EN

TRM210

PID controller

User guide

TRM210_2018.04_0240_EN

CE

Contents

1 Overview

This guide describes the functions, system configuration, operating instructions, programming and troubleshooting of the PID controller TRM210 (hereinafter referred to as TRM210, device or controller).

1.1 Documentation

Data sheet (PDF document to download)

Data sheet contains general information, ordering information and technical data needed for purchase decision.

Short guide (PDF document to download / printed document in the box)

Short guide contains the most important information about installation, wiring, configuration and operation of the device.

User guide (PDF document to download)

User guide contains the complete information about the device.

Modbus access (PDF document to download / printed document in the box)

The document contains the information about the Modbus functions and the Modbus register allocation of the device.

All PDF documents can be downloaded from www.akytec.de.

1.2 Functions

The PID controller TRM210 is designed for creating automatic control and regulation systems of various technological processes in different areas of industry, agriculture and utilities.

The controller provides following basic functions:

– measuring of the process value and its transformation according to the sensor type
– displaying the process values and configuration parameters on two 4-digit LED displays
– scaling and filtering of input signal
– signal correction
– PID control (pulse or analog) or on-off control
– autotuning function
– stand-alone control
– manual control
– network control (RS485 interface) with akYtec, Modbus-RTU and Modbus-ASCII protocols as a Slave
– signal retransmission using analog output 4-20 mA or 0-10 V
– alarm output
– sensor / input error and Loop Break Alarm detection
– error indication
– remote start/stop using digital input
– configuration via the functional keys

1.3 RS485 network

The TRM210 uses the common standard RS485 for data exchange.

Serial interface RS485 enables communication via two-wired line in half-duplex mode. The device supports the Modbus RTU, Modbus ASCII and akYtec protocols with automatic protocol detection.

The network consists of a Master device and can contain up to 32 Slave devices. Maximum length is 1200 m. The number of Slave devices and network length can be increased by using RS485 interface repeater.

Devices are connected to a network according to linear (bus) topology. It means that the line goes from the first device to the second one, from the second one to the third one, etc. Star connection and spur lines are not allowed.

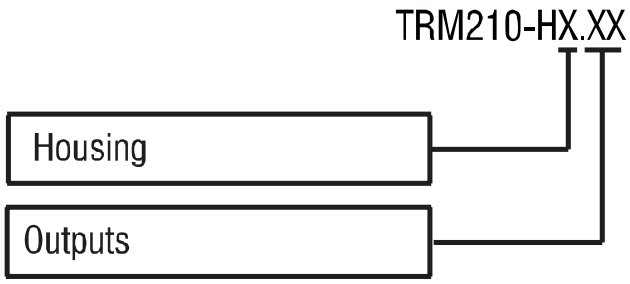
Line reflections always occur at each of the two ends of the bus (the first and the last node). The higher the data transmission rate, the stronger the reflections are. A terminating resistor is needed to minimize reflections. 150 ohm (0.5 W) resistor can be used as a line termination.

The TRM210 can only be used as a Slave device. PLC, computer with SCADA software or device can be used as a Master device.

To establish the communication via Modbus see section 7.6.

1.4 Ordering information

The TRM210 can be ordered in different variants depending on the required housing and output type.



Housing:

H1 - panel mount (96 x 96 x 70 mm)

H2 - panel mount (96 x 48 x 100 mm)

H3 - wall mount (105 x 130 x 65 mm)

Outputs:

R - Relay

T - NPN transistor

C - TRIAC

S - Solid state relay

I - 4-20 mA

U - 0-10 V

2 Specifications

Table 2.1 General Specifications

Power supply		230 (90…245) V AC, 50 (47…63) Hz		
Power consumption, max.		6 VA		
Analog input		1		
Input resistance	4-20 mA	external resistor R_{IN} = 100 ohm (in parallel)		
	0-1 V	≥ 100 kohm		
Digital input		1		
	ON resistance	< 1 kohm		
	OFF resistance	> 100 kohm		
Optional output		2		
Sampling rate, max.		1 s		
RS485 interface	Terminals	D+, D-		
	Protocols	Modbus RTU/ASCII, akYtec		
	Baud rate	2.4…115.2 kbit/s		
	Cable	Shielded twisted pair (STP)		
Enclosure		H1	H2	H3
Dimension, mm		96 x 96 x 70	96 x 48 x 100	105 x 130 x 65
IP Code		front IP54	front IP54	IP44

Table 2.2 Linear signals

Signal type	Measurement range, %	Accuracy, %
0-1 V	0…100	±0.5
-50…+50 mV	0…100	
0-5 mA	0…100	
0-20 mA	0…100	
4-20 mA	0…100	

Table 2.3 Temperature sensors

Signal type	Measurement range, °C	Temperature coefficient, $°C^{-1}$	Accuracy, %
RTD according to IEC 60751:2008			
Pt50	–200…+750	0.00385	±0.25
Pt100	–200…+750		
RTD according to GOST 6651			
50P	-200...+750	0.00391	±0.25
50M	-190…+200	0.00428	
Cu50	-50…+200	0.00426	
100P	-200...+750	0.00391	
100M	-190…+200	0.00428	
Cu100	-50…+200	0.00426	
53M	–50…+200	0,00426	
46P	–200…+750	0,00428	
TC according to IEC 60584-1:2013			
J	-200…+1200	-	±0.5
N	-200…+1300	-	
K	-200…+1300	-	
S	0…+1750	-	
R	0…+1750	-	
A	0…+2500	-	

Signal type	Measurement range, °C	Temperature coefficient, °C^{-1}	Accuracy, %
T	–200…+400	-	
B	+200…+1800		
TC according to GOST 8.585			
L	-200…+800	-	±0.5
A-2	0…+1800	-	
A-3	0…+1800	-	

Table 2.4 Optional outputs

Ordering code	Output type	Loading capacity
R	Relay	1 A (PID control) / 8 A (alarm) 30 V DC / 230 V AC, cos φ ≥ 0.4
T	NPN transistor	200 mA, 40 V DC
C	TRIAC	50 mA, 240 V AC (constant operation) 0.5 A (f ≤ 50 Hz, pulse duration ≤ 5 ms)
S	Solid state relay	100 mA, 4…6 V DC
I	4-20 mA	10…36 V, max. 1 kohm
U	0-10 V	15…36 V, min. 2 kohm

2.1 Environmental conditions

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

The following environment conditions must be met:

– clean, dry and controlled environment, low dust level

– closed non-hazardous areas, free of corrosive or flammable gases

Table 2.5

Conditions	Permissible range
Ambient temperature	+1…+50°C
Storage temperature	-25…+55°C
Relative humidity	up to 80% (at +35°C, non-condensing)
Altitude	up to 2000 m above sea level

3 Safety

Explanation of the symbols and keywords used:

DANGER ***DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.***

WARNING ***WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.***

CAUTION ***CAUTION indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury***

NOTICE ***NOTICE indicates a potentially harmful situation which, if not avoided, may result in damage of the product itself or of adjacent objects.***

3.1 Intended use

The device has been designed and built solely for the intended use described in this guide, and may only be used accordingly. The technical specifications contained in this guide must be observed.

The device may be operated only in properly installed condition.

Improper use

Any other use is considered improper. Especially to note:

– This device should not be used for medical devices which receive, control or otherwise affect human life or physical health.
– The device should not be used in an explosive environment.
– The device should not be used in an atmosphere with chemically active substance.

4 Installation

⚠ CAUTION

Improper installation
Improper installation can cause serious or minor injuries and device damage.
Installation must be performed only by fully qualified personnel.

The device is designed in a plastic enclosure for panel or wall mounting. For the dimension drawings see Appendix A.

4.1 Requirements

– Install the device in a cabinet with clean, dry and controlled environment. For further details see 2.1.
– The device is designed for natural convection cooling that should be taken into account when choosing the installation site.
– The seal contact surface must be clean and smooth, so that the IP54 protection (for H1 and H2) can be provided.
– The device can be placed at any angle.
– Maximum panel thickness is 15 mm.

4.2 Mounting

Mounting procedure for panel mount (H1 or H2 housing):

– prepare the mounting cutout for H1 (Fig. A.1) or H2 (Fig. A.2 and Fig. 4.1) housing
– make sure that the device is provided with the mounting seal
– fit the device into the cutout
– insert the 2 fastening clips into the slots on the sides of the device
– insert the screws and tighten them to fix the device

Mounting procedure for wall mount (H3):

– prepare three drilled holes according to Fig. A.3
– fix the triangle mounting bracket to the wall using three M4x20 screws (not included) (see Fig. A.3 and Fig. 4.2a)
– hook the angle bracket on the back of the device on the upper edge of the triangle bracket (Fig. 4.2b)
– fix the device to the triangle bracket with the screw supplied (Fig. 4.2c)

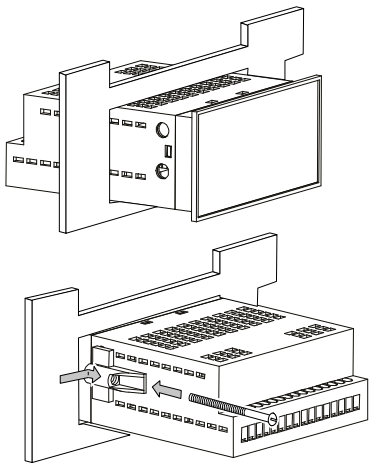
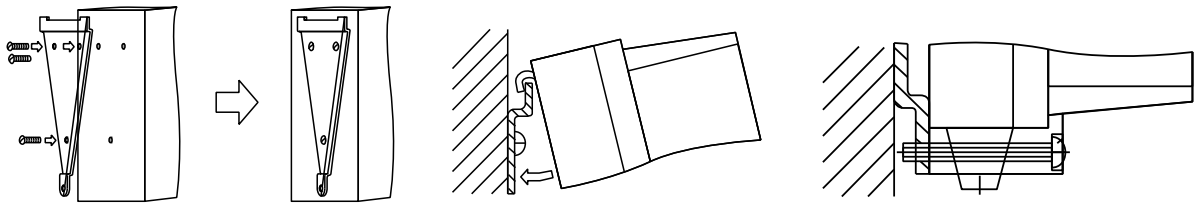


Fig. 4.1 Panel mount



a) *b)* *c)*

Fig. 4.2 Wall mount

5 Wiring

DANGER

Dangerous voltage
Electric shock could kill or seriously injure.
All electrical connections must be performed by a fully qualified electrician.
Ensure that the mains voltage matches the voltage marked on the nameplate.
Ensure that the device is provided with its own power supply line and electric fuse.

