

# RTD Insert for Temperature Sensor *omniset TPR100*

**Mineral insulated insert  
Thermoresistance sensing element  
PCP (4...20 mA), HART® or PROFIBUS-PA® electronics**



The TPR100 is a thermoresistance insert designed to be the universal measurement probe of RTD sensors, and it is often utilized as a replaceable measuring element in thermometers.

Constructed in compliance with the standards DIN EN 60751 and DIN 43735, it consists of a mineral insulated cable and a Pt100 sensing element. It can be connected to the conversion electronics by means of flying leads or in alternative with a terminal block.

The TPR100, thanks to the numerous available versions, satisfies the most part of industrial and laboratory needs.

Among the structure's options, the user can choose several types of Pt100 for the different applications, different kinds of stem and certification too.

The use of wire wound or thin film sensing element, allows two different operating measurement ranges, respectively -200...600 °C and -50...400 °C.

## Features and benefits

- Mineral insulated cable sheathed in SS 316L/1.4404
- 3 or 6 mm diameter stem or tapered
- Customized immersion length
- Different kinds of Pt100 and classes of tolerance (DIN EN 60751):
  - wire wound type, class A or 1/3 DIN B, single or double
  - thin film type, class A or 1/3 DIN B
- 4 wires connection for single Pt100, 3 wires connection for double Pt100
- Electronics included in the ordering structure: PCP (4...20 mA, also with enhanced accuracy), HART® and PROFIBUS-PA® 2-wire transmitters
- Factory calibration certificate
- ATEX 1 GD EEx ia certification

Endress + Hauser

The Power of Know How



## Areas of application

TPR100 is an universal RTD insert; it is the fundamental part of a thermometer assembly. It can be used in various kinds of application: from the food industry to the chemistry one, thanks to its characteristics and enclosed certifications.

## Function and system design

### Measuring principle

In RTD (Resistance Temperature Detector) inserts the sensing element consists of an electrical resistance with value of  $100\ \Omega$  at  $0\ ^\circ\text{C}$  (called Pt100, in compliance with standard DIN EN 60751), which increases at higher temperatures according to a coefficient characteristic of the resistor material (Platinum). In industrial thermometers compliant with DIN EN 60751 standard, the value of that coefficient is  $\alpha=3.85\cdot 10^{-3}\ ^\circ\text{C}^{-1}$ , calculated between 0 and  $100\ ^\circ\text{C}$ .

### Equipment architecture

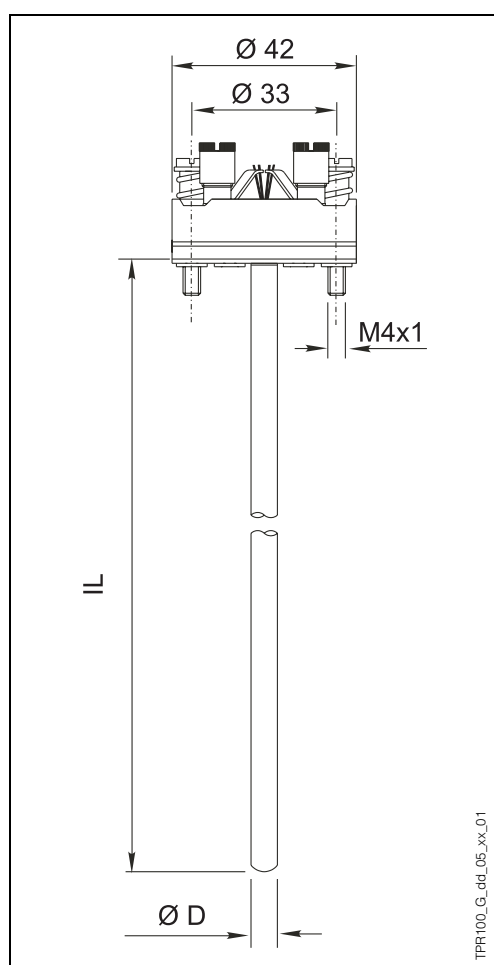


Fig. 1: Overall dimensions of TPR 100

The TPR100 is made up of a MgO cable sheathed in SS 316L/1.4404 with 6 or 3 mm diameter; the sensing element (Pt100) is positioned close to the tip of the probe. A tapered tip is also available and it's obtained from a 6 mm sheath reduced in the last 50 mm to a 3 mm outer diameter. At the opposite extremity the insert has a washer, which is crimped on the stem. The function of the washer is to stop the insert at the right insertion length, when assembled with a connection head.

The version having the flying leads as terminals, is indicated if the insert has to be connected directly to a head transmitter, otherwise there is the alternative with the terminal block, which is permanently fixed to the washer.

