TRD 1

Compact Controller
with program function

Operating Manual

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

Contents

Contents

1 Introduction

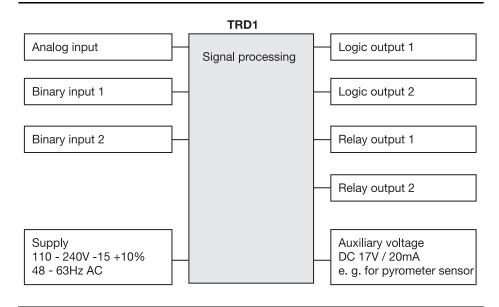## 1.1 Description and scope of delivery

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.

TRD1

Analog input	Signal processing	Logic output 1
Binary input 1		Logic output 2
Binary input 2		Relay output 1
		Relay output 2
Supply 110 - 240V -15 +10% 48 - 63Hz AC		Auxiliary voltage DC 17V / 20mA e. g. for pyrometer sensor

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

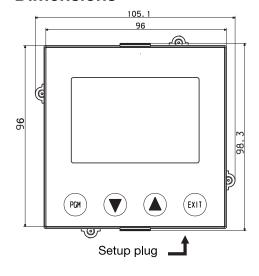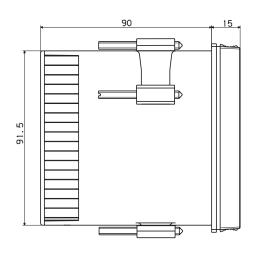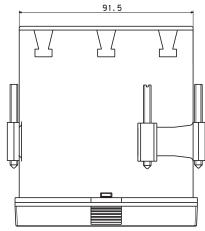## 2.1 Mounting site and climatic conditions
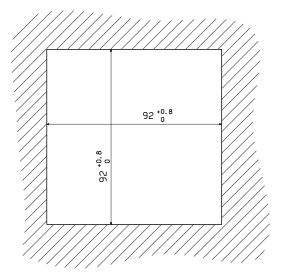
The conditions on the mounting site must meet the requirements specified in the technical data. The ambient temperature on the mounting site can be from 0 to 55 °C, with a relative humidity of not more than 90 %.

2.2 Dimensions

Setup plug

2.3 Side-by-side mounting
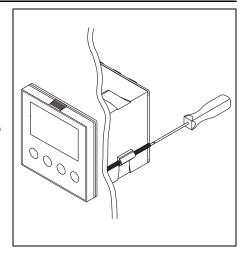
Minimum spacing of panel cut-outs

horizontal: 11 mm
vertical: 30 mm

2 Mounting

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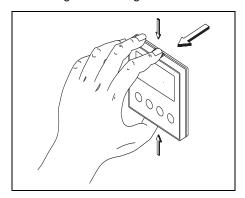
Care of the front panel   The front panel can be cleaned with normal commercial washing, rinsing and cleaning agents. It has a limited resistance to organic solvents (e.g. methylated spirits, white spirit, P1, xylol etc.). Do not use high-pressure cleaning equipment.

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 Electrical connection

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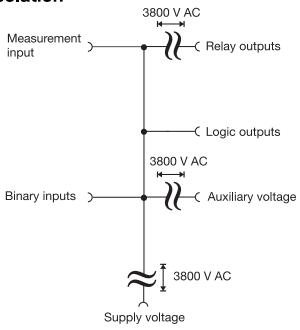
The instrument version can be identified by the type code.

