ECONIX LTD

pH-METER-ION METER ECOTEST-120

Manual Instruction

Moscow 1998

CONTENTS

INTRODUCTION

The present manual instruction aims to introduce the performance, principles and rules of operating the pH-meter - ion-meter Ecotest-120, referred below as «instrument», developed for the potentiometric measurements of the activity of hydrogen ions (pH), the activity (pX) or concentration (C) of other ions and temperature (T) and also for use as a high-Ohmic voltmeter to measure the redox potentials (Eh), chemical oxygen demand (COD), potentiometric titrations, measurement using standard additions method and also other potentiometric measurements in aqueous solutions of samples of food products, soils, technological solutions, tap, waste and surface water.

The peculiarities of the performance are

-portability
-microprocessor control
-the possibility to use all types of ion-selective electrodes
-the possibility to use outer commutation units, which enables to attach up to 21 electrodes - simultaneously
-it allows to save in memory from 2 to 5 calibration points for every measured ion
-automatic temperature compensation
-automatic calculation and presentation on the indicator of the molar and mass concentration of ions
-easy connection to any IBM-compatible PC
-double power supply - from battery and using net adapter
-the possibility to use in laboratory and in the field conditions
-possibility of illumination of the liquid crystal indicator, which enables to operate in the conditions of insufficient illumination outside
-a user-friendly menu, help mode.

1. General description and use of the instrument

1.1. The goals and field of application

1.1.1. pH-meter Ecotest-120 (further referred as instrument) supplied with ionselective electrodes aims to measure the activity of hydrogen ions (pH), the activity (pX) or concentration (C) of other ions and temperature (T) and also for use as a high-Ohmic voltmeter to measure the redox potentials (Eh), chemical oxygen demand (COD), potentiometric titrations, measurement using standard additions method and also other potentiometric measurements in aqueous solutions of samples of food products, soils, technological solutions, tap, waste and surface water.

The instrument belongs to the group of portable automatic potentiometric analyzers of liquids.

The instrument consists of the electrode system (the primary transducer) and the electronic part, performed on the basis of a microprocessor with autonomic power supply and with indication of the readings on a liquid-crystalline display (LCD).

The principle of the operating is based on the measurement of the potential difference (EMF) between the indicator (working) electrode (IE) and a reference electrode (RE) with the successive calculation of the chemical parameters of the solution.

The memory of the instrument contains the constants for 27 ions (the name, the molar mass and the charge), the last results of the calibration for each type of ions, and also three additional cells to enter such constants for other (new) ions, chosen by user.

The instrument with attached temperature sensor is fit to measure the temperature in aqueous solutions.

The instrument can be used as a voltmeter with a high input resistance to measure redox potentials (Eh), chemical oxygen demand (COD), potentiometric titrations, measurement using standard additions method and also other potentiometric measurements according to procedures of quantitative chemical analysis

The instrument is supplied with the interface RS232C to be attached to the COM-port of IBM-compatible personal computers.

The application of the external unit of commutation of channels enables to use the instrument as multichannel one.

The instrument is developed to be used in chemical, technological, agrochemical, ecological and analytic laboratories, industry, research, state enterprises. The instrument can be used in industrial, laboratory and field conditions.

1.1.2. The working conditions of operating.

The temperature of the ambient air, ^oC	5-40
The relative humidity of the ambient air at 25 ^oC, %, not more than	90
The ambient pressure, kPa	84 - 106,7
Torr	630-800
Temperature of the tested solution, ^oC	5-80
The Voltage of the power supply battery, V	4-9
The resistance of the circuit of the indicator electrode, MOhm, not more	1000
The resistance of the circuit of the reference electrode, kOhm, not more	20

1.2. Technical data

1.2.1. The range of the measurements and the precision of the presentation on LCD are presented in table 1.

Operating mode	Measured parameter	Measurement range	Precision of indication
pH-meter-ionometer	pX	-20 - +20	0.001
	pH	-1 - +14	0.001
	mass concentration (C), mg/dm^3	0,001	0.001
	molar concentration (Cm) $mole/dm^3$	10^{-6} - 10	10^{-6}
	EMF, mV	-4000 - 4000	0.1
Voltmeter	Potential difference, mV	-4000 - 4000	0.1
Thermometer	Temperature, ^oC	-5 +150	0.1

1.2.2. The limit of the allowed absolute deviation of the instrument is not more than

In the mode of pH-meter-ionometer	± 0.005
In the mode of voltmeter	± 0.2
In the mode of thermometer, ^oC	± 0.5

1.2.3. The deviation of the thermocompensation in the range from 5 to 80 ^{o}C is not more than ±0.005 pX

1.2.4. The limit of the allowed deviation of the instrument during measurement of pH using the electrode ECOM-pH is not more than ±0.03.

1.2.5. The instrument must meet the demands of item 1.2.4. at normal conditions of operating:

The temperature of the ambient air, ^{o}C	5-40
The relative humidity of the ambient air at 25 ^{o}C, %, not more than	90
The ambient pressure, kPa	84 - 106,7
Torr	630-800
Temperature of the tested solution, ^{o}C	5-80
The Voltage of the power supply battery, V	6±2
The resistance of the circuit of the indicator electrode, MOhm, not more	1000
The resistance of the circuit of the reference electrode, kOhm, not more	20

1.2.6. Input resistance not less than $1*10^{11}$ Ohm.

1.2.7. Time to establish a stable reading when measuring EMF is not more than 10 s.

1.2.8. Power supply of the instrument is performed using 4 alkaline elements type AA with nominal voltage 1.5 V or using external power supply block BPU 6/0.2-9/0.1. With nominal voltage 6 V the current consumption is not more than 100 mA (when the LCD illumination is off).

If the power supply voltage falls below 4 V a note appears at LCD : «Change batteries».

