Operating Instructions

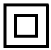
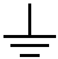
R2900

Compact Controller, 96 x 96 mm

3-349-203-15
7/4.21

Contents

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:

Gossen Metrawatt 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 2nd 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					1st switching point: transistor output 2nd switching point: relay output	A2
2 / 3-step controller with heating current monitoring					1st switching point: relay output 2nd switching point: transistor output	A3
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		B1
		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)	
		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 mutually configured as per B1 for **differential controller**.						B3
1st measurement input same as B1, 2nd same as B2, can be configured for **slave controller**						B4
Auxiliary Voltage	AC 110 ... 230 V					C1
Limit Contacts	None					D0
	Two				2 relay outputs	D1
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 ⚠

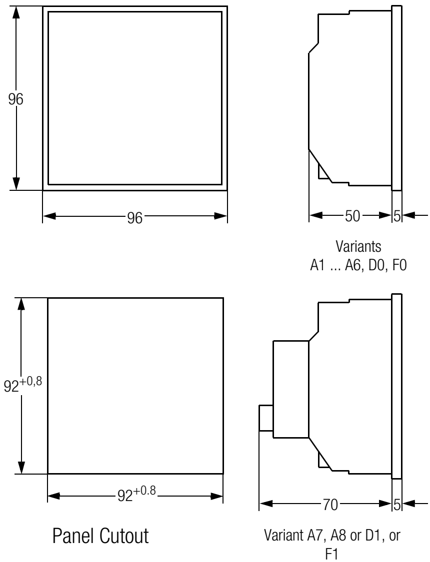
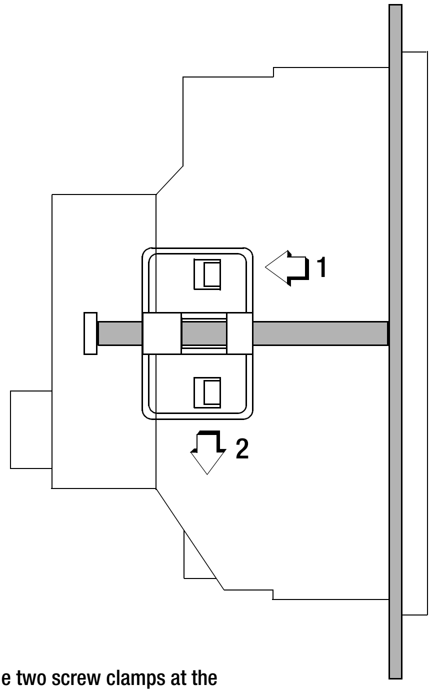


Figure 1, Housing Dimensions and Panel Cutout

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.

