Technical Information
TI 268T/02/en
60019747

RTD Insert for Temperature Sensor *omniset TPR 100*

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











The TPR 100 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 Pt 100 sensing element. It can be connected to the conversion electronics by means of flying leads or in alternative with a terminal block.
The TPR 100, 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 Pt 100 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 Pt 100 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 Pt 100, 3 wires connection for double Pt 100
- 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

TPR 100 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 Ω at 0°C (called Pt 100, 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 $\alpha=3.85*10^{-3}$ °C^{-1}, calculated between 0 and 100°C.

Equipment architecture

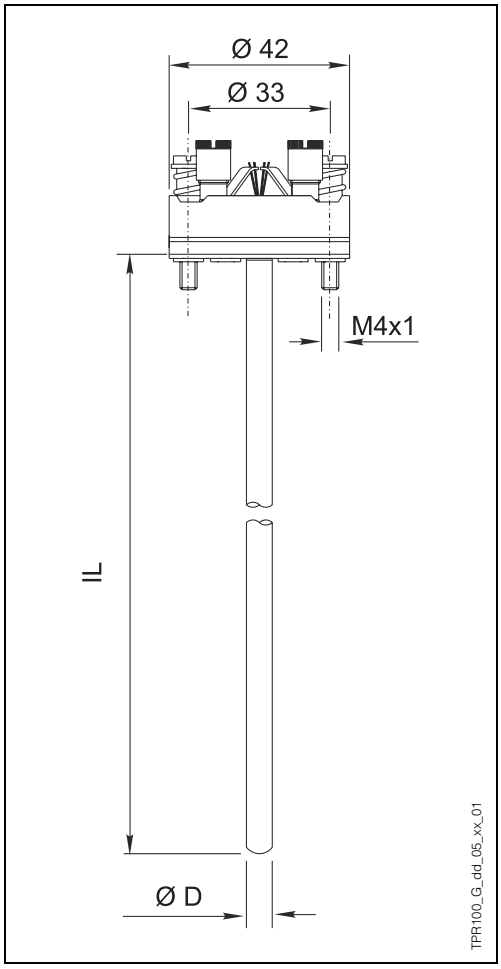


Fig. 1: Overall dimensions of TPR 100

The TPR 100 is made up of a MgO cable sheathed in SS 316L/1.4404 with 6 or 3 mm diameter; the sensing element (Pt 100) 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 TPR 100 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 DXR 275 (Universal HART® Communicator) hand-held operating module.
A PCP (4…20 mA) model (TMT 180) 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.

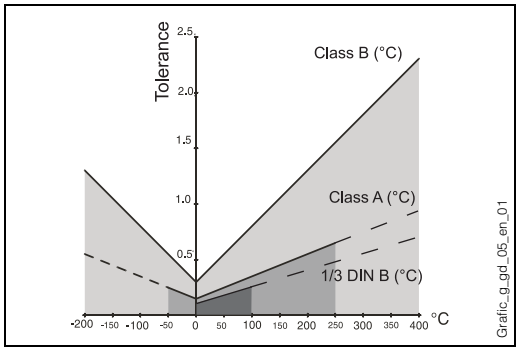
Shock and vibration resistance

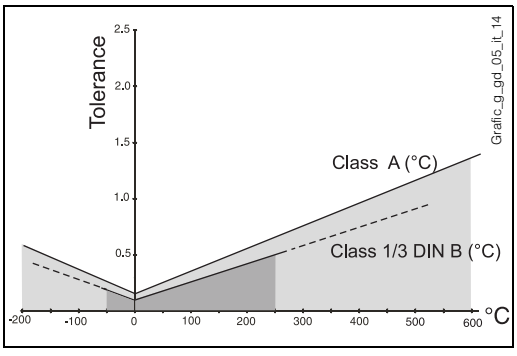
According to DIN EN 60751 2.8 g peak / 10÷500 Hz

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 (Pt 100 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 Pt 100, 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 Pt 100 value. The incidence of this source of inaccuracy increases with longer insertion lengths.

Measurement range

- wire wound Pt 100 -200…600°C
- thin film Pt 100 -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
TPR 100 (Ø 6)	t_{50}	3.5 s
	t_{90}	8 s
TPR 100 (Ø 3 or tapered tip)	t_{50}	2 s
	t_{90}	5 s

Insulation

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

Self heating

Negligible when E+H iTEMP® transmitters are employed.

