TRD 1

Compact Controller
with program function

Operating Manual

2009-05-27/00456143

Please read this Operating Manual before commissioning the instrument.
Keep the manual in a place which is accessible to all users at all times.

Please assist us to improve this operating manual. Your comments will be appreciated.

All necessary settings are described in this operating manual. If any difficulties should still arise during start-up, please do not carry out any unauthorized manipulations on the unit. You could endanger your rights under the instrument warranty!

Please contact the Elstein-Werk plant or the nearest Elstein representative.

This manual is valid from **instrument software version 192.02.05**.

It appears by simultaneously pressing the PGM and ▲ keys.

When accessing the inner parts of the unit and returning modules, assemblies or components, please observe the regulations accordings to EN 61340-5-1 and EN 61340-5-2 „Protection of electrostatic sensitive devices“. Only use **ESD** packaging for transport.

Please note that we cannot accept any liability for damage caused by ESD.

ESD=**E**lectro **S**tatic **D**ischarge

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1.1 Description and scope of delivery

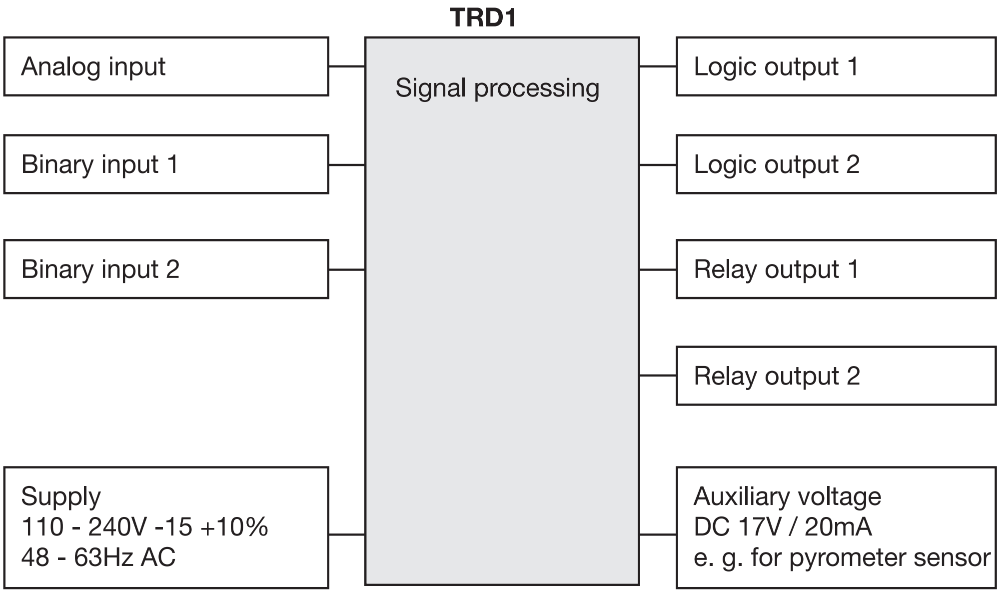
The freely programmable controller in DIN format is used to control temperature. It has been pre-programmed with a type K thermocouple for Elstein infrared radiators. After connecting up the power supply, the thermocouple and the controller output, the controller can be commissioned without any further configuration. Please refer to “Note” under item 6.

The high-contrast, multicolor LCD display for process value, setpoint and operator prompting contains two four-digit 7-segment displays, two single-character 16-segment displays, display of the active setpoints, six status indicators, and displays for the unit, ramp function and manual operation.

Just four keys on the front panel are needed for operation, parameterization and configuration. The software includes a program or ramp function, parameter set changeover, autotuning (self-optimization), a math and logic module, as well as 4 limit comparators.

Linearizations for the usual transducers are stored, and a customer-specific linearization table can be programmed.

The electrical connection is made at the back of the instrument, via screw terminals.



Scope of delivery

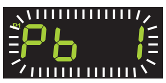
1 controller

1 seal

fixing items

1 Introduction

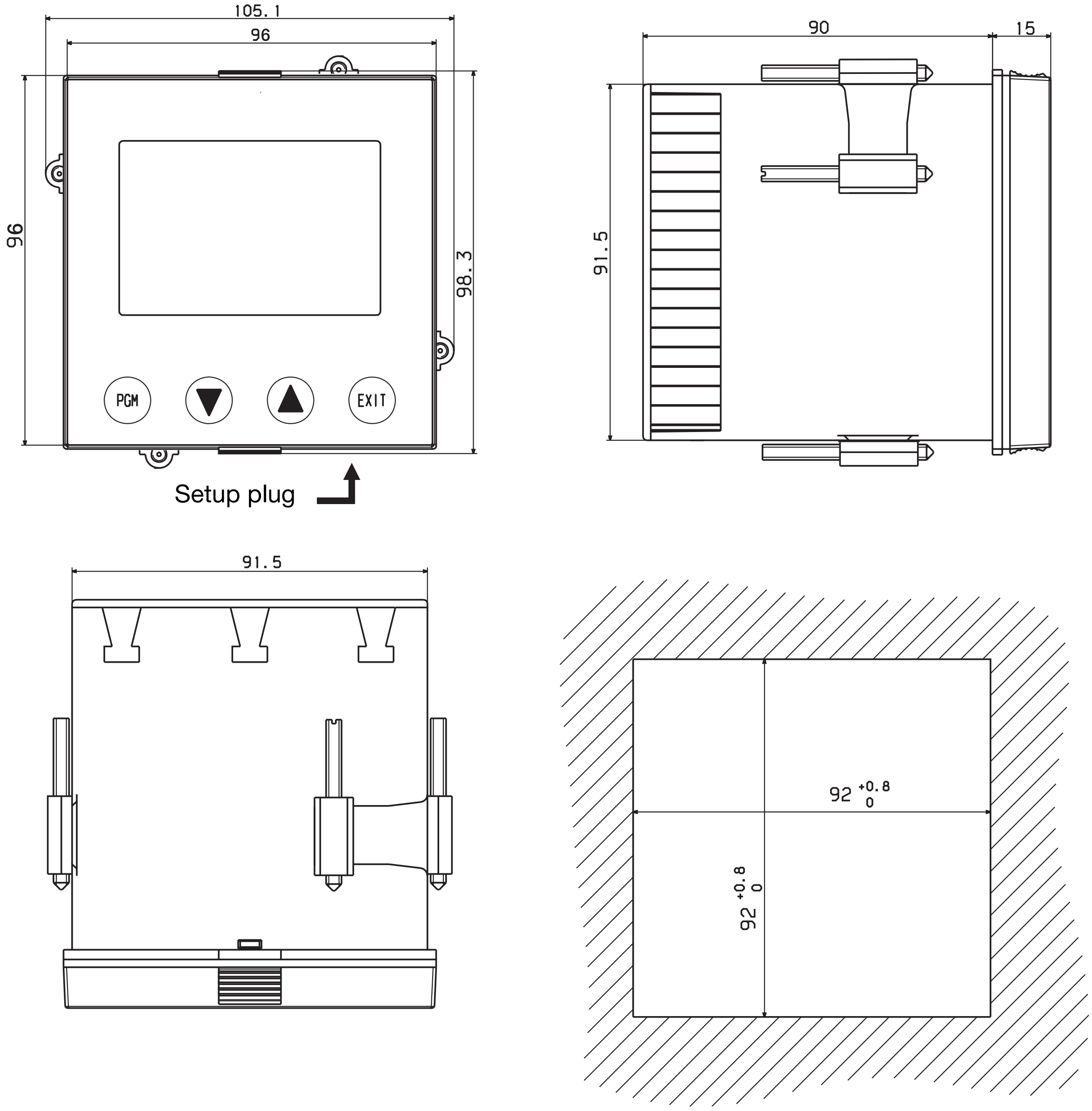
1.2 Typographical conventions

Warning signs		**Danger**	This symbol is used when there may be **danger to personnel** if the instructions are ignored or not followed correctly!
		Caution	This symbol is used when there may be **damage to equipment or data** if the instructions are ignored or not followed correctly!
		Caution	This symbol is used where special care is required when handling components liable to damage through electrostatic discharge.
Note signs		**Note**	This symbol is used when **your special attention** is drawn to a remark.
		Reference	This symbol refers to further information in other operating instructions, chapters or sections.
	*	**Action instruction**	This symbol indicates that an action to be performed is described. The individual steps are marked by this asterisk, e.g. * Press EXIT
Representation		**Menu items**	Texts from the setup program are shown in italics, for example: *edit program.*
		Blinking display	

2.1 Mounting site and climatic conditions

The conditions on the mounting site must meet the requirements specified in the technical data. The ambient temperature on the mounting site can be from 0 to 55 °C, with a relative humidity of not more than 90 %.

2.2 Dimensions



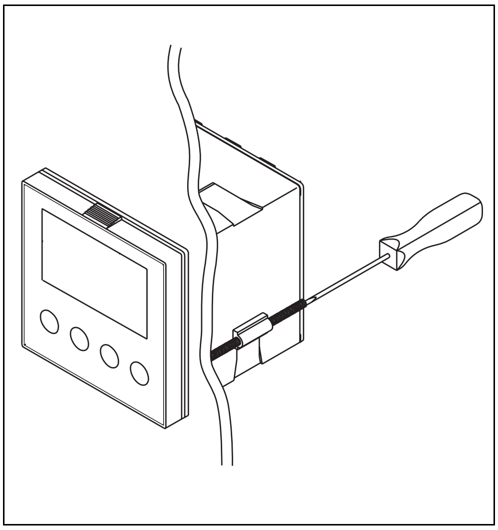
2.3 Side-by-side mounting

Minimum spacing of panel cut-outs

horizontal: 11 mm
vertical: 30 mm

2.4 Fitting in position

* Fit the seal that is supplied onto the instrument body.
* Insert the controller from the front into the panel cut-out.
* From behind the panel, slide the mounting brackets into the guides on the sides of the housing.
  The flat faces of the mounting brackets must lie against the housing.
* Push the mounting brackets up to the back of the panel, and tighten them evenly with a screwdriver.



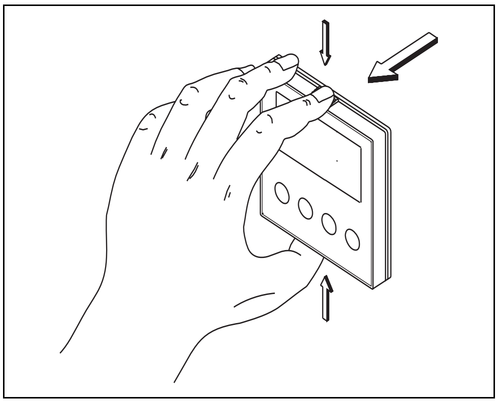
Care of the front panel

The front panel can be cleaned with normal commercial washing, rinsing and cleaning agents. It has a limited resistance to organic solvents (e.g. methylated spirits, white spirit, P1, xylol etc.). Do not use high-pressure cleaning equipment.

2.5 Removing the controller module

The controller module can be removed from its housing for servicing.

* Press together the knurled areas (top and bottom, or left and right for landscape format) and pull out the controller module.



☞ When inserting the controller module, make sure that the latches (below the knurled areas) snap into place.

The modules can be damaged by electrostatic discharge. So avoid electrostatic charge during fitting and removal. Carry out retrofitting on an workbench that is earthed.

3.1 Installation notes

- The choice of cable, the installation and the electrical connection must conform to the requirements of VDE 0100 “Regulations on the Installation of Power Circuits with Nominal Voltages below 1000 V” or the appropriate local regulations.
- The electrical connection must only be carried out by qualified personnel.
- If contact with live parts is possible while working on the unit, it must be disconnected from the supply on both poles.
- A fuse interrupts the supply circuit in the event of a short-circuit. The load circuit must be fused for the maximum relay current, in order to prevent the output relay contacts becoming welded in the event of a short circuit.
- Electromagnetic compatibility conforms to the standards and regulations cited in the technical data.

⇨ Chapter 9.1 “Technical data”

- Run input, output and supply cables separately and not parallel to one another.
- Sensor and interface cables should be shielded cables with twisted conductors. Do not run them close to current-carrying components or cables. Ground the shielding on one side.
- Do not connect any additional loads to the supply terminals of the instrument.
- The instrument is not suitable for use in areas with an explosion hazard (Ex areas).
- In addition to faulty installation, incorrect settings on the controller (setpoint, data of the parameter and configuration levels, internal alterations) can also interfere with the correct operation of dependent processes, or even cause damage. Safety devices should always be provided that are independent of the controller (such as temperature limiters/monitors) and only capable of adjustment by specialist personnel. Please observe the relevant safety regulations for such matters. Since adaptation (self-optimization) can not be expected to handle all possible control loops, an unstable parameterization is theoretically possible. The stability of the actual value that is produced should therefore be checked.

