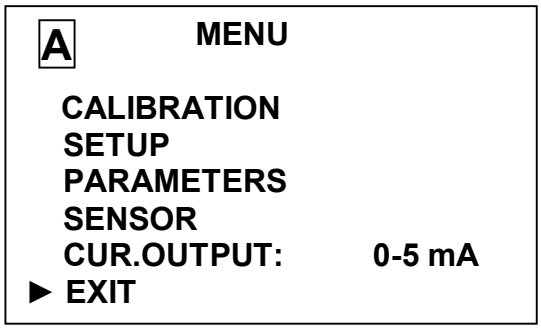


Fig.0.9

► **CALIBRATION** is a menu item used to select the CALIBRATION sub-menu (see 2.3.4, 2.3.5, 2.3.6).

► **SETUP** −is a menu item used to view and change the upper limit of the programmable measuring range and to view and change minimum and maximum threshold values.

The screen is as shown in Fig.1.10.

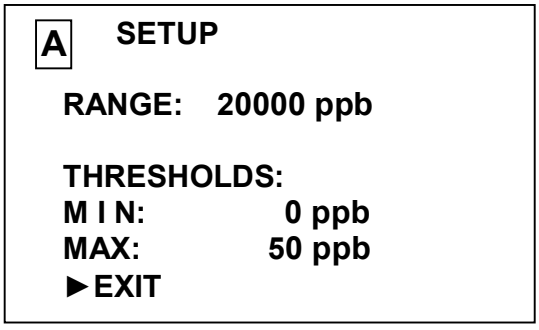


Fig.0.10

The upper limit of the programmable measuring range may be set within 10 to 20,000 ppb.

Threshold setting range:

– **MIN** – from 0 to 1,999 ppb;
– **MAX** – from 1 to 20,000 ppb;

The entered **MAX** threshold value must be greater than the **MIN** threshold value by no less than 1 ppb.

Once all the required values are set, press the "$\frac{\text{MENU}}{\text{ENTER}}$" button.

This action will cause the pH-meter confirmation screen as shown in Fig.1.11 to be displayed.

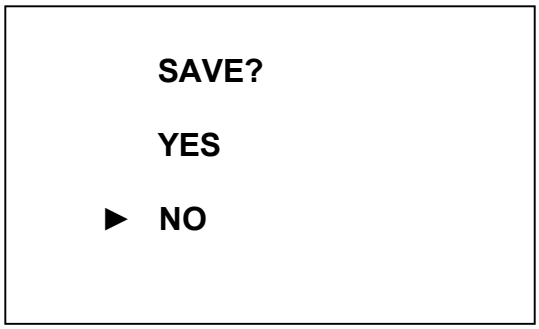


Fig.0.11

Use "⇓"/"⇑" buttons to set the "►" marker at **YES** and press the "$\frac{\text{MENU}}{\text{ENTER}}$" button.

The analyzer will change over to the **MENU** mode, saving the set values of the upper limit of the programmable measuring range and new threshold values.

Note: The analyzer is supplied with the set upper limit of the programmable measuring range (20,000 ppb) and the following threshold settings:

– **MIN** is 0 ppb;
– **MAX** is 20,000 ppb.

► **PARAMETERS** is a menu item meant to view the thermo channel parameters, enter or change values of analyte water salinity and of the extension cable length.

The screen is as shown in Fig.1.12.

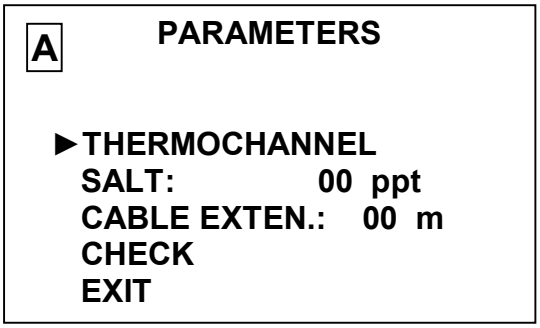


Fig.0.12

THERMOCHANNEL is a submenu item intended to view heat sensor parameters (shift, mV, and slope, mV/°C) entered into the sensor chip nonvolatile memory.

The screen is as shown in Fig.1.13.

Temperature sensor parameter data is housekeeping and only used to adjust the analyzer.

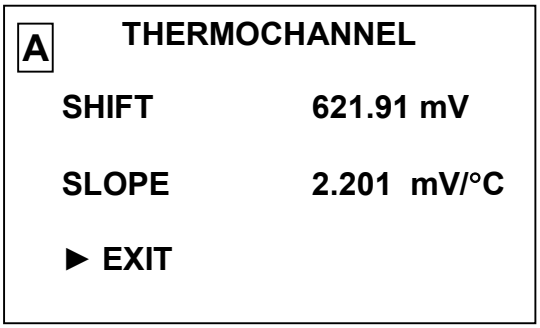


Fig.0.13

SALT: – a submenu item intended to enter a new salinity value.

Sample salinity value range – 0 to 99 ppt.

Note: The analyzer is supplied with the zero salinity value entered into the sensor chip nonvolatile memory.

CABLE EXTEN.: is a submenu item intended to enter the inserted cable length value. Connect the inserted cable and enter an inserted cable length value in meters (the same procedure as used for setting a programmable measuring range).

The range of inserted cable length values is from 5 to 95 m.

Note: If the analyzer delivery set includes an inserted cable, the inserted cable length value is entered into the sensor chip nonvolatile memory. When the sensor is connected to any channel, its readings will allow for the previously entered value of inserted cable length. The inserted cable length value need not be additionally entered into the analyzer memory.

CHECK is a service submenu item designed to view the analyzer channel real parameters.

The screen is as shown in Fig.1.14.

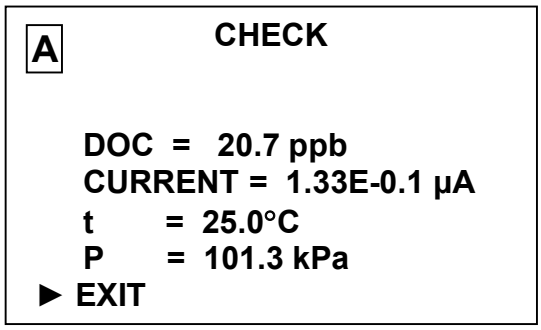


Fig.0.14

Data displayed:

– analyzer readings;
– sensor current (in engineering format);
– measured temperature;
– measured atmospheric pressure.

These data cannot be changed or deleted.

► **PROBE** is a menu item intended to change over to the sensor parameter checkout mode.

The screen is as shown in Fig.1.15.

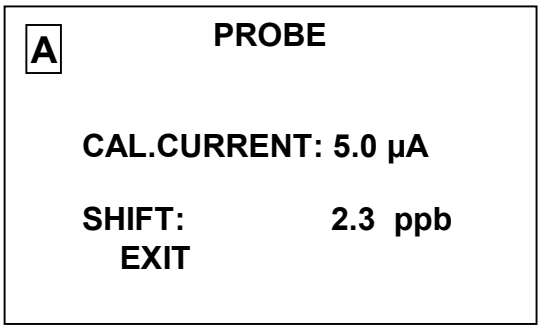


Fig.0.15

The display will show parameters of the sensor DOC parameter measuring channel, entered into the sensor chip nonvolatile memory:

– sensor current in µA measured during calibration by atmospheric air referred to 20°C and a normal atmospheric pressure of 101.325 kPa (CAL.CURRENT:);

– analyzer readings in ppb, with the sensor immersed in “zero” solution during calibration (SHIFT:).

A serviceable sensor parameters must be within the following range:
– CAL.CURRENT: from 1.4 to 4.9 μA;
– SHIFT: from –3 to +3 ppb.
The same procedure is used to check and change parameters in channel B.

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

The **MENU [A] [B]** screen (Fig.1.16) enables the user to change analyzer parameters common for both channels.

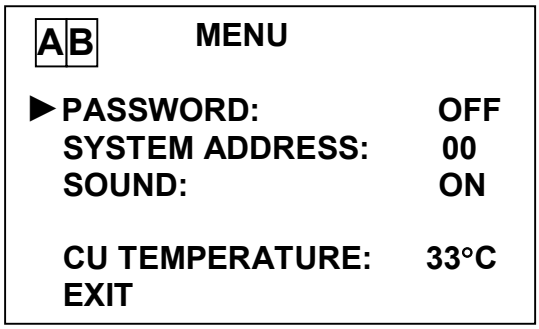


Fig.0.16

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

► **PASSWORD: ON** is a menu item intended to restrict access to changing analyzer 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 analyzer will request to enter the password (**12**) for changeover from the measuring mode to the **MENU** mode.

The screen as shown in Fig.1.17 below will appear.

Fig.0.17

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 "$\frac{\text{MENU}}{\text{ENTER}}$" button. As the second digit starts flashing on the screen, set the password value (**2**) and press the "$\frac{\text{MENU}}{\text{ENTER}}$" button.

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

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

► **SOUND**: is a menu item intended to disable the analyzer alarm signal, if necessary.

► **CU TEMPERATURE:** is a menu item intended to indicate the CU case inside temperature.

1.5.5.5 Warning and failure screens

Whenever the screens as shown in figures 1.18 through 1.21 appear, refer to 2.5 of this Operation Manual.

The screen as shown in Fig.1.18 will appear if the probe is not connected to channel A.

Fig.0.18

The screen as shown in Fig.1.19 will appear if the amplifier unit is not responding.

Fig.0.19

The screen as shown in Fig.1.20 with blinking "**M**" symbol appears in case of failure in channel A probe memory.

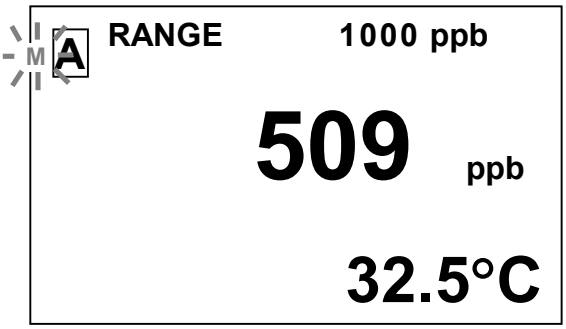


Fig.0.20

The screen as shown in Fig.1.21 with blinking "**M**" symbol appears in case of failure in channel A and B probe memory.

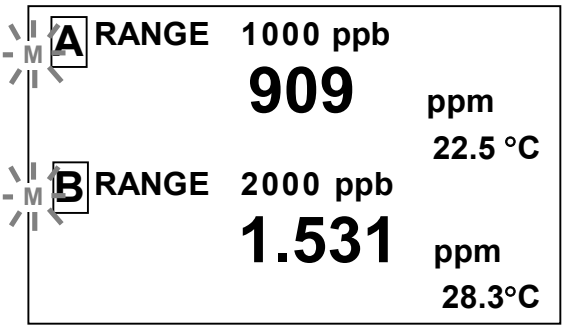


Fig.0.21

If, during graduation, the warning screens as shown in figures 1.22 through 1.23 appear, refer to 2.5 of this Operation Manual.

In order to go into the measuring mode from these screens, press the "$\frac{\text{MENU}}{\text{ENTER}}$" button.

The warning screen as shown in Fig.1.22 will appear in case of failure during calibration by air oxygen (probe current under 1 μA at 20°C).

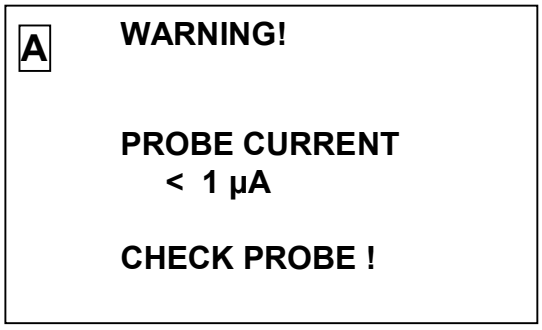


Fig.0.22

The warning screen as shown in Fig.1.23 will appear in case of failure during calibration by air oxygen (probe current over 10 µA at 20°C).

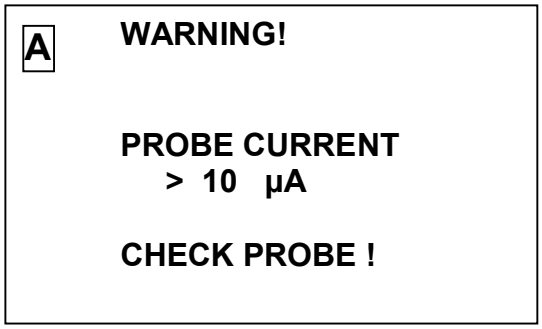


Fig.0.23

On the warning screens as shown in Fig.1.24 through 1.26 the OVERLOAD! and blinking captions will disappear after the overload on the indicated parameter is corrected.

