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Technical Information
iTHERM SurfaceLine TM611

Surface thermometer
Non-invasive RTD/TC thermometer with high measurement performance for demanding applications



Application

- Can be used universally in all industries
- Ideal for demanding process conditions such as high flow velocities, high process pressures, viscous or corrosive media, abrasion, pigging or small pipe diameters
- Perfect for subsequent installation for measurements in existing facilities for energy and safety monitoring

Your benefits

- Comparable measurement accuracy and response time as for invasive measurements
- No process opening required, no leakage risk
- Increased safety for personnel, plant and the environment
- User-friendly from product selection to installation and maintenance
- Significant cost savings: shorter development and project planning times, reduced expenses for installation, certification and inspections as well as no costs for thermowells, nozzles and flanges, weld seam inspections and pipe extensions
- iTEMP temperature transmitter with all common communication protocols and optional Bluetooth® connectivity
- International certification: e.g. explosion protection according to ATEX, IECEx, CSA and NEPSI; functional safety (SIL)

Endress+Hauser
People for Process Automation

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Function and system design

Measuring principle

Resistance thermometers (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):WW** In these thermometers, a double coil of fine, high-purity platinum wire is accommodated in a ceramic support. This support 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 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. It should be noted that, due to the operating principle of TF sensors, they frequently exhibit a relatively slight deviation in their resistance/temperature characteristic from the standard characteristic defined in IEC 60751 at higher temperatures. As a result, the tight limit values of tolerance class 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.

Non-invasive temperature measurement

Temperature measurements are critically important in the process industry to ensure product quality, safety, and process efficiency. RTD and TC thermometers are used and always only measure the temperature of their own sensor. The most efficient possible heat transfer from the medium to the sensor element is therefore the decisive factor for fast and accurate temperature measurement.

Application and benefits

Non-invasive temperature measurement is mainly used on pipelines. With this measurement method, the thermometer does not penetrate the pipe wall and does not come into direct contact with the process medium. As a result, leaks, contamination, and process disturbances are eliminated. Non-invasive thermometers are easy to install, even retroactively, and are virtually maintenance-free.

Comparison with invasive temperature measurement

When precise measurements are required, invasive temperature measurements are typically used in the process industry. In this measurement method, the thermometer with the sensor element is immersed directly into the process medium. The term "invasive temperature measurement" is also used when thermometers are installed in thermowells.

Non-invasive thermometers, on the other hand, are mounted to the outer walls of pipes or vessels using a coupling element. They therefore measure the surface temperature of the pipe, which under optimal conditions corresponds to the temperature of the process medium.

Influence of ambient conditions

The measured values can be negatively influenced in both invasive and non-invasive temperature measurements.

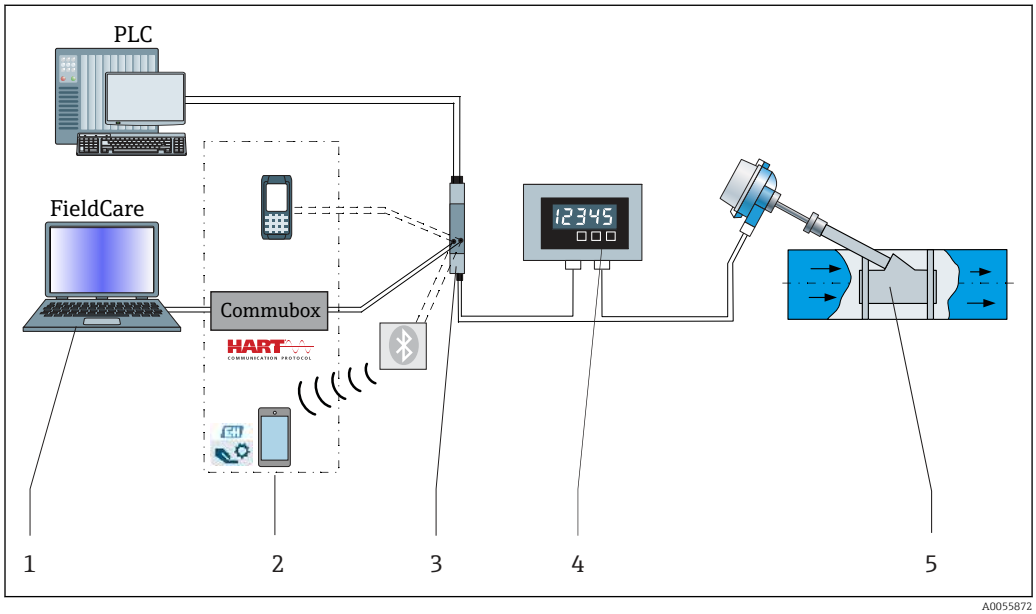
The following external factors play a role, among others:
- Ambient temperature
- Thermal masses
- Air gaps
- Surface conditions

Therefore, thermal insulation of the measuring point is required for most applications. If non-invasive measurement is additionally performed with skilful thermal coupling between the pipe and the thermometer, this type of measurement can achieve accuracies and response times comparable to those obtained with measurements using a thermowell.

Measuring system

The manufacturer provides a complete portfolio of optimized components for the temperature measuring point – everything you need for the seamless integration of the measuring point into the overall facility. This includes:
- Power supply unit/barrier
- Display units

For more information, see the brochure "System Components - Solutions for a Complete Measuring Point" (FA00016K)

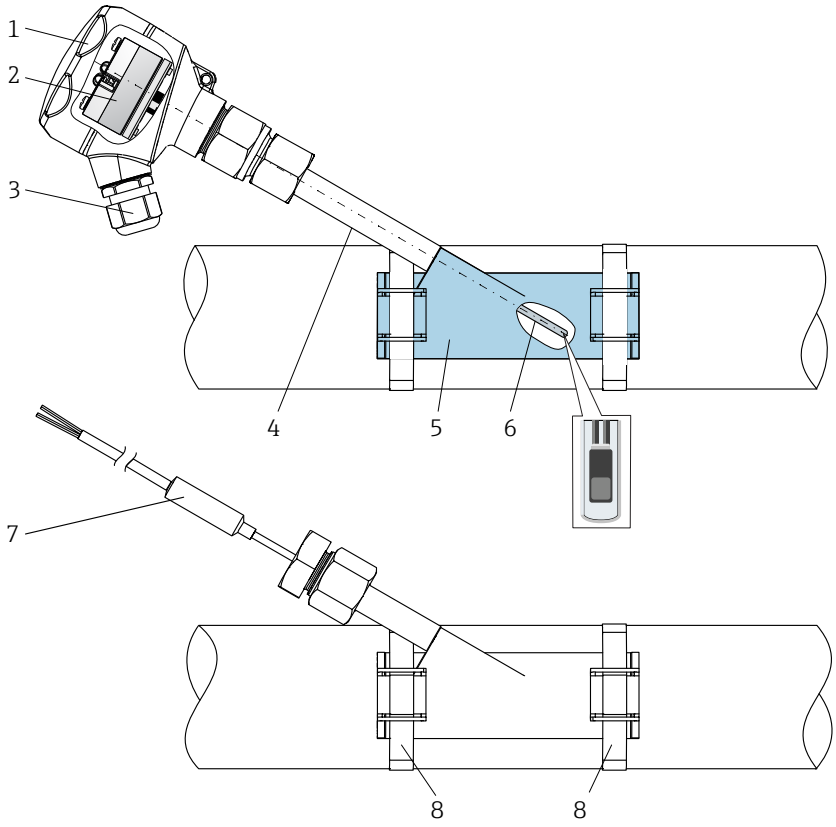


1 Example of application, measuring point layout with additional Endress+Hauser components

1 *FieldCare is a FDT-based plant asset management tool from Endress+Hauser, for details see section "accessories".*
2 *Communication examples: HART® Communicator (handheld terminal), FieldXpert, Commubox FXA195 for intrinsically safe HART® communication with FieldCare via the USB interface, Bluetooth® technology with SmartBlue app.*
3 *RN series active barriers - The RN series active barrier (e.g. with 17.5 V_{DC}, 20 mA) has a galvanically isolated output for supplying voltage to 2-wire transmitters. The universal power supply works with an input supply voltage of 24 to 230 V AC/DC, 0/50/60 Hz, which means that it can be used in all international power grids. More information on this can be found in the Technical Information under "Documentation".→ 36*
4 *2-wire process indicator from the RIA product range. The process indicator is integrated into the current loop and displays the measuring signal or HART® process variables in digital form. The process indicator does not require an external power supply. It is powered directly from the current loop. More information on this can be found in the technical documentation under "Documentation".→ 36*
5 *Installed iTHERM thermometer with HART® communication protocol.*

Equipment architecture

Construction



Options	

1: Terminal head	Variety of terminal heads made of aluminum, polyamide or stainless steel
	Your benefits:
	▪ Optimum terminal access thanks to low housing edge of bottom section:
	  ▪ Easier to use
	  ▪ Lower installation and maintenance costs
	▪ Optional display: local process indicator for added reliability

2: Wiring, electrical connection, output signal	▪ Ceramic terminal block ▪ Flying leads ▪ iTEMP head transmitter (4 to 20 mA, HART®, PROFINET® with Ethernet-APL™, PROFIBUS® PA, FOUNDATION™ Fieldbus), single channel or dual channel ▪ Plug-in display ▪ IO-Link®
3: Plug or cable gland	▪ M12 plug, PROFIBUS® PA/FOUNDATION ™ Fieldbus/PROFINET®, 4-pin ▪ Cable glands of polyamide or nickel-plated brass
4: Extension neck	Extension piece to guide the connection to the thermometer through a pipe insulation to restrict the temperature in the terminal head if necessary.
5: Coupling element	Shape and size adapted to pipe diameter for optimized heat transfer from the pipe surface to the sensor element. A coupling foil is affixed to the inner side of the coupling element. The coupling foil is used to transfer heat and is therefore an essential part of the device. It can be ordered at a later stage if necessary.
6: Insert with sensor element	Sensor models: RTD - wire wound (WW), thin-film sensor (TF) or thermocouples (TC) type J or K. Insert diameter Ø3 mm (0.12 in). The insert is not replaceable in the iTHERM SurfaceLine TM611.

Construction	
7: Cable thermometer	Thermometer with variable connecting cable without terminal head. Lightweight and flexible version, e.g. for use with remotely mounted field transmitter or DIN rail transmitter in cabinet.
8: Hose clips	Made from stainless steel for reliable mounting on the pipe.

Input

Measured variable

Temperature (temperature-linear transmission behavior)

Measuring range

Due to the design of the non-invasive thermometer, the measuring range is limited to temperatures between −196 to +400 °C.

Depends on the type of sensor used

Sensor type [1]	Measuring range
Pt100 (WW)	−200 to +600 °C (−328 to +1 112 °F)
Pt100 (TF) Basic	−50 to +200 °C (−58 to +392 °F)
Pt100 (TF) Standard	−50 to +400 °C (−58 to +752 °F)
Pt100 (TF) iTHERM QuickSens	−50 to +200 °C (−58 to +392 °F)
Pt100 (TF) iTHERM StrongSens	−50 to +500 °C (−58 to +932 °F)
Thermocouple TC, type J	−40 to +750 °C (−40 to +1 382 °F)
Thermocouple TC, type K	−40 to +1 100 °C (−40 to +2 012 °F)
Thermocouple TC, type N	

1) Options depend on product and configuration

Output

Output signal

The measured values can be transmitted in two ways:

- Via directly-wired sensors: sensor measured values are forwarded without an iTEMP transmitter.
- By selecting the appropriate iTEMP transmitter via all common protocols.

All iTEMP transmitters 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 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.

