



Measurement & Analytics | Measurement made easy

# Temperature measurement solutions Precision and flexibility in temperature measurement for process efficiency

Power and productivity  
for a better world™



# Expertise in technology

## More than a century of experience

To operate any process efficiently, it is essential to measure, actuate, record and control. With ABB's measurement and analytical products and solutions, you are receiving the best technology combined with the most reliable products available on the market.

ABB offers a broad range of life cycle services for optimum product performance. A global network of specialists delivers local service and support.

Research and development is a vital source of ABB's technology leadership. It builds on the foundation of existing technologies for new applications, and continues to develop the breakthrough technologies needed to meet the challenges of the future.

ABB and its heritage companies have been leaders in innovation and technology for more than 100 years.

Aztec

**Bailey**

**BOMEM**

Bush Beach Engineering  
Limited

FISCHER  
& PORTER **P**

**Hartmann & Braun**

**K-TEK**

Kent

**L G R**  
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Pressductor®

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*Taylor*

**TBI-Bailey**

**TORBAR**  
FLOWMETERS LTD

**TOTALFLOW**  
MEASUREMENT & CONTROL SYSTEMS

# Comprehensive measurement solutions

## Serving your industry

### ABB's product portfolio:

- Analytical measurement
- Flow measurement
- Natural gas measurement
- Actuators and positioners
- Pressure measurement
- Temperature measurement
- Recorders and controllers
- Level measurement
- Device management
- Force measurement
- Service

ABB measurement and analytical products provide world-class solutions for any industry, utility or municipality. Innovations deliver technological solutions to make it easier for you to run your plants. ABB's measurement and analytical products are based on common technology, providing a common look and feel and method of operation. This results in products, that are easy to configure, easy to integrate, and easy to maintain.

For more information please visit:  
[www.abb.com/measurement](http://www.abb.com/measurement)

1 Water and waste water | 2 Power and industrial steam | 3 Chemical and petrochemical | 4 Oil and gas | 5 Pulp and paper | 6 Minerals | 7 Metals | 8 Food and beverage | 9 Marine



# Global access and availability

## A partner to rely on

### Wherever you are, whatever you need – you can rely on ABB service

ABB's vast base of globally installed products and systems is coupled with technical and process expertise, backed up by a broad scope of services that lay the foundation for end-to-end support for your enterprise. ABB's automated monitoring and reporting products are simple and accurate, so critical information is always readily accessible.

ABB's full scope of measurement and analytical products services cover everything from start-up and commissioning through to lifecycle support, giving you all you need to maximize the accuracy and reliability of your assets. The global strength of ABB means that service and support are available wherever and whenever help is needed.

### Information whenever you need it – Device management, fieldbus and wireless

ABB's measurement and analytical products feature the latest in onboard diagnostics and intelligence to help you run your business more effectively. ABB gives you the choice to decide which communication protocols you would like to use to access this information. You can select from a family of tools and from different ways to manage the lifecycle of the devices in order to get the most out of your investment.

#### ABB's device management product range includes

- Fieldbus and wireless solutions
- Mobility handhelds
- Asset vision software
- Scalable service management

ABB service: available wherever you are



ABB's wireless measurement: truly autonomous with Energy Harvester



# Temperature measurement solutions

## Offering precision and flexibility

Precise temperature measurement is fundamental for successful process operations in a variety of industries. Customers benefit from ABB's extensive experience in the field of temperature measurement, yielding one of the most comprehensive product portfolios on the market. ABB provides the support needed to choose the device or system that perfectly suits your process requirements. A full range of reliable temperature measurement products tailored to serve special industry applications is available from ABB.

With innovative temperature sensors and transmitters from ABB, you benefit from low investment costs and standardized modules with impressive long-term stability. The versatile family of temperature measurement products is based on a

modular design principle allowing for the utmost flexibility. ABB offers extremely short delivery times for its standard versions and a simple ordering process due to the clear portfolio structure.

Temperature measurement in an Oil and Gas application




High-temperature measurement for up to 1800 °C (3272 °F) solutions



# SensyTemp temperature sensors

## Portfolio overview

	Process measurement	High-temperature measurement
<b>Product series</b>	SensyTemp TSP100 and TSP300	SensyTemp TSH200
		
<b>Applications</b>	<ul style="list-style-type: none"> <li>– Oil and gas industry</li> <li>– Petrochemical industry</li> <li>– Chemical industry</li> <li>– Power generation</li> <li>– Process industry</li> <li>– Plant construction</li> </ul>	<ul style="list-style-type: none"> <li>– Power generation</li> <li>– Metals processing</li> <li>– Cement industry</li> <li>– Glass industry</li> <li>– Garbage incineration</li> <li>– Basic industry</li> </ul>
<b>Process connections</b>	<ul style="list-style-type: none"> <li>– Insertion in an existing thermowell</li> <li>– Thermowells with cylindrical or conical thread connections</li> <li>– Thermowells with flanges in acc. with international standards</li> </ul>	<ul style="list-style-type: none"> <li>– Threaded socket</li> <li>– Stop flange with counterflange</li> <li>– Welded standard flange</li> <li>– Ceramic thermowell</li> <li>– Metal thermowell</li> </ul>
<b>Measuring ranges</b>	<ul style="list-style-type: none"> <li>– Resistance thermometers: -196...600 °C (-320.8...1112 °F)</li> <li>– Thermocouples: -40...1100 °C (-40...2012 °F)</li> </ul>	Thermocouples up to 1800 °C (3272 °F)
<b>Functional safety</b>	SIL2 in accordance with IEC 61508	
<b>Approvals for explosion protection</b>	IECEX, ATEX, GOST, Other approvals are pending	
<b>Data sheet</b>	DS/TSP1xx, DS/TSP3xx	DS/TSH2xx

### Process measurement

SensyTemp TSP series sensors allow for measuring inset replacement during operation. With their short response time and high vibration resistance these devices meet the most demanding process requirements.

### High-temperature measurement

SensyTemp TSH series temperature sensors have been designed to meet the requirements of temperature applications from 600 °C to 1800 °C (1112 °F to 3272 °F). ABB assists customers in selecting the appropriate thermowell for demanding high-temperature measurements in combustion, annealing or smelting processes.

# Temperature sensors

## Components

### 1. Connection head

Connection heads of temperature sensors comply with EN 50446. This industry standard defines the electrical and mechanical connection conditions for the thermowell, measuring inset or transmitter and the connection cable. For decades, ABB has continuously advanced the connection head design for one and two transmitters.

### 2. Extension tube

The extension tube protects the electronics from high process temperatures. When process lagging is used, the extension tube enables accessibility of the connections above the lagging.

### 3. Process connection

Measuring elements can be connected directly into the process using compression fittings. When a thermowell is used it can be connected to the process via a screwed connector or a flange to any of a number of international standards. Additionally a thermowell may also be provided in a design suitable for welding into position.

### 4. Thermowell

A fabricated thermowell consists of a seamless pipe sealed at the process end with a welded piece. A solid drilled thermowell is manufactured from a single piece of bar material with a hole drilled to within a few millimeters of the tip. Both of these thermowell types provide protection for the temperature sensor.

### (a) Measuring inset

The measuring inset protects the temperature sensor and increases measuring accuracy. The measuring inset can be replaced at any time while the system is running, without opening the process or shutting down the plant. This allows for easy calibration of the measuring inset.



# SensyTemp TSP series 100

## Advanced sensors for the process industry

Product series	TSP111	TSP121	TSP131
Process connections	<ul style="list-style-type: none"> <li>- Without thermowell</li> <li>- Insertion in an existing thermowell</li> </ul>	<ul style="list-style-type: none"> <li>- With welded tubular thermowell</li> <li>- Screw-in thread</li> <li>- Flange</li> <li>- Compression fitting</li> </ul>	<ul style="list-style-type: none"> <li>- With drilled barstock thermowell</li> <li>- Screw-in thread</li> <li>- Flange</li> <li>- Weld-in socket</li> </ul>
Modular design	<ul style="list-style-type: none"> <li>- Flexible</li> <li>- Measuring inset, thermowell, extension tube, connection head, transmitter</li> <li>- Interchangeable measuring inset</li> <li>- Connection heads               <ul style="list-style-type: none"> <li>- BUZ: Aluminum, with hinged cover</li> <li>- BUZH: Aluminum, with upper hinged cover</li> <li>- BUZHD: Aluminum, with upper hinged cover and LCD indicator type AS</li> <li>- BUKH: Plastic, with upper hinged cover</li> <li>- Other heads in various designs and materials</li> </ul> </li> <li>- Transmitter in connection head (4...20 mA HART, FF, PA)</li> <li>- Suited to explosion protection, intrinsic safety</li> </ul>		
Measuring ranges	<ul style="list-style-type: none"> <li>- Resistance thermometers: -196...600 °C (-320.8...1112 °F)</li> <li>- Thermocouples: -40...1100 °C (-40...2012 °F)</li> </ul>		
Measuring insets	In accordance with DIN 43735, replaceable		
Display (optional)	Transmitter-controlled graphic (alphanumeric) LCD indicator type AS for process-, sensor- or current-value display		
Functional safety	SIL2 in accordance with IEC 61508		
Approvals for explosion protection	IECEX, ATEX, GOST, other approvals are pending		
Connection heads	<div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>BUZ</p> </div> <div style="text-align: center;">  <p>BUZH</p> </div> <div style="text-align: center;">  <p>BUZHD</p> </div> <div style="text-align: center;">  <p>BUKH</p> </div> </div> <p style="text-align: center; margin-top: 10px;">Display type AS</p>		
Data sheet	DS/TSP1x1		





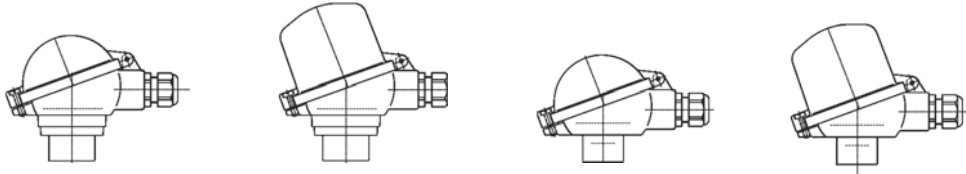
# SensyTemp TSP series 300

## Meeting most demanding requirements

<b>Product series</b>	<b>TSP311</b> 	<b>TSP321</b> 	<b>TSP331</b> 
<b>Process connections</b>	<ul style="list-style-type: none"> <li>- Without thermowell</li> <li>- Insertion in an existing thermowell</li> </ul>	<ul style="list-style-type: none"> <li>- With welded tubular thermowell</li> <li>- Screw-in thread</li> <li>- Flange</li> <li>- Compression fitting</li> </ul>	<ul style="list-style-type: none"> <li>- With drilled barstock thermowell</li> <li>- Screw-in thread</li> <li>- Flange</li> <li>- Weld-in socket</li> </ul>
<b>Modular design</b>	<ul style="list-style-type: none"> <li>- Sturdy and versatile               <ul style="list-style-type: none"> <li>- Measuring inset, thermowell, extension tube, connection head, transmitter</li> <li>- Interchangeable measuring inset</li> </ul> </li> <li>- Connection heads               <ul style="list-style-type: none"> <li>- AGL: Aluminum, with screw-on cover</li> <li>- AGLH: Aluminum, with upper screw-on cover</li> <li>- AGLD: Aluminum, with screw-on cover and LCD indicator type A / AS</li> <li>- AGS: Stainless steel, with screw-on cover</li> <li>- AGSH: Stainless steel, with upper screw-on cover</li> <li>- AGSD: Stainless steel, with screw-on cover and LCD indicator type A / AS</li> </ul> </li> <li>- Transmitter in connection head (4...20 mA HART, FF, PA)</li> <li>- Suited to explosion protection, intrinsic safety and flameproof enclosure</li> </ul>		
<b>Measuring ranges</b>	<ul style="list-style-type: none"> <li>- Resistance thermometers: -196...600 °C (-320.8...1112 °F)</li> <li>- Thermocouples: -40...1100 °C (-40...2012 °F)</li> </ul>		
<b>Measuring insets</b>	In accordance with DIN 43735, replaceable		
<b>Display (optional)</b>	Transmitter-controlled graphic (alphanumeric) LCD indicator type A / AS with dual function <ul style="list-style-type: none"> <li>- Transmitter configuration via button (HMI)</li> <li>- Process-, sensor- or current value display</li> </ul>		
<b>Functional safety</b>	SIL2 in accordance with IEC 61508		
<b>Approvals for explosion protection</b>	IECEx, ATEX, FM, CSA, GOST, other approvals are pending		
<b>Connection heads</b>	 <p>           AGL                      AGLH                      AGLD                      AGS                      AGSH                      AGSD            Display type A / AS                      Display type A / AS         </p>		
<b>Data sheet</b>	DS/TSP3x1		

# SensyTemp TSH series 200

## High temperature up to 1800 °C (3272 °F)

<b>Product series</b>	<b>TSH210</b> 	<b>TSH220</b> 
<b>Process connections</b>	Metal thermowell Stop flange with counterflange, threaded socket, welded standard flange	Ceramic thermowell
<b>Modular design</b>	<ul style="list-style-type: none"> <li>- Supports numerous applications             <ul style="list-style-type: none"> <li>- In accordance with EN 50446 and also available in accordance with ABB standard</li> </ul> </li> <li>- Connection heads             <ul style="list-style-type: none"> <li>- AUZ: Aluminum, with hinged cover</li> <li>- AUZH: Aluminum with upper hinged cover</li> <li>- BUZ: Aluminum, with hinged cover</li> <li>- BUZH: Aluminum, with upper hinged cover</li> <li>- Other heads in various forms and materials</li> </ul> </li> <li>- Transmitter in connection head (4...20 mA HART, FF, PA)</li> </ul>	
<b>Max. operating temperature</b>	1300 °C (2372 °F)	1800 °C (3272 °F)
<b>Connection heads (selection)</b>	 <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <span data-bbox="453 1451 496 1472">AUZ</span> <span data-bbox="719 1451 778 1472">AUZH</span> <span data-bbox="986 1451 1029 1472">BUZ</span> <span data-bbox="1252 1451 1311 1472">BUZH</span> </div>	
<b>Data sheet</b>	DS/TSH2x0	

# Wireless made easy

## Truly autonomous with Energy Harvester

Product series	TSP3xx-W	TSP3xx-W	TTF3xx-W
			
Communication protocol	WirelessHART	WirelessHART	WirelessHART
Device type	Battery supply without Energy Harvester	Battery supply with Energy Harvester	Battery supply without Energy Harvester
Input	<ul style="list-style-type: none"> <li>– Two sensors inputs <ul style="list-style-type: none"> <li>- Resistance thermometers, resistance-type remote sensor (0...5000 Ohm)</li> <li>- Thermocouples, voltages, mV voltages (-125...1100 mV)</li> </ul> </li> </ul>		
Sensor connection	<ul style="list-style-type: none"> <li>– Pt100 2-, 3-, 4 wire, thermocouple with internal reference junction</li> <li>– 2x Pt100 2- and 3 wire, 2x thermocouple or 1x Pt100 2-, 3-, 4 wire and 1x thermocouple</li> </ul>		
Technical features	<ul style="list-style-type: none"> <li>– Continuous sensor monitoring and self-monitoring <ul style="list-style-type: none"> <li>- Supply voltage, wire break and corrosion monitoring</li> </ul> </li> <li>– Sensor error adjustment</li> <li>– Electrical isolation</li> <li>– Specific linearization <ul style="list-style-type: none"> <li>- Callendar-Van Dusen coefficients, table of value pairs / 32 points</li> </ul> </li> <li>– Innovative energy management</li> </ul>		
Indicator (optional)	Transmitter-controlled graphic (alphanumeric) LCD indicator type B with dual function: <ul style="list-style-type: none"> <li>– Transmitter configuration via push button</li> <li>– Process-, sensor- or current-value display</li> </ul>		
Configuration	Via HART handheld (DTM, EDD, HMI)		
Approvals for explosion protection	IECEX, ATEX, other approvals are pending		
Data sheet	DS/TSP3x1-W		DS/TTF300-W

The WirelessHART temperature sensor TSP300-W with Energy Harvester is the world's first self-powered wireless measurement devices requiring no wiring, no external power supply and ideally no battery replacement.

# Oil and gas temperature measurement

## Safe tough and reliable

Temperature measurement systems for the oil and gas industry are engineered, manufactured and documented by ABB engineers. Traceability is maintained at all times for both materials and processes. All wetted material can be traced from the mill to the finished product.

### Wake frequency design assurance

In high flow installations, unsupported thermowells can produce wake vibrations that could approach their resonant frequency leading to serious cracking and even destruction of the thermowell. ABB engineers know where potential problems could occur and recommend available options.

### Thermowells, sensors, cables and transmitters – all manufactured by ABB

A key component of ABB's quality confidence comes from the use of own cables, components, thermowells and transmitters. The control of quality and materials is maintained at every critical stage. From sensors that are laser welded to thermowells manufactured on dedicated machines, temperature solutions from ABB are safe, tough and reliable.

### Solutions for the full oil and gas production cycle

- Exploration
- Production (on shore, off shore and sub-sea)
- Transportation
- Refining

### Standard qualifications

- ISO 9001
- ISO 14001
- OHAS 18001
- PED

### Products qualifications

- X-ray PMI
- Dye Penetration
- X-ray Weld verification
- Ultrasonic Weld verification
- Full material traceability
- Thermowell concentricity and dimensional reporting
- Full design and third party approved welding procedures
- Fully forged flanges to ANSI standards
- RTD and TC calibration traceable to NAMAS
- NACE
- NORSOK

### Hazardous area applications

- Explosion proof
- Intrinsic safety
- Non-sparking
- Non-incendive



# Multipoint temperature measurement

## Unique solutions for specific tasks

ABB's multipoint temperature solutions allow plant operators to monitor more than one temperature measurement point through a single vessel entry. Typically the sensors are distributed along the length of a large diameter pipe type thermowell, touching the surface at the point the measurement needs to be made. Some designs allow for the extraction and replacement of the temperature measuring elements whilst the plant is still operating.

Multipoints are by their very nature highly specific to their intended operation. They are usually designed to the exact requirements of the customer. ABB engineers bring their extensive knowledge of temperature measurement techniques and pressure vessel design and materials together, to provide unique solutions to customer specific measurement tasks. ABB has got a large installed base of multipoint temperature measurement devices in several industries.

Applications for Multipoints vary considerably. They are used in vessels rather than pipes. Multipoints have been mounted both vertically and horizontally to give a cross sectional view of the temperature distribution within the vessel. Both RTD based instruments and thermocouple based instruments are available from ABB, depending on the application requirements of the customer.



# Temperature sensor solutions

## First choice for any application

### Intrinsic safety at chemical plants

Many processes and products in chemical plants are potentially explosive. Electrical equipment needs to be prevented from igniting. The best way this can be done is by using intrinsically safe products. These make sure that the electrical equipment does not develop the energy needed to cause an explosion, even under fault conditions.

#### The safe solution

ABB's TSP range of temperature sensors can be fitted with the head mounting transmitters TTH200 and TTH300. Both product lines are available with the intrinsic safety option. Due to this electrical protection standard, the reliable and durable TSP sensor will never produce the amount of energy required to cause an explosion. The building of intrinsically safe circuits is a highly specialized engineering discipline. To support these engineers, ABB provides all the information needed in well-structured, easy to read TSP documentation and certification material.

#### Functional safety according to IEC 61508

ABB offers temperature sensors and transmitters with SIL certification for safety relevant applications.

### Thermowells for oil and gas

For the Oil and Gas industry, the specification of a thermowell is the most demanding aspect of temperature instrumentation. An LNG (Liquid Natural Gas) plant takes natural gas and processes it into a liquid at very low temperatures of up to  $-163\text{ }^{\circ}\text{C}$  ( $-261.4\text{ }^{\circ}\text{F}$ ). Ordinary stainless steel thermowells are not advised for cryogenic temperatures.

ABB worked together closely with Oil and Gas plant engineers and developed a solution which uses a high Chromium Molybdenum alloy (F44, 1.4547), known as 6% Mo and is suited for this particular measuring task.

In case given process conditions might lead to wake vibrations close to the thermowells' resonant frequency, the product is subjected to a wake frequency assessment. This helps to preserve product quality of customized products even in very specific situations.

The finished design of ABB's thermowell products is manufactured and documented to the most exacting standards and can be confidently fitted into the customers plant.

Temperature measurement of a process gas with temperature sensor TSP131



# Reliable temperature measurement Solutions for your industry

## Cement plant measurement tasks

The production of cement from raw meal involves intensive and finely controlled heating. Temperatures that are too low result in a poor finished product yield, temperatures that are too high cause excessive energy consumption. Only an accurate and robust high temperature measurement solution will satisfy the need for balance between quality and cost.

### Erosive and explosive environment – the challenge

The kiln operates between 1400 and 1500 °C (2552 and 2732 °F), with preheaters operating between 1100 and 1300 °C (2012 and 2372 °F). Cement products are extremely erosive. A plant atmosphere which could contain hot powder presents a potentially explosive atmosphere.

### The high temperature solution

ABB's TSH high temperature measurement products offer a range of solutions all engineered to the highest degree. For measurements of up to 1100 °C (2012 °F) simple thermocouples and metal protection tubes are the cost effective choice. For higher temperature applications precious metal thermocouples and ceramic protection tubes offer reliable measurement and erosion resistance. Standard copper based thermocouples begin to melt at higher temperatures. ABB combines precious metal thermocouples and ceramic tubes to resist temperatures up to 1800 °C (3272 °F) with reasonable life expectancy.

## Specialized temperature measurement

Pressurized Water Reactors (PWR) use high pressure water in their primary loop. It transfers its energy through a system of heat exchangers which raise the steam for the turbines. One of the most critical measurements in this kind of reactor is the temperature of the primary loop. This measurement is needed to enable the efficient running of the system and as a safety feature to shut the reactor down, if the loop temperature exceeds a certain limit.

### The solution to control primary loop temperature



Specialized ABB temperature products have been developed for this demanding role. Using the highest integrity stainless steel for the thermowell and an ultra fast design of tip and sensor, the ABB nuclear temperature sensor has been passed fit for service by both KTA in Germany and IEEE in the USA. Using a PT200 platinum resistance sensor as the basis of the measurement enables a very good signal to noise ratio over the long four wire connection. No head mounting transmitter is used as semiconductors are very sensitive to ionizing radiation. The sensors have been rated at up to 2.3 MGy radiation resistance for 40 years. ABB also supplies non-critical equipment into the nuclear power industry to monitor such diverse tasks as pump bearing temperatures and turbine temperatures. ABB temperature measurement products supplied to the nuclear power industries are certified to withstand high levels of shock of up to 5 g, that might be caused by natural or man made hazardous causes.

ABB high temperature sensor installed in a kiln



# Temperature transmitter series 200

## For demanding applications

<b>Product series</b>	<b>TTH200</b>	<b>TTR200</b>
		
<b>Communication protocol</b>	HART	
<b>Device type</b>	Head mounted temperature transmitter	Rail mounted temperature transmitter
<b>Input</b>	<ul style="list-style-type: none"> <li>- One sensor</li> <li>- Resistance thermometers, resistance-type transmitters (0...5000 Ohm)</li> <li>- Thermocouples, voltages, mV transmitter (-125...1100 mV)</li> </ul>	
<b>Sensor connection</b>	Pt100 2-, 3-, 4 wire, thermocouple with internal cold junction	
<b>Technical features</b>	<ul style="list-style-type: none"> <li>- Continuous sensor monitoring and self-monitoring</li> <li>- Supply voltage monitoring</li> <li>- Wire break and corrosion monitoring</li> <li>- Sensor error adjustment</li> <li>- Electrical isolation</li> </ul>	
<b>Display (optional)</b>	Transmitter-controlled graphic (alphanumeric) LCD display type AS for process-, sensor- or current-value display	
<b>Configuration</b>	DTM, EDD	
<b>Functional safety</b>	SIL2, SIL3 in Dual Configuration in accordance with IEC 61508	
<b>Approvals for explosion protection</b>	IECEx, ATEX, FM, CSA, GOST, other approvals are pending	
<b>Data sheet for detailed information</b>	DS/TTH200	DS/TTR200





# Temperature transmitter series 300

## For most demanding applications

Product series	TTH300	TTF300
		
Communication protocol	HART, FF, PA	HART, FF, PA
Device type	Head-mounted temperature transmitter	Field-mounted temperature transmitter, single compartment technology, 2 cable glands
Input	<ul style="list-style-type: none"> <li>- Two sensors</li> <li>- Resistance thermometers, resistance-type remote sensor (0...5000 Ohm)</li> <li>- Thermocouples, voltages, mV voltages (-125...1100 mV)</li> </ul>	
Sensor connection	<ul style="list-style-type: none"> <li>- Pt100, 2-, 3-, 4 wire, thermocouple with internal reference junction</li> <li>- 2x Pt100 2- and 3-wire, 2x thermocouple or 1x Pt100 2-, 3-, 4 wire and 1x thermocouple</li> </ul>	
Technical features	<ul style="list-style-type: none"> <li>- Continuous sensor monitoring and self-monitoring</li> <li>- Supply voltage, wire break and corrosion monitoring</li> <li>- Sensor error adjustment</li> <li>- Electrical isolation</li> <li>- Specific linearization</li> <li>- Callendar-Van Dusen coefficients, table of value pairs / 32 points</li> </ul>	
Indicator (optional)	Transmitter-controlled graphic (alphanumeric) LCD indicator type A (TTH300) or type B (TTF300) with dual function: <ul style="list-style-type: none"> <li>- Transmitter configuration via push button</li> <li>- Process-, sensor- or current-value display</li> </ul>	
Configuration	Via HART (DTM, EDD, HMI), FF (EDD, HMI), PA (DTM, EDD, HMI, GSD)	
Functional safety	HART, SIL2/SIL3 in dual configuration in accordance with IEC 61508	
Approvals for explosion protection	IECEX, ATEX, FM, CSA, GOST, other approvals are pending	
Data sheet	DS/TTH300	DS/TTF300



# Temperature transmitter solutions

## First choice for any application

### Reliable temperature measurement

A typical power plant has hundreds of temperature measurements. Most of them are concerned with the burning of fuel to raise steam for the massive turbines which power the generators. A wide range of operation is demanded from a temperature sensor used in this application. The majority of these measurements are therefore made using thermocouples, which are ideally suited due to their wide temperature range.

#### The intelligent temperature measurement solution

ABB's TTR200 rail mounted temperature transmitter converts the voltage signal of the thermocouple to a robust communication protocol such as 4...20 mA or HART. Nevertheless thermocouple signals are very small, with the correct compensation cable they can run over relatively long distances without any significant loss in accuracy. The thermocouple sensors themselves are very quick to respond to temperature changes and extremely robust. The TTR200 is a rail mounting version of the TTH200 transmitter with the addition of two indicator LED(s). A green LED indicates that the transmitter is powered. A red LED would indicate a fault in either the unit or the sensor. TTR200 units can be placed in cabinet racks.

#### TTR200 benefits

- Universal sensor input for reduced spares holding
- Mechanical configuration lock to prevent unintended tampering

TTR200 rail mounted temperature transmitters installed in cabinet rack



### Comfortable temperature measurement

In certain process conditions it is not possible to install head mounted transmitters directly on top of temperature sensors. Excessively high or low temperatures would influence the life time of the electronics. Vibrations or placement close to an electromagnetic source can change measurements significantly. In other installations it is not possible to see the display or easily reach the transmitter for further configuration.

#### The solution

ABB's field mounted temperature transmitters TTF300 are the cost effective solution to this challenge. For measurements in harsh operating conditions, a transmitter with a stainless steel housing is available, withstanding temperatures of -50 °C (-58 °F). The TTF300 can be supplied with a display that allows for making configuration without using a handheld terminal. In addition, sensor redundancy check, sensor drift detection and customer specific characteristic curves are available.

With their completely sealed electronic unit, the influence from outside is reduced to a minimum, resulting in a reliable solution with long term stability. Full certification complying with different plant environments are provided, as well as SIL2, fulfilling today's standards for the process industry.

Temperature transmitter TTF300 for field mounting



# Temperature measurement under control

## The LCD indicator

### Operating concept

ABB offers an optional LCD indicator for temperature sensors, which provides for convenient parameter reading directly at the device. Two LCD indicator variants are available: The indicator type AS provides a pure display function, whereas type A / B additionally allows configuration options via four keys. The intuitively operable menu is very user-friendly. The keys and the LCD indicator are protected by a housing cover with window.

### Configuration options of the type A indicator

- Sensor configuration
- Measuring range
- Failure mode (HART)
- Software write protection for configuration data
- Device address for FOUNDATION Fieldbus, PROFIBUS PA and WirelessHART

LCD indicator type A and type B



LCD indicator type AS



### Function keys

- 1 Exit/cancel
- 2 Previous
- 3 Next
- 4 Select



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# SensyTemp TSP111, TSP121, TSP131 Temperature Sensors

Modular design equals  
flexibility



## DIN 43772 Design

### Modular design

- Measuring inset, thermowell, extension tube, connection head, transmitter

### Interchangeable measuring inset

- Interchangeable measuring inset

### Transmitter in connection head

- Optional LCD indicator
- Optional display function (type AS) or display with configuration function (type A)
- SIL2 for transmitter

## Approvals

- SIL2 for temperature sensor
- ATEX
- GOST

## Applications

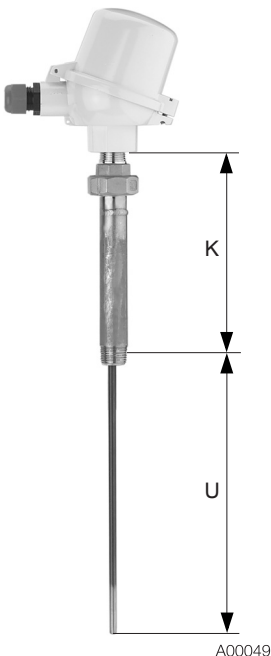
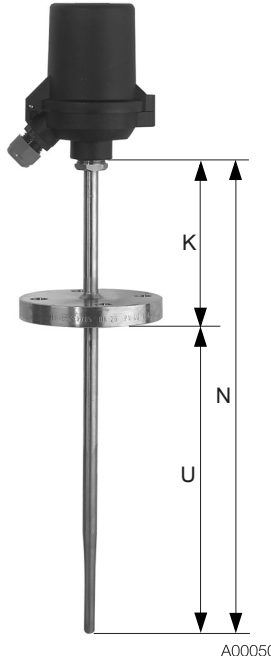
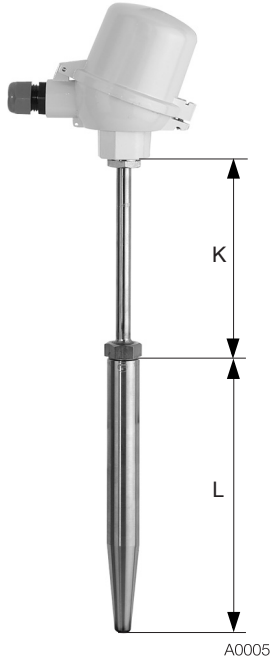
- Chemical industry
- Energy industry
- General process engineering
- Tank and pipeline construction
- Mechanical and plant engineering

## Contents

<b>1</b>	<b>General information</b>	<b>3</b>
1.1	Overview of DIN 43772 temperature sensors with exchangeable measuring inset	3
1.2	Overview of measuring insets	4
1.3	Installation instructions	4
<b>2</b>	<b>Measuring inset specifications</b>	<b>5</b>
2.1	Resistance thermometer design	5
2.2	Thermocouple design	7
2.3	Insulation resistance of measuring inset	7
2.4	Response times	7
<b>3</b>	<b>Thermowells</b>	<b>8</b>
3.1	Tubular thermowells	8
3.2	Drilled thermowells	11
3.3	Pressure and vibration resistance of thermowell	13
<b>4</b>	<b>Process connections</b>	<b>15</b>
4.1	SensyTemp TSP121 temperature sensor	15
4.2	SensyTemp TSP131 temperature sensor	15
<b>5</b>	<b>Extension tubes</b>	<b>16</b>
5.1	Extension tube models	17
<b>6</b>	<b>Connection heads</b>	<b>17</b>
6.1	Ambient temperature at connection head	18
<b>7</b>	<b>Transmitter</b>	<b>19</b>
<b>8</b>	<b>Type A and type AS LCD indicator</b>	<b>19</b>
<b>9</b>	<b>Functional safety (SIL)</b>	<b>19</b>
<b>10</b>	<b>Ex relevant specifications</b>	<b>20</b>
10.1	Intrinsic safety ATEX "Ex i"	20
10.2	Dust ignition protection (enclosure)	21
<b>11</b>	<b>Approvals</b>	<b>22</b>
<b>12</b>	<b>Tests and certificates</b>	<b>22</b>
<b>13</b>	<b>Additional information</b>	<b>23</b>
13.1	Supplementary documents	23
13.2	Information about ordering information	23
<b>14</b>	<b>Ordering information</b>	<b>24</b>
14.1	SensyTemp TSP111	24
14.2	SensyTemp TSP121	28
14.3	SensyTemp TSP131	34

## 1 General information

### 1.1 Overview of DIN 43772 temperature sensors with exchangeable measuring inset

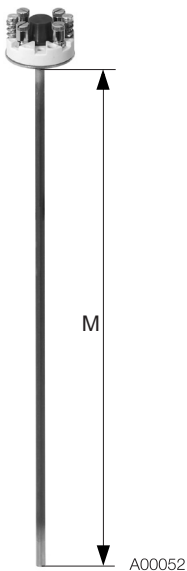
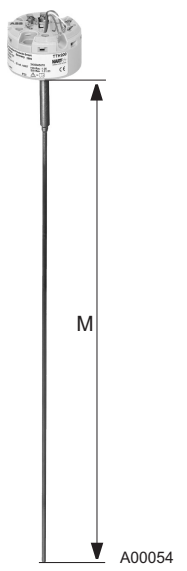
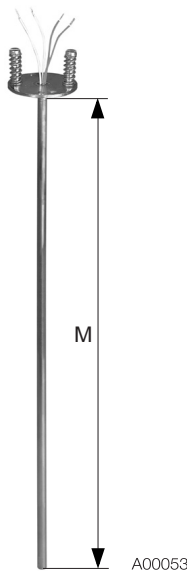
Type	TSP111	TSP121	TSP131	
<b>Legend</b>  K = Ext. tube length U = Installation length N = Nominal length L = Thermowell length				
Design	No thermowell, for installation in existing thermowell Measuring inset, extension tube with thermowell interface, connection head, transmitter, optional LCD indicator	Welded protective fitting manufactured from pipe material	Drilled thermowell manufactured from bar stock material transmitter, optional LCD indicator	
Process connection	Insertion in an existing thermowell. Functional safety is only assured with an additional thermowell!	Screw-in thread, flange, compression fitting	Welded connections, screw-in thread, flange	
Transport temperature / Storage temperature	-20 ... 70 °C (-4 ... 158 °F)			
Maximum temperature limits	(depending on the sensor and material selected, the lower temperature value in each case counts)			
Sensor	Thin film measurement resistor: 500 °C (932 °F) Wire-wound measurement resistor: 600 °C (1,112 °F) Type K, N, J, and E thermocouples: 1,250 °C (2,282 °F)			
Material	316L / 1.4404	≤ 600 °C (1,112 °F)		
	316Ti / 1.4571	≤ 800 °C (1,472 °F)		
	Hastelloy C276 / 2.4819	≤ 1,100 °C (2,012 °F)		
	Inconel 600 / 2.4816	-	≤ 1,100 °C (2,012 °F)	≤ 1,100 °C (2,012 °F)
	Monel 400 / 2.4360	-	-	550 °C (1,022 °F)
	1.7335	-	-	≤ 540 °C (1,004 °F)
	1.7380	-	-	≤ 570 °C (1,058 °F)
	1.5415	-	-	≤ 500 °C (932 °F)
	E-CTFE	-	≤ 120 °C (248 °F)	≤ 120 °C (248 °F)
Tantalum	-	≤ 200 °C (392 °F)	≤ 200 °C (392 °F)	
Pressure	-	Maximum 40 ... 100 bar (580.15 ... 1,450.38 psi)	Maximum 700 bar (10,152.64 psi)	



#### Important

The maximum temperatures and pressures specified are maximum values and do not take into consideration process-related stress. The effects of viscosity, flow rate, pressure, and temperature in the process usually cause these values to drop.

## 1.2 Overview of measuring insets

Type	TSA101		
<b>Legend</b>  M = Measuring inset length U = Installation length K = Ext. tube length N = Nominal length L = Thermowell length D = Outer diameter  TSP111 $M = U + K + 40 \text{ mm}$  TSP121 $M = N + 40 \text{ mm}$  TSP131 $M = L + K + 40 \text{ mm}$	 <p style="text-align: center;">A00052</p>	 <p style="text-align: center;">A00054</p>	 <p style="text-align: center;">A00053</p>
<b>Design</b>	Ceramic base with connection terminals	Permanently-mounted transmitter	Open leads
	<ul style="list-style-type: none"> <li>• Bendable and vibration-resistant ABB plastic-sheathed cable. The sheath for the resistance thermometer is manufactured from stainless steel 1.4571 (316Ti) or highly heat-resistant steel 2.4816 (alloy 600) for thermocouples.</li> <li>• Sensors conforming to IEC 60751 platinum resistance thermometer with measuring ranges of <math>-196 \dots 600 \text{ }^\circ\text{C}</math> (<math>-384.8 \dots 1,112 \text{ }^\circ\text{F}</math>) in three tolerance classes or thermocouples conforming to IEC 60584 and ANSI MC96.1 with measuring ranges of <math>-40 \dots 1,100 \text{ }^\circ\text{C}</math> (<math>-40 \dots 2,012 \text{ }^\circ\text{F}</math>), each in two tolerance classes.</li> <li>• Fitted with single or double sensors.</li> <li>• Optimum clamping at the measuring inset's holding plate is assured by generous spring travel (10 mm (0.39 inch)) on the part of the clamping springs.</li> <li>• Measuring insets are available with outer diameters of 3.0 mm (0.12 inch), 6.0 mm (0.24 inch), 8.0 mm (0.318 inch), and 10.0 mm (0.39 inch).</li> </ul>		

## 1.3 Installation instructions

Ideally, in the case of pipes, the tip of the thermometer should be located in the center of the pipe. If this is not possible, both in the case of pipes and with containers, a minimum insertion depth of 10 to 15 times the thermowell diameter is assumed to be sufficient.

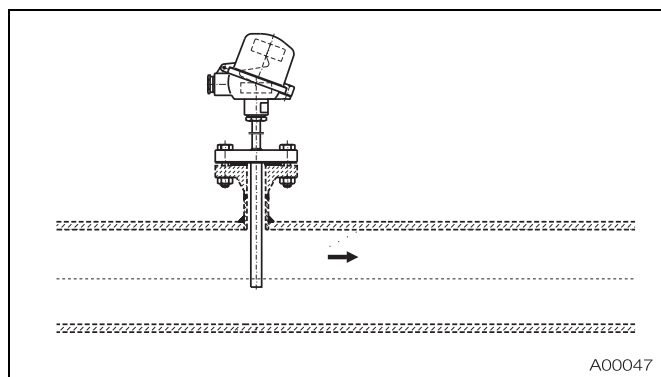


Fig. 1

### 1.3.1

### Insufficient nominal diameter

Pipes with very small nominal diameters, insertion inside an elbow pipe is recommended. The tip of the thermowell should be set in the opposite direction of the flow.. Inserting the thermowell with an adapter at an acute angle against the flow direction can also distort measurement results.

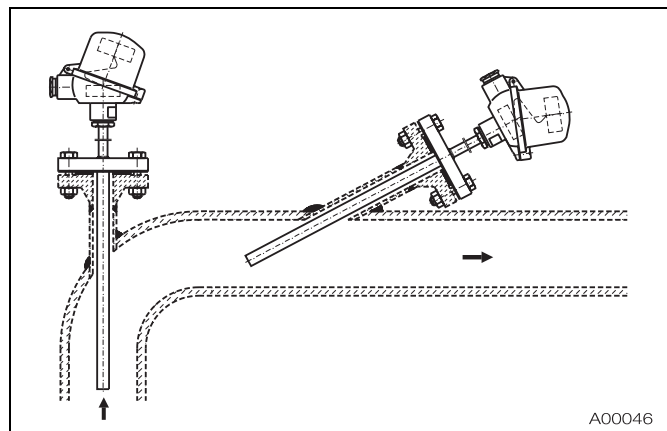


Fig. 2



## 2 Measuring inset specifications

### 2.1 Resistance thermometer design

The vibration resistance of ABB's uniquely designed inset is extraordinary.

The acceleration values of 3 g, defined in accordance with IEC 60751 for additional requirements, are exceeded by all measuring inset models in TSP temperature sensors.

The following table provides an overview of the vibration resistance of the measuring inset models at the measuring point.

Resistance thermometer to IEC 60751		
Basic design, thin film measurement resistor	10 g	-50 ... 400 °C (-58 ... 752 °F)
Increased vibration strength, thin film measurement resistor	60 g	-50 ... 400 °C (-58 ... 752 °F)
Extended measuring range, wire-wound measurement resistor, vibration strength to IEC 60751	3 g	-196 ... 600 °C (-320.8 ... 1112 °F)
Extended measuring range, wire-wound measurement resistor, increased vibration strength	10 g	-196 ... 600 °C (-320.8 ... 1112 °F)

The following table provides an overview of the temperature-sensitive section and the non-bendable section at the tip of the measuring inset.

	Temperature-sensitive section	Non-bendable length
Basic design	7 mm (0.28 inch)	30 mm (1.18 inch)
Extended vibration resistance	10 mm (0.39 inch)	40 mm (1.57 inch)
Extended measuring range	50 mm (1.97 inch)	60 mm (2.36 inch)
Extended measuring range, increased vibration strength	50 mm (1.97 inch)	60 mm (2.36 inch)

### 2.1.1 Accuracy classes of measurement resistors to IEC 60751

Even with restricted accuracy F0,1 or F/W0,15, both layer and wire-wound multiplier resistors to IEC 60751 can be used throughout the entire application range. However, ultimately, only the accuracy class of the temperature range used can apply.

Example: A class F0,1 sensor is used at 290 °C (554 °F). After this albeit brief application, class F0,15 applies for this sensor.

#### Accuracy classes to IEC 60751

Thin film measurement resistor (SMW)	
Class F 0.3: $\Delta t = \pm (0.30 + 0.0050 t )$	-50 ... 400 °C (-122 ... 752 °F)
Class F 0.15: $\Delta t = \pm (0.15 + 0.0020 t )$	-30 ... 300 °C (-22 ... 572 °F)
Class F 0.1: $\Delta t = \pm (0.10 + 0.0017 t )$	0 ... 100 °C (32 ... 212 °F)
Wire-wound measurement resistor (DMW)	
Class W 0.3: $\Delta t = \pm (0.30 + 0.0050 t )$	-196 ... 600 °C (-320.8 ... 1112 °F)
Class W 0,15: $\Delta t = \pm (0.15 + 0.0020 t )$	-196 ... 500 °C (-320.8 ... 932 °F)

The resistance of the copper inner conductor of the measuring inset affects the measurement value of two-wire circuits and must be taken into consideration. It is determined by the diameter and length of the measuring inset.

If the error cannot be compensated mechanically, the following values apply:

- Measuring inset Ø 3 mm (0.12 inch): (0.281 Ω/m ⇒ +0.7 °C/m)
- Measuring inset Ø 6 mm (0.24 inch): (0.1 Ω/m ⇒ +0.25 °C/m)

For this reason ABB supplies three-wire or four-wire circuits as standard.

## 2.1.2 Versions

### Basic Version

Thin film measurement resistor (SMW)  
 Measuring range -50 ... 400 °C (-122 ... 752 °F)  
 Vibration-resistant up to 10 g

	Single sensor			Double sensor		
	2-w.	3-w.	4-w.	2-w.	3-w.	4-w.
3 mm, class B	●	●	●			
3 mm, class A		●	●			
6 mm, class B	●	●	●	●	●	●
6 mm, class A		●	●		●	●
6 mm, class AA		●	●		●	●

### Increased vibration resistance

Thin film measurement resistor (SMW)  
 Measuring range -50 ... 400 °C (-122 ... 752 °F)  
 Vibration-resistant up to 60 g

	Single sensor			Double sensor		
	2-w.	3-w.	4-w.	2-w.	3-w.	4-w.
3 mm, class B						
3 mm, class A						
6 mm, class B	●	●	●	●	●	●
6 mm, class A		●	●		●	●

### Extended measuring range

Wire-wound measurement resistor (DMW)  
 Measuring range -196 ... 600 °C (-320.8 ... 1,112 °F)  
 Vibration-resistant up to 3 g

	Single sensor			Double sensor		
	2-w.	3-w.	4-w.	2-w.	3-w.	4-w.
3 mm, class B	●	●	●	●	●	
3 mm, class A		●	●			
6 mm, class B	●	●	●	●	●	●
6 mm, class A		●	●			

### Extended measuring range, increased vibration strength

Wire-wound measurement resistor (DMW)  
 Measuring range -196 ... 600 °C (-320.8 ... 1,112 °F)  
 Vibration-resistant up to 10 g

	Single sensor			Double sensor		
	2-w.	3-w.	4-w.	2-w.	3-w.	4-w.
3 mm, class B	●	●	●	●	●	
3 mm, class A		●	●			
6 mm, class B	●	●	●	●	●	●
6 mm, class A		●	●			

## 2.2 Thermocouple design

The measuring accuracy of ABB's standard thermocouples complies with international standard IEC 60584. Thermocouples compliant with ANSI MC96.1 are also available on request. Since the values of both standards vary only marginally in the lower temperature range (up to approx. 300 °C (572 °F)), we recommend the use of thermocouples compliant with international standard IEC 60584. Tolerance data is listed in the "Tolerance classes" table.

The following table provides an overview of the temperature-sensitive section and the non-bendable section at the tip of the measuring inset.

Measuring inset	Temperature-sensitive section	Non-bendable length
Basic design	7 mm (0.28 inch)	30 mm (1.18 inch)

### 2.2.1 Accuracy classes to IEC 60584 and ANSI MC96.1

IEC 60584	Class	Temperature range	Maximum deviation
K (NiCr-Ni)	2	-40 ... 333 °C	±2.5 °C
		333 ... 1200 °C	±0.0075 x [t]
	1	-40 ... 375 °C	±1.5 °C
		375 ... 1000 °C	±0.0040 x [t]
J (Fe-CuNi)	2	-40 ... 333 °C	±2.5 °C
		333 ... 750 °C	±0.0075 x [t]
	1	-40 ... 375 °C	±1.5 °C
		375 ... 750 °C	±0.0040 x [t]
N (NiCrSi-NiSi)	2	-40 ... 333 °C	±2.5 °C
		333 ... 1200 °C	±0.0075 x [t]
	1	-40 ... 375 °C	±1.5 °C
		375 ... 1000 °C	±0.0040 x [t]

ANSI MC 96.1	Class	Temperature range	Maximum deviation
K (NiCr-Ni)	Standard	-0 ... 293 °C	±2.2 °C
		293 ... 1250 °C	±0.0075 x [t]
	Special	-0 ... 275 °C	±1.1 °C
		275 ... 1250 °C	±0.0040 x [t]
J (Fe-CuNi)	Standard	-0 ... 293 °C	±2.2 °C
		293 ... 750 °C	±0.0075 x [t]
	Special	-0 ... 275 °C	±1.1 °C
		275 ... 750 °C	±0.0040 x [t]
N (NiCrSiNiSi)	Standard	-0 ... 293 °C	±2.2 °C
		293 ... 1250 °C	±0.0075 x [t]
	Special	-0 ... 275 °C	±1.1 °C
		275 ... 1250 °C	±0.0040 x [t]

## 2.2.2 Versions

Basic versions  
Vibration-resistant up to 60 g

	1xK	2xK	1xJ	2xJ	1xN	2xN
3 mm, class 2	●	●	●	●		
3 mm, class 1	●	●	●	●		
6 mm, class 2	●	●	●	●	●	●
6 mm, class 1	●	●	●	●	●	●

## 2.3 Insulation resistance of measuring inset

IEC 60751 requires a measurement between fitting and measurement circuit with at least 100 V DC and an insulation resistance in excess of 100 MΩ. Test conditions at ABB are more stringent, requiring 500 V DC and  $R_{iso} \geq 500 \text{ M}\Omega$  at an ambient temperature of 15 ... 35 °C (59 ... 95 °F) and air humidity of less than 80 %.

## 2.4 Response times

The thermowell used in each application and the thermal contact between thermowell and measuring inset have an impact on the response times of TSP temperature sensors. In the case of TSP121 and TSP131 temperature sensors, the design of the thermowell tip has been adapted to the measuring inset. This maximizes heat transmission.

The following table shows typical response times for the SensyTemp TSP series, measured in accordance with IEC 60751 in water with 0.4 m/s and a temperature rise from 25 °C (77 °F) to 35 °C (95 °F).