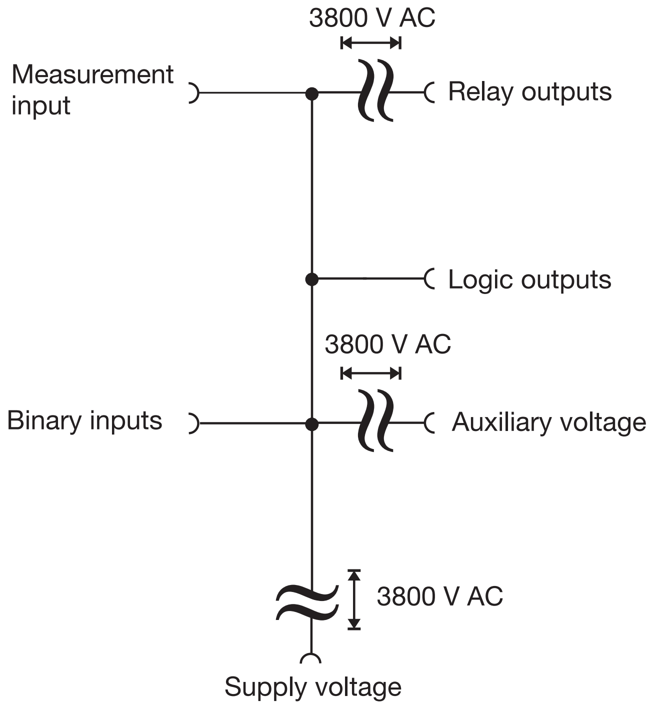
⚠ The electrical connection must only be carried out by specialist personnel.

☞ The instrument version can be identified by the type code.

Conductor cross-sections and core-end ferrules for installation

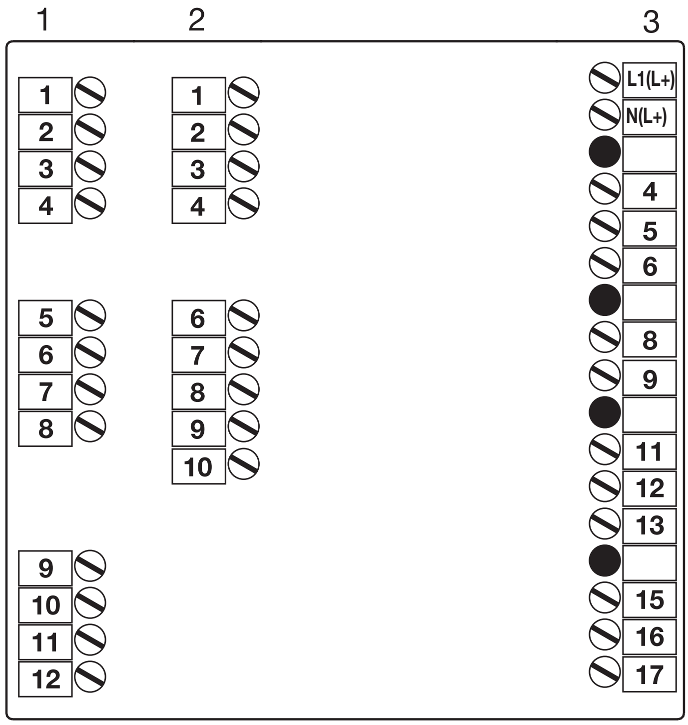
	Minimum cross-section	**Maximum cross-section**	**Min. length of core-end ferrule**
Without core-end ferrule	0.34mm^2	2.5mm^2	10mm (stripped)
Core-end ferrule, no lip	0.25mm^2	2.5mm^2	10mm
Core-end ferrule, lip up to 1.5mm^2	0.25mm^2	1.5mm^2	10mm
Core-end ferrule, lip above 1.5mm^2	1.5mm^2	2.5mm^2	12mm
Twin ferrule with lip	0.25mm^2	1.5mm^2	12mm

3.2 Electrical isolation

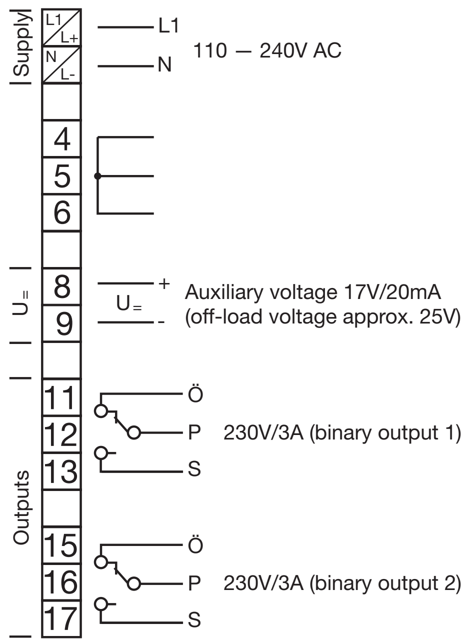


3.3 Connection diagram

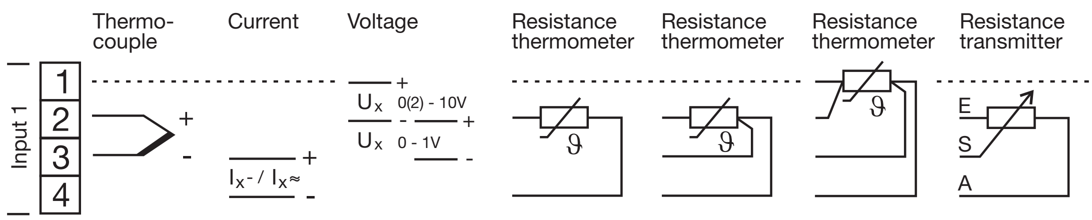
The electrical connection must only be carried out by specialist personnel.

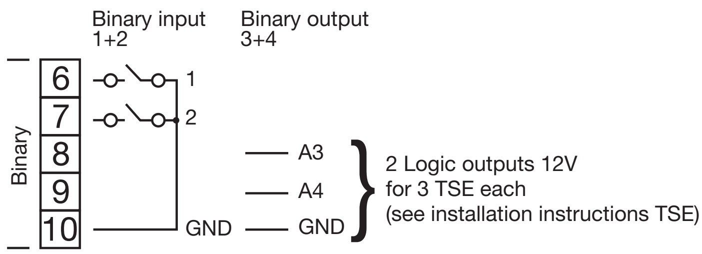


Terminal strip 3

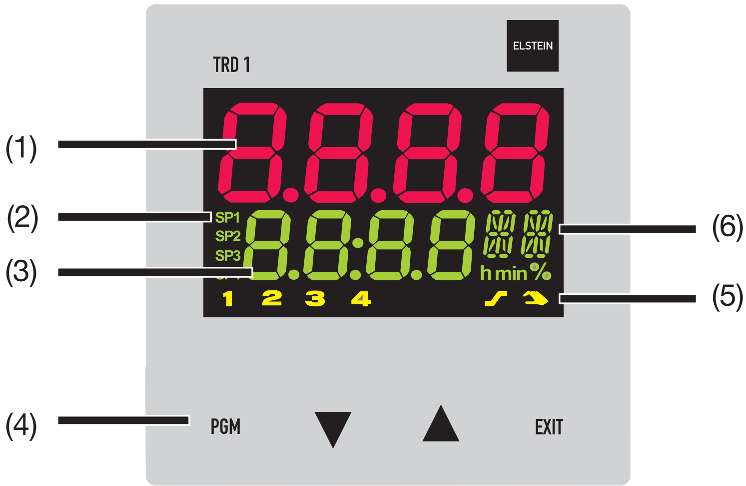


Terminal strip 2





4.1 Displays and keys



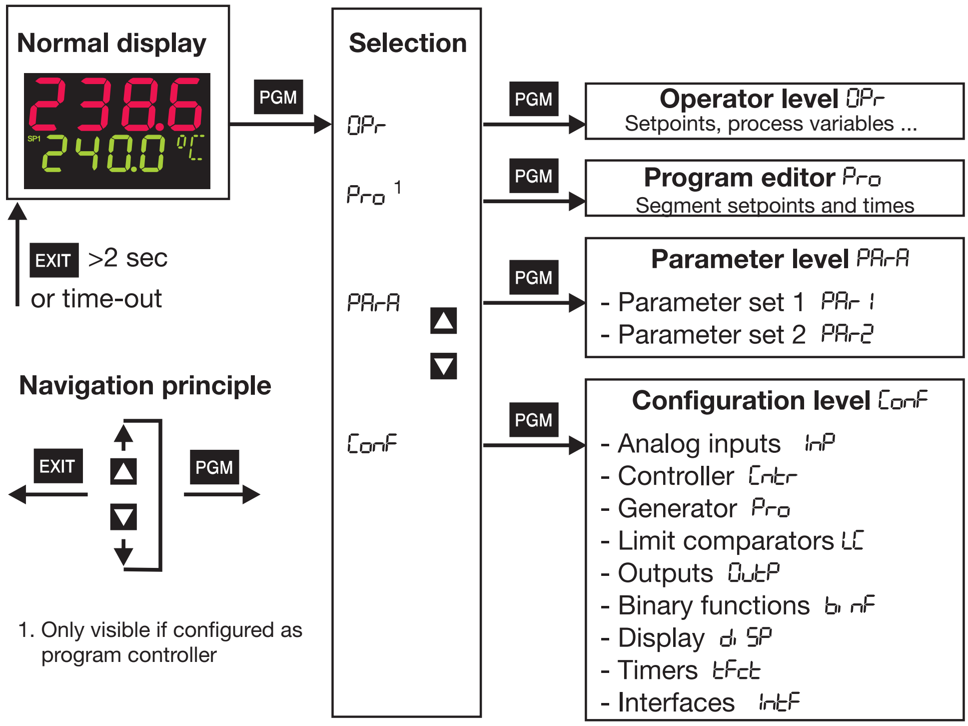
(1)	**7-segment display** (factory setting: process value) four-digit, red, decimal place is configurable (automatic adjustment on display overflow)
(2)	**Active setpoint** (factory setting: SP1) SP1, SP2, SP3, SP4 (SP=setpoint); green;
(3)	**7-segment display** (factory setting: setpoint) four-digit, green; decimal place is configurable; also used for operator prompting (display of parameter and level symbols)
(4)	**Keys**
(5)	**Indication** yellow, for - switch status of binary outputs 1 — 4 (display lights up = on) - ramp/program function is active - manual operation is active
(6)	**16-segment display + dim. units** two-digit, green; for the unit °C/°F and symbols for h, min, %

The displays are configurable.

⇨ Chapter 7.8 “Display “diSP””

4.2 Level concept

The parameters for making the settings on the instrument are arranged at different levels.



Time-out
If no key is pressed for 30 sec, the instrument returns to normal display.

⇨ Chapter 5 “Operator level”

⇨ Chapter 6 “Parameter level”

⇨ Chapter 7 “Configuration”

4.3 Level inhibit

The access to the individual levels can be prevented.

Code	Operator level	Parameter level	Configuration level
0	enabled	enabled	enabled
1	enabled	enabled	inhibited
2	enabled	inhibited	inhibited
3	inhibited	inhibited	inhibited

* Go to code entry with PGM and ▼ (simultaneously for >5 sec).
* Alter code with PGM (display blinks!)
* Enter code with ▲ and ▼. Ex-factory: all levels enabled.
* Return to normal display with EXIT or automatically after approx. 30 sec

The parameter and configuration levels can also be inhibited via the binary function.

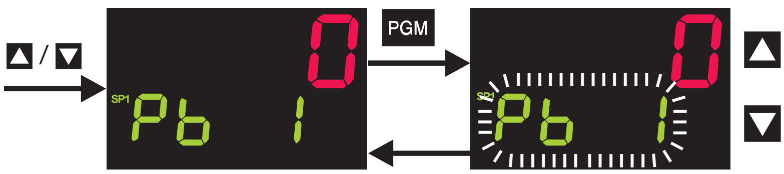
⇨ Chapter 7.7 “Binary functions “binF””

4.4 Entries and operator prompting

Entering values

When entries are made within the levels, the parameter symbol is shown in the lower display.

