LABORATORY ION METER
И-160М

Instruction Manual

МТИС2.840.009 РЭ

2002

CONTENTS

Laboratory ion meter И-160М (the instrument below) is designed to measure the temperature of the analyzable medium, automatic conversion of electric input signals from primary converters of the pX or redox potential of aqueous solutions into proportional signals of measurement data induced on the digital display and into analog and digital output signals.

The instrument is applicable to measuring the oxygen indicator (pH) and the indicator of activity of univalent and bivalent anions and cations (the activity of ions, pX, below), the redox potential (Eh), temperature (T) and concentration of ions (cX) in aqueous solutions (in accordance with the effective methods of measurement).

The instrument is intended to be used at industrial and research laboratories in various branches.

The instrument comprises a measuring converter (the converter below) and a set of measuring auxiliaries.

1 DESIGN AND PRINCIPLE OF OPERATION

1.1 Principle of operation

1.1.1 The instrument operates on the basis of the potentiometric method of measuring pX (pH) and Eh of the controlled solution.

The operation of the converter is based on the conversion of the EMF of the probe system and other EMF sources into the proportional voltage followed y its conversion into a digital code or an analog output signal.

The probe system for measuring pX (pH) or Eh of solutions comprises a measuring and an auxiliary probes. When the probe system is immersed into the controlled solution an EMF appears linearly dependent on the activity of ions and the temperature of the solution.

The electrolytic contact between the auxiliary probe and the controlled solution is established through a porous membrane at the tip of the probe to let the saturated KCl solution ooze into the controlled solution. When the potassium chloride solution continuously penetrates through the membrane, it suppresses the penetration of foreign ions from the controlled solution into the auxiliary probe system that might otherwise alter the magnitude of the probe’s potential.

1.1.2 When measuring pH the result is determined with formula (1).

$$pH = pH_I + \frac{E - E_I}{K_S \cdot S_{t\ ttheor}}, \qquad (1)$$

where pH – the pH of the analyzable solution, pH, displayed as a result;

E – the EMF value read by the converter of the probe system immersed into the controlled solution, mV;

PH_I – the coordinate of the isopotential point of the probe, pH. It is determined during adjustment and stored by the converter.

E_I – the coordinate of the isopotential point f the probe, mV. It is determined during adjustment and stored by the converter.

Ks- the correction factor allowing for the deviation of the real slope from the theoretical value. It I calculated during adjustment and stored by the converter.

$S_{t\ theor}$ – the theoretical slope of the probe system. It is a function of the temperature of the analyzable t and it is calculated with formula (2).

$$S_{t\ thor} = -0{,}1984 \cdot (273{,}16 + t) / n, \qquad (2)$$

where t - the temperature of the test solution, °C. It is measured by the converter or set by the user manually depending on the type of the set temperature compensation (4.2.2).

n – the coefficient depending on the ion type and valence:

univalent cations, including pH,	n = 1;
univalent anions,	n = - 1;
bivalent cations,	n = 2;
bivalent anions,	n = - 2.

The point at which the potential of the probe system is temperature independent is termed the isopotential point. The values E_I and pH_I are the coordinates of the isopotential point.

1.1.3 When measuring the activity of other ions the result is calculated with formula (3).

$$pX = pX_I + \frac{E - E_I}{K_S \cdot S_{ttheor}}, \qquad (3)$$

where pX – the pX value of the analyzable ion in the solution, pX, displayed as a result;

E - the EMF of the probe system measured by the converter when the probe system is immersed into the analyzable solution, mV.

PX_I – the coordinate of the isopotential point of the probe couple, pX. It is determined during adjustment and stored by the converter.

E_I - the coordinate of the isopotential point of the probe couple, mV. It is determined during adjustment and stored by the converter.

$S_{t\ theor}$ – the theoretical slope of the probe system, it is calculated for the temperature of the analyzable (or adjustment) solution with formula (2).

Ks – the correction factor allowing for the deviation of the real slope from the theoretical value. It is determined during adjustment and stored by the converter.

When the probes with nonstandardized coordinates of the isopotential point (excepting glass Na^+, Li^+ selective probes) the coordinates pX_I and E_I are assumed respectively equal to the activity of the first reference solution (pX1) and the EMF registered during adjustment with the first reference solution (E1). In this case the temperature compensation is ineffective, measurements should made at the temperature of adjustment.

1.1.4 The result of measurement in the units of concentration cX (for all ions, excepting H^+), depending on the selected dimensions, is determined with rescaling formulas (4) – (6).

$$cX = 10^{-pX} \cdot K, \qquad (4)$$

where cX - concentration, mole/l;

K – the coefficient of activity. It depends on the type of the ion to be analyzed and is assumed 1. In measurements K is achieved close to by the method of preparation of the solution to be analyzed;

$$cX' = M \cdot 10^{-pX} \cdot K, \qquad (5)$$

where cX' - concentration, g/l;

M – the ion molar mass, g/mole;

$$cX'' = |n| \cdot 10^{-pX} \cdot K, \qquad (6)$$

where cX'' - concentration, mole/l equivalent;

n – the coefficient determined by the ion type and valence (see explanation of formula 2).

1.1.5 A submersible temperature compensator serves to measure the temperature of the solution. The temperature of its sensitive element determines the resistance of the temperature compensator. The converter measures the resistance and converts it into the temperature of the solution.

1.1.6 The probe system for measuring the redox potential (Eh) comprises a redox measuring probe and an auxiliary chlorine-silver probe.

1.2 Design of the instrument

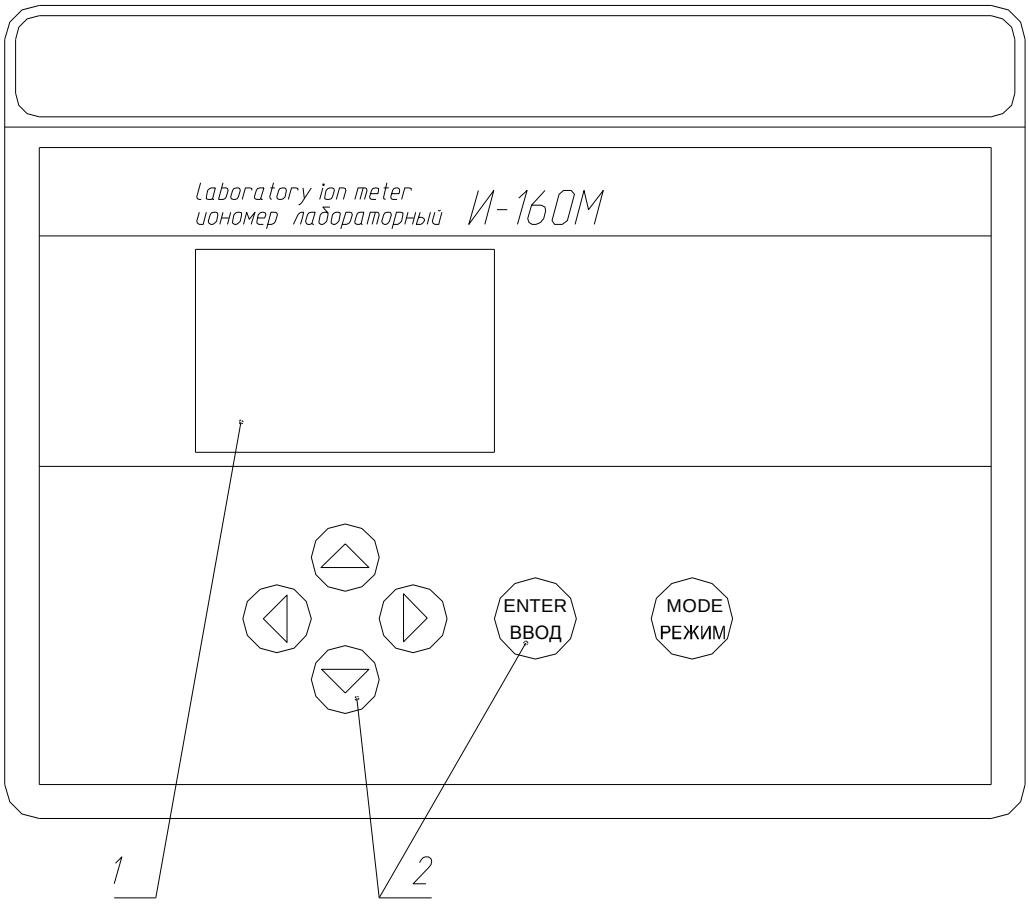
The instrument consists of the converter, the stand and the probe system.

