

MICROPROCESSOR-BASED pH CONTROLLER

MS8102EL

TECHNICAL DESCRIPTION AND INSTRUCTION FOR USAGE

PLOVDIV 2002

I. TECHNICAL DATA

1. Inputs

- 1) analog
 - voltage from combined pH electrode -700 ÷ 700 mV
 - temperature from Pt100 0.0 ÷ 100.0 °C
- 2) digital
 - HOLD - blocking dry contact

2. Outputs

- 1) relay 250 V / 8A
 - K1 and K2 (BASE and ACID)
 - Alarm
- 2) Analog current 0 (4) ÷ 20 mA
 - 2 transmitting or controlling (programmable)

4. Input resistance (input mV) $> 10^{12}$ Ohm

5. Input current < 1 pA

6. Calibration automatic

7. Buffers for calibration

- NBS (DIN 19266) : 1.68; 3.78; 4.01; 6.86; 9.18; 12.45;
- Free programmable: 0.00 ÷ 14.00.

8. Accuracy at correction of the value of the calibration buffers depending on the temperature for NBS standard 0.003 pH

9. Isopotential of the electrode system:

- By the axis of pH 7 (± 2) pH
- By the axis of mV 0 (± 100) mV

10. Ranges and accuracy of measurement

- pH 0.00 ÷ 14.00 (± 0.01)
- mV -700 ÷ 700 (± 1)
- °C 0.0 ÷ 100.0 (± 0.1)

11. Indicator 2x16 LCD

12. Keyboard folio

13. Overall dimensions (WxHxL) 235x185x105 mm

14. Weight max. 2 kg

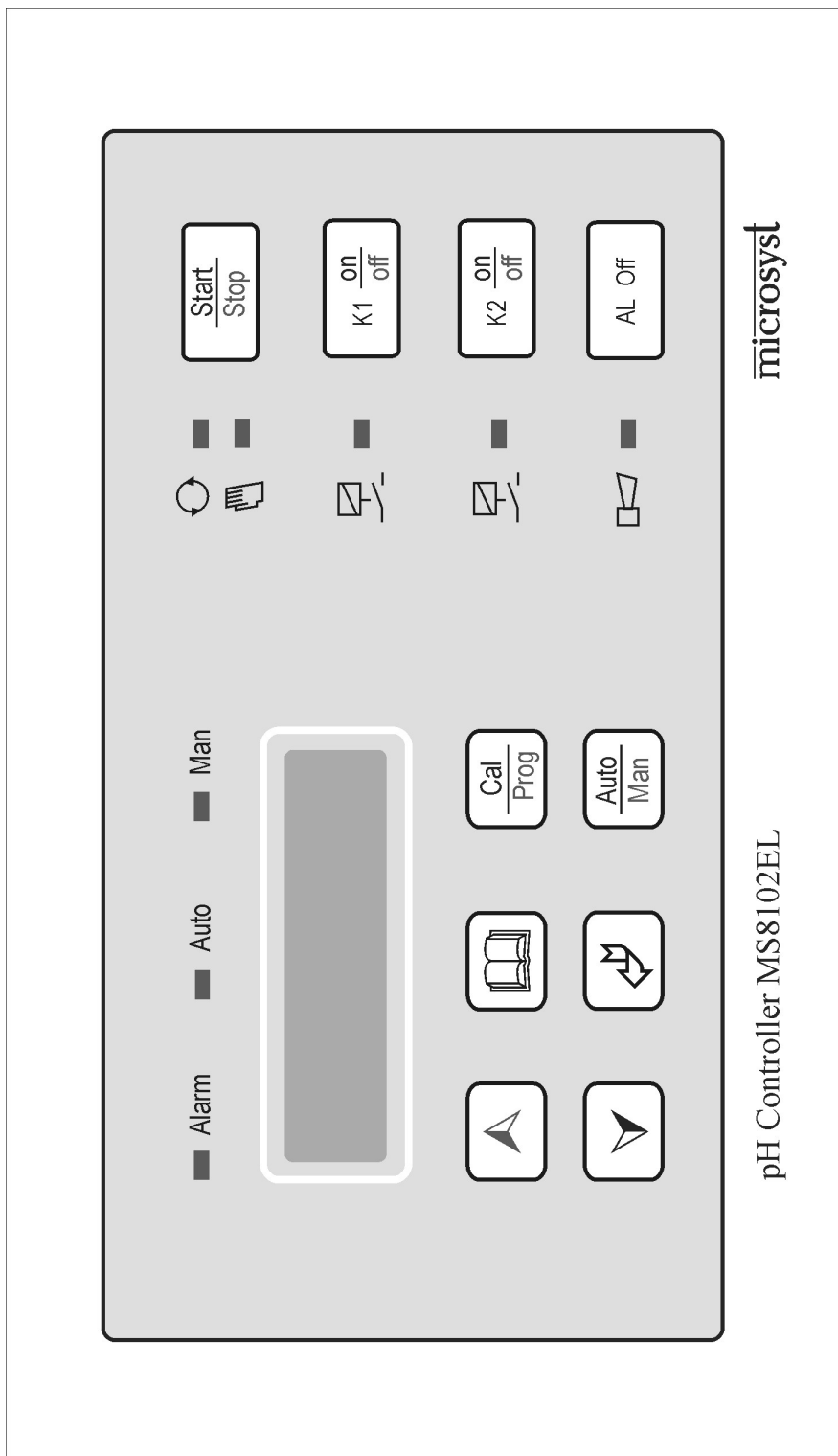
15. Power supplying voltage 220 V $\frac{10}{100}$ %