1.2.9. The presentation of results at LCD is combined of figures and text and is placed at two 16 symbol lines .

1.2.10. The memory of the instrument after shipping contains and can send to LCD the constants (name, atomic or molecular mass and the charge) for the following ions :
H^{+}, Cl^{-}, Br^{-}, I^{-}, Na^{+}, K^{+}, NH_4^{+}, NO_3^{-}, Ag^{+}, S^{-2}, Cu^{+2}, Cd^{+2}, Pb^{+2}, Hg^{+2}, Ca^{+2}+2, Ba^{+2}, CO_3^{-2}, ClO_4^{-}, ReO_4^{-}, F^{-}, $AuCl_4^{-}$, Zn^{+2} , Fe^{+3}, Ca^{+2} + Mg $^{+2}$ (water hardness), HPO_4^{-2}, NO_2^{-} and also three free cells to insert the constants for other ions chosen by user.

1.2.11. The size of the separate parts of instruments is:

The electronic block of instrument, mm, not more than-	200*105*60
Commutation unit KM-7, mm, not more than	120*180*60
The electrode stand SL-4, mm, not more than	150*120*350
Electrodes and temperature sensor	according to documents of electrodes and the sensor

1.2.12. The mass of the separate parts of the instrument is:

The electronic block of the instrument, kg, not more than	0.5
Commutation unit KM-7, kg, not more than	0,3
The electrode stand SL-4, kg, not more than	0.5
Electrodes and thermosensor according to documents of electrodes and the sensor	

1.2.13. The instrument is a product, which can be repaired in case of troubleshooting. Average period of time before need to repair in normal conditions is not less than 20000 hours. Average time of repair is not more than 1 hour. Average period of work is 10 years.

1.3. Instrument shipping kit parts list.

Instrument shipping kit parts list is presented in Table 2.

Table 2.

#	Subject	quantity
1	The main electronic unit of the instrument	1
2	Electrode Ecom-pH	1
3	Silverchloride reference electrode EVL-1M3[a]	1
4	Temperature sensor Pt-100[a]	1
5	Ionselective electrodes «Ecom»[b]	to be ordered
6	Commutation unit	from 1 up to 3 (to be ordered)
7	The cable to attach the instrument to computer	1 (to be ordered)
8	The cable to attach the commutation unit to the instrument	from 2 to 6 (to be ordered with commutation units)
9	The electrode stand SL-4	1 (to be ordered)
10	Laboratory beaker, 100 ml	1(to be ordered)
11	Power supply unit BPU 6/0,2-9/0,1	1(to be ordered)
12	Manual instruction	1
13	The procedure of official test.	1

Notes: [a]It is possible to use other sensors with analogous technical data
[b]See item 1.2.10 of the present Manual instruction.

1.4. The philosophy and the basics of operation

1.4.1. The main principles of potentiometry

The main principle for the measurement of the activity pX (pH) and the concentration (C) of ions in aqueous solution is potentiometric analysis with ionoselective electrodes.

The method of potentiometry is based on the measurement of the potential difference between an indicator ionoselective electrode and a reference electrode in the solution to be investigated. Being a function of the concentration of the measured ion and the temperature this potential difference allows to calculate the concentration of the measured ions.

The electrode function of the dependence of the EMF of the electrode system upon the activity of an ion can be expressed with a linear Nernst equation:

$$E = E_o + S \lg a \qquad (1)$$

where:
E is the potential difference between the indicator and reference electrode (EMF),.
Eo - the value of the potential difference between the indicator and reference electrode (EMF), mV with the activity of the measured ion equal to 1 mole/l mV.
S - the slope of the electrode function. The value of this slope is the function of temperature and also of the charge of the measured ion. The calculated value of S at 20 ^oC for monovalent ions is 58.16 mV/(pX unit).

A - activity or effective concentration of free ions in solution, connected with concentration by following expression:

$$a = \gamma C \quad (2)$$

where
C is the molar concentration and
γ - activity coefficiency

For very diluted solutions the activity coefficiency is very close to unity and the activity itself is very close to concentration.
If activity coefficiency is hold constant, Nernst equation turns into

$$E = E_o + S \lg C \quad (3)$$

The activity coefficiency being constant can be achieved, if while measuring the concentration the ion strength of the solution is maintained constant n all calibration and investigated solutions by addition of ion strength adjuster (ISA).
So, provided the ion strength of the solution and temperature are constant, one can obtain a linear plot of the EMF of the electrode system versus the logarithm of concentration of the measured ion in a wide range without any thermocompensation.

The dependence of EMF of the electrode system versus measured activity when the thermocompensation regime is on is expressed by equation:

$$E=Ei + S_{(T)\ calc}\ (pX-pXi) \quad (4)$$

$$S_{(T)\ calc} = -0.1984(273.16 +T)/n \quad (5)$$

where Ei and pXi are the coordinates of isopotential point of the electrode system, mV and pX units respectively (isopotential point is the pX value, where the potential difference is temperature independent),
T - the temperature of the analyzed solution (measured or entered by hand depending on the type of thermocompensation), ^oC,
$S_{(T)\ calc}$ - the theoreticaly calculated value of the slope of the electrode function of the given electrode system at given temperature, mV/pX.
n - the charge of ion (for pH equals +1)
Given type of electrode function (eq.4) is characteristic of electrodes with definite coordinates of the isopotential point (for example, pH-sensitive electrodes. While working with such electrodes in the mode with thermocompensation the coordinates of the isopotential point are entered manually during calibrating the instrument.

1.4.2. The principle of the operation of ion-meter

The measurement of the concentration and the activity of ions.

Most ionometric measurements are made directly using the calibration plot, which does not exclude the use of the ion-meter for other potentiometric methods of measurements (for example, titration) according to relevant procedures of quantitative chemical analysis (PQCA).

The method of the calibration curve consists of the building a plot of EMF of the electrode system vs concentration of the calibration (standard) solution with the known concentrations with the successive determination of the EMF for the investigated solution and of the concentration of the investigated solution using the calibration plot.

The calibration plot is built by the microprocessor of the instrument automatically, using the entered values of EMF of the electrode system and the relevant values of pX while calibrating the ion-meter using calibrating solutions (two or more). The value of pX for the measured ion in the investigated solution is determined automatically using the calibration plot through the value of EMF (E).

As pX= -lgC, the value of the molar concentration is automatically calculated using the equation

$$C = 10^{pX} \quad (6)$$

where C is the concentration, mole/l.

