

Technical Information

Omnigrad TST90, TET90

Resistance thermometer and insert for thermal energy measurement



High-precision measurement of temperature differences with matched sensor pairs

Application

- Universally usable for thermal energy measurements
- Measuring range: -200 to 600 °C (-328 to 1112 °F)
- Sensors in matched pairs within the range:
 - 0 to 120 °C (± 0.05 K)
 - -40 to 0 °C (± 0.1 K)
- Protection class: up to IP68

Your benefits

- Fast replaceability of the insert
- High degree of insert compatibility and design as per DIN 43772
- Fast response time with reduced tip

Function and system design

Measuring principle

Resistance thermometer (RTD)

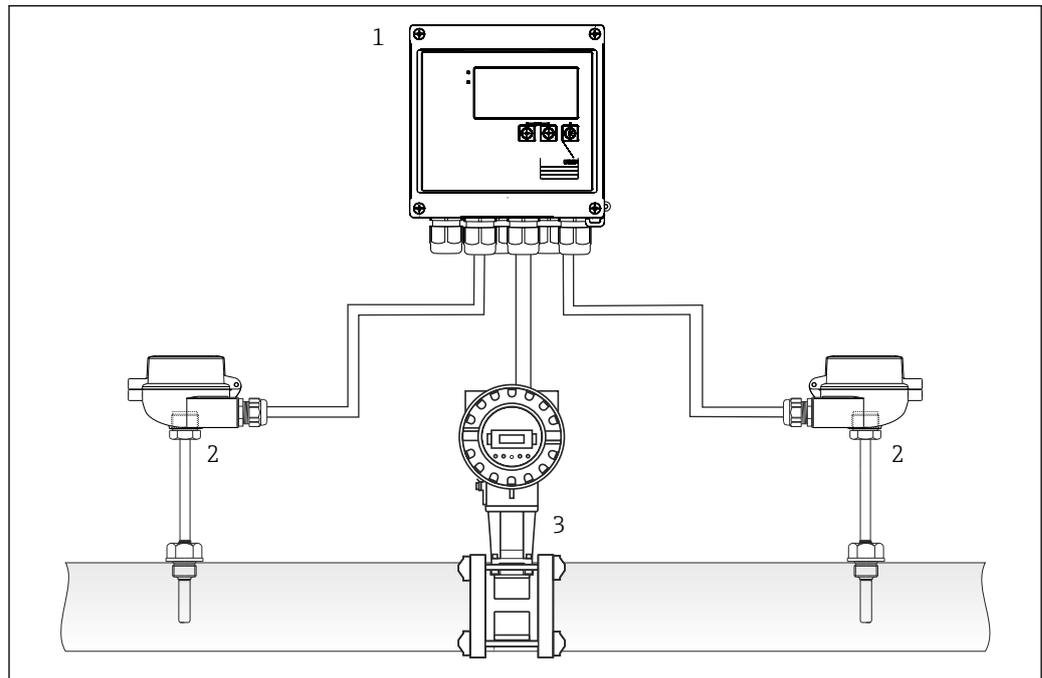
These resistance thermometers use a Pt100 temperature sensor according to IEC 60751. The temperature sensor is a temperature-sensitive platinum resistor with a resistance of 100 Ω at 0 °C (32 °F) and a temperature coefficient $\alpha = 0.003851 \text{ } ^\circ\text{C}^{-1}$.

There are generally two different kinds of platinum resistance thermometers:

- **Wire wound (WW):** Here, a double coil of fine, high-purity platinum wire is located in a ceramic support. This is then sealed top and bottom with a ceramic protective layer. Such resistance thermometers not only facilitate very reproducible measurements but also offer good long-term stability of the resistance/temperature characteristic within temperature ranges up to 600 °C (1 112 °F). This type of sensor is relatively large in size and it is comparatively sensitive to vibrations.
- **Thin film platinum resistance thermometers (TF):** A very thin, ultrapure platinum layer, approx. 1 μm thick, is vaporized in a vacuum on a ceramic substrate and then structured photolithographically. The platinum conductor paths formed in this way create the measuring resistance. Additional covering and passivation layers are applied and reliably protect the thin platinum layer from contamination and oxidation, even at high temperatures.

