OPTITEMP TRA-CXX Handbook

Industrial compact sensors

KROHNE

IMPRINT

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 compact sensors are used to measure the temperature of gases, liquids, vapour and solids in industrial applications with limited installation space. The devices are particularly suited to the measurement of

- liquids with low viscosity
- water and chemicals with low corrosiveness

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 compact thermometers. For this reason, neither a conformity assessment nor a CE marking is possible. The EC directives applicable to temperature transmitters are contained in transmitter part of this documentation.

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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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 or incidental 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 or 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 icons as shown below.

1.3.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.

DANGER!
This warning 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

INFORMATION!
Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

INFORMATION!
Do a check of the packing list to make sure that you have all the elements given in the order.

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

The manufacturer delivers all industrial temperature sensors with the relevant technical documentation. The following table illustrates which sensor is delivered with which documentation (HB = Handbook):

Scope of order	HB for temperature sensors	HB for transmitters
Compact sensor without transmitter	X	-
Compact sensor with built in transmitter	X	-
Compact sensor with rail mount transmitter	X	X

2.2 Device description

2.2.1 Design of the compact sensors

INFORMATION!
In this documentation, the term "compact sensor" refers to all temperature assemblies featuring with/without built-in transmitter.

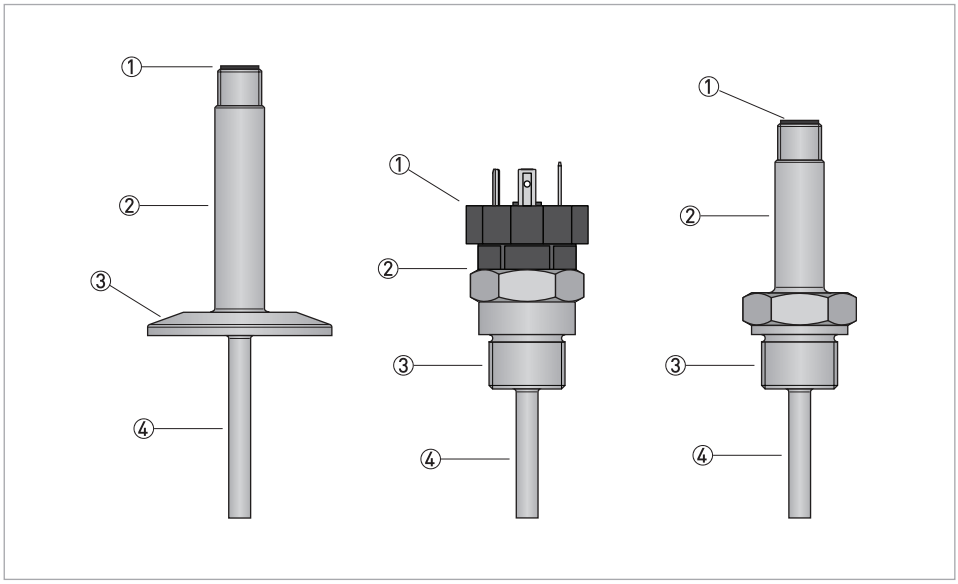


Figure 2-1: Design of all compact sensors

① Electrical connection
② Housing
③ Process connection
④ Thermowell

OPTITEMP compact sensors consist of a measuring probe with a process connection and a neck tube with an electrical connection at the end. The sensors are avaiable with a built in transmitter.

The transmitter linearizes to measured value to a 4... 20mA output and has a built in failure mode, loop.

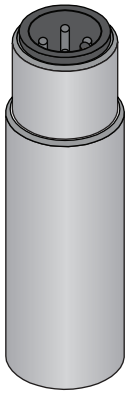
2.2.2 Types of electrical connections

Electrical connections protects the temperature transmitter from environmental effects (e. g. dirt or dust). They are available as:

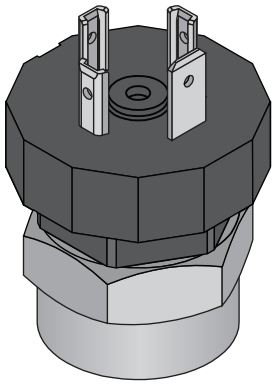
- M12 connector
- Valve EN 175301-803 connector

Electrical connections available

M12 connector



Valve EN 175301-803 connector



2.2.3 Types of temperature transmitters

Electrical temperature assemblies 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. The operator alone is responsible for this decision.

There are two types of temperature transmitters:

- Built-in transmitter: Located in the housing of the temperature assembly
- Rail-mounted transmitter: Located in the control cabinet or field housing, recognisable by the "R" in the product name (e. g. TT 50 R); they are usually used when the temperature in the connection head does not allow for the use of a head-mounted transmitter

Built in transmitters

The built-in transmitters convert the temperature sensor's small signal into a standardised output signal of 4...20 mA, not susceptible to interference. Which built in transmitter that is used depends on the choice of the sensor.

The temperature range is set at factory:

- 0... +100°C / +32... +212°F
- -50... +150°C / -58... +302°F

Other temperature ranges are available on request.

Rail mounted transmitters

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

Available rail mounted transmitters
TT 10 R (analogue, 4...20 mA)
TT 11 R (analogue 3-wire transmitter, output: 0...10 VDC)
TT 30 R (digital, 4...20 mA)
TT 31 R (digital, 4...20 mA, 1- & 2-channel)
TT 32 R (digital 4-wire, outputs: 0/4...20 mA, 0/1...5 VDC, 0/2...10 VDC)
TT 40 R (digital, 4...20 mA, precise)
TT 50 R (digital, 4...20 mA, HART®)
TT 51 R (digital, 4...20 mA, HART®, SIL2, precise)
TT 60 R (digital, Profibus-PA)

INFORMATION!
Consult the relevant transmitter handbook for more detailed information on the rail mountesd temperature transmitters.

