MACX MCR(-EX)-TS-I-OLP(-SP)(-C)

Output loop-powered temperature transducer for transmitting up to two sensor signals



Data sheet
108133_en_01

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1 Description

The device is an output loop-powered temperature transducer for transmitting up to two sensor signals and HART® communication for conversion of different input signals in a scalable analog 4 mA ... 20 mA output signal.

The device contains two measuring inputs for

- Resistance thermometers (RTD)
- Thermocouples (TC)
- Resistance-type sensors (Ω)
- Voltage sensors (mV)

The device can be snapped onto all 35 mm DIN rails in accordance with EN 60715.

The device can be universally programmed via the USB interface of a PC prior to installation or during measurement operation.

Features

- Safe operation in the Ex area because of international approvals
- SIL certification in accordance with IEC 61508:2010
- Reliable measurement operation through sensor monitoring and device hardware error recognition
- Diagnostic information in accordance with NAMUR NE107
- Different mounting versions and sensor connection combinations
- Write protection for device parameters

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This document is valid for the products listed in Section “Ordering data” on page 4.

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2 Ordering data

Products

Description	Type	Item No.	Pcs./Pkt.
Output loop-powered temperature transducer for transmitting up to two sensor signals from RTD and TC sensors, as well as from resistance-type sensors and voltage sensors via 4mA...20mA, Hart. Freely configurable, Safety Integrity Level (SIL, IEC 61508): 2, Systematic Capability: 3, screw connection	MACX MCR-TS-I-OLP	2908662	1
Output loop-powered temperature transducer for transmitting up to two sensor signals from RTD and TC sensors, as well as from resistance-type sensors and voltage sensors via 4mA...20mA, Hart. Freely configurable, Safety Integrity Level (SIL, IEC 61508): 2, Systematic Capability: 3, Push-in connection	MACX MCR-TS-I-OLP-SP	2908664	1
Output loop-powered temperature transducer for transmitting up to two sensor signals from RTD and TC sensors, as well as from resistance-type sensors and voltage sensors via 4mA...20mA, Hart. Order configuration, freely configurable, Safety Integrity Level (SIL, IEC 61508): 2, systematic capability: 3, screw connection	MACX MCR-TS-I-OLP-C	1012249	1
Ex-i output loop-powered temperature transducer for transmitting up to two sensor signals from RTD and TC sensors, as well as from resistance-type sensors and voltage sensors via 4mA...20mA, Hart. Freely configurable, Safety Integrity Level (SIL, IEC 61508): 2, Systematic Capability: 3, screw connection	MACX MCR-EX-TS-I-OLP	2908660	1
Ex-i output loop-powered temperature transducer for transmitting up to two sensor signals from RTD and TC sensors, as well as from resistance-type sensors and voltage sensors via 4mA...20mA, Hart. Freely configurable, Safety Integrity Level (SIL, IEC 61508): 2, Systematic Capability: 3, Push-in connection	MACX MCR-EX-TS-I-OLP-SP	2908661	1
Ex-i output loop-powered temperature transducer for transmitting up to two sensor signals from RTD and TC sensors, as well as from resistance-type sensors and voltage sensors via 4mA...20mA, HART. Order configuration, freely configurable, Safety Integrity Level (SIL, IEC 61508): 2, systematic capability: 3, screw connection	MACX MCR-EX-TS-I-OLP-C	1012248	

Accessories

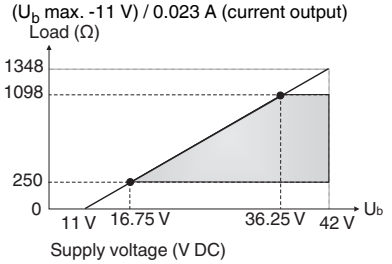
Description	Type	Item No.	Pcs./Pkt.
Programming adapter with USB and T port interface, 2.4 m for programming FA MCR-...-, MCR-...-LP-...-, and MCR-...-HT-...- modules	MCR PAC-T-USB	2309000	1

Documentation

Description	Type	Item No.	Pcs./Pkt.
Packing slip	MACX MCR-TS-I-OLP(-SP)(-C)	9076237	1
Packing slip	MACX MCR-EX-TS-I-OLP(-SP)(-C)	9076236	1

3 Technical data

Input data (see “Input measuring ranges” on page 8)	
Resistance thermometer	Pt, Ni, Cu sensors: 2, 3, 4-conductor
Thermocouple sensors	A, B, C, D, E, J, K, L, N, R, S, T, U
Linear resistance range	10 Ω ... 2,000 Ω (minimum measurement range: 10 Ω)
Input voltage range	-20 mV ... 100 mV
Temperature measuring range	
Range depending on the sensor type	-250°C ... 2,500°C
Measuring range span	
Resistance thermometer	>10 K
Thermocouples	>50 K
Resistance	>10 Ω
Voltage sensors (mV)	>5 mV

Output data	
Output signal	HART® 4 mA ... 20 mA 20 mA ... 4 mA
Current output signal, maximum	23 mA
HART® coding	FSK ±0.5 mA
HART® version	7
Transmission speed	1200 baud
Mains frequency filter	50/60 Hz
Load R_B	(U_b max. -11 V) / 0.023 A (current output) 
Communication resistance	≥250 Ω
Switch-on delay	
HART®	Approx. 10 s
Measured value	Approx. 28 s
Residual ripple	Permanent residual ripple U_{ss} ≤3 V for U_b ≥13.5 V, $f_{max.}$ = 1 kHz

Connection data	Screw connection	Push-in connection
Conductor cross-section, rigid/flexible/AWG	0.2 mm² ... 2.5 mm²/ 0.2 mm² ... 2.5 mm²/24 ... 14	0.2 mm² ... 1.5 mm²/ 0.2 mm² ... 1.5 mm²/24 ... 16
Stripping length	7 mm	8 mm
Tightening torque	0.5 ... 06 Nm	-
Screw thread	M3	-

Failure information in accordance with NAMUR NE43

Failure information is created when the measuring information is invalid or missing. A complete list of all errors occurring in the measuring system is issued.

Measuring value underrange	Linear drop of 4.0 mA ... 3.8 mA
Measuring value overrange	Linear increase from 20.0 mA ... 20.5 mA
Failure, e.g., sensor break, sensor short circuit	≤3.6 mA (“low”) or ≥21 mA (“high”) can be selected The alarm setting “high” can be set between 21.5 mA and 23 mA, in this way providing the necessary flexibility in order to fulfil the requirements of different control systems. Only the alarm setting “low” is possible in SIL mode.

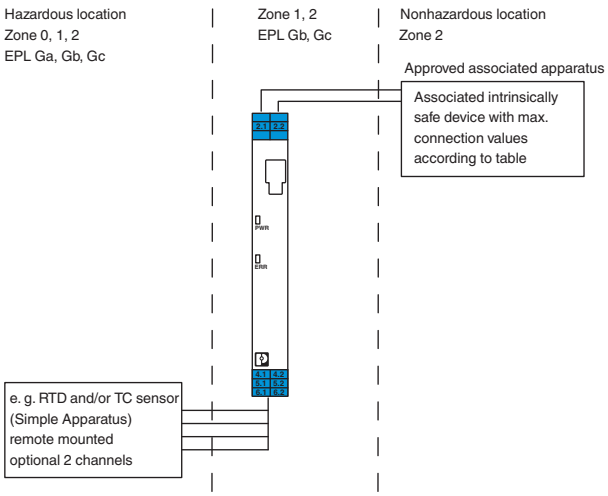
General data

Supply voltage range	
Standard	12 V ... 42 V
SIL active	12 V ... 32 V
Ex	12 V ... 30 V
Maximum current consumption	≤23 mA
Step response (0-99%)	
Thermocouples	0.8 s
Resistance thermometer	0.9 s ... 1.3 s
Ambient temperature range	
Operation	-40°C ... 85°C
Operation (SIL active)	-40°C ... 70°C
Storage/transport	-40°C ... 100°C
Humidity, non-condensing permitted	5% ... 95%
Maximum altitude for use above sea level	≤4,000 m
Climate class	B2
Degree of protection	IP20
Pollution degree	2
Overvoltage category	II
Electrical isolation of input/output	2 kV AC
Dimensions W / H / D	12.5 mm / 99 mm / 114.5 mm

Conformity / approvals

CE compliant	
ATEX	
	Ⓔx II 3G Ex nA IIC T6...T4 Gc (Item No.: 2908662/2908664/1012249)
EPS 17 ATEX 1 130 X	Ⓔx II 2 (1) G Ex ib [ia Ga] IIC T6...T4 Gb (Item No.: 2908660/2908661/1012248)
IECEx	
IECEx EPS 17.0076X	Ex ib [ia Ga] IIC T6...T4 Gb (Item No.: 2908660/2908661/1012248)
UL, USA / Canada	UL 61010 Recognized
Shipbuilding approval	
DNV GL TAA00002GX	
Temperature	D
Humidity	B
Vibration	A
EMC	B
Enclosure	A
Safety Integrity Level (SIL, IEC 61508)	2
Systematic Capability	3
CSA	See Control Drawing in the packing slip
FM	See Control Drawing in the packing slip

3.1 Safety-related data MACX MCR-EX-TS-I-OLP(-SP)(-C) (Item No.: 2908660/2908661/1012248)



Supply		Terminals 2.1 (+) and 2.2 (-)
U_I	=	≤30 V DC
I_I	=	≤130 mA
P_I	=	≤770 mW
C_i	=	Negligible
L_i	=	Negligible

Sensor circuit		Terminals 4.1, 4.2, 5.1, 5.2, 6.1, 6.2
U_O	=	≤9 V DC
I_O	=	≤13 mA
P_O	=	≤29.3 mW

Sensor circuit		Max. connection values				
Ex ia IIC	C_o	=	0.93 µF	L_o	=	5 mH
Ex ia IIB	C_o	=	3.8 µF	L_o	=	20 mH
Ex ia IIA	C_o	=	4.8 µF	L_o	=	50 mH

Temperature classes		
T6	=	-40°C ... 46°C
T5	=	-40°C ... 61°C
T4	=	-40°C ... 85°C

Electrical connection values		
U_b	=	12 V DC ... 30 V DC
OUT	=	4 mA ... 20 mA
Power consumption	=	≤23 mA

Category	Type of protection (ATEX)	Type of protection (IEC)
II2(1)G	Ex ib [ia Ga] IIC T6...T4 Gb	Ex ib [ia Ga] IIC T6...T4 Gb

3.2 Input measuring ranges

Table 1 Resistance thermometer and resistance-type sensor

Standard	Designation	Measuring range limits	Measurement deviation (±)		
			Digital [1]		D/A [2]
			Maximum[3]	Related to measured value	
IEC 60751:2008	Pt 100 (1)	–200°C … +850°C (–328°F … +1,562°F)	≤0.12°C (0.21°F)	0.06°C (0.11°F) + 0.006% x (MV - MRS)	0.03% (4.8 µA)
	Pt 200 (2)	–200°C … +850°C (–328°F … +1,562°F)	≤0.30°C (0.54°F)	0.11°C (0.2°F) + 0.018% x (MV - MRS)	
	Pt 500 (3)	–200°C … +510°C (–328°F … +950°F)	≤0.16°C (0.29°F)	0.05°C (0.09°F) + 0.015% x (MV - MRS)	
	Pt 1000 (4)	–200°C … +250°C (–328°F … +482°F)	≤0.09°C (0.16°F)	0.03°C (0.05°F) + 0.013% x (MV - MRS)	
JIS C1604:1984	Pt 100 (5)	–200°C … +510°C (–328°F … +950°F)	≤0.09°C (0.16°F)	0.05°C (0.09°F) + 0.006% x (MV - MRS)	
GOST 6651-94	Pt 50 (8)	–185°C … +1,100°C (–301°F … +2,012°F)	≤0.20°C (0.36°F)	0.1°C (0.18°F) + 0.008% x (MV - MRS)	
	Pt 100 (9)	–200°C … +850°C (–328°F … +1,562°F)	≤0.11°C (0.2°F)	0.05°C (0.09°F) + 0.006% x (MV - MRS)	
DIN 43760 IPTS-68	Ni 100 (6)	–60°C … +250°C (–76°F … +482°F)	≤0.05°C (0.09°F)	0.05°C (0.09°F) – 0.006% x (MV - MRS)	
	Ni 120 (7)	–60°C … +250°C (–76°F … +482°F)	≤0.05°C (0.09°F)	0.05°C (0.09°F) – 0.006% x (MV - MRS)	
OIML R84: 2003, GOST 6651-2009	Cu 50 (10)	–180°C … +200°C (–292°F … +392°F)	≤0.11°C (0.2°F)	0.09°C (0.16°F) + 0.006% x (MV - MRS)	
	Cu 100 (11)	–180°C … +200°C (–292°F … +392°F)	≤0.06°C (0.11°F)	0.05°C (0.09°F) + 0.003% x (MV - MRS)	
	Ni 100 (12)	–60°C … +180°C (–76°F … +356°F)	≤0.05°C (0.09°F)	0.05°C (0.09°F) – 0.005% x (MV - MRS)	
	Ni 120 (13)	–60°C … +180°C (–76°F … +356°F)	≤0.05°C (0.09°F)	0.05°C (0.09°F) – 0.005% x (MV - MRS)	
OIML R84: 2003, GOST 6651-94	Cu 50 (14)	–50°C … +200°C (–58°F … +392°F)	≤0.11°C (0.02°F)	0.1°C (0.18°F) + 0.004% x (MV - MRS)	
Resistance-type sensor	Resistance Ω	10 Ω ... 400 Ω	32 mΩ		0.03% (4.8 µA)
		10 Ω ...2000 Ω	300 mΩ		

[1] Measured value transmitted with HART®

[2] Percent values with regard to the configured measuring range of the analog output signal

[3] Maximum measurement deviation from the specified measuring range

Table 2 Thermocouples and voltage sensors

Standard	Designation	Measuring range	Measurement deviation (±)		
			Digital [1]		D/A [2]
			Maximum[3]	Related to measured value	
IEC 60584-1	Type A (30)	0°C … +2,500°C (+32°F … +4,532°F)	≤1.33°C (2.39°F)	0.8°C (1.44°F) + 0.021% x MV	0.03% (4.8 µA)
	Type B (31)	+500°C … +1,820°C (+932°F … +3,308°F)	≤1.5°C (2.7°F)	1.5°C (2.7°F) – 0.06% x (MV - MRS)	
IEC 60584-1; ASTM E988-96	Type C (32)	0°C … +2,000°C (+32°F … +3,632°F)	≤0.68°C (1.22°F)	0.55°C (1.0°F) + 0.0055% x MV	
ASTM E988-96	Type D (33)	0°C … +2,000°C (+32°F … +3,632°F)	≤0.75°C (1.35°F)	0.75°C (1.35°F) + 0.008% x MV	
IEC 60584-1	Type E (34)	–150°C … +1,000°C (–238°F … +1,832°F)	≤0.22°C (0.4°F)	0.22°C (0.4°F) – 0.006% x (MV - MRS)	
	Type J (35)	–150°C … +1,200°C (–238°F … +2,192°F)	≤0.26°C (0.47°F)	0.27°C (0.49°F) – 0.005% x (MV - MRS)	
	Type K (36)	–150°C … +1,200°C (–238°F … +2,192°F)	≤0.35°C (0.63°F)	0.35°C (0.63°F) – 0.005% x (MV - MRS)	
	Type N (37)	–150°C … +1,300°C (–238°F … +2,372°F)	≤0.48°C (0.86°F)	0.48°C (0.86°F) – 0.014% x (MV - MRS)	
	Type R (38)	+50°C … +1,768°C (+122°F … +3,214°F)	≤1.12°C (2.0°F)	1.12°C (2.0°F) – 0.03% x (MV - MRS)	
	Type S (39)	+50°C … +1,768°C (+122°F … +3,214°F)	≤1.15°C (2.07°F)	1.15°C (2.07°F) – 0.022% x (MV - MRS)	
	Type T (40)	–150°C … +400°C (–238°F … +752°F)	≤0.36°C (0.65°F)	0.36°C (0.65°F) – 0.04% x (MV - MRS)	
DIN 43710	Type L (41)	–150°C … +900°C (–238°F … +1,652°F)	≤0.29°C (0.52°F)	0.29°C (0.52°F) – 0.009% x (MV - MRS)	
	Type U (42)	–150°C … +600°C (–238°F … +1,112°F)	≤0.33°C (0.6°F)	0.33°C (0.6°F) – 0.028% x (MV - MRS)	
GOST R8.8585-20 01	Type L (43)	–200°C … +800°C (–328°F … +1,472°F)	≤2.2°C (3.89°F)	2.2°C (3.96°F) – 0.015% x (MV - MRS)	
Voltage sensors (mV)		–20 mV … +100 mV	10 µV	7.7 µV + 0.0025% x (MV - MRS)	4.8 µA

[1] Measured value transmitted with HART®

[2] Percent values with regard to the configured measuring range of the analog output signal

[3] Maximum measurement deviation from the specified measuring range

MV = Measured value

MRS = Measuring range start value of the relevant sensor

Total measurement deviation of the measuring transducer at the current output = √(Measurement deviation digital^2 + Measurement deviation D/A^2)

Sample calculation with Pt 100, 0°C … +200°C (+32°F … +392°F) measuring range, 25°C (77°F) ambient temperature, 24 V supply voltage

Measurement deviation digital = 0.06°C + 0.006% x (200°C - (-200°C)):	0.084°C (0.151°F)
Measurement deviation D/A = 0.03% of 200°C (360°F)	0.06°C (0.108°F)
Measurement deviation of digital value (HART®):	0.084°C (0.151°F)
Measurement deviation of analog value (current output): √(Measurement deviation digital^2 + Measurement deviation D/A^2)	0.103°C (0.185°F)

Sample calculation with Pt 100, 0°C … +200°C (+32°F … +392°F) measuring range, 35°C (95°F) ambient temperature, 30 V supply voltage

Measurement deviation digital = 0.06°C + 0.006% x (200°C - (-200°C)):	0.084°C (0.151°F)
Measurement deviation D/A = 0.03% of 200°C (360°F)	0.06°C (0.108°F)
Influence of the ambient temperature (digital) = (35 - 25) x (0.002% x 200°C - (-200°C)), mind. 0.005°C	0.08°C (0.144°F)
Influence of the ambient temperature (D/A) = (35 - 25) x (0.001% x 200°C)	0.02°C (0.036°F)
Influence of the supply voltage (digital) = (30 - 24) x (0.002% x 200°C - (-200°C)), mind. 0.005°C	0.048°C (0.086°F)
Influence of the supply voltage (D/A) = (30 - 24) x (0.001% x 200°C)	0.012°C (0.022°F)
Measurement deviation of digital value (HART®): √(Measurement deviation digital^2 + Influence of ambient temperature (digital)^2 + Influence of supply voltage (digital)^2	0.126°C (0.227°F)
Measurement deviation of analog value (current output): √(Measurement deviation digital^2 + Measurement deviation D/A^2 + Influence of ambient temperature (digital)^2 + Influence of ambient temperature (D/A)^2 + Influence of supply voltage (digital)^2 + Influence of supply voltage (D/A)^2	0.141°C (0.254°F)



In SIL mode, other measurement deviations apply (see “Safety measurement deviation” on page 64).

Operational influence

The information on the measurement deviation correspond to an extended measuring insecurity of ±2 s (Gaussian normal distribution). Information under reference conditions. Total measurement deviation of the temperature transducer at the voltage output = measurement deviation digital + measurement deviation D/A.

