

ANALYTICAL EQUIPMENT FOR



ECOLOGY AND POWER INDUSTRY

МАРК-903 pH-METER

Operation Manual



АЯ 74

Nizhny Novgorod
2011

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

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

Postal address: 603106, Russia, Nizhny Novgorod, POB 253

Telephone: + 7 (831) 229-65-67, 412-29-40

E-mail: market@vzor.nnov.ru

Website: www.vzornn.com

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1 DESCRIPTION AND OPERATION

1.1 Purpose

1.1.1 Product name and identification

pH-meter with a combined electrode:
 MAPK-903 pH-meter. TU 4215-027-39232169-2007

pH-meter with individual electrodes:
 MAPK-903/1 pH-meter. TU 4215-027-39232169-2007

1.1.2 Purpose

pH-meter is used to measure hydrogen ion activity index (pH), aqueous solution temperature and electromotive force (U).

1.1.3 Applications

pH-meter is used in heat engineering, various industries and agriculture.

1.1.4 Type of measuring convertor unit:

- working with the sensitive element to measure pH;
- without galvanic separation of input and output;
- as a portable small-size unit with an integrated display;
- with measurement results feed via a USB port to a personal computer (PC);
- with a submersible sensitive element; and
- with electronic pre-amplifier integrated with the transducer.

Types of electrodes in various pH-meter versions are shown in Table 1.1.

Table 1.1 – Types of applicable electrodes

pH-meter version	Type of applicable electrodes	No in National Register	Manufacturer
MAPK-903	ЭСК-10601/7(K80.7) combined glass electrode	16767-03	IT Measuring Equipment NPO LLC, Moscow, Russia
	ЭСК-10601/4(K80.7) combined glass electrode	16767-03	
	ЭСКЛ-08М combined laboratory glass electrode	6530-99	Gomel Measuring Instrumentation Factory RUP, Gomel, Belarus Republic
	ЭСКЛ-08М.1 combined laboratory glass electrode	6530-99	
	201020/51-10-04-22-120/000 combined pH-electrode with gel filler	–	JUMO GmbH & CO Fulda Germany

Table 1.1 (Continue)

pH-meter version	Type of applicable electrodes	No in National Register	Manufacturer
MAPK-903/1	ЭС-10601/7(K80.7) glass electrode	16393-03	IT Measuring Equipment NPO LLC, Moscow, Russia
	ЭС-10601/4(K80.7) glass electrode	16393-03	
	ЭСр-10101-3,0(K80.4) reference electrode	17908-02	
	ЭСр-10103-3,0(K80.4) reference electrode	17908-02	
	ЭСЛ-43-07СР laboratory glass electrode	2875-98	Gomel Measuring Instrumentation Factory RUP, Gomel, Belarus Republic
	ЭВЛ-1М3.1 laboratory auxiliary electrode	2189-99	

Note – Types of electrodes used are specified on ordering pH-meter.

1.2 Main parameters

1.2.1 By resistance to climatic load the pH-meter version belongs to B4 group according to GOST 12997-84.

1.2.2 By resistance to mechanical action the pH-meter version belongs to L1 group according to GOST 12997-84.

1.2.3 By protection from environmental exposure the pH-meter (except electrodes) version belongs to IP65 category according to GOST 14254-96.

1.2.4 By resistance to atmospheric pressure the pH-meter version belongs to P1 group according to GOST 12997-84 (atmospheric pressure from 84 to 106.7 kPa).

1.2.5 Parameters of analyzable fluid

1.2.5.1 Analyzable fluid temperature range (aqueous solutions) on pH measurements is the same as pH-meter temperature compensation range shown in Table 1.2 and is governed by the type of electrode used.

Table 1.2 – pH-meter temperature compensation range

Type of electrodes used	pH-meter temperature compensation range, °C
ЭСК-10601/7(K80.7) combined glass electrode	from 5 to 50
ЭСК-10601/4(K80.7) combined glass electrode	
ЭСКЛ-08M combined laboratory glass electrode	
ЭСКЛ-08M.1 combined laboratory glass electrode	
201020/51-10-04-22-120/000 combined pH-electrode with gel filler	
ЭС-10601/7(K80.7) glass electrode	
ЭС-10601/4(K80.7) glass electrode	
ЭСр-10101-3,0(K80.4) reference electrode	
ЭСр-10103-3,0(K80.4) reference electrode	
ЭСЛ-43-07CP laboratory glass electrode	
ЭВЛ-1М3.1 laboratory auxiliary electrode	from 5 to 40

1.2.6 Operating conditions:

- ambient air temperature, °C from plus 5 to plus 50;
- ambient air relative humidity at temperature of plus 35 °C and below without moisture condensation, %, maximum 80;
- atmospheric pressure, kPa (mm of Hg) from 84.0 to 106.7 (from 630 to 800).

1.2.7 The pH-meter is powered up from a self-contained power supply with voltage 2.4 to 3.4 V (two AA alkaline dry cells) or two nickel-metal hydride batteries (AA).

1.2.8 Power consumption at rated supply voltage of 3.0 V, mW, maximum:

- with display illumination off 20;
- with display illumination on 300.

1.2.9 The electrode system in the pH-meter may be set to the parameters shown in Table 1.3.

Table 1.3 – Parameters of electrode system

Slope of electrode system hydrogen curve in the linear part thereof, at least (in absolute figures)	Coordinates of electrode system isopotential point	
	E_i , mV	pH_i , pH
-52.2 mV/pH (at temperature of 20 °C)	0±30	4.0±0.3
	18±30	6.7±0.3
	0±45	7.0±0,3

1.2.10 Dimensions and weight of the pH-meter main components are shown in Table 1.4.

Table 1.4 – Dimensions and weight of the pH-meter main components

pH-meter version	Identification of components	Dimensions, mm, maximum	Weight, kg, maximum
MAPK-903, MAPK-903/1	BP48.01.000 convertor unit	65×130×28	0.12
	BP48.01.400 temperature sensor	Ø11×128	0.05
MAPK-903	ЭСК-10601/7(K80.7) glass combined electrode	Ø12×170	0.10
	ЭСК-10601/4(K80.7) glass combined electrode		
	ЭСКЛ-08М glass laboratory combined electrode	Ø20×175	
	ЭСКЛ-08М.1 glass laboratory combined electrode		
201020/51-10-04-22-120/000 (Jumo) combined pH-electrode with gel filler	Ø12×170		
MAPK-903/1	ЭС-10601/7(K80.7) glass electrode	Ø12×170	0.10
	ЭС-10601/4(K80.7) glass electrode		
	ЭСр-10101-3,0(K80.4) reference electrode		
	ЭСр-10103-3,0(K80.4) reference electrode	Ø13×160	
	ЭСЛ-43-07СР glass laboratory electrode		
	ЭВЛ-1М3.1 auxiliary laboratory electrode		

1.2.11 Conditions of transportation in shipping crates as per GOST 12997-84:

- temperature, °C from minus 5 to plus 50;
- air relative humidity at 35 °C, % 95;
- sinusoidal vibration of 5-35 Hz frequency, shift amplitude of 0.35 mm in

direction shown by the "Top" sign on a crate.

1.2.12 Safety requirements

- average time between failures (except electrodes), h, minimum 20000;
- mean recovery time, h, maximum 2;
- pH-meter average life span, years, minimum 10.

1.2.13 Convertor unit protection level ensured by enclosure IP65 meets GOST 14254-96.

1.3 Technical data

1.3.1 Range of hydrogen-ion activity index measurements by pH-meter at analyzable fluid temperature of $(25.0 \pm 0.2) ^\circ\text{C}$, pH 0.000 to 12.000.

1.3.2 The range of pH-meter allowable basic absolute accuracy on measuring pH at analyzable fluid temperature of $(25.0 \pm 0.2) ^\circ\text{C}$ and ambient air temperature of $(20 \pm 5) ^\circ\text{C}$, pH ± 0.050 .

1.3.3 The range of pH-meter allowable complementary absolute accuracy on measuring pH caused by changes in analyzable fluid temperature within pH-meter temperature compensation range as shown in Table 1.2, pH ± 0.100 .

1.3.4 The pH-meter analyzable fluid temperature measuring range, $^\circ\text{C}$ 0.0 to plus 70.0.

1.3.5 The range of pH-meter allowable basic absolute accuracy on measuring analyzable fluid temperature at ambient air temperature of $(20 \pm 5) ^\circ\text{C}$, $^\circ\text{C}$ ± 0.3 .

1.3.6 The range of pH-meter allowable complementary absolute accuracy on measuring analyzable fluid temperature caused by deviation of ambient air temperature from the normal one $(20 \pm 5) ^\circ\text{C}$ per each $\pm 10 ^\circ\text{C}$ within the operating temperature range from plus 5 to plus 50 $^\circ\text{C}$, $^\circ\text{C}$ ± 0.1 .

1.3.7 pH-meter U measuring range, mV...from minus 1.000.0 to plus 1.000.0.

1.3.8 The range of transducer allowable basic absolute accuracy on U measurements at ambient air temperature of $(20 \pm 5) ^\circ\text{C}$, mV ± 0.5 .

1.3.9 The range of transducer allowable complementary absolute accuracy on U measurements caused by deviation of ambient air temperature from the normal one $(20 \pm 5) ^\circ\text{C}$ per each $\pm 10 ^\circ\text{C}$ within the operating temperature range from plus 5 to plus 50 $^\circ\text{C}$, mV ± 0.3 .

1.3.10 Transducer pH measuring range, pH from 0.000 to 15.000.

1.3.11 The range of transducer allowable basic absolute accuracy on pH measurements at ambient air temperature of $(20 \pm 5) ^\circ\text{C}$, pH ± 0.020 .