The value of the mass concentration of ion is also calculated automatically, using the expression:

$$C = M*10^{pX} \quad (7)$$

where C is mass concentration, g/l
M is molar mass, g/mole.

The example of determination of the concentration of the measured ion in the analyzed solution with the help of the calibration plot is shown in Fig.1.

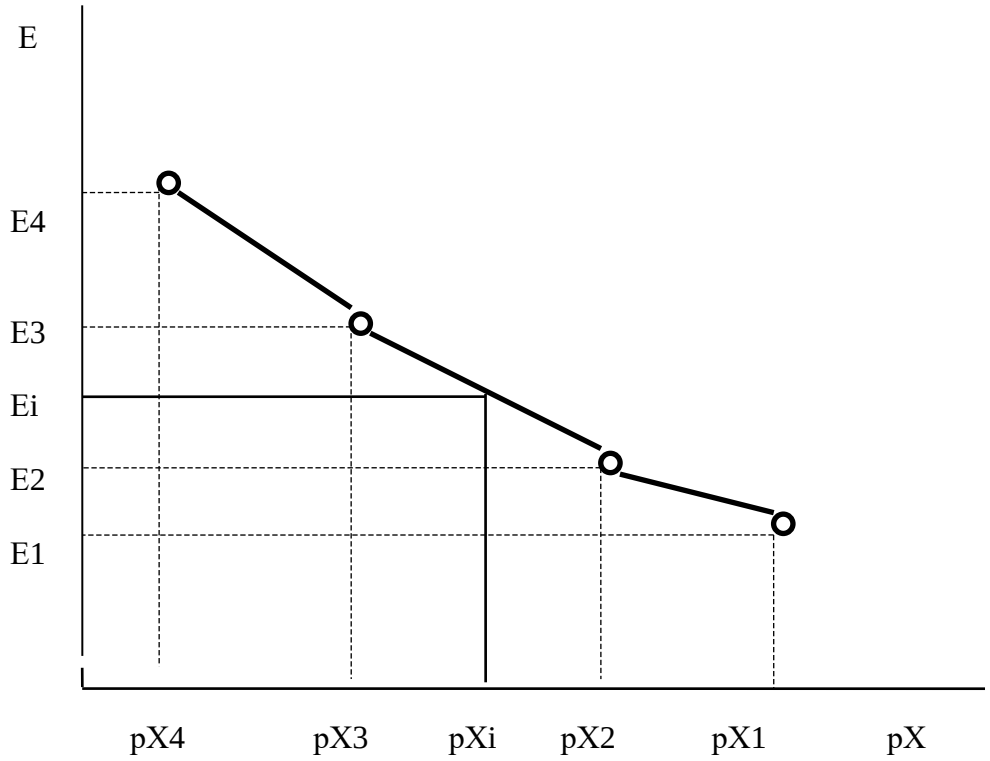


Fig.1

A representative calibration plot of EMF versus the activity of the measured ion in solution (pX).
Here E1, E2, E3, E4 are the values of EMF of the electrode system in standard solutions.
PX1, pX2, pX3, pX4 are the values of pX of standard solutions
pXi, Ei are the values of pX and EMF of the electrode system in the investigated solution.

Temperature measurement.

The principle of temperature measurement is the measuring of the dependence of the resistance of the thermosensitive element of the thermosensor upon temperature. When

measuring temperature the instrument measures the resistance of the thermosensor and calculates the temperature of the solution.

The measurement of the redox potemtial.

In order to measure the redox potential (Eh) of the solution one uses the electrode system, consisting of redox-sensitive (platinum or glass) indicator electrode and silver-chloride reference electrode.

1.4.3. The performance of the ion-meter.

1.4.3.1.The performance of the electronic part of the instrument.

pH-meter-ion-meter Ecotest-120 consists of the electronic part with a number of accessories. (see Table 2.)

The appearance of the electronic part of the instrument (from upstairs) is shown in Fig.2.

Keyboard and the outer connections of the electronic part are marked by proper signs.

Keyboard and the liquid-crystalline display are placed on the front panel of the block.

Fig.2

The outer connections are placed at the back wall of the electronic block (Fig.3).

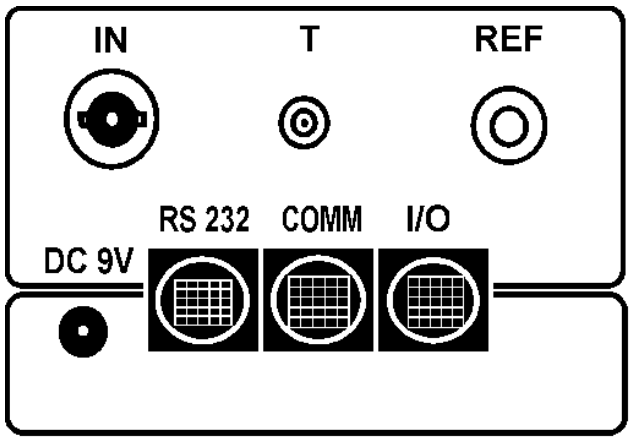


Fig.3

- the plug for the external power supply block
- the plug for the ion-selective electrode or the commutation unit KM-7
- the jack for the RE (reference electrode)
- T - for the temperature sensor
- for the controller circuit of the commutation unit
- to RS-232 of PC
- to an analogous input

The bottom of the electronic block contains the cell for batteries.

1.4.3.2. The outline scheme of the electronic block.

The outline scheme of the electronic is shown in fig.4.

The principle of operating of the electronic block is the transforming of the EMF of the electrode system and other sources into a proportional voltage signal, which is then transformed into the digital code and analogous output signal.

The mathematical transformations and other functions are performed by microprocessor, which is the main component of the electronic scheme.

