Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Technical Information

Omnigrad T TSC310

Thermocouple thermometer
Can be screwed in or inserted
With fixed connected cable and anti-kink spring

Application

The resistance thermometer is specially suited to temperature measurement in machinery, power stations and plants in gaseous or liquid media like air, steam, water and oil.

Your benefits

- High flexibility through user-specific insertion lengths and variable process connections
- Fast response time
- Different types of thermocouples according to DIN EN 60584 and ASTM E230/ANSI MC96.1:
  - Type J (Fe-CuNi)
  - Type K (NiCr-Ni)
- Types of protection for use in hazardous locations:
  Intrinsic Safety (Ex ia)
  Non-Sparking (Ex nA)
- NEPSI approval (Ex ia)

TI00255T/09/en
71106955

Endress+Hauser
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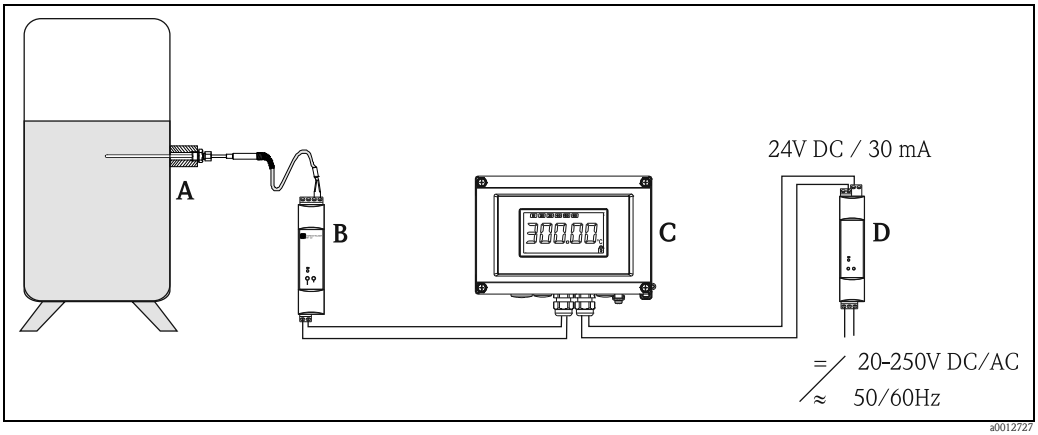
Function and system design

Measuring principle

Thermocouples are comparatively simple, robust temperature sensors which use the Seebeck effect for temperature measurement: if two electrical conductors made of different materials are connected at a point, a weak electrical voltage can be measured between the two open conductor ends if the conductors are subjected to a thermal gradient. This voltage is called thermoelectric voltage or electromotive force (emf.). Its magnitude depends on the type of conducting materials and the temperature difference between the "measuring point" (the junction of the two conductors) and the "cold junction" (the open conductor ends). Accordingly, thermocouples primarily only measure differences in temperature. The absolute temperature at the measuring point can be determined from these if the associated temperature at the cold junction is known or is measured separately and compensated for. The material combinations and associated thermoelectric voltage/ temperature characteristics of the most common types of thermocouple are standardized in the IEC 60584 and ASTM E230/ANSI MC96.1 standards.