16. Frequency of the power supplying voltage 50 Hz (± 1 Hz)

17. Operating temperature 0 ÷ 50 °C

18. Operating relative humidity 0 ÷ 80% RH

II. GENERAL APPEARANCE



III. INSTRUCTIONS FOR USAGE

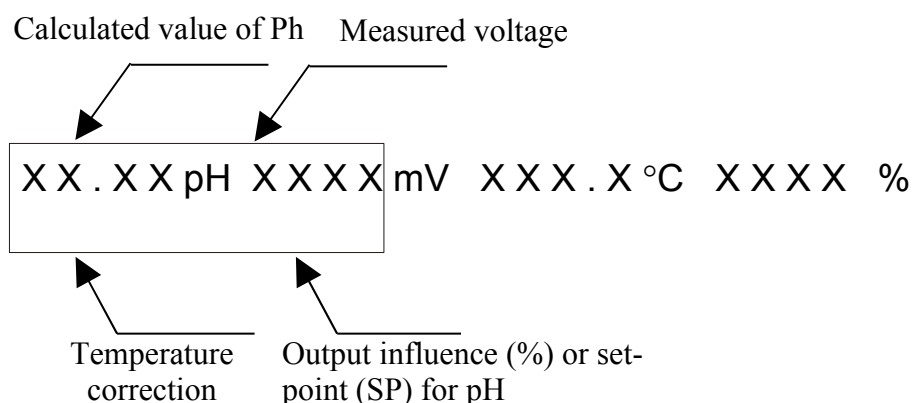
The device is designed for switching in different systems for automatic control of pH. The controller uses PID algorithm of control.

After switching on of the power supply, the controller enters the last operating mode - automatic or manual, direct control of the outputs or not. If the controller is in manual mode, the output influence remains the same as it was before the power fault.

1. LCD indication

The controller has one operating display, and on it three parameters pH, mV and °C and the set-point for control (SP) or the output influence (Out %) are indicated. The indicated temperature can be measured by an outer sensor or set-pointed by the keyboard of the device. The selection of set-point (SP) or output influence (Out %) can be done by

the buttons  and .



2. LED indication

Auto – The controller is in automatic mode and the output influence is calculated automatically

Man – The controller is in manual mode and the output influence is set-pointed by the keyboard

Alarm – Activates when alarm situation appears



- Direct control of the outputs BASE and ACID by the buttons K1 and K2



- Forbidding of the direct control of the outputs BASE and ACID



- Switching on of the respective output



- Forbidding of activation of output Alarm

3. Buttons



- Switching off of the alarm output



- Direct control of the relay outputs



- control of output K1 at switched on 



- control of output K2 at switched on 



- Up



- Automatic/manual mode of control of the outputs



- Down



- Tuning of parameters



- Confirmation



- Calibration

IV. TUNING AND CALIBRATION OF pH

1. Instructions for operation with electrodes and buffer solutions

1.1. General instructions

- 1.1.1. For precise measurement you have to observe all technological rules for correct measurement
- 1.1.2. The storage, the preparation for work and the usage of the electrodes and the buffer solutions is realized according to the requirements of the company producer
- 1.1.3. Before usage the instrument must be tuned to nominal operating conditions, according to the technical data

1.2. Preparation for work

- 1.2.1. The jacks of the temperature and the combined pH electrodes must be switched on to the jacks of the instrument
- 1.2.2. pH electrode must be prepared according to its passport
- 1.2.3. The temperature electrode does not require special preparation