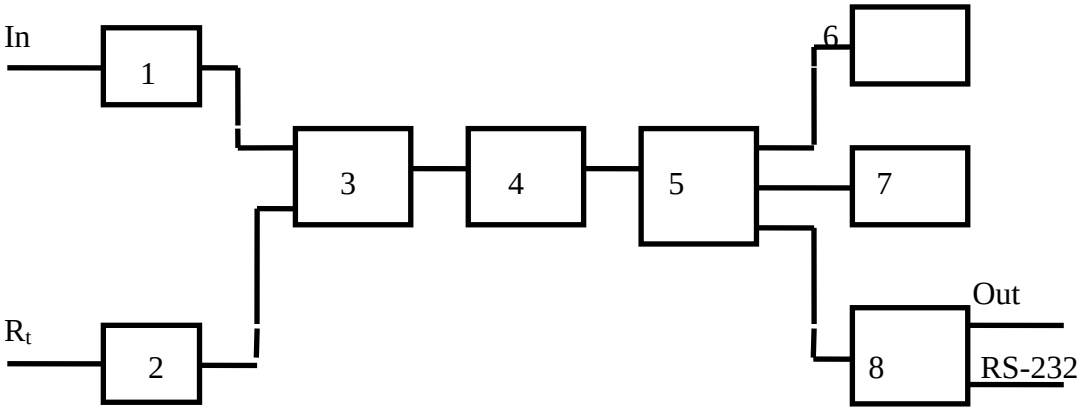


Fig.4.
The outline scheme of the electronic block

1. The input amplifier
2. The temperature measurement circuit
3. The selector of modes
4. ADC
5. Microprocessor scheme
6. Display controller
7. Controller
8. The generator of the input and output signals

1.4.3.3. Electrode systems (ES)

The number and types of ISE and RE are chosen by user in the shipping contract according to measured ions (item 1.2.10 of the present manual instruction).

All electrodes should have connection cables with plugs, corresponding to relevant plugs on the electronic block and the commutation unit (the standard BNC plug in case of ISE).

All indicator electrodes should meet the demands of passports and other documents enclosed to them.

1.4.3.4. Temperature sensor.

In order to measure temperature and to run the automatic thermocompensation of the changes of the readings of the instruments depending of the temperature of the tested solution the temperature sensor is used, which resistance is temperature-dependent. The thermosensor should meet the demands of the passport, enclosed to it.

1.4.3.5. Commutation unit.

Commutation unit KM-7 is a special device, which can be used only together with the electronic unit of Ecotest-120. It is controlled by the electronic block and provides a series of out put signals from the electrode system, which are sent to the input of the electronic block.

In order to increase the number of channels thus measured, one, two or three commutation units can be attached to the electronic block successively. Each commutation unit has 7 channels for measurement and and two connection cables enclosed to be attached to input and output of electronic block or other commutation unit.

The elements of the electric junctions of commutation unit have corresponding signs.

There are 7 jacks at the front panel of the commutation unit to attach ISE and 7 adapters for reference electrodes under each jack numbered from 1 to 7. When attaching to the electronic block more than one commutation units (2 or 3), the numeration of the jacks and adapters is made automatically so that the have numbers from 1 to 7 jacks at the first commutation unit, from 8 to 14 at the second one from 15 to 21 and at the third one.

The rear panel of the commutation unit has sockets:

- to obtain the command from electronic block or the previous commutation unit to select the channel number
- to read the information, coming from the electrode system through next commutation unit
- to transmit the output command to the next commutation unit to select the channel
- to transmit the information from the electrode system to the electronic block or previous commutation unit.

So, using the commutation units, one can measure the signals from 7, 14 or 21 channels simultaneously.

1.4.3.6. The electrode stand.

The electrode stand provides the possibility to set and fix reliably the electrode system. It has holes for four electrodes with fixing screws.

1.4.4. Operating modes.

Main operating modes are presented in Table 3.

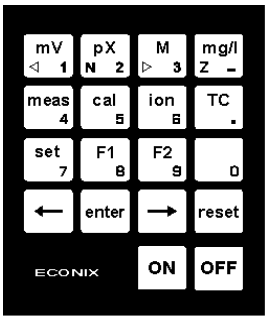
Table 3.

Operation mode	Type of measurements	Indicator units
pH-meter-ionometer	Activity of H^+ ions Activity of cations and anions molar concentration, C mass concentration, C_m EMF	pH pX mole/l mg/l mV
Voltmeter (Eh)	EMF	mV
Thermometer	Temperature of the test solution	^oC
Options	Measurements, like ones in «pH-meter-ionometer» mode, but with commutation unit attached, calibration and adjustment of the electric scheme of the electronic block under production according to production documents	
Additional regime	The memory reserve to perform additional types of measurements: COD measurements, potentiometric titrations etc, according to special programs.	

1.4.5. Operating control.

Operating control is available with keyboard, placed on the front panel of the electronic block.

Keyboard



Key functions

- enters figure «1», selects EMF measuring mode, selects the previous channel when working with the commutation unit
- enters figure «2», selects the number of calibrating points, chooses the pX measuring mode
- enters figure «3», selects the mode of measurement of the molar concentration of ions, selects next channel when working with commutation unit.
- enters figure «4», selects regime of EMF measurement in the modes «pH-meter-ionometer», «Voltmeter», and temperature measurement in «Thermometer» mode
- enters figure «5», selects the regime of calibration of the ionometric channels
- enters figure «6», selects the type of the measured ion (the memory of the instrument contains the constants for 27 ions:

H^+ (pH), Cl^-, Br^-, I^-, Na^+, K^+, NH_4^+, NO_3^-, Ag^+, S^{-2}, Cu^{+2}, Cd^{+2}, Pb^{+2}, Hg^{+2}, Ca^{+2}+2, Ba^{+2}, CO_3^{-2}, ClO_4^-, ReO_4^-, F^-, $AuCl_4^-$, Zn^{+2} , Fe^{+3}, Ca^{+2} + Mg^{+2} (water hardness), HPO_4^{-2}, NO_2^- and also three free cells to insert the constants for other ions chosen by user.