Installation

TPR 100 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 TPR 100 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.
TPR 100 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) Pt 100, 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).

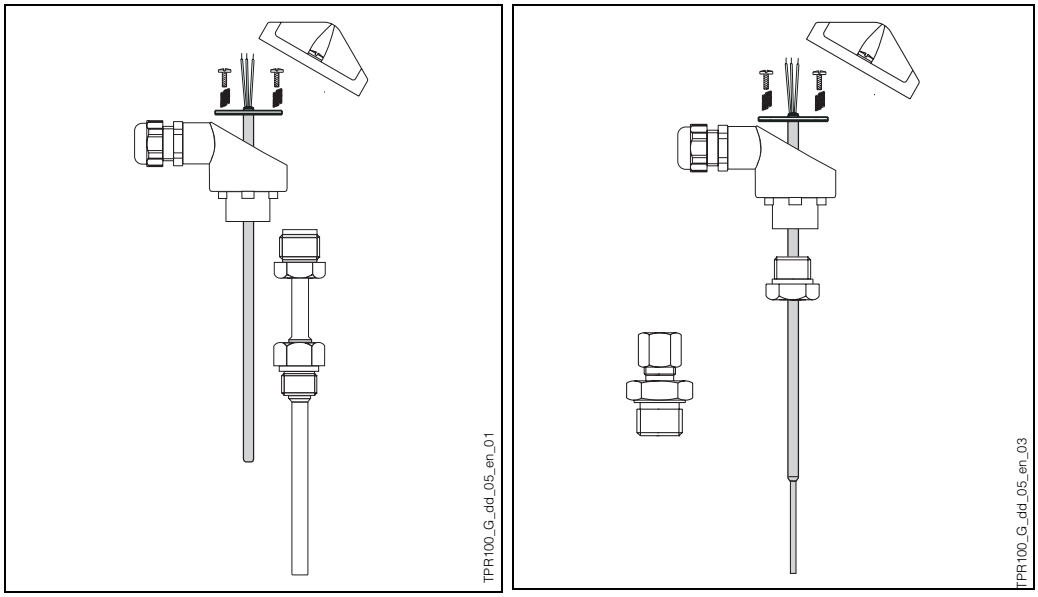


Fig. 2: General installation solutions: into an assembly with thermowell (right), direct measurement (left)

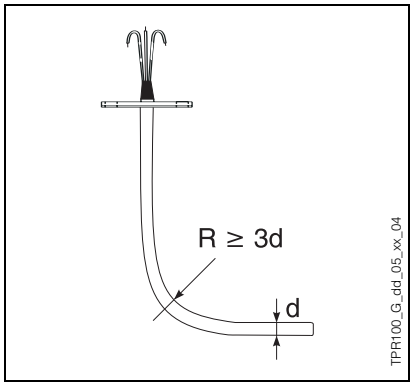


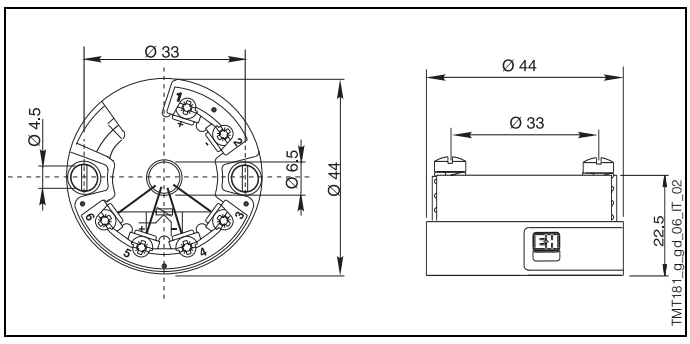
Fig. 3: Possible bending of TPR 100 stem

System components

Head transmitter

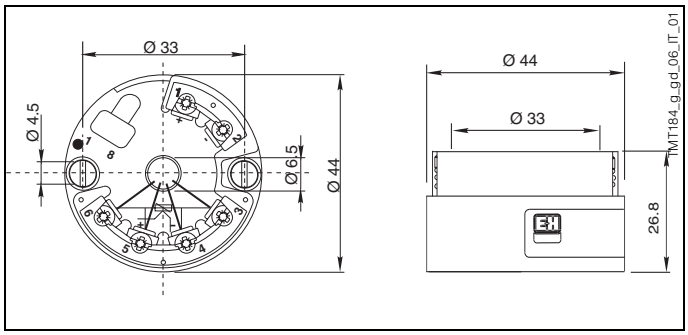
The head-mounted transmitters available are (see also the "Electronics" section):

- TMT 180 PCP 4…20 mA
- TMT 181 PCP 4…20 mA
- TMT 182 Smart HART®
- TMT 184 PROFIBUS-PA®.