2.2.4 Housing

The housing connects the process connection (i.e. screw socket or flange) to the electrical contact. Its function is to thermally decouple the connection and transmitter so the ambient temperature doesn't exceed the permissible limits.

The materials of the housing and the thermowell are identical.

2.2.5 Thermowells

The thermowell is designed to prevent external loads (e. g. static pressure, flowing and aggressive media) from damaging the sensor element. As a rule, the thermowell is made of the same material as the system in which the measuring is done. The thermowell is built up from multiple part and welded together.

2.3 Process connections and areas of application

2.3.1 Threaded sensor

The gas tight threaded process connection is suitable for general applications with none or low pressure. Can be mounted on pipes or tanks like in the chemical industry and into a solid part as in the equipment industry. Depending on the application there are several types of threads and standards to consider.

2.3.2 Flange sensor

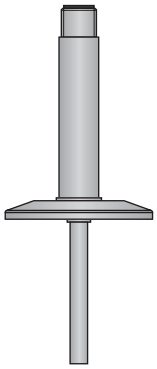
The ISO 2852 Stainless steel clamp is a pipe coupling for the food and beverage industry. It is an international standard defining a non-permanent hygienic piping interconnect method. Mainly used in the food processing industry and with dairy farm equipment. The connection is built up with a flange on the instrument and a counter flange in the pipe or tank. Between the flanges a polymer sealing gasket fitting is placed. An enclosing clamp covers the outer circumference of the flange to squeeze the two flanges together and with help of the gasket make a tight and solid connection.
This clamp connection makes it easy to connect and disconnect without any special tools, suitable for processes where continues cleaning is required like the food and beverage industry. Companies that supply products according to the specifications of ISO 2852 do not necessarily mention the ISO standard as such, instead referring to the equipment by terms common in the relevant industries or applications like Tri-clamp or S-clamp.

2.4 Overview of available versions

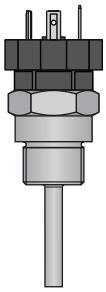
INFORMATION!
The beginning of the product name refers to the type of sensor in the temperature assembly:

- *TRA: Sensor with Pt100, RTD*
- *C: Compact series*

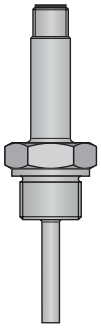
TRA-C10



TRA-C20



TRA-C30



2.5 Nameplate

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

The nameplate is located on the housing, it measures 42.4 mm x 8.5 mm / 1.67" x 0.33":

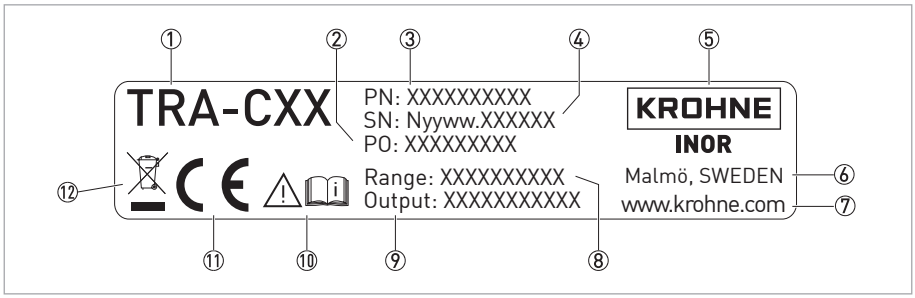


Figure 2-2: Sample nameplate

① Type of compact sensor
② Production Order
③ Part number
④ Individual serial number
⑤ Manufacturer
⑥ Production site
⑦ Manufacturer's website
⑧ Range
⑨ Output
①⓪ Note that the handbook is available for download from the manufacturer's website
①① CE Marking
①② WEEE Marking

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

3.1 General notes on installation

CAUTION!
Installation, assembly, start-up and maintenance may only be performed by appropriately trained personnel. The regional occupational health and safety directives must always be observed.

INFORMATION!
Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

INFORMATION!
Do a check of the packing list to make sure that you have all the elements given in the order.

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

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

3.2 Storage

CAUTION!
Always store industrial temperature assemblies in a dry place protected from dust. The permissible range for storage temperatures is -40...+70° C / -40...+176° F.

3.3 Transport

CAUTION!
Always transport industrial temperature assemblies 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

CAUTION!
Take the following points into consideration prior to installing the temperature assembly:

- *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.*

3.4.1 Possible installations

Installations include the parameters "installation site", "installation angle" and "insertion length". Depending on the space available and the diameter of the pipe, three installations are recommended for pipes with flowing product:

- 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).

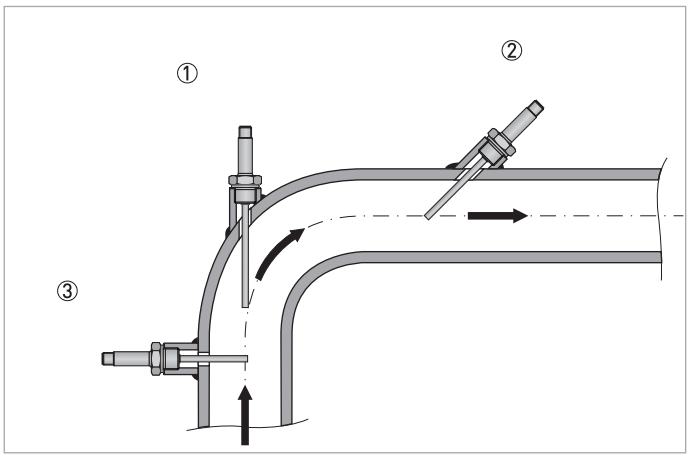


Figure 3-1: Recommended installations

Permitted 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) or the bottom of the flange (for flange thermometers) to the tip of the thermowell or sheath. 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 requirement:

- Tubes with Ø < 300 mm / 11.8": thermowell tip should project past the middle of the pipe is possible, if the flow velocity of the product allows it.