Operational influence taken into account:
- Long-term drift
- Influence of the ambient temperature
- Influence of the supply voltage

Table 3 Resistance thermometer and resistance-type sensor

Standard	Designation	Ambient temperature: effect (±) per 1°C (1.8°F) change			Supply voltage: effect (±) per V change		
		Digital [1]		D/A [2]	Digital [1]		D/A [2]
		Maximum	Related to measured value		Maximum	Related to measured value	
IEC 60751:2008	Pt 100 (1)	≤0.02°C (0.036°F)	0.002% x (MV - MRS), min. 0.005°C (0.009°F)	0.001%	≤0.02°C (0.036°F)	0.002% x (MV - MRS), min. 0.005°C (0.009°F)	0.001%
	Pt 200 (2)	≤0.026°C (0.047°F)	-		≤0.026°C (0.047°F)	-	
	Pt 500 (3)	≤0.014°C (0.025°F)	0.002% x (MV - MRS), min. 0.009°C (0.016°F)		≤0.014°C (0.025°F)	0.002% x (MV - MRS), min. 0.009°C (0.016°F)	
	Pt 1000 (4)	≤0.01°C (0.018°F)	0.002% x (MV - MRS), min. 0.004°C (0.007°F)		≤0.01°C (0.018°F)	0.002% x (MV -MRS), min. 0.004°C (0.007 F	
JIS C1604:1984	Pt 100 (5)		0.002% x (MV - MRS), min. 0.005°C (0.009°F)			0.002% x (MV - MRS), min. 0.005°C (0.009°F)	
GOST 6651-94	Pt 50 (8)	≤0.03°C (0.054°F)	0.002% x (MV - MRS), min. 0.01°C (0.018°F)		≤0.03°C (0.05°F)	0.002% x (MV - MRS), min. 0.01°C (0.018°F)	
	Pt 100 (9)	≤0.02°C (0.036°F)	0.002% x (MV - MRS), min. 0.005°C (0.009°F)		≤0.02°C (0.036°F)	0.002% x (MV - MRS), min. 0.005°C (0.009°F)	
DIN 43760 IPTS-68	Ni 100 (6)	≤0.005°C (0.009°F)	-		≤0.005°C (0.009°F)	-	
	Ni 120 (7)		-			-	
OIML R84: 2003, GOST 6651-2009	Cu 50 (10)	≤0.008°C (0.014°F)	-		≤0.008°C (0.014°F)	-	
	Cu 100 (11)		0.002% x (MV - MRS), min. 0.004°C (0.007°F)			0.002% x (MV - MRS), min. 0.004°C (0.007°F)	
	Ni 100 (12)	≤0.004°C (0.007°F)	-		≤0.004°C (0.007°F)	-	
	Ni 120 (13)		-			-	
OIML R84: 2003, GOST 6651-94	Cu 50 (14)	≤0.008°C (0.014°F)	-		≤0.008°C (0.014°F)	-	
Resistance-type sensors							
10 Ω ... 400 Ω		≤6 mΩ	0.015% x (MV -MRS), min. 1.5 mΩ	0.001%	≤6 mΩ	0.015% x (MV -MRS), min. 1.5 mΩ	0.001%
10 Ω ... 2,000 Ω		≤30 mΩ	0.0015% x (MV -MRS), min. 15 mΩ		≤30 mΩ	0.0015% x (MV -MRS), min. 15 mΩ	

[1] Measured value transmitted with HART®

[2] Percent values with regard to the configured measuring range of the analog output signal

Table 4 Thermocouples and voltage sensors

Standard	Designation	Ambient temperature: effect (±) per 1°C (1.8°F) change			Supply voltage: effect (±) per V change		
		Digital [1]		D/A [2]	Digital [1]		D/A [2]
		Maximum	Related to measured value		Maximum	Related to measured value	
IEC 60584-1	Type A (30)	≤0.14°C (0.25°F)	0.0055% x (MV - MRS), min. 0.03°C (0.054°F)	0.001%	≤0.13°C (0.23°F)	0.0055% x (MV - MRS), min. 0.03°C (0.054°F)	0.001%
	Type B (31)	≤0.06°C (0.11°F)	-		≤0.01°C (0.02°F)	-	
IEC 60584-1; ASTM E988-96	Type C (32)	≤0.09°C (0.16°F)	0.0045% x (MV - MRS), min. 0.03°C (0.054°F)		≤0.08°C (0.14°F)	0.0045% x (MV - MRS), min. 0.03°C (0.054°F)	
ASTM E988-96	Type D (33)	≤0.08°C (0.14°F)	0.004% x (MV - MRS), min. 0.035°C (0.063°F)		≤0.09°C (0.16°F)	0.004% x (MV - MRS), min. 0.035°C (0.063°F)	
IEC 60584-1	Type E (34)	≤0.02°C (0.04°F)	0.003% x (MV - MRS), min. 0.016°C (0.029°F)		≤0.03°C (0.05°F)	0.003% x (MV - MRS), min. 0.016°C (0.029°F)	
	Type J (35)	≤0.08°C (0.14°F)	0.0028% x (MV - MRS), min. 0.02°C (0.036°F)		≤0.04°C (0.07°F)	0.0028% x (MV - MRS), min. 0.02°C (0.036°F)	
	Type K (36)	≤0.04°C (0.07°F)	0.003% x (MV - MRS), min. 0.013°C (0.023°F)		≤0.04°C (0.07°F)	0.003% x (MV - MRS), min. 0.013°C (0.023°F)	
	Type N (37)		0.0028% x (MV - MRS), min. 0.020°C (0.036°F)			0.0028% x (MV - MRS), min. 0.020°C (0.036°F)	
	Type R (38)	≤0.06°C (0.11°F)	0.0035% x (MV - MRS), min. 0.047°C (0.085°F)		≤0.05°C (0.09°F)	0.0035% x (MV - MRS), min. 0.047°C (0.085°F)	
	Type S (39)	≤0.05°C (0.09°F)	-			-	
	Type T (40)	≤0.01°C (0.02°F)	-		≤0.01°C (0.02°F)	-	
DIN 43710	Type L (41)	≤0.02°C (0.04°F)	-		≤0.03°C (0.05°F)	-	
	Type U (42)	≤0.01°C (0.02°F)	-		≤0.02°C (0.04°F)	-	
GOST R8.8585-20 01	Type L (43)	≤0.01°C (0.02°F)	-		≤0.03°C (0.05°F)	-	
Voltage sensor (mV)							
-20 mV ... 100 mV	-	≤3 µV	-	0.001%	≤3 µV	-	0.001%

[1] Measured value transmitted with HART®

[2] Percent values with regard to the configured measuring range of the analog output signal

MV = Measured value

MRS = Measuring range start value of the relevant sensor

Total measurement deviation of the temperature transducer at the current output = √(Measurement deviation digital^2 + Measurement deviation D/A^2)

Table 5 Long-term drift resistance thermometer and resistance-type sensor

Standard	Designation	Long-term drift (±)		
		After 1 year	After 3 years	After 5 years
		Related to measured value		
IEC 60751:2008	Pt 100 (1)	≤0.03°C (0.05°F) + 0.024% x MV - MRS	≤0.042°C (0.076°F) + 0.035% x measuring span	≤0.051°C (0.092°F) + 0.037% x measuring span
	Pt 200 (2)	≤0.17°C (0.31°F) + 0.016% x measuring span	≤0.28°C (0.5°F) + 0.022% x measuring span	≤0.343°C (0.617°F) + 0.025% x measuring span
	Pt 500 (3)	≤0.067°C (0.121°F) + 0.018% x measuring span	≤0.111°C (0.2°F) + 0.025% x measuring span	≤0.137°C (0.246°F) + 0.028% x measuring span
	Pt 1000 (4)	≤0.034°C (0.06°F) + 0.02% x measuring span	≤0.056°C (0.1°F) + 0.029% x measuring span	≤0.069°C (0.124°F) + 0.032% x measuring span
JIS C1604:1984	Pt 100 (5)	≤0.03°C (0.054°F) + 0.022% x measuring span	≤0.042°C (0.076°F) + 0.032% x measuring span	≤0.051°C (0.092°F) + 0.034% x measuring span
GOST 6651-94	Pt 50 (8)	≤0.055°C (0.1°F) + 0.023% x measuring span	≤0.089°C (0.16°F) + 0.032% x measuring span	≤0.1°C (0.18°F) + 0.035% x measuring span
	Pt 100 (9)	≤0.03°C (0.054°F) + 0.024% x measuring span	≤0.042°C (0.076°F) + 0.034% x measuring span	≤0.051°C (0.092°F) + 0.037% x measuring span
DIN 43760 IPTS-68	Ni 100 (6)	≤0.025°C (0.045°F) + 0.016% x measuring span	≤0.042°C (0.076°F) + 0.02% x measuring span	≤0.047°C (0.085°F) + 0.021% x measuring span
	Ni 120 (7)	≤0.021°C (0.038°F) + 0.018% x measuring span	≤0.032°C (0.058°F) + 0.024% x measuring span	≤0.036°C (0.065°F) + 0.025% x measuring span
OIML R84: 2003, GOST 6651-2009	Cu 50 (10)	≤0.053°C (0.095°F) + 0.013% x measuring span	≤0.084°C (0.151°F) + 0.016% x measuring span	≤0.094°C (0.169°F) + 0.016% x measuring span
	Cu 100 (11)	≤0.027°C (0.049°F) + 0.019% x measuring span	≤0.042°C (0.076°F) + 0.026% x measuring span	≤0.047°C (0.085°F) + 0.027% x measuring span
	Ni 100 (12)	≤0.026°C (0.047°F) + 0.015% x measuring span	≤0.04°C (0.076°F) + 0.02% x measuring span	≤0.046°C (0.083°F) + 0.02% x measuring span
	Ni 120 (13)	≤0.021°C (0.038°F) + 0.017% x measuring span	≤0.034°C (0.061°F) + 0.022% x measuring span	≤0.038°C (0.068°F) + 0.023% x measuring span
OIML R84: 2003, GOST 6651-94	Cu 50 (14)	≤0.056°C (0.1°F) + 0.009% x measuring span	≤0.089°C (0.16°F) + 0.011% x measuring span	≤0.1°C (0.18°F) + 0.011% x measuring span
Resistance-type sensors				
10 Ω ... 400 Ω		≤10 mΩ + 0.022% x measuring span	≤14 mΩ + 0.031% x measuring span	≤16 mΩ + 0.033% x measuring span
10 Ω ... 2,000 Ω		≤44 mΩ + 0.019% x measuring span	≤238 mΩ + 0.026% x measuring span	≤294 mΩ + 0.028% x measuring span

Table 6 Long-term drift thermocouples and voltage sensors

Standard	Designation	Long-term drift (±)		
		After 1 year	After 3 years	After 5 years
		Related to measured value		
IEC 60584-1	Type A (30)	≤0.17°C (0.306°F) + 0.021% x measuring span	≤0.27°C (0.486°F) + 0.03% x measuring span	≤0.38°C (0.683°F) + 0.035% x measuring span
	Type B (31)	≤0.5°C (0.9°F)	≤0.75°C (1.35°F)	≤1.0°C (1.8°F)
IEC 60584-1; ASTM E988-96	Type C (32)	≤0.15°C (0.27°F) + 0.018% x measuring span	≤0.24°C (0.43°F) + 0.026% x measuring span	≤0.34°C (0.61°F) + 0.027% x measuring span
ASTM E988-96	Type D (33)	≤0.21°C (0.38°F) + 0.015% x measuring span	≤0.34°C (0.61°F) + 0.02% x measuring span	≤0.47°C (0.85°F) + 0.02% x measuring span
IEC 60584-1	Type E (34)	≤0.06°C (0.11°F) + 0.018% x measuring span	≤0.09°C (0.162°F) + 0.025% x measuring span	≤0.13°C (0.234°F) + 0.026% x measuring span
	Type J (35)	≤0.06°C (0.11°F) + 0.019% x measuring span	≤0.1°C (0.18°F) + 0.025% x measuring span	≤0.14°C (0.252°F) + 0.027% x measuring span
	Type K (36)	≤0.09°C (0.162°F) + 0.017% x (MV + 150°C (270°F))	≤0.14°C (0.252°F) + 0.023% x measuring span	≤0.19°C (0.342°F) + 0.024% x measuring span
	Type N (37)	≤0.13°C (0.234°F) + 0.015% x (MV + 150°C (270°F))	≤0.2°C (0.36°F) + 0.02% x measuring span	≤0.28°C (0.5°F) + 0.02% x measuring span
	Type R (38)	≤0.31°C (0.558°F) + 0.011% x (MV + 50°C (90°F))	≤0.5°C (0.9°F) + 0.013% x measuring span	≤0.69°C (1.241°F) + 0.011% x measuring span
	Type S (39)	≤0.31°C (0.558°F) + 0.011% x measuring span		≤0.7°C (1.259°F) + 0.011% x measuring span
	Type T (40)	≤0.09°C (0.162°F) + 0.011% x measuring span	≤0.15°C (0.27°F) + 0.013% x measuring span	≤0.2°C (0.36°F) + 0.012% x measuring span
DIN 43710	Type L (41)	≤0.06°C (0.108°F) + 0.017% x measuring span	≤0.1°C (0.18°F) + 0.022% x measuring span	≤0.14°C (0.252°F) + 0.022% x measuring span
	Type U (42)	≤0.09°C (0.162°F) + 0.013% x measuring span	≤0.14°C (0.252°F) + 0.017% x measuring span	≤0.2°C (0.360°F) + 0.015% x measuring span
GOST R8.8585-20 01	Type L (43)	≤0.08°C (0.144°F) + 0.015% x measuring span	≤0.12°C (0.216°F) + 0.02% x measuring span	≤0.17°C (0.306°F) + 0.02% x measuring span
Voltage sensor (mV)				
-20 mV ... 100 mV	-	≤2 µV + 0.022% x measuring span	≤3.5 µV + 0.03% x measuring span	≤4.7 µV + 0.033% x measuring span

4 Safety notes

4.1 MACX MCR-TS-I-OLP(-SP)(-C) (Item No.: 2908662/2908664/1012249)

4.1.1 Installation notes

- The device is an item of equipment (category 3) with “non-sparking equipment” type of protection and may be installed in zones up to zone 2. It satisfies the requirements of the following standards.

  IEC/EN 60079-0, IEC/EN 60079-15

  For detailed information, please refer to the declarations of conformity.
- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described.
- When installing and operating the device, observe the applicable regulations and safety directives (including national safety directives), as well as the generally recognized technical regulations.
- Observe the safety information, conditions, and limits of use specified in the product documentation. Comply with them.
- Install the device in accordance with the manufacturer’s information and the valid standards and regulations (e.g. IEC/EN 60079-14).
- Do not open or make changes to the device.
- The IP20 degree of protection (IEC/EN 60529) of the device is intended for use in a clean and dry environment. Do not subject the device to mechanical and/or thermal stress that exceeds the specified limits.
- Do not repair the device yourself; replace it with an equivalent device. Repairs may only be carried out by the manufacturer. The manufacturer is not liable for damage resulting from non-compliance.
- The device complies with the EMC regulations for industrial areas (EMC class B). When used in residential areas, the device may cause radio interference.
- Operate the device only under the approved ambient conditions.
- Only operate the device when it has no errors and is in an operationally reliable condition.

4.1.2 Installation in potentially explosive areas (zone 2)

- Observe the specified conditions for use in potentially explosive areas! For installation in Zone 2, the devices must be installed in a suitable housing that satisfies the demands of IEC/EN 60079-15 (at least IP54) or a different type of protection in accordance with IEC/EN 60079-0, Section 1.
- In potentially explosive areas, connecting and disconnecting cables and plugs in non-intrinsically safe circuits and the latching of devices onto and unlatching devices from the DIN rail connector is only permitted in a de-energized state or when the atmosphere is not potentially explosive.
- Only devices which are designed for operation in Ex zone 2 and are suitable for the conditions at the installation location may be connected to circuits in Ex zone 2.
- In potentially explosive areas, only connect and disconnect cables when the power is disconnected.
- The device must be stopped and immediately removed from the Ex area if it is damaged, was subjected to an impermissible load, stored incorrectly, or if it malfunctions.
- For operation at ambient temperatures below -20°C, use suitable cables and cable entries approved for this application.
- During installation ensure that the used housing and cable glands correspond to the requirements of the IEC/EN 60079-0 for category 3 or group III housing.
- At ambient temperatures above +70°C, use suitable heat-resistant cables, cable entries, and seals whose operating temperature is Ta +5 K above the ambient temperature.
- Set up the device such that electrostatic charge is not possible, for example by installing it in a grounded housing.
- Do not use the programming interface for configuration in a potentially explosive area.

4.2 MACX MCR-EX-TS-I-OLP(-SP)(-C) (Item No.: 2908660/2908661/1012248)

4.2.1 Installation notes

- The device is an item of equipment (category 2) with “intrinsic safety” type of protection, and may be installed in zones up to zone 1. It satisfies the requirements of the following standards.

  EN/IEC 60079-0, EN/IEC 60079-11

  For detailed information, please refer to the declarations of conformity.
- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described.
- When installing and operating the device, observe the applicable regulations and safety directives (including national safety directives), as well as the generally recognized technical regulations.
- Observe the safety information, conditions, and limits of use specified in the product documentation. Comply with them.
- Install the device in accordance with the manufacturer’s information and the valid standards and regulations (e.g. IEC/EN 60079-14).
- Do not open or make changes to the device.
- The IP20 degree of protection (IEC/EN 60529) of the device is intended for use in a clean and dry environment. Do not subject the device to mechanical and/or thermal stress that exceeds the specified limits.
- Do not repair the device yourself; replace it with an equivalent device. Repairs may only be carried out by the manufacturer. The manufacturer is not liable for damage resulting from non-compliance.
- The device complies with the EMC regulations for industrial areas (EMC class B). When used in residential areas, the device may cause radio interference.
- Operate the device only under the approved ambient conditions.
- Only operate the device when it has no errors and is in an operationally reliable condition.
- The device is intended for installation in a control box.

4.2.2 Installation in potentially explosive areas

- The device must be stopped and immediately removed from the Ex area if it is damaged, was subjected to an impermissible load, stored incorrectly, or if it malfunctions.
- During installation make sure that the safety distance between the intrinsically safe circuits and the non-intrinsically safe circuits is 50 mm.
- In potentially explosive areas, connecting and disconnecting cables and plugs in non-intrinsically safe circuits and the latching of devices onto and unlatching devices from the DIN rail connector is only permitted in a de-energized state or when the atmosphere is not potentially explosive.
- When interconnecting the measuring device with certified intrinsically safe circuits of the category “ib” with the explosion protection group IIC or IIB, the type of protection changes: Ex ib IIC or Ex ib IIB.
- Do not use the programming interface for configuration in a potentially explosive area.
- This equipment may be used in accordance with the manufacturer’s information in zone 1 (category 2) or zone 2 (category 3).
- The safe sensor circuit may be introduced into zone 0 (category 1).
- The device is approved for intrinsically safe (Ex i) circuits up to zone 0 (gas) of the Ex area. The safety values of the intrinsically safe equipment and of the connecting cables must be observed during connection (IEC/EN 60079-14) and must comply with the values specified in these installation notes or the EC examination certificate.
- During measurements on the intrinsically safe side, the relevant regulations with regard to the connection of intrinsically safe equipment must be observed. Only use measuring devices approved for intrinsically safe circuits.
- If the device has been used in non-intrinsically safe circuits, it must not be used again in intrinsically safe circuits. The device must be clearly marked as non-intrinsically safe.

4.3 Occupational safety

When working on and with the device, wear the required personal safety equipment as stipulated by national regulations.

4.4 Operational safety

Risk of injury

– Only operate the device when it has no errors and is in an operationally safe condition.
– The operator is responsible for error-free operation of the device.

4.5 Product safety

This measuring device has been built and tested for operational safety in line with the latest technology and good engineering practice. The device left the factory in a safe and error-free condition.

The device fulfils general safety and legal requirements.

The device complies with the EC directives that are listed in the device-specific EC declaration of conformity. By affixing the CE mark, Phoenix Contact confirms this situation.

5 Scope of supply

The scope of supply of the device consists of:

– Temperature transducer
– Packing slip with installation and safety notes, and initial commissioning

6 Installation

6.1 Transport and storage

Please note the following points:

- Pack the device for storage and transport so that it is protected against shock. The original packaging provides optimum protection for this.
- The permissible storage temperature is -40°C … +100°C (-40°F … +212°F).

6.2 Installation conditions

Operating temperature range:

– -40°C … +85°C (–40°F … 185°F)
– SIL operation: –40°C … 70°C (-40°F … 158°F)

6.3 Installation dimensions

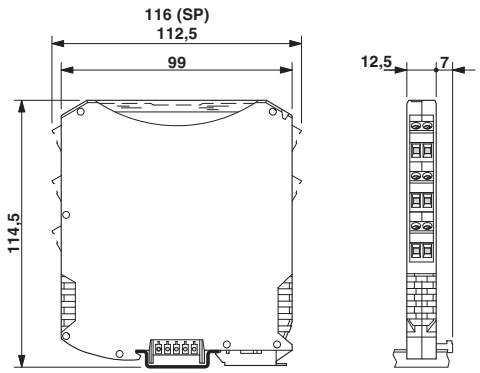


Figure 1 Dimensions

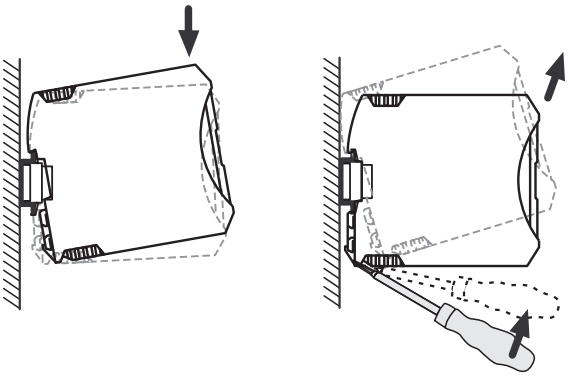
6.4 Mounting location

The device can be snapped onto all 35 mm DIN rails in accordance with EN 60715.

6.5 Mounting

NOTE: Electrostatic discharge

Take protective measures against electrostatic discharge before opening the front cover.



An ME 6,2 TBUS-2 DIN rail connector (Item No.: 2869728) is used to supply active devices. A DIN rail connector is not required to operate this passive device.

This device can be snapped onto a DIN rail connector – an electrically conductive connection is not established. This means that there is no need to disconnect an existing DIN rail connector element connection.

6.6 Installation check

- Is the device undamaged (visual inspection)?
- Do the ambient conditions correspond to the device specifications?

6.7 Electrical connection

WARNING: Risk of electric shock!

Keep the device disconnected from the power supply when making electrical connections.

NOTE: Damage to the electronics

Use the programming interface only for the programming adapter.

Violation can lead to the destruction of the electronics.

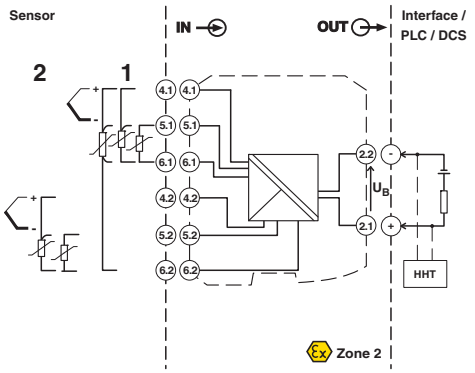


Figure 2 Terminal connection assignment MACX MCR-TS-I-OLP(-SP)(-C) (Item No.: 2908662/2908664/1012249)

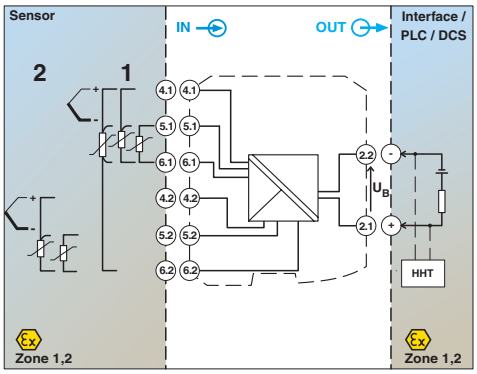


Figure 3 Terminal connection assignment MACX MCR-EX-TS-I-OLP(-SP)(-C) (Item No.: 2908660/2908661/1012248)

A minimum load of 250 Ω is required in the signal circuit for device operation via the HART® protocol (terminals 1 and 2).

NOTE: Damage to the device by high-energy transients

Provide suitable upstream surge protection.

6.7.1 Connecting the cables

Screw connection

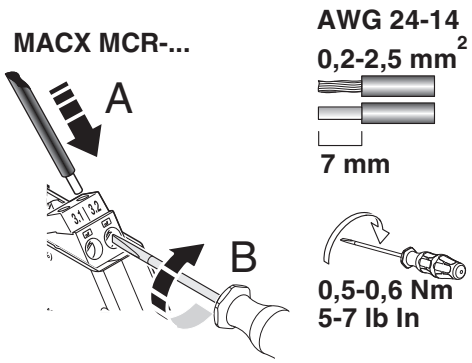


Figure 4 Screw connection

- Strip the conductor by 7 mm and crimp with ferrules.
- Insert the conductor into the corresponding connection terminal block.
- Use a screwdriver to tighten the screw in the opening above the connection terminal block.

