EN

TRM212

PID controller

User guide

TRM212_2018.05_0241_EN

Contents

1 Overview

This guide describes the functions, system configuration, operating instructions, programming and troubleshooting of the PID controller TRM212 (hereinafter referred to as TRM212, 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 one channel PID controller TRM212 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, square root function
– calculation of the sum or the ratio of the signals, the difference or the root of the difference between two signals
– PID control of the measured or calculated value with an analog or three-step control valves
– remote setpoint adjustment in accordance with an external parameter
– autotuning function
– stand-alone control
– manual control
– network control (RS485 interface) with akYtec, Modbus-RTU and Modbus-ASCII protocols as a Slave
– 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 TRM212 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.

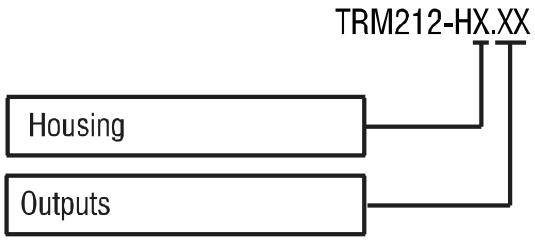
Line reflections always occur at each of the two ends of the bus (the first and the last node). The higher the data transmission rate, the stronger the reflections are. A terminating resistor is needed to minimize reflections. 150 ohm (0.5 W) resistor can be used as a line termination.

The TRM212 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 TRM212 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*

** only for Output 1 available*

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		2		
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 damage the device.
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)

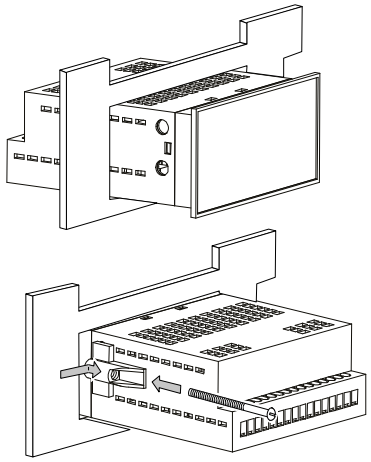
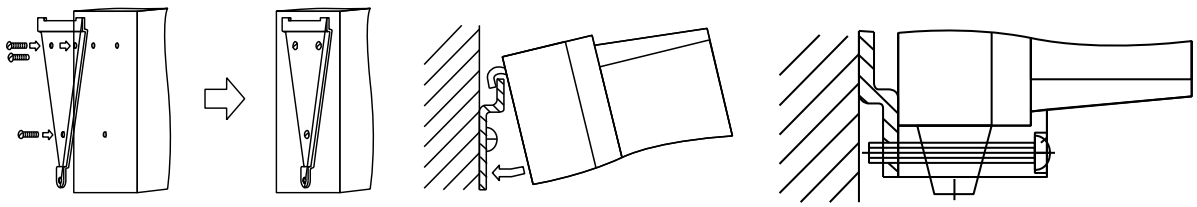


Fig. 4.1 Panel mount



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, 5.2
- The outputs should be wired in accordance with Fig. 5.3...5.9
- 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.

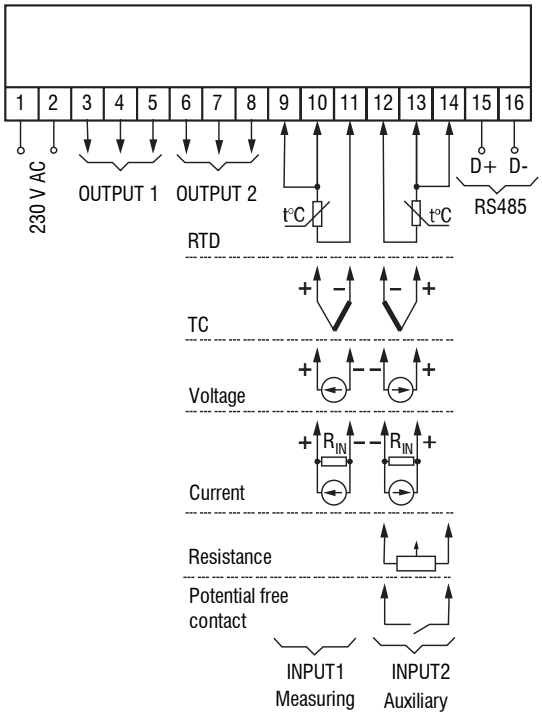


Fig. 5.1 Terminal block layout

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	see 5.1
13		
14		
15	D+	RS485
16	D-	

5.2 Inputs

Supported signals (see Table 2.2 and 2.3):

– Thermocouple (TC) – Input 1, 2
– Resistance thermometer (RTD) – Input 1, 2
– Linear current / voltage signal – Input 1, 2
– Position sensor (resistive or current) – Input 2
– Isolated contact – Input 2

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***

5.2.2 Position sensor

The resistive position sensor (potentiometer) should be connected according to Fig. 5.2. The current position sensor should be connected as the other current sensors according to 5.1 and Fig. 5.1. The valid measuring ranges are 0-2 kohm, 4-20 mA, 0-20 mA, 0-5 mA.

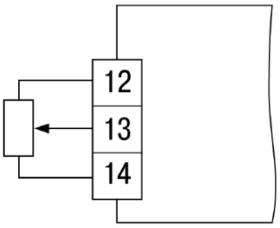


Fig. 5.2 Potentiometer

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)

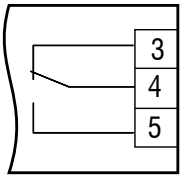


Fig. 5.3 Relay output

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.

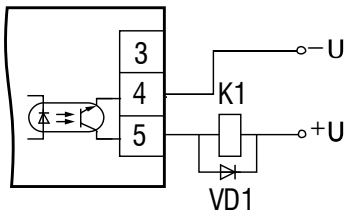


Fig. 5.4 NPN transistor outputs

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 voltage surges an RC protect circuit should be connected in parallel to load: R2 (47…68 ohm) and C1 (0.1 x 630 V).

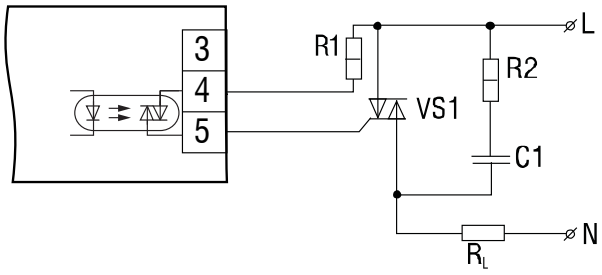


Fig. 5.5 Power TRIAC connection

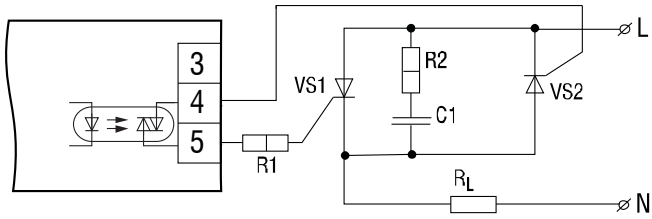


Fig. 5.6 Inverse-parallel connection of two thyristors

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.

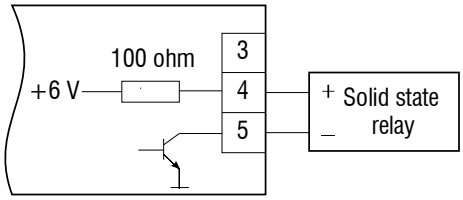


Fig. 5.7 SSR output

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.

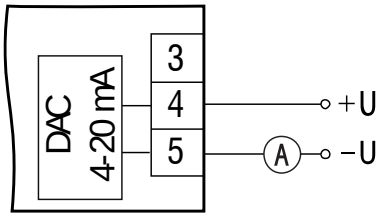


Fig. 5.8 4-20 mA output

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.

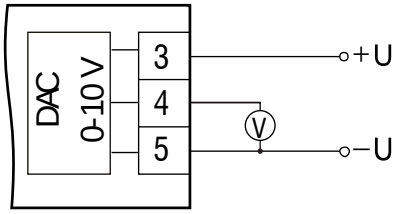


Fig. 5.9 0-10 V output

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.

