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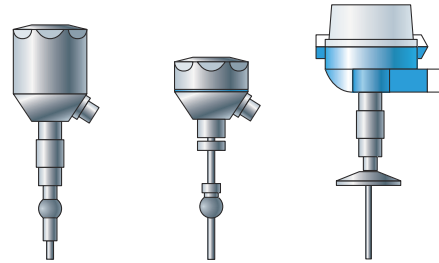
Operating Instructions
Modular hygienic thermometers

Universal modular thermometers with RTD insert for hygienic applications



Endress+Hauser
People for Process Automation

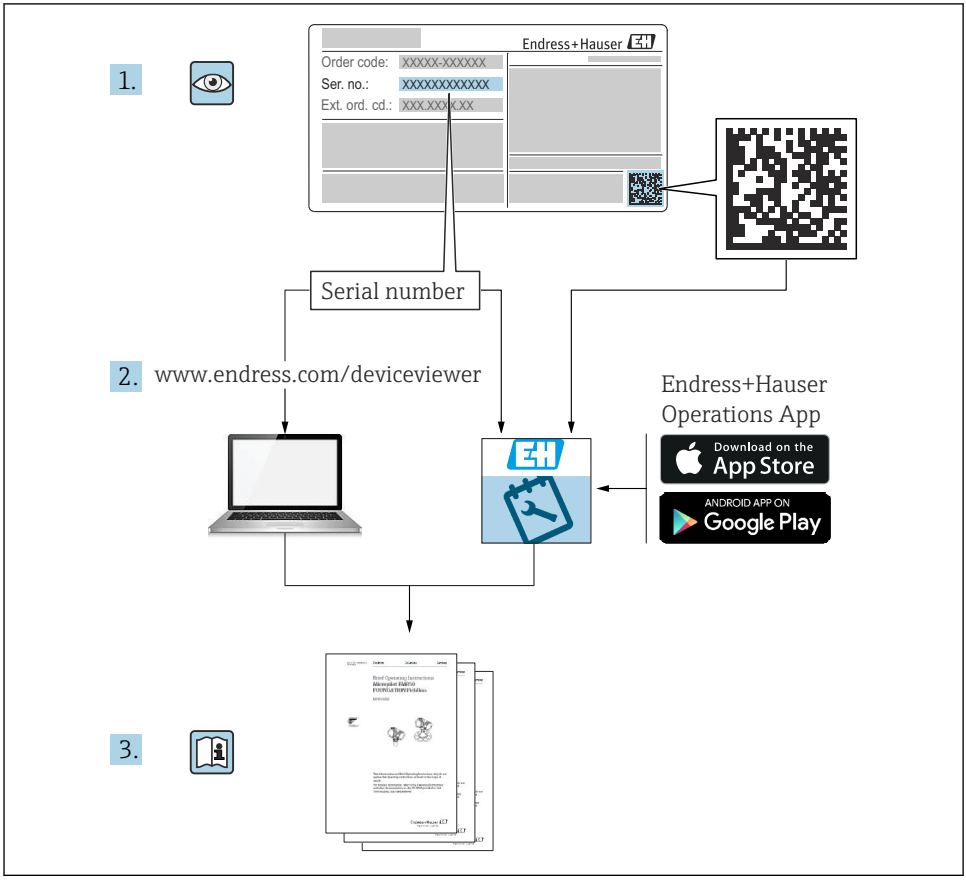

1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXXX
Ext. ord. cd.: XXX.XXX.XXX
Serial number
2.
www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the
App Store
ANDROID APP ON
Google Play
3.

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Table of contents

1 About this document

These instructions are only valid for the following devices in the Endress+Hauser iTHERM ModuLine product family:

Direct installation without a thermowell	Installation with thermowell
iTHERM ModuLine TM401	iTHERM ModuLine TM411
iTHERM ModuLine TM402	iTHERM ModuLine TM412

1.1 Document function

These Operating Instructions contain all the information required in the various life cycle phases of the device: from product identification, incoming acceptance and storage, to installation, connection, operation and commissioning, through to troubleshooting, maintenance and disposal.

1.2 Symbols

1.2.1 Safety symbols

DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING
This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION
This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol alerts you to a potentially harmful situation. Failure to avoid this situation can result in damage to the product or something in its vicinity.

1.2.2 Symbols for certain types of information

Symbol	Meaning
	**Permitted** Procedures, processes or actions that are permitted.
	**Preferred** Procedures, processes or actions that are preferred.
	**Forbidden** Procedures, processes or actions that are forbidden.
	**Tip** Indicates additional information.

Symbol	Meaning
	Reference to documentation
	Reference to page
	Reference to graphic
	Notice or individual step to be observed
1., 2., 3...	Series of steps
	Result of a step
	Help in the event of a problem
	Visual inspection

1.2.3 Symbols in graphics

Symbol	Meaning	Symbol	Meaning
1, 2, 3,...	Item numbers	1., 2., 3...	Series of steps
A, B, C, ...	Views	**A-A, B-B, C-C, ...**	Sections
	Hazardous area		Safe area (non-hazardous area)

1.3 Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:

- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

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.

2 Basic safety requirements

2.1 Requirements for the personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:

- Trained, qualified specialists must have a relevant qualification for this specific function and task.
- Are authorized by the plant owner/operator.
- Are familiar with federal/national regulations.
- Before starting work, read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Follow instructions and comply with basic conditions.

The operating personnel must fulfill the following requirements:

- Are instructed and authorized according to the requirements of the task by the facility's owner-operator.

- ▶ Follow the instructions in this manual.

2.2 Intended use

The devices described in this document are resistance thermometers for temperature measurement in hygienic applications.

Non-designated use

Only use the devices for temperature measurement. The manufacturer is not liable for harm caused by improper or non-designated use.

2.3 Operational safety

Damage to the device!
- ▶ Operate the device in proper technical condition and fail-safe condition only.
- ▶ The operator is responsible for the interference-free operation of the device.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers!
- ▶ If modifications are nevertheless required, consult with the manufacturer.

Repair

To ensure continued operational safety and reliability:
- ▶ Carry out repairs on the device only if they are expressly permitted.
- ▶ Observe federal/national regulations pertaining to the repair of an electrical device.
- ▶ Use only original spare parts and accessories.

2.4 Product safety

This state-of-the-art device is designed and tested in accordance with good engineering practice to meet operational safety standards. It left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EU directives listed in the device-specific EU declaration of conformity. The manufacturer confirms this by affixing the CE mark.