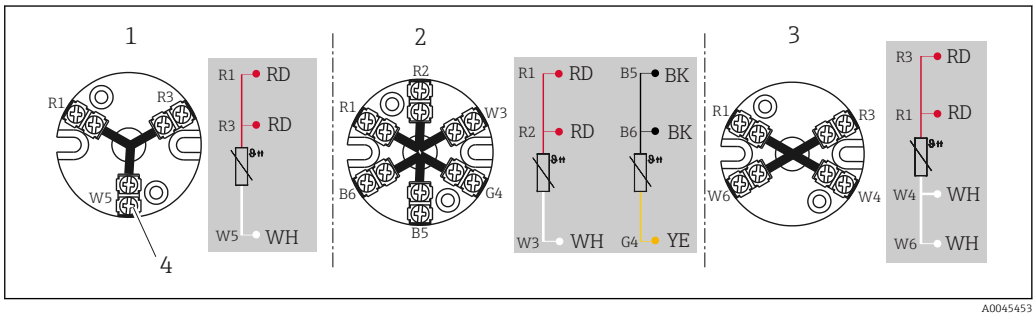
Advantages of the iTEMP transmitters:
- Double or single sensor input (optionally for certain transmitters)
- Attachable display (optionally for certain transmitters)
- Unsurpassed reliability, accuracy and long-term stability in critical processes
- Mathematical functions
- Monitoring of the thermometer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

Power supply

The sensor connection cables of the industrial thermometer are fitted with terminal lugs. The nominal diameter of the cable lugs is ø1.3 mm (0.05 in).

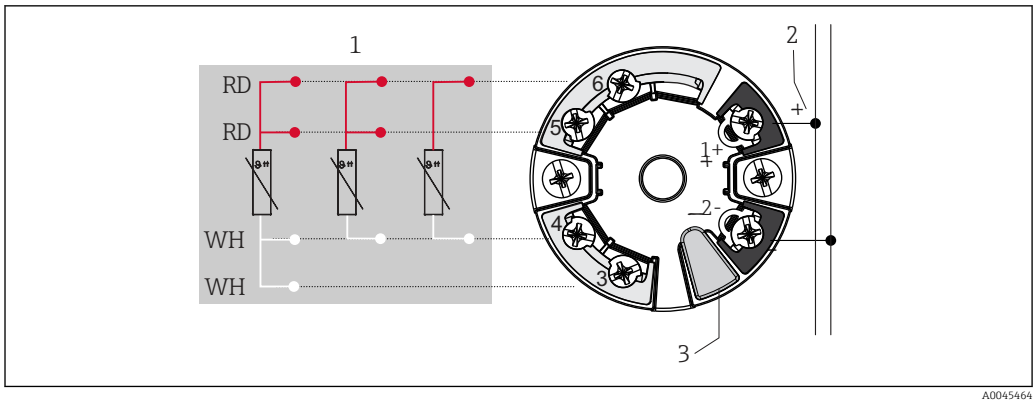
Terminal assignment

Sensor connection type: RTD industrial thermometer



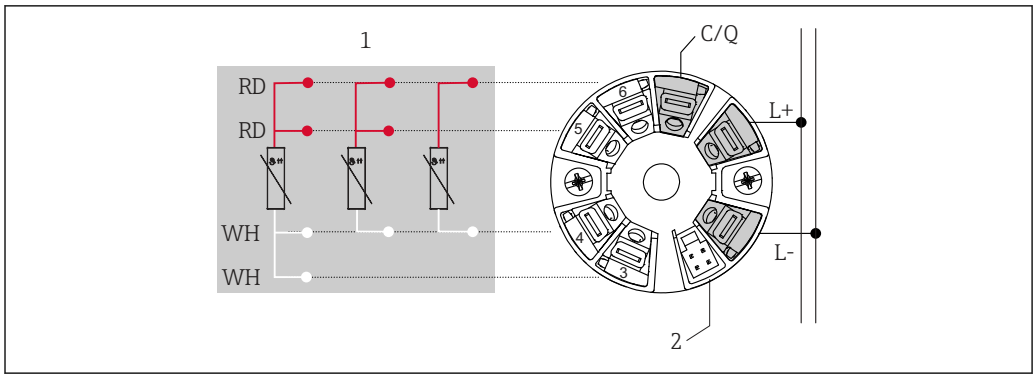
2 *Mounted ceramic terminal block*

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



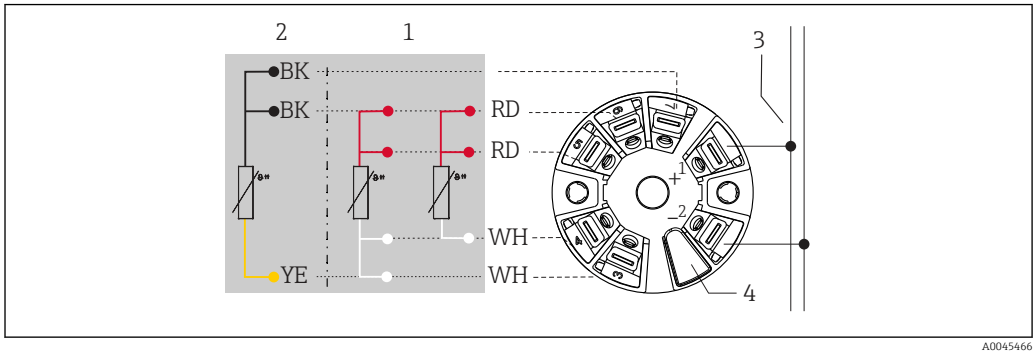
3 *Head-mounted iTEMP TMT7x transmitter or iTEMP TMT31 (single sensor input)*

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



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

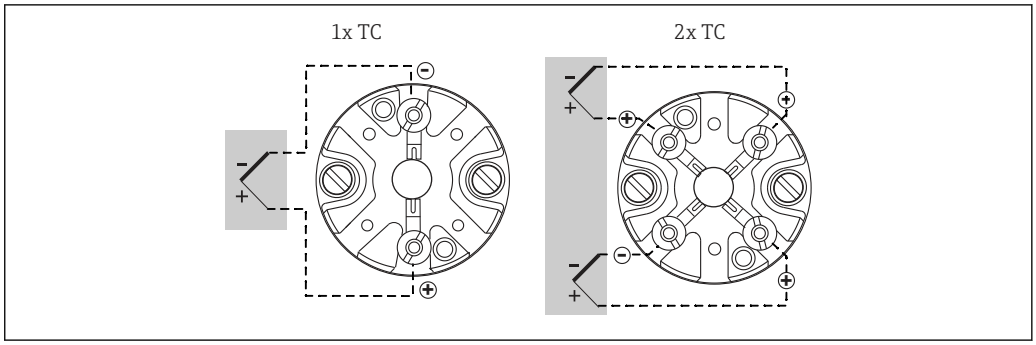
1 RTD sensor input: 4-, 3- and 2-wire
2 Display connection
L+ 18 to 30 V_{DC} power supply
L- 0 V_{DC} power supply
C/Q IO-Link or switch output



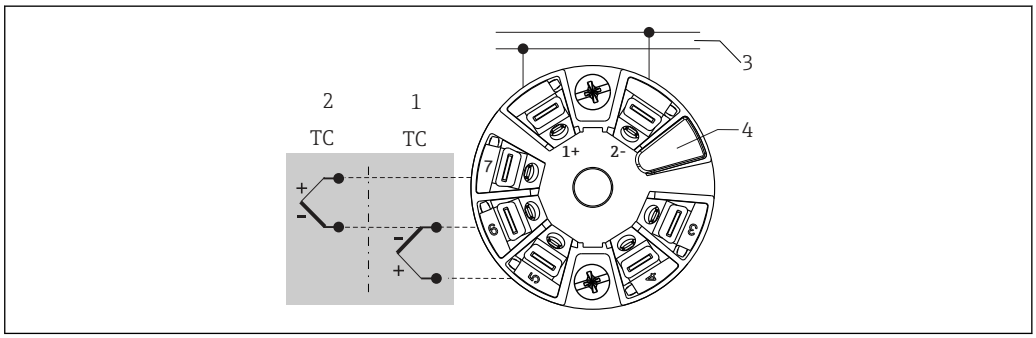
5 *Head-mounted iTEMP TMT8x transmitter (dual sensor input)*

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

Sensor connection type: Thermocouple (TC) industrial thermometer

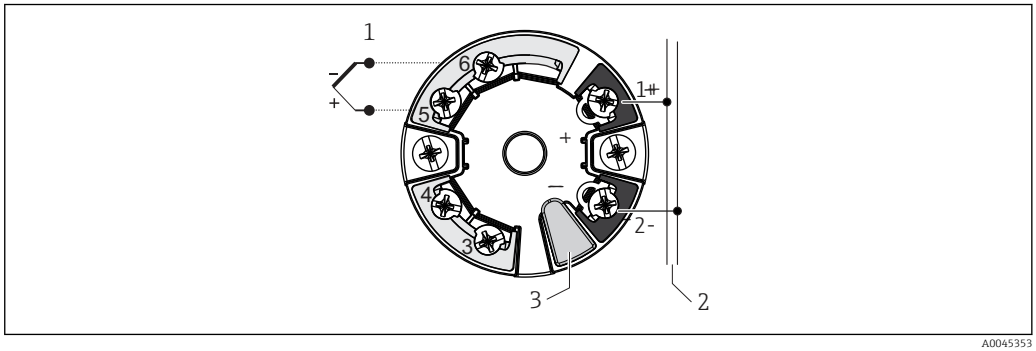


6 *Installed ceramic terminal block for thermocouples.*



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*



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

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

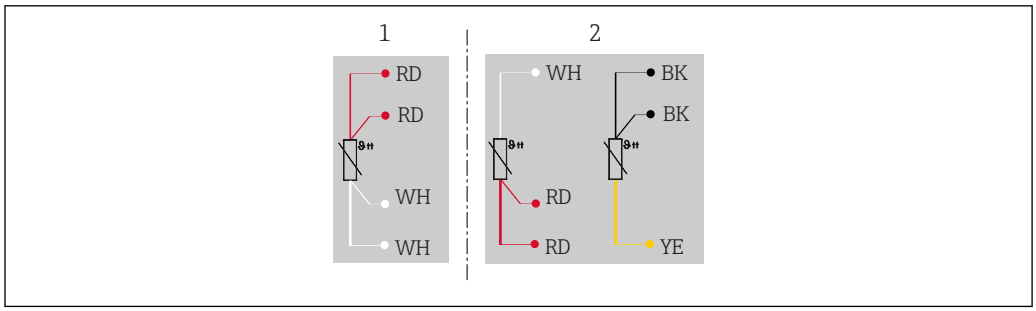
Sensor connection type: RTD cable thermometer

The sensor connection cables of the cable thermometer are fitted with terminal lugs. The nominal diameter of the end ferrules is ø 1 mm (0.03 in).

Wiring diagram

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

Wire cross-section: ≤ 0.382 mm² (AWG 22) with ferrules, length = 5 mm (0.2 in).



9 *Wiring diagram for RTD cable thermometer*

1 1x Pt100, 4-wire
2 2x Pt100, 3-wire

For the highest accuracy, a 4-wire connection is recommended or use of a transmitter.

Sensor connection type: TC cable thermometer

Wiring diagram

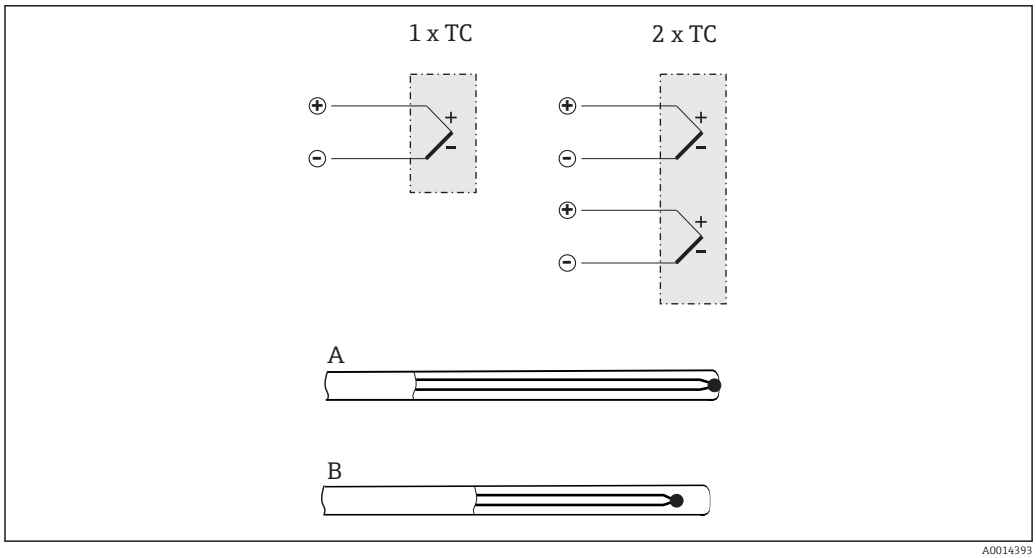
The cable thermometer is wired to the flying leads of the connection cable. The cable thermometer can be connected to a separate iTEMP temperature transmitter, for example.