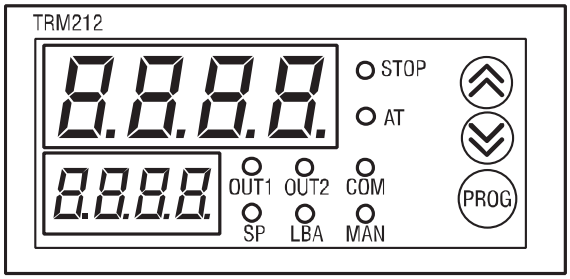


Fig. 6.1 Front view (H2 housing)

The operation of the device can be controlled with two 4-digit displays, three buttons and eight LEDs on the front panel. 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
SP	lights	Setpoint manual setting 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 + ∧	Manual Control activation

6.2 Principle of operation

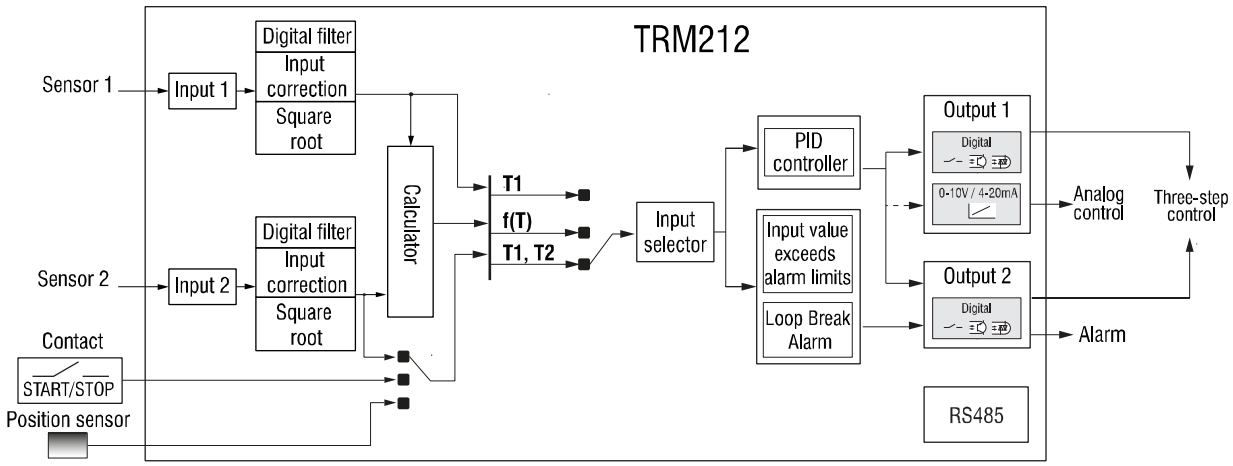


Fig. 6.2 Block diagram

The device has two inputs. The process variable is connected to the Input 1 (main), other analog signal (temperature, linear or position sensor) or digital signal (isolated contact) can be connected to the Input 2 (auxiliary).

In the control mode the inputs are continuously sampled, the signals are converted according to the selected sensor type (**in.t** parameter, see Table B.1) and the measured value is displayed and processed using the following functions: scaling, filtering, signal correction and square root function.

If a signal from a temperature or linear sensor is connected to the auxiliary input, the sum or the ratio of the signals, the difference or the root of the difference between two signals can be calculated.

The Input selector specifies the signal that will be used for PID control, alarm or remote setpoint adjustment. The second temperature sensor is usually used for remote setpoint adjustment.

The device can be ordered in two versions (see 1.4 “Ordering information”):

– with analog Output 1 for analog control and digital Output 2 for alarm
– with two digital outputs for three-step control

6.3 Configuration

In the system menu the parameters are subdivided into 7 groups: **LvoP**, **init**, **Adv**, **vALv**, **diSP**, **GrAF**, **Comm** (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.

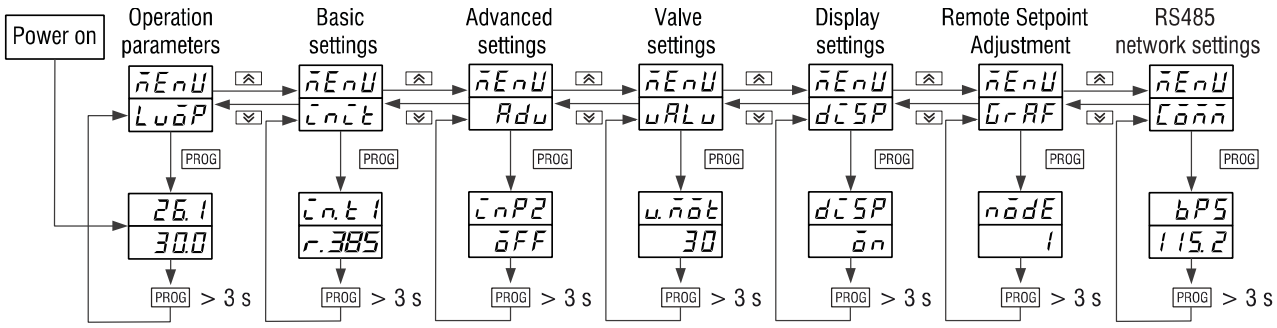


Fig. 6.3 Parameter groups

– **LvoP** – operation parameters (Process value, Setpoint, Current output signal, Remote Start/Stop, Autotuning), displayed at the device start
– **init** – basic settings
– **Adv** – advanced settings
– **vALv** – valve settings
– **diSP** – display settings
– **GrAF** – Remote Setpoint Adjustment
– **Comm** – RS485 network settings

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

6.4 Auxiliary input

To specify the type of the control process, the auxiliary input function should be selected in the parameter **inP2** (**Adv** group).

inP2 = OFF – Control is carried out with one process variable; the auxiliary input has no functionality.

inP2 = in.t2 – Control is carried out using the second sensor; the auxiliary input is connected with the sensor, selected in the parameter **in.t2**. The second input signal can be used to calculate the input for the control unit from the two input signals (see 6.9.1) or for the Remote setpoint adjustment (see 6.9.2).

inP2 = Evnt – Control is carried out with Remote start/stop; the auxiliary input is connected with an isolated contact.

inP2 = v.Ptr – Control is carried out with feedback; the auxiliary input is connected with the resistive position sensor (potentiometer). The setting is not available for the devices with an analog output.

inP2 = v.CS – Control is carried out with feedback; the auxiliary input is connected with the current position sensor. The setting is not available for the devices with an analog output.

Note: Changing the parameter **inP2** is only possible when control is stopped (**r-S** = StoP).

Note: If **inP2** = in.t2, the sensors with the equal measuring units for both inputs must be selected.

Note: The position sensor can be used only with the device with digital outputs.

Note: If the control with feedback is selected, only the type of the position sensor is specified (resistive or current). The signal range (0-2 kohm, 4-20 mA, 0-20 mA, 0-5 mA) will be specified during the “position sensor - controller” joint calibration (see App. E).

6.5 Temperature sensor

The signal from the resistance thermometer or thermocouple is converted according to the sensor curve. The type of the connected sensor should be set in the parameter **in.t1**, **in.t2** (I1, I2 Sensor, **init** group).

When the RTD or TC is used, the display accuracy for the measured temperature can be set in the parameter **dPt1**, **dPt2** (Decimal point displayed). The parameter is not available in the menu for sensors with a linear output or potentiometers. For the thermocouples with the upper limit above 1000°C is recommended to set **dPt** = 1, for other temperature sensors set **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.

6.6 Linear signal

There are additional functions for linear signal processing: Decimal point position, Scaling and Square root.

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.L1 (**in.L2**) – signal lower limit

in.H1 (**in.H2**) – signal upper limit

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

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

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

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

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** (**Adv** group) have to be set again (see 6.10)

6.6.1 Position sensor

Position sensors are used to determine the current position of the control valve. The controller supports the current position sensors with outputs 4-20 mA, 0-20 mA or 0-5 mA and potentiometers up to 2 kohm. For further details about assigning a position sensor to the auxiliary input see 6.4 “Auxiliary input”.

Note: The “Position sensor - Controller” joint calibration must be carried out (see. App. E)

6.6.2 Square root function

The function is intended for transmitters with output signal proportional to the square of the measured signal. To enable the function for the input, the parameter **Sqr1, Sqr2** (**init** group) must be set to ON.
Note: If the function is used, the calculator will take the square root of the input value as its input.