When a TPR100 is mounted into a sensor with thermowell, it is fixed by means of two spring-loaded screws, which allow the tip of the insert to go properly in contact with the bottom of the thermowell, ensuring in this way a better thermal contact. The springs are useful also to compensate the thermal expansion.

The electrical structure of the instrument always complies with DIN EN 60751 standard rules.

The sensing element is supplied in the two versions thin film (TF) or wire wound (WW), the last having an extended range of measurement and accuracy.

### Material

Stem in SS 316L/1.4404, terminal block in ceramics.

### Weight

From 0.1 to 0.3 kg for standard options.

## Electronics

The required type of output signal can be obtained by choosing the right head-mounted transmitter.

Endress + Hauser supplies state-of-the-art transmitters (iTEMP® series) built in 2-wire technology and with 4...20 mA, HART® or PROFIBUS-PA® output signal. All the transmitters are easily programmable with a personal computer through the ReadWin® 2000 public domain software (for 4...20 mA and HART® transmitters) or Commuwin II software (for PROFIBUS-PA® transmitters). HART® transmitters can be programmed also with the DXR275 (Universal HART® Communicator) hand-held operating module.

A PCP (4...20 mA) model (TMT180) with enhanced accuracy is available.

For detailed information regarding transmitters, please refer to the relevant documentation (see TI codes at the end of this document).

## Performance

### Operating conditions

#### Maximum process pressure

Stem

2 MPa (20 bar) at 20 °C

#### Process temperature

Same of measurement range.

#### Maximum flow velocity

When in direct contact with process fluid, the highest flow velocity tolerated by the insert stem diminishes with increasing lengths exposed to the stream of fluid.

#### Shock and vibration resistance

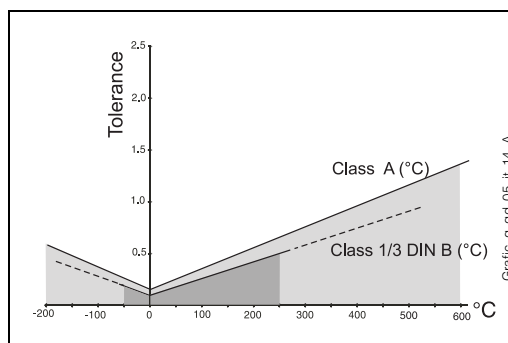
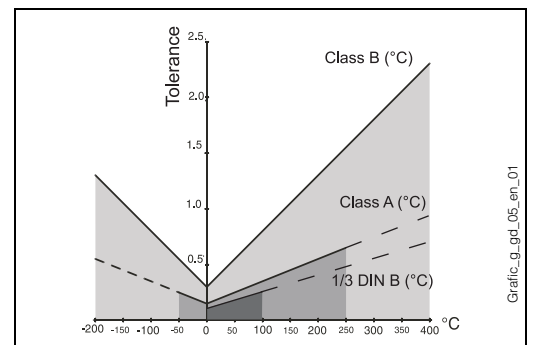
According to DIN EN 60751

2.8 g peak / 10÷500 Hz

### Accuracy

#### Probe maximum error (Pt 100 type TF)

- cl. A
  - $3\sigma = 0.15 + 0.0020|t|$       -50...250 °C
  - $3\sigma = 0.30 + 0.0050|t|$       250...400 °C
- cl. 1/3 DIN B
  - $3\sigma = 0.10 + 0.0017|t|$       0...100 °C
  - $3\sigma = 0.15 + 0.0020|t|$       -50...0 / 100...250 °C
  - $3\sigma = 0.30 + 0.0050|t|$       250...400 °C



#### Probe maximum error (Pt100 type WW)

- cl. A
  - $3\sigma = 0.15 + 0.0020|t|$       -200...600 °C
- cl. 1/3 DIN B
  - $3\sigma = 0.10 + 0.0017|t|$       -50...250 °C
  - $3s = 0.30 + 0.0050|t|$       -200...-50 / 250...600 °C

(|t| = absolute value of temperature in °C)

**Transmitter maximum error**

See relevant documentation (codes at the end of this document).

The "4 wires" configuration, supplied as standard for single Pt100, ensures no additional errors in case of long connecting cables (without head-mounted transmitter). Generally speaking, there is a higher guarantee of accuracy in the "4-wires" configuration.

The "2 wires" connection, employed in the ATEX certified version of the insert, could cause an additional error due to the resistance of the (copper) conductors in the mineral insulated cable, which adds to the Pt100 value. The incidence of this source of inaccuracy increases with longer insertion lengths.

