# Temperature Measurement
## Transmitters for mounting in sensor head
### SITRANS TH200
### two-wire system, 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.
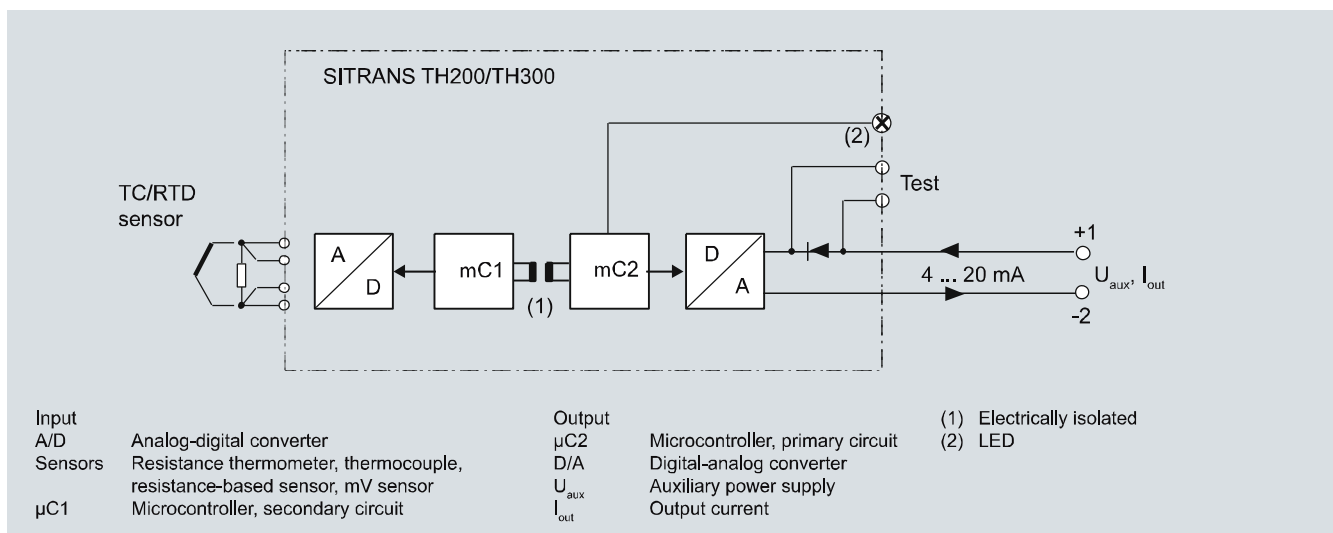
Transmitters of the "intrinsically safe" type of protection can be installed within potentially explosive atmospheres. The devices comply with the Directive 94/9/EC (ATEX), as well as FM and CSA regulations.

## 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.



| Input | | Output | | (1) | Electrically isolated |
|---|---|---|---|---|---|
| A/D | Analog-digital converter | μC2 | Microcontroller, primary circuit | (2) | LED |
| Sensors | Resistance thermometer, thermocouple, resistance-based sensor, mV sensor | D/A | Digital-analog converter | | |
| | | $U_{aux}$ | Auxiliary power supply | | |
| μC1 | Microcontroller, secondary circuit | $I_{out}$ | Output current | | |

SITRANS TH200 function diagram

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### Technical specifications

**Input**

_Resistance thermometer_

| | |
|---|---|
| Measured variable | Temperature |
| Sensor type | |
| • to IEC 60751 | Pt25 … Pt1000 |
| • To JIS C 1604; a = 0.00392 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 ≤ 100 Ω (loop resistance) |
| • Three-wire system | No balancing required |
| • Four-wire system | No balancing required |
| Sensor current | ≤ 0.45 mA |
| Response time | ≤ 250 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 | Ω |
| 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 ≤ 100 Ω (loop resistance) |
| • Three-wire system | No balancing required |
| • Four-wire system | No balancing required |
| Sensor current | ≤ 0.45 mA |

| | |
|---|---|
| Response time | ≤ 250 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 Ω (see table "Digital measuring errors") |
| Min. measured span | 5 Ω … 25 Ω (see Table "Digital measuring errors") |
| Characteristic curve | Resistance-linear or special characteristic |

_Thermocouples_

| | |
|---|---|
| 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 | ≤ 250 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 60571 (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 |

_mV sensor_

| | |
|---|---|
| Measured variable | DC voltage |
| Sensor type | DC voltage source (DC voltage source possible over an externally connected resistor) |
| Units | mV |
| Response time | ≤ 250 ms for 1 sensor with open-circuit monitoring |
| Open-circuit monitoring | Can be switched off |
| 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 | $\geq 1\ M\Omega$ |
| Characteristic curve | Voltage-linear or special characteristic |

