LUMEL
EVERYTHING COUNTS

TEMPERATURE CONTROLLER 76x34 mm

RE01

USER'S MANUAL

Contents

The manual applies to the controller with software v1.02 or higher.

1. APPLICATION

Controller RE01 is designed to control temperature. It cooperates directly with resistance-type sensors Pt100, Pt1000 and NTC.

The controller has one output for on-off control and one output for alarm signalling. The on-off control employs the PID or on-off algorithm. For the on-off control, the minimum on and off times for the output may be set. The control output has a changeover contact and allows for the direct control of low-power objects.

An innovative SMART PID algorithm is implemented in the controller.

In addition, the controller has a binary input to control the controller's functions and an internal sound signalling device.

2. CONTROLLER SET

The delivered controller set is composed of:

1. controller .... 1 piece
2. contact with 7 screw terminals........ 1 piece
3. contact with 3 screw terminals........ 1 piece
4. clamp for on-board mounting.......... 4 piece
5. gasket .... 1 piece

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:

- The assembly and installation of electrical connections shall be performed by a person qualified for the assembly of electrical devices.
- Check if the connections are made correctly before powering on the controller.
- Power off the controller and disconnect measuring circuits before removing the controller’s housing.
- The removal of the controller’s housing during the validity of the warranty agreement nullifies the agreement.
- The devices is designed for installation and use in industrial, electromagnetic environmental conditions.
- The installation should be fitted with a switch or circuit-breaker located near the device, easily accessible to the operator and with appropriate marking.

4. INSTALLATION

4.1. Controller Installation

Attach the controller to the board with four screw mounts in line with Fig. 1. The hole in the board should be $71^{+0.7}$ x $29^{+0.6}$ mm. The board material may be up to 15 mm thick.

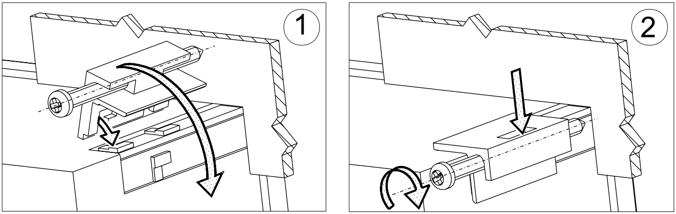


Fig. 1. Attaching the controller

The controller's dimensions are shown on Fig. 2.

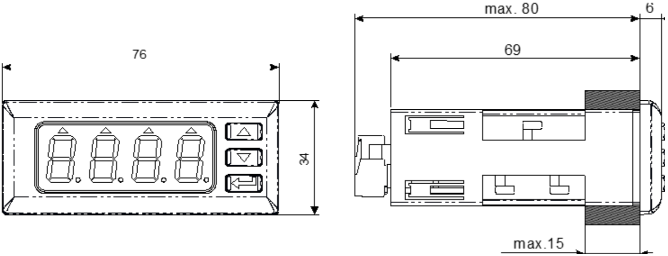


Fig. 2. Controller dimensions.

4.2. Electrical Connections

The controller has two disconnectable strips with screw terminals. One strip allows for the connection of power supply and output with a wire up to 2.5 mm^2 in size and the other strip for the connection of input signals with a wire up to 1.5 mm^2 in size.

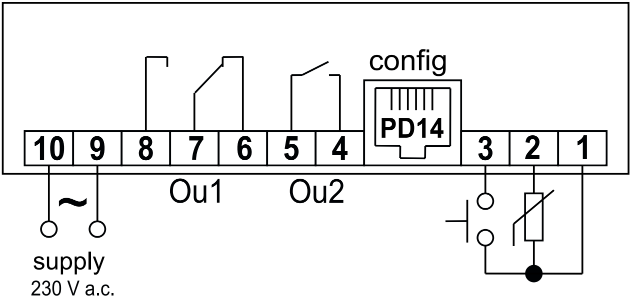


Fig. 3. View of the controller's connection strips.

4.3. Installation recommendations

To obtain full resistance to electromagnetic interference, observe the following rules:

- do not power the controller from the mains near equipment generating impulse interference and do not use common earthing circuits for them,
- use line filters,
- measuring signal input wires should be screened twisted pairs and wires for resistance sensor in three-wire systems formed by screened twisted wires with the same length, size and resistance,
- all the screens should be earthed or connected to a protective cable, on one side, as close to the controller as possible,
- follow the general principle that wires which transmit different signals should run as far from each other as possible (no less than 30 cm) and bundles should cross each other at the angle of 90^o.

5. Commencement of operation

Description of the controller

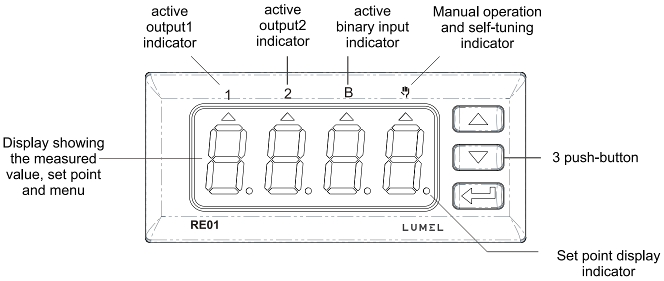


Fig. 4. View of the controller's front panel.

Power on

Once powered on, the controller performs a display test, shows rE01, software version and then the measured value.
The display may show a sign message on irregularities (see Table no. 13).
The on-off control algorithm with hysteresis 2.0°C is factory set.

Change of the set point

To display the set point, press [▼] or [▲], the dot for the last digit lights up then. To change the set point, press again [▼] or [▲] (Fig. 5). The dot flashes to signal the start of change. Accept the new set point with [↵] within 30 seconds from the last pressed [▼] or [▲]; otherwise the controller changes over to display the measured value with the previously set-up set point.