6.7 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 **Fb1**, **Fb2** 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).

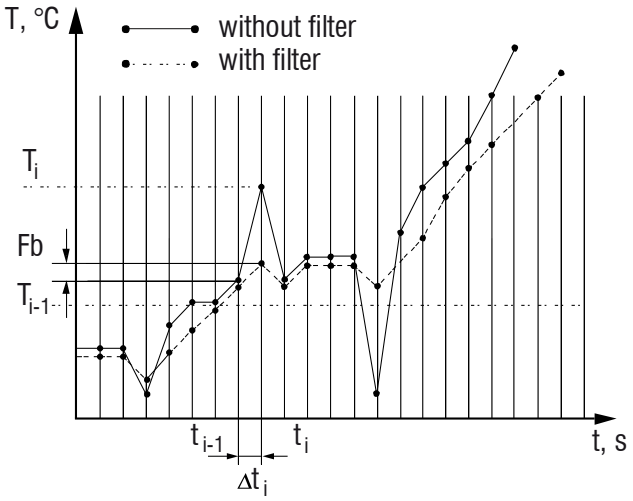


Fig. 6.4 Filter bandwidth

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

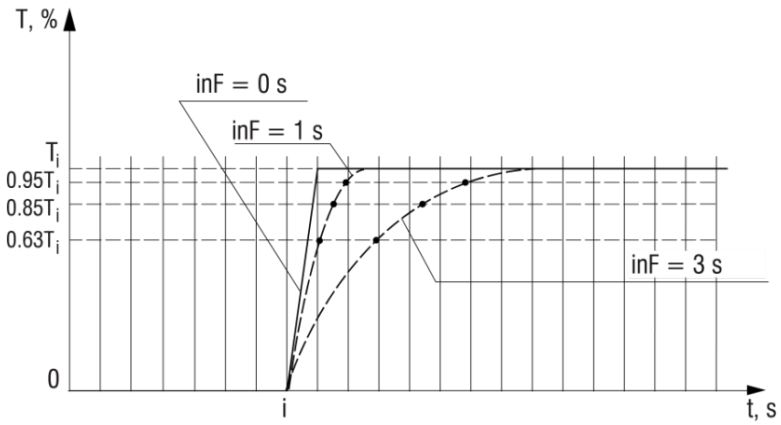


Fig. 6.5 Filter time constant

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

2. The **Damping** with the parameter **inF1**, **inF2** 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.

Note: The parameters **Fb** and **inF** are not available in the menu, if the auxiliary input is used for a position sensor or an isolated contact.

6.8 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 parameters **SH1**, **SH2** in measuring units in the range of -500.0…+500.0 to correct the sensor initial error.

– Slope can be set in the parameters **KU1**, **KU2** 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.

Note: The parameters **SH2** and **KU2** are not available in the menu if the auxiliary input is used for a position sensor or an isolated contact.

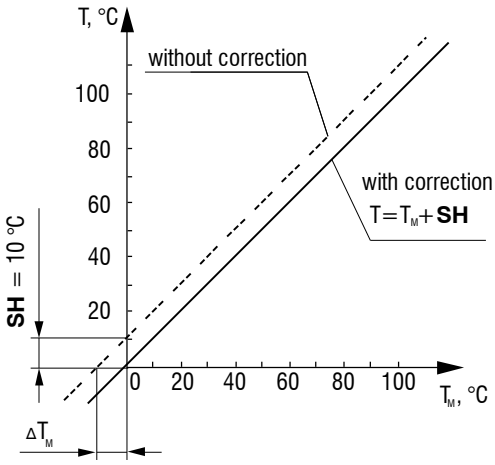


Fig. 6.6 Offset

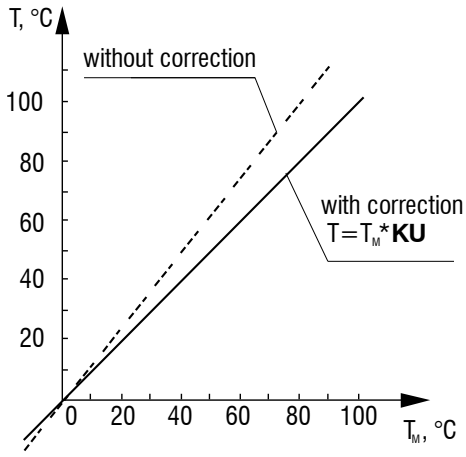


Fig. 6.7 Slope

6.9 Calculator

If Input 2 is used as a measuring input (**inP2** = in.t2), the control unit starts to control the calculator output value. The output of the calculator is the input for the control unit. The function of the calculator is selected in the parameter **CALC** (**Adv** group). The calculator can be used in two ways (see 6.9.1, 6.9.2).

6.9.1 Two inputs calculation

The calculator uses the two input values to calculate one of the following values:

CALC = A.SUm – Weighted sum: K1 x **Pv1** + K2 x **Pv2**

CALC = rAt – Ratio: K1 x **Pv1** / K2 x **Pv2**

CALC = SQPv – Square root of weighted sum: √ (K1 x **Pv1** + K2 x **Pv2**)

where

Pv1 – I1 Process value

Pv2 – I2 Process value

K1, K2 – weight coefficients

The weight coefficients can be set in the parameters **KPv1**, **KPv2** in the range of -19.99…+99.99. If **inP2** ≠ in.t2, the parameters are not available in the menu.

Note: The setting **KPv2** = 0 is not allowed, if **CALC** = rAt, otherwise the calculation error (Err.C) will be displayed.

Note: The difference between the input values can be calculated using the function “Weighted sum” with a negative coefficient.

Note: The output signals from diaphragm, nozzle or Venturi tube for the flow control can be processed with the function “Square root of weighted sum” (for further details contact the Technical Support of akYtec GmbH).

6.9.2 Remote Setpoint Adjustment

If it is necessary to change the setpoint as a function of outside air temperature or some other external signal, the “corrective value – external parameter” dependence diagram should be created. To use the function Remote Setpoint Adjustment select **CALC** = GrAF.
If Remote setpoint adjustment is selected, the setpoint will be changed in accordance with the signal on the auxiliary input, the main input will be directly used as an input for the control unit.
In the control process the calculated corrective value is added to the set point and the control unit will use result instead of the setpoint **SP:**

Current setpoint (**SEt.P**) = Setpoint (**SP**) + Corrective value (**Y**)

To create the corrective curve set the nodes (maximal 10), that will be automatically connected by the line segments to form a polyline. Proceed as follows:

– Set the necessary number of nodes in the parameter nodE (**GrAF** group) in the range 1…10. The parameters **Xi** (External parameter) and **Yi** (Corrective value) will appear in the group for each node.
– Set the coordinates **Xi** and **Yi** for each node in the range -1999…+3000.
– During the operation the nodes will be automatically sorted by the parameter **Xi** and located on the curve.
– To delete a node in the created curve reduce the number of nodes in the parameter nodE (the nodes with higher numbers will be deleted).
– A node in the middle of the curve can be removed in two ways:
  - o reduce the number of nodes by one and adjust the coordinates of the nodes with higher numbers
  - o assign the coordinates of any neighbouring point to the node witch should be removed, without changing the number of nodes
– If the same value of the parameter **Xi** is given to two or more successive nodes, the corrective value **Yi** of the node with a lowest number will be taken into account.

The Current setpoint (**SEt.P**) is only accessible via the network.

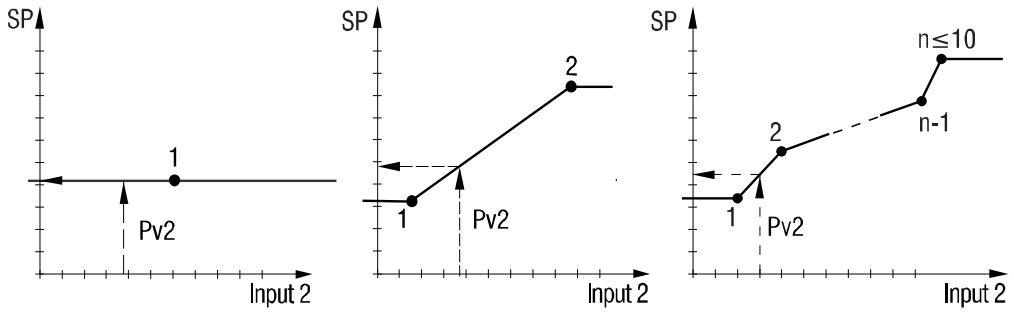


Fig. 6.8 Setpoint corrective curve

6.10 Setpoint limits

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

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

Note: The parameters **SL-L, SL-H** are affected by the parameter **dP** (Decimal point).

