

R2900

Compact Controller, 96 x 96 mm

3-349-203-15
7/12.18



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Meanings of symbols on the instrument



Indicates EC conformity



Continuous doubled or reinforced insulation



Warning concerning a source of danger
Attention: observe documentation!



Functional earth terminal,
earthing for functional purposes only
(no safety function)



The device may not be disposed of with the trash. Further information regarding the WEEE mark can be accessed on the Internet at www.gossenmetrawatt.com under the search term WEEE

Safety Features and Precautions

The R2900 controller is manufactured and tested in accordance with safety regulations IEC 61010-1 / DIN EN 61010-1 / VDE 0411-1.

If used for its intended purpose, safety of the user and of the device is assured.

Read the operating instructions completely and carefully before using the device, and follow all instructions included therein. The operating instructions should be made available to all users.

Observe the following safety precautions:

- The device may only be connected to electrical systems which comply with the specified nominal range of use (see circuit diagram and serial plate), and which are protected with a fuse or circuit breaker with a maximum nominal current rating of 16 A.
- The installation must include a switch or a circuit breaker which serves as a disconnecting device.

The controller may not be used:

- If visible damage is apparent
- If it no longer functions flawlessly
- After lengthy periods of storage under unfavorable conditions (e.g. humidity, dust, temperature)

In such cases the device must be removed from service and secured against any possible inadvertent use.

Maintenance

Housing

No special maintenance is required for the housing. Keep outside surfaces clean. Use a slightly dampened cloth for cleaning. Avoid the use of solvents, cleansers and abrasives.

Repair and Parts Replacement

Repairs and the replacement of parts conducted at a live open instrument may only be carried out by trained personnel who are familiar with the dangers involved.

Repair and Replacement Parts Service

When you need service, please contact:

GMC-I Service GmbH
Service-Center
Beuthener Strasse 41
90471 Nürnberg • Germany
Phone +49 911 817718-0
Fax +49 911 817718-253
E-Mail service@gossenmetrawatt.com

This address is only valid in Germany.

Please contact our representatives or subsidiaries for service in other countries.

Product Support

When you need support, please contact:

GMC-I Messtechnik GmbH
Product Support Hotline
Phone +49 911 8602-500
Fax +49 911 8602-340
E-Mail support@gossenmetrawatt.com

Device Identification

Electronic controller with self-tuning and 2 nd setpoint, front panel dimensions: 96 x 96 mm		R2900
Controller Types		
2 / 3-step controller with heating current monitoring / step-action controller	2 transistor outputs	A1
2 / 3-step controller with heating current monitoring	1 st switching point: transistor output	A2
	2 nd switching point: relay output	
2 / 3-step controller with heating current monitoring	1 st switching point: relay output	A3
	2 nd switching point: transistor output	
2 / 3-step controller with heating current monitoring / step-action controller	2 relay outputs	A4
Step-action controller with repeater / 3-step controller	2 transistor outputs	A5
Step-action controller with repeater / 3-step controller	2 relay outputs	A6
Cont.-action contr. / step-action contr. / 3-step contr. w. heat current monit.	1 cont. output and 2 transistor outputs	A7
Cont.-action contr. / step-action contr. / 3-step contr. w. heat current monit.	1 continuous output and 2 relay outputs	A8
Measuring Ranges		
Input	Thermocouple, configurable	
	Type J, L -18 ... 850 °C / 0 ... 1562 °F	
	Type K -18 ... 1200 °C / 0 ... 2192 °F	
	Type S, R -18 ... 1770 °C / 0 ... 3218 °F	
	Type B 0 ... 1820 °C / 32 ... 3308 °F (especially 600 °C)	B1
	Type N -18 ... 1300 °C / 0 ... 2372 °F	
	Resistance thermometer	
	Pt 100 -100 ... 500 °C / -148 ... 932 °F	
Input	Standard signal, configurable	
	0 / 2 ... 10 V or 0 / 4 ... 20 mA	B2
Both measurement inputs can be <u>mutually</u> configured as per B1 for differential controller .		B3
1 st measurement input same as B1, 2 nd same as B2, can be configured for slave controller		B4
Auxiliary Voltage	AC 110 ... 230 V	C1
Limit Contacts	None	D0
	Two	D1
		2 relay outputs
Data Interface	None	F0
	RS 485 or RS 232 (internally selectable)	F1
Configuration	Default settings	K0
	Configure per customer requirements	K9
Operating Instructions	German / English	L0
	French / Italian	L1
	None	L2

Data Interface

Refer to operating instructions 3-349-204-15 for detailed information regarding the data interface.

Mechanical Installation / Preparation

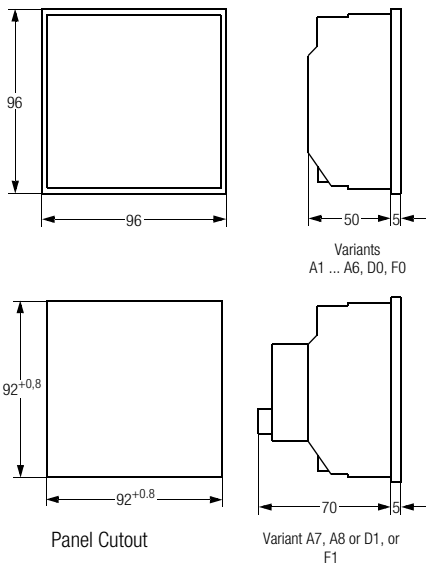
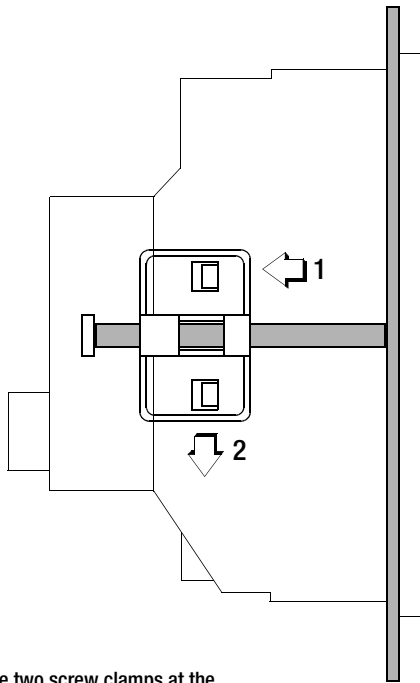


Figure 1, Housing Dimensions and Panel Cutout

The R2900 controller is intended for installation to a control panel. The installation location should be vibration-free to the greatest possible extent. Aggressive vapors shorten the service life of the controller. Requirements set forth in VDE 0100 must be observed during the performance of all work. Work on the device may only be carried out by trained personnel who are familiar with the dangers involved.

Set the housing into the panel cutout from the front, and secure it from behind at the left and right-hand sides with the two included screw clamps. Typical tightening torque amounts to 10 Ncm, and a value of 20 Ncm should not be exceeded.

In general, unobstructed air circulation must be assured when one or several devices are installed. The ambient temperature underneath the devices may not exceed 50 °C.