Select parameter **Alter parameter**



- ✱ Select parameter with ▲ or ▼
- ✱ Change to entry mode with PGM (lower display blinks!)
- ✱ Alter value with ▲ and ▼
  The value alters dynamically with the duration of the key stroke.
- ✱ Accept the setting with PGM or automatically after 2 sec

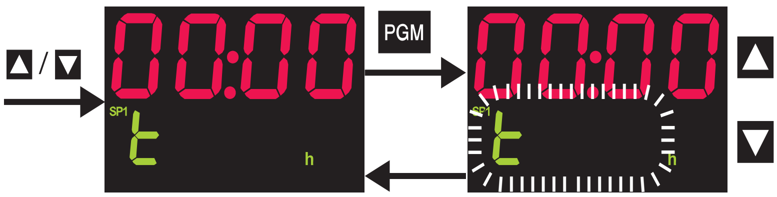
or

- ✱ Cancel entry with EXIT.
  The value is not accepted.

Entering times

When entering times (e.g. timer time), the time unit is shown in addition.

Select parameter **Alter parameter**



The highest time unit of the display is shown for the unit.

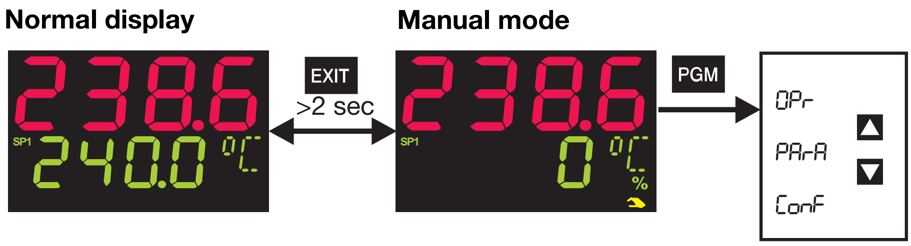
If, for instance, “h” is shown for the hour, then the time format for the value is hh:mm.

- ✱ Select parameter with ▲ or ▼
- ✱ Change over to the entry mode using PGM (lower display blinks!)
- ✱ Alter value with ▲ and ▼
  The value alters dynamically with the duration of the key stroke.
- ✱ Accept the setting with PGM or automatically after 2 sec

or

- ✱ Cancel entry with EXIT.
  The value is not accepted.

4.5 Operation of the fixed-setpoint controller / Manual mode



Altering the setpoint

In normal display:

* Alter the present setpoint with ▲ and ▼
  (the value is accepted automatically)

Manual mode

In manual mode, the controller output can be altered by hand.

* Change to manual mode with EXIT (press for more than 2 seconds)

The output appears in the lower display. The hand symbol and the unit “%” light up in addition.

* Alter the output with ▲ and ▼

In the case of a modulating controller, the actuator is opened or closed using the keys.

The various levels can be accessed from the manual mode.

* Return to the normal display with EXIT (press for more than 2 seconds)

The output entry on a changeover is configurable. The manual mode can be inhibited.

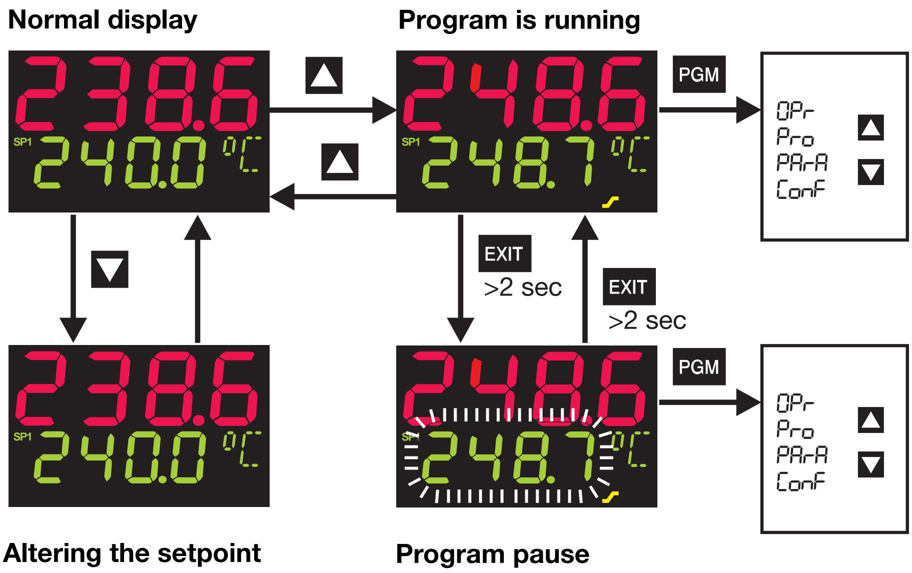
⇨ Chapter 7.3 “Controller “Cntr””

Additional operating options for the fixed-setpoint controller can be implemented via the binary functions.

⇨ Chapter 7.7 “Binary functions “binF””

On overrange/underrange and probe break, the controller automatically changes over to manual mode.

4.6 Operation of the program controller



Normal display

No program run in normal display, the controller controls to the selected setpoint.

Altering the setpoint

From normal display:

✱ Change to setpoint input with ▼

✱ Alter the present setpoint with ▲ and ▼
(the value is accepted automatically)

Starting the program

From normal display:

✱ Start program with ▲
(the ramp symbol lights up!)

Canceling the program

When the program is running:

✱ Cancel program with ▲

Pausing the program

When the program is running:

✱ Pause program with EXIT (press for more than 2 seconds)
(the lower display blinks!)

✱ Continue with EXIT (press for more than 2 seconds)

The program is canceled in the event of a power failure.

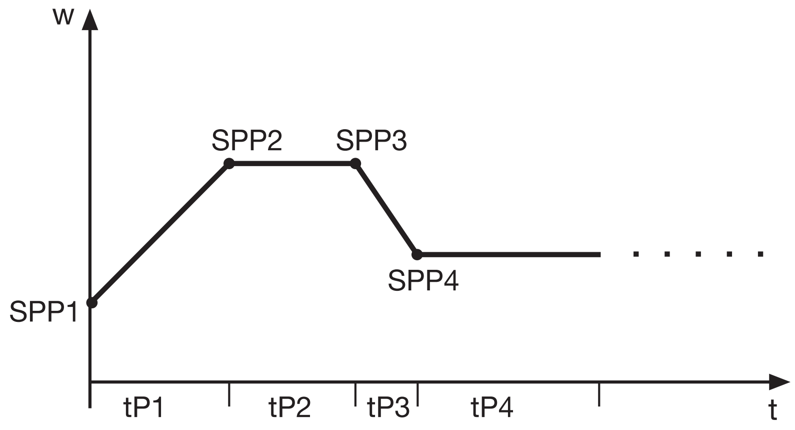
Additional program control functions via binary functions.

⇨ Chapter 7.7 “Binary functions “binF””

4.6.1 Entering programs

Function

A setpoint profile can be implemented with a maximum of 8 program segments.



Entry on the instrument

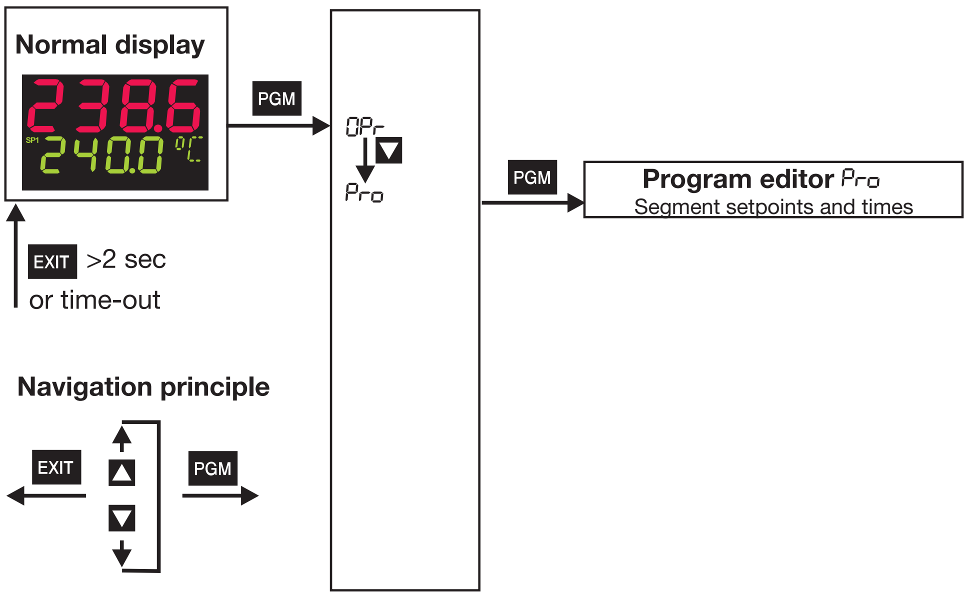
The instrument must be configured as a program controller/generator.

⇨ Chapter 7.4 “Generator “Pro”” (Function)

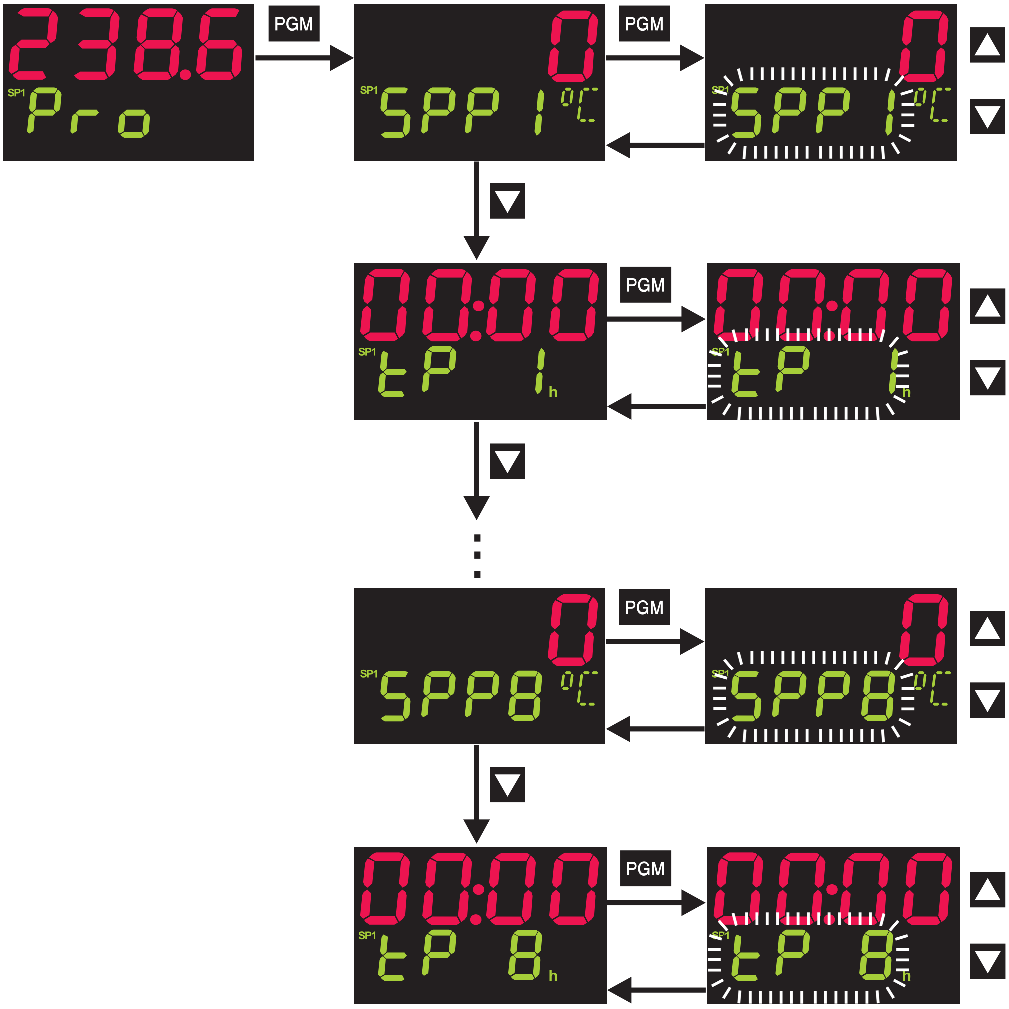
Configurable time base: mm:ss, hh:mm und dd:hh (s=seconds, m=minutes, h=hours, d=days).