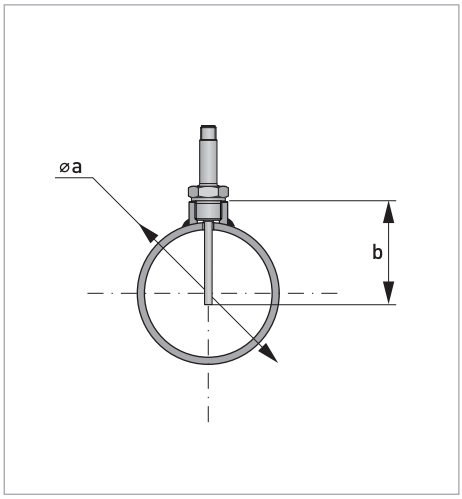


Figure 3-2: Permitted insertion length

3.4.2 Other installation requirements

DANGER!
When a seal is damaged or incorrect, the medium may leak out, causing material damage or bodily harm! It is the sole responsibility of the operator to select the right seal.

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

3.5 Load limits

The load limits of compact sensors depend on several factors:

- Dimensions and design of the measuring tip (especially the insertion length and diameter)
- Tip material
- Mechanical conditions the tip 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. For further information, please contact the manufacturer.

3.5.1 Vibration load

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

All industrial temperature assemblies that feature an insert and neck tube and are attached to the process connection have two components that can vibrate: the insert and the neck tube with the neck tube. That is why the terms "insert resonance" and "neck tube resonance" are commonly heard.

An insert 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, there is generally no damage is caused. The opposite is true, however, if the vibrations remain permanently in the resonance range.

3.5.2 Temperature load

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

CAUTION!
When the temperature is too high, the connection and the components found in the neck tube (e. g. temperature transmitter) can be damaged or destroyed! It is your responsibility as the operator to ensure that the connection and transmitter does not get too hot. If this does happen, select another installation site or a longer neck tube.

CAUTION!
Sometimes even a neck tube cannot prevent the maximum permissible temperature in the transmitter or electrical connection from being exceeded! It does cause extensive thermal decoupling of the connection but you still have to always take into consideration the installation situation as well as the ambient and process temperatures!

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 Threaded compact sensor

A threaded compact sensor 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 / 0.8" require a sleeve to be welded in; these are not included in delivery but make up part of the accessories range.

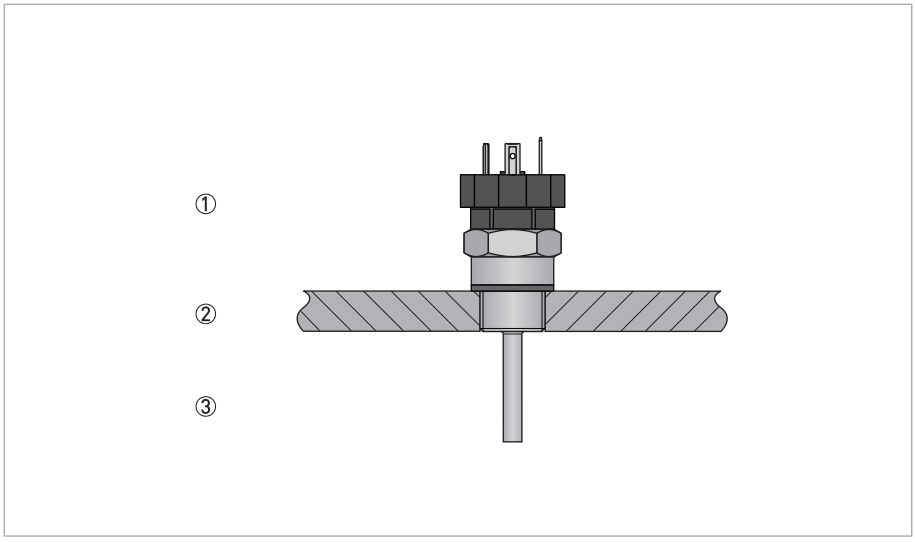


Figure 3-3: Compact sensor for direct screw-in

① Housing
② Threading into application's wall
③ Thermowell

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! It does cause extensive thermal decoupling of the connection head but you still have to always take into consideration the installation situation as well as the ambient and process temperatures!

3.6.2 Flange sensor

The compact flange sensor can be installed using a ISO 2852 DN25/38 clamp, for example, as shown in the following drawing:

