

# Mini resistance thermometer

TR33 type



Art. No. 148317

Type No. TR33.100.3.A.12.200



Exemplary illustration

Resistance thermometer of these series are used as universal thermometers for the measurement of liquid and gaseous media. This resistance thermometer consists of a protection tube with a fixed process connection and is screwed directly into the process. All electrical components are protected against humidity and designed to withstand vibration.

## Technical data

|                       |                                  |
|-----------------------|----------------------------------|
| WIKA type             | TR33                             |
| Housing               | CrNi steel 1.4571                |
| Indicating range      | -30 to 150 °C                    |
| Ambient temperature   | -40 to 85 °C                     |
| Protection IP         | IP 67                            |
| Accuracy              | class A                          |
| Output signal         | Pt100, 3-wire                    |
| Installation length   | 200 mm                           |
| Thread                | G 1/2 ET                         |
| Wetted parts          | CrNi steel 1.4571                |
| Electrical connection | circular plug-in connector M12x1 |

Other special versions with different insertion lengths, process connections, sensors and connection methods can be individually selected for the respective application and are available on request. The electrical connection is made via an M12x1 circular connector. An adapter for electrical connection with angular connector is optionally available.

## Commercial data

|                         |                     |
|-------------------------|---------------------|
| Customs tariff number   | 90251900            |
| Country of origin       | PL                  |
| eCl@ss 5.1.4            | 27270101            |
| eCl@ss 9.0              | 27270101            |
| UNSPSC_Code_v190501     | 41112200            |
| UNSPSC_CodeDesc_v190501 | Temperature sensors |

## Miniature resistance thermometer Threaded Model TR33

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for further approvals  
see page 6

### Applications

- Machine building, plant and vessel construction
- Propulsion technology, hydraulics

### Special features

- Very compact design, high vibration resistance and fast response time
- With direct sensor output (Pt100, Pt1000 in 2-, 3- or 4-wire connection) or integrated transmitter with 4 ... 20 mA output signal
- Integrated transmitter is individually parameterisable with free-of-charge WIKAsoft-TT PC configuration software
- Sensor element with accuracy class A per IEC 60751

### Description

Resistance thermometers of these series are used as universal thermometers for the measurement of liquid and gaseous media in the range -50 ... +250 °C [-58 ... +482 °F].

They can be used for pressures up to 140 bar [2,030 psi] with 3 mm [0.12 in] protection tube diameters and up to 270 bar [3,916 psi] with 6 mm [0.24 in] protection tube diameters, depending on the instrument version. All electrical components are protected against humidity (IP67 or IP69K) and designed to withstand vibration (20 g, depending on instrument version).

The resistance thermometer is available with direct sensor output or integrated transmitter, which can be configured individually via the WIKAsoft-TT PC configuration software. Measuring range, dampening, error signalling per NAMUR NE 043 and tag no. can be adjusted.



**Fig. left: Resistance thermometer, model TR33**  
**Fig. right: M12 x 1 adapter to DIN EN 175301-803 angular connector**

Insertion length, process connection, sensor and connection method can each be selected for the respective application within the ordering information. The model TR33 resistance thermometer consists of a protection tube with a fixed process connection and is screwed directly into the process. The electrical connection is made via an M12 x 1 circular connector. An adapter for electrical connection with angular connector per DIN EN 175301-803 is optionally available (patent, industrial property right: 001370985).

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Data sheets showing similar products and accessories:  
Resistance thermometer, compact version; model TR30; see data sheet TE 60.30  
Miniature resistance thermometer, explosion-protected version; model TR34; see data sheet TE 60.34  
OEM threaded thermometer with plug connection; model TF35; see data sheet TE 67.10



## Specifications

| Measuring element  |  |   |
|--|--|---|
| Type of measuring element  |  |   |
| Version 4 ... 20 mA (model TR33-Z-TT)                                | Pt1000<br>(measuring current < 0.3 mA; self-heating can be ignored)  |   |
| Version Pt100 (model TR33-Z-Px) / Pt1000 (model TR33-Z-Sx)           | <div><div></div>■ Pt100 (measuring current: 0.1 ... 1.0 mA)</div> <div><div></div>■ Pt1000 (measuring current: 0.1 ... 0.3 mA)</div> |   |
|  | → For detailed specifications for Pt sensors, see Technical information IN 00.17 at <a href="http://www.wika.com">www.wika.com</a> . |   |
| Connection method  |  |   |
| Version 4 ... 20 mA (model TR33-Z-TT)                                | 2-wire   |   |
| Version Pt100 (model TR33-Z-Px) / Pt1000 (model TR33-Z-Sx)           | 2-wire   | The lead resistance is recorded as an error in the measurement        |
|  | 3-wire   | With a cable length of 30 m or longer, measuring deviations can occur |
|  | 4-wire   | The lead resistance can be ignored                                    |
| Tolerance value of the measuring element <sup>1)</sup> per IEC 60751 |  |   |
| Version 4 ... 20 mA (model TR33-Z-TT)                                | Class A  |   |
| Version Pt100 (model TR33-Z-Px) / Pt1000 (model TR33-Z-Sx)           | <div><div></div>■ Class A</div> <div><div></div>■ Class B at 2-wire</div>  |   |

| Accuracy specifications (4 ... 20 mA version)                               |  |
|---|--|
| <b>Tolerance value of the measuring element <sup>1)</sup> per IEC 60751</b> | Class A  |
| <b>Measuring deviation of the transmitter per IEC 62828</b>                 | ±0.25 K  |
| <b>Total measuring deviation per IEC 62828</b>                              | Measuring deviation of the measuring element + transmitter     |
| <b>Influence of the ambient temperature</b>                                 | 0.1 % of the set measuring span / 10 K T <sub>a</sub>          |
| <b>Influence of supply voltage</b>  | ±0.025 % / V (depending on the supply voltage U <sub>B</sub> ) |
| <b>Influence of the load</b>  | ±0.05 % / 100 Ω  |
| <b>Linearisation</b>  | Linear to temperature per IEC 60751                            |
| <b>Output error</b>   | ±0.1 % <sup>2)</sup>   |
| <b>Reference conditions</b>   |  |
| Ambient temperature T <sub>a</sub> ref                                      | 23 °C  |
| Supply voltage U <sub>B</sub> ref   | DC 12 V  |

1) Depending on the process connection, the deviation can be bigger.

