LENNTECH
WATER TREATMENT SOLUTIONS

Technical Information
Omnigrad S
TAF11, TAF12x, TAF16

High temperature assemblies
With metal or ceramic protection tubes



Adjustable process connection
Thermocouple sensor types J, K, N, R, S, B

Application

TAF11
- Applicable for steel treatment (annealing), concrete furnaces and primaries. It contains a single or double TC insert and a ceramic protection tube.

TAF12x
- The versions S/D/T are assemblies with **s**ingle/**d**ouble/**t**riple ceramic protection tubes, designed specifically for applications such as ceramic baking ovens, brickworks, porcelain production and glass industries. They contain a single or double TC insert in ceramic insulators.

TAF16
- Applicable for cement production, steel treatment, incinerators and fluidized bed furnaces. The TAF16 contains a single or double TC insert and a metal or ceramic protection tube.

Process temperatures:
- TAF11 up to +1600 °C (+2912 °F)
- TAF12 up to +1700 °C (+3092 °F)
- TAF16 up to +1700 °C (+3092 °F)

Your benefits

- Long lifetime by usage of innovative protection tube materials with increased wear and chemical resistance
- Long term stable measurement due to sensor protection with non-porous materials
- Flexible product selection by modular design
- Optimized life cycle costs by means of replaceable spare parts

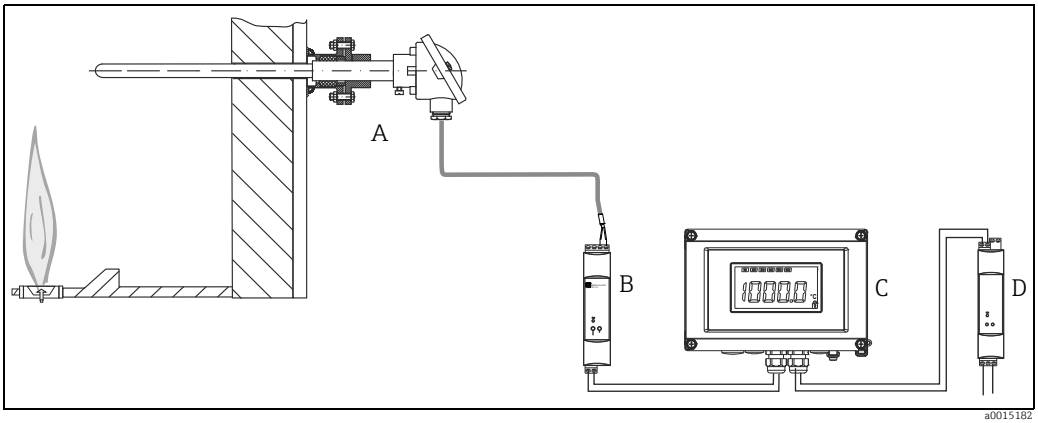
Endress+Hauser
People for Process Automation

Function and system design

Measuring principle

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



Example of an application

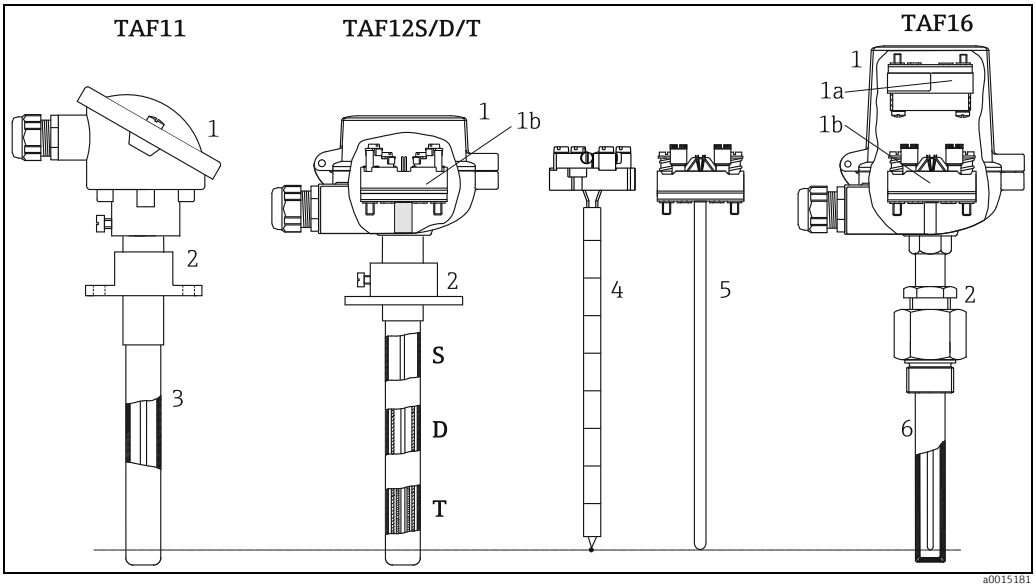
A Thermometer of the TAF series, installed in the reactor wall of a furnace

B Temperature transmitter iTEMP® DIN rail TMT12x. The two-wire transmitter detects the measurement signals of the
thermocouple thermometer and converts them into an analog 4 to 20 mA measurement signal.

C 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").

D Active barrier RN221N
- The RN221N active barrier (24 V DC, 30 mA) has an 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



High temperature assemblies design

1 Terminal head DIN A (see left side) or DIN B (e.g. see right side) with following available electrical connections:
1a – Terminal block DIN B with head transmitter (only in high cover terminal head)
1b – Terminal block (DIN B) or
– Flying leads, only with MgO insulated insert
2 Available process connections:
Stop flange according to DIN EN 50446, adjustable flange, or gas-tight compression fitting
3 Ceramic protection tube (external sheath for TAF11)
S (Single) ceramic protection tube external sheath for TAF12
D (Double) ceramic protection tube external and middle sheath for TAF12
T (Triple) ceramic protection tube external, middle and internal sheath for TAF12
4 Measuring insert TPC200 with ceramic isolation
5 Measuring insert TPC100 with MgO insulation and metallic sheath, selectable for TAF11 and TAF16
6 Metal or ceramic protection tube for TAF16

TAF series high temperature assemblies are manufactured according to international DIN EN 50446 standards. These products consist of a measuring insert, a protection tube, a metal sleeve (only TAF11/ TAF12x) and a terminal head, which contains a transmitter or terminal block as electrical connection.

Measuring insert
The measuring point of the thermocouple is located close to the tip of the insert. The operating temperature ranges (→ 🖹 4) and permissible deviation limits of the thermoelectric voltages from the standard characteristic (→ 🖹 5) vary according to the type of thermocouple used. The thermocouple wires are inserted in appropriate high-temperature-resistant ceramic isolators or in a mineral insulated insert.