<b>Measurement range</b>	• wire wound Pt100	-200...600 °C
	• thin film Pt100	-50...400 °C

**Response time** Test in water at 0.4 m/s (according to DIN EN 60751; 23 to 33 °C step changes):

	Response time	Type TF & WW
TPR100 (∅ 6)	t <sub>50</sub>	3.5 s
	t <sub>90</sub>	8 s
TPR100 (∅ 3 or tapered tip)	t <sub>50</sub>	2 s
	t <sub>90</sub>	5 s

<b>Insulation</b>	Insulation resistance between terminals and probe sheath (according to DIN EN 60751, test voltage 250 V)	more than 100 MΩ at 25 °C more than 10 MΩ at 300 °C
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**Self heating** Negligible when E+H iTEMP® transmitters are employed.

## Installation

TPR100 is normally mounted into thermometer assemblies where a thermoresistance is required. The installation inside an assembly is very easy: it's enough to insert the TPR100 into a housing and to screw down in the appropriate holes the two spring-loaded screws, in order to fix the washer to the internal base of the housing (see fig. 2).

The insertion length (IL) of an insert has a considerable role, since the tip of the probe must be in contact with the bottom of the host thermowell. In this way the thermal transfer from the wall of the thermowell to the sensing element is assured, and the response time will be surely reduced. Moreover it should be a good rule to leave less empty space as possible between insert and thermowell, in order to enhance the heat transmission; therefore the right stem diameter must be chosen with regard to the well bore diameter.

TPR100 can be also used directly for the temperature measurement, avoiding the employment of a protection well; for this solution a process connection (usually an adjustable one like a compression fitting) will fix the insert to the pipe or vessel, and define the right immersion length (see fig. 2).

Thanks to the construction with mineral insulated cable, the insert can be easily bended up to a radius of 3 times the stem diameter (see fig. 3, not for tapered tip version).

In case of vibrations, the thin film (TF) sensing element may offer some advantages, but the behaviour depends on intensity, direction and dominant frequency in the vibrational motion.

On the contrary the wire wound (WW) Pt100, besides a wider range of measurement and accuracy, assures a better long term stability.

For detailed information regarding adjustable process connections, as well as on ATEX-certified components (transmitter, insert), please refer to the relevant documentation (see TI codes at the end of this document).

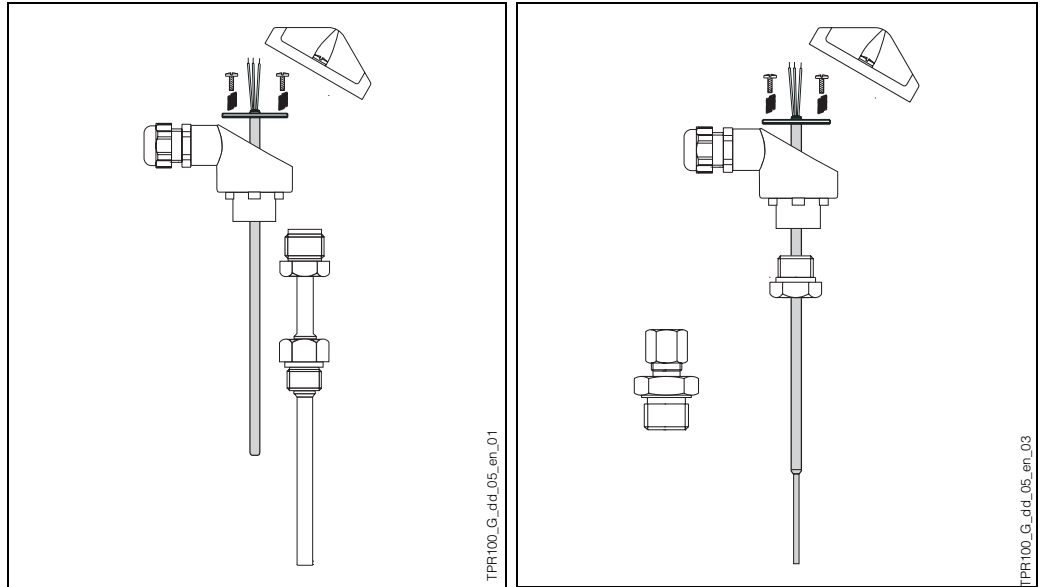


Fig. 2: General installation solutions: into an assembly with thermowell (right), direct measurement (left)

