LUMEL
EVERYTHING COUNTS

TEMPERATURE CONTROLLER

RE81

USER'S MANUAL

CE

Contents

1. APPLICATION

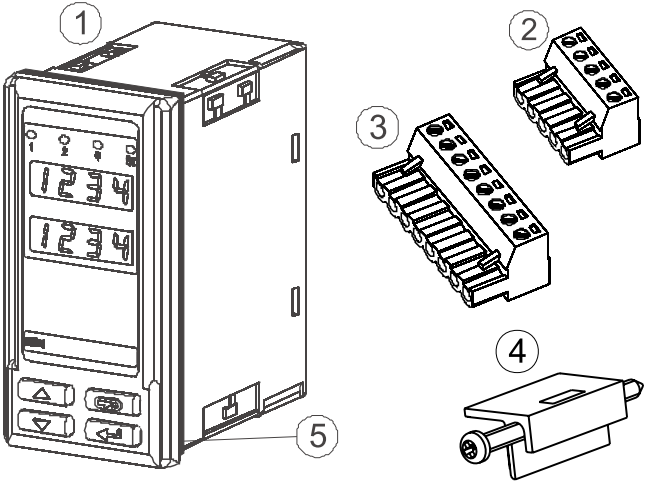
The RE81 controller is destined for the temperature control in plastics, food, dehydration industries and everywhere when the temperature stabilizing is necessary.

The controller co-operates directly with resistance thermometers (RTD) or thermocouple sensors (TC),

The controller has two outputs enabling the two-step control, step-by-step three-step control and alarm signaling. The two-step control is acc. to the PID or ON-OFF algorythm.

The innovative SMART PID algorithm has been implemented in the controller.

2. CONTROLLER SET



The delivered controller set is composed of:

1. RE81 controller ..... 1 pc
2. Plug with 5 screw terminals ..... 1 pc
3. Plug with 8 screw terminals ..... 1 pc
4. Screw clamp to fix the controller in the panel ..... 4 pcs
5. Seal ..... 1 pc
6. User's manual ..... 1 pc
7. Guarantee card ..... 1 pc

When unpacking the controller, please check whether the type and execution code on the data plate correspond to the order.

3. BASIC REQUIREMENTS, OPERATIONAL SAFETY

In the safety service scope, the controller meets to requirements of the EN 61010-1 standard.

Observations Concerning the Operational Safety:

- All operations concerning transport, installation, and commissioning as well as maintenance, must be carried out by qualified, skilled personnel, and national regulations for the prevention of accidents must be observed,
- Before switching the controller on, one must check the correctness of connections to the network,
- Do not connect the controller to the network through an autotransformer,
- Before removing the controller casing, one must switch the supply off and disconnect measuring circuits,
- The removal of the controller casing during the guarantee contract period may cause its cancellation,
- The controller fulfills requirements related to electromagnetic compatibility in the industrial environment,

- When connecting the supply, one must remember that a switch or a circuit-breaker should be installed in the room. This switch should be located near the controller, easy accessible by the operator, and suitably marked as an element switching the controller off,
- Non-authorized removal of the casing, inappropriate use, incorrect installation or operation, creates the risk of injury to personnel or meter damage.

For more detailed information, please study the User's Manual.

4. INSTALLATION

4.1. Controller Installation

Fix the controller in the panel, which the thickness should not exceed 15 mm, by means of four screw clamps acc. the fig. 1.

The panel cut-out should have $45^{+0,6}$ x $92^{+0,6}$ mm dimensions.

The controller must be introduced from the panel front with disconnected supply voltage. Before the insertion into the panel, one must check the correct placement of the seal.

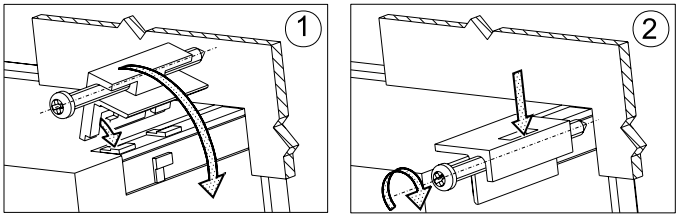


Fig. 1. Controller fixing in the panel.

Controller overall dimensions are presented on the fig. 2.

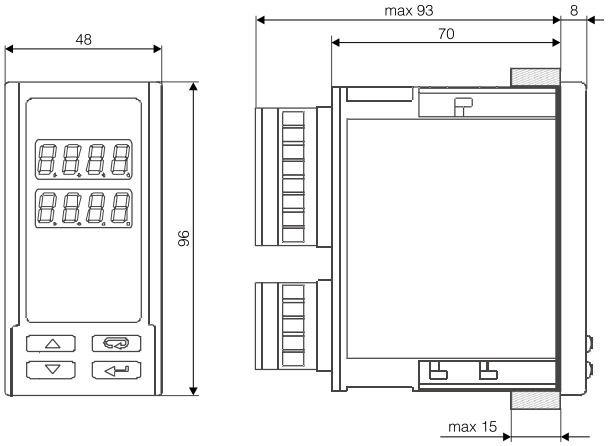


Fig. 2. Controller overall dimensions

4.2. Electrical Connections

The controller has two separable terminal strips with screw terminals, which enable the wire connection of 2.5 mm^2 cross-section.