Measuring system



Example of an application

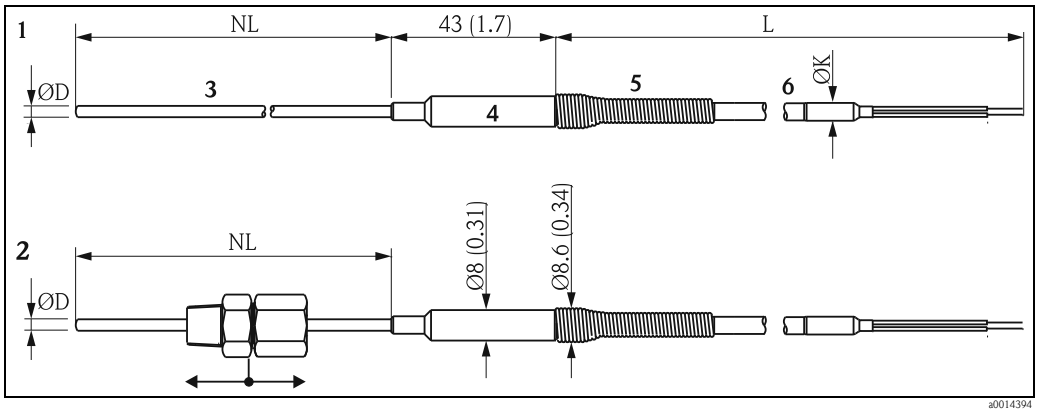
A Built-in thermocouple thermometer TSC310

B Temperature transmitter iTEMP® DIN rail TMT12x. The two-wire transmitter detects the measurement signals of the thermocouple thermometer and converts them into an analog 4 to 20 mA measurement signal.

C RIA16 field display unit
- The display unit measures the analog signal from the transmitter and shows this on the display. The LC display shows the current measured value in digital form and as a bar graph indicating a limit value violation. The display unit is looped into the 4 to 20 mA circuit and gets the required energy from there. More information on this can be found in the Technical Information (see "Documentation").

D Active barrier RN221N
- The RN221N active barrier (24 V DC, 30 mA) has an galvanically isolated output for supplying voltage to loop powered transmitters. The universal power supply works with an input supply voltage of 20 to 250 V DC/AC, 50/ 60 Hz, which means that it can be used in all international power grids. More information on this can be found in the Technical Information (see "Documentation").

Equipment architecture



Design of the Omnigrad T TSC310, dimensions in mm (in)

1 Without process connection
2 With adjustable compression fitting
3 Cable sensor with ØD: 1 mm (0.04 in), 1.5 mm (0.06 in), 2 mm (0.08 in), 3 mm (0.12 in), 4.5 mm (0.18 in) oder 6 mm (0.24 in)
4 Transition sleeve
5 Anti-kink spring, 50 mm (1.97 in)
6 Connecting cable with variable cable diameter ØK, see table 'Connection cable'
L Connection cable length
NL Insertion length

The thermocouple thermometers of the Omnigrad T TSC310 series are designed as cable sensors. The measuring point of the thermocouple is located close to the tip of the insert. The thermocouple wire combinations of iron/cupronickel and nickel-chromium/nickel (thermocouple type J and type K as per IEC 60584 and ASTM E230/ANSI MC96.1) are used as standard. The operating temperature ranges and permissible deviation limits of the thermoelectric voltages from the standard characteristic (→ 🖹 5) vary according to the type of thermocouple used. The sensors are primarily made of a mineral-insulated sheathed cable with thermo wires to which a connection cable (extension cable) is connected via a transition sleeve. The thermometer can be installed using a movable compression. In addition, versions can be delivered for insertion without a special process connection. For detailed process connection versions, see → 🖹 7.

Connection cable (extension cable)

Cable insulation; sheating; leads	Cable diameter ØK in mm (in)
PVC; PVC; 2- or 4-wire	5 (0.2) for 2-wire and 6 (0.24) for 4-wire
Glass fiber; glass fiber; 2- or 4-wire	3.6 (0.14) for 2-wire and 4.1 (0.16) for 4-wire

Measuring range

Input	Designation	Measuring range limits	Min. span
Thermocouples (TC) - flying leads - as per IEC 60584 and ASTM E230/ANSI MC96.1	Type J (Fe-CuNi)	-210 to +760 °C (-346 to 1400 °F), Typical sensitivity above 0 °C ≈ 55 µV/K	-
	Type K (NiCr-Ni)	-270 to +1100 °C (-454 to 2012 °F)[1)], Typical sensitivity above 0 °C ≈ 40 µV/K	-

