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Technical Information
iTHERM ModuLine TM121

Thermometer with RTD or TC insert complete with manufactured thermowell produced from pipe material

Metric version with basic technology for all standard applications. Insert replaceable without process interruption

Application

- Universal range of application
- For use in non-hazardous areas
- Measuring range: −50 to +650 °C (−122 to +2 012 °F)
- Pressure range up to 50 bar (725 psi)
- Degree of protection: up to IP 68

Head transmitter

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®-protocol

Your benefits

- Economical, reliable measurement
- User-friendly from product selection to maintenance
- Wide range of process connections
- Bluetooth® connectivity (optional)

Endress+Hauser
People for Process Automation

Table of contents

Function and system design

iTHERM ModuLine - thermometer for General Application

This thermometer is part of the product line of modular thermometers for industrial applications.

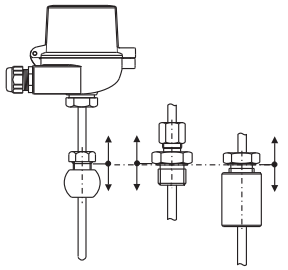
Differentiating factors when selecting a suitable thermometer

Direct contact ↓ | Version with thermowell ↓

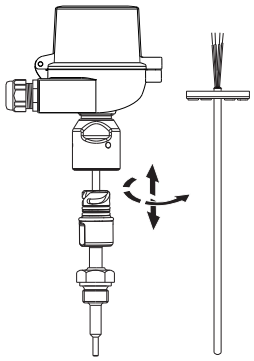
Advanced technology

Advanced thermometers offer cutting-edge technology with features such as a replaceable insert, quick-fastening extension neck (iTHERM QuickNeck), vibration-resistant and fast-response sensor technology (iTHERM StrongSens and QuickSens) and safety features like approvals for use in hazardous areas, second process barrier "Dual Seal" or SIL thermometers

TM111 advanced



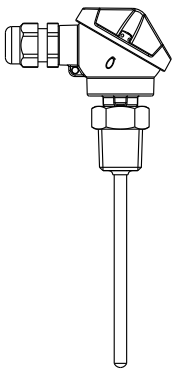
TM131 advanced



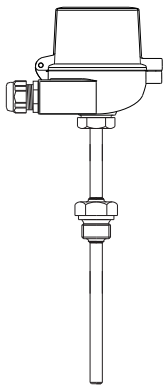
Basic technology

Basic thermometers are characterized by basic sensor technology with features such as a fixed, non-replaceable insert, application in non-hazardous areas, standard extension neck, low-cost unit

TM101 basic



TM121 basic



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)

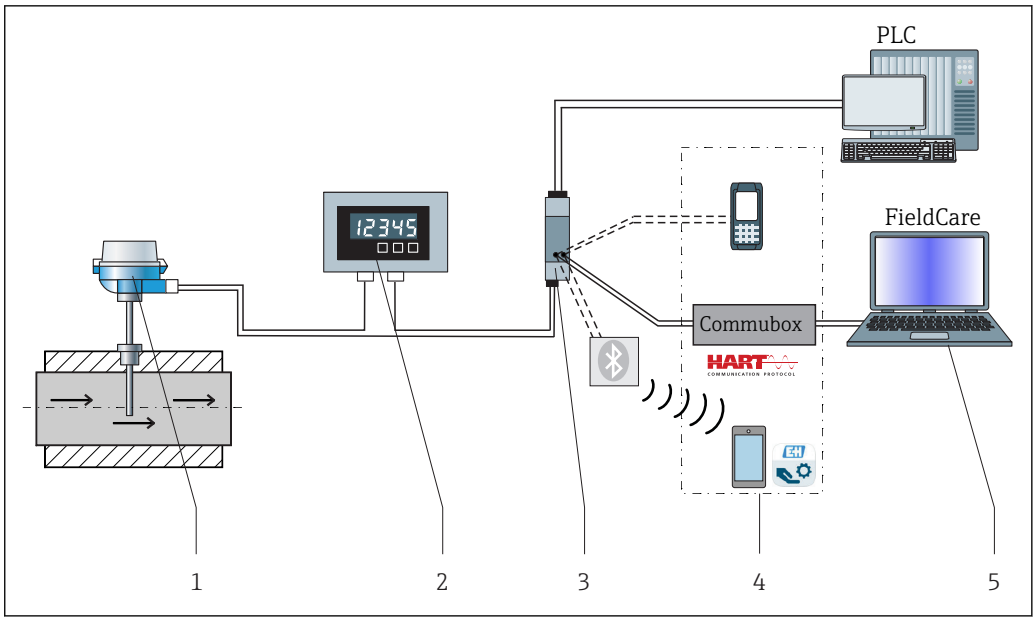
Thermocouples are comparatively simple, robust temperature sensors which use the Seebeck effect for temperature measurement: if two electrical conductors made of different materials are connected at a point, a weak electrical voltage can be measured between the two open conductor ends if the conductors 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

Endress+Hauser offers 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
- Overvoltage protection

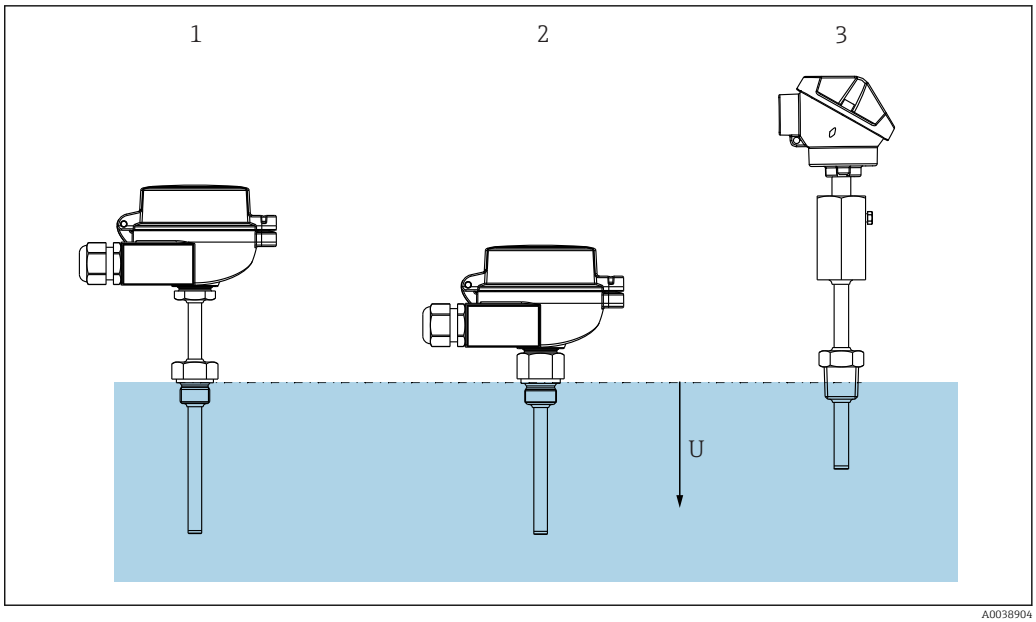
For more information, see the brochure 'System Components - Solutions for a Complete Measuring Point' (FA00016K/EN)



