Technical manual BA 1010

Temperature

Thermocont TS

temperature switch

for monitoring of process temperatures
in gases, steam, liquids and dusts

Process temperature from – 99,9°C to +500°C

Long term stable temperature sensor platinum Pt100 class A – DIN EN 60751

Self-supervising measuring system with second temperature sensor
for drift supervising and redundancy function

Comfortable operation in each mounting position by beveled display

Rotateability of housing and display value

Integrated evaluation electronic with
- two pnp switching outputs and
- one current output 4...20mA in 3-wire-technology

Short response time and excellent accuracy

Hygienic optimized design with closed operation surface

Password function for protection of the settings against alternation

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know how mit system

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1. Application

The devices of series **Thermocont TS** with integrated digital evaluation electronic are compact temperature switches for monitoring, control as well as continuous measurement of process temperatures from –99,9°C to +500°C in gases, vapors, liquids and dusts in all industrial application fields at process pressures of up to 60 bar.

2. Function

The device is mounted into the wall of the container or of the pipeline.

By using a neck tube of a adequate length between the respective process connection and the connection housing at high medium temperatures it can be achieved that the temperature in the area of the connection housing does not exceed the permitted environmental temperatures.

The sensor tube is the junction point with the applied medium and is in direct contact with it. It contains the temperature sensor that is used for recording the temperature and converting it into an electrical signal.

At the device **Thermocont TSS** the recording of the process temperature is made by a resistive temperature sensor element Pt100 of class A. This allows a precise and long term stable temperature measurement.

At device **Thermocont TSD** the recording of the process temperature is made in parallel at first by a resistive temperature sensor element Pt100 of class A and second by a semiconductor temperature sensor.
Because of the parallel measurement with two different thermal coupled sensor elements, the temperature switch detects impermissible drifts of a sensor and errors at the temperature measurement automatically.
At the failure of one of the two sensor elements the temperature measurement can be also continued with the second element, what realizes a redundancy function.

Signal processing

The temperature signal that recorded by the respective temperature sensor is transmitted into an electrical signal that is recorded and processed in high resolution by a processor.
The pnp switching output resp. outputs are driven according to the respective settings.
When using the analogue signal current output the recorded temperature signal is adjusted according to the settings and transformed into a high resolution output signal of 4...20mA.
By 3 sensor keys and the four-digit LED display all settings for the pnp switching output resp. outputs, the display and also the analogue output can be set resp. adjusted.

3. Variant overview

	Thermocont TSS	Thermocont TSD
Sensor element	Pt100	Pt100 / semiconductor
Application range	Monitoring, control and continuous measurement of process temperatures	Monitoring, control and continuous measurement of process temperatures with drift monitoring and redundancy function
Measuring range	-99,9°C to +200°C / -99,9°C to +500°C	-50...+175°C

4. Unit conversion

Conversion °C into °K	➔ °C + 273,15 = °K	e.g. 0°C = 273,15°K / 100°C = 373,15°K
Conversion °K into °C	➔ °K – 273,15 = °C	e.g. 0°K = -273,15°C / 100°K = -173,15°C
Conversion °C into °F	➔ (9 / 5) x °C +32 = °F	e.g. 0°C = 32°F / 100°C = 212°F
Conversion °F into °C	➔ (5 / 9) x (°F – 32) = °C	e.g. 0°F = -17,8°C / 100°F = 37,8°C

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5. Safety notes

Each person that is engaged with inauguration and operation of this device, must have read and understood this technical manual and especially the safety notes.

Installation, electrical connection, inauguration and operation of the device must be made by a qualified employee according to the informations in this technical manual and the relevant standards and rules.

The device may only be used within the permitted operation limits that are listed in this technical manual. Every use besides these limits as agreed can lead to serious dangers.

The materials of the device must be chosen resp. checked for suitability to the respective application requirements (contacting substances, process temperature). An unsuitable material can lead to damage, abnormal behavior or destruction of the device and to the resulting dangers.

The device may not be used as sole measure for prevention of dangerous conditions in machines and plants.

The device meets the legal requirements of all relevant EC directives. CE

6. Installation

Drive the system pressure free prior installation resp. deinstallation of the device. Be also sure that no medium is flowing in the system. At extreme system or medium temperatures there could exist serious dangers.

The tightening of the process connection may only be done at the hexagon by a suitable tool.
The maximum permitted torque strength is 50 Nm.
The screw in of the process connection by using the connection housing is not permitted.

The housing can be rotated every time, also at operation, without a tool by 340°.
The display can be rotated electronically by 180°.

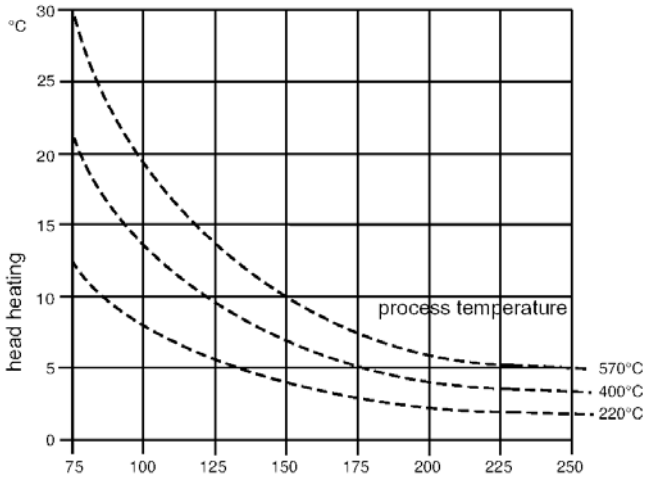
The correct function of the device within the specified technical data can only be guaranteed, if the permissible temperature in the area of the connection housing from – 40°C to +85°C will not be exceeded.
This can be achieved by the using a neck tube or also by isolation of the medium carrying part of the plant or by other constructive measures to reduce the transferring of an extreme temperature to the connection housing.

Max. permissible process temperature dependent of the environmental temperature

environmental temperature in the area of the connection housing	maximum permitted process temperature without using a neck tube
up to +25°C	+150°C
up to +40°C	+135°C
up to +60°C	+120°C
up to +85°C	+100°C

Neck tube

The neck tube is used to decouple the temperatures between medium and the connection housing in order to reduce the temperature at the connection housing.



By using a neck tube at extreme process temperatures it can be achieved, that the permitted environmental temperature range of – 40°C...+85°C in the area of the connection housing will not be exceeded.
The length of the needed neck tube depends on the height of the process temperature and the respective installation situation.
Like shown in the graphic besides, the length of the neck tube can considerably influence the temperature at the connection housing.

The graphic is only a approximately guide, because the real heating of the connection housing can be influenced by additional factors, e.g. a system isolation or also the position of the connection housing.

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Installation position

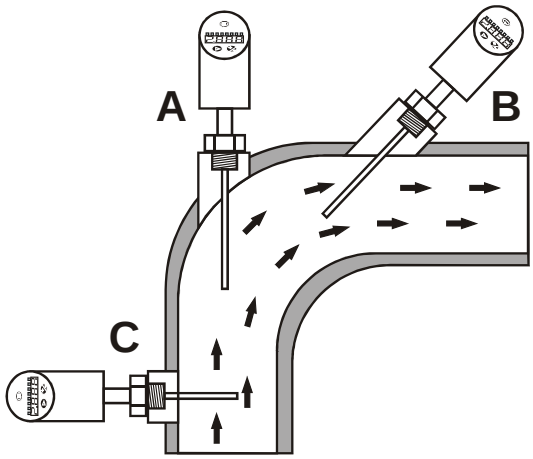
The choice of the place of installation of the sensor and the length of the sensor tube are of considerable importance for the quality and the reliability of the measuring results.

