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Technical Information
TR13, TC13

Modular thermometer with extension neck, thermowell and flange

TR13 with resistance insert (RTD)
TC13 with thermocouple insert (TC)

Application

- Universal range of application
- Measuring range:
  - Resistance insert (RTD): −200 to 600 °C (−328 to 1 112 °F)
  - Thermocouple (TC): −40 to 1 100 °C (−40 to 2 012 °F)
- Pressure range up to 100 bar (1 450 psi)
- Degree of protection: up to IP 68

Head transmitter

All Endress+Hauser transmitters are available with enhanced accuracy and reliability compared to directly wired sensors. Easy customizing by choosing one of the following outputs and communication protocols:

- Analog output 4 to 20 mA
- HART®
- PROFIBUS® PA
- FOUNDATION Fieldbus™

Your benefits

- High degree of flexibility thanks to modular design with standard terminal heads as per DIN EN 50446 and customer-specific immersion lengths
- High degree of insert compatibility and design as per DIN 43772
- Extension neck to protect the head transmitter from overheating
- Fast response time with reduced/tapered tip form
- Types of protection for use in hazardous locations:
  - Intrinsic Safety (Ex ia)
  - Non-sparking (Ex nA)

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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 α = 0.003851 $°C^{-1}$.

There are generally two different kinds of platinum resistance thermometers:

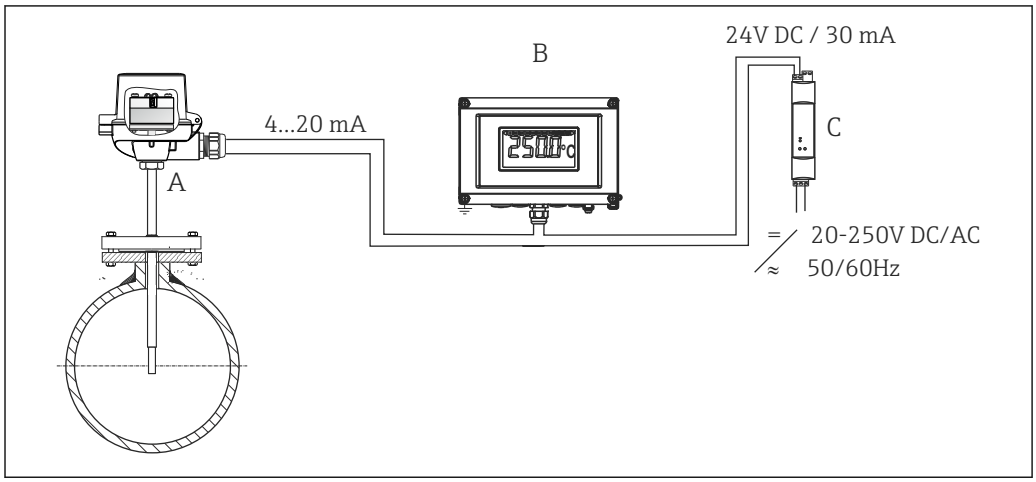
- **Wire wound (WW):** Here, a double coil of fine, high-purity platinum wire is located in a ceramic support. This is then sealed top and bottom with a ceramic protective layer. Such resistance thermometers not only facilitate very reproducible measurements but also offer good long-term stability of 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.

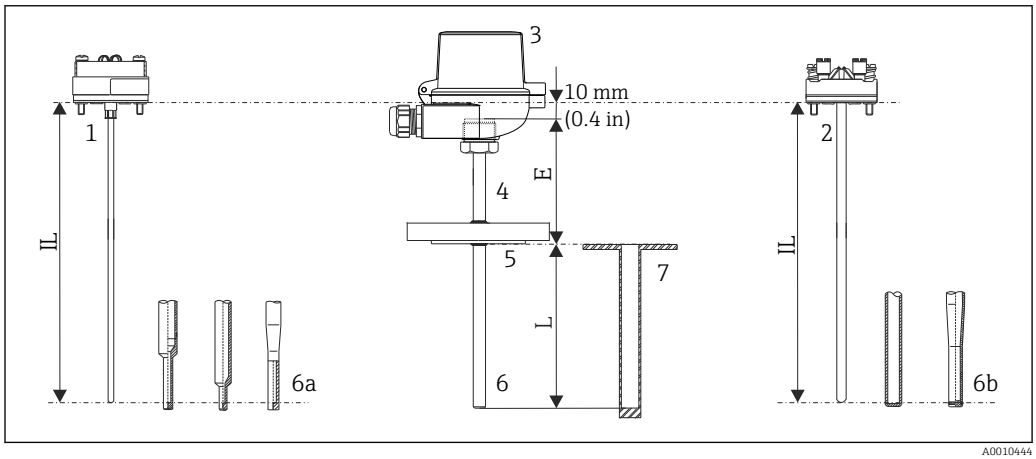
Measuring system



1 Application example

A Mounted thermometer with head transmitter installed.
B RIA16 field display unit - The display unit records the analog measuring signal from the head 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").
C RN22: 1- or 2-channel active barrier for the separation of 0/4 to 20 mA standard signal circuits, optionally available as a signal doubler, 24 V DC. HART-transparent
C RN42: 1-channel active barrier with wide range power supply for the safe separation of 0/4 to 20 mA standard signal circuits, HART-transparent

Design



2 Thermometer design

1 Insert with mounted head transmitter (example with Φ3 mm (0.12 in))
2 Insert with mounted ceramic terminal block (example with Φ6 mm (0.24 in))
3 Terminal head
4 Thermowell
5 Process connection: flange
6 Various types of tip - for detailed information, see Section "Shape of tip":
6a Reduced or tapered for inserts with Φ3 mm (0.12 in)
6b Straight or tapered for inserts with Φ6 mm (0.24 in)
7 Protective sheath
E Extension neck length
L Immersion length
IL Insertion length

The TR13 and TC13 thermometers have a modular design. The terminal head is used as a connection module for the mechanical and electrical connection of the insert. The position of the actual thermometer sensor in the insert ensures that it is mechanically protected. The insert can be replaced or calibrated without interrupting the process. Either ceramic terminal blocks or transmitters can be fitted to the internal terminal block.

Input

Measuring variable

Temperature (temperature-linear transmission behavior)

Measuring range

Depends on the sensor type used

RTD resistance thermometer:

Sensor type	Measuring range	Connection type	Temperature-resistant 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 2x3-wire	10 mm (0.39 in)
Basis Pt100 (TF)	−50 to 200 °C (−58 to 392 °F)	3- or 4-wire 2x3-wire	10 mm (0.39 in)

TC thermocouple:

Sensor type	Measuring range	Connection type	Temperature-resistant length
Type K	−40 to 1 100 °C (−40 to 2 012 °F)	Grounded or ungrounded	Insert length
Type J	−40 to 750 °C (−40 to 1 382 °F)	Grounded or ungrounded	Insert length
Type N	−40 to 1 100 °C (−40 to 2 012 °F)	Grounded or ungrounded	Insert length

Wire resistance

Sensor type	Insert diameter	Wire resistance in Ω/m (3.28 ft)	Connection type
iTHERM StrongSens [1)]	6 mm (0.24 in)	3 Ω	3- or 4-wire
iTHERM QuickSens	6 mm (0.24 in)	3 Ω	3- or 4-wire
iTHERM QuickSens	3 mm (0.12 in)	0.2 Ω	3- or 4-wire
1x thin film sensor (TF)	6.35 mm (¼ in)	0.07 Ω	3- or 4-wire
2x thin film sensor (TF)	6.35 mm (¼ in)	0.07 Ω	2x3-wire
1x wire wound sensor (WW)	6.35 mm (¼ in)	0.6 Ω	3- or 4-wire
2x wire wound sensor(WW)	6.35 mm (¼ in)	0.6 Ω	2x3-wire
1x wire wound sensor (WW)	3 mm (0.12 in)	0.03 Ω	3- or 4-wire
2x wire wound sensor (WW)	3 mm (0.12 in)	0.17 Ω	2x3-wire

1) It is recommended to use a 3- or 4-wire measurement. If using a 2-wire measurement the resistance of the wires will influence the measured value.

