



OPTITEMP TRA/TCA Handbook

Industrial thermometers with replaceable measuring inserts.

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1.1 Intended use

**CAUTION!**

Responsibility for the use of the measurement devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.

**INFORMATION!**

The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.

The OPTITEMP thermometer is used to measure the temperature of gases, liquids, vapour and solids in industrial applications. The devices are particularly suited to the measurement of

- liquids with low viscosity,
- water and chemicals with low corrosiveness,
- saturated steam and superheated steam.

1.2 Approvals and certifications

1.2.1 CE

Article 1, section 2.1.4 of the Pressure Equipment Directive 97/23/EC does not apply to the OPTITEMP thermometer. For this reason, neither a conformity assessment nor a CE marking is possible. The EC directives applicable to temperature transmitters are contained in the corresponding transmitter documentation.

1.2.2 ATEX

ATEX approval for the OPTITEMP thermometer is pending. As soon as this is available, you have the option of ordering Ex-approval according to ATEX. The relevant Ex handbook contains more detailed information.

1.3 Safety instructions from the manufacturer

1.3.1 Copyright and data protection

The contents of this document have been created with great care. Nevertheless, we provide no guarantee that the contents are correct, complete or up-to-date.

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We draw your attention to the fact that data transmission over the Internet (e.g. when communicating by e-mail) may involve gaps in security. It is not possible to protect such data completely against access by third parties.

We hereby expressly prohibit the use of the contact data published as part of our duty to publish an imprint for the purpose of sending us any advertising or informational materials that we have not expressly requested.

1.3.2 Disclaimer

The manufacturer will not be liable for any damage of any kind by using its product, including, but not limited to direct, indirect, incidental, punitive and consequential damages.

This disclaimer does not apply in case the manufacturer has acted on purpose or with gross negligence. In the event any applicable law does not allow such limitations on implied warranties or the exclusion of limitation of certain damages, you may, if such law applies to you, not be subject to some or all of the above disclaimer, exclusions or limitations.

Any product purchased from the manufacturer is warranted in accordance with the relevant product documentation and our Terms and Conditions of Sale.

The manufacturer reserves the right to alter the content of its documents, including this disclaimer in any way, at any time, for any reason, without prior notification, and will not be liable in any way for possible consequences of such changes.

1.3.3 Product liability and warranty

The operator shall bear responsibility for the suitability of the device for the specific purpose. The manufacturer accepts no liability for the consequences of misuse by the operator. Improper installation and operation of the devices (systems) will cause the warranty to be void. The respective "Standard Terms and Conditions" which form the basis for the sales contract shall also apply.

1.3.4 Information concerning the documentation

To prevent any injury to the user or damage to the device it is essential that you read the information in this document and observe applicable national standards, safety requirements and accident prevention regulations.

If this document is not in your native language and if you have any problems understanding the text, we advise you to contact your local office for assistance. The manufacturer can not accept responsibility for any damage or injury caused by misunderstanding of the information in this document.

This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device. Special considerations and precautions are also described in the document, which appear in the form of underneath icons.

1.3.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.



DANGER!

This information refers to the immediate danger when working with electricity.



DANGER!

This warning refers to the immediate danger of burns caused by heat or hot surfaces.



DANGER!

This warning refers to the immediate danger when using this device in a hazardous atmosphere.



DANGER!

These warnings must be observed without fail. Even partial disregard of this warning can lead to serious health problems and even death. There is also the risk of seriously damaging the device or parts of the operator's plant.



WARNING!

Disregarding this safety warning, even if only in part, poses the risk of serious health problems. There is also the risk of damaging the device or parts of the operator's plant.



CAUTION!

Disregarding these instructions can result in damage to the device or to parts of the operator's plant.



INFORMATION!

These instructions contain important information for the handling of the device.



LEGAL NOTICE!

This note contains information on statutory directives and standards.



• **HANDLING**

This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.

➔ **RESULT**

This symbol refers to all important consequences of the previous actions.

1.4 Safety instructions for the operator



WARNING!

*In general, devices from the manufacturer may only be installed, commissioned, operated and maintained by properly trained and authorized personnel.
This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device.*

2.1 Scope of delivery

The manufacturer delivers all industrial thermometers with the relevant technical documentation. The documentation for the temperature transmitter always contains Ex-relevant information (Hb. = handbook):

Scope of order	Hb. for thermometers	Ex-hb. for thermometers	Hb. for measuring inserts	Ex-hb. for measuring inserts	Hb. for transmitters
Thermometer without transmitter	X	-	X	-	-
Thermometer with transmitter	X	-	X	-	X
Ex-thermometer without transmitter	X	X	X	X	-
Ex-thermometer with transmitter	X	X	X	X	X

2.2 Device description

2.2.1 Design of industrial thermometers



INFORMATION!

In this documentation, the term "industrial thermometer" refers to all thermometer assemblies featuring multipart, welded thermowells.

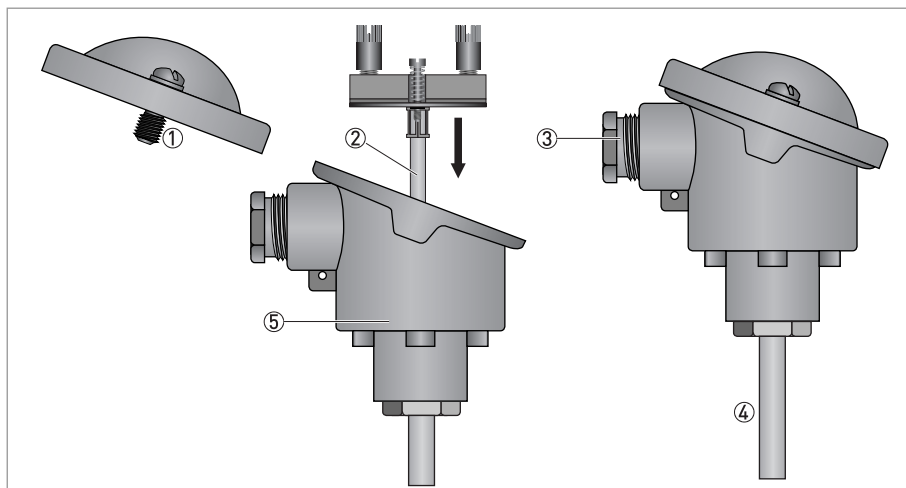


Figure 2-1: Design of an industrial thermometer

- ① Connection head cover
- ② Measuring insert
- ③ Cable entry
- ④ Thermowell
- ⑤ Connection head

OPTITEMP thermometers consist of a thermowell with a process connection and a connection head. There are versions in which the connection head and the thermowell are thermally decoupled by way of a neck tube.

All of the manufacturer's thermowells and neck tubes feature an M24 x 1.5 thread to screw into the connection head. This connection head thread makes it possible to align the connection head so that the cable entry point always faces the desired direction (during assembly, the connection head is aligned first before screwing in the thread using the hex nut).

The thermowell contains either a measuring insert with a resistance thermometer (OPTITEMP TR 100) or with a thermocouple (OPTITEMP TC 100). Both measuring inserts are available in three different versions and the manufacturer also offers three different thermowell tips.

2.2.2 Types of connection heads

Connection heads protect the terminals and the temperature transmitter from environmental influences (e. g. dirt and dust). They have an M20 x 1.5 thread at the cable entry. The covers feature oil-resistant rubber seals (can be used up to 100°C ambient temperature). The connection heads are available in the following materials:

- Die-cast aluminium for standard applications (Types: BA, BUZ-T/S/H/HW, BGK and AXD)
- Stainless steel (type BVA), especially for the pharmaceutical and food and beverage industries
- Plastic (type BBK)

Type "BUZ-HW" is the only connection head with a display, type "AXD" is in an explosion-proof enclosure.

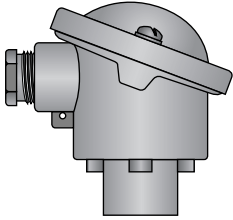


INFORMATION!

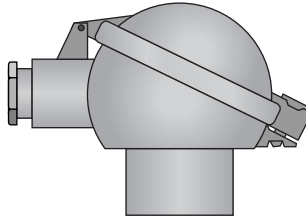
The inside dimensions of the connection heads depicted here comply with DIN 43735-2.

Connection heads available

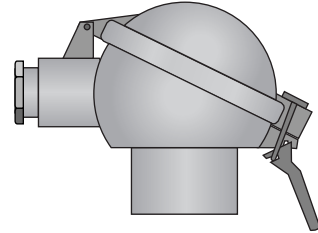
BA (aluminium, IP65)



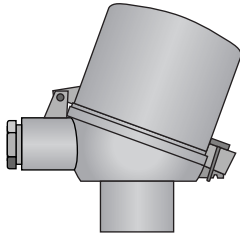
BUZ-T (aluminium, IP65)



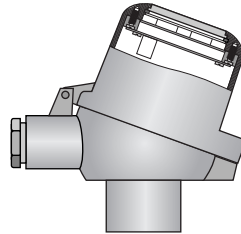
BUZ-S (aluminium, IP65)



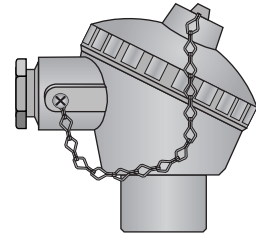
BUZ-H (aluminium, IP65)



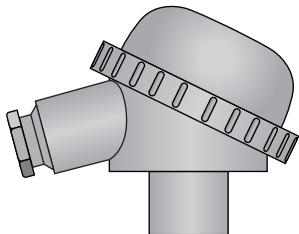
BUZ-HW (aluminium, IP65)



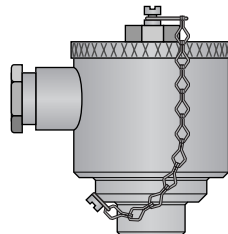
BGK (aluminium, IP67)



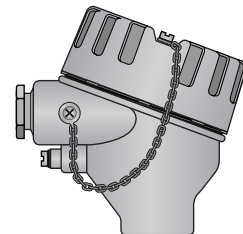
BBK (PA, IP54)



BVA (VA, IP65)



AXD (aluminium, IP68)

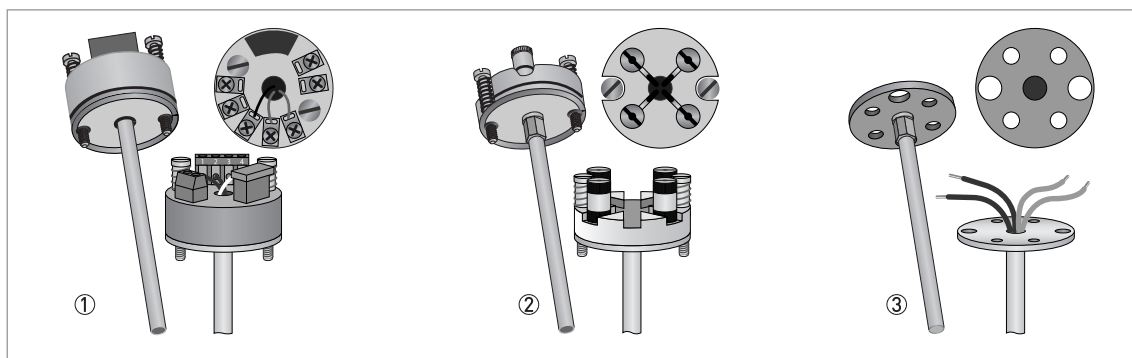


2.2.3 Types of measuring inserts and measuring insert lengths

**INFORMATION!**

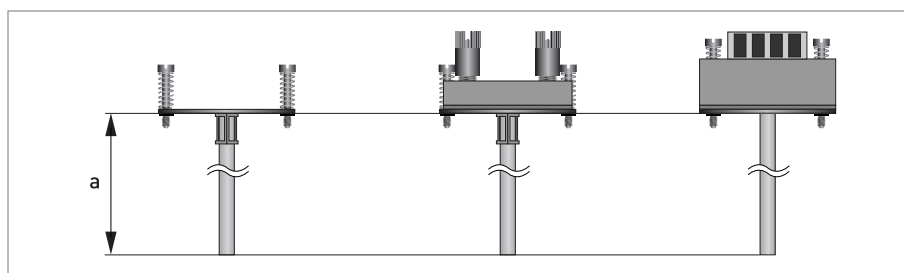
The versions, dimensions and other construction features of the measuring inserts are standardised in DIN 43735-1.

