Installing and Using JUMO Thermometers

Operating Manual

90000000T90Z001K000

V1.00/EN/00759990/2022-01-20

JUMO

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1.1 Safety information

1.1.1 Warning symbols

DANGER!

This symbol indicates that **personal injury from electrocution** may occur if the appropriate precautionary measures are not taken.

WARNING!

This symbol in connection with the signal word indicates that **personal injury** may occur if the respective precautionary measures are not carried out.

CAUTION!

This symbol in connection with the signal word indicates that **material damage or data loss** will occur if the respective precautionary measures are not taken.

READ THE DOCUMENTATION!

This symbol, which is attached to the device, indicates that the associated **documentation for the device** must be **observed**. This is necessary to identify the nature of the potential hazard, and to take measures to prevent it.

1.1.2 Note symbols

Note symbols

NOTE!

This symbol refers to **important information** about the product, its handling, or additional benefits.

REFERENCE!

This symbol refers to **additional information** in other sections, chapters, or other manuals.

DISPOSAL!

At the end of its service life, this device and any batteries present do not belong in the trash! Dispose of batteries properly and in an **environmentally friendly manner**.

1.2 Intended use

NOTE!

To ensure operational safety, it is essential to use the thermometers properly and install them correctly.

Before carrying out installation work, it is therefore crucial to familiarize yourself with the thermometer, its proper use, and the installation process. This document is a key reference work in this respect, along with product-specific operating manuals in individual cases.

Observe the accident prevention regulations and safety provisions.

The manufacturer shall not be held liable for damage or loss resulting from:

- a failure to use the device in accordance with its proper use
- a failure to observe the specifications in this manual
- the use of unqualified personnel
- unauthorized conversions or modifications
- the use of external spare parts

DANGER!

Non-approved batteries constitute a safety risk!

Non-approved batteries may ignite potentially explosive atmospheres.

▶ The Ex approval becomes null and void if non-approved batteries are used.

NOTICE!

Contamination may destroy the device!

Make sure that pollutants, moisture, and steam cannot enter the device.

▶ When inserting or changing the battery, make sure that the device is not exposed to pollutants, moisture, or steam.

NOTICE!

Damage to the device caused by incorrect battery polarity!

If the polarity is incorrect the device will be irreparably damaged.

▶ Make sure that the battery poles are correctly connected.

2.1 General information

This operating manual supplements product-specific data sheets and applies generally for JUMO thermometers used for contact-based temperature measurement.

NOTE!

Additional useful literature is referenced in chapter 12 "Further information and downloads", Page 45. If you have any doubts, follow the specifications in the product-specific operating manuals or data sheets.

WARNING!

Risk of personal injury or damage to property!

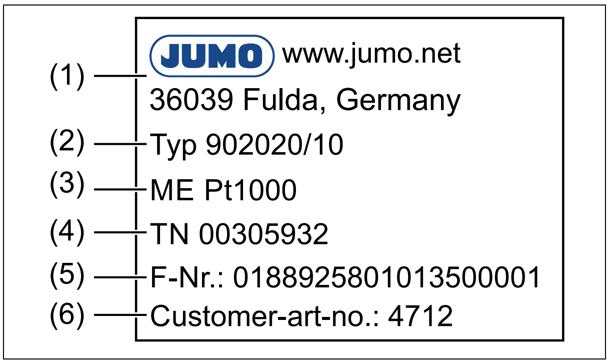
Improperly performed work will result in personal injury or damage to property.

▶ As a basic principle, installation and startup work for JUMO thermometers may only be performed by qualified and authorized personnel who strictly follow this manual, the relevant standards and legal regulations, the safety provisions, and the application-specific certificates.

2.2 Identifying the device version

In addition to clearly defined outer geometries, color coding for the connection lines, and resistance measurements between the connection poles, thermometers are also identified by their nameplates and labeling.

Labeling example



(1) Company identifier
(2) Probe type
(3) Sensing element
(4) Part number, 8-digit
(5) Fabrication number, max. 19-digit
(6) Customer text

NOTE!

The fabrication number on the nameplate is the most important specification when communicating with JUMO.

Thermocouple or RTD temperature probe?

The following table serves as a general guide for comparing RTD temperature probes and thermocouples. The particular features in individual cases are determined by the specific thermometer design.

Factor	RTD temperature probe	Thermocouple
Dimensions	Comparatively large sensor surface	Can be very small
Temperature range	Up to approx. 600 °C[a]	Very high temperatures possible
Response times	Relatively long	Short
Accuracy	Very high	High
Long-term stability[b]	Very good	Satisfactory
Self-heating	Must be taken into account	-
Vibration resistance	Robust	Very robust

Factor	RTD temperature probe	Thermocouple
Cold junction	Not required	Required
Measuring current supplied	Yes	No
Measuring point	Sensor	Pair of thermal wires
Signal output	Resistance	Voltage

[a] However, pronounced drift effects from approx. 400 °C

[b] Depends on the operating temperatures

3.1 Design

An RTD temperature probe essentially comprises a temperature sensor, connection lines, and a protection tube. The temperature sensor is connected to a connection line/connection wires, insulated, and inserted into a protection tube (usually filled with a heat-conducting medium). The connection side can be designed as a line end that has been kept free, or designed with a terminal head, with a connector, etc.

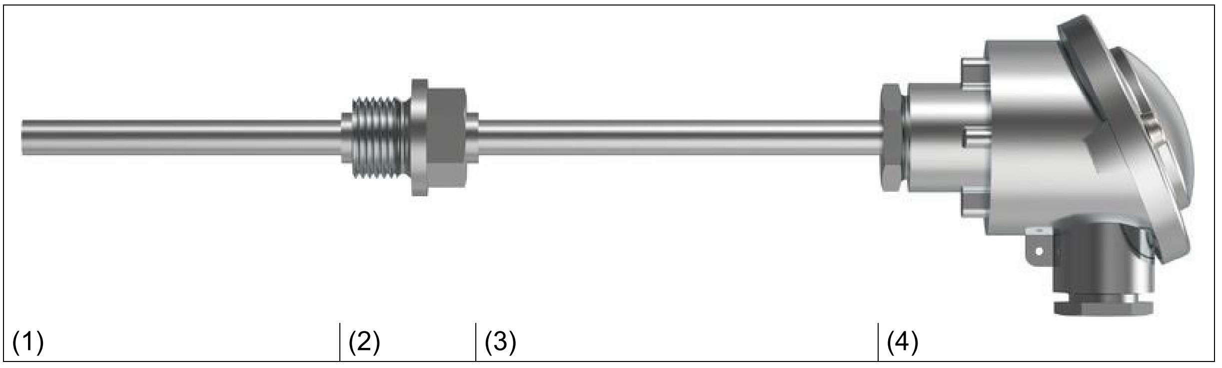
Alongside a variety of special versions, some RTD temperature probes are described fully by standards, such as

- Straight thermometers with interchangeable sensor units – DIN 43764
- Threaded-stem thermometers with G 1/2 mounting thread – DIN 43765
- Threaded-stem thermometers with G 1 mounting thread – DIN 43766
- Welded-stem thermometers – DIN 43767
- Thermometers not fitted with protecting tubes – DIN 43769
- Fast response thermometers – DIN 43771

In some cases, individual components are also described by standards, such as

- Protective tubes – DIN 43772
- Flanges – DIN EN 1092

Variant with terminal head



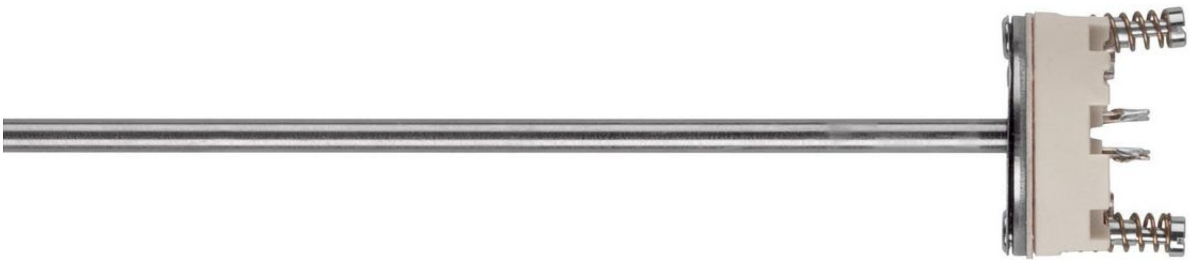
(1) Protection tube
  - In contact with the process
  - Protects the measuring insert against the medium (pressure, flow, etc.)
  - On versions with immersion sleeves, the need to open the process can be avoided, for example to replace the thermometer or measuring insert

(2) Process connection
  - Interface with the process
  - Thread, flange, etc.

(3) Extension tube
  - Protects the components (such as the transmitter) against excess temperatures in the area of the terminal head
  - Spans the insulation, such as on pipes or furnaces; the terminal head should always be outside the insulation

(4) Terminal head
  - Contains and protects the connection components
  - Display optional

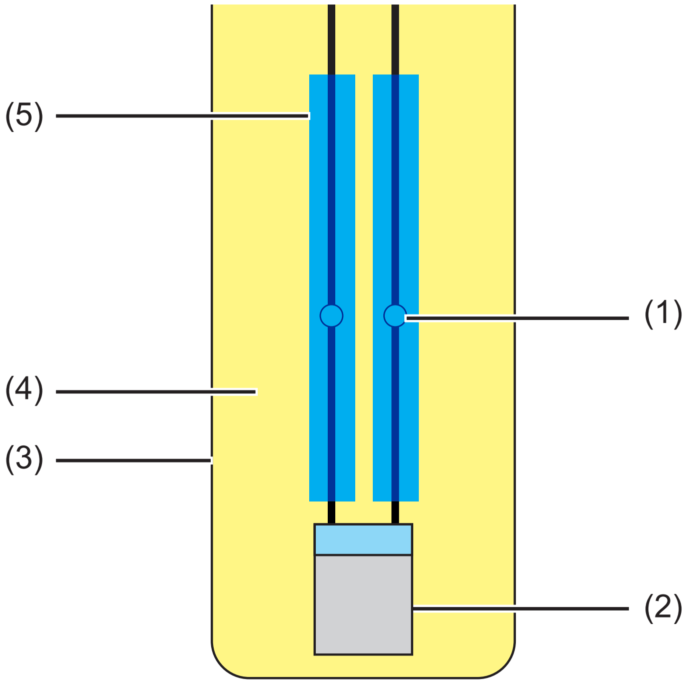
3 RTD temperature probe



(5)

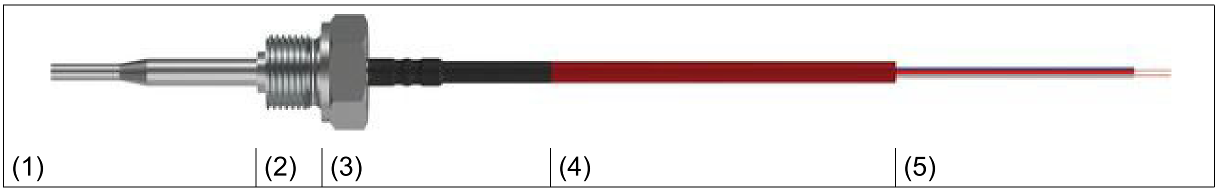
(5) Measuring insert
- Contains the temperature sensor
- Replaceable or permanently installed
- Version with connection socket or transmitter is commonly found

Example schematic of the construction of a measuring insert for RTD temperature probes:



(1) Connection points
(2) Sensor
(3) Protection tube
(4) Filled with heat-conducting medium
(5) Insulation

Variant with connection line



(1) Protection tube
- In contact with the process
- Protects the measuring insert against the medium (pressure, flow, etc.)
- On versions with immersion sleeves, the need to open the process can be avoided, for example to replace the thermometer or measuring insert

(2) Process connection
- Interface with the process
- Thread, flange, etc.