If the sensor isn't installed deeply enough, an error in the measured temperature can occur because of the different process flow temperature at the pipeline wall and the heat transfer along the sensor tube.
The appearance of the error should not be ignored if a considerable difference between process temperature and environmental temperature exists. Thus it is suggested to use an installation length of at least 80...100 mm. The shorter the installation length, the greater is the deviation against the real medium temperature caused by the heat transfer.

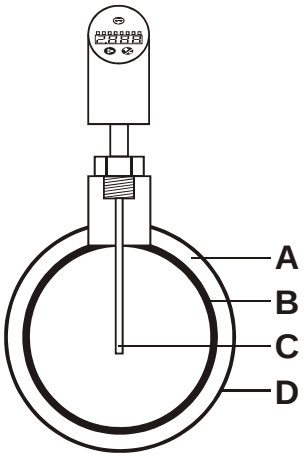
The following general recommendations can be applied as approximately guideline:

- In liquids, the sensor tube length should be 5...6 times greater then the diameter of the sensor tube plus the sensitive length of 50 mm.
- In steam, air and gases, the sensor tube length should be 10...15 times greater then the diameter of the sensor tube plus the sensitive length of 50 mm.

In pipelines with small diameter the tip of the sensor tube should reach the axis line, that means the middle of the pipeline, and if possible additionally a little more.
By isolating the external parts of the sensor, the effect caused by too low installation depth, can be reduced.
An additional solution for optimizing the measurement quality of small formatted pipelines could be the installation of the sensor tube diagonal to the pipeline longitudinal axis or the installation of the sensor tube in the pipeline arc (see illustration).



A) In the pipe arc against the flow direction
B) In small pipes diagonal against the flow direction
C) Vertical to the flow direction



A) Isolation
B) Pipe
C) Sensor tube
D) External cover

7. Maintenance

The device is free of maintenance.

8. Repair

A repair may only be carried out by the manufacturer.

If the device must be sent back for repair, the following informations must be enclosed:

- An exact description of the application.
- The chemical and physical characteristics of the product.
- A short description of the occurred error.

Before returning the device for repair, the following measures must be proceeded:

- All adhesive product residues must be removed. This is especially important, if the product is unhealthily, e.g. caustic, toxic, carcinogenic, radioactive etc.
- A returning must be refrained, if it is not absolutely possible to remove unhealthily products completely, because e.g. they have been penetrated into cracks or are diffused through plastic.

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9. Electrical connection

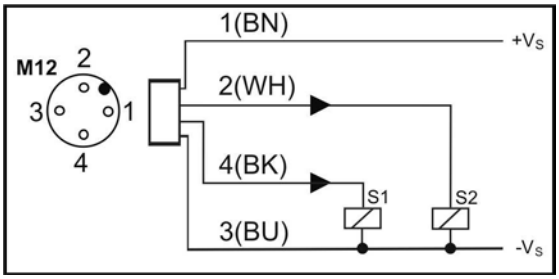
The electrical connection of the device must be carried out according to the respective country specific standards. Incorrect installation or adjustment could cause applicationally conditioned risks.

Use only twisted shielded signal and measurement wires and install these wires separated from power leading wires. Connect the cable shield only at one side to earth, ideally at the installation place of the device.
The device must be grounded. The metallic parts of the device are electrically connected with the socket of the plug M12. Due to this the grounding can be carried out by the process connection.

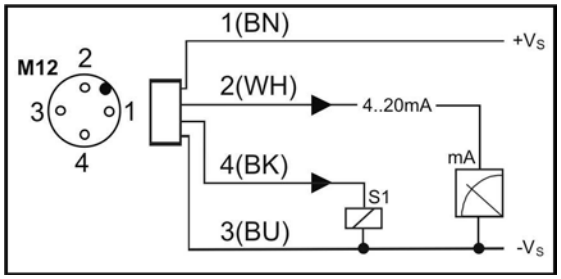
For the voltage supply of the device a rectified and sufficiently filtered direct voltage from 11,2...35V must be used. If the alternating voltage fraction is too high, this can lead to malfunctions.
The voltage applied to the terminal contacts may not exceed 35 V to avoid damage of the electronic. All connections are polarity protected.

Inductive loads at the pnp switching outputs, e.g. relays or contactors may only be used with a free-wheeling diode or a RC protection circuit to avoid high voltage peaks.

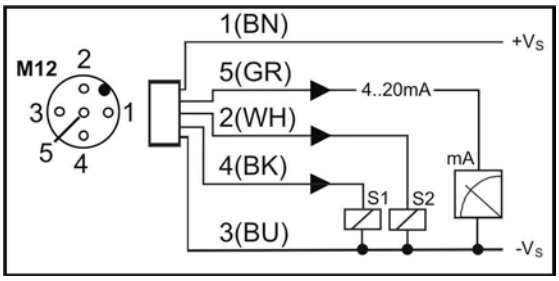
Concerning to the analogue output, the device operates in 3-wire-technology.



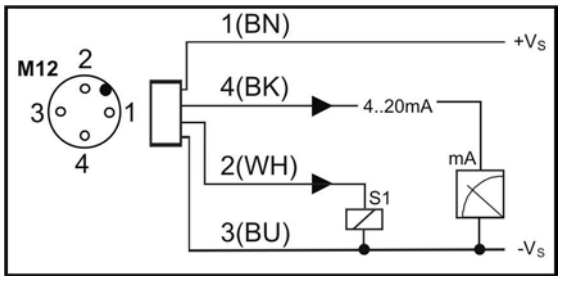
Type A PNP switching output S1
PNP switching output S2



Type B PNP switching output S1
Analogue output 4...20mA



Type C PNP switching output S1
PNP switching output S2
Analogue output 4...20mA



Type D PNP switching output S1
Analogue output 4...20mA
Pin assignment desina compliant

Conductor color standard connection cable: BN = brown, GR = grey, WH = white, BK = black, BU = blue
The connection cable in not enclosed in the delivery contents.

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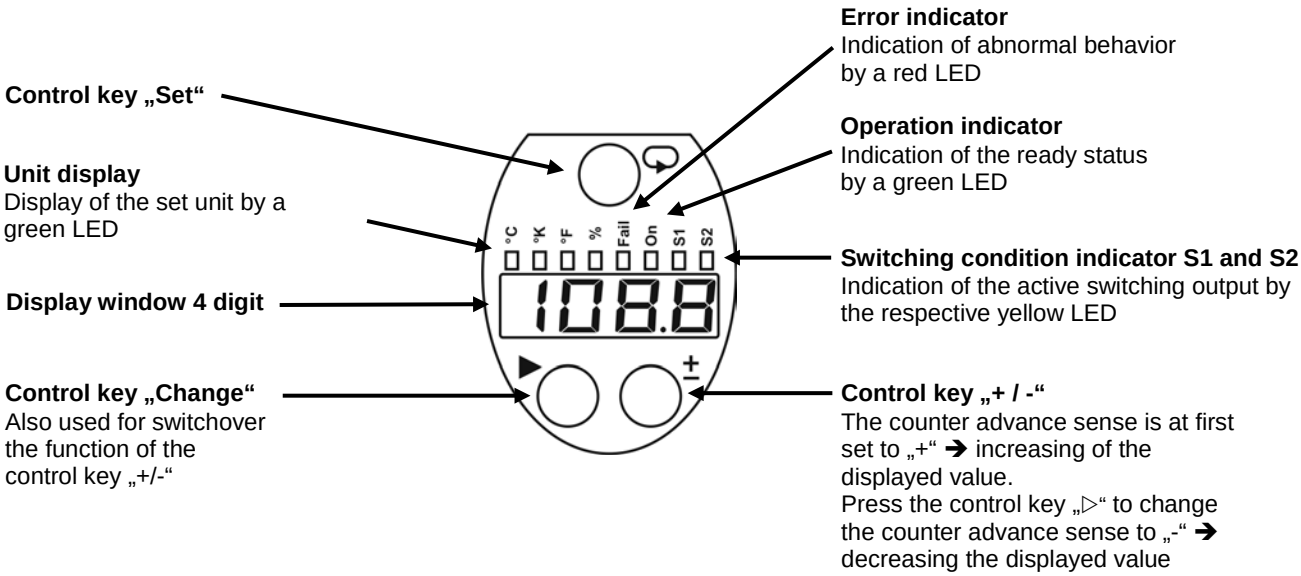
10. Operation and display elements



