Microprocessor-based
Timer Temperature controller

MS8109TU

TECHNICAL DESCRIPTION AND INSTRUCTIONS FOR USAGE

PLOVDIV 2003

I. TECHNICAL DATA

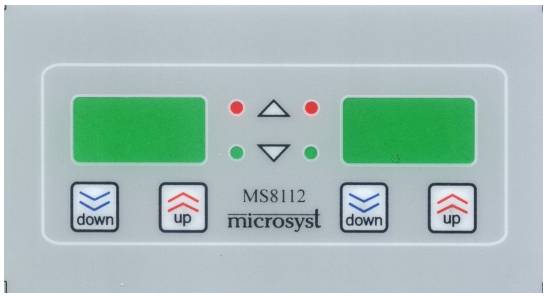
Analog inputs	1
RTD Sensor	Pt 100
Thermocouple	J, K, S …
Linear – voltage, current	0…5 (10) V; 0 (4) … 20 mA
Digital input	1
Start of the timer	TTL active 0
Outputs	3
K1 – ON / OFF or PWM	Relay 250 V / 5,10 A or OK for TTL
K2 – Timer	Relay 250 V / 5,10 A
K3 – Alarm	Relay 250 V / 5,10 A
Options	Triac 250 V / 2 A; Relay 250 V/ 5,10 A OK for TTL or SSR 250 V/ 10,20,40 A
Indication and keypad	
Display	2 x 3 digits LED 10 mm
Range of the display	0 … 999
Accuracy	± 1 LSB
Format of the display	X.XX XX.X XXX
Keypad	Four membrane keys
Power supply	
Power supplying voltage	220 V / max 20 mA
Frequency of the power supplying voltage	50 Hz (± 1 Hz)
Operating conditions	
Operating temperature	0 … 50 °C
Operating relative humidity	0 … 80 % RH
Dimensions	
Overall dimensions (WxHxL)	96 x 48 x 128 mm
Installation	Panel in hole 90 x 44 mm
Weight	max 300 g
Degree of protection	IP40
Storage	
Storage Temperature	-10 … 70 °C
Storage Relative humidity	0 … 95 % RH

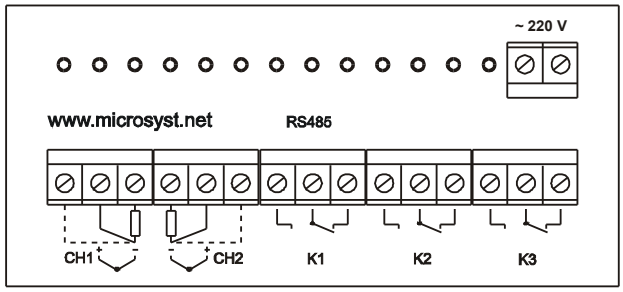
II. DESIGNATION

The model **MS8109TU** is designed for controlling of one process parameter (temperature) and one timer block. The temperature channel and the timer block work independently or with a connection between them. The timer can work in different formats of the time – 99.9 seconds, 999 seconds or 999 minutes.

MS8109TU has one analog input and three discrete outputs. The outputs can be – one controlling, one alarm and one controlled by the built-in timer block. The controller can realize ON/OFF or proportional algorithm of controlling (program selectable). The output is controlled respectively by logic ON/OFF or by pulse width modulation (PWM).

III. FRONT AND BACK PANEL





IV. CONNECTION OF INPUT-START TIMER

The start of the timer can be done by button, connected as it is shown on fig.1.

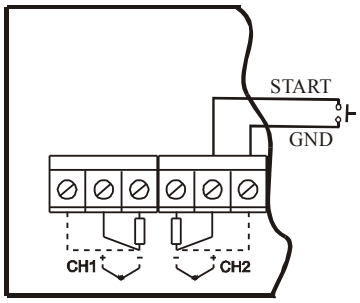


Fig. 1

V. CONNECTION OF TEMPERATURE SENSORS AND TRANSMITTERS

For the correctness of the work it is important the probe to be installed at a suitable place in the environment, in which the temperature will be controlled. When it is installed in a hole, it is good a seal, which improve the heat release, to be used.