- enters figure «7», selects the regime to enter the molecular mass of an ion in the regime of ion selection and also to enter the pX value of the standard solution in the calibration mode.
- enters figure «8», selects additional programs
- enters figure «9», selects additional programs
- enters the sign «-», selects the regime to enter the charge of the ion, which is not saved in the memory of the instrument, selects the regime to calculate the mass concentration of the measured ion.
- enter the sign «.» (point), selects the mode of automatic temperature compensation
- enters figure «0», swithes on and off the illumination of the display
- select modes and regimes, type of ion also when working with the commutation unit, the number of calibration points, choose the number of the actual calibration point

- enters data
- transfers the instrument from each mode or regime into previous mode or regime
- switches power on
- switches power off

1.4.6. Data exchange with the commutation unit and PC

1.4.6.1. When the concentrations of several ions are to be measured simultaneously, one should attach to the electronic block one, two or three commutation units.

When working with the commutation unit, attach it to electronic block with the connecting cables. When using one commutation unit connect the socket «» to the socket «» of the electronic block. When using two or three commutation units attach the socket «» and «»of each next commutation unit to sockets «» and «» of the previous one. Attach the indicator electrodes to plugs «» and the reference electrodes to adapters «» at the front panel of the commutation unit. The scheme of junction is presented in Fig5

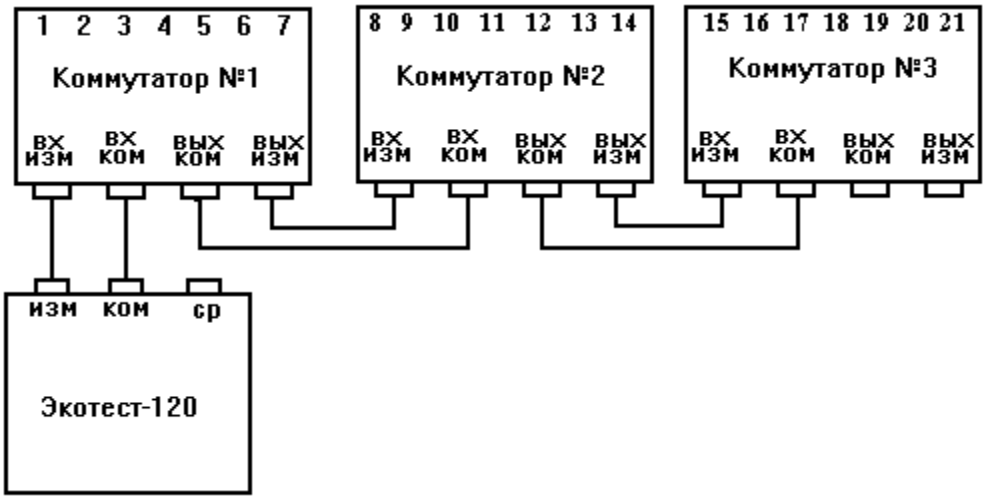


Fig. 5.

The scheme to attach three commutation units to the electronic block of the instrument.

Here 1...21 are the numbers of the plugs and adapters to attach the indicator electrodes and reference electrodes.

1.4.6.2. When working with PC, if necessary, attach the connecting cable to RS-232 socket of the electronic block of the instrument and to the successive port (COM 1 or COM 2) of PC. Then follow the instruction, enclosed to the program on the diskette.

1.4.7. Signs and stamps.

1.4.7.1. The electronic block of the instrument has the following signs:

At the front wall: the name of the instrument «pH-meter-ionometer Ecotest-120», the trade mark and the name of the company.

At the bottom: the serial number of the instrument according to the numeration of the company, the month and year of production.

At the rear wall: «Ind», «Ref» - the adapters to atach the indicator and reference electrodes, «T» - the adapter for temperature sensor, «KOM» - the adapter to attach the

commutation unit, «RS-232» - the port to be attached to PC, «DC 12 V»-the jack for the power supply block, «ABB» - analogous input/output.

1.4.7.2. The commutation unit has the following signs:

At the front wall: the numeration from 1 to 7 of the adapters to attach the indicator and reference electrodes. When the shipping kit contains more than one commutation units, thenumeration reads from 1 to 7 on the first one, from 8 to 14 on the second one and from 15 to 21 on the third.

At the rear wall

- socket to obtain the command from electronic block or the previous commutation unit to select the channel number
- socket to read the information, coming from the electrode system through next commutation unit
- socket to transmit the output command to the next commutation unit to select the channel
- socket to transmit the information from the electrode system to the electronic block or previous commutation unit.

1.4.7.3. The sign of official test is included into manual instruction.

1.4.7.4. The instrument is protected by a polymeric stamp in the hole of the screw, connecting the cover and body of the electronic block.

1.4.7.5. The shipping signs are fit to international standards.

1.4.8. Packing cover

1.4.8.1. The instrument is placed into a hermetic polyethylene package and thus placed into a paper box together with accessories.

1.4.8.2. Electrodes and the thermosensor are packed into a polymeric box. Manual instruction, the official test and shipping documentation are put into a paper envelope.

1.4.8.3. The polymeric box, the envelope, commutation units, the electrode stand and laboratory beaker, protected by special paper are placed into the paper box together with the electronic block.

2.Operating.

2.1. The practical hints of operating

2.1.1. The work with the instrument should be made in conditions, which are not beyond the limits of the normal operating conditions.

2.1.2. When working with solutions, containing organic substances,the sample pretreatment should be done according to the relevant procedure of quantitative chemical analysis.

2.2. The preparation of the instrument.

2.2.1. Before working with the instrument read the present manual instruction, the principle of operating, and the meaning of keys on the keyboard, and also the manual instructions for the power supply block, indicator electrodes and reference electrode.

2.2.2. Insert batteries into the battery cell or attach the power supply block to the corresponding jack of the electronic block of the instrument.(when the power supply block is attached, the batteries are cut off automatically.

2.2.3. Select the needed indicator electrode depending on the wanted ion to be tested and after necessary preparation attach them to the electronic block: the indicator electrode to the plug «Ind» and the reference electrode to the socket «Ref». Place the electrodes into the electrode stand and insert them into the laboratory beaker with the tested solution.

2.2.4. When working without thermocompensation or in the mode of thermocompensation with manual temperature adjustment, place a thermometer into the beaker with the tested solution and the electrode system.

