



TCR10

Single-channel microprocessor PID controller

User guide

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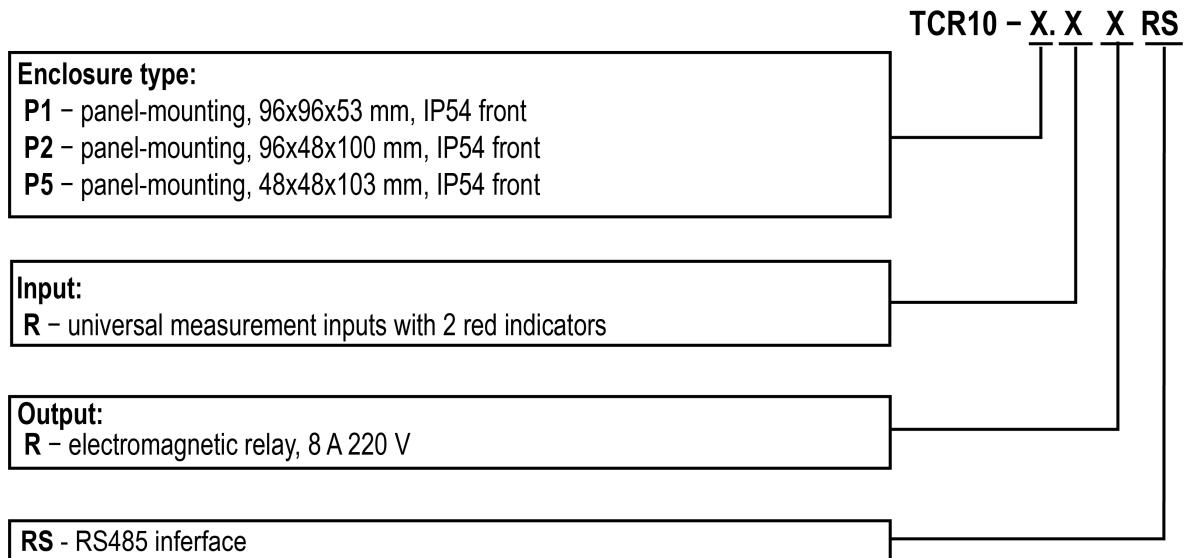
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1 Introduction

This user guide is intended to familiarize the operating personnel with the device, principle of operation, design, technical operation and maintenance of the TCR10 single-channel microprocessor PID controller, hereinafter referred to as "device" or "TCR10".

Connection, setup and maintenance of the device must be performed only by fully qualified personnel after reading this user guide.

The device has the following modifications. The marking is explained below:



1.1 Symbols and key words


WARNING

WARNING indicates a potentially dangerous situation that could result in death or serious injuries.


CAUTION

CAUTION indicates a potentially dangerous situation that could result in minor injuries.


NOTICE

NOTICE indicates a potentially dangerous situation that could result in damage to property.


NOTE

NOTE indicates helpful tips and recommendations, as well as information for efficient and trouble-free operation.

1.2 Recycling and disposal



The device is considered an electronics device for disposal in terms of European Directive 2012/19/EU and may not be disposed of as domestic garbage.

- Dispose of the device through channels provided for this purpose.
- Comply with all local and currently applicable laws and regulations.

1.3 Terms and abbreviations

- **CJS** – Cold junction sensor
- **CJC** – Cold junction compensation
- **NSC** – Nominal static characteristic
- **PC** – Personal computer

1 Introduction

- **TC** – Thermocouple
- **RTD** – Resistance temperature detector
- **PWM** – Pulse width modulation
- **DO** – Digital output
- **AI** – Analog input
- **ADC** – Analog digital converter
- **PID** – Proportional–integral–derivative (controller)

1.4 Intended use

The device has been designed and built solely for the intended use described here, and may only be used accordingly. The technical specifications contained in this document must be observed. The device may be operated only in properly installed condition.

Improper use

Any other use is considered improper. Especially to note:

- The device may not be used for medical applications.
- The device may not be used in explosive environment.
- The device may not be used in atmosphere in which there are chemically active substances.

1.5 Limitation of liability

Our company does not bear any responsibility with respect to breakdowns or damages caused by using the product in a manner other than described in the manual or in violation of the current regulations and technical standards.

1.6 Safety



WARNING

Ensure the mains voltage matches the voltage marked on the nameplate. Ensure the device is provided with its power supply line and electric fuse.



WARNING

The device terminals may be under a dangerous voltage. Before working on the device, de-energize it and all connected devices. Switch on the power supply only after completing all work on the device.



NOTICE

If the device is brought from a cold to a warm environment, condensation may form inside the device. To avoid damage to the device, keep the device in the warm environment for at least 1 hour before powering on.



NOTICE

Do not connect wires to unused terminals.

1.7 Indicator symbols

The indicator symbols correspond to the Latin letter as shown below:

A	b	C	d	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A	b	C	d	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

2 Overview

The device is designed to measure and automatically control temperature (using RTD or TC as sensors), as well as other physical parameters (pressure, humidity, flow, level, etc.), the value of which can be converted by sensors into DC voltage or a unified electric signal (U / I signals), in units of physical quantity or in percent of the maximum value.

Main functions:

Input signals:

- Measuring temperature, pressure, humidity, flow, level, etc. via one channel
- Input signal processing:
 - Digital filtering and correction
 - Input signal scaling
- Calculation and indication of:
 - The square root of the measured value
- Operation with sensors connected through an intrinsic safety barrier
- Analyzing the dynamics of input signals (growth, fall, hold)

Indication and setup:

- Displaying the current measured value, setpoint, output power, calculated mathematical function, signal dynamics on the digital indicator
- Automatic switching of parameters displayed on the digital indicator
- Reset the device to factory settings
- Hiding menu items and protecting from editing parameters

Executing mechanism control:

- Configurable logic unit operation ("heating", "cooling", signaling device, PID controller)
- Generation of output current 4...20 mA or voltage 0...10 V for control in accordance with "Alarm within limits"-rule

Failure handling:

- Monitoring the break and "sticking" in the control loop, the sensor break and the measured signal out the limits for the selected sensor type
- Automatic restoration of the control process when the problem of a sensor break or readings out the measuring range limits is eliminated
- Switching the outputs to the safe state in case of failure and in the Stop mode

USB Type-C interface:

- Device configuration via a PC

RS485 interface:

- Data logging and device configuration via a PC over RS485
- Remote process control (start, stop, change of modes and set points)

3 Specifications and environmental conditions

3.1 Specifications

Table 3.1 Specifications

Parameter	Value
Electrical	
Power supply	<ul style="list-style-type: none"> – 230 (90...264) V AC at 50 (47...63) Hz – 24 (21...120) V DC
Power consumption, max.	<ul style="list-style-type: none"> – 11 VA – 9 W
Appliance class	II
Measuring input	
Number	1
Sampling time, max.	1 s
Full-scale accuracy ¹⁾	
– RTD	0.25 %
– TC with CJC enabled	0.5 %
– TC with CJC disabled	0.25 %
– I signals (4...20 mA, 0...5 mA, 0...20 mA)	0.25 %
– U signals (–50...+50 mV, 0...1 V, 0...5 V, 0...10 V)	0.25 %
Temperature influence	
– In current measurement mode	0.25 % of full-scale accuracy limit / 10 °C
– In voltage measurement mode	0.25 % of full-scale accuracy limit / 10 °C
– For TC, max	0.25 % of full-scale accuracy limit / 10 °C
– For RTD, max	0.25 % of full-scale accuracy limit / 10 °C
Input resistance at voltage measuring, min.	300 kΩ
Maximum permissible voltage at the measuring terminals	12 V
Time to readiness for measuring input signals, max.	10 min
Digital input	
Number	1
Maximum input current, min.	10 mA
Maximum permissible voltage at terminals	12 V
Switch type	NPN transistor (open collector), switch contact
Galvanic isolation	No
Processing frequency of the digital input signal	1 Hz (no high-frequency signals)

Parameter	Value
Outputs	
Number	2 (see Table 3.3)
Configuration interface	
Type	USB CDC
Connector	USB Type-C
Protocol	Modbus RTU
Mode	Client (Slave)
Device power supply	Yes (indication works)
Consumption current, max.	500 mA
Cable length, max	3 m
Data exchange interface	
Interface	RS485
Data exchange protocol	Modbus RTU, Modbus ASCII
Mode	Client (Slave)
Baud rate	2.4; 4.8; 9.6; 14.4; 19.2; 28.8; 38.4; 57.6; 115.2 kbps
Data exchange parameters	7e1 ² , 7e2 ² , 7o1 ² , 7o2 ² , 8n1, 8n2, 8e1, 8e2, 8o1, 8o2
Device response delay	0...20 ms
Mechanical	
Dimensions	
– P1 enclosure	(96 × 96 × 53) ± 1 mm
– P2 enclosure	(96 × 48 × 100) ± 1 mm
– P5 enclosure	(48 × 48 × 103) ± 1 mm
IP code (front / rear)	IP54 / IP20
Weight (gross / net)	approx. 400 g / 250 g
Average service life	12 years
<div>  NOTE ¹⁾ Taking into account the ageing over the verification interval. For the RTD, data is with CJC enabled. ²⁾ Modbus ASCII only. </div>	

Table 3.2 Sensors and input signals

Description	Measurement range	Measurement resolution, not less	Value of the least significant digit ¹⁾
RTD			
50M ($\alpha = 0,00428 \text{ }^{\circ}\text{C}^{-1}$)	–180...+200 °C	0.1 °C	0.1; 1.0 °C
Pt50 ($\alpha = 0.00385 \text{ }^{\circ}\text{C}^{-1}$)	–200...+850 °C		0.1; 1.0 °C

Description	Measurement range	Measurement resolution, not less	Value of the least significant digit ¹⁾
50P ($\alpha = 0.00391\text{ }^{\circ}\text{C}^{-1}$)	−200...+850 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
Cu50 ($\alpha = 0.00426\text{ }^{\circ}\text{C}^{-1}$)	−50...+200 $^{\circ}\text{C}$		0.1 $^{\circ}\text{C}$
100M ($\alpha = 0.00428\text{ }^{\circ}\text{C}^{-1}$)	−180...+200 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
Pt100 ($\alpha = 0.00385\text{ }^{\circ}\text{C}^{-1}$)	−200...+850 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
100P ($\alpha = 0.00391\text{ }^{\circ}\text{C}^{-1}$)	−200...+850 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
Cu100 ($\alpha=0.00426\text{ }^{\circ}\text{C}^{-1}$)	−50...+200 $^{\circ}\text{C}$		0.1 $^{\circ}\text{C}$
100N ($\alpha = 0.00617\text{ }^{\circ}\text{C}^{-1}$)	−60...+180 $^{\circ}\text{C}$		0.1 $^{\circ}\text{C}$
500M ($\alpha = 0.00428\text{ }^{\circ}\text{C}^{-1}$)	−180...+200 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
Pt500 ($\alpha = 0.00385\text{ }^{\circ}\text{C}^{-1}$)	−200...+850 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
500P ($\alpha = 0.00391\text{ }^{\circ}\text{C}^{-1}$)	−200...+850 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
Cu500 ($\alpha = 0.00426\text{ }^{\circ}\text{C}^{-1}$)	−50...+200 $^{\circ}\text{C}$		0.1 $^{\circ}\text{C}$
500N ($\alpha = 0.00617\text{ }^{\circ}\text{C}^{-1}$)	−60...+180 $^{\circ}\text{C}$		0.1 $^{\circ}\text{C}$
1000M ($\alpha = 0.00428\text{ }^{\circ}\text{C}^{-1}$)	−180...+200 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
Pt1000 ($\alpha = 0.00385\text{ }^{\circ}\text{C}^{-1}$)	−200...+850 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
1000P ($\alpha = 0.00391\text{ }^{\circ}\text{C}^{-1}$)	−200...+850 $^{\circ}\text{C}$		0.1; 1.0 $^{\circ}\text{C}$
Cu1000 ($\alpha = 0.00426\text{ }^{\circ}\text{C}^{-1}$)	−50...+200 $^{\circ}\text{C}$		0.1 $^{\circ}\text{C}$
1000N ($\alpha = 0.00617\text{ }^{\circ}\text{C}^{-1}$)	−60...+180 $^{\circ}\text{C}$		0.1 $^{\circ}\text{C}$
TC			
L	−200...+800 $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
E	−200...+900 $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$
J	−200...+1200 $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
S	−50...+1750 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
N	−200...+1300 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
K	−200...+1360 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
R	−50...+1750 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
B	+200...+1800 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
A-1	0...+2500 $^{\circ}\text{C}$	0.4 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
A-2	0...+1800 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
A-3	0...+1800 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
T	−250...+400 $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	0.1; 1.0 $^{\circ}\text{C}$
Unified signals			
0...1 V	0...1 V	0.1 mV	0.001 V
0...5 mA	0...5 mA	0.01 mA	0.001 mA
0...20 mA	0...20 mA	0.01 mA	0.01 mA

Description	Measurement range	Measurement resolution, not less	Value of the least significant digit ¹⁾
4...20 mA	4...20 mA	0.01 mA	0.01 mA
DC voltage signal			
–50...+50 mV	–50...+50 mV	0.01 mV	0.01/0.1 ²⁾
Unified signals			
0...5 V	0...5 V	0.1 mV	0,001 V
0...10 V	0...10 V	0.1 mV	0.001 V
Pyrometers³⁾			
RK–15	+400...+1500 °C	0.1 °C	1
RK–20	+600...+2000 °C	0.1 °C	1
RS–20	+900...+2000 °C	0.1 °C	1
RS–25	+1200...+2500 °C	0.1 °C	1
Non-standard signals³⁾			
Cu53 ($\alpha = 0.00426 \text{ °C}^{-1}$)	–50...+200 °C	0.1 °C	0.1
Typ L in accordance with DIN 43710	0...+900 °C	0.1 °C	0.1
i NOTE ¹⁾ It depends on the dPt decimal point position parameter and the value of $ind.L$ and $ind.H$ parameters. ²⁾ It is 0.01 mV at the input signal within –19.99 ... 50.00 mV and 0.1 mV at the input signal within –50.0...–20.0 mV. ³⁾ Maximum allowed basic measurement error (reduced to measurement range) is not more than 0.5% for pyrometers and not more than 0.25% for Cu53 ($\alpha = 0.00426 \text{ °C}^{-1}$).			

Table 3.3 In-built output

Designation	Type	Specifications
Digital output		
R	electromagnetic relay contacts	Max current 8 A at AC voltage $\leq 250 \text{ V}$ and $\cos(\varphi) > 0.9$ Max current 3 A at DC voltage $\leq 30 \text{ V}$

3.2 Environmental conditions

The device is designed for natural convection cooling which should be taken into account when choosing the installation site.

The following environmental conditions must be observed:

- clean, dry and controlled environment, low dust level
- closed non-hazardous areas, free of corrosive or flammable gases

Table 3.4 Environmental conditions

Condition	Permissible range
Ambient temperature	–40...+55 °C
Relative humidity	up to 80 % (non-condensing)
Altitude	up to 2000 m ASL
Vibration / shock resistance	conforms to IEC 61000-6-2:2005
EMC emission / immunity	

**NOTE**

Requirements regarding external factors are mandatory as they relate to safety requirements.

4 Mounting

4.1 Mounting the device (P1 enclosure)

To mount the device:

1. Using the supplied cutout template, prepare the mounting cutout in the control panel where the device should be mounted (see [Fig. 4.2](#)).
2. Ensure the sealing gasket is not damaged and installed evenly on the device enclosure.
3. Place the device with the installed gasket in the prepared mounting cutout.
4. Insert the supplied retainers in the holes on the sides of the device vertically or horizontally.



NOTE

The scope of delivery includes two retainers. The figures show all possible positions of the retainers.

5. Screw the supplied screws into the holes of each retainer so that the device is pressed firmly and evenly against the front of the control panel.

Removing proceeds in the reverse order.