The replaceable measuring insert contains the temperature sensor, which may be either a Pt100 RTD or a thermocouple. The measuring insert is pushed through the open connection head into the thermometer assembly and attached using two spring loaded M4 screws (this guarantees that the tip of the measuring insert is in constant contact with the bottom of the thermowell). The following versions of measuring insert are available:



- ① Measuring insert with head-mounted temperature transmitter
- ② Measuring insert with ceramic terminal block
- ③ Measuring insert with flying wires

One distinguishing dimension of the measuring insert is its length. The length is measured from the bottom edge of the base to the tip of the immersion tube ("a" in the drawing below):



The selection of the right measuring insert depends on the conditions of use:

- A measuring insert with a thermocouple is better suited to heavy thermal or mechanical loads.
- When increased accuracy is required, a measuring insert with a resistance thermometer is better suited for temperatures up to +500°C / 932°F and in exceptional cases up to +600°C / 1112°F.



INFORMATION!

Consult the handbook "OPTITEMP TR/TC 100" for more detailed information on the measuring inserts.

2.2.4 Types of temperature transmitters

Electrical thermometers have just one, weak, interference-prone output signal. If this signal has to travel a great distance or if a standard signal of 4...20 mA is required, use of a temperature transmitter is recommended:



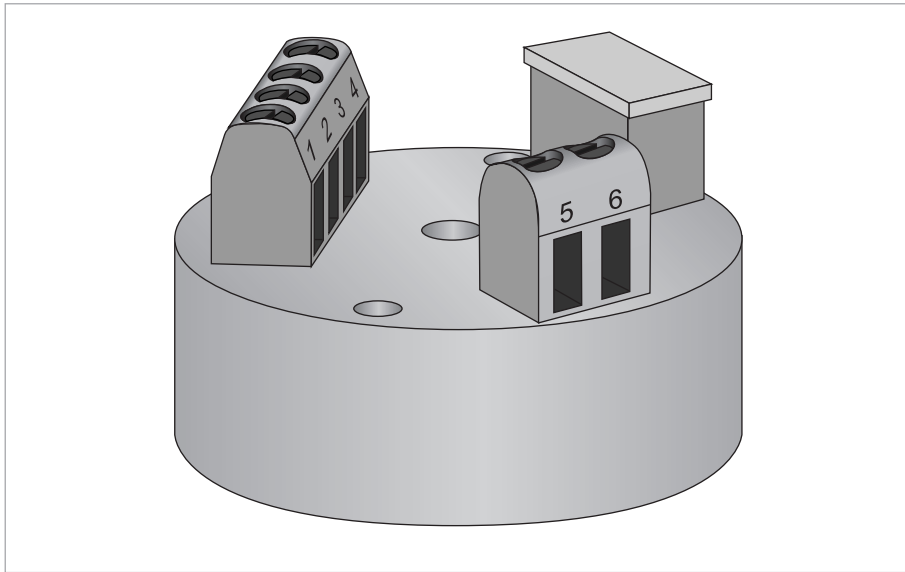
INFORMATION!

The manufacturer cannot make any general statement as to the distance from which the use of a temperature transmitter is necessary as it depends on the specific interference associated with the installation site. You, the customer, decide whether it is necessary.

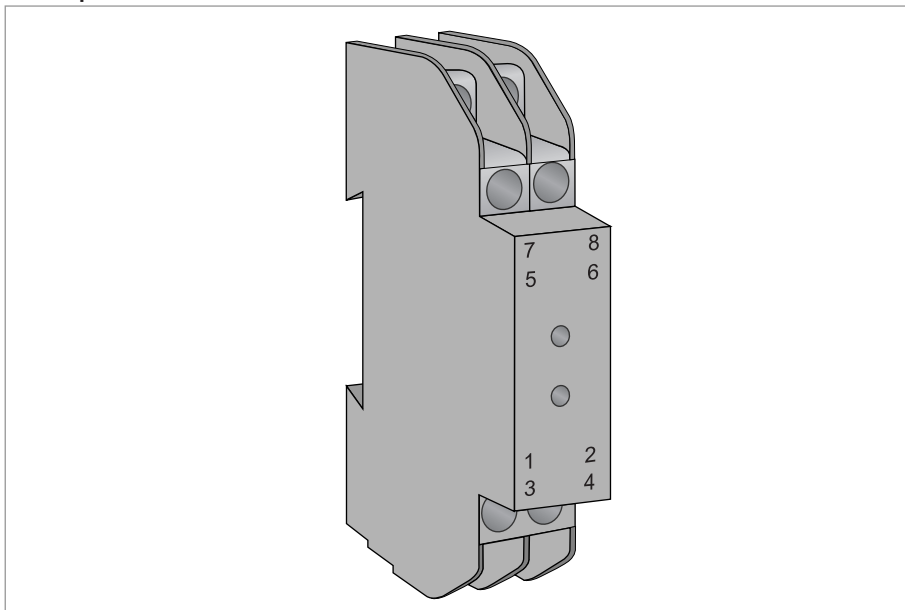
There are two types of temperature transmitters:

- Head-mounted transmitter: Located on the measuring insert and thus in the connection head of the industrial thermometer during operation, recognisable by the "C" in the product name (e. g. TT 10 C).
- Rail-mounted transmitter: Located in the switch cabinet or field housing, recognisable by the "R" in the product name (e. g. TT 11 R); they are usually used when the temperature in the connection head does not allow for the use of a head-mounted transmitter.

Example of a head-mounted transmitter



Example of a rail-mounted transmitter



Head-mounted and rail-mounted transmitters both convert the temperature sensor's small signal into a standardised output signal of 4...20 mA, not susceptible to interference, or into a digital signal. The output signal depends on the type of temperature transmitter, the manufacturer currently offers three different technologies:

- Two-wire technology with 4...20 mA
- HART®
- Profibus-PA

You can parameterise almost any temperature transmitter using a PC and a computer program. The only exceptions are the TT 10 C/R and TT 11 C/R versions, whose measuring ranges must be set using solder bridges. The manufacturer offers the following temperature transmitters:

Available in both head-mounted and rail-mounted version	Only available in rail-mounted version
TT 10 C/R (analogue, standard)	TT 31 R (one or two-channel)
TT 11 C/R (analogue, 3-wire circuit)	TT 32 R
TT 20 C/R (analogue)	
TT 30 C/R (digital, standard)	
TT 40 C/R (digital, precise)	
TT 50 C/R (digital, HART®)	
TT 51 C/R (digital, HART®, SIL2)	
TT 60 C/R (digital, Profibus-PA)	



INFORMATION!

Consult the relevant transmitter handbook for more detailed information on the temperature transmitters.

2.2.5 Neck tubes

The neck tube connects the process connection (i.e. screw socket or flange) to the connection head. Its function is to thermally decouple the connection head so that it and any existing temperature transmitter do not heat up too much. See below for an example of a neck tube:

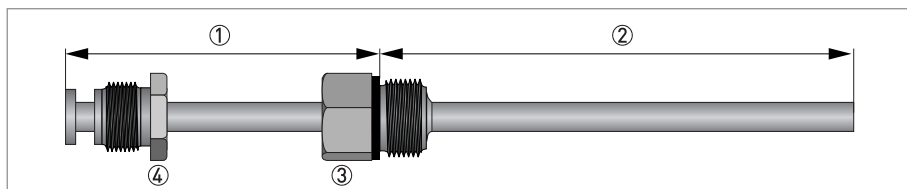


Figure 2-2: Neck tube

- ① Neck tube
- ② Thermowell
- ③ Process connection (here with G½" thread)
- ④ Connection head thread M24 x 1.5

The materials, diameter and wall thickness of the neck tube and the thermowell are identical. The standard length of a neck tube is 145 mm / 5.7" (with screw-in thread as process connection) or 80 mm / 3.1" (with flange as process connection). The manufacturer can provide other neck tube lengths on request.

2.2.6 Thermowells and thermowell tips

The thermowell is designed to prevent external loads (e. g. static pressure, flowing and aggressive media) from damaging the measuring insert. As a rule, thermowells are made of the same material as the system in which the measuring is done. In terms of the material and design, we can distinguish between two types of thermowells:

- Multipart, welded thermowells
- One-piece bar stock thermowells

This handbook deals with thermometers with multipart, welded thermowells. The "Industrial thermometers for increased requirements" handbook contains information about industrial thermometers with bar stock thermowells.

**INFORMATION!**

The manufacturer checks all of the thermowells for leaks. An optional certified pressure test is available for a fee.

The tip of the thermowell comes in three different shapes, however the tapered tip is not available on the threaded thermometer without neck tube (to see what the thermowell tips look like, refer to the control drawing in the "Technical Data" section):

- Straight thermowell tip (standard), available in 9 mm / 0.35", 11 mm / 0.43" and 12 mm / 0.47" diameters.
- Reduced thermowell tip to reduce response time, available in 11 mm / 0.43" and 12 mm / 0.47" diameters.
- Tapered thermowell tip to reduce response time (similar to Form 3 as per DIN 43772, previous NAMUR variant), available in 12 mm / 0.47" diameter.

**INFORMATION!**

Both the reduced and the tapered tip feature a shorter response time than a straight thermowell. However, compared to the reduced tip, the tapered tip withstands higher pressures and offers maximum resistance to vibration.

Thermowells with reduced tips require a measuring insert with a diameter of 3 mm / 0.12". Both of the versions with a straight thermowell and tapered tip require a measuring insert with a diameter of 6 mm / 0.24".

2.3 Process connections and areas of application

2.3.1 Insertion type thermometer (with and without thermowell)

Insertion-type thermometers are suitable for applications that do not have high pressure or high flow velocities. Their use is particularly recommended in variable configurations or for the measurement of air and flue gas temperatures.

In the version without a thermowell, the measuring insert immersion tube is in direct contact with the medium being measured. This allows the thermometer to react more quickly to changes in temperature. This feature is especially important when measuring gas temperatures and temperatures of very slow flowing media.

For reasons of stability, the manufacturer offers only one measuring insert with an immersion tube diameter of 6 mm / 0.24" for the insertion-type thermometer without thermowell.

2.3.2 Threaded thermometer

Threaded thermometers without neck tubes are particularly suited to the mid temperature range (up to +250°C / +482°F) in industrial applications. They are recommended for general measuring tasks in chemical process technology and in engineering where the most common process adaptation is screwing into pipelines and tanks.

For higher process temperatures (from +250°C / +482°F), threaded thermometers with neck tubes are recommended. The neck tube increases the distance between the process connection and the connection head so that the latter does not overheat. It also makes it possible to install connection heads outside of the insulation of pipelines and tanks.

For threaded thermometers with and without neck tubes, the manufacturer offers three different thermowell tips (straight thermowell, tapered tip, reduced tip). The tapered tip version is, however, only available with a neck tube. G or NPT thread variants are available.

2.3.3 Flange thermometer

All of the flange thermometers available from the manufacturer feature a neck tube (to thermally decouple the process connection and the connection head). They are used in the upper temperature range in industrial applications (up to +600°C / +1112°F). They are particularly suited to tanks, especially ones coated on the inside.

According to the requirements for chemical resistance, the manufacturer can coat the flange thermometer with Teflon, PTFE or a customer-specific material as an option. Both DIN and ASME flanges are available. The surface roughness of the flange sealing surface is 3.2...12.5 µm (DIN EN flange) or 3.2...6.3 µm (ASME flange).

Customers can choose from three different thermowell tips (straight thermowell, tapered tip, reduced tip) for flange thermometers too. The manufacturer offers flanges in compliance with DIN or ASME standards.

2.4 Overview of available versions

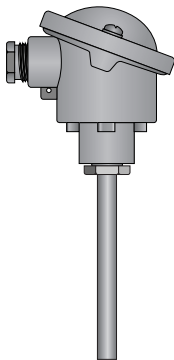


INFORMATION!

