

## Temperature Measurement

Transmitters for mounting in sensor head

### SITRANS TH200 (Universal)

#### Overview



#### Ultra flexible - with the universal SITRANS TH200 transmitter

- Two-wire devices for 4 to 20 mA
- Mounting in the connection head of the temperature sensor
- Universal input for virtually any type of temperature sensor
- Configurable over PC

#### Benefits

- Compact design
- Flexible mounting and center hole allow you to select your preferred type of installation
- Electrically isolated
- Test sockets for multimeters
- Diagnostics LED (green/red)
- Sensor monitoring open circuits and short-circuits
- Self-monitoring
- Configuration status stored in EEPROM
- SIL2 (with Order code C20), SIL2/3 (with C23)
- Expanded diagnostic functions, such as slave pointer, operating hours counter, etc.
- Special characteristic
- Electromagnetic compatibility to EN 61326 and NE21

#### Application

SITRANS TH200 transmitters can be used in all industrial sectors. Due to their compact size they can be installed in the connection head type B (DIN 43729) or larger. The following sensors/signal sources can be connected over their universal input module:

- Resistance thermometers (2, 3 or 4-wire system)
- Thermocouples
- Resistance-based sensors and DC voltage sources

The output signal is a direct current from 4 to 20 mA in accordance with the sensor characteristic.

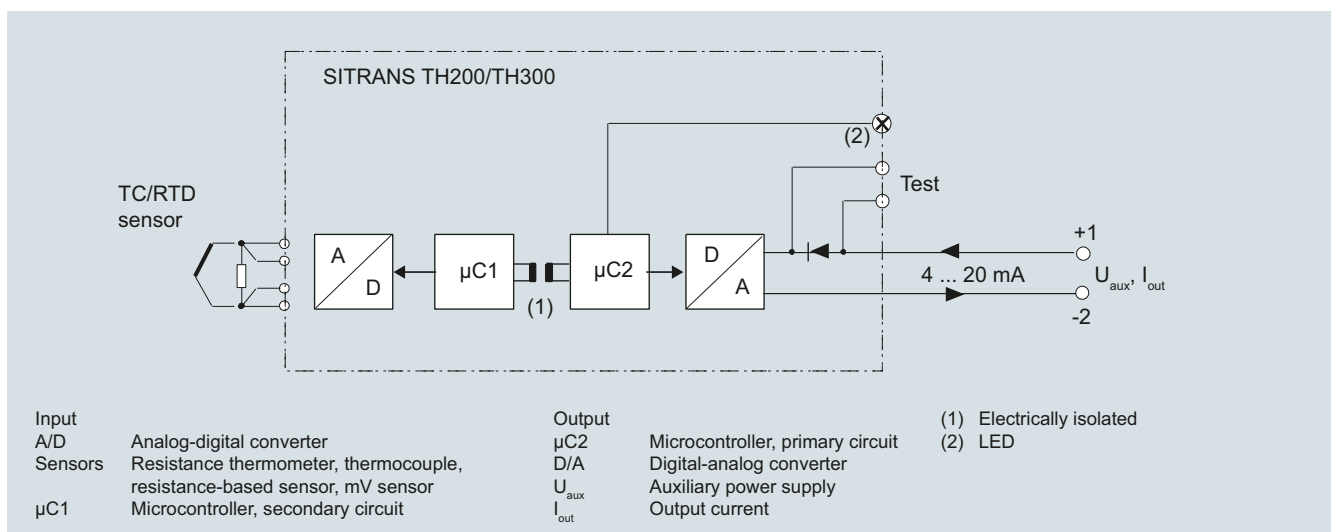
Transmitters of the "intrinsically safe" type of protection can be installed within potentially explosive atmospheres. The devices comply with the Directive 2014/34/EU (ATEX), as well as FM and CSA regulations.

#### Function

The SITRANS TH200 is configured over a PC. A USB or RS 232 modem is linked to the output terminals for this purpose. The configuration data can now be edited using the SIPROM T software tool. The configuration data are then permanently stored in the non-volatile memory (EEPROM).

Once the sensors and power supply have been correctly connected, the transmitter outputs a temperature-linear output signal and the diagnostics LED displays a green light. In the case of a sensor short-circuit, the LED flashes red, an internal device fault is indicated by a steady red light.

The test socket can be used to connect an ammeter at any time for monitoring purposes and plausibility checks. The output current can be read without any interruption, or even without opening the current loop.



SITRANS TH200 function diagram

### Technical specifications

#### Input

##### Resistance thermometer

Measured variable	Temperature
Sensor type	
• to IEC 60751	Pt25 ... Pt1000
• To JIS C 1604; $\alpha = 0.00392 \text{ K}^{-1}$	Pt25 ... Pt1000
• to IEC 60751	Ni25 ... Ni1000
• Special type	over special characteristic (max. 30 points)
Sensor factor	0.25 ... 10 (adaptation of the basic type, e.g. Pt100 to version Pt25 ... 1000)
Units	°C or °F
Connection	
• Standard connection	1 resistance thermometer (RTD) in 2-wire, 3-wire or 4-wire system
• Generation of average value	2 identical resistance thermometers in 2-wire system for generation of average temperature
• Generation of difference	2 identical resistance thermometers (RTD) in 2-wire system (RTD 1 – RTD 2 or RTD 2 – RTD 1)
Interface	
• Two-wire system	Parameterizable line resistance $\leq 100 \Omega$ (loop resistance)
• Three-wire system	No balancing required
• Four-wire system	No balancing required
Sensor current	$\leq 0.45 \text{ mA}$
Response time	$\leq 250 \text{ ms}$ for 1 sensor with open-circuit monitoring
Open-circuit monitoring	Always active (cannot be disabled)
Short-circuit monitoring	can be switched on/off (default value: ON)
Measuring range	parameterizable (see table "Digital measuring errors")
Min. measured span	10 °C (18 °F)
Characteristic curve	Temperature-linear or special characteristic

##### Resistance-based sensors

Measured variable	Actual resistance
Sensor type	Resistance-based, potentiometers
Units	$\Omega$
Connection	
• Normal connection	1 resistance-based sensor (R) in 2-wire, 3-wire or 4-wire system
• Generation of average value	2 resistance-based sensors in 2-wire system for generation of average value
• Generation of difference	2 resistance thermometers in 2-wire system (R1 – R2 or R2 – R1)
Interface	
• Two-wire system	Parameterizable line resistance $\leq 100 \Omega$ (loop resistance)
• Three-wire system	No balancing required
• Four-wire system	No balancing required
Sensor current	$\leq 0.45 \text{ mA}$