6.11 Control function

One of the following control functions (**orEU**) must be selected (see Fig. 6.9):

orEU = or-r – Heating (output signal decreases with the increase of the process value)

orEU = or-d – Cooling (output signal increases with the increase of the process value)

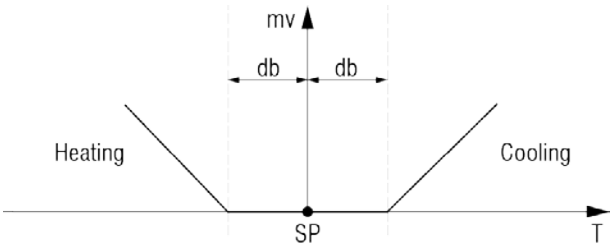


Fig. 6.9 Control function

6.12 Control initial value

The initial value of the control variable is the process value at zero output signal and is a start value for the control process (see 7.1). It can be set in the parameter **Pv0** in measurement units in the range -100…+2000. The default setting is 20, which corresponds to the room temperature.
The parameter is a characteristic of the controlled system and will be used by Autotuning function.

6.13 “Quickly to SP” mode

This mode enables to reach the setpoint with the maximum speed and the 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).

6.14 PID control unit

The PID control unit generates the control signal on the output to reduce the deviation between the process value **Pv** and the setpoint **SP**.

6.14.1 Basic parameters

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 the most efficient operation of the PID control unit it is necessary to set correct values of the coefficients **P**, **i** and **d** for the specific controlled system. They can be defined by using Autotuning (see 7.3) or Manual Tuning (see 7.4). PID control is used with all types of output:

1. In case of the analog control the output signal of the PID control unit is converted into a proportional voltage or current signal.
2. In case of the three-step control (with two digital outputs) the output signal of the PID control unit is converted into signals “forward”, “back”, “stop” as follows:
   a) The pulse duration is calculated:
      $t_{IMP} = \Delta Y \times t_{FC}$
      where
      $\Delta Y = Y_i - Y_{i-1}$ – PID control unit output signal change
      t_{FC} – full stroke time of the valve (**v.mot**, see 6.18)
      t_{IMP} – pulse length
   b) if $\Delta Y > 0$, the Output 1 is activated for t_{IMP} time
      if $\Delta Y < 0$, the Output 2 is activated for t_{IMP} time
      if $\Delta Y = 0$, no output is activated, the valve remains in the same position.

6.14.2 Control 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 the temperature sensors (RTD and TC) and within the range 0…200 in the measuring units for linear signals.

6.14.3 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 is. Increase the value or set **vSP** = 0 if the process cannot be controlled properly.

6.15 Outputs

The device with the main analog output is used to control the analog control valve. The auxiliary digital output is used for alarm (see 6.10).

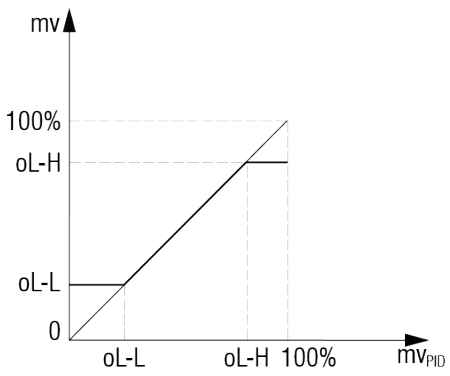


Fig. 6.10

The analog output signal is limited in the following parameters:

oL-L – Output lower limit in % in the range 0…**oL-H**

oL-H – Output upper limit in % in the range **oL-L**…100

Note: The parameters **oL-L** and **oL-H** can only be set if a position sensor is assigned to the auxiliary input of digital type (**inP2** = v.Prt or v.CS). The parameters specify the minimum and maximum opening position of the control valve. The limits have no effect if the position sensor error occurs (Err.P). The limits **oL-L** and **oL-H** have effect during the stand-alone (see 7.2) and network control (see. 7.6), as well as in the states "Error" (except Err.P) and "Control stop" (see. 6.17).

The device with two digital outputs is used to control the three-step control valve and has no alarm output.

The 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.

6.16 Alarm

There are two alarm functions: Range Alarm and Loop Break Alarm (LBA). Both alarm functions can control the digital output 2.

6.16.1 Range Alarm

The function Range Alarm is only available in the devices with an analog output. The alarm is activated when the process value is out of the valid range. If the alarm occurs, the indicator **OUT2** flashes on. To use the function the following parameters should be set:

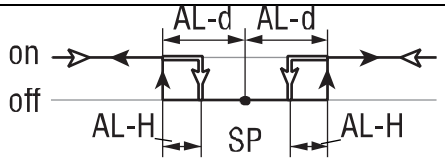
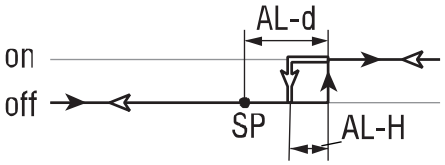
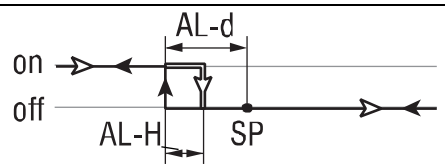
ALt – Alarm Mode: one of the 14 standard alarm comparator schemes can be selected (see Table. 6.4)

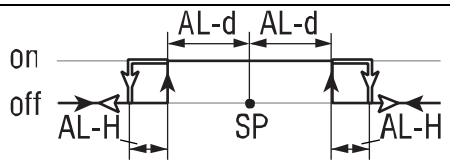
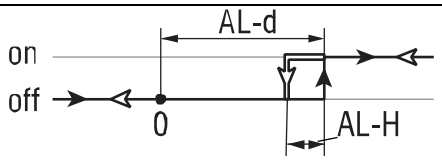
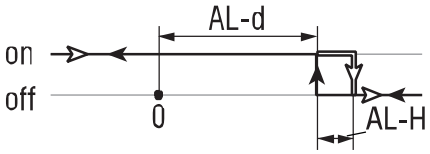
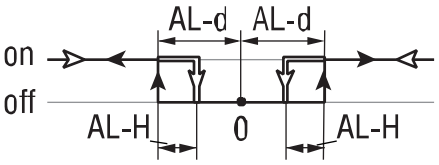
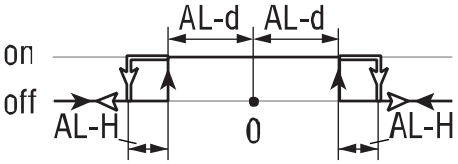
AL-d – Alarm Threshold

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, 14 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	
12	Value outside range ± **AL-d**	
13	Value within range ± **AL-d**	
14	As for 12 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.
Alarm Threshold (**AL-d**) can assume values within the range 0...3000.
Alarm Hysteresis (**AL-H**) can assume values within the range -1999...+3000.
Note: If Remote setpoint adjustment is active (**CALC** = GrAF, see 6.9.2), the setpoint **SP** will be replaced with the current setpoint **SEt.P** in the alarm level calculation.

6.16.2 Loop Break Alarm

Loop Break Alarm is available for the devices:

– with an analog output

– with a digital output and a position sensor that provides a feedback signal.