1.3.12 The range of transducer allowable complementary absolute accuracy on pH measurements caused by variations of analyzable fluid temperature from 0 to plus 70 $^\circ\text{C}$ (transducer temperature compensation accuracy), pH ± 0.020 .

1.3.13 The range of transducer allowable complementary absolute accuracy on pH measurements caused by deviation of ambient air temperature from the normal one $(20 \pm 5) ^\circ\text{C}$ per each $\pm 10 ^\circ\text{C}$ within the operating temperature range from plus 5 to plus 50 $^\circ\text{C}$, pH ± 0.005 .

1.3.14 The range of transducer allowable complementary absolute accuracy on U measurements caused by resistance effect in the measuring electrode circuit per each 500 M Ω at variations from 0 to 1.000 M Ω , mV ± 0.2 .

1.3.15 Transducer output (reading) setting time, s, maximum 10.

1.3.16 pH-meter output (reading) setting time, min, maximum 10.

1.3.17 When connected to a PC through a USB jack, the pH-meter communicates with the PC.

1.4 Apparatus components

1.4.1 According to version and delivery set the apparatus is composed of:

- convertor unit with temperature sensor;
- electrodes as shown in Table 1.1; and
- tools and accessories kit.

1.5 Design and operation

1.5.1 pH-meter general data

MAPK-903 (MAPK-903/1) pH-meter is a small-size microprocessor instrument used to measure pH or U and temperature of aqueous solutions.

Measured temperature, pH and U (depending on measurement conditions) are read from a digital liquid crystal display (hereafter display) with the least significant digit 0.1 °C; 0.001 pH or 0.1 mV.

The pH-meter makes it possible to enter the measurement results in an electronic scratchpad.

According to the version, the pH-meter may use a combined electrode or individual electrodes (measuring electrode and reference electrode).

Note – To monitor water chemistry at heat engineering facilities, based on data in MU 34-70-114-85 Document the pH-meter may reduce pH-value pH_t measured at temperature t to pH_{25} value that corresponds to the value at temperature of 25 °C.

pH_t values may be reduced to pH_{25} in the range from plus 5 to plus 50 °C. The reduced pH_{25} value may be read from the display.

The pH-value of highly dilute alkaline and acid solutions and analyzable fluid temperature relationship implemented in the pH-meter is graphically shown in Attachment B.

1.5.2 pH-meter operating principle

The pH-meter operation is based on the potentiometric analyzable solution pH measuring method.

The electrode system immersed in an analyzable solution generates U linearly dependent on pH value.

Signals (U) from the electrode system and temperature sensor are applied to the convertor unit where they are amplified and digitized.

The measured U of the pH-meter electrode system is translated into pH value in view of analyzable solution temperature, i.e. temperature compensation occurs automatically. The compensation relates to only U variations of the electrode system.

1.5.3 pH-meter design

MAPK-903 pH-meter is shown in Figure 1.1a and MAPK-903/1 pH-meter is illustrated in Figure 1.1b.

The convertor unit 1 enclosed in a plastic tight casing, transforms signals from the electrode system, displays measurement results and transmits data to a PC.

The convertor unit front panel carries:

- a display screen 2 to show measured pH, pH_{25} , U, and temperature; indicate battery charge, date, time, and navigate in the display menu; and
- keys 3.

The convertor unit rear panel bears a cover of the dry cell compartment.

The upper end face of the MAPK-903 pH-meter convertor unit carries:

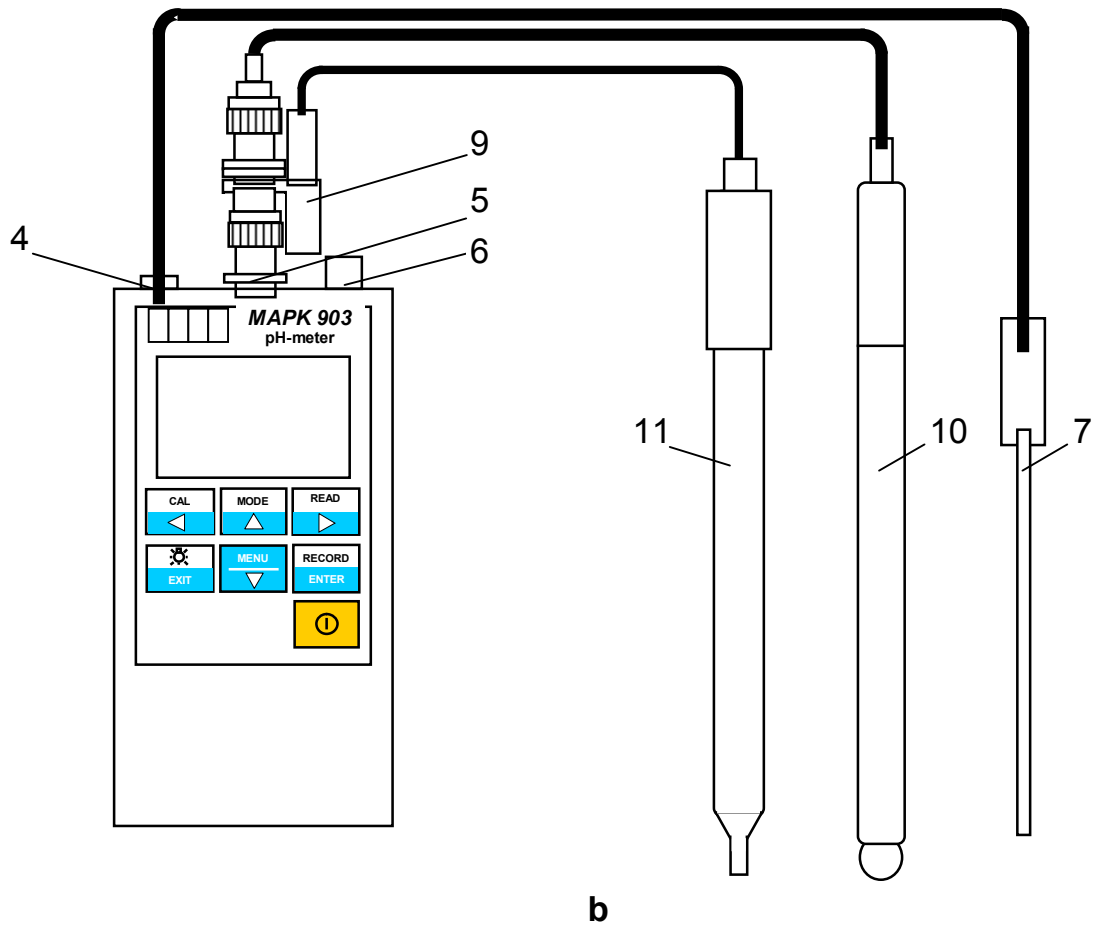
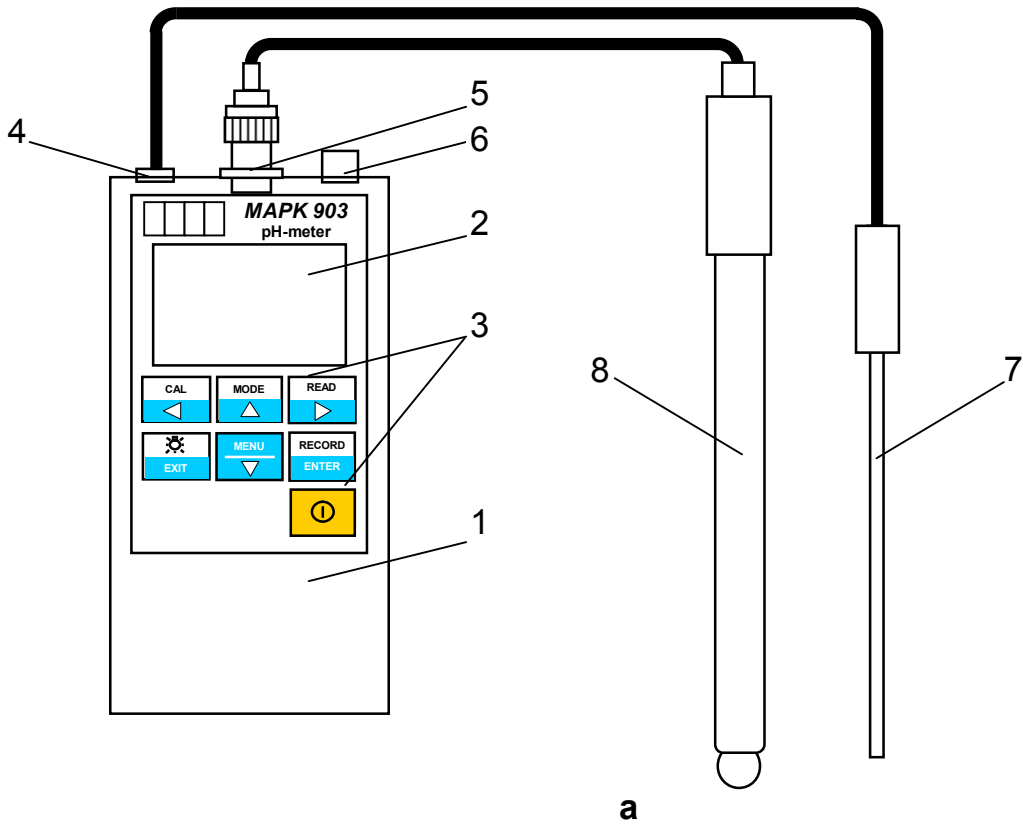
- a tight cable entry 4 from temperature sensor 7;
- jack 5 for connection of the combined electrode 8; and
- jack 6 for connection to PC.

