TI01014T/09/EN/08.24-00
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2024-11-28

Technical Information
iTHERM TS111

Insert for installation in thermometers

Applications

- For universal use
- RTD measuring range: –200 to +600 °C (–328 to +1 112 °F)
- TC measuring range: –40 to +1 100 °C (–40 to +2 012 °F)
- For installation in thermometers

Head transmitter

All Endress+Hauser transmitters are available with enhanced measurement accuracy and reliability compared to directly wired sensors. They offer easy customizing, with a choice of the following outputs and communication protocols:

- Analog output 4 to 20 mA
- HART®
- PROFIBUS® PA
- FOUNDATION Fieldbus™
- PROFINET® with Ethernet-APL
- IO-Link®

Your benefits

- Quick to exchange during operation in modular thermometers
- Easy and fast recalibration due to iTHERM QuickNeck
- High degree of flexibility thanks to customized immersion lengths
- High degree of compatibility and design as per IEC 60751
- Extremely vibration-resistant
- Very fast response times
- Types of protection for use in hazardous locations:
  - Intrinsic Safety (Ex ia)
  - Non-sparking (Ex nA)

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People for Process Automation

Table of contents

Function and system design

Measuring principle

Resistance thermometer (RTD)

The insert is a universal temperature measuring element that can be used as a replaceable insert as per DIN 43735 for modular thermometers and thermowells in accordance with DIN 43772. With this insert, a Pt100 as per IEC 60751 or a thermocouple type K, J or N as per IEC 60584-2 or ASTM E230-11 can be used as the temperature sensor. The PT100 is a temperature-sensitive platinum resistor with a resistance of 100 Ω at 0 °C (32 °F) and a temperature coefficient $\alpha = 0.003851\ °C^{-1}$.

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).

Thermocouples (TC)

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.

Input

Measuring range

RTD resistance thermometers

Sensor type	Measuring range	Connection	Temperature-sensitive length
Pt100 (IEC 60751, TF) iTHERM StrongSens	−50 to +500 °C (−58 to +932 °F)	3- or 4-wire	7 mm (0.27 in)
iTHERM® QuickSens	−50 to +200 °C (−58 to +392 °F)	3- or 4-wire	5 mm (0.20 in)
Pt100 thin-film sensor (TF)	−50 to +400 °C (−58 to +752 °F)	3- or 4-wire	10 mm (0.39 in)
Pt100 wire-wound sensor (WW)	−200 to +600 °C (−328 to +1 112 °F)	3- or 4-wire	10 mm (0.39 in)

TC thermocouples:

Sensor type	Measuring range	Connection	Temperature-sensitive length
Thermocouple type K	–40 to +1 100 °C (–40 to +2 012 °F)	Grounded or insulated connection	Insert length
Thermocouple type J	–40 to +750 °C (–40 to +1 382 °F)	Grounded or insulated connection	Insert length
Thermocouple type N	–40 to +1 100 °C (–40 to +2 012 °F)	Grounded or insulated connection	Insert length

Output

Output signal

Generally, the measured value can be transmitted in one of two ways:

- Directly-wired sensors - sensor measured values forwarded without a transmitter.
- Via all of the usual protocols by selecting an appropriate Endress+Hauser iTEMP temperature transmitter. All the transmitters listed below are mounted directly in the washer of the insert and wired with the sensory mechanism. This part of the insert is later inserted into the terminal head of the thermometer.

Family of temperature transmitters

Thermometers fitted with iTEMP transmitters are an installation-ready complete solution to improve temperature measurement by significantly increasing measurement accuracy and reliability, when compared to direct wired sensors, as well as reducing both wiring and maintenance costs.

4 to 20 mA head transmitters
They offer a high degree of flexibility, thereby supporting universal application with low inventory storage. The iTEMP transmitters can be configured quickly and easily at a PC. Endress+Hauser offers free configuration software which can be downloaded from the Endress+Hauser Website.

HART® head transmitters
The iTEMP transmitter is a 2-wire device with one or two measuring inputs and one analog output. The device not only transfers converted signals from resistance thermometers and thermocouples, it also transfers resistance and voltage signals using HART® communication. Swift and easy operation, visualization and maintenance using universal configuration software like FieldCare, DeviceCare or FieldCommunicator 375/475. Integrated Bluetooth® interface for the wireless display of measured values and configuration via Endress +Hauser SmartBlue (app), optional.

PROFIBUS® PA head transmitters
Universally programmable iTEMP transmitter with PROFIBUS® PA communication. Conversion of various input signals into digital output signals. High measurement accuracy over the complete ambient temperature range. PROFIBUS PA functions and device-specific parameters are configured via fieldbus communication.

FOUNDATION Fieldbus™ head transmitter
Universally programmable iTEMP transmitter with FOUNDATION Fieldbus™ communication. Conversion of various input signals into digital output signals. High measurement accuracy over the complete ambient temperature range. All iTEMP are approved for use in all the main process control systems. The integration tests are performed in Endress+Hauser's 'System World'.

Head transmitter with PROFINET® and Ethernet-APL™
The iTEMP transmitter is a 2-wire device with two measuring inputs. The device not only transfers converted signals from resistance thermometers and thermocouples, it also transfers resistance and voltage signals using the PROFINET® protocol. Power is supplied via the 2-wire Ethernet connection according to IEEE 802.3cg 10Base-T1. The iTEMP can be installed as an intrinsically safe electrical apparatus in Zone 1 hazardous areas. The device can be used for instrumentation purposes in the terminal head form B (flat face) according to DIN EN 50446.

Head transmitter with IO-Link®
The iTEMP transmitter is an IO-Link® device with a measurement input and an IO-Link® interface. It offers a configurable, simple and cost-effective solution thanks to digital communication via IO-Link®. The device is mounted in a terminal head form B (flat face) as per DIN EN 5044.

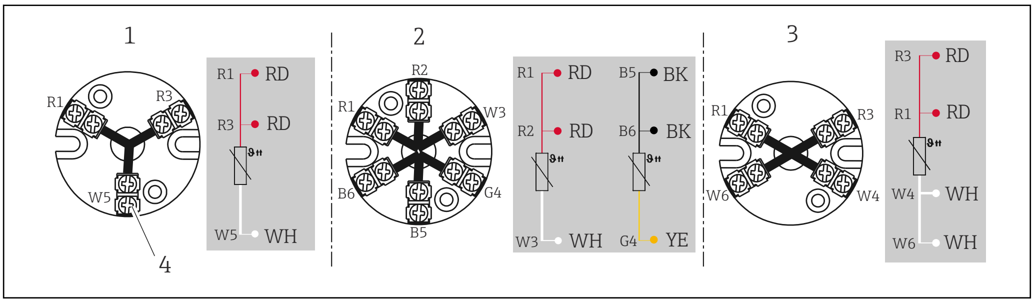
Advantages of the iTEMP transmitters:
- Double or single sensor input (optionally for certain transmitters)
- Attachable display (optionally for certain transmitters)
- Unsurpassed reliability, accuracy and long-term stability in critical processes
- Mathematical functions
- Monitoring of the thermometer drift, sensor backup functionality, sensor diagnostic functions
- Sensor-transmitter-matching based on the Callendar van Dusen coefficients (CvD).