3 Product description

3.1 Notes on selecting the right device

iTHERM ModuLine, hygienic

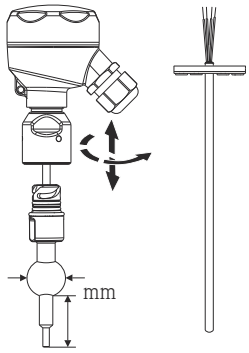
This device is part of the product line of modular thermometers for hygienic and aseptic applications.

Differentiating factors when selecting a suitable thermometer

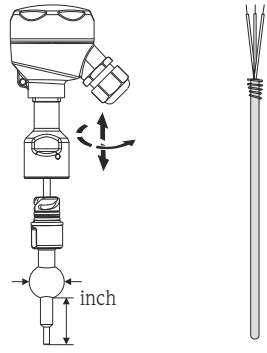
iTHERM ModuLine TM4x**1**	iTHERM ModuLine TM4x**2**
Metric version	Imperial version
↓	↓

TM4**1**x characterizes the device that uses 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 approval for use in hazardous areas

iTHERM ModuLine TM411



iTHERM ModuLine TM412



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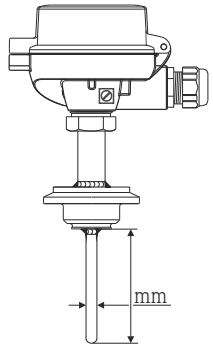
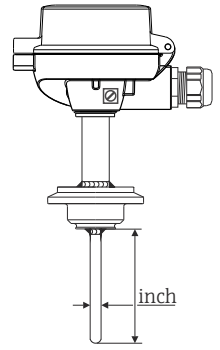
TM4**0**x characterizes the device that uses basic technology, with features such as a fixed, non-replaceable insert, application in non-hazardous areas, standard extension neck, low-cost unit

iTHERM ModuLine TM401



iTHERM ModuLine TM402



4 Incoming acceptance and product identification

4.1 Incoming acceptance

On receipt of the delivery:

1. Check the packaging for damage.
   ↳ Report all damage immediately to the manufacturer.
   Do not install damaged components.
2. Check the scope of delivery using the delivery note.
3. Compare the data on the nameplate with the order specifications on the delivery note.
4. Check the technical documentation and all other necessary documents, e.g. certificates, to ensure they are complete.

If one of the conditions is not satisfied, contact the manufacturer.

4.2 Product identification

The device can be identified in the following ways:
- Nameplate specifications
- Enter the serial number from the nameplate into *Device Viewer* (www.endress.com/deviceviewer): all the information about the device and an overview of the Technical Documentation supplied with the device are displayed.
- Enter the serial number from the nameplate into the *Endress+Hauser Operations App* or scan the 2-D matrix code (QR code) on the nameplate with the *Endress+Hauser Operations App*: all the information about the device and the technical documentation pertaining to the device is displayed.

4.2.1 Nameplate

Do you have the correct device?

The nameplate provides you with the following information on the device:
- Manufacturer identification, device designation
- Order code
- Extended order code
- Serial number
- Tag name (TAG) (optional)
- Technical values, e.g. supply voltage, current consumption, ambient temperature, communication-specific data (optional)
- Degree of protection
- Approvals with symbols
- Reference to Safety Instructions (XA) (optional)

► Compare the information on the nameplate with the order.

4.2.2 Name and address of manufacturer

Name of manufacturer:	Endress+Hauser Wetzer GmbH + Co. KG
Address of manufacturer:	Obere Wank 1, D-87484 Nesselwang or www.endress.com

4.3 Storage and transport

Junction box	
With head transmitter	−40 to +95 °C (−40 to +203 °F)
With DIN rail transmitter	−40 to +95 °C (−40 to +203 °F)

4.3.1 Humidity

Condensation according to IEC 60068-2-33:
- Head transmitter: Permitted
- DIN rail transmitter: Not permitted

Maximum relative humidity: 95% according to IEC 60068-2-30

Pack the device for storage and transportation in such a way that it is reliably protected against impact and external influences. The original packaging offers the best protection.

Avoid the following environmental influences during storage:
- Direct sunlight
- Proximity to hot objects
- Mechanical vibration
- Aggressive media

4.4 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**.

5 Installation

5.1 Installation requirements

For the intended use of the devices described in this document, certain ambient conditions must be met at the installation location. These include the ambient temperature, degree of protection, or climate class. For specifications and further details, as well as device dimensions, refer to the corresponding Technical Information.

5.1.1 Orientation

No restrictions. Ensure self-draining in the process. If there is an opening to detect leaks at the process connection, this opening must be at the lowest possible point.

5.1.2 Installation instructions

The requirements of the EHEDG and the 3-A Sanitary Standard must be adhered to:
- Installation instructions EHEDG/cleanability: Lt ≤ (Dt-dt)
- Installation instructions 3-A/cleanability: Lt ≤ 2 (Dt-dt)

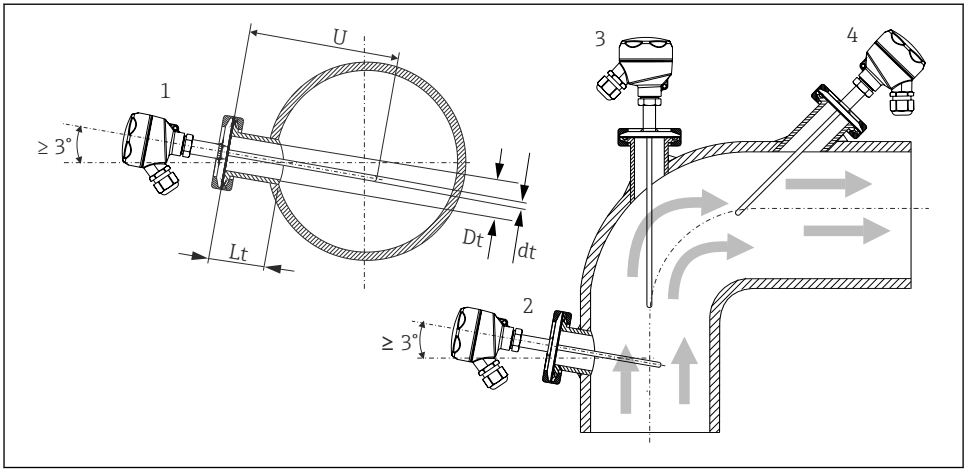
When using the measuring instrument in a hazardous area, the relevant national standards and regulations, as well as the safety instructions or installation regulations must be observed.