⇨ Chapter 7.4 “Generator “Pro”” (unit)

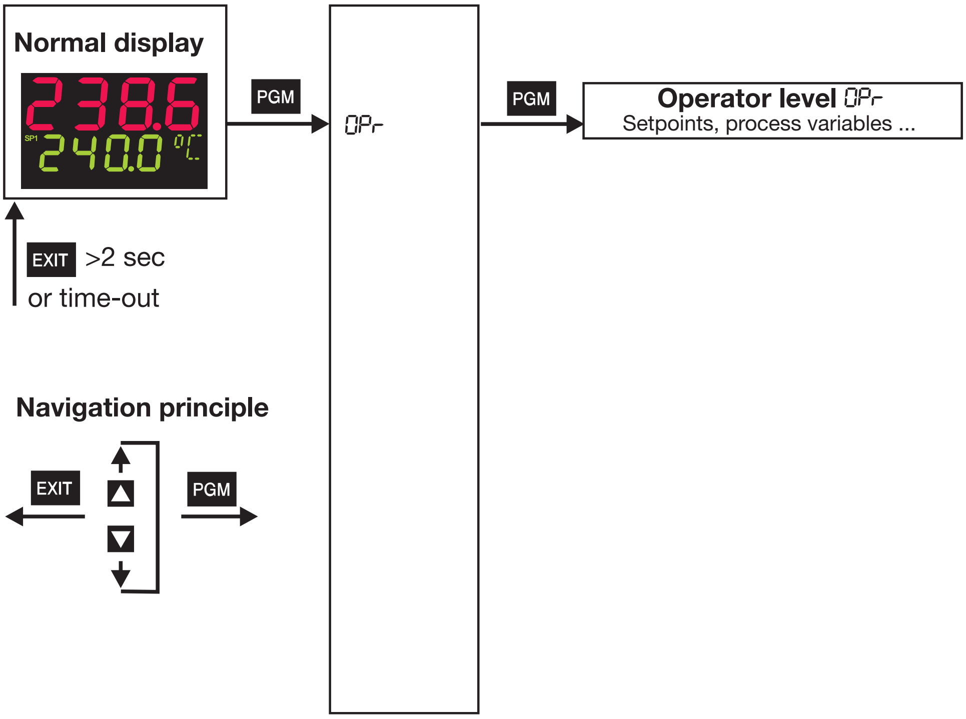
The segment setpoints (SPP1 — SPP8) and segment times (tP1 — tP8) are set in the program editor.



The program segments (up to eight) are defined by the segment setpoint and the segment time.



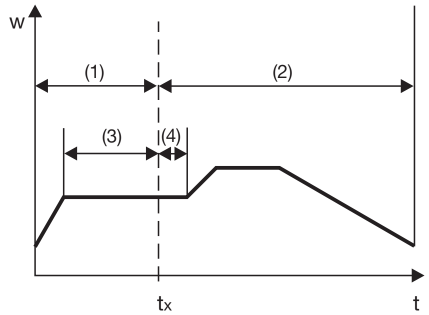
Access



The four setpoints are displayed and edited here, and additional process variables are shown in accordance with the configuration.

Symbol	Meaning
SP 1	Setpoint 1 (editable)
SP 2	Setpoint 2 (editable)
SP 3	Setpoint 3 (editable)
SP 4	Setpoint 4 (editable)
SPr	Ramp setpoint (only if configured)
InP1	Measurement of analog input 1
InP2	Measurement of analog input 2 (only if available)
F1	Calculated result of math formula 1 (only if available)
F2	Calculated result of math formula 2 (only if available)
y	Controller output
trun	Program run time (only with program controller/generator)
trES	Residual program time (only with program controller/generator)
t1	Timer: time 1 (only if configured)
t2	Timer: time 2 (only if configured)

Definition of the program times

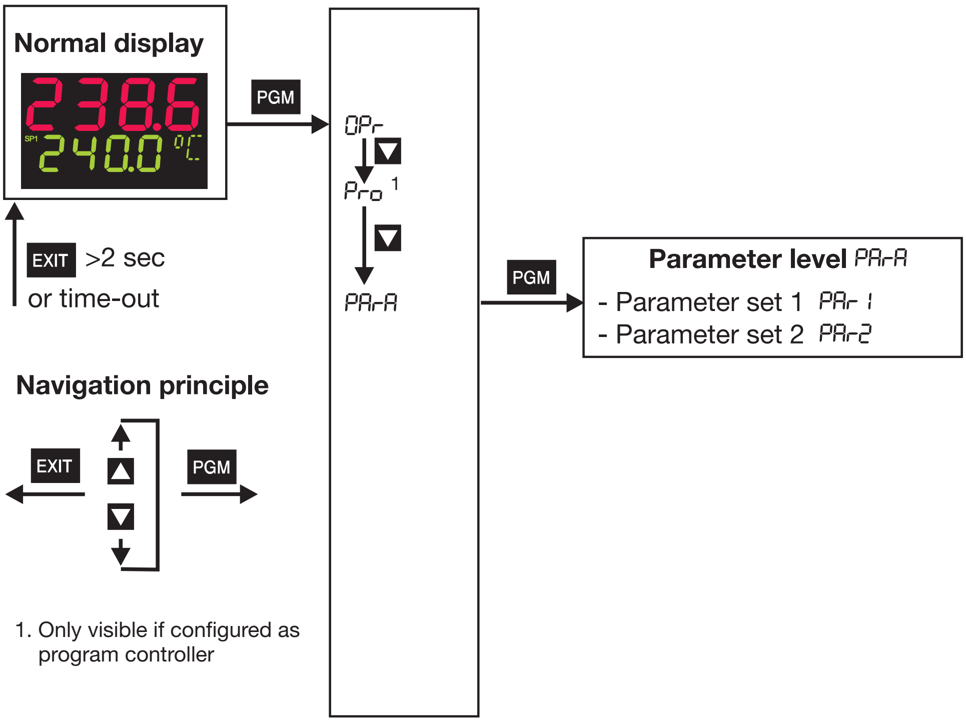


(1) Program run time	(3) Segment run time
(2) Residual program time	(4) Residual segment time

General

Two parameter sets (PAr1 and PAr2) can be stored.

Access



The level can be inhibited.

Applications

- Parameter set switching via binary function

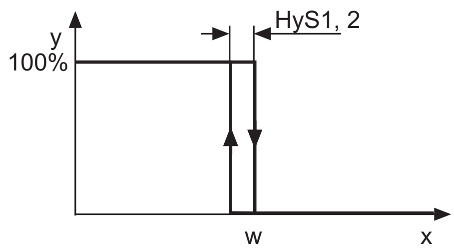
⇨ Chapter 7.7 “Binary functions “binF””

Note

Parameter set 1 is preprogrammed for Elstein radiators, except for type HLS
Pb1 = 10°C, dt = 2s, rt = 8s, Cy1 = 1s

Parameter set 2 is preprogrammed for Elstein radiators type HLS
Pb1 = 40°C, dt = 6s, rt = 25s, Cy1 = 1s

PArA → PAr1 (PAr2)

Parameter	Display	Value range	Factory setting	Meaning
Proportional band	Pb1	0…9999	10 (40)	Size of the proportional band
Derivative time	dt	0…9999 s	2s (6s)	Influences the differential component of the controller output signal The effect of the D component increases with increasing derivative time.
Reset time	rt	0…9999 s	8s (25s)	Influences the integral component of the controller output signal The effect of the I component decreases with increasing reset time.
Cycle time	CY1	0.0…999.9s	1s (1s)	With a switched output, the cycle time should be chosen so that a) the pulsed energy flow to the process does not cause any impermissible PV fluctuations and b) the switching elements are not overloaded.
Contact spacing	db	0.0…999.9	0	The spacing between the two control contacts for 3-state or modulating controllers.
Switching differential	HYS1	0.0…999.9	1	Hysteresis for switching controllers with Pb1,2 = 0. 
	HYS2	0.0…999.9	1	
Actuator time	tt	5…3000 s	60 s	Actuator time range used by the control valve for modulating controllers.
Working point	Y0	-100…+100%	0%	Output for P and PD controllers (when x = w then y = Y0).
Output limiting	Y1	0…100%	100%	The maximum limit for the output.
	Y2	-100…+100 %	-100%	The minimum limit for the output.

The parameters Pb2, Cy2, HyS2 and y2 refer to the second controller output for a 3-state or modulating controller.

The decimal place of some parameters depends on the decimal place setting in the displays.

☞ The parameter display on the instrument depends on the controller type selected.

⇨ Chapter 7.3 “Controller “Cntr””

General

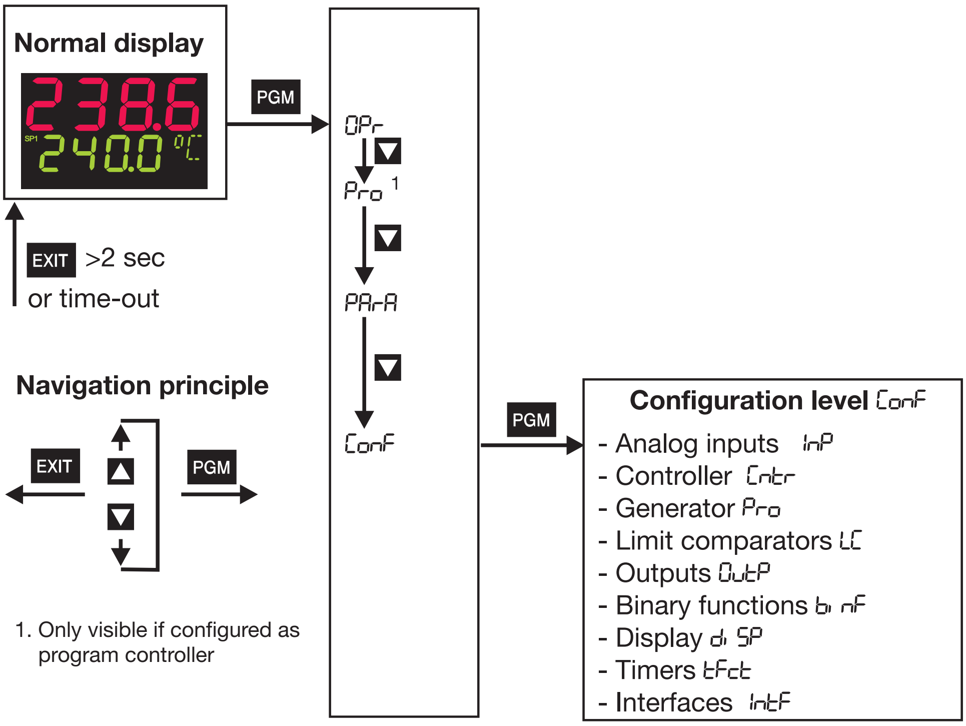
The following applies to the visualization at the configuration level of the parameters and functions listed below:

The parameter is not shown or cannot be selected if:

- the equipment level does not permit the function assigned to the parameter.
  Example: Analog output 2 cannot be configured if no
  analog output 2 is available in the instrument.

The symbol (appears in the display) that corresponds to the menu item is shown in the chapter headings (e.g. Chapter 7.2 “Analog input “InP””).

Access to level



Levels can be inhibited.

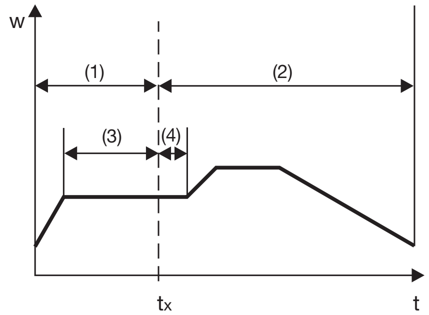
⇨ Chapter 4.3 “Level inhibit”

Analog selector

With some parameters, you can choose from a series of analog values. To provide you with an overview, this selection is listed below.