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

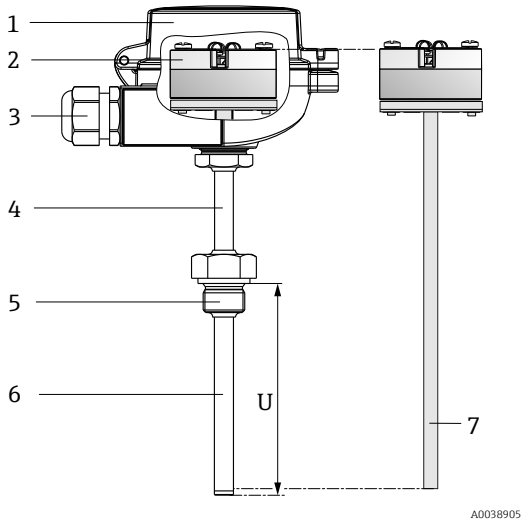
1 *Installed iTHERM thermometer with HART® communication protocol*
2 *RIA15 loop powered process display - It is integrated in the current loop and displays the measuring signal or HART® process variables in digital form. The process display unit does not require an external power supply. It is powered directly from the current loop. More information on this can be found in the Technical Information, see "Documentation", .*
3 *Active barrier RN221N - The RN221N (24 V DC, 30 mA) active barrier has a galvanically isolated output for supplying voltage to loop-powered transmitters. The universal power supply works with an input supply voltage of 20 to 250 V DC/AC, 50/60 Hz, which means that it can be used in all international power grids. More information on this can be found in the Technical Information, see "Documentation", .*
4 *Communication examples: HART® handheld communicator FieldXpert, Commubox FXA195 for intrinsically safe HART® communication with FieldCare via the USB interface, Bluetooth® technology with SmartBlue App.*
5 *FieldCare is a FDT-based plant asset management tool from Endress+Hauser, more details see section 'accessories'.*

Modular design



2 *The thermometer is available in various versions generally*

1 *With thermowell and lagging, various process connections*
2 *With thermowell and threaded process connection without lagging*
3 *Special design with Mignon head*
U *Immersion length*

Design		Options
	1: Terminal head	▪ Aluminum, high or low head, with or without display window ▪ Mignon miniature head, offering no space for transmitter (or: provided for directly wired sensors) **Your benefits:** ▪ Cost effective small terminal heads ▪ Optional display: local process display unit for added reliability
	2: Wiring, electrical connection, output signal	▪ Ceramic terminal block ▪ Flying leads ▪ Head transmitter (4 to 20 mA, HART® ▪ Attachable display, optional
	3: Connector or cable gland	▪ M12 connector ▪ Polyamide cable glands
	4: Lagging	The lagging is part of the thermowell and not removable
	5: Process connection	▪ Threaded process connection M-, NPT- or G-thread ▪ Compression fittings ▪ Flange according to DIN or ASME
	6: Thermowell	▪ Diameter Ø9 mm (0.35 in) or Ø11 mm (0.43 in) ▪ Straight tip ▪ Special design for assembly with Mignon miniature terminal head It is possible to check the mechanical loading capacity as a function of the installation and process conditions online in the TW Sizing Module for protection tubes in the Endress+Hauser Applicator software. This is valid for DIN thermowell calculations. See 'Accessories' section. → 🖹 24
	7: Insert	Diameter Ø6 mm (¼ in) ▪ RTD thin-film (TF) sensor for measuring range: −50 to +200 °C (−58 to +392 °F) ▪ Thermocouple type K for measuring range up to 650 °C (1 202 °F) **Your benefits:** Reliable, robust and cost effective temperature measurement

Input

Measured variable

Temperature (temperature-linear transmission behavior)

Measuring range

Depends on the type of sensor used

Sensor type	Measuring range
Pt100 thin-film	−50 to +200 °C (−58 to +392 °F)
Thermocouple TC, type K	−40 to +650 °C (−40 to +1 202 °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.
- Via all common protocols by selecting an appropriate Endress+Hauser iTEMP temperature transmitter. 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.

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

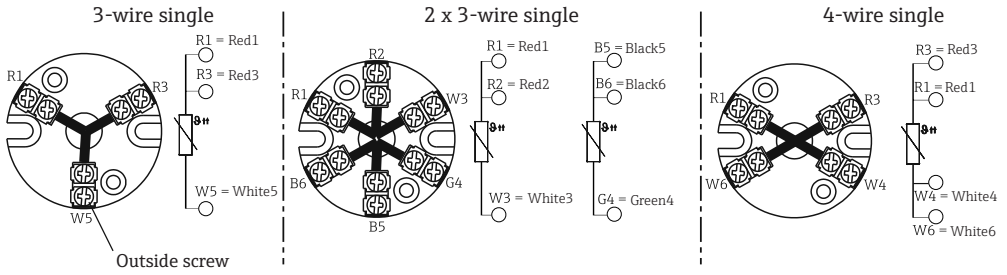
Power supply

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

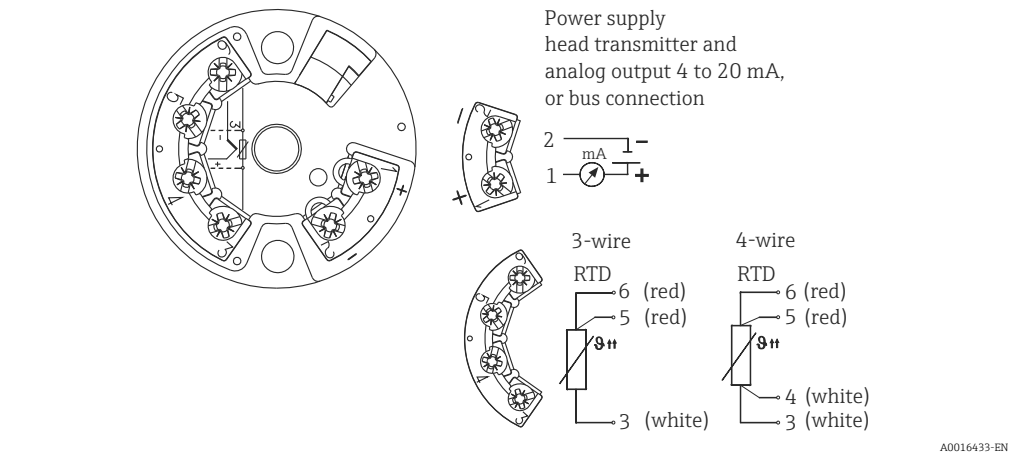
Terminal assignment

Type of sensor connection RTD

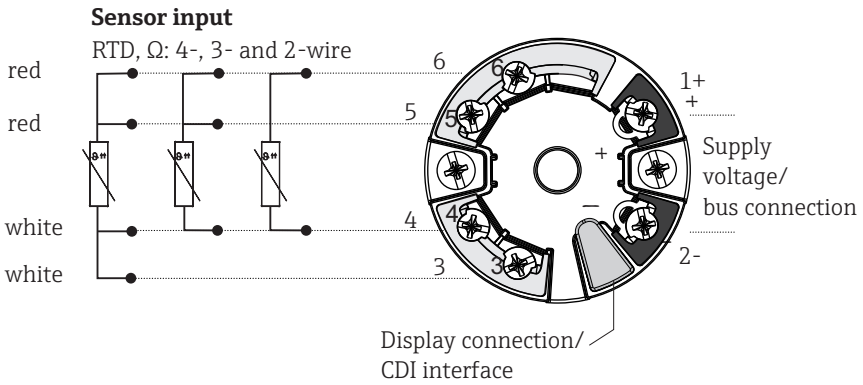
Terminal block mounted



Head mounted transmitter TMT18x (single input)