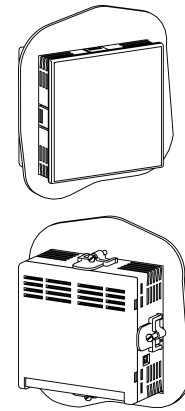


Fig. 4.1 Mounting the device (P1 enclosure)

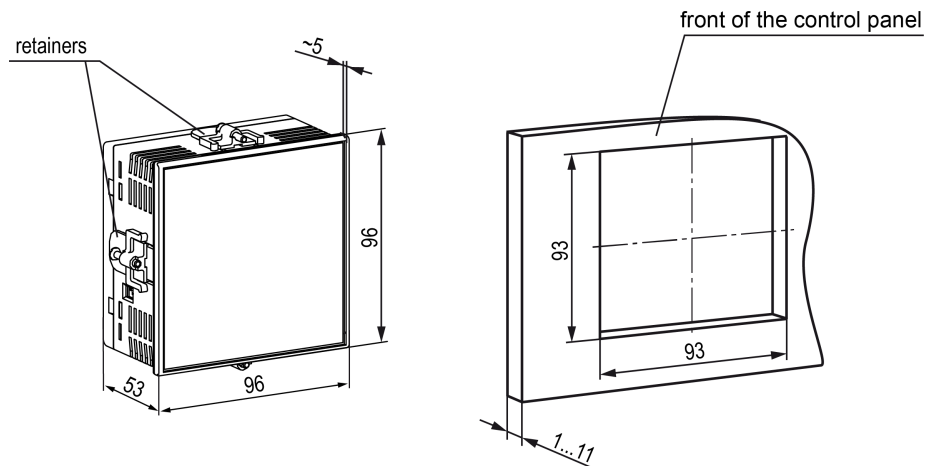


Fig. 4.2 Dimensions of P1 enclosure and mounting cutout

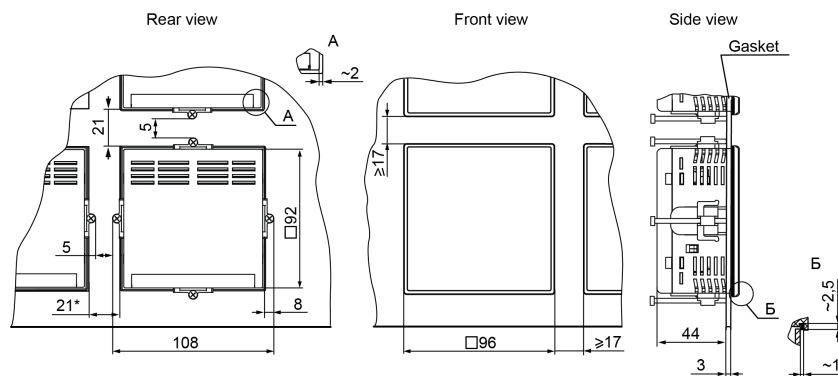


Fig. 4.3 Device in P1 enclosure mounted in 3 mm thick control panel



NOTE

* Minimum mounting distance. The recommended distance for convenient connection of the USB type-C connector is 60 mm.

4.2 Mounting the device (P2 enclosure)

To mount the device:

1. Using the supplied cutout template, prepare the mounting cutout in the control panel where the device should be mounted (see [Fig. 4.5](#)).



NOTE

The mounting cutout dimensions shown in [Fig. 4.5](#) are selected to ensure IP54 on the front of the control panel. When preparing the cutout, it is advisable to take into account the features of the tool used.

2. Ensure the sealing gasket is not damaged and installed evenly on the device enclosure.
3. Place the device with the installed gasket in the prepared mounting cutout.
4. Insert the supplied retainers in the holes on the sides of the device vertically or horizontally.



NOTE

The scope of delivery includes two retainers. The figures show all possible positions of the retainers.

5. Screw the supplied screws into the holes of each retainer so that the device is pressed firmly and evenly against the front of the control panel.

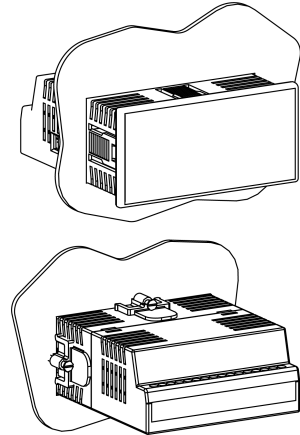


Fig. 4.4 Mounting the device (P2 enclosure)

Removing proceeds in the reverse order.

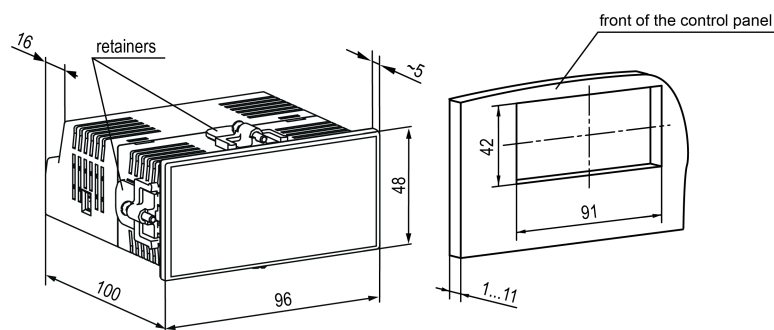


Fig. 4.5 Dimensions of P2 enclosure and mounting cutout

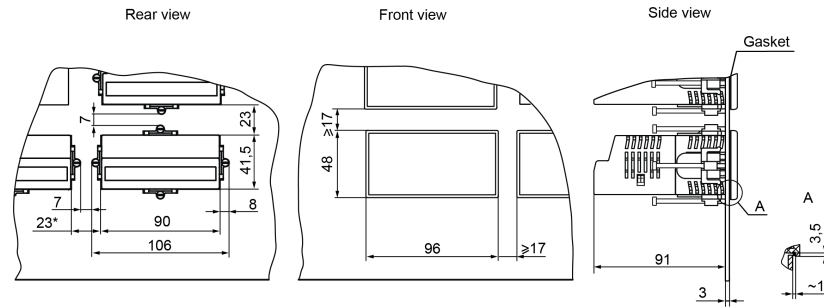


Fig. 4.6 Device in P2 enclosure mounted in 3 mm thick control panel



NOTE

* Minimum mounting distance. The recommended distance for convenient connection of the USB type-C connector is 60 mm.

4.3 Mounting the device (P5 enclosure)

To mount the device:

1. Using the supplied cutout template, prepare the mounting cutout in the control panel where the device should be mounted (see [Fig. 4.8](#)).
2. Ensure the sealing gasket is not damaged and installed evenly on the device enclosure.
3. Place the device with the installed gasket in the prepared mounting cutout.
4. Insert the supplied retainers in the holes on the sides of the device vertically or horizontally.



NOTE

The scope of delivery includes two retainers. The figures show all possible positions of the retainers.

5. Screw the supplied screws into the holes of each retainer so that the device is pressed firmly and evenly against the front of the control panel.

Removing proceeds in the reverse order.

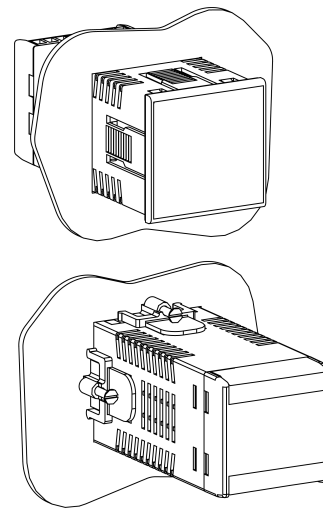


Fig. 4.7 Mounting the device (P5 enclosure)

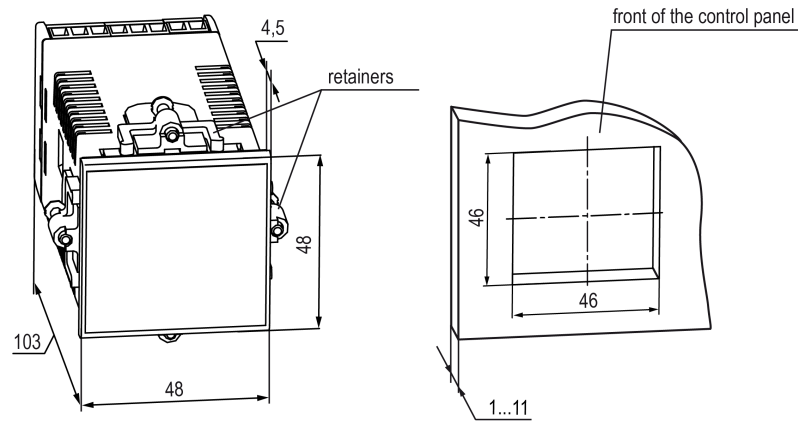


Fig. 4.8 Dimensions of P5 enclosure and mounting cutout

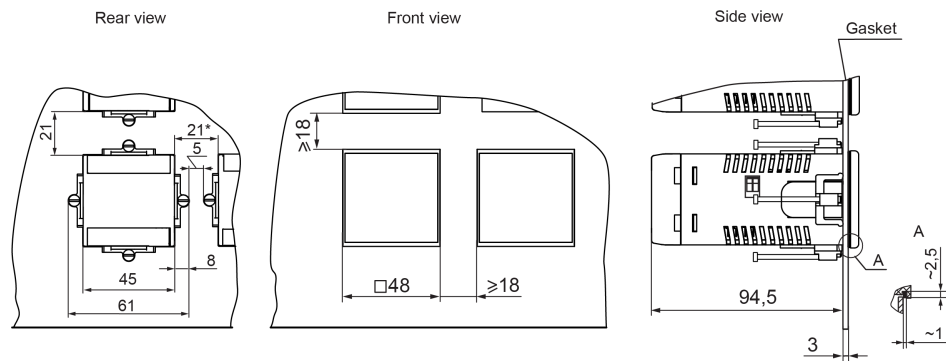


Fig. 4.9 Device in P5 enclosure mounted in 3 mm thick control panel



NOTE

* Minimum mounting distance. The recommended distance for convenient connection of the USB type-C connector is 60 mm.

5 Electrical connections

5.1 Wiring recommendations

To ensure the reliability of electrical connections, use copper single or multi-core cables. The wire ends should be carefully stripped. Multi-core wires should be tinned or use cable lugs. Cable cross section requirements are shown in the figure below:

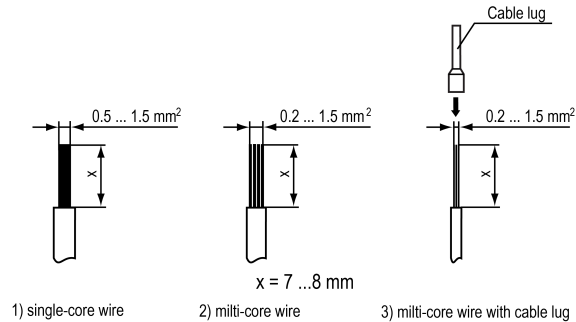


Fig. 5.1 Cable requirements

General requirements for connection lines:

- Signal cables should be routed separately from the power supply cables as well as from the cables which are sources of high-frequency and impulse interference.
- To protect the device input from the influence of industrial electromagnetic interference, the “device-sensor” communication lines should be shielded. Special cables with shielding or grounded steel pipes of suitable diameter can be used as screens. The cable shielding should be connected to the functional ground terminal (FE) in the control panel.
- Network interference filters should be installed in the power supply lines.
- Spark-suppression filters should be installed in the power equipment switching lines.

When mounting the system where the device is used, the rules for effective grounding should be taken into account:

- All grounding lines must be laid in “star”-connected circuit, ensuring good contact with the grounding element.
- All earthing circuits must be made with wires of the largest possible cross-section.
- It is forbidden to connect the device terminals with grounding lines.

5.2 Galvanic isolation

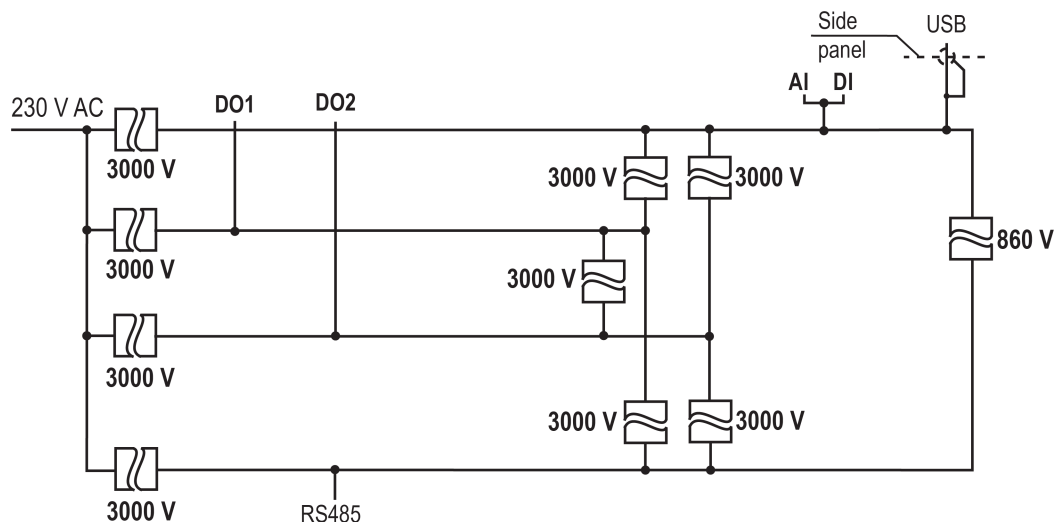


Fig. 5.2 Galvanic isolation

5.3 Startup



NOTICE

After unpacking the device, ensure it has not been damaged during transportation.

Startup procedure:

1. Connect the "device - sensors" communication lines to sensors and device inputs.
2. Connect the device to the power supply.



NOTICE

Check the voltage before powering on.

3. Power on the device.



NOTICE

To avoid damage to the object of control, do not connect the control circuits before setting up the device.

4. Set up the device.
5. Power off the device.

5.4 Terminal assignment



NOTE

If a DC power supply is used, the polarity may not be observed during connection to the mains terminals.

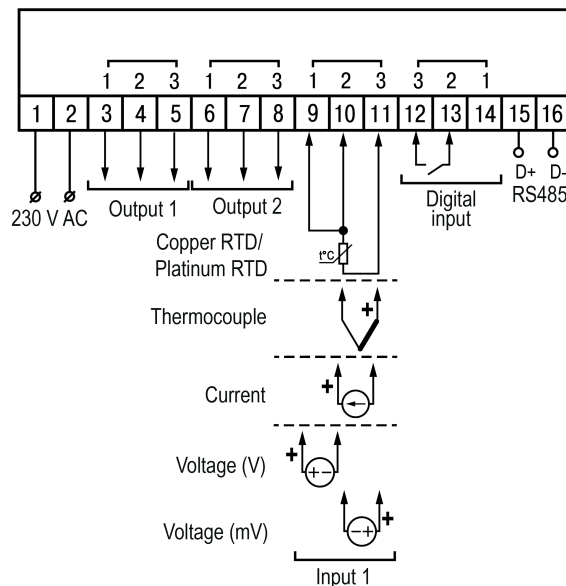


Fig. 5.3 Terminal assignment for P1 / P2 enclosure

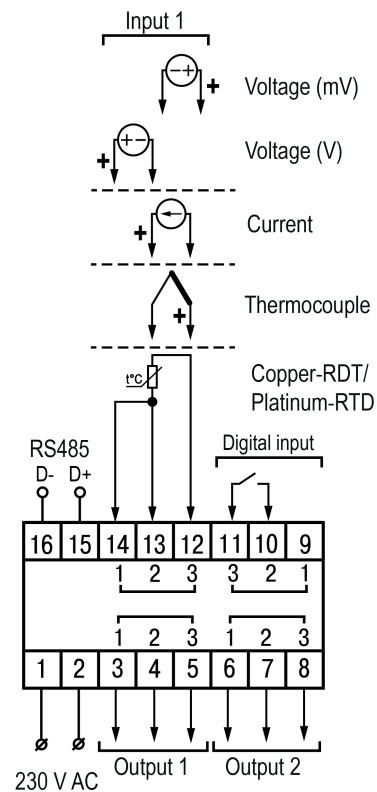


Fig. 5.4 Terminal assignment for P5 enclosure

5.5 Connection over USB

To configure the device, use the USB interface (see [Section 7.1](#)). Set up the device using *akYtec Tool Pro* (hereinafter referred to as well as "configurator"). Connection to *akYtec Tool Pro* is described in [Section 7.1](#).

i **NOTE**
USB is for setup only.