1.2.1 Design of the converter.

The measuring converter consists of a body with a measuring card inside. A digital display and controls (a keyboard) are arranged on the front panel.

The controls and external electric terminals have corresponding markings.

Fig. 1 shows the general view of the converter and its components.

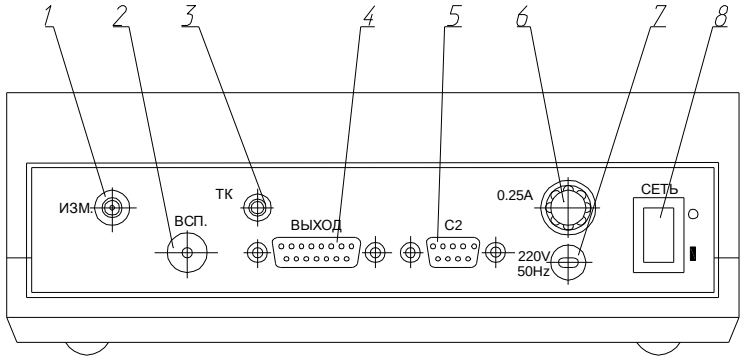


1. Digital display.
2. Controls.

ENTER **MODE**

Fig. 1

Fig. 2 shows the rear panel of the converter.



1. “MEAS” connector for connecting the measuring or combination probe.
2. The “AUX” socket for connecting the auxiliary probe.
3. The «C2» connector for PC.
4. The “Output” connector for execution devices (a recording potentiometer, an automatic titration unit or external channel selector).
5. The “TC” connector for the temperature compensator.
6. A mains cord.
7. A mains fuse.
8. A mains switch.

Fig. 2

Appendix B contains the table of contacts of the “Output” connector.

1.2.2 Stand.

The stand is delivered disassembled. The manual for the stand included into the standard delivery set describes its design and assembly.

1.2.3 Electrolytic bridge.

The electrolytic bridge serves to measure the activity (concentration) of ions with the probe that senses the ions of potassium and chlorine and to measure small-volume samples.

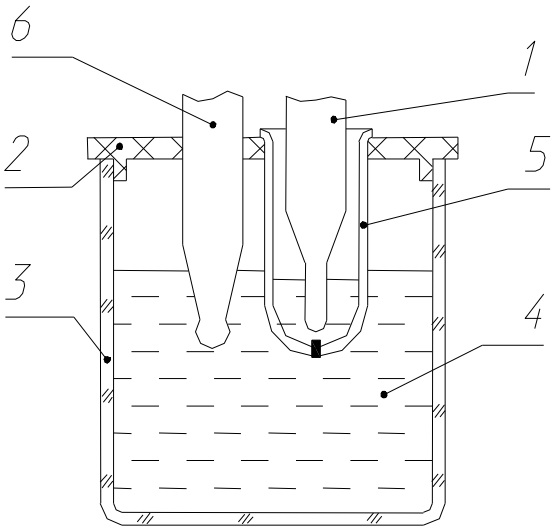
The bridge is shaped as a cylinder with a spherical bottom to which a porous material is soldered to establish the electric coupling between the sample and the probe.

The bridge is designed tight to prevent potassium chloride from penetrating into the reference and test solutions in case the chloride leaks from the auxiliary probe body or if it is contained in the cup during micromeasurements.

To prepare the bridge it is first soaked in distilled water during 24 h.

1.2.3.1 A cup with a cap serve to measure with probes that sense potassium and chlorine ions, the cap has holes to hold the measuring probe, the temperature compensator (or a thermometer) and the electrolytic bridge (Fig. 3).

The measuring probe is inserted directly into the cup holding the test solution; the auxiliary probe is inserted through the electrolytic bridge. The electrolytic bridge should be filled up with the solution described in the instruction manual for the measuring probe used.



1. Auxiliary probe;
2. Cap;
3. Cup;
4. Sample;
5. Electrolytic bridge;
6. Measuring probe.

Fig. 3

1.2.3.2 The configuration is similar for micromeasurements; only the micro-dose and the working portion of the measuring probe are placed in the hollow portion of the bridge, while the auxiliary probe is immersed into the cup filled up with a saturated KCl solution. The level of the KCl solution should establish a reliable contact with the porous portion of the bridge.

1.3 Indication and control

The results of measurement and other information are displayed on the matrix display on the front panel of the converter.

The following pushbuttons serve to control the instrument:

MODE - selection of the model of operation of the instrument.

ENTER - confirmation of the mode, symbols, set numerical values (i.e., when the pushbutton is pressed the converter switches over to the selected mode, stores the symbol or numerical value).

◀ and ▶ - cursor right and left movement;

▲ and ▼ a) cursor up and down movement;

b) changing (editing) symbols or numerical values selected with the blinking cursor (Fig. 4).

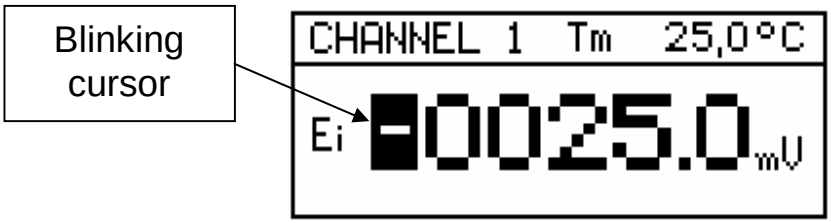


Fig. 4

2 SAFETY

Operators of the instrument should thoroughly study the present instruction manual, the effective rules of operating electrical devices and handling chemical agents.