Protection tube

Two types are commonly used in this type of assembly:
- Metallic protection tube, usually machined from tubes or bars.
- Ceramic protection tube.

The selection of the protection tube materials majorly depends on the following material properties, which will directly influence the lifetime of the sensor:
- Hardness
- Chemical resistance
- Maximum operating temperature
- Wear/abrasion resistance
- Brittleness
- Porosity for process gases
- Creep resistance

Ceramic materials are commonly used for highest temperatures and, due to their hardness, for applications with high abrasion rates. Attention has to be paid regarding the brittleness of these materials when exposed to high mechanical loads inside the process. When using porous ceramics as

external protection sheath, an additional, non-porous inner protection sheath has to be used in order to protect the noble sensor elements from contamination leading to temperature drift.
Metal alloys generally show higher mechanical resistance but lower maximum temperature limits and less abrasion resistance. All metal alloys are non-porous and usually there is no need for an additional inner protection sheath.

Metal sleeve and process connection
The TAF11 and TAF12 ceramic protection tubes are mounted into a metal sleeve which connects them towards the terminal head. Also the process connection is fitted on the metal sleeve due to its higher mechanical strength. The dimensions and material type for the sleeve are related to the process temperatures and insertion length of the ceramic protection tubes.
All high temperature assemblies are available with an adjustable flange, stop flanges or gas tight compression fittings.

Measuring range

Input	Designation	Measuring range limits[1)]	Min. span
Thermocouples (TC) as per IEC 60584, part 1 - using an Endress+Hauser - iTEMP® temperature head transmitter	Type J (Fe-CuNi) Type K (NiCr-NiAl) Type N (NiCrSi-NiSi) Type S (PtRh10-Pt) Type R (PtRh13-Pt) Type B (PtRh30-PtRh6)	typ. -200... +1200 °C (-328... +2192 °F) typ. -200... +1372 °C (-328... +2502 °F) typ. -270... +1300 °C (-454... +2372 °F) typ. -50... +1768 °C (-58... +3214 °F) typ. -50... +1768 °C (-58... +3214 °F) typ. +40... +1820 °C (+104... + 3308 °F)	50 K 50 K 50 K 500 K 500 K 500 K
	▪ Internal cold junction (Pt100) ▪ Cold junction accuracy: ± 1 K ▪ Max. sensor resistance 10 kΩ		
Thermocouples (TC)[2)] - flying leads - as per IEC 60584	Type J (Fe-CuNi) Type K (NiCr-NiAl) Type N (NiCrSi-NiSi) Type S (PtRh10-Pt) Type R (PtRh13-Pt) Type B (PtRh30-PtRh6)	-210... +1200 °C (-346... +2192 °F), typical sensitivity ≈ 55 µV/K -270... +1372 °C (-454... +2502 °F), typical sensitivity ≈ 40 µV/K -270... +1300 °C (-454... +2372 °F), typical sensitivity ≈ 40 µV/K -50... +1768 °C (-58... +3214 °F), typical sensitivity ≈ 11 µV/K -50... +1768 °C (-58... +3214 °F), typical sensitivity ≈ 13 µV/K 0... +1820 °C (+32... +3308 °F), typical sensitivity ≈ 9 µV/K	

1) For definite ranges see respective Technical Information (→ 🖹 18) of the head transmitters.

2) Typical sensitivity above 0 °C (+32 °F)

Performance characteristics

Operating conditions

Ambient temperature

Terminal head	Temperature in °C (°F)
Without mounted head transmitter	Depends on the terminal head and cable gland used, see 'Terminal heads' section, → 🖹 8
With mounted head transmitter	-40 to +85 °C (-40 to +185 °F)

Process pressure

Depends on material.
High temperature assemblies are generally designed for use in pressureless processes. Available process connections can be gas tight up to 1 bar, details → 🖹 12.

Permitted flow rate as a function of immersion length

Depends on material and application. For process pressures ≥ 1 bar and a flow rate ≥ 1 m/s it is recommended to order a protection tube stress calculation, please contact your nearest Endress+Hauser sales organisation.

Shock and vibration resistance

Valid for MgO insulated inserts: 4g / 2 to 150 Hz as per IEC 60068-2-6

Accuracy

Permissible deviation limits of thermoelectric voltages from standard characteristic for thermocouples as per IEC 60584:

Standard	Type	Standard tolerance		Special tolerance	
		Class	Deviation	Class	Deviation
IEC 60584	J (Fe-CuNi)	2	±2.5 °C (-40 to 333 °C) ±0.0075 |t| [1] (333 to 750 °C)	1	±1.5 °C (-40 to 375 °C) ±0.004 |t| [1] (375 to 750 °C)
	K (NiCr-NiAl)	2	±2.5 °C (-40 to 333 °C) ±0.0075 |t| [1] (333 to 1200 °C)	1	±1.5 °C (-40 to 375 °C) ±0.004 |t| [1] (375 to 1000 °C)
	N (NiCrSi-NiSi)	2		1	
	R (PtRh13-Pt) and S (PtRh10-Pt)	2	±1.5 °C (0 to 600 °C) ±0.0025 |t| [1] (600 to 1600 °C)	1	±1 °C (0 to 1100 °C) ±[1 + 0.003(|t| [1] -1100)] (1100 °C to 1600 °C)
	S (PtRh13-Pt)	2		1	
	B (PtRh30-PtRh6)	2	±1.5 °C or ±0.0025 |t| [1] (600 to 1700 °C)	-	-

1) |t| = Absolute temperature value in °C

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

Response time

Assembly probe	Response time[1] for fast temperature change from 1000 °C (1832 °F) to room temperature in stationary air	
TAF12T with Ø26/Ø14/Ø9 mm triple ceramic protection tube (material C530+C610)	t_{50} t_{90}	195 s 500 s

1) For the assembly without transmitter

Insulation resistance

Insulation resistance between each terminal and the sheath is measured with a voltage of 500 V DC.
Insulation resistance ≥ 1000 MΩ at ambient temperature 25 °C (77 °F).
Insulation resistance ≥ 5 MΩ at temperature 500 °C (932 °F).
For TAF16 with 6 mm (0.24 in) mineral insulated insert versions, standard DIN EN 61515 is applied.