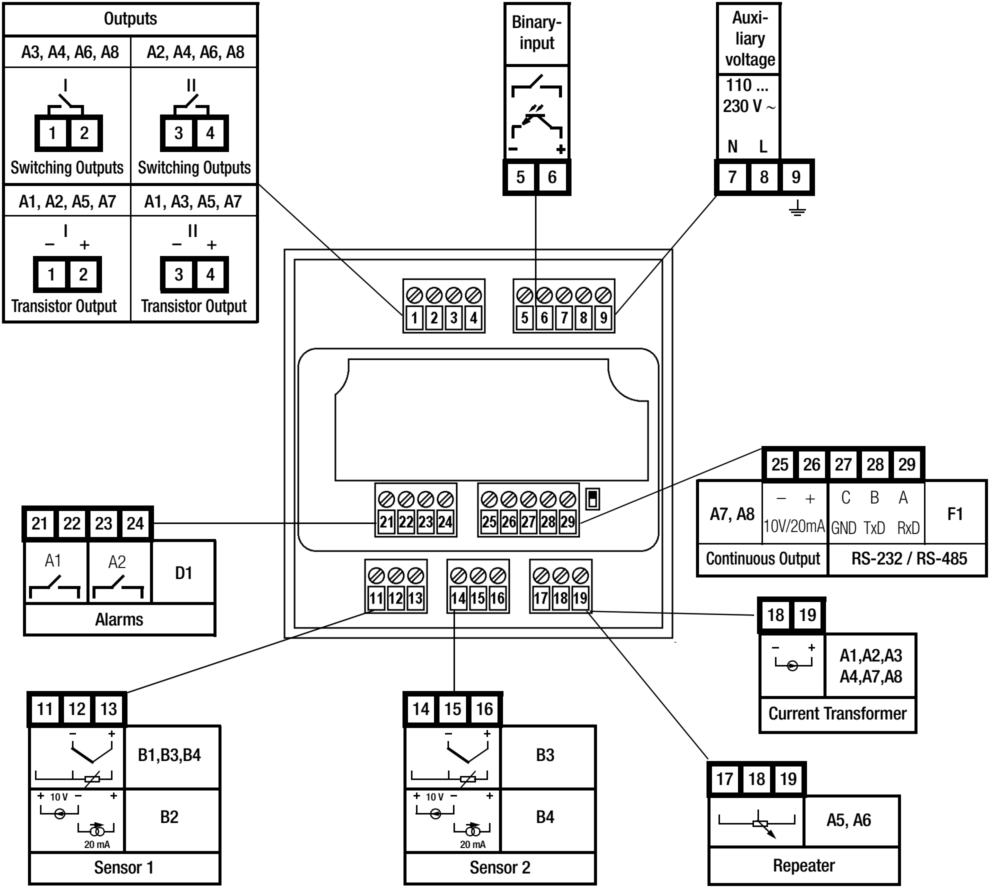


Securing the two screw clamps at the right and left-hand sides of the housing:

- 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

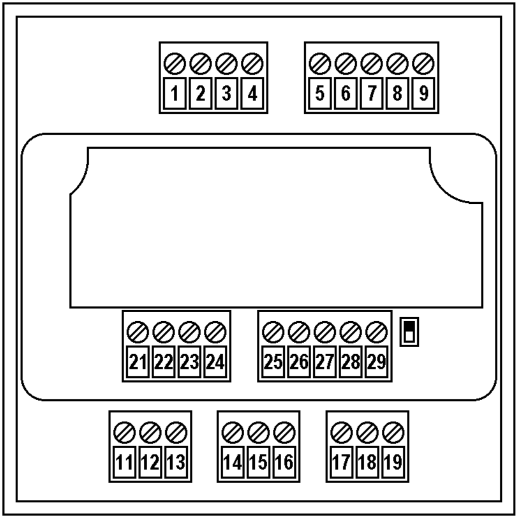
Electrical Connection



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.

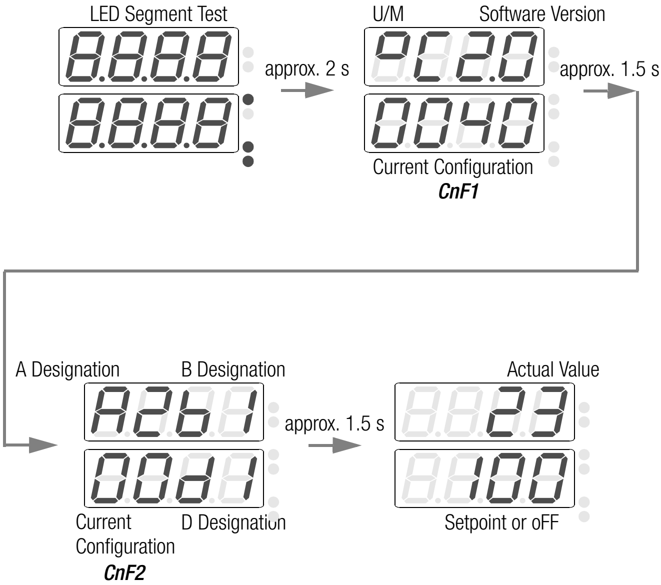


Connectors: Screw terminals for wire with a cross section of 1.5 square mm or two-core wire-end ferrules with a cross-section of 2 x 0.75 square mm