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	$0.34\,mm^2$	$2.5\,mm^2$	10mm (stripped)
Core-end ferrule, no lip	$0.25\,mm^2$	$2.5\,mm^2$	10mm
Core-end ferrule, lip up to 1.5mm^2	$0.25\,mm^2$	$1.5\,mm^2$	10mm
Core-end ferrule, lip above 1.5mm^2	$1.5\,mm^2$	$2.5\,mm^2$	12mm
Twin ferrule with lip	$0.25\,mm^2$	$1.5\,mm^2$	12mm

3 Electrical connection
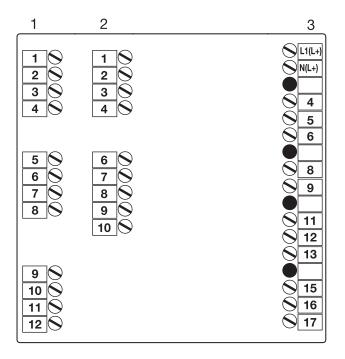
3.2 Electrical isolation

3800 V AC

Measurement input ———— Relay outputs

———— Logic outputs

3800 V AC

Binary inputs ———— Auxiliary voltage

3800 V AC

Supply voltage
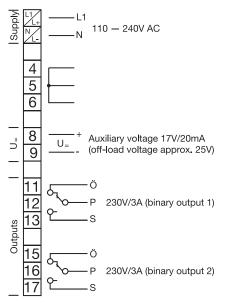
3.3 Connection diagram
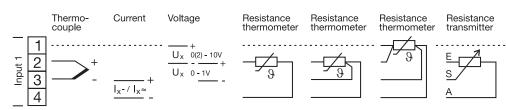
⚠️ The electrical connection must only be carried out by specialist personnel.

Terminal strip 3

Supply
| L1/L+ | — L1 |
| N/L- | — N | 110 — 240V AC

4
5
6

U= | 8 | U= | + | Auxiliary voltage 17V/20mA |
| 9 | | | (off-load voltage approx. 25V) |

Outputs
11	Ö
12	P	230V/3A (binary output 1)
13	S

15	Ö
16	P	230V/3A (binary output 2)
17	S

Terminal strip 2

Input 1

	Thermo-couple	Current	Voltage	Resistance thermometer	Resistance thermometer	Resistance thermometer	Resistance transmitter
1							
2			U_x 0(2) - 10V				E
3		I_x - / I_x ≈	U_x 0 - 1V				S
4							A

Binary

Binary input 1+2   Binary output 3+4

6	1
7	2
8	— A3
9	— A4
10	GND — GND

2 Logic outputs 12V
for 3 TSE each
(see installation instructions TSE)

3 Electrical connection

4 Operation

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, %
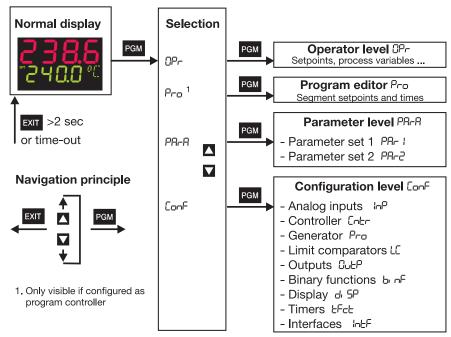
The displays are configurable.

⇨ Chapter 7.8 "Display "diSP""

4 Operation

4.2 Level concept

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

Normal display

238.6
240.0 °C

EXIT >2 sec
or time-out

Navigation principle

EXIT PGM

1. Only visible if configured as program controller

Selection

OPr

Pro ¹

PArA

ConF

PGM	**Operator level** OPr Setpoints, process variables ...
PGM	**Program editor** Pro Segment setpoints and times
PGM	**Parameter level** PArA - Parameter set 1 PAr1 - Parameter set 2 PAr2
PGM	**Configuration level** ConF - Analog inputs InP - Controller Cntr - Generator Pro - Limit comparators LC - Outputs OutP - Binary functions binF - Display diSP - Timers tFct - Interfaces IntF

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**
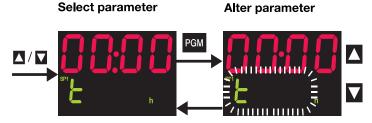
✱ Select parameter with ▲ or ▼

✱ 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.
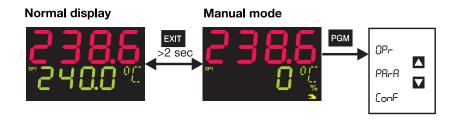
✱ Select parameter with ▲ or ▼