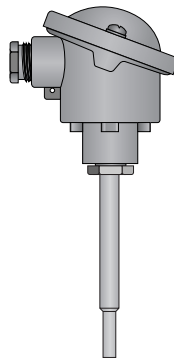
The beginning of the product name refers to the type of sensor in the measuring insert:

- TRA: Thermometer with Pt100 RTD
- TCA: Thermometer with thermocouple

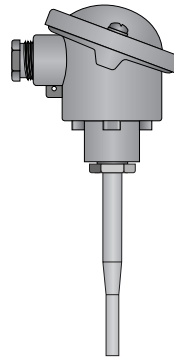
TRA-P10 / TCA-P10



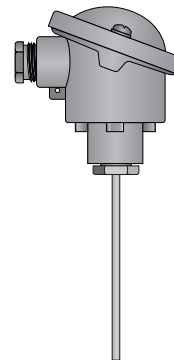
TRA-P20 / TCA-P20



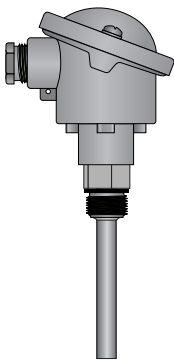
TRA-P40 / TCA-P40



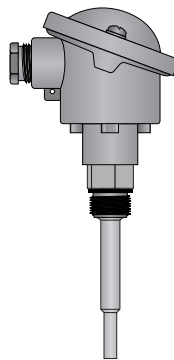
TRA-P14 / TCA-P14



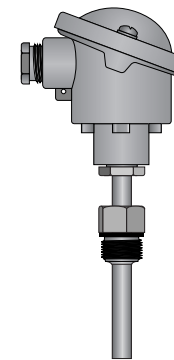
TRA-S11 / TCA-S11



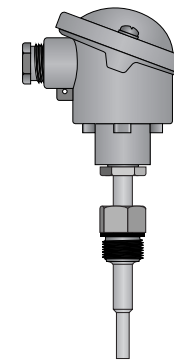
TRA-S21 / TCA-S21



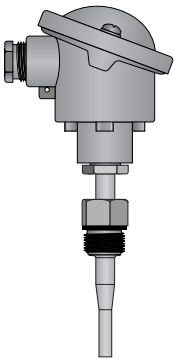
TRA-S12 / TCA-S12



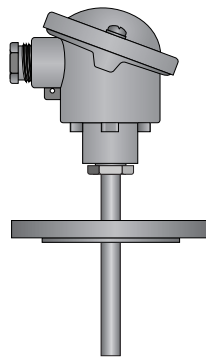
TRA-S22 / TCA-S22



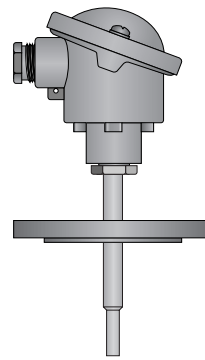
TRA-S41 / TCA-S41



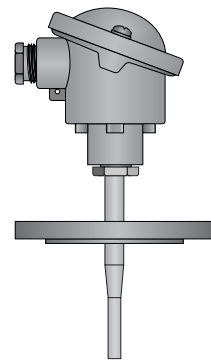
TRA-F13 / TCA-F13



TRA-F23 / TCA-F23



TRA-F42 / TCA-F42



2.5 Nameplate



INFORMATION!

Look at the device nameplate to ensure that the device is delivered according to your order.

The nameplate on an OPTITEMP thermometer is located on the connection head, it measures 70 mm x 18 mm / 2.76 x 0.71":

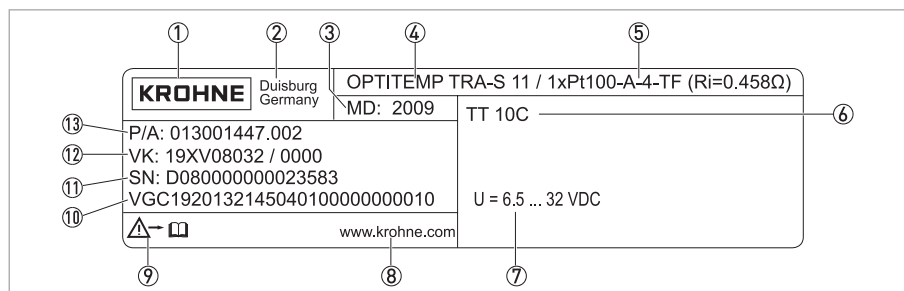


Figure 2-3: Sample nameplate (measuring insert with Pt100 RTD)

- ① Manufacturer
- ② Production site
- ③ Manufacturing year
- ④ Type of thermometer
- ⑤ Measuring insert specification
- ⑥ Type of temperature transmitter
- ⑦ Allowable voltage range of power supply
- ⑧ Manufacturer's website
- ⑨ Note that the handbook is available for download from the manufacturer's website.
- ⑩ Type code (consists of 30 characters)
- ⑪ Individual serial number
- ⑫ VK number
- ⑬ Production order number



INFORMATION!

For a customer-specific TAG No., the manufacturer can print out a separate label if required.

If the thermometer has a transmitter or an Ex approval, this information is found on the right side of the nameplate.

3.1 Notes on installation

**INFORMATION!**

Inspect the cartons carefully for damage or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

**INFORMATION!**

Check the packing list to check if you received completely all that you ordered.

**INFORMATION!**

Look at the device nameplate to ensure that the device is delivered according to your order.

3.2 Storage

**CAUTION!**

Store industrial thermometers in a dry place protected from dust. The permissible range for storage temperatures is $-40...+70^{\circ}\text{C}$ / $-40...+176^{\circ}\text{F}$.

3.3 Transport

**CAUTION!**

Always transport industrial thermometers in their original packaging. Do not expose the devices to moisture or vibration during transport. The information that applies to storage also applies to transport.

3.4 Proper installation

**DANGER!**

For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.

**CAUTION!**

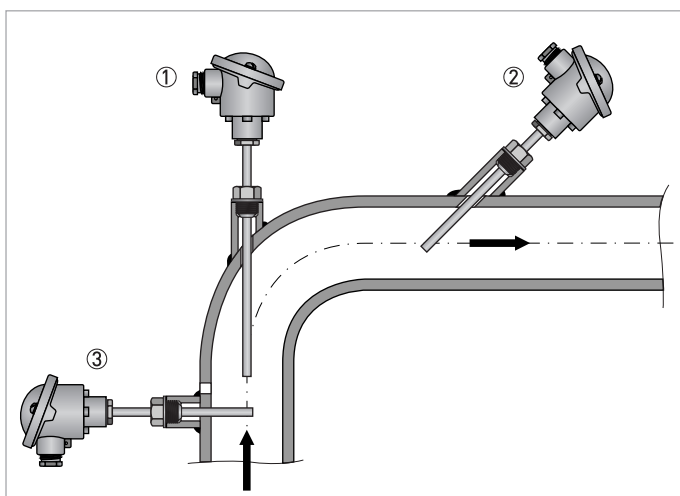
Ensure that you have taken the following points into consideration prior to installing the thermometer:

- *The dimensions of the thermowell (length, diameter, wall thickness, type of tip) comply with the requirements of the measuring point. The mechanical load as a result of flowing media, vibration and resonances is the focus here. In addition, incorrect dimensions can lead to measurement errors.*
- *The thermowell is sufficiently resistant to chemically aggressive media (refer to the generally accessible corrosion tables). Otherwise, corrosion may occur or the medium may penetrate into the thermowell. When in doubt, select a thermowell made from the same material as your system.*

Installation site, angle and length

These three parameters depend upon the space available and the diameter of the pipe. The manufacturer generally recommends three possible installation scenarios in pipes with flowing media:

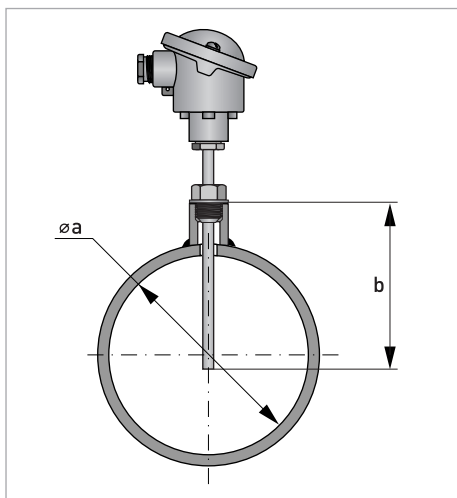
- Small pipe diameter: Installation directly against the direction of flow in a bend in the pipe (①).
- Small pipe diameter: Installation diagonally against the direction of flow, if a bend in the pipe is available (②).
- Large pipe diameter: Vertical installation, if flow-induced periodic vortex shedding does not cause the thermometer to vibrate in its resonance frequency (③).



Insertion length of the thermowell or measuring insert

The "insertion length" of the thermowell or measuring insert refers to the distance from the seal of the process connection (for G threads), two-thirds of the thread height (for NPT threads) or the bottom of the flange (for flange thermometers) to the tip of the thermowell or immersion tube. This length determines how far the sensor projects into the measured medium. To avoid measurement errors, ensure that the insertion length ("b" in the drawing below) meets the following requirements:

- Insertion length = 10...15 x thermowell diameter, but at least 100 mm / 3.94" (shorter insertion lengths are possible but they impair measuring accuracy).
- Tubes with $\varnothing < 300$ mm / 11.8": thermowell tip should project past the middle of the pipe if possible.



INFORMATION!

For more information on the maximum insertion length, please refer to the subsection "Typical load types".

Other installation requirements

- A well-insulated pipeline or tank around the measuring point reduces thermal dissipation and the distorting influence of the ambient temperature.
- To avoid measurement errors caused by poor thermal dissipation, the measuring insert must always be in contact with the bottom of the thermowell (this is normally guaranteed by the spring-loaded version of the measuring insert).
- Choosing the right seal for the process connection depends on the process conditions; the manufacturer can thus only give the general recommendation that the seal must comply with the individual requirements of the measuring point (e.g. pressure, temperature, chemically aggressive media).

**WARNING!**

When a seal is damaged or incorrect, the medium may leak out, causing material damage or bodily harm! The sole responsibility of selecting the right seal lies with you, the operator.

3.5 Load limits

The load limits of industrial thermometers depend on several factors:

- Dimensions and design of the thermowell (especially the insertion length and diameter)
- Thermowell material
- Mechanical conditions the thermowell is subject to due to the measured medium (pressure, temperature, flow velocity, viscosity, density)
- Sealable pressure of the process connection
- Vibration load

**INFORMATION!**

The "sealable pressure" is the maximum pressure the process connection can seal against.

The sheer number of factors at play illustrates the difficulty in making universally valid statements about the load limits. The diagrams in the next subsection serve as an initial assessment.

3.5.1 Typical load types



DANGER!

To prevent destruction or damage, never operate the thermometer outside of its permissible mechanical, thermal or chemical limits. For further information refer to the rest of this section and the "Technical Data" section.



DANGER!

The information in this subsection is informative only and does not reflect the vibration load caused by flow-induced vibration. If necessary, prior to purchasing and installing an industrial thermometer, have a specific strength calculation performed (e. g. per DITTRICH or MURDOCK).



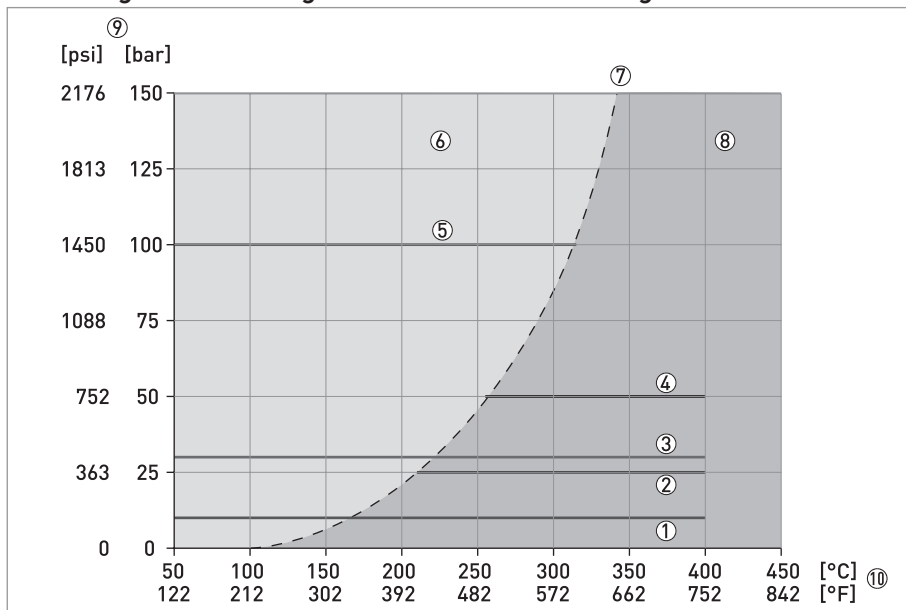
INFORMATION!

The manufacturer can provide an optional strength calculation for a fee.