To connect over USB, use a USB type C — USB A cable.

i **NOTE**
A USB cable is not included in the scope of delivery.

You can set up the device via the USB interface without main power supply. The RS485 interface doesn't work when the device is powered via USB.

The USB port position depends on the enclosure type and is shown in the figures below.

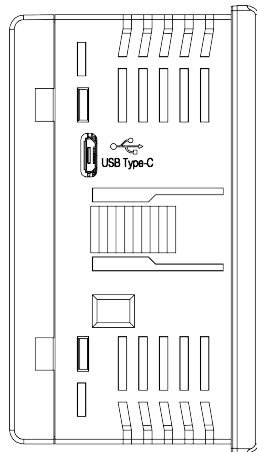


Fig. 5.5 USB port in P1 enclosure

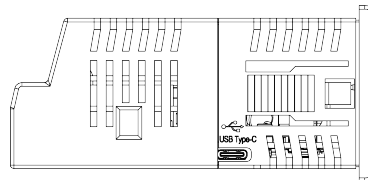


Fig. 5.6 USB port in P2 enclosure

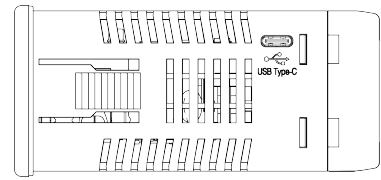


Fig. 5.7 USB port in P5 enclosure

5.6 Connection over RS485

To exchange data in the network via the Modbus protocol, you need a network server (master). The main function of the network server is to initialize the communication between the sender and the receiver. As the server of the network, you should use a PC with a connected akYtec company interface adapter or devices with the server function of the Modbus network (for example, a PLC, etc).

All devices in the network are connected to a serial bus. An example of device connection is shown in Fig. 5.8. For quality operation of transmitters/receivers and to prevent interference, you should install 120 Ω terminating resistors at the ends of the communication line. The resistor should be connected directly to the device terminals.

Example:

The device is connected to a PC via a RS485 $\leftrightarrow$ USB interface adapter. You can use the ICA-4M device of akYtec company as the interface adapter.

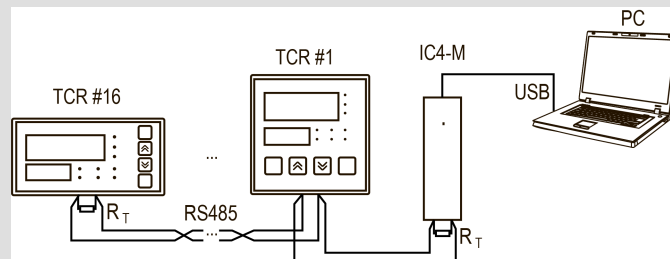


Fig. 5.8 Device connection over RS485

To operate via the RS485 interface:

1. Connect the device to the RS485 network.

2. Set network parameters of the device (see [Section 7.8](#)).

A list of Modbus registers is given in [Appendix B](#).

5.7 Wiring to digital input

The digital input is used to control the **Automatic control** mode. Operation of the digital input can be configured in the `in2` parameter (see [Section 7.3.2](#)).

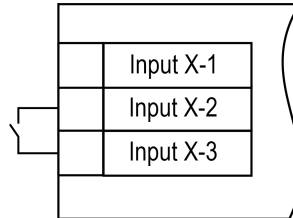


Fig. 5.9 Wiring to digital input

5.8 Sensor connection

5.8.1 General information



WARNING

To protect the device input circuits from possible breakdown by static electricity charges accumulated on the “device-sensor” communication lines, before connecting to the device terminal block, de-energize the sensor and connect its wires for 1-2 seconds to the functional earthing (FE) contact of the panel.

De-energize the device during the check of the “device-sensor” communication line.

To avoid the device failure during checking of the electrical contact in the circuits, use the measuring devices with supply voltage not more than 4.5 V. At higher supply voltages of such devices it is obligatory to disconnect the sensor from the device.

Parameters of the “device-sensor” communication line are given in [Table 5.1](#).

Table 5.1 Sensor line parameters

Sensor type	Line resistance, max., Ω	Line design
RTD	15	Three-wire-cable, wires of equal length and cross-section
TC	100	Thermocouple (compensating) cable
Unified I signal	100	Two-wire cable
Unified U signal	5	Two-wire cable



NOTICE

The wiring diagrams show X (e.g., X-1) instead of the input (output) number. It is recommended to check the connection by the engraving on the enclosure.

5.8.2 RTD (3-wire configuration)

The 3-wire RTD connection diagram is shown in the figure below.

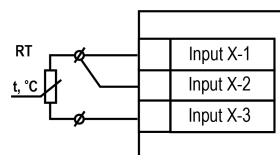


Fig. 5.10 RTD wiring (3-wire configuration)

5.8.3 RTD (2-wire configuration)

The 2-wire RTD connection diagram is shown in the figure below.

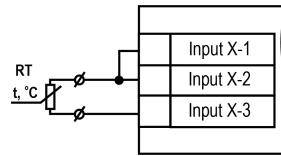


Fig. 5.11 RTD wiring (2-wire configuration)

To compensate for the wire resistance in a 2-wire configuration:

1. Before starting work, set jumpers between contacts Input X-1 and Input X-2 of the device terminal block and connect the two-wire line to contacts Input X-2 and Input X-3.
2. Connect the resistance box with accuracy class not more than 0.05 instead of the RTD sensor in the "device-sensor" communication line.
3. Set the resistance box value equal to the resistance of the RTD sensor at the temperature 0 °C (according to the NSC of the used RTD).
4. Power on the device.
5. Correct the device reading at 0 °C according to [Section 7.3.1.1](#).

**NOTE**

If necessary, carry out compensation of connecting wires in case of 2-wire RTD connection in accordance with [Section 7.3.1.1](#).

6. Exit the menu and ensure the deviation of the value on the digital indicator from the NSC does not exceed the allowed absolute error for the used RTD sensor.

Example of the allowed absolute error calculation for the 100 M sensor:

$$\Delta = \frac{X_n}{100} \cdot \gamma \quad (5.1)$$

where Δ – absolute measurement error

$\gamma = 0,25 \%$ (see [Table 3.2](#)) – basic reduced error

$X_n = 380 \text{ }^{\circ}\text{C}$ ($-180 \dots +200 \text{ }^{\circ}\text{C}$, see [Table 3.2](#)) – full measurement range

$$\Delta = \frac{380}{100} \cdot 0,25 = 0,95 \quad (5.2)$$

The maximum value of deviation of device readings from 0 °C for the 100M sensor should not exceed 0.95 °C.

7. Power off the device, disconnect the communication line from the resistance box and connect it to the RTD sensor.

If it is not possible to use a resistance box, compensate for wire resistance as follows:

1. Measure the total resistance of the conductors of the connecting line.
2. According to the NSC table of the corresponding sensor, determine the temperature corresponding to the measured line resistance.
3. With the sensor connected, correct the actually measured temperature upwards by the value determined in the previous point.

5.8.4 TC

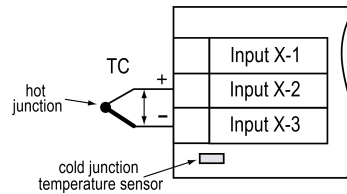


Fig. 5.12 TC wiring

Use thermocouple (compensating) cables to connect the TC to the device. Observe the polarity when connecting the compensating cables to the TC. If these conditions are not met, significant measurement errors may occur.

**CAUTION**

TC hot junction must be electrically insulated from external equipment!

The device has automatic compensation of the cold junction temperature. The cold junction temperature sensor is mounted near the device terminal block. The CJS can be disabled and enabled from the device menu.

5.8.5 U/I signals

**NOTE**

If the input is set to measure voltage or current, then when the device is turned on, the *n.o.d.t.* error may be displayed on the display for 10-15 seconds which disappears after the operating mode is set at the input.

Sensors can be connected directly to the input terminals of the device.

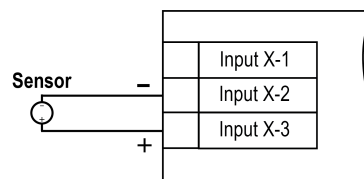


Fig. 5.13 Voltage sensor wiring (-50...+50 mV or 0...1 V)

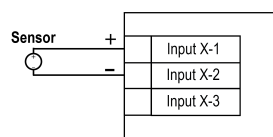


Fig. 5.14 Voltage sensor wiring (0...5 V or 0...10 V)

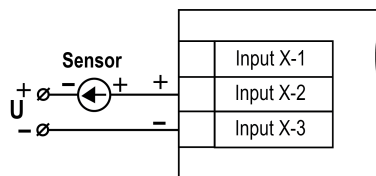


Fig. 5.15 Current sensor wiring (0...5 mA or 0 (4)...20 mA)

5.9 Output connection

5.9.1 Relay output

Relay output wiring is shown in Fig. 5.16.

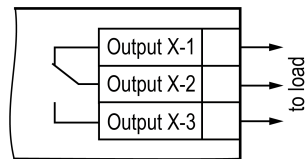


Fig. 5.16 Relay output wiring

6 Operation

6.1 Principle of operation

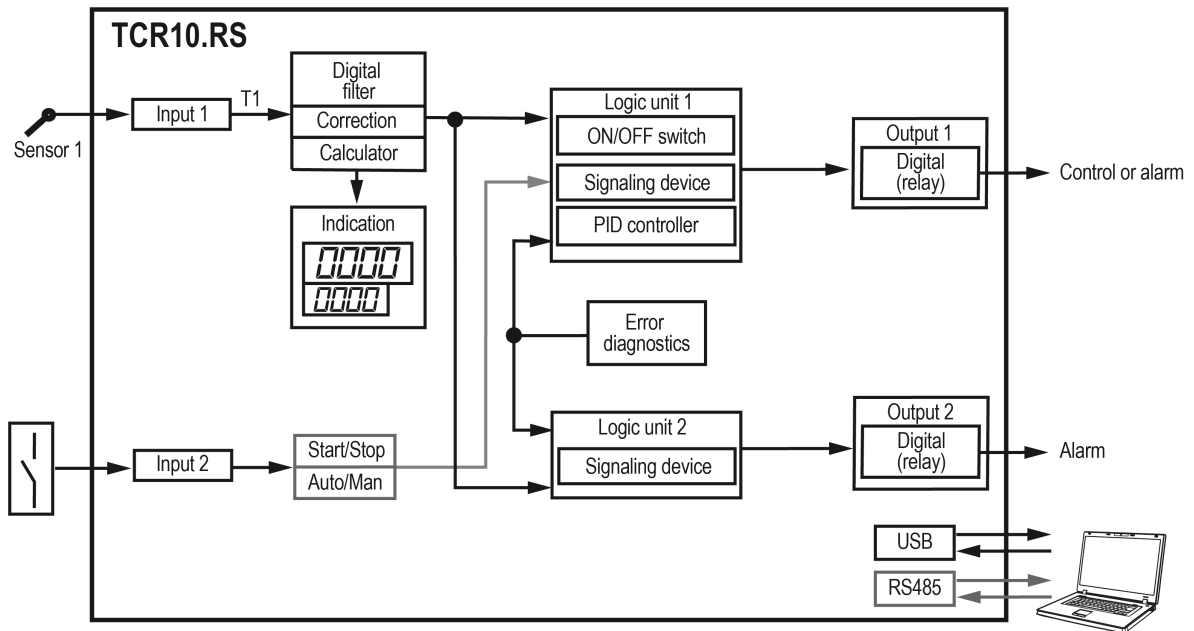


Fig. 6.1 Operation diagram

The signal at Input 1 is converted according to the type of sensor selected. The signal of RTD and TC sensors is converted to a temperature value according to the NSC of the selected sensor. For sensors with unified output signals, a linear signal conversion is performed.

The following functions can be used to process the measured value:

- Digital filtering of measurements (to reduce the influence of external impulse interference)
- Correction of the measuring characteristic of sensors (to eliminate the initial conversion error of input signals and errors introduced by connecting wires)
- Root square extraction

Digital input 2 is intended for switching the device's operating modes. Depending on the setting, the device switches between **Automatic control** and **Stop** modes, or between **Automatic control** and **Manual control**.

The output is controlled based on the data received from Input 1 as well as the logic unit settings. The logic unit compares the setpoint value with the input value. As a result of the comparison, the logic unit issues a command to control the output according to the selected logic ("heating", "cooling", signaling device, PID controller).

The PID controller should maintain the controlled variable at a value close to the setpoint by controlling the "heating" and the "cooling" (see [Section 6.1.1](#) for a description of the PID controller operating principle). The setpoint can be changed using the digital display or by sending Modbus requests.

The device has the following operating modes:

Table 6.1 Operating modes

Mode	Description
Automatic control	The setpoint value is compared with the measured input signal. Depending on the selected logic, a control signal is sent to the output.
Manual control	Manual control of output power (output) via PWM. Without input feedback.
Stop	The control process is stopped. Outputs are in a safe state.
Error	The control process has been stopped due to an error. Outputs are in a safe state.

The device monitors the following errors:

- Internal errors
- Input errors: sensor break, readings outside the measuring range
- Output errors: break or "sticking" of the control loop

In case of errors, the device enters the **Error** mode (LED ST1 (ST2) is flashing). Internal and input errors are displayed to the digital indicator. The control loop break error is signaled by LED ST1 (ST2).

Any type of error will cause the control to stop. Each channel is switched off independently of each other.

The error is eliminated in one of the following ways:

- By switching the device to the **Stop** or **Manual control** mode and restarting it to the **Automatic control** mode
- Automatically when sensor readings are restored

6.1.1 General principles of PID control

The PID controller generates a control (output) signal Y_i , at its output, which is intended to minimize the deviation E_i :

$$Y_i = \frac{1}{X_p} \left(E_i + \frac{1}{\tau_{\text{int}}} \sum_{i=0}^n E_i \Delta t_{\text{meas}} + \tau_d \frac{\Delta E_i}{\Delta t_{\text{meas}}} \right) \quad (6.1)$$

where

X_p – Proportional band (adjustable parameter P_{idP})

E_i – Difference between the set T_{SP} and the current T_i value of the measured parameter or error

τ_d – Derivative time constant (adjustable parameter P_{idD} — «**PID derivative term**»)

ΔE_i – Difference between two adjacent measurements E_i and E_{i-1}

Δt_{meas} – Time between two adjacent measurements T_i and T_{i-1}

τ_{int} – Integral time constant (adjustable parameter P_{idI} — «**PID integral term**»)

$\sum_{i=0}^n E_i \Delta t_{\text{meas}}$ – Sum of errors

The formula shows that during PID control, the control signal depends on:

- Difference between the current parameter T_i and the set value T_{SP} of the measured parameter E_i , which responds to the instant control error (ratio $\frac{E_i}{X_p}$).

- Rate of change of parameter $\frac{\Delta E_i}{\Delta t_{\text{meas}}}$, which improves the quality of the transient process.

Expression $\tau_d \frac{1}{X_p} \frac{\Delta E_i}{\Delta t_{\text{meas}}}$ is referred to as the differential component of the output signal.

- Accumulated control error $\sum_{i=0}^n E_i \Delta t_{\text{meas}}$, that allows the setpoint temperature to be reached as quickly as possible. Expression $\frac{1}{X_p} \frac{1}{\tau_{\text{int}}} \sum_{i=0}^n E_i \Delta t_{\text{meas}}$ is referred to as the integral component of the output signal.

To make the PID controller work efficiently, set the optimal values of coefficients X_p , τ_d and τ_{int} , for a particular control object, which can be determined in the autotuning mode or in the manual tuning mode.

6.1.2 PID controller operation when switching over the device operation modes

When switching over between **Automatic control** and **Manual control** and vice versa, the $out.P$ power value is retained. All accumulated integral and derivative terms are saved and remain in effect when returning to the **Automatic control** mode. In the **Manual control** mode, you can't limit the value of output power.

When switching to the **Stop** mode, all accumulated integral and derivative terms are reset. The output power of the output unit takes on the $Set.P$ value, i.e. in the **Stop** mode the device can maintain the set output power, but doesn't monitor the input state.

In the **Error** mode the integral and derivative terms are also reset. The output power of the output unit takes on the $Err.P$, i.e. in the **Error** mode the device can maintain the set output power, but doesn't monitor the input state.

