ANALYTICAL EQUIPMENT FOR

VZOR

ECOLOGY AND POWER INDUSTRY

MAPK-1002 SODIUM METER

Operation Manual

АЯ 74

Nizhny Novgorod
2011

VZOR will appreciate any suggestions and comments aimed at product quality improvement.

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

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C O N T E N T S

1 DESCRIPTION AND OPERATION

1.1 Purpose

1.1.1 Product name and designation

Analyzer rated for measurement range C_{Na} from 0.7 to 500 ppb with a panel converter unit:

MAPK-1002 Sodium analyzer ТУ 4215-028-39232169-2010.

Analyzer rated for measurement range C_{Na} from 0.7 to 500 ppb with a wall-mounted converter unit:

MAPK-1002/1 Sodium analyzer ТУ 4215-028-39232169-2010.

Analyzer rated for measurement range C_{Na} from 0.7 to 2,000 ppb with a panel converter unit:

MAPK-1002/P Sodium analyzer ТУ 4215-028-39232169-2010.

Analyzer rated for measurement range C_{Na} from 0.7 to 2,000 ppb with a wall-mounted converter unit:

MAPK-1002/1P Sodium analyzer ТУ 4215-028-39232169-2010.

1.1.2 The analyzer is used to continuously measure activity of sodium ions in aqueous solutions and temperature of aqueous solutions.

1.1.3 Applications: heat engineering, chemical, steel-and-iron, and pharmaceutical industries, farming, biology and other areas.

1.1.4 Types of electrodes used are tabulated in table 1.1.

Table1.1 − Types of electrodes used

Electrode intended use	*Types of electrodes used*	*Manufacturer*
Ion-selective electrode responsive to sodium ions (sodium electrode)	ЭС-10-07 glass electrode	Gomel Measuring Instrumentation Factory
	ЭЛИС-212Na/3 (К 80.7) ion-selective glass electrode	Measuring Equipment
	Type 8480 B Na-selective electrode	Polymetron
	DX 223 Na-selective electrode	Mettler Toledo
Ion-selective electrode responsive to hydrogen ions (pH-electrode)	ЭСЛ-43-07СР glass electrode	Gomel Measuring Instrumentation Factory
	ЭС-10601/7 (К 80.7) glass electrode	IT Measuring Equipment
	Type 8402 B pH-electrode	Polymetron
Reference electrode	ЭВЛ-1М3.1 reference electrode	Gomel Measuring Instrumentation Factory
	ЭСр-10103-3,0 (К 80.4) reference electrode	Measuring Equipment
	ЭСр-10101-3,0 (К 80.4) reference electrode	

Note: Types of electrodes used are specified when placing an order for the analyzer.

1.2 Main Parameters

1.2.1 Table 1.2 gives the versions of the analyzer components in environmental impact protection.

Table1.2 − Versions of analyzer components

Analyzer version marking	Description and designation of components	Versions according to GOST 14254
MAPK-1002 MAPK-1002/P	Converter unit BP49.01.000 (panel version)	IP30
MAPK-1002/1 MAPK-1002/1P	Converter unit BP49.01.000-01 (wall-mounted version)	IP65
MAPK-1002 MAPK-1002/1 MAPK-1002/P MAPK-1002/1P	PS-1002 Power Supply BP49.04.000	IP32
	HP-1002 Hydraulic Panel BP49.02.000 (except for electrodes): – amplifier unit BP49.02.700; – automatic batching unit BP49.02.300; – compressor BP49.02.400	 IP62 IP32 IP41

1.2.2 Analyzed parameters

1.2.2.1 Temperature of tested water (aqueous solutions), °C…….. from plus 10 to plus 40.

1.2.2.2 Tested water flow rate through the hydraulic panel, dm^3/h…….. from 3 to 200.

1.2.2.3 Tested water specific electrical conductance (U) at hydraulic panel inlet due to dissolved components except ammonia is given in table 1.3.

Table1.3

Analyzer version	Measurement range	Maximum tested water U at hydraulic panel inlet, μS/cm
MAPK-1002, MAPK-1002/1	0.7 to 500 ppb	3.0
MAPK-1002/P, MAPK-1002/1P	0.7 to 500 ppb	3.0
	500 to 2000 ppb	11.0

1.2.3 Working conditions

1.2.3.1 Ambient air temperature, °C …..... from plus 5 to plus 50.

1.2.3.2 Maximum relative ambient air humidity at 35 °C and lower temperature without water condensation, % ..... 80.

1.2.3.3 Atmospheric pressure, kPa (mm Hg) …..... from 84.0 to106.7 (from 630 to 800).

1.2.4 Analyzer is supplied with 220 V AC, (50 ± 1) Hz.

1.2.5 Allowable voltage variations – from minus 15 to plus 10 %.

Maximum power consumption of the converter unit and amplifier, V·A…….…….. 10.

Maximum power consumption of the PS-1002 power supply (for automatic batching device), V·A.……..……..…… 95.

1.2.6 The analyzer may be adjusted to the parameters of pair of electrodes with pH-electrode parameters stated in table 1.4.

Table1.4 − pH-electrode parameters

Minimum slope of hydrogen curve linear part at 20 °C, mV/pH	pH-electrode isopotential point coordinates	
	E_i, mV	pH_i, pH
minus 57.0	-25 ± 30	7.0 ± 0.3

1.2.7 Dimensions and mass of analyzer components are tabulated in table 1.5.

Table1.5 − Dimensions and mass of analyzer components

Analyzer version marking	Description and designation of components	Maximum dimensions, mm	Maximum mass, kg
MAPK-1002 MAPK-1002/P	Converter unit BP49.01.000	252×146×100	2.60
MAPK-1002/1 MAPK-1002/1P	Converter unit BP49.01.000-01	266×170×95	2.60
MAPK-1002 MAPK-1002/1 MAPK-1002/P MAPK-1002/1P	HP-1002 Hydraulic panel BP49.02.000	300×650×200	4.00
	PS-1002 Power supply BP49.04.000	156×160×x100	1.10

1.2.8 Analyzer carriage conditions in a transit container according to GOST 12997-84:

- temperature, °C …….....…….……. minus 10 to plus 55;
- maximum air relative humidity at 25 °C, % ……..…... 95;
- sinusoidal vibration of 5 to 35 Hz frequency, 0.35 mm shift amplitude in directions shown on the container by the "Up" marking.

1.2.9 Minimum electrical insulation resistance of analyzer power supply circuits between plug pins and case, MΩ:

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

1.2.10 Electrical insulation of analyzer power supply circuits relative to converter unit case resists for 1 min test 1.5 kV voltage of sinusoidal 50 Hz AC at (20 ± 5) °C ambient temperature and 30 to 80 % relative humidity.

1.2.11 Maximum electrical resistance between external terminal (contact) of converter unit protective ground and its case, Ω ……..…… 0.1.

1.3 Specifications

1.3.1 Sodium ion activity measurement range (C_{Na}), ppb:

– MAPK-1002, MAPK-1002/1 analyzers ……..... from 0.7 to 500;

– MAPK-1002/P, MAPK-1002/1P analyzers ……..…….... from 0.7 to 2000.

1.3.2 Limits of analyzer allowable basic absolute error when C_{Na} is red by display at (25.0 ± 0.2) °C analyze temperature and (20 ± 5) °C ambient temperature are given in table 1.6.

Table1.6

Analyzer version	Measurement range, ppb	Limits of analyzer allowable basic absolute error when C_{Na} is red by display, ppb
MAPK-1002, MAPK-1002/1	from 0.7 to 500	± (0.5 + 0.12C_{Na})
MAPK-1002/P, MAPK-1002/1P	from 0.7 to 500	± (0.5 + 0.12C_{Na})
	from 500 to 2000	± 0.3C_{Na}
C_{Na} − measured sodium ion activity value, ppb.		

1.3.3 The function of transformation of the C_{Na} value measured, ppb, into analyzer output current I_{out}, mA, is expressed as follows:

– for current output from 4 to 20 mA on the load that does not exceed 500 Ω:

$$I_{out} = 4 + 16 \cdot \frac{C_{Na} - C_{Na}^{start}}{C_{Na}^{range}}; \qquad (1.1)$$

– for current output from 0 to 5 mA on the load that does not exceed 2 kΩ:

$$I_{out} = 5 \cdot \frac{C_{Na} - C_{Na}^{start}}{C_{Na}^{range}}, \qquad (1.2)$$

where C_{Na}^{range} – pre-set measurement range of C_{Na} for output current, ppb (from now on “measurement range of C_{Na} for output current”), determined as a difference between "END" and "START" values of the programmed current output dependent C_{Na} measurement range;

C_{Na}^{start} − "START" value of the pre-set C_{Na} measurement range, ppb.

1.3.4 Limits of analyzer allowable basic absolute error when C_{Na} is measured against current output at (25.0 ± 0.2) °C analyze temperature and (20 ± 5) °C ambient temperature are given in table 1.7.

Table1.7

Analyzer version	Measurement range, ppb	Limits of analyzer allowable basic absolute error when C_{Na} is measured against current output, ppb
MAPK-1002, MAPK-1002/1	from 0.7 to 500	$\pm [(0.5 + 0.002 C_{Na}^{range}) + 0.12 C_{Na}]$
MAPK-1002/P, MAPK-1002/1P	from 0.7 to 500	$\pm [(0.5 + 0.002 C_{Na}^{range}) + 0.12 C_{Na}]$
	from 500 to 2000	$\pm (0.002 C_{Na}^{range} + 0.3 C_{Na})$
C_{Na}^{range} – pre-set measurement range of C_{Na} for output current, ppb.		

1.3.5 Limits of analyzer allowable basic absolute error when measuring C_{Na} due to change in analyze temperature within working temperature range from plus 10 to plus 40 °C (analyzer temperature compensation error) are given in table 1.8.

Table1.8

Analyzer version	Measurement range, ppb	Temperature compensation error, ppb
MAPK-1002, MAPK-1002/1	from 0.7 to 500	$\pm (1.0 + 0.24 C_{Na})$
MAPK-1002/P, MAPK-1002/1P	from 0.7 to 500	$\pm (1.0 + 0.24 C_{Na})$
	from 500 to 2000	$\pm 0.3 C_{Na}$

1.3.6 Limits of analyzer allowable additional absolute error when measuring C_{Na} due to change in ambient temperature by each ± 10 °C from normal temperature (20 ± 5) °C within working temperature range from plus 5 to plus 50 °C, ppb:

– by display ……. $\pm (0.05 + 0.035 C_{Na})$;

– by output current …….…… $\pm [(0.05 + 0.0025 C_{Na}^{range}) + 0.035 C_{Na}]$.

1.3.7 Analyst temperature measurement range, °C ……. from 0 to plus 50.

1.3.8 Limits of analyzer allowable basic absolute error when measuring analyst temperature at ambient temperature of (20 ± 5) °C, °C ……. ± 0.3.

1.3.9 Limits of analyzer allowable additional absolute error when measuring temperature due to change in ambient temperature by each ± 10 °C from normal temperature (20 ± 5) °C within working temperature range from plus 5 to plus 50 °C, °C……..... ± 0.1.

1.3.10 Maximum settling time of analyzer output signal, min ……..…….. 15.

1.3.11 If C_{Na} or temperature value measured goes beyond the measurement range, it activates audible alarm and "**ALARM**" display on the analyzer front panel. The display panel shall display "**Overload!**" message.

1.3.12 If C_{Na} value measured goes beyond the setting limits, the analyzer display panel shall display icon " ▼ " or " ▲ " and the setting relay operates.

1.3.13 The analyzer shall communicate with a PC when connected to it through RS-485 interface.

1.4 Product components

1.4.1 The product is composed of:
- panel or wall-mounted converter unit dependent on analyzer version;
- HP-1002 hydraulic panel;
- PS-1002 power supply;
- connecting cables;
- probe maintenance kit;
- spare parts kit.

1.5 Description and operation

1.5.1 Analyzer general data

The analyzer is a double-channel measuring device for continuous measuring sodium ion activity in a solution (C_{Na}) in ppb and temperature of the solution in Celsius degrees.

C_{Na} is measured by MAPK-1002 and MAPK-1002/1 analyzers in the range from 0.7 to 500 ppb and in the range from 0.7 to 2000 ppb by MAPK-1002/P and MAPK-1002/1P analyzers.

To easily record the measured C_{Na} using a recorder due to analyzer current outputs, a provision is made for setting the low and high limits of C_{Na} measurement range against current output.

Solution C_{Na} and temperature values measured are displayed on the display panel of the converter unit. Indication may comprise the first or the second channel, or both.

For each C_{Na} measurement channel the analyzer has an assigned current output with unified DC signals from 0 to 5 mA or from 4 to 20 mA. Unified output signals (from 0 to 5 mA or from 4 to 20 mA) may be set individually for each channel. The low (0 or 4 mA) and high (5 or 20 mA) limits of the current output range correspond to the start and end points of the predetermined C_{Na} measurement range against current output.

C_{Na} measurement ranges by output current in each channel may be predetermined separately. If the value measured goes beyond any limit of the C_{Na} measurement range by output current, the display panel shall display **"OVERLOAD!"** message.

In each analyzer channel a provision is made for programmed settings which determine the lower and upper limits for C_{Na} measured value control. If C_{Na} values go beyond the setting limits, the relay “dry” contacts close and display panel displays an icon corresponding to the setting high or low limit.

The analyzer complete set includes HP-1002 hydraulic panel. The hydraulic panel carries a flow module intended to make tested solution flow stable, clean it of mechanical impurities and saturate with ammonia vapor. The flow module houses the sodium electrode, pH-electrode and temperature sensor.

The hydraulic panel also carries AU-1002 amplifier unit connected to the converter unit by a cable 5 to 100 m long, the both making a converter.

The hydraulic panel also includes the automatic ammonia vapor batching device. The automatic batching device consists of a compressor and automatic batching unit (ABD) with SC-1002 sensor.

For easy testing of a sample, the analyzer may indicate logarithmic sodium ion activity display in the pNa from 4.06 to 8.36 and indicate U in the range from minus 1000 to plus 1000 mV.

In pNa indication mode a provision is made for setting lower and upper limits of pNa measurement range by output current and entering setting values by pNa.

In singe channel indication mode a provision is made for double indication: C_{Na} and pNa. Main indication data units of which are used for setting the range of C_{Na} measurement by output current and setting values are illuminated in a large type in the middle of the display panel, while the additional data is illuminated in small type in the display top.

In addition to common DC output signals from 0 to 5 mA or from 4 to 20 mA, the analyzer menu provides for setting common output signal from 0 to 20 mA in each channel.

1.5.2 Analyzer components

1.5.2.1 Converter unit

The converter unit is a microprocessor which makes measurement results (C_{Na}, temperature) to be displayed on the graphical liquid-crystal display (LCD) (hereinafter display), shapes signal at current outputs and controls the setting relay and communication with a PC. The converter unit is powered up from 220 V, 50 Hz AC power supply. The converter unit is manufactured in the panel and wall-mounted versions.

As shown in Fig. 1.1, the front panel of the converter unit in panel and wall-mounted versions carries the following:

- display panel used to display measured valued of C_{Na}, temperature, pNa, electrode system mV, and analyzer working modes;
- "**POWER**" switch for analyzer energizing and de-energizing;
- "⇩", " ⇧" buttons to shift the cursor in the analyzer menu up and down in order to select a working mode, change measurement ranges and setting values;
- "**CHANNEL**" button to change channel display and channel menu;
- "**menu** / **enter**" button to enter the menu and acknowledge selection of values and working modes when programming;
- " ☼ " button to turn on/off the display panel light;
- "**ALARM**" red LED to indicate that values fall outside current output, temperature and U ranges;
- "**POWER**" green LED to indicate that analyzer is powered up.

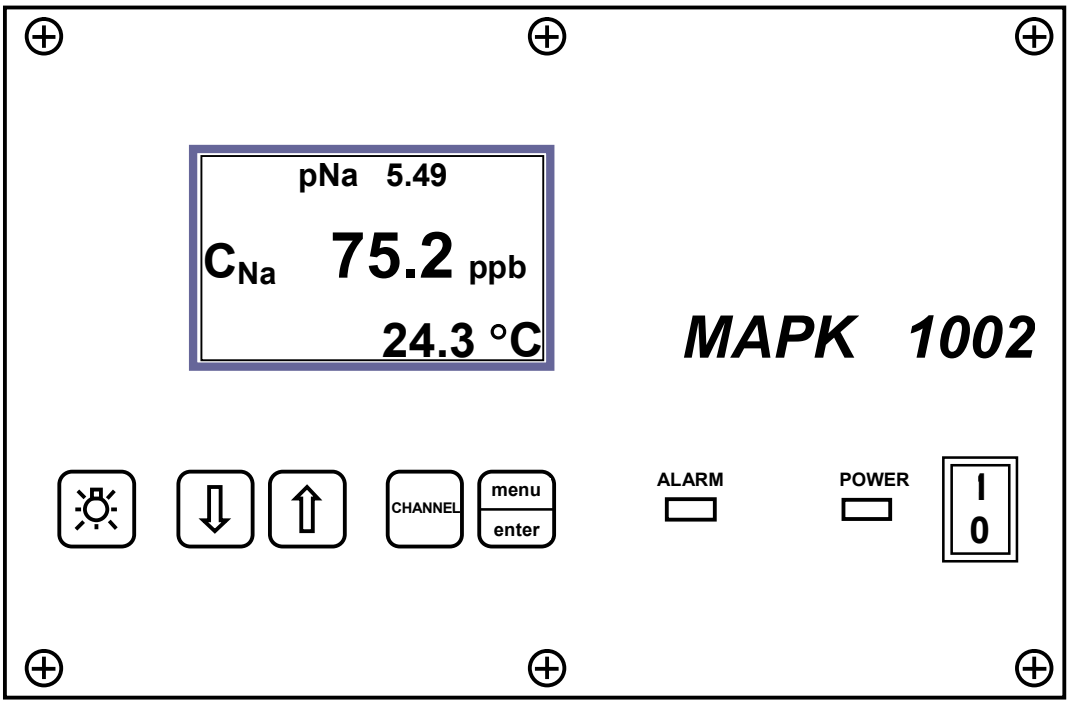


Fig 1.1 − Layout of controls and display on the converter unit front panel

The back panel of the panel-type converter unit, as shown in Fig. 1.2, and the underside of the wall-mounted converter unit, as shown in Fig. 1.3, carry the following:

- two "**CHANNEL A**" and "**CHANNEL B**" jacks of A and B channels for connection of cables running from AU-1002 amplifier units to the converter unit;
- "**RS-485**" computer interface jack for connection of analyzer to a PC;
- "**SIGNALLING**" jack for connection of actuators;
- "**CURRENT OUTPUT**" jack;
- " ⏚ " terminal for connection of protective grounding to the analyzer case.

The back panel of panel-type converter unit carries the power supply jack "**~220 V 50 Hz 10 V·A 1.0 A**".

The underside of the wall-mounted converter unit carries leak-tight power cable "**~220 V 50 Hz 10 V·A**".