11. Function modes

run mode

The device records the applied physical measurand and proceeds the chosen functions according to the set parameter. The active operation is confirmed by the green operation light-emitting diode.

The measuring value is displayed in the display window and the chosen unit is marked through the come on of the respective green unit light-emitting diode.

The switching outputs and the analogue output are driven, whereby an active switched on switching output is signaled by the come on of the respective yellow switching condition light-emitting diode.

The exceedance of the frame specifications, abnormal behavior conditions and also device malfunctions are displayed static or flashing by the red error indication light-emitting diode.

Programming mode

The jump into the password request is made by simultaneous pressing the two control keys „Set“ and „Change“ for 3 seconds. The access to the one of the three function menus is made by the respective password.

In the ***switching function menu*** **– password 1903 –** all the adjustable parameter and functions are chosen especially for the use of the device as switch.

In the ***transmitter function menu*** **– password 3009 –** all the adjustable parameter and functions are chosen especially for the use of the device as transmitter by using the analogue output.

In the ***switching point menu*** **– password 1111 –** only switching resp. switching back point of the PNP switching output resp. outputs are accessible for fast adjustment. The function of the switching outputs can be displayed.

The display settings, the service parameters system damping, error memory and minimum / maximum value memory and also the reset of all parameter to factory values can be equally accessed from all two menu structures.

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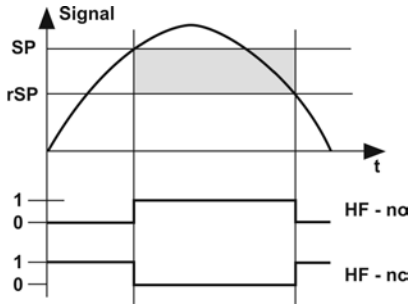
12. Function switching output

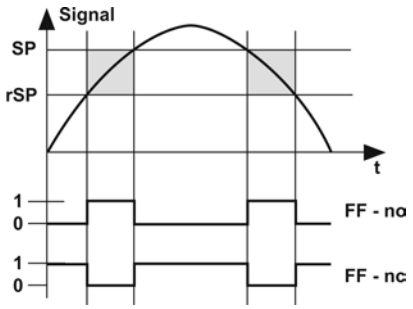
Hysteresis function – HF –



The hysteresis function realizes a stable switching state, independent from system conditioned signal fluctuations around the adjusted set point. It be used for realizing a signal controlled two-position control.

The switching range is determined by input the switch point – SP – and switch back point – rSP – for the respective switching output.
The actual applied measuring signal can directly applied as switch resp. switch back point by pushing a control key or an arbitrary value can be set.
The working principle can be set separately for each switching output to: no normally open contact or to nc normally closed contact

Window function – FF –



The window function realizes a signal range – acceptance region –, where the switching output is set to a definitive switching state.

The switching range is determined by input the upper switch point – SP – and lower switch point – rSP – for the respective switching output.
The actual applied measuring signal can directly applied as upper resp. lower switch point by pushing a control key or an arbitrary value can be set.
The working principle can be set separately for each switching output to: no normally open contact or to nc normally closed contact

For both switching functions, there is no default minimum difference (hysteresis) between switch resp. switch back point resp. between upper and lower switch point.

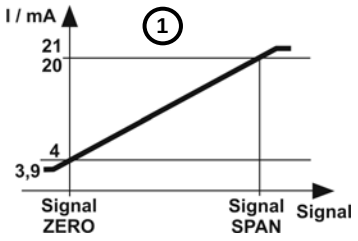
If the switch back point is set higher or equal to the switch point resp. the lower switch point is set higher or equal to the upper switch point the switch back point is set automatically to the switch point resp. the lower switch point is set automatically to the upper switch point. The red error indication light-emitting diode is flashing and in the error memory *service* SEr – *error memory* ErrM there will be the indication of the concerning switching output S1oG or S2oG.

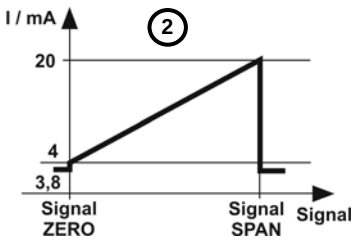
13. Function analogue signal output

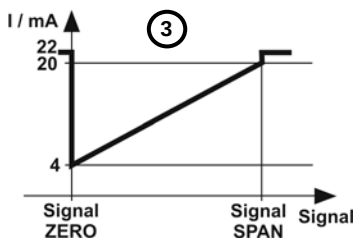
The measuring signal is transmitted to the analogue output, whereas the adjusted signal zero value equals an output current of 4 mA and the adjusted signal end value equals an output current of 20 mA. At an adjustment without applying signal the required signal zero resp. signal end value can be assigned to the analogue signal.

The output current behaves in three different possibilities depending on the set mode:

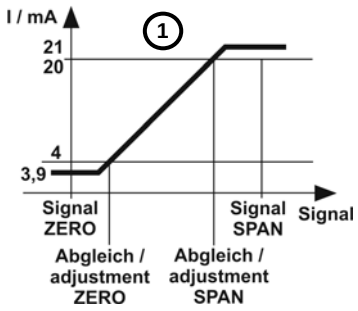
1. Linear transmission from 3,9 mA to 21 mA. Limit values are kept at exceedance or underrun.
2. Linear transmission from 4 mA to 20 mA. At exceedance jump to 3,8 mA for error evaluation.
3. Linear transmission from 4 mA to 20 mA. At exceedance jump to 22 mA for error evaluation.

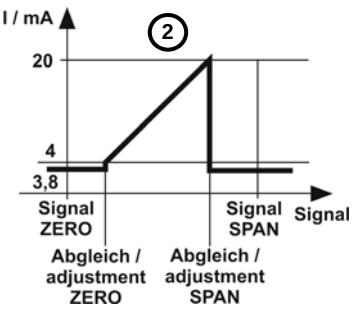


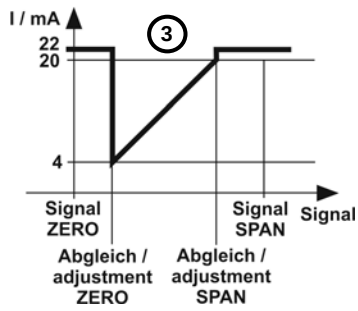




At an adjustment with applying measuring signal additionally to a shift of signal zero value resp. signal end value the zero (4 mA) resp. end value (20 mA) of the analogue output in the range from 3,9 mA to 21 mA can be shift. At this an inverting of the analogue signal is possible.







