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TEMPERATURE CONTROLLER

R - 703

USER'S GUIDE

List of contents

1.Temperature controller characteristics

R-703 type temperature controller is a general-purpose single-channel microprocessor unit that performs followings features:

- Its input to be easily adapted to all most often applied types thermocouples and thermoresistors
- PID or hysteresis control algorithm is to be selected by the user
- A relay is operated by five programmable modes
- Double four digit LED-display and supplementary two lamps of relays states
- High power output relay or output for SSR ;
- Sygnalization of sensor damaged

2.Connection diagram

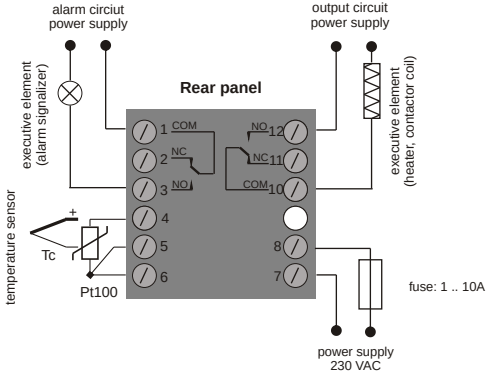
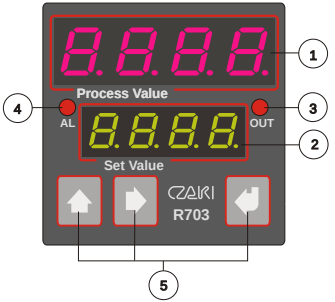


Fig. 1 Controller wiring

3. Front panel description

Controller R-703 has double display and three push-button keyboard placed on the temperature controller front wall. Appearance of the front panel is show in the figue below:

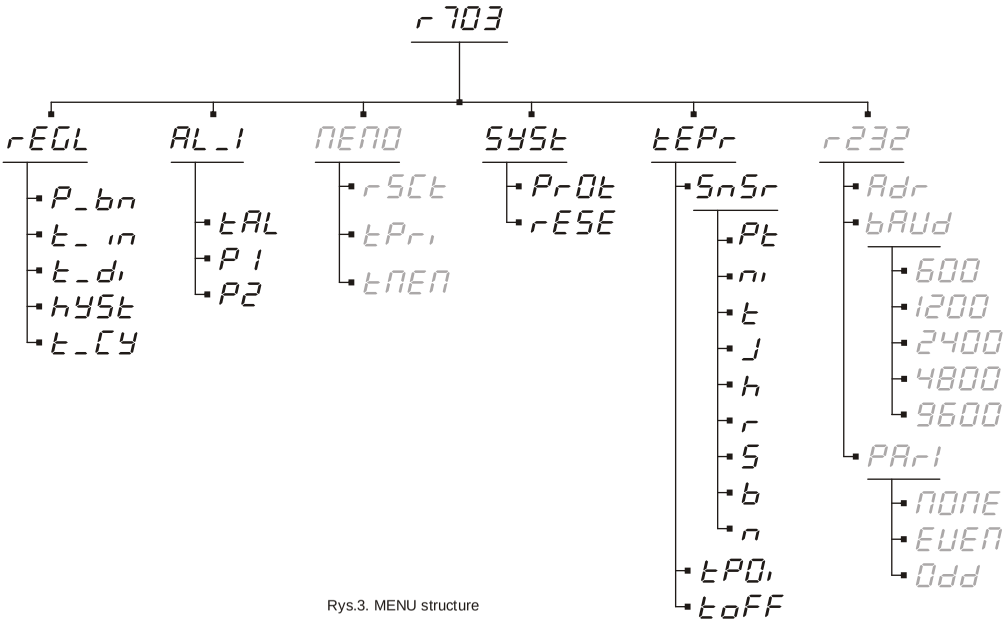


1 - process temperature display (PV)
2 - set temperatue display (SV)
3 - output indicator
4 - alarm indicator
5 - keyboard