### Resistance thermometer

Thermowell form	Diameter [mm]	t <sub>0.5</sub> [s]	t <sub>0.9</sub> [s]
2, 2G, 2F, 2G0	9 x 1	25	77
	11 x 2	23	64
3, 3G, 3F	9 mm tip	15	38
2S, 2GS, 2FS, 2GS0	6 mm tip	21	55

### Thermocouples

Thermowell form	Diameter [mm]	t <sub>0.5</sub> [s]	t <sub>0.9</sub> [s]
2, 2G, 2F, 2G0	9	10	24
	11	12	28
3, 3G, 3F	12	12	24
2S, 2GS, 2FS, 2GS0	12	6	14
	14	6	14

### 3 Thermowells

#### Thermowell functions

- Protection against aggressive media, high process pressures, and high flow rates
- Replacement or recalibration of the measuring unit without interrupting the process

Depending on the medium, temperature, and process pressure, several different designs and materials are available. The thermowells are divided into 2 categories:

- Welded protective fittings manufactured from pipe material for TSP121
- Drilled thermowells manufactured from bar stock material for TSP131

Available in accordance with DIN 43772 or ABB standard.

#### Use in highly aggressive media

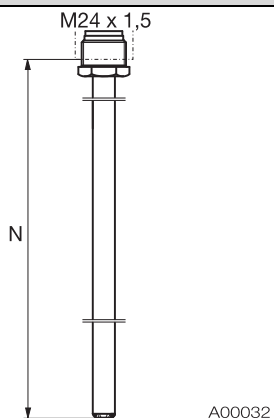
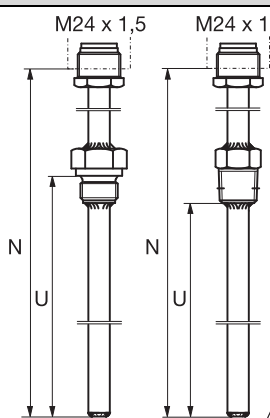
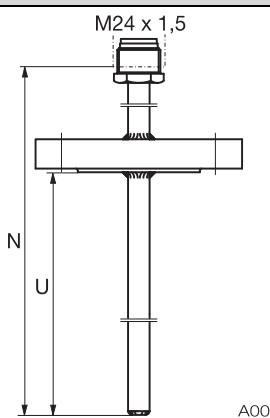
- A special coating can be applied to stainless steel flange thermowells, e.g., 0.5 mm (0.02 inch) E-CTFE.

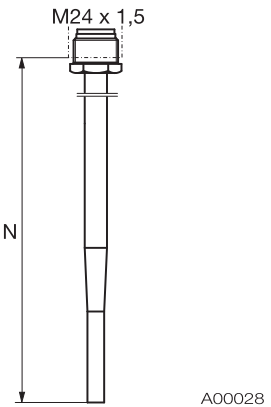
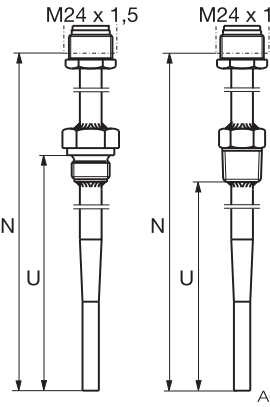
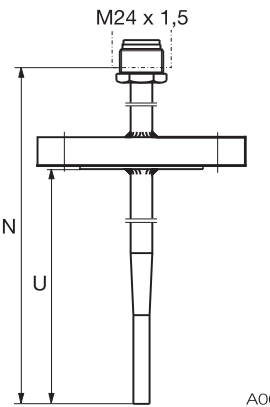
#### Use in highly corrosive applications

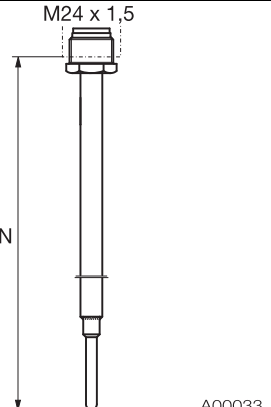
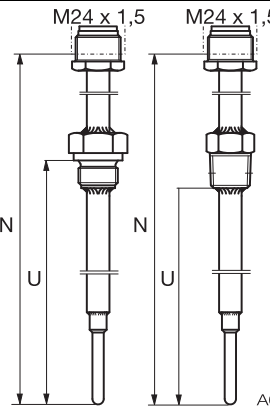
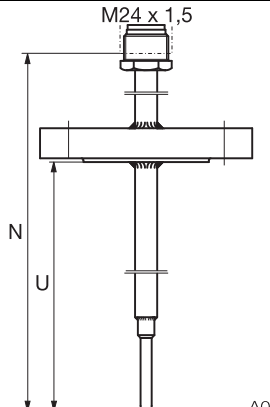
- Thermowells can also be given a tantalum sheath consisting of a single-sided, closed tube with a 13 mm (0.51 inch) diameter and flange disc. Requirements:
  - TSP121 with flange thermowell (form 2F or 3F)
  - Diameter 12 mm (0.47 inch)
  - Material 1.4571 or 1.4404

Standard lengths for welded thermowells	
N = 230 mm (9.06 inch)	U = 100 mm (3.94 inch)
N = 290 mm (11.42 inch)	U = 160 mm (6.3 inch)
N = 380 mm (14.96 inch)	U = 250 mm (9.84 inch)
N = 530 mm (20.87 inch)	U = 400 mm (15.75 inch)

#### 3.1 Tubular thermowells

Thermowell type	DIN 43772 – Form 2		DIN 43772 – Form 2G		DIN 43772 – Form 2F
Thermowell form	 <p style="text-align: right;">A00032</p>		 <p style="text-align: right;">A00030</p>		 <p style="text-align: right;">A00029</p>
Design	Straight shaft		Straight shaft		Straight shaft
Material Diameter	1.4571 1.4404	12, 14 12, 14	1.4571 1.4404 2.4819 <sup>1)</sup>	9, 11, 12, 14 12, 14 13,7	1.4571 1.4404 2.4819 <sup>2)</sup>
Measuring inset diameter	SR-Ø 12: 6 SR-Ø 12: 6		SR-Ø 9, 11, 12, 13,7: 6 SR-Ø 14: 6		SR-Ø 11, 12, 13,7: 6 SR-Ø 14: 6

Thermowell type	DIN 43772 – Form 3		DIN 43772 – Form 3G		DIN 43772 – Form 3F	
Thermowell form						
Design	Tapered tip		Tapered tip		Tapered tip	
Material	1.4571	12/9	1.4571	12/9	1.4571	12/9
Diameter (shaft / tip)	1.4404	12/9	1.4404	12/9	1.4404	12/9
Measuring inset diameter	6		6		6	

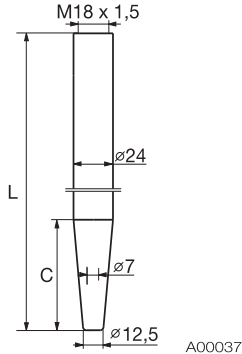
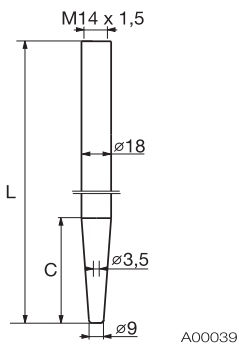
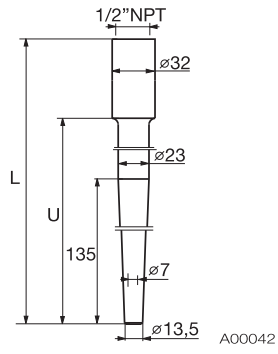
Thermowell type	ABB – Form 2S		ABB – Form 2GS		ABB – Form 2FS	
Thermowell form						
Design	Stepped tip		Stepped tip		Stepped tip	
Material	1.4571	12/6, 14/6	1.4571	11/6, 12/6, 14/6	1.4571	11/6, 12/6, 14/6
Diameter (shaft / tip)	1.4404	12/6, 14/6	1.4404	12/6, 14/6	1.4404	12/6, 14/6
			2.4819 <sup>1)</sup>	13,7/6	2.4819 <sup>2)</sup>	13,7/6
Measuring inset diameter	3		3		3	

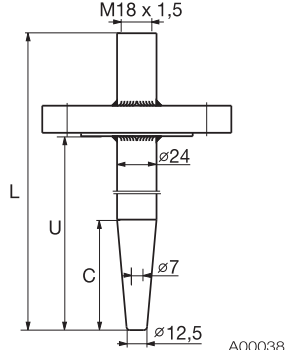
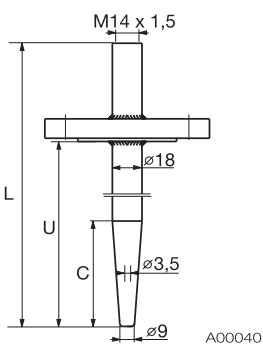
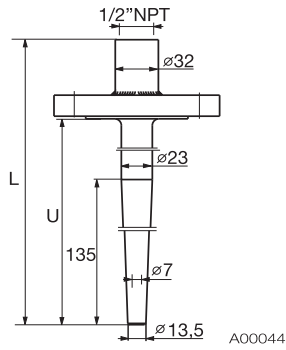
Thermowell type	ABB – 2G0		ABB – 2GS0	
Thermowell form				
Design	No extension tube, straight shaft		No extension tube, stepped tip	
Material	1.4571 <sup>1)</sup>	9, 11	1.4571 <sup>1)</sup>	11/6
Diameter (shaft / tip)				
Measuring inset diameter	6		3	

Dimensions in mm

1) Only with G1/2A, 1/2" NPT thread  
 2) 1.4571 flange, 2.4819 flange disc

3.2 Drilled thermowells

Thermowell form / Thermowell type	DIN 43772 - Form 4 - M18 x 1.5	ABB – Form 4S (DIN 43772 – Form 4 - M14 x 1.5)	ABB - Form PW
	 A00037	 A00039	 A00042
Design	Weld-in thermowell	Weld-in thermowell	Weld-in thermowell
Material Diameter (shaft / tip)	1.4571, 1.4404, 24h7/12,5 1.7335, 1.5415	1.4571, 1.4404, 18h7/9 1.7335, 1.5415	1.4404, 1.4571, 2.4819, 32/13,5 1.4876, 2.4360, 2.4816
Standard lengths	L = 140 / C = 65 L = 200 / C = 65 L = 200 / C = 125 L = 260 / C = 125 L = 410 / C = 275	L = 110 / C = 65 L = 140 / C = 65	U = 100, 150, 200, 250, 300, 350 L = U + 65
Measuring inset diameter	6	3	6

Thermowell form / Thermowell type	DIN 43772 - Form 4F - M18 x 1.5	ABB – Form 4FS (DIN 43772 - Form 4FS M14 x 1.5)	ABB - Form PF
	 A00038	 A00040	 A00044
Design	Flange thermowell	Flange thermowell	Flange thermowell
Material Diameter (shaft / tip)	1.4571 24/12,5 1.4404	1.4571 18/9 1.4404	1.4404, 1.4571, 2.4819, 23/13,5 1.4876, 2.4360, 2.4816 <sup>1)</sup>
Standard lengths	U = 130 / L = 200 / C = 65 U = 190 / L = 260 / C = 125 U = 340 / L = 410 / C = 275		U = 100, 150, 200, 250, 300, 350 L = U + 65
Measuring inset diameter	6	3	6

Thermowell form / Thermowell type	ABB - Form PS		
	<p style="text-align: right;">A00043</p>	<p style="text-align: right;">A00041</p>	<p style="text-align: right;">A00045</p>
Design	Screw-in thermowell, 1" NPT thread	Screw-in thermowell, 3/4" NPT thread	Screw-in thermowell, 1/2" NPT thread
Material Diameter (shaft / tip)	1.4404, 1.4571, 2.4819, 25/16 1.4876, 2.4360, 2.4816	1.4404, 1.4571, 2.4819, 20/13,5 1.4876, 2.4360, 2.4816	1.4404, 1.4571, 2.4819, 17/13,5 1.4876, 2.4360, 2.4816
Standard lengths	U = 100, 150, 200, 250, 300, 350 L = U + 65	U = 100, 150, 200, 250, 300, 350 L = U + 65	U = 100, 150, 200, 250, 300, 350 L = U + 65
Measuring inset diameter	6	6	6

Dimensions in mm

1) 1.4876, 2.4360, 2.4816, 2.4819 with 1.4571-material flange and flange disc



### 3.3 Pressure and vibration resistance of thermowell

The permissible compressive loads for thermowells at various temperatures are illustrated in the following figures (thermowells conforming to DIN 43772).

The curves can also be applied to identical thermowell models.

#### Thermowell form 2 (material 1.4571)

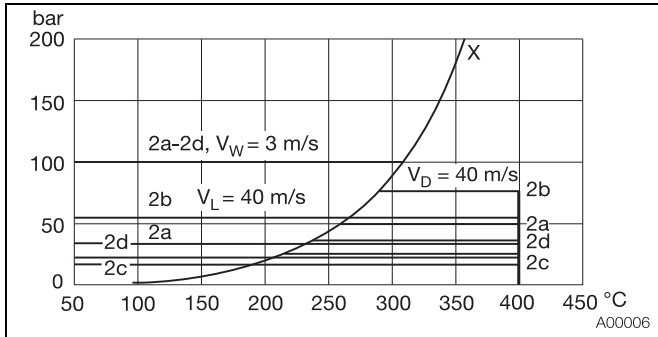


Fig. 1

X Vapor-pressure curve  
 VL Flow rate in air  
 Vw Flow rate in water  
 VD Flow rate in vapor

Curve	Insertion depth [mm]	Thermowell diameter [mm]
2a	250	11
2b	250	14
2c	400	11
2d	400	14

#### Thermowell form 3 (material 1.4571)

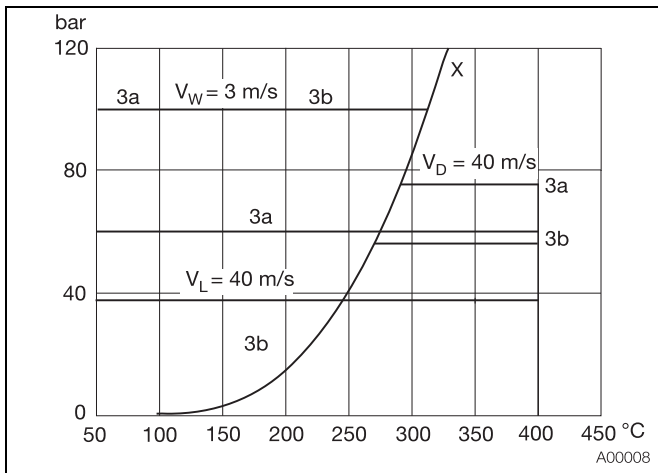


Fig. 2

X Vapor-pressure curve  
 VL Flow rate in air  
 Vw Flow rate in water  
 VD Flow rate in vapor

Curve	Insertion depth [mm]	Thermowell diameter [mm]
3a	225	12/9
3b	285	12/9

#### Thermowell form 4 (material 1.4571)

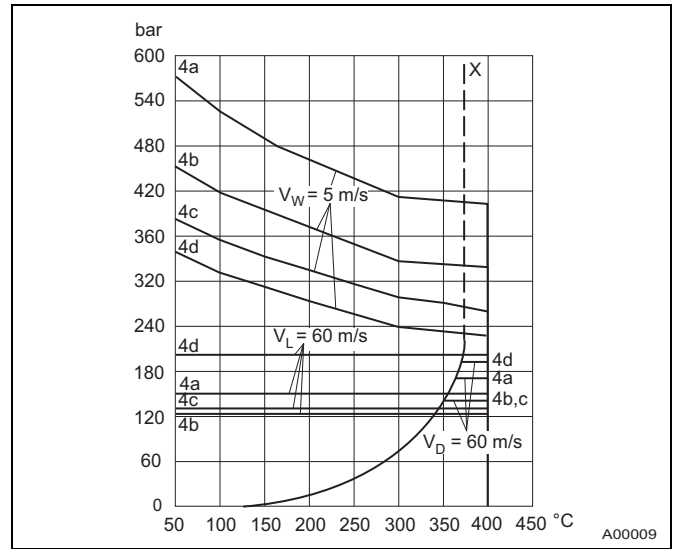


Fig. 3

X Vapor-pressure curve  
 VL Flow rate in air  
 Vw Flow rate in water  
 VD Flow rate in vapor

Curve	Insertion depth [mm]	Thermowell diameter [mm]
4a	65	18
4b	125	24
4c	125	26
4d	125	32

**Thermowell form 4 (material 1.7335 and 1.7380)**

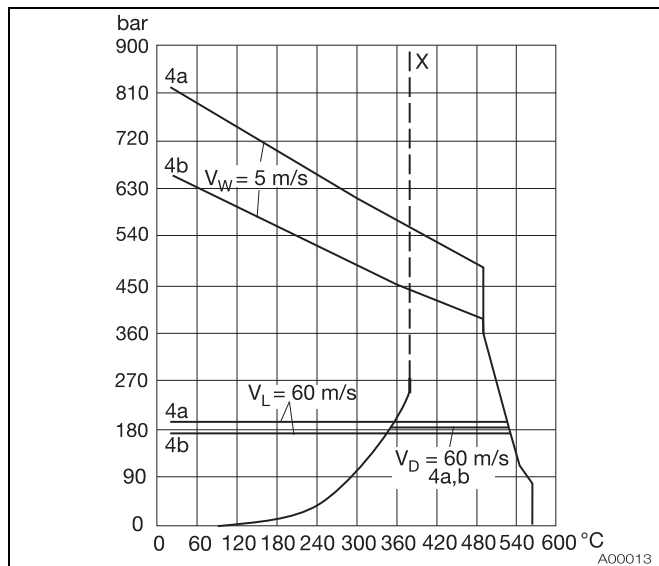


Fig. 4  
 X Vapor-pressure curve       $V_L$  Flow rate in air  
 $V_W$  Flow rate in water       $V_D$  Flow rate in vapor

Curve	Insertion depth [mm]	Thermowell diameter [mm]
4a	65	18
4b	125	24

**i Important**

The above diagrams have been taken from DIN 43772 and are based on the Dittrich calculation model. They do not take possible vibration caused by vortex excitation of the flowing medium into account.

ABB's standard thermowells are sufficiently robust for most industrial applications provided that design, material, and length are properly selected.

Most thermowell failures are caused by flow-related vibration. For this reason, ABB offers a stress analysis for ABB thermowells, based on the respective usage parameters.

The stress analysis conforms to ASME PTC 19.3. It is based on recognized theoretical methods and is intended to support thermowell selection.

It is not, however, a guarantee against failure of the thermowell.

Given the relatively unreliable computational estimation of the natural frequency of a thermowell and taking the numerous influencing factors into account, experimental testing is recommended in critical cases.

For more detailed information about thermowell loads and calculation methods, please see DIN 43772.

## 4 Process connections

### 4.1 SensyTemp TSP121 temperature sensor

#### 4.1.1 Weld-in / Plug-in thermowells

Type	Compression fitting
Straight form (DIN 43772 – 2)	G 1/2A, 1/2" NPT
Tapered tip (DIN 43772 – 3)	
Stepped tip (ABB – 2S)	



#### Important

All ABB compression fittings are manufactured from stainless steel and are supplied without material confirmation with acceptance certificate in accordance with EN 10204.

#### 4.1.2 Screw-in thermowells

Type	Screw-in thread
Straight form (DIN 43772 – 2G)	G 1/2"A, G 3/4"A, G 1"A, 1/2" NPT, 3/4" NPT, 1" NPT, M20 x 1,5, M27 x 2, 1/2" BSPT, 3/4" BSPT, 1" BSPT
Tapered tip (DIN 43772 – 3G)	
Stepped tip (ABB – 2GS)	
No ext. tube (ABB – 2G0)	G1/2A, 1/2" NPT
No ext. tube, stepped tip (ABB – 2GS0)	

#### 4.1.3 Flange thermowells

Type	B1 flange, EN 1092-1	RF flange, ANSI / ASME B16.5	Tri-Clamp flange BS 4825
Straight form (DIN 43772 – 2F)	DN25 PN40, DN40 PN40, DN50 PN40	1" 150 lbs., 1" 300 lbs., 1,5" 150 lbs., 1,5" 300 lbs., 1,5" 600 lbs., 2" 150 lbs., 2" 300 lbs., 2" 600 lbs	1.5", 2", 2.5", 3", 4"
Tapered tip (DIN 43772 – 3F)			
Stepped tip (ABB – 2FS)			

### 4.2 SensyTemp TSP131 temperature sensor

#### 4.2.1 Screw-in thermowells

Type	Screw-in thread
Thermowell manufactured from bar stock material (ABB - PS)	1/2" NPT, 3/4" NPT, 1" NPT

#### 4.2.2 Flange thermowells

Type	B1 flange, EN 1092-1	RF flange, ANSI / ASME B16.5	Tri-Clamp flange BS 4825
Thermowell manufactured from bar stock material (ABB - PF)	DN25 PN40, DN40 PN40, DN50 PN40	1" 150 lbs., 1" 300 lbs., 1,5" 150 lbs., 1,5" 300 lbs., 1,5" 600 lbs., 2" 150 lbs., 2" 300 lbs., 2" 600 lbs.	2", 2.5", 3", 4"
Thermowell manufactured from bar stock material (DIN 43772 – 4F, F2 = 24 mm)			
Thermowell manufactured from bar stock material, fast-acting (DIN 43772 – 4F, F2 = 18 mm, ABB – 4FS)			1.5", 2", 2.5", 3", 4"

## 5 Extension tubes

The extension tube is the component between thermowell and connection head. It is used to bridge existing insulation or serves as a cooling section between the transmitter's temperature-sensitive electronics (in the connection head) and the process. The relation illustrated in Fig. 3 led to the selection of the standard extension tube with a length  $K = 130$  mm (5.12 inch). If the two threads are manufactured in one part (known as a double nipple), a minimum length of  $K = 25$  mm (0.98 inch) is possible.

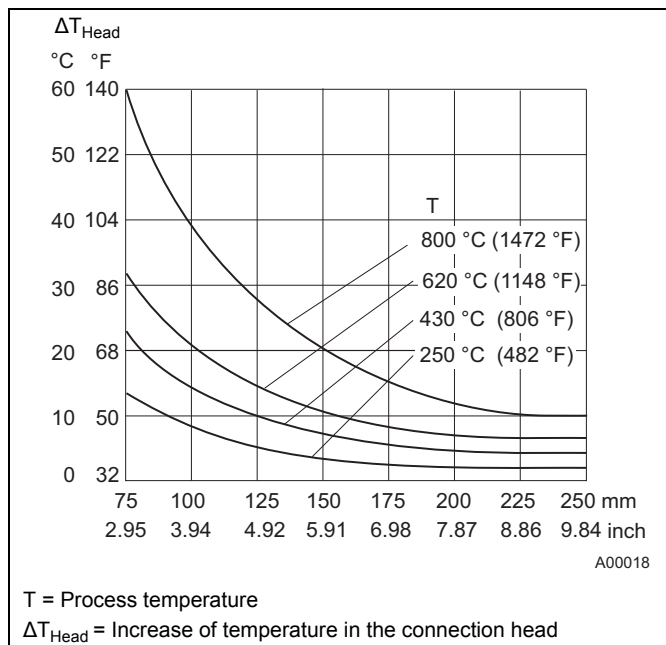
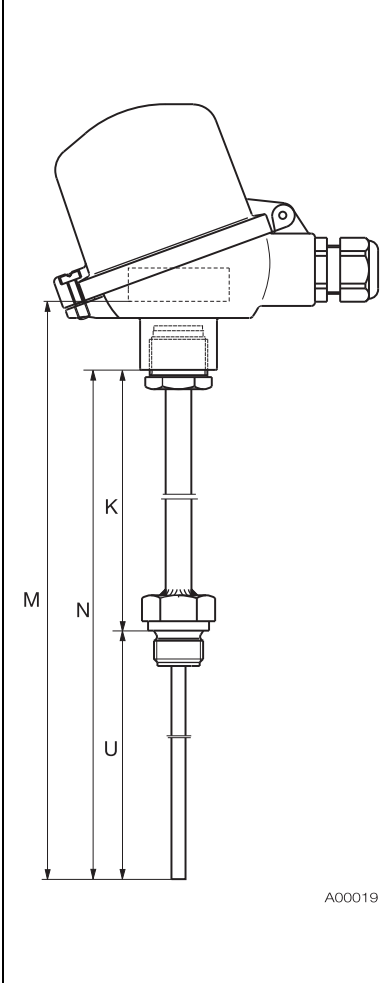
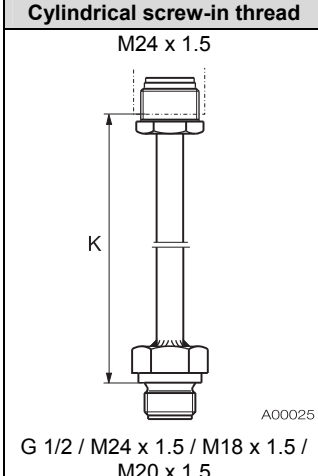
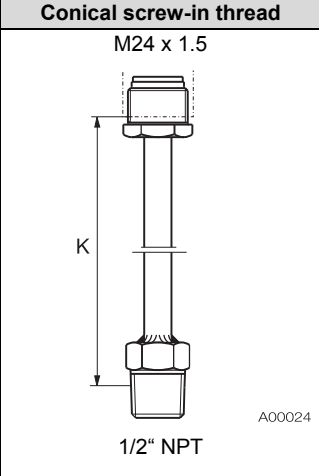
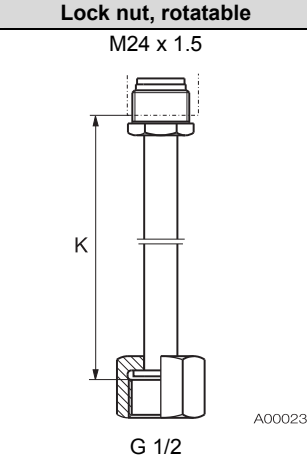
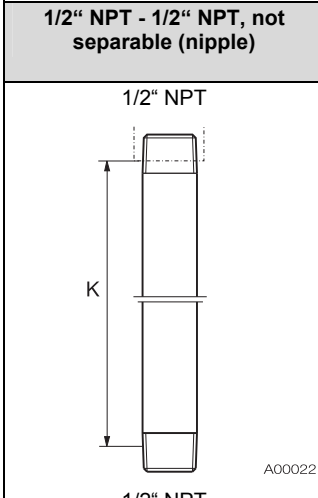
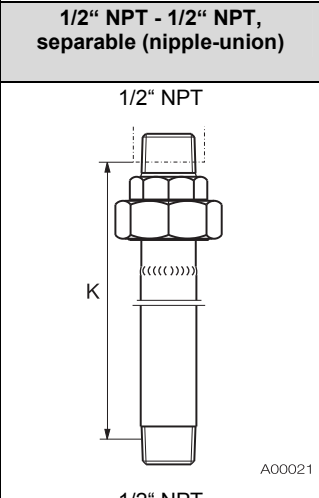
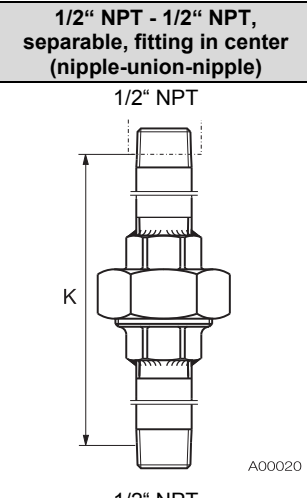


Fig. 3: Diagram illustrating extension tube length

## 5.1 Extension tube models

	Cylindrical screw-in thread	Conical screw-in thread	Lock nut, rotatable
	M24 x 1.5  A00025 G 1/2 / M24 x 1.5 / M18 x 1.5 / M20 x 1.5	M24 x 1.5  A00024 1/2" NPT	M24 x 1.5  A00023 G 1/2
	1/2" NPT - 1/2" NPT, not separable (nipple)	1/2" NPT - 1/2" NPT, separable (nipple-union)	1/2" NPT - 1/2" NPT, separable, fitting in center (nipple-union-nipple)
1/2" NPT  A00022 1/2" NPT	1/2" NPT  A00021 1/2" NPT	1/2" NPT  A00020 1/2" NPT	

When the "no ext. tube" design is ordered, an ext. tube length of  $K = 0$  mm is assumed. As a result, only  $U$  needs to be specified. In this case, the installation length  $U$  is the same as the nominal length  $N$ .

## 6 Connection heads

### Functions of the connection head

- Housing for a transmitter or a terminal block
- Protection of the connection area against adverse environmental effects

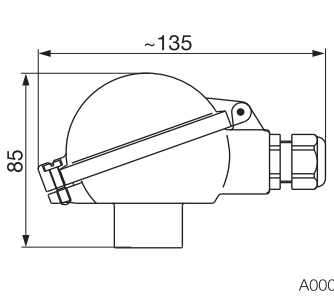
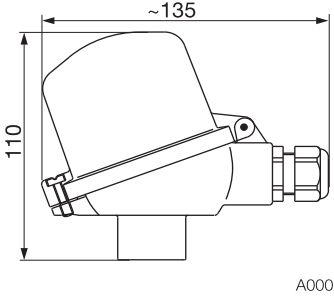
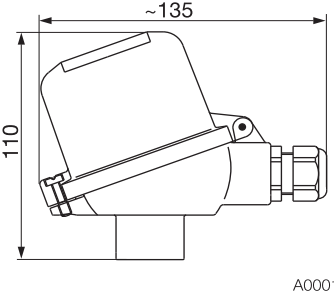
All ABB standard heads provide ingress protection of at least IP 66, in combination with an ABB thermowell and the M20 x 1.5 cable gland (supplied).

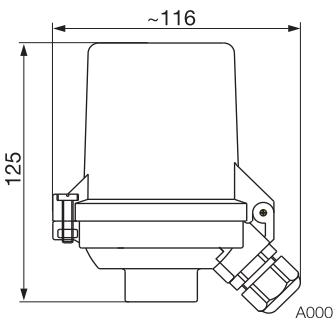
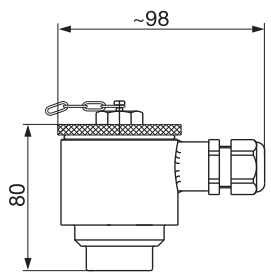
### **i** Important

The cable glands used are suitable for permanent cable installation.

As an option, the connection heads are also available with a cable entry with a 1/2" NPTF thread (without cable gland). In this case, the user must put appropriate measures in place to ensure that the required ingress protection level is maintained.

Several connection heads are available, manufactured from various materials and with different cap locking systems.

Head form	BUZ	BUZH	BUZHD
			
Material	Aluminum, epoxy-coated		
Cover locking system	Hinged cover		
Cable gland	M20 x 1.5, optional cable entry 1/2" NPTF, without cable gland		
Ingress protection	IP 66		
Built-in LCD indicator	No	No	Yes
Transmitter mounting	On the measuring inset	In the cap (mounting on the measuring inset available as an option)	On the measuring inset

Head form	BUKH	BEG
		
Material	Polyamide	Stainless steel
Cover locking system	Hinged cover	Screw-on cap
Cable gland	M20 x 1.5, optional cable entry 1/2" NPTF, without cable gland	
Ingress protection	IP 66	
Built-in LCD indicator	No	No
Transmitter mounting	In the cap (mounting on the measuring inset available as an option)	On the measuring inset

Dimensions in mm

### 6.1 Ambient temperature at connection head

Connection head without transmitter	-40 ... 130 °C (-40 ... 266 °F)
Connection head with transmitter	-40 ... 85 °C (-40 ... 185 °F)
Connection head with LCD indicator	-20 ... 70 °C (-4 ... 158 °F)

The most commonly used cable gland is suited to temperatures between -20 and 100 °C (-4 ... 212 °F). For temperatures outside this range, an appropriate cable gland can be installed.






## 7 Transmitter

Installing a transmitter has the following advantages:

- Cost reduction due to less wiring expense
- Magnification of the sensor signal at the measuring point and conversion to standard signal format (thereby increasing the signal's interference immunity)
- Option to install an LCD indicator in the connection head
- SIL2 with appropriately classified transmitter

The output signal of a temperature sensor is determined by the selection of the corresponding transmitter. When using ABB transmitters, self-heating can be ignored.

The following output signals are available:

Type	
TR04 4 ... 20 mA	
TTH200 HART 4 ... 20 mA, HART	
TTH300 HART 4 ... 20 mA, HART	
TTH300 PA PROFIBUS PA	
TTH300 FF FOUNDATION Fieldbus H1	

## 8 Type A and type AS LCD indicator

The BUZHD connection head is equipped with a digital LCD indicator. A suitable transmitter is connected via an add-on interface cable.

We recommend using an LCD indicator with type AS display function if you are using a TTH200. If the TTH300 transmitter is selected, the type A LCD indicator can also be used for configuring it.

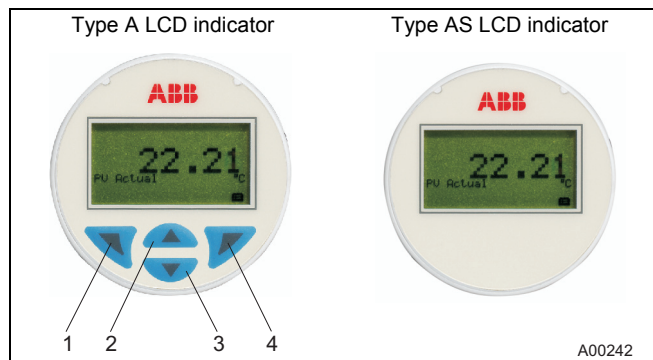


Fig. 4

- |                 |                  |
|-----------------|------------------|
| 1 Exit / Cancel | 3 Scroll forward |
| 2 Scroll back   | 4 Select         |

In the SensyTemp TSP300 temperature sensor series, it is possible to configure the TTH300 using a built-in display.

## 9 Functional safety (SIL)

SensyTemp TSP temperature sensors are available with a certificate of conformity for use in safety-relevant applications up to and including SIL Level 2.

This applies both for temperature sensors without transmitters and those with built-in SIL-certified transmitters.

Information regarding functional safety for SensyTemp TSP temperature sensors can be found in the SIL safety instructions.

## 10 Ex relevant specifications

### 10.1 Intrinsic safety ATEX "Ex i"

For use in thermowells, the surface temperature on the thermowell is correspondingly lower.

The operator assumes responsibility for correct and proper installation when replacing the measuring inset in a thermometer. ABB requires the manufacturing number marked on the old part so that the conformity of the ordered design can be checked with the initial delivery and the valid approvals.

Max. inner inductivity:  $L_i = 15 \text{ mH/m}$

Max. inner capacitance:  $C_i = 280 \text{ pF/m}$

#### 10.1.1 Electrical power limit "EEx i"

The following electrical values must not be exceeded:

U <sub>i</sub> (input voltage)	I <sub>i</sub> (input current)
30 V	101 mA
25 V	158 mA
20 V	309 mA
P <sub>i</sub> (inner power) = according to calculation using thermal resistance R <sub>th</sub>	
L <sub>i</sub> (inner inductivity) = 15 μH per meter	
C <sub>i</sub> (inner capacitance) = 280 pF per meter	

#### 10.1.2 Thermal resistance

The following table lists thermal resistances for measuring insets with diameter 3.0 mm (0.12 inch) and 6.0 mm (0.24 inch). The values have been specified subject to the conditions "Gas with a flow velocity of 0 m/s" and "Measuring inset without or with an additional thermowell".

Thermal resistance R <sub>th</sub>	Measuring inset Ø 3 mm (0.12 inch)	Measuring inset Ø 6 mm (0.24 inch)
Without thermowell		
Resistance thermometer	200 K/W	84 K/W
Thermocouple	30 K/W	30 K/W
With thermowell		
Resistance thermometer	70 K/W	40 K/W
Thermocouple	30 K/W	30 K/W

K/W = Kelvin per watt

#### 10.1.3 Output power P<sub>o</sub>

Transmitter type	P <sub>o</sub>
TTH200 HART	≤ 38 mW
TTH300 HART	≤ 38 mW
TTH300 PA	≤ 38 mW
TTH300 FF	≤ 38 mW
TR04	≤ 383 mW

All other information required to prove intrinsic safety (U<sub>o</sub>, I<sub>o</sub>, P<sub>o</sub>, L<sub>o</sub>, C<sub>o</sub> etc.) can be taken from the EC type-examination certificates for the relevant transmitter models.

#### 10.1.4 Special requirements (temperature rise)

In the event of a fault, the temperature sensors will exhibit a temperature rise Δt as appropriate for the applied power. This temperature rise Δt must be taken into account with regard to the difference between process temperature and temperature class.

#### **i** Important

In the event of a fault (short circuit), the dynamic short-circuit current which occurs in the measurement circuit for a matter of milliseconds not relevant with regard to temperature rise. The permissible outer capacitance is based on the dynamic short-circuit current.

The temperature rise Δt can be calculated as follows:

$$\Delta t = R_{th} \times P_o \text{ [K/W} \times \text{W]}$$

Δt = Temperature rise

R<sub>th</sub> = Thermal resistance

P<sub>o</sub> = Output power

#### Example:

Resistance thermometer diameter 3 mm (0.12 inch) without thermowell

R<sub>th</sub> = 200 K/W,

TTHXXX temperature transmitter P<sub>o</sub> = 38 mW.

$$\Delta t = 200 \text{ K/W} \times 0.038 \text{ W} = 7.6 \text{ K}$$

Therefore, at a transmitter output power P<sub>o</sub> = 38 mW, the maximum temperature rise in the event of a fault is approximately 8 K.

This results in the following maximum process temperatures T<sub>medium</sub>:

#### Maximum process temperature T<sub>medium</sub> in Zone 0:

<b>T6 (85 °C)</b> 80 % = 68 °C	<b>T5 (100 °C)</b> 80 % = 80 °C	<b>T4 (135 °C)</b> 80 % = 108 °C
T <sub>medium</sub> = 60 °C	T <sub>medium</sub> = 72 °C	T <sub>medium</sub> = 100 °C
<b>T3 (200 °C)</b> 80 % = 160 °C	<b>T2 (300 °C)</b> 80 % = 240 °C	<b>T1 (450 °C)</b> 80 % = 360 °C
T <sub>medium</sub> = 152 °C	T <sub>medium</sub> = 232 °C	T <sub>medium</sub> = 352 °C

The surface temperature of Category 1 devices must not exceed 80 % of the ignition temperature of a flammable gas or liquid.

#### Possible process temperature T<sub>med</sub> in Zone 1:

<b>T6 (85 °C)</b> - 5 °C = 80 °C	<b>T5 (100 °C)</b> - 5 °C = 95 °C	<b>T4 (135 °C)</b> - 5 °C = 130 °C
T <sub>medium</sub> = 72 °C	T <sub>medium</sub> = 87 °C	T <sub>medium</sub> = 122 °C
<b>T3 (200 °C)</b> - 5 °C = 195 °C	<b>T2 (300 °C)</b> - 10 °C = 290 °C	<b>T1 (450 °C)</b> - 10 °C = 440 °C
T <sub>medium</sub> = 187 °C	T <sub>medium</sub> = 282 °C	T <sub>medium</sub> = 432 °C

To calculate the temperature classes for T6, T5, T4, and T3 deduct 5 K each; for T2 and T1, deduct 10 K each.



## 10.2 Dust ignition protection (enclosure)

The power feed can come from a power supply with intrinsically-safe output circuit of protection type "EEx ia IIB" or "EEx ia IIC", or can be non intrinsically safe. In the case of a non-intrinsically-safe power feed, the current is limited by an upstream fuse conforming to IEC 127 with a fuse nominal current of 32 mA.

Highest value for connection to an intrinsically-safe power supply unit of protection type "Ex ia IIB / IIC":



### Important

When using two transmitters and / or measuring insets, the sum of the voltages, currents, and outputs must not exceed the values specified in the EC type-examination certificate.

### 10.2.1 Thermal data

	Approved ambient temperature at connection head	Approved process temperature at thermowell	Maximum temperature at the process connection on the connection head side	Maximum surface temperature at the connection head	Maximum surface temperature at the thermowell
Category 1D or Category 1/2 with intrinsically-safe transmitter installed	-40 ... 85 °C (-40 ... 185 °F)	-40 ... 85 °C -40 ... 200 °C <sup>1)</sup> -40 ... 300 °C <sup>1)</sup> -40 ... 400 °C <sup>1)</sup>	85 °C 164 °C 251 °C 346 °C	120 °C	133 °C 200 °C 300 °C 400 °C
Category 1D or Category 1/2 with fuse protection of installed transmitter by means of external IEC fuse	-40 ... 85 °C (-40 ... 185 °F)	-40 ... 85 °C -40 ... 200 °C <sup>1)</sup> -40 ... 300 °C <sup>1)</sup> -40 ... 400 °C*	85 °C 164 °C 251 °C 346 °C	133 °C <sup>2)</sup> 150 °C <sup>3)</sup>	133 °C 200 °C 300 °C 400 °C
Category 1D or Category 1/2D Measurement circuit intrinsically-safe transmitter external or non-intrinsically-safe via external IEC fuse in the power feed circuit of the external transmitter	-40 ... 85 °C -40 ... 120 °C -40 ... 120 °C -40 ... 120 °C	-40 ... 85 °C -40 ... 200 °C -40 ... 300 °C -40 ... 400 °C	85 °C 200 °C 251 °C 346 °C	85 °C 200 °C 200 °C 200 °C	133 °C 200 °C 300 °C 400 °C

1) The user must take suitable measures to ensure that the maximum permissible ambient temperature of 85 °C (185 °F) at the connection head is not exceeded.

2) Fitted with a transmitter with and without display.

3) Fitted with two transmitters.

## 11 Approvals

TSP1X1 temperature sensors are approved for a variety of applications.

These range from metrological approvals to explosion-protection certification for individual countries as well as ATEX certificates valid throughout the EU.

Specifically, these are:

- ATEX EEx i                    PTB 01 ATEX 2200 X
- ATEX dust ignition protection            BVS 06 ATEX E 029
- Ex n - Zone 2 and 22        Manufacturer declaration no. 22 – 2006 X
- GOST Russia
- GOST Kazakhstan
- GOST Ukraine

### **i** Important

For devices with ATEX EEx d certification, refer to the documentation for the TSP3X1 temperature sensor.

### **i** Important

Temperature sensors with measuring insets that conform to the requirements of both the type-examination certificate for ATEX EEx i and Namur specification NE 24 are available on request.

## 12 Tests and certificates

To increase the safety and accuracy of your process, ABB provides a number of mechanical and electrical tests. The results of these tests are certified in accordance with EN 10204.

The following EN 10204 certificates are issued:

- Certificate of compliance 2.1 for order conformity
- Acceptance test certificate 3.1 for the following tests:
  - Material confirmation for wetted parts
  - Visual, dimensional, and functional checks for temperature sensor
  - Helium leak test for thermowell
  - X-ray inspection of thermowell for bore hole concentricity on request
  - Dye penetration test at the weld seams of the thermowell
  - Compression test of thermowell
  - Reference measurement for calibration of measuring inset
- Acceptance test certificate 3.2 is available on request

For measurements requiring extremely high accuracy, ABB can calibrate the temperature sensor in its own DKD calibration lab.

When DKD calibration is performed, a separate certificate is provided for each temperature sensor.

Reference measurements and DKD calibrations are performed on the measuring inset or, if applicable, on the transmitter.

To obtain accurate measurements, observe the minimum depth for the measuring inset.

- For low to medium temperatures: 100 ... 150 mm
- For temperatures above 500 °C (932 °F): 300 ... 350 mm

These are recommended values. If in doubt, your ABB partner is available for on-site assistance.

For reference measurements and DKD calibration, the individual characteristics of the temperature sensor can be calculated and a separate transmitter can be programmed based on freestyle characteristics.

Adjusting the transmitter to the sensor characteristic can considerably improve the measuring accuracy of the temperature sensor. This requires that measurements are taken at a minimum of three different temperatures.

## 13 Additional information

### 13.1 Supplementary documents

Device		Data sheet
<b>Temperature transmitter for sensor head mounting</b>		
TR04	4 ... 20 mA, fixed measuring range	10/11-8.14
TTH200 HART	4 ... 20 mA, HART	DS/TTH200
TTH300 HART	4 ... 20 mA, HART	DS/TTH300
TTH300 PA	PROFIBUS PA	DS/TTH300
TTH300 FF	FOUNDATION Fieldbus H1	DS/TTH300
<b>Interchangeable measuring insets</b>		
SensyTemp TSA101	measuring insets	DS/TSA101

### 13.2 Information about ordering information.

Order codes cannot be combined at will. Your ABB partner will be happy to answer any questions you might have regarding installation feasibility.

All documentation, declarations of conformity, and certificates are available in ABB's download area.

## 14 Ordering information

### 14.1 SensyTemp TSP111

		Main order number																								Add. order no.
Version number	1-6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26					
<b>SensyTemp temperature sensor</b>	<b>TSP111</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX			
<b>Explosion protection / Approvals</b>																								XX		
None		Y	0																							
Intrinsic safety: ATEX II 1 G EEx ia IIC T6 ... T1 - Zone 0, 1, 2		A	1																							
Dust ignition protection: ATEX II 1 D IP6X T133 ... T400 - Zone 20, 21, 22		A	3																							
Dust ignition protection and intrinsic safety: ATEX II 1 D IP6X T133 ... T400 and ATEX II 1 G EEx ia IIC T6 ... T1 - Zone 0, 1, 2, 20, 21, 22		1) A	4																							
ATEX II 3 G EEx nA II T6 ... T1 and ATEX II 3 D IP6X T133 ... T300 - Zone 2 and 22		1) B	1																							
Others		Z	9																							
<b>Ext. tube length K</b>																										
150 mm		K	1																							
Variable ext. tube length		Z	9																							
<b>Thermowell connection</b>																										
Parallel screw-in thread G 1/2 A		G	1																							
Parallel screw-in thread M14 x 1.5		M	1																							
Parallel screw-in thread M18 x 1.5		M	2																							
Parallel screw-in thread M20 x 1.5		M	3																							
Tapered screw-in thread 1/2 NPT		N	1																							
1/2 in NPT - 1/2 in NPT, not separable		N	2																							
1/2 in NPT - 1/2 in NPT, separable		N	3																							
Others		Z	9																							
<b>Installation length U</b>																										
U = 140 mm		U	2																							
U = 200 mm		U	4																							
U = 260 mm		U	6																							
Acc. to customer requirements		Z	9																							
<b>Measuring inset type</b>																										
Basic version, thin film measurement resistor, measuring range -50 ... 400 °C, vibration resistance 10 g		S	1																							
Resistance thermometer, thin film measurement resistor, measuring range -50 ... 400 °C, vibration resistance 60 g		S	2																							
Resistance thermometer, extended measuring range -196 ... 600 °C, wire-wound measurement resistor, vibration resistance 10 g		D	1																							
Resistance thermometer, extended measuring range -196 ... 600 °C, wire-wound measurement resistor, vibration resistance 3 g		D	2																							
Thermocouple		T	1																							
Others		Z	9																							

1) Use in explosive hybrid mixtures (where explosive dusts and gases are present simultaneously) is not currently permitted in accordance with EN 60079-0 and EN 61241-0.

