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Valid as of version
01.00 (device version)

Operating Instructions
iTHERM TrustSens TM371

Compact thermometer in metric style with self-calibration
HART communication

Table of contents

1 About this document

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 dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

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

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

1.2.2 Electrical symbols

Symbol	Meaning
⎓	Direct current
~	Alternating current
⎓ ~	Direct current and alternating current
⏚	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
⏚	**Potential equalization connection (PE: protective earth)** Ground terminals that must be connected to ground prior to establishing any other connections. The ground terminals are located on the interior and exterior of the device: ▪ Interior ground terminal: potential equalization is connected to the supply network. ▪ Exterior ground terminal: device is connected to the plant grounding system.

1.2.3 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.

Symbol	Meaning
	Tip Indicates additional information.
	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

1.2.4 Tool symbols

Symbol	Meaning
 A0011222	Open-ended wrench

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.

1.3.1 Document function

The following documentation may be available depending on the version ordered:

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 the 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.

Document type	Purpose and content of the document
Safety Instructions (XA)	Depending on the approval, safety instructions for electrical equipment in hazardous areas are also supplied with the device. The Safety Instructions are an integral part of the Operating Instructions. Information on the Safety Instructions (XA) relevant to the device is provided on the nameplate.
Supplementary device-dependent documentation (SD/FY)	Always comply strictly with the instructions in the relevant supplementary documentation. The supplementary documentation is an integral part of the device documentation.

2 Basic safety instructions

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 device is a hygienic compact thermometer, which features an automatic self-calibration function. It is applied for the acquisition and conversion of temperature input signals for industrial temperature measurement.
- The manufacturer is not liable for damage caused by improper or non-intended use.

2.3 Operation safety

NOTICE

Operation safety
- Operate the device in proper technical condition and fail-safe condition only.
- The operator is responsible for interference-free operation of the device.

Conversions to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers.
- If, despite this, modifications are required, consult with Endress+Hauser.

Repair

Due to its design, the device cannot be repaired.
- However, it is possible to send the device in for examination.
- To ensure continued operational safety and reliability, use original spare parts and accessories from Endress+Hauser only.

2.4 Product safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and 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 to the device.

2.5 IT security

Our warranty is valid only if the product is installed and used as described in the Operating Instructions. The product is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the product and associated data transfer, must be implemented by the operators themselves in line with their security standards.

3 Incoming acceptance and product identification

3.1 Incoming acceptance

Proceed as follows on receipt of the device:

1. Check whether the packaging is intact.
2. If damage is discovered:
   Report all damage immediately to the manufacturer.
3. Do not install damaged components, as the manufacturer cannot otherwise guarantee the material resistance or compliance with the original safety requirements, and can also not be held responsible for the consequences that may result.
4. Compare the scope of delivery against the contents of your order.
5. Remove all the packaging material used for transportation.
6. Do the data on the nameplate match the ordering information on the delivery note?
7. Are the technical documentation and all other necessary documents provided, e.g. certificates?

If one of the conditions is not satisfied, contact your Sales Center.

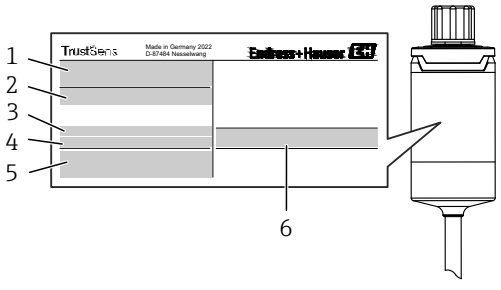
3.2 Product identification

The following options are available for identification of the device:
- Nameplate specifications
- Enter the serial number from the nameplate in the *Device Viewer* (www.endress.com/deviceviewer): All data relating to the device and an overview of the Technical Documentation supplied with the device are displayed.

3.2.1 Nameplate

Is this the correct device?

Compare and check the data on the nameplate of the device against the requirements of the measuring point:



1 *Nameplate of the compact thermometer (example)*

1	Order code, serial number
2	Supply voltage and current consumption
3	Device revision and firmware version
4	Ambient temperature
5	Approvals with symbols
6	Device TAG name

3.2.2 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

3.2.3 Certificates and approvals

For certificates and approvals valid for the device: see the data on the nameplate

Approval-related data and documents: www.endress.com/deviceviewer → (enter the serial number)

Hygiene standard

- EHEDG certification, type EL - CLASS I. EHEDG certified/tested process connections → 66
- 3-A authorization no. 1144, 3-A Sanitary standard 74-07. Listed process connections → 66
- ASME BPE, certificate of conformity can be ordered for indicated options
- FDA-compliant
- All surfaces in contact with the medium are free of animal derived ingredients (ADI/TSE) and do not contain any materials derived from bovine or animal sources.

Materials in contact with food/product (FCM)

The materials of the thermometer in contact with food/product (FCM) comply with the following European regulations:
- (EC) No. 1935/2004, Article 3, paragraph 1, Articles 5 and 17 on materials and articles intended to come into contact with food.
- (EC) No. 2023/2006 on good manufacturing practice for materials and articles intended to come into contact with food.
- (EU) No. 10/2011 on plastic materials and articles intended to come into contact with food.

3.3 Storage and transport

Storage temperature: −40 to +85 °C (−40 to +185 °F)

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

Avoid the following environmental influences during storage and transport:
- Direct sunlight
- Vibration
- Aggressive media

4 Mounting

4.1 Mounting requirements

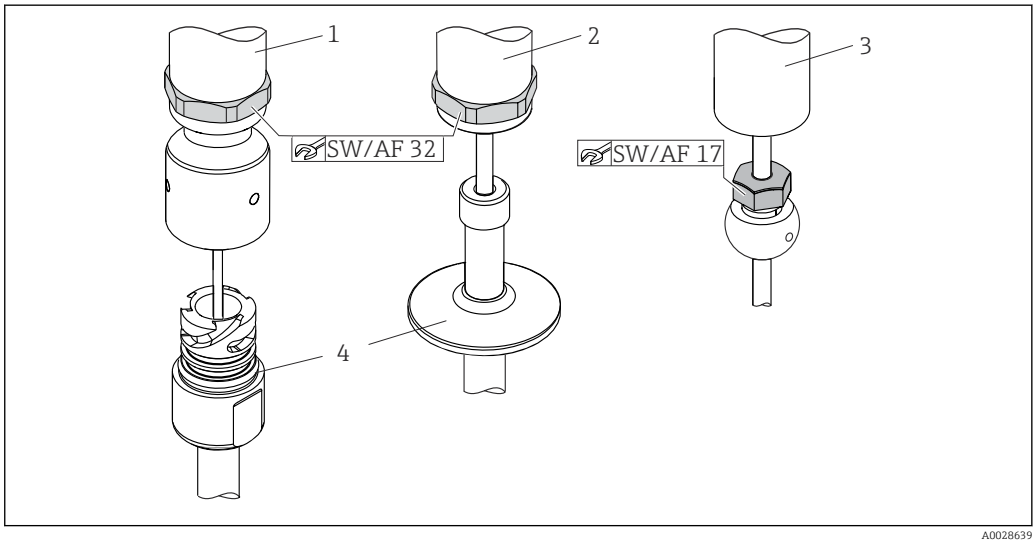
Information about the conditions, which have to be existent at the mounting location for a designated use, such as ambient temperature, degree of protection, climate class, etc., as well as device dimensions - see section 'Technical Data', → 48

The immersion length of the thermometer can influence the accuracy. If the immersion length is too small then errors in the measurement are caused by heat conduction via the process connection. If installing into a pipe then the immersion length should ideally be half of the pipe diameter. → 11

- Installation possibilities: Pipes, tanks or other plant components
- Orientation: no restrictions. However, self-draining in the process must be guaranteed. If there is an opening to detect leaks at the process connection, this opening must be at the lowest possible point.

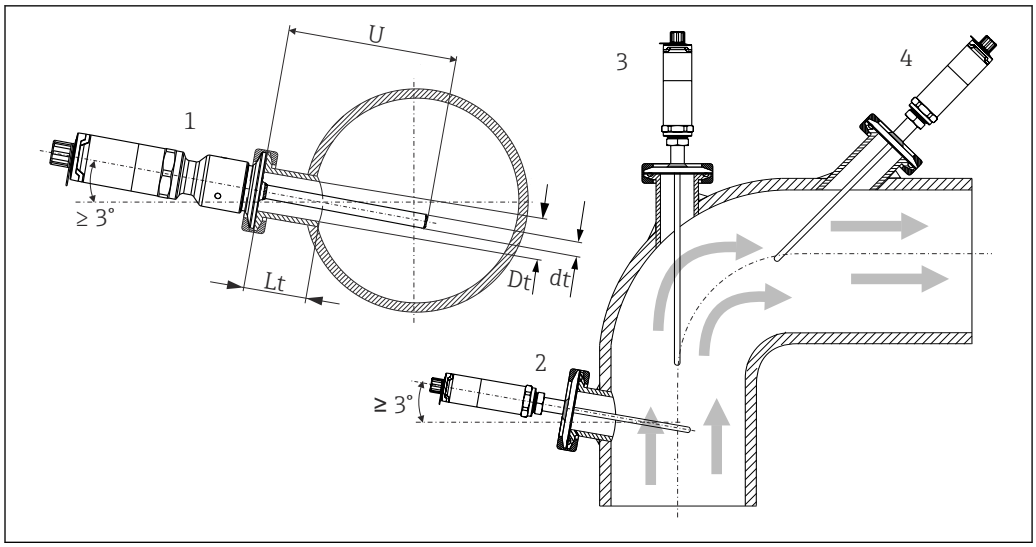
4.2 Mounting the measuring device

Required tools for mounting in an existing protection tube: Open-end wrench or mounting socket wrench SW/AF 32



2 *Mounting process of the compact thermometer*

1 *Mounting of iTHERM QuickNeck connection to the existing protection tube with iTHERM QuickNeck bottom part - no tools required*
2 *Hexagonal head SW/AF 32 for the mounting in an existing protection tube for M24-, G3/8"-thread*
3 *Adjustable compression fitting TK40 - mounting of the hexagonal screw with open-end wrench SW/AF 17 only*
4 *Protection tube*



3 Mounting possibilities in the process

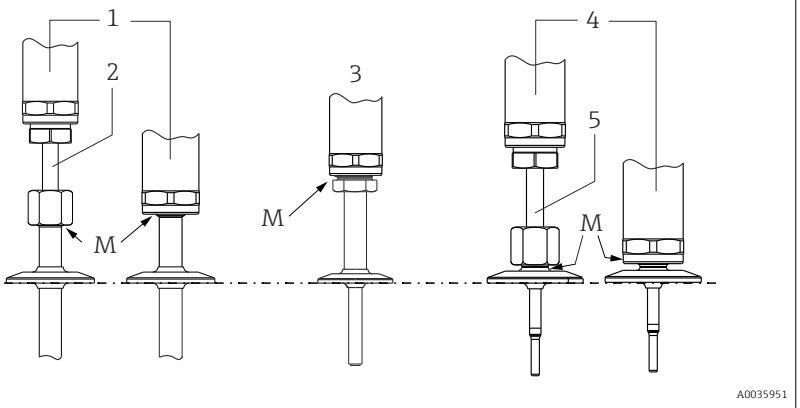
1, 2 Perpendicular to flow direction, installed at a min. angle of 3° to ensure self-draining
3 On elbows
4 Inclined installation in pipes with a small nominal diameter
U Immersion length

The requirements of the EHEDG and the 3-A Sanitary Standard must be adhered to.

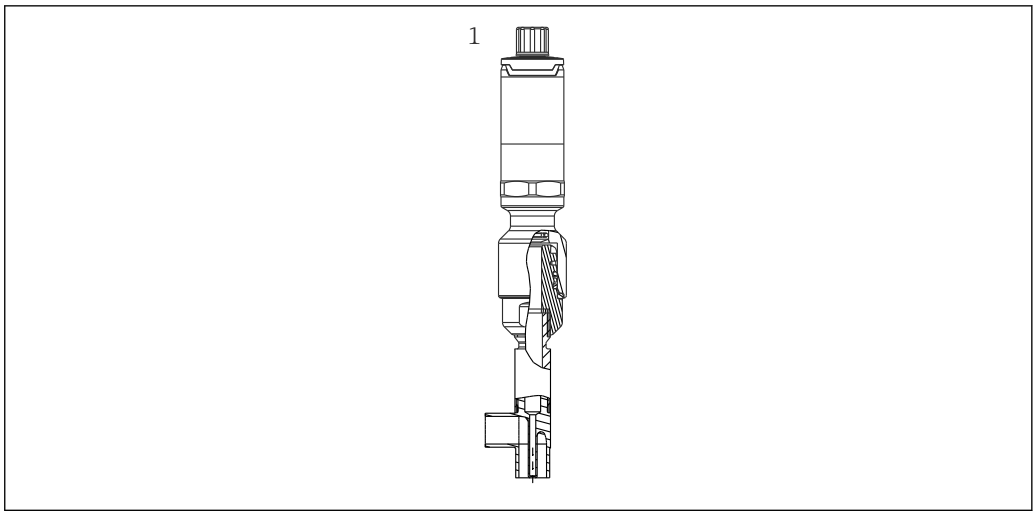
Installation instructions EHEDG/cleanability: Lt ≤ (Dt-dt)

Installation instructions 3-A/cleanability: Lt ≤ 2 (Dt-dt)

In the case of pipes with a small nominal diameter, it is advisable for the tip of the thermometer to project well into the process so that it extends past the pipe axis. Installation at an angle (4) could be another solution. When determining the immersion length or installation depth all the parameters of the thermometer and of the medium to be measured must be taken into account (e.g. flow velocity, process pressure).

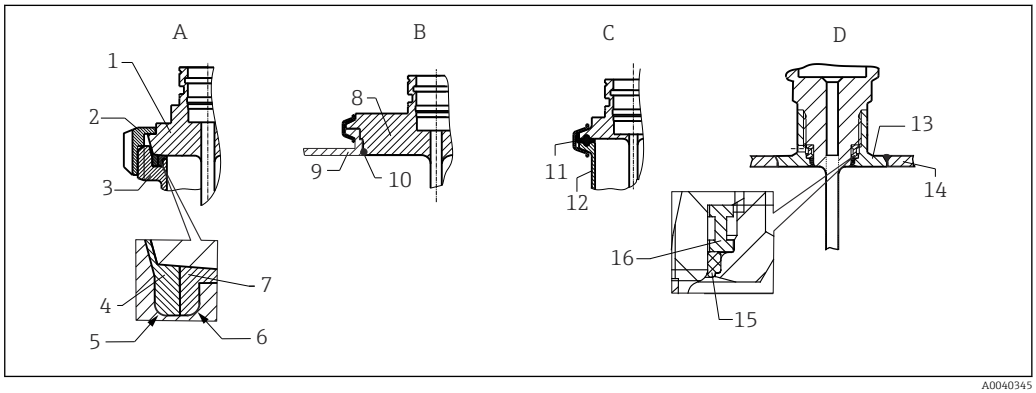
Maximum torque			
			
Protection tube version	TT411, Φ6 mm (0.24 in) (1) TT411, Φ6 mm (0.24 in) and Necktube TE411 (2)	TT411, Φ9 mm (0.35 in) (3)	TT411, Φ12.7 mm (½ in) (4) TT411, Φ12.7 mm (½ in) and Necktube TE411 (5)
Torque M	3 to 5 Nm (2.2 to 3.7 lbf ft)	10 Nm (7.4 lbf ft)	3 to 5 Nm (2.2 to 3.7 lbf ft)

When connecting the device with the protection tube: only turn the hexagonal spanner flat on the bottom of the housing.



4 Process connections for thermometer installation in pipes with small nominal diameters

1 Elbow thermowell for weld-in as per DIN 11865 / ASME BPE 2012



5 Detailed installation instructions for hygiene-compliant installation (depends on the version ordered)

A Milk pipe connection according to DIN 11851, only in connection with EHEDG certified and self-centering sealing ring
1 Sensor with milk pipe connection
2 Groove slip-on 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
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

NOTICE

The following actions must be taken if a sealing ring (O-ring) or seal fails:

- The thermometer must be removed.
- The thread and the O-ring joint/sealing surface must be cleaned.
- The sealing ring or seal must be replaced.
- CIP must be performed after installation.

The counterpieces for the process connections and the seals or sealing rings are not included in the scope of supply for the thermometer. Liquiphant M weld-in adapters with associated seal kits are available as accessories. → 44

In the case of weld-in connections, exercise the necessary degree of care when performing the welding work on the process side:

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

1. As a general rule, the thermometers should be installed in such a way that does not impact their ability to be cleaned (the requirements of the 3-A Sanitary Standard must be observed).
2. The Varivent® and Liquiphant-M weld-in adapter and Ingold (+ weld-in adapter) connections enable flush-mounted installation.

4.3 Post-mounting check

❑	Is the device undamaged (visual inspection)?
❑	Is the device fixed appropriately?
❑	Does the device comply to the measurement point specifications, such as ambient temperature, etc.? → 48

5 Electrical connection

5.1 Connecting requirements

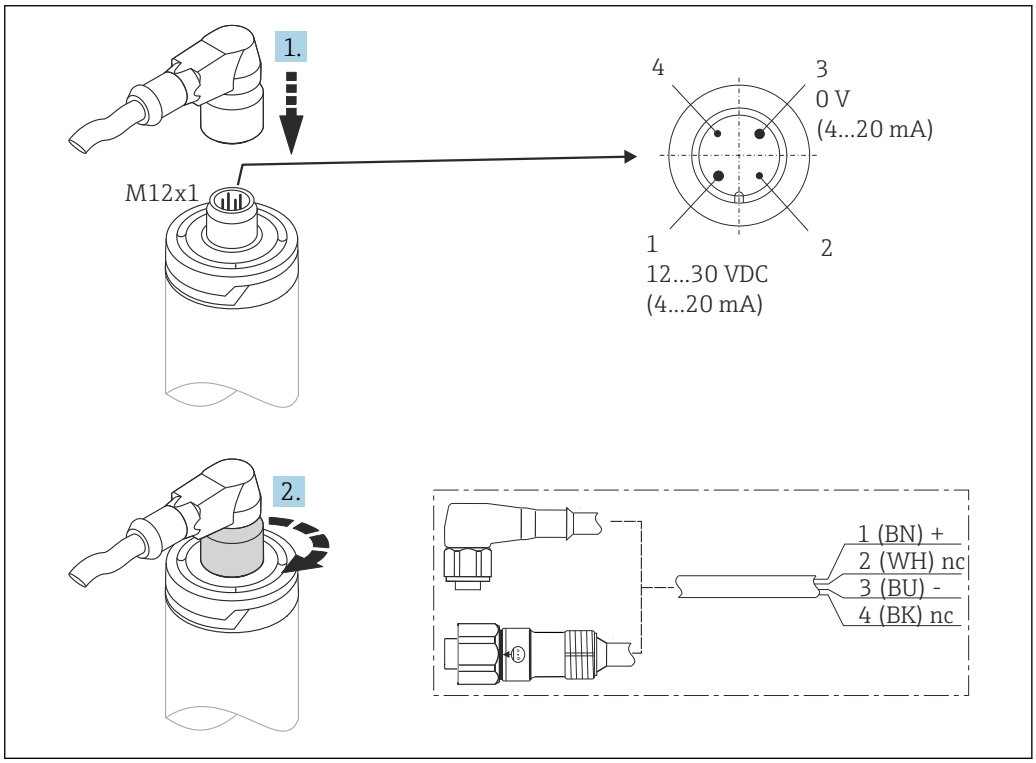
According to the 3-A Sanitary Standard and EHEDG electrical connecting cables must be smooth, corrosion-resistant and easy to clean.

5.2 Connecting the measuring device

NOTICE

To prevent damage to the device

- To prevent any kind of damage from the device electronics, leave the pins 2 and 4 unconnected. They are reserved for the connection of the configuration cable.
- Do not tighten the M12 plug too much, in order to prevent damage to the device.



6 *Cable plug M12x1 and PIN assignment of the connection socket at the device*

If voltage supply is connected correctly and the measuring device is operational, the LED is illuminated green.

5.3 Ensuring the degree of protection

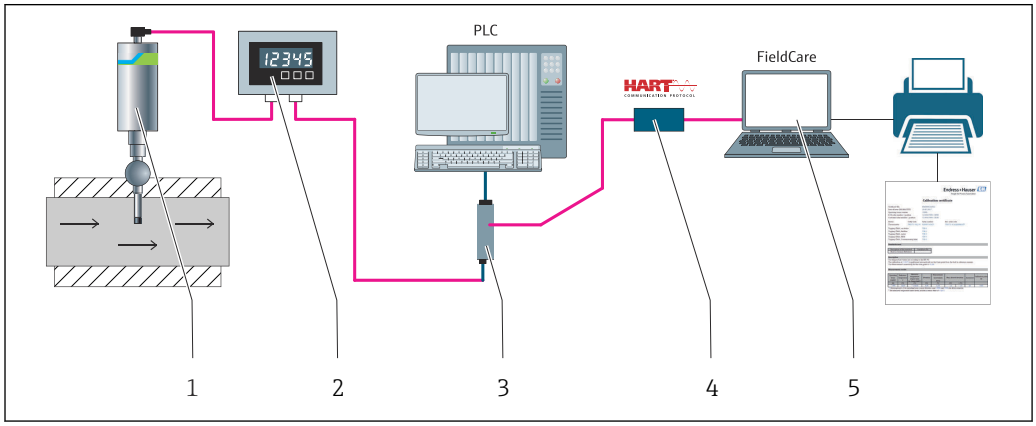
The specified degree of proctection is ensured when the M12x1 cable plug is tightened. In order to reach IP69 degree of protection, appropriate cord sets with straight or angle plugs are available as accessories.

5.4 Post-connection check

❑	Is the device or cable undamaged (visual check)?
❑	Do the cables have adequate strain relief?
❑	Does the supply voltage match the specifications on the nameplate?

6 Operability

6.1 Overview of operation options

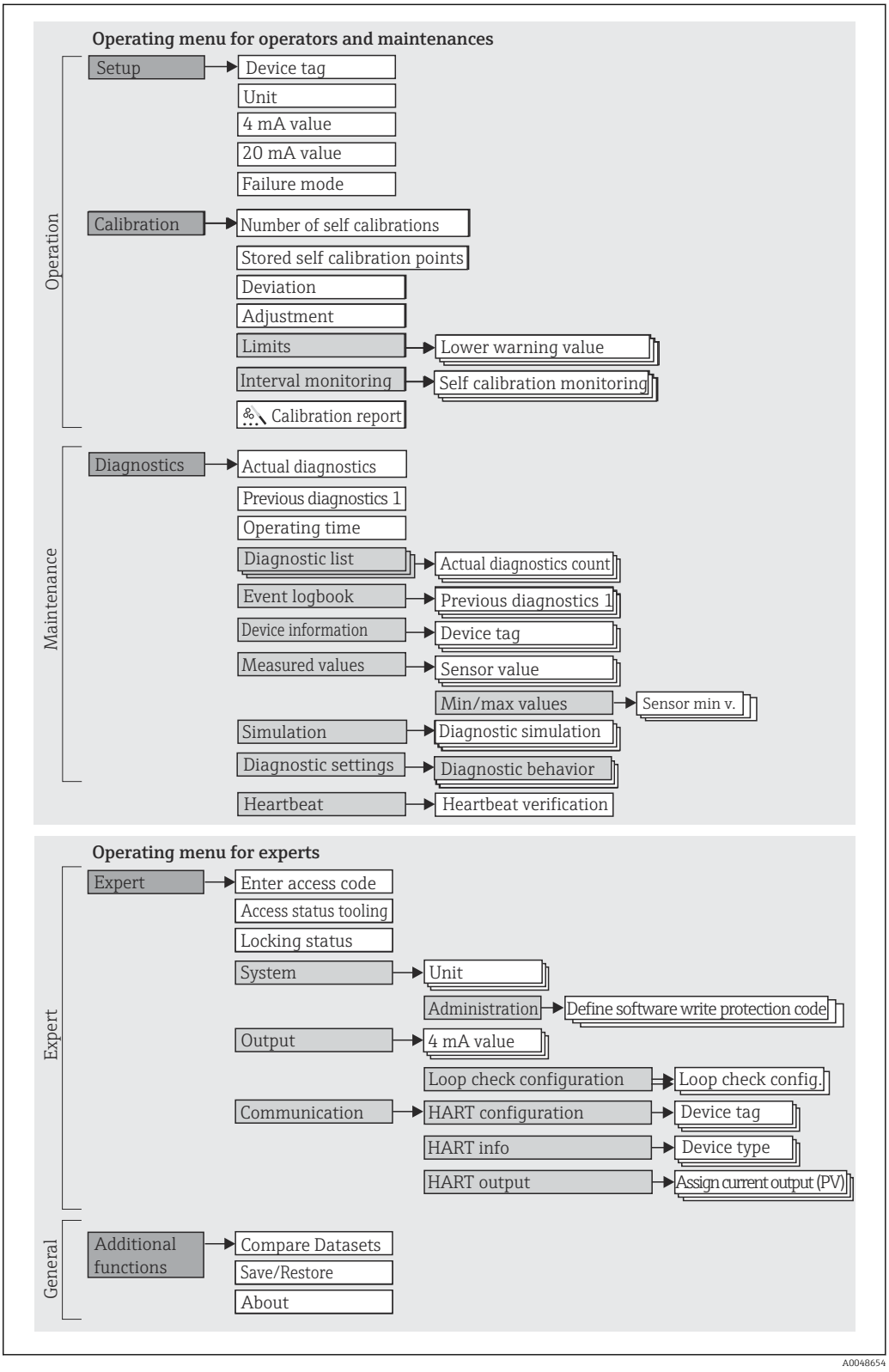


7 *Operating options of the device*

1 *Installed iTHERM compact 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.*
3 *Active barrier RN42 – The active barrier is used for transmission and galvanic isolation of 4 to 20 mA/HART signals and supplying loop powered transmitters. The universal power supply works with an input supply voltage of 19.20 to 253 V DC/AC, 50/60 Hz, which means that it can be used in all international power grids.*
4 *Commubox FXA195 for intrinsically safe HART communication with FieldCare via the USB interface.*
5 *FieldCare is a FDT-based plant asset management tool from Endress+Hauser, more details see section 'accessories'. The acquired self-calibration data is stored in the device (1) and can be read using FieldCare. This also enables an auditable calibration certificate to be created and printed.*

6.2 Structure and function of the operating menu

6.2.1 Structure of the operating menu



Submenus and user roles

Certain parts of the menu are assigned to certain user roles. Each user role corresponds to typical tasks within the lifecycle of the device.