  Tightening torque: 0.6 Nm

Push-in connection

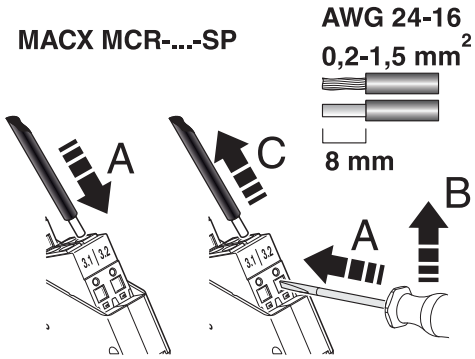


Figure 5 Push-in connection

If you want to use conductors with ferrule:

- Strip the conductor by 8 mm and crimp with ferrules.
- Insert the conductor into the corresponding connection terminal block.
- To release, press the pushbutton using a screwdriver.

If you want to use conductors without ferrule:

- Push the pushbutton in with a screwdriver.
- Insert the conductor into the corresponding connection terminal block.
- To release, press the pushbutton using a screwdriver.

6.7.2 Connecting the sensor cables

NOTE: Invalid measured values

Make sure that while connecting the two sensors there is no direct connection between the sensors (e.g. through the grounding of both sensors).

The resulting compensating currents lead to considerable distortions of the measurement.

If you cannot ensure this, then you must use two temperature transducers.

The following assignments are possible:

		Sensor input 1			
		RTD or resistance-type sensor, 2-conductor	RTD or resistance-type sensor, 3-conductor	RTD or resistance-type sensor, 4-conductor	Thermocouple (TC), voltage transmitter
Sensor input 2	RTD or resistance-type sensor, 2-conductor	Yes	Yes	No	Yes
	RTD or resistance-type sensor, 3-conductor	Yes	Yes	No	Yes
	RTD or resistance-type sensor, 4-conductor	No	No	No	No
	Thermocouple (TC), voltage transmitter	Yes	Yes	Yes	Yes

6.7.3 Connecting the signal line (supply)

Without HART® communication, a normal installation cable is sufficient.

With HART® communication, we recommend a shielded cable.

The signal line connectors (2.1 + and 2.2 -) are protected against polarity reversal.

6.7.4 Connection check

- Is there any damage to the device or cables?
- Does the supply voltage comply with the specifications on the rating plate?
- Is strain relief provided for the cables?
- Are the auxiliary energy and signal cables connected correctly?
- Are all the screw terminal blocks securely tightened and the connections of the spring clamps checked?
- Are all the cable entries mounted, securely tightened and sealed?
- Are all the housing covers mounted and securely tightened?

7 Configuration

7.1 Default configuration

The device is supplied with the following standard configuration:

Sensor input 1 active , Pt 100 3-conductor, -200°C ...850°C, sensor input 2 inactive

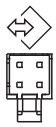
7.2 Configuration via software

CAUTION: Undefined behavior of the output during configuration possible

Do not configure the device while a process is running.

For device connection, use the MCR-PAC-T-USB programming adapter (Item No. 2309000) or one of the possibilities from Section “Overview of operating possibilities” on page 23.

PC software configuration interface



Connect the device to your PC to configure the device using the software solution. This requires the MCR-PAC-T-USB programming adapter (Item No. 2309000) and the FDT/DTM software packages, which already contain the driver for the programming adapter.

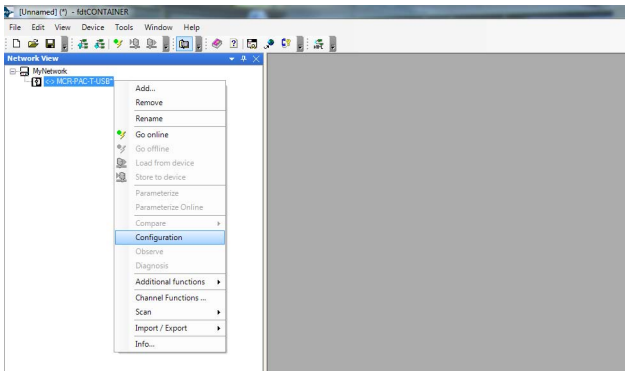
The software solution can be downloaded free of charge from the following address: phoenixcontact.net/products. Make sure to download and install both the FDT framework application and the DTM package.

Setting the programming interface

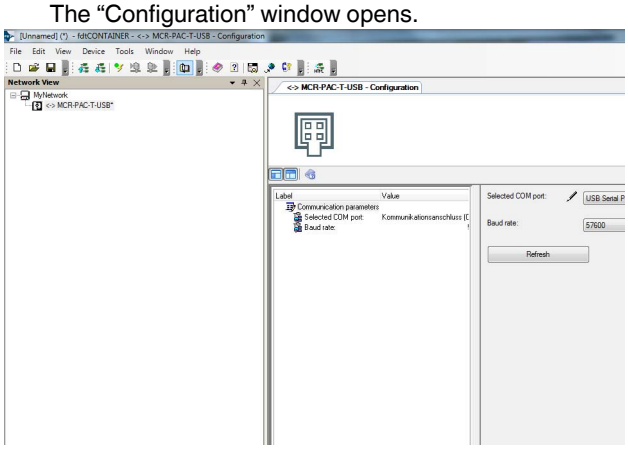
When you create a new project in your FDT/DTM program, you have to select the programming interface in the configuration window once.

To do so, proceed as follows:

- Load the DTM for the MCR-PAC-T-USB programming adapter to your project.
- Right-click on the MCR-PAC-T-USB. Select “Configuration”.



The “Configuration” window opens.



- In the “Selected COM port” field, select the “USB Serial Port (COM xxx)” entry.
- Confirm your selection with <Enter>.
- Load the DTM of the display into your project.

  Communication is established.

7.3 HART® communication interface

HART® functions as well as device-specific parameters are configured via HART® communication or the programming interface of the device. For this, special configuration tools from different manufacturers are available. For further information, contact your Phoenix Contact sales employee.

7.4 Device status display

The device has the following operating and indication elements.

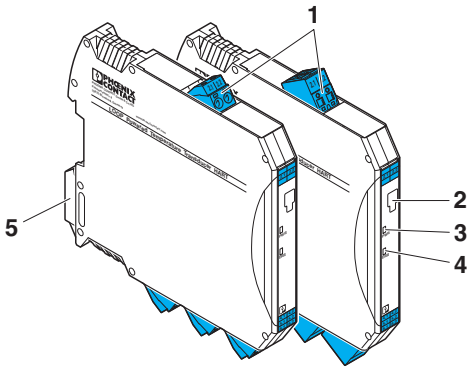


Figure 6 Operating and indication elements

1 COMBICON pluggable screw or Push-in connection terminal block
2 Programming interface
3 Green “PWR” LED for power supply
4 Red “ERR” LED as error display
5 Snap-on foot for DIN rail mounting

LED	Color/status	Description
PWR	Green	Supply voltage
	On	Supply voltage is present
ERR	Red	Diagnostics
	Flashing	Diagnostic message, category C, S, or M
	On	Diagnostic message, category F

A description of the categories can be found in “Status signals” on page 55.

8 Commissioning

8.1 Installation check and switching on the device

Perform all final checks before starting up the device:

– Checklist “Installation check” on page 18
– Checklist “Connection check” on page 20

During initial commissioning of the device, program the setup in accordance with the descriptions in the following sections.

8.2 General information on device configuration

You can commission and configure your device as follows:

– Using the HART® protocol
– Using the MCR PAC-T-USB adapter via PC

8.3 Overview of operating possibilities

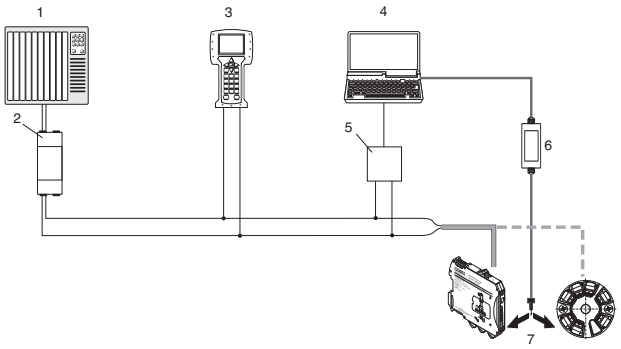


Figure 7 Overview of operating possibilities

1 PLC (programmable logic controller)
2 Measuring transducer supply device, e.g., MACX MCR-EX-SL-RPSSI-I-SP (Item No. 2924016) (with communication resistance)
3 Hand-held device, e.g., from Fisher Rosemount
4 PC with operating tool (e.g. M&M Container or IFS Conf)
5 HART® modem
6 MCR-PAC-T-USB programming adapter (Item No. 2309000)
7 Temperature transducer

8.4 Integrating the temperature transducer via HART® protocol

For HART® communication, measured values are transmitted from the temperature transducer via the HART® protocol to a connected control system where they are further processed.

Table 1 Version data of the device

Firmware version	01.01.zz	On the rating plate *Firmware version* parameter Diagnostics, device information, firmware version
Manufacturer ID	0xB0	*Manufacturer ID* parameter Diagnostics, device information, manufacturer ID
Device type ID	MACX MCR-(EX)-TS-I-OLP(-SP)	*Device type* parameter Diagnostics, device information, device type
HART® protocol revision	7.0	---
Device revision	2	On the temperature transducer rating plate *Device revision* parameter Diagnostics, device information, device revision

8.4.1 HART® device variables and measured values

The device variables are assigned the following measured values by default:

Device variable	Measured value
PV	Sensor 1
SV	Device temperature
TV	Sensor 1
QV	Sensor 1

Assignment of the device variables to the process variable can be changed in the following menu:

Expert, Communication, HART output

8.4.2 Device variables and measured values

The individual device variables are assigned the following measured values:

Device variable	Measured values
0	Sensor 1
1	Sensor 2
2	Device temperature
3	Mean value from sensor 1 and sensor 2
4	Difference from sensor 1 and sensor 2
5	Sensor 1 (backup sensor 2)
6	Sensor 1 with switchover to sensor 2 if a limit value is exceeded
7	Mean value from sensor 1 and sensor 2 with backup



The device variables can be retrieved from a HART® master via HART® command 9 or 33.

8.4.3 Supported HART® commands

The HART® protocol enables transmission of measured and device data between the HART® master and the corresponding field device for configuration and diagnostic purposes. HART® masters, such as the hand-held operator panel or PC-based operating programs (e.g., M&M Container), require device description files (DD = Device Descriptions, DTM) that allow for access to all information in a HART® device. This type of information is only transmitted via “commands”.

Universal commands:

Universal commands are supported and used by all HART® devices.

Connected functions include the following:

– Detection of HART® devices
– Reading digital measured values

Common practice commands:

The common practice commands provide functions that can be supported or executed by many but not by all field devices.

Device-specific commands:

These commands allow for access to device-specific functions that are not standardized for HART®. These commands access individual field device information, for example.

Command No.	Designation
Universal commands	
0, Cmd0	Read unique identifier
1, Cmd001	Read primary variable
2, Cmd002	Read loop current and percent of range
3, Cmd003	Read dynamic variables and loop current
6, Cmd006	Write polling address
7, Cmd007	Read loop configuration
8, Cmd008	Read dynamic variable classifications
9, Cmd009	Read device variables with status
11, Cmd011	Read unique identifier associated with TAG
12, Cmd012	Read message
13, Cmd013	Read TAG, descriptor, date
14, Cmd014	Read primary variable transducer information
15, Cmd015	Read device information
16, Cmd016	Read final assembly number
17, Cmd017	Write message
18, Cmd018	Write TAG, descriptor, date
19, Cmd019	Write final assembly number
20, Cmd020	Read long TAG (32-byte TAG)
21, Cmd021	Read unique identifier associated with long TAG
22, Cmd022	Write long TAG (32-byte TAG)
38, Cmd038	Reset configuration changed flag
48, Cmd048	Read additional device status
Common practice commands	
33, Cmd033	Read device variables
34, Cmd034	Write primary variable damping value
35, Cmd035	Write primary variable range values
36, Cmd036	Set primary variable upper range value
37, Cmd037	Set primary variable lower range value
40, Cmd040	Enter/Exit fixed current mode
42, Cmd042	Perform device reset
44, Cmd044	Write primary variable units
45, Cmd045	Trim loop current zero
46, Cmd046	Trim loop current gain
50, Cmd050	Read dynamic variable assignments
51, Cmd051	Write dynamic variable assignments

Command No.	Designation
54, Cmd054	Read device variable information
59, Cmd059	Write number of response preambles
103, Cmd103	Write burst period
104, Cmd104	Write burst trigger
105, Cmd105	Read burst mode configuration
107, Cmd107	Write burst device variables
108, Cmd108	Write burst mode command number
109, Cmd109	Burst mode control

8.5 Operating menu and parameter description

The following table lists all parameters that contain the operating menus “Setup”, “Diagnostics”, and “Expert”. The page numbers refer to the description of the associated parameter.

Not all submenus and parameters are available on every device, depending on the configuration. Details are given in the description of the parameters under the “Requirements” category.

The parameter groups for the expert setup contain all parameters of the operating menu “Setup”, “Diagnostics”, as well as additional parameters that are exclusively reserved for the experts.

The configuration in SIL mode is different from standard mode and is described in “Use in safety equipment” on page 70.

Setup,	Measuring point designation	Page 31
	Unit	Page 31
	Sensor type 1	Page 31
	Connection method 1	Page 31
	2-conductor compensation 1	Page 31
	Cold junction 1	Page 32
	Cold junction preset value 1	Page 32
	Sensor type 2	Page 31
	Connection method 2	Page 31
	2-conductor compensation 2	Page 31
	Cold junction 2	Page 32
	Cold junction preset value 2	Page 32
	Current output assignment (PV)	Page 32
	Start of measuring range	Page 33
	End of measuring range	Page 33

Setup, Advanced Setup,	Enter release code	Page 34
	Operating software access rights	Page 34
	Interlock status	Page 34
	Device temperature alarm	Page 34

Setup, Advanced Setup, Sensors,	Sensor offset 1	Page 35
	Sensor offset 2	Page 35
	Corrosion detection	Page 35
	Drift/Difference monitoring	Page 35
	Drift/Difference alarm category	Page 35
	Drift/Difference alarm delay	Page 36
	Drift/Difference limit value	Page 36
	Sensor switchover limit value	Page 36

Setup,	Advanced Setup,	Current output,	Output current	Page 36
			Measuring mode	Page 37
			Out of range category	Page 37
			Failure mode	Page 37
			Residual current	Page 37
			Voltage trim 4 mA	Page 37
			Voltage trim 20 mA	Page 37

Setup,	Advanced Setup,	SIL,	SIL option	Page 38
			Operating state	Page 38
			Enter SIL checksum	Page 38
			Time stamp SIL configuration	Page 38
			SIL startup mode	Page 38
			SIL HART mode	Page 39
			Force safe state	Page 39

Setup,	Advanced Setup,	Administration,	Device reset	Page 39
			Define write-protect code	Page 40

Diagnostics,			Current diagnostics	Page 41
			Troubleshooting measure	Page 41
			Last diagnostics 1	Page 41
			Operating time	Page 41

Diagnostics,	Diagnostic list,		Number of current diagnostic messages	Page 41
			Current diagnostics	Page 41
			Current diagnostics channel	Page 41

Diagnostics,	Event log,		Last diagnostics n	Page 42
			Last diagnostics channel n	Page 42

Diagnostics,	Device information,		Measuring point designation	Page 42
			Serial number	Page 42
			Firmware version	Page 42
			Device name	Page 42
			Configuration counter	Page 43

Diagnostics,	Measured values,		Value sensor 1	Page 43
			Value sensor 2	Page 43
			Device temperature	Page 43

Diagnostics, Measured values, Min./Max. values,	Sensor n min. value	Page 43
	Sensor n max. value	Page 43
	Reset sensor min/max values	Page 43
	Device temperature min.	Page 43
	Device temperature max.	Page 44
	Reset device temperature max./min.	Page 43

Diagnostics, Simulation,	Current output simulation	Page 44
	Current output value	Page 44

Expert,	Enter release code	Page 34
	Operating software access rights	Page 34
	Interlock status	Page 34

Expert, System,	Unit	Page 31
	Attenuation	Page 45
	Alarm delay	Page 45
	Mains frequency filter	Page 45
	Device temperature alarm	Page 45

Expert, System, Administration,	Device reset	Page 39
	Define write-protect code	Page 40

Expert, Sensors, Sensor n [1],	Sensor type n	Page 31
	Connection method n	Page 31
	2-conductor compensation n	Page 31
	Cold junction n	Page 32
	Cold junction preset value	Page 32
	Sensor offset n	Page 35
	Lower sensor limit n	Page 45
	Upper sensor limit n	Page 45
	Serial number sensor	Page 45

[1] n = number of sensor inputs (1 and 2)

Expert, Sensors, Sensor n, [1] Sensor trim,	Sensor trim	Page 46
	Sensor trim initial value	Page 46
	Sensor trim final value	Page 46
	Sensor trim min. range	Page 46

[1] n = number of sensor inputs (1 and 2)

Expert, Sensors, Sensor n [1], Linearization,	Lower sensor limit n	Page 47
	Upper sensor limit n	Page 47
	Call.-v. Dusen coeff. R0, A,B, C	Page 47
	Polynomial coeff. R0, A, B	Page 47

[1] n = number of sensor inputs (1 and 2)

Expert,	Sensors,	Diagnostic settings,	Corrosion detection	Page 35
			Drift/Difference monitoring	Page 35
			Drift/Difference alarm category	Page 35
			Drift/Difference alarm delay	Page 36
			Drift/Difference limit value	Page 36
			Sensor switchover limit value	Page 36
			Calibration counter start	Page 48
			Calibration counter alarm category	Page 48
			Calibration counter start value	Page 48
			Countdown calibration	Page 48

Expert,	Output,	Output current	Page 36
		Measuring mode	Page 37
		Start of measuring range	Page 33
		End of measuring range	Page 33
		Out of range category	Page 37
		Failure mode	Page 37
		Residual current	Page 37
		Voltage trim 4 mA	Page 37
		Voltage trim 20 mA	Page 37

Expert,	Communication,	HART configuration,	Measuring point designation	Page 42
			HART short description	Page 49
			HART address	Page 49
			No. of preambles	Page 49
			Configuration changed	Page 49
			Configuration changed, reset flag	Page 49

Expert,	Communication,	HART info,	Device type	Page 50
			Device revision	Page 50
			HART revision	Page 50
			HART description	Page 50
			HART message	Page 50
			Hardware revision	Page 50
			SWRev	Page 50
			HART date	Page 50

Expert,	Communication,	HART output,	Current output assignment (PV)	Page 32
			PV	Page 51
			SV assignment	Page 51
			SV	Page 51
			TV assignment	Page 51
			TV	Page 51
			QV assignment	Page 51
			QV	Page 51

Expert, Communication, Burst configuration,	Burst mode	Page 52
	Burst command	Page 52
	Burst variables 0...3	Page 52
	Burst trigger mode	Page 53
	Burst trigger value	Page 53
	Burst min. time period	Page 53
	Burst max. time period	Page 53

Expert, Diagnostics,	Current diagnostics	Page 41
	Troubleshooting measure	Page 41
	Last diagnostics 1	Page 41
	Operating time	Page 41

Expert, Diagnostics, Diagnostic list,	Number of current diagnostic messages	Page 41
	Current diagnostics	Page 41
	Current diagnostics channel	Page 41

Expert, Diagnostics, Event log,	Last diagnostics n	Page 42
	Last diagnostics channel	Page 42

Expert, Diagnostics, Device information,	Measuring point designation	Page 31
	Serial number	Page 42
	Firmware version	Page 42
	Device name	Page 42
	ENP version	Page 54
	Device revision	Page 54
	Manufacturer ID	Page 54
	Manufacturer	Page 54
	Hardware revision	Page 54
	Configuration counter	Page 43

Expert, Diagnostics, Measured values,	Value sensor n	Page 43
	Sensor n raw value	Page 54
	Device temperature	Page 43

Expert, Diagnostics, Measured values, Min./Max. values,	Sensor n min. value	Page 43
	Sensor n max. value	Page 43
	Reset sensor min/max values	Page 43
	Device temperature min.	Page 43
	Device temperature max.	Page 44
	Reset device temperature max./min.	Page 44

Expert, Diagnostics, Simulation,	Current output simulation	Page 44
	Current output value	Page 44

8.5.1 “Setup” menu

All parameters used for basic device settings are available here.