2) ±0.2 % for start of measuring range less than 0 °C [32 °F]

### Example calculation: Total measuring deviation

(measuring range 0 ... 150 °C, load 200 Ω, supply voltage 16 V, ambient temperature 33 °C, process temperature 100 °C)

|   |          |
|---|----------|
| Sensor element (class A per IEC 60751: 0.15 + (0.0020(t))):                   | ±0.350 K |
| Measuring deviation of the transmitter ±0.25 K:                               | ±0.250 K |
| Output error ±(0.1 % of 150 K):   | ±0.150 K |
| Influence of load ±(0.05 % / 100 Ω of 150 K):                                 | ±0.150 K |
| Influence of supply voltage ±(0.025 % / V of 150 K):                          | ±0.150 K |
| Influence of the ambient temperature ±(0.1 % / 10 K T <sub>a</sub> of 150 K): | ±0.150 K |

### Measuring deviation (typical)

$$\sqrt{(0.35 \text{ K}^2 + 0.25 \text{ K}^2 + 0.15 \text{ K}^2 + 0.15 \text{ K}^2 + 0.15 \text{ K}^2)}$$

$$\sqrt{(0.275 \text{ K}^2)} = 0.524 \text{ K}$$

### Measuring deviation (maximum)

$$0.35 \text{ K} + 0.25 \text{ K} + 0.15 \text{ K} + 0.15 \text{ K} + 0.15 \text{ K} + 0.15 \text{ K} = 1.2 \text{ K}$$

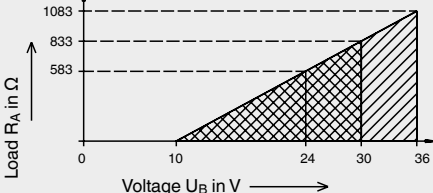
| Measuring range  |  |
|--|--|
| Temperature range  |  |
| Version 4 ... 20 mA (model TR33-Z-TT)                      | Without neck tube -30 ... +150 °C [-22 ... +302 °F]<br>With neck tube -30 ... +250 °C [-22 ... +482 °F] <sup>1)</sup><br>Version with FKM O-ring: -20 ... +125 °C [-4 ... +257 °F] |
| Version Pt100 (model TR33-Z-Px) / Pt1000 (model TR33-Z-Sx) | Class A Without neck tube -30 ... +150 °C [-22 ... +302 °F]<br>With neck tube -30 ... +250 °C [-22 ... +482 °F]<br>Version with FKM O-ring: -20 ... +125 °C [-4 ... +257 °F]       |
|  | Class B Without neck tube -50 ... +150 °C [-58 ... +302 °F]<br>With neck tube -50 ... +250 °C [-58 ... +482 °F]  |
| Unit (4 ... 20 mA version)                                 | Configurable °C, °F, K   |
| Temperature at the connector (Pt100, Pt1000 version)       | Max. 85 °C [185 °F]  |
| Measuring span (4 ... 20 mA version)                       | Minimum 20 K, maximum 300 K  |

1) The temperature transmitter should therefore be protected from temperatures over 85 °C [185 °F].

| Process connection              |   |
|---------------------------------|---|
| Type of process connection      | <ul style="list-style-type: none"> <li>■ G ¼ B</li> <li>■ G ⅜ B</li> <li>■ G ½ B</li> <li>■ ¼ NPT</li> <li>■ ½ NPT</li> <li>■ M12 x 1.5</li> <li>■ M20 x 1.5</li> <li>■ 7/16-20 UNF-2A</li> </ul>   |
| Protection tube                 |   |
| Protection tube diameter        | <ul style="list-style-type: none"> <li>■ 3 mm [0.12 in]</li> <li>■ 6 mm [0.24 in]</li> </ul>  |
| Insertion length U <sub>1</sub> | <ul style="list-style-type: none"> <li>■ 50 mm [1.97 in]</li> <li>■ 75 mm [2.95 in] <sup>1)</sup></li> <li>■ 100 mm [3.94 in] <sup>1)</sup></li> <li>■ 120 mm [4.72 in] <sup>1)</sup></li> <li>■ 150 mm [5.91 in] <sup>1)</sup></li> <li>■ 200 mm [7.87 in] <sup>1)</sup></li> <li>■ 250 mm [9.84 in] <sup>1)</sup></li> <li>■ 300 mm [11.81 in] <sup>1)</sup></li> <li>■ 350 mm [13.78 in] <sup>1)</sup></li> <li>■ 400 mm [15.75 in] <sup>1)</sup></li> </ul> |
|                                 | Other insertion lengths on request  |
| Material (wetted)               | Stainless steel 1.4571  |

1) Not for protection tube diameter 3 mm [0.12 in]

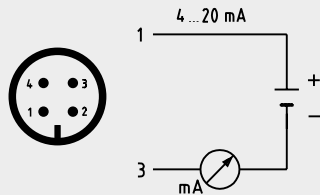
If the resistance thermometer is to be operated in an additional protection tube, a spring-loaded compression fitting must be used.

| Output signal (4 ... 20 mA version)           |  |
|---|--|
| <b>Analogue output</b>                        | 4 ... 20 mA, 2-wire  |
| <b>Load <math>R_A</math></b>                  | $R_A \leq (U_B - 10 \text{ V}) / 23 \text{ mA}$ with $R_A$ in $\Omega$ and $U_B$ in V<br>The permissible load depends on the loop supply voltage. For communication with the instrument with programming unit PU-548, a max. load of 350 $\Omega$ is admissible. |
| <b>Load diagram</b>                           |    |
| <b>Factory configuration</b>                  |  |
| Measuring range                               | Measuring range 0 ... 150 °C [32 ... 302 °F]<br>Other measuring ranges are adjustable  |
| Current signals for error signalling          | Configurable in accordance with NAMUR NE 043<br>downscale $\leq 3.6 \text{ mA}$<br>upscale $\geq 21.0 \text{ mA}$  |
| Current value for sensor short-circuit        | Not configurable in accordance with NAMUR NE 043<br>downscale $\leq 3.6 \text{ mA}$  |
| <b>Communication</b>                          |  |
| Info data                                     | Tag no., description and user message can be stored in transmitter   |
| Configuration and calibration data            | Permanently stored   |
| Configuration software                        | WIKAsoft-TT<br>→ Configuration software (multilingual) as a download from <a href="http://www.wika.com">www.wika.com</a>   |
| <b>Voltage supply</b>                         |  |
| Supply voltage $U_B$                          | DC 10 ... 30 V   |
| Supply voltage input                          | Protected against reverse polarity   |
| Permissible residual ripple of supply voltage | 10 % generated by $U_B < 3 \%$ ripple of the output current  |
| <b>Time response</b>                          |  |
| Switch-on delay, electrical                   | Max. 4 s (time before the first measured value)  |
| Warm-up time                                  | After approx. 4 minutes, the instrument will function to the specifications (accuracy) given in the data sheet.  |

| Electrical connection |                                    |
|-----------------------|------------------------------------|
| Connection type       | M12 x 1 circular connector (4-pin) |
| Material              | Stainless steel 1.4571             |