**Output**

| | |
|---|---|
| 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 | $(U_{aux} - 11\ V)/0.023\ A$ |
| 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$_{eff}$) |

**Measuring accuracy**

| | |
|---|---|
| Digital measuring errors | See table "Digital measuring errors" |
| Reference conditions | |
| • Auxiliary power | 24 V ± 1 % |
| • Load | 500 $\Omega$ |
| • 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 $\Omega$ |
| 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 |

**Conditions of use**

Ambient conditions

| | |
|---|---|
| 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 mm² (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<br>II 2 (1) G Ex ia/ib IIC T6/T4<br>II 3(1) G Ex ia/ic IIC T6/T4<br>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<br>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 ABCDEFG T6, T5, T4<br>CI I / ZN 0 / AEx ia IIC T6, T5, T4<br>NI / CI I / Div 2 / GP ABCDFG T6, T5, T4<br>NI / CI I / ZN 2 / IIC T6, T5, T4 |
| Explosion protection to FM for Canada ($_cFM_{US}$) | |
| • FM approval | FM 3024169C |
| • Degree of protection | IS / CI I, II, III / Div 1/ GP ABCDEFG T6, T5, T4<br>NI / CI I / DIV 2 / GP ABCD T6, T5, T4<br>NIFW / CI I, II, III / DIV 2 / GP ABCDFG T6, T5, T4<br>DIP / CI II, III / Div 2 / GP FG T6, T5, T4<br>CI I / ZN 0 / Ex ia IIC T6, T5, T4<br>CI I / ZN 2 / Ex nA nL IIC T6, T5, T4 |
| Other certificates | GOST, NEPSI, PESO, IEC, EXPOLABS |

**Software requirements for SIPROM T**

| | |
|---|---|
| PC operating system | Windows ME, 2000 and XP; also Windows 95, 98 and 98 SE, but only in connection with RS 232 modem. |

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
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### *Digital measuring errors*

Resistance thermometer

| Input | Measuring range | | Min. measured span | | Digital accuracy | |
|---|---|---|---|---|---|---|
| | °C / (°F) | | °C | (°F) | °C | (°F) |
| **to IEC 60751** | | | | | | |
| 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) |
| **to JIS C1604-81** | | | | | | |
| 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 | Min. measured span | Digital accuracy |
|---|---|---|---|
| | Ω | Ω | Ω |
| Resistance | 0 ... 390 | 5 | 0,05 |
| Resistance | 0 ... 2200 | 25 | 0,25 |

Thermocouples

| Input | Measuring range | | Min. measured span | | Digital accuracy | |
|---|---|---|---|---|---|---|
| | °C/(°F) | °C | (°F) | °C | (°F) | |
| Type B | 0 ... 1820 (32 ... 3308) | 100 | (180) | 2[1] | (3.60)[1] | |
| Type C (W5) | 0 ... 2300 (32 ... 4172) | 100 | (180) | 2 | (3.60) | |
| Type D (W3) | 0 ... 2300 (32 ... 4172) | 100 | (180) | 1[2] | (1.80)[2] | |
| Type E | -200 ... +1000 (-328 ... +1832) | 50 | (90) | 1 | (1.80) | |
| Type J | -210 ... +1200 (-346 ... +2192) | 50 | (90) | 1 | (1.80) | |
| Type K | -230 ... +1370 (-382 ... +2498) | 50 | (90) | 1 | (1.80) | |
| Type L | -200 ... +900 (-328 ... +1652) | 50 | (90) | 1 | (1.80) | |
| Type N | -200 ... +1300 (-328 ... +2372) | 50 | (90) | 1 | (1.80) | |
| Type R | -50 ... +1760 (-58 ... +3200) | 100 | (180) | 2 | (3.60) | |
| Type S | -50 ... +1760 (-58 ... +3200) | 100 | (180) | 2 | (3.60) | |
| Type T | -200 ... +400 (-328 ... +752) | 40 | (72) | 1 | (1.80) | |
| Type U | -200 ... +600 (-328 ... +1112) | 50 | (90) | 2 | (3.60) | |

[1] The digital accuracy in the range 0 to 300 °C (32 to 572 °F) is 3 °C (5.4 °F).