Power supply

Terminal assignment

ℹ The sensor connection wires are equipped with terminal lugs. The nominal diameter of the cable lug is 1.3 mm (0.05 in)

RTD sensor connection type



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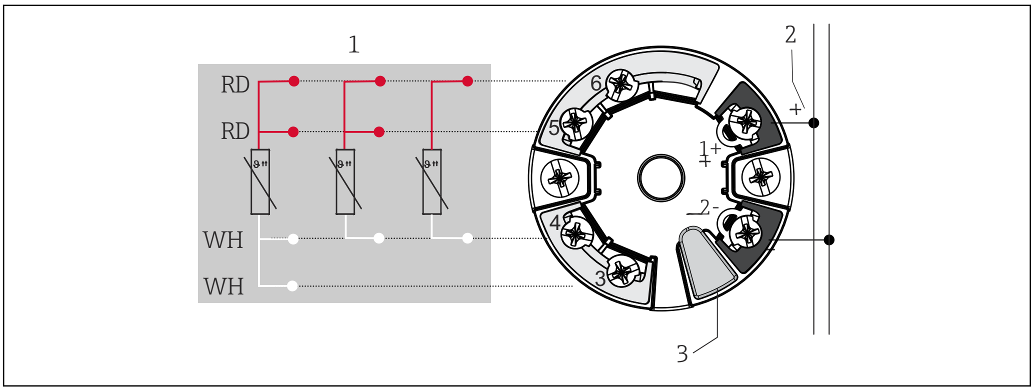
1 Mounted ceramic terminal block

1 *3-wire*
2 *2x3-wire*
3 *4-wire*
4 *Outside screw*



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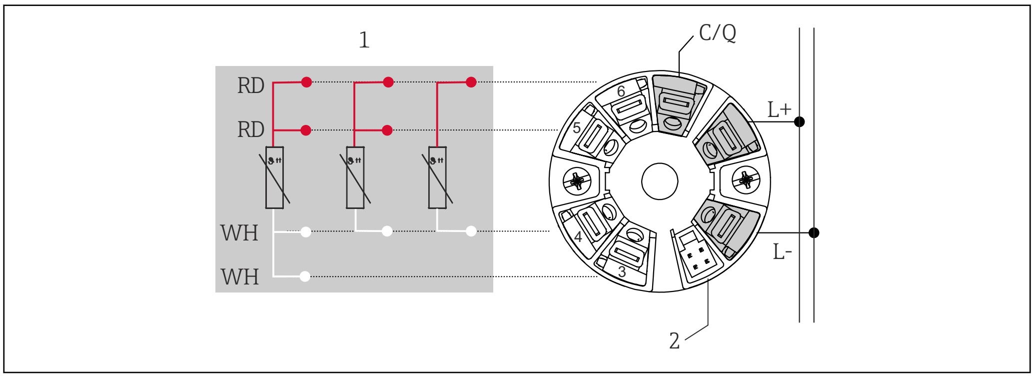
2 Head-mounted iTEMP TMT7x transmitter or iTEMP TMT31 (single sensor input)

1 *Sensor input, RTD, 4-, 3- and 2-wire*
2 *Power supply/bus connection*
3 *Display connection/CDI interface*



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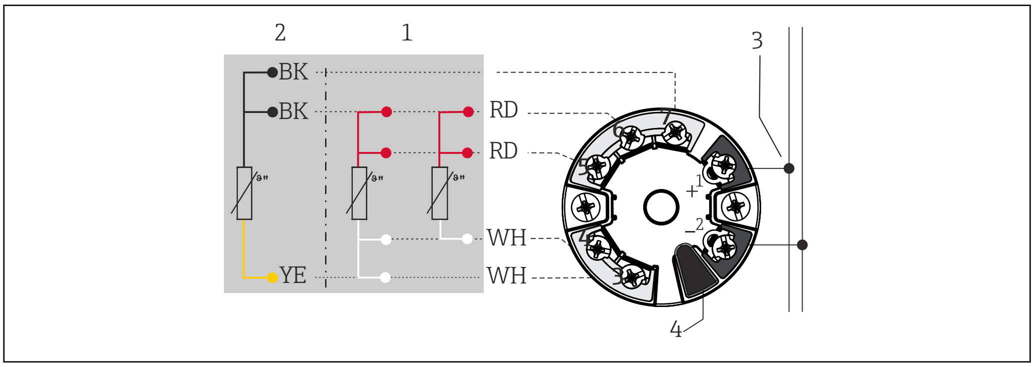
3 *Head-mounted iTEMP TMT36 transmitter (single sensor input)*

- *1 RTD sensor input: 4-, 3- and 2-wire*
- *2 Display connection*
- *L+ 18 to 30 V_{DC} power supply*
- *L- 0 V_{DC} power supply*
- *C/Q IO-Link or switch output*



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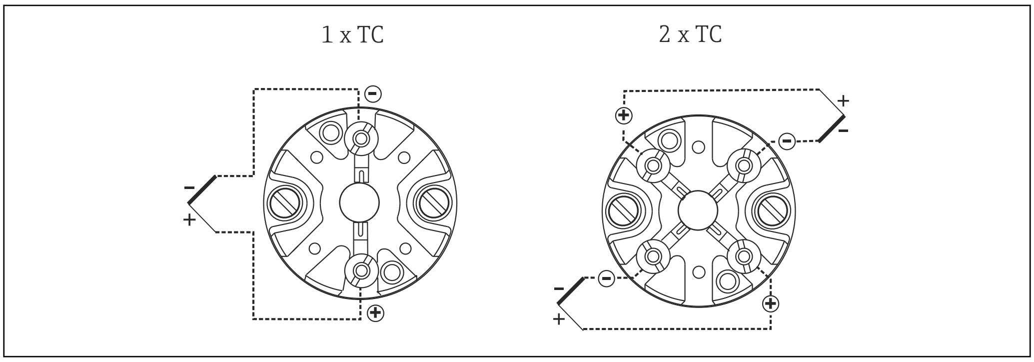
4 *Head-mounted iTEMP TMT8x transmitter (dual sensor input)*

- *1 Sensor input 1, RTD, 4- and 3-wire*
- *2 Sensor input 2, RTD, 3-wire*
- *3 Fieldbus connection and power supply*
- *4 Display connection*