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14. Function drift supervising

The function drift supervising is only adjustable at devices of the series Thermocont TSD.

Each sensor element that is used for the recording of temperatures has the unavoidable characteristic a specific behavior concerning long term drift and ageing.
This behavior is very similar if not identically at physically equal-type sensor elements like e.g. more resistive sensor elements Pt100.
At physically different sensor elements like resistive sensor elements Pt100 and semiconductor sensor elements or also NTC however these characteristics are serious different.

In the tip of the sensor tube are two physically different sensor elements mounted thermal coupled.
For the realizing of a reliable drift supervising a different drift behavior of the two sensor elements is necessary. Therefore e.g. not two resistive sensor elements Pt100 are uses, but only one resistive sensor element Pt100 and a semiconductor sensor element.

Under nominal conditions the temperature measuring values, that are recorded by the sensor elements and transmitted to the processor are identically. Because of the not exactly identical position of both sensor elements within the sensor tube, the installation position of the sensor tube and the present process conditions temperature differences of up to ± 0,1K can occur, already at a new device.
This does not affect the function of the drift supervision concerning ageing.

Because of the use of two physically different sensor elements it is guaranteed, that the ageing conditioned characteristic drift of both sensor elements is different. At the occurring of a ageing conditioned characteristic drift in one or also in both sensor elements the difference between the temperature measuring values of both sensor elements increases.

The detected difference between the temperature measuring values is compared with the set drift response value dr RL by the processor.
If the temperature difference between the temperature measuring values transgresses the set drift response value dr RL , the drift alarm will be registered in the error memory Err M , the red error indication LED starts flashing and the switching output, if configured for error function, will be activated corresponding to the settings in normally open or normally closed function.
The display and the analogue current output generates furthermore a temperature proportional signal, referring to the temperature measuring value of the primary sensor element, the resistive sensor element Pt100. The switching outputs that are configured for normal function refers also to this temperature measuring values.

Because of the different response time of the two sensor elements, at fast and strong temperature fluctuations in the measured medium, e.g. at filling a hot medium in a cold container, it can come to short time differences between the two temperature measuring values that are higher than the set drift response value dr RL .
A wrong drift alarm would be detected
For the compensation of such wrong behaviors a drift delay time dr d can be set.
Due to this a drift alarm will only be detected, if after the transgression of the drift response value dr RL and after the set drift delay time dr d the set drift response value dr RL is already transgressed.

15. Function redundancy function

The function drift supervising is only adjustable at devices of the series Thermocont TSD.

The display, the switching output resp. outputs and the analogue current output refers principally to the temperature measuring value of the primary sensor element, the resistive sensor element Pt100.

In the case of a short circuit or a wire break of the primary sensor element, the resistive sensor element Pt100 there is the possibility at the temperature switch Thermocont TSD to continue the measurement automatically with the secondary sensor element, the semiconductor sensor element.

The display, the switching output resp. outputs and the analogue current output refers now to the temperature measuring value of the secondary sensor element, the semiconductor sensor element.

A drift supervision is not possible in the case of the failure of one of the two sensor elements.

The behavior of the temperature switch in the case of the failure of the primary sensor element Pt100 resp. the activation of the redundancy function is made by the parameter dr b .

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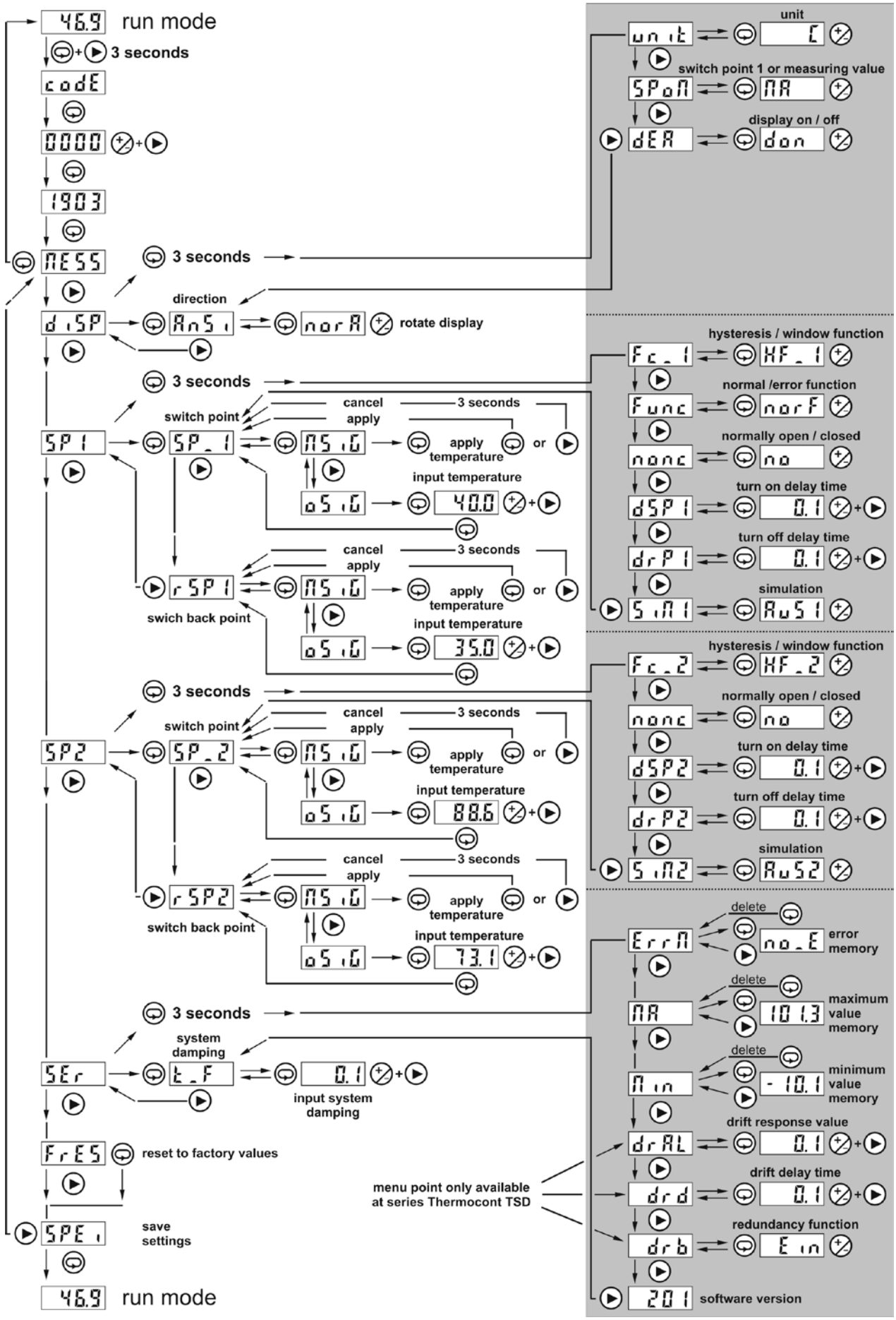
16. Overview switching function menu – password 1903