The first diagram applies to the following of the manufacturer's thermometers:

- TRA/TCA-P10, -S11, -F13
- Ø 11 x 2 mm / 0.43 x 0.08"
- Material 1.4571

Load diagram for straight thermowells according to DIN 43772 (Forms 2, 2G and 2F)

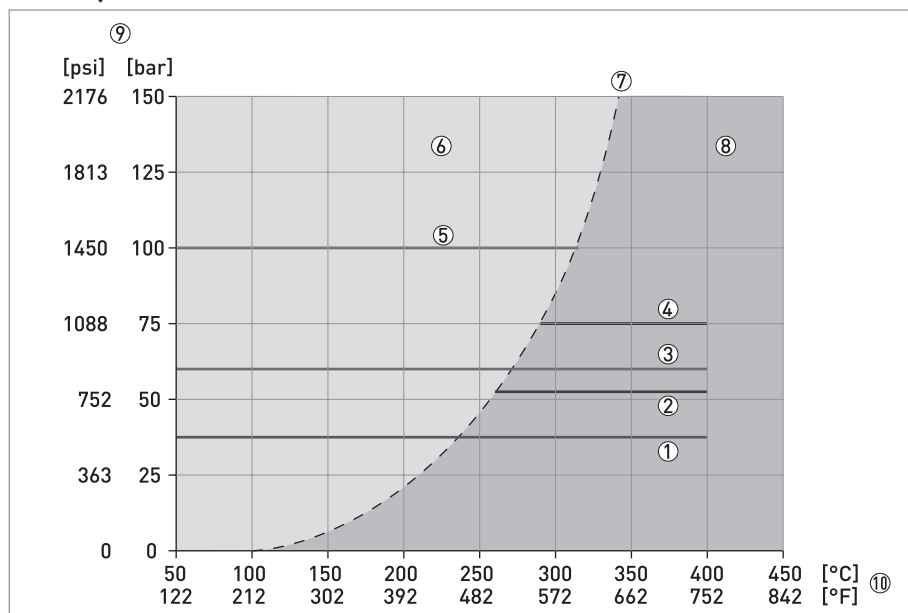


- ① Insertion length 400 mm (15.75"), air with 40 m/s (131.2 ft/s)
- ② Insertion length 400 mm (15.75"), steam with 40 m/s (131.2 ft/s)
- ③ Insertion length 250 mm (9.84"), air with 40 m/s (131.2 ft/s)
- ④ Insertion length 250 mm (9.84"), steam with 40 m/s (131.2 ft/s)
- ⑤ Insertion length 250...400 mm (9.84...15.75"), water with 3 m/s (9.8 ft/s)
- ⑥ Water
- ⑦ Vapour pressure curve
- ⑧ Steam
- ⑨ Pressure of the measured medium
- ⑩ Temperature of the measured medium

The second diagram applies to the following of the manufacturer's thermometers:

- TRA/TCA-P40, -S41, -F42
- Ø 12 x 2.5 mm / 0.47 x 0.1"
- Material 1.4571

Load diagram for thermowells with tapered tip according to DIN 43772 (Forms 3, 3G and 3F)



- ① Insertion length 280 mm (11.02"), air with 40 m/s (131.2 ft/s)
- ② Insertion length 280 mm (11.02"), steam with 40 m/s (131.2 ft/s)
- ③ Insertion length 220 mm (8.66"), air with 40 m/s (131.2 ft/s)
- ④ Insertion length 220 mm (8.66"), steam with 40 m/s (131.2 ft/s)
- ⑤ Insertion length 220...280 mm (8.66...11.02"), water with 3 m/s (9.8 ft/s)
- ⑥ Water
- ⑦ Vapour pressure curve
- ⑧ Steam
- ⑨ Pressure of the measured medium
- ⑩ Temperature of the measured medium

3.5.2 Vibration load



CAUTION!

Permanently operating the thermowell in its natural resonance can quickly damage or destroy the thermometer! So, prior to installation, ensure that this does not happen and select a thermowell with a different length, diameter or material if necessary.

All thermometers that feature a thermowell and neck tube and are attached to the process connection have two components that can vibrate: the thermowell and the connection head with the neck tube. That is why the terms "thermowell resonance" and "head resonance" are commonly heard.

A thermowell surrounded by the measured medium is a body behind which vortices periodically are released ("Kármán vortex street"). If the frequency of the vortex detachment is equal to the resonance frequency of the thermowell, it starts to vibrate. If this happens for a short period of time, such as when starting up the system and the frequency of the vortex detachment passes through the resonance range of the thermowell, no damage is caused. The opposite is true, however, if the vibrations remain permanently in the resonance range.

3.5.3 Temperature load

The temperature of the measured medium and the thermal dissipation via thermowell and neck tube also cause the connection head to heat up. After some time, the interior of the connection head and any existing head-mounted transmitter heat up to the temperature of the housing. This occurs in thermometers with and without neck tubes. A neck tube, however, causes thermal decoupling and can prevent the connection head or temperature transmitter from overheating at high process temperatures.



CAUTION!

When the temperature is too high, the connection head and the components found in it (e. g. temperature transmitter or display) can be damaged or destroyed! It is your responsibility as the operator to ensure that the connection head does not get too hot. If this does happen, select another installation site or a thermometer with a neck tube or, with insertion-type thermometers, increase the distance between the connection head and the process connection.



CAUTION!

Sometimes even a neck tube cannot prevent the maximum permissible temperature in the connection head from being exceeded! The connection head on thermometers without a neck tube heats up faster than thermometers with neck tubes but you still must always take into consideration the installation situation as well as the ambient and process temperatures!

The following diagram will aid in the selection of the right neck tube length and shows how the process temperature and the neck tube length impact the temperature of the connection head:



CAUTION!

The diagram only shows the amount by which the temperature of the connection head increases. To determine the actual temperature of the connection head you must add the ambient temperature to it in a second step!

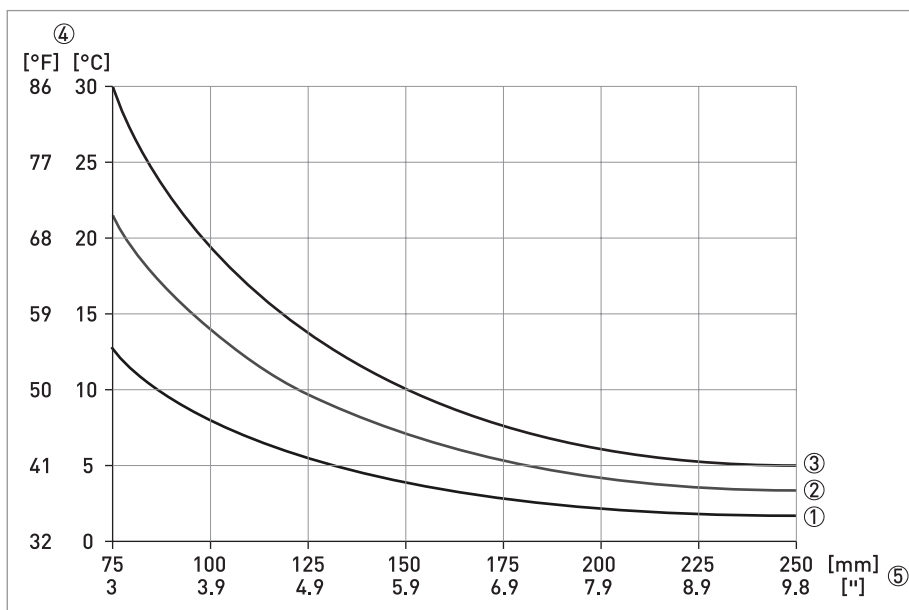


Figure 3-1: Heating of the connection head

- ① Process temperature +220°C / +428°F
- ② Process temperature +400°C / +752°F
- ③ Process temperature +570°C / +1058°F
- ④ Temperature of the connection head
- ⑤ Length of neck tube



INFORMATION!

For more information regarding the maximum allowable temperatures, please refer to the "Technical Data" section.

3.6 Installation notes on the individual device classes

3.6.1 Insertion-type thermometer

Insertion-type thermometers can be installed in three different ways:

- Insertion
- Attachment with a compression fitting
- Welding



DANGER!

Note that compression fittings with plastic rings are less resistant to pressure and temperature than compression fittings with metal rings! For information regarding the limit values of compression fittings, refer to the "Technical Data" section.



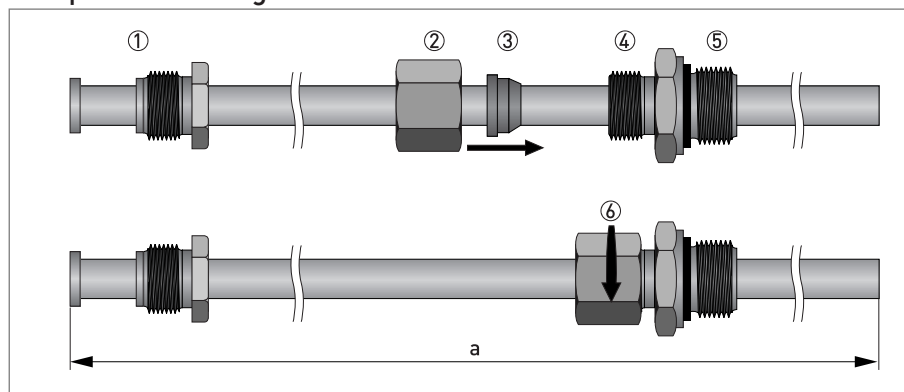
INFORMATION!

A thermometer that is welded allows for higher process pressures and temperatures than thermometers attached with compression fittings.

For fixing, the manufacturer offers two types of compression fitting connections with the threads G $\frac{1}{2}$ ", G $\frac{3}{4}$ ", G1", $\frac{1}{2}$ " NPT or $\frac{3}{4}$ " NPT (measurement "a" in the following drawing is the "insertion length"):

- Using a metal ring clamped to the thermowell or measuring insert to prevent any subsequent movement, thus preventing any change in the immersion depth
- Using a plastic ring which can subsequently move on the thermowell or measuring insert, allowing changes in the immersion depth

Compression fitting



- ① Thread to screw into the connection head
- ② Union nut
- ③ Compression ring
- ④ Thread for the union nut
- ⑤ Process thread
- ⑥ Tightened union nut

3.6.2 Threaded thermometer

A threaded thermometer can be installed two different ways:

- Screwed in directly: Pipes with a wall thickness ≥ 20 mm / 0.8" make it possible to drill a hole and cut a thread.
- Screw into threaded sleeves: Pipes with a wall thickness < 20 mm require a sleeve to be welded in; these are not included in delivery but make up part of the accessories range.



CAUTION!

You, the user, are responsible for selecting a suitable sealing material for the process connection, not the manufacturer! When installing the seals to the process connection, always ensure a good fit!



CAUTION!

Sometimes even a neck tube cannot prevent the maximum permissible temperature in the connection head from being exceeded! The connection head on thermometers without a neck tube heats up faster than thermometers with neck tubes but you still must always take into consideration the installation situation as well as the ambient and process temperatures!

3.6.3 Flange thermometer



CAUTION!

When attaching the flange, tighten the screws evenly and crosswise to avoid leaks at the process connection.



CAUTION!

You, the user, are responsible for selecting a suitable sealing material for the process connection, not the manufacturer! When installing the seals to the process connection, always ensure a good fit!

3.6.4 Insertion-type thermometer without thermowell

As with the installation of an insertion-type thermometer with a thermowell, the version without a thermowell can be installed in two different ways:

- Insertion
- Attachment with a compression fitting

You may bend measuring inserts, but be advised of the following restrictions:



CAUTION!

Ensure that when bending the sheath, the smallest bending radius is at least three times the diameter of the sheath! Otherwise you may damage or destroy the mineral insulated sheathed cable and thus the measuring insert.



CAUTION!

Do not bend the bottom 50 mm / 2" of the sheath! This may damage or destroy the RTD or the thermocouple.

Also keep in mind the following information regarding the maximum allowable loads:



CAUTION!

Only operate the industrial thermometer without a thermowell if the static process pressure is in the range of 0.8...1.2 bara / 11.6...17.4 psia! If the static process pressure is too high (over 1.2 bara / 11.6 psia) or too low (below 1.2 bara / 17.4 psia) the measuring insert may be damaged or destroyed.



CAUTION!

If you are unsure as to whether the device can withstand the loads of the process when using an insertion-type thermometer without thermowell, have a separate strength calculation done (e.g. per DITTRICH or MURDOCK)! For further information contact the manufacturer.

4.1 Safety instructions

**DANGER!**

All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!