1. Connection of resistive sensor (Pt100 or other)

The sensor can be connected by two-wire or three-wire line. The connection of two-wire sensor with three-wire line can be done as it is shown on fig. 2, and between terminals 1 and 2 of the controller cable jumper must be obligingly put.

When the distances between sensor and controller are bigger it is recommended a three-wire line to be used, because the error in measurement of the temperature, made by the added resistance of the connecting wires, is compensated with it. The connection of three-wire sensor with the controller can be done as it is shown on fig. 3, and with terminals 1 and 2 of the controller are connected the shortly connected cables in the sensor.

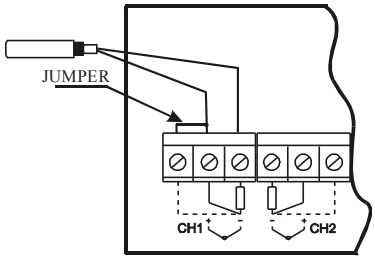


Fig. 2

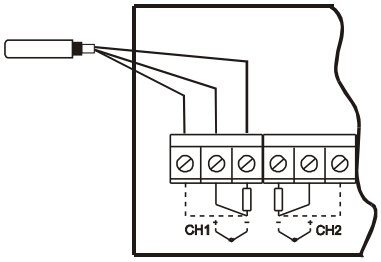


Fig. 3

2. Connection of thermocouple

When a sensor – thermocouple is connected, we have to pay attention to the polarity of the sensor. When the polarity is not right the indications of the instrument will be incorrect.

When you work with thermocouples you have to use a compensating cable, suitable for the kind of the used thermocouple (fig. 4).

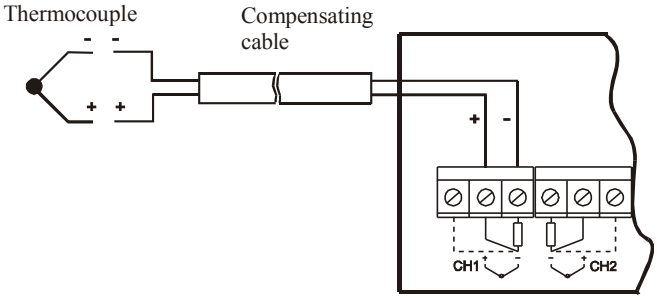


Fig. 4

3. Connection of transmitter

1) Transmitter with two-wire switching on (loop power)

The power for the transmitter is supplied by the instrument.