The primary advantages of thin film temperature sensors over wire wound versions are their smaller sizes and better vibration resistance. A relatively low principle-based deviation of the resistance/temperature characteristic from the standard characteristic of IEC 60751 can frequently be observed among TF sensors at high temperatures. As a result, the tight limit values of tolerance category A as per IEC 60751 can only be observed with TF sensors at temperatures up to approx. 300 °C (572 °F). For this reason, thin-film sensors are generally only used for temperature measurements in ranges below 400 °C (932 °F).

Measuring system

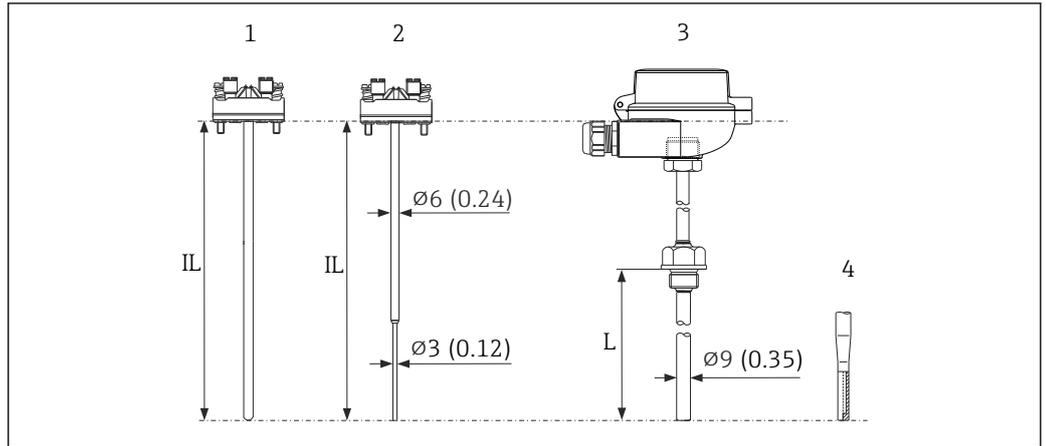


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1 Application example

- 1 EngyCal® - The BTU meter is used to measure the heat and cold in systems with liquid heat transfer fluids. It is easy to install and read. Thanks to its verified long-term stability and high-precision measurements, the device helps optimize processes and control costs in the process. More information on this can be found in the Technical Information ([→ 13](#)).
- 2 Mounted thermometers TST90
- 3 Flow meter

Design



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2 Design

- 1 Insert with mounted ceramic connection socket (example with $\phi 6$ mm (0.24 in))
- 2 Insert with reduced tip and mounted ceramic connection socket
- 3 Thermometer with terminal head
- 4 Reduced tip
- IL Total length of insert
- L Thermometer immersion length

Measurement range

- RTD: -200 to 600 °C (-328 to 1112 °F)
- Sensors in matched pairs within the range:
 - 0 to 120 °C (± 0.05 K)
 - -40 to 0 °C (± 0.1 K)