Continued on next page

	Main order number																		Add. order no.			
Version number	1 - 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
<b>SensyTemp temperature sensor</b>	<b>TSP111</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX
<b>Measuring inset diameter</b>																						
3 mm												D	3									
6 mm												D	6									
8 mm, with 80 mm long sleeve, to DIN 43735												H	8									
10 mm, with 80 mm long sleeve												H	1									
Others												Z	9									
<b>Sensor type and circuit type</b>																						
1 x Pt100, two-wire														P	1							
1 x Pt100, three-wire														P	2							
1 x Pt100, four-wire														P	3							
2 x Pt100, two-wire														P	4							
2 x Pt100, three-wire														P	5							
2 x Pt100, four-wire														P	6							
1 x type K (NiCr-Ni)														K	1							
2 x type K (NiCr-Ni)														K	2							
1 x type J (Fe-CuNi)														J	1							
2 x type J (Fe-CuNi)														J	2							
1 x type N (NiCrSi-NiSi)														N	1							
2 x type N (NiCrSi-NiSi)														N	2							
Others														Z	9							
<b>Sensor accuracy</b>																						
Class B to IEC 60751																						B 2
Class A to IEC 60751, measuring range -30 ... 300 °C																						S 1
Class A to IEC 60751, measuring range -196 ... 500 °C																						D 1
Class 2 to IEC 60584																						T 2
Class 1 to IEC 60584																						T 1
Class AA to IEC 60751, measuring range 0 ... 100 °C																						S 3
Others																						Z 9
<b>Connection head</b>																						
BUZ / Aluminum, with hinged cover																						B 1
BUZH / Aluminum, with upper hinged cover																						B 2
BUZHD / Aluminum, with upper hinged cover and display																						B 3
BUKH / Plastic, with upper hinged cover																						K 1
BEG / Stainless steel, with screw-on cover																						E 1
Others																						Z 9

Continued on next page

		Main order number																				Add. order no.			
Version number		1 - 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	XX	XX	
<b>SensyTemp temperature sensor TSP111</b>		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
<b>Transmitter</b>																									
Without transmitter, measuring inset with ceramic terminal bloc																							Y	1	
Without transmitter, measuring inset with flying leads																								Y	2
TR04, fixed measuring range, 4 ... 20 mA																								R	1
TR04-Ex, fixed measuring range, 4 ... 20 mA																								R	2
TTH200 HART, adjustable, 4 ... 20 mA																								H	6
TTH200 HART-Ex, adjustable, 4 ... 20 mA																								H	7
TTH300 HART, adjustable, 4 ... 20 mA																								H	4
TTH300 HART-Ex, adjustable, 4 ... 20 mA																								H	5
TTH300 PA, adjustable, PROFIBUS PA																								P	6
TTH300 PA-Ex, adjustable, PROFIBUS PA																								P	7
TTH300 FF, adjustable, FOUNDATION Fieldbus H1																								F	6
TTH300 FF-Ex, adjustable, FOUNDATION Fieldbus H1																								F	7
Others																								Z	9
<b>Inscription plate</b>																									
Stainless steel plate with TAG no.																									T1
<b>Certificates</b>																									
TÜV certificate for functional safety SIL2 to IEC 61508																									CS
Declaration of compliance 2.1 to EN 10204 with order																									C4
Inspection test certificate 3.1 to EN 10204 for visual, dimensional, and functional checks																									C6
Inspection test certificate 3.1 to EN 10204 for sensor calibration 1 x Pt100																									CD
Inspection test certificate 3.1 to EN 10204 for sensor calibration 2 x Pt100																									CE
Inspection test certificate 3.1 to EN 10204 for sensor calibration 1 x thermocouple																									CF
Inspection test certificate 3.1 to EN 10204 for sensor calibration 2 x thermocouple																									CG
DKD calibration 1 x Pt100 with calibration certificate for each thermometer																									CH
DKD calibration 2 x Pt100 with calibration certificate for each thermometer																									CJ
DKD calibration 1 x thermocouple with calibration certificate for each thermometer																									CK
DKD calibration 2 x thermocouple with calibration certificate for each thermometer																									CL
Others																									CZ
<b>Temperatures for sensor calibration</b>																									
0 °C / 32 °F																									V1
100 °C / 212 °F																									V2
400 °C / 752 °F																									V3
0 °C and 100 °C / 32 °F and 212 °F																									V4
0 °C and 400 °C / 32 °F and 752 °F																									V5
0 °C, 100 °C, and 200 °C / 32 °F, 212 °F, and 392 °F																									V7
0 °C, 200 °C, and 400 °C / 32 °F, 392 °F, and 752 °F																									V8
Acc. to customer specifications																									V6

Continued on next page

Main order number																				Add. order no.	
1-6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	XX
<b>TSP111</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	<b>XX</b>
<b>Temperatures for DKD calibration</b>																					
0 °C / 32 °F																				D1	
100 °C / 212 °F																				D2	
400 °C / 752 °F																				D3	
0 °C and 100 °C / 32 °F and 212 °F																				D4	
0 °C and 400 °C / 32 °F and 752 °F																				D5	
0 °C, 100 °C, and 200 °C / 32 °F, 212 °F, and 392 °F																				D7	
0 °C, 200 °C, and 400 °C / 32 °F, 392 °F, and 752 °F																				D8	
Acc. to customer specifications																				D6	
<b>Cable entry options</b>																					
1 x 1/2 in NPT, without cable gland																				U2	
Others																				UZ	
<b>Measuring range of the transmitter</b>																					
-30 ... 60 °C																				A1	
-20 ... 40 °C																				A2	
0 ... 40 °C																				A3	
0 ... 60 °C																				A4	
0 ... 100 °C																				A5	
0 ... 120 °C																				A6	
0 ... 150 °C																				A7	
0 ... 200 °C																				A8	
0 ... 250 °C																				AF	
0 ... 300 °C																				AG	
0 ... 400 °C																				AH	
0 ... 600 °C																				AJ	
0 ... 800 °C																				AK	
0 ... 1000 °C																				AL	
Others																				AZ	

14.2 SensyTemp TSP121

Version number	Main order number																															Add. order no.
	1	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					
<b>SensyTemp temperature sensor TSP121</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX		
<b>Explosion protection / Approvals</b>																														XX		
None			Y	0																												
Intrinsic safety: ATEX II 1 G EEx ia IIC T6 ... T1 - Zone 0, 1, 2			A	1																												
Dust ignition protection: ATEX II 1 D IP6X T133 ... T400 - Zone 20, 21, 22			A	3																												
Dust ignition protection and intrinsic safety: ATEX II 1 D IP6X T133 ... T400 and ATEX II 1 G EEx ia IIC T6 ... T1 - Zone 0, 1, 2, 20, 21, 22			1) A	4																												
ATEX II 3 G EEx nA II T6 ... T1 and ATEX II 3 D IP6X T133 ... T300 - Zone 2 and 22			1) B	1																												
Others			Z	9																												
<b>Material for wetted parts</b>																																
Stainless steel 1.4404 / 316 L					S	1																										
Stainless steel 1.4571 / 316 Ti					S	2																										
Hastelloy C-276 / 2.4819 (stainless steel flange with flange disc manufactured from Hastelloy C-276)					N	1																										
Others					Z	9																										
<b>Thermowell type</b>																																
Straight thermowell (form 2 to DIN 43772)					A	1																										
Straight flange thermowell (form 2F to DIN 43772)					A	2																										
Straight screw-in thermowell (form 2G to DIN 43772)					A	3																										
Tapered thermowell (form 3 to DIN 43772)					C	1																										
Tapered flange thermowell (form 3F to DIN 43772)					C	2																										
Tapered screw-in thermowell (form 3G to DIN 43772)					C	3																										
Thermowell with stepped tip (ABB form 2S)					B	1																										
Flange thermowell with stepped tip (ABB form 2FS)					B	2																										
Screw-in thermowell with stepped tip (ABB form 2GS)					B	3																										
Screw-in thermowell, no ext. tube (ABB form 2G0)					A	4																										
Screw-in thermowell with stepped tip, no ext. tube (ABB form 2GS0)					B	4																										
Others					Z	9																										

1) Use in explosive hybrid mixtures (where explosive dusts and gases are present simultaneously) is not currently permitted in accordance with EN 60079-0 and EN 61241-0.

Continued on next page



	Main order number																															Add. order no.		
	Version number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		31	
<b>SensyTemp temperature sensor</b>	<b>TSP121</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX
<b>Process connection</b>																																		XX
Without process connection																	Y	0	0															
Adjustable compression fitting G 1/2 A																	A	0	1															
Adjustable compression fitting 1/2 NPT																	A	0	2															
Parallel screw-in thread G 1/2 A																	S	0	1															
Parallel screw-in thread G 3/4 A																	S	0	2															
Parallel screw-in thread G 1 A																	S	0	3															
Tapered screw-in thread 1/2 NPT																	S	0	4															
Tapered screw-in thread 3/4 NPT																	S	0	5															
Tapered screw-in thread 1 NPT																	S	0	6															
Parallel screw-in thread M20 x 1.5																	S	0	7															
Parallel screw-in thread M27 x 2																	S	0	8															
Tapered screw-in thread 1/2 BSPT																	S	0	9															
Tapered screw-in thread 3/4 BSPT																	S	1	0															
Tapered screw-in thread 1 BSPT																	S	1	1															
Flange DN25 PN10 ... PN40, to EN 1092-1																	F	0	3															
Flange DN40 PN10 ... PN40, to EN 1092-1																	F	0	4															
Flange DN50 PN10 ... PN40, to EN 1092-1																	F	0	5															
Flange 1 in 150 lbs, to ANSI/ASME B16.5																	F	0	7															
Flange 1 in 300 lbs, to ANSI/ASME B16.5																	F	0	8															
Flange 1.5 in 150 lbs, to ANSI/ASME B16.5																	F	1	1															
Flange 1.5 in 300 lbs, to ANSI/ASME B16.5																	F	1	2															
Flange 1.5 in 600 lbs, to ANSI/ASME B16.5																	F	1	3															
Flange 2 in 150 lbs, to ANSI/ASME B16.5																	F	1	5															
Flange 2 in 300 lbs, to ANSI/ASME B16.5																	F	1	6															
Flange 2 in 600 lbs, to ANSI/ASME B16.5																	F	1	7															
Tri-Clamp flange 1 in ... 1.5 in, ISO 2852 DN15 ... DN25 / DIN 32676 DN25 ... DN40 / BS 4825																	T	0	1															
Tri-Clamp flange 2 in, ISO 2852 DN32 ... DN40 / DIN 32676 DN50 / BS 4825																	T	0	2															
Tri-Clamp flange 2.5 in, ISO 2852 DN50 / BS 4825																	T	0	3															
Tri-Clamp flange 3 in, ISO 2852 DN65 / DIN 32676 DN65 / BS 4825																	T	0	4															
Tri-Clamp flange 4 in, DIN 32676 DN100 / BS 4825																	T	0	5															
Others																	Z	9	9															
<b>Thermowell diameter</b>																																		
9 mm																	A	1																
11 mm																	A	2																
12 mm																	A	3																
14 mm																	A	4																
13,7 mm																	B	2																
Others																	Z	9																

Continued on next page

		Main order number																														XX	
Version number		1 - 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	XX					
<b>SensyTemp temperature sensor</b>		<b>TSP121</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX					
<b>Insertion length U</b>																															XX		
No fixed installation length															Y	0																	
U = 100 mm															U	1																	
U = 160 mm															U	3																	
U = 250 mm															U	5																	
U = 400 mm															U	7																	
Acc. to customer requirements															Z	9																	
<b>Nominal length N</b>																																	
N = 230 mm															N	1																	
N = 290 mm															N	3																	
N = 380 mm															N	5																	
N = 530 mm															N	7																	
Acc. to customer requirements															Z	9																	
<b>Measuring inset type</b>																																	
Basic version, thin film measurement resistor, measuring range -50 ... 400 °C, vibration resistance 10 g															S	1																	
Resistance thermometer, thin film measurement resistor, measuring range -50 ... 400 °C, vibration resistance 60 g															S	2																	
Resistance thermometer, extended measuring range -196 ... 600 °C, wire-wound measurement resistor, vibration resistance 10 g															D	1																	
Resistance thermometer, extended measuring range -196 ... 600 °C, wire-wound measurement resistor, vibration resistance 3 g															D	2																	
Thermocouple															T	1																	
Others															Z	9																	
<b>Sensor type and circuit type</b>																																	
1 x Pt100, two-wire															P	1																	
1 x Pt100, three-wire															P	2																	
1 x Pt100, four-wire															P	3																	
2 x Pt100, two-wire															P	4																	
2 x Pt100, three-wire															P	5																	
2 x Pt100, four-wire															P	6																	
1 x type K (NiCr-Ni)															K	1																	
2 x type K (NiCr-Ni)															K	2																	
1 x type J (Fe-CuNi)															J	1																	
2 x type J (Fe-CuNi)															J	2																	
1 x type N (NiCrSi-NiSi)															N	1																	
2 x type N (NiCrSi-NiSi)															N	2																	
Others															Z	9																	

Continued on next page

		Main order number																														Add. order no.		
Version number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	XX	
<b>SensyTemp temperature sensor TSP121</b>		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX	XX
<b>Sensor accuracy</b>																												<b>B</b>	<b>2</b>					
Class B to IEC 60751																												S	1					
Class A to IEC 60751, measuring range -30 ... 300 °C																												D	1					
Class A to IEC 60751, measuring range -196 ... 500 °C																												T	2					
Class 2 to IEC 60584																												T	1					
Class 1 to IEC 60584																												S	3					
Class AA to IEC 60751, measuring range 0 ... 100 °C																												Z	9					
Others																																		
<b>Connection head</b>																												B	1					
BUZ / Aluminum, with hinged cover																												<b>B</b>	<b>2</b>					
BUZH / Aluminum, with upper hinged cover																												B	3					
BUZHD / Aluminum, with upper hinged cover and display																												K	1					
BUKH / Plastic, with upper hinged cover																												E	1					
BEG / Stainless steel, with screw-on cover																												Z	9					
Others																																		
<b>Transmitter</b>																												Y	1					
Without transmitter, measuring inset with terminal bloc																												Y	2					
Without transmitter, measuring inset with flying leads																												R	1					
TR04, fixed measuring range, 4 ... 20 mA																												R	2					
TR04-Ex, fixed measuring range, 4 ... 20 mA																												H	6					
TTH200 HART, adjustable, 4 ... 20 mA																												H	7					
TTH200 HART-Ex, adjustable, 4 ... 20 mA																												H	4					
TTH300 HART, adjustable, 4 ... 20 mA																												H	5					
TTH300 HART-Ex, adjustable, 4 ... 20 mA																												P	6					
TTH300 PA, adjustable, PROFIBUS PA																												P	7					
TTH300 PA-Ex, adjustable, PROFIBUS PA																												F	6					
TTH300 FF, adjustable, FOUNDATION Fieldbus H1																												F	7					
TTH300 FF-Ex, adjustable, FOUNDATION Fieldbus H1																												Z	9					
Others																																		

Continued on next page

Main order number																															Add. order no.
1 - 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	XX					
<b>TSP121</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	<b>XX</b>				
<b>Name plate</b>																															
Stainless steel plate with TAG no.																								T1							
<b>Certificates</b>																															
TÜV certificate for functional safety SIL2 to IEC 61508																								CS							
Inspection test certificate 3.1 to EN 10204 material confirmation for wetted parts																								C2							
Declaration of compliance 2.1 to EN 10204 for order conformity																								C4							
Inspection test certificate 3.1 to EN 10204 for visual, dimensional, and functional checks																								C6							
Inspection test certificate 3.1 to EN 10204 for helium leak test																								C7							
Inspection test certificate 3.1 to EN 10204 for x-ray inspection																								C8							
Inspection test certificate 3.1 to EN 10204 for dye penetration test																								C9							
Inspection test certificate 3.1 to EN 10204 for compression test of thermowell																								CB							
Inspection test certificate 3.1 to EN 10204 for sensor calibration 1 x Pt100																								CD							
Inspection test certificate 3.1 to EN 10204 for sensor calibration 2 x Pt100																								CE							
Inspection test certificate 3.1 to EN 10204 for sensor calibration 1 x thermocouple																								CF							
Inspection test certificate 3.1 to EN 10204 for sensor calibration 2 x thermocouple																								CG							
DKD calibration 1 x Pt100 with calibration certificate for each thermometer																								CH							
DKD calibration 2 x Pt100 with calibration certificate for each thermometer																								CJ							
DKD calibration 1 x thermocouple with calibration certificate for each thermometer																								CK							
DKD calibration 2 x thermocouple with calibration certificate for each thermometer																								CL							
Others																								CZ							
<b>Temperatures for sensor calibration</b>																															
0 °C / 32 °F																								V1							
100 °C / 212 °F																								V2							
400 °C / 752 °F																								V3							
0 °C and 100 °C / 32 °F and 212 °F																								V4							
0 °C and 400 °C / 32 °F and 752 °F																								V5							
0 °C, 100 °C, and 200 °C / 32 °F, 212 °F, and 392 °F																								V7							
0 °C, 200 °C, and 400 °C / 32 °F, 392 °F, and 752 °F																								V8							
Acc. to customer specifications																								V6							
<b>Temperatures for DKD calibration</b>																															
0 °C / 32 °F																								D1							
100 °C / 212 °F																								D2							
400 °C / 752 °F																								D3							
0 °C and 100 °C / 32 °F and 212 °F																								D4							
0 °C and 400 °C / 32 °F and 752 °F																								D5							
0 °C, 100 °C, and 200 °C / 32 °F, 212 °F, and 392 °F																								D7							
0 °C, 200 °C, and 400 °C / 32 °F, 392 °F, and 752 °F																								D8							
Acc. to customer specifications																								D6							

Continued on next page

Main order number																															Add. order no.
1-6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	XX					
<b>TSP121</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	<b>XX</b>				
<b>Thermowell options</b>																															
Stainless steel with additional tantalum sheath																										S1					
Thermowell with 0.5 mm E-CTFE / Halar coating, wetted parts incl. flange sealing surface																										S2					
Special cleaning of the thermowell for oxygen applications																										S9					
Others																										SZ					
<b>Flange connection options</b>																															
Flange facing with form C (tongue) to EN 1092																										F1					
Flange facing with form D (groove) to EN 1092																										F2					
Flange facing form RTJ to ASME B16.5v																										F3					
Others																										FZ					
<b>Cable entry options</b>																															
1 x 1/2 in NPT, without cable gland																										U2					
Others																										UZ					
<b>Measuring range of the transmitter</b>																															
-30 ... 60 °C																										A1					
-20 ... 40 °C																										A2					
0 ... 40 °C																										A3					
0 ... 60 °C																										A4					
0 ... 100 °C																										A5					
0 ... 120 °C																										A6					
0 ... 150 °C																										A7					
0 ... 200 °C																										A8					
0 ... 250 °C																										AF					
0 ... 300 °C																										AG					
0 ... 400 °C																										AH					
0 ... 600 °C																										AJ					
0 ... 800 °C																										AK					
0 ... 1000 °C																										AL					
Others																										AZ					

14.3 SensyTemp TSP131

		Main order number																																Add. order no.
Version number	1 - 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	XX					
<b>SensyTemp temperature sensor TSP131</b>		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX				
<b>Explosion protection / Approvals</b>																																		
None			Y	0																														
Intrinsic safety: ATEX II 1 G																																		
EEx ia IIC T6 ... T1 - Zone 0, 1, 2			A	1																														
Dust ignition protection: ATEX II 1 D																																		
IP6X T133 ... T400 - Zone 20, 21, 22			A	3																														
Dust ignition protection and intrinsic safety: ATEX II 1 D IP6X T133 ... T400 and ATEX II 1 G EEx ia IIC T6 ... T1 - Zone 0, 1, 2, 20, 21, 22			1)	A	4																													
ATEX II 3 G EEx nA II T6 ... T1 and ATEX II 3 D IP6X T133 ... T300 - Zone 2 and 22			1)	B	1																													
Others			Z	9																														
<b>Material for wetted parts</b>																																		
Stainless steel 1.4404 / 316 L				S	1																													
Stainless steel 1.4571 / 316 Ti				S	2																													
Heat-resistant steel 1.7335 (13CrMo44)				W	1																													
Heat-resistant steel 1.5415 (15Mo3)				W	3																													
Hastelloy C-276 / 2.4819 (stainless steel flange with flange disc manufactured from Hastelloy C-276)				N	1																													
Others				Z	9																													
<b>Thermowell type</b>																																		
Weld-in thermowell manufactured from bar stock material to DIN 43772, form 4, F2 = 24 mm				D	1																													
Weld-in thermowell manufactured from bar stock material to DIN 43772, form 4, fast-acting, F2 = 18 mm (ABB form 4S)				D	2																													
Flange thermowell manufactured from bar stock material to DIN 43772, form 4F, F2 = 24 mm				D	3																													
Flange thermowell manufactured from bar stock material to DIN 43772, form 4F, fast-acting, F2 = 18 mm (ABB form 4FS)				D	4																													
Weld-in thermowell manufactured from bar stock material to ABB standard, form PW, F2 = 32 mm				P	1																													
Flange thermowell manufactured from bar stock material to ABB standard, form PF				P	2																													
Screw-in thermowell manufactured from bar stock material to ABB standard, form PS				P	3																													
Others				Z	9																													

1) Use in explosive hybrid mixtures (where explosive dusts and gases are present simultaneously) is not currently permitted in accordance with EN 60079-0 and EN 61241-0.

Continued on next page

Add.  
order  
no.

		Main order number																																						
Version number	1 - 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	XX											
<b>SensyTemp temperature sensor</b>	<b>TSP131</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX										
<b>Process connection</b>																																								
Without process connection								Y	0	0																														
Tapered screw-in thread 1/2 NPT								S	0	4																														
Tapered screw-in thread 3/4 NPT								S	0	5																														
Tapered screw-in thread 1 NPT								S	0	6																														
Flange DN25 PN10 ... PN40, to EN 1092-1								F	0	3																														
Flange DN40 PN10 ... PN40, to EN 1092-1								F	0	4																														
Flange DN50 PN10 ... PN40, to EN 1092-1								F	0	5																														
Flange 1 in 150 lbs, to ANSI/ASME B16.5								F	0	7																														
Flange 1 in 300 lbs, to ANSI/ASME B16.5								F	0	8																														
Flange 1.5 in 150 lbs, to ANSI/ASME B16.5								F	1	1																														
Flange 1.5 in 300 lbs, to ANSI/ASME B16.5								F	1	2																														
Flange 1.5 in 600 lbs, to ANSI/ASME B16.5								F	1	3																														
Flange 2 in 150 lbs, to ANSI/ASME B16.5								F	1	5																														
Flange 2 in 300 lbs, to ANSI/ASME B16.5								F	1	6																														
Flange 2 in 600 lbs, to ANSI/ASME B16.5								F	1	7																														
Tri-Clamp flange 1 in ... 1.5 in, ISO 2852																																								
DN15 ... DN25 / DIN 32676 DN25 ... DN40 / BS 4825								T	0	1																														
Tri-Clamp flange 2 in, ISO 2852 DN32 ... DN40 / DIN 32676 DN50 / BS 4825								T	0	2																														
Tri-Clamp flange 2.5 in, ISO 2852 DN50 / BS 4825								T	0	3																														
Tri-Clamp flange 3 in, ISO 2852 DN65 / DIN 32676 DN65 / BS 4825								T	0	4																														
Tri-Clamp flange 4 in, DIN 32676 DN100 / BS 4825								T	0	5																														
Others								Z	9	9																														
<b>Extension length K</b>																																								
150 mm								K	1																															
Variable ext. tube length								Z	9																															
<b>Thermowell connection</b>																																								
Parallel screw-in thread M14 x 1.5												M	1																											
Parallel screw-in thread M18 x 1.5												M	2																											
Tapered screw-in thread 1/2 NPT												N	1																											
1/2 in NPT - 1/2 in NPT, not separable												N	2																											
1/2 in NPT - 1/2 in NPT, separable												N	3																											
Others												Z	9																											

Continued on next page

		Main order number																																	Add. order no.
Version number	1 - 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	XX						
<b>SensyTemp temperature sensor</b>	<b>TSP131</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX						
<b>Insertion length U</b>																																			
No fixed length																																			Y 0
U = 130 mm																																			D 1
U = 190 mm																																			D 2
U = 340 mm																																			D 3
U = 100 mm																																			P 1
U = 150 mm																																			P 2
U = 200 mm																																			P 3
U = 250 mm																																			P 4
U = 300 mm																																			P 5
U = 350 mm																																			P 6
Acc. to customer requirements																																			Z 9
<b>Thermowell length L</b>																																			
L = 110 mm, C = 65 mm																																			D 1
L = 140 mm, C = 65 mm																																			D 3
L = 200 mm, C = 65 mm																																			D 4
L = 200 mm, C = 125 mm																																			D 5
L = 260 mm, C = 125 mm																																			D 6
L = 410 mm, C = 275 mm																																			D 7
To ABB standard (insertion depth + 65 mm)																																			P 1
Acc. to customer requirements																																			Z 9
<b>Measuring inset type</b>																																			
Basic version, thin film measurement resistor, measuring range -50 ... 400 °C, vibration resistance 10 g																																			S 1
Increased vibration resistance, thin film measurement resistor, measuring range -50 ... 400 °C, vibration resistance 60 g																																			S 2
Extended measuring range -196 ... 600 °C, wire-wound measurement resistor, vibration resistance 10 g																																			D 1
Extended measuring range -196 ... 600 °C, wire-wound measurement resistor, vibration resistance 3 g																																			D 2
Thermocouple																																			T 1
Others																																			Z 9
<b>Sensor type and circuit type</b>																																			
1 x Pt100, two-wire																																			P 1
1 x Pt100, three-wire																																			P 2
1 x Pt100, four-wire																																			P 3
2 x Pt100, two-wire																																			P 4
2 x Pt100, three-wire																																			P 5
2 x Pt100, four-wire																																			P 6
1 x type K (NiCr-Ni)																																			K 1
2 x type K (NiCr-Ni)																																			K 2
1 x type J (Fe-CuNi)																																			J 1
2 x type J (Fe-CuNi)																																			J 2
1 x type N (NiCrSi-NiSi)																																			N 1
2 x type N (NiCrSi-NiSi)																																			N 2
Others																																			Z 9

Continued on next page



Add.  
 order  
 no.

Main order number

Version number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33				
<b>SensyTemp temperature sensor</b>	<b>TSP131</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX		
<b>Sensor accuracy</b>																																					
Class B to IEC 60751																																					
Class A to IEC 60751, measuring range -30 ... 300 °C																																					
Class A to IEC 60751, measuring range -196 ... 500 °C																																					
Class 2 to IEC 60584																																					
Class 1 to IEC 60584																																					
Class AA to IEC 60751, measuring range 0 ... 100 °C																																					
Others																																					
<b>Connection head</b>																																					
BUZ / Aluminum, with hinged cover																																					
BUZH / Aluminum, with upper hinged cover																																					
BUZHD / Aluminum, with upper hinged cover and display																																					
BUKH / Plastic, with upper hinged cover																																					
BEG / Stainless steel, with screw-on cover																																					
Others																																					
<b>Transmitter</b>																																					
Without transmitter, measuring inset with ceramic terminal bloc																																					
Without transmitter, measuring inset with flying leads																																					
TR04, fixed measuring range, 4 ... 20 mA																																					
TR04-Ex, fixed measuring range, 4 ... 20 mA																																					
TTH200 HART, adjustable, 4 ... 20 mA																																					
TTH200 HART-Ex, adjustable, 4 ... 20 mA																																					
TTH300 HART, adjustable, 4 ... 20 mA																																					
TTH300 HART-Ex, adjustable, 4 ... 20 mA																																					
TTH300 PA, adjustable, PROFIBUS PA																																					
TTH300 PA-Ex, adjustable, PROFIBUS PA																																					
TTH300 FF, adjustable, FOUNDATION Fieldbus																																					
TTH300 FF-Ex, adjustable, FOUNDATION Fieldbus																																					
Others																																					

Continued on next page

Add.  
 order  
 no.

Main order number

1 - 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	
<b>TSP131</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

XX
<b>XX</b>

<b>Name plate</b> Stainless steel plate with TAG no.	T1
<b>Certificates</b> TÜV certificate for functional safety SIL2 to IEC 61508 Inspection test certificate to EN 10204 material confirmation for wetted parts Declaration of compliance 2.1 to EN 10204 for order conformity Inspection test certificate 3.1 to EN 10204 for visual, dimensional, and functional checks Inspection test certificate 3.1 to EN 10204 for helium leak test Inspection test certificate 3.1 to EN 10204 for x-ray inspection Inspection test certificate 3.1 to EN 10204 for dye penetration test Inspection test certificate 3.1 to EN 10204 for compression test of thermowell Inspection test certificate 3.1 to EN 10204 for sensor calibration 1 x Pt100 Inspection test certificate 3.1 to EN 10204 for sensor calibration 2 x Pt100 Inspection test certificate 3.1 to EN 10204 for sensor calibration 1 x thermocouple Inspection test certificate 3.1 to EN 10204 for sensor calibration 2 x thermocouple DKD calibration 1 x Pt100 with calibration certificate for each thermometer DKD calibration 2 x Pt100 with calibration certificate for each thermometer DKD calibration 1 x thermocouple with calibration certificate for each thermometer DKD calibration 2 x thermocouple with calibration certificate for each thermometer Others	CS C2 C4 C6 C7 C8 C9 CB CD CE CF CG CH CJ CK CL CZ
<b>Temperatures for sensor calibration</b> 0 °C / 32 °F 100 °C / 212 °F 400 °C / 752 °F 0 °C and 100 °C / 32 °F and 212 °F 0 °C and 400 °C / 32 °F and 752 °F 0 °C, 100 °C, and 200 °C / 32 °F, 212 °F, and 392 °F 0 °C, 200 °C, and 400 °C / 32 °F, 392 °F, and 752 °F Acc. to customer specifications	V1 V2 V3 V4 V5 V7 V8 V6
<b>Temperatures for DKD calibration</b> 0 °C / 32 °F 100 °C / 212 °F 400 °C / 752 °F 0 °C and 100 °C / 32 °F and 212 °F 0 °C and 400 °C / 32 °F and 752 °F 0 °C, 100 °C, and 200 °C / 32 °F, 212 °F, and 392 °F 0 °C, 200 °C, and 400 °C / 32 °F, 392 °F, and 752 °F Acc. to customer specifications	D1 D2 D3 D4 D5 D7 D8 D6

Continued on next page

Add.  
 order  
 no.

Main order number

1 - 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	
<b>TSP131</b>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

XX
<b>XX</b>

**Thermowell options**

Thermowell design with tests and certificates to NACE MR 0175	S8
Special cleaning of the thermowell for oxygen applications	S9
Others	SZ

**Flange connection options**

Flange facing with form C (tongue) to EN 1092	F1
Flange facing with form D (groove) to EN 1092	F2
Flange facing form RTJ to ASME B16.5v	F3
Flange full penetration welded	F4
Others	FZ

**Cable entry options**

1 x 1/2 in NPT, without cable gland	U2
Others	UZ

**Measuring range of the transmitter**

-30 ... 60 °C	A1
-20 ... 40 °C	A2
0 ... 40 °C	A3
0 ... 60 °C	A4
0 ... 100 °C	A5
0 ... 120 °C	A6
0 ... 150 °C	A7
0 ... 200 °C	A8
0 ... 250 °C	AF
0 ... 300 °C	AG
0 ... 400 °C	AH
0 ... 600 °C	AJ
0 ... 800 °C	AK
0 ... 1000 °C	AL
Others	AZ

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# SensyTemp TSHY (HY R) Resistance thermometer for the food and beverage industries

## Measurement made easy



### For insertion in pipelines and vessels

#### Fast response

- Halftime < 2.5 s

#### Various designs

- Sensor smooth, with threaded compression fitting or welded flange

#### Corrosion-resistant

- Sensor and connection head made of stainless steel, IP 66

#### Hygienic

- Materials permissible for use with food, surface polished smooth, mounting suitable for CIP (Cleaning In Place)

### Selectable transmission of measured values

- Pt 100 signal or 4 ... 20 mA with installed transmitter

### High operational reliability

- Components have long-term stability and are maintenance-free, environment-resistant and vibration-resistant

### Type approved

- for use in milk-heating plants which require approval, in accordance with Directive 85/357/EEC or the German Milk Executive Order (MVO)

## General description

The temperature sensors TSHY (SensyTemp HY R) have been designed, in terms of construction, choice of materials and mounting, specially for use in the food and beverage industries.

Several designs are available for mounting at measuring junctions. The hygienic conditions are complied with as well as the requirement of reliable cleaning using the CIP method.

Another special feature is the halftime of < 2.5 seconds. With this short halftime, the measurement and control tasks on the large-surface heat exchangers in these industries with their short reaction times are performed reliably.

The measured value can be transmitted as a Pt 100 signal or by the installed transmitter as a 4...20 mA current signal. A programmable or HART-compatible transmitter can be integrated upon request.

Sensors with installed head-mounted transmitters comply with the EMC Directive 89/336/EEC of May 1989 and the EU Directive for CE conformity identification.

## Design and dimensions

### Temperature sensor TSHY (SensyTemp HY R-1E)

The typical feature of the HY R-1E sensor is its smooth polished sensor tube with 6 mm external diameter.

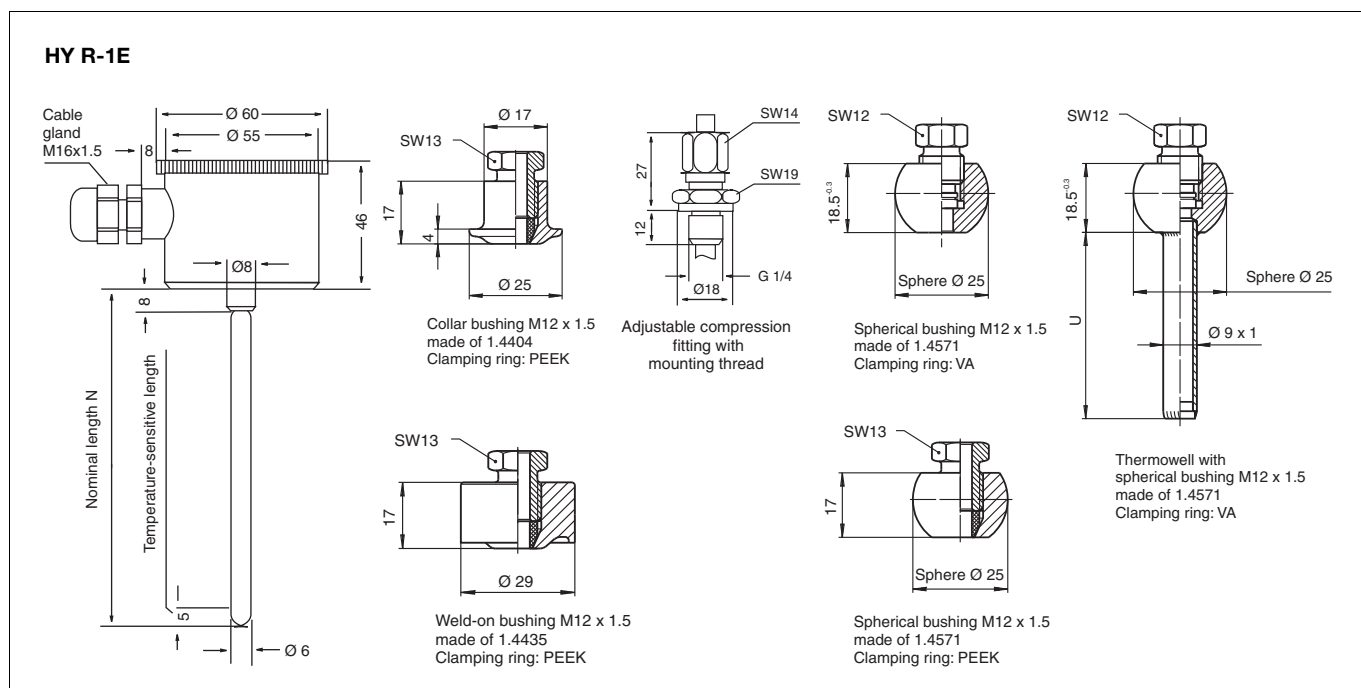
The HY R-1E sensor is variable in terms of the selectable process connector. For applications where the sensor is exposed to the medium, the immersion depth can be determined individually. A minimum immersion depth of at least 3 to 5 times the thermowell diameter should be observed. The immersion depth must not be less than the length of the temperature-sensitive part.

Due to the additional thermowell with weld-in type spherical bushing the temperature sensor can be exchanged and calibrated without the need to open the product chamber. Both the thermowell and the spherical bushing are made of stainless steel and, thus, meet all hygienic requirements and resist to process pressures up to 40 bars. Thermowells are available with insertion lengths of 50 mm and 180 mm.

The following connection options are possible for direct exposure of the HY R-1E sensor to the medium, i.e. without using a thermowell:

1. With threaded compression fitting G 1/4A. Made of 1.4571, with stainless steel clamping ring. For general industrial mounting. Pressure-resistant up to 40 bar.
2. With spherical bushing M12 x 1.5. Made of 1.4571, with stainless steel clamping ring. For general industrial mounting. Pressure-resistant up to 40 bar.
3. With spherical bushing M12 x 1.5. Made of 1.4571, PEEK clamping ring. Hygienic design. The shape of the PEEK clamping ring prevents an angular gap between the thermowell and the bushing. Pressure-resistant up to 10 bar.
4. Weld-on bushing M12 x 1.5. Made of 1.4435, PEEK clamping ring. Hygienic mounting without gap. Pressure-resistant up to 10 bar.
5. Collar-type bushing M12 x 1.5. Made of 1.4404. PEEK clamping ring. Hygienic mounting without gap. Pressure-resistant up to 10 bar.

The HY R-1E with transmitter measuring range 0...100 °C and 50...100 °C is approved for use in milk-heating plants acc. MVO.



**Temperature sensor TSHY (SensyTemp HY R-2E)**

The typical features of the HY R-2E sensor are its fixed insertion length and the small dimensions of the temperature-sensitive sensor tube and the high pressure resistance up to 140 bar.

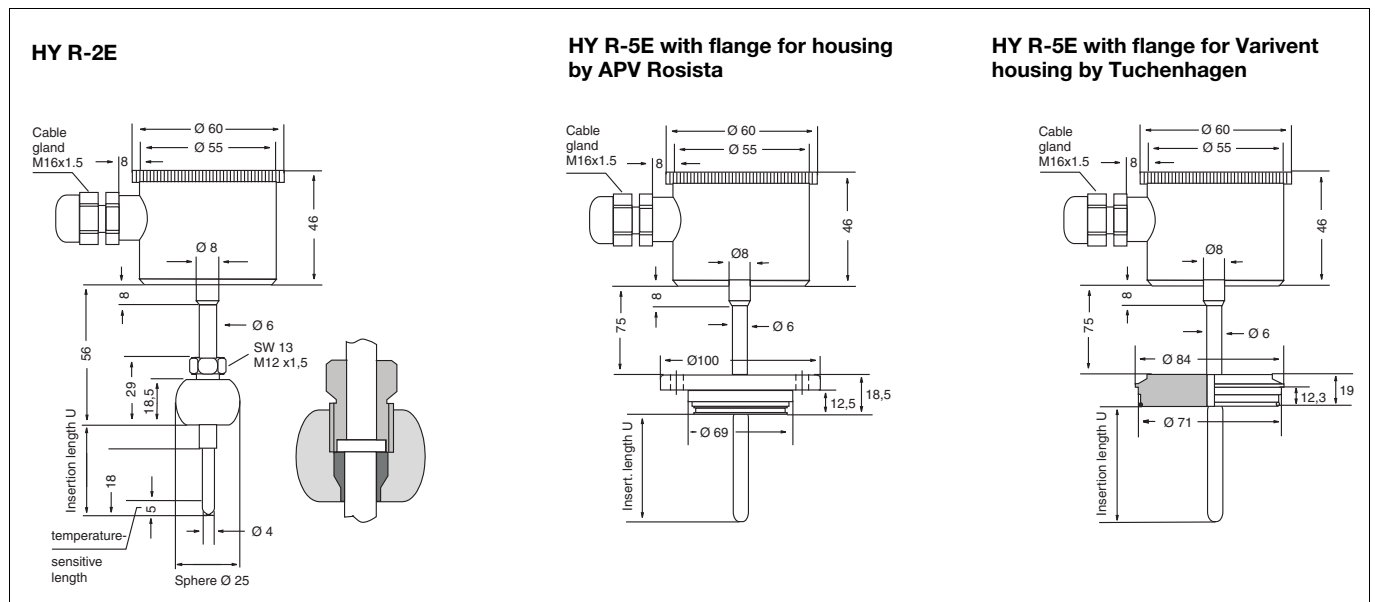
It is possible to choose between the insertion lengths 20 and 60 mm. The spherical welded bushing is fixed by a collar welding onto the sensor tube.

An additional PEEK ring prevents the formation of an annular gap between the sensor tube and the welded bushing. The HY R-2E sensor thus meets the highest hygiene and cleaning requirements.

**Temperature sensor TSHY (SensyTemp HY R-5E) (inline)**

The typical feature of the HY R-5E sensor is the flange which is welded to the sensor tube. The flange allows inline mounting in connection with housings of make "APV-Rosista" or "Tuchen-hagen".

With inline technology, measuring junctions for various process variables are standardized. This technology, which has been specially developed for the food and beverage industries, also meets the highest hygiene and cleaning requirements.

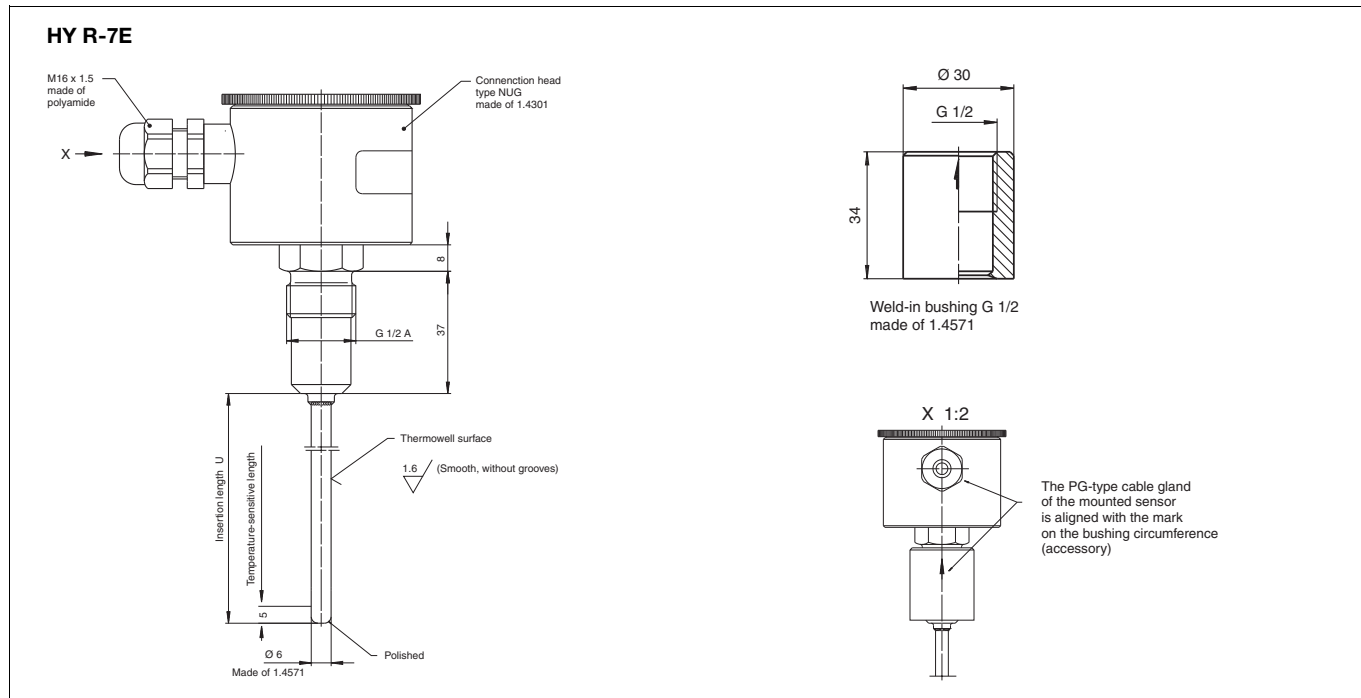


**Temperature sensor TSHY (SensyTemp HY R-7E)**

The typical features of the HY R-7E sensor are its fixed insertion length and the metal-type sealing system. In conjunction with the appropriate welded bushing this design ensures sealing without clearance volume and in compliance with the hygienic requirements of food applications. No additional seal is required.

When the system is mounted properly, the temperature sensor's cable gland is aligned with the mark on the bushing circumference.

A tightening moment of 30...50 Nm should be applied. The sealing system is pressure-resistant up to 10 bar. Various insertion lengths are available.

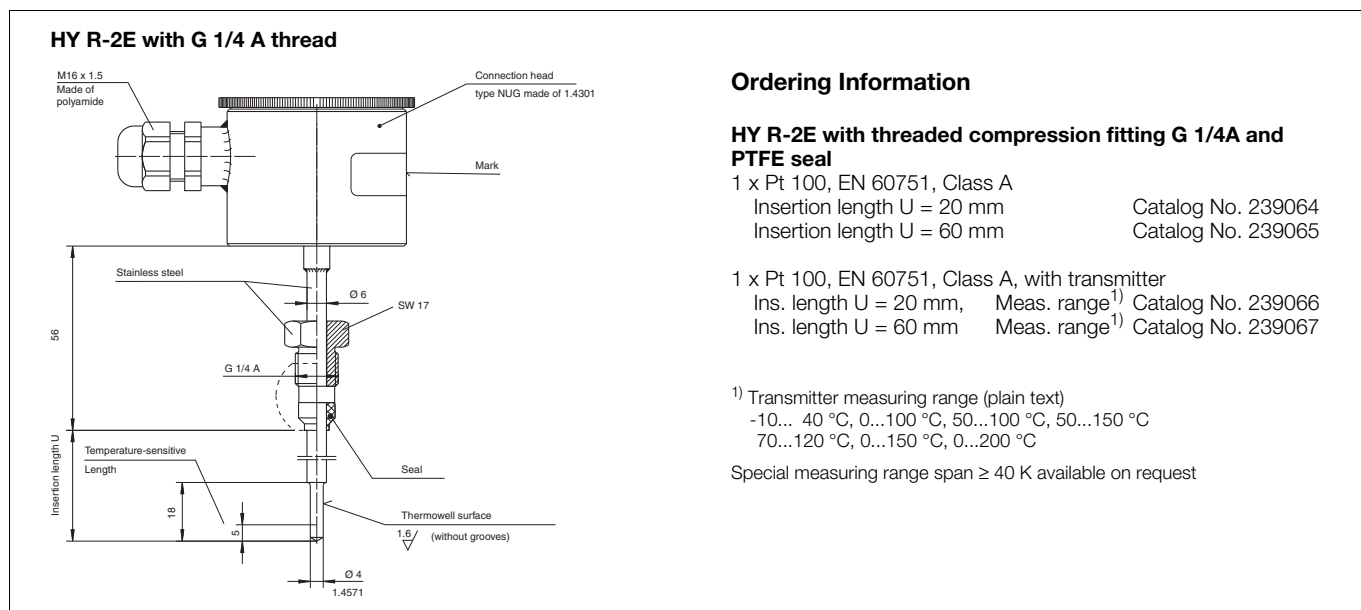


**Temperature sensor TSHY (SensyTemp HY R-2E) with G 1/4 A thread**

This sensor is intended to be used as a spare part for existing systems with spherical welded bushing, with G 1/4 thread and PTFE seal.

Since this type has been replaced with the welded bushing M12 x 1.5 with PEEK seal, the welded sphere G 1/4 is not included in the scope of delivery.

If the welded sphere should be defective, please use type M12 x 1.5 with PEEK seal.



**Ordering Information**

**HY R-2E with threaded compression fitting G 1/4A and PTFE seal**

- 1 x Pt 100, EN 60751, Class A  
Insertion length U = 20 mm      Catalog No. 239064  
Insertion length U = 60 mm      Catalog No. 239065

- 1 x Pt 100, EN 60751, Class A, with transmitter  
Ins. length U = 20 mm,    Meas. range<sup>1)</sup> Catalog No. 239066  
Ins. length U = 60 mm    Meas. range<sup>1)</sup> Catalog No. 239067

<sup>1)</sup> Transmitter measuring range (plain text)  
-10... 40 °C, 0...100 °C, 50...100 °C, 50...150 °C  
70...120 °C, 0...150 °C, 0...200 °C

Special measuring range span ≥ 40 K available on request



## Technical data

### Temperature sensor

#### Resistance element

1 x Pt 100 in accordance with EN 60751, class A, 3-wire circuit  
or  
2 x Pt 100 in accordance with EN 60751, class B, 2-wire circuit

#### Measuring range

Temperature: -50...+250 °C  
Pressure: For HY R-1E see details about compression fitting on page 2  
max. 140 bar  
For HY R-2E in accordance with the pressure class of the housing  
For HY R-5E

#### Response time

acc. to VDE/VDI 3511, media water,  $v = 0,4 \text{ m/s}$   
HY R-1E + R-5E + R-7E    HY R-1E with SR    HY R-2E  
 $t_{0,5}$                             < 2.5 s                            5.0 s                            2.0 s  
 $t_{0,9}$                             < 5.2 s                            11.4 s\*                        3.4 s  
\* This value can be reduced to 6 s by using heat-conductive paste.