When the device is reset, the integral and derivative terms are reset.

When changing the $P_{id}P$, $P_{id}I$, $P_{id}D$ parameters using the device menu or the Modbus interface, the accumulated integral and derivative terms are not reset. The device calculates the output power for the output unit according to the new coefficients, but the already accumulated components are not reset, i.e. the transition to the new control parameters is smooth. To reset the already accumulated parameters it is necessary to restart the device.

6.2 Indication and control

The front panel of the device has indication and control elements:

- Two four-digit seven-segment indicators (digital indicators)
- Seven LEDs
- Four control buttons

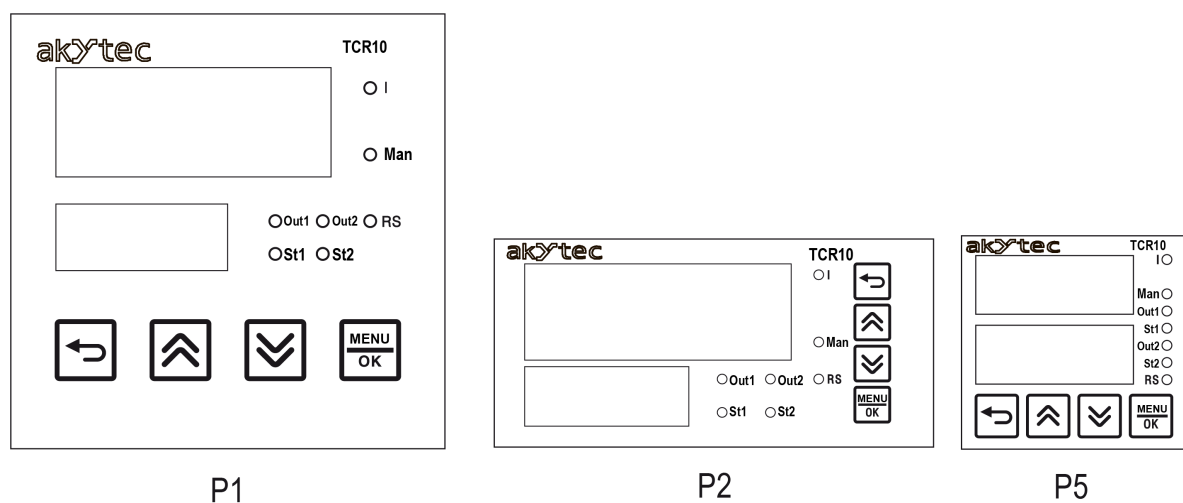


Fig. 6.2 Front panel

Digital indicators

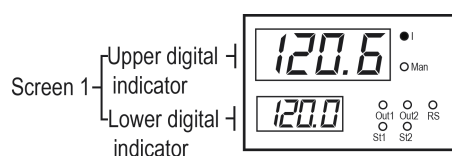


Fig. 6.3 User screen

The information is displayed on the device digital indicators. The user screen consists of the upper and lower digital indicators. The information displayed on the digital indicators can be customized (see [Section 7.7](#)). Up to six screens can be configured in the device.

Table 6.2 Information displayed on the digital indicators

Device state	Displayed information (for default settings)	
	Upper digital indicator	Lower digital indicator
Loading*	Device name	Firmware version
Control	Current measured value	Value of setpoint
Menu	Name of setting parameter	Value of setting parameter
	Name of parameter group	Inscription $\tilde{E}_{nu}$

Device state	Displayed information (for default settings)	
	Upper digital indicator	Lower digital indicator
Error	Error designation of the selected measuring channel (see Table 6.3)	
<div>  NOTE * After powering on, all indicators on the front panel of the device light up. Then the device name and firmware version are displayed. </div>		

Table 6.3 Error indication

Indication	Description
n.d.t	The data isn't ready yet.
OCL.H	The CJC sensor has exceeded the upper measuring limit (+105 °C).
OCL.L	The CJC sensor is below the lower measurement limit (–50 °C).
HHHH	The calculated input value is above the permissible limit.
LLLL	The calculated input value is below the permissible limit. The "device-sensor" communication line is broken.
H.	The calculated input value is above the permissible indication limit. The measured value can't be displayed due to the dPt parameter (decimal point position).
L.	The calculated input value is below the permissible indication limit. The measured value can't be displayed due to the dPt parameter (decimal point position).
! - - !	Sensor break or significant exceeding of the indication range
F.Err	Function calculation error
Err	ADC communication error

LEDs

Table 6.4 LEDs

LED	State	Description
I	ON	The digital indicator displays the Input 1 value (including the failure value) or setup of the parameter related to the channel (input or output) is performed.
	Flashing	Error at the input (sensor break, readings out of the measurement range), the input value is not displayed on the digital indicator.
	OFF	The input value is not displayed on the digital indicator and no error at the input.
Man	ON	Manual control mode of output power
	OFF	Automatic control mode or Stop mode
Out1, Out2	ON	Output closed
	OFF	Output open
RS	OFF	No data exchange over the RS485 interface
	ON (10 s)	Data exchange over the RS485 interface

LED	State	Description
	Flashing	A package intended for this device has been detected.
St1	ON	Channel 1: Automatic control mode
	OFF	Channel 1: Manual control mode of output power or Stop mode
	Flashing	Channel 1 has switched from the Automatic control mode to the Error mode due to sensor break or readings out of measurements range.
	Flashing (twice)	Channel 1 has switched from the Automatic control mode to the Error mode due to break or "sticking" of the control loop.
St2	ON	Logic unit 2 is on.
	OFF	Logic unit 2 is off.
	Flashing	Error at Input 1

Control buttons

Table 6.5 Control buttons

Button	Digital indicator state	Type of pressing	Description
	Operation	Hold for more than 2 s	Enter the menu to select the operation mode: – <i>run</i> – Automatic control . – <i>man</i> – Manual control . – <i>stop</i> – Stop .
	Menu	Single press	Return to the main screen or to the previous level of the menu. Undo the change of parameter value and return to the original value.
	Operation	Hold	Display the configuration of the current screen.
 or 	Operation	Single press	Switch the screens.
	Menu	Single press	Switch the menu items. Change the parameter value.
		Hold	Speed up the process of parameter change.
	Operation	Hold for more than 2 s	Enter the menu.
		Single press	Switch to change the setpoint or output power.
	Menu	Single press	Enter the menu item. Switch to edit the parameter. Save the changed parameter value into the device memory

Button	Digital indicator state	Type of pressing	Description
Button combinations to enter the special modes			
 + 	Operation	Hold for more than 2 s	Switch to set up protection of $SLr.t$ parameter (see Section 7.9).
 + 	Operation	Hold for more than 2 s	Reset to factory settings. Before pressing, set the jumper (see Section 7.10).

6.3 Startup and operation



NOTICE

If the device is brought from a cold to a warm environment, condensation may form inside the device. To avoid damage to the device, keep the device in the warm environment for at least 1 hour before powering on.

When the device is switched on, the LEDs are checked (all LEDs light up for 2 seconds).

After checking, the upper indicator will display the measured value from the sensor, the lower indicator will display the setpoint value for logic unit 1 (for the default value of the $SLr.1$ parameter).

You can switch screens with the  and  buttons. The screens can be configured with the $SLr.1$... $SLr.6$ parameters (see [Section 7.7](#)). The screens can be enabled or disabled. The disabled screens are not displayed. The $SLr.1$ screens are enabled by default.



NOTE

The $SLr.1$ screen cannot be disabled.

To select the operation mode:

1. Press and hold (2 seconds) the  button regardless of the selected screen.
2. Select the mode with the  and  buttons.
3. Press the  button to confirm.

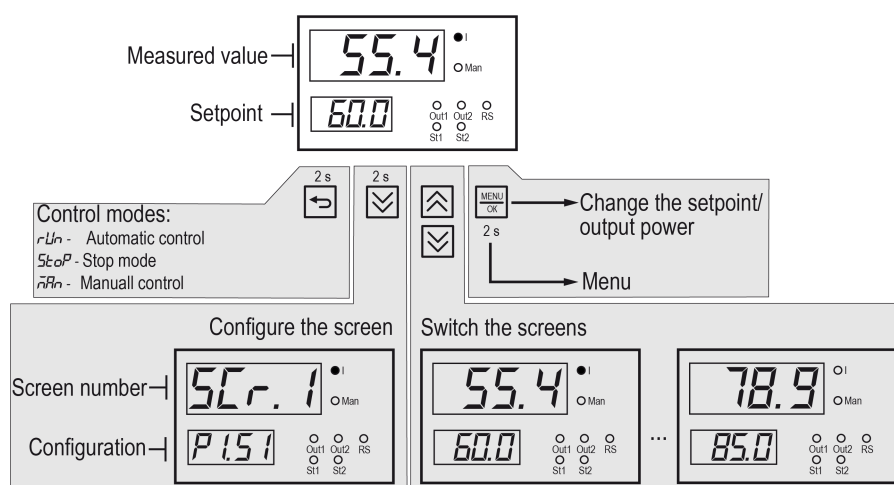


Fig. 6.4 Switching from the main screen

7 Setup

7.1 Setup using akYtec Tool Pro

You can set up the device via the USB or RS485 interfaces.

To connect to the device, you must specify:

1. The number of the COM port to which the device is connected (the IC4-M converter for setting via RS485). You can check the COM number in Windows Device Manager.



NOTE

Only one device can be connected to one PC.

2. Protocol — **Modbus RTU**.
3. Baud rate — **9600**.
4. Select the device model from **Devices** drop-down menu in the **Controllers**.
5. Enter any address for USB or 16 for configuration via RS485.
6. Click the **Add** button.

To get more information about the connection and operation of the device, use the HELP menu of akYtec Tool Pro or press **F1** to call up HELP in the program.

7.2 Parameter setup using front panel buttons

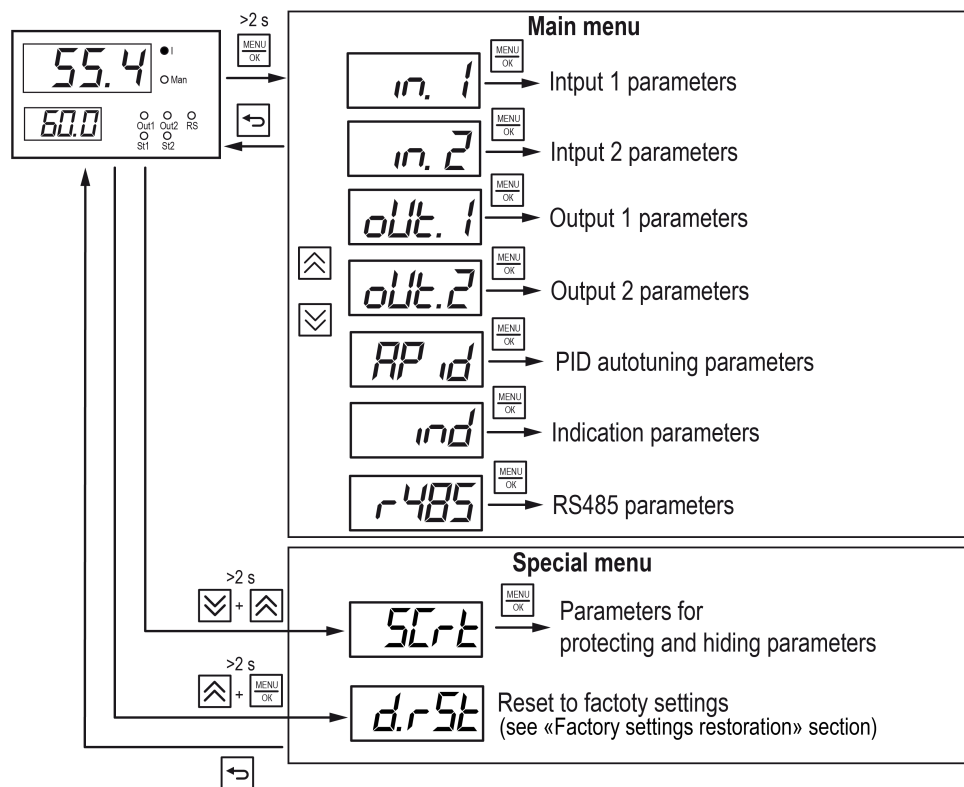


Fig. 7.1 Menu

The current parameter is edited by briefly pressing the  button.

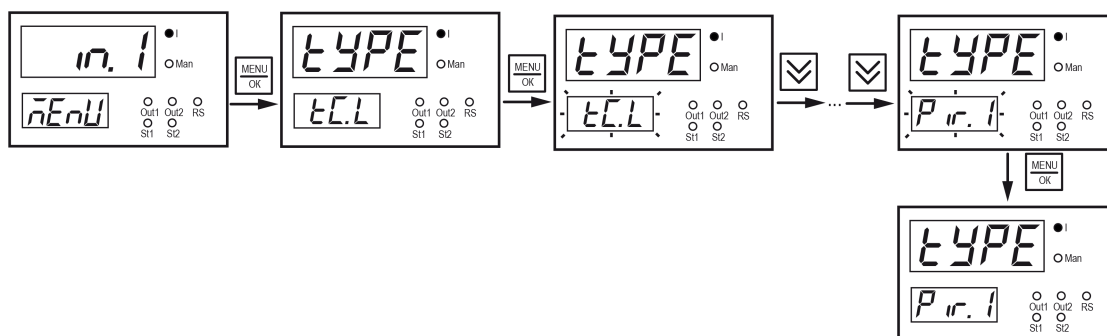


Fig. 7.2 Parameter setup

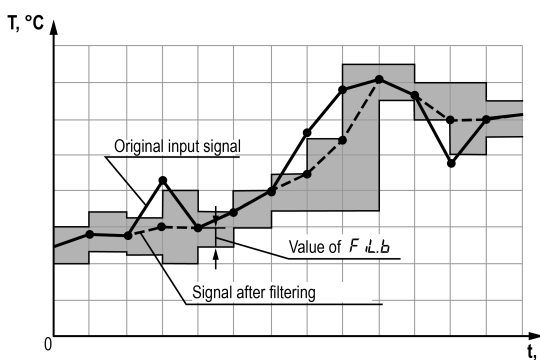
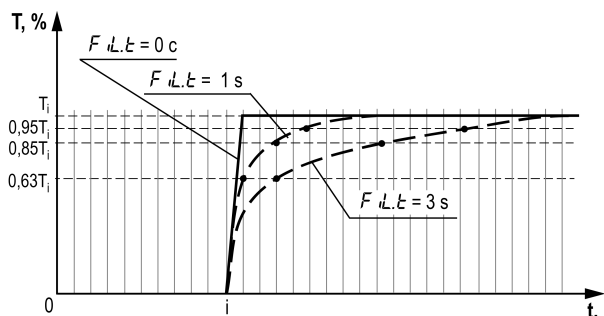
7.3 Input setup

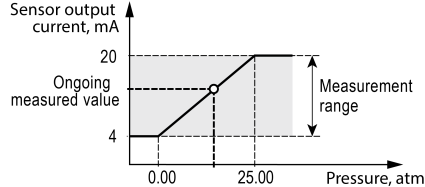
7.3.1 Input 1 setup

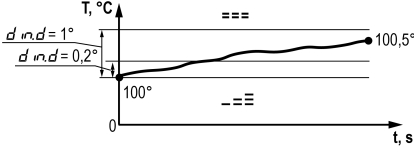
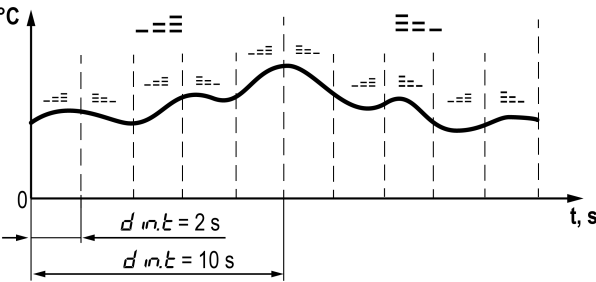
Parameters for inputs 1 (menu *in 1*) are given in [Table 7.1](#).

