

Technical Information

MLTTS01

Modular thermometer for use in the Oil & Gas industry



With resistance insert (RTD) or
with thermocouple insert (TC)

Application

- Universal range of application
- Measuring range:
 - Resistance insert (RTD): -50 to +500 °C (-58 to +932 °F)
 - Thermocouple (TC): -40 to +1 100 °C (-40 to +2 012 °F)
- Pressure range up to 63 bar (914 psi)
- Degree of protection: up to IP68

Head transmitter

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

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

Your benefits

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

Function and system design

Measuring principle

Resistance thermometer (RTD)

These resistance thermometers use a Pt100 temperature sensor according to IEC 60751. The temperature sensor is a temperature-sensitive platinum resistor with a resistance of 100 Ω at 0 °C (32 °F) and a temperature coefficient $\alpha = 0.003851 \text{ } ^\circ\text{C}^{-1}$.

There are generally two different kinds of platinum resistance thermometers:

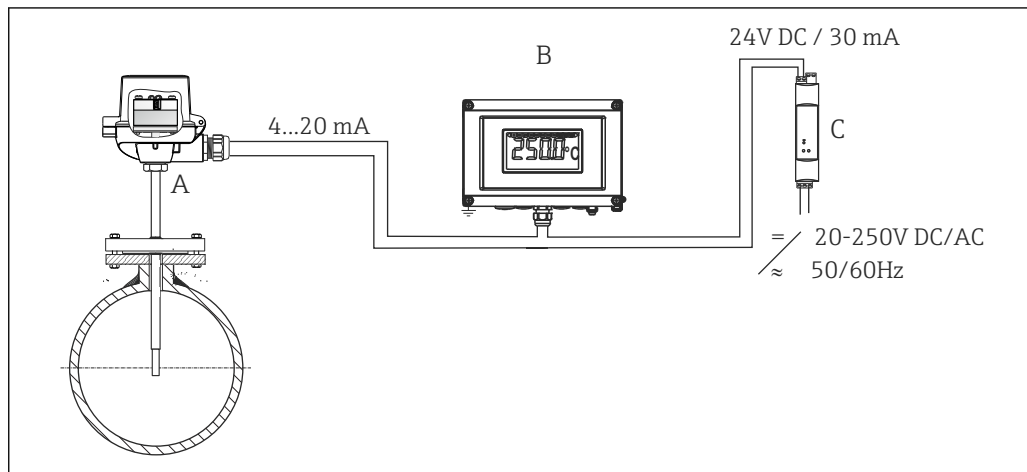
- **Wire wound (WW):** Here, a double coil of fine, high-purity platinum wire is located in a ceramic support. This is then sealed top and bottom with a ceramic protective layer. Such resistance thermometers not only facilitate very reproducible measurements but also offer good long-term stability of the resistance/temperature characteristic within temperature ranges up to 600 °C (1 112 °F). This type of sensor is relatively large in size and it is comparatively sensitive to vibrations.
- **Thin film platinum resistance thermometers (TF):** A very thin, ultrapure platinum layer, approx. 1 μm thick, is vaporized in a vacuum on a ceramic substrate and then structured photolithographically. The platinum conductor paths formed in this way create the measuring resistance. Additional covering and passivation layers are applied and reliably protect the thin platinum layer from contamination and oxidation, even at high temperatures.

The primary advantages of thin film temperature sensors over wire wound versions are their smaller sizes and better vibration resistance. A relatively low principle-based deviation of the resistance/temperature characteristic from the standard characteristic of IEC 60751 can frequently be observed among TF sensors at high temperatures. As a result, the tight limit values of tolerance category A as per IEC 60751 can only be observed with TF sensors at temperatures up to approx. 300 °C (572 °F). For this reason, thin-film sensors are generally only used for temperature measurements in ranges below 400 °C (752 °F).

Thermocouples (TC)

Thermocouples are comparatively simple, robust temperature sensors which use the Seebeck effect for temperature measurement: if two electrical conductors made of different materials are connected at a point, a weak electrical voltage can be measured between the two open conductor ends if the conductors are subjected to a thermal gradient. This voltage is called thermoelectric voltage or electromotive force (emf.). Its magnitude depends on the type of conducting materials and the temperature difference between the "measuring point" (the junction of the two conductors) and the "cold junction" (the open conductor ends). Accordingly, thermocouples primarily only measure differences in temperature. The absolute temperature at the measuring point can be determined from these if the associated temperature at the cold junction is known or is measured separately and compensated for. The material combinations and associated thermoelectric voltage/temperature characteristics of the most common types of thermocouple are standardized in the IEC 60584 and ASTM E230/ANSI MC96.1 standards.

Measuring system

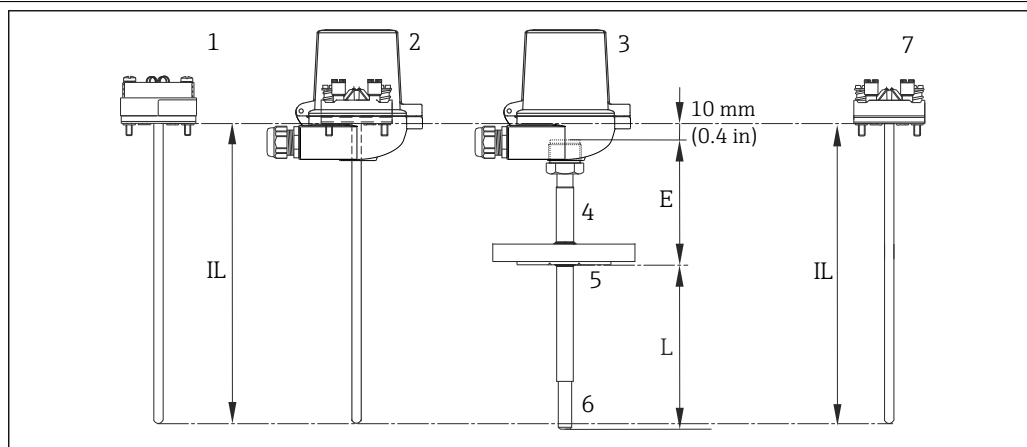


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1 Application example

- A Mounted thermometer with fitted head transmitter
- B RIA16 field display unit - The display unit records the analog measuring signal from the head transmitter and shows this on the display. The LC display shows the current measured value in digital form and as a bar graph indicating a limit value violation. The display unit is looped into the 4 to 20 mA circuit and gets the required energy from there. More information on this can be found in the Technical Information (see "Documentation").
- C Active barrier RN221N - The RN221N (24 V DC, 30 mA) active barrier has a galvanically isolated output for supplying voltage to loop-powered transmitters. The universal power supply works with an input supply voltage of 20 to 250 V DC/AC, 50/60 Hz, which means that it can be used in all international power grids. More information on this can be found in the Technical Information (see "Documentation").