The instrument should be disconnected from the mains for maintenance and repairs.

3 PREPARATION FOR OPERATION

3.1 Preparation of the instrument.

To operate the converter should be connected to the mains and warmed up during 30 min.

3.1.1 The probe couple for measurements comprises a measuring and an auxiliary probes. The measuring probe is optional and it is selected suitable for the type of the ion to be measured, for the range of measurement and the temperature of the solution. The auxiliary reference probe is included into the standard delivery set.

If the instrument is intended to measure pH, a combination pH-probe with the measuring and the auxiliary probes arranged in a common body.

The measuring and the auxiliary probes are mounted on the stand and connected to the «**MEAS**» and «**AUX**» sockets of the converter.

The combination pH-probe is connected to the «**MEAS**» socket of the converter. In this case the auxiliary probe from the standard set is not used.

3.1.2 When instrument is actuated for the first time or after a long idle time it should be tuned up (4.4).

Reference solutions are used for tuning.

Buffer solutions of the 2nd category under GOST 8.135 serve for reference for adjusting pH measurements.

The pH values of the buffer solutions as a function of their temperature are listed in GOST 8.134 and Appendix A.

For measuring the activity (concentration) of other ions the reference solutions for tuning are prepared following the instructions in the methods of measurement and instruction manuals for ion selective probes to be used.

3.1.3 Solutions can be measured automatically or by manual setting of their temperatures when determining the activity (concentration) of ions.

The temperature is set manually when the temperature of the solutions is constant.

A reference thermometer is mounted on the stand to enter the temperature of the test solution manually using the keyboard (4.2.3).

Automatic temperature measurements are performed when solutions have variable temperature and the temperature compensator is required.

The temperature compensator performs the following functions:

- automatic compensation of EMF variations of the probe system when the temperature of the solution changes, (in Russian), it is used only with the probe systems in which the coordinate of the isopotential point are standardized (1.1.2, 1.1.3);
- control of the correlation between the temperature of the test solution and the temperature of reference solutions;
- control of the correlation between the temperature of the first and second reference solutions.

Top operate the temperature compensator should be immersed into the test solution at least 30 mm deep.

One and the same type of temperature compensation and the range of measurement should be used for tuning and in the process of measurement.

The temperature compensator is mounted on the stand and connected to the «**ТС**» connector.

3.2 Preparation of probes for operation.

Before operation the probes should be prepared in accordance with their instruction manuals.

4 OPERATING THE INSTRUMENT

4.1 The modes of operation of the instrument

The instrument operates in the following modes:

- measurement;
- adjustment;
- control of parameters;
- settings.

The main menu is displayed by pressing the **MODE**, the user then can access the modes of «**ADJUSTMENT**», «**CONTROL**», «**SETTINGS**» (Fig. 5).

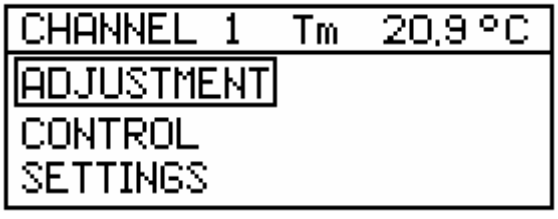


Fig. 5.

The «**ADJUSTMENT**» mode serves to adjust the instrument using the reference solutions.

The «**CONTROL**» mode serves to monitor the parameters of the probe system and the conditions of tuning of the selected channel.

The «**SETTINGS**» mode serves to select the type of measured ions, units of measurement, coordinates of the isopotential point of the measuring probe.

4.2 «ADJUSTMENT» mode

The instrument should be prepared (3) and adjusted (4.4) in order to measure with a normalizable error.

Once the converter is connected to the mains, the «**MEASUREMENT**» mode starts automatically.

The umber of channel 1, the type of temperature compensation 2, temperature 3, units of measurement 4, the type of ions 5 and the current result of measurement 6 appear on the display of the converter (Fig. 6).

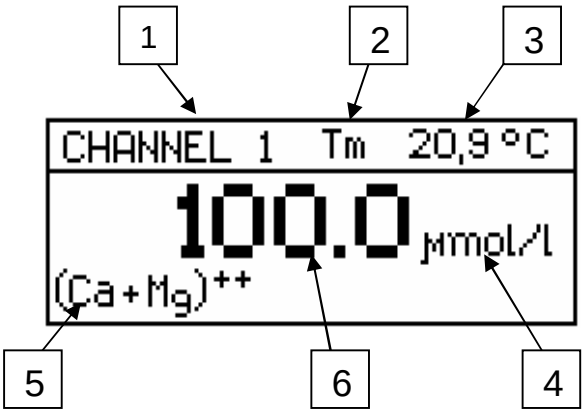


Fig. 6

After the probe system us immersed into the test solution the display of the converter shows the current result of measurement 6 (Fig. 6).

The time of stabilization of readings is usually below 3 min.

Yet, when measuring solutions with low concentrations or the pH of concentrated acid or alkaline solutions with temperature close to 0 °C, readings may stabilize after as long as 10 min.

When the instrument is in operation, it is advised to check periodically (at least once in 1 or 2 weeks) the characteristics (4.5.4, 4.6.3, 4.7.3), if necessary, the selected channel of measurement should be readjusted.

The «**MEASUREMENT**» mode allows the use to select the number of a channel, the type of temperature compensation and the temperature (when the temperature compensation is manual).

When measuring the activity (concentration) of H^+, Na^+, Li^+ ions, solutions with different temperatures can be measured, in this case automatic temperature measurement is advised to maintain automatic compensation of the temperature changes of the EMF of the probe system.

When manual temperature compensation is used, the temperature compensation of the EMF variations of the probe system, the temperature of the test solutions should be checked with a reference thermometer and set manually (4.2.3).

When the probes are used for measurements with the nonstandardized coordinates of the isopotential point, the temperature of the test solution should be equal to the temperature of the reference solution that served to adjust the instrument in order to achieve the standard error. If the difference between the temperatures of the test and reference solutions exceeds 1.5 ºC, a relevant warning should appear on the display (5).

A single probe system (the measuring and auxiliary probes or the combination probe) is connected to the input connectors of the converter.

The available nine working channels allow to maintain the settings of nine different probe systems, i.e. each channel can be adjusted to its individual probe system.

Different measuring probes can be used by suitable adjustment of the channels in advance.

4.2.1 Selection of the measurement channel.

Table 1 shows the sequence of selection of the working channel.

Table 1

	Operations	Displayed information
1	Press ◄ and ► to move the cursor to the figure designation the channel number.	
2	Press ▲ and ▼ to select the channel number. Press **ENTER**.	

4.2.2 Setting the type of temperature compensation.

The instrument can operate with automatic **«Ta»** or manual **«Tm»** temperature compensation.

The type of temperature compensation can be changed only when the temperature compensator is connected to the converter.

When the temperature compensator is off, the converter automatically switches over to manual temperature compensation.

Table 2 lists the operations to change the type of temperature compensation.