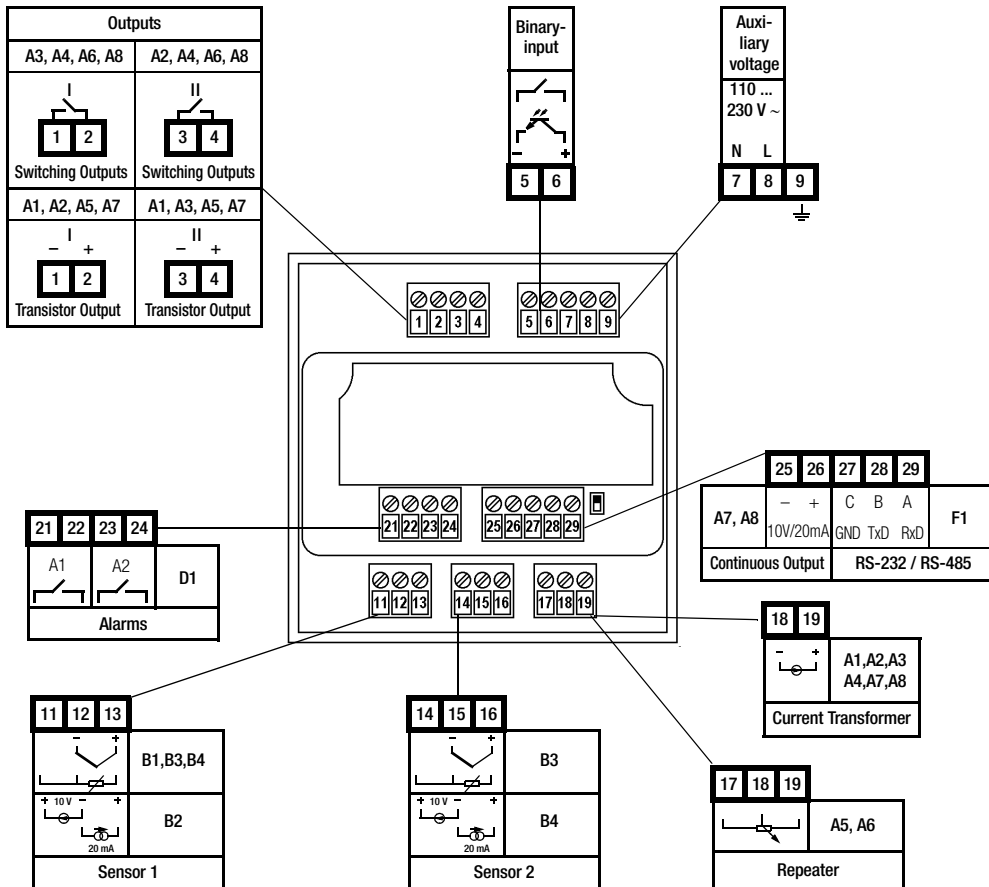


Securing the two screw clamps at the right and left-hand sides of the housing:

- Push in direction **1** all the way up to the limit stop
- Push in direction **2** all the way up to the limit stop

Figure 2, Securing the Housing

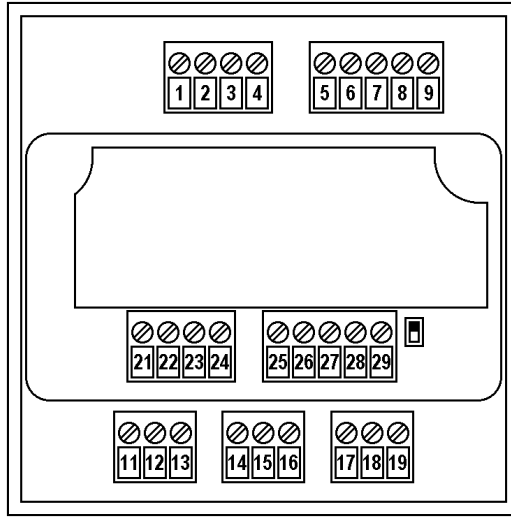
Electrical Connection



EN 55022 requires the following warning as regards electromagnetic compatibility:

Warning

This is a class A device. It may cause radio interference in residential surroundings. If this is the case, the operator may be required to implement appropriate corrective measures.

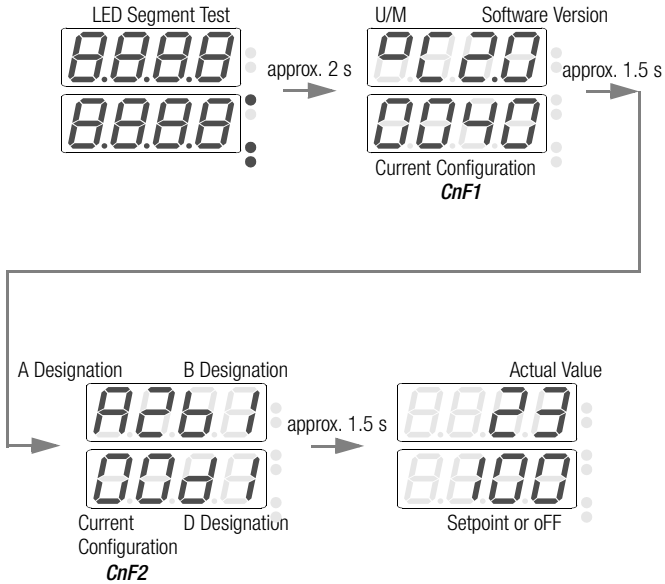


Connectors: Screw terminals for wire with a cross section of 1.5 square mm or two-core wire-end ferrules with a cross-section of 2 x 0.75 square mm

Tighten screws with a manual screwdriver only! Tightening torque for all screw terminals: max. 0.6 Nm