Equipment architecture



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2 Thermometer design

- 1 Insert with head transmitter mounted
- 2 Thermometer version without thermowell
- 3 Thermometer version with thermowell
- 4 Thermowell
- 5 Process connection: Flange
- 6 Reduced tip shape
- 7 Insert with terminal block mounted
- E Length of extension neck
- L Immersion length
- IL Insertion length

The thermometer series have a modular design. The terminal head is used as a connection module for the mechanical and electrical connection of the insert. The position of the actual thermometer sensor in the insert ensures that it is mechanically protected. If installed in a thermowell the insert can be exchanged and calibrated without interrupting the process. Either ceramic terminal blocks or transmitters can be fitted to the internal base washer.

Measurement range

- RTD: -50 to +500 °C (-58 to +932 °F)
- TC: -40 to +1 100 °C (-40 to +2 012 °F)

Performance characteristics

Operating conditions

Ambient temperature

Terminal head	Temperature in °C (°F)
Without mounted head transmitter	Depends on the terminal head used and the cable gland or fieldbus connector, see 'Terminal heads' section
With mounted head transmitter	-40 to 85 °C (-40 to 185 °F)
With mounted head transmitter and display	-20 to 70 °C (-4 to 158 °F)

Process pressure

The maximum process pressure depends on the process temperatures and the maximum permitted flow velocity. Occasionally, the pressure loading capacity of the process connection can be considerably lower. The maximum allowable process pressure for a specific thermometer is derived from the lower pressure value of the thermowell and process connection.


Maximum process pressure process connection:

Process connection	Standard	Max. process pressure
Flange	EN1092-1	<ul style="list-style-type: none"> ▪ DN25 PN40 B1: 40 bar (580 psi) at 20 °C (68 °F) ▪ DN25 PN63 B2: 63 bar (914 psi) at 20 °C (68 °F)

Permitted flow velocity depending on the immersion length

The highest flow velocity tolerated by the thermometer diminishes with increasing immersion length exposed to the stream of the fluid. In addition, it is dependent on the diameter of the tip of the thermowell, the medium type, process temperature and process pressure.

Thermowell sizing tool

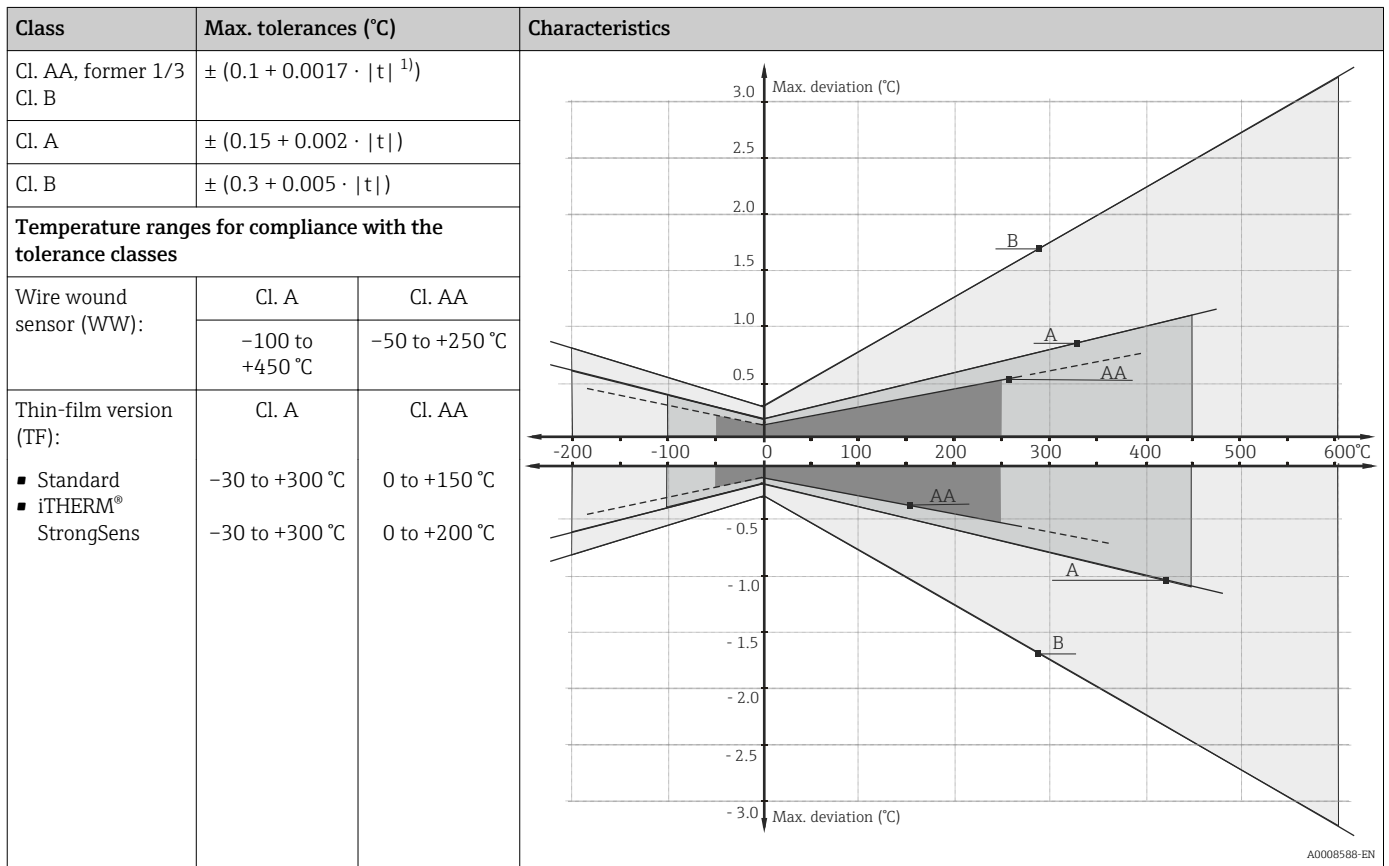
 The 'Thermowell sizing' tool can be found on the Endress+Hauser website for online calculation and engineering of all Endress+Hauser thermometer thermowells. See <https://wapps.endress.com/applicator>