Wire cross-section:

- ≤ 0.205 mm² (AWG 24) for 4-wire connection
- ≤ 0.518 mm² (AWG 20) for 2-wire connection

Thermocouple wire colors

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



10 *Wiring diagram*

A Grounded connection
B Ungrounded connection

Supply voltage

U = max. 9 to 42 V_{DC}, depending on the iTEMP temperature transmitter used.

See technical documentation of the specific iTEMP transmitter.

Current consumption

I ≤ 23 mA, depending on the iTEMP temperature transmitter used.

See technical documentation of the specific iTEMP transmitter.

Terminals

iTEMP head transmitters fitted with push-in terminals unless screw terminals are explicitly selected or a double sensor is installed.

Cable entries

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

Plug-in connector

The manufacturer 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.

The manufacturer advises 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. The thermocouples are connected in combination with a iTEMP 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	PK	Pink
BU	Blue	GN	Green
GY	Gray	BK	Black

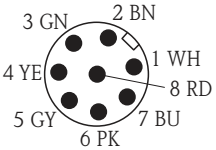
Terminal head with a cable entry [1)]

Connector	**1x PROFIBUS® PA**								**1x FOUNDATION™ Fieldbus (FF)**				**1x PROFINET® and Ethernet-APL™**			
Plug thread	M12				7/8"				7/8"				M12			
PIN number	1	2	3	4	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		RD	RD	WH	
4-wire terminal block (1x Pt100)			WH	WH			WH	WH			WH	WH			WH	WH
6-wire terminal block (2x Pt100)	RD (#1) [2)]	RD (#1)	WH (#1)		RD (#1)	RD (#1)	WH (#1)		RD (#1)	RD (#1)	WH (#1)				WH (#1)	
1x TMT 4 to 20 mA or HART®	+	i	-	i	+	i	-	i	+	i	-	i	Cannot be combined			
2x TMT 4 to 20 mA or HART® in the terminal head with a high cover	+(#1)	+(#2)	-(#1)	-(#2)	+(#1)	+(#2)	-(#1)	-(#2)	+(#1)	+(#2)	-(#1)	-(#2)	Cannot be combined			
1x TMT PROFIBUS® PA	+	i	-	GND [3)]	+	i	-	GND [3)]	Cannot be combined							
2x TMT PROFIBUS® PA	+(#1)		-(#1)		+		-									

<table>
<tr><th>Connector</th><th colspan="2">1x PROFIBUS® PA</th><th colspan="4">1x FOUNDATION™ Fieldbus (FF)</th><th colspan="4">1x PROFINET® and Ethernet-APL™</th></tr>
<tr><td>1x TMT FF</td><td rowspan="4">Cannot be combined</td><td rowspan="4">Cannot be combined</td><td>-</td><td>+</td><td rowspan="2">GND</td><td rowspan="2">i</td><td colspan="4" rowspan="2">Cannot be combined</td></tr>
<tr><td>2x TMT FF</td><td>-(#1)</td><td>+(#1)</td></tr>
<tr><td>1x TMT PROFINET®</td><td colspan="4" rowspan="2">Cannot be combined</td><td>APL signal -</td><td>APL signal +</td><td rowspan="2">GND</td><td rowspan="2">-</td></tr>
<tr><td>2x TMT PROFINET®</td><td>APL signal - (#1)</td><td>APL signal + (#1)</td></tr>
<tr><td>PIN position and color code</td><td>
1 BN
2 GNYE
3 BU
4 GY
A0018929</td><td>
1 BN
2 GNYE
3 BU
4 GY
A0018930</td><td colspan="4">
1 BU
2 BN
3 GY
4 GNYE
A0018931</td><td colspan="4">
1 RD
2 GN
A0052119</td></tr>
</table>

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

Terminal head with a cable entry [1)]

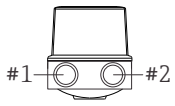
<table>
<tr><th>Connector</th><th colspan="8">4-pin/8-pin</th></tr>
<tr><td>Plug thread</td><td colspan="8">M12</td></tr>
<tr><td>PIN number</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td colspan="9">Electrical connection (terminal head)</td></tr>
<tr><td>Flying leads and TC</td><td colspan="8">Not connected (not insulated)</td></tr>
<tr><td>3-wire terminal block (1x Pt100)</td><td rowspan="3">RD</td><td rowspan="3">RD</td><td colspan="2">WH</td><td colspan="4" rowspan="2">i</td></tr>
<tr><td>4-wire terminal block (1x Pt100)</td><td>WH</td><td>WH</td></tr>
<tr><td>6-wire terminal block (2x Pt100)</td><td colspan="2">WH</td><td>BK</td><td>BK</td><td colspan="2">YE</td></tr>
<tr><td>1x TMT 4 to 20 mA or HART®</td><td rowspan="2">+(#1)</td><td rowspan="2">i</td><td rowspan="2">-(#1)</td><td rowspan="2">i</td><td colspan="4">i</td></tr>
<tr><td>2x TMT 4 to 20 mA or HART® in the terminal head with a high cover</td><td>+(#2)</td><td>i</td><td>-(#2)</td><td>i</td></tr>
<tr><td>1x TMT PROFIBUS® PA</td><td colspan="8" rowspan="2">Cannot be combined</td></tr>
<tr><td>2x TMT PROFIBUS® PA</td></tr>
<tr><td>1x TMT FF</td><td colspan="8" rowspan="2">Cannot be combined</td></tr>
<tr><td>2x TMT FF</td></tr>
<tr><td>1x TMT PROFINET®</td><td colspan="8">Cannot be combined</td></tr>
<tr><td>2x TMT PROFINET®</td><td colspan="8">Cannot be combined</td></tr>
<tr><td>PIN position and color code</td><td colspan="4">
1 BN
2 GNYE
3 BU
4 GY
A0018929</td><td colspan="4">
A0018927</td></tr>
</table>

1) Options depend on product and configuration

Terminal head with one cable entry

Plug	1x IO-Link®, 4-pin			
Plug thread	M12			
PIN number	1	2	3	4
Electrical connection (terminal head)				
Flying leads	Not connected (not insulated)			
3-wire terminal block (1x Pt100)	RD	i	RD	WH
4-wire terminal block (1x Pt100)	Cannot be combined			
6-wire terminal block (2x Pt100)				
1x TMT 4 to 20 mA or HART®	Cannot be combined			
2x TMT 4 to 20 mA or HART® in the terminal head with a high cover				
1x TMT PROFIBUS® PA	Cannot be combined			
2x TMT PROFIBUS® PA				
1x TMT FF	Cannot be combined			
2x TMT FF				
1x TMT PROFINET®	Cannot be combined			
2x TMT PROFINET®				
1x TMT IO-Link®	L+	-	L-	C/Q
2x TMT IO-Link®	L+ (#1)	-	L- (#1)	C/Q
PIN position and color code	 1 BN 3 BU 4 BK A0055383			

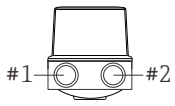
Terminal head with two cable entries [1)]

Connector	2x PROFIBUS® PA								2x FOUNDATION™ Fieldbus (FF)				2x PROFINET® and Ethernet-APL™			
Plug thread  A0021706	M12(#1) / M12(#2)				7/8"(#1)/7/8"(#2)				7/8"(#1)/7/8"(#2)				M12 (#1)/M12 (#2)			
PIN number	1	2	3	4	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/i	RD/i	WH/i		RD/i	RD/i	WH/i		RD/i	RD/i	WH/i		RD/i	RD/i	WH/i	
4-wire terminal block (1x Pt100)			WH/i	WH/i			WH/i	WH/i			WH/i	WH/i			WH/i	WH/i
6-wire terminal block (2x Pt100)	RD/BK	RD/BK	WH/YE		RD/BK	RD/BK	WH/YE		RD/BK	RD/BK	WH/YE		RD/BK	RD/BK	WH/YE	
1x TMT 4 to 20 mA or HART®	+/i	i/i	-/i	i/i	+/i	i/i	-/i	i/i	+/i	i/i	-/i	i/i	+/i	i/i	-/i	i/i
2x TMT 4 to 20 mA or HART® in the terminal head with a high cover	+ (#1)/ + (#2)		- (#1)/ -(#2)		+ (#1)/ + (#2)		- (#1)/ -(#2)		+ (#1)/ + (#2)		- (#1)/ -(#2)		+ (#1)/ +(#2)		- (#1)/ -(#2)	

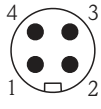
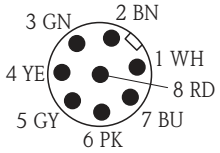
Connector	2x PROFIBUS® PA								2x FOUNDATION™ Fieldbus (FF)				2x PROFINET® and Ethernet-APL™			
1x TMT PROFIBUS® PA	+/i		-/i	GND/ GND	+/i		-/i	GND/ GND	Cannot be combined							
2x TMT PROFIBUS® PA	+ (#1)/ + (#2)		- (#1)/ -(#2)		+ (#1)/ + (#2)		- (#1)/ -(#2)									
1x TMT FF	Cannot be combined				Cannot be combined				-/i	+/i	i/i	GND/ GND	Cannot be combined			
2x TMT FF									- (#1)/ -(#2)	+ (#1)/ + (#2)						
1x TMT PROFINET®	Cannot be combined				Cannot be combined				Cannot be combined				APL signal -	APL signa l +	GND	i
2x TMT PROFINET®	Cannot be combined				Cannot be combined				Cannot be combined				APL signal - (#1) and (#2)	APL signa l + (#1) and (#2)	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 RD 2 GN A0052119			

1) Options depend on product and configuration

Terminal head with two cable entries [1)]

Connector	4-pin/8-pin							
Plug thread  A0021706	M12 (#1)/M12 (#2)							
PIN number	1	2	3	4	5	6	7	8

Electrical connection (terminal head)					
Flying leads and TC	Not connected (not insulated)				
3-wire terminal block (1x Pt100)	RD/i	RD/i	WH/i		i/i
4-wire terminal block (1x Pt100)			WH/i	WH/i	
6-wire terminal block (2x Pt100)	RD/BK	RD/BK	WH/YE		
1x TMT 4 to 20 mA or HART®	+/i	i/i	-/i	i/i	
2x TMT 4 to 20 mA or HART® in the terminal head with a high cover	+(#1)/ +(#2)		-(#1)/-(#2)		
1x TMT PROFIBUS® PA	Cannot be combined				
2x TMT PROFIBUS® PA					
1x TMT FF	Cannot be combined				
2x TMT FF					

Connector	4-pin/8-pin	
1x TMT PROFINET®	Cannot be combined	
2x TMT PROFINET®	Cannot be combined	
PIN position and color code	 1 BN 2 GNYE 3 BU 4 GY A0018929	 A0018927

1) Options depend on product and configuration

Terminal head with two cable entries

Plug	2x IO-Link®, 4-pin			
Plug thread	M12(#1)/M12 (#2)			
PIN number	1	2	3	4
Electrical connection (terminal head)				
Flying leads	Not connected (not insulated)			
3-wire terminal block (1x Pt100)	RD	i	RD	WH
4-wire terminal block (1x Pt100)	Cannot be combined			
6-wire terminal block (2x Pt100)	RD/BK	i	RD/BK	WH/YE
1x TMT 4 to 20 mA or HART®	Cannot be combined			
2x TMT 4 to 20 mA or HART® in the terminal head with a high cover				
1x TMT PROFIBUS® PA	Cannot be combined			
2x TMT PROFIBUS® PA				
1x TMT FF	Cannot be combined			
2x TMT FF				
1x TMT PROFINET®	Cannot be combined			
2x TMT PROFINET®				
1x TMT IO-Link®	L+	-	L-	C/Q
2x TMT IO-Link®	L+ (#1) and (#2)	-	L- (#1) and (#2)	C/Q
PIN position and color code	 1 BN 3 BU 4 BK A0055383			

Connection combination: insert - transmitter [1)]