WARNING

Switch on the power supply only after wiring of the device has been completed.

WARNING

Terminals 1…8 for connecting power supply and outputs are designed for a maximum voltage of 250 V. Don't apply voltage above 250 V to the terminals 1...8 to avoid an insulation breakdown or flashover. Different phases are not allowed.

5.1 General

- The layout of terminal blocks is shown in Fig. 5.1 and the terminal assignments in Table 5.1
- Ensure that the device is provided with its own power supply line and electric fuse I = 0.5 A
- Connect the power supply to the terminals L / N
- The inputs should be wired in accordance with Fig. 5.1
- The outputs should be wired in accordance with Fig. 5.2...5.8
- The maximum conductor cross-section is 1.5 mm²

NOTICE

Signal cables should be routed separately or screened from the supply cables. Only a shielded cable may be used for signal lines.

- Connect the RS485 lines to terminals D+ and D-.
- Twisted pair cable should be used for the connection to RS485 interface. Maximal cable length is 1200 m.

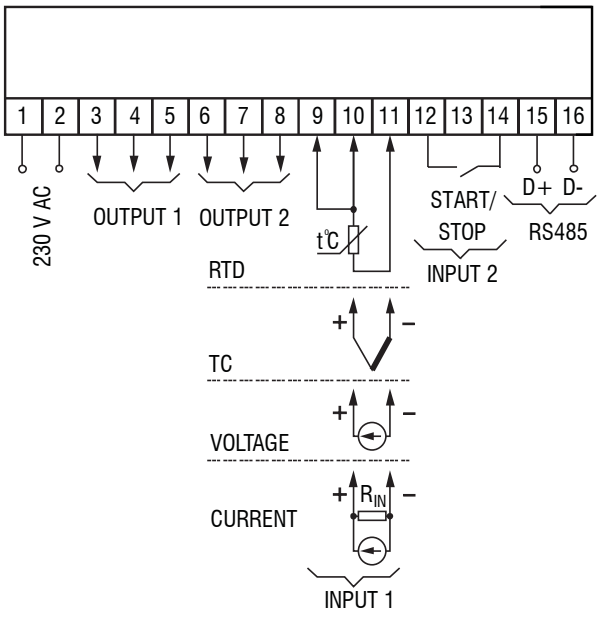


Fig. 5.1 Terminal block layout

Table 5.1 Terminal assignment

No	Designation	Description
1	N	Power supply 230 V AC
2	L	
3	Output 1	see 5.2
4		
5		
6	Output 2	see 5.2
7		
8		
9	Input 1	+ (three-wire RTD)
10		+
11		-
12	Input 2	DI
13		not connected
14		DI
15	D+	RS485
16	D-	

5.2 Inputs

Supported signals (see Table 2.2 and 2.3):

– Thermocouple (TC)
– Resistance thermometer (RTD)
– Linear current / voltage signal

Table 5.2 Sensor cables

Sensor type	Cable length, max.	Resistance (per wire), max.	Cable type
RTD	100 m	15 ohm	Equal length and cross-section, (2- or 3-wire)
TC	20 m	100 ohm	Compensation cable
Current signal	100 m	100 ohm	2-wire
Voltage signal	100 m	5 ohm	2-wire

– Use wires of equal length and cross section when connecting RTD
– Use a thermocouple cable when connecting TC
– Thermocouple sensing junctions of both inputs must be isolated from each other and from the grounded equipment
– Cold junction compensation (CJC) is provided.

5.2.1 Linear signals

Connect the current or voltage signal according to Fig. 5.1. An auxiliary voltage source is needed.

▶ **NOTICE** ***To measure a current signal a shunt resistor R_{IN} = 100 ohm (±1%) should be connected in parallel.***

Voltage signal can be connected directly to the input terminals.

▶ **NOTICE** ***The auxiliary voltage must not exceed 36 V***

5.3 Outputs

Optional outputs (see Table 2.4):

– Relay
– NPN transistor
– TRIAC
– Solid state relay
– Analog 4-20 mA
– Analog 0-10 V

5.3.1 Relay outputs (R)

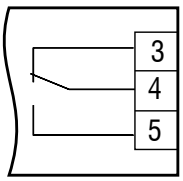


Fig. 5.2 Relay output

5.3.2 NPN transistor (T)

The NPN transistor outputs of T type are designed to control low voltage relay up to 60 V DC / 400 mA.

► **NOTICE**

As a precaution against inadvertent current reversal on the output, a parallel diode (Imax = 1 A, Umax=100 V) is usually included in the output circuit.

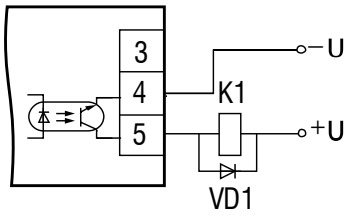


Fig. 5.3 NPN transistor outputs

5.3.3 TRIAC (C)

The resistor R1 (5…20 kohm) is used to limit the load current.

► **NOTICE**

To protect thyristors and TRIACs from overload a RC protect circuit should be connected in parallel to load: R2 (47…68 ohm) and C1 (0.1 x 630 V).

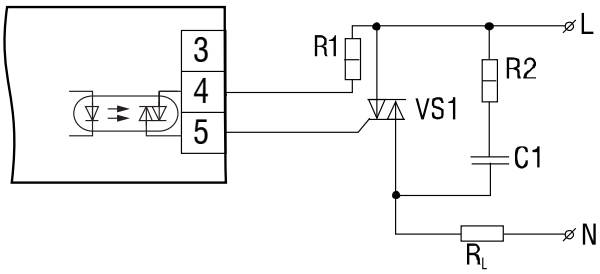


Fig. 5.4 Power TRIAC connection

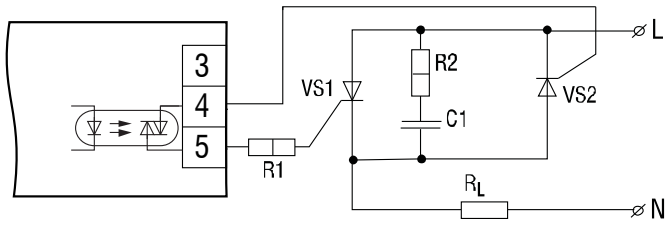


Fig. 5.5 Inverse-parallel connection of two thyristors

5.3.4 Solid state relay (S)

The logic output of S type is designed to control solid state relay with rating voltage 4…6 V DC and current up to 100 mA.

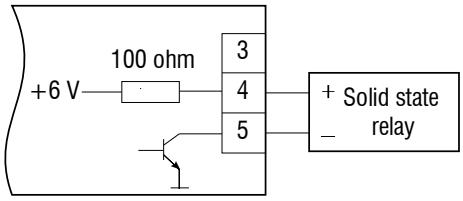


Fig. 5.6 SSR output

5.3.5 Analog 4-20 mA (I)

For the current output an external voltage source is required.

► **NOTICE**

The auxiliary voltage must not exceed 36 V
The output is designed for maximal load resistance of 1 kohm.

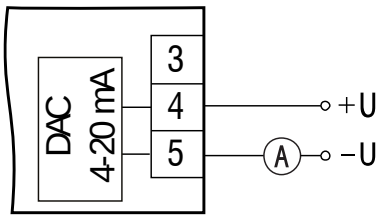


Fig. 5.7 4-20 mA output

5.3.6 Analog 0-10 V (U)

An external power supply is required for analog output 0-10 V

► **NOTICE**

The auxiliary voltage must not exceed 36 V.
The output is designed for minimal load resistance of 2 kohm.

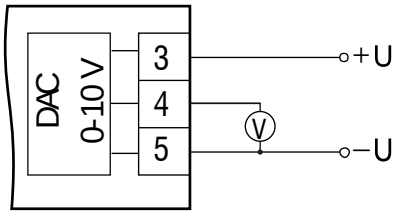


Fig. 5.8 0-10 V output

6 Operation and Configuration

6.1 Control elements

The device is designed in a plastic enclosure for panel or wall mounting, depending on the model. The indicators and control elements are located on the front side of the device.

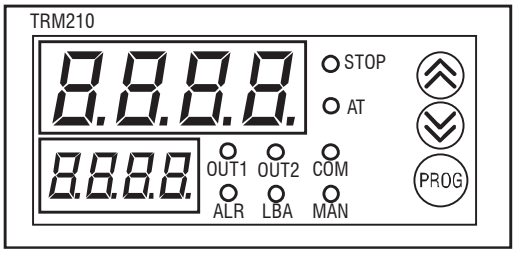


Fig. 6.1 Front view (H2 housing)

The operation of the device can be controlled with two 4-digit displays, three buttons and eight LEDs on the front panel. The indicators inform the operator about the controller and output status. Displays show following information:

Table 6.1 Displays

Display	Mode	Displayed information
Upper display (red)	Operation	Process value
	Configuration	Parameter name
	Menu	“MENU”
	Error	Error name
Lower display (green)	Operation	Setpoint
	Configuration	Parameter value
	Menu	Parameter group

For display functions during the configuring see section 6.3 “Configuration”.