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

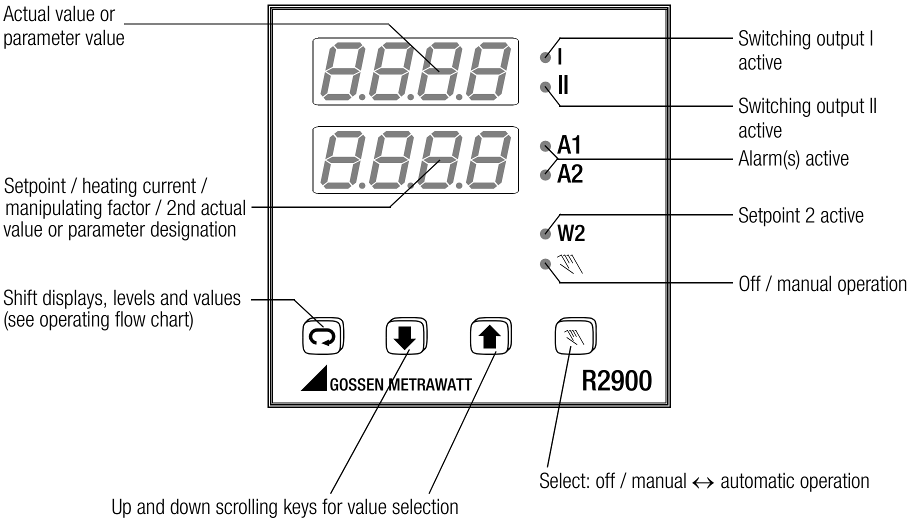


Figure 4, Controls

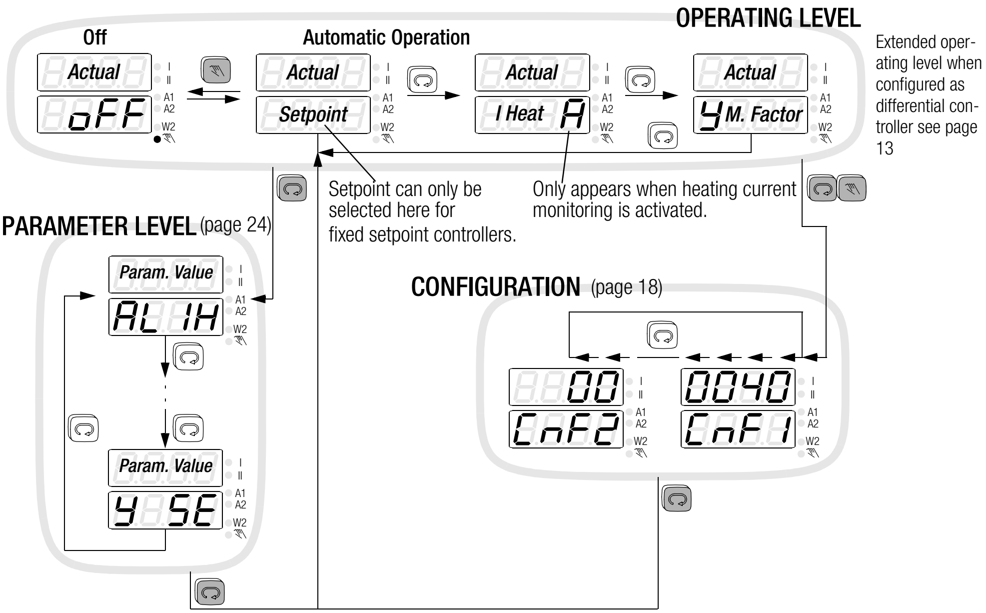
Value Selection

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.