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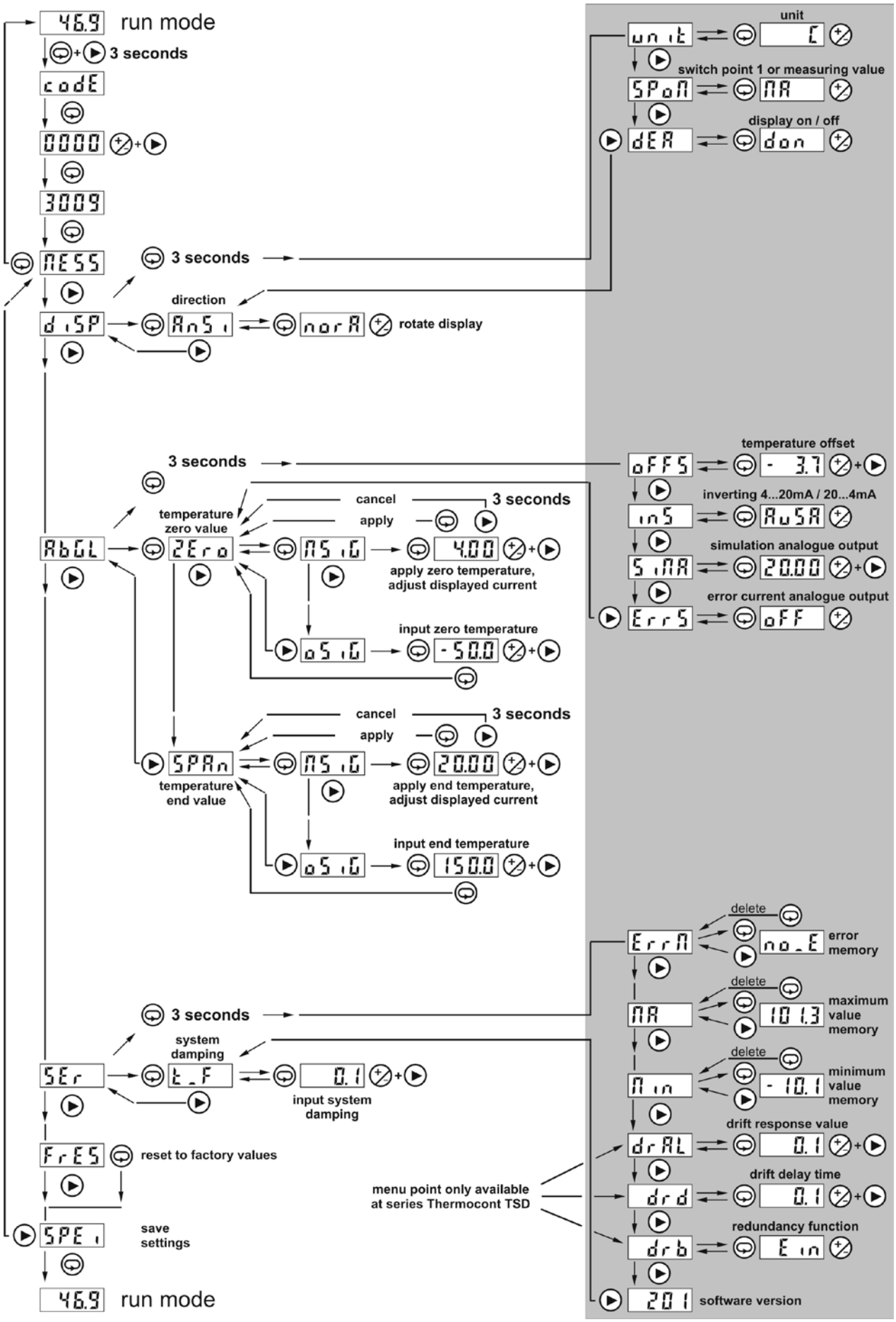
17. Overview transmitter function menu – password 3009



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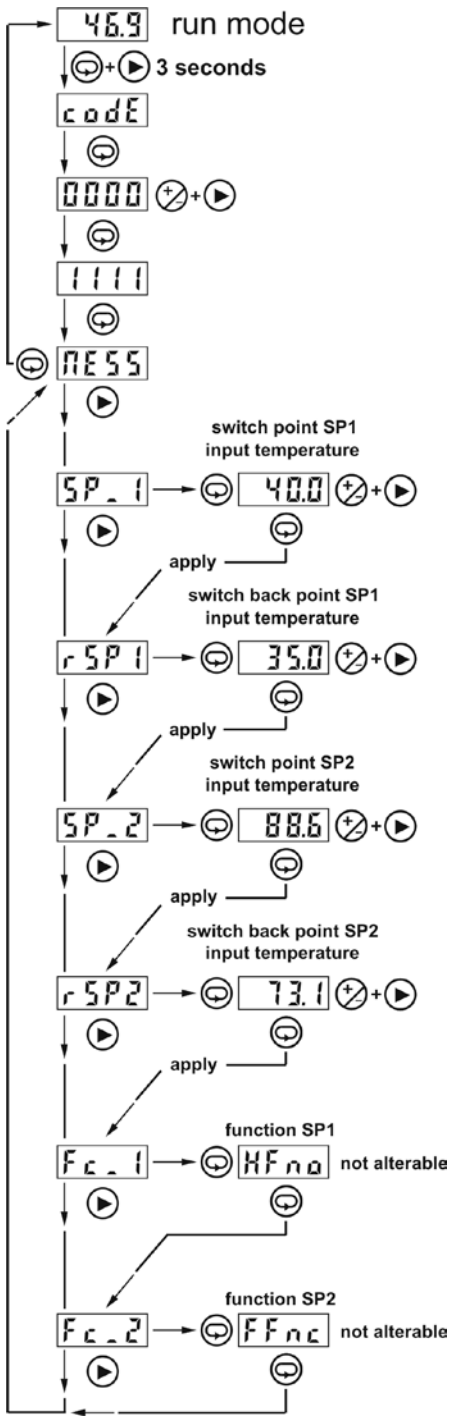
18. Overview switching point menu – password 1111



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19. Parameter overview

menu group	function	input	description
codE		3009 1903 1111	Password input for the access to the transmitter function menu Password input for the access to the switching function menu Password input for the access to the switching point menu
diSP			**DISPLAY** – includes all parameters concerning the display
	AnSi	norA tEdA	**View** normal View rotated by 180°
	Unit	C K F	**Unit** °C Unit °K Unit °F
	SPoM	MA SPA	**display measuring value** - the actual measuring value is shown in the display **display switching value** - the upper limit value of the switch point 1 is shown in the display
	dEA	don doFF	**Display indication on** – measurement value and status LED are indicated **Display indication off** – measurement value and unit LED are deactivated in the run mode. The operation, error and switching condition indicator LED are still in process. When accessing the password input by simultaneous pushing the two operation keys +/- and ▷ for three seconds, the complete display is switched on again.