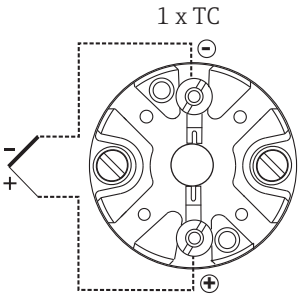


Head mounted transmitter TMT7x (single input)

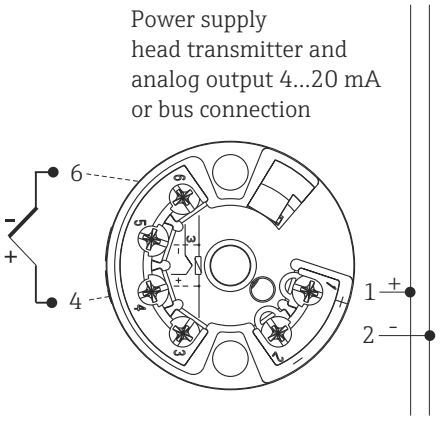


Type of sensor connection thermocouple (TC)

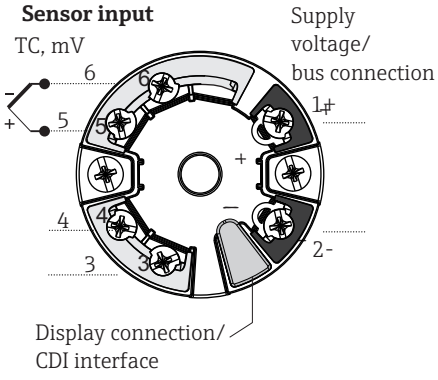
Terminal block mounted



Head mounted transmitter TMT18x (single input)



Head mounted transmitter TMT7x (single input)



Thermocouple wire colors

As per IEC 60584	As per ASTM E230
Type K: green (+), white (-)	Type K: yellow (+), red (-)

Cable entries

See 'Terminal heads' section → 🖹 21

The cable entries has to be selected during configuration of the device.

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.

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 one cable entry

Plug				
Plug thread	M12			
PIN number	1	2	3	4
Electrical connection (terminal head)				
Flying leads, thermocouples are not connected	Not connected (not insulated)			
3-wire terminal block (1x Pt100)	RD	RD	WH	
4-wire terminal block (1x Pt100)			WH	WH
6-wire terminal block (2x Pt100)	RD (#1) [1]	RD (#1) [1]	WH (#1) [1]	
1x TMT 4 to 20 mA or HART®	+	i	-	i
2x TMT 4 to 20 mA or HART® in the terminal head with a high cover	+(#1)	+(#2)	-(#1)	-(#2)
PIN position and color code	 1 BN 2 GNYE 3 BU 4 GY A0018929			

1) Second Pt100 is not connected

Connection combination: insert - transmitter

Insert	**Transmitter connection [1]**
	1x 1-channel
1x Pt100 or 1x TC, flying leads	Pt100 or TC (#1) : transmitter (#1)
2x Pt100, flying leads	Pt100 (#1) : transmitter (#1) Pt100 (#2) insulated
1x Pt100 or 1x TC with terminal block [2]	Pt100 or TC (#1) : transmitter in cover
2x Pt100 with terminal block [2]	Pt100 (#1) : transmitter in cover Pt100 (#2) not connected

1) 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 2nd transmitter as standard. The bus address is set to the default value and, if necessary, must be changed manually before commissioning.
2) Only in the terminal head with a high cover, only 1 transmitter possible. A ceramic terminal block is automatically fitted on the insert.

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.

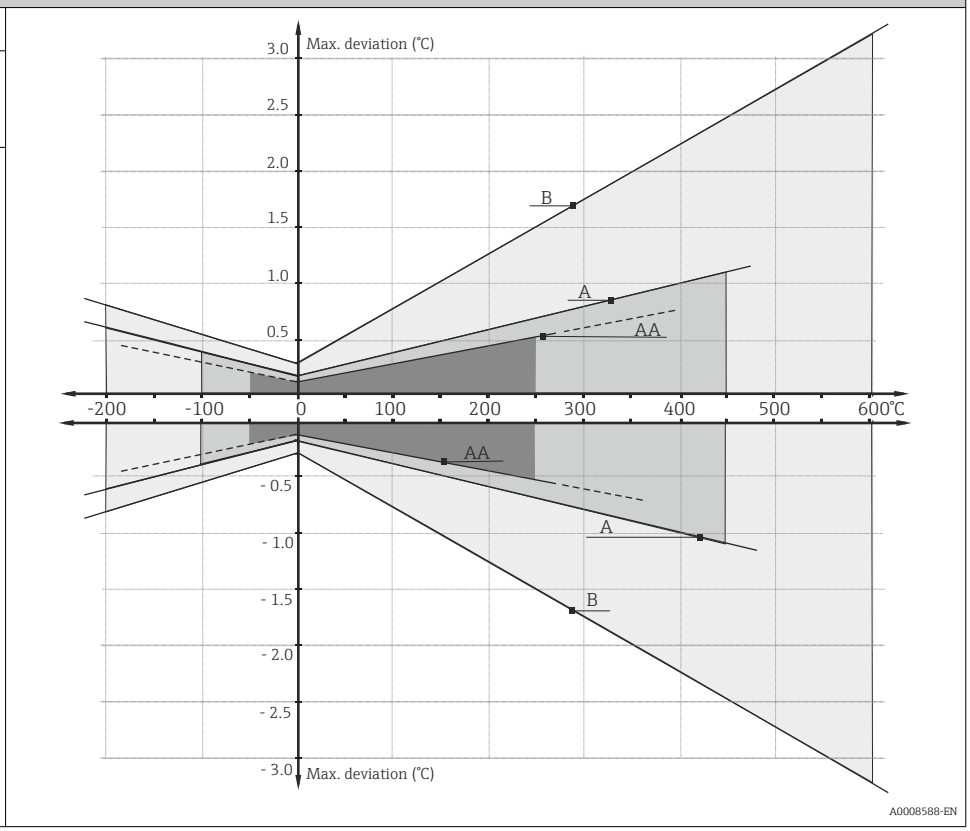
Performance characteristics

Reference conditions

These data are relevant for determining the accuracy of the temperature transmitters used. More information on this can be found in the Technical Information of the iTEMP temperature transmitters.

Maximum measured error

RTD resistance thermometer corresponding to IEC 60751

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

1) |t| = absolute value °C

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

Temperature ranges

Sensor type	Operating temperature range (Class A and B)
Pt100 (TF)	−50 to +200 °C (−58 to +392 °F)

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

Standard	Type	Standard tolerance		Special tolerance	
IEC 60584		Class	Deviation	Class	Deviation
	K (NiCr-NiAl)	2	±2.5 °C (−40 to 333 °C) ±0.0075 |t| (333 to 1 200 °C)	1	±1.5 °C (−40 to 375 °C) ±0.004 |t| (375 to 1 000 °C)

Standard	Type	Standard tolerance	Special tolerance
ASTM E230/ANSI MC96.1		Deviation, the larger respective value applies	
	K (NiCr-NiAl)	±2.2 K or ±0.02 |t| (−200 to 0 °C) ±2.2 K or ±0.0075 |t| (0 to 1 260 °C)	±1.1 K or ±0.004 |t| (0 to 1 260 °C)

Influence of ambient temperature

Depends on the head transmitter used. For details, see Technical Information.

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.

Response time

Tests in water at 0.4 m/s (1.3 ft/s), according to IEC 60751; 10 K temperature step change.