You can commission the temperature transducer with this limited parameter record.

n = place-holder for number of sensor inputs (1 and 2)

Measuring point designation	
Navigation	Setup, Measuring point designation Diagnostics, Device information, Measuring point designation Expert, Diagnostics, Device information, Measuring point designation
Description	Enter a clear designation for the measuring point to be able to quickly identify it within the system. It is indicated in the header of the plug-in display (Page 22).
Input	Maximum of 32 characters such as letters, numerals, or special characters (e.g., @, %, /)
Default setting	-none-

Unit	
Navigation	Setup, Unit Expert, System, Unit
Description	Selects the measuring unit for all measured values
Selection	– °C – °F – K – °R – Ohm – mV
Default setting	°C

Sensor type n	
Navigation	Setup, Sensor type n Expert, Sensors, Sensor n, Sensor type n
Description	Selection of the sensor type for the respective sensor input – Sensor type 1: Settings for sensor input 1 – Sensor type 2: Settings for sensor input 2 Observe the terminal assignment when connecting the individual sensors (Page 18). When connecting two sensors, also observe the possible connection combinations.
Selection	You can find a list of all possible sensor types in “Technical data” on page 5.
Default setting	– Sensor type 1: Pt 100 IEC751 – Sensor type 2: No sensor

Connection method n	
Navigation	Setup, Connection method n Expert, Sensors, Sensor n, Connection method n
Requirements	An RTD sensor must be specified as the sensor type.
Description	Selects the connection method of the sensor
Selection	– Sensor 1 (connection method 1): 2-conductor, 3-conductor, 4-conductor – Sensor 2 (connection method 2): 2-conductor, 3-conductor
Default setting	– Sensor 1 (connection method 1): 4-conductor – Sensor 2 (connection method 2): 2-conductor

2-conductor compensation n	
Navigation	Setup, 2-conductor compensation n Expert, Sensors, Sensor n, 2-conductor compensation n
Requirements	An RTD sensor with 2-conductor connection method must be specified as the sensor type.
Description	Determination of resistance value for two-conductor compensation in the case of RTDs
Input	0 ohm … 30 ohm
Default setting	0

Cold junction n	
Navigation	Setup, Cold junction n Expert, Sensors, Sensor n, Cold junction n
Requirements	A thermocouple (TC) sensor must be selected as the sensor type.
Description	Selection of cold junction measurement for temperature compensation of thermocouples (TC) – In the case of the “preset value”, the compensation value is specified via the *Cold junction preset value* parameter. – A temperature measurement for channel 2 has to be configured for the “Measured value sensor 2” selection
Selection	– No compensation: no temperature compensation is used. – Internal measurement: Internal cold junction temperature is used. – Preset value: Fixed preset value is used. – Measured value sensor 2: measured value of sensor 2 is used. The measured value sensor 2 selection is not possible for the cold junction 2 parameter.
Default setting	Internal measurement

Cold junction preset value n	
Navigation	Setup, Cold junction preset value Expert, Sensors, Sensor n, Cold junction, Preset value
Requirements	The Preset value parameter has to be set for the Cold junction n selection.
Description	Determines the fixed preset value for temperature compensation
Input	–50°C … +85°C
Default setting	0.00

Current output assignment (PV)	
Navigation	Setup, Current output assignment (PV) Expert, Communication, HART output, Assignment, Current output (PV)
Description	Assignment of a measured variable for the first HART® value (PV)
Selection	– Sensor 1 (measured value) – Sensor 2 (measured value) – Mean value of the two measured values: 0.5 x (SV1+SV2) – Difference between Sensor 1 and Sensor 2: SV1-SV2 – Sensor 1 (backup Sensor 2): If Sensor 1 fails, the value of Sensor 2 automatically becomes the first HART® value (PV): Sensor 1 (OR Sensor 2) – Sensor switchover: If the set threshold value T is exceeded for Sensor 1, the measured value of Sensor 2 becomes the first HART® value (PV). Switching back to Sensor 1 is done when the measured value of Sensor 1 is at least 2 K below T: Sensor 1 (Sensor 2, if Sensor 1 > T) – Mean value: 0.5 x (SV1+SV2) with backup (measured value of Sensor 1 or Sensor 2 in the case of sensor errors of the other sensor) The threshold value can be set with the *Sensor switchover limit value* parameter (Page 36). Two sensors can be combined by the temperature-dependent switchover, which have their advantages in different temperature ranges.
Default setting	Sensor 1

Start of measuring range	
Navigation	Setup, Start of measuring range Expert, Output, Start of measuring range
Description	Assignment of a measured value to the current value 4 mA The adjustable limit value depends on the sensor type used in the *Sensor type* parameter (Page 31), and the assigned measured variable in the *Current output assignment (PV)* parameter.
Input	Depending on the sensor type and the current output assignment (PV)
Default setting	0

End of measuring range	
Navigation	Setup, End of measuring range Expert, Output, End of measuring range
Description	Assignment of a measured value to the current value 20 mA The adjustable limit value depends on the sensor type used in the *Sensor type* parameter (Page 31), and the assigned measured variable in the *Current output assignment (PV)* parameter.
Input	Depending on the sensor type and the current output assignment (PV)
Default setting	100

"Advanced setup" submenu

Corrosion monitoring

The corrosion of sensor connection lines can lead to a falsification of the measured value. The device thus offers you the possibility of recognizing the corrosion before a measured value falsification occurs. The corrosion monitoring is only possible for a RTD with 4-conductor termination and thermocouples.

Drift/Difference monitoring

A signal status is generated as diagnostic event when the measured values differ by a specified value in the case of two connected sensors. The correctness of the measured values can be verified with the drift/difference monitoring, and a mutual monitoring of the connected sensors performed. The drift/difference monitoring is activated with the *Drift/Difference monitoring* parameter. A distinction is made between two different modes. A status message is issued for underrange selection (ISV1-SV2I < Drift/Difference limit value) if the limit value is not reached, or, for *Overrange (Drift)* selection (ISV1-SV2I > Drift/ Difference limit value), if the limit value is exceeded.

Configuration procedure of drift/difference monitoring

1. For drift/difference monitoring, select *Overrange* for drift detection, *Underrange* for difference monitoring.
2. Set alarm category for drift/difference monitoring to *Does not conform to the specification* (S), *Maintenance required* (M) or *Failure* (F) in accordance with your needs.
3. Set limit value for drift/difference monitoring to desired value.

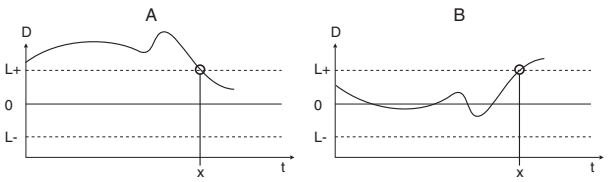


Figure 8 Drift/Difference monitoring

A	Below limit value
B	Above limit value
D	Drift
L+, L-	Upper (+) or lower (-) limit value
t	Time
x	Diagnostic event, status signal is created

Enter release code	
Navigation	Enter Setup, Advanced setup, Release code Enter Expert, Release code
Description	Release of service parameters via operating tool. If an incorrect release code is entered, the user keeps his current access rights. If an entered value is not equal to the release code, the parameter is automatically set to 0. The service parameters should only be changed by the service organization.
Additional information	The software device write-protection is also switched on and off via this parameter. Software device write-protection linked to the download from an off-line capable operating tool – A download where the device has no defined write-protect code is carried out normally. – Download with defined write-protect code: the device is not locked. – *Enter release code* parameter (offline) contains the correct write-protect code: The download is performed; the device is not locked after the download. The write-protect code in the enter release code parameter is set to 0. – *Enter release code* parameter (offline) does not contain the correct write-protect code: The download is performed; the device is locked after the download. The write-protect code in the *Enter release code* parameter is reset to 0. – Download with defined write-protect code: the device is locked. – *Enter release code* parameter (offline) contains the correct write-protect code: The download is performed; the device is locked after the download. The write-protect code in the *Enter release code* parameter is reset to 0. – *Enter release code* parameter (offline) does not contain the correct write-protect code: The download is not performed. No values in the device are changed. The value of the *Enter release code* parameter (offline) is not changed either.
Input	0 ... 9,999
Default setting	0

Operating software access rights	
Navigation	Setup, Advanced setup, Operating software access rights Expert, Operating software access rights
Description	Display of access rights on the parameters
Additional information	If an additional write-protect is active, this further limits the current access rights. The write-protect can be displayed via the *Interlock status* parameter.
Selection	– Operator – Service
Default setting	Operator

Interlock status	
Navigation	Setup, Advanced setup, Interlock status Expert, Interlock status
Description	Displays the status of device locking. The DIP switch for the hardware interlock is mounted on the optional display module (head-mounted transducer only).

Device temperature alarm	
Navigation	Setup, Advanced setup, Device temperature alarm
Description	Selection of category (status signal) of how the device reacts in the case of exceeding or falling below the electronic temperature of the temperature transducer <-40°C (-40°F) or >+85°C (+185°F)
Selection	– Off – Out of specification (S) – Failure (F)
Default setting	Out of specification (S)

“Sensors” submenu

Sensor offset n	
n = place-holder for number of sensor inputs (1 and 2)	
Navigation	Setup, Advanced setup, Sensors, Sensor offset n Expert, Sensors, Sensor n, Sensor offset n
Description	Sets zero point correction (offset) for the sensor measured value. The specified value is added to the measured value.
Input	-10.0 ... +10.0
Default setting	0.0

Corrosion detection	
Navigation	Setup, Advanced setup, Sensors, Corrosion detection Expert, Sensors, Diagnostic settings, Corrosion detection
Description	Selection of category (status signal) with which the sensor connection lines are displayed for corrosion detection Only possible for RTD sensors with 4-conductor termination and thermocouples (TC)
Selection	– Maintenance required (M) – Failure (F)
Default setting	Maintenance required (M)

Drift/Difference monitoring	
Navigation	Setup, Advanced setup, Sensors, Drift/Difference monitoring Expert, Sensors, Diagnostic settings, Drift/Difference monitoring
Description	Selection of whether the device reacts to the drift/difference limit value being exceeded or fallen below Can only be selected when connecting two sensors
Additional information	– A status signal is displayed for the *Overrange (Drift)* selection when the absolute sum of the difference value exceeds the drift/difference limit value – A status signal is displayed for the *Underrange* selection when the absolute sum of the difference value falls below the drift/difference limit value.
Selection	– Off – Overrange (Drift) – Under-range
Default setting	Off

Drift/Difference alarm category	
Navigation	Setup, Advanced setup, Sensors, Drift/Difference alarm category Expert, Sensors, Diagnostic settings, Drift/Difference alarm category
Requirements	The *Drift/Difference monitoring* parameter must be activated with the *Overrange (Drift)* or *Underrange* selection.
Description	Selection of the category (status signal) of how the device reacts between Sensor 1 and Sensor 2 in the case of drift/difference detection
Selection	– Out of specification (S) – Maintenance required (M) – Failure (F)
Default setting	Maintenance required (M)

Drift/Difference alarm delay	
Navigation	Setup, Advanced setup, Sensors, Drift/Difference alarm delay Expert, Sensors, Diagnostic settings, Drift/Difference alarm delay
Requirements	The *Drift/Difference monitoring* parameter must be activated with the *Overrange (Drift)* or *Underrange* selection (Page 35).
Description	Alarm delay of drift detection monitoring Helpful, e.g., in the case of different thermal masses of sensors in conjunction with a high temperature gradient in the process
Input	0 s … 255 s
Default setting	0 s

Drift/Difference limit value	
Navigation	Setup, Advanced setup, Sensors, Drift/Difference limit value Expert, Sensors, Diagnostic settings, Drift/Difference limit value
Requirements	The *Drift/Difference monitoring* parameter must be activated with the *Overrange (Drift)* or *Underrange* selection.
Description	Setting of maximum permitted measured value deviation between Sensor 1 and Sensor 2 that leads to a drift/difference detection
Selection	0.1 K ... 999.0 K (0.18°F ... 1,798.2°F)
Default setting	999.0

Sensor switchover limit value	
Navigation	Setup, Advanced setup, Sensors, Sensor switchover, Limit value Expert, Sensors, Diagnostic settings, Sensor switchover, Limit value
Description	Setting of the threshold value of the sensor switchover (Page 32)
Additional information	The threshold value is relevant if a HART® variable (PV, SV, TV, QV) is assigned to the sensor switchover function.
Selection	Depending on the selected sensor types
Default setting	850°C

“Current output” submenu

Adjustment of analog output (4 mA and 20 mA voltage trim)

Voltage trimming is used for the compensation of the analog output (D/A conversion). The output current of the temperature transducer can be adapted to match the expected value at the higher-level system.

Voltage trimming does not affect the digital HART® value. This can lead to the displayed measured value on the plugged-in display (head-mounted transducer only) differing only minimally from the display value in the higher-level system.

The digital measured values can be adapted with the *Sensor trim* parameter in the “Expert, Sensors, Sensor trim” menu.

Procedure

1. Install a precise ampere meter (higher precision than the temperature transducer) in the current loop.
2. Switch on simulation of the current output and set the simulation value to 4 mA.
3. Measure the loop current using the ampere meter and take a note of it.
4. Set the simulation value to 20 mA.
5. Measure the loop current using the ampere meter and take a note of it.
6. Enter determined current values as comparison values in the voltage trim parameter 4 mA or 20 mA

Output current	
Navigation	Setup, Advanced setup, Current output, Output current Expert, Output, Output current
Description	Display of the calculated output current in mA.

Measuring mode	
Navigation	Setup, Advanced setup, Current output, Measuring mode Expert, Output, Measuring mode
Description	Enables the inversion of the output signal
Additional information	– Standard The output current rises when the temperature increases – Inverted The output current lowers when the temperature increases
Selection	– Standard – Inverted
Default setting	Standard

Out of range category	
Navigation	Setup, Advanced setup, Current output, Out of range category Expert, Output, Out of range category
Description	Selection of the category (status signal), how the device reacts when leaving the set measuring range
Selection	– Out of specification (S) – Maintenance required (M) – Failure (F)
Default setting	Maintenance required (M)

Failure mode	
Navigation	Setup, Advanced setup, Current output, Error handling Expert, Output, Error handling
Description	Selection of the failure signal level that the current output issues in the case of an error
Additional information	For the *max*. selection, the failure signal level is specified via the *Residual current* parameter.
Selection	– Min. – Max.
Default setting	Max.

Residual current	
Navigation	Setup, Advanced setup, Current output, Residual current Expert, Output, Residual current
Requirements	The Max. selection is activated in the *Error handling* parameter.
Description	Setting the current value that the current output issues in the event of a malfunction
Input	21.5 mA ... 23.0 mA
Default setting	22.5 mA

Voltage trim 4 mA	
Navigation	Setup, Advanced setup, Current output, Voltage trim 4 mA Expert, Output, Voltage trim 4 mA
Description	Setting the correction value for the current output at measuring range start at 4 mA (Page 36)
Input	3.85 mA ... 4.15 mA
Default setting	4 mA

Voltage trim 20 mA	
Navigation	Setup, Advanced setup, Current output, Voltage trim 20 mA Expert, Output, Voltage trim 20 mA
Description	Setting the correction value for the current output at measuring range end 20 mA (Page 36)
Input	19.850 mA ... 20.15 mA
Default setting	20 mA

“SIL” submenu

The *SIL option* parameter displays whether the device can be operation in SIL mode. In order to activate SIL mode for the device, the menu-guided operation, *Activate SIL*, has to be performed (see “Use in safety equipment” on page 70).

SIL option	
Navigation	Setup, Advanced setup, SIL, SIL option
Description	Display of the SIL option
Selection	– No – Yes
Default setting	Yes

Operating state	
Navigation	Setup, Advanced setup, SIL, Operating state
Description	Display of the device operating state in SIL mode
Display	– Check SIL option – Startup in normal operation – Waiting for checksum – Self-diagnostics – Normal operation – Download active – SIL mode active – Start safe configuration – Safe configuration active – Save parameter values – Parameter test – Restart pending – Rest checksum – Safe state - Active – Check download – Upload active – Safe state - Passive – Safe state - Panic In the case of a device restart with the setting “SIL startup mode, not active”, the display “Waiting for checksum” appears in this parameter. The SIL checksum has to be manually entered here.
Default setting	Normal operation

Enter SIL checksum	
Navigation	Enter Setup, Advanced setup, SIL, SIL checksum
Description	Enter the SIL checksum during the safe configuration and startup in connection with the parameter setting “SIL startup mode, not active”. Entering the value “0” in connection with the parameter setting “SIL startup mode, active” terminates automatic startup and discards the SIL settings.
Input	0 ... 65,535
Default setting	0

Time stamp SIL configuration	
Navigation	Setup, Advanced setup, SIL, Time stamp SIL configuration
Description	Entry of date and time at which the safe configuration concludes or the SIL checksum was calculated This is not automatically created by the device. The data and time must be entered manually.
Input	DD.MM.YYYY hh:mm
Default setting	0

SIL startup mode	
Navigation	Setup, Advanced setup, SIL, SIL startup mode
Description	Setting the repeat automatic startup of the device in SIL mode, e.g. after a “power cycle” The “not active” setting requires the manual entry of the SIL checksum in order to be able to start the device again in SIL mode.
Selection	– Not active – Active
Default setting	Active

SIL HART mode	
Navigation	Setup, Advanced setup, SIL, SIL HART mode
Description	Setting HART® communication during SIL mode The setting “HART not active” deactivates HART® communication in SIL mode (only 4 mA … 20 mA communication is active).
Selection	– HART not active – HART active
Default setting	HART active

Force safe state	
Navigation	Setup, Advanced setup, SIL, Force safe state
Requirements	The *Operating state* parameter displays *SIL mode active*.
Description	During the SIL repeat test, the error detection and the safe state of the device are tested with this parameter. Please see “Commissioning or repeat test of the temperature transducer” on page 77 for a detailed description of the SIL repeat test.
Selection	– On – Off
Default setting	Off

“Administration” submenu

Device reset	
Navigation	Setup, Advanced setup, Administration, Reset device Expert, System, Reset device
Description	Reset the entire device configuration or part of it to a defined state
Selection	– Not active The parameter is exited without action. – To default settings All parameters are reset to the default settings. – To delivery state All parameters are reset to the delivery state. The delivery state can differ from the default settings if customer-specific parameter values were specified when ordering. – Restart the device The device restarts with an unchanged device configuration.
Default setting	Not active

Define write-protect code	
Navigation	Setup, Advanced setup, Administration, Define write-protect code Expert, System, Define write-protect code
Description	Setting a device write-protect code If the code is saved in the device firmware, this code is saved in the device and the operating tool displayed the value 0, so that that defined write-protect code cannot be displayed in a way that can be freely read.
Input	0 ... 9,999
Default setting	0 The device write protection is not active if delivered with this default setting.

Additional information	– Activate the device write protection: For this, enter a value in the *Enter release code* parameter that does not correspond with the write-protect code defined here.
	– Deactivate the device write protection: Enter the defined write protect code in the *Enter release code* parameter if there is active device write protection.
	– After resetting the device to default or configured delivery state, the defined write-protect code is no longer valid. The code takes on the default setting (= 0).
	– The hardware write protection (DIP switch) is active:
	  – The hardware write protection has a higher priority than the software write protection described here.
	  – No value can be entered in the *Enter release code* parameter. The parameter can now be read.
	  – The device write-protect via software can first be defined and activated if the hardware write protection is deactivated via the DIP switch (“Device status display” on page 22).
	
	If the write-protect code was forgotten, it can be deleted or over-written by the service organization.

8.5.2 “Diagnostics” menu

All the information that describes the device status and the process conditions are found in this group.

Current diagnostics 1	
Navigation	Diagnostics, Current diagnostics Expert, Diagnostics, Current diagnostics 1
Description	Displays the currently pending diagnostic message. If multiple messages occur simultaneously, the message with the highest priority will be displayed.
Display	Symbol for event behavior and diagnostic event
Additional information	Example of display format: F261 electronics modules

Troubleshooting measure	
Navigation	Diagnostics, Troubleshooting measure Expert, Diagnostics, Troubleshooting measure
Description	Display of the troubleshooting measures for current diagnostic message

Last diagnostics 1	
Navigation	Diagnostics, Last diagnostics 1 Expert, Diagnostics, Last diagnostics 1
Description	Display of the last pending diagnostic message with the highest priority
Display	Symbol for event behavior and diagnostic event
Additional information	Example of display format: F261 electronics modules

Operating time	
Navigation	Diagnostics, Operating time Expert, Diagnostics, Operating time
Description	Display of time that the device is in operation up to the present time
Display	Hours (h)

“Diagnostic list” submenu

In this submenu, up to 3 currently pending diagnostic messages are displayed.

If more than 3 messages are pending, those with the highest priority are displayed. Information on the diagnostic measures of the device and all diagnostic messages at a glance (see “Troubleshooting” on page 55).

Number of current diagnostic messages	
Navigation	Diagnostics, Diagnostic list, Number of current diagnostic messages Expert, Diagnostics, Diagnostic list, Number of current diagnostic messages
Description	Display of number of diagnostic messages currently in the device

Current diagnostics	
Navigation	Diagnostics, Diagnostic list, Current diagnostics Expert, Diagnostics, Diagnostic list, Current diagnostics
Description	Display of the currently pending diagnostic messages with the highest to third-highest priority
Display	Symbol for event behavior and diagnostic event
Additional information	Example of display format: F261 electronics modules

Current diagnostics channel	
Navigation	Diagnostics, Diagnostic list, Current diagnostics, Channel Expert, Diagnostics, Diagnostic list, Current diagnostics, Channel
Description	Display of the sensor input to which the diagnostic message refers
Display	– Sensor 1 – Sensor 2 – - - - - -

“Event log” submenu

Last diagnostics n	
n = number of diagnostic messages (n = 1 ... 5)	
Navigation	Diagnostics, Diagnostic list, Last diagnostics n Expert, Diagnostics, Diagnostic list, Last diagnostics n
Description	Displays the diagnostic messages that have occurred in the past. The last 5 messages are listed chronologically.
Display	Symbol for event behavior and diagnostic event
Additional information	Example of display format: F261 electronics modules

Last diagnostics channel	
Navigation	Diagnostics, Diagnostic list, Last diagnostics channel Expert, Diagnostics, Diagnostic list, Last diagnostics channel
Description	Display of the possible sensor input which the diagnostic message refers to
Display	– Sensor 1 – Sensor 2 – - - - - -

“Device information” submenu

Measuring point designation	
Navigation	Setup, Measuring point designation Diagnostics, Device information, Measuring point designation Expert, Diagnostics, Device information, Measuring point designation
Description	Enter a clear designation for the measuring point to be able to quickly identify it within the system. It is indicated in the header of the plug-in display (head-mounted transducer only).
Input	Maximum of 32 characters such as letters, numerals, or special characters (e.g., @, %, /)
Default setting	-none-

Serial number	
Navigation	Diagnostics, Device information, Serial number Expert, Diagnostics, Device information, Serial number
Description	Displays the serial number of the device. It is also found on the rating plate.
Display	Max. 11-digit string of letters and numbers

Firmware version	
Navigation	Diagnostics, Device information, Firmware version Expert, Diagnostics, Device information, Firmware version
Description	Display of the installed device firmware version Firmware changes of the back two positions zz have no influence on the behavior of the device.
Display	6-digit string, maximum, in xx.yy.zz format

Device name	
Navigation	Diagnostics, Device information, Device name Expert, Diagnostics, Device information, Device name
Description	Displays the device name. It can also be found on the rating plate.

Configuration counter	
Navigation	Diagnostics, Device information, Configuration counter Expert, Diagnostics, Device information, Configuration counter
Description	Displays the counter value for changes of device parameters Static parameters of which the values change during optimization or configuration cause this parameter to increment by 1. This supports parameter version management. The counter can display a higher value if several parameters are changed, e.g., by loading parameters of M&M Container, etc. in the device. The counter can never be reset, and even after a device reset it is not reset to a default value. If the counter overruns (16 bit), it begins again at 1.

"Measured values" submenu

Value sensor n	
n = place-holder for number of sensor inputs (1 and 2)	
Navigation	Diagnostics, Measured value, Value sensor n Expert, Diagnostics, Measured values, Value sensor n
Description	Display of the current measured value at the respective sensor input

Device temperature	
Navigation	Diagnostics, Measured values, Device temperature Expert, Diagnostics, Measured values, Device temperature
Description	Displays the current electronics temperature

"Min./Max. values" submenu

Sensor n min. value	
n = place-holder for number of sensor inputs (1 and 2)	
Navigation	Diagnostics, Measured values, Min./Max. values, Sensor n min. value Expert, Diagnostics, Measured values, Min./Max. values, Sensor n min. value
Description	Display of minimum temperature measured in the past at sensor input 1 or 2 (drag pointer).