Calibration specifications

Endress+Hauser provides comparison temperature calibration from -80 to +1400 °C (-110 °F to 2552 °F) based on the International Temperature Scale (ITS90). Calibrations are traceable to national and international standards. The calibration report is referenced to the serial number of the thermometer. Only the measurement insert is calibrated. In the case of thermometers without a replaceable insert, the entire thermometer - from the process connection to the tip of the thermometer - is calibrated.

	Minimum insertion length IL in mm (in)	
Temperature range	without head transmitter	with head transmitter
-80 °C to -40 °C (-110 °F to -40 °F)	200 (7.87)	
-40 °C to 0 °C (-40 °F to 32 °F)	160 (6.3)	
0 °C to 250 °C (32 °F to 480 °F)	120 (4.72)	150 (5.9)
250 °C to 550 °C (480 °F to 1020 °F)	300 (11.81)	
550 °C to 1400 °C (1020 °F to 2552 °F)	450 (17.75)	

Material

Sheath and protection tube.
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.
Endress+Hauser supplies DIN/EN threaded process connections and flanges made of stainless steel according to AISI 316L (DIN/EN material number 1.4404 or 1.4435). With regard to their temperature stability properties, the materials 1.4404 and 1.4435 are grouped under 13E0 in EN 1092-1 Tab. 18. The chemical composition of the two materials can be identical.

Material name	Short form	Recommended max. temperature for continuous use in air	Properties
AISI 316L/ 1.4404 1.4435	X2CrNiMo17-12-2 X2CrNiMo18-14-3	650 °C (1200 °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 ▪ Compared to 1.4404, 1.4435 has even higher corrosion resistance and a lower delta ferrite content
AISI 310/ 1.4841	X15CrNiSi25-20	1100 °C (2012 °F)	▪ Austenitic, stainless steel ▪ Good resistance to oxidizing and reducing atmospheres ▪ Due to the higher chromium content well resistant to oxidizing aqueous solution and neutral salts melting at higher temperatures ▪ Only weakly resistant to sulphurous gases
AISI 304/ 1.4301	X5CrNi18-10	850 °C (1562 °F)	▪ Austenitic, stainless steel ▪ Well usable in water and lowly pollute waste water ▪ Only at relatively low temperatures resistant to organic acids, saline solutions, sulphates, alkaline solutions, etc.
AISI 446/ ~1.4762/ ~1.4749	X10CrAl24 / X18CrNi24	1100 °C (2012 °F)	▪ A ferritic, heat resistant, high-chromium stainless steel ▪ Very high resistance to reducing sulphurous gases and salts with low content of oxygen ▪ Very good resistance to constant as well as cyclical thermal stress, to incineration ash-corrosion and to melts of copper, lead and tin ▪ Poorly resistant to gases containing nitrogen
INCONEL®600 / 2.4816	NiCr15Fe	1100 °C (2012 °F)	▪ A nickel/chromium alloy with very good resistance to aggressive, oxidizing and reducing atmospheres, even at high temperatures ▪ Resistant to corrosion caused by chlorine gas and chlorinated media as well as many oxidizing mineral and organic acids, sea water etc. ▪ Corrodible by ultrapure water ▪ Not to be used in a sulfur-containing atmosphere
INCONEL®601 / 2.4851	NiCr23Fe	1200 °C (2192 °F)	▪ High temperature corrosion resistance enhanced by aluminum content ▪ Resistance to oxide spalling and carburization under thermal cycling ▪ Good resistance against molten salt corrosion ▪ Particularly susceptible to sulfidation
INCOLOY®800 HT / 1.4959	X8NiCrAlTi32-21	1100 °C (2012 °F)	▪ A nickel/chromium/iron alloy that has the same basic composition as INCOLOY®800, but has significantly higher creep rupture strength, resultant from the close control of the carbon, aluminum and titanium contents. ▪ Good strength and excellent resistance to oxidation and carburization at high temperature environments. ▪ Good resistance to stress corrosion cracking, attack by sulfur, internal oxidation, scaling and corrosion in a multitude of industrial environments. Suitable for sulfurous environments.
Kanthal AF	FeCrAl	1300 °C (2372 °F)	▪ A high-temperature ferritic iron/chromium/aluminum alloy ▪ High resistance to sulfurous, carburizing and oxidising environments ▪ Good hardness and weldability ▪ Good form stability at high temperature ▪ Not to be used in a chloride-containing atmosphere and in nitrogenous gases (cracked ammonia)

Material name	Short form	Recommended max. temperature for continuous use in air	Properties
Special nickel/ cobalt alloy	NiCo	1200 °C (2192 °F)	▪ Very good resistance to sulfidation and chloride environment ▪ Exceptionally good resistance to oxidation, hot corrosion, carburization, metal dusting, and nitridation ▪ Good creep resistance ▪ Average surface hardness ▪ High wear resistance **Recommended applications** ▪ Cement industry – gas standpipe: successfully tested with up to 20 times longer life span compared to AISI310 – clinker cooler: successfully tested with up to 5 times longer life span compared to AISI310 ▪ Waste incinerators: successfully tested with up to 12 times longer life span than INCONEL®600 and C276 ▪ Fluidized bed furnace (biogas reactor): successfully tested with up to 5 times longer life span than e.g. INCOLOY®800HT or INCONEL®600.
Ceramic material types according to DIN VDE0335			
C530		1400 °C (2552 °F)	▪ Al_2O_3-content approx. 73-75 % ▪ The cheapest porous ceramic material ▪ Very resistant to temperature shocks, mainly used as external protection tube
C610		1500 °C (2732 °F)	▪ Al_2O_3-content approx. 60 %, alkali-content 3 % ▪ The most economic non porous ceramic material ▪ Highly resistant to hydrogen fluoride, temperature shocks and mechanical influences, used for internal and external protection tube as well as insulators
C799		1800 °C (3272 °F)	▪ Al_2O_3-content approx. 99.7 % ▪ Can be used for both internal and external protection tubes and insulators ▪ Resistance to hydrogen fluoride gases and alkaline vapors, to oxydizing, reducing and neutral atmospheres as well as temperature changes ▪ This material is very pure and has a very low porosity (gas tight) compared to all other types of ceramics
Sinterized silicon carbide	SiC	1650 °C (3000 °F)	▪ High thermal shock resistance due to its porosity ▪ Good thermal conductivity ▪ Very hard and stable at high temperature **Recommended applications** ▪ Glass industry: glass feeders, float glass production ▪ Ceramic industry ▪ Furnaces
Kanthal Super	$MoSi_2$ with a glass phase component	1700 °C (3092 °F)	▪ High thermal shock resistance ▪ Very low porosity (< 1%) and very high hardness ▪ Not to be used in environments with chlorine and fluorine compounds ▪ Not suitable for mechanical shock affected applications ▪ Not to be used in applications with powder
Special silicon nitride ceramic	SiN	1400 °C (2552 °F)	▪ Excellent wear and thermal shock resistance ▪ No porosity ▪ Good heat response ▪ Not resistant to impacts (brittleness) **Recommended applications** ▪ Cement industry – Cyclone preheater: successfully tested with up to 5 times longer life span compared to AISI310 – Secondary air pipe ▪ Generally all applications with extreme abrasive conditions; mechanical shocks/ impacts have to be avoided because of brittleness