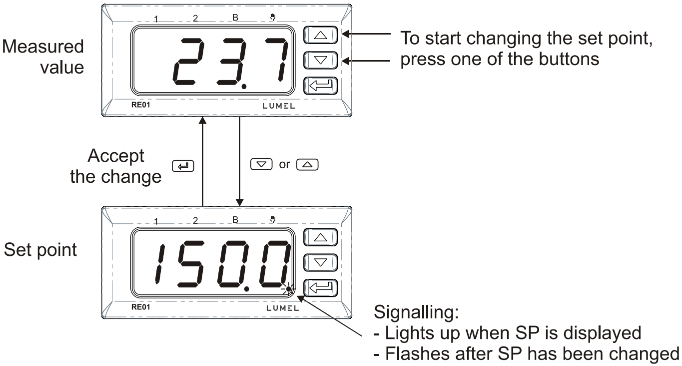


Fig. 5. Changing the set point.

6. OPERATION

Fig. 6 shows the operation of the controller.

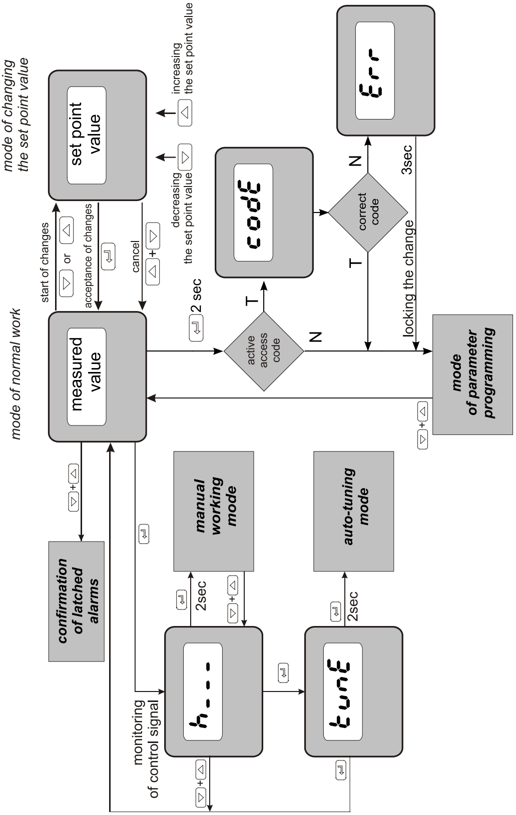


Fig. 6. Controller operation menu

6.1. Programming of controller parameters

Press and hold [↵] for approx. 2 seconds to enter the programming matrix. The programming matrix may be protected with an access code. If a wrong code is inserted, one may only view the settings without changing them.

Fig. 7 shows the navigation matrix in the programming mode. To go from one level to another, use [▼] or [▲] and to select a level, use [↵] . Once the level is selected [▼] or [▲] are used to navigate among parameters. In order to change the parameter setting, follow point Change of the setting. To exit the selected level, go from parameter to parameter u til the symbol [. . .] appears and press [↵]. To exit the programming matrix for the normal operation mode, go from level to level until the symbol [. . .] appears and press [↵].

Some parameters of the controller may be hidden, depending on the current configuration. The parameters are described in Table no. 1. 30 seconds from the last button pressed, the device returns automatically to the normal operation mode.

6.2. Programming Matrix

inP Input parameters	unit Unit	in.tY Input type	r-Li Line resistance	dP Decimal point position	SHiF Measured value shift	bnin Binary input function	. . . ⮌ Go one level up		
outP Output parameters	out1 Output 1 configuration	out2 Output 2 configuration	. . . ⮌ Go one level up						
ctrL Control parameters	ALG Control algorithm	tYPE Control type	dEFr Defrost function	d.mod Defrost function operation mode	dt in Defrost duration	d.SP Defrost termination temperature	d.dur Defrost switching on interval	HY Hysteresis	
	t.on Output minimum on time	t.oFF Output minimum off time	St.Lo Lower threshold for self-tuning	St.Hi Upper threshold for self-tuning	YFL Sensor failure control signal	. . . ⮌ Go one level up			
Pid PID parameters	Pb Proportional band	ti Integration Time constant	td Derivative time constant	Y0 Control signal adjustment, for P/PD-type control	to Pulse repetition period	. . . ⮌ Go one level up			
ALAr Alarm parameters	A1SP Absolute alarm 1 set point	A1du Deviation from relative alarm 1 set point	A1HY Alarm 1 hysteresis	A1Lt Alarm 1 memory	A2SP Absolute alarm 2 set point	A2du Deviation from relative alarm 2 set point	A2HY Alarm 2 hysteresis	A2LE Alarm 2 memory	. . . ⮌ Go one level up
SPP Set-point value parameters	SPL set point setting lower limit	SPH set point setting upper limit	. . . ⮌ Go one level up						
SErv Service parameters	SECU Access code	St.Fn Self-tuning function	bufn Buzzer function	. . . ⮌ Go one level up					
. . . ⮌ Exit from menu									

Fig. 7. Programming matrix

6.3. Change of the setting

To start changing the parameter setting, press while the parameter name is displayed. Press and to select the setting and press to accept it. A change is cancelled when you press and at the same time or automatically after 30 seconds from the last button pressed.

Fig. 8 shows how to change settings.