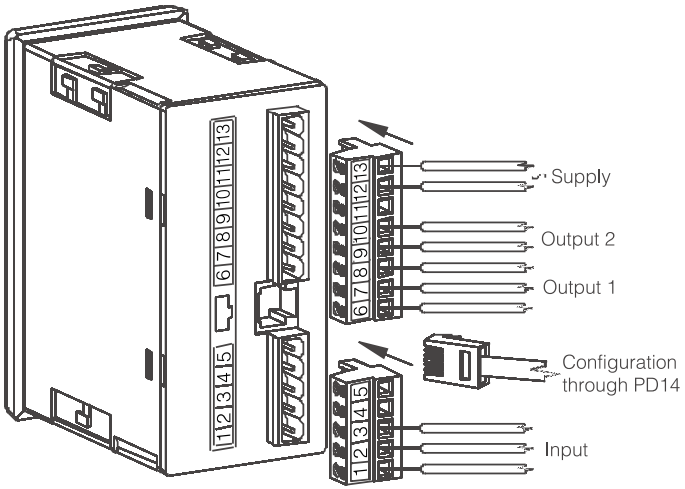


Fig. 3. View of controller connection strips

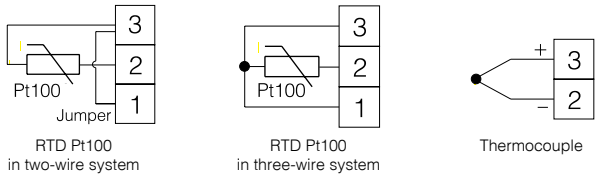


Fig. 4. Connection of input signals

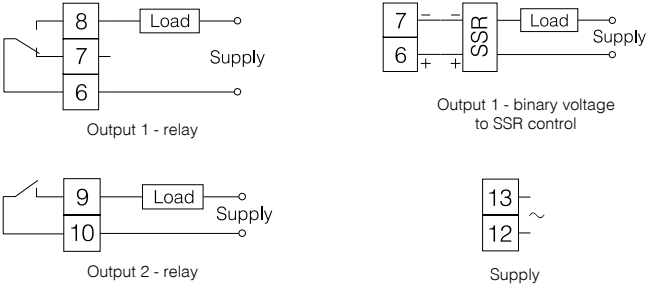


Fig. 5. Supply and load circuit connection

4.3. Installation Recommendations

In order to obtain a full fastness against electromagnetic noise, it is recommended to observe following principles:

- do not supply the controller from the network in the proximity of devices generating high pulse noise and do not apply common earthing circuits,
- apply network filters,
- apply metallic shields in the shape of tubes or braids to conduct supplying wires,
- wires leading measuring signals should be twisted in pairs, and for resistance sensors in 3-wire connection, twisted of wires of the same length, cross-section and resistance, and led in a shield as above,
- all shields should be one-side earthed or connected to the protection wire, the nearest possible to the controller,
- apply the general principle, that wires leading different signals should be led at the maximal distance between them (no less than 30 cm), and the crossing of these groups of wires made at right angle (90°).

5. STARTING TO WORK

After turning the supply on, the controller carries out the display test, displays the **rE81** inscription, the program version and next, displays the measured value. A character message informing about abnormalities may appear on the display (table 4).
The On-Off control algorythm is set by the manufacturer with hysteresis given in the table 2.

Changing the Set Value

One can change the set point value by pressing the [▼] or the [▲] button (fig. 6). The beginning of change is signaled by the flickering point of the lower display. One must accept the new set point value by pressing the [↵] button during 30 seconds since the last pressure of the [▼] or [▲] button. In the contrary, the old value will be restored.

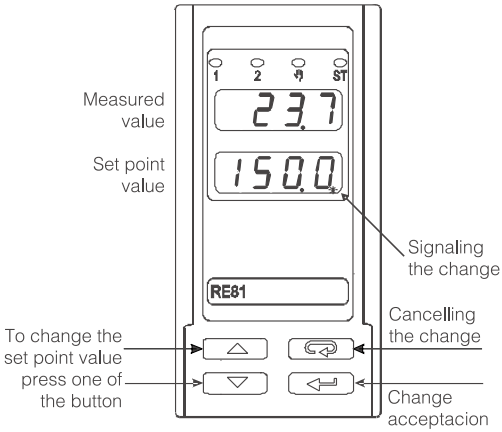
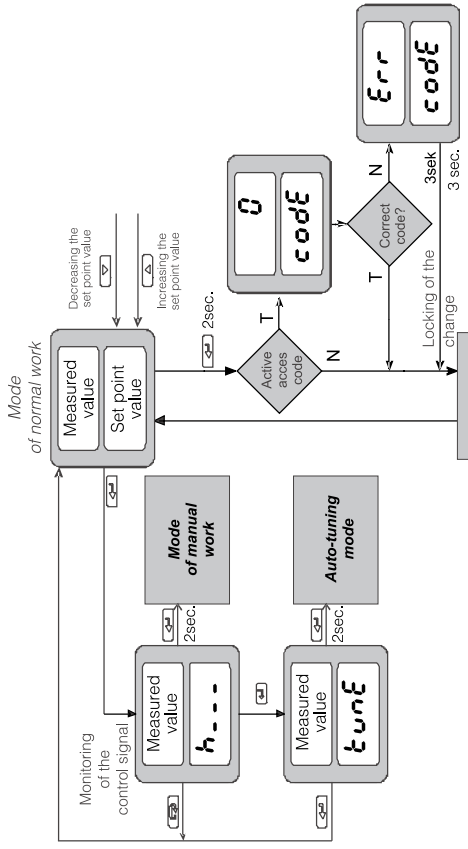


Fig. 6. Change of the set point value

6. SERVICE

The controller service is presented on the fig. 7.