✱ 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 Operation

4.5   Operation of the fixed-setpoint controller / Manual mode

Normal display   **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.
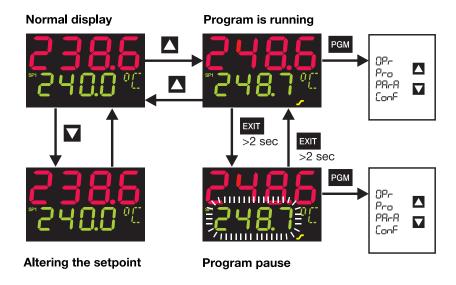
4.6 Operation of the program controller

Normal display

Program is running

Altering the setpoint

Program pause

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.
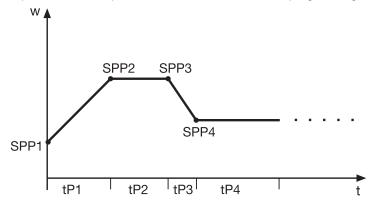
⇨ Chapter 7.7 "Binary functions "binF""

4 Operation

4.6.1 Entering programs

Function

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

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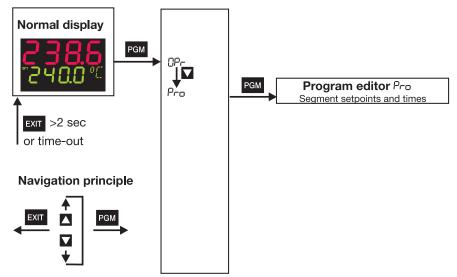
The instrument must be configured as a program controller/generator.

⇨ Chapter 7.4 "Generator "Pro"" (Function)
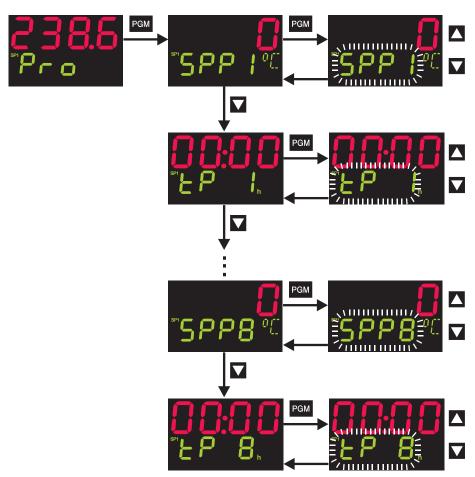
Configurable time base: mm:ss, hh:mm und dd:hh (s=seconds, m=minutes, h=hours, d=days).

⇨ Chapter 7.4 "Generator "Pro"" (unit)

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

18
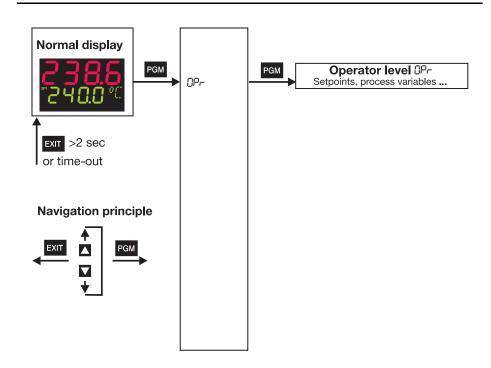
The program segments (up to eight) are defined by the segment setpoint and the segment time.

4 Operation

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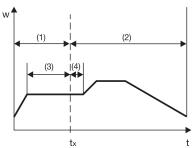
The four setpoints are displayed and edited here, and additional process variables are shown in accordance with the configuration.