Typical values

Thermowell diameter: 9 mm (0.35 in)	t_{50}	t_{90}
RTD insert	30 s	90 s
Thermocouple (TC) insert	20 s	60 s

Typical values

Thermowell diameter: 11 mm (0.43 in)	t_{50}	t_{90}
RTD insert	40 s	100 s
Thermocouple (TC) insert	30 s	90 s

Calibration

Calibration of thermometers

Calibration involves comparing the measured values of a device under test (DUT) with those of a more precise calibration standard using a defined and reproducible measurement method. The aim is to determine the deviation of the DUT's measured values from the true value of the measured variable. Two different methods are used for thermometers:

- Calibration at fixed-point temperatures, e.g. at the freezing point of water at 0 °C,
- Calibration compared against a precise reference thermometer.

The thermometer to be calibrated must display the fixed point temperature or the temperature of the reference thermometer as accurately as possible. Temperature-controlled calibration baths with very homogeneous thermal values, or special calibration furnaces into which the DUT and the reference thermometer, where necessary, can project to a sufficient degree, are typically used for thermometer calibrations. The measurement uncertainty can increase due to heat dissipation errors and short immersion lengths. The existing measurement uncertainty is listed on the individual calibration certificate. For accredited calibrations according to ISO17025, the measurement uncertainty shouldn't be twice as high as the accredited measurement uncertainty. If this is exceeded, only a factory calibration can be performed.

Evaluation of thermometers
If a calibration with an acceptable uncertainty of measurement and transferable measurement results is not possible, Endress+Hauser offers customers a thermometer evaluation measurement service, if technically feasible. This is the case when:
- The process connections/flanges are too big or the immersion length (IL) is too short to allow the DUT to be immersed sufficiently in the calibration bath or furnace (see the following table), or
- Due to heat conduction along the thermometer tube, the resulting sensor temperature generally deviates significantly from the actual bath/furnace temperature.

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

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

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

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

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

Due to restrictions of the furnace geometries, minimum immersion lengths must be maintained at high temperatures in order to be able to perform a calibration with acceptable measurement uncertainty. The same applies when a temperature head transmitter is used. Due to the heat dissipation, minimum immersion lengths must be maintained in order to ensure 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 needed [2]
251 to 550 °C (483.8 to 1022 °F)	300 mm (11.81 in)
551 to 600 °C (1023.8 to 1112 °F)	400 mm (15.75 in)

1) With TMT a minimum of 150 mm (5.91 in) is required
2) At a temperature of +80 to +250 °C (+176 to +482 °F) with TMT a minimum of50 mm (1.97 in) is required

Insulation resistance

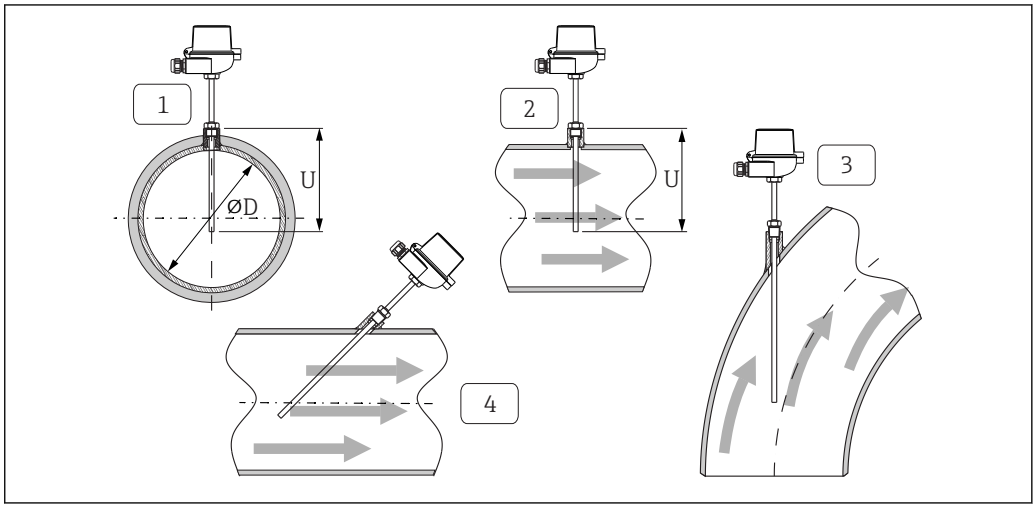
- RTD:
  Insulation resistance according to IEC 60751 > 100 MΩ at 25 °C between terminals and sheath material measured with a minimum test voltage of 100 V DC
- TC:
  Insulation resistance according to IEC 1515 between terminals and sheath material with a test voltage of 500 V DC:
  - > 1 GΩ at 20 °C
  - > 5 MΩ at 500 °C

Installation

Orientation

No restrictions. However, self-draining in the process should be guaranteed depending on the application.

Installation instructions



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3 Installation examples

1 - 2 In pipes with a small cross-section, the sensor tip should reach or extend slightly past the center axis of the pipe (=U).
3 - 4 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. Therefore, if installing in a pipe the immersion length should be at least half the pipe diameter. Installation at an angle (see 3 and 4) 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).

The counterparts for process connections and seals are not supplied with the thermometer and must be ordered separately if needed.

Environment

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)

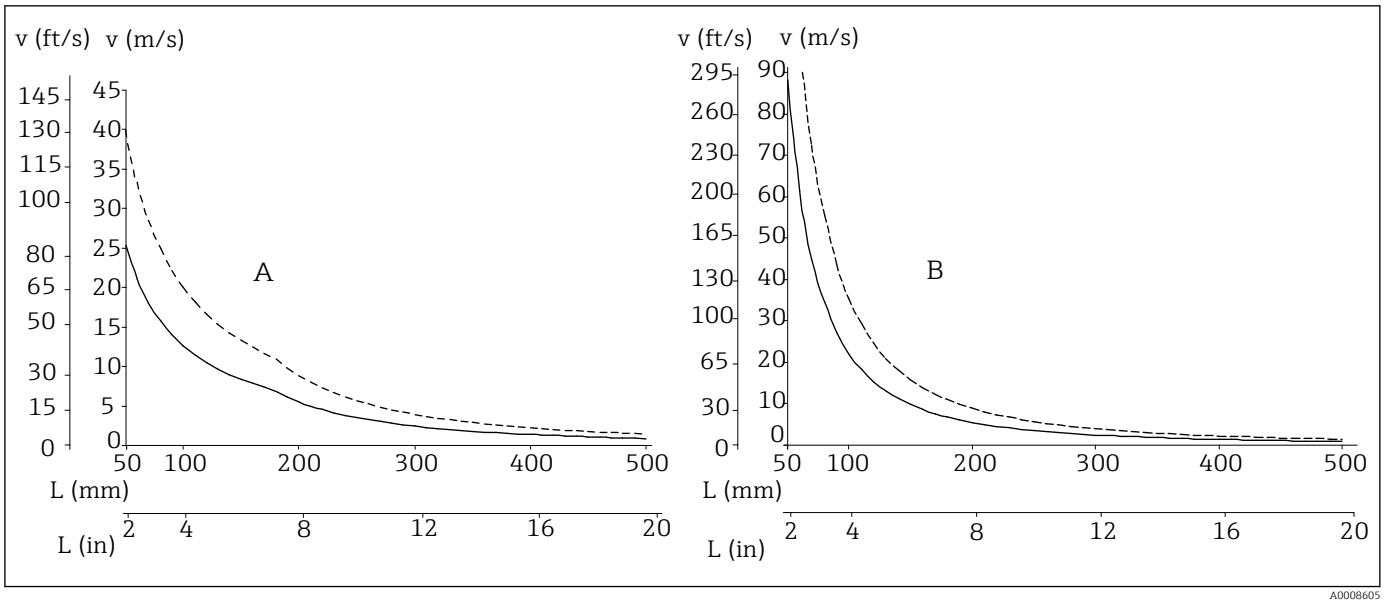
Storage temperature	For information, see the ambient temperature
Humidity	Depends on the transmitter used. If Endress+Hauser iTEMP head transmitters are used: ▪ Condensation permitted as per IEC 60 068-2-33 ▪ Max. rel. humidity: 95% as per IEC 60068-2-30
Climate class	As per EN 60654-1, Class C
Degree of protection	Max. IP 66 (NEMA Type 4x encl.), depending on the design (terminal head, connector, etc.)
Shock and vibration resistance	The Endress+Hauser inserts exceed the IEC 60751 requirements stating a shock and vibration resistance of 3 g within a range of 10 to 500 Hz.
Electromagnetic compatibility (EMC)	Depends on the head transmitter used. For details see the Technical Information.