TMT 180 and TMT 181 are PC Programmable transmitters. TMT 180 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. TMT 182 output consists of 4…20 mA and HART® superimposed signals.

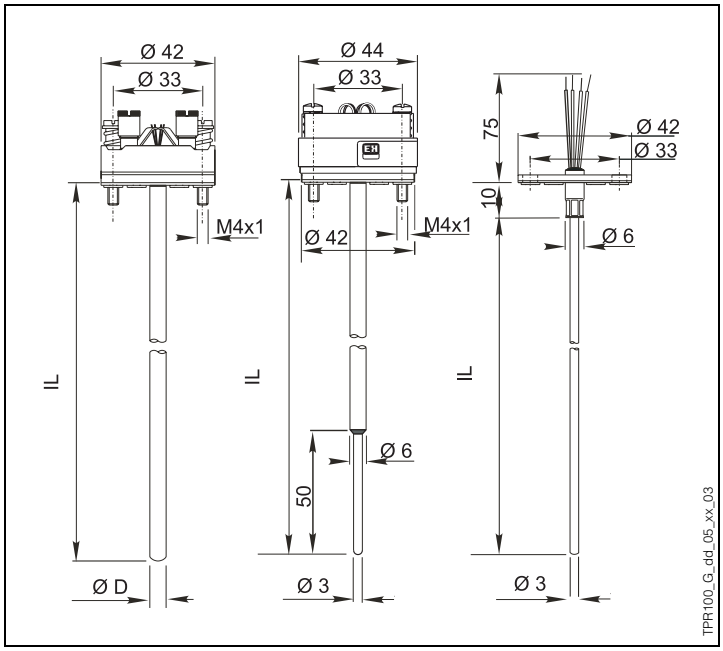
Fig. 4: TMT 180-181-182



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.

Fig. 5: TMT 184

Probe



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.

Fig. 6: Different types of TPR 100

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 trasmitter 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.

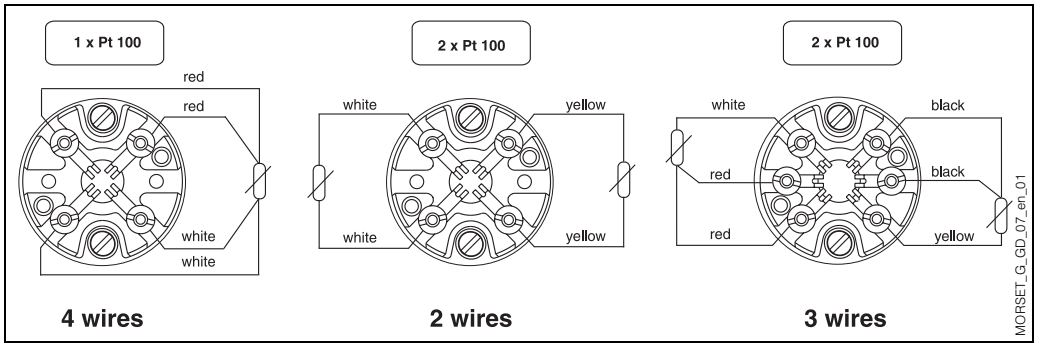


Fig. 7: Standard wiring diagrams (terminal block)

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).

Further details

Maintenance

TPR 100 does not require specific maintenance. In case of ATEX certification, please refer to the relevant documentation (see the code at the end of this document).

Delivery time

For small quantities (about 10 units) and standard options, generally 10 days.