**DANGER!**

Observe the national regulations for electrical installations!

**DANGER!**

For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.

**WARNING!**

Observe without fail the local occupational health and safety regulations. Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.

**INFORMATION!**

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

4.2 Grounding

The manufacturer's industrial thermometer thermowells are grounded via the process connection. No additional grounding is required.

4.3 Protection category

The IP protection class of an industrial thermometer depends on the type of connection head. The following protection classes are available: P 54 (BKK), IP 65 (BA, BUZ-T/S/H/HW, BVA), IP 67 (BGK), IP 68 (AXD).

4.4 Power supply

The only components of an industrial thermometer that must be supplied with power are the measuring insert and any temperature transmitter used. Please consult the product-specific handbooks for information regarding the power supply of these components.

5.1 Start-up

**CAUTION!**

Double check the following things prior to starting up an industrial thermometer in order to avoid measuring errors as well as damage to or the destruction of the thermometer:

- Ensure that the thermowells have been properly installed according to the manufacturer's instructions.
- Ensure that the process connection has been successfully tested for leaks.
- Ensure that the measuring insert sits firmly on the bottom of the thermowell.
- Ensure that the measuring insert has been properly electrically connected according to the manufacturer's instructions (refer to measuring insert handbook).

**CAUTION!**

When operating the converters and the display in the BUZ-HW connection head, always refer to the technical documentation of these devices.

5.2 Normal operation

During the course of normal operation, it is not necessary to make any adjustments to the thermometer, measuring insert, temperature transmitter or temperature indicator.

**WARNING!**

Never touch the thermowell, neck tube or connection head in operation without protective gloves! These components can become very hot during operation and cause burns.

5.3 Faults and damage: Reasons and remedies

**INFORMATION!**

The most probable cause of a fault is the measuring insert itself and its electronic components (see the handbook for measuring inserts, subsection "Faults: Reasons and Remedies"). The following issues come into question here:

- Short circuit or open circuit
- Insulation resistance too low
- Ageing
- Wrong thermocouple wire or compensating line

In addition, the following faults and damage may occur:

Liquid on the process connection

A damaged or incorrect seal can lead to a leak at the process connection. Should this occur, replace the seal and ensure that the new one meets the individual requirements of the measuring point (pressure, temperature, chemically aggressive media). It is the sole responsibility of the operator of the device to select the right seal.

Temperature indication too high or too low

When reference measurements result in an incorrect temperature indication, three causes come into question:

- Severe thermal dissipation caused by too short insertion length of thermowell or measuring insert: the thermometer indicates a temperature that is too low when it is above the ambient temperature and one that is too high when it is below the ambient temperature.
- Severe thermal dissipation via the process connection, the pipeline or the tank wall due to a lack of insulation.
- Incorrect thermowell dimensions (diameter, wall thickness).

To keep thermal dissipation to a minimum, either increase the insertion length of the thermometer or improve the insulation of the measuring point. You can implement these measures together or separately.

Slow response to changes in temperature

If the measuring insert is not resting firmly on the bottom of the thermowell, the response to any changes in temperature may be slowed. So, ensure that the measuring insert touches the bottom of the thermowell using the spring-loaded mounting. If the thermometer is to react to changes in temperature as quickly as possible, the manufacturer recommends thermowells with a tapered or reduced tip.

Damage to the thermowell and penetrating liquid

If the thermowell is not sufficiently resistant to chemically aggressive media, corrosion may occur and the measured medium may penetrate. In case of doubt, choose a thermowell made of the same material as the pipe or tank in which the medium is located.

Breaks or tears

It is possible for breaks or tears to occur due to the force of the media flowing against the thermowell. It is also possible for vibrations in the resonance range to damage or destroy the thermowell. Superimposition of the two causes or a combination of insufficient mechanical and chemical resistance is also possible. The following are starting points for troubleshooting:

- Selection of a thermowell with different dimensions
- Change in neck tube length at critical head resonances
- Selection of a different installation site

6.1 Replacing the electronics

When it comes to the manufacturer's industrial thermometers, it is only possible to replace an electronic component if the measuring insert features a temperature transmitter ("head-mounted transmitter"). Consult the handbook for the temperature transmitter to learn what you need to take into consideration when replacing the electronics.

6.2 Cleaning and maintenance

As a rule, the manufacturer's industrial thermometers require no cleaning or maintenance. However, depending on the conditions of use and the thermal and mechanical load, they can age. This is true of both measuring inserts with Pt100 RTDs and measuring inserts with thermocouples.

As a result of the ageing process, the characteristics ("characteristic curve") can change. That means that the relationship between the electrical resistance (measuring insert with Pt100 RTD) or the thermovoltage (measuring insert with thermocouple) and the temperature changes. In this case, calibration shows whether any deviations in measurement values are still within permissible tolerances.

6.3 Spare parts availability

The manufacturer adheres to the basic principle that functionally adequate spare parts for each device or each important accessory part will be kept available for a period of 3 years after delivery of the last production run for the device.

This regulation only applies to spare parts which are under normal operating conditions subjects to wear and tear.

6.4 Availability of services

The manufacturer offers a range of services to support the customer after expiration of the warranty. These include repair, technical support and training.



INFORMATION!

For more precise information, please contact your local representative.

6.5 Returning the device to the manufacturer

6.5.1 General information

This device has been carefully manufactured and tested. If installed and operated in accordance with these operating instructions, it will rarely present any problems.



CAUTION!

Should you nevertheless need to return a device for inspection or repair, please pay strict attention to the following points:

- *Due to statutory regulations on environmental protection and safeguarding the health and safety of our personnel, manufacturer may only handle, test and repair returned devices that have been in contact with products without risk to personnel and environment.*
- *This means that the manufacturer can only service this device if it is accompanied by the following certificate (see next section) confirming that the device is safe to handle.*



CAUTION!

If the device has been operated with toxic, caustic, flammable or water-endangering products, you are kindly requested:

- *to check and ensure, if necessary by rinsing or neutralizing, that all cavities are free from such dangerous substances,*
- *to enclose a certificate with the device confirming that is safe to handle and stating the product used.*

6.5.2 Form (for copying) to accompany a returned device

Company:		Address:	
Department:		Name:	
Tel. no.:		Fax no.:	
Manufacturer's order no. or serial no.:			
The device has been operated with the following medium:			
This medium is:	water-hazardous		
	toxic		
	caustic		
	flammable		
	We checked that all cavities in the device are free from such substances.		
	We have flushed out and neutralized all cavities in the device.		
We hereby confirm that there is no risk to persons or the environment through any residual media contained in the device when it is returned.			
Date:		Signature:	
Stamp:			

6.6 Disposal



CAUTION!

Disposal must be carried out in accordance with legislation applicable in your country.

7.1 Measuring principle

All of the thermometers described here belong to the class known as "contact thermometers". Unlike "radiation thermometers", these thermometers come into direct contact with the medium whose temperature they are to measure.

The "OPTITEMP TR/TC 100" handbook goes into more detail regarding the various basic physical foundations of temperature measurement using measuring inserts with a Pt100 RTD or thermocouple.

7.2 Technical data tables



INFORMATION!

- *The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local representative.*
- *Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Download Center).*

Measuring system

Application range	Measuring the temperature of gases, liquids, vapours and solid bodies in industrial processes. The devices are particularly suited to liquids with low viscosity, water and chemicals with low corrosiveness as well as saturated steam and superheated steam.
Measuring principle	Contact thermometer
Measured value	Temperature

Design

Modular design	Industrial thermometers consist of several components which, together, form an assembly: <ul style="list-style-type: none"> • Measuring insert with temperature sensor • Thermowell with or without neck tube (no thermowell with version TRA/TCA-P14) • Connection head • Transmitter (either inside on the measuring insert or outside)
Signal converter	Analogue or digital temperature transmitter in the TT family as head-mount or rail-mount transmitter.
Sensor	Pt100 RTD as thin layer variant (TF) or as wire wound variant (WW) as per DIN EN 60751. "J" or "K" type thermocouple as per DIN EN 60584.
Measuring range	See "Operating conditions".

Display and user interface	
Display	Only in connection head "BUZ-HW": 4...20 mA, non-illuminated, LCD, loop display.
Operating	Only in connection head "BUZ-HW": interior keys.
Display functions	Temperature, either as output signal (HART® penetrable) in mA or scaled to °C/°F.

Measuring accuracy

Reference conditions	Ambient temperature: +23°C / +73.4°F (fluctuations due to air pressure and density have no impact on measuring accuracy).
Maximum measuring error	<p>More detailed information in the subsection "Measurement Error", this section. The maximum measurement error also depends on the type of sensor:</p> <ul style="list-style-type: none"> • Measuring insert with Pt100 RTD: measurement error in accordance with tolerance classes A, B and 1/3 B as per DIN EN 60751. • Thermocouple: measurement error in accordance with tolerance class 1 as per DIN EN 60584.

Operating conditions

Load limits	The load limits depend on several factors (e.g. dimensions, design and material of thermowell). Other information can be found in the "Installation" section or in separate subsections of this section.
	Thermometer without thermowell: 0.8...1.2 bara / 11.6...17.4 psia.
Temperature	
Process temperature	Maximum -200...+600°C / -328...+1112°F, depending on measuring insert, design and material.
Ambient temperature	Maximum -40...+100°C / -40...+212°F, depending on the connection head and measuring insert.
Storage temperature	-40...+70°C / -40...+158°F at 40...60% relative humidity.
Other conditions	
Protection categories	Dependent on the connection head: IP 54 (BKK), IP 65 (BA, BUZ-T/S/H/HW, BVA), IP 67 (BGK), IP 68 (AXD).

Installation conditions

Insertion angle	90° to the flow, directly against or diagonally against the flow.
Insertion length	10...15 x thermowell diameter, minimum 100 mm / 3.94" (shorter insertion lengths possible but they impair measuring accuracy).
Pipes with $\varnothing < 300$ mm / 11.8"	Thermowell tip should project past the middle of the pipe.
Bending radius	The immersion tubes on the measuring inserts can be bent but the smallest bending radius must be at least three times the diameter of the immersion tube. Note: Do not bend the bottom 50 mm / 2"!

Materials

Thermowells (including process connection)	The materials of the thermowells, neck tubes, flanges and threads as process connections are always identical:
	Standard: 1.4571 / AISI 316 Ti (X6CrNiMoTi 17-12-2)
	Option: 1.4841 / AISI 314/310 (X15CrNiSi 25-20) or 1.4404 / AISI 316 L (X2CrNiMo 17-12-2)
Compression fitting	1.4571 / AISI 316 Ti (X6CrNiMoTi 17-12-2), metal or PTFE compression ring
Connection heads	Aluminium (powder coated), plastic or stainless steel
Measuring inserts	With Pt100 RTD: 1.4404 / AISI 316 L (X2CrNiMo 17-12-2)
	With thermocouple: Inconel 600®

Process connections and connection head thread

Insertion-type thermometer (including version without thermowell)	Insert, weld in (not possible with TRA/TCA-P14) or attach using compression fitting (thread: G½", G¾", G1", ½" NPT or ¾" NPT).
Threaded thermometer (with and without neck tube)	Thread as per DIN/ISO 228 (G½", G¾" or G1") or ANSI/ASME B1.20.1 (½" NPT and ¾" NPT), other sizes on request.
	Attachment using welding sleeves. Starting at a wall thickness of 20 mm / 0.8", it is possible to screw in directly with thread in the pipe.
Flange thermometer	As per DIN EN 1092-1: B1-DN25 / PN40, B1-DN50 / PN40, other sizes on request.
	As per ASME B16.5: RF 1" / 150 lb, RF 1" / 300 lb, RF 1½" / 150 lb, RF 1½" / 300 lb, other sizes on request.
	Surface roughness of the flange sealing face is 3.2...12.5 µm (DIN EN flange) or 3.2...6.3 µm (ASME flange).
Connection head	M24 x 1.5 thread to connect the thermowell or neck tube.

Electrical connections

Power supply	Only necessary when using a temperature transmitter and depends on transmitter type, typically 24 VDC.
Power consumption	Only when using a temperature transmitter, typically 550 mW.
Cable entry (connection head)	M20 x 1,5
Current output	
Output range	Exists only when using a temperature transmitter and depends on transmitter type, typically 4...20 mA, HART [®] , Profibus-PA.
Error signal	According to NAMUR NE 43, selectable: upper value ≥ 21.0 mA, lower value ≤ 3.6 mA.
Load	Relevant only when using a temperature transmitter and then dependent on transmitter type (typically 250 Ω).
Other electrical features	
Galvanic isolation	Relevant only when using a temperature transmitter (see transmitter handbook).
Time constant	More detailed information can be found in the "Response times" subsection, this section.