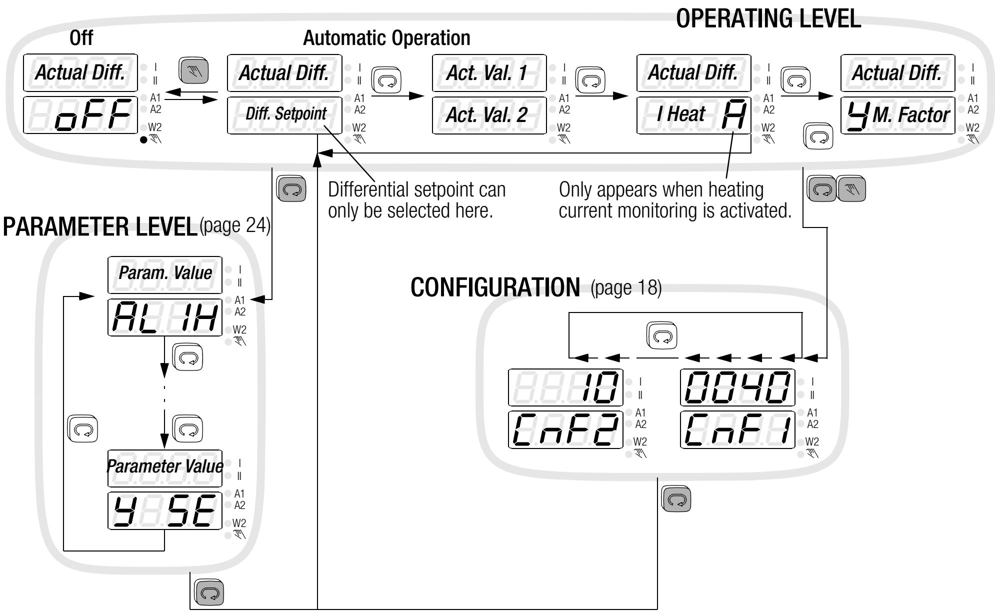
The display goes dark briefly to indicate activation of the selected value.

Operating Flowchart, “Discontinuous-Action Controller”



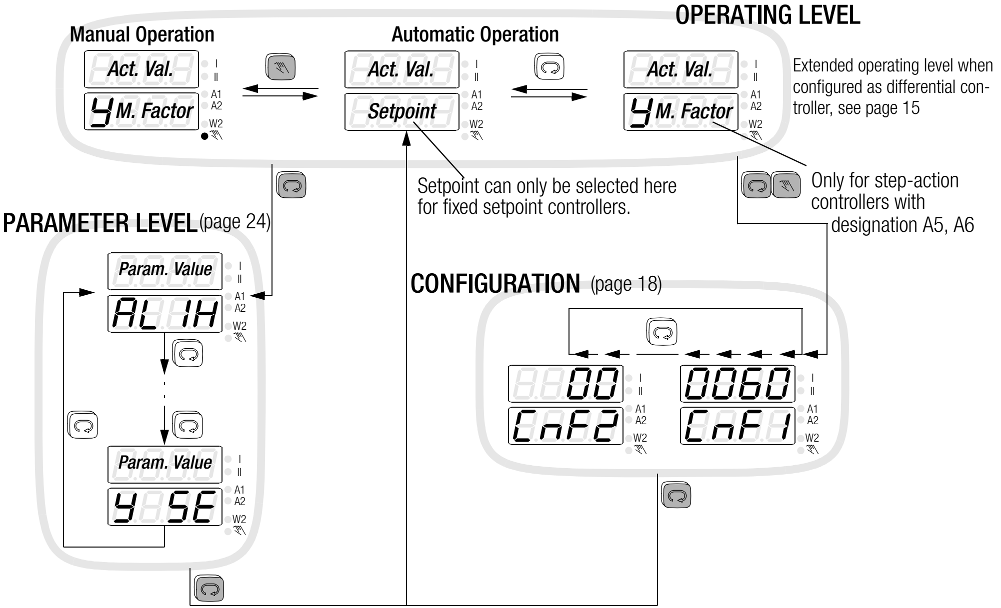
(key, white)	Press key briefly.
(key, grey)	Press and hold key until the display is switched.
(two keys, grey)	Press and hold both keys until the display is switched.