Ordering information

Product structure

TPR100-	Safety (Ex) certification
	A Ex certification not required
	B ATEX II 1 GD EEx ia IIC certified
	C *NAMUR NE 24 certified
	D *Manufacturer's declaration acc. EN50020

	Insert length
	IL (80-5000 mm)
	AA 120 mm insertion length
	AB 145 mm insertion length
	AC 160 mm insertion length
	AE 215 mm insertion length
	AF 275 mm insertion length
	AH 315 mm insertion length
	AJ 345 mm insertion length
	AL 375 mm insertion length
	AM 405 mm insertion length
	AN 435 mm insertion length
	AP 465 mm insertion length
	AR 525 mm insertion length
	AT 555 mm insertion length
	AU 585 mm insertion length
	AV 655 mm insertion length
	AY 735 mm insertion length
	AZ 825 mm insertion length
	BA 940 mm insertion length
	BB 1025 mm insertion length
	XX insertion length IL to specify
	YY special insertion length IL to specify

		Diameter of mineral insulated insert
		1 O.D. 3 mm SS 316L/1.4404
		2 O.D. 6 mm SS 316L/1.4404
		3 O.D. 6 mm tapered 3x50 mm, SS 316L/1.4404

			Terminal type or built-in transmitter
			C ceramic terminal block
			F flying leads
			P TMT181-A PCP, 2-wire, isolated, programmable from ... to ... °C
			Q TMT181-B PCP ATEX, 2-wire, isolated, programmable from ... to ... °C
			R TMT182-A HART®, 2-wire, isolated, programmable from ... to ... °C
			S TMT184-A Profibus-PA®, 2-wire, programmable from ... to ... °C
			T TMT182-B HART® ATEX, 2-wire, isolated, programmable from ... to ... °C
			V TMT184-A Profibus-PA® ATEX, 2-wire, programmable from ... to ... °C
			2 fixed range TMT180-A21, accuracy 0.2 K, span limit -200/650°C, from ... to ... °C
			3 fixed range TMT180-A22, accuracy 0.1 K, span limit -50/250°C, from ... to ... °C
			4 programmable TMT180-A11, accuracy 0.2 K, span limit -200/650°C, from ... to ... °C
			5 programmable TMT180-A12, accuracy 0.1 K, span limit -50/250°C, from ... to ... °C
			9 special version

				RTD type, temperature range, wiring diagram
				B 2 Pt 100, wire wound, class A, -200...600°C, 3 wires
				C 1 Pt 100, wire wound, class A, -200...600°C, 4 wires
				D 2 Pt 100, wire wound, class A, -200...600°C, 2 wires
				F 2 Pt 100, wire wound, class 1/3 DIN B, -200...600°C, 3 wires
				G 1 Pt 100, wire wound, class 1/3 DIN B, -200...600°C, 4 wires
				3 1 Pt 100, thin film, class A, -50...400°C, 4 wires
				7 2 Pt 100, thin film, class 1/3 DIN B, -50...400°C, 4 wires
				Y special version

					Test report
					A standard test report on insert
					B standard test report on loop insert + transmitter
					0 test report not required
					Y special version

									Calibration
									A factory calibration, single RTD, 0-100°C
									B factory calibration, loop single RTD, 0-100°C
									C factory calibration, double RTD, 0-100°C
									E factory calibration, single RTD, 0-100-150°C
									F factory calibration, loop single RTD 0-100-150°C
									G factory calibration, double RTD, 0-100-150°C
									0 calibration not required
									Y special version
									Additional options
									0 additional options not required
									9 special version
									Additional specification
									tagging according to customer specification
TPR100-									Complete order code

Supplementary documentation

❑ RTD thermometers Omnigrad TST - General information	TI 088T/02/en
❑ Terminal housings - Omnigrad TA 20	TI 072T/02/en
❑ Temperature head transmitter iTEMP® Pt TMT 180	TI 088R/09/en
❑ Temperature head transmitter iTEMP® PCP TMT 181	TI 070R/09/en
❑ Temperature head transmitter iTEMP® HART® TMT 182	TI 078R/09/en
❑ Temperature head transmitter iTEMP® PA TMT 184	TI 079R/09/en
❑ Safety instructions for use in hazardous areas	XA 003T/02/z1
❑ TA fittings and sockets	TI 091T/02/en
❑ E+H Thermolab - Calibration certificates for industrial thermometers and working standards. *RTD's and thermocouples*	TI 236T/02/en

Subject to modification

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