Process

Process temperature range	Depends on the type of sensor and material used, maximum −200 to +650 °C (−328 to +1 202 °F).
Process pressure range	The maximum possible process pressure depends on various influencing factors, such as the design, process connection and process temperature. For information on the maximum possible process pressures for the individual process connections, see the 'Process connection' section. It is possible to check the mechanical loading capacity as a function of the installation and process conditions online in the TW Sizing Module for protection tubes in the Endress+Hauser Applicator software. See 'Accessories' section. → 24

Permitted flow velocity depending on the immersion length and process medium

The highest flow velocity tolerated by the thermometer diminishes with increasing insert immersion length exposed to the stream of the fluid. In addition it is dependent on the diameter of the thermometer tip, on the kind of measuring medium, on the process temperature and on the process pressure. The following figures exemplify the maximum permitted flow velocities in water and superheated steam at a process pressure of 50 bar (725 psi).



4 *Maximum flow velocity with thermowell diameter 9 mm (0.35 in) (————) or 12 mm (0.47 in) (-----)*

A Medium water at T = 50 °C (122 °F)
B Medium superheated steam at T = 400 °C (752 °F)
L Immersion length
v Flow velocity

Mechanical construction

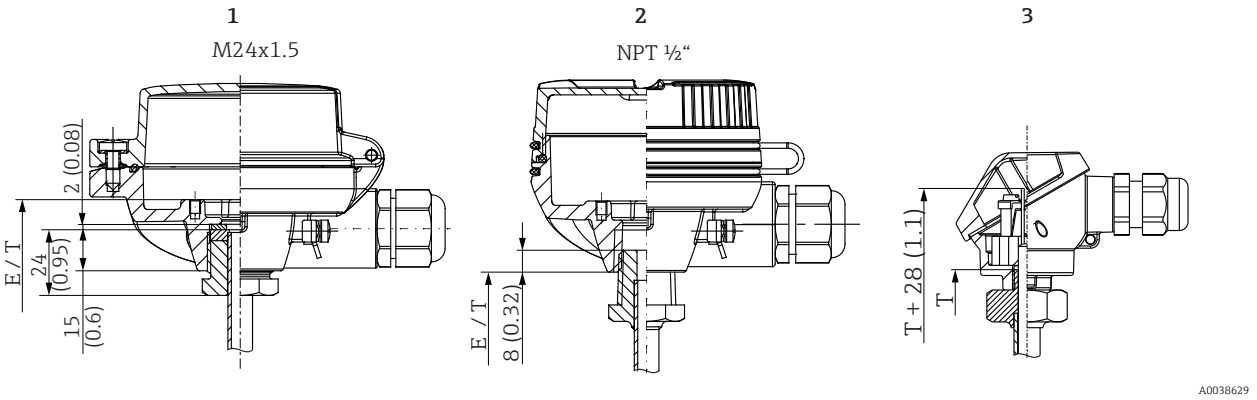
Design, dimensions

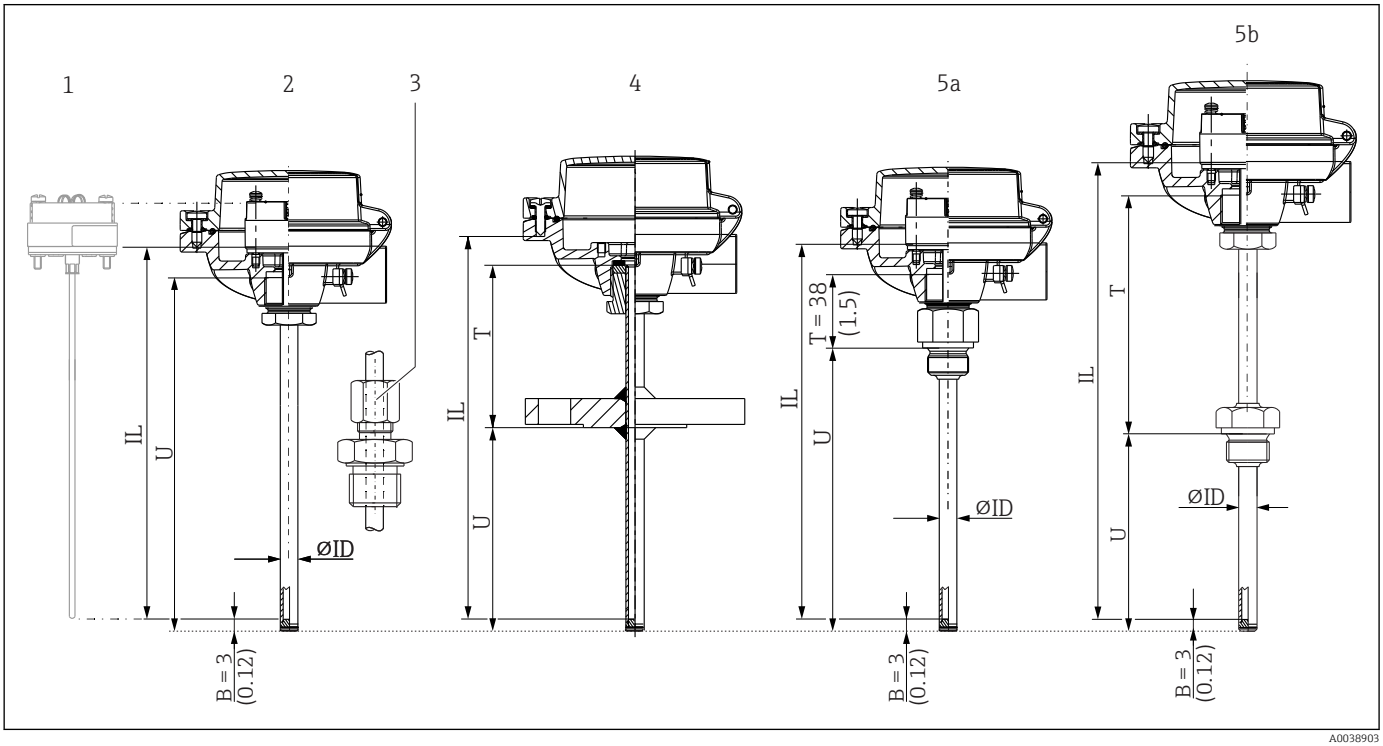
All dimensions in mm (in). The design of the thermometer depends on the general design version used:
- Thermometer without lagging DIN43772 Form 2
- Lagging DIN 43772 Form 2G, 2F, 3G, 3F
- Design with Mignon head