Rys. 7. Menu of controller service

6.1. Programming Controller Parameters

The pressure and holding down the [↵] button during ca 2 sec. causes the entry in the programming matrix. The programming matrix can be protected by an access code. In case when giving a wrong value of the code, it is only possible to see settings through – without the possibility of changes.

The fig 8. presents the transition matrix in the programming mode. The transition between levels is carrying out by means of [▼] and [▲] buttons and the level selection by means of the [↵] button. After selecting the level, the transition between parameters is carried out by means of [▼] and [▲] buttons. In order to change the parameter setting, one must proceed acc. to the section 6.3. "**setting change**". In order to exit from the selected level, one must transit between parameters until the symbol [. . .] appears and press the [↵] button. In order to exit from the programming matrix to the normal working mode, one must transit between levels until the symbol [. . .] appears and press the [↵] button.

Some controller parameters can be invisible – it depends on the current configuration.

The table 1 includes the description of parameters. The return to the normal working mode follows automatically after 30 seconds since the last button pressure.

6.2. Programming Matrix

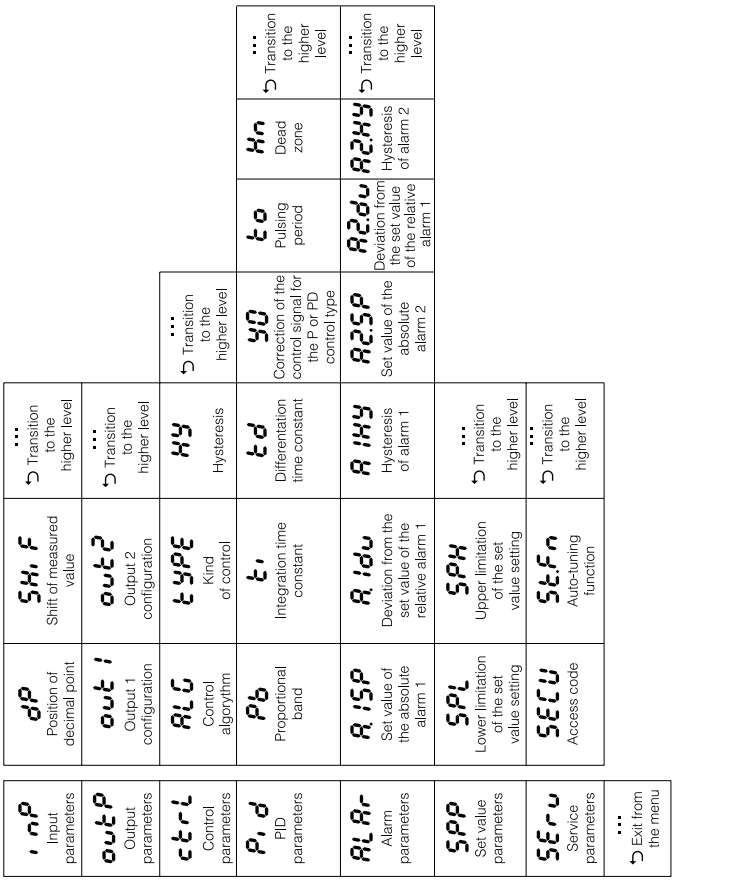


Fig. 8. Programming matrix

6.3. Setting Change

The change of the parameter setting begins after pressing the [↵] button during the display of the parameter name. The setting selection is carried out through [▼] and [▲] buttons, and accepted by the [↵] button. The change cancellation follows after pressing the [↩] button or automatically after 30 sec since the last button pressure.

The way to change the setting is shown on the fig. 9.

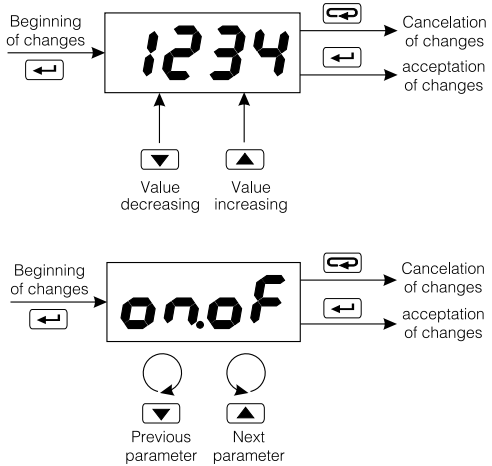


Fig. 9. Change of number and text parameter settings

6.4. Parameter Description

The list of parameters in the menu is presented in the table 1.