Unlike MAPK-903 pH-meter, the jack 5 of MAPK-903/1 pH-meter convertor unit is used for connection of an adapter 9 of which jack accepts the measuring electrode 10. The socket on the adapter bracket accepts the reference electrode plug 11.

The upper end face of the MAPK-903 pH-meter convertor unit carries:

- a tight cable entry 4 from temperature sensor 7;
- jack 5 for connection of the combined electrode 8; and
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Unlike MAPK-903 pH-meter, the jack 5 of MAPK-903/1 pH-meter convertor unit is used for connection of an adapter 9 of which jack accepts the measuring electrode 10. The socket on the adapter bracket accepts the reference electrode plug 11.



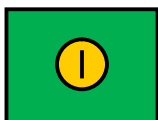
b
Figure 1.1

1.5.4 Functions of keys on the convertor unit front panel

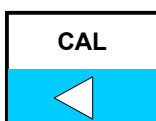
The pH-meter uses non-locking keys.

Symbols on the light key space show their functions in measurement mode.

Symbols on the dark key space reflect their functions when working with the electronic scratchpad and display menu.

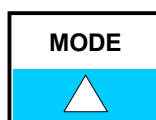


The green key is used to turn on and off the pH-meter. It is to be depressed for 2 s.



The key is used:

- in the measurement mode – to move to the pH-meter calibration mode. It is to be held depressed for 0.5 s;
- when working with the electronic scratchpad and display menu – to move leftward in a line.



The key is used:

- in the measurement mode – to select mode of pH, pH₂₅, U measurement (out of available modes, see 1.5.8 **MENU/ MEASURING MODES**). The key is to be depressed for 0.5 s;
- when working with the electronic scratchpad and display menu – to move upward in a line.



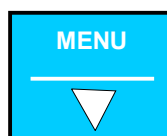
The key is used:

- in the measurement mode – to move from measurement mode to the mode of viewing data entered into the electronic scratchpad. It is to be held depressed for 0.5 s;
- when working with the electronic scratchpad and display menu – to move rightward in a line.



The key is used:

- in the measurement mode – to turn on and off display light;
- when working with the electronic scratchpad and display menu – to exit from electronic scratchpad and display menus.



The key is used:

- in the measurement mode – to enter the display menu. It is to be depressed for 0.5 s;
- when working with the electronic scratchpad and display menu – to move downward in a line.



The key is used:

- in the measurement mode – to enter data into the electronic scratchpad. It is to be held depressed for 0.5 s;
- when working with the electronic scratchpad and display menu – to confirm selected parameters and operating modes.

1.5.5 Measurement mode

1.5.5.1 Measurement displays

Display screen in pH measurement mode is shown in Fig. 1.2.

Display screen in pH₂₅ measurement mode is shown in Fig. 1.3.

Display screen in U measurement mode is shown in Fig. 1.4.

Figures displayed may be different.



Fig. 1.2

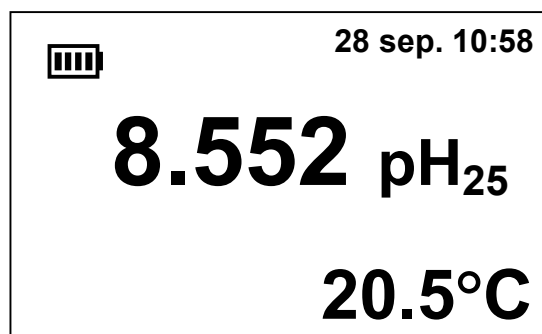


Fig. 1.3

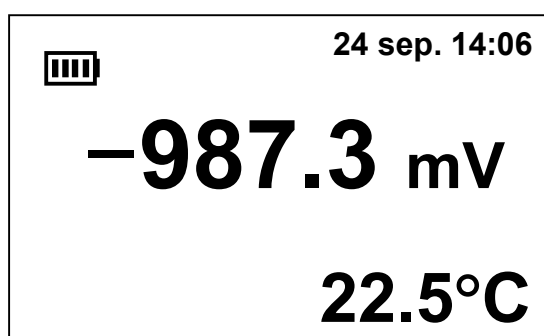




Fig. 1.4

The display screen shows the following:

- dry cell charge. The number of bars in the symbol shows the dry cell charge level as follows: one bar – 25 %, two bars – 50 %, three bars – 75 %, four bars – 100 %;


- date (day and month) and current time. The date and time are set up as described in 1.5.8 (**DATE TIME** menu command);
- measured pH, pH₂₅, U values. U is measured in mV. pH₂₅ and U measurement modes are made accessible on pH-meter adjustment according to 1.5.8 (**MEASURING MODES** menu command). If the modes are available, to move from pH measurement mode to pH₂₅, U measurement modes the key  is to be depressed;
- temperature of analyzable fluid, °C.




Display light is turned on and off using  key.

According to 1.5.8 (**ADDITIONAL SETTINGS** menu command), a time period in seconds when illumination is on if any of the keys is depressed, may be set up.

If the display shows intermittent messages or dashes rather than pH, pH₂₅, U or temperature values and the audible overload signal is on, refer to 1.5.9.

1.5.6 Measurement results saving in the electronic scratchpad

To enter measurement results in the electronic scratchpad, depress  key for 0.5 s.

The display shall show the list of folders made by a user including **SHARED FOLDER**. Using  and  keys move the cursor against the folder required, for instance, **SHARED FOLDER**, and depress the key .

If there are no folders made by a user, data shall be entered in the **SHARED FOLDER**.

The display shown in Fig. 1.5 shall appear for 2 s, and then the pH-meter shall change the current mode to the measurement mode.

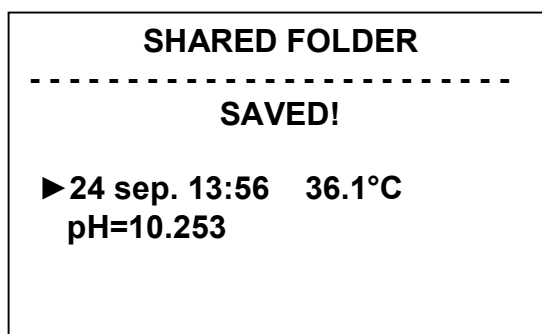



Fig. 1.5

The selected folder shall contain the following:

- date and time of measurement;
- temperature of analyzable fluid;
- pH, pH₂₅ or U values measured according to the selected operating mode.




If the scratchpad is filled to capacity, on entering data the display shall show the message **"SAVING IS IMPOSSIBLE, SCRATCHPAD IS OVERFILLED"**.



1.5.7 View of records in the electronic scratchpad

To view records, depress  key for 0.5 s in the measurement mode.

The display **LIST OF FOLDERS** shall show the list of folders made by a user. The **SHARED FOLDER** comes first in the list. The other folders shall appear in the order they have been made. The intermittent cursor shall automatically appear against the folder that has been requested last.

If space on the screen is not enough for the whole list, a scroll bar shall come up on the right side of the screen. The dark colour square on the scroll bar shall show an approximate location of the visible part of the list relative to the whole list.

Using keys  and  move the cursor to the folder needed and press the key .

If keys  and  are depressed for more than 1 s, the list shall be automatically scrolled in the respective direction.

If there are no folders made by the user, **SHARED FOLDER** shall automatically open.

The display shall show measurements saved in the folder according to date and time. The intermittent cursor shall automatically move to the last entry.

If space on the screen is not enough for measurement data, arrows at the top and bottom of the scroll bar shall show where (at the top or bottom of the list) the measurement data invisible on the screen are to be found.

To scroll the data list use keys  and . If the keys are depressed for more than 1 s, the list shall be automatically scrolled in the respective direction.

Since on scrolling the list it moves itself, the cursor shall always remain against the message shown on the screen.

If entry in the scratchpad has been made in the U measurement mode, the display shown in Fig. 1.6 shall come up.

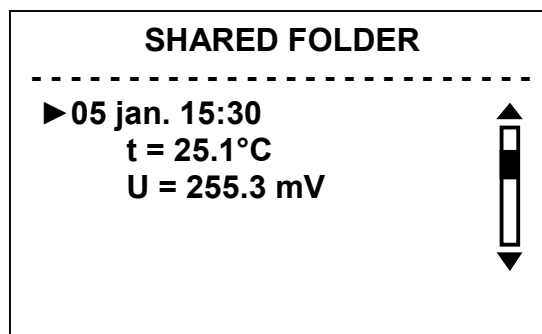


Fig. 1.6

If entry in the scratchpad has been made in the pH measurement mode, the display shown in Fig. 1.7 shall come up.

If entry in the scratchpad has been made in the pH₂₅ measurement mode, the display shown in Fig. 1.8 shall come up.

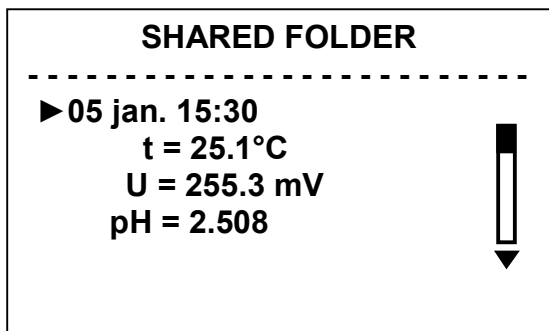


Fig. 1.7

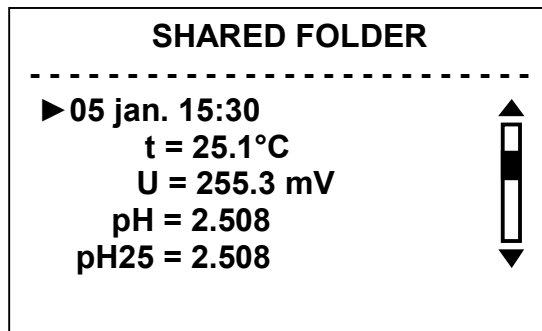



Fig. 1.8

If there are no entries in the folder, the respective message shall come up.