Fig. 2 Wiew of front wall

Key	Controller work mode	Action
Up 	1. NORMAL mode, holding time >3s. 2. MENUmode: - during moving at menu structure - during changing parameter value	- enter to MENU mode - back off about one level in MENU structure - increment about one parameter value
Shift 	1. NORMAL mode, holding time >3s. 2. MENUmode: - during moving at menu structure - during changing parameter value	- modify set temperature (SV) - rewrap next MENU positions - change of modified figure
Enter 	1. NORMAL mode 2. MENU mode	- change displayed value between SV or PWM - confirm choose

Tab. 1 Key functions.



Rys.3. MENU structure

List of parameters and their symbols.

Symbol on display		Range of value	Factory settings	Meaning /sign in manual text
rEGL	P_bn	0.0 ... ! ÜêÀ	^Xâa	proportional gain/ P_bn
	t_in	0 ... 1000 [s]	1000 [s]	integral time / t_in
	t_di	0 ... 9.99 [s]	0 [s]	derative time / t_di
	HYSt	0.0 ... 100.0 [°C]	1.0 [°C]	hysteresis / hyst
	Cy_t	0 ... 240 [s]	10 [s]	okres impulsowania / cy_t
AL_1	tAL	0 ...	0	alarm mode / tal
	P1	-99.9 ... 1800 [°C]	2 [°C]	first level / P1
	P2	-99.9 ... 1800 [°C]	4 [°C]	second level / P2
MEMO	rSCt	ES ns/ Ä'	10 [s]	read period /rSCt
	tPrI	ES ,	0	read results / tPrI
	tNEN	ES ,	0	save results / tNEN
SYSt	PrOt	0 ... ,	0	protection / PrOt
	rESE	0, 1	0	reset / rESE
tEPr	SnSr	T,J,K,R,S,B,N, Pt100,Ni100	K	sensor type / SnSr
	tPOi	0, 1	0	resolution / tPOi
	toFF	-9.9 ... 9.9 [°C]	0.0 [°C]	offset / toFF
r232	Adr	ES , ¾	1	meter address / adres
	bAUd	1200,2400, 4800,9600	2400	speed of serial transmision / bAUd
	PArI	Even,odd,none	none	parity of serial transmision / PArI

Tab. 2

Attention! *Parameters in gray background can be modidying only in |SPEC mode. Also grayed parameters (conected with serial port) are not implemented in controller R-703.*

4. Modes of work

Controller R-703 can work in two modes:

1. **NORMAL** - controller executes all charged control and alarm functions. Upper display show measured temerature, and bottom show (despide of choose) set temperature (SV) or average power (PWM) expressed in percentages.

2. **SPEC** - realized all functions mode NORMAL and also it makes possible modifying parameters at grey background at table 1.
   To enter SPEC mode turn off the unit and next press  button and still pressing that key turned on the unit. Key must be pressed until unit enters to menu.

R-703 offers following types of algorithms:

On/Off with hysteresis, P, PI, PID

Choice between algorithms users makes by setting parameters like in table 2.

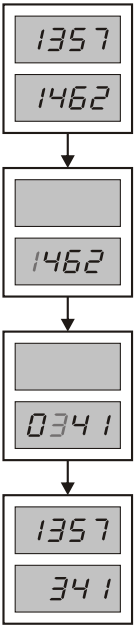
Type of controller	P_bn	t_in	t_di	HYSt
On/Off	0	-/-	-/-	= 0
On/Off with hysteresis	= 0	-/-	-/-	0
P	‹0	= 0	= 0	-/-
PI	0	ˆ0	= 0	-/-
PID	‰	\0	X0	-/-

Tab. 3

5.1. Setting the value of temperature set.

Value of temperature set can be setting only in NORMAL mode.

The folowing diagram shows action how to change temperature set.



Press and hold about 3 second key.