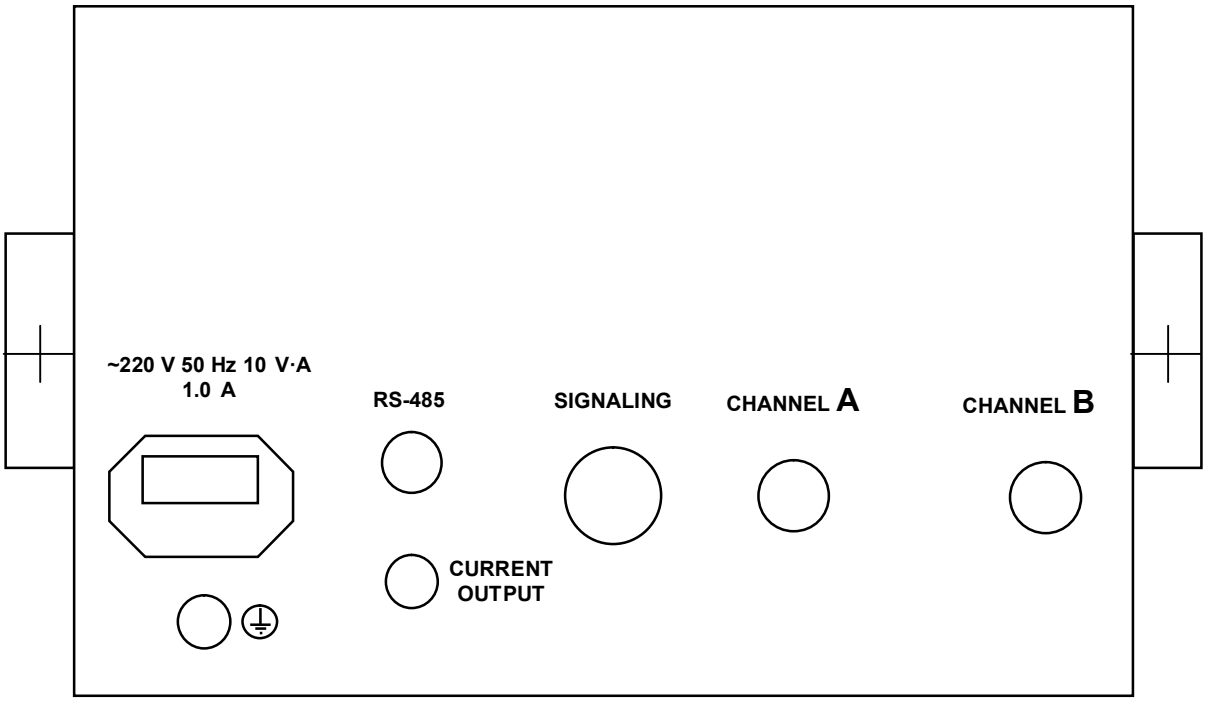


Fig 1.2 − Layout of jacks on the back panel of panel-type converter unit

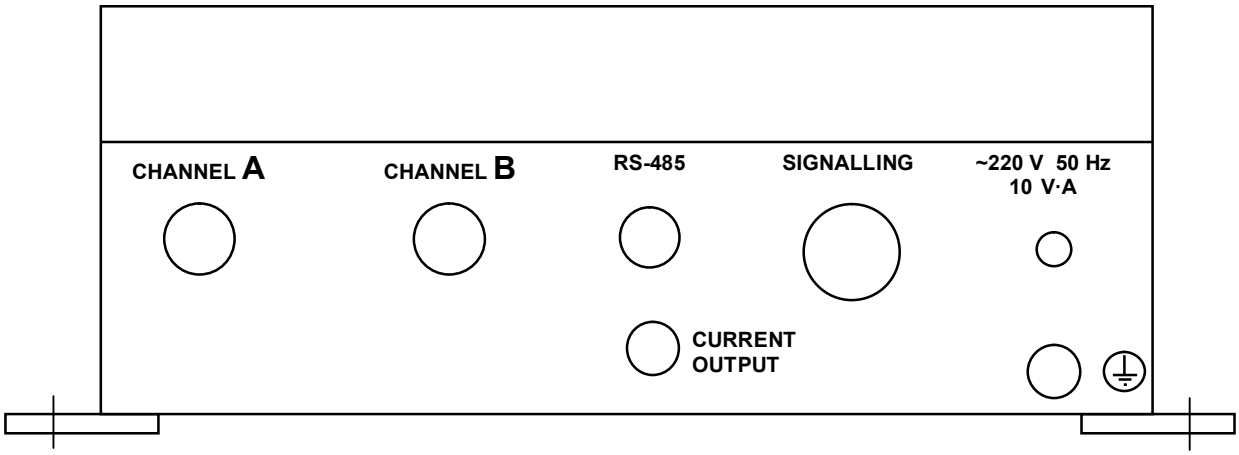


Fig 1.3 − Layout of jacks on the underside of wall-mounted converter unit

1.5.2.2 HP-1002 hydraulic panel

HP-1002 hydraulic panel is shown in Fig. 1.4. Electrical and hydraulic connections of the hydraulic panel are not shown.

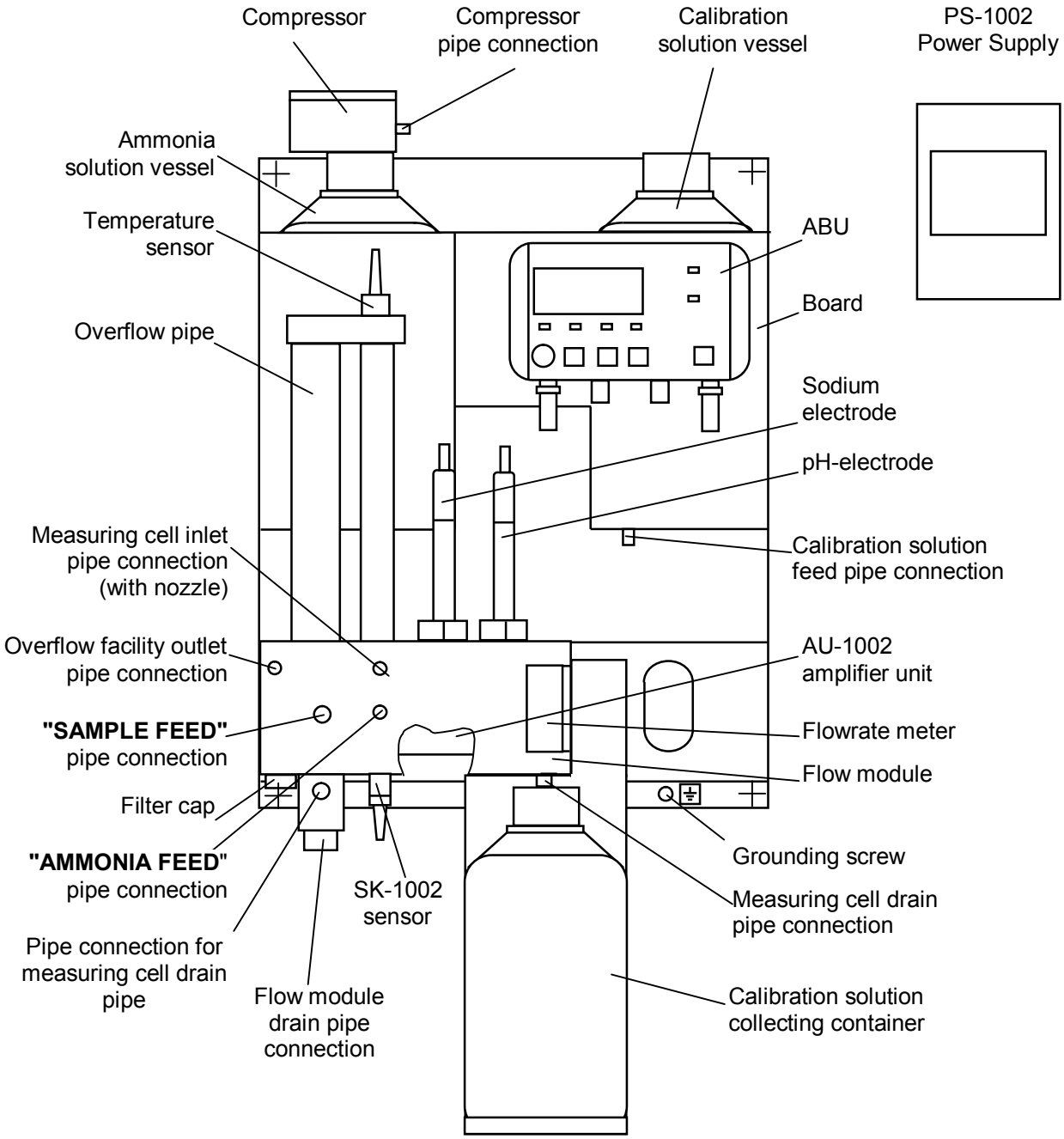


Fig. 1.4 − Basic components of HP-1002 hydraulic panel

All components of the hydraulic panel are mounted on the *panel*.

The tested solution flows from the sampler to the *flow module* which comprises a flow stabilizer and a measuring cell. The tested solution through the "**PROBE SUPPLY**" *pipe* flows to the overflow facility. Excessive solution from the *overflow pipe* is drained through the *flow module drain pipe connection point*.

From the overflow facility the tested solution is fed to the filter for removing mechanical impurities. The filter is packed with a filtering material comprising synthetic wool. The detachable *filter cap* provides for replacement of the wool as required. The tested water goes out of the filter through the *overflow facility outlet pipe connection point* and then through the flexible hose connected to the *measuring cell inlet pipe* flows to the measuring cell.

The measuring cell houses a temperature sensor, the sodium electrode and the pH-electrode.

Ammonia vapors used for raising the tested solution pH, as required, are fed to the measuring cell by means of the *compressor* from the *ammonia solution vessel* through the *compressor pipe connection point* connected via a flexible hose to the "**AMMONIA SUPPLY**" *pipe connection point*. Ammonia flow rate is controlled automatically using the automatic batching device (*ABD*).

PS-1002 power supply provides 24 V DC for the ABD.

Flow rate indicator comprising a drain pipe in open space makes it possible to visually control the tested solution flow through the measuring cell.

Confluent tested water flows from the measuring cell and overflow facility are drained via the *flow module drain pipe connection point*.

For this purpose *the measuring cell (flow indicator) drain pipe connection point* is connected via a flexible hose to the flow module drain pipe.

Calibration solutions are fed to the measuring cell bypassing the overflow facility and filter. Besides, one of calibration procedures implies collection of solution flowing via the measuring cell. Diagram of hydraulic connections required for calibration is given in the appropriate Section. The calibration procedure also implies use of the *calibration solution collecting container*.

For measurements the *calibration solution vessel* is not used.

AU-1002 amplifier unit connections layout is shown in Fig. 1.5.

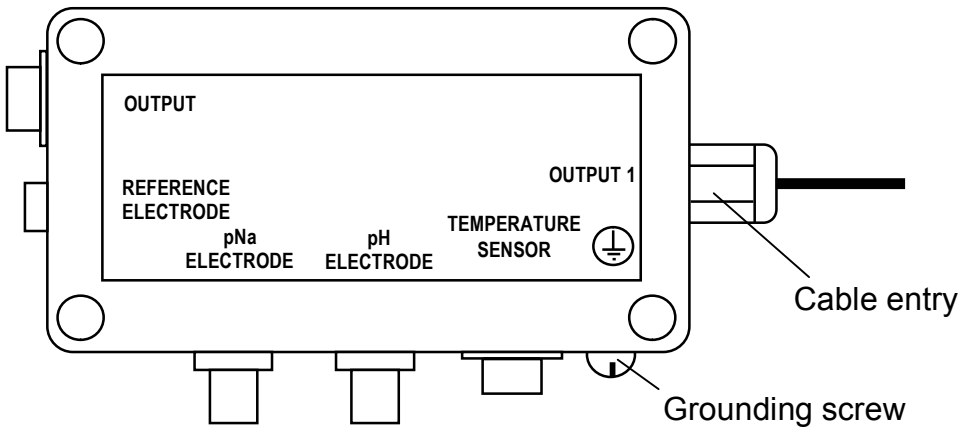


Fig. 1.5 − AU-1002 amplifier unit connection points layout

The sodium electrode, pH-electrode, temperature sensor, and reference electrode are connected in conformity with connection marking. "**OUTPUT**" connection point is connected to "**CHANNEL**" connection point of one of the converter unit channels, and the connection on the cable end running through the "**OUTPUT 1**" *cable entry* is connected to "**AU-1002**" connection point of the ABD.

When ammonia flowrate is controlled, *ABD* controls the compressor and, consequently, saturation of tested water with ammonia.

ABD controls and connections layout is shown in Fig. 1.6.

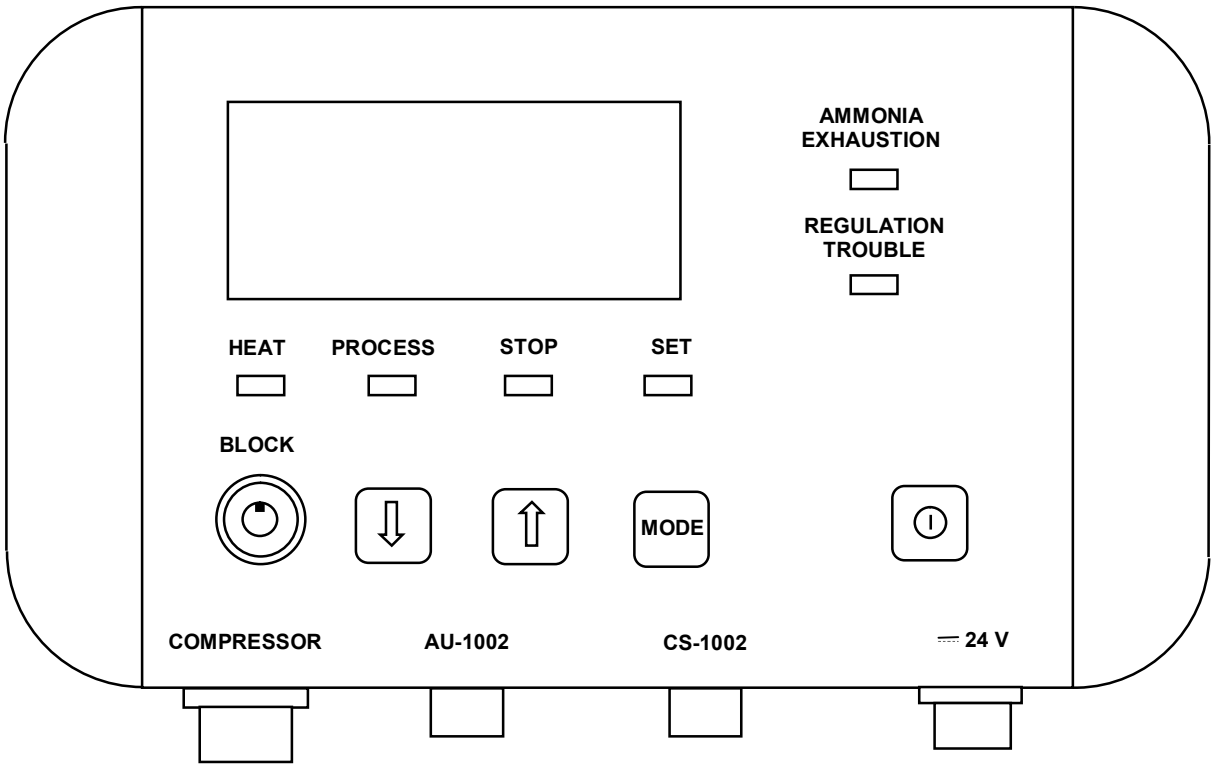


Fig. 1.6 − ABD controls and connections layout

The ABD front panel carries:

- display panel to display ammonia flowrate in nominal units to the measuring cell;
- "⏻" button to turn on and off the ABD. Holding time for button operation is 1 s;
- "**MODE**" button to select operating mode. Modes are selected by depressing alternately the "**MODE**" button which turns on "**PROCESS**" or "**STOP**" LEDs, respectively. If the "**MODE**" button is held for more than 0.5 s, "**SET**" mode is selected;
- " ⇧ ", " ⇩ " buttons to change setting value in "**SET**" mode;
- "**HEAT**" LED indicating operation of the heater located in the ammonia solution vessel. The heater is actuated automatically when ammonia concentration drop below the specified level;
- "**AMMONIA EXHAUSTION**" LED indicating unallowable drop of ammonia concentration in the ammonia solution vessel;
- "**REGULATION TROUBLE**" LED indicating abnormal operation of the automatic ammonia vapor batching unit;
- "**BLOCK**" switch which prevents unauthorized operation of buttons on the ABD front panel.

The following connectors are located on the ABD underside:

- "**COMPRESSOR**" for connection of compressor cable;
- "AU **- 1002**" for connection of AU-1002 cable;
- "CS **- 1002**" for connection of CS-1002 sensor;
- "⎓ **24 V** " for connection of PS-*1002 power supply*.

1.5.3 Measurement displays

1.5.3.1 Types of measurement displays

The analyzer has the following measurement displays:
- single channel (A or B) measurement display as shown in Fig. 1.7, 1.8, 1.9;
- double channel (A and B) measurement display as shown in Fig 1.10.

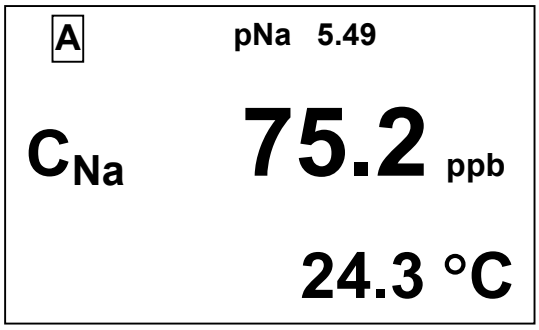


Fig. 1.7

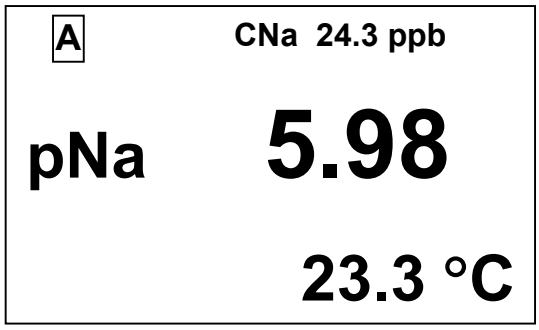


Fig. 1.8

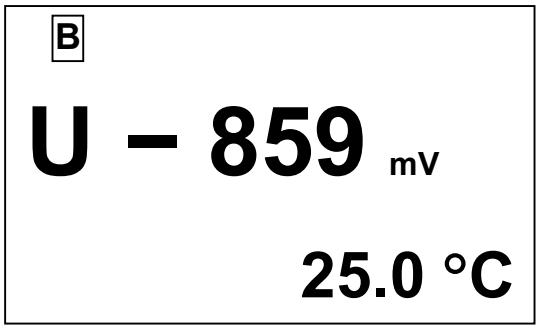


Fig 1.9

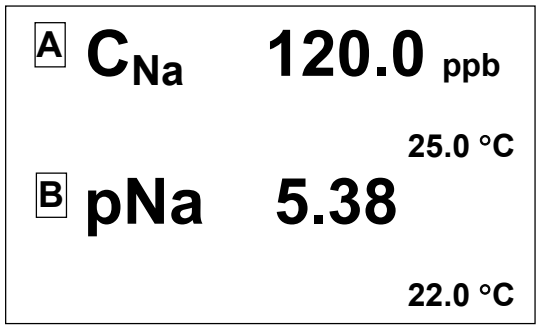


Fig. 1.10

The display indicates channel symbols (A and B) and measured values of C_{Na}, pNa or mV, and temperature.

Single indication mode provides for double indication: C_{Na} and pNa. Major indicated data the units of which are applied to current output and settings is presented in a large typeface, while additional indicated data is given in small typeface in the top of the display.

Measurement channel indications are changed by consecutive depressing "**CHANNEL**" button and the display indicates channel symbols A or B or both.

If the analyzer operates using one hydraulic panel, indication shall refer to the channel connected to the hydraulic panel.

1.5.4 Types of displays for setting value control and change (MENU mode)

1.5.4.1 General information on using **MENU**

Analyzer parameters are controlled and changed using display menus.

To enter **MENU** mode from measurement mode, button "**menu / enter**" is to be pressed.

Analyzer has three display menus:

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

To move from one display menu to another, press "**CHANNEL**" button.

Displays **MENU [A]**, **MENU [B]** show individual channel parameters as demonstrated in Fig. 1.11.

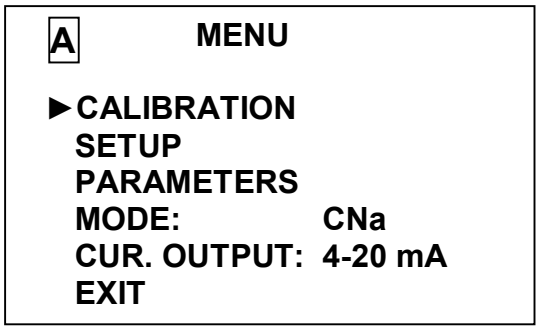


Fig. 1.11

Display **MENU [A] [B]** shows the analyzer parameters common for both measurement channels as demonstrated in Fig. 1.12.

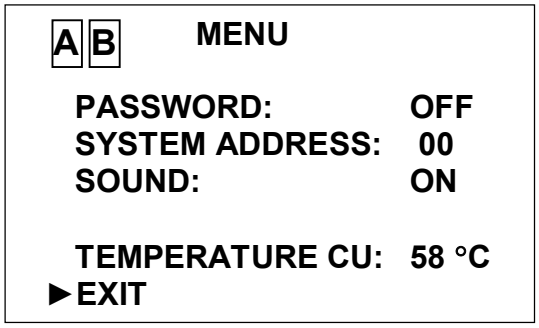


Fig. 1.12

The required line in the menu is selected by the pointer "►". To move the pointer "►" up and down, use " ⇩ ", " ⇧ " buttons.

When the pointer "►" is moved to the line required, press "**menu / enter**" button.

To exit from **MENU** displays, highlight the **EXIT** line and press "**menu / enter**" button.

1.5.4.2 Procedure for typing numerical values in **MENU [A]**, **MENU [B]** and **MENU [A] [B]**

The analyzer provides for, if required, changing numerical values in lines or enter new ones. This applies, for instance, to selection of measurement range against current output, entry of setting values, entry of C_{Na} values during calibration and more.