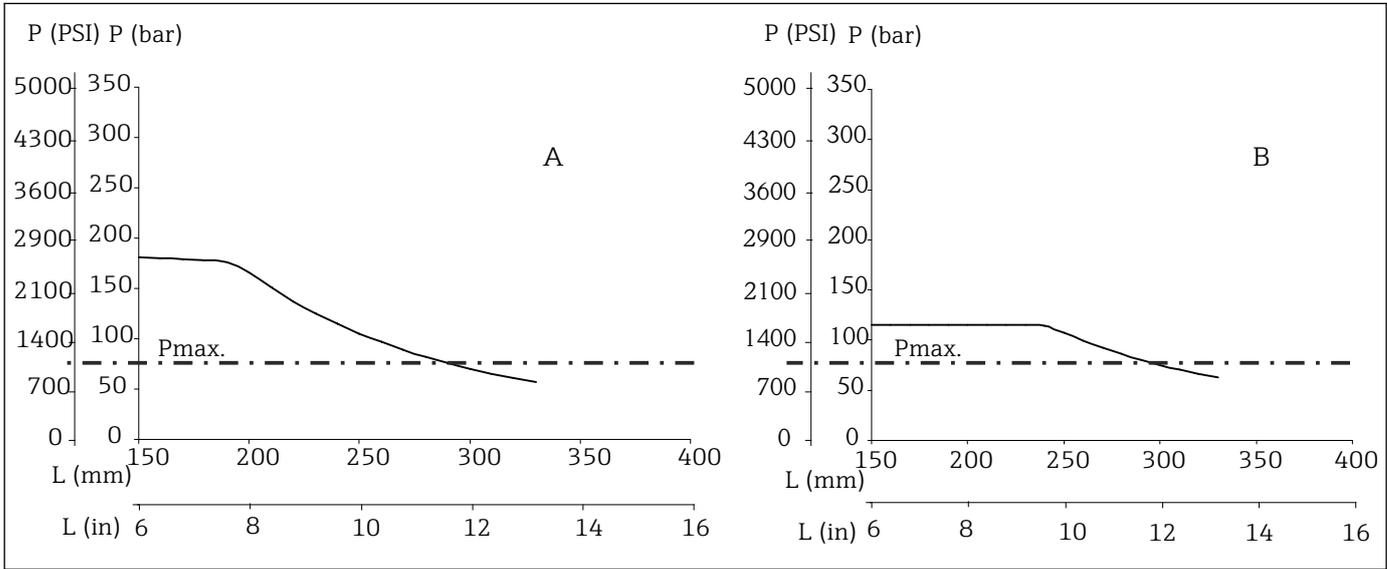
Performance characteristics

Sensor technology,
measurement range

Sensor type Pt100 (TF)	Tolerance	Measurement range	Connection type
Matched sensor pairs	±0.05 K	0 to 120 °C (32 to 248 °F)	2- or 4-wire
	±0.1 K	-40 to 0 °C (-40 to 32 °F)	4-wire

Process pressure

The pressure values to which the actual thermowell can be subjected at the various temperatures and maximum permitted flow velocity are illustrated by the figure below. Occasionally, the pressure loading capacity of the process connection can be considerably lower. The maximum allowable process pressure for a specific thermometer is derived from the lower pressure value of the thermowell and process connection.

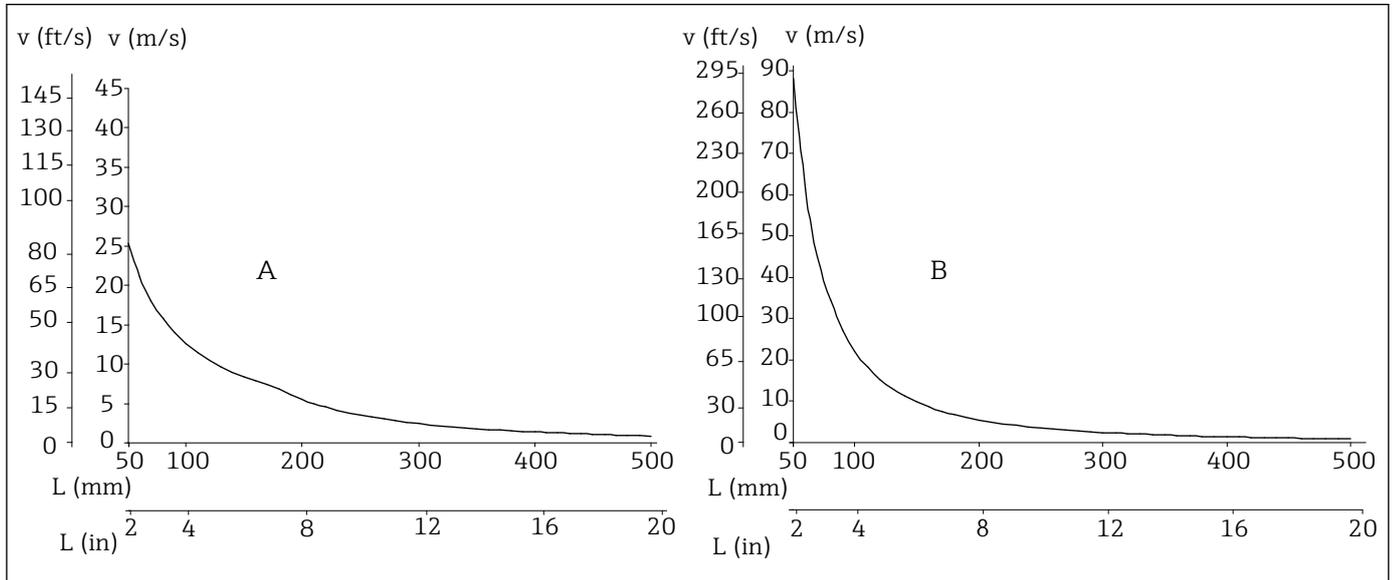


3 Maximum permitted process pressure for tube diameter, limited to 75 bar (1088 psi) by the threaded process connection

- A Medium water at T = 50 °C (122 °F)
- B Medium superheated steam at T = 400 °C (752 °F)
- L Immersion length
- P Process pressure
- Pmax. Maximum permitted process pressure, limited by the process connection
- Thermowell diameter 9 x 1 mm (0.35 in)

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 5 MPa (50 bar).