Upper display will be turned off, and the bottom will show actual temperature set with flashing figure.

Value of flashing figure are incremented by pressing key

To change figure to modify press

To confirm press key

After confirm controller going back to normal work.

5. Algorithms of control

5.1 Algorithm On/Off type and On/Off with hysteresis.

This algorithm is the simplest type of controlller without correction.It means, that output signal may heve two values only 0 or 100%.

As it is easy to notice, object temperature (see fig. under) oscillates around temperature set with hysteresis.

Controller with hysteresis is suitable for the objects with small interference influence. In case of the object with high delay values, is accompanied with overshoot.

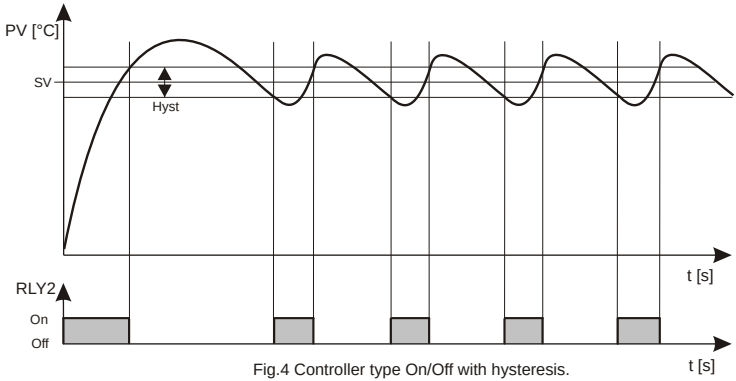
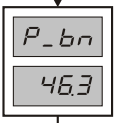


Fig.4 Controller type On/Off with hysteresis.

5.1.1. The choice of algorithm On/Off.

Press and hold about 3 second key.

Press the key



Upper display will show flashing P_bn symbol, and bottom its value. To modify value press key .

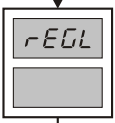
After that, modifying value will be flashing.

Value of flashing figure are incremented by pressing the key

To change figure to modify press

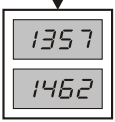
To confirm press .

After confirm flashing value stops, and start flashing parameters name.



We move about one level higer in structure of menu across press the key

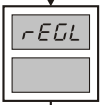
At this time it is possible to exit menu or choose another parameter to modify.



Back to normal controllers work are realized by pressing the key

6.1.2. Setting hysteresis value.

Press and hold about 3 second key.



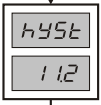
Press the key

Upper display will show flashing P_bn symbol, and bottom its value. To select hysteresis press three times

And then confirm by pressing

Upper display will show flashing hysteresis symbol, and bottom its value. To modify value press the key .

After that, modifying value will be flashing.

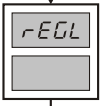


Value of flashing figure are incremented by pressing the key

To change figure to modify press

To confirm press .

After confirm flashing value stops, and start flashing parameters name.



We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

5.2 Algorithm P, PI, PID

Temperature control basing on quasi-linear algorithm proportional (P) integral (I) and Derative (D) makes possible:

* selection of characteristics of reaching the temperature set by selection of three parameters
* easy control of properties of the line object-controller
* elimination static error
* smaller interference influence

Gain (P_bn).

Proportional gain (P_bn) in a basic parameter of PID algorithm, it affects in equal degree on all parameters of control algorithm. In case of R-703 controller proportional amplification is expressed in percentages of temperature range (individual for each sensor type).

Increase of proportional amplification increase sensivity to temperature changes of the object and narrow the linear zone of controller's work.

Integral time-constant (t_in).

The integral element eliminates static component error. Incresase of t_in parameter slows down the process of reaching the steady state (SV) of object temperature (PV).

Derivative time-constant (t_di).