1) Limited by jacket material of insert

Performance characteristics

Operating conditions

Ambient temperature

The permitted ambient temperature is dependent on the material used for the electrical connecting cable and the cable sheath insulation:

Material Connection cable / sheath insulation	Max. temperature in °C (°F)
PVC / PVC	80 °C (176 °F)
Glass fiber / Glass fiber	400 °C (751 °F)

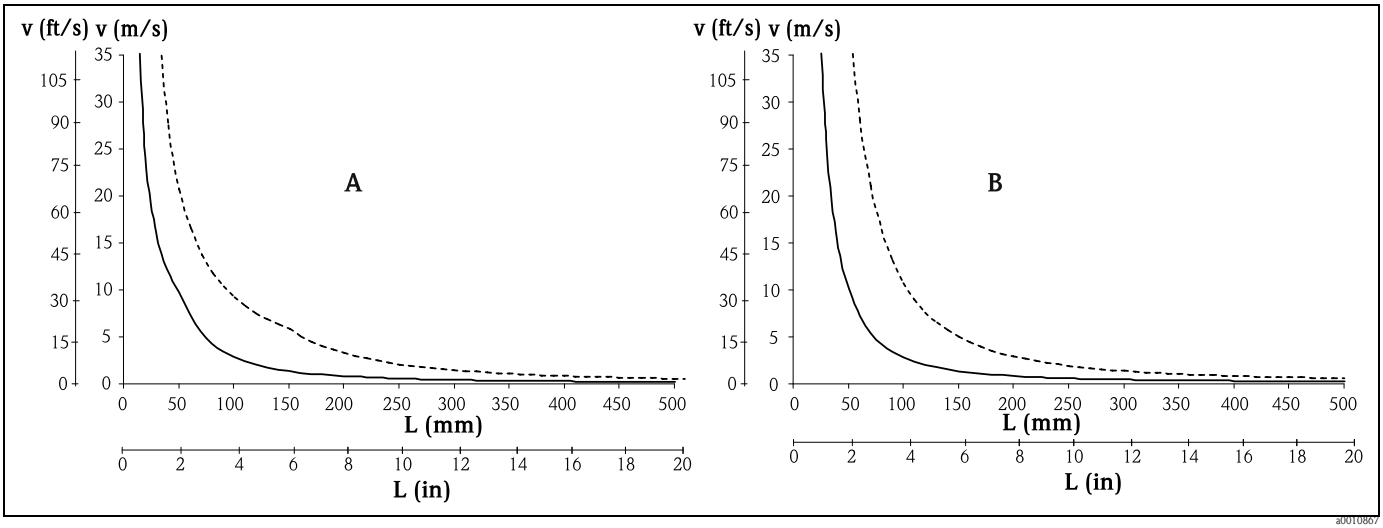
Process pressure

Max. process pressure (static) ≤ 40 bar (580 psi).

Note!
For the maximum permitted process pressures for the respective process connections, refer to the Chapter "Process connection" → 🖹 7.

Permitted flow velocity depending on the immersion length

The highest flow velocity tolerated by the thermometer diminishes with increasing immersion length exposed to the stream of the fluid. In addition it is dependent on the diameter of the thermometer tip, on the kind of measuring medium, on the process temperature and on the process pressure. The following figures exemplify the maximum permitted flow velocities in water and superheated steam at a process pressure of 1 MPa (10 bar = 145 PSI).