User role	Typical tasks	Menu	Content/meaning
Maintenance Operator	Commissioning: ▪ Configuration of the measurement. ▪ Configuration of data processing (Measurement range, etc.). Reading measured values. Calibration: ▪ Configuration of the warning and alarm limit values as well as interval monitoring. ▪ Configuration and creation of a calibration report (wizard).	"Setup" "Calibration"	Contains all parameters for commissioning and calibration: ▪ **Setup parameters** Once values have been set for these parameters, the measurement should generally be completely configured. ▪ **Calibration parameters** Contains all information and parameters for the self-calibration, including a wizard for creating a calibration report. This wizard is available in the online parameterization.
	Fault elimination: ▪ Diagnosing and eliminating process errors. ▪ Interpretation of device error messages and correcting associated errors.	"Diagnostics"	Contains all parameters for detecting and analyzing errors: ▪ **Diagnostic list** Contains up to 3 currently pending diagnostic messages. ▪ **Event logbook** Contains the last 5 diagnostic messages (no longer pending). ▪ **"Device information" submenu** Contains information for identifying the device. ▪ **"Measured values" submenu** Contains all current measured values. ▪ **"Simulation" submenu** Is used to simulate measured values or output values. ▪ **Diagnostic settings** Configuration of diagnostic behavior and status signal according to NE107
	Heartbeat: Creation of a Heartbeat report (wizard)	"Heartbeat"	Contains a wizard for creating a calibration report. This wizard is available in the online parametrization.
Expert	Tasks that require detailed knowledge of the function of the device: ▪ Commissioning measurements under difficult conditions. ▪ Optimal adaptation of the measurement to difficult conditions. ▪ Detailed configuration of the communication interface. ▪ Error diagnostics in difficult cases.	"Expert"	Contains all parameters of the device (including those that are already in one of the other menus). The structure of this menu is based on the function blocks of the device: ▪ **"System" submenu** Contains all higher-order device parameters that do not pertain either to measurement or the measured value communication. ▪ **"Output" submenu** Contains all parameters for configuring the analog current output and the loop check. ▪ **"Communication" submenu** Contains all parameters for configuring the digital communication interface.

6.3 Access to the operating menu via an operating tool

6.3.1 FieldCare

Function scope

FDT/DTM-based plant asset management tool from Endress+Hauser. It can configure all smart field units in a system and help you manage them. By using the status information, it is also a simple but effective way of checking their status and condition. Access takes place via the HART protocol or CDI (= Endress+Hauser Common Data Interface).

Typical functions:
- Configuring parameters of the device
- Loading and saving device data (upload/download)
- Documentation of the measuring point

For iTHERM TrustSens thermometers, FieldCare provides convenient access to automatically created self-calibration reports.

For details, see Operating Instructions BA00027S/04 and BA00065S/04 in the download area on www.endress.com.

Source for device description files

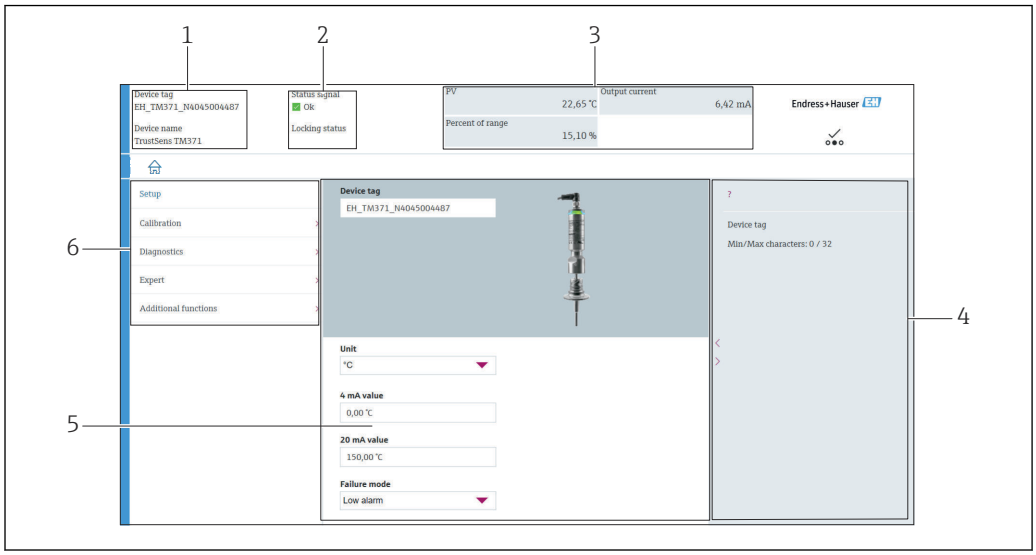
See data → 22

Establishing a connection

As example: via HART modem Commubox FXA191 (RS232) or FXA195 (USB)

1. Make sure to update the DTM library for all connected devices (e.g. FXA19x, iTHERM TrustSens TM371).
2. Start FieldCare and create a project.
3. Go to View --> Network: Right-click on **Host PC** Add Device...
   ↳ The **Add New Device** window opens.
4. Select the **HART Communication** option from the list and press **OK** to confirm.
5. Double-click on **HART Communication** DTM instance.
   ↳ Check the Serial Interface port for the correct modem and press **OK** to confirm.
6. Right-click on **HART Communication** and select the **Add Device...** option in the context menu that opens.
7. Select the desired device from the list and press **OK** to confirm.
   ↳ The device appears in the network list.
8. Right-click on this device and select the **Connect** option in the context menu that opens.
   ↳ The CommDTM appears in green color.
9. Double-click on the device in the network list to establish the online connection to the device.
   ↳ The online parameterization is available.

User interface



8 *User interface with device information via HART®-communication*

1 *Device tag and device name*
2 *Status area for the status signal*
3 *Measured values with general device information: PV, output current, percent of range*
4 *Helping area/additional information*
5 *Display and input area*
6 *Navigation area with operating menu structure*

6.3.2 DeviceCare

Function scope

DeviceCare is a free configuration tool for Endress+Hauser devices. It supports devices with the following protocols, provided a suitable device driver (DTM) is installed: HART, PROFIBUS, FOUNDATION Fieldbus, Ethernet/IP, Modbus, CDI, ISS, IPC and PCP. The tool is aimed at customers without a digital network in plants and workshops as well as Endress +Hauser service technicians. The devices can be connected directly via a modem (point-to-point) or a bus system. DeviceCare is fast, easy and intuitive to use. It can run on a PC, laptop or tablet with a Windows operating system.

Source for device description files

See data → 22

6.3.3 Field Xpert

Function scope

Field Xpert is an industrial PDA (personal digital assistant) with integrated touchscreen for commissioning and maintaining field devices in explosion hazardous and non-hazardous areas. It allows efficient configuration of FOUNDATION fieldbus, HART and WirelessHART devices.

Source for device description files

See data → 22

6.3.4 AMS Device Manager

Function scope

Program from Emerson Process Management for operating and configuring measuring devices via the HART protocol.

Source for device description files

See data → 22

6.3.5 SIMATIC PDM

Function scope

SIMATIC PDM is a standardized, manufacturer-independent program from Siemens for the operation, configuration, maintenance and diagnosis of intelligent field devices via the HART protocol.

Source for device description files

See data → 22

6.3.6 Field Communicator 375/475

Function scope

Industrial handheld terminal from Emerson Process Management for remote configuration and measured value display via the HART protocol.

Source for device description files

See data → 22

7 System integration

7.1 Overview of device description files

Version data for the device

Firmware version	01.00.zz	The firmware version can be found: ▪ on the nameplate → 🖹 9 ▪ in the operating menu: Diagnostics → Device information → Firmware version ▪ ℹ Please make sure to use the operating instructions valid for the device. The corresponding firmware versions for each operating instructions can be found on its title page.
Manufacturer ID	(17) 0x11	Operating menu: Diagnostics → Device information → Manufacturer ID
Device type	0x11CF	Operating menu: Expert → Communication → HART info → Device type
HART protocol revision	7	Operating menu: Expert → Communication → HART info → HART revision
Device revision	1	▪ On the nameplate → 🖹 9 ▪ Operating menu: Expert → Communication → HART info → Device revision

The suitable device driver software (DD/DTM) for the individual operating tools can be obtained from different sources:
- www.endress.com --> Downloads --> Media Type: Software --> Software Type: Application Software
- www.endress.com --> Products: individual product page e.g. TM371 --> Documents / Manuals / Software: Electronic Data Description (EDD) or Device Type Manager (DTM).
- via DVD (contact your local Endress+Hauser sales center)

Endress+Hauser supports all common operating tools of different manufacturers (e.g. Emerson Process Management, ABB, Siemens, Yokogawa, Honeywell and many more). The Endress+Hauser operating tools FieldCare and Device care can also be obtained per download (www. endress.com --> Downloads --> Media Type: Software --> Application Software) or via optical data storage medium (DVD) from your local Endress+Hauser sales center.

7.2 Measured variables via HART protocol

The measured values (device variables) are assigned to the device variables as follows:

Dynamic variable	Device variable
Primary value (PV)	Temperature
Secondary value (SV)	Device temperature
Tertiary value (TV)	Number of self-calibrations
Quaternary value (QV)	Calibration deviation

7.3 Supported HART® commands

The HART® protocol enables the transfer of measurement data and device data between the HART® master and the field device. HART® masters such as the above listed operating tools require an appropriate device driver software (DD or DTM) to establish the data exchange. The data exchange is initiated via commands.

There are three different types of commands.

- Universal commands:
  All HART® devices support and use universal commands. These are associated with the following functionalities for example:
  - Recognition of HART® devices
  - Reading digital measured values
- Common practice commands:
  Common practice commands offer functions which are supported and can be executed by many but not all field devices.
- Device-specific commands:
  These commands allow access to device-specific functions which are not HART® standard. Such commands access individual field device information.

Command No.	Designation
Universal commands	
0, Cmd0	Read unique identifier
1, Cmd001	Read primary variable
2, Cmd002	Read loop current and percent of range
3, Cmd003	Read dynamic variables and loop current
6, Cmd006	Write polling address
7, Cmd007	Read loop configuration
8, Cmd008	Read dynamic variable classifications
9, Cmd009	Read device variables with status
11, Cmd011	Read unique identifier associated with TAG
12, Cmd012	Read message
13, Cmd013	Read TAG, descriptor, date
14, Cmd014	Read primary variable transducer information
15, Cmd015	Read device information
16, Cmd016	Read final assembly number
17, Cmd017	Write message
18, Cmd018	Write TAG, descriptor, date
19, Cmd019	Write final assembly number
20, Cmd020	Read long TAG (32-byte TAG)
21, Cmd021	Read unique identifier associated with long TAG
22, Cmd022	Write long TAG (32-byte TAG)
38, Cmd038	Reset configuration changed flag
48, Cmd048	Read additional device status
Common practice commands	
33, Cmd033	Read device variables
34, Cmd034	Write primary variable damping value
35, Cmd035	Write primary variable range values
40, Cmd040	Enter/Exit fixed current mode

Command No.	Designation
42, Cmd042	Perform device reset
44, Cmd044	Write primary variable units
45, Cmd045	Trim loop current zero
46, Cmd046	Trim loop current gain
50, Cmd050	Read dynamic variable assignments
54, Cmd054	Read device variable information
59, Cmd059	Write number of response preambles
95, Cmd095	Read Device Communication Statistics
100, Cmd100	Write Primary Variable Alarm Code
516, Cmd516	Read Device Location
517, Cmd517	Write Device Location
518, Cmd518	Read Location Description
519, Cmd519	Write Location Description
520, Cmd520	Read Process Unit Tag
521, Cmd521	Write Process Unit Tag
523, Cmd523	Read Condensed Status Mapping Array
524, Cmd524	Write Condensed Status Mapping Array
525, Cmd525	Reset Condensed Status Mapping Array
526, Cmd526	Write Simulation Mode
527, Cmd527	Simulate Status Bit

8 Commissioning

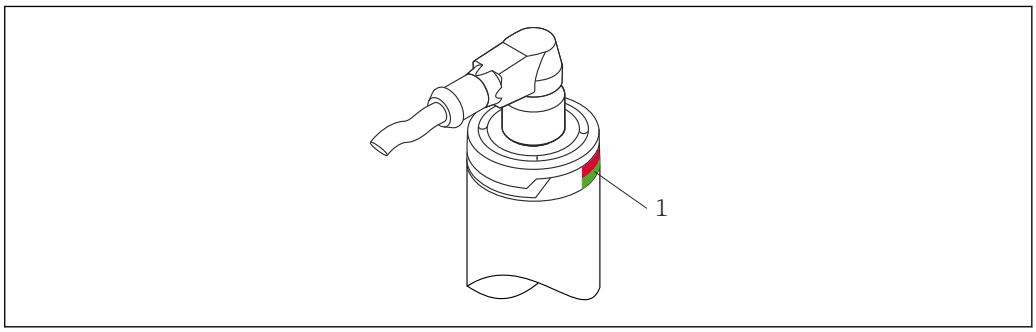
8.1 Function check

Before commissioning the device make sure that all final checks have been carried out:
- Checklist "Post-mounting check" , → 14
- Checklist "Post-connection check", → 16

8.2 Switching on the measuring device

Once the final checks have been successfully completed, it is time to switch on the supply voltage. The device performs a number of internal test functions after power-up. This is indicated by red LED-flashing. The device is operational after approx. 10 seconds in normal operating mode. The LED on the device is illuminated green.

8.2.1 Display elements



1 LED signals for device status indication.

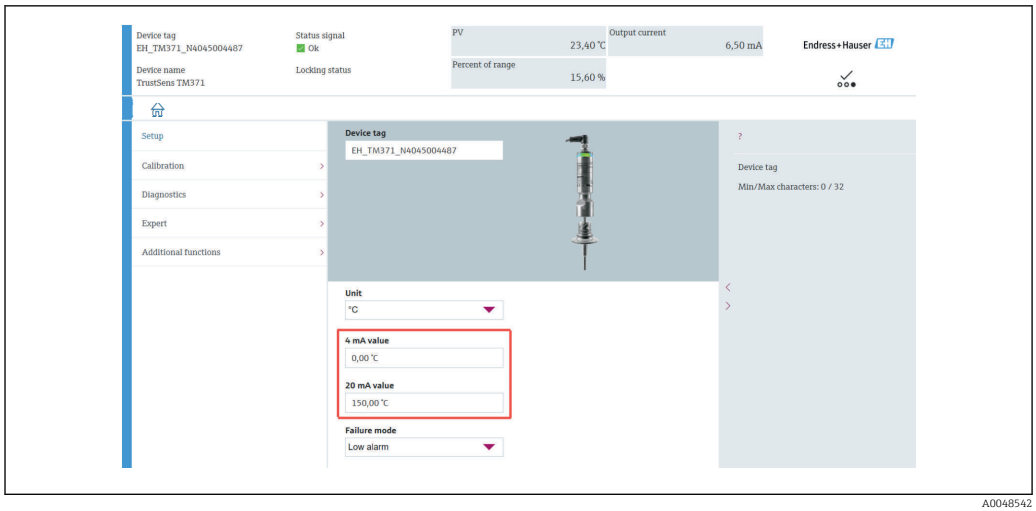
Function description of the different LED signals, see → 37

8.3 Configuring the measuring device

See 'Operating menu and parameter description'→ 77

8.3.1 Defining the measurement range

To configure the measurement range, enter the **4 mA value** and the **20 mA value**.



A0048542

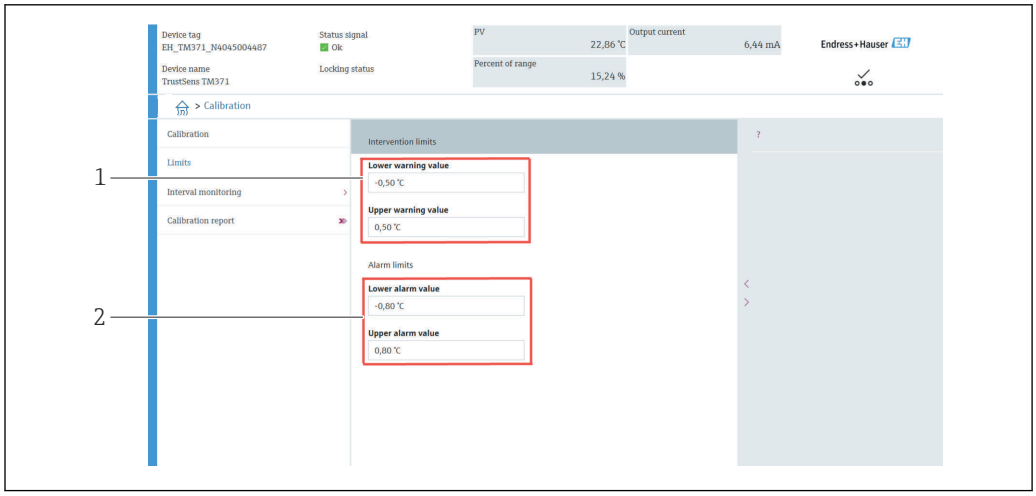
Navigation

"Setup" menu → 4 mA value

"Setup" menu → 20 mA value

1. In the **4 mA value** input window, enter the lower range value of your process measurement range and press ENTER to confirm.
2. In the **20 mA value** input window, enter the upper range value of your process measurement range and press ENTER to confirm.

8.3.2 Defining the warning limits for the self-calibration



A0048543

1 Values to be entered for the warning limits
2 Values to be entered for the alarm limits

Use this function to define the lower and upper warning limit. As a result of each self-calibration the deviation between the reference sensor and the Pt100 sensor is being determined. If this deviation exceeds the defined warning limit, the device will transmit the defined status signal and show the defined diagnostic behavior via the LED. (Factory setting = Warning - LED red flashes, diagnostic number 144. Measured value status = Uncertain / Not limited).

Navigation

"Calibration" menu → Limits → Intervention limits

1. In the **Lower warning value** input window, enter the lower warning limit for the self-calibration deviation and press ENTER to confirm.

2. In the **Upper warning value** input window, enter the upper warning limit for the self-calibration deviation and press ENTER to confirm.

8.3.3 Defining the alarm limits for the self-calibration

Use this function to define the lower and upper alarm limit. As a result of each self-calibration the deviation between the reference sensor and the Pt100 sensor is being determined. If this deviation exceeds the defined alarm limit, the device will transmit the defined status signal and show the defined diagnostic behavior via the LED. (Factory setting = Warning - LED red flashes, diagnostic number 143. Measured value status = Uncertain / Not limited.)

Navigation

"Calibration" menu → Limits → Alarm limits

1. In the **Lower alarm value** input window, enter the lower limit for the self-calibration deviation and press ENTER to confirm.
2. In the **Upper alarm value** input window, enter the upper warning limit for the self-calibration deviation and press ENTER to confirm.

8.4 Creating a calibration report

The "calibration report" wizard guides you systematically through the process for creating a calibration report for a pre-selected calibration point.

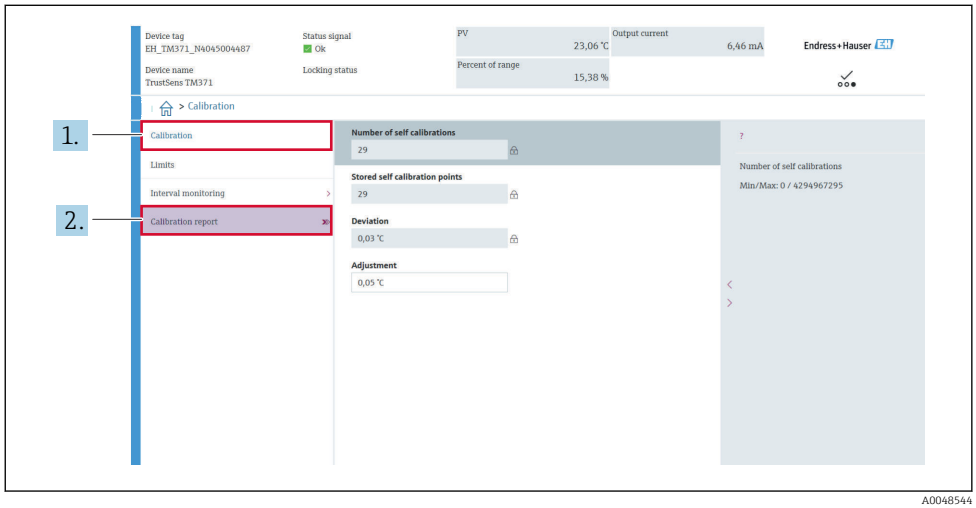
Navigation

"Calibration" menu → Calibration report

At least one stored self-calibration point must be in the device to start the online wizard.

Configuration and creation of a calibration report

1.

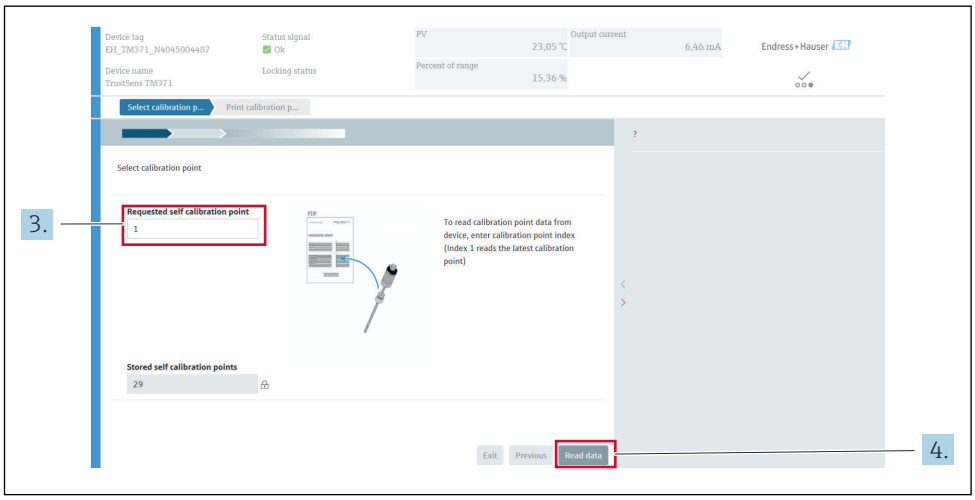


A0048544

Press CALIBRATION to enter the calibration menu.

2. Press CALIBRATION REPORT to open the calibration wizard.

3.



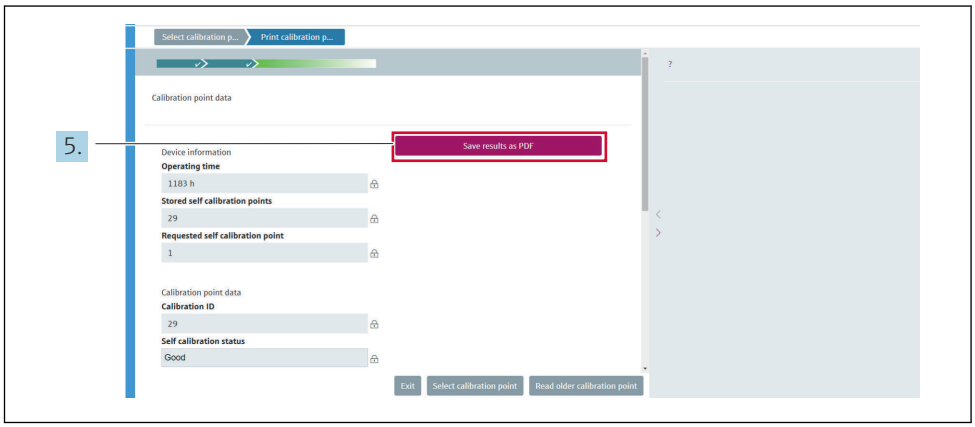
A0048545

To read the calibration point data from the device, enter the calibration point index. Index 1 reads the latest calibration point.

4. Press READ DATA to confirm.

↳ An overview of device information and calibration point data appears. See table below for detailed information.