Table 7.1 Input 1 setup

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
tYPE	oFF	tCL	Sensor type Sensor types are given in Appendix A .
	Sensor types		
F iL.b*	oFF	1	<p>Filter band</p> <p>Allows you to filter out single interference. The filter band is specified in units of the measured value.</p> <p>T_i – measured absolute value of the signal. T_{i-1} – previous absolute value of the signal.</p> <p>If $T_i > T_{i-1} \pm F iL.b$, then T_i is assigned the value of $T_{i-1} \pm F iL.b$ (depending on the upward or downward movement of the value) and $F iL.b = 2 * F iL.b$ (the filter band value is doubled).</p> <p>If the value of $T_i < T_{i-1} \pm F iL.b$, the value of $F iL.b$ is returned to the original value.</p> <p>A narrow filter bandwidth leads to a slower reaction to rapid changes of the input signal.</p> <p>When the interference level is low or when working with rapidly changing processes, it is recommended to increase the $F iL.b$ parameter value or disable the filter stage by setting the parameter $F iL.b = oFF$.</p> <p>When working in conditions of strong interferences, it is recommended to decrease the parameter value to eliminate their influence on the device operation.</p>
	Delta-Sens**		

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
			
$F_{iL.t}$	dFF 1...999	10	<p>Filter time constant (t_f)</p> <p>The interval within which the signal reaches 0.63 of the value of each T_i measurement.</p> <p>The signal value is calculated by the formula: $T_i = T_{i-tr} + (T_i - T_{i-tr}) * 0.63$.</p> <p>Decreasing the $F_{iL.t}$ parameter values leads to faster response to temperature jumps, but reduces noise immunity. Increasing of $F_{iL.t}$ increases the inertia and improves the noise immunity.</p> 
$dPct$	0 1 2 3 R_{uto}	1	<p>Decimal point position</p> <p>The number of decimal places that will be displayed on the digital indicator.</p> <p>The R_{uto} value – point position is automatically selected to display the maximum possible number of digits.</p> <p>If the value cannot be displayed on the digital indicator, the H_i or L_o error messages will be displayed on the digital indicator.</p>
$ind.L^*$	– 1999...99-99	0.0	<p>Parameters to convert the indication of measured current and voltage values to the value of a physical quantity.</p> <p>Parameters are adjusted for signals 0...5 mA, 0...20 mA, 4...20 mA, –50...+50 mV, 0...1 V, 0...5 V and 0...10 V. For other sensor types, these parameters are hidden.</p> <p>$ind.L$ – indication at the minimum signal value (0 mA, 4 mA, –50 mV, 0 V).</p> <p>$ind.H$ – indication at maximum signal value (5 mA, 20 mA, 50 mV, 1 V, 5 V, 10 V).</p> <p>All other intermediate indication values are arranged linearly and calculated by the device according to the formula: $T = ind.L + I_x * (ind.H - ind.L)$,</p>
$ind.H^*$	– 1999...99-99	100.0	

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
			<p>where I_x is the value of the signal from the sensor in relative units of the range from 0.000 to 1.000.</p> <p>Example. A sensor with output current of 4...20 mA is used to monitor pressure within the range of 0...25 atm. The <i>ind.L</i> parameter value is set to 0.00, the <i>ind.H</i> parameter value is set to 25.00. Now values will be displayed in atmospheres.</p> 
Func			Mathematical functions
	oFF		oFF – mathematical functions are not used
	59rL		59rL – calculation of the square root from the current value: $T = \sqrt{I}$
	59rI	oFF	<p>59rI – calculation of flow rate using differential pressure sensors with current output To work with differential pressure sensors, a function is used which, taking into account the scaling settings, is calculated using the following formula:</p> $T = ind.L + \sqrt{\frac{I - SensMin}{DeltaSense} \cdot (ind.H - ind.L)}$ <p>I – Current value of the signal from the sensor, mA Ind.L – Indication at the minimum signal value Ind.H – Indication at maximum signal value SensMin – Lower limit of sensor measurement, mA DeltaSense – Sensor measurement range, mA</p>
Corr* Cor.1* Cor.2* Cor.3*	oFF SensMin... SensMax**	oFF	<p>Submenu</p> <p>Parameters to adjust the controller chart They are used to compensate for the error of the connected sensors or to compensate for the wire resistance (for connection of the RTD sensor via two-wire configuration), when it is possible to determine with the help of additional equipment the exact value of the measured signal, thus correcting the readings of the device. The correction method is given in Section 7.3.1.1.</p>
d ind	0...30	10	Parameters of the input signal dynamics tracking function <i>d ind</i> is the dynamic signal analysis sampling period.
d ind	0.2... Delta- Sens**	0.2	<i>d ind</i> is the delta of the signal dynamics. The dynamics of signal change is analyzed for a given period (<i>d ind</i>). The device subtracts the previous value from the current measured value and adds the difference to the accumulation buffer. After accumulation of the buffer for the

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
			<p>period d_{int}, the comparison of its contents with the value of the delta of the dynamics of the signal $d_{int,d}$ modulo is performed.</p>  <p>The buffer is sliding, i.e. a new value appears in the next second and the end value is excluded from the buffer. The dynamics are then recalculated.</p>  <p>If the current buffer value is less than $d_{int,d}$, the signal dynamics is defined as "no change". If the current buffer value is greater than $d_{int,d}$, the dynamics is determined by the buffer sign (positive value - increasing, negative value - decreasing). The lower indicator will display the dynamics of the measured value at the corresponding input.</p> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;"> - - - - - - - - - </div> Decreasing </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;"> - - - - - - - - - </div> Increasing </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;"> - - - - - - - - - </div> No changes </div>
$bArr$	oFF		<p>Connection of the intrinsic safety barrier</p> <p>i NOTE The $bArr$ parameter is available only for RTD sensors.</p> <p>Set the parameter value to on for operation with RTD sensors connected via an intrinsic safety barrier. The input resistance measurement range will be extended to compensate for the transfer impedance of the intrinsic safety barrier. To maintain measurement accuracy, it is recommended to perform the correction procedure according to the resistance compensation of the connecting wires for a three-wire line.</p> <p>i NOTE With $bArr = on$ the additional reduced error is no more than 0.5%. The value of the additional reduced error is determined by the type and characteristics of the intrinsic safety barrier used.</p>
	on	oFF	

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	



NOTE

* The decimal point position is determined by the dPt parameter.

** SensMin – lower limit of sensor measurement, SensMax – upper limit of sensor measurement, DeltaSens – sensor measurement range.

7.3.1.1 Correction of readings

To eliminate the initial conversion error of the input signals and the errors introduced by the connecting wires, the value measured by the device can be corrected.

The NSC graph is adjusted depending on the number of set points. If one point is set, the entire graph will be shifted up or down by a specified value. If two or three points are set, the graph will be plotted using splines between the two closest points that define the absolute offset or slope (see [Fig. 7.3](#)).

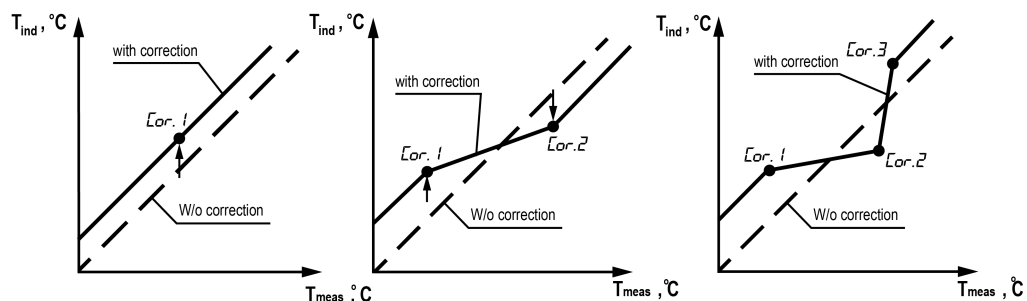


Fig. 7.3 Graph correction: T_{meas} — measured temperature, T_{ind} — temperature displayed on digital indicator

To correct the device readings:

1. Select one of the parameters $E_{or.1}$, $E_{or.2}$ or $E_{or.3}$ and press the  button. The adjustment will start.
The lower digital indicator displays the measured temperature calculated according to the sensor's NSC (the value is flashing), the upper digital indicator displays the number of the correction point.
2. Using the  and  buttons, adjust the temperature value on the lower digital indicator to match the connected reference gauge of the input signal (a resistance box, voltage calibrator, current calibrator, etc.) or the readings of the reference device.
3. After setting the corrected value, press the  button to fix readings. The corrected value will be recorded on the lower digital indicator and the indicator will stop flashing.

Pressing the  button briefly will display the offset value on the upper digital indicator.

If you hold down the  button for a long time (3 seconds), you make a request to delete the correction point. The E_{r5} value is flashing on the lower digital indicator.

If you press the  button, the correction point is deleted and the digital indicator displays oFF .

If you press the  button, the parameter deletion process is cancelled.

 **NOTE**
If the sensor type is changed, the correction parameters are retained. For a new sensor, delete the correction points or perform the correction again.

7.3.2 Input 2 setup

Parameters for Input 2 (menu *in2*) are given in [Table 7.2](#).

Table 7.2 Input 2 setup

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
TYPE			Operation parameter of the digital input
	OFF	0	Digital input off
	dStP	1	Switching from the Automatic control mode to the Stop mode. The closed state of the input corresponds to the enabled Stop mode.
	dMn	2	Switching from the Automatic control mode to the Manual control mode. The closed state of the input corresponds to the enabled Manual control mode
	dblC		Switching from the Automatic control mode to the Stop (does not make changes to the CTRL device operation register). The closed state corresponds to the enabled Automatic control mode. The open state corresponds to the enabled Stop mode.

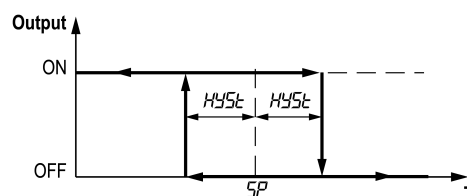
7.4 Output setup

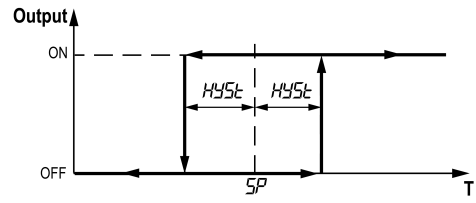
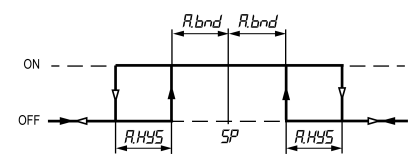
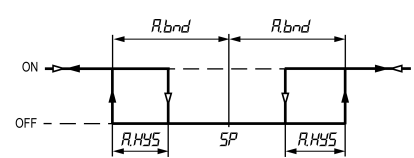
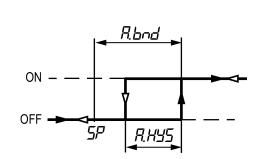
7.4.1 Output 1 setup

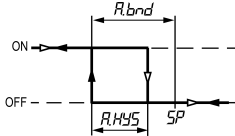
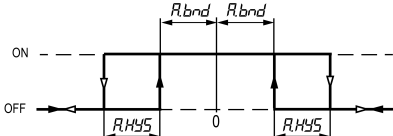
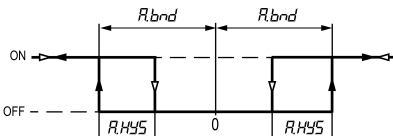
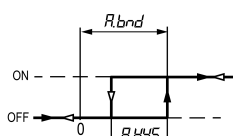
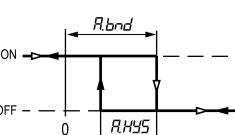
Output parameters (menu *out 1*) are given in [Table 7.3](#).

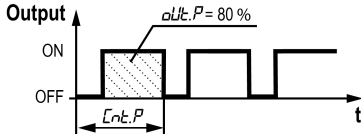
Table 7.3 Output 1 parameters

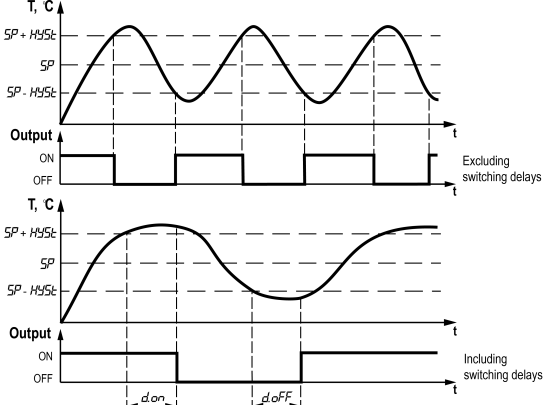
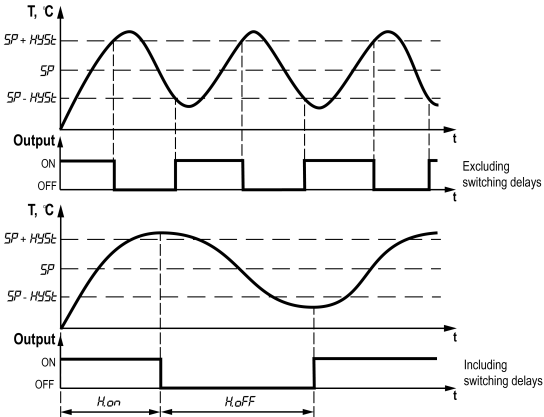
Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
LOGIC			Logic type
	OFF		The controller is off. Output is in a safe state.
	HEAT	H.P. id	On-Off "heating" control The controller is used to control the operation of the heater or alarm about the current measured value (T) is less than the setpoint value (SP). The controller is triggered by the lower limit. The output device connected to the logic unit switches on at $T < SP - HYSL$ and switches off at $T > SP + HYSL$. Two-position control takes place at setpoint SP with hysteresis $\pm HYSL$.
	COOL		On-Off "cooling" control The controller is used to control the operation of the cooler or alarm about the current measured value (T) exceeds the setpoint value (SP).



Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
			<p>The controller is triggered by the upper limit. The output device connected to the logic unit switches on at $T > SP + HYS$ and switches off at $T < SP - HYS$.</p> 
	$ALr\bar{n}$		<p>Alarm</p> <p>The alarm logic type is set in the $ALYP$ parameter.</p> <p>The alarm continues to operate in the Stop and Manual control modes.</p> <p>The alarm is restored when the input error is gone.</p>
	$HPid$		"Heating" PID controller
	$CPid$		"Cooling" PID controller
$ALYP$			<p>Alarm triggering logic type</p> <p>The parameter appears when $LoG.d = ALr\bar{n}$</p>
	oFF		Alarm is off
	SPn		<p>The alarm switches on when the measured value is within the range $SP \pm R.bnd$ taking into account the $R.HYS$ parameter.</p> <p>The $R.bnd$ parameter is an alarm triggering threshold.</p> <p>The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$SP.u$	$SP.u$	<p>The alarm switches on when the measured value is out of the range $SP \pm R.bnd$ taking into account the $R.HYS$ parameter.</p> <p>The $R.bnd$ parameter is an alarm triggering threshold.</p> <p>The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$SP.H$		<p>The alarm switches on when the measured value exceeds SP by $R.bnd$.</p> <p>The $R.bnd$ parameter is an alarm triggering threshold.</p> <p>The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$SP.Lo$		<p>The alarm switches on when the measured value is lower SP by $R.bnd$.</p>

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
			<p>The $R.bnd$ parameter is an alarm triggering threshold. The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$0.N$		<p>The alarm switches on when the measured value is within the range $0 \pm R.bnd$ taking into account the $R.HYS$ parameter. The $R.bnd$ parameter is an alarm triggering threshold. The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$0.U$		<p>The alarm switches on when the measured value is out of the range $0 \pm R.bnd$ taking into account the $R.HYS$ parameter. The $R.bnd$ parameter is an alarm triggering threshold. The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$0.H, \uparrow$		<p>The alarm switches on when the measured value exceeds 0 by $R.bnd$. The $R.bnd$ parameter is an alarm triggering threshold. The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$0.Lo$		<p>The alarm switches off when the measured value exceeds 0 by $R.bnd$. The $R.bnd$ parameter is an alarm triggering threshold. The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
SP^*	$SP.Lo... SP.H, \uparrow$	30.0	<p>Setpoint The required value of the controlled variable to be maintained by the controller.</p>
$SP.Lo^*$	SensMin**... $SP.H, \uparrow$	-199.9	<p>Lower and upper limits to select the range of values of the setpoint parameter (SP). The limits are set in the same units as the setpoint parameter.</p>