Response time	$\leq 250 \text{ ms}$ for 1 sensor with open-circuit monitoring
Open-circuit monitoring	Always active (cannot be disabled)
Short-circuit monitoring	can be switched on/off (default value: OFF)
Measuring range	parameterizable max. 0 ... 2200 $\Omega$ (see table "Digital measuring errors")
Min. measured span	5 $\Omega$ ... 25 $\Omega$ (see Table "Digital measuring errors")
Characteristic curve	Resistance-linear or special characteristic
<b>Thermocouples</b>	
Measured variable	Temperature
Sensor type (thermocouples)	
• Type B	Pt30Rh-Pt6Rh to DIN IEC 584
• Type C	W5 %-Re acc. to ASTM 988
• Type D	W3 %-Re acc. to ASTM 988
• Type E	NiCr-CuNi to DIN IEC 584
• Type J	Fe-CuNi to DIN IEC 584
• Type K	NiCr-Ni to DIN IEC 584
• Type L	Fe-CuNi to DIN 43710
• Type N	NiCrSi-NiSi to DIN IEC 584
• Type R	Pt13Rh-Pt to DIN IEC 584
• Type S	Pt10Rh-Pt to DIN IEC 584
• Type T	Cu-CuNi to DIN IEC 584
• Type U	Cu-CuNi to DIN 43710
Units	°C or °F
Connection	
• Standard connection	1 thermocouple (TC)
• Generation of average value	2 thermocouples (TC)
• Generation of difference	2 thermocouples (TC) (TC1 – TC2 or TC2 – TC1)
Response time	$\leq 250 \text{ ms}$ for 1 sensor with open-circuit monitoring
Open-circuit monitoring	Can be switched off
Cold junction compensation	
• Internal	With integrated Pt100 resistance thermometer
• External	With external Pt100 IEC 60751 (2-wire or 3-wire connection)
• External fixed	Cold junction temperature can be set as fixed value
Measuring range	Parameterizable (see table "Digital measuring errors")
Min. measured span	Min. 40 ... 100 °C (72 ... 180 °F) (see table "Digital measuring errors")
Characteristic curve	Temperature-linear or special characteristic
<b>mV sensor</b>	
Measured variable	DC voltage
Sensor type	DC voltage source (DC voltage source possible over an externally connected resistor)
Units	mV
Response time	$\leq 250 \text{ ms}$ for 1 sensor with open-circuit monitoring
Open-circuit monitoring	Can be switched off
Measuring range	-10 ... +70 mV-100 ... +1100 mV

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Min. measured span	2 mV or 20 mV
Overload capability of the input	-1.5 ... +3.5 V DC
Input resistance	≥ 1 MΩ
Characteristic curve	Voltage-linear or special characteristic
<b>Output</b>	
Output signal	4 ... 20 mA, 2-wire
Auxiliary power	11 ... 35 V DC ((to 30 V for Ex ia and ib; to 32 V for Ex nA / nL / ic)
Max. load	(U <sub>aux</sub> - 11 V)/0.023 A
Overrange	3.6 ... 23 mA, infinitely adjustable (default range: 3.80 mA ... 20.5 mA)
Error signal (e.g. following sensor fault) (conforming to NE43)	3.6 ... 23 mA, infinitely adjustable (default value: 22.8 mA)
Sample cycle	0.25 s nominal
Damping	Software filter 1st order 0 ... 30 s (parameterizable)
Protection	Against reversed polarity
Electrically isolated	Input against output (1 kV <sub>eff</sub> )
<b>Measuring accuracy</b>	
Digital measuring errors	See table "Digital measuring errors"
Reference conditions	
• Auxiliary power	24 V ± 1 %
• Load	500 Ω
• Ambient temperature	23 °C
• Warming-up time	> 5 min
Error in the analog output (digital/analog converter)	< 0.025 % of span
Error due to internal cold junction	< 0.5 °C (0.9 °F)
Influence of ambient temperature	
• Analog measuring error	0.02 % of span/10°C (18 °F)
• Digital measuring errors	
- with resistance thermometers	0.06 °C (0.11 °F)/10°C (18 °F)
- with thermocouples	0.6 °C (1.1 °F)/10°C (18 °F)
Auxiliary power effect	< 0.001 % of span/V
Effect of load impedance	< 0.002 % of span/100 Ω
Long-term drift	
• In the first month	< 0.02 % of span
• After one year	< 0.2 % of span
• After 5 years	< 0.3 % of span
<b>Conditions of use</b>	
<u>Ambient conditions</u>	
Ambient temperature range	-40 ... +85 °C (-40 ... +185 °F)
Storage temperature range	-40 ... +85 °C (-40 ... +185 °F)
Relative humidity	< 98 %, with condensation
Electromagnetic compatibility	acc. to EN 61326 and NE21
<b>Construction</b>	
Material	Molded plastic
Weight	50 g (0.11 lb)
Dimensions	See "Dimensional drawings"
Cross-section of cables	Max. 2.5 mm <sup>2</sup> (AWG 13)
Degree of protection to IEC 60529	
• Enclosure	IP40
• Terminals	IP00

#### Certificates and approvals

Explosion protection ATEX

EC type test certificate

• "Intrinsic safety" type of protection

• "Operating equipment that is non-ignitable and has limited energy" type of protection

Explosion protection: FM for USA

• FM approval

• Degree of protection

Explosion protection to FM for Canada (cFM<sub>US</sub>)

• FM approval

• Degree of protection

Other certificates

#### Software requirements for SIPROM T

PC operating system

#### Factory setting:

- Pt100 (IEC 751) with 3-wire circuit
- Measuring range: 0 ... 100 °C (32 ... 212 °F)
- Fault current: 22.8 mA
- Sensor offset: 0 °C (0 °F)
- Damping 0.0 s

PTB 05 ATEX 2040X

II 1 G Ex ia IIC T6/T4  
II 2 (1) G Ex ia/ib IIC T6/T4  
II 3(1) G Ex ia/ic IIC T6/T4  
II 1D Ex iaD 20 T115 °C

II 3 G Ex nL IIC T6/T4  
II 3 G Ex nA IIC T6/T4

FM 3024169

IS / CI I, II, III / Div 1 / GP ABC-DEFG T6, T5, T4  
CI I / ZN 0 / AEx ia IIC T6, T5, T4  
NI / CI I / Div 2 / GP ABCDFG T6, T5, T4  
NI / CI I / ZN 2 / IIC T6, T5, T4

FM 3024169C

IS / CI I, II, III / Div 1 / GP ABCDEFG T6, T5, T4  
NI / CI I / DIV 2 / GP ABCD T6, T5, T4  
NIFW / CI I, II, III / DIV 2 / GP ABCDFG T6, T5, T4  
DIP / CI II, III / Div 2 / GP FG T6, T5, T4  
CI I / ZN 0 / Ex ia IIC T6, T5, T4  
CI I / ZN 2 / Ex nA nL IIC T6, T5, T4

EAC Ex(GOST), NEPSI, IEC, EXPOLABS

Windows ME, 2000, XP, Win 7 and Win 8; can also be used in connection with RS 232 modem under Windows 95, 98 and 98SE

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### Digital measuring errors