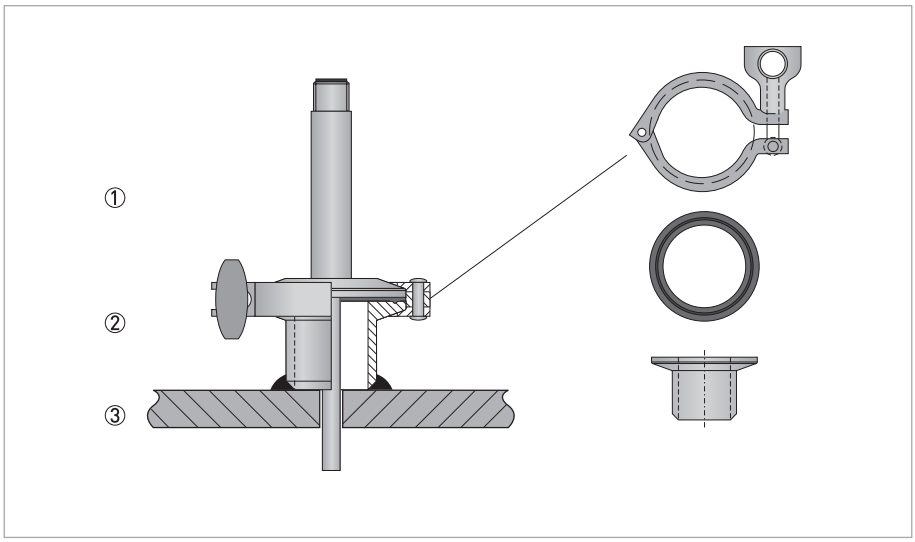


Figure 3-4: Installing a compact sensor with a ISO 2852 DN25/38 clamp

① Housing
② ISO 2852 DN25/38 clamp
③ Application wall

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!

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!

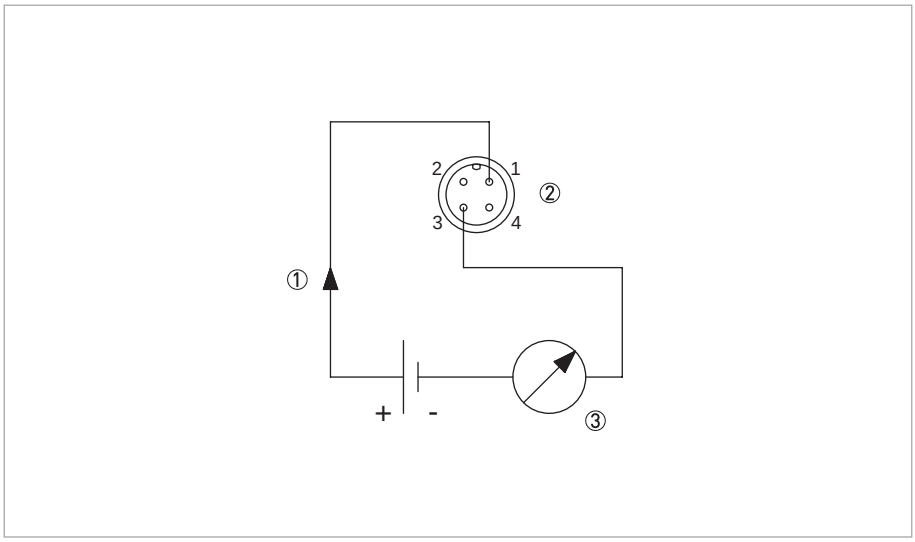
DANGER!
Observe the national regulations for electrical installations!

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.

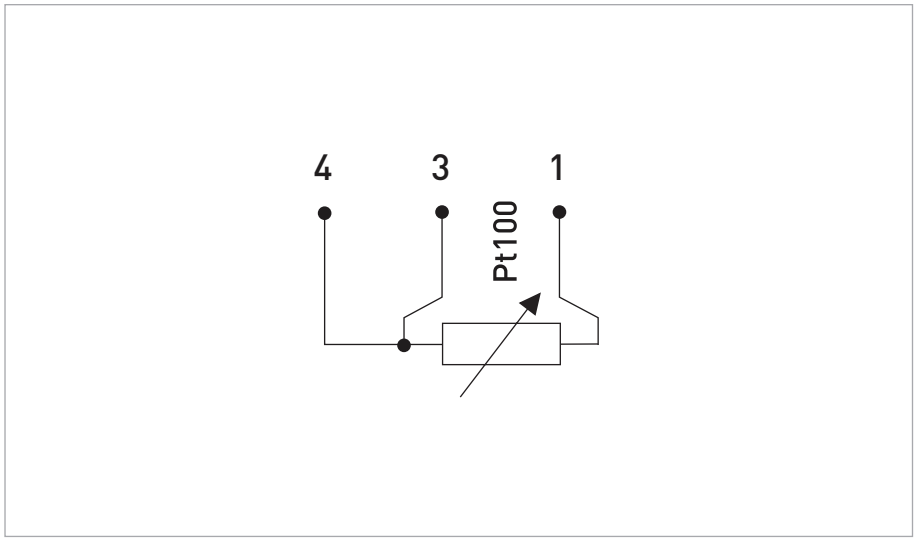
4.2 Electrical connection of M12 connector

Electrical connection with transmitter



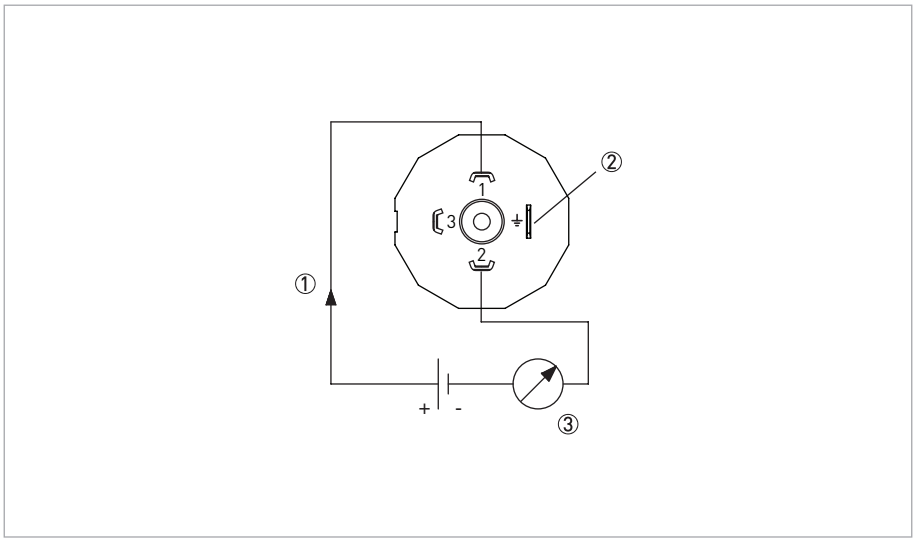
① Out
② M12-connector front view
③ R_{Load}