Table 6.2 Indicators

LED	Indication	Description
OUT1	lights	Output 1 is ON
OUT2	lights	Output 2 is ON
ALR	blinks	Alarm is activated
LBA	blinks	Loop Break Alarm is activated
STOP	lights	Control is stopped by user
	blinks	Control is stopped due to a hardware error or LBA
AT	lights	Autotuning in progress
	blinks	Autotuning failure
COM	flashes for 0.1 s	on data transmission
MAN	lights	Manual control is activated

Table 6.3 Function keys

Key	Description
⋀	Increase value or menu navigation
⋁	Decrease value or menu navigation
PROG	Press > 3 s – enter the configuration mode – exit the parameter group Press < 1 s: – enter the parameter group – save the parameter and go the next one
PROG + ⋀ + ⋁	Passcode access
PROG + ⋀	Modify the decimal part of parameter (Configuration)
PROG + ⋁	Go back to modify the integer part of parameter (Configuration)

6.2 Principle of operation

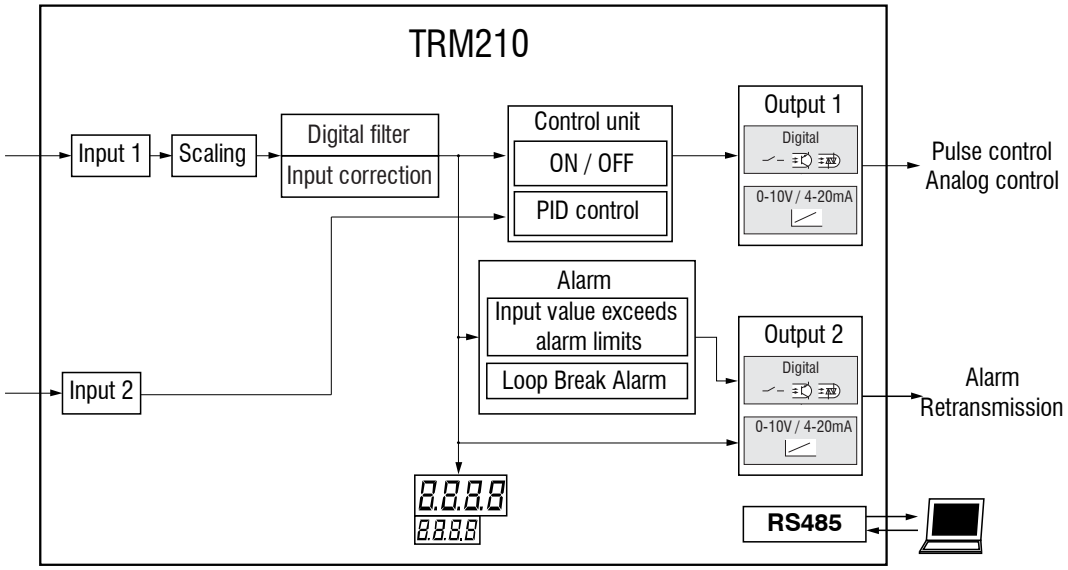


Fig. 6.2 Block diagram

The device has one control channel with one analog input. The digital input has only one function i.e. Remote start/stop (see 6.8).

In the control mode the analog input is continuously sampled, the signal is converted according to the selected sensor type (**in-t** parameter, see Table B.1) and the measured value is displayed and processed according to the input settings.

The Control Unit analyses the input value and generates the control signal on the Output 1. The Output 2 is used for alarm or signal retransmission.

The device can be ordered with analog or digital outputs (see 1.4 “Ordering information”).

6.3 Configuration

In the system menu the parameters are divided into 5 groups: **LvoP**, **iniT**, **Adv**, **Comm** and **LmAn** (Fig. 6.3).

The full list of the programmable parameters is given in Table B.1.

The parameters are saved in the memory registers according to the Table C.3.

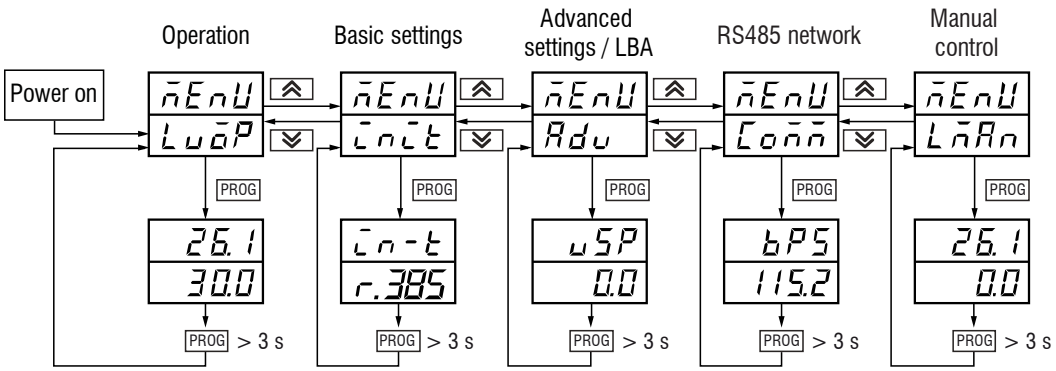


Fig. 6.3 Parameter groups

- **LvoP** – operation parameters (Process value, Setpoint, Current output signal, Remote Start/Stop, Autotuning), displayed at the device start
- **init** – basic settings
- **Adv** – advanced settings / LBA
- **Comm** – RS485 network settings
- **LmAn** – Manual control settings

To use the functional keys in Configuration refer to Table 6.3.

6.4 Temperature sensor

The signal from the resistance thermometer or thermocouple is converted according to the sensor curve for the selected sensor. The type of the connected sensor should be set in the parameter **in-t** (Sensor).

When the RTD or TC is used, the displayed accuracy for the measured temperature can be set in the parameter **dPt** (Decimal point displayed). The parameter is not available in the menu for sensors with the linear output. For the thermocouples with the upper limit above 1000°C is recommended to set **dPt** = 1, for other temperature sensors **dPt** = 0.

When the thermocouple is used, Cold junction compensation (CJC) enables precise temperature measurement. The reference junction sensor is located near the input terminals. The function is active by default. It should be deactivated only during the calibration. Set the parameter **wXC** (Calibration parameters) to OFF to disable this function.

6.5 Linear signal

There are additional functions for linear signal processing: decimal point position and scaling.

When a linear sensor is used, the accuracy can be set in the parameter **dP** (Decimal point). For temperature sensors the parameter **dP** = 1 and is not available in the menu.

Note: The parameter **dP** affects other parameters (see Table B.1).

The measurement range can be defined in the parameters:

in-L – signal lower limit

in-H – signal upper limit

If **in-L** < **in-H**, then

$$Measured\ value = \boldsymbol{in\text{-}L} + \frac{(\boldsymbol{in\text{-}H} - \boldsymbol{in\text{-}L}) * (S_i - S_{min})}{S_{max} - S_{min}}$$

If **in-L** > **in-H**, then

$$Measured\ value = \boldsymbol{in\text{-}L} - \frac{(\boldsymbol{in\text{-}L} - \boldsymbol{in\text{-}H}) * (S_i - S_{min})}{S_{max} - S_{min}}$$

where

S_{max} – max. input signal (for example, 20 for 4-20 mA signal)

S_{min} – min. input signal (for example, 4 for 4-20 mA signal)

S_i – current signal value

Note:

After the Signal limits are set so that **in-L** > **in-H**, the Setpoint limits **SL-L**, **SL-H** and the Retransmission limits **An-L**, **An-H** (**init** group) have to be set again (see 6.9, 6.12)

6.6 Filter

The digital filter consists of two stages.

1. The **Comparator** is used at the first stage to detect apparent "gaps" or "outliers" in the input signal. The Filter bandwidth for the comparator should be specified in the parameter **Fb** in measuring units within the range 0…9999. The filter is disabled if the bandwidth is set to 0.

The difference between the last two measurements T_i and T_{i-1} is determined and compared with the bandwidth. If the difference exceeds the bandwidth, the last measurement T_i will be replaced with the (T_{i-1} + **Fb**) and the bandwidth will be doubled to smooth the characteristic curve. A smaller filter bandwidth slows down the response to input signal variations (Fig. 6.4).

It is recommended to increase the filter bandwidth or disable the parameter when a low level of interference or rapidly varying process.

If the process signal has high interferences, decrease the bandwidth to reduce the impact on the process.

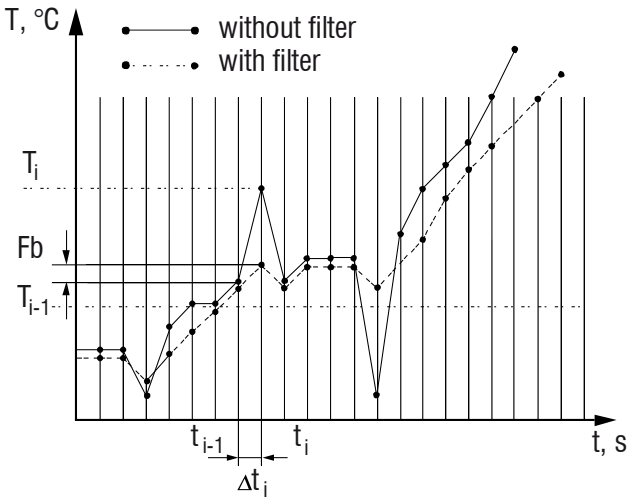


Fig. 6.4 Filter bandwidth

2. The **Damping** with the parameter **inF** is used at the second stage. The filter time constant can be set within the range 1…999 seconds. The higher the value, the higher the noise resistance and the slower the output response are. When the value is set to 0, the damping is deactivated.