Thermocouple (TC) sensor connection type



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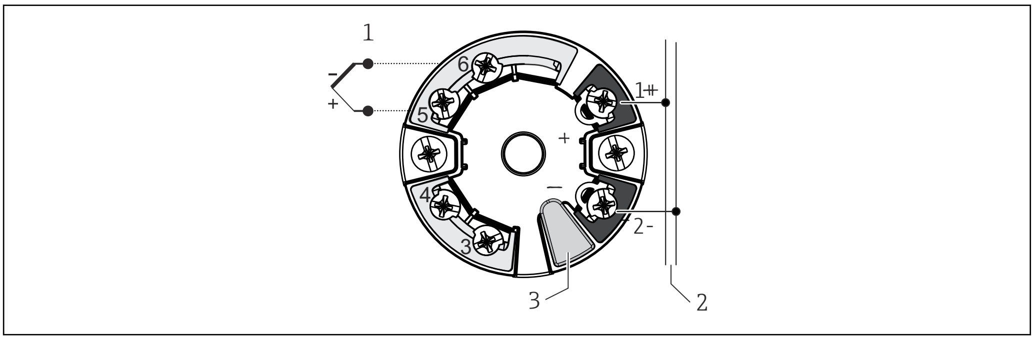
5 *Mounted ceramic terminal block*



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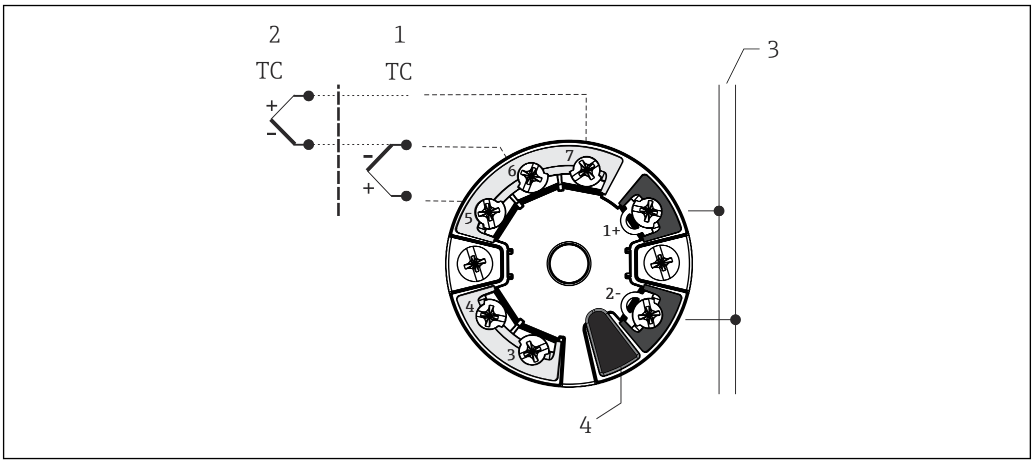
6 *Head-mounted iTEMP TMT7x transmitter (single sensor input)*

1 *Sensor input*
2 *Power supply and bus connection*
3 *Display connection and CDI interface*



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7 *Head-mounted iTEMP TMT8x transmitter (dual sensor input)*

1 *Sensor input 1*
2 *Sensor input 2*
3 *Fieldbus connection and power supply*
4 *Display connection*

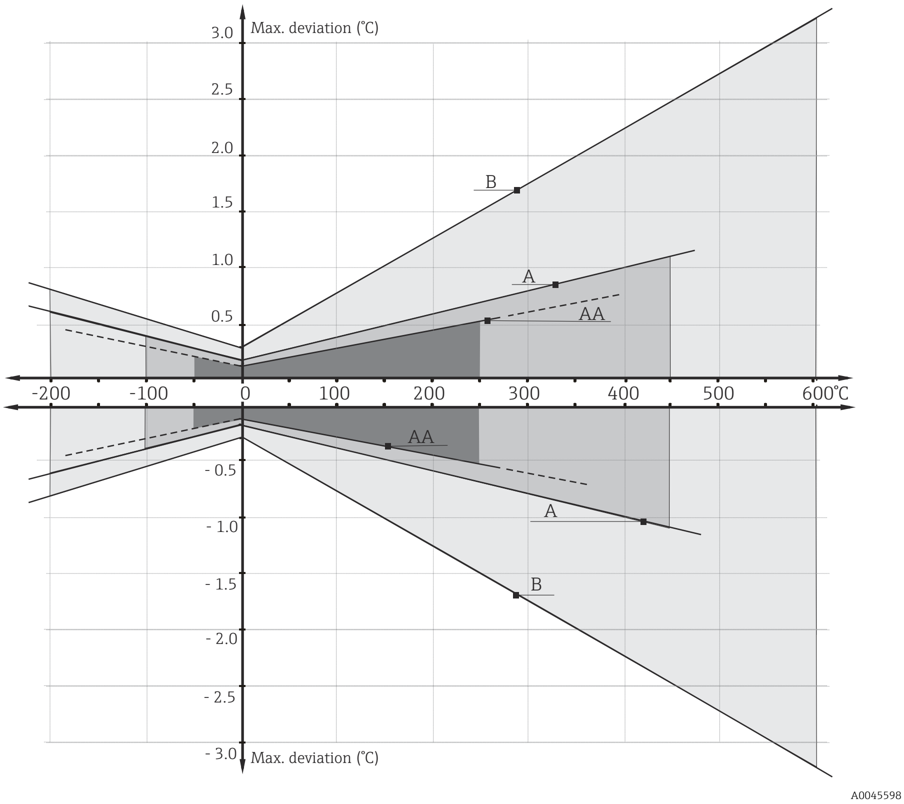
Thermocouple wire colors

As per IEC 60584	As per ASTM E230
▪ Type J: black (+), white (-) ▪ Type K: green (+), white (-) ▪ Type N: pink (+), white (-)	▪ Type J: white (+), red (-) ▪ Type K: yellow (+), red (-) ▪ Type N: orange (+), red (-)

Performance characteristics

Maximum measured error **RTD resistance thermometer as per IEC 60751:**

Class	max. Tolerances (°C)	Characteristics
RTD maximum error type TF		
Cl. A	$\pm (0.15 + 0.002 \cdot \lvert t \rvert)$ [1]	
Cl. AA, former 1/3 Cl. B	$\pm (0.1 + 0.0017 \cdot \lvert t \rvert)$ [1]	
Cl. B	$\pm (0.3 + 0.005 \cdot \lvert t \rvert)$ [1]	



1) |t| = absolute value °C

For measurement errors in °F, calculate using equations in °C, then multiply the outcome by 1.8.