In the mode of automatic thermocompensation place the thermosensor into the beaker with the tested solution and the electrode system. Attach the temperature sensor to the jack «T» of the electronic block.

The measurements without thermocompensation should be performed under the conditions of constant temperature (for example, with a thermostated cell). The conditions of changing temperature want using the automatic thermocompensation.

2.2.5. Preparation of the standard solutions.

Using the instrument one should use standard solutions to calibrate it. While pH measurement it is necessary to use any type of standard buffer solutions, prepared from dry chemicals, or obtain as solutions. While pX measurement the preparation of the standard solutions for calibration and also when measuring different types of ions should be performed according to documents for corresponding electrodes.

2.2.6. Preparation of electrodes.

Prepare the electrodes according to directions, written in passports or manual instructions for electrodes. The reference electrode should be filled with the saturated solution of potassium chloride according to its passport.

2.3. The application of the ion-meter.

The direct measurements of physical values are made with the ion-meter while measuring voltage in the «voltmeter» mode and while measuring temperature in the «Thermometer» mode.

Ionometric measurements of pH of the solution, activity of the ions (pX) or their concentration (C) are made in the mode «pH-meter-ion-meter» and include the following steps:

- the selection of the ionometric channel
- calibration of the ionometric channels using standard solution when measuring without thermocompensation or adjustment of the isoelectricpoint when working with automatic thermocompensation.
- EMF measurement
- pX calculating
- calculating the molar concentration of ions
- calculating the mass concentration of ions.

The measurements with automatic thermocompensation can be made with electrodes with known coordinates of the isoelectric point only.

The measurements without thermocompensation are performed under stabilized temperature of the solution with indicator electrodes with unknown coordinates of the isoelectric

point and also with electrodes with known coordinates of the isoelectric point if an improved precision of measurement is wanted.

2.3.1. The ionometric measurements.

2.3.1.1.The ionometric measurements without thermocompensation.

The ionometric measurements without thermocompensation include the selection of the ionometric channel, calibration of the ionometric channels (the insertion of the parameters of the standard solutions into the memory of the instrument) and the following ionometric measurements of the parameters of the investigated solution.

The instrument allows to insert the values of pX and EMF for from 2 to 5 calibration points for each ion.

Selection of the ionometric channel.

Switch the instrument on, pressing the key «On». The display reads:

Mode selection ←→
pH-meter-ion-meter

You are already in «pH-meter-ion-meter» mode.

It is necessary to select the ion, for which the calibration should be made. For that press the key «Ion» and select the wanted ion from the list of ions in the memory of the instrument, for example, Cl^- using «←» «→» keys. The display reads:

Cl Charge -
35.4530 M.M.

So the memory of the instrument contains all necessary constants for the wanted ion.
Pressing key «Enter», you return to «pH-meter-ion-meter» mode.
If you want to measure an ion, which is not in the list, you can select one of three additional channels (#1, #2 and #3). Then display reads:

#1 Charge ?
00.0 M.M.

In order to enter the charge for this ion, press key «Z». At each pressing of this key the charge will change cyclically from -2 to +3. Select the necessary value of the charge. In order to enter the value of the molecular mass press key «Num». The display reads**:**

Enter number

Print the value of the molecular mass of the wanted ion on the keyboard and press «Enter». Wanted parameters are entered into thememory of the instrument.

Press «Enter». The display reads:

Mode selection ←→
pH-meter-ion-meter

Calibration.

The way to calibrate is given using the Cl^- ion as an illustrative example.

After selecting the ion and returning to the mode «pH-meter-ion-meter» press «Clb» key. Display of the indicator reads:

Cl ???? -
???? mV n1

Press «N». The display reads:

Number of clb
points 2←→

The selection of the number of calibration points is made using keys «←» and «→». After selecting the wanted number of calibration points press «Enter». Display reads again:

Cl ???? -
???? mV n1

Attach the electrodes (the indicator and reference ones) to the instruments, if you have not made it before. Insert the electrodes and the thermometer into the beaker, filled with the first standard solution (usually the most diluted one).

Press «Num». The indicator reads:

Enter number

Print the pX value of the standard solution (say, 4.000) and press «Enter». The reading is:

Save change?
Y-Enter N-Reset

Press «Enter». The reading is:

Cl 4.000
???? mV n1

Press «Meas». The display reads:

Calibr. pX 0:02
-232.1 mV

The measurement of EMF and also of time starts. After stabilization of the EMF value (the rate of change becomes less than 1 mV/min), press «Enter». The reading is

Save change?
Y-Enter N-Reset

Press «Enter». The reading is:

Cl 4.000
-234.4 mV n1

Take the electrodes off the beaker, rinse with distilled water and dry with filter paper. Insert the electrodes into the second standard solution. Using "**→"** come over to the next calibrating point. The calibrating for the second and every folloing solution is made in the same way as for the first one. After the calibration is completed press "Reset". Display reads again:

Mode selection ←→
pH-meter-ion-meter

Now the memory of the instrument contains the results of the last calibration for the selected ion, which can be called from the memory and looked through.

Looking through previous calibrations

In order to look through previous calibrations press "ion" and using keys «←» and «→» select the wanted ion, for example Cl^-.

The display reads:

Cl Charge -
35.4530 M.M.

Press «Enter». The display reads:

Mode selection ←→
pH-meter-ion-meter

Press “Clb”. Display shows the values for the first calibration point:

Cl 4.000
-234.4 mV n1

In order to read the values for the next calibration point, press «→». In order to finish the looking through the previus calibrations press “Reset”. Display reads:

Mode selection ←→
pH-meter-ion-meter

Ionometric measurements

The temperature of the tested solution when measuring should be the same, as one for the calibrating solutions.

Select mode “**pH-meter-ion-meter”**.

Press “ion” and using keys «←» and «→» select the wanted ion from the list. Let it be Cl^-. Display reads:

Cl Charge -
35.4530 M.M.