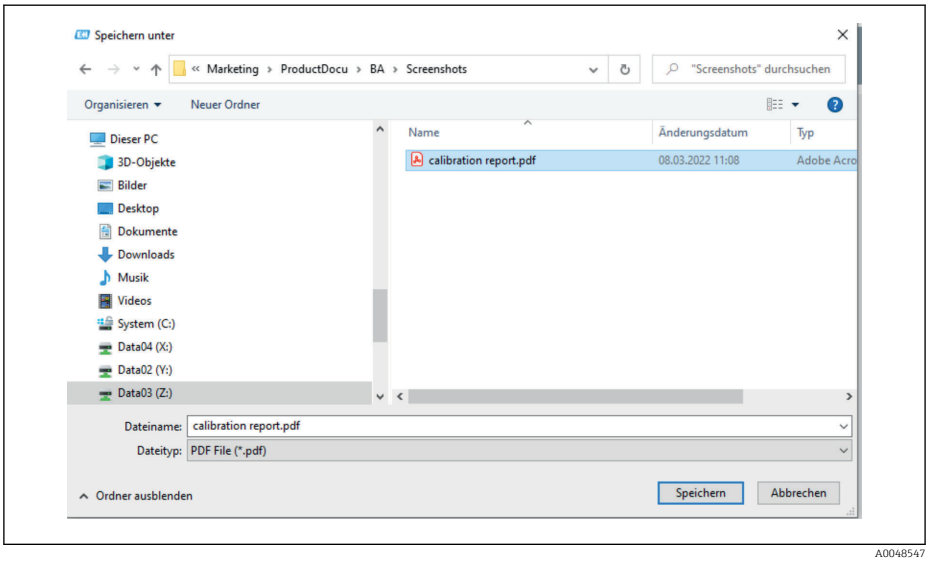
5.



A0048546

Press SAVE RESULTS AS PDF to confirm.

↳



A0048547

Your file system explorer window appears. You are asked to save the calibration report as a PDF file.

6. Enter a file name for the calibration report and select a memory location in your file system.
   ↳ The calibration report is just being saved on your file system.
7. Either press EXIT to end the calibration report wizard, press SELECT CALIBRATION POINT to select another stored self-calibration point or press READ OLDER CALIBRATION POINT to switch to the previous self-calibration point.

The creation of a self-calibration report is finished. The saved PDF-file can be opened to read or to print the calibration report.

Relevant self-calibration data for creating a report

Device information	
Operating time	Use this function to display the total count of hours when the device was powered.
Stored self-calibration points	Displays the amount of all stored self-calibration points. This device is able to store 350 self-calibration points. As soon as the memory would reach its limit, the oldest self-calibration point will be overwritten.
Requested self-calibration point	Enter the number of the requested self-calibration point. The latest self-calibration point always has the number **"1"**.
Calibration point data	
Calibration ID	Use this number to identify a self-calibration point. Each number is unique and is not editable.
Self-calibration status	This function shows the validity of the self-calibration point data.
Operating hours	This function displays the value of the operating hours counter of the shown self-calibration point.
Measured temperature value	This function displays the measured Pt100 temperature value at that specific time of the self-calibration.
Deviation	This function displays the measured Pt100 self-calibration deviation from the reference temperature. The deviation is calculated as follows: Self-calibration deviation = reference temperature - measured Pt100 temperature value + adjustment
Adjustment	This function displays the adjustment value added to the measured Pt100 value. This influences the self-calibration deviation. → 🖹 83 New adjustment = Adjustment - deviation of last self-calibration point
Measurement uncertainty	This functions displays the maximum measurement uncertainty at the self-calibration temperature.
Lower alarm value	This function displays the defined lower alarm limit value. → 🖹 84
Upper alarm value	This function displays the defined upper alarm limit value. → 🖹 84
Device restart counter	Displays the device restarts between now and when the displayed self-calibration was executed.

8.5 Protecting settings from unauthorized access

Use this function to protect the device from unwanted changes.

Navigation

🖳 Expert menu → System → Administration → Define device write protection code

If the code is programmed into the device firmware it is saved in the device and the operating tool displays the value **0** so that the defined write protection code is not openly displayed for viewing.

User entry: 0 to 9 999

Factory default: 0 = write protection is not active.

To activate the write protection please go through the following steps:

1. Define a write protection in the **Enter access code** parameter.
2. Enter a code which does not correspond to the one which is defined in step 1.
   ↳ The device is now write protected.

Deactivate the write protection

▶ Enter the defined code in the **Enter access code** parameter.
↳ The device is not write protected.

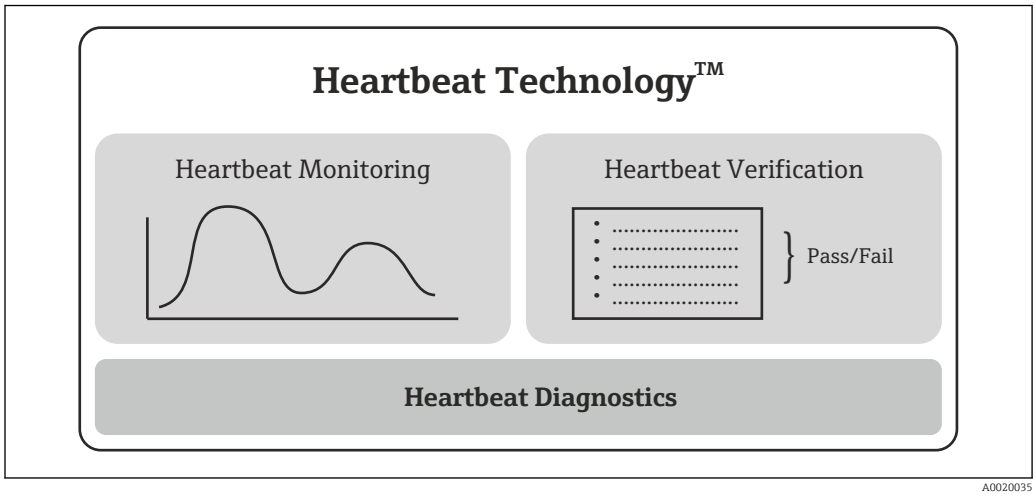
If the write protection code has been forgotten, it can be deleted or overwritten by the service organization.

8.6 Advanced settings

The section contains a description of the additional parameters and technical data that are available with the **Heartbeat Verification** and **Heartbeat Monitoring** application packages.

8.6.1 Heartbeat Technology modules

Overview



9 *Heartbeat Technology modules*

The modules are available in all the device versions. The Heartbeat Technology functionality is available with the revised device driver software (DTM, version 1.11.zz and higher).

Short description of the modules

Heartbeat Diagnostics

Function

- Continuous self-monitoring of the device.
- Diagnostic messages output to
  - a local display, optional
  - an asset management system (e.g. FieldCare/DeviceCare)
  - an automation system (e.g. PLC)

Advantages

- Device condition information is available immediately and processed in time.
- The status signals are classified in accordance with VDI/VDE 2650 and NAMUR recommendation NE 107 and contain information about the cause of the error and remedial action.

Detailed description

→ 🖹 31

Heartbeat Verification

Device functionality checked on demand

- Verification of the correct functioning of the measuring device within specifications.
- The verification result provides information about the condition of the device: "Passed" or "Failed".
- The results are documented in a verification report.
- The automatically generated report supports the obligation to demonstrate compliance with internal and external regulations, laws and standards.
- Verification is possible without interrupting the process.

Advantages

- No onsite presence is required to use the function.
- The DTM [1] triggers verification in the device and interprets the results. No specific knowledge is required on the part of the user.
- The verification report can be used to prove quality measures to a third party.
- **Heartbeat Verification** can replace other maintenance tasks (e.g. periodic check) or extend the test intervals.

Detailed description

→ 🖹 32

Heartbeat Monitoring

Function

Calibration information is logged in addition to the verification parameters. 350 calibration points are saved in the device (FIFO memory).

Advantages

- Early detection of changes (trends) to ensure plant availability and product quality.
- Use of information for the proactive planning of measures (e.g. maintenance).

Detailed description

→ 🖹 35

8.6.2 Heartbeat Diagnostics

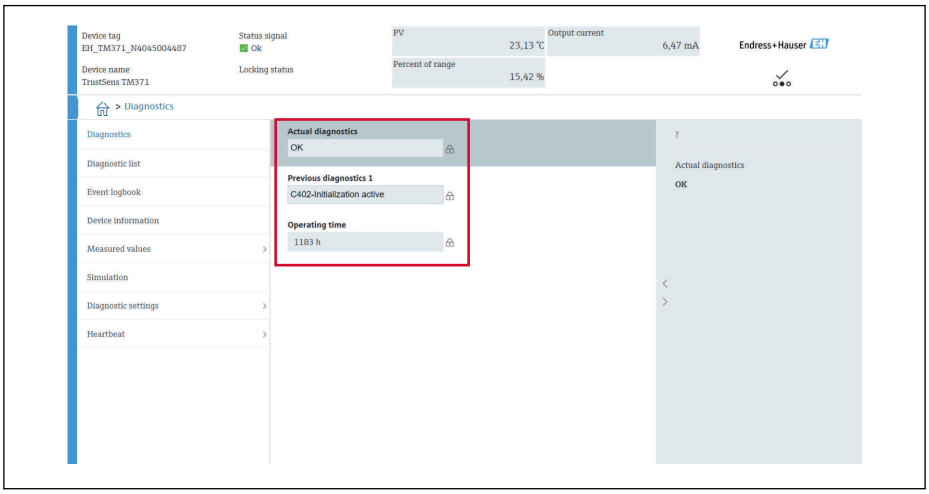
Device diagnostic messages, along with remedial measures, are displayed in the operating tool (FieldCare/DeviceCare).

For information on using the diagnostic messages, see the "Diagnostics and troubleshooting" section. → 🖹 37

1) DTM: Device Type Manager; controls device operation via DeviceCare, FieldCare, PACTware or a DTM-based control system.

Diagnostic message in the operating tool

1. Navigate to the "**Diagnostics**" menu.
   ↳ The diagnostic event, along with the event text, is displayed in the **Actual diagnostics** parameter.
2. In the display area, hover the cursor over the "**Actual diagnostics**" parameter.



A0048549

8.6.3 Heartbeat Verification

Verification report

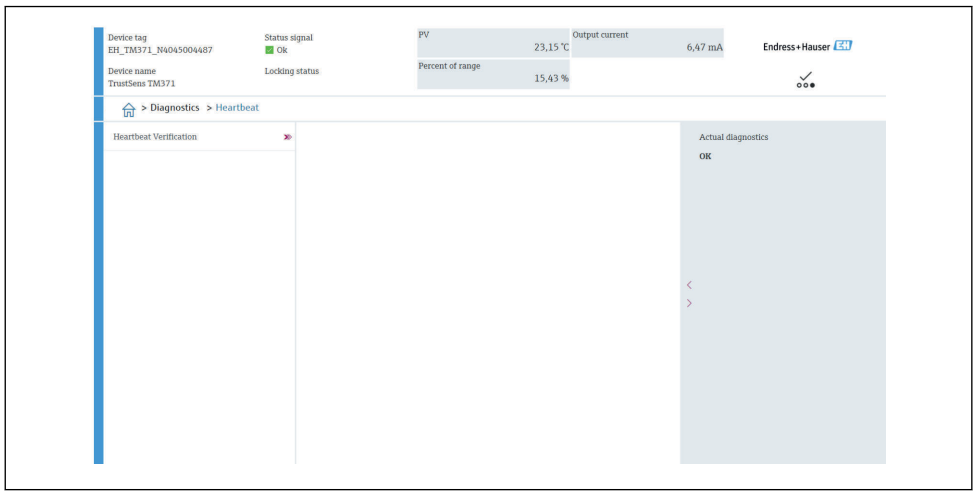
Creating the verification report using the wizard

The wizard to create a verification report is only available if the device is operated via FieldCare, DeviceCare, PACTware or a DTM-based control system.

Navigation

Menu "Diagnostics → Heartbeat" → Heartbeat Verification

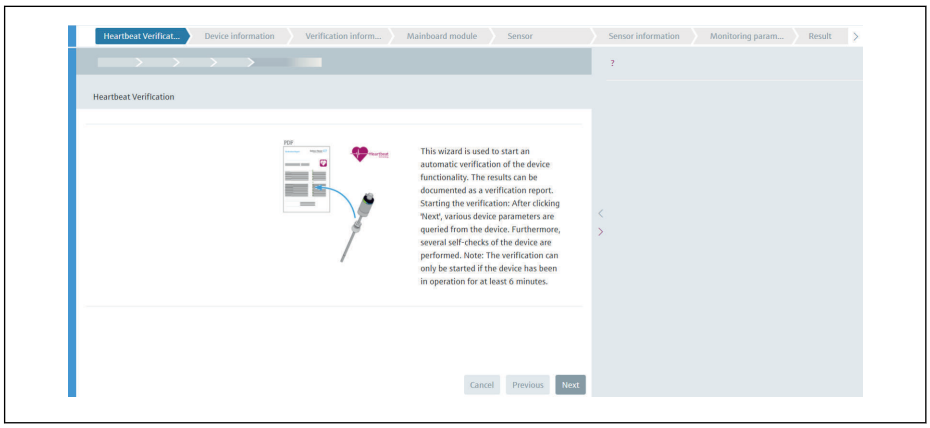
1.



A0048550

Press the **Heartbeat Verification** button.

↳



A0048551

The user-guided wizard appears.

2. Follow the instructions given by the wizard.

↳ The wizard guides you through the entire process for creating the verification report. The verification report can be saved in PDF and XML format.

The device must be in operation for at least 6 minutes before a verification can be performed.

Content of the verification report

The verification report contains the results of the test objects: **Passed** or **Failed** is indicated as the result.

Verification report: general information

Parameter	Description/comments
Device information	
System operator	Name of the system operator; is defined when the verification report is created.
Location	Location of the device within the plant; is defined when the verification report is created.
Device tag	Unique name for the measuring point so it can be identified quickly within the plant. Is defined when commissioning the device.
Device name	Displays the device name. It can also be found on the nameplate. It cannot be changed.
Serial number	Displays the serial number of the device. It can also be found on the nameplate. It cannot be changed.
Order code	Displays the order code of the device. It can also be found on the nameplate. It cannot be changed.
Firmware version	Displays the device firmware version installed. It cannot be changed.
Verification information	
Operating time	Indicates how long the device has been in operation up to this point.
Date/time	Displays the current computer system time.
Comments	Allows the user to enter optional comments, which appear in the verification report.
Verification results	
The test result for all the test objects is given on the subsequent pages. The following results are possible:	▪ ☑: Passed ▪ ☒: Failed

Verification criteria for the test objects

Test object	Verification criterion
Mainboard module	
Electronics	Checks the correct functioning of the electronics.
Memory content	Checks the correct functioning of the data memory.
Supply voltage	Checks the permitted supply voltage range.
Electronics temperature	Checks the permitted electronics temperature range or device temperature range.

Test object	Verification criterion
Sensor module	
Sensor	Checks whether the sensor works as per the specifications.
Reference temperature	Checks whether the reference sensor works as per the specifications.
Sensor drift warning limit exceeded	Checks whether the configured warning limits are exceeded.
Sensor drift alarm limit exceeded	Checks whether the configured alarm limits are exceeded.
Sensor information	
Number of self-calibrations	Displays all the self-calibrations executed up to now. This value cannot be reset.
Deviation	Displays the deviation of the measured value from the reference temperature.
Adjustment of the measurement	Displays the adjustment of the calibration deviation.
Monitoring parameters	
Device temperature min:	Displays the minimum electronics temperature measured in the past (peakhold indicator).
Device temperature max:	Displays the maximum electronics temperature measured in the past (peakhold indicator).
Sensor min value:	Displays the minimum temperature measured in the past at the sensor input (peakhold indicator).
Sensor max. value:	Displays the maximum temperature measured in the past at the sensor input (peakhold indicator).

Summary of results

Overall results	Displays the overall result of the verification. The verification report can be saved in PDF and XML format. To save the report, click the **Save results as PDF** button or the **Save results as XML** button. If the verification fails, try again or contact the Service Organization.

8.6.4 Heartbeat Monitoring

Calibration information is logged in addition to the verification parameters.

HART variable	Output	Unit
PV	Temperature	°C/°F
SV	Device temperature	°C/°F
TV	Calibration counter	-
QV	Calibration deviation	°C/°F

Monitoring information can be read out and analyzed as described below:
A higher-level controller is configured in such a way that calibration deviations and the calibration counter are saved when the calibration counter changes. This type of function is supported by Endress+Hauser's Advanced Data Manager Memograph M RSG45, for example. The following table provides a sample overview of the monitoring analysis using the Field Data Manager software MS20:

Time stamp	Device name	Category	Text
25.07.2018	TrustSens 1 (example)	Self-calibration	EH_TM371_M7041504487: self-calibration (ID=183) Serial number: M7041504487 Device name: iTHERM TM371/372 Operating hours: 1626 h Reference temperature: 118.67 °C Measured temperature value: 118.68 °C Deviation: 0.01 °C Measuring uncertainty (k=2): 0.35 °C Max. permitted deviation: -0.80 / +0.80 °C Assessment
...	...	...	...

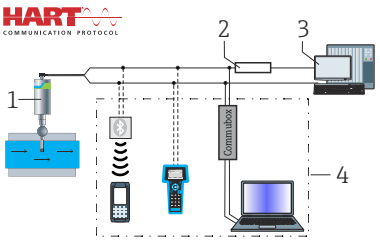
9 Diagnostics and troubleshooting

9.1 Troubleshooting

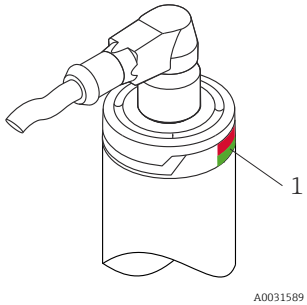
Always start troubleshooting with the checklists below if faults occur after start up or during operation. This takes you directly (via various queries) to the cause of the problem and the appropriate remedial measures.

Due to its design, the device cannot be repaired. However, it is possible to send the device back for examination. See the information in the "Return" section. → 43

General errors

Problem	Possible cause	Remedy
Device is not responding.	Supply voltage range does not match that specified on the nameplate.	Apply correct voltage, see nameplate.
	M12 plug is not connected correctly, wrong cable wiring.	Check the wiring.
Output current < 3.6 mA	Device is defective.	Replace the device.
HART communication is not working.	Missing or incorrectly installed communication resistor.	Install the communication resistor (250 Ω) correctly.  A0032326 *1 TrustSens compact thermometer* *2 HART® communication resistor, R = ≥ 250 Ω* *3 PLC/DCS* *4 Configuration examples: FieldCare with Commubox, HART® handheld communicator as well as via Field Xpert SFX350/370*
	Commubox is not properly connected.	Connect Commubox correctly .

9.2 Diagnostic information via LEDs

Position	LEDs	Function description
 A0031589 *1 LED for device status indication*	LED green (gn) is illuminated	Voltage supply is correct. The device is operational and the set limit values are met.
	LED green (gn) is flashing	With a frequency 1 Hz: self-calibration currently being performed. With a frequency 5 Hz for 5 s: self-calibration finished and valid, all process criteria were within specifications. Calibration data stored.
	LED red (rd) and green (gn) are flashing alternating	Self-calibration process finished but not valid, violation of necessary process criteria. Calibration data not stored.
	LED red (rd) is flashing	Presence of a diagnostic event: "Warning"
	LED red (rd) is illuminated	Presence of a diagnostic event: "Alarm"

9.3 Diagnostic information

Status signal and diagnostic behavior can be configured manually.

Status signal - Digital information available via HART® communication

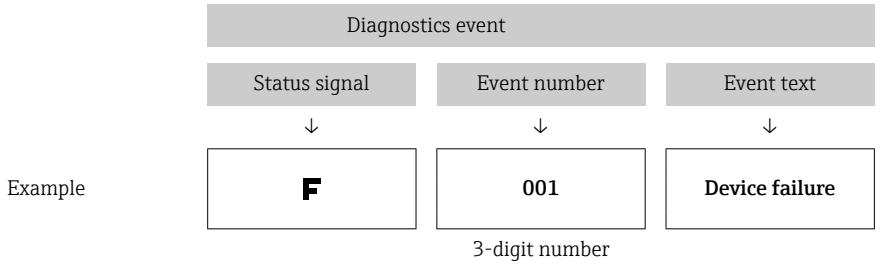
Letter/ symbol	Status signal	Meaning of the status signal [1]
F	Failure	The device or its periphery behaves in such a way that the measurement value is no longer valid. This includes faults/failures which are caused by the process being measured, but have an impact on the ability to perform a measurement e.g. “no process signal” detected.
C	Function check	The device is deliberately serviced, configured, parameterized or is in simulation mode. A situation exists where the output signal does not represent the process value and is therefore not valid.
S	Out of specification	The device is operating outside of its technical specifications or internal diagnostic functions indicate that the current process conditions increase the measurement uncertainty (i.e. during plant start-up or cleaning processes).
M	Maintenance required	Deviation from normal operation, the device still works, but should be attended to soon to ensure continued operation, e.g. build-up, corrosion, zero point adjustment not possible or memory for data storage almost full.

1) Valid for the default mappings to the diagnostic numbers

Diagnostic behavior - Analog information via current output and LED

Diagnostic behavior	Meaning of the behavior
Alarm	Measurement is interrupted. Mostly the measured data is invalid and the configured failure current is set. A diagnostic message is generated.
Warning	Usually, the device continues to measure. A diagnostic message is generated.
Disabled	The diagnostic event is completely surpressed even if the device is not working properly.

Diagnostics event and event text



The fault can be identified by means of the diagnostics event. The event text helps you by providing information about the fault.

9.4 Overview of diagnostics events

Diagnostic events are assigned to a certain diagnostic number and a status signal. The user can change this assignment for certain diagnostic events.

Example:

		Settings		Device behavior			
Configuration example	**Diagnostic number**	**Status signal**	**Diagnostic behavior (settings)**	**Status signal (output via HART® protocol)**	**Output current**	**PV, status**	**LED**
Default setting	143	S	Warning	S	Measured value	Measured value, UNCERTAIN	Red is flashing
Manual configuration: Status signal S is switched to F	143	F	Warning	F	Measured value	Measured value, UNCERTAIN	Red is flashing
Manual configuration: diagnostic behavior **Warning** is switched to **Alarm**	143	S	Alarm	S	Configured failure current	Measured value, BAD	Red is illuminated
Manual configuration: **Warning** is switched to **Disabled**	143	S [1]	Disabled	- [2]	Last valid measured value [3]	Last valid measured value, GOOD	Green is illuminated

1) Setting is not relevant.
2) Status signal is not indicated.
3) If there is no valid measured value, it is set to the failure current

Diagnostic number	**Priority**	**Short text**	**Remedy**	**Status signal (factory default)**	✅ **Configurable** [1] ❌ **Not configurable**	**Diagnostic behavior from the factory**	✅ **Configurable** [2] ❌ **Not configurable**
Diagnostics							
001	1	Device failure	1. Restart device. 2. Replace electronics.	F	❌	Alarm	❌
004	2	Sensor defective	Replace device.	F	✅	Alarm	✅
047	22	Sensor limit reached	1. Check sensor. 2. Check process conditions.	S	✅	Warning	✅
105	26	Manual calibration interval expired	1. Execute calibration and reset calibration interval. 2. Switch off calibration counter	M	✅	Warning	✅
143	21	Sensordrift Alarm limit exceeded	1. Check self calibration alarm limits. 2. Check value of adjustment. 3. Replace device	S	✅	Warning	✅
144	27	Sensordrift warning limit exceeded	1. Check self calibration warning limits. 2. Check value of adjustment. 3. Replace device	M	✅	Warning	✅
221	29	Reference sensor defective [3]	Replace device.	M	✅	Warning	✅

Diagnostic number	Priority	Short text	Remedy	Status signal (factory default)	☑ Configurable [1] / ☒ Not configurable	Diagnostic behavior from the factory	☑ Configurable [2] / ☒ Not configurable
401	15	Factory reset active	Factory reset in progress, please wait.	C	☒	Warning	☒
402	16	Initialization active	Initialization in progress, please wait.	C	☒	Warning	☒
410	3	Data transfer failed	1. Check connection. 2. Repeat data transfer.	F	☒	Alarm	☒
411	17	Up-/download active	Up-/download in progress, please wait.	C	☒	Warning	☒
435	5	Linearization faulty	Check linearization.	F	☒	Alarm	☒
437	4	Configuration incompatible	Execute factory reset.	F	☒	Alarm	☒
438	30	Dataset different	1. Check data set file. 2. Check device parameterization. 3. Download new device parameterization.	M	☒	Warning	☒
485	18	Process variable simulation active-Sensor	Deactivate simulation.	C	☑	Warning	☑
491	19	Output simulation - current output	Deactivate simulation.	C	☑	Warning	☑
495	20	Diagnostic event simulation active	Deactivate simulation.	C	☑	Warning	☑
501	6	Wiring error [4]	Check wiring.	F	☒	Alarm	☒
531	6	Factory adjustment missing	1. Contact service organization. 2. Replace device.	F	☒	Alarm	☒
	8	Factory adjustment missing-Sensor					
	9	Factory adjustment missing-Reference sensor					
	10	Factory adjustment missing-Current output					
537	11	Configuration	1. Check device configuration 2. Up- and download new configuration	F	☒	Alarm	☒
	12	Configuration-Sensor	1. Check sensor configuration. 2. Check device configuration.				
	13	Configuration-Reference sensor					
	14	Configuration-Current output	1. Check application 2. Check the current output parameterization				
801	23	Supply voltage too low	Increase supply voltage.	S	☑	Alarm	☒
825	24	Operating temperature	1. Check ambient temperature. 2. Check process temperature.	S	☑	Warning	☑

Diagnostic number	Priority	Short text	Remedy	Status signal (factory default)	☑ Configurable [1] / ☒ Not configurable	Diagnostic behavior from the factory	☑ Configurable [2] / ☒ Not configurable
844	25	Process value out of specification	1. Check process value. 2. Check application. 3. Check sensor.	S	☑	Warning	☑
905	28	Self calibration interval expired	1. Initiate self-calibration. 2. Deactivate self-calibration interval monitoring. 3. Replace device	M	☑	Warning	☑

1) F, C, S, M, N can be configured
2) 'Alarm', 'Warning' and 'Disabled' can be configured
3) Reference sensor defective if temperature range of −45 to +200 °C (−49 to +392 °F) is exceeded. Temperature measurement continues, but self-calibration is permanently disabled.
4) Leading error cause: CDI modem and loop are connected simultaneously, based on wrong connection (CDI modem or loop only) or defective cable plug.