(3) Transition between protection fitting and line
- Used to fasten (strain relief) and seal the line
- Available with bend protection as an optional extra (spring or tube)

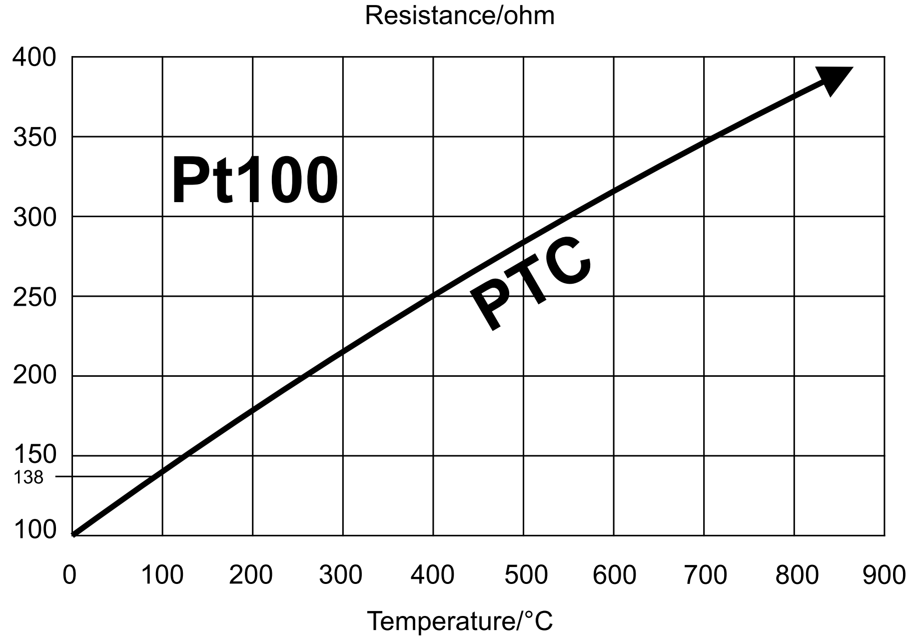
(4) Connection line
- For signal transmission

(5) Contacting
- Version as ferrule, connector, etc.

A measuring insert can be found in this variant as well.

3.2 Operating principle

RTD temperature probes take advantage of the temperature-dependent change in the resistance of the metals. For PTC resistors (PTC; positive temperature coefficient) such as platinum, the resistance increases as the temperature rises.



For thermistors (NTC; negative temperature coefficient), however, the resistance decreases as the temperature rises.

For platinum sensors, the characteristic line has been defined between -200 °C and +850 °C according to DIN EN 60751. (However, the standard stipulates that limit deviations are only defined up to max. 660 °C.)

As a result, resistance measurements taken using the connection lines and the measuring surface of the temperature sensor allows conclusions to be drawn about the temperature, provided that the exact relationship between temperature and resistance has been established.

For PTCs, the nominal value is taken to be the resistance at 0 °C.

Example:

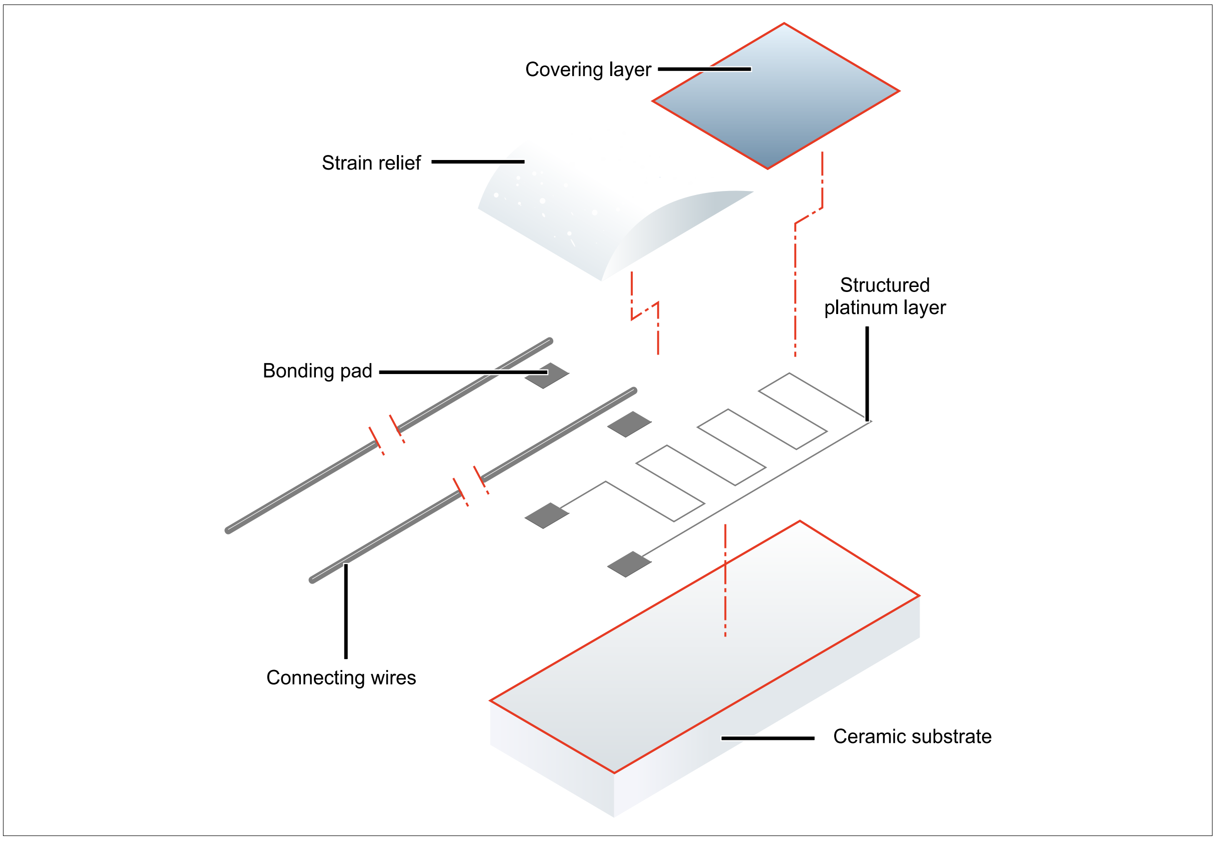
Resistance at 0 °C	Nominal value	Sensor designation
100 Ω	100	Pt100 temperature sensor

3.3 Sensor types

Sensors come in different versions. We essentially distinguish between thin-film sensors and sensors with a solid wire winding.

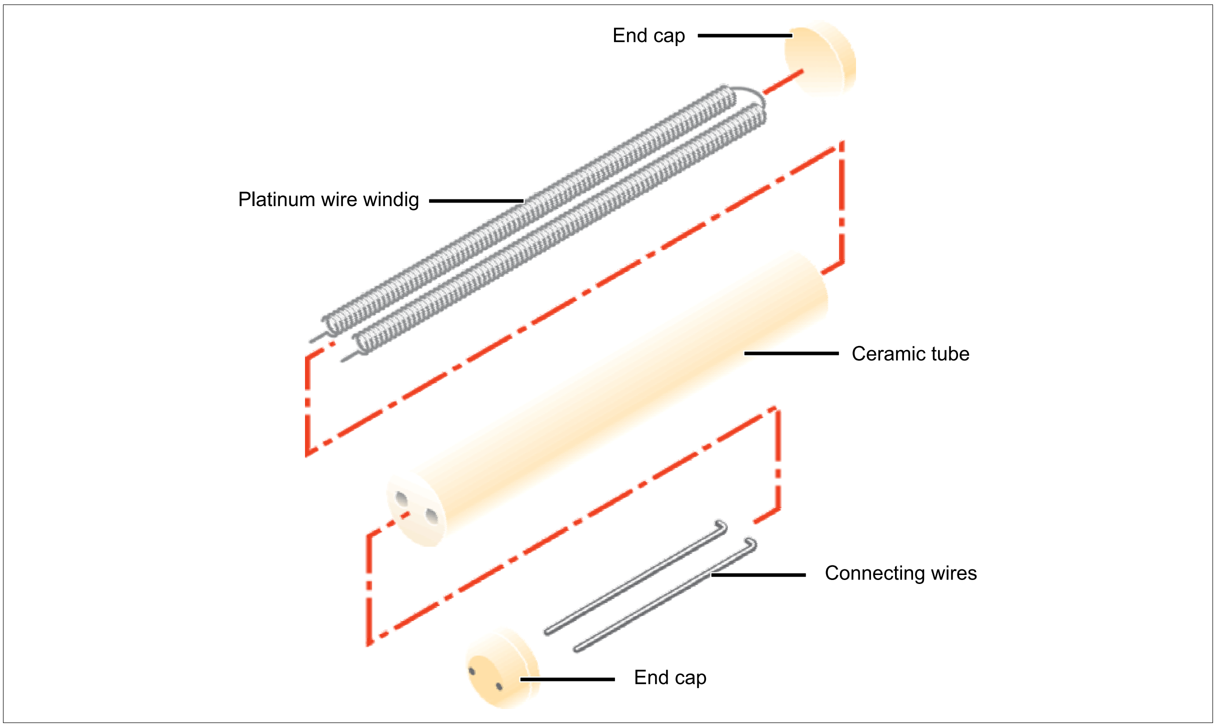
The most common sensors are shown below.