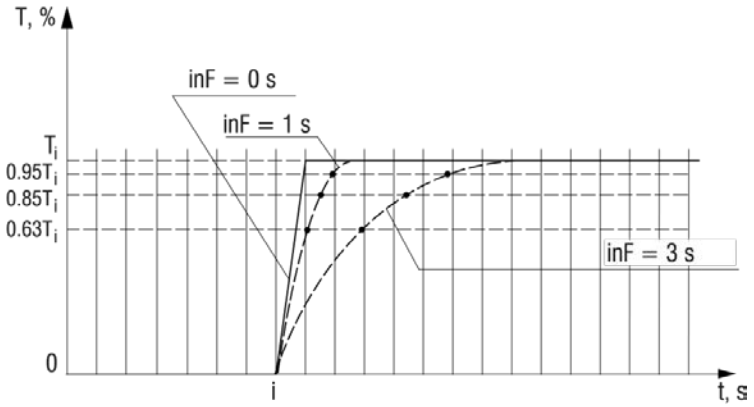


Fig. 6.5 Filter time constant

6.7 Correction

The sensor characteristic curve can be corrected by the user. Two correction parameters, Offset and Slope, are provided:

– Offset can be set in the parameter **SH** in measuring units in the range of -500.0…+500.0 to correct the sensor initial error.

– Slope can be set in the parameter **KU** within the range 0.5…2.0.

Set the correction parameters **SH** and **KU** if necessary. When the resistance thermometer in 2-wire connection is used, Offset should be set to compensate the sensor line resistance.

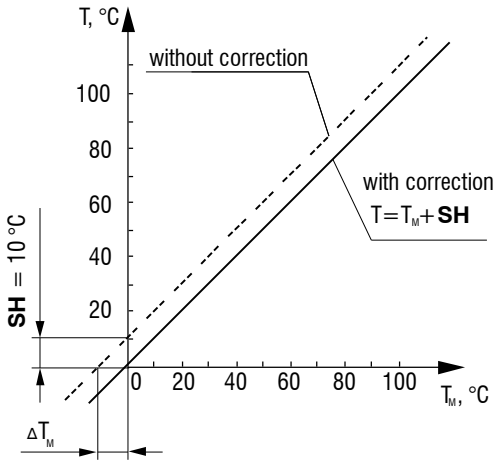


Fig. 6.6 Offset

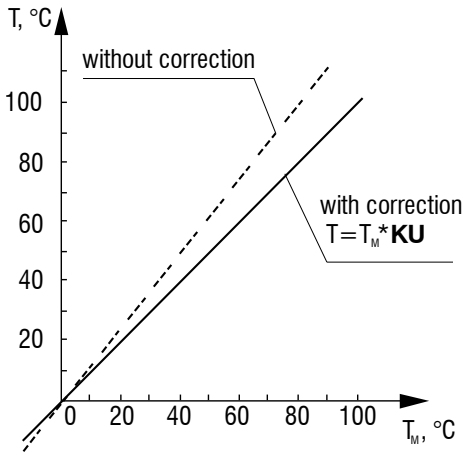


Fig. 6.7 Slope

6.8 Digital input

The control process can be stopped or started with a switch connected to the digital input (see Fig. 6.2). The parameter **Ev-1** (Digital Input Function) specifies whether the function Remote start/stop with a closed or an open contact is active.

Ev-1 = nonE – digital input inactive

Ev-1 = n-o – control start with an open contact, control stop with a closed contact

Ev-1 = n-C – control start with a closed contact, control stop with an open contact

Note: If **Ev-1** ≠ nonE, the parameter **r-S** is not available in the menu, only the remote start/stop is enabled.

The logical state of the digital input depends on the contact resistance:

– Open contact resistance: < 1 kohm

– Closed contact resistance: > 100 kohm

If these requirements are not observed, the state of the digital input is undefined.

The indicator **STOP** lights if the control is stopped.

6.9 Setpoint limits

The valid range for the setpoint **SP** is limited by the Setpoint limits **SL-L** and **SL-H**.

The Setpoint limits are limited too. They can assume the values only within the measurement range for the selected sensor.

Note:

The parameters **SP**, **SL-L**, **SL-H**, **An-L**, **An-H** can assume the values above 1000°C for the thermocouples with the upper limit above 1000°C. In this case the value is displayed on the lower display without decimal part but with the flashing point after the last digit:

[1000.]. The flashing point indicates that the number has a decimal part.

To display and to modify the decimal part press the PROG + ⋀ keys, then [- - - .0] will be displayed. To modify the decimal part press the ⋀ or ⋁ keys. To go back to the integer part press the PROG + ⋁ keys.

6.10 Control modes

The setpoint **SP** should be set as the main control parameter. For further details see 6.9 “Setpoint limits” and 6.10.6 “Setpoint Ramp”.

The control procedure depends on the output type and can be set in the parameters described below (see 6.10.1-6.10.6).

6.10.1 Control type

CntL = Pid – PID control

CntL = onoF – on-off control

Note: If Control is started, the parameter **CntL** is not available in the menu. The parameter can be only modified when the control process is stopped:

– in the menu by setting **r-S** = StoP, if the parameter **Ev-1** “DI function” is set to nonE

– by switching the digital input, if the parameter **Ev-1** “DI function” is set to n-o or n-C (see 6.8).

6.10.2 Control function

One of the following control functions (**orEU**) can be selected:

orEU = or-r – Heating

orEU = or-d – Cooling

– Function “Heating” is used to control the heating process or to generate an alarm signal if the process value **Pv** is below the setpoint **SP**. The output is activated when the **Pv** < (**SP**. – **HYSt**) and deactivated when **Pv** > (**SP** + **HYSt**).

– Function “Cooling” is used to control the cooling process or to generate an alarm signal if the process value **Pv** is above the setpoint **SP**. The output is activated when the **Pv** > (**SP** + **HYSt**) and deactivated when **Pv** < (**SP** – **HYSt**).

6.10.3 “Quickly to SP” mode

This mode enables to reach the setpoint with the maximum speed and minimum overshoot. To activate the mode set the parameter **rAmP** = ON.

Note: Before activating the mode “Quickly to SP” Autotuning should be carried out (see 7.3).

6.10.4 Control hysteresis

The Control hysteresis **HYSt** (**Adv** group) is a configurable parameter for output types R, T, C, S (see Fig. 6.8) in the on-off control mode.

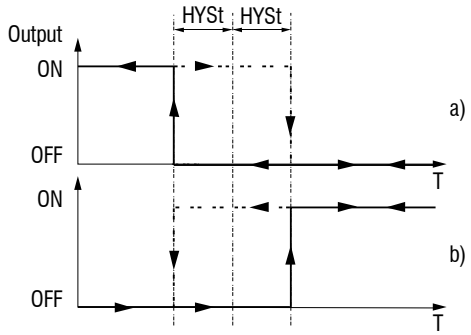


Fig. 6.8 Heating (a) and Cooling (b)

The Control hysteresis (**HYSt**) can be set within the range 0.0…999.9 ºC for temperature sensors (RTD or TC) and within the range 0…9999 for linear signals.

6.11 PID-control

PID control can be used (**CntL** = Pid) with all types of output.

The controller generates the control signal on the output to reduce the deviation between the process value **Pv** and the setpoint **SP**. The control signal depends on:

– P-component – defined by the proportional band constant, that multiplies the deviation (**Pv** – **SP**)

– I-component – defined by the integral time constant, the time required by the integral component to generate the output equivalent to the proportional component

– D-component – defined by the derivative time constant, the time required by the proportional component P to repeat the output provided by the derivative component D

For efficient operation of the PID controller it is necessary to set correct values of the coefficients **P**, **i** and **d** for the specific control object. They can be defined by using Autotuning (see 7.3) or Manual Tuning (see 7.4).

One of the control functions, Heating or Cooling, should be selected in the parameter **orEU** (see Fig. 6.9).

Heating – output signal decreases with the increase of the process value

Cooling – output signal increases with the increase of the process value

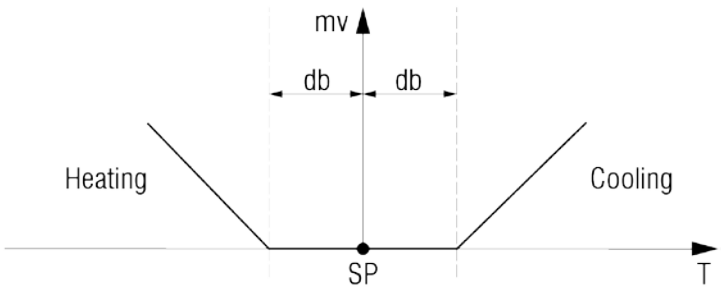


Fig 6.9 Control function

6.11.1 Deadband

Control deadband is the range through which an input signal can be varied without initiating any change in the output signal. To avoid an unnecessary output bouncing by small signal deviations the deadband **db** should be set (see Fig. 6.9). The deadband must not exceed the required control accuracy. The deadband should be set within the range 0.0…20.0°C for temperature sensors (RTD and TC) and within the range 0…200 in the measuring units for linear signals.

6.11.2 Setpoint Ramp

The transition from one setpoint value to another during the process can be smoothed using the parameter **vSP** (Setpoint Ramp), the maximum setpoint rate of change.

After switching on the device, the current process value is used as the initial setpoint and then it cannot be changed by more than the value specified in the parameter **vSP** per minute.

The higher the Setpoint Ramp, the slower the response time. Increase the value or set **vSP** = 0, if the process cannot be controlled properly.

6.12 Outputs

In the device with the digital output the PID control is applied as a pulse width modulation (PWM) with Pulse period **CP** and Pulse duration of (Output signal x **CP**).