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. 6.11):
LbA – LBA Time
LbAb – LBA Range

Point A – the heater fails and the temperature goes down (Fig. 6.11a), the output signal increases and the deviation grows (Fig. 6.11b)

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. 6.11c)

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. 6.11c)

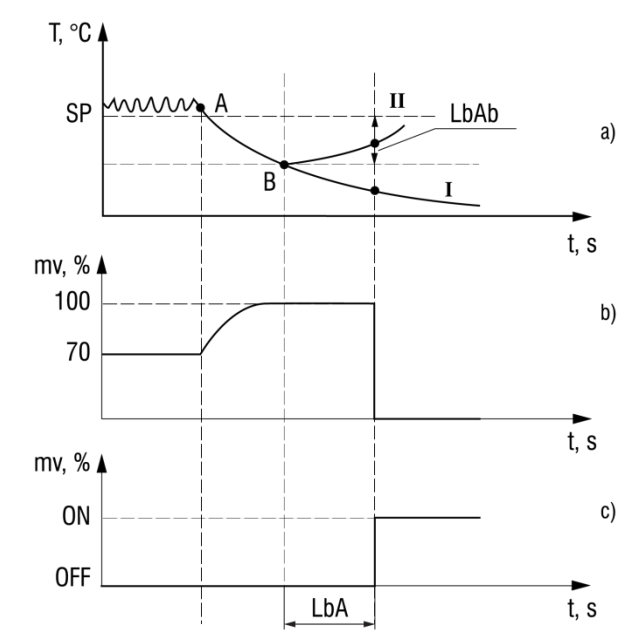


Fig. 6.11

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

– set the maximum output signal

– 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.

6.16.3 Safe state

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

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

– in case of the three-step control the outputs will be set to the level specified in the parameter mvEr, till the control valve is in the specified position, than both outputs will be deactivated.

mvEr = CLoS – closed

mvEr = oPEn – open

mvEr = HoLd – stop

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.

6.17 Stop state

When control is stopped (**r-S** = StoP), the control output will be set to the level specified in the parameter:

– **mdSt** (Output stop state) – for analog control

mdSt = o – the output signal will be set to the last saved output level

mdSt = mvST – the output signal will be set to the level specified in the parameter **mvSt**

– **mvSt** (Output stop level) – for three-step control

mvSt = CLoS – closed

mvSt = oPEn – open

mvSt = HoLd – stop

6.18 Valve settings

The valve settings must always be set before the optimization. Following parameters are provided:

– **v.mot** – Full stroke time. It is the time that valve takes to travel from fully open to fully closed position, specified in the valve characteristics. The parameter can be set in the range 5…999 sec.

– **v.GAP** – Dead time, the time that valve takes to start moving. The parameter can be set in the range 0…10.0 sec.

– **v.db** – Valve deadband. The output signal is always 0, if the calculated pulse duration (signal level) is less than the set value.

  - For the digital output the parameter can be set in the range 0…9999 ms and is the minimum signal duration to which the valve should react.
  - For the analog output the parameter can be set in the range 0…100 % and is the minimum degree of valve opening.

– **v.rEv** – Backlash, the time that valve takes to reverse the moving direction. The parameter can be set in the range 0…10.0 sec.

– **v.toF** – Forcing pulse interval is the interval between one second pulses to force the control valve without position sensors to stay in the end position. It is set to prevent the influence of the valve positioning errors and can be set in the range 0…9 sec. If **v.toF** = OFF, no pulse will be generated.

Note: The parameters **v.GAP**, **v.rEv** and **v.toF** are not available for the device with an analog output.
Note: The parameter **v.mot** must be always set to make control possible.
The parameters **v.GAP**, **v.dB**, **v.rEv** should be set if there is information about their values, this will improve the quality of regulation and prolong the valve service life.
Simultaneous use of the parameters **v.GAP** and **v.toF** is impractical because the Wind-up pulse compensates the Dead time.

6.19 Display settings

In the control mode the measured value on the input 1 is shown in the upper display and the setpoint in the lower display by default. The user can use four additional display modes (see Table 6.5).

Table 6.5 Display modes

Display mode	1	2	3	4	5
				Analog output only	
Upper display	Input 1	Input 1	Calculator output	Input 1	Calculator output

Display mode	1	2	3	4	5
				Analog output only	
Lower display	Setpoint	Input 2	Setpoint	Output 1	Output 1

Each of the five modes can be turned on or off in **diSP** group. If one of the parameters **diS1**…**diS5** in the group is set to ON, the display mode with the same number will be added to the list of display modes. If the parameter is set to OFF, this display mode will be removed from the list.

If two or more modes are included in the list, press the key PROG to switch between them in the control mode.

Note:

1. To display the signal from the position sensor use the display mode 2.
2. It is not recommended to add more than one display mode, for it will be difficult for operator to recognise which parameter is currently displayed. This can be done only indirectly: in the display modes 1 and 3 the indicator **SP** is ON, indicating that the Setpoint manual setting is activated (see 7.2).
3. A mode can be hidden, if the use of this mode is not possible. For example, diS3 is hidden when the input 2 is not used, assigned to a position sensor or an isolated contact. If the mode is hidden, it will be removed from the list.

Switching between control and configuration modes is carried out using the key PROG by default. If you want the switch from the configuration mode to the control mode automatically, use the parameter **rEt** (Rest time). If no keypad activity is detected during the Rest time, the configuration mode will be ended. The parameter can be set in the range 5…99 sec. By default **rEt** = OFF.

6.20 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** = oUEn and **A.LEn** = 8

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

0…247 for **Prot** = nrtU or nASC

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 Modbus).

The following invariable network parameters are not available in the system menu (see Table 6.6).

Table 6.6 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

6.21 Access protection

Three security parameters are available for the parameter access protection (**SECr** group):

– **oAPt** – read access
  - o **oAPt** = 0 – Access to all parameters
  - o **oAPt** = 1 – Access only to **LvoP** group
  - o **oAPt** = 2 – Access only to **SP**

– **wtPt** – write access
  - o **wtPt** = 0 – Access to all parameters
  - o **wtPt** = 1 – Access only to **LvoP** group
  - o **wtPt** = 2 – Access only to **r-S** and **SP**
  - o **wtPt** = 3 – Access only to **SP**
  - o **wtPt** = 4 – No access

To access the group **SECr** enter the passcode 100 using the keys  and  . These parameters have no effect on the access via RS485 network.

6.22 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.

6.23 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, except the Position sensor joint calibration (see App. E).

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 via network.

After the device is powered on, the self-test is carried out, all LEDs are off and the digital outputs get deactivated for 2 seconds. If the self-test is not successful, the error cause is displayed (see Table D.1). 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. Close the contact on the digital input, if Remote start/stop is activated (**inP2** = Evnt, see 6.4)
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 the digital output:

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

In the devices with an 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.

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 6.19). Press  key to save the setpoint and go to the next operation parameter. Alternatively the setpoint can be modified via system menu (see 6.3) in the group **LvoP**.

Note: Select the mode in which the setpoint is displayed if more than one display modes are included (see 6.18). The function Setpoint manual setting is in the display modes 1 and 3 available.

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 Control initial value **Pv0** (see 6.12)

– set **r-S** = rUn to start control
– set **At** = rUn to start the Autotuning (not available if **r-S** = StoP)

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

During the Autotuning the regulator operates in the on-off control mode. The parameters **P**, **i**, **d** will be calculated and saved.

Once the Autotuning has been finished, the **AT** indicator turns off and the Control mode is started. If an error occurs during the Autotuning, the Autotuning 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.

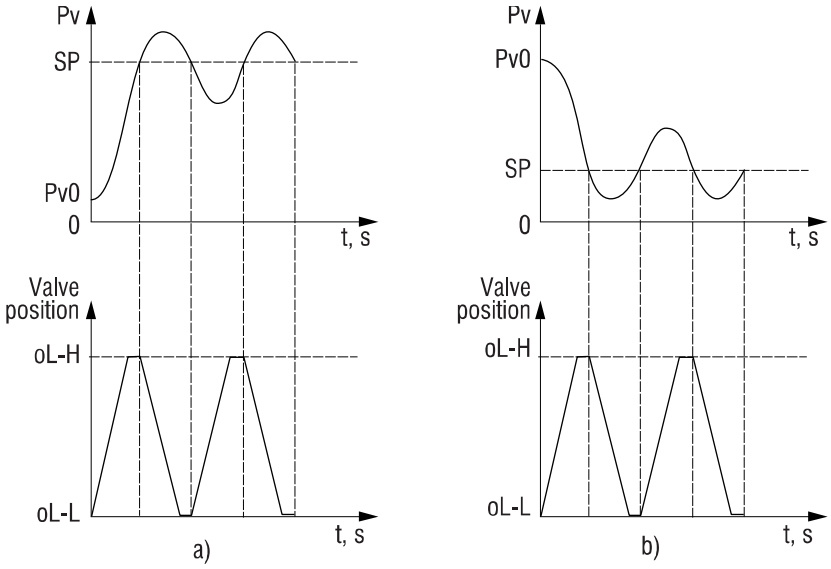


Fig. 7.1 Autotuning

7.4 Manual Tuning

If the characteristics of the process are known, the 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.