The warning screen as shown in Fig.1.24 appears when a measured DOC value falls outside the upper limit of the programmable measuring range. It is necessary to set the appropriate limit of the programmable current output range.

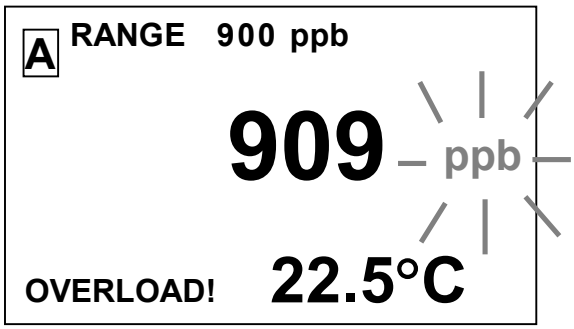


Fig.0.24

The warning screen as shown in Fig.1.25 appears when a measured value of analyte medium temperature exceeds 70°C.

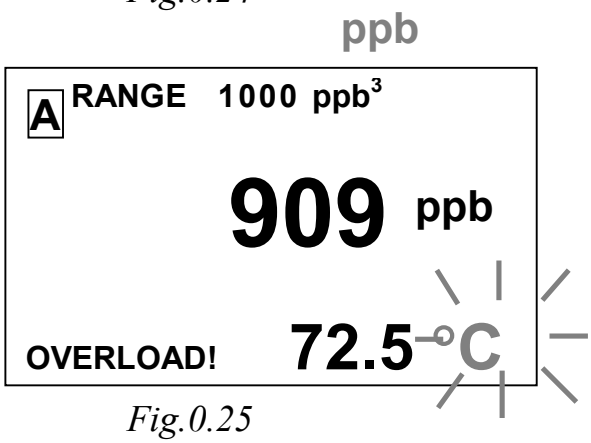


Fig.0.25

The warning screen as shown in Fig.1.26 appears when a measured DOC value exceeds the measuring range upper limit in channel A and when measured temperature value exceeds 70°C in channel B.

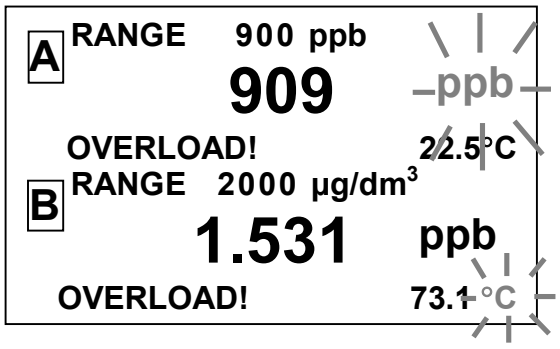


Fig.0.26

When the warning screen appear as shown in figures 1.27 through 1.29, the "▲" or "▼" symbols will disappear after excess by the measured DOC value of the threshold limits is corrected.

The warning screen as shown in Fig.1.27 appears if the measured DOC value falls outside the lower threshold.

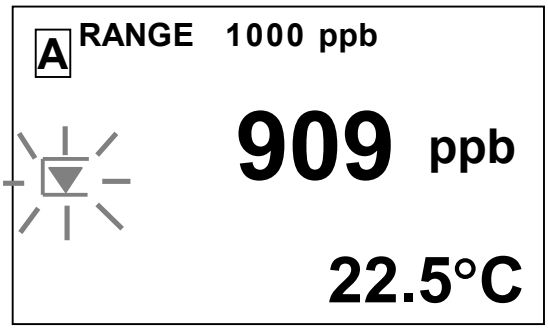


Fig.0.27

The warning screen as shown in Fig.1.28 appears if the measured DOC value falls outside the upper threshold.

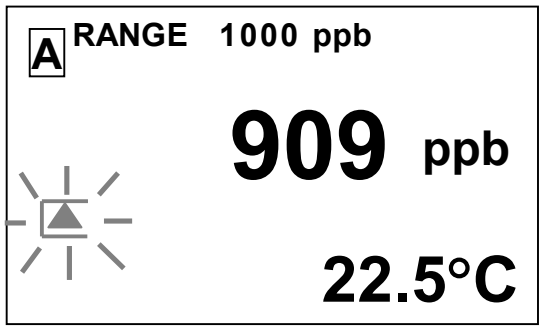


Fig.0.28

The warning screen as shown in Fig.1.29 appears if the DOC value measured in channel A falls outside the lower threshold and that measured in channel B falls outside the upper threshold.

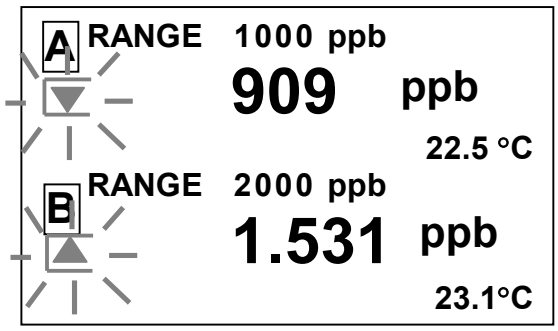


Fig.0.29

1.6 Measuring instruments, tools and accessories

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

- KH-100-19/26 flask;
- beaker;
- sodium (potassium) hydroxide;
- hydroquinone.

2 INTENDED USE

2.1 Operating limitations

2.1.1 Apart from heat power engineering applications for DOC control in deaerated water, the analyzer may be used for measurements in surface and waste waters, including turbid and colored water containing organic contaminants. Permissible concentrations of some of the components affecting measuring results are provided in 1.2.6.

2.1.2 The analyzer must be installed so as to prevent ingress of water into the MAPK-409 analyzer converting unit as its case has IP30 protection.
The MAPK-409/1 analyzer converting unit has a case with IP65 protection.

2.1.3 The probe is designed for use in a temperature range from 0 to +70°C. It withstands temperatures of up to 100°C for short periods of time (up to 15 min), but extended overheating may cause deformation of the probe case and its failure.

2.1.4 When using the analyzer, protect the oxygen probe against impacts as it comprises glass components.

2.2 Safety precautions

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

2.2.2 The analyzer 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.

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

2.2.4 The analyzer 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.

A shielded cable is used to connect sensors to the converting unit.

2.3 Analyzer setting-up procedures

2.3.1 Receipt of analyzer

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

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

2.3.2 Converting unit setting-up procedure

2.3.2.1 Converting unit installation

Install the converting unit so that the de-energizing of the analyzer is not hindered.

The layout of CU attachment holes provided in the panel for a panel-mounted converting unit is shown in Fig.2.1.

The converting unit of a panel-mounted analyzer is installed on the panel inside. The plate included in the panel-mounted analyzer delivery set is installed on the panel face.

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.2.2.

Attachment is with M4 screws included in the delivery set.

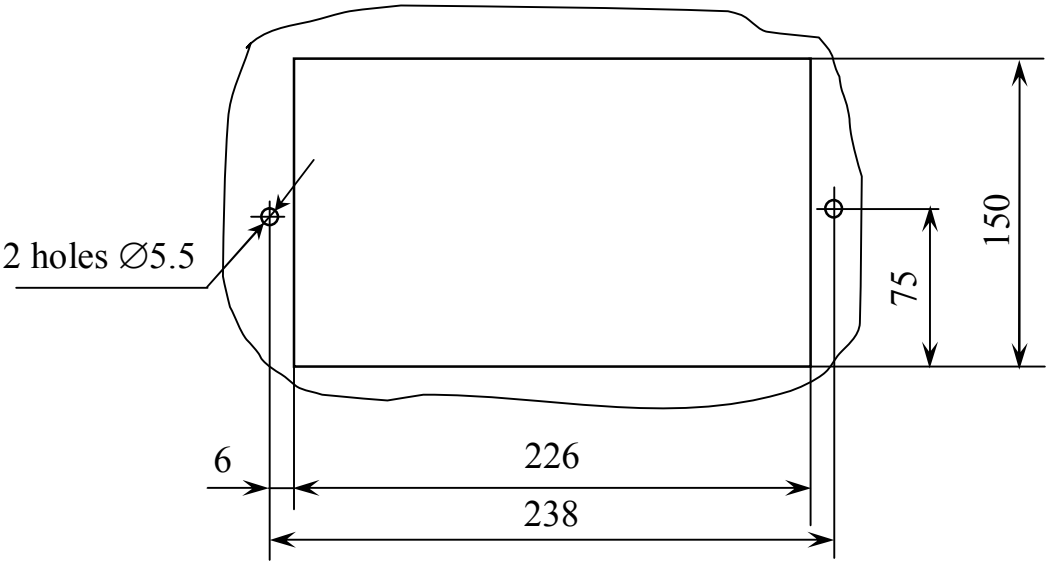


Fig.2.1 – Layout of attachment holes for the converting unit of the MAPK-409 panel-mounted analyzer

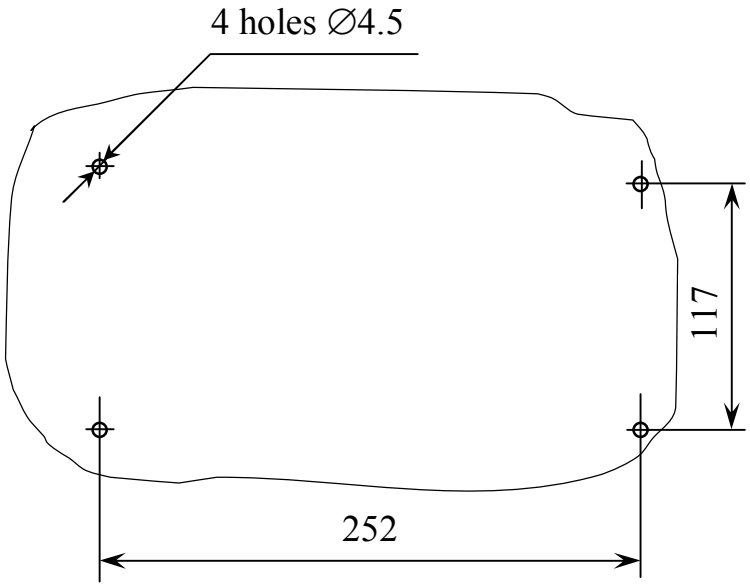


Fig.2.2 – Layout of holes for vertical attachment of the converting unit of the MAPK-409/1 wall-mounted analyzer

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.

2.3.2.2 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.2.3.

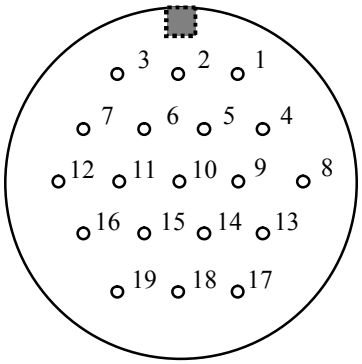


Fig.2.3

2.3.2.3 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.

2.3.2.4 RS-485 interface connection

Connection of the PC's RS-485 port to the converting 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 converting unit before connecting them.

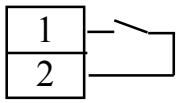
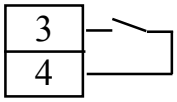
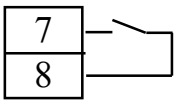
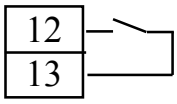
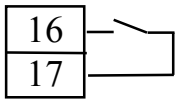
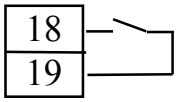
Rate of exchange – 19,200 bps.
Data communications protocol – as per Appendix B.

2.3.2.5 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 DOC and analyte medium temperature values exceed the specified limits, the relay dry contacts close the circuits between the connector, as per Table 2.3.

Table 2.3

Controlled parameter	Channel	Controlled parameter value	No. of contacts, between which circuit is closed
Measured DOC value, ppb	A	excess of programmable measuring range limits	
Measured temperature value, °C		over 70 °C	
Measured DOC value, ppb	B	excess of programmable measuring range limits	
Measured temperature value, °C		over 70 °C	
Measured DOC value, ppb	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.

2.3.3 Oxygen probe setting-up

2.3.3.1 The oxygen probe in the analyzer set is delivered without electrolyte. Before use, therefore, it must be filled with electrolyte from the delivery set in accordance with 2.5.3.