To delete the entry against the cursor, depress  key. The display shown in Fig. 1.9 shall come up.

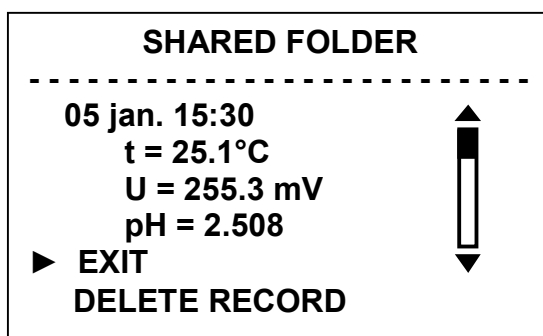







Fig. 1.9

Using either of the keys  or  move the cursor against **DELETE RECORD** and depress key . Data on the screen shall be deleted. The "**RECORD DELETED!**" message shall appear on the screen for 2 s.


If the cursor is moved against **EXIT** and the key  is depressed, the displays shown in Fig. 1.6-1.8 come up.

Pad shall be edited including clearing of folders, making new folders, folder deletion as described in 1.5.8 (**SCRATCHPAD EDITOR** menu command).

To go over to the measurement mode or exit from any display and return to the previous display, press the key .

1.5.8 MENU mode

The pH-meter parameters shall be viewed and changed in the **MENU** mode.

To move from the measurement mode to the **MENU** mode, depress the key  for 0.5 s. **MENU** display is shown in Fig. 1.10.

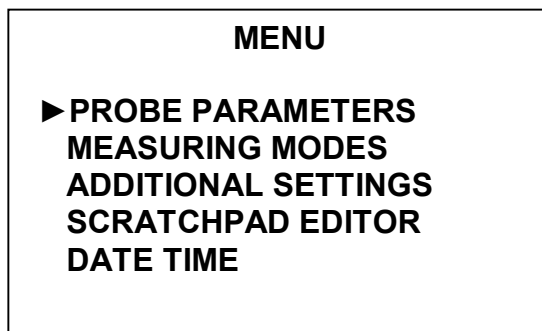







Fig. 1.10

To exit from any display of **MENU**, depress the key .

To move the marker "►" in the menu, the keys  and  are used. If the keys  and  are depressed for more than 1 s, the cursor shall automatically start moving in the respective direction.

To select the menu command needed, move the marker to the entry and press the key .

1.5.8.1 ► PROBE PARAMETERS

► **PROBE PARAMETERS** is the menu command to view parameters of the electrode system.

On selection of this menu command the display shown in Fig. 1.11 shall come up.

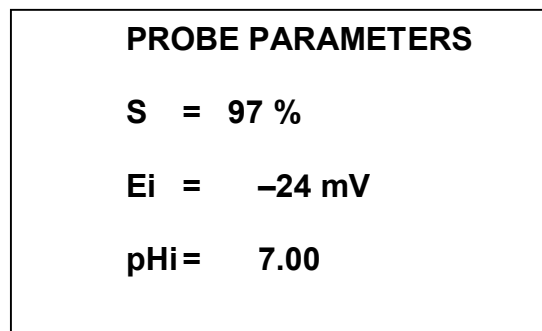


Fig. 1.11

The display shall show the electrode system parameters based on the last calibration:

S is electrode system slope in % of the rated value;

pHi and **Ei** are the coordinates of the electrode system isopotential point.

1.5.8.2 ► MEASURING MODES

► **MEASURING MODES** is a command in the menu to add U and pH₂₅ measurement modes to the list of accessible measurement modes or remove them from the list.

On selection of this menu command the display shown in Fig. 1.12 shall come up.

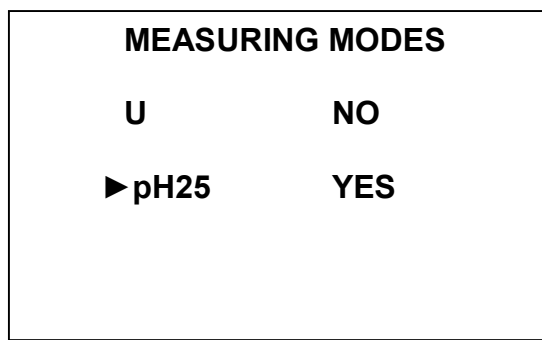



Fig. 1.12

Move the cursor to the command required and select the mode needed using  key.

1.5.8.3 ► ADDITIONAL SETTINGS

► **ADDITIONAL SETTINGS** is the menu command intended to select the needed value of the pHi isopotential point and set the time of pH-meter automatic deactivation and automatic light actuation.

On selection of this menu command the display shown in Fig. 1.13 shall come up.

ADDITIONAL SETTINGS	
▶ SETTING pHi	7.00
AUTOSHUTDOWN	OFF
AUTOBACKLIGHT	10 s

Fig. 1.13

▶ **SETTING pHi** is the sub-menu command intended to select the needed value of the pHi 7.00; 6.70 or 4.00 isopotential points.

On selection of this sub-menu command the display shown in Fig. 1.14 shall come up.

Select the needed pHi value and press the  key.

SETTING pHi	
▶	7.00
	6.70
	4.00

Fig. 1.14

▶ **AUTOSHUTDOWN** is the sub-menu command intended to set pH-meter deactivation time of 15 min or 30 min once any of the keys is depressed.

On selection of this sub-menu command the display shown in Fig. 1.15 shall come up.

If the cursor is moved to **OFF** command, pH-meter may not be deactivated automatically.

Choose required parameter and press the  key.

AUTOSHUTDOWN	
▶	OFF
	15 min
	30 min

Fig. 1.15

► **AUTOBACKLIGHT** is the sub-menu command intended to set illumination time of 10 s or 30 s once any of the keys is depressed.

On selection of this sub-menu command the display shown in Fig. 1.16 shall come up.

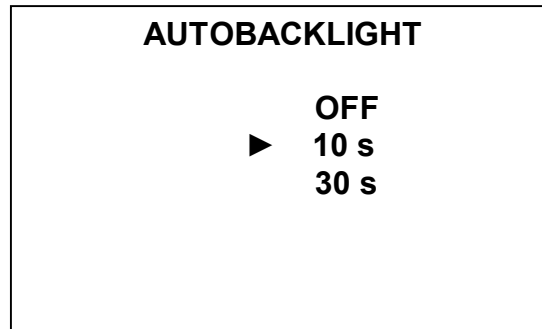


Fig. 1.16

If the cursor is moved against **OFF**, automatic illumination shall not work.

Select parameter needed and depress

RECORD
ENTER

 key.

Note – At supply voltage of 2.4V and below display illumination does not work.

1.5.8.4 ► **SCRATCHPAD EDITOR**

SCRATCHPAD EDITOR is the display shown in Fig. 1.17.

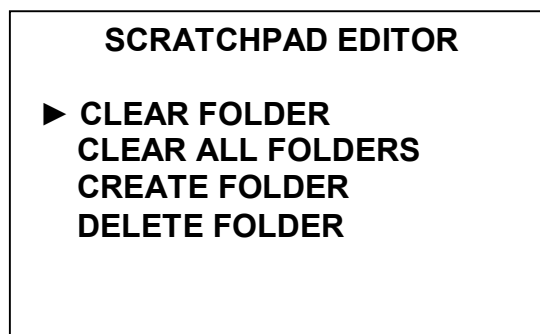


Fig. 1.17

1 CLEAR FOLDER display is shown in Fig. 1.18.

Names of folders may be different.

The cursor is always moved to **SHARED FOLDER**, first.

To clear a folder with records, paste it using the cursor and press the

RECORD
ENTER

 key.

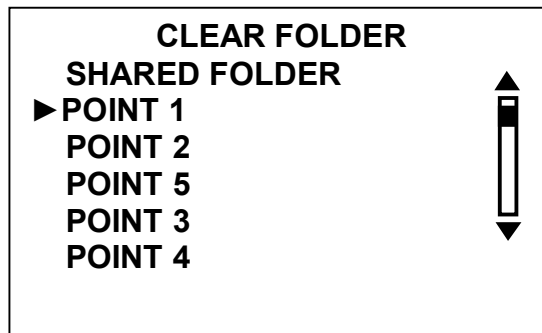


Fig. 1.18

The display shall show the name and content of the folder as shown, for instance, in Fig. 1.19.

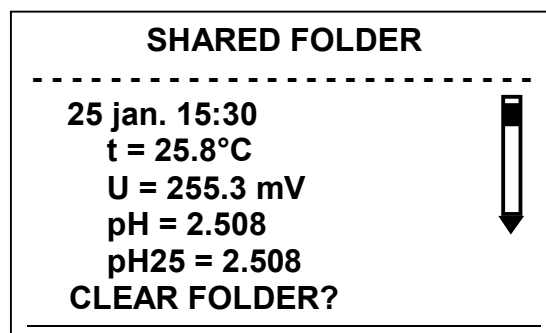



Fig. 1.19

Press the key . The folder is clear. The display shall show **NO RECORDS** message for 2 s and the pH-meter shall go over to the **CLEAR FOLDER** display.

The other folders may be cleared in the same manner.