9.5 Diagnostic list

If more than three diagnostic events occure simultaneously, only the messages with the highest priorities are shown in the **Diagnostics list**. → 🖹 87 Characteristic feature of the displayed priority is the status signal in the following order: F, C, S, M. If there are several diagnostic events with the same status signal, the priority values from the table above are used for ordering the diagnostic events, e.g.: F001 appears first, F501 appears second and S047 appears last.

9.6 Event logbook

Diagnostic events that are no longer pending are shown in the **Event logbook** submenu. → 🖹 88

9.7 Firmware history

Revision history

The firmware version (FW) on the nameplate and in the Operating Instructions indicates the device release: XX.YY.ZZ (example 01.02.01).

XX Change to main version. No longer compatible. Changes in the device and Operating Instructions.

YY Change to functions and operation. Compatible. Changes in the Operating Instructions.

ZZ Bug fixing. No changes to the Operating Instructions.

Date	Firmware Version	Modifications	Documentation
09/17	01.00.zz	Original firmware	BA01581T/09

10 Maintenance

In general, no specific maintenance is required for this device.

10.1 Cleaning

The sensor has to be cleaned as required. The cleaning can also be proceeded when the device is installed (e.g. CIP Cleaning in Place / SIP Sterilization in Place). Care must be taken to ensure that the sensor is not damaged during the cleaning.

The housing is resistant to typical cleaning agents from the outside. It passed the Ecolab test.

11 Repair

Due to its design, the device cannot be repaired.

11.1 Spare parts

Currently available spare parts for your product can be found online at: http://www.products.endress.com/spareparts_consumables. When ordering spare parts, please quote the serial number of the device!

Type	Order number
Plug screw fitting G1/2 1.4435	60022519
Spare Part Kit Press-Screw TK40 G1/4 d6	71215757
Spare Part Kit Press-Screw TK40 G1/2 d6	71217633
Weld-in adapter G3/4 d=50, 316L, 3.1	52018765
Weld-in adapter G3/4, d=29, 316L, 3.1	52028295
G1/2 metal to metal weld in adapter	60021387
Weld in adapter M12x1.5 316L&1.4435	71405560
O-ring 14.9x2.7 VMQ, FDA, 5 pieces	52021717
Weld-in adapter G3/4 d=55, 316L	52001052
Weld-in adapter G3/4, 316L, 3.1	52011897
O-ring 21.89x2.62 VMQ, FDA, 5 pcs.	52014473
Weld-in adapter G1, d=60, 316L	52001051
Weld-in adapter G1, d=60, 316L, 3.1	52011896
Weld-in adapter G1, d=53, 316L, 3.1	71093129
O-ring 28.17x3.53 VMQ, FDA, 5 pcs.	52014472
Adapter for Ingold connection	60017887
O-ring set for Ingold connection	60018911
Grip cap flexible yellow TPE	71275424
iTHERM TK40 compression fitting	TK40-
Spare Part Kit sealing TK40	XPT0001-
iTHERM TT411 thermowell	TT411-

11.2 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: http://www.endress.com/support/return-material
   ↳ Select the region.
2. Return the device if repairs or a factory calibration are required, or if the wrong device was ordered or delivered.

11.3 Disposal

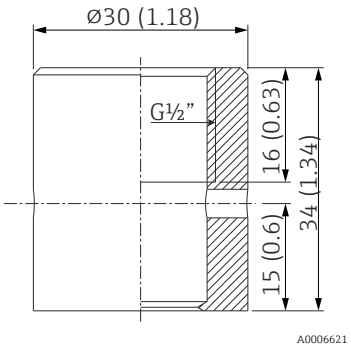
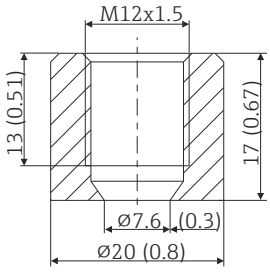
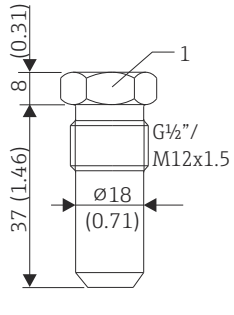
The device contains electronic components and must therefore be disposed of as electronic waste. Please pay particular attention to the national disposal regulations in your country. Please seperate the different components according to their material consistence.

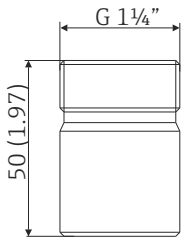
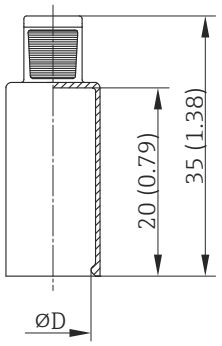
12 Accessories

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.

12.1 Device-specific accessories

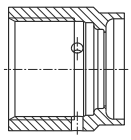
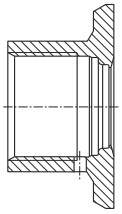
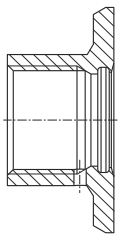
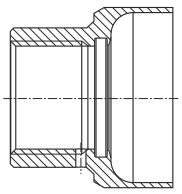
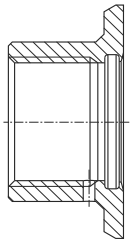
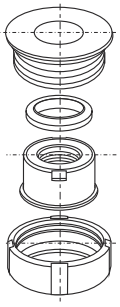
Device-specific accessories

Accessories	Description
Welding boss with sealing taper (metal - metal)  	Welding boss for G½" and M12x1.5 thread Metal-sealing; conical Material of wetted parts: 316L/1.4435 Max. process pressure 16 bar (232 PSI) **Order number:** ▪ 71424800 (G½") ▪ 71405560 (M12x1.5)
Dummy plug  *1 Size across flats SW22*	Dummy plug for G½” or M12x1.5 conical metal-sealing welding boss Material: SS 316L/1.4435 **Order number:** ▪ 60022519 (G½") ▪ 60021194 (M12x1.5)

Weld-in adapter for Ingold process connection (OD 25 mm (0.98 in) x 46 mm (1.81 in) 	Material of wetted parts: 316L/1.4435 Weight: 0.32 kg (0.7 lb) Order numbers: ▪ 71531585 - with 3.1 material certificate ▪ 71531588 O-ring seal set ▪ Silicone O-ring in accordance with FDA CFR 21 ▪ Maximum temperature: 230 °C (446 °F) ▪ **Order number:** 60018911
Flexible handle cap to cover the QuickNeck bottom part 	Diameter ØD: 24 to 26 mm (0.94 to 1.02 in) Material: Thermoplastic polyolefin - elastomer (TPE), free from plasticizers Maximum temperature: +150 °C (+302 °F) **Order number:** 71275424

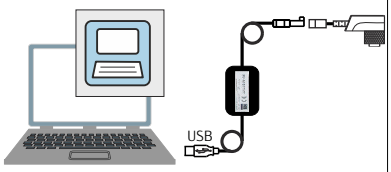
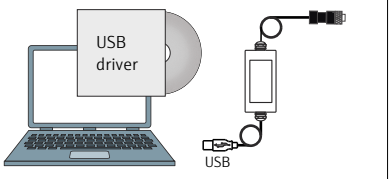
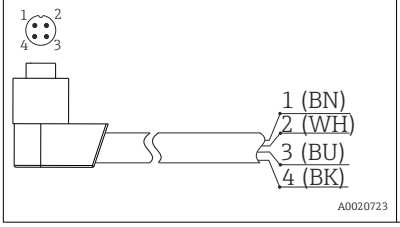
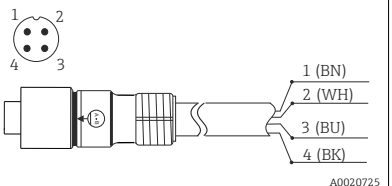
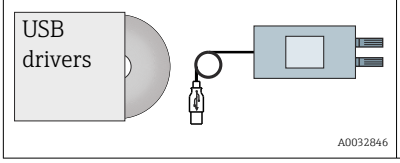
12.1.1 Weld-in adapter

For more information about order codes and hygienic compliance of the adapters and spare parts, see Technical Information (TI00426F).

Weld-in adapter						
	G ¾", d=29 for pipe-mounting	**G ¾", d=50 for vessel-mounting**	**G ¾", d=55 with flange**	**G 1", d=53 without flange**	**G 1", d=60 with flange**	**G 1" adjustable**
Material	316L (1.4435)	316L (1.4435)	316L (1.4435)	316L (1.4435)	316L (1.4435)	316L (1.4435)
Roughness µm (µin) process side	≤1.5 (59.1)	≤0.8 (31.5)	≤0.8 (31.5)	≤0.8 (31.5)	≤0.8 (31.5)	≤0.8 (31.5)

Maximum process pressure for the weld-in adapters:
- 25 bar (362 PSI) at maximum 150 °C (302 °F)
- 40 bar (580 PSI) at maximum 100 °C (212 °F)

12.2 Communication-specific accessories

Configuration kit TXU10 	Configuration kit for CDI communication with PC-programmable devices. Includes interface cable for PC with USB port and M12x1 coupling (Non-Ex area). Order code: TXU10-BD
Commubox FXA291 	Connects Endress+Hauser field devices with a CDI interface (= Endress+Hauser Common Data Interface) and the USB port of a computer or laptop (Non-Ex area and Ex area). For details, see Technical Information TI00405C
Cordset M12x1, angle plug 	PVC cable, 4 x 0.34 mm² (22 AWG) with M12x1 coupling; angle plug; screw plug; length 5 m (16.4 ft); IP69K Order number: 71387767 Core colours: ▪ 1 = BN brown (+) ▪ 2 = WH white (nc) ▪ 3 = BU blue (-) ▪ 4 = BK black (nc)
Cordset M12x1, straight 	PVC cable, 4 x 0.34 mm² (22 AWG) with M12x1 coupling nut made of epoxy coated zinc; straight female connector type; screw plug; length 5 m (16.4 ft); IP69K Order number: 71217708 Core colors: ▪ 1 = BN brown (+) ▪ 2 = WH white (nc) ▪ 3 = BU blue (-) ▪ 4 = BK black (nc)
Commubox FXA195 HART 	For intrinsically safe HART communication with FieldCare via the USB interface. For details, see Technical Information TI00404F
HART Loop Converter HMX50	Is used to evaluate and convert dynamic HART process variables to analog current signals or limit values. For details, see Technical Information TI00429F and Operating Instructions BA00371F
Field Xpert SMT70	The Field Xpert SMT70 tablet PC for device configuration enables mobile plant asset management in hazardous (Ex Zone 2) and non-hazardous areas. It is suitable for commissioning and maintenance staff For details, see Technical Information TI01342S

12.3 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

Accessories	Description
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 at: 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.

Accessories	Description
W@M	Life cycle management for your plant W@M offers assistance with a wide range of software applications over the entire process: from planning and procurement to the installation, commissioning and operation of the measuring devices. All the relevant information is available for every measuring device over the entire life cycle, such as the device status, device-specific documentation, spare parts etc. The application already contains the data of your Endress+Hauser device. Endress+Hauser also takes care of maintaining and updating the data records. W@M is available: Via the Internet: www.endress.com/lifecyclemanagement

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
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

12.4 System components

Advanced Data Manager Memograph M	The Advanced Data Manager Memograph M is a flexible and powerful system for organizing process values. The measured process values are clearly presented on the display and logged safely, monitored for limit values and analyzed. Via common communication protocols, the measured and calculated values can be easily communicated to higher-level systems or individual plant modules can be interconnected. For details, see Technical Information TI01180R/09

RN42	1-channel active barrier with wide range power supply for the safe separation of 0/4 to 20 mA standard signal circuits, HART-transparent For details, see Technical Information TI01584K

RNS221	Supply unit for powering two 2-wire measuring devices in the non-Ex area. Bidirectional communication is possible via the HART communication jacks. For details, see Technical Information TI00081R

13 Technical Data

13.1 Input

Measuring range

Pt100 thin-film (TF):
- −40 to +160 °C (−40 to +320 °F)
- Optional −40 to +190 °C (−40 to +374 °F)

13.2 Output

Output signal

Analog output	4 to 20 mA
Digital output	HART protocol (revision 7)

Failure information

Failure information as per NAMUR NE43:

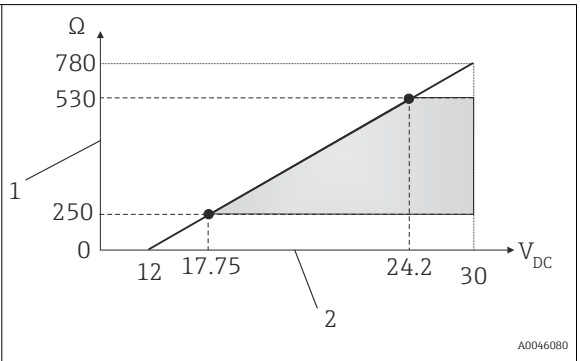
Failure information is created if the measuring information is missing or not valid. A complete list of all the errors occurring in the measuring system is created.

Underranging	Linear decrease from 4.0 to 3.8 mA
Overranging	Linear increase from 20.0 to 20.5 mA
Failure, e.g. sensor breakage, sensor short-circuit	≤ 3.6 mA ("low") or ≥ 21.5 mA ("high"), can be selected The "high" alarm setting can be set between 21.5 mA and 23 mA, thus providing the flexibility needed to meet the requirements of various control systems.

Load

Maximum possible HART communication resistance

$R_{b\ max.}$= ($U_{b\ max.}$ - 12 V) / 0.023 A (current output)



1 Load
2 Supply voltage U_b

Linearization/transmission behavior

Temperature-linear

Filter

1st order digital filter: 0 to 120 s, factory setting: 0 s (PV)

Protocol-specific data

HART

Manufacturer ID	17 (0x11)
Device type ID	0x11CF
HART revision	7
Device description files (DTM, DD)	Information and files at: ▪ www.endress.com/downloads ▪ www.fieldcommgroup.org
HART load	Min. 250 Ω
HART device variables	**Measured value for PV (primary value)** Temperature **Measured values for SV, TV, QV (secondary, tertiary and quaternary variable)** ▪ SV: Device temperature ▪ TV: Calibration counter ▪ QV: Calibration deviation
Supported functions	▪ Additional transmitter status ▪ NE107 diagnostics

Startup behavior / wireless HART data

Minimum start-up voltage	12 V_{DC}
Start-up current	3.58 mA
Start-up time	< 7 s, until the first valid measured value signal is present at the current output
Minimum operating voltage	12 V_{DC}
Multidrop current	4 mA
Lead time	0 s

13.3 Wiring

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

Supply voltage

U_b = 12 to 30 V_{DC}

The device may only be powered by a power supply unit with a limited energy electric circuit in accordance with UL/EN/IEC 61010-1 chapter 9.4 or Class 2 according to UL 1310, "SELV or Class 2 cir-cuit".

Current consumption

- I = 3.58 to 23 mA
- Minimum current consumption: I = 3.58 mA, multi-drop mode I =4 mA
- Maximum current consumption: I ≤ 23 mA

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.

For more information see the Technical Information 'HAW562 Surge arrester' TI01012K

13.4 Performance characteristics

Reference operating conditions

- Ambient temperature: 25 °C ± 5 °C (77 °F ± 9 °F)
- Supply voltage: 24 V_{DC}

Internal calibration points

118 °C (244.4 °F) +1.2 K / −1.7 K
▪ Lowest possible calibration point = 116.3 °C (241.3 °F) ▪ Highest possible calibration point = 119.2 °C (246.6 °F)

The individual calibration point of each iTHERM TrustSens device is indicated in the ex-works calibration certificate enclosed with the shipment.

Measurement uncertainty

The given uncertainty values includ non-linearity and non-repeatability and correspond to 2Sigma (95% confidence level according to tha Gaussian distribution curve).

Each iTHERM TrustSens is calibrated and matched by default before shipment to guarantee the given accuracy.

Uncertainty of self-calibration at the calibration point: [1]	
Option: 118 °C (244 °F); self-calibration with excellent uncertainty 118 °C (244 °F); self-calibration with standard uncertainty	Uncertainty: < 0.35 K (0.63 °F) < 0.55 K (0.99 °F)
Uncertainty of the temperature sensor inclusive digital output (HART value) at reference conditions in delivery state:	

Process temperature: +20 to +135 °C (+68 to +275 °F) +135 to +160 °C (+275 to +320 °F) +160 to +170 °C (+320 to +338 °F) +170 to +180 °C (+338 to +356 °F) +180 to +190 °C (+356 to +374 °F) 0 to +20 °C (+32 to +68 °F) −20 to 0 °C (−4 to +32 °F) −40 to −20 °C (−40 to −4 °F)	 < 0.22 K (0.4 °F) < 0.38 K (0.68 °F) < 0.5 K (0.90 °F) < 0.6 K (1.08 °F) < 0.8 K (1.44 °F) < 0.27 K (0.49 °F) < 0.46 K (0.83 °F) < 0.8 K (1.44 °F)
Uncertainty of D/A converter (analog output current)	0.03 % of the measurement range

1) The uncertainty of the self-calibration can be compared to the uncertainty of a manual on-site calibration with a mobile dry-block-calibrator. Depending on the used equipment and the qualification of the person who is performing the calibration an uncertainty of > 0.3 K (0.54 °F) is standard.

Long-term drift

Pt100 sensing element	< 1000 ppm/1000 h [1]
A/D converter (digital output - HART)	< 500 ppm/1000 h [1]
D/A converter (analog output - current)	< 100 ppm/1000 h

1) This would be detected by the self-calibration

Long-term drift decreases at an exponential rate over time. So it may not be extrapolated in a linear way for time spans longer than the above given values.

Influence of ambient temperature

A/D converter (digital output - HART) at typical operating conditions	< 0.05 K (0.09 °F)
A/D converter (digital output - HART) at maximum operating conditions	< 0.15 K (0.27 °F)
D/A converter (analog output - current)	≤ 30 ppm/°C (2σ), related to the deviation from the reference temperature

Typical operating conditions
- Ambient temperature: 0 to +40 °C (+32 to +104 °F)
- Process temperature: 0 to +140 °C (+32 to +284 °F)
- Power supply: 18 to 24 V_{DC}

Influence of supply voltage

According to IEC 61298-2:

A/D converter (digital output - HART) at typical operating conditions	< 15 ppm/V [1]
D/A converter (analog output - current)	< 10 ppm/V [1]

1) Related to the deviation from the reference supply voltage

Sample calculation with Pt100, measuring range +20 to +135 °C (+68 to +275 °F), ambient temperature +25 °C (+77 °F), supply voltage 24 V:

Measured error digital	0.220 K (0.396 °F)
Measured error D/A = 0.03 % x 150 °C (302 °F)	0.045 K (0.081 °F)
Measured error digital value (HART):	0.220 K (0.396 °F)
Measured error analog value (current output): √(Measured error digital² + Measured error D/A²)	0.225 K (0.405 °F)

Sample calculation with Pt100, measuring range +20 to +135 °C (+68 to +275 °F), ambient temperature +35 °C (+95 °F), supply voltage 30 V:

Measured error digital	0.220 K (0.396 °F)
Measured error D/A = 0.03 % x 150 °C (302 °F)	0.045 K (0.081 °F)
Influence of ambient temperature (digital)	0.050 K (0.090 °F)
Influence of ambient temperature (D/A) = (35 °C - 25 °C) x (30 ppm/°C x 150 °C)	0.045 K (0.081 °F)
Influence of supply voltage (digital) = (30 V - 24 V) x 15 ppm/V x 150 °C	0.014 K (0.025 °F)
Influence of supply voltage (D/A) = (30 V - 24 V) x 10 ppm/V x 150 °C	0.009 K (0.016 °F)
Measured error digital value (HART): √(Measured error digital² + Influence of ambient temperature (digital)² + Influence of supply voltage (digital)²	**0.226 K (0.407 °F)**
Measured error analog value (current output): √(Measured error digital² + Measured error D/A² + Influence of ambient temperature (digital)² + Influence of ambient temperature (D/A)² + Influence of supply voltage (digital)² + Influence of supply voltage (D/A)²	**0.235 K (0.423 °F)**

Response time

Tests in water at 0.4 m/s (1.3 ft/s), according to IEC 60751; 10 K temperature step change. t_{63} / t_{90} are defined as the time that passes until the instrument output reaches 63% / 90% of the new value.

Response time with heat transfer paste [1)]

Protection tube	Shape of tip	Insert	t_{63}	t_{90}
Ø6 mm (0.24 in)	Reduced 4.3 mm (0.17 in) x 20 mm (0.79 in)	Ø3 mm (0.12 in)	2.9 s	5.4 s
Ø9 mm (0.35 in)	Straight	Ø6 mm (0.24 in)	9.1 s	17.9 s
	Reduced 5.3 mm (0.21 in) x 20 mm (0.79 in)	Ø3 mm (0.12 in)	2.9 s	5.4 s
Ø12.7 mm (½ in)	Straight	Ø6 mm (0.24 in)	10.9 s	24.2 s
	Reduced 5.3 mm (0.21 in) x 20 mm (0.79 in)	Ø3 mm (0.12 in)	2.9 s	5.4 s
	Reduced 8 mm (0.31 in) x 32 mm (1.26 in)	Ø6 mm (0.24 in)	10.9 s	24.2 s

1) Between the insert and the protection tube.

Response time without heat transfer paste

Protection tube	Shape of tip	Insert	t_{63}	t_{90}
Without protection tube	-	Ø6 mm (0.24 in)	5.3 s	10.4 s
Ø6 mm (0.24 in)	Reduced 4.3 mm (0.17 in) x 20 mm (0.79 in)	Ø3 mm (0.12 in)	7.4 s	17.3 s
Ø9 mm (0.35 in)	Straight	Ø6 mm (0.24 in)	24.4 s	54.1 s
	Reduced 5.3 mm (0.21 in) x 20 mm (0.79 in)	Ø3 mm (0.12 in)	7.4 s	17.3 s
Ø12.7 mm (½ in)	Straight	Ø6 mm (0.24 in)	30.7 s	74.5 s
	Reduced 5.3 mm (0.21 in) x 20 mm (0.79 in)	Ø3 mm (0.12 in)	7.4 s	17.3 s
	Reduced 8 mm (0.31 in) x 32 mm (1.26 in)	Ø6 mm (0.24 in)	30.7 s	74.5 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

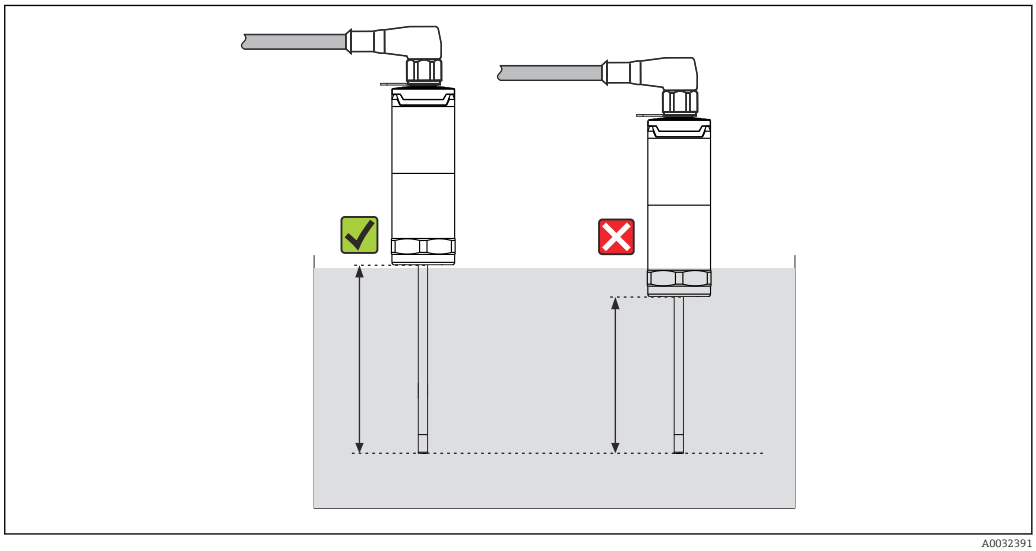
from the true value of the measured variable. Two different methods are used for thermometers:
- Calibration at fixed-point temperatures, e.g. at the freezing point of water at 0 °C,
- Comparison calibration against a precise reference thermometer.

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 or special calibration furnaces with homogeneous distribution of temperature are typically used for thermometer calibrations. The DUT and the reference thermometer are placed closely together into the bath or furnace at a sufficient depth.

The measurement uncertainty can increase due to heat conduction errors and short immersion lengths. The existing measurement uncertainty is listed on the individual calibration certificate.

For accredited calibrations according to IEC/ISO 17025, the measurement uncertainty must not be twice as high as the accredited measurement uncertainty of the laboratory. If the limit value is exceeded, only a factory calibration can be carried out.

For manual calibration in calibration baths the maximum immersion length of the device ranges from the sensor tip to the lower part of the electronic housing. Do not immerse the housing into the calibration bath!