#### Resistance thermometer

Input	Measuring range °C / (°F)	Min. mea- sured span		Digital accuracy	
		°C	(°F)	°C	(°F)
<b>to IEC 60751</b>					
Pt25	-200 ... +850 (-328 ... +1562)	10	(18)	0.3	(0.54)
Pt50	-200 ... +850 (-328 ... +1562)	10	(18)	0.15	(0.27)
Pt100 ... Pt200	-200 ... +850 (-328 ... +1562)	10	(18)	0.1	(0.18)
Pt500	-200 ... +850 (-328 ... +1562)	10	(18)	0.15	(0.27)
Pt1000	-200 ... +350 (-328 ... +662)	10	(18)	0.15	(0.27)
<b>to JIS C1604-81</b>					
Pt25	-200 ... +649 (-328 ... +1200)	10	(18)	0.3	(0.54)
Pt50	-200 ... +649 (-328 ... +1200)	10	(18)	0.15	(0.27)
Pt100 ... Pt200	-200 ... +649 (-328 ... +1200)	10	(18)	0.1	(0.18)
Pt500	-200 ... +649 (-328 ... +1200)	10	(18)	0.15	(0.27)
Pt1000	-200 ... +350 (-328 ... +662)	10	(18)	0.15	(0.27)
Ni 25 ... Ni1000	-60 ... +250 (-76 ... +482)	10	(18)	0.1	(0.18)

#### Resistance-based sensors

Input	Measuring range Ω	Min. mea- sured span Ω	Digital accuracy Ω
Resistance	0 ... 2200	25	0.25

### Thermocouples

Input	Measuring range °C/(°F)	Min. mea- sured span		Digital accuracy (°F)
		°C	(°F)	
Type B	100 ... 1820 (212 ... 3308)	100	(180)	2 <sup>1)</sup> (3.6) <sup>1)</sup>
Type C (W5)	0 ... 2300 (32 ... 4172)	100	(180)	2 (3.6)
Type D (W3)	0 ... 2300 (32 ... 4172)	100	(180)	1 <sup>2)</sup> (1.8) <sup>2)</sup>
Type E	-200 ... +1000 (-328 ... +1832)	50	(90)	1 (1.8)
Type J	-200 ... +1200 (-328 ... +2192)	50	(90)	1 (1.8)
Type K	-200 ... +1370 (-328 ... +2498)	50	(90)	1 (1.8)
Type L	-200 ... +900 (-328 ... +1652)	50	(90)	1 (1.8)
Type N	-200 ... +1300 (-328 ... +2372)	50	(90)	1 (1.8)
Type R	-50 ... +1760 (-58 ... +3200)	100	(180)	2 (3.6)
Type S	-50 ... +1760 (-58 ... +3200)	100	(180)	2 (3.6)
Type T	-200 ... +400 (-328 ... +752)	40	(72)	1 (1.8)
Type U	-200 ... +600 (-328 ... +1112)	50	(90)	2 (3.6)

<sup>1)</sup> The digital accuracy in the range 100 to 300 °C (212 to 572 °F) is 3 °C (5.4 °F).

<sup>2)</sup> The digital accuracy in the range 1750 to 2300 °C (3182 to 4172 °F) is 2 °C (3.6 °F).

#### mV sensor

Input	Measuring range mV	Min. measured span mV	Digital accuracy μV
mV sensor	-100 ... +1100	20	400

The digital accuracy is the accuracy after the analog/digital conversion including linearization and calculation of the measured value.

An additional error is generated in the output current 4 to 20 mA as a result of the digital/analog conversion of 0.025 % of the set span (digital-analog error).

The total error under reference conditions at the analog output is the sum from the digital error and the digital-analog error (poss. with the addition of cold junction errors in the case of thermocouple measurements).

## Temperature Measurement

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#### SITRANS TH200 (Universal)

##### Selection and Ordering data

Article No.

##### Temperature transmitter SITRANS TH200

for installation in connection head, type B (DIN 43729), two-wire system, 4 ... 20 mA, programmable, with electrical isolation

- Without explosion protection
- With explosion protection
  - to ATEX
  - to FM ( $c_{FMUS}$ )

7NG3211-1NN00

7NG3211-1AN00

7NG3211-1BN00

##### Further designs

Order code

Add '-Z' to Article No. and specify Order code(s)

With test protocol (5 measuring points)

C11

Functional safety SIL2

C20

Functional safety SIL2/3

C23

##### Customer-specific programming

Add '-Z' to Article No. and specify Order code(s)

Measuring range to be set  
Specify in plain text (max. 5 digits):  
Y01: ... to ... °C, °F

Y01<sup>1)</sup>

Measuring point no. (TAG), max. 8 characters

Y17<sup>2)</sup>

Measuring point descriptor, max. 16 characters

Y23<sup>2)</sup>

Measuring point message, max. 32 characters

Y24<sup>2)</sup>Pt100 (IEC) 2-wire,  $R_L = 0 \Omega$ U02<sup>3)</sup>

Pt100 (IEC) 3-wire

U03<sup>3)</sup>

Pt100 (IEC) 4-wire

U04<sup>3)</sup>

Thermocouple type B

U20<sup>3)4)</sup>

Thermocouple type C (W5)

U21<sup>3)4)</sup>

Thermocouple type D (W3)

U22<sup>3)4)</sup>

Thermocouple type E

U23<sup>3)4)</sup>

Thermocouple type J

U24<sup>3)4)</sup>

Thermocouple type K

U25<sup>3)4)</sup>

Thermocouple type L

U26<sup>3)4)</sup>

Thermocouple type N

U27<sup>3)4)</sup>

Thermocouple type R

U28<sup>3)4)</sup>

Thermocouple type S

U29<sup>3)4)</sup>

Thermocouple type T

U30<sup>3)4)</sup>

Thermocouple type U

U31<sup>3)4)</sup>

With TC: CJC external (Pt100, 3-wire)

U41

With TC: CJC external with fixed value, specify in plain text

Y50

Special differing customer-specific programming, specify in plain text

Y09<sup>5)</sup>

Fail-safe value 3.6 mA (instead of 22,8 mA)

U36<sup>2)</sup>

Cable extension

Transmitter with installed cable extension  
150 mm (5.91 inch),  
for Pt100 in four-wire system

W01

##### Accessories

Further accessories for assembly, connection and transmitter configuration, see page 2/238.

Article No.

##### Modem for SITRANS TH100, TH200, TR200 and TF with TH200 incl. SIPROM T parameterization software

With USB connection

7NG3092-8KN

##### DIN rail adapters for head transmitters

(Quantity delivered: 5 units)

7NG3092-8KA

##### Connecting cable

4-wire, 150 mm, for sensor connections when using head transmitters in the high hinged cover (set with 5 units)

7NG3092-8KC

- 1) For customer-specific programming for RTD and TC, the start value and the end value of the required measuring span must be specified here.
- 2) For this selection, Y01 or Y09 must also be selected.
- 3) For this selection, Y01 must also be selected.
- 4) Internal cold junction compensation is selected as the default for TC.
- 5) For customer-specific programming, for example mV and ohm, the start value and the end value of the required measuring span and the unit must be entered here.

Supply units see Chapter "Supplementary Components".