0 no function
1 analog input 1
2 analog input 2
3 process value
4 present setpoint
5 ramp end value
6 program setpoint
7 math 1
8 math 2
9 setpoint 1
10 setpoint 2
11 setpoint 3
12 setpoint 4
13 controller output level
14 controller output 1
15 controller output 2
21 program run time in sec
22 residual program time in sec
23 segment run time in sec
24 residual segment time in sec
25 timer run time for timer 1 in sec
26 timer run time for timer 2 in sec
27 residual run time for timer 1 in sec
28 residual run time for timer 2 in sec
29 present segment end value
30 analog marker (Profibus)
31 reserved
32 reserved
33 reserved

Definition of the program times



(1) Program run time	(3) Segment run time
(2) Residual program time	(4) Residual segment time

7.1 Overview of the configuration levels

Level 3	4	5	
InP	InP1	SEnS	Sensor type
Page 28	InP2	Lin	Linearization
		OFFS	Measurement offset
		SCL	Display start
		SCH	Display end
		dF	Filter time constant
		FtS	Fine tuning start value
		FtE	Fine tuning end value
		HEAt	Heater current monitoring
	InP12	Unit	Unit
		CYcL	Sampling cycle time
Cntr		CtYP	Controller type
Page 32		CAct	Control action
		InHA	Inhibit manual mode
		HAnd	Manual output
		rOut	Range output
		SPL	Setpoint low
		SPH	Setpoint high
		CPr	Controller process value
		ESP	external setpoint
		FEEd	Output feedback
		tYPt	Method of tuning
		InHt	Inhibit tuning
		Ott1	Output of tuning 1
		Ott2	Output of tuning 2
		SOut	Controller standby output
		StS1	Step size
Pro		Fnct	Function
Page 34		Unit	Unit of slope
		rASL	Ramp slope
		toLP	Tolerance band
LC	LC1	Fnct	Function
Page 36	LC2	AL	Limit value
	LC3	HYSt	Switching differential
	LC4	AcrA	Action/Range response
		tOn	Switch-on delay
		tOFF	Switch-off delay
		AcnL	acknowledgement
		tPuL	pulse time
		LCPr	Limit comparator PV
		LCSP	Limit comparator SP
OutP	OutL	Out1	Binary output 1
Page 40		...	...
		Out4	Binary output 4
binF		bin1	Binary input 1
Page 41		...	...
		bin2	Binary input 2
		LC1	Limit comparator 1
		...	...
		LC4	Limit comparator 4
		tF1	Timer 1
		tF2	Timer 2
		Lo1	Logic 1
		Lo2	Logic 2
		CC1	Control contact 1
		...	...
		CC4	Control contact 4
		toLS	Tolerance band alarm signal
		PrES	Program end signal
diSP		diSU	Upper display
Page 44		diSL	Lower display
		dEcP	Decimal point
		diSt	16-segment display
tFct	tF1	Fnct	Function
Page 45	tF2	t	Timer time
		toLt	Tolerance band

7.2 Analog input “InP”

Configuration
Analog input
Controller
Generator
Limit comparators
Outputs
Binary functions
Display
Timer
Interfaces

Analog input 1 InP 1 →

	Symbol	Value/selection	Description
Sensor type	SEnS	0	no function
		1	Resistance thermometer in 3-wire circuit
		2	Resistance thermometer in 2-wire circuit
		3	Resistance thermometer in 4-wire circuit
		4	**Thermocouple**
		5	Resistance transmitter
		6	Heater current 0 — 50mA AC (analog input 2 only)
		7	0 — 20mA
		8	4 — 20mA
		9	0 — 10V
		10	2 — 10V
		11	0 — 1V
			factory-set on analog input 2: no function
Linearization	Lin	0	Linear
		1	Pt100
		2	Pt500
		3	Pt1000
		4	KTY11-6
		5	W5Re_W26Re C
		6	W3Re_W25Re D
		7	NiCr-Con E
		8	Cu-Con T
		9	Fe-Con J
		10	Cu-Con U
		11	Fe-Con L
		12	**NiCr-Ni K**
		13	Pt10Rh-Pt S
		14	Pt13Rh-Pt R
		15	Pt30Rh-Pt6Rh B
		16	NiCrSi-NiSi N
		17	W3Re_W26Re

Factory settings are shown **bold**.

Analog input - continued

Analog input 1 **InP 1 →**

	Symbol	Value/selection	Description
Measurement offset	OFFS	-1999… **0**… +9999	The measurement offset is used to correct a measured value by a certain amount upwards or downwards. Examples: Measured value / offset / Displayed value 294.7 / +0.3 / 295.0 295.3 / - 0.3 / 295.0 The controller uses the corrected value (= displayed value) for its calculation. This value is not the same as the actually measured value. If incorrectly applied, this can result in impermissible values of the control variable. Special case: 2-wire circuit If the input is connected to a resistance thermometer in 2-wire circuit, then the lead resistance is set in ohms here.
Display start	SCL	-1999…**0**…+9999	On transducers with standard signal and on potentiometers, a display value is assigned to the physical signal. Example: 0 — 20mA ≙ 0 — 1500°C. The range of the physical signal can be 20 % wider or narrower without generating an out-of-range signal.
Display end	SCH	-1999…**100**…+9999	
Filter time constant	dF	0…**0.6**…100 s	To adjust the digital input filter (0sec = filter off). 63% of the alterations are acquired after 2x filter time constant at a signal step change. When the filter time constant is large: - high damping of disturbance signals - slow reaction of the process value display to process value changes - low limit-frequency (2nd order low-pass filter)
Fine tuning start value	FtS	-1999… **0**…+9999	See description on the following pages. If these values are altered by mistake, then this setting has to be canceled, using the procedure described under "Customized fine tuning". As a rule, these values can not be adopted by another instrument.
Fine tuning end value	FtE	-1999…**1**…+9999	
Heater current monitoring (output)	HEAt	**0**	**No function**

Factory settings are shown **bold**.

Analog input (general) **In 12 →**

	Symbol	Value/selection	Description
Temperature unit	Unit	**0** 1	deg. Celsius deg. Fahrenheit Unit for temperature values
Sampling cycle time	CYcL	0 1 2 **3**	50msec 90msec 150msec **250msec**

Factory settings are shown **bold**.

7 Configuration

7.2.1 Customized fine tuning

Principle

The customized fine tuning (= fine adjustment) is used to correct the values displayed by the device. This may be necessary, for example, after a system validation, if the displayed values no longer coincide with the actual values at the point where the measurement is taken.

Using a reference measuring instrument, two measured values are determined which should be as far apart as possible (start value, end value). Ensure that the measuring conditions are stable. Enter the reference value found as the start value (FtS) or end value (FtE) on the device to be adjusted.

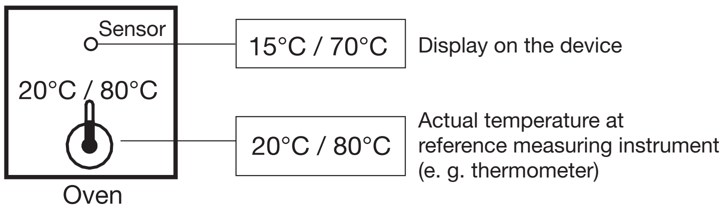
Caution:

If start value and/or end value deviate from the factory-set values (FtS=0 and FtE=1), a fine adjustment has already been done before. In this case the fine adjustment has to be reset (see below).

Repeating fine adjustment without doing a reset before means that an already adjusted characteristic curve is used. This leads to wrong values.

Example

The temperature inside an oven is measured with a resistance thermometer and displayed on a device. The reading on the device deviates from the actual temperature as a result of the sensor temperature drifting. At 20 °C the device reads 15 °C, at 80 °C it shows 70 °C (exaggerated example for better understanding).

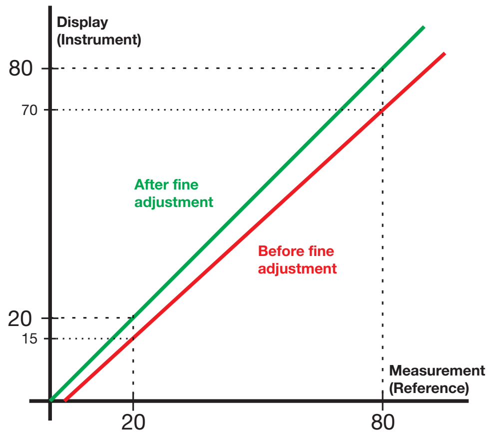


Procedure

* Determine lower measurement value (as low as possible and constant) with a reference measuring instrument;
  Example: Oven temperature 20°C (= room temperature)
* Set start value at the device to this lower measurement value;
  Example: Set start value (FtS) to 20
* Increase temperature and determine higher measurement value (as high as posible and constant) with reference measuring instrument;
  Example: Increase oven temperature to 80°C
* Set end value at the device to this higher measurement value;
  Example: Set end value (FtE) to 80

Characteristic curve

The following diagram shows the changes in the characteristic curve caused by the fine adjustment (point of intersection with the x axis as well as ascent)



Special case: Offset

If the deviation between measured value and displayed value at the low and high measuring point is identical, an offset correction is sufficient (ascent remains unchanged). In this case, fine adjustment is not required.

⇨ Chapter 7.2 “Analog input “InP”” Parameter OFFS

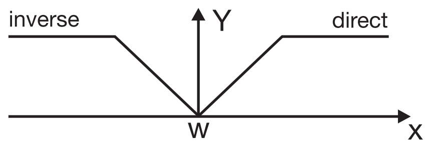
Reset fine adjustment

In order to reset fine adjustment, the same value hast to be given to start value (FtS) and end value (FtE) (e. g. set both parameters to 0). This automatically sets the start value to 0 and the end value to 1 (factory setting).

7.3 Controller “Cntr”

Configuration
- Analog inputs
- **Controller**
- Generator
- Limit comparators
- Outputs
- Binary functions
- Display
- Timer
- Interfaces

The following are set here: controller type, input variables of the controller, the setpoint limits, conditions for manual mode and the presettings for autotuning (self-optimization).

	Symbol	Value/selection	Description
	Configuration		
Controller type	CtYP	0 **1** 2 3 4	no function **2-state controller** 3-state controller Modulating controller Continuous controller
Control action	CAct	0 **1**	Direct Inverse  inverse: The controller output Y is > 0 when the process value is smaller than the setpoint (e. g. heating). direct: The controller output Y is > 0 when the process value is larger than the setpoint (e. g. cooling).
Inhibit manual mode	InHA	**0** 1	**enabled** inhibited If the manual mode is inhibited, changing over to “manual” is not possible from the keys or via the binary input.
Manual output	HAnd	-100…**101**	Defines the controller output level after changing over to manual mode. 101 = last output, acceptance with manual mode Please take note of the output limiting y1 and y2 on page 22.
Range output	rOut	-100…**0**…101	Output on over/underrange. 101 = last output

Factory settings are shown **bold**.

Controller - continued

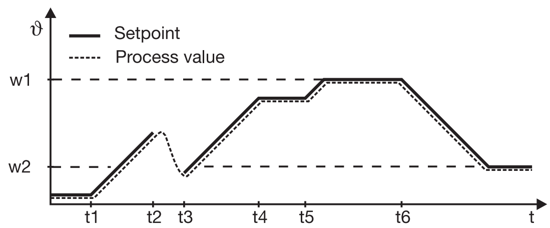
	Symbol	Value/selection	Description
Setpoint low	SPL	-1999…**0**…+9999	Setpoint limiting prevents the input of values outside the defined range.
Setpoint high	SPH	-1999…**1100**…+9999	The correction value is limited for external setpoint with correction.
	Inputs		
Controller process value	CPr	(analog selector) **1 (Analog inp. 1)**	Defines the source for the process value of the control channel. ⇨ See “Analog selector” on Page 26.
External setpoint	ESP	(analog selector) **0 (switched off)**	Activates the external setpoint input and defines the source for the external setpoint. ⇨ See “Analog selector” on Page 26.
Output feedback	FEEd	(analog selector) **0 (switched off)**	Defines the source for output feedback for a modulating controller. ⇨ See “Analog selector” on Page 26.
	Autotuning		
Method of tuning	tYPt	**0** 1	Oscillation method Step response method ⇨ Chapter 8.1 “Autotuning (self-optimization)”
Inhibit tuning	InHt	**0** 1	**enabled** inhibited The start of autotuning can be inhibited from the keys or through the binary function.
Output of tuning 1	Ott 1	0 **1** 2	Relay **Solid-state + logic** Continuous
Output of tuning 2	Ott2		
Controller standby output	SOut	-100…**0**…+100%	Initial output with step response
Step size	StS 1	10…**30**…100%	Step size with step response

Factory settings are shown **bold**.