Use the key combination PROG + ⌃ to start Manual Control. If Manual Control is active, the indicator **MAN** lights and the outputs remain in the last position before mode activation.

To exit the Manual control mode press the key PROG > 3 sec. The device will run the control mode specified in the parameter **r-L**.

7.5.1 Digital output option

Display functions for the device with a position sensor:

Upper display – I1 Process value **Pv1**
Lower display – I2 Process value **Pv2** (position sensor)

Display functions for the device without position sensor:

Upper display – I1 Process value **Pv1**
– Calculator output value **LUPv**, if **inP2** = in.t2 and **CALC** = GrAF
Lower display – no function

Use the key ⩓ to open the valve and ⩔. to close it.

7.5.2 Analog output option

Display functions:

Upper display – I1 Process value **Pv1**
– Calculator output value **LUPv**, if **inP2** = in.t2 and **CALC** = GrAF
Lower display – valve position

Use the key ⩓ and ⩔. to set the desired valve position on the lower display. When Manual Control has been ended, the calculated valve position is displayed. It can differ from the desired position because of the speed limitation.

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 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.

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 value of the parameter **r.oUt** (Network control signal) should be specified in the range:

-1.000…+1.000 – output state for digital output
0.000…1.0000 – output level for analog output

For the device with digital outputs the parameter **r.oUt** specifies the next step, not the valve position:

r.oUt = -1 – signal to close the valve
-1 < **r.oUt** < 0 – signal to close the valve by (**r.oUt** x 100%)
r.oUt = 0 – signal to stop the valve
0 < **r.oUt** < 1 – signal to open the valve by (**r.oUt** x 100%)
r.oUt = 1 – signal to open the valve

Note: Prove if **r.oUt** = 0 (current value) before writing the new value for the device with digital outputs. Otherwise, you can lose control over the real position of the valve.

For the device with analog output the parameter **r.oUt** specifies the valve position:

r.oUt = 0 – signal to close the valve
r.oUt = 1 – signal to open the valve

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 Errors

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 of errors 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 6.16.3.

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

–	TRM212	1
–	Short guide	1
–	Mounting kit	1
–	Gasket	1

Appendix A Dimensions

Max. panel thickness 15 mm

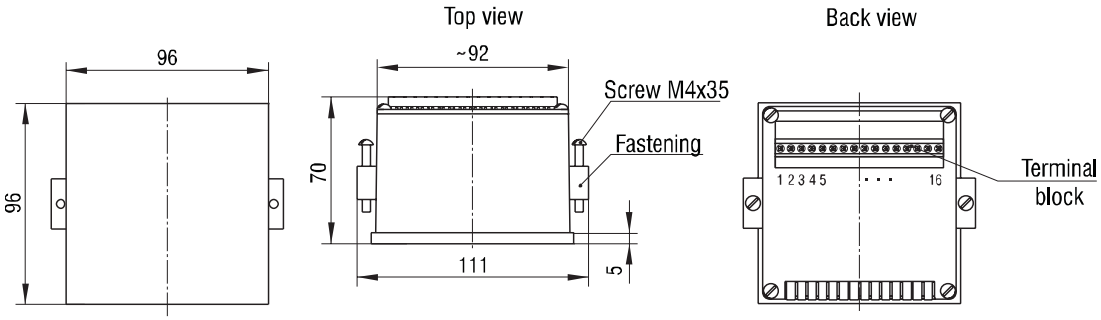


Fig. A.1 External dimensions TRM212-H1

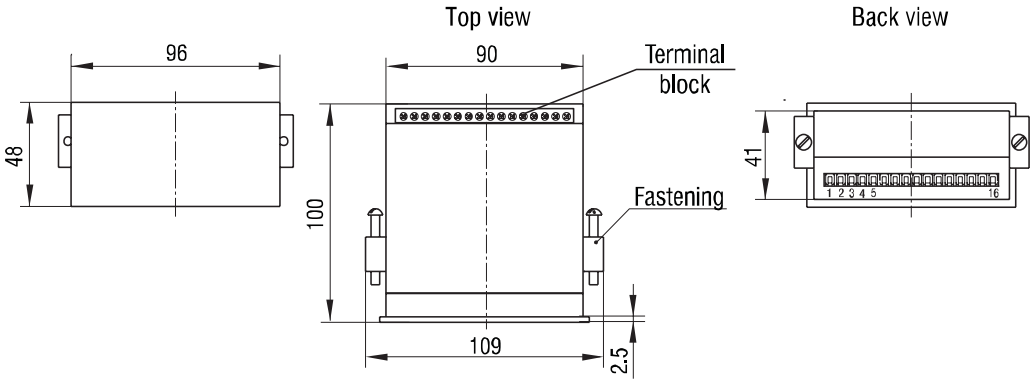


Fig. A.2 External dimensions TRM212-H2

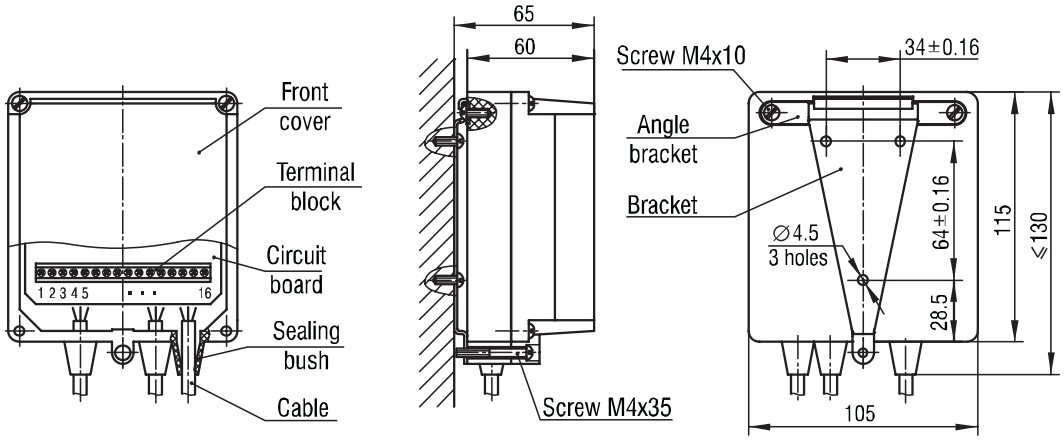


Fig. A.3 External dimensions TRM212-H3

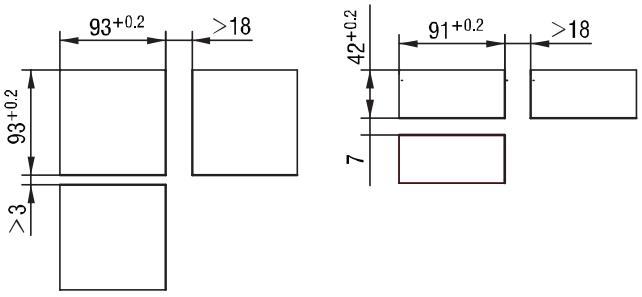


Fig. A.4 Panel mount TRM212-H1 (left) and TRM212-H2 (right)

Appendix B Configuration parameters

Table B.1 Configuration parameters

No	Name	Display	Parameter	Valid value	Meaning	Factory
Operation (LvoP)						
1	**Pv1**	Pu1	I1 Process value			
2	**Pv2**	Pu2	I2 Process value			
3	**LUPv**	LUPu	Calculator output value	-1999…9999		
4	**SP**	SP	Setpoint	SL-L…SL-H		30.0
5	**SEt.P**	SEt.P	Current setpoint value	SL-L…SL-H		
6	**r-S**	r-S	Remote Start/Stop	rUn	Start	Stop
				StoP	Stop	
7	**At**	At	Autotuning (1)	rUn	Start	Stop
				StoP	Stop	
8	**o**	o	Current output signal	0…100 %	read only	
Basic settings (init)						
1	**in.t1**	in.t1	I1 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	