Operating Flowchart, "Discontinuous-Action Controller" with Differential Control



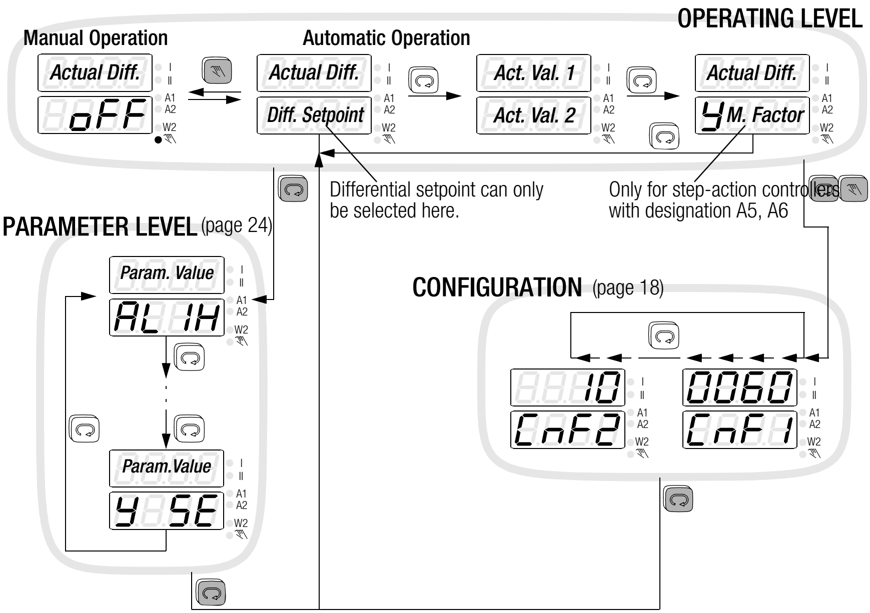
(white key)	Press key briefly.
(grey key)	Press and hold key until the display is switched.
(two grey keys)	Press and hold both keys until the display is switched.

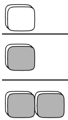
Operating Flowchart, “Continuous-Action and Step-Action Controllers”



(key outline)	Press key briefly.
(grey key)	Press and hold key until the display is switched.
(two grey keys)	Press and hold both keys until the display is switched.

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

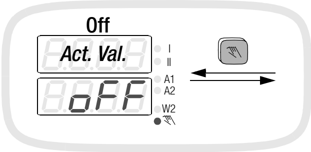




	Press key briefly.
	Press and hold key until the display is switched.
	Press and hold both keys until the display is switched.

Off / Manual Operation

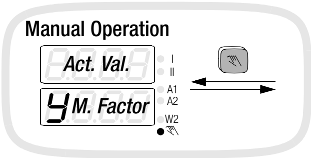
OPERATING LEVEL, DISCONTINUOUS-ACTION CONTROLLER



- No alarm function
- No indication of errors

- 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.

OPERATING LEVEL, CONTINUOUS-ACTION STEP-ACTION CONTROLLERS



- 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.

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 YSt 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 YSt.
- It is reduced by the same value when the contact is opened.
- No function during self-tuning
- Where YSt = 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).

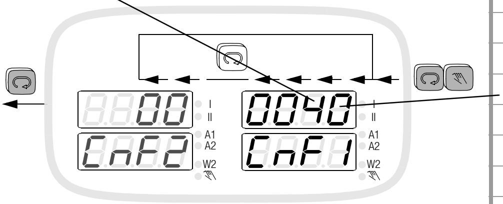
Example:
If a machine requires an average of 70% heating power during production operation, but only 10% during idle time, the difference of YSt is set to 60%, and the binary input is only activated during production.

Configuration

(continued on page 20)

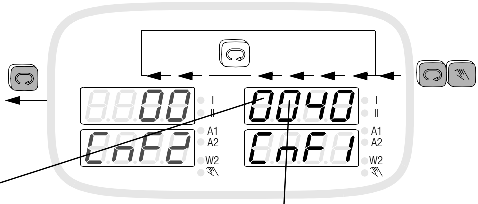
	Controller Sort
Code	
0	Limit transducer
1	Actuator
2	2-step controller, heat *)
3	2-step controller, cooling *)
4	3-step controller *)
5	3-step controller, water cooling
6	Step-action controller

*) 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		
3	Absolute			
4	Relative	Inactive	NC contact	
5	Absolute			
6	Relative	Active		
7	Absolute			
8	Relative	Inactive	NO contact	Active
9	Absolute			
A	Relative	Active		
b	Absolute			
C	Relative	Inactive	NC contact	
d	Absolute			
E	Relative	Active		
F	Absolute			

