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71490614
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Technical Information
TSC310

Thermocouple thermometer

Screw-in or insertion version
With connecting cable and anti-kink spring

Application

Suitable for temperature measurement in machinery, power stations and plants with gaseous or liquid media such as air, steam, water and oil.

Your benefits

- High degree of flexibility thanks to 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:
  - Intrinsically safe (Ex ia)
  - Non-sparking (Ex nA)
- NEPSI approval (Ex ia)

Endress+Hauser
People for Process Automation

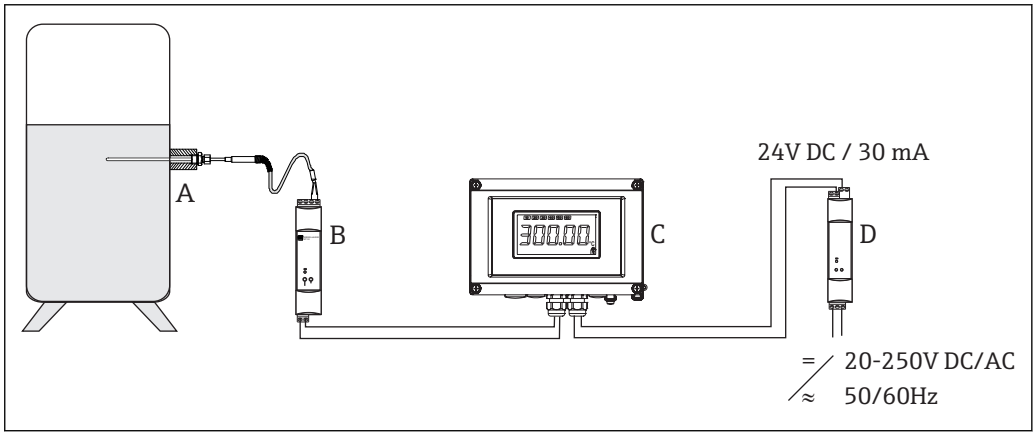
Table of contents

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 still 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



1 Application example

A Installed thermocouple thermometer TSC310

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

C RIA16 field indicator - The indicator records the analog measuring signal from the temperature transmitter and shows it 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 indicator 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 a galvanically isolated output for powering 2-wire 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").

Input

Measuring range

Input	Designation	Measuring range limits
Thermocouples (TC) according to IEC 60584 and ASTM E230/ANSI MC96.1	Type J (Fe-CuNi)	−210 to +760 °C (−346 to 1 400 °F), typical sensitivity above 0 °C ≈ 55 µV/K
	Type K (NiCr-Ni)	−270 to +1 100 °C (−454 to 2 012 °F) [1], typical sensitivity above 0 °C ≈ 40 µV/K

1) Limited by jacket material of insert

Wiring

Wiring diagram

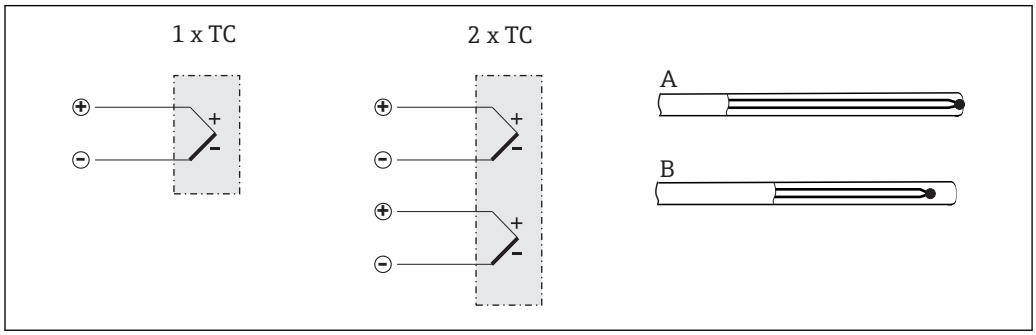
The thermometer is wired with the flying leads of the connection cable. The thermometer can be connected to a separate temperature transmitter, for example.

Wire cross-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 (-)



2 Wiring diagram

A Grounded connection
B Ungrounded connection

Performance characteristics

Maximum measured error

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)

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

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

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 were performed in water at 0.4 m/s (according to IEC 60584) and with a 10 K temperature step change:

Cable sensor diameter	Response time	
Grounded thermocouple		
6 mm (0.24 in)	t_{50}	2 s
	t_{90}	5 s
3 mm (0.12 in)	t_{50}	0.8 s
	t_{90}	2 s
Ungrounded thermocouple		
6 mm (0.24 in)	t_{90}	2.5 s
	t_{50}	7 s
3 mm (0.12 in)	t_{50}	1 s
	t_{90}	1.5 s

Response time for TC cable sensor without transmitter.