The derivative element influences on value of average power between sampling of temperature. If temperature grows up, then derativatve element reduces power, the growth temperature slows down. If value of temperature falls down, derivative element increases heater power. Influence of derivative upon heater power is the higer, the higer is the value of derivative time t_di.

This parameter should be used with fast-changed object, where immediate reaction is requied on appearing changes.

Pulse repetition period (cy_t).

Value cy_t should be several times shorter than object time-constant. Too small value of this paramater can shorten the time of life relay contacts.

EXAMPLE

temperature set(SV) = 400.0 °C
temperature measured(PV) = 310.0 °C
amplification(P_bn) = 10.0
integral element(t_in) = 0 s
derivative element(t_di) = 0 s
pulse repetition period(CY_t) = 10 s
Tmax. = 1800 °C

proportional range(PR) = (1/P_bn) x Tmax.
PR = 0.1 x 1800 °C = 180 °C

linear work range:

LW = (SV - PR)

LW = (400.0 - 180.0) = 220.0 °C

PWM value for PV = 310.0 °C

$$PWM = \frac{SV - PV}{PR} \times 100\ \%$$

$$PWM = \frac{400.0 - 310.0}{180.0} \times 100.0\ \%$$

PWM = 50.0 %

time of relay on t_on:

t_on =CY_t * PWM
t_on = 10s * 50.0 %
t_on = 5.0 s

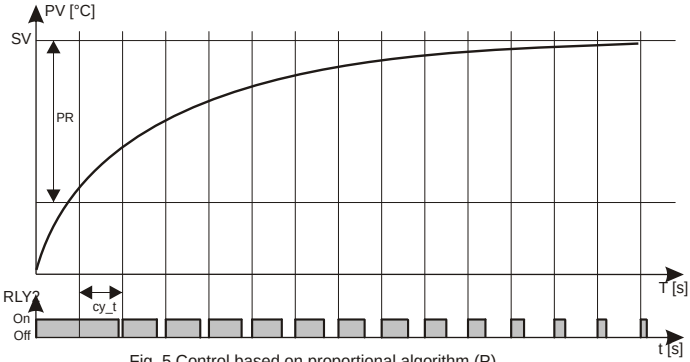
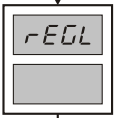


Fig. 5 Control based on proportional algorithm (P)

5.2.1. Setting proportional gain (P_bn).

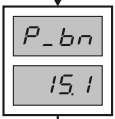
Press and hold about 3 second key.



Press the key

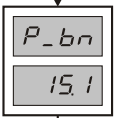
Upper display will show flashing P_bn symbol, and bottom its value. To modify value press key .

After that, modifying value will be flashing.



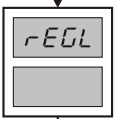
Value of flashing figure are incremented by pressing the key

To change figure to modify press



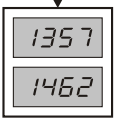
To confirm press .

After confirm flashing value stops, and start flashing parameters name.



We move about one level higer in structure of menu across press the key

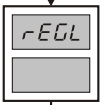
At this time it is possible to exit menu or choose another parameter to modify.



Back to normal controllers work are realized by pressing the key

5.2.2. Setting integral time-constant value (t_in).

Press and hold about 3 second key.



Press the key

Upper display will show flashing P_bn symbol, and bottom its value. To select integral time press the key

And then confirm by pressing

Upper display will show flashing integral time symbol, and bottom its value. To modify value press the key .

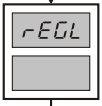
After that, modifying value will be flashing.

Value of flashing figure are incremented by pressing the key

To change figure to modify press

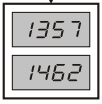
To confirm press .

After confirm flashing value stops, and start flashing parameters name.



We move about one level higer in structure of menu across press the key

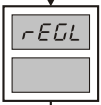
At this time it is possible to exit menu or choose another parameter to modify.



Back to normal controllers work are realized by pressing the key

5.2.3. Setting derivative time-constant value (t_di).

Press and hold about 3 second key.