To move along the line to the left, use "**CHANNEL**" button.

To move along the line to the right, use "**menu / enter**" button.

To increase or decrease values, use " ⇩ ", " ⇧ " buttons.

To change units of measurement (ppt, ppm, ppb), use " ⇩ ", " ⇧ " buttons.

To enter or change a numerical value, proceed as follows:

- set the pointer "►" against the line required;
- press "**menu / enter**" button. The first digit shall blink;
- using " ⇩ ", " ⇧ " buttons, set value of the first digit;
- press "**menu / enter**" button. The second digit shall blink;
- using " ⇩ ", " ⇧ " buttons, set value of the second digit;
- press "**menu / enter**" button. Set other digits.

After all digits and measurement units are set (when neither any digit, nor measurement unit blinks), using " ⇩ ", " ⇧ " buttons set the pointer "►" against another line and set the second value, if required.

After all digits and measurement units are set (when neither any digit, nor measurement unit blinks), using " ⇩ ", " ⇧ " buttons set the pointer "►" against **EXIT** line and press "**menu / enter**" button.

1.5.4.3 Use of display **MENU [A]** and **MENU [B]** (Fig. 1.13)

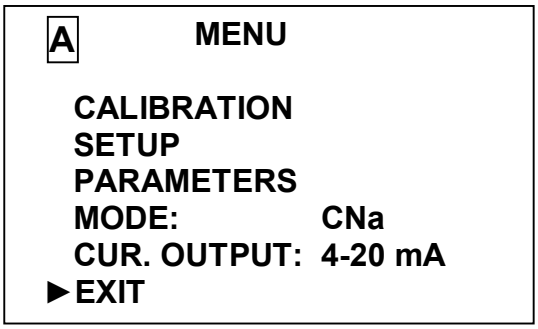


Fig. 1.13

► **CALIBRATION** is a line in the **MENU [A], MENU [B]** used to select analyzer calibration mode (refer to 2.3.6, 2.3.7).

► **SETUP** is a line in the **MENU [A], MENU [B]** used to view and change C_{Na} or pNa measurement range against current output as well as to view and change minimum and maximum C_{Na} or pNa setting values.

The display is shown in Fig. 1.14.

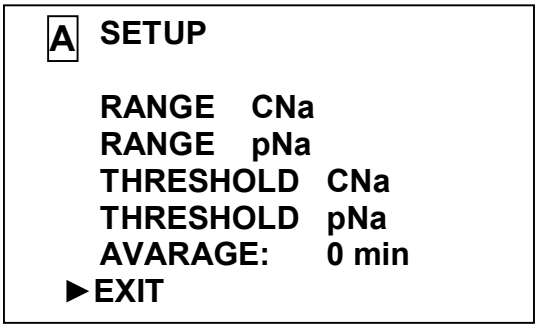


Fig. 1.14

► **RANGE CNa**

Submenu display is shown in Fig. 1.15.

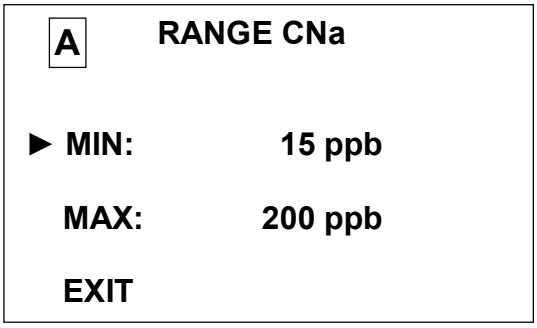


Fig. 1.15

In **MIN** line values from 0 to 1990 ppb with increment of 1 ppb may be set.

In **MAX** line values from 5 to 2000 ppb with increment of 1 ppb may be set.

After measurement range values are set (there are no blinking characters) set the pointer "►" against **EXIT** line and press "$\frac{\textbf{menu}}{\textbf{enter}}$" button.

The analyzer shall change to **SETUP** submenu.

► **RANGE pNa**

Submenu display is shown in Fig. 1.16.

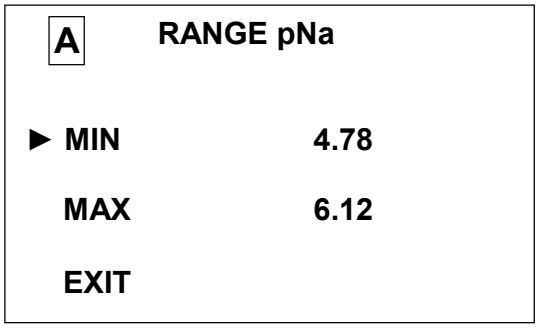


Fig 1.16

In **MIN** line values from 4.06 to 8.26 pNa (with increment of 0.01 pNa) may be set, and in **MAX** line values from 4.16 to 8.36 pNa (with increment of 0.01 pNa) may be set.

Difference between values of pNa in **MAX** and **MIN** lines is at least 1 pNa.

► THRESHOLD CNa

Submenu display is shown in Fig. 1.17.

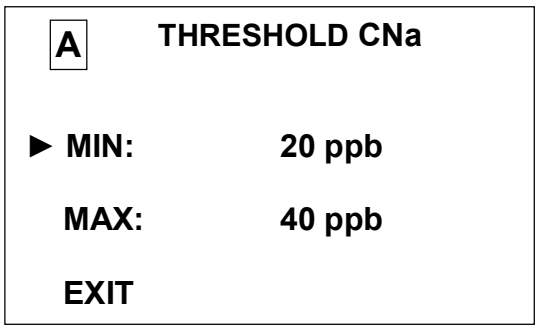


Fig. 1.17

If C_{Na} values go beyond setting limits, "dry" relay contacts connected to the "**ALARM**" connector on the MAPK-1002 and MAPK-1002/P analyzer back panel and MAPK-1002/1 and MAPK-1002/1P analyzer underside close.

In **MIN** line values from 0 to 1990 ppb with increment of 1 ppb may be set.

In **MAX** line values from 1 to 2000 ppb with increment of 1ppb may be set.

► THRESHOLD pNa

Submenu display is shown in Fig. 1.18.

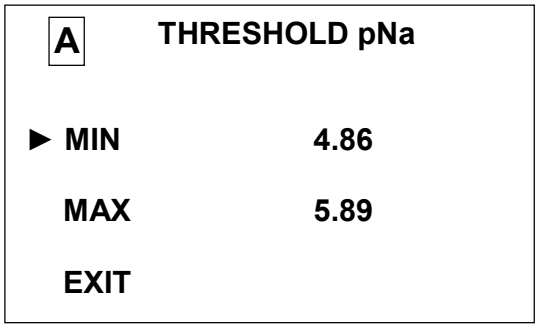


Fig. 1.18

In **MIN** line pNa values from 4.06 to 8.26 (with increment of 0.01 pNa) and in **MAX** line pNa values from 4.16 to 8.36 (with increment of 0.01 pNa) may be set.

► **AVERAGE** is the submenu line intended to set time of electrode system signal averaging.

Averaging time is set within the range from 0 to 9 min.

Averaging time is changed using " ⇩ ", " ⇧ " buttons.

► **PARAMETERS** is a line in **MENU [A], MENU [B]** intended to view and select electrodes and parameters of calibration.

Submenu display is shown in Fig. 1.19.

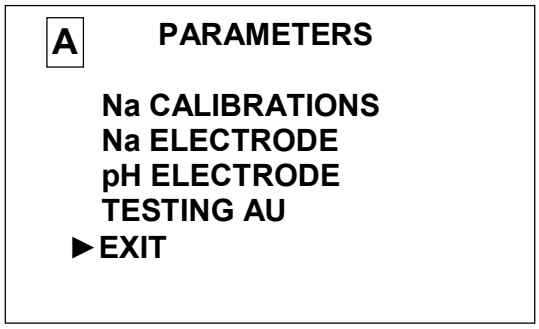


Fig. 1.19

► **Na CALIBRATIONS** is a submenu line used to overview the list of last calibrations from the analyzer storage.

Moving the pointer ► to this line and pressing "**menu / enter**" button shall cause **Na CALIBRATION PARAMETERS** submenu display as shown in Fig. 1.20.

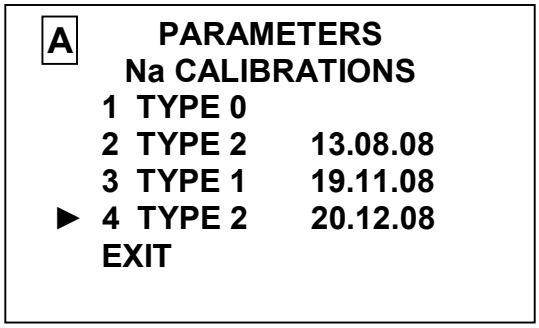


Fig. 1.20

The analyzer storage keeps **TYPE 0** calibration data calculated on the basis of electrode theoretical (certificate) data and data of three last calibrations including type (**TYPE 1** or **TYPE 2**) and date of calibration. Applicable parameters comprise parameters of the last calibration indicated in the list and having No 4.

The next calibration shall erase calibration No 2 data and parameters of the new calibration shall appear in the end of the list against No 4.

If to move pointer to line No 4 and press "**menu** / **enter**" button, the display shall appear as shown in Fig. 1.21.

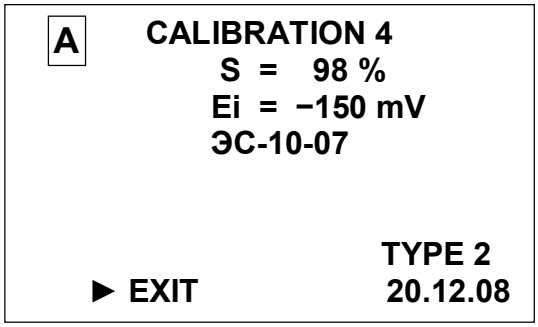


Fig. 1.21

The following data of the applicable calibration may be viewed which may be neither changed nor deleted:

S – electrode curve slope in % of the nominal value;

Ei – electrode isopotential point coordinate, mV.

If to move pointer to line No 3 and press "**menu** / **enter**" button, the display shall appear as shown in Fig. 1.22.

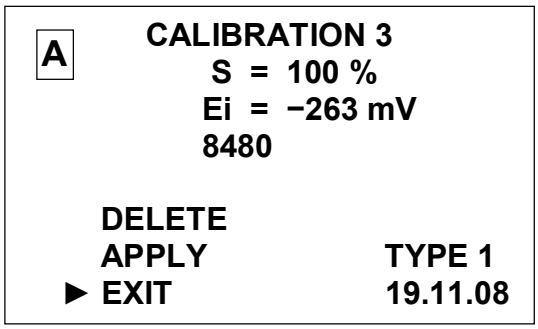


Fig. 1.22

Calibration data may be viewed.

If to move pointer to **DELETE** line and press "**menu** / **enter**" button, calibration data shall be deleted from the analyzer storage and calibration list.

If to move pointer to **APPLY** line and press "**menu** / **enter**" button, calibration data shall be applied during measurement and in the calibration list it shall move to line No 4.

"**TYPE 0**" calibration is the first in the list which is calculated on the basis of electrode theoretical (certificate) data. If to move pointer to this line and press "**menu**/**enter**" button, the display shall appear as shown in Fig. 1.23.

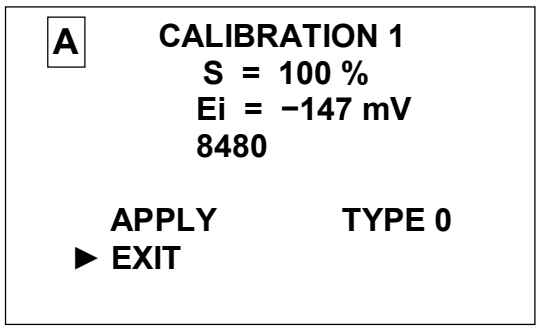


Fig. 1.23

If to move pointer to **APPLY** line and press "**menu**/**enter**" button, calibration data shall be applied during measurement and in the calibration list it shall move to line No 4.

► **Na ELECTRODE** is the submenu line intended to view the sodium electrode parameters and select α factor according to the type of electrode used.

The display is shown in Fig. 1.24.

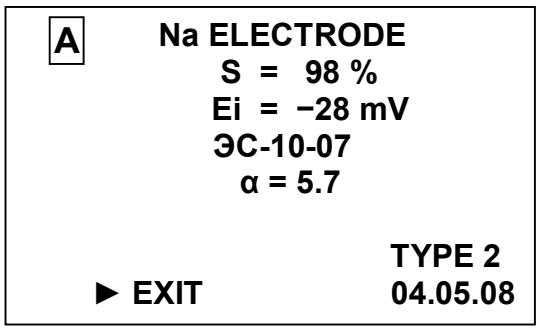


Fig. 1.24

The display shall show the sodium electrode data determined on the basis of the calibration used:

S – electrode curve slope in % of the nominal value;

Ei – pNa electrode isopotential point coordinates, mV.

Next lines show the type of the electrode used and α factor value for such type of electrode.

To change type of electrode used move pointer "►" to this line and press "**menu**/**enter**" button. This shall cause "**CHOOSE α**" display shown in Fig. 1.25 with the list of electrodes, parameters of which are kept in the analyzer storage.

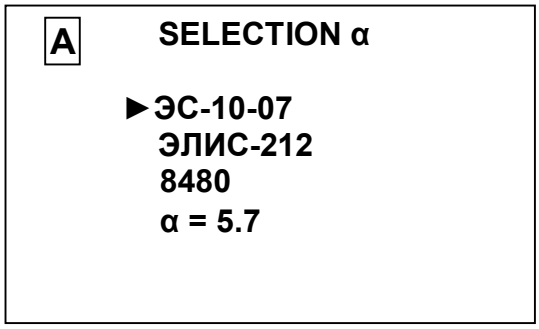


Fig. 1.25

The pointer "►" shall be set against the line indicating the type of electrode used. To change an electrode move the pointer to the line indicating another type of electrode or enter α factor value manually.

Value of the α factor may be changed **only** on advice of the analyzer manufacturer.

α factor has the following established values:

- **5.7** for ЭС-10-07, ЭЛИС-212Na/3, DX 223 electrodes;
- **4.2** for 8480B electrode.

To exit from "SELECTION α" display, press "**menu** / **enter**" button. This shall cause the display as shown in Fig. 1.24.

If type of electrode and α factor value are changed, when exiting from the display shown in Fig. 1.25, one shall see the reminder display as shown in Fig. 1.32 with a notice to carry out calibration.

► **pH ELECTRODE** is the submenu line intended to view the pH electrode parameters resulting from the latest calibration. Move the pointer "►" to the menu line and press "**menu** / **enter**" button.

The analyzer screen shall show the display as shown in Fig. 1.26.

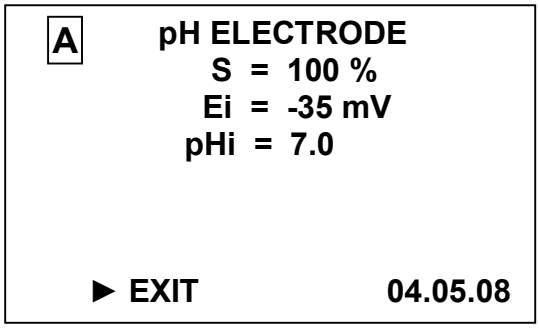


Fig. 1.26

The display shall show pH-electrode parameter values determined on the basis of the last calibration data:

S – electrode curve slope in % of the nominal value;

Ei and **pHi** – pH-electrode isopotential point coordinates.

To exit from the display, press "**menu** / **enter**" button.

► **TESTING AU** is the submenu line intended for moving to "**TESTING AU** " mode used for the converter unit test in compliance with TU ("Technical Conditions", a Russian standard).

ATTENTION: When measuring, this mode is not used!

► **MODE** is a **MENU [A], MENU [B]** line used to select analyzer indication modes (C_{Na}, pNa, mV).

To change indication mode, move the pointer "►" to this menu line. Each time the button "**menu** / **enter**" is pressed, analyzer consecutively moves to measurement modes C_{Na}, pNa, mV.

Once the indication mode required is selected, move pointer "►" to **EXIT** line using " ⇩ ", " ⇧ " buttons and press "**menu** / **enter**" button.

The analyzer shall enter into the mode of the selected parameter measurement.

►**CURRENT OUTPUT: 0-5 mA** is a **MENU [A], MENU [B]** line is used to select analyzer current output range (0-5 mA, 4-20 mA or 0-20 mA).

To select a current output range, move pointer "►" to this menu line and press "**menu** / **enter**" button. Current output range shall change.

1.5.4.4 Use of display **MENU [A] [B]**

Display **MENU [A] [B]** as shown in Fig. 1.27 makes it possible to change analyzer parameters shared by both channels.

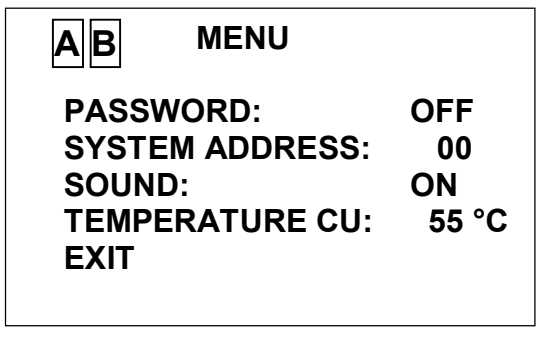


Fig. 1.27

Operation of the display menu is similar to operation of the display **MENU [A]**, **MENU [B]**.

► **PASSWORD: ON** is a **MENU [A] [B]** line used to limit opportunities to change analyzer parameters.

If password is off "**PASSWORD: OFF**", moving from measurement mode to **MENU** mode is possible without requesting the password.

If password is on "**PASSWORD: ON**", when moving from measurement mode to **MENU** mode analyzer shall request the user to enter the password (number **12**).

This shall cause the display as shown in Fig. 1.28.

Fig. 1.28

Enter password (number "**12**") and press "**menu / enter**" button.

If the password is correct, **MENU** display shall appear. If the password is wrong, the analyzer shall return to the measurement mode.

► **SYSTEM ADDRESS: 00** is a **MENU [A] [B]** line used to identify a network address when a few operating analyzers are combined in a single network through RS-485 interface. The network address identifies an analyzer in the network and has numbers from "**00**" to "**32**". Operation beyond a network makes the network address dispensable.

► **TEMPERATURE CU:** is a **MENU [A] [B]** line used to indicate temperature inside the converter unit casing.

1.5.4.5 Warning and failure displays

Warning display, as shown in Fig. 1.29, shall appear in case of discrepancy between calibration data and parameters of the sodium electrode used.

Fig. 1.29

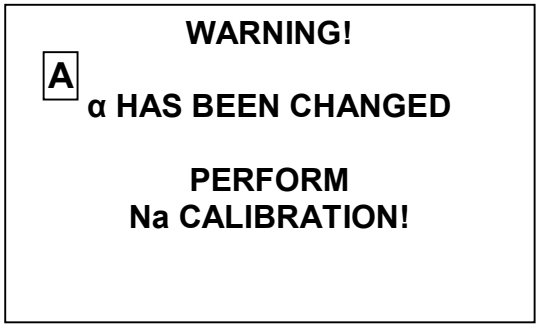
Warning display, as shown in Fig. 1.30, shall appear, when a connecting cable from AU-1002 amplifier unit is not connected to an appropriate "**CHANNEL**" connector of A or B channel.

Fig. 1.30

Warning display, as shown in Fig. 1.31, shall appear if the connecting cable fails. Refer to 2.5 of the Operation Manual (Troubleshooting. Table 2.4).

Fig. 1.31

Warning display, as shown in Fig. 1.32, shall appear if α factor changes. When the "**menu**/**enter**" button is



pressed, the analyzer shall move to Na calibration mode.

Fig. 1.32

Warning display, as shown in Fig. 1.33, shall appear when a failure occurs during pH-electrode calibration if a buffer solution is not established. When this display appears, refer to 2.5 of the Operation Manual (Trouble-shooting. Table 2.4).

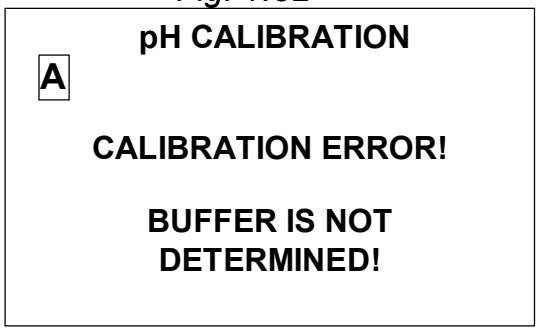


Fig. 1.33

Warning display, as shown in Fig. 1.34, shall appear when the ABD fails.