Electrical connection without transmitter



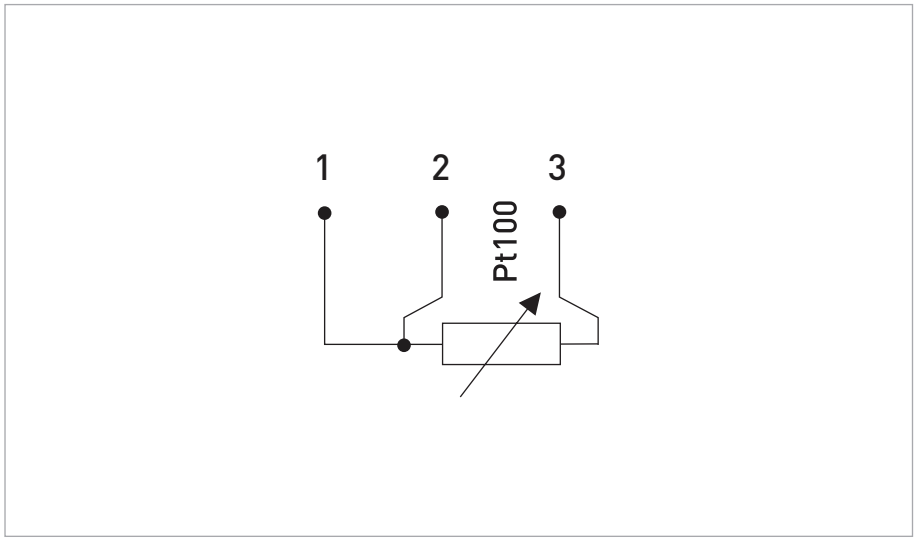
4.3 Electrical connection of Valve EN 175301-803 connector

Electrical connection with transmitter



① I_{Out}
② Grounding not connected
③ R_{Load}

Electrical connection without transmitter



4.4 Grounding

DANGER!
The thermowells on the industrial temperature assemblies are grounded via the process connection. No additional grounding is required.

4.5 Protection category

The IP protection category of an compact sensors depends on connection contact. When the cable contact is connected properly the compact sensors TRA-C10 and TRA-C30 are available in class IP67 and TRA-C20 in class IP65.

4.6 Power supply

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

5.1 Start-up

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

- *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 compact sensor has been properly electrically connected according to the manufacturer's instructions. refer to Electrical connections on page 24*

5.2 Normal operation

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

5.3 Faults and damage: reason and remedies

INFORMATION!
The most probable cause of a fault is the sensor element itself and its electronic components. The following issues come into question here:

- *Short circuit or open circuit*
- *Insulation resistance too low*

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 heat transfer caused by too short insertion length of thermowell: the compact sensor 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 heat transfer via the process connection, the pipeline or the tank wall due to a lack of insulation.
- Incorrect thermowell dimensions (diameter, wall thickness).

To keep the heat transfer to a minimum, either increase the insertion length of the compact sensor or improve the insulation of the measuring point.

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 Cleaning and maintenance

As a rule, the temperature assemblies 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.

6.2 Availability of services

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

INFORMATION!
For more precise information, please contact your local sales office.

6.3 Returning the device to the manufacturer

6.3.1 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 the personnel, the 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 neutralising, 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.*

6.3.2 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:	☐	radioactive
	☐	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:		

6.4 Disposal

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

7.1 Measuring principle

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

The type of measuring principle depends on the sensor that you combine with the transmitter. Two different sensor types are available for transmitters, RTD and thermocouple. The RTD's measuring principle are used in the compact sensors and described in the following subsection.

7.1.1 Resistance temperature sensor

The measuring insert with a temperature-sensitive sensor made from a platinum RTD, whose value at 0°C / +32°F is 100 Ω. That is where the name "Pt100" comes from.

It is generally valid that the electric resistance of metals increases according to a mathematical function as the temperature rises. This effect is taken advantage of by resistance temperature sensors to measure temperature. The "Pt100" temperature sensors features a measuring resistance with defined characteristics, standardised in IEC 60751. The same is true for the tolerances. The average temperature coefficient of a Pt100 is 3.85 x 10^{-3} K^{-1} in the range from 0...+100°C / +32...+212°F.

During operation, a constant current I (≤ 1 mA) flows through the Pt100 RTD, which brings about a voltage drop U. The resistance R is calculated using Ohm's Law (R=U/I). As the voltage drop U at 0°C / +32°F is 100 mV, the resulting resistance of the Pt100 temperature assembly is 100 Ω (100 mV / 1 mA = 100 Ω).

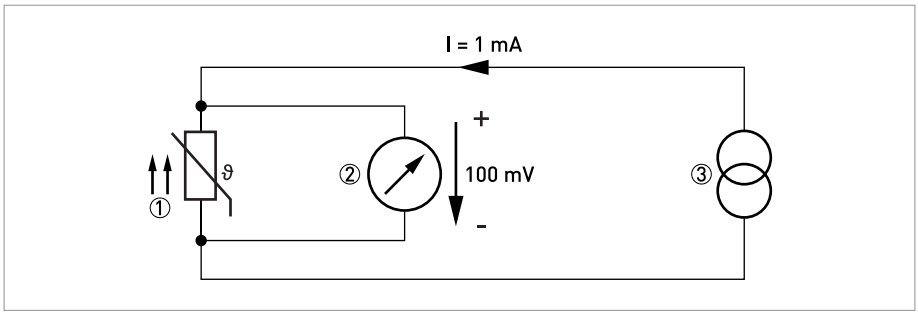


Figure 7-1: Pt100 resistance temperature sensor in 4-wire connection at 0°C / +32°F, schematic.