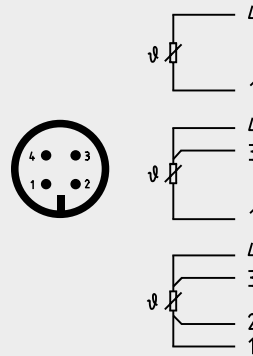
#### Pin assignment

Output signal 4 ... 20 mA  
M12 x 1 circular connector (4-pin)



| Pin | Signal | Description   |
|-----|--------|---------------|
| 1   | L+     | 10 ... 30 V   |
| 2   | VQ     | not connected |
| 3   | L-     | 0 V           |
| 4   | C      | not connected |

Output signal Pt100 or Pt1000 sensor  
M12 x 1 circular connector (4-pin)



| Operating conditions  |  |
|---|--|
| <b>Ambient temperature range</b>  |  |
| Version 4 ... 20 mA (model TR33-Z-TT)   | -40 ... +85 °C [-40 ... +185 °F]<br>Version with FKM O-ring: -20 °C [-4 °F]                        |
| Version Pt100 (model TR33-Z-Px) / Pt1000 (model TR33-Z-Sx)  | -50 ... +85 °C [-58 ... +185 °F]<br>Version with FKM O-ring: -20 °C [-4 °F]                        |
| <b>Storage temperature range</b>  |  |
| -40 ... +85 °C [-40 ... +185 °F]<br>Version with FKM O-ring: -20 °C [-4 °F]   |  |
| <b>Climate class per IEC 60654-1</b>  |  |
| Version 4 ... 20 mA (model TR33-Z-TT)   | Cx (-40 ... +85 °C [-40 ... +185 °F], 5 ... 95 % r. h.)<br>Version with FKM O-ring: -20 °C [-4 °F] |
| Version Pt100 (model TR33-Z-Px) / Pt1000 (model TR33-Z-Sx)  | Cx (-50 ... +85 °C [-58 ... +185 °F], 5 ... 95 % r. h.)<br>Version with FKM O-ring: -20 °C [-4 °F] |
| <b>Maximum permissible humidity, condensation</b>   |  |
| 100 % r. h., condensation allowed   |  |
| <b>Maximum operating pressure <sup>1) 2)</sup></b>  |  |
| For protection tube diameter 3 mm [0.12 in]   | 140 bar [2,030 psi]  |
| For protection tube diameter 6 mm [0.24 in]   | 270 bar [3,916 psi]  |
| <b>Salt fog</b>   |  |
| IEC 60068-2-11  |  |
| <b>Vibration resistance per IEC 60751</b>   |  |
| 10 ... 2,000 Hz, 20 g <sup>1)</sup>   |  |
| <b>Shock resistance per IEC 60068-2-27</b>  |  |
| 50 g, 6 ms, 3 axes, 3 directions, three times per direction   |  |
| <b>Maximum permissible autoclaving conditions</b>   |  |
| Max. 134 °C, 3 bar abs., 100 % r. h., duration 20 min., max. 50 cycles  |  |
| Autoclavable with mounted protective cap at coupler connector   |  |
| <b>Conditions for outdoor use (only applies to UL approval)</b>   |  |
| <ul style="list-style-type: none"> <li>■ The instrument is suitable for applications with pollution degree 3.</li> <li>■ The power supply must be suitable for operation above 2,000 m should the temperature transmitter be used at this altitude.</li> <li>■ The instrument shall be installed in locations sheltered from the weather.</li> <li>■ The instrument shall be installed sun/UV irradiation protected.</li> </ul> |  |




| Operating conditions                        |   |
|---|---|
| Ingress protection (IP code)                |   |
| Case with connected connector <sup>3)</sup> | <ul style="list-style-type: none"> <li>■ IP67 per IEC/EN 60529</li> <li>■ IP69 per IEC/EN 60529</li> <li>■ IP69K per ISO 20653</li> </ul> <p>The stated ingress protection only applies when plugged in using line connectors that have the appropriate ingress protection.</p> |
| Coupler connector, not connected            | IP67 per IEC/EN 60529   |
| <b>Weight</b>                               | approx. 0.2 ... 0.7 kg [0.44 ... 1.54 lbs] - depending on version   |

1) Dependent on the instrument version




2) Reduced operating pressure when using a compression fitting: Stainless steel = max. 100 bar [1,450 psi] / PTFE = max. 8 bar [116 psi]

3) Not tested with UL

## Approvals

| Logo  | Description  | Country        |
|---|--|----------------|
|    | <b>EU declaration of conformity</b><br>EMC directive <sup>1) 2)</sup><br>EN 61326 emission (group 1, class B) and immunity (industrial application)<br>Configuration at 20 % of the full measuring range<br>RoHS directive | European Union |
|  | <b>CSA</b><br>Safety (e.g. electr. safety, overpressure, ...)  | USA and Canada |
|  | <b>UL</b><br>Safety (e.g. electr. safety, overpressure, ...)   | USA and Canada |

## Optional approvals

| Logo  | Description  | Country                     |
|---|--|-----------------------------|
|  | <b>EAC</b><br>EMC directive <sup>1)</sup>              | Eurasian Economic Community |
|  | <b>GOST</b><br>Metrology, measurement technology       | Russia                      |
|  | <b>KazInMetr</b><br>Metrology, measurement technology  | Kazakhstan                  |
| -   | <b>MTSCHS</b><br>Permission for commissioning          | Kazakhstan                  |
|  | <b>BelGIM</b><br>Metrology, measurement technology     | Belarus                     |
|  | <b>UkrSEPRO</b><br>Metrology, measurement technology   | Ukraine                     |
|  | <b>Uzstandard</b><br>Metrology, measurement technology | Uzbekistan                  |

1) Only for built-in transmitter

2) During transient interferences (e.g. burst, surge, ESD) take into account an increased measuring deviation of up to 2 %.