Gray highlighting: default setting K0



Code	U/M [1]	Output Range [2]	Output Quantity [2]
	[1] Sensor / Continuous Output [2] Unit of Measure		
0	°C	0 ... 20 mA	Actual value (step-action controller)
1	°F	0 ... 10 V	
2	°C	4 ... 20 mA	
3	°F	2 ... 10 V	
4	°C	0 ... 20 mA	Manipulating factor (cont.-action controller)
5	°F	0 ... 10 V	
6	°C	4 ... 20 mA	
7	°F	2 ... 10 V	
8	°C	0 ... 20 mA	Select output quantity with Cont (see also page 23)
9	°F	0 ... 10 V	
A	°C	4 ... 20 mA	
b	°F	2 ... 10 V	
C		(no function)	
d		⚠ Saving and loading device settings: see page 21	
E			
F			

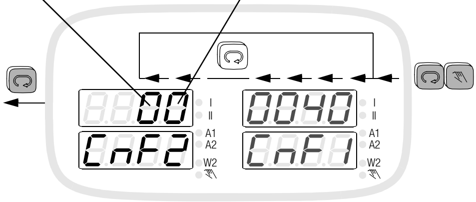
1) Switching to and from °C and °F is only effective for designations B1, B3 and B4.
2) Only effective for designations A7 and A8

Code	Type	Design	Condition
	Sensor type		
0	J	Thermo-couple	For measurement input 1 with designation B1, B4
1	L		
2	K		
3	B		
4	S		
5	R		For both measurement inputs with designation B3
6	N		
7	1 ° Display	Pt 100	
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		

Configuration (continued)

	Function, Measurement Input 2		Standard Signal 2
Code	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	–		
6	–	Slave controller	
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 offset
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
d	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.
E	User-defined default settings [1)] are loaded. If settings have not already been saved with d 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.
F	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 ± 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 (SP2).
- 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 SPL and SPH 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 HYSt. Switching status changes are possible once per tc.
1	Actuator	Read-out of a constant actuating signal to switching output I where YSt > 0, or switching output II where YSt < 0. The actuating cycle is equal to at least *tc*. 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 tc.
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 tc. 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 tc.
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 tc. 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 YSt.
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. tc 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 tc. 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 Cont" ("sensor U/M / continuous output" configuration digit = 8, 9, A, b)**

Cont	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	AL 1H	oFF, 1 ... MR oFF, X1 ... X2	oFF oFF	Relative (= default config.) Absolute
Lower limit value for relay A1	AL 1L			
Upper limit value for relay A2	AL 2H			
Lower limit value for relay A2	AL 2L			
Setpoint 2	SP 2	SPL ... SPH	X1	
Ramp for rising setpoints	SPuP	oFF, 1 ... MR per min.	oFF	
Ramp for falling setpoints	SPdn	oFF, 1 ... MR per min.	oFF	
Heating current setpoint (see Balancing)	AMPS	Auto, oFF, 0.1 ... A H	oFF	Not with step-action controllers 1)
Proportional band heating	Pb I	0.1 ... 999.9%	10.0	
Proportional band cooling	Pb II	0.1 ... 999.9%	10.0	Only with 3-step controllers 2)
Dead band	dbnd	0 ... MR	0	Not with 2-step controllers 3)
Path delay time	tu	0 ... 9999 s	100	
Read-out cycle time	tc	0.5 ... 600.0 s	10.0	4)
Motor run-time	tY	5 ... 5000 s	60	Only with step-action controllers 5)
Switching hysteresis	HYSt	0 ... 1.5 % MR	0.5 % MR	For limit value monitoring and limit transducers
Maximum setpoint	SP H	SPL ... X2	X2	
Minimum setpoint	SP L	X1 ... SPH	X1	
Maximum manipulating factor	Y H	–100 ... 100 %	100	
Actual value correction (see Balancing)	CAL	(Auto), –MR/4 ... +MR / 4	0	Only with designations B1, B3 and B4
Decimal point position	dPnt	9999, 999•9, 99•99, 9•999	9999	Only with designation B2
Upper range limit, standard signal	rn H	rnL ... 9999	100	Only with designations B2, B4, A7 and A8
Lower range limit, standard signal	rn L	–1500 ... rnH	0	

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

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: CAL)

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

– Short circuit the sensor **at the measuring point**.
– Set the CAL value to Auto.