NOTICE

In the event of a defective sealing ring (O-ring) or seal, perform the following steps:
- ▶ Remove the thermometer.
- ▶ Clean the thread and the O-ring joint/sealing surface.
- ▶ Replace the sealing ring and the seal.
- ▶ Perform Cleaning In Place (CIP) after installation.

The immersion length of the device influences the measurement accuracy considerably. If the immersion length is too short, measurement errors occur as a result of heat conduction via the process connection and the vessel wall. For installation of the device in a pipe, allow for an immersion length that is equal to half the pipe diameter.

The devices can be installed in pipes, tanks or other plant components.



1 Installation examples

1, 2 Perpendicular to the flow direction, installed at a min. angle of 3° to ensure self-draining
3 On elbows
4 Inclined installation in pipes with a small nominal diameter
U Immersion length

Installation in pipes with small nominal diameters

In the case of small nominal diameters, position the tip of the thermometer in such a way that it protrudes past the pipe axis into the medium. It can be installed at an angle (see Figure 4). The immersion length depends on the properties of the thermometer and the medium. Relevant influencing factors include flow velocity and process pressure.

Welding

Pay attention to the following in the process when carrying out welding work on welded connections:

1. Ensure the surface is honed and mechanically polished, Ra ≤ 0.76 µm (30 µin).
2. Use suitable welding material.
3. Avoid crevices, folds or gaps.
4. Flush-weld or weld with welding radius ≥ 3.2 mm (0.13 in).

Welding work has been carried out properly.

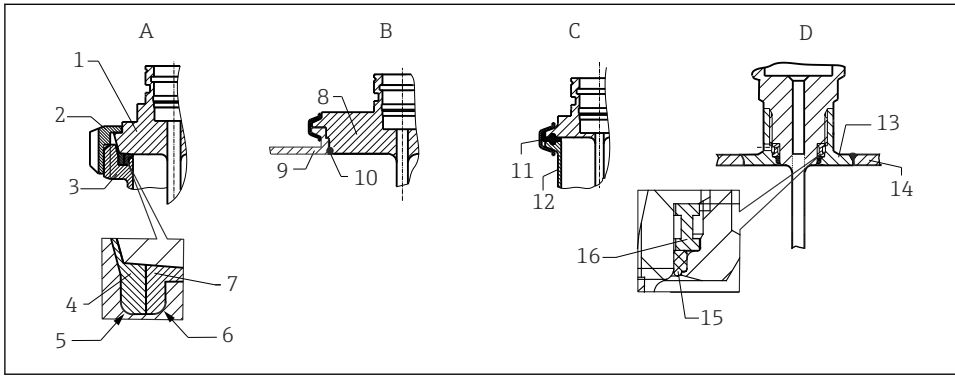
Cleanability

To ensure that cleaning performance is not impaired, observe the following when installing the thermometer:

1. When installed, the sensor is suitable for CIP (Cleaning In Place) cleaning.

2. Clean it together with the pipe or tank.
3. For tank installation, use process connection nozzles to ensure the cleaning assembly directly sprays this area to clean it effectively.
4. The Varivent® connections enable flush-mounted installation.

Device is installed without affecting cleanability.



2 *Process connections for hygiene-compliant installation*

A Milk pipe connection according to DIN 11851, only in conjunction with EHEDG-certified, self-centering sealing ring
1 Sensor with milk pipe connection
2 Grooved union nut
3 Counterpart connection
4 Centering ring
5 R0.4
6 R0.4
7 Sealing ring
B Varivent® process connection for VARINLINE® housing
8 Sensor with Varivent® connection
9 Counterpart connection
10 O-ring
C Clamp according to ISO 2852 only in conjunction with seal in accordance with the EHEDG position paper
11 Molded seal
12 Counterpart connection
D Process connection Liquiphant M G1", horizontal installation
13 Weld-in adapter
14 Vessel wall
15 O-ring
16 Thrust collar

The counterpieces for the process connections and the seals or sealing rings are not supplied with the thermometer. Liquiphant M weld-in adapters with associated seal kits are available as accessories.

Ambient temperature range

T_a	–40 to +85 °C (–40 to +185 °F)

Process temperature range

Depends on the type of sensor used, maximum:

T_a	–200 to +600 °C (–328 to +1 112 °F)

5.2 Installing the thermometer

Prior to installation:

1. Make sure that the device is installed and secured before applying the process pressure.
2. Inspect the device for any damage caused during transportation.
3. Notify of any damage immediately.
4. Check whether the thermometer may be installed directly in the process or whether a thermowell must be used.
5. Check if it is necessary to calculate the static and dynamic load capacity.
6. The permitted loading capacity of the process connections can be found in the relevant standards.
7. The process connection and compression fitting must comply with the maximum specified process pressure.
8. Adjust the loading capacity of the thermowell to the process conditions.

Installation requirements are clear.

It is possible to verify the mechanical loading capacity depending on the installation and process conditions using the online TW Sizing Module for thermowells in the Endress +Hauser Applicator software. See 'Accessories' section.

5.2.1 Removable process connections

Seals and sealing rings are not included in the scope of delivery.

5.2.2 Weld-in thermowells

Weld-in thermowells can be welded directly into the pipe or vessel wall, or secured using a welding socket. The specifications on the relevant material data sheets and the applicable guidelines and standards regarding welding procedures, heat treatment and/or welding fillers must be observed.

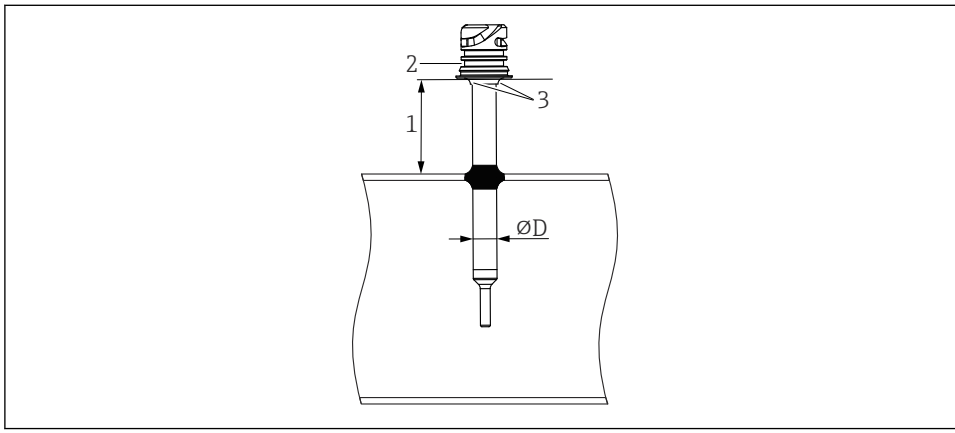
5.2.3 Weld-in compression fittings

The operator of the plant must check if a seal is necessary.