Figure 3. Connector Terminal Positions

Performance After Activating Auxiliary Voltage



Operation

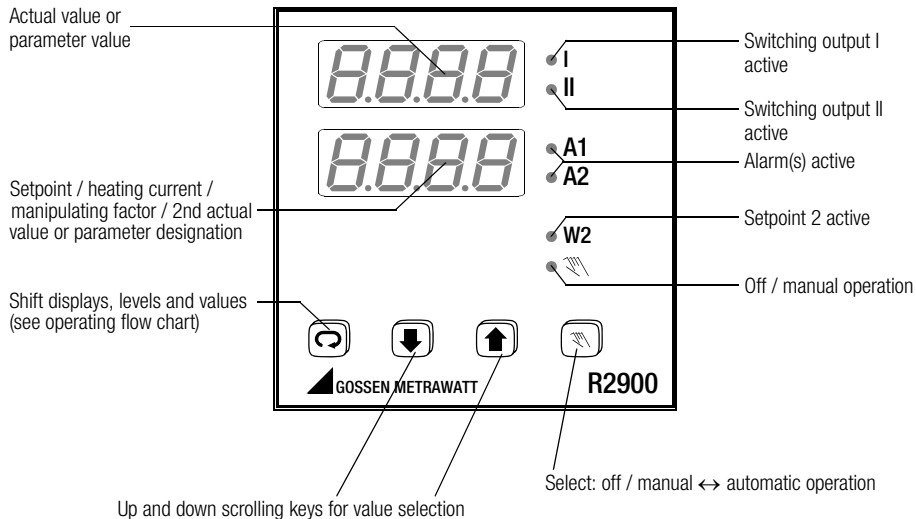



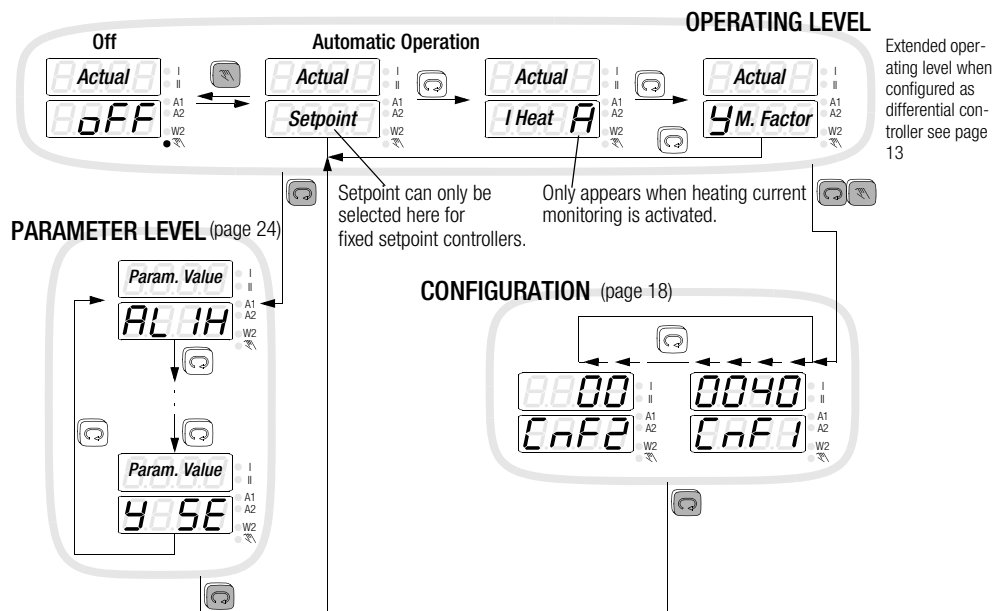
Figure 4, Controls




Value Selection

The selected value can be changed using the up and down scrolling keys.

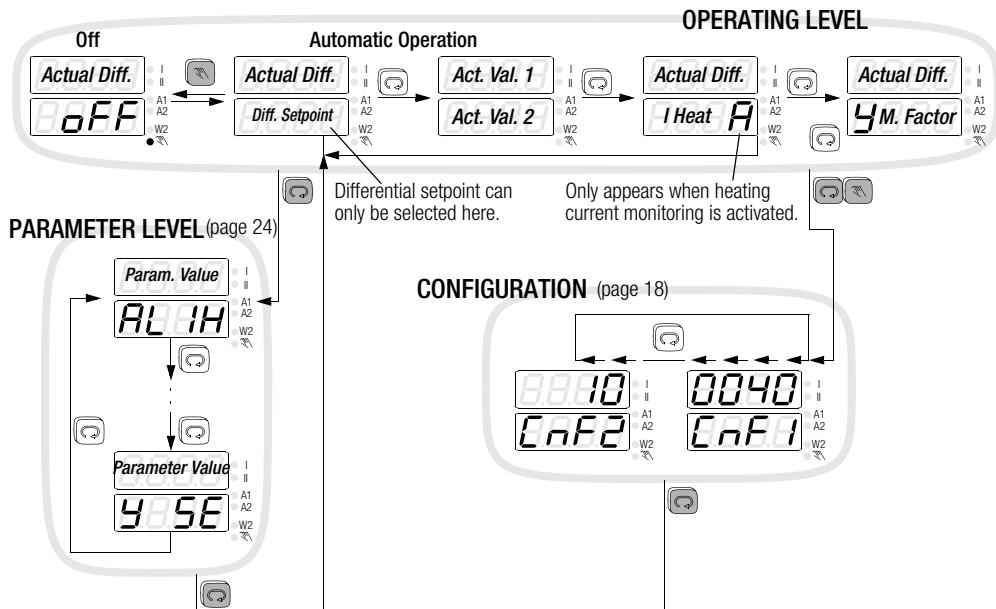
The selected value is saved to memory and becomes active after 2.5 seconds, or after pressing the  key. The display goes dark briefly to indicate activation of the selected value.




Operating Flowchart, “Discontinuous-Action Controller”



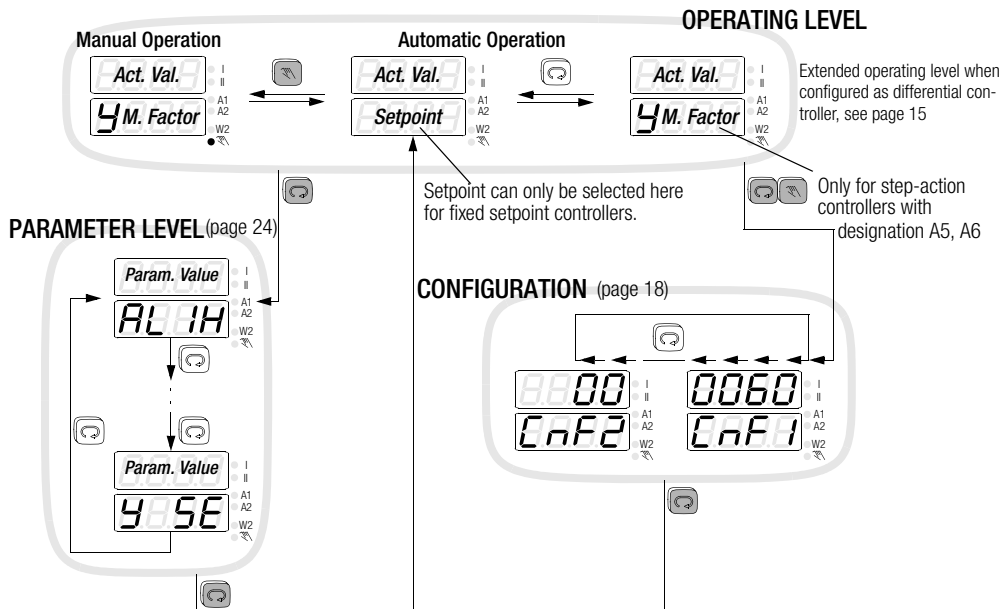
- | | |
|---|---|
|  | Press key briefly. |
|  | Press and hold key until the display is switched. |
|  | Press and hold both keys until the display is switched. |




Operating Flowchart, “Discontinuous-Action Controller” with Differential Control



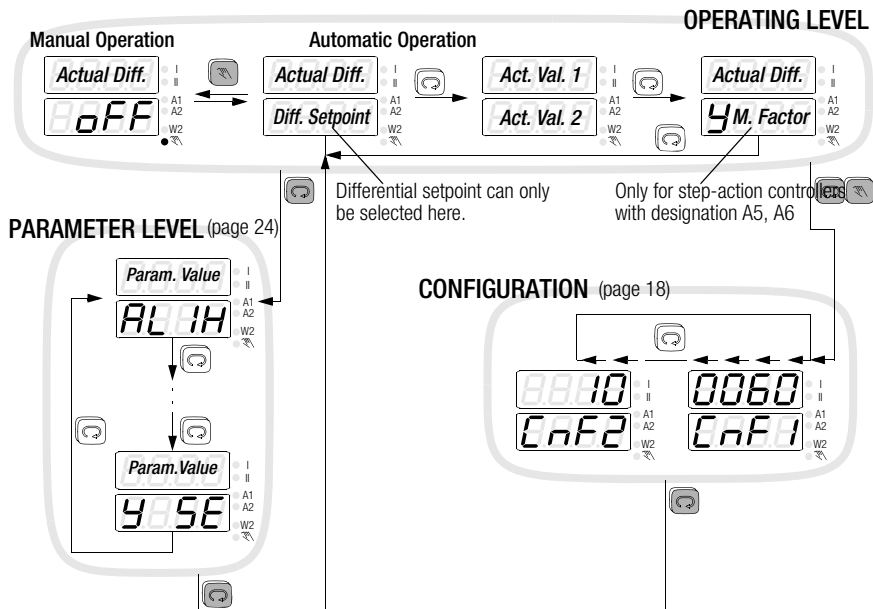
	Press key briefly.
	Press and hold key until the display is switched.
	Press and hold both keys until the display is switched.