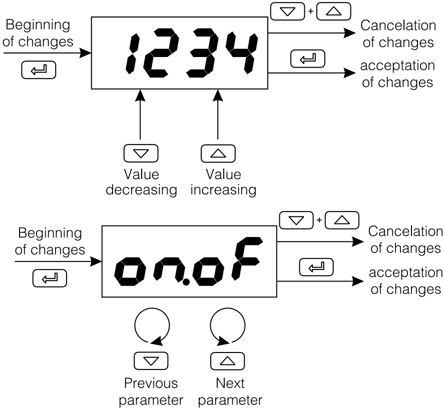


Fig. 8. Changing the settings of numerical and text parameters.

6.4. Parameter Description

A list of parameters is given in Table no. 1.

List of configuration parameters *Table 1*

Parameter symbol	Parameter description	Manufac-turer setting	Range of parameter changes
inP – Input parameters			
unit	Unit	°C	°C: Celsius degrees °F: Fahrenheit degrees
inty	Input range [1]	Pt1	P1A: Pt100 (-50...100 °C) P1b: Pt1000 (0...250 °C) P1c: Pt100 (0...600 °C) P10A: Pt1000 (-50...100 °C) P10b: Pt1000 (0...250 °C) P10c: Pt1000 (0...600 °C) ntc: Ntc (-40...100 °C)
r-Li	Line resistance for sensor Pt100 [2]	0.0 Ω	0.0…15.0 Ω
dP	Position of the main input decimal point	1-dP	0-dP: without decimal point 1-dP: 1 decimal place
SHiF	Measured value shift of the main input	0,0 °C (0,0 °F)	-100,0...100,0 °C (-180,0...180,0 °F)
bnin	Binary input function	nonE	nonE: no function StoP: control stop rSAL: alarm reset out: output control KLCK: keyboard lock dEFr: defrost function on (reaction to accretion

outP – Output parameters			
out1	Output 1 configuration	y	oFF: switched off y: control dignal AHi : absolute higher alarm ALo: absolute lower alarm du.Hi : relative higher alarm du.Lo: relative lower alarm dui n: relative internal alarm du.ou: relative external alarm bi n.d: direct control through binary input bi n.i : inverse control through binary input
out2	Output 2 configuration	oFF	oFF: switched off AHi : absolute higher alarm ALo: absolute lower alarm du.Hi : relative higher alarm du.Lo: relative lower alarm dui n: relative internal alarm du.ou: relative external alarm bi n.d: direct control through binary input bi n.i : inverse control through binary input dEFr: output controlled during defrost

ctrL – Control parameters [3]			
ALG	Control algorithm	on.oF	on.oF: on-off control algorithm Pi d: PID control algorithm
tYPE	Control type	inu	di r: direct control (cooling) inu: inverse control (heating)
dEFr	Defrost function [11) 13)]	oFF	oFF: defrost function switched off Auto: defrost is switched on at specified time interval (d.dur parameter) hAnd: defrost function is manually switched on
d.mod	Defrost function operation mode [13)]	ti mE	ti mE: defrost for a period of time set by d.ti m parameter tEmP: defrost until temperature set by d.SP parameter is reached [12)]

dtim	Defrost duration 13)	2	1...10 h
dSP	Defrost temperature 13)	6.0 °C (42.8 °F)	0.0...0.0 °C (32.0...50.0 °F)
ddur	Time interval for defrost switching on 13)	24	10...168 h
HY	Hysteresis 4)	2.0 °C (3.6 °F)	0.2...100.0 °C (0.2...180.0 °F)
t.on	Output 1 minimum on time 4)	0	0...999 s
t.oFF	Output 1 minimum off time 4)	0	0...999 s
St.Lo	Lower threshold for self-tuning 5)	-50.0 °C (-58.0 °F)	MIN…MAX 6)
St.Hi	Upper threshold for self-tuning 5)	100.0 °C (212.0 °F)	MIN…MAX 6)
Y.FL	Control output control signal for sensor failure 10)	0	0.0...100.0%
Pid – PID parameters 7)			
Pb	Proportional band	30.0 °C (54.0 °F)	0.1...550.0 °C (0.1...990.0 °F)
ti	Integration time constant	300	0...9999 s
td	Derivative time constant	60.0	0.0...2500 s
Y0	Control signal adjustment, for P or PD-type control	0.0	0...100.0 %
to	Pulse repetition period 5)	20.0	5.0...99.9 s

ALAr – Alarm parameters [8]			
A1.SP	Set point value for absolute alarm1	0.0 °C (32.0 °F)	MIN...MAX [6]
A1.du	Deviation from set point for relative alarm 1	2.0 °C (3.6 °F)	See Table no. 3
A1.HY	Hysteresis for alarm 1	1.0 °C (1.8 °F)	0.2...100.0 °C (0.2...180.0 °F)
A1.Lt	Alarm 1 memory	oFF	oFF: disabled on: enabled
A2.SP	Set point for absolute alarm 2	0.0 °C (32.0 °F)	MIN...MAX [6]
A2.du	Deviation from set point for relative alarm 2	2.0 °C (3.6 °F)	See Table no. 3
A2.HY	Hysteresis for alarm 2	1.0 °C (1.8 °F)	0.2...100.0 °C (0.2...180.0 °F)
A2.Lt	Alarm 2 memory	oFF	oFF: disabled on: enabled
SPP – Set point parameters			
SPL	Set point setting lower limit	-50.0 °C (-58.0 °F)	MIN...MAX [6]
SPH	Set point setting upper limit	100.0 °C (212.0 °F)	MIN...MAX [6]
SErv – Service parameters			
SECU	Access code [9]	0	0...9999
St.Fn	Self-tuning function	on	oFF: locked on: available
bu.Fn	Sound signalling function	on	oFF: disabled on: enabled

