

# Temperature Measurement

## Temperature transmitters

### Field transmitters/field indicator / SITRANS TF field transmitter

#### Overview



#### Our field devices for heavy industrial use

- HART, Universal
- 4 to 20 mA, universal

The temperature transmitter SITRANS TF works where others feel uncomfortable.

#### Benefits

- Universal use
  - as transmitter for resistance thermometer, thermocouple element,  $\Omega$  or mV signal
  - as field indicator for any 4 to 20 mA signals
- Local sensing of measured values over digital display
- Rugged two-chamber enclosure in die-cast aluminum or stainless steel
- IP66/67/68 degree of protection
- Test terminals for direct read-out of the output signal without breaking the current loop
- Can be mounted elsewhere if the measuring point
  - is difficult to access
  - has high temperatures
  - experiences vibrations due to the process cell
  - is to avoid long neck pipes and thermowells
- Can be mounted directly on American-design sensors
- Wide range of approvals for use in potentially explosive atmospheres. Types of protection "Intrinsically safe, non-sparking and flameproof", for Europe and the USA.
- SIL2 (with order note C20), SIL2/3 (with C23)

#### Application

SITRANS TF can be used everywhere where temperatures need to be measured under particularly adverse conditions, or where a convenient local display is ideal. Which is why users from all industries have opted for this field device. The rugged enclosure protects the electronics. The stainless steel model is almost completely resistant to sea water and other aggressive substances. The inner workings offer high measuring accuracy, universal input and a wide range of diagnostic options.

#### Function

##### Configuration

The communication capability over the HART protocol V 5.9 of the SITRANS TF with an integrated SITRANS TH300 permits parameterization using a PC or HART communicator (hand-held communicator). The SIMATIC PDM makes it easy.

For the SITRANS TF with integrated programmable SITRANS TH200, parameters are assigned with the PC. Available for this purpose are a special modem and the software tool SIPROM T.

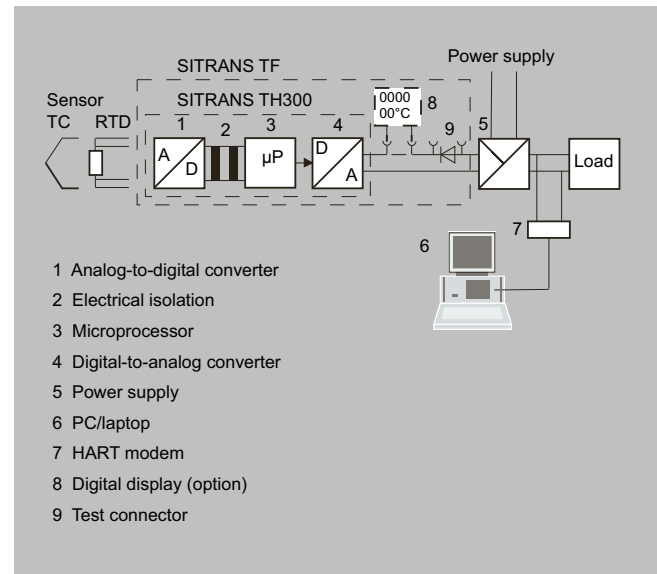
##### Mode of operation

##### Mode of operation of SITRANS TF as temperature transmitter

The sensor signal, whether resistance thermometer, thermocouple element or  $\Omega$  or mV signal, is amplified and linearized. Sensor and output side are electrically isolated. An internal cold junction is integrated for measurements with thermocouples.

The device outputs a temperature-linear direct current from 4 to 20 mA. As well as the analog transmission of measured values from 4 to 20 mA, the HART version also supports digital communication for online diagnostics, measured value transmission and configuration.

SITRANS TF automatically detects when a sensor should be interrupted or is indicating a short-circuit. The practical test terminals allow direct measurement of 4 to 20 mA signals over an ammeter without interrupting the output current loop.