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
$SP.H^*$	$SP.Lo... Sen-sMax^{**}$	999.9	<p>When changing the $SP.Lo$ and $SP.H$ parameters, their values are limited by the measurement range of the current sensor at the corresponding input.</p> <p>i NOTE They do not change when changing the sensor type.</p>
$HYSL^*$	0.. Delta-Sens ^{**}	1.0	<p>Hysteresis</p> <p>The dead zone when switching the output state. It is used to avoid output bounce at input values close to the setpoint. Hysteresis is set in units of input measurement.</p>
$P_{id.P}$	0.001...9-999 [*]	10.0	<p>PID proportional band</p> <p>Values are set in units of measurement taking into account the position of the decimal point.</p>
$P_{id.I}$	0..3999 s	10.0	<p>PID integral term</p> <p>If the value is set to 0, the controller disables the integral term.</p>
$P_{id.D}$	0..3999 s	10.0	PID derivative term
$Ent.P$	1...250 s	5	<p>Pulse period</p>  <p>i NOTE The minimum possible pulse length is 50 ms.</p>
USP^*	OFF... Delta-Sens ^{**}	OFF	<p>Rate of change of PID controller setpoint</p> <p>The rate of change of setpoint is used to smooth the transition from the current setpoint value to the set value. When changing the setpoint, the PID controller calculates the setpoint according to the formula:</p> $SP_{current} = SP_{previous} + USP \text{ within a minute,}$ <p>where $SP_{current}$ – current SP value, $SP_{previous}$ – previous SP value. The setpoint is increased (decreased) until $SP_{current}$ is equal to SP. When the device is switched on or when switching from Stop or Manual control to Automatic control, the current value at Input 1 is used as the initial value of $SP_{previous}$.</p> <p>OFF – no rate of change limit</p>
$db.d$	0.02...9.-99 s	0.02	<p>Minimum PWM duration</p> <p>The output signal is applied to the executing mechanism when the calculated ON (OFF) pulse duration is greater than or equal to $db.d$. Actions not applied are accumulated until $db.d$ is reached. The parameter refers to both the ON and OFF times of the output.</p> <p>i NOTE In the Manual control mode, a control action cannot be less than $db.d$.</p> <p>The $db.d$ value should be less than 50% $Ent.P$</p>
$d.bnd^*$	0... Delta-Sens ^{**}	0	<p>Dead zone of PID controller</p> <p>Values are set in units of measurement taking into account the position of the decimal point.</p>

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
			If the measured signal is within $SP \pm d.bnd$, the PID controller will not change the output power until the controlled variable goes out-of-range.
$oL.L$	0...100.0	0.0	Minimum output power (lower limit) of PID controller Values (%) from 0 to $oL.H$.
$oL.H$	0...100.0	100.0	Maximum output power (upper limit) of PID controller Values (%) from $oL.L$ to 100.
$oL.u$	0.2...100 %/s	100.0	Maximum rate of change of PID controller output power The $out.P$ value can change by this value in 1 second.
$d.on$	0...250 s	0	<p>$d.on$ – delay in switching on the controller. The time that elapses after the controller condition is triggered before the output closes. If the condition of switching on the controller is reset during this time, the countdown is reset to zero.</p> <p>$d.off$ – delay in switching off the controller. The time that elapses after the controller condition is triggered before the output opens. If the condition of switching off the controller is reset during this time, the countdown is reset to zero.</p> 
$d.off$	0...250 s	0	
$H.on$	0...250 s	0	<p>$H.on$ – minimum time for the controller to be in the ON state. After closing the output, the controller operating conditions are ignored for the set time.</p> <p>$H.off$ – minimum time for the controller to be in the OFF state. After opening the output, the controller operating conditions are ignored for the set time.</p> 
$H.off$	0...250 s	0	
			<p>During the delay time, On-Off controller operation is suspended. All events other than alarms are ignored.</p>

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
<i>Err.P</i>	0...100 %	0.0	Output 1 value in the Error mode if the PID controller is used.
<i>StP.P</i>	0...100 %	0.0	Output 1 value in the Stop mode if the PID controller is used.
<i>Albnd*</i>	0... Delta-Sens**	20	Alarm triggering threshold The parameter appears when $LoG.d = ALr\bar{n}$.
<i>AlHYS*</i>	0... Delta-Sens**	1.0	Alarm triggering hysteresis The parameter appears when $LoG.d = ALr\bar{n}$.
<i>F.bLC</i>	<i>on</i>	<i>oFF</i>	Blocking of the first alarm triggering The parameter appears when $LoG.d = ALr\bar{n}$. <i>on</i> – blocked. <i>oFF</i> – not blocked. i NOTE The blocking is used to prevent the alarm from triggering when the device is switched on before the control system enters the preset operating mode. If after switching on the device the measured signal value of the input is outside the alarm zone, blocking of the first alarm triggering is reset. The flag is reset when switching from the Stop mode to the Automatic control mode.
	<i>oFF</i>		
<i>Err.d</i>	<i>oFF</i>	<i>oFF</i>	Output state in the Error mode: <i>on</i> – enabled. <i>oFF</i> – disabled
	<i>on</i>		
<i>StP.d</i>	<i>oFF</i>	<i>oFF</i>	Output state in the Stop mode: <i>on</i> – enabled. <i>oFF</i> – disabled. For alarm ($LoG.d = ALr\bar{n}$), the <i>StP.d</i> parameter is hidden.
	<i>on</i>		
<i>LbR.t</i>	<i>oFF</i>	<i>oFF</i>	Function to diagnose the control loop break. See Section 7.5 for function description. For alarm ($LoG.d = ALr\bar{n}$), the <i>LbR.t</i> and <i>LbR.b</i> parameters are hidden.
	1...9999 s		
<i>LbR.b*</i>	0... Delta-Sens**	10	<i>LbR.t</i> – time to diagnose the control loop break. When <i>LbR.t</i> = <i>oFF</i> , the function to diagnose the control loop break is disabled. <i>LbR.b</i> – band width of control loop break diagnostics. The parameter appears if <i>LbR.t</i> differs from <i>oFF</i> .
<i>RrEC</i>	<i>oFF</i>	<i>oFF</i>	Automatic restoration of the control process after an error at the corresponding input. If an emergency stop has occurred in the Automatic control mode due to sensor break or readings going beyond the measurement range, then when the measurement is restored, the control process automatically starts after <i>RrEC</i> seconds. If <i>RrEC</i> = <i>oFF</i> , to restore the Automatic control mode: 1. Switch to the Manual control or Stop mode. 2. Switch to the Automatic control mode.
	0...999 s		

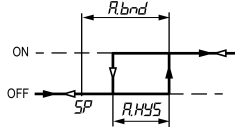
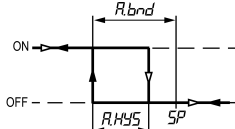
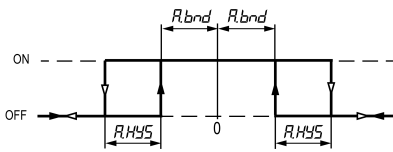
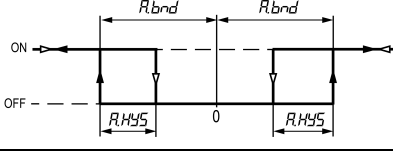
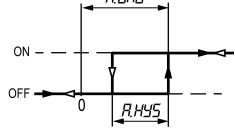
Pa- rame- ter	Values (1) Default values (2)		Description
	(1)	(2)	
			<div> <div>i</div> <div> NOTE The automatic restoration of the control process does not apply to control loop break. Control loop break requires manual restoration. </div> </div>
			<div> <div>i</div> <div> NOTE * The decimal point position is determined by the dPt parameter. ** SensMin – lower limit of sensor measurement, SensMax – upper limit of sensor measurement, DeltaSens – sensor measurement range. </div> </div>

7.4.2 Output 2 setup

Output parameters (menu *out2*) are given in [Table 7.4](#).

Table 7.4 Output 2 parameters

Pa- rame- ter	Values (1) Default values (2)		Description
	(1)	(2)	
<i>LoG.d</i>			Logic type
	<i>oFF</i>		The controller is off. Output is in a safe state.
	<i>ALrñ</i>	<i>ALrñ</i>	Alarm The alarm logic type is set in the <i>ALYP</i> parameter. The alarm continues to operate in the Stop and Manual control modes. The alarm goes to the state set in the <i>Err.d</i> parameter in case of an error at Input 1 and Output 1. The alarm is restored when the input error is gone.
<i>ALYP</i>			Alarm triggering logic type
	<i>oFF</i>		Alarm is off
	<i>SP.n</i>	<i>SP.u</i>	The alarm switches on when the measured value is within the range $SP \pm R.bnd$ taking into account the <i>ALYS</i> parameter. The <i>R.bnd</i> parameter is an alarm triggering threshold. The <i>ALYS</i> parameter is an alarm triggering hysteresis. <div> </div>
	<i>SP.u</i>		The alarm switches on when the measured value is out of the range $SP \pm R.bnd$ taking into account the <i>ALYS</i> parameter. The <i>R.bnd</i> parameter is an alarm triggering threshold. The <i>ALYS</i> parameter is an alarm triggering hysteresis. <div> </div>

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
	$SP.H$		<p>The alarm switches on when the measured value exceeds SP by $R.bnd$.</p> <p>The $R.bnd$ parameter is an alarm triggering threshold.</p> <p>The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$SP.Lo$		<p>The alarm switches on when the measured value is lower SP by $R.bnd$.</p> <p>The $R.bnd$ parameter is an alarm triggering threshold.</p> <p>The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$0.N$		<p>The alarm switches on when the measured value is within the range $0 \pm R.bnd$ taking into account the $R.HYS$ parameter.</p> <p>The $R.bnd$ parameter is an alarm triggering threshold.</p> <p>The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$0.O$		<p>The alarm switches on when the measured value is out of the range $0 \pm R.bnd$ taking into account the $R.HYS$ parameter.</p> <p>The $R.bnd$ parameter is an alarm triggering threshold.</p> <p>The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$0.H$		<p>The alarm switches on when the measured value exceeds 0 by $R.bnd$.</p> <p>The $R.bnd$ parameter is an alarm triggering threshold.</p> <p>The $R.HYS$ parameter is an alarm triggering hysteresis.</p> 
	$0.Lo$		<p>The alarm switches off when the measured value exceeds 0 by $R.bnd$.</p> <p>The $R.bnd$ parameter is an alarm triggering threshold.</p> <p>The $R.HYS$ parameter is an alarm triggering hysteresis.</p>

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
R_{bnd}^*	0... Delta-Sens**	20	Alarm triggering threshold
R_{hys}^*	0... Delta-Sens**	1.0	Alarm triggering hysteresis
F_{bLC}	on off	off	<p>Blocking of the first alarm triggering on – blocked. off – not blocked.</p> <p>i NOTE The blocking is used to prevent the alarm from triggering when the device is switched on before the control system enters the preset operating mode. If after switching on the device the measured signal value of the input is outside the alarm zone, blocking of the first alarm triggering is reset.</p> <p>The flag is reset when switching from the Stop mode to the Automatic control mode.</p>
$Err.d$	off on	off	<p>Output state in the Error mode: on – enabled. off – disabled</p>
<p>i NOTE * The decimal point position is determined by the dPt parameter. ** SensMin – lower limit of sensor measurement, SensMax – upper limit of sensor measurement, DeltaSens – sensor measurement range.</p>			

7.5 Diagnosis of faults in control loop

Diagnosis of faults in the control loop is used for the "heating" or "cooling" logic. The device monitors the system's response to a control action:

- For "heating": at maximum output power (output closed) the input readings increase, at open output — decrease.
- For "cooling": at maximum output power (output closed) the input readings decrease, at open output — increase.

When the output is closed or open, the timer $LbRt$ is started. If during the time of $LbRt$ the input value changes to a value greater $LbRb$, then the timer $LbRt$ is reset. If not, an fault is registered due to a malfunction of the control loop. LED **ST1** lights up and the device stops and the outputs are switched to the safe state according to the parameters $Err.d$ (digital output) and $Err.P$ (PID controller).

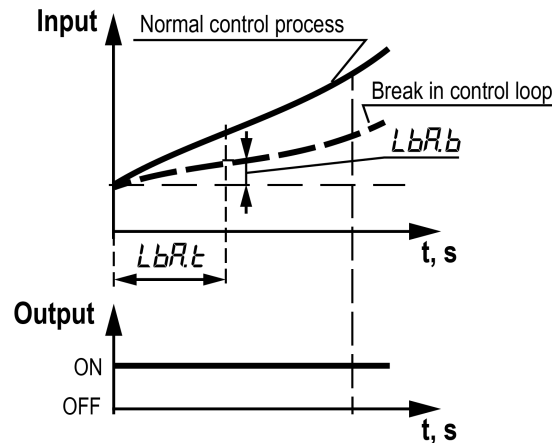


Fig. 7.4 Diagnosis of faults in control loop

Principle of operation

For "heating":

- If the output corresponds to the maximum value, the device records the value at the input. If the input signal does not change by a value of $LbR.b$ or more during the time of $LbR.t$, the device detects a fault of the control loop.
- If the output corresponds to the minimum value, the device records the value at the input. If the input signal does not change by a value of $LbR.b$ or more during the time of $LbR.t$, the device detects a fault of the control loop.

For "cooling":

- If the output corresponds to the maximum value, the device records the value at the input. If the input signal does not change by a value of $LbR.b$ or more during the time $LbR.t$, the device detects a fault of the control loop.
- If the output corresponds to the minimum value, the device records the value at the input. If the input signal does not change by a value of $LbR.b$ or more during the time $LbR.t$, the device detects a fault of the control loop.

If the output value changes during $LbR.t$, the timer is reset every time there is a change in the output or the value of the output has an intermediate value between the minimum and maximum.

If the value of the input signal has changed by $LbR.b$ before the timer $LbR.t$ has been triggered, then the device registers the new input value at this moment and resets the timer $LbR.t$ (if the output is in an extreme position all this time).

For the initial selection of the time value of the loop break diagnosis ($LbR.t$):

1. Set the output signal to the maximum level.
2. Measure the time it takes for the measured value to change to the width of the loop break diagnostic zone (the $LbR.b$ parameter).
3. Double the measured time and take it as the open loop diagnosis time.

The automatic recovery function (the $RrEC$ parameter) does not work for this error type.

After the causes of the error have been eliminated, the automatic control process must be resumed manually. To do this, switch the device to the **Stop** mode or **Manual control** mode and then switch it to the **Automatic control** mode.

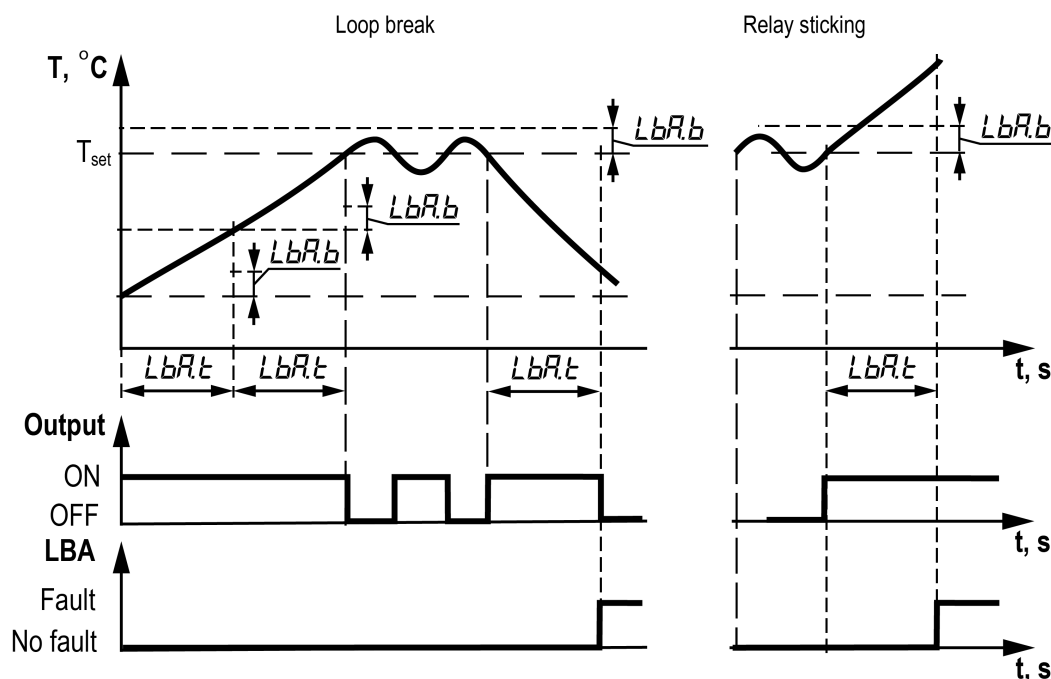


Fig. 7.5 Fault diagnosis of the control loop

7.6 PID autotuning

PID autotuning parameters (menu $\overline{P}id$) are given in [Table 7.5](#).