Platinum-chip temperature sensors with connection wires, type PCA

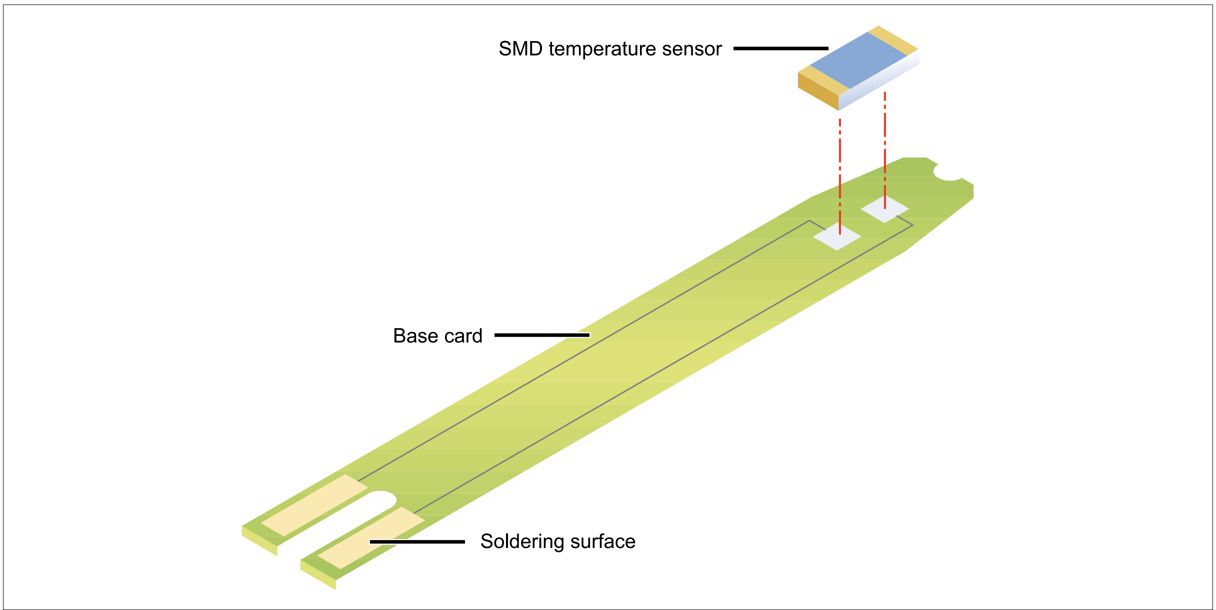


3 RTD temperature probe

Platinum-ceramic temperature sensors, type PK

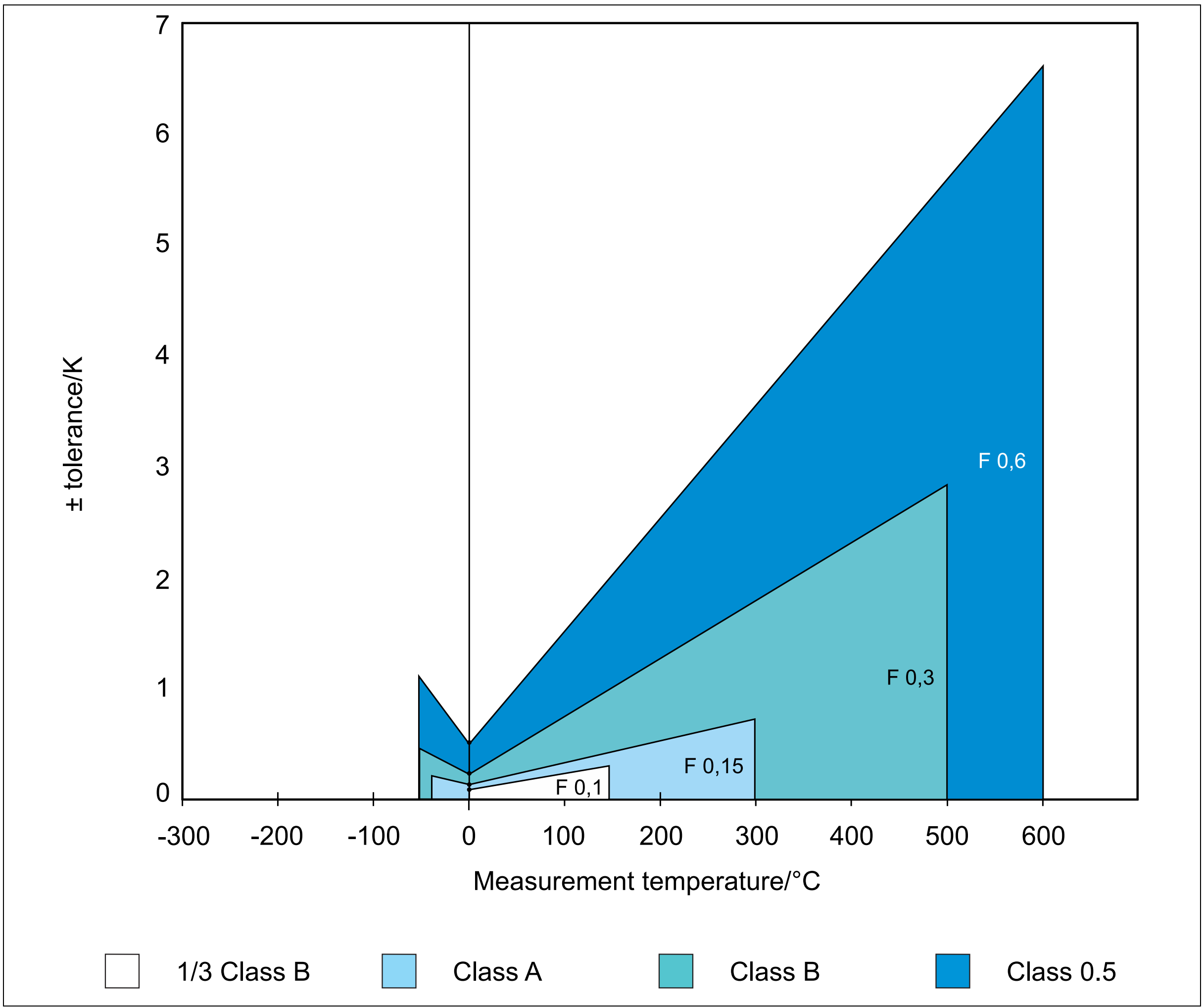


Platinum-chip temperature sensors on an epoxy PCB, type PCSE



3.4 Tolerance classes

Change in tolerance depending on the measurement temperature (thin film)



Tolerance classes – temperature validity range (from DIN EN 60751)

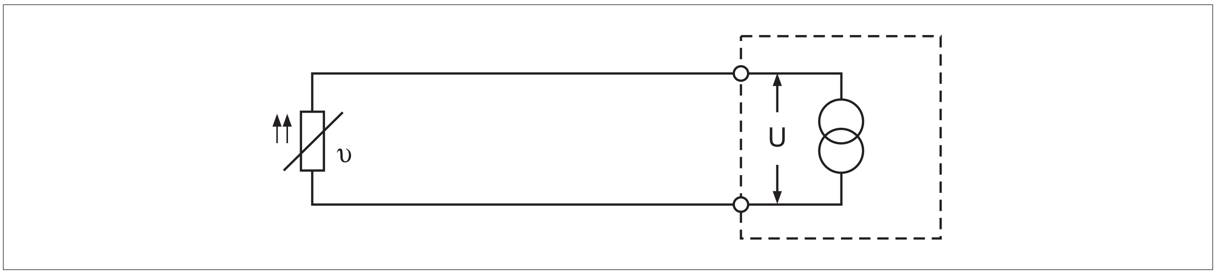
Tolerance class	Sensor category	Temperature range	Tolerance
F 0.1	Thin film	0 to 150 °C	± (0.1 K + 0.0017 × |t|)
F 0.15	Thin film	-30 to +300 °C	± (0.15 K + 0.002 × |t|)
F 0.3	Thin film	-50 to +500 °C	± (0.3 K + 0.005 × |t|)
F 0.6	Thin film	-50 to +600 °C	± (0.6 K + 0.01 × |t|)
W 0.1	Wire winding	-50 to +250 °C	± (0.1 K + 0.0017 × |t|)
W 0.15	Wire winding	-100 to +450 °C	± (0.15 K + 0.002 × |t|)
W 0.3	Wire winding	-196 to +660 °C	± (0.3 K + 0.005 × |t|)
W 0.6	Wire winding	-196 to +660 °C	± (0.6 K + 0.01 × |t|)

t = measurement temperature in °C

3.5 Circuit types

3.5.1 Two-wire circuit

The two-wire circuit is the simplest circuit type for RTD temperature probes.



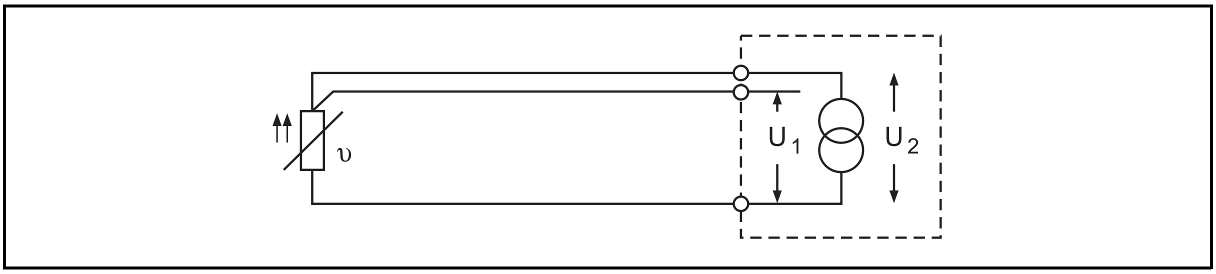
Three and four-wire circuits are also used to enable more accurate measurements.

With two-wire circuits, the line resistance influences the measurement result. This means that to obtain accurate measurement results, the line resistance must be deducted or needs to be corrected at the evaluation electronics; please see chapter 5.1.1 "Correcting line resistances", Page 22.

Minor deviations in the line resistance may occur due to fluctuations in temperature and the production process.

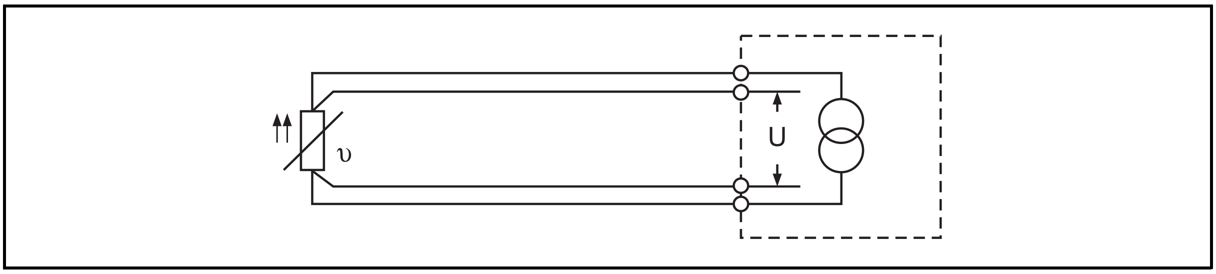
3.5.2 Three-wire circuit

With three-wire circuits, it is possible to partially compensate the influence of the line resistances as a result of temperature fluctuations. An additional measuring circuit is formed, which can be used as a reference. For this to work, the wire features must be identical.



3.5.3 Four-wire circuit

With a four-wire circuit, two measuring circuits are formed. The deviations (temperature-dependent supply line resistances, differing line resistances, etc.) can be fully compensated.



4.1 Design

A thermocouple essentially comprises a pair of thermal wires, which can be insulated and are inserted into protection tubes. The thermal wires are connected to thermal or compensating cables. Their connection side can be designed as a line end that has been kept free, or designed with a terminal head, with a connector, etc.

Alongside a variety of special versions, some thermocouples are described fully by standards, such as

- Straight thermometers with interchangeable sensor units – DIN 43764
- Threaded-stem thermometers with G 1/2 mounting thread – DIN 43765
- Threaded-stem thermometers with G 1 mounting thread – DIN 43766
- Welded-stem thermometers – DIN 43767
- Thermometers not fitted with protecting tubes – DIN 43769
- Fast response thermometers – DIN 43771
- Mineral insulated metal-sheathed thermocouple cables and thermocouples – DIN EN 61515

In some cases, individual components are also described by standards, such as

- Protective tubes – DIN 43772
- Flanges – DIN EN 1092

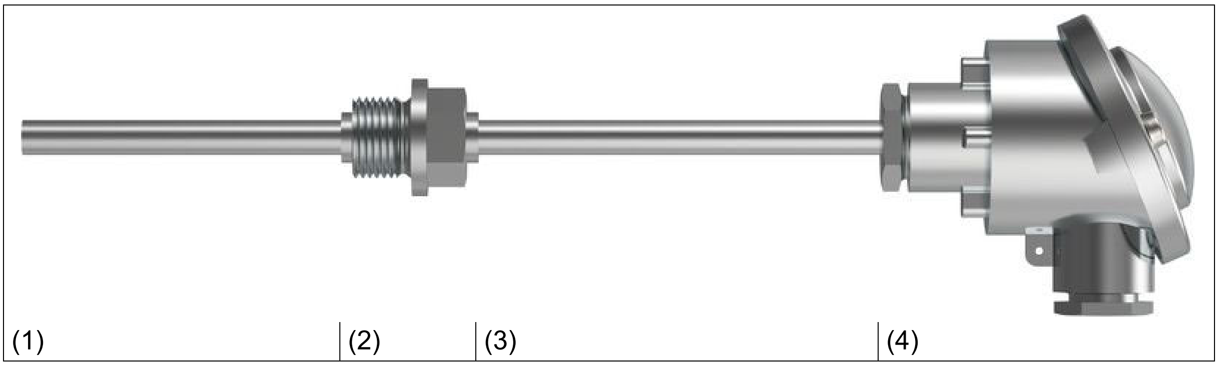
The basic construction is similar to that of RTD temperature probes.

⇨ chapter 3.1 "Design", Page 9

The main difference lies in the construction of the measuring insert.