Permitted flow velocity
- Insert diameter 3 mm (0.12 in) ————
- Insert diameter 6 mm (0.24 in) - - - - - -

A Medium water at T = 50 °C (122 °F)
B Medium superheated steam at T = 400 °C (752 °F)
L Immersion length
v Flow velocity

Shock and vibration resistance

4g / 2 to 150 Hz as per IEC 60068-2-6

Degree of protection

IP65

Accuracy

Permissible deviation limits of thermoelectric voltages from standard characteristic for thermocouples as per IEC 60584 and ASTM E230/ANSI MC96.1:

Standard	Type	Standard tolerance		Special tolerance (on request)	
IEC 60584		Class	Deviation	Class	Deviation
	J (Fe-CuNi)	2	±2.5 °C (-40 to 333 °C) ±0.0075 |t|[1] (333 to 750 °C)	1	±1.5 °C (-40 to 375 °C) ±0.004 |t|[1] (375 to 750 °C)
	K (NiCr-Ni)	2	±2.5 °C (-40 to 333 °C) ±0.0075 |t|[1] (333 to 1200 °C)	1	±1.5 °C (-40 to 375 °C) ±0.004 |t|[1] (375 to 1000 °C)

Standard	Type	Standard tolerance	Special tolerance (on request)
ASTM E230/ MC 96.1		Deviation, the larger respective value applies	
	J (Fe-CuNi)	±2.2 K or ±0.0075 |t|[1] (0 to 760 °C)	±1.1 K or ±0.004 |t|[1] (0 to 760 °C)
	K (NiCr-Ni)	±2.2 K or ±0.02 |t|[1] (-200 to 0 °C) ±2.2 K or ±0.0075 |t|[1] (0 to 1260 °C)	±1.1 K or ±0.004 |t|[1] (0 to 1260 °C)

1) |t| = Absolute temperature value in °C

Note!
In order to obtain the maximum tolerances in °F, the results in °C must be multiplied by a factor of 1.8.

Response time

Tests in water at 0.4 m/s (1.3 ft/s), according to IEC 60584; 10 K temperature step change:

Cable probe diameter	Response time	
Grounded thermocouple		
6 mm (0.24 in)	t_{50} t_{90}	2 s 5 s
3 mm (0.12 in)	t_{50} t_{90}	0.8 s 2 s
Ungrounded thermocouple		
6 mm (0.24 in)	t_{50} t_{90}	2.5 s 7 s
3 mm (0.12 in)	t_{50} t_{90}	1 s 2.5 s

Note!
Response time for the cable probe without transmitter.

Insulation resistance

Insulation resistance (measured with a voltage of 100 V DC) ≥100 MΩ at ambient temperature.

Calibration specifications

Endress+Hauser provides comparison temperature calibration from -80 to +1400 °C (-110 °F to 2552 °F) based on the International Temperature Scale (ITS90). Calibrations are traceable to national and international standards. The calibration report is referenced to the serial number of the thermometer.

Cable probe Ø: 6 mm (0.24 in) and 3 mm (0.12 in)	Minimum insertion length IL in mm (in)
Temperature range	
-80 °C to -40 °C (-110 °F to -40 °F)	200 (7.87)
-40 °C to 0 °C (-40 °F to 32 °F)	160 (6.3)
0 °C to 250 °C (32 °F to 480 °F)	120 (4.72)
250 °C to 550 °C (480 °F to 1020 °F)	300 (11.81)
550 °C to 1400 °C (1020 °F to 2552 °F)	450 (17.75)

Material

Cable probe and process connection.
The temperatures for continuous operation specified in the following table are only intended as reference values for use of the various materials in air and without any significant compressive load. The maximum operation temperatures are reduced considerably in some cases where abnormal conditions such as high mechanical load occur or in aggressive media. Please observe also the measuring range of the temperature sensor (→ 🖹 3).