### Certificates (option)

| Certification type                | Measurement accuracy | Material certificate |
|-----------------------------------|----------------------|----------------------|
| 2.2 test report                   | x                    | x                    |
| 3.1 inspection certificate        | x                    | x                    |
| DKD/DAkkS calibration certificate | x                    | -                    |

The different certifications can be combined with each other.

For calibration, the measuring insert is removed from the thermometer. The minimum length (metal part of the probe) for carrying out a 3.1 measurement accuracy test or DKD/DAkkS is 100 mm [3.94 in].  
Calibration of shorter lengths on request.

Approvals and certificates, see website

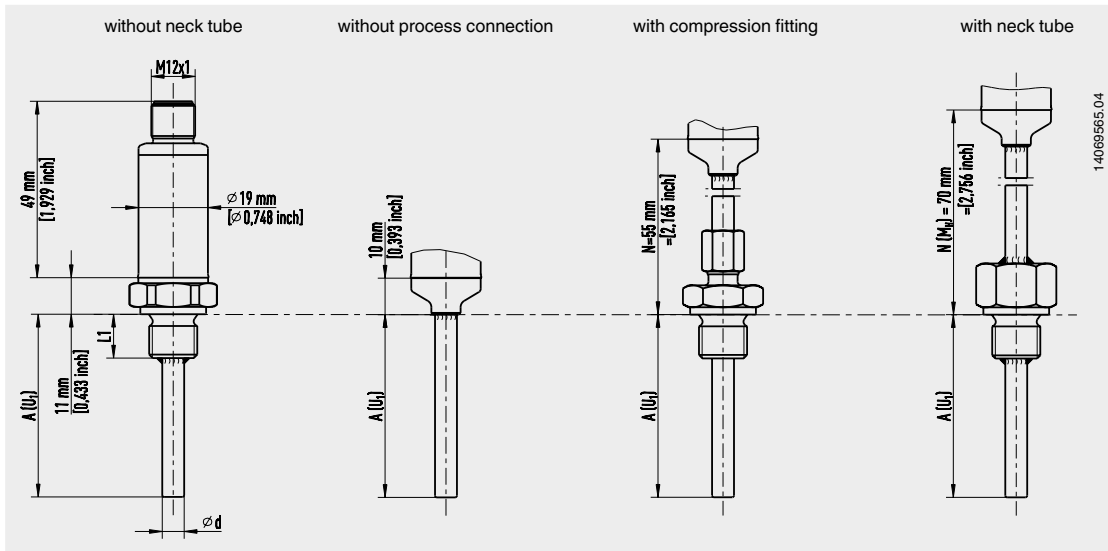
### Patents, property rights

M12 x 1 adapter to DIN EN 175301-803 angular connector (001370985)

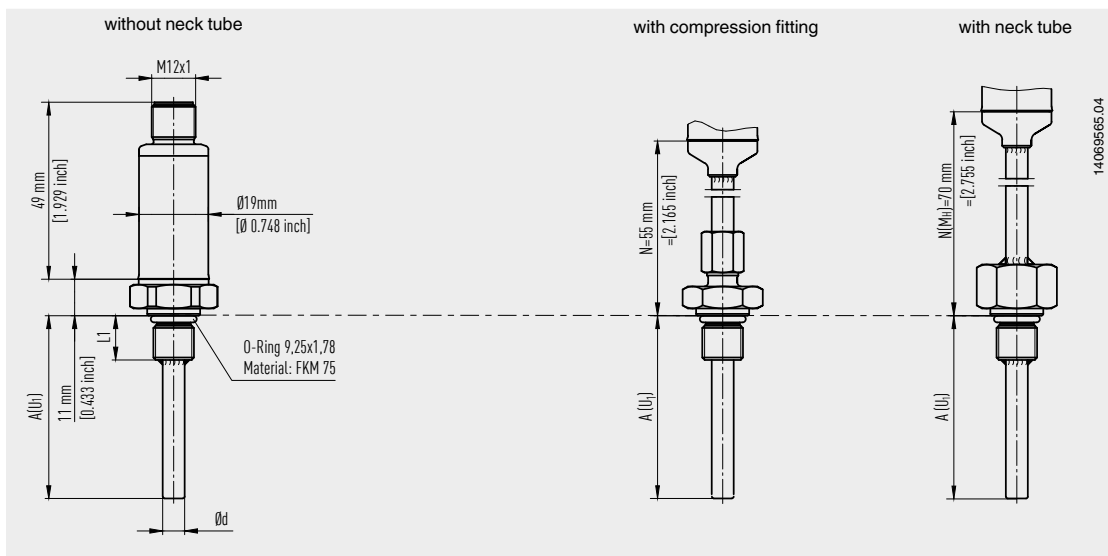


## Dimensions in mm [in]

### Process connection with parallel thread (or without process connection)



### Process connection with parallel thread (7/16-20 UNF-2A) and O-ring



The FKM O-ring must be protected from temperatures lower than -20 °C [-4 °F] and higher than 125 °C [257 °F].