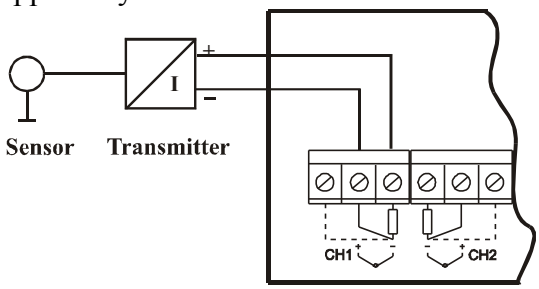


Fig. 5

***** The instrument provides voltage from 11,5V to 14,5V / max 50mA which is not stable.

2) Transmitter with own power supply

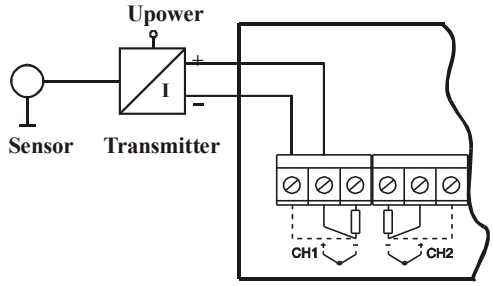


Fig. 6

3) Three-wire transmitter power supplied by the instrument

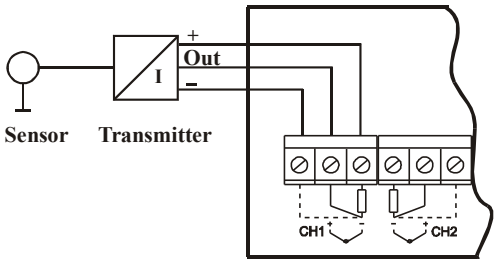


Fig. 7

***** The instrument provides voltage from 11,5V to 14,5V / max 50mA which is not stable.

VI. CONNECTION OF THE OUTPUTS OF THE CONTROLLER

When the outputs are realized by relays, in parallel with the contacts of the relays there are RC groups for higher noise immunity. *Minimal current flows in trough* the opened contact of the relay in an AC circuit. The connection of an output of the controller, when it is type SSR, with the charge can be done as it is shown on fig. 8.

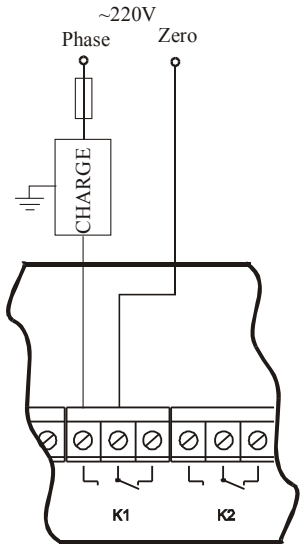


Fig. 8

VII. WORK PRINCIPLE

Basic parameters used in the instrument:

SP -set-point for controlling of temperature
SPt -set-point of the timer section
ε -proportional band or hysteresis *(when the value of the parameter is positive – logic heating, when it is negative – logic cooling)*
PV -input parameter
H -higher limit of the alarm
L -lower limit of the alarm
P -period of PWM = ti+tp *(at 0 – ON/OFF algorithm of controlling)*
ti -time for impulse at PWM controlling
tp -time for pause at PWM

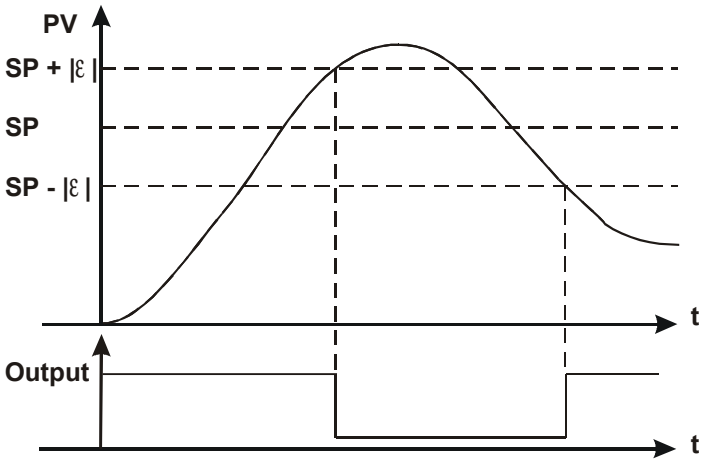


Fig. 9

On Fig. 9 is shown the principle operation of a 2 ON/OFF controller with output logic "heating" (**ε**>0).