1.3. General instructions for washing of the electrodes

- 1.3.1. The glass membrane and the internal surface of the electrode must be washed well with distilled water
- 1.3.2. The pH electrode must be dried by filter paper ONLY from its outer side. Do not rub the spherical membrane
- 1.3.3. In the measuring container must be poured approximately 5 ml of the next solution for analysis – buffer or sample
- 1.3.4. The electrodes must be dipped in the liquid


- 1.3.5. The solution must be stirred energetically by spinning motion for approximately 10 seconds, so the liquid must wet well the glass membrane
- 1.3.6. After this procedure the pH electrode is prepared for measurement and it must be dipped in the measured solution
- 1.3.7. The electrodes must remain dipped in the liquid for approximately 30 seconds, after that the reading of the data can be realized




* For a new measurement you have to repeat points 3.1. to 3.7.

* It is recommended the washing of the pH electrodes to be realized by special sprayer, loaded with deionized water.

2. Temperature correction





The controller has automatic or manual temperature correction of the value of pH. The device recognizes when the Pt100 sensor is not switched on and automatically passes to mode "Manual temperature correction". On the display it is indicated by flashing symbol "°C". In this status you can adjust the temperature of the analyzed solution.


For tuning of the temperature press and hold the button  for 2 sec.

By pressing  and  you can select the desired value. By  you will pass to the basic menu.

3. Selection of standard of calibration solutions


The device has automatic correction of the values of the calibration buffers of NBS standard (1.68, 3.78, 6.86, 9.18, 12.45 pH). The controller operates with all the rest of the buffers 0.00 ÷ 14.00 pH, but it doesn't correct their values.







To enter the menu press and hold  and  for 2 sec. By  and  you can select **NBS** standard or **Free** – free standard.

By  you will pass to the basic menu.

Attention! Selection of standard of calibration buffers can be done only in manual mode.


4. Correction of the indications in mV and temperature compensation











By pressing  at power supplying you will enter menu for tuning of the offset of the indications for **mV** and temperature.

By the buttons  and  you can correct the offset in the input in mV. By  you will confirm the change and pass to correction of the temperature compensation again by  and . By the button  you will confirm the change and you will pass to the basic display.

Attention! This procedure must be realized in a service. It is not recommended to be done by unauthorized people.


5. Mode "Calibration"

To enter the menu press and hold  for 2 sec. and pass through the following stages:

Stage 1	" LoadBuffer"	Load the first calibration buffer in the measuring vessel, keeping the procedure from point IV.1.3
Stage 2		Confirm to pass to the next stage.
Stage 3	"Buffer XX.XX pH"	The value of the first calibration buffer is on the display. It can be corrected by pressing the buttons  and/ or  .
Stage 4		Confirm to pass to the next stage.
Stage 5*	"T corr. XX.X °C"	The value of the temperature is on the display. It can be corrected by pressing the buttons  and/ or  .
Stage 6*		Confirm to pass to the next stage.
Stage 7	"Wait >>> XXX mV"	Data calculation for the first electrode. The device automatically passes to the next stage of the procedure.
Stage 8	"Change Buffer"	Change of the calibration buffers in the measuring vessel, keeping the procedure from point IV.1.3.
Stage 9		By analogy with stage 2.
Stage 10	"Buffer XX.XX pH"	By analogy with stage 3.
Stage 11		By analogy with stage 4.
Stage 12*	"T corr. XX.X °C"	By analogy with stage 5.
Stage 13*		By analogy with stage 6.
Stage 14	"Wait >>> XXX mV"	Data calculation for the second electrode. The device automatically passes to the next stage of the procedure.
Stage 15	"Wait Compute"	Data calculation. The device automatically passes to the basic mode.

Note:

* When the temperature electrode is switched on – the stages 5,6,12 and 13 are missed.

** In Stage 1 there is a possibility to refuse calibration by pressing a button different from .

Attention! Calibration can be done only in manual mode. In mode calibration the outputs of the controller must be switched off.

6. Determination of the parameters of the electrode system

The methods aim at determination of the coordinate of the isopotential system in mV and of the real temperature coefficient. To do this it is necessary to take down the potentials of the electrode system corresponding to two buffer solutions at two temperatures kept by thermostat.