Shock and vibration resistance

- RTD: 3G / 10 to 500 Hz according to IEC 60751
- TC: 4G / 2 to 150 Hz according to IEC 60068-2-6

Accuracy

RTD resistance thermometer as per IEC 60751



1) |t| = absolute value °C



In order to obtain the maximum tolerances in °F, the results in °C must be multiplied by a factor of 1.8.

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

Standard	Type	Standard tolerance		Special tolerance	
		Class	Deviation	Class	Deviation
IEC 60584	K (NiCr-NiAl)	2	$\pm 2.5 \text{ °C}$ (-40 to 333 °C)	1	$\pm 1.5 \text{ °C}$ (-40 to 375 °C)
			$\pm 0.0075 t $ (333 to 1200 °C)		$\pm 0.004 t $ (375 to 1000 °C)

Standard	Type	Standard tolerance		Special tolerance	
		Deviation, the larger respective value applies			
ASTM E230/ANSI MC96.1	K (NiCr-NiAl)	$\pm 2.2 \text{ K}$ or $\pm 0.02 t $ (-200 to 0 °C)	$\pm 1.1 \text{ K}$ or $\pm 0.004 t $ (0 to 1260 °C)	$\pm 1.1 \text{ K}$ or $\pm 0.004 t $ (0 to 1260 °C)	
		$\pm 2.2 \text{ K}$ or $\pm 0.0075 t $ (0 to 1260 °C)			

Response time

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

Complete assembly:

Thermometer type	Diameter	$t_{(x)}$	Reduced tip
Resistance thermometer (measuring probe Pt100, TF)	16 mm (0.63 in)	t_{50}	30 s
		t_{90}	116 s

Thermometer type	Diameter	t _(x)	Reduced tip
Thermocouple (ungrounded)	16 mm (0.63 in)	t ₅₀	40 s
		t ₉₀	130 s

 Response time for the sensor assembly without transmitter.

Insulation resistance

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

Dielectric strength

≥1 000 V DC between terminals and insert sheath, tested at room temperature for 5 s.

Self heating

RTD elements are passive resistances that are measured using an external current. This measurement current causes a self-heating effect in the RTD element itself which in turn creates an additional measurement error. In addition to the measurement current, the size of the measurement error is also affected by the temperature conductivity and flow velocity of the process. This self-heating error is negligible when an Endress+Hauser iTEMP® temperature transmitter (very small measurement current) is connected.

Calibration

Endress+Hauser provides comparison temperature calibration from -80 to +1 400 °C (-110 to +2 552 °F) based on the International Temperature Scale (ITS90). Calibrations are traceable to national and international standards. The calibration certificate is referenced to the serial number of the thermometer. Only the insert is calibrated.

Insert: Ø6 mm (0.24 in) and 3 mm (0.12 in)	Minimum insertion length of insert in mm (in)	
	without head transmitter	with head transmitter
-80 to -40 °C (-110 to -40 °F)	200 (7.87)	
-40 to 0 °C (-40 to 32 °F)	160 (6.3)	
0 to 250 °C (32 to 480 °F)	120 (4.72)	150 (5.91)
250 to 550 °C (480 to 1020 °F)	300 (11.81)	
550 to 1 400 °C (1 020 to 2 552 °F)	450 (17.72)	

Material

Extension neck, thermowell and insert

The temperatures for continuous operation specified in the following table are only intended as reference values for use of the various materials in air and without any significant compressive load.

The maximum operation temperatures are reduced considerably in some cases where abnormal conditions such as high mechanical load occur or in aggressive media.

Material name	Short form	Recommended max. temperature for continuous use in air	Properties
AISI 316L, corresponds to 1.4404 or 1.4435	X2CrNiMo17-12-2 X2CrNiMo18-14-3	650 °C (1202 °F)	<ul style="list-style-type: none"> ▪ Austenitic, stainless steel ▪ High corrosion resistance in general ▪ Particularly high corrosion resistance in chlorine-based and acidic, non-oxidizing atmospheres through the addition of molybdenum (e.g. phosphoric and sulfuric acids, acetic and tartaric acids with a low concentration) ▪ Increased resistance to intergranular corrosion and pitting ▪ Compared to 1.4404, 1.4435 has even higher corrosion resistance and a lower delta ferrite content
AISI 316Ti/1.4571	X6CrNiMoTi17-12-2	700 °C (1292 °F)	<ul style="list-style-type: none"> ▪ Properties comparable to AISI316L ▪ Addition of titanium means increased resistance to intergranular corrosion even after welding ▪ Broad range of uses in the chemical, petrochemical and oil industries as well as in coal chemistry ▪ Can only be polished to a limited extent, titanium streaks can form
Inconel600/ 2.4816	NiCr15Fe	1 100 °C (2012 °F)	<ul style="list-style-type: none"> ▪ A nickel/chromium alloy with very good resistance to aggressive, oxidizing and reducing atmospheres, even at high temperatures ▪ Resistance to corrosion caused by chlorine gases and chlorinated media as well as many oxidizing mineral and organic acids, sea water etc. ▪ Corrosion from ultrapure water ▪ Not to be used in sulfur-containing atmospheres

Components

Family of temperature transmitters

Thermometers fitted with iTEMP® transmitters are an installation-ready complete solution to improve temperature measurement by significantly increasing accuracy and reliability, when compared to direct wired sensors, as well as reducing both wiring and maintenance costs.