## Accessories

| Model  | Description  | Order no. |
|--|--|-----------|
|  <b>Programming unit Model PU-548</b>   | <ul style="list-style-type: none"> <li>■ Easy to use</li> <li>■ LED status display</li> <li>■ Compact design</li> <li>■ No further voltage supply needed, neither for the programming unit nor for the transmitter</li> </ul> (replaces programming unit model PU-448)   | 14231581  |
|  <b>Adapter cable M12 to PU-548</b>   | Adapter cable for the connection of a model TR33 resistance thermometer to the model PU-548 programming unit   | 14003193  |
|  <b>M12 x 1 transmitter adapter to DIN EN 175301-803 angular connector</b><br>(yellow female connector element) | Adapter for the connection of a resistance thermometer with a DIN EN 175301-803 angular connector form A with a 4 ... 20 mA output signal<br>→ see data sheet AC 80.17<br><br>Case: PA<br>Ambient temperature: -40 ... +115 °C [-40 ... +239 °F]<br>Union nut: Zinc die-cast<br>Contacts: Copper-zinc alloy, tinned<br>Dielectric strength: 500 V<br>Ingress protection: IP65<br><br><div style="display: flex; justify-content: space-around;"> <div> <p><b>M12 x 1 connector</b></p>  </div> <div> <p><b>Angular connector</b></p>  </div> </div>         | 14069503  |
|  <b>M12 x 1 Pt adapter to DIN EN 175301-803 angular connector</b><br>(black female connector element)         | Adapter for the connection of the resistance thermometer with a DIN EN 175301-803 form A angular connector with direct resistance output signal<br>→ see data sheet AC 80.17<br><br>Case: PA<br>Ambient temperature: -40 ... +115 °C [-40 ... +239 °F]<br>Union nut: Zinc die-cast<br>Contacts: Copper-zinc alloy, tinned<br>Dielectric strength: 500 V<br>Ingress protection: IP65<br><br><div style="display: flex; justify-content: space-around;"> <div> <p><b>M12 x 1 connector</b></p>  </div> <div> <p><b>Angular connector</b></p>  </div> </div> | 14061115  |
|  <b>Angular connector</b>   | Per DIN EN 175301-803 form A   | 11427567  |
|  <b>Sealing for angular connector</b>   | For use with angular connector DIN EN 175301-803-A EPDM, brown   | 11437902  |

| Model                         | Description   | Order no.                            |
|-------------------------------|---|--------------------------------------|
| - <b>M12 connection cable</b> | Cable socket straight, 4-pin, ingress protection IP67<br>Temperature range -20 ... +80 °C [-4 ... +176 °F]  | Cable length 2 m [6.56 ft] 14086880  |
|                               |   | Cable length 5 m [16.40 ft] 14086883 |
|                               | Cable socket straight, 4-pin, ingress protection IP69K, hygienic design<br>Union nut from stainless steel<br>Temperature range -40 ... +80 °C [-40 ... +176 °F]   | Cable length 3 m [9.84 ft] 14137167  |
|                               |   | Cable length 5 m [16.40 ft] 14137168 |
|                               | Angled socket, 4-pin, ingress protection IP67<br>Temperature range -20 ... +80 °C [-4 ... +176 °F]  | Cable length 2 m [6.56 ft] 14086889  |
|                               |   | Cable length 5 m [16.40 ft] 14086891 |
|                               | Angled socket, 4-pin, ingress protection IP69K, hygienic design<br>Union nut from stainless steel<br>Temperature range -40 ... +80 °C [-40 ... +176 °F]   | Cable length 3 m [9.84 ft] 14137169  |
|                               |   | Cable length 5 m [16.40 ft] 14137170 |
| - <b>M12 connector</b>        | Female angled, 4-pin, ingress protection IP67<br>Screw connection for conductor cross-section 0.25 ... 0.75 mm <sup>2</sup> [24 ... 18 AWG]<br>Cable gland Pg7, outside diameter of cable 4 ... 6 mm [0.16 ... 0.24 in]<br>Temperature range -40 ... +80 °C [-40 ... +176 °F] | 14136815                             |

### Ordering information

Model / Output signal / Transmitter temperature unit / Process temperature / Transmitter initial value / Transmitter end value / Process connection / Protection tube diameter / Insertion length A (U<sub>1</sub>) or A (U<sub>2</sub>) / Neck length N (M<sub>H</sub>) / Accessories / Certificates

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The specifications given in this document represent the state of engineering at the time of publishing.  
We reserve the right to make modifications to the specifications and materials.

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**WIKA Alexander Wiegand SE & Co. KG**  
Alexander-Wiegand-Straße 30  
63911 Klingenberg/Germany  
Tel. +49 9372 132-0  
Fax +49 9372 132-406  
info@wika.de  
www.wika.de

## Operating limits and tolerances of platinum resistance thermometers per DIN EN IEC 60751

WIKA data sheet IN 00.17

### General information

Temperature is a measurement for the thermal state of a material - so a measurement of the average kinetic energy of its molecules. A close thermal contact between two bodies is needed in order that these bodies adopt the same temperature (temperature equalisation). The body to be measured should be coupled as closely as possible to the temperature sensor system.

The most established temperature measurement methods are based on material or body properties that change depending on the temperature. One of the most-used methods is the measurement with a resistance thermometer.

This document outlines the recurrent concepts and technologies that apply to all resistance thermometers produced by WIKA.

#### Standard version

If there are no additional specifications or customer requirements, we will recommend this selection, or we will select this option when offering or producing the thermometer.

### Sensor technology

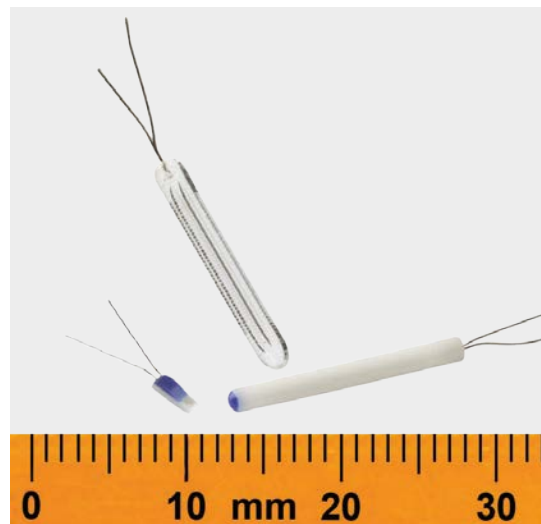
The electrical resistance of a resistance thermometer's sensor changes with the temperature. As the resistance increases when temperature is raised, we refer to it as PTC (**P**ositive **T**emperature **C**oefficient).

Pt100 or Pt1000 measuring resistors are normally used for industrial applications. The exact characteristics of these measuring resistors, and the thermometers based on them, are defined in IEC 60751. The most important characteristics are described in this document.

#### Resistance basic values at 0 °C

| Designation   | Basic value in $\Omega$ |
|---------------|-------------------------|
| <b>Pt100</b>  | 100                     |
| <b>Pt1000</b> | 1,000                   |

**Bold: Standard version**



**Fig. left: Thin-film measuring resistor**

**Fig. centre: Glass measuring resistor**

**Fig. right: Ceramic measuring resistor**

## Measuring resistor designs

Those measuring resistors used in thermometers can be wire-wound measuring resistors (W = Wire-Wound) or thin-film resistors (F = Thin-Film).