Values are valid for single wire resistance and ambient temperature at 20 °C (68 °F)

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.
- By selecting the corresponding Endress+Hauser iTEMP temperature transmitter via all common protocols. All the transmitters listed below are mounted directly in the terminal head and wired with the sensory mechanism.

Family of temperature transmitters

Thermometers fitted with iTEMP transmitters are an installation-ready complete solution to improve temperature measurement by significantly increasing 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. More information can be found in the Technical Information.

HART® head transmitters
The 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 device configuration tools like FieldCare, DeviceCare or FieldCommunicator 375/475. Integrated Bluetooth® interface for the wireless display of measured values and configuration via E+H SmartBlue (app), optional. For more information, see the Technical Information.

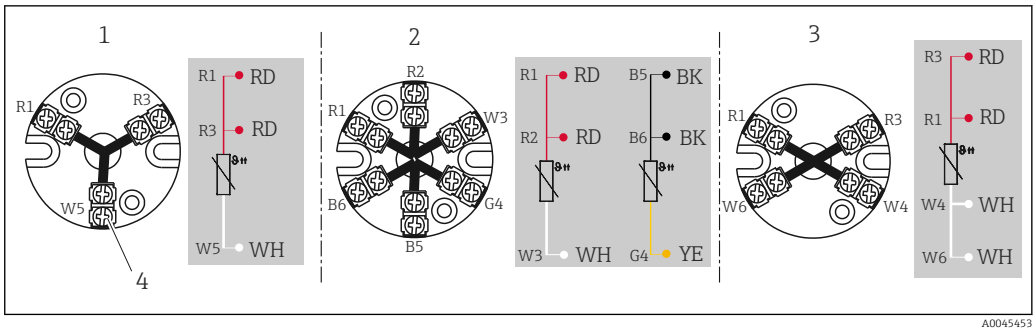
PROFIBUS® PA head transmitters
Universally programmable head transmitter with PROFIBUS® PA communication. Conversion of various input signals into digital output signals. High accuracy over the complete ambient temperature range. The configuration of PROFIBUS PA functions and of device-specific parameters is performed via fieldbus communication. For more information, see the Technical Information.

FOUNDATION Fieldbus™ head transmitters
Universally programmable head transmitter with FOUNDATION Fieldbus™ communication. Conversion of various input signals into digital output signals. High accuracy over the complete ambient temperature range. All transmitters are released for use in all important process control systems. The integration tests are performed in Endress+Hauser's "System World". For more information, see the Technical Information.

Advantages of the iTEMP transmitters:
- Dual or single sensor input (optionally for certain transmitters)
- Pluggable 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 for dual sensor input transmitters, based on Callendar-Van-Dusen-coefficients (CvD).

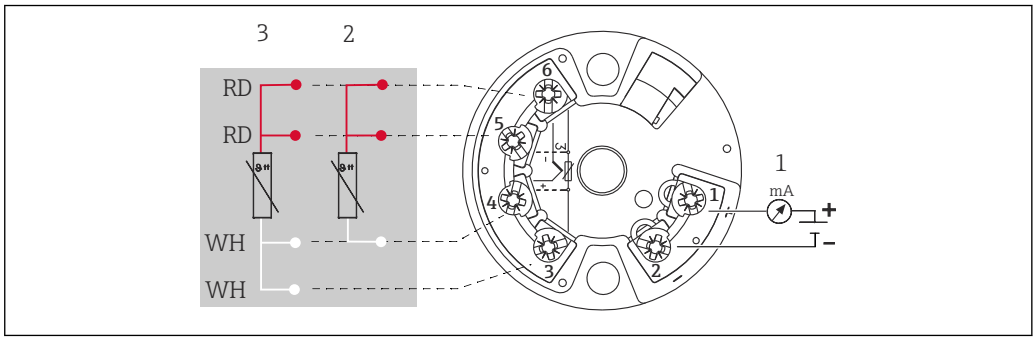
Energy supply

Type of sensor connection RTD



3 *Terminal block mounted*

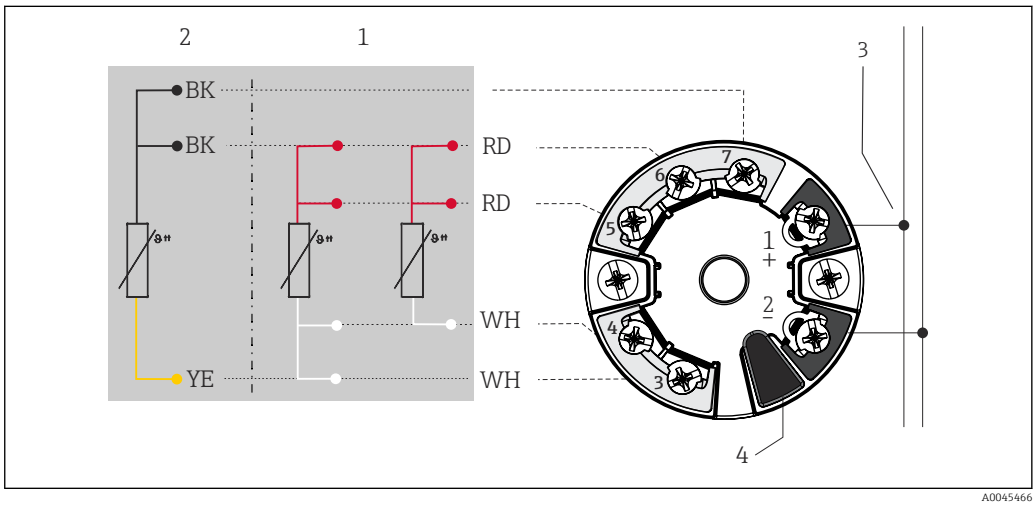
1 3-wire, single
2 2 x 3-wire, single
3 4-wire, single
4 Outside screw



4 *Head mounted transmitter TMT18x (single sensor input)*

1 Power supply, head transmitter and analog output 4 to 20 mA or fieldbus connection
2 RTD, 3-wire
3 RTD, 4-wire

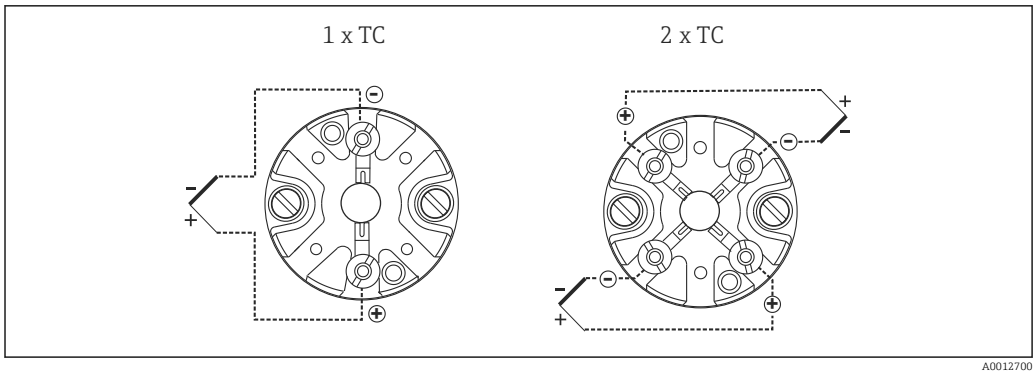
Only available with screw terminals



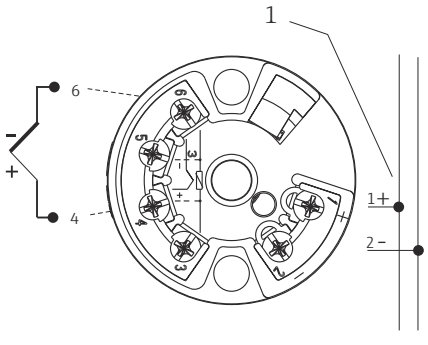
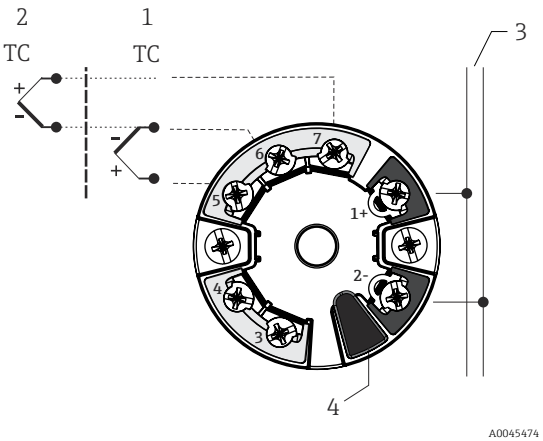
5 *Head mounted transmitter TMT8x (dual sensor input)*

1 Sensor input 1, RTD: 4- and 3-wire
2 Sensor input 2, RTD: 3-wire
3 Power supply or fieldbus connection
4 Display connection

Type of sensor connection thermocouple (TC)



6 *Terminal block mounted*

Head mounted transmitter TMT18x (single sensor input) [1]	Head mounted transmitter TMT8x (dual sensor input) [2]
 *1 Power supply, head transmitter and analog output 4 to 20 mA or fieldbus communication*	 *1 Sensor input 1* *2 Sensor input 2* *3 Fieldbus communication and power supply* *4 Display connection*

1) Fitted with screw terminals
2) Fitted with spring terminals if screw terminals are not explicitly selected or a dual sensor is installed.