2 CLEAR ALL FOLDERS display is shown in Fig. 1.20.

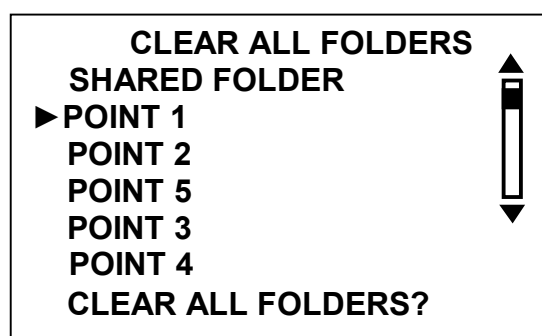



Fig. 1.20

Press the key . All folders are clear. The display shall show **NO RECORDS** message for 2 s and the pH-meter shall go over to the **SCRATCHPAD EDITOR** display.

3 MAKE FOLDER display is shown in Fig. 1.21.

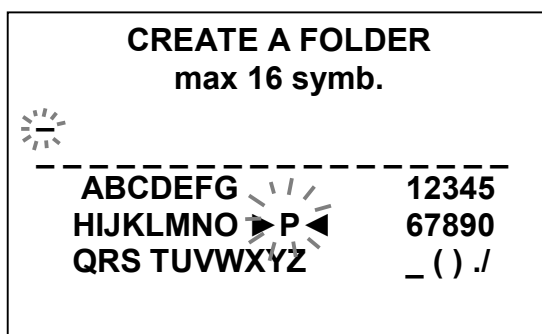







Fig. 1.21

If the scratchpad is filled to capacity, the "CREATION OF NEW FOLDER IS IMPOSSIBLE. DELETE ANY FOLDER" message shall appear on the screen.

To enter the name of a folder, paste any symbol using the cursor "► ◀". Move the cursor "► ◀" using the keys: , , , .

Once the key  is depressed, the pasted symbol shall be entered into the folder name, and the display shown in Fig. 1.22 shall come up.

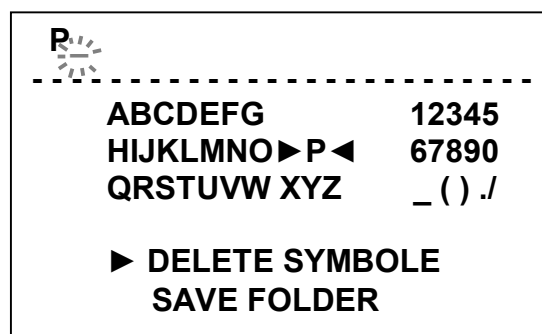






Fig. 1.22


To delete a symbol, move the cursor to DELETE SYMBOL and depress the  key. The last entered symbol shall be deleted.


If sixteen symbols were entered, the alphabet shall disappear, and the cursor shall automatically move to **DELETE SYMBOL** command.

Using the  key delete as many symbols as needed.

Depress the key , the alphabet shall appear again and the folder name may be entered on.

To save the folder you created, move the cursor to SAVE FOLDER command and depress the  key. The pH-meter shall go over to the **SCRATCHPAD EDITOR** display.

If the scratchpad contains a folder bearing the name which is entered, on pressing the  key, the "FOLDER WITH SUCH NAME ALREADY EXISTS" message shall appear on the screen. The cursor may be moved against DELETE SYMBOL command to change the folder name.

If the key  is depressed, the "CREATED FOLDER IS NOT SAVED" message shall appear for 2 s. The analyzer shall go over to the **SCRATCHPAD EDITOR** display.

4 DELETE FOLDER display is shown in Fig. 1.23.
The folders are saved in the order they have been made.

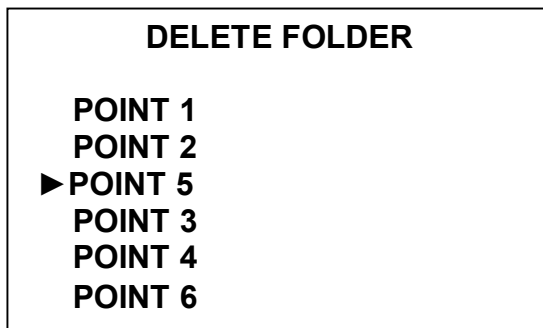



Fig. 1.23

To delete a folder, paste the folder using the cursor. Press the  key. The display shall show the name and content of the folder as shown, for instance, in Fig. 1.24.

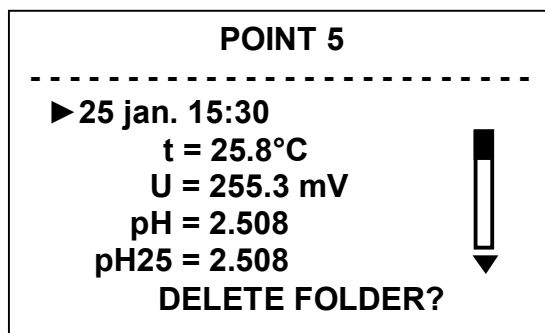



Fig. 1.24

If a folder contains no entries, the display shall show NO RECORDS message.



Press the  key. The FOLDER DELETED message shall appear on the screen for 2 s and the pH-meter shall go over to **DELETE FOLDER** display.

Other folders except **SHARED FOLDER** may be deleted in the same manner.

1.5.8.5 ▶ DATE TIME

▶ **DATE TIME** is the menu command to enter date and time.
The **DATE TIME** display is shown in Fig. 1.25.

Date and time shall be entered separately in any order: date, month, hours, and minutes.

Moving to the left and to the right is carried out using the ,  keys. In this case the parameter that may be changed starts flickering.

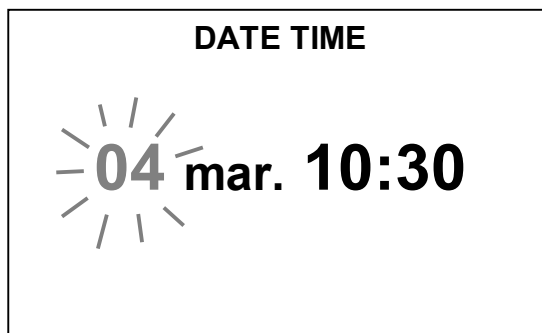


Fig. 1.25

Parameters shall be changed using the ,  keys.

In open **DATE TIME** display the clock stops, and it is actuated on exit from this display.

1.5.9 Warning displays

On appearing displays shown in Fig. 1.26-1.28 refer to 2.5 of the Operation Manual (Troubleshooting. Table 2.1).

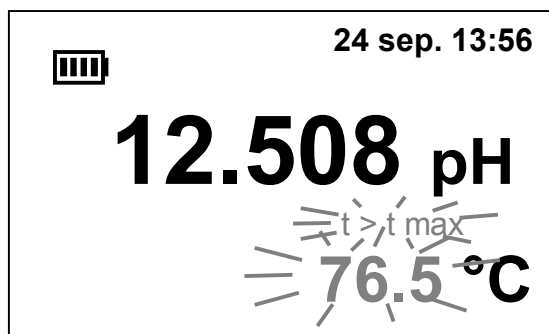


Fig. 1.26

The display shown in Fig. 1.26 comes up when analyzable fluid temperature exceeds 70.0 °C.

Simultaneously an audible signal comes on.

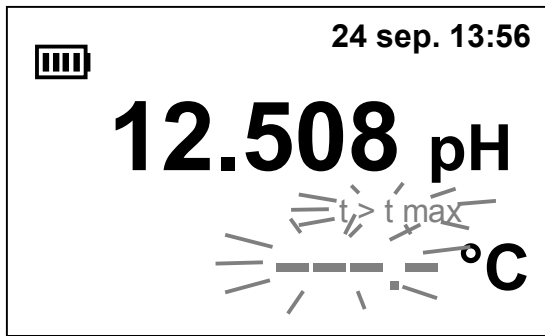


Fig. 1.27

The display shown in Fig. 1.27 comes up when temperature exceeds 999.9 °C (failure in the temperature measuring channel).

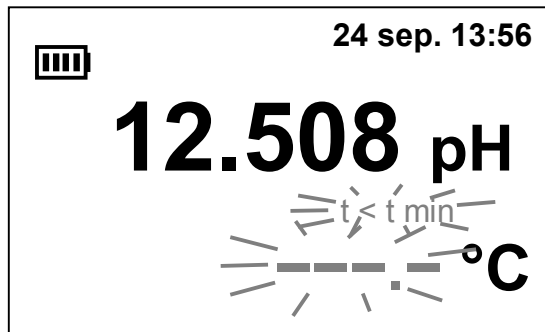


Fig. 1.28

The display shown in Fig. 1.28 comes up when analyzable fluid temperature is below 0 °C.

1.5.10 Error displays

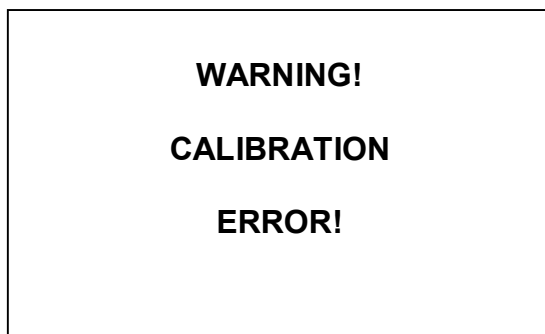


Fig. 1.29

The display shown in Fig. 1.29 comes up, if on calibration the buffer solution is not identified.