Sensor n max. value	
n = place-holder for number of sensor inputs (1 and 2)	
Navigation	Diagnostics, Measured values, Min./Max. values, Sensor n max. value Expert, Diagnostics, Measured values, Min./Max. values, Sensor n max. value
Description	Display of maximum temperature measured in the past at sensor input 1 or 2 (drag pointer)

Reset sensor min/max values	
Navigation	Diagnostics, Measured values, Min./Max. values, Reset sensor Min./Max. values Diagnostics, Measured values, Min./Max. values, Reset sensor min./max. values
Description	Resets the drag pointer of the minimum and maximum measured temperature at the sensor inputs
Selection	– No – Yes
Default setting	No

Device temperature min.	
Navigation	Diagnostics, Measured values, Min./Max. values, Device temperature min. Expert, Diagnostics, Measured values, Min./Max. values, Device temperature min.
Description	Display of minimum electronics temperature measured in the past (drag pointer)

Device temperature max.	
Navigation	Diagnostics, Measured values, Min./Max. values, Device temperature max. Expert, Diagnostics, Measured values, Min./Max. values, Device temperature max.
Description	Display of maximum electronics temperature measured in the past (drag pointer)

Reset device temp. min/max values	
Navigation	Diagnostics, Measured values, Min./Max values, Reset device temp. max./min. Expert, Diagnostics, Measured values, Min./Max values, Reset device temp. min/max values
Description	Resets the drag pointer of the minimum and maximum measured electronic temperature
Selection	– No – Yes
Default setting	No

“Simulation” submenu

Current output simulation	
Navigation	Diagnostics, Simulation, Simulation current output Expert, Diagnostics, Simulation, Simulation current output
Description	Switches simulation of the current output on and off. If the simulation is active, a diagnostic message of the function control (C) category is displayed in the change to the measured value display.
Display	Measured value display ↔ C491 (Simulation current output)
Selection	– Off – On
Default setting	Off
Additional information	The desired simulation value is specified in the *Current output value* parameter.

Current output value	
Navigation	Diagnostics, Simulation, Value current output Expert, Diagnostics, Simulation, Current output value
Additional information	The *Simulation current output* parameter has to be set with the *On* selection.
Description	Sets a current value for the simulation. In this way, correct adjustment of the current output and correct function of downstream evaluation devices can be checked.
Input	3.59 mA ... 23.0 mA
Default setting	3.59 mA

8.5.3 “Expert” menu

The parameter groups for the expert setup contain all parameters of the operating menu “Setup” and “Diagnostics”, as well as additional parameters that are exclusively reserved for the experts.

This section contains the descriptions of the additional parameters. All basic parameter settings for commissioning and diagnostic evaluation of the device are described in ““Setup” menu” on page 31 and ““Diagnostics” menu” on page 41.

“System” submenu

Attenuation	
Navigation	Expert, System, Attenuation
Description	Sets the time constants for attenuation of the power output.
Input	0 s ... 120 s
Default setting	0.00 s
Additional information	Measured value fluctuations take effect at the power output with an exponential delay whose time constant is specified through these parameters. In the case of a low time constant, the power output follows the measured value quickly. If there is a high time constant, however, following is delayed.

Alarm delay	
Navigation	Expert, System, Alarm delay
Description	Sets the delay by which a diagnostic signal is suppressed before it is output.
Input	0 s ... 5 s
Default setting	2 s

Mains frequency filter	
Navigation	Expert, System, Mains frequency filter
Description	Selects the mains filter for A/D conversion
Selection	– 50 Hz – 60 Hz
Default setting	50 Hz

Device temperature alarm (Page 34)	
Navigation	Expert, System, Device temperature alarm

“Administration” submenu

For a detailed description, see Page 39.

“Sensors” submenu

“Sensor 1/2” submenu



n = place-holder for number of sensor inputs (1 and 2)

Lower sensor limit n	
Navigation	Expert, Sensors, Sensor n, Lower sensor limit n
Description	Display of minimum physical measuring range final value

Upper sensor limit n	
Navigation	Expert, Sensors, Sensor n, Upper sensor limit n
Description	Display of maximum physical measuring range final value

Serial number sensor	
Navigation	Expert, Sensors, Sensor n, Serial number, Sensor
Description	Entry of serial number of the connected sensor
Input	Number and text entry up to 12 positions
Default setting	“ “ (no text)

"Sensor trim" submenu

Adjustment of sensor error (sensor trim)

The sensor trim is for adapting the actual sensor signal to the linearization of the selected sensor type saved in the temperature transducer. In contrast to sensor measuring transducer matching, the sensor trim is only performed at the start and end value, and so does not achieve the same high precision.

The sensor trim is not for adapting the measuring range, rather for adapting the sensor signal to the linearization saved in the temperature transducer.

Procedure

1. Set *Sensor trim* parameter to the *customer-specific* selection.
2. Bring the sensor connected to the temperature transducer to a known and stable temperature with water/oil bath or oven. We recommend a temperature near the set measuring range start.
3. Enter reference temperature for the value at the measuring range start at the *Sensor trim initial value* parameter. The temperature transducer calculates internally a correction factor from the difference between the specified reference temperature and the actual measured temperature at the input. This is now used for the linearization of the input signal.
4. Bring the sensor connected to the temperature transducer to a known and stable temperature close to the set measuring area end with water/oil bath or oven.
5. Enter reference temperature for the value at the measuring range end at the *Sensor trim initial value* parameter.

Sensor trim	
Navigation	Expert, Sensors, Sensor n, Sensor trim, Sensor trim
Description	Selection of which linearization method is used for the connected sensor. The original linearization can be reestablished by resetting this parameter to the *Default setting* selection.
Selection	– Default setting – Custom
Default setting	Default setting

Sensor trim initial value	
Navigation	Expert, Sensors, Sensor n, Sensor trim, Sensor trim initial value
Requirements	The *Customer-specific* selection is activated in the *Sensor trim* parameter (Page 46).
Description	The lower point for linear characteristic curve adjustment (offset and gradient are influenced by this)
Input	Depending on the selected sensor type and the current output assignment (PV)
Default setting	-200°C

Sensor trim final value	
Navigation	Expert, Sensors, Sensor n, Sensor trim, Sensor trim final value
Requirements	The *Customer-specific* selection is activated in the *Sensor trim* parameter.
Description	The upper point for linear characteristic curve adjustment (offset and gradient are influenced by this)
Input	Depending on the selected sensor type and the current output assignment (PV)
Default setting	850°C

Sensor trim min. range	
Navigation	Expert, Sensors, Sensor n, Sensor trim, Sensor trim min. range
Requirements	The *Customer-specific* selection is activated in the *Sensor trim* parameter.
Description	Display of minimum possible range between sensor trim start and final value

"Linearization" submenu

Procedure for setting a linearization while using the Callendar-Van Dusen coefficients from a calibration certificate

Procedure

1. Set current output assignment (PV) = sensor 1 (measured value).
2. Select unit (°C).
3. Select sensor type (linearization type) "RTD platinum (Callendar-Van Dusen)".
4. Select connection method e.g. 3-conductor.
5. Set lower and upper sensor limits.
6. Enter the 4 coefficients A, B, C and R0.
7. If a special linearization is also used for the second sensor, repeat steps 1 to 6.

Lower sensor limit n	
Navigation	Expert, Sensors, Sensor n, Linearization, Lower sensor limit n
Requirements	The selection RTD platinum, RTD poly nickel or RTD polynomial copper is activated in the *Sensor type* parameter
Description	Sets the lower calculation limit for the special sensor linearization
Input	Depends on the selected sensor type
Default setting	-200°C

Upper sensor limit n	
Navigation	Expert, Sensors, Sensor n, Linearization, Upper sensor limit n
Requirements	The selection RTD platinum, RTD poly nickel or RTD polynomial copper is activated in the *Sensor type* parameter
Description	Sets the upper calculation limit for the special sensor linearization
Input	Depends on the selected sensor type
Default setting	850°C

Call.-v. Dusen coeff. R0	
Navigation	Expert, Sensors, Sensor n, Linearization, Call.-V. Dusen coeff. R0
Requirements	The selection RTD platinum (Callendar-Van Dusen) is activated in the *Sensor type* parameter
Description	Sets the R0 value for linearization with the Callendar/Van Dusen polynomial
Input	40 ohm … 1,050 ohm
Default setting	100 ohm

Call.-v. Dusen coeff. A, B, and C	
Navigation	Expert, Sensors, Sensor n, Linearization, Call.-V. Dusen coeff. A, B, C
Requirements	The selection RTD platinum (Callendar-Van Dusen) is activated in the *Sensor type* parameter
Description	Setting the coefficients for the sensor linearization in accordance with the Callendar-Van Dusen method
Default setting	– A: 3.910000e-003 – B: -5.780000e-007 – C: -4.180000e-012

Polynomial coeff. R0	
Navigation	Expert, Sensors, Sensor n, Linearization, Polynomial coeff. R0
Requirements	The selection RTD poly nickel or RTD polynomial copper is activated in the *Sensor type* parameter
Description	Setting the R0 value for the linearization of nickel/copper sensors
Input	40 ohm … 1,050 ohm
Default setting	100 ohm

Polynomial coeff. A, B	
Navigation	Expert, Sensors, Sensor n, Linearization, Polynomial coeff. A, B
Requirements	The selection RTD poly nickel or RTD polynomial copper is activated in the *Sensor type* parameter
Description	Setting the coefficients for the sensor linearization of copper/nickel resistance thermometer
Default setting	– Polynomial coeff. A = 5.49630e-003 – Polynomial coeff. B = 6.75560e-006

"Diagnostics settings" submenu

Calibration counter start	
Navigation	Expert, Sensors, Diagnostic settings, Calibration counter start
Description	Selection in order to control the calibration counter – The duration (in days) of the countdown is specified with the *Calibration counter start value* parameter. – The status signal for reaching the limit value is specified with the *Calibration counter alarm category* parameter.
Selection	– Off: stopping the calibration counter – On: starting the calibration counter – Reset + starting: resetting to the set start value and starting the calibration counter
Default setting	Off

Calibration counter alarm category	
Navigation	Expert, Sensors, Diagnostic settings, Calibration counter alarm category
Description	Selection of the category (status signal) of how the device reacts at elapse of the set calibration countdown
Selection	– Maintenance required (M) – Failure (F)
Default setting	Maintenance required (M)

Calibration counter start value	
Navigation	Expert, Sensors, Diagnostic settings, Calibration counter start value
Description	Setting the start value for the calibration counter
Input	0 d ... 365 d (days)
Default setting	365 d

Countdown calibration	
Navigation	Expert, Sensors, Diagnostic settings, Countdown calibration
Description	Display of remaining time until the next calibration The countdown of the calibration counter only runs when the device is active. Example: If the calibration counter was set to 365 days on 1.1.2011 and the device is disconnected for 100 days, the alarm for calibration appears on April 10, 2012.

"Output" submenu

Measuring mode	
Navigation	Expert, Output, Measuring mode
Description	Enables the inversion of the output signal
Additional information	– Standard The output current rises when the temperature increases – Inverted The output current lowers when the temperature increases
Selection	– Standard – Inverted
Default setting	Standard

“Communication” submenu

“HART configuration” submenu

Measuring point designation (Page 31)	
Navigation	Diagnostics, Device information, Measuring point designation Expert, Communication, HART configuration, Measuring point designation

HART short description	
Navigation	Expert, Communication, HART configuration, HART short description
Description	Defines a short description for the measuring point
Input	Up to 8 alphanumeric characters (letters, numbers, special characters)
Default setting	SHORTTAG

HART address	
Navigation	Expert, Communication, HART configuration, HART address
Description	Definition of HART® address of the device
Input	0 ... 63
Default setting	0
Additional information	Measured value transfer via the current value is only possible for address “0”. With all other addresses, the current is fixed to 4.0 mA (multidrop mode).

No. of preambles	
Navigation	Expert, Communication, HART configuration, Preamble number
Description	Specification of the preamble number in the HART® telegram
Input	2 ... 20
Default setting	5

Configuration changed	
Navigation	Expert, Communication, HART configuration, Configuration changed
Description	Display of whether the configuration of the device was changed by a master (primary or secondary)

Configuration changed, reset flag	
Navigation	Expert, Communication, HART configuration, Configuration changed, Reset flag
Description	Resetting the information *Configuration changed* by a master (primary or secondary)

“HART Info” submenu

Device type	
Navigation	Expert, Communication, HART info, Device type
Description	Display of device type with which the device is registered at the HART® Communication Foundation. The device type is specified by the manufacturer. It is required to assign the matching device description file (DD) to the device.
Display	2-digit hexadecimal number
Default setting	0xB005

Device revision	
Navigation	Expert, Communication, HART info, Device revision
Description	Display of device revision with which the device is registered at the HART® Communication Foundation. It is required to assign the matching device description file (DD) to the device.
Default setting	2

HART revision	
Navigation	Expert, Communication, HART info, HART revision
Description	Display of the HART® revision of the device

HART description	
Navigation	Expert, Communication, HART info, HART description
Description	Defines a description for the measuring point
Input	Up to 32 alphanumeric characters (letters, numbers, special characters)
Default setting	The respective device name

HART message	
Navigation	Expert, Communication, HART info, HART message
Description	Definition of a HART® message that is sent on request from the master via the HART® protocol.
Input	Up to 32 alphanumeric characters (letters, numbers, special characters)
Default setting	The respective device name

Hardware revision	
Navigation	Expert, Diagnostics, Device information, Hardware revision Expert, Communication, HART info, Hardware revision
Description	Display of the hardware revision of the device

SWRev	
Navigation	Expert, Communication, HART info, SWRev
Description	Displays the software revision of the device

HART date	
Navigation	Expert, Communication, HART info, HART date
Description	Defines date information for individual use
Input	Date in format: year-month-day (YYYY-MM-DD)
Default setting	2010-01-01

“HART output” submenu

Current output assignment (PV)	
Navigation	Expert, Communication, HART output, Assignment, Current output (PV)
Description	Assignment of a measured variable for the first HART® value (PV)
Selection	– Sensor 1 (measured value) – Sensor 2 (measured value) – Device temperature – Mean value of the two measured values: 0.5 x (SV1+SV2) – Difference between Sensor 1 and Sensor 2: SV1-SV2 – Sensor 1 (backup Sensor 2): If Sensor 1 fails, the value of Sensor 2 automatically becomes the first HART® value (PV): Sensor 1 (OR Sensor 2) – Sensor switchover: If the set threshold value T is exceeded for Sensor 1, the measured value of Sensor 2 becomes the first HART® value (PV). Switching back to Sensor 1 is done when the measured value of Sensor 1 is at least 2 K below T: Sensor 1 (Sensor 2, if Sensor 1 > T) – Mean value: 0.5 x (SV1+SV2) with backup (measured value of Sensor 1 or Sensor 2 in the case of sensor errors of the other sensor) The threshold value can be set with the Sensor switchover limit value parameter. Two sensors can be combined by the temperature-dependent switchover, which have their advantages in different temperature ranges.
Default setting	Sensor 1

PV	
Navigation	Expert, Communication, HART output, PV
Description	Display of the first HART value

SV assignment	
Navigation	Expert, Communication, HART output, Assignment SV
Description	Assignment of a measured variable for the second HART® value (PV)
Selection	See *Current output assignment (PV)* parameter (Page 51)
Default setting	Device temperature

SV	
Navigation	Expert, Communication, HART output, SV
Description	Display of the second HART® value

TV assignment	
Navigation	Expert, Communication, HART output, Assignment TV
Description	Assignment of a measured variable for the third HART® value (TV)
Selection	See *Current output assignment (PV)* parameter (Page 51)
Default setting	Sensor 1

TV	
Navigation	Expert, Communication, HART output, TV
Description	Display of the third HART® value

QV assignment	
Navigation	Expert, Communication, HART output, Assignment QV
Description	Assignment of a measured variable for the fourth HART® value (QV)
Selection	See *Current output assignment (PV)* parameter (Page 51)
Default setting	Sensor 1

QV	
Navigation	Expert, Communication, HART output, QV
Description	Display of the fourth HART® value

“Burst configuration” submenu

Up to 3 burst modes can be configured.

Burst mode	
Navigation	Expert, Communication, Burst configuration, Burst mode
Description	Activation of the HART® burst mode for the burst message X. Message 1 has the highest priority, message 2 the second highest, etc.
Selection	– Off The device only sends data to the bus on request of a HART® master. – On The device regularly sends data to the bus without being requested.
Default setting	Off

Burst command	
Navigation	Expert, Communication, Burst configuration, Burst command
Requirements	This parameter can only be selected if the *Burst mode* selection is activated.
Description	Selection of the command whose response is sent in activated burst mode to the HART® master.
Selection	– Command 1 Reading out the primary variable – Command 2 Reading out the current and the main measured value in percent – Command 3 Reading out the dynamic HART® variables and the current – Command 9 Reading out the dynamic HART® variables including the corresponding status – Command 33 Reading out the dynamic HART® variables including the corresponding unit
Default setting	Command 2
Additional information	Command 1, 2, 3, and 9 are universal HART® commands. Command 33 is a “Common Practice” HART® command. Details on this are given in the HART® specifications.

Burst variable n	
n = number of burst variables 0 ... 3	
Navigation	Expert, Communication, Burst configuration, Burst variable n
Requirements	This parameter can only be selected if the *Burst mode* selection is activated.
Description	Assignment of a measured variable for slot 0 to 3 This assignment is **only** relevant for burst mode. The measured variables are assigned to the 4 HART® variables (PV, SV, TV, QV) in ““HART output” submenu” on page 51.
Selection	– Sensor 1 (measured value) – Sensor 2 (measured value) – Device temperature – Mean value of the two measured values: 0.5 x (SV1+SV2) – Difference between Sensor 1 and Sensor 2: SV1-SV2 – Sensor 1 (backup Sensor 2): If Sensor 1 fails, the value of Sensor 2 automatically becomes the first HART® value (PV): Sensor 1 (OR Sensor 2) – Sensor switchover: If the set threshold value T is exceeded for Sensor 1, the measured value of Sensor 2 becomes the first HART® value (PV). Switching back to Sensor 1 is done when the measured value of Sensor 1 is at least 2 K below T: Sensor 1 (Sensor 2, if Sensor 1 > T) The threshold value can be set with the Sensor switchover limit value parameter. Two sensors can be combined by the temperature-dependent switchover, which have their advantages in different temperature ranges. Mean value: 0.5 x (SV1+SV2) with backup (measured value of Sensor 1 or Sensor 2 in the case of sensor errors of the other sensor)
Default setting	– Burst variable 0: Sensor 1 – Burst variable 1: Device temperature – Burst variable 2: Sensor 1 – Burst variable 3: Sensor 1

Burst trigger mode	
Navigation	Expert, Communication, Burst configuration, Burst trigger mode
Require-ments	This parameter can only be selected if the *Burst mode* selection is activated.
Description	Selection of the event that triggers the burst message X – Continuously: The message is triggered time-controlled: at least at the interval of the time span specified in *Burst min time period X*. – Interval: The message is triggered when the specified measured value has changed by the value in the *Burst trigger value X* parameter. – Increasing: The message is triggered when the specified measured value exceeds the value in the *Burst trigger value X* parameter. – Falling: The message is triggered when the specified measured value falls below the value in the *Burst trigger value X* parameter. – If changed: The message is triggered when any desired measured value has changed the message.
Selection	– Continuous – Interval – Increasing – Falling – If changed
Default set-ting	Continuous

Burst trigger value	
Navigation	Expert, Communication, Burst configuration, Burst trigger value
Require-ments	This parameter can only be selected if the *Burst mode* selection is activated.
Description	Entry of the value that determines the time of the burst message 1 together with the trigger mode. This value determines the time of the message.
Input	$-1.0e^{+20}$ ... $+1.0e^{+20}$
Default set-ting	$-1.0e^{+20}$

Burst min. time period	
Navigation	Expert, Communication, Burst configuration, Burst min. time period
Require-ments	This parameter can only be selected if the *Burst mode* selection is activated.
Description	Entry of the minimum time period between two burst commands of burst message X. Entry is made in the unit 1/32 milliseconds.
Input	500 ... [entered value of the maximum time period in the *Burst max. time period* parameter] in whole numbers
Default set-ting	1000

Burst max. time period	
Navigation	Expert, Communication, Burst configuration, Burst max time period
Require-ments	This parameter can only be selected if the *Burst mode* selection is activated.
Description	Entry of the maximum time period between two burst commands of burst message X. Entry is made in the unit 1/32 milliseconds.
Input	[Entered value of the minimum time period in the *Burst min. time period* parameter] ... 3600000 in whole numbers
Default set-ting	2000

“Diagnostics” submenu

“Diagnostic list” submenu

For a detailed description, see Page 53.

“Event log” submenu

For a detailed description, see Page 42.

“Device information” submenu

ENP version	
Navigation	Expert, Diagnostics, Device information, ENP version
Description	Display of the version of the electronic rating plate (Electronic Name Plate)
Display	6-digit number in xx.yy.zz format

Device revision	
Navigation	Expert, Diagnostics, Device info, Device revision Expert, Communication, HART info, Device revision
Description	Display of device revision with which the device is registered at the HART® Communication Foundation. It is required to assign the matching device description file (DD) to the device.
Display	2-digit hexadecimal number

Manufacturer ID	
Navigation	Expert, Diagnostics, Device information, Manufacturer ID
Description	Display of manufacturer ID with which the device is registered at the HART® Communication Foundation.
Display	2-digit hexadecimal number
Default setting	176

Manufacturer	
Navigation	Expert, Diagnostics, Device information, Manufacturer
Description	Display of the manufacturer’s name

Hardware revision	
Navigation	Expert, Diagnostics, Device information, Hardware revision Expert, Communication, HART info, Hardware revision
Description	Display of the hardware revision of the device

“Measured values” submenu

Sensor n raw value	
n = place-holder for number of sensor inputs (1 and 2)	
Navigation	Expert, Diagnostics, Measured values, Sensor n raw value
Description	Displays the non-linearized mV/ohm value at the respective sensor input

“Min./Max. values” submenu

For a detailed description, see Page 43.

“Simulation” submenu

For a detailed description, see Page 44.

9 Maintenance

The device does not require special service or maintenance.