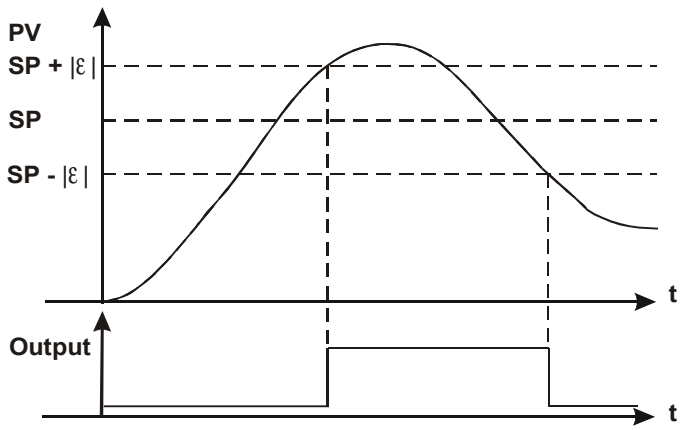


Fig. 10

On Fig. 10 is shown the principle operation of a 2 ON/OFF controller with output logic "cooling" (**ε**<0).

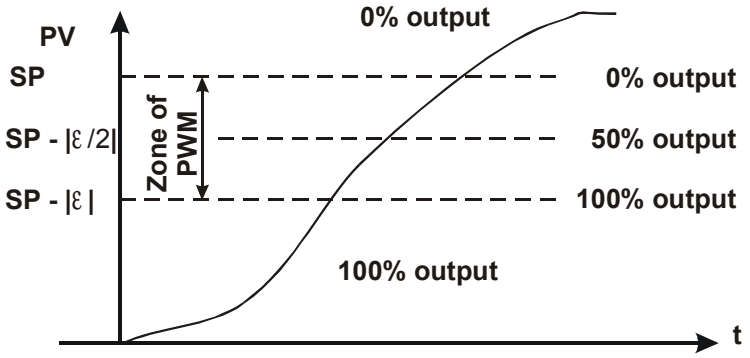


Fig. 11

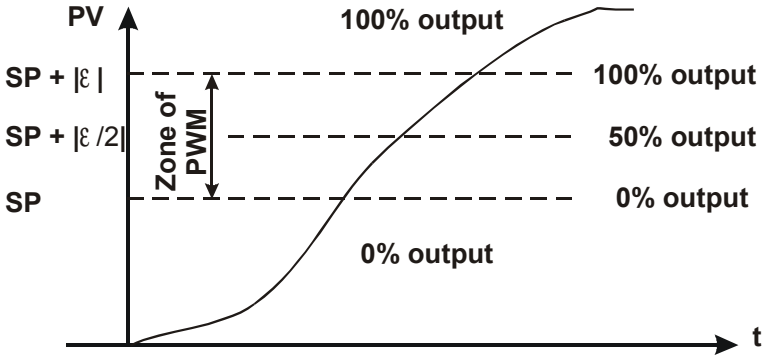


Fig. 12

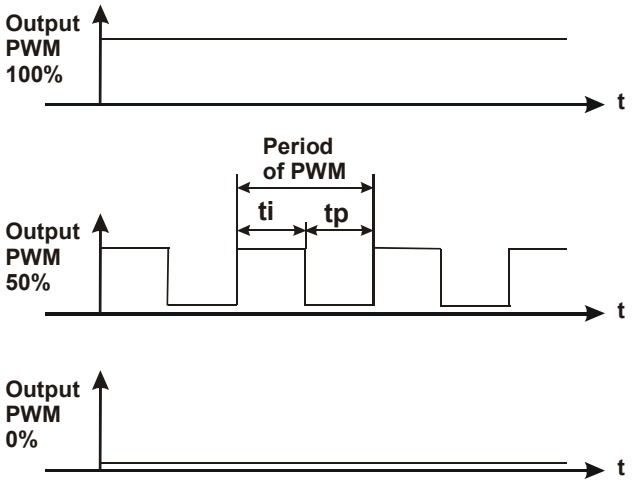


Fig. 13

On Fig. 11 is shown the principle operation of controller with PWM output logic "heating" (**ε**>0), and on Fig. 12 – the principle operation of controller with PWM output with logic "cooling" (**ε**<0). On Fig. 13 is shown the principle operation of PWM output. At 50% PWM output ti=tp.

For changing the logic of work of the controller to logic "cooling" you have to make negative the parameter ε.