Press the key

Upper display will show flashing derivative time symbol, and bottom its value.To select hysteresis press two times

And then confirm by pressing

Upper display will show flashing derivative time symbol, and bottom its value. To modify value press

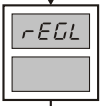
After that, modifying value will be flashing.

Value of flashing figure are incremented by pressing the key

To change figure to modify press

To confirm press .

After confirm flashing value stops, and start flashing parameters name.



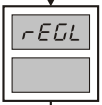
We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

5.2.4. Setting pulse repetition period value (CY_t).

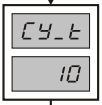
Press and hold about 3 second key.



Press the key

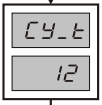
Upper display will show flashing P_bn symbol, and bottom its value. To select period value press three times

And then confirm by pressing



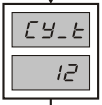
Upper display will show flashing period value symbol, and bottom its value. To modify value press the key .

After that, modifying value will be flashing.



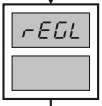
Value of flashing figure are incremented by pressing the key

To change figure to modify press



To confirm press .

After confirm flashing value stops, and start flashing parameters name.



We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

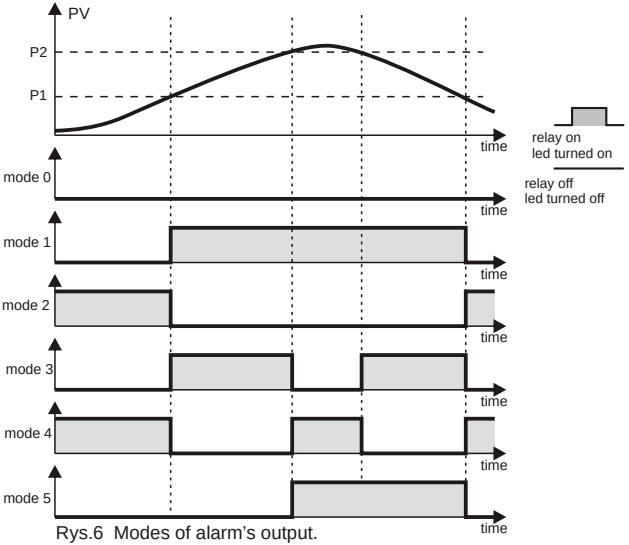
6. Alarm

The R-703 controller is equiped with level alarm, wich can work in one of five modes of work. Could be used by user to monitoring the control process, informing about corrent state of process and possible risk of overheating.

Alarm can be used also as additional control output working in On/Off mode or On/Off with hysteresis mode.

Mode of alarm output ilustrates fig. 6 below.

Attention!!!

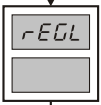


Rys.6 Modes of alarm's output.

Value od alarm's level should be P1<P2, in other time alarm didn't work property

6.1. Setting alarm mode (tAL).

Press and hold about 3 second key.

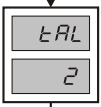


Press the key

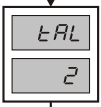
Press the key

Upper display will show flashing alam mode symbol, and bottom its value. To modify alam mode press .

After that, modifying value will be flashing.

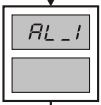


Value of flashing figure are incremented by pressing the key



To confirm press .

After confirm flashing value stops, and start flashing parameters name.



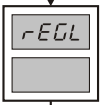
We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

6.2. Setting first threshold value of alarm (P1).

Press and hold about 3 second key.

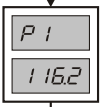


Press the key

Press the key

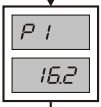
Upper display will show flashing alarm mode symbol, and bottom its value.To select first level press the key

And then confirm by pressing



Value of flashing figure are incremented by pressing the key

To change figure to modify press

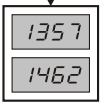


To confirm press .

After confirm flashing value stops, and start flashing parameters name.