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 (-)

Cable entries

See "Terminal heads" section

The cable entries must be selected during device configuration. Different terminal heads offer different options in terms of the thread and number of available cable entries.

Connectors

Endress+Hauser offers a wide variety of connectors for the simple and fast integration of the thermometer into a process control system. The following tables show the PIN assignments of the various plug connector combinations.

We advise against connecting thermocouples directly to connectors. The direct connection to the pins of the plug might generate a new 'thermocouple' which influences the accuracy of the measurement. Therefore we do not connect thermocouples directly to connectors. The thermocouples are connected in conjunction with a transmitter.

Abbreviations

#1	Order: first transmitter/insert	#2	Order: second transmitter/insert
i	Insulated. Wires marked 'i' are not connected and are insulated with heat shrink tubes.	YE	Yellow
GND	Grounded. Wires marked 'GND' are connected to the internal grounding screw in the terminal head.	RD	Red
BN	Brown	WH	White
GNYE	Green-yellow		
BU	Blue		
GY	Gray		

Terminal head with one cable entry

Connector	**1x PROFIBUS PA**								**1x FOUNDATION™ Fieldbus (FF)**			
Plug thread	M12				7/8"				7/8"			
PIN number	1	2	3	4	1	2	3	4	1	2	3	4
Electrical connection (terminal head)												
Flying leads and TC	Not connected (not insulated)											
3-wire terminal block (1x Pt100)	RD	RD	WH		RD	RD	WH		RD	RD	WH	
4-wire terminal block (1x Pt100)			WH	WH			WH	WH			WH	WH
6-wire terminal block (2x Pt100)	RD (#1) [1]	RD (#1)	WH (#1)		RD (#1)	RD (#1)	WH (#1)		RD (#1)	RD (#1)	WH (#1)	
1x TMT 4 to 20 mA or HART®	+	i	-	i	+	i	-	i	+	i	-	i
1x TMT PROFIBUS® PA	+	i	-	GND [2]	+	i	-	GND [2]	Cannot be combined			
1x TMT FF	Cannot be combined				Cannot be combined				-	+	GND	i
PIN position and color code	 1 BN 2 GNYE 3 BU 4 GY A0018929				 1 BN 2 GNYE 3 BU 4 GY A0018930				 1 BU 2 BN 3 GY 4 GNYE A0018931			

1) Second Pt100 is not connected
2) If a head is used without grounding screw, e.g. plastic housing TA30S or TA30P, insulated 'i' instead of grounded GND

Overvoltage protection

To protect against overvoltage in the power supply and signal/communication cables for the thermometer electronics, Endress+Hauser offers the HAW562 surge arrester for DIN rail mounting and the HAW569 for field housing installation.

For more information see the Technical Information "HAW562 Surge arrester" TI01012K and "HAW569 Surge arrester" TI01013K.

Performance characteristics

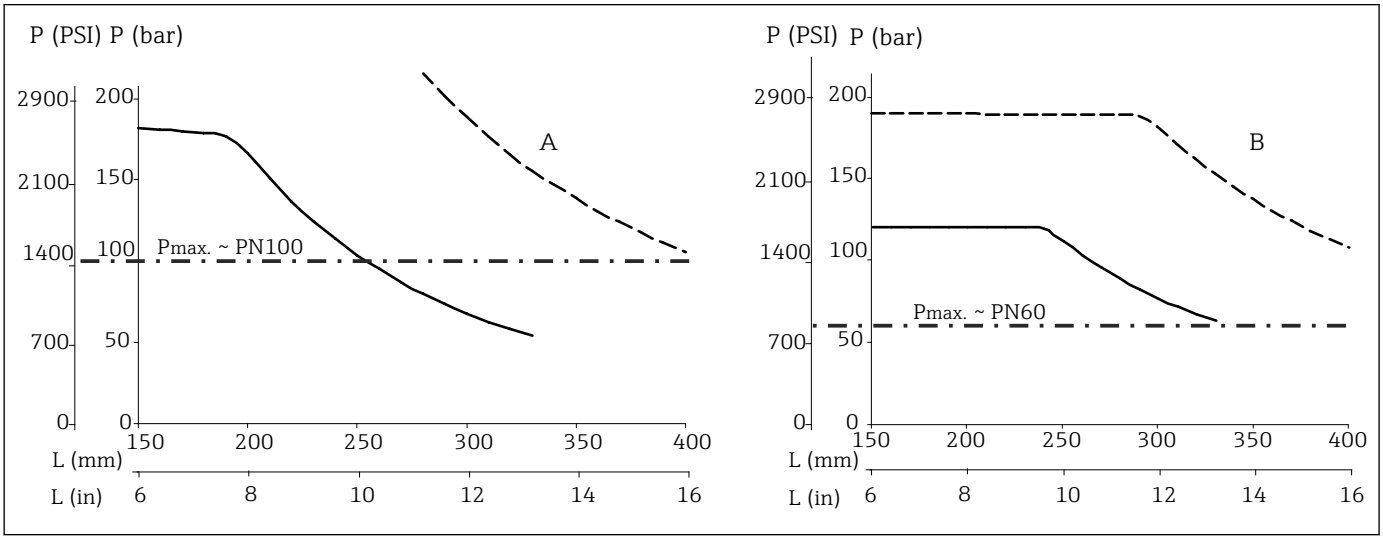
Operating conditions

Ambient temperature range

Terminal head	Temperature in °C (°F)
Without mounted head transmitter	Depends on the terminal head used and the cable gland or fieldbus connector, see 'Terminal heads' section
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)