[1] Parameter changeable depending on the performance code.
[2] Parameter visible only with Pt100-type sensors.
[3] Parameter group visible only when the output is set to the control signal.
[4] Parameter visible only when the control algorithm is set as on-off.
[5] Parameter visible only when the control algorithm is set as PID
[6] See Table no. 2.
[7] Parameter group visible only when the control algorithm is set as PID.
[8] Parameter group visible only when the output is set to alarm.
[9] Parameter hidden when parameters are viewed in the read-only mode.
[10] Parameter visible only when the output 1 function is set to y: control signal. For control with ALG = onoF and y.FL <= 50% the control signal h = 0%, y.FL > 50%, the control signal h = 100%.
[11] Function available only for direct control dir - cooling. Manual or automatic operation of the defrost function will take place only when the measured PV value is lower than the value that causes the end of the defrost (d.SP parameter) and the cooling cycle is completed (i.e. the measured PV value reaches the SP setpoint).
[12] Defrosting continues until the PV measured value reaches the temperature specified by d.SP parameter but not longer than the time set by d.tim parameter. If the sensor is defective, defrosting will end after the time set by d.tim parameter.
[13] Parameters visible only when direct control dir is set.

Measurement ranges for inputs Table 2

Input / sensor	MIN		MAX	
	°C	°F	°C	°F
Pt100 thermistor	-50 °C	-58 °F	100 °C	212 °F
Pt100 thermistor	0 °C	32 °F	250 °C	482 °F
Pt100 thermistor	0 °C	32 °F	600 °C	1112 °F
Pt1000 thermistor	-50 °C	-58 °F	100 °C	212 °F
Pt1000 thermistor	0 °C	32 °F	250 °C	482 °F
Pt1000 thermistor	0 °C	32 °F	600 °C	1112 °F
NTC	-40 °C	-40 °F	100 °C	212 °F

Ranges of deviation from set point Table 3

sensor type	range	
	UNIT = °C [x10]	UNIT = °F [x10]
Pt100 (-50...100°C)	-150...150	-238...302
Pt100 (0...250°C)	-250...250	-418...482
Pt100 (0...600°C)	-600...600	-1048...1112
Pt1000 (-50...100°C)	-150...150	-238...302
Pt1000 (0...250°C)	-250...250	-418...482
Pt1000 (0...600°C)	-600...600	-1048...1112
NTC	-140..140	-220...284

7. CONTROLLER INPUTS AND OUTPUTS

7.1. Measuring Input

The measurement input is a source of the measured value used in the control or for the alarm. Depending on the design, Pt100, Pt1000 or NTC sensors may be connected to the input.

First, use the parameter un it to set the displayed temperature unit. A change of the unit sets factory settings for parameters whose ranges are different for Celsius and Fahrenheit degrees.

The input signal range is set with the parameter in.tY.

An additional parameter is the decimal point position which determines the display format of the measured and set points. It is set with the parameter dP. The measured value indication is adjusted with the parameter Sh iF. For the Pt100 sensor, one may also set the line resistance with the parameter r-Li.

7.2. Binary input

To set the function of the binary input, use the parameter bn. in.

The following functions of the binary input are available:

- no function – the status of the binary input does not affect the controller's operation,
- control stop – the control is interrupted, the control output operates as if the sensor were damaged, the alarm operates independently,
- alarm reset – resetting the alarm memory,
- output control – direct control of inputs (the output status depends of the input status or may be reversed),
- keyboard lock – push-buttons locked in the normal operation mode.
- defrost – defrost function is switched on

7.3. Outputs

The controller has two outputs. Control may only use output 1. Both outputs may be used for alarms and control through the binary input.

8. CONTROL

In the controller you may choose the on-off control or proportional control (PID). For both algorithms you may choose either heating or cooling operation.

8.1. On-off algorithm

When the high accuracy of temperature control is not required, especially for objects with a high time constant and low delay, we may employ on-off control with hysteresis. The advantages of this control method is its simplicity and reliability, while the drawback is the generation of oscillation even with low values of hysteresis.

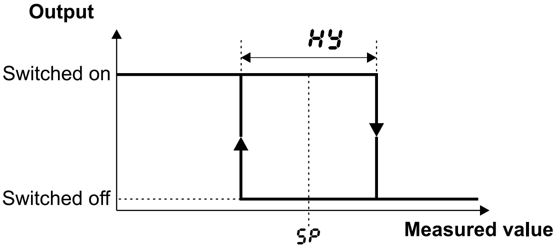


Fig. 4. Heating-type output operation method for on-off control

In addition, you may set the output minimum on time with the parameter t.on and the output minimum off time with the parameter t.oFF.

8.2. SMART PID innovative algorithm

When the high accuracy of temperature control is required, use the PID algorithm. The employed SMART PID algorithm is characterised with improved accuracy for the extended range of control object classes.

The controller is tuned to match the object by way of automatic selection of PID parameters with the self-tuning function or by way of manual setting of the values for proportional, integral and derivative elements.

8.2.1. Pulse repetition period

The pulse repetition period is the time between the subsequent times when the input is enabled during proportional control. Select the duration of the pulse repetition period depending on the dynamic characteristics of the object and as appropriate for the output device. The relay output is used to control the object in slow-changing processes. Employing a long pulse repetition period for controlling fast-changing periods may bring about adverse effects of oscillation. Theoretically, the shorter the pulse repetition period is, the better control; however, for the relay output, it should be as long as possible in order to extend the relay's life.

Impulse period recommendations Table 4

Output	Impulse repetition period	Load
electromagnetic relay	Recommended > 20s min. 10 s	10 A/230 V a.c. or contactor
	min. 5 s	5 A/230 V a.c.