⚠ CAUTION

Incorrectly designed, faulty or leaking welding seams may lead to uncontrolled discharge of the process medium.

- ▶ Ensure that welding work is carried out by qualified specialists only.
- ▶ When designing the welded seam, the requirements arising from the process conditions must be taken into account.



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3 Detailed instructions for welding work on thermowell øD:12.7 mm (0.5 in) and 9 mm (0.35 in)

1 Minimum distance of 65 mm (2.56 in) to welded seam
2 If the minimum distance of 65 mm (2.56 in) to the welded seam cannot be met, remove the sealing rings during welding.
3 Welded (not secured with Locktite).

5.3 Post-installation check

❑	Is the device undamaged (visual inspection)?
❑	Is the device correctly secured?
❑	Does the device correspond to the specifications at the measuring point, e.g. ambient temperature, measuring range etc.?

6 Electrical connection

6.1 Connection requirements

NOTICE

Risk of short-circuit – may cause the device to malfunction.

- ▶ Check for damage to cables and wires, and check connection points.

According to the 3-A® Sanitary Standard and the EHEDG, electrical connecting cables must be smooth, corrosion-resistant and easy to clean.

Terminal assignment

⚠ WARNING

Risk of injury from the uncontrolled activation of processes!

- ▶ Switch off the supply voltage before connecting the device.
- ▶ Ensure that downstream processes are not started unintentionally.

⚠ WARNING

There is a risk of short circuit if the supply voltage is connected!

- ▶ Switch off the supply voltage before connecting the device.

⚠ WARNING

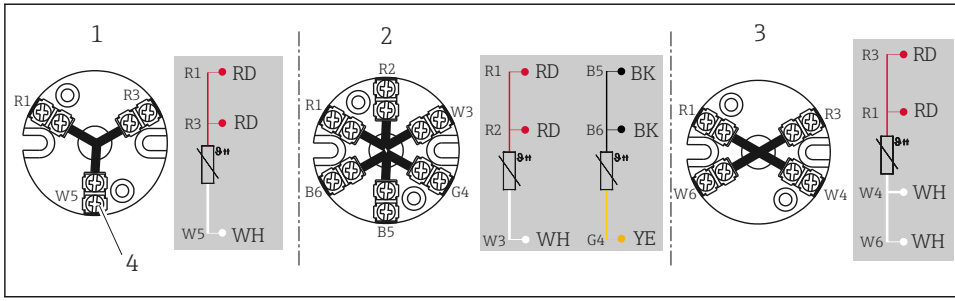
Reduced electrical safety due to incorrect connection!

- ▶ When using the measuring instrument in a hazardous area, the relevant national standards and regulations, as well as the safety instructions or installation regulations must be observed.
- ▶ All data relating to explosion protection is contained in the separate Ex documentation. The Ex documentation is supplied as standard with all devices approved for use in explosion hazardous areas.

Refer to the Technical Information when connecting the transmitter electrically.

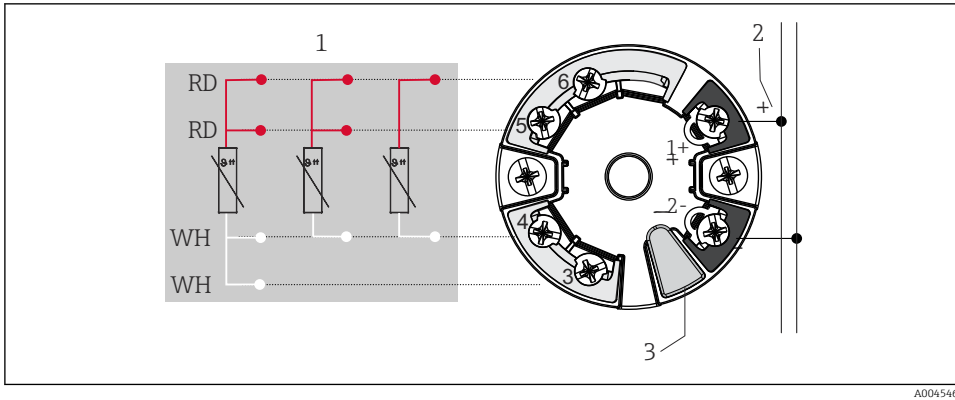
6.2 Wiring diagram

The terminal assignments for iTEMP transmitters and connection heads that can be configured for the devices described in this document are shown below as examples.