List of configuration parameters *Table 1*

Parameter symbol	Parameter description	Manufacturer setting	Change range of the parameter
inP — Input parameters			
dP	Position of the decimal point	1-dP	0_dP: without decimal point 1_dP: 1 decimal place
Sh.F	Shift of the measured value	0.0	-99.9...99.9°C
outP — Output parameters			
out1	Configuration of output 1	y	oFF: not used y: control signal AH1: upper absolute alarm AL o: lower absolute alarm dAH1: upper relative alarm dAL o: lower relative alarm dAi n: internal relative alarm dAou: external relative alarm y.oP: control signal for valve opening
out2	Configuration of output 2	oFF	oFF: not used AH1: upper absolute alarm AL o: lower absolute alarm dAH1: upper relative alarm

out2	Configuration of output 2	oFF	dulo: lower relative alarm dul n: internal relative alarm duou: external relative alarm YCL: control signal for valve closing
ctrL – Control parameters [1]			
ALG	Control algorythm	onoF	onoF: On-Off control algorythm P id: PID control algorythm
tYPE	Kind of control	inu	d ir: direct control (cooling) inu: reverse control (heating)
HY	Hysteresis [4]	HY_FABR [6]	0.2...99.9°C
P id – PID parameters [2]			
Pb	Proportional band	PB_FABR [6]	0.1...999.9°C
t i	Integration time constant	300	0...9999 s
td	Differentiation time constant	60.0	0...999.9 s
Y0	Correction of the control signal for P or PD type control	0.0	0...100.0%
to	Pulse repetition period	20.0	0.5...99.9 s
Hn	Dead zone	10.0	0.0...99.9°C
ALAr – Alarm parameters [3]			
A 1SP	Set value for absolute alarm 1	0.0	MIN...MAX [6]
A 1du	Deviation from the set value for the relative alarm 1	0.0	-199.9...199.9°C

A1HY	Hysteresis for the alarm 1	2,0	0,2...99,9°C
A2SP	Set value for absolute alarm 2	0,0	Measuring range of the input
A2dv	Deviation from the set value for the relative alarm 2	0,0	-199,9...199,9°C
A2HY	Hysteresis for the alarm 2	2,0	0,2...99,9°C
SPP — Parameters of the set value			
SPL	Lower limitation of the set value	-199,0	MIN...MAX 6)
SPH	Upper limitation of the set value	850,0	MIN...MAX 6)
SErP — Service parameters			
SECU	Access code 5)	0	0...9999
St.Fn	Auto-tuning function	on	oFF: locked on: available

1) Group of parameters visible only when setting the output on the control signal.
2) Group of parameters visible only when setting the control algorythm on PID.
3) Group of parameters visible only when setting the output on one of the alarm.
4) Parameter visible only when setting the control algorithm on On-Off.
5) Parameter hidden only for readout in the parameter monitoring mode.
6) See table 2.

Parameters depending on the measuring range table 2

Sensor	MIN	MAX	PB_FABR	HY_FABR
Pt100 RTD -50...100°C	-50.0	100.0	15.0	1.1
Pt100 RTD 0...250°C	0.0	250.0	20.0	1.8
Pt100 RTD 0...600°C	0.0	600.0	30.0	4.2
thermocouple of J type 0...250°C	0.0	250.0	20.0	1.8
thermocouple of J type 0...600°C	0.0	600.0	30.0	4.2
thermocouple of J type 0...900°C	0.0	900.0	40.0	6.3
thermocouple of K type 0...600°C	0.0	600.0	30.0	4.2
thermocouple of K type 0...900°C	0.0	900.0	40.0	6.3
thermocouple of K type 0...1300°C	0	1300	45.0	9.1
thermocouple of S type 0...1600°C	0	1600	50.0	11.2

7. CONTROL

7.1. On-Off Control

When a high accuracy of temperature control is not required, especially for objects with a high time constant and not big delay, one can apply the On-Off control with hysteresis.

Features of this method are simplicity and reliability. Disadvantage of this method is the occurrence of oscillations, even at small hysteresis values.

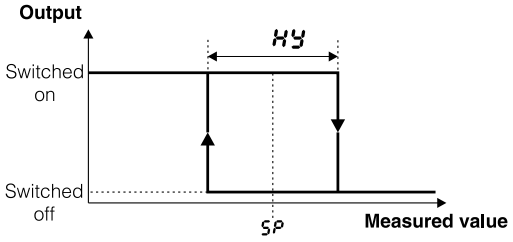


Fig. 10. Operation way of the heating output type for the On-Off control.

7.2. Innovative SMART PID Algorythm

When we want to obtain a higher accuracy of temperature control, one must use the PID algorythm. The fine tuning of the controller to the object consists on the manual setting of the proportional element value, integration element, differentiation element, or automatically – by means of the auto-tuning function.

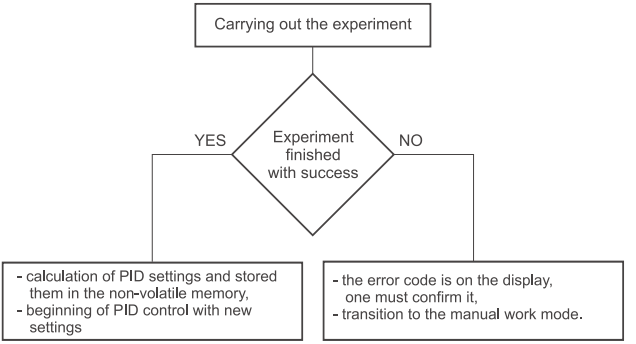
7.2.1. Auto-tuning

The controller has the function enabling the selection of PID settings. These settings ensure the optimal control in most of cases.

To begin the auto-tuning, one must transit to the **tunE** parameter (acc. to the fig. 7) and hold down the [↵] button during at least 2 sec. If the control algorithm is set on ON-OFF or the auto-tuning function is locked, then the **tunE** message is hidden.