[2] 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 | Min. measured span | Digital accuracy |
|---|---|---|---|
| | mV | mV | μV |
| mV sensor | -10 ... +70 | 2 | 40 |
| 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).

| Selection and Ordering data | | Order 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 | ▶ | **7NG3211-1NN00** |
| • With explosion protection | | |
|   - to ATEX | ▶ | **7NG3211-1AN00** |
|   - to FM ($_c$FM$_{US}$) | ▶ | **7NG3211-1BN00** |
| *Further designs* | | Order code |
| Add "-Z" to Order 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 Order No. and specify Order code(s) | | |
| Customer specific programming, specify **measuring range** in plain text | | **Y01**[1] |
| Measuring point no. (TAG), max. 8 characters | | **Y17**[1] |
| Measuring point descriptor, max. 16 characters | | **Y23**[1] |
| Measuring point message, max. 32 characters | | **Y24**[1] |
| Pt100 (IEC) 2-wire, $R_L = 0\ \Omega$ | | **U02**[1] |
| Pt100 (IEC) 3-wire | | **U03**[1] |
| Pt100 (IEC) 4-wire | | **U04**[1] |
| Thermocouple type B | | **U20**[1] |
| Thermocouple type C (W5) | | **U21**[1] |
| Thermocouple type D (W3) | | **U22**[1] |
| Thermocouple type E | | **U23**[1] |
| Thermocouple type J | | **U24**[1] |
| Thermocouple type K | | **U25**[1] |
| Thermocouple type L | | **U26**[1] |
| Thermocouple type N | | **U27**[1] |
| Thermocouple type R | | **U28**[1] |
| Thermocouple type S | | **U29**[1] |
| Thermocouple type T | | **U30**[1] |
| Thermocouple type U | | **U31**[1] |
| With TC: CJC internal | | **U40**[1] |
| With TC: CJC external (Pt100, 3-wire) | | **U41**[1] |
| With TC: CJC external with fixed value, specify in plain text | | **Y50**[1] |
| Special differing customer-specific programming, specify in plain text | | **Y09**[2] |
| Fail-safe value 3.6 mA (instead of 22,8 mA) | | **U36**[1] |

| Accessories | | Order No. |
|---|---|---|
| **Modem for SITRANS TH100, TH200 and TR200 incl. SIPROM T parameterization software**<br>With USB connection | ▶ | **7NG3092-8KU** |
| **CD for measuring instruments for temperature**<br>With documentation in German, English, French, Spanish, Italian, Portuguese and SIPROM T parameterization software | ▶ | **A5E00364512** |
| **DIN rail adapters for head transmitters**<br>(Quantity delivered: 5 units) | ▶ | **7NG3092-8KA** |
| **Connecting cable**<br>4-wire, 150 mm, for sensor connections when using head transmitters in the high hinged cover (set with 5 units) | | **7NG3092-8KC** |

▶ Available ex stock.

[1] Here, you enter the initial and final value of the desired measurement range for customer-specific programming for RTD and TC.

[2] If needed, here you can mention settings, which cannot be specified with existing order codes (e.g.: programming for mV, $\Omega$).

Supply units see Chap. 8 "Supplementary Components".

Ordering example 1:

7NG3211-1NN00-Z Y01+Y17+U03
Y01: 0...100 C
Y17: TICA123

Ordering example 2:

7NG3211-1NN00-Z Y01+Y23+ U25+U40
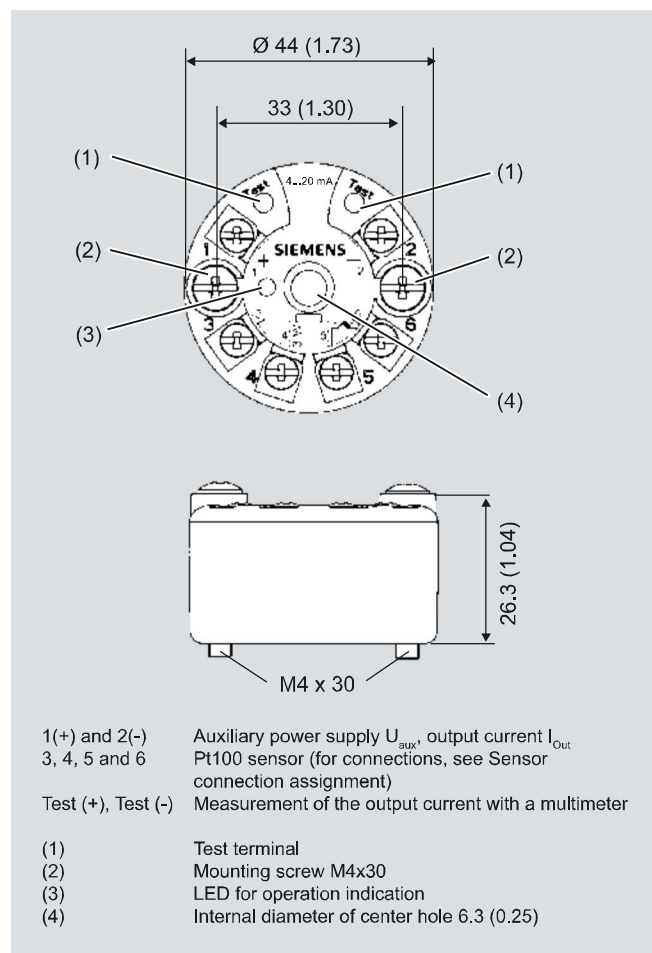Y01: 0...100 C
Y23: TICA1234HEAT