VIII. OPERATING MODE

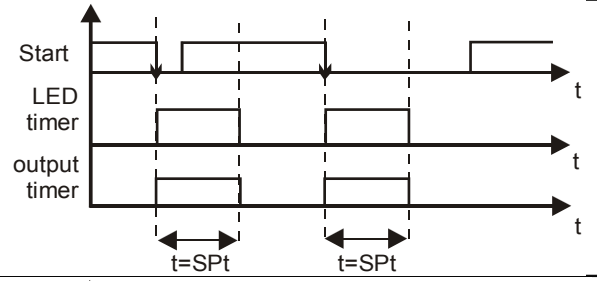
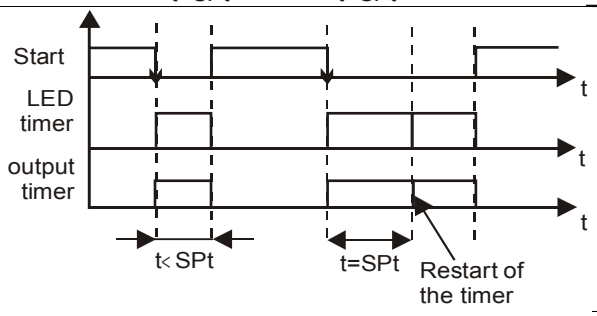
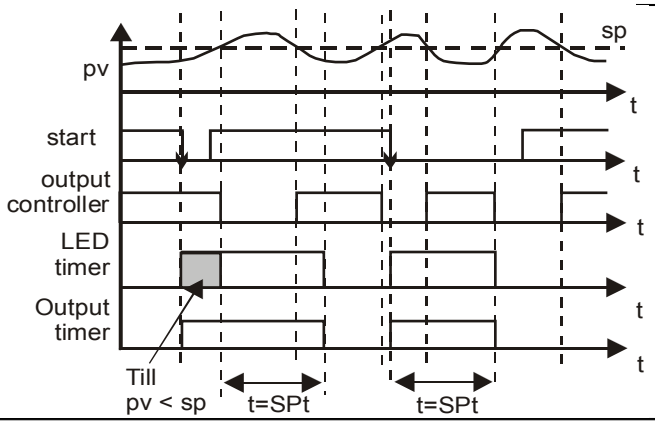
In operating mode on the left display is read the value of the temperature channel, on the right – the indication of the timer (if it is not tuned to be hidden see p.IX.2). The left red LED indicates if the output of the temperature channel is active. The right red LED indicates if the output of the timer section is active.