##### Ordering example 1:

7NG3211-1NN00-Z Y01+Y17+U03  
Y01: -10 ... +100 °C  
Y17: TICA123

##### Ordering example 2:

7NG3211-1NN00-Z Y01+Y23+U25  
Y01: -10 ... +100 °C  
Y23: TICA1234HEAT

##### Factory setting:

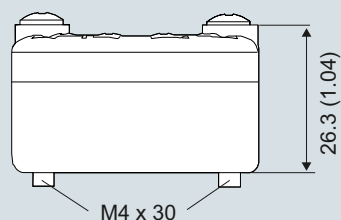
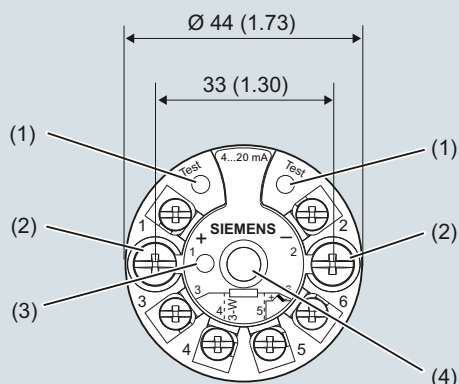
- Pt100 (IEC 751) with 3-wire circuit
- Measuring range: 0 ... 100 °C (32 ... 212 °F)
- Fault current: 22.8 mA
- Sensor offset: 0 °C (0 °F)
- Damping 0.0 s

## Temperature Measurement

### Transmitters for mounting in sensor head

SITRANS TH200 (Universal)

#### Dimensional drawings

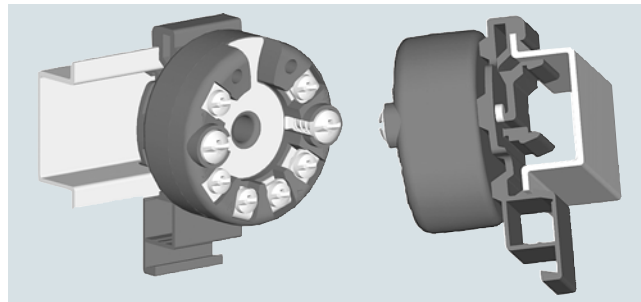


1(+) and 2(-) Auxiliary power supply  $U_{aux1}$ , output current  $I_{out}$   
 3, 4, 5 and 6 Pt100 sensor (for connections, see Sensor connection assignment)  
 Test (+), Test (-) Measurement of the output current with a multimeter

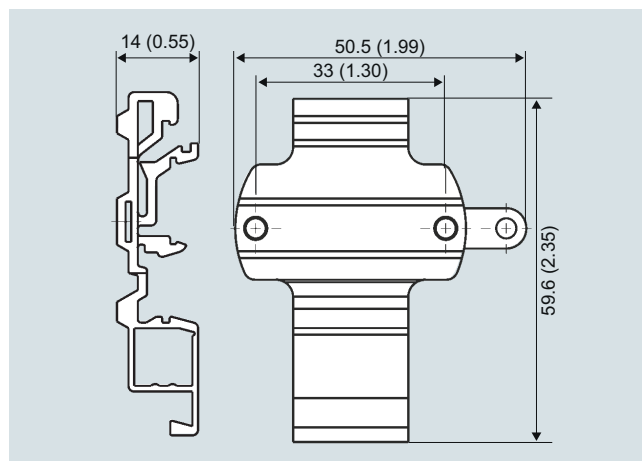
- (1) Test terminal
- (2) Mounting screw M4x30
- (3) LED for operation indication
- (4) Internal diameter of center hole 6.3 (0.25)

SITRANS TH200, dimensions and pin assignment, dimensions in mm (inch)

#### Mounting on DIN rail



SITRANS TH200, mounting of transmitter on DIN rail



DIN rail adapter, dimensions in mm (inch)

2

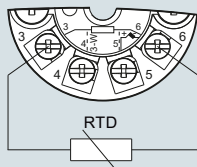
# Temperature Measurement

Transmitters for mounting in sensor head

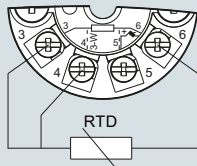
## SITRANS TH200 (Universal)

### Schematics

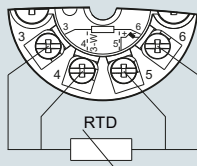
#### Resistance thermometer



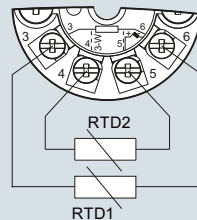
Two-wire system <sup>1)</sup>



Three-wire system



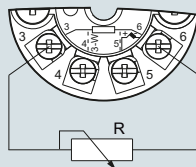
Four-wire system



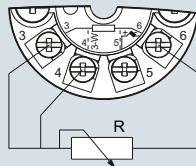
Generation of average value / difference <sup>1)</sup>

<sup>1)</sup> Programmable line resistance for the purpose of correction.

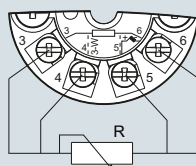
#### Resistance



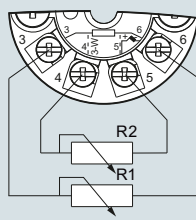
Two-wire system <sup>1)</sup>



Three-wire system

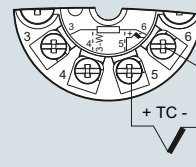


Four-wire system

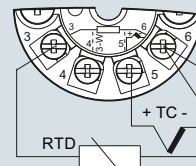


Generation of average value / difference <sup>1)</sup>

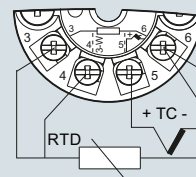
#### Thermocouple



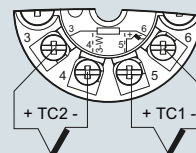
Cold junction compensation  
Internal/fixed value



Cold junction compensation with  
external Pt100 in two-wire system <sup>1)</sup>

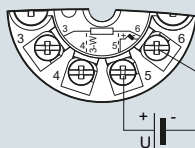


Cold junction compensation with  
external Pt100 in three-wire system

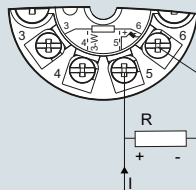


Generation of average value / difference  
with internal cold junction compensation

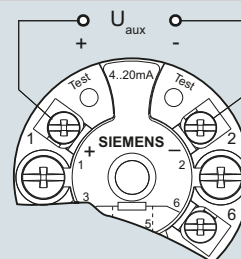
#### Voltage measurement



#### Current measurement



#### Connection of auxiliary power supply (U<sub>aux</sub>)



SITRANS TH200, sensor connection assignment

## Temperature Measurement

### Transmitters for mounting in sensor head

#### SITRANS TH300 (Universal, HART)

#### Overview



#### "HART" to beat - the universal SITRANS TH300 transmitter

- Two-wire devices for 4 to 20 mA, HART
- Mounting in the connection head of the temperature sensor
- Universal input for virtually any type of temperature sensor
- Configurable over HART

#### Benefits

- Compact design
- Flexible mounting and center hole allow you to select your preferred type of installation
- Electrically isolated
- Test sockets for multimeters
- Diagnostics LED (green/red)
- Sensor monitoring open circuits and short-circuits
- Self-monitoring
- Configuration status stored in EEPROM
- SIL2 (with Order code C20), SIL2/3 (with C23)
- Expanded diagnostic functions, such as slave pointer, operating hours counter, etc.
- Special characteristic
- Electromagnetic compatibility to EN 61326 and NE21

#### Application

SITRANS TH300 transmitters can be used in all industrial sectors. Due to their compact size they can be installed in the connection head type B (DIN 43729) or larger. The following sensors/signal sources can be connected over their universal input module:

- Resistance thermometers (2, 3 or 4-wire system)
- Thermocouples
- Resistance-based sensors and DC voltage sources

The output signal is a direct current from 4 to 20 mA in accordance with the sensor characteristic, superimposed by the digital HART signal.