① Pt100 RTD
② Voltage meter
③ Current source

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 sales office.*
- *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 sensor
Measured value	Temperature

Design

Modular design	Industrial temperature sensors consist of several components which, together, form a thermometer assembly: • Thermowell • Housing • Electrical connection • Transmitter (built in or rail mounted)
Signal converter	Built-in analog transmitter, OPTITEMP OEM 201 Analogue or digital temperature transmitter in the TT family as rail-mount transmitter.
Sensor	Pt100 RTD as thin layer (TF), class A with a characteristic according to DIN EN 60751.
Surface roughness(only valid for TRA-C10)	Ra 0.8, Ra <0.8 electropolished available on request
Measuring range	Refer to "Operating conditions".

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	More detailed information in the subsection "Measurement Error" (also in the "Technical data" section). The maximum measurement error also depends on the type of sensor: • Sensor element with Pt100 RTD: measurement error in accordance with tolerance class A, according to DIN EN 60751.
Long term stability for built-in transmitter	±0.1% of span per year
Influence of ambient for bulit in transmitter	Max. of ±0.01°C or ±0.01% of span per °C Max. of ±0.01°F or ±0.006% of span per °F
Response time for built in transmitter	< 10 ms

Operating conditions

Load limits	The load limits depend on several factors (e.g. dimensions, design and material of thermowell). The compact sensor TRA-C10 can handle pressure up to 16 bar / 232 psia while TRA-C20 and TRA-C30 can handle pressures up to 40 bar / 580 psia. This applies only if the sensor is mounted properly.
Temperature	
Process temperature	Maximum -50...+200°C / -50...+392°F, depending on design and material.
Pre-configured temperature ranges	-50...+150°C / -58...+302°F or 0...+100°C / 32... +212°F (Other ranges available on request)
Ambient temperature	Maximum -40...+85°C / -40...+185°F, depending on media temperature, sensor design and material.
Storage temperature	-40...+70°C / -40...+158°F at 40...60% relative humidity.
Other conditions	
Protection categories	Following protection categories can be provided if the connection cable is properly connected: OPTITEMP TRA-C10, TRA-C30: IP67 OPTITEMP TRA-C20: IP65
Shock resistance:	Acc. to IEC60068-2-31, test Ec
Vibrations resistance:	Acc. to IEC60068-2-6, test Fc, 10-2000Hz, 4g

Installation conditions

Insertion angle	90° to the flow, directly against or diagonally against the flow.
Insertion length	Recommendable: 10...15 x thermowell diameter for gas, 5...10 x thermowell diameter for liquids (short insertion lengths may impair measuring accuracy).

Materials

Thermowells (including process connection)	The metal materials of the thermowells, neck tubes, flanges and threads as process connections are always identical:
	Standard:
	1.4404 / AISI 316 L (X2CrNiMo 17-12-2)

Process connections

Threaded thermometer	Gastight thread acc. to ISO 228/1: G½, 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	Acc. to ISO 2852: DN25/38, other sizes on request.

Electrical connections

Power supply	Only necessary when using a temperature transmitter and depends on transmitter type, typically 24 VDC. 7.5...32VDC for the built-in transmitter.
Power consumption	Only when using a temperature transmitter, typically 550 mW.
Electrical connection	M12-connector (for TRA-C10 and TRA-C30) or Valve EN 175301-803 (for TRA-C20)
Current output	
Output range	Exists only when using a temperature transmitter, 4...20 mA
Error signal	Sensor break: Upscale (>=21,0 mA) Sensor short-circuit: Downscale (<=3,6 mA)
Load	Relevant only when using a temperature transmitter (typically 250 Ω).
Other electrical characteristics	
Galvanic isolation	Relevant only when using a temperature external transmitter (see transmitter handbook).
Time constant	More detailed information can be found in the subsection "Response times" of the section "Technical data".

Approvals and certificates

Electromagnetic compatibility	For bulit in transmitter EN 61326-1 ESD, Radiated EM-field: Criteria A, Surge: max 3% of span during disturbance influence Burst and Conducted RF: max 1% of span during disturbance influence For external transmitter, refer to handbook for used temperature transmitter.
CE	The device fulfils the statutory requirements of the EC directives. The Manufacturer certifies that these requirements have been met by applying the CE marking.

7.3 Dimensions

7.3.1 Compact sensors

The dimensions for the compact sensors given in this subsection are standard measurements. Upon request the manufacturer can supply devices with other dimensions.