Insulation resistance

Insulation resistance (at 100 V DC) ≥1000 MΩ at ambient temperature.

Calibration

Endress+Hauser offers a calibration at a reference temperature of −80 to +1 400 °C (−110 to 2 552 °F) based on the International Temperature Scale (ITS90). Calibrations are traceable to national and international standards. The calibration certificate is referenced to the serial number of the thermometer.

Cable sensor: Ø6 mm (0.24 in) and Ø3 mm (0.12 in)	Minimum insertion length of cable sensor
Temperature range	
−80 to −40 °C (−110 to −40 °F)	No minimum immersion length required
−40 to 0 °C (−40 to 32 °F)	
0 to 250 °C (32 to 480 °F)	
250 to 550 °C (480 to 1 020 °F)	300 mm (11.81 in)
550 to 1 400 °C (1 020 to 2 552 °F)	450 mm (17.72 in)

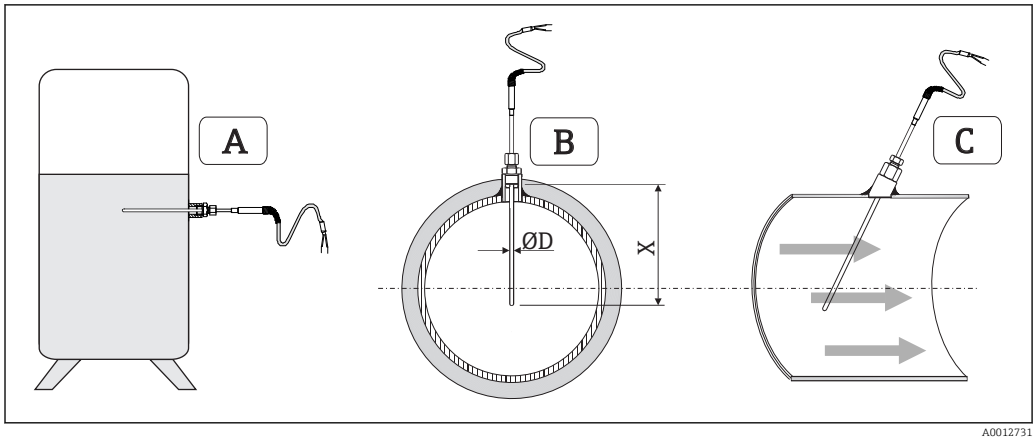
Installation

Installation conditions

Orientation

No restrictions.

Installation instructions



3 Installation examples

A Installation in a tank
B In the case of cables with a small cross-section, the sensor tip must reach as far as the pipe axis or a little farther (=X)
C Installation at an angle

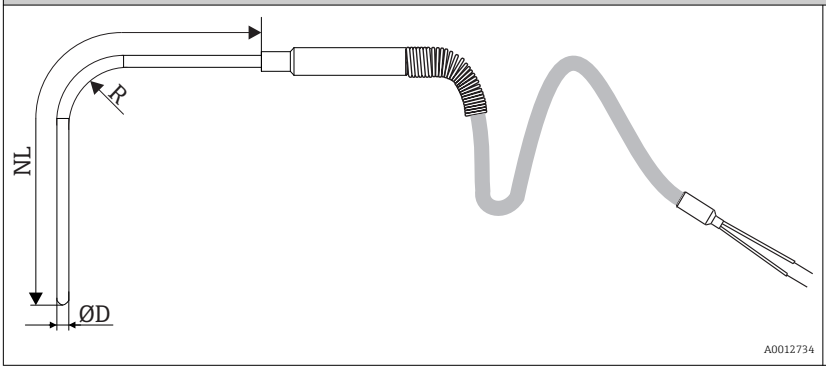
The immersion length of the thermometer can influence the accuracy. If the immersion length is too small, errors in the measurement can be caused by heat conduction via the process connection and the vessel wall. If installing in a pipe, therefore, the immersion length should ideally be half of the pipe diameter (see Figure "Installation examples", item B).

- Installation possibilities: Pipes, tanks or other plant components
- The insertion length should correspond to at least about 10 times the cable sensor diameter (ØD) in the case of the bendable version, and to at least about 30 times the cable sensor diameter in the case of the non-bendable version. 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!