Process pressure

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



7 *Maximum permitted process pressure for pipe diameter*

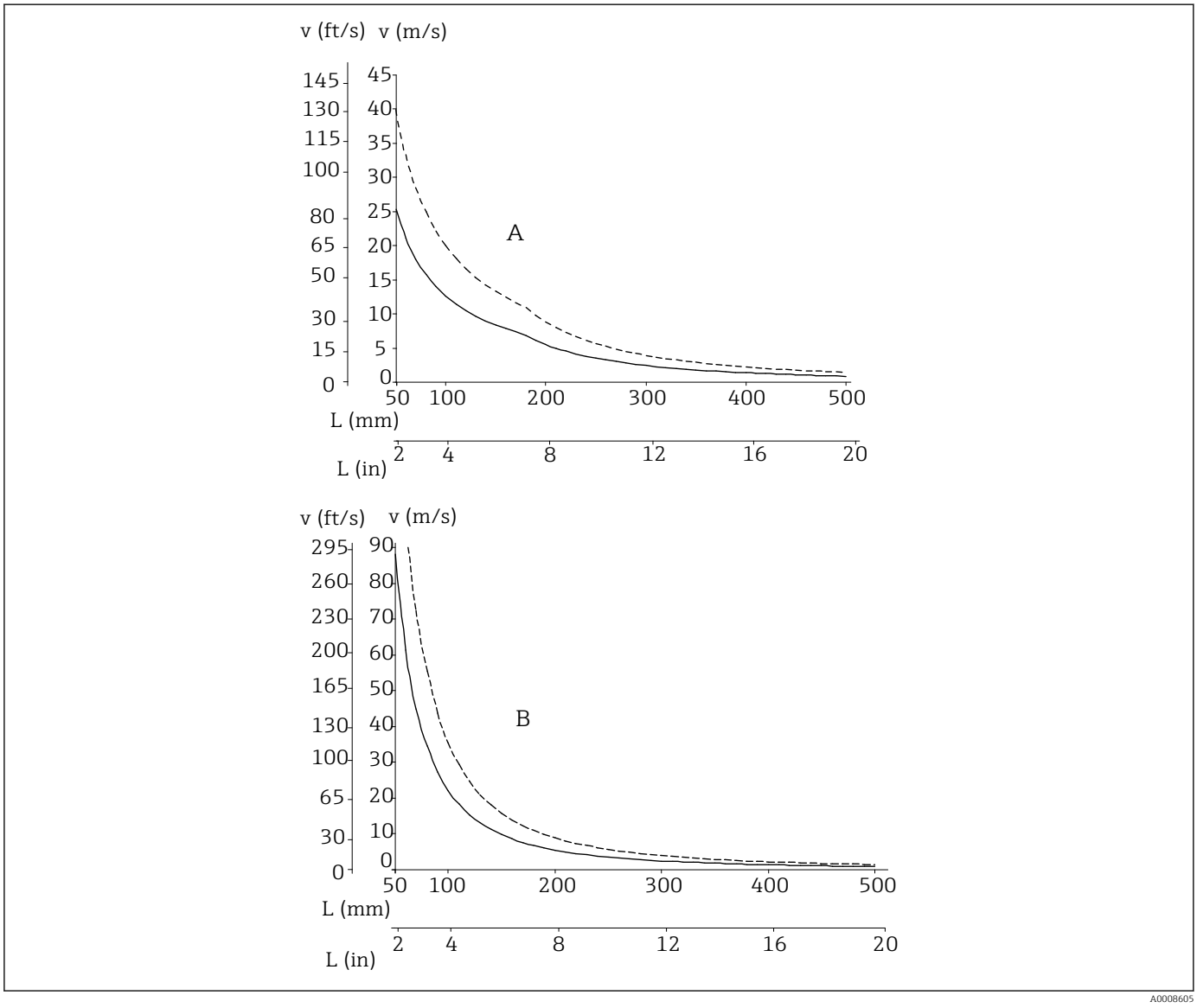
A Medium water T = 50 °C (122 °F)
B Medium superheated steam at T = 400 °C (752 °F)
L Immersion length
P Process pressure
___ Thermowell diameter 9 x 1 mm (0.35 in)
- - - Thermowell diameter 12 x 2.5 mm (0.47 in)

Please note the restriction on the maximum process pressure to the flange pressure ratings specified in the table below.

Process connection	Standard	Max. process pressure
Flange	EN1092-1 or ISO 7005-1	Depending on the flange pressure rating PNxx: 20, 40, 50 or 100 bar at 20 °C (68 °F)
	ASME B16.5	150 or 300 psi at 20 °C (68 °F) depending on the flange pressure rating
	JIS B 2220	20K, 25K or 40K depending on the flange pressure rating
	DIN2526/7	PN40 at 20 °C (68 °F) depending on the flange pressure rating

Maximum flow velocity

The maximum flow velocity tolerated by the thermowell diminishes with increasing immersion of the sensor in the liquid flow. See the figures below for more detailed information.



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8 Flow velocity depending on the immersion depth

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)
- - - Thermowell diameter 12 x 2.5 mm (0.47 in)

Shock and vibration resistance

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

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

Version	Vibration resistance for the sensor tip
Pt100 (WW or TF)	30 m/s^2 (3g) [1] quick-release fastener
iTHERM® StrongSens Pt100 (TF) iTHERM® QuickSens Pt100 (TF), version: Ø6 mm (0.24 in)	> 600 m/s^2 (60g) for sensor tip

1) Vibration resistance also valid for iTHERM QuickNeck

Accuracy

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

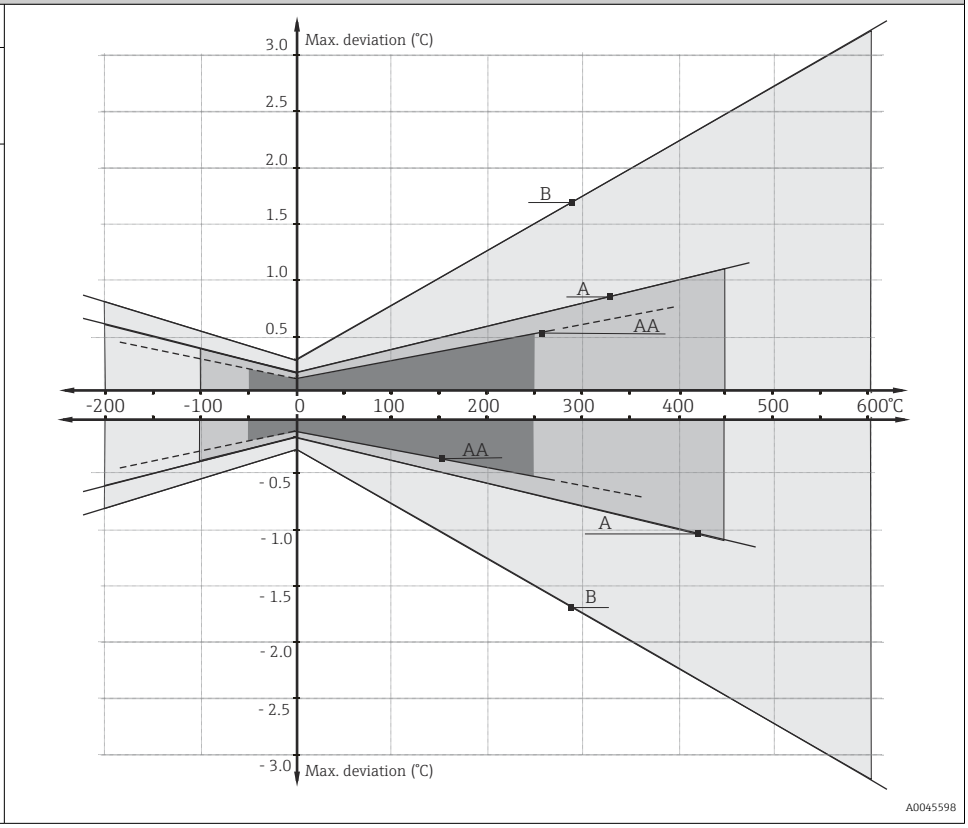
Standard	Type	Standard tolerance		Special tolerance	
IEC 60584		Class	Deviation	Class	Deviation
	J (Fe-CuNi)	2	±2.5 °C (−40 to 333 °C) ±0.0075 |t| [1] (333 to 750 °C)	1	±1.5 °C (−40 to 375 °C) ±0.004 |t| [1] (375 to 750 °C)
	K (NiCr-NiAl)	2	±2.5 °C (−40 to 333 °C) ±0.0075 |t| [1] (333 to 1200 °C)	1	±1.5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

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

Standard	Type	Standard tolerance	Special tolerance
ASTM E230/ANSI MC96.1		Deviation, the larger value applies in each case	
	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-NiAl)	±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\| = temperature absolute value in °C

RTD resistance thermometer as per IEC 60751

Class	Max. tolerances (°C)	Characteristics
RTD maximum error type TF		
Cl. A	± (0.15 + 0.002 · |t| [1])	
Cl. AA, formerly 1/3 Cl. B	± (0.1 + 0.0017 · |t|) [1]	
Cl. B	± (0.3 + 0.005 · |t| [1])	

1) |t| = absolute temperature value in °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

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

Complete assembly:

Thermometer type	Diameter	$t_{(x)}$	Reduced tip	Tapered tip	Straight tip
Resistance thermometer (measuring probe Pt100, TF/WW)	9 mm (0.35 in)	t_{50}	7.5 s	11 s	18 s
		t_{90}	21 s	37 s	55 s
	11 mm (0.43 in)	t_{50}	7.5 s	not available	18 s
		t_{90}	21 s	not available	55 s
	12 mm (0.47 in)	t_{50}	not available	11 s	38 s
		t_{90}	not available	37 s	125 s

Thermo-meter type	Diameter	$t_{(x)}$	Grounded			Ungrounded		
			Reduced tip	Tapered tip	Straight tip	Reduced tip	Tapered tip	Straight tip
Thermo-couple	9 mm (0.35 in)	t_{50}	5.5 s	9 s	15 s	6 s	9.5 s	16 s
		t_{90}	13 s	31 s	46 s	14 s	33 s	49 s
	11 mm (0.43 in)	t_{50}	5.5 s	not available	15 s	6 s	not available	16 s
		t_{90}	13 s	not available	46 s	14 s	not available	49 s
	12 mm (0.47 in)	t_{50}	not available	8.5 s	32 s	not available	9 s	34 s
		t_{90}	not available	20 s	106 s	not available	22 s	110 s

Response times for insert without transmitter.