Operating Flowchart, “Continuous-Action and Step-Action Controllers”



	Press key briefly.
	Press and hold key until the display is switched.
	Press and hold both keys until the display is switched.

Operating Flowchart, “Cont.-Action and Step-Action Controller” with Diff. Control

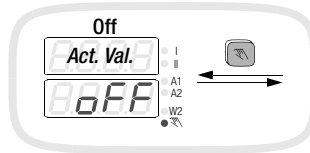




	Press key briefly.
	Press and hold key until the display is switched.
	Press and hold both keys until the display is switched.



Off / Manual Operation



- No alarm function
- No indication of errors

OPERATING LEVEL, DISCONTINUOUS-ACTION CONTROLLER





- The actuator outputs are inactive as long as the keys are not activated.
- When the  or  key is activated, switching output I ("heat") or II ("cool") is triggered directly.

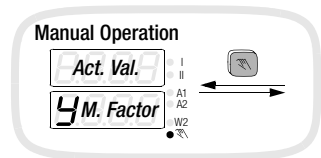
- Alarm function and error indication identical to automatic operating mode.
- The actuator outputs are controlled with the  and  keys and not by the controller function.
- Switching between manual and automatic modes is bumpless in both directions.
- Continuous-action controller:

Manipulating factor is displayed in %. Values are changed with the  and  keys, and are forwarded immediately to the control outputs.

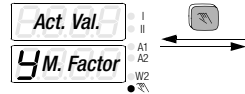
- Step-action controller:

Switching output I (more) or II (less) is triggered directly by pressing the  or  key. If position acknowledgement is utilized (designations A5 and A6), the measured position is displayed as a percentage, and bars are displayed for all other designations.


OPERATING LEVEL, CONTINUOUS-ACTION STEP-ACTION CONTROLLERS






Manual Operation



Manual Operation with Binary Input

Switching to manual operation is possible via the binary input (terminals 5 and 6). This is distinguished from off / manual operation with the  key as follows:

- Bumpless switching to manual operation with **all** controller sorts
- The last manipulating factor is “frozen” for step-action controllers as well.
- The last switching status is retained for limit transducers.
- Operation and display are identical to automatic operation, except that the  LED lights up and the manipulating factor can be changed in the manipulating factor display with the  and  keys.
- When configured as a step-action or a continuous-action controller (controller sort set to 2 through 5), the $Y5t$ parameter **must** be set to 0.
- The “alarm 2” configuration digit must be set to a value of 8 ... F to this end (see also $CnF2$ on page 20).

PWR Out Offset with Binary Input

When configured as a step-action or a continuous-action controller (controller sort set to 2 through 5), control quality can be significantly improved by means of PWR out offset where abrupt load fluctuations prevail.

- When the contact at the binary input is closed, the controller’s manipulating factor is increased by an amount equaling $Y5t$.
- It is reduced by the same value when the contact is opened.
- No function during self-tuning
- Where $Y5t = 0$, the binary input activates manual operation (see above).
- The “alarm 2” configuration digit must be set to a value of 8 ... F to this end (see also $CnF2$ on page 20).

Example:

If a machine requires an average of 70% heating power during production operation, but only 10% during idle time, the difference of $Y5t$ is set to 60%, and the binary input is only activated during production.

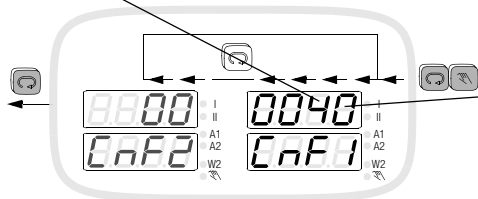
Configuration

(continued on page 20)

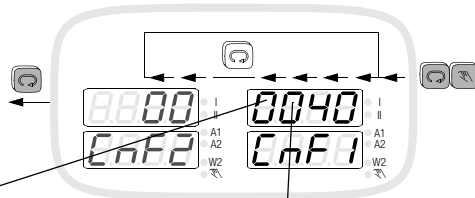
Controller Sort	
Code	
0	Limit transducer
1	Actuator
2	2-step controller, heat *)
3	2-step controller, cooling *)
4	3-step controller *)
5	3-step controller, water cooling
6	Step-action controller

*) Settings for continuous-action controller: see page 23


Alarm 1				
Code		Actuation Suppression	Contact	Heating Circuit Monitoring
0	Relative	Inactive	NO contact	Inactive
1	Absolute			
2	Relative	Active	NC contact	
3	Absolute			
4	Relative	Inactive	NC contact	
5	Absolute			
6	Relative	Active	NC contact	
7	Absolute			
8	Relative	Inactive	NO contact	Active
9	Absolute			
A	Relative	Active	NO contact	
b	Absolute			
C	Relative	Inactive	NC contact	
d	Absolute			
E	Relative	Active	NC contact	
F	Absolute			



Gray highlighting: default setting K0



1) Sensor / Continuous Output ²⁾		Unit of Measure	
Code	U/M ¹⁾	Output Range ²⁾	Output Quantity ²⁾
0	°C	0 ... 20 mA	
1	°F	0 ... 10 V	Actual value
2	°C	4 ... 20 mA	(step-action controller)
3	°F	2 ... 10 V	
4	°C	0 ... 20 mA	Manipulating factor
5	°F	0 ... 10 V	(cont.-action controller)
6	°C	4 ... 20 mA	Select output quantity
7	°F	2 ... 10 V	with <i>Cont</i>
8	°C	0 ... 20 mA	(see also page 23)
9	°F	0 ... 10 V	
A	°C	4 ... 20 mA	
b	°F	2 ... 10 V	
c		(no function)	
d			
e			
f			

 Saving and loading device settings: see page 21

Sensor type			
Code	Type	Design	Condition
0	J		
1	L		
2	K	Thermo-couple	For measurement input 1 with designation B1, B4
3	B		
4	S		
5	R	Pt 100	For both measurement inputs with designation B3
6	N		
7	1 ° Display		
8	0,1 ° Display		
0	0 ... 20 mA / 0 ... 10 V	Std. signal	For measurement input 1 with designation B2
1	4 ... 20 mA / 2 ... 10 V		

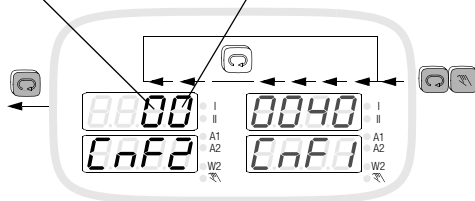
1) Switching to and from °C and °F is only effective for designations B1, B3 and B4.