Fig. 1.34

When warning displays appear, as shown in Fig. 1.35-1.40, blinking indications shall disappear once overload in the parameter indicated is removed including: temperature, C_{Na}, pNa, or mV.

Warning display, as shown in Fig. 1.35, shall appear when C_{Na} value measured goes beyond the limits of the preset C_{Na} measurement range against current outputs. In this case an appropriate C_{Na} measurement range against current output is to be set.

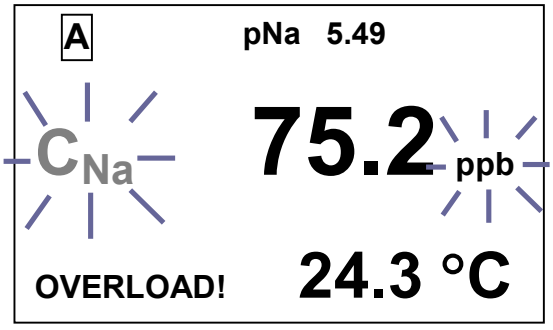
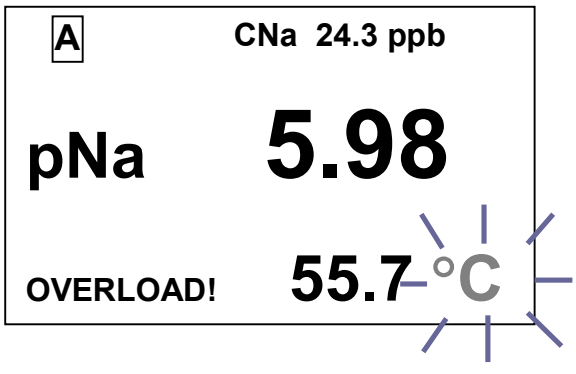


Fig. 1.35

Warning display, as shown in Fig. 1.36, shall appear when temperature of the solution tested goes be-



yond the range limits (from 0 to plus 50 °C).

Fig. 1.36

Warning display, as shown in Fig. 1.37, shall appear when temperature of the solution tested goes beyond the range limits (from 0 to plus 50 °C) and pNa value measured goes beyond the limits of the preset pNa measurement range against current outputs.

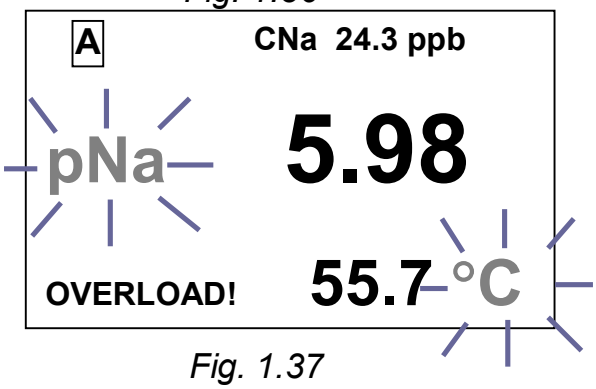
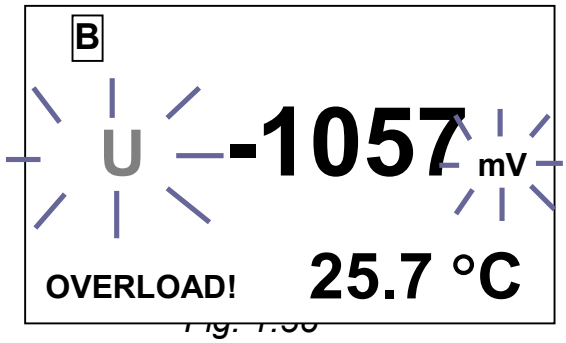


Fig. 1.37

Warning display, as shown in Fig. 1.38, shall appear when mV value measured goes beyond the range limits (from minus 1000 to plus 1000 mV).



Warning display, as shown in Fig. 1.39, shall appear when pNa value measured falls beyond the low setting limit.

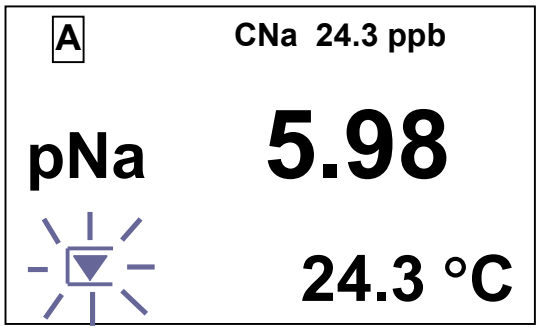


Fig. 1.39

Warning display, as shown in Fig. 1.40, shall appear when the value measured falls beyond:

− the lower setting limit for pNa in A channel;

− the upper setting limit for C_{Na} in B channel.

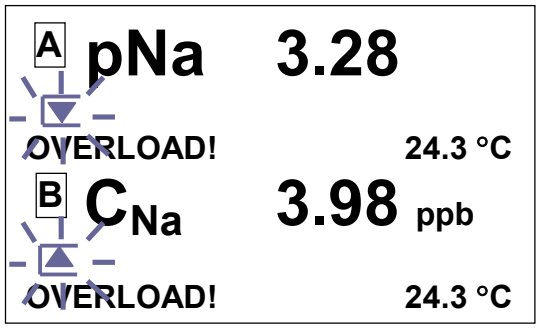


Fig. 1.40

1.6 Instrumentation, tools and accessories

The analyzer maintenance requires additional tools and accessories which are not included in the delivery set and tabulated in table 1.9.

Table1.9

Description	Specifications	Qty
Thermometer	Measurement range from 0 to 55 °C, division 0.1 °C	1
Analytical balance	Weighing range from 0,02 to 150 g Maximum weighing error ± 5 mg	1
Analytical balance	Weighing range from 0,5 to 1,500 g Maximum weighing error ±30 mg	
Liquid thermostat	Temperature range from 0 to 100 °C, Maximum temperature holding error ±0,2 °C	1
2-1000-2 volumetric flasks	1000 cm^3	3
Plastic volumetric flasks	1000 cm^3, class B	1
2-1-2-10 pipette	10 cm^3	1
2-2-50 pipette	50 cm^3	1
2-2-100 pipette	100 cm^3	1
Reagent grade sodium chloride		
Aqueous ammonia, high-purity 23-5		
Purified water		

Note – Other instruments and equipment may be used provided they have similar or better characteristics.

2 2 INTENDED USE

2.1 Operating Limitations

2.1.1 If the analyzer complete set includes a panel-type converter unit, it should be installed so that water ingress is prevented since the casing of the unit is of IP30 protection level.

2.1.2 During analyzer operation protect electrodes and the converter unit from hits since they have glass elements.

2.1.3 Do not take measurements of C_{Na}, pNa and temperature in solutions containing hydrofluoric acid or salt thereof and substances that deposit or form films on the electrode surfaces.

2.1.4 Do not keep electrodes dry, since sodium electrodes completely degrade when dried.

2.2 Safety Precautions

2.2.1 The analyzer is to be operated only by personnel who have read this manual, existing electrical equipment manuals and reagent operating procedures.

2.2.2 When working with high-purity aqueous ammonia solution, wear personal protective equipment in compliance with standard industry rules. Prevent ammonia solution ingestion, skin and eye contact.

2.2.3 The space with working HP-1002 hydraulic panel must be equipped with suction-and-exhaust ventilation.

2.2.4 Fill containers with high-purity aqueous ammonia for preparation of ammonia solution under an exhaust hood.

2.2.5 Service personnel must be instructed and qualified for operation of electrical equipment rated for voltage up to 1,000 V in compliance with current safety regulations.

2.2.6 Do not operate the analyzer with the converter unit and PS-1002 power supply hoods removed and converter unit casing and HP-1002 hydraulic panel board ungrounded.

2.2.7 The electrical circuits that provide connection to "**RS-485**", "**CURRENT OUTPUT**" and "**ALARM**" connector must use a shielded cable.

2.3 Making analyzer available for use

2.3.1 Analyzer receiving procedure

When receiving the analyzer, open packing container, check completeness of the delivery set and make sure that the packed items are intact.

After holding the analyzer in cold conditions keep it at room temperature for at least 1 hour and then make it available for operation.

2.3.2 Making converter unit available for use

2.3.2.1 Converter unit installation

Install the converter unit in a location accessible for disconnection of the analyzer from the power source.

The panel-type converter unit mounting holes are shown in Fig. 2.1.

The panel-type converter unit is mounted on the inner side of the board. The faceplate in the delivery set of the panel-type converter unit is mounted on the front side of the board.

M5 screws with nuts completing the delivery set are to be used for fixing.

Layout of holes for mounting the panel-type converter unit on the vertical surface is shown in Fig. 2.2.

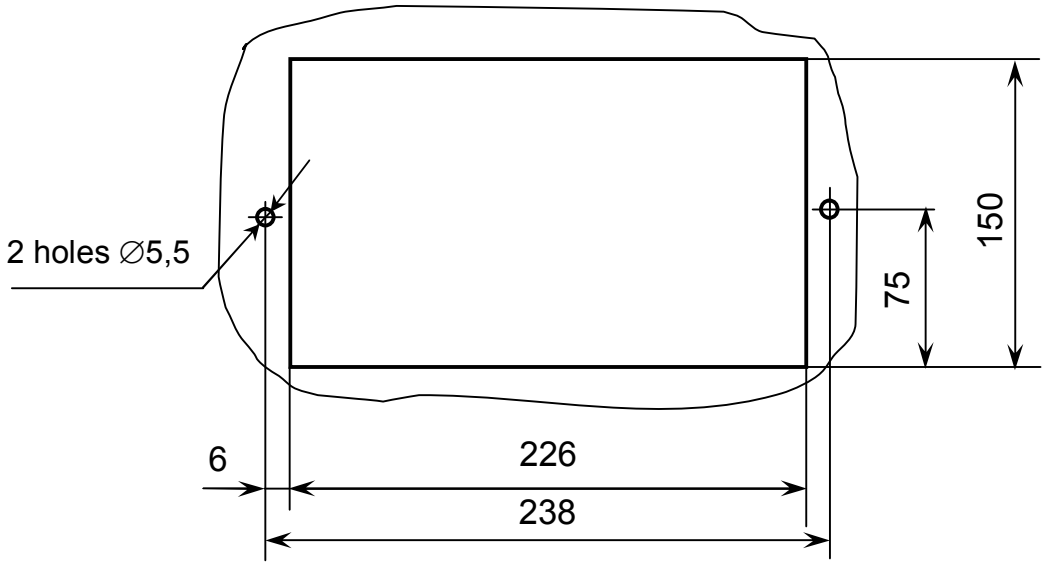


Fig. 2.1 − Layout of holes for mounting the panel-type converter unit

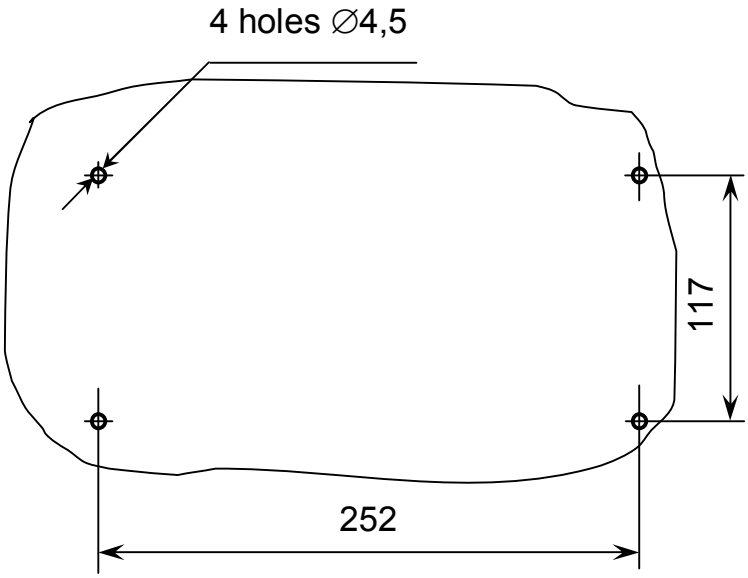


Fig. 2.2 − Layout of holes for mounting the wall-mounted converter unit

Connect 220 V, 50 Hz power supply.

Ground the converter unit casing using a copper wire of at least 0.35 mm^2 section which is connected to the casing grounding terminal.

2.3.2.2 Converter unit external connections

Connection to the converter unit is provided through jacks on the rear panel of the panel-type converter unit and on the underside of the wall-mounted converter unit according to Fig. 1.2 and 1.3.

2.3.2.3 Connection of the external recorder

Connection of the external recorder to the converter unit is provided through "**CURRENT OUTPUT**" connector using PC4TB socket from the mounting accessories set according to table 2.1.

Table 2.1

Contact No	1	2	3	4
Circuit	Channel A (+)	Channel A (–)	Channel B (+)	Channel B (−)

Contact 2 and 3 are interconnected.

Arrangement of contacts in PC4TB socket is shown in Fig. 2.3 (view from contact soldering side).

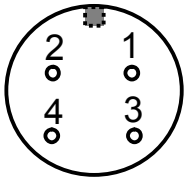


Fig. 2.3

In 4-20 mA range load shall not exceed 500 Ω.

In 0-5 mA range load shall not exceed 2 kΩ.

2.3.2.4 Connection of RS-485 interface

Port RS-485 is connected to the converter unit through a shielded cable with earthed shield in compliance with table 2.2 using PC7TB socket from the mounting accessories set.

Table 2.2

Contact	Circuit
5	SG (signal ground)
6	DAT+ (Data +)
7	DAT- (Data -)

ATTENTION: Connect computer to the converter unit when both are de-energized!

Arrangement of contacts in PC7TB socket is shown in Fig. 2.4 (view from contact soldering side).

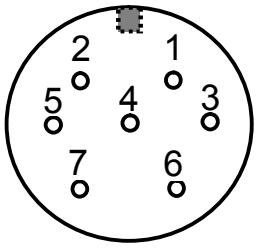


Fig. 2.4

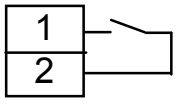
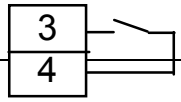
Rate of exchange is 19200 bit/s.

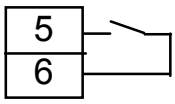
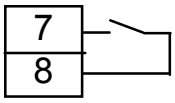
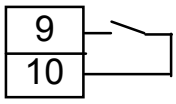
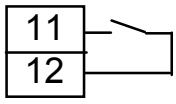
2.3.2.5 Connection of external operational units and attention devices

External actuators, indicators and alarms are connected to the converter unit through "**ALARM**" connector using PC19TB socket from the mounting accessories set.

If measured values of C_{Na}, pNa, mV and temperature of tested solution fall beyond the preset limits, the "dry" relay contacts complete the circuits between PC19TB socket contacts as shown in table 2.3.

Table 2.3

Parameter measured	Channel	Value of measured parameter	Numbers of contacts completing circuit
Measured values of C_{Na}, ; pNa; mV	A	overrange	
Measured temperature value, °C		above 70°C	
Measured values of C_{Na}, ppb, pNa, mV	B	overrange	
		above 70°C	

Measured temperature value, °C			
Measured values of C_{Na}, ppb; pNa	A	below MIN setting value	
		above MAX setting value	
	B	below MIN setting value	
		above MAX setting value	

Setting values are changed according to 1.5.5.

Maximum switching current is 150 mA at 36 V AC.

Arrangement of contacts in PC19TB socket is shown in Fig. 2.5 (view from contact soldering side).

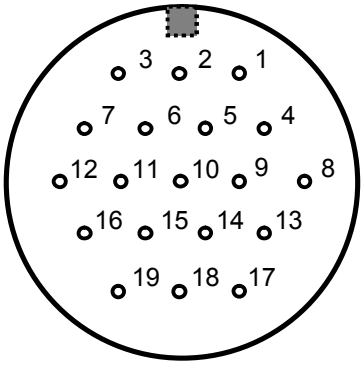


Fig. 2.5

2.3.3 HP-1002 hydraulic panel pre-operation procedures

Mount HP-1002 hydraulic panel in a convenient location in close vicinity of the sampler. Arrangement of holes for securing the hydraulic panel is shown in Fig. 2.6.

Place PS-1002 power supply in a location convenient for connection to 220 V, 50 Hz mains. Arrangement of holes for securing the power supply is shown in Fig. 2.7*a*.

Prepare the sodium electrode in conformity with the electrode certificate.

Prepare the pH-electrode in conformity with the electrode certificate.

To install electrodes, unscrew the appropriate coupling nut for electrode securing from the flow module, remove a rubber O-ring and plexiglas ring.

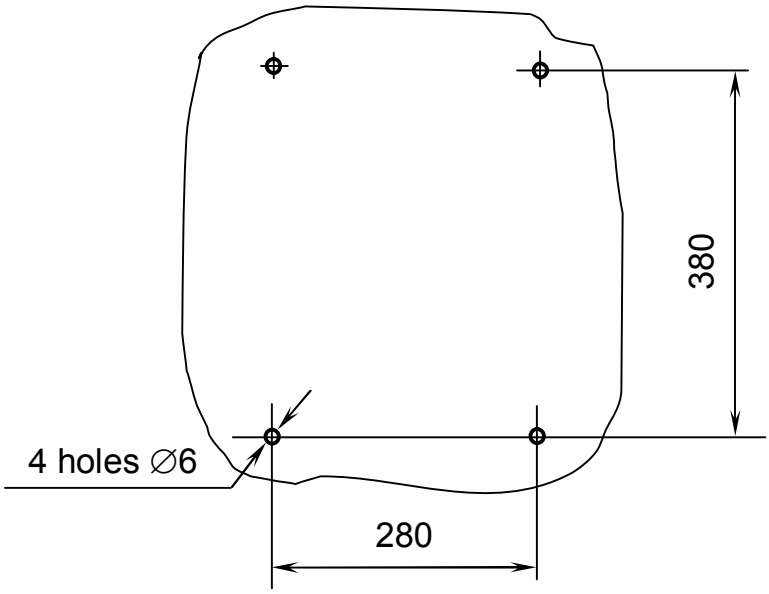
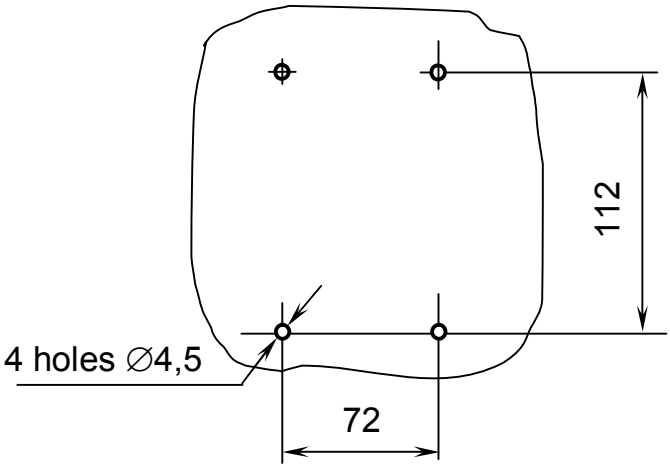


Fig. 2.6 − Arrangement of holes for securing the HP-1002 hydraulic panel



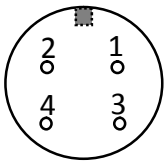
a

Power supply DR-4524

Circuit	Contact
+V	1
+V	2
-V	3
-V	4
GND	5
N	6
L	7

Socket PC4TB

Contact	Circuit
1	+V
2	+V
3	GND
4	GND



(view from contact bending side)

b

Fig. 2.7 − Arrangement of holes for securing the PS-1002 power supply and scheme of cable connection

As shown in Fig. 2.8, put the screw, the plexiglas ring with chamfer downward and the rubber O-ring onto the electrode from below.

The electrode lower edge and the rubber O-ring should be about 40 cm apart.

Install the electrode in the socket in the flow module as shown in Fig. 2.8 and tighten the coupling nut.

Connect electrode connectors to the appropriate connectors of AU-1002 amplifier unit.

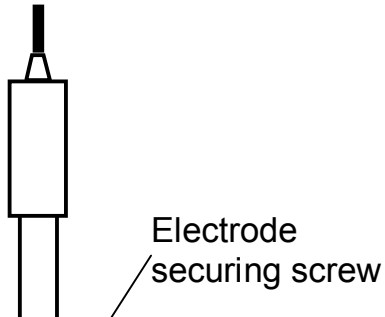


Fig. 2.8

Hydraulic panel connections diagram for calibration against Na is shown in Fig. 2.9.
Hydraulic panel connections diagram for measurements is shown in Fig. 2.42.