Mode of operation of SITRANS TF with integrated SITRANS TH300 and digital display

### Selection and ordering data

Temperature transmitter in field enclosure 2-wire system 4 ... 20 mA, with galvanic isolation	Article No. 7NG313				
Click the article number for online configuration in the PIA Life Cycle Portal.					
<b>Built-in transmitter</b>					
SITRANS TH200, programmable					
• Without Ex protection	5	0			
• With Ex ia (ATEX)	5	1			
• With Ex nAL for Zone 2 (ATEX)	5	2			
• Total device SITRANS TF Ex d (ATEX) <sup>1)</sup>	5	4			
• Total device SITRANS TF acc. to FM (XP, DIP, NI, S) <sup>1)</sup>	5	5			
SITRANS TH300, communication-capable according to HART V 5.9					
• Without Ex protection	6	0			
• With Ex ia (ATEX)	6	1			
• With Ex nAL for Zone 2 (ATEX)	6	2			
• Total device SITRANS TF Ex d (ATEX) <sup>1)</sup>	6	4			
• Total device SITRANS TF acc. to FM (XP, DIP, NI, S) <sup>1)</sup>	6	5			
<b>Enclosure</b>					
Die-cast aluminum				A	
Stainless steel precision casting				E	
<b>Connections/cable entry</b>					
Screw glands M20×1.5					B
Screw glands ½-14 NPT					C
<b>Digital indicator</b>					
None					0
With					1
<b>Mounting bracket and fastening parts</b>					
None					0
Made of steel					1
Made of stainless steel					2

<sup>1)</sup> Without cable gland.

Options	Order code
<b>Add "-Z" to article number, specify order code and, if applicable, plain text</b>	
Test report (5 measuring points)	<b>C11</b>
Functional safety SIL2	<b>C20</b>
Functional safety SIL2/3	<b>C23</b>
<b>Explosion protection</b>	
• Explosion protection Ex i according to NEPSI (China) (only for 7NG313.-1...)	E55 <sup>1)</sup>
• Explosion protection Ex d according to NEPSI (China) (only for 7NG313.-4...)	E56 <sup>1)</sup>
• Explosion protection Ex nA according to NEPSI (China) (only for 7NG313.-2...)	E57 <sup>1)</sup>
• Explosion protection Ex d according to KOSHA (Korea) (only for 7NG313.-4...)	E70 <sup>1)</sup>
<b>Marine approvals</b>	
• Det Norske Veritas Germanischer Lloyd (DNV GL)	D01
Two-layer coating of enclosure and lid (PU on epoxy)	<b>G10</b>
Transient protection	<b>J01</b>
Cable gland CAPRI ½ NPT ADE 4F, nickel-plated brass (CAPRI 848694 and 810634) included	<b>D57</b>
Cable gland ½ NPT ADE 1F, cable diameter 6 ... 12 (CAPRI 818694 and 810534) flexible	<b>D58</b>
Cable gland ½ NPT ADE 4F, stainless steel (CAPRI 848699 and 810634) included	<b>D59</b>

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#### Selection and ordering data (continued)

Options Add "-Z" to article number, specify order code and, if applicable, plain text	Order code
Cable gland ½ NPT ADE 1F, cable diameter 4 ... 8.5 (CAPRI 818674 and 810534) flexible	D60
<b>Customer-specific programming</b>	
Measuring range to be set Specify in plain text (max. 5 digits): Y01: ... to ... °C, °F	Y01 <sup>2)</sup>
Measuring point number (TAG) max. 8 characters	Y17 <sup>3)</sup>
Measuring point description, max. 16 characters	Y23 <sup>4)</sup>
Measuring point description, max. 32 characters	Y24 <sup>4)</sup>
Labeling of measuring point plate only, specify in plain text: Measuring range	Y22 <sup>4)</sup>
Pt100 (IEC) 2-wire, R <sub>L</sub> = 0 Ω	U02 <sup>5)</sup>
Pt100 (IEC) 3-wire	U03 <sup>5)</sup>
Pt100 (IEC) 4-wire	U04 <sup>5)</sup>
Type B thermocouple	U20 <sup>5)6)</sup>
Type C thermocouple (W5)	U21 <sup>5)6)</sup>
Type D thermocouple (W3) <sup>5)6)</sup>	U22 <sup>5)6)</sup>
Type E thermocouple	U23 <sup>5)6)</sup>
Type J thermocouple	U24 <sup>5)6)</sup>
Type K thermocouple	U25 <sup>5)6)</sup>
Type L thermocouple	U26 <sup>5)6)</sup>
Type N thermocouple	U27 <sup>5)6)</sup>
Type R thermocouple	U28 <sup>5)6)</sup>
Type S thermocouple	U29 <sup>5)6)</sup>
Type T thermocouple	U30 <sup>5)6)</sup>
Type U thermocouple	U31 <sup>5)6)</sup>
For TC: Cold junction compensation: external (Pt100, 3-wire)	U41
For TC: Cold junction compensation: external with fixed value: Specify in plain text	Y50
Enter special deviating customer-specific setting in plain text	Y09 <sup>7)</sup>
Fault current 3.6 mA (instead of 22.8 mA)	U36 <sup>3)</sup>

1) Option does not include ATEX/IECEx approval, only country-specific approval.