Temperature ranges

Sensor type [1]	Operating temperature range	Class B	Class A	Class AA
Pt100 (TF) Basic	−50 to +200 °C (−58 to +392 °F)	−50 to +200 °C (−58 to +392 °F)	−30 to +200 °C (−22 to +392 °F)	-
Pt100 (TF) Standard	−50 to +400 °C (−58 to +752 °F)	−50 to +400 °C (−58 to +752 °F)	−30 to +250 °C (−22 to +482 °F)	0 to +150 °C (32 to 302 °F)
Pt100 (TF) iTHERM QuickSens	−50 to +200 °C (−58 to +392 °F)	−50 to +200 °C (−58 to +392 °F)	−30 to +200 °C (−22 to +392 °F)	0 to +150 °C (32 to 302 °F)
Pt100 (TF) iTHERM StrongSens	−50 to +500 °C (−58 to +932 °F)	−50 to +500 °C (−58 to +932 °F)	−30 to +300 °C (−22 to +572 °F)	0 to +150 °C (+32 to +302 °F)
Pt100 (WW)	−200 to +600 °C (−328 to +1 112 °F)	−200 to +600 °C (−328 to +1 112 °F)	−100 to +450 °C (−148 to +842 °F)	−50 to +250 °C (−58 to +482 °F)

1) Selection depending on product and configuration

TC thermocouples: Permitted 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	
		Class	Deviation	Class	Deviation
IEC 60584	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-NiAl) N (NiCrSi-NiSi)	2	±2.5 °C (−40 to +333 °C) ±0.0075 |t| [1] (333 to 1 200 °C)	1	±1.5 °C (−40 to +375 °C) ±0.004 |t| [1] (375 to 1 000 °C)

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

Self-heating

RTD elements are passive resistance temperature sensors, which must be supplied with a measuring current in order to determine the measured values. This measurement current causes a self-heating effect in the RTD element itself which in turn creates an additional measurement error. The extent of this measurement error is influenced not only by the measuring current but also by the temperature conductivity and the thermal coupling of the resistance sensor with the environment. This self-heating error is negligible when an Endress+Hauser iTEMP temperature transmitter (very low measured current) is used.

Sensor type	Diameter ID	Typical values for self-heating (measured in water at 20 °C)
Pt100 (TF) Standard	Ø3 mm (0.12 in)	36 mΩ/mW or 94 mK/mW
	Ø6 mm (0.24 in)	120 mΩ/mW or 310 mK/mW
Pt100 (TF) iTHERM StrongSens	Ø6 mm (0.24 in)	≤ 25 mΩ/mW or ≤ 64 mK/mW
Pt100 (TF) iTHERM QuickSens	Ø3 mm (0.12 in)	13 mΩ/mW or 35 mK/mW
	Ø6 mm (0.24 in)	11.5mΩ/mW or 30 mK/mW
Pt100 (WW)	Ø3 mm (0.24 in)	15 mΩ/mW or 39 mK/mW
	Ø6 mm (0.24 in)	50 mΩ/mW or 130 mK/mW
Pt100 (TF) Basic	Ø6 mm (0.24 in)	120 mΩ/mW or 310 mK/mW

Response time

RTD resistance thermometers tested in accordance with IEC 60751 in flowing water (0.4 m/s at 30 °C):

Insert			
Sensor type	**Diameter ID**	**Response time**	
Pt100 (TF) Standard	Ø3 mm (0.12 in)	t_{50} t_{90}	<2.5 s <5.5 s
	Ø6 mm (0.24 in)	t_{50} t_{90}	<5.0 s <13 s
Pt100 (TF) iTHERM StrongSens	Ø6 mm (0.24 in)	t_{50} t_{90}	< 5.5 s < 16 s
Pt100 (TF) iTHERM QuickSens	Ø3 mm (0.12 in)	t_{50} t_{90}	<0.5 s <1.2 s
	Ø6 mm (0.24 in)	t_{50} t_{90}	<0.5 s <1.5 s
Pt100 (WW)	Ø3 mm (0.12 in)	t_{50} t_{90}	<2 s <5 s
	Ø6 mm (0.24 in) single sensor	t_{50} t_{90}	<4 s <10.5 s
	Ø6 mm (0.24 in) double sensor	t_{50} t_{90}	<4.5 s <12 s

Insert			
Sensor type	**Diameter ID**	**Response time**	
Pt100 (TF) Basic	Ø6 mm (0.24 in) single sensor	t_{50} t_{90}	<6.5 s <15.5 s
	Ø6 mm (0.24 in) double sensor	t_{50} t_{90}	<9.5 s <22.5 s

TC thermocouples:

Insert			
Sensor type	**Diameter ID**	**Response time**	
Thermocouples (K, J and N)	Ø3 mm (0.12 in)	t_{50} t_{90}	1 s 3 s
	Ø6 mm (0.24 in)	t_{50} t_{90}	2.5 s 6 s

Response time for insert without transmitter.

Calibration

Calibration of thermometers
Calibration involves comparing the measured values of a device under test (DUT) with those of a more precise calibration standard using a defined and reproducible measurement method. The aim is to determine the deviation of the DUT's measured values from the true value of the measured variable. Two different methods are used for thermometers:
- Calibration at fixed-point temperatures, e.g. at the freezing point of water at 0 °C,
- Calibration compared against a precise reference thermometer.

The thermometer to be calibrated must display the fixed point temperature or the temperature of the reference thermometer as accurately as possible. Temperature-controlled calibration baths with very homogeneous thermal values, or special calibration furnaces are typically used for thermometer calibrations. The measuring uncertainty may increase due to heat conduction errors and short immersion lengths. The existing measuring uncertainty is recorded on the individual certificate of calibration. For accredited calibrations in accordance with ISO17025, a measuring uncertainty that is twice as high as the accredited measuring uncertainty is not permitted. If this limit is exceeded, only a factory calibration is possible.

The measured value of the DUT is determined using the maximum possible immersion depth and the specific measuring conditions and measurement results are documented on an evaluation certificate.

Sensor transmitter matching
The resistance/temperature curve of platinum resistance thermometers is standardized but in practice it is rarely possible to keep to the values precisely over the entire operating temperature range. For this reason, platinum resistance sensors are divided into tolerance classes, such as Class A, AA or B as per IEC 60751. These tolerance classes describe the maximum permissible deviation of the specific sensor characteristic curve from the standard curve, i.e., the maximum temperature-dependent characteristic error that is permitted. The conversion of measured sensor resistance values to temperatures in temperature transmitters or other meter electronics is often susceptible to considerable errors as the conversion is generally based on the standard characteristic curve.

When using Endress+Hauser temperature transmitters, this conversion error can be reduced significantly by sensor-transmitter matching:
- Calibration at three temperatures at least and determination of the actual temperature sensor characteristic curve,
- Adjustment of the sensor-specific polynomial function using Calendar-van Dusen (CvD) coefficients,
- Configuration of the temperature transmitter with the sensor-specific CvD coefficients for resistance/temperature conversion, and
- another calibration of the reconfigured temperature transmitter with connected resistance thermometer.

Endress+Hauser offers its customers this kind of sensor-transmitter matching as a separate service. Furthermore, the sensor-specific polynomial coefficients of platinum resistance thermometers are always provided on every Endress+Hauser calibration certificate where possible, e.g. at least three calibration points, so that users themselves can also appropriately configure suitable temperature transmitters.

For the device, Endress+Hauser offers standard calibrations at a reference temperature of −80 to +600 °C (−112 to +1 112 °F) based on the ITS90 (International Temperature Scale). Calibrations in other temperature ranges are available from your Endress+Hauser sales center on request. Calibrations are traceable to national and international standards. The calibration certificate is referenced to the serial number of the device. Only the insert is calibrated.