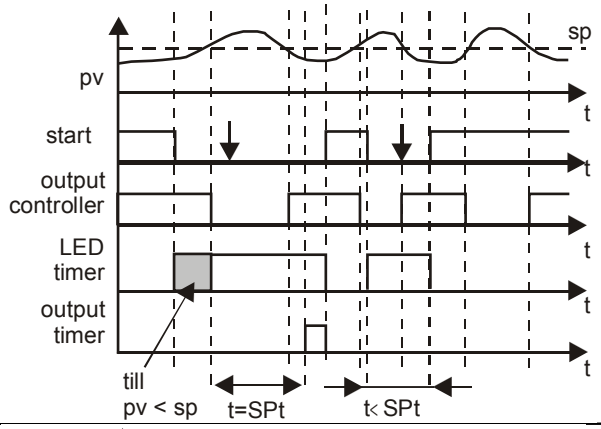
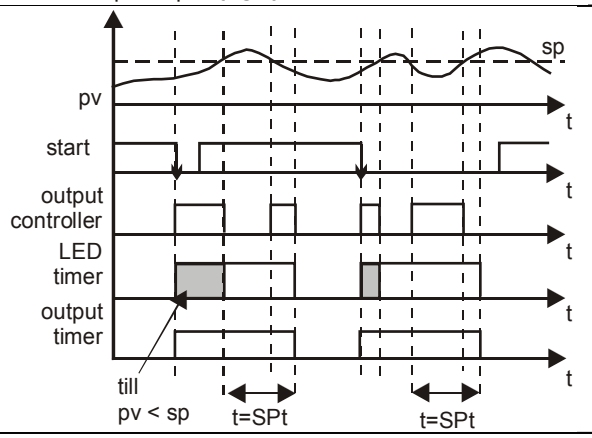
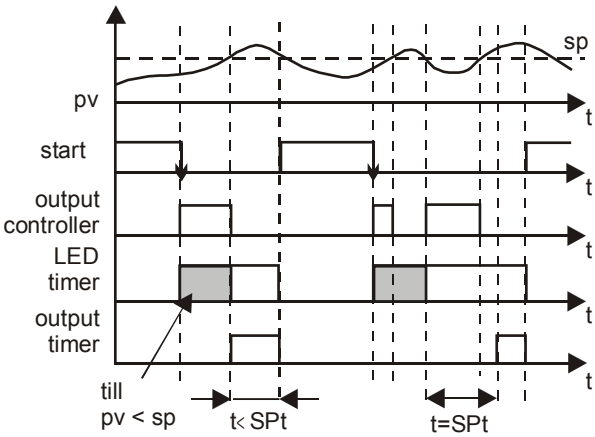
When the value of the temperature is bigger than (or less than) the higher (lower) limit of the alarm, it activates and on the display for the channel a message "**ALL**" starts appearing periodically.

The timer section works independently or by reciprocal connection with the temperature channel and its operating mode depends on the schemes described below. The output of the timer is active till the time is up.

1. Operating mode and start of the timer

The operating mode of the timer depends on the value of the parameter **tm**.

Graphics	Description
	1 - Start by edge. The output of the timer is switched on while it counting off. The temperature channel controls independently on the timer.
	2 – Start by edge. The output of the timer is switched on while it is counting off. The temperature channel is controlling independently on the timer. If after the end of counting, the input is in active level, the timer restarts.
	3 - Start by edge, but the timer starts counting after **PV>SP-H**. The situation, **PV<SP-H** after start, is indicated by flashing of the timer LED. The output of the timer is activated by the start and stays active till the set-pointed time is up. The temperature channel is controlling independently on the timer.

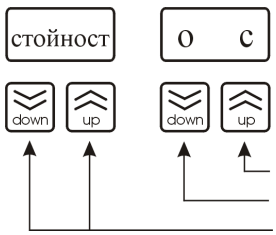
	4 – Start by level, but the timer starts counting after **PV>SP-H**. The situation while **PV<SP-H** is indicated by flashing of the timer LED. The output of the timer is activated after counting off, till there is an active level of the input ("**End**" is flashing on the display of the timer). Each change of the input in inactive level is a reason for stop of the timer and end (during the counting). The temperature channel is controlling independently on the timer.
	5 – As in operating mode **3**, but the temperature channel controls (controls output) after the timer has been started, till the end of the counting. Start by edge, but the timer starts counting after **PV>SP-H**. The situation, **PV<SP-H** after start, is indicated by flashing of the timer LED. The output of the timer is activated by the start and stays active till the set-pointed time is up.
	6 - As in operating mode **4**, but the temperature channel is controlling (controls output) after the timer has been started, till the end of the counting. Start by level, but the timer starts counting after **PV>SP-H**. The situation while **PV<SP-H** is indicated by flashing of the timer LED. The output of the timer is activated after counting off, till there is an active level of the input ("**End**" is flashing on the display of the timer). Each change of the input in inactive level is a reason for stop of the timer and end (during the counting).

Note – In operating mode 3, 4, 5 and 6 on the graphics the activation of the timer is shown at parameter H = 0, an so there is a change of the condition for start of the timer from"PV > SP – H" to "PV > SP"

IX. LEVELS OF PROGRAMMING

Principle operation of the keypad:

- When there is a symbol (parameter) on the display, the button under the symbol selects its editing
- When on the display there is the number written by the buttons under it the value is changed, and by the buttons under the symbols "**o**" and "**c**" this value can be confirmed or refused.