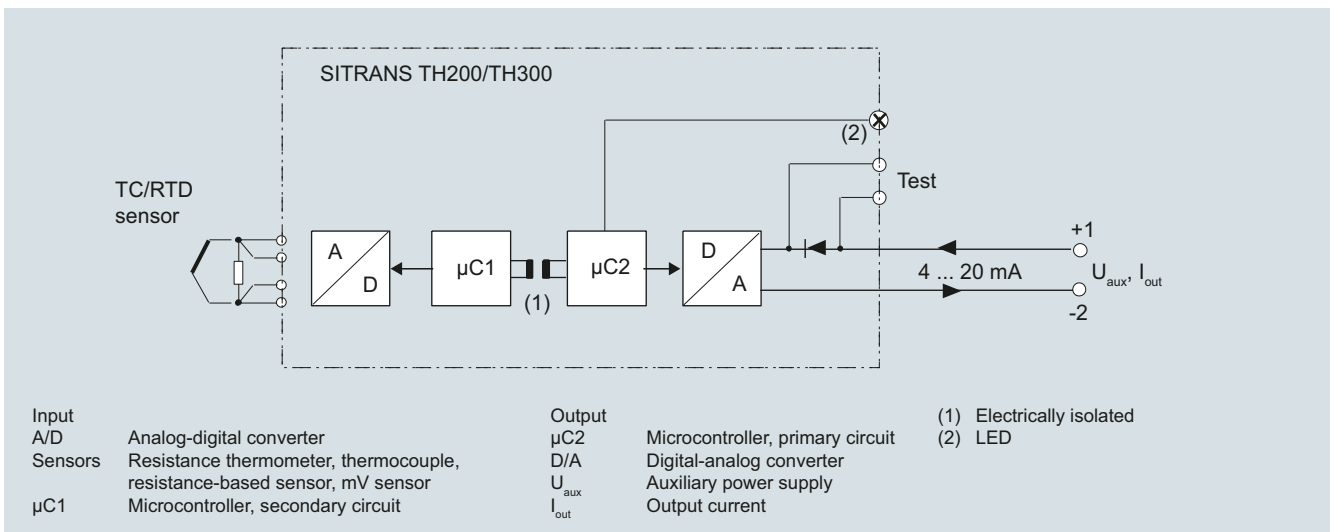
Transmitters of the "intrinsically safe" type of protection can be installed within potentially explosive atmospheres. The devices comply with the Directive 2014/34/EU (ATEX), as well as FM and CSA regulations.

#### Function

The SITRANS TH300 is configured over HART. This can be done using a handheld communicator or even more conveniently with a HART modem and the SIMATIC PDM parameterization software. The configuration data are then permanently stored in the non-volatile memory (EEPROM).

Once the sensors and power supply have been correctly connected, the transmitter outputs a temperature-linear output signal and the diagnostics LED displays a green light. In the case of a sensor short-circuit, the LED flashes red, an internal device fault is indicated by a steady red light.

The test socket can be used to connect an ammeter at any time for monitoring purposes and plausibility checks. The output current can be read without any interruption, or even without opening the current loop.



SITRANS TH 300 function diagram



## Temperature Measurement

### Transmitters for mounting in sensor head

#### SITRANS TH300 (Universal, HART)

#### Technical specifications

##### Input

##### Resistance thermometer

Measured variable	Temperature
Sensor type	
• To IEC 60751	Pt25 ... Pt1000
• To JIS C 1604; $\alpha = 0.00392 \text{ K}^{-1}$	Pt25 ... Pt1000
• To IEC 60751	Ni25 ... Ni1000
• Special type	over special characteristic (max. 30 points)
Sensor factor	0.25 ... 10 (adaptation of the basic type, e.g. Pt100 to version Pt25 ... 1000)
Units	°C or °F
Connection	
• Standard connection	1 resistance thermometer (RTD) in 2-wire, 3-wire or 4-wire system
• Generation of average value	2 identical resistance thermometers in 2-wire system for generation of average temperature
• Generation of difference	2 identical resistance thermometers (RTD) in 2-wire system (RTD 1 – RTD 2 or RTD 2 – RTD 1)
Interface	
• Two-wire system	Parameterizable line resistance $\leq 100 \Omega$ (loop resistance)
• Three-wire system	No balancing required
• Four-wire system	No balancing required
Sensor current	$\leq 0.45 \text{ mA}$
Response time	$\leq 250 \text{ ms}$ for 1 sensor with open-circuit monitoring
Open-circuit monitoring	Always active (cannot be disabled)
Short-circuit monitoring	can be switched on/off (default value: ON)
Measuring range	parameterizable (see table "Digital measuring errors")
Min. measured span	10 °C (18 °F)
Characteristic curve	Temperature-linear or special characteristic

##### Resistance-based sensors

Measured variable	Actual resistance
Sensor type	Resistance-based, potentiometers
Units	$\Omega$
Connection	
• Normal connection	1 resistance-based sensor (R) in 2-wire, 3-wire or 4-wire system
• Generation of average value	2 resistance-based sensors in 2-wire system for generation of average value
• Generation of difference	2 resistance thermometers in 2-wire system (R1 – R2 or R2 – R1)
Interface	
• Two-wire system	Parameterizable line resistance $\leq 100 \Omega$ (loop resistance)
• Three-wire system	No balancing required
• Four-wire system	No balancing required
Sensor current	$\leq 0.45 \text{ mA}$