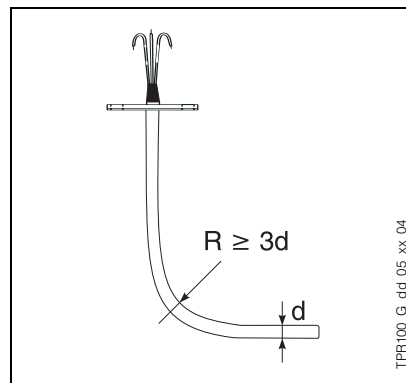


Fig. 3: Possible bending of TPR 100 stem

## System components

### Head transmitter

The head-mounted transmitters available are (see also the "Electronics" section):

- TMT180 PCP 4...20 mA
- TMT181 PCP 4...20 mA
- TMT182 Smart HART®
- TMT184 PROFIBUS-PA®

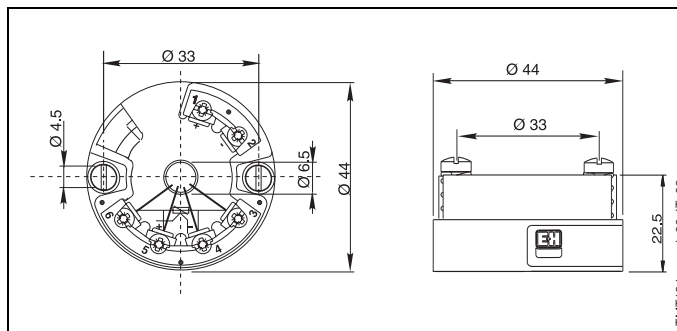


Fig. 4: TMT 180-181-182

TMT180 and TMT181 are PC Programmable transmitters. TMT180 can be supplied in a version with improved accuracy (0.1°C vs. 0.2°C) in the bandwidth -50...250°C, and a model with a fixed measurement range (specified by the customer in the order phase) is also available. TMT182 output consists of 4...20 mA and HART® superimposed signals.

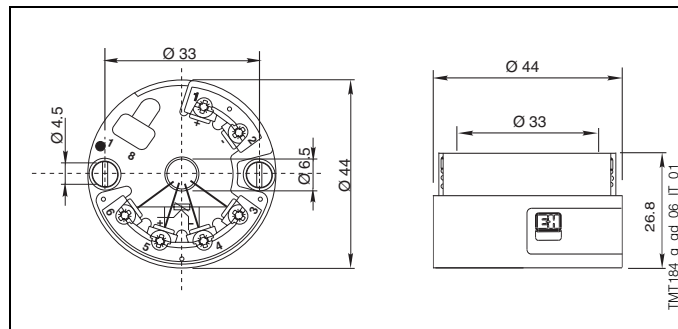


Fig. 5: TMT 184

For TMT 184, with PROFIBUS-PA® output signal, the communication address can be set via software or by means of a mechanical dip-switch. The customer may specify the desired configuration in the order phase.

## Probe

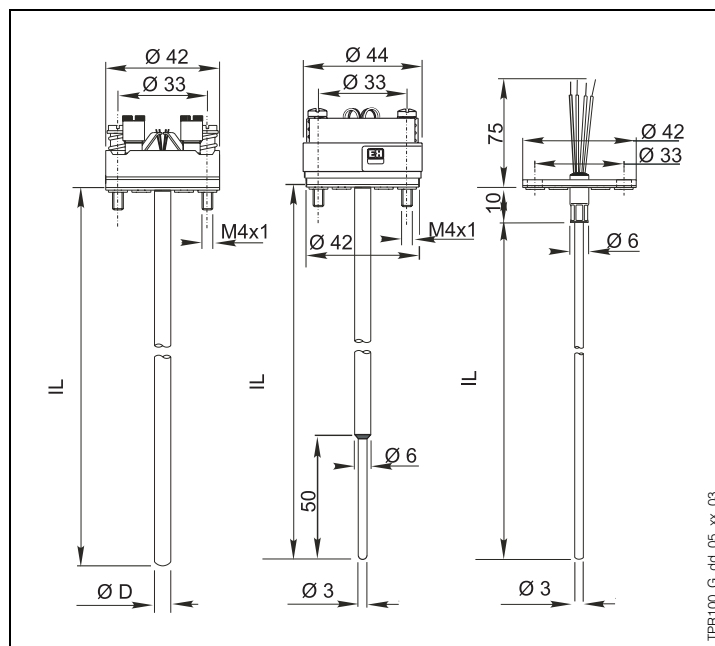


Fig. 6: Different types of TPR 100

TPR 100 is a measuring probe itself, constituted by a mineral insulated (MgO) cable, usually positioned inside a protection well.

The outer diameter of the mineral insulated cable can be 6 or 3 mm in the straight version, or 6 mm tapered to 3 mm in the last 50 mm.