Switching point menu			
SP_1			The current **switch point / upper switch point** of switching output 1is shown in the display and can be adjusted by the control keys +/- and ▷.
rSP1			The current **switch back point / lower switch point** of switching output 1 is shown in the display and can be adjusted by the control keys +/- and ▷.
SP_2			The current **switch point / upper switch point** of switching output 2 is shown in the display and can be adjusted by the control keys +/- and ▷.
rSP2			The current **switch back point / lower switch point** of switching output 2 is shown in the display and can be adjusted by the control keys +/- and ▷.
Fc_1			The set switching function of the switching output 1 is displayed. This setting can not be changed here.
		HFno	The switching output 1 operates in **hysteresis function** with working principle **normal open**
		HFnc	The switching output 1 operates in **hysteresis function** with working principle **normal closed**
		FFno	The switching output 1 operates in **window function** with working principle **normal open**
		FFnc	The switching output 1 operates in **window function** with working principle **normal closed**
Fc_2			The set switching function of the switching output 2 is displayed. This setting can not be changed here.
		HFno	The switching output 2 operates in **hysteresis function** with working principle **normal open**
		HFnc	The switching output 2 operates in **hysteresis function** with working principle **normal closed**
		FFno	The switching output 2 operates in **window function** with working principle **normal open**
		FFnc	The switching output 2 operates in **window function** with working principle **normal closed**

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menu group	function	input	description
SP1			**Switching output 1** – includes all parameters concerning the switching output 1
	SP_1	MSIG	**Adjustment with applied signal** – The actual applied temperature value is captured as **switch point resp. upper switch point**
		oSIG	**Adjustment without applied signal** – The actual **switch point / upper switch point** is shown in the display and can now be adjusted by the operation keys +/- and ▷.
	rSP1	MSIG	**Adjustment with applied signal** – The actual applied temperature value is captured as **switch back point resp. lower switch point**
		oSIG	**Adjustment without applied signal** – The actual **switch back point / lower switch point** is shown in the display and can now be adjusted by the operation keys +/- and ▷.
	Fc_1	HF_1	The switching output 1 operates in **hysteresis function** with switch point and switch back point
		FF_1	The switching output 1 operates in **window function** with lower and upper switch point
	Func	norF	**Normal function** – The switching output 1 operates in hysteresis or in window function
		ErrF	**Error indication function** – The switching output 1 operates in error indication function for the analogue current output. At underrun of 4 mA resp. at exceedance of 20 mA, the switching output 1 is activated depending on the settings as closed-circuit or as open-circuit.
	nonc	no	The switching output 1 operates in open-circuit principle resp. – **no normally open**
		nc	The switching output 1 operates in closed-circuit principle resp. – **nc normally closed**
	dSP1		**Switch delay time for switch point / upper switch point** of switching output 1. The switching output 1 is only activated, if after the entrance of the switch condition and after the set switch delay time the temperature signal already fulfills the switch conditions. By this e.g. short temperature fluctuations can be eliminated. The adjustment range is 0...99 seconds, in steps of 0,1 seconds
	drP1		**Switch delay time for switch back point / lower switch point** of switching output 1. The switching output 1 is only activated, if after the entrance of the switch back condition and after the set switch delay time the pressure signal already fulfills the switch back conditions. By this e.g. short temperature fluctuations can be eliminated. The adjustment range is 0...99 seconds, in steps of 0,1 seconds
	SiM1	AuS1	**Simulation** – the switching output 1 is deactivated
		Ein1	Simulation – the switching output 1 is activated
SP2			**Switching output 2** – includes all parameters concerning the switching output 2
	SP_2	MSIG	**Adjustment with applied signal** – The actual applied temperature value is captured as **switch point resp. upper switch point**
		oSIG	**Adjustment without applied signal** – The actual **switch point / upper switch point** is shown in the display and can now be adjusted by the operation keys +/- and ▷.
	rSP2	MSIG	**Adjustment with applied signal** – The actual applied temperature value is captured as **switch back point resp. lower switch point**
		oSIG	**Adjustment without applied signal** – The actual **switch back point / lower switch point** is shown in the display and can now be adjusted by the operation keys +/- and ▷.
	Fc_2	HF_2	The switching output 2 operates in **hysteresis function** with switch point and switch back point
		FF_2	The switching output 2 operates in **window function** with lower and upper switch point
	nonc	no	The switching output 2 operates in open-circuit principle resp. – **no normally open**
		nc	The switching output 2 operates in closed-circuit principle resp. – **nc normally closed**
	dSP2		**Switch delay time for switch point / upper switch point** of switching output 2. The switching output 2 is only activated, if after the entrance of the switch condition and after the set switch delay time the temperature signal already fulfills the switch conditions. By this e.g. short temperature fluctuations can be eliminated. The adjustment range is 0...99 seconds, in steps of 0,1 seconds
	drP2		**Switch delay time for switch back point / lower switch point** of switching output 2. The switching output 2 is only activated, if after the entrance of the switch back condition and after the set switch delay time the temperature signal already fulfills the switch back conditions. By this e.g. short temperature fluctuations can be eliminated. The adjustment range is 0...99 seconds, in steps of 0,1 seconds
	SiM2	AuS2	**Simulation** – the switching output 2 is deactivated
		Ein2	Simulation – the switching output 2 is activated

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menu group	function	input	description
AbGL			**Adjustment** – includes all parameters concerning the temperature adjustment
	ZEro	nS.G	**Adjustment lower temperature reference value with applied signal** - The actual applied temperature value is captured as lower temperature reference value. - The output current signal of 4mA, that can adjusted by the control keys +/- and ▷ arbitrarily is assigned to this temperature reference value. Adjustment range 3,9mA to 21mA. - The ZEro value of the display refers to this temperature reference value. - If the adjusted measuring range is lower than 25% of the nominal measuring range, the change will be refused and the display shows EEEE.
		oS.G	**Adjustment lower temperature reference value without applied signal** - The freely adjustable temperature value, in the set unit - Un.tE -, is captured as lower temperature reference value. - The ZEro value of the display refers to this temperature reference value. - The lower output current end value, 4mA, refers to this temperature reference value. - The measuring span can not be adjusted lower than 25% of the nominal measuring range.
	SPAn	nS.G	**Adjustment upper temperature reference value with applied signal** - The actual applied temperature value is captured as upper temperature reference value. - The output current signal of 20mA, that can adjusted by the control keys +/- and ▷ arbitrarily is assigned to this temperature reference value. Adjustment range 3,9mA to 21mA. - The SPAn value of the display refers to this temperature reference value. - If the adjusted measuring range is lower than 25% of the nominal measuring range, the change will be refused and the display shows EEEE.
		oS.G	**Adjustment upper temperature reference value without applied signal** - The freely adjustable temperature value, in the set unit - Un.tE -, is captured as upper temperature reference value. - The SPAn value of the display refers to this temperature reference value. - The upper output current end value, 20mA, refers to this temperature reference value. - The measuring span can not be adjusted lower than 25% of the nominal measuring range.
	oFFS		The temperature measuring value can be shift by an **offset** of up to ± 25°C. This can be necessary in unfavorable installation situations or at considerable temperature differences between medium and measurement position.
	inS	AUSA	The output current signal corresponds to the assignment of the adjustment **➔ 4...20mA**
		E.inA	The output current signal behaves inverted to the assignment of the adjustment **➔ 20...4mA**
	S.mA		The analogue current output signal can be arbitrarily **simulated** in the whole utilizable range from 3,8 mA to 22mA by using the operation keys +/- and ▷
	ErrS	oFF	The current output signal operates linear in the range from 3,9 mA to 21,0 mA. A signal output besides this limits is not possible, the end values are kept at exceedance. An **error signal current output** at underrun resp. exceedance does not occur.
		FS38	The current output signal operates linear in the range from 4,0 mA to 20,0 mA. At underrun of 4mA resp. at exceedance of 20mA a constant signal of 3,8 mA is generated.
		FS22	The current output signal operates linear in the range from 4,0 mA to 20,0 mA. At underrun of 4mA resp. at exceedance of 20mA a constant signal of 22 mA is generated.