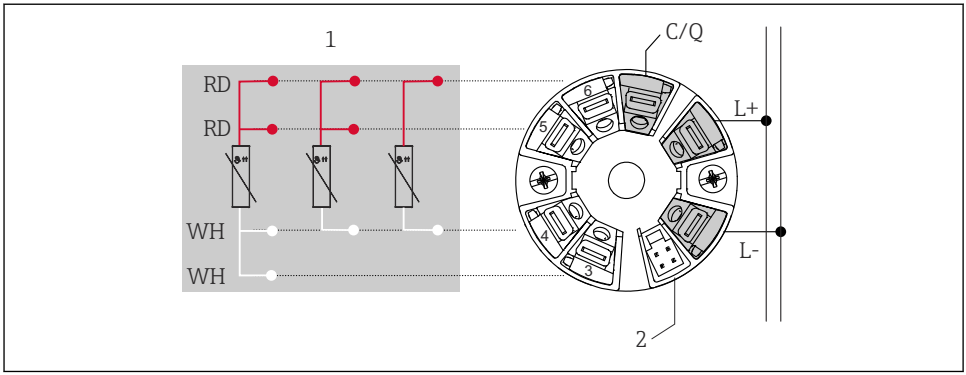
4 *Mounted ceramic terminal block*

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



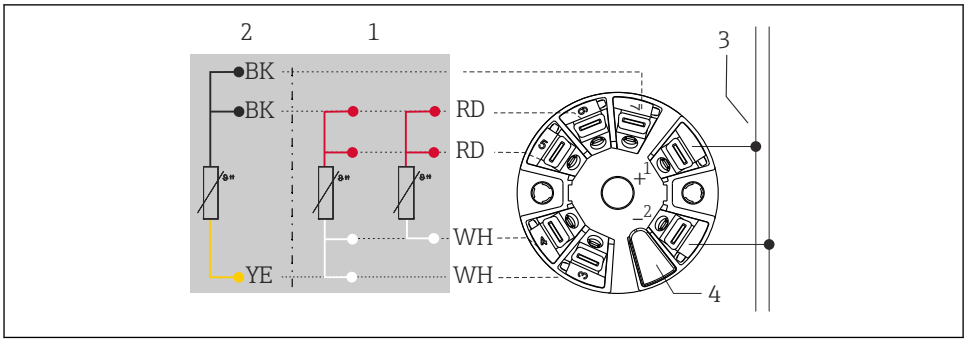
5 *Head-mounted iTEMP TMT7x transmitter or iTEMP TMT31 (single sensor input)*

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



6 *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



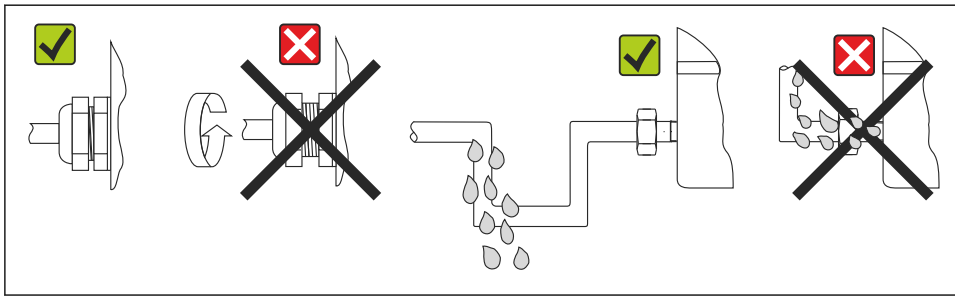
7 *Head-mounted iTEMP TMT8x transmitter (dual sensor input)*

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

6.3 Ensuring the degree of protection

The device meets all of the requirements in accordance with the degree of protection indicated on the nameplate. Compliance with the following points is mandatory following installation in the field or servicing in order to ensure that the housing degree of protection is maintained:

- The housing seals must be clean and undamaged when inserted into their grooves. If the seal or sealing groove is dirty, dry, clean or replace it.
- All housing screws and screw caps must be firmly tightened.
- The cables used for the connection must have the specified outer diameter (e.g. M20x1.5, cable diameter 8 to 12 mm).
- Firmly tighten the cable gland, and use it only in the specified clamping area (the cable diameter must be appropriate to the cable gland).
- The cables must loop down before they enter the cable gland ("water trap"). This means that any moisture that may form cannot enter the gland. The device must be installed so that the cable glands are not facing upwards.
- Do not twist the cables, and use only round cables.
- Replace unused cable glands with a dummy plug (included in the scope of delivery).
- Do not remove the grommet from the cable gland.
- Repeated opening/closing of the device is possible but has a negative impact on the degree of protection.



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8 Connection instructions for compliance with the degree of protection

6.4 Post-connection check

❑	Are the device and cable undamaged (visual check)?
❑	Do the mounted cables have suitable strain relief?
❑	Does the supply voltage match the information on the nameplate?

7 Maintenance

As a general rule, no specific maintenance work is required.

7.1 Cleaning

7.1.1 Cleaning of surfaces not in contact with the medium

- Recommendation: Use a lint-free cloth that is either dry or slightly dampened using water.
- Do not use any sharp objects or aggressive cleaning agents that corrode the surfaces (displays, housing, for example) and seals.
- Do not use high-pressure steam.
- Observe the degree of protection of the device.

The cleaning agent used must be compatible with the materials of the device configuration. Do not use cleaning agents with concentrated mineral acids, bases or organic solvents.

7.1.2 Cleaning of surfaces in contact with the medium

Note the following for cleaning and sterilization in place (CIP/SIP):

- Use only cleaning agents to which the materials in contact with the medium are sufficiently resistant.
- Observe the permitted maximum medium temperature.

7.2 Maintenance services

Service	Description
Calibration	RTD inserts may drift depending on the application. Regular recalibration to verify accuracy is recommended. The calibration can be performed by the manufacturer or by qualified technical staff using calibration devices onsite.

8 Repair

8.1 Spare parts

Product spare parts that are currently available can be found online at: www.endress.com/onlinetools

8.2 Return

The requirements for safe device return can vary depending on the device type and national legislation.

1. Refer to the web page for information: https://www.endress.com
2. If returning the device, pack the device in such a way that it is reliably protected against impact and external influences. The original packaging provides the best protection.

8.3 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

9 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**.

10 Technical data

10.1 Input

10.1.1 Measured variable

Temperature (temperature-linear transmission behavior)

10.1.2 Measuring range

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)

1) Options depend on product and configuration. Only RTD sensors can be configured for hygienic thermometers.

10.2 Output

10.2.1 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 or as field transmitter and wired with the sensory mechanism.

10.2.2 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).