- Isopotential of the electrode system

$$E_0 = \frac{(E_2 - E_1) \cdot (pH_3 \cdot E_4 + pH_4 \cdot E_3) - (E_4 - E_3) \cdot (pH_1 \cdot E_2 + pH_2 \cdot E_1)}{(pH_4 + pH_3) \cdot (E_2 - E_1) - (pH_2 + pH_1) \cdot (E_4 - E_3)}$$

- Real temperature coefficient

$$F = \frac{[(E_4 - E_3) / (pH_3 - pH_4) - (E_2 - E_3) / (pH_1 - pH_2)]}{(t_2 - t_1)}$$

where,

t1 - value of the first temperature in °C

t2 - value of the second temperature in °C

pH1 - value of the first buffer solution at t1

pH2 - value of the second buffer solution at t1

pH3 - value of the first buffer solution at t2



pH4 - value of the second buffer solution at t2




E1 - potential of the electrode system in mV for pH1 at t1




E2 - potential of the electrode system in mV for pH2 at t1

E3 - potential of the electrode system in mV for pH1 at t2

E4 - potential of the electrode system in mV for pH2 at t2

By pressing  and  for 2 sec. you will enter the menu for tuning of **Eo** and **rtc**.

By  and  you can correct the isopotential of the electrode (**Eo**). By  you will confirm the change and you will pass to correction of the temperature coefficient (**rtc**)


again by  and . By pressing  you will confirm the change and you will pass to the basic display.

Theoretic **rtc** = 1984 (real temperature coefficient)

Theoretic **Eo** = 0.0 (isopotential of the electrode system, mV)

Only for displaying of the values of **rtc** and **Eo** press and hold the button  for 2 sec.

7. Reading of sensitivity and pH of the potential point of the electrode system

For displaying of the values of the sensitivity (SLP) and asymmetry (AST) hold  for 2 sec.

8. Errors

Error may appear after calculation of the sensitivity - SLP and asymmetry - AST of the electrode system, if one of the two parameters is out of the range of their admissible meanings. In this case -- . -- appears on the display and passing from manual to automatic operating mode is not admissible.

Range of the admissible meanings of the sensitivity and asymmetry

$$30.0 < \text{SLP} < 60.0 \text{ mV/pH}$$

$$5.00 < \text{AST} < 9.00 \text{ pH}$$

Probable reasons for appearing of errors:

- Inconformity of the set-pointed value of the calibration buffer and the solution in the measuring vessel.
- Damaged electrode system
- Broken connection of the electrode system

V. TUNING OF THE PARAMETERS AND THE ALGORITHM OF CONTROL

1. Work principle of the PID controller

Sequence






1.1. Linearization

1.2. Check about alarm


- 1.3. Calculation of the error E(n)
- 1.4. Check about dead zone
- 1.5. Calculation of the difference between the set-point and the current value of the input parameter x(n)
- 1.6. Calculation of the integral component, based on the accumulated sum of calculated differences and the coefficient of integration, and limitation in ISum
- 1.7. Calculation of the differential component, based on the previous and the current differences between the set-point and the input parameter and the coefficient of differentiation
- 1.8. Summing of the three components with the offset **Offset** and output formation




$$Out = \frac{1}{Zone} \times \Delta(n) + \frac{1}{Zone} \times \frac{T_0}{T_n} \times \sum_{i=1}^n \Delta(i) + \frac{1}{Zone} \times \frac{T_d}{T_0} \times [\Delta(n) - \Delta(n-1)] + OFFS$$

2. Tuning of set-point and change of the output

Selection of set-point (SP) or output influence (Out %) can be done by the buttons  and . To change the respective parameter press , and by  and  change its value. In automatic mode the output influence is calculated by the controller and it can't be changed by the keyboard.



3. Change of the parameters

To enter the menu for tuning of parameters press and hold the button  for 2 sec.

When changing the parameters the button  is used for confirmation and passing to the next parameter, and by  and  you can change its value.

Name	Description	Values
time cycle	Tact of calculation of the PID algorithm	0 ÷ 255 sec.
time BASE	Time for activity of relay K1 at 100 % calculated or set-pointed output	0 ÷ time cycle
time ACID	Time for activity of relay K2 at 100 % calculated or set-pointed output	0 ÷ time cycle
Proport. band	Proportional band	1 ÷ 99.99 pH
reset	Time constant of integration	0 ÷ 9999 sec.
rate	Time constant of differentiation	0 ÷ 999.9 sec.
ISum Min	Minimum limit of the accumulation of the integral component	-100 ÷ 0 %
ISum Max	Maximum limit of the accumulation of the integral component	0 ÷ 100 %
Offset	Addition of the PID algorithm	-100 ÷ 100 %
dead band	Dead band	0 ÷ 14.00 pH
Alarm Min	Minimum limit of alarm or offset downwards according to the set-point, defining the minimum relative alarm	0 ÷ 14.00 pH
Alarm Max	Maximum limit of alarm or offset upwards according to the set-point, defining the maximum relative alarm	0 ÷ 14.00 pH

4. System parameters

The change of system parameters is possible after entering menu for tuning by holding of  and  for 2 sec. They appear at the end of the table with standard parameters.