PC programmable head transmitters

They offer a high degree of flexibility, thereby supporting universal application with low inventory storage. The iTEMP® transmitters can be configured quickly and easily at a PC. Endress+Hauser offers free configuration software which can be downloaded from the Endress+Hauser Website. More information can be found in the Technical Information.

HART® programmable head transmitters

The transmitter is a 2-wire device with one or two measuring inputs and one analog output. The device not only transfers converted signals from resistance thermometers and thermocouples, it also transfers resistance and voltage signals using HART® communication. It can be installed as an intrinsically safe apparatus in Zone 1 hazardous areas and is used for instrumentation in the terminal head (flat face) as per DIN EN 50446. Swift and easy operation, visualization and maintenance by PC using operating software, Simatic PDM or AMS. For more information, see the Technical Information.

PROFIBUS® PA head transmitters

Universally programmable head transmitter with PROFIBUS® PA communication. Conversion of various input signals into digital output signals. High accuracy over the complete ambient temperature range. Swift and easy operation, visualization and maintenance using a PC directly from the control panel, e. g. using operating software, Simatic PDM or AMS. For more information, see the Technical Information.

FOUNDATION Fieldbus™ head transmitters

Universally programmable head transmitter with FOUNDATION Fieldbus™ communication. Conversion of various input signals into digital output signals. High accuracy over the complete ambient temperature range. Swift and easy operation, visualization and maintenance using a PC

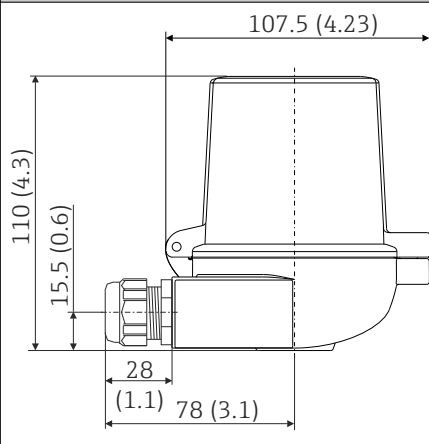
directly from the control panel, e.g. using operating software such as ControlCare from Endress +Hauser or NI Configurator from National Instruments. For more information, see the Technical Information.

Advantages of the iTEMP® transmitters:

- Dual or single sensor input (optionally for certain transmitters)
- Unsurpassed reliability, accuracy and long-term stability in critical processes
- Mathematical functions
- Monitoring of the thermometer drift, sensor backup functionality, sensor diagnostic functions
- Sensor-transmitter matching for dual sensor input transmitters, based on Callendar/Van Dusen coefficients

Terminal heads

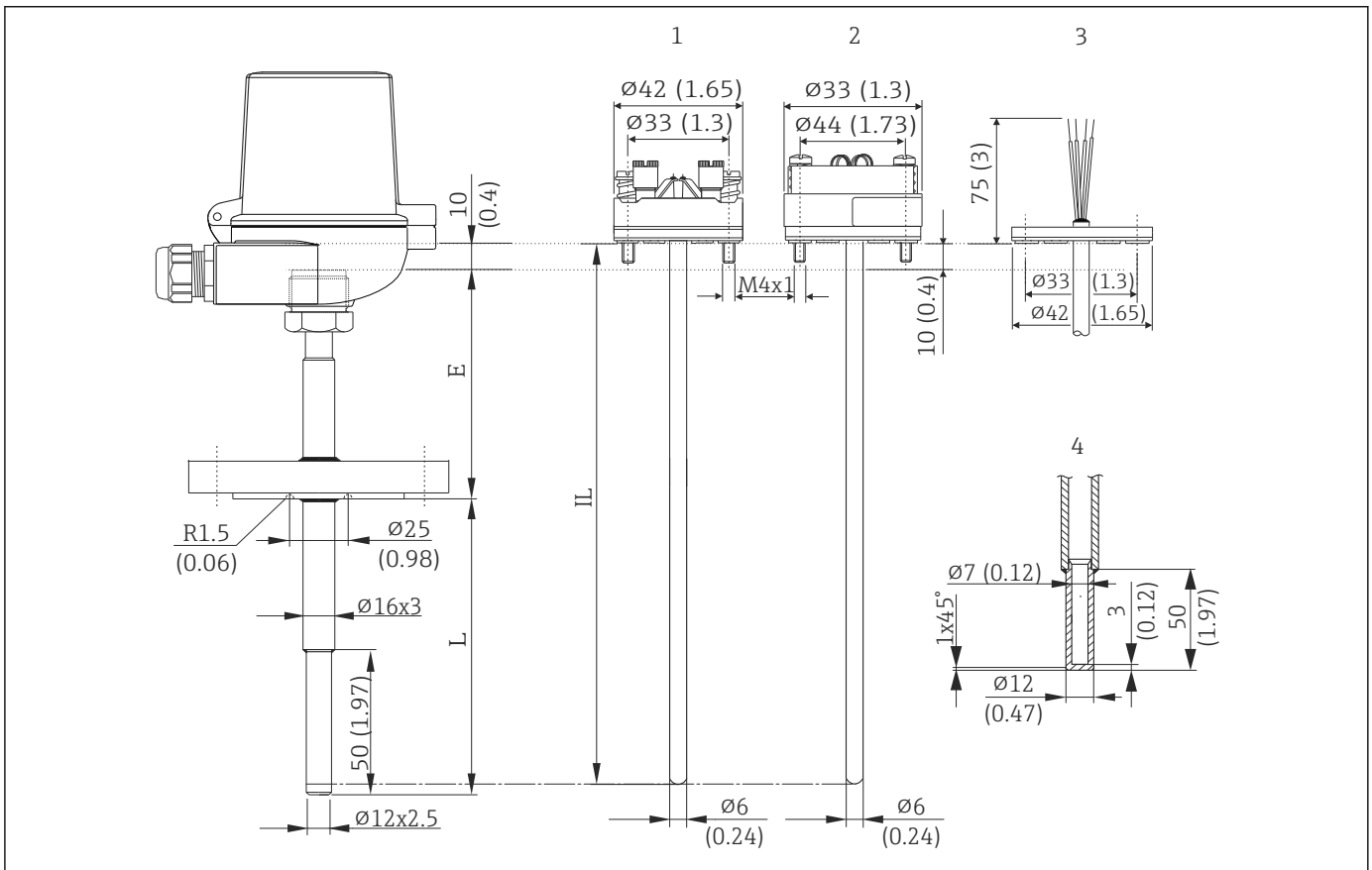
All terminal heads have an internal shape and size in accordance with DIN EN 50446 flat face and a thermometer connection of M24x1.5 thread. All dimensions in mm (in). Specifications without head transmitter installed. For ambient temperatures with head transmitter installed, see "Operating conditions" section.