Connect the probe to one of the converting unit channels.

If the delivery set includes another probe it must also be filled with electrolyte and connected to the other channel.

Turn on the analyzer and immerse the probes, membrane down, into distilled water for 8 h. Polarizing voltage will be supplied to the probe to stabilize the electrode system.

IMPORTANT: De-energize the converting unit before connecting and disconnecting the probes.

2.3.3.2 Probe calibration is performed with an oxygen-free ("zero") solution.

Proceed as follows to prepare the solution:

– prepare an alkali solution (KOH or NaOH) with a concentration of 5 ppt, using distilled or boiled water;

– pour it into a 0.3-0.5 dm^3 vessel to a minimum level of 50 mm; add 0.3-0.5 g of hydroquinone and stir.

The obtained solution is good for use for one month if kept in a tightly closed container of dark glass. If kept opened, it becomes unfit for use after 2 to 3 hours.

Reagents intended for calibration must be freshly prepared, otherwise the time for attainment of zero readings during analyzer checkout may extend and the GRADUATION ERROR N2 indication may come on during probe calibration against "zero" solution.

2.3.3.3 At the start of all calibration types the analyzer with connected probes must have been on for at least 3 h, because if the instrument has been off for a long time the probe rate of response to oxygen may decrease substantially.

Calibration should be carried out with the inserted cable connected, if it is included in the delivery set. After the probe is connected the inserted cable length value will be displayed in the **PARAMETERS** menu**,** line CABLE EXT., of the channel, to which the probe is connected.

If a membrane or teflon film has been replaced, the probe must be held in distilled water for at least 8 h before calibration to stabilize tension of the membrane or teflon film.

2.3.4 Checking the probe and null solution calibration

2.3.4.1 The check of the probe against the null solution for checking the response speed of the probe and its ability of measuring the null is the basic one of the prompt checks.

Such checks become necessary:

– after the membrane unit replacement;
– after the Teflon film replacement;
– when you have doubts about correct measuring of the analyzer;
– after the analyzer has been out of operation for a long period.

The probe check includes:
– the probe response on oxygen;
– looping of the probe.

2.3.4.2 Probe response on oxygen check

To do this:
– Prepare null solution following instructions of 2.3.3.2;
– Take the probe out of water, shake water drops off the membrane and keep the probe in the air at 15-30° decline as shown in Fig. 2.4;

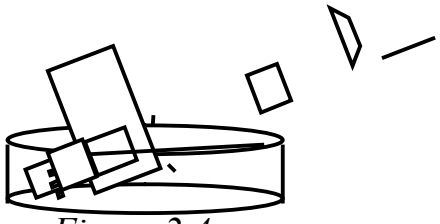


Figure 2.4

– Keep the probe in the air for 5 minutes: the readings of the probe must fall within 3 to 15 ppm;
– Dip the probe into the null solution, membrane down, as shown in Fig. 2.5, stirring it slightly to eliminate air-bubbles that can possibly accumulate on the membrane. The reading of the indicator must gradually drop down;
– Keep the probe in the null solution for 30 minutes.

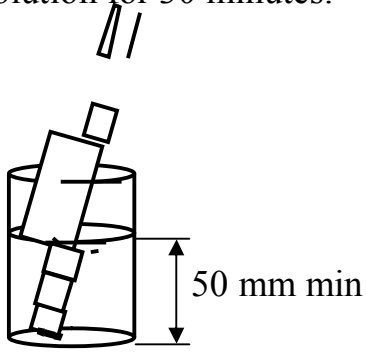


Figure 2.5

If in 30 minutes time the null solution indication does not drop below 50 ppb, go over to 2.5 (Troubleshooting. Table 2.5).

If the indication falls below 3 ppb, you need to go over to air oxygen calibration (see 2.3.5).

If in 30 minutes time the null solution indication is above 3 ppb, go over to looping of the probe (see 2.3.4.3) to enhance the oxygen response of the probe.

2.3.4.3 Looping of the probe

To do this:

– Turn on the probe in the measuring mode;

– Prepare null solution following instructions of 2.3.3.2;

– Dip the probe into the null solution, membrane down, as shown in Fig. 2.5, stirring it slightly to eliminate air-bubbles that can possibly accumulate on the membrane;

– keep the probe in the null solution for 15 minutes, then take it out and keep in air for 5 minutes previously shaking the water drops off the membrane;

– Repeat the null solution – air cycle for 3-4 times;

– Dip the probe into the null solution again;

– Take the reading of the probe in 30 minutes.

The normal tolerance of the probe null solution readings is ± 3 ppb; this means that the meter's sensitivity and accuracy correspond to the requirement of the specification. After that you need go over to the air oxygen calibration (section 2.3.5).

If necessary, you may also carry out an additional null solution calibration (section 2.3.4.4) to zero set the readings.

If the null readings are higher than 3 ppb, you need turn to section 2.5 of the Operation Manual (Troubleshooting. Table 2.5), or carry out the null solution calibration (see 2.3.4.4).

2.3.4.4 Null solution calibration

Null solution calibration enables you to correct the zero setting of the probe within narrow limits (± 3 ppb). The stability of the probe performance is very reliable, that is why you will only need null solution calibration in exceptional cases.

To prepare for this:

– prepare null solution following instructions of 2.3.3.2;

– keep the probe in air for 5 minutes, and then dip the probe into the null solution, membrane down, as shown in Fig. 2.5, stirring it slightly to eliminate air-bubbles that can possibly accumulate on the membrane;

– turn on the channel mode to which the probe is connected (e. g., channel A).

Carrying out the null solution calibration

1 Pressing $\frac{\text{MENU}}{\text{ENTER}}$ recall **MENU [A]**.

2 Choose the **CALIBRATION** line and press $\frac{\text{MENU}}{\text{ENTER}}$ and the probe will switch to **CALIBRATION** screen. The screen as follows will appear (Fig. 2.6).

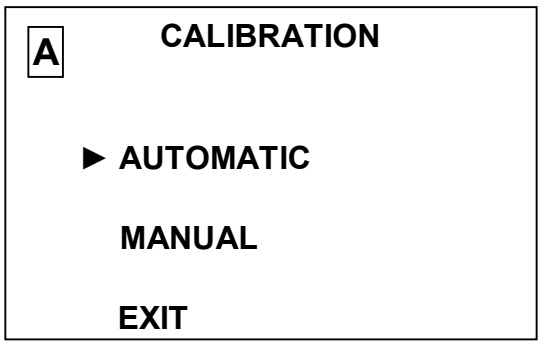


Figure 2.4

Choosing **AUTOMATIC**, press $\frac{\text{MENU}}{\text{ENTER}}$. The screen as shown in Fig. 2.7 will appear.

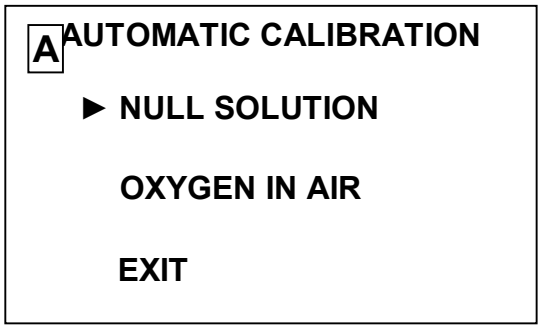


Figure 2.7

Choose NULL SOLUTION line and pressing $\frac{\text{MENU}}{\text{ENTER}}$ switch to null solution calibration. The following screen will appear (Fig. 2.8).

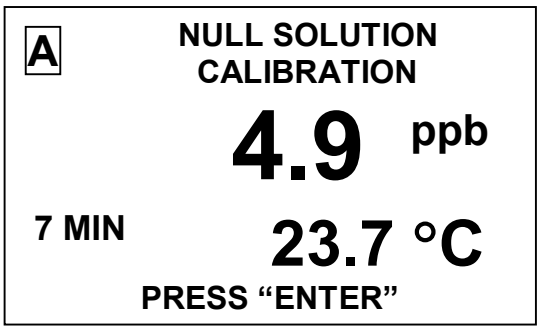


Figure 2.8

The bottom left of the screen shows the timer as soon as the null solution calibration has been turned on. DOC readings must go down and in 30 minutes Z_0, must not be higher than 3.0 ppb.

3 Having waited for at least 30 minutes, press $\frac{\text{MENU}}{\text{ENTER}}$, and the probe will perform null solution calibration. You will switch to the following screen (Fig. 2.9).

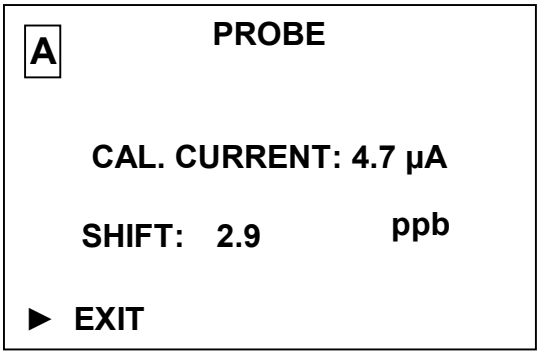


Figure 2.9

If $\frac{\text{MENU}}{\text{ENTER}}$ is not pressed in 30 minutes time, the analyzer will automatically exit the null solution calibration in 35 minutes and switch to the screen as in Fig. 2.9.

4 Press $\frac{\text{MENU}}{\text{ENTER}}$; the to the screen will appear as shown in Fig. 2.10.

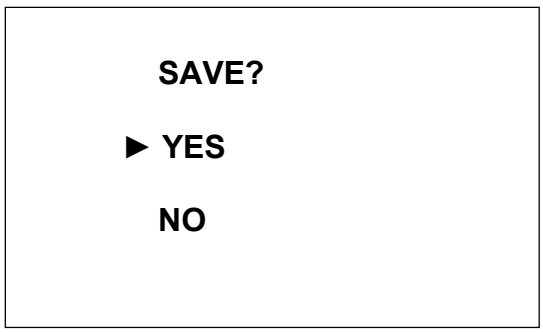


Figure 2.10

5 Choose **YES** and press $\frac{\text{MENU}}{\text{ENTER}}$; the probe will switch to the screen as in Fig. 2.11.

If you choose **NO** and press $\frac{\text{MENU}}{\text{ENTER}}$, the probe will switch to the **CALIBRATION** menu (Fig. 2.6).

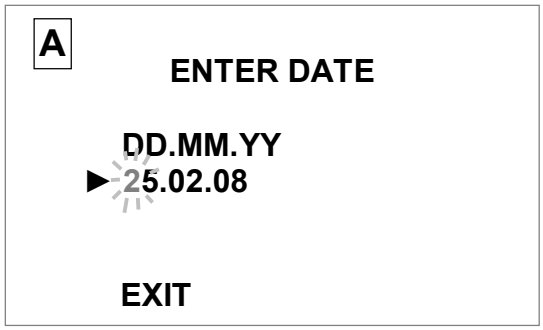


Figure 2.11

6 Enter the date of calibration, choose **EXIT** and press $\frac{\text{MENU}}{\text{ENTER}}$, and the analyzer will switch to **MENU [A]**.

As a result of the null solution calibration all readings of the analyzer will shift, and a new DOC reading will appear when the analyzer will switch to measuring mode:

– 0.0; if -3.0 ppb ≤ Z_0 ≤ 3.0 ppb;
– Z_0−3.0; if Z_0 > 3.0 ppb;
– Z_0+3.0; if Z_0 < -3.0 ppb,

where Z_0 is the reading of the analyzer in the null solution in 30 minutes after the start of the calibration.

2.3.5 Atmospheric oxygen calibration (**automatic**)

Air oxygen calibration is carried out:
– after the electrode system of the probe has been stabilized (2.3.3.1);
– after the membrane has been replaced;
– after the Teflon film has been replaced;
– if you doubt about the correctness of the readings;
– each quarter.

Note: air oxygen calibration may be carried out at atmospheric temperature 15 °C plus to 55 °C plus. The best way to carry out this calibration is at the room temperature.

To carry out the calibration at the room temperature:

– turn on the channel mode to which the probe is connected (e. g., channel A);

– dip the probe completely into the water at the room temperature for 20 minutes;

– rinse the probe in some distilled water;

– shake water drops off the probe membrane and put it into a conic bottle KH-100-19/26 or similar with a 10-15 mm layer of water at the bottom as shown in Fig. 2.12 (the probe membrane must not touch the water);

– place the bottle at a declining angle of 15-30° to drain the residual water off the membrane.