For pipes with small diameters, sometimes only small thermometer insertion lengths are possible. Improvements can be achieved by installing the thermometer at an angle (see Figure "Installation examples", item C). The parameters of the thermometer and of the process to be measured (e.g. flow velocity, process pressure) must always be taken into consideration when determining the necessary insertion lengths. Installation of the thermometer in a thermowell is not recommended.

Bendable cable sensor

Cable sensors with an MgO tube are bendable, taking into account the minimum dimensions specified in the table.

Bending radius R	
	R >15 mm (0.6 in) with ØD = 3 mm (0.12 in), NL ≥ 25 mm (1 in)

Environment

Ambient temperature range

The permitted ambient temperature depends on the material used for the electrical connecting cable and the connecting cable insulation:

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

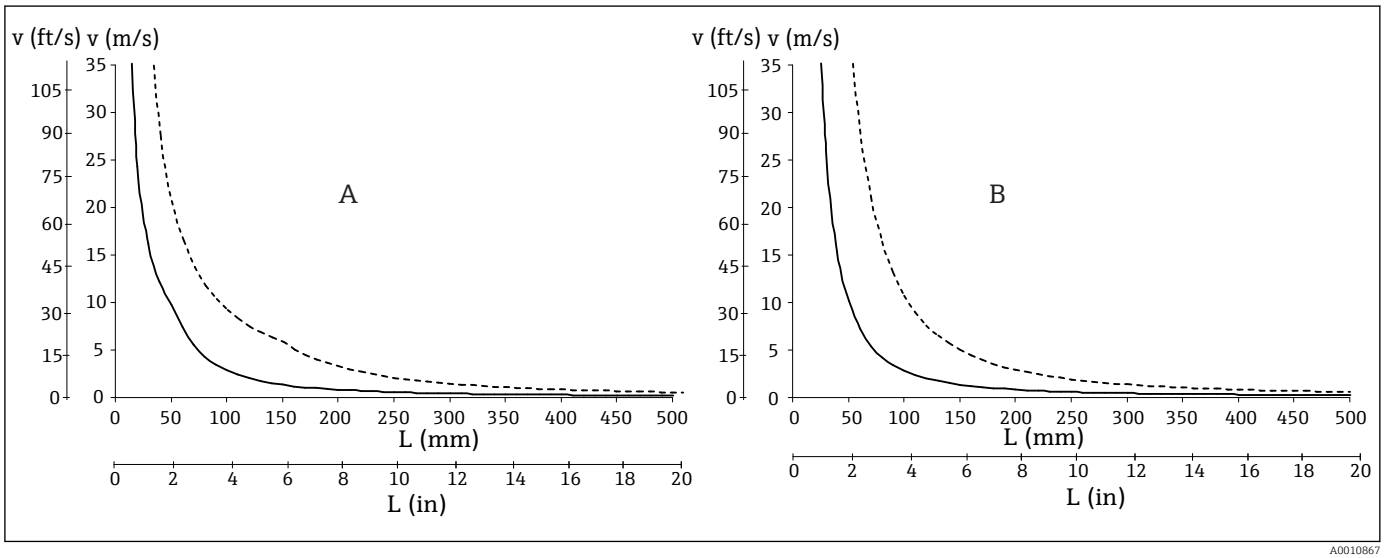
Process pressure

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

Information on the maximum permitted process pressures for the individual process connections is provided in the "Process connection" section → 9.

Permitted flow velocity depending on the immersion length

The highest flow velocity tolerated by the thermometer diminishes with increasing sensor immersion length exposed to the stream of the fluid. The flow velocity is also dependent on the diameter of the thermometer tip, the type of medium being measured, the process temperature and 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).



4 *Permitted flow velocity: Ø 3 mm (0.12 in) (solid line), Ø 6 mm (0.24 in) (dashed line)*

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

Degree of protection

Vibration- and shock-resistance

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

Degree of protection

IP65

Process

Process pressure range

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

For information on the maximum permitted process pressures for the individual process connections, see the "Process connection" section → 9.