We move about one level higer in structure of menu across press the key

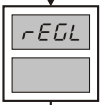
At this time it is possible to exit menu or choose another parameter to modify.



Back to normal controllers work are realized by pressing the key

6.3. Setting second treshold value of alarm (P2)6

Press and hold about 3 second key.



Press the key

Press the key

Upper display will show flashing alarm mode symbol, and bottom its value.To select second level press twice

And then confirm by pressing

Value of flashing figure are incremented by pressing the key

To change figure to modify press

To confirm press .

After confirm flashing value stops, and start flashing parameters name.

We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

Example.
The drawing represents control using on/off with hysteresis control algorithm, with normal closed relay contacts (NC) alarm's output. Value of level:
P1 =110.2 °C, P2=125.7 °C, Tal=5.

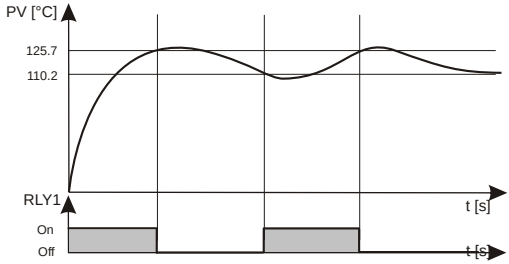


Fig. 7 On/Off controller using alarm's normal close relay contacts

7. Measuring unit.

7.1 Sensors (SnSr)

The controller R-703 is universal controller, which work with all kind of sensors offered through Czaki Thermo Product.

* with thermoresistance sensors (PN-EN60751+A2):

- Pt100 => 0.0 ... +850.0 °C;
- Ni100 => 0.0 ... +180.0 °C;

* and thermocouple sensors (PN-EN60584):

- J (Fe-CuNi) => 0.0 ... +1000 °C;
- K (NiCr-NiAl) => 0.0 ... +1200 °C;
- T (Cu-CuNi) => 0.0 ... +230.0 °C;
- R (PtRh13-Pt) => +200.0 ... +1600 °C;
- B (PtRh30-PtRh6) => +400.0 ... +1800 °C;
- S (PtRh10-Pt) => +200.0 ... +1600 °C;
- N (NiCrSi-NiSi) => 0.0 ... +1300 °C;

7.2 Resolution of displayed value (tPOI)

R-703 could displayed measured temperature with 1°C or 0.1°C resolution.

It is depending of parametr TPOI. If TPOI is:

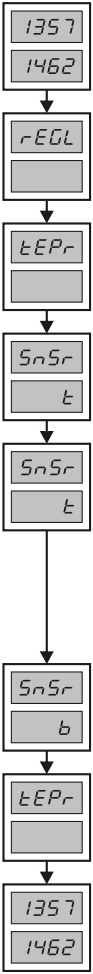
0 - results are displayed with 0.1° C resolution;

1 - results are displayed with 1° C resolution.

7.3 Offset (toFF)

Offset is setting in case of solid difference between real temperature and measure temperature. This parameter can compensate for example, the influence of wires resistance when is udes two-wire thermoresistance sensors.

7.4. The choice of sensor type (SnSr).



Modyfication only in SPEC mode (see page7).

Press and hold about 3 second key.

Press four times the key

Press the key

Upper display will show flashing sensor symbol, and bottom its type.To change sensor typel press

Changes between sensor types are realized by pressing

At that time bottom display is showing possible to select types of sensors:

Pt
J
h
C
S
b

To confirm press .

After confirm flashing value stops, and start flashing parameters name.

We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

7.5. Setting resolution of displayed value (tPOI).

Press and hold about 3 second key.

Press four times the key

Press the key

Pressone time the key

Upper display will show flashing resolution symbol, and bottom its value.To change resolution press

Value of flashing figure are incremented by pressing the key

To confirm press .

After confirm flashing value stops, and start flashing parameters name.