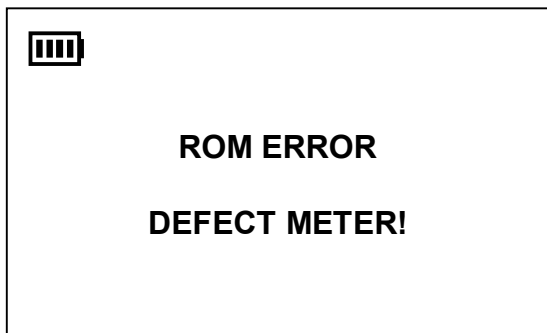


Fig. 1.30

The display shown in Fig. 1.30 comes up (error No 1) in the event of pH-meter program failure. Refer to 2.5 of the Operation Manual (Troubleshooting. Table 2.1).



Fig. 1.31

The display shown in Fig. 1.31 comes up (error No 2) in the event of pH-meter program failure. Refer to 2.5 of the Operation Manual (Troubleshooting. Table 2.1).

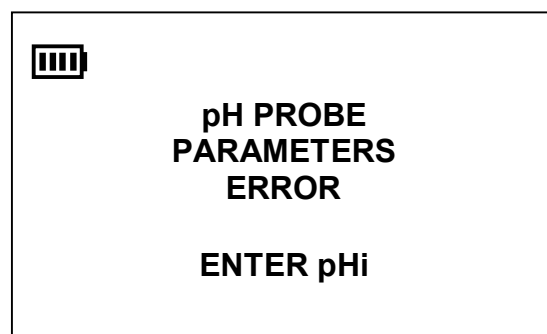


Fig. 1.32

The display shown in Fig. 1.32 comes up (error No 3) in the event of pH-meter program failure. Move to the **SETTING pH_i** sub-menu command and enter pH_i value required according to the electrode type: 7.00; 6.70 or 4.00.

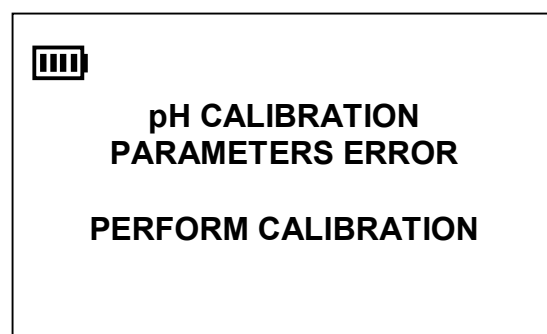


Fig. 1.33

The display shown in Fig. 1.33 (error No 4) comes up in the event of pH-meter program failure. Carry out pH-meter calibration using electrodes as described in 2.3.3.2.

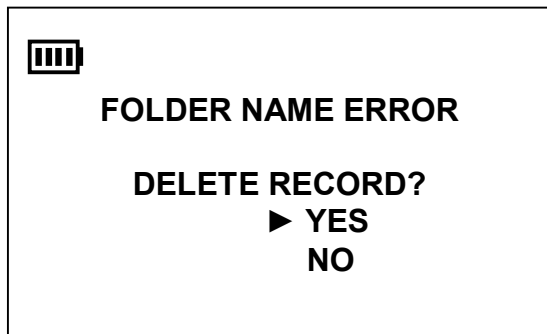


Fig. 1.34

The display shown in Fig. 1.34 (error No 5) comes up in the event of erroneous entry in the scratchpad.

If **YES** command is selected, the entry is deleted without warning and the apparatus comes back to the measurement mode.

If **NO** command is selected, the apparatus comes back to the measurement mode.

On viewing this entry in the scratchpad the display shall show an **ERROR** message.

1.6 Measuring instruments, tools and appliances

The pH-meter maintenance shall additionally require the following tools and appliances not included into the delivery set:

- 2 mm screwdriver;
- 2 cm³ syringe to fill an electrode with electrolyte;
- K-2-1000-50 flask;
- B-1-250 beaker;
- KCl solution of 3 mol/dm³ concentration;
- HCl solution of 0.1 mol/dm³ concentration.

2 INTENDED USE

2.1 Operating limitations

2.1.1 The pH-meter is used to measure hydrogen-ion activity index (from 0 to 12 pH), temperature of aqueous solutions (from 0 to plus 70 °C), and U (from minus 1.000 to plus 1.000 mV).

2.1.2 When working with pH-meter, protect electrodes and convertor unit from shocks since fragile materials have been employed in their design.

2.1.3 On pH measurements electrodes are to be immersed in a solution at least 16 mm deep.

2.1.4 Electrolyte level in electrodes on measurements is to be above the analyzable solution level.

2.1.5 Avoid pH, U and temperature measurements in solutions containing hydrofluoric acid or salts thereof and substances that form deposits and films on electrode surfaces as well as operation and storage of dry electrodes.

2.1.6 Avoid PC output short-circuit.

2.2 Safety Precautions

2.2.1 Electric safety of operating personnel is ensured due to use of self-contained DC power supply of voltage from 2.2 to 3.4 V.

2.2.2 The pH-meter is to be operated by people who acquainted themselves with this manual and safety rules for handling reagents.

2.3 pH-meter preliminary operating procedures

Before use unpack pH-meter, check components and make sure that the apparatus is free of damage.

If the pH-meter stayed in cold environment, keep it at room temperature for at least 8 h and then start preliminary operating procedures.

2.3.1 Connection of power supply

To connect power supply, remove the dry cell compartment cover on the rear panel of the convertor unit. Install two AA alkaline dry cells or two charged AA nickel-metal hydride batteries according to marking in the compartment. Close the dry cell compartment cover.

When the pH-meter is turned on, the display shall show the cell charge level. The number of bars in the cell symbol shows the dry cell charge level as follows: one bar – 25 %, two bars – 50 %, three bars – 75 %, four bars – 100 %.

1 IMPORTANT: OBSERVE POLARITY when connecting power supply. Otherwise this may cause pH-meter failure!

2 IMPORTANT: Connect power supply only when the pH-meter is de-energized!

3 IMPORTANT: To prevent date and time resetting and loss of data in the electronic scratchpad, batteries or dry cell are to be replaced within a 30 s period!

Nickel-metal hydride batteries shall be charged with 5 V voltage and analyzer connected to the PC USB port.

2.3.2 To make electrode (electrodes) available

2.3.2.1 Make electrode (electrodes) available in compliance with the electrode certificate (certificates) attached to the delivery set.

2.3.2.2 Connect electrode (electrodes) to the convertor unit as shown in Fig. 1.1a or 1.1b according to pH-meter version.

2.3.3 pH-meter calibration

2.3.3.1 General guidelines


When operating the apparatus, periodically calibrate it with connected electrodes. Calibration is to be carried out against buffer solutions comprising Category 2 pH working standards that meet GOST 8.135-2004 and TU 2642-002-42218836-96 Specifications.

The pH-meter is to be calibrated at buffer solution temperature of (20 ± 5) °C. In this case temperatures of the two calibration solutions shall not differ by more than 0.5 °C.

Prior to calibration the reference electrode or combined electrode filling hole is to be opened.

2.3.3.2 pH-meter calibration procedure

Calibration is undertaken against one of the two buffer solutions exhibiting 1.65 and 9.18 pH values at solution temperature of (25.0 ± 0.2) °C.

- 1 Clean electrode (electrodes) and temperature sensor in distilled water, first, (in two vessels in succession) and then in the first buffer solution against which calibration is to be undertaken which exhibits pH = 1.65 at solution temperature of (25.0 ± 0.2) °C.
- 2 Power up the pH-meter. Press the  key. The display shown in Fig. 2.1 shall come up.

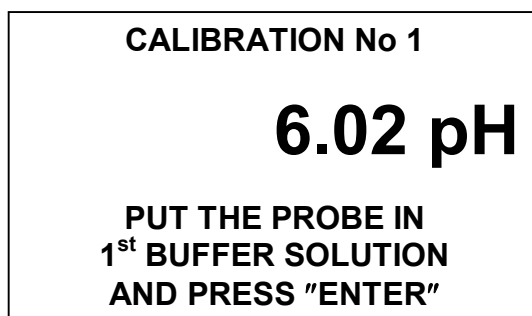



Fig. 2.1

- 3 Place pH-electrode (electrodes) and temperature sensor in the first fresh buffer solution. Press the  key. The first buffer solution shall be identified. The display shown in Fig. 2.2 shall come up.

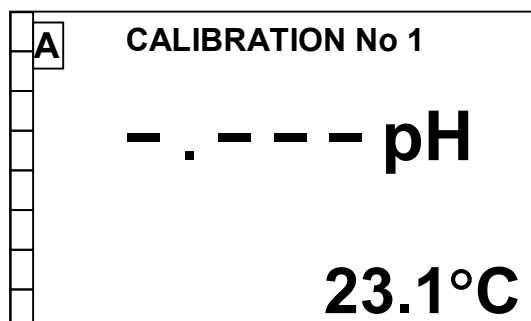


Fig. 2.2

- 4 If buffer solution pH value is not identified automatically, the display shown in Fig. 2.3 shall come up. Refer to 2.5 of the Operation Manual (Troubleshooting. Table 2.1).

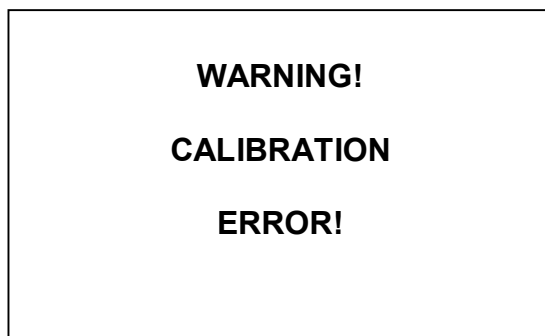


Fig. 2.3

- 5 If buffer solution pH value is identified automatically, it shall appear and the meter in the left part of the screen shall be pasted. Once readings become stable, the meter shall be pasted, the display shown in Fig. 2.4 shall come up.