Display

Buttons

Return back without confirmation of the changes
Confirmation (OK)
Change of the value of the parameter

1. User level

Display temperature and timer

Set-point1 (SP) for the temperature channel appears on the left display, and *Set-point2* (SPt) for the timer block appears on the right display. When the button is released the instrument returns to normal operating mode, where the parameter, which is read at the moment, appears on the display.

Tuning of the set-point of the temperature channel

The buttons must be pressed at one and the same time and the set-point appears and starts flashing on the left display. Its value can be changed by the same buttons and the display stops flashing. If you don't press any button in 5 seconds, till the value flashes on the display or a new value is already set-pointed, the new set-point is saved and the instrument returns to operating mode. (-199 ÷ 999°C)

Tuning of the set-point of the timer channel

The buttons must be pressed at one and the same time and the set-point appears and starts flashing on the right display. The value of the SPt can be changed by the same buttons and the display stops flashing. If you don't press any button in 5 seconds, till the value flashes on the display or a new value is already set-pointed, it returns to operating mode. **If the timer works while its set-point is changing, the new set-point comes into effect at the next start of the timer.** (1 ÷ 999)*

Software RESET of the timer

Software RESET of the timer can be realized at any time by the pressing of these buttons. Symbols for restart "---" must appear on the display of the timer.

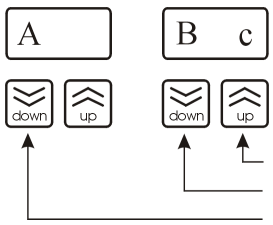
***** The format of the time depends on the tunings of the system parameter "P".

2. Level "system parameters"

Enter operating mode – tuning of system parameters

Hold the buttons 3 seconds, after that the main menu for programming appears on the both displays.

1) Main menu

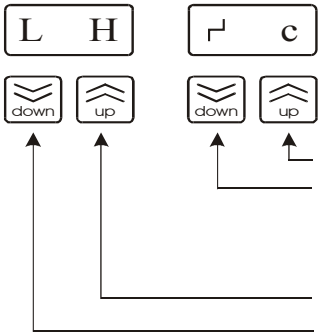


Display

Buttons

Return to operating mode
Parameters for tuning of the timer
Parameters for temperature channel

2) Menu for selection of parameters for temperature channel

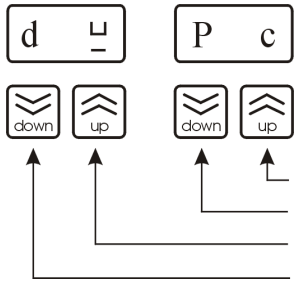


Display

Buttons

Return to main menu
ε - proportional band or hysteresis at **ε**>0 logic "heating", **ε**<0 logic "cooling"(-199 ÷ 999°C)
Higher limit of the alarm (-199 ÷ 999)*
Lower limit of the alarm (-199 ÷ 999)*

3) Menu for selection of parameters for tuning on timer



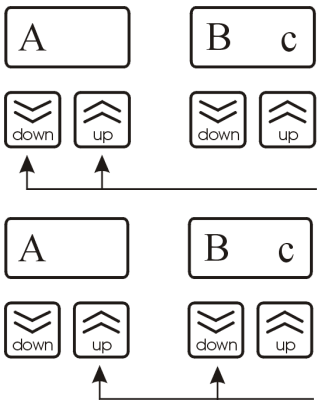
Display

Buttons

Return to main menu
Format of the time of the timer (1 ÷ 3)*
Operating mode and start of the timer (1 ÷ 6)**
Display the set-point of the timer ***

* The following formats are valid:
1 – 99.9 seconds
2 – 999 seconds
3 – 999 minutes
** for the different operating mode see p.VII
*** The following values are valid:
0 – The set-point is displayed
1 – The set-point is not displayed. Only the current value at counting appears on the timer display.