Insert	Transmitter connection [2)]			
	iTEMP TMT31/iTEMP TMT7x		iTEMP TMT8x	
	1x 1-channel	2x 1-channel	1x 2-channel	2x 2-channel
1x sensor (Pt100 or TC), flying leads	Sensor (#1) : transmitter (#1)	Sensor (#1) : transmitter (#1) (Transmitter (#2) not connected)	Sensor (#1) : transmitter (#1)	Sensor (#1) : transmitter (#1) Transmitter (#2) not connected
2x sensor (2x Pt100 or 2x TC), flying leads	Sensor (#1) : transmitter (#1) Sensor (#2) insulated	Sensor (#1) : transmitter (#1) Sensor (#2): transmitter (#2)	Sensor (#1) : transmitter (#1) Sensor (#2): transmitter (#1)	Sensor (#1) : transmitter (#1) Sensor (#2): transmitter (#1) (Transmitter (#2) not connected)

Insert	Transmitter connection [2]			
	iTEMP TMT31/iTEMP TMT7x		iTEMP TMT8x	
	1x 1-channel	2x 1-channel	1x 2-channel	2x 2-channel
1x sensor (Pt100 or TC),with terminal block [3]	Sensor (#1) : transmitter in cover	Cannot be combined	Sensor (#1) : transmitter in cover	Cannot be combined
2x sensor (2x Pt100 or 2x TC) with terminal block	Sensor (#1) : transmitter in cover Sensor (#2) not connected		Sensor (#1) : transmitter in cover Sensor (#2): transmitter in cover	
2x sensors (2x Pt100 or 2x TC) in conjunction with feature 600, option MG [4]	Cannot be combined	Sensor (#1) : transmitter (#1) Sensor (#2): transmitter (#2)	Cannot be combined	Sensor (#1): transmitter (#1) - channel 1 Sensor (#2): transmitter (#2) - channel 1

1) Options depend on product and configuration
2) If 2 transmitters are selected in a terminal head, transmitter (#1) is installed directly on the insert. Transmitter (#2) is installed in the high cover. A TAG cannot be ordered for the second transmitter as standard. The bus address is set to the default value and, if necessary, must be changed manually before commissioning.
3) Only in the terminal head with a high cover, only 1 transmitter possible. A ceramic terminal block is automatically fitted on the insert.
4) Individual sensors each connected to channel 1 of a transmitter

Performance characteristics

Conditions for accurate non-invasive temperature measurement

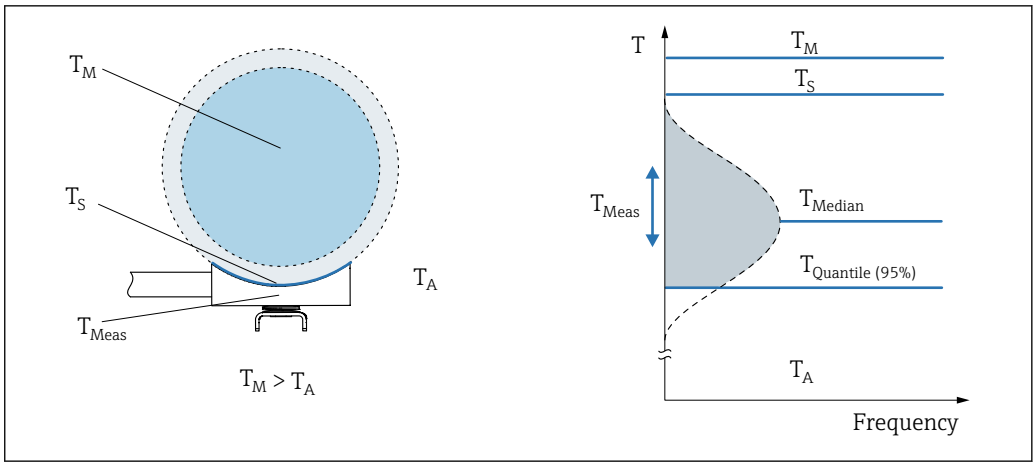
The measurement result and the measurement uncertainty of thermometers depend on many factors. For the iTHERM SurfaceLine TM611, these include in particular the type of medium, the flow velocity, and the properties of the pipe (type, material, and surface) to which the thermometer is mounted. In addition, the design of the thermometer and, above all, ambient conditions play a role in the measurement result and uncertainty.

To enable fast and accurate temperature measurement with the non-invasive thermometer iTHERM SurfaceLine TM611, the following conditions must be met:
- The coupling element of the thermometer must match the outer diameter of the pipe to be measured.
- A clean, bare pipe surface ensures the best possible measurement results.
- Ensure the thermometer is firmly seated and that the coupling element is in good contact with the pipe.
- Thermal insulation of the measuring point (between coupling element and surrounding area) is recommended.

The pipe surface in the area of the coupling element must be smooth and free from damage. This area must not contain any weld seams or similar irregularities.

Measurement error in non-invasive applications

The target variable of the temperature measurement is the medium temperature T_M. Due to the design and application of iTHERM SurfaceLine TM611, thermal measurement errors ΔT_M occur when the ambient temperature T_A differs from T_M. In such cases, the temperature T_{Meas} measured by the sensor of the thermometer deviates from the medium temperature T_M. The meaurement errors or deviations are calculated using the following formula: $\Delta T_M = T_{Meas} - T_M$. As a result, it is not possible to determine the exact medium temperature T_M, or in rarer cases, the exact measurement of the surface temperature T_S target variable of a pipe.



However, the thermometer is designed such that measurement errors are minimized, thereby optimising the accuracy of the temperature measurement.

Nevertheless, thermometers may display deviating values under identical measurement conditions - for example, due to variations during installation. This leads to a distribution of the measured values as shown in the figure above. The distribution of the measured values is characterized by T_{MEDIAN} [1] and the $T_{Quantile\ (95\%)}$ [2]

Thermal measurement errors

Thermal measurement errors ΔT_M occur with surface thermometers when the medium temperature T_M differs from the ambient temperature T_A. The greater the difference between these two values, the larger the ΔT_M. When $T_M = T_A$, there is no deviation. Based on this, the measurement errors can also be calculated using the formula: $\Delta T_M = B \times (T_M - T_A)$.

The factor B is a quality factor for the measurement and is specific to a thermometer. The lower the value of B, the lower the measurement error. If B is known, for example, the following factors may be calculated:

- $\Delta T_{M,\ Median} = B_{Median} \times (T_M - T_A)$
- $\Delta T_{M,\ Quantile\ (95\%)} = B_{Quantile\ (95\%)} \times (T_M - T_A)$

From this, the expected measurement error with iTHERM SurfaceLine TM611 for the predefined values T_M und T_A can be determined.

The following statements about measurement errors can be derived from the predefined values T_M and T_A:

- With a probability of 95% (k = 2) the measurement error at medium temperature T_M and ambient temperature T_A is less than $\Delta T_{M,\ Quantile}$.
- At medium temperature T_M and ambient temperature T_A, 50% of all measuring points will show a measurement error less than $\Delta T_{M,\ Median}$.

For the iTHERM SurfaceLine TM611 thermometer, the values for B_{Median} and $B_{Quantile\ (95\%)}$ in the temperature range 20 to 130 °C were determined under the following conditions:

- Installation of a iTHERM SurfaceLine TM611 on a pipe with a nominal diameter matching the thermometer.
- Uncoated surface with roughness as per standard and without geometric deformation.
- Wall thickness of pipe is ≤ the value defined in the standard.
- Thermal conductivity of pipe material is λ ≥ 15 W/m/K.
- Tightening torque of securing screws ≥ 2 Nm.
- The measuring point is insulated with insulation material with a U-value ≤ 0.85 W/m2/K.
- The insulating material fully encloses both the thermometer and the pipe. It is flush with the coupling element.
- Measurement conducted on water with v > 0.1 m/s.

If the above conditions are met for the iTHERM SurfaceLine TM611 thermometer, the values listed below apply for factor B. The measurement uncertainty of factor U(B) is 0.005 at k = 2.

1) 50% of all measurement results are above and 50% are below T_{Median}.
2) 95% of all measurement results are closer to T_M than to $T_{Quantile\ (95\%)}$.

Median

B_{Median}

Sensor	ø d_a ≥ 13.5 mm	ø d_a ≥ 33.7 mm	ø d_a ≥ 60.3 mm
Pt100 (TF), standard	0.015	0.007	0.004
Pt100 (WW), wire-wound	0.02	0.01	0.006

Quantile = 95 %

95% of measurements are better than the values given in the table.

$B_{Quantile\ (95\%)}$

Sensor	ø d_a ≥ 13.5 mm	ø d_a ≥ 33.7 mm	ø d_a ≥ 60.3 mm
Pt100 (TF), standard	0.02	0.014	0.010
Pt100 (WW), wire-wound	0.024	0.018	0.015

Maximum measurement error and measurement uncertainty

The iTHERM SurfaceLine TM611 thermometer can be configured with various thermometers, such as iTHERM ModuLine TM111 and temperature transmitters. Their measurement accuracy also contributes to the overall measurement accuracy in addition to the thermal measurement error ΔT_M.

The measurement errors are added according to the following formula:

$\Delta T_{TM611} = B \times (T_M - T_A) + \Delta T_{TM111} + \Delta T_{Trans}$

Here, ΔT_{TM111} is the measurement error of the thermometer used (in this case, the iTHERM ModuLine TM111) and ΔT_{Trans} is the measurement error of the temperature transmitter used.

This allows the measurement uncertainty of iTHERM SurfaceLine TM611 to be calculated as follows:

$$U(T_{TM611}) = \sqrt{((T_M - T_A) \times U(B))^2 + (U(T_{TM111}))^2 + (U(T_{Trans}))^2}$$

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The contribution $U(T_{Trans})$ is the overall accuracy of the temperature transmitter and can be found in the relevant Technical Documentation. $U(T_{TM111})$ is the contribution from the characteristic accuracy or tolerance of the thermometer used, here shown using the example of iTHERM ModuLine TM111.

The following table shows the procedure for a thermometer iTHERM SurfaceLine TM611 with a standard thin-film Pt100 insert, class A and iTEMP TMT71 with analog output, on a pipe with a nominal diameter of DN 60.3:

$B_{Quantile\ (95\ \%)}$ according to Table $B_{Quantile}$ $B_{Quantile\ (95\%)}$ = 0.01		$U(T_{TM111})$ according to IEC 60751		$U(T_{Trans})$ according to data sheet	
U(B) [1], k = 2 (2 σ)	u(B) [2], k = 1 (1 σ)	Tolerance class A	$u(T_{TM111})$, k = 1 (1 σ)	$U(T_{Trans})$, k = 2 (2 σ)	$u(T_{Trans})$, k = 1, (1 σ)
0.005	0.0025	0.15 °C + 0.002 x T_M	$\frac{1}{3}(0{,}15°C + 0{,}002 \times T_M)$	0.13 °C	0.065 °C

1) U = expanded uncertainty at k = 2.
2) u = expanded uncertainty at k = 1.

This results in a total uncertainty of:

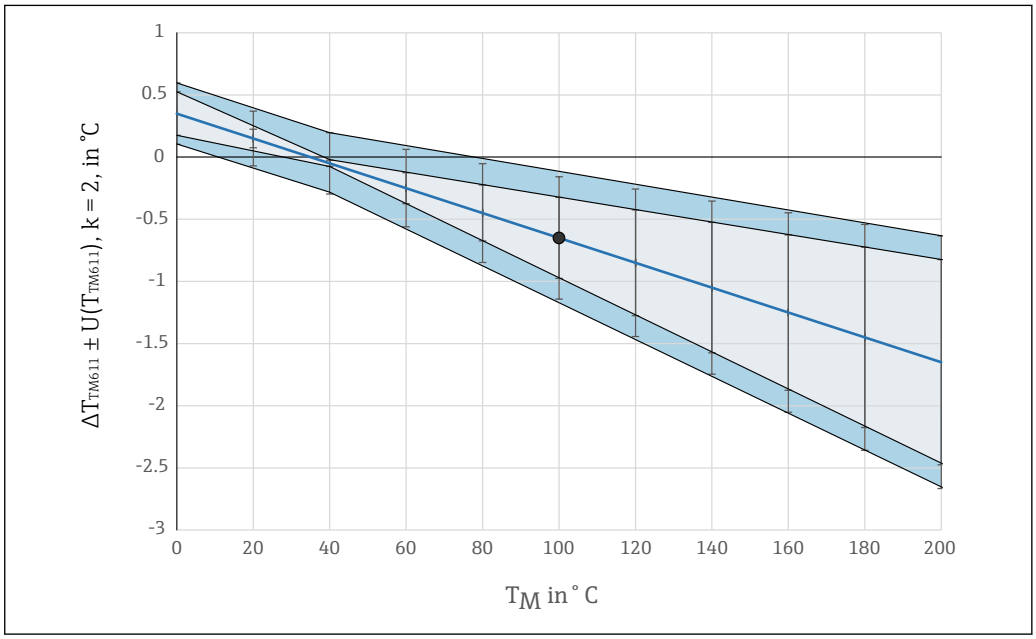
$$u(T_{TM611}) = \sqrt{\frac{1}{3}(0{,}15°C + 0{,}002 \times (T_M))^2 + (0{,}065°C)^2 + (0{,}0025 \times (T_M - T_A))^2}$$

A0058549

The expanded uncertainty for k = 2, (2 σ) is:

$U\ (T_{TM611}) = 2 \times u(T_{TM611})$.