#### Insulation voltage

Max. 250 V DC

#### Sensor tube

For HY R-1E                    Smooth without compression fitting  
For HY R-2E                    With fixed insertion length, spherical welded bushing  
  
For HY R-5E                    With fixed insertion length and weld-on flange  
For HY R-7E                    With fixed insertion length, metal sealing system  
Length                            In accordance with order details or dimensional drawings  
  
Diameter                        6 or 6/4 mm (see dimensional drawings)  
Material                         Stainless steel 1.4571 (AISI 316-TI)

#### Connection head

Stainless steel 1.4301 (AISI 304) with screwed lid, sealable  
Degree of protection IP 66  
Cable gland M16 x 1.5 for cable diameter 3.5...8.0 mm  
Screw terminals for the connection cable

## Transmitter

### Design TSHY (SensyTemp HY R)

Installation design, suitable for the connection head of the HY R temperature sensor, only possible in connection with a single winding

#### Input

Pt 100 (EN 60751),  
3-wire circuit, fixed ranges

#### Output

4...20 mA, temperature linear

#### Power supply

$U_s = 10.5...30 \text{ V DC}$ , polarity safe

### Climatic conditions

#### Ambient temperature

-40...+85 °C

#### Relative humidity

≤ 100 % (condensation possible)

### Characteristics at rated conditions

(percentage referred to the measuring span)

#### Measurement deviation (upper-range value)

nominal value 0 °C: ≤ 0.15 % or 0.15 K  
nominal value < or > 0 °C: ≤ 0.2 % or 0.2 K

#### Deviation of linearity

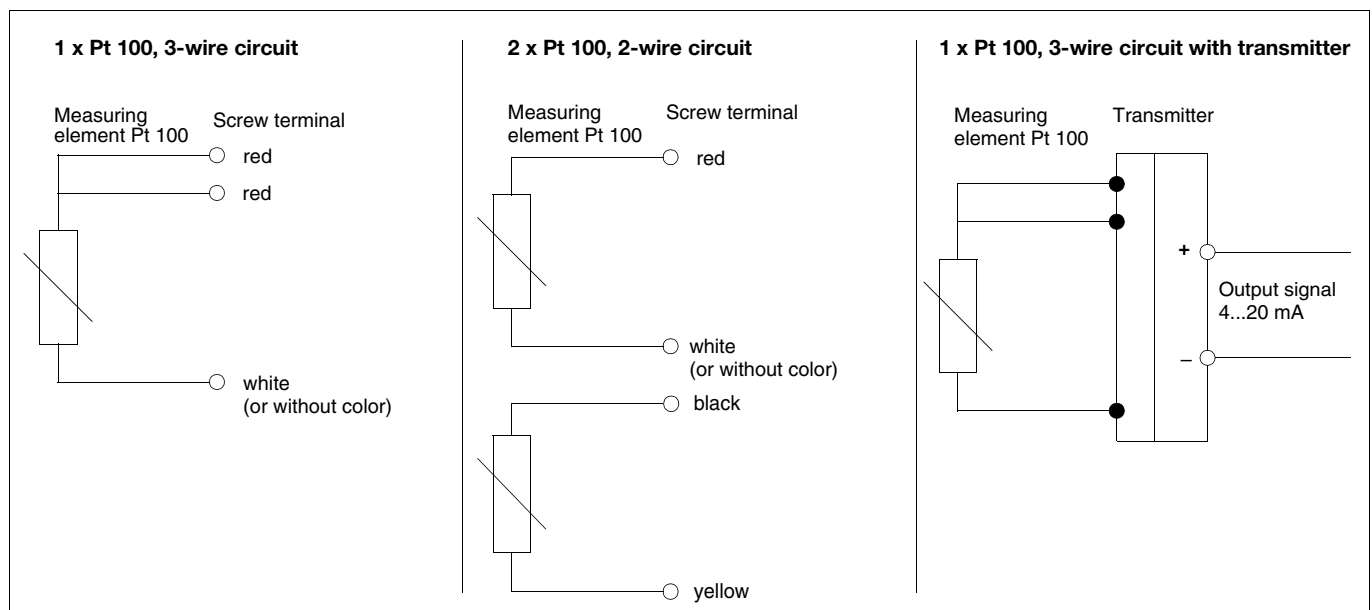
< 0.10 %

### Electromagnetic compatibility

according to NAMUR NE 21

### CE conform

## Connection diagram



## Ordering Information

	Catalog No.		
<b>Temperature sensor TSHY (SensyTemp HY R-1E)</b>			
<b>Sensor smooth, without threaded compression fitting</b>			
1 x Pt 100, EN 60751, class A, 3-wire circuit			
Sensor nominal length	N = 100 mm		7963706
	N = 250 mm		7963705
	N = 450 mm		7963704
2 x Pt 100, EN 60751, class B, 2-wire circuit			
Sensor nominal length	N = 100 mm		7963703
	N = 250 mm		7963702
	N = 450 mm		7963701
1 x Pt 100, EN 60751, class A, 3-wire circuit with head mounted transmitter 4...20 mA			
Sensor nominal length	N = 100 mm	Measuring range -10...+40 °C	7958188
	N = 100 mm	Measuring range 0...100 °C	2) 7958189
	N = 100 mm	Measuring range 50...100 °C	2) 7958190
	N = 100 mm	Measuring range 50...150 °C	7958191
	N = 100 mm	Measuring range 70...120 °C	7958192
	N = 100 mm	Measuring range 0...150 °C	7958219
	N = 100 mm	Measuring range 0...200 °C	7958218
	N = 100 mm	Measuring range	1) 7963709
	N = 250 mm	Measuring range	1) 7963708
	N = 450 mm	Measuring range	1) 7963707
<b>Temperature sensor TSHY (SensyTemp HY R-2E)</b>			
<b>Sensor with fixed spherical welded bushing M12 x 1,5</b>			
1 x Pt 100, EN 60751, class A, 3-wire circuit			
Insertion length	U = 20 mm		7963710
	U = 60 mm		7963711
2 x Pt 100, EN 60751, class B, 2-wire circuit			
Insertion length	U = 20 mm		7963714
	U = 60 mm		7963715
1 x Pt 100, EN 60751, class A, 3-wire circuit with head mounted transmitter 4...20 mA			
Insertion length	U = 20 mm	Measuring range	1) 7963712
	U = 60 mm	Measuring range	1) 7963713
<b>Temperature sensor TSHY (SensyTemp HY R-5E)</b>			
<b>Sensor with fixed flange for "inline" mounting</b>			
1 x Pt 100, EN 60751, class A, 3-wire circuit			
Flange for Varivent housing DN 40...125 by Tuchenhausen			
Insertion length	U = 25 mm		7963723
Flange for case DN 40...125 by APV-Rosista			
Insertion length	U = 25 mm		7963724
2 x Pt 100, EN 60751, class B, 2-wire circuit			
Flange for Varivent housing DN 40...125 by Tuchenhausen			
Insertion length	U = 25 mm		7963725
Flange for case DN 40...125 by APV-Rosista			
Insertion length	U = 25 mm		7963726
1 x Pt 100, EN 60751, class A, 3-wire circuit with head mounted transmitter 4...20 mA			
Flange for Varivent housing DN 40...125 by Tuchenhausen			
Insertion length	U = 25 mm	Measuring range	1) 7963727
Flange for case DN 40...125 by APV-Rosista			
Insertion length	U = 25 mm	Measuring range	1) 7963728

1) Measuring range of the head mounted transmitter (clear text)

-10...+40 °C, 0...100 °C, 50...100 °C, 50...150 °C

70...120 °C, 0...150 °C, 0...200 °C

2) Certified for use in milk-heating plants acc. to MVO

Other versions on request

**Ordering Information (continued)**

	Catalog No.		
<b>Temperature sensor TSHY (SensyTemp HY R-7E)</b>			
<b>with fixed insertion length and metal-type conical nipple</b>			
1 x Pt 100, EN 60751, class A, 3-wire circuit			
Insertion length	U = 50 mm	238380	
	U = 100 mm	7958106	
	U = 250 mm	7958107	
1 x Pt 100, EN 60751, class A, 3-wire circuit with head mounted transmitter			
Insertion length	U = 50 mm	Measuring range 0...100 °C	238376
	U = 50 mm	Measuring range 1)	238374
	U = 100 mm	Measuring range 1)	238375
	U = 250 mm	Measuring range 1)	241664

<b>Accessories</b>			
	Catalog No.		
<b>Mounting material for the TSHY (SensyTemp HY R-1E) sensor</b>			
Spherical bushing M12 x 1.5, made of 1.4571, clamping ring made of PEEK		7963731	
Spherical bushing M12 x 1.5, made of 1.4571, clamping ring made of VA		7962518	
Weld-on bushing M12 x 1.5, made of 1.4435, clamping ring made of PEEK		239904	
Collar bushing M12 x 1.5, made of 1.4404, clamping ring made of PEEK		240604	
Adjustable threaded compression fitting G 1/4A, made of stainless steel, clamping ring made of VA		7962519	
Thermowell with spherical bushing M12 x 1.5, made of 1.4571, clamp. ring made of VA			
Insertion length U =	50 mm	7963729	
	U = 180 mm	7963730	
<b>Mounting material for the TSHY (SensyTemp HY R-7E) sensor</b>			
Weld-in bushing G 1/2 made of 1.4571		7958116	

1) Measuring range of the head mounted transmitter (clear text)  
-10...+40 °C, 0...100 °C, 50...100 °C, 50...150 °C  
70...120 °C, 0...150 °C, 0...200 °C

Other versions on request

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3KXT171002R1001



Sales



Service

# TSW400 series Thermowells

Safe, tough and reliable thermowells for  
the Oil & Gas industry

Measurement made easy



#### Engineered to international standards

- ISO19001:2000

#### Manufactured with full material control

- 3.1 certification
- Traceability to producing mill
- X-Ray PMI available

#### Documented to Oil & Gas industry standards

- Documents compiled on electronic media
- Material certification
- Welding certification

#### Applications

- Oil & Gas downstream
- Oil & Gas upstream
- Arduous applications requiring high specification

# TSW400 series Thermowells

## Available designs

The following designs are available from ABB's standard range of thermowells. However, many organizations have their own standard designs and these can be accommodated by selecting 'other design' and providing a drawing for quotation.

### Flanged

Flanged thermowells are available in three manufacturing options:

#### **Welded with a fillet and groove weld**

- fillet and groove welding is perfectly adequate in most circumstances; the weld is designed to be stronger than the required duty pressure.

#### **Welded with a full penetration weld**

- full penetration welding provides a stronger weld joint and is specified when absolute assurance of pipe-work integrity is required.

#### **Manufactured from a single piece, shaped forging**

- fully forged thermowells are manufactured from a shaped forging formed to closely resemble the final shape of the finished thermowell. This ensures correct granular alignment of all the thermowell components – absolutely vital in ensuring resistance to corrosion cracking.

### Weld-in and threaded

Manufactured from a single piece of high quality material, there is no welding in any of ABB's weld-in or threaded designs.

### Profiles

Three basic profiles are available:

#### **Straight**

- the stem diameter is consistent from the root to the tip

#### **Tapered**

- the profile tapers from the root to the tip

#### **Stepped**

- the lower portion of the thermowell steps to a smaller diameter.

A version of the stepped profile is available in the DIN designs where the step is a taper towards the tip. See the illustrations on pages 4 to 25 for details.

### Velocity collars

There are times when thermowell design fails to satisfy ASME PTC19.3 2010 TW criteria. Under these circumstances, it is advisable to shorten the thermowell and change the diameters of the stem root and tip. ABB engineers are available to advise on this. Where the thermowell would become too short, a velocity collar can be used.

**Caution.** A velocity collar relies on an interference fit between the thermowell collar and the mounting branch. The interference fit is the responsibility of the installation team and, although ABB can advise on the procedure, ABB cannot be held responsible for incorrect fitting of velocity collars.

## Dimensions

The key dimensions of a thermowell are related to the stem. The dimensions of the flange or screw thread are given by international standards.

### Immersion length (U)

- the length of the thermowell from the underside of the flange to the tip. This is the unsupported length of the thermowell and, in the case of a threaded thermowell, is measured from the start of the screw thread. In the case of a threaded, tapered thermowell, it is normally measured 10 mm (4 in.) in from the start of the thread and for a threaded, parallel thermowell it is measured from the back of the thread.

### External length (T)

- the additional length of the thermowell.  
U + T gives the total length of the thermowell.

### Tip diameter (P1)

- the diameter of the stem at the tip (the part of the thermowell furthest from the process connection).

### Stem diameter (P2)

- the diameter of the stem on the process side of the connection (also referred to as the stem root).

### Instrument connection diameter (P3)

- the diameter of the stem where it connects to the instrument.

### Internal bore

- the diameter of the hole in the stem.

### Step position

- the distance from the tip to the beginning of the step. A stepped thermowell is a straight thermowell with a step down to a smaller diameter near the tip. A number of the DIN designs taper from the stepped position to the tip diameter.

### Velocity collar position

- the position from the tip to the underside of the velocity collar.

### Velocity collar diameter

- the diameter of the velocity collar (specified to the nearest millimeter).

### Tip thickness

- the standard tip thickness is 6 mm.

**Note.** If a different tip thickness is required, *it must be specified when ordering*. Failure to specify will result in the order being completed with the standard 6 mm tip thickness.

### Stem-to-flange radius

- the standard stem-to-flange radius is 3 mm.

**Note.** If a different stem-to-flange radius is required, *it must be specified when ordering*. Failure to specify will result in the order being completed with the standard 3 mm stem-to-flange radius.

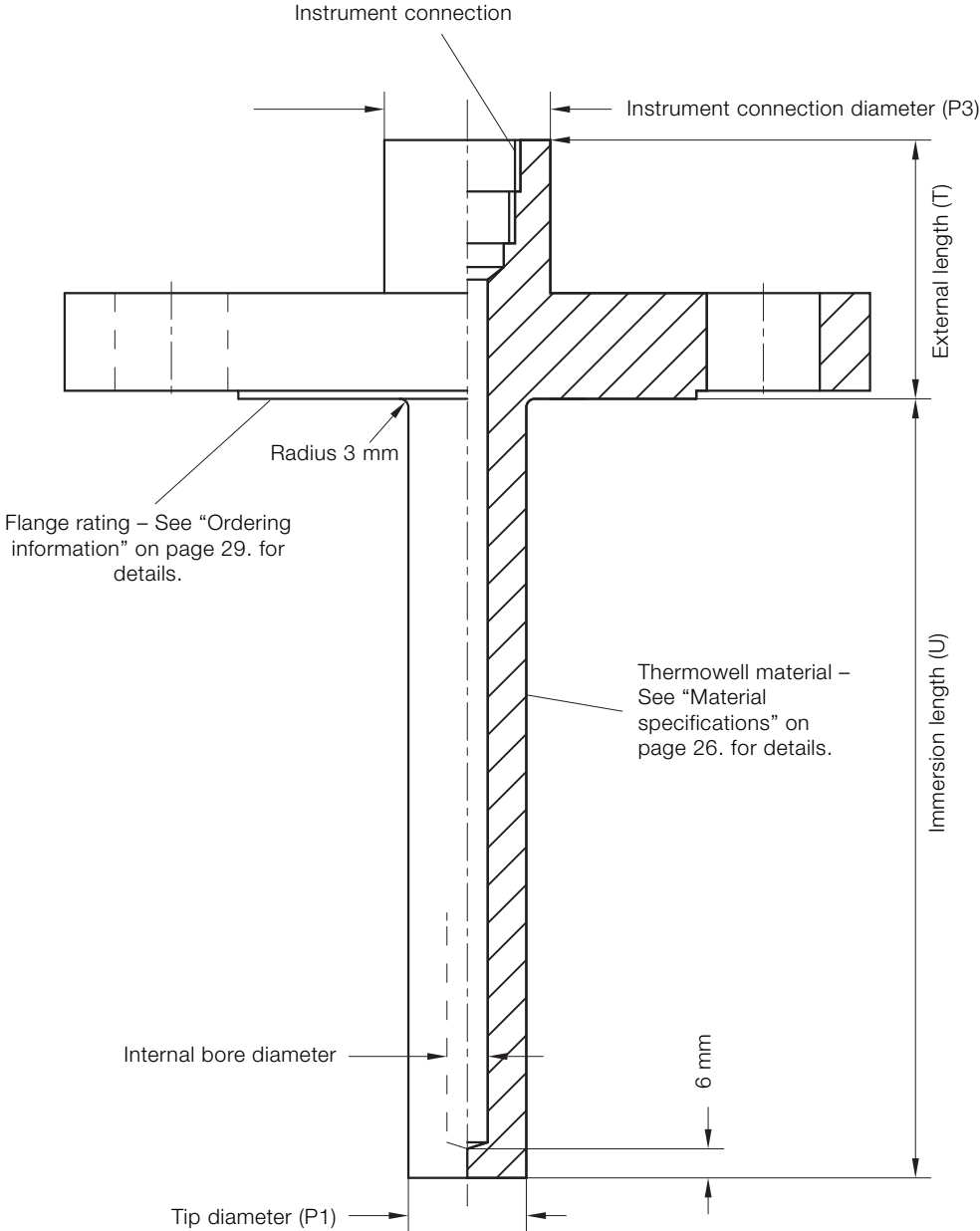
The thermowell style illustrations on pages 4 to 25 each give the dimension of the solid portion of the thermowell from the end of the bore to the end of the tip.

# TSW400 series Thermowells

## Thermowell styles

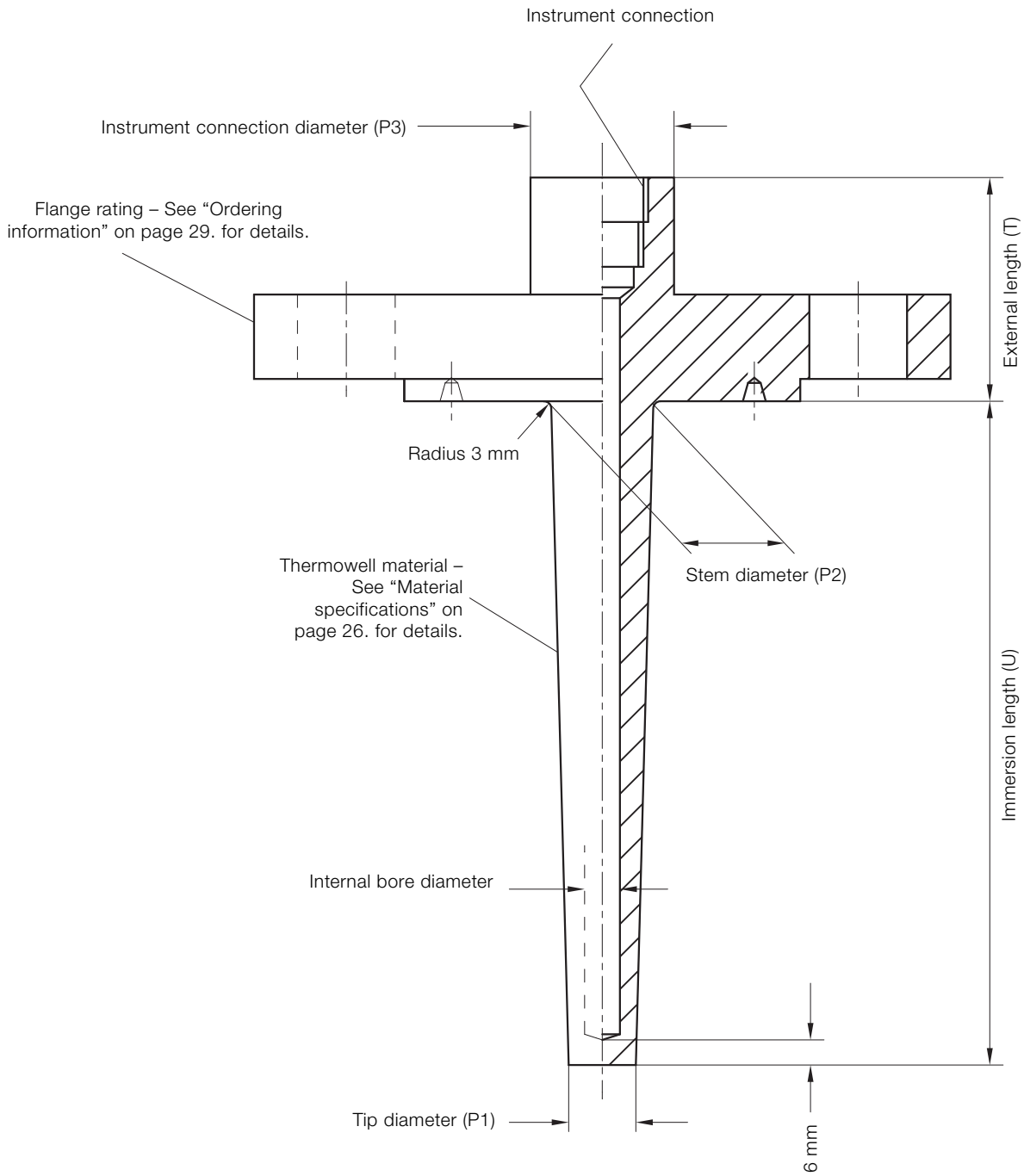
Pages 4 to 25 show the style of thermowell available and is the first consideration when selecting a thermowell.

### Flanged, straight, forged – E1



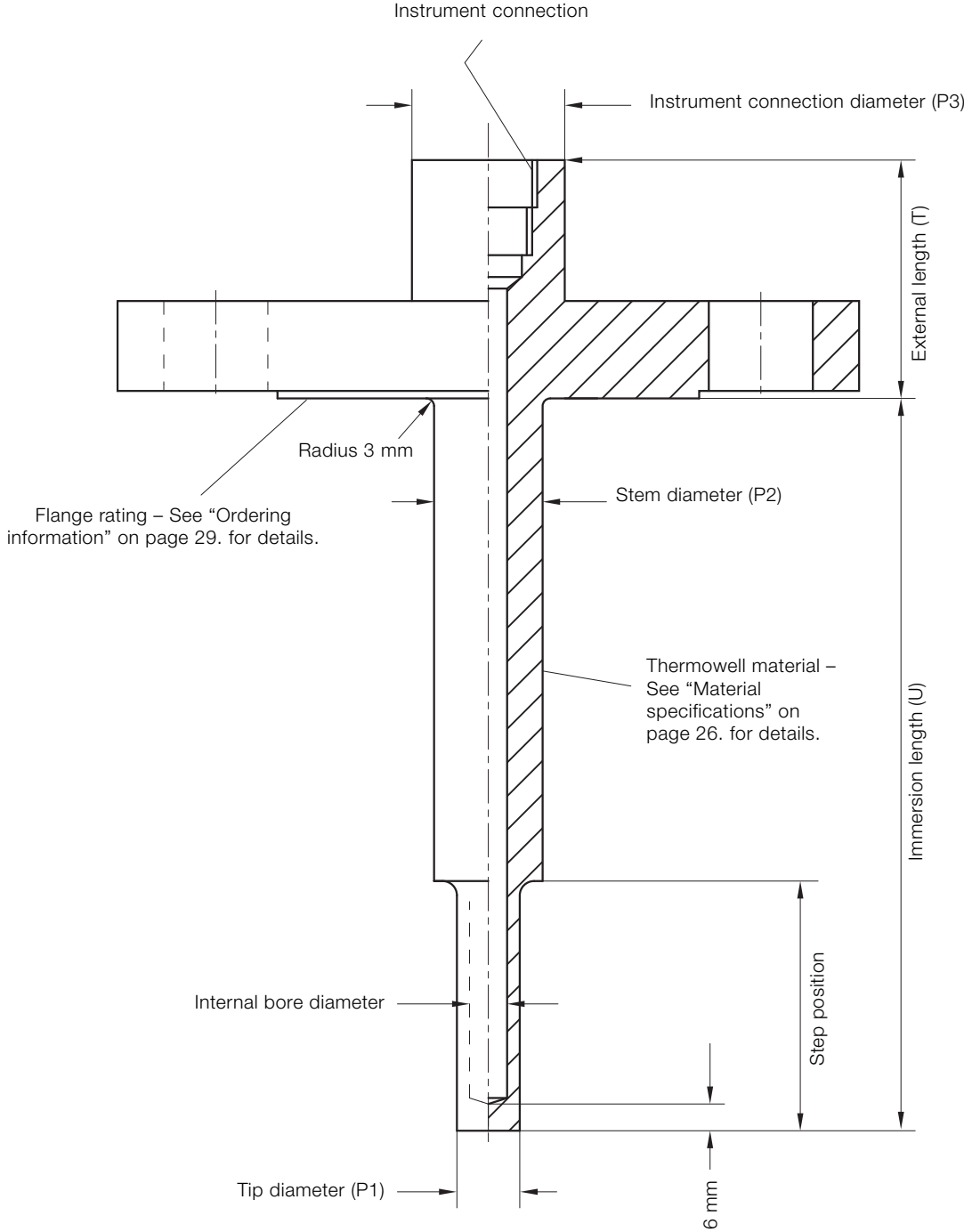


Flanged, tapered, forged – E2

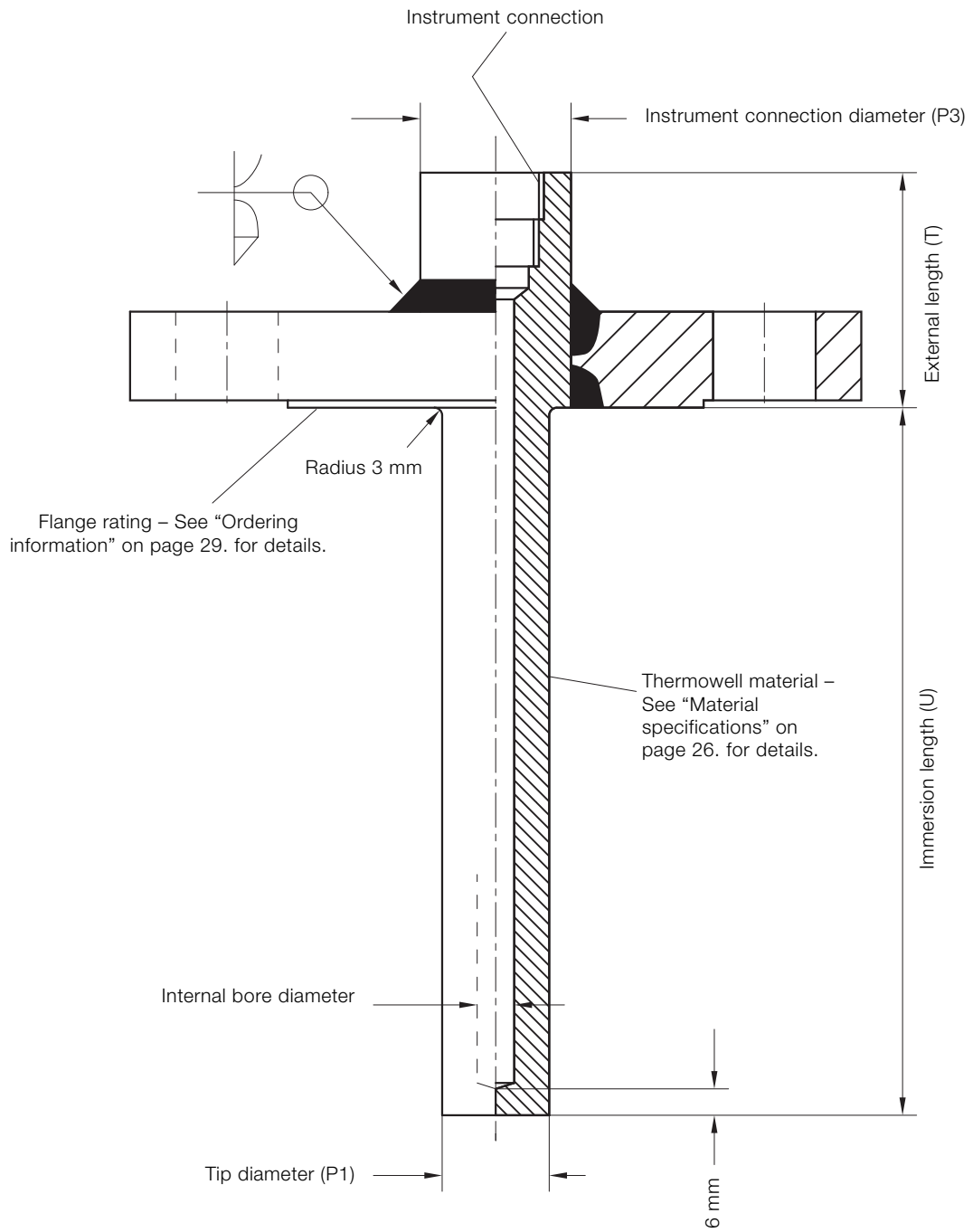


# TSW400 series Thermowells

## Flanged, stepped, forged – E3

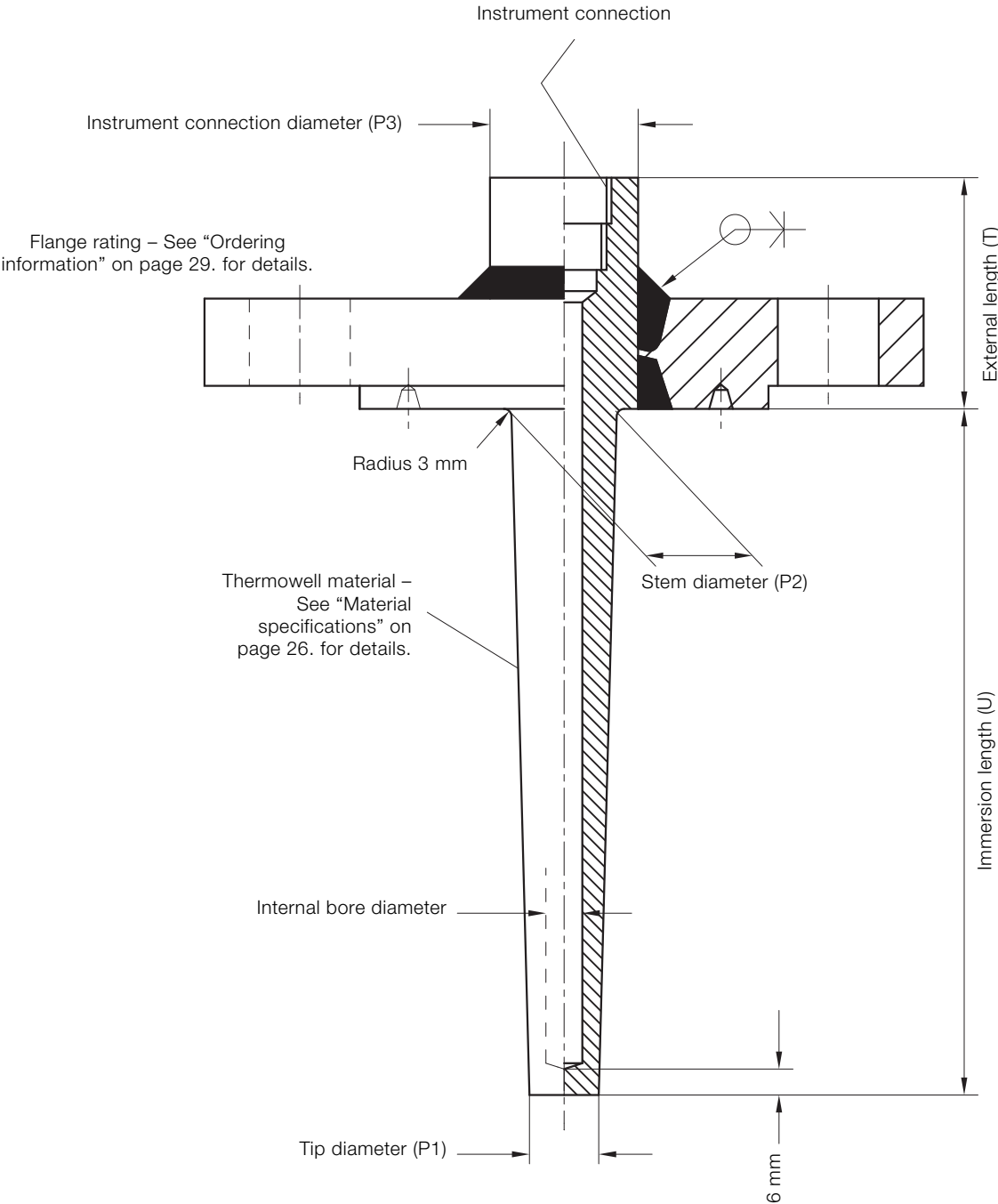


**Flanged, straight, full penetration weld – E4**

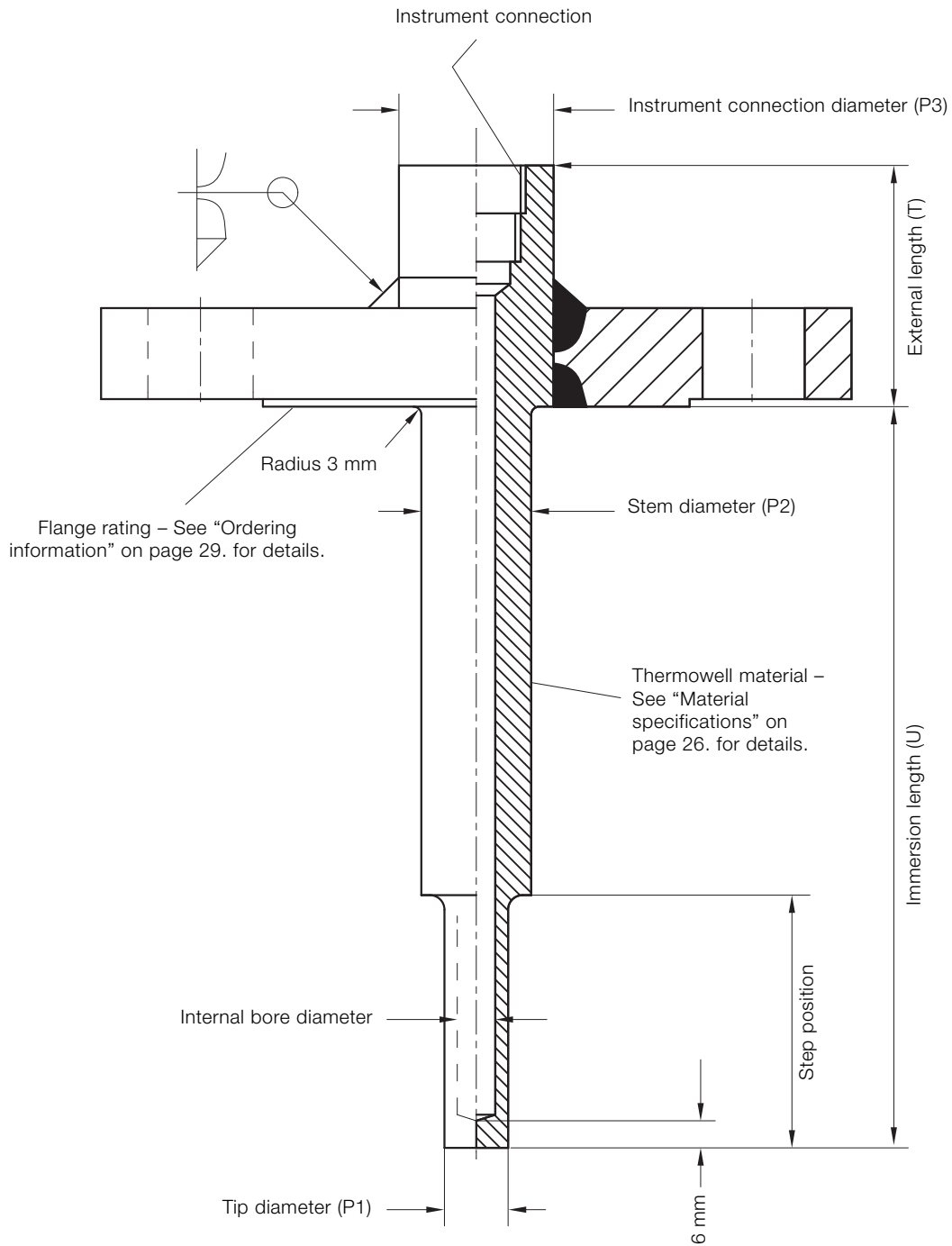


# TSW400 series Thermowells

## Flanged, tapered, full penetration weld – E5

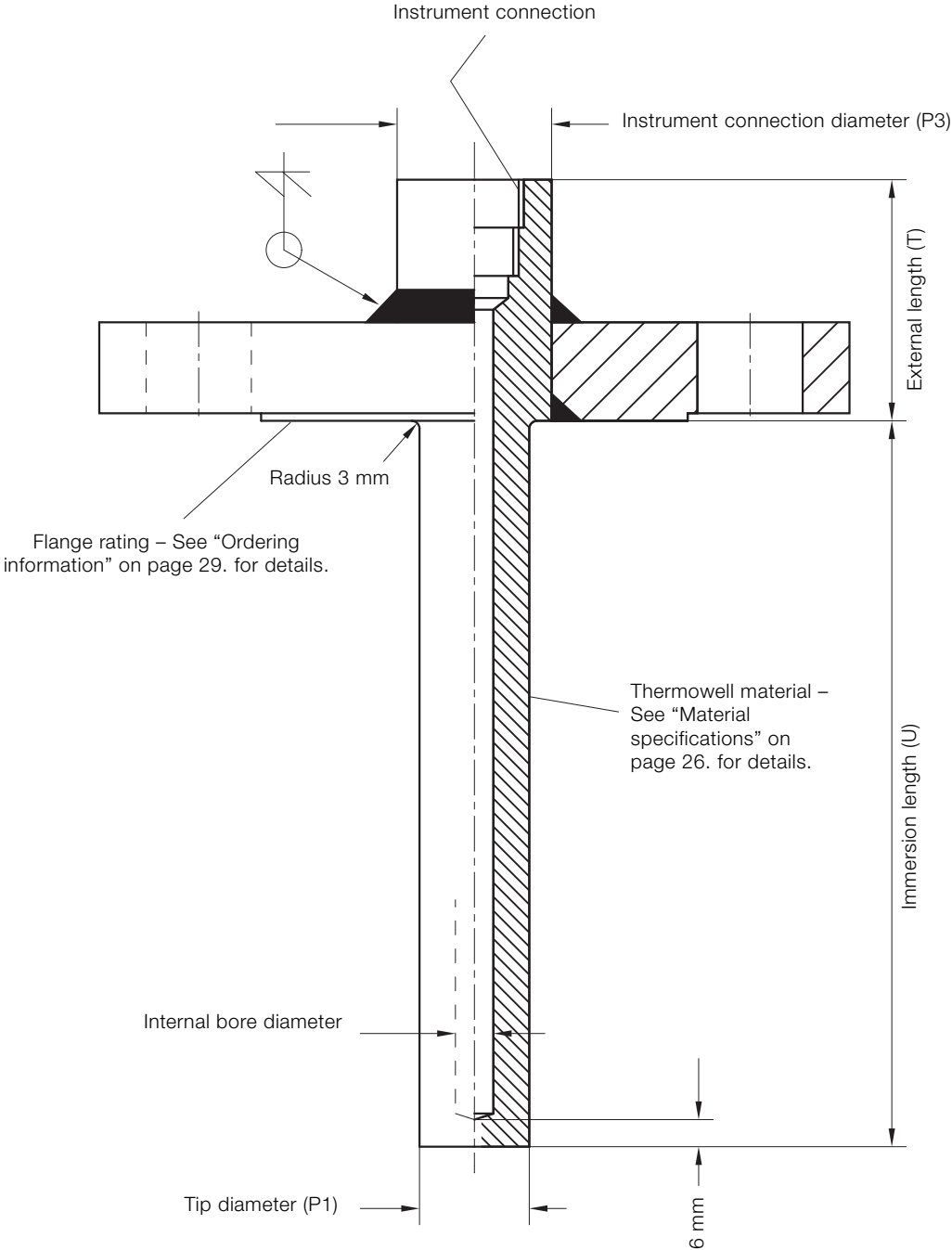


Flanged, full penetration weld – E6

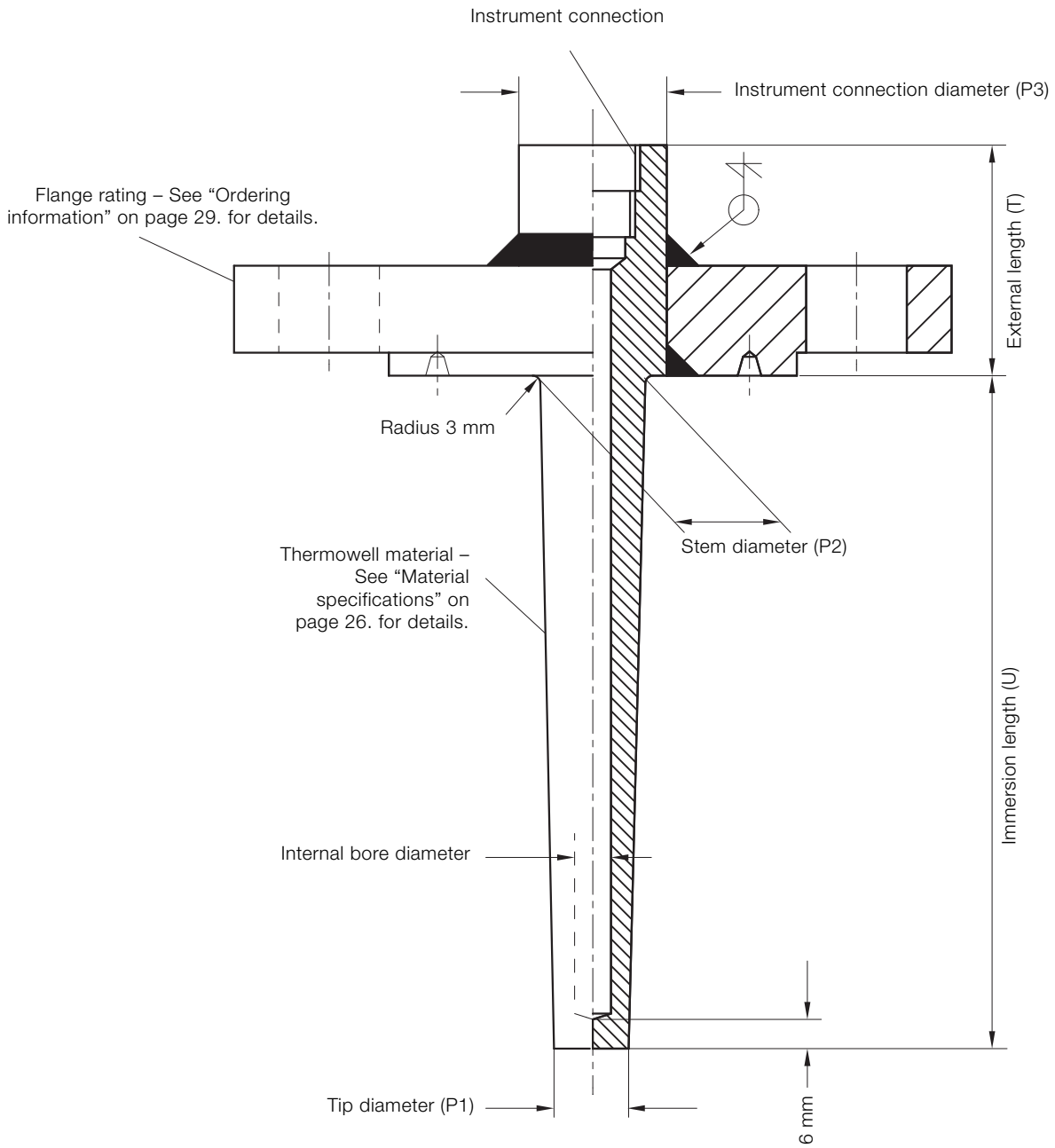


# TSW400 series Thermowells

## Flanged, straight, fillet and groove weld – E7

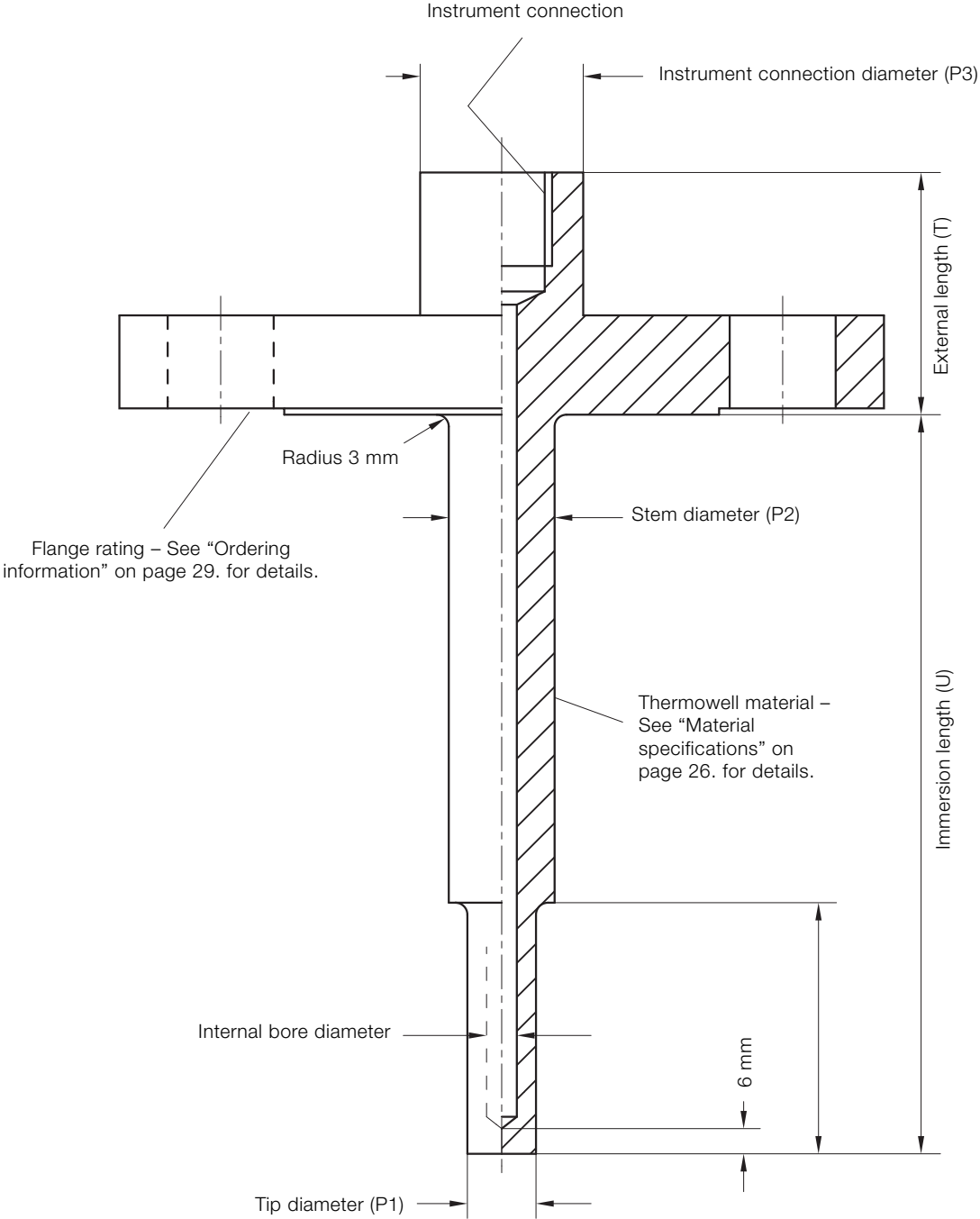


**Flanged, tapered, fillet and groove weld – E8**



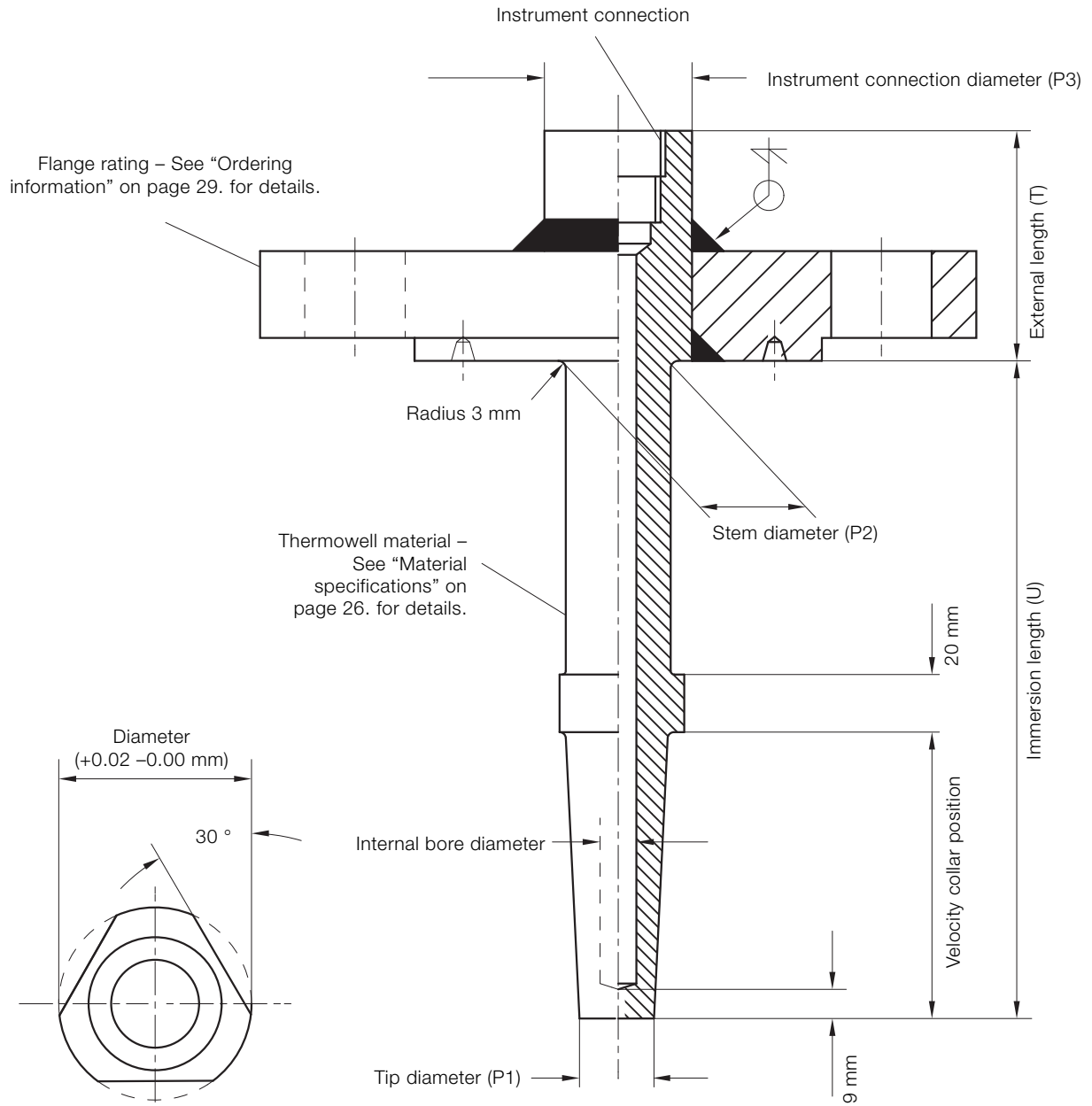
# TSW400 series Thermowells

## Flanged, stepped, fillet and groove weld – G1





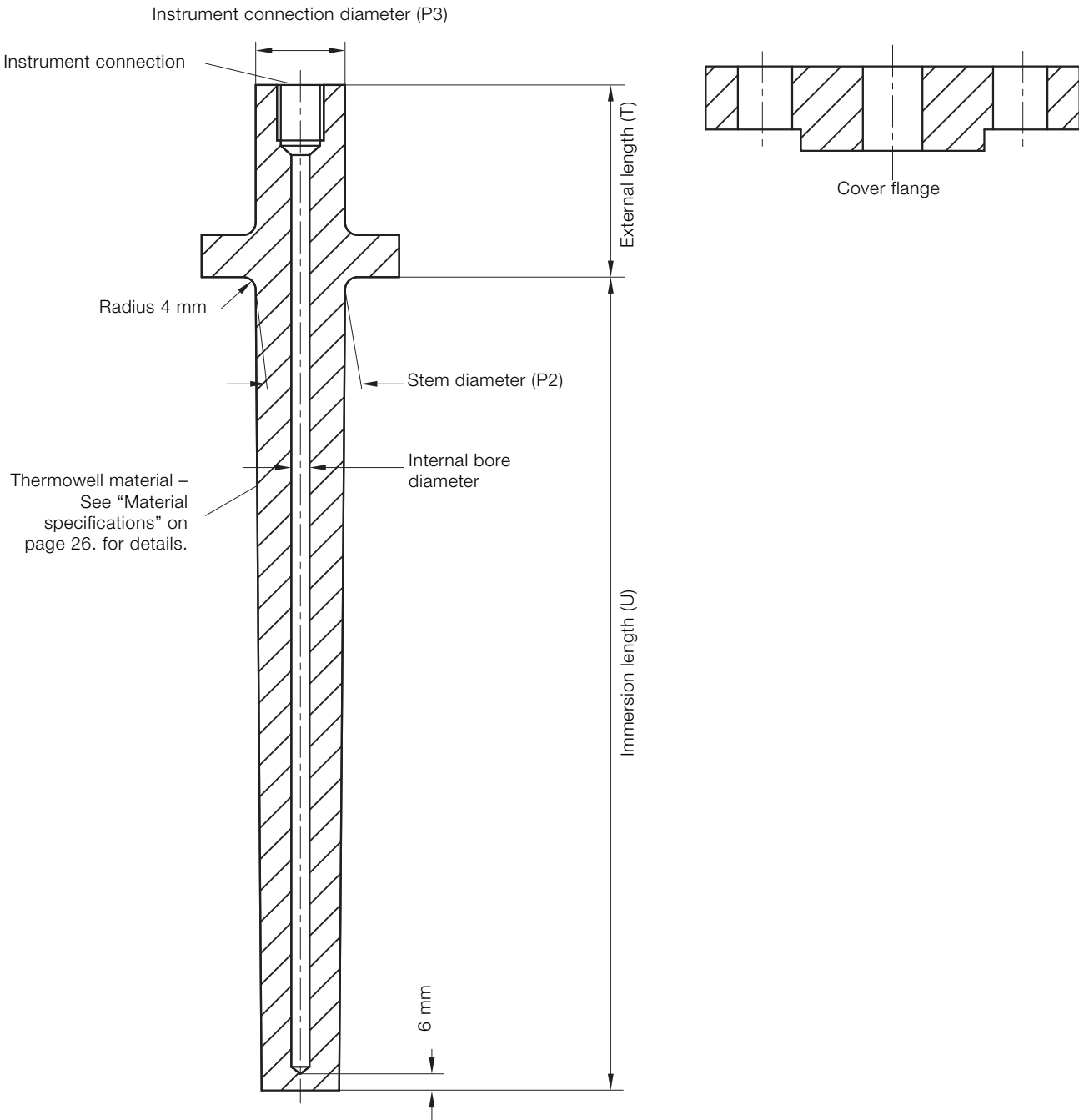
**Flanged, tapered, fillet and groove weld with velocity collar – H1**