4 Thermocouples

Variant with terminal head

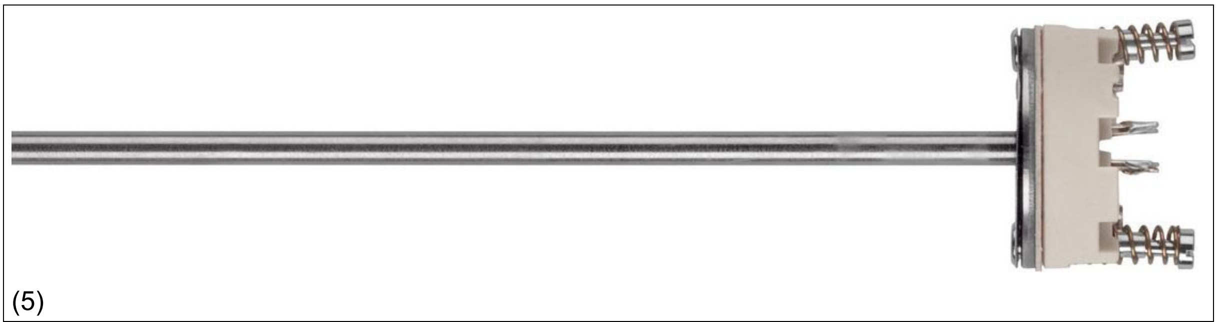


(1) Protection tube
- In contact with the process
- Protects the measuring insert against the medium (pressure, flow, etc.)
- On versions with immersion sleeves, the need to open the process can be avoided, for example to replace the thermometer or measuring insert

(2) Process connection
- Interface with the process
- Thread, flange, etc.

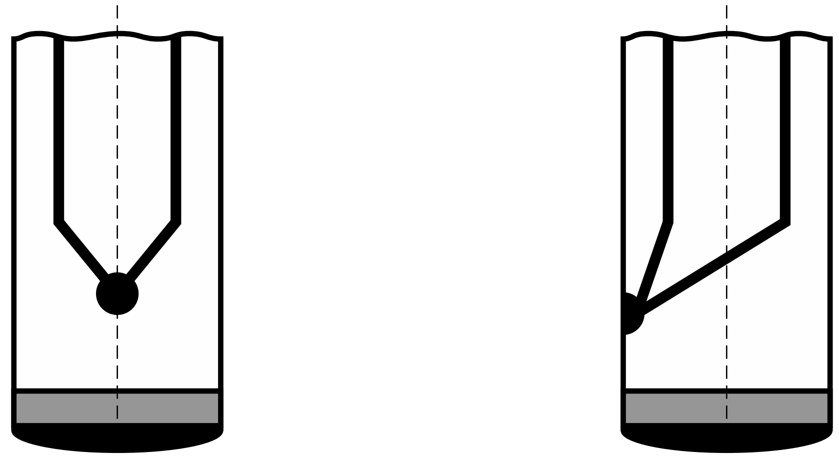
(3) Extension tube
- Protects the components (such as the transmitter) against excess temperatures in the area of the terminal head
- Spans the insulation, such as on pipes or furnaces; the terminal head should always be outside the insulation

(4) Terminal head
- Contains and protects the connection components
- Display optional



(5) Measuring insert
- Contains the thermocouple
- Replaceable or permanently installed

Thermocouples may be insulated or non-insulated/grounded.



Insulated construction Non-insulated construction

The non-insulated construction produces faster response times. However, no electrical insulation and no galvanic isolation between the thermocouple and the protection tube can be provided here. Take this into account when connecting the thermocouple, so as to prevent potential entrainments, etc.

4.2 Operating principle

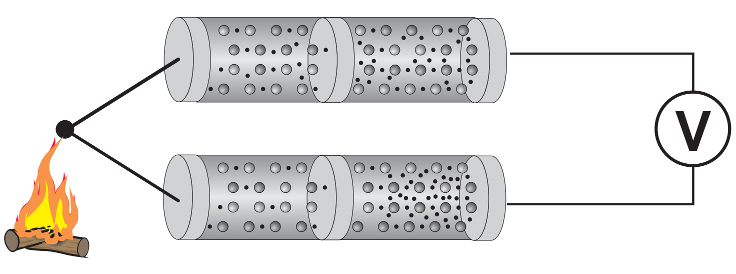
The Seebeck effect (= thermoelectric effect) is the key factor determining how thermocouples operate.

Its basic principle is as follows:

If there is a temperature difference along a wire, this will cause the charge carriers to move. The extent to which the charge carriers move depends on the electrical features of the material.

If two wires made of different materials are connected and exposed to a temperature difference, a voltage that depends on the prevailing temperature difference will be present at both open ends.

If the temperature at the open end is known, you can infer the temperature at the connection point.



To carry out the temperature measurement, the temperature at the open end (right) must be known. If this is not the case, thermal cables will need to be used to extend the thermocouple into a zone that has a known, constant temperature. If a constant temperature cannot be ensured, the temperature of the cold junction will need to be acquired.

4.3 Thermocouple types

Below you will find a table of thermocouples listing standardized voltage series and limit deviations.

In this context, the maximum temperature is the temperature up to which the limit deviations have been defined. The voltage series has been standardized up to the temperature listed under "Defined up to."

Thermocouples according to DIN EN 60584/IEC 584

Element		Maximum temperature	Defined up to	Positive leg	Negative leg
Fe-CuNi	Type J	750 °C	1200 °C	Black (magnetic)	White
Cu-CuNi	Type T	350 °C	400 °C	Brown (copper colored)	White
NiCr-Ni	Type K	1200 °C	1370 °C	Green	White (magnetic)
NiCr-CuNi	Type E	900 °C	1000 °C	Violet	White
NiCrSi-NiSi	Type N	1200 °C	1300 °C	Pink	White
Pt10Rh-Pt	Type S	1600 °C	1540 °C	Orange	White (softer)
Pt13Rh-Pt	Type R	1600 °C	1760 °C	Orange	White (softer)
Pt30Rh-Pt6Rh	Type B	1700 °C	1820 °C	Gray	White

Thermocouples according to DIN 43710

Element		Maximum temperature (continuous temperature in clean air)	Defined up to	Positive leg	Negative leg
Fe-CuNi	Type L	700 °C	900 °C	Red	Blue
Cu-CuNi	Type U	400 °C	600 °C	Red	Brown

The specified maximum temperatures may be reduced by the design of the overall probe (protection fittings, thermocouple dimensions, insulation components, etc.). Also observe the environmental influences.

Thermocouples according to DIN EN 60584 have been assigned to up to three tolerance classes. These tolerance classes apply to the thermometers in their as-delivered condition. Depending on the specific environmental influences involved, use of the devices at higher temperatures may quickly alter the original tolerance class supplied (aging).

The user must evaluate the extent of the drift (aging) caused by the operating conditions in their application. They must decide on a case-by-base basis how often thermocouples need to be replaced or recalibration is required. The choice of thermocouple diameter is also a crucial factor in the aging.

Limit deviations according to DIN EN 60584

Thermo-couple type	Admissible limit deviations (±°C)			Validity limits for temperature (°C)		
	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
Type T	0.5 °C or 0.004 × |t|	1 °C or 0.0075 × |t|	1 °C or 0.015 × |t|	-40 to +350	-40 to +350	-200 to +40
Type E	1.5 °C or 0.004 × |t|	2.5 °C or 0.0075 × |t|	2.5 °C or 0.015 × |t|	-40 to +800	-40 to +900	-200 to +40
Type J	1.5 °C or 0.004 × |t|	2.5 °C or 0.0075 × |t|	-	-40 to +750	-40 to +750	-
Type K	1.5 °C or 0.004 × |t|	2.5 °C or 0.0075 × |t|	2.5 °C or 0.015 × |t|	-40 to +1000	-40 to +1200	-200 to +40
Type N	1.5 °C or 0.004 × |t|	2.5 °C or 0.0075 × |t|	2.5 °C or 0.015 × |t|	-40 to +1000	-40 to +1200	-200 to +40
Type R Type S	t < 1100 °C: 1 °C, t > 1100 °C: (1 + 0.003 × [t - 1100])	1.5 °C or 0.0025 × |t|	-	0 to 1600	0 to 1600	-
Type B	-	1.5 °C or 0.0025 × |t|	4 °C or 0.005 × |t|	-	600 to 1700	600 to 1700
Type C	-	0.01 × |t|	-	-	426 to 2315	-
Type A	-	0.01 × |t|	-	-	1000 to 2500	-

If the data has been specified both as the admissible limit deviation in °C and as a function of the temperature, the higher value applies in each case.

Limit deviations according to DIN EN 43710

Element		Tolerance classes		
Fe-CuNi	Type L	100 to 400 °C	±0.0075 × |t|	±3 K
		400 to 900 °C	±0.0075 × |t|	±3 K
Cu-CuNi	Type U	100 to 400 °C	±0.0075 × |t|	±3 K
		400 to 600 °C	±0.0015 × |t|	±3 K

4.4 Type K thermocouples

A symptom known as green rot may occur on type K thermocouples (NiCr-Ni). It usually occurs between 800 and 1050 °C. If a type K thermocouple is used in environments containing oxygen or water vapor, the chromium will oxidize but the nickel will not. This results in green rot, which can cause measurement errors of up to several 100 K.

Over time, this will destroy the thermocouple. In the temperature range from 400 to 600 °C, the positive leg undergoes a reversible change in structure, amounting to changes of up to 5 K in the output signal.

5 Lines

All lines used must be in perfect electrical order and must not exhibit any damage. Corrosion, humidity, or pollutants on the lines must be prevented and removed if required.

Lines with glass fiber insulation or wire mesh may only be used in dry areas. In this case, the presence of moisture can cause shunts or the formation of additional galvanic elements.

The lines may have been shielded. Shielding is used to keep away external magnetic or electrical fields. Additionally, the area around the fields may also be protected, starting from the thermometer and its line. The electromagnetic compatibility improves and signal transmission is ensured.

To provide the greatest possible protection against electromagnetic radiation, the lines of the sensing elements must be routed separately from the lines of the power electronics.

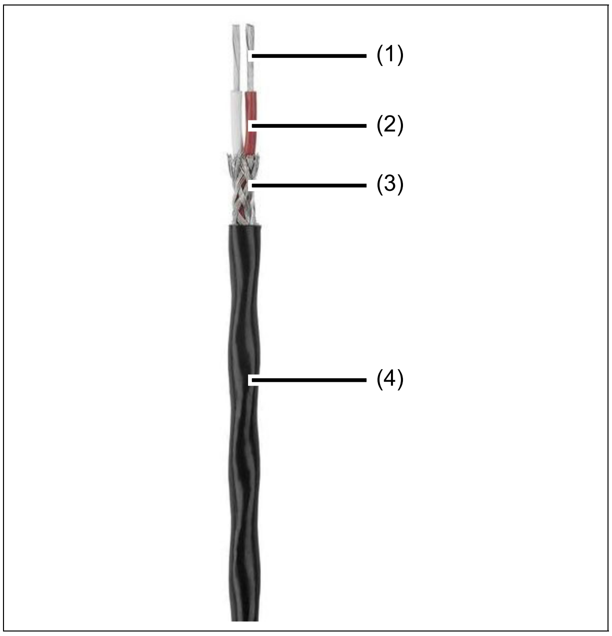
5.1 Lines of RTD temperature probes

Connection lines of RTD temperature probes are available with a range of sheath and stranded wire insulation materials. The diameter and the number of stranded wires also vary.

When mounting and routing the lines, pay attention to the operating temperatures as they depend on the materials used. The typical maximum application temperatures are shown below. Follow the particular specifications for the temperature probe in individual cases.

Shielding may be installed as an optional extra.

(1) Stranded wire
(2) Stranded wire insulation
(3) Shielding
(4) Sheath



Material	Typical maximum application temperatures
Glass fiber	400 to 600 °C
Wire mesh	400 °C
PTFE/Kapton/PFA	260 °C
FEP	200 °C
Silicone	180 °C
TPE/PE/rubber	90 °C
PVC	80 °C

⇨ Data sheet 909735 (compensating cables and connection lines)

5.1.1 Correcting line resistances

Please note the following for RTD temperature probes with a two-wire circuit:

An almost constant error is produced with two-wire circuits depending on the stranded wire cross section and the line length. This error can be corrected at the evaluation unit (by using zero point correction, for example). However, the resistance of the connection line also depends on the temperature. This additional influence cannot be taken into account.