As shown in the diagram below, for an ambient temperature of T_A = 35 °C, the measurement error ΔT_{TM611} and the uncertainty $U(T_{TM611})$ are as represented in the following diagram. From the marked data point, it can be read that for T_M = 100 °C and T_A = 35 °C on a pipe DN 60.3, in 95% of all measuring points, a deviation $\Delta T_{TM611} \leq 0.65$ °C will occur. The uncertainty $U(T_{TM611})$ = 0.5 °C (k = 2), where the contribution from $U\ (\Delta T_M)$ is 0.33 °C.



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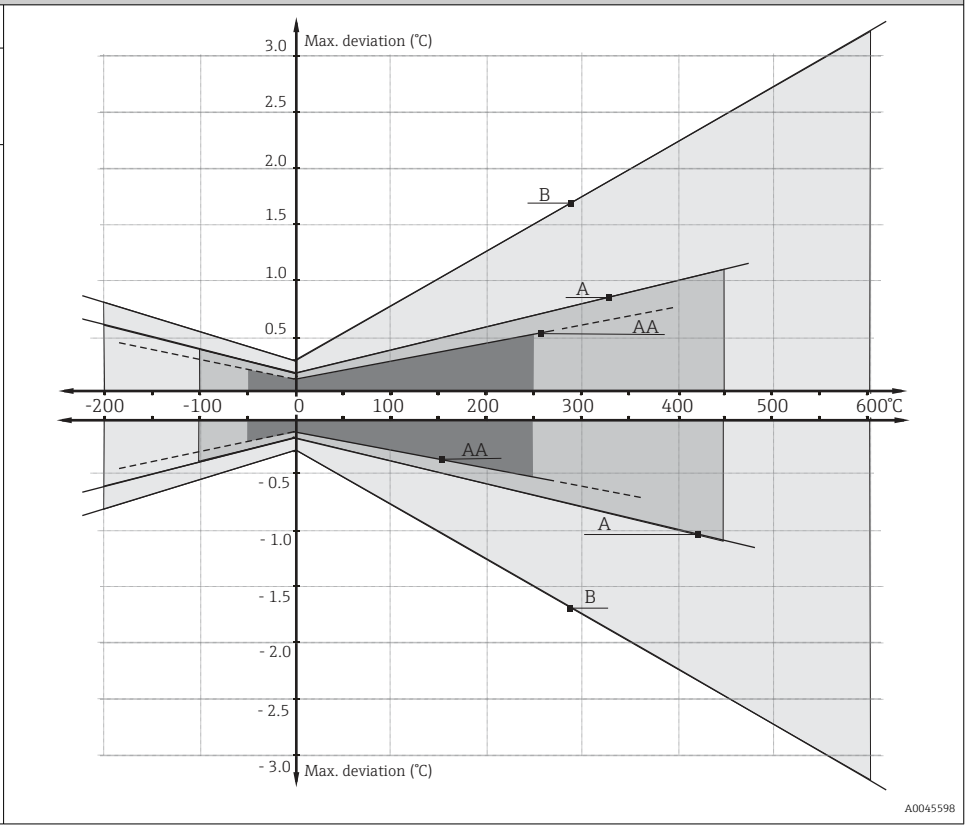
11 Measurement error for B = 0.01 and T_A = 35 °C (95 °F)

Reference operating conditions

This data is relevant for determining the measurement accuracy of the iTEMP transmitters used. See technical documentation of the specific iTEMP transmitter.

Maximum measurement error

RTD resistance thermometers as per IEC 60751:

Class	Max. tolerances (°C)	Characteristics
RTD maximum sensor error		
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| = Temperature absolute value in °C

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

The measurement error of the system depends on the installation position, the environment and insulation of the coupling element.

Temperature ranges

Sensor type [1]	Operating temperature range	Class B	Class A	Class AA
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)
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)

1) Options depend on product and configuration

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

Standard	Type [1]	Standard tolerance		Special tolerance	
IEC 60584		Class	Deviation	Class	Deviation
	J (Fe-CuNi)	2	±2.5 °C (−40 to +333 °C) ±0.0075 |t| [2] (333 to 750 °C)	1	±1.5 °C (−40 to +375 °C) ±0.004 |t| [2] (+375 to +750 °C)
	K (NiCr-NiAl) N (NiCrSi-NiSi)	2	±0.0075 |t| [2] (+333 to +1 200 °C) ±2.5 °C (−40 to +333 °C) ±0.0075 |t| [2] (+333 to +1 200 °C)	1	±1.5 °C (−40 to +375 °C) ±0.004 |t| [2] (+375 to +1 000 °C)

1) Options depend on product and configuration
2) |t| = absolute value in °C

Thermocouples made of base metals are generally supplied so that they comply with the manufacturing tolerances specified in the tables for temperatures > −40 °C (−40 °F). These materials are generally not suitable for temperatures < −40 °C (−40 °F). Class 3 tolerances cannot be satisfied. A separate material must be selected for this temperature range. This cannot be processed via the standard product.

Standard	Type [1]	Tolerance class: Standard	Tolerance class: Special
ASTM E230/ANSI MC96.1		Deviation; the larger value applies in each case	
	J (Fe-CuNi)	±2.2 K or ±0.0075 |t| [2] (0 to 760 °C)	±1.1 K or ±0.004 |t| [2] (0 to 760 °C)
	K (NiCr-NiAl) N (NiCrSi-NiSi)	±2.2 K or ±0.02 |t| [2] (−200 to 0 °C) ±2.2 K or ±0.0075 |t| [2] (0 to 1 260 °C)	±1.1 K or ±0.004 |t| [2] (0 to 1 260 °C)

1) Options depend on product and configuration
2) |t| = absolute value in °C

The materials for thermocouples are generally supplied in such a way that they comply with the tolerances specified in the table for temperatures > 0 °C (32 °F). These materials are generally not suitable for temperatures < 0 °C (32 °F). The specified tolerances cannot be satisfied. A separate material must be selected for this temperature range. This cannot be processed via the standard product.

Response time

The response time of non-invasive thermometers for water with a flow velocity 1 m/s ranges between 45 to 65 s and thus in the same range as invasive thermometers with a thermowell. The quality of the coupling, as well as the material and surface of the pipe, in addition to the insulation of the measuring point, have the greatest influence here.

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

Calibration of thermometers
Calibration refers to the comparison between the display of a piece of measuring equipment and the true value of a variable provided by the calibration standard under defined conditions. The aim is to determine the deviation or measurement errors of the UUT from the true value of the measured variable. For thermometers, calibration is usually only performed on the inserts. This checks only the deviation of the sensor element caused by the insert design. However, in most applications, the deviations caused by the design of the measuring point, integration into the process, the influence of ambient conditions, and other factors are significantly greater than the deviations related to the insert. Calibration of inserts is generally carried out using two methods:
- Calibration at fixed points, 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 either 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 measurement uncertainty may increase due to heat conduction errors and short immersion lengths. The existing measurement uncertainty is recorded on the individual calibration certificate. For accredited calibrations in accordance with ISO 17025, a measurement uncertainty that is twice as high as the accredited measurement uncertainty is not permitted. If this limit is exceeded, only a factory calibration is possible.

The device is calibrated without a coupling element. The application and the installation position of the measuring point have a significant influence on the measurement accuracy.

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 Endress+Hauser iTEMP temperature transmitters are used, 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 an 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 immersion length (IL) for inserts required to perform a correct calibration

Due to the limitations of furnace geometries, the minimum immersion lengths must be observed at high temperatures to enable a calibration to be performed with an acceptable degree of measurement 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 immersion 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 immersion length required [2]
+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) With iTEMP head transmitter min. 150 mm (5.91 in) is required
2) at a temperature of +80 to +250 °C (+176 to +482 °F), the iTEMP head transmitter requires min. 50 mm (1.97 in)

For the iTHERM SurfaceLine TM611, no replaceable insert is available. The measuring insert length relevant for calibration of the thermometer in the iTHERM SurfaceLine TM611 is calculated using the following formula: IL = extension neck length + 60 mm.

Insulation resistance

- RTD:
  Insulation resistance between the terminals and the extension neck, as per IEC 60751 > 100 MΩ at +25 °C, measured with a minimum testing voltage of 100 V_{DC}.
- TC:
  Insulation resistance as per IEC 61515 between terminals and sheath material for a test voltage of 500 V_{DC}:
  - > 1 GΩ at +20 °C
  - > 5 MΩ at +500 °C

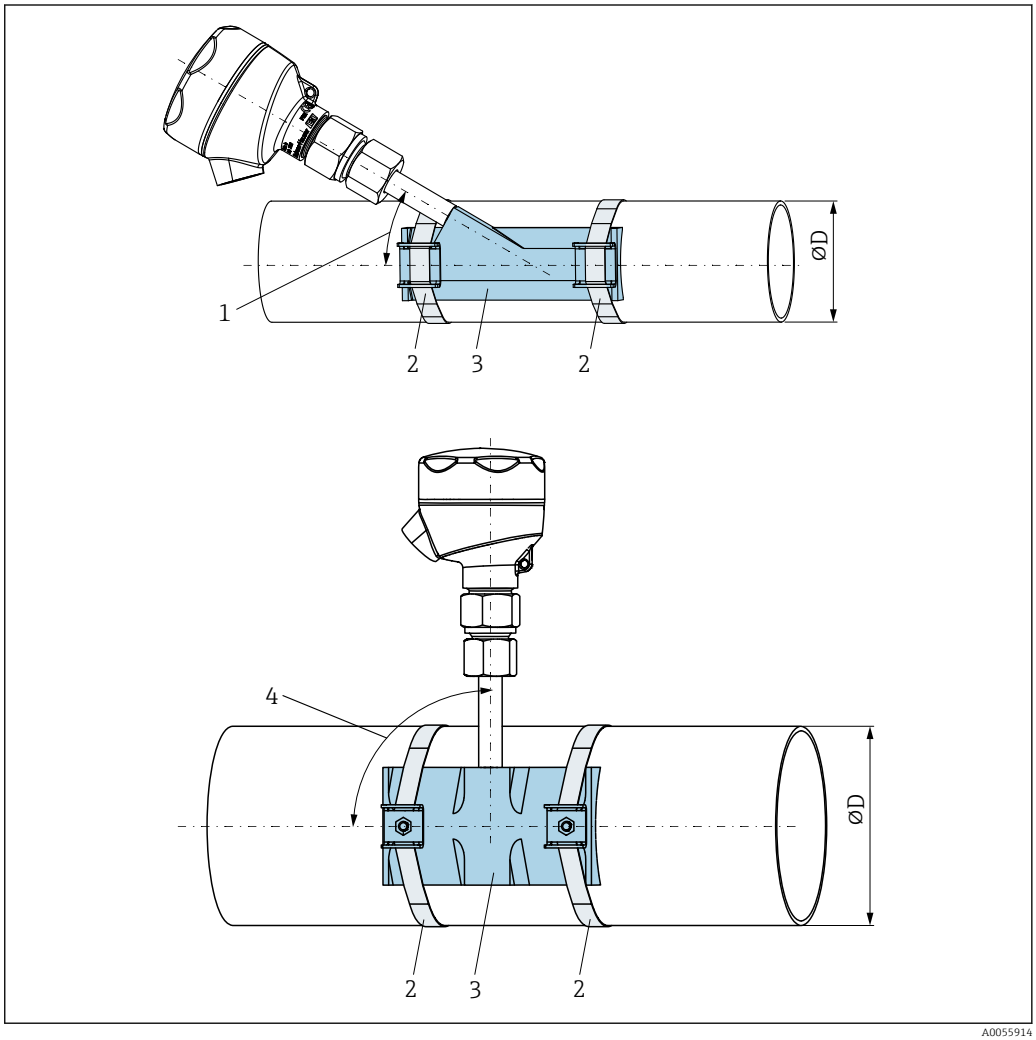
Installation

Orientation

The orientation of the thermometer can influence the measurement accuracy. The highest measurement accuracy is achieved when the terminal head is installed above the pipe and against the direction of flow.