We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

7.6. Setting offset (toFF).

Modyfication only in SPEC mode (see page7).

Press and hold about 3 second key.

Press four times the key

Press the key

Press two times the key

Upper display will show flashing offset symbol, and bottom its value.To change offset level press the key

Value of flashing figure are incremented by pressing the key

To change figure to modify press

To confirm press .

After confirm flashing value stops, and start flashing parameters name.

We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

8. Systems parameters.

8.1 Protection

The controllers offers the possibility of blocking set the parameters of work, to making impossible the access unauthorised personel.

Protection can accept three values:

0 - switched off protections;

1 - protection for all parameters without same protection;

2 - protection for all parameters with protection too;

In this case, all changes are blocked.

Removal protection is possible only in SPEC mode.

8.2 Reset.

This option restores factory setting of parameters from schedule 4.

To restore parameters put value 1, exit from MENU, turned off the unit and again turned on the unit.

8.3. Protection setting (Prot).

Press and hold about 3 second key.

Press three times the key

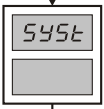
Press the key

Upper display will show flashing protection symbol, and bottom its value.To change protection level press

Value of flashing figure are incremented by pressing the key

To confirm press .

After confirm flashing value stops, and start flashing parameters name.

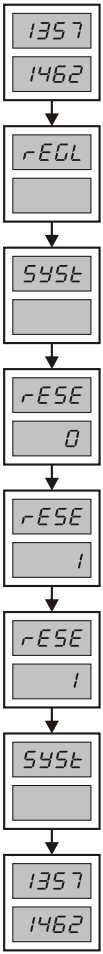


We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

8.4. Restoring factory settings (rESE).



Modyfication only in SPEC mode (see page7).

Press and hold about 3 second key.

Press three times the key

Press the key

Upper display will show flashing reset symbol, and bottom its value.To change reset settings press the key

Value of flashing figure are incremented by pressing the key

To confirm press .

After confirm flashing value stops, and start flashing parameters name.

We move about one level higer in structure of menu across press the key

At this time it is possible to exit menu or choose another parameter to modify.

Back to normal controllers work are realized by pressing the key

9. Technical data

Working temperature range	**J** (Fe-CuNi) [0 .. +1000] °C **K** (NiCr-NiAl) [0 .. +1200] °C **T** (Cu-CuNi) [0 .. +230.0] °C **R** (PtRh13-Pt) [+200.0 .. +1600] °C **S** (PtRh10-Pt) [+200.0 .. +1600] °C **B** (PtRh30-PtRh6) [+400.0 .. +1800] °C **N** (NiCrSi-NiSi) [0 .. +1300] °C **Pt100** [0 .. +850.0] °C **Ni100** [0 .. +180.0] °C
Resolution of temperature measurement	0.1 [°C] dla T<1000[°C] 1 [°C] dla T>1000[°C]
Temperature measurement error	< 0.3 [°C] typ. 1 digits, T<200.0[°C] < 0.7 [°C] typ. 1 digit, 200.0<T<500.0[°C] < 1.5 [°C] typ. 1 digit, 500.0<T<1000[°C] < 2 [°C] typ. 1/2 digitt, T>1000[°C]
Reading temperature period	1 [sec.]
Ranges of paramaters	see table 2
Type of outputs	mechanical relay
Max. curent of relay	5 [A]
Max. switching voltage	250 [V] AC
Max. switching power	1000 [VA]
Max. frequecy switching	600 cycle/h at nominal duty 72 000 cycle/h without duty
Protection rating	IP 40 from front wall IP 30 from rear (conectors) wall
Power supply	230V +10% -20%, 50...60Hz, 3 VA
Ambient temperature	0 ..+50 [°C]
Relative humidity	< 80 [%]
Weight	ca. 0.4 [kg]
Dimensions (h x w x d)	48 x 48 x 140 [mm]
Mounting window dimensions	44 x 44 [mm]

NOTES