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Self-calibration

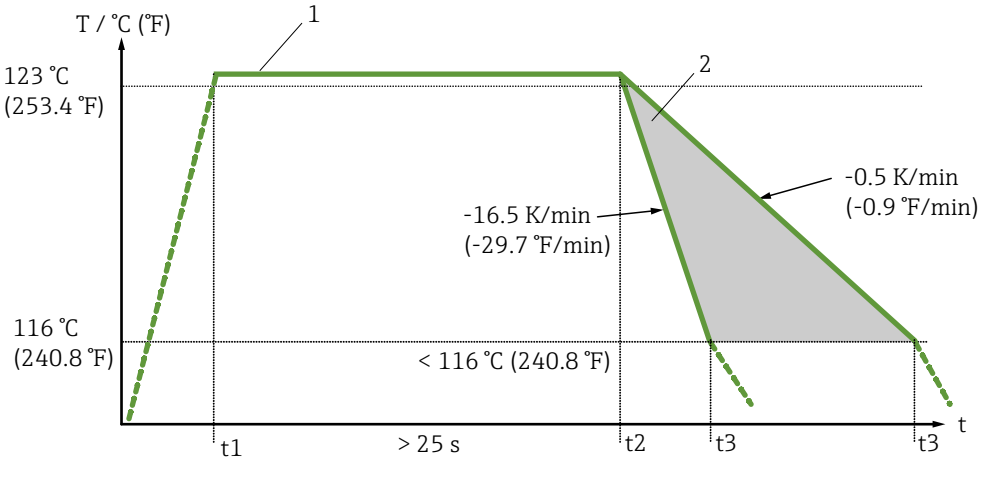
The self-calibration procedure uses the Curie temperature (Tc) of a reference material as a built-in temperature reference. A self-calibration is performed automatically, when the process temperature (Tp) falls below the nominal Curie Temperature (Tc) of the device. At the Curie temperature, a phase change of the reference material takes place, which is associated with a change in its electrical properties. The electronics automatically detects this change and simultaneously calculates the deviation of the measured Pt100-temperature to the known, physically fixed Curie temperature. The iTHERM TrustSens thermometer is calibrated. A green flashing LED light indicates the ongoing self-calibration process. Subsequently the thermometer electronics stores the results of this calibration. The calibration data can be read via an asset management software like FieldCare or DeviceCare. A self-calibration certificate can be created automatically. This in-situ self-calibration allows a continuous and repeated monitoring of changes to the Pt100 sensor and to the electronics' characteristics. As the inline calibration is being performed under real ambient or process conditions (e.g. heating of electronics), the result is closer to reality than a sensor calibration under laboratory conditions.

Process criteria for self-calibration

To ensure a valid self-calibration within the given measurement accuracy, the process temperature characteristics needs to fulfil the criteria, which are checked by the device

automatically. Based on this, the device is ready to perform a self-calibration under the following conditions:

Calibration point 118 °C (244.4 °F)
Process temperature > calibration temperature + 3 °C (5.4 °F) for 25 s before cooling down; t1 - t2.
Cooling rate: 0.5 to 16.5 K/min (0.9 to 29.7 °F/min), while the process temperature crosses the Curie temperature; t2 - t3 + 10 s. The process temperature ideally declines continuously below 116 °C (240.8 °F). A valid self-calibration process is done when the green LED flashes with a frequency 5 Hz for 5 s.



10 Needed process temperature profile for self-calibration

1 Process temperature 123 °C (253.4 °F)
2 Allowed self-calibration range

Calibration monitoring

Available in conjunction with Advanced Data Manager Memograph M (RSG45). → 48

Application package:
- Up to 20 devices can be monitored via the HART interface
- Self-calibration data displayed on screen or via the Web server
- Generation of a calibration history
- Creation of a calibration protocol as an RTF file directly at the RSG45
- Evaluation, analysis and further processing of the calibration data using "Field Data Manager" (FDM) analysis software

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}.

13.5 Environment

Ambient temperature range

Ambient temperature T_a	−40 to +60 °C (−40 to +140 °F)
Maximum electronics temperature T	−40 to +85 °C (−40 to +185 °F)

Storage temperature range

T = −40 to +85 °C (−40 to +185 °F)

Climate class

As per IEC 60654-1, Class Dx

Degree of protection

- IP54 for the version without protection tube provided for installation in an existing protection tube
- IP65/67 for housing with LED status indication
- IP69 for housing without LED status indication and only if appropriate cord-set with M12x1 coupling is connected. → 46

The specified rating IP65/67 or IP69 for the compact thermometer is only assured when an approved M12 connector with a suitable IP rating is installed according to its manual.

Shock and vibration resistance

Endress+Hauser temperature sensors meet the requirements of IEC 60751 which specify shock and vibration resistance of 3g in the range from 10 to 500 Hz. This also applies for the quick-fastening iTHERM QuickNeck.

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. All tests were passed both with and without ongoing HART® communication.

All EMC measurements were performed with a turn down (TD) = 5:1. 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.

13.6 Mechanical construction

Design, dimensions

All dimensions in mm (in). The design of the thermometer depends on the protection tube version used:

- Thermometer without a protection tube
- Diameter 6 mm (0.24 in)
- Diameter 9 mm (0.35 in)
- Diameter 12.7 mm (½ in)
- Tee thermowell and elbow thermowell version as per DIN 11865 / ASME BPE 2012 for weld-in

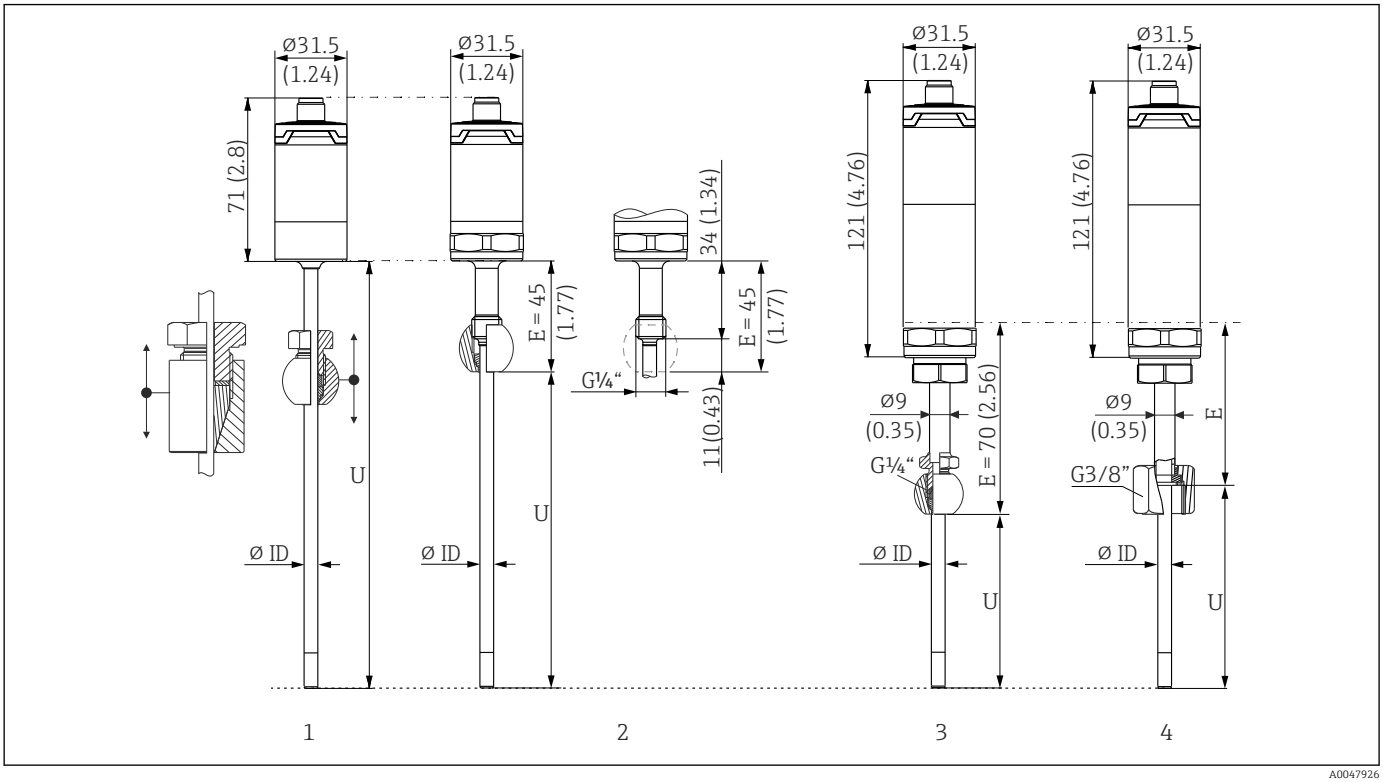
Various dimensions, such as the immersion length U for example, are variable values and are therefore indicated as items in the following dimensional drawings.

Variable dimensions:

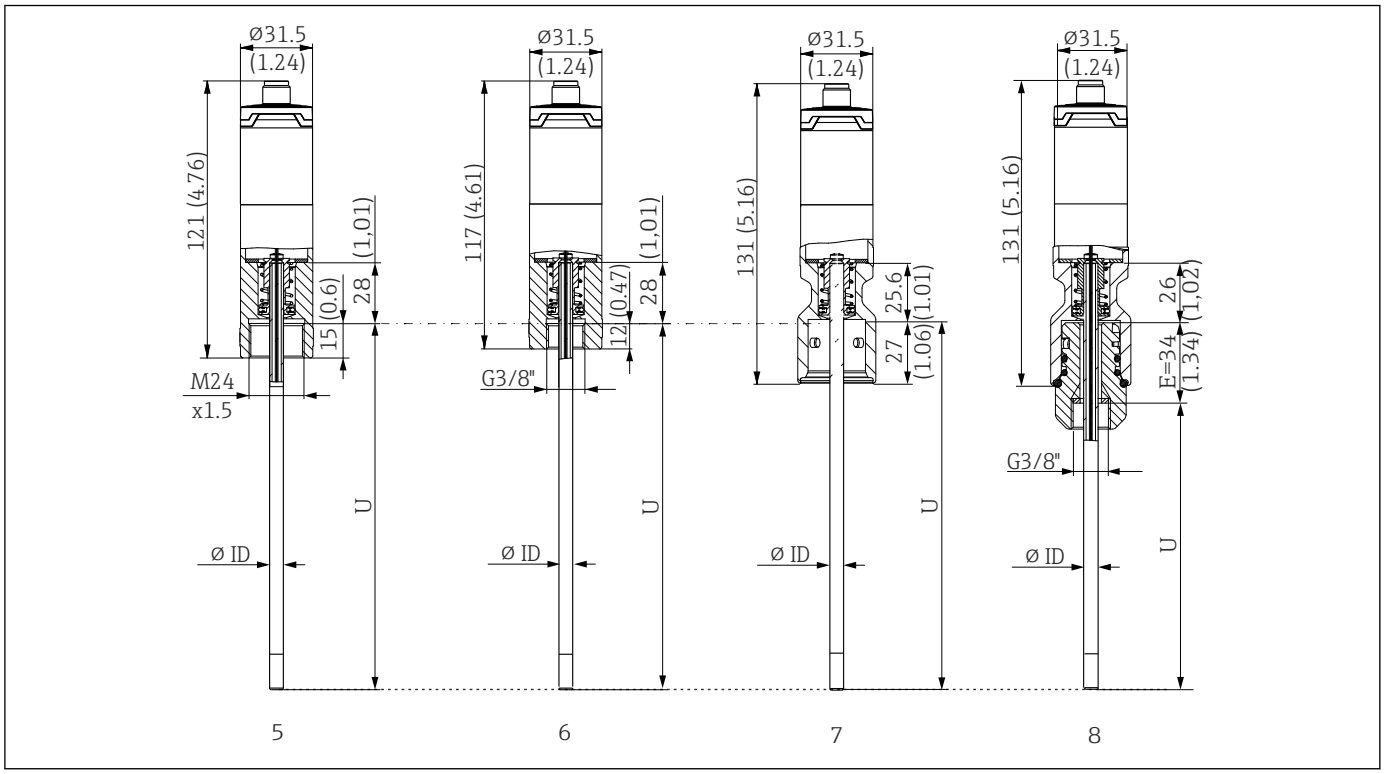
Item	Description
E	Extension neck length, variable depending on the configuration or predefined for the version with iTHERM QuickNeck
L	Protection tube length (U+T)
B	Protection tube bottom thickness: predefined, depends on protection tube version (see also the individual table data)
T	Length of protection tube shaft: variable or predefined, depends on protection tube version (see also the individual table data)
U	Immersion length: variable, depending on the configuration
ØID	Insert diameter 6 mm (0.24 in) or 3 mm (0.12 in)

Without protection tube

For installation with compression fitting TK40 as process connection and the insert in direct contact with the process or in an existing protection tube.



1 Thermometer without extension neck, for mounting with adjustable compression fitting TK40, spherically and cylindrically, only ØID = 6 mm
2 Thermometer with extension neck, for mounting with or in on-site existing compression fitting TK40 in fix position, only ØID = 6 mm
3 Thermometer with compression fitting TK40 fixed by extension neck, connection thread M24x1.5, ØID = 6 mm
4 Thermometer with neck tube TE411, G3/8" thread adapter nut



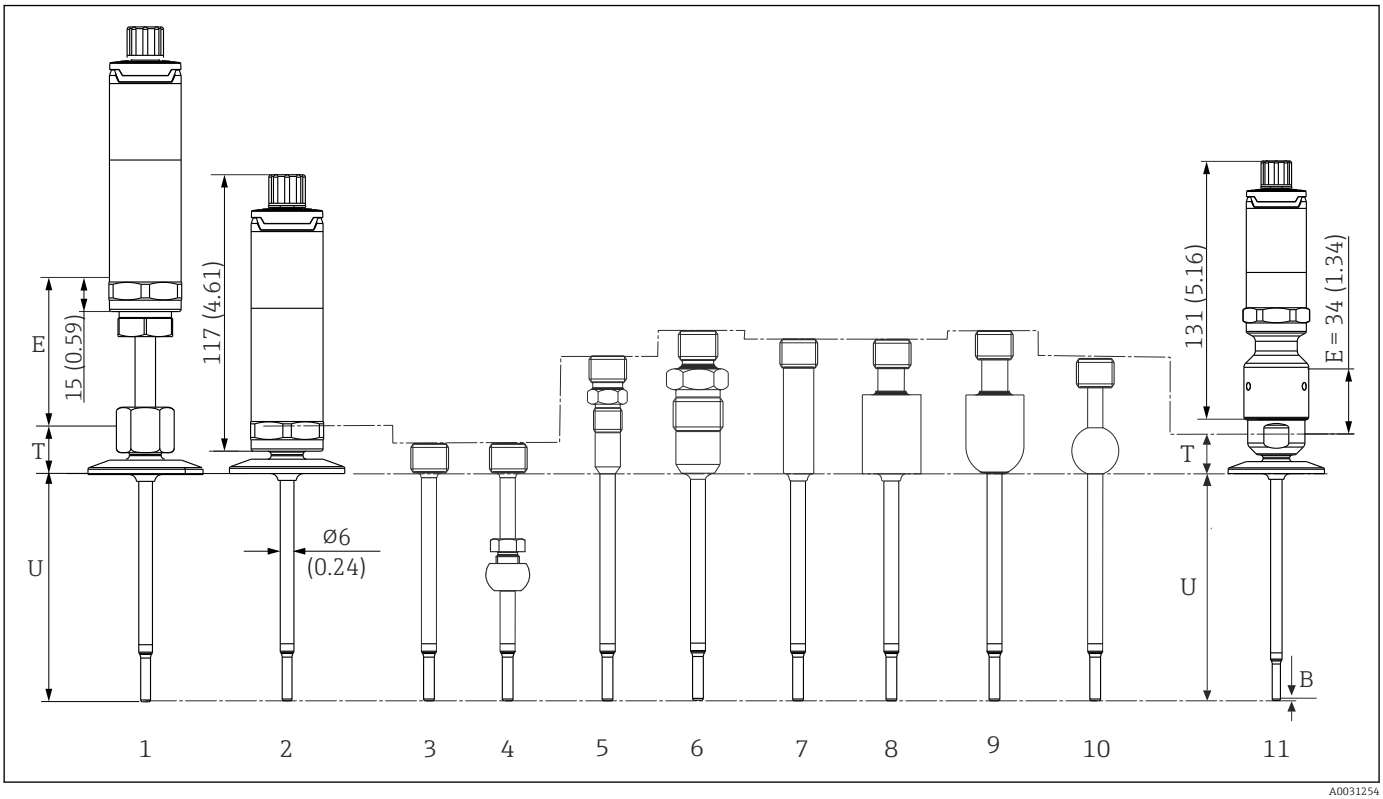
5 Thermometer with M24x1.5 female thread and spring load for protection tube connection, e.g. TT411, ØID = 3 mm or 6 mm
6 Thermometer with G3/8" female thread and spring load for protection tube connection, e.g. TT411, ØID = 3 mm or 6 mm
7 Thermometer with iTHERM QuickNeck top part and spring load for protection tube with iTHERM QuickNeck connection, ØID = 3 mm or 6 mm
8 Thermometer with iTHERM QuickNeck and spring load to mount in existing thermowell with G3/8" female thread

Item	Description
$U_{(protection\ tube)}$	Immersion length of the protection tube available at point of installation
$T_{(protection\ tube)}$	Shaft length of protection tube available at point of installation
E	Length of the extension neck at point of installation (provided one is available)
$B_{(protection\ tube)}$	Base thickness of protection tube

Pay attention to the following equations when calculating the immersion length U for immersion into a protection tube TT411 already available:

Version 5 and 7	$U = U_{(protection\ tube)} + T_{(protection\ tube)} + E + 3\ mm - B_{(protection\ tube)}$
Version 3, 4 and 6	$U = U_{(protection\ tube)} + T_{(protection\ tube)} + 3\ mm - B_{(protection\ tube)}$

With protection tube diameter 6 mm (0.24 in)



1 Thermometer with extension neck and process connection as clamp version
2 Thermometer without extension neck and process connection as clamp version
3 Without process connection
4 Process connection version as spherical compression fitting TK40
5 Process connection version as metal sealing system M12x1
6 Process connection version as metal sealing system G½"
7 Process connection version as cylindrical weld-in adapter Ø12 x 40 mm
8 Process connection version as cylindrical weld-in adapter Ø30 x 40 mm
9 Process connection version as spherical-cylindrical weld-in adapter Ø30 x 40 mm
10 Process connection version as spherical weld-in adapter Ø25 x mm
11 Thermometer with quick-fastening iTHERM QuickNeck and process connection as sanitary connection (clamp version)

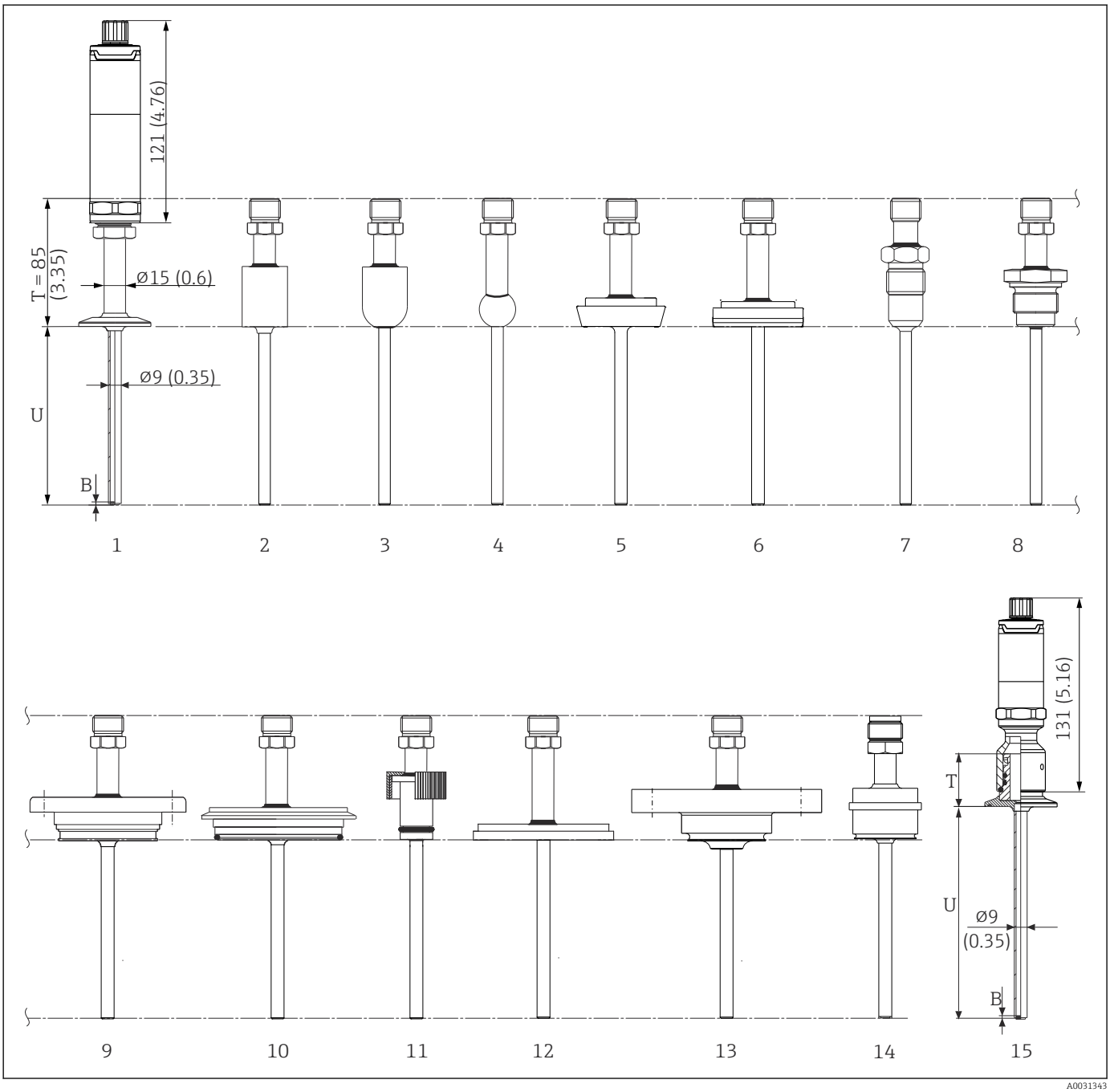
G3/8" thread for protection tube connection

Item	Version	Length
Extension neck E	Without extension neck	-
	Replaceable extenstion neck, Ø9 mm (0.35 in)	Variable, depending on the configuration
	iTHERM QuickNeck	34 mm (1.34 in)
Length of protection tube shaft T [1)]	Clamp DN12 according to ISO 2852	24 mm (0.94 in)
	Clamp DN25/DN40 according to ISO 2852	21 mm (0.83 in)
	Without process connection (only G3/8" thread), where necessary with compression fitting TK40	12 mm (0.47 in)
	Metal sealing system M12x1	46 mm (1.81 in)
	Metal sealing system G½"	60 mm (2.36 in)
	Cylindrical weld-in adapter Ø12 mm (0.47 in)	55 mm (2.17 in)
	Cylindrical weld-in adapter Ø30 mm (1.18 in)	55 mm (2.17 in)
	Spherical-cylindrical weld-in adapter	58 mm (2.28 in)

Item	Version	Length
	Spherical weld-in adapter	47 mm (1.85 in)
	Tri-clamp (0.5"-0.75")	24 mm (0.94 in)
	Microclamp (DN8-18)	23 mm (0.91 in)
	Sanitary connection DN25/DN32/DN40 according to DIN 11851	29 mm (1.14 in)
Immersion length U	Independent of the version	Variable, depending on the configuration
Bottom thickness B	Reduced tip ⌀4.3 mm (0.17 in)	3 mm (0.12 in)

1) Variable, depending on the configuration

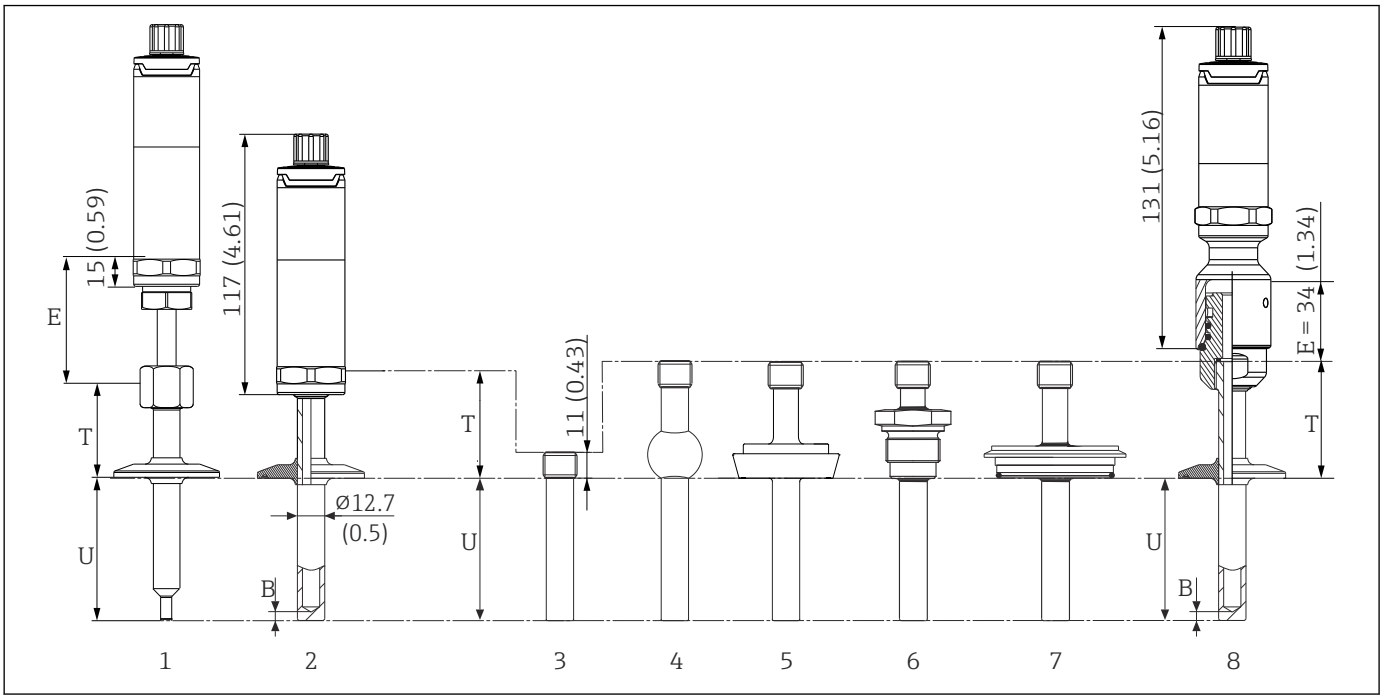
With protection tube diameter 9 mm (0.35 in)