The flickering **AT** symbol informs about the activity of the auto-tuning function. The auto-tuning duration time depends on dynamic properties of the object and can last maximally 10 hours. During the auto-tuning or directly after it, over-regulations can occur and for these reasons, one must set a less set point value, if it possible.

The auto-tuning is composed of following stages:



The auto-tuning process will be broken without PID settings calculation, if a controller supply decay occurs or the [↵] button is pressed. In such a case, the control with current PID settings will begin.

If the auto-tuning experiment does not end with success then, an error code will be displayed acc. to the table 3.

Error codes for auto-tuning Table 3

Error code	Reason	Proceeding
E5.01	P or PD control has been selected.	One must select PI, PID control, i.e. the TI unit must be higher than zero.
E5.03	The [↵] button has been pressed.	
E5.04	The maximal auto-tuning duration time has been exceeded.	Check, if the temperature sensor is correctly situated, if the set point value is not set too higher for the given object.
E5.05	The waiting time of switching has been exceeded.	
E5.06	The input measuring range has been exceeded.	Take note of the way to append the sensor. Do not admit, that the overflow resulted in exceeding of the input measuring range.
E5.20	Very non-linear object, preventing to obtain correct values of PID parameters, or an interference has occurred.	Carry out the auto-tuning again. If that does not help, choose PID parameters manually.

7.2.2. Proceeding Way in Case of an Unsatisfactory PID Control

It is recommended to select PID parameters, changing the value in a twice higher or twice less. During the change, one must respect following principles.

a) Slow response of the jump:

– decrease the proportional band,
– decrease the integration and differentiation time.

b) Over-regulations

– increase the proportional band,
– increase the differentiation time.

c) Oscillations
– increase the proportional band,
– increase the integration time,
– decrease the differentiation time.
d) Instability
– Increase the integration time.

7.3. Step-by-step Three-state Control

The step-by-step 3-state control is applied to the valve control. One must set the **out 1** on **StP** and
out2 on **zCL** and set the **Hn** dead zone around the set value. The first line – valve opening – operates for a set value equal SP – **Hn**/2, as a reverse controller, the second line – valve closure – operates for a set value equal SP + **Hn**/2 as a non-reverse controller. Parameters for the second line are identical as for the first line. For the step-by-step control the PD algorithm is recommended.
The operation of the step-by-step three-state controller with the PD algorithm is unattainable for the step-by-step control.

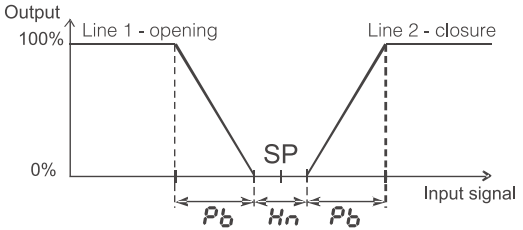


Fig.11. Step-by-step three-state control

8. ALARMS

One can configure controller outputs as alarm outputs. For this aim, one must set the **out 1** and/or **out2** parameter as one of the alarms.
Available types of alarms are given on the fig. 12.

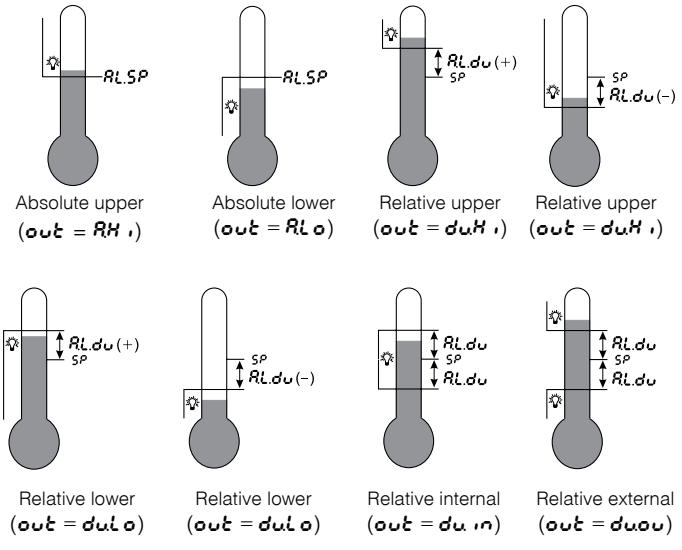


Fig.12. Kind of alarms

The set point value for absolute alarms is the value defined by the **AL.SP** (**A2SP**) parameter, and for relative alarms, it is the deviation from the set point value - **AL.du** (**A2 du**) parameter.

Alarm hysteresis, i.e. the zone around the set point value in which the input state is not changed is defined by the **AL.HY** (**A2HY**) parameter.

9. ADDITIONAL FUNCTIONS

9.1. Display of the Control Signal

After pressing the [↵] button, the value (0...100%) of the control signal is displayed on the display. The index h is displayed on the first digit (for the step-by-step control: index o – for opening and c – for closure) The control signal will be displayed when **out 1**=**y** or **out 1**=**yoP** and **out2**=**yCL**. For the step-by-step control, switching between opening and closure is carried out after pressing the [▼] or [▲] button.

9.2. Manual Control

The manual control gives the possibility of the object identification, testing or control it after the sensor damage.

The entry to the manual control follows after holding down the [↵] button during the control signal display. The manual control is signaled by the diode pulsation with the ✋ symbol. The controller interrupts the automatic control and begins the manual control of the output.