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

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. → 18

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. → 18

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. → 18

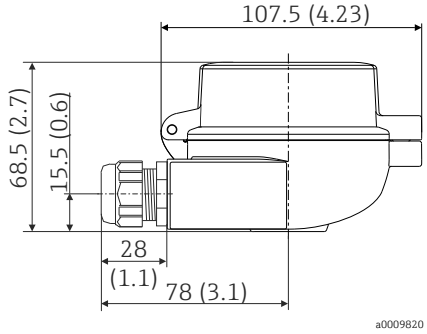
FOUNDATION Fieldbus™ head transmitters

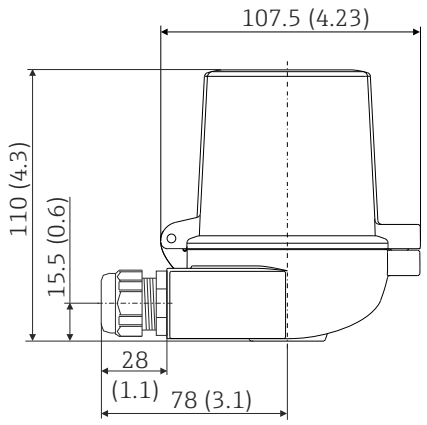
Universally programmable head transmitter with FOUNDATION Fieldbus™ communication. Conversion of various input signals into digital output signals. High accuracy over the complete ambient temperature range. Swift and easy operation, visualization and maintenance using a PC directly from the control panel, e.g. using operating software such as ControlCare from Endress+Hauser or NI Configurator from National Instruments. For more information, see the Technical Information. → 18

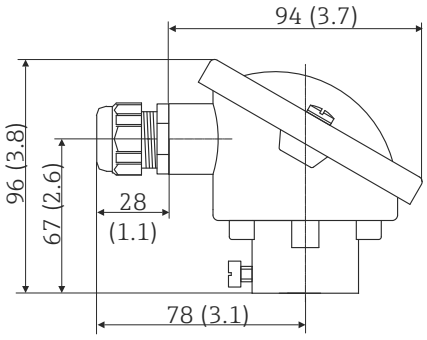
Advantages of the iTEMP® transmitters:
- Dual or single sensor input (optionally for certain transmitters)
- Unsurpassed reliability, accuracy and long-term stability in critical processes
- Mathematical functions
- Monitoring of the thermometer drift, sensor backup functionality, sensor diagnostic functions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

Terminal heads

All terminal heads have an internal shape and size in accordance with DIN EN 50446, form B.
All dimensions in mm (in). The cable glands in the diagrams correspond to M20x1.5 connections.
Specifications without head transmitter installed. For ambient temperatures with head transmitter installed, see 'Operating conditions' section. → 4

TA30A	Specification
	▪ Available with one or two cable entries ▪ Protection class: IP66/68 (NEMA Type 4x encl.) ▪ Max. temperature: -50...150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Cable entry incl. glands: ½" NPT and M20x1.5, only thread: G ½", plugs: M12x1 PA, 7/8" FF ▪ Head color: blue RAL 5012 ▪ Cap color: grey RAL 7035 ▪ Weight: 330 g (11.64 oz) ▪ Ground terminal, internal and external

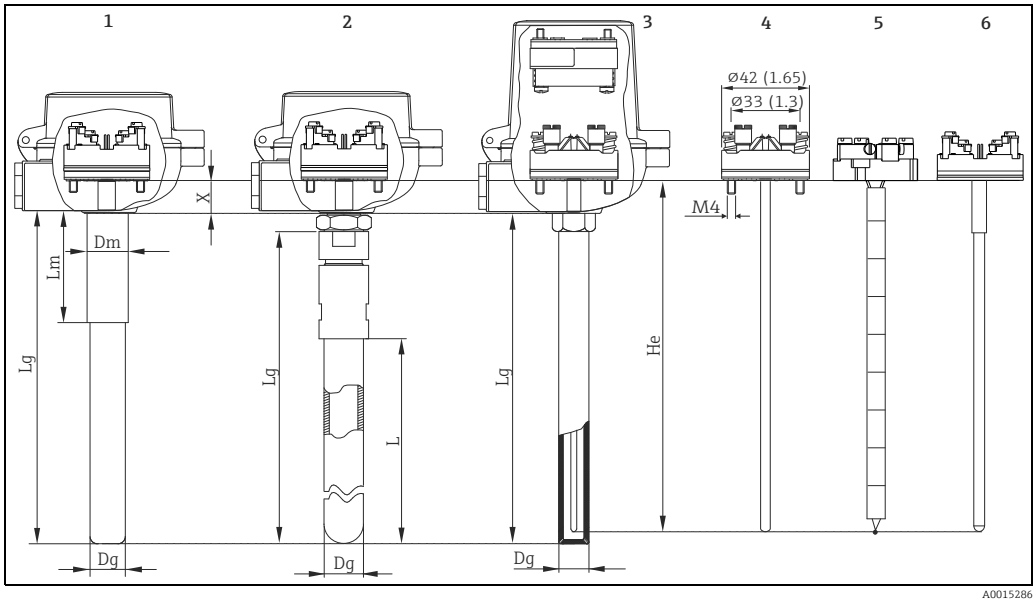
TA30D	Specification
	▪ Available with one or two cable entries ▪ Protection class: IP66/68 (NEMA Type 4x encl.) ▪ Max. temperature: -50…150 °C (−58 to +302 °F) without cable gland ▪ Material: aluminum, polyester powder coated Seals: silicone ▪ Cable entry incl. glands: ½" NPT and M20x1.5, only thread: G ½", plugs: M12x1 PA, 7/8" FF ▪ 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: grey RAL 7035 ▪ Weight: 390 g (13.75 oz) ▪ Ground terminal, internal and external

DIN A	Specification
	▪ Degree of protection: IP66 ▪ Max. temperature: 130 °C (266 °F) ▪ Material: aluminum, polyester powder coated Seals: CR (Neoprene® rubber) ▪ Cable entry: G ½" ▪ Head and cap color: white RAL 9006 ▪ Weight: 270 g (9.52 oz)

Maximum ambient temperatures for cable glands	
Type	**Temperature range**
Cable gland ½" NPT, M20x1.5 (non Ex)	-40 … +100 °C (-40 … +212 °F)
Cable gland M20x1.5 (for dust ignition-proof area)	-20 … +95 °C (-4 … +203 °F)

Design, dimensions

All dimensions in mm (in).