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

Variable dimensions:

Item	Description
IL	Insertion length of insert
B	Thermowell base thickness: predefined, depends on thermowell version (see also the individual table data)
T	Length of thermowell lagging: variable or predefined, depends on thermowell version (see also the individual table data)
U	Immersion length: variable, depending on the configuration

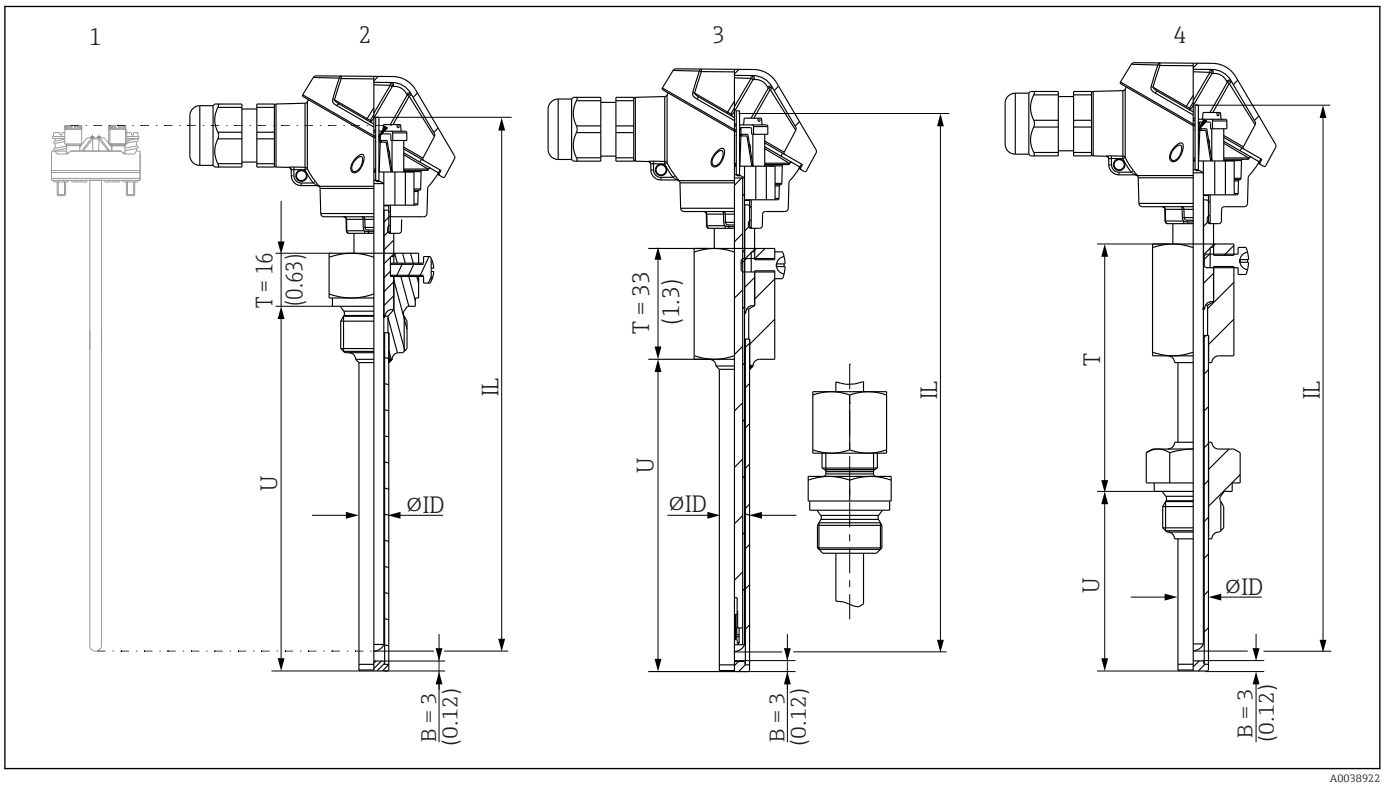
Item	Description
	Variable for calculating the insertion length of the insert, depending on different screw-in lengths in terminal head thread M24x1.5 or ½" NPT, see insert length calculation (IL).  *5 Different screw-in lengths in terminal head thread for M24x1.5 and ½" NPT* *1 Metric thread M24x1.5* *2 Conical thread NPT ½"* *3 M10x1 adapter for Mignon terminal head*
ØID	Thermowell diameter, 9x1.25 mm or 11x2 mm



1 Measuring insert with mounted transmitter
2 Without process connection
3 With compression fitting
4 With flanged process connection, with lagging
5a With threaded process connection, without lagging
5b With threaded process connection, with lagging

Calculation of insert length IL

Version 2 and 3:	For connection head with M24 thread (with head TA30A, TA20AB: **IL = U + 11 mm (28 in)** For connection head with ½" NPT thread (with head TA30EB): **IL = U + 26 mm (66 in)**
Version 4 and 5 (a + b):	For connection head with M24 thread (with head TA30A, TA20AB: **IL = U + T + 11 mm (28 in)** For connection head with ½" NPT thread (with head TA30EB): **IL = U + T + 26 mm (66 in)**

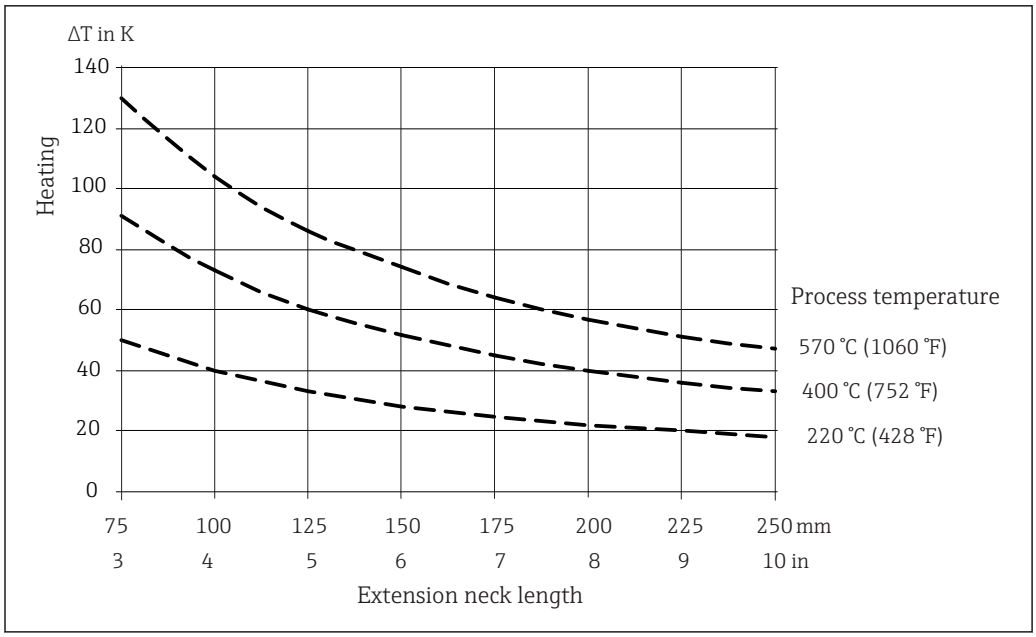


6 Thermometer design with Mignon head

1 Measuring insert with terminal block mounted
2 With threaded process connection, without lagging
3 Without process connection, alternatively with compression fitting
4 With process connection, thread or flange, with lagging

Calculation of insert length: IL = U + T + 38 mm (96.5 in)

As illustrated in the following figure, the extension neck length may influence the temperature in the terminal head. It is necessary that this temperature is kept within the limit values defined in the chapter "Operating conditions".