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

Balancing can also be performed manually if the sensor temperature is known:
CAL = known sensor temperature – displayed temperature value

Scaling for Heating Current Monitoring (parameter: A 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)

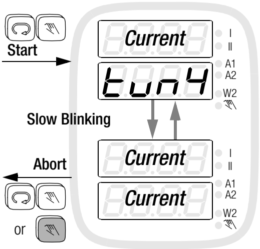
Calibration is performed in the manual operating mode at the parameter level with the device configured as a step-action controller (“controller sort” configuration digit = 6):

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



Self-tuning is used to achieve optimized controller dynamics, i.e. parameters Pb I, Pb II, tu and tc are determined.
Read-out cycle time tc is not changed during self-tuning.
We recommend for tc a value of tu/12 to guarantee satisfactory controller dynamics. When controlling contactors, tc 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.
- tun 1...tun8 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.

Manual Self-Tuning

Parameters *Pb I*, *Pb II*, *tu* and *tc* 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

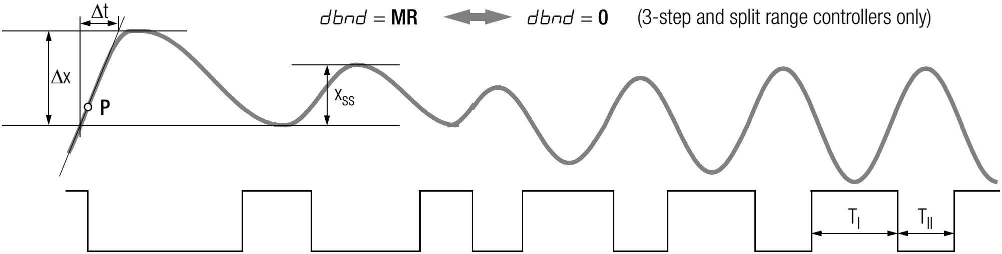
- **Complete configuration** (page 18) and **parameter settings** (page 24) must first be entered for use of the controller.
- The actuators should be deactivated with the **off / manual operation** function (page 16).
- A **recorder** must be connected to the sensor and adjusted appropriately to prevailing 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: *tc* = **0.5**.
- If possible, deactivate manipulating factor limiting. *YH* = **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 $\mathbf{x}_{SS}$, 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
tu	1.5 • Δt				Δt – (tY / 4)
tc	tu / 12 [1)]				tY / 100
Pb I	(x_{SS} / MR) • 100 %		(x_{SS} / MR) • 200 %		(Δx / MR) • 50 %
Pb II	–	Pb I• (T_I / T_{II})	–	Pb I• (T_I / T_{II})	–

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

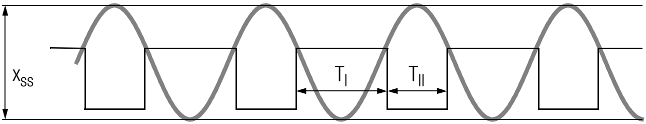
If manipulating factor limiting was active, the proportional band must be corrected:

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 *tu* 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
tu [1]	$0.3 \cdot (T_I + T_{II})$				$0{,}2 \cdot (T_I + T_{II} - 2tY)$
tc	*tu* / 12 [2]				*tY* / 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 *tu* is too large.
2) When controlling contactors, *tc* should be adequately increased.

Correction with manipulating factor limiting
YH positive: *Pb I* multiply by 100% / *YH*
YH negative: *Pb II* multiply by –100% / *YH*

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

Multiply Pb I by $\frac{tY \bullet tY}{T_I \bullet T_I}$, if T_I is smaller, or by $\frac{tY \bullet tY}{T_{II} \bullet T_{II}}$, if T_{II} is smaller.

The value for tu 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 SPuP and SPdn cause a gradual temperature change (rising / falling) in degrees per minute.
Activation	– 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.