⇨ chapter 3.5 "Circuit types", Page 16

The following table can be used to estimate the measurement errors for copper stranded wires:

Cross section in mm²	**Measurement error per m of line (per loop)**		
	Pt100	**Pt500**	**Pt1000**
0.14	0.64 K	0.08 K	0.06 K
0.22	0.41 K	0.07 K	0.04 K
0.25	0.36 K	0.05 K	0.04 K
0.34	0.26 K	0.04 K	0.03 K
0.50	0.18 K	0.03 K	0.02 K
0.61	0.15 K	0.02 K	0.01 K
0.75	0.12 K	0.13 K	0.01 K
1.00	0.09 K	0.02 K	0.01 K

The measurement error depends on the construction of the stranded wire, the surface, etc. The specified values are therefore average values for copper stranded wires at room temperature.

A loop resistance (Ω/m) can also be estimated for stranded wires made of thermal material for thermocouples (the specifications apply for room temperature):

Cross section in mm²	**Thermocouple Pt100**	**Resistance in Ω/m**	**Loop resistance (2 conductors) in Ω/m**
0.22	Fe	0.5	2.5
	CuNi	2.0	
	NiCr	3.3	4.5
	Ni	1.2	
0.5	Fe	0.25	1.25
	CuNi	1.0	
	NiCr	1.45	2.0
	Ni	0.55	
	PtRh	0.07	0.2
	Pt	0.13	
1.5	Fe	0.08	0.42
	CuNi	0.34	
	NiCr	0.5	0.7
	Ni	0.2	
	PtRh	0.025	0.07
	Pt	0.045	

Follow the relevant data sheets/drawings in individual cases

5.2 Lines of thermocouples

Thermal cables or compensating cables can be used for thermocouples.

Thermal and compensating cables differ as follows:
Thermal cables are made of the same material as the element itself.
Compensating cables are made of special materials with identical thermoelectric features in restricted temperature ranges.

When mounting and routing the lines, pay attention to the operating temperatures as they depend on the materials used. The typical maximum application temperatures are shown in chapter 5.1 "Lines of RTD temperature probes", Page 22. Follow the particular specifications for the temperature probe in individual cases.

⇨ Data sheet 909735 (compensating cables and connection lines)

Identification marking for compensating cables:

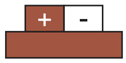
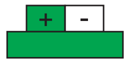
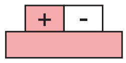
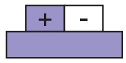
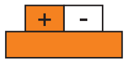
1st letter	Identifier for the type of element according to the standard
2nd letter	X = same material as the element according to the standard C = special material
3rd letter	If there are several compensating cables, the third letter differentiates them.

Example: KX = thermal cable NiCr-Ni element type "K" made of thermal material

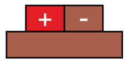
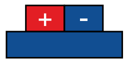
Element and wire type	**Limit deviation classes**		**Application temperature range**	**Measurement temperature**
	1	**2**	**In °C**	**In °C**
"JX"	±85 µV/±1.5 K	±140 µV/±2.5 K	-25 to +200	500
"TX"	±30 µV/±0.5 K	±60 µV/±1.0 K	-25 to +100	300
"EX"	±120 µV/±1.5 K	±200 µV/±2.5 K	-25 to +200	500
"KX"	±60 µV/±1.5 K	±100 µV/±2.5 K	-25 to +200	900
"NX"	±60 µV/±1.5 K	±100 µV/±2.5 K	-25 to +200	900
"KCA"	-	±100 µV/±2.5 K	0 to 150	900
"KCB"	-	±100 µV/±2.5 K	0 to 100	900
"NC"	-	±100 µV/±2.5 K	0 to 150	900
"RCA"	-	±30 µV/±2.5 K	0 to 100	1000
"RCB"	-	±60 µV/±5.0 K	0 to 200	1000
"SCA"	-	±30 µV/±2.5 K	0 to 100	1000
"SCB"	-	±60 µV/±5.0 K	0 to 200	1000

The limit deviations (in µV or K) only apply at the measurement temperature (right-hand column) here. This is due to the non-linear nature of the thermoelectric voltage.

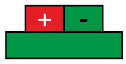
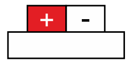
Color coding for elements according to DIN EN 60584

Element	Type	Sheath	Positive leg	Negative leg	
Cu-CuNi	"T"	Brown	Brown	White	
Fe-CuNi	"J"	Black	Black	White	
NiCr-Ni	"K"	Green	Green	White	
NiCrSi-NiSi	"N"	Pink	Pink	White	
NiCr-CuNi	"E"	Lilac	Lilac	White	
Pt10Rh-Pt	"S"	Orange	Orange	White	
Pt3Rh-Pt	"R"	Orange	Orange	White	

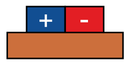
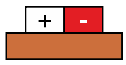
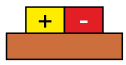
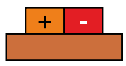
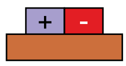
Color coding for elements according to DIN EN 43713

Element	Type	Sheath	Positive leg	Negative leg	
Cu-CuNi	"U"	Brown	Red	Brown	
Fe-CuNi	"L"	Blue	Red	Blue	

Color coding for elements according to DIN EN 43714

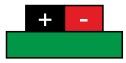
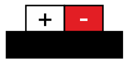
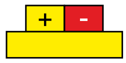
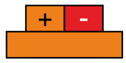
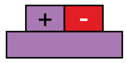
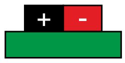
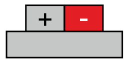
Element	Type	Sheath	Positive leg	Negative leg	
NiCr-Ni	"K"	Green	Red	Green	
Pt10Rh-Pt	"S"	White	Red	White	
Pt13Rh-Pt	"R"	White	Red	White	

Color coding for elements according to ANSI MC96.1 (USA) – pair of thermal wires

Element	Type	Sheath	Positive leg	Negative leg	
Cu-CuNi	"T"	Brown	Blue	Red	
Fe-CuNi	"J"	Brown	White	Red	
NiCr-Ni	"K"	Brown	Yellow	Red	
NiCrSi-NiSi	"N"	Brown	Orange	Red	
NiCr-CuNi	"E"	Brown	Lilac	Red	

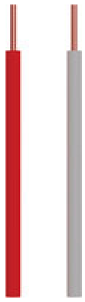
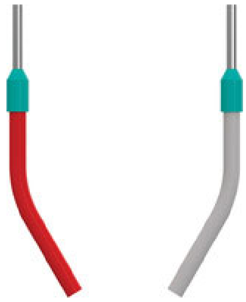
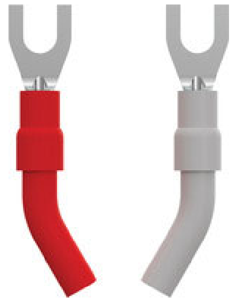
5 Lines

Color coding for elements according to ANSI MC96.1 (USA) – compensating cable

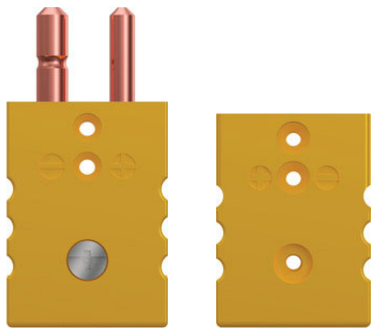
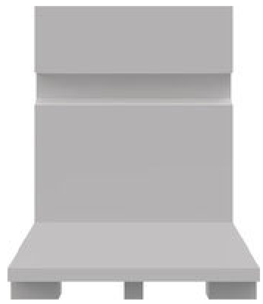
Element	Type	Sheath	Positive leg	Negative leg	
Cu-CuNi	"T"	Green	Black	Red	
Fe-CuNi	"J"	Black	White	Red	
NiCr-Ni	"K"	Yellow	Yellow	Red	
NiCrSi-NiSi	"N"	Orange	Orange	Red	
NiCr-CuNi	"E"	Purple	Purple	Red	
Pt10Rh-Pt	"S"	Green	Black	Red	
Pt13Rh-Pt	"R"	Green	Black	Red	
Pt30Rh-Pt	"B"	Gray	Gray	Red	

5.3 Cable ends and connectors

Some examples of the cable ends and connectors used for thermometers are shown below:

Bare	Ferrules	Ring cable lug	Forked cable lug
			

Some examples of parts used as connectors are shown below:

LEMO connector	Thermo connector/coupling	M12 connector	JST terminal strip
			

⇨ Data sheet 909760 for various connectors

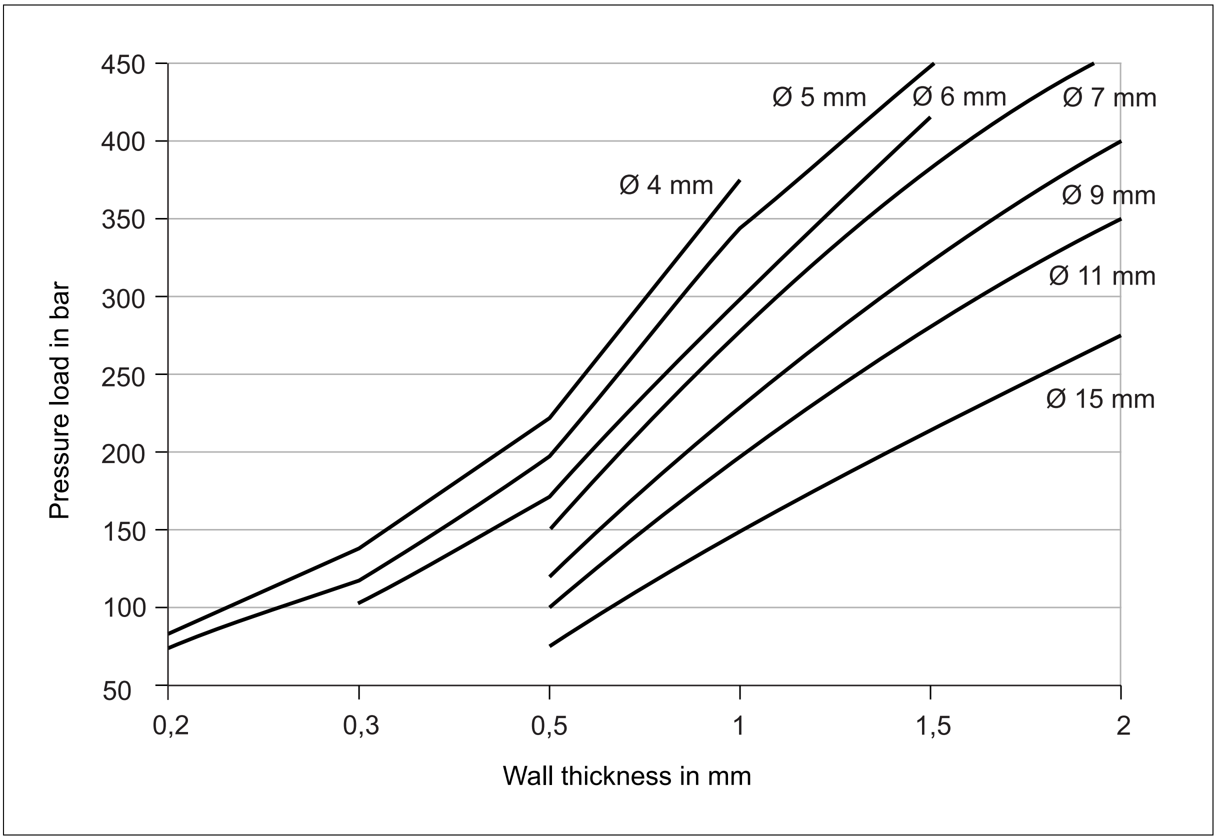
For thermocouples, please either ensure that you use contact materials that have the same thermoelectric features as the thermocouple itself, or ensure that the temperature is uniformly distributed within the plug connection. If this instruction is not followed, any additional voltages will falsify the measurement result.