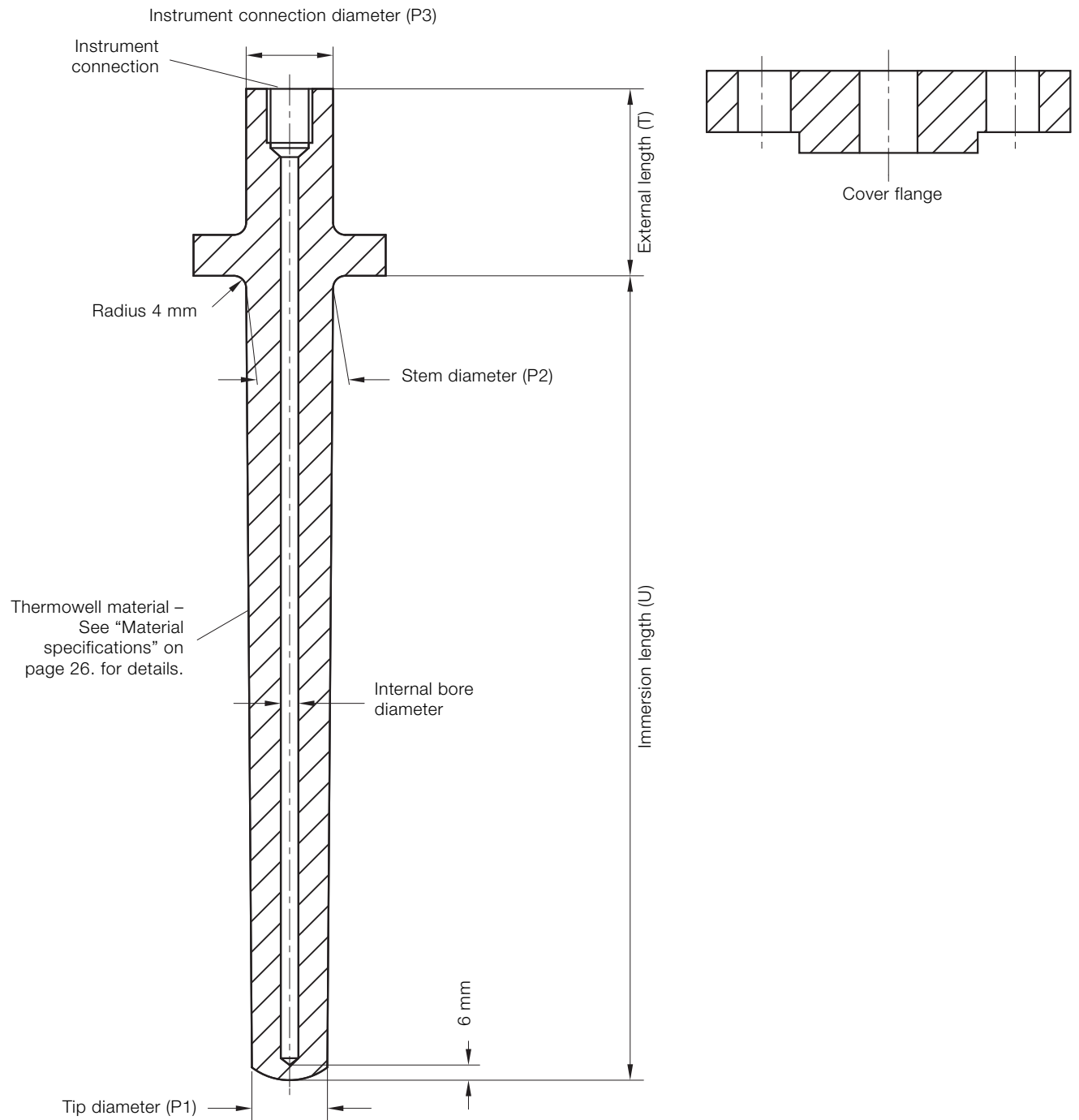
**Velocity collar detail showing chamfers.**  
 Applies also to G2, G3, G4, G5, G6, G7, G8,  
 H1 and H2

# TSW400 series Thermowells

## Van Stone, straight with cover flange – H3

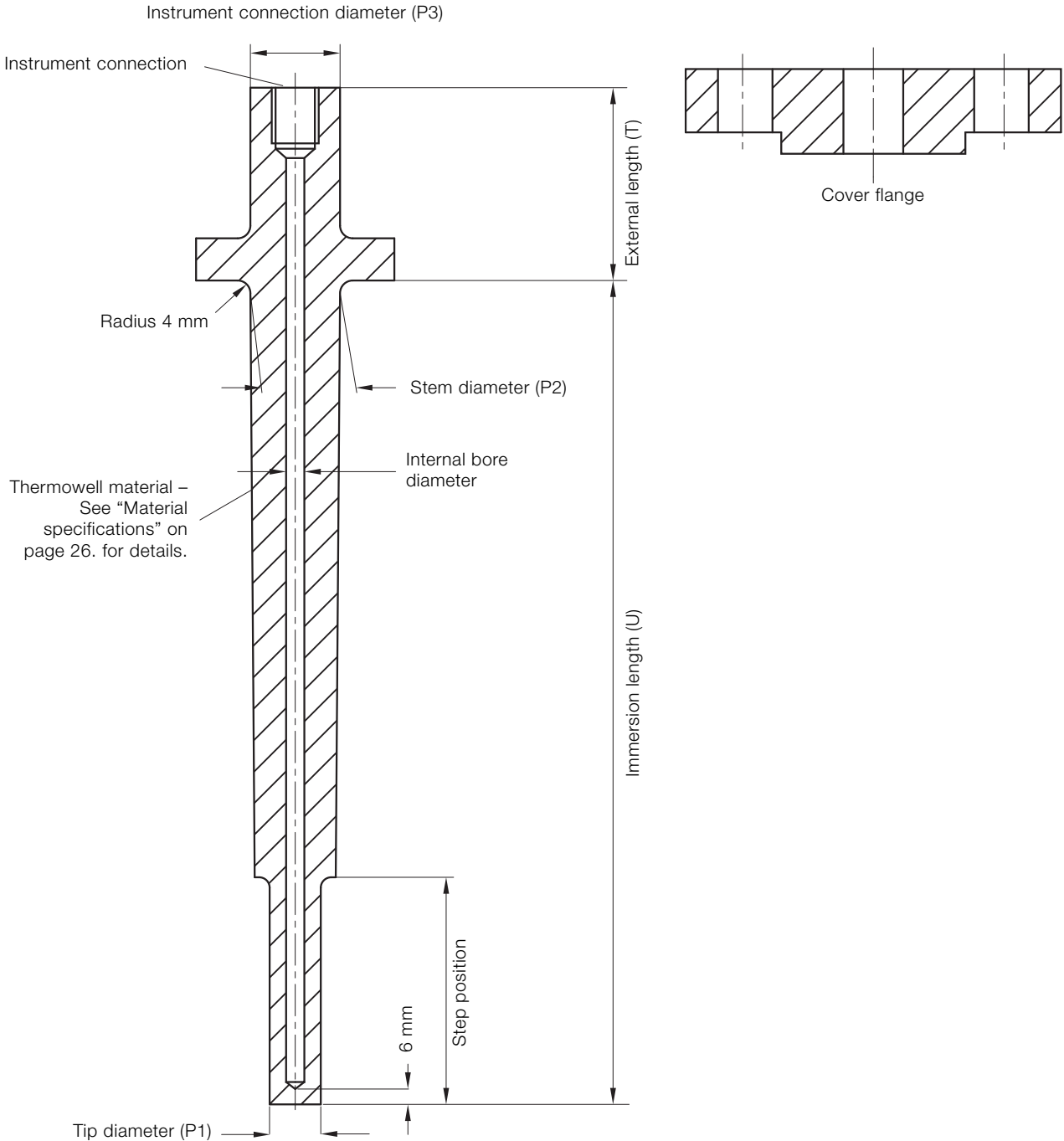


### Van Stone, tapered with cover flange – H4

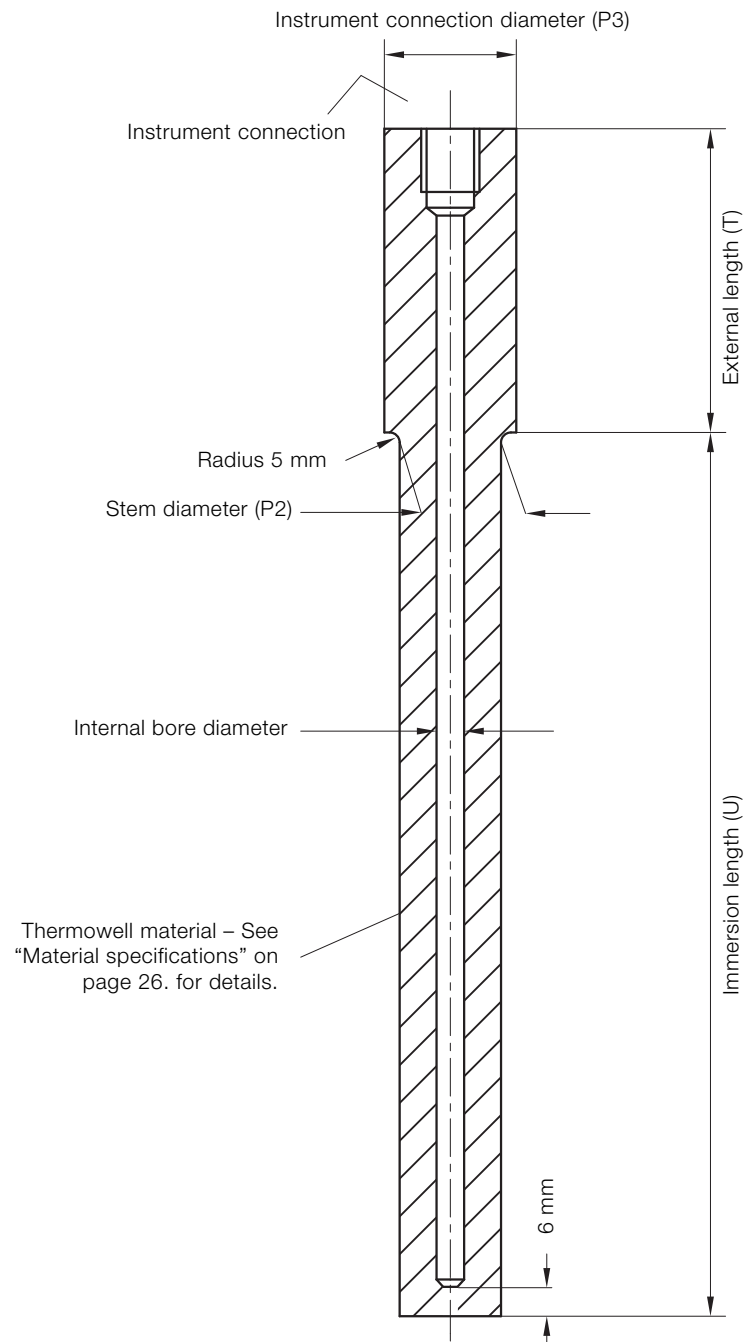


# TSW400 series Thermowells

## Van Stone, stepped with cover flange – H5

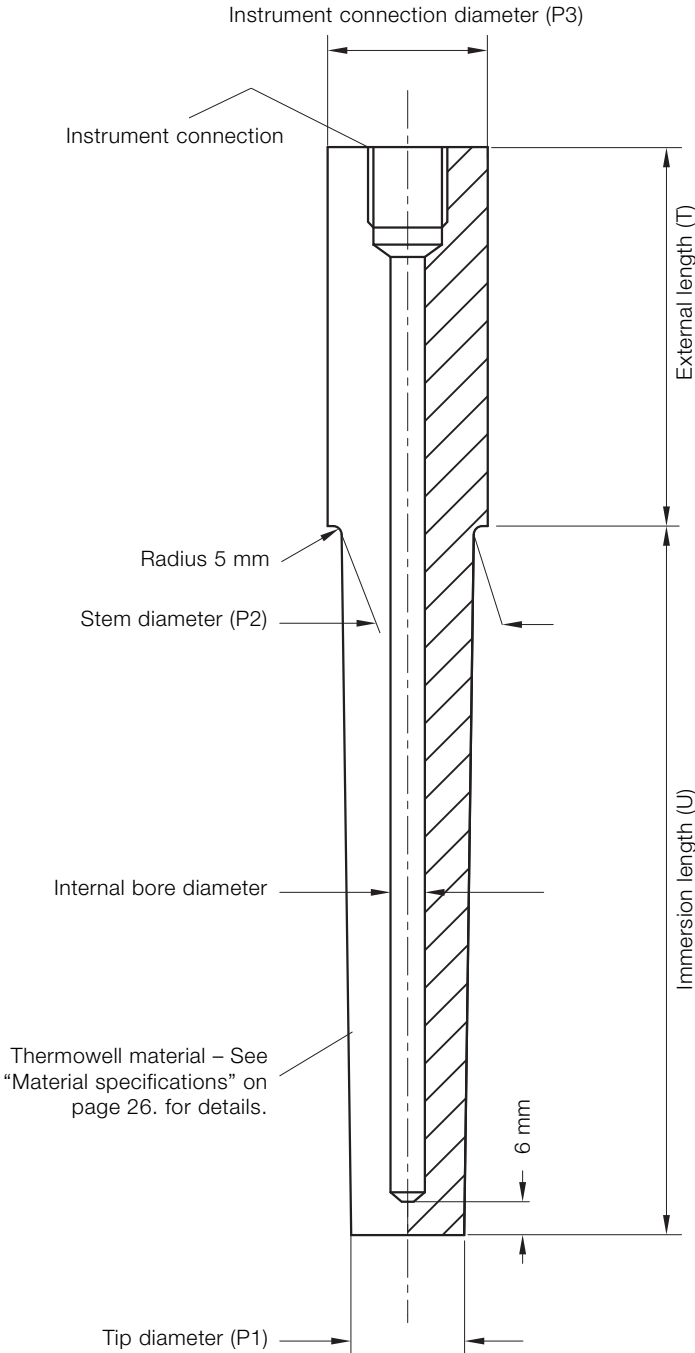


## Weld-in, straight – J1

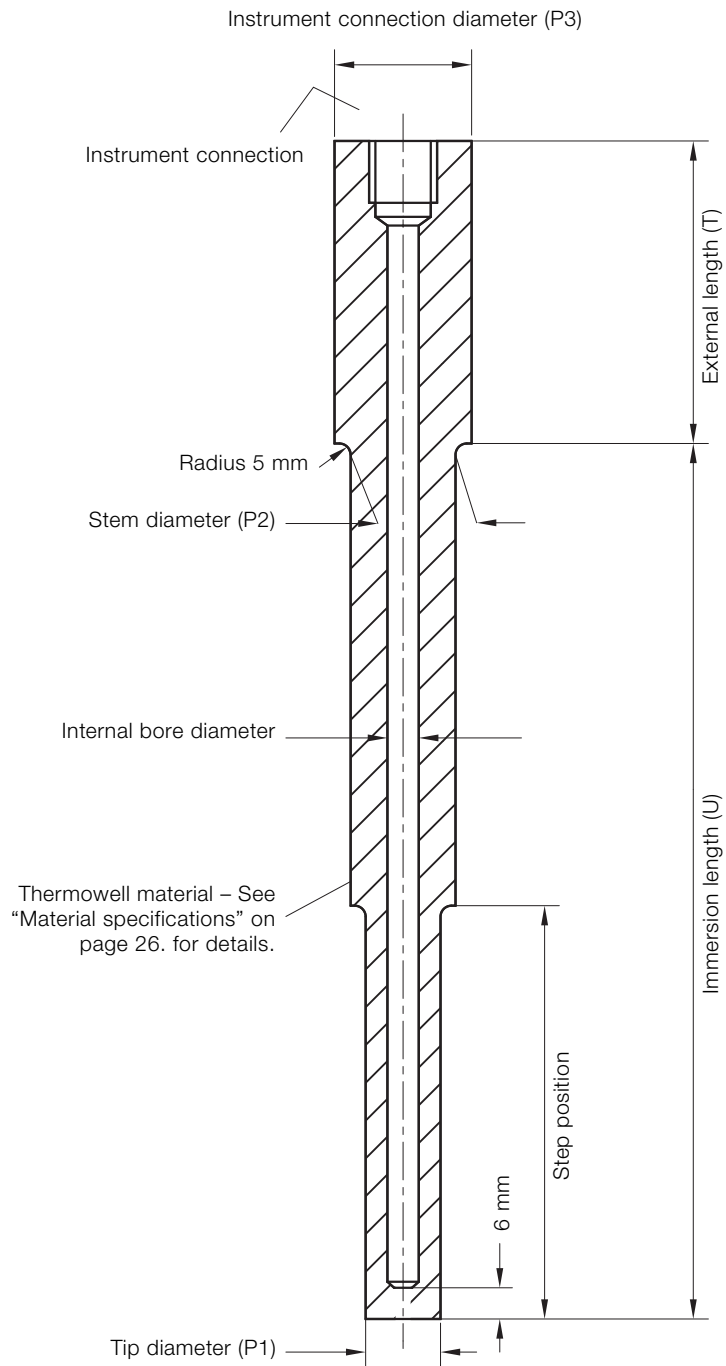


# TSW400 series Thermowells

## Weld-in, tapered – J2

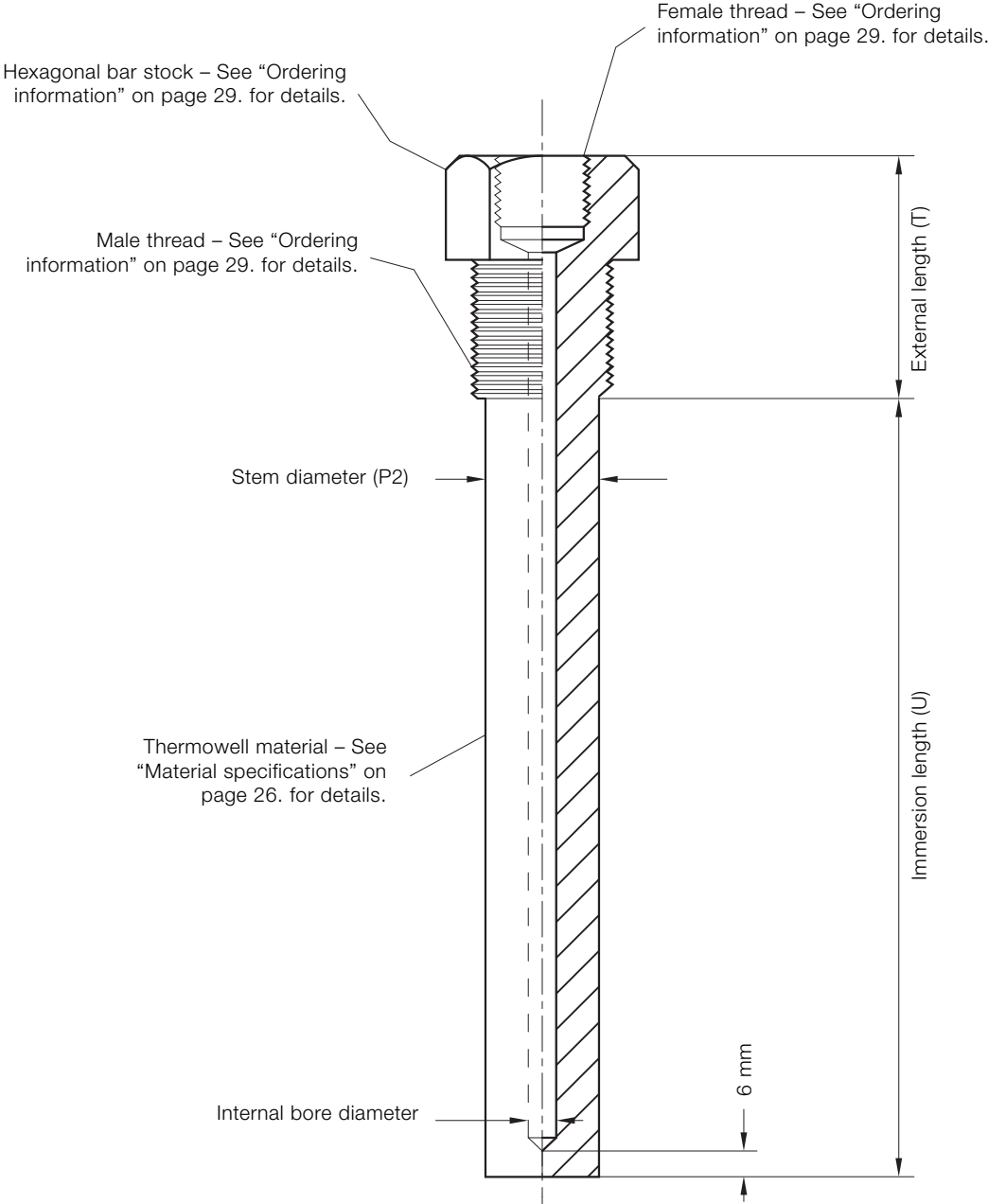


## Weld-in, stepped – J3



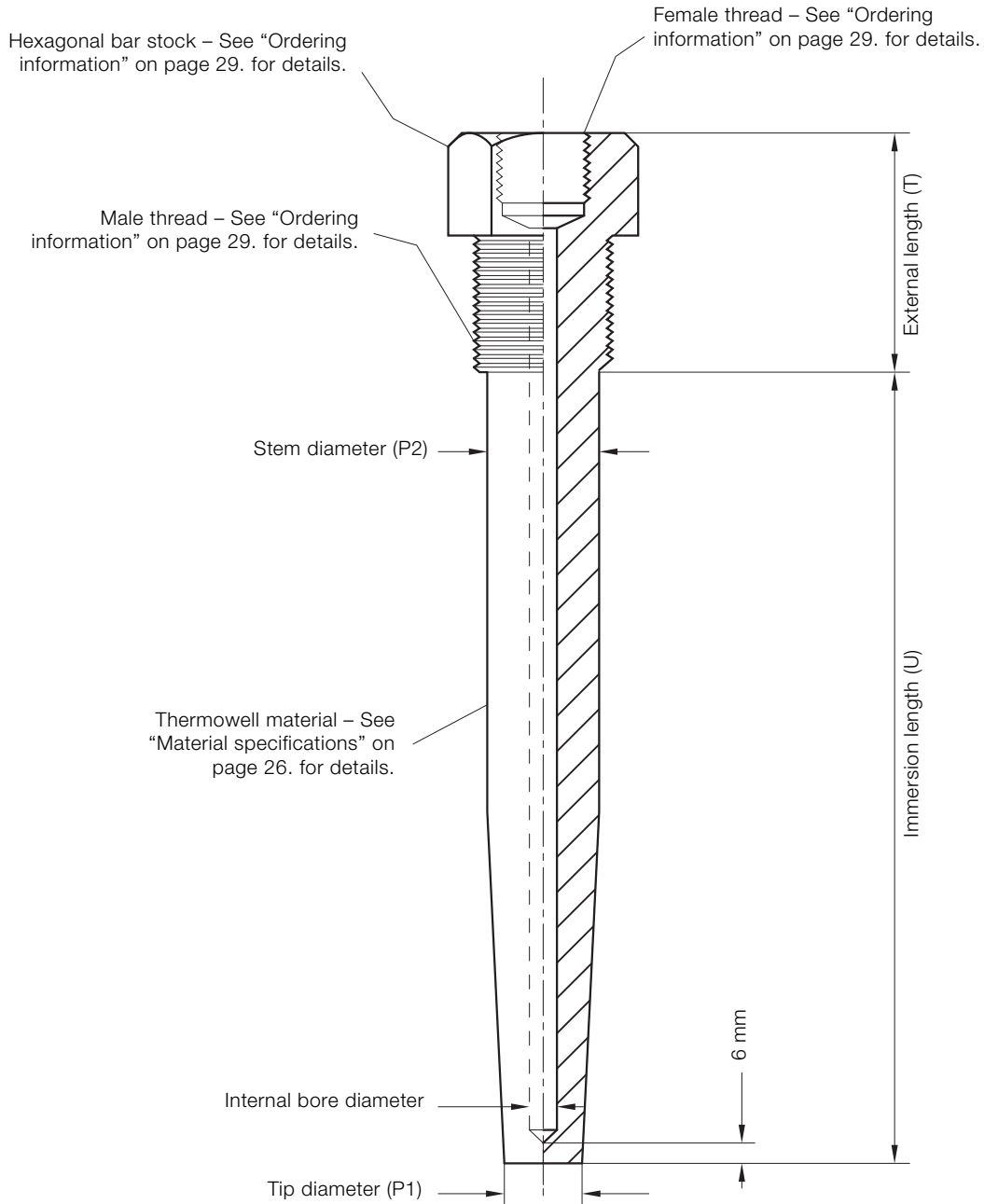
# TSW400 series Thermowells

## Threaded, straight – J4



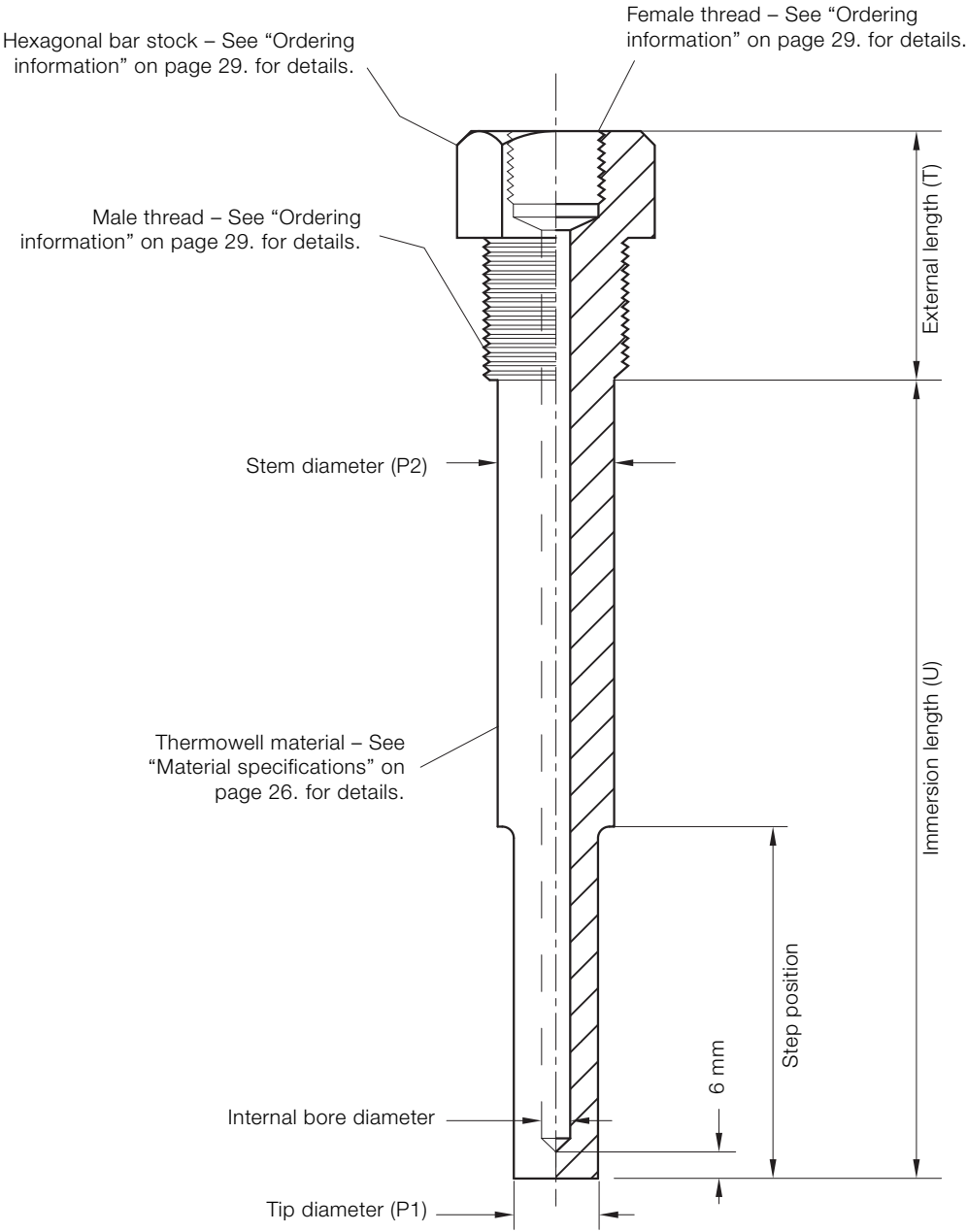


## Threaded, tapered – J5

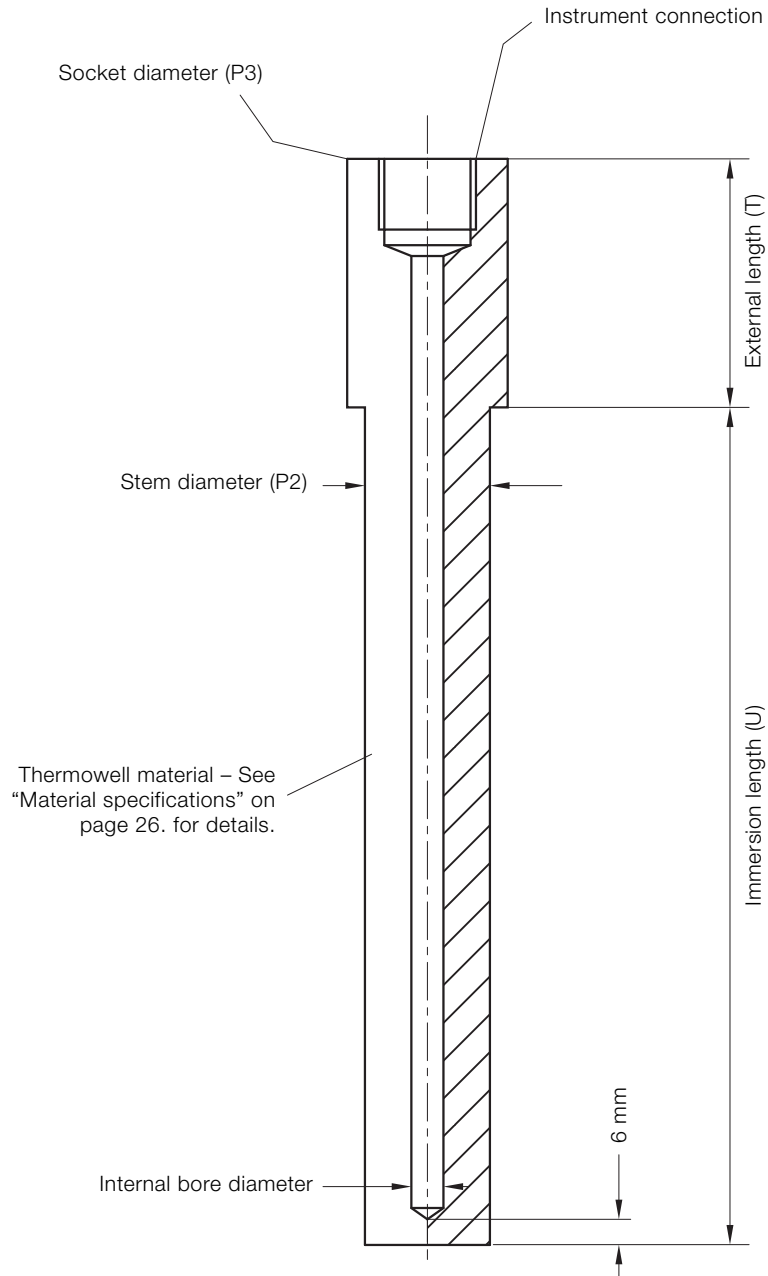


# TSW400 series Thermowells

## Threaded, stepped – J6

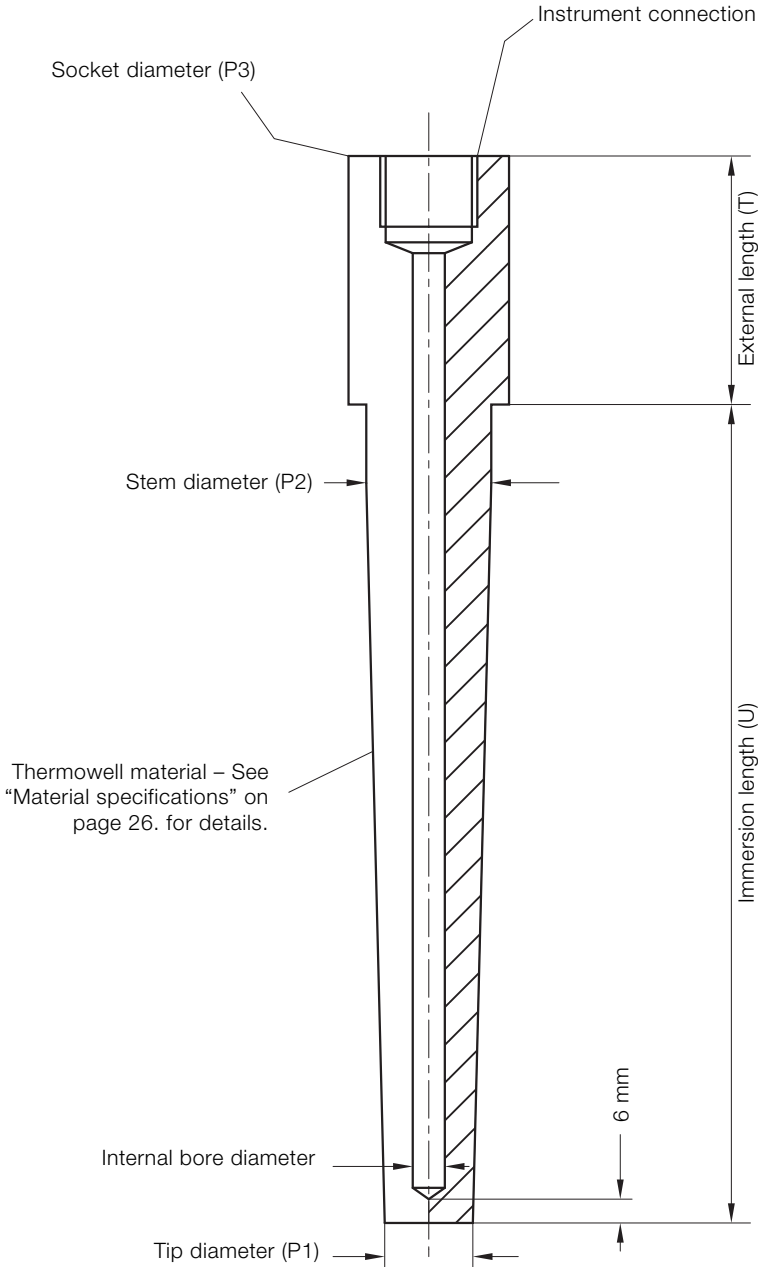


Socket-weld, straight – J7

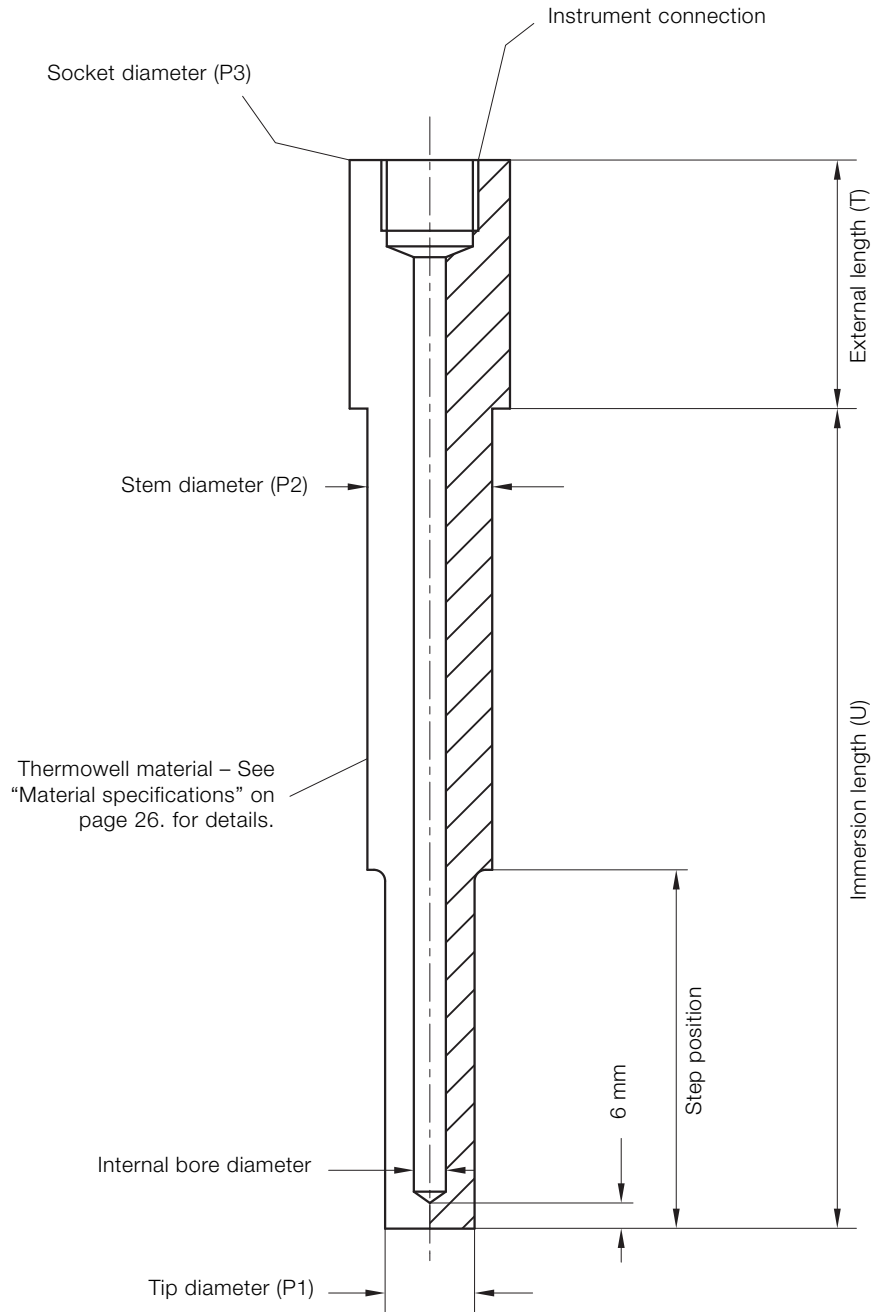


# TSW400 series Thermowells

## Socket-weld, tapered – J8



Socket-weld, stepped – L1



# TSW400 series Thermowells

## Material specifications

ABB can manufacture thermowells from almost any commercially available material. If the material required is not in the following list, contact ABB for advice.

- **316/ 316L stainless steel**  
the most commonly used material for thermowells combining excellent corrosion resistance with good strength and availability.
- **316Ti stainless steel**  
an enhanced version of 316 – a small amount of titanium is added to help stabilize the material at temperatures over 800 °C (1472 °F).
- **321 stainless steel**  
offers similar properties to 316 and 316Ti but is more suitable for operation at higher temperatures.
- **Hastelloy C-276**  
a material favored for chloride atmospheres and processes. 300 series stainless steels are not recommended for use in high chloride and low oxygen environments.
- **Inconel 600**  
a high nickel alloy containing chromium – suitable for use at high temperatures and in both oxidizing and reducing atmospheres.
- **Monel 400**  
a high nickel alloy containing copper – highly resistant to corrosion in a wide variety of environments.
- **Duplex**  
a stainless steel designed specifically for use in salt water environments where it offers excellent corrosion resistance.
- **Super duplex**  
a variant of duplex steel that includes a small amount of copper – preferred over duplex for its enhanced high temperature properties.

**Note.** ABB are unable to specify a particular material for a process plant as this requires detailed process knowledge. However, ABB can discuss the implications of such choices on speed of delivery and cost. In addition, ABB welding engineers are available to advise on welding procedures for all materials.

## Additional material specifications

Materials for use in 'sour' environments (environments containing high concentrations of hydrogen sulphide) normally demand material that complies with the NACE standard. ABB can comply fully with all these requirements.

Certain countries require that materials conform to particular requirements (for example, the NORSOK standard for materials for use in the North Sea).

### ASME PTC 19.3 2010 TW stress calculations

The only published international code for the evaluation of the stresses placed on thermowells in service. ABB engineers can perform a calculation to the ASME code on request. Certification is supplied when requested.

### X-ray fluorescence PMI

When absolute verification of the material supplied is required, ABB can perform an in-house X-ray fluorescence examination. This technique provides a quantitative analysis of the heavy elements in the chemical makeup of the material. The result can then be compared to the certification supplied by the producing mill.

### Pressure testing

Two types of hydrostatic pressure test are offered by ABB:

- **External**  
tests the thermowell with pressure applied externally to the thermowell at 1.5 times the flange rating.
- **Internal**  
tests the thermowell internally for leaks.

### Weld integrity testing

Weld integrity can be determined using:

- **dye penetrant**  
to detect external flaws in the weld
- **X-ray**  
to look deeply into the weld to detect internal flaws.

Only X-ray testing produces a permanent record of the weld integrity test in the form of a photograph (X-ray radiograph).

### Bore concentricity

The concentricity of the thermowell bore is vitally important to the performance and safety of the thermowell. ABB uses specially designed, deep-hole drilling machines to produce an absolute confidence in bore concentricity. Additional ultrasonic testing of bore concentricity is standard practice in ABB factories. Additional verification is available in the form of two-axis radiographs that show the concentric bore.

### Stainless steel surface treatment

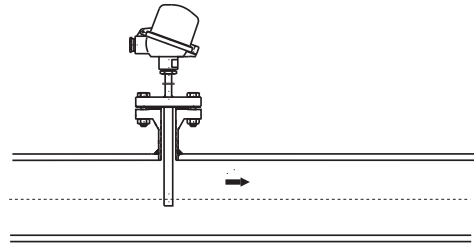
Stainless steels retain their stainless properties by virtue of a thin chromium oxide layer. This layer can be damaged by contaminants during manufacturing. The removal of these contaminants to enable the oxide layer to rebuild is vital for thermowell corrosion integrity. ABB standard practice is to thoroughly degrease each thermowell, both externally and internally, before delivery.

Upon request, ABB can also arrange for a separate 'pickling and passivation' procedure. This is done by first immersing the thermowell in a hot acid bath to remove any contaminants. The thermowell is then 'passivated' to rebuild the chromium oxide layer.

## Other considerations

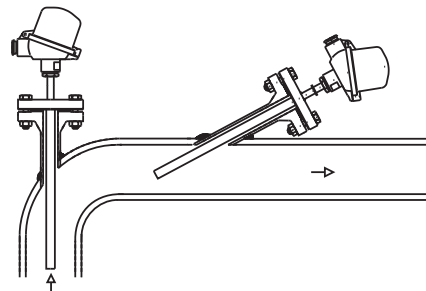
### Thermowell insertion depth

Ideally, the thermowell tip should be positioned in the center third of the pipe. In this position, the temperature measured is an accurate representation of the process temperature.



Additionally, the stem of the thermowell must be at least ten times longer than the tip diameter to minimize heat conduction errors. For example, a thermowell with a tip diameter of 16 mm (0.63 in.) must have a stem that is at least 160 mm (6.3 in.) long.

Narrow pipelines may prevent these two conditions from being met. In this case, it is acceptable to fit the thermowell into the pipe-line at angle or in a bend to accommodate the minimum recommended stem length.



However, if the pipeline is well lagged, a shorter thermowell may also provide a high degree of accuracy.

# TSW400 series Thermowells

## Speed of response

The factors that affect speed of response are many and varied. They include:

- the thermal conductivity of the medium
- the flow rate of the medium
- the thermal conductivity of the thermowell material
- the thermowell dimensions

All these factors play a part in the eventual speed of response.

In general, thermowell-mounted instruments respond to changes in temperature faster than the process itself. If an increased rate of response is required, it can be achieved only by reducing the amount of material surrounding the measuring element therefore a stepped design thermowell must be used. However, a compromise must be made between the rate of response achievable and the strength required from the thermowell design.