For the On-Off control – one can set the control signal on 0% or 100% by [▼] and [▲] buttons. The control signal value is on the lower display, preceded by the **h** symbol.

For the PID control – one can set the control signal by [▼] and [▲] buttons on any value from the 0.0...100% range. The control signal value is on the lower display preceded by the **h** symbol.

For the step-by-step control – the valve opening is carried out during holding the [▲] button down, the closure during holding the [▼] button down. The valve state is displayed on the lower display:

StOP – stopped, **OPEn** – opening, **CLOS** – closure.

The exit to the normal working mode follows after pressing the [↩] button.

9.3. Manufacturer's Settings

One can restore manufacturer's settings by holding down [▼] and [▲] buttons during the supply turning on, till the moment when the inscription **F.Abr** appears on the upper display.

10. ERROR SIGNALING

Character messages signaling the incorrect controller operation Table 4

Error code (upper display)	Reason	Procedure
	Down overflow of the measuring range or lack of RTD.	Check, if the type of chosen sensor is in compliance with the connected one. Check if input signal values are situated in the appropriate range – If yes, check if there is not a short circuit in the RTD or the thermocouple is connected inversely.
	Upper overflow of the measuring range or break in the sensor circuit	Check, if the type of chosen sensor is in compliance with the connected one. Check if input signal values are situated in the appropriate range – If yes, check if there is no break in the sensor circuit.
	Input discalibrated	Connect the controller supply again and if that is not effective, contact the nearest service shop.
	Check sum error of configuration parameters	Connect the controller supply again and if that is not effective, contact the nearest service shop.
	Incorrect controller configuration	When selecting the step-by-step control, both outputs must be set as follows: out1 = **y.OP.** and out2 = **y.CL**.

11. CONTROLLER CONFIGURATION BY MEANS OF THE LPCon PROGRAM

The LPCon program is destined for the controller configuration. One must connect the PC computer through the PD14 programmer and after selecting the **Option → Connection configuration** menu, configure the connection (for the RE81 controller we choose the address 1, baud rate 9600, RTU mode, 1000 ms timeout, and the suitable COM port, under which, the controller of the PD14 programmer has been installed).

Caution!

The programming of RE81 controller parameters must be carried out at disconnected measured circuits.

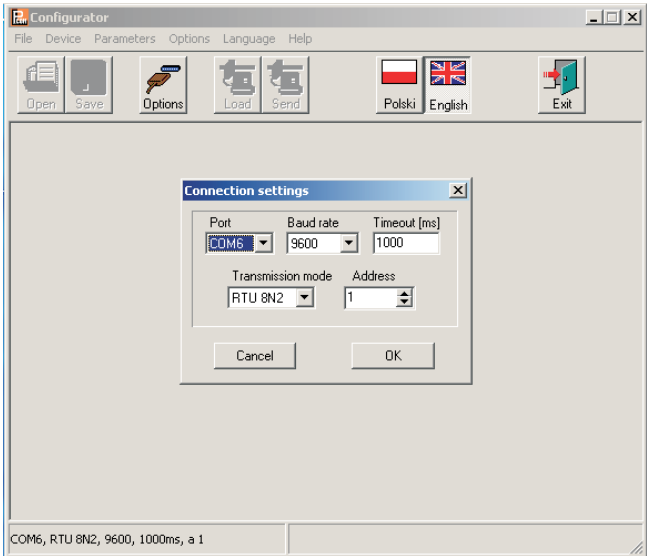
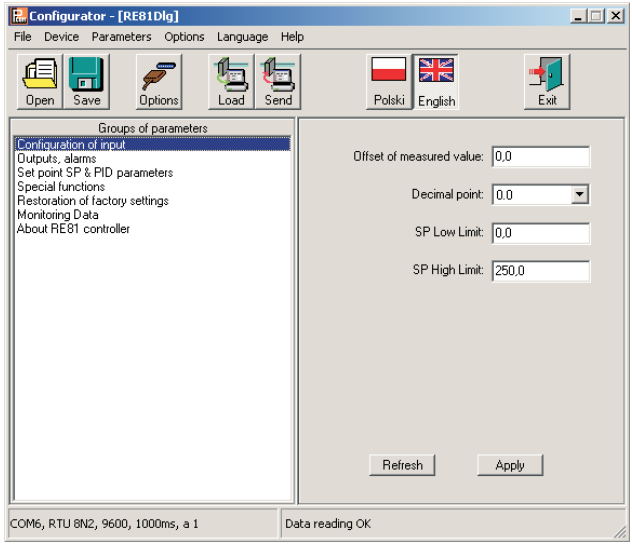
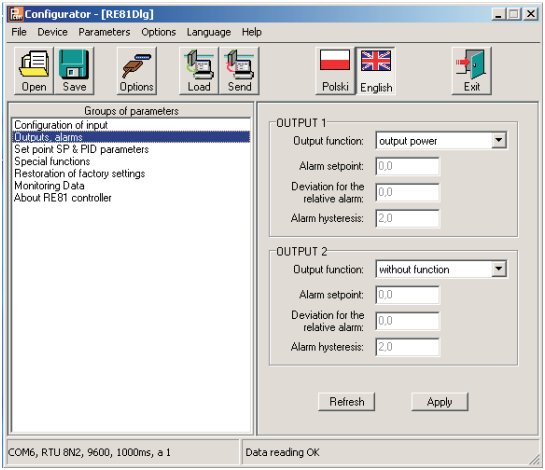