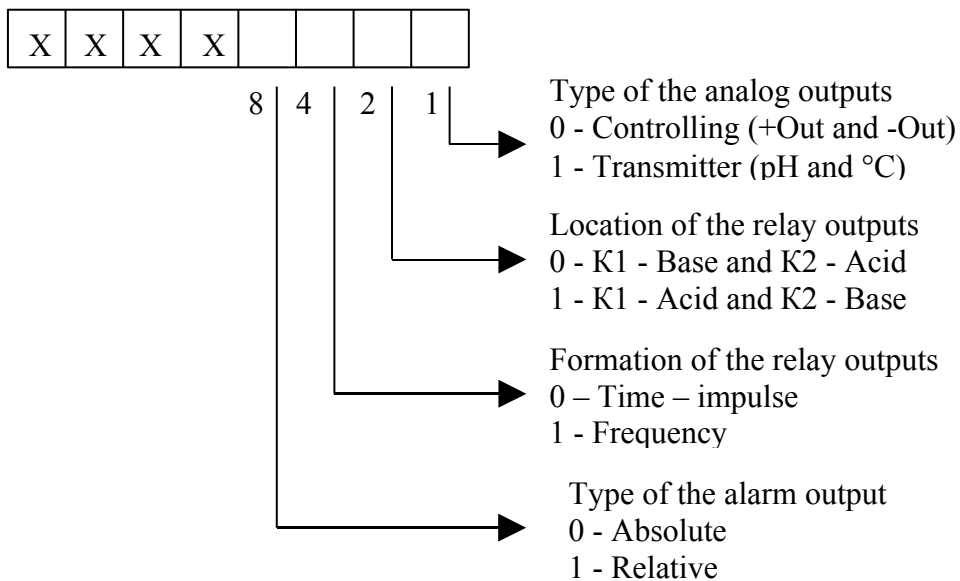
Name	Description	Values
Alarm t	Time delay of activation of alarm	0 ÷ 80 sec.
Filter 1	Coefficient of the filter of the input for mV. The smaller is the value, the deeper is the filter	0.01 ÷ 1.00
Jump 1	Value of change of the input signal (jump), causing clearing of the filter of the channel	0 ÷ 255 mV
tJump 1	Time to wait, at jump of the input parameter before clearing of the filter	0 ÷ 255 sec. * 0.5
Filter 2	Coefficient of the filter of the input for °C. The smaller is the value, the deeper is the filter	0.01 ÷ 1.00
Jump 2	Value of change of the input signal (jump), causing clearing of the filter of the channel	0 ÷ 255 °C
tJump 2	Time to wait, at jump of the input parameter before clearing of the filter	0 ÷ 255 sec. * 0.5
AOut 1	Multiplying coefficient for analog output 1 (+Out or pH)	-10000 ÷ 10000
AOut 2	Offset coefficient for analog output 1 (+Out or pH)	-10000 ÷ 10000
BOut 1	Multiplying coefficient for analog output 1 (-Out or °C)	-10000 ÷ 10000
BOut 2	Offset coefficient for analog output 1 (-Out or °C)	-10000 ÷ 10000
Freq Max	Maximum number of impulses for 1 minute (at 100% Out)	1 ÷ 3000 imp/min
Freq High	Impulse duration (1)	1 ÷ 255 ms * 10
Syst Word	System configuration word (2)	0 ÷ 15

Notes:

1) If the value **Freq High** is set-pointed bigger than the minimum period (60/Fr), it is corrected automatically to the biggest possible value.

When using frequency-impulse output **time BASE** and **time ACID** are not taken into consideration.

2) Definition of the bits in the system word:



Attention! Tuning of the parameters can be done only in manual mode.

Bulgaria, 4000 Plovdiv, 4 Murgash str.

Tel.: (+359 32) 430 019, 640 446 Fax: (+359 32) 640 446, 634 117

www.microsyst.net e-mail: info@microsyst.net