TA30D	Specification
	<ul style="list-style-type: none"> ■ Available with one or two cable entries ■ Protection class: IP66/68 (NEMA Type 4x encl.) ■ Temperature: -50 to +150 °C (-58 to +302 °F) without cable gland ■ Material: aluminum, polyester powder coated ■ Seals: silicone ■ Threaded cable entry: G ½", ½" NPT and M20x1.5 ■ Protection armature connection: M24x1.5 ■ Two head transmitters can be mounted. In the standard version, one transmitter is mounted in the terminal head cover and an additional terminal block is installed directly on the insert. ■ Head color: blue, RAL 5012 ■ Cap color: gray, RAL 7035 ■ Weight: 390 g (13.75 oz) ■ Ground terminal, internal and external ■ With 3-A® symbol

Maximum ambient temperatures for cable glands and fieldbus connectors	
Type	Temperature range
Cable gland ½" NPT, M20x1.5 (non Ex)	-40 to +100 °C (-40 to +212 °F)
Cable gland M20x1.5 (for dust ignition-proof area)	-20 to +95 °C (-4 to +203 °F)
Fieldbus connector (M12x1 PA, 7/8" FF)	-40 to +105 °C (-40 to +221 °F)

Design, dimensions

All dimensions in mm (in).



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- 1 Insert with terminal block mounted
 2 Insert with head transmitter mounted
 3 Insert with flying leads
 4 Tip shape
 E Extension neck length
 IL Total length of insert
 L Immersion length

Insert

Depending on the application different inserts are available for the assembly:

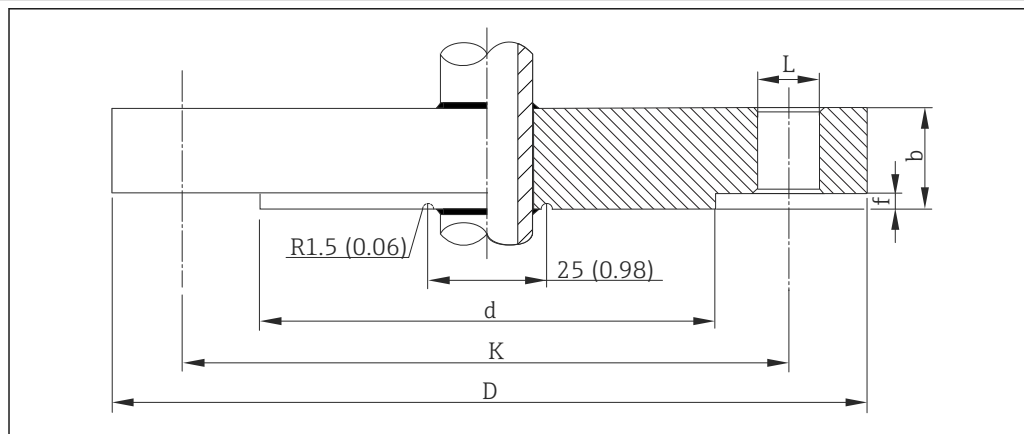
RTD	
Selection in order code	1
Sensor design; connection method	1x Pt100 TF; 4-wire
Vibration resistance of the insert tip	iTHERM® StrongSens® vibration resistance > 60g
Measuring range; accuracy class with temperature range	-50 to +500 °C; Cl. A, -30 to +300 °C
Insert type	iTHERM® TS111
Diameter	Ø6 mm (0.24 in)

TC	
Selection in order code	2
Sensor design; material	2x K; INCONEL600
Measuring range according to: DIN EN 60584	-40 to +1200 °C

TC	
ANSI MC 96.1	0 to +1 250 °C
TC standard; accuracy	IEC 60584-2; Class 1 ASTM E230-03; special
Insert type	TPC100
Diameter	Ø6 mm (0.24 in)

Weight From 1 to 4 kg (2.2 to 8.8 lbs) for standard options.

Process connection



3 Standard process connection flange. Basic dimensions of the available flanges.

Available flange connections according to EN 1092-1:

- EN 1092-1, DN25 PN63
- EN 1092-1, DN25 PN40

Spare parts

Spare part	Order no.
Thermowell (→ 16)	MLTWS01-.....
Gasket set M24x1.5, aramid+NBR	60001329
RTD insert iTHERM StrongSens (→ 16)	TS111-.....
Thermocouple insert (→ 16)	TPC100-.....

The inserts are made from mineral insulated cable (MgO) with a sheath in AISI316L/1.4404 (RTD) or Inconel600 (TC).