Tested in accordance with IEC 60751 in flowing water (0.4 m/s at 30 °C):

Insert:

Sensor type	Diameter ID	Response time	Thin film (TF)
iTHERM® StrongSens	6 mm (0.24 in)	t_{50}	< 3.5 s
		t_{90}	< 10 s
TF Sensor	3 mm (0.12 in)	t_{50}	2.5 s
		t_{90}	5.5 s
	6 mm (0.24 in)	t_{50}	5 s
		t_{90}	13 s
WW Sensor	3 mm (0.12 in)	t_{50}	2 s
		t_{90}	6 s
	6 mm (0.24 in)	t_{50}	4 s
		t_{90}	12 s
Thermocouple (TPC100) grounded	3 mm (0.12 in)	t_{50}	0.8 s
		t_{90}	2 s
	6 mm (0.24 in)	t_{50}	2 s
		t_{90}	5 s
Thermocouple (TPC100) ungrounded	3 mm (0.12 in)	t_{50}	1 s
		t_{90}	2.5 s
	6 mm (0.24 in)	t_{50}	2.5 s
		t_{90}	7 s

Response time for the sensor assembly without transmitter.

Insulation resistance

- RTD:
  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
- TC:
  Insulation resistance according to IEC 1515 between terminals and sheath material with a test voltage of 500 V DC:
  - > 1 GΩ at 20 °C
  - > 5 MΩ at 500 °C

Dielectric strength

Tested at room temperature for 5 s:

- Ø 6: ≥ 1 000 V DC between terminals and insert sheath
- Ø 3: ≥ 250 V DC between terminals and insert sheath

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 +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. 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)	
Temperature range	**without head transmitter**	**with head transmitter**
−80 to 250 °C (−110 to 480 °F)	No minimum immersion length required	
250 to 550 °C (480 to 1 020 °F)	300 (11.81)	
550 to 1 400 °C (1 020 to 2 552 °F)	450 (17.72)	

Material

Extension neck and thermowell, insert

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 some cases where abnormal conditions such as high mechanical load occur or in aggressive media.

Designation	Short form	Recommended max. temperature for continuous use in air	Properties
Wetted parts			
AISI 316L/ 1.4404 1.4435	X2CrNiMo17-12-2 X2CrNiMo18-14-3	650 °C (1 202 °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) ▪ Increased resistance to intergranular corrosion and pitting ▪ Compared to 1.4404, 1.4435 has even higher corrosion resistance and a lower delta ferrite content
AISI 316Ti/ 1.4571	X6CrNiMoTi17-12-2	700 °C (1 292 °F) [1]	▪ Properties comparable with AISI 316L ▪ The addition of titanium increases 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
Inconel 600/2.4816	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
Hastelloy C276/2.4819	NiMo16Cr15W	1 100 °C (2 012 °F)	▪ Nickel-based alloy with very good resistance to oxidizing and reducing atmospheres, even at high temperatures ▪ Particularly resistant to chlorine gas and chlorides as well as many oxidizing mineral and organic acids
Protective sheath			

Designation	Short form	Recommended max. temperature for continuous use in air	Properties
PTFE (Teflon)	Polytetrafluorethylene	100 °C (212 °F)	▪ Resistance to almost all chemicals ▪ High temperature resistance ▪ Maximum permitted process pressure: <2 bar (29 psi)
PVDF	Polyvinylidene fluoride	80 °C (176 °F)	▪ High stability ▪ High creepage stability under continuous load ▪ Good low-temperature properties
Tantalum	-	250 °C (482 °F)	▪ With the exception of hydrofluoric acid, fluorine and fluorides, excellent resistance to most mineral acids and saline solutions ▪ Prone to oxidation and embrittlement at high temperatures in air

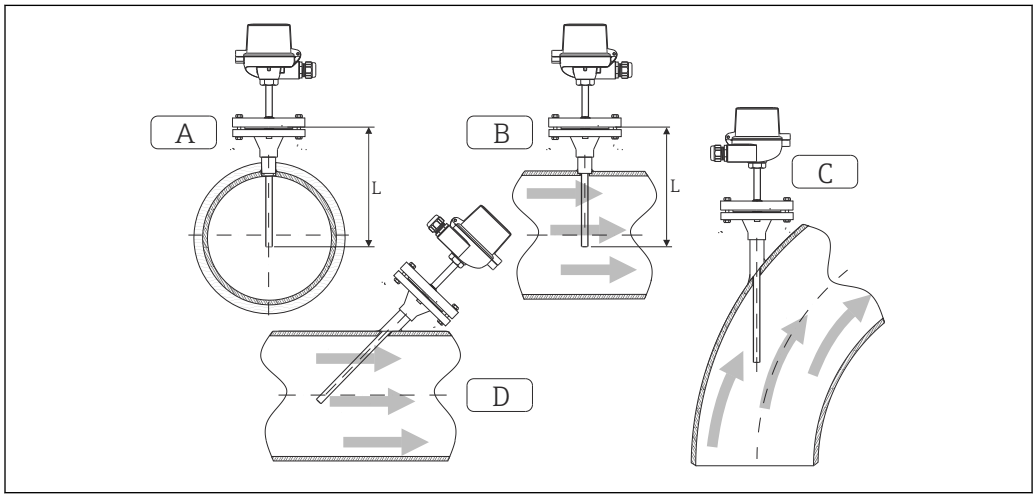
1) Can be used to a limited extent up to 800 °C (1472 °F) for low compressive loads and in non-corrosive media. Please contact your Endress+Hauser sales team for further information.

Installation

Orientation

No restrictions.

Installation instructions



9 Installation examples

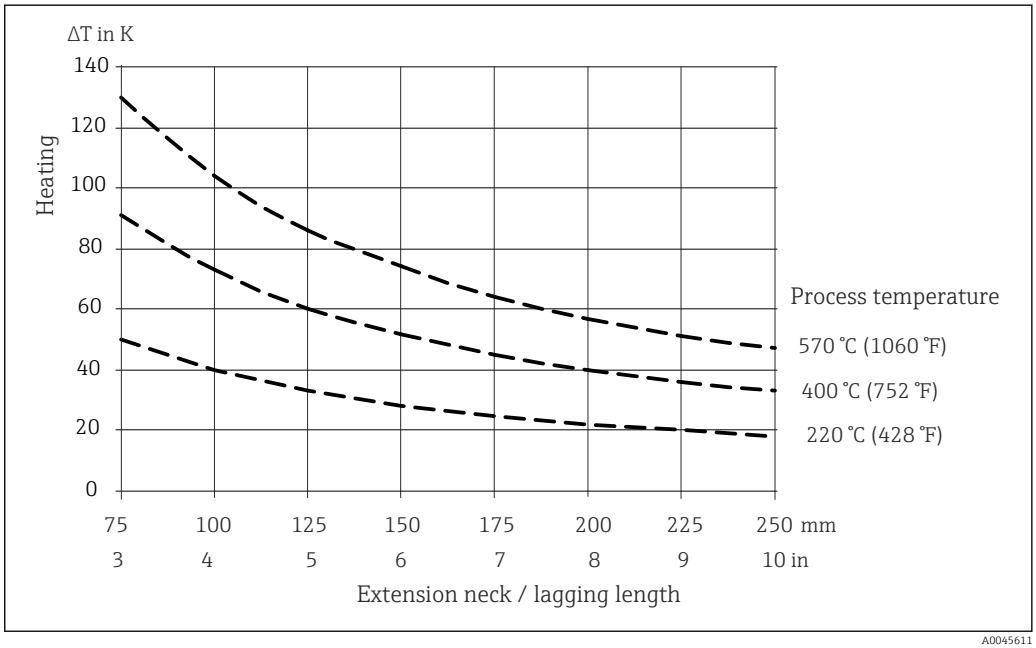
A - B In pipes with a small cross-section, the sensor tip should reach or extend slightly past the center axis of the pipe (= L).
C - D Slanted orientation.