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menu group	function	input	description
SEr			**Service** – includes all parameters concerning service purposes
	t_F		Input of the **system damping** for extraction of short temperature bursts resp. also for reassuring of cyclic fluctuating temperature signals. The adjustment range is 0...40 seconds, in steps of 0,1 seconds
	ErrM	noE	No error recorded in the **error memory.**
		brch	A wire break at the internal connections of the sensor element has been detected.
		Kur	A short circuit at the internal connections of the sensor element has been detected.
		FLAS	An error in the internal nonvolatile data memory (flash) has been detected.
		MunE	The lower measuring range limit value (display zero) has been underrun.
		MuEb	The upper measuring range limit value (display span) has been exceeded.
		AunE	The lower limit value of the analogue output, 3,9 mA, has been underrun.
		AuEb	The upper limit value of the analogue output, 21 mA, has been exceeded.
		S1oG	The switch back point rSP1 of the switching output 1 has been adjusted higher or equal to the switch point SP_1.
		S2oG	The switch back point rSP2 of the switching output 2 has been adjusted higher or equal to the switch point SP_2.
		S1oP	The switching output 1 is not activated, although it should be.
		S2oP	The switching output 2 is not activated, although is should be.
		rAM	An error in the internal working memory (RAM) has been detected.
		drFt	The exceedance of the set drift threshold value has been detected. The detection of one of these errors leads to the activation of the switching output 1, if this output is activated for error function.
	MA		**Maximum value memory** – display of the highest measured temperature value.
	Min		**Minimum value memory** – display of the lowest measured temperature value.
	drAL		A drift alarm is only made, if the set **drift threshold value**, the difference between the temperature measuring values of the two sensor elements, has been exceeded. The adjustment range is 0,2...5 K, in steps of 0,1K. This menu point is only available at devices of the series Thermocont TSD.
	drd		A drift alarm is only made, if after the exceedance of the drift threshold value and after the set drift delay time the drift threshold value has been already exceeded. By this, e.g. the different response time of the two sensor elements at temperature deviations can be compensated. The adjustment range is 0...300 seconds, in steps of 1 second. This menu point is only available at devices of the series Thermocont TSD.
	drb	AUS	The **redundancy function** is deactivated
		Ein	The redundancy function is activated. At the failure of the sensor element Pt100 the measuring is continued with the semiconductor sensor element. This menu point is only available at devices of the series Thermocont TSD.
	201		Version number of the installed firmware
FrES			**Factory Reset** – reset of all parameters to factory values
SPEi			**Storage** – loss protected storage of all parameters

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20. Error indication at operation

The red error indication light-emitting diode indicates the exceedance of operation limit values, faulty inputs or also device errors.
The information, what reason has led to an error indication can be found in each of the two ***function menus*** in the area ***extended functions*** of the menu point ***service***.
Only the last detected error is displayed.
The error information in the service menu is not stored in the case of a voltage fail.
At every restart of the device the system is completely tested concerning the parameters and settings.

light-emitting diode	**error indication in service menu**	**description / *remedy***
red yellow – flashing	no	Short circuit at the switching output, whose yellow switching condition LED is flashing. *Check the load at the respective switching output.*
red	brch	The internal self-supervision has detected a wire break of the sensor element Pt100. *If the error can not be removed after repeated restart of the device by short voltage interrupts, there can be an irreversible device defect .* *By using the redundancy function (only TSD) it can be switched to the second sensor.*
red	Kur	The internal self-supervision has detected a short circuit of the sensor element Pt100. *If the error can not be removed after repeated restart of the device by short voltage interrupts, there can be an irreversible device defect .* *By using the redundancy function (only TSD) it can be switched to the second sensor.*
red	FLAS	An error in the internal nonvolatile data memory (flash) has bee detected. *If the error can not be removed after repeated restart of the device by short voltage interrupts, there can be an irreversible device defect .*
red – flashing	Munt	The lower measuring range limit value (-50°C / -99,9°C) has been underrun. *Check the system temperature of your plant.* *This temperature may be lower than the measuring range zero value.*
red – flashing	MuEb	The upper measuring range limit value (+175°C / +200°C / +500°C) has been exceeded. *Check the system temperature of your plant.* *This temperature may be higher than the measuring range end value.*
red – flashing	Aunt	The lower limit value of the analogue signal current output, 3,9mA, has been underrun. *Check the adjustment of the analogue output. The system temperature is lower than the temperature concerning to the analogue output at 3,9mA.*
red – flashing	AuEb	The upper limit value of the analogue signal current output, 21mA, has been transgressed. *Check the adjustment of the analogue output. The system temperature is higher than the temperature concerning to the analogue output at 21mA.*
red – flashing	S1oG	The switch back point rSP1 of the switching output 1 has been adjusted higher or equal to the switch point SP_1. *Check the adjustment of the switching output 1*
red – flashing	S2oG	The switch back point rSP2 of the switching output 2 has been adjusted higher or equal to the switch point SP_2. *Check the adjustment of the switching output 2*
red – flashing	S1oP	An error has been detected at switching output 1. *Detach the output load of the switching output 1. If the error can not be removed after repeated restart of the device by short voltage interrupts, there can be an irreversible device defect .*
red – flashing	S2oP	An error has been detected at switching output 2. *Detach the output load of the switching output 2. If the error can not be removed after repeated restart of the device by short voltage interrupts, there can be an irreversible device defect .*
red – flashing	rAM	An error in the internal working memory (RAM) has been detected. *If the error can not be removed after repeated restart of the device by short voltage interrupts, there can be an irreversible device defect .*
red – flashing	drFt	The transgression of the set drift threshold value has been detected. *Increase the drift threshold value or the drift delay time.* *Replace, if necessary, the temperature switch*

EEEE	Display while operation	Wrong password entered – *Acknowledgment by control key „Enter“* Measuring range adjusted to ≤ 25% of the nominal range – *Readjustment necessary* Maximum display value of 9999 has been exceeded – *Readjustment necessary*
-EEE	Display while operation	Minimum display value of -999 has been underrun – *Readjustment necessary*

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21. Technical data

Auxiliary power supply	SELF, PELV	DIN EN 50178
Permissible supply voltage:	11,2 V to 35 V DC	polarity protected
Ripple voltage:	≤ 2 V_{PP}	condition: within the permissible supply voltage range
Supply current:	≤ 50mA	incl. analogue output with max. 22,5 mA switching output with no load

Switching outputs (S1 / S2)

Function:	PNP switching to +V_s	
Output voltage:	V_{OUT} ≥ +V_s – 2 V	
Output current:	≤ 250 mA	current limited, short circuit protected
Rise time:	< 30 µs	R_L < 3 kΩ resp. I_L > 4,5 mA
Response time:	≤ 3 ms	at set system damping 0 s
Switching cycles:	≥ 100.000.000	

Analogue output 4...20mA

Working range:	4...20mA with error current 3,8 mA resp. 22 mA or alternatively 3,9...21 mA linearly	
Permissible load:	R_L max = (V_S – 11,2 V) / 20mA + 280Ω	
Resolution:	≤ 1 µA	
Response time:	≤ 3 ms	at set system damping 0 s
Influence of supply voltage:	≤ ±0,02% FS [2] / 10V	

Measuring accuracy

Characteristic deviation TSS [5] [6]:	*Display and switching output:* ≤ ± (0,4 K + 0,002 * [t]) with [t] = process temperature in °C, no sign, with unit K	equals e.g. ≤ ± 0,6 K at ±100°C
	analogue output: ≤ characteristic deviation display and switching output + 0,1% FS [2] e.g. ≤ ±0,9 K at ±100°C / meas. range –99,9°C..+200°C / TD [7] = 1	
Characteristic deviation TSD [5]:	*display and switching output:*	≤ ±0,2 K
	analogue output:	≤ ±0,4 K
	drift supervising:	≤ ±0,2 K
Nonrecurrentability:	≤ ±0,1 K	
Long term drift [12]:	≤ ±0,1K / year [8]	
Temperature deviation [12]:	*Display and switching output:*	≤ ±0,03% FS [2] / 10 K
	Analogue output:	≤ ±0,08% FS [2] / 10 K
Response time [9]:	t_{90} ≤ 10 s at sensor tube diameter 6 mm resp. reduced tip to 6mm t_{90} ≤ 14 s at sensor tube diameter 8 mm t_{90} ≤ 17 s at sensor tube diameter 10 mm	