8.2.2. Self-tuning

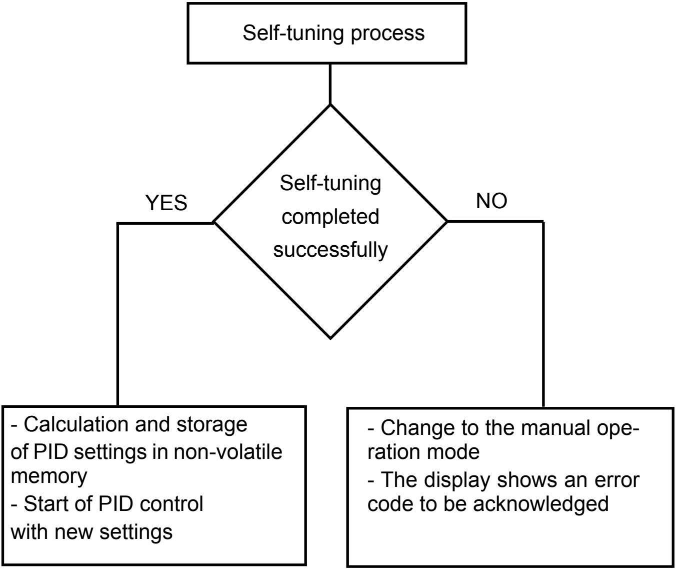
The controller has a function to select PID settings. In most cases the settings ensure optimum control.

To start self-tuning, go to the message tunE (according to Fig. 6) and hold ↵ pressed for 2 seconds at least. If the control algorithm is set to on-off or the self-tuning function is locked, the message tunE is hidden.

To carry out the self-tuning properly, the parameters St.Lo and St.Hi need to be set. Set the parameter St.Lo - St.Hi to a value corresponding the maximum value measured when the full-power control is on.

The lit symbol indicated the active self-tuning function. The self-tuning duration depends on the dynamic characteristics of the object and may take up to 10 hours. During or immediately after self-tuning, overshoots may appear, thus a lower set point should be set if possible.

Self-tuning consists of the following stages:



The self-tuning process will be interrupted and PID settings will not be calculated if there is a loss of power to the controller, if ↵ is pressed or if there is the error ES.01, ES.02. In such a case the control is started with the current PID settings.

If a self-tuning experiment fails, an error code will appear acc. to Table no. 5.

Self-tuning error codes Table 5

Error code	Reason	How to proceed
ES.01	P or PD control has been selected.	Select PI or PID control, i.e.. the TI element needs to exceed zero.
ES.02	Wrong set point.	Change the temperature set point or parameters St.Lo, St.Hi. The set point needs to be within the range: (St.Lo + 10% of the range … St.Hi - 10% of the range) range = St.Hi - St.Lo Example: St.Lo = -50°C, St.Hi = 100°C range = 150°C, 10% of the range = 15°C range of the set point (-35°C...135°C)
ES.03	↵ has been pressed.	
ES.04	The maximum duration of self-tuning has been exceeded.	Check if the temperature sensor is located in the right place and if the set point is not set too high for the object.
ES.05	The change-over waiting time has been exceeded.	

ES.06	The measurement range of the input has been exceeded.	Check the sensor's connection method. Do not let the over-shoot exceed the input's mea-surement range.
ES.20	A very non-linear obje-ct which makes it im-possible to obtain the right values of PID pa-rameters or there has been interference.	Perform self-tuning again. If this does not solve the problem, se-lect PID parameters manually.

8.2.3. Procedure to follow when the PID control is unsatisfactory

It is best to select PID parameters by changing the value to one that is twice higher or twice lower. Observe the following principles when making changes.

a) Stroke slow response:

- reduce the proportional band,
- reduce the integral and derivative time.

b) Overshoots

- increase the proportional band,
- increase the integral time.

c) Oscillations

- increase the proportional band,
- increase the integral time,
- reduce the derivative time.

d) Instability

- increase the integral time.

9. ALARM AND SOUND ALARM

The controller allows for the setting of up to two alarms. The sound alarm is also available. Alarm types are given in Fig. 5.

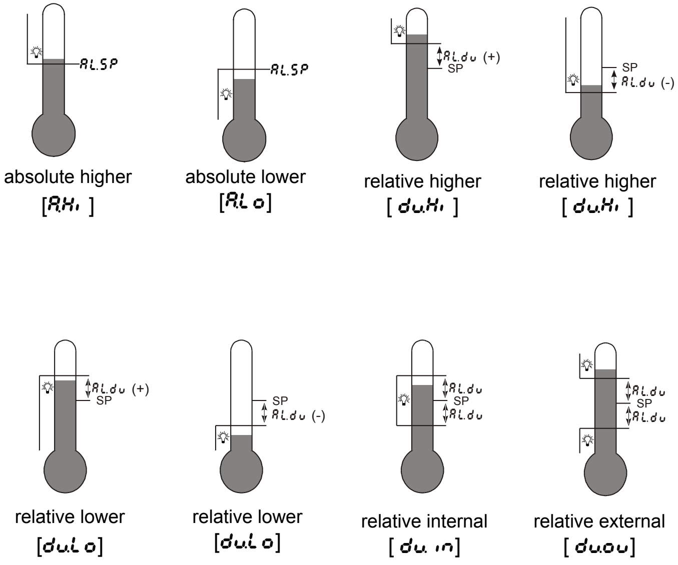


Fig. 5. Alarm types

The set point for absolute alarms is the measured value determined by the parameter A1SP, (A2SP) and for relative alarms is the control deviation (SP – PV) from the set point - the parameter A1du, (A2du). The alarm hysteresis, i.e. the area around the set point in which the output status is not changed, is determined by the parameter A1HY, (A2HY).