Table 2

	Operations	Displayed information
1	By pressing ► move the cursor to the symbol of the type of temperature compensation.	
2	By pressing ▲ and ▼ select the type of temperature compensation (e.g., **«Ta»**). Press **ENTER.**	

4.2.3 Manual temperature setting.

Temperature is set manually only in the mode of manual temperature compensation.

Table 3 lists the operations of manual temperature setting.

Table 3

	Operations	Displayed information
1	Press ► to move the cursor to the field of temperature.	
2	Press ◄, ► и ▲ , ▼ (1.3) to set the sign and bit-by-bit beginning with the high order digit, enter the required temperature, e.g. «+20,0 °C». Press **ENTER**.	

Note. The sign «+» when the temperature is positive or insignificant zeroes are not displayed after the temperature is edited.

4.2.4 Measurement of the redox potential Eh and the potential of the probe system.

To measure the redox potential Eh the measuring redox-probe, such as ЭПКЛ-03М or similar, and the auxiliary probe ЭВЛ-1М3 should be connected to the converter, the units of measurement «**mV**» should be selected (4.3.2).

When using a platinum measuring probe and in order to check the fitness of the instrument for measuring Eh, the probes are inserted into the measuring cell containing a fresh-prepared solution with the composition:

$$\frac{K_4[Fe(CN)_6]\cdot 3H_2O}{K_3[Fe(CN)_6]} = \frac{3{,}8}{13{,}5}, \text{ g/l.}$$

The converter at a temperature of the solution 25 °C should read (275 ± 15) mV.

When a different type of the measuring probe is used, in order to check the fitness of the instrument for measuring Eh, the instructions in the manual for the relevant measuring probe should be followed.

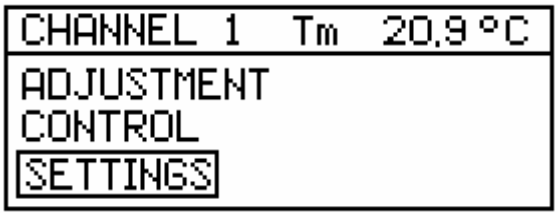
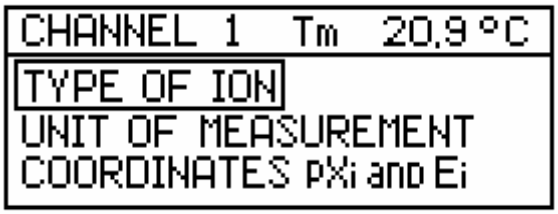
Similarly, the potential of any probe system can be measured by selecting the units of measurement «**mV**» (4.3.2).

4.3 The «SETTINGS» mode

The «**SETTINGS**» mode allows to select the type of ions, the units of measurement and to set the coordinates of the isopotential point of the measuring probe (if the selected channel is set to measure the H^+, Na^+, Li ions).

Table 4 lists the sequence of actuating the «**SETTINGS**» mode.

Table 4

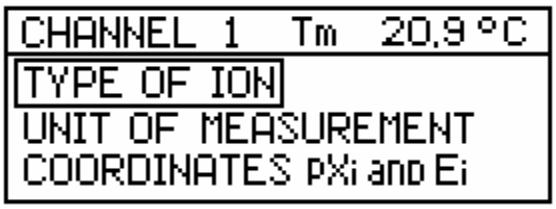
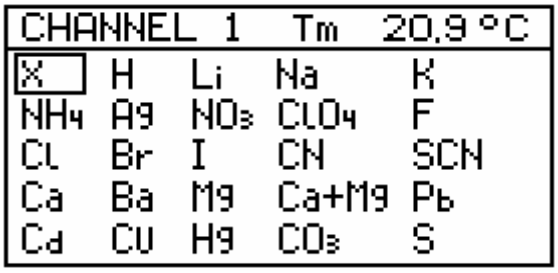
	Operations	Displayed information
1	By pressing ▲ and ▼ highlight «**SETTINGS**» in the main menu. Press **ENTER**.	
2	The menu is displayed that allows to set: - the type of ions; - the units of measurement; - the coordinates of the isopotential point of the measuring probe.	

Note. The line «**COORDINATES of pX_I and E_I**» is displayed only if the selected channel is adjusted to operate with H^+, Na^+, Li^+ ions.

4.3.1 Selection of the ion type.

Table 5 shows the routine of selecting ion type.

Table 5

	Operations	Displayed information
1	Press ▲, ▼ in the «**SETTINGS**» mode to highlight «**ION TYPE**». Press **ENTER**.	
2	Press ▲, ▼ и ◄, ► to highlight the required ion. Press **ENTER**.	

If the required ion is not listed, select the symbol «**X**». When the symbol «**X**» is entered, the converter requests the charge and the valence of the ion to be measured:

« - »,« - - », « + », « + + ».

Attention!

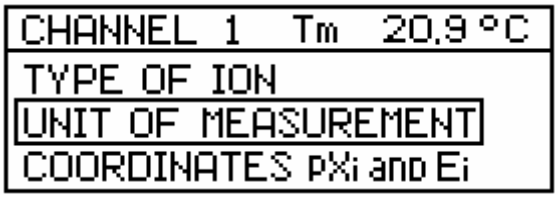
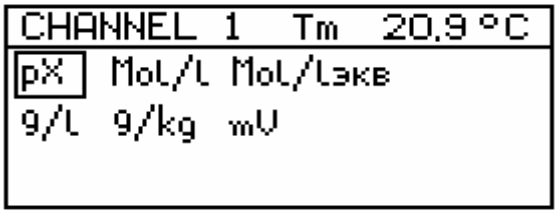
1 When the ion type is hanged in any channel the converter automatically switches over to the mode of adjustment of the channel. The probe system suitable for the selected ion should be connected and adjusted.

2 When H^+, Na^+, Li^+ ions the converter prompts first to enter (to change) the coordinates of the isopotential point (4.3.3).

4.3.2 Selection of the units of measurement.

Table 6 shows the routine of selection of the units of measurement.

Table 6

	Operations	Displayed information
1	Press ▲ , ▼ to highlight «**UNIT OF MEASUREMENT**» in the «**SETTINGS**» mode. Press **ENTER**.	
2	Press ▲ , ▼ и ◄ , ► to highlight the required unit of measurement, e.g., «**pX**». Press **ENTER**.	

Notes:

1 If the channel is adjusted to the ion «**H**» (4.3.1) the units of measurement «**pH**» and «**mV**» are displayed only.

2 When measuring in the units of concentration (e.g., «**g/l**») the converter automatically selects the multiple units («**mg/l**» и «**µg/l**») in response to the result of measurement.

The results of measurements can be displayed in various units, though it impairs the accuracy.

To measure in different units without impairing the accuracy is possible providing the selected channel is adjusted for each set of units.

The converter stores the performed adjustments of all units of measurements.

If the selected units of measurement have not been adjusted before, any transition to other units requires recalculations using the formula in Table 7. Yet the accuracy of measurement declines.