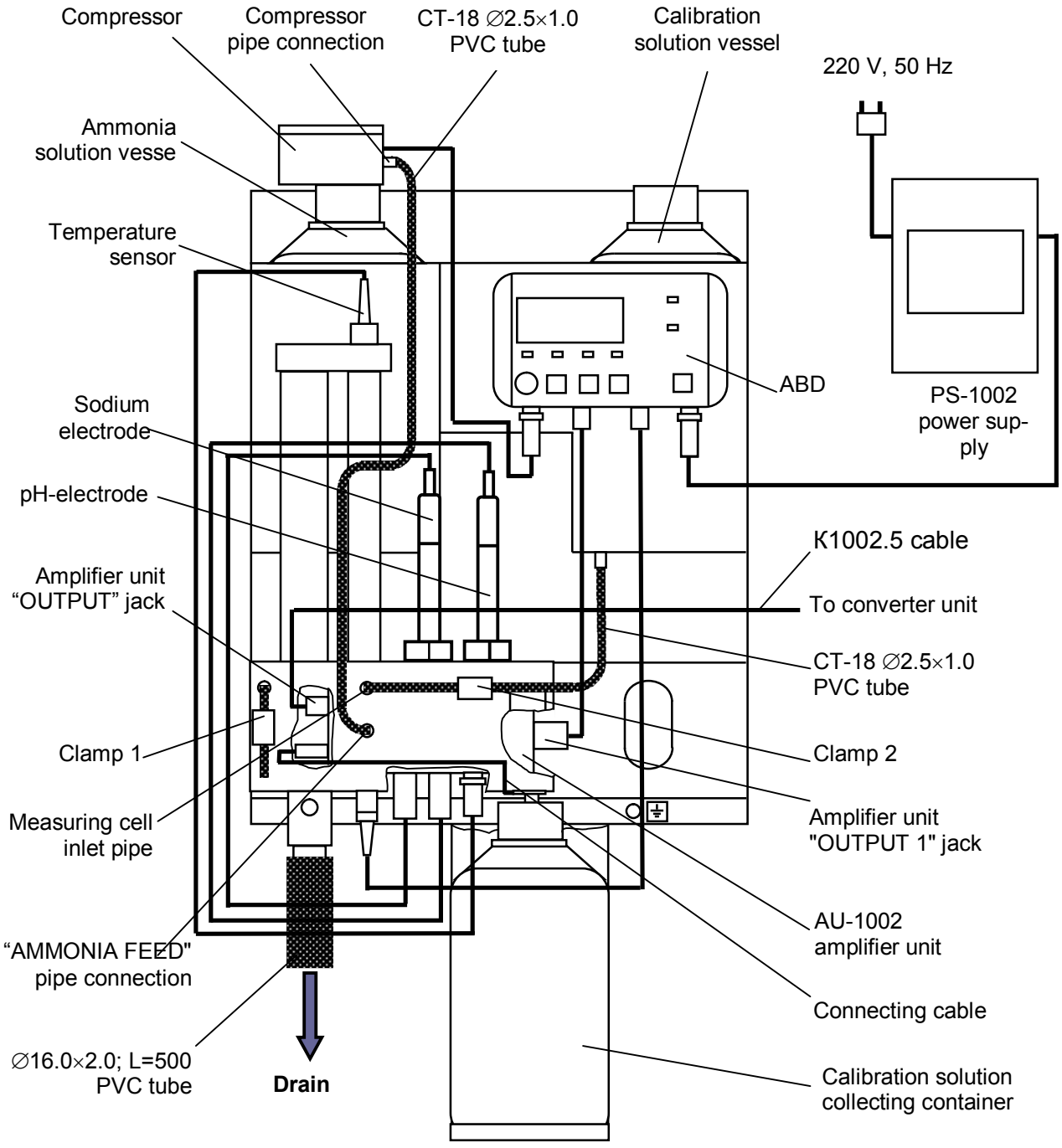


Fig. 2.9 − Hydraulic panel connections diagram for C_{Na} calibration

If ambient air temperature does not exceed 30 °C, fill the vessel for ammonia solution with 1 dm^3 of reagent grade concentrated aqueous ammonia solution 23-5 according to 2.5.6.

If ambient air temperature exceeds 30 °C, reagent grade aqueous ammonia 23-5 before filling is to be diluted in the ratio 1:1.

Connect the amplifier unit to the "**sensor A**" or "**sensor B**" jack of the converter unit using К1002.5 or К1002.L cable from the delivery set.

If the delivery set includes two hydraulic panels, make the second electrode set available in a similar way and connect it to the second amplifier unit.

Once the electrodes are installed in the flow module, fill it immediately with water from the sampler, feeding water in compliance with the connections diagram shown in Fig. 2.42. Once water has appeared in the flowmeter, shut off water supply. The measuring cell shall be filled with water.

The flow module may be filled with distilled water. To do so, fill the vessel for calibration solution with distilled water and unscrew the clamp 1. The connections diagram is shown in Fig. 2.9. Once water has appeared in the flowmeter, tighten the clamp 1. The measuring cell shall be filled with water.

1 ATTENTION: When filling the measuring cell with water AVOID OVERFLOW in the flowmeter providing water drain!

2 ATTENTION: GROUND the board of the hydraulic panel and amplifier unit using copper wires of at least 0.35 mm^2 section by connecting them to the earthing screws of the hydraulic panel and amplifier unit!

Once hydraulic panel preliminary operating procedures are over, turn on "**POWER**" switch on the converter unit. The green indicator light on the front panel shall come on. Converter unit activation is accompanied by an audio signal. In a few seconds the analyzer shall be in the measurement mode.

2.3.4 Controlling and changing analyzer parameters

To do so:

– press "$\frac{\textbf{menu}}{\textbf{enter}}$" button. The analyzer shall enter into the mode of controlling and changing parameters of one of the channels and the display shown in Fig. 1.8 shall appear, for instance, **MENU [A]**;

– check (or set) parameters of the channel in compliance with point 1.5.4;

– change the analyzer to the mode of controlling and changing parameters of the second channel, using "**CHANNEL**" button;

– check (or set) parameters of the second channel in compliance with point 1.5.4;

– press "**CHANNEL**" button. The analyzer shall enter into the mode of controlling parameters common for both channels A and B and the **MENU [A] [B]** display shown in Fig. 1.9 shall appear;

– check (or set) parameters common for channels A and B in compliance with point 1.5.4.

ATTENTION: If another type of sodium electrode is installed on the hydraulic panel, one needs to change the type of the electrode used in PARAMETERS menu, or select another α factor and then carry out calibration against sodium ion concentration!

2.3.5 Ammonia Baching Unit (ABD) Preparation

Turn on the ABD using button " ⏻ " on the front panel thereof. Check setting value. To do so, press "**MODE**" button and keep it pressed for at least 1 s. The ABD display panel shall show the value of adjustment setting in nominal units.

The value of adjustment setting for electrodes of all types is 100 units.

For ЭС-10-07 glass sodium electrode setting value may be equal to 70 units. In this case ammonia flowrate drops approximately two-fold.

If setting value differs from the recommended value, set the value required using buttons "⇩" and " ⇧" on the ABD front panel. Using "**MODE**" button move to "**PROCESS**" mode and turn off the ABD.

When compressor is started up for the first time after long-term storage in dry conditions, there may be sticking of the outlet valve to be remedied in compliance with 2.5.5.

2.3.6 pH-electrode calibration

pH-electrode shall be calibrated:

- once every 6 months;
- if readings seem to be doubtful.

2.3.6.1 Pre-calibration procedures

Connections of electrodes to AU-1002 amplifier unit for pH-electrode calibration are shown in Fig. 2.10.

Pull out the connecting cable plug from the socket of "**REFERENCE ELECTRODE**" connector and insert the reference electrode plug from the tools and accessories kit.

Note − Connections that do not play any role in pH-electrode calibration are shown in Fig. 2.10 by thinner lines.

Remove the temperature sensor and pH-electrode from the flow module.

pH-electrode must be calibrated at buffer solution temperature of (20.0 ± 5.0) °C and the difference between temperatures of two buffer solutions shall not exceed ± 2 °C.

Open the reference electrode filling hole before calibration.

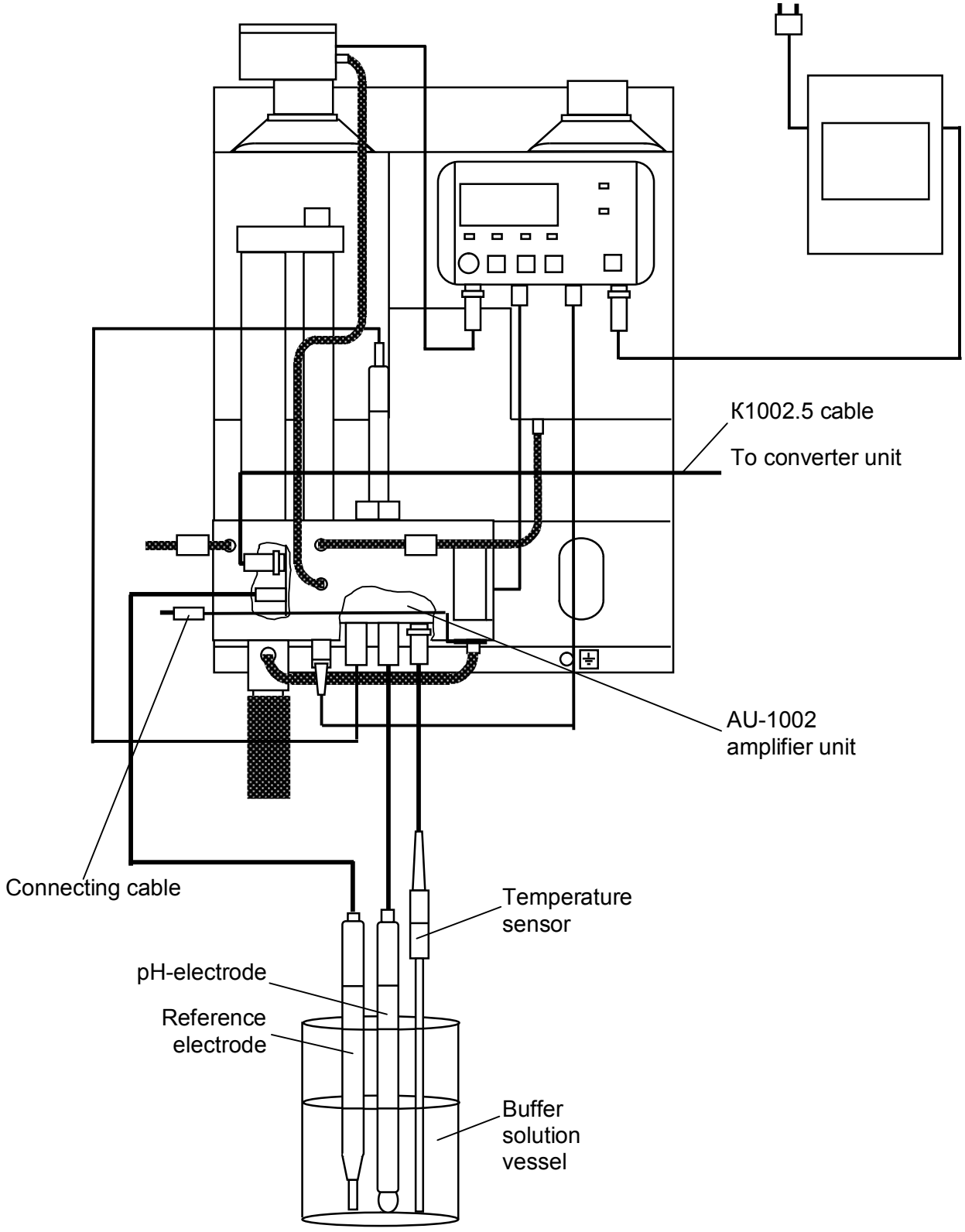


Fig. 2.10 − Connections of electrodes to AU-1002 amplifier unit for pH-electrode calibration

2.3.6.2 pH-electrode calibration procedure

1 Rinse pH-electrode, temperature sensor and reference electrode, first, in distilled water (in two vessels in a row) and then in the first buffer solution against which calibration is to be carried out where pH=1.65 at solution temperature of (25.0 ± 0.2) °C.

2 Place electrodes and temperature sensor, as shown in Fig. 2.10, in the first fresh buffer solution and keep electrodes in the buffer solution for 10 min.

3 Press "**CHANNEL**" button to enter into channel indication mode where calibration of channel A, for instance, is to be carried out.

4 Press "**menu** / **enter**" button and display shown in Fig. 2.11 shall appear.

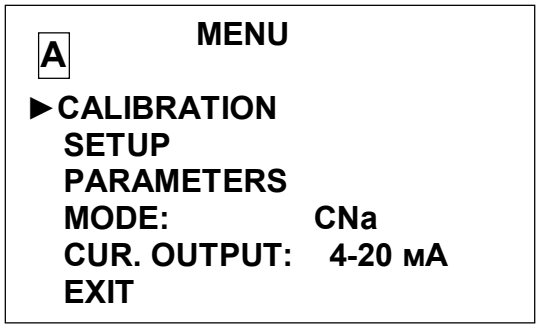


Fig. 2.11

5 Move pointer "►" to **CALIBRATION** line and press "**menu** / **enter**" button, and display shown in Fig. 2.12 shall come up.

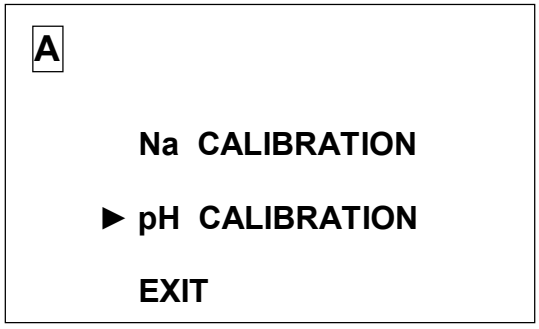


Fig. 2.12

6 Move pointer "►" to **pH CALIBRATION** line and press "**menu** / **enter**" button. The display shown in Fig. 2.13 shall come up.

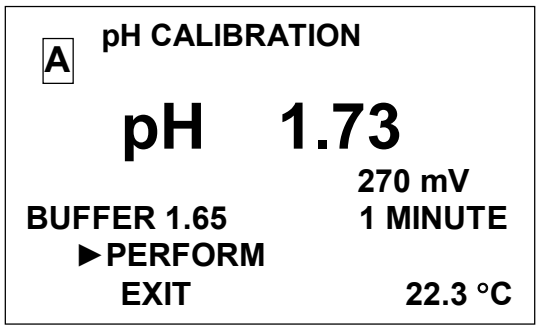


Fig. 2.13

7 Move pointer "►" to **PERFORM** button and press "**menu / enter**" button. The display shown in Fig. 2.14 shall come up.

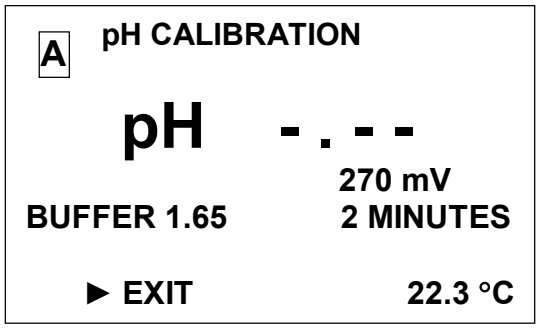


Fig. 2.14

8 If pH of the buffer solution is not determined automatically, the display shown in Fig. 2.15 shall come up. Refer to Section 2.5 of the Operation Manual (Troubleshooting. Table 2.4). If "**menu / enter**" button is pressed, analyzer shall enter into **MENU** mode.

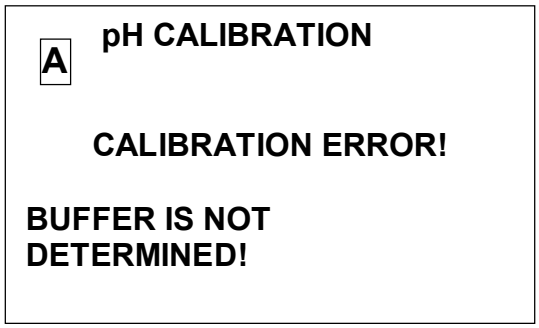


Fig. 2.15

9 If pH of the buffer solution is determined automatically, pH value shall appear and the progress meter shall be filled up.
Once the progress meter is full, the display shown in Fig. 2.16 shall come up.

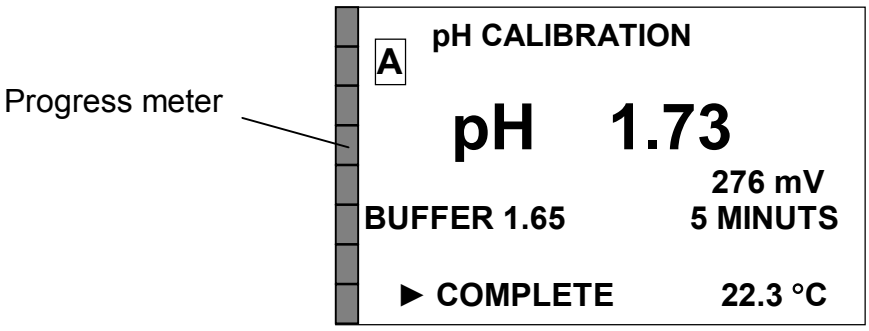


Fig. 2.16

10 Press "**menu / enter**" button and the display shown in Fig. 2.17 shall come up. The analyzer shall enter into the second buffer solution calibration mode with pH=9.18 at temperature of (25.0 ± 0.2) °C.

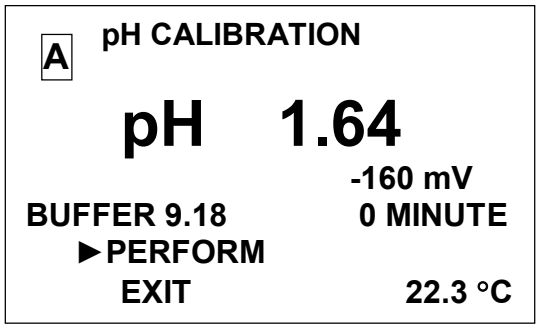


Fig. 2.17

11 Remove electrodes and temperature sensor from the first buffer solution and rinse them in distilled water (in two vessels in a row).

12 Rinse them in a separate portion of the second buffer solution and place into unused buffer solution with pH=9.18. Hold electrodes in the buffer solution for 10 min.

13 Move pointer "►" to **PERFORM** line and press "**menu / enter**" button and the display shown in Fig. 2.18 shall come up.

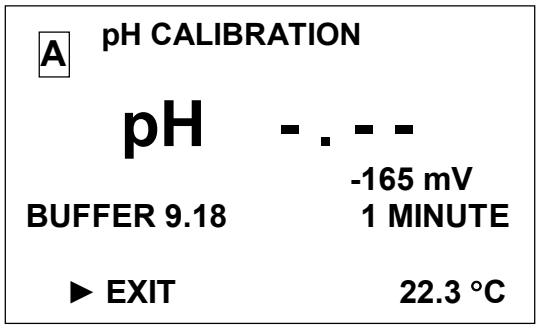


Fig. 2.18

14 If pH of the buffer solution is not determined automatically, the display shown in Fig. 2.15 shall come up. Refer to Section 2.5 of the Operation Manual (Troubleshooting. Table 2.4).

15 If pH of the buffer solution is determined automatically, pH value shall appear and the progress meter shall be filled up.
Once the progress meter is full, the display shown in Fig. 2.19 shall come up.

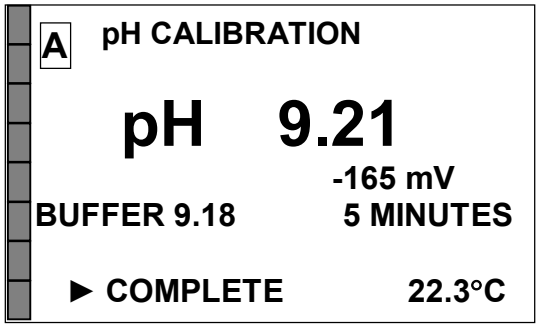


Fig. 2.19

16 Press "**menu / enter**" button and the display shown in Fig. 2.20 shall come up.

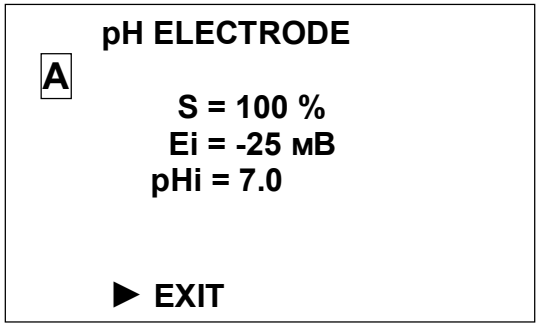


Fig. 2.20

If the indicated values fall beyond allowable limits, the "**CHECK ELECTRODE!**" blinking message shall appear in the last line on the display. One needs to check electrodes (good condition of electrodes and electrolyte level in the reference electrode). Check buffer solutions. After that re-calibrate pH-electrode. If the "**CHECK ELECTRODE!**" blinking message does not come up, press "**menu / enter**" button. The display shown in Fig. 2.21 shall come up.