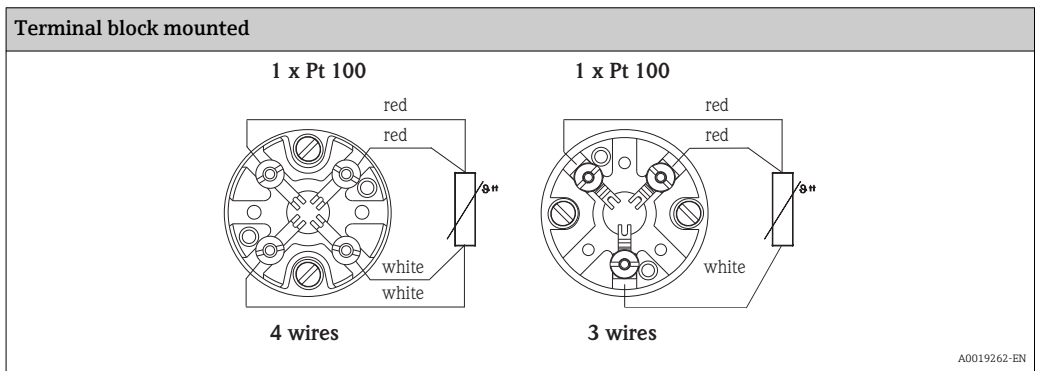
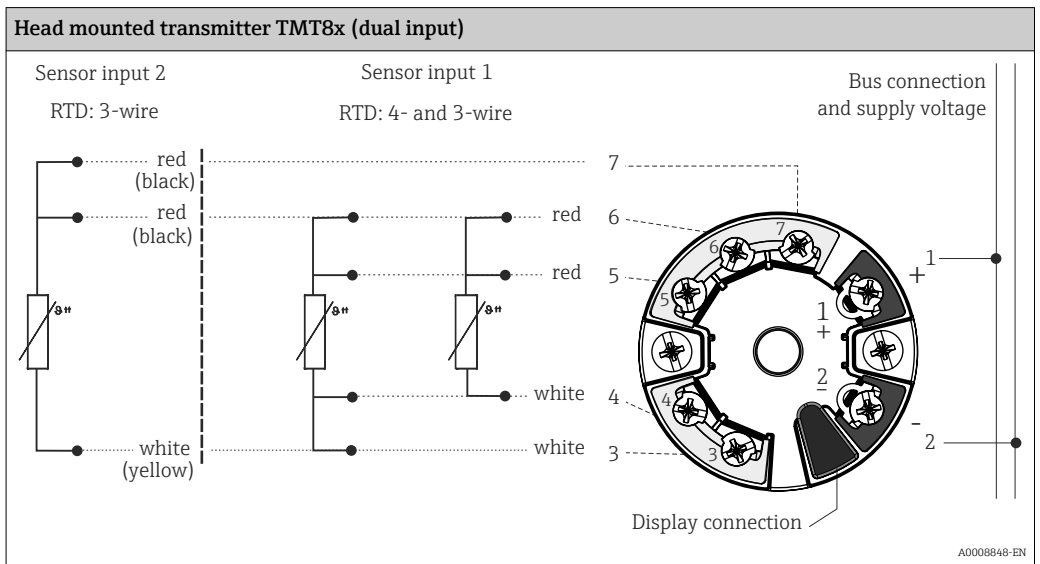
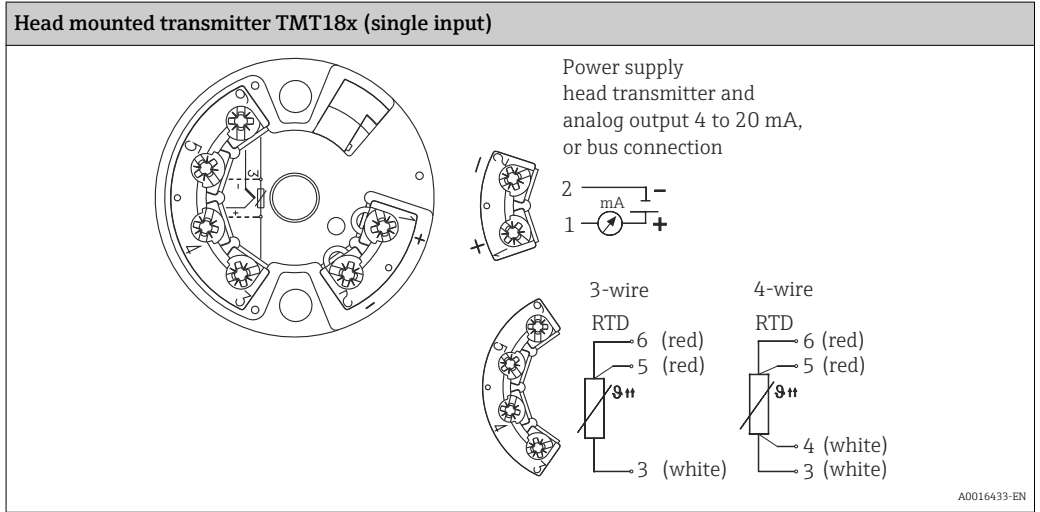
If inserts are required as spare part, refer to the following equation:

Insertion length IL = E + L + 10 mm (0.4 in)