Press «Enter». The display reads:

Mode selection ←→
pH-meter-ion-meter

Press “Meas”. The display reads:

Calibr. pX 0:02
--354.5 mV

The measurement of EMF and also of time starts.
In order to obtain the result in pX units, mole/l or mg/l press “pX”, “M” or “mg/l”respectively.
In order to finish the measrement press “Reset”. Display reads:

Mode selection ←→
pH-meter-ion-meter

The ionometric measurements with thermocompensation

The ionometric measurements with thermocompensation can be performed only with electrodes with known coordinates of the isoelectric point. Such measurements include the selection of the ionomentric channel, saving the coordinates of the isoelectric point in the memory and saving or measuring temperature and directly the ionometric measurements. The selection of the ionomentric channel is made according to the previous section of the present manual.

Saving the coordinates of the isoelectric point

When working with pH electrodes and other electrodes with known coordinates of the isoelectric point in the regime with thermocompensation it is necessary to enter the coordinates of the isoelectric point into the memory of the instrument before measurement.

For that enter mode "**pH-meter-ion-meter",** press **"ion"** and using keys «←» and «→» select the wanted ion from the list, for example, pH. Press "Enter", exit to the mode "**pH-meter-ion-meter",** press "**Clb**", "then "**TC**". Display reads:

Thermocompensation
xxxx.x mV

Press «Num». The indicator reads:

Enter number

Print the EMF coordinate value of the isoelectric point in millivolts from the passport of the electrode, for example, -1905.0 for ECOM-pH and press «Enter». The reading is:

Save change?
Y-Enter N-Reset

Press «Enter». The reading is:

Thermocompensation
-1905.0 mV

Press «Enter». The indicator reads:

Thermocompensation
xxxx.x pX

Press «Num». The indicator reads:

Enter number

Print the value of the pX (pH) coordinate from the passport for the electrode, for example 1.3 for ECOM-pH electrode an press "Enter".
The reading is:

Save change?
Y-Enter N-Reset

Press «Enter». The reading is:

Thermocompensation
1.3 pX

Press «Enter» and "Reset". Display reads:

Mode selection ←→
pH-meter-ion-meter

Adjusting the value of the temperature of the solution

In the regime of thermcompensation two ways to enter the value of temperature are possible: manual and automatic ones. To run the manual enter of temperature a thermometer is placed into the solution together with electrodes and the reading of the thermometer is inserted into memory manually. By automatic enter of temperature attach the temperature sensor to the jack "T" on the rear wall of the electronic block and place it into the tested solution together with electrodes.

In order to select the manual or automatic enter of temperature enter the moe "pH-meter-ionometer" and press the button "TC". The reading is:

Enter temperature
Automate

or

Enter temperature

Manual

By manual enter select “Manual” using keys «←» and «→» and press «Enter». The indicator reads:

Enter number

Print the value of temperature, for example, 20 ^{o}C , printing 20 and “**Enter”.** The reading is:

Save change?
Y-Enter N-Reset

Print successively “**Enter”** and **“Reset**”. So you return to the mode “pH-meter-ionometer”.

By automatic enter select “Automate” using keys «←» and «→» and press «Enter» and **“Reset**”. So you return to the mode “pH-meter-ionometer”.

Ionometric measurements

Measurements are performed as in the previous section. Select the wanted ion in the mode “pH-meter-ionometer”. Enter the measurement mode by pressing”Meas”. Then press “TC”. he results of measurement are shown at the display with account of the temperature compensation. The current value of temperature, entered manually or automatically is shown in the upper right corner of the display.

2.3.2. Direct measurements.

EMF measurements

The use of the instrument as a voltmeter with high input resistance can be made in the mode “Voltmeter (Eh)”. The mode of the direct measurement of the EMF allows to use the method of the calibrating plot, and also other methods: the measurement of the redox potential of the solution, which characterizes the redox systems present.

Normally one distinguishes direct measurements from potentiometric titrations. The titrations are not described in the present manual. For that see the procedures of quantitative chemical analyses.

For direct EMF measurement of the electrode system attach the electrode system (the indicator and reference ones) to the electronic block. Insert the electodes into tested solution.

Switch the instrument on by pressing “On”. The display reads:

Mode selection ←→
pH-meter-ion-meter

Select the mode “Voltmeter (eH)” using «←» «→» keys. The display reads:

Mode selection ←→
Voltmeter (Eh)

Press “Meas”. The display reads:

Voltmeter 0:02
-2220.01 mV

The measurement of EMF and time begin.

Read the stabilized value of the EMF (the rate of changes should be less, than 1 mV/min).

Press “Reset”. You are again in the mode “Voltmeter (eH)”.

Temperature measurement.

To measure temperature attach the temperature sensor to the instrument. Switch the instrument on by pressing “On”. The display reads:

Mode selection ←→
pH-meter-ion-meter

Select the mode “Thermometer” using «←» «→» keys. The display reads:

Mode selection ←→
Thermometer

Press “Meas”. The display reads:

Thermometer 0:02
20.46 C

The measurement of temperature and time begin.

Read the stabilized value of the temperature (the rate of changes should be less, than 0.1 ^{o}C/min). Press “Reset”. You are again in the mode “Thermometer”.

2.3.3. **Operating with the commutation unit.**

The commutation unit increases the number of the ionometric channels up to 7 when one commutation unit is attached, up to 14 when to ones are attached and up to 21 when three commutation units are attached.

If the increase of the number of the ionometric channels is necesary, attach the wante number of commutation units to the electronic block according to item 1.4.6.1. of the present Manual.

Selection an adjustment of the regime of operating with commutation

Switch the instrument on by pressing “On”. The display reads:

Mode selection ←→
pH-meter-ion-meter

Select the mode “Options” using «←» «→» keys. The display reads:

Mode selection ←→
Options

Press “Enter”. The display reads:

Options (←→Reset)
Commutator

Press “Enter”. The display reads:

Instrument state
No commutator

or

Instrument state
With commutator

Using «←» «→» keys, select the mode

Instrument state

With commutator

Press “Enter”. The display reads:

Options (←→Reset)
Commutator

Press “Reset”. The display reads:

Mode selection ←→
Options

Using «**←**» «**→**» keys enter the mode “pH-meter-ionometer”. The display reads:

Mode selection ←→
pH-meter-ion-meter

Press “Ion”. The display reads the parameters of the ion and the number of the ionometric channel:

Cl Charge -
[1] 35.4530 M.M.