## Special designs

There may be occasions where a design of thermowell is required that cannot be developed from the available codes. ABB engineers can help with such a requirement. ABB has experience of delivering specialist designs within the Oil & Gas industry and can quote for such a need.

Some customers require approval before manufacture of designs; this can be achieved using ABB-engineered special designs.

Whatever the need – be it a special design or a problem with erosion or corrosion – ABB engineers can help.



## Ordering information

TSW 400 series thermowells	TSW400	Main code										Optional code						
		XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX
<b>Thermowell design</b>																		
Flanged, straight, forged	E1																	
Flanged, tapered, forged	E2																	
Flanged, stepped, forged	E3																	
Flanged, straight, full penetration weld	E4																	
Flanged, tapered, full penetration weld	E5																	
Flanged, stepped, full penetration weld	E6																	
Flanged, straight, fillet & groove	E7																	
Flanged, tapered, fillet & groove	E8																	
Flanged, stepped, fillet & groove	G1																	
Flanged, straight, forged with velocity collar	G2																	
Flanged, tapered, forged with velocity collar	G3																	
Flanged, stepped, forged with velocity collar	G4																	
Flanged, straight, full penetration weld with velocity collar	G5																	
Flanged, tapered, full penetration weld with velocity collar	G6																	
Flanged, stepped, full penetration weld with velocity collar	G7																	
Flanged, straight, fillet & groove with velocity collar	G8																	
Flanged, tapered, fillet & groove with velocity collar	H1																	
Flanged, stepped, fillet & groove with velocity collar	H2																	
Van Stone, straight	H3																	
Van Stone, tapered	H4																	
Van Stone, stepped	H5																	
Van Stone, straight with velocity collar	H6																	
Van Stone, tapered with velocity collar	H7																	
Van Stone, stepped with velocity collar	H8																	
Weld-in, straight	J1																	
Weld-in, tapered	J2																	
Weld-in, stepped	J3																	
Threaded, straight	J4																	
Threaded, tapered	J5																	
Threaded, stepped	J6																	
Socket-weld, straight	J7																	
Socket-weld, tapered	J8																	
Socket-weld, stepped	L1																	
DIN 43772 form 4	D1																	
ABB form 4S	D2																	
ABB form PW	P1																	
DIN 43772 form 4F	D3																	
ABB form 4FS	D4																	
ABB form PF	P2																	
ABB form PS	P3																	
Other	Z9																	

See page 34

Continued on next page ...

# TSW400 series Thermowells

TSW 400 series thermowells	TSW400	Main code										Optional code						
		XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX
	See page 29																	
<b>Immersion length (U)</b>																		
50 to 100 mm																		
101 to 150 mm																		
151 to 200 mm																		
201 to 250 mm																		
251 to 300 mm																		
301 to 350 mm																		
351 to 400 mm																		
401 to 450 mm																		
451 to 500 mm																		
501 to 550 mm																		
551 to 600 mm																		
601 to 650 mm																		
651 to 700 mm																		
701 to 750 mm																		
751 to 800 mm																		
801 to 850 mm																		
851 to 999 mm																		
<b>Thermowell material</b>																		
Stainless steel 1.4404 / 316L																		
Stainless steel 1.4571 / 316Ti																		
Stainless steel 1.4541 / 321L																		
Hastelloy C-276 / 2.4819																		
Monel 400																		
Inconel 600																		
Duplex																		
Super duplex																		
Others																		

Continued on next page ...

**TSW 400 series thermowells**

**TSW400** **XX** **XX** **XX** **XXX** **X** **XX** **X** **XX** **XX** **X** **XXX**  
 See pages 29 and 30

**Main code**

**Optional code**

**XX** **XXX** **XX** **XX** **XX** **XX** **XX**  
 See page 34

**Process connection type**

None	Y00
Flanged 1 in. ASME B16.5 CL 150 RF	F07
Flanged 1 in. ASME B16.5 CL 300 RF	F08
Flanged 1 in. ASME B16.5 CL 600 RF	F09
Flanged 1 in. ASME B16.5 CL 600 RTJ	J09
Flanged 1 in. ASME B16.5 CL 900 RF	F21
Flanged 1 in. ASME B16.5 CL 900 RTJ	J21
Flanged 1 in. ASME B16.5 CL 1500 RF	F22
Flanged 1 in. ASME B16.5 CL 1500 RTJ	J22
Flanged 1½ in. ASME B16.5 CL 150 RF	F11
Flanged 1½ in. ASME B16.5 CL 300 RF	F12
Flanged 1½ in. ASME B16.5 CL 600 RF	F13
Flanged 1½ in. ASME B16.5 CL 600 RTJ	J13
Flanged 1½ in. ASME B16.5 CL 900 RF	F14
Flanged 1½ in. ASME B16.5 CL 900 RTJ	J14
Flanged 1½ in. ASME B16.5 CL 1500 RF	F25
Flanged 1½ in. ASME B16.5 CL 1500 RTJ	J25
Flanged 1½ in. ASME B16.5 CL 2500 RTJ	J26
Flanged 2 in. ASME B16.5 CL 150 RF	F15
Flanged 2 in. ASME B16.5 CL 300 RF	F16
Flanged 2 in. ASME B16.5 CL 600 RF	F17
Flanged 2 in. ASME B16.5 CL 600 RTJ	J17
Flanged 2 in. ASME B16.5 CL 900 RF	F18
Flanged 2 in. ASME B16.5 CL 900 RTJ	J18
Flanged 2 in. ASME B16.5 CL 1500 RF	F19
Flanged 2 in. ASME B16.5 CL 1500 RTJ	J19
Flanged 2 in. ASME B16.5 CL 2500 RTJ	J20
Flanged DN 25 EN1092 PN 10	D21
Flanged DN 25 EN1092 PN 16	D22
Flanged DN 25 EN1092 PN 40	D24
Flanged DN 40 EN1092 PN 10	D41
Flanged DN 40 EN1092 PN 16	D42
Flanged DN 40 EN1092 PN 40	D44
Flanged DN 50 EN1092 PN 10	D51
Flanged DN 50 EN1092 PN 16	D52
Flanged DN 50 EN1092 PN 40	D54
Threaded M20 x 1.5	S07
Threaded M27 x 2	S08
Threaded ½ in. NPT	S04
Threaded ¾ in. NPT	S05
Threaded 1 in. NPT	S06
Others	Z99

Continued on next page ...

# TSW400 series Thermowells

TSW 400 series thermowells	Main code										Optional code							
	TSW400	XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX
	See pages 29 to 31										See page 34							
<b>Instrument connection</b>																		
1/2 in. NPT (standard)						A												
M20 x 1.5						D												
1/2 in. BSP						E												
<b>External length (T)</b>																		
0 mm to...											00							
90 mm											90							
<b>Instrument connection diameter (P3)</b>																		
32 mm												A						
35 mm													B					
40 mm														C				
Others														Z				
<b>Stem diameter (P2)</b>																		
16 mm to...													16					
38 mm													38					

Continued on next page ...

**TSW 400 series thermowells**

**Main code**

TSW400 

XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX
----	----	----	-----	---	----	---	----	----	---	-----

  
See pages 29 to 32

**Optional code**

XX	XXX	XX	XX	XX	XX	XX
----	-----	----	----	----	----	----

  
See page 34

**Tip diameter (P1)**

12 mm	A1
12.5 mm	A2
13 mm	A3
13.5 mm	A4
14 mm	A5
14.5 mm	A6
15 mm	A7
15.5 mm	A8
16 mm	A9
16.5 mm	B0
17 mm	B1
17.5 mm	B2
18 mm	B3
18.5 mm	B4
19 mm	B5
19.5 mm	B6
20 mm	B7
20.5 mm	B8
21 mm	B9
21.5 mm	C0
22 mm	C1
22.5 mm	C2
23 mm	C3
23.5 mm	C4
24 mm	C5
24.5 mm	C6
25 mm	C7
25.5 mm	C8
26 mm	C9
26.5 mm	D0
27 mm	D1
27.5 mm	D2
28 mm	D3
28.5 mm	D4
29 mm	D5
29.5 mm	D6
30 mm	D7

Continued on next page ...

# TSW400 series Thermowells

TSW 400 series thermowells	Main code										Optional code									
	TSW400	XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX	XX	
	See pages 29 to 33																			
<b>Internal bore</b>																				
3.5 mm																				A
6.5 mm																				B
7.0 mm																				C
8.0 mm																				D
9.0 mm																				E
9.5 mm																				F
10 mm																				G
13 mm																				H
<b>Step position</b>																				
None																				000
50 mm to...																				050
150 mm																				150
<b>Usage certifications</b>																				
3.1 cert materials traceability report																				C2
Certificate of conformity																				C4
Dimensional report																				C6
NACE material certification																				CN
<b>Other usage certifications</b>																				
Russia, Metrological and GOST-R certificate																				CG1
NORSOK																				CN2
<b>Plug and chain</b>																				
Plug and chain (stainless steel)																				H8
<b>Documentation language</b>																				
German																				M1
Spanish																				M3
French																				M4
English																				M5
<b>Non-destructive tests</b>																				
X-ray fluorescence PMI																				N1
Dye penetration of weld integrity																				N2
Ultrasonic tip concentricity																				N3
Helium leak testing																				N4
Pressure test external (water)																				N5
Pressure test internal (water)																				N6
Radiograph process connection																				N7
Radiograph tip concentricity																				N8

Continued on next page ...

**TSW 400 series thermowells**

Main code											Optional code							
TSW400	XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX	XX
See pages 29 to 34											See page 34							

**Reporting options**

Weld location report	ND
Weld qualification report	NE
Wake frequency calculation	NG
Hardness report	NH

**Operations options**

De-pip, to produce a flat bore end	SB
Non standard flange to stem weld radius	SW
Non Standard tip thickness	ST
Non Standard tip profile (chamfered)	SH
Non Standard tip profile (domed)	SR
Pickling and passivation	SC
Material source limitations apply	SD
European only materials	SE

**Added characteristics**

- Actual immersion length (mm)
- Velocity collar diameter (mm)
- Velocity collar position (mm)
- Tag number
- Material source limitations
- Non standard flange to stem weld radius
- Non standard tip thickness

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3KXT181401R1001



Sales



Service



# TTF300

## Field mounted Temperature Transmitter

Sensor error adjustment  
Sensor redundancy  
Sensor drift monitoring



**HART, PROFIBUS, FOUNDATION Fieldbus, Pt100 (RTD), thermocouples, electrical isolation**

### Input

- Resistance thermometer
- Thermocouples
- Resistance-type transmitters
- Voltages, mV voltages

### Input functionality

- 1 or 2 sensors
- 2 x Pt100 three-wire circuit

### Output

- 4 ... 20 mA, HART
- PROFIBUS PA, profile 3.01
- FOUNDATION Fieldbus H1, ITK version 5.2

### Specific linearization

- Callendar-Van Dusen coefficients
- Table of variate pairs / 32 points

### Continuous sensor monitoring and self-monitoring

- Supply voltage monitoring
- Wire break and corrosion monitoring in accordance with NE 89
- Extended diagnostics in accordance with NE 107

### Device safety in accordance with NE 53 and NE 79

### SW write protection, HW write protection

### SIL2/3 in accordance with IEC 61508 (for HART)

### Approvals for explosion protection

- ATEX, IECEx
- FM / CSA
- GOST (for HART)

### Configuration

- LCD indicators
- DTM
- EDD

### Service interface

## Contents

<b>1</b>	<b>Specifications</b>	<b>4</b>
1.1	Input	4
1.2	Output	5
1.3	Power supply (polarity safe)	5
<b>2</b>	<b>General information</b>	<b>6</b>
2.1	Ambient conditions	6
2.2	SIL functional safety	6
2.3	ElectroMagnetic Compatibility	6
2.4	Interference immunity	6
2.5	Mechanical design	6
2.6	Measuring accuracy	7
2.7	Operating influences	8
<b>3</b>	<b>Communication</b>	<b>9</b>
3.1	Configuration parameters	9
3.2	HART	9
3.3	PROFIBUS PA	10
3.4	FOUNDATION Fieldbus	10
<b>4</b>	<b>Electrical connections</b>	<b>11</b>
<b>5</b>	<b>Dimensions</b>	<b>12</b>
<b>6</b>	<b>Ordering information</b>	<b>13</b>
6.1	Documentation available for ordering	15
<b>7</b>	<b>Ex relevant specifications</b>	<b>15</b>
7.1	TTF300-E1X, intrinsic safety ATEX	15
7.2	TTF300-H1X, intrinsic safety IECEx	15
7.3	Safety specifications for Intrinsic Safety ATEX / IECEx	15
7.4	TTF300-E5X, non-sparking + dust explosion protection ATEX	16
7.5	TTF300-D1X, dust explosion protection ATEX	16
7.6	TTF300-D2X, dust explosion protection + intrinsic safety ATEX	16
7.7	TTF300-E3X, flameproof enclosure ATEX	16
7.8	TTF300-E4X, flameproof enclosure + intrinsic safety ATEX	16
7.9	TTF300-L1X, intrinsically safe FM	16
7.10	TTF300-L2X, non-incendive FM	16
7.11	TTF300-L3X, explosion proof FM	16
7.12	TTF300-L7X, explosion proof + intrinsically safe FM	16
7.13	TTF300-R1X, intrinsically safe CSA	16
7.14	TTF300-R2X, non-incendive CSA	16
7.15	TTF300-R3X, explosion proof CSA	16
7.16	TTF300-R7X, explosion proof + intrinsically safe CSA	16
<b>8</b>	<b>Type B LCD</b>	<b>17</b>

8.1	Features .....	17
8.2	Specifications .....	17
8.3	Configuration function .....	17
8.4	Ex relevant specifications .....	17
<b>9</b>	<b>Order form configuration.....</b>	<b>19</b>
9.1	HART device design: Data relating to customer-specific configuration .....	19
9.2	PROFIBUS PA / FOUNDATION Fieldbus device design .....	20

## 1 Specifications

### 1.1 Input

#### 1.1.1 Resistance thermometers / Resistors

##### Resistance thermometers

Pt100 in accordance with IEC 60751, JIS C1604-89,  
MIL-T-24388,  
Ni in accordance with DIN 43760, Cu

##### Resistance measurement

0 ... 500  $\Omega$   
0 ... 5000  $\Omega$

##### Sensor connection type

Two-, three-, four-wire circuit

##### Connecting cable

Maximum sensor line resistance ( $R_W$ ) for each line 50  $\Omega$   
according to NE 89 (January 2009)  
Three-wire circuit:  
symmetrical sensor line resistances  
Two-wire circuit:  
compensation up to 100  $\Omega$  total line resistance

##### Measurement current

< 300  $\mu$ A

##### Sensor short circuit

< 5  $\Omega$  (for resistance thermometer)

##### Sensor wire break

Measuring range: 0 ... 500  $\Omega$  > 0.6 ... 10 k $\Omega$   
Measuring range: 0 ... 5 k $\Omega$  > 5.3 ... 10 k $\Omega$

##### Corrosion detection in accordance with NE 89

Three-wire resistance measurement > 50  $\Omega$   
Four-wire resistance measurement > 50  $\Omega$

##### Sensor error signaling

Resistance thermometers: Short circuit and wire break  
Linear resistance measurement: Wire break

#### 1.1.2 Thermocouples / Voltages

##### Types

B, E, J, K, N, R, S, T in accordance with IEC 60584  
U, L in accordance with DIN 43710  
C, D in accordance with ASTM E-988

##### Voltages

-125 ... 125 mV  
-125 ... 1100 mV

##### Connecting cable

Maximum sensor line resistance ( $R_W$ ) for each line: 1.5 k $\Omega$ ,  
total: 3 k $\Omega$

##### Sensor wire-break monitoring in accordance with NE 89

Pulsed with 1  $\mu$ A outside measurement interval  
Thermocouple measurement 5.3 ... 10 k $\Omega$   
Voltage measurement 5.3 ... 10 k $\Omega$

##### Input resistance

> 10 M $\Omega$

##### Internal reference point

Pt1000, IEC 60751 Cl. B  
(no additional jumpers necessary)

##### Sensor error signaling

Thermocouple: Wire break  
Linear voltage measurement: Wire break

#### 1.1.3 Functionality

##### Freestyle characteristics and 32-point sampling table

Resistance measurement up to maximum 5 k $\Omega$   
Voltages up to maximum 1.1 V

##### Sensor error adjustment

Via Callendar van Dusen coefficients  
Via table of 32 sampling points  
Via single-point adjustment (offset adjustment)  
Via two-point adjustment

##### Input functionality

1 sensor  
2 sensors:  
mean measurement,  
differential measurement,  
sensor redundancy,  
sensor drift monitoring

## 1.2 Output

### 1.2.1 HART output

#### Transmission characteristics

Temperature linear  
Resistance linear  
Voltage linear

#### Output signal

Configurable 4 ... 20 mA (standard)  
Configurable 20 ... 4 mA  
(dynamic range: 3.8 ... 20.5 mA in accordance with NE 43)

#### Simulation mode

3.5 ... 23.6 mA

#### Induced current consumption

< 3.5 mA

#### Maximum output current

23.6 mA

#### Configurable error current signal

Override 22 mA (20.0 ... 23.6 mA)  
Underdrive 3.6 mA (3.5 ... 4.0 mA)

### 1.2.2 PROFIBUS PA output

#### Output signal

PROFIBUS – MBP (IEC 61158-2)  
baud rate 31.25 kbit/s  
PA profile 3.01  
FISCO-compliant (IEC 60079-27)  
IDENT\_ NUMBER: 0x3470 [0x9700]

#### Error current signal

FDE (Fault Disconnection Electronic)

#### Block structure

Physical block  
transducer block 1 – temperature  
transducer block 2 – HMI (LCD)  
transducer block 3 – extended diagnostics  
analog input 1 – primary value (calculated value\*)  
analog input 2 – SECONDARY VALUE\_1 (sensor 1)  
analog input 3 – SECONDARY VALUE\_2 (sensor 2)  
analog input 4 – SECONDARY VALUE\_3 (reference point temp.)  
analog output – optional HMI display (transducer block 2)  
discrete input 1 – extended diagnostics 1 (transducer block 3)  
discrete input 2 – extended diagnostics 2 (transducer block 3)  
\* Sensor 1, sensor 2, or difference, or mean

### 1.2.3 FOUNDATION Fieldbus output

#### Output signal

FOUNDATION Fieldbus H1 (IEC 61158-2)  
Baud rate 31.25 kbit/s, ITK 5.2  
FISCO-compliant (IEC 60079-27)  
Device ID: 0003200125

#### Error current signal

FDE (Fault Disconnection Electronic)

#### Block structure <sup>1)</sup>

Resource block  
Transducer block 1 – temperature  
Transducer block 2 – HMI (LCD)  
Transducer block 3 – extended diagnostics  
Analog input 1 – PRIMARY\_VALUE\_1 (sensor 1)  
Analog input 2 – PRIMARY\_VALUE\_2 (sensor 2)  
Analog input 3 – PRIMARY\_VALUE\_3 (calculated value\*)  
Analog input 4 – SECONDARY\_VALUE (reference point temp.)  
Analog output – optional HMI display (transducer block 2)  
Discrete input 1 – extended diagnostics 1 (transducer block 3)  
Discrete input 2 – extended diagnostics 2 (transducer block 3)  
PID – PID controller  
\* Sensor 1, sensor 2, or difference, or mean

#### LAS (Link Active Scheduler) link master functionality

<sup>1)</sup> For the block description, block index, execution times, and block class, refer to the interface description.

## 1.3 Power supply (polarity safe)

Two-wire technology; supply power lines = signal lines

### 1.3.1 HART supply power

#### Supply voltage

Non-ignition-proof application:  $U_S = 11 \dots 42 \text{ V DC}$   
Ignition-proof applications:  $U_S = 11 \dots 30 \text{ V DC}$

#### Max. permissible residual ripple for supply voltage

During communication in accordance with HART FSK  
"Physical Layer" specification, version 8.1 (August 1999) Section 8.1

#### Undervoltage detection

$U_{\text{Terminal-Mu}} < 10 \text{ V}$  results in  $I_a = 3.6 \text{ mA}$

#### Maximum load

$R_{\text{Load}} = (\text{supply voltage} - 11 \text{ V}) / 0.022 \text{ A}$

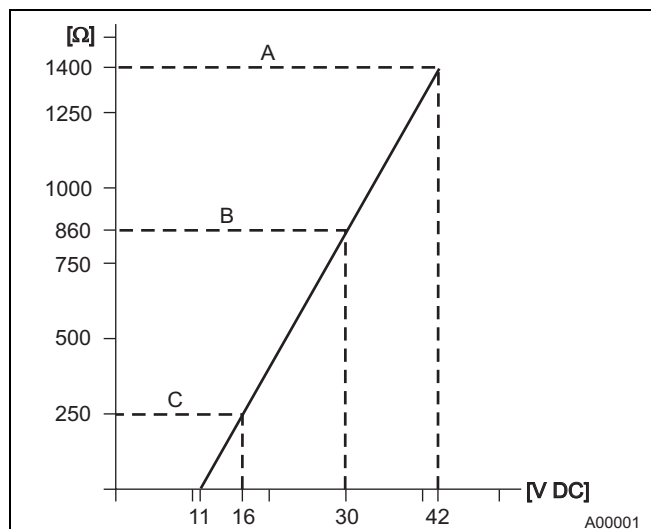


Fig. 1: Maximum load depending on supply voltage

- A TTF300
- B TTF300 In ia hazardous area design
- C HART communication resistor

#### Maximum power consumption

$P = U_S \times 0.022 \text{ A}$

e.g.,  $U_S = 24 \text{ V} \rightarrow P_{\text{max}} = 0.528 \text{ W}$

### 1.3.2 PROFIBUS / FOUNDATION Fieldbus supply power

#### Supply voltage

Non-ignition-proof application:  $U_S = 9 \dots 32 \text{ V DC}$

Ignition-proof applications:

$U_S = 9 \dots 17.5 \text{ V DC}$  (FISCO)

$U_S = 9 \dots 24 \text{ V DC}$  (Fieldbus Entity model I.S.)

Current consumption  $\leq 12 \text{ mA}$

## 2 General information

### CE marking

The TTF300 meets all requirements as regards the CE marking in accordance with the applicable guidelines.

### Electrical isolation

3.5 kV DC (approx. 2.5 kV AC), 60 s, input to output

### MTBF time

28 years at 60 °C ambient temperature

### Input filter

50 / 60 Hz

### Switch-on delay

HART: < 10 s ( $I_a \leq 3.6$  mA during starting cycle)

PROFIBUS: 10 s, max. 30 s

FOUNDATION Fieldbus: < 10 s

### Warm-up time

5 minutes

### Ramp-up time $t_{90}$

400 ... 1000 ms

### Rate updated

10/s with 1 sensor, 5/s with 2 sensors, depending on sensor type and sensor circuit

### Output filter

Digital filter 1st order: 0 ... 100 s

### 2.1 Ambient conditions

#### Ambient temperature

Standard: -40 ... 85 °C (-40 ... 185 °F)

Optional: -50 ... 85 °C (-58 ... 185 °F)

Restricted range with hazardous area design

#### Transport / storage temperature

-50 ... 85 °C (-58 ... 185 °F)

#### Climate class

Cx -40 ... 85 °C (-40 ... 185 °F) at

5 ... 95 % relative humidity, DIN EN 60654-1

#### Max. permissible humidity

100 % relative humidity, IEC 60068-2-30

#### Vibration resistance

10 ... 2000 Hz at 5 g in acc. with IEC 60068-2-6, during operation and transport

#### Shock

gn = 30 in acc. with IEC 68-2-27, during operation and transport

#### Degrees of protection

IP 66 and IP 67; NEMA 4X, ENCL 4X

### 2.2 SIL functional safety

Conforms with IEC 61508 as regards use in safety-related applications, up to and including SIL 2/3.

Only applies to the HART version.

### 2.3 ElectroMagnetic Compatibility

Emitted interference in accordance with IEC 61326 (2005) and Namur NE 21 (08/2007)

### 2.4 Interference immunity

Interference-immune in accordance with IEC 61326 (2005) and Namur NE 21 (08/2007)

Pt100: measuring range 0 ... 100 °C (32 ... 212 °F), span 100 K

Type of test	Testing accuracy	Influence
Burst to signal/data lines	2 kV	< 0.5 %
Static discharge:		
• Contact plate (indirect)	8 kV	No
• Supply terminals <sup>1)</sup>	6 kV	No
• Sensor terminals <sup>1)</sup>	4 kV	No
Radiated field 80 MHz ... 2 GHz	10 V/m	< 0.5 %
Coupling 150 kHz ... 80 MHz	10 V	< 0.5 %
Surge:		
between the supply lines	0.5 kV	No malfunction
Line to ground	1 kV	No malfunction

1) Air discharge (at 1 mm (0.04 inch) distance)

### 2.5 Mechanical design

#### Dimensions

See Section 5, "Dimensions"

#### Weight

1.25 kg (2.76 lb)

#### Material

Housing: die-cast aluminum, epoxy-coated

Color: gray RAL 9002

Stainless steel

#### Installation conditions

Installation position: no limitations

#### Electrical connection

Thread (selectable) 2 x M20 x 1.5 / 2 x 1/2" NPT / 2 x 3/4" NPT (via reducing piece), ground screw external 6 mm<sup>2</sup>, M5 internal 2 x 2.5 mm<sup>2</sup>, M4 connection terminals for lines up to maximum of 2.5 mm<sup>2</sup> and handheld terminal interface

#### Cable gland 2 x M20 1.5:

maximum cable outer diameter 5 ... 9 mm (0.2 ... 0.35 inch), temperature range in acc. with data sheet of the cable gland used

- For non-ignition-proof and non-incendive polyamide, gray

- For intrinsically safe design and intrinsic safety polyamide, blue

#### Metal cable gland:

dust-ignition proof, flameproof enclosure, explosion proof, maximum cable outer diameter 6 ... 7.5 mm (0.24 ... 0.3 inch), temperature range: -20 ... 85 °C (-4 ... 185 °F)

#### Lightning protection

For cable gland M20 x 1.5

(see data sheet 10/63-6.15)

Non-ignition-proof: model NGV220-NO

Intrinsically safe: model NGV220-EX

## 2.6 Measuring accuracy

Includes linearity deviation. reproducibility / hysteresis at 23 °C (73.4 °F) ± 5 K and 20 V supply voltage

Information on measuring accuracy corresponds to 3  $\sigma$  (Gaussian distribution)

Input element		Measuring range limits	Minimum span	Digital measuring accuracy (24-bit A/D converter)	D/A measuring accuracy <sup>1)</sup> (16-bit DA)
Standard	Sensor				
<b>Resistance thermometer / Resistor</b>					
<b>DIN IEC 60 751</b>	Pt10 (a=0.003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.80 °C (± 1.44 °F)	± 0.05 %
	Pt50 (a=0.003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.16 °C (± 0.29 °F)	± 0.05 %
	Pt100 (a=0.003850) <sup>2)</sup>	<b>-200 ... 850 °C (-328 ... 1562 °F)</b>	10 °C (18 °F)	± 0.08 °C (± 0.14 °F)	± 0.05 %
	Pt200 (a=0.003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.24 °C (± 0.43 °F)	± 0.05 %
	Pt500 (a=0.003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.16 °C (± 0.29 °F)	± 0.05 %
	Pt1000 (a=0.003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.08 °C (± 0.14 °F)	± 0.05 %
<b>JIS C1604-89</b>	Pt10 (a=0.003916)	-200 ... 645 °C (-328 ... 1193 °F)	10 °C (18 °F)	± 0.80 °C (± 1.44 °F)	± 0.05 %
	Pt50 (a=0.003916)	-200 ... 645 °C (-328 ... 1193 °F)	10 °C (18 °F)	± 0.16 °C (± 0.29 °F)	± 0.05 %
	Pt100 (a=0.003916)	-200 ... 645 °C (-328 ... 1193 °F)	10 °C (18 °F)	± 0.08 °C (± 0.14 °F)	± 0.05 %
<b>MIL-T-24388</b>	Pt10 (a=0.003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.80 °C (± 1.44 °F)	± 0.05 %
	Pt50 (a=0.003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.16 °C (± 0.29 °F)	± 0.05 %
	Pt100 (a=0.003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.08 °C (± 0.14 °F)	± 0.05 %
	Pt200 (a=0.003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.24 °C (± 0.43 °F)	± 0.05 %
	Pt500 (a=0.003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.16 °C (± 0.29 °F)	± 0.05 %
	Pt1000 (a=0.003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0.08 °C (± 0.14 °F)	± 0.05 %
<b>DIN 43760</b>	Ni50 (a=0.006180)	-60 ... 250 °C (-76 ... 482 °F)	10 °C (18 °F)	± 0.16 °C (± 0.29 °F)	± 0.05 %
	Ni100 (a=0.006180)	-60 ... 250 °C (-76 ... 482 °F)	10 °C (18 °F)	± 0.08 °C (± 0.14 °F)	± 0.05 %
	Ni120 (a=0.006180)	-60 ... 250 °C (-76 ... 482 °F)	10 °C (18 °F)	± 0.08 °C (± 0.14 °F)	± 0.05 %
	Ni1000 (a=0.006180)	-60 ... 250 °C (-76 ... 482 °F)	10 °C (18 °F)	± 0.08 °C (± 0.14 °F)	± 0.05 %
	Cu10 (a=0.004270)	-50 ... 200 °C (-58 ... 392 °F)	10 °C (18 °F)	± 0.80 °C (± 1.44 °F)	± 0.05 %
	Cu100 (a=0.004270)	-50 ... 200 °C (-58 ... 392 °F)	10 °C (18 °F)	± 0.08 °C (± 0.14 °F)	± 0.05 %
	Resistance measurement	0 ... 500 $\Omega$	4 $\Omega$	± 32 m $\Omega$	± 0.05 %
	Resistance measurement	0 ... 5000 $\Omega$	40 $\Omega$	± 320 m $\Omega$	± 0.05 %
<b>Thermocouples<sup>3)</sup> / voltages</b>					
<b>IEC 60584</b>	Type K (Ni10Cr-Ni5)	-270 ... 1372 °C (-454 ... 2502 °F)	50 °C (90 °F)	± 0.35 °C (± 0.63 °F)	± 0.05 %
	Type J (Fe-Cu45Ni)	-210 ... 1200 °C (-346 ... 2192 °F)	50 °C (90 °F)	± 0.35 °C (± 0.63 °F)	± 0.05 %
	Type N (Ni14CrSi-NiSi)	-270 ... 1300 °C (-454 ... 2372 °F)	50 °C (90 °F)	± 0.35 °C (± 0.63 °F)	± 0.05 %
	Type T (Cu-Cu45Ni)	-270 ... 400 °C (-454 ... 752 °F)	50 °C (90 °F)	± 0.35 °C (± 0.63 °F)	± 0.05 %
	Type E (Ni10Cr-Cu45Ni)	-270 ... 1000 °C (-454 ... 1832 °F)	50 °C (90 °F)	± 0.35 °C (± 0.63 °F)	± 0.05 %
	Type R (Pt13Rh-Pt)	-50 ... 1768 °C (-58 ... 3215 °F)	100 °C (180 °F)	± 0.95 °C (± 1.71 °F)	± 0.05 %
	Type S (Pt10Rh-Pt)	-50 ... 1768 °C (-58 ... 3215 °F)	100 °C (180 °F)	± 0.95 °C (± 1.71 °F)	± 0.05 %
	Type B (Pt30Rh-Pt6Rh)	-0 ... 1820 °C (32 ... 3308 °F)	100 °C (180 °F)	± 0.95 °C (± 1.71 °F)	± 0.05 %
<b>DIN 43710</b>	Type L (Fe-CuNi)	-200 ... 900 °C (-328 ... 1652 °F)	50 °C (90 °F)	± 0.35 °C (± 0.63 °F)	± 0.05 %
	Type U (Cu-CuNi)	-200 ... 600 °C (-328 ... 1112 °F)	50 °C (90 °F)	± 0.35 °C (± 0.63 °F)	± 0.05 %
<b>ASTM E 988</b>	Type C	-0 ... 2315 °C (32 ... 4200 °F)	100 °C (180 °F)	± 1.35 °C (± 2.43 °F)	± 0.05 %
	Type D	-0 ... 2315 °C (32 ... 4200 °F)	100 °C (180 °F)	± 1.35 °C (± 2.43 °F)	± 0.05 %
	Voltage measurement	-125 ... 125 mV	2 mV	± 12 $\mu$ V	± 0.05 %
	Voltage measurement	-125 ... 1100 mV	20 mV	± 120 $\mu$ V	± 0.05 %

### Long-term drift

± 0.05 °C (± 0.09 °F) or ± 0.05 %<sup>1)</sup> per year. the larger value applies.

1) Percentages refer to the configured measuring span

2) Standard model

3) Include the internal reference point error for digital measuring accuracy: Pt1000. DIN IEC 60751 Cl. B

4) Without reference junction error

## 2.7 Operating influences

The percentages refer to the configured measuring span.

**Influence of supply voltage / load:** within the specified limits for the voltage / load, the total influence is less than 0.001 % per volt

Normal-mode rejection: > 65 dB at 50 / 60 Hz,

Common-mode rejection: > 120 dB at 50 / 60 Hz

**Influence of ambient temperature:** based on 23 °C (73.4 °F) for an ambient temperature range of -40 ... 85 °C (-40 ... 185 °F) <sup>4)</sup>

Sensor	Influence of ambient temperature per 1 °C (1.8 °F) deviation from 23 °C (73.4 °F) for digital measurement	Influence of ambient temperature <sup>1)2)</sup> per 1 °C (1.8 °F) deviation from 23 °C (73.4 °F) for D/A converter
Resistance thermometer for two-, three-, four-wire circuits		
Pt10 IEC, JIS, MIL	± 0,04 °C (± 0,072 °F)	± 0,003 %
Pt50 IEC, JIS, MIL	± 0,008 °C (± 0,014 °F)	± 0,003 %
Pt100 IEC, JIS, MIL	± 0,004 °C (± 0,007 °F)	± 0,003 %
Pt200 IEC, MIL	± 0,02 °C (± 0,036 °F)	± 0,003 %
Pt500 IEC, MIL	± 0,008 °C (± 0,014 °F)	± 0,003 %
Pt1000 IEC, MIL	± 0,004 °C (± 0,007 °F)	± 0,003 %
Ni50 DIN 43760	± 0,008 °C (± 0,014 °F)	± 0,003 %
Ni100 DIN 43760	± 0,004 °C (± 0,007 °F)	± 0,003 %
Ni120 DIN 43760	± 0,003 °C (± 0,005 °F)	± 0,003 %
Ni1000 DIN 43760	± 0,004 °C (± 0,007 °F)	± 0,003 %
Cu10	± 0,04 °C (± 0,072 °F)	± 0,003 %
Cu100	± 0,004 °C (± 0,007 °F)	± 0,003 %
Resistance measurement		
0 ... 500 Ω	± 0,002 Ω	± 0,003 %
0 ... 5000 Ω	± 0,02 Ω	± 0,003 %
Thermocouple, for all defined types	± [(0,001 % x (ME[mV] / MS[mv]) + (100 % x (0,009 °C / MS [°C]))] <sup>3)</sup>	± 0,003 %
Voltage measurement		
-125 ... 125 mV	± 1,5 μV	± 0,003 %
-125 ... 1100 mV	± 15 μV	± 0,003 %

1) Percentages refer to the configured measuring span of the analog output signal

2) Influence of the D/A converter omitted for PROFIBUS PA and FOUNDATION Fieldbus H1

3) ME = voltage value of the thermocouple at the end of the measuring range in accordance with the standard  
MA = voltage value of the thermocouple at the start of the measuring range in accordance with the standard  
MS = voltage value of the thermocouple over the measuring span in accordance with the standard. MS = (ME - MA)

4) In the case of the option to expand the ambient temperature range down to -50 °C (-58 °F), the causal variables are doubled in the range between -50 ... -40 °C (-58 ... -40 °F).



### 3 Communication

#### 3.1 Configuration parameters

##### Measurement type

- Sensor type, connection type
- Error signaling
- Measuring range
- General information, e.g., TAG number
- Damping
- Warning and alarm limits
- Signal simulation of output
- For additional information, see Section 9, "Order form configuration"

##### Write protection

- Software and hardware write protection

##### Diagnostic information in accordance with NE 107

###### Standard:

- Sensor error (wire break or short circuit)
- Device error
- Over / under alarm limits
- Over / under measuring range
- Simulation active

###### Advanced:

- Sensor redundancy / sensor backup active (in case sensor fails) with configurable analog alarm pulse signaling
- Drift monitoring with configurable alarm pulse signaling
- Sensor / sensor supply line corrosion
- Supply voltage undershoot
- Drag indicator for sensor 1, sensor 2, and ambient temperature
- Ambient temperature overshoot
- Ambient temperature undershoot
- Operating hours counter

#### 3.2 HART

The device is listed with the HART Communication Foundation.

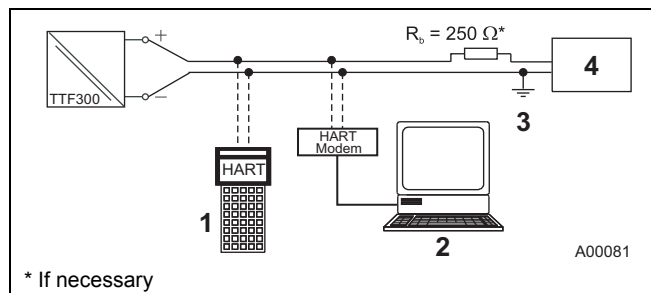


Fig. 2: Example for HART interface connection

- 1 Handheld terminal
- 2 FDT / DTM technology
- 3 Ground connection (optional)
- 4 Power unit (process interface)

Manufacturer ID:	0x1A
Device ID:	0x0A
Profile:	HART 5.1
Configuration:	Directly on the device DTM EDD
Transmission signal:	BELL Standard 202

##### Operating modes

- Point-to-point communication mode: standard (general address 0)
- Multidrop mode (addressing 1 ... 15)
- Burst mode

##### Configuration options and tools

###### Driver-independent:

- LCD indicators with configuration function

###### Driver-dependent:

- Device management / asset management tools
- DTM technology – via TTX300 DTM driver
- EDD - via TTX300 EDD driver

##### Diagnostic signaling

- Overdrive / underdrive in accordance with NE 43
- HART diagnostics

### 3.3 PROFIBUS PA

The interface conforms to profile 3.01 (PROFIBUS standard, EN 50170, DIN 1924 [PRO91]).

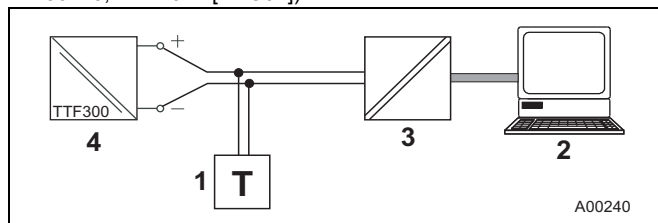


Fig. 3: Example for PROFIBUS PA interface connection

- 1 Bus termination
- 2 PC / DCS
- 3 Segment coupler
- 4 Transmitter

Manufacturer ID:	0x1A
IDENT_NUMBER:	0x3470 [0x9700]
Profile:	PA 3.01
Configuration:	Directly on the device DTM EDD GSD
Transmission signal:	IEC 61158-2

#### Voltage / current consumption

Average current consumption: 12 mA  
 In the event of an error, the integrated FDE (= Fault Disconnection Electronic) function integrated in the device ensures that the current consumption can rise to a maximum of 20 mA.

### 3.4 FOUNDATION Fieldbus

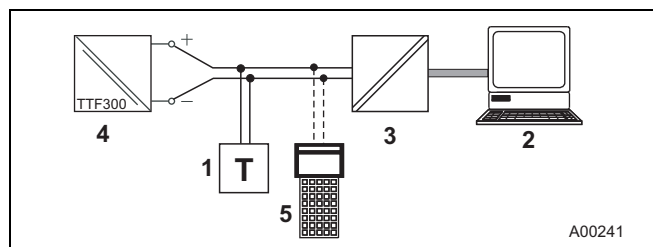


Fig. 4: Example for FOUNDATION Fieldbus interface connection

- 1 Bus termination
- 2 PC / DCS
- 3 Linking device
- 4 Transmitter
- 5 Handheld terminal

DEVICE ID:	000320001F...
ITK:	5.2
Configuration:	Directly on the device EDD
Transmission signal:	IEC 61158-2

#### Voltage / current consumption

Average current consumption: 12 mA  
 In the event of an error, the integrated FDE (= Fault Disconnection Electronic) function integrated in the device ensures that the current consumption can rise to a maximum of 20 mA.

## 4 Electrical connections

### Resistance thermometers (RTD) / resistors (potentiometers)

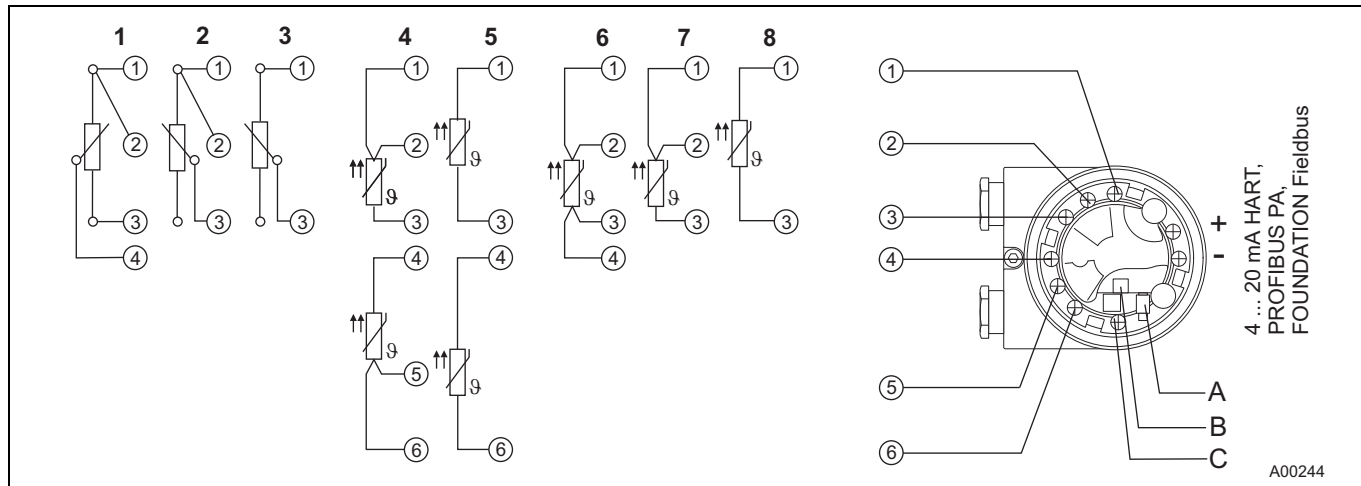


Fig. 5

- |   |   |   |   |   |   |
|---|---|---|---|---|---|
| A | Interface for LCD indicators and service  | 1 | Potentiometer, four-wire circuit          | 5 | 2 x RTD, two-wire circuit <sup>1)</sup> |
| B | DIP switch 1: on, hardware write protection is enabled<br>DIP switch 2: no function | 2 | Potentiometer, three-wire circuit         | 6 | RTD, four-wire circuit                  |
| C | Ground terminals for sensor and supply- / signal-cable shield connection            | 3 | Potentiometer, two-wire circuit           | 7 | RTD, three-wire circuit                 |
|   |   | 4 | 2 x RTD, three-wire circuit <sup>1)</sup> | 8 | RTD, two-wire circuit                   |

<sup>1)</sup> Sensor backup / redundancy, sensor drift monitoring, mean measurement or differential measurement

### Thermocouples / voltages and resistance thermometer (RTD) / thermocouple combinations

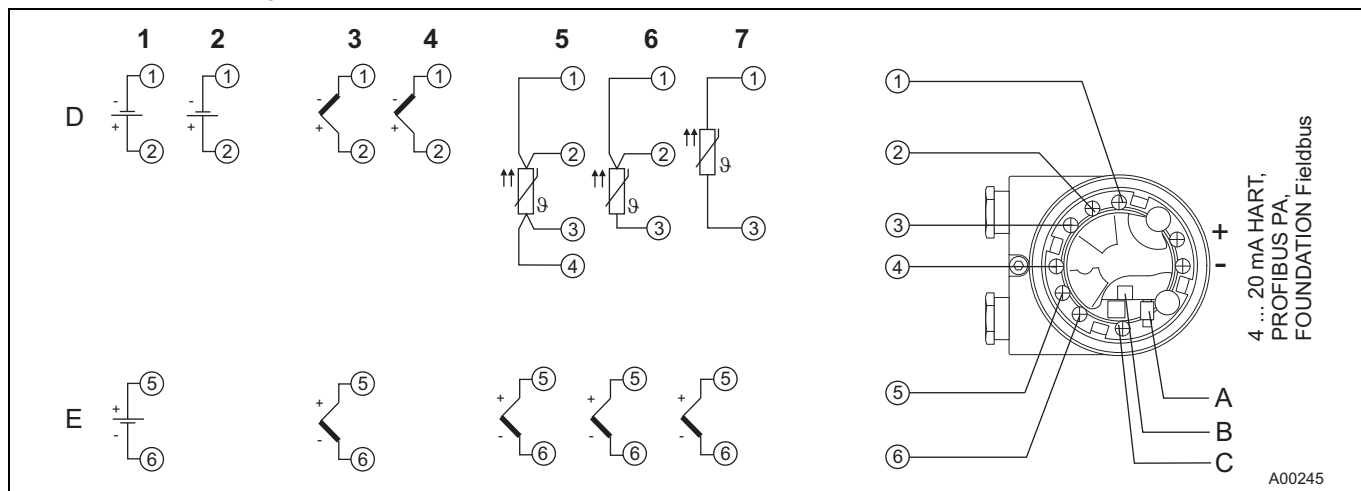


Fig. 6

- |   |   |   |                                       |   |   |
|---|---|---|---------------------------------------|---|---|
| A | Interface for LCD indicators and service  | 1 | 2 x voltage measurement <sup>1)</sup> | 5 | 1 x RTD, four-wire circuit, and thermocouple <sup>1)</sup>  |
| B | DIP switch 1: on, hardware write protection is enabled<br>DIP switch 2: no function | 2 | 1 x voltage measurement               | 6 | 1 x RTD, three-wire circuit, and thermocouple <sup>1)</sup> |
| C | Ground terminals for sensor and supply- / signal-cable shield connection            | 3 | 2 x thermocouple <sup>1)</sup>        | 7 | 1 x RTD, two-wire circuit, and thermocouple <sup>1)</sup>   |
| D | Sensor 1  | 4 | 1 x thermocouple                      |   |   |
| E | Sensor 2  |   |                                       |   |   |

<sup>1)</sup> Sensor backup / redundancy, sensor drift monitoring, mean measurement or differential temperature measurement

## 5 Dimensions

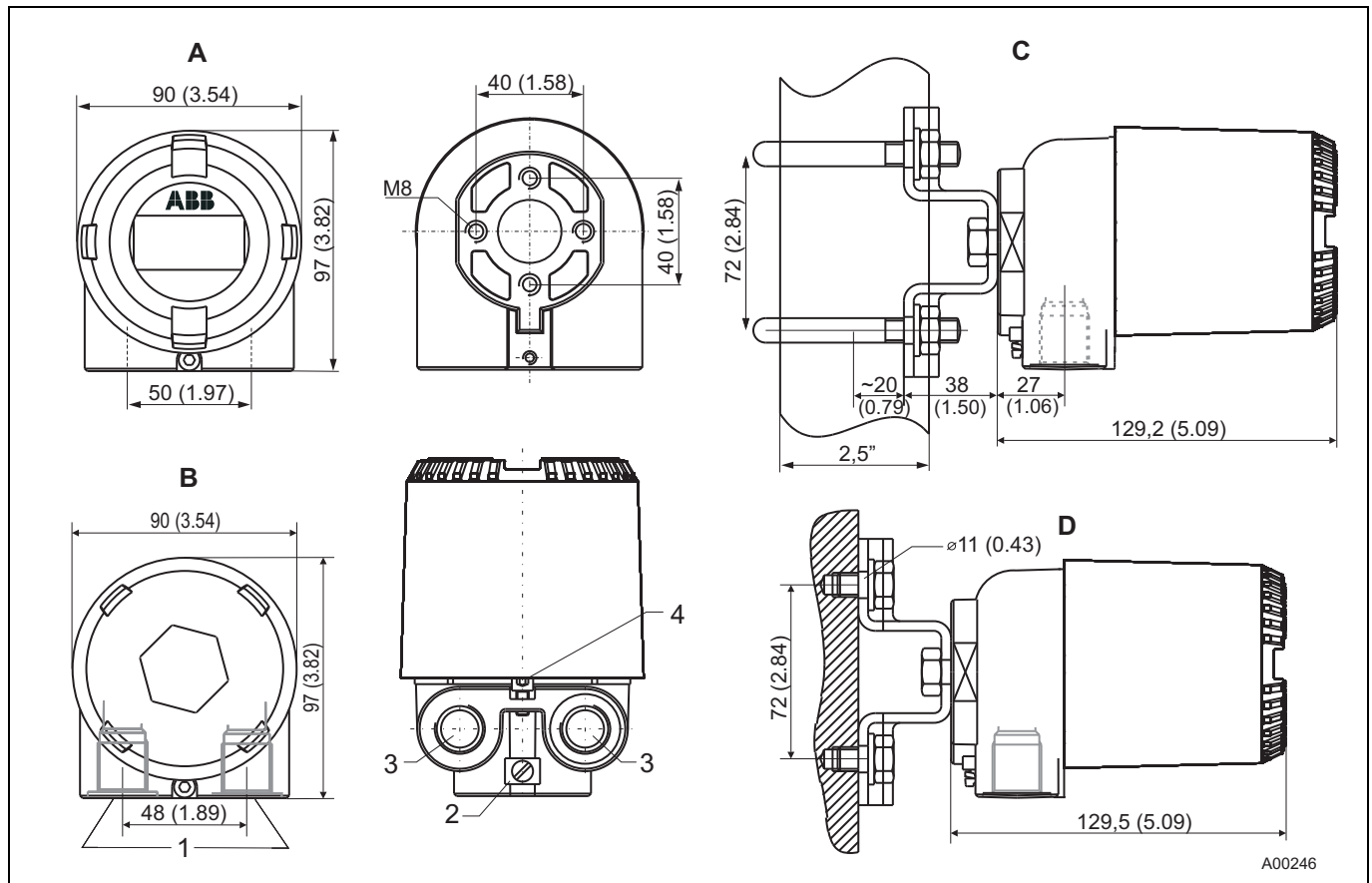


Fig. 7: Dimensions in mm (inch)