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

Using the diagramm, the temperature of the transmitter can be calculated.

Example: At a process temperature of 220 °C (428 °F) and a lagging length of 100 mm (3.94 in) the heat transfer is 40 K (72 °F). Thus the transmitter temperature is 40 K (72 °F) plus the ambient temperature, e.g. 25 °C (77 °F): 40 K (72 °F) + 25 °C (77 °F) = 65 °C (149 °F).

Result: The temperature of the transmitter is o.k., the length of the lagging is sufficient.

Weight

1 to 10 kg (2 to 22 lbs) for standard options.

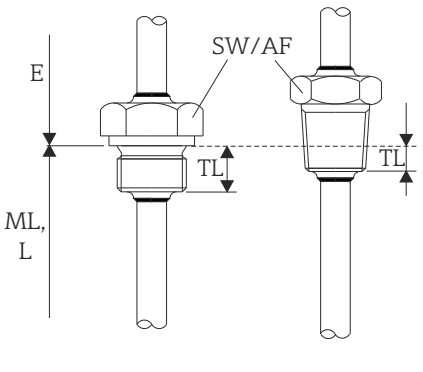
Material

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

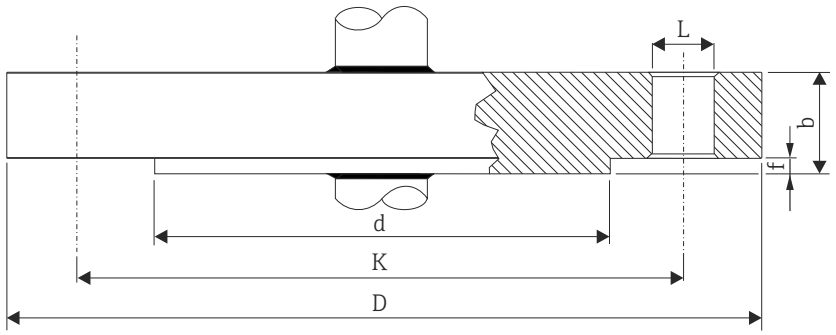
Please be aware, the maximum temperature is always also depending on the used temperature sensor!

Material name	Short form	Recommended max. temperature for continuous use in air	Properties
AISI 316L/1.4404 1.4435	X2CrNiMo17-12-2 X2CrNiMo18-14-3	650 °C (1 202 °F)	▪ Austenitic, stainless steel ▪ High corrosion resistance in general ▪ Particularly high corrosion resistance in chlorine-based and acidic, non-oxidizing atmospheres through the addition of molybdenum (e.g. phosphoric and sulfuric acids, acetic and tartaric acids with a low concentration) ▪ Increased resistance to intergranular corrosion and pitting ▪ Compared to 1.4404, 1.4435 has even higher corrosion resistance and a lower delta ferrite content
Alloy600/2.4816	NiCr15Fe	1 100 °C (2 012 °F)	▪ A nickel/chromium alloy with very good resistance to aggressive, oxidizing and reducing atmospheres, even at high temperatures ▪ Resistance to corrosion caused by chlorine gases and chlorinated media as well as many oxidizing mineral and organic acids, sea water etc. ▪ Corrosion from ultrapure water ▪ Not to be used in sulfur-containing atmospheres

Process connections

Threaded process connection	Version		Thread length TL in mm (in)	Width across flats AF (mm)
	M	M20x1.5	14 mm (0.55 in)	27
		M27x2	16 mm (0.63 in)	32
		M33x2	18 mm (0.71 in)	41
	G	G ½" DIN / BSP	15 mm (0.6 in)	27
	NPT	NPT ½"	8 mm (0.32 in)	22

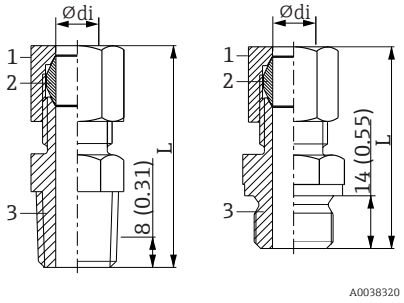
8 Cylindrical (left side) and conical (right side) version

Flange with standard designation of the dimensions	
	
For detailed information on the flange dimensions refer to the following flange standards: ▪ ANSI/ASME B16.5 ▪ EN 1092-1	The flange material must be the same as of the stem of the thermowell. Models in Hastelloy® have flanges in basic material 316L/1.4404 and a disc in Hastelloy® or Inconel Alloy600 on the surface in contact with the process media. The standard surface finish of the coupling side of flanges ranges from 3.2 to 6.4 µm (Ra). Other types of flanges can be supplied on request.

Due to deformation 316L compression fittings can only be used once, all parts of it! The assembly must be fixed in different positions (grooves in thermowell). PEEK compression fittings must never be run at a temperature below the assembly temperature because of loss of tightness by thermal contraction of PEEK.

For higher requirements: SWAGELOCK or similar fittings are urgently recommended

Compression fitting

Type TK40	Version	Dimensions			Technical properties [1]
		Φdi	L	Width across flats AF	
 *1 Nut* *2 Sleeve* *3 Process connection*	NPT ½" , ferrule material 316L G ½" , ferrule material 316L G 1", ferrule material 316L	9 mm (0.35 in) 11 mm (0.43 in)	NPT ½": 52 mm (2.05 in) G ½": 47 mm (1.85 in) G 1": 66 mm (2.6 in)	NPT ½": 24 mm (0.95 in) G½": 27 mm (1.06 in) G1": 41 mm (1.61 in)	▪ $P_{max.}$: 40 bar (580 psi) at +200 °C (+392 °F) ▪ $P_{max.}$: 25 bar (363 psi) at +400 °C (+752 °F) Min. torque: 70 Nm

1) Pressure specifications apply for cyclic temperature load

Inserts

The device has got a non-replaceable insert. The sheath is welded to the process connection to ensure thightness.

Sensor	Standard thin-film
Sensor design; connection method	1x or 2x Pt100, 3- or 4-wire, basic version, stainless steel sheath
Vibration resistance of the insert tip	Up to 3g
Measuring range; accuracy class	−50 to +200 °C (−58 to +392 °F), Class A or B
Diameter	6 mm (¼ in)

TC thermocouples	Type K
Sensor design	Mineral insulated, alloy600 sheated TC cable
Vibration resistance of the insert tip	Up to 3g
Measuring range	−270 to 1 100 °C (−454 to 2 012 °F)
Connection type	Ungrounded hot junction
Temperature-sensitive length	Insert length
Diameter	6 mm (¼ in)

The iTHERM inserts are available as a spare part. The insertion length (IL) depends on the immersion length of the thermowell (U), the thickness of the base (B), the length of the thermowell shaft (L) for example. The insertion length (IL) must be taken into consideration when replacing the unit. Formulas for calculating IL → 15

For more information on the deployed insert iTHERM TS111 and TS211 with enhanced vibration resistance and fast-response sensor, see the Technical Information (TI01014T/09/ and TI01411T/09/).

Spare parts currently available for your product can be found online at: http://www.products.endress.com/spareparts_consumables. Choose the corresponding product root. Always quote the serial number of the device when ordering spare parts! The insertion length IL is automatically calculated using the serial number.