The immersion length of the thermometer influences the accuracy. If the immersion length is too small, errors in the measurement are caused by heat conduction via the process connection and the container wall. For installation in a pipe, therefore, the recommended installation depth ideally corresponds to half of the pipe diameter. Installation at an angle (see C and D) could be another solution. When determining the immersion length or installation depth all the parameters of the thermometer and of 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 depth: 80 to 100 mm (3.15 to 3.94 in)
  The immersion length should correspond to at least 8 times the thermowell diameter. Example: thermowell diameter 12 mm (0.47 in) x 8 = 96 mm (3.8 in). We recommend a standard immersion depth of 120 mm (4.72 in).
- ATEX certification: Observe the installation instructions in the Ex documentation!

Extension neck length

The extension neck is the part between the process connection and the terminal head. As illustrated in the following diagram, the extension neck length influences the temperature in the terminal head. This temperature must remain within the limit values defined in the "Operating conditions" section.

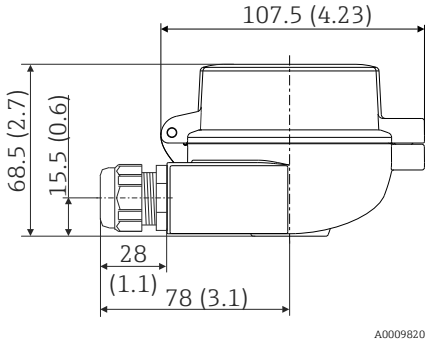


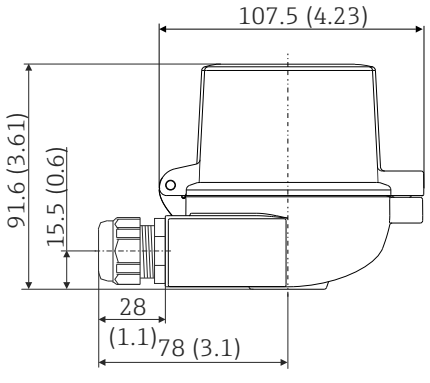
10 Heating of the terminal head as a function of the process temperature. Temperature in terminal head = ambient temperature 20 °C (68 °F) + ΔT

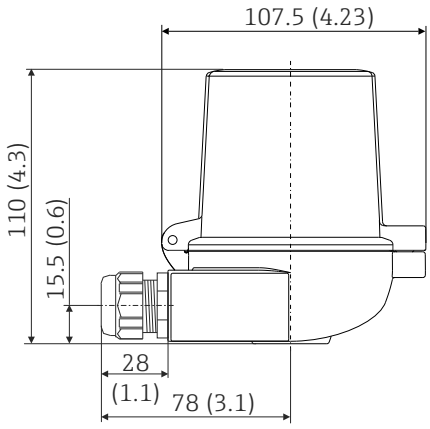
Mechanical construction

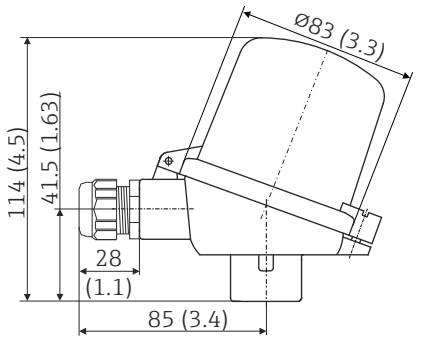
Terminal heads

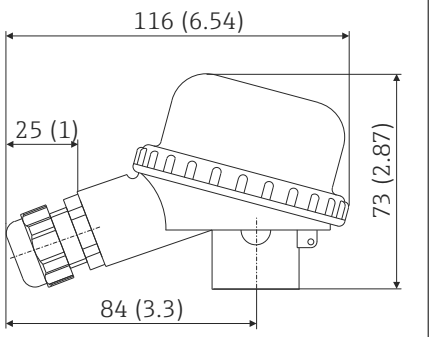
All terminal heads have an internal shape and size in accordance with DIN EN 50446, flat face and a thermometer connection of M24x1.5, G1/2" or 1/2" NPT thread. All dimensions in mm (in). The cable glands in the diagrams correspond to M20x1.5 connections. Specifications without head transmitter installed.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

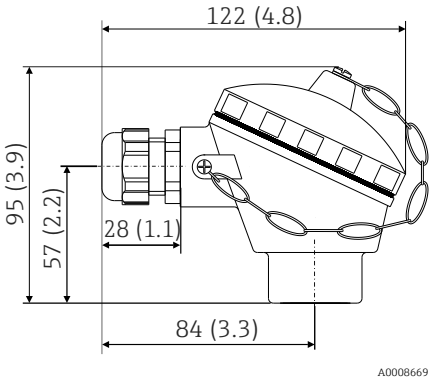
TA30A	Specification
	▪ Degree of protection: ▪ IP66/68 (NEMA Type 4x encl.) ▪ For ATEX: IP66/67 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Cable entry thread: G ½", ½" NPT and M20x1.5; ▪ Protective fitting connection: M24x1.5 ▪ Head color: blue, RAL 5012 ▪ Cap color: gray, RAL 7035 ▪ Weight: 330 g (11.64 oz) ▪ Ground terminal, internal and external ▪ Available with sensors with 3-A® symbol

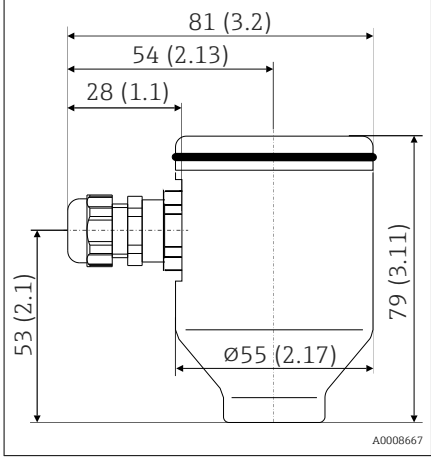
TA30A with display window in cover	Specification
	▪ Degree of protection: ▪ IP66/68 (NEMA Type 4x encl.) ▪ For ATEX: IP66/67 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Cable entry thread: G ½", ½" NPT and M20x1.5 ▪ Protective fitting connection: M24x1.5 ▪ Head color: blue, RAL 5012 Cap color: gray, RAL 7035 ▪ Weight: 420 g (14.81 oz) ▪ With TID10 display ▪ Ground terminal, internal and external ▪ Available with sensors with 3-A® symbol

TA30D	Specification
	▪ Degree of protection: ▪ IP66/68 (NEMA Type 4x encl.) ▪ For ATEX: IP66/67 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Cable entry thread: G ½", ½" NPT and M20x1.5 ▪ Protective fitting connection: M24x1.5 ▪ Two head transmitters can be mounted. In the standard configuration 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 ▪ Available with sensors with 3-A® symbol

TA30P	Specification
	▪ Degree of protection: IP65 ▪ Max. temperature: −40 to +120 °C (−40 to +248 °F) ▪ Material: polyamide (PA12), antistatic Seals: silicone ▪ Threaded cable entry: M20x1.5 ▪ Protective fitting connection: M24x1.5 ▪ Two head transmitters can be mounted. In the standard configuration one transmitter is mounted in the terminal head cover and an additional terminal block is installed directly on the insert. ▪ Head and cap color: black ▪ Weight: 135 g (4.8 oz) ▪ Type of protection: intrinsic safety (G Ex ia) ▪ Ground terminal: only internal via auxiliary terminal ▪ Available with sensors with 3-A® symbol