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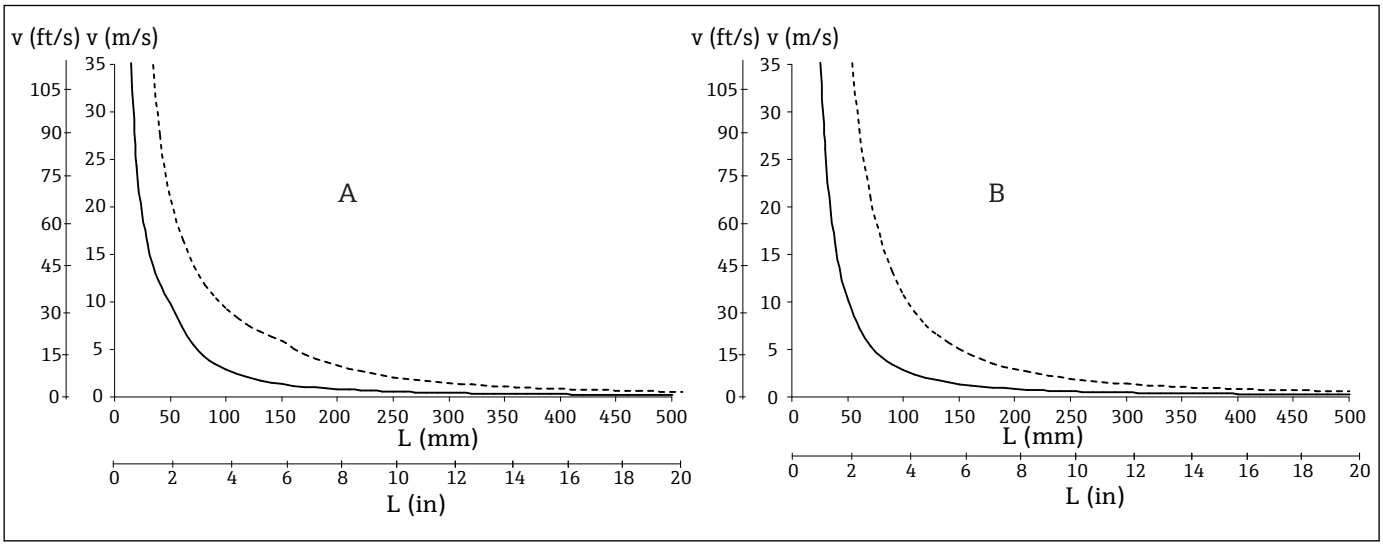
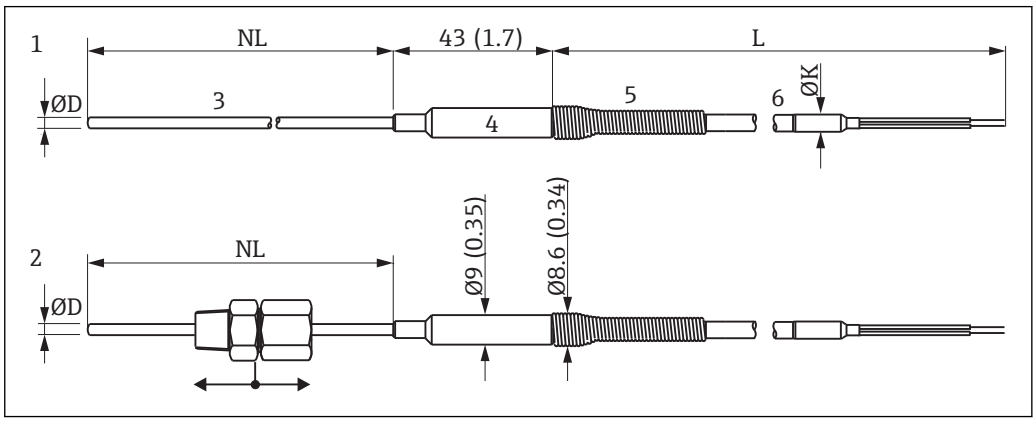


5 Permitted flow velocity: Ø 3 mm (0.12 in) (solid line), Ø 6 mm (0.24 in) (dashed line)

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

Mechanical construction

Design



6 Design of TSC310, dimensions in mm (in)

1 Without process connection
2 With adjustable compression fitting
3 ØD, depending on the design: 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)or 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 'Connecting cable' table
L Length of connecting cable
NL Insertion length

The thermocouple thermometers of the 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/copper-nickel 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 (→ 4) vary depending on type of thermocouple used. The sensors are primarily made of a mineral-insulated tube with thermocouple wires to which a connecting cable (thermocouple cable) is connected via a transition sleeve. The thermometer can be installed using a movable compression fitting. In addition, the insertion version can be supplied without a special process connection. For detailed information on the process connections, see → 9.