10 Troubleshooting

10.1 Diagnostics results

Table 1 Status signals

Symbol	Event category	Meaning
F	Operational error	An operational error has occurred. The measured value is no longer valid.
C	Service mode	The device is in service mode (e.g., during a simulation).
S	Out of specification	The device is being operated outside its technical specifications (e.g., during startup or cleaning).
M	Maintenance required	Maintenance is required. The measured value is still valid.

Table 2 Diagnostic behavior

Alarm	Measurement is interrupted. The signal outputs take on the defined alarm status. A diagnostic message is generated (status signal F).
Warning	The device continues measuring. A diagnostic message is generated (status signal M, C, or S).

Diagnostic event and event text

The malfunction can be identified using the diagnostic event. The event text helps by supplying information on the malfunction.

	Diagnostic event		
	Status signal	Event number	Event text
	↓	↓	↓
Example	F	042	Sensor corrosion
		3-digit number	

If multiple diagnostic events occur simultaneously, only the diagnostic message with the highest priority will be displayed. Further pending diagnostic messages are displayed in the “Diagnostic list” submenu (see Page 53).

Past diagnostic messages that are no longer pending are displayed in the “Event logbook” submenu (Page 42).

10.2 Overview of diagnostic events

Each diagnostic event is assigned to a specific event behavior by default. The users can change this assignment for particular diagnostic events.

The sensor input relevant for these diagnostic events can be identified with the *Current diagnostics channel* parameter (see Page 41).

Diagnostic number	Short text	Remedy measure	Default status signal Can be changed to	Default diagnostic behavior
Diagnostics for sensor				
001	Device fault	1. Restart the device 2. Check electronic connection of sensor 1 3. Check/Replace sensor 1 4. Replace the electronics	F	Alarm
006	Redundancy active	1. Check the electronic wiring. 2. Replace the sensor. 3. Check the configuration of the connection method.	M	Warning
041	Sensor failure	1. Check the electronic wiring. 2. Replace the sensor. 3. Check the configuration of the connection method.	F	Alarm
042	Sensor corrosion	1. Check electronic wiring of sensor. 2. Replace the sensor.	M F	Warning [1]
043	Short circuit	1. Check the electronic wiring. 2. Replace the sensor.	F	Alarm
044	Sensor drift	1. Check the sensors. 2. Check process temperatures.	M F, S	Warning [1]
045	Workspace	1. Check the ambient temperature. 2. Check external reference measuring point.	F	Alarm
062	Sensor connection	1. Check the electronic wiring. 2. Replace the sensor. 3. Check the configuration of the connection method. 4. Contact the service department.	F	Alarm
101	Drop below operating range	1. Check process temperatures. 2. Check the sensor. 3. Check sensor type.	S F	Warning
102	Operating range exceeded	1. Check process temperatures. 2. Check the sensor. 3. Check sensor type.	S F	Warning

Diagnostic number	Short text	Remedy measure	Default status signal Can be changed to	Default diagnostic behavior
104	Backup active	1. Check electronic wiring of Sensor 1. 2. Replace Sensor 1. 3. Check the configuration of the connection method.	M	Warning
105	Calibration interval	1. Carry out calibration and reset calibration interval. 2. Switch off calibration counter.	M F	Warning[1]
106	Backup not available	1. Check electronic wiring of Sensor 2. 2. Replace Sensor 2. 3. Check the configuration of the connection method.	M	Warning
Diagnostics for electronics				
201	Device fault	Replace the electronics.	F	Alarm
221	Reference measurement	Replace the electronics.	F	Alarm
241	Software	1. Restart the device. 2. Execute device reset. 3. Replace the device.	F	Alarm
242	Software incompatible	Contact the service department.	F	Alarm
261	Electronics module	Replace the electronics.	F	Alarm
262	Module connection short circuit	1. Check seat of the display module on the head-mounted transducer. 2. Test display module with other, suitable head-mounted transducers. 3. Display module defective? Replace module.	M	Warning
282	Data storage system	Replace the device.	F	Alarm
283	Storage contents	Replace the electronics.	F	Alarm
301	Supply voltage	1. Increase the supply voltage. 2. Check connection conductors for corrosion.	F	Alarm
Diagnostics for configuration				
401	Factory reset	Please wait until the reset process ends.	C	Warning
402	Initiation	Please wait until the start process is completed.	C	Warning
410	Data transmission	Check HART® communication.	F	Alarm
411	Download active	Please wait until the up-/download is complete.	F, M, or C [2]	-
431	Factory calibration[3]	Replace the electronics.	F	Alarm
435	Linearization	1. Check the configuration of the sensor parameters. 2. Check the configuration of the special sensor linearization. 3. Contact the service department. 4. Replace the electronics.	F	Alarm

Diagnostic number	Short text	Remedy measure	Default status signal Can be changed to	Default diagnostic behavior
437	Configuration	1. Check the configuration of the sensor parameters. 2. Check the configuration of the special sensor linearization. 3. Check the configuration of the temperature transducer settings. 4. Contact the service department.	F	Alarm
438	Data record	Perform new safe configuration.	F	Alarm
451	Data processing	Please wait until the data processing is complete.	C	Warning
483	Simulation input	Switch off simulation.	C	Warning
485	Simulation measured value			
491	Current output simulation			
501	PC connection	Remove programming connector.	C	Warning
525	HART® communication	1. Check communication path. 2. Check HART® master. 3. Is the power supply sufficient? 4. Check HART® communication settings. 5. Contact the service department.	F	Alarm
Diagnostics for process				
803	Loop current	1. Check cabling. 2. Replace the electronics.	F	Alarm
842	Process limit value	Check scaling of analog output.	M F, S	Warning [1]
925	Device temperature	Maintain ambient temperature in accordance with specification.	S F	Warning

[1] Diagnostic behavior is changeable: “Alarm” or “Warning”

[2] The status signal depends on the communication system used and cannot be changed.

[3] With this diagnostic event, the device always emits the alarm state “low” (output current ≤3.6 mA).

11 Disposal

The device contains electronic components. It must therefore be disposed of as electronic waste. Observe local disposal regulations.

12 Safety function

12.1 Definition of the safety function

Permitted safety functions of the device are:

• “Limit value monitoring” on page 60

• “Safe measurement” on page 61

12.1.1 Safety-related output signal

The safety-related signal of the device is the analog output signal 4 mA … 20 mA in accordance with NAMUR NE43. All safety measures are exclusively related to this signal.

The safety-related output signal is conveyed to a downstream logic unit, e.g., a programmable logic controller or a limit switch, and is monitored there:

– Exceeding and/or falling below a specified limit value
– Occurrence of a malfunction, e.g., residual current (≤3.6 mA, ≥21 mA, interruption or short circuit of the signal line).

The current output cannot be configured to an inverse display in SIL mode.

12.1.2 Dangerous undetected error in this analysis

An incorrect output signal is viewed as a “dangerous undetected error”, which deviates from the value specified in this document, while the output signal remains in the range of 4 mA … 20 mA.

12.1.3 Limit value monitoring

The safety function is for monitoring the measured value. In SIL mode, in the case of measurement outside a user-defined measuring range (X_{min} … X_{max}), a residual current is emitted depending on the setting of the “Area infringement category” parameter (F, S, M).

Example in the figure: $I_{4\ mA}$ = -100°C, $I_{20\ mA}$ = +400°C

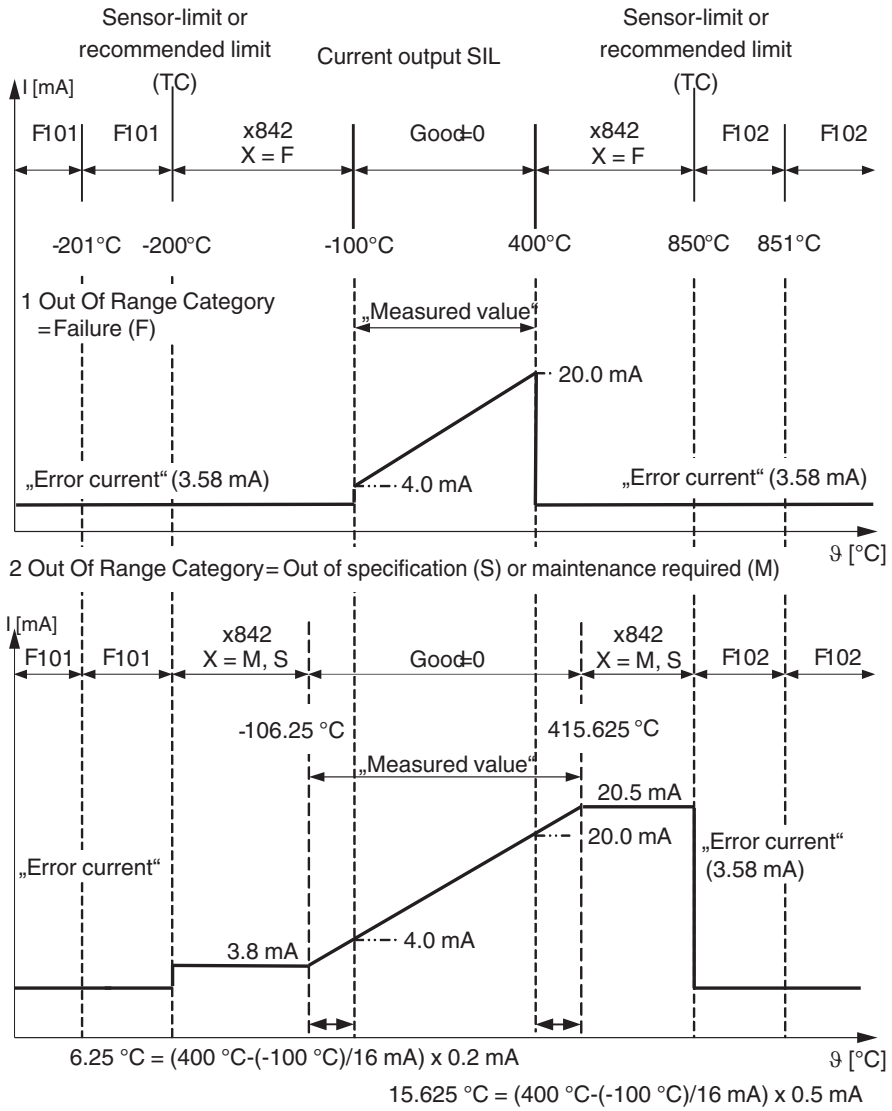


Figure 9 Limit value monitoring

1 Out of range category curve = Status signal failure (F)

2 Out of range category curve = Status signal failure outside the specification (S) or maintenance required (M)

12.1.4 Safe measurement

The safety function of the temperature transmitter is to output a current proportional to the voltage, resistance, or temperature value. In order to be able to use the safety functions, the device must be safely configured using an operating tool and changed into SIL mode (“Increased configuration safety mode, safe configuration (SiPA)” on page 72 or “Expert mode, SIL mode activation (SiMA)” on page 74).

Ensure that only the measured value of a sensor or the value of a function (mean value/difference of both measured values) can always be emitted at the current output. A limit value monitoring can be set separately for both inputs.

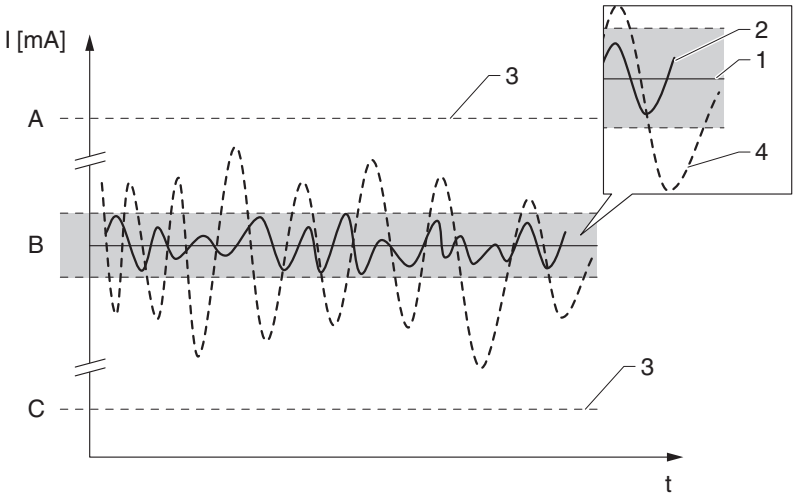
12.2 Restrictions for use in safety-related operation

- Use the measuring system for the specified purpose and in consideration of the medium's properties and ambient conditions. Observe the information on critical process situations and installation behavior. The application-specific limits are to be maintained.
- Information on the safety-related signal (see Page 59)
- The specifications in this document must not be exceeded (see "Documentation").
- The following restriction also applies for safety-related use:

  The tolerance range (safety measurement deviation) is sensor specific and is defined by default in accordance with FMEDA (Failure Modes, Effects and Diagnostic Analysis). All the influencing factors described in the associated documentation are already included: non-linearity, non-repeatability, hysteresis, zero point deviation, temperature drift, EMC influence.

  The safety technology errors are divided into different categories in accordance with IEC / EN 61508 (see following table). The table shows the effects on the safety-related output signal and the measuring insecurity.

Safety technology error	Explanation	Effect on the safety-related output signal (position, see following figure)
No device error	Safe: no error occurred	1: Is within the specification
λ_{SD}	Safe detected: safe and detected error	3: Device goes to failure signal ("Device behavior in operation and in the event of a malfunction" on page 70)
λ_{SU}	Safe undetected: safe but undetected error	2: Is within the specified tolerance range ("Safety measurement deviation" on page 64)
λ_{DD}	Dangerous detected: dangerous but detected error (diagnostics in the device)	3: Device goes to failure signal ("Device behavior in operation and in the event of a malfunction" on page 70)
λ_{DU}	Dangerous undetected: Dangerous and undetected error	4: Can be outside the specified tolerance range ("Safety measurement deviation" on page 64)



A High alarm ≥21 mA

B Tolerance range (“Safety measurement deviation” on page 64)

C Low alarm ≤3.6 mA

12.3 Safety measurement deviation

Table 1 Thermocouples

Standard	Designation	Min. measuring span	Limited safety measurement area	Measurement deviation (+A/D), -40 ... +70°C (-40 ... +158°F)	Measurement deviation (D/A)	Long-term drift in °C/year[1]
IEC 60584-1	Type A (W5Re-W20Re) (30)	50 K (90°F)	0°C … +2,500°C (+32°F … +4,532°F)	12 K (21.6°F)	0.5%[2]	1.42
	Type B (PtRh30-PtRh6) (31)	50 K (90°F)	+500°C … +1,820°C (+932°F … +3,308°F)	5.1 K (9.2°F)		2.01
	Type E (NiCr-CuNi) (34)	50 K (90°F)	–150°C … +1,000°C (–238°F … +1,832°F)	4.9 K (8.8°F)		0.43
	Type J (Fe-CuNi) (35)	50 K (90°F)	–150°C … +1,200°C (–238°F … +2,192°F)	4.9 K (8.8°F)		0.46
	Type K (NiCr-Ni) (36)	50 K (90°F)	–150°C … +1,200°C (–238°F … +2,192°F)	5.1 K (9.2°F)		0.56
	Type N (NiCrSi-NiSi) (37)	50 K (90°F)	–150°C … +1,300°C (–238°F … +2,372°F)	5.5 K (9.9°F)		073
	Type R (PtRh13-Pt) (38)	50 K (90°F)	+50°C … +1768°C (+122°F … +3,214°F)	5.6 K (10.1°F)		1.58
	Type S (PtRh10-Pt) (39)	50 K (90°F)	+50°C … +1,768°C (+122°F … +3,214°F)	5.6 K (10.1°F)		1.59
	Type T (Cu-CuNi) (40)	50 K (90°F)	–150°C … +400°C (–238°F … +752°F)	5.2 K (9.4°F)		0.52
IEC 60584-1; ASTM E988-96	Type C (W5Re-W26Re) (32)	50 K (90°F)	0°C … +2,000°C (+32°F … +3,632°F)	7.6 K (13.7°F)		0.94
ASTM E988-96	Type D (W3Re-W25Re) (33)	50 K (90°F)	0°C … +2,000°C (+32°F … +3,632°F)	7.1 K (12.8°F)		1.14
DIN 43710	Type L (Fe-CuNi) (41)	50 K (90°F)	–150°C … +900°C (–238°F … +1,652°F)	4.2 K (7.6°F)		0.42
	Type U (Cu-CuNi) (42)	50 K (90°F)	–150°C … +600°C (–238°F … +1,112°F)	5.0 K (9°F)		0.52
GOST R8.8585-20 01	Type L (NiCr-CuNi) (43)	50 K (90°F)	–200°C … +800°C (–328°F … +1,472°F)	8.4 K (15.1°F)		0.53
Voltage sensors (mV)		5 mV	–20 mV … 100 mV	200 µV		27.39 µV/a

[1] Entries for 25°C: values must be calculated for other temperatures, if necessary.

[2] With regard to the measurement range

Table 2 Resistance temperature detectors

Standard	Designation	Min. measuring span	Limited safety measurement area	Measurement deviation (+A/D), -40°C ... +70°C (-40°F ... +158°F)	Measurement deviation (D/A),	Long-term drift in °C/year or Ω/year[1]
IEC 60751:2008	Pt 100 (1)	10 K (18°F)	–200°C … +600°C (–328°F … +1,112°F)	1.1 K (2.0 °F)	0.5%[2]	0.23
	Pt 200 (2)	10 K (18°F)	–200°C … +600°C (–328°F … +1,112°F)	1.6 K (2.9°F)		0.92
	Pt 500 (3)	10 K (18°F)	–200°C … +500°C (–328°F … +932°F)	0.9 K (1.6°F)		0.38
	Pt 1000 (4)	10 K (18°F)	–200°C … +250°C (–328°F … +482°F)	0.6 K (1.1°F)		0.19
JIS C1604:1984	Pt 100 (5)	10 K (18°F)	–200°C … +510°C (–328°F … +950°F)	1.0 K (1.8°F)		0.32
DIN 43760 IPTS-68	Ni 100 (6)	10 K (18°F)	–60°C … +250°C (–76°F … +482°F)	0.4 K (0.7°F)		0.22
	Ni 120 (7)	10 K (18°F)	–60°C … +250°C (–76°F … +482°F)	0.3 K (0.54°F)		0.18
GOST 6651-94	Pt 50 (8)	10 K (18°F)	–180°C … +600°C (–292°F … +1,112°F)	1.3 K (2.34°F)		0.61
	Pt 100 (9)	10 K (18°F)	–200°C … +600°C (–328°F … +1,112°F)	1.2 K (2.16°F)		0.34
OIML R84: 2003, GOST 6651-2009	Cu 50 (10)	10 K (18°F)	–180°C … +200°C (–292°F … +392°F)	0.7 K (1.26°F)		0.46
	Cu 100 (11)	10 K (18°F)	–180°C … +200°C (–292°F … +392°F)	0.5 K (0.9°F)		0.23
	Ni 100 (12)	10 K (18°F)	–60°C … +180°C (–76°F … +356°F)	0.4 K (0.7°F)		0.21
	Ni 120 (13)	10 K (18°F)	–60°C … +180°C (–76°F … +356°F)	0.3 K (0.54°F)		0.18
OIML R84: 2003, GOST 6651-94	Cu 50 (14)	10 K (18°F)	–50°C … +200°C (–58°F … +392°F)	0.7 K (1.26°F)		0.45
Resistance-type sensor Ω	400 Ω	10 Ω	10 Ω ... 400 Ω	0.5 Ω		0.096 Ω
	2000 Ω	100 Ω	10 Ω ...2000 Ω	2.1 Ω		0.51 Ω

[1] Entries for 25°C: values must be calculated for other temperatures, if necessary.

[2] With regard to the measurement range

No deviations because of the influence of EMC are considered in these specifications. In the case of EMC malfunctions that are not negligible, add an additional deviation of 0.5% of the measurement range to the above values.

Validity of the specifications on safety measurement deviation:

- Total permitted temperature range of the temperature transducer in SIL mode
- Defined range of supply voltage
- Limited safety measurement area of the sensor element
- Precision includes all linearization and rounding errors
- Observe the minimum measurement range of each sensor
- Housing designs of DIN rails and head-mounted transducers
- Specifications are 2σ values, i.e., 95.4% of all measured values are within the specifications

12.4 Restrictions of the device specification in safe operation

- Comply with the ambient conditions in accordance with IEC 61326-3-2 Appendix B.
- Permitted voltage range in SIL mode:
  V_{cc} = 12 V … 32 V
- The power supply has to be short-circuit-proof, and be able to drive the upper residual current at any time.
- Use a shielded cable for the DIN rail variant from a sensor cable length of 30 m (98.4 ft). The use of shielded sensor cables is generally recommended.
- Permissible storage temperature:
  –40°C … +100°C (–40°F … +212°F)
- Permissible ambient temperature –40°C … +70°C (–40°F … +158°F)
- The use of the programming adapter MCR PAC-T-USB (Item No.: 2309000) is not possible for safe configuration (only with HART® communication).
- Set correct mains frequency filter (50 Hz/60 Hz).
- Maximum permitted sensor cable resistance for voltage measurement: 1,000 Ω

HART® communication

The temperature transducer also carries out the communication via HART® in SIL mode. This includes all the supported HART® features with additional device information. The HART® communication is **not** part of the safety function.

NOTE:

Use shielded supply lines.