4 Maximum flow velocity

- 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
- Thermowell diameter 9 x 1 mm (0.35 in)

Shock and vibration resistance

The Endress+Hauser inserts exceed the IEC 60751 requirements stating a shock and vibration resistance of 3 g within a range of 10 to 500 Hz.

Accuracy RTD resistance thermometer as per IEC 60751

Class	Max. tolerances (°C)	Temperature range	Characteristics
RTD max. error type TF - range: -50 to +500 °C			
Cl. AA, former 1/3 Cl. B	$\pm (0.1 + 0.0017 \cdot t ^{1.1})$	0 to +150 °C	
Cl. A	$\pm (0.15 + 0.002 \cdot t ^{1.1})$	-30 to +300 °C	
Cl. B	$\pm (0.3 + 0.005 \cdot t ^{1.1})$	-50 to +500 °C	
RTD maximum error type WW - range: -196 to +600 °C			
Cl. AA, former 1/3 Cl. B	$\pm (0.1 + 0.0017 \cdot t ^{1.1})$	-50 to +250 °C	
Cl. A	$\pm (0.15 + 0.002 \cdot t ^{1.1})$	-100 to +450 °C	
Cl. B	$\pm (0.3 + 0.005 \cdot t ^{1.1})$	-196 to +600 °C	

1) |t| = absolute value °C

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

Response time

Calculated at an ambient temperature of approx. 23 °C by immersing in running water (0.4 m/s flow rate, 10 K excess temperature):

Type	t _(x)	Straight tip	Reduced tip
Resistance thermometer (measuring probe Pt100, TF/ WW)	t ₅₀	18 s	11 s
	t ₉₀	55 s	37 s
Insert TET90	t ₅₀	2.5 s	2 s
	t ₉₀	5.5 s	5 s

Insulation resistance

Insulation resistance according to IEC 60751 > 100 MΩ at 25 °C between terminals and sheath material measured with a minimum test voltage of 100 V DC.

Self heating

RTD elements are passive resistances that are measured using an external current. This measurement current causes a self-heating effect in the RTD element itself which in turn creates an additional measurement error. In addition to the measurement current, the size of the measurement error is also affected by the temperature conductivity and flow velocity of the process. This self-heating error is negligible when an Endress+Hauser iTEMP® temperature transmitter (very small measurement current) is connected.

Calibration

Endress+Hauser provides comparison temperature calibration from -80 to +600 °C (-110 to +1 112 °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. Only the insert is calibrated.

Insert: Ø6 mm (0.24 in) and 3 mm (0.12 in)	Minimum insertion length of insert in mm (in)	
	without head transmitter	with head transmitter
Temperature range		
-80 to -40 °C (-110 to -40 °F)	200 (7.87)	
-40 to 0 °C (-40 to 32 °F)	160 (6.3)	
0 to 250 °C (32 to 480 °F)	120 (4.72)	150 (5.91)
250 to 550 °C (480 to 1 020 °F)	300 (11.81)	
550 to 650 °C (1 020 to 1 202 °F)	400 (15.75)	

Material

Extension neck and thermowell

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.

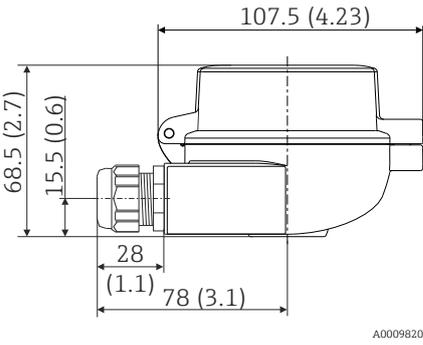
Material name	Short form	Recommended max. temperature for continuous use in air	Properties
AISI 316Ti/ 1.4571	X6CrNiMoTi17-12-2	700 °C (1 292 °F) ¹⁾	<ul style="list-style-type: none"> ▪ Properties comparable to AISI316L ▪ Addition of titanium means increased resistance to intergranular corrosion even after welding ▪ Broad range of uses in the chemical, petrochemical and oil industries as well as in coal chemistry ▪ Can only be polished to a limited extent, titanium streaks can form