Keys ⇐ and ⇒ select the number of the channel of the commutation unit. Using keys «←» and «→» select the wanted ion which is thus connected with the selected number of channel. After selecting a measured ion to every channel press “Enter”. Thus you return to the mode “pH-meter-ionometer”. Later on when selecting any ion by pressing “Ion” the display of the indicator will show the number of the channel, which measures this ion besides the parameters of this ion.

Attach the electrodes (the indicator electrodes and reference electrodes) to plugs and sockets of the chosen channels of the commutation unit. Insert the electrodes and temperature sensor into the analyzed solution.

Calibrating the instrument when working with the commutation unit

To calibrate enter the mode “pH-meter-ionometer”. Select any wanted ion by pressing “Ion”. Let it be chloride. The display of the indicator will show the number of the channel, which measures this ion besides the parameters of this ion. Press “Enter “ to return to the mode “pH-meter-ionometer” and press “Cal”. Display of the indicator reads the name of the selected ion and also the number of the selected ionometric channel :

Cl ???? -[1]
???? mV n1

Then perform the calibration as in the case of working without the commutation unit.

Ionometric measurements when working with the commutation unit

Select the mode “pH-meter-ionometer”. The display reads:

Mode selection ←→
pH-meter-ion-meter

Press “Ion”. The display reads the parameters of the ion and the number of the ionometric channel which measures the given ion:

Cl Charge -
[1] 35.4530 M.M.

Then perform the measurement as in the case of working without the commutation unit.

Exit from the regime of operating with commutation

In order to end the work with the commutator select the mode “Options”, enter the option “Commutator” and then using «←» «→» keys, select the mode

Instrument state
No commutator

Press “Enter”. The display reads:

Options (←→Reset)
Commutator

Press “Reset”. The display reads:

Mode selection ←→
Options

Using «←» «→» keys return to the mode “pH-meter-ionometer”.

3.MAINTENANCE

3.1. General directions.

The technical maintenance of the instrument during use is easy, can be charachterized as profilactic one an could be divided into three types:
- external examination
-current operating test
-official test..

The first two types of technical maintenance can be made by the user. The period of time to make it is not pointed and depends upon the intensity of using the instrument.

The last type of measurement, the official test, is mae by the representatives of official organisations.

3.2. External examination

The external examination is made directly before using of the instrument and includes the check of the body, plugs and sockets and connecting cables of the instrument. Examine also the surface of the temperature sensor, the contact surfaces of the batteries and contact plates in the batteries cell. If signs of corrosion are found, clean it with the abrasive paper #0.

3.3 . Current operating test

Check if the batteries are present in the batteries cell. Press “On” at the front panel. The display of the indicator should read as follows:

Econix LTD

Normal voltage

Mode selection ←→
pH-meter-ion-meter

When no readings are seen or the reading is “Change batteries”, change the elements in the batteries cell.

3.4. Demands to the qualification of user.

The measurements and data processing can be done by personnel with higher or secondary special education, who was instructed by a professional or has an experience to work in the chemical laboratory.

3.5. Safety conditions.

When working with the instrument, one should fulfill the general safety rules for electric instruments up to 1000 V and general safety rules for chemical laboratories.

3.6. Official test.

Official test is made for every instrument after production. Later on it is made according to national regulation rules.

4.CURRENT REPAIR

4.1. Conditions of repair

The ionometer is a complicated electonic instrument, so it can be repaired only by personnel of the producing company or its official dealers on the conditions of service. Official test is necessry after each repair.

When repairing one should fulfill the general safety rules for electric instruments up to 1000 V.

4.2. Troubleshouting and the ways to remove it.

The most often met troubleshouting is listed in Table 5.

Table 5.

Troubleshouting	Possible reasons	Way to remove
No information on the indicator after switching on	1. No batteries or poor batteries 2. No current in the net 3. Poor power supply block	1. Install or change the batteries 2. Use right socket 3. Use right power supply block
The indicator reads: "Change batteries"	Poor batteries	Change batteries

5. SHIPPING AND STORAGE

5.1. Shipping of the instrument is made in shipping packing in closed transport of every type at conditions, which are not beyond of the following limits:

-temperatire of the ambient air from -25 to +55 ^{o}C
-Relative humidity of the ambient air up to 95% by 25^{o}C,
atmosphere pressure, kPa (Torr) 84-106 (630-800)
Transport vibrations:
number of blows per minute 80-120
maximal acceleration, m/s^2, 30
duration, hours 1.

5.2. Storage before use is made at stores in the packing of the producing company at the temperature of the ambient air 5-40 ^{o}C and relative humidity up to 90% at 25 ^{o}C.

The storage of the ionometer when unpacke should be done at the temperature of the ambient air from 10 to 35 ^{o}C and relative humidity up to 80% at 25 ^{o}C.

The room for storage should not contain dust, vapours of acids or alkali, aggressive gases and other corrosive agents.

6. QUALITY CERTIFICATE

pH-meter-ionometer-Ecotest-120,
Factory number_____fits the quality demands TU 4215-004-41541647-98, passed the official test and approved for use.

Production date_____199___

Representative of the Test service_____(Signture)

Periodic tests

_____ _____

_____ _____

_____ _____

_____ _____ _____

_____ _____

_____ _____

7. GUARANTIES

7.1. The guaranty duration for use is established as 24 months from the sale date.

7.2. The guaranty duration for storage is 6 months from the day of production.

7.3. The averge duration of use 10 years.

7.4. Free repair (change) of the instrument is made during the guaranty time by the producing company if the user fulfilled the use, shipping and storage rules and the stamp on the screw is intact.

7.5. In case of reclaimation the guaranty time is prolonged for the period of time during which the instrument was not used because of the troubleshooting.

7.6. The guaranty time does not relate to electrodes and power supply block. Please, contact the producing companies directly.

7.7. Any reclaimation is fixed with an official document, which should be sent to the producing company.