12.5 Parameters and default settings for the increased parameter safety and expert mode

Parameter	Default settings
Firmware version	Display of the installed device firmware version Display of max. 6-digit string in xx.yy.zz format. Refer to the rating plate or the associated documentation for the currently valid firmware version.
Serial number	Displays the serial number of the device It is also found on the rating plate. Max. 11-digit string of letters and numbers.
Enter release code	Release of service parameters via operating tool Default setting: **0**
Device reset	Reset the entire device configuration or part of it to a defined state Default setting: **Not active**
Hardware revision	Display of the hardware revision of the device
Current output simulation	Switches simulation of the current output on and off If the simulation is active, a diagnostic message of the function control (C) category is displayed in the change to the measured value display. Default setting: **Off** (cannot be changed in the safe configuration)
Simulation current output value	Sets a current value for the simulation In this way, correct adjustment of the current output and correct function of downstream evaluation devices can be checked. Default setting: **3.58 mA** (cannot be changed in the safe configuration)
Voltage trim 20 mA	Setting the correction value for the current output at measuring range end 20 mA Default setting: **20.000 mA** (cannot be changed in the safe configuration)
Voltage trim 4 mA	Setting the correction value for the current output at measuring range start at 4 mA Default setting: **4 mA** (cannot be changed in the safe configuration)

Parameter	Default settings
Start of measuring range	Assignment of a measured value to the current value 4 mA Default setting: **0**
End of measuring range	Assignment of a measured value to the current value 20 mA Default setting: **100**
Residual current	Setting the current value that the current output issues in the event of a malfunction SIL mode: **3.58 mA** (cannot be changed in the safe configuration)
Failure mode	Selection of the failure signal level that the current output issues in the case of an error Default setting: **Min.** (cannot be changed in the safe configuration)
Out of range category	Selection of the category (status signal), how the device reacts when leaving the set measuring range Default setting: **Maintenance requirement (M)**
Minimum measurement range	A measurement range is the difference between the temperature at 4 mA and at 20 mA. The minimum measurement range is the minimum permitted setting or sensible setting for a sensor type of this difference in the temperature transducer.
HART® address	Definition of HART® address of the device Default setting: **0** (cannot be changed in the safe configuration)
Minimum measurement range	A measurement range is the difference between the temperature at 4 mA and at 20 mA. The minimum measurement range is the minimum permitted setting or sensible setting for a sensor type of this difference in the temperature transducer.
HART® address	Definition of HART® address of the device Default setting: **0** (cannot be changed in the safe configuration)
Device revision	Display of device revision with which the device is registered at the HART® Communication Foundation. It is required to assign the matching device description file (DD) to the device. Default setting: **2** (fixed value)

Parameter	Default settings
Measuring mode	Possibility of the inversion of the output signal. Selection: Standard (4 mA … 20 mA) or inverted (20 mA … 4 mA) Default setting: **Standard** (cannot be changed in the safe configuration)
Sensor type n	Selection of the sensor type for the respective sensor input n: – Sensor type 1: Settings for sensor input 1 – Sensor type 2: Settings for sensor input 2 Default setting: – **Sensor type 1: Pt 100 IEC751** – **Sensor type 2: No sensor**
Upper sensor limit n	Display of maximum physical measuring range final value Default setting: – For sensor type 1 = Pt 100 IEC751: **+850°C (+1 562°F)** – Sensor type 2 = No sensor
Lower sensor limit n	Display of minimum physical measuring range final value Default setting: – For sensor type 1 = Pt 100 IEC751: **–200°C (–328°F)** – Sensor type 2 = No sensor
Sensor offset n	Sets zero point correction (offset) for the sensor measured value. The specified value is added to the measured value. Default setting: **0.0**
Connection method n	Selects the connection method of the sensor Default setting: – Sensor 1 (connection method 1): **4-conductor** – Sensor 2 (connection method 2): **2-conductor**
Cold junction n	Selection of cold junction measurement for temperature compensation of thermocouples (TC) Default setting: **Internal measurement**

Parameter	Default settings
Cold junction preset value n	Determines the fixed preset value for temperature compensation. The **Preset value** parameter has to be set for the **Cold junction n** selection. Default setting: **0.00**
Call.-v. Dusen coeff. A, B, and C	Setting the coefficients for the sensor linearization in accordance with the Callendar-Van Dusen method Prerequisite: The selection RTD platinum is activated in the **Sensor type** parameter (Callendar- Van Dusen). Default setting: – **Coefficient A: 3.910000e-003** – **Coefficient B: -5.780000e-007** – **Coefficient C: -4.180000e-012**
Call.-v. Dusen coeff. R0	Sets the R0 value for linearization with the Callendar/Van Dusen polynomial Prerequisite: The selection RTD platinum (Callendar-Van Dusen) is activated in the **Sensor type** parameter. Default setting: **100 Ω**
Polynomial coeff. A, B	Setting the coefficients for the sensor linearization of copper/nickel resistance thermometer Prerequisite: The selection RTD poly nickel or RTD polynomial copper is activated in the **Sensor type** parameter. Default setting: – **Polynomial coeff. A = 5.49630e-003** – **Polynomial coeff. B = 6.75560e-006**
Polynomial coeff. R0	Setting the R0 value for the linearization of nickel/copper sensors Prerequisite: The selection RTD poly nickel or RTD polynomial copper is activated in the **Sensor type** parameter. Default setting: **100 Ω**
Sensor trim	Selection of which linearization method is used for the connected sensor Default setting: **FactoryTrim** (cannot be changed in the safe configuration)

Parameter	Default settings
Unit	Selects the measuring unit for all measured values Default settings: °**C**
Mains frequency filter	Selects the mains filter for A/D conversion Default setting: **50 Hz**
Drift/Difference monitoring	Selection of whether the device reacts to the drift/difference limit value being exceeded or fallen below. Can only be selected for 2-channel operation. Default setting: **Off**
Drift/Difference alarm category	Selection of the category (status signal) of how the device reacts between Sensor 1 and Sensor 2 in the case of drift/difference detection. Requirement: The **Drift/Difference monitoring** parameter must be activated with the **Overrange (Drift)** or **Underrange** selection. Default setting: **Maintenance requirement (M)**
Drift/Difference limit value	Setting of maximum permitted measured value deviation between Sensor 1 and Sensor 2 that leads to a drift/difference detection. Requirement: The **Drift/Difference monitoring** parameter must be activated with the **Overrange (Drift)** or **Underrange** selection. Default setting: **999.0**
Drift/Difference alarm delay	Alarm delay of drift detection monitoring Requirement: The **Drift/Difference monitoring** parameter must be activated with the **Overrange (Drift)** or **Underrange** selection. Default setting: **0 s** (cannot be changed in the safe configuration)
Device temperature alarm	Selection of category (status signal) of how the device reacts in the case of exceeding or falling below the electronic temperature of the temperature transducer <-40°C (-40°F) or >+82°C (+180°F) Default setting: **Error (F)** (cannot be changed in the safe configuration)

Parameter	Default settings
SIL HART mode	Setting HART® communication during SIL mode. The setting **HART not activated in SIL mode** deactivates HART® communication in SIL mode (only 4 mA … 20 mA communication is active). Default settings: **HART activated in SIL mode**
SIL startup mode	Setting the repeat automatic startup of the device in SIL mode, e.g., after a “power cycle” Default settings: **Activated**
Force safe state	During startup or repeat test, the error detection and the safe state of the device are tested with this parameter. Requirement: The **Operating state** parameter displays **SIL mode active**. Default setting: Off
Current output assignment (PV)	Assignment of a measured variable for the first HART® value (PV) Default setting: **Sensor 1**
SV assignment	Assignment of a measured variable for the second HART® value (PV) Default setting: **Device temperature**
TV assignment	Assignment of a measured variable for the third HART® value (TV) Default setting: **Sensor 1**
QV assignment	Assignment of a measured variable for the fourth HART® value (QV) Default setting: **Sensor 1**
Attenuation	Sets the time constants for attenuation of the current output Default setting: **0.00 s** (cannot be changed in the safe configuration)
Burst mode	Activation of the HART® burst mode for the burst message X. Message 1 has the highest priority, message 2 the second highest, etc. Default setting: **Off** (cannot be changed in the safe configuration)

13 Use in safety equipment

13.1 Device behavior in operation and in the event of a malfunction

13.1.1 Device behavior during power on

After switching on, the device goes through a diagnostics phase. During this time, the power output is at fault current (low alarm).

No communication is possible via the programming interface or via HART® during the diagnostics phase.

Table 3 Device behavior during power on depending on the configuration

		SIL startup mode **parameter**	
		ON	OFF
SIL HART mode **parameter**	ON	Approx. 30 s start time, SIL measuring mode	Waiting for SIL checksum entry
	OFF	Approx. 120 s start time, SIL measuring mode Within this time period, a termination of the SIL mode is possible by entering a SIL checksum = 0.	Waiting for SIL checksum entry

13.1.2 Device behavior during normal operation (SIL measuring mode)

The device issues a current value that corresponds to the monitoring measured value. This must be monitored and further processed in a connected automation system.

13.1.3 Device behavior in the case of demand of the safety function

In the event of demand, the power is ≤3.6 mA (low-alarm - safe state).

13.1.4 Safe states

Safe state	
Active safe state	Passive safe state
Output residual current, ≤3.6 mA (= low alarm)	Output residual current, ≤3.6 mA (= low alarm) System reset is initiated automatically.
In the active safe state, communication with the temperature transducer can continue via HART®; the current output, however, permanently outputs a residual current. This state is maintained until the temperature transducer is restarted. All parameters can be read and parameters not relevant to safety can be be changed.	In the passive safe state, communication with the temperature transducer is not possible via HART®. The system stops immediately and restarts after 0.5 s at the latest. The device does not issue any more error messages. Parameters cannot be changed any more.

Depending on the recognized error, the system takes on one of the two states. The system only continues in the active safe state, without a restart being triggered by itself.

13.1.5 Device behavior in the event of alarms and warnings

The output current in the case of an alarm ≤3.6 mA. In some cases (e.g. short circuit of supply line), output currents are ≥21 mA independently of the defined residual current. For alarm monitoring, the downstream logic unit has to be able to recognize high alarms (≥21 mA) and low alarms (≤3.6 mA).

Alarm and warning messages

The alarm and warning messages in the form of diagnostic events and corresponding event texts issued on the on-site display or in the operating tool are additional information.

For an overview of the diagnostic events, refer to Section 10.2 on page 56.

The following diagnostic events that are configurable in normal mode lead to the active safe state in SIL mode, and thus to a residual current being emitted:

– Permitted device ambient temperature exceeded/not reached (diagnostic message F925)
– Sensor corrosion (diagnostics F042)

During transfer of the device into SIL mode, additional diagnostics are activated (e.g. a comparison of the read-back output current to the setpoint). If one to these diagnostics causes an error message (e.g. F041 sensor break), a residual current is emitted. After the error is rectified, it is necessary to restart the device.

- For this, briefly disconnect the device from the power supply, or
- Send a corresponding command via HART®, or execute a comparable function in the operating tool.

During the subsequent restart of the device, a self-test takes place, and the error message is reset, if necessary.

13.2 Device configuration for safety-related applications

13.2.1 Configuration of the measuring point

When using the devices in PCE safety equipment, the device configuration must fulfil two requirements:

– Confirmation concept

  Proven independent test of entered safety-relevant parameters.

– Interlock concept

  Interlock of the device after conclusion of configuration (in accordance with IEC 61511-1 Section 11.6.4)

To activate SIL mode, an operating sequence has to be gone through, whereby operation can be in the Asset Management Tool, (e.g. M&M Container, AMS, PDM, Field Communicator 375/475) for which the device driver files (DD or DTM) are available.

Two methods for device configuration are available. Their essential difference lies in the confirmation concept:

Increased configuration safety mode (safe configuration = SiPA, Page 72)

At the start of the increased configuration safety mode

– All safety-relevant parameters are set to defined values, and
– The temperature transducer configured with a guided safe configuration.

A limited parameter record is available for this.

Expert mode (SIL mode activation = SiMA, Page 74)

The current settings of the temperature transducer for SIL mode are taken on here (for restrictions, see “Parameters and default settings for the increased parameter safety and expert mode” on page 66). In this way, defined or preconfigured settings can be used for the suitable application.

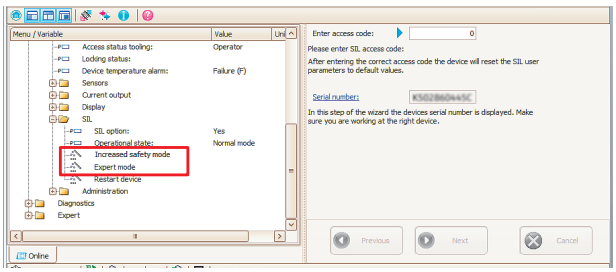


Figure 10 Methods for device configuration: increased configuration safety mode and expert mode

13.2.2 Increased configuration safety mode, safe configuration (SiPA)

The user interface may deviate from the illustrations shown here depending on the operating tool used and the selected language.

Performance of the safe configuration has to be documented.

Enter the configured parameters in the documentation. The date, time, and the subsequently displayed SIL checksum have to be noted.

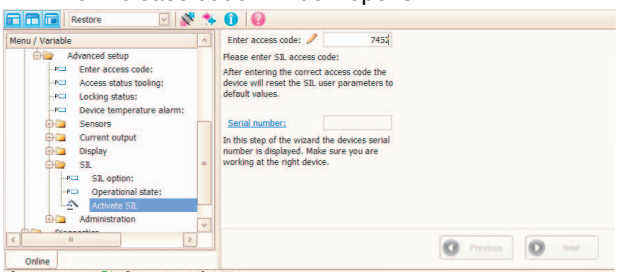
It generally has to be ensured that burst and multidrop mode are deactivated.

During the safe configuration process, the temperature transducer emits a residual current ≤3.6 mA (low alarm). If an error occurs during the safe configuration, or if a parameter check is negative, the safe configuration has been unsuccessful and needs to be repeated.

Safe configuration procedure

1. The safe configuration can only be performed during online operation. Start safe configuration in the “Setup, Advanced setup, SIL” submenu using the “Increased configuration safety mode” wizard.

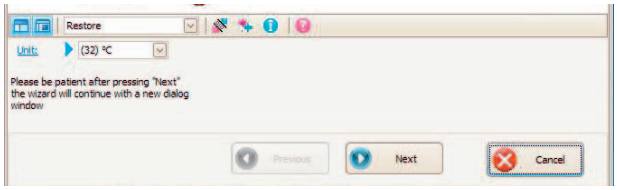
   The “Release code” window opens

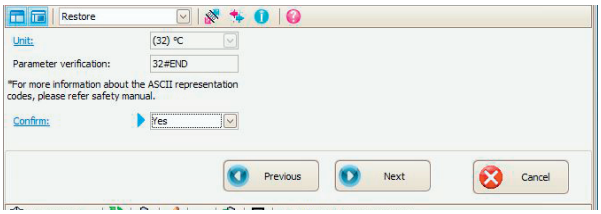


2. Enter the number code “7452” in the “Enter release code” input window.
3. Confirm by pressing “Enter”.
4. Then continue with the “Next” button.

   The safety-relevant parameters are reset to the default settings (“Parameters and default settings for the increased parameter safety and expert mode” on page 66).

   The input windows for the device settings then open in a specified sequence, starting with the unit of measured variables.

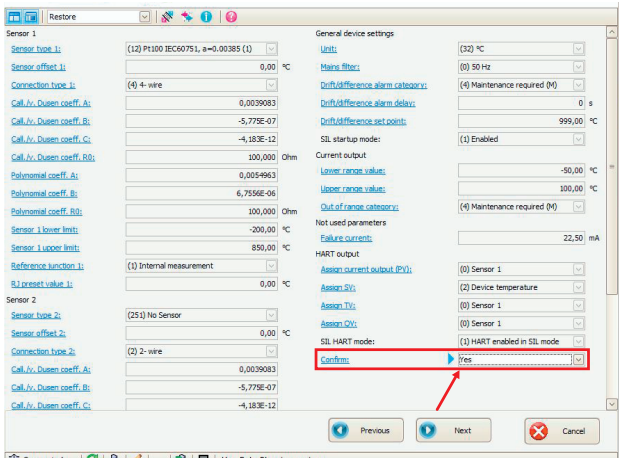




5. Check the input parameters in the subsequent window.
6. In the case of agreement, select YES in the “confirm” selection and confirm with the “Enter” key.
7. Continue with the “Next” button.

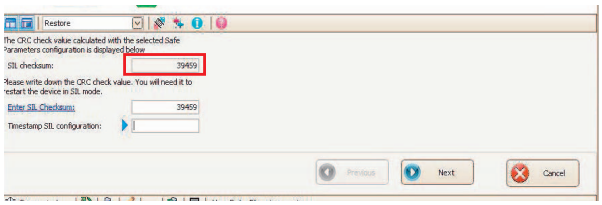
If for Callendar-Van Dusen or polynomial copper/nickel sensors, the units Fahrenheit (°F) or Rankine (°R) are selected, it may occur during the parameter test, that the saved parameter value deviates by 0.01°F or °R from the entered parameter value. This deviation can occur with the following parameters: *Start of measuring range (4 mA)*, *End of measuring range (20 mA)*, *Sensor offset*, *Drift/Difference monitoring*, *Upper sensor limit,* and *Lower sensor limit*.

An overview of all non-changeable standard values follows the entering of all safety relevant parameters. After confirmation, all the entered safety-relevant parameters are displayed to be checked again.



8. If all the settings are correct, select YES in the “confirm” selection and confirm with the “Enter” key.

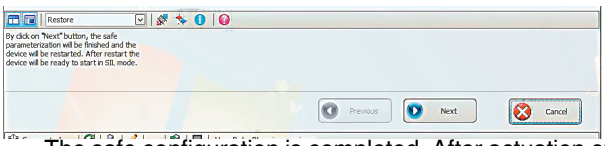
9. Continue with the “Next” button.



This value in the SIL checksum display is required in order to activate the SIL mode when the *SIL startup mode* is set to DEACTIVATED.

Always note the value in the SIL checksum display for this measuring point in the documentation.

10. Enter the displayed SIL checksum in the field “Enter SIL checksum”, and fill the current date and time into the “Time stamp SIL configuration” field.
11. Confirm the entry by pressing “Enter”.
12. Continue with the “Next” button.



The safe configuration is completed. After actuation of the “Next” button, the device independently restarts in SIL mode (“Device behavior in operation and in the event of a malfunction” on page 70).

13. Check the operating state of the temperature transducer (SIL mode active) before use in safety equipment.

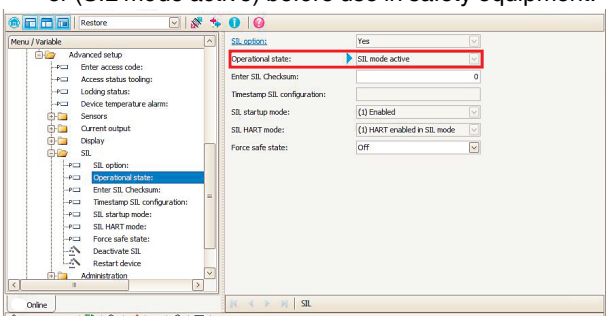


Figure 11 Operating state display

14. Carry out a commissioning test in SIL mode before commissioning the temperature transducer (Page 76).

13.2.3 Expert mode, SIL mode activation (SiMA)

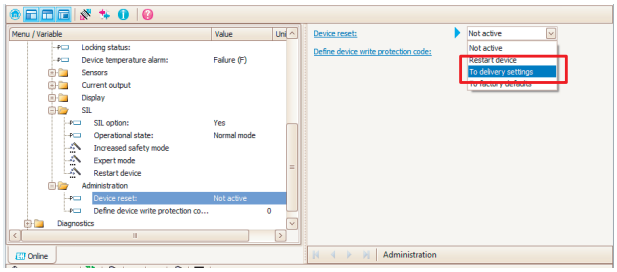
The user interface may deviate from the illustrations shown here depending on the operating tool used and the selected language.

During the SIL mode activation process in expert mode, the temperature transducer emits a residual current ≤3.6 mA (low-alarm). If an error occurs during the SIL mode activation in expert mode, or if this is terminated, the SIL mode activation has not been successful and has to be repeated.

SIL mode activation procedure

If the temperature transducer is not in the original delivery state, do the following:

1. Select “TO DEFAULT SETTINGS” in the “Setup, Advanced setup, Administration” menu in the “Reset Device” selection.

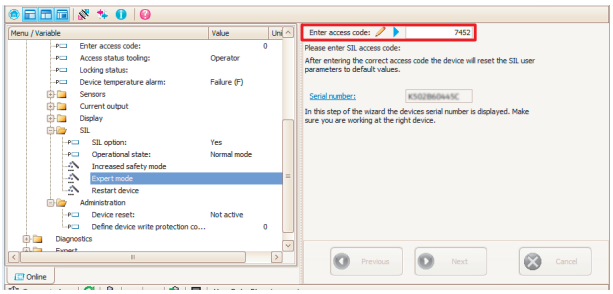


2. Confirm with the “Enter” key.
3. Set all the parameters that are required for use in the safety equipment.

   All tools that the device supports can be used for this.
4. SIL mode activation can only be carried out in online operation via the HART® communication.

   Start the “Expert mode” wizard in the “Setup, Advanced setup, SIL” submenu.

   The “Expert mode” wizard opens.



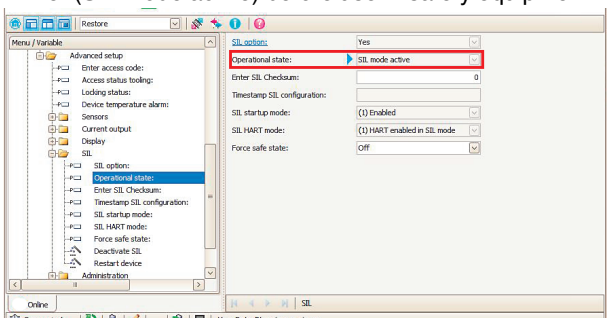
5. Enter the number code **7452** in the “Enter release code” input window.
6. Confirm by pressing “Enter”.
7. Continue with the “Next” button.

   The parameters that are relevant for the safety of the device and that may not be changed in SIL mode are reset to default setting (see “Parameters and default settings for the increased parameter safety and expert mode” on page 66). All other safety-relevant parameters are taken on by the device and protected against manipulation.
8. 

   After actuation of the “Next” button, the device independently restarts in SIL mode.

   SIL mode activation in expert mode is completed.
9. The *Time stamp SIL configuration* parameter can be set to the most current value in SIL mode.
10. Note the SIL checksum.

    This can be used to verify the setting of several devices.
11. Check the operating state of the temperature transducer (SIL mode active) before use in safety equipment.



12. Carry out a commissioning test in SIL mode before commissioning the temperature transducer (Page 76).

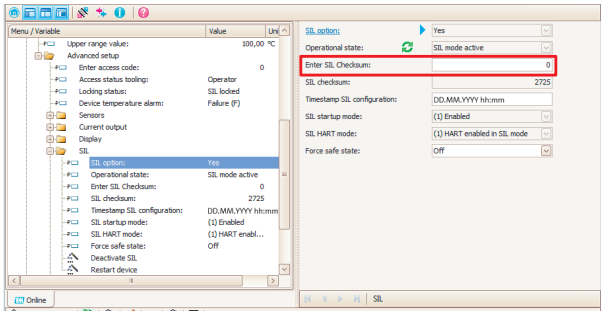
You can check the current setting of the temperature transducer in SIL mode, for example using the hand-held operator panel FC475.