Connecting cable (thermocouple cable)

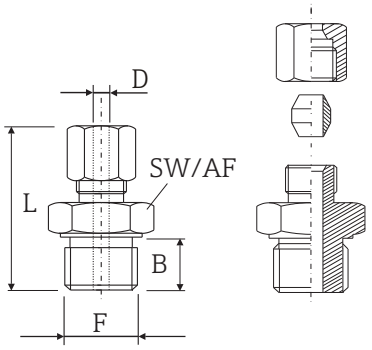
Cable insulation; sheathing; connecting wires	Cable diameter ØK in mm (in)
PVC; PVC; 2-wire or 4-wire	5 (0.2) for 2-wire and 6 (0.24) for 4-wire
Glass fiber; glass fiber; 2-wire or 4-wire	3.6 (0.14) for 2-wire and 4.1 (0.16) for 4-wire

Process connection

The process connection refers to the connection between the thermometer and the process. This connection is realized by the connection thread on an adjustable compression fitting. Here, the thermometer is pushed through a gland and fixed using a clamping ring (K). SS316 clamping ring: Can only be used once; the position of the compression fitting cannot be changed once it has been

installed. Fully adjustable insertion length on initial installation. Maximum process pressure: 40 bar at 20 °C (580 psi at 68 °F).

Process connection
Threaded compression fitting (TA50)



Version	F in mm (in)		L in mm (in)	B in mm (in)	Clamping ring material
TA50	G1/8"	SW/AF 14	35 mm (13.8 in)	10 mm (3.9 in)	SS316 [1]
	G¼"	SW/AF 19	40 mm (15.7 in)	10 mm (3.9 in)	SS316 [1]
	G3/8"	SW/AF 22	45 mm (17.7 in)	15 mm (5.9 in)	SS316 [1]
	G½"	SW/AF 27	45 mm (17.7 in)	15 mm (5.9 in)	SS316 [1]
	NPT1/8"	SW/AF 12	35 mm (13.8 in)	4 mm (1.6 in)	SS316 [1]
	NPT¼"	SW/AF 14	40 mm (15.7 in)	6 mm (2.3 in)	SS316 [1]
	NPT3/8"	SW/AF 19	45 mm (17.7 in)	6 mm (2.3 in)	SS316 [1]
	NPT½"	SW/AF 22	50 mm (19.7 in)	8 mm (3.1 in)	SS316 [1]

1) SS316 clamping ring: Can only be used once. Once released the compression fitting cannot be repositioned on the thermowell. Fully adjustable immersion length on initial installation

Materials

Cable sensors 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 operating temperatures are reduced considerably in cases where process conditions such as high mechanical load occur or in aggressive media. The measuring range of the cable sensor must also be observed (→ 🖹 3).

Designation	Short formula	Recommended max. temperature for continuous use in air	Features
AISI 316/ 1.4401	X5CrNiMo17-12-2	650 °C (1 200 °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)
Alloy600/ 2.4816	NiCr15Fe	1 100 °C (2 012 °F)	▪ A nickel/chromium alloy with very good resistance to aggressive, oxidizing and reducing atmospheres, even at high temperatures ▪ Resistance to corrosion caused by chlorine gases and chlorinated media as well as many oxidizing mineral and organic acids, sea water etc. ▪ Corrosion from ultrapure water ▪ Not to be used in sulfur-containing atmospheres

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 resistant to acid ▪ High degree of 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 the version, e.g. 150 g (5.3 oz) for version NL = 100 mm (3.93 in) and compression fitting G½".

Spare parts

Spare part	Order No.
Ø6.1 mm (0.24 in); G¼", G3/8", G½", ¼" NPT, ½" NPT, 3/8" NPT; material of clamping ring SS 316 (10 pieces)	60011599
Ø3 mm (0.12 in); G1/8", G¼"; material of clamping ring SS 316 (10 pieces)	60011575

Certificates and approvals

CE mark

The product meets the requirements of the harmonized European standards. As such, it complies with the legal specifications of the EC directives. The manufacturer confirms successful testing of the product by affixing to it the CE-mark.

Ex approvals

More information on the hazardous area versions currently available (ATEX, FM, CSA, etc.) is available from your Endress+Hauser sales center. Separate Ex documentation contain all the data relevant for explosion protection.

Other standards and guidelines

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

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

Detailed ordering information is available for your nearest sales organization www.addresses.endress.com or in the Product Configurator under www.endress.com :

1. Click Corporate
2. Select the country
3. Click Products
4. Select the product using the filters and search field
5. Open the product page

The Configuration button to the right of the product image opens the Product Configurator.

Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Supplementary documentation

Supplementary ATEX documentation:
RTD/TC thermometer 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)
- Temperature transmitter iTEMP PCP DIN rail TMT121 (TI087r/09/en)
- Field indicator RIA16 (TI144r/09/en)
- Active barrier RN221N (TI073r/09/en)