10.3 Environment

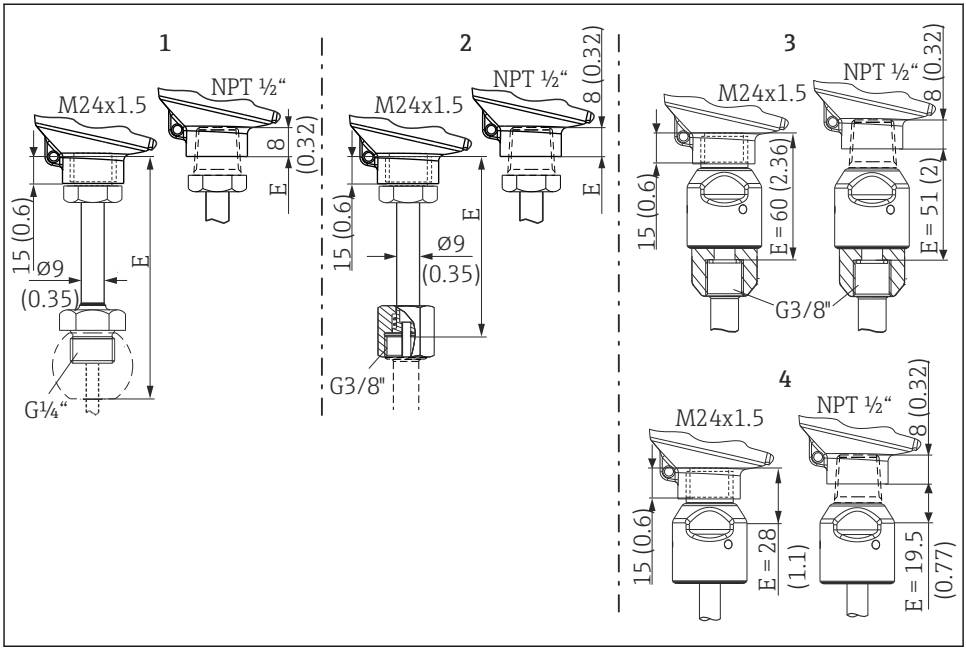
10.3.1 Ambient temperature range

Terminal head	Temperature in °C (°F)
Without mounted head transmitter	Depends on the terminal head used and the cable gland or fieldbus connector See the Technical Information of the relevant thermometer, "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)

Extension neck	Temperature in °C (°F)
Quick-fastening iTHERM QuickNeck	−50 to +140 °C (−58 to +284 °F)

10.3.2 Extension neck

Standard version of extension neck, or optionally with quick-fastening iTHERM QuickNeck.
- Tool-free removal of the insert:
  - Saves time/costs on frequently calibrated measuring points
  - Wiring mistakes avoided
- IP69K protection class



9 Dimensions of extension neck type TE411, different versions, each with M24x1.5 or NPT ½" thread to the terminal head

1 With G¼" male thread for compression fitting TK40, 3-A marked
2 With G3/8" union nut for thermowell version: Ø6 mm (¼ in), Ø12.7 mm (0.5 in) and T-piece and elbow piece thermowell versions
3 Quick-fastening iTHERM QuickNeck for thermowell version: Ø6 mm (¼ in), Ø12.7 mm (0.5 in) and T-piece and elbow piece thermowell versions
4 Quick-fastening iTHERM QuickNeck - top part, for installation in an existing thermowell with iTHERM QuickNeck

10.3.3 Storage temperature

−40 to +80 °C (−40 to +176 °F)

10.3.4 Operating altitude

Up to 2 000 m (6 561 ft) above sea level in accordance with IEC 61010-1

10.3.5 Climate class

See Technical Information for the corresponding, mounted transmitter.

10.3.6 Degree of protection

Max. IP69, depending on the design (terminal head, connector, etc.).

10.3.7 Shock- and vibration-resistance

See Technical Information of the relevant thermometer.

10.3.8 Electromagnetic compatibility (EMC)

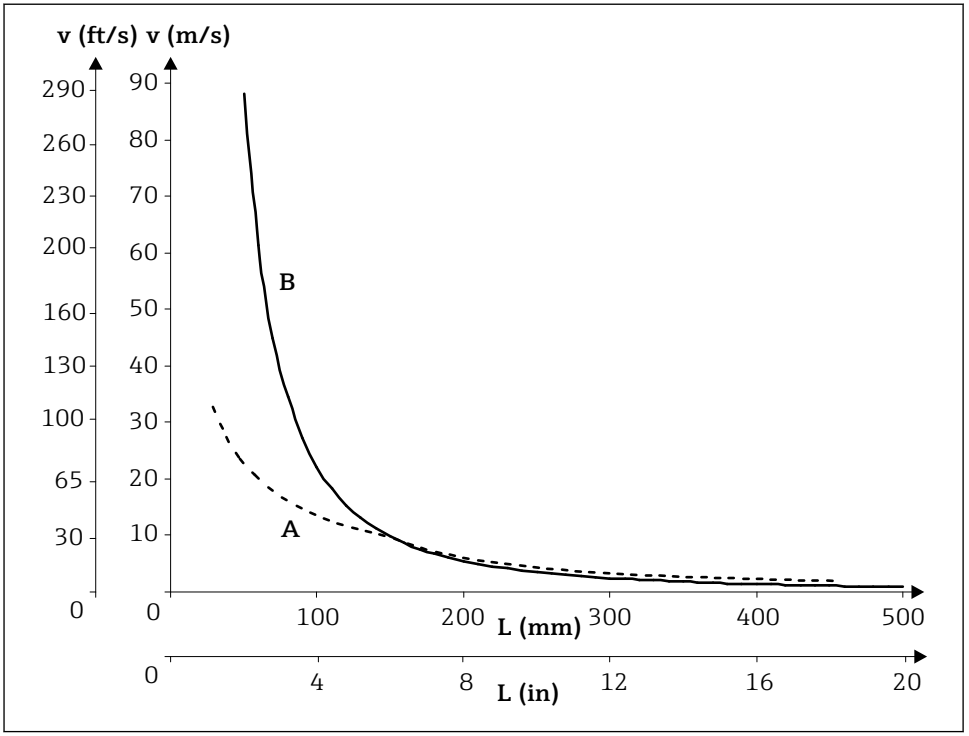
Depends on the head transmitter used. See Technical Information for the corresponding, mounted transmitter.

10.3.9 Process temperature range

The maximum possible process pressure depends on various influencing factors, such as the design, process connection and process temperature.

See Technical Information for the relevant thermometer, "Process connection" section.

It is possible to verify the mechanical loading capacity depending on the installation and process conditions using the online TW Sizing Module for thermowells in the Endress +Hauser Applicator software. See 'Accessories' section.



10 Permitted flow velocity, thermowell diameter 9 mm (0.35 in)

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

Example of the permitted flow velocity depending on the immersion length and process medium

The maximum flow velocity tolerated by the thermometer diminishes with increasing immersion of the insert in the flow of the medium being measured. In addition, it is dependent on the diameter of the thermometer tip, the medium type, the process temperature and the process pressure. The following diagrams exemplify the maximum permitted flow velocities in water and superheated steam at a process pressure of 40 bar (580 PSI).