Installation instructions

A coupling foil is attached to the inside of the coupling element for heat transfer. Do not remove the coupling foil from the coupling element.



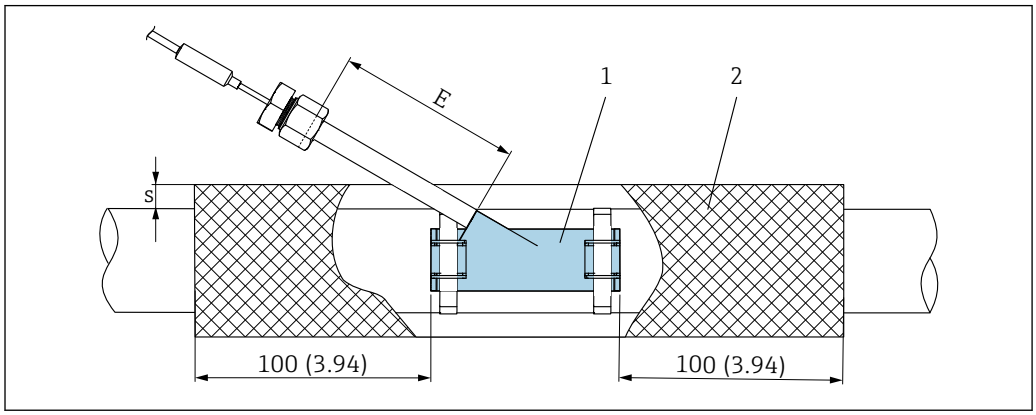
12 *Installation examples*

1 *Inclined connection angle 20°, 30° or 40 ° for pipe outer diameters of ØD < DN100*
2 *Hose clips with tightening torque = 5 Nm*
3 *Coupling element with coupling foil on the inner side*
4 *Vertical connection angle 90° for pipe outer diameters of ØD ≥ DN100*

Insulation of the measuring point

To ensure a high level of measurement accuracy, the manufacturer recommends thermal insulation of the coupling element against the environment over a length of 100 mm (3.94 in) on both sides of the coupling.

The accuracy tests were conducted with the measuring point insulated using insulation material with a U-value ≤ 0.85 W/m2/K.



1 Coupling element
2 Thermal insulation
E Extension neck length
s Thickness of the insulation

The maximum permissible thickness of the insulation depends on extension neck length E and can be calculated using the following formula:

Connection angle	Formula
90 °	0.85 x extension neck length E
20 °	0.33 x extension neck length E
30 °	0.46 x extension neck length E
40 °	0.54 x extension neck length E

Environment

Ambient temperature range

RTD and TC industrial thermometers

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 iTEMP head transmitter	−40 to +85 °C (−40 to +185 °F)
With mounted iTEMP head transmitter and display	−30 to +85 °C (−22 to 185 °F)

RTD cable thermometers

Material Connecting cable/tube insulation	Temperature in °C (°F)
PVC/PVC	80 °C (176 °F)
PTFE/silicone	180 °C (356 °F)
PTFE/PTFE	200 °C (392 °F)

TC cable thermometers

Material Connecting cable/tube insulation	Temperature in °C (°F)
PVC/PVC	80 °C (176 °F)
Glass fiber / glass fiber	400 °C (751 °F)

Storage temperature

−40 to +85 °C (−40 to +185 °F).

Operating altitude

Up to 2 000 m (6 561 ft) above sea level.

Humidity

Depends on the iTEMP transmitter used. When using iTEMP head transmitters:
- Condensation permitted as per IEC 60068-2-33
- Max. relative humidity: 95% in accordance with IEC 60068-2-30

Climate class

As per EN 60654-1, Class D

Degree of protection

Max. IP 66 (NEMA Type 4x encl.)	Depending on the design (terminal head, connector, etc.)
Partly IP 68	Tested in 1.83 m (6 ft) over 24 h

Shock and vibration resistance

The Endress+Hauser inserts exceed the requirements of IEC 60751 with regard to shock and vibration resistance of 3g in a range of 10 to 500 Hz. The vibration resistance of the measuring point depends on sensor type and design:

Sensor type [1]	Vibration resistance for the sensor tip
Pt100 (WW)	≤ 30 m/s² (≤ 3g)
Pt100 (TF) Basic	
Pt100 (TF) Standard	≤ 40 m/s² (≤ 4g)
Pt100 (TF) iTHERM StrongSens	600 m/s² (60g)
Pt100 (TF) iTHERM QuickSens, version: ø6 mm (0.24 in)	600 m/s² (60g)
Pt100 (TF) iTHERM QuickSens, version: ø3 mm (0.12 in)	≤ 30 m/s² (≤ 3g)
Thermocouple TC, type J, K, N	≤ 30 m/s² (≤ 3g)

1) Options depend on product and configuration

The vibration resistance of the entire device (thermometer and coupling element) for marine applications is ≤ 0.7 g.

Electromagnetic compatibility (EMC)

Electromagnetic compatibility in accordance with all the relevant requirements of the IEC/EN 61326 series and NAMUR Recommendation EMC (NE21). For details refer to the EU Declaration of Conformity.

Maximum measurement error < 1% of the measuring range.

Interference immunity as per IEC/EN 61326 series, industrial requirements

Interference emission as per IEC/EN 61326 series, Class B equipment

Pollution degree

Pollution degree 2.

Process

Process temperature range

Depends on sensor type and material used, max. −200 to +400 °C (−328 to +752 °F).

Process pressure range

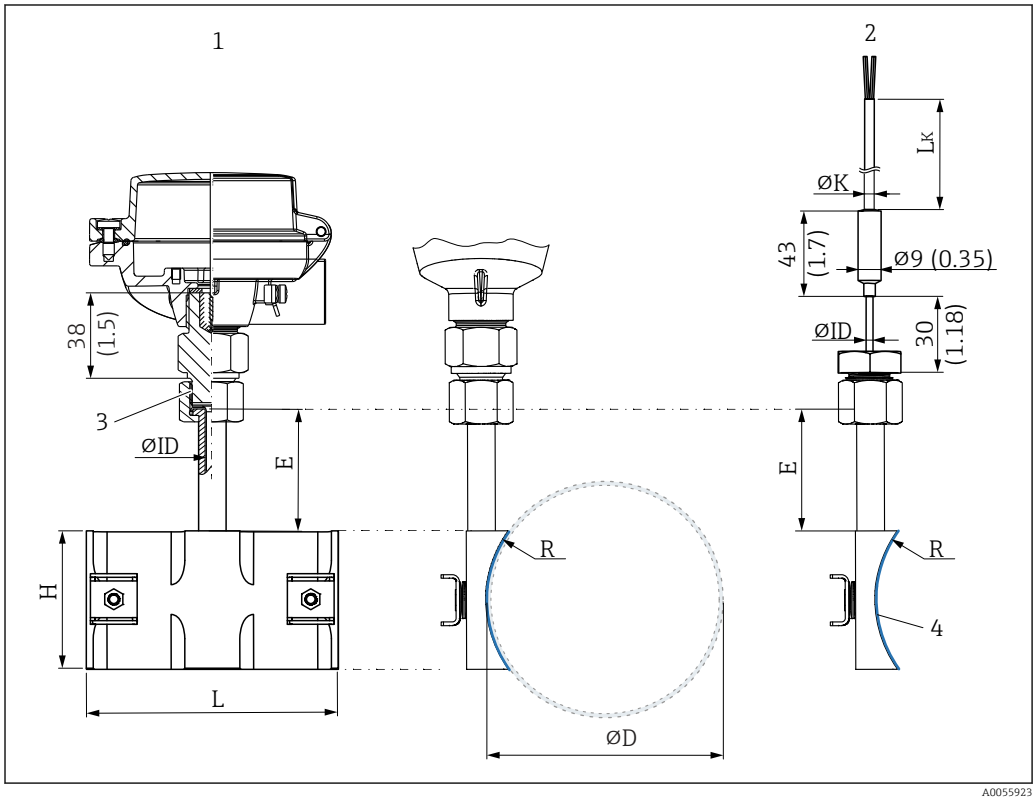
No restrictions as measurement by the thermometer is non-invasive.

Mechanical construction

Design, dimensions

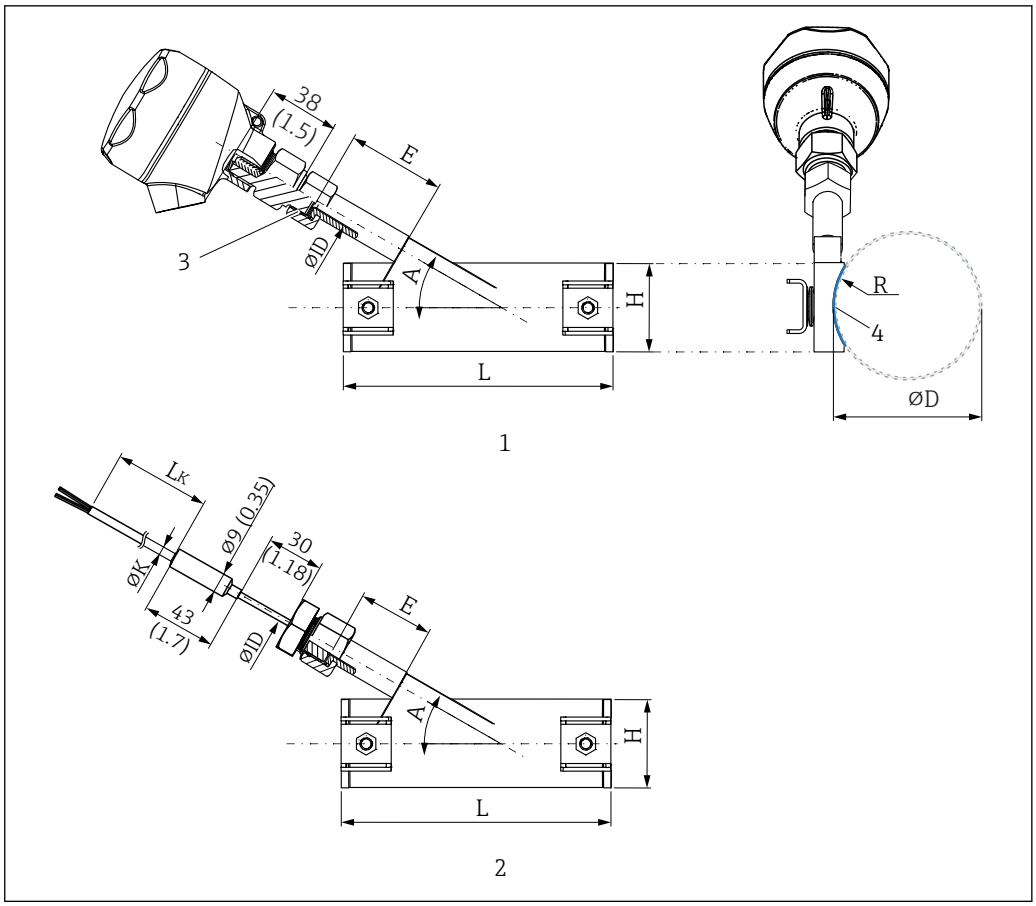
All dimensions in mm (in).

Various dimensions, such as extension neck length E for example, are variable values and are therefore indicated as items in the following dimensional drawings.