Heading 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 oFF, as well as in the case of continuous and step-action controllers.

AMPS current setpoint

Heater phase current is entered for this parameter. AMPS can be set to Auto for automatic adjustment with the heater switched on. The measured current value is saved to memory.

Heating Circuit Monitoring

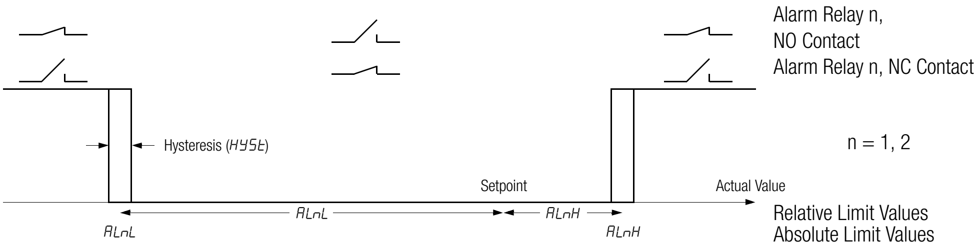
Function

- Can be set to active or inactive with the “alarm” configuration digit (see Configuration).
- Without external transformer, without additional parameters
- Assumes correct optimization of tu and Pb I 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 tu parameter must be observed:

  $$\text{minimum } tu = \frac{Pb\ I}{50\,\%} \cdot \frac{MR}{\Delta\vartheta / Dt}$$

  $\Delta\vartheta / Dt$ = maximum temperature rise during actuation
- Error message LE appears after approximately 2 times tu, if heat remains on at 100% and measured temperature rise is too small.
- Monitoring is not active:
  where controller sort = limit transducer, actuator or step-action controller
  during self-tuning
  with standard signal input (designation B2)
  where manipulating factor limiting YH < 20%

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:

1. 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.
2. 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.
3. The display is switched to the operating level 30 seconds after value selection has been completed during configuration or parameter setting.
4. Exceptions and additional information are included in the following table:

<table>
<tr><th>Display</th><th></th><th>Error Message Source</th><th>Response</th><th>Remedy</th></tr>
<tr><td>SE H</td><td>sensor error high</td><td>Broken sensor or actual value greater than upper range limit</td><td rowspan="2"><table>
<tr><th>Ctr. Sort</th><th colspan="2">Manipulating Factor Read-Out</th></tr>
<tr><td rowspan="2">2 or 3-step</td><td>YSE = –100/0/100%</td><td>YSE ≠ –100/0/100%</td></tr>
<tr><td>–100/0/100%</td><td>If the controller has settled in: last “plausible” manipulating factor, if not: YSE</td></tr>
<tr><td>Step</td><td colspan="2" rowspan="2">YSE</td></tr>
<tr><td>On/off ctr.</td></tr>
<tr><td>Actuator</td><td colspan="2">No response to error</td></tr>
</table></td><td rowspan="2">1</td></tr>
<tr><td>SE L</td><td>sensor error low</td><td>Sensor polarity reversed or actual value less than lower range limit</td></tr>
<tr><td>CE</td><td>current error</td><td>Current transformer has reversed polarity, is unsuitable or defective</td><td>Same as heating current monitoring alarm
Continues to control temperature</td><td>2</td></tr>
<tr><td>YE</td><td>y error</td><td>Position ackn. incorrectly calibrated, Y 100 ≤ Y0</td><td><u>No</u> response to error</td><td>3</td></tr>
<tr><td>no t</td><td>no tune</td><td>Self-tuning cannot be started (controller sort: “actuator” or “limit transducer”)</td><td>No response to error
Error message is not cleared until key is pressed</td><td>–</td></tr>
</table>

Display		Error Message Source	Response	Remedy
tE 2	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
LE	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
PE	parameter error	Parameter not within permissible limits	Control outputs I and II inactive. The parameter level is disabled.	6
dE	digital error	Error detected by digital component monitoring	Control outputs I and II inactive	7
AE	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 tu and Pb 1.
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

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

Aux. Voltage	**Nominal Ranges of Use**		**Power Consumption**
Nominal Value	**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	> $2 \bullet 10^5$ 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

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

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