No	Name	Display	Parameter	Valid value	Meaning	Factory
				U-50	-50…+50 mV	
				U0_1	0-1 V	
2	**dPt1**	dPt1	I1 Decimal point displayed (3)	0	0000	1
				1	000.0	
3	**dP1**	dP1	I1 Decimal point (4)	0	0000	1
				1	000.0	
				2	00.00	
				3	0.000	
4	**in.L1**	in.L1	I1 Signal lower limit (4)	–1999...9999	affected by **dP1**	0.0
5	**in.H1**	in.H1	I1 Signal upper limit (4)	–1999...9999	affected by **dP1**	100.0
6	**Sqr1**	Sqr1	I1 Square root (3)	ON	-	OFF
				OFF		
7	**SH1**	SH1	I1 Offset	-500…500	affected by **dP1**	0.0
8	**KU1**	KU1	I1 Slope	0.5…2.0		1.000
9	**Fb1**	Fb1	I1 Filter bandwidth	0….9999	affected by **dP1**	0.0
10	**inF1**	inF1	I1 Filter time constant	OFF	-	OFF
				1…999 s		
11	**in.t2**	in.t2	I2 Sensor (5)	see **in.t1**		Pt100
12	**dPt2**	dPt2	I2 Decimal point displayed (3)(5)	0	0000	1
				1	000.0	
13	**dP2**	dP2	I2 Decimal point (4)(5)	0	0000	1
				1	000.0	
				2	00.00	
				3	0.000	
14	**in.L2**	in.L2	I2 Signal lower limit (4)(5)	–1999...9999	affected by **dP2**	0.0
15	**in.H2**	in.H2	I2 Signal upper limit (4)(5)	–1999...9999	affected by **dP2**	100.0
16	**Sqr2**	Sqr2	I2 Square root (4)(5)	ON		OFF
				OFF		
17	**SH2**	SH2	I2 Offset (5)	-500…500	affected by **dP2**	0.0
18	**KU2**	KU2	I2 Slope (5)	0.5…2.0		1.000
19	**Fb2**	Fb2	I2 Filter bandwidth (5)	0….9999	affected by **dP2**	0.0
20	**inF2**	inF2	I2 Filter time constant (5)	OFF		OFF
				1…999 s		
Advanced settings / LBA (Adv)						
1	**inP2**	inP2	Auxiliary input function (2)	OFF	no function	OFF
				in.t2	in **in.t2** selected sensor	
				Evnt	Remote start/stop (isolated contact)	
				v.Ptr	Potentiometer	

No	Name	Display	Parameter	Valid value	Meaning	Factory
				v.CS	Position sensor with current output	
2	**CALC**	CALC	Calculator function (5)	A.SUm	weighted sum (K1*Pv1+K2*Pv2)	A.SUm
				rAt	ratio (K1*Pv1/K2*Pv2)	
				SqPv	square root of weighted sum	
				GrAF	setpoint correction	
3	**KPv1**	KPv1	**Pv1** weight factor (5)(8)	-19.99...99.99		1.00
4	**KPv2**	KPv2	**Pv2** weight factor (5)(8)	-19.99...99.99	KPv2 ≠ 0 if CALC= rAt	1.00
5	**SL-L**	SL-L	Setpoint lower limit	-1999...3000	affected by **dP1**	–199,9
6	**SL-H**	SL-H	Setpoint upper limit	-1999...3000	affected by **dP1**	3000
7	**orEU**	orEU	Control function	or-r	Heating	or-r
				or-d	Cooling	
8	**Pv0**	Pv0	Initial value	-100...200		20
9	**rAmP**	rAmP	„Quickly to Setpoint“ mode	OFF		OFF
				ON		
10	**P**	P	P component (proportional band)	0.001...9999	affected by **dP1**	30.0
11	**i**	i	I component (integral time)	0...3999 s		100
12	**d**	d	D component (derivative time)	0...3999 s		20
13	**db**	db	Control deadband	0...200	affected by **dP1**	0.0
14	**vSP**	vSP	Setpoint ramp	0...9999	affected by **dP1**	0.0
15	**oL-L**	oL-L	Output lower limit	0...**oL-H** %		0
16	**oL-H**	oL-H	Output upper limit	**oL-L**…100 %		100
17	**mvEr**	mvEr	Output safe state	CLoS	closed	CLOS
				HoLd	stop	
				oPEn	open	
				0...100	analog value	0
18	**mdSt**	mdSt	Output stop state (6)	mVSt	**mvSt** value	mVSt
				o	last output value	
19	**mVSt**	mVSt	Output stop level	see **mdSt**		
20	**LbA**	LbA	LBA time	0...9999 s	deactivated if **LbA** = 0	0
21	**LbAb**	LbAb	LBA range	0...9999	not available if **LbA** = 0	10.0
22	**ALt**	ALt	Alarm mode (6)	see Table 6.4		0
23	**AL-d**	AL-d	Alarm threshold (6)	-1999...3000	affected by **dP1**	10.0

No	Name	Display	Parameter	Valid value	Meaning	Factory
24	**AL-H**	AL-H	Alarm Hysteresis	0...3000	affected by **dP1**	0.0
Valve settings (vALv)						
1	**v.mot**	u.not	Full stroke time	5...999 s		30
2	**v.db**	u.db	Valve deadband	0...9999 ms	for analog output	0
				0...100 %	for digital output	
3	**v.GAP**	u.GAP	Dead time (7)	0.0...10.0 s		0.0
4	**v.REV**	u.rEu	Backlash time (7)	0.0...10.0 s		0.0
5	**v.toF**	u.toF	Forcing pulse interval (7)	OFF	to hold the valve without position sensor in the end position	2
				0.0...9.0		
Display settings (diSP)						
1	**diS1**	dis1	Display mode 1	ON		ON
				OFF		
2	**diS2**	dis2	Display mode 2	ON		OFF
				OFF		
3	**diS3**	dis3	Display mode 3	ON		OFF
				OFF		
4	**diS4**	dis4	Display mode 4 (6)	ON		OFF
				OFF		
5	**diS5**	dis5	Display mode 5 (6)	ON		OFF
				OFF		
6	**rEt**	rEt	Rest time	5...99 s	quit configuration if no keypad activity	OFF
				OFF	function inactive	
Remote Setpoint Adjustment (GrAF)						
1	**nodE**	nodE	Number of nodes	1...10		1
2	**X1**	x 1	Auxiliary input signal	-1999...3000	affected by **dP2**	0.0
3	**Y1**	y 1	Corrective value	-1999...3000	affected by **dP1**	0.0
	...	...	…	…	…	…
20	**X10**	x 10	Auxiliary input signal	-1999...3000	affected by **dP2**	
21	**Y10**	y 10	Corrective value	-1999...3000	affected by **dP1**	
RS485 network (Comm)						
1	**Prot**	Prot	Protocol	oAkYE	akYtec	oAkYE
				oM.rtU	Modbus RTU	
				oM.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 (9)	0…2047		0
5	**rSdL**	rSdL	Respose delay	1…45 ms		20
Access protection (SECr) PASS = 100						
1	**oAPt**	oAPt	Read access	0	to all parameters	0
				1	only to **LvoP** group	
				2	only to **SP**	
2	**wtPt**	wtPt	Write access	0	to all parameters	0

No	Name	Display	Parameter	Valid value	Meaning	Factory
				1	only to **LvoP** group	
				2	only to **r-S** and **SP**	
				3	only to **SP**	
				4	no access	

*(1) Displayed if **r-S** = rUn*

*(2) Displayed if **r-S** = StoP*

(3) Displayed for temperature sensor only

(4) Displayed for linear signal only

*(5) Displayed if **inP2** = int2*

(6) Displayed for analog output option

(7) Displayed for digital output option

*(8) Displayed if **CALC** ≠ GrAF*

(9) Valid values:

- *0…255 for **Prot** = oUEn and **A.LEn** = 8*
- *0…2047 for **Prot** = oUEn and **A.LEn** = 11*
- *0…247 for **Prot** = mrtU or mbSC*