2) For customer-specific programming for RTD and TC, the start value and the end value of the required measuring span must be specified here. For specification on TAG plate, please select Y22.

3) For this selection, Y01 or Y09 must also be selected. For specification on TAG plate, please select Y23.

4) If only Y22, Y23 or Y24 is ordered and if the labeling is only noted on the measuring point plate, do not specify Y01.

5) For this selection, Y01 must also be selected.

6) Internal cold junction compensation is selected as the default for TC.

7) 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.

#### Accessories

	Article No.
See section "Other accessories for assembly, connection and transmitter configuration"	
<b>Modems</b>	
HART modem with USB interface	7MF4997-1DB
Modem with USB interface and SIPROM T software	7NG3092-8KN
<b>SIMATIC PDM parameterization software</b> Also for SITRANS TH300	See section 8
<b>Mounting bracket and fastening parts</b>	
Made of steel for 7NG313.-..B..	7MF4997-1AC
Made of steel for 7NG313.-..C..	7MF4997-1AB

### Selection and ordering data (continued)

	Article No.
Made of stainless steel for 7NG313-...B..	7MF4997-1AJ
Made of stainless steel for 7NG313-...C..	7MF4997-1AH
Made of stainless steel 316L for 7NG313-...B..	7MF4997-1AQ
Made of stainless steel 316L for 7NG313-...C..	7MF4997-1AP
<b>Digital display<sup>1)</sup></b>	<b>7MF4997-1BS</b>
<b>Connection board</b>	<b>A5E02226423</b>
For supply units, see Catalog FI 01 section "Supplementary components".	

<sup>1)</sup> Retrofitting not possible with Ex devices.

#### Ordering example 1

7NG3135-0AB11-Z Y01+Y23+U03

Y01: -10 ... +100 °C

Y23: TICA1234HEAT

#### Ordering example 2

7NG3136-0AC11-Z Y01+Y23+Y24+U25

Y01: -10 ... +100 °C

Y23: TICA 1234 ABC

Y24: Heating Boiler 56789

#### Factory setting of the transmitter

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

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#### Technical specifications

SITRANS TF, field transmitter	
<b>Input</b>	
<b><u>Resistance thermometer</u></b>	
Measured variable	Temperature
Input type	
• According to IEC 60751	Pt25 ... Pt1000
• According to JIS C 1604; $\alpha=0.00392$ K-1	Pt25 ... Pt1000
• According to IEC 60751	Ni25 ... Ni1000
Units	°C and °F
Connection	
• Standard connection	1 resistance thermometer (RTD) in 2-wire, 3-wire or 4-wire connection
• Averaging	Series or parallel connection of several resistance thermometers in the 2-wire connection for the generation of average temperatures or for adaptation to other device types
• Differentiation	2 resistance thermometers (RTD) in 2-wire connection (RTD 1 – RTD 2 or RTD 2 – RTD 1)
Connection	
• 2-wire connection	Wire resistance can be configured $\leq 100 \Omega$ (loop resistance)
• 3-wire connection	No trim necessary
• 4-wire connection	No trim necessary
Sensor current	$\leq 0.45$ mA
Response time	$\leq 250$ ms for 1 sensor with break monitoring
Break monitoring	Always active (cannot be switched off)
Short-circuit monitoring	Can be switched on/off (default value: ON)
Measuring range	Assignable (see "Digital measuring error" table)
Min. measuring span	10 °C (18 °F)
Characteristic curve	Temperature-linear or special characteristic curve
<b><u>Resistance-based sensor</u></b>	
Measured variable	Ohmic resistance
Sensor type	Resistance-based, potentiometers
Units	$\Omega$
Connection	
• Standard connection	1 resistance-based sensor (R) in 2-wire, 3-wire or 4-wire connection
• Averaging	2 resistance-based sensors in 2-wire connection for averaging
• Differentiation	2 resistance-based sensors in 2-wire connection (R 1 – R 2 or R 2 – R 1)
Connection	
• 2-wire connection	Wire resistance can be configured $\leq 100 \Omega$ (loop resistance)
• 3-wire connection	No trim necessary
• 4-wire connection	No trim necessary
Sensor current	$\leq 0.45$ mA
Response time	$\leq 250$ ms for 1 sensor with break monitoring
Break monitoring	Can be switched off
Short-circuit monitoring	Can be switched off (value is adjustable)
Measuring range	Assignable max. 0 ... 2200 $\Omega$ (see "Digital measuring error" table)
Min. measuring span	5 ... 25 $\Omega$ (see "Digital measuring error" table)
Characteristic curve	Resistance-linear or special characteristic curve
<b><u>Thermocouples</u></b>	
Measured variable	Temperature
Sensor type (thermocouples)	