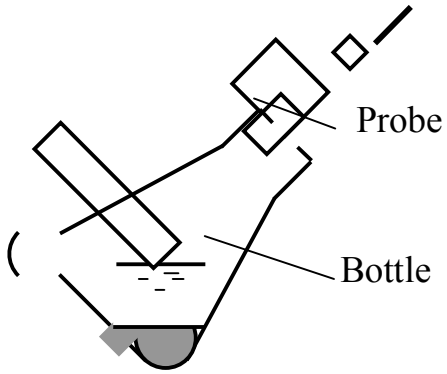


Figure 2.5

Atmospheric oxygen calibration

1 By pressing $\frac{\text{MENU}}{\text{ENTER}}$ switch to **MENU [A]**.

2 Choose **CALIBRATION** and press $\frac{\text{MENU}}{\text{ENTER}}$, and the analyzer will switch to **CALIBRATION** menu; the screen will appear as shown in Fig. 2.6.

3 Choose **AUTOMATIC** line and press $\frac{\text{MENU}}{\text{ENTER}}$. The screen will appear as shown in Fig. 2.13.

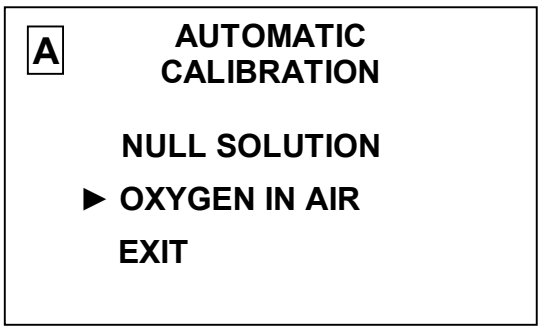


Figure 2.13

4 Choose **AIR OXYGEN** and press $\frac{\text{MENU}}{\text{ENTER}}$. The anayzer will switch to air oxygen calibration, and the screen will appear as shown in Fig. 2.14.

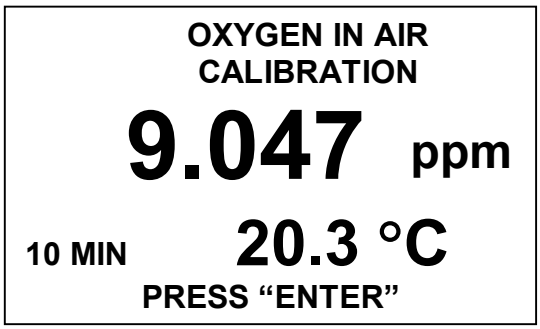


Figure 2.14

The left bottom of the screen will show the time passing from the moment of the start of the air oxygen calibration.

5 In 10 minutes, press $\frac{\text{MENU}}{\text{ENTER}}$. The analyzer will exit from the air oxygen calibration mode and switch to the probe parameter review. The probe will switch to the screen as shown in Fig. 2.15.

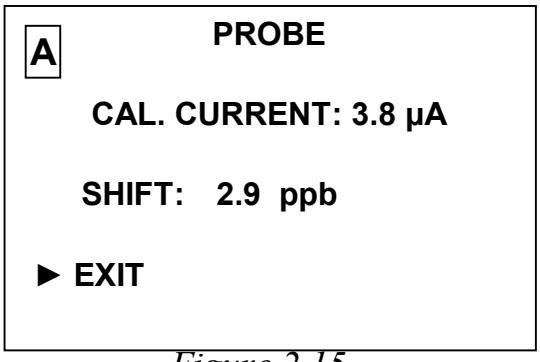


Figure 2.15

If $\frac{\text{MENU}}{\text{ENTER}}$ is not pressed in 10 minutes, in 15 minutes after the air oxygen calibration started, the probe will automatically quit the air oxygen calibration mode and switch to the screen as in Fig. 2.15.

6 Press $\frac{\text{MENU}}{\text{ENTER}}$ once again, and the probe will switch to the screen as shown in Fig. 2.16.

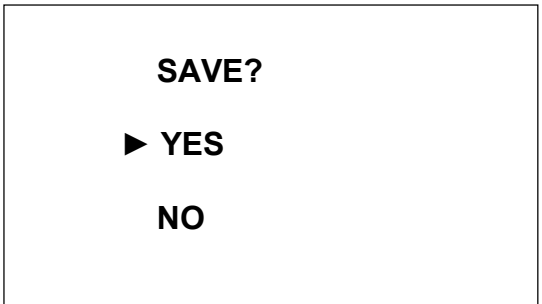


Figure 2.16

7 Choose **YES** and press $\frac{\text{MENU}}{\text{ENTER}}$. The probe nonvolatile memory will record the new probe parameters after the calibration and new calibrating coefficients. The probe will switch to the screen as shown in Fig. 2.11.

If you choose **NO** and press $\frac{\text{MENU}}{\text{ENTER}}$; the analyzer will switch to the **CALIBRATION** menu (Fig. 2.6) with its old calibrating coefficients.

8 Enter the date of calibration, choose **EXIT** and press $\frac{\text{MENU}}{\text{ENTER}}$, and the analyzer will switch to **MENU [A]**.

9 In **MENU [A]** choose **EXIT** and press $\frac{\text{MENU}}{\text{ENTER}}$; the analyzer will switch to the Channel A measuring mode.

The probe readings with accuracy ± 0.5 % are calculated with the following formula:

$$C = \frac{P_{atm}}{101.325} \cdot \alpha \cdot Co_{2air}(t),$$

where P_{atm} is atmospheric pressure in KPa;

α is the salinity coefficient;

$Co_{2air}(t)$ is the oxygen solubility in water at temperature *t*, °C in accordance with the data from Appendix A; temperature measured by the probe.

If you choose **NO** and press $\frac{\text{MENU}}{\text{ENTER}}$, the analyzer will switch to **MENU [A]** saving old calibrating coefficients in nonvolatile memory.

As a result, alarm messages may be generated in the screen as shown in Figs. 1.22 and 1.23. This can testify to the probe abnormality (see 2.5, Troubleshooting).

If after the above alarm generation you press $\frac{\text{MENU}}{\text{ENTER}}$, the probe will switch to the measuring mode with old calibrating coefficients.

If after the calibration in Channel A you switch the calibrated probe to Channel B, you will not need another calibration as the calibration has been preserved in the probe nonvolatile memory.

In a similar way, calibrate the second probe with the null solution and air oxygen if the delivery set includes two meters.

After the calibration, the probe is available for use.

Notes

1 It is allowable to carry out air oxygen calibration without the bottle by placing the probe in the air at 15-30° declination, but inaccuracy of DOC measurements may increase.

2 To decrease the additional inaccuracy of the analyzer caused by temperature variations, the probe temperature when performing the air oxygen calibration must be close to that of the measured medium.

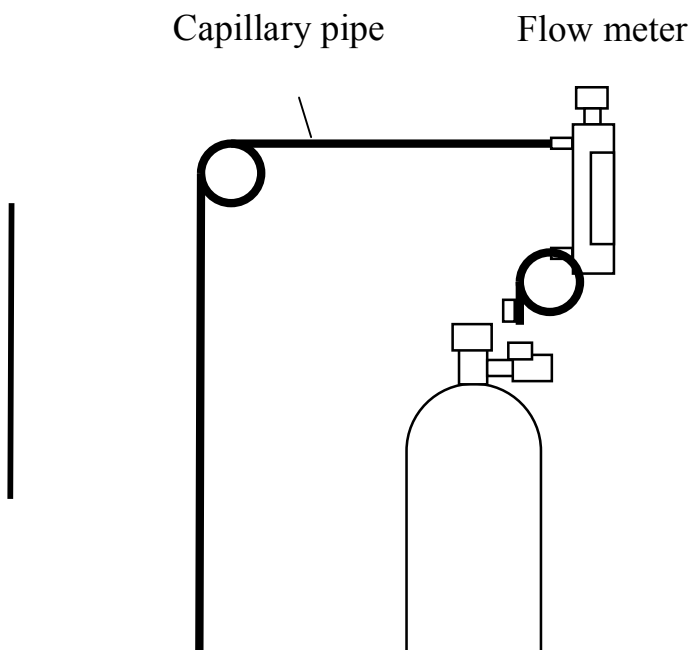
For this purpose, decline the bottle with the probe at 15-30° prior to calibration, and put either into the thermostatic oven (for temperatures higher than the room temperature) or into the low-temperature chamber (for temperatures lower than the room temperature) for at least 2 hours and perform the calibration in accordance with 2.3.5.2.

2.3.6 Analyzer GSO CGM calibration against control gas mixture or against a solution with known DOC, % (**manual**)

We recommend that both in the control gas mixture calibration of the probe and in the calibration against a solution with known DOC the oxygen content must be close to the supposed oxygen content in the medium to be analyzed, which will reduce inaccuracy.

2.3.6.1 Control gas mixture calibration

To carry out the calibration, assemble the unit as shown in Fig. 2.17.



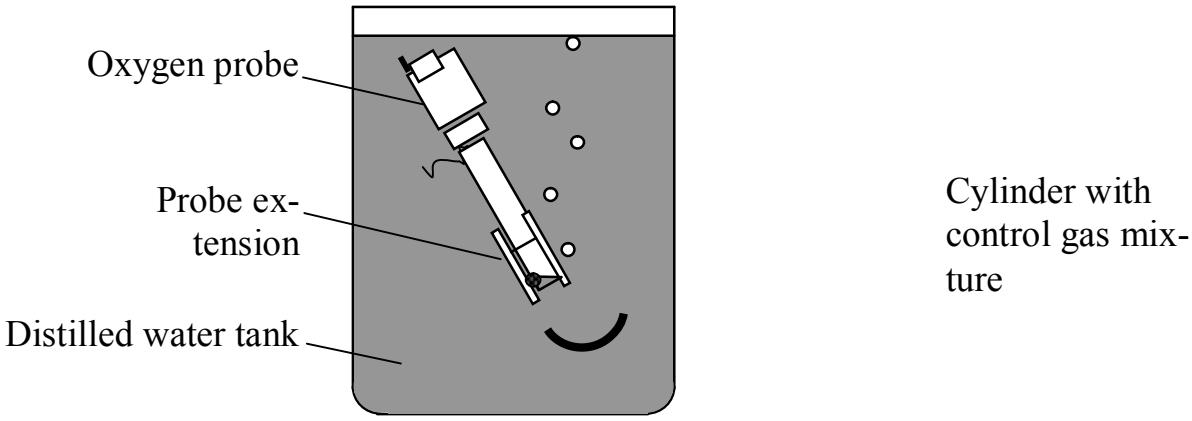


Figure 2.17

Pour distilled water at the room temperature into the tank.

Arrange inside the tank:

– the probe with an extension made of a piece of PVC pipe extending from the end of the probe by 30-35 mm. The probe must be declined at 60-70° inside the tank;

– an angled capillary pipe connected to the control gas mixture cylinder outlet.

After that:

– turn on the channel mode to which the probe is connected (e. g., channel A);

– keep the probe with the extension for at least 30 minutes in the tank;

– with the capillary pipe, direct the control gas mixture to the membrane of the probe. Using the flow probe, set the flow so that the bubble inside the cap is renewed each 3-5 seconds. Wait until the reading settles.

Control gas mixture calibration

1 By pressing $\frac{\text{MENU}}{\text{ENTER}}$ switch to **MENU [A]**.

2 Choose **CALIBRATION** and press $\frac{\text{MENU}}{\text{ENTER}}$, and the analyzer will switch to **CALIBRATION** menu; the analyzer will switch to the screen as in Fig. 2.6.

3 Choose **MANUAL** and press $\frac{\text{MENU}}{\text{ENTER}}$. The analyzer will switch to the

screen as in Fig. 2.18.