6 Protection tubes

Various parameters (such as temperature, pressure, and oscillations) place loads on thermometers and their protection fittings. The protection fittings must therefore be designed accordingly. The variables in this respect include the material, insertion length, and diameter.

DIN 43772 contains an overview of various metal protection tubes for thermocouples and RTD temperature probes. It also provides installation notes.

Protection tubes can be designed according to the following diagram. However, this information only serves as a rough guideline. In the diagram, the maximum pressure load is listed as a function of the wall thickness at different pipe diameters. The diagram applies to protection tubes made of stainless steel 1.4571 and with an insertion length of 100 mm and flow velocities of 10 m/s in air and 4 m/s in water (temperature range: -20 to +100 °C, safety factor 1.8).



The following table can be used if different materials are being used:

Material	Temperature	Reduction
CrNi 1.4571	Up to 200 °C	-10 %
	Up to 300 °C	-20 %
	Up to 400 °C	-25 %
	Up to 500 °C	-30 %
CuZn 2.0401	Up to 100 °C	-15 %
	Up to 175 °C	-60 %

Thermometers manufactured according to DIN or application-specific directives require the use of various pressure tests in accordance with the specific application in question. For this reason, specify the necessary tests/directives when ordering the thermometers.

⇨ Data sheet 902000 for further information

Avoid internal components in areas containing a change of diameter or bends. Higher loads may be exerted on the temperature probes/protection fittings in these installation locations. When performing installation work, ensure a sufficient clearance is maintained from these installation locations.

Transmitters convert the sensor signal into a standardized, temperature-linear current or voltage signal.

The advantage of two-wire transmitters is that they amplify the signal, making it much less sensitive to interference.

Several design types are available for positioning the transmitter as required. To make the signal less susceptible to interference, the section covered by the non-amplified signal should be kept as short as possible. For this reason, the transmitter can be mounted directly in the thermometer, for example in the terminal head. However, while this may be the optimal solution, it may be rendered unviable by design constraints or the fact that the transmitter may be difficult to access in the event of a malfunction. In such cases, a transmitter for mounting rail installation in the control cabinet is used. In this case, the advantage of having better access comes at the expense of a longer section that the non-amplified signal has to cover. If required, a transmitter can also be latched into the line.

NOTICE!

Damage to property due to high ambient temperatures!

The device's functionality cannot be ensured and there is a risk of component damage.

▶ Observe the admissible ambient temperature for the device.

⇨ Detailed information on the transmitters can be found in the relevant data sheets.

Extra code	Transmitter	Data sheet	Output
330	Analog transmitter Type 707031	707030	4 to 20 mA
331	Programmable transmitter Type 707014	707010	4 to 20 mA, 20 to 4 mA
333	Analog transmitter Type 707033	707030	0 to 10 V
334	2x analog transmitter Type 707031	707030	4 to 20 mA
335	2x programmable transmitter Type 707014	707010	4 to 20 mA, 20 to 4 mA
337	2x analog transmitter Type 707033	707030	0 to 10 V
550	Programmable transmitter Type 707050	707050	4 to 20 mA, 20 to 4 mA (USB)
551	2x programmable transmitter Type 707050	707050	4 to 20 mA, 20 to 4 mA (USB)
859	Programmable head transmitter Wtrans B with wireless data transmission Type 707060	707060	
866	Programmable two-channel transmitter with HART® Type 707080	707080	4 to 20 mA
867	Programmable two-channel transmitter with HART®/SIL Type 707081	707080	4 to 20 mA

8 Handling

8.1 Transport

Avoid vibrations when transporting the thermometer. Also ensure that the thermometer is not exposed to humidity.

When the goods are received, check whether the packaging and thermometer are free of transport damage and mechanical damage. If you discover damage, do not use the thermometer.

The devices must be stored properly. Observe the storage temperature of between 10 and 45 °C.

8.2 Mounting

In addition to the criteria listed below, also consult VDI/VDE 3511 sheet 5 and the explanations therein on the installation process for thermometers.

Before mounting a thermometer, check that it is suitable for the operating conditions. Consider the following key technical data:

- Measuring and operating temperature range
- Dimensions (insertion length and protection tube diameter)
- Maximum pressure resistance in connection with the flow velocity
- Protection type according to DIN EN 60529
- The suitability of all the components (seals, protection tubes, etc.) for use in the medium/atmosphere

It is also important to ensure the device is correctly mounted in the installation location. Information on this is provided in the following subchapters. The plant's process connection must match the thermometer connection.

The probes should be inserted slowly into any processes where the temperature differs from the ambient temperature. This is particularly important for thermometers with a ceramic protection tube.

When selecting the installation location, ensure that the thermometer will be protected against vibrations (caused by flows, motors, pumps, etc.). Similarly, do not install it in the vicinity of electromagnetic fields (such as from motors or transformers).

Observe the recommended measuring current and the maximum current for the sensors of the RTD temperature probes.

Sensor	Recommended measuring current/mA	Maximum current/ mA
Pt100 (PCA, PCR, PCS, PCSE)	1.0	7.0
Pt500 (PCA, PCR, PCS, PCSE)	0.7	3.0
Pt1000 (PCA, PCR, PCS, PCSE)	0.1	1.0
PK	1.0	20.0

⇨ Further information and measuring currents for special sensors can be found in data sheet 906121 (PCA sensors), 906022 (PK sensors), 906125 (PCS sensors), 906123 (PCKL sensors), 906124 (PC sensors in a cylindrical style), etc.

Thermometers with a ceramic tube must not fall to the ground or be subjected to any other impacts during their entire lifespan. The ceramic tube is brittle and could easily break if subjected to such loads.

8.2.1 Installation location and alignment

To ensure ease of access in the installation location, sockets are often used to mount the thermometers.

Please note the following for the mounting work:

The larger the immersion depth into the measurement medium, the more accurate the measurement result will be as heat conduction errors will be reduced.

The probe tip usually needs to be positioned in the center of the pipe.

In many cases, minimum immersion depths will have been defined for your specific thermometer and recorded in the documents provided.

NOTE!

The minimum immersion depths must be complied with!

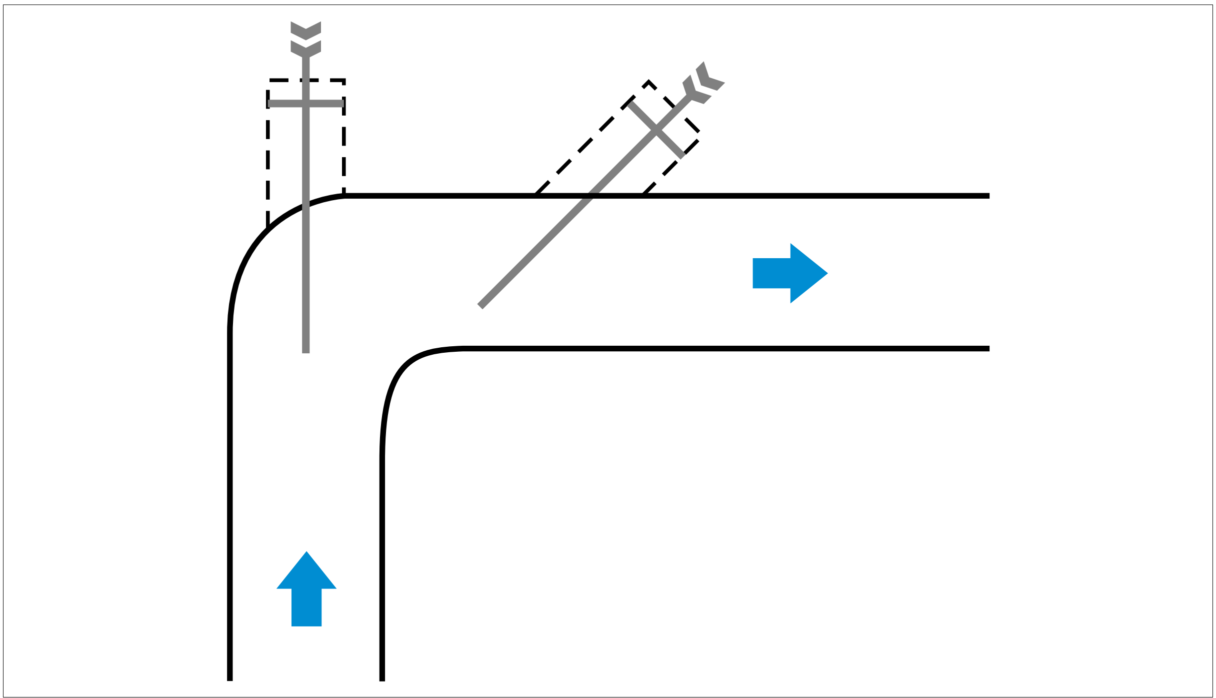
If the minimum immersion depth is not known and an immersion depth cannot be inferred by other means, the following rule of thumb can be used as a rough guideline:

For measurements in liquid media: an immersion depth ≥ 5 to 10 × the protection tube diameter

For measurements in gaseous media: an immersion depth ≥ 15 to 20 × the protection tube diameter

If a sufficient immersion depth cannot be provided due to a lack of space, you can choose an installation position that is tilted against the flow direction by way of a remedy. It may also be worthwhile installing the device in a pipe bend.

An inflow from the direction of the extended probe tip is preferable to an inflow perpendicular to the probe.



It is also recommended to insulate the pipes, as inadequate insulation will encourage heat conduction errors.

A good thermal connection between thermometers is important, particularly when using thermowells. This can be ensured by reducing the clearance between the thermometer and thermowell or by introducing a heat-conducting medium or similar. (When using a heat-conducting medium, observe the maximum admissible temperature.) Before installing the thermometers, the thermowells must be fitted with a plug to stop pollutants entering the interior.

Avoid twisted and/or tensioned lines. For this reason, always route connection lines correctly. Route connection lines separately from the lines of the power electronics.

The area around the thermometer must also be kept clean because aggressive media in particular could chemically attack the thermometer, potentially damaging the construction. If the thermometer needs to be used in aggressive media or contact with such media cannot be ruled out, it must be ensured that the probe features are tailored to the respective installation situation.

NOTE!

Cable passages must match the respective cable diameter. If the cables have not been properly routed, it will not be possible to ensure a reliable seal or compliance with the protection types.

8.2.2 Screw-in thermometer

NOTE!

Do not exceed the specified maximum torques!

If a maximum torque has not been specified, it must be determined empirically.

The tightening torques from the table below apply as a general guideline. The values specified here apply to dry screw connections (steel to steel).

External thread	Protection tube diameter mm	Tightening torque (guideline) Nm (±10 %)
G 1/4 A	6	40
	7	40
	8	30
	9	25
G 1/2 A	6	40
	7	40
	8	40
	9	40
	10	40
	13.2	40
M8	4.8	4
	5	2.5
M10 × 1	6	15
	7	15
	8	2.5

Responsibility for choosing the correct tightening torques always lies with the user, because the torques essentially depend on the respective installation situation and the specific thermometer.

8.2.3 Welded-stem thermometer

The quality of the welded joint plays a crucial role in determining the leak-tightness and strength of the construction.

WARNING!

Personal injury and damage to property due to a poor-quality welded joint!

Poor-quality welded joints in combination with high pressure or overheating can cause leaks. If touched, these can cause burns or destroy the device.

- ▶ Have welding work on thermometers carried out by adequately trained personnel only. Make sure that the personnel are familiar with and understand the contents of the operating manual. Any safety information and notes on proper use are particularly important.

8.2.4 Mineral-insulated thermocouples and RTD temperature probes

Mineral-insulated thermocouples and RTD temperature probes can be bent. The bending radius must be at least five times the diameter (R ≥ 5D). When bending the devices, ensure no load is exerted on the connection point of the adapter sleeve (to the rigid part of the protection tube). A minimum distance of 15 mm from the bend must be maintained in this respect.