### Technical specifications (continued)

<b>SITRANS TF, field transmitter</b>	
• Type B	Pt30Rh-Pt6Rh acc. to IEC 584
• Type C	W5%-Re acc. to ASTM 988
• Type D	W3%-Re acc. to ASTM 988
• Type E	NiCr-CuNi acc. to IEC 584
• Type J	Fe-CuNi acc. to IEC 584
• Type K	NiCr-Ni acc. to IEC 584
• Type L	Fe-CuNi acc. to DIN 43710
• Type N	NiCrSi-NiSi acc. to IEC 584
• Type R	Pt13Rh-Pt acc. to IEC 584
• Type S	Pt10Rh-Pt acc. to IEC 584
• Type T	Cu-CuNi acc. to IEC 584
• Type U	Cu-CuNi acc. to DIN 43710
Units	°C or °F
Connection	
• Standard connection	1 thermocouple (TC)
• Averaging	2 thermocouples (TC)
• Differentiation	2 thermocouples (TC) (TC 1 – TC 2 or TC 2 – TC 1)
Response time	≤ 250 ms for 1 sensor with break monitoring
Break 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	Reference junction temperature can be set as fixed value
Measuring range	Assignable (see "Digital measuring error" table)
Min. measuring span	Min. 40 ... 100 °C (72 ... 180 °F) (see "Digital measuring error" table)
Characteristic curve	Temperature-linear or special characteristic curve
<b><u>mV sensor</u></b>	
Measured variable	DC voltage
Sensor type	DC voltage source (DC voltage source possible over externally connected resistance)
Units	mV
Response time	≤ 250 ms for 1 sensor with break monitoring
Break monitoring	Can be switched off
Measuring range	<ul style="list-style-type: none"> <li>• -10 ... +70 mV</li> <li>• -100 ... +1100 mV</li> </ul>
Min. measuring 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 curve
<b>Output</b>	
Output signal	4 ... 20 mA, 2-wire
Communication with SITRANS TH300	According to HART Rev. 5.9
<b>Digital display</b>	
Digital indicator (optional)	In current loop
Display	Max. 5 digits
Digit height	9 mm (0.35")
Display range	-99 999 ... +99 999
Units	Any (max. 5 char.)
Setting:	Using 3 buttons
Zero point, full-scale value and unit	
Load voltage	2.1 V

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#### Technical specifications (continued)