1 TAF11/TAF12
2 TAF16 with SiN protection tube
3 TAF16 with metallic protection tube
4 TPC100: Insert with MgO insulation, metallic sheath and mounted terminal block (DIN B) for TC types J, K and N
5 TPC200: Insert with segmented ceramic insulation and mounted terminal block (DIN B) for TC types J and K
6 TPC200: Insert with ceramic insulation and mounted terminal block (DIN B) for TC types B, R and S

Lg Immersion length
L Usable immersion length, L = Lg - 97 mm (3.82 in)
Lm Sleeve length
Dg Diameter protection tube
Dm Diameter of sleeve
He Insert length:
- for TAF16 is simplified: He = Lg + 80 mm (3.15 in)
- for replacement of the insert is: He = Lg + X
X Additional length, see table below

For replacement of the insert, it is necessary to refer to the following table. The length of the insert (He) is calculated adding the total length of the protection tube (Lg) and a defined length (X), which depends on the protection tube material used. Dimensions in mm (in).

Insert length He calculation rules (He = Lg + X)						
Material	**Insert TPC 200**		**Insert TPC100, MgO insulation**			
			Without internal ceramic sheath 14x10 (contact with tip)		With internal ceramic sheath 14x10 (-10 mm)	
	Terminal head DIN A (41 mm)	Terminal head DIN B (26 mm)	Terminal head DIN A (41 mm)	Terminal head DIN B (26 mm)	Terminal head DIN A (41 mm)	Terminal head DIN B (26 mm)
TAF11 protection tube:						
C610 + sleeve	Lg + 30 (1.2)	Lg + 15 (0.6)	Lg + 30 (1.2)	Lg + 15 (0.6)	-	-
Sinterized silicon carbide SIC + sleeve	Lg + 20 (0.8)	Lg + 5 (0.2)	Lg + 20 (0.8)	Lg + 5 (0.2)	-	-
Special silicon nitride ceramic SiN + sleeve	Lg + 25 (1.0)	Lg + 10 (0.4)	Lg + 25 (1.0)	Lg + 10 (0.4)	-	-
TAF16 protection tube:						
NiCo special nickel/cobalt alloy (metal cap)	Lg + 20 (0.8)	Lg + 5 (0.2)	Lg + 30 (1.2)	Lg + 15 (0.6)	Lg + 20 (0.8)	Lg + 5 (0.2)
All metal protection tubes, e. g. 310, 446, 316, etc.	Lg + 30 (1.2)	Lg + 15 (0.6)	Lg + 40 (1.57)	Lg + 25 (1.0)	Lg + 30 (1.2)	Lg + 15 (0.6)
Protection tube tip made from bar stock material NiCo and INCOLOY 800HT	Lg + 25 (1.0)	Lg + 10 (0.4)	Lg + 30 (1.2)	Lg + 15 (0.6)	Lg + 20 (0.8)	Lg + 5 (0.2)
Kanthal Super	Lg + 25 (1.0)	Lg + 10 (0.4)	Lg + 25 (1.0)	Lg + 10 (0.4)	Lg + 15 (0.6)	Lg + 0 (0)

Insert length He calculation rules (He = Lg + X)						
Material	**Insert TPC 200**		**Insert TPC100, MgO insulation**			
SiN (special silicon nitride ceramic)	Lg + 25 (1.0)	Lg + 10 (0.4)	Lg + 25 (1.0)	Lg + 10 (0.4)	Lg + 15 (0.6)	Lg + 0 (0)
Kanthal AF	Lg + 25 (1.0)	Lg + 10 (0.4)	Lg + 40 (1.57)	Lg + 25 (1.0)	Lg + 30 (1.2)	Lg + 15 (0.6)

When configuring the high temperature assemblies of the TAF family the thermocouple wire diameter also needs to be defined. The higher the temperature the larger the wire diameter needs to be selected. A large wire diameter will increase the lifetime of the sensor. The insert diameter depends on the inner diameter of the protection tube. If possible, the insert with the greater diameter will be installed. This leads to a stable measurement of high temperatures.

Replaceable insert TPC200:

Type of insert	Wire diameter in mm (in)	Maximum temperature as per IEC EN 60584-1	Recommended max. temperature for continuous use	Insert diameter in mm (in)
1x K, 2x K	1.63 (0.06)	1200 °C (2192 °F)	1100 °C (2012 °F)	8 (0.31), 12 (0.47), 14 (0.55)
1x K, 2x K	2.3 (0.09)			
1x K, 2x K	3.26 (0.13)			12 (0.47), 14 (0.55)
1x J, 2x J	1.63 (0.06)	750 °C (1382 °F)	700 °C (1292 °F)	8 (0.31), 12 (0.47), 14 (0.55)
1x J, 2x J	2.3 (0.09)			
1x J, 2x J	3.26 (0.13)			12 (0.47), 14 (0.55)
1x S, 2x S	0.35 (0.014)	1600 °C (2912 °F)	1300 °C (2372 °F)	6 (0.24)
1x S, 2x S	0.5 (0.02)		1500 °C (2732 °F)	
1x R, 2x R	0.5 (0.02)			
1x B, 2x B	0.5 (0.02)	1700 °C (3092 °F)	1600 °C (2912 °F)	

Replaceable insert TPC100:

Type of insert	MgO-sheath material	Maximum temperature as per IEC EN 60584-1	Recommended max. temperature for continuous use	Insert diameter in mm (in)
1x K, 2x K	INCONEL® 600	1100 °C (2012 °F)		6 (0.24)
1x J, 2x J	INCONEL® 600	750 °C (1382 °F)		
1x N, 2x N	Pyrosil®	1150 °C (2102 °F)		

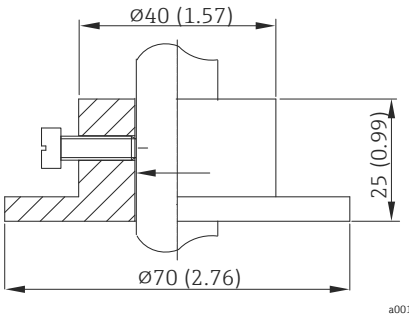
Protection tubes Diameter ceramic tubes. Dimensions in mm.