13 *Dimensions of iTHERM SurfaceLine TM611, vertical connection angle A = 90 °*

1 Industrial thermometer with terminal head
2 RTD or TC cable thermometer
3 Thermometer connection thread - Coupling element G½" (AF 27)
4 Coupling foil
ØID Insert diameter: Ø3 mm (0.12 in)



14 *Dimensions of iTHERM SurfaceLine TM611, inclined connection angle A < 90°*

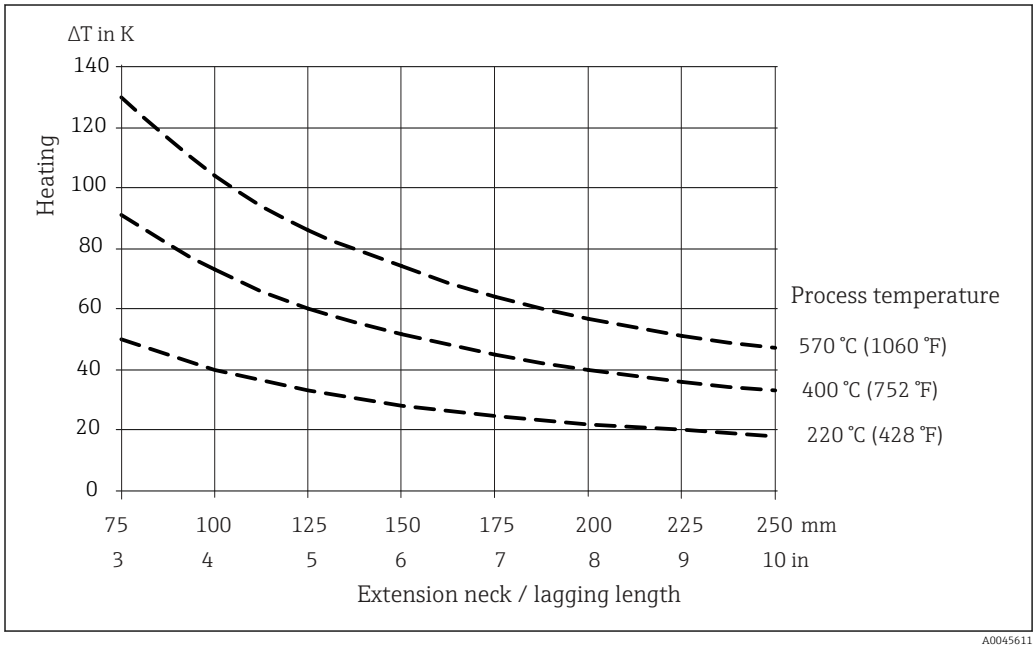
1 Industrial thermometer with terminal head
2 RTD or TC cable thermometer
3 Thermometer connection thread - Coupling element G½" (AF 27)
4 Coupling foil
ØID Insert diameter: Ø3 mm (0.12 in)

Variable dimensions:

Position	Description	Dimensions
E	Extension neck length	Standard lengths User configurable
L_K	Connecting cable length	User configurable

Pipe outer diameter ØD	Thermometer connection angle A	Coupling element radius R	Coupling element length L	Coupling element height H
DN8, ¼ in, 13.5 mm	20 °	6.75 mm (0.27 in)	120 mm	15 mm
DN15, ½ in, 21.3 mm		10.65 mm (0.42 in)	110 mm	20 mm
DN25, 1 in, 33.7 mm	30 °	16.85 mm (0.66 in)	110 mm	31 mm
DN40, 1½ in, 48.3 mm		24.15 mm (0.95 in)	110 mm	36 mm
DN50, 2 in, 60.3 mm		30.15 mm (1.19 in)	110 mm	36 mm
DN80, 3 in, 88.9 mm	40 °	44.45 mm (1.75 in)	110 mm	44 mm
DN100, 4 in, 114.3 mm	90 °	57.15 mm (2.25 in)	110 mm	65 mm
DN150, 6 in, 168.3 mm		84.15 mm (3.31 in)	110 mm	70 mm

Connecting cable; sheath insulation	Diameter ØK in mm (in)
PTFE; PTFE; 4-wire RTD	4.5 mm (0.178 in)
PTFE; silicone; 2x3-wire RTD	5.2 mm (0.2 in)
Glass fiber; 1x or 2x TC	3.6 mm (0.14 in) for 1x TC connection 4.1 mm (0.16 in) for 2x TC connection
PVC blue, 1x or 2x TC	5 mm (0.2 in) for 1x TC connection 6 mm (0.24 in) 2x TC connection



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

The diagram can be used to calculate the transmitter temperature.

Example: At a process temperature of 220 °C (428 °F) and with a total lagging and extension neck length (T+ E) of 100 mm (3.94 in), the heat conduction is 40 K (72 °F). The determined transmitter temperature is less than 85 °C(maximum ambient temperature for iTEMP temperature transmitter).

Result: The temperature of the transmitter is OK; the length of the lagging is sufficient.

Weight

Depends on product and configuration.

1 kg for standard version. [3)]

Materials

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 can be reduced considerably in cases where abnormal conditions such as high mechanical load occur or in aggressive media.

Note: The maximum temperature depends on the temperature sensor used!

3) E. g. Coupling element with short extension neck and iTHERM ModuLine TM111 with terminal head TA30R.

Material name	Short form	Recommended max. temperature for continuous use in air	Properties
AISI 316L/ 1.4404	X2CrNiMo17-12-2	650 °C (1202 °F) [1]	▪ Austenitic stainless steel ▪ High corrosion resistance in general ▪ Particularly high corrosion resistance in chlorinated 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

1) Contact the manufacturer's sales department for further information.

Inserts

The inserts are not replaceable due to the design of the device.

Sensor type RTD [1]	Pt100 (TF), basic thin film	Pt100 (TF), standard thin film	Pt100 (TF), iTHERM StrongSens	Pt100 (TF), iTHERM QuickSens [2]	Pt100 (WW), wire-wound	
Sensor design; connection method	1x Pt100, 3- or 4-wire	1x Pt100, 3- or 4-wire, mineral-insulated	1x Pt100, 3- or 4-wire, mineral-insulated	1x Pt100, 3- or 4-wire ▪ ø6 mm (0.24 in), mineral-insulated ▪ ø3 mm (0.12 in), Teflon-insulated	1x Pt100, 3- or 4-wire, mineral-insulated	2x Pt100, 3-wire, mineral-insulated
Vibration resistance of the insert tip	≤ 3g	≤ 4g	Increased vibration resistance 60 g	▪ ø3 mm (0.12 in) ≤ 3g ▪ ø6 mm (0.24 in) ≤ 60g	≤ 3g	
Measuring range; accuracy class	−50 to +200 °C (−58 to +392 °F), Class A or AA	−50 to +400 °C (−58 to +752 °F), Class A or AA	−50 to +500 °C (−58 to +932 °F), Class A or AA	−50 to +200 °C (−58 to +392 °F), Class A or AA	−200 to +600 °C (−328 to +1112 °F), Class A or AA	
Diameter	ø 3 mm (0.12 in) ø 6 mm (0.24 in)	ø 3 mm (0.12 in) ø 6 mm (0.24 in)	ø 6 mm (0.24 in)	ø 3 mm (0.12 in) ø 6 mm (0.24 in)		

1) Options depend on product and configuration
2) Recommended for immersion lengths U < 70 mm (2.76 in)

Sensor type TC [1]	Type K	Type J	Type N
Sensor design	Mineral-insulated, with Alloy600 sheathed cable	Mineral-insulated, stainless steel sheathed cable	Mineral-insulated, with Alloy TD sheathed cable
Vibration resistance of the insert tip	≤ 3g		
Measuring range	−40 to +1100 °C (−40 to +2012 °F)	−40 to +750 °C (−40 to +1382 °F)	−40 to +1100 °C (−40 to +2012 °F)
Connection type	Grounded or ungrounded		
Temperature-sensitive length	Insert length		
Diameter	ø 3 mm (0.12 in) ø 6 mm (0.24 in)		

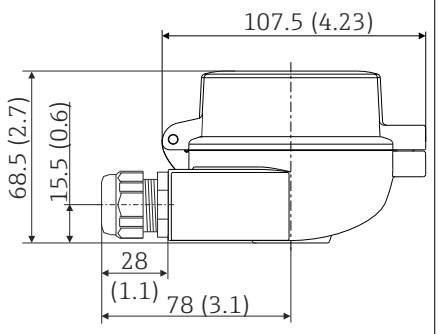
1) Options depend on product and configuration

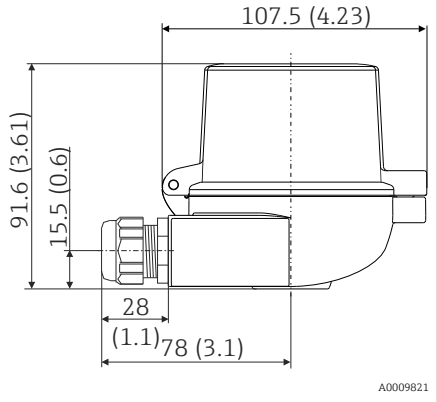
Terminal heads

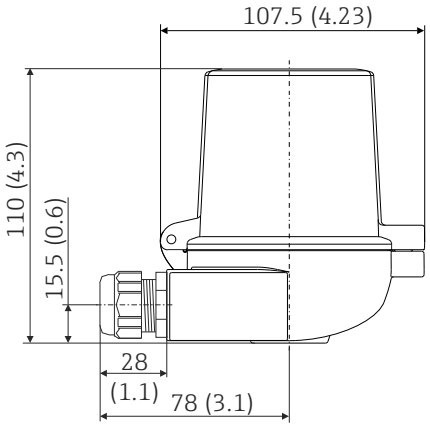
All terminal heads have an internal shape and size in accordance with DIN EN 50446, flat face, and a thermometer connection with a M24x1.5 or ½" NPT thread. All dimensions in mm (in). The sample cable glands in the diagrams correspond to M20x1.5 connections with non-Ex polyamide cable glands. Specifications without head transmitter installed. For ambient temperatures with head transmitter installed, see the "Ambient temperature range" section. → 🖹 24

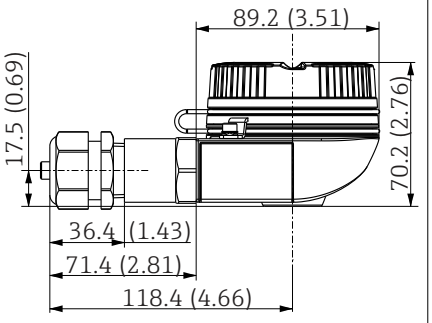
As a special feature, Endress+Hauser offers terminal heads with optimized terminal accessibility for easy installation and maintenance.

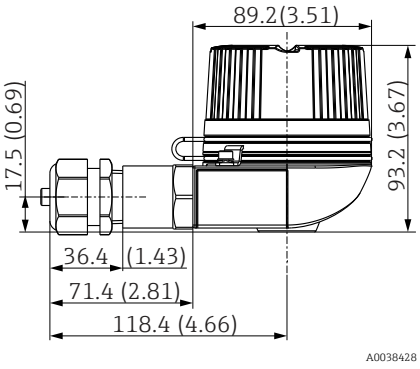
If the device is selected as a cable thermometer, no terminal head can be configured. See the "Function and system design" section.