OPTITEMP TRA-C10

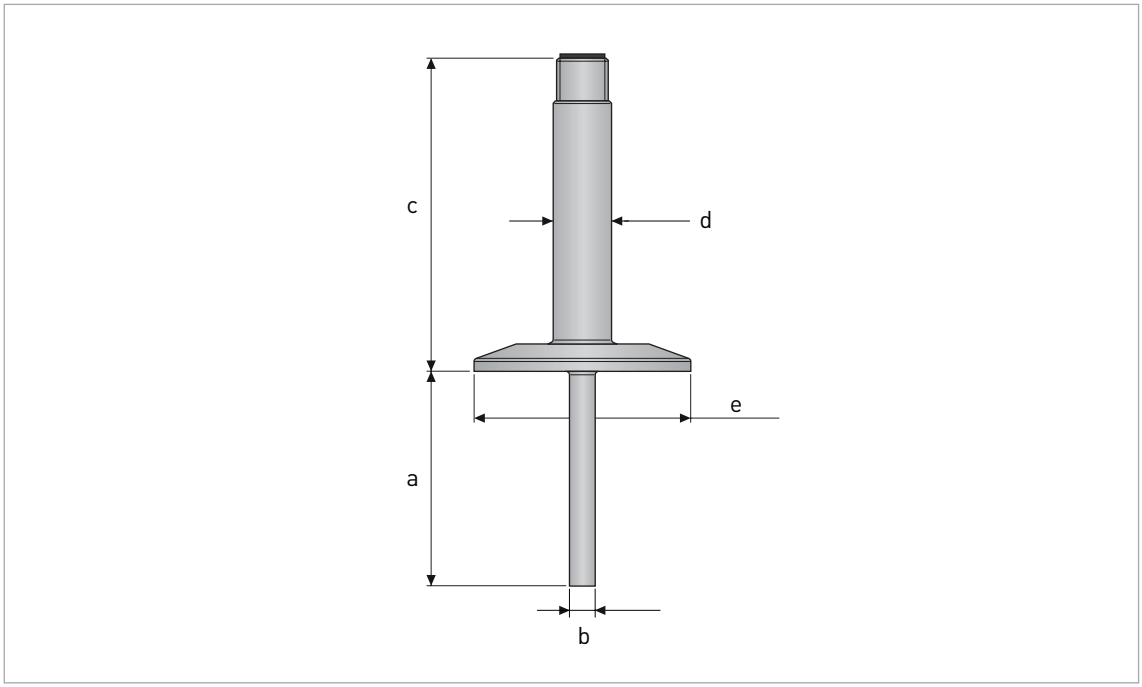


Figure 7-2: Dimensions of OPTITEMP TRA-C10

TRA-C10									
"a" (insertion length)		"b" (thermowell diameter)		"c" (housing length)		"d" (housing diameter)		"e" (flange diameter)	
[mm]	["]	[mm]	["]	[mm]	["]	[mm]	["]	[mm]	["]
50	1.97	6	0.24	73	2.87	13.5	0.53	50.5	1.99
100	3.94	6	0.24	73	2.87	13.5	0.53	50.5	1.99
50	1.97	6	0.24	88	3.46	13.5	0.53	50.5	1.99
100	3.94	6	0.24	88	3.46	13.5	0.53	50.5	1.99

OPTITEMP TRA-C20

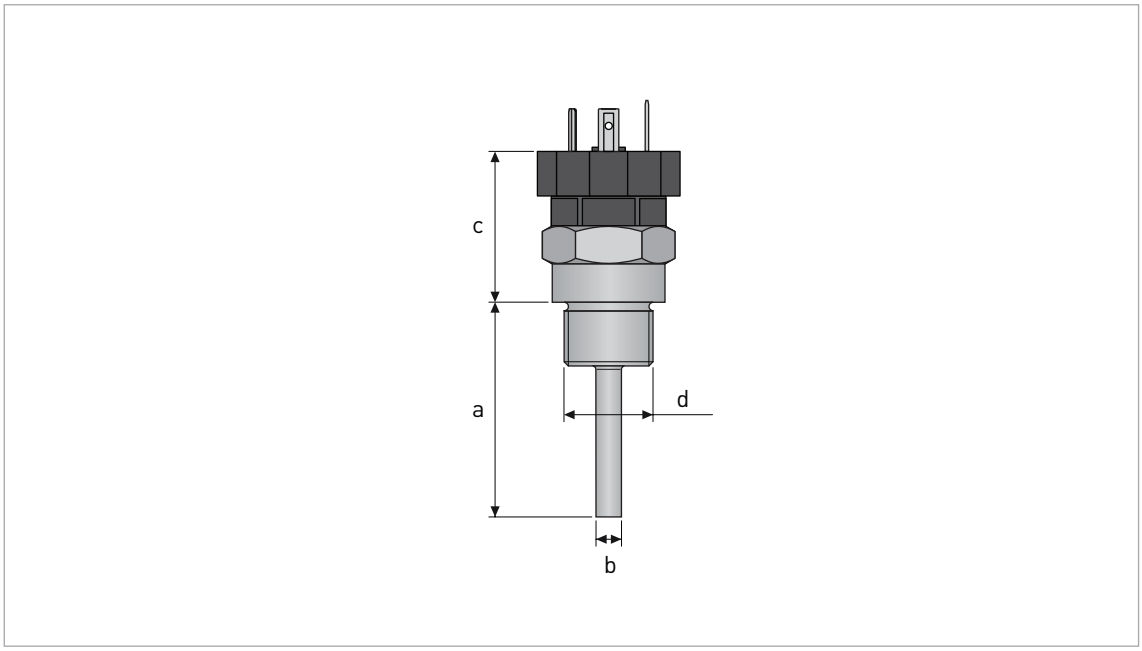


Figure 7-3: Dimensions of OPTITEMP TRA-C20

TRA-C20							
"a" (insertion length)		"b" (thermowell diameter)		"c" (housing length)		"d" (thread dimension)	
[mm]	["]	[mm]	["]	[mm]	["]	[mm]	["]
50	1.97	6	0.24	35.5	1.40	G1/2"	G1/2"
100	3.94	6	0.24	35.5	1.40	G1/2"	G1/2"