Material name	Short form	Recommended max. temperature for continuous use in air	Properties
AISI 316/ 1.4401	X2CrNiMo17-12-2	650 °C (1200 °F)[1)]	■ Austenitic, stainless steel ■ High corrosion resistance in general ■ Particularly high corrosion resistance in chlorine-based and acidic, non-oxidizing atmospheres through the addition of molybdenum (e.g. phosphoric and sulfuric acids, acetic and tartaric acids with a low concentration)
Inconel600/ 2.4816	NiCr15Fe	1100 °C (2012 °F)	■ A nickel/chromium alloy with very good resistance to aggressive, oxidizing and reducing atmospheres, even at high temperatures ■ Resistant to corrosion caused by chlorine gas and chlorinated media as well as many oxidizing mineral and organic acids, sea water etc. ■ Corrosion from ultrapure water ■ Not to be used in a sulfur-containing atmosphere

1) Can be used to a limited extent up to 800 °C (1472 °F) for low compressive loads and in non-corrosive media. Please contact your Endress+Hauser sales team for further information.

Connecting cable insulation

Designation	Features
PVC (polyvinyl chloride)	■ Very good acid resistance ■ High hardness, resistance to inorganic chemicals, particularly acids and alkalis ■ Low impact strength and low temperature stability
Glass fiber	■ Suitable for use in dry environments at high temperatures ■ Non-flammable, no formation of corrosive fumes ■ Only limited tension resistance ■ Fixed or flexible cable installation is generally possible. The cable should no longer be bent following temperature loads above 180 °C ■ Not suitable for constant movements. Avoid buckling at all times

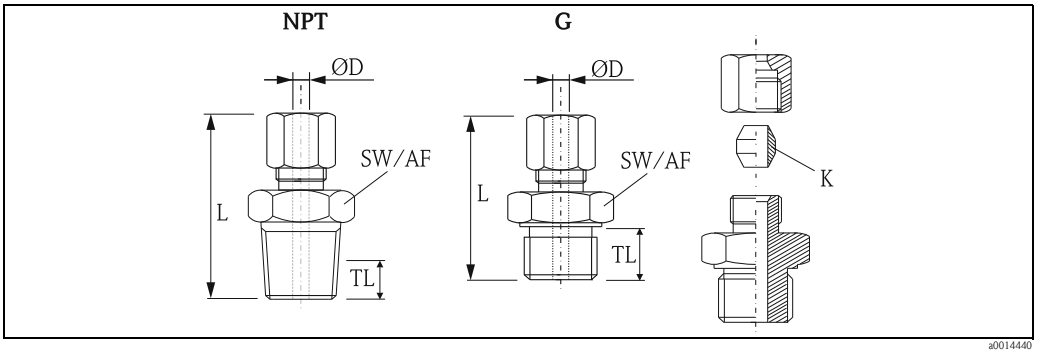
Weight

≥ 100 g (3.53 oz), depending on version, e. g. 150 g (5.3 oz) for version NL = 100 mm (3.93 in) and compression fitting G½".

Components

Process connection

The process connection is the connection between the process and the thermometer. This connection is realized by an adjustable compression fitting. The thermometer is pushed through a gland and fixed using a compression ferrule (K).
SS316-compression ferrule: Can only be used once, the compression fitting cannot be repositioned on the protection tube after loosening. Fully adjustable insertion length on initial installation. Maximum process pressure: 40 bar at 20 °C (580 psi at 68 °F).



Adjustable compression fitting with connection thread as process connection. Dimensions in mm (in).

Type	Connection thread	L in mm (in)	TL in mm (in)	Width across flats SW/AF
Compression fitting	G1/8"	35 (1.38)	10 (0.4)	14
	G¼"	40 (1.57)		19
	G3/8"	45 (1.77)	15 (0.6)	22
	G½"			27
	1/8" NPT	37 (1.45)	4 (0.16)	12
	¼" NPT	40 (1.57)	6 (0.24)	14
	3/8" NPT	50 (1.97)	8 (0.32)	19
	½" NPT			22

Spare parts

Spare part set TA50 compression fitting	Order-No.
∅ 6.1 mm (0.24 in); G¼", G3/8", G½", ¼" NPT, ½" NPT, 3/8" NPT; material ferrule SS 316 (10 pieces)	60011599
∅ 3 mm (0.12 in); G1/8", G¼"; material ferrule SS 316 (10 pieces)	60011575