Response time	$\leq 250 \text{ ms}$ for 1 sensor with open-circuit monitoring
Open-circuit monitoring	Always active (cannot be disabled)
Short-circuit monitoring	can be switched on/off (default value: OFF)
Measuring range	parameterizable max. 0 ... 2200 $\Omega$ (see table "Digital measuring errors")
Min. measured span	5 ... 25 $\Omega$ (see table "Digital measuring errors")
Characteristic curve	Resistance-linear or special characteristic
<u>Thermocouples</u>	
Measured variable	Temperature
Sensor type (thermocouples)	
• Type B	Pt30Rh-Pt6Rh to DIN IEC 584
• Type C	W5 %-Re acc. to ASTM 988
• Type D	W3 %-Re acc. to ASTM 988
• Type E	NiCr-CuNi to DIN IEC 584
• Type J	Fe-CuNi to DIN IEC 584
• Type K	NiCr-Ni to DIN IEC 584
• Type L	Fe-CuNi to DIN 43710
• Type N	NiCrSi-NiSi to DIN IEC 584
• Type R	Pt13Rh-Pt to DIN IEC 584
• Type S	Pt10Rh-Pt to DIN IEC 584
• Type T	Cu-CuNi to DIN IEC 584
• Type U	Cu-CuNi to DIN 43710
Units	°C or °F
Connection	
• Standard connection	1 thermocouple (TC)
• Generation of average value	2 thermocouples (TC)
• Generation of difference	2 thermocouples (TC) (TC1 – TC2 or TC2 – TC1)
Response time	$\leq 250 \text{ ms}$ for 1 sensor with open-circuit monitoring
Open-circuit monitoring	can be switched off
Cold junction compensation	
• Internal	With integrated Pt100 resistance thermometer
• External	With external Pt100 IEC 60751 (2-wire or 3-wire connection)
• External fixed	Cold junction temperature can be set as fixed value
Measuring range	parameterizable (see table "Digital measuring errors")
Min. measured span	Min. 40 ... 100 °C (72 ... 180 °F) (see table "Digital measuring errors")
Characteristic curve	Temperature-linear or special characteristic
<u>mV sensor</u>	
Measured variable	DC voltage
Sensor type	DC voltage source (DC voltage source possible over an externally connected resistor)
Units	mV
Response time	$\leq 250 \text{ ms}$ for 1 sensor with open-circuit monitoring
Open-circuit monitoring	Can be switched off

## Temperature Measurement

### Transmitters for mounting in sensor head

#### SITRANS TH300 (Universal, HART)

Measuring range	-10 ... +70 mV -100 ... +1100 mV
Min. measured span	2 mV or 20 mV
Overload capability of the input	-1.5 ... +3.5 V DC
Input resistance	≥ 1 MΩ
Characteristic curve	Voltage-linear or special characteristic
<b>Output</b>	
Output signal	4 ... 20 mA, 2-wire with communication acc. to HART Rev. 5.9
Auxiliary power	11 ... 35 V DC (to 30 V for Ex ia and ib; to 32 V for Ex nA/nL/ic)
Max. load	(U <sub>aux</sub> - 11 V)/0.023 A
Overrange	3.6 ... 23 mA, infinitely adjustable (default range: 3.80 mA ... 20.5 mA)
Error signal (e.g. following sensor fault) (conforming to NE43)	3.6 ... 23 mA, infinitely adjustable (default value: 22.8 mA)
Sample cycle	0.25 s nominal
Damping	Software filter 1st order 0 ... 30 s (parameterizable)
Protection	Against reversed polarity
Electrically isolated	Input against output (1 kV <sub>eff</sub> )
<b>Measuring accuracy</b>	
Digital measuring errors	See Table "Digital measuring errors"
Reference conditions	
• Auxiliary power	24 V ± 1 %
• Load	500 Ω
• Ambient temperature	23 °C
• Warming-up time	> 5 min
Error in the analog output (digital/analog converter)	< 0.025 % of span
Error due to internal cold junction	< 0.5 °C (0.9 °F)
Influence of ambient temperature	
• Analog measuring error	0.02 % of span/10°C (18 °F)
• Digital measuring errors	
- with resistance thermometers	0.06 °C (0.11 °F)/10°C (18 °F)
- with thermocouples	0.6 °C (1.1 °F)/10°C (18 °F)
Auxiliary power effect	< 0.001 % of span/V
Effect of load impedance	< 0.002 % of span/100 Ω
Long-term drift	
• In the first month	< 0.02 % of span
• After one year	< 0.2 % of span
• After 5 years	< 0.3 % of span
<b>Conditions of use</b>	
<u>Ambient conditions</u>	
Ambient temperature range	-40 ... +85 °C (-40 ... +185 °F)
Storage temperature range	-40 ... +85 °C (-40 ... +185 °F)
Relative humidity	< 98 %, with condensation
Electromagnetic compatibility	acc. to EN 61326 and NE21

**Construction**

Material	Molded plastic
Weight	50 g (0.11 lb)
Dimensions	See "Dimensional drawings"
Cross-section of cables	Max. 2.5 mm <sup>2</sup> (AWG 13)
Degree of protection to IEC 60529	
• Enclosure	IP40
• Terminals	IP00

**Certificates and approvals**

Explosion protection ATEX	
EC type test certificate	PTB 05 ATEX 2040X
• "Intrinsic safety" type of protection	II 1 G Ex ia IIC T6/T4 II 2 (1) G Ex ia/ib IIC T6/T4 II 3(1) G Ex ia/ic IIC T6/T4 II 1D Ex iaD 20 T115 °C
• "Operating equipment that is non-ignitable and has limited energy" type of protection	II 3 G Ex nL IIC T6/T4 II 3 G Ex nA IIC T6/T4
Explosion protection: FM for USA	
• FM approval	FM 3024169
• Degree of protection	IS / CI I, II, III / Div 1 / GP ABC-DEFG T6, T5, T4 CI I / ZN 0 / AEx ia IIC T6, T5, T4 NI / CI I / Div 2 / GP ABCDFG T6, T5, T4 NI / CI I / ZN 2 / IIC T6, T5, T4
Explosion protection to FM for Canada (cFM <sub>US</sub> )	
• FM approval	FM 3024169C
• Degree of protection	IS / CI I, II, III / Div 1 / GP ABC-DEFG T6, T5, T4 NI / CI I / DIV 2 / GP ABCD T6, T5, T4 NIFW / CI I, II, III / DIV 2 / GP ABCDFG T6, T5, T4 DIP / CI II, III / Div 2 / GP FG T6, T5, T4 CI I / ZN 0 / Ex ia IIC T6, T5, T4 CI I / ZN 2 / Ex nA nL IIC T6, T5, T4
Other certificates	EAC Ex(GOST), NEPSI, IEC, EXPOLABS

**Factory setting:**

- Pt100 (IEC 751) with 3-wire circuit
- Measuring range: 0 ... 100 °C (32 ... 212 °F)
- Fault current: 22.8 mA
- Sensor offset: 0 °C (0 °F)
- Damping 0.0 s