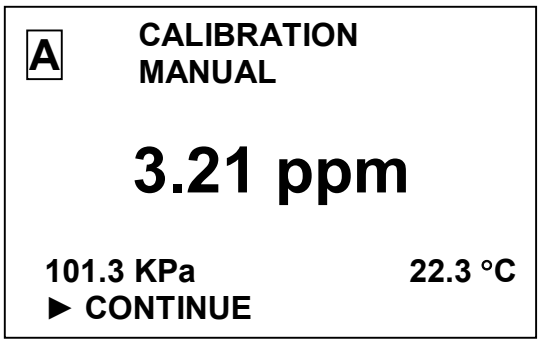


Figure 2.18

4 By pressing $\frac{\text{MENU}}{\text{ENTER}}$ switch to the screen as shown in Fig. 2.19.

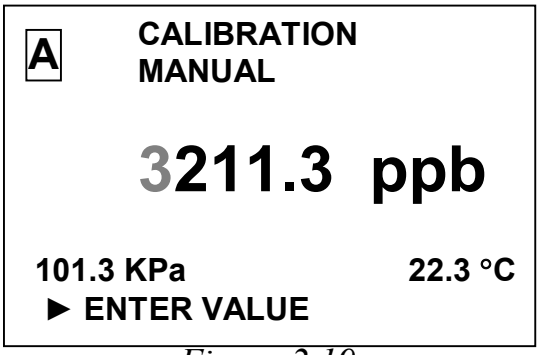


Figure 2.19

5 Enter digit by digit *C* value, ppb calculated as follows:

$$C = \frac{P_0}{20.95} \cdot \frac{P_{atm}}{101.325} \cdot Co_{2air}(t) \cdot 1000,$$

where P_0 is the volume fraction of oxygen in the control gas mixture (percentage);

P_{atm} is the atmospheric pressure shown in the screen;

$Co_{2air}(t)$ is the air oxygen solubility in water at temperature shown in the screen, taken from Appendix B, ppm;

1000 is the factor for calculation of the DOC table value in ppm into ppb.

6 After the number has been completely entered (no digits blinking) press $\frac{\text{MENU}}{\text{ENTER}}$. The probe will switch to the screen as sown in Fig. 2.20 showing DOC in ppm.

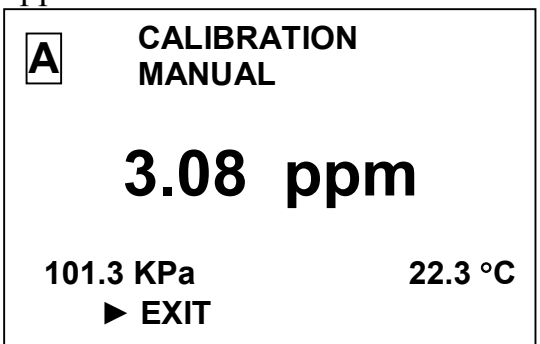


Figure 2.20

7 Press $\frac{\text{MENU}}{\text{ENTER}}$. The probe will exit from the air oxygen calibration mode and switch to the probe parameter review. The probe will switch to the screen as shown in Fig. 2.15.

8 Press $\frac{\text{MENU}}{\text{ENTER}}$ again. The probe will switch to the screen as shown in Fig. 2.16.

Choose **YES** and press $\frac{\text{MENU}}{\text{ENTER}}$; the nonvolatile memory will record the new parameters and new calibrating coefficients resulting from control gas mixture calibration. The probe will switch to the screen as shown in Fig 2.11.

Enter the date of calibration, choose **EXIT** and press $\frac{\text{MENU}}{\text{ENTER}}$, and the analyzer will switch to **MENU [A]**.

If you choose **NO** and press $\frac{\text{MENU}}{\text{ENTER}}$; the analyzer will switch to the **CALIBRATION** menu (Fig. 2.6) with its old calibrating coefficients.

In **MENU [A]** choose **EXIT** and press $\frac{\text{MENU}}{\text{ENTER}}$; the analyzer will switch to the Channel A measuring mode.

2.3.6.2 Analyzer calibration against a solution with known DOC

Calibration against a solution with known DOC is recommended to carry out using a reference analyzer. Calibration is carried out after both the reference and the operational meters' readings settle.

Calibration against a solution with known DOC

1 By pressing $\frac{\text{MENU}}{\text{ENTER}}$ switch to **MENU [A]**.

2 Choose **CALIBRATION** and press $\frac{\text{MENU}}{\text{ENTER}}$, and the analyzer will switch to the **CALIBRATION** menu; the analyzer will switch to the screen as shown in Fig. 2.6.

3 Choose **MANUAL** and press $\frac{\text{MENU}}{\text{ENTER}}$. The analyzer will switch to the screen as shown in Fig. 2.21.

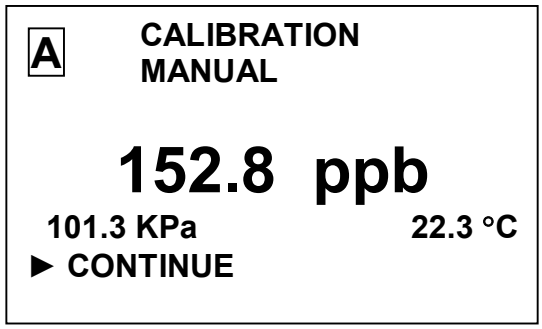


Figure 2.21

4 Press $\frac{\text{MENU}}{\text{ENTER}}$. The screen as shown in Fig. 2.22 will appear.

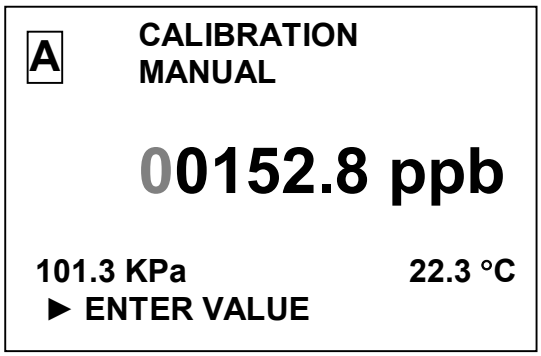


Figure 2.22

Enter digit by digit DOC value, ppb, equal to the reference analyzer reading.

5 After the number has been completely entered (no digits blinking) press $\frac{\text{MENU}}{\text{ENTER}}$. The screen as shown in Fig. 2.23 will appear.

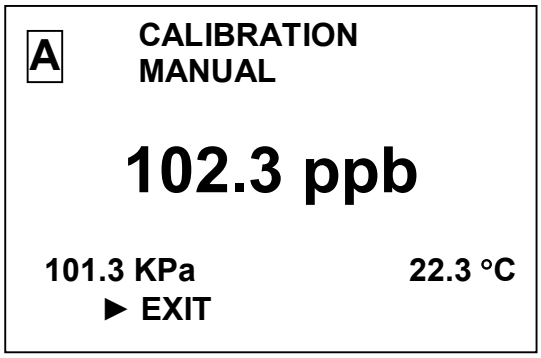


Figure 2.23

6 Press $\frac{\text{MENU}}{\text{ENTER}}$. The probe will exit the calibration mode and switch to the probe parameter review. The analyzer will switch to the screen as shown in Fig. 2.15.

7 Press $\frac{\text{MENU}}{\text{ENTER}}$ again. The analyzer will switch to the screen as shown in Fig. 2.16.

Choose **YES** and press $\frac{\text{MENU}}{\text{ENTER}}$; the nonvolatile memory will record the new parameters and new calibrating coefficients resulting from the calibration. The analyzer will switch to the screen as shown in Fig 2.11.

Enter the date of calibration, choose **EXIT** and press $\frac{\text{MENU}}{\text{ENTER}}$, and the analyzer will switch to **MENU [A]**.

If you choose **NO** and press $\frac{\text{MENU}}{\text{ENTER}}$; the analyzer will switch to the **CALIBRATION** menu (Fig. 2.6) with its old calibrating coefficients.

In **MENU [A]** choose **EXIT** and press $\frac{\text{MENU}}{\text{ENTER}}$; the probe will switch to the Channel A measuring mode.

2.3.7 Analyzer parameters control

Before taking measurements, check the parameters set in **MENU [A]**, **MENU [B]**, and **MENU [A,B]** and correct them if necessary following instructions in 1.5.5.2, setting ranges, pre-stored levels and saline content, and in accordance with 1.5.5.3, setting common for A and B channels parameters.

2.3.8 Preparing for measurements using the water flow stabilizing module SM-402M in accordance with BP13.00.000OM.

The water flow stabilizing module is used when the flow rate is 0.07 to 5.00 dm^3/min.

2.3.9 Preparing for measurements using the flow cell BP11.03.000.

The water flow cell is used when the flow rate is 0.07 to 0.60 dm^3/min.

To arrange the measurement with the flow cell:

– Slacken the nut;

– Install the probe into the flow cell as shown in Fig. 2.24 at the maximal depth (up to the stop);

– draw up the nut.

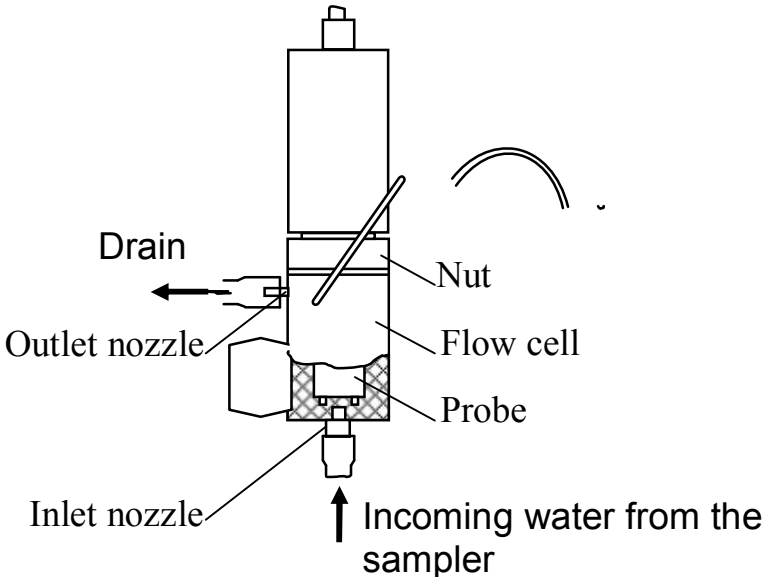


Figure 2.24 Position of the probe in the flow cell

Before disassembling the probe and the flow cell, remove the hose from the outlet nozzle and slacken the nut.

The flow cell can be used for storing and carrying the probe. To do this, loop the flow cell hoses between themselves without draining the water.

In a similar way, you can add the second probe to the flow cell assembly if it is included into the delivery set.

2.4 Conducting measurements

2.4.1 Measurements using the water flow stabilizing module or the flow cell

Put the water flow stabilizing module on a vertical or horizontal surface close to the sampling point.

If the flow cell is used, put it as close to the vertical upright position as possible.

Using a flexible hose, connect the inlet nozzle of the water flow stabilizing module SM-402M or of the flow cell with the probe installed to the water piping to be analyzed.

If the water flow stabilizing module SM-402M/1 is used, connect the module to the piping with a metal hose.

Check all the connections. The piping must be air-tight everywhere to exclude spontaneous addition of external oxygen.

Feed the sample water. Check that the flow does not include and the membrane does not accumulate air bubbles.

Accumulation of air bubbles in the bends of the hose, on the probe membrane or in the leg of the piping may seriously influence the accuracy of the results. One of the signs testifying to air bubbles in the system is a long-time settling of the reading (readings continually fall). This fall in the readings is caused by continual addition of oxygen from the air bubbles to the flow, and it may continue for one or two hours.

If the flow cell is used, carefully shake the cell with the probe to remove the bubbles from the membrane.

To remove the bubbles from the flow of the sampler, increase the flow sharply for 10-20 seconds and then resume the normal flow.

If you use the flow cell, remove the probe from the cell for the time you increase the flow.

If the probe is used continually for a long time, ensure that the probe is not overheated (higher than 70 °C).

When you use the flow cell, sustain the water flow within the limits of 0.07 to 0.60 dm^3/minutes. A higher rate may cause unstable readings. A too-high rate may damage the membrane.

2.4.2 Measurements without a water flow stabilizing module or flow cell

If you use the probe as a laboratory instrument, pour the sample water into a suitable vessel and ensure that the flow rate relative to the membrane is at least 5 cm/s. To ensure this rate, we recommend a magnetic stirrer.

2.5 Troubleshooting

2.5.1 Troubleshooting data is given in Table 2.4.

In the event of any of the problems described in Table 2.4, act as recommended in the Remedial Actions column.