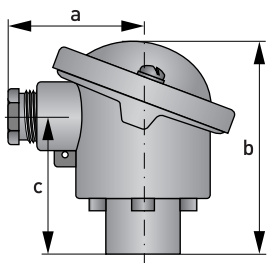
Approvals and certificates

Electromagnetic compatibility	See handbook for temperature transmitter used.
ATEX	Ex-i available for all thermometers with a measuring insert featuring a diameter of 6 mm / 0.24" and the following sensor: 1 x Pt100, class A, wire-wound RTD.
Safety integration level	SIL2 with temperature transmitter TT51 C/R

7.3 Dimensions

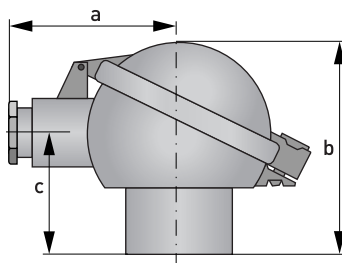
7.3.1 Connection heads

BA (aluminium, IP65)



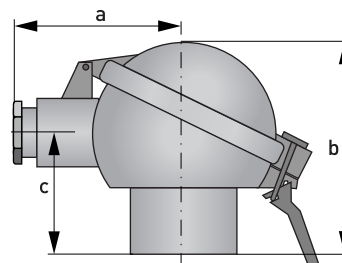
a: 47 mm / 1.85"
 b: 75 mm / 2.95"
 c: 50 mm / 1.97"

BUZ-T (aluminium, IP65)



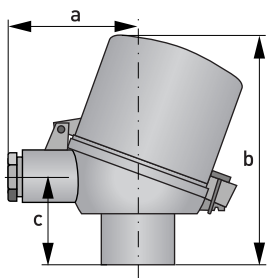
a: 64 mm / 2.52"
 b: 83 mm / 3.26"
 c: 41.5 mm / 1.63"

BUZ-S (aluminium, IP65)



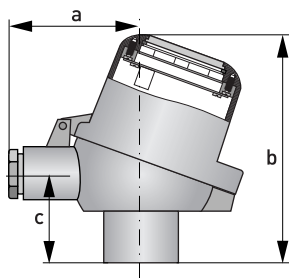
a: 64 mm / 2.52"
 b: 83 mm / 3.26"
 c: 41.5 mm / 1.63"

BUZ-H (aluminium, IP65)



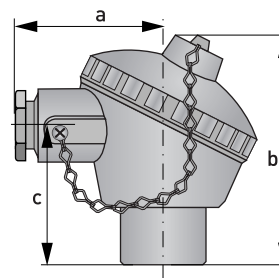
a: 63 mm / 2.48"
 b: 114 mm / 4.45"
 c: 41.5 mm / 1.63"

BUZ-HW (aluminium, IP65)



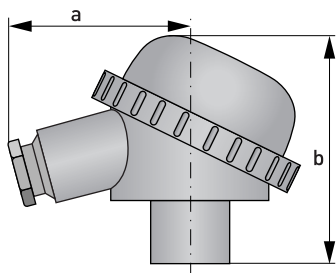
a: 63 mm / 2.48"
 b: 114 mm / 4.45"
 c: 41.5 mm / 1.63"

BGK (aluminium, IP67)



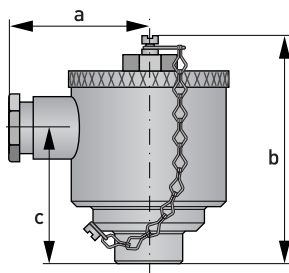
a: 60 mm / 2.36"
 b: 95 mm / 3.74"
 c: 57 mm / 2.24"

BBK (PA, IP54)



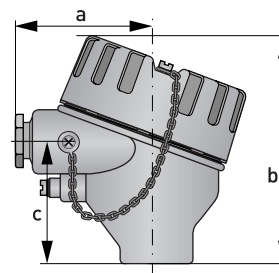
a: 70 mm / 2.76"
 b: 72 mm / 2.83"

BVA (VA, IP65)



a: 49 mm / 1.93"
 b: 85 mm / 3.35"
 c: 50 mm / 1.97"

AXD (aluminium, IP68)

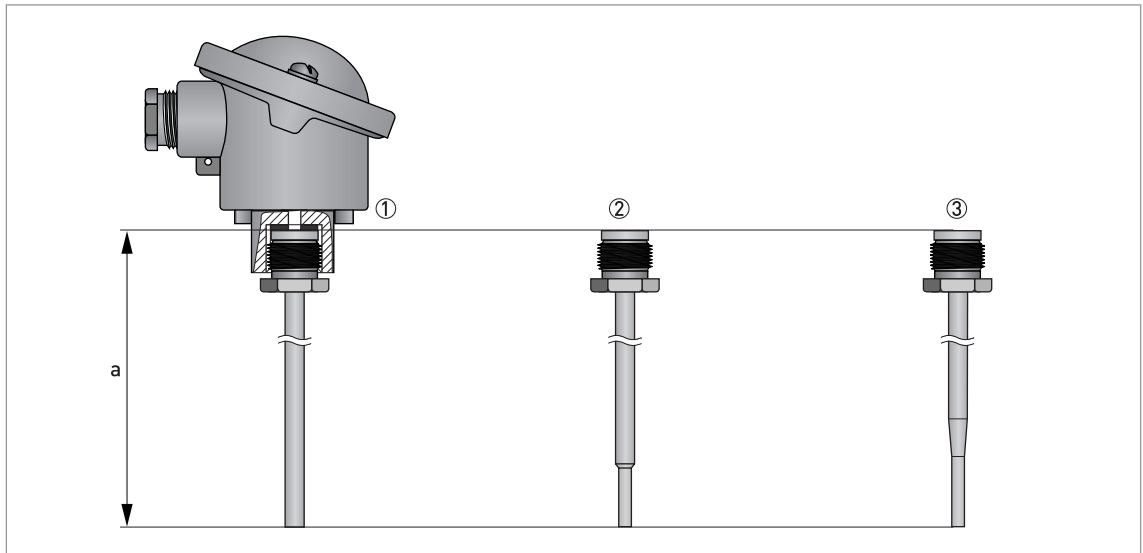


a: 64 mm / 2.52"
 b: 115 mm / 4.53"
 c: 64 mm / 2.52"

7.3.2 Lengths of thermowells


INFORMATION!

The lengths indicated in this subsection for the thermowells are standard lengths. Special lengths are available as an option.

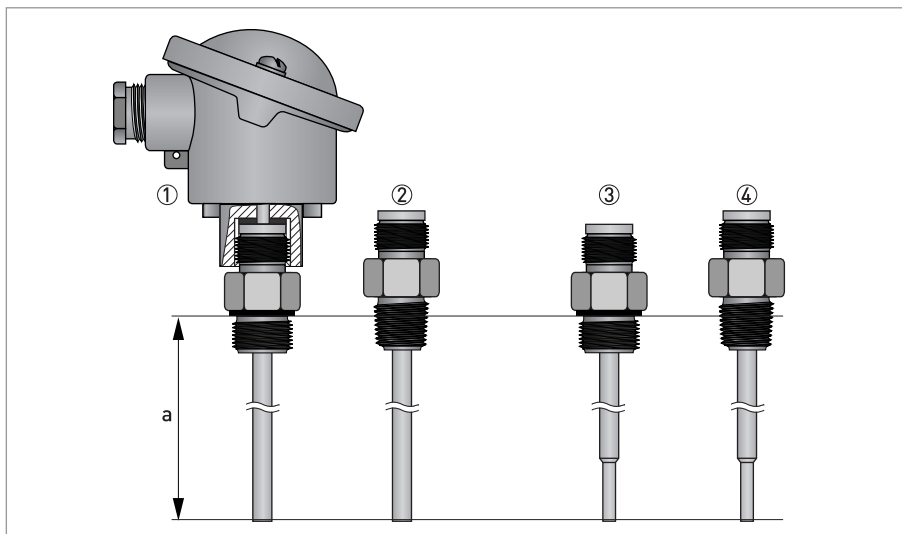
Insertion-type thermometer


- ① TRA/TCA-P10
- ② TRA/TCA-P20
- ③ TRA/TCA-P40

Thermowell length "a" (TRA/TCA-P10 and P20)	
[mm]	["]
305	12.01
395	15.55
545	21.46

Thermowell length "a" (TRA/TCA-P40)	
[mm]	["]
307	12.09
367	14.45
427	16.81

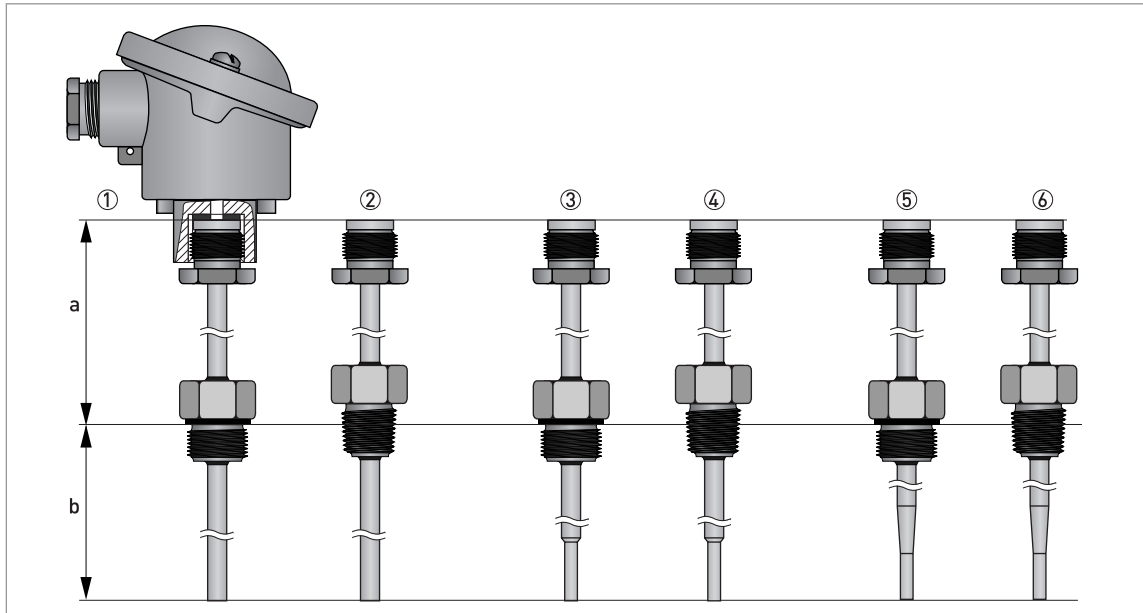
Threaded thermometer without neck tube



- ① TRA/TCA-S11 (G thread)
- ② TRA/TCA-S11 (NPT thread)
- ③ TRA/TCA-S21 (G thread)
- ④ TRA/TCA-S21 (NPT thread)

Insertion length "a" (all versions)	
[mm]	["]
75	2.95
100	3.94
115	4.53
270	10.93
390	15.35