Table 7

Units of measurement of the activity and concentration o reference solutions	Units of information				
	pX	Mole/l	Mole/l equivalent	g/l	g/kg
pX		10^{pX}	$n10^{pX}$	$M10^{pX}$	$kM10^{pX}$
Mole/l (cX)	- lg cX		n cX	M cX	kM cX
Mole/l equiv (cX')	-lg cX'+lg(n)	cX'/n		M cX '/n	KM cX'/n
g/l (cX'')	-lg cX''+lg(M)	cX''/M	n cX''/M		K cX''
g/kg (cX''')	-lg cX '''+lg(kM)	cX'''/kM	n cX'''/kM	cX'''/k	

The legend in Table 7:
M - ion molar mass, g/mole;
n - ion charge;
k - correction factor determined by the method of ion measurement.

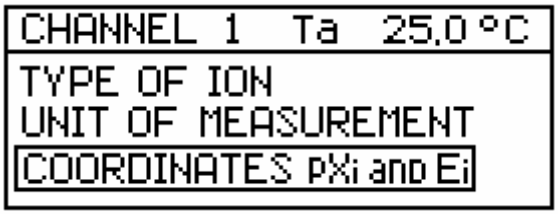
4.3.3 Setting the coordinates of the isopotential point.

Before adjusting the units of activity (concentration) of H^+, Na^+, Li^+ ions the coordinates of the isopotential point (pX_I and E_I) should be entered.

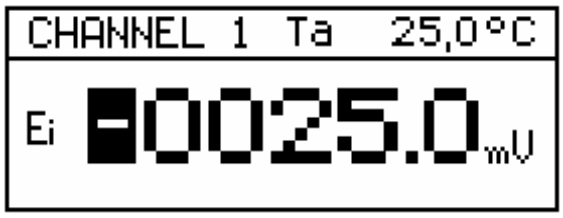
The isopotential point coordinates are indicated in the instruction manuals of the relevant measuring probes.

Table 8 shows the routine of entering the isopotential point coordinates.

Table 8

	Operations	Displayed information
1	Press ▲ , ▼ in the «**SETTINGS**» mode to highlight the «**COORDINATES pX_I and E_I**». Press **ENTER**.	
2	The display shows the pX_I value prompted by the converter, e.g. «7.000 pH». If necessary, press ◄ , ► and ▲ , ▼ , to enter a different pX_I. Press **ENTER**.	

Continuation of Table 8

3	The display shows the E_I value prompted by the converter or a previously set value, e.g. «– 0025.0 mV». If necessary, press ◄ , ► and ▲ , ▼ to enter a different E_I. Press **ENTER**.	

4.4 «ADJUSTMENT» mode

The instrument is to be adjusted with reference solutions in the following cases:

- when the instrument is restarted after repairs or long-term storage;
- after a periodic check of the instrument's characteristics if the results show their deviation from the standard parameters;
- before the instrument is tested;
- when the range of measurement of the instrument is changed.

Also, to improve accuracy, it is advised to adjust the instrument when different units of measurement are entered (4.3.2).

Adjustment should follow preparation (3).

To begin the channel (4.1.1), the type of temperature compensation (4.1.2), the on type (4.3.1), the units of measurement (4.3.2) and if necessary, the isopotential point coordinates (4.3.3) are selected.

Attention!

To avoid loss of adjustment data in the memory of the converter, it is recommended to resort to the «ADJUSTMENT» mode only when it is absolutely necessary.

In case of accidental loss of the adjustment data the adjustment is to be repeated from the start.

Table 9 specifies the conditions of adjustment to maintain the accuracy of pX measurement within ± 0,1; ± 0,05; ± 0,02 pX.

Table 9

Ser nos	Influencing factors	Error of measurement		
		± 0.1 pX	± 0.05 pX	± 0.02 pX
1.	Error of testing of reference solutions, pX	± 0.05	± 0.025	± 0.005
2.	Accuracy of maintaining the temperature of reference solutions, °C	± 1.0	± 0.5	± 0.1
3.	The need of adjustment using the second heated / cooled reference solution [1]	-	Possible	Mandatory
4.	Maximum effective range (pX) when adjusting with one solution [2]	± 2 pX	± 1 pX	± 0.4 pX

Note:

1 Adjustment using the second heated / cooled reference solution is possible only when measuring the concentration (activity) of H^+, Na^+, Li^+ ions and it is used when the scatter of temperatures of the test solutions is over 10 °C.

2 During measurements after adjustment with a single solution the maximum effective range of test solutions (pX) is indicated in relation to the pX value of the reference solution providing the temperatures of the test and reference solutions are equal.

When adjusting by submersion of the probe system and the temperature compensator (thermometer) into the reference solution, they should be washed with distilled water having the temperature equal to that of the reference solutions, the remaining water is removed with filter paper.

4.5 Adjustment of the instrument to measure pH

Depending on the pH range and the temperature of the test solution it is recommended to use measuring probe, e.g., ЭСЛ-43-07СР or ЭСЛ-63-07СР, or a combination probe, e.g., ЭСК-10601 or ЭСК-10301 (optional).

Adjustment is performed after preparatory operations (3, 4.4).

Two buffer solutions are used to adjust the instrument in pH units.

The first buffer solution should be most close to the beginning of the range o measurement, the second buffer solution should be most close to the end of it.

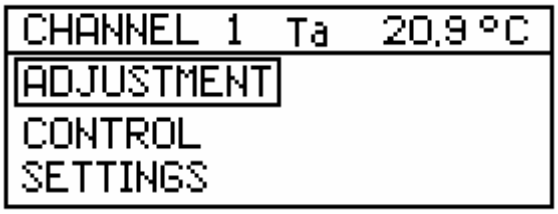
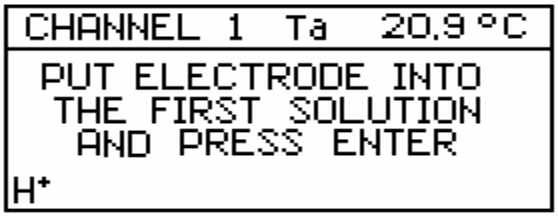
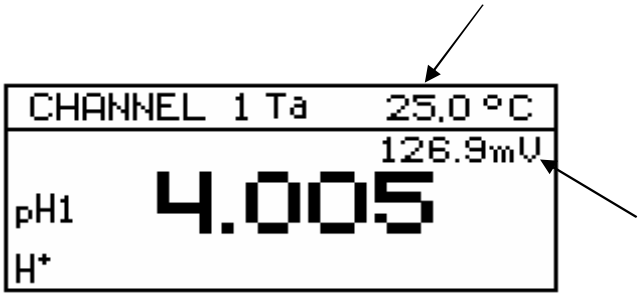
Adjustment is checked with a third buffer solution in the «**MEASUREMENT**» mode.

When two standard buffer solutions under GOST 8.135 are used to adjust the instrument the converter selects automatically the activity value of the applied standard solution that corresponds to the temperature of the buffer solution (Appendix A), this value is displayed.