Wiring

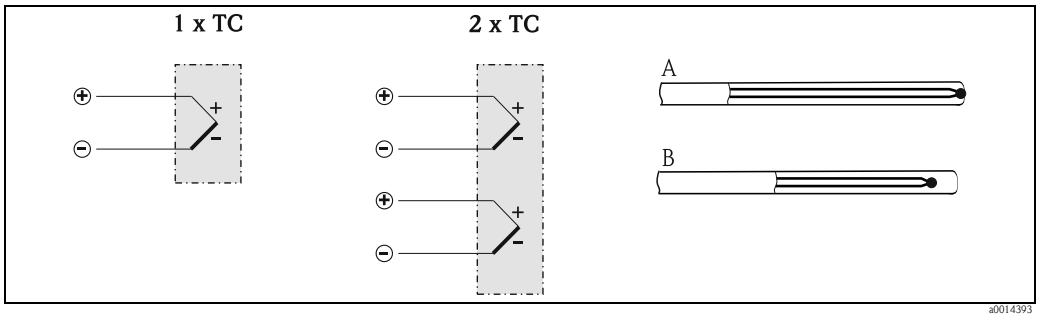
Wiring diagrams

The thermometer is wired with the flying leads of the connection cable. The thermometer can be connected to a separate temperature transmitter, for example.

Cross core-section:
- ≤ 0.205 mm² (AWG 24) for 4-wire connection
- ≤ 0.518 mm² (AWG 20) for 2-wire connection

Thermocouple wire colors

As per IEC 60584	As per ASTM E230/ANSI MC96.1
■ Type J: black (+), white (-) ■ Type K: green (+), white (-)	■ Type J: white (+), red (-) ■ Type K: yellow (+), red (-)



Wiring diagram

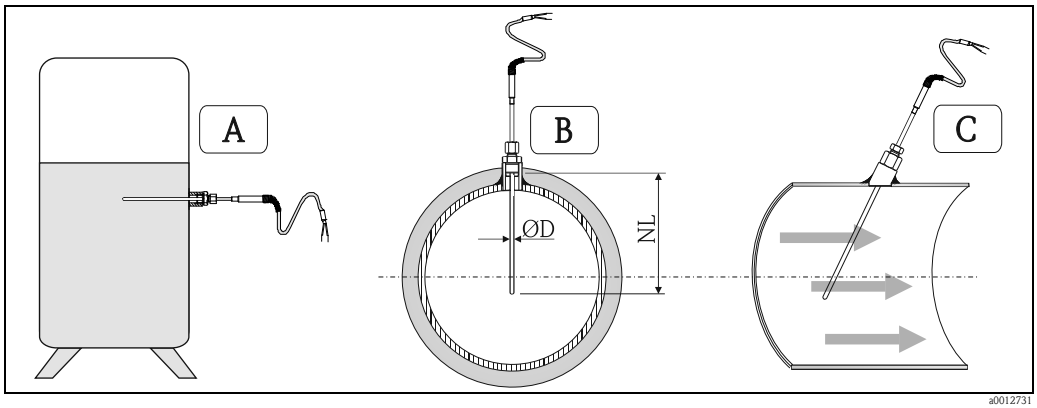
A Grounded hot junction
B Ungrounded hot junction

Installation conditions

Orientation

No restrictions.

Installation instructions



Installation examples

A: Installation in a tank.
B: For pipes with a small cross-section, the sensor tip must reach to the piping axis or a little farther (=NL).
C: Tilted orientation.