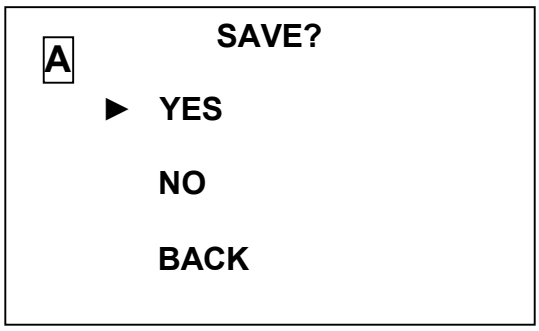


Fig. 2.21

17 Move pointer "►" to **YES** line and press "**menu/enter**" button. The display shown in Fig. 2.22 shall come up. Enter calibration date.

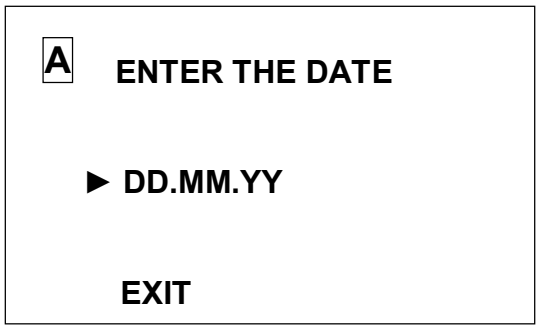


Fig. 2.22

18 If pointer "►" is moved to **NO** line and "**menu/enter**" button is pressed, the analyzer shall enter into measurement mode with previous calibration data stored.

19 Move pointer to **EXIT** line and press "**menu/enter**" button, the analyzer shall enter into measurement mode.

On completion of pH-electrode calibration remove the reference electrode connector from the socket of the "**REFERENCE ELECTRODE**" connector in AU-1002 amplifier unit and insert the connecting cable male plug in the socket.

2.3.7 Sodium ion concentration calibration of the analyzer

2.3.7.1 Description of calibration types

The analyzer provides for two types of calibration against sodium ion concentration.

Calibration of **TYPE 1** is a one-point calibration used for adjustment of measured performance shift. Calibration may be carried out using one calibration

solution with sodium ion concentration within the analyzer measurement range. For measurement of low volume sodium ion concentrations, the concentration of the calibration solution should be from 10 to 100 ppb. For measurement of other sodium ion concentrations calibration solutions of other concentrations may be used.

This type of calibration is recommended as a major type of calibration using the analyzer.

To start calibration select and apply "**TYPE 0**" calibration from "**Na CALIBRATION PARAMETERS**" submenu, parameters of which are calculated on the basis of theoretical (certificate) characteristics of electrodes.

The main point of **TYPE 1** calibration is that an operator allowing calibration solution to flow through the flow cell sets sodium ion concentration value corresponding to this solution on the display.

For this calibration type, it is necessary to know the initial sodium ion concentration in the water used for preparation of the solution so as to receive the exact concentration in the calibration solution. Thus, the sequence of actions should be: initial calibration, initial concentration measurement, final calibration.

Calibration of **TYPE 2** is a three-point calibration where reference points comprise initial water with a small amount of sodium ion added and two solutions prepared using this water with known amount of sodium ion added. This calibration type does not require that sodium ion concentration value in the initial water be known.

This calibration type is recommended for use when service life of electrodes is exhausted to a great extent and slope of electrode curves appreciably differs from the theoretical one. This type of calibration may be required when the analyzer measurement errors fall beyond the acceptable rates and one-point calibration fails to reduce them. We should note that if sensors are defective (glass membrane cracked, leaks etc.), serviceability of the analyzer may not be recovered by calibration.

Such calibration may be carried out in two manners.

Calibration using routine classical procedure implies separate preparation of initial water with a small amount of sodium ion added and two calibration solutions using this water with known amount of sodium ion added.

Calibration may be carried out in compliance with a little bit different procedure which involves preparation of solutions in a single container by dispensing small amounts of a sodium salt concentrated solution. This type is preferable because it significantly prevents uncontrollable contamination of calibration solutions during preparation thereof.

The backbone of the calibration is that the flow cell is consecutively used to pass initial water with a small amount of sodium ions added which has been used (or will be used) for preparation of solutions, and two solutions with known amount of sodium ion added.

At operator's command the analyzer registers the voltage difference between electrodes both in the initial water with sodium ions added and each solution. Then the operator enters sodium ion concentrations in portions added into the analyzer with no (**!**) consideration for ion concentration in the initial water.

Based on data obtained, the analyzer determines the slope of electrode curve of the working pair and shift of this curve. Uncontrollable and unknown so-

dium ion concentration in the initial water within 7 ppb limit has no impact on calibration quality.

The abovementioned procedure for preparation of calibration solutions in a single container consists in that the whole capacity of the container with the initial water is mentally divided into approximately three parts. In the beginning the first third of initial water with sodium ion added is drained (and, naturally, passed through the measuring cell). Then the flow of water and ammonia batching are discontinued, and an added portion is injected into the water left in the container, i.e. a small portion of concentrated sodium solution. Water is stirred up and water flow and ammonia batching are resumed. The procedure is repeated after next third of water is drained.

At operator's command the analyzer registers the voltage difference between electrodes both in the initial water with sodium ion added and each solution.

To determine precisely sodium ion concentration in calibration solutions, each portion of drained water is sampled. Then volume of each portion of water is measured (by weighing or using volumetric containers) and concentrations are calculated. The results obtained are entered into the analyzer.

If the sodium electrode is new, its potential is to be checked in 0.1N NaCl solution to make certain that it complies with certificate data for this electrode.

Important to note that in all types of calibration procedures calibration solutions are fed to the measuring cell from a special-purpose vessel located in the right top of the hydraulic panel. Solutions are fed from the vessel directly to the flow cell with electrodes mounted passing by the flow stabilizer.

The PVC tube connecting the vessel containing the calibration solution with the inlet pipe of the measuring cell contains a special-purpose injector with a small orifice. It minimizes flowrate of calibration solutions. Solution flowrate with full container is approximately 20 cm^3/min; the rate gradually decreases as the container is getting empty.

2.3.7.2 Pre-calibration procedure

Analyzer is to be calibrated:

- once every 6 months;
- if readings seem to be doubtful.

Note − As practice shows, time of potential stabilization for some electrodes varies from 1.5 to 2 months. Therefore, it is recommended that once a month during the first quarter of electrode operation C_{Na} measurement errors be checked using reference sodium chloride solution with sodium ion concentration of 23 ppb prepared in compliance with Appendix A. Carry out calibration, if required.

Interconnections between hydraulic panel components during calibration are shown in Fig. 2.9. The PVC tube with clamp 1 running from the overflow vessel outlet pipe connection must be disconnected from the measuring cell inlet pipe connection. The PVC tube with clamp 2 running from the calibration solution vessel

must be connected to the measuring cell inlet pipe connection.

Press "**CHANNEL**" button to set the channel indication mode where calibration is required, for instance, channel A.

Before calibration thoroughly clean the flow cell with electrodes mounted therein of dirt. To do so, it is recommended that the hydraulic panel be connected to the sampler as shown in Fig. 2.42, where the analyzer is expected to be used, and provide water flow from the sampler.

Turn on the ABD.

Note − The analyzer is to be calibrated at ambient air temperature from plus 15 to plus 30 °C.

After 1-2 days of cleaning by continuous flow the flow cell may be deemed to be appropriately cleaned and electrode system potentials deemed to be stabilized.

To check quality of cleaning, it is recommended that analyzer type 1 preliminary one-point calibration be carried out according to 2.3.7.3, then pass clear water through the flow cell for at least 30 min. Purified water is to be fed from the calibration solution vessel which shall save water.

The analyzer readings rely on quality of purified water. If water is appropriately purified, the readings shall drop 3 ppb. In this case it is possible to proceed with the final calibration.

Tighten clamp 2.

Shift ABD to "**STOP**" mode.

2.3.7.3 **Type 1** analyzer calibration procedure using one calibration solution

In compliance with Appendix A prepare 1 dm^3 of sodium chloride solution with sodium ion concentration $C_{Na}^{calibration}$, for instance, of 23 ppb.

Measure sodium ion concentration in initial purified water used for preparation of the solution $C_{Na}^{iniitial}$, ppb.

1 Drain purified water from the calibration solution vessel, and fill it with sodium chloride calibration solution with sodium ion concentration of 23 ppb (or another solution with known concentration).

2 Unscrew clamp 2.

3 Set ABD to "**PROCESS**" mode.

4 Press "$\frac{\textbf{menu}}{\textbf{enter}}$" button and the display shown in Fig. 2.11 shall come up.

5 Move pointer "►" to **CALIBRATION** line and press "$\frac{\textbf{menu}}{\textbf{enter}}$" button, and the display shown in Fig. 2.12 shall come up.

6 Move pointer "►" to **Na CALIBRATION** line and press "$\frac{\textbf{menu}}{\textbf{enter}}$" button. The display shown in Fig. 2.23 shall come up.

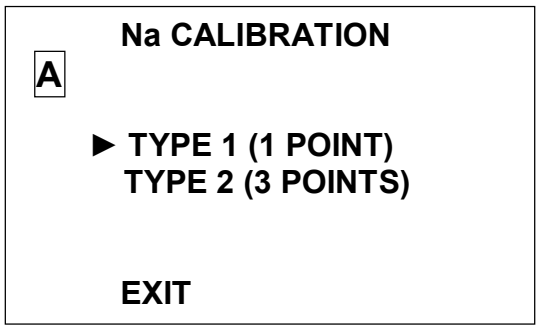


Fig. 2.23

7 Move pointer "►" to **TYPE 1** line and press "**menu / enter**" button and the display shown in Fig. 2.24 shall come up which shall show the solution current C_{Na} measured value with previous calibrated factors.

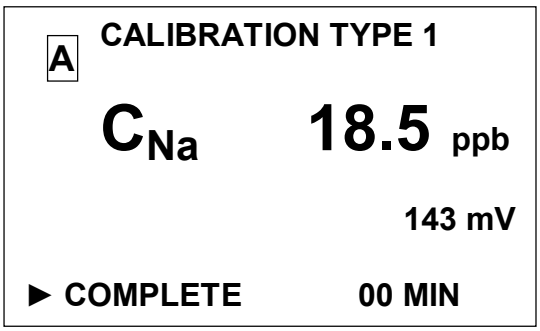


Fig. 2.24

8 After readings are specified (approximately in 10-15 min), press "**menu / enter**" button, and the display shown in Fig. 2.25 shall come up.

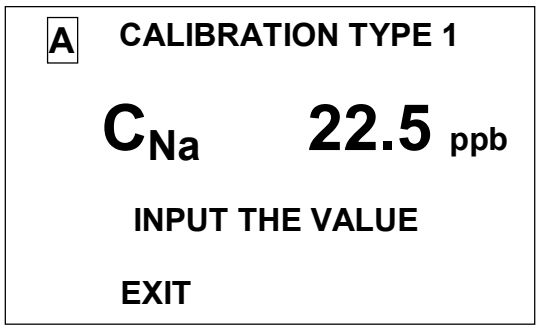


Fig. 2.25

9 Type precise value equal to the sum of values of the prepared solution sodium ion concentration C_{Na}^{cal}, ppb, and initial water sodium ion concentration $C_{Na}^{imitial}$, ppb. Press "**menu / enter**" button and pointer "►" shall be opposite **EXIT** line.

10 Press "**menu / enter**" button and the display shown in Fig. 2.26 shall come up.

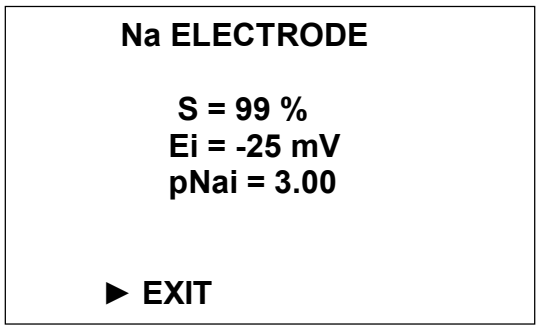


Fig. 2.26

If the indicated values fall beyond allowable limits, the "**CHECK ELECTRODE!**" blinking message shall appear in the last line on the display. One needs to check electrodes for good condition.

If the "**CHECK ELECTRODE!**" blinking message does not come up, press "**menu / enter**" button. The display shown in Fig. 2.27 shall come up.

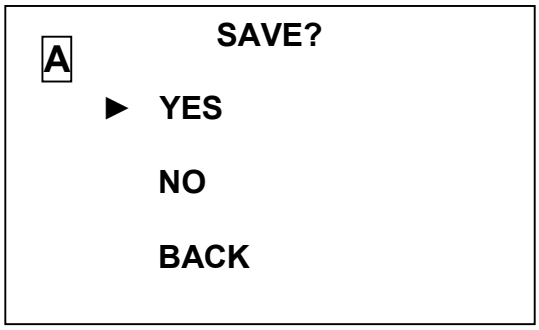


Fig. 2.27

11 Move pointer "►" to **YES** line and press "**menu / enter**" button. The display shown in Fig. 2.22 shall come up. Enter calibration date.

12 Moving pointer "►" to **NO** line and pressing "**menu / enter**" button account for abandoning of the calibration performed, and the analyzer shall enter into measurement mode with previous calibration data stored.

13 If value entered is wrong, the pointer may be moved to **BACK** line and the display shown in Fig. 2.25 shall come up. Re-entry is possible.

14 Once the date is entered, move pointer "►" to **EXIT** line and press "**menu / enter**" button. The analyzer shall enter into the measurement mode.

2.3.7.4 **Type 2** analyzer calibration procedure using three calibration solutions which are prepared in a single calibration vessel.

In compliance with Appendix A prepare 1 dm^3 of sodium chloride solutions:
- with 2.3 ppm sodium ion concentration;
- with 13.8 ppm sodium ion concentration;
- with 69 ppm sodium ion concentration.

The analyzer is to be calibrated at calibration solution temperature of (20 ± 5) °C. The temperatures of three calibration solutions for type 2 calibration should not differ by more than ± 2 °C.

1 Fill the calibration solution vessel with purified water. Pipette 1 cm^3 of NaCl solution with sodium ion concentration of 2.3 ppm to the calibration solution vessel. Stir using a mixer (a rod secured to the calibration solution vessel cover).

2 Drain water completely from the vessel for collecting calibration solution. Put the vessel in place.

3 Unscrew the clamp 2.

4 Set ABD to "**PROCESS**" mode.

5 Press "**menu** / **enter**" button and the display shown in Fig. 2.11 shall come up.

6 Move pointer "►" to **CALIBRATION** line and press "**menu** / **enter**" button and the display shown in Fig. 2.12 shall come up.

7 Move pointer "►" to **Na CALIBRATION** line and press "**menu** / **enter**" button. The display shown in Fig. 2.23 shall come up.

8 Move pointer "►" to **TYPE 2** line and press "**menu** / **enter**" button and the display shown in Fig. 2.28 shall come up which shall show the solution C_{Na} current measured value with previous calibrated factors.

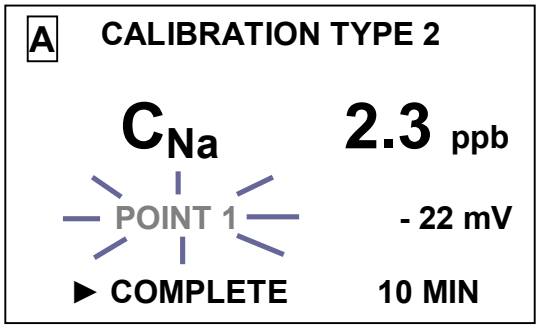


Fig. 2.28

9 When the calibration solution vessel shall contain about 2/3 of the previous volume, press "**menu** / **enter**" button, and the display shown in Fig. 2.29 shall come up.

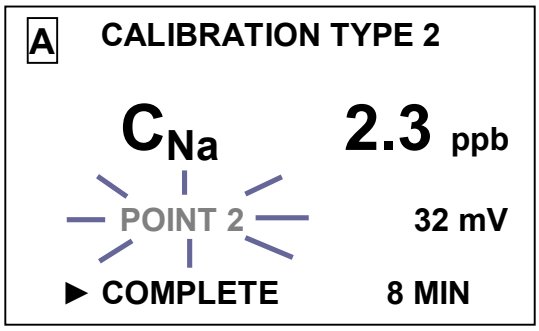


Fig. 2.29

10 Tighten clamp 2.
11 Shift ABD to "**STOP**" mode.
12 Wait till water flow from the flow module is discontinued and completely drain water with added sodium ions from the calibration solution collecting container. Put the container in place.
13 Pipette 1 cm^3 of NaCl solution with sodium ion concentration C^1_{Na} of 13.8 ppm to the calibration solution vessel. Stir using a mixer (a rod secured to the calibration solution vessel cover).
14 Unscrew the clamp 2.
15 Set ABD to "**PROCESS**" mode.
16 When the calibration solution vessel shall contain 1/3 of the initial volume, press "**menu** / **enter**" button, and the display shown in Fig. 2.30 shall come up.
17 Tighten clamp 2.

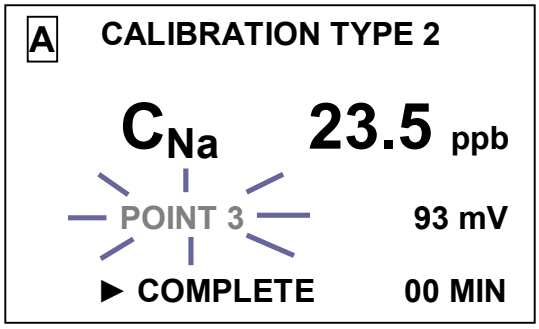


Fig. 2.30

18 Shift ABD to "**STOP**" mode.
19 Wait till water flow from the flow module is discontinued and transfer solution from the calibration solution collecting container to a volumetric flask 2-1000-2, or weigh solution using the analytical balance to an accuracy of no more than ± 0.02 g. Make record of the obtained V_1 value in cm^3 or in g. Put empty vessel in to position.
20 Pipette 1 cm^3 of NaCl solution with sodium ion concentration C^2_{Na} of 69 ppm to the calibration solution vessel. Stir using a mixer (a rod secured to the calibration solution vessel cover).

21 Unscrew the clamp 2.
22 Set ABD to "**PROCESS**" mode.
23 When calibration solution in the vessel is almost exhausted and the analyzer readings do not rise, press "**menu / enter**" button, and the display shown in Fig. 2.31 shall come up.

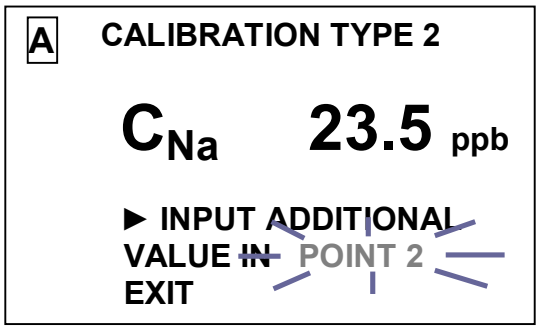


Fig. 2.31

24 Tighten clamp 2.
25 Shift ABD to "**STOP**" mode.
26 Transfer solution from the calibration solution collecting container and remaining solution from the calibration vessel to a volumetric flask 2-1000-2 or weigh solution using the analytical balance to an accuracy of no more than ± 0.02 g. Make record of the obtained V_2 value in cm^3 or in g. Put empty vessel in to position.
27 Calculate precise values of sodium ion concentrations in added portions in calibration solutions C_{Na}^{cal1}, ppb, и C_{Na}^{cal2}, ppb, from the formulae:

$$C_{Na}^{cal1} = C_{Na}^{1} \cdot \frac{V_{added}}{V_1 + V_2} \cdot 1000;$$

$$C_{Na}^{cal2} = C_{Na}^{2} \cdot \frac{V_{added}}{V_2} \cdot 1000 + C_{Na}^{cal1},$$

where C_{Na}^{1} − sodium ion concentration in the first portion equal to 13.8 ppm;

C_{Na}^{2} − sodium ion concentration in the second portion added equal to 69 ppm;

V_{added} − volume of portion added amounting to 1 cm^3;

1000 ppb − coefficient for conversion of obtained sodium ion concentration value in the portion added expressed in ppm into the value in ppb.