7.4 Generator “Pro”

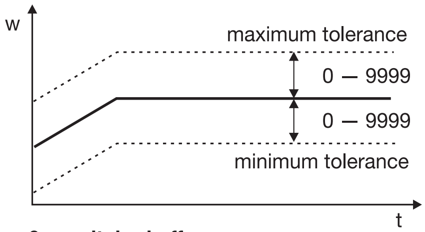
Configuration
- Analog inputs
- Controller
- **Generator**
- Limit comparators
- Outputs
- Binary functions
- Display
- Timer
- Interfaces

The basic function of the instrument is defined here. The instrument can be operated as a fixed-setpoint controller with or without a ramp function, or warm-up ramp for hot-channel equipment, program controller or program generator.

	Symbol	Value/selection	Description
	General		
Function	Fnct	**0** 1 2 3 4	Fixed-setpoint controller Ramp function Program controller Program generator Hot-channel controller Ramp function: A rising or a falling ramp function can be implemented. The ramp end value is determined by the setpoint input.  t1 Power on (w1 aktiv) t2…t3 Power failure / manual operation / probe break t4…t5 Ramp stop t6 Setpoint changeover to w2 The ramp function can be paused or canceled via the binary functions. ⇨ Chapter 7.7 “Binary functions “binF”” ☞ The ramp function is interrupted on a probe break, or for manual mode. The outputs react as for overrange/ underrange (configurable). Program generator: The setpoint profile is output via a continuous output.
Unit of slope	Unit	 **0** 1 2	**Ramp function** / **Program** °C/min / mm:ss °C/hour / hh:mm °C/day / dd:hh s=seconds; m=minutes; h=hours;d=days Unit of ramp slope in °C per time unit, or format of segment times for program controller/generator.

Factory settings are shown **bold**.

Generator - continued

	Symbol	Value/selection	Description
Ramp slope	rASL	**0**…9999	Value of slope for ramp function
Tolerance band	toLP	**0**…999	0=off For a program controller/generator and ramp function, the process value can be monitored by applying a tolerance band around the setpoint profile. If the upper or lower limit is infringed, a tolerance limit signal is generated, which is internally processed or produced via an output.  **0 = switched off** Processing the tolerance limit signal, see: ⇨ Chapter 7.6 “Outputs “OutP”” ⇨ Chapter 7.7 “Binary functions “binF””

Factory settings are shown **bold**.

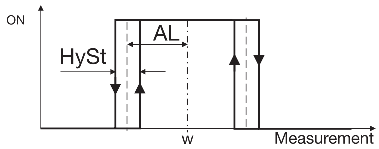
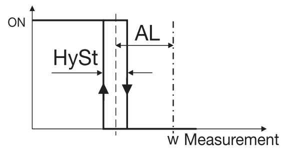
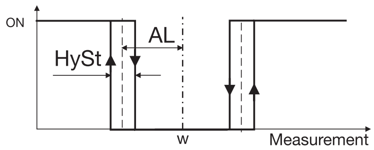
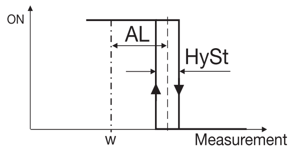
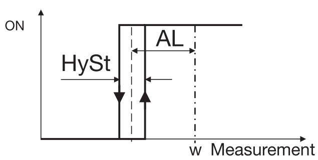
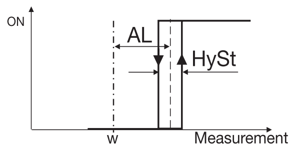
7.5 Limit comparators “LC”

Configuration
- Analog inputs
- Controller
- Generator
- **Limit comparators**
- Outputs
- Binary functions
- Display
- Timer
- Interfaces

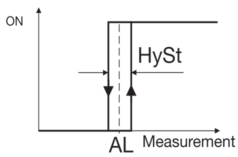
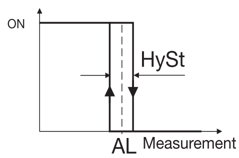
Limit comparators (threshold monitors, limit contacts) can be used to monitor an input variable (process value for the limit comparator) against a fixed limit or another variable (the setpoint for the limit comparator). When a limit is exceeded, a signal can be output or an internal controller function initiated.

4 limit comparators are available.

Limit comparator functions (lk)

	Hysteresis function		Hysteresis function
lk1		**lk4**	
lk2		**lk5**	
lk3		**lk6**	

In the case of the limit comparator functions lk7 and lk8, the measurement that is set is monitored with respect to a fixed value AL.

	Hysteresis function		Hysteresis function
lk7		**lk8**	

Limit comparators - continued

Limit comparator 1 LC 1 →
Limit comparator 2 LC2 →
Limit comparator 3 LC3 →
Limit comparator 4 LC4 →

	Symbol	Value/selection	Description
Function	FnCt	**0** 1 2 3 4 5 6 7 8	no function lk1 lk2 lk3 lk4 lk5 lk6 lk7 lk8
Limit value	AL	-1999…**0**…+9999	Limit value to be monitored Limit range for lk1 and lk2: 0 — 9999
Switching differential	HYSt	0…**1**…9999	Switching differential

Factory settings are shown **bold**.

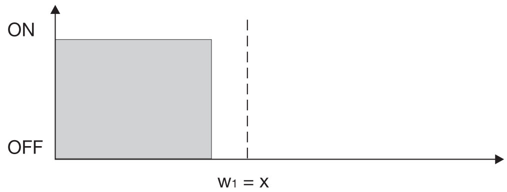
7 Configuration

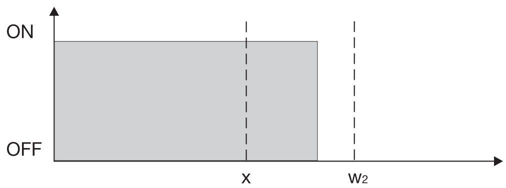
Limit comparators - continued

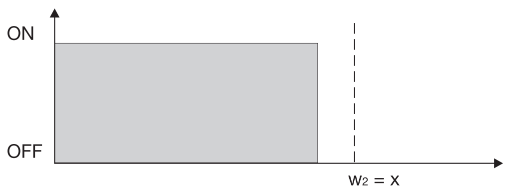
Limit comparator 1 LC1 →
Limit comparator 2 LC2 →
Limit comparator 3 LC3 →
Limit comparator 4 LC4 →

<table>
<tr><th></th><th>Symbol</th><th>Value/selection</th><th>Description</th></tr>
<tr><td>Action/
range response</td><td>AcrA</td><td>0
1
2
3</td><td>absolute/off
relative/off
absolute/on
relative/on

Action:
Defines the switching action of the limit comparators on a setpoint change or power-on.

absolute:
At the time of alteration, the limit comparator acts according to its function.
relative:
The limit comparator is in the OFF status.
An alteration of the limit value or the (limit comparator) setpoint could cause the limit comparator to switch ON. Such a reaction will be suppressed, and this condition is maintained until the (limit comparator) process value has moved out of the switch-on region (gray area).
Example:
Monitoring the (controller) process value x with function lk4
Setpoint alteration $w_1 \rightarrow w_2$
a) Initial condition


b) Condition at the time of the alteration
The limit comparator remains OFF, although the process value is within the switch-on region.


c) Stabilized condition
The limit comparator again operates in accordance with its function.


This function also prevents a limit comparator from being triggered during the approach phase.</td></tr>
</table>

Factory settings are shown **bold**.

Limit comparators - continued

Limit comparator 1 LC 1 →
Limit comparator 2 LC2 →
Limit comparator 3 LC3 →
Limit comparator 4 LC4 →

	Symbol	Value/selection	Description
Switch-on delay	tOn	**0**…9999	Delays the switch-on edge by a definable time period
Switch-off delay	tOFF	**0**… 9999 s	Delays the switch-off edge by a definable time period
Acknowledgement	AcnL	**0** 1 2	no acknowledgement acknowledgement; only with inactive limit comparator acknowledgement; always possible For settings with acknowledgement, the limit comparator is latching, which means it remains ON, even when the switch-on condition is no longer present. The limit comparator must be reset via the ▼ + EXIT keys or binary signal.
Pulse time	tPuL	**0**… 9999 s	The limit comparator is automatically reset after an adjustable time period.
Limit comparator PV	LCPr	(analog selector) **1 (analog input 1)**	see circuit diagrams ⇨ See “Analog selector” on Page 26.
Limit comparator SP	LCSP	(analog selector) **4 (present setpoint)**	see circuit diagrams (only with lk1 — lk6) ⇨ See “Analog selector” on Page 26.

Factory settings are shown **bold**.

7.6 Outputs "OutP"

Configuration
Analog inputs
Controller
Generator
Limit comparators
Outputs
Binary functions
Display
Timer
Interfaces

Numbering of the outputs

(Binary) output 1 = relay — Terminal strip 3 see page 9
(Binary) output 2 = relay — Terminal strip 3 see page 9
(Binary) output 3 = logic output — Terminal strip 2 see page 9
(Binary) output 4 = logic output — Terminal strip 2 see page 9

***Binary outputs* OutL**

	Symbol	Value/selection	Description
Binary output 1	Out 1	0	no function
		1	Controller output 1
		2	Controller output 2
...	...	5	Binary input 1
		6	Binary input 2
Binary output 4	Out4	13	Limit comparator 1
		14	Limit comparator 2
		15	Limit comparator 3
		16	Limit comparator 4
		17	Control contact 1
		18	Control contact 2
		19	Control contact 3
		20	Control contact 4
		21	Logic formula 1
		22	Logic formula 2
		23	Timer 1 active
		24	Timer 2 active
		25	Program active
		26	Program end signal
		27	Tolerance limit signal
		28	Manual mode on/off
		29	Binary marker
		30	Any binary value from storage address (only through setup)
		31	always active
			Function of the binary output

Factory settings

Out 1	13	Limit comparator 1
Out2	14	Limit comparator 2
Out3	1	Controller Output 1
Out4	1	Controller Output 1

7.7 Binary functions “binF”

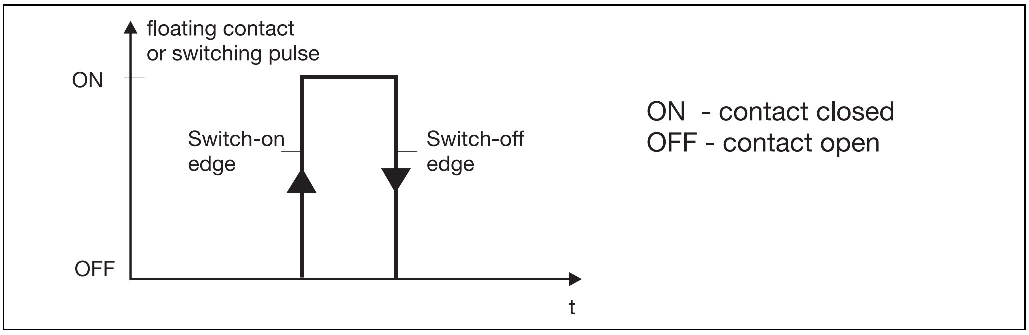
Configuration
Analog inputs
Controller
Generator
Limit comparators
Outputs
Binary functions
Display
Timer
Interfaces

Functions are assigned here to the binary signals of the binary inputs and limit comparators.

In addition, the functions for control contacts, tolerance limit signal and program end signal are defined for program controllers/generators.

In the case of a fixed-setpoint controller, functions can be assigned to the ramp end signals.

Switching action



The functions are arranged in two groups:

Edge-triggered functions

The binary function reacts to switch-on edges.

The following functions are edge-triggered:

- Start/stop of autotuning
- Acknowledge limit comparators
- Program start/cancel
- Start timer
- Segment change

State-triggered functions

The binary function reacts to switch-on or switch-off states.

- All remaining functions

Binary functions - continued

	Symbol	Value/selection	Description
Binary input 1	bin1	0	no function
		1	Start autotuning
...		2	Cancel autotuning
		3	Change to manual mode
Binary input 2	bin2	4	Controller off (controller outputs are switched off)
		5	Inhibit manual mode
Limit comparator 1	LC1	6	Hold ramp
		7	Cancel ramp
...		8	Setpoint changeover
		9	Parameter set switching
Limit comparator 4	LC4	10	Key inhibit
		11	Level inhibit
Timer 1	tF1	12	Display “off” with key inhibit
		13	Acknowledge limit comparators
Timer 2	tF2	14	Inhibit program start
		15	Start program
Logic 1	Lo1	16	Pause program
		17	Cancel program
Logic 2	Lo2	18	Segment change
		19	Start timer 1
		20	Start timer 2
		21	Cancel timer 1
		22	Cancel timer 2
			Level inhibit: The parameter and configuration levels are inhibited.