Threaded thermometer with neck tube

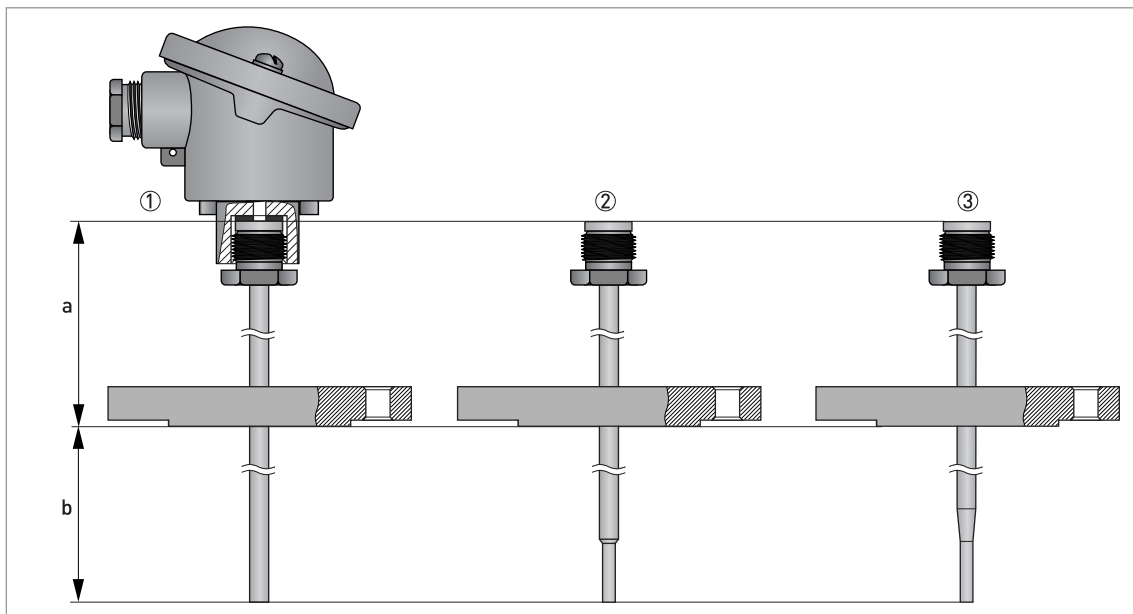


- ① TRA/TCA-S12 (G thread)
- ② TRA/TCA-S12 (NPT thread)
- ③ TRA/TCA-S22 (G thread)
- ④ TRA/TCA-S22 (NPT thread)
- ⑤ TRA/TCA-S41 (G thread)
- ⑥ TRA/TCA-S41 (NPT thread)

Versions TRA/TCA-S12 and -S22					
Neck tube length "a"		Insertion length "b"		Thermowell length "a + b"	
[mm]	["]	[mm]	["]	[mm]	["]
145	5.71	160	6.30	305	12.01
145	5.71	250	9.84	395	15.55
145	5.71	400	15.75	545	21.46

Version TRA/TCA-S41					
Neck tube length "a"		Insertion length "b"		Thermowell length "a + b"	
[mm]	["]	[mm]	["]	[mm]	["]
147	5.79	160	6.30	307	12.09
147	5.79	220	8.66	367	14.45
147	5.79	280	11.02	427	16.81

Flange thermometer



- ① TRA/TCA-F13
- ② TRA/TCA-F23
- ③ TRA/TCA-F42

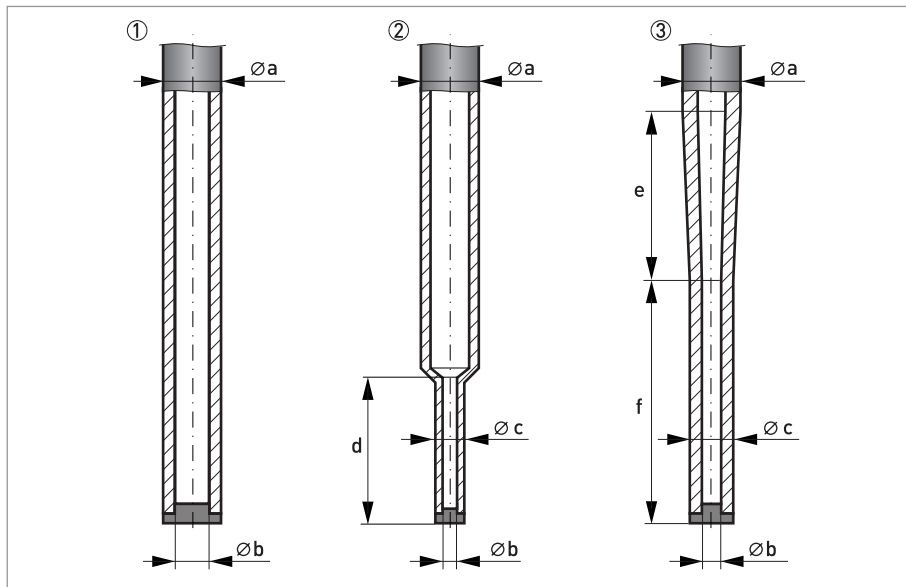
Versions TRA/TCA-F13 and -F23					
Neck tube length "a"		Insertion length "b"		Thermowell length "a + b"	
[mm]	["]	[mm]	["]	[mm]	["]
80	3.15	225	8.86	305	12.01
80	3.15	315	12.40	395	15.55
80	3.15	465	18.31	545	21.46

Versions TRA/TCA-F42					
Neck tube length "a"		Insertion length "b"		Thermowell length "a + b"	
[mm]	["]	[mm]	["]	[mm]	["]
82	3.23	225	8.86	307	12.09
82	3.23	285	11.22	367	14.45
82	3.23	345	13.58	427	16.81

7.3.3 Thermowells: Diameter, wall thickness, tips

There are three different thermowell diameters and wall thicknesses for the thermometer variants (for which the following specifications apply: \varnothing x wall thickness):

- 9 mm x 1 mm / 0.35" x 0.04" (only available for straight thermowells)
- 11 mm x 2 mm / 0.43" x 0.08"
- 12 mm x 2.5 mm / 0.47" x 0.1"



- ① Straight thermowell tip (standard)
 ② Reduced thermowell tip
 ③ Tapered thermowell tip

Measurement	Straight thermowell		Reduced thermowell tip		Tapered thermowell tip	
	[mm]	["]	[mm]	["]	[mm]	["]
a	9 / 11 / 12	0.35 / 0.43 / 0.47	11 / 12	0.43 / 0.47	12	0.47
b	7	0.28	3.1	0.12"	6.1	0.16
c	-	-	6	0.24"	9	0.35
d	-	-	30	1.18"	-	-
e	-	-	-	-	35	-
f	-	-	-	-	50	-

7.3.4 Measuring inserts: Diameter and standard lengths

The diameter the thermometer's measuring insert must have depends on the existence of a thermowell and its tip:

- Thermowell with reduced tip: Measuring insert with \varnothing 3 mm / 0.12"
- Straight thermowell and thermowell with tapered tip: \varnothing 6 mm / 0.24"
- Version without thermowell: \varnothing 6 mm / 0.24"



INFORMATION!

The lengths given for the thermowells and measuring inserts in the following tables are standard lengths. The manufacturer can provide other lengths on request.

Insertion-type thermometer (TRA/TCA-P10/20/40)

Thermowell length		Length of the measuring insert	
[mm]	["]	[mm]	["]
305	12.01	315	12.40
395	15.55	405	15.94
545	21.46	555	21.85



INFORMATION!

The following applies when determining the length of the measuring insert for insertion-type thermometers: length of the thermowell + 10 mm / 0.4".

Threaded thermometer (TRA/TCA-S11/21)

Insertion length		Length of the measuring insert	
[mm]	["]	[mm]	["]
75	2.95	120	4.7
100	3.94	145	5.7
115	4.53	160	6.3
270	10.63	315	12.4
390	15.35	435	17.1



INFORMATION!

The following applies when determining the length of the measuring insert for threaded thermometers: Distance from the underside of the seal (G thread) / two-thirds of the thread height from the bottom (NPT thread) to the tip of the thermowell + 45 mm / 1.8".

Threaded thermometer with neck tube (TRA/TCA-S12/22/41)

TRA/TCA-S12/22			
Thermowell length		Length of the measuring insert	
[mm]	["]	[mm]	["]
160	6.30	315	12.40
250	9.84	405	15.94
400	15.75	555	21.85

TRA/TCA-S41			
Thermowell length		Length of the measuring insert	
[mm]	["]	[mm]	["]
160	6.30	315	12.40
220	8.66	375	14.76
280	11.02	435	17.13

**INFORMATION!**

The following applies when determining the length of the measuring insert for threaded thermometers with neck tubes: distance from the underside of the seal (G thread) / two-thirds of the thread height from the bottom (NPT thread) to the tip of the thermowell + 155 mm / 6.10".

Flange thermometer (TRA/TCA-F13/23/42)

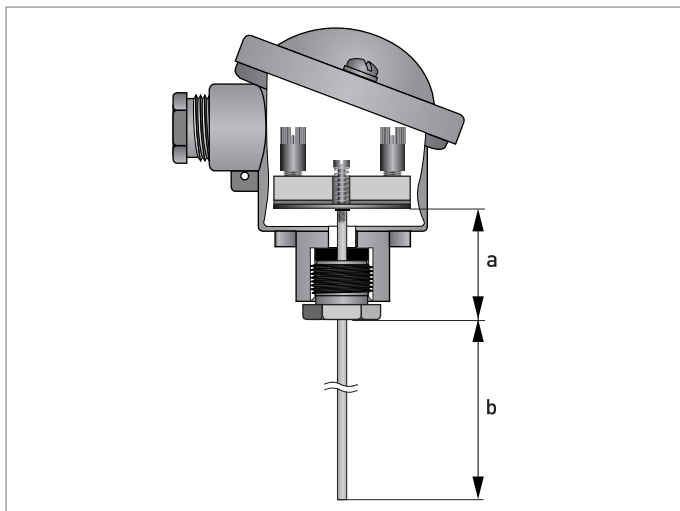
TRA/TCA-F12/23			
Insertion length		Length of the measuring insert	
[mm]	["]	[mm]	["]
225	8.9	315	12.4
315	12.4	405	15.9
465	18.3	555	21.9

TRA/TCA-F42			
Insertion length		Length of the measuring insert	
[mm]	["]	[mm]	["]
225	8.86	315	12.40
285	11.22	375	14.76
345	13.58	435	17.13

**INFORMATION!**

The following applies when determining the length of the measuring insert for flange thermometers: distance from the bottom of the flange to the tip of the thermowell + 90 mm / 3.54".

Insertion-type thermometer without thermowell (TRA-P14, TCA-P14)



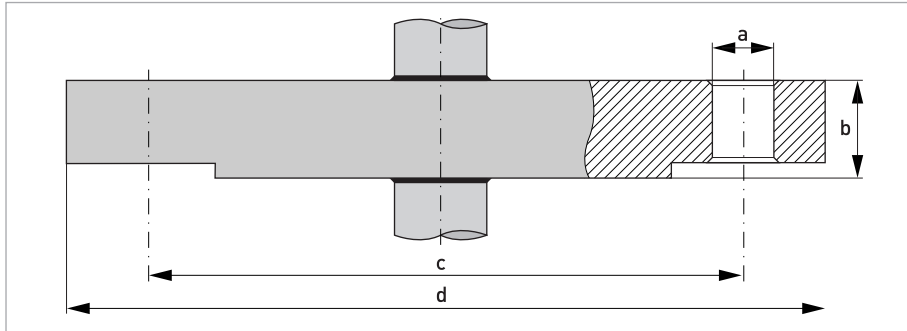
Versions TRA/TCA-S12 and S22					
Length "a"		Insertion length "b"		Measuring insert length "a + b"	
[mm]	["]	[mm]	["]	[mm]	["]
20	0.79	295	11.61	315	12.40
20	0.79	385	15.16	405	15.94
20	0.79	535	21.06	555	21.85

7.3.5 Flange dimensions



INFORMATION!

Upon request the manufacturer can supply flanges with dimensions other than those specified here.



Type of flange	a		b		c		d	
	[mm]	["]	[mm]	["]	[mm]	["]	[mm]	["]
B1-DN25 / PN40 (EN 1092-1)	14	0.55	18	0.71	85	3.35	115	4.53
B1-DN50 / PN40 (EN 1092-1)	18	0.71	20	0.79	125	4.92	165	6.50
RF 1" / 150 lb (ASME B16.5)	15.9	0.63	14.7	0.58	79.4	3.13	110	4.33
RF 1" / 300 lb (ASME B16.5)	19.1	0.75	17.9	0.70	88.9	3.5	125	4.92
RF 1½" / 150 lb (ASME B16.5)	15.9	0.63	17.9	0.70	98.4	3.87	125	4.92
RF 1½" / 300 lb (ASME B16.5)	22.3	0.88	21.1	0.83	114.3	4.5	155	6.10

7.4 Measuring accuracy

The measuring accuracy depends largely on the following factors:

- The version of the measuring insert (type of sensor, type of circuit, measuring range).
- The correct dimensions (diameter, wall thickness) and insertion length of the thermowell for good thermal coupling to the process temperature (insufficient insertion depth often results in measurement errors).
- The type of temperature transmitter used.



INFORMATION!

Please consult the appropriate handbook for further information regarding the accuracy of the measuring inserts and the temperature transmitters.