Table 2.4

Trouble	Possible Reason	Remedial Actions
1 The analyzer does not turn on	Power cable is out of order	Check the power cable
	Fuses are out of order	For the electric cabinet option, see 2.5.9. For the on-wall instalment option, factory repair is recommended
2 The screen shows the channels A (B) and alarm WARNING! PROBE IS NOT CONNECTED!	The probe is disconnected from A (B) channel	Connect the probe to A (B) channel
3 Unreal temperature indications (about 150 °C)	Breakage of the temperature probe cable	Factory repair
4 In air oxygen calibration, the screen shows PROBE CURRENT > 10 μA	Teflon film breakage	See 2.5.7. Replace the Teflon film

Table 2.4 - continued

Trouble	Possible Reason	Recommended Actions
5 In air oxygen calibration, the screen shows PROBE CURRENT < 10 μA	Probe not in the air	Move the probe to air
	Electrolyte low	See 2.5.3. Top up electrolyte
	Membrane soiled	See 2.5.2. Clean membrane
	Membrane dried	Keep the probe in distilled water for 1-2 days
6 In null solution calibration, in 30 minutes readings are higher than 50 ppb. After looping of the probe readings are higher than 3 ppb in null solution.	Bad null solution	See 2.3.3.2. Prepare different null solution
	Breakage or puncture of membrane or diaphragm (air-tightness defect), Teflon film breakage	See 2.5.3-2.5.7. Replace the membrane unit or diaphragm. Replace Teflon film. Replace electrolyte.
	Glass pipe holding of electrodes is broken (has a crack)	Factory repair
7 Too long response to oxygen concentration change	Long time out of work	See 2.3.4.3. Conduct looping of the probe
	Membrane soiled	See 2.5.2. Clean membrane
	Membrane stretched	See 2.5.6. Replace the membrane unit
	Excess of electrolyte (diaphragm bulging)	Remove the excess of electrolyte
8 Sudden changes of readings and unstable readings	Flow rate through the flow cell is too high	Set the flow rate through the flow cell at 200 to 600 cm^3/min
	Unstable flow	Stabilize the flow

Table 2.4 (continued)

Trouble	Possible Reason	Remedial Actions
9 Alarm message WARNING! NO RESPONSE FROM AMPLIFIER UNIT!	No connection between indication board and amplifier board	Factory repair of the converting unit
10 Left of the channel indication (A or B) symbol M blinking	Memory error	Check the connector contact Turn the probe off and then on again If M remains, probe needs factory repair

NOTE: If the connecting cable insulation between the probe and the converting unit is damaged, you will need to replace the cable at factory, as any moist inside the cable upsets the probe operation completely!

2.5.2 Membrane cleaning

To clean the membrane, wipe it with soft cloth soaked in spirit.

You may also dip the probe membrane into a weak solution of sulfuric acid (2%) for about 1 hour and then rinse the membrane in flowing water.

2.5.3 Electrolyte topping up

To top up electrolyte (Fig. 2.25):

– Undo the screwed cap counter clockwise, and damp the inside of the membrane and the rubber ring with electrolyte;

– Screw the screwed cap home clockwise to press the membrane against the platinum cathode;

– Unscrew the protection cap;

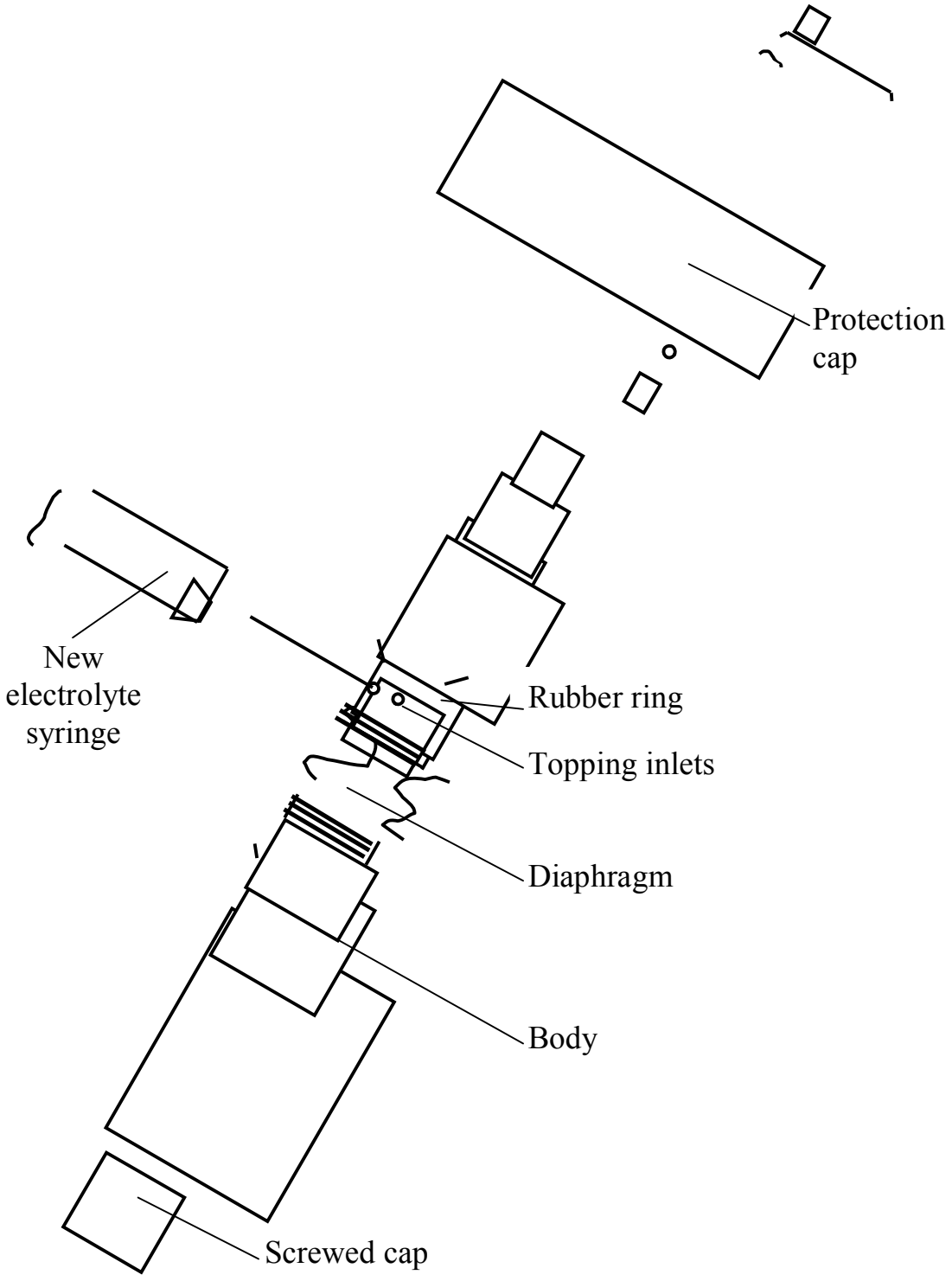


Figure 2.25 Electrolyte topping-up

– shift the protection cap from the probe body onto the cable;

– pour 4 cm^3 electrolyte through one of the inlets in the body of the probe with the syringe; the probe must be declined at 30-45°, and you may shake the probe several times to ensure that the electrolyte reached the electrodes;

– shift the rubber ring so that it covers both topping-up inlets;
– screw the protection cap home.

1 NOTE: DO NOT overfill the probe with electrolyte (so that the diaphragm does not bulge)!

2 NOTE: ELECTROLYTE CONTAINS ALKALI. IN THE EVENT OF SKIN CONTACT RINSE WITH FLOWING WATER!

Electrolyte composition: KCl, chemically clean – 14 g; KOH, chemically clean – 0.2 g; versene – 0.15 g; distilled water up to 0.1 dm^3. Filter the solution before use.

2.5.4 Electrolyte replacement

Electrolyte replacement is required when it has been soiled because of the membrane or diaphragm leakage. Corresponding signs are unstable readings of the probe and showing large values for the null solution.

Unscrew the protection cap as shown in Fig. 2.26. Shift the rubber ring to open the topping-up inlets.

Turn the probe membrane up. Pump off the old electrolyte with the syringe through one of the inlets.

Pour in the new electrolyte as described in 2.5.3.

2.5.5 Diaphragm replacement

2.5.5.1 Leakage of the diaphragm may cause leaking or impurity of electrolyte.

Unscrew the protection cap as shown in Fig. 2.26 and check the diaphragm. In the event of visible mechanical damage (cracks or holes) it must be replaced by a new one out of spare parts kit.

When the diaphragm is replaced, the new diaphragm is fixed with the help of a bandage made of line.

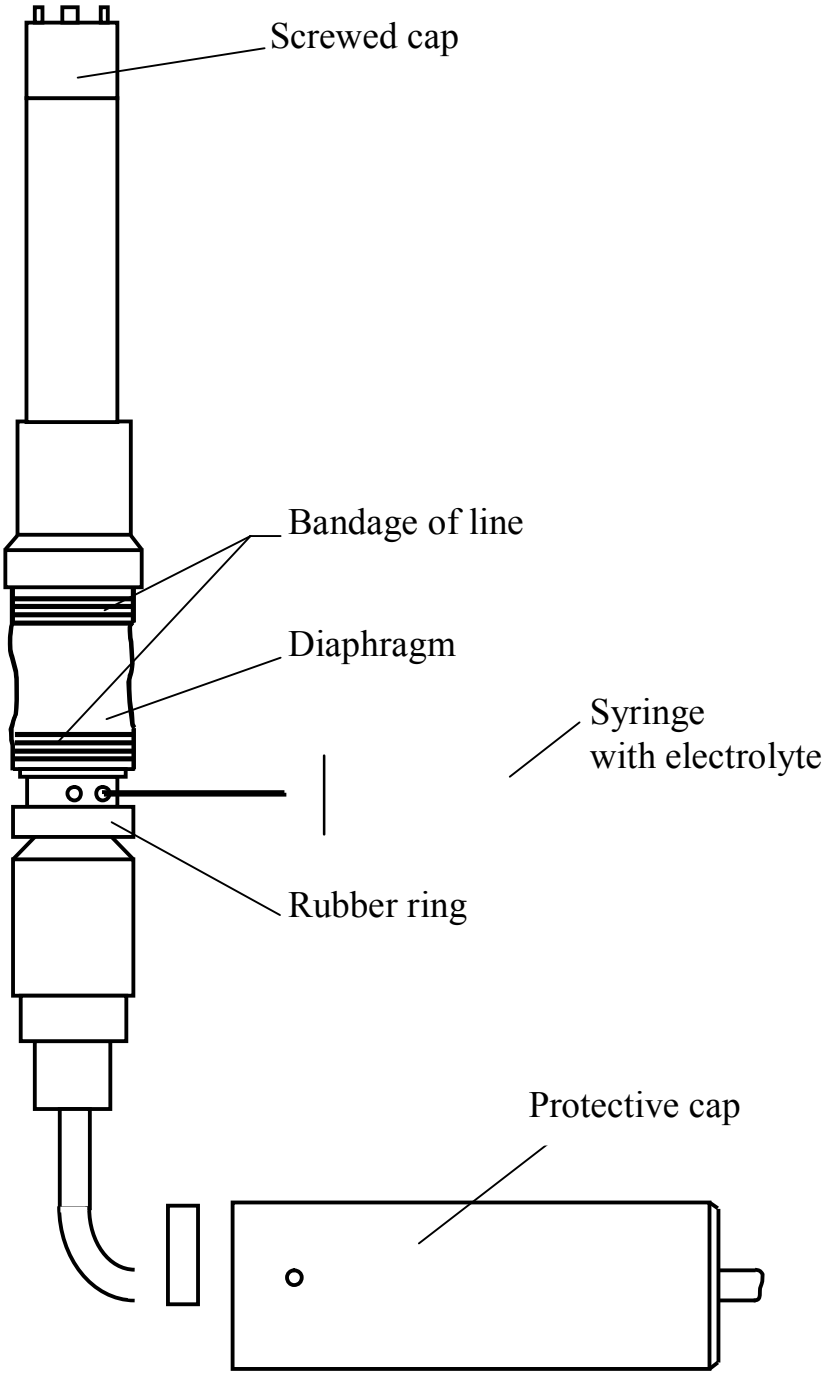


Figure 2.26 Electrolyte and diaphragm replacement

To do this:

– Remove the damaged diaphragm;

– Put on the new one out of the spare parts kit and spread it smoothly to place it on the rubber ring seals;

– Double one end of the line and out along the diaphragm as shown in Fig. 2.27*a*;

– Coil the line in 5-6 coils over the loop in the place of the silicone ring, and then thread the end of the line through the diaphragm loop as shown in Fig. 2.27*b*;

– Pulling at the line ends, shift the resulting knot under the coils of the line as shown in Fig. 2.27*c*;

– Cut excess line as shown in Fig. 2.27*d*;

– Similarly, fix the diaphragm in the place of the second silicone ring.

After the diaphragm replacement screw on the protection cap.