2) Only effective for designations A7 and A8

Configuration (continued)


Code	Function, Measurement Input 2		Standard Signal 2
	B3	B4	B4
0	Fixed setpoint contr. (int. setpoint)		0 ... 20 mA 0 ... 10 V
1	Differential	Fixed setpoint	
2	–	Slave controller	
3	–		
4	–	Fixed setpoint controller	4 ... 20 mA 2 ... 10 V
5	–	Slave controller	
6	–		
7	–		

Alarm 2				
Code		Actuation suppression	Contact	Binary input
0	Relative	Inactive	NO contact	Setpoint 2 delete!!!
1	Absolute			
2	Relative	Active		
3	Absolute			
4	Relative	Inactive	NC contact	
5	Absolute			
6	Relative	Active		
7	Absolute			
8	Relative	Inactive	NO contact	Manual / automatic or PWR out off-set
9	Absolute			
A	Relative	Active		
b	Absolute			
C	Relative	Inactive	NC contact	
d	Absolute			
E	Relative	Active		
F	Absolute			



Gray highlighting: default setting K0

Saving and Loading Device Settings:

Code	Function	 Comment
<i>d</i>	Current settings ¹⁾ are saved as user-defined default settings.	A configuration per customer specifications (K9) is stored here, and is overwritten in the process.
<i>E</i>	User-defined default settings ¹⁾ are loaded. If settings have not already been saved with <i>d</i> in the past, the factory default settings or a configuration per customer specifications (K9) is loaded.	All entries, including self-tuning and calibration results, are overwritten in the process.
<i>F</i>	Factory default settings ¹⁾ are loaded.	

¹⁾ The configuration digits and all parameters except for the interface address **Addr**

Differential Controller *Parameters: see page 24*

- Actual value difference, i.e. 1st actual value – 2nd actual value, is regulated to the selected differential setpoint.
- The differential setpoint can be set within a range of \pm one half of the measuring range.
- Limit value monitoring is relative to actual value difference, and not the two actual values.
- If an attempt is made at the operating level to change the differential setpoint (display mode: 1st actual value / 2nd actual value), *no* appears briefly at the bottom display.

Slave Controller *Parameters: see page 24*

- The external setpoint which is applied to the 2nd measurement input replaces the internal setpoint.
- The setpoint ramp function (see page 31) is retained.
- After switching to setpoint 2 via the binary input, the controller becomes a **fixed setpoint controller using setpoint 2 (5P2)**.
- Upper and lower limits for the external setpoint are scaled with the *rnL* and *rnH* parameters (2nd measurement input, standard signal for designation B4).
- The *5PL* and *5PH* parameters limit the external setpoint for control and display purposes.
- If an attempt is made at the operating level to change the setpoint (display mode: actual value / setpoint), *no* appears briefly at the bottom display.

Controller Sorts

Parameters: see page 24

Code	Controller Sort	Comment
0	Limit transducer	Switching output I is active where actual value < current setpoint, and switching output II is active where actual value > current setpoint + $dbnd$. Switching hysteresis is equal to $HYSL$. Switching status changes are possible once per t_c .
1	Actuator	Read-out of a constant actuating signal to switching output I where $YSL > 0$, or switching output II where $YSL < 0$. The actuating cycle is equal to at least t_c . No alarm functions.
2	2-step controller, "heat"	A harmonic-free PDPI control algorithm regulates switching output I in order to increase / decrease the actual value. The actuating cycle is equal to at least t_c .
3	2-step controller, "cooling"	
4	3-step controller	A harmonic-free PDPI control algorithm regulates switching output I in order to increase the actual value, or switching output II in order to decrease the actual value. The actuating cycle is equal to at least t_c . The dead band $dbnd$ suppresses switching back and forth between "heating" and "cooling" if no lasting deviation occurs.
5	3-step controller, water cooling	The manipulating factor at switching output II is adapted to the non-linear performance characteristics of a water cooler. The actuating cycle is equal to t_c .
6	Step-action controller	A harmonic-free PDPI control algorithm regulates switching output I or II in order to increase or decrease the actual value. The duration of the actuating impulse is equal to t_c . The dead band $dbnd$ is symmetric to the setpoint.

Configuration of the Controller with Continuous Output (desig. A7 and A8)

- **Continuous output = actual value** (“sensor U/M / continuous output” configuration digit = 0, 1, 2, 3)
 - The controller sorts demonstrate the same performance characteristics as with designations A1 to A4.
 - Read-out of the actual value (actual value difference for differential controllers) is scaled with the rnL and rnH parameters.
- **Continuous output = manipulating factor** (“sensor U/M / continuous output” configuration digit = 4, 5, 6, 7)
 - Switching output I is inactive.
 - The various continuous controller sorts result from the “controller sort” configuration digit:

Code	Controller Sort	Comment
0	Limit transducer	Read-out of a manipulating factor which can be adjusted with the YH parameter where actual value < setpoint
1	Actuator	Read-out of a manipulating factor which can be adjusted with parameter $Y5L$.
2	Continuous controller with falling characteristic curve	A harmonic-free PDPI control algorithm regulates the continuous output every 0.5 seconds. An output filter assures smoothest possible actuating signal characteristics. τ_c is used to set the time constant for an additional actual value filter.
3	Continuous controller with rising characteristic curve	
4	Split range controller	Continuous controller with falling characteristic curve for positive manipulating factors (increase actual value). Negative manipulating factors are read out via switching output II (decrease actual value). The actuating cycle for switching output II has a duration of at least τ_c . The dead band $dbnd$ suppresses rapid switching back and forth between the continuous output and switching output II if no lasting deviation occurs.
5, 6		No practically relevant function

- **Continuous output = “select with \mathcal{L}_{ont} ”** (“sensor U/M / continuous output” configuration digit = 8, 9, A, b)

\mathcal{L}_{ont}	Cont. Output	Comment
0	Current setpoint	The read-out is scaled with the rnL and rnH parameters (the current differential setpoint for differential controllers). The controller sorts demonstrate the same performance characteristics as with designations A1 to A4.
1	“Cooling” manip. factor	Negative manipulating factors are read out continuously, and switching output II remains inactive. Controller sort = 4: split range controller with inverted output performance

Parameters Configuration

X1 = lower range limit, X2 = upper range limit, MR = X2 - X1

Parameter	Display	Range	Default	Comment
Upper limit value for relay A1	<i>AL 1H</i>			
Lower limit value for relay A1	<i>AL 1L</i>	oFF, 1 ... MR	oFF	Relative (= default config.) Absolute
Upper limit value for relay A2	<i>AL 2H</i>	oFF, X1 ... X2	oFF	
Lower limit value for relay A2	<i>AL 2L</i>			
Setpoint 2	<i>SP 2</i>	<i>SP L ... SP H</i>	X1	
Ramp for rising setpoints	<i>SP uP</i>	oFF, 1 ... MR per min.	oFF	
Ramp for falling setpoints	<i>SP d n</i>	oFF, 1 ... MR per min.	oFF	
Heating current setpoint (see Balancing)	<i>ANPS</i>	Auto, oFF, 0.1 ... <i>AH</i>	oFF	Not with step-action controllers ¹⁾
Proportional band heating	<i>Pb 1</i>	0.1 ... 999.9%	10.0	
Proportional band cooling	<i>Pb 11</i>	0.1 ... 999.9%	10.0	Only with 3-step controllers ²⁾
Dead band	<i>dbnd</i>	0 ... MR	0	Not with 2-step controllers ³⁾
Path delay time	<i>t u</i>	0 ... 9999 s	100	
Read-out cycle time	<i>t c</i>	0.5 ... 600.0 s	10.0	⁴⁾
Motor run-time	<i>t y</i>	5 ... 5000 s	60	Only with step-action controllers ⁵⁾
Switching hysteresis	<i>HYS t</i>	0 ... 1.5%MR	0.5%MR	For limit value monitoring and limit transducers
Maximum setpoint	<i>SP H</i>	<i>SP L ... X2</i>	X2	
Minimum setpoint	<i>SP L</i>	X1 ... <i>SP H</i>	X1	
Maximum manipulating factor	<i>y H</i>	-100 ... 100 %	100	
Actual value correction (see Balancing)	<i>CAL</i>	(Auto), -MR/4 ... +MR / 4	0	Only with designations B1, B3 and B4
Decimal point position	<i>dP n t</i>	9999, 999.9, 99.99, 9.999	9999	Only with designation B2
Upper range limit, standard signal	<i>r n H</i>	<i>r n L ... 9999</i>	100	Only with designations
Lower range limit, standard signal	<i>r n L</i>	-1500 ... <i>r n H</i>	0	B2, B4, A7 and A8