Wiring

Wiring diagrams for RTD

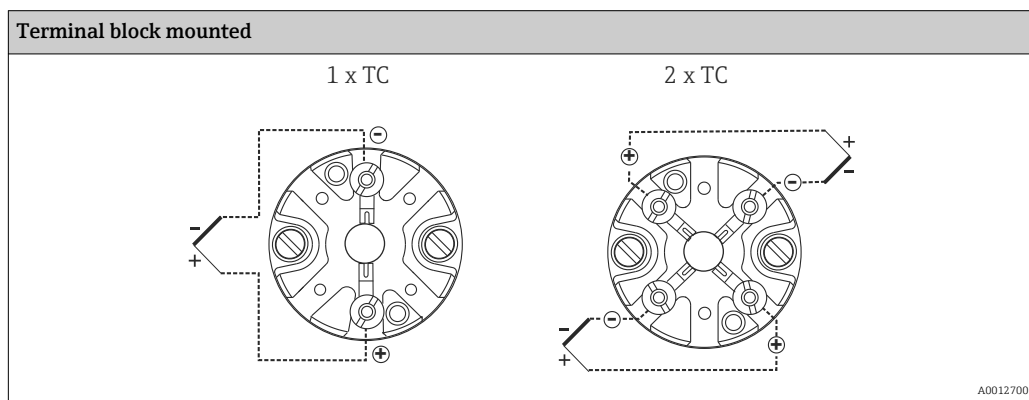
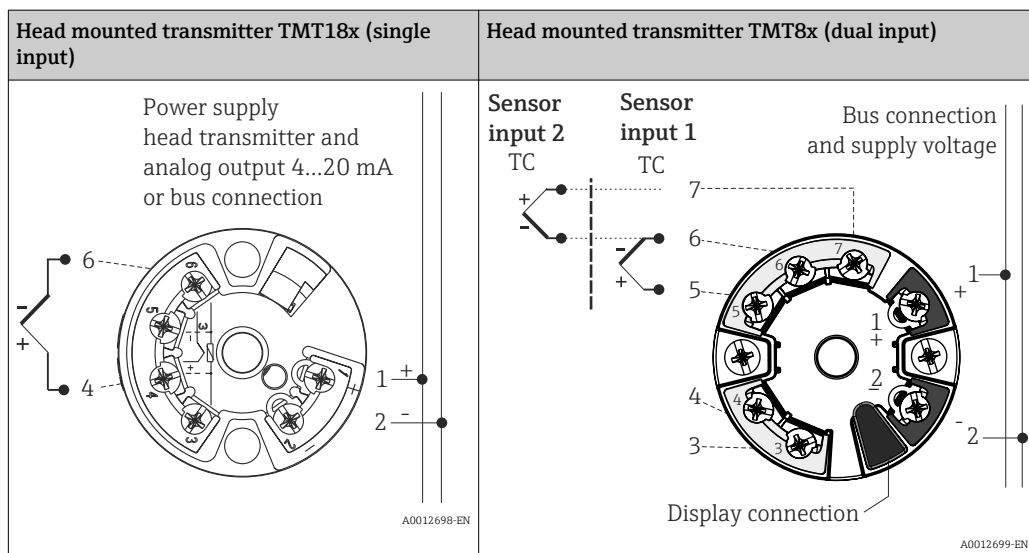
Type of sensor connection



Wiring diagrams for TC

Thermocouple wire colors

As per IEC 60584	As per ASTM E230
<ul style="list-style-type: none"> Type J: black (+), white (-) Type K: green (+), white (-) 	<ul style="list-style-type: none"> Type J: white (+), red (-) Type K: yellow (+), red (-)

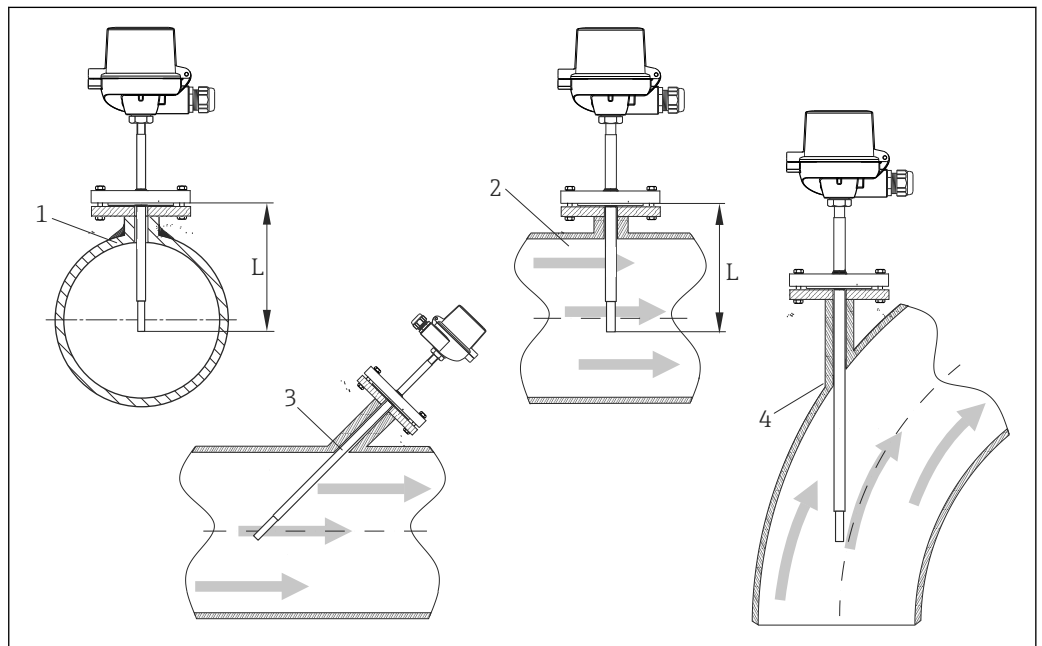


Installation conditions

Orientation

No restrictions.

Installation instructions



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4 Installation examples

- 1, 2 In pipes with a small cross section the thermowell tip should reach or extend slightly past the center line of the pipe (=L).
 3, 4 Angled installation.

The immersion length of the thermometer influences the accuracy. If the immersion length is too small then errors in the measurement are caused by heat conduction via the process connection and the container wall. If installing into a pipe then the immersion length should be at least half of the pipe diameter. A further solution could be an angled (tilted) installation, see (3) and (4). When determining the immersion length all thermometer parameters and the process to be measured must be taken into account (e.g. flow velocity, process pressure).

- Installation possibilities: Pipes, tanks or other plant components
- The immersion length should correspond to at least 8 times of the thermowell diameter
- ATEX certification: Always take note of the installation regulations!

Extension neck length

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

Certificates and approvals

CE Mark

The device meets the legal requirements of the EC directives if applicable. Endress+Hauser confirms that the device has been successfully tested by applying the CE mark.

Hazardous area approvals

For further details on the available Ex versions (ATEX, CSA, FM etc.), please contact your nearest Endress +Hauser sales organization. All relevant data for hazardous areas can be found in separate Ex documentation.