The device with the analog output is used for analog PID control or for retransmitting the signal to other devices e. g. for recording.

Output circuits are galvanically isolated from other circuits, except the output type S, because the galvanic isolation is provided by the solid state relay itself.

6.12.1 Output signal limitation

The value and the rate of change of the output signal can be limited in following parameters:

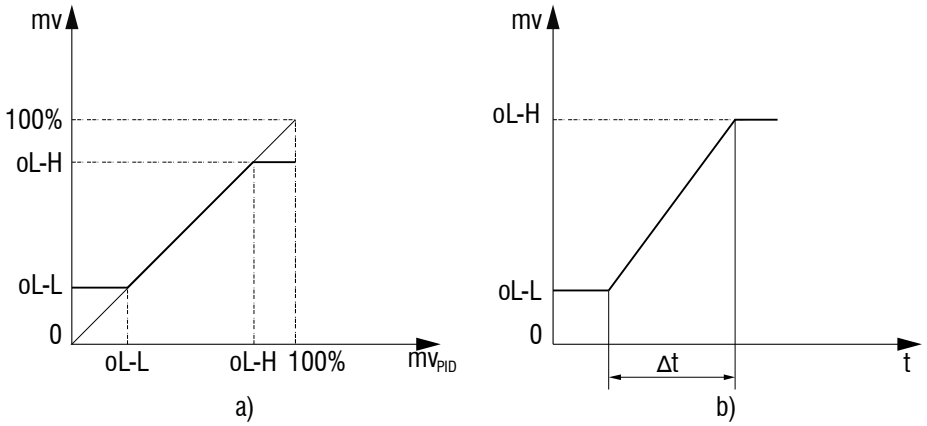


Fig. 6.10

oL-L – Control signal lower limit in %

oL-H – Control signal upper limit in % (see Fig. 6.10a)

orL – Control signal ramp in %/s (see Fig. 6.10b)

6.12.2 Output pulse period

When the digital output with PID control is used, the output pulse period CP should be specified. The higher the period, the faster the response to the process value variation.

In the device with analog output the parameter CP has no influence on the control process. The parameter CP is usually optimised during the autotuning (see 7.3).

In the ideal case, the output pulse period should coincide with the input polling period. When a thyristor output is used, it is recommended to set the CP parameter to 1...2 s.

When a relay output is used, the life cycle of the contacts can be extended by increasing the output pulse period, yet it can impair the control performance.

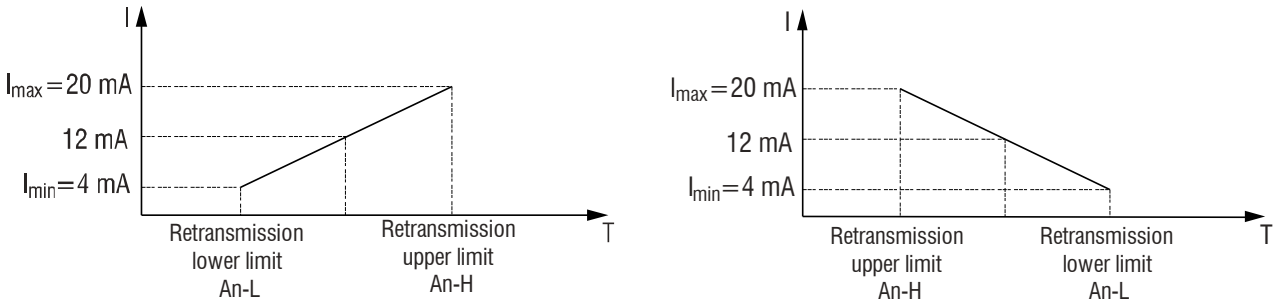
6.13 Signal retransmission

Linear signal 4-20 mA or 0-10 V can be scaled and transmitted to the analog output.

Configurable parameters for outputs of type U, I:

An-L – Retransmission lower limit

An-H – Retransmission upper limit



a) An-L < An-H *b) An-L > An-H*

Fig. 6.11 Retransmission

The parameters **An-L** and **An-H** can be set in measuring units and are only for analog output available. The valid range for **An-L** and **An-H** is limited by the measuring range for temperature sensors or by **in-L**, **in-H** parameters for linear signals. The setting **An-L** = **An-H** is not allowed.

6.14 Alarm

There are two alarm functions: Range Alarm and Loop Break Alarm (LBA). Both alarm functions can control digital output 2. If the alarm occurs, the respective LED (**ALR** or **LBA**) flashes on.

6.14.1 Range Alarm

The alarm is activated when the process value is out of valid range. The following parameters should be set:

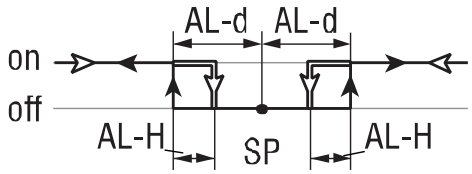
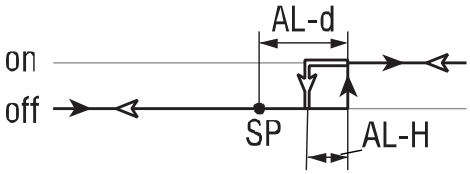
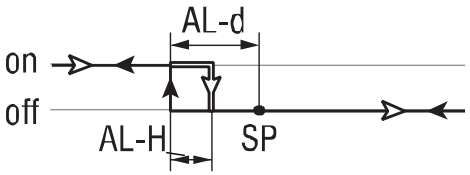
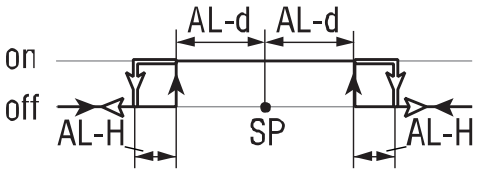
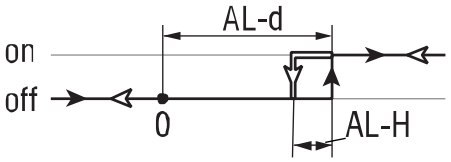
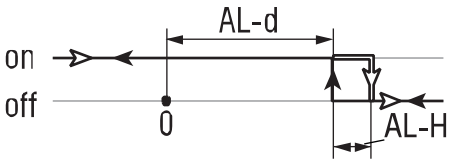
ALt – Alarm Mode: one of the 11 standard alarm comparator schemes (Table. 6.4) can be selected

AL-d – Alarm Threshold

AL-H – Alarm Hysteresis

In case the initial **Pv** is definitely less than **SP** it is reasonable to use First Alarm Blocking function that prevents the alarm activation at startup. Select the schemes 5…7, 10, 11 to use the function.

Table 6.4 Range Alarm

ALt	Alarm Mode	Output state
00	Alarm disabled (default)	OFF
01	Value outside range **SP ± AL-d**	
02	Value greater than **SP + AL-d**	
03	Value less than **SP - AL-d**	
04	Value within range **SP ± AL-d**	
05	As for 01 but with blocking of the first alarm	
06	As for 02 but with blocking of the first alarm	
07	As for 03 but with blocking of the first alarm	
08	Value greater than **AL-d**	
09	Value less than **AL-d**	
10	As for 08 but with blocking of the first alarm	
11	As for 09 but with blocking of the first alarm	

If **ALt** = 0, the alarm comparator will be deactivated and the parameters **AL-d** and **AL-H** unavailable.

AL-d parameter can assume values within the range from the lower to the upper limit for the selected input signal.

AL-H parameter can assume values within the range from 0 to the upper limit for the selected input signal.

6.14.2 Loop Break Alarm

The control loop break occurs and Loop Break Alarm (LBA) is activated, if the maximum or minimum output signal is generated, but the process value remains unchanged within the specified time. Once LBA has been activated, the control process will be stopped, the alarm output activated and the **LBA** indicator flashes on.
The function is defined by two parameters in **Adv** group (see Fig. 6.12):

LbA – LBA Time

LbAb – LBA Range

Point A – the heater fails and the temperature goes down (Fig. 6.12a), the output signal increases and the deviation grows (Fig. 6.12b)

Point B – the temperature keeps going down and the output signal reaches 100%, LBA Time countdown begins

Curve I – if the LBA Time is exceeded and the temperature keeps going down, the alarm is activated (Fig. 6.12c)

Curve II – if the process value starts growing, but the variation does not reach the LBA Range within the LBA Time, the alarm is activated as well (Fig. 6.12c)

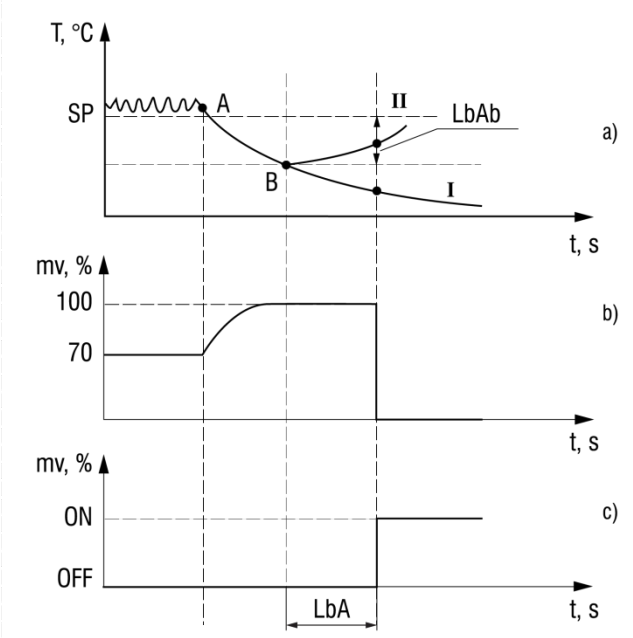


Fig 6.12

LBA Time is measured in seconds and can be determined as follows:

– set the output signal to maximum
– measure the time it takes the process value to change by the LBA Range value (10 by default)
– double the measured value and set the result as the LBA Time

If **LbA** = 0, the LBA function is deactivated and **LbAb** not available.
LBA Range should be set in measuring units within the range 0.0…999.9 for the temperature sensors (RTD or TC) and within the range 0…9999 for the linear signals.