Table 7.5 PID autotuning parameters

Parameter	Values (1) Default values (2)		Description
	(1)	(2)	
$\overline{P}id$	oFF		PID autotuning As a result of PID autotuning, the device calculates optimal values of PID controller and filter coefficients. Initial conditions to start PID autotuning: – set the measured current value below the setpoint (for 'heating') and above (for 'cooling') as $in\ tF_{IL,t} = 0$ – the device is the Stop mode To start autotuning, set the $\overline{P}id$ parameter to <i>run</i> . Then the device performs autotuning according to the specified algorithm. During this period the upper digital indicator displays $\overline{P}id$, the lower digital indicator displays the current measured temperature. The temperature is displayed immediately after the PID autotuning is started. During the period while the autotuning is in progress, it can be cancelled without saving the new coefficients by pressing the  button. When the autotuning is completed, parameters $\overline{P}idP$, $\overline{P}idI$, $\overline{P}idD$, $F_{IL,b}$ and $F_{IL,t}$ are assigned new values. The digital indicator displays <i>Good</i> . If the auto-tuning has failed, the digital indicator displays <i>FRIL</i> . After autotuning the device switches to the Automatic control mode.

7.7 Indication setup

Indication setup parameters (the *ind* menu) are given in [Table 7.6](#).

Table 7.6 Indication parameters

Pa- ra-me- ter	Values (1) Default (2)		Description												
	(1)	(2)													
Scr. 1	P 15 1	P 15 1	Screen configuration setup Display of the selected parameter values on the upper and lower indicators The following parameters are available for display: <table><tr><th>Description</th><th>Name</th><th>Indication</th></tr><tr><td>Current measured value</td><td>PU</td><td>P 1 (P2)</td></tr></table>	Description	Name	Indication	Current measured value	PU	P 1 (P2)						
	Description			Name	Indication										
	Current measured value			PU	P 1 (P2)										
	P 1o 1														
	P 1d 1														
	F 15 1														
	F 1o 1														
	F 1d 1														
P 1P2															
F 1P2															
Scr.2 Scr.3 Scr.4 Scr.5 Scr.6	oFF	oFF	<div> NOTE When you select P2, the digital indicator displays the device status (Stop/Run or Stop/Alarm) depending on the digital input settings (see Section 7.3.2)</div> <table><tr><td>Setpoint</td><td>SP</td><td>5 1</td></tr><tr><td>Output power (see Section 7.7.1) Display is set in the out.5 parameter.</td><td>out.P</td><td>o 1</td></tr><tr><td>The calculated value of a mathematical function</td><td>Fun</td><td>F 1</td></tr><tr><td>Dynamics of signal</td><td>d in</td><td>d 1</td></tr></table> <p>The procedure for setting the screen configuration is described in Section 7.7.2. In the Manual control mode, instead of displaying the SP setpoint, the out.P value is displayed according to the out.5 parameter settings. If Fun = oFF, then the inscription F.Err is displayed when the Fun 1 parameter is displayed.</p>	Setpoint	SP	5 1	Output power (see Section 7.7.1) Display is set in the out.5 parameter.	out.P	o 1	The calculated value of a mathematical function	Fun	F 1	Dynamics of signal	d in	d 1
	Setpoint			SP	5 1										
	Output power (see Section 7.7.1) Display is set in the out.5 parameter.			out.P	o 1										
	The calculated value of a mathematical function			Fun	F 1										
	Dynamics of signal			d in	d 1										
	P 15 1														
	P 1o 1														
	P 1d 1														
	F 15 1														
	F 1o 1														
	F 1d 1														
	P 1P2														
F 1P2															
out.5	PERC	PERC	Selection of the absolute or relative power PERC – the percentage of output power is displayed. dREL – the absolute output value (4...20 mA or 0...10 V)) proportional to the selected power out.P is displayed.												
	dREL														
ret.t	oFF	30	Time (in seconds) for automatic return from the settings menu to the operation mode when there is no activity (pressing of buttons). The oFF value– no automatic return. <div> NOTE There is no automatic return while editing a parameter.</div>												
	5														
	10														
	30														
	60														
chg.t	oFF	oFF	Time (in seconds) for automatic change of the screens (Scr. 1–Scr.6). The oFF value – no automatic screen change.												
	5														
	10														
	30														
	60														

Parameter	Values (1) Default (2)		Description
	(1)	(2)	
	120		

7.7.1 Output power

Output power ($out.P$).



NOTE

The $out.P$ parameter is only available for the Modbus protocol. The parameter is not displayed in the menu.

Digital output

For a digital output, the pulse length of a digital output depends on the pulse period and the calculated power.

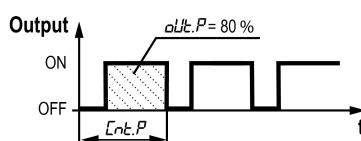


Fig. 7.6 Digital output power

$$D = \text{Len.P} \times out.P / 100,$$

D – pulse length, s;

Len.P – pulse period, s;

$out.P$ – output power.

For the **Manual control** mode, power changes are available on the digital indicator and via the Modbus protocol.

When switching from the **Stop** mode to the **Manual control** mode, the output power is equal to $Set.P$.

When switching from the **Automatic control** mode to the **Manual control** mode, the power is equal to the last power value in the **Automatic control** mode. When switching from the **Manual control** mode to the **Automatic control** mode, the power of the **Manual control** mode is retained.

If the device is reset in the **Manual control** mode, the output power is equal to the last set value.

7.7.2 Screen setup

To set up the screen configuration:

1. Select the screen ($Scr. 1 \dots Scr. 5$).

2. Press the  button.

The upper digital indicator displays the parameter to be edited (flashing): $PU I$, $F_{un I}$.

3. Select the parameter you need.

Once the parameter you need is selected, it is fixed (not flashing) and editing proceeds to the parameter on the lower digital indicator.

4. Select the parameter on the lower digital indicator.

Depending on the selected value on the upper digital indicator, the following parameters are available on the lower digital indicator:

Upper digital indicator	Lower digital indicator
<i>Pu1</i>	<i>SP1, out1, din1, PU2</i>
<i>FUn1</i>	<i>SP1, out1, din1, PU2</i>

NOTE
The *out1* parameter is the output power displayed in units set in the *out.5* parameter.

5. Press the  button to fix the parameter displayed on the lower digital indicator.

After fixation the upper digital indicator will display the screen number *Scr...*, the lower indicator will display the screen configuration as a number of abbreviated parameters.

An example of screen setup is shown in the figure below:

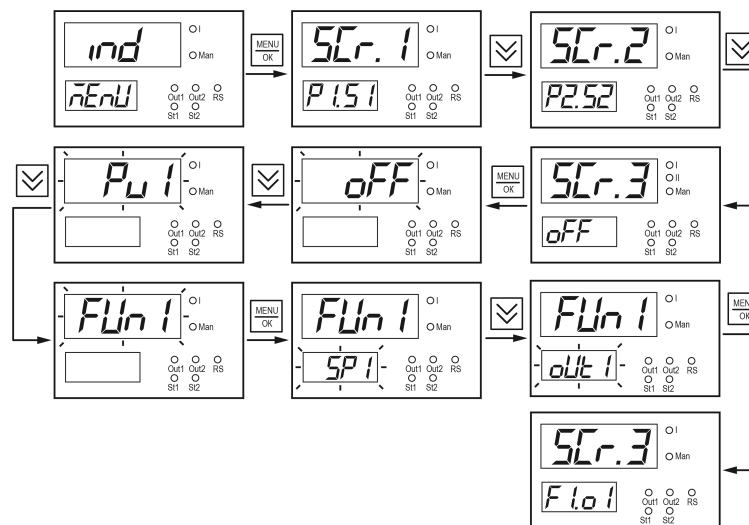


Fig. 7.7 Screen setup

7.8 RS485 setup

RS485 parameters (menu *r485*) are given in [Table 7.7](#).

Table 7.7 RS485 parameters

Parameter	Values (1) Default (2)		Description
	(1)	(2)	
<i>Prot</i>	<i>rtu</i>	<i>rtu</i>	RS485 communication protocol <i>rtu</i> – Modbus RTU <i>ASC</i> – Modbus ASCII
	<i>ASC</i>		
<i>Addr</i>	1...247	16	RS485 device address
<i>baud</i>	2.4	9.6	RS485 baud rate (Kbaud)
	4.8		
	9.6		
	14.4		
	19.2		
	28.8		
	38.4		

Parameter	Values (1) Default (2)		Description
	(1)	(2)	
	57.6		
	115.2		
dPS	Bn1	0	Data sending format: – Data bits: – 7 (for Modbus ASCII only) – 8 – Parity: – n – none – o – odd – E – even – Stop bits: – 1 – 2
	Bo1	1	
	BE1	2	
	Bn2	3	
	Bo2	4	
	BE2	5	
	7o1	6	
	7E1	7	
	7o2	8	
	7E2	9	
idLE	0...20	2	Delay (in ms) before the device responds over R485. If the value is 0, the delay is set automatically.
b.ord	n5b	n5b	The byte order in the register. It is required to match data packets with the Modbus Network Server (Master). n5b – big endian L5b – little endian
	L5b		

7.9 Setup of protection from editing and hiding parameters



NOTE

The *SEt* menu is accessed by entering the password set in the *PRSS* parameter.

Parameters of editing protection (menu *SEt*) are given in [Table 7.8](#).

Table 7.8 Protection parameters

Parameter	Values (1) Default (2)		Description
	(1)	(2)	
PRSS	0...9999	10-0	SEt menu access password
Pr.t.E		oFF	Protection from editing parameter values To unlock or restore parameter visibility, go to the <i>SEt</i> menu and set <i>Pr.t.E</i> =oFF.
	oFF		Protection is disabled, all parameters are available for editing.
	SEt		Locking the editing of parameters. Only editing of set points, output power, and operation mode selection is available.
	ALL		Locking the editing of all parameters. Viewing of parameters is available.
	Hi.de		Hide all parameters. No access to the main settings menu.
Pl.t.E		oFF	Displaying the selected parameters in the menu. Each parameter of the main menu has a visibility attribute. Depending on the value of the attribute, the parameter is displayed in the menu or not.

Parameter	Values (1) Default (2)		Description
	(1)	(2)	
	oFF		Enable displaying all parameters regardless of the value of their visibility attributes.
	Ed it		Manually editing the visibility attribute for each parameter After setting <i>Ed it</i> , the attribute values are displayed in the parameter values. You can edit with the  button. To edit an attribute: 1. Set <i>Attr.E</i> = <i>Ed it</i> . 2. Exit the <i>SLt</i> menu. 3. Enter the main menu and the submenu you need. The visibility attribute value (<i>SHoW</i> or <i>Hi dE</i>) is now displayed for each parameter on the lower digital indicator. 4. Use the parameter value selection procedure to select the attribute value for individual parameters. By default, the attributes of all parameters are set to <i>SHoW</i> . 5. To return to the operating state of the main menu, return to the <i>SLt</i> menu and select the values of the <i>Attr.E</i> parameter other than <i>Ed it</i> . <i>SHoW</i> – display the parameter, <i>Hi dE</i> – hide the parameter.
	on		Parameters with the <i>Hi dE</i> value of the visibility attribute are not displayed in the main menu. Parameters with the <i>SHoW</i> value of the visibility attribute are displayed. The availability of visible parameters for editing is determined by setting the <i>Prt.E</i> parameter in the <i>SLt</i> menu.
CJSE			Enabling / disabling the CJS
	on	on	CJS enabled
	oFF		CJS disabled

7.10 Factory settings restoration

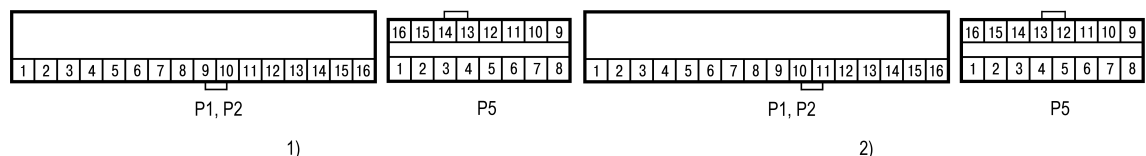


NOTE

Restoration of factory settings resets the value of all parameters to factory settings.

To restore to factory settings:

1. Set the jumper as shown below.



- 1) for all signals except for 0...10 V;
- 2) for signals 0...10 V.

Fig. 7.8 Jumper position



NOTICE

Before setting the jumper, make sure the sensor is not connected to Input 1.

2. Press and hold the  and  button on the front panel until you see *drSt*.
3. Enter password "100" and press the  button.

4. Set the *dr5t* parameter value to *on*.
5. The lower indicator will display *r5t* for 5 seconds. Then, the device will restore to factory settings.

8 Maintenance

The safety requirements (see Section 1.6) must be observed when the maintenance is carried out.

**WARNING**

Cut off all power before maintenance.

The maintenance includes:

- Cleaning of the housing and terminal blocks from dust, dirt and debris
- Checking the device fastening
- Checking the wiring (connecting wires, terminal connections, absence of mechanical damages)

**NOTICE**

The device should be cleaned with a dry or slightly damp cloth only. No abrasives or solvent-containing cleaners may be used.

9 Scope of delivery

– TCR10	1 pc.
– Gasket	1 pc.
– Short guide	1 pc.
– Fasteners	1 set
– Self-adhesive cutout template	1 pc.



NOTE

The manufacturer reserves the right to make changes to the scope of delivery.

10 Transportation and storage

Pack the device in such a way as to protect it reliably against impact for storage and transportation. The original packaging provides optimum protection.

If the device is not taken immediately after delivery into operation, it must be carefully stored at a protected location. The device should not be stored in an atmosphere with chemically active substances.

The environmental conditions must be taken into account during transportation and storage.



NOTICE

The device may have been damaged during transportation.

Check the device for transport damage and completeness!

Report the transport damage immediately to the shipper and akYtec GmbH!

Appendix A. Sensors

Table A.1 Sensors

Type	Indication	Description	Display range*
No	oFF	not connected	—
RTD	C 50	Cu50	-55...+205 °C
	C 53	Cu53	-55...+205 °C
	C 100	Cu100	-55...+205 °C
	C 500	Cu500	-55...+205 °C
	C 10	Cu1000	-55...+205 °C
	50 C	50M	-185...+205 °C
	100 C	100M	-185...+205 °C
	500 C	500M	-185...+205 °C
	10 C	1000M	-185...+205 °C
	P 50	Pt50	-205...+855 °C
	P 100	Pt100	-205...+855 °C
	P 500	Pt500	-205...+855 °C
	P 10	Pt1000	-205...+855 °C
	50 P	50P	-205...+855 °C
	100 P	100P	-205...+855 °C
	500 P	500P	-205...+855 °C
	10 P	1000P	-205...+855 °C
	100 n	100N	-65...+184.4 °C
	500 n	500N	-65...+185 °C
	10 n	1000N	-65...+185 °C
TC	tC.L	L	-205...+805 °C
	tC.KR	K	-240...+1372 °C
	tC.J	J	-210...+1205 °C
	tC.n	N	-270...+1305 °C
	tC.t	T	-270...+405 °C
	tC.S	S	-55...+1768 °C
	tC.r	R	-55...+1768 °C
	tC.b	B	0...+1820 °C
	tC.A1	A-1	-5...+2505 °C
	tC.A2	A-2	-5...+1805 °C
	tC.A3	A-3	-5...+1805 °C
	tC.dL	Typ.L (DIN 43710)	-205...+905 °C
	tC.E	E	-268...+1000 °C

Type	Indication	Description	Display range*
Pyrometers	$P_{ir.1}$	RK-15	+395,4...+1505 °C
	$P_{ir.2}$	RK-20	+595,5...+2005 °C
	$P_{ir.3}$	RS-20	+895,3...+2005 °C
	$P_{ir.4}$	RS-25	+1195...+2505 °C
Unified signals	$i_{0.5}$	0...5 mA	-0.01...5.25 mA
	$i_{0.20}$	0...20 mA	-0.01...22 mA
	$i_{4.20}$	4...20 mA	3.5...22 mA
	$u_{-5.5}$	-50...50 mV	-55...55 mV
	$u_{0.1}$	0...1 V	-0.1...1.1 V
	u_5	0...5 V	-0.1 ... 5.5 V
	u_{10}	0...10 V	-1 ... 11 V

**NOTE**

* This column specifies the ranges for displaying readings on the digital indicator. The display range is wider than the measurement range in [Table 3.2](#). The errors in [Table 3.1](#) are given for measurement ranges.