Surface roughness

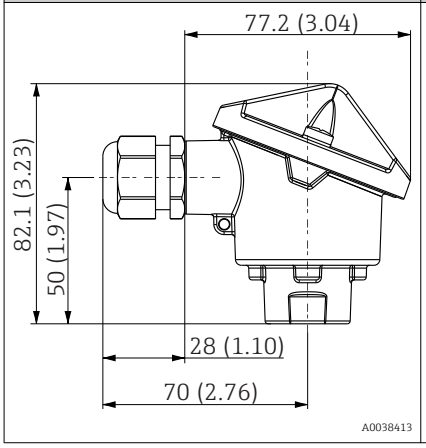
Values for wetted surfaces:

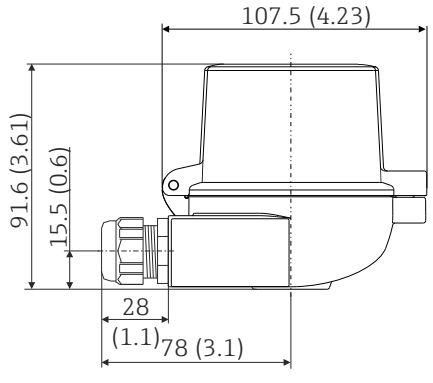
Standard surface	$R_a \leq$ 0.76 µm (0.03 µin)

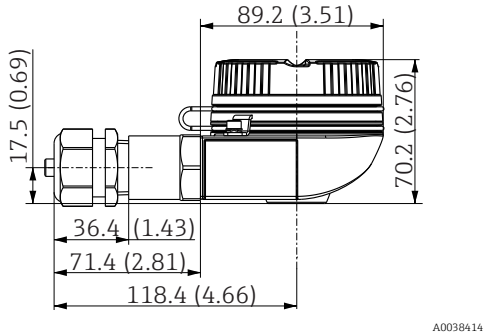
Terminal heads

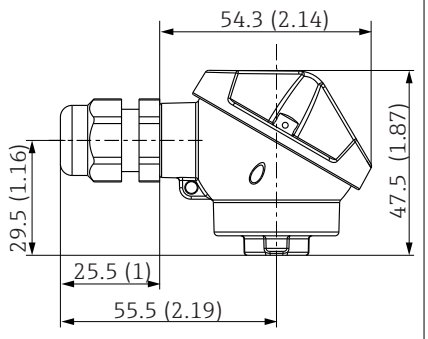
All terminal heads have an internal shape and size in accordance with DIN EN 50446, flat face and a thermometer connection with a M24x1.5 or ½" NPT thread. All dimensions in mm (in). The sample cable glands in the diagrams correspond to M20x1.5 connections with non-Ex polyamide cable glands. Specifications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

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

TA20AB	Specification
	▪ Protection class: IP 66/68, NEMA 4x ▪ Temperature: −40 to +100 °C (−40 to +212 °F), polyamide cable gland ▪ Material: aluminum; polyester powder coated Seals: silicone ▪ Threaded cable entry: NPT ½" and M20x1.5 ▪ Color: blue, RAL 5012 ▪ Weight: approx. 300 g (10.6 oz)

TA30A with display window	Specification
	▪ Available with one or two cable entries ▪ Protection class: IP66/68 (NEMA Type 4x encl.) ▪ Temperature: −50 to +150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Threaded cable entry: G ½", ½" NPT and M20x1.5 ▪ Protection armature 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 ▪ 3-A® marked

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 coated ▪ Thread: M20x1.5 ▪ Extension neck/thermowell connection: NPT ½" ▪ Color of head: blue, RAL 5012 ▪ Color of cap: gray, RAL 7035 ▪ Weight: approx. 400 g (14.11 oz) ▪ Ground terminal: internal and external

TA20L Mignon	Specification
	▪ Protection class: IP66 ▪ Temperature: −50 to +150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Threaded cable entry: M16x1.5 ▪ Protection armature connection: M10x1 ▪ Head color: blue, RAL 5012 Cap color: gray, RAL 7035 ▪ Weight: 420 g (14.81 oz) ▪ No ground terminal

Cable glands and connectors

Type	Suitable for cable entry	Degree of protection	Temperature range
Cable gland, polyamide connector (M12, 4-pin)	½" NPT, M20x1.5	IP68	−40 to +100 °C (−40 to +212 °F)

Certificates and approvals

CE mark

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

Other standards and guidelines

- EN 60079: ATEX certification for hazardous areas
- IEC 60529: Degrees of protection provided by enclosures (IP code)
- IEC 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use
- IEC 60751: Industrial platinum resistance thermometers
- EN 50281-1-1: Electrical apparatus protected by enclosures
- DIN 43772: Protection tubes
- DIN EN 50446: Terminal heads

Electromagnetic compatibility (EMC)

EMC to all relevant requirements of the IEC/EN 61326-series and NAMUR Recommendation EMC (NE21). For details, refer to the Declaration of Conformity.

Maximum fluctuations during EMC-tests: < 1 % of measuring span.

Interference immunity to IEC/EN 61326-series, requirements for industrial areas

Interference emission to IEC/EN 61326-series, electrical equipment Class B

PED approval

The thermometer complies with paragraph 3.3 of the Pressure Equipment Directive (97/23/CE) and is not marked seperately.

Test on thermowell

Thermowell pressure tests are carried out in accordance with the specifications in DIN 43772. With regard to thermowells with tapered or reduced tips that do not comply with this standard, these are tested using the pressure of corresponding straight thermowells. Sensors for use in hazardous areas are also always subjected to a comparative pressure during the tests. Tests according to other specifications can be carried out on request. The liquid penetration test verifies that there are no cracks in the welded seams of the thermowell.

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 construction of the single sensor and 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.

Calibration

The "Factory calibration" is carried out according to an internal procedure in a laboratory of Endress +Hauser accredited by the European Accreditation Organization (EA) to ISO/IEC 17025. A calibration which is performed according to EA guidelines (SIT/Accredia) or (DKD/DAkkS) may be requested separately. The calibration is performed on the replaceable insert of the thermometer. In the case of thermometers without a replaceable insert, the entire thermometer - from the process connection to the tip of the thermometer - is calibrated.

Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configurator on the Endress+Hauser website: www.endress.com -> Click "Corporate" -> Select your country -> Click "Products" -> Select the product using the filters and search field -> Open product page -> The "Configure" button to the right of the product image opens the Product Configurator.
- From your Endress+Hauser Sales Center: www.addresses.endress.com

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
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 The Configurator is available on the Endress+Hauser website: www.endress.com -> Click "Corporate" -> Select country -> Click "Products" -> Select the product using the filters and search field -> Open product page -> The "Configure" button to the right of the product image opens the Product Configurator.
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
W@M	Life cycle management for your plant W@M supports with a wide range of software applications over the entire process: from planning and procurement, to the installation, commissioning and operation of the measuring devices. All the relevant device information, such as the device status, spare parts and device-specific documentation, is available for every device over the entire life cycle. 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

Documentation

Operating manual for modular thermometers in industrial applications (BA01915T/09)

Technical Information:
- iTEMP temperature head transmitter:
  - TMT71, PC-programmable, single-channel, RTD, TC, Ω, mV (TI01393T/09/en)
  - HART® TMT72, PC-programmable, single-channel, RTD, TC, Ω, mV (TI01392T/09/en)
  - TMT180, PC-programmable, single-channel, Pt100 (TI088R/09/en)
- Insert:
  Resistance thermometer iTHERM TS111 (TI01014T/09/en)

www.addresses.endress.com

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