6.14.3 Safe state

In case of an error or LBA the control will be stopped and

– in case of the on-off control Output 1 will be set to the level specified in the parameter **onEr** (On-off safe state)

– in case of the analog control Output 1 will be set to the level specified in the parameter **mvEr** (PID safe state)

In the Network control mode the output signal will be set to the last saved output level.

Set **r-S** = StoP to deactivate the alarm. Set **r-S** = rUn to resume control. The detailed descriptions of errors and remedy actions are given in Table D.1.

6.15 Stop state

When control is stopped, the control output will be set to the level specified in the parameter:

– **onST** – Output 1 state when on-off control is OFF

– **mdST** – Output 1 state when PID control is OFF

If **mdST** = o, the output signal will be set to the last saved output level

If **mdST** = mvST, the output signal will be set to the level specified in the parameter **mvST** (PID stop level).

6.16 RS485 network settings

To establish communication via RS485 connect the RS485 lines to terminals D+ and D- (see 5.1) and set the following network parameters in the menu group **Comm** (see Table C.1):

Prot – Protocol (akYtec, Modbus RTU, Modbus ASCII)

bPS – Baud rate (2.4…115.2 kbit/s)

A.LEn – Address bits (7, 8)

Addr – Network address. Valid values:

0…255 for **Prot** = oYEn and **A.LEn** = 8

0…2047 for **Prot** = oYEn and **A.LEn** = 11

0…247 for **Prot** = mrtU or mASt

rSdL – Response delay (1…45 ms)

Note: The changed network parameter values come into effect only after restarting the device (power off and on again or via Network).

The following invariable network parameters are not available in the system menu (see Table 6.5).

Table 6.5 Invariable network parameters

Parameter	Name	Protocol		
		akYtec	Modbus RTU	Modbus ASCII
Stop bits	**Sbit**	1	2	2
Data bits	**LEn**	8 bit	8 bit	7 bit
Parity	**PrtY**	none	none	none

6.17 Factory settings

To reset the device to the default settings switch it off **at least for 1 minute,** hold the ⏫ and ⏬ keys together and then switch the device on. When [– – – –] appears on the upper display, release the keys. The settings will be reset to default values.

6.18 Calibration

The device should be calibrated to restore the accuracy after a long-term operation or repair works with an effect on the measurement system. Calibration has to be carried out by the manufacturer.

Contact the Technical Support of akYtec GmbH for further details.

7 Control

▶ NOTICE

Before starting

Before switching on, make sure that the device was stored at the specified ambient temperature (+1... +50 °C) for at least 30 minutes.

7.1 General

Three control modes are available: stand-alone, manual and control via network.

After the device is powered on, the self-test is carried out, all LEDs flash on and the digital outputs get deactivated for 2 seconds. If the self-test is not successful, error cause is displayed (see 7.7). Otherwise the process value is displayed on the upper display and the setpoint on the lower, the indicator **SP** lights that indicates that the Setpoint manual setting is activated (see 7.2).

The stand-alone control can be started or stopped in three ways:

1. Set **r-S** = rUn to start control, set **r-S** = StoP to stop it (see Table B.1, **LvoP** group).
2. Switch the contact on the digital input, if Remote start/stop is activated (see 6.8)
3. Change the **r-S** value via RS485 network

Note: Remote start/stop has a higher priority than the functional keys, but in the Manual control mode the functional keys have the highest priority (see 7.5).

The operator can control the state of the outputs with the indicators **OUT1**, **OUT2**. The indication depends on the type of output. For digital output:

– indicator is on – the output is activated
– indicator is off – the output is deactivated

In the devices with analog output the flashing indicator shows the output signal level:

– The indicator is off when the output signal is at its lowest level (4 mA for current, 0 V for voltage).
– The indicator starts to flash once per second, when the output signal level begins to grow.
– The indicator is steadily on, when the signal level reaches 20 mA or 10 V accordingly.

If the PID control is selected (see 6.10.1), an Autotuning should be carried out (see 7.3).

7.2 Stand-alone control

In the Stand-alone control mode the output control signal is calculated by the control unit, the user only needs to optimise the PID settings (see. 7.3, 7.4), adjust the setpoint value and start the control mode.

The setpoint can be modified with the  and  keys, if no access protection is activated (see 6.17). Press  key to go to the next operation parameter. Alternatively the setpoint can be modified via system menu (see 6.3) in the group **LvoP**.

7.3 Autotuning

The Autotuning determines the best PID components with respect to the process behaviour. To start the Autotuning:

– set the setpoint **SP** (see 7.2)
– set **r-S** = rUn to start control
– set **At** = rUn to start the Autotuning

The **AT** indicator is on if the Autotuning is active.

During the Autotuning the control unit operates in the on-off control mode. The parameters **P**, **i**, **d**, **inF** (Filter time constant) and **CP** (Pulse period) will be calculated.

When the Autotuning is over, the **AT** indicator turns off and the Control mode is started. If an error occurs during the Autotuning, the Control mode will be stopped and the indicator **AT** starts to blink.

Note:

- Use the Autotuning only when the controlled system allows noticeable fluctuations of the process value relative to the setpoint. Otherwise, the PID parameters should be set manually (see 7.4) on the basis of existing information on the process inertia.
- It is not recommended to modify the parameters during the Autotuning.
- If Autotuning fails, stop control, restart the device and start the Autotuning again.

7.4 Manual Tuning

If the characteristics of the process are known, PID factors can be set manually.

The parameter **P** can be set in measuring units within the range 0.1…999.9 for temperature sensors (RTD and TC) and within the range 0.001…9999 for linear signals.

The parameter **i** can be set in seconds within the range 0…3999. If **i** = 0, the component I is not included in the control algorithm.

The parameter **d** can be set in seconds within the range 0…3999. If **d** = 0, the component D is not included in the control algorithm.

7.5 Manual Control

If Manual control is activated, the outputs of the controller are only controlled by the operator using the functional keys; also Remote start/stop is not available.

To use the Manual Control go to the **LmAn** menu group. To display the group in the menu make sure that:

- **CntL** = Pid
- Stand-alone control is activated (see 7.2)
- **At** = StoP

Otherwise the group **LmAn** doesn't appear in the menu.

Press the key PROG to enter the group. Once the first parameter **o-Ed** (Manual output signal) has been selected, the control will be stopped, the process value **Pv** displayed on the upper display, the **o-Ed** on the lower display and the **MAN** indicator will flash on. The output signal **o-Ed** can be modified within the range from **oL-L** to **oL-H** by using the keys ⏫ and ⏬.

The limitation by the Output signal ramp **orL** (see 6.9) can cause the deviation of the Manual control (**o.**) from the Manual output signal (**o-Ed**). After the parameter **o-Ed** has been set check if the Current output signal has reached the set value.

To switch between the parameters within the group press the key PROG.

To exit the Manual control mode press and hold down the key PROG > 3 sec. The device will run the control mode specified in the parameter **r-L** (see 7.6).

7.6 Control over Network

If Network control is activated, the outputs are only controlled by the Master device. The controller operates only as a Slave.

The device supports control via Modbus over RS485 interface with the protocols Modbus RTU / Modbus ASCII.

The supported Modbus functions are shown in the Table C.1.

The implemented Modbus Exception Codes are shown in the Table C.2.

The complete list of parameters that can be accessed via Modbus network is shown in the Table C.3 “Modbus Registers”.

To select the control mode the parameter **r-L** (Network control) should be set:

r-L = 0 – Stand-alone control (default)
r-L = 1 – Network control

If **r-L** = 1, all control functions are deactivated, the indicator **COM** lights.

If **r-L** = 0, Stand-alone control is activated, the indicator **COM** is off.

To set the desired output signal via Modbus the parameter **r.oUt** (Network control signal) should be specified:

r.oUt = 0 or 1 – output state for on-off control
r.oUt = 0…1.0 – output level for PID control

Note:

1. The parameters **r-L** and **r.oUt** are only available via network.
2. The parameter **r-L** is initiated with 0 every time the device is switched on or restarted via Modbus using the command **init** (see Table C1, **Comm** group).

7.7 Error

The device monitors the integrity of the transmitters connected to the inputs. Sensor error is generated when the sensor fails or when the measured value is outside the measuring range (see Table 2.3).

In case of a thermocouple shirt-circuit the "cold end" temperature will be displayed.

The detailed descriptions and remedy actions are given in Table D.1.

▶ **NOTICE**

Switch off the device before checking the sensor and connection lines.
Use only the measuring device with the output voltage max. 4.5 V to prevent the device damage during the circuit integrity check. Disconnect the sensor in case of higher voltages.

For Output safe state in case of error see 6.14.3.

8 Maintenance

The maintenance includes:

– cleaning of the housing and terminal blocks from dust, dirt and debris
– checking the fastening of the device
– checking the wiring (connecting leads, fastenings, mechanical damage).

The device should be cleaned with a damp cloth only. No abrasives or solvent-containing cleaners may be used. The safety information in section 3 must be observed when carrying out maintenance.

9 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.

Permitted storage temperature: -25...+55 °C

▶ **NOTICE**

Transport damage, completeness
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!

10 Scope of delivery

–	TRM210	1
–	Short guide	1
–	Mounting kit	1
–	Gasket	1

Appendix A Dimensions

Max. panel thickness 15 mm.