The sound alarm is active after at least one alarm occurs. The sound alarm may be turned off by setting the parameter bufn to oFF.

You may set the alarm interlock, which means that the alarm status is remembered once the alarm conditions are removed (parameter Ax.Lt= on). You may reset the alarm memory by pressing ▼ and ▲ at the same time in the normal operation mode or via the interface or binary input.

10. ADDITIONAL FUNCTIONS

10.1. SMART PID innovative algorithm

When you press [↵] the display show the value of the control signal (0...100%). The h symbol appears on the first digit. The control signal may be displayed if the parameter out 1 is set to Y.

10.2. Manual control

Manual control enables you to identify, test the object and control it when the sensor is damaged, among other things.

To enter the manual control mode, hold [↵] while the control signal is displayed. Manual control is indicated by the pulsating LED with the symbol . The controller interrupts the automatic control and starts the manual control of the output. The display shows the value of the control signal preceded by the symbol h.

For the on-off control, the control signal may be set with [▼] and [▲] to 0% or 100%.

For the PID control, the control signal may be set with [▼] and [▲] to any value within 0.0...100%.

To enter the normal operation mode, press [▼] and [▲] at the same time.

10.3 Defrost

The controller is equipped with a defrost function. This function only works when the dir type control (cooling) is switched on. The defrost function can be enabled by setting dEFr parameter to Auto or hAnd or by short-circuit of the contacts at the binary input (when bn.in = dEFr) regardless of the value of defr parameter. The ongoing defrosting process is signaled on the display by alternating display of the measured PV value (for 2 seconds) and defr message (for 1 second)

The defrosting process is performed:

– cyclically after expiration of the defrost switching on interval d.dur if dEFr = Auto,

– on demand when dEFr = hAnd or when binary input terminals are shorted and bn.in = dEFr,

Setting the above parameters do not yet guarantee the implementation of the defrosting process. The defrosting process will only be performed if the following is met:

10.3.1 Additional necessary conditions for switching on the defrosting process:

- the cooling cycle has been completed (PV measured value <= setpoint SP), and
- the cooling output (OUT1) is not controlled, and
- the PV measured value is smaller than the value that switches defrost off d.SP

When all the above conditions needed for switching the defrosting process on are not met, the defrost request is stored in memory (until the power supply is switched off) and the defrost is carried out immediately after **the additional conditions for switching on the defrosting process** are met.

10.3.2 Conditions for terminating the defrosting process:

If d.mod parameter is set to tEmP

- PV measured value must reach the temperature set by d.SP parameter or the defrost time must expire - d.t im parameter.

If d.mod parameter is set to timE

- the defrost time must expire - d.t im parameter.

If the sensor is defective, defrosting will end after the time set by d.t im parameter.

10.3.3 Termination of the defrosting process

The defrosting process can be terminated immediately if:

– manual control is enabled,
– self-tuning process is enabled,
– defrosting process is switched off by setting dEFr = oFF.

10.3.4 Cyclical defrost

The cyclical defrost is enabled by setting dEFr parameter to Auto. Cyclical defrost is carried out at a specified time (when **the additional conditions for switching on the defrosting** process are met) and lasts until the temperature set by d.SP parameter is reached or for a specified time set by d.t im parameter (see **condition for terminating the defrosting process**).

10.3.5 Defrost on demand

The cyclical defrost is activated by setting dEFr = hAnd or when binary input terminals are shorted and bn. in = dEFr,

• Defrosting using the binary input

The activation of defrosting request takes place when the contacts on the binary input are shorted if bn. in parameter is set to dEFr value, regardless of the value of dEFr parameter.

The defrosting process will start immediately if the additional conditions for switching on the defrosting process are met, otherwise it is paused until they are met.

The defrosting process ends when **the conditions for terminating the defrosting process** are met, regardless of the state of the binary input.

Subsequent activation of the defrosting process via the binary input is possible after re-opening and shorting of contacts at the binary input (reaction to the edge)

If dEFr parameter is set to Auto, after defrosting, the subsequent defrosting processes are carried out cyclically according to the time set by d.dur parameter.

• Defrosting by setting the dEFr parameter = hAnd

The defrosting process will start immediately if **the additional conditions for switching on the defrosting** process are met, otherwise it is paused until they are met. Defrosting will be performed only once and after the defrosting process is completed dEFr parameter will be set to oFF.

10.3.6. Using OUT2 output in the defrosting process

In order to speed up the defrosting process, you can use the Out2 output to switch on the fans or additional heaters. To use the Out2 output in the defrosting process, out2 parameter should be set to dEFr.

10.3. Factory settings

You may restore the factory setting by holding ▼ and ▲ when powering on until the word FAbr appears in the display.

11. PROGRAMMING INTERFACE

11.1. Introduction

The controller RE01 has a serial interface for configuration by means of the programmer PD14. The MODBUS communication protocol is implemented in the interface. The interface is used only to configure the controller before you start to use it. You may do it with the free software available at www.lumel.com.pl.

List of parameters of the serial interface in the controller RE01:

- device address: 1,
- baud rate: 9600 bit/s,
- operating mode: RTU,
- information unit: 8N2,
- data format: integer (16 bit),
- maximum response time: 500 ms,
- maximum number of registers read/written with one command: 40.

The controller RE01 performs the following protocol functions:

Table 6

Code	Meaning
03	read out of n-registers
06	write of 1 register
16	write of n-registers
17	identification of the slave device

11.2. Error Codes

If the controller receives a query with a transmission error or checksum error, it will be ignored. For a query which is synthetically correct but has wrong values, the controller will send a response with an error code.

Table no. 7 lists possible error codes and their meanings.