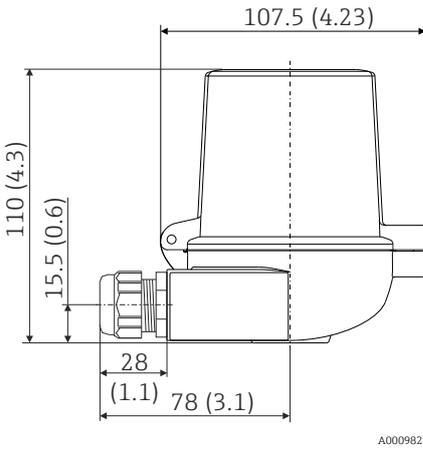
1) Can be used to a limited extent up to 800 °C (1472 °F) for low compressive loads and in non-corrosive media. Please contact your Endress+Hauser sales team for further information.

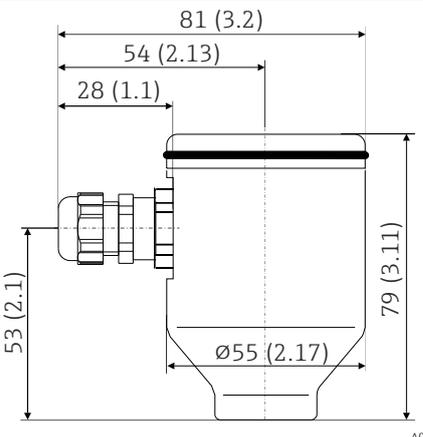
Components

Terminal heads

All terminal heads have an internal shape and size in accordance with DIN EN 50446, flat face and a thermometer connection of M24x1.5, G1/2" or 1/2" NPT thread. All dimensions in mm (in). The cable glands in the diagrams correspond to M20x1.5 connections. Specifications without head transmitter installed. For ambient temperatures with head transmitter installed, see "Operating conditions" section.

TA30A	Specification
	<ul style="list-style-type: none"> ▪ Available with one or two cable entries ▪ Protection class: IP66/68 (NEMA Type 4x encl.) ▪ Temperature: -50 to +150 °C (-58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated ▪ Seals: silicone ▪ Threaded cable entry: G 1/2", 1/2" NPT and M20x1.5; ▪ Protection armature connection: M24x1.5 ▪ Head color: blue, RAL 5012 ▪ Cap color: gray, RAL 7035 ▪ Weight: 330 g (11.64 oz) ▪ Ground terminal, internal and external ▪ 3-A[®] marked