1 Thermometer with extension neck, process connection as clamp version
2 Process connection version as cylindrical weld-in adapter Ø30 x 40 mm
3 Process connection version as spherical-cylindrical weld-in adapter Ø30 x 40 mm
4 Process connection version as spherical weld-in adapter Ø25 x mm
5 Process connection version as sanitary connection according to DIN 11851
6 Process connection version as aseptic pipe union according to DIN 11864-1 Form A
7 Process connection version as metal sealing system G½"
8 Process connection version as thread according to ISO 228 for Liquiphant weld-in adapter
9 Process connection version APV Inline
10 Process connection version Varivent®
11 Process connection version Ingold connection
12 Process connection to SMS 1147
13 Process connection version Neumo Biocontrol
14 Process adapter D45
15 Thermometer with quick-fastening iTHERM QuickNeck and process connection, as clamp version for example

Item	Version	Length
Extension neck E	No separate extension neck available	-
Length of protection tube shaft T	Without quick-fastening iTHERM QuickNeck independent of the process connection	85 mm (3.35 in)
	Without quick-fastening iTHERM QuickNeck in combination with Ingold connection Ø25 mm (0.98 in) x 46 mm (1.81 in)	100 mm (3.94 in)
	With quick-fastening iTHERM QuickNeck, depending on the process connection: SMS 1147, DN25	40 mm (1.57 in)
	SMS 1147, DN38	41 mm (1.61 in)
	SMS 1147, DN51	42 mm (1.65 in)
	Varivent, type F, D = 50 mm (1.97 in) Varivent, type N, D = 68 mm (2.67 in)	52 mm (2.05 in)
	Varivent, type B, D = 31 mm (1.22 in)	56 mm (2.2 in)
	Thread G1" according to ISO 228 for Liquiphant weld-in adapter	77 mm (3.03 in)
	Spherical-cylindrical weld-in adapter	70 mm (2.76 in)
	Cylindrical weld-in adapter	67 mm (2.64 in)
	Aseptic pipe union according to DIN11864-A, DN25	45 mm (1.77 in)
	Aseptic pipe union according to DIN11864-A, DN40	
	Sanitary connection according to DIN 11851, DN32	47 mm (1.85 in)
	Sanitary connection according to DIN 11851, DN40	
	Sanitary connection according to DIN 11851, DN50	48 mm (1.89 in)
	Clamp according to ISO 2852, DN12	
	Clamp according to ISO 2852, DN25	37 mm (1.46 in)
	Clamp according to ISO 2852, DN40	39 mm (1.54 in)
	Clamp according to ISO 2852, DN63.5	
	Clamp according to ISO 2852, DN70	
	Microclamp (DN18)	47 mm (1.85 in)
	Tri-clamp (0.75")	46 mm (1.81 in)
	Ingold connection Ø25 mm (0.98 in) x 30 mm (1.18 in)	78 mm (3.07 in)
	Ingold connection Ø25 mm (0.98 in) x 46 mm (1.81 in)	94 mm (3.7 in)
	Metal sealing system G½"	77 mm (3.03 in)
	APV-Inline, DN50	51 mm (2.01 in)
Immersion length U	Independent of the version	Variable, depending on the configuration
Bottom thickness B	Reduced tip Ø5.3 mm (0.21 in)x 20 mm (0.79 in)	4 mm (0.16 in)
	Straight tip	2 mm (0.08 in)

With protection tube diameter 12.7 mm (½ in)

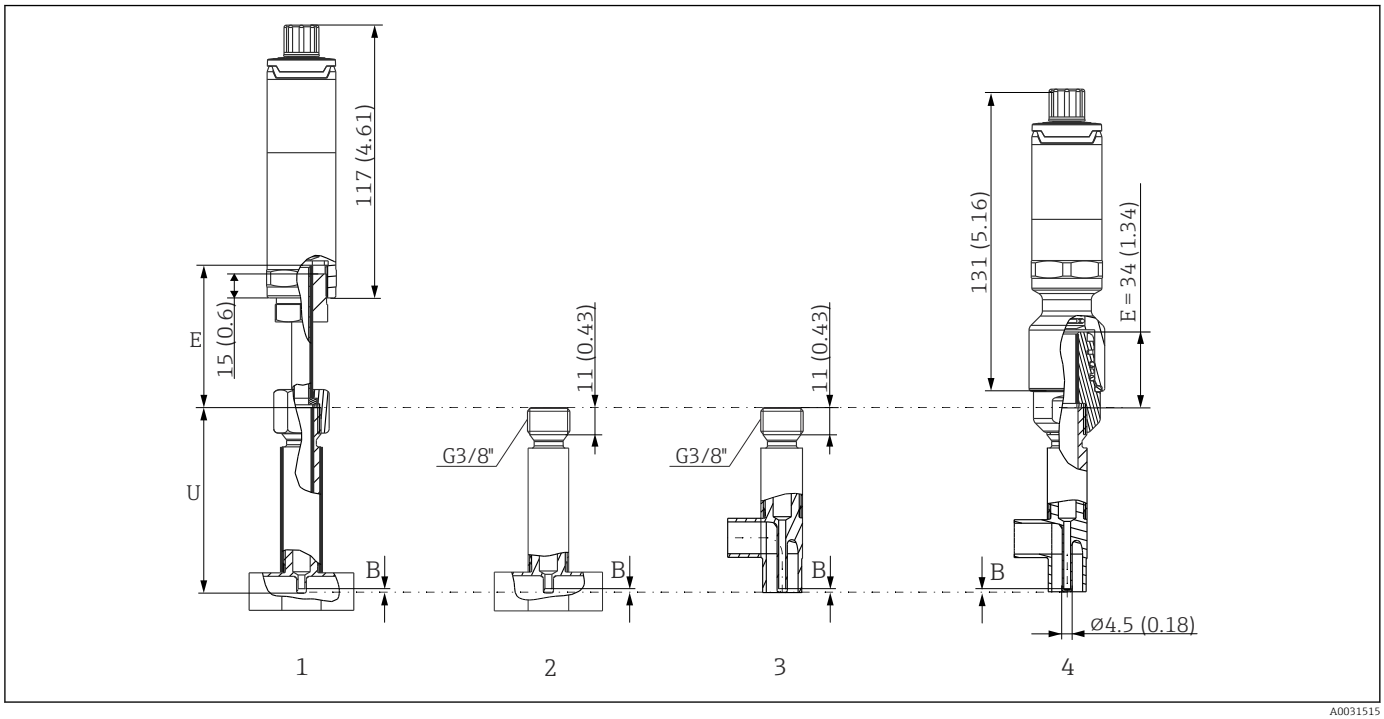


1 Thermometer with standard extension neck, thread and process connection as clamp version
2 Thermometer with extension neck and process connection as clamp version
3 Process connection version as cylindrical weld-in adapter Ø 12.7 mm (½ in)
4 Process connection version as spherical weld-in adapter Ø25 mm (1 in)
5 Process connection version as sanitary connection according to DIN 11851
6 Thread according to ISO 228 for Liquiphant weld-in adapter
7 Process connection version Varivent
8 Thermometer with quick-fastening iTHERM QuickNeck and process connection, as clamp version for example

- G3/8" thread for protection tube connection
- Protection tube made from solid bar stock drilled for L ≤ 200 mm (7.87 in)
- Welded protection tube for L > 200 mm (7.87 in)

Item	Version	Length
Extension neck E	Without extension neck	-
	Replaceable extension neck, Ø9 mm (0.35 in)	Variable, depending on the configuration
	iTHERM QuickNeck	34 mm (1.34 in)
Length of protection tube shaft T	Weld-in adapter, cylindrical, Ø12.7 mm (½ in)	12 mm (0.47 in)
	All other process connections	65 mm (2.56 in)
Immersion length U	Independent of the process connection	Variable, depending on the configuration
Bottom thickness B	Reduced tip Ø5.3 mm (0.21 in)x 20 mm (0.79 in)	2 mm (0.08 in)
	Reduced tip Ø8 mm (0.31 in)x 32 mm (1.26 in)	4 mm (0.16 in)
	Straight tip	6 mm (0.24 in)

With tee- or elbow thermowell version



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1 Thermometer with extension neck and tee thermowell
2 Version with tee thermowell
3 Version with elbow thermowell
4 Thermometer with quick-fastening iTHERM QuickNeck and elbow thermowell

Item	Version	Length
Extension neck E	Without extension neck	-
	Replaceable extension neck, Ø9 mm (0.35 in)	Variable, depending on the configuration
	iTHERM QuickNeck	34 mm (1.34 in) 71.05 mm (2.79 in)
Bottom thickness B	Independent of the version	0.7 mm (0.03 in)
Immersion length U	G3/8" connection QuickNeck connection	85 mm (3.35 in) 119 mm (4.7 in)

- Pipe sizes according to DIN11865 series A (DIN), B (ISO) and C (ASME BPE)
- Nominal diameters > DN25, with 3-A symbol
- IP69 protection class

- Material 1.4435+316L, Delta ferrite content <0.5%
- Temperature measurement range: −60 to +200 °C (−76 to +392 °F)
- Pressure range: PN25 according to DIN11865

As a general rule, the longer the immersion length U the better the accuracy. For small pipe diameters it is advisable to use elbow thermowells to enable a maximum immersion length U.

Suitable immersion lengths for the following thermometers with G3/8" thermometer connection:
- Easytemp TMR35: 83 mm (3.27 in)
- iTHERM TM411: 85 mm (3.35 in)
- iTHERM TM311: 85 mm (3.35 in)
- iTHERM TrustSens TM371: 85 mm (3.35 in)

Suitable immersion lengths for the following thermometers with iTHERM QuickNeck thermometer connection:
- Easytemp TMR35: 117 mm (4.6 in)
- iTHERM TM411: 119 mm (4.68 in)
- iTHERM TM311: 119 mm (4.68 in)
- iTHERM TrustSens TM371: 119 mm (4.68 in)

Weight

0.2 to 2.5 kg (0.44 to 5.5 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 compressive load. The maximum operating temperatures can be reduced considerably in cases where abnormal conditions such as high mechanical load occur or in aggressive media.

Designation	Short form	Recommended max. temperature for continuous use in air	Properties
AISI 316L (corresponds to 1.4404 or 1.4435)	X2CrNiMo17-13-2, X2CrNiMo18-14-3	650 °C (1202 °F) [1]	▪ Austenitic, stainless steel ▪ High corrosion resistance in general ▪ Particularly high corrosion resistance in chlorine-based and acidic, non-oxidizing atmospheres through the addition of molybdenum (e.g. phosphoric and sulfuric acids, acetic and tartaric acids with a low concentration) ▪ Increased resistance to intergranular corrosion and pitting ▪ The wetted part in a protective tube is made of 316L or 1.4435+316L passivated with 3% sulfuric acid.
1.4435+316L, delta ferrite < 1% or < 0.5%	With regard to analytical limits, the specifications of both materials (1.4435 and 316L) are met simultaneously. In addition, the delta ferrite content of the wetted parts is limited to <1% or <0.5% ≤3% at weldings (following Basel Standard II)		

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

Surface roughness

Values for process/product contact surfaces:

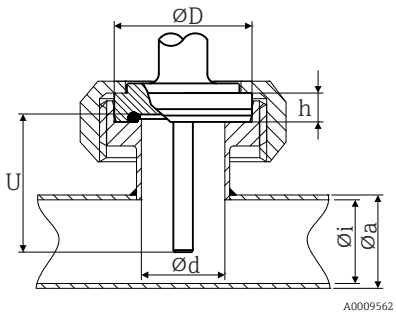
Standard surface, mechanically polished [1]	$R_a \leq 0.76$ µm (30 µin)
Mechanically polished [1], buffed [2]	$R_a \leq 0.38$ µm (15 µin)
Mechanically polished [1], buffed and electropolished	$R_a \leq 0.38$ µm (15 µin)+ electropolished

1) Or any other finishing method that meets the R_a max
2) Non-compliant with ASME BPE

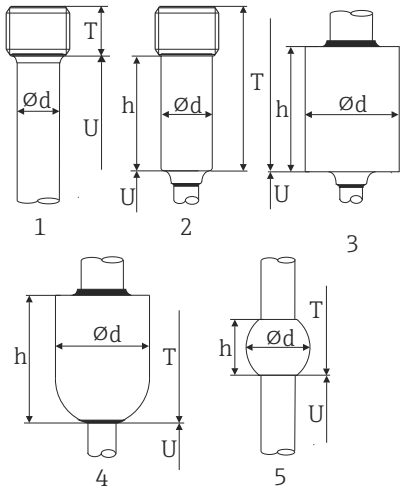
Protection tube

Process connections

All dimensions in mm (in).

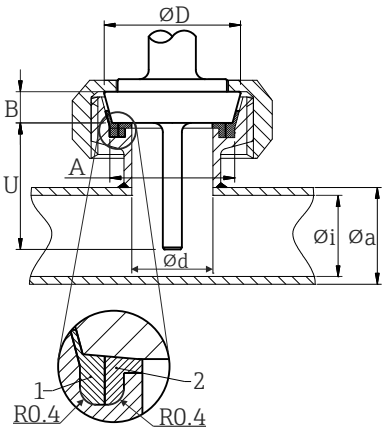
Type	Version	Dimensions					Technical properties
		ϕd	ϕD	ϕi	ϕa	h	
Aseptic pipe union according to DIN 11864-1, Form A 	DN25	26 mm (1.02 in)	42.9 mm (1.7 in)	26 mm (1.02 in)	29 mm (1.14 in)	9 mm (0.35 in)	▪ $P_{max.}$ = 40 bar (580 psi) ▪ 3-A marked and EHEDG certified ▪ ASME BPE compliance
	DN40	38 mm (1.5 in)	54.9 mm (2.16 in)	38 mm (1.5 in)	41 mm (1.61 in)	10 mm (0.39 in)	

For welding in

Type	Version	Dimensions	Technical properties
Weld-in adapter 	1: Cylindrical [1]	ϕd = 12.7 mm (½ in), U = immersion length from lower edge of thread, T = 12 mm (0.47 in)	▪ $P_{max.}$ depends on the weld-in process ▪ 3-A marked and EHEDG certified ▪ ASME BPE compliance
	2: Cylindrical [2]	ϕd x h = 12 mm (0.47 in) x 40 mm (1.57 in), T = 55 mm (2.17 in)	
	3: Cylindrical	ϕd x h = 30 mm (1.18 in) x 40 mm (1.57 in)	
	4: Spherical-cylindrical	ϕd x h = 30 mm (1.18 in) x 40 mm (1.57 in)	
	5: Spherical	ϕd = 25 mm (0.98 in) h = 24 mm (0.94 in)	

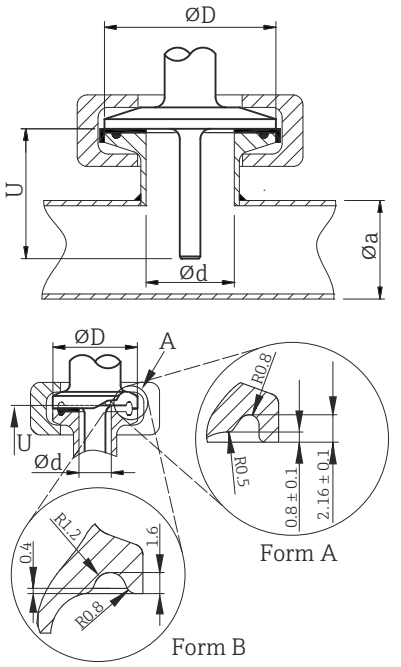
1) For protection pipe ϕ12.7 mm (½ in)
2) For protection pipe ϕ6 mm (¼ in)

Releasable process connection

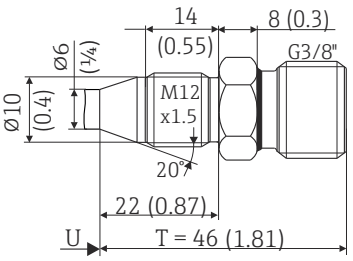
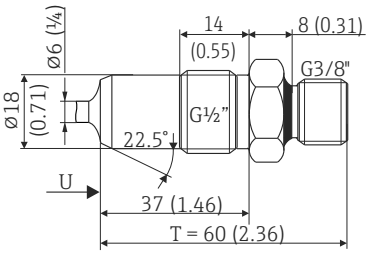
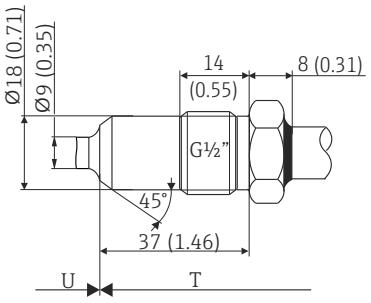
Type	Technical properties
Sanitary connection according to DIN 11851  A0009561 *1 Centering ring* *2 Sealing ring*	▪ 3-A marked and EHEDG certified (only with EHEDG-certified and self-centering sealing ring). ▪ ASME BPE compliance

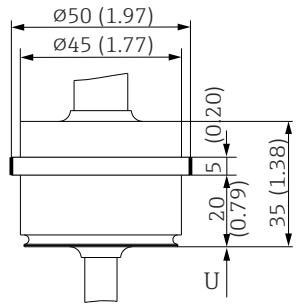
Version [1]	Dimensions					$P_{max.}$
	ΦD	A	B	Φi	Φa	
DN25	44 mm (1.73 in)	30 mm (1.18 in)	10 mm (0.39 in)	26 mm (1.02 in)	29 mm (1.14 in)	40 bar (580 psi)
DN32	50 mm (1.97 in)	36 mm (1.42 in)	10 mm (0.39 in)	32 mm (1.26 in)	35 mm (1.38 in)	40 bar (580 psi)
DN40	56 mm (2.2 in)	42 mm (1.65 in)	10 mm (0.39 in)	38 mm (1.5 in)	41 mm (1.61 in)	40 bar (580 psi)
DN50	68 mm (2.68 in)	54 mm (2.13 in)	11 mm (0.43 in)	50 mm (1.97 in)	53 mm (2.1 in)	25 bar (363 psi)

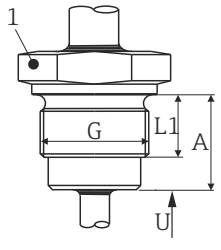
1) Pipes in accordance with DIN 11850

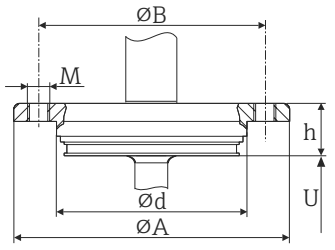
Type	Version	Dimensions		Technical properties	Conformity
	ϕd [1]	ϕD	ϕa		
Clamp according to ISO 2852  Form A: In compliance with ASME BPE Type A Form B: In compliance with ASME BPE Type B and ISO 2852	Microclamp [2] DN8-18 (0.5"-0.75") [3], Form A	25 mm (0.98 in)	-	▪ $P_{max.}$ = 16 bar (232 psi), depends on clamp ring and suitable seal ▪ 3-A marked	-
	Tri-clamp DN8-18 (0.5"-0.75") [3], Form B		-		Based on ISO 2852 [4]
	Clamp DN12-21.3, Form B	34 mm (1.34 in)	16 to 25.3 mm (0.63 to 0.99 in)		ISO 2852
	Clamp DN25-38 (1"-1.5"), Form B	50.5 mm (1.99 in)	29 to 42.4 mm (1.14 to 1.67 in)	▪ $P_{max.}$ = 16 bar (232 psi), depends on clamp ring and suitable seal ▪ 3-A marked and EHEDG certified (in connection with Combifit seal) ▪ Can be used with "Novaseptic Connect (NA Connect)" which enables flush-mount installation	ASME BPE Type B; ISO 2852
	Clamp DN40-51 (2"), Form B	64 mm (2.52 in)	44.8 to 55.8 mm (1.76 to 2.2 in)		ASME BPE Type B; ISO 2852
	Clamp DN63.5 (2.5"), Form B	77.5 mm (3.05 in)	68.9 to 75.8 mm (2.71 to 2.98 in)		ASME BPE Type B; ISO 2852
	Clamp DN70-76.5 (3"), Form B	91 mm (3.58 in)	> 75.8 mm (2.98 in)		ASME BPE Type B; ISO 2852

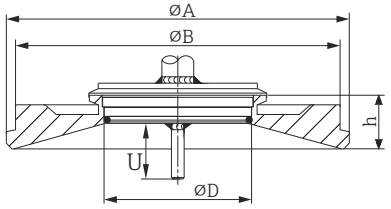
1) Pipes in accordance with ISO 2037 and BS 4825 Part 1
2) Microclamp (not in ISO 2852); no standard pipes
3) DN8 (0.5") only possible with protection pipe diameter = 6 mm (¼ in)
4) Groove diameter = 20 mm

Type		Version	Technical properties
Metal sealing system		Protection pipe diameter 6 mm (¼ in)	$P_{max.}$ = 16 bar (232 psi) Maximum torque = 10 Nm (7.38 lbf ft)
M12x1.5	**G½"**		
			
-		Protection pipe diameter 9 mm (0.35 in)	$P_{max.}$ = 16 bar (232 psi) Maximum torque = 10 Nm (7.38 lbf ft)

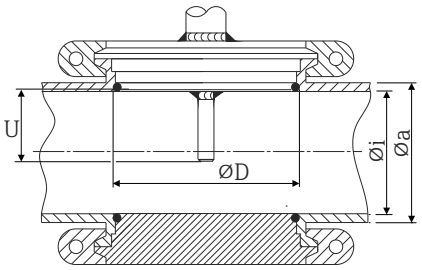
Type	Version	Technical properties
Process adapter 	D45	-

Type	Version G	Dimensions			Technical properties
		L1 thread length	A	1 (SW/AF)	
Thread according to ISO 228 (for Liquiphant weld-in adapter) 	G¾" for FTL20/31/33 adapter	16 mm (0.63 in)	25.5 mm (1 in)	32	▪ $P_{max.}$ = 25 bar (362 psi) at max. 150 °C (302 °F) ▪ $P_{max.}$ = 40 bar (580 psi) at max. 100 °C (212 °F) ▪ Information about hygienic compliance in connection with FTL31/33/50 adapter see TI00426F
	G¾" for FTL50 adapter				
	G1" for FTL50 adapter	18.6 mm (0.73 in)	29.5 mm (1.16 in)	41	

Type	Version	Dimensions					Technical properties
		ϕd	ϕA	ϕB	M	h	
APV Inline 	DN50	69 mm (2.72 in)	99.5 mm (3.92 in)	82 mm (3.23 in)	2xM8	19 mm (0.75 in)	▪ $P_{max.}$ = 25 bar (362 psi) ▪ 3-A marked and EHEDG certified ▪ ASME BPE compliance

Type	Version	Dimensions				Technical properties	
		ϕD	ϕA	ϕB	h	$P_{max.}$	
Varivent® 	Type B	31 mm (1.22 in)	105 mm (4.13 in)	-	22 mm (0.87 in)	10 bar (145 psi)	▪ 3-A marked and EHEDG certified ▪ ASME BPE compliance
	Type F	50 mm (1.97 in)	145 mm (5.71 in)	135 mm (5.31 in)	24 mm (0.95 in)		
	Type N	68 mm (2.67 in)	165 mm (6.5 in)	155 mm (6.1 in)	24.5 mm (0.96 in)		

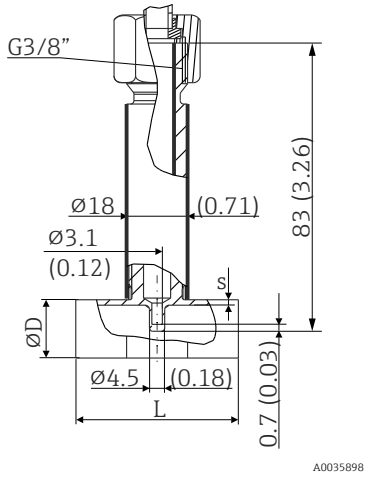
The VARINLINE® housing connection flange is suitable for welding into the conical or torispherical head in tanks or containers with a small diameter (≤ 1.6 m (5.25 ft)) and up to a wall thickness of 8 mm (0.31 in).