Error codes

Table 7

Code	Meaning	reason
01	unacceptable function	the function is not handled by the controller
02	unacceptable data address	the register's address is out of the range
03	unacceptable value of data	the register's value is out of the range

11.3. Register Map

In the controller, data is stored in 16-bit registers. The number of registers for writing and readout is given in Table no. 8. The „R-" operation stands for the readout possibility, the „-W" operation for the writing possibility and the „RW" operation for the readout and writing possibilities.

Register map from address 4000 Table 8

register's address	designation	operations	parameter range	description
4000		-W	1…3	Command register 1 – restore factory settings (for °C) 2 – restore factory settings (for °F) 3 – reset the alarm memory
4001		R-	100…999	Software version number [x100]
4002			1…3	Controller performance code 1 – Pt100 input 2 – Pt1000 input 3 – NTC input 2.7k
4003		R-	1301…9999	4 older digits of the serial number
4004		R-	1…9999	4 younger digits of the serial number
4005		R-	0…0xFFFF	Controller status – description in Table no. 9
4006		R-	0…0xFFFF	Error register – description in Table no. 10
4007		R-	as per Table no. 11	Measured value PV
4008		RW	as per Table no. 11	Set point SP
4009		R-	0…1000	Control signal [% x10]
4010	UNIT	RW	0…1	Unit 0 – Celsius degrees 1 – Fahrenheit degrees

4011	INPT	RW	0…6	Main input type: 0 – Pt100 (-50...100°C) 1 – Pt100 (0...250°C) 2 – Pt100 (0...600°C) 3 – Pt1000 (-50...100°C) 4 – Pt1000 (0...250°C) 5 – Pt1000 (0...600°C)
4012	R-LI	RW	0…150 [x10 W]	Line resistance
4013	DP	RW	0…1	Decimal point position for the main input 0 – no decimal place 1 – 1 decimal place
4014	SHIF	RW	-1000…1000 [x10 °C] -1800…1800 [x10 °F]	Measured value shift for the main input
4015	BNIN	RW	0…5	Binary input function 0 – none 1 – control stop 2 – reset of alarms 3 – control of outputs 4 – keyboard lock 5 – defrost function on
4016	OUT1	RW	0…9	Output 1 function 0 – off 1 – control signal 2 – absolute higher alarm 3 – absolute lower alarm 4 – relative higher alarm 5 – relative lower alarm 6 – relative internal alarm 7 – relative external alarm 8 – direct control through binary input 9 – inverse control through binary input

4017	OUT2	RW	0…9	Output 2 function 0 – off 1 – absolute higher alarm 2 – absolute lower alarm 3 – relative higher alarm 4 – relative lower alarm 5 – relative internal alarm 6 – relative external alarm 7 – direct control through binary input 8 – inverse control through binary input 9 – output controlled during defrost
4018	ALG	RW	0…1	Control algorithm 0 – on-off 1 – PID
4019	TYPE	RW	0…1	Control type 0 – direct control – cooling 1 – inverse control – heating
4020	HY	RW	2…1000 [x10 °C] 2…1800 [x10 °F]	Hysteresis HY
4021	TON	RW	0…999 [s]	Output 1 minimum on time
4022	TOFF	RW	0…999 [s]	Output 1 minimum off time
4023	STLO	RW	as per Table no. 11	Lower threshold for self--tuning
4024	STHI	RW	as per Table no. 11	Upper threshold for self--tuning
4025	PB	RW	1…5500 [x10 °C] 1…9900 [x10 °F]	Proportional band PB
4026	TI	RW	0…9999	Integral time constant TI [s]
4027	TD	RW	0…25000	Derivative time constant TD [s x10]
4028	Y0	RW	0…1000	Control signal adjustment Y0 (for P or PD control) [% x10]

4029	TO	RW	50…999	Output pulse repetition period [s x10]
4030	A1SP	RW	as per Table no. 11	Set point for absolute alarm 1 [x10]
4031	A1DV	RW	as per Table no. 12	Deviation from set point for relative alarm 1
4032	A1HY	RW	2…1000 [x10 °C] 2…1800 [x10 °F]	Hysteresis for alarm 1
4033	A1LT	RW	0…1	Alarm 1 memory 0 – off 1 – on
4034	A2SP	RW	as per Table no. 11	Set point for absolute alarm 2 [x10]
4035	A2DV	RW	as per Table no. 12	Deviation from set point for relative alarm 2
4036	A2HY	RW	2…1000 [x10 °C] 2…1800 [x10 °F]	Hysteresis for alarm 2
4037	A2LT	RW	0…1	Alarm 2 memory 0 – off 1 – on
4038	SPL	RW	as per Table no. 11	Set point change lower limit
4039	SPH	RW	as per Table no. 11	Set point change upper limit
4040	SECU	RW	0…9999	Code of access to menu
4041	STFN	RW	0…1	Self-tuning function 0 – locked 1 – unlocked
4042	BUFN	RW	0…1	Sound signalling function 0 – off 1 – on
4043	YFL	RW	0..1000	Control output control signal for sensor failure [1)]

4044	DEFR	RW	0...2	Defrost function [2) 4)] 0 – defrost function switched off 1 – defrost at time interval 2 – defrost function manually on
4045	DMOD	RW	0...1	Defrost function operation mode [4)] 0 - defrost for a period of time set by dt in parameter 1 - defrost until temperature set by dSP parameter is reached [3)]
4046	DTIM	RW	1...10 [h]	Defrost duration [4)]
4047	DSP	RW	0...100 [x10 °C] (320...500 [x10 °F])	Defrost termination temperature [4)]
4048	DDUR	RW	10...168 [h]	Time interval for defrost switching on [4)]

1) For control with ALG = onoF and YFL <= 50% the control signal h = 0%, YFL > 50%, the control signal h = 100%.