Type	Order option sheath material, diameter, maximum length	External sheath (Ø outside x inside)	Wall thick-ness	Material	Middle sheath (Ø outside x inside)	Wall thick-ness	Material	Internal sheath (Ø outside x inside)	Wall thick-ness	Material
TAF11	AA/AB/AC	14 x 10	2	C610	-	-	-	-	-	-
	AD/AE/AF	17 x 13	2		-	-	-	-	-	-
	AG/AH/AJ	24 x 19	2.5		-	-	-	-	-	-
	BA/BB/BC	17 x 7	5	SiC, sinterized	-	-	-	-	-	-
	BD/BE/BF/BG/ BH/BI	26.6 x 13	6.8		-	-	-	-	-	-
	CA/CB/CC	16 x 9	3.5	SiN	-	-	-	-	-	-
	CD/CE/CF/CG	22 x 12	5		-	-	-	-	-	-
TAF12S	SA/SB/SC/SD/SE/ SF	9 x 6	1.5	C610 or C799	-	-	-	-	-	-
TAF12D	DA/DB/DC	14 x 10	2	C610	-	-	-	9 x 6	1.5	C610
	DD/DE/DF	15 x 11		C799	-	-	-	9 x 6	1.5	C799
TAF12T	TA/TB/TC	26 x 18	4	C530	14 x 10	2	C610	9 x 6	1.5	C610
	TD/TE/TF				15 x 11	2	C799	9 x 6	1.5	C799
	TG/TH/TJ	24 x 18	3	C799	15 x 11	2	C799	9 x 6	1.5	C799

Weight From 2 to 30 kg (4.4 to 66.1 lbs), depending on version. Some examples:

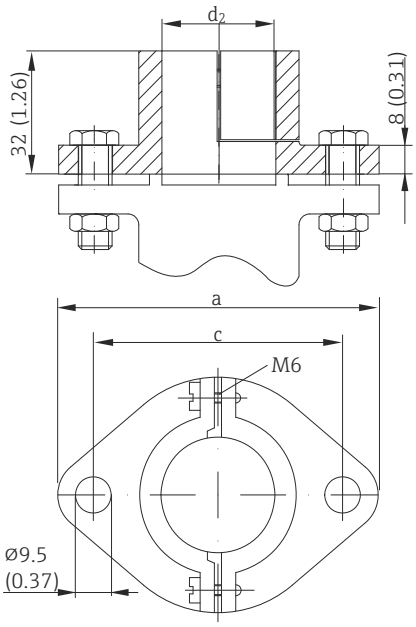
- TAF11, length 1000 mm, metallic sleeve 100 mm, terminal head DIN B: 2 kg (4.4 lbs)
- TAF12S, length 1000 mm, metallic sleeve 100 mm, terminal head DIN B: 2 kg (4.4 lbs)
- TAF12D, length 1000 mm, metallic sleeve 100 mm, terminal head DIN B: 2.5 kg (5.5 lbs)
- TAF12T, length 1000 mm, metallic sleeve 100 mm, terminal head DIN B: 3 kg (6.6 lbs)
- TAF16, length 1000 mm, tube A106, D=22 mm, terminal head DIN B: 3 kg (6.6 lbs)

Process connection

Type		
Adjustable flange  	▪ Max. temperature: +350 °C (+662 °F) ▪ Material: Aluminum ▪ Diameter depends on sleeve (TAF11 and TAF12) or protection tube pipe (TAF16) diameter ▪ No gas tight connection	
	Internal diameter in mm (in):	Order numbers for order as accessories:
	22 (0.87)	71217094
	14.5 (0.57)	71217093

Type

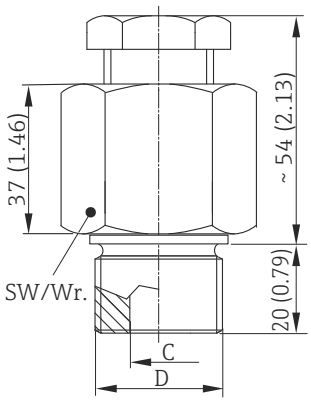
Stop flange according to DIN EN 50446



- Max. temperature: +400 °C (+752 °F)
- Material: Cast iron
- No gas tight connection
- Counter flange and gasket is not provided

d2 in mm (in)	a in mm (in)	c in mm (in)	Clampable sleeve diameter in mm (in):	Order numbers for order as accessories:
23 (0.91)	90 (3.54)	70 (2.76)	21...22 (0.83...0.87)	60000516
33 (1.3)	90 (3.54)	70 (2.76)	31...33 (1.22...1.3)	60000517
16 (0.63)	75 (2.95)	55 (2.16)	14...15 (0.55...0.59)	60008385
29 (1.14)	90 (3.54)	70 (2.76)	27...28 (1.06...1.1)	71039792

Gas tight GCP assembly



- Max. temperature: +350 °C (+662 °F)
- Material: AISI 316Ti
- Maximum process pressure ≤ 1 bar (14.5 psi)

D	C in mm (in)	Clampable sleeve diameter in mm (in)	SW/Wr.	Order numbers for order as accessories:
G½"	15.5 (0.61) 17.5 (0.69)	13.7...14 (0.54...0.55) 17...17.2 (0.67)	36 36	60019126 60019129
G¾"	15.5 (0.61) 18 (0.71) 19 (0.75) 22.5 (0.89)	13.7...14 (0.54...0.55) 17...17.2 (~0.67) 17.5...18 (0.69...0.71) 21.3...22 (0.84...0.86)	36 36 36 41	71031438 60019130 71125362 60020836
G1"	15.5 (0.61) 18 (0.71) 19 (0.75) 22.5 (0.89) 28 (1.1)	13.7...14 (0.54...0.55) 17...17.2 (~0.67) 17.5...18 (0.69...0.71) 21.3...22 (0.84...0.86) 26.7...27 (1.05...1.06)	41 41 41 41 46	60022699 60021758 71125364 60021757 71001827
G1¼"	29 (1.14)	27.5...28 (~1.1)	55	71125353
G1½"	22.5 (0.89) 29 (1.14) 35 (1.38)	21.3...22 (0.84...0.86) 27.5...28 (~1.1) 33.4...34 (1.32...1.34)	55 55 55	60021425 71125354 60022497