Type	Technical properties
Varivent® for VARINLINE® housing for installation in pipes 	▪ 3-A marked and EHEDG certified ▪ ASME BPE compliance

Version	Dimensions			$P_{max.}$
	ϕD	ϕi	ϕa	
Type N, according to DIN 11866, series A	68 mm (2.67 in)	DN40: 38 mm (1.5 in)	DN40: 41 mm (1.61 in)	DN40 to DN65: 16 bar (232 psi)
		DN50: 50 mm (1.97 in)	DN50: 53 mm (2.1 in)	
		DN65: 66 mm (2.6 in)	DN65: 70 mm (2.76 in)	
		DN80: 81 mm (3.2 in)	DN80: 85 mm (3.35 in)	DN80 to DN150: 10 bar (145 psi)
		DN100: 100 mm (3.94 in)	DN100: 104 mm (4.1 in)	
		DN125: 125 mm (4.92 in)	DN125: 129 mm (5.08 in)	
		DN150: 150 mm (5.9 in)	DN150: 154 mm (6.06 in)	
Type N, according to EN ISO 1127, series B	68 mm (2.67 in)	38.4 mm (1.51 in)	42.4 mm (1.67 in)	42.4 mm (1.67 in) to 60.3 mm (2.37 in): 16 bar (232 psi)
		44.3 mm (1.75 in)	48.3 mm (1.9 in)	

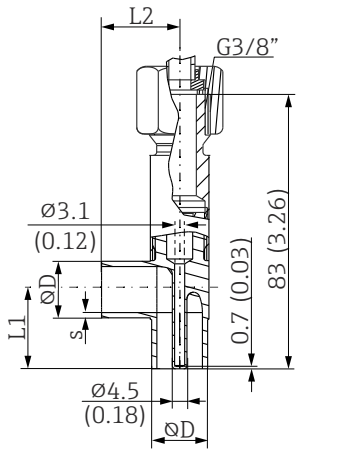
Type				Technical properties
		56.3 mm (2.22 in)	60.3 mm (2.37 in)	
		72.1 mm (2.84 in)	76.1 mm (3 in)	76.1 mm (3 in) to 114.3 mm (4.5 in): 10 bar (145 psi)
		82.9 mm (3.26 in)	42.4 mm (3.5 in)	
		108.3 mm (4.26 in)	114.3 mm (4.5 in)	
Type N, according to DIN 11866, series C	68 mm (2.67 in)	OD 1½": 34.9 mm (1.37 in)	OD 1½": 38.1 mm (1.5 in)	OD 1½" to OD 2½": 16 bar (232 psi)
		OD 2": 47.2 mm (1.86 in)	OD 2": 50.8 mm (2 in)	
		OD 2½": 60.2 mm (2.37 in)	OD 2½": 63.5 mm (2.5 in)	
Type N, according to DIN 11866, series C	68 mm (2.67 in)	OD 3": 73 mm (2.87 in)	OD 3": 76.2 mm (3 in)	OD 3" to OD 4": 10 bar (145 psi)
		OD 4": 97.6 mm (3.84 in)	OD 4": 101.6 mm (4 in)	

T-piece, optimized (no welding, no dead legs)

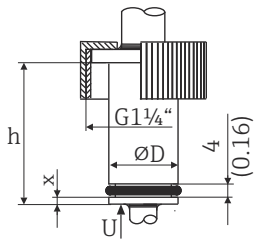
Type	Version		Dimensions in mm (in)			Technical properties
			ϕD	L	s [1]	
T-piece for weld-in as per DIN 11865 (series A, B and C) 	Series A	DN10 PN25	13 mm (0.51 in)	48 mm (1.89 in)	1.5 mm (0.06 in)	▪ $P_{max.}$ = 25 bar (362 psi) ▪ 3-A marked [2] and EHEDG certified [2] ▪ ASME BPE compliance [2]
		DN15 PN25	19 mm (0.75 in)			
		DN20 PN25	23 mm (0.91 in)			
		DN25 PN25	29 mm (1.14 in)			
		DN32 PN25	32 mm (1.26 in)			
	Series B	DN13.5 PN25	13.5 mm (0.53 in)		1.6 mm (0.063 in)	
		DN17.2 PN25	17.2 mm (0.68 in)			
		DN21.3 PN25	21.3 mm (0.84 in)			
		DN26.9 PN25	26.9 mm (1.06 in)			
		DN33.7 PN25	33.7 mm (1.33 in)		2 mm (0.08 in)	
	Series C	DN12.7 PN25 (½")	12.7 mm (0.5 in)		1.65 mm (0.065 in)	
		DN19.05 PN25 (¾")	19.05 mm (0.75 in)			
		DN25.4 PN25 (1")	25.4 mm (1 in)			
		DN38.1 PN25 (1½")	38.1 mm (1.5 in)			

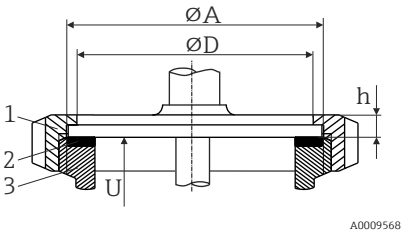
1) Wall thickness
2) Applies to ≥ DN25. The radius ≥ 3.2 mm (⅛ in) cannot be maintained for smaller nominal diameters.

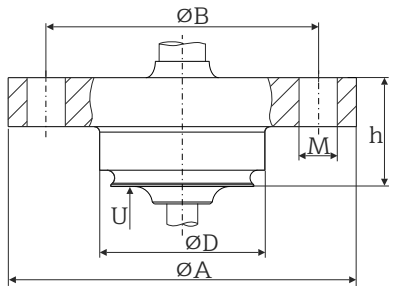
Elbow piece, optimized (no welding, no dead legs)

Type	Version		Dimensions				Technical properties
			⌀D	L1	L2	s [1]	
Elbow piece for weld-in as per DIN 11865 (series A, B and C) 	Series A	DN10 PN25	13 mm (0.51 in)	24 mm (0.95 in)		1.5 mm (0.06 in)	▪ $P_{max.}$ = 25 bar (362 psi) ▪ 3-A marked [2] and EHEDG certified [2] ▪ ASME BPE compliance [2]
		DN15 PN25	19 mm (0.75 in)	25 mm (0.98 in)			
		DN20 PN25	23 mm (0.91 in)	27 mm (1.06 in)			
		DN25 PN25	29 mm (1.14 in)	30 mm (1.18 in)			
		DN32 PN25	35 mm (1.38 in)	33 mm (1.3 in)			
	Series B	DN13.5 PN25	13.5 mm (0.53 in)	32 mm (1.26 in)		1.6 mm (0.063 in)	
		DN17.2 PN25	17.2 mm (0.68 in)	34 mm (1.34 in)			
		DN21.3 PN25	21.3 mm (0.84 in)	36 mm (1.41 in)			
		DN26.9 PN25	26.9 mm (1.06 in)	29 mm (1.14 in)			
		DN33.7 PN25	33.7 mm (1.33 in)	32 mm (1.26 in)		2.0 mm (0.08 in)	
	Series C	DN12.7 PN25 (½")	12.7 mm (0.5 in)	24 mm (0.95 in)		1.65 mm (0.065 in)	
		DN19.05 PN25 (¾")	19.05 mm (0.75 in)	25 mm (0.98 in)			
		DN25.4 PN25 (1")	25.4 mm (1 in)	28 mm (1.1 in)			
		DN38.1 PN25 (1½")	38.1 mm (1.5 in)	35 mm (1.38 in)			

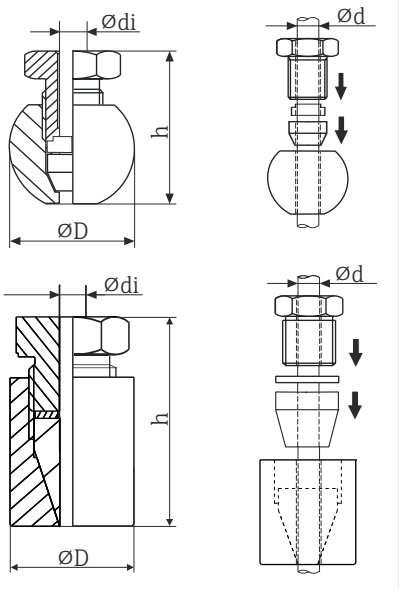
1) Wall thickness
2) Applies to ≥ DN25. The radius ≥ 3.2 mm (⅛ in) cannot be maintained for smaller nominal diameters.

Type	Version, dimensions ⌀D x h	Technical properties
Ingold connection 	⌀25 mm (0.98 in) x 30 mm (1.18 in) x = 1.5 mm (0.06 in)	$P_{max.}$ = 25 bar (362 psi) A seal is included in the scope of delivery. V75SR material: Complies with FDA, 3-A Sanitary Standard 18-03 Class 1 and USP Class VI
	⌀25 mm (0.98 in) x 46 mm (1.81 in) x = 6 mm (0.24 in)	

Type	Version	Dimensions			Technical properties
		ΦD	ΦA	h	
SMS 1147  *1 Coupling nut* *2 Sealing ring* *3 Counterpart connection*	DN25	32 mm (1.26 in)	35.5 mm (1.4 in)	7 mm (0.28 in)	$P_{max.}$ = 6 bar (87 psi)
	DN38	48 mm (1.89 in)	55 mm (2.17 in)	8 mm (0.31 in)	
	DN51	60 mm (2.36 in)	65 mm (2.56 in)	9 mm (0.35 in)	
The counterpart connection must fit the sealing ring and fix it in place.					

Type	Version	Dimensions					Technical properties
		ΦA	ΦB	ΦD	Φd	h	
Neumo Biocontrol  	D25 PN16	64 mm (2.52 in)	50 mm (1.97 in)	30.4 mm (1.2 in)	7 mm (0.28 in)	20 mm (0.79 in)	▪ $P_{max.}$ = 16 bar (232 psi) ▪ 3-A marked
	D50 PN16	90 mm (3.54 in)	70 mm (2.76 in)	49.9 mm (1.97 in)	9 mm (0.35 in)	27 mm (1.06 in)	
	D65 PN25	120 mm (4.72 in)	95 mm (3.74 in)	67.9 mm (2.67 in)	11 mm (0.43 in)		

Compression fitting

Type	Version	Dimensions			Technical properties [1]
	Spherical or cylindrical	ϕdi	ϕD	h	
Compression fitting TK40 for weld-in 	Spherical Material of sealing taper PEEK or 316L Thread G¼"	6.3 mm (0.25 in) [2]	25 mm (0.98 in)	33 mm (1.3 in)	▪ $P_{max.}$ = 10 bar (145 psi), $T_{max.}$ = +150 °C (+302 °F) for PEEK material, tightening torque = 10 Nm ▪ $P_{max.}$ = 50 bar (725 psi), $T_{max.}$ = +200 °C (+392 °F) for 316L material, tightening torque = 25 Nm ▪ PEEK compression fitting is EHEDG tested, 3-A marked
	Cylindrical Material of sealing taper ELASTOSIL® Thread G½"	6.2 mm (0.24 in) [2] 9.2 mm (0.36 in)	30 mm (1.18 in)	57 mm (2.24 in)	▪ $P_{max.}$ = 10 bar (145 psi) ▪ $T_{max.}$ for ELASTOSIL® sealing taper = +200 °C (+392 °F), tightening torque = 5 Nm ▪ The Elastosil® compression fitting is EHEDG tested and 3-A marked

1) All the pressure specifications apply for cyclic temperature load
2) For insert or protection pipe diameter Ød = 6 mm (0.236 in).

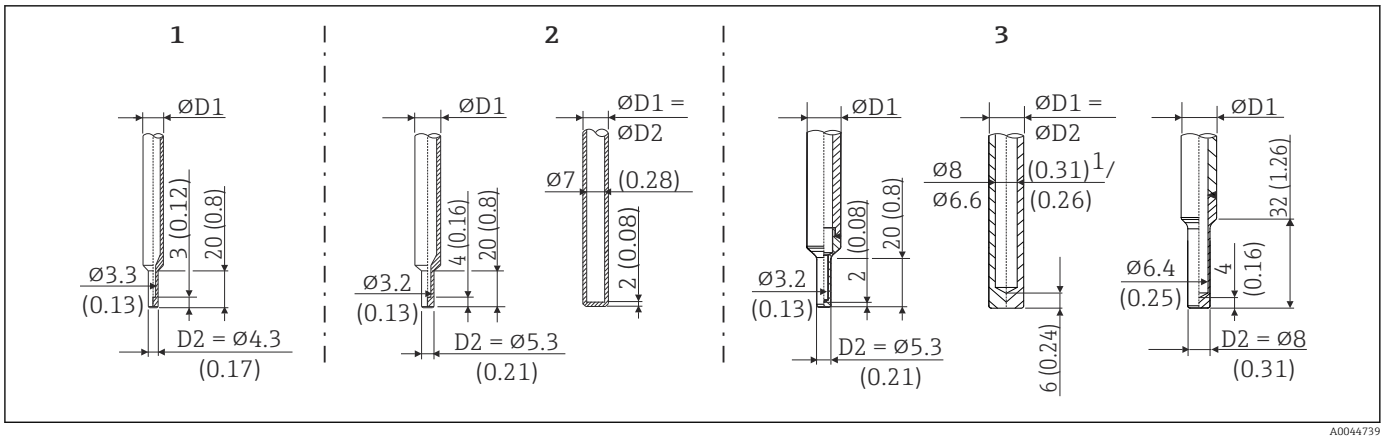
The 316L compression fittings can only be used once due to deformation. This applies to all the components of the compression fittings! A replacement compression fitting must be attached in a different position (grooves in the protection pipe). PEEK compression fittings must never be used at a temperature that is lower than the temperature present when the compression fitting is secured. This is because the fitting would no longer be leak-tight as a result of heat contraction of the PEEK material.

SWAGELOCK or similar fittings are strongly recommended for higher requirements.

Tip shape

The thermal response time, the reduction of the flow cross-section and the mechanical load that occurs in the process are the criteria that matter when selecting the shape of the tip. Advantages of using reduced or tapered thermometer tips:

- A smaller tip shape has less impact on the flow characteristics of the pipe carrying the medium.
- The flow characteristics are optimized, thereby increasing the stability of the thermowell.
- Endress+Hauser offers users a range of thermowell tips to meet every requirement:
  - Reduced tip with Ø4.3 mm (0.17 in) and Ø5.3 mm (0.21 in): walls of lower thickness significantly reduce the response times of the overall measuring point.
  - Reduced tip with Ø8 mm (0.31 in): walls of greater thickness are particularly well suited to applications with a higher degree of mechanical load or wear (e.g. pitting, abrasion etc.).



11 *Thermowell tips available (reduced, straight or tapered)*

Item No.	Thermowell (ØD1)		Insert (ØID)
1	Ø6 mm (¼ in)	Reduced tip	Ø3 mm (⅛ in)
2	Ø9 mm (0.35 in)	▪ Reduced tip with Ø5.3 mm (0.21 in) ▪ Straight tip	▪ Ø3 mm (⅛ in) ▪ Ø6 mm (¼ in) ▪ Ø3 mm (⅛ in)
3	Ø12.7 mm (½ in)	▪ Reduced tip with Ø5.3 mm (0.21 in) ▪ Straight tip ▪ Reduced tip with Ø8 mm (0.31 in)	▪ Ø3 mm (⅛ in) ▪ Ø6 mm (¼ in) ▪ Ø6 mm (¼ in)

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 thermowells in the Endress+Hauser Applicator software. See "Accessories" section.

13.7 Certificates and approvals

Current certificates and approvals that are available for the product can be selected via the Product Configurator at www.endress.com:

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

MTBF	For the transmitter: 180 years - according to Siemens Standard SN29500
Hygiene standard	▪ EHEDG certification, type EL CLASS I. EHEDG certified/tested process connections. → 66 ▪ 3-A authorization no. 1144, 3-A Sanitary standard 74-07. Listed process connections. → 66 ▪ ASME BPE, certificate of conformity can be ordered for indicated options ▪ FDA-compliant ▪ All surfaces in contact with the medium are free of animal derived ingredients (ADI/TSE) and do not contain any materials derived from bovine or animal sources

Materials in contact with food/product (FCM)	The materials of the thermometer in contact with food/product (FCM) comply with the following European regulations: ▪ (EC) No. 1935/2004, Article 3, paragraph 1, Articles 5 and 17 on materials and articles intended to come into contact with food. ▪ (EC) No. 2023/2006 on good manufacturing practice for materials and articles intended to come into contact with food. ▪ (EU) No. 10/2011 on plastic materials and articles intended to come into contact with food.
CRN approval	The CRN approval is only available for certain options of protection tubes. These will be marked and shown during the configuration of this device. Detailed ordering information is available from the following sources: ▪ In the download area on the Endress+Hauser website: www.endress.com → Select your country → Downloads → Enter product code or device → Media type: Approvals & certificates → Select type of approval → Start search ▪ From your nearest Endress+Hauser sales organization: www.addresses.endress.com
Surface purity	Cleaned from oil and grease for O_2 applications, optional
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
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 analog current output of the device is calibrated.
Protection tube testing and load capacity calculation	▪ Protection tube pressure tests are carried out in accordance with the specifications in DIN 43772. With regard to protection tubes with tapered or reduced tips that do not comply with this standard, these are tested using the pressure of corresponding straight protection tubes. Tests according to other specifications can be carried out on request. ▪ Load capacity calculation for the protection tube as per DIN43772

14 Operating menu and parameter description

The following tables list all the parameters in the "Setup", "Calibration", "Diagnostics" and "Expert" operating menus. The page reference indicates where a description of the parameter can be found in the manual.

Depending on the parameter configuration, not all submenus and parameters are available in every device. Information on this can be found in the parameter description under "Prerequisite".

This symbol indicates how to navigate to the parameter using operating tools (e.g. FieldCare).

Setup →	Device tag	→ 81
	Unit	→ 81
	4 mA value	→ 81
	20 mA value	→ 82
	Failure mode	→ 82

Calibration →	Number of self-calibrations	→ 82
	Stored self calibration points	→ 82
	Deviation	→ 83
	Adjustment	→ 83

Calibration →	**Limits →**	Lower warning value	→ 83
		Upper warning value	→ 83
		Lower alarm value	→ 84
		Upper alarm value	→ 84

Calibration →	**Interval monitoring** [1] **→**	Control	→ 85
		Start value	→ 85
		Countdown value	→ 85

1) Same parameter settings both for self calibration monitoring and manual calibration reminder

Calibration →	Calibration report	→ 86
	Online wizard	

Diagnostics →	Actual diagnostics	→ 86
	Previous diagnostics 1	→ 86
	Operating time	→ 87

Diagnostics →	**Diagnostic list →**	Actual diagnostics count	→ 87
		Actual diagnostics	→ 87
		Actual diag (n) channel [1]	→ 87

1) n = 2, 3; diagnostics messages with the highest priority to the third-highest priority

Diagnostics →	**Event logbook →**	Previous diagnostics n [1)]	→ 88
		Previous diag (n) channel	→ 88

1) n = Number of diagnostics messages (n = 1 to 5)

Diagnostics →	**Device information →**	Device tag	→ 81
		Tagging (TAG)	→ 89
		Serial number	→ 89
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		Order code	→ 89
		Extended order code (2, 3)	→ 90
		Manufacturer ID	→ 90
		Manufacturer	→ 90
		Hardware revision	→ 90
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Diagnostics →	**Measured values →**	Sensor value	→ 91
		Sensor raw value	→ 91
		Device temperature	→ 91

Diagnostics →	**Measured values →**	**Min/max values →**	Sensor min value	→ 92
			Sensor max value	→ 92
			Reset sensor min/max values	→ 92
			Device temperature min.	→ 92
			Device temperature max.	→ 92
			Reset device temp. min/max values	→ 93

Diagnostics →	**Simulation →**	Diagnostic simulation	→ 93
		Current output simulation	→ 93
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		Sensor simulation	→ 94
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Diagnostics →	**Diagnostic settings →**	Diagnostic behavior	→ 94

Diagnostics →	**Diagnostic settings →**	Status signal	→ 95

Diagnostics →	**Heartbeat →**	Heartbeat verification Online wizard	→ 95

Expert →	Enter access code	→ 95
	Access status tooling	→ 96
	Locking status	→ 96

Expert →	**System →**	Unit	→ 81
		Damping	→ 97

Expert →	**System →**	**Administration →**	Define device write protection code	→ 97
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			Assign SV	→ 107
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			Assign TV	→ 108
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14.1 Setup menu

This menu contains all the parameters that are needed to configure the basic settings of the device. The thermometer can be put into operation with this limited parameter set.

Device tag

Navigation
Setup → Device tag
Diagnostics → Device information → Device tag
Expert → Communication → HART configuration → Device tag

Description
Use this function to enter a unique name for the measuring point so it can be identified quickly within the plant.

User entry
Max. 32 characters, such as letters, numbers or special characters (e.g. @, %, /)

Factory setting
Depends on the product root and the serial number

Unit

Navigation
Setup → Unit
Expert → System → Unit

Description
Use this function to select the engineering unit for all the measured values.

Options
- °C
- °F
- K
- °R

Factory setting
°C

Additional information
Please note that if the factory setting (°C) is switched to another unit, all the temperature value settings will be converted to fit to the setted temperature unit. Example: Upper range value is set to 150 °C. After the unit was switched to °F, the new converted upper range value = 302 °F.

4 mA value

Navigation
Setup → Lower range value
Expert → Output → 4 mA value

Description
Use this function to assign a measured value to the current value 4 mA.

Factory setting
0 °C

20 mA value

Navigation Setup → Upper range value
Expert → Output → 20 mA value

Description Use this function to assign a measured value to the current value 20 mA.

Factory setting 150 °C

Failure mode

Navigation Setup → Failure mode
Expert → Output → Failure mode

Description Use this function to select the signal on alarm level of the current output in an event of an error.

Options
- High alarm
- Low alarm

Factory setting Low alarm

14.2 Calibration menu

All the information that describes the self-calibration procedure as well as the online wizard creating a calibration report.

Number of self-calibrations

Navigation Calibration → Number of self-calibrations

Description This counter displays the amount of all executed self-calibrations. It cannot be reset.

Stored self-calibration points

Navigation Calibration → Stored self-calibration points

Description Displays the amount of all stored self-calibration points. This device is able to store 350 self-calibration points. As soon as the memory would reach its limit, the oldest self-calibration point will be overwritten.

Display 0 to 350

Deviation

Navigation Calibration → Deviation

Description This function displays the measured Pt100 self-calibration deviation from the reference temperature. The deviation is calculated as follows: Self-calibration deviation = reference temperature - measured Pt100 temperature value + adjustment

Display _.__ °C

Factory setting 0

Adjustment

Navigation Calibration → Adjustment

Description Use this function to adjust the measured Pt100 value. This value will be added to the measured Pt100 value and therefore influences also the self-calibration deviation.
Self-calibration deviation = reference temperature - measured Pt100 temperature value + adjustment

User entry $-1.0 \cdot 10^{20}$ to $+1.0 \cdot 10^{20}$

Factory setting 0.000

14.2.1 "Limits" submenu

Lower warning value

Navigation Calibration → Limits → Lower warning value

Description Enter the lower warning limit for the self-calibration deviation.

User entry $-1.0 \cdot 10^{20}$ to −0.5 °C

Factory setting −0.5 °C

Additional information Use this function to define the lower warning limit. If the self-calibration deviation exceeds the defined limit, the device will transmit the defined status signal and shows the defined diagnostic behavior via the LED (diagnostic event 144).
(**Factory setting** = Warning - LED red flashes).

Upper warning value

Navigation Calibration → Limits → Upper warning value

Description Enter the upper warning limit for the self calibration deviation.

User entry +0.5 to +1.0 · 10^{20} °C

Factory setting +0.5 °C

Additional information Use this function to define the upper warning limit. If the self-calibration deviation exceeds the defined limit, the device will transmit the defined status signal and shows the defined diagnostic behavior via the LED.
(**Factory setting** = Warning - LED red flashes).

Lower alarm value

Navigation Calibration → Limits → Lower alarm value

Description Enter the lower alarm limit for the self-calibration deviation.

User entry −1.0 · 10^{20} to −0.8 °C

Factory setting −0.8 °C

Additional information Use this function to define the lower alarm limit. If the self-calibration deviation exceeds the defined limit, the device will transmit the defined status signal and show the defined diagnostic behavior via the LED (diagnostic event 143).
(**Factory setting** = Warning - LED red flashes).

Upper alarm value

Navigation Calibration → Limits → Upper alarm value

Description Enter the upper alarm limit for the self-calibration deviation.

User entry +0.8 to +1.0 · 10^{20} °C

Factory setting +0.8 °C

Additional information Use this function to define the upper alarm limit. If the self-calibration deviation exceeds the defined limit, the device will transmit the defined status signal and shows the defined diagnostic behavior via the LED.
(**Factory setting** = Warning - LED red flashes).

14.2.2 "Interval monitoring" submenu

The parameter configuration in this submenu is allocated into two calibration items:
Self-calibration monitoring: Monitoring function for the start of the next self-calibration.
Manual calibration reminder: This function signalizes when the next manual calibration has to be performed.

Control

Navigation Calibration → Interval monitoring → Self-calibration monitoring / Manual calibration reminder → Control

Description **Self-calibration monitoring:** Use this function to activate the self-calibration countdown. This counter will count down from its start value until the next self-calibration is executed. A successful self-calibration will set the counter to its start value. If the calibration counter value reaches zero, the device will transmit the defined status signal and shows the defined diagnostic behavior via the LED (Factory default = Alarm - red).
Manual calibration reminder: Use this function to set the start value for the calibration counter.