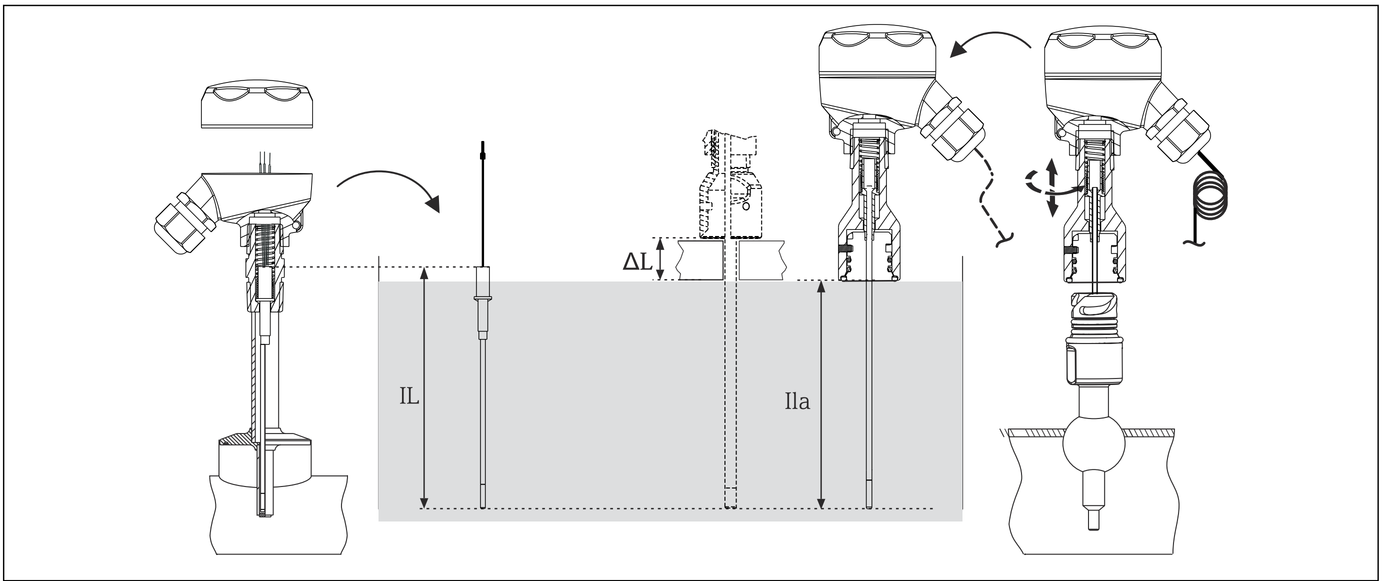
Minimum insertion length (IL) for inserts required to perform a correct calibration

Due to the limitations of furnace geometries, the minimum insertion lengths must be observed at high temperatures to enable a calibration to be performed with an acceptable degree of measuring uncertainty. The same applies when using a head transmitter. Due to heat conduction, minimum lengths must be observed in order to guarantee the functionality of the transmitter −40 to +85 °C (−40 to +185 °F)

Calibration temperature	Minimum insertion length IL in mm without head transmitter
−196 °C (−320.8 °F)	120 mm (4.72 in) [1]
−80 to +250 °C (−112 to +482 °F)	No minimum insertion length required [2]

Calibration temperature	Minimum insertion length IL in mm without head transmitter
251 to 550 °C (483.8 to 1 022 °F)	300 mm (11.81 in)
551 to 600 °C (1 023.8 to 1 112 °F)	400 mm (15.75 in)

1) Min. 150 mm (5.91 in) required with iTEMP head transmitters
2) At a temperature of 80 to 250 °C (176 to 482 °F) and with iTEMP head transmitters, min. 50 mm (1.97 in) is required



8 Insertion lengths for sensor calibration

IL Insertion length for factory calibration or recalibration onsite without the iTHERM QuickNeck extension neck
ILa Insertion length for recalibration onsite with the iTHERM QuickNeck extension neck
ΔL Additional length, depending on the calibration unit, if the insert cannot be fully immersed

- To check the actual accuracy rating of the thermometers installed, a cyclic calibration of the installed sensor needs to be performed frequently. The insert is normally removed for comparison with a precise reference thermometer in the calibration bath (see graphic, left part).
- The iTHERM QuickNeck enables quick, tool-free removal of the insert for calibration purposes. The entire upper part of the thermometer is released by turning the terminal head. The insert is removed from the protection tube and directly immersed into the calibration bath (see graphic, right part). Make sure that the cable is long enough to be able to reach the mobile calibration bath with the cable connected. If this is not possible for the calibration, it is advisable to use a connector.

Advantages of iTHERM QuickNeck:
- Considerable time savings when recalibrating the device (up to 20 minutes per measuring point)
- Wiring mistakes avoided when re-installing
- Minimum plant downtime, thereby saving costs

Insulation resistance

RTD resistance thermometers

Insulation resistance as per IEC 60751 with a minimum test voltage of 100 V DC:
>100 MΩ at 25 °C

TC thermocouples

Insulation resistance as per DIN EN 60584 between the connecting wires and the sheath material with a minimum test voltage of 500 V DC:
- >1 GΩ at 25 °C
- >5 MΩ at 500 °C

Dielectric strength

Dielectric strength between terminals and insert sheath (for RTD only):
- For all Ø6 mm (0.24 in) inserts: ≥ 1 000 V DC over 5 s
- For Ø3 mm (0.12 in) QuickSens: ≥ 500 V DC over 5 s
- For all other Ø3 mm (0.12 in) inserts: ≥ 250 V DC over 5 s

Transmitter specifications

<table>
<tr><th></th><th>Pt100 accuracy</th><th>Sensor current</th><th>Galvanic isolation</th></tr>
<tr><td>iTEMP TMT180 PCP
Pt100</td><td>0.2 °C (0.36 °F), optional
0.1 °C (0.18 °F) or 0.08 % [1]</td><td rowspan="2">I ≤ 0.6 mA</td><td>-</td></tr>
<tr><td>iTEMP TMT181 PCP
RTD, TC, Ω, mV</td><td rowspan="2">0.2 °C (0.36 °F) or 0.08 %</td><td rowspan="2">U = 2 kV AC</td></tr>
<tr><td>iTEMP TMT182 HART
RTD, TC, Ω, mV</td><td>I ≤ 0.2 mA</td></tr>
<tr><td>iTEMP TMT82 HART
RTD, TC, Ω, mV</td><td>0.08 °C (0.14 °F)
0.1 °C (0.18 °F) [2]</td><td rowspan="2">I ≤ 0.3 mA</td><td rowspan="2">U = 2 kV AC</td></tr>
<tr><td>iTEMP TMT84 PA
iTEMP TMT85 FF
RTD, TC, Ω, mV</td><td>0.08 °C (0.14 °F) digital</td></tr>
<tr><td>iTEMP TMT71</td><td>0.07 °C (0.13 °F) digital
0.1 °C (0.18 °F) [2]</td><td rowspan="2">I ≤ 0.3 mA</td><td rowspan="2">U = 2 kV AC</td></tr>
<tr><td>iTEMP TMT72 HART
RTD, TC, Ω, mV</td><td>0.1 °C (0.18 °F) [2]</td></tr>
</table>