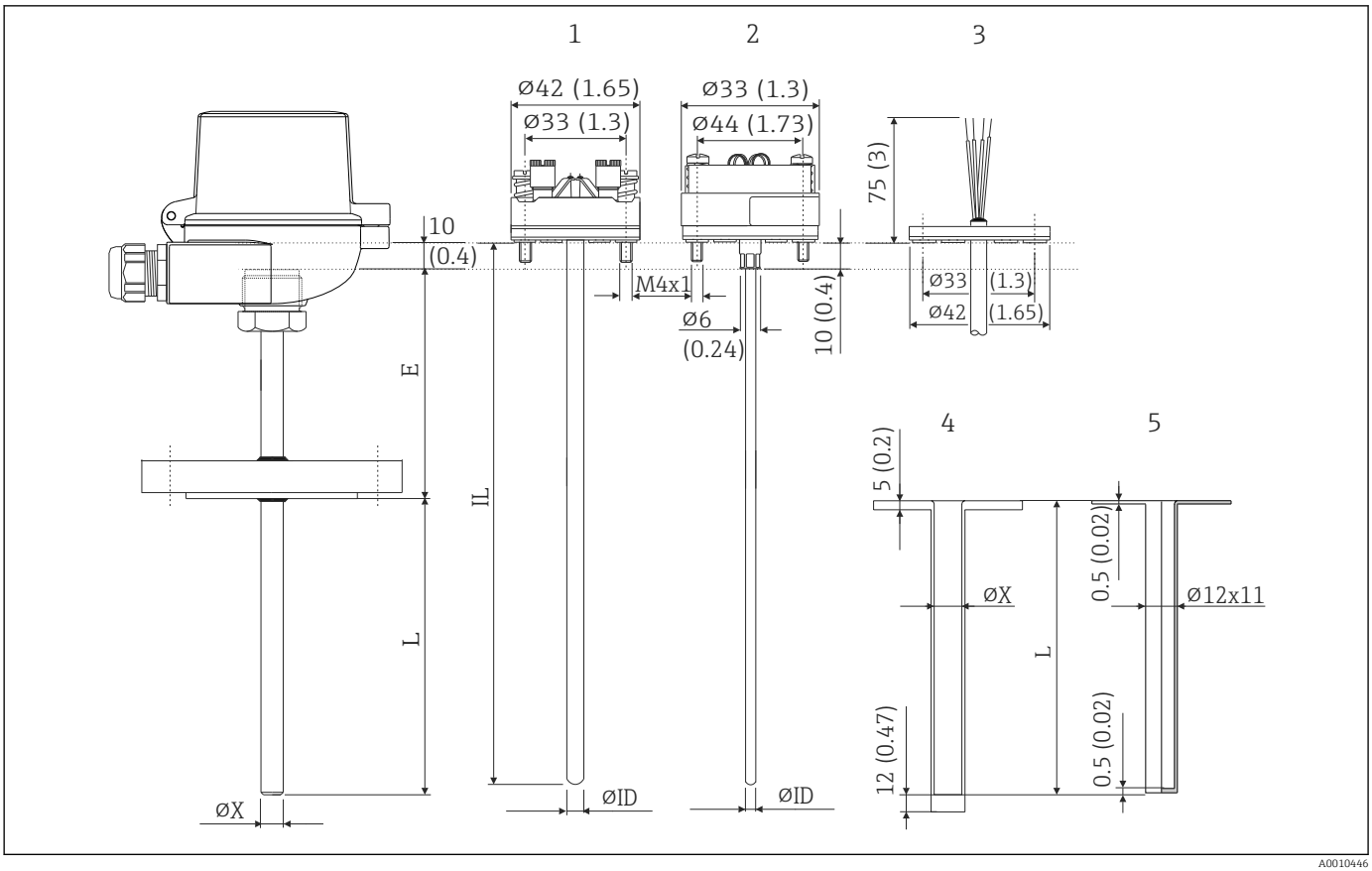
TA20B	Specification
	▪ Degree of protection: IP65 ▪ Max. temperature: −40 to +80 °C (−40 to +176 °F) without cable gland ▪ Material: polyamide (PA) ▪ Cable entry: M20x1.5 ▪ Head and cap color: black ▪ Weight: 80 g (2.82 oz) ▪ With 3-A® symbol

TA21E	Specification
	▪ Protection class: IP65 (NEMA Type 4x encl.) ▪ Temperature: −40 to 130 °C (−40 to 266 °F) silicone, up to 100 °C (212 °F) rubber seal without cable gland (observe max. permitted temperature of the cable gland!) ▪ Material: aluminum alloy with polyester or epoxy coating, rubber or silicone seal under the cover ▪ Cable entry: M20x1.5 or plug M12x1 PA ▪ Protection armature connection: M24x1.5, G 1/2" or NPT 1/2" ▪ Head color: blue, RAL 5012 ▪ Cap color: gray, RAL 7035 ▪ Weight: 300 g (10.58 oz) ▪ 3-A® marked

TA20R	Specification
	▪ Protection class: IP66/67 ▪ Max. temperature: −40 to +100 °C (−40 to +212 °F) without cable gland ▪ 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 and fieldbus connectors	
Type	**Temperature range**
Cable gland ½" NPT, M20x1.5 (non Ex)	−40 to +100 °C (−40 to +212 °F)
Cable gland M20x1.5 (for dust ignition-proof area)	−20 to +95 °C (−4 to +203 °F)
Fieldbus connector (M12x1 PA, 7/8" FF)	−40 to +105 °C (−40 to +221 °F)

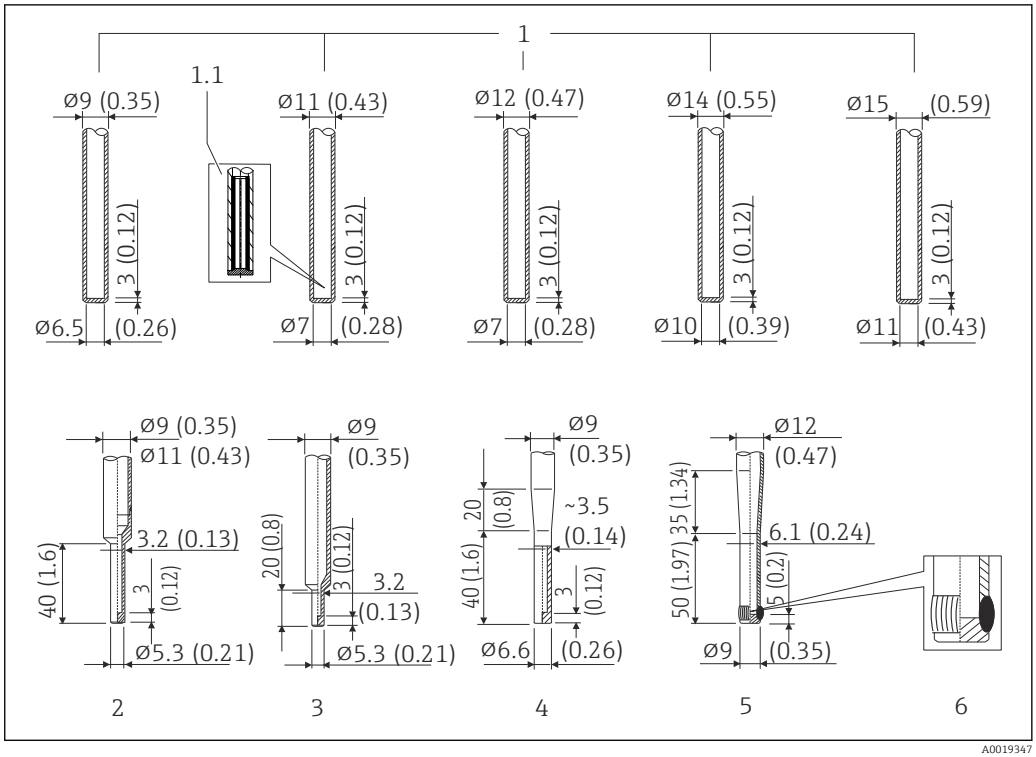
Design All dimensions in mm (in).