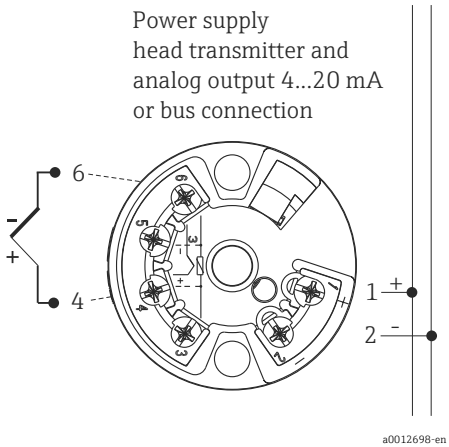
Wiring

Wiring diagrams

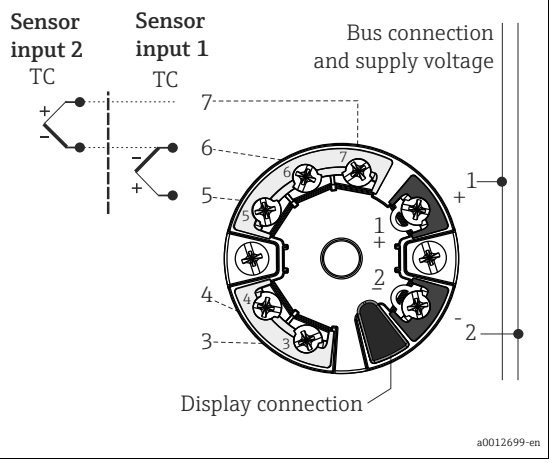
Thermocouple wire colors

As per IEC 60584	
▪ Type J: black (+), white (-) ▪ Type K: green (+), white (-) ▪ Type N: pink (+), white (-)	▪ Type B: grey (+), white (-) ▪ Type R: orange (+), white (-) ▪ Type S: orange (+), white (-)

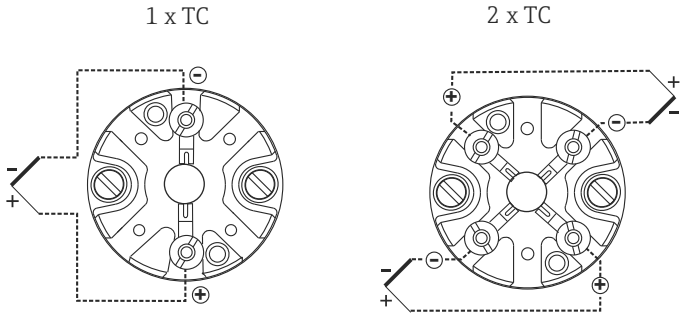
Head mounted transmitter TMT18x (single input)



Head mounted transmitter TMT8x (dual input)



Terminal block mounted

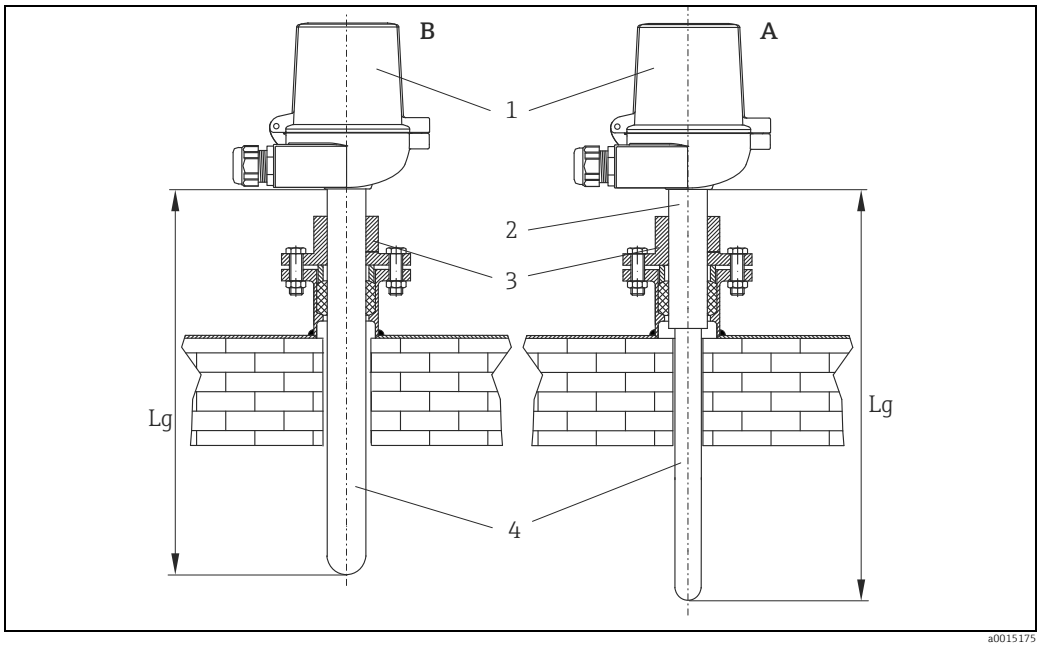


Installation conditions

Orientation

Vertical and horizontal installation. A vertical installation should be preferred due to possible irreversible bending of metal tubes and the brittleness of the ceramic materials, which could be hit by falling parts.

Installation instructions



Examples of vertical thermometer installation

A = TAF11 and TAF12x with ceramic protection tube
B = TAF16 with metal or ceramic protection tube

1 Terminal head
2 Metal sleeve
3 Stop flange according to DIN EN 50446
4 Protection tube
Lg Immersion length

Recommended maximum immersion length Lg for horizontal mounting:
- 1500 mm (59 in) for diameter > 20 mm (0.8 in)
- 1200 mm (47.3 in) for diameter < 20 mm (0.8 in)

When installing longer lengths than the recommended maximum in horizontal position, the protection tube might be bend irreversibly under its own weight in the hot environment.