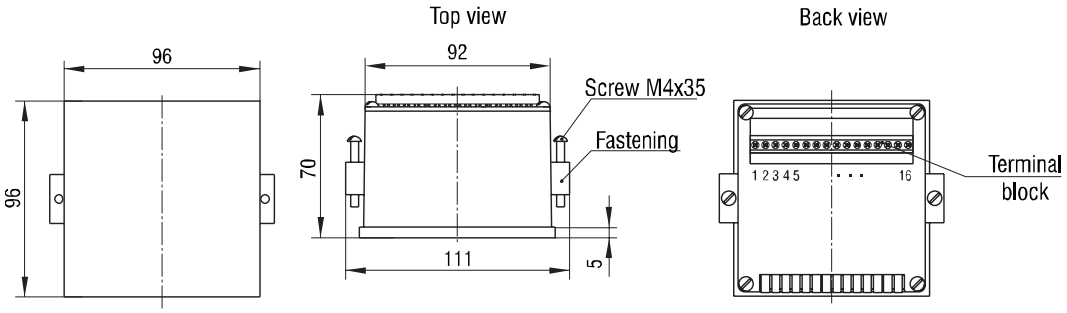


Fig. A.1 External dimensions TRM210-H1

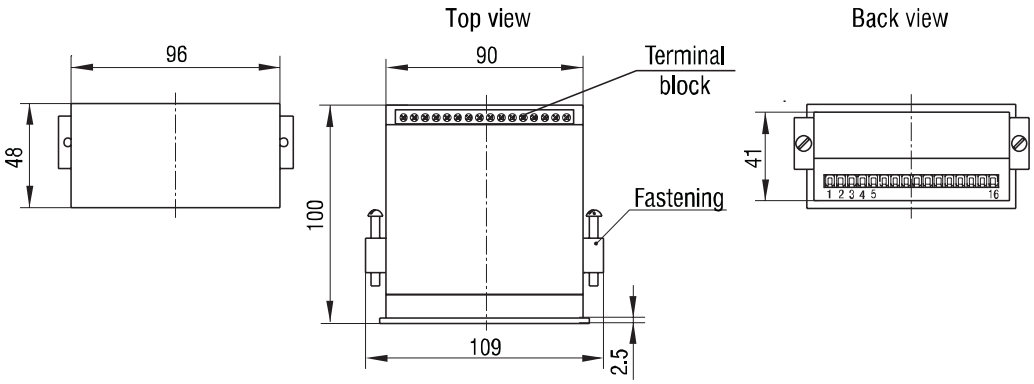


Fig. A.2 External dimensions TRM210-H2

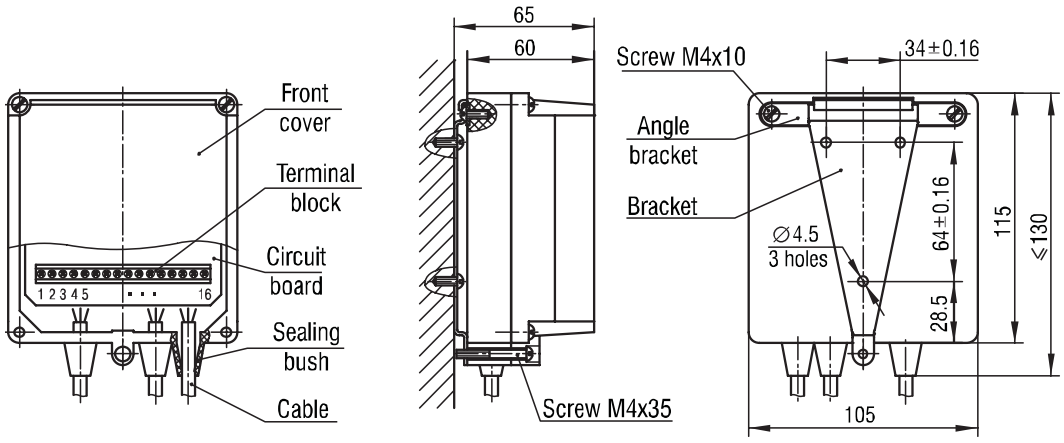


Fig. A.3 External dimensions TRM210-H3

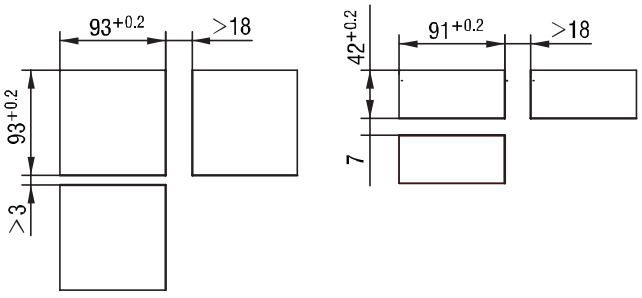


Fig. A.4 Panel mount TRM210-H1 (left) and TRM210-H2 (right)

Appendix B Configuration parameters

Table B.1 Configuration parameters

No	Name	Display	Parameter	Valid value	Meaning	Factory
Operation (LvoP)						
1	**Pv**	Pu	Process value			
2	**SP**	SP	Setpoint	SL-L…SL-H	affected by **dP**	30.0
3	**r-S**	r-S	Remote Start/Stop	rUn	Start	StoP
				StoP	Stop	
4	**At**	At	Autotuning	rUn	Start	StoP
				StoP	Stop	
5	**o**	o	Control	0…100 %	read only	
Basic settings (init)						
1	**in-t**	in-t	Sensor	r385	Pt50	Pt100
				r.385	Pt100	
				r391	50P (GOST)	
				r.391	100P (GOST)	
				r-21	46P (GOST)	
				r426	Cu100	
				r.426	Cu50	
				r-23	53M (GOST)	
				r428	50M (GOST)	
				r.428	100M (GOST)	
				E_A1	A	
				E_A2	A-2 (GOST)	
				E_A3	A-3 (GOST)	
				E__b	B	
				E__J	J	
				E__K	K	
				E__L	L (GOST)	
				E__n	N	
				E__r	R	
				E__S	S	
				E__t	T	
				C0_5	0-5 mA	
				C0.20	0-20 mA	
				C4.20	4-20 mA	
				U-50	-50…+50 mV	
				U0_1	0-1 V	
2	**dPt**	dPt	Decimal point displayed (1)	0	0000	1
				1	000.0	

No	Name	Display	Parameter	Valid value	Meaning	Factory
3	**dP**	dP	Decimal point (2)	0	0000	1
				1	000.0	
				2	00.00	
				3	0.000	
4	**in-L**	in-L	Signal lower limit (2)	–1999...9999	affected by **dP**	0.0
5	**in-H**	in-H	Signal upper limit (2)	–1999...9999	affected by **dP**	100.0
6	**SL-L**	SL-L	Setpoint lower limit	-1999...9999	affected by **dP**	-199.9
7	**SL-H**	SL-H	Setpoint upper limit	-1999...9999	affected by **dP**	800
8	**SH**	SH	Offset	-500…500	affected by **dP**	0.0
9	**KU**	KU	Slope	0.5…2.0	-	1.000
10	**Fb**	Fb	Filter bandwidth	0….9999	affected by **dP**	0.0
11	**inF**	inF	Filter time constant	OFF	-	OFF
				1…999 s		
12	**ALt**	ALt	Alarm mode	00	OFF	00
				01	outside range **SP ± AL-d**	
				02	greater than **SP ± AL-d**	
				03	less than **SP ± AL-d**	
				04	within range **SP ± AL-d**	
				05	01 with blocking of the first alarm	
				06	02 with blocking of the first alarm	
				07	03 with blocking of the first alarm	
				08	greater than AL-d	
				09	less than **AL-d**	
				10	08 with blocking of the first alarm	
				11	09 with blocking of the first alarm	
13	**AL-d**	AL-d	Alarm threshold	**in-L**…**in.H**	not displayed when **ALt** = 00	10.0
14	**AL-H**	AL-H	Alarm hysteresis	**in-L**…**in.H**	not displayed when **ALt** = 00	0.0
15	**An-L**	An-L	Retransmission lower limit (3)	-1999...9999	affected by **dP**	0.0
16	**An-H**	An-H	Retransmission upper limit (3)	-1999...9999	affected by **dP**	100.0
17	**Ev-1**	Ev-1	DI function	nonE	OFF	nonE
				n-o	Start with open contact	
				n-C	Start with closed contact	
18	**orEU**	orEU	Control function	or-d	Cooling	or-d
				or-r	Heating	
19	**CP**	CP	Pulse period	1…250 s		1

No	Name	Display	Parameter	Valid value	Meaning	Factory
Advanced settings / LBA (Adv)						
1	**vSP**	uSP	Setpoint Ramp	0…9999	affected by **dP**	0.0
2	**CntL**	CntL	Control type	Pid	PID	Pid
				onoF	on-of	
3	**HYSt**	HYSt	Control hysteresis (4)	0…9999	affected by **dP**	1.0
4	**onSt**	onSt	On-off stop state (4)	ON		OFF
				OFF		
5	**onEr**	onEr	On-off safe state (4)	ON		OFF
				OFF		
6	**rAmP**	rAmP	"Quickly to Setpoint" mode	ON		OFF
				OFF		
7	**P**	P	P component (proportional band) (5)	1…9999	affected by **dP**	30.0
8	**i**	i	I component (integral time) (5)	0…3999 s	affected by **dP**	100
9	**d**	d	D component (derivative time) (5)	0…3999 s	affected by **dP**	20
10	**db**	db	Deadband (5)	0…200	affected by **dP**	0
11	**oL-L**	oL-L	Output lower limit(5)	0…**oL-H** %		0
12	**oL-H**	oL-H	Output upper limit(5)	**oL-L**…100 %		100
13	**orL**	orL	Output signal ramp (5)	0.2…100 %/s		100
14	**mvEr**	mvEr	PID safe state (5)	0…100 %		0
15	**mdSt**	mdSt	PID stop state (5)	mvSt	**mvSt** value	mvSt
				o	last output value	
16	**mvSt**	mvSt	PID stop level (5)	0…100 %		0
17	**LbA**	LbA	LBA time (5)	0…9999 s	disabled when **LbA** = 0	0
18	**LbAb**	LbAb	LBA range (5)	0…9999 s	not displayed when **LbA** = 0	10.0
RS485 network (Comm)						
1	**Prot**	Prot	Protocol	dbUEn	akYtec	dbUEn
				n.rtU	Modbus RTU	
				n.ASC	Modbus ASCII	
2	**bPS**	bPS	Baud rate	2.4…115.2 kbit/s		115.2
3	**A.LEn**	A.LEn	Address bits	8		8
				11		
4	**Addr**	Addr	Address (6)			0
5	**rSdL**	rSdL	Response delay	1…45 ms		20
Manual control (LmAn)						
1	**o-Ed**	o-Ed	Manual output signal	0…100 %	Manually set out-put signal	0.0
2	**o.**	o.	Manual control	0…100 %	Currnet output signal	Read only