Factory settings : Bin1 = 8, Bin2 = 10

Setpoint and parameter set switching

A binary function can be used to switch between setpoint 1 and setpoint 2 or parameter set 1 and parameter set 2.

Setpoint switching	Parameter set switching	Binary signal
Setpoint 1 active	Parameter set 1 active	0/contact open
Setpoint 2 active	Parameter set 2 active	1/contact closed

In order to switch between the four possible setpoints, two binary functions must be configured to “setpoint switching”. The states of the two binary functions are designated Z1 and Z2 and switch the setpoints over as shown in the table below:

Setpoint	Z2	Z1
Setpoint 1	0	0
Setpoint 2	0	1
Setpoint 3	1	0
Setpoint 4	1	1

0 = contact open /OFF 1 = contact closed /ON

Binary functions - continued

The states Z1 and Z2 are assigned to the binary functions in descending order (see list on the right), i. e. the first binary function selected in the list is Z1.

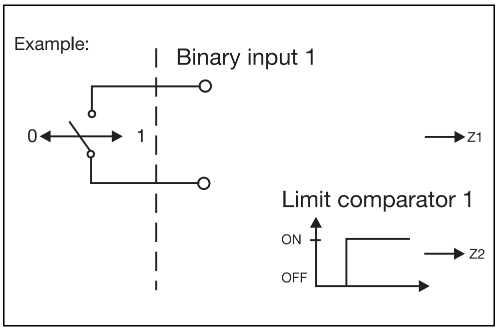
Control variable	State Z
Binary input 1	
...	
Binary input 8	
Limit comparator 1	
...	
Limit comparator 4	
Timer 1	Z1
Timer 2	Z2

Example:

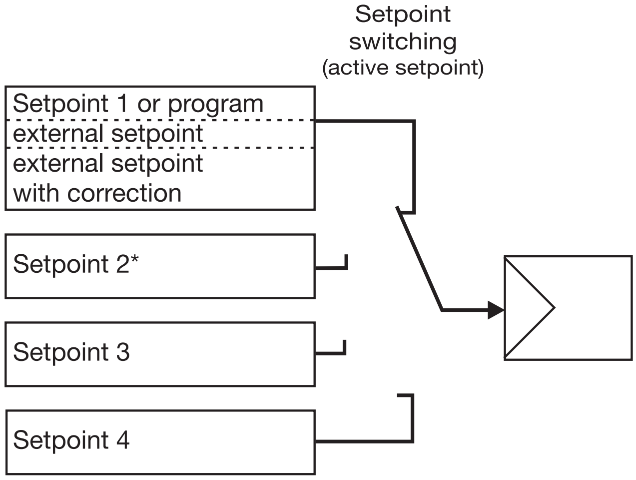
The setpoint is to be selected via a binary input and the state of one limit comparator.

This results in the following assignment:
Z1 - binary input 1
Z2 - limit comparator 1

The binary function for the binary input 1 and limit comparator 1 have to be configured to "setpoint switching"



Depending on the further configuration, the following diagram applies:



* An exception to this is the configuration for a program controller with external setpoint input, with or without correction. Setpoint 2 is the program setpoint in this case.

7.8 Display "diSP"

Configuration
Analog inputs
Controller
Generator
Limit comparators
Outputs
Binary functions
Display
Timer
Interfaces

	Symbol	Value/selection	Description
	General		
Upper display	di SU	(analog selector) **1 (controller process value)**	Displayed value for the upper display ⇨ See "Analog selector" on Page 26.
Lower display	di SL	(analog selector) **4 (controller setpoint)**	Displayed value for the lower display ⇨ See "Analog selector" on Page 26.
Decimal point	dEcP	**0** 1 2	no decimal place one decimal place two decimal places If the value that is be displayed can no longer be represented with the programmed decimal point, then the number of decimal places will be automatically reduced. If, subsequently, the measured value decreases, the number increases to the programmed value of the decimal point.
16-segment display	di St	 0 **1** 2 3 4	Displayed value for the two-digit 16-segment display switched off **Unit (°C or °F)** current segment current parameter set no function

Factory settings are shown **bold**.

7.9 Timer “tFct”

Configuration
Analog inputs
Controller
Generator
Limit comparators
Outputs
Binary functions
Display
Timer
Interfaces

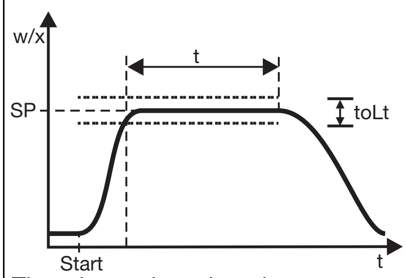
Time-dependent control actions can be carried out with the help of the timer. The timer signal (timer 1+ 2) shows whether the timer is active. It can be output via the binary outputs or processed internally.

The timers are started or canceled via the binary functions.

⇨ Chapter 7.7 “Binary functions “binF””

The current times for the timers can be viewed at the operator level (process data).

Timer 1 tF1 →
Timer 2 tF2 →

	Symbol	Value/selection	Description
Function	Fnct	**0** 1 2 3	no function with the timer running: binary signal=1 (signal is active) with the timer running: binary signal=0 (signal is not active) Tolerance band Function: “Tolerance band”  Timer is running when the process value has reached a tolerance band around the setpoint.
Timer time	t	0...99:59 (hh:mm)	Time input
Tolerance limit	toLt	**0**…999	0=off

Factory settings are shown **bold**.

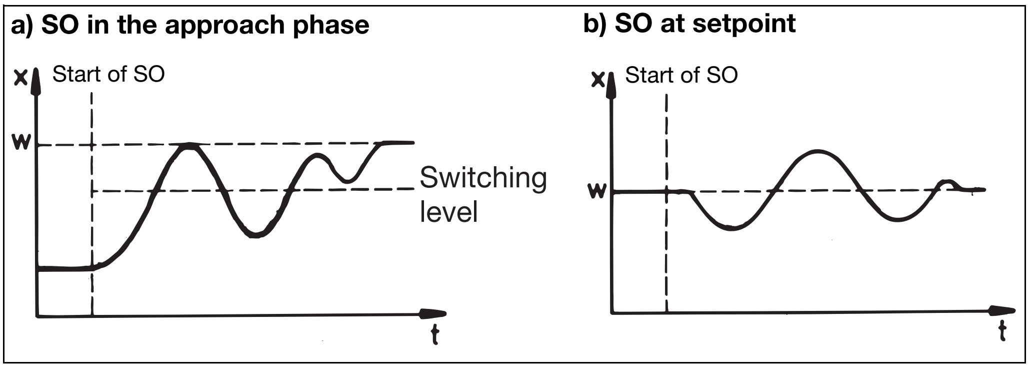
8.1 Autotuning (self-optimization)

Oscillation method

Autotuning (self-optimization, SO) establishes the optimum controller parameters for a PID or PI controller.

Depending on the controller type, the following controller parameters can be defined: Reset time (rt), derivative time (dt), proportional band (Pb), cycle time (Cy), filter time constant (dF)

The controller selects one of two procedures (**a** or **b**), depending on the size of the control deviation:



Step response method

This type of optimization involves determining the control parameters through an output step that is applied to the process. First a standby output is produced until the process value is “steady” (constant). Afterwards, an output step (step size), which can be defined by the user, is automatically applied to the process. The resulting response of the process value is used to calculate the control parameters.

Autotuning establishes the optimum control parameters for a PID or PI controller, according to the selected control structure.

Depending on the controller type, the following control parameters can be determined: Reset time (rt), derivative time (dt), proportional band (Pb), cycle time (Cy), filter time constant (dF)

Autotuning can be started from any system status, and can be repeated as often as is required.

The controller outputs (logic, relay), the controller standby output and the step size (min. 10%) have to be defined.

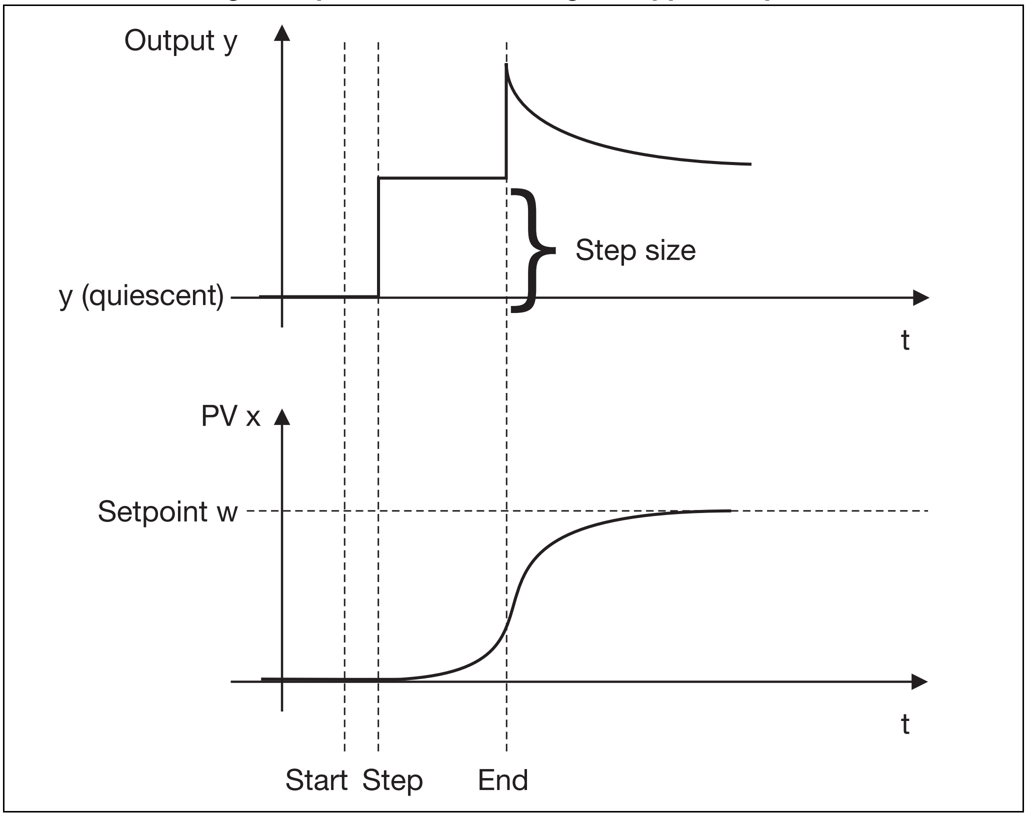
Principal applications of the step response method

- Autotuning instantly after “power on”, during the approach phase
  Considerable time savings, setting: controller standby output = 0 %.
- The process does not readily permit oscillations (e.g. highly insulated furnaces with small losses, long oscillation period)
- Process value must not exceed setpoint
  If the output (with stabilized setpoint) is known, overshoot can be avoided through the following adjustment:
  standby output + step size <= output in stabilized condition

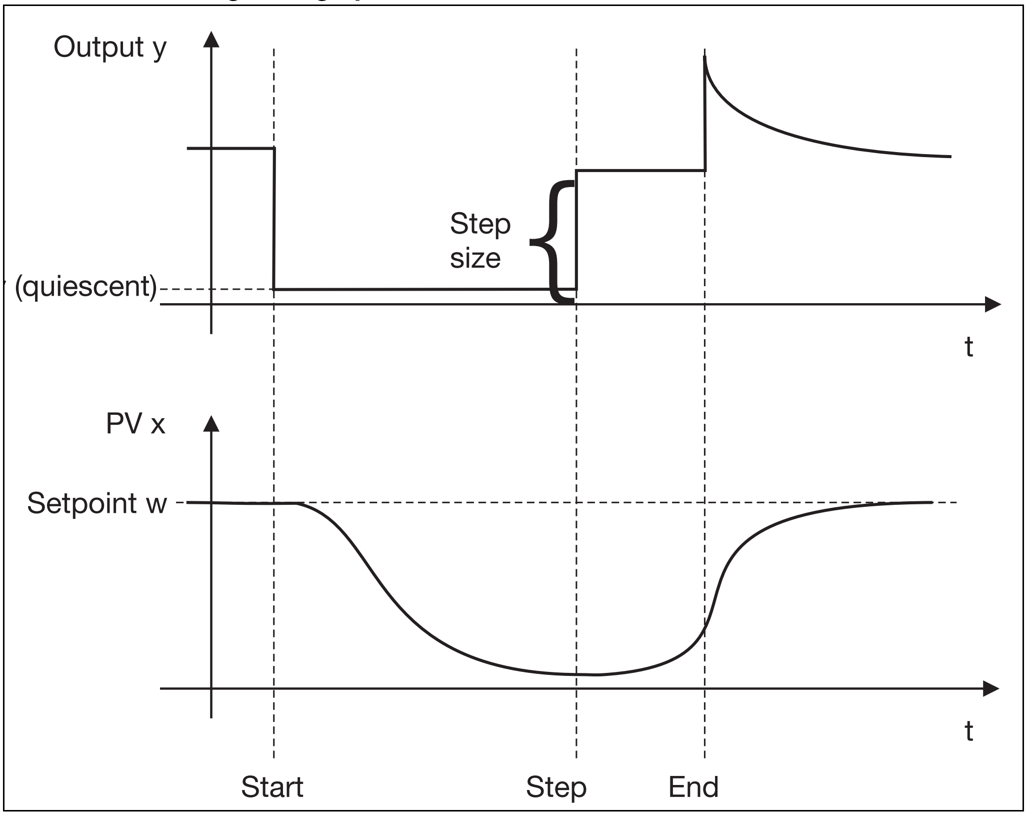
☞ With the “relay” output type, care has to be taken that the process value is not influenced by the cycle time, since otherwise autotuning can not be completed successfully.