The tapered version is used for a fast response time in reduced tip thermowells; for this version an immersion length of at least 80 mm is required. The sensing element is placed in the ending part of the insert in order to go strict in contact with the bottom of the hosting thermowell; at the opposite side of the insert a washer is crimped.

Its function is to stop the insert at the right position when it has to be assembled into a protective housing and to be the support base of a transmitter or the ceramic block. The flying leads allow the connection to the head transmitter, while the ceramic terminal block (fixed onto the washer) is suggested where no head transmitter is employed (see fig. 6).

For its replacement, the insert length (IL) must be chosen depending on the kind of sensor (with or without extension neck) and the related immersion length (L) of the thermowell.

Should a spare part be required, please refer to the technical information of the thermometer assembly.

The immersion length is available in some standard values or it can be supplied in a "customized" version within a range (please see the product structure in the last pages of this document).

Although the wiring diagram of single Pt 100s is always supplied with 4 wires configuration, the connection of a transmitter can be executed with 3 wires as well, by avoiding to connect whichever of the terminals.

The double Pt 100 version with 2 wires connection is available only for TPR 100 with Atex certification.

The use of standard lengths allows the customer to obtain short delivery times and so to reduce the necessity of big stocks. Standard lengths moreover, facilitate the exchangeability of inserts in standard length thermowells.

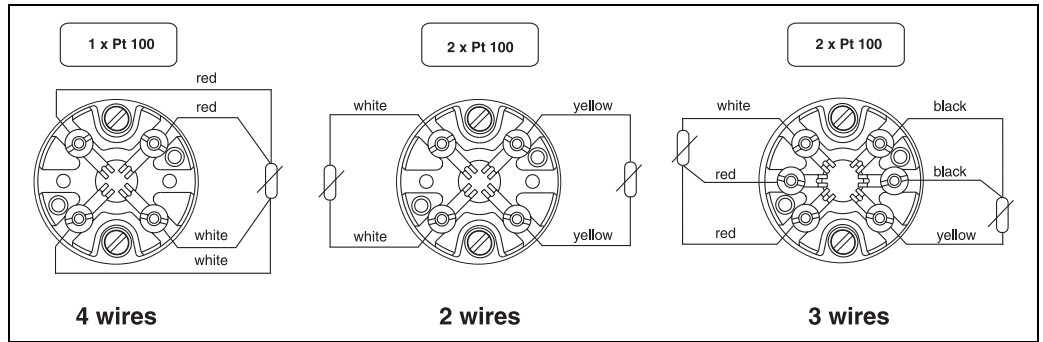


Fig. 7: Standard wiring diagrams (terminal block)

## Certificates & approvals

### Ex approval

ATEX certificate KEMA 01 ATEX1169 X (1 GD IIC EEx ia T6...T1 T85...450 °C).  
Concerning the NAMUR NE 24 and the Manufacturer's declaration according EN 50020, detailed information will be given from the EH Service Department.

### Test report & calibration

Regarding testing and calibration, the "inspection test report" consists of a declaration of conformity with the essential points of standard DIN EN 60751.

The "Factory calibration" is carried out in the E+H EA (European Accreditation) accredited laboratory for temperature calibrations, following an internal procedure. A calibration performed according to an EA accredited procedure (SIT calibration) may be requested separately.

To ensure a precise calibration, a minimum immersion length is required: for example 80 mm for inserts with diameter 3 mm, 120 mm for 6 mm inserts (range 0÷250 °C).

### Examination certificate

In compliance with WELMEC 8.8: "Guide on the General and Administrative Aspects of the Voluntary System of Modular Evaluation of Measuring Instruments."

## Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configurator on the Endress+Hauser website: [www.endress.com](http://www.endress.com) ct Select your country ct Products ct Select measuring technology, software or components ct Select the product (picklists: measurement method, product family etc.) -> Device support (right-hand column): Configure the selected product ct The Product Configurator for the selected product opens.
- From your Endress+Hauser Sales Center: [www.addresses.endress.com](http://www.addresses.endress.com)

### Product Configurator - the tool for individual product configuration

- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

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## Supplementary documentation

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- RTD thermometers Omnigrad TST - General information
- Terminal housings - Omnigrad TA 20
- Temperature head transmitter iTEMP® Pt TMT 180
- Temperature head transmitter iTEMP® PCP TMT 181
- Temperature head transmitter iTEMP® HART® TMT 182
- Safety instructions for use in hazardous areas

TI 088T/02/en  
TI 072T/02/en  
TI 088R/09/en  
TI 070R/09/en  
TI 078R/09/en  
XA 003T/02/z1

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