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	–
Pv1	I1 Process value	0x0001	INT16	*
Pv2	I2 Process value	0x0002	INT16	**
LUPv	Calculator output value	0x0003	INT16	*
SP	Setpoint	0x0004	INT16	*
SEt.P	Current setpoint value	0x0005	INT16	*
o	Calculated control signal	0x0006	UINT16	0
Function 0x03/0x10, read/write				
r-L	Network control	0x0007	UINT16	0
r.oUt	Network control signal	0x0008	UINT16	3
r-S	Remote Start/Stop	0x0009	UINT16	0
At	Autotuning	0x000A	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	–
Pv1	I1 Process value	0x1009…0x100A	Float32	–
Pv2	I2 Process value	0x100B…0x100C	Float32	–
LUPv	Calculator output value	0x100D…0x100E	Float32	–
SP	Setpoint	0x100F…0x1010	Float32	–

SEt.P	Current setpoint value	0x1011…0x1012	Float32	–
o	Calculated control signal	0x1013…0x1014	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.t1	I1 Sensor	0x0200	UINT16	0
dPt1	I1 Decimal point displayed	0x0201	UINT16	0
dP1	I1 Decimal point	0x0202	UINT16	0
in.L1	I1 Signal lower limit	0x0203	INT16	*
in.H1	I1 Signal upper limit	0x0204	INT16	*
SH1	I1 Offset	0x0205	INT16	*
KU1	I1 Slope	0x0206	UINT16	3
Fb1	I1 Filter bandwidth	0x0207	UINT16	*
inF1	I1 Filter time constant	0x0208	UINT16	0
Sqr1	I1 Square root	0x0209	UINT16	0
in.t2	I2 Sensor	0x020A	UINT16	0
dPt2	I2 Decimal point displayed	0x020B	UINT16	0
dP2	I2 Decimal point	0x020C	UINT16	0
in.L2	I2 Signal lower limit	0x020D	INT16	*
in.H2	I2 Signal upper limit	0x020E	INT16	*
SH2	I2 Offset	0x020F	INT16	*
KU2	I2 Slope	0x0210	UINT16	3
Fb2	I2 Filter bandwidth	0x0211	UINT16	*
inF2	I2 Filter time constant	0x0212	UINT16	0
Sqr2	I2 Square root	0x0213	UINT16	0
inP2	Auxiliary input function	0x0300	UINT16	0
CALC	Calculator function	0x0301	UINT16	0
kPv1	PV1 weight factor	0x0302	INT16	2
kPv2	PV2 weight factor	0x0303	INT16	2
SL-L	Setpoint lower limit	0x0304	INT16	*

SL-H	Setpoint upper limit	0x0305	INT16	*
orEU	Control function	0x0306	UINT16	0
Pv0	Initial value	0x0307	INT16	0
rAmP	“Quickly to Setpoint” mode	0x0308	UINT16	0
P	P component (proportional band)	0x0309	UINT16	*
i	I component (integral time)	0x030A	UINT16	0
d	D component (derivative time)	0x030B	UINT16	0
db	Control deadband	0x030C	UINT16	*
vSP	Setpoint ramp	0x030D	UINT16	*
oL-L	Output lower limit	0x030E	UINT16	0
oL-H	Output upper limit	0x030F	UINT16	0
LbA	LBA detection time	0x0310	UINT16	0
LbAb	LBA detection range	0x0311	UINT16	*
mvEr	Output safe state	0x0312	UINT16	0
mvSt	Output stop level	0x0313	UINT16	0
mdSt	Output stop state	0x0314	UINT16	0
ALt	Alarm mode	0x0315	UINT16	0
AL-d	Alarm threshold	0x0316	UINT16	*
AL-H	Alarm Hysteresis	0x0317	UINT16	*
v.mot	Full stroke time	0x0400	UINT16	0
v.db	Valve deadband	0x0401	UINT16	0
v.GAP	Dead time	0x0402	UINT16	1
v.rEv	Backlash time	0x0403	UINT16	1
v.toF	Forcing pulse interval	0x0404	UINT16	0
rEt	Rest time	0x0500	UINT16	0
diS1	Display mode 1	0x0501	UINT16	0
diS2	Display mode 2	0x0502	UINT16	0
diS3	Display mode 3	0x0503	UINT16	0
diS4	Display mode 4	0x0504	UINT16	0
diS5	Display mode 5	0x0505	UINT16	0
nodE	Number of nodes	0x0500	UINT16	0
X1	Auxiliary input signal	0x0501	INT16	*
Y1	Corrective value	0x0502	INT16	*
X2…X10 **Y2…Y10**	X2 (0x0603) Y2 (0x0604) X3 (0x0605) Y3 (0x0606) X4 (0x0607) Y4 (0x0608) X5 (0x0609) Y5 (0x060A) X6 (0x060B) Y6 (0x060C) X7 (0x060D) Y7 (0x060E) X8 (0x060F) Y8 (0x0610) X9 (0x0611) Y9 (0x0612) X10 (0x0613) Y10 (0x0614)		INT16	*
oAPt	Read access	0x0700	UINT16	0
wtPt	Write access	0x0701	UINT16	0

Note*:*
** – see **dP1***
*** – see **dP2***

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 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 for I1 and 13-14 for I2
	Incorrect sensor connection	See Fig. 5.1
	4-20 mA signal connected without shunt resistor	Connect a shunt resistor (see 5.2.1)
Err.P displayed in the lower display, control mode, position sensor connected	Position sensor break	Replace the sensor
	Open circuit or short circuit between the sensor and the device	Remove the cause
	Incorrect position sensor connection	See Fig. 5.1
	Wrong position sensor type	Select the correct sensor type
	Position sensor has not been calibrated	Carry out the joint calibration (see App. E)
Err.C displayed in the upper display, control mode, sensor connected	Zero denominator in ratio calculation	Set **KPv2** ≠ 0 Check the signal on the Input 2
	Negative number in square calculation	*Check the correct input connections and polarity; eventually swap the sensors on the inputs.*
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 **dPt1** (**dPt2**) **=** 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 **dPt1** (**dPt2**) **=** 0
Displayed temperature does not correspond to the current temperature (Control mode)	Wrong sensor type	Select the correct sensor type
	Wrong settings for Offset or Slope	Set the correct values in parameters **SH1** (**SH2**) or **KU1** (**KU2**)**.** If no correction is required, set **SH** = 0 and **KU** = 1.
	2-wire connection without correction	See 6.8 “Correction”
	Electromagnetic interference	Use only shielded sensor line, ground the shield on one point
Zeros are displayed for the current signal	Incorrect current sensor connection	See 5 “Wiring”
The temperature decreases when heating and increases when cooling	Incorrect TC connection	Change TC polarity (see Fig. 5.1)

Appendix D Error causes and remedies

Error	Potential cause	Remedy
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)
Control stopped, **LBA** indicator lights	LBA Time (**LbA**) is too short	Increase the LBA Time or set **LbA** = 0 (see 6.16.2)
Settings cannot be modified	Access protection is set	Adjust the Access protection (see 6.21)

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

Appendix E Position sensor joint calibration

To carrying out the “Position sensor - Controller” joint calibration proceed as follows:

1. Connect the position sensor to the auxiliary input (see 5.1).
2. Turn on the controller and set the sensor type in the parameter **inp2** (see 6.4).
3. Set **dis2** = ON to add the display mode 2 to the display list (see 6.19).
4. Set the output lower (**oL-L**) and upper (**oL-H**) limits according to the valve end positions.

Note: If it is necessary to calibrate the sensor in other positions, set the parameters **oL-L** and **oL-H** to the desired values, carry out the closed position calibration for **oL-L** and the open position calibration for **oL-H** and then set the parameters **oL-L** and **oL-H** back to real end positions.

5. To get access to the calibration parameters use the key combination PROG + ⌃ + ⌄. When PASS is on the upper display, enter the passcode 104, using the keys ⌃ and ⌄, and press PROG.
6. Set the valve to the closed position and find the menu item **CLvC**, set it to rUn and press PROG to run the closed position calibration. The process will normally take about 2 seconds.
7. Set the valve to the open position and repeat 6. with the menu item **CLvo** to run the open position calibration.
8. To proof the calibration result start Control, set the valve to one of the end positions and check the position on the display. If the result is not satisfactory, repeat the calibration.