### Thin-film measuring resistors (F), standard version

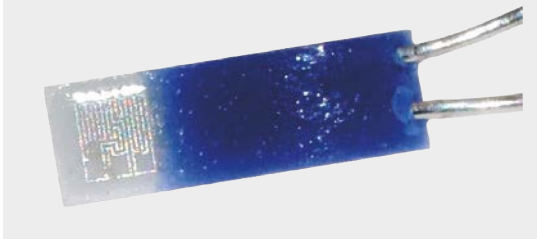
For thin-film measuring resistors, a very thin platinum film is applied to a ceramic carrier plate. Then, connecting wires are attached. Finally, the platinum film and the connecting wire connection are sealed against external effects by a layer of glass.

#### The thin-film measuring resistor is characterised by

- Temperature range: -50 ... +500 °C <sup>1)</sup>
- High vibration resistance
- Very small size
- Good price/performance ratio

Thin-film measuring resistors are the standard design unless the temperature range or an explicit customer request exclude them.

Thin-film measuring resistor



### Wire-wound measuring resistors (W)

In this design, a very thin platinum wire is encased within a round protective body. This design has been well-established for decades and is accepted worldwide.

Two subtypes are available that differ in the choice of insulating material.

#### ■ Glass measuring resistor

The bifilar wire of the glass measuring resistor is fused within a glass body.

The glass measuring resistor is characterised by:

- Temperature range: -196 ... +400 °C <sup>1)</sup>
- High vibration resistance

Glass measuring resistor



#### ■ Ceramic measuring resistor

The platinum wire of a ceramic measuring resistor is spiral-wound and located in a cylindrical cavity in the protective body.

The ceramic measuring resistor is characterised by:

- Temperature range: -196 ... +600 °C <sup>1)</sup>
- Limited vibration resistance

Ceramic measuring resistor

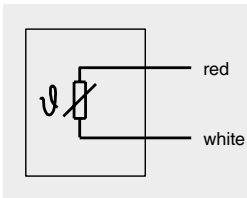


<sup>1)</sup> The specifications apply to class B, see also table on page 4

## Sensor connection methods

### ■ 2-wire connection

The lead resistance to the sensor is recorded as an error in the measurement. For this reason, this connection type is not advisable when using Pt100 measuring resistors for tolerance classes A and AA, since the electrical resistance of the connecting cables and their own temperature dependency are fully included in the measuring result and thus falsify it.

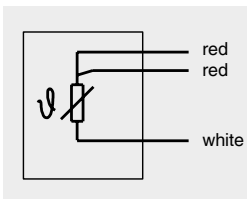


#### Applications

- Connecting cables up to 250 mm
- Standard when using Pt1000 measuring resistors

### ■ 3-wire connection (standard version)

The influence of the lead resistance is compensated as far as possible. The maximum length of the connecting cable depends on the conductor cross-section and the compensation options of the evaluation electronics (transmitter, display, controller or process control system).



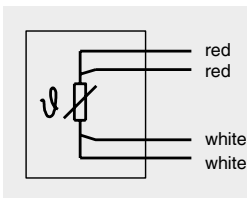
#### Applications

- Connecting cables up to approx. 30 m

### ■ 4-wire connection

The influence of the connecting cable on the measuring result is completely eliminated since any possible asymmetries in the connecting cable's lead resistance are also compensated.

The maximum length of the connecting cable depends on the conductor cross-section and the compensation options of the evaluation electronics (transmitter, display, controller or process control system). A 4-wire connection can also be used as a 2-wire or 3-wire connection by disconnecting the unnecessary conductors.



#### Applications

- Laboratory technology
- Calibration technology
- Tolerance class A or AA
- Connecting cables up to 1,000 m

## Dual sensors

### In the standard version a single sensor is fitted.

The combination of black and yellow is reserved for an optional second measuring resistor. For certain combinations (e.g. small diameter) dual sensors are not possible for technical reasons.

## Relationship between temperature and resistance

For each temperature there is exactly one resistance value.  
This clear relationship can be described by mathematical formulae.

For the temperature range -200 ... 0 °C the following applies, irrespective of the resistor design:

$$R_t = R_0 [1 + At + Bt^2 + C(t - 100 \text{ °C}) \cdot t^3]$$

For the temperature range 0 ... 600 °C the following applies:

$$R_t = R_0 [1 + At + Bt^2]$$

Legend:

t = Temperature in °C  
R<sub>t</sub> = Resistance in ohms at the measured temperature  
R<sub>0</sub> = Resistance in ohms at t = 0 °C (e.g. 100 ohms)

**For the calculation, the following constants apply**

$$\begin{aligned} A &= 3.9083 \cdot 10^{-3} \text{ (°C}^{-1}\text{)} \\ B &= -5.7750 \cdot 10^{-7} \text{ (°C}^{-2}\text{)} \\ C &= -4.1830 \cdot 10^{-12} \text{ (°C}^{-4}\text{)} \end{aligned}$$

## Operating limits and tolerance classes

Both measuring resistor versions (wire-wound/thin-film) differ in the possible tolerances at the operating temperatures.

| Class    | Temperature range in °C |                     | Tolerance value                             |
|----------|-------------------------|---------------------|---|
|          | Wire-wound (W)          | Thin-film (F)       |   |
| <b>B</b> | <b>-196 ... +600</b>    | <b>-50 ... +500</b> | <b>±(0.30 + 0.0050   t  ) <sup>1)</sup></b> |
| A        | -100 ... +450           | -30 ... +300        | ±(0.15 + 0.0020   t  ) <sup>1)</sup>        |
| AA       | -50 ... +250            | 0 ... 150           | ±(0.10 + 0.0017   t  ) <sup>1)</sup>        |

1) | t | is the numerical value of the temperature in °C irrespective of the sign.

**Bold: Standard version**

Under certain conditions, thermometers/measuring inserts with built-in measuring resistors can be operated in a temperature range outside the temperature range of the specified class.