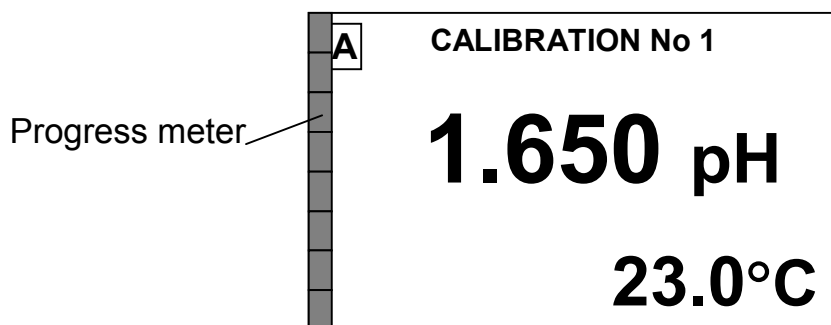



Fig. 2.4

- 6 Press the  key. The display shown in Fig. 2.5 shall come up. The pH-meter shall enter the calibration mode against the second buffer solution exhibiting pH = 9.18 at the solution temperature of (25.0±0.2) °C.

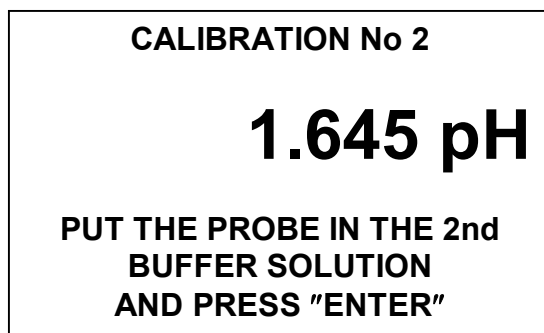




Fig. 2.5

- 7 If calibration against the second buffer solution is not needed, press the  key. The pH-meter calibration to one point is completed. The display shown in Fig. 2.8 shall come up. The pH-meter shall go to step 13.
- 8 If calibration against the second buffer solution is required, remove electrodes and temperature sensor from the first buffer solution and wash them in distilled water (in two vessels in succession) and then in a volume of the second buffer solution.
- 9 Place electrodes and temperature sensor in fresh second buffer solution. Press the  key. The second buffer solution shall be identified. The display shown in Fig. 2.6 shall come up.

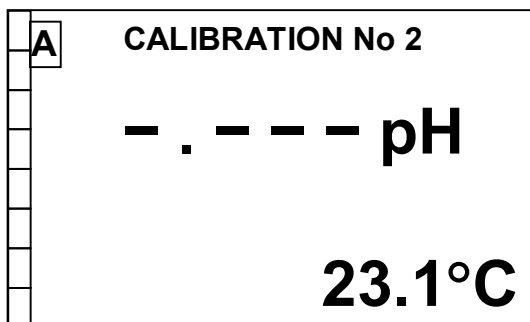


Fig. 2.6

- 10 If pH value of the second buffer solution is not identified automatically, the display shown in Fig. 2.3 shall come up. Refer to 2.5 of the Operation Manual (Troubleshooting. Table 2.1).
- 11 If buffer solution pH value is identified automatically, it shall appear and the meter in the left part of the screen shall be pasted. Once the meter is pasted, the display shown in Fig. 2.7 shall come up.

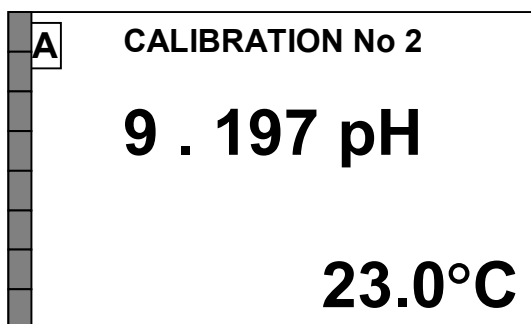



Fig. 2.7

- 12 Press the  key. Calibration to two points is completed and the display shown in Fig. 2.8 shall come up.

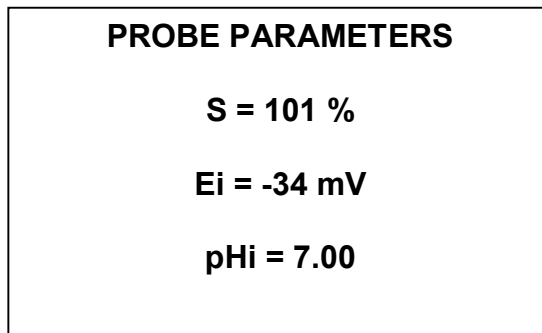



Fig. 2.8

- 13** Press the  key. Calibration is completed and the display shown in Fig. 2.9 shall come up.

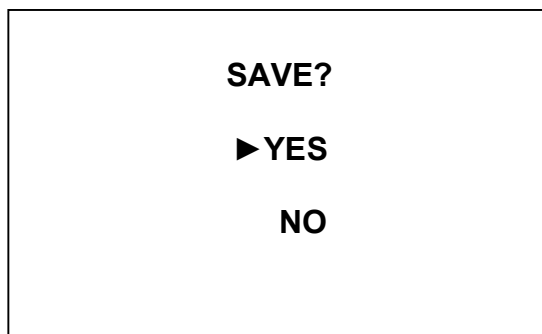



Fig. 2.9

- 14** Move the cursor against YES and press the  key. The pH-meter shall go to the measurement mode.

2.4 Measurement procedure

2.4.1 Procedure of measurements without the protective case

Components of the pH-meter must be available for operation according to 2.3.

Prior to measurements open the electrode filling hole and remove the protective cap.

Wash an electrode (electrodes) and temperature sensor in distilled water and immerse into the analyzable solution. On pH measurements an electrode is to be immersed in a solution at least 16 mm deep. Electrolyte level in an electrode on measurements is to be above the analyzable solution level.

On pH or U measurements take readings after they have stabilized.

Usually in measurements using electrodes readings stabilize within maximum of 10 min. However, in some solutions at temperature close to 0 °C readings may stabilize within 15 min.

Storage between measurements is to meet requirements set out in the electrode (electrodes) certificates. To reduce electrolyte consumption in the electrode, the electrode filling hole is to be closed within idling periods.

2.4.2 Procedure of measurements using the protective case

The protective case protects electrodes in measurements and in pH-meter haulage. It is supplied as agreed to by a customer with any type of electrodes except ЭСКЛ-08М and ЭСКЛ-08М.1 combined laboratory glass electrodes.

Moisten an electrode (electrodes) and the sensor in distilled water and place them in the protective case in the sockets as shown in Fig. 2.10.

Prior to measurements screw out the protective case base and proceed with measurements as described in 2.4.1 immersing the case with electrodes and temperature sensor into a solution.

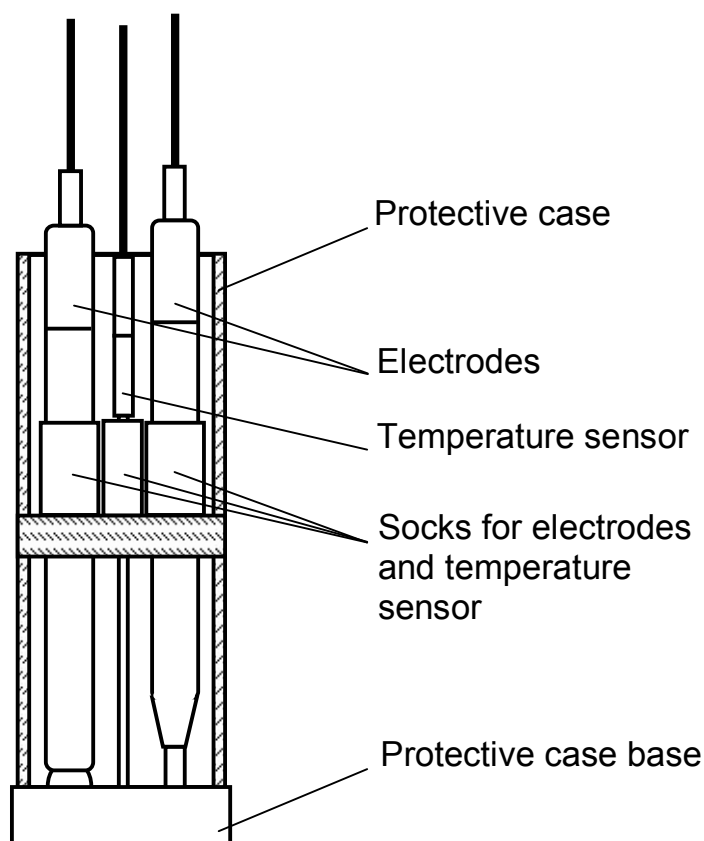


Fig. 2.10

On completion of measurements wash electrodes and the protective case with distilled water and screw the base onto the case.

In case of long breaks in measurements remove the electrode (electrodes) from the protective case and store them as described in their certificates.

To reduce electrolyte consumption in the electrode, the electrode filling hole is to be closed within idling periods.

2.4.3 Procedure for measurements using FM-901/903 flow-through module


To measure pH of "pure" water, use is to be made of the FM-901/903 BP24.16.100 flow-through module from the pH-meter tools and accessories kit supplied as agreed to by a customer.

The FM-901/903 flow-through module stabilizes water flow from a sampler, ensures metering and visual control of water flow rate to the combined electrode. It is intended to measure pH_{25} in water with specific conductance over $0.2 \mu\text{S}/\text{cm}$. At conductance below $0.2 \mu\text{S}/\text{cm}$ measurement accuracy is not regulated.

pH is reduced to pH_{25} in the range from plus 5 to plus 50.