<b>SITRANS TF, field transmitter</b>	
<b>Measuring accuracy</b>	
Digital measuring error	See "Digital measuring error" table
Reference conditions	
• Auxiliary power	24 V ± 1%
• Load	500 Ω
• Ambient temperature	23 °C (73.4 °F)
• Warming-up time	> 5 min
Error in the analog output (digital/analog converter)	< 0.025% of measuring span
Error due to internal reference junction	< 0.5 °C (0.9 °F)
Effect of ambient temperature	
• Analog measuring error	0.02% of measuring span/10 °C (18 °F)
• Digital measuring error	
• 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 measuring span/V
Effect of load impedance	< 0.002% of meas. span/100 Ω
Long-term drift	
• In the first month	< 0.02% of measuring span
• After one year	< 0.2% of measuring span
• After 5 years	< 0.3% of measuring span
<b>Rated conditions</b>	
<b>Ambient conditions</b>	
Ambient temperature	-40 ... +85 °C (-40 ... +185 °F)
Condensation	Permissible
Electromagnetic compatibility	According to EN 61326 and NAMUR NE21
Degree of protection acc. to EN 60529	IP66/67/68
<b>Structural design</b>	
Weight	Approx. 1.5 kg (3.3 lb) without options
Dimensions	See "Dimensional drawings"
Enclosure material	Die-cast aluminum, low in copper, GD-AISI 12 or stainless steel, polyester-based lacquer, stainless steel nameplate
Electrical connection, sensor connection	Screw terminals, cable entry via M20 x 1.5 or ½-14 NPT screw gland
Mounting bracket (optional)	Steel, zinc-plated and chrome-plated or stainless steel
<b>Auxiliary power</b>	
Without digital indicator	11 ... 35 V DC (30 V with Ex ib; 32 V with Ex ic and Ex nA)
With digital indicator	13.1 ... 35 V DC (30 V with Ex ib; 32 V with Ex ic and Ex nA)
Galvanic isolation	Between input and output
• Test voltage	$U_{rms} = 1 \text{ kV}$ , 50 Hz, 1 min
<b>Certificates and approvals</b>	
ATEX explosion protection	
• "Intrinsic safety" type of protection	With digital indicator: <ul style="list-style-type: none"> <li>• II 2 (1) G Ex ib [ia Ga] IIC T4 Gb</li> <li>• II 2 G Ex ib IIC T4 Gb</li> <li>• II 2 D Ex ia IIIC T100°C Db</li> </ul> Without digital indicator: <ul style="list-style-type: none"> <li>• II 2 (1) G Ex ib [ia Ga] IIC T6 Gb</li> <li>• II 2 G Ex ib IIC T6 Gb</li> <li>• II 2 D Ex ia IIIC T100°C Db</li> </ul>
• EC type-examination certificate	ZELM 11 ATEX 0471 X
• "Non-sparking and energy-limited equipment for Zone 2" type of protection	<ul style="list-style-type: none"> <li>• II 3 G Ex ic IIC T6/T4 Gc</li> <li>• II 3 G Ex nA IIC T6/T4 Gc</li> <li>• II 3 G Ex nA [ic] IIC T6/T4 Gc</li> </ul>
• EC type-examination certificate	ZELM 11 ATEX 0471 X

### Technical specifications (continued)

SITRANS TF, field transmitter	
<ul style="list-style-type: none"> <li>• "Flameproof enclosure" type of protection</li> <li>• EC type-examination certificate</li> <li>Explosion protection acc. to FM</li> <li>• Identification (XP, DIP, NI, S)</li> </ul>	<ul style="list-style-type: none"> <li>• II 2 G Ex d IIC T6/T5 Gb</li> <li>• II 2 D Ex tb IIIC T100 °C Db</li> </ul> ZELM 11 ATEX 0472 X Certificate of Compliance 3017742 <ul style="list-style-type: none"> <li>• XP/II/1/BCD/T5 Ta = 85 °C (185 °F), T6 Ta = 60 °C (140 °F), Type 4X</li> <li>• DIP/II, III/1/EFG/T5 Ta = 85 °C (185 °F), T6 Ta = 60 °C (140 °F), Type 4X</li> <li>• NI/II/2/ABCD/T5 Ta = 85 °C (185 °F), T6 Ta = 60 °C (140 °F), Type 4X</li> <li>• S/II, III/2/FG/T5 Ta = 85 °C (185 °F), T6 Ta = 60 °C (140 °F), Type 4X</li> </ul>
Other certificates	EAC Ex, NEPSI, KOSHA
Hardware and software requirements	
<ul style="list-style-type: none"> <li>• For the SIPROM T parameterization software for SITRANS TF with TH200</li> <li>• Personal computer</li> <li>• PC operating system</li> <li>• For the SIMATIC PDM parameterization software for SITRANS TH300</li> </ul>	PC with CD-ROM drive and USB interface Windows 98, NT, 2000, XP, Win 7, 8 and 10 See "Digitalization and Communication" - "SIMATIC PDM"
Communication	
Load for HART connection	230 ... 1100 Ω
• Two-core shielded	≤ 3.0 km (1.86 miles)
• Multi-core shielded	≤ 1.5 km (0.93 mile)
Protocol	HART protocol, version 5.9