The following must be observed regarding the compliance with the tolerance class:

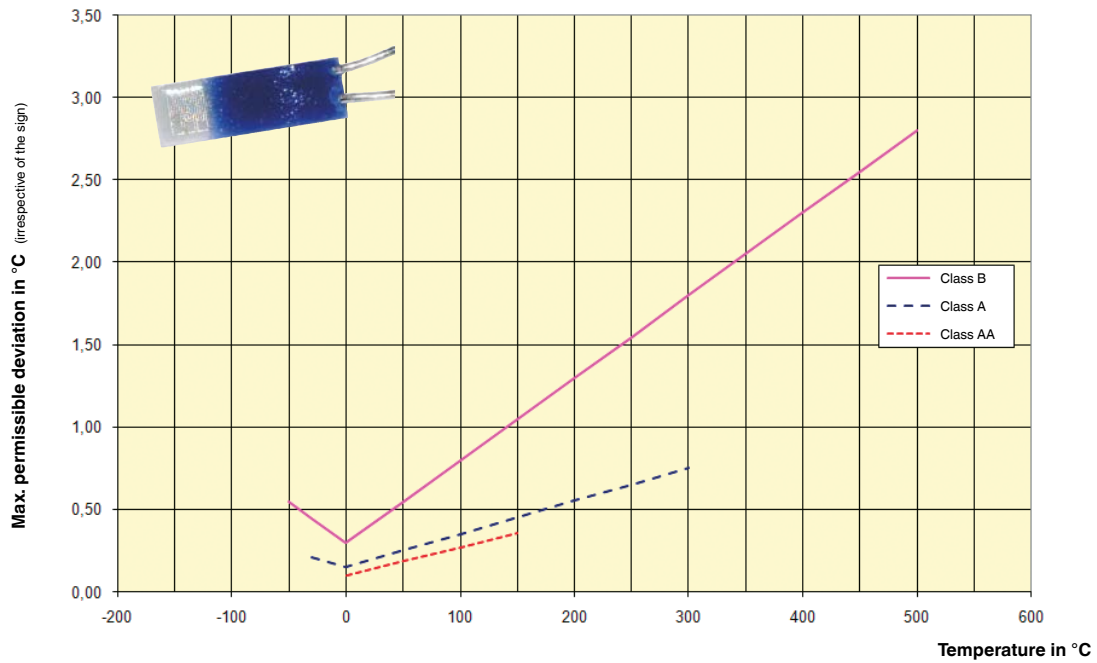
With standard instruments, the class A specified before can no longer be confirmed if the thermometer or measuring insert was operated above or below the class A temperature range. The dwell time is not relevant here.

Even if the temperature is in the range of class A again, the tolerance class of the measuring resistor is no longer defined.

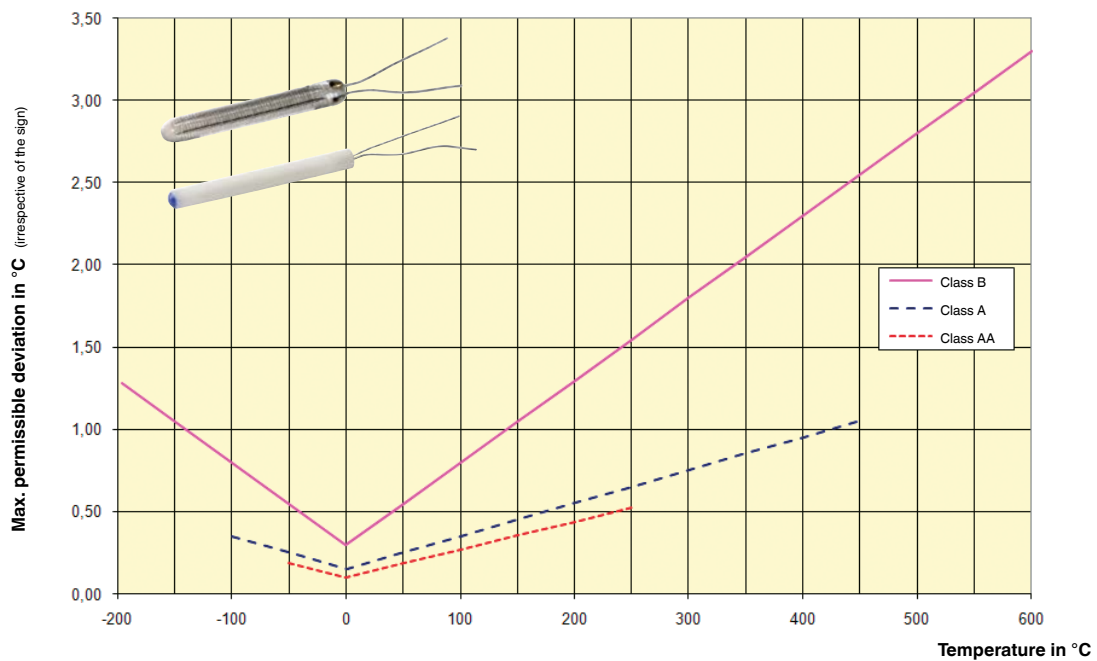


## Resistance values and tolerance values with selected temperatures (Pt100)

Tolerance value IEC 60751 for resistance thermometers with film measuring resistors



Tolerance value IEC 60751 for resistance thermometers with wire-wound measuring resistors



### Temperature values and tolerance values with selected resistance values (Pt100)

| Resistance value in $\Omega$ | Temperature value in $^{\circ}\text{C}$ (ITS 90) |                     |                     |
|------------------------------|--|---------------------|---------------------|
|                              | Tolerance class B                                | Tolerance class A   | Tolerance class AA  |
| 50                           | -126.07 ... -124.22                              | -125.55 ... -124.75 | -125.46 ... -124.83 |
| 80                           | -51.32 ... -50.22                                | -51.02 ... -50.52   | -50.96 ... -50.58   |
| 100                          | -0.30 ... +0.30                                  | -0.15 ... +0.15     | -0.10 ... +0.10     |
| 110                          | 25.26 ... 26.11                                  | 25.48 ... 25.89     | 25.54 ... 25.83     |
| 150                          | 129.50 ... 131.40                                | 130.04 ... 130.86   | 130.13 ... 130.77   |
| 200                          | 264.72 ... 267.98                                | 265.67 ... 267.03   | 265.80 ... 266.90   |
| 300                          | 554.60 ... 560.78                                | 556.42 ... 558.95   | 556.64 ... 558.74   |

This table can be used to check the evaluation electronics, e.g. by means of a decade resistor:

This means if the sensor or the measuring resistor is simulated by a decade resistor, the evaluation electronics must display a temperature value within the limit values specified above.