To make measurements easy the FM-901/903 flow-through module and convertor unit are placed on a support from MAPK-903 pH-meter tools and accessories kit supplied as agreed to by a customer.

Add pH_{25} measurement mode to the accessible modes list (**MEASURING MODES** menu in 1.5.8.2).

Move from **MENU** mode to the measurement mode and select pH_{25} measurement mode using the  key.

Measurements using FM-901/903 flow-through module are to be undertaken as described in FM-901/903 BP24.06.100PЭ flow-through module operation manual.

2.5 Troubleshooting

2.5.1 Probable causes and remedies are laid down in Table 2.1.



Table 2.1

Trouble and symptoms	Probable cause	Remedy
1 pH-meter is not powered up or is de-energized once it is turned on	Poor contact with power supply	Open the dry cell compartment and clean contacts of convertor unit, dry cells or batteries
	Supply voltage is below 2.2 V	Replace dry cells or charge batteries
2 pH-meter readings are unstable	Cable rupture or poor contact in the electrode cable connector	Check for safe contact or repair cable rupture
3 In measurements in different buffer solutions apparatus readings remain nearly the same when pH-electrode (electrodes) is transferred from one buffer solution into another one	Defective electrode (one of electrodes)	Replace electrode
4 Temperature measured (under normal use) differs from actual value by more than 0.3°C	Defective temperature sensor	To be repaired at factory
5 "WARNING! CALIBRATION ERROR" message on the screen	pH of the buffer solution is different from pH = 1.65 or pH = 9.18	Prepare fresh buffer solution
	Cable rupture or poor contact in the electrode cable connector	Repair rupture. Ensure safe contact
	Defective electrode	Replace electrode
6 "ROM ERROR, DEFECT METER" message on the screen	pH-meter program failure	To be repaired at factory
7 "METER SETTINGS ERROR, DEFECT METER" message on the screen	pH-meter program failure	To be repaired at factory
8 "pH PROBE PARAMETERS ERROR. ENTER pHi" message on the screen	pH-meter program failure	Enter pHi value
9 "pH CALIBRATION PARAMETERS ERROR. PERFORM CALIBRATION" message on the screen	pH-meter program failure	Calibrate

2.5.2 Setting of predetermined parameters of electrode system pH calibration

Setting of predetermined parameters of electrode system pH calibration is used for checking the transducer if pH-meter readings seem to be doubtful.

To set predetermined parameters, proceed as follows:

- turn off pH-meter;
- press the  key and holding it turn on the pH-meter;
- depress the  key.

One of the displays shown in Fig. 2.11-2.13 shall come up.

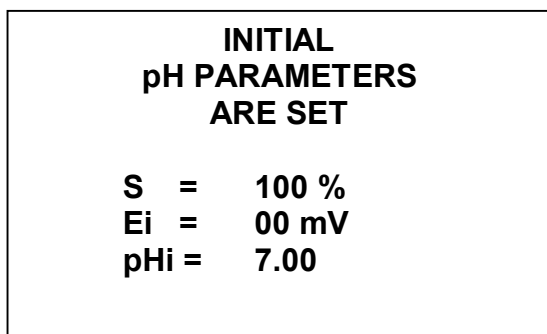


Fig. 2.11

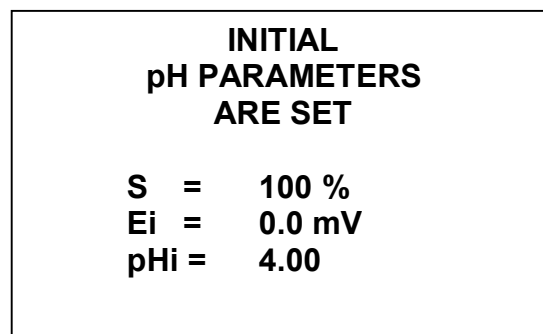


Fig. 2.12

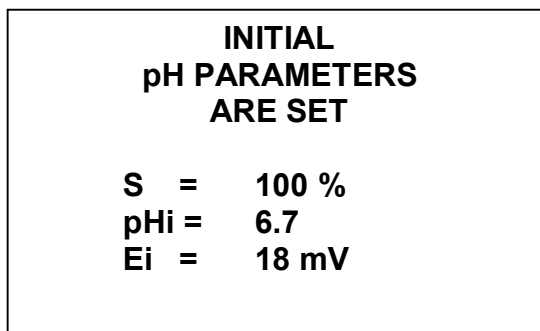


Fig. 2.13

The display shall show computed values of electrode system parameters for selected value of the isopotential point:

S is electrode system slope;

pHi and **Ei** are the coordinates of electrode system isopotential point versus pHi value compliant with type of electrodes used and defined in **ADDITIONAL SETTINGS** menu.

IMPORTANT: Once the pH-meter is de-energized and then turned on the **PROBE PARAMETERS** menu shall show parameters of the pH-meter last calibration rather than preset parameters!

To check the transducer move to pH measurement mode and apply E_U to the transducer input, mV, according to the equation:

$$E = E_i + S_t \cdot (pH - pH_i),$$

where E_i , pH_i are the coordinates of electrode system isopotential point given in the **PROBE PARAMETERS** menu according to Fig. 2.11-2.13;

pH is a simulated value of hydrogen-ion activity in the range from 0 to 10 pH;

S_t is the electrode system slope, mV/pH.

S_t value is found from the equation

$$S_t = -0.1984 \cdot (273.16 + t),$$

where t is pH-meter readings at temperature of, °C.

3 MAINTENANCE

3.1 pH-meter scheduled maintenance

3.1.1 On-going inspection of the convertor unit, electrodes and connecting cables for damage.

3.1.2 Cleaning of dirty external surfaces of the convertor unit using soft detergents.

3.1.3 pH-meter calibration against buffer solutions according to 2.3.3.

pH-meter calibration against buffer solutions is to be undertaken:

- once a month;
- if pH-meter proper workability is doubtful;
- after pH-meter repair or long storage; and
- on electrode replacement.

4 DELIVERY SET

4.1 Delivery set is shown in table 4.1.

Table 4.1

Description and identification of components	Version	
	MAPK-903	MAPK-903/1
1 BP48.01.000 convertor unit with BP48.01.400 temperature sensor	1	1
2 ЭСК-10601/7(K80.7) combined glass electrode	1*	–
3 ЭСК-10601/4(K80.7) combined glass electrode	1*	–
4 ЭСКЛ-08М combined laboratory glass electrode	1*	–
5 ЭСКЛ-08М.1 combined laboratory glass electrode	1*	–
6 201020/51-10-04-22-120/000 combined pH-electrode with gel filler	1*	–
7 ЭС-10601/7(K80.7) glass electrode	–	1*
8 ЭС-10601/4(K80.7) glass electrode	–	1*
9 ЭСр-10101-3,0(K80.4) reference electrode	–	1*
10 ЭСр-10103-3,0(K80.4) reference electrode	–	1*
11 ЭСЛ-43-07СР laboratory glass electrode	–	1*
12 ЭВЛ-1М3.1 laboratory auxiliary electrode	–	1*
13 BP48.04.000 tools and accessories kit	1	1
14 BP48.00.000РЭ Operation Manual	1	1
* Type of electrodes shall depend on version and as agreed to by a customer.		

ATTACHMENT A

(reference)

pH of standard buffer solutions versus temperature

Table A.1

Temperature, °C	Chemistry of buffer solutions					
	$\text{KH}_3(\text{C}_2\text{O}_4)_2 \times 2\text{H}_2\text{O}$ tetraoxalate, 2-aqueous, (25.219 g/dm ³)	$\text{KHC}_4\text{H}_4\text{C}_5$ potassium hydrotartrate, saturated at 25 °C, (7.868 g/dm ³)	$\text{KC}_8\text{H}_5\text{O}_4$ potassium hydrophthalate (10.120 g/dm ³)	$\text{KH}_2\text{PO}_4 + \text{Na}_2\text{HPO}_4$ potassium dihydrophosphate(3.3880 g/dm ³) +sodium monohydrophosphate (3.5330 g/dm ³)	$\text{Na}_2\text{B}_4\text{O}_7 \times 10\text{H}_2\text{O}$ sodium tetraborate, 10-aqueous (3.8064 g/dm ³)	$\text{Na}_2\text{CO}_3 + \text{NaHCO}_3$ sodium carbonate (2.6428 g/dm ³) + sodium carbonate, acidic (2.0947 g/dm ³)
	1.65	3.56	4.01	6.86	9.18	10.00
0	-	-	4.000	6.961	9.475	10.273
5	-	-	3.998	6.935	9.409	10.212
10	1.638	-	3.997	6.912	9.347	10.154
15	1.642	-	3.998	6.891	9.288	10.098
20	1.644	-	4.001	6.873	9.233	10.045
25	1.646	3.556	4.005	6.857	9.182	9.995
30	1.648	3.549	4.011	6.843	9.134	9.948
37	1.649	3.544	4.022	6.828	9.074	9.889
40	1.650	3.542	4.027	6.823	9.051	9.866
50	1.653	3.544	4.050	6.814	8.983	9.800
60	1.660	3.553	4.080	6.817	8.932	9.753
70	1.67	3.57	4.12	6.83	8.90	9.730
80	1.69	3.60	4.16	6.85	8.88	9.73
90	1.72	3.63	4.21	6.90	8.84	9.75
95	1.73	3.65	4.24	6.92	8.89	-

ATTACHMENT B

(reference)

pH of highly dilute alkaline and acid solutions as a function of analyzable fluid temperature computed on the basis of the data from MU 34-70-114-85