Other standards and guidelines

- EN 60079: ATEX certification for hazardous areas
- IEC 60529: Degree of protection of housing (IP code)
- IEC 61010-1: Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures
- IEC 60751: Industrial platinum resistance thermometers
- IEC 60584 and ASTM E230/ANSI MC96.1: Thermocouples
- DIN 43772: Thermowells
- DIN EN 50446: Terminal heads
- IEC 61326-1: Electromagnetic compatibility (EMC requirements)

PED approval

The thermometer complies with paragraph 3.3 of the Pressure Equipment Directive 97/23/EC and is not marked separately.

Material certification

The material certificate 3.1 (according to 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 if necessary.

Test on thermowell

Helium leak test as per EN 1779	Leak test for thermowells, welding seams and threaded joints. Depending on the design and size of the thermowell, it can be subjected to helium gas internally or externally. With inspection certificate
Pressure test, external procedure	External and internal pressure test to check the pressure resistance and leak-tightness of thermowells, without flanges. With inspection certificate
Positive material identification (PMI) test	Nondestructive material identification and testing of welded joints. Material identification check, X-ray fluorescence analysis. With inspection certificate
Load capacity calculation for the thermowell	In accordance with DIN 43772 or ASME PTC19.3 with calculation certificate
Dye penetration test as per ASME V and EN571-1	Suitable for checking welding seam surfaces, e.g. detection of small cracks, etc. With inspection certificate
Radiographic test as per ASME V, VIII, TW welding	With inspection certificate


Test report and 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) according to ISO/IEC 17025. A calibration which is performed according to EA guidelines (SIT/Accredia or DKD/DAKks calibration) may be requested separately. The calibration is performed on the replaceable insert of the thermometer. In the case of thermometers without a replaceable insert, the entire thermometer - from the process connection to the tip of the thermometer - is calibrated.

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.

Communication-specific accessories




Configuration kit TXU10	Configuration kit for PC-programmable transmitter with setup software and interface cable for PC with USB port Order code: TXU10-xx
Commubox FXA195 HART	For intrinsically safe HART communication with FieldCare via the USB interface.  For details, see "Technical Information" TI00404F

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.  For details, see "Technical Information" TI00405C
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
Wireless HART adapter SWA70	Is used for the wireless connection of field devices. The WirelessHART adapter can be easily integrated into field devices and existing infrastructures, offers data protection and transmission safety and can be operated in parallel with other wireless networks with minimum cabling complexity.  For details, see Operating Instructions BA061S
Fieldgate FXA320	Gateway for the remote monitoring of connected 4-20 mA measuring devices via a Web browser.  For details, see "Technical Information" TI00025S and Operating Instructions BA00053S
Fieldgate FXA520	Gateway for the remote diagnostics and remote configuration of connected HART measuring devices via a Web browser.  For details, see "Technical Information" TI00025S and Operating Instructions BA00051S
Field Xpert SFX100	Compact, flexible and robust industry handheld terminal for remote configuration and for obtaining measured values via the HART current output (4-20 mA).  For details, see Operating Instructions BA00060S

Service-specific accessories

Accessories	Description
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> Via the Internet: https://wapps.endress.com/applicator On CD-ROM for local PC installation.
W@M	Life cycle management for your plant W@M supports you with a wide range of software applications over the entire process: from planning and procurement, to the installation, commissioning and operation of the measuring devices. All the relevant device information, such as the device status, spare parts and device-specific documentation, is available for every device over the entire life cycle. The application already contains the data of your Endress+Hauser device. Endress+Hauser also takes care of maintaining and updating the data records. W@M is available: <ul style="list-style-type: none"> Via the Internet: www.endress.com/lifecyclemanagement On CD-ROM for local PC installation.
FieldCare	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 BA00059S

System components

Accessories	Description
Field display unit RIA16	<p>The display unit records the analog measuring signal from the head transmitter and shows this on the display. The LC display shows the current measured value in digital form and as a bar graph indicating a limit value violation. The display unit is looped into the 4 to 20 mA circuit and gets the required energy from there.</p> <p> For details, see the "Technical Information" document TI00144R/09/en</p>
RN221N	<p>Active barrier with power supply for safe separation of 4-20 mA standard signal circuits. Offers bidirectional HART transmission.</p> <p> For details, see "Technical Information" TI00073R and Operating Instructions BA00202R</p>
RNS221	<p>Supply unit for powering two 2-wire measuring devices solely in the non-Ex area. Bidirectional communication is possible via the HART communication jacks.</p> <p> For details, see "Technical Information" TI00081R and Brief Operating Instructions KA00110R</p>

Documentation

Technical Information:

- iTEMP® Temperature head transmitter:
 - TMT180, PC programmable, single-channel, Pt100 (TI088R/09/en)
 - PCP TMT181, PC programmable, single-channel, RTD, TC, Ω, mV (TI00070R/09/en)
 - HART® TMT182, single-channel, RTD, TC, Ω, mV (TI078R/09/en)
 - HART® TMT82, two-channel, RTD, TC, Ω, mV (TI01010T/09/en)
 - PROFIBUS® PA TMT84, two-channel, RTD, TC, Ω, mV (TI00138R/09/en)
 - FOUNDATION Fieldbus™ TMT85, two-channel, RTD, TC, Ω, mV (TI00134R/09/en)
- Inserts:
 - Thermocouple insert Omniset TPC100 (TI278t/02/en)
 - iTHERM® TS111 Insert for installation in thermometers (TI01014T/09/en)
- Thermowell:
 - Thermometer thermowell MLTWS01 (TI01141T/09/en)
- Application example:
 - RN221N Active barrier, for supplying loop-powered transmitters (TI073R/09/en)
 - RIA16 Field display unit, loop-powered (TI00144R/09/en)

Supplementary ATEX documentation:

- RTD/TC thermometer Omnigrad TRxx, TCxx, TxCxxx, ATEX II 1GD or II 1/2GD Ex ia IIC T6...T1 (XA00072R/09/a3)
- Measurement inserts Omniset TPR100, TPC100, ATEX/IECEx Ex ia (XA00100T/09/a3)

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