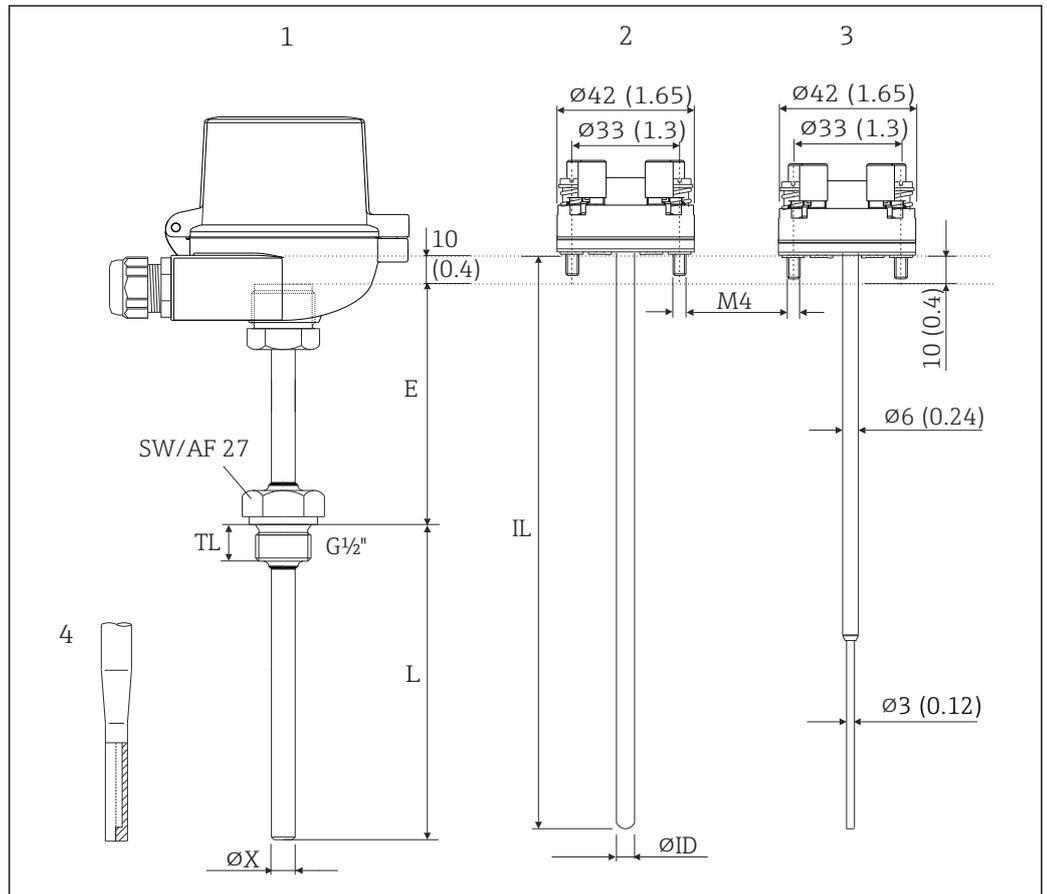
TA30D	Specification
	<ul style="list-style-type: none"> ▪ Available with one or two cable entries ▪ Protection class: IP66/68 (NEMA Type 4x encl.) ▪ Temperature: -50 to +150 °C (-58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated ▪ Seals: silicone ▪ Threaded cable entry: G 1/2", 1/2" NPT and M20x1.5 ▪ Protection armature connection: M24x1.5 ▪ Two head transmitters can be mounted. In the standard version, one transmitter is mounted in the terminal head cover and an additional terminal block is installed directly on the insert. ▪ Head color: blue, RAL 5012 ▪ Cap color: gray, RAL 7035 ▪ Weight: 390 g (13.75 oz) ▪ Ground terminal, internal and external ▪ 3-A[®] marked

TA20R	Specification
	<ul style="list-style-type: none"> ▪ Protection class: IP66/67 ▪ Max. temperature: 100 °C (212 °F) ▪ Material: SS 316L (1.4404) stainless steel ▪ Cable entry: 1/2" NPT, M20x1.5 or plug M12x1 PA ▪ Head and cap color: stainless steel ▪ Weight: 550 g (19.4 oz) ▪ LABS-free ▪ 3-A[®] marked

Maximum ambient temperatures for cable glands	
Type	Temperature range
Cable gland ½" NPT, M20x1.5 (non Ex)	-40 to +100 °C (-40 to +212 °F)

Design

All dimensions in mm (in)

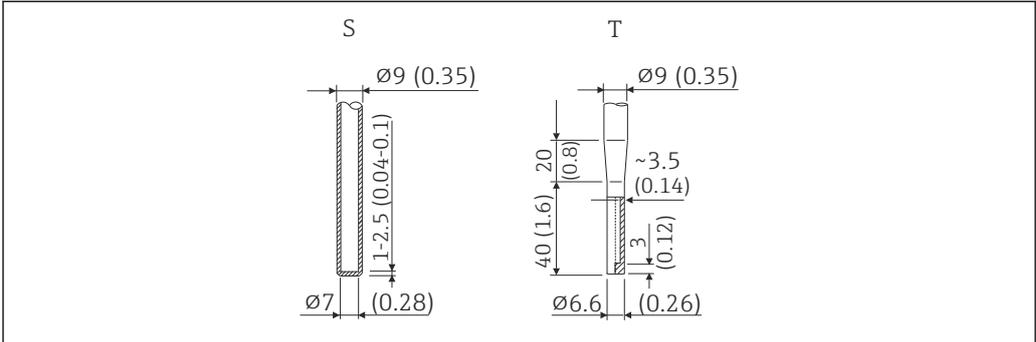


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5 Dimensions

- 1 Complete thermometer with terminal head
- 2 Insert with terminal block mounted (example with Ø6 mm (0.24 in))
- 3 Reduced insert with terminal block mounted
- 4 Reduced tip
- E Extension neck length
- ØID Insert diameter
- IL Insertion length = E + L + 10 mm (0.4 in)
- L Immersion length
- SW/AF Width across flats
- TL Thread length 15 mm (0.6 in)
- ØX Thermowell diameter