With mineral-insulated thermocouples, the ideal solution is to select a suitable thermal cable. It is also possible to use compensating cables provided they have been selected very carefully.

With mineral-insulated thermocouples, measurement deviations should be prevented by means of insulation on the adapter sleeve or connection points.

Observe the maximum temperatures for the adapter sleeve and any adhesive used.

8.2.5 Surface probe for surface measurements

In addition to temperature probes (which are immersed into the media being measured), surface probes are also available.

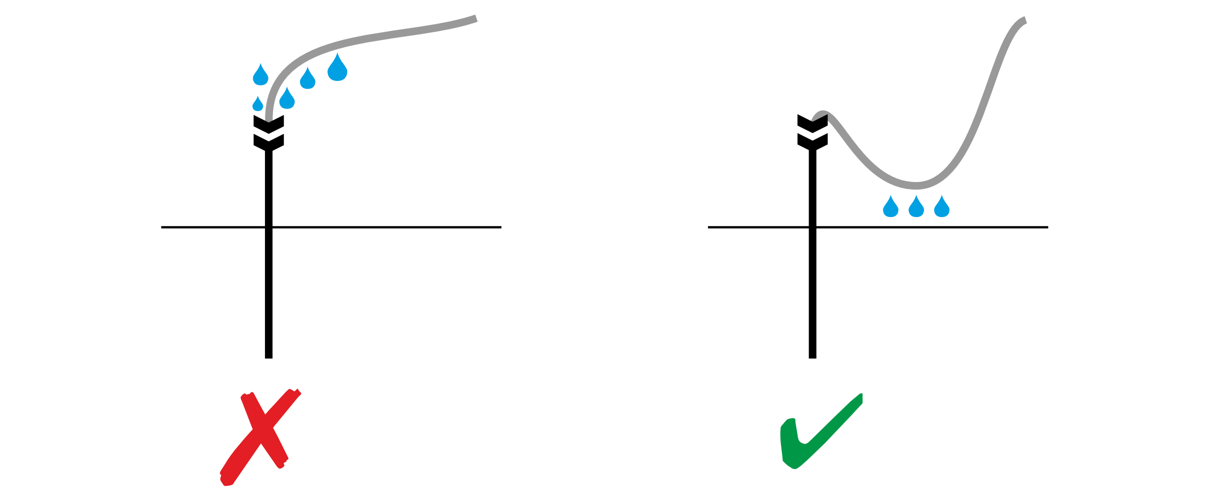
Observe the following points when mounting surface probes:

- The measurement surfaces must lie flat against one another
- The contact surfaces must be free of corrosion; clean them before starting the mounting work
- Insulate the measuring point incl. the surface probe accordingly to prevent heat dissipation
- A constant ambient temperature is desirable/there should be no impact on the measurement object from convection caused by equipment such as fans or air conditioning systems
- Securely fasten the surface probe to the pipe, applying the correct contact pressure
- To improve the measurement result, use heat-conducting paste in the area of the contact point
- Mount the device a minimum of 10 cm from pipe bends, radial weld seams, and similar

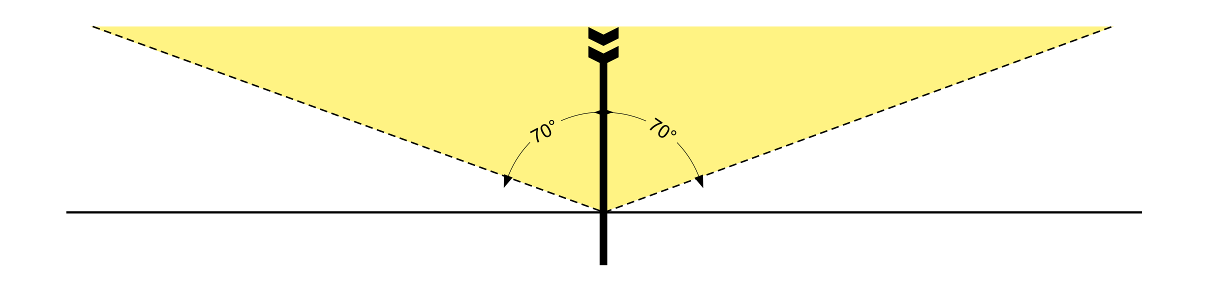
8.2.6 Special installation situations

When measuring temperatures below the ambient temperature, it is important to prevent condensate formation in the area of the electrical connection. Mount the line inputs and sealing areas such that any condensate that is formed can drain away.

When routing the connection line, likewise bear in mind the possibility of moisture forming (from condensation, rainfall, etc.). Moisture must not be allowed to form permanently on the cable fitting.



Always install the thermometers upright as far as possible, and no further than ±70° from vertical. This will mitigate any negative effects from oscillations and/or vibrations. Always avoid the use of internal components where the terminal head or line output is located underneath the measurement tip. Probes with a short insertion length have smaller degrees of freedom (i.e. their susceptibility to oscillations) and are therefore preferable with a view to mitigating vibrations.



8.2.7 Electrical connection

The terminal assignment must be implemented according to the connection diagram. If there is no connection diagram for a thermometer (such as those with a connection line), the table in chapter 9.1 "Connection types", Page 39 shows the relevant terminal assignment.

Customer-specific terminal assignments may differ from the JUMO standards.

NOTICE!

Incorrect measurement results!

Incorrect polarity will cause major measurement deviations.

- ▶ Ensure that the polarity (+/-) is correct for thermocouples.

NOTE!

When establishing the electrical connection for RTD temperature probes, bear in mind the correction of the line resistances; see chapter 5.1.1 "Correcting line resistances", Page 22.

NOTICE!

Damage to property due to overvoltage!

Incorrectly connecting the shielding will result in potential entrainments.

- ▶ Ensure a sufficient distance is maintained between power and supply lines and cables.
  Observe the relevant EMC requirements when using signal and data cables and data lines. Take into account the manufacturers' operating manual.

8.3 Functional test

Startup checklist

- ☐ Is the thermometer suitable for the ambient temperatures?
- ☐ Is the thermometer suitable for the maximum operating temperature?
- ☐ Is the thermometer suitable for the maximum operating pressure?
- ☐ Is the protection tube resistant to the environment (chemicals, particles, etc.)?
- ☐ Has the thermometer's IP protection type been selected correctly?
- ☐ Is the connection area in an area with a uniform, constant temperature, particularly for thermocouples?
- ☐ Has the minimum immersion depth been achieved?
- ☐ Are the installation location and line routing free of electromagnetic interference?
  Ensure that the lines of the temperature sensor system are routed separately to the power electronics/are shielded accordingly.
- ☐ If present: Has the shielding been applied correctly?
- ☐ Has the measuring circuit been properly insulated against the protection tube (insulation test)?
- ☐ Has the electrical connection been fitted correctly?

8.4 Maintenance

To ensure the thermometers work reliably, their functionality must be checked at regular intervals. This check should look at the functionality of the measuring circuits and whether there is any damage to the protection tubes.

Individual items from the functional check (chapter 8.3 "Functional test", Page 36) can be repeated if required. We recommend measuring the insulation resistance of the measuring circuit against the protection fitting every 12 months (except for welded mineral-insulated thermocouples). If there are several measuring circuits, also check the insulation between them.

The minimum insulation resistance should generally be 100 MΩ at DC 100 V (measured at room temperature). DIN EN 61515 provides a more detailed description of how to measure the insulation resistance for thermocouples. The specifications in the standard are decisive.

Drift effects in temperature probes (caused by moisture) are often not detected but nevertheless cause significant measurement deviations. Checking the insulation resistance enables this error to be detected and subsequently remedied.

Also check the following points:

- Corrosion and correct positioning of the contacts and terminals of cable connections
- The seals of terminal heads and cable runs
- Damage and corrosion on protection tubes
- Interruptions, testing through "knocking" on the thermometer/measuring insert
- Acquisition of a reference value (check the process value using a reference thermometer)

The check intervals can be based on the following guideline values, but will need to be tailored to the operating location and conditions in individual cases:

Maximum operating temperature	**Pt RTD temperature probe**	**Thermocouple**
200 °C	5 years	5 years
550 °C	2 years	5 years
700 °C	1 year	2 years
1000 °C		1 year (2 years for precious metals)
1500 °C		1 year

8.5 Dismounting

WARNING!

Risk of electric shocks!

There is a risk of serious injury or even death.

- Before dismounting the device, switch off the voltage supply and release the electrical connections. Release process connections only when the device has been acclimatized and depressurized. Adjust the temperature of the pipe/process in line with the ambient temperature. Always observe the relevant accident prevention regulations and safety requirements for electrical devices.

NOTICE!

Damage to property due to the type of process medium!

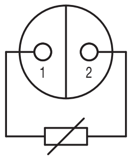
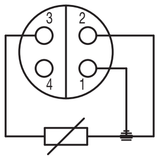
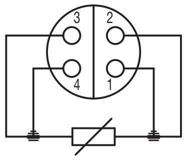
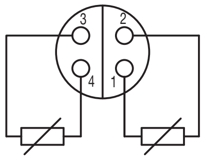
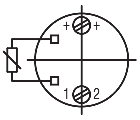
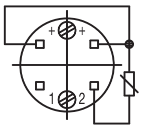
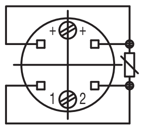
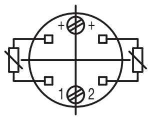
Improper handling may cause liquid to escape from the device. This may impair the device's functionality or even destroy it.

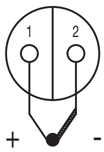
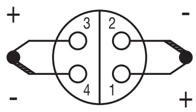
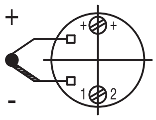
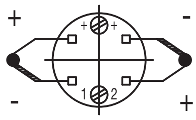
- Acclimatize and depressurize the device.
  Collect any process medium that has leaked out and dispose of it in an environmentally friendly manner.
  Make sure that the personnel are familiar with and understand the contents of the operating manual. Any safety information and notes on proper use are particularly important.

9.1 Connection types

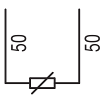
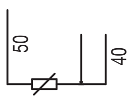
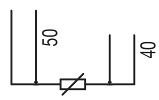
To ensure consistent terminal assignments for all measuring probe versions, JUMO RTD temperature probes and thermocouples are manufactured according to an in-house standard. This is a standard specification. Differing specifications are possible if desired by the customer. Observe the connection diagrams.