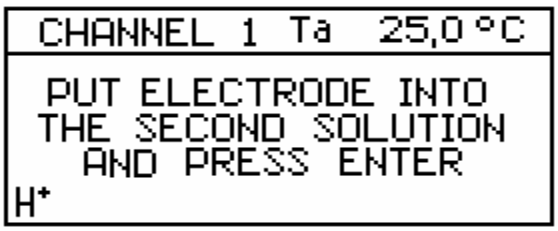
4.5.1 Adjustment with the first buffer solution.

Table 10 shows the routine of adjustment with the first buffer solution.

Table 10

	Operations	Displayed information
1	Press ▲ and ▼ to highlight «**ADJUSTMENT**» in the main menu. Press **ENTER**.	
2	Dip the probe system and the temperature compensator (or a reference thermometer) into the first buffer solution. *(When using manual temperature compensation (Tm) the temperature of the first buffer should be entered after its measurement with the reference thermometer, 4.2.3.)* Press **ENTER**.	
3	Wait until temperature and EMF readings stabilize (shown by arrows). The display shows the pH of the first buffer solution automatically determined by the converter, e.g. 4.005 pH.	

Continuation of Table 10

	If the pH of the first buffer is not edited, press **ENTER**. If it is necessary to edit it, press ◄ , ► and ▲ , ▼ to enter the required pH of the first buffer solution and press **ENTER**.	
4	The converter prompts adjustment using the second buffer solution (4.5.2).	

NOTE. When the «**MODE**» button is pressed at any step of adjustment (4.5.1, 4.5.2, 4.5.3) the display shows the menu (Fig. 7) allowing to finish the adjustment and proceed to the «**MEASUREMENT**» mode or to repeat the preceding adjustment step.

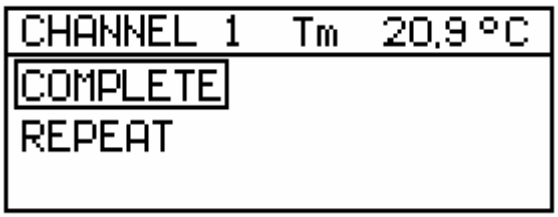


Fig. 7.

4.5.2 Adjustment with the second buffer solution

When the instrument operates within a narrow pH range it is permitted to adjust it with a single solution (Table 9).

The second buffer solution should used to adjust for measurements within a broader range.

Adjustment with the second buffer solution is like that with the first solution (4.5.1).

After the pH of the second buffer solution is entered the converter prompts to carry out adjustment using this solution after it is heated / cooled (4.5.3).

Attention!

*1 In case in the process of measurement with both the solution a message «**Ks<0.8 (Ks>1.2)**» appears in the left lowermost corner of the display, the reference solutions are to be replaced and the adjustment is to be repeated. If the message reappears the probes are to be replaced.*

*2 In case the solutions with equal activities are used for adjustment by mistake, the display reads: «**ATTENTION! pH1=pH2** **PRESS ENTER**». To correct the mistake p*ress **ENTER** and repeat the adjustment with the second buffer *solution.*

4.5.3 Adjustment with the second buffer solution with heating/cooling.

Adjustment with the heated / cooled solution is performed when it is projected to measure the samples with the temperature different from the temperature of the buffer more than 10 °C.

When the solution is heated / cooled for adjustment the isopotential point coordinates are corrected (entered according to 4.3.3) to the real values of the probe in use. The accuracy of measurement improves strongly.

Table 11 shows the routine of adjustment with the heated / cooled solution when the **automatic temperature compensation** «**Ta**» is set.

Table 11

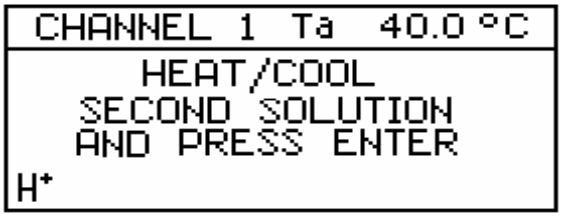
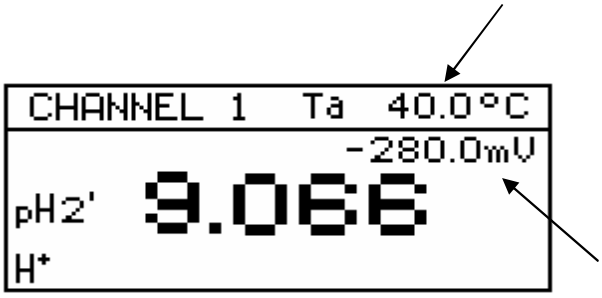
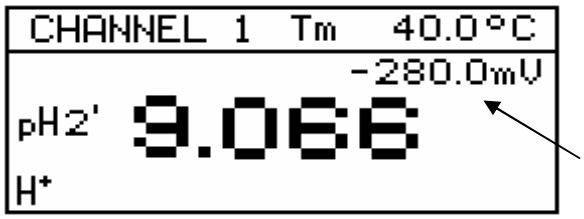
	Operations	Displayed information
1	Immerse the probe system and the temperature compensator into the heated / cooled second buffer solution. Press **ENTER**.	
2	Wait until the temperature and EMF readings stabilize (shown by arrows). The display shows the pH of the second buffer solution automatically measured by the converter, e.g. 9.066 pH.	
3	The pH is not needed for editing, press **ENTER**. If it is necessary to edit press ◄ , ► and ▲ , ▼ to enter the required pH of the second buffer solution and press **ENTER**. The instrument automatically switches to the «**MEASUREMENT**» mode.	
4	The adjustment is checked in the «**MEASUREMENT**» mode with the third buffer solution (4.5.4).	

Table 12 shows the routine of adjustment with the heated / cooled solution when the **temperature compensation** «**Tm**» is **manual**.

Table 12

	Operations	Displayed information
1	Dip the probe system and the reference thermometer into the heated / cooled second buffer solution. Wait until the readings of the thermometer stabilize. Press ◄ , ► and ▲ , ▼ to set the sign and the temperature in accordance with the readings of the reference thermometer, e.g. 40.0 °C (shown by the arrow). Press **ENTER**.	
3	Wait until the EMF readings stabilize (shown by the arrow). The display shows the pH of the second buffer solution automatically measured by the converter, e.g. 9.066 pH. Other operations are similar to those when adjustment is performed with the automatic temperature compensation (Table 11, item 3).	

4.5.4 Adjustment check with the third buffer solution.

The check is made in the «**MEASUREMENT**» mode.

Rinse and immerse the probe system and the temperature compensator (or the reference thermometer) into the third buffer solution, e.g., 6.823 pH.

With manual temperature compensation enter the temperature of the solution (4.2.3).

After readings on the display stabilize the pH should appear different from the activity of the third solution by the value below the tolerable error (Table 9). In the opposite case the adjustment should be repeated.

Attention!

For each relocation of the probe system from one solution into another it should be thoroughly washed in distilled water at the temperature of the buffer solutions. Water drops are removed with filter paper.

4.6 Adjustment of the instrument for the units of activity pX

Select the measuring probe in accordance with the type of the ion to be measured and the range of temperatures of the test solution.

This section deals with an example of adjustment of the instrument in the units of activity of NO_3^- ions. A suitable measuring probe for this case is ЭМ-02.06.04 or similar (optional).