10.3.10 Electrical safety

- Protection class III
- Overvoltage category II
- Pollution degree 2

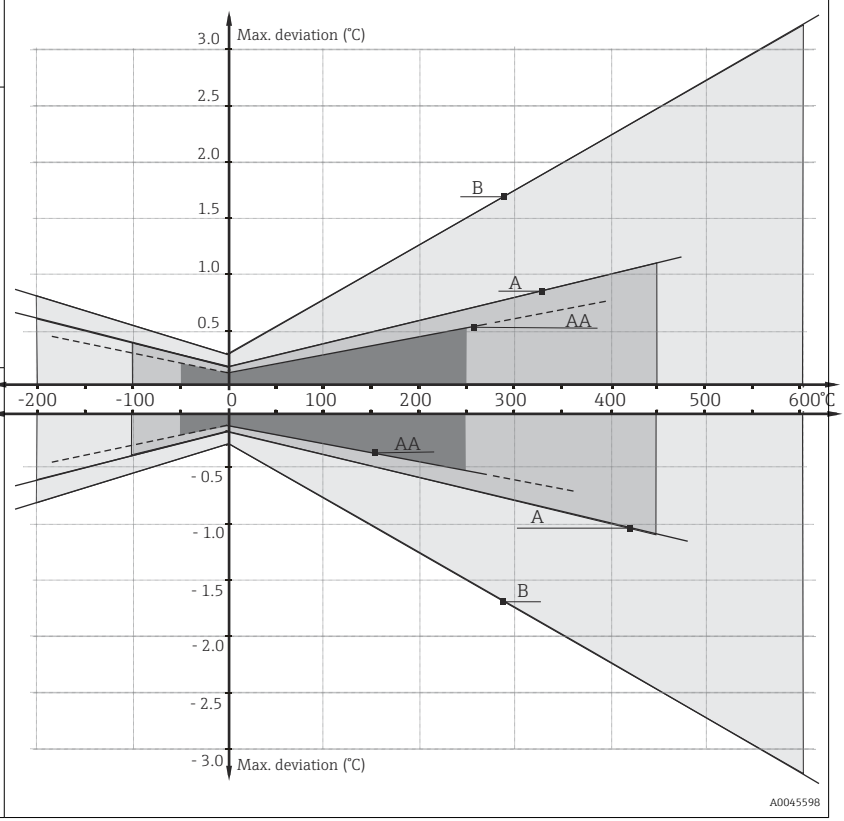
10.4 Performance characteristics

10.4.1 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.

10.4.2 Maximum measurement error

RTD resistance thermometer corresponding to IEC 60751

Class	Max. tolerances (°C)	Characteristics
RTD maximum sensor error		
Cl. A	± (0.15 + 0.002 · |t|) [1]	
Cl. AA, previously 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

To obtain the maximum tolerances in °F, multiply the results in °C by a factor of 1.8.

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

10.4.3 Influence of ambient temperature

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

10.4.4 Self-heating

RTD elements are passive resistors 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. The self-heating is negligible if an iTEMP temperature transmitter (extremely low measuring current) from Endress+Hauser is used.

10.4.5 Response time

Tests have been performed in water at 0.4 m/s (according to IEC 60751) and with a 10 K temperature change.

Response time with heat transfer paste [1)]

Thermowell	Shape of tip	Insert	1x Pt100 iTHERM QuickSens, TF		1x Pt100 iTHERM StrongSens, TF		1x Pt100 wire wound WW		2x Pt100 wire wound WW		1x Pt100 standard thin-film TF	
			t_{50}	t_{90}	t_{50}	t_{90}	t_{50}	t_{90}	t_{50}	t_{90}	t_{50}	t_{90}
Ø6 mm (¼ in)	Reduced 4.3 mm (0.17 in) x 20 mm (0.79 in)	Ø3 mm (⅛ in)	1 s	2.5 s	-		8.5 s	26 s	5.5 s	18 s	8 s	23 s
Ø9 mm (0.35 in)	Straight	Ø6 mm (¼ in)	2 s	9 s	8 s	27 s	15 s	45 s	15 s	45 s	9.5 s	27 s
	Reduced 5.3 mm (0.21 in) x 20 mm (0.79 in)	Ø3 mm (⅛ in)	1.25 s	4 s	-		7 s	20 s	7 s	20 s	7 s	23 s
	Tapered 6.6 mm (0.26 in) x 60 mm (2.36 in)	Ø3 mm (⅛ in)	2.5 s	12 s	-		14 s	49 s	12 s	40 s	15 s	51 s
Ø12.7 mm (½ in)	Straight	Ø6 mm (¼ in)	4 s	26 s	12 s	54 s	23 s	81 s	23 s	81 s	31 s	100 s
	Reduced 5.3 mm (0.21 in) x 20 mm (0.79 in)	Ø3 mm (⅛ in)	1.5 s	5.5 s	-		9 s	27 s	9 s	27 s	6.5 s	21 s
	Reduced 8 mm (0.31 in) x 32 mm (1.26 in)	Ø6 mm (¼ in)	6 s	36 s	11 s	44 s	22 s	69 s	22 s	69 s	26 s	90 s

1) If using a thermowell.

Response time without heat transfer paste [1)]

Thermowell	Shape of tip	Insert	1x Pt100 iTHERM QuickSens, TF		1x Pt100 iTHERM StrongSens, TF		1x Pt100 wire wound WW		2x Pt100 wire wound WW		1x Pt100 standard thin-film TF	
			t_{50}	t_{90}	t_{50}	t_{90}	t_{50}	t_{90}	t_{50}	t_{90}	t_{50}	t_{90}
Without thermowell	-	Ø3 mm (⅛ in)	0.5 s	0.75 s	-		1.75 s	5 s	2 s	6 s	2.5 s	5.5 s
		Ø6 mm (¼ in)		1.5 s	2.5 s	16 s	4 s	10.5 s	4.5 s	12 s	4.75 s	13 s
Ø6 mm (¼ in)	Reduced 4.3 mm (0.17 in) x 20 mm (0.79 in)	Ø3 mm (⅛ in)	1 s	3 s	-		9 s	27 s	7.5 s	24 s	8.5 s	28 s
Ø9 mm (0.35 in)	Straight	Ø6 mm (¼ in)	2 s	9 s	8 s	29 s	19 s	62 s	19 s	62 s	13.5 s	42 s