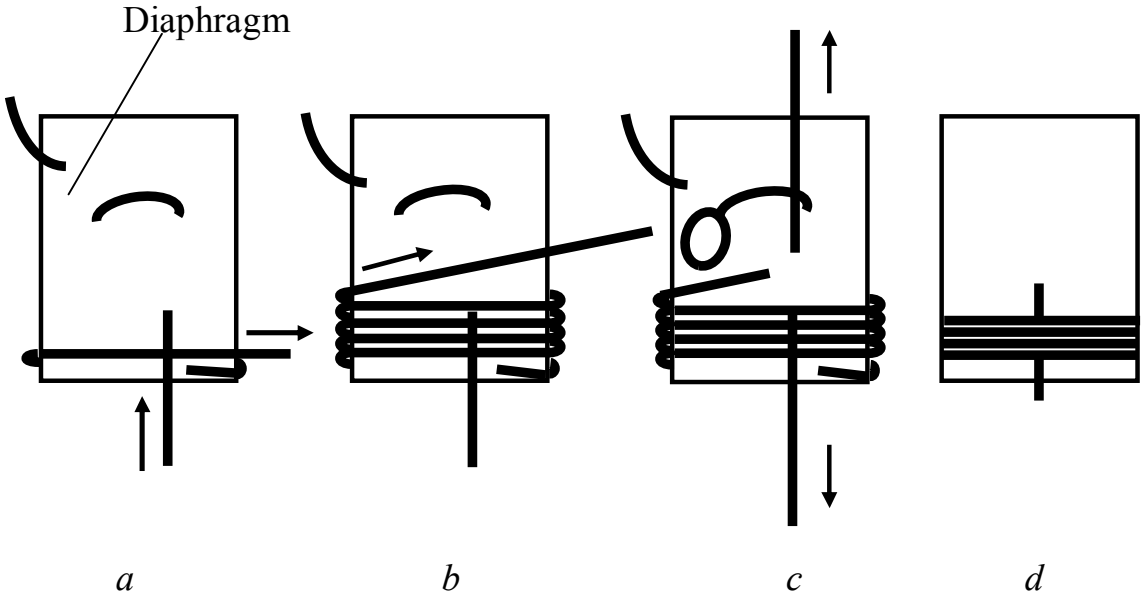


Figure 2.27

2.5.6 Membrane replacement

You need to replace the membrane if it was mechanically damaged (stretched or cracked). Unstable readings, high values in null solution measuring, or long response time may be the signs testifying this.

Turn the probe the membrane unit up to prevent spilling of electrolyte. Unscrew the screwed cap (Fig. 2.28), remove the old membrane unit (crown plug with a rubber ring and membrane). Make sure that the Teflon film has no defects (holes, cracks or furrows) and is tight against the platinum cathode.

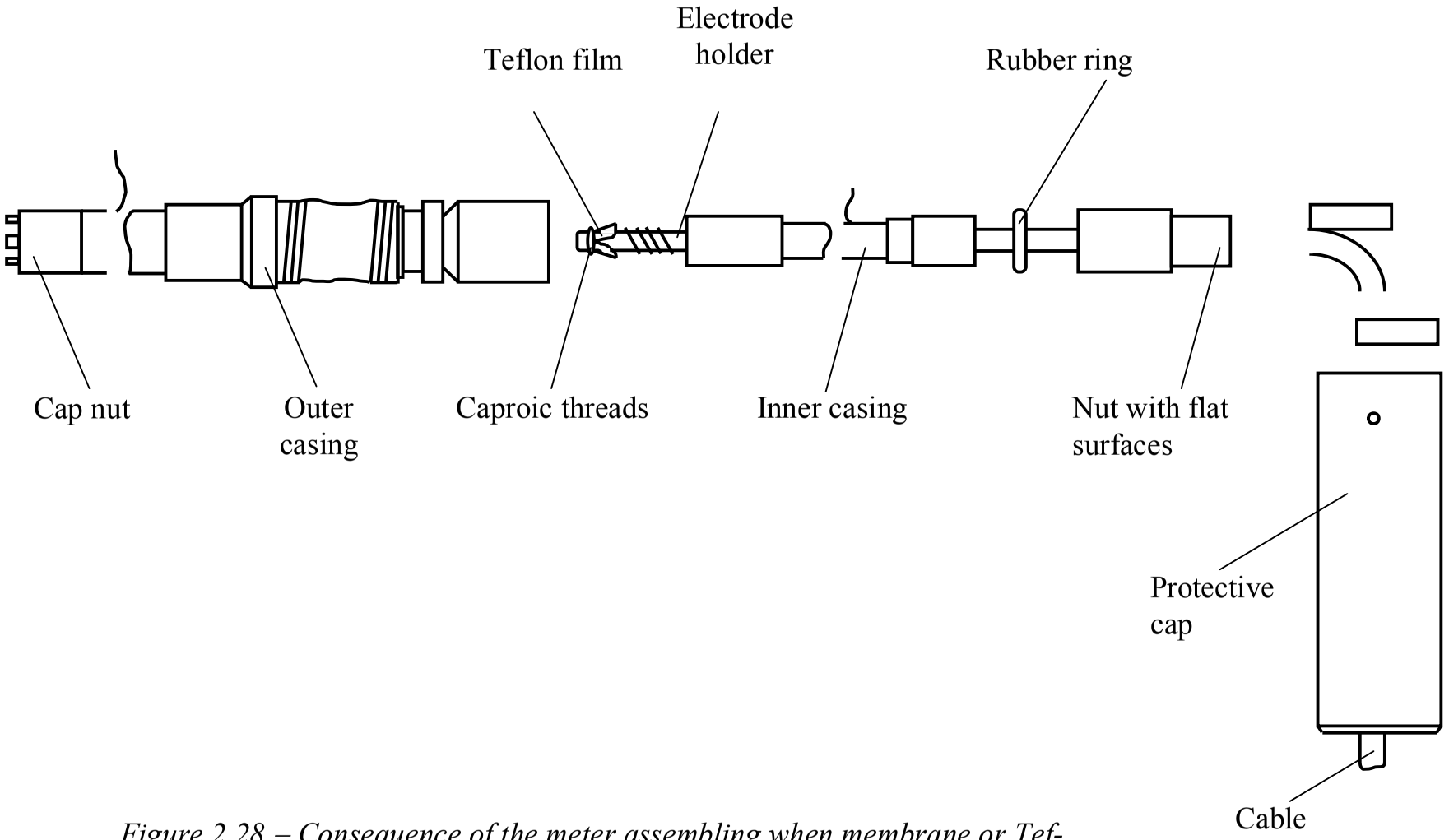


Figure 2.28 – Consequence of the meter assembling when membrane or Teflon film are replaced

If the defects are found, replace the film as described in 2.5.7.

If no defects are found, install a new membrane assembly to the screwed cap from spare parts kit, damp the membrane and the rubber ring with electrolyte on the inside, and then screw the cap home.

Top up electrolyte as described in 2.5.3, dip the probe into distilled water for at least 8 hours, after that go over to 2.3.3-2.3.5.

2.5.7 Teflon film replacement

Teflon film replacement is required when visible defects are found on the film or when the membrane assembly or diaphragm replacement did not restored normal functioning.

Unscrew the protection cap as shown in Fig. 2.28, and unscrew the nut with flattened surfaces.

Remove the rubber ring with pincers. Carefully remove the inner casing of the probe out of the outer and drain electrolyte from the latter. Remove the old Teflon film. Visually check the electrodes; they must look as follows:

– the platinum cathode inserted in the glass tube must be clean;
– the silver anode coiled around the tube must be grey in colour.

If necessary, clean the electrodes with some soft cloth soaked in spirit.

After cleaning of the electrodes, rinse the probe in distilled water.

WARNING: DO NOT USE ABRASIVES FOR ELECTRODE CLEANING !

Install a new Teflon film out of spare parts kit. To do this, put it on the cathode flat surface, press the edges of the film against the side of the glass tube and holding them with the hand coil 5-6 coils of Capron thread and tie 2-3 knots.

The film must be tight against the cathode.

WARNING: NO BREAKAGE OR PUNCTURES ON THE TEFLON FILM ARE ALLOWABLE!

Assembly the probe in the following way.

Insert the inner casing into the outer one and install the rubber ring. Screw the cap home. Pour electrolyte as described in 2.5.3. Screw the protective cap home.

After the overhaul, keep the turned-on probe in water for at least 3 hours and then go over to 2.3.3-2.3.5.

2.5.8 Cleaning the platinum electrode

The platinum electrode cleaning is necessary to perform in 6-12 months from the start of use; special cleansing solution is used. An earlier cleaning is not practical.

To do this:

- Prepare the special solution.
  Solution ingredients:
  acetic acid (80-100%) 50 cm^3,
  chlorhydric acid (concentrated) 20 cm^3,
  distilled water up to 100 cm^3;
- pour the solution into the vessel, the level of the solution must not exceed 3 mm;
- remove the Teflon film;
- put the probe into the solution and keep for 30 min;

WARNING: DO NOT DIP the silver anode into the solution!

- rinse the electrodes with distilled water.

2.5.9 Power fuses

For the electric cabinet option, power fuses must be replaced after the problem which caused destruction of the fuses has been eliminated.

The primary coil of the power transformer is provided with two fuses, ВП2Б-1В (0.5 A/250 V).

The secondary coil has four fuses ВП4-3 (1 A/250 V).

2.5.10 Initial Parameters Setting

2.5.10.1 Initial parameters setting mode

To switch to the initial parameters setting mode:

- switch to the screen of the respective channel measurements;

– turn off the power;
– Press ⇓ and while holding it turn on the power.
The probe will switch to the screen as shown in Fig. 2.29.

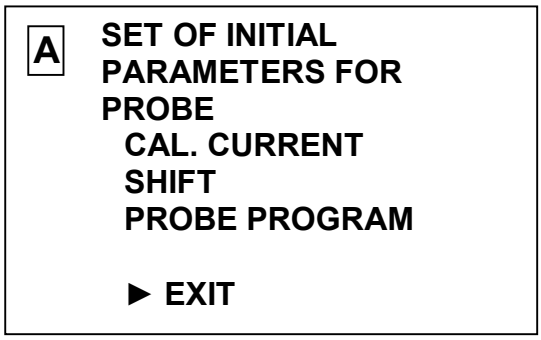


Figure 2.29

If you place «►» to **EXIT**, when $\frac{\text{MENU}}{\text{ENTER}}$ is pressed, the analyzer will switch to the measuring mode.

The analyzer features the following parameters:
– setting of the slope as a primary parameter (CAL. CURRENT);
– zero shift setting (SHIFT);
These settings will allow starting the calibration with the initial settings.

We recommend using them if you have doubts as to the correctness of the probe calibration.

– setting of all initial parameters of the probe including the thermal channel parameters (PROBE PROGRAM).

Note – This is a maintenance operation and is not used when the analyser is operated.

2.5.10.2 Initial slope setting

Place «►» to CAL. CURRENT and press $\frac{\text{MENU}}{\text{ENTER}}$. The analyzer will switch to the screen as shown in Fig. 2.30.

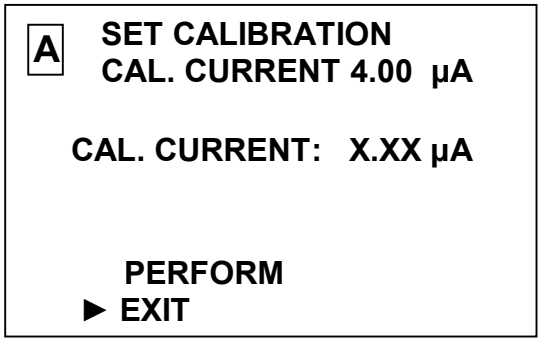


Figure 2.30

Place «►» to PERFORM and press $\frac{\text{MENU}}{\text{ENTER}}$. The analyzer will switch to the screen as shown in Fig. 2.31.

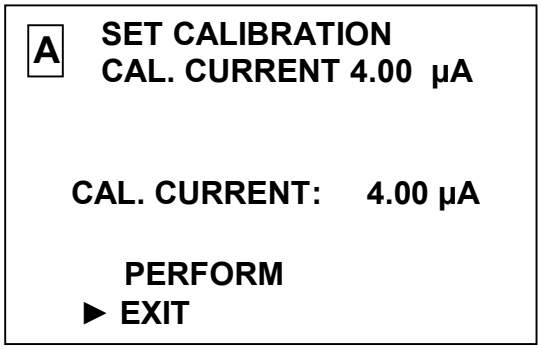


Figure 2.31

Press $\frac{\text{MENU}}{\text{ENTER}}$. The analyser will switch to the screen as shown in Fig. 2.29. The mean slope corresponding to 4 µA current of the probe has been set.