Tip shape



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6 Available tip shapes (straight or reduced). Maximum surface roughness Ra ≤ 0.8 μm (31.5 μin)

Pos. No.	Tip shape, L = immersion length	φ Insert	Outer diameter φD
S	Straight	6 mm (0.24 in)	9 mm (0.35 in)
T	Reduced, L ≥ 90 mm (3.54 in)	3 mm (0.12 in)	9 mm (0.35 in)

Spare parts

- The thermowell is available as spare part TW10 (refer to Technical Information in the chapter "Documentation").
- The gasket M2 1-G½", copper is available as spare part (material no. 60001328).
- The paired RTD inserts are available as spare part TET90 (refer to Technical Information in the chapter "Documentation").

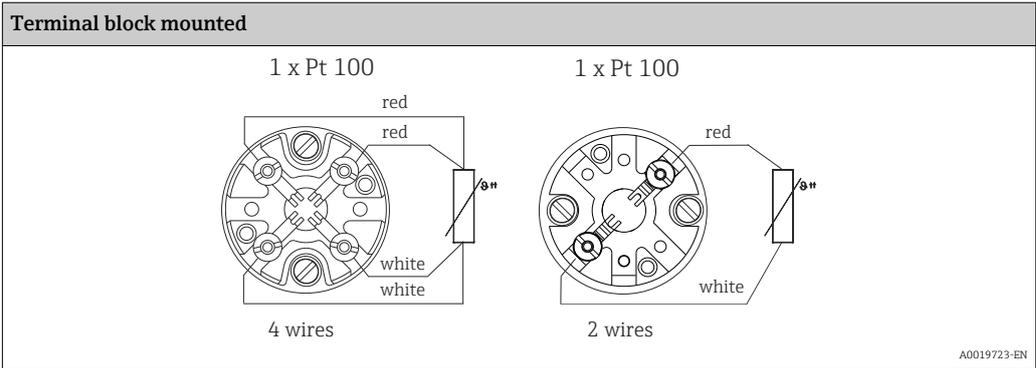
If inserts are required as spare parts refer to the following equation:

Insertion length IL = E + L + 10 mm (0.4 in)

Wiring

Wiring diagram for RTD

Type of sensor connection

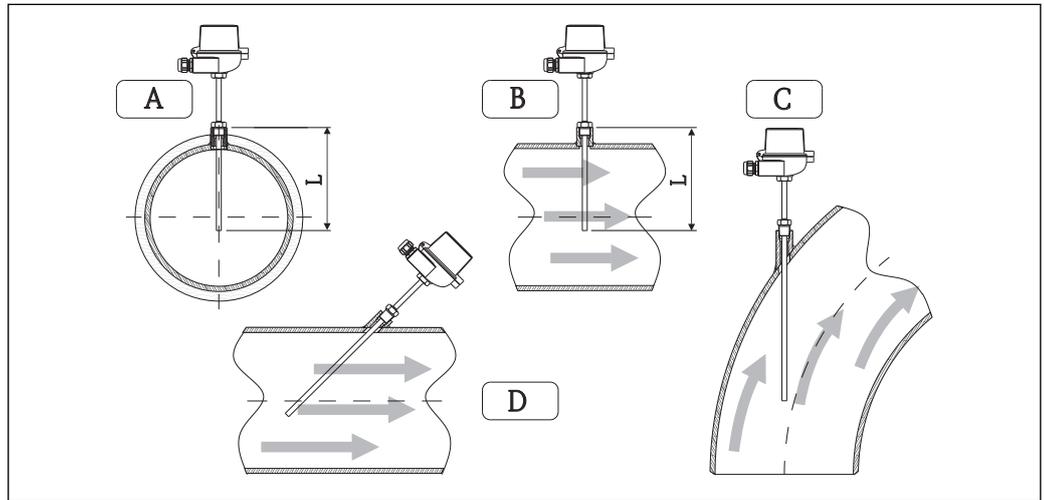


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Installation conditions

Orientation No restrictions.