28 Enter C_{Na}^{cal1} value calculated from the formula on the display as shown in Fig. 2.31.
29 Move pointer "►" to **EXIT** line and press "**menu / enter**" button. The display shown in Fig. 2.32 shall come up.

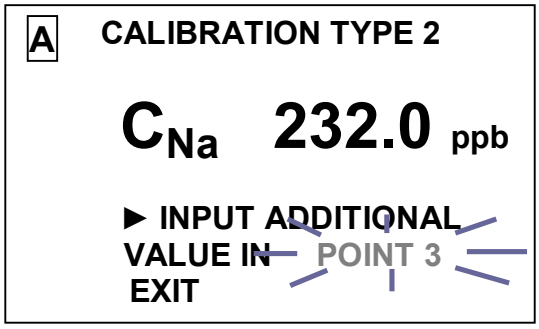


Fig. 2.32

30 Enter C_{Na}^{cal2} value calculated from the formula on the display as shown in Fig. 2.32.

31 Move pointer "►" to **EXIT** line and press "**menu** / **enter**" button. The display shown in Fig. 2.33 shall come up.

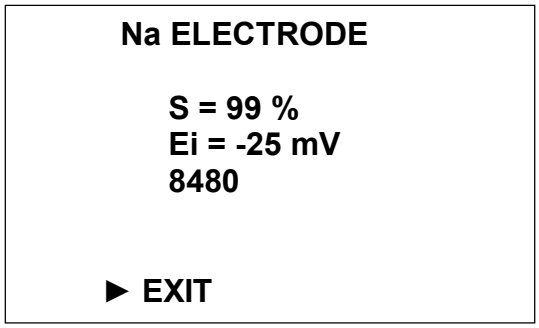


Fig. 2.33

If the indicated values fall beyond allowable limits, the "**CHECK ELECTRODE!**" blinking message shall appear in the last line on the display. One needs to check electrodes for good condition.

If the "**CHECK ELECTRODE!**" blinking message does not come up, press "**menu** / **enter**" button. The display shown in Fig. 2.34 shall come up.

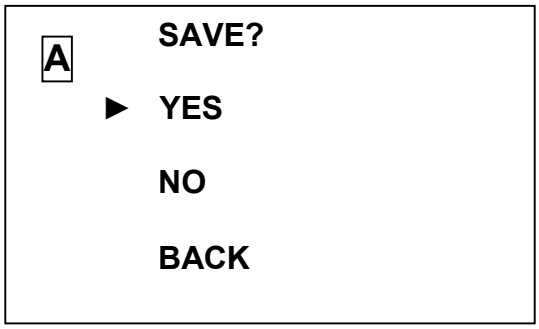


Fig. 2.34

32 If value entered is wrong, pointer may be moved to **BACK** line and the analyzer display shown in Fig. 2.31 shall come up. Calculated values

$C_{Na}^{cal\,1}$ and then $C_{Na}^{cal\,2}$ may be re-entered.

33 If pointer "►" is moved to **YES** line and button "**menu** / **enter**" is pressed, the display shown in Fig. 2.22 shall come up with advice to enter calibration date.

34 Moving pointer "►" to **NO** line and pressing "**menu** / **enter**" button account for abandoning of the calibration performed, and the analyzer shall enter into measurement mode with previous calibration data stored.

35 Once the date is entered, move pointer "►" to **EXIT** line and press "**menu** / **enter**" button. The analyzer shall enter into the measurement mode.

2.3.7.4 **Type 2** analyzer calibration procedure using three calibration solutions prepared in individual vessels

For calibration solutions with sodium ion concentrations of 23 ppb and 230 ppb are recommended. The solutions shall be prepared using water with sodium ion concentrations of 2 to 7 ppb. Precise initial water concentration value is not important and is not accounted for when solutions are prepared. The key point is that both solutions are prepared using the same water. Therefore, for analyzer calibration one needs to take minimum of 3 dm^3 of water.

The initial water with sodium ion concentrations of 2 to 7 ppb may be prepared using purified water with high-concentrated NaCl solution added (refer to Appendix A for preparation of solution with concentration of 2,3 ppb).

Such water also may be obtained using a distilling apparatus with quartz or metal fittings. To control sodium ion content in water, you may use either a different known-good analyzer or the same after one-point calibration.

The water prepared is divided into three portions of 1 dm^3 each. In compliance with Appendix A, solutions are prepared to have sodium ion concentrations of 23 ppb and 230 ppb. Sodium ion concentration in initial water is not accounted for.

The analyzer calibration procedure is entirely similar to the abovementioned calibration procedure using solutions prepared in a single vessel. The following is passed through the flow module:

– initial water (solution with sodium ion concentration of 2.3 ppb) used for preparation of solutions;

– solution with concentration of 23 ppb;

– solution with concentration of 230 ppb[3].

In each case at operator's command the analyzer stores the electrode potential difference. After that the operator enters solution with concentration values for each calibration point with no consideration for sodium ion concentration in the initial water. Entry of sodium ion concentration in the initial water is not required.

Below is the sequence of calibration operations.

Type 2 analyzer calibration shall be carried out at calibration solution temperature of (20 ± 5) °C, and the difference between temperatures of the three calibration solutions for type 2 calibration shall not exceed ± 2 °C.

1 Fill the calibration solution vessel with at least 0.5 dm^3 of initial water used for preparation of calibration solutions.

2 Unscrew clamp 2.

3 Set ABD to "**PROCESS**" mode.

4 Press "**menu / enter**" button and the display shown in Fig. 2.14 shall come up.

5 Move pointer "►" to **CALIBRATION** line and press "**menu / enter**" button and the display shown in Fig. 2.13 shall come up.

6 Move pointer "►" to **Na CALIBRATION** line and press "**menu / enter**" button. The display shown in Fig. 2.23 shall come up.

7 Move pointer "►" to **TYPE 2** line and press "**menu / enter**" button and the display shown in Fig. 2.35 shall come up which shall show the solution current C_{Na} measured value with previous calibrated factors.

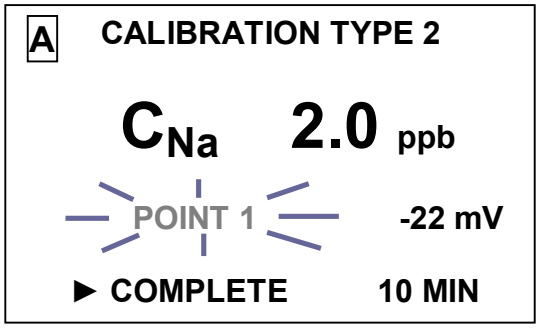


Fig. 2.35

8 When calibration solution in the vessel is almost exhausted, press "**menu / enter**" button, and the display shown in Fig. 2.36 shall come up.

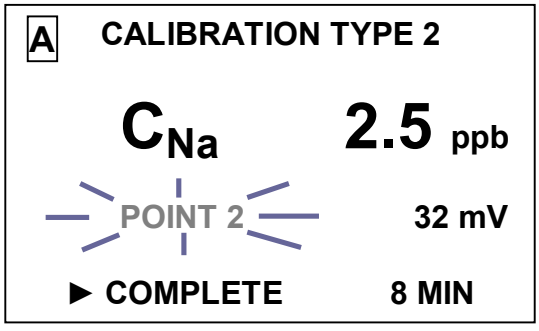


Fig. 2.36

9 Tighten clamp 2.

10 Shift ABD to "**STOP**" mode.
11 Drain remaining solution from the calibration solution vessel.
12 Fill the vessel with at least 0.5 dm^3 of calibration solution with sodium ion concentration of 23 ppb.
13 Unscrew clamp 2.
14 Set ABD to "**PROCESS**" mode.
15 When calibration solution in the vessel is almost exhausted, press "**menu** / **enter**" button, and the display shown in Fig. 2.37 shall come up.

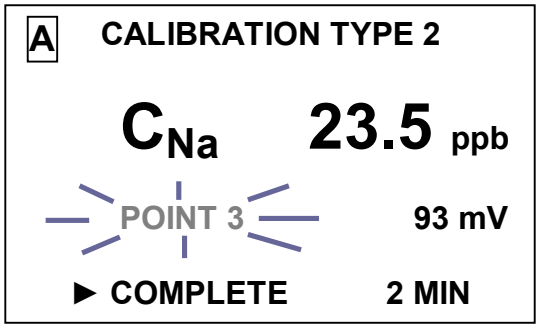


Fig. 2.37

16 Tighten clamp 2.
17 Shift ABD to "**STOP**" mode.
18 Drain remaining solution from the calibration solution vessel.
19 Fill the vessel with at least 0.5 dm^3 of calibration solution with sodium ion concentration of 230 ppb.
20 Unscrew clamp 2.
21 Set ABD to "**PROCESS**" mode.
22 When calibration solution in the vessel is almost exhausted, press "**menu** / **enter**" button, and the display shown in Fig. 2.38 shall come up.

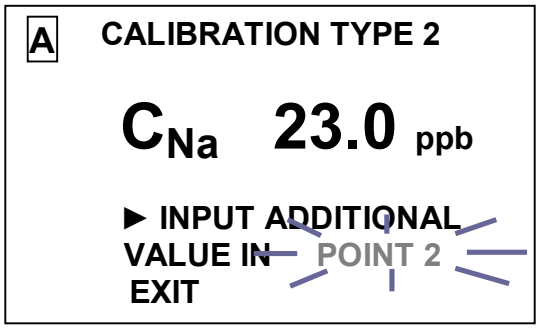


Fig. 2.38

23 Tighten clamp 2.
24 Shift ABD to "**STOP**" mode.
25 Enter 23.0 ppb value on the display as shown in Fig. 2.38.

26 Move pointer "►" to **EXIT** line and press "**menu / enter**" button. The display shown in Fig. 2.39 shall come up.

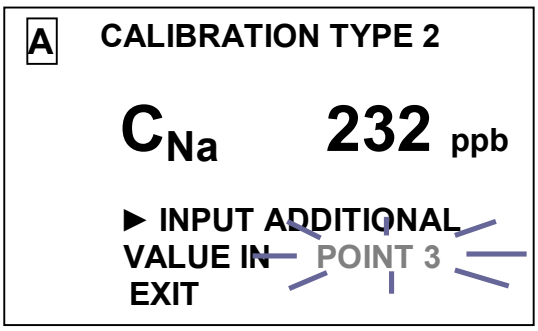


Fig. 2.39

27 Enter 230 ppb value on the display as shown in Fig. 2.39.

28 Move pointer "►" to **EXIT** line and press "**menu / enter**" button. The display shown in Fig. 2.40 shall come up.

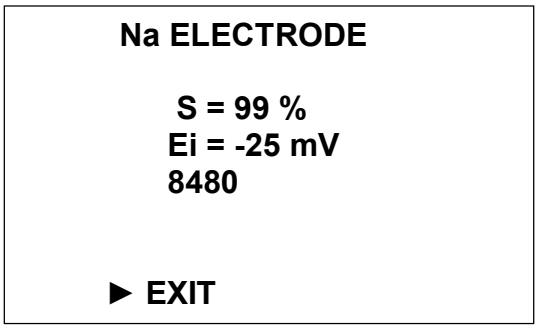


Fig. 2.40

If the indicated values fall beyond allowable limits, the "**CHECK ELECTRODE!**" blinking message shall appear in the last line on the display. One needs to check electrodes for good condition. If the "**CHECK ELECTRODE!**" blinking message does not come up, press "**menu / enter**" button. The display shown in Fig. 2.41 shall come up.

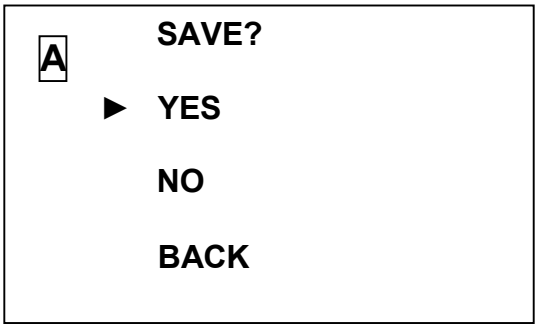


Fig. 2.41

29 If value entered is wrong, the pointer may be moved to **BACK** line and the display shown in Fig. 2.38 shall come up. Re-entry of 23 ppb and then 230 ppb value is possible.

30 Move pointer "►" to **YES** line and press "**menu**/**enter**" button. The display shown in Fig. 2.22 shall come up. Enter calibration date.

31 Moving pointer "►" to **NO** line and pressing "**menu**/**enter**" button account for abandoning of the calibration performed, and the analyzer shall enter into measurement mode with previous calibration data stored.

32 Once the date is entered, move pointer "►" to **EXIT** line and press "**menu**/**enter**" button. The analyzer shall enter into the measurement mode.

2.4 Measurement procedure

Components of the analyzer must be available for operation according to 2.3.1-2.3.5.

The analyzer is factory-calibrated and may be operated off hand.

2.4.1 Measurements in the flow with sample feed from the process line

2.4.1.1 Preliminary measurement procedures.

Interconnections between hydraulic panel components for measurements with sample feed from the process line are shown in Fig. 2.42.

The PVC tube with clamp 1 running from the overflow facility outlet pipe connection must be connected to the measuring cell inlet pipe connection.

Measuring cell drain pipe must be connected to the flow module drain pipe by means of CT-18 PVC tube Ø4.0×1.5; L=150.

Connect the flow module inlet pipe to the sampler using CT-18 PVC tube Ø4.0×1.5; L=150.

Connect the flow module inlet; L=1000.

2.4.1.2 Measurement procedure

Turn on the analyzer and set necessary indications, measurement ranges against current output, current output ranges, and settings values.

Feed tested water from the sampler. Water flowrate is to be from 3 to 200 dm^3/h.

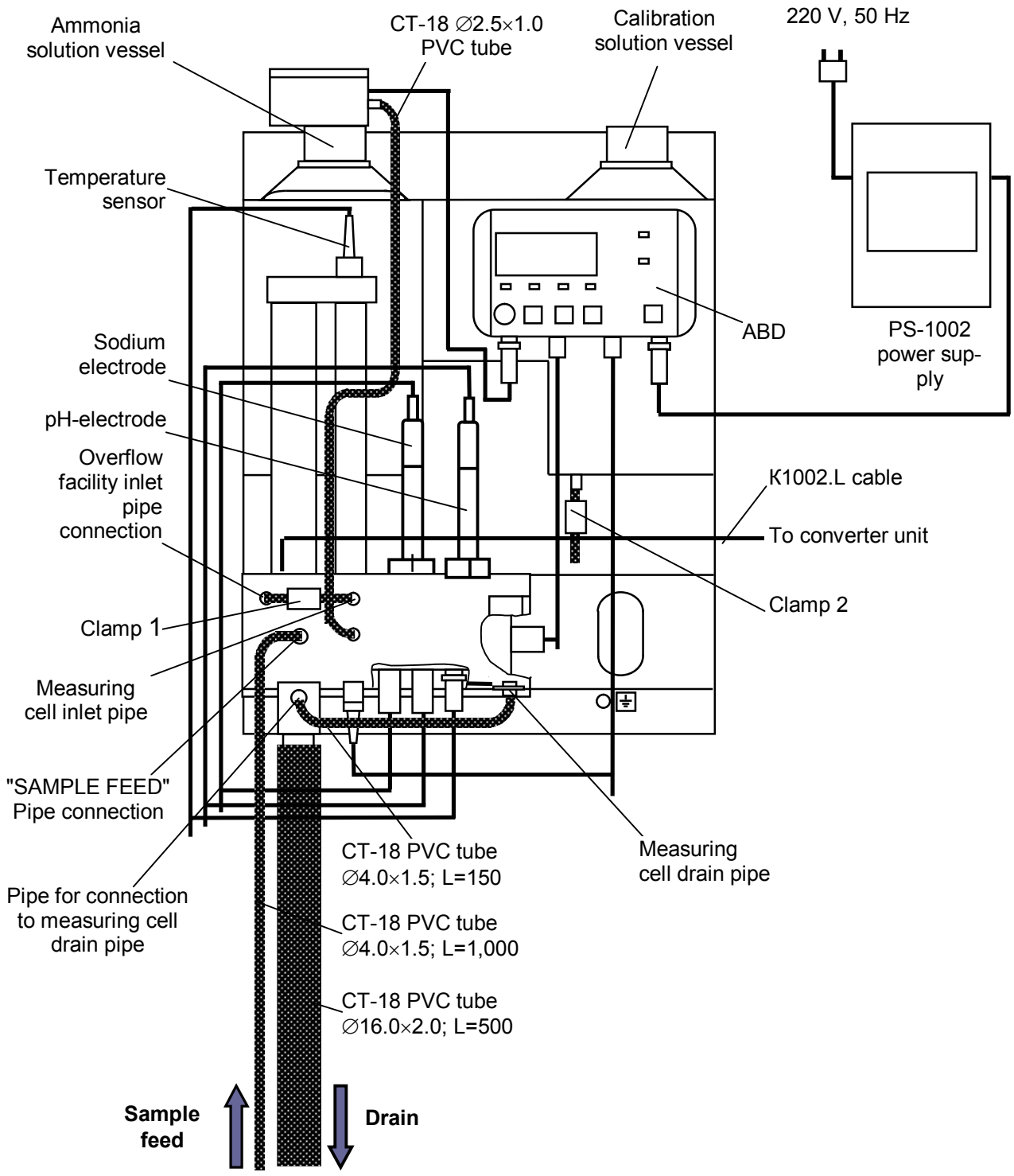


Fig. 2.42 − Interconnections between hydraulic panel components for measurements with sample feed from the process line

ATTENTION: AVOID OVERFLOW in the flowmeter and provide free water drain!

Turn on ABD to "**PROCESS**" mode by pressing " ⏻ " button and holding it for 1 s.

ABD start-up is accompanied by relatively long circulation of air-ammonia mix. Then ABD enters into automatic ammonia feed control mode.

Transient process with steady flow of the tested water lasts for no more than 10-15 min. On completion of the transient process the ABD display readings shall comply with setting values to the accuracy of ± 5 units (variations within the above limits are possible). In normal ABD operation the first flow cell chamber clearly demonstrates air-ammonia mix bubbles. Absence of bubbles is indicative of the compressor valve sticking (see table 2.4, point 9), it may happen with new valves.

"**REGULATION TROUBLE**" indicator comes on, if the unit fails to set ammonia batching rate in compliance with the setting. This may occur due to: absence of tested water, ammonia exhaustion or excessive ammonia concentration (which may occur at high ambient temperature). When tested water flow is recovered, ammonia batching control shall be automatically restored.

With gradual ammonia exhaustion the unit turns on heating (which is confirmed by the indicator light on the front panel). This makes it possible to use 100 % of the ammonia solution. When ammonia is exhausted, control is impossible (ammonia batching is always below rating) and "**AMMONIA EXHAUSTION**" and "**REGULATION TROUBLE**" indicator lights come on. It is evident that ammonia solution is to be replenished.

The situation with excessive ammonia concentration – display readings are always higher than the setting values – is indicative of discrepancy between ammonia solution concentration and ambient air temperature. Though such overbatching has effect on automatic control, it has no impact on sodium ion concentration measurement error. Since this phenomenon is undesired, it is recommended that ammonia solution be diluted in 1:1 ratio.

Note − When water feed from the sampler is discontinued, the measuring cell contains water remainder to avoid electrode drying.

ATTENTION: Prior to long-term outage of the analyzer drain ammonia solution from the vessel to avoid damage to compressor components!

2.4.2 Measurements in a limited-volume sample (in laboratory)

Measurements in a limited-volume sample may be carried out:

- using a calibration solution vessel;
- using an optional special pump.

2.4.2.1 Measurements using a calibration solution vessel

Disconnect the inlet pipe of the measuring cell from the overflow facility outlet pipe and connect to the calibration solution vessel (as in analyzer calibration against sodium).

Turn on analyzer and set necessary operating modes.

Pour sample to the calibration solution vessel and unscrew clamp 2.

Turn on ABD. Take readings in 10-20 min.

The minimum sample volume for measurement does not exceed 300 cm^3.

2.4.2.2 Measurements using a pump

For independent sample feed from any convenient container (for instance, from a beaker) the analyzer delivery set may include a peristaltic dosing pump of B-V Series 2-2 Type with a capillary tube and two CT-18 PVC tubes Ø2.5×1.0; L=600.

The pump is mounted in compliance with Installation and Service Manual and Certificate for peristaltic dosing pump of B Series.

Interconnections between components of HP-1002 hydraulic panel for measurements using a pump are shown in Fig. 2.43.

The PVC tube with clamp 1 running from the overflow vessel outlet pipe connection must be disconnected from the measuring cell inlet pipe.

The measuring cell drain pipe must be connected to the flow module drain pipe by means of CT-18 PVC tube Ø4.0×1.5; L=150.