2.5.10.3 Zero shift setting

Place «►» to SHIFT and press $\frac{\text{MENU}}{\text{ENTER}}$. The analyzer will switch to the screen as shown in Fig. 2.32.

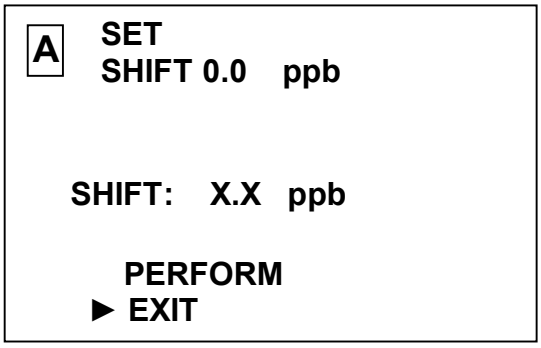


Figure 2.32

Place «►» to SHIFT and press $\frac{\text{MENU}}{\text{ENTER}}$. The analyzer will switch to the screen as shown in Fig. 2.33.

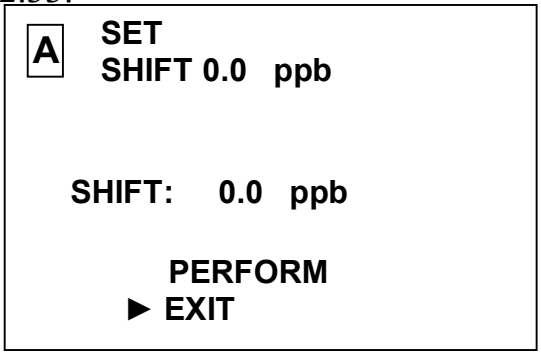


Figure 2.33

Press $\frac{\text{MENU}}{\text{ENTER}}$. The analyzer will switch to the screen as in Fig. 2.29. The zero shift has been set.

3 MAINTENANCE

3.1 The null solution calibration (see 2.3.4) is recommended to perform:
- whenever the membrane unit has been replaced;
- whenever Teflon film has been replaced;
- if you doubt the correctness of the readings;
- after a long period out of use.

3.2 Air oxygen calibration (see 2.3.5) is recommended to perform:
- each quarter;
- whenever the membrane unit has been replaced;
- whenever Teflon film has been replaced;
- if you doubt the correctness of the readings.

3.3 Looping of the probe (see 2.3.4.3) is recommended to perform if the analyzer was out of operation for more than 1 day. This will enable the best response in DOC measurements.

3.4 Cleaning of the outside of the converting unit must be performed with low-active cleansing agents, without letting the moist inside the converting unit of model МАРК-409.

3.5 Cleaning of the flow water stabilizing unit, flow cell, hoses, and metal pipe is done with 10% solution of sulfuric or chlorhydric acid with consequent rinsing.

4 DELIVERY SET

4.1 Delivery set as per Table 4.1.

Table 4.1

Name	Denomination	Quantity per model	
		МАРК-409	МАРК-409/1
Converting unit	BP37.01.000	1	-
	BP40.01.000	-	1
Oxygen probe DOP-409	BP40.02.000	1*	1*
	BP40.02.000-01	1*	1*
Maintenance kit	BP37.03.000	1	1
Spare parts kit	BP37.04.000	1	1
Maintenance kit	BP37.08.000	1	–
Operation Manual	BP37.00.000OP	1	1

* Quantity as agreed with the Customer

APPENDIX A
(FOR REFERENCE)

TEMPERATURE-DEPENDENT AIR OXYGEN SOLUBILITY AT 100 % HUMIDITY IN DISTILLED WATER

P_{atm}=101.325 KPa

Table A.1 *ppm*

t °C	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9
0	14.62	14.58	14.54	14.50	14.46	14.42	14.38	14.34	14.30	14.26
1	14.22	14.18	14.14	14.10	14.06	14.02	13.98	13.94	13.90	13.87
2	13.83	13.79	13.75	13.72	13.68	13.64	13.60	13.57	13.53	13.49
3	13.46	13.42	13.39	13.35	13.32	13.28	13.24	13.21	13.17	13.14
4	13.11	13.07	13.04	13.00	12.97	12.93	12.90	12.87	12.83	12.80
5	12.77	12.74	12.70	12.67	12.64	12.61	12.57	12.54	12.51	12.48
6	12.45	12.41	12.38	12.35	12.32	12.29	12.26	12.23	12.20	12.17
7	12.14	12.11	12.08	12.05	12.02	11.99	11.96	11.93	11.90	11.87
8	11.84	11.81	11.79	11.76	11.73	11.70	11.67	11.64	11.62	11.59
9	11.56	11.53	11.51	11.48	11.45	11.42	11.40	11.37	11.34	11.32
10	11.29	11.26	11.24	11.21	11.18	11.16	11.13	11.11	11.08	11.06
11	11.03	11.00	10.98	10.95	10.93	10.90	10.88	10.85	10.83	10.81
12	10.78	10.76	10.73	10.71	10.68	10.66	10.64	10.61	10.59	10.56
13	10.54	10.52	10.49	10.47	10.45	10.42	10.40	10.38	10.36	10.33
14	10.31	10.29	10.27	10.24	10.22	10.20	10.18	10.15	10.13	10.11
15	10.08	10.06	10.04	10.02	10.00	9.98	9.96	9.94	9.92	9.90
16	9.87	9.85	9.83	9.81	9.79	9.77	9.75	9.73	9.71	9.69
17	9.66	9.64	9.62	9.60	9.58	9.56	9.54	9.52	9.50	9.49
18	9.47	9.45	9.43	9.41	9.39	9.37	9.36	9.34	9.32	9.30
19	9.28	9.26	9.24	9.22	9.21	9.19	9.17	9.15	9.13	9.11
20	9.09	9.08	9.06	9.04	9.02	9.01	8.99	8.97	8.95	8.93
21	8.91	8.89	8.87	8.86	8.85	8.83	8.81	8.80	8.78	8.76
22	8.74	8.73	8.71	8.69	8.68	8.66	8.64	8.63	8.61	8.60
23	8.58	8.56	8.55	8.53	8.51	8.50	8.48	8.47	8.45	8.43
24	8.42	8.40	8.39	8.37	8.36	8.34	8.32	8.31	8.29	8.28
25	8.26	8.25	8.23	8.22	8.20	8.19	8.17	8.16	8.14	8.13
26	8.11	8.10	8.08	8.07	8.05	8.04	8.02	8.01	7.99	7.98
27	7.97	7.95	7.94	7.92	7.91	7.89	7.88	7.87	7.85	7.84
28	7.83	7.81	7.80	7.78	7.77	7.76	7.74	7.73	7.71	7.70
29	7.69	7.67	7.66	7.65	7.63	7.62	7.61	7.59	7.58	7.57
30	7.56	7.54	7.53	7.52	7.50	7.49	7.48	7.46	7.45	7.44

Table A.1 (continued)

t °C	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
31	7.44	7.44	7.43	7.42	7.41	7.39	7.38	7.37	7.36	7.35
32	7.33	7.32	7.31	7.30	7.29	7.28	7.26	7.25	7.24	7.23
33	7.22	7.21	7.19	7.18	7.17	7.16	7.15	7.14	7.13	7.11
34	7.10	7.09	7.08	7.07	7.06	7.05	7.04	7.03	7.01	7.00
35	6.99	6.98	6.97	6.96	6.95	6.94	6.93	6.92	6.90	6.89
36	6.82	6.81	6.80	6.78	6.77	6.76	6.75	6.74	6.73	6.72
37	6.71	6.70	6.69	6.68	6.67	6.66	6.65	6.64	6.63	6.62
38	6.61	6.60	6.59	6.58	6.57	6.56	6.55	6.54	6.53	6.52
39	6.51	6.50	6.49	6.48	6.47	6.46	6.45	6.44	6.43	6.42
40	6.41	6.40	6.39	6.38	6.37	6.36	6.35	6.34	6.33	6.32
41	6.31	6.30	6.29	6.28	6.27	6.26	6.25	6.24	6.23	6.22
42	6.21	6.20	6.19	6.19	6.18	6.17	6.16	6.15	6.14	6.13
43	6.12	6.11	6.10	6.09	6.08	6.07	6.06	6.05	6.04	6.04
44	6.03	6.02	6.01	6.00	5.99	5.98	5.97	5.96	5.95	5.94
45	5.93	5.92	5.92	5.91	5.90	5.89	5.88	5.87	5.86	5.85
46	5.84	5.83	5.82	5.82	5.81	5.80	5.79	5.78	5.77	5.76
47	5.75	5.74	5.74	5.73	5.72	5.71	5.70	5.69	5.68	5.67
48	5.66	5.66	5.65	5.64	5.63	5.62	5.61	5.60	5.59	5.59
49	5.58	5.57	5.56	5.55	5.54	5.53	5.52	5.52	5.51	5.50
50	5.49	5.48	5.47	5.47	5.46	5.45	5.44	5.44	5.43	5.42
51	5.41	5.41	5.40	5.39	5.38	5.38	5.37	5.36	5.35	5.34
52	5.34	5.33	5.32	5.31	5.31	5.30	5.29	5.28	5.27	5.27
53	5.26	5.25	5.24	5.23	5.23	5.22	5.21	5.20	5.19	5.19
54	5.18	5.17	5.16	5.16	5.15	5.14	5.13	5.12	5.12	5.11
55	5.10	5.09	5.08	5.07	5.07	5.06	5.05	5.04	5.03	5.03
56	5.02	5.01	5.00	4.99	4.99	4.98	4.97	4.96	4.95	4.94
57	4.94	4.93	4.92	4.91	4.90	4.90	4.89	4.88	4.87	4.86
58	4.85	4.85	4.84	4.83	4.82	4.81	4.80	4.80	4.79	4.78
59	4.77	4.76	4.75	4.74	4.74	4.73	4.72	4.71	4.70	4.69
60	4.69	4.68	4.67	4.66	4.66	4.65	4.64	4.64	4.63	4.62
61	4.61	4.61	4.60	4.59	4.58	4.58	4.57	4.56	4.55	4.55
62	4.54	4.53	4.52	4.52	4.51	4.50	4.49	4.49	4.48	4.47
63	4.46	4.45	4.45	4.44	4.43	4.42	4.41	4.41	4.40	4.39
64	4.38	4.38	4.37	4.36	4.35	4.34	4.33	4.33	4.32	4.31
65	4.30	4.29	4.29	4.28	4.27	4.26	4.25	4.24	4.23	4.23
66	4.22	4.21	4.20	4.19	4.18	4.18	4.17	4.16	4.15	4.14
67	4.13	4.12	4.11	4.11	4.10	4.09	4.08	4.07	4.06	4.05
68	4.04	4.03	4.03	4.02	4.01	4.00	3.99	3.98	3.97	3.96
69	3.95	3.94	3.93	3.93	3.92	3.91	3.90	3.89	3.88	3.87
70	3.86	3.85	3.84	3.83	3.82	3.81	3.80	3.79	3.78	3.77

APPENDIX B

(FOR REFERENCE)

CONVERTING UNIT MAPK-409 AND PC EXCHANGE PROTOCOL

(20.01.2005)

Physical format of single byte exchange.
1 start bit;
8 bits data;
1 stop bit;
odd-even check not used;
rate – 19,200 bits/s.

Frame format sent by PC:
Parcel format – 7 bytes:
1 – preamble (255);
2 – network address (0 – 255);
3 – channel (0 – converting unit, 1 – channel A, 2 – channel B);
4 – operation part (high bit: 1 – recording, 0 – reading);
5 – data high byte;
6 – data low byte;
7 – control total (CRC).

Table B.1 − Channel 0

Preamble	Network address	Channel	Operation code	Data high byte	Data low byte	CRC	Comments
255	DEV	0	1	0	0	CRC	Test
255	DEV	0	2	0	0	CRC	Network device type reading
255	DEV	0	3	0	0	CRC	RegIndChannel Reading
255	DEV	0	4	0	0	CRC	OfficialMaster Reading
255	DEV	0	5	0	0	CRC	OfficialMaster1 Reading
255	DEV	0	6	0	0	CRC	OfficialSlave Reading
255	DEV	0	7	0	KeyKod	CRC	KeyKod pressing imitation
255	DEV	0	131	0	RegInd-Channel	CRC	RegIndChannel recording

Network device type:
3 – МАРК-409.