OPTITEMP TRA-C30

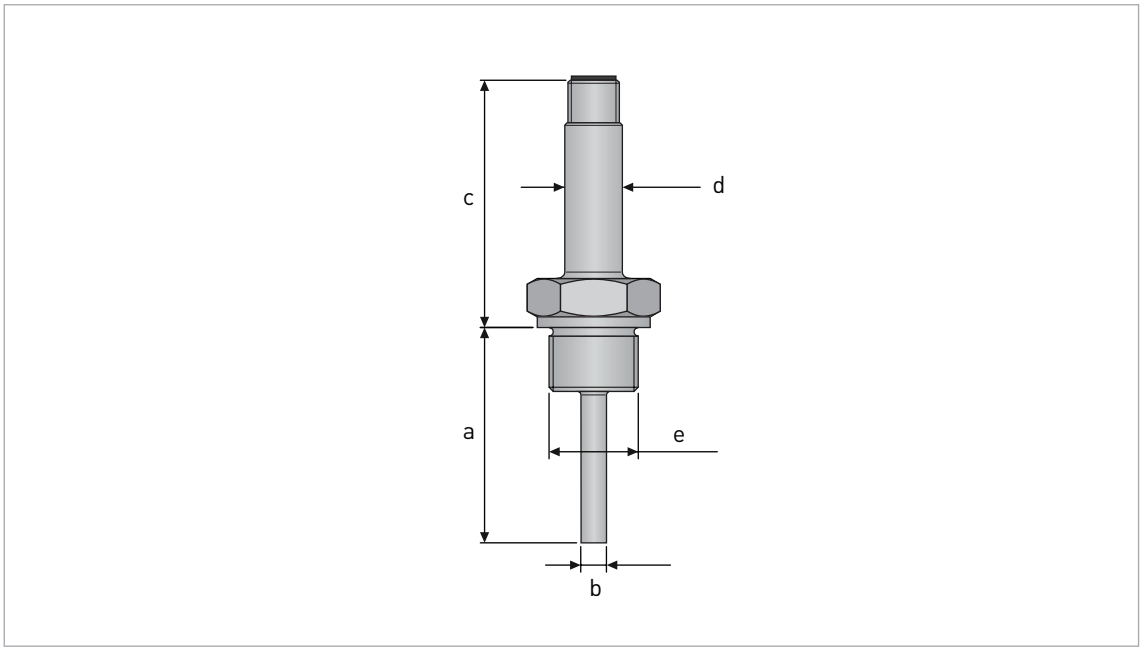


Figure 7-4: Dimensions of OPTITEMP TRA-C30

TRA-C30									
"a" (insertion length)		"b" (thermowell diameter)		"c" (housing length)		"d" (housing diameter)		"e" (thread dimension)	
[mm]	["]	[mm]	["]	[mm]	["]	[mm]	["]	[mm]	["]
50	1.97	6	0.24	56	2.2	13.5	0.53	G1/2"	G1/2"
100	3.94	6	0.24	56	2.2	13.5	0.53	G1/2"	G1/2"
50	1.97	6	0.24	72	2.83	13.5	0.53	G1/2"	G1/2"
100	3.94	6	0.24	72	2.83	13.5	0.53	G1/2"	G1/2"

7.4 Measuring accuracy

The measuring accuracy depends largely on the following factors:

- The type of the measuring 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 external temperature transmitters.

With the exception of the TT 60 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. The measuring accuracy of the RTD sensor without transmitter is class A according to IEC 60751.

Temperature transmitter

Type of temperature transmitter	Accuracy (% of the measuring range or °K)
Built-in transmitter OPTITEMP OEM 201 (analogue, 4...20 mA)	± 0.15%
TT 10 R (analogue, 4...20 mA)	± 0.15%
TT 11 R (analogue 3-wire transmitter, output: 0...10 VDC)	± 0.15%
TT 30 R (digital, 4...20 mA)	± 0.10%
TT 31 R (digital, 4...20 mA, 1- & 2-channel)	± 0.10%
TT 32 R (digital 4-wire, outputs: 0/4...20 mA, 0/1...5 VDC, 0/2...10 VDC)	± 0.10%
TT 40 R (digital, 4...20 mA, precise)	± 0.05%
TT 50 R (digital, 4...20 mA, HART®)	± 0.10%
TT 51 R (digital, 4...20 mA, HART®, SIL2, precise)	± 0.05%
TT 60 R (digital, Profibus-PA)	± 0.10°K

7.5 Process connections

Threaded compact sensor

Process connection	Ø of thermowell (material 1.4404 / 316 L)	
	[mm]	["]
Thread G½"	6	0.24

Flange compact sensor

Process connection	Ø of thermowell (material 1.4404 / 316 L)	
	[mm]	["]
ISO 2852 Clamp DN25/38	6	0.24

7.6 Sensor response time

Sensor response times are generally indicated as "50% time" (t_{05}) and "90% time" (t_{09}). "50% time" refers to the time needed for a temperature sensor 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.

Compact sensor with thermowell, with measuring element Pt100 RTD

Ø of thermowell		Water with 0.4 m/s or 1.31 ft/s	
[mm]	["]	t_{05} [s]	t_{09} [s]
6	0.24	3.2	9.0
Water flows against the compact sensor at 0.4 m/s or 1.31 ft/s			

The transmitter response time is <10 ms.

8.1 Technical legislation in effect

Standard	Title
VDE/VDI 3511	Technical temperature measurements
VDI/VDE 3522	Response time of contact temperature assemblies.
IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors.

KROHNE product overview

- Electromagnetic flowmeters
- Variable area flowmeters
- Ultrasonic flowmeters
- Mass flowmeters
- Vortex flowmeters
- Flow controllers
- Level meters
- Temperature assemblies
- Pressure transmitters
- Analysis products
- Products and systems for the oil & gas industry
- Measuring systems for the marine industry

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