Appendix B. Modbus register map

Table B.1 Reading and writing parameters via the Modbus protocol

Operation	Function
Read	0x03 or 0x04
Write	0x10

Access: R — read only, W — write only, R/W — read and write.

Table B.2 Common registers of operational exchange

Parameter	Description	Register address (HEX)	Access	Data type
DEVICE	Device type	1000	R	CHAR[8]
VERSION	Firmware version	1004	R	CHAR[8]
STATUS*	Device status (bit mask)	1008	R	UINT16
F_{un1}	Measured value at Input 1 (after function applied)	1009	R	FLOAT32
$SP1$	Setpoint for channel 1	100B	R/W	FLOAT32
SP_{curr}	Current setpoint value	100D	R	FLOAT32
$out.P$	Output 1 power	100F	R/W	FLOAT32
$\mathcal{C}trl^{**}$	Control mode	1011	R/W	UINT16
RESET	Remote device reset	1012	W	UINT16



NOTE

* Description of STATUS register bits:

- 0 – Error at Input 1
- 2 – Error in calculating the function at Input 1
- 4 – Internal error of the device
- 5 – Triggering Output 1
- 6 – Triggering Output 2
- 7 – Manual control mode is enabled
- 8 – STOP mode is enabled
- 9 – Break of control loop 1
- 11 – PID autotuning is in progress
- 12 – PID autotuning



NOTE

**Values of $\mathcal{C}trl$ register:

- 0 – STOP;
- 1 – RUN;
- 2 – MAN.

Table B.3 Modbus register

Parameter	Description	Register address (HEX)	Access	Data type	Value range	
Input 1						
<i>Fun 1</i>	Measured value at input (after function applied)	0000	R	FLOAT32		
<i>PU 1</i>	Input value (before function applied)	0002	R	FLOAT32		
<i>tYPE</i>	Input sensor type	0004	R/W	UINT16	<i>oFF</i>	0
					<i>C 50</i>	1
					<i>C 53</i>	2
					<i>C 100</i>	3
					<i>C500</i>	4
					<i>C 1.0</i>	5
					<i>50 C</i>	6
					<i>100C</i>	7
					<i>500C</i>	8
					<i>1.0 C</i>	9
					<i>P 50</i>	10
					<i>P 100</i>	11
					<i>P500</i>	12
					<i>P 1.0</i>	13
					<i>50 P</i>	14
					<i>100P</i>	15
					<i>500P</i>	16
					<i>1.0 P</i>	17
					<i>100n</i>	18
					<i>500n</i>	19
					<i>1.0 n</i>	20
					<i>tC.L</i>	21
					<i>tC.HR</i>	22
					<i>tC.J</i>	23
					<i>tC.n</i>	24
					<i>tC.t</i>	25
					<i>tC.S</i>	26
					<i>tC.r</i>	27
					<i>tC.b</i>	28

Parameter	Description	Register address (HEX)	Access	Data type	Value range	
					<i>tC.R1</i>	29
					<i>tC.R2</i>	30
					<i>tC.R3</i>	31
					<i>tC.dL</i>	32
					<i>tC.E</i>	33
					<i>P_{ir.1}</i>	34
					<i>P_{ir.2}</i>	35
					<i>P_{ir.3}</i>	36
					<i>P_{ir.4}</i>	37
					<i>10.5</i>	38
					<i>10.20</i>	39
					<i>14.20</i>	40
					<i>u-5.5</i>	41
					<i>u0.1</i>	42
					<i>u5</i>	43
					<i>u10</i>	44
<i>F_{IL.b}</i>	Filter band	0005	R/W	FLOAT32	oFF, DeltaSens*	
<i>F_{IL.t}</i>	Filter time constant	0007	R/W	UINT16	oFF, 1...999	
<i>dPt</i>	Decimal point position	0008	R/W	UINT16	0	0
					1	1
					2	2
					3	3
					Auto	4
<i>ind.L</i>	Lower indication limit	0009	R/W	FLOAT32	-1999...9999	
<i>ind.H</i>	Upper indication limit	000B	R/W	FLOAT32	-1999...9999	
<i>FunC</i>	Mathematical function type	000D	R/W	UINT16	<i>oFF</i>	0
					<i>Sqr.t</i>	1
					<i>Sqr.1</i>	2
<i>d_{in.t}</i>	Dynamic signal analysis sampling period	0012	R/W	UINT16	0...30	
<i>d_{in.d}</i>	Signal dynamics delta	0013	R/W	FLOAT32	0.2...DeltaSens*	
<i>bArr</i>	IS barrier connection	0015	R/W	UINT16	oFF	0
					on	1

Parameter	Description	Register address (HEX)	Access	Data type	Value range	
<i>Cor1Po int</i>	Point 1 value of input correction	0016	R/W	FLOAT32	oFF, SensMin... SensMax*	
<i>Cor1 OFFSEt</i>	Offset for Point 1 of input correction	0018	R/W	FLOAT32	oFF, SensMin... SensMax*	
<i>Cor1CLr</i>	Reset of Point 1 correction	001A	R/W	UINT16	0	0
					1	1
<i>Cor2Po int</i>	Point 2 value of input correction	001B	R/W	FLOAT32	oFF, SensMin... SensMax*	
<i>Cor2 OFFSEt</i>	Offset for Point 2 of input correction	001D	R/W	FLOAT32	oFF, SensMin... SensMax*	
<i>Cor2CLr</i>	Reset of Point 2 correction	001F	R/W	UINT16	0	0
					1	1
<i>Cor3Po int</i>	Point 3 value of input correction	0020	R/W	FLOAT32	oFF, SensMin... SensMax*	
<i>Cor3 OFFSEt</i>	Offset for Point 3 of input correction	0022	R/W	FLOAT32	oFF, SensMin... SensMax*	
<i>Cor3CLr</i>	Reset of Point 3 correction	0024	R/W	UINT16	0	0
					1	1
Input 2						
<i>tYPE</i>	Digital input operation	0104	R/W	UINT16	<i>oFF</i>	0
					<i>d.StP</i>	45
					<i>d.nRn</i>	46
					<i>d.bLC</i>	47
Output 1 (common)						
<i>SP</i>	Setpoint at output	0200	R/W	FLOAT32	<i>SP.Lo... SP.Hi</i>	
<i>SP.Lo</i>	Setpoint lower limit	0202	R/W	FLOAT32	SensMin**... <i>SP.Hi</i>	
<i>SP.Hi</i>	Setpoint upper limit	0204	R/W	FLOAT32	SensMin**... <i>SP.Hi</i>	
<i>out.P</i>	Output power	0206	R/W	FLOAT32	0..100.0	
<i>LbR.t</i>	Circuit break diagnostic time	0208	R/W	UINT16	<i>oFF</i> 1...9999 s	
<i>LbR.b</i>	Width of the circuit break diagnostic zone	0209	R/W	FLOAT32	0...DeltaSens**	
<i>R.rEC</i>	Automatic recovery after error	020B	R/W	UINT16	<i>oFF</i>	-1
					0...999 s	
Output 1 (digital)						

Parameter	Description	Register address (HEX)	Access	Data type	Value range	
<i>LoG.d</i>	Logic type	0220	R/W	UINT16	<i>oFF</i>	0
					<i>HEAt</i>	1
					<i>CoOL</i>	2
					<i>ALrñ</i>	3
					<i>H.P id</i>	4
					<i>C.P id</i>	5
<i>HYSt</i>	Hysteresis	0221	R/W	FLOAT32	0..DeltaSens**	
<i>d.on</i>	Delay before the controller turns on	0223	R/W	UINT16	0...250 s	
<i>d.oFF</i>	Delay before the controller turns off	0224	R/W	UINT16	0...250 s	
<i>H.on</i>	Minimum time for the controller to be on	0225	R/W	UINT16	0...250 s	
<i>H.oFF</i>	Minimum time for the controller to be off	0226	R/W	UINT16	0...250 s	
<i>Ent.P</i>	Pulse period	0227	R/W	UINT16	1..250 s	
<i>Err.d</i>	Output safe state in the Error mode	0228	R/W	UINT16	<i>oFF</i>	0
					<i>on</i>	1
<i>StP.d</i>	Output state in the Stop mode	0229	R/W	UINT16	<i>oFF</i>	0
					<i>on</i>	1
<i>R.tYP</i>	Alarm logic type	0240	R/W	UINT16	<i>oFF</i>	0
					<i>SP.n</i>	1
					<i>SP.u</i>	2
					<i>SP.H i</i>	3
					<i>SP.Lo</i>	4
					<i>Q.n</i>	5
					<i>Q.u</i>	6
					<i>Q.H i</i>	7
					<i>Q.Lo</i>	8
<i>R.bnd</i>	Alarm boundary	0241	R/W	FLOAT32	0...DeltaSens*	
<i>R.HYS</i>	Alarm hysteresis	0243	R/W	FLOAT32	0...DeltaSens*	
<i>F.bLC</i>	First alarm block depending on logic type	0245	R/W	UINT16	<i>on</i>	0
					<i>oFF</i>	1
Output 1 (Alarm) <i>LoG.d</i> = <i>ALrñ</i> in group <i>out. i</i>						

Parameter	Description	Register address (HEX)	Access	Data type	Value range	
<i>R.tYP</i>	Alarm logic type	0240	R/W	UINT16	<i>oFF</i> 0 <i>SP.n</i> 1 <i>SP.u</i> 2 <i>SP.H.i</i> 3 <i>SP.Lo</i> 4 <i>Q.n</i> 5 <i>Q.u</i> 6 <i>Q.H.i</i> 7 <i>Q.Lo</i> 8	
<i>R.bnd</i>	Alarm boundary	0241	R/W	FLOAT32	0...DeltaSens*	
<i>R.HYS</i>	Alarm hysteresis	0243	R/W	FLOAT32	0...DeltaSens*	
<i>F.blk</i>	First alarm block	0245	R/W	UINT16	<i>on</i> 0 <i>oFF</i> 1	
Output 1 (PID controller)						
<i>P.id.P</i>	PID proportional band	0280	R/W	FLOAT32	0.001...9999	
<i>P.id.i</i>	PID integral term	0282	R/W	UINT16	0..3999 s	
<i>P.id.d</i>	PID derivative term	0283	R/W	UINT16	0..3999 s	
<i>Ent.P</i>	PWM period	0284	R/W	UINT16	1...250 s	
<i>USP</i>	PID setpoint change rate	0285	R/W	FLOAT32	<i>oFF</i> ...DeltaSens*	
<i>d.bnd</i>	Dead zone of PID controller	0289	R/W	FLOAT32	0...DeltaSens*	
<i>oL.L</i>	Minimum output power (lower limit) of PID controller	028F	R/W	FLOAT32	0...100.0	
<i>oL.H</i>	Maximum output power (upper limit) of PID controller	0291	R/W	FLOAT32	0...100.0	
<i>oL.U</i>	Maximum rate of change of PID controller output power	0293	R/W	FLOAT32	0.2..100 %/s	
<i>Err.P</i>	Output 1 value in the Error mode if the PID controller is used	0295	R/W	FLOAT32	0...100 %	
<i>StP.P</i>	Output 1 value in the Stop mode if the PID controller is used	029A	R/W	FLOAT32	0...100 %	

Parameter	Description	Register address (HEX)	Access	Data type	Value range	
Output 2 (common)						
Func	Mathematical function type	030B	R/W	UINT16	oFF	0
					59rt	1
RrEE	Automatic recovery after error	020B	R/W	UINT16	oFF	-1
					0...999 s	
Output 2 (digital)						
LoG.d	Logic type	0320	R/W	UINT16	oFF	0
					RLrñ	3
Output 2 (Alarm) LoG.d = RLrñ in group out.2						
RLtYP	Alarm logic type	0340	R/W	UINT16	oFF	0
					SP.n	1
					SP.u	2
					SP.H.i	3
					SP.Lo	4
					Q.n	5
					Q.u	6
					Q.H.i	7
					Q.Lo	8
R.bnd	Alarm boundary	0341	R/W	FLOAT32	0...DeltaSens*	
R.HYS	Alarm hysteresis	0343	R/W	FLOAT32	0...DeltaSens*	
F.bLC	First alarm block	0345	R/W	UINT16	on	0
					oFF	1
PID autotuning						
Rnr	PID autotuning	02B0	R/W	UINT16	oFF	0
					run	1
Indication						
Scr.1	User screen 1	0400	R/W	UINT16	P15.1	1
					P16.1	2
					P18.1	3
					F15.1	4
					F16.1	5
					F18.1	6
					P1P2	13
					F1P2	15

Parameter	Description	Register address (HEX)	Access	Data type	Value range	
<i>Scr2</i>	User screen 2...6	0401	R/W	UINT16	<i>oFF</i>	0
<i>Scr3</i>		0402	R/W	UINT16	<i>P151</i>	1
<i>Scr4</i>		0403	R/W	UINT16	<i>P101</i>	2
<i>Scr5</i>		0404	R/W	UINT16	<i>P1d1</i>	3
<i>Scr6</i>		0405	R/W	UINT16	<i>F151</i>	4
					<i>F101</i>	5
					<i>F1d1</i>	6
					<i>P1P2</i>	13
					<i>F1P2</i>	15
<i>out.5</i>	Select the absolute or relative power	0406	R/W	UINT16	<i>PERC</i>	0
					<i>dPRC</i>	1
<i>ret.t</i>	Delay before the device returns from the settings menu	0407	R/W	UINT16	<i>oFF</i>	0
					5	1
					10	2
					30	3
					60	4
<i>CHG.t</i>	Screen switching time	0408	R/W	UINT16	<i>oFF</i>	0
					5	1
					10	2
					30	3
					60	4
					120	5
RS485						
<i>Prot</i>	Communication protocol	0500	R/W	UINT16	<i>rtu</i>	0
					<i>RSC</i>	1
<i>Addr</i>	Device address in the Modbus network	0501	R/W	UINT16	1...247	
<i>brud</i>	Baud rate	0502	R/W	UINT16	2.4	0
					4.8	1
					9.6	2
					14.4	3
					19.2	4
					28.8	5
					38.4	6
					57.6	7
					115.2	8
<i>dPS</i>	Data sending format	0503	R/W	UINT16	<i>Br1</i>	0
					<i>Bo1</i>	1
					<i>BE1</i>	2

Parameter	Description	Register address (HEX)	Access	Data type	Value range	
					Bn2	3
					Bo2	4
					BE2	5
					7b1	6
					7E1	7
					7o2	8
					7E2	9
idLE	Device response delay	0504	R/W	UINT16	0...20	
b.ord	Byte order in the register	0505	R/W	UINT16	75b	0
					L5b	1
RPLY	Apply the RS485 settings	0506	R/W	UINT16	0	0
					1	1
Hidden parameters menu						
PRSS	Menu access password	0800	R/W	UINT16	0...9999	
Pr.t.E	Protection from editing the parameter values	0801	R/W	UINT16	oFF	0
					SEtt	1
					ALL	2
					H idE	3
Attr.E	Enabling the attributes to hide parameters	0802	R/W	UINT16	oFF	0
					on	1
					Ed it	2
CJS.E	Enabling / disabling CJS	0803	R/W	UINT16	on	0
					oFF	1



NOTE
* SensMin – lower limit of sensor measurement, SensMax – upper limit of sensor measurement, DeltaSens – sensor measurement range.