### Resistance values and tolerance values with selected temperatures (Pt100)

| Temperature in $^{\circ}\text{C}$ (ITS 90) | Resistance value in $\Omega$ |                   |                    |
|--|------------------------------|-------------------|--------------------|
|  | Tolerance class B            | Tolerance class A | Tolerance class AA |
| -196                                       | 19.69 ... 20.80              | -                 | -                  |
| -100                                       | 59.93 ... 60.58              | 60.11 ... 60.40   | -                  |
| -50  | 80.09 ... 80.52              | 80.21 ... 80.41   | 80.23 ... 80.38    |
| -30  | 88.04 ... 88.40              | 88.14 ... 88.30   | 88.16 ... 88.28    |
| 0  | 99.88 ... 100.12             | 99.94 ... 100.06  | 99.96 ... 100.04   |
| 20   | 107.64 ... 107.95            | 107.72 ... 107.87 | 107.74 ... 107.85  |
| 100  | 138.20 ... 138.81            | 138.37 ... 138.64 | 138.40 ... 138.61  |
| 150  | 156.93 ... 157.72            | 157.16 ... 157.49 | 157.91 ... 157.64  |
| 250  | 193.54 ... 194.66            | 193.86 ... 194.33 | 193.91 ... 194.29  |
| 300  | 211.41 ... 212.69            | 211.78 ... 212.32 | -                  |
| 450  | 263.31 ... 265.04            | 263.82 ... 264.53 | -                  |
| 500  | 280.04 ... 281.91            | -                 | -                  |
| 600  | 312.65 ... 314.77            | -                 | -                  |

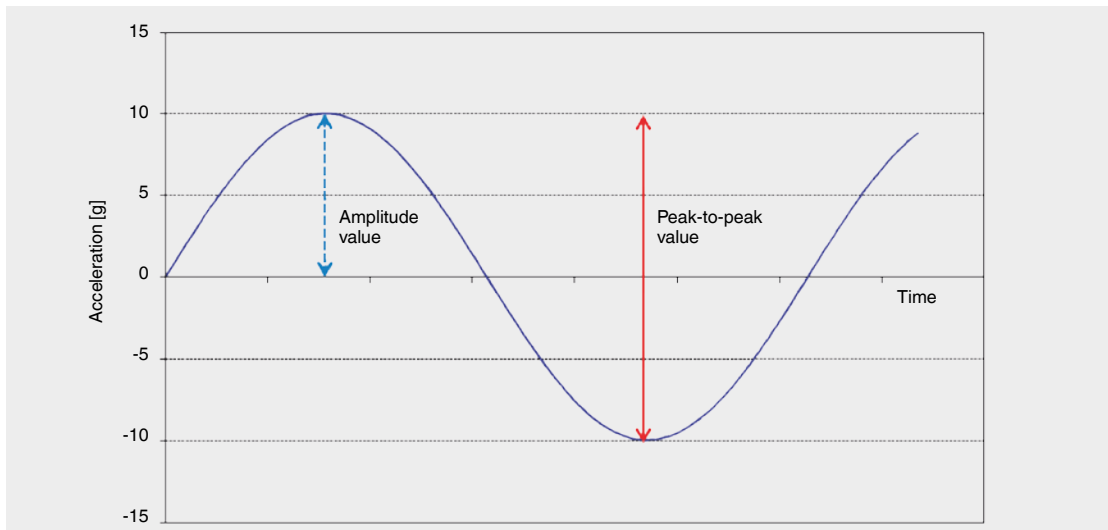
This table represents the calibration process with predefined temperatures.

This means if a temperature standard is available, the resistance value of the test item must lie within the limits specified above.

## Vibration resistance of resistance thermometers

In accordance with IEC 60751, the design of a resistance thermometer can be influenced by vibration-induced accelerations that can be up to 3 g (30 m/s<sup>2</sup>) and occur in a frequency range from 10 ... 500 Hz.

The vibration resistance data listed in the data sheets of the electrical thermometers from WIKA refer to the "peak-to-peak" value.



| Version   | Required vibration resistance per IEC 60751 in g <sup>1)</sup> (peak-to-peak) | Determined vibration resistance WIKA per IEC 60751 in g <sup>1)</sup> (peak-to-peak) |
|---|---|--|
| <b>Standard</b>   | 3   | 6  |
| <b>Vibration resistant</b><br>(optional, thin-film measuring resistor)                    | -   | 20   |
| <b>Highly vibration resistant</b><br>(special construction, thin-film measuring resistor) | -   | 50   |

1) 9.81 m/s<sup>2</sup>

| Measuring resistor                    |                        | Vibration resistance (peak-to-peak) |      |      |                   |      |      |
|---------------------------------------|------------------------|-------------------------------------|------|------|-------------------|------|------|
|                                       |                        | Ø 3 mm (MI cable)                   |      |      | Ø 6 mm (MI cable) |      |      |
|                                       |                        | 6 g                                 | 20 g | 50 g | 6 g               | 20 g | 50 g |
| <b>Thin-film (F)</b>                  | 1 x Pt100 / 1 x Pt1000 | x                                   | x    | x    | x                 | x    | x    |
|                                       | 2 x Pt100 / 2 x Pt1000 | x                                   | x    | -    | x                 | x    | x    |
| <b>Thin-film, face-sensitive (FS)</b> | 1 x Pt100 / 1 x Pt1000 | x                                   | -    | -    | x                 | -    | -    |
| <b>Wire-wound (W)</b>                 | 1 x Pt100 / 1 x Pt1000 | x                                   | -    | -    | x                 | -    | -    |
|                                       | 2 x Pt100 / 2 x Pt1000 | x                                   | -    | -    | x                 | -    | -    |

The vibration resistance data listed in the data sheets of the electrical thermometers from WIKA only refer to the sensor tip.

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**WIKA Alexander Wiegand SE & Co. KG**  
Alexander-Wiegand-Straße 30  
63911 Klingenberg/Germany  
Tel. +49 9372 132-0  
Fax +49 9372 132-406  
info@wika.de  
www.wika.de

## Accessories

|  | Art. No. | Type No.    |
|--|----------|-------------|
| Adapter M12 for resistance thermometer, 4 to 20 mA output signal, form A | 148344   | A.4-20.TR33 |
| Adapter M12 for resistance thermometer, resistance output signal, form A | 148345   | A.W.TR33    |
| Straight connector, 4-pole, with PUR cable 10 m                          | 148334   | EDS-KG10    |
| Angled connection plug, 4-pole, with PUR cable 10 m                      | 148338   | EDS-KW10    |