Solution: Reduce the cycle time Cy, until the process value is no longer influenced. (Manual mode can be used for the adjustment!)

Start of autotuning after power-on and during the approach phase



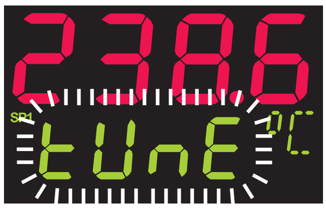
Start of autotuning during operation



Starting auto-tuning

* Start with ▲ and ▼ (simultaneously >2 sec)
  “tUnE” is shown, blinking, in the lower display

Autotuning is ended when the display automatically changes over to normal display.
The duration of autotuning depends on the control process.



The controller output types have to be defined for autotuning.

⇨ Chapter 7.3 “Controller “Cntr””

For a program controller, autotuning can only be started in the normal display.

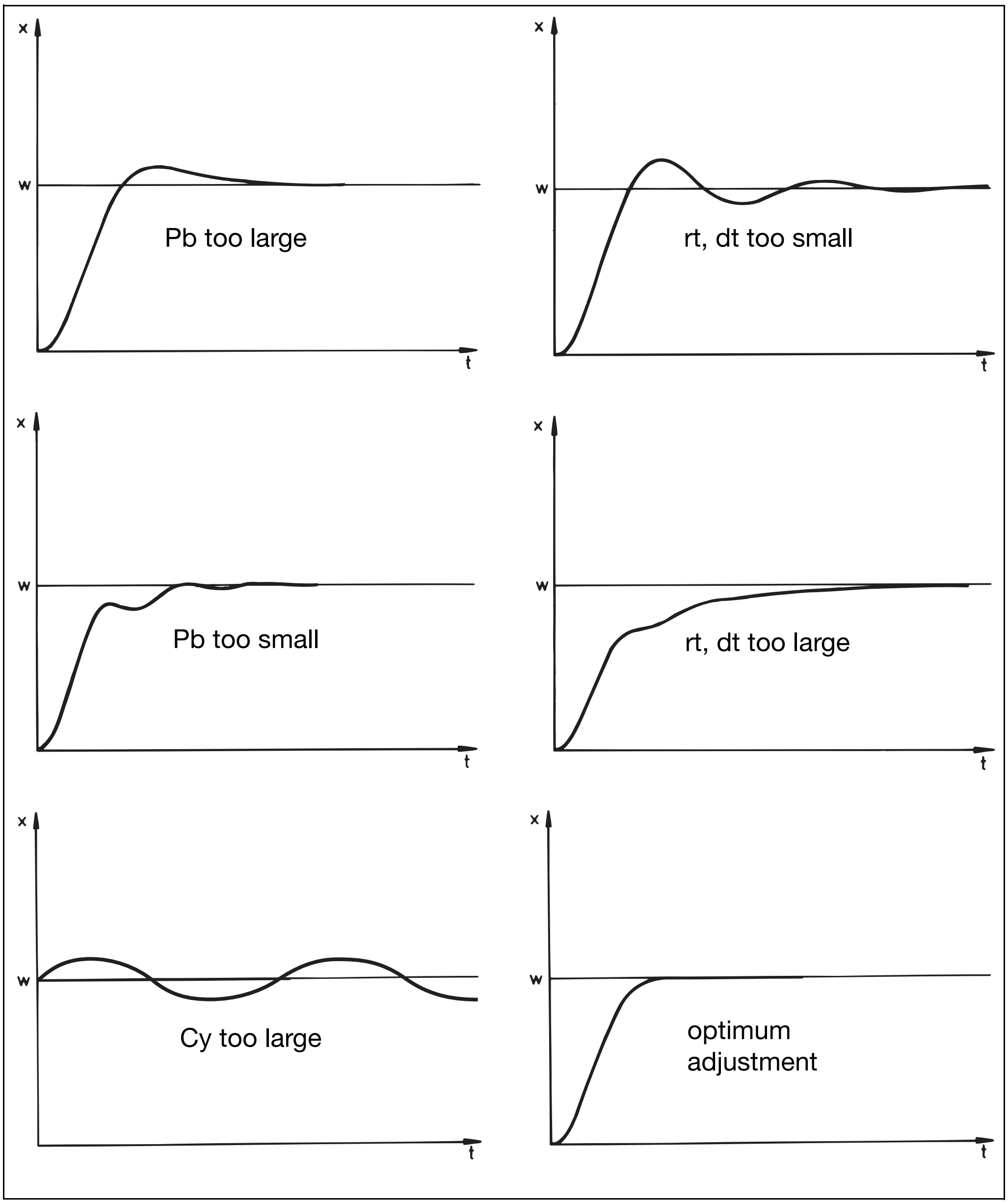
Canceling auto-tuning

* Cancel with ▲ and ▼ (simultaneously)

8.2 Check of the tuning

The optimum adaptation of the controller to the process can be checked by recording the approach phase with the control loop closed. The diagrams below indicate possible maladjustments and how these can be corrected.

The control response of a third-order control loop for a PID controller is shown as an example. However, the procedure for adjusting the controller parameters can also be applied to other control loops.



9.1 Technical data

Thermocouple input

Designation		Measuring range	Measuring accuracy	Ambient temperature error
Fe-Con L		-200 to + 900°C	≤0.25%	100 ppm /°C
Fe-Con J	EN 60584	-200 to +1200°C	≤0.25%	100 ppm /°C
Cu-Con U		-200 to + 600°C	≤0.25%	100 ppm /°C
Cu-Con T	EN 60584	-200 to + 400°C	≤0.25%	100 ppm /°C
NiCr-Ni K	**EN 60584**	**-200 to +1372°C**	**≤0.25%**	**100 ppm /°C**
NiCr-Con E	EN 60584	-200 to +1000°C	≤0.25%	100 ppm /°C
NiCrSi-NiSi N	EN 60584	-100 to +1300°C	≤0.25%	100 ppm /°C
Pt10Rh-Pt S	EN 60584	0 to 1768°C	≤0.25%	100 ppm /°C
Pt13Rh-Pt R	EN 60584	0 to 1768°C	≤0.25%	100 ppm /°C
Pt30Rh-Pt6Rh B	EN 60584	0 to 1820°C	≤0.25%[1]	100 ppm /°C
W5Re-W26Re C		0 to 2320 °C	≤0.25%	100 ppm /°C
W3Re-W25Re D		0 to 2495 °C	≤0.25%	100 ppm /°C
W3Re-W26Re		0 to 2400 °C	≤0.25%	100 ppm /°C
Cold junction		Pt100, internal		

1. in the range 300 to1820°C

Input for resistance thermometer

Designation		Connection	Measuring range	Measuring accuracy		Ambient temperature error
				3-/4-wire	2-wire	
Pt100	EN 60751	2-wire / 3-wire / 4-wire	-200 to +850°C	≤0.05%	≤0.4%	50 ppm / °C
Pt500	EN 60751	2-wire / 3-wire / 4-wire	-200 to +850°C	≤0.2%	≤0.4%	100 ppm /°C
Pt1000	EN 60751	2-wire / 3-wire / 4-wire	-200 to +850°C	≤0.1%	≤0.2%	50 ppm /°C
KTY11-6		2-wire	-50 to +150°C	≤1.0%	≤2.0%	50 ppm /°C
Sensor lead resistance		max. 30Ω per lead for 3-wire or 4-wire circuit				
Measuring current		approx. 250µA				
Lead compensation		Not required for 3-wire or 4-wire circuit. With a 2-wire circuit, the lead resistance can be compensated in software by a correction of the process value.				

Input for standard signals

Designation	Measuring range	Measuring accuracy	Ambient temperature error
Voltage	0(2) — 10V 0 — 1V input resistance R_{IN} > 100kΩ	≤0.05% ≤0.05%	100 ppm / °C 100 ppm / °C
Current	0(4) — 20mA, voltage drop ≤ 1.5V	≤0.05%	100 ppm / °C
Heating current	0 — 50mA AC	≤1%	100 ppm / °C
Resistance transmitter	min. 100Ω, max. 4kΩ	±4Ω	100 ppm / °C

Binary inputs

Floating contacts	

Factory settings are shown **bold**.

9 Appendix

Measuring circuit monitoring

In the event of a fault, the outputs move to a defined (configurable) status.

Sensor	Overrange / underrange	Probe or lead short-circuit	Probe or lead break
Thermocouple	•	-	•
Resistance thermometer	•	•	•
Voltage 2 — 10V 0 — 10V 0 — 1V	• • •	• - -	• - -
Current 4 — 20mA 0 — 20mA	• •	• -	• -
Resistance transmitter	-	-	•

• = recognized - = not recognized

Outputs

Relay (changeover) contact rating contact life	 3A at 230V AC resistive load 350,000 operations at rated load / 750,000 operations at 1A
Logic output	0/12V / 30mA max. (sum of all output currents)
Auxiliary voltage	DC 17V at 20mA load, 25V with no load, electrically isolated, not stabilized

Controller

Controller type	**2-state controller,** 3-state controller, modulating controller, continuous controller
Controller structures	P/PD/PI/PID
A/D converter	dynamic resolution up to 16-bit
Sampling cycle time	**250msec** 50msec, 90msec, 150msec, 250msec

Electrical data

Supply voltage (switchmode PSU)	110 — 240V AC -15/+10%, 48 — 63Hz
Electrical safety	to EN 60730 Overvoltage category III, pollution degree 2
Power consumption	max. 7VA
Data backup	EEPROM
Electrical connection	at the back, via screw terminals, conductor cross-section up to 2.5mm^2 with core ferrules (length: 10mm)
Electromagnetic compatibility interference emission interference immunity	EN 61326-1 Class B to industrial requirements

Housing

Housing type	plastic housing for panel mounting to IEC 61554
Depth behind panel	90 mm
Ambient/storage temperature range	0 to 55°C / -30 to +70°C
Climatic conditions	rel. humidity ≤90% annual mean, no condensation
Operating position	horizontal
Enclosure protection	to EN 60529, front IP65 / back IP20
Weight	420g

Factory settings are shown **bold**.

9.2 Alarm messages

Display	Cause	Fault removal test/repair/replace
- 1999 (blinking!)	Underrange for the value being displayed.	- Check that the connected probe complies with the configured sensor type and linearization - Check the probe connection and the terminals - Check the cable - Check probe for short-circuit and probe break - In case of standard signal: Is the signal within the permissible range (e.g. 4 - 20mA)?
9999 (blinking!)	Overrange for the value being displayed.	
9999 (lower display)	Error in output feedback of modulating controller	Check the source signal for output feedback
---- (blinking!)	Source signal for controller process value is switched off	Select a source signal in configuration level
all displays on; lower 7-segment display is blinking	Watchdog or power-on trigger initialization (reset).	Replace the controller if the initialization continues for more than 5sec
OPt	Hardware configuration error	Check which option boards are installed in the slots

Overrange / underrange covers the following events:
- Probe break or short-circuit
- Measurement is outside the controllable range for the probe that is connected
- Display overflow

9 Appendix

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