1) % refers to the adjusted measuring range (the greater value applies)
2) At current output

Installation

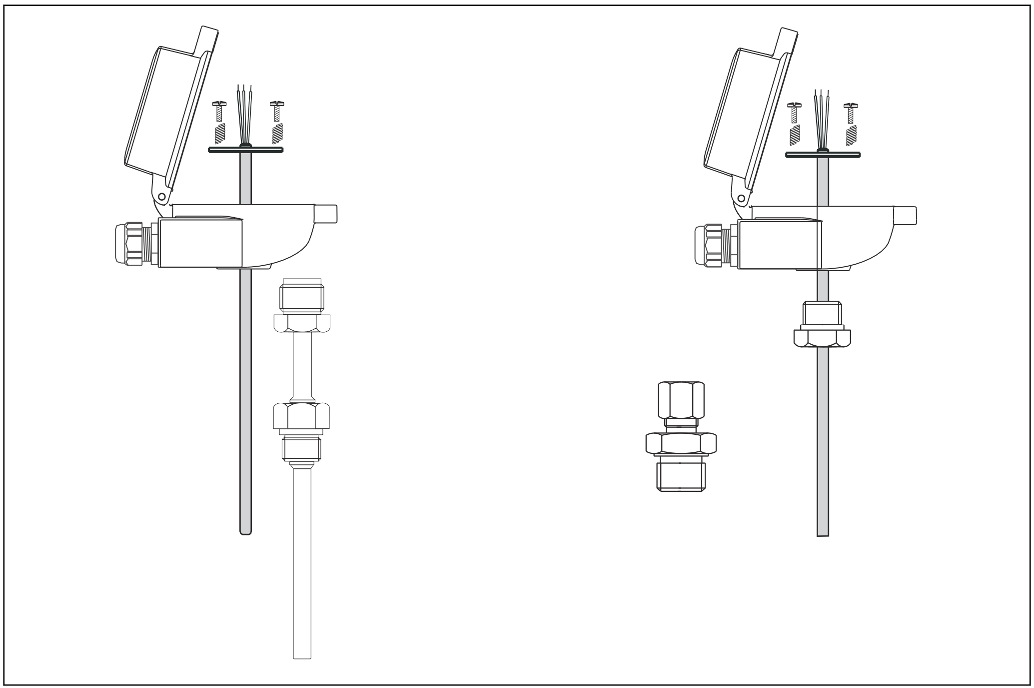
Orientation

No restrictions.

Installation instructions

The iTHERM TS111 insert should be mounted in thermometers with a flat face terminal head as per DIN EN 50446. When installing in a thermometer with a thermowell, the insert is secured in the thermometer's terminal head by means of spring loaded screws. This means that the insert tip is always pressed against the internal floor of the thermowell, thereby ensuring good thermal contact.

The prerequisite is an insert length (IL) that is adapted to the thermowell. This can be calculated using the formula IL = E + T + U + X (E = extension neck length, T = thermowell extension, U = immersion length of thermowell, X = variable for calculating length of insert). The electrical connection is established as detailed in the "Power supply" section.



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9 *General installation options: in an assembly with thermowell (left), direct measurement (right)*

Immersion length

RTD resistance thermometers:

Error caused by heat conduction ≤ 0.1 K; measured according to IEC 60751 at 100 °C in liquid medium

Sensor type [1]	Diameter ID	Immersion length
Pt100 (TF) standard	Ø3 mm (0.12 in)	≥ 30 mm (1.18 in)
	Ø6 mm (0.24 in)	≥ 50 mm (1.97 in)
Pt100 (TF) iTHERM StrongSens	Ø6 mm (0.24 in)	≥ 40 mm (1.57 in)
Pt100 (TF) iTHERM QuickSens	Ø3 mm (0.12 in)	≥ 25 mm (0.98 in)
	Ø6 mm (0.24 in)	
Pt100 (WW)	Ø3 mm (0.12 in)	≥ 60 mm (2.36 in)
	Ø6 mm (0.24 in)	
	Ø6.35 mm (¼ in)	
Pt100 (TF) basic	Ø6 mm (0.24 in)	≥ 50 mm (1.97 in)
	Ø6.35 mm (¼ in)	

1) Options depend on product and configuration

TC thermocouples:

Sensor type [1]	Diameter ID	Immersion length
Thermocouple types J, K and N	Ø3 mm (0.12 in)	30 mm (1.18 in)
	Ø6 mm (0.24 in)	
	Ø6.35 mm (¼ in)	

1) Options depend on product and configuration

Terms of delivery

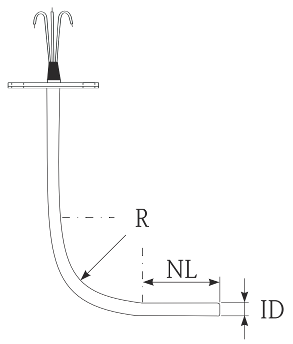
Inserts with an insertion length of IL > 1000 mm (48 in) are delivered coiled. Along with the insert, users will receive instructions for straightening the coiled insert.

Possible bending radius

Sensor type [1]	Diameter ID	Bending radius R	Non-bendable length (tip) NL [2]
Pt100 (TF) Standard	Ø6 mm (0.24 in)	Non-bendable	Non-bendable
Pt100 (TF) iTHERM StrongSens	Ø6 mm (0.24 in)	R ≥ 3 x ID	30 mm (1.18 in)
Pt100 (TF) iTHERM QuickSens	Ø3 mm (0.12 in)	Non-bendable	Non-bendable
	Ø6 mm (0.24 in)	R ≥ 3 x ID	30 mm (1.18 in)
Pt100 (WW)	Ø3 mm (0.12 in)	R ≥ 3 x ID	30 mm (1.18 in)
	Ø6 mm (0.24 in)		
	Ø6.35 mm (¼ in)		
Pt100 (TF) basic	Ø6 mm (0.24 in)	Non-bendable	Non-bendable
	Ø6.35 mm (¼ in)		
Thermocouple types J, K, N	Ø3 mm (0.12 in)	R ≥ 3 x ID	30 mm (1.18 in)
	Ø6 mm (0.24 in)		
	Ø6.35 mm (¼ in)		

1) Options depend on product and configuration
2) If a sleeve is overlapped, NL increases to 80 mm.

Inserts with an insertion length IL > 1 000 mm (39.4 in) are coiled when delivered. Users will receive instructions with the insert detailing how to replace the rolled insert.