(1) Displayed for temperature sensor only

(2) Displayed for linear signal only

(3) Displayed for analog output 2 only

*(4) Displayed for on-off control only (**CntL**=onof)*

*(5) Displayed for PID control only (**CntL**=Pid)*

(6) Valid values:

- *0…255 for **Prot** = oUEn and **A.LEn** = 8*
- *0…2047 for **Prot** = oUEn and **A.LEn** = 11*
- *0…247 for **Prot** = n.rtU or n.ASC*

Appendix C Modbus register

Table C.1 Modbus Functions Supported

Function code (hex)	Description	Note
03 (0x03)	Read Holding Registers	Group request not enabled
16 (0x10)	Write Multiple Registers	Group request not enabled
08 (0x08)	Serial line diagnostic	Only sub-function 0 supported - Return Query Data

Table C.2 Modbus Exception Codes

Code	Name	Meaning
01	ILLEGAL FUNCTION	Function not supported
02	ILLEGAL DATA ADDRESS	Invalid register number (not used)
03	ILLEGAL DATA VALUE	Invalid data: - Value out of range - Response is longer than the size of communication buffer - Number of data bytes does not match the declared one
04	SLAVE DEVICE FAILURE	Command cannot be executed

Table C.3 Modbus Registers

Parameter name	Description	Address (hex)	Data format	Decimal places
Function 0x03, read only				
StAt	Status Register (see Table C.5)	0x0000	Binary	–
Pv	Process value	0x0001	INT16	*
SP	Setpoint	0x0002	INT16	*
SEt.P	Current setpoint value	0x0003	INT16	*
o	Control	0x0004	UINT16	0
Function 0x03/0x10, read/write				
r-L	Network control	0x0005	INT16	0
r.oUt	Network output signal	0x0006	INT16	3
r-S	Remote Start/Stop	0x0007	UINT16	0
At	Autotuning	0x0008	UINT16	0
Function 0x03, read only				
DEv	Device name	0x1000…0x1003	Char[8]	–
vEr	Firmware version	0x1004…0x1007	Char[8]	–
StAt	Status Register (see Table C.5)	0x1008	Binary	–
Pv	Process value	0x1009…0x100A	Float32	–
SP	Setpoint	0x100B…0x100C	Float32	–
SEt.P	Current setpoint value	0x100D…0x100E	Float32	–
o	Control	0x100F…0x1010	Float32	–
Function 0x03/0x10, read/write				
Prot	Protocol	0x0100	UINT16	0

bPS	Baud rate	0x0101	UINT16	0
A.LEn	Address bits	0x0102	UINT16	0
Addr	Address	0x0103	UINT16	0
rSdL	Response delay	0x0104	UINT16	0
LEn	Data bits	0x0105	UINT16	0
PrtY	Parity	0x0106	UINT16	0
Sbit	Stop bits	0x0107	UINT16	0
n.Err	Last network error code	0x0108	Hex word	0
PrtL	Apply new network protocol (command)	0x0109	UINT16	–
APLY	Apply new network settings (command)	0x010A	UINT16	–
init	Device restart (command)	0x010B	UINT16	–
in-t	Sensor	0x0200	UINT16	0
dPt	Decimal point displayed	0x0201	UINT16	0
dP	Decimal point	0x0202	UINT16	0
in-L	Signal lower limit	0x0203	INT16	*
in-H	Signal upper limit	0x0204	INT16	*
SH	Offset	0x0205	INT16	*
KU	Slope	0x0206	UINT16	3
Fb	Filter bandwidth	0x0207	UINT16	*
inF	Filter time constant	0x0208	UINT16	0
SL-L	Setpoint lower limit	0x0300	INT16	*
SL-H	Setpoint upper limit	0x0301	INT16	*
orEU	Control function	0x0302	UINT16	0
CntL	Control type	0x0303	UINT16	0
CP	Pulse period	0x0304	UINT16	0
rAmP	“Quickly to Setpoint” mode	0x0305	UINT16	0
P	P component (proportional band)	0x0306	UINT16	*
i	I component (integral time)	0x0307	UINT16	0
d	D component (derivative time)	0x0308	UINT16	0
db	Deadband	0x0309	UINT16	*
vSP	Setpoint Ramp	0x030A	UINT16	*
oL-L	Output lower limit	0x030B	UINT16	0
oL-H	Output upper limit	0x030C	UINT16	0
orL	Output signal ramp	0x030D	UINT16	1
mvEr	PID safe state	0x030E	UINT16	0
mdSt	PID stop state	0x030F	UINT16	0
mvSt	PID stop level	0x0310	UINT16	0
HYSt	Control hysteresis	0x0311	UINT16	*
onSt	On-off stop state	0x0312	UINT16	0
onEr	On-off safe state	0x0313	UINT16	0
Ev-1	DI function	0x0400	UINT16	0

LbA	LBA time	0x0401	UINT16	0
LbAb	LBA range	0x0402	UINT16	*
ALt	Alarm mode	0x0403	UINT16	0
AL-d	Alarm threshold	0x0404	UINT16	*
AL-H	Alarm hysteresis	0x0405	UINT16	*
An-L	Retransmission lower limit	0x0406	INT16	*
An-H	Retransmission upper limit	0x0407	INT16	*

Note:
* – *see **dP***

Table C.4 Data format

Data format	Description
UINT16	2-byte integer When transmitting the parameter the format $X*10^{-n}$ is used, where X – integer value n – power of 10 (specified in the column "Decimal places" for each parameter)
INT16	2-byte signed integer When transmitting the parameter the format $X*10^{-n}$ is used, where X – integer value n – power of 10 (specified in the column "Decimal places" for each parameter)
Float32	4-byte floating-point “Big-endian”
Char[8]	String of 8 symbols 1 byte each, direct order
Hex word	2-byte integer in hexadecimal format
Binary	2-byte numbers in binary format When transmitting the bit numbering starts at zero for the most significant bit (MSB 0)

*Table C.5 Parameter **StAt** – bit assignment*

Bit No.	Assignment
0	Analog input error
1	0
2	0
3	Other error (e.g. **Er.Ad**, **Er.64**)
4	Relay 1 on
5	Relay 2 on
6	Network control (**r-L**)
7	0
8	Manual control
9	Remote Start/Stop
10	Autotuning
11	LBA
12 - 15	0

Appendix D Error causes and remedies

Table D.1

Error	Potential cause	Remedy
Err.5 displayed in Control mode, sensor connected	Sensor failure	Replace the sensor
	Open circuit or short circuit between the sensor and the device	Remove the cause
	Wrong sensor type	Select the correct sensor type
	Incorrect 2-wire connection	Install the jumper between terminals 9-10
	Incorrect sensor connection	Check the sensor connection diagram given in Fig. 5.1
	4-20 mA signal connected without shunt resistor	Connect a shunt resistor (see 5.1.1)
Er.64	Memory error	Contact the Technical Support of akYtec GmbH
Er.Ad	ADC conversion error	
JJJJ displayed in Control mode	The input value exceeds 999.9 and cannot be displayed on the 4 digit display with the accuracy 0.1°C	Set **dPt =** 0
CCCC displayed in Control mode	The input value is less than -199.9 and cannot be displayed on the 4 digit display with the accuracy 0.1°C	Set **dPt =** 0
Displayed temperature differs from the current temperature (Control mode)	Wrong sensor type	Select the correct sensor type
	Incorrect Offset or Slope settings	Set the correct values in parameters **SH** or **KU.** If no correction is required, set **SH** = 0 and **KU** = 1.
	2-wire connection without correction	See 6.7 “Correction”
	Electromagnetic interference	Use only shielded sensor line, ground the shield on one point
Zeros are displayed for the current process value	Incorrect sensor connection	See 5 “Wiring”
The temperature decreases when heating and increases when cooling	Incorrect TC connection	Change TC polarity (see Fig. 5.1)
Output relay does not switch	Incorrect Alarm settings (see 6.14.1 “Range Alarm”)	Adjust the parameters **AL-d** and **AL-H**
	Control stopped	Set **r-S** = rUn
Unable to reach the setpoint	Deadband **db** is too large	Adjust the parameter **db** (0…1°C recommended)
	Incorrect **P**, **I**, **D** coefficients	Use Autotuning (see 7.3) or Manual Tuning (see 7.4)
Settings cannot be modified	Access protection is set	Adjust the Access protection (see 6.17)
Control stopped, LBA indicator lights	LBA Time (**LbA**) is too short	Increase the LBA Time or set **LbA** = 0 (see 6.14.2)

** If the error or potential cause is not specified in the table above, contact the Technical Support of akYtec GmbH*