Adjustment is performed after preparatory operations (3, 4.4).

Two reference solutions with equal temperatures are used to adjust the instrument in the mode of measuring the activity pX (Table 9).

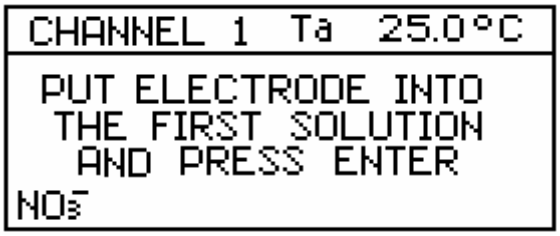
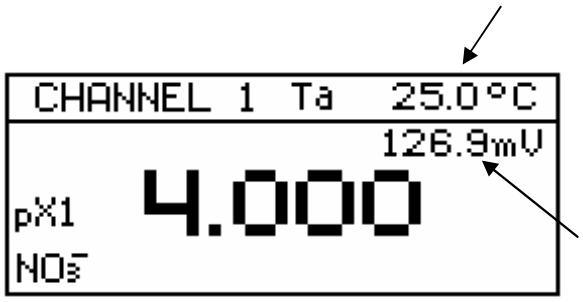
The first reference solution should be close to the beginning and the second to the end of the range of measurement.

The adjustment is checked with the third reference solution in the «**MEASUREMENT**» mode.

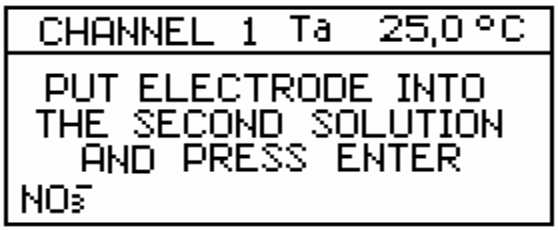
The reference solutions are prepared according to the methods determined by the type of the ion to be measured, e.g. «Methodological guides of determination of nitrates and nitrites in plant cultivation».

4.6.1 Adjustment with the first reference solution.
Table 13 shows the routine of adjustment with the first reference solution.

Table 13

	Operations	Displayed information
1	Press ▲ and ▼ to highlight «**ADJUSTMENT**» in the main menu. Press **ENTER**.	
2	Dip the probe system and the temperature compensator (or the reference thermometer) into the first reference solution, e.g. 4.000 pX. *(With manual temperature compensation (Tm) it is necessary to enter the temperature of the first reference solution measured by the reference thermometer (4.2.3.).* Press **ENTER**. The display shows the pX of the first reference solution in the preceding adjustment.	
3	Wait until the temperature and EMF readings stabilize (shown by the arrow). If the concentration of the first is not edited, press **ENTER**. If it is necessary to edit it press ◄ , ► and ▲ , ▼ to enter the required pX of the first reference solution and press **ENTER**.	

Continuation of Table 13

4	The converter prompts the adjustment with the second reference solution (4.6.2).	

Note. When **MODE** is pressed at any step of adjustment (4.6.1, 4.6.2) the display shows the menu (Fig. 7) allowing to finish the adjustment and to switch over to the «**MEASUREMENT**» mode or to repeat the preceding step of adjustment.

4.6.2 Adjustment with the second reference solution

When the instrument operates within a narrow range of pX measurement the adjustment is performed with a single solution (Table 9). Adjustment should be performed with the second solution for measurements within a broad range.

The adjustment with the second solution is similar to that with the first solution (4.6.1).

The temperature of the second reference solution should be equal to the temperature of the first solution (Table 9).

After the pX of the second reference solution is entered the instrument automatically switches to the «**MEASUREMENT**» mode.

Attention!

*1 In case during adjustment with both solutions a message «**Ks<0.8 (Ks>1.2)**» appears in the right lowermost corner of the display, the reference solutions should be replaced and the adjustment should be repeated. If the message repeats, the probes are to be replaced.*

*2 When the solutions with similar activities are used for adjustment by mistake, a message appears on the display «**ATTENTION! pX1 = pX2 PRESS ENTER**». To correct the mistake press **ENTER** and repeat adjustment with the second reference solution.*

3. The display shows a message «$\Delta t > 1.5$ °C» during automatic temperature measurement if the tolerable difference between the temperatures of the reference solutions is exceeded.

4.6.3 Check of adjustment with the third reference solution.

The check is performed in the «**MEASUREMENT**» mode.

Wash and immerse the probe system and the temperature compensator (or the reference thermometer) into the third reference solution, e.g., 3.000 pX.

When temperature compensation is manual, enter the temperature of the solution (4.2.3).

After the readings on the display stabilize the pX should appear different from the activity of the third solution by the magnitude below the tolerable error (Table 9). In the opposite case the adjustment should be repeated.

Attention!

During each relocation of the probe system from one solution into another it should be thoroughly washed in distilled water at the temperature of the buffer solutions. Water drops are removed with filter paper.

4.7 Adjustment of the instrument in the units of concentration.

Select the measuring probe depending on the type of the ion to be measured and the range of temperature of the test solution.

This section deals with an example of adjustment of the instrument in the units of concentration of NO_3^- ions. In this case the recommended measuring probe is ЭМ-02.06.04 (optional).

The adjustment is performed after preparatory operations (3, 4.4).

Two reference solutions with equal temperatures are used to adjust the instrument in the mode of concentration measurement (Table 9).

The first reference solution should be close to the beginning and the second to the end of the range of measurement.

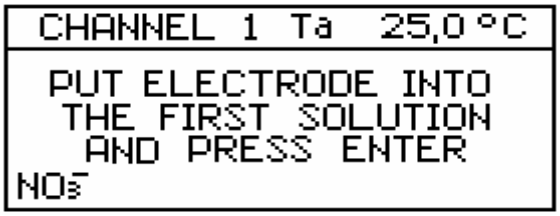
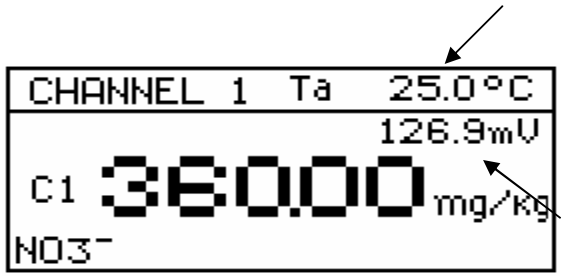
The adjustment is checked with the third reference solution in the «**MEASUREMENT**» mode.

The reference solutions are prepared according to the methods determined by the type of the ion to be measured, e.g. «Methodological guides of determination of nitrates and nitrites in plant cultivation».

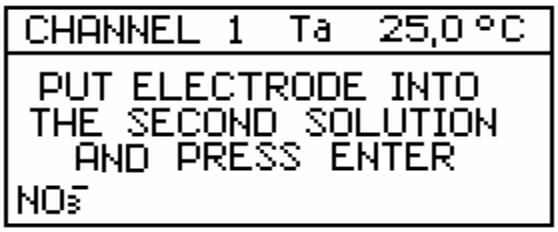
4.7.1 Adjustment with the first reference solution.