Parameters to be tested	Use of the function key sequence on the FC475 (HART7)
Operating state (SIL mode active)	3, 3
Start of measuring range (4 mA)	3, 6, 3
End of measuring range (20 mA)	3, 6, 4
PV	3, 7, 3, 1
Sensor type 1	1, 3
Sensor type 2	1, 7
Connection method 1	1, 4
Connection method 2	1, 8
Sensor offset 1	3, 5, 1, 5
Sensor offset 2	3, 5, 2, 5
Unit	1, 2
Mains frequency filter	3, 4, 4

13.2.4 Deactivating SIL mode

There are two possibilities (A or B) of deactivating SIL mode. Switch off the hardware write-protect of the temperature transducer if necessary.

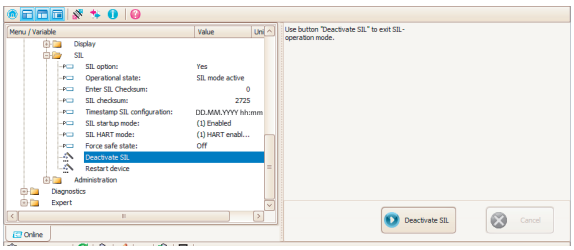
1.



A) Enter the number 0 in the “SIL checksum” field.

2. Confirm with the “Enter” key.
3. Restart device: Execute the “Restart device” function or interrupt the supply voltage for the temperature transducer.

After restarting, the device is in non-secure mode (normal mode). In order, in turn, to change to SIL mode, another safe configuration (SiPA, Page 72) or SIL mode activation (SiMA, Page 74) must be started at this point.



B) Start the “Deactivate SIL” function in the submenu: Setup, Advanced setup, SIL

4. Activate the “Deactivate SIL” field again.
   After automatic restart, the device is in non-secure mode (normal mode).

Diagnostics are deactivated by ending SIL mode. The device can no longer perform the safety function. Therefore it has to be ensured through appropriate measures that no hazard can occur during the time in which SIL mode is deactivated.

– In the event that HART® communication is switched off in SIL mode (*SIL HART mode* parameter = deactivated), restart the device. Deactivation methods A and B are available for 90 s during the start phase of the temperature transducer. (HART® is active during this time). In order to change back to SIL mode, another safe configuration has to be started (see “Increased configuration safety mode, safe configuration (SiPA)” on page 72).

13.3 Commissioning and repeat test

Test the function of the temperature transducer in SIL mode during commissioning and at appropriate time intervals.

NOTE:

The safety function is not guaranteed during a startup or repeat test. Process reliability has to be guaranteed during the test by suitable measures.

– The safety-related output signal 4 mA … 20 mA must not be used for the safety equipment during the test.
– Document a test that has been carried out.

13.3.1 Repeat test of the safety function

1. Test the safety function at appropriate intervals for its function.
2. The operator specifies the testing interval and this has to be considered when determining the probability of failure PFD_{avg} of the sensor system.

   In the case of single-channel system architecture, the mean probability of failure PFD_{avg} of the measurement sensor results approximately from the testing interval T_i of the failure rate of the dangerous non-recognizable error λ_{du}, the test depth PTC, and the assumed duration of use:

   $PFD_{avg} \approx \lambda_{du} \times (PTC/2 \times T_i + (1 - PTC) / 2 \times MT)$

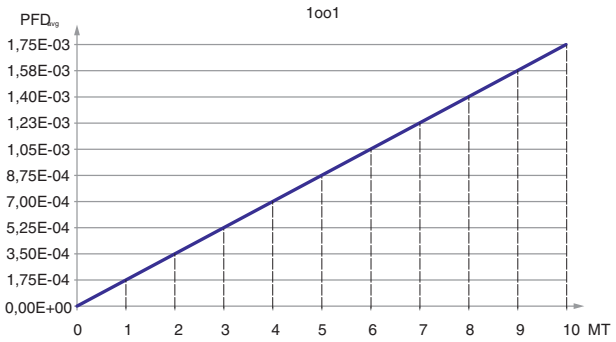
MT	Duration of use
PTC	Proof Test Coverage
T_i	Test interval

3. The operator also specifies the procedure for the repeat test.

NOTE:

According to IEC 61511, an independent repeat test of the subsystems, e.g., the temperature transducer, is permitted as an alternative to testing the safety function of the entire system.

Mean probability of failure and duration of use PFD_{avg} for a single-channel system (without performing repeat tests).



MT	Duration of use in years
PFD_{avg}	Mean probability of failure of a hazardous failure on demand
1oo1	Single-channel architecture

13.4 Commissioning or repeat test of the temperature transducer

If no operator-specific information for the repeat test is available, there is the following alternative possibility for testing the temperature transducer dependent on the measured variable used for the safety function. The respective coverage levels (PTC = proof test coverage) are specified for the following test sequences that can be used for calculation.

The device can be tested as follows:

– Test sequence A: complete test with HART® operation
– Test sequence C: simplified test with or without HART® operation

Observe in the case of test sequences:

– Test sequence C is not permitted for a startup test.
– The test of the temperature transducer without sensor can be done with a corresponding sensor simulator (resistance decade, reference voltage source, etc.). The temperature transducer goes into the safe state because of the sensor error triggered by re-clamping, and has to be restarted.
– The precision of the measuring device used must suffice for the specification of the temperature transducer.
– If both input channels of the temperature transducer are used, repeat the test for the second sensor accordingly.
– When a customer-specific linearization is used (e.g. with CvD coefficients), perform a three-point calibration.

NOTE:

For test sequences A, C: The influence of systematic errors on the safety function is not completely covered by the test. Systematic errors can be caused, for example, by measuring material properties, operating conditions, buildup, or corrosion.

– Take measures for reducing systematic errors.
– If one of the test criteria of the described test sequences is not fulfilled, the temperature transducer may no longer be used as part of safety equipment.

Observe the following in the case of a **startup test** in addition to test sequence A:

– If both input channels of the temperature transducer are used, the dual-channel functions like sensor drift or backup (channel assignment at the power output) also have to be tested.
– When using thermocouples, check the setting of the *Cold junction* selection and its preset value.
– The function of the out of range category has to be tested at its limits, 3.8 mA or 20.5 mA.
– The operating state of the temperature transducer has to be tested (SIL mode active).

13.4.1 Test sequence A

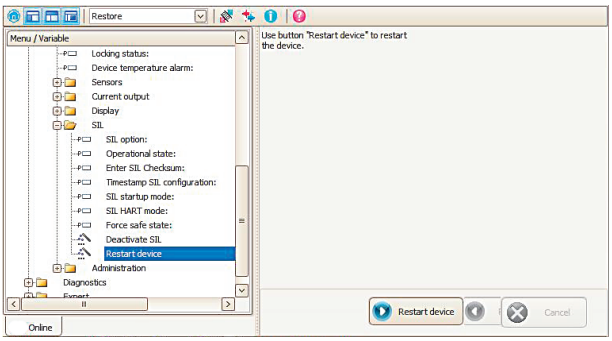
1. Two-point calibration

   Test the power output by applying the reference temperature to the sensor or a corresponding reference signal (resistance, current) at two points. For the measurement start: **4 mA to +20% of the range** and for the measurement end: select **20 mA to –20% of the range**.

   The measurement results have to be within the specified safety measurement deviation, otherwise the test is not passed.

2. Test of the safe state (low alarm)

   Force the safe state of the temperature transducer by provoking a sensor error (e.g. by cable break or short circuit of the sensor lines). Check if the power emitted at the power output corresponds to low alarm (≤3.6 mA).

3. 

   Triggering of a device restart with the corresponding function in the operating tool used or with HART® command 42.

96% of the dangerous undetected failures are detected by this test (diagnostics coverage level of the repeat test, PTC = 0.96). During the test procedure, the power output of the device typically behaves as shown in “Current flow during repeat test A” on page 79.

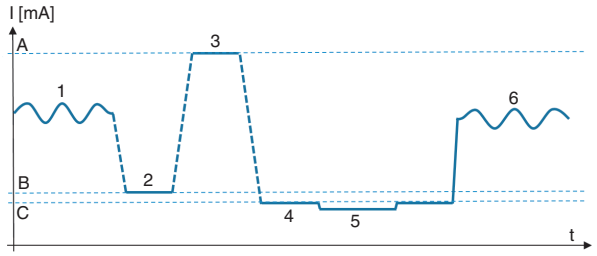


Figure 12 Current flow during repeat test A

A 20 mA
B 4 mA
C ≤3.6 mA
1 Measuring mode
2 Adjustment of measurement start (two-point calibration)
3 Adjustment of measurement end (two-point calibration)
4 Low alarm test
5 Restart of the temperature transducer (via HART® or plug-in display)
6 Measuring mode

13.4.2 Test sequence C

1. Test current measuring signal for plausibility. The measured value needs to be evaluated based on values experienced while operating the plant. This is the operator's responsibility.
2. Triggering of a device restart with the corresponding function in the operating tool used or HART® command 42.
3. Check if the power emitted at the power output corresponds to the low alarm (≤3.6 mA).

   See the following diagram.

58% of the dangerous undetected failures are detected by this test (diagnostics coverage level of the repeat test, PTC = 0.58). Test sequence C is not permitted for a startup test.

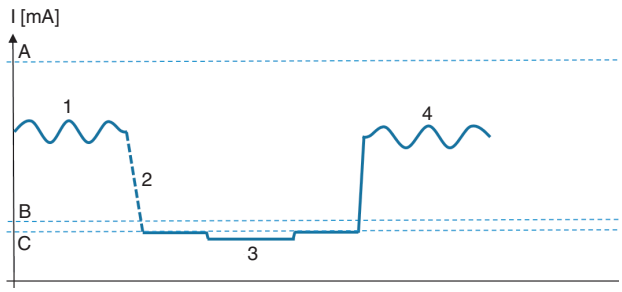


Figure 13 Current flow during repeat test C

A 20 mA
B 4 mA
C ≤3.6 mA
1 Measuring mode
2 Restart of the temperature transducer (via HART®)
3 Low alarm test
4 Measuring mode

14 Life cycle

14.1 Requirements on personnel

Personnel for installation, startup, diagnostics, and maintenance must meet the following requirements:

– Trained personnel, qualified for this function and activity
– Authorized by the plant operator
– Familiar with the national regulations
– Before beginning work: read and understand instructions in manual and additional documentation, as well as certificates (depending on use)
– Follow instructions and general conditions

The operating personnel must meet the following requirements:

– Instructed and authorized by the plant operator in accordance with the task requirements
– Follow instructions in this manual

14.2 Installation

Assembly and wiring of the device, as well as the permitted mounting position, are described in the corresponding packing slip (see “Dokumentation”).

14.3 Commissioning

The commissioning of the device is described in “Commissioning” on page 23.

Perform a commissioning test before operation in safety equipment.

14.4 Operation

Operation of the device is described in “Commissioning” on page 23.

14.5 Maintenance

Maintenance instructions can be found in “Maintenance” on page 54.

Undertake alternative monitoring measures to guarantee process reliability during configuration, the repeat test, and maintenance work at the device.

14.6 Repairs

The following components may be exchanged by the customer’s specialist personnel if original spare parts are used, and the respective assembly instructions observed:

Component	Device test after repair
Housing cover	Visual check if all parts are present and mounted properly, and if the device is in its proper state.
Connection terminal blocks and fixing slide	

The exchanged components must be submitted to the manufacturer for error analysis if the device was operated in safety equipment, and a device fault cannot be excluded.

14.7 Modification

Modifications are changes to already delivered or installed SIL devices. Normally, modifications of SIL devices are carried out at the manufacturer’s plant. Modifications to SIL devices on-site at the user’s are possible after release by the manufacturer. In this case, the modifications must be undertaken and documented by a service technician from the manufacturer.

NOTE:

Modifications of SIL devices by the user are not allowed.

15 Measuring function

NOTE: Electrical isolation

Ensure electrical isolation of the sensors when connecting two sensors to the temperature transducer.

15.1 Function for transmitting two sensor signals

Two sensors can be connected to the temperature transducer and the following safe functions operated:

- Two independent measurements:

  Here, two possibly different sensors, e.g., TC and 3-wire RTD, are connected to the temperature transducer. Both measuring channels can be used for safety-relevant functions. In order to evaluate the measured values of both sensors, the safe proprietary HART® protocol extension must be used here.
- Function mean value:

  The measured values M1, M2 of the two sensors are emitted as arithmetical mean (M1+M2)/2.
- Function difference:

  The measured values M1, M2 of the two sensors are emitted as difference M1-M2.
- Function backup:

  If a sensor fails, the other measurement channel is automatically switched to. Here, the sensor types must be identical, e.g. two x 3-conductor RTD Pt 100. The backup function is for increasing the availability or improving the diagnostics capabilities.

  The following sensor types are thus permitted in SIL mode:
  - 2x thermocouple (TC)
  - 2x RTD, 2/3-conductor
- Sensor drift function:

  When redundant sensors are used, the long-term drift of a sensor can be recognized, for example. This is a diagnostics measure as the signal of the second sensor is used exclusively for this diagnosis. If identical sensors are used, the **backup** function can additionally be used.

The set drift difference limit value should correspond to at least 2x the value of the safety precision.

15.2 Homogenous redundant SIL 3 configuration

Two temperature transducers, each with one sensor, are required for an SIL 3 measuring point.

The measured values of the two temperature transducers are evaluated in a logic unit with the aid of a secure voter.

16 Safety-related characteristics

General		
Device designation and permitted versions	FA MCR(-EX)-HT-TS-I-OLP(-PT) MACX MCR(-EX)-TS-I-OLP(-SP)(-C)	
Safety-related output signals	4 mA … 20 mA	
Residual current	3.58 mA	
Evaluated measured variable / Function	Temperature / Voltage / Resistance	
Safety function(s)	Min., Max., Range	
Device type in accordance with IEC 61508-2	Type B	
Operating mode	Low demand mode, high demand	
Valid hardware version	Head-mounted transducer: 01.00.07 or later DIN-rail measuring transducer: 01.00.06 or later	
Valid firmware version	2021-01-01 (dev. rev.: 2 or later)	
Safety manual	Head-mounted transducer: 108101_en_00 DIN-rail measuring transducer: 108133_en_01	
Type of evaluation	Complete HW/SW evaluation accompanying development, including FMEDA and modification process in accordance with IEC 61508-2, 3	
Test documents	Development documents, test reports, data sheets	
SIL Integrity		
Systematic safety integrity		SIL 3 capable
Hardware safety integrity	Single-channel use (HFT = 0)	SIL 2 capable
	Multi-channel use (HFT ≥ 1)	SIL 3 capable
FMEDA	**Head-mounted transducer**	**DIN-rail measuring transducer**
Safety function(s)	Min., Max., Range	Min., Max., Range
λ_{DU} [1, 2]	40 FIT	41 FIT
λ_{DD} [1, 2]	258 FIT	258 FIT
λ_{SU} [1, 2]	127 FIT	123 FIT
λ_{SD} [1, 2]	3 FIT	3 FIT
SFF - Safe Failure Fraction	91%	90%
PFD_{avg} for T1 = 1 year [2] (single-channel architecture)	$1.75 * 10^{-4}$	$1.79 * 10^{-4}$
PFD_{avg} for T1 = 5 years [2] (single-channel architecture)	$8.76 * 10^{-4}$	$8.98 * 10^{-4}$
PFH	$4.0 * 10^{-8}$ * 1/h	$4.1 * 10^{-8}$ * 1/h
PTC [3]	96%	96%
MTBF [4]	156 years	156 years
Diagnostic test interval [5]	32 min	32 min
Error response time [6]	<10.7 s	<10.7 s
Process safety time [7]	53 h	53 h
Explanation		
Our internal company quality management secures the information on safety-relevant systematic errors that become known in the future.		

[1] FIT = Failure In Time, number of failures per 10^9 h

[2] Applicable for measured ambient temperatures up to +40°C (+104°F). A factor of 2.1 should be considered in the event of an average permanent usage temperature near +60°C (+140°F)

[3] PTC = Proof Test Coverage (diagnostic coverage rate of device errors in the case of manual repeat test)

[4] This value considers all failure types of the electronic components in accordance with Siemens SN 29500

[5] In this time, all diagnostic functions are executed at least once.

[6] Maximum time between error detection and error reaction

[7] The process safety time is: diagnostics test interval x 100 (calculation in accordance with IEC 61508)

Key figure assignment parameter

Kennzahl (de)/ Integer value (en)	Parameter (de)	Parameterwert (de)	Parameter (en)	Parameter value (en)
8	Bereichsverletzung Kategorie	Außerhalb der Spezifikation (S)	Out of range category	Out of specification (S)
4		Wartungsbedarf (M)		Maintenance required (M)
1		Ausfall (F)		Failure (F)
12	Sensortyp	Pt100 IEC60751, a=0.00385 (1)	Sensor type	Pt100 IEC60751, a=0.00385 (1)
13		Pt200 IEC60751, a=0.00385 (2)		Pt200 IEC60751, a=0.00385 (2)
14		Pt500 IEC60751, a=0.00385 (3)		Pt500 IEC60751, a=0.00385 (3)
15		Pt1000 IEC60751, a=0.00385 (4)		Pt1000 IEC60751, a=0.00385 (4)
22		Pt100 JIS C1604, a=0.003916 (5)		Pt100 JIS C1604, a=0.003916 (5)
72		Ni100 DIN 43760, a=0.00618 (6)		Ni100 DIN 43760, a=0.00618 (6)
73		Ni120 DIN 43760, a=0.00618 (7)		Ni120 DIN 43760, a=0.00618 (7)
248		Ni100 OIML/GOST 6651-09, a=0.00617 (12)		Ni100 OIML/GOST 6651-09, a=0.00617 (12)
249		Ni120 OIML/GOST 6651-09, a=0.00617 (13)		Ni120 OIML/GOST 6651-09, a=0.00617 (13)
246		Typ A (W5Re-W20Re) IEC60584-2013 (30)		Type A (W5Re-W20Re) IEC60584-2013 (30)
131		Typ B (PtRh30-PtRh6) IEC60584 (31)		Type B (PtRh30-PtRh6) IEC60584 (31)
132		Typ C (W5Re-W26Re) IEC60584 (32)		Type C (W5Re-W26Re) IEC60584 (32)
133		Typ D (W3Re-W25Re) ASTM E988-96 (33)		Type D (W3Re-W25Re) ASTM E988-96 (33)
134		Typ E (NiCr-CuNi) IEC60584 (34)		Type E (NiCr-CuNi) IEC60584 (34)
136		Typ J (Fe-CuNi) IEC60584 (35)		Type J (Fe-CuNi) IEC60584 (35)
137		Typ K (NiCr-Ni) IEC60584 (36)		Type K (NiCr-Ni) IEC60584 (36)
138		Typ N (NiCrSi-NiSi) IEC60584 (37)		Type N (NiCrSi-NiSi) IEC60584 (37)
139		Typ R (PtRh13-Pt) IEC60584 (38)		Type R (PtRh13-Pt) IEC60584 (38)
140		Typ S (PtRh10-Pt) IEC60584 (39)		Type S (PtRh10-Pt) IEC60584 (39)
141		Typ T (Cu-CuNi) IEC60584 (40)		Type T (Cu-CuNi) IEC60584 (40)
142		Typ L (Fe-CuNi) DIN43710 (41)		Type L (Fe-CuNi) DIN43710 (41)
148		Typ L (NiCr-CuNi) GOST R8.8585-01 (43)		Type L (NiCr-CuNi) GOST R8.8585-01 (43)
143		Type U (Cu-CuNi) DIN43710 (42)		Type U (Cu-CuNi) DIN43710 (42)
241		Pt50 GOST 6651-94, a=0.00391 (8)		Pt50 GOST 6651-94, a=0.00391 (8)
242		Pt100 GOST 6651-94, a=0.00391 (9)		Pt100 GOST 6651-94, a=0.00391 (9)
243		Cu50 GOST 6651-09, a=0.00428 (10)		Cu50 GOST 6651-09, a=0.00428 (10)
105		Cu100 OIML/GOST 6651-09, a=0.00428 (11)		Cu100 OIML/GOST 6651-09, a=0.00428 (11)
244		Cu50 OIML R84:2003, a=0.00428 (10)		Cu50 OIML R84:2003, a=0.00428 (10)
245		Cu50 OIML/GOST 6651-94, a=0,00426 (14)		Cu50 OIML/GOST 6651-94, a=0,00426 (14)
3		RTD Platin (Callendar/van Dusen)		RTD Platinium (Callendar/van Dusen)
240		RTD Poly Nickel (OIML R84, GOST 6651-94)		RTD Poly Nickel (OIML R84, GOST 6651-94)
247		RTD Polynom Kupfer (OIML R84:2003)		RTD Polynomial Copper (OIML R84:2003)
1		10...400 Ohm		10...400 Ohm
2		10...2000 Ohm		10...2000 Ohm
129		-20...100 mV		-20...100 mV
251		Kein Sensor		No Sensor
2	Anschlussart	2- Leiter	Connection type	2- wire
3		3- Leiter		3- wire
4		4- Leiter		4- wire
0	Vergleichsstelle	Keine Kompensation	Reference junction	No compensation
1		Interne Messung		Internal measurement
3		Vorgabewert		Fixed Value
4		Wert Sensor 2		Sensor 2 value
32	Einheit	°C	Unit	°C
33		°F		°F
35		K		K
34		°R		°R
37		Ohm		Ohm
36		mV		mV
0	Netzfrequenzfilter	50 Hz	Mains filter	50 Hz
1		60 Hz		60 Hz
12	Drift/Differenz-überwachung	Aus	Drift/difference mode	Off
0		Überschreitung (Drift)		Out band (drift)
1		Unterschreitung		In band
0	SIL HART Modus	HART im SIL Mode nicht aktiviert	SIL HART mode	HART disabled in SIL mode
1		HART im SIL Mode aktiviert		HART enabled in SIL mode
0	SIL Startup Modus	Deaktiviert	SIL startup mode	Disabled
1		Aktiviert		Enabled
0	Zuordnung Stromausgang (PV, SV, TV, QV)	Sensor 1	Assign current output (PV, SV, TV, QV)	Sensor 1
1		Sensor 2		Sensor 2
2		Gerätetemperatur		Device temperature
3		Mittelwert		Average
4		Differenz		Difference
5		Sensor 1 (Backup Sensor 2)		Sensor 1 (Backup Sensor 2)
6		Sensorumschaltung		Sensor switching
7		Mittelwert mit Backup		Average with backup