Thermowell	Shape of tip	Insert	1x Pt100 iTHERM QuickSens, TF		1x Pt100 iTHERM StrongSens, TF		1x Pt100 wire wound WW		2x Pt100 wire wound WW		1x Pt100 standard thin-film TF	
			t_{50}	t_{90}	t_{50}	t_{90}	t_{50}	t_{90}	t_{50}	t_{90}	t_{50}	t_{90}
	Reduced 5.3 mm (0.21 in) x 20 mm (0.79 in)	Ø3 mm (⅛ in)	1.5 s	5 s	-		7 s	21 s	7 s	21 s	8 s	22 s
	Tapered 6.6 mm (0.26 in) x 60 mm (2.36 in)	Ø3 mm (⅛ in)	5 s	23 s	-		13 s	45 s	13 s	45 s	15.5 s	60 s
Ø12.7 mm (½ in)	Straight	Ø6 mm (¼ in)	5.5 s	41 s	12 s	54 s	23 s	82 s	23 s	82 s	32 s	105 s
	Reduced 5.3 mm (0.21 in) x 20 mm (0.79 in)	Ø3 mm (⅛ in)	2 s	6 s	-		10 s	30 s	10 s	30 s	8 s	30 s
	Reduced 8 mm (0.31 in) x 32 mm (1.26 in)	Ø6 mm (¼ in)	14.5 s	65 s	16 s	53 s	26 s	85 s	26 s	85 s	32 s	108 s

1) If using a thermowell.

Response time for directly wired insert without transmitter.

10.4.6 Response time

Tests have been performed in water at 0.4 m/s (according to IEC 60751) and with a 10 K temperature change.

Pipe diameter	Shape of tip	1x Pt100 thin-film sensor	
		Response time	
		t_{50}	t_{90}
Ø6 mm (¼ in)	Straight	5 s	11 s
	Reduced 4.5 mm (0.18 in) x 18 mm (0.71 in)	3.5 s	9 s
Ø8 mm (0.31 in)	Reduced 5.3 mm (0.21 in) x 20 mm (0.79 in)	5 s	10.5 s

Response time without transmitter.

10.4.7 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.

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 +1022 °F)	300 mm (11.81 in)
+551 to +600 °C (+1023.8 to +1112 °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)

10.4.8 Insulation resistance

Insulation resistance ≥ 100 MΩ at ambient temperature, measured between the terminals and the outer jacket with a minimum voltage of 100 V_{DC}.

10.5 Environment

10.5.1 Ambient temperature range

Terminal head [1]	Temperature in °C (°F)
Without head transmitter installed	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) SIL mode (HART 7 transmitter): −40 to 70 °C (−40 to 158 °F)
With mounted head transmitter and display	−30 to +85 °C (−22 to +185 °F)
With mounted field transmitter	▪ Without display: −40 to 85 °C (−40 to 185 °F) ▪ With display: −40 to +80 °C (−40 to +176 °F) ▪ SIL mode: −40 to +75 °C (−40 to +167 °F)

1) Depends on product and configuration.

Extension neck	Temperature in °C (°F)
iTHERM QuickNeck	−50 to +140 °C (−58 to +284 °F)

10.5.2 Storage temperature

−40 to 85 °C (−40 to 185 °F).

10.5.3 Humidity

Depending on the transmitter used. If Endress+Hauser iTEMP head transmitters are used:
- Condensation permitted as per IEC 60 068-2-33.
- Maximum relative humidity: 95% as per IEC 60068-2-30.

10.5.4 Climate class

As per EN 60654-1, Class C.

10.5.5 Degree of protection

Max. IP69K, depending on the design (terminal head, connector, etc.).

10.5.6 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

10.5.7 Electromagnetic compatibility (EMC)

Depends on the iTEMP head transmitter used. See the technical documentation of the specific device.

10.6 Mechanical construction

Depends on the device used from the iTHERM ModuLine TM4xx product family. See the technical documentation of the specific device for details.

10.7 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**.

10.7.1 Hygiene standard

- ASME BPE (latest revision), Certificate of Conformance can be ordered for designated options.
- 3-A Certificate Authorization number 1144, 3-A Sanitary Standard 74-07. Listed process connections.
- EHEDG Certificate, Type EL CLASS I. EHEDG certified/tested process connections.
- FDA-compliant.
- All process contact parts comply with the requirements of guidance EMA/410/01 Rev.3. Furthermore, no grinding and polishing agents of animal origin have been used during the entire production of the process contact parts.

10.7.2 Materials in contact with food/product (FCM)

The process contact parts (FCM) are in conformity with the following European Regulations:
- Regulation (EC) No 1935/2004, on materials and articles intended to come into contact with food, article 3, paragraph 1, article 5 and 17.
- Regulation (EC) No 2023/2006 on good manufacturing practice for materials and articles intended to come into contact with food.
- Regulation (EU) No 10/2011 on plastic materials and articles intended to come into contact with food.

10.7.3 Other standards and guidelines

- 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
- ASTM E 1137/E1137M-2008: Standard Specification for Industrial Platinum Resistance Thermometers
- EN 50281-1-1: Electrical apparatus protected by enclosures
- DIN EN 50446: Terminal heads
- IEC 61326-1: Electromagnetic compatibility (electrical equipment for measurement, control and laboratory use - EMC requirements)
- PMO: Pasteurized Milk Ordinance 2001 Revision, U.S. Food and Drug Administration, Center for Food Safety & Applied Nutrition

10.7.4 Material resistance

Material resistance - including resistance of housing - to the following Ecolab cleaning/ disinfection agents:
- P3-topax 66
- P3-topactive 200
- P3-topactive 500
- P3-topactive OKTO
- And demineralized water

10.7.5 CRN approval

The CRN approval is only available for certain thermowell versions. These versions are identified and displayed accordingly during the configuration of the device.

Detailed ordering information is available for your nearest sales organization www.addresses.endress.com or in the Download Area under www.endress.com :

1. Select the country
2. Select Downloads
3. In the search area: select Approvals/approval type
4. Enter the product code or device
5. Start the search

10.7.6 Surface purity

Free from oil and grease, optional.

10.7.7 Thermowell testing and load capacity calculation

- Thermowell pressure tests are carried out in accordance with the specifications in DIN 43772. With regard to thermowells with reduced tip that do not comply with this standard, these are tested using the pressure of corresponding straight thermowells. 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.
- PMI test, dye penetration test, TW welding, internal hydrostatic pressure, etc. each with inspection certificate
- Load capacity calculation for the thermowell as per DIN 43772

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