Symbol	Meaning
5P 1	Setpoint 1 (editable)
5P 2	Setpoint 2 (editable)
5P 3	Setpoint 3 (editable)
5P 4	Setpoint 4 (editable)
5Pr	Ramp setpoint (only if configured)
InP 1	Measurement of analog input 1
InP2	Measurement of analog input 2 (only if available)
F 1	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)
trE5	Residual program time (only with program controller/generator)
t 1	Timer: time 1 (only if configured)
t2	Timer: time 2 (only if configured)

5 Operator level

Definition of the program times
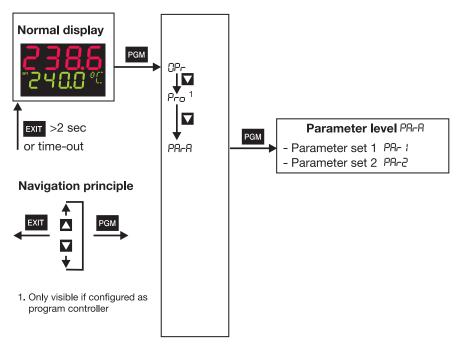
(1) Program run time	(3) Segment run time
(2) Residual program time	(4) Residual segment time

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

6 Parameter level

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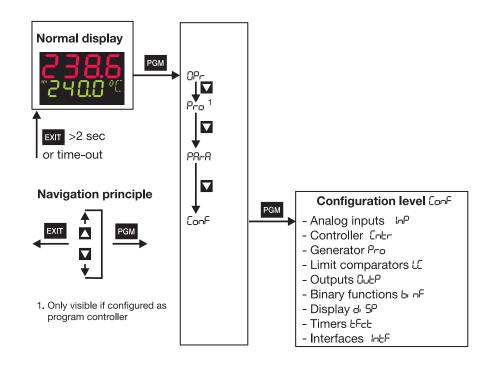
The following applies to the visualization at the configuration level of the parameters and functions listed below:

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

Normal display

EXIT >2 sec
or time-out

Navigation principle

1. Only visible if configured as program controller

OPr
Pro 1
PArA
ConF

Configuration level ConF
- Analog inputs InP
- Controller Cntr
- Generator Pro
- Limit comparators LC
- Outputs OutP
- Binary functions bInF
- Display diSP
- Timers tFct
- Interfaces IntF

☞ Levels can be inhibited.
    ⇨ Chapter 4.3 "Level inhibit"

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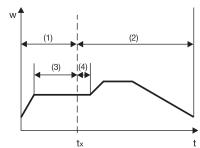
Analog selector   With some parameters, you can choose from a series of analog values. To provide you with an overview, this selection is listed below.

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

Definition of the program times

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

7 Configuration

7.1 Overview of the configuration levels

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

7 Configuration

7.2 Analog input "InP"

Analog input 1 $InP\;1$ →

	Symbol	Value/selection	Description
Sensor type	$5En5$	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.
Display end	`SCH`	-1999…**100**…+9999	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.
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.
Fine tuning end value	`FtE`	-1999…**1**…+9999	☞ 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.
Heater current monitoring (output)	`HEAt`	0	No function

Factory settings are shown **bold**.

Analog input (general) `In i2` →

	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**	50 msec 90 msec 150 msec **250 msec**

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.
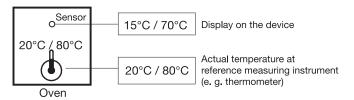
Caution:

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).
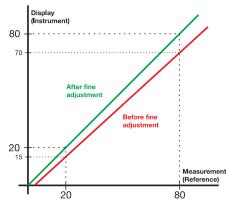
Procedure

✻ 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)

Display (Instrument)

After fine adjustment

Before fine adjustment

80
70
20
15

20   80

Measurement (Reference)

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 Configuration

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 — `[ヒ౿P`	0 **1** 2 3 4	no function **2-state controller** 3-state controller Modulating controller Continuous controller
Control action — `[Rcヒ`	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 — `InHR`	**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 — `HRnd`	-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 — `rOuヒ`	-100...**0**...101	Output on over/underrange. 101 = last output