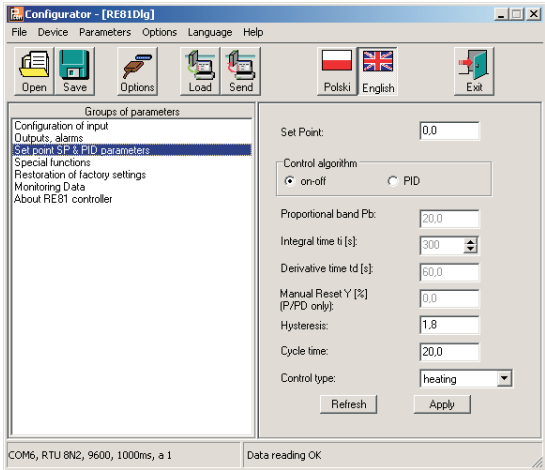
Fig. 13. Connection configuration to the RE81 controller.

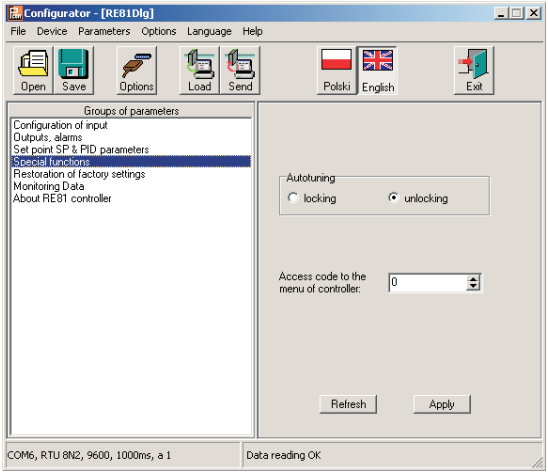
After the connection configuration one must choose **Device** → **Controllers** → **RE81** from the menu and next, click the **Readout** icon in order to read out all parameters. One can also read out parameters in each group by clicking the **Refresh** button. To change the setting, one must write the new value in the parameter window and click the **Apply** button.

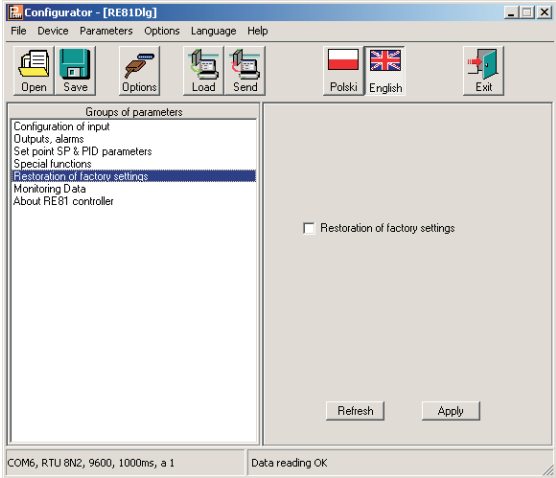
Windows with controller configuration parameters are shown on the fig. 14. Some edition fields may be locked. This means, that they are not used in the current controller configuration.




Configurator - [RE81Dlg]
File Device Parameters Options Language Help
Open Save Options Load Send Polski English Exit
Groups of parameters
Configuration of input
Outputs, alarms
Set point SP & PID parameters
Special functions
Restoration of factory settings
Monitoring Data
About RE81 controller
OUTPUT 1
Output function: output power
Alarm setpoint: 0.0
Deviation for the relative alarm: 0.0
Alarm hysteresis: 2.0
OUTPUT 2
Output function: without function
Alarm setpoint: 0.0
Deviation for the relative alarm: 0.0
Alarm hysteresis: 2.0
Refresh Apply
COM6, RTU 8N2, 9600, 1000ms, a 1
Data reading OK


Configurator - [RE81Dlg]
File Device Parameters Options Language Help
Open Save Options Load Send Polski English Exit
Groups of parameters
Configuration of input
Outputs, alarms
Set point SP & PID parameters
Special functions
Restoration of factory settings
Monitoring Data
About RE81 controller
Set Point: 0,0
Control algorithm
on-off PID
Proportional band Pb: 20,0
Integral time ti [s]: 300
Derivative time td [s]: 60,0
Manual Reset Y [%] (P/PD only): 0,0
Hysteresis: 1,8
Cycle time: 20,0
Control type: heating
Refresh Apply
COM6, RTU 8N2, 9600, 1000ms, a 1
Data reading OK


Configurator - [RE81Dlg]
File Device Parameters Options Language Help
Open Save Options Load Send Polski English Exit
Groups of parameters
Configuration of input
Outputs, alarms
Set point SP & PID parameters
Special functions
Restoration of factory settings
Monitoring Data
About RE81 controller
Autotuning
locking
unlocking
Access code to the menu of controller:
0
Refresh
Apply
COM6, RTU 8N2, 9600, 1000ms, a 1
Data reading OK


Configurator - [RE81Dlg]
File Device Parameters Options Language Help
Open Save Options Load Send Polski English Exit
Groups of parameters
Configuration of input
Outputs, alarms
Set point SP & PID parameters
Special functions
Restoration of factory settings
Monitoring Data
About RE81 controller
Restoration of factory settings
Refresh
Apply
COM6, RTU 8N2, 9600, 1000ms, a 1
Data reading OK