## Temperature Measurement

Transmitters for mounting in sensor head

### SITRANS TH300 (Universal, HART)

#### Digital measuring errors

##### Resistance thermometer

Input	Measuring range °C/(°F)	Min. mea- sured span		Digital accuracy	
		°C	(°F)	°C	(°F)
<b>to IEC 60751</b>					
Pt25	-200 ... +850 (-328 ... +1562)	10	(18)	0.3	(0.54)
Pt50	-200 ... +850 (-328 ... +1562)	10	(18)	0.15	(0.27)
Pt100 ... Pt200	-200 ... +850 (-328 ... +1562)	10	(18)	0.1	(0.18)
Pt500	-200 ... +850 (-328 ... +1562)	10	(18)	0.15	(0.27)
Pt1000	-200 ... +350 (-328 ... +662)	10	(18)	0.15	(0.27)
<b>to JIS C1604-81</b>					
Pt25	-200 ... +649 (-328 ... +1200)	10	(18)	0.3	(0.54)
Pt50	-200 ... +649 (-328 ... +1200)	10	(18)	0.15	(0.27)
Pt100 ... Pt200	-200 ... +649 (-328 ... +1200)	10	(18)	0.1	(0.18)
Pt500	-200 ... +649 (-328 ... +1200)	10	(18)	0.15	(0.27)
Pt1000	-200 ... +350 (-328 ... +662)	10	(18)	0.15	(0.27)
Ni 25 ... Ni1000	-60 ... +250 (-76 ... +482)	10	(18)	0.1	(0.18)

##### Resistance-based sensors

Input	Measuring range Ω	Min. mea- sured span Ω	Digital accuracy Ω
Resistance	0 ... 2200	25	0.25

#### Thermocouples

Input	Measuring range °C/(°F)	Min. mea- sured span		Digital accuracy	
		°C	(°F)	°C	(°F)
Type B	100 ... 1820 (212 ... 3308)	100	(180)	2 <sup>1)</sup>	(3.6) <sup>1)</sup>
Type C (W5)	0 ... 2300 (32 ... 4172)	100	(180)	2	(3.6)
Type D (W3)	0 ... 2300 (32 ... 4172)	100	(180)	1 <sup>2)</sup>	(1.8) <sup>2)</sup>
Type E	-200 ... +1000 (-328 ... +1832)	50	(90)	1	(1.8)
Type J	-200 ... +1200 (-328 ... +2192)	50	(90)	1	(1.8)
Type K	-200 ... +1370 (-328 ... +2498)	50	(90)	1	(1.8)
Type L	-200 ... +900 (-328 ... +1652)	50	(90)	1	(1.8)
Type N	-200 ... +1300 (-328 ... +2372)	50	(90)	1	(1.8)
Type R	-50 ... +1760 (-58 ... +3200)	100	(180)	2	(3.6)
Type S	-50 ... +1760 (-58 ... +3200)	100	(180)	2	(3.6)
Type T	-200 ... +400 (-328 ... +752)	40	(72)	1	(1.8)
Type U	-200 ... +600 (-328 ... +1112)	50	(90)	2	(3.6)

1) The digital accuracy in the range 100 to 300 °C (212 to 572 °F) is 3 °C (5.4 °F).

2) The digital accuracy in the range 1750 to 2300 (3182 to 4172 °F) is 2 °C (3.6 °F).

#### mV sensor

Input	Measuring range mV	Min. mea- sured span mV	Digital accuracy μV
mV sensor	-100 ... +1100	20	400

The digital accuracy is the accuracy after the analog/digital conversion including linearization and calculation of the measured value.

An additional error is generated in the output current 4 to 20 mA as a result of the digital/analog conversion of 0.025 % of the set span (digital-analog error).

The total error under reference conditions at the analog output is the sum from the digital error and the digital-analog error (poss. with the addition of cold junction errors in the case of thermocouple measurements).

## Temperature Measurement

### Transmitters for mounting in sensor head

#### SITRANS TH300 (Universal, HART)

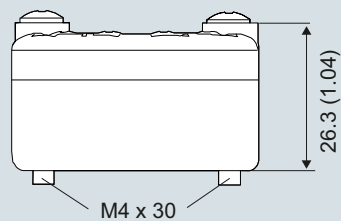
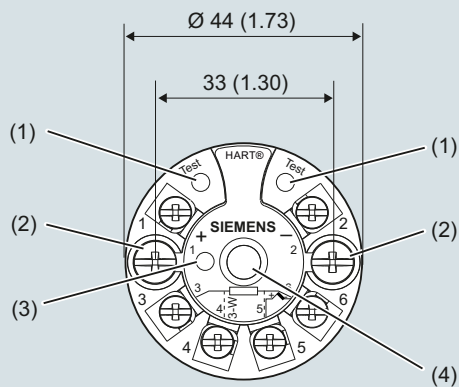
Selection and Ordering data	Article No.	Accessories	Article No.
<b>Temperature transmitter SITRANS TH300</b> for installation in connection head, type B (DIN 43729), two-wire system 4 ... 20 mA, communication capable to HART, with galvanic isolation <ul style="list-style-type: none"> <li>Without explosion protection</li> <li>With explosion protection               <ul style="list-style-type: none"> <li>to ATEX</li> <li>to FM (C<sub>FMUS</sub>)</li> </ul> </li> </ul>	<b>7NG3212-0NN00</b>  <b>7NG3212-0AN00</b> <b>7NG3212-0BN00</b>	Further accessories for assembly, connection and transmitter configuration, see page 2/238. <b>HART modem</b> <ul style="list-style-type: none"> <li>With USB connection</li> </ul>	<b>7MF4997-1DB</b> <b>See Section 8</b>
<b>Further designs</b> Add <b>"-Z"</b> to Article No. and specify Order code(s) with test protocol (5 measuring points) Functional safety SIL2 Functional safety SIL2/3	Order code  <b>C11</b> <b>C20</b> <b>C23</b>	<b>SIMATIC PDM operating software</b> <b>DIN rail adapters for head transmitters</b> (Quantity delivered: 5 units) <b>Connecting cable</b> 4-wire, 150 mm, for sensor connections when using head transmitters in the high hinged cover (set with 5 units)	<b>7NG3092-8KA</b>  <b>7NG3092-8KC</b>
<b>Customer-specific programming</b> Add <b>"-Z"</b> to Article No. and specify Order code(s) Measuring range to be set Specify in plain text (max. 5 digits): Y01: ... to ... °C, °F Measuring point no. (TAG), max. 8 characters Measuring point descriptor, max. 16 characters Measuring point message, max. 32 characters Pt100 (IEC) 2-wire, R <sub>L</sub> = 0 Ω Pt100 (IEC) 3-wire Pt100 (IEC) 4-wire Thermocouple type B Thermocouple type C (W5) Thermocouple type D (W3) Thermocouple type E Thermocouple type J Thermocouple type K Thermocouple type L Thermocouple type N Thermocouple type R Thermocouple type S Thermocouple type T Thermocouple type U With TC: CJC external (Pt100, 3-wire) With TC: CJC external with fixed value, specify in plain text Special differing customer-specific programming, specify in plain text Fail-safe value 3.6 mA (instead of 22,8 mA) Cable extension Transmitter with installed cable extension 150 mm (5.91 inch), for Pt100 in four-wire system	<b>Y01<sup>1)</sup></b>  <b>Y17<sup>2)</sup></b> <b>Y23<sup>2)</sup></b> <b>Y24<sup>2)</sup></b> <b>U02<sup>3)</sup></b> <b>U03<sup>3)</sup></b> <b>U04<sup>3)</sup></b> <b>U20<sup>3)4)</sup></b> <b>U21<sup>3)4)</sup></b> <b>U22<sup>3)4)</sup></b> <b>U23<sup>3)4)</sup></b> <b>U24<sup>3)4)</sup></b> <b>U25<sup>3)4)</sup></b> <b>U26<sup>3)4)</sup></b> <b>U27<sup>3)4)</sup></b> <b>U28<sup>3)4)</sup></b> <b>U29<sup>3)4)</sup></b> <b>U30<sup>3)4)</sup></b> <b>U31<sup>3)4)</sup></b> <b>U41</b> <b>Y50</b>  <b>Y09<sup>5)</sup></b> <b>U36<sup>2)</sup></b> <b>W01</b>	1) For customer-specific programming for RTD and TC, the start value and the end value of the required measuring span must be specified here. 2) For this selection, Y01 or Y09 must also be selected. 3) For this selection, Y01 must also be selected. 4) Internal cold junction compensation is selected as the default for TC. 5) For customer-specific programming, for example mV and ohm, the start value and the end value of the required measuring span and the unit must be entered here.  Supply units see Chapter "Supplementary Components".  <u>Ordering example 1:</u> 7NG3212-0NN00-Z Y01+Y17+U03 Y01: -10 ... +100 °C Y17: TICA123  <u>Ordering example 2:</u> 7NG3212-0NN00-Z Y01+Y23+U25 Y01: -10 ... +100 °C Y23: TICA1234HEAT  <u>Factory setting:</u> <ul style="list-style-type: none"> <li>Pt100 (IEC 751) with 3-wire circuit</li> <li>Measuring range: 0 ... 100 °C (32 ... 212 °F)</li> <li>Fault current: 22.8 mA</li> <li>Sensor offset: 0 °C (0 °F)</li> <li>Damping 0.0 s</li> </ul>	