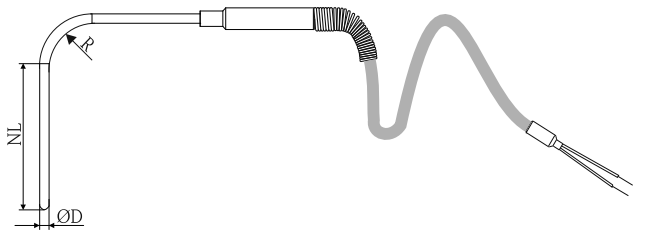
The insertion length of the thermometer can influence the accuracy. If the insertion length is insufficient, heat dissipation via the process connection and the container wall can cause measurement errors. For installation in a pipe, therefore, the recommended insertion length ideally corresponds to half of the pipe diameter (see Figure 'Installation examples', Pos. B).

- Installation possibilities: Pipes, tanks or other plant components
- The insertion length for the bendable version should correspond to at least about ten times the cable sensor diameter (ØD); for the non-bendable version with insulated sensor wires it should correspond to at least about thirty times the cable sensor diameter.
  Example: Diameter 3 mm (0.12 in) x 30 = 90 mm (3.54 in). A standard insertion length of > 60 mm (2.36 in) is recommended for the bendable version and > 180 mm (7.1 in) for the non-bendable version.
- ATEX certification: Observe the installation instructions in the Ex documentation!

Note!
For pipes with small diameters, sometimes only small thermometer insertion lengths are possible. Improvements can be achieved by inserting the thermometer at a tilted installation (see Figure 'Installation examples', Pos. C). To determine the necessary insertion lengths, the parameters of the thermometer and of

the process to be measured must always be taken into consideration (e.g. flow velocity, process pressure). Installation of the thermometer in a thermowell is not recommended.

Bendable cable sensor
Cable sensors with a MgO sheathed cable are bendable, taking into account the minimum dimensions specified in the table.

Bending radius R	
	■ R > 15 mm (0.6 in) for ØD = 3 mm (0.12 in), NL ≥ 25 mm (1 in) ■ R > 30 mm (1.2 in) for ØD = 6 mm (0.24 in), NL ≥ 65 mm (2.56 in)

Certificates and approvals

CE Mark

The device meets the legal requirements of the EC directives if applicable. Endress+Hauser confirms that the device has been successfully tested by applying the CE mark.

Hazardous area approvals

For further details on the available Ex versions (ATEX, CSA, FM, etc.), please contact your nearest Endress+Hauser sales organization. All relevant data for hazardous areas can be found in separate Ex documentation.

Other standards and guidelines

- IEC 60529:
  Degrees of protection by housing (IP-Code).
- IEC 61010-1:
  Safety requirements for electrical measurement, control and laboratory instrumentation.
- IEC 60584 and ASTM E230/ANSI MC96.1:
  Thermocouples
- IEC 61326-1:
  Electromagnetic compatibility (EMC requirements)

PED approval

The thermometer complies with paragraph 3.3 of the Pressure Equipment Directive (97/23/CE) and is not marked separately.

Test report and calibration

The "Factory calibration" is carried out according to an internal procedure in a laboratory of Endress+Hauser accredited by the European Accreditation Organization (EA) to ISO/IEC 17025. A calibration which is performed according to EA guidelines (SIT or DKD calibration) may be requested separately. The entire thermometer – from the process connection to the tip of the thermometer – is calibrated.

Ordering information

Product structure

This information provides an overview of the order options available. The information is not exhaustive, however, and may not be fully up to date. More detailed information is available from your local Endress+Hauser representative.