2) Function available only for direct control dir - cooling. Manual or automatic operation of the defrost function will take place only when the measured PV value is lower than the value that causes the end of the defrost (dSP parameter) and the cooling cycle is completed (i.e. the measured PV value reaches the SP setpoint).

3) Defrosting continues until the PV measured value reaches the temperature specified by dSP parameter but not longer than the time set by dt in parameter. If the sensor is defective, defrosting will end after the time set by dt in parameter.

4) Parameters visible only when direct control dir is set.

Register 4005 – controller status Table 9

bit	description
0-7	Reserved
8	Defrosting: 0 – none, 1 – in progress
9	Binary input status: 0 – open, 1 - closed
10	Self-tuning" 0 – no self-tuning, 1 – active self-tuning
11	Automated/manual control: 0 – auto, 1 – manual
12	Alarm 1 status: 0 – disabled, 1 – enabled
13	Alarm 2 status: 0 – disabled, 1 – enabled
14	Measured value out of the measuring range
15	Controller error – see the error register

Register 4006 – error register Table 10

bit	description
0-13	Reserved
9	Out-of-scale input
10	CRC error of configuration parameters

Input ranges Table 11

sensor type	range	
	UNIT = °C [x10]	UNIT = °F [x10]
Pt100 (-50...100°C)	-500...1000	-580...2120
Pt100 (0...250°C)	0...2500	320...4820
Pt100 (0...600°C)	0...6000	320..11120
Pt1000 (-50...100°C)	-500...1000	-580..2120
Pt1000 (0...250°C)	0..2500	320..4820
Pt1000 (0...600°C)	0..6000	320..11120
NTC	-400...1000	-400..2120

Ranges of deviation from set point Table 12

sensor type	range	
	UNIT = °C [x10]	UNIT = °F [x10]
Pt100 (-50...100°C)	-1500...1500	-2380...3020
Pt100 (0...250°C)	-2500...2500	-4180...4820
Pt100 (0...600°C)	-6000...6000	-10480...11120
Pt1000 (-50...100°C)	-1500...1500	-2380...3020
Pt1000 (0...250°C)	-2500...2500	-4180...4820
Pt1000 (0...600°C)	-6000...6000	-10480...11120
NTC	-1400...1400	-2200...2840

12. ERROR SIGNALING

Sign messages to indicate the controller's malfunction Table 13

Error code	Reason	Procedure
	Measuring underrange or lack of thermistor	Check, if the input signal values are within the appropriate range; if so, check whether there is a short-circuit in the thermistor.
	Measuring overrange or the sensor circuit interrupted	Check, if the input signal values are within the appropriate range; if so, check whether the sensor circuit is not interrupted.
	Out-of-scale input	Again connect the power supply to the controller; if the problem still persists, contact the nearest service centre.
	Configuration parameter checksum error	Again connect the power supply to the controller; if the problem still persists, contact the nearest service centre.

13. TECHNICAL DATA

Input signals according to Table no. 14

Input signals and measuring ranges Table 14

Sensor type	Standard	Designa-tion	Range
Pt100	EN 60751+A2:1997	Pt100	(-50…100 °C) (0…250 °C) (0…600 °C)
Pt1000	EN 60751+A2:1997	Pt1000	(-50…100 °C) (0…250 °C) (0…600 °C)
NTC		NTC 2.7K	(-40…100 °C)

Sensor line resistance <10 Ω /wire; for the connection, use wires with the same size and length

Fundamental error of measurement of the measured value

- 0.5% of the measuring range,

Measurement time 0.25 s

Detection of error in the measuring circuit:

Pt100, PT1000, NTC measuring out of range

Binary input - voltage binary input, without galvanic insulation on the sensor side,

Output types:

– output 1 - relay, no-voltage output	change-over contact, load capacity 10 A/250 V a.c., 10 A/30 V d.c. minimum 100 thousand change-over cycles for the maximum load
– output 2 - relay, no-voltage output	normally open contact, load capacity 5 A/250 V a.c., 5 A/28 V d.c. minimum 100 thousand change-over cycles for the maximum load

Output one operation method:

- inverse	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
- air relative humidity	< 95 % (no condensation of steam)
- pre-heating time	30 min
- operating position	any

Power input < 4 VA

Weight < 0.25 kg

Protection grade ensured by the casing acc. to EN 60529

- from the frontal plate	IP65
- from the terminal side	IP20

Additional errors in rated operating conditions caused by:

- a change in the line resistance of the thermal resistance sensor	≤ 50% of the fundamental error value
- a change in the ambient temperature	≤ 100% of the fundamental error value /10 K

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

- insulation between circuits	basic
- installation category	III,
- pollution level	2,
- maximum phase-to-earth operating voltage:	
- for supply circuits, output	300 V
- for input circuits	50 V
- altitude above sea level	< 2000 m

Electromagnetic compatibility

- noise immunity	acc. to EN 61000-6-2 standard
- noise emissions	acc. to EN 61000-6-4 standard

14. CONTROLLER VERSION CODES

The coding is given in Table no. 15.

Table 15

Ordering Code	Description
RE01 100M0*	Controller RE01 1x input Pt100, 2x relay output, supply 230VAC, documentation and descriptions in Polish and English, test certificate

* Upon agreement, an option to order a calibration certificate for the product is available against payment. Then, in the execution code, in the place of the last character, enter the digit **2**, e.g. **RE01 100M2**. The customer will then receive a standard test certificate and a calibration certificate (against payment).

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RE01-09B-R1