## Temperature Measurement

Transmitters for mounting in sensor head

### SITRANS TH300 (Universal, HART)

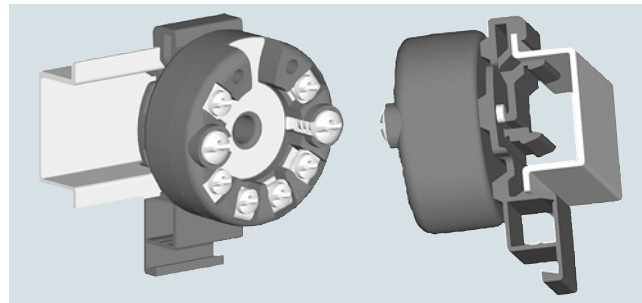
#### Dimensional drawings



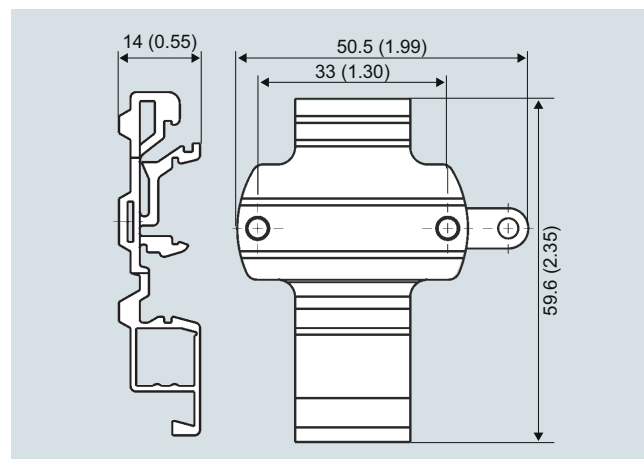
- |           |          |  |
|-----------|----------|--|
| 1(+)      | and 2(-) | Auxiliary power supply $U_{aux}$ , output current $I_{out}$      |
| 3, 4, 5   | and 6    | Pt100 sensor (for connections, see Sensor connection assignment) |
| Test (+), | Test (-) | Measurement of the output current with a multimeter              |
| (1)       |          | Test terminal  |
| (2)       |          | Mounting screw M4x30   |
| (3)       |          | LED for operation indication                                     |
| (4)       |          | Internal diameter of center hole 6.3 (0.25)                      |

SITRANS TH300, dimensions and pin assignment, dimensions in mm (inch)

#### Mounting on DIN rail



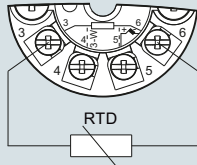
SITRANS TH300, mounting of transmitter on DIN rail



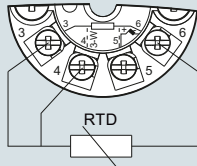
DIN rail adapter, dimensions in mm (inch)

## Schematics

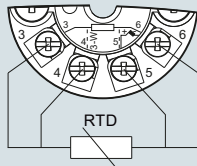
### Resistance thermometer



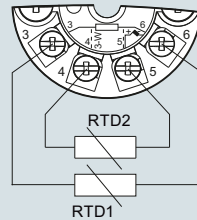
Two-wire system <sup>1)</sup>



Three-wire system



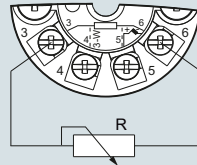
Four-wire system



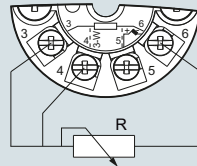
Generation of average value / difference <sup>1)</sup>

<sup>1)</sup> Programmable line resistance for the purpose of correction.

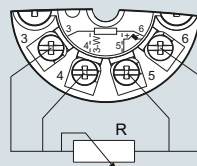
### Resistance



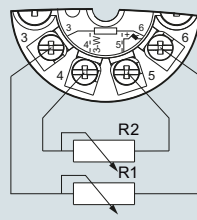
Two-wire system <sup>1)</sup>



Three-wire system

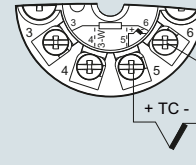


Four-wire system

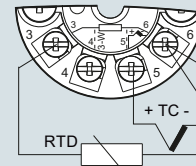


Generation of average value / difference <sup>1)</sup>

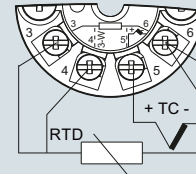
### Thermocouple



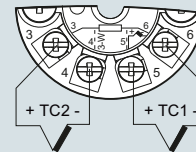
Cold junction compensation  
Internal/fixed value



Cold junction compensation with  
external Pt100 in two-wire system <sup>1)</sup>

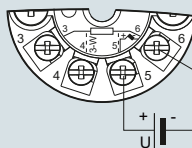


Cold junction compensation with  
external Pt100 in three-wire system

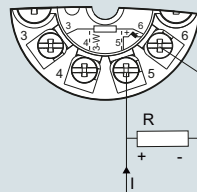


Generation of average value / difference  
with internal cold junction compensation

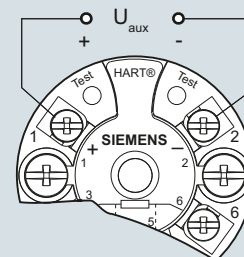
### Voltage measurement



### Current measurement



### Connection of auxiliary power supply (U<sub>aux</sub>)



SITRANS TH300, sensor connection assignment