Rinse the capillary tube in reagent grade purified water in deionized water of low sodium content.

Turn on analyzer and set necessary operating modes.

Immerse the capillary tube into the beaker with tested solution and turn on the pump.

The pump may set flowrate to 33 cm^3/min. The best flowrate for measurements is 20 cm^3/min.

Using flowrate controller knob set desired solution flowrate. Prime the pump and connect a PVC tube running from the device to the flow cell inlet pipe connection. Start ammonia batching (according to 2.4.2.1).

Take stable analyzer readings.

For measurements in another sample, again rinse the capillary tube in reagent grade purified water. If the difference between samples in sodium ion concentration is not twice as much, rinsing of the capillary tube may be excluded when changing samples.

Note − To save a sample, it is recommended to carry out measurements with flow interruption, because the sodium analyzer response is governed by the electrode response rate rather than the velocity of the tested fluid flow through the measuring cell.

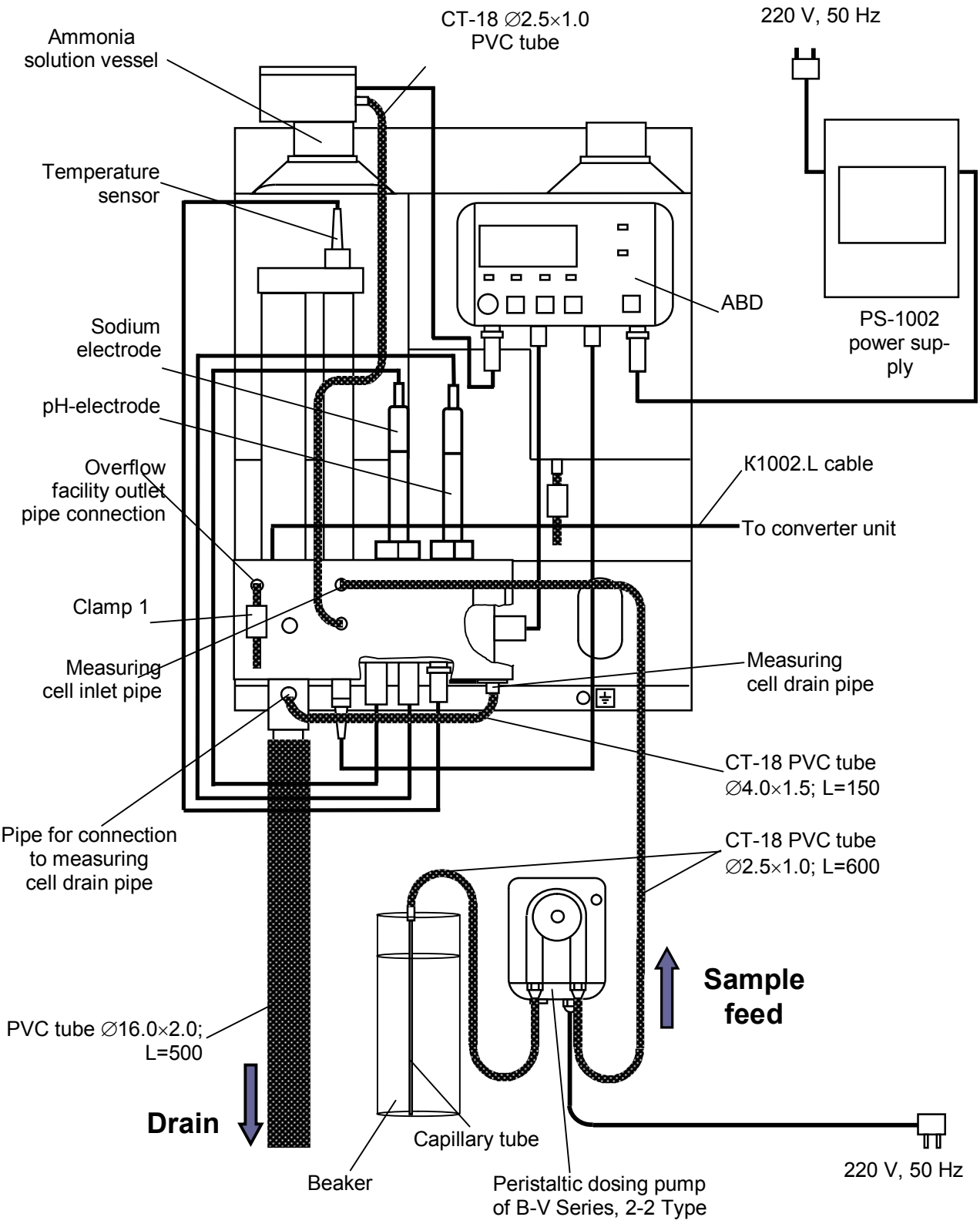


Fig. 2.43 − Interconnections between hydraulic panel components for measurements in a laboratory using a pump

In this mode sample, first, flows through the measuring cell discontinuously for 5 min. During this period of time fluid in the measuring cell with electrodes is changed.

Then sample flow is to be left for 5-7 min, turn off the pump and stop ammonia batching (press "**STOP**" button on the ABD). This time is sufficient for electrodes to respond to a new value of sodium ion concentration in the tested solution. After that turn on the pump, resume ammonia batching and in 2-3 min take analyzer steady reading.

If electrodes are not used for a **long** time, they should be stored in compliance with certificates of the electrodes used.

2.5 Troubleshooting

2.5.1 List of probable troubles and remedies is given in table 2.4.

Table 2.4

	Trouble, symptoms	Probable cause	Remedy
1	Analyzer does not turn on	Burnt fuses	To be remedied at factory
2	Analyzer readings are not steady	Cable break or lack of contact in the electrode cable connector	Check for and ensure contact or remedy the break
3	When calibrating analyzer against calibration solutions, analyzer readings almost remain the same when electrodes contact calibration solutions with different C_{Na} values	Defective one of the electrodes	Replace electrode
4	Temperature value measured (under normal working conditions) differs from the real one by more than 0.3 °C	Defective temperature sensor	To be remedied at factory
5	With analyzer energized or when measuring C_{Na} of the tested solution, display shows "**WARNING! SENSOR IS NOT CONNECTED!**" message	Connecting cable of the sensor unit is not connected to channel A or B "**SENSOR**" jack of the converter unit	Connect the connecting cable of the sensor unit to channel A or B "**SENSOR**" jack of the converter unit
6	In process of pH-electrode calibration display indicates "WARNING! CALIBRATION ERROR!" message	Buffer solution pH is not determined	Turn off analyzer. Check buffer solutions Check electrodes

Table 2.4 (Continue)

	Trouble, symptoms	Probable cause	Remedy
7	When analyzer is energized or when measuring tested fluid display indicates "**WARNING! SENSOR IS NOT CONNECTED!**" message	Connecting cable (between converter unit and amplifier unit) is not connected to amplifier unit jack	Connect cable to the amplifier unit
		Damaged connecting cable	Repair the connecting cable
		Wrong soldered contact in jacks connected to the amplifier or converter unit.	Repair the connecting cable
8	No sample flow through flowmeter, though overflow occurs in the overflow facility	Clogged filter	2.5.2 Replace filter packing
		Clogged injector in the measuring cell inlet pipe	2.5.3 Clean injector
9	With working compressor there are no ammonia vapors in the measuring cell and bubbles in the vessel with ammonia	Bent CT-18 PVC tube	Correct bending
		Stuck compressor outlet valve	2.5.5 Correct sticking
10	With working compressor there are no ammonia vapors in the measuring cell though bubbles are visible in the vessel with ammonia	Loose compressor fitting onto the vessel with ammonia	Tighten coupling nut
		Damaged sealing rings on ammonia solution vessel plug	2.5.4 Replace sealing rings on ammonia solution vessel plug
11	Level rise (overflow) in flowmeter	There is no water outflow from the measuring cell	Provide water drain from PVC tube Ø16.0×2.0; L=500
		Excessive water flowrate in the flow module	Set maximum water flowrate of 200 dm^3/h
12	There is no sample flow through flowmeter	No water feed from sampler	Ensure water feed from the sampler
		Clogged filter	2.5.2 Replace filter packing
		Clogged injector in the measuring cell inlet pipe	2.5.3 Clean injector

Table 2.4 (Continue)

	Trouble, symptoms	Probable cause	Remedy
13	"**REGULATION TROUBLE**" message on ABD display	Bent CT-18 PVC tube	Correct bending
		Loose compressor fitting onto the vessel with ammonia	Tighten coupling nut 2.5.4 Replace sealing rings on ammonia solution vessel plug
		Stuck compressor outlet valve	2.5.5 Correct outlet valve sticking
		No sample flow	Restore sample flow
14	"**AMMONIA EXHAUSTION**" message on ABD display	Ammonia solution in vessel exhausted or absent	2.5.6 Fill ammonia solution

2.5.2 Replacement of filtration medium in the overflow device of the flow module

To replace filtration medium it is necessary to:
- unscrew filter cover;
- replace filtration medium using synthetic wool from probe maintenance kit;
- put filter cover in place.

2.5.3 Cleaning of the injector in measuring cell inlet pipe

To clean the injector remove CT-18 PVC tube from the pipe connection (unscrew pipe, if required) and blow down the injector. It may be cleaned using a copper wire or sharp wood stick.

The injector bore diameter is 0.75 mm.

2.5.4 Replacement of sealing rings on the ammonia solution vessel plug

The ammonia solution vessel plug is closed by the coupling nut used for compressor mounting on the vessel neck.

To replace the plug sealing rings it is required to:

- unscrew the coupling nut from the ammonia solution vessel neck preventing compressor rotation;
- remove the compressor and close the ammonia solution vessel. Clean components of the device that contacted ammonia with water;
- remove damaged sealing ring which may be cut beforehand;
- install a new sealing ring from the probe maintenance kit;
- mount the compressor onto the vessel, tighten the coupling nut so as to ensure tightness.

2.5.5 Remedy for compressor outlet valve sticking

The compressor outlet valve is located on the compressor tube end immersed into ammonia solution. Half of the valve leaf is glued to the silicon sleeve as shown in Fig. 2.44.

To remedy sticking it is necessary to:

– unscrew the coupling nut from the ammonia solution vessel neck preventing compressor rotation;

– remove the compressor and close the ammonia solution vessel. Clean components of the device that contacted ammonia with water;

– carefully raise and drop the valve leaf using a sharp wooden thing;

– mount the compressor onto the vessel, tighten the coupling nut so as to ensure tightness.

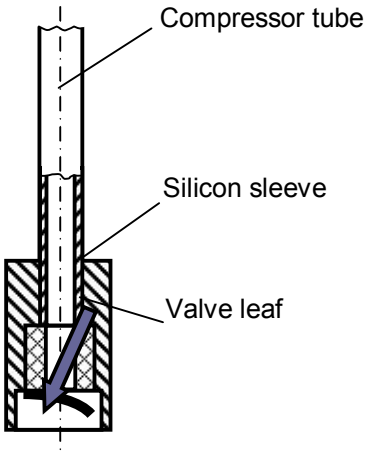


Fig. 2.44

2.5.6 Ammonia solution filling

To do so it is required to:

– disconnect CT-18 PVC tube from the compressor pipe connection;

– unplug compressor cable connector from the ABD;

– remove the ammonia solution vessel from the holder;

– place the vessel in the exhaust hood;

– unscrew the coupling nut from the ammonia solution vessel neck preventing compressor rotation;

– remove compressor;

– fill the vessel with 1 dm^3 of reagent grade concentrated aqueous ammonia solution 23-5 GOST 24147-80 and, if required (at temperature above 30 °C), dilute it in the ratio 1:1;

– mount the compressor onto the vessel, tighten the coupling nut so as to ensure tightness;

– install the vessel with ammonia solution onto the hydraulic panel;

– put CT-18 PVC tube onto the compressor pipe connection;

– connect compressor cable connector to the ABD.

ATTENTION: AVOID ingress of ammonia solution on painted surfaces of hydraulic panel components, ABD and converter unit to prevent damage!

2.5.7 Supply-line fuses

Fuses are replaced at factory after correction of faults that caused fuse destruction.

The supply transformer primary winding contains two ВП2Б-1В (1 А/250 В) fuses.

3 MAINTENANCE

3.1 Analyzer scheduled maintenance

3.1.1 On-going inspection of the converter unit, hydraulic panel and connecting cables for mechanical damage.

3.1.2 Check of connections between hydraulic panel components fir tightness. Hydraulic panel pipe connections are to be sealed with rings 004-006-14. If required, install new rings from the probe maintenance kit.

3.1.3 On-going check of adequate amount of reagent grade aqueous ammonia in the ammonia solution vessel (at least 2/3 of the vessel capacity) and timely replenishment as it is exhausted with glowing "**AMMONIA EXHAUSTION**" LED on the ABD.

ATTENTION: Prior to long-term outage of the analyzer drain ammonia solution from the vessel to avoid damage to compressor components!

3.1.4 Cleaning of external surfaces of the converter unit and hydraulic panel components using soft detergents.

ATTENTION: AVOID moisture ingress into the panel-type converter unit during cleaning!

3.1.5 On-going replacement of filtration medium in the overflow facility of the flow module.

3.1.6 Analyzer calibration using calibration solutions according to 2.3.7.

4 SCOPE OF SUPPLY

4.1 Scope of supply is tabulated in table 4.1.

Table4.1

Description	Code	Qty per version	
		1002, 1002/P	1002/1, 1002/1P
1 Converter unit	BP49.01.000	1	–
	BP49.01.000-01		1
2 HP-1002 hydraulic panel	BP49.02.000	(1 or 2)*	(1 or 2)*
3 Sodium electrodes: – ЭС-10-07 glass electrode;		(2 or 4)*	(2 or 4)*
– ЭЛИС-212Na/3 (К 80.7) ion-selective glass electrode;		*	*
– Type 8480 B Na-selective electrode;		*	*
– DX 223 Na-selective electrode.		*	*
4 pH-electrodes: – ЭСЛ-43-07СР glass electrode;		(2 or 4)*	(2 or 4)*
– ЭС-10601/7 (К 80.7) glass electrode;		*	*
– Type 8402 B pH-electrode.		*	*
5 Reference electrodes: – ЭВЛ-1М3.1 reference electrode;		(2 or 4)*	(2 or 4)*
– ЭСр-10103-3,0 (К 80.4) reference electrode;		*	*
– ЭСр-10101-3,0 (К 80.4) reference electrode.		*	*
6 К1002.5 connecting cable	BP49.03.000	**	**
7 К1002.L*** connecting cable	BP49.03.000-01	*	*
8 PS-1002 power supply	BP49.04.000	**	**
9 Probe maintenance kit	BP49.06.000	1	–
10 Probe maintenance kit	BP49.10.000	1	1
11 Spare parts kit	BP49.02.950	**	**
12 Probe collecting kit	BP49.02.980	*	*
13 Operation Manual	BP49.00.000РЭ	1	1

* To be agreed upon with a customer.
** Quantity corresponds to the quantity of hydraulic panels.
*** Length to be agreed upon with a customer (from 5 to 100 m).

5 TRANSPORT AND STORAGE

5.1 Analyzer transport conditions in a manufacturer's container shall comply with storage conditions 5 according to GOST15150 and rules and regulations now in force in each kind of transport.

5.2 Electrode transport conditions in a manufacturer's container shall comply with storage conditions 5 according to GOST15150 at temperature not below minus 10 °C.

5.3 Analyzers shall be stored in a manufacturer's container in sheltered space on racks in compliance with storage conditions 1 according to GOST15150.

5.4 Storage spaces must be free from dust, acid and alkali fumes, corrosive gases and other harmful corrosive impurities.

APPENDIX A

(compulsory)

Reference solution preparation techniques

A.1 Preparation of sodium chloride solution with sodium ion concentration of 2.3 ppt

Take 5.85 g of sodium chloride weighed amount dried for 1-2 h at 110 °C (the weighed amount may be replaced by phyxanal of 0.1N NaCl ОСЧ МРТУ 6-09-292-70). Transfer the weighed amount into a 1000 см^3 volumetric flask.

Fill the flask with 500-700 cm^3 of chemically pure water (henceforth purified water).

Stir to completely dissolve the salt.

Make to 1-3 cm below the mark with purified water.

Place the flask in thermostat for at least 0.5 h at temperature of (20 ± 1) °C.

Make to the mark with purified water, close with plug and mix well.

Transfer solution into a glass or polyethylene (polypropylene) container with tight cover.

Solution maximum storage period is 6 months.

A.2 Preparation of sodium chloride solution with sodium ion concentration of 230 ppm

Pipette 100 cm^3 of NaCl solution with 2.30 ppt sodium ion concentration into a 1000 cm^3 volumetric flask.

Make to 1-3 cm below the mark with purified water.

Place the flask in thermostat for at least 0.5 h at temperature of (20 ± 1) °C.

Make to the mark with purified water, close with plug and mix well.

Transfer solution into a glass or polyethylene (polypropylene) container with tight cover.

Solution maximum storage period is 6 months.

A.3 Preparation of sodium chloride solution with sodium ion concentration of 69 ppm

Pipette 30 cm^3 of NaCl solution with 2.3 ppt sodium ion concentration into a 1000 cm^3 volumetric flask.

Make to 1-3 cm below the mark with purified water.

Place the flask in thermostat for at least 0.5 h at temperature of (20 ± 1) °C.

Make to the mark with purified water, close with plug and mix well.

Transfer solution into a polyethylene (polypropylene) container with tight cover. Do not store solution in a glass container.

Solution maximum storage period is 1 month.

A.4 Preparation of sodium chloride solution with sodium ion concentration of 13.8 ppm

Pipette 6 cm^3 of NaCl solution with 2.3 ppt sodium ion concentration into a 1000 cm^3 volumetric flask.

Make to 1-3 cm below the mark with purified water.

Place the flask in thermostat for at least 0.5 h at temperature of (20 ± 1) °C.

Make to the mark with purified water, close with plug and mix well.

Transfer solution into a glass or polyethylene (polypropylene) container with tight cover.

Solution maximum storage period is 1 month.

A.5 Preparation of sodium chloride solution with sodium ion concentration of 2.3 ppm

Pipette 10 cm^3 of NaCl solution with 230 ppm sodium ion concentration into a 1000 cm^3 volumetric flask.

Make to 1-3 cm below the mark with purified water.

Place the flask in thermostat for at least 0.5 h at temperature of (20 ± 1) °C.

Make to the mark with purified water, close with plug and mix well.

Transfer solution into a polyethylene (polypropylene) container with tight cover. Do not store solution in a glass container.

Solution maximum storage period is 1 month.

A.6 Preparation of sodium chloride solution with sodium ion concentration of 230 ppb

Preparation of the solution requires painstaking accuracy. For preparation use polyethylene (polypropylene) ware with exception for a pipette which may be made of glass. Volumetric ware used must thoroughly be cleaned with purified water. Do not touch the parts of ware which contact the solution prepared.

Pipette 100 cm^3 of NaCl solution with 2.3 ppm sodium ion concentration into a 1000 cm^3 volumetric flask.

Make to 1-3 cm below the mark with purified water.

Place the flask in thermostat for at least 0.5 h at temperature of (20 ± 1) °C.

Make to the mark with purified water, close with plug and mix well.

Solution is not to be stored.

A.7 Preparation of sodium chloride solution with sodium ion concentration of 23 ppb

Preparation of the solution requires painstaking accuracy. For preparation use polyethylene (polypropylene) ware with exception for a pipette which may be

made of glass. Volumetric ware used must thoroughly be cleaned with purified water. Do not touch the parts of ware which contact the solution prepared.

Pipette 10 cm^3 of NaCl solution with 2.3 ppm sodium ion concentration into a 1000 cm^3 volumetric flask.

Make to 1-3 cm below the mark with purified water.

Place the flask in thermostat for at least 0.5 h at temperature of (20 ± 1) °C.

Make to the mark with purified water, close with plug and mix well.

Solution is not to be stored.

A.8 Preparation of sodium chloride solution with sodium ion concentration of 2.3 ppb

Preparation of the solution requires painstaking accuracy. For preparation use polyethylene (polypropylene) ware with exception for a pipette which may be made of glass. Volumetric ware used must thoroughly be cleaned with purified water. Do not touch the parts of ware which contact the solution prepared.

Pipette 1 cm^3 of NaCl solution with 2.3 ppm sodium ion concentration into a 1000 cm^3 volumetric flask.

Make to 1-3 cm below the mark with purified water.

Place the flask in thermostat for at least 0.5 h at temperature of (20 ± 1) °C.

Make to the mark with purified water, close with plug and mix well.

Solution is not to be stored.

Note − The above techniques complies with Appendix A "Preparation of reference solutions" to the document "ЭЛИС-212Na" ion-selective electrodes. Calibration techniques. ГРБА.418422.012-03МП".