With the exception of the TT 60 C/R version, all of the temperature transmitters generate an analogue output signal. For this reason, the following table indicates the measuring accuracy of most of the transmitters as a percentage of the measuring range:

Temperature transmitter

Type of temperature transmitter	Accuracy (% of the measuring range or °K)
TT 10 C/R (analogue, standard)	± 0.15%
TT 11 C/R (analogue, voltage output)	± 0.15%
TT 20 C/R (analogue)	± 0.10%
TT 30 C/R (digital, standard)	± 0.10%
TT 40 C/R (digital, precise)	± 0.05%
TT 50 C/R (digital, HART®)	± 0.10%
TT 51 C (digital, HART®, SIL2)	± 0.05%
TT 60 C/R (digital, Profibus)	± 0.10°K

7.5 Process connections

Insertion-type thermometer with thermowell

Type of process connection	Materials	Ø of thermowell	
		[mm]	["]
Compression fitting	1.4571	9 / 11 / 12	0.35 / 0.43 / 0.47

Insertion-type thermometer without thermowell

Type of process connection	Material	Ø of immersion tube	
		[mm]	["]
Compression fitting	1.4571	6	0.24

Threaded thermometer with and without neck tube

Type of process connection	Materials	Ø of thermowell	
		[mm]	["]
G½"	1.4571	9 / 11 / 12	0.35 / 0.43 / 0.47
G¾"		11 / 12	0.43 / 0.47
G1"		11 / 12	0.43 / 0.47
½" NPT		9 / 11 / 12	0.35 / 0.43 / 0.47
¾" NPT		11 / 12	0.43 / 0.47



INFORMATION!

The manufacturer offers the flange thermometer with process connections as per DIN EN 1092-1 or ASME/ANSI 16.5. For DIN flanges the sealing surface complies with Form B1 and with ASME flanges, type "RF".

Flange thermometer with neck tube

Type of process connection	Material	Ø of thermowell	
		[mm]	["]
DN25 / PN40	1.4571	9 / 11 / 12	0.35 / 0.43 / 0.47
DN50 / PN40		11 / 12	0.43 / 0.47
1" / 150 lb		9 / 11 / 12	0.35 / 0.43 / 0.47
1½" / 150 lb		11 / 12	0.43 / 0.47
1" / 300 lb		11 / 12	0.43 / 0.47
1½" / 300 lb		11 / 12	0.43 / 0.47

7.6 Measuring range and permitted load

Temperatures that can be measured with an industrial thermometer depend largely on the load of the thermometer. Load limits are defined through a variety of factors (see the subsection "Load limits" in the "Installation" section). For this reason, the manufacturer cannot make any universally valid statements about the measuring range and permissible load.

To prevent destruction or damage, never operate the thermometer outside of its permissible mechanical, thermal or chemical limits. For further information refer to the rest of this section and the "Technical Data" section.



CAUTION!

The information in this subsection is informative only and does not reflect the vibration load caused by flow-induced vibration. If necessary, prior to purchasing and installing an industrial thermometer, have a specific strength calculation performed (e. g. per DITTRICH or MURDOCK). For further information contact the manufacturer.



CAUTION!

To prevent destruction or damage, only operate a thermometer without a thermowell in the range of 0.8...1.2 bara / 11.6...17.4 psia.



INFORMATION!

The manufacturer can provide an optional strength calculation for a fee.

Operating limits of thermowells with \varnothing 9 mm / 0.35"

Process connection	Insertion length		p_{\max} at +20°C / +400°C (+68°F / +752°F), air		p_{\max} at +20°C / +400°C (+68°F / +752°F), water / steam	
	[mm]	["]	[bar]	[psi]	[bar]	[psi]
Thread G $\frac{1}{2}$ ", G $\frac{3}{4}$ ", G1", $\frac{1}{2}$ " NPT, $\frac{3}{4}$ " NPT	160	6.3	50 / 36	725 / 522	50 / 36	725 / 522
	250	9.8	40 / 36	580 / 522	40 / 36	580 / 522
	400	15.7	16 / 18	232 / 261	18 / 18	261 / 261
Flanges DN25 and 50 (PN40)	160...250	6,3...9.8	40 / 29.2	580 / 424	40 / 29.2	580 / 424
	400	15.7	16 / 18	232 / 261	18 / 18	261 / 261
Flanges ASME 1" and 1 $\frac{1}{2}$ " (150 lb)	160...250	6,3...9.8	19 / 6.5	276 / 94.3	19 / 6.5	276 / 94.3
	400	15.7	16 / 6.5	232 / 94.3	18 / 6.5	261 / 94.3
Flanges ASME 1" and 1 $\frac{1}{2}$ " (300 lb)	160	6.3	49.6 / 29.4	719 / 426	49.6 / 29.4	719 / 426
	250	9.8	40 / 29.4	580 / 426	40 / 29.4	580 / 426
	400	15.7	16 / 18	232 / 261	18 / 18	261 / 261

- Straight thermowell
- Air flows against the thermometer at 25 m/s (82 ft/s), water / steam at 3 m/s (9.8 ft/s)
- Material 1.4571

Operating limits of thermowells with \varnothing 11 mm / 0.43"

Process connection	Insertion length		p_{\max} at +20°C / +400°C (+68°F / +752°F), air		p_{\max} at +20°C / +400°C (+68°F / +752°F), water / steam	
	[mm]	["]	[bar]	[psi]	[bar]	[psi]
Thread G $\frac{1}{2}$ ", G $\frac{3}{4}$ ", G1", $\frac{1}{2}$ " NPT, $\frac{3}{4}$ " NPT	160	6.3	83 / 57	1204 / 827	100 / 80	1450 / 1160
	250	9.8	35 / 50	508 / 725	50 / 50	725 / 725
Flanges DN25 and 50 (PN40)	160...250	6.3...9.8	35 / 29.2	508 / 424	40 / 29.2	580 / 424
Flanges ASME 1" and 1 $\frac{1}{2}$ " (150 lb)	160...250	6.3...9.8	19 / 6.5	276 / 94.3	19 / 6.5	276 / 94.3
Flanges ASME 1" and 1 $\frac{1}{2}$ " (300 lb)	160	6.3	49.6 / 29.4	719 / 426	49.6 / 29.4	719 / 426
	250	9.8	36 / 29.4	522 / 426	36 / 29.4	522 / 426

- Straight thermowell and thermowell with reduced tip
- Air flows against the thermometer at 40 m/s (131.2 ft/s), water / steam at 5 m/s (16.4 ft/s)
- Material 1.4571

Operating limits of thermowells with \varnothing 12 mm / 0.47"

Process connection	Insertion length		p_{\max} at +20°C / +400°C (+68°F / +752°F), air		p_{\max} at +20°C / +400°C (+68°F / +752°F), water / steam	
	[mm]	["]	[bar]	[psi]	[bar]	[psi]
Thread G $\frac{1}{2}$ ", G $\frac{3}{4}$ ", G1", $\frac{1}{2}$ " NPT, $\frac{3}{4}$ " NPT	160	6.3	100 / 100	1450 / 1450	100 / 100	1450 / 1450
	220	8.7	58 / 78	841 / 1131	100 / 78	1450 / 1131
	280	11	36 / 53	522 / 769	100 / 55	1450 / 798
Flanges DN25 and 50 (PN40)	160	6.3	40 / 29.2	580 / 424	40 / 29.2	580 / 424
	280	11	36 / 29.2	522 / 424	36 / 29.2	522 / 424
Flanges ASME 1" and 1 $\frac{1}{2}$ " (150 lb)	160...280	6.3...11	19 / 6.5	276 / 94.3	19 / 6.5	276 / 94.3
Flanges ASME 1" and 1 $\frac{1}{2}$ " (300 lb)	160	6.3	49.6 / 29.4	719 / 426	49.6 / 29.4	719 / 426
	280	11	36 / 29.4	522 / 426	36 / 29.4	522 / 426

- Straight thermowell and thermowells with reduced or tapered tips
- Air flows against the thermometer at 40 m/s (131.2 ft/s), water / steam at 5 m/s (16.4 ft/s)
- Material 1.4571

7.7 Permissible temperatures

7.7.1 Connection head

Temperature transmitter	Connection head		Temperature range	Maximum temperature limiting component
	Material	Display		
None	Metal	No	-40...+100°C / -40...+212°F	Seal between connection head cover and cable entry
None	Plastic	No	-40...+80°C / -40...+176°F	Connection head material
Yes	Metal	No	-40...+85°C / -40...+185°F	Temperature transmitter
Yes	Plastic	No	-40...+80°C / -40...+176°F	Connection head material
Yes	Metal	Yes	-40...+70°C / -40...+158°F	Display

7.7.2 Unloaded thermowell and immersion tubes

The temperatures specified in the following tables are valid only for thermowells and immersion tubes that do not project into flowing media or media under pressure. The maximum permissible temperature is reduced under load:



DANGER!

If you are unsure as to whether the device can withstand the loads of the process when using an insertion-type thermometer without thermowell, have a separate strength calculation done (e.g. per DITTRICH or MURDOCK)! For further information contact the manufacturer.



INFORMATION!

The manufacturer can provide an optional strength calculation for a fee.

Thermowells

Type of thermowell	Material	Permissible temperature range
Any	1.4571 / AISI 316 Ti (Standard)	-200...+600°C / -328...+1112°F
	1.4404 / AISI 316 L (optional)	-200...+600°C / -328...+1112°F
	1.4841 / AISI 314/310 (optional)	0...+1000°C / +32...+2012°F

Measuring insert immersion tubes

Type of sensor	Material	Permissible temperature range
Pt100 RTD	1.4404 / AISI 316 L	-200...+600°C / -328...+1112°F
Thermocouple	Inconel® 600	-40...+1100°C / -40...+1832°F

7.8 Sensor response times

Thermometer response times are generally indicated as "50% time" (t_{05}) and "90% time" (t_{09}). "50% time" refers to the time needed for a thermometer signal to achieve 50% of its end value in the face of erratic temperature changes (this applies analogously to "90% time")



INFORMATION!

You can find more information about response times in VDI 3522.

Pt100-RTD, water with 0.4 m/s (1.31 ft/s)

Ø of thermowell		Straight thermowell		Reduced tip		Tapered tip	
[mm]	[""]	t_{05} (s)	t_{09} (s)	t_{05} (s)	t_{09} (s)	t_{05} (s)	t_{09} (s)
9	0.35	17	52	Not available		Not available	
11	0.43	21	58	8	22	Not available	
12	0.47	22	66	10	26	12	30

Thermocouple, water with 0.4 m/s (1.31 ft/s)

Ø of thermowell		Straight thermowell		Reduced tip		Tapered tip	
[mm]	[""]	t_{05} (s)	t_{09} (s)	t_{05} (s)	t_{09} (s)	t_{05} (s)	t_{09} (s)
9	0.35	14	42	Not available		Not available	
11	0.43	17	46	7	18	Not available	
12	0.47	18	54	8	21	10	24

The following table contains information regarding the response times of the thermometer without thermowell (TRA/TCA-P14):

Without thermowell (TRA/TCA-P14 with Ø 6 mm / 0.24")

sensor	Water with 0.4 m/s (1.31 ft/s)		Air with 1 m/s (3.28 ft/s)	
	t_{05} (s)	t_{09} (s)	t_{05} (s)	t_{09} (s)
Pt100 RTD	3.5	8	24	54
Thermocouple	2.5	7	21	50

7.9 Limit values for compression fittings

Material	Maximum process temperature		Maximum pressure at a process temperature of +20°C / +68°F	
	[°C]	[°F]	[bar]	[psi]
PTFE	+200	+392	10	145
Steel	+400	+752	25	362.6

8.1 Technical legislation in effect

Standard	Title
VDE/VDI 3511	Technical temperature measurements
VDI/VDE 3522	Response time of contact thermometers.
DIN 43735-1	Control technology - Electrical temperature sensors for resistance thermometers and thermocouples - Part 1: replaceable measuring inserts
DIN 43735-2	Control technology - Electrical temperature sensors for resistance thermometers and thermocouples - Part 2: Installation size connection head
DIN 43735-3	Control technology - Electrical temperature sensors for resistance thermometers and thermocouples - Part 3: Allocation of dimensions
DIN 43771	Measurement, control; electrical temperature sensor; thermometer with short response time
DIN 43772	Control technology - Metal thermowells and neck tubes for machine glass thermometers, dial thermometers, thermocouples and resistance thermometers - dimensions, materials, testing



KROHNE product overview

- Electromagnetic flowmeters
- Variable area flowmeters
- Ultrasonic flowmeters
- Mass flowmeters
- Vortex flowmeters
- Flow controllers
- Level meters
- Temperature meters
- Pressure meters
- Analysis products
- Measuring systems for the oil and gas industry
- Measuring systems for sea-going tankers

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