Thermocouple thermometer TSC310

010	**TC Insert; Diameter; Material:**					
	AN	1x J; 2 mm; 316, -40..750 °C				
	AP	1x J; 3 mm; 316				
	AQ	1x J; 4,5 mm; 316				
	AR	1x J; 6 mm; 316				
	AT	2x J; 2 mm; 316				
	AU	2x J; 3 mm; 316				
	AW	2x J; 4,5 mm; 316				
	AX	2x J; 6 mm; 316				
	BA	1x K; 1,5 mm; INCONEL600, -40..1100 °C				
	BB	1x K; 2 mm; INCONEL600				
	BC	1x K; 3 mm; INCONEL600				
	BD	1x K; 4,5 mm; INCONEL600				
	BE	1x K; 6 mm; INCONEL600				
	BG	2x K; 2 mm; INCONEL600				
	BH	2x K; 3 mm; INCONEL600				
	BK	2x K; 4,5 mm; INCONEL600				
	BL	2x K; 6 mm; INCONEL600				
	BM	1x K; 1,5 mm; 316, -40..800 °C				
	BN	1x K; 2 mm; 316				
	BP	1x K; 3 mm; 316				
	BQ	1x K; 4,5 mm; 316				
	BR	1x K; 6 mm; 316				
	BU	2x K; 3 mm; 316				
	BW	2x K; 4,5 mm; 316				
	BX	2x K; 6 mm; 316				
	B1	1x K; 1 mm; INCONEL600				
	YY	Special version, TSP-no. to be spec.				
020		**Insertion Length NL:**				
		A	100 mm			
		B	250 mm			
		C	350 mm			
		D	150 mm			
		E	300 mm			
		F	500 mm			
		G	800 mm			
		H	1200 mm			
		X	..... mm			
		Y	..... Special version, TSP-No. to be specified			
030			**Hot Junction; Approval:**			
			E	ungrounded, ATEX II1/2D Ex iaD,1G Ex ia IIC		
			G	grounded		
			H	grounded; ATEX II 1 G Ex ia IIC		
			I	grounded; ATEX II 3 GD Ex nA II		
			J	ungrounded		
			K	ungrounded; ATEX II 1 G Ex ia IIC		
			L	ungrounded; ATEX II 3 GD Ex nA II		
			M	grounded; NEPSI Ex ia IIC T6		
			N	ungrounded; NEPSI Ex ia IIC T6		
			O	grounded; IECEx Ga Ex ia IIC T6		
			P	ungrounded; IECEx Ga Ex ia IIC T6		
040				**TC Standard; Class; Purity:**		
				1	IEC60584; class 2; standard	
				2	ANSI MC96.1; standard; standard	
				9	Special version, TSP-No. to be specified	
050					**Thermocouple; Extension:**	
					1	Type J; glass fiber, ANSI MC96.1
					2	Type K, glass fiber, ANSI MC96.2

050	**Thermocouple; Extension:**	
	3	Type J, glass fiber, IEC584-2
	4	Type K, glass fiber, IEC584-2
	5	Type K, PVC blue, IEC584-2
	9	Special version, TSP-No. to be specified
060	**Length ExtensionL:**	
	1	1000 mm
	2	2000 mm
	3	3500 mm
	4	4000 mm
	8	..... mm
	9	..... mm, Special version, TSP-No. to be specified
070	**Compression Fitting; Material Ferrule:**	
	A	Not needed
	B	1/8" NPT; 316
	C	¼" NPT; 316
	D	3/8" NPT; 316
	E	½" NPT; 316
	F	G1/8"; 316
	G	G¼"; 316
	H	G3/8"; 316
	J	G½"; 316
	Y	Special version, TSP-No. to be specified
995	**Marking:**	
	TAG	Tagging (TAG)
TSC310-		**← Order code (complete)**

Documentation

Hazardous area supplementary documentation:
- RTD/TC Thermometer Omnigrad TRxx, TCxx, TSTxxx, TxCxxx ATEX II3GD (XA044r/09/a3)
- RTD/TC inserts and cable thermometers Omniset TPR100, TPC100, TST310, TSC310 ATEX II1GD or II 1/2GD (XA087r/09/a3)

Application example

Technical Information:
- Temperature transmitter:
  – iTEMP® HART® DIN rail TMT122 (TI090r/09/en)
  – iTEMP® PCP DIN rail TMT121 (TI087r/09/en)
- Field display RIA16 (TI144r/09/en)
- Active barrier with power supply RN221N (TI073r/09/en)

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People for Process Automation

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