#### Factory setting of the transmitter:

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

#### Digital measuring error

##### Resistance thermometer

Input	Measuring range		Minimum measuring span		Digital accuracy	
	°C	(°F)	°C	(°F)	°C	(°F)
<b>According 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>According 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)



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#### Technical specifications (continued)

##### Resistance-based sensor

Input	Measuring range Ω	Minimum measuring span Ω	Digital accuracy Ω
Resistance	0 ... 390	5	0.05
Resistance	0 ... 2200	25	0.25

##### Thermocouples

Input	Measuring range		Minimum measuring span		Digital accuracy	
	°C	°C (°F)	°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	-20 ... +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).

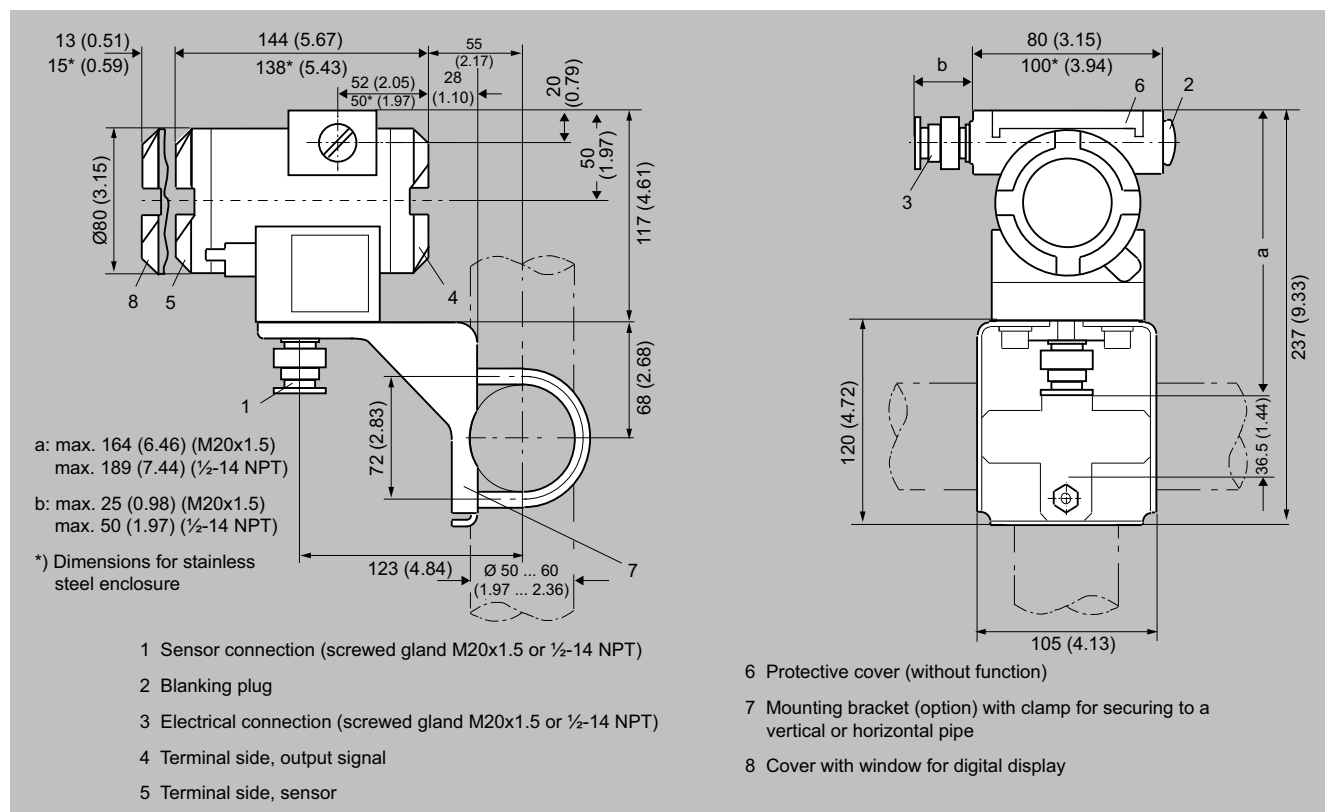
##### mV sensor

Input	Measuring span mV	Minimum measuring span mV	Digital accuracy 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 measuring 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 reference junction errors in the case of thermocouple measurements).