Table 14 shows the operations of adjustment with the first reference solution.

Table 14

	Operations	Displayed information
1	Press ▲ and ▼ to highlight «**ADJUSTMENT**» in the main menu. Press **ENTER**.	
2	Immerse the probe system and the temperature compensator (or the reference thermometer) into the first reference solution, e.g. 36 mg/kg. *(In case of manual temperature compensation (Tm) enter the temperature of the first reference solution measured by the reference thermometer, 4.2.3.)* Press **ENTER**. The display shows the concentration of the first reference solution in the preceding adjustment.	
3	Wait until the temperature and EMF readings stabilize (shown by the arrow). If it is not required to edit concentration of the first solution, press **ENTER**. If it is required, press ◄ , ► and ▲ , ▼ to enter the required concentration of the first reference solution and press **ENTER**.	

Continuation of Table 14

4	The converter prompts adjustment with the second reference solution (4.7.2).	

Note. When **MODE** button is pressed at any step of adjustment (4.7.1, 4.7.2) the display shows the menu (Fig. 7) allowing to finish adjustment or switch over to the «**MEASUREMENT**» mode and repeat the preceding step of adjustment.

4.7.2 Adjustment with the second reference solution.

When the instrument operates within a narrow range of concentration measurements the adjustment can be performed with a single solution (Table 9). The adjustment within a broad range is performed with the second solution.

The adjustment with the second solution is similar to that with the first solution (4.7.1).

The temperature of the second reference solution should be equal to the temperature of the first solution (Table 9).

After the concentration of the second reference solution is entered the instrument automatically changes to the «**MEASUREMENT**» mode.

Attention!

*1 In case during adjustment with both solutions a message «**Ks<0.8 (Ks>1.2)**» appears in the right lowermost corner of the display the reference solutions should be replaced and the adjustment repeated. If the message repeats the probes are to be replaced.*

*2 When the solutions with similar activities are used for adjustment by mistake, a message appears on the display «**ATTENTION! C1 = C2 PRESS ENTER**». To correct the mistake press «**ENTER**» and repeat adjustment with the second reference solution..*

3. The message «$\Delta t > 1.5\ ^\circ C$» appears on the display during automatic temperature measurement when the tolerable difference between the temperatures of the reference solutions is exceeded.

4.7.3 Check of adjustment with the third reference solution.

The check is performed in the «**MEASUREMENT**» mode.

Wash and immerse the probe system and the temperature compensator (or the reference thermometer) into the third reference solution, e.g., 360 mg/kg.

When manual temperature compensation is used, enter the temperature of the solution (4.2.3).

After the reading of the display stabilizes a value should show different from the concentration of the third solution by the magnitude below the tolerable error. In the opposite case the adjustment is to be repeated.

Attention!

During each relocation of the probe system from one solution into another it should be thoroughly washed in distilled water at the temperature of the buffer solutions. Water drops are removed with filter paper.

4.8 The mode of controlling parameters

The «**CONTROL**» mode allows to monitor the parameters of the probe system and the conditions of adjustment of the selected channel.

Press ▲ and ▼ to highlight «**CONTROL**» in the main menu (4.1). Press **ENTER**.

The following is consecutively displayed in the «**CONTROL**» mode:

1) the isopotential point coordinates (if the selected channel is adjusted to operate with H^+, Na^+, Li^+ ions); the coefficient of slope of the probe system Ks; the averaged temperature of the reference solutions;
2) the activity (concentration) of the first reference solution and its temperature;
3) the activity (concentration) of the second reference solution and its temperature.

Press ▲ and ▼ to move between the groups of monitored parameters.

4.9 Operation with PC.

The converter can operate with a compatible PC.

Optionally the instrument may include a diskette with the handshake software, the manual how to install and run the software (a *readme.doc* file) and a cable to connect the converter to the PC.

The cable is connected to the “C2” of the converter and to the “RS-232C” connector of the PC.

5 TYPICAL FAULTS AND REMEDIES

Table 15 lists typical faults and remedies.

Table 15

Faults, observed manifestations and additional symptoms	Probable cause	Remedy
1	2	3
1 When the converter is connected to the mains the display does not light up.	Burnt fuse, the mains cord is broken.	Check and replace the fuse, check and repair the mains cord.
2 The readings of the converter are unstable or the display reads: «**INPUT OVERLOAD**».	No contact in cable connectors of probes. Faulty probes.	Check and make a reliable contact, check the resistance of the auxiliary probe, if necessary recharge or replace the probe, check fitness of the measuring probe.
3 The display reads: «**CALCULATION OVERFLOW**».	The result of measurement exceeds the range of the converter. Adjustment is incorrect. No contact in cable connectors of probes. Faulty probes.	Repeat adjustment of the channel with fresh-prepared solutions, check fitness of the probes.

Continuation of Table 15

1	2	3
4 After adjustment of the instrument the display erroneously reads: «**Ks < 0.8**» or «**Ks > 1.2**»	Faulty adjustment. Faulty probes.	Repeat adjustment of the channel with fresh-prepared solutions, check fitness of the probes.
5 During measurement the display reads: «D**t > 1.5 °C**»	The temperature of the test solution is different from the temperatures of the reference solutions by more than 1.5 ºС.	Make the temperature of the test solution corresponding to the temperature of the reference solutions.
6 When the instrument is adjusted with reference solutions the readings on the display remain almost unchanged.	Faulty probes.	Check and replace the probes

APPENDIX A
(Reference)

pH values of buffer solutions

Table A.1

°C	0.05 M solution of potassium tetra oxalate	Potassium oxytartrate solution saturated at 20°C	0.05 M potassium oxyphthalate solution	0.025 M potassium monosubstituted oxyphosphate solution and 0.025 M sodium disubstituted phosphate	0.01 M sodium tetraborate solution
0	-	-	4.000	6.961	9.451
5	-	-	3.998	6.935	9.388
10	1.638	-	3.997	6.912	9.329
15	1.642	-	3.998	6.891	9.275
20	1.644	-	4.001	6.873	9.225
25	1.646	3.556	4.005	6.857	9.179
30	1.648	3.549	4.011	6.843	9.138
37	1.649	3.544	4.022	6.828	9.086
40	1.650	3.542	4.027	6.823	9.066
50	1.653	3.544	4.050	6.814	9.099
60	1.660	3.553	4.080	6.817	8.965
70	1.67	3.57	4.12	6.83	8.93
80	1.69	3.60	4.16	6.85	8.91
90	1.72	3.63	4.21	6.90	8.90
95	1.73	3.65	4.24	6.92	8.89

APPENDIX B
(Reference)

Purpose of “Output” contacts

Table B.1

Contact number	Purpose
8	Analog output «0 … 2 V»
6	«Common» analog output
7	Analog output «0 … 100 mV»
10	Digital code of channel number. Code 1
3	Digital code of channel number. Code 2
11	Digital code of channel number. Code 4
4	Digital code of channel number. Code 8
9	«Common» digital output