Installation instructions



7 Installation examples

A - B In pipes with a small cross section the sensor tip should reach or extend slightly past the center line of the pipe ($= L$).

C - D Tilted installation.

The immersion length of the thermometer influences the accuracy. If the immersion length is too small then errors in the measurement are caused by heat conduction via the process connection and the container wall. If installing into a pipe then the immersion length should be half of the pipe diameter, if possible (see A and B). A further solution could be an angled (tilted) installation (see C and D). When determining the immersion length all thermometer parameters and the process to be measured must be taken into account (e.g. flow velocity, process pressure).

- Installation possibilities: Pipes, tanks or other plant components
- Recommended minimum immersion length: 80 to 100 mm (3.15 to 3.94 in)
The immersion length should correspond to at least 8 times of the thermowell diameter. Example: Thermowell diameter 12 mm (0.47 in) $\times 8 = 96$ mm (3.8 in). A standard immersion length of 120 mm (4.72 in) is recommended

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.
Other standards and guidelines	<ul style="list-style-type: none"> ■ IEC 60529: Degree of protection of housing (IP code) ■ IEC 61010-1: Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures ■ IEC 60751: Industrial platinum resistance thermometers ■ DIN 43772: Thermowells ■ DIN EN 50446: Terminal heads ■ 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 on thermowell	Thermowell pressure tests are carried out in accordance with the specifications in DIN 43772. With regard to thermowells with tapered or reduced tips that do not comply with this standard, these are tested using the pressure of corresponding straight thermowells. Sensors for use in hazardous areas

are also always subjected to a comparative pressure during the tests. Tests according to other specifications can be carried out on request. The liquid penetration test verifies that there are no cracks in the welded seams of the thermowell.

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) according to ISO/IEC 17025. A calibration which is performed according to EA guidelines (SIT/Accredia or DKD/DAKks calibration) may be requested separately. The calibration is performed on the replaceable insert of the thermometer. In the case of thermometers without a replaceable insert, the entire thermometer - from the process connection to the tip of the thermometer - is calibrated.

Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configurator on the Endress+Hauser website: www.endress.com → Select country → Instruments → Select device → Product page function: Configure this product
- From your Endress+Hauser Sales Center: www.endress.com/worldwide

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

Accessories

Various accessories, which can be ordered with the device or subsequently from Endress+Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Service-specific accessories

Accessories	Description
Applicator	<p>Software for selecting and sizing Endress+Hauser measuring devices:</p> <ul style="list-style-type: none"> ■ Calculation of all the necessary data for identifying the optimum measuring device: e.g. pressure loss, accuracy or process connections. ■ Graphic illustration of the calculation results <p>Administration, documentation and access to all project-related data and parameters over the entire life cycle of a project.</p> <p>Applicator is available:</p> <ul style="list-style-type: none"> ■ Via the Internet: https://wapps.endress.com/applicator ■ On CD-ROM for local PC installation.
Konfigurator ^{+temperature}	<p>Software for selecting and configuring the product depending on the measuring task, supported by graphics. Includes a comprehensive knowledge database and calculation tools:</p> <ul style="list-style-type: none"> ■ For temperature competence ■ Quick and easy design and sizing of temperature measuring points ■ Ideal measuring point design and sizing to suit the processes and needs of a wide range of industries <p>The Konfigurator is available: On request from your Endress+Hauser sales office on a CD-ROM for local PC installation.</p>

W@M	<p>Life cycle management for your plant</p> <p>W@M supports you with a wide range of software applications over the entire process: from planning and procurement, to the installation, commissioning and operation of the measuring devices. All the relevant device information, such as the device status, spare parts and device-specific documentation, is available for every device over the entire life cycle.</p> <p>The application already contains the data of your Endress+Hauser device. Endress +Hauser also takes care of maintaining and updating the data records.</p> <p>W@M is available:</p> <ul style="list-style-type: none"> ▪ Via the Internet: www.endress.com/lifecyclemanagement ▪ On CD-ROM for local PC installation.
FieldCare	<p>FDT-based plant asset management tool from Endress+Hauser.</p> <p>It can configure all smart field units in your system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition.</p> <p> For details, see Operating Instructions BA00027S and BA00059S</p>

Documentation

Technical Information:

- EngyCal® RH33 Custody transfer BTU meter (TI00151K/09/en)
- Thermowell for temperature sensors Omnigrad M TW10 (TI261T/02/en)



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