## Dimensional drawings



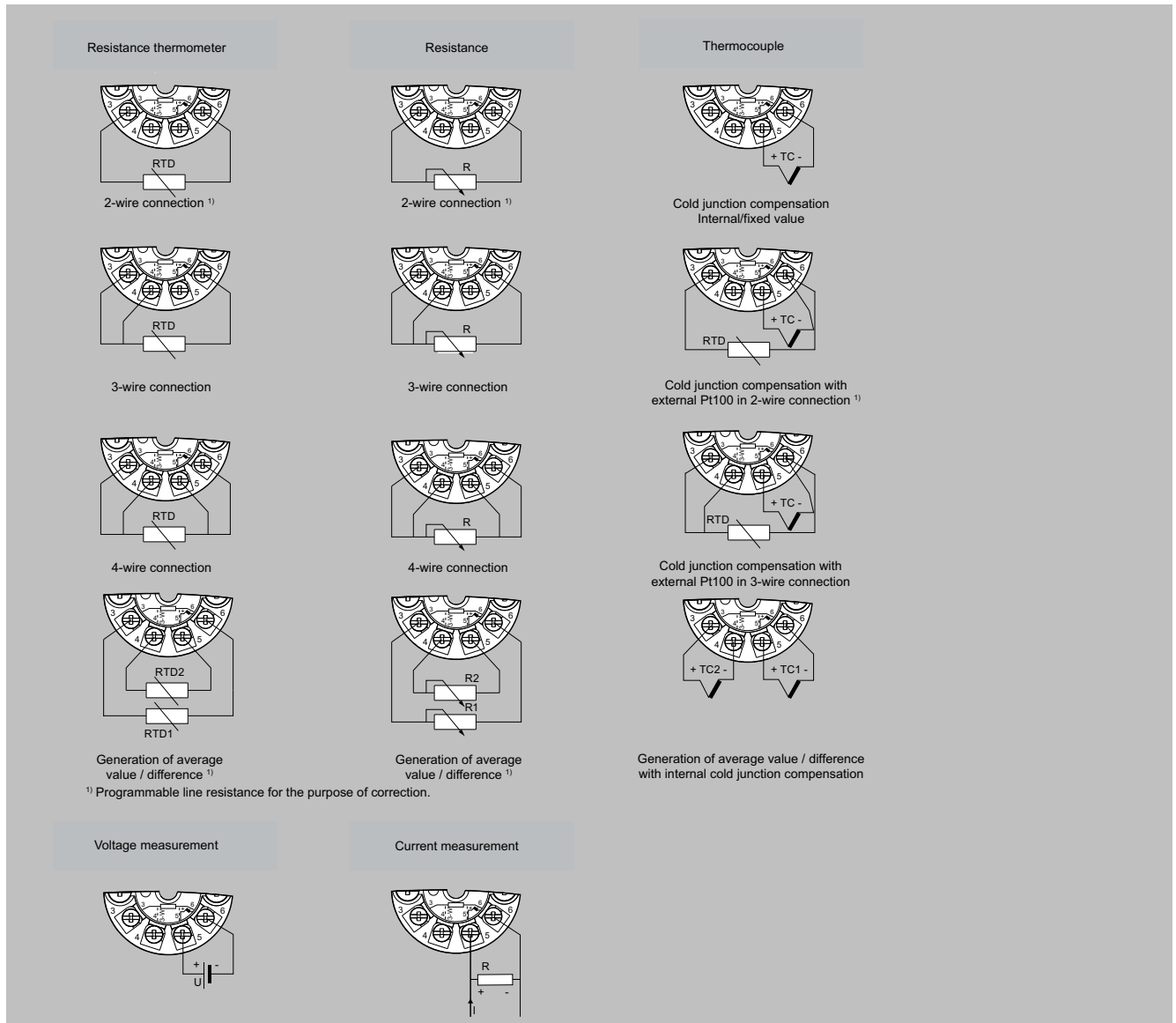
SITRANS TF, dimensions in mm (inch)

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### Field transmitters/field indicator / SITRANS TF field transmitter

#### Circuit diagrams



SITRANS TF, sensor connection assignment