Factory settings are shown **bold.**

32

Controller - continued

	Symbol	Value/selection	Description
Setpoint low	⤳PL	-1999…**0**…+9999	Setpoint limiting prevents the input of values outside the defined range.
Setpoint high	⤳PH	-1999…**1100**…+9999	☞ The correction value is limited for external setpoint with correction.
Inputs			
Controller process value	⌐P⌐	(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	⌐SP	(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	FEE⌐	(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	⊢YP⊢	0 1	Oscillation method Step response method ⇨ Chapter 8.1 "Autotuning (self-optimization)"
Inhibit tuning	⌐nH⊢	0 1	**enabled** inhibited The start of autotuning can be inhibited from the keys or through the binary function.
Output of tuning 1	⌐⊢⊢ ⌐	0 **1**	Relay **Solid-state + logic**
Output of tuning 2	⌐⊢⊢⌐	2	Continuous
Controller standby output	⤳⌐u⊢	-100…**0**…+100%	Initial output with step response
Step size	⤳⊢⤳ ⌐	10…**30**…100%	Step size with step response

Factory settings are shown **bold.**

7 Configuration

7.4 Generator "Pro"

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.
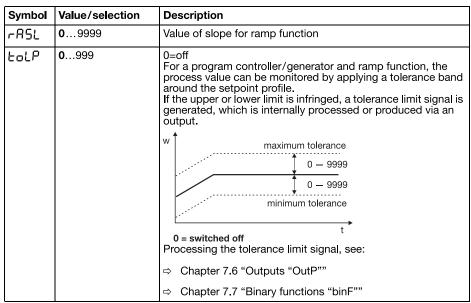
Factory settings are shown **bold.**

Generator - continued

	Symbol	Value/selection	Description
Ramp slope	⌐ᴀ5ʟ	**0**…9999	Value of slope for ramp function
Tolerance band	ʇoʟP	**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 Configuration

7.5   Limit comparators "LC"
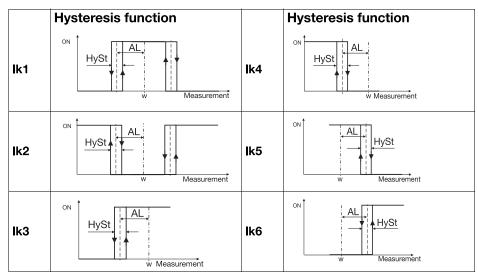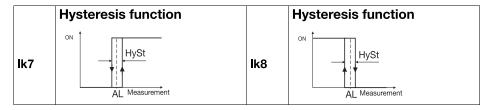
Limit comparators (threshold monitors, limit contacts) can be used to monitor an input variable (process value for the limit comparator) against a fixed limit or another variable (the setpoint for the limit comparator). When a limit is exceeded, a signal can be output or an internal controller function 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 LC1 →
Limit comparator 2 LC2 →
Limit comparator 3 LC3 →
Limit comparator 4 LC4 →
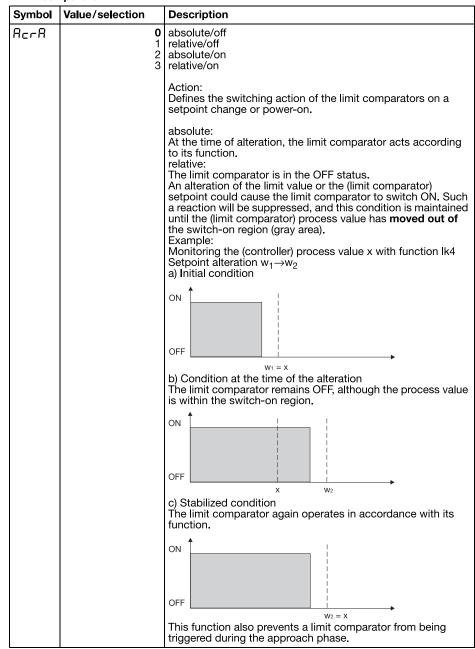
	Symbol	Value/selection	Description
Function	Fnct	**0** 1 2 3 4 5 6 7 8	no function Ik1 Ik2 Ik3 Ik4 Ik5 Ik6 Ik7 Ik8
Limit value	AL	-1999…**0**…+9999	Limit value to be monitored Limit range for Ik1 and Ik2: 0 — 9999
Switching differential	HYSt	0…**1**…9999	Switching differential