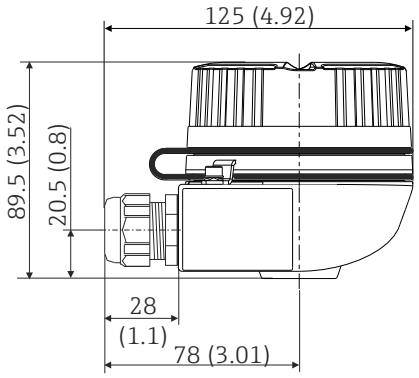
TA30A	Specification
	▪ Protection degree: ▪ IP66/68 (NEMA Type 4x encl.) ▪ For ATEX: IP66/67 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Threaded cable entry: G ½", NPT ½" and M20x1.5; ▪ Head color: blue, RAL 5012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

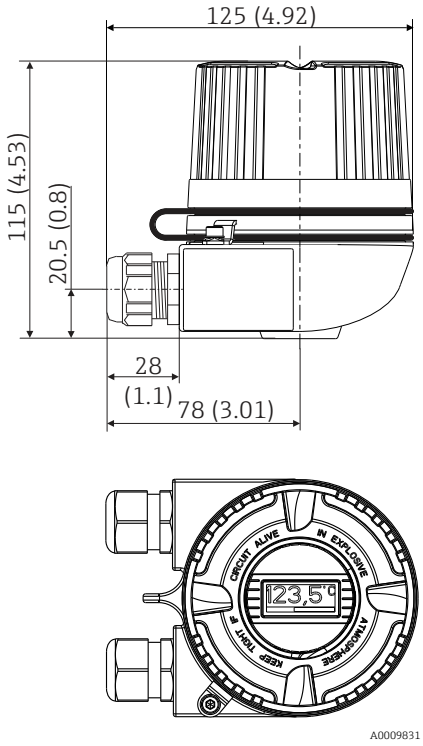
TA30A with display window in cover	Specification
	▪ Protection degree: ▪ IP66/68 (NEMA Type 4x encl.) ▪ For ATEX: IP66/67 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Threaded cable entry: G ½", NPT ½" and M20x1.5 ▪ Head color: blue, RAL 5012 Cap color: gray, RAL 7035 ▪ Weight: 420 g (14.81 oz) ▪ Display window: single-pane safety glass according to DIN 8902 ▪ Display window in cover for head transmitter with TID10 display ▪ Ground terminal, internal and external ▪ Available with sensors with 3-A® symbol

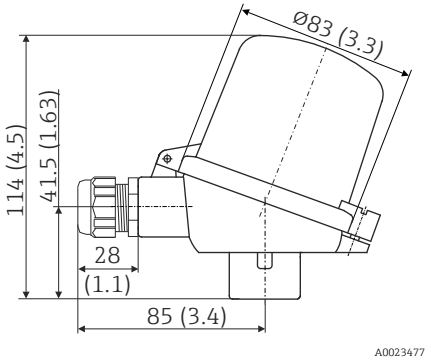
TA30D	Specification
	▪ Protection degree: ▪ IP66/68 (NEMA Type 4x encl.) ▪ For ATEX: IP66/67 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Threaded cable entry: G ½", NPT ½" and M20x1.5 ▪ Two head transmitters can be 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

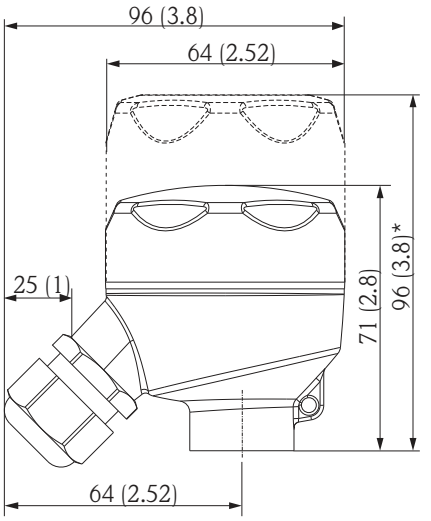
TA30EB	Specification
	▪ Screw cap ▪ Degree of protection: IP 66/68, NEMA 4x ▪ Temperature: −50 to +150 °C (−58 to +302 °F) ▪ Material: aluminum; polyester powder coating; Klüber Syntheso Glep 1 dry-film lubricant ▪ Thread: M20x1.5 ▪ Head color: blue, RAL 5012 ▪ Cap color: gray, RAL 7035 ▪ Weight: approx. 400 g (14.11 oz) ▪ Ground terminal: internal and external When the housing cover is unscrewed: Before fastening, clean the threads in the cover and on the lower part of the housing and lubricate if necessary (recommended lubricant: Klüber Syntheso Glep 1)

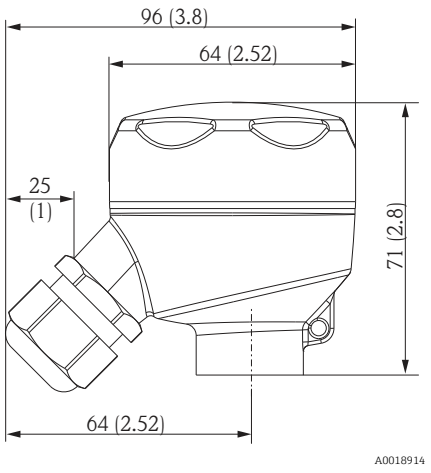
TA30EB with display window in cover	Specification
	▪ Screw cap ▪ Degree of protection: IP 66/68, NEMA 4x Ex-version: IP 66/68 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) for rubber seal without cable gland (observe max. permitted temperature of cable gland!) ▪ Material: aluminum; polyester powder coating; Klüber Syntheso Glep 1 dry-film lubricant ▪ Display window: single-pane safety glass according to DIN 8902 ▪ Thread: NPT ½", NPT ¾", M20x1.5, G½" ▪ Head color: blue, RAL 5012 ▪ Cap color: gray, RAL 7035 ▪ Weight: approx. 400 g (14.11 oz) When the housing cover is unscrewed: Before fastening, clean the threads in the cover and on the lower part of the housing and lubricate if necessary (recommended lubricant: Klüber Syntheso Glep 1)

TA30H	Specification
	▪ Flameproof (XP) version, explosion-protected, captive screw cap, available with one or two cable entries ▪ Degree of protection: IP 66/68, NEMA Type 4x Encl. Ex-version: IP 66/67 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) for rubber seal without cable gland (observe max. permitted temperature of cable gland!) ▪ Material: ▪ Aluminum, with polyester powder coating ▪ Stainless steel 316L without coating ▪ Dry lubricant Klüber Syntheso Glep 1 ▪ Thread: NPT ½", NPT ¾", M20x1.5, G½" ▪ Color of aluminum head: blue, RAL 5012 ▪ Color of aluminum cap: gray, RAL 7035 ▪ Weight: ▪ Aluminum: approx. 640 g (22.6 oz) ▪ Stainless steel: approx. 2 400 g (84.7 oz) When the housing cover is unscrewed: Before fastening, clean the threads in the cover and on the lower part of the housing and lubricate if necessary (recommended lubricant: Klüber Syntheso Glep 1)

TA30H with display window in cover	Specification
	▪ Flameproof (XP) version, explosion-protected, captive screw cap, available with one or two cable entries ▪ Degree of protection: IP 66/68, NEMA Type 4x Encl. Ex-version: IP 66/67 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) for rubber seal without cable gland (observe max. permitted temperature of cable gland!) ▪ Material: ▪ Aluminum; polyester powder coated ▪ Stainless steel 316L without coating ▪ Dry lubricant Klüber Syntheso Glep 1 ▪ Display window: single-pane safety glass according to DIN 8902 ▪ Thread: NPT ½", NPT ¾", M20x1.5, G½" ▪ Color of aluminum head: blue, RAL 5012 ▪ Color of aluminum cap: gray, RAL 7035 ▪ Weight: ▪ Aluminium approx. 860 g (30.33 oz) ▪ Stainless steel approx. 2 900 g (102.3 oz) ▪ Head transmitter optionally available with TID10 display When the housing cover is unscrewed: Before fastening, clean the threads in the cover and on the lower part of the housing and lubricate if necessary (recommended lubricant: Klüber Syntheso Glep 1)

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 ▪ 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 and cap color: black ▪ Weight: 135 g (4.8 oz) ▪ Type of protection: intrinsic safety (G Ex ia) ▪ Ground terminal: only internal via auxiliary clamp ▪ Available with sensors with 3-A® symbol

TA30R (optionally with display window in cover)	Specification
 * Dimensions of version with display window in cover	▪ Degree of protection - standard version: IP69K (NEMA Type 4x encl.) Degree of protection - version with display window: IP66/68 (NEMA Type 4x encl.) ▪ Temperature: −50 to +130 °C (−58 to +266 °F) without cable gland ▪ Material: stainless steel 316L, abrasive-blasted or polished Seals: silicone, optional EPDM for applications free from paint-wetting impairment substances Display window: polycarbonate (PC) ▪ Cable entry thread NPT ½" and M20x1.5 ▪ Weight ▪ Standard version: 360 g (12.7 oz) ▪ Version with display window: 460 g (16.23 oz) ▪ Display window in cover optionally for head transmitter with display TID10 ▪ Ground terminal: internal as standard ▪ Available with sensors with 3-A® symbol ▪ Not allowed for Class II and III applications

TA30R	Specification
	▪ Degree of protection - standard version: IP69K (NEMA Type 4x encl.) ▪ Temperature: −50 to +130 °C (−58 to +266 °F) without cable gland ▪ Material: stainless steel 316L, abrasive-blasted or polished Seals: EPDM ▪ Cable entry thread ½" NPT and M20x1.5 ▪ Weight: 360 g (12.7 oz) ▪ Protection armature connection: M24x1.5 or ½" NPT ▪ Ground terminal: internal as standard ▪ Not allowed for Class II and III applications ▪ Available with 3-A marked sensors

Cable glands and connectors [1)]

Type	Suitable for cable entry	Degree of protection	Temperature range	Suitable cable diameter
Cable gland, polyamide blue (indication of Ex-i circuit)	½" NPT	IP68	−30 to +95 °C (−22 to +203 °F)	7 to 12 mm (0.27 to 0.47 in)
Cable gland, polyamide	½" NPT, ¾" NPT, M20x1.5 (optionally 2x cable entry)	IP68	−40 to +100 °C (−40 to +212 °F)	5 to 9 mm (0.19 to 0.35 in)
	½" NPT, M20x1.5 (optionally 2x cable entry)	IP69K	−20 to +95 °C (−4 to +203 °F)	
Cable gland for dust ignition-proof area, polyamide	½" NPT, M20x1.5	IP68	−20 to +95 °C (−4 to +203 °F)	
Cable gland for dust ignition-proof area, nickel-plated brass	M20x1.5	IP68 (NEMA Type 4x)	−20 to +130 °C (−4 to +266 °F)	
M12 plug, 4-pin, 316 (PROFIBUS® PA, Ethernet-APL™, IO-Link®)	½" NPT, M20x1.5	IP67	−40 to +105 °C (−40 to +221 °F)	-
M12 plug, 8-pin, 316	M20x1.5	IP67	−30 to +90 °C (−22 to +194 °F)	-
7/8" plug, 4-pin, 316 (FOUNDATION ™ Fieldbus, PROFIBUS® PA)	½" NPT, M20x1.5	IP67	−40 to +105 °C (−40 to +221 °F)	-

1) Depending on product and configuration

Cable glands are not available for encapsulated, flameproof thermometers.

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**.

Service-specific accessories

Modems/Edge devices

Netilion
With the Netilion IIoT 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

Software

DeviceCare SFE100
DeviceCare is an Endress+Hauser configuration tool for field devices using the following communication protocols: HART, PROFIBUS DP/PA, FOUNDATION Fieldbus, IO/Link, Modbus, CDI and Endress+Hauser Common Data Interfaces.

Technical Information TI01134S

www.endress.com/sfe100

FieldCare SFE500
FieldCare is a configuration tool for Endress+Hauser and third-party field devices based on DTM technology.
The following communication protocols are supported: HART, WirelessHART, PROFIBUS, FOUNDATION Fieldbus, Modbus, IO-Link, EtherNet/IP, PROFINET and PROFINET APL.

Technical Information TI00028S

www.endress.com/sfe500

Online tools

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

System components

Data Manager of the RSG product family

Data Managers are flexible and powerful systems to organize process values. Up to 20 universal inputs and up to 14 digital inputs for direct connection of sensors, optionally with HART, are available as an option. The measured process values are clearly presented on the display and logged safely, monitored for limit values and analyzed. The values can be forwarded via common communication protocols to higher-level systems and connected to one another via individual plant modules.

For more information, please refer to: www.endress.com

Process indicators from the RIA product family

Easily readable process indicators with various functions: loop-powered indicators for displaying 4 to 20 mAvalues, display of up to four HART variables, process indicators with control units, limit value monitoring, sensor power supply, and galvanic isolation.

Universal application thanks to international hazardous area approvals, suitable for panel mounting or field installation..

For more information, please refer to: www.endress.com

RN series active barrier

Single- or two-channel active barrier for safe separation of 0/4 to 20 mA standard signal circuits with bidirectional HART transmission. In the signal duplicator option, the input signal is transmitted to two galvanically isolated outputs. The device has one active and one passive current input; the outputs can be operated actively or passively.

For more information, please refer to: www.endress.com

Documentation

The following document types are available in the Downloads area of the Endress+Hauser website (www.endress.com/downloads), depending on the device version:

Document type	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** 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, safety instructions for electrical equipment in hazardous areas are also supplied with the device. 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 a constituent part of the device documentation.

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