Parameter	Display	Range	Default	Comment
Upper range limit, heating current (see Balancing)	<i>A H</i>	1.0 ... 99.9 A	42.7	Not with step-action controllers ¹⁾
Calibration, position acknowledgement	<i>Y 100</i>	See Balancing		Only with step-action controllers with position acknowledgement ⁶⁾
	<i>Y0</i>			
Manipulating factor for actuator mode, or for PWR out offset	<i>Y St</i>	-100 ... 100%	0	
Sensor error manipulating factor	<i>Y SE</i>	-100 ... 100%	0	
Continuous signal	<i>Cont</i>	See page 23	0	Only for designations A7 and A8
Interface address	<i>Addr</i>	0 ... 250	250	Only with designation F1

¹⁾ Only where: "controller sort" configuration digit ≠ 6 and designation ≠ A5, A6

²⁾ Only where: "controller sort" configuration digit = 4 or 5

³⁾ Only where: "controller sort" configuration digit = 0, 4, 5 or 6

⁴⁾ Additional actual value filter for continuous-action controllers (controller sort = 2 or 3), **tc** = time constant

⁵⁾ Only where: "controller sort" configuration digit = 6

⁶⁾ Only where: "controller sort" configuration digit = 6 and designation = A5, A6

Parameters *Pb 1* through *Addr* are disabled for the operator during self-tuning.

Balancing

Thermocouple Correction (parameter: LR_L)

The correction value is selected in °C or °F. The displayed correction value is added to the measured temperature.

Cable Compensation for Pt 100 with 2-Wire Connection (parameter: LR_L)

The correction value can be determined automatically in the “Off / manual operation” mode:

- Short circuit the sensor **at the measuring point**.
- Set the LR_L value to R_{ut0} .

Measured cable resistance is converted to temperature change and is entered as the LR_L value.

Balancing can also be performed manually if the sensor temperature is known:




$LR_L = \text{known sensor temperature} - \text{displayed temperature value}$

Scaling for Heating Current Monitoring (parameter: R_H)

The default setting for the GTZ 4121 is 42.7 A. If the GTZ 4121 current transformer is not used for acquiring heating current, the current value must be selected at which the utilized transformer generates an output voltage of 10 V DC.

Calibrating the Position Acknowledgement Display (parameter: Y_{100} , Y_0)

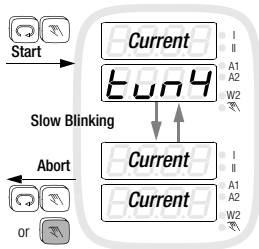
Calibration is performed in the manual operating mode at the parameter level with the device configured as a step-action controller (“controller sort” configuration digit = 6):

1. Select parameter Y_{100} . The stored value appears at first: a standardized value between 0 and 255. The scroll up key  controls switching output I directly (more), and the currently measured actuator position appears at the display. The scroll up key  must be pressed and held until the displayed value no longer fluctuates. The displayed value is saved to memory.
2. Select parameter Y_0 . Same procedure as for parameter Y_{100} . In this case, the scroll down key  must be pressed and held. It controls switching output II directly (less).

Y_{100} must be greater than Y_0 !

The Y_{100} and Y_0 parameters are displayed only in the automatic operating mode.

Self-Tuning






- $t_{un1} \dots t_{unB}$ blinks at the display at all operating levels during self-tuning.
- The controller is switched to the automatic operating mode after self-tuning has been successfully completed.
- In the case of 3-step controllers (controller sorts 4 and 5), cooling is activated if the upper limit value is exceeded in order to prevent overheating. Self-tuning then performs an oscillation test around the setpoint.

Sequence

- The setpoint which is active when tuning is started remains valid and can no longer be changed (slave controllers: changing external setpoints are only displayed).
- Activation or deactivation of setpoint 2 does **not** become effective.
- Selected setpoint ramps are not taken into consideration.
- If started at the operating point (actual value approximates the setpoint value), overshooting cannot be avoided.

Abort

- Self-tuning can be aborted at any time with the   keys (→ automatic operating mode), or by switching to manual / off with the  key.
- If an error occurs during self-tuning, the controller no longer reads out an actuating signal. Self-tuning must be aborted in this case.

Additional information regarding error messages upon request.

Self-tuning is used to achieve optimized controller dynamics, i.e. parameters $P_b I$, $P_b II$, t_U and t_C are determined.



Read-out cycle time t_C is not changed during self-tuning.

We recommend for t_C a value of $t_U/12$ to guarantee satisfactory controller dynamics. When controlling contactors, t_C should be adequately increased.

Preparation

- Complete configuration must be performed before self-tuning is started.
- The setpoint value is adjusted to the value which is required after self-tuning.

Start

- Briefly press the   keys simultaneously at the operating level (automatic or manual / off operating mode) in order to trigger self-tuning. Self-tuning cannot be started in the “actuator” or “limit transducer” mode.

Manual Self-Tuning

Parameters $Pb\ I$, $Pb\ II$, t_U and t_C are determined by means of manual self-tuning in order to maintain optimized controller dynamics. An actuation test or an oscillation test is performed to this end.

Preparation

- **Complete configuration** (page 18) and **parameter settings** (page 24) must first be entered for use of the controller.
- The actuators should be deactivated with the **off / manual operation** function (page 16).
- A **recorder** must be connected to the sensor and adjusted appropriately to prevailing circuit dynamics and the setpoint.
In the case of differential controllers, the actual value difference must be recorded.
- For 3-step or split range controllers, on and off-time must be recorded for switching output I or the continuous output (e.g. with an additional recorder channel or a stopwatch).
- Configure as **limit transducer** (controller sort = 0).
- Set read-out cycle time to the minimum value: $t_C = 0.5$.
- If possible, deactivate manipulating factor limiting. $UH = 100$.
- Reduce (or increase) the **setpoint** so that overshooting and undershooting do not cause any impermissible values.

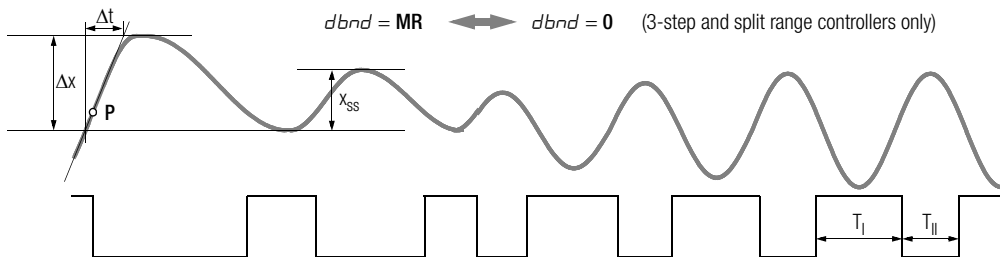
Performing the Actuation Test

- $dbnd = MR$ Setting for 3-step and split range controllers (switching output II may not be triggered)
- $dbnd = 0$ Setting for step-action controllers (switching output II must be triggered)
- Start the recorder.
- Activate the actuators with **automatic operation**.
- Record two overshoots and two undershoots.