X. LEVEL "service parameters"



Display

Buttons

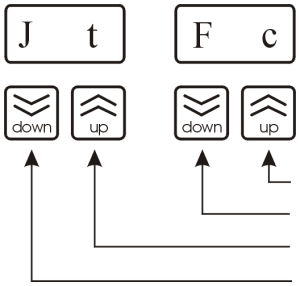
Tuning of the parameters of the filter of the temperature channel

Display

Buttons

Tuning of the period of PWM and shift in comparison with the set-point

1) Menu for selection of parameters for the filter



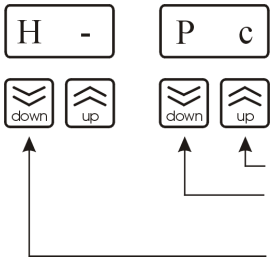
Display

Buttons

Return to main menu
Coefficient of the filter (1 ÷ 128)*
Time for jump of the filter (1 ÷ 255sec.)
Jump of the filter (1 ÷ 255°C)

* The smaller is the value of the coefficient, the heavier is the filter.

2) Menu for selection of parameters for period of PWM and shift in comparison with the set-point



Display

Buttons

Return to main menu
Period of PWM of the temperature channel (1 ÷ 255 *0,5sec.)*
Shift in comparison with the set-point of the temperature channel (1÷255°C)**

***** At setting of value "0" the temperature channel passes into ON/OFF algorithm of controlling and the parameter **ε** is hysteresis. In the other cases **ε** is proportional band.

****** It is used in operating mode 3,4,5 and 6 of the Timer. The comparison for the start of the counting of the timer is realized at the condition PV > (SP-H).

XI. USER TUNING OF THE OFFSET OF THE TEMPERATURE CHANNEL

In this operating mode, the users can input freely programmable coefficient, which will be added always at the measuring of the channel (the so called "offset"). This operation must be realized with a great attention, because the instrument is tuned by the factory. The measuring can be realized indirectly.

Operating mode "offset"

To enter this operating mode, press the button at the supply of the power of the instrument. During the period of time in which you are pressing the button an inscription "**OFFSEt"** appears on the display. After releasing the button, the controller passes into normal operating mode.

The set-point of every offset can be realized in the way, in which the tuning of the set point for controlling (**SP**) of every channel in normal operating mode can be realized (see VIII.1). The value, which is set up, is more precise than the measured parameter with one digit. **At entry in editing you always have to specify value 0, i. e. the current value of the channel on the display is accepted as basic.**

EXAMPLES FOR USER TUNING

1. Indication on display: 129
2. Input coefficient: 3.4
3. New indication on display: 132
4. Input coefficient: 0.6
5. New indication on display: 133
6. Input coefficient: -1.0
7. New indication on display: 132

XII. MEASURES AGAINST INTERFERENCE

1. Recommendations for usage of connecting conductors

- Conductors, which carry signals close by type, can be packed together, but if the signals are different, the conductors have to be separated for to be prevented from capacitive and inductive interaction.

- When signals have to be crossed with different by type signals, this have to be done at right angles and maximum distance.

- Conductors, which carry weak signals and conductors which connect the sensors with the controller must not be near contactors, motors, generators, radio transmitters and conductors which carry big currents, which are switched on and off.

2. Limiting of the noise by using of the built-in filter

- If the input parameter is not stable you have to reduce the coefficient of the filter **F.** The smaller is the value of the coefficient of the filter, the heavier is the filter and the input parameter changes more slowly.

- If the input parameter overshoots periodically for short intervals of time, it is necessary the parameter "time for overshoot of the filter" **t** to be increased. At increase of that parameter the instrument responds more slowly at sharp change of the input parameter, but it ignores the brief interferences.