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>A Housing with display window in cover</li> <li>B Closed housing</li> <li>C Pipe installation</li> <li>D Wall mount, 4-hole wall attachment, <math>\varnothing 11</math> mm (0.43 inch), quadratically arranged, at distance of 72 mm (2.84 inch)</li> </ul> | <ul style="list-style-type: none"> <li>1 Electrical connections</li> <li>2 Equipotential bonding screw M5</li> <li>3 Thread M20 x 1.5 or 1/2" NPT</li> <li>4 Lock screw</li> </ul> |
|---|--|

## 6 Ordering information

	Main order number							Add. order no.
	7	8	9	10	11	12	13	
Version number 1 – 6								XX
<b>TTF300 Field Mounted Temperature Transmitter, Pt100 (RTD), Thermocouples, Electrical Isolation</b>	<b>X</b>	<b>X</b>	X	X	X	X	X	XX
<b>Explosion Protection</b>								
Without explosion protection	Y	0						
ATEX Intrinsic Safety type of protection:	E	1						
Zone 0: II 1 G Ex ia IIC T6,								
Zone 1 (0): II 2 (1) G Ex [ia] ib IIC T6,								
Zone 1 (20): II 2 G (1D) Ex [iaD] ib IIC T6								
ATEX Non-sparking type of protection:	E	5						
Zone 2 / Zone 22: II 3 G Ex nA II T6 and II 3 D IP 65 T 135 °C (Not for application in hybrid mixtures)	1)							
ATEX Dust Explosion Protection:	D	1						
Zone 20: II 1 D IP 65 T 135 °C								
ATEX Dust Explosion Protection and Intrinsic Safety:	D	2						
Zone 0 / Zone 20: II 1 G Ex iA IIC T6 and II 1 D IP 65 T 135 °C (Not for application in hybrid mixtures)	1)							
ATEX Flameproof type of protection:	E	3						
Zone 1: II 2 G Ex d IIC T6								
ATEX Flameproof and Intrinsic Safety type of protection:	E	4						
Zone 1 / Zone 0: II 2 G Ex d IIC T6 and II 1 G Ex ia IIC T6								
IECEX Intrinsic Safety type of protection:	H	1						
Zone 0: Ex ia IIC T6,								
Zone 1 (0): Ex [ia] ib IIC T6,								
Zone 1 (20): Ex [iaD] ib IIC T6								
FM Intrinsic Safety (IS):	L	1						
Class I, Div. 1+2, Groups A, B, C, D, Class II, E, F, G, Class III, Class I, Zone 0, AEx ia IIC T6								
FM Non-incendive (NI):	L	2						
Class I, Div. 2, Groups A, B, C, D, Class II, E, F, G, Class III								
FM Explosionproof (XP):	L	3						
XP, NI, DIP, Class I, II, III, Div. 1+2, Groups A-G, factory sealed								
FM Explosionproof (XP) and Intrinsic Safety (IS):	L	7						
XP, NI, DIP, Class I, II, III, Div. 1+2, Groups A-G, factory sealed and IS, Class I, Div. 1+2, Groups A, B, C, D, Class II, E, F, G, Class III, Class I, Zone 0, AEx ia IIC T6								
CSA Intrinsic Safety (IS):	R	1						
Class I, Div. 1+2, Groups A, B, C, D, Class II, E, F, G, Class III								
CSA Non-incendive (NI):	R	2						
Class I, Div. 2, Groups A, B, C, D, Class II, E, F, G, Class III								
CSA Explosionproof (XP):	R	3						
XP, NI, DIP, Class I, II, III, Div. 1+2, Groups A-G, factory sealed								
CSA Explosionproof (XP) and Intrinsic Safety (IS):	R	7						
XP, NI, DIP, Class I, II, III, Div. 1+2, Groups A-G, factory sealed and IS, Class I, Div. 1+2, Groups A, B, C, D, Class II, E, F, G, Class III								
Russia - metrological approval	2)	G	1					
Russia - metrological approval and GOST Ex i	2)	G	2					
Russia - metrological approval and GOST Ex d	2)	G	7					
Russia - metrological approval and GOST Ex i and Ex d	2)	G	8					
Kazakhstan - metrological approval	2)	G	3					
Kazakhstan - metrological approval and GOST Ex i	2)	G	4					
Kazakhstan - metrological approval and GOST Ex d	2)	M	1					
Kazakhstan - metrological approval and GOST Ex i and Ex d	2)	M	2					
Ukraine - metrological approval	2)	G	5					
Ukraine - metrological approval and GOST Ex i	2)	G	6					
Ukraine - metrological approval and GOST Ex d	2)	G	9					
Ukraine - metrological approval and GOST Ex i and Ex d	2)	M	3					
Belarus - metrological approval	2)	M	5					
Belarus - metrological approval and GOST Ex i	2)	M	6					
Belarus - metrological approval and GOST Ex d	2)	M	7					
Belarus - metrological approval and GOST Ex i and Ex d	2)	M	8					

Continued on next page

	Main order number								Add. order no.
	Version number 1 – 6	7	8	9	10	11	12	13	
<b>TTF300 Field Mounted Temperature Transmitter, Pt100 (RTD), Thermocouples, Electrical Isolation</b>	TTF300	X	X	X	X	X	X	X	XX
<b>Housing / Indicators</b>									
Single-chamber housing (aluminum) / Without indicators				A					
Single-chamber housing (stainless steel) / Without indicators				B					
Single-chamber housing (aluminum) / with LCD indicator HMI				C					
Single-chamber housing (stainless steel) / with LCD indicator HMI				D					
<b>Cable Entry</b>									
Thread 2 x M20 x 1.5				3)	1				
Thread 2 x 1/2 in. NPT					2				
Thread 2 x 3/4 in. NPT				4)	3				
Cable gland 2 x M20 x 1.5				5)	4				
<b>Communication Protocol</b>									
HART						H			
PROFIBUS PA						P			
FOUNDATION Fieldbus						F			
<b>Configuration</b>									
Standard configuration							B	S	
Customer-specific configuration with report, except user curve						6)	B	F	
Customer-specific configuration with report, including user curve							B	G	
<b>Certificates</b>									
SIL2 - declaration of conformity								2)	CS
Declaration of compliance with the order 2.1 acc. EN 10204									C4
Inspection certificate 3.1 acc. EN 10204 for visual and functional test									C6
<b>Calibration Certificates</b>									
With 5-point factory certificate									EM
Inspection certificate 3.1 acc. EN 10204 for 5-point calibration									EP
<b>Mounting Bracket</b>									
Wall mounting / 2 in. pipe mounting bracket (stainless steel)									K2
<b>Cable Entry Options</b>									
Cable screw connection 2 x 1/2 in. NPT								7)	U5
<b>Expanded Ambient Temperature Range</b>									
-50 ... 85 °C (-58 ... 185 °F)								8)	SE
<b>Device Identification Plate</b>									
Stainless steel									T0
<b>Additional Tag Plate</b>									
Stainless steel									I1
<b>Customer-specific Versions</b>									
(Please provide details)									Z9
<b>Language of Documentation</b>									
German									M1
English									M5
Language package Western Europe / Scandinavia (Languages: DE, EN, DA, ES, FR, IT, NL, PT, FI, SV)									MW
Language package Eastern Europe (Languages: DE, EL, CS, ET, LV, LT, HU, PL, SK, SL, RO, BG)									ME

- 1) According EN 60079-0 and EN 61241-0, the application in hybrid mixtures (concomitance of potentially explosive dust and gas) is currently not allowed
- 2) Only available with Communication Protocol code H (HART)
- 3) Not available with Explosion Protection code L1, L2, L3, L7, R1, R2, R3, R7, D1, D2
- 4) Only available with Housing / Indicators code A, C
- 5) Not available with Explosion Protection code L3, L7, R3, R7, G7, G8, G9, M1, M2, M3, M7, M8
- 6) E.g., set measuring range, TAG no.
- 7) Only available with cable entry code 2
- 8) Not available with Explosion Protection code L1, L2, L3, L7, R1, R2, R3, R7, D1, D2, E3, E4, G7, G8, G9, M1, M2, M3, M7, M8

## 6.1 Documentation available for ordering

Description	Order number
TTF300 Documentation CD-ROM	3KXT221001R0800
TTF300 Commissioning Instructions, English	3KXT221001R4401
TTF300 Commissioning Instructions, German	3KXT221001R4403
TTF300 Commissioning Instructions, Language package Western Europe / Scandinavia	3KXT221001R4493
TTF300 Commissioning Instructions, Language package Eastern Europe	3KXT221001R4494

## 7 Ex relevant specifications

### 7.1 TTF300-E1X, intrinsic safety ATEX

#### Explosion protection

Approved for use in Zone 0, 1, and 2

#### Designation

II 1G Ex ia IIC T6 (Zone 0)  
II 2(1)G Ex [ia] ib IIC T6 (Zone 1 [0])  
II 2G(1D) Ex [iaD] ib IIC T6 (Zone 1 [20])

TTF300-E1H:

EC type-examination test certificate PTB 05 ATEX 2017 X

TTF300-E1P / E1F:

EC type-examination test certificate PTB 09 ATEX 2016 X

### 7.2 TTF300-H1X, intrinsic safety IECEx

#### Designation

Ex ia IIC T6  
Ex [ia] ib IIC T6  
Ex [iaD] ib IIC T6

TTF300-H1H:

IECEx certificate of conformity IECEx PTB 09.0014X

TTF300-H1P / H1F:

IECEx certificate of conformity

### 7.3 Safety specifications for Intrinsic Safety ATEX / IECEx

#### Temperature table

Temperature class	Permissible ambient temperature range	
	Device category 1 use	Device category 2 use
T6	-50 ... 44 °C (-58 ... 111,2 °F)	-50 ... 56 °C (-58 ... 132,8 °F)
T5	-50 ... 56 °C (-58 ... 132,8 °F)	-50 ... 71 °C (-58 ... 159,8 °F)
T4, T3, T2, T1	-50 ... 60 °C (-58 ... 140,0 °F)	-50 ... 85 °C (-58 ... 185,0 °F)

#### Intrinsic safety Ex ia IIC type of protection (part 1)

	TTF300-E1H TTF300-H1H Supply circuit	TTF300-E1P / -H1P TTF300-E1F / -H1F Supply circuit 1)	
		FISCO	ENTITY
Max. voltage	$U_i = 30 \text{ V}$	$U_i \leq 17.5 \text{ V}$	$U_i \leq 24.0 \text{ V}$
Short-circuit current	$I_i = 130 \text{ mA}$	$I_i \leq 183 \text{ mA}^{2)}$	$I_i \leq 250 \text{ mA}$
Max. power	$P_i = 0.8 \text{ W}$	$P_i \leq 2.56 \text{ W}^{2)}$	$P_i \leq 1.2 \text{ W}$
Internal inductance	$L_i = 0.5 \text{ mH}$	$L_i \leq 10 \mu\text{H}$	$L_i \leq 10 \mu\text{H}$
Internal capacitance	$C_i = 5 \text{ nF}$	$C_i \leq 5 \text{ nF}$	$C_i \leq 5 \text{ nF}$

1) FISCO in accordance with IEC 60079-27

2) II B FISCO:  $I_i \leq 380 \text{ mA}$ ,  $P_i \leq 5.32 \text{ W}$

#### Intrinsic safety Ex ia IIC type of protection (part 2)

	Measurement current circuit: resistance thermometers, resistors	Measurement current circuit: thermocouples, voltages
Max. voltage	$U_o = 6.5 \text{ V}$	$U_o = 1.2 \text{ V}$
Short-circuit current	$I_o = 25 \text{ mA}$	$I_o = 50 \text{ mA}$
Max. power	$P_o = 38 \text{ mW}$	$P_o = 60 \text{ mW}$
Internal inductance	$L_i = 0 \text{ mH}$	$L_i = 0 \text{ mH}$
Internal capacitance	$C_i = 49 \text{ nF}$	$C_i = 49 \text{ nF}$
Maximum permissible external inductance	$L_o = 5 \text{ mH}$	$L_o = 5 \text{ mH}$
Maximum permissible external capacitance	$C_o = 1.55 \mu\text{F}$	$C_o = 1.05 \mu\text{F}$

#### Intrinsic safety Ex ia IIC type of protection (part 3)

	LCD indicator interface
Max. voltage	$U_o = 6.2 \text{ V}$
Short-circuit current	$I_o = 65.2 \text{ mA}$
Max. power	$P_o = 101 \text{ mW}$
Internal inductance	$L_i = 0 \text{ mH}$
Internal capacitance	$C_i = 0 \text{ nF}$
Maximum permissible external inductance	$L_o = 5 \text{ mH}$
Maximum permissible external capacitance	$C_o = 1.4 \mu\text{F}$

## 7.4 TTF300-E5X, non-sparking + dust explosion protection ATEX

### Explosion protection

Approved for use in Zone 2 and Zone 22

### Designation

II 3G Ex nA II T6

II 3 D IP 65 T 135 °C

ABB manufacturer's declaration in accordance with ATEX Directive

### Temperature table

Temperature class	Device category 3 use
T6	-50 ... 56 °C (-58 ... 132,8 °F)
T5	-50 ... 71 °C (-58 ... 159,8 °F)
T4	-50 ... 85 °C (-58 ... 185,0 °F)

## 7.5 TTF300-D1X, dust explosion protection ATEX

### Explosion protection

Approved for use in Zone 20

### Designation

II 1D Ex tD A20 IP66 T135°C

EC type-examination test certificate BVS 06 ATEX E 029

## 7.6 TTF300-D2X, dust explosion protection + intrinsic safety ATEX

### Explosion protection

Approved for use in Zone 20 and Zone 0

### Designation

II 1D Ex tD A20 P66 T135°C

II 1G Ex ia IIC T6

EC type-examination test certificate BVS 06 ATEX E 029

EC type-examination test certificate PTB 05 ATEX 2017 X

EC type-examination test certificate PTB 05 ATEX 2016 X

## 7.7 TTF300-E3X, flameproof enclosure ATEX

### Explosion protection

Approved for use in Zone 1

### Designation

II 2G Ex d IIC T6

EC type-examination test certificate PTB 99 ATEX 1144

## 7.8 TTF300-E4X, flameproof enclosure + intrinsic safety ATEX

### Explosion protection

Approved for use in Zone 1

### Designation

II 2G Ex d IIC T6

II 1G Ex ia IIC T6

EC type-examination test certificate PTB 99 ATEX 1144

EC type-examination test certificate PTB 05 ATEX 2017 X

EC type-examination test certificate PTB 05 ATEX 2016 X

## 7.9 TTF300-L1X, intrinsically safe FM

Class I, Div. 1 + 2, Groups A, B, C, D

Class I, Zone 0, AEx ia IIC

TTF300-L1H: Control Drawing: SAP\_214832

TTF300-L1P: Control Drawing: TTF300-L1..P (IS)

TTF300-L1F: Control Drawing: TTF300-L1..F (IS)

## 7.10 TTF300-L2X, non-incendive FM

Class I, Div. 2, Groups A, B, C, D

Class I Zone 2 Group IIC T6

TTF300-L2H:

Control Drawing: SAP\_214828

Control Drawing: SAP\_214830

TTF300-L2P:

Control Drawing: TTF300-L2..P (NI\_PS), TTF300-L2..P (NI\_AA)

TTF300-L2F:

Control Drawing: TTF300-L2..F (NI\_PS), TTF300-L2..F (NI\_AA)

## 7.11 TTF300-L3X, explosion proof FM

XP,NI, DIP Class I, II, III, Div. 1 + 2, Groups A-G, factory sealed

## 7.12 TTF300-L7X, explosion proof + intrinsically safe FM

XP, NI, DIP Class I, II, III, Div. 1 + 2, Groups A-G, factory sealed

Class I, Div. 1 + 2, Groups A, B, C, D

Class I, Zone 0, AEx ia IIC T6

TTF300-L1H: Control Drawing: SAP\_214832

TTF300-L1P: Control Drawing: TTF300-L1..P (IS)

TTF300-L1F: Control Drawing: TTF300-L1..F (IS)

## 7.13 TTF300-R1X, intrinsically safe CSA

Class I, Div. 1 + 2, Groups A, B, C, D

Class I, Zone 0, Ex ia IIC

TTF300-R1H: Control Drawing: SAP\_214825

TTF300-R1P: Control Drawing: TTF300-R1..P (IS)

TTF300-R1F: Control Drawing: TTF300-R1..F (IS)

## 7.14 TTF300-R2X, non-incendive CSA

Class I, Div. 2, Groups A, B, C, D

TTF300-R2H:

Control Drawing: SAP\_214827

Control Drawing: SAP\_214895

TTF300-R2P:

Control Drawing: TTF300-R2..P (NI\_PS), TTF300-R2..P (NI\_AA)

TTF300-R2F:

Control Drawing: TTF300-R2..F (NI\_PS), TTF300-R2..F (NI\_AA)

## 7.15 TTF300-R3X, explosion proof CSA

XP,NI, DIP Class I, II, III, Div. 1 + 2, Groups A-G, factory sealed

## 7.16 TTF300-R7X, explosion proof + intrinsically safe CSA

XP,NI, DIP Class I, II, III, Div. 1 + 2, Groups A-G, factory sealed

Class I, Div. 1 + 2, Groups A, B, C, D

Class I, Zone 0, Ex ia Group IIC T6

TTF300-R1H: Control Drawing: SAP\_214825

TTF300-R1P: Control Drawing: TTF300-R1..P (IS)

TTF300-R1F: Control Drawing: TTF300-R1..F (IS)



## 8 Type B LCD

### CE marking

The type B LCD indicator meets all requirements as regards the CE marking in accordance with IEC 61326 (2005).

### 8.1 Features

#### Transmitter-controlled graphic (alphanumeric) LCD indicator

- Character height, mode-dependent
- Sign, 4 digits, 2 decimal places
- Bar graph display

#### Display options

- Sensor 1 process value
- Sensor 2 process value
- Electronics / ambient temperature
- Output value
- Output %

Display diagnostic information related to transmitter and sensor status

### 8.2 Specifications

#### Temperature range

- 20 ... 70 °C (-4 ... 158 °F)
- Restricted display function (contrast, reaction time) in the temperature ranges:
- 50 ... -20 °C (-58 ... -4 °F)
- and
- 70 ... 85 °C (158 ... 185 °F)

#### Humidity

0 ... 100 %, condensation permitted

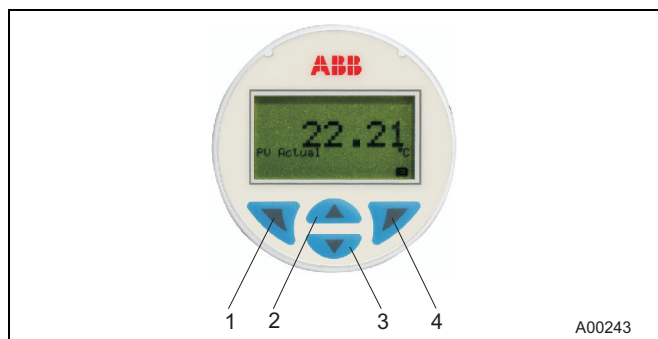


Fig. 8: Type B LCD indicator

- |                 |                  |
|-----------------|------------------|
| 1 Exit / Cancel | 3 Scroll forward |
| 2 Scroll back   | 4 Select         |

### 8.3 Configuration function

#### Sensor configuration for standard sensors

#### Measuring range

#### Behavior in the event of a fault (HART)

#### Software-write protection for configuration data

#### Device address for HART and PROFIBUS PA

### 8.4 Ex relevant specifications

#### 8.4.1 Intrinsic safety ATEX

##### Explosion protection

Approved for use in Zone 0

##### Designation

II 1G Ex ia IIC T6

EC type-examination test certificate PTB 05 ATEX 2079 X

#### 8.4.2 Intrinsic safety IECEx

##### Explosion protection

Approved for use in Zone 0

##### Designation

Ex ia IIC T6

IECEx certificate of conformity IECEx PTB

#### 8.4.3 Safety specifications for intrinsic safety ATEX / IECEx

##### Temperature table

Temperature class	Permissible ambient temperature range	
	Device category 1 use	Device category 2 use
T6	-40 ... 44 °C (-40 ... 111.2 °F)	-40 ... 56 °C (-40 ... 132.8 °F)
T5	-40 ... 56 °C (-40 ... 132.8 °F)	-40 ... 71 °C (-40 ... 159.8 °F)
T4	-40 ... 60 °C (-40 ... 140 °F)	-40 ... 85 °C (-40 ... 185 °F)

##### Protection type intrinsic safety Ex ia IIC

	Supply circuit
Max. voltage	U <sub>i</sub> = 9 V
Short circuit current	I <sub>i</sub> = 65.2 mA
Max. power	P <sub>i</sub> = 101 W
Internal inductance	L <sub>i</sub> = 0 mH
Internal capacitance	C <sub>i</sub> = 0 nF

**8.4.4 Intrinsically Safe FM**

I.S. Class I Div 1 and Div 2, Group: A, B, C, D or  
I.S. Class I Zone 0 AEx ia IIC T\*  
Temp. Ident: T6 T<sub>amb</sub> 56 °C, T4 T<sub>amb</sub> 85 °C  
 $U_i / V_{max} = 9V$ ,  $I_i / I_{max} < 65.2 \text{ mA}$ ,  $P_i = 101 \text{ mW}$   
 $C_i = 0.4 \mu\text{F}$ ;  $L_i = 0$   
Control Drawing: SAP\_214 748

**8.4.5 Non-Incendive FM**

N.I. Class I Div 2, Group: A, B, C, D or  
Ex nL IIC T\*, Class I Zone 2  
Temp. Ident: T6 T<sub>amb</sub> 60 °C, T4 T<sub>amb</sub> 85 °C  
 $U_i / V_{max} = 9V$ ,  $I_i / I_{max} < 65.2 \text{ mA}$ ,  $P_i = 101 \text{ mW}$   
 $C_i = 0.4 \mu\text{F}$ ;  $L_i = 0$   
Control Drawing: SAP\_214 751

**8.4.6 Intrinsically Safe CSA**

I.S. Class I Div 1 and Div 2; Group: A, B, C, D or  
I.S. Zone 0 Ex ia IIC T\*  
\*Temp. Ident T6 T<sub>amb</sub> 56 °C, T4 T<sub>amb</sub> 85 °C  
 $U_i / V_{max} = 9V$ ,  $I_i / I_{max} < 65.2 \text{ mA}$ ,  $P_i = 101 \text{ mW}$   
 $C_i < 0.4 \mu\text{F}$ ,  $L_i = 0$   
Control Drawing: SAP\_214 749

**8.4.7 Non-Incendive CSA**

N.I. Class I Div 2, Group: A, B, C, D or  
Ex nL IIC T\*, Class I Zone 2  
\*Temp. Ident T6, T<sub>amb</sub> 60 °C, T4 T<sub>amb</sub> 85 °C  
 $U_i / V_{max} = 9V$ ,  $I_i / I_{max} < 65.2 \text{ mA}$ ,  $P_i = 101 \text{ mW}$   
 $C_i < 0.4 \mu\text{F}$ ,  $L_i = 0$   
Control Drawing: SAP\_214 750











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3KXT221001R1001



# TTR200

## Rail mounted Temperature Transmitter



**HART, Pt100 (RTD), Thermocouples,  
Electrical isolation**

### Input

- Resistance thermometer
- Thermocouples
- Resistance-type transmitters
- Voltages, mV voltages

### Output

- 4 ... 20 mA, HART

### Measurement deviation

- 0.1 K

### Sensor error adjustment

### Continuous sensor monitoring and self-monitoring

- Two function LEDs
- Supply voltage monitoring
- Wire break and corrosion monitoring in accordance with NE 89

### Device safety in accordance with NE 53

### SIL2 acc. to IEC 61508

### Approvals for explosion protection

- ATEX, IECEx, Zone 0
- FM / CSA

### Configuration

- DTM
- EDD

## Contents

<b>1</b>	<b>Specifications</b>	<b>3</b>
1.1	Input	3
1.2	Output	3
1.3	Power supply (polarity safe)	3
<b>2</b>	<b>General information</b>	<b>4</b>
2.1	Ambient conditions	4
2.2	ElectroMagnetic Compatibility	4
2.3	Interference immunity	4
2.4	Mechanical design	4
2.5	SIL functional safety	4
2.6	Measuring accuracy	5
2.7	Operating influences	6
<b>3</b>	<b>Communication</b>	<b>7</b>
3.1	Configuration parameters	7
3.2	HART	7
<b>4</b>	<b>Electrical connections</b>	<b>8</b>
<b>5</b>	<b>Dimensions</b>	<b>8</b>
<b>6</b>	<b>Ordering information</b>	<b>9</b>
6.1	Documentation available for ordering	9
<b>7</b>	<b>Ex relevant specifications</b>	<b>10</b>
7.1	TTR200-E1, Intrinsic Safety ATEX	10
7.2	TTR200-H1, Intrinsic Safety IECEx	10
7.3	Safety specifications for Intrinsic Safety ATEX / IECEx	10
7.4	TTR200-E2, Non-Sparking ATEX	10
7.5	TTR200-L6, intrinsically safe FM	10
7.6	TTR200-L6, non-incendive FM	10
7.7	TTR200-R6, intrinsically safe CSA	10
7.8	TTR200-R6, non-incendive CSA	10
<b>8</b>	<b>Order form configuration</b>	<b>11</b>

## 1 Specifications

### 1.1 Input

#### 1.1.1 Resistance thermometers/Resistors

##### Resistance thermometer

Pt100 in accordance with IEC 60751, JIS C1604-81, MIL-T-24388,  
Ni in accordance with DIN 43760, Cu

##### Resistance measurement

0 ... 500 Ω  
0 ... 5000 Ω

##### Sensor connection type

Two-, three-, four-wire circuit

##### Connecting cable

Maximum sensor line resistance ( $R_W$ ) for each line 50 Ω according to NE 89 (January 2009)  
Three-wire circuit:  
symmetrical sensor line resistances  
Two-wire circuit:  
compensation up to 100 Ω total line resistance

##### Measurement current

< 300 μA

##### Sensor short circuit

< 5 Ω (for resistance thermometer)

##### Sensor wire break

Measuring range: 0 ... 500 Ω > 0.6 ... 10 kΩ  
Measuring range: 0 ... 5 kΩ > 5.3 ... 10 kΩ

##### Corrosion detection in accordance with NE 89

Three-wire resistance measurement > 50 Ω  
Four-wire resistance measurement > 50 Ω

##### Sensor error signaling

Resistance thermometers: Short circuit and wire break  
Linear resistance measurement: Wire break

#### 1.1.2 Thermocouples/Voltages

##### Types

B, E, J, K, N, R, S, T in accordance with IEC 60584  
U, L in accordance with DIN 43710  
C, D in accordance with ASTM E-988

##### Voltages

-125 ... 125 mV  
-125 ... 1100 mV

##### Connecting cable

Maximum sensor line resistance ( $R_W$ ) for each line: 1.5 kΩ, total: 3 kΩ

##### Sensor wire-break monitoring in accordance with NE 89

Pulsed with 1 μA outside measurement interval  
Thermocouple measurement 5.3 ... 10 kΩ  
Voltage measurement 5.3 ... 10 kΩ

##### Input resistance

> 10 MΩ

##### Internal reference point

Pt1000, IEC 60751 Cl. B  
(no additional jumpers necessary)

##### Sensor error signaling

Thermocouple: Wire break  
Linear voltage measurement: Wire break

### 1.2 Output

##### Transmission characteristics

Temperature linear  
Resistance linear  
Voltage linear

##### Output signal

Configurable 4 ... 20 mA (standard)  
Configurable 20 ... 4 mA  
(dynamic range: 3.8 ... 20.5 mA in accordance with NE 43)

##### Simulation mode

3.5 ... 23.6 mA

##### Induced current consumption

< 3.5 mA

##### Maximum output current

23.6 mA

##### Configurable error current signal

Override 22 mA (20.0 ... 23.6 mA)  
Underdrive 3.6 mA (3.5 ... 4.0 mA)

### 1.3 Power supply (polarity safe)

Two-wire technology; power lines = signal lines

##### Supply voltage

Non ignition-proof application:  $U_S = 11 \dots 42$  V DC  
Ex applications:  $U_S = 11 \dots 30$  V DC

##### Max. permissible residual ripple for supply voltage

During communication in accordance with HART FSK  
"Physical Layer" specification, version 8.1 (August 1999) Section 8.1

##### Undervoltage detection

$U_{\text{Terminal-Mu}} < 10$  V results in  $I_a = 3.6$  mA

##### Maximum load

$R_{\text{Load}} = (\text{supply voltage} - 11 \text{ V})/0.022 \text{ A}$

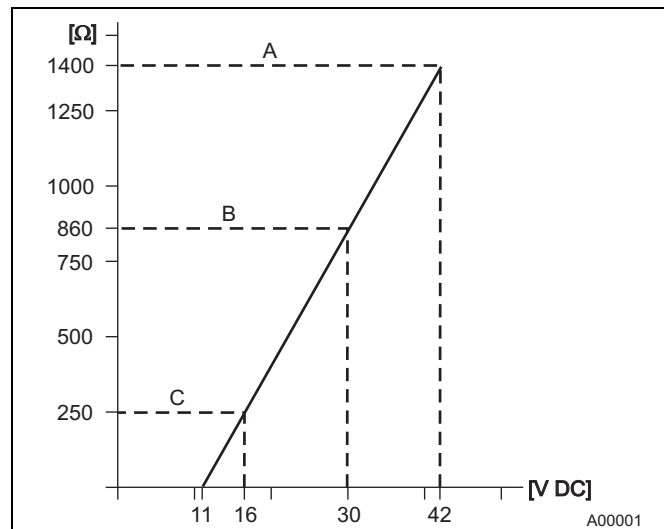


Fig. 1: Max. load depending on supply voltage

- A TTR200
- B TTR200 In ia hazardous area design
- C HART communication resistor

##### Maximum power consumption

$P = U_S \times 0.022 \text{ A}$

e.g.,  $U_S = 24 \text{ V} \rightarrow P_{\text{max}} = 0.528 \text{ W}$

## 2 General information

### CE Marking

The TTR200 meets all requirements for the CE mark in accordance with IEC 61326 (2006)

### Electrical isolation

3.5 kV DC (approx. 2.5 kV AC) 60 s, input to output

### MTBF time

28 years at 60 °C ambient temperature

### Input filter

50 / 60 Hz

### Switch-on delay

< 10 s ( $I_a \leq 3.6$  mA during starting cycle)

### Warm-up time

5 minutes

### Ramp-up time $t_{90}$

400 ... 1000 ms

### Rate updated

10/s, independent of sensor type and sensor circuit

### Output filter

Digital filter 1st order: 0 ... 100 s

## 2.1 Ambient conditions

### Ambient temperature

Standard: -40 ... 85 °C (-40 ... 185 °F)

Restricted range with hazardous area design

### Transport/storage temperature

-40 ... 85 °C (-40 ... 185 °F)

### Climate class

Cx -40 ... 85 °C (-40 ... 185 °F) at

5 ... 95 % relative humidity, DIN EN 60654-1

### Max. permissible humidity

100 % relative humidity, IEC 60068-2-30

### Vibration resistance

10 ... 2000 Hz at 5 g, IEC 60068-2-6,  
during operation and transport

### Shock

$g_n = 30$ , IEC 68-2-27,  
during operation and transport

### Ingress protection

IP 20 or IP class of the bay

## 2.2 ElectroMagnetic Compatibility

Emitted interference in accordance with IEC EN 61326 (2006) and Namur NE 21 (February 2004)

## 2.3 Interference immunity

Interference-immune in accordance with IEC 61326 (2006) and Namur NE 21 (August 2007)

Pt100: measuring range 0 ... 100 °C (32 ... 212 °F), span 100 K

Type of test	Testing accuracy	Influence
Burst to signal/data lines	2 kV	< 0.5 %
Static discharge:		
• Contact plate (indirect)	8 kV	No
• Supply terminals <sup>1)</sup>	6 kV	No
• Sensor terminals <sup>1)</sup>	4 kV	No
Radiated field 80 MHz ... 2 GHz	10 V/m	< 0.5 %
Coupling 150 kHz ... 80 MHz	10 V	< 0.5 %
Surge:		
between the supply lines	0.5 kV	No malfunction
Line to ground	1 kV	No malfunction

1) Air discharge (at 1 mm (0.04 inch) distance)

## 2.4 Mechanical design

### Dimensions

See Section 5, "Dimensions"

### Weight

180 g

### Material

Housing: polycarbonate

Color: Gray RAL 9002

Sealing compound: Hard sealing compound

### Installation conditions

Installation position: No limitations

Installation options: 35 mm rail mounting acc. to EN 60175

### Electrical connection

Terminals (captive screws) with screw connections, plug-in  
Lines up to max. 2.5 mm<sup>2</sup> (AWG 14)

## 2.5 SIL functional safety

Conforms with IEC 61508 as regards use in safety-related applications, up to and including SIL 2.

## 2.6 Measuring accuracy

Includes linearity deviation, reproducibility/hysteresis at 23 °C (73.4 °F) ± 5 K and 20 V supply voltage

Information on measuring accuracy corresponds to 3 σ (Gaussian distribution)

Input element		Measuring range limits	Minimum span	Digital measuring accuracy (24-bit A/D converter)	D/A measuring accuracy (16-bit DA)
Standard	Sensor				
<b>Resistance thermometer/resistor</b>					
<b>IEC 60 751</b>	Pt10 (a=0,003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,80 °C (± 1,44 °F)	± 0,05 %
	Pt50 (a=0,003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,16 °C (± 0,29 °F)	± 0,05 %
	Pt100 (a=0,003850) <sup>2)</sup>	<b>-200 ... 850 °C (-328 ... 1562 °F)</b>	10 °C (18 °F)	± 0,08 °C (± 0,14 °F)	± 0,05 %
	Pt200 (a=0,003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,24 °C (± 0,43 °F)	± 0,05 %
	Pt500 (a=0,003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,16 °C (± 0,29 °F)	± 0,05 %
	Pt1000 (a=0,003850)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,08 °C (± 0,14 °F)	± 0,05 %
<b>JIS C1604-81</b>	Pt10 (a=0,003916)	-200 ... 645 °C (-328 ... 1193 °F)	10 °C (18 °F)	± 0,80 °C (± 1,44 °F)	± 0,05 %
	Pt50 (a=0,003916)	-200 ... 645 °C (-328 ... 1193 °F)	10 °C (18 °F)	± 0,16 °C (± 0,29 °F)	± 0,05 %
	Pt100 (a=0,003916)	-200 ... 645 °C (-328 ... 1193 °F)	10 °C (18 °F)	± 0,08 °C (± 0,14 °F)	± 0,05 %
<b>MIL-T-24388</b>	Pt10 (a=0,003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,80 °C (± 1,44 °F)	± 0,05 %
	Pt50 (a=0,003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,16 °C (± 0,29 °F)	± 0,05 %
	Pt100 (a=0,003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,08 °C (± 0,14 °F)	± 0,05 %
	Pt200 (a=0,003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,24 °C (± 0,43 °F)	± 0,05 %
	Pt500 (a=0,003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,16 °C (± 0,29 °F)	± 0,05 %
	Pt1000 (a=0,003920)	-200 ... 850 °C (-328 ... 1562 °F)	10 °C (18 °F)	± 0,08 °C (± 0,14 °F)	± 0,05 %
<b>DIN 43760</b>	Ni50 (a=0,006180)	-60 ... 250 °C (-76 ... 482 °F)	10 °C (18 °F)	± 0,16 °C (± 0,29 °F)	± 0,05 %
	Ni100 (a=0,006180)	-60 ... 250 °C (-76 ... 482 °F)	10 °C (18 °F)	± 0,08 °C (± 0,14 °F)	± 0,05 %
	Ni120 (a=0,006180)	-60 ... 250 °C (-76 ... 482 °F)	10 °C (18 °F)	± 0,08 °C (± 0,14 °F)	± 0,05 %
	Ni1000 (a=0,006180)	-60 ... 250 °C (-76 ... 482 °F)	10 °C (18 °F)	± 0,08 °C (± 0,14 °F)	± 0,05 %
	Cu10 (a=0,004270)	-50 ... 200 °C (-58 ... 392 °F)	10 °C (18 °F)	± 0,80 °C (± 1,44 °F)	± 0,05 %
Cu100 (a=0,004270)	-50 ... 200 °C (-58 ... 392 °F)	10 °C (18 °F)	± 0,08 °C (± 0,14 °F)	± 0,05 %	
	Resistance measurement	0 ... 500 Ω	4 Ω	± 32 mΩ	± 0,05 %
	Resistance measurement	0 ... 5000 Ω	40 Ω	± 320 mΩ	± 0,05 %
<b>Thermocouples<sup>3)</sup>/voltages</b>					
<b>IEC 60584</b>	Type K (Ni10Cr-Ni5)	-270 ... 1372 °C (-454 ... 2502 °F)	50 °C (90 °F)	± 0,35 °C (± 0,63 °F)	± 0,05 %
	Type J (Fe-Cu45Ni)	-210 ... 1200 °C (-346 ... 2192 °F)	50 °C (90 °F)	± 0,35 °C (± 0,63 °F)	± 0,05 %
	Type N (Ni14CrSi-NiSi)	-270 ... 1300 °C (-454 ... 2372 °F)	50 °C (90 °F)	± 0,35 °C (± 0,63 °F)	± 0,05 %
	Type T (Cu-Cu45Ni)	-270 ... 400 °C (-454 ... 752 °F)	50 °C (90 °F)	± 0,35 °C (± 0,63 °F)	± 0,05 %
	Type E (Ni10Cr-Cu45Ni)	-270 ... 1000 °C (-454 ... 1832 °F)	50 °C (90 °F)	± 0,35 °C (± 0,63 °F)	± 0,05 %
	Type R (Pt13Rh-Pt)	-50 ... 1768 °C (-58 ... 3215 °F)	100 °C (180 °F)	± 0,95 °C (± 1,71 °F)	± 0,05 %
	Type S (Pt10Rh-Pt)	-50 ... 1768 °C (-58 ... 3215 °F)	100 °C (180 °F)	± 0,95 °C (± 1,71 °F)	± 0,05 %
	Type B (Pt30Rh-Pt6Rh)	-0 ... 1820 °C (32 ... 3308 °F)	100 °C (180 °F)	± 0,95 °C (± 1,71 °F)	± 0,05 %
<b>DIN 43710</b>	Type L (Fe-CuNi)	-200 ... 900 °C (-328 ... 1652 °F)	50 °C (90 °F)	± 0,35 °C (± 0,63 °F)	± 0,05 %
	Type U (Cu-CuNi)	-200 ... 600 °C (-328 ... 1112 °F)	50 °C (90 °F)	± 0,35 °C (± 0,63 °F)	± 0,05 %
<b>ASTM E-988</b>	Type C	-0 ... 2315 °C (32 ... 4200 °F)	100 °C (180 °F)	± 1,35 °C (± 2,43 °F)	± 0,05 %
	Type D	-0 ... 2315 °C (32 ... 4200 °F)	100 °C (180 °F)	± 1,35 °C (± 2,43 °F)	± 0,05 %
	Voltage measurement	-125 ... 125 mV	2 mV	± 12 μV	± 0,05 %
	Voltage measurement	-125 ... 1100 mV	20 mV	± 120 μV	± 0,05 %

### Long-term drift

± 0.05 °C (± 0.09 °F) or ± 0.05 %<sup>1)</sup> per year, the larger value applies.

1) Percentages refer to the configured measuring span

2) Standard model

3) Include the internal reference point error for digital measuring accuracy: Pt1000, IEC 60751 Cl. B

4) Without reference point error

## 2.7 Operating influences

The percentages refer to the configured measuring span.

**Supply voltage influence/load influence:** within the specified limits for the voltage/load, the total influence is less than 0.001 % per volt

**Common-mode interference:** no influence up to 100 V<sub>eff</sub> (50 Hz) or 50 V DC

**Ambient temperature influence:** based on 23 °C (73.4 °F) for ambient temperature range -40 ... 85 °C (-40 ... 185 °F)

Sensor	Influence of ambient temperature per 1 °C (1.8 °F) deviation to 23 °C (73.4 °F) for digital measurement	Influence of ambient temperature <sup>1)2)</sup> per 1 °C (1.8 °F) deviation to 23 °C (73.4 °F) for D/A converter
Resistance thermometer for two-, three-, four-wire circuits		
Pt10 IEC, JIS, MIL	± 0,04 °C (± 0,072 °F)	± 0,003 %
Pt50 IEC, JIS, MIL	± 0,008 °C (± 0,014 °F)	± 0,003 %
Pt100 IEC, JIS, MIL	± 0,004 °C (± 0,007 °F)	± 0,003 %
Pt200 IEC, MIL	± 0,02 °C (± 0,036 °F)	± 0,003 %
Pt500 IEC, MIL	± 0,008 °C (± 0,014 °F)	± 0,003 %
Pt1000 IEC, MIL	± 0,004 °C (± 0,007 °F)	± 0,003 %
Ni50 DIN 43760	± 0,008 °C (± 0,014 °F)	± 0,003 %
Ni100 DIN 43760	± 0,004 °C (± 0,007 °F)	± 0,003 %
Ni120 DIN 43760	± 0,003 °C (± 0,005 °F)	± 0,003 %
Ni1000 DIN 43760	± 0,004 °C (± 0,007 °F)	± 0,003 %
Cu10	± 0,04 °C (± 0,072 °F)	± 0,003 %
Cu100	± 0,004 °C (± 0,007 °F)	± 0,003 %
Resistance measurement 0 ... 500 Ω	± 0,002 Ω	± 0,003 %
0 ... 5000 Ω	± 0,02 Ω	± 0,003 %
Thermocouple, for all defined types	± [(0,001 % x (ME[mV] / MS[mv]) + (100 % x (0,009 °C / MS [°C]))] <sup>3)</sup>	± 0,003 %
Voltage measurement -125 ... 125 mV	± 1,5 μV	± 0,003 %
-125 ... 1100 mV	± 15 μV	± 0,003 %

1) Percentages refer to the configured measuring span of the analog output signal

2) Effect on DA converter

3) ME = voltage value of the thermocouple at the end of the measuring range in accordance with the standard  
MA = voltage value of the thermocouple at the start of the measuring range in accordance with the standard  
MS = voltage value of the thermocouple over the measuring span in accordance with the standard. MS = (ME - MA)

### 3 Communication

#### 3.1 Configuration parameters

##### Measurement type

- Sensor type, connection type
- Error signaling
- Measurement range
- General information, e.g., TAG number
- Damping
- Signal simulation of output
- For additional information, see Section 8, "Order form configuration"

##### Write protection

- Software write protection

##### Diagnostic information in accordance with NE 107

- Sensor error (wire break or short circuit)
- Device error
- Over/under alarm limits
- Over/under measuring range
- Simulation activated

##### Diagnostic signaling

- Over/underdrive in accordance with NE 43
- HART diagnostics

#### 3.2 HART

The device is listed with the HART Communication Foundation.