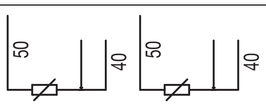
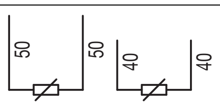
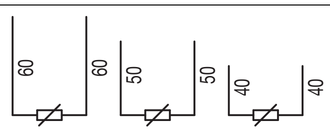
Connection instructions

Connection type	RTD temperature probes			
	Two-wire	**Three-wire**	**Four-wire**	**2x Pt**
Standard connector (multiple-pole plug connector)				
Connection socket				

Connection type	Thermocouples	
	Single	**Double**
Standard connector (multiple-pole plug connector)		
Connection socket		

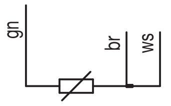
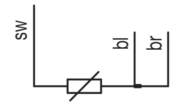
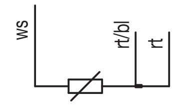
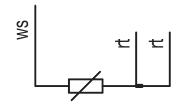
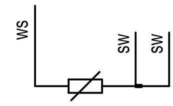
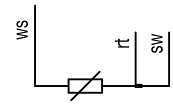
Identification marking for stranded wires on RTD temperature probes

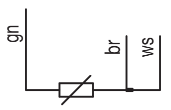
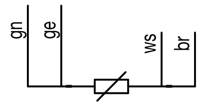
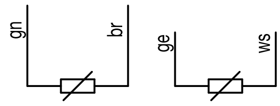
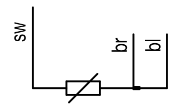
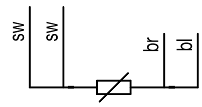
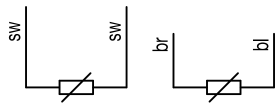
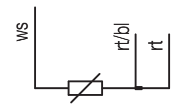
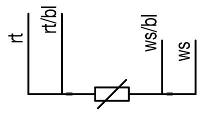
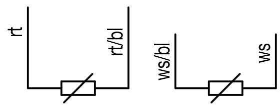
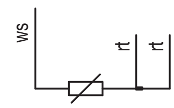
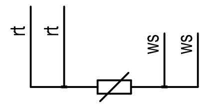
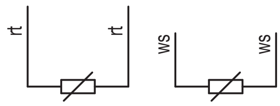
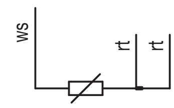
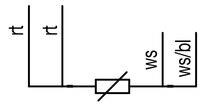
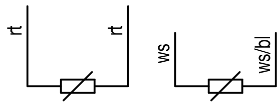
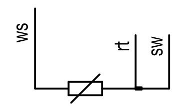
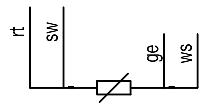
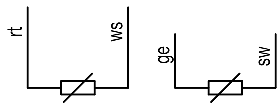
Two-wire	Three-wire	Four-wire
		

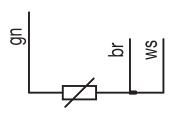
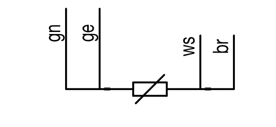
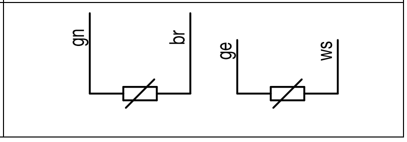
2x three-wire	2x Pt	3x Pt
		

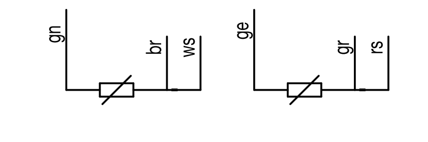
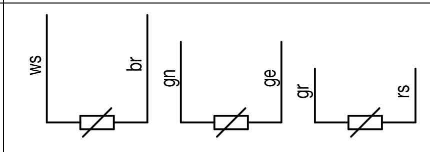
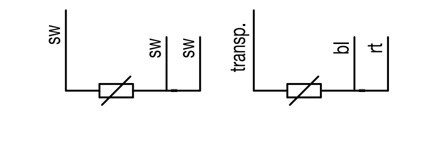
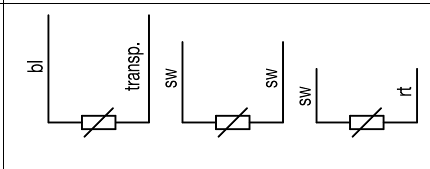
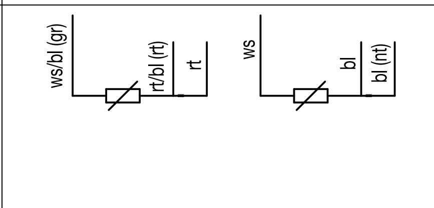
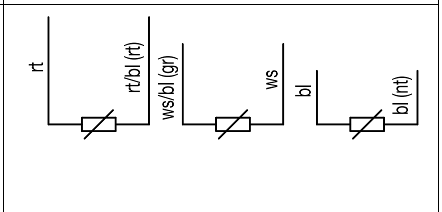
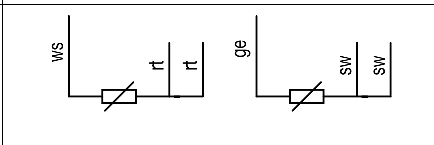
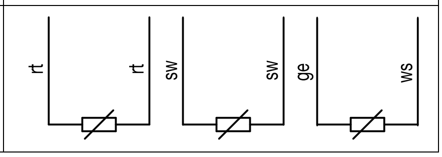
9 General product information

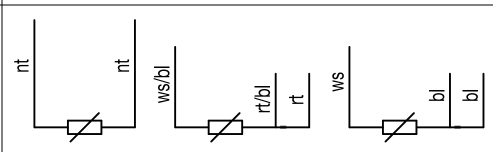
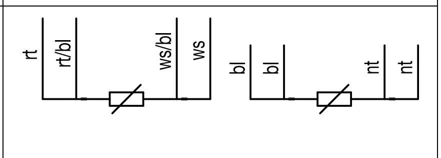
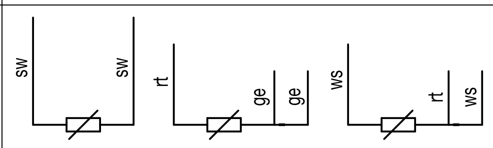
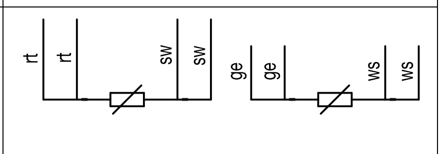
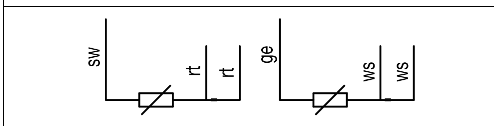
Connection coding – lines

3-conductor line	1x three-wire
Color sequence (DIN 47100): white, brown, green	
Color sequence (VDE 0293-0): black, blue, brown	
Color sequence (DIN 47100): red, red/blue, white	
Color sequence (IEC 751): red, red, white	
Color sequence: black, black, white	
Color sequence: white, red, black	

4-conductor line	1x three-wire	1x four-wire	2x Pt
Color sequence (DIN 47100): white, brown, green, yellow			
Color sequence (VDE 0293-0): black, black, brown, blue			
Color sequence: red, red/blue, white/blue, white			
Color sequence (IEC 751, not for 2x Pt): red, red, white, white			
Color sequence: red, red, white, white/blue			
Color sequence: red, white, yellow, black			

5-conductor line	1x three-wire	1x four-wire	2x Pt
Color sequence (DIN 47100): white, brown, green, yellow, gray			

6-conductor line	2x three-wire	3x Pt
Color sequence (DIN 47100): white, brown, green, yellow, gray, pink		
Color sequence (VDE 0293-0): black, black, black, red, blue, transparent		
Color sequence: red, red/blue, white/blue, white, blue, blue (natural) Alternatively: red, red, gray, white, blue, blue		
Color sequence: red, red, black, black, yel-low, white		

8-conductor line	1x two-wire and 2x three-wire	2x four-wire
Color sequence: red, red/blue, white/ blue, white, blue, blue, natural, natural		
Color sequence: red, red, white, white, yellow, yellow black, black		
		

10 Troubleshooting

Specific errors for thermocouples

Error	Possible cause	Remedy
Indicating device displays room temperature	Thermocouple or line interrupted	Replace measuring insert
Only the amount is correct on the display	Incorrect polarity on the indicating device	Change the polarity
Displayed temperature is much too high/drifts	Incorrect polarity of the compensating cable in the terminal head	Change the polarity
	Incorrect compensating cables	Replace the compensating cable
Data displayed is much too high or much too low	Incorrect linearization in the indicating device	Change the linearization
	Incorrect compensating cable/incorrect polarity of the connection	Replace the compensating cable/change the polarity
Temperature indicator is too low	The resistance of the measuring circuit is too high relative to the input resistance of the device	Select a device with a high input resistance
Data displayed is too high or too low by a fixed amount	Incorrect cold junction temperature	Acquire the cold junction temperature
Data displayed correctly, drifts slowly	Cold junction temperature is not constant or has not been acquired	Acquire the cold junction temperature/keep it constant
Data displayed is incorrect by 20 to 25 °C	Element type J has been linearized as type L or vice versa	Change the linearization
A value is still displayed when a single-pole element is disconnected	Electromagnetic interference is being coupled to the input line	Remedy the electromagnetic interference
	Parasitic voltages are being looped in due to a lack of galvanic isolation or poor-quality insulation	Improve the insulation or replace the probe
An excessively high value is displayed when a double-pole element is disconnected	Electromagnetic interference is being coupled to the input line	Remedy the electromagnetic interference
	Parasitic galvanic voltages (caused by humidity in the compensating cable, for example)	Eliminate the parasitic voltages or replace the thermometer

Specific errors for RTD temperature probes

Error	Possible cause	Remedy
Temperature indicator is too high	Self-heating	Improve the heat conduction
	Influence of the measuring line	Minimize the supply power
Incorrect measured value	Parasitic thermoelectric voltage	Eliminate the parasitic voltages or replace the thermometer
	Heat conduction error	Increase the immersion depth or use a contact agent
Measured value drops over time	Sensor aging	Replace the measuring insert, check the temperature range
Differing temperature indicators	Power supply is not constant	Replace the power supply unit
	Two-wire circuit with fluctuating temperature in the area of the supply line	Switch to a three-wire circuit

General errors for thermometers

Error	Possible cause	Remedy
Time behavior is very slow or measured values are delayed	Deposits on the protection tube	Clean the protection tube
	Protection tube diameter is too large	Modify the protection tube design
	Heat conduction error	Increase the mounting depth or use a contact agent
	Protection tube is located in a "shadow" area with little flow	Change the installation site
Incorrect measured value	Influence of an additional heat source	Optimize the installation situation
	Measuring circuit is interrupted by vibrations, etc.	Change the installation location, use vibration-damping measures on the plant, modify the design
Protection tube broken	Solids in the measurement medium, flow velocity too high, etc.	Minimize the immersion depth, change the installation location, modify the design, or replace the protection tube
Corrosion	The protection tube material and the medium have not been coordinated with one another	Change the protection tube material, check the medium
Temperature indicator is too low	Poor-quality insulation resistance or drift caused by moisture	Carry out an insulation test and, if necessary, improve the insulation or replace the probe
Thermometer cannot be inserted into the protection tube	The protection tube or probe is bent	Replace the bent part
	Foreign bodies in the protection tube (such as pollutants)	Clean the protection tube or remove the foreign bodies

Common causes of errors can be avoided by following the explanations in this operating manual as well as the product-specific data sheets and manuals.

In particular, it is important to consider the specific installation situation in each case. It may be necessary or advisable to consult qualified personnel and the Technical Support team from JUMO.

⇨ The contact addresses and telephone numbers can be found on the last page

11 Maintenance, cleaning, returns, and disposal

11.1 Maintenance

The RTD temperature probes and thermocouples require no maintenance.

We recommend checking them at regular intervals.

11.2 Cleaning

NOTE!

Avoid damage to the device due to improper cleaning.

Do not damage the RTD temperature probes or thermocouples, in particular the parts in contact with the medium. The cleaning agent must not attack the surface and seals.

11.3 Returns

WARNING!

Personal injury, property damage, environmental damage

Residual medium on the removed product can cause damage to persons, the environment and equipment.

▶ Take adequate precautionary measures.

NOTE!

The device may only be disassembled in a safe and voltage-free state of the plant by qualified personnel.

NOTE!

All information necessary for return is included in the Supplementary sheet for product returns.

11.4 Disposal

WARNING!

Risk of injury due to hazardous substance residue in device

Risk of serious injuries in the event of contact with the medium!

▶ Before disposing of the device, rinse hazardous substances out of all hollow spaces in the device, and neutralize them!

DISPOSAL

Devices and/or replaced parts should not be placed in the trash at the end of their service life as they consist of materials that can be recycled by specialist recycling plants.

Dispose of the device and the packaging material in a responsible and environmentally friendly manner.

For this purpose, observe the country-specific laws and regulations for waste treatment and disposal.

12 Further information and downloads

Also consult the data sheet and, if available, the product-specific operating manual in individual cases.

In addition to this manual, further information can be found in the download center at www.jumo.net:

- Electrical Temperature Measurement with thermocouples and resistance thermometers; Matthias Nau (2007)
- JUMO catalog "Sensors - Temperature, Humidity"
- Data sheets for the individual thermometer versions
- Data sheets on general matters relating to thermometers

qr-900000-en.jumo.info

12 Further information and downloads

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