The actuation test is now complete for 2-step, continuous-action and step-action controllers.

Continue as follows for 3-step and split range controllers:

- Set $dbnd$ to **0** in order to cause further overshooting with active switching output II. Record two overshoots and two undershoots.
- Record **on-time** T_I and **off-time** T_{II} at switching output I or the continuous output for the last oscillation.



Evaluating the Actuation Test

- Apply a tangent to the curve at the intersection of the actual value and the setpoint, or at the cut-off point of the output.
- Measure time Δt .
- Measure oscillation amplitude x_{ss} , or overshooting for step-action controllers Δx .

Parameter	Parameter Values				
	2-step controller	3-step controller	Continuous-action controller	Split range controller	Step-action controller
t_U	$1.5 \cdot \Delta t$				$\Delta t - (t_Y / 4)$
t_C	$t_U / 12^{1)}$				$t_Y / 100$
$Pb \ I$	$(x_{ss} / MR) \cdot 100 \%$		$(x_{ss} / MR) \cdot 200 \%$		$(\Delta x / MR) \cdot 50 \%$
$Pb \ II$	–	$Pb \ I \cdot (T_I / T_{II})$	–	$Pb \ I \cdot (T_I / T_{II})$	–

1) When controlling contactors, t_C should be adequately increased.

If manipulating factor limiting was active, the proportional band must be corrected:

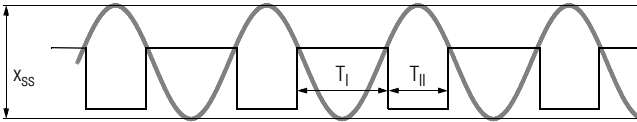
YH positive: $Pb \ I$ multiply by $100\% / YH$

YH negative: $Pb \ II$ multiply by $-100\% / YH$

Performing the Oscillation Test

If an actuation test is not possible, for example if neighboring control loops influence the actual value too greatly, if switching output II must be active in order to maintain the actual value (cooling operating point), or if optimization is required directly to the setpoint for any given reason, control parameters can be determined by means of sustained oscillation. However, calculated values for ϵ_U may be very inaccurate in this case under certain circumstances.

- Preparation as described above. The test can be performed without a recorder if the actual value is observed at the display, and if times are measured with a stopwatch.
- $dbnd = 0$ Setting for 3-step, split range and step-action controllers
- Activate the actuators with **automatic operation**, and start the recorder if applicable. Record several oscillations until they become uniform in size.
- Measure **oscillation amplitude** x_{SS} .
- Record **on-time** T_I and **off-time** T_{II} at switching output I or the continuous output for the oscillations.



Evaluating the Oscillation Test

Parameter	Parameter Values				
	2-step controller	3-step controller	Continuous-action controller	Split range controller	Step-action controller
ϵ_U ¹⁾	$0.3 \cdot (T_I + T_{II})$				$0.2 \cdot (T_I + T_{II} - 2\epsilon_U)$
ϵ_C	$\epsilon_U / 12$ ²⁾				$\epsilon_U / 100$
$Pb \ I$	$\frac{x_{SS} \cdot 100 \%}{MR}$	$\frac{x_{SS} \cdot T_{II} \cdot 100 \%}{MR (T_I + T_{II})}$	$\frac{x_{SS} \cdot 200 \%}{MR}$	$\frac{x_{SS} \cdot T_{II} \cdot 200 \%}{MR (T_I + T_{II})}$	$\frac{x_{SS} \cdot 50 \%}{MR}$
$Pb \ II$	–	$Pb \ I \cdot (T_I / T_{II})$	–	$Pb \ I \cdot (T_I / T_{II})$	–

1) If either T_I or T_{II} is significantly greater than the other, value ϵ_U is too large.

2) When controlling contactors, ϵ_C should be adequately increased.

Correction with manipulating factor limiting

$\mathcal{Y}H$ positive:

$Pb \ I$ multiply by $100\% / \mathcal{Y}H$

$\mathcal{Y}H$ negative:

$Pb \ II$ multiply by $-100\% / \mathcal{Y}H$

Correction for step-action controllers in the event that T_I or T_{II} is smaller than εY :

Multiply Pb / by $\frac{\varepsilon Y \cdot \varepsilon Y}{T_I \cdot T_I}$, if T_I is smaller, or by $\frac{\varepsilon Y \cdot \varepsilon Y}{T_{II} \cdot T_{II}}$, if T_{II} is smaller.

The value for εY is very inaccurate in this case. It should be optimized in the closed loop control mode.

Closed Loop Control Mode

The closed loop control mode is started after self-tuning has been completed:

- Configure the desired control algorithm with **controller sort**.
- Adjust the **setpoint** to the required value.
- The dead band can be increased from $dbnd = 0$ for 3-step, split range and step-action controllers if control of switching output I (or the continuous output) and II changes too rapidly, for example due to an unsteady actual value.

Setpoint Ramps

Function	Parameters SP_{UP} and SP_{DN} cause a gradual temperature change (rising / falling) in degrees per minute.
Activation	<ul style="list-style-type: none">– When auxiliary power is switched on– When the current setpoint is changed– When setpoint 2 is activated– After switching from manual to automatic operation
Setpoint display	The targeted setpoint is displayed (not the currently valid setpoint) with a blinking r at the left-hand digit.
Limit values	Relative limit values make reference to the ramp, not the targeted setpoint. As a rule, no alarm is triggered for this reason.

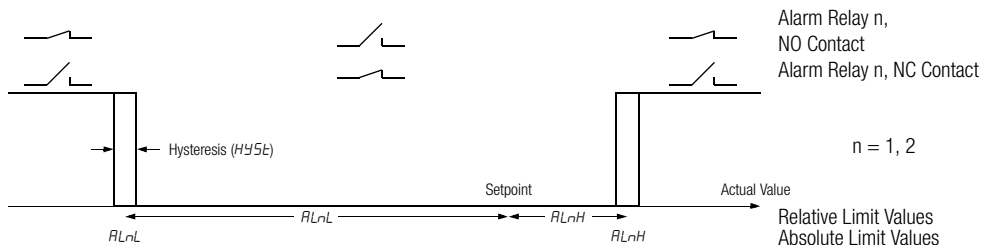
Heating Current Monitoring

Function	Heating current is acquired with an external transformer (e.g. GTZ 4121). An alarm is triggered if the current setpoint is fallen short of by more than 20% with activated heat (control output I active), or if current is not “off” when the heat is switched off. The alarm is not triggered until heating current is high enough when output I is active, or when current drops to zero when output I is inactive. Monitoring is inactive if the controller is switched to <i>σFF</i> , as well as in the case of continuous and step-action controllers.
<i>RNP5</i> current setpoint	Heater phase current is entered for this parameter. <i>RNP5</i> can be set to <i>RuEd</i> for automatic adjustment with the heater switched on. The measured current value is saved to memory.