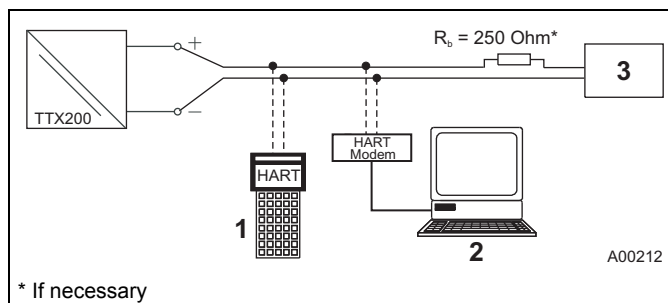


Fig. 2: Example for HART interface connection

- 1 Handheld terminal
- 2 FDT/DTM technology
- 3 Power unit (process interface)

Manufacturer ID:	0x1A
Device ID:	0x0A
Profile:	HART 5.1
Configuration:	DTM EDD
Transmission signal:	BELL Standard 202

##### Operating modes

- Point-to-point communication mode: standard (general address 0)
- Multidrop mode (addressing 1 ... 15)
- Burst mode

##### Configuration options and tools

- Device management/asset management tools
- FDT/DTM technology – via TTX200 DTM driver
- EDD - via TTX200 EDD driver

##### Diagnostic signaling

- Over/underdrive in accordance with NE 43
- HART diagnostics

## 4 Electrical connections

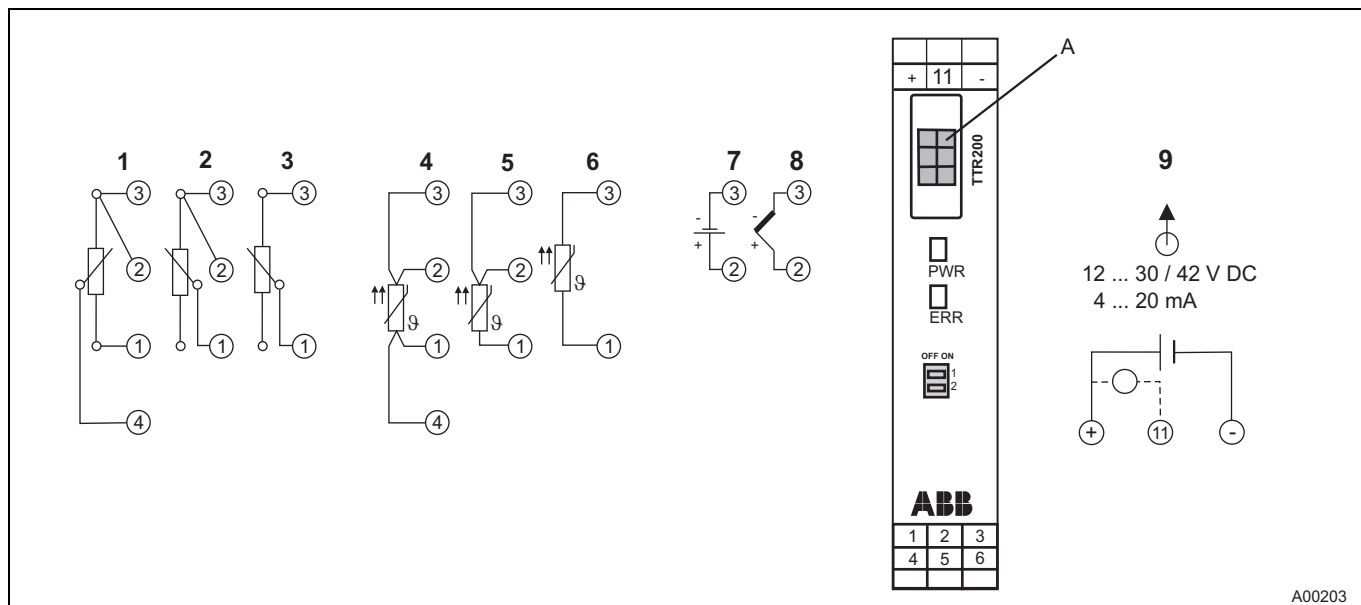


Fig. 3

- |                                     |                           |  |
|-------------------------------------|---------------------------|--|
| 1 Potentiometer, four-wire circuit  | 4 RTD, four-wire circuit  | 7 Voltage measurement  |
| 2 Potentiometer, three-wire circuit | 5 RTD, three-wire circuit | 8 Thermocouple   |
| 3 Potentiometer, two-wire circuit   | 6 RTD, two-wire circuit   | 9 Terminal 11: Measurement of 4 ... 20 mA output current without opening / interrupting the current loop |
- A: no function

- PWR / green LED: Supply voltage display
- ERR / red LED: sensor, sensor lead & unit fault signaling
- DIP switch 1: on -> Hardware write protection is enabled
- DIP switch 2: no function

## 5 Dimensions

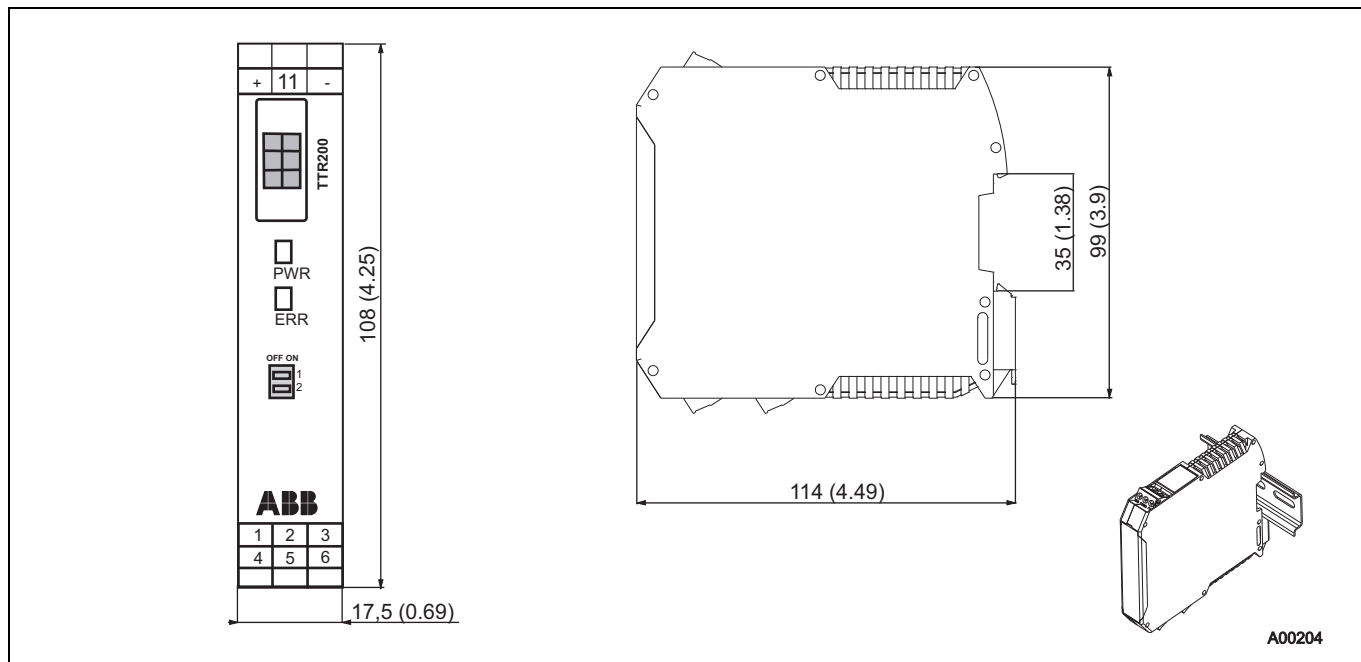


Fig. 4: Dimensions in mm (inch)



## 6 Ordering information

	Main order number						Add. order no.
	Version number	1	6	7	8	9	
<b>TTR200 rail-mounted temperature transmitter, HART, Pt100 (RTD), thermocouples, electrical isolation</b>	TTR200	X	X	X	X	X	XX
<b>Explosion protection</b>							
Without explosion protection				Y	0		
ATEX intrinsic safety type of protection:				E	1		
Zone 0: II 1 G Ex ia IIC T6, zone 1 (0): II 2 (1) G Ex [ia] ib IIC T6,							
Zone 1 (20): II 2 G (1D) Ex [iaD] ib IIC T6							
ATEX non-sparking type of protection:				E	2		
Zone 2: II 3 G Ex nA II T6							
IECEX intrinsic safety type of protection:				H	1		
Zone 0: II 1 G Ex ia IIC T6,							
Zone 1 (0): II 2 (1) G Ex [ia] ib IIC T6,							
Zone 1 (20): II 2 G (1D) Ex [iaD] ib IIC T6							
FM				L	6		
Intrinsic safety (IS): Class I, Div. 1+2, Groups A, B, C, D, Class I, Zone 0, AEx ia IIC T6,							
Non-incendive (NI): Class I, Div. 2, Groups A, B, C, D							
CSA				R	6		
Intrinsic safety (IS): Class I, Div. 1+2, Groups A, B, C, D,							
Non-incendive (NI): Class I, Div. 2, Groups A, B, C, D							
Kazakhstan - metrological approval				G	3		
Kazakhstan - metrological approval and GOST Ex i				G	4		
Ukraine - metrological approval				G	5		
Ukraine - metrological approval and GOST Ex i				G	6		
Belarus - metrological approval				M	5		
Belarus - metrological approval and GOST Ex i				M	6		
<b>Communication protocol</b>							
HART						H	
<b>Configuration</b>							
Standard configuration							B S
Customer-specific configuration with report, no spec. user characteristics					1)		B F
<b>Calibration certificates</b>							
5-point factory calibration certificate							EM
Acceptance test certificate 3.1 to EN 10204 for 5-point calibration							EP
<b>Certificates</b>							
SIL2 declaration of conformity							CS
Certificate of compliance 2.1 to EN 10204 for order conformity							C4
Acceptance test certificate 3.1 to EN 10204 for visual and functional checks							C6
<b>Customer-specific designs</b>							
(Please provide)							Z9
<b>Language of documentation</b>							
German							M1
English							M5
Western Europe/Scandinavia language package (languages: DE, EN, DA, ES, FR, IT, NL, PT, FI, SV)							MW
Eastern Europe language package (languages: DE, EL, CS, ET, LV, LT, HU, PL, SK, SL, RO, BG)							ME

1) E.g., customer-specific measuring range, TAG no.

### 6.1 Documentation available for ordering

Description	Order number
TTR200 documentation on CD-ROM	3KXT241001R0800
TTR200 commissioning instructions, English	3KXT241001R4401
TTR200 commissioning instructions, German	3KXT241001R4403
TTR200 commissioning instructions, Western Europe / Scandinavia language package	3KXT241001R4493
TTR200 commissioning instructions, Eastern Europe language package	3KXT241001R4494

## 7 Ex relevant specifications

The TTR200 complies with the requirements of ATEX Directive 94/9/EC.

### 7.1 TTR200-E1, Intrinsic Safety ATEX

#### Explosion protection

Approved for use in Zone 0 and 1

#### Designation

II 1G Ex ia IIC T6 (Zone 0)  
II 2(1)G Ex [ia] ib IIC T6 (Zone 1 [0])  
II 2G(1D) Ex [iaD] ib IIC T6 (Zone 1 [20])

EC type-examination test certificate PTB 05 ATEX 2017 X

### 7.2 TTR200-H1, Intrinsic Safety IECEx

#### Designation

Ex ia IIC T6  
Ex [ia] ib IIC T6  
Ex [iaD] ib IIC T6

IECEx certificate of conformity IECEx PTB 09.0014X

### 7.3 Safety specifications for Intrinsic Safety ATEX / IECEx

#### Temperature table

Temperature class	Permissible ambient temperature range	
	Device category 1 use	Device category 2 use
T6	-50 ... 44 °C (-58 ... 111,2 °F)	-50 ... 56 °C (-58 ... 132,8 °F)
T5	-50 ... 56 °C (-58 ... 132,8 °F)	-50 ... 71 °C (-58 ... 159,8 °F)
T4, T3, T2, T1	-50 ... 60 °C (-58 ... 140,0 °F)	-50 ... 85 °C (-58 ... 185,0 °F)

#### Type of protection intrinsic safety Ex ia IIC (Part 1)

	Supply circuit
Max. voltage	$U_i = 30 \text{ V}$
Short circuit current	$I_i = 130 \text{ mA}$
Max. power	$P_i = 0.8 \text{ W}$
Internal inductance	$L_i = 0.5 \text{ mH}$
Internal capacitance	$C_i = 5 \text{ nF}$

#### Type of protection intrinsic safety Ex ia IIC (Part 2); thermocouples, voltages

	Measurement current circuit: resistance thermometers, resistors	Measurement current circuit: thermocouples, voltages
Max. voltage	$U_o = 6.5 \text{ V}$	$U_o = 1.2 \text{ V}$
Short circuit current	$I_o = 25 \text{ mA}$	$I_o = 50 \text{ mA}$
Max. power	$P_o = 38 \text{ mW}$	$P_o = 60 \text{ mW}$
Internal inductance	$L_i = 0 \text{ mH}$	$L_i = 0 \text{ mH}$
Internal capacitance	$C_i = 49 \text{ nF}$	$C_i = 49 \text{ nF}$
Maximum permissible external inductance	$L_o = 5 \text{ mH}$	$L_o = 5 \text{ mH}$
Maximum permissible external capacitance	$C_o = 1.55 \text{ }\mu\text{F}$	$C_o = 1.05 \text{ }\mu\text{F}$

### 7.4 TTR200-E2, Non-Sparking ATEX

#### Explosion protection

Approved for use in Zone 2

#### Designation

II 3 G Ex nA II T6

ABB manufacturer's declaration in accordance with ATEX Directive

#### Temperature table

Temperature class	Device category 3 use
T6	-50 ... 56 °C (-58 ... 132,8 °F)
T5	-50 ... 71 °C (-58 ... 159,8 °F)
T4	-50 ... 85 °C (-58 ... 185,0 °F)

### 7.5 TTR200-L6, intrinsically safe FM

Class I, Div. 1 + 2, Groups A, B, C, D  
Class I, Zone 0, AEx ia IIC T6  
Control drawing: TTR200-L6H (I.S.)

### 7.6 TTR200-L6, non-incendive FM

Class I, Div. 2, Groups A, B, C, D  
Control drawing: TTR200-L6H (N.I.)

### 7.7 TTR200-R6, intrinsically safe CSA

Class I, Div. 1 + 2, Groups A, B, C, D  
Class I, Zone 0, Ex ia Group IIC T6  
Control drawing: TTR200-R6H (I.S.)

### 7.8 TTR200-R6, non-incendive CSA

Class I, Div. 2, Groups A, B, C, D  
Control drawing: TTR200-R6H (N.I.)

## 8 Order form configuration

Data relating to customer-specific configuration

Configuration		Selection
IEC 60 751	Resistance thermometer	<input type="checkbox"/> Pt10 <input type="checkbox"/> Pt50 <input type="checkbox"/> <b>Pt100</b> (standard)
		<input type="checkbox"/> Pt200 <input type="checkbox"/> Pt500 <input type="checkbox"/> Pt1000
JIS C1604-81		<input type="checkbox"/> Pt10 <input type="checkbox"/> Pt50 <input type="checkbox"/> Pt100
MIL-T-24388		<input type="checkbox"/> Pt10 <input type="checkbox"/> Pt50 <input type="checkbox"/> Pt100 <input type="checkbox"/> Pt200 <input type="checkbox"/> Pt500 <input type="checkbox"/> Pt1000
DIN 43760		<input type="checkbox"/> Ni50 <input type="checkbox"/> Ni100 <input type="checkbox"/> Ni120 <input type="checkbox"/> Ni1000
Cu	<input type="checkbox"/> Cu10 <input type="checkbox"/> Cu100	
	Resistance measurement	<input type="checkbox"/> 0 ... 500 Ω <input type="checkbox"/> 0 ... 5000 Ω
IEC 60584	Thermocouple	<input type="checkbox"/> Type K <input type="checkbox"/> Type J <input type="checkbox"/> Type N <input type="checkbox"/> Type R <input type="checkbox"/> Type S <input type="checkbox"/> Type T <input type="checkbox"/> Type E <input type="checkbox"/> Type B
DIN 43710		<input type="checkbox"/> Type L <input type="checkbox"/> Type U
ASTM E-988		<input type="checkbox"/> Type C <input type="checkbox"/> Type D
	Voltage measurement	<input type="checkbox"/> -125 ... 125 mV <input type="checkbox"/> -125 ... 1100 mV
Sensor circuit (for resistance thermometer and resistance measurement only)		<input type="checkbox"/> Two-wire <input type="checkbox"/> <b>Three-wire</b> (standard) <input type="checkbox"/> Four-wire Two-wire circuit: Compensation of sensor line resistance max. 100 Ω <input type="checkbox"/> .....Ω
Reference point (for thermocouples only)		<input type="checkbox"/> Internal (for standard thermocouples except type B) <input type="checkbox"/> None (type B) <input type="checkbox"/> External/temperature: ..... °C
Measurement range		<input type="checkbox"/> Measuring start: ..... (Standard: <b>0</b> ) <input type="checkbox"/> Measuring end: ..... (Standard: <b>100</b> )
Unit		<input type="checkbox"/> <b>Celsius</b> (standard) <input type="checkbox"/> Fahrenheit <input type="checkbox"/> Rankine <input type="checkbox"/> Kelvin
Characteristic behavior		<input type="checkbox"/> <b>Rising 4 ... 20 mA</b> (standard) <input type="checkbox"/> Falling 20 ... 4 mA
Output behavior for error		<input type="checkbox"/> <b>Override/22 mA</b> (standard) <input type="checkbox"/> Underdrive/3.6 mA
Output attenuation (T <sub>63</sub> )		<input type="checkbox"/> <b>Off</b> (standard) <input type="checkbox"/> ..... seconds (1 ... 100 s)
Sensor number		<input type="checkbox"/> ..... (max. 8 characters)
TAG number		<input type="checkbox"/> ..... (max. 8 characters)
Software write protection		<input type="checkbox"/> <b>Off</b> (standard) <input type="checkbox"/> On

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**SensyMIC – Mineral Insulated Cables**

	Page
<b>General Information</b> . . . . .	2
<b>Delivery Program</b> . . . . .	2
Standard types . . . . .	2
Special manufactures . . . . .	2
Production lengths . . . . .	2
Minimum order value . . . . .	2
<b>Technical Data</b> . . . . .	3
Insulation ceramic . . . . .	3
Insulation resistance . . . . .	3
Loop resistance (resistance of inner conductors) . . . . .	3
Processing . . . . .	3
Dimensions . . . . .	4
Tolerances and temperature ranges . . . . .	4
<b>The Short-range Ordered State in NiCr-Ni Thermocouples (Type K)</b> . . . . .	5
<b>Standard Sheath Materials</b> . . . . .	7
<b>Mineral Insulated Thermocouple Cables</b> . . . . .	9
<b>Mineral Insulated Cables</b> . . . . .	11
<b>Mineral Insulated Cables with Precious Metal Thermocouples</b> . . . . .	12
Application . . . . .	12
Standard types . . . . .	12
Special manufacture . . . . .	12
Maximum production lengths . . . . .	12

**SensyHeat – Heaters**

<b>SensyHeat – Heaters</b> . . . . .	13
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## SensyMIC – Mineral Insulated Cables

### General Information

Mineral insulated cables have an outer sheath of metal with 2 to 8 inner conductors. The insulation material is made from a highly compressed metal-oxide powder (preferably MgO or Al<sub>2</sub>O<sub>3</sub>).

Mineral insulated thermocouple cables have inner conductors of thermocouple base material. Mineral insulated cables for RTDs have inner conductors of copper, copper-nickel alloys, nickel, nickel-chromium or nickel-plated copper.

Mineral insulated cables are designed for high-temperature applications and are used wherever there are particularly strict requirements with regard to mechanical, chemical and electrical stability.

On account of their good flexibility, the use of mineral insulated cables is preferred in areas where mounting is difficult and where a high degree of flexibility is required (for example, laboratories or pilot manufacturing plants). The minimum bending radius is 3 times the outer diameter of the mineral insulated cable.

Innovations in technology and manufacturing have made it possible for these cables to be used increasingly frequently as a material in the manufacture of standardized thermocouples and RTDs, in particular in industrial measuring and control technology and in automotive sensor technology.

### Delivery Program

SENSYCON offers a wide range of mineral insulated cables for the production of mineral insulated thermocouples and mineral insulated RTDs.

All standardized thermocouples type K, J, L, T, U, E and N and the precious metal thermocouples type R, S and B are available as mineral insulated thermocouple cables. Various mineral insulated cables with copper, copper-nickel, nickel and nickel-chromium inner conductors are also available ex stock.

However, not all combinations of sheath material and thermocouple are possible as, for example, for high-temperature-resistant sheath materials some of the necessary heat treatments considerably exceed the maximum permissible temperatures for the leads.

The following steels and alloys are available as sheath materials:

1.4301	complies with	AISI 304
1.4306	complies with	AISI 304 L
1.4404	complies with	AISI 316 L
1.4541	complies with	AISI 321
1.4571	complies with	AISI 316 TI
1.4749	complies with	AISI 446
1.4841	complies with	AISI 314
1.4845	complies with	AISI 310 S
1.4876	complies with	INCOLOY 800
2.4816	complies with	INCONEL 600
2.4851	complies with	INCONEL 601
2.4951	complies with	Nimonic 75
Platinum 10 % Rhodium		

### Special Materials

Special manufactures can be produced for special applications, for example using special materials and insulation materials or designed within specific tolerances.

### Standard Types

The catalog numbers printed in bold are standard types and can be delivered at short notice.

### Special Manufactures

The catalog numbers printed normally are special manufactures and are not available ex stock. However, they can be produced with a minimum order quantity (one production length) and a minimum production time.

### Production Lengths

The production lengths of mineral insulated cables depend on the length of the available tubes.

The following lengths can be delivered:

Outer Ø (mm)	Production length (approx.)
0.5	500 m
1.0	600/1.000 m
1.5	310/1.500 m
1.6	250/1.300 m
2.0	700 m
3.0	420/530 m
3.2	365/460 m
4.5	180 m
4.8	160 m
6.0	105 m
6.4	88 m
8.0	58 m
10.0	35 m

### Minimum Order Value

The minimum order value is DEM 300.00/Euro 150.00.

For order values less than DEM 300.00/Euro 150.00 and quantities less than one production length, a surcharge of 25% is added.

**SensyMIC – Mineral Insulated Cables**

**Technical Data**

**Insulation Ceramics**

SENSYCON supplies MgO as the standard insulator with a purity of  $\geq 96\%$  as well as MgO with a purity of  $\geq 99.4\%$  and  $Al_2O_3$ .

**Insulation Resistance**

The insulation resistance depends on the purity of the insulation ceramics used as well as the manufacturing process and the humidity content of the insulation. The cables are supplied fully dried with ends that are hermetically sealed. The following values of the insulation resistance are guaranteed upon delivery (see table 1).

The insulation resistance also depends on the length of the cable. Therefore, it is listed as a length-related resistance in  $\Omega \times m$ .

Example:  $L = 100\text{ m}; R_{is} = 10\text{ M}\Omega$   
 $R_{is} = 10\text{ M}\Omega \times 100\text{ m} = 1000\text{ M}\Omega \times m$

The minimum value at room temperature is  $1000\text{ M}\Omega \times m$  acc. to DIN EN 61515.

DIN EN 61515 provides for the minimum requirements stated in table 1.

**Test voltages**

Outer diameter  $\leq 1.5\text{ mm}$ :  $75\text{ V} \pm 25\text{ V DC}$   
 Outer diameter  $> 1.5\text{ mm}$ :  $500\text{ V} \pm 50\text{ V DC}$

The minimum values at higher temperatures can be confirmed on request.

**Loop Resistance (resistance of inner conductors)**

In order to assess measuring errors, the loop resistance is an important parameter in addition to the insulation resistance. The lower the loop resistance, the lower its influence on the measuring accuracy.

The maximum loop resistance of the various MI cables is shown in table 2.

**Processing**

It is absolutely necessary that the cable is sufficiently dried after the seal is opened or after the mineral insulated cable is cut into the lengths required. Immediately after drying, the cable must be sealed. The cable must not be stored with open ends.

**Table 1: Insulation Resistance Values at Ambient and Elevated Temperatures**  
 (The values are intended to specify the minimum requirements for operations but not for manufacturer's quality control tests)

	Minimum immersed length at test temperature m	Test temperature °C	Minimum insulation resistance MΩm
Ambient temperature	1	$20 \pm 15$	1000
Elevated temperature type J, E, K and N	0.5	$500 \pm 15$	5
Elevated temperature Type T	0.5	$300 \pm 10$	500

**Note** – The insulant of a mineral insulated thermocouple cable or thermocouple has a finite conductivity and therefore the insulation resistance decreases as the length of the cable or thermocouple increases. The conductance of a specific cable or thermocouple is therefore expressed in  $S\text{m}^{-1}$  (equivalent to  $\Omega^{-1} \cdot \text{m}^{-1}$ ) and hence the minimum specified insulation resistance is expressed in  $\Omega\text{m}$  or  $\text{M}\Omega\text{m}$  for cables or thermocouples longer than 1 m. For shorter lengths, it is expressed in  $\text{M}\Omega$ .

**Table 2: Loop Resistance for 1 Thermocouple at 20 °C in Ω/m (approx. values)**

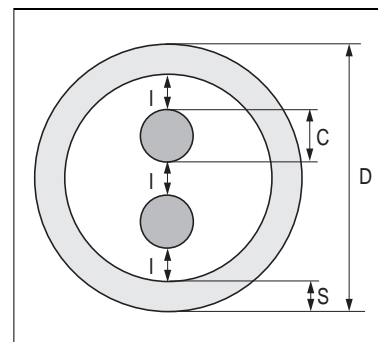
Thermocouple (TP = Thermocouple)	Outer Ø mm											
	0.5	1.0	1.5	1.6	2.0	3.0	3.2	4.5	4.8	6.0	6.4	8.0
1 TP NiCr-Ni	150	32/44	15/19	13/18	10.5	6.4	5.3	2.8	2.5	1.6	1.4	0.9
2 TP NiCr-Ni						6.2		3.1		1.6		0.8
1 TP Fe-CuNi	130	34	15	13	8.6	4.2	3.0	1.7	1.4	1.0	0.7	0.5
2 TP Fe-CuNi						3.7		1.8		1.0		0.5

## SensyMIC – Mineral Insulated Cables

### Dimensions

The following table shows the tolerances of the outer diameter, minimum wall thickness, minimum conductor diameter and thickness of the insulation according to DIN EN 61515.

Outer diameter of the cable (D) Nominal value ± tolerance, mm	Minimum wall thickness (S), mm	Minimum diameter of the inner conductor (C), mm	Minimum thickness (l) of the insulation, mm
0.5 ± 0.025	0.05	0.08	0.04
1.0 ± 0.025	0.10	0.15	0.08
1.5 ± 0.025	0.15	0.23	0.12
1.6 ± 0.025	0.16	0.24	0.13
2.0 ± 0.025	0.20	0.30	0.16
3.0 ± 0.030	0.30	0.45	0.24
3.2 ± 0.030	0.32	0.48	0.26
4.0 ± 0.045	0.40	0.60	0.32
4.5 ± 0.045	0.45	0.68	0.36
4.8 ± 0.045	0.48	0.72	0.38
6.0 ± 0.060	0.60	0.90	0.48
6.4 ± 0.060	0.64	0.96	0.51
8.0 ± 0.080	0.80	1.20	0.64
10.0 ± 0.100	1.00	1.50	0.80



D = Outer diameter  
C = Conductor diameter  
S = Wall thickness  
l = Insulation thickness

### Excerpt from the Tolerances and Temperature Ranges for Thermocouples

Thermocouple Type	Temperature Range °C	Tolerance
<b>Thermocouples according to DIN EN 60584</b>		
<b>Class 1</b>		
E	- 40 to + 800	± 1.5 °C or ± 0.004 ×  t
J	- 40 to + 750	± 1.5 °C or ± 0.004 ×  t
K/N	- 40 to + 1000	± 1.5 °C or ± 0.004 ×  t
<b>Class 2</b>		
E	- 40 to + 900	± 2.5 °C or ± 0.0075 ×  t
J	- 40 to + 750	± 2.5 °C or ± 0.0075 ×  t
K/N	- 40 to + 1200	± 2.5 °C or ± 0.0075 ×  t
T	- 40 to + 350	± 1.0 °C or ± 0.0075 ×  t
R/S	± 0 to + 1600	± 1.5 °C or ± 0.0025 ×  t
<b>Class 3</b>		
B	+ 600 to + 1700	± 4.0 °C or ± 0.005 ×  t
<b>Thermocouples according to DIN 43 710</b>		
U	- 200 to + 600	from 0 to + 400 °C ± 3 °C from + 400 to + 600 °C ± 0.0075 ×  t
L	- 200 to + 900	from 0 to + 400 °C ± 3 °C from + 400 to + 900 °C ± 0.0075 ×  t



**SensyMIC – Mineral Insulated Cables****The short-range ordered state in NiCr-Ni thermocouples (type K)**

Type K thermocouples are the most widely used thermocouples in process measuring technology, and not only there. Why?

- Their wide temperature range from – 200 to 1200 °C
- Their excellent long-term stability under oxidizing conditions
- Their high sensitivity of 40  $\mu\text{V}/^\circ\text{C}$
- Their superior suitability within mineral insulated thermocouples
- Their moderate price compared to precious metals

make these thermocouples an optimal solution both technically and financially.

From time to time arguments come up denying the suitability of this thermocouple type for the accuracy required in industrial measuring and control technology because these alloys are subject to the short-range ordered state.

**What is the short-range ordered state?**

The short-range ordered state is a phenomenon which occurs with nickel-chromium alloys and predominantly affects their thermoelectric properties. It is a magnetic ordering state of the individual elements of the matrix.

A distinction is made between

- the ordered state, the so-called **K state**, and
- the disordered state, which will be called **U state**.

One can imagine that in the K state the matrix elements stand in rank and file, whereas in the U state there is no order to their positions.

These states can be produced by certain temperature treatments and can easily be reversed.

In addition, transition states between the above states often occur.

**What is the effect of the ordering states?**

The electromotive force (e.m.f.) of a nickel-chromium wire in the K state may differ from an identical wire in the U state by the equivalent of 2 to 3 °C depending on the temperature and test method. In the transition states this value is lower.

**How are the ordering states created?**

Above 600 °C nickel-chromium alloys are always in the disordered or U state. After reaching this temperature the U state is formed very quickly.

If the alloy is cooled rapidly (in a few minutes) to room temperature, the U state will be kept as long as the temperature of the alloy is not raised above room temperature. The U state is "frozen in".

If the alloy is cooled slowly (in a few hours) to room temperature, a transition state between K and U generally appears.

If the alloy is kept for an extended period (one or two days) within a temperature range of 250 to 500 °C, the K state will be formed and sustained until the alloy is heated to 600 °C or above again.

**What heat treatment is applied to mineral insulated thermocouples before delivery?**

All manufacturers apply annealing after the last drawing step to reduce any hardening of the sheath and wires caused by plastic deformation, i.e. to make the mineral insulated thermocouple soft and thus flexible and to reverse major changes in e.m.f.

This annealing is applied at temperatures above 600 °C, i.e. the wires are in the U state.

After annealing, the cables are usually cooled as quickly as possible in order to avoid precipitation processes, for example in sheaths of austenitic stainless steels (1.4571 or similar), which would impair the weld ability. This results in a more or less undefined transition state between K and U in the wires; it is possible to achieve such rapid cooling that the U state is frozen in in small cable cross-sections only in some continuous cooling plants.

**What is the behaviour of thermocouples in the different modes of delivery?**

The majority of thermocouples are installed so that the measuring junction is at an elevated temperature and so that the temperature along the length of the thermocouple decreases with various slopes down to room temperature.

With a perfectly homogeneous thermocouple, i.e. the individual wires are completely identical over their whole length and do not have any local impurities or irregularities in their matrix, the e.m.f. will depend exclusively on the difference between the measuring junction and the reference junction.

However, if the thermocouple is not homogeneous, deviations from the original e.m.f. will occur, which depend on the nature and amount of the inhomogeneity and the temperature profile along the thermocouple.

Every thermocouple type K, regardless of the mode of delivery, will change after installation and when first used because it is always led through a temperature range in which the K state is formed after an extended period of time.

It is important to consider that the K state will also be formed at temperatures slightly below 250 °C, but much more slowly, it may take weeks.

**SensyMIC – Mineral Insulated Cables****What happens when first heated to 600 °C and above?**

The following is based on a "regular" installation of the thermocouple as it is common in process control:

The insertion length of the thermocouple is fixed and the operating temperature does not vary significantly.

*1. Delivery in the U state*

At the measuring junction, nothing happens because the U state is already present. In the so-called temperature gradient, i.e. where the temperature decreases towards the end of the thermocouple, the K state will gradually be formed over weeks (see above). During this period, the deviation from true e.m.f. changes continuously. Reliable temperature measurement and control are not possible. At the cold end of the thermocouple, a local transition from the K state to the U state appears, another inhomogeneity with additional influence on the e.m.f.

*2. Delivery in the transition state*

At the measuring junction, the U state is formed relatively quickly. In the temperature gradient a creeping transition into the K state occurs and at the cold end a local transition from the K state to the transition state is formed as an additional source of errors.

*3. Delivery in the K state*

At the measuring junction the U state develops very quickly. In the temperature gradient and at the cold end, nothing happens as the K state is already present everywhere here, i.e. this mode of delivery offers immediate stable and reliable temperature indication.

**How are mineral insulated thermocouples tested?**

For a reliable e.m.f. test, the samples are transferred to the K state. If this is not done, the effects shown above for the first two delivery modes occur during calibration.

**When can reliable temperature measurement be expected?**

Reliable temperature measurement which also corresponds to the e.m.f. determined in the test can only be expected if the mineral insulated thermocouples are delivered in the stable K state. Therefore, mineral insulated thermocouples should only be delivered in the stable K state.

SENSYCON is the only manufacturer to apply expensive second final annealing which ensures that all cables are delivered in the stable K state.

## SensyMIC – Mineral Insulated Cables

## Standard Sheath Materials

## Mineral Insulated Cables

Mineral insulated thermocouples can be manufactured from all ductile sheath materials, especially from the full range of austenitic stainless steels. Nickel-alloy materials can also be used for certain applications. Special sheath materials can also be supplied.

Max. operating temperature	Sheath material	Material properties	Applications
800 °C	1.4301 <b>AISI 304</b> 1.4306 <b>AISI 304 L</b>	Materials 1.4301 and 1.4306 have different low carbon contents and differ, in particular, in their resistance to intercrystalline corrosion. Good resistance to organic acids at moderate temperatures, saline solutions, such as sulphates, sulphides and sulphites, and alkaline solutions at moderate temperatures.  Good welding properties. Welding retreatment is generally not necessary, in particular with 1.4306.	Chemical apparatus engineering, nuclear power, textile and paper industry, grease and soap industry, food processing industry, dairies and breweries, nitric acid industry.
800 °C	1.4404 <b>AISI 316 L</b>	As a result of the addition of molybdenum, this material has higher corrosion resistance in non-oxidizing acids such as ethanolic acid, tartaric acid, phosphoric acid, sulphuric acid and others. Increased pitting resistance.  Good welding properties. Heat treatment is generally not necessary.	Sulphite, pulp, textile, dyeing, fatty acid, soap and pharmaceutical industries.
800 °C	1.4541 <b>AISI 321</b>	Good resistance to intercrystalline corrosion, also after welding. Good resistance to heavy oil products, steam and exhaust gases. Good oxidation resistance. Can be used continuously up to approximately 800 °C.  Good welding properties in all standard welding processes without the need for welding retreatment. Good ductility.	Nuclear power and reactor construction, chemical apparatus engineering, annealing furnaces, heat exchangers, paper and textile industry, petrochemical and crude oil industry, grease and soap industry, food processing industry.
800 °C	1.4571 <b>AISI 316 TI</b>	Increased resistance against corrosion from certain acids due to the addition of molybdenum. Resistant against pitting, salt water and aggressive industrial influences. Can be used continuously up to approximately 800 °C.  Good welding properties in all standard welding processes without the need for welding retreatment. Good ductility.	Nuclear power and reactor construction, chemical apparatus engineering, furnace construction, chemical and pharmaceutical industries.
1150 °C	1.4749 <b>AISI 446</b>	Extremely good resistance to reducing, sulphurous atmospheres. Very good resistance to oxidation and air. Good resistance to corrosion caused by incinerator slag and copper, lead and tin smelts.  Good welding properties in arc welding and WIG welding. Preheating to 200 - 400 °C is recommended. Retreatment is not necessary.	Petrochemical industry, metallurgy, power technology, recuperators, heat treatment kilns, vortex firing installations, waste incinerators.

## SensyMIC – Mineral Insulated Cables

Max. operating temperature	Sheath material	Material properties	Applications
1150 °C	1.4841 <b>AISI 314</b>	Excellent resistance to corrosion, also at high temperatures. Also suitable in atmospheres containing carbon and sulphur. Resistant to oxidation in air up to 1000 °C (interrupted service) or 1150 °C (continuous service). Well suited with high thermal cycling. Recommended for long-term continuous use in the temperature range from 425 to 850 °C.  Good welding properties in arc welding processes. Thermal retreatment is not necessary. The material has good ductility on delivery. After a long period of use, however, the material can become slightly brittle.	Boilers and blast furnaces, cement and brick kilns, glass production, crude oil and petrochemical industries, furnace construction and power stations.
1100 °C	1.4845 <b>AISI 310 S</b>	Good resistance to oxidation and sulphidisation. Due to the high content of chromium, the material is resistant to oxidizing hydrous solutions and has good resistance to chlorine-induced tension crack corrosion. Good resistance in cyanide smelts and neutral salt melts at high temperatures. Not susceptible to green mould.  Good welding properties. It is recommended to weld with low heat input. Apply solution annealing after welding to avoid the danger of intercrystalline corrosion.	As 1.4841
1100 °C in air	1.4876 <b>Incoloy 800™*</b>	This material provides superior thermal stability due to the addition of titanium and aluminium. Suitable for applications requiring maximum stability under load in addition to scaling resistance. Excellent resistance to carburisation and nitrogenisation.  The material has good welding properties in arc and WIG welding processes. Heat treatment is not necessary after welding.	Power stations, crude oil and petrochemical industries, furnace construction.
1100 °C	2.4816 <b>Inconel 600™*</b>	Good general resistance to corrosion, resistant to tension crack corrosion. Excellent resistance to oxidation. Not recommended with gases containing CO <sub>2</sub> and sulphur above 550 °C and sodium above 750 °C. In air, resistant up to 1100 °C.  Good welding properties for all types of welding processes. Excellent ductility even after long-term use.	PWR, nuclear power, furnace construction, plastics industry, heat treatment, paper and food processing industries, boilers, aircraft engines.
1100 °C	2.4951 <b>Nimonic 75™*</b>	Excellent high-temperature stability and resistance to oxidation and carburisation. Due to the combination of nickel and chromium, the material has very good resistance to hot, gaseous media. Resistance to thermal fatigue and thermal shock.  Good welding properties for all types of welding processes. Excellent ductility even after long-term use.	Space travel, aircraft construction, nuclear reactors, mechanical engineering, metal working, thermal materials processing.
1300 °C	Pt 10 % Rh	High-temperature resistance up to 1300 °C under oxidizing conditions. High heat resistance up to 1200 °C in the presence of oxygen, sulphur and silicon. Especially resistant to halogens, ethanolic acids, NaHCl-solutions, etc. Can become brittle through the absorption of silicon from armouring ceramics. Sulphur eutectics possible at temperatures over 1000 °C. Sensitive to phosphorus.	Glass, electrochemical and catalytic technology, chemical industry, laboratories, melting and annealing furnaces and other furnaces, final storage of nuclear power products.

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**SensyMIC – Mineral Insulated Cables**

<b>Mineral Insulated Thermocouple Cables</b>													
Type		K (NiCr-Ni)		J (Fe-CuNi)		L (Fe-CuNi)		E (NiCr-CuNi)		N (NiCrSi-NiSi)		T (Cu-CuNi)	
Sheath material	Ø mm	1 TP	2 TP	1 TP	2 TP	1 TP	2 TP	1 TP	2 TP	1 TP	2 TP	1 TP	2 TP
<b>1.4301 AISI 304</b>	3.0								7963328				
	4.5		7963404										
	6.0	7963532	7963441						7963359				
<b>1.4306 AISI 304 L</b>	4.5		7963502										
<b>1.4404 AISI 316 L</b>	1.5	7963424											
	2.0	7963416											
	3.2	7963473											
	6.0	7963425	7963426										
<b>1.4541 AISI 321</b>	1.0			7961457		7963301		7960340				7963371	
	1.5	<b>7960336</b>		<b>7960376</b>								7963304	
	2.0			<b>7960377</b>	7960384	7963321							
	2.4	7963341											
	3.0	<b>7960351</b>	<b>7960352</b>	<b>7960379</b>	7960385	<b>7960347</b>	7960348	7960391				7960388	
	4.0			<b>7960383</b>		7960360							
	4.5	<b>7960353</b>	7961453	7961460	7963347	7963349	7963348	7963498	7963499			7963346	
	4.8	7963526											
	6.0	<b>7960354</b>	7960355	<b>7960381</b>	<b>7960387</b>	<b>7960349</b>	7960350	7963360	7963450			<b>7960390</b>	7963517
	6.35								7963403				
	9.5				7963475								
<b>1.4571 AISI 316 TI</b>	1.0	<b>7960312</b>		<b>7963494</b>		<b>7960308</b>						<b>7963386</b>	
	1.5	7960313		<b>7963307</b>	7963524	<b>7960309</b>		7963306				7963308	
	1.6	<b>7961469</b>											
	2.0	<b>7963490</b>				7963449							
	3.0	<b>7960314</b>	<b>7960315</b>	7961458	7963525	7960310	7963330	7963331				7960389	
	3.2	<b>7960361</b>	7963535									7963461	
	4.5	7963467	7963351	7961461		7963353	7963352						
	4.8	7960372	7963438										
	6.0	7960316	<b>7960317</b>	<b>7960382</b>	7963436		7960311						7963365
	6.4	7960373	7963519										
	8.0	<b>7960318</b>	7963397										
<b>1.4749 AISI 449</b>	1.5	7963309									7963446		
	3.0	7963332									7963333		
	6.0	7963367	7963366							7963448	7963447		
	12.7	7963329											
Double sheath	12.7	<b>7963311</b>											
<b>1.4841 AISI 314</b>	1.0	<b>7960358</b>											
	1.5	<b>7960345</b>											
	2.0	7963410											
	3.0	<b>7960346</b>	<b>7960341</b>										
	4.0	7961452	<b>7960342</b>										
	4.5	7963355											
	6.0	<b>7960337</b>	7960356										
8.0	7963378												

**SensyMIC – Mineral Insulated Cables**

<b>Mineral Insulated Thermocouple Cables</b>													
Type		K (NiCr-Ni)		J (Fe-CuNi)		L (Fe-CuNi)		E (NiCr-CuNi)		N (NiCrSi-NiSi)		T (Cu-CuNi)	
Sheath material	Ø mm	1 TP	2 TP	1 TP	2 TP	1 TP	2 TP	1 TP	2 TP	1 TP	2 TP	1 TP	2 TP
<b>1.4845</b> <b>AISI 310 S</b>	3.0	<b>7960368</b>											
	4.5	7960369											
	6.0	<b>7960370</b>	7960371										
<b>1.4876</b> <b>Incoloy 800™</b>	1.5	7963310											
	1.8	7963316											
	3.0	<b>7960357</b>	7963413										
	4.5	7963395											
	6.0	<b>7960344</b>	7963368			<b>7963369</b>							
	8.0	7963379	7963419										
	9.5	7963523	7963444										
	10.0	7963382	7961454										
	12.0	7963383											
<b>1.4893</b>	3.0										7963442		
<b>2.4816</b> <b>Inconel 600™</b>	0.25	7963538											
	0.5	<b>7960325</b>											
	0.8	7963539											
	1.0	<b>7960326</b>		7963303		7960359				7963302			
	1.5	<b>7960327</b>	7960362	7960375	7963305	7960319	7963312			7960364			
	1.6	<b>7960338</b>		7963315									
	2.0	<b>7960339</b>	<b>7963325</b>	7963417			7963324						
	2.3	<b>7963396</b>											
	2.5	7963326											
	3.0	<b>7960328</b>	<b>7960329</b>	7960378	7961462	<b>7960320</b>	7963340	<b>7963431</b>	7963339	7960365	7963336		
	3.2	<b>7960343</b>	7963536							7963527			
	4.5	<b>7960330</b>	<b>7960331</b>	7961459	7963439	7960321	7960322			7960572	7963356		
	Double sheath	4.5	7963433										
	4.8	<b>7961455</b>											
	6.0	<b>7960332</b>	<b>7960333</b>	<b>7960380</b>	<b>7960386</b>	7960323	7960324	7963375	7960586	7960366	7963372		
	Double sheath	6.4	<b>7960363</b>	7960367									
	6.5	7963509	7963492										
7.8	7963455	7963456			7963377								
8.0	<b>7960334</b>	<b>7960335</b>	7963430		7963380				7963381				
9.0		7963334											
9.5	7963454	7963453											
<b>2.4951</b> <b>Nimonic 75™</b>	1.8	7963317											
	3.0	7963342											
	Double sheath	3.0	7963412										
	Double sheath	6.0	7963435										
	8.0	7963489											
10.0	7963443												

™ Trade mark of Inco Alloys

## SensyMIC – Mineral Insulated Cables

Mineral Insulated Cables					
Con-ductors	Ø mm	Material			
		1.4404	1.4541	1.4571	2.4816
2 x Cu	1.50		7963414		
	1.60		7963313	7963314	
	2.00		7963320		
	3.00		<b>7960400</b>	7961464	
	4.50			7963496	
	4.78	7963415		7963521	
	6.00		<b>7960401</b>	<b>7960395</b>	
3 x Cu	1.60			7963459	
	2.00		7963319		
	3.00				7963338
	4.78	7963471		<b>7961467</b>	
4 x Cu	1.00 S		7963506		
	1.30 S		7963507		
	2.00		7963318		
	2.80		7963389		
	3.00		<b>7960399</b>	<b>7960396</b>	7963337
	4.00		7963343	7963344	
	4.50	7963357	7963350	<b>7960404</b>	
	4.78	7963460		7961468	
	4.80		7963387		
	5.00		7963385	7963358	
	5.00 S		7963495		
	6.00		<b>7960402</b>	<b>7960397</b>	7963373
	6.00 S		7963364		
	6.40			7960588	
	8.00			7963451	
6 x Cu	4.50			7963409	
	4.80		7963388		
	5.00		7963508	7963502	
	6.00		<b>7960403</b>	7961465	
	6.00 S		7963491		
	8.00			7963362	

Mineral Insulated Cables					
Con-ductors	Ø mm	Material			
		1.4404	1.4541	1.4571	2.4816
8 x Cu	3.00			7963539	
	6.00		7963420		
3 x CuNi	6.00		7963402		
4 x CuNi	6.00		7963280		
6 x CuNi	6.00		7963281		
2 x Ni	3.00		7963354		
3 x Ni	2.40			7963411	
	3.00		7963501		
	4.50	7963466			
	6.00	7963408			
4 x Ni	3.20 S			7963398	
	3.50 S	7963445			
	4.50			7963695	
	4.80 S		7963694	7963399	
	6.00	7963465			
	6.40 S			7963400	
6 x Ni	8.00			7963401	
	6.00	7963423			
	2.50				7963327
2 x NiCr	3.00		7961463		
	6.00		7963361		
	2.00				7963323
4 x NiCr	3.00		7960392	7963468	
	4.50		7963345		
	6.00		7960393	7963469	
	6.00 S		<b>7961466</b>		
	6.00		<b>7960394</b>	7963470	
6 x NiCr	8.00		7963457		
	6.00		7960398		
8 x NiCr	6.00		7960398		
2 x 2.4816	6.00				7963374

S = Special manufacture

**SensyMIC – Mineral Insulated Cables**

**Mineral Insulated Thermocouple Cables with Precious Metal Thermocouples**

Precious metal thermocouples are exceptionally suited for high-temperature applications under oxidizing conditions. They are used in chemical plants when absolute resistance to all kinds of acids is required.

Resistance of Precious Metal Mineral Insulated Thermocouples in different Atmospheres									
Sheath material	Thermo-couple	Max. operating temperature	Oxygen	Nitrogen	Hydrogen	Carbon	Chlorine	Sulphur	Class of tolerance
2.4816	Type S	1100 °C *	good	good	good	good	good	conditional	2
	Type R	1100 °C *	good	good	good	good	good	conditional	2
	Type B	1100 °C *	good	good	good	good	good	conditional	3
Pt10%Rh	Type S	1300 °C *	good	good	conditional	conditional	conditional	conditional	2
	Type R	1300 °C *	good	good	conditional	conditional	conditional	conditional	2
	Type B	1300 °C *	good	good	conditional	conditional	conditional	conditional	3

\* Because of the drift behaviour at high temperatures, the recommended maximum temperature is 900 °C.

**Application**

When using precious metal thermocouples, it is necessary to be aware that the insulation resistance of the insulation ceramics used decreases very much at high temperatures (over 1000 °C). If big lengths of the sheath material are exposed to high temperatures, measuring errors can occur as a result of a mean value being taken over the installation length.

Mineral insulated cables with a Pt10%Rh sheath are available in type S with diameter 1.5 mm and 3.0 mm and in type R in 1.6 mm ex stock.

Product nos.		
S 1.5	Pt10%Rh	7960445
S 3.0	Pt10%Rh	7960446
R 1.6	Pt10%Rh	7960459

**Standard Type**

The standard mineral insulated cables have a 2.4816 sheath with diameter 1.5 mm and 3.0 mm in type S and diameter 1.6 mm and 3.2 mm in type R.

Product nos.		
S 1.5	2.4816	7960435
S 3.0	2.4816	7960436
R 1.6	2.4816	7960456
R 3.2	2.4816	7960463

**Special Manufacture**

Special manufactures are always possible in other dimensions on request. Sheath materials with other PtRh - alloys can be supplied.

The minimum production length is 1.5 m. The following table provides an overview of the maximum production lengths of the most popular dimensions. Bigger lengths are possible in special cases on request.

Maximum Production Lengths											
Sheath	TP	Ø 1.0 mm	Ø 1.5 mm	Ø 1.6 mm	Ø 2.0 mm	Ø 3.0 mm	Ø 3.2 mm	Ø 4.5 mm	Ø 4.8 mm	Ø 6.0 mm	Ø 6.4 mm
Pt10%Rh	1 × S	20 m	20 m	18 m	9 m	6 m	5 m	6 m	5 m	3 m	
	2 × S	20 m	20 m	18 m	9 m	6 m	5 m	6 m	5 m	3 m	
	1 × R	20 m	20 m	18 m	9 m	6 m	5 m	6 m	5 m	3 m	
	2 × R	20 m	20 m	18 m	9 m	6 m	5 m	6 m	5 m	3 m	
2.4816	1 × S	35 m	310 m	265 m	155 m	90 m	80 m	18 m	7 m	10 m	8.5 m
	2 × S		14 m	265 m	155 m	90 m	80 m	18 m	7 m	10 m	8.5 m
	1 × R	35 m	14 m	265 m	155 m	90 m	80 m	18 m	7 m	10 m	8.5 m
	2 × R		14 m	265 m	155 m	90 m	80 m	18 m	7 m	10 m	8.5 m



**SensyHeat – Heaters****SensyHeat**

SensyHeat Mineral Insulated Heating Cable is an electrical metal sheath heating cable with high economic efficiency (specific heating capacity up to 300 W/m). It is the most rugged and durable type of heating cable. Mineral Insulated Heating Cable is applicable for operation in high temperatures and explosion-proof areas. It can have a very high watt output and is used for process heating applications at temperatures where plastics insulated heating cables are not suitable. When properly installed, it has a very high lifetime.

Mineral Insulated Heaters are applicable in the following industries:

Machinery, power generating industry, chemical and petrochemical industry as well as research and development.

Resistance Wire	Sheath Material	Operating Temperature up to
NiCr alloy	2.4816 (Inconel)	800 °C
CuNi alloy	1.4541 (AISI 321)	500 °C

<b>Technical Data – Standard program</b>				
<b>Conductors NiCr 8020, applicable for temperatures up to 800 °C</b>				
Outer Ø mm	Resistance at 20 °C Ω/m	Conductor Ø mm	Wall thickness mm	Length m
3.2	10.00	0.38	0.34	100
3.2	6.30	0.48	0.34	360
3.2	4.00	0.61	0.34	360
3.6	2.50	0.77	0.38	270
3.8	1.60	0.96	0.40	240
4.1	1.00	1.21	0.43	200
4.5	0.63	1.52	0.48	170
5.0	0.40	1.91	0.53	140
5.6	0.25	2.42	0.59	110
6.5	0.16	3.03	0.69	80
<b>Conductors CuNi, applicable for temperatures up to 500 °C</b>				
3.5	1.3	0.70	0.37	280
3.7	0.8	0.88	0.39	250
4.0	0.5	1.12	0.42	220
4.4	0.3	1.44	0.47	180
4.9	0.2	1.77	0.52	150
5.8	0.1	2.50	0.61	100

Tolerance for the resistance per m: ± 10 %  
Tolerance for the outer diameter: according to DIN EN 61515

In order to assure a sufficient electrical strength between conductor and sheath, the insulation thickness is specified with 1.0 mm for all types of the standard program.