Options
- **Off:** Stops the calibration counter
- **On:** Starts the calibration counter
- **Reset + run:** Resets the calibration counter to the set start value and starts the calibration counter

Factory setting Off

Start value

Navigation Calibration → Interval monitoring → Self-calibration monitoring / Manual calibration reminder → Start value

Description **Self-calibration monitoring:** Enter the maximum days until a self-calibration must be initiated. This function can be used to monitor the self-calibration interval (e.g. 1 year self-calibration interval corresponds to a start value of 365 days).
Manual calibration reminder: Use this function to set the start value for the calibration counter.

User entry 0 to 1826 d (days)

Factory setting 1826 d

Countdown value

Navigation Calibration → Interval monitoring → Self-calibration monitoring / Manual calibration reminder → Countdown value

Description **Self-calibration monitoring:** Displays the remaining time in days until a self-calibration must be initiated. A successful self-calibration will set the counter to its start value. If the countdown value reaches zero, the device will transmit the defined status signal and show the defined diagnostic behavior via the LED, Factory default = Alarm - LED red illuminated
Manual calibration reminder: Indication of the remaining time up to the next calibration.

Display Remaining time in days, from max. 1826 d to 0 d.

Additional information Use this function to view the time remaining until the next calibration. The countdown of the calibration counter is only running if the device is switched on.
Example: The calibration counter is set to 365 days on January 1st, 2011. If the device will be switched off for 100 days, the calibration counter alarm is displayed on April 10th, 2012.

Online wizard 'Calibration report'

Calibration report

Navigation Calibration → Calibration report

Description Online wizard for creating a calibration report.

Additional information For a detailed procedure description see → 27

14.3 Diagnostics menu

Actual diagnostics

Navigation Diagnostics → Actual diagnostics

Description Use this function to display the current diagnostic message. If two or more messages occur simultaneously, the message with the highest priority is shown.

Additional information Example for display format:
F001-Device failure

Previous diagnostics 1

Navigation Diagnostics → Previous diagnostics 1

Description Use this function to display the last diagnostic message with the highest priority.

Additional information Example for display format:
F001-Device failure

Operating time

Navigation Diagnostics → Operating time

Description Use this function to display the length of time the device has been in operation up to now.

Display Hours (h)

14.3.1 "Diagnostic list" submenu

Up to 3 diagnostic messages currently pending are displayed in this submenu. If more than 3 messages are pending, the messages with the highest priority are shown on the display. Overview of all the diagnostic messages and remedies → 39.

Actual diagnostics count

Navigation Diagnostics → Diagnostic list → Actual diagnostics count

Description Use this function to display the number of diagnostic messages currently pending in the device.

Actual diagnostics

Navigation Diagnostics → Diagnostics list → Actual diagnostics

Description Use this function to display the current diagnostic messages with the highest priority to the third-highest priority.

Additional information Example for display format:
F001-Device failure

Actual diag channel

Navigation Diagnostics → Diagnostic list → Actual diag channel

Description Indication of the sensor input which this diagnostic message refers.
Use this function to display the current diagnostic message. If two or more messages occur simultaneously, the message with the highest priority is shown.

Display
- ----------
- Sensor
- Device temperature
- Reference sensor
- Current output

14.3.2 "Event logbook" submenu

Previous diagnostics n

n = Number of diagnostic messages (n = 1 to 5)

Navigation Diagnostics → Event logbook → Previous diagnostics n

Description Indication of the diagnostic messages appeared in the past.
Use this function to display the diagnostic messages that occurred in the past. The last 5 messages are listed in chronological order.

Additional information Example for display format:
S844-Process value out of specification

Previous diag channel

Navigation Diagnostics → Event logbook → Previous diag channel

Description Indication of the sensor input which this diagnostic message refers.
Use this function to display the possible sensor input to which the diagnostic message refers.

Display
- ----------
- Sensor
- Device temperature
- Reference sensor
- Current output

14.3.3 "Device information" submenu

Device tag → 81

Navigation Setup → Device tag
Diagnostics → Device information → Device tag
Expert → Communication → HART configuration → Device tag

Tagging (TAG), metal/RFID

Navigation Diagnostics → Device information → Tagging (TAG), metal/RFID

Description Use this function to enter a unique name for the measuring point so it can be identified quickly within the plant.

User entry Max. 32 characters, such as letters, numbers or special characters (e.g. @, %, /)

Factory setting -none-

Serial number

Navigation Diagnostics → Device information → Serial number

Description Use this function to display the serial number of the device. It can also be found on the nameplate.

Uses of the serial number
- To identify the measuring device quickly, e.g. when contacting Endress+Hauser.
- To obtain specific information on the measuring device using the Device Viewer: www.endress.com/deviceviewer

Display Max. 11-digit character string comprising letters and numbers.

Firmware version

Navigation Diagnostics → Device information → Firmware version

Description Use this function to view the device firmware version installed.

Display Max. 6-digit character string in the format xx.yy.zz

Device name

Navigation Diagnostics → Device information → Device name

Description Displays the device name. It can also be found on the nameplate.

Order code

Navigation Diagnostics → Device information → Order code

Description Use this function to display the order code of the device. It can also be found on the nameplate. The order code is generated from the extended order code, which defines all the device features of the product structure. In contrast, the device features cannot be read directly from the order code.

Uses of the order code
- To order an identical spare device.
- To identify the device quickly and easily, e.g. when contacting the manufacturer.

Extended order code n

n = Number of parts of the extended order code (n = 1 to 3)

Navigation Diagnostics → Device information → Extended order code n

Description Use this function to display the first, second and/or third part of the extended order code. On account of length restrictions, the extended order code is split into a maximum of 3 parameters. The extended order code indicates the version of all the features of the product structure for the device and thus uniquely identifies the device. It can also be found on the nameplate.

- Uses of the extended order code
- To order an identical spare device
- To check the ordered device features against the shipping note

Manufacturer ID

Navigation Diagnostics → Device information → Manufacturer ID
Expert → Communication → HART info → Manufacturer ID

Description Use this function to view the manufacturer ID with which the device is registered with the HART FieldComm Group.

Display 2-digit hexadecimal number

Factory setting 0x11

Manufacturer

Navigation Diagnostics → Device information → Manufacturer

Description Indication of the manufacturer name.

Hardware revision

Navigation Diagnostics → Device information → Hardware revision

Description Indication of the hardware revision of the device.

Configuration counter

Navigation Diagnostics → Device information → Configuration counter

Description Use this function to display the counter reading for changes to device parameters.

Static parameters, whose values change during optimization or configuration, cause this parameter to increment by 1. This supports parameter version management. If several parameters change, e. g. due to loading of parameters from FieldCare, etc. in the device, the counter can show a higher value. The counter cannot be reset and is also not reset to the default value when the device is reset. If the counter overflows, (16 bit), it starts again at 1.

14.3.4 "Measured values" submenu

Sensor value

Navigation Diagnostics → Measured values → Sensor value

Description Use this function to display the current measured value at the sensor input.

Sensor raw value

Navigation Diagnostics → Measured values → Sensor raw value

Description Use this function to display the non-linearized mV/Ohm value at the specific sensor input.

Device temperature

Navigation Diagnostics → Measured values → Device temperature

Description Use this function to display the current electronics temperature.

"Min/max values" submenu

Sensor min value

Navigation Diagnostics → Measured values → Min/max values → Sensor min value

Description Use this function to display the minimum temperature measured in the past at sensor input (peakhold indicator).

Sensor max value

Navigation Diagnostics → Measured values → Min/max values → Sensor max value

Description Use this function to display the maximum temperature measured in the past at sensor input (peakhold indicator).

Reset sensor min/max values

Navigation Diagnostics → Measured values → Min/max values → Reset sensor min/max values

Description Use this function to reset min/max values of the sensor to its default values.

User entry By clicking the button **Reset sensor min/max values** the reset function is activated. As a result, the sensor min./max. values are just indicating the reset, temporary values.

Device temperature min.

Navigation Diagnostics → Measured values → Min/max values → Device temperature min.

Description Use this function to display the minimum electronics temperature measured in the past (maximum indicator).

Device temperature max.

Navigation Diagnostics → Measured values → Min/max values → Device temperature max.

Description Use this function to display the maximum electronics temperature measured in the past (peakhold indicator).

Reset device temp. min/max values

Navigation Diagnostics → Measured values → Min/max values → Reset device temp. min/max values

Description Use this function to reset the maximum indicators for the minimum and maximum electronic temperatures measured.

User entry By clicking the button **Reset device temp. min/max values** the reset function is activated. As a result, the device temperature min/max values are just indicating the reset, temporary values.

14.3.5 "Simulation" submenu

Diagnostic simulation

Navigation Diagnostics → Simulation → Diagnostic simulation

Description Use this function to switch diagnostic simulation on and off.

Options Use the dropdown menu to enter one of the diagnostic events → 39. In the simulation mode the assigned status signals and diagnostic behaviors are applied.
Example: x001-Device failure

Factory setting Off

Current output simulation

Navigation Diagnostics → Simulation → Current output simulation

Description Use this function to switch simulation of the current output on and off. The status signal indicates a diagnostic message of the "function check" category (C) while simulation is in progress.

Options
- Off
- On

Factory setting Off

Value current output

Navigation Diagnostics → Simulation → Value current output

Description Use this function to set a current value for the simulation. In this way, users can verify the correct adjustment of the current output and the correct function of downstream switching units.

User entry 3.58 to 23 mA

Factory setting 3.58 mA

Sensor simulation

Navigation Diagnostics → Simulation → Sensor simulation

Description Use this function to switch simulation of the sensor temperature on and off. The status signal indicates a diagnostic message of the "function check" category (C) while simulation is in progress.

Options
- Off
- On

Factory setting Off

Sensor simulation value

Navigation Diagnostics → Simulation → Sensor simulation value

Description Use this function to set a sensor temperature for the simulation. In this way, users can verify the correct adjustment of the sensor temperature limits and the correct function of downstream switching units.

User entry $-1.0 \cdot 10^{20}$ to $+1.0 \cdot 10^{20}$ °C

Factory setting 0.00 °C

14.3.6 "Diagnostic settings" submenu

Diagnostic behavior

Navigation Diagnostics → Diagnostic settings → Diagnostic behavior

Description Each diagnostic event is assigned to a certain diagnostic behavior. The user can change this assignment for certain diagnostic events. → 39

Options
- Alarm
- Warning
- Disabled

Factory setting See overview of diagnostic events → 39

Status signal

Navigation Diagnostics → Diagnostic settings → Status signal

Description Each diagnostic event is assigned to a certain status signal [1] from the factory. The user can change this assignment for certain diagnostic events. → 39

1) Digital information available via HART® communication

Options
- Failure (F)
- Function check (C)
- Out of specification (S)
- Maintenance required (M)
- No effect (N)

Factory setting See overview of diagnostic events → 39

14.3.7 "Heartbeat" submenu

Online wizard 'Heartbeat verification'

Heartbeat verification

Navigation Diagnostics → Heartbeat → Heartbeat verification

Description Online wizard for creating a Heartbeat verification report.

Additional information For a detailed procedure description → 32

14.4 Expert menu

Enter access code

Navigation Expert → Enter access code

Description Use this function to enable the service parameters via the operating tool. If an incorrect access code is entered, the user retains his current access authorization.

If a value is entered that is not to equal to the access code, the parameter is automatically set to **0**. The service parameters should only be modified by the service organization.

Additional information Software device write protection is also switched on and off with this parameter.

Software device write protection in conjunction with download from an operating tool with offline capabilities
- Download, the device does not have a defined write protection code:
  The download is performed as normal.
- Download, defined write protection code, device is not locked.
  - The **Enter access code** parameter (offline) contains the correct write protection code: the download is carried out, and the device is not locked following the download. The write protection code in the **Enter access code** parameter is set to **0**.
  - The **Enter access code** parameter (offline) does not contain the correct write protection code: the download is carried out, and the device is locked following the download. The write protection code in the **Enter access code** parameter is reset to **0**.
- Download, defined write protection code, device is locked.
  - The **Enter access code** parameter (offline) contains the correct write protection code: the download is carried out, and the device is locked following the download. The write protection code in the **Enter access code** parameter is reset to **0**.
  - The **Enter access code** parameter (offline) does not contain the correct write protection code: the download is not carried out. No values are changed in the device. The value of the **Enter access code** parameter (offline) is also not changed.

User entry 0 to 9 999

Factory setting 0

Access status tooling

Navigation Expert → Access status tooling

Description Use this function to show access authorization to the parameters.

Additional information If additional write protection is active, this restricts the current access authorization even further. The write protection status can be viewed via the **Locking status** parameter.

Options
- Operator
- Service

Factory setting Operator

Locking status

Navigation Expert → Locking status

Description Use this function to view the device locking status. When write protection is activated, write access to the parameters is disabled.

Display Activated or de-activated box: **Write protected by software**

14.4.1 "System" submenu

Unit → 81

Navigation Setup → Unit
Expert → System → Unit

Damping

Navigation Expert → System → Damping

Description Use this function to set the time constant of the measured value.

User entry 0 to 120 s

Factory setting 0 s

Additional information The current output reacts with an exponential delay to fluctuations in the measured value. The time constant of this delay is specified by this parameter. If a low time constant is entered, the current output follows the measured value quickly. On the other hand, if a high time constant is entered, the current output reaction is delayed.

"Administration" submenu

Define device write protection code

Navigation Expert → System → Administration → Define device write protection code

Description Sets a write protection code for the device.

If the code is programmed into the device firmware it is saved in the device and the operating tool displays the value **0** so that the defined write protection code is not openly displayed.

User entry 0 to 9 999

Factory setting 0

If the device is delivered with this factory setting the device write protection is not active.

Additional information

- Activating device write protection: A value must be entered in the **Enter access code** parameter, which is not corresponding to this defined device write protection code.
- Deactivating device write protection: if device write protection is activated, enter the defined write protection code in the **Enter access code** parameter.
- Once the device has been reset to the factory setting or the order configuration, the defined write protection code is no longer valid. The code adopts the factory setting (= 0).

If the device write protection code was forgotten, it can be deleted or overwritten by the service organization.

Device reset

Navigation Expert → System → Administration → Device reset

Description Use this function to reset the device configuration - either entirely or in part - to a defined state.

Options

- **Restart device**
  The device is restarted but the device configuration remains unchanged.
- **To delivery settings**
  All the parameters are reset to the order configuration. The order configuration can differ from the factory setting if customer-specific parameter values were defined when the device was ordered.
- **To factory defaults**
  All the parameters are reset to the factory setting.

14.4.2 "Output" submenu

4 mA value → 81

Navigation Setup → Lower range value
Expert → Output → 4 mA value

20 mA value → 82

Navigation Setup → 20 mA value
Expert → Output → 20 mA value

Failure mode → 82

Navigation Setup → Failure mode
Expert → Output → Failure mode

Failure current

Navigation Expert → Output → Failure current

Prerequisite The option **High alarm** is enabled in the failure mode.

Description Use this function to set the value the current output adopts in an alarm condition.

User entry 21.5 to 23 mA

Factory setting 22.5

Adjustment of the analog output (4 and 20 mA current trimming)

Current trimming is used to compensate the analog output (D/A conversion). Here, the output current of the transmitter must be adapted so that it suits the value expected at the higher-order system.

Current trimming does not affect the digital HART® value. This can cause the measured value shown on a locally installed display to differ from the value displayed in the higher-order system.

Procedure

1. Start
↓
2. Install an accurate amperemeter (more accurate then the transmitter) in the current loop.
↓
3. Switch on current output simulation and set the simulation value to 4 mA.
↓
4. Measure the loop current with the amperemeter and make a note of the value.
↓
5. Set the simulation value to 20 mA.
↓
6. Measure the loop current with the amperemeter and make a note of the value.
↓
7. Enter the current values determined as adjustment values in the **Current trimming 4 mA / 20 mA** parameters
↓
8. End

Current trimming 4 mA

Navigation Expert → Output → Current trimming 4 mA

Description Use this function to set the correction value for the current output at the start of the measuring range at 4 mA.

User entry 3.5 to 4.25 mA

Factory setting 4 mA

Additional information The trimming only affects current loop values from 3.8 to 20.5 mA. Failure mode with **Low Alarm** and **High Alarm** current values are not subjected to the trimming.

Current trimming 20 mA

Navigation Expert → Output → Current trimming 20 mA

Description Use this function to set the correction value for the current output at the end of the measuring range at 20 mA.

User entry 19.50 to 20.5 mA

Factory setting 20.000 mA

Additional information The trimming only affects current loop values from 3.8 to 20.5 mA. Failure mode with **Low Alarm** and **High Alarm** current values are not subjected to the trimming.

"Loop check configuration" submenu

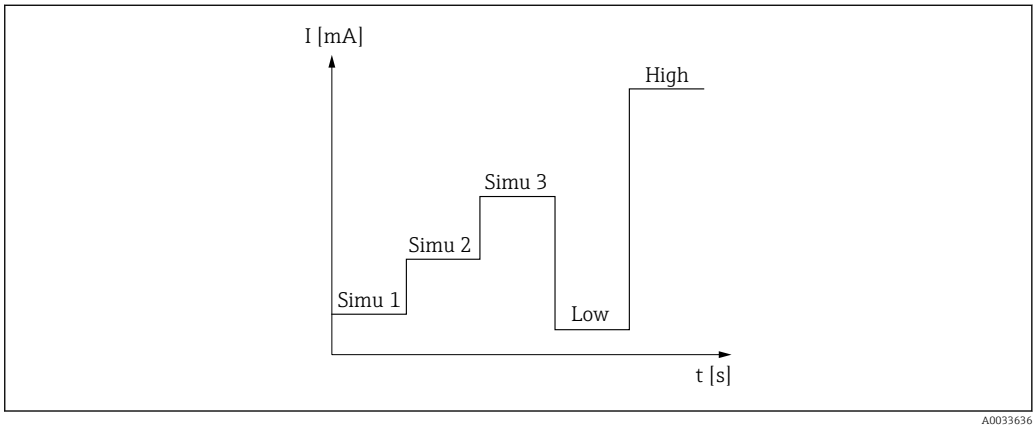
Loop check configuration

Navigation Expert → Output → Loop check configuration → Loop check configuration

Description This function is active when there is at least one value defined. The loop check function will run by each restart (power up) of the device. Measure the loop current with the amperemeter. If the measured values deviates from the simulation values, these current output values have to be adjusted.
To activate the loopcheck, define and activate at least one of the following values.

Additional information

After the device has been started up the loop check starts and the activated simulation values will be checked. These loop current values can be measured with a accurate amperemeter. If the measured values deviates from the set simulation values, it is recommended to adjust these current output values. For **current trimming 4 mA/20 mA** see description above.



12 Loop check curve

If there is one of the following diagnostic events active at the start up process, the device cannot perform a loop check: 001, 401, 411, 437, 501, 531 (channel "-------" or "Current output"), 537 (channel "-------" or "Current output"), 801, 825. If the device is operating in the multidrop mode, the loop check cannot be performed.

Options

Activation of the check values:
- **Simulation value 1**
- **Simulation value 2**
- **Simulation value 3**
- **Low alarm**
- **High alarm**

Simulation value n

n = number of simulation values (1 to 3)

Navigation

Expert → Output → Loop check configuration → Simulation value n

Description

Use this function to adjust the first, second or third value which will be simulated after each restart to check the current loop.

Options

Enter the current values to check the loop

- **Simulation value 1**
  User entry: 3.58 to 23 mA
- **Simulation value 2**
  User entry: 3.58 to 23 mA
- **Simulation value 3**
  User entry: 3.58 to 23 mA

Factory setting

- **Simulation value 1**: 4.00 mA, not activated
- **Simulation value 2**: 12.00 mA, not activated
- **Simulation value 3**: 20.00 mA, not activated
- **Low alarm** and **High alarm** not activated

Loop check interval

Navigation Expert → Output → Loop check configuration → Loop check interval

Description Displays the duration each single value is simulated.

User entry 4 to 255 s

Factory setting 4 s

14.4.3 "Communication" submenu

"HART configuration" submenu

Device tag → 81

Navigation Setup → Device tag
Expert → Communication → HART configuration → Device tag

HART short tag

Navigation Expert → Communication → HART configuration → HART short tag

Description Use this function to define a short tag for the measuring point.

User entry Up to 8 alphanumeric characters (letters, numbers and special characters).

Factory setting 8 x '?'

HART address

Navigation Expert → Communication → HART configuration → HART address

Description Use this function to define the HART address of the device.

User entry 0 … 63

Factory setting 0

Additional information The measured value can only be transmitted via the current value is the address is set to "0". The current is fixed at 4.0 mA for all other addresses (Multidrop mode).

No. of preambles

Navigation Expert → Communication → HART configuration → No. of preambles

Description Use this function to define the number of preambles in the HART telegram.

User entry 5 to 20

Factory setting 5

Configuration changed

Navigation Expert → Communication → HART configuration → Configuration changed

Description Indicates whether the configuration of the device has been changed by a master (primary or secondary).

"HART info" submenu

Device type

Navigation Expert → Communication → HART info → Device type

Description Use this function to view the device type with which the device is registered with the HART FieldComm Group. The device type is specified by the manufacturer. It is needed to assign the appropriate device description file (DD) to the device.

Display 4-digit hexadecimal number

Factory setting 0x11CF

Device revision

Navigation Expert → Communication → HART info → Device revision

Description Use this function to view the device revision with which the device is registered with the HART® FieldComm Group. It is needed to assign the appropriate device description file (DD) to the device.

Display 2-digit hexadecimal number

Factory setting 0x01

Device ID

Navigation Expert → Communication → HART info → Device ID

Description A unique HART identifier is saved in the device ID and used by the control systems to identify the device. The device ID is also transmitted in command 0. The device ID is determined unambiguously from the serial number of the device.

Display ID generated for specific serial number

Manufacturer ID → 88

Navigation Diagnostics → Device information → Manufacturer ID
Expert → Communication → HART info → Manufacturer ID

HART revision

Navigation Expert → Communication → HART info → HART revision

Description Display of the HART revision of the device.

HART descriptor

Navigation Expert → Communication → HART info → HART descriptor

Description Definition of a description for the measuring point.

User entry Up to 16 alphanumeric characters (letters, numbers and special characters)

Factory setting 16 x '?'

HART message

Navigation Expert → Communication → HART info → HART message

Description Use this function to define a HART message which is sent via the HART protocol when requested by the master.

User entry Up to 32 alphanumeric characters (letters, numbers and special characters)

Factory setting 32 x '?'

Hardware revision

Navigation Expert → Communication → HART info → Hardware revision

Description Display of the hardware revision for the device.

Software revision

Navigation Expert → Communication → HART info → Software revision

Description Display of the software revision of the device.

HART date code

Navigation Expert → Communication → HART info → HART date code

Description Definition of a date information for individual use.

User entry Date in the format year-month-day (YYYY-MM-DD)

Factory setting 2010-01-01

Process unit tag

Navigation Expert → Communication → HART info → Process unit tag

Description Use this function to define a tag description for the process unit.

User entry Up to 32 alphanumeric characters (letters, numbers and special characters)

Factory setting 32 x '?'

Location description

Navigation Expert → Communication → HART info → Location description

Description Enter the location description to find the device in the plant.

User entry Up to 32 alphanumeric characters (letters, numbers and special characters)

Factory setting 32 x '?'

Longitude

Navigation Expert → Communication → HART info → Longitude

Description Use this function to enter the longitude coordinates that describe the device location.

User entry −180.000 to +180.000 °

Factory setting 0

Latitude

Navigation Expert → Communication → HART info → Latitude

Description Use this function to enter the latitude coordinates that describe the device location.

User entry −90.000 to +90.000 °

Factory setting 0

Altitude

Navigation Expert → Communication → HART info → Altitude

Description Use this function to enter the altitude data that describe the device location.

User entry $-1.0 \cdot 10^{+20}$ to $+1.0 \cdot 10^{+20}$ m

Factory setting 0 m

Location method

Navigation Expert → Communication → HART info → Location method

Description Use this function to select the data format for specifying the geographic location. The codes for specifying the location are based on the US National Marine Electronics Association (NMEA) Standard NMEA 0183.

Options
- No fix
- GPS or Standard Positioning Service (SPS) fix
- Differential PGS fix
- Precise positioning service (PPS)
- Real Time Kinetic (RTK) fixed solution
- Real Time Kinetic (RTK) float solution
- Estimated dead reckoning
- Manual input mode
- Simulation mode

Factory setting Manual input mode

"HART output" submenu

Assign current output (PV)

Navigation Expert → Communication → HART output → Assign current output (PV)

Description Allocation of the measured variable to the primary HART® value (PV).

Display Temperature

Factory setting Temperature (Fixed assignment)

PV

Navigation Expert → Communication → HART output → PV

Description Use this function to display the primary HART value

Assign SV

Navigation Expert → Communication → HART output → Assign SV

Description Allocation of a measured variable to the secondary HART value (SV).

Display Device temperature (Fixed assignment)

SV

Navigation Expert → Communication → HART output → SV

Description Use this function to display the secondary HART value

Assign TV

Navigation Expert → Communication → HART output → Assign TV

Description Allocation of a measured variable to the tertiary HART value (TV).

Display Number of self calibrations (fixed assignment)

TV

Navigation Expert → Communication → HART output → TV

Description Use this function to display the tertiary HART value

Assign QV

Navigation Expert → Communication → HART output → Assign QV

Description Assignment of a measured variable to the quaternary (fourth) HART value (QV).

Display Deviation (fixed assignment)

QV

Navigation Expert → Communication → HART output → QV

Description Use this function to display the quaternary HART value

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