Heating Circuit Monitoring

Function	<ul style="list-style-type: none">– Can be set to active or inactive with the “alarm” configuration digit (see Configuration).– Without external transformer, without additional parameters– Assumes correct optimization of t_U and P_b / control parameters, i.e. heating circuit monitoring must be activated before self-tuning is started. In the event of manual optimization or subsequent adaptation of control parameters, the lower limit value for the t_U parameter must be observed: $\text{minimum } t_U = \frac{P_b}{50\%} \cdot \frac{MR}{\Delta\theta / Dt}$$\Delta\theta / Dt = \text{maximum temperature rise during actuation}$– Error message <i>LE</i> appears after approximately 2 times t_U, if heat remains on at 100% and measured temperature rise is too small.– Monitoring is not active:<ul style="list-style-type: none">where controller sort = limit transducer, actuator or step-action controller during self-tuningwith standard signal input (designation B2)where manipulating factor limiting $y_H < 20\%$
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Limit Value Monitoring



Actuation suppression: Alarm suppression remains inactive during actuation (configuration digit “alarms 1 and 2”) until temperature has exceeded the lower limit value for the first time. During cooling, suppression is active until temperature has fallen below the upper limit value for the first time. Suppression is active when auxiliary power is activated, if the current setpoint is changed or setpoint 2 is activated, or if switching takes place from off to automatic operation.

Alarms

Blinking Display (at operating level only)	Error Message Source	Display	Response	Comment
Heating current	Heating current monitoring	LED A1 blinks	Alarm output A1 and LED A1 are activated ¹⁾	NO / NC contact selected in configuration digits “alarms 1 and 2” LED blinks at all levels
Actual value	Limit value monitoring 1	LED A1 blinks	Alarm output A1 and LED A1 are activated ¹⁾	
Actual value	Limit value monitoring 2	LED A2 blinks	Alarm output A2 and LED A2 are activated ²⁾	

¹⁾ Only for designation D1

²⁾ In the case of designation D0 and configuration as a 2-step controller


The display is switched to the operating level 30 seconds after value selection has been completed during configuration or parameter setting.

Error Messages

Responses in the event of an error:

- Alarm output A1 is activated, output performance is determined by the "alarm 1" configuration digit (see Configuration on page 18).
In the case of designation D0 and configuration as a 2-step controller, read-out takes place at switching output II. The LED lights up when relay contact II is closed and/or transistor output II is active.
- LED A1 blinks at all levels. The (blinking) error message only appears at the operating level: in the event of faulty measured values at the display, at which the error-free measured value is otherwise displayed (*SEH*, *SEL*, *CE* and *YE*) when other error messages appear in the upper display.
- The display is switched to the operating level 30 seconds after value selection has been completed during configuration or parameter setting.
- Exceptions and additional information are included in the following table:

Display		Error Message Source	Response	Remedy																	
<i>SE H</i>	sensor error high	Broken sensor or actual value greater than upper range limit	<table border="1"> <tr> <td rowspan="2">Ctr. Sort</td> <td colspan="2">Manipulating Factor Read-Out</td> </tr> <tr> <td><i>YSE</i> = -100/0/100%</td> <td><i>YSE</i> ≠ -100/0/100%</td> </tr> <tr> <td>2 or 3-step</td> <td>-100/0/100%</td> <td>If the controller has settled in: last "plausible" manipulating factor, if not: <i>YSE</i></td> </tr> <tr> <td>Step</td> <td colspan="2"><i>YSE</i></td> </tr> <tr> <td>On/off ctr.</td> <td colspan="2"></td> </tr> <tr> <td>Actuator</td> <td colspan="2">No response to error</td> </tr> </table>	Ctr. Sort	Manipulating Factor Read-Out		<i>YSE</i> = -100/0/100%	<i>YSE</i> ≠ -100/0/100%	2 or 3-step	-100/0/100%	If the controller has settled in: last "plausible" manipulating factor, if not: <i>YSE</i>	Step	<i>YSE</i>		On/off ctr.			Actuator	No response to error		1
Ctr. Sort	Manipulating Factor Read-Out																				
	<i>YSE</i> = -100/0/100%	<i>YSE</i> ≠ -100/0/100%																			
2 or 3-step	-100/0/100%	If the controller has settled in: last "plausible" manipulating factor, if not: <i>YSE</i>																			
Step	<i>YSE</i>																				
On/off ctr.																					
Actuator	No response to error																				
<i>SEL</i>	sensor error low	Sensor polarity reversed or actual value less than lower range limit	Same as heating current monitoring alarm Continues to control temperature	2																	
<i>CE</i>	current error	Current transformer has reversed polarity, is unsuitable or defective	<u>No</u> response to error	3																	
<i>YE</i>	y error	Position ackn. incorrectly calibrated, $Y_{100} \leq Y_0$	No response to error Error message is not cleared until key is pressed	-																	
<i>no t</i>	no tune	Self-tuning cannot be started (controller sort: "actuator" or "limit transducer")	No response to error Error message is not cleared until key is pressed	-																	

Display		Error Message Source	Response	Remedy
<i>EE 2</i>	tune error 2	Disturbance in self-tuning sequence in steps 1 through 13 (step 2 in this case)	Control outputs I and II inactive Self-tuning must be aborted.	4
<i>LE</i>	loop error	Measured temperature rise is too small with heat on at 100%	Control outputs I and II inactive. Error message is not cleared until  key is pressed and held.	5
<i>PE</i>	parameter error	Parameter not within permissible limits	Control outputs I and II inactive. The parameter level is disabled.	6
<i>dE</i>	digital error	Error detected by digital component monitoring	Control outputs I and II inactive	7
<i>AE</i>	analog error	Hardware error detected by analog component monitoring	Control outputs I and II inactive	7

Remedies

1. Eliminate sensor error.
2. Inspect current transformer.
3. Check for correct connection of the position acknowledgement potentiometer and re-calibrate.
4. Avoid disturbances which impair the self-tuning sequence, e.g. sensor errors.
5. Close the control loop: Check the sensor, the actuators and the heater for correct functioning. Check sensor-heater assignments (wiring).
Correctly optimize control parameters E_U and P_b I.
6. Restore default configuration and default parameters, and then reconfigure, or load user-defined default settings.
7. Arrange for repair at authorized service center.

Technical Data

For complete technical data refer to the following data sheet:
order no. 3-349-202-03

Annual mean relative humidity, no condensation	75%
Ambient temperature	
Nominal range of use	0 °C ... + 50 °C
Operating range	0 °C ... + 50 °C
Storage range	-25 °C ... + 70 °C

Aux. Voltage Nominal Value	Nominal Ranges of Use		Power Consumption
	Voltage	Frequency	
AC 110 V / AC 230 V	AC 95 V ... 253 V	48 Hz ... 62 Hz	Max. 10 VA typically 6 W

Relay Output	Floating, normally open contact
Switching capacity	AC/DC 250 V, 2 A, 500 VA / 50 W
Service life	> 2•10 ⁵ switching cycles at nominal load
Interference suppression	Utilize external RC element (100 Ω - 47 nF) at contactor

Transistor output suitable for commercially available semiconductor relays (SSR)		
Switching Status	Open-Circuit Voltage	Output Current
Active (load ≤ 800 Ω)	< DC 17 V	10 ... 15 mA
Inactive	< DC 17 V	< 0.02 mA
Overload limit	Short-circuit, continuous interruption	

Electrical Safety	
Safety class	II, panel-mount device, DIN EN 61010-1 section 6.50.4
Fouling factor	1, per DIN EN 61010-1 section 3.7.3.1 and IEC 664
Overvoltage category	II, per DIN EN 61010 appendix J and IEC 664
Operating voltage	300 V per DIN EN 61010
EMC requirements	IEC/EN 61326

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