Factory settings are shown **bold.**

7 Configuration

Limit comparators - continued

Limit comparator 1 ⌊⌈⌉ →
Limit comparator 2 ⌊⌈⌸ →
Limit comparator 3 ⌊⌈⌹ →
Limit comparator 4 ⌊⌈⌺ →

	Symbol	Value/selection	Description
Action/ **range response**	⟑⌐⟑	**0** 1 2 3	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 ON OFF $w_1 = x$ b) Condition at the time of the alteration The limit comparator remains OFF, although the process value is within the switch-on region. ON OFF x w_2 c) Stabilized condition The limit comparator again operates in accordance with its function. ON OFF $w_2 = x$ This function also prevents a limit comparator from being triggered during the approach phase.

Factory settings are shown **bold.**

Limit comparators - continued

Limit comparator 1 �
Limit comparator 2 ⌂ →
Limit comparator 3 ⌂ →
Limit comparator 4 ⌂ →

	Symbol	Value/selection	Description
Switch-on delay	ⴶ⌂ⴖ	**0**…9999	Delays the switch-on edge by a definable time period
Switch-off delay	ⴶ⌂ⴲⴲ	**0**…9999 s	Delays the switch-off edge by a definable time period
Acknowledgement	ⴷⵛⴖⵘ	**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	ⴶⴎⵣⵘ	**0**…9999 s	The limit comparator is automatically reset after an adjustable time period.
Limit comparator PV	ⵘⴷⴎⵕ	(analog selector) **1 (analog input 1)**	see circuit diagrams ⇨ See "Analog selector" on Page 26.
Limit comparator SP	ⵘⴷⵛⴎ	(analog selector) **4 (present setpoint)**	see circuit diagrams (only with lk1 — lk6) ⇨ See "Analog selector" on Page 26.

Factory settings are shown **bold**.

7 Configuration

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 ⎕ᴜᵗᴸ

	Symbol	Value/selection	Description
Binary output 1	⎕ᴜᵗ¹	0	no function
		1	Controller output 1
		2	Controller output 2
...	...	5	Binary input 1
		6	Binary input 2
Binary output 4	⎕ᴜᵗᔆ	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

Symbol		Value	Description
⎕ᴜᵗ¹		13	Limit comparator 1
⎕ᴜᵗᔆ		14	Limit comparator 2
⎕ᴜᵗᔆ		1	Controller Output 1
⎕ᴜᵗᔆ		1	Controller Output 1

40

7.7 Binary functions "binF"
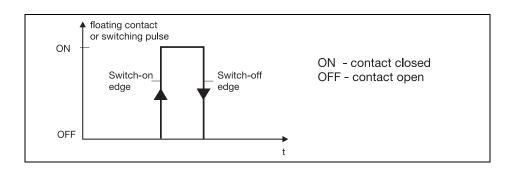
Functions are assigned here to the binary signals of the binary inputs and limit comparators.

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

7 Configuration

Binary functions - continued

	Symbol	Value/selection	Description
Binary input 1 **...** **Binary input 2** **Limit comparator 1** **...** **Limit comparator 4** **Timer 1** **Timer 2** **Logic 1** **Logic 2**	bın1 bın2 LC1 LC4 tF1 tF2 Lo1 Lo2	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	no function Start autotuning Cancel autotuning Change to manual mode Controller off (controller outputs are switched off) Inhibit manual mode Hold ramp Cancel ramp Setpoint changeover Parameter set switching Key inhibit Level inhibit Display "off" with key inhibit Acknowledge limit comparators Inhibit program start Start program Pause program Cancel program Segment change Start timer 1 Start timer 2 Cancel timer 1 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:
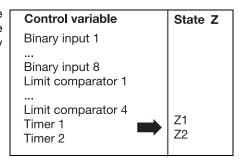
Setpoint	Z2	Z1
Setpoint 1	0	0
Setpoint 2	0	1
Setpoint 3	1	0
Setpoint 4	1	1

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.