11 TR13 and TC13 dimensions

1 Insert with head transmitter mounted
2 Insert with head transmitter mounted
3 Insert with flying leads
4 Protective sheath (PTFE/PVDF)
5 Protective sheath (tantalum)
E Extension neck length
ΦID Insert diameter
IL Installation length of insert
L Immersion length
ΦX Thermowell diameter

Shape of tip



12 Thermowell tips available (reduced, straight or tapered). Maximum surface roughness Ra ≤ 1.6 µm (62.9 µin)

Item	Shape of tip	Insert diameter
1	Straight	6 mm (0.24 in)
2	Reduced, L ≥ 50 mm (1.97 in)	3 mm (0.12 in)
3	Reduced, L ≥ 30 mm (1.18 in) [1]	3 mm (0.12 in)
4	Tapered, L ≥ 70 mm (2.76 in) [1]	3 mm (0.12 in)
5	Tapered DIN 43772-3G, L ≥ 90 mm (3.54 in) [1]	6 mm (0.24 in)
6	Welded seam, welded seam quality according to EN ISO 5817 - Quality level B	

1) not for Hastelloy® C276/2.4819 and Inconel 600

Protective sheath

A protective cover made of PTFE (Teflon®), PVDF or tantalum is available for thermowells with straight tips and diameters measuring 11 mm (PTFE/tantalum) and 12 mm (PVDF) (0.43 and 0.47 in). If a protective cover is used, the thermowell outer diameter is 15 mm (PTFE) and 16 mm (PVDF) (0.6 and 0.63 in), 12 mm (0.47 in) for tantalum. The immersion depth L is slightly higher because of the different thermal expansion of the thermowell and protective cover. The upper part of the protective cover is fitted with a disc that is inserted between the flange and counterflange when the thermowell is installed.

Insert Different inserts are available for the thermometer depending on the application:

RTD													
Selection in the order code	A	B	C	F	G	2	3	6	7	S	T	U	V
Sensor design; connection method	1x Pt100 WW; 3-wire	2x Pt100 WW; 3-wire	1x Pt100 WW; 4-wire	2x Pt100 WW; 3-wire	1x Pt100 WW; 4-wire	1x Pt100 TF; 3-wire	1x Pt100 TF; 4-wire	1x Pt100 TF; 3-wire	1x Pt100 TF; 4-wire	1x Pt100 TF; 3-wire	1x Pt100 TF; 4-wire	1x Pt100 TF; 3-wire	1x Pt100 TF; 4-wire
Vibration resistance of the insert tip	Vibration resistance up to 3g					Increased vibration resistance up to 4g				iTHERM StrongSens vibration resistance > 60g			
Measuring range; accuracy class with temperature range	−200 to 600 °C; Cl. A, −200 to 600 °C			−200 to 600 °C; Cl. AA, 0 to 250 °C		−50 to 400 °C; Cl. A, −50 to 250 °C		−50 to 400 °C; Cl. AA, 0 to 150 °C		−50 to 500 °C; Cl. A, −30 to 300 °C		−50 to 500 °C; Cl. AA, 0 to 200 °C	
Insert type	TPR100									iTHERM TS111			
Diameter	Φ3 mm (0.12 in) or Φ6 mm (0.24 in), depending on the thermowell tip selected									Φ6 mm (0.24 in)			

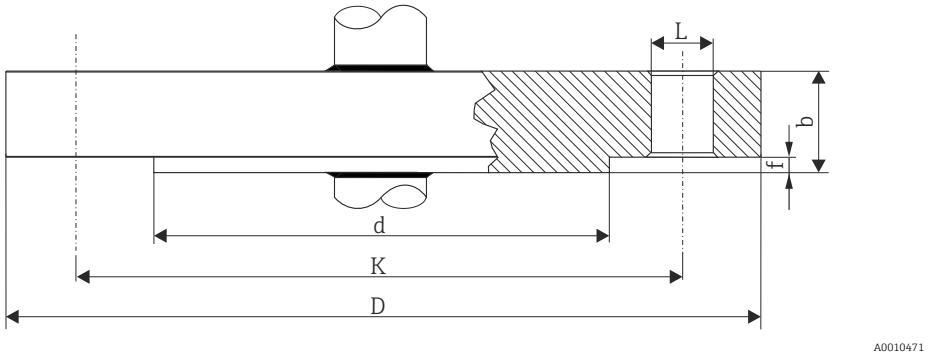
TC				
Selection in the order code	A	B	E	F
Sensor design; material	1x K; INCONEL 600	2x K; INCONEL 600	1x J; 316L	2x J; 316L
Measuring range according to:				
DIN EN 60584	−40 to 1200 °C		−40 to 750 °C	
ANSI MC 96.1	0 to 1250 °C		0 to 750 °C	
TC standard; accuracy	IEC 60584-2; Class 1 ASTM E230-03; special			
Insert type	TPC100			
Diameter	Φ3 mm (0.12 in) or Φ6 mm (0.24 in), depending on the thermowell tip selected			

Weight From 1.5 to 3.5 kg (3.3 to 7.7 lb) for standard versions.

Process connection

The following diagram shows the basic dimensions of the available flanges.

Flange



For detailed information on the flange connections, refer to the following flange standards:

- ANSI/ASME B16.5
- ISO 7005-1
- EN 1092-1
- JIS B 2220 : 2004

Ideally the flange should be made from the same material as the thermowell. The flanges are therefore available in 316L/1.4404 and in 316Ti/1.4571. Models in Hastelloy® have flanges in basic material 316L/1.4404 and a disc in Hastelloy® on the surface in contact with the process media. An additional protective sheath with a disc at the upper end is used for the PTFE/PVDF/tantalum thermowell version. The surface roughness of the standard flanges ranges from 3.2 to 6.4 µm (Ra). Other types of flanges can be supplied on request.

Spare parts

For the spare parts available for the device, refer to the relevant product page at: www.endress.com → (search for device name)

Certificates and approvals

For the approvals available, see the Configurator on the specific product page: www.endress.com → (search for device name)

Other standards and guidelines

- IEC 60529: Degree of protection of housing (IP code)
- IEC/EN 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use
- IEC 60751: Industrial platinum resistance thermometers
- IEC 60584 and ASTM E230/ANSI MC96.1: Thermocouples
- DIN 43772: Thermowells
- DIN EN 50446: Terminal heads

Material certification

The material certificate 3.1 (according to standard EN 10204) can be requested separately. The "short form" certificate includes a simplified declaration with no enclosures of documents related to the materials used in the design of the individual sensor but guarantees the traceability of the materials through the identification number of the thermometer. The data related to the origin of the materials can subsequently be requested by the client if necessary.

Thermowell testing

Thermowell pressure tests are carried out in accordance with the specifications in DIN 43772. Thermowells with tapered or reduced tips that do not comply with this standard are tested using the pressure of the corresponding straight thermowell. 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.

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

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	Software for selecting and sizing Endress+Hauser measuring devices: ▪ 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 Administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: Via the Internet: https://portal.endress.com/webapp/applicator
DeviceCare SFE100	Configuration tool for devices via fieldbus protocols and Endress+Hauser service protocols. DeviceCare is the tool developed by Endress+Hauser for the configuration of Endress+Hauser devices. All smart devices in a plant can be configured via a point-to-point or point-to-bus connection. The user-friendly menus enable transparent and intuitive access to the field devices. For details, see Operating Instructions BA00027S
FieldCare SFE500	FDT-based plant asset management tool from Endress+Hauser. 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. For details, see Operating Instructions BA00027S and BA00065S

Accessories	Description
W@M	Life cycle management for your plant W@M offers assistance 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 information is available for every measuring device over the entire life cycle, such as the device status, device-specific documentation, spare parts etc. The application already contains the data of your Endress+Hauser device. Endress+Hauser also takes care of maintaining and updating the data records. W@M is available: Via the Internet: www.endress.com/lifecyclemanagement

Thermowell sizing tool

The 'Thermowell sizing' tool can be found on the Endress+Hauser website for online calculation and engineering of all Endress+Hauser thermometer thermowells. See https://wapps.endress.com/applicator

Documentation

The following document types are available on the product pages and in the download area of the Endress+Hauser website (www.endress.com/downloads):

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 comprehensive reference** The Operating Instructions contain all the information that is required in various phases of the life cycle 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.
Safety Instructions (XA)	Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions. The nameplate indicates the Safety Instructions (XA) that are relevant to the device.
Supplementary device-dependent documentation	Additional documents are supplied depending on the device version ordered: Always comply strictly with the instructions in the supplementary documentation. The supplementary documentation is an integral part of the device documentation.

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