[2] Referring to nominal measuring span resp. full scale (FS)
[5] Limit point adjustment
[6] Specification values for analogue output only valid if set measuring range = nominal measuring range, resp. for TD [7] = 1
At TD [7] ≥ 1 (set measuring range ≤ nominal measuring range):
Specification at set measuring range = specification at nominal measuring range x TD [7]
[7] Turn-Down TD = nominal measuring range (FS [2]) / set measuring range)
[8] At reference conditions
[9] Acc. to DIN EN 60751 / water / 0,4 m/s / temperature step 23 to 33°C

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Materials

Sensor tube: (medium contact)	Steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti)
Process connection:	Steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti)
Surface roughness:	R_a < 0,8µm (sensor tube)
Neck tube:	CrNi-steel
Connection housing:	CrNi steel / PC polycarbonate
Device plug M12x1:	Socket CrNi steel, insert PUR, contacts gold-plated
Gaskets:	Medium contact ➔ FPM – fluoroelastomer EPDM – etylene-propylene-diene-rubber Other ➔ FPM – fluoroelastomer

Environmental conditions

Environmental temperature:	– 40°C...+85°C		
Process temperatures:	*TSS:*		
	Standard	– 99,9°C...+200°C	max. – 130°C...+230°C
	Extended	– 99,9°C...+500°C	max. – 130°C...+530°C
	TSD:		
	Standard	– 50°C...+175°C	max. – 55°C...+180°C

Limitation by material of gaskets type 4 / 5	Process temperature range
Gasket FPM	-25...+200°C
Gasket EPDM	-40...+130°C

Process pressure:	≤ 60 bar		
Weight:	0,3 kg		
Torque strength:	≤ 50 Nm		
Protection classification:	IP68 / 1mH_2O for 1h	DIN EN 60529	
Climatic classification:	4K4H	DIN EN 60721-3-4	
Shock classification:	50 g / 11 ms	DIN EN 60068-2-27	
Vibration classification:	20 g / 10 – 2000 Hz	DIN EN 60068-2-6	
EM – compatibility:	Emission	DIN EN 61326-1	operation device class B
	Immunity	DIN EN 61326-1	industrial range
Reference conditions:	DIN EN 60770-1 T = 25 °C, rel. humidity 45...75 %, environm. air pressure 860...1060 kPa		

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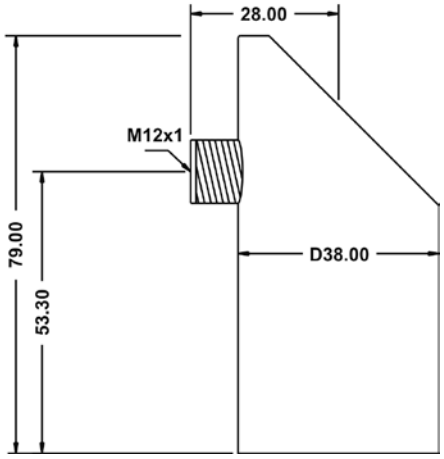
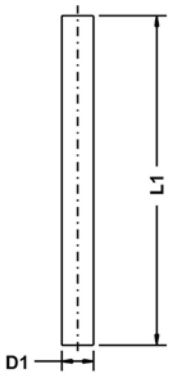
22. Dimension drawings

Connection housing



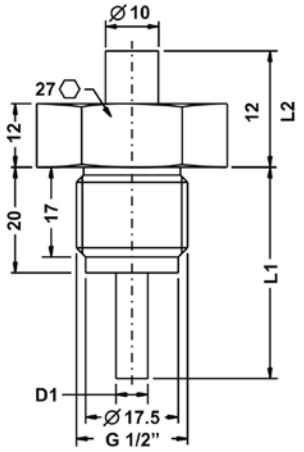
Type TS _ 0

without process connection



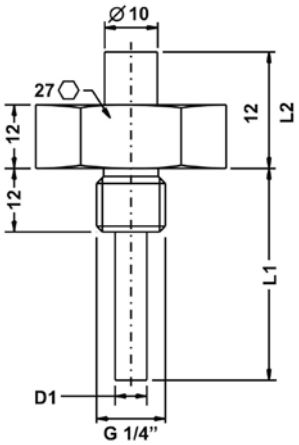
Type TS _ 1

G ½“



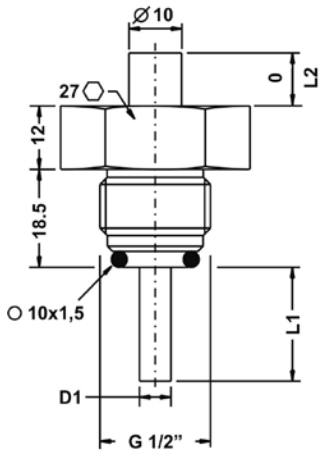
Type TS _ 3

G ¼“



Type TS _ 4 / TS _ 5

G ½“
front flush O-ring gasket



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23. Order code overview

Type:
TS Standard

Measuring system:
S Resistance sensor Pt100
D Resistance sensor Pt100 + semiconductor sensor — for drift detection and redundancy function

Process connection:

0	Without process connection	for weld in sleeve or clamp screw
1	G ½“ B DIN EN ISO228-1	
3	G ¼“ B DIN EN ISO228-1	
4	G ½“ B DIN EN ISO228-1	front flush O-ring gasket FPM (Viton®)
5	G ½“ B DIN EN ISO228-1	front flush O-ring gasket EPDM
Y	Other process connection	separate specification necessary

Sensor – diameter / material – process side (medium connection):

K	∅ 6 mm		steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti)
N	∅ 8 mm		steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti)
L	∅ 10 mm		steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti)
M	∅ 8 mm	red. tip ∅ 5mm / L 40mm	steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti) only TSS
O	∅ 10 mm	red. tip ∅ 6mm / L 40mm	steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti)
R	∅ 8 mm	red. tip ∅ 3mm / L 40mm	steel 1.4404 (AISI 316L) / 1.4571 (AISI 316Ti) only TSS
S	other diameter / material		separate specification necessary

Neck tube:

0	without neck tube		
1	with neck tube	standard length	L2 = 100mm
Y	with neck tube	other length	separate specification necessary

Material connection housing:
C CrNi steel

Measuring range:

2	-99,9°C to +200°C	only TSS
3	-99,9°C to +500°C	only TSS
4	-50°C to +175°C	only TSD
Y	Special measuring range	separate specification necessary

Electronic - output: — other output signals on request

A	2x PNP switching output		
B	1x PNP switching output	+ analogue output 4...20 mA	3-wire-technology
C	2x PNP switching output	+ analogue output 4...20 mA	3-wire-technology
D	1x PNP switching output	+ analogue output 4...20 mA	3-wire-technology connection desina compl.

0

Electrical connection:
S Plug M 12x1

Length L1 – sensor in mm

Length L2 – neck tube in mm

Thermocont TS _ _ _ _ C _ _ 0 S _ _

Installation material and connection cable are not enclosed in the delivery contents.

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