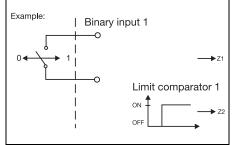| Control variable	State Z
Binary input 1	
...	
Binary input 8	
Limit comparator 1	
...	
Limit comparator 4	
Timer 1	Z1
Timer 2	Z2

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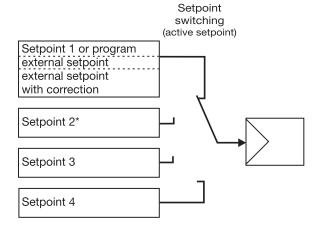
The binary function for the binary input 1 and limit comparator 1 have to be configured to "setpoint switching"

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 Configuration

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"

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 ᴷF ᴵ →
Timer 2 ᴷFᴰ →

	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.**

7 Configuration

8 Tuning (optimization)
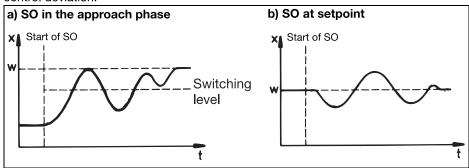
8.1 Autotuning (self-optimization)

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.
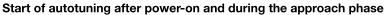
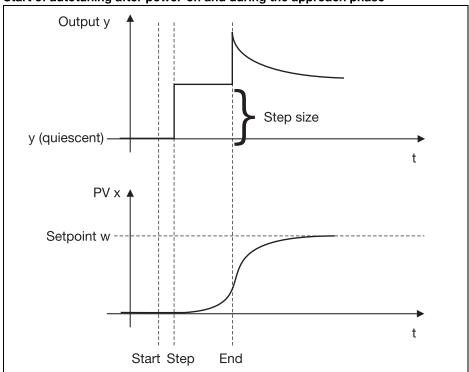**Principal applications of the step response method**

- 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
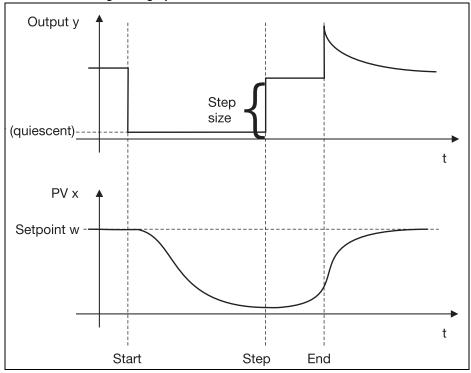
8 Tuning (optimization)

☞ 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

8 Tuning (optimization)

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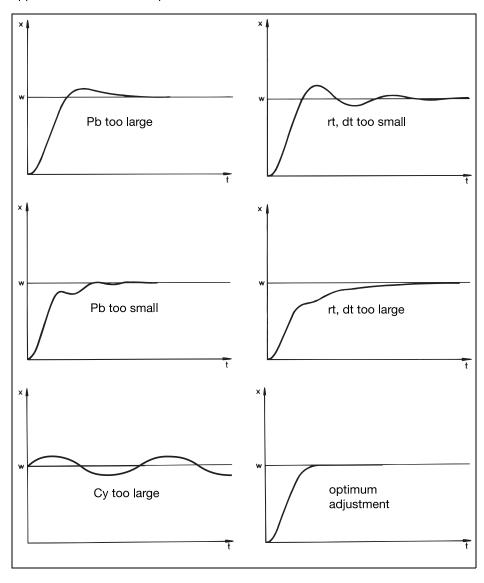
For a program controller, autotuning can only be started in the normal display.

Canceling auto-tuning

✱ Cancel with ▲ and ▼ (simultaneously)

49

8 Tuning (optimization)

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.

Pb too large

rt, dt too small

Pb too small

rt, dt too large

Cy too large

optimum adjustment

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 3-/4-wire	2-wire	Ambient temperature error
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 - 20 mA)?
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 5 sec
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

10 Index

W
Warranty *2*

Industrial Heat Sources

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