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Environment

Ambient temperature range

Terminal head	Temperature in °C (°F)
Without head transmitter installed	Depends on the terminal head used and the cable gland or fieldbus connector
With mounted head transmitter	–40 to +85 °C (–40 to +185 °F)
With mounted head transmitter and display	–20 to +70 °C (–4 to +158 °F)

Vibration resistance

RTD resistance thermometers:

The Endress+Hauser inserts exceed the requirements of IEC 60751, which specify shock and vibration resistance of 3 g in the range from 10 to 500 Hz.

The vibration resistance at the measuring point depends on the sensor type and design, see the following table:

Sensor type	Vibration resistance for the sensor tip [1)]
Pt100 (TF) Standard	≤ 4g
Pt100 (TF) iTHERM StrongSens (vibration-resistant)	≤ 600 m/s^2 (≤ 60g)
Pt100 (TF) iTHERM QuickSens	3 mm (0.12 in) ≤ 3g 6 mm (0.24 in) ≤ 60g
Pt100 (WW)	≤ 3g
Pt100 (TF) Basic	≤ 3g
Thermocouples, type K, J, N (based on IEC 60751)	≤ 3g

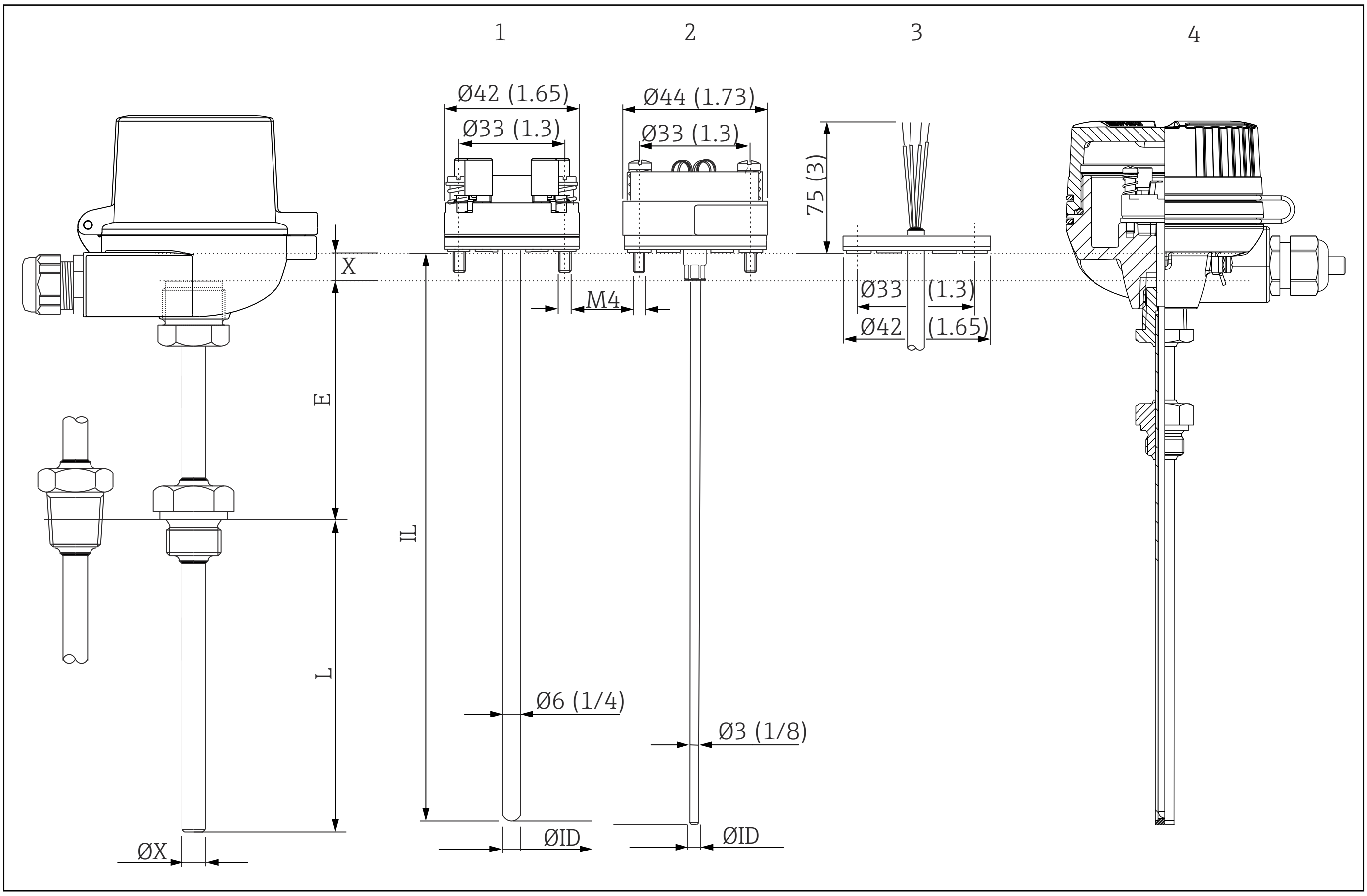
1) (measured according to IEC 60751 with varying frequencies in the range of 10 to 500 Hz)

Shock resistance

≥ 4 J (measured according to IEC 60079-0)

Mechanical construction

Design, dimensions



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10 *All dimensions in mm (in).*

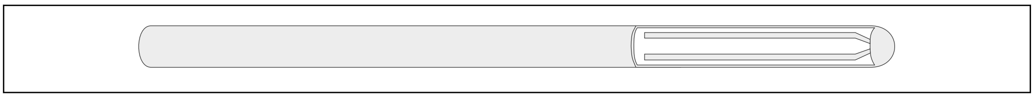
- 1 *Insert with mounted ceramic terminal block (example with Ø6 mm (0.24 in)), spring pre-load > 6 mm*
- 2 *Insert with mounted head transmitter (example with Ø3 mm (0.12 in)), spring pre-load > 6 mm*
- 3 *Insert with flying leads (standard version), spring pre-load > 6 mm*
- 4 *Thermometer with insert, spring pre-load > 6 mm*
- E *Extension neck length*
- ØID *Insert diameter Ø3 mm (0.12 in) or Ø6 mm (0.24 in)*
- IL *Insert length*
- L *Immersion length*
- ØX *Thermowell diameter*

The prerequisite is that the insert length (IL) must be adapted to the thermowell. This can be calculated by means of the above stated formulas.

The insert comprises three main components: a sensor at the tip, an electrical connection at the upper end and in between the two a mineral insulated sheathed cable or a stainless steel tube with insulated wires. Depending on the sensor type, the sensor element of the RTD is firmly embedded with ceramic potting compound in a sensor cap, soldered to the base of the sensor cap, or embedded in compacted mineral insulation.

There are two different designs available for thermocouples:

Grounded version: Here, the thermocouple at the junction is mechanically and electrically connected to the inside of the sheathed cable. This results in good heat transfer from the sensor wall to the measuring tip of the thermocouple.