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

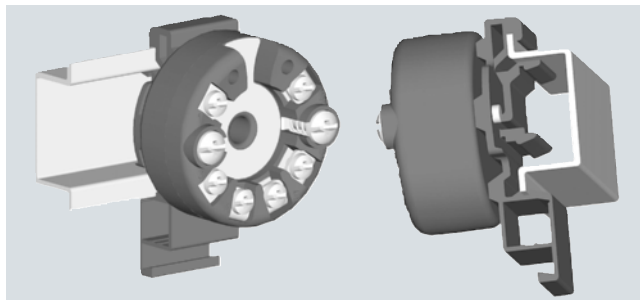# Temperature Measurement
## Transmitters for mounting in sensor head

**■ 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 TH200, dimensions and pin assignment, dimensions in mm (inch)

*Mounting on DIN rail*



SITRANS TH200, mounting of transmitter on DIN rail
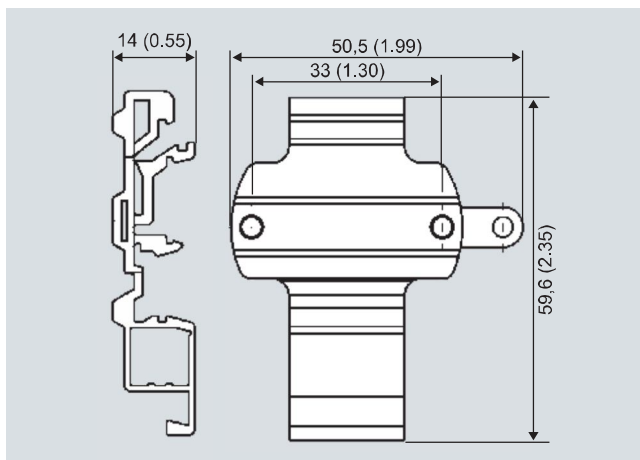


DIN rail adapter, dimensions in mm (inch)

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# Temperature Measurement
## Transmitters for mounting in sensor head
### SITRANS TH200
### two-wire system, universal

## Schematics



Resistance thermometer — Two-wire system [1], Three-wire system, Four-wire system, Generation of average value / difference [1]
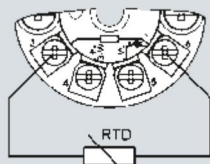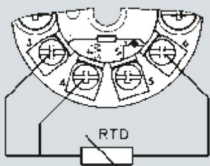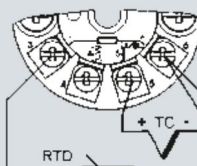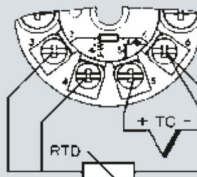
Resistance — Two-wire system [1], Three-wire system, Four-wire system, Generation of average value / difference [1]
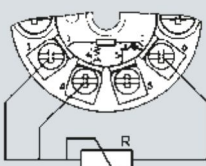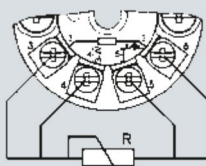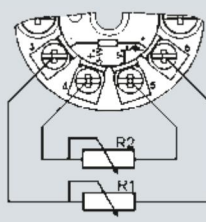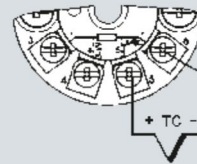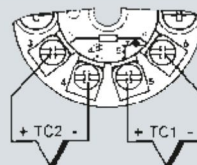
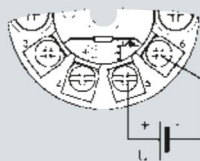Thermocouple — Cold junction compensation Internal/fixed value, Cold junction compensation with external Pt100 in two-wire system [1], Cold junction compensat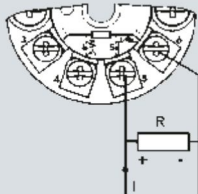ion with external Pt100 in three-wire system, Generation of average value / difference with internal cold junction compensation
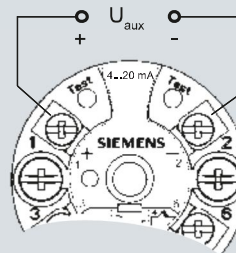
[1] Programmable line resistance for the purpose of correction.

Voltage measurement, Current measurement, Connection of auxiliary power supply ($U_{aux}$)

SITRANS TH200, sensor connection assignment