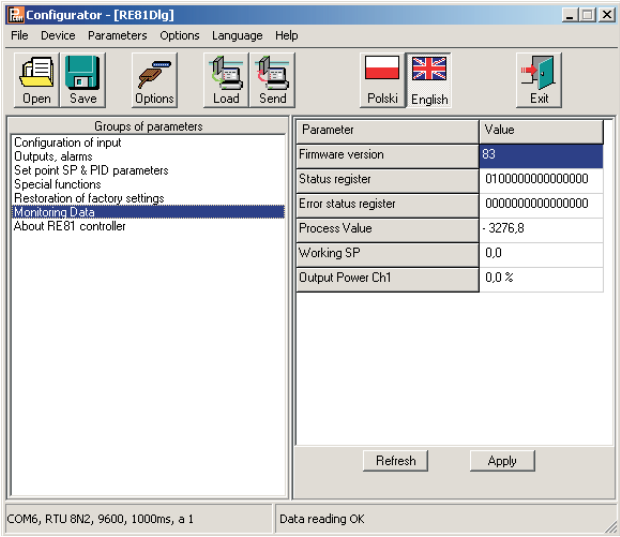


Fig. 14. View of Windows for the RE81 controller configuration.

12. TECHNICAL DATA

Input signals to the table 5

Input signals and measuring ranges for inputs *Tablica 5*

Sensor type	Range	Basic error
Resistance thermometer (acc. to EN 60751), measuring current 0.25mA		
Pt100*)	-50...100	±0.8
	0...250	±1.3
	0...600	±3.0
Thermocouple of J type (acc. to EN 60584-1)		
Fe-CuNi	0...250	±2.0
	0...600	±3.0
	0...900	±4.0
Thermocouple of K type (acc. to EN 60584-1)		
NiCr-NiAl	0...600	±3.0
	0...900	±4.0
	0...1300	±6.0
Thermocouple of S type (acc. to EN 60584-1)		
PtRh10-Pt	0...1600	±8.0

*) Resistance of the sensor line < 10 Ω/wire; one must connect with wires of the same section and length.

Measurement time 0.33 s

Detection of error in the measurement circuit:

- termocouple, Pt100 overflow of measuring range

Kinds of outputs:

for output 1:

- voltageless relay	switching contact, overload 5 A/230 V,
- binary voltage	6 V, for Imax = 50 mA 11 V without load

for output 2:

- voltageless relay	NOC contakt, overload capacity 1 A/230 V,

Way of output operation:

- reverse	for heating
- direct	for cooling

Rated operating conditions:

- supply voltage	230 V a.c. ±10%
- supply voltage frequency	50/60 Hz
- ambient temperature	0...23...50°C
- storage temperature	-20...+70°C
- relative air humidity	< 85% (without water vapour condensation)
- external magnetic field	< 400 A/m
- warm-up time	30 min
- operating position	any

Power consumption	< 5 VA
Weight	< 0.25 kg
Protection grade ensured by the casing:	acc. to EN 60529 [1)]
- from frontal side	IP 65
- from terminal side	IP 20

Additional errors in rated operating conditions caused by:

- compensation of reference junction temperature changes	≤ 2°C,

- line resistance change of the thermocouple sensor	≤ 50% of the basic error value
- change of the ambient temperature	≤ 100% of the basic error/10 K

Safety requirements acc. to EN 61010-1 [1)]

- isolation between circuits	basic
- installation category	III
- pollution level	2
- maximal phase-to-earth operating voltage:	
- for supply circuit, outputs	300 V
- for input circuits	50 V
- altitude above sea level	2000 m

Electromagnetic compatibility:

- noise immunity	acc. to EN 61000-6-2[1)]
- noise emissions	acc. to EN 61000-6-4[1)]

[1)] Current standard editions are in Conformity Declaration.

13. ORDER CODES

The coding way is given in the table 6.

Ordering codes: Table 6

Temperature Controller RE81 -	XX	X	XX	X	X

Input:

RTD Pt100	(-50...100°C)	**01**
RTD Pt100	(0...250°C)	**02**
RTD Pt100	(0...600°C)	**03**
thermocouple J (Fe-CuNi)	(0...250°C)	**04**
thermocouple J (Fe-CuNi)	(0...600°C)	**05**
thermocouple J (Fe-CuNi)	(0...900°C)	**06**
thermocouple K (NiCr-NiAl)	(0...600°C)	**07**
thermocouple K (NiCr-NiAl)	(0...900°C)	**08**
thermocouple K (NiCr-NiAl)	(0...1300°C)	**09**
thermocouple S (PtRh10-Pt)	(0...1600°C)	**10**

Output 1*:

relay	**1**
binary 0/6 V for SSR control	**2**

Version:

standard	**00**
custom-made**	**XX**

Language:

Polish	**P**
English	**E**
other**	**X**

Acceptance tests:

without additional requirements	**0**
with an extra quality inspection certificate	**1**
acc. to the customer's request**	**X**

* Output 2 - relay.

** After agreement with the manufacturer.

Example of Order:

The code: **RE81 - 06 2 00 E 0** means:

RE81 – temperature controller of RE81 type
06 – input: TC J, (0...900°C)
2 – output: binary 0/6 V for SSR control
00 – standard version
E – English language
0 – without extra quality requirements

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