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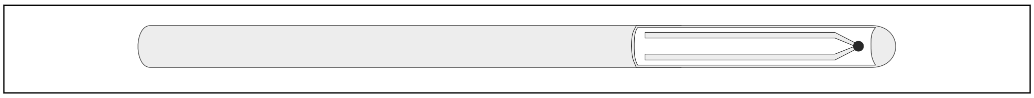
Ungrounded version: If the probe is ungrounded, there is no connection between the thermocouple and the sensor wall. This is also referred to as an insulated measuring point. The response time is slower than in a grounded version.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RTD resistance thermometers:

Sensor type	Sheathed cable, outer diameter ID; material
Pt100 (TF) iTHERM StrongSens	Ø6 mm (0.24 in) The sheath is made of stainless steel and is filled with a magnesium oxide (MgO) powder. The primary sensor is permanently encapsulated in the sensor cap to ensure maximum vibration resistance.
Pt100 (TF) iTHERM QuickSens	Ø3 mm (0.12 in)[1)] The sheath is made of stainless steel. The primary sensor is welded onto the base of the sensor cap to ensure the shortest response times.
	Ø6 mm (0.24 in) The sheath is made of stainless steel and is filled with a magnesium oxide (MgO) powder. The primary sensor is welded onto the base of the sensor cap to ensure the shortest response times.
Pt100 (TF) Standard	Ø3 mm (0.12 in)/Ø6 mm (0.24 in) The sheath is made of stainless steel and is filled with a magnesium oxide (MgO) powder. The primary sensor is embedded in compacted MgO powder in the insert tip.
Pt100 (WW) extended measurement range	Ø3 mm (0.12 in)/Ø6 mm (0.24 in) The sheath is made of stainless steel and is filled with a magnesium oxide (MgO) powder. The primary sensor is embedded in compacted MgO powder in the insert tip. The wire-wound sensor enables a measuring range of −200 to +600 °C (−328 to +1 112 °F). Single or double sensor elements are available.
Pt100 (TF) Basic	Ø6 mm (0.24 in) The sheath is made of stainless steel SS316L. The primary sensor, a thin-film Pt100, is installed in the tip of the insert.

1) If the insertion length IL is > 1 400 mm (55 in), the measuring insert diameter is 3 mm (0.12 in) at the sensor tip and 6 mm (0.24 in) at the top.

The spring load of the insert equals to ½ in.

TC thermocouples:

Sensor type	Sheathed cable, outer diameter ID; material
Thermocouple type K	The type K thermocouples are available as single or double sensors. The wires made of nickel-chromium and nickel are embedded in magnesium oxide (MgO) powder within the sheathed cable made of Alloy 600. The measuring point can be insulated or grounded (electrically conductive, connected to sheathed cable).
Thermocouple type J	The type J thermocouples are available as single or double sensors. The wires made of iron and copper-nickel are embedded in magnesium oxide (MgO) powder within the sheathed cable made of stainless steel SS316L. The measuring point can be insulated or grounded (electrically conductive, connected to sheathed cable).
Thermocouple type N	The type N thermocouples are available as single or double sensors. The wires made of nickel-chromium-silicon and nickel-silicon are embedded in magnesium oxide (MgO) powder within the sheathed cable made of Alloy TD (Pyrosil, Nicrobell or similar). The measuring point can be insulated or grounded (electrically conductive, connected to sheathed cable). Compared to type K thermocouples, type N thermocouples are significantly less prone to what is known as "green rot".

The insert comes with free wires that can be used for direct electrical connection to a head transmitter. Alternatively, a ceramic terminal block can be used, which is mounted securely on a washer.

Inserts with an insertion length IL > 1 000 mm (39.4 in) are coiled when delivered. You will receive instructions with the insert detailing how to replace the rolled insert.

Materials

The temperatures for continuous operation specified in the following table are intended only as reference values when using the various materials in air. In exceptional cases, the maximum operating temperatures are sometimes significantly lower.

Description	Recommended max. temperature for continuous use in air	Properties
AISI 316L	650 °C (1 202 °F)	▪ 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) ▪ Increased resistance to intergranular corrosion and pitting
Alloy 600	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
Alloy TD	1 100 °C (2 012 °F)	▪ Nickel-chromium alloy, which was designed for thermocouple sheaths ▪ High degree of temperature corrosion resistance and robustness without the use of elements that can cause thermocouple contamination over time ▪ Excellent resistance to nitration up to 1 177 °C (2 151 °F) ▪ Resistant to oxide spalling

Certificates and approvals

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

MID

Test certificate (only in SIL mode). In compliance with:
- WELMEC 8.8: "Guide on the general and administrative aspects of the voluntary system of modular evaluation of measuring instruments"
- OIML R117-1, Edition 2007 (E), "Dynamic measuring system for liquids other than water"
- EN 12405-1/A2, Edition 2010, "Gas meters - Converters - Part 1: Volume conversion"
- OIML R140-1, Edition 2007 (E), "Measuring systems for gaseous fuels"

Ordering information

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

1. Select the product using the filters and search field.
2. Open the product page.

3. Select **Configuration**.

Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: direct input of information specific to the measuring point, such as the 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

The accessories currently available for the product can be selected at www.endress.com:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Spare parts & Accessories**.

Software

Netilion
With the Netilion lloT ecosystem, Endress+Hauser enables the optimization of plant performance, digitization of workflows, sharing of knowledge and improved collaboration. Drawing upon decades of experience in process automation, Endress+Hauser offers the process industry an IIoT ecosystem designed to effortlessly extract insights from data. These insights allow process optimization, leading to increased plant availability, efficiency, reliability and ultimately a more profitable plant.

www.netilion.endress.com

Online tools

Product information over the entire life cycle of the device: www.endress.com/onlinetools

Documentation

The following types of documentation are available on the product pages and in the Download Area of the Endress+Hauser website (www.endress.com/downloads) (depending on the selected device version):

Document	Purpose and content of the document
Technical Information (TI)	**Planning aid for your device** The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.
Brief Operating Instructions (KA)	**Guide that takes you quickly to the 1st measured value** The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.
Operating Instructions (BA)	**Your reference document** These Operating Instructions contain all the information that is required in the various life cycle phases of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning, through to troubleshooting, maintenance and disposal.
Description of Device Parameters (GP)	**Reference for your parameters** The document provides a detailed explanation of each individual parameter. The description is aimed at those who work with the device over the entire life cycle and perform specific configurations.

Document	Purpose and content of the document
Safety Instructions (XA)	Safety Instructions (XA) are supplied with the device, depending on the approval. These are an integral part of the Operating Instructions. The nameplate indicates which Safety Instructions (XA) apply to the device.
Supplementary device-dependent documentation (SD/FY)	Always comply strictly with the instructions in the relevant supplementary documentation. The supplementary documentation is an integral part of the device documentation.

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