Installation of ceramic sheaths

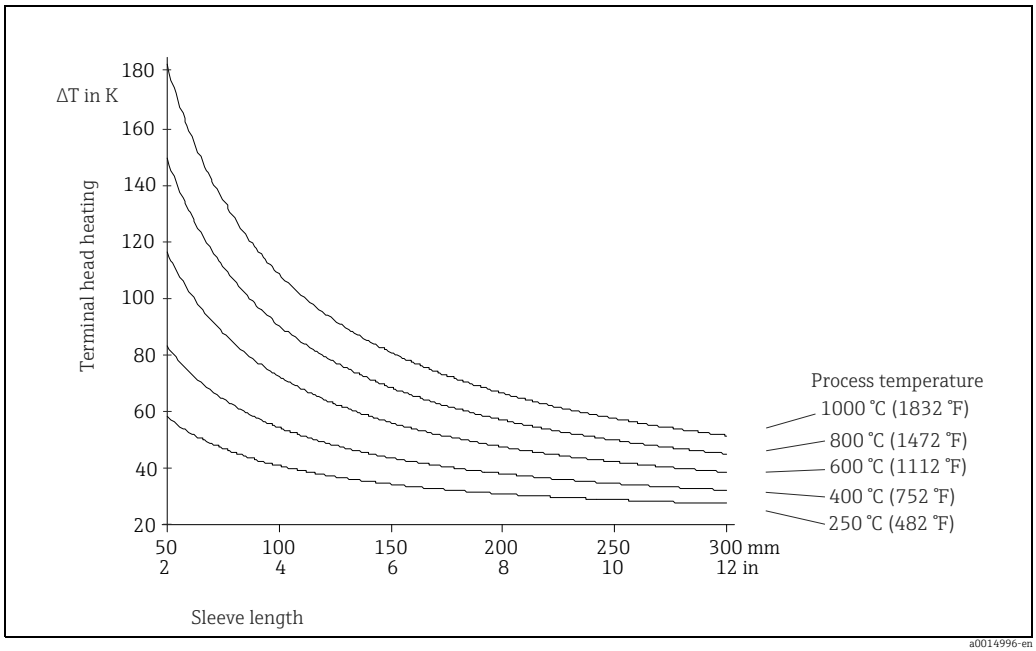
Gas tight ceramic protection tubes and inserts are sensitive to fast temperature changes: In order to reduce the risk of thermal shock and prevent the sheaths from failure, gas tight ceramic sheaths must be heated before installation. Two possibilities are applicable:

- Installation with pre-heating
  At process temperatures ≥ 1000 °C (1832 °F) the ceramic part of the protection tube must be pre-heated from room temperature to 400 °C (752 °F). It is suggested to use a horizontal, cylindrical cross-section oven or cover the ceramic part with electric heating elements. Do not use direct flames. It is suggested to pre-heat the ceramic sheath in situ and then proceed immediately with the insertion. The protection tube and inserts shall be installed carefully with an insertion rate of 100 mm/min, avoiding any mechanical shock. If it is not possible to run the pre-heating phase near the plant, the insertion rate must be lowered to 30 mm/min because of the cooling of the system during the transportation.
- Installation without pre-heating
  The insert shall be installed at process working temperature inserting the ceramic sheath in the plant for a length equal to the wall thickness, including the insulation material, and left in that position for 2 hours.
  After this time, the device shall be installed at a rate of 30 mm/min avoiding any mechanical shock.

At process temperatures < 80 °C (176 °F) it is not necessary to consider any insertion rate. It is recommended to avoid any impact or collision among the ceramic sheath and the components of the plant.

Sleeve length

The sleeve is the part between the process connection and the terminal head.
As illustrated in the following figure, the sleeve length may influence the temperature in the terminal head. It is necessary that this temperature is kept within the limit values defined in the chapter "Operating conditions".



Heating of the terminal head consequent to the process temperature
Temperature in terminal head = ambient temperature 20 °C (68 °F) + ΔT

Sleeve-diameter = ¾" schedule 40

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.

Other standards and guidelines

- IEC 60529:
  Degrees of protection by housing (IP-Code).
- IEC 61010-1:
  Safety requirements for electrical measurement, control and laboratory instrumentation.
- IEC 60584:
  Thermocouples
- DIN EN 50446:
  Straight thermocouple assembly with metal or ceramic protection tube and accessories, including 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/CE) and is not marked separately.

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) 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.

Ordering information

Product structure

Detailed ordering information is available from the following sources:
- In the **Product Configurator** on the Endress+Hauser website:
  www.endress.com ➞ Select country ➞ Instruments ➞ Select device ➞ Product page function: Configure this product
- From your Endress+Hauser Sales Center:
  www.endress.com/worldwide

Product Configurator - the tool for individual product configuration:
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Accessories

Various accessories, which can be ordered with the device or subsequently from Endress+Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: **www.endress.com**.

Device-specific accessories

Accessories	Order codes or documentation codes
Protection tubes: TWF11 for high temperature assembly TAF11 TWF16 for high temperature assembly TAF16	 TWF11- TWF16-
Inserts: TPC100, for high temperature assemblies TAF11 and TAF16 TPC200, for high temperature assemblies TAF11, TAF12D, TAF12T and TAF16	 TPC100- TPC200-
Process connections: Adjustable flange, stop flange according to DIN EN 50446 and gas tight GCP assembly	All types are available as accessories, order numbers see chapter 'Process connection'. → 12

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://wapps.endress.com/applicator ▪ On CD-ROM for local PC installation.
Konfigurator$^{+temperature}$	Software for selecting and configuring the product depending on the measuring task, supported by graphics. Includes a comprehensive knowledge database and calculation tools: ▪ For temperature competence ▪ Quick and easy design and sizing of temperature measuring points ▪ Ideal measuring point design and sizing to suit the processes and needs of a wide range of industries The Konfigurator is available: On request from your Endress+Hauser sales office on a CD-ROM for local PC installation.

Accessories	Description
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: ▪ 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 units RIA14, RIA16	The display unit is looped into the 4...20 mA circuit and gets the required energy from there, RIA14 is available with explosion proof metallic enclosure. For details: Technical Information TI143R/09 and TI144R/09
RN221N	Active barrier with power supply for safe separation of 4...20 mA standard signal circuits. Offers bidirectional HART transmission. For details: Technical Information TI073R/09

Documentation

Technical Information:
- iTEMP® Temperature head transmitter:
  - TMT181, PC programmable, single input, RTD, TC, Ω, mV (TI070R/09/en)
  - TMT182 HART®, single input, RTD, TC, Ω, mV (TI078R/09/en)
  - TMT82 HART®, dual input, RTD, TC, Ω, mV (TI01010T/09/en)
  - TMT84 PROFIBUS® PA, dual input, RTD, TC, Ω, mV (TI138R/09/en)
  - TMT85 FOUNDATION Fieldbus™, dual input, RTD, TC, Ω, mV (TI134R/09/en)
- Protection tubes:
  TWF11, TWF16 (TI01015T/09/en)
- Inserts:
  TPC100 (TI278T/02/en)
  TPC200 (TI01016T/09/en)

Application example

Technical Information:
- Field display RIA16 (TI144R/09/en)
- Active barrier with power supply RN221N (TI073R/09/en)

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