Technical Information
TI 278T/02/en
60022421

Thermocouple insert for Temperatur Sensor
omniset TPC 100

Thermocouple mineral insulated insert
PCP (4...20 mA), HART® or PROFIBUS-PA® electronics











The TPC 100 is a thermocouple insert utilized as a replaceable measuring element in thermometers.
Constructed in compliance with the standards DIN EN 60584 and DIN 43735, it consists of a mineral insulated cable with a sensing element inside (type K or J). It can be connected to the conversion electronics by means of flying leads or in alternative with a terminal block.
The TPC 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 TC sensing element for the different applications, different kinds of stem and certification too.

Features and benefits

- Mineral insulated cable sheathed in SS 316L or Inconel 600®
- 3 or 6 mm diameter
- Customized immersion length
- Electronics included in the ordering structure: PCP (4...20 mA, also with enhanced accuracy), HART® and PROFIBUS-PA® 2-wire transmitters
- Thermocouple sensing element type K or J, DIN EN 60584 or ANSI MC96.1
- Class 1/special accuracy
- Single or double, grounded or ungrounded measurement junction

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Areas of application

The TPC 100 is an universal thermocouple insert; it is the fundamental part of a thermometer assembly. It can be used in various kinds of application from the chemical industry to the energy one, thanks to its characteristics and enclosed certifications.

Function and system design

Measuring principle

The thermocouple thermometer's sensing element consists of two metal wires that are homogeneous but different one from the other and insulated along their entire length. The two wires are welded together at one end, known as the "measurement or hot junction".
The other end, where the wires are free, is known as the "cold or reference junction" and is connected to a electromotive force measurement circuit where the force is generated by the different thermoelectric power of each of the thermocouple's wires if there is a temperature difference between the hot joint (T1) and the cold joint (Seebeck effect). The cold junction has to be "compensated" with reference to the temperature of 0°C (T0). The function that links the electromotive force to the temperatures T1 and T0 is a curve whose characteristics depend on the materials used in the construction of the thermocouple. Some thermocouples curves, and particularly those most reliable for the purposes of industrial readings, are those compliant with standards DIN EN 60584 and ANSI MC96.1.

Equipment architecture

The TPC 100 is made up of a MgO cable sheathed in SS 316L/1.4404 or Inconel 600®/2.4816 with 6 or 3 mm diameter; the sensing element is positioned close to the tip of the probe. 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 TPC 100 is mounted into the thermometer 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 instrument always complies with DIN EN 60584/61515 or ANSI MC96.1/ASTM E585 standard rules.
The sensing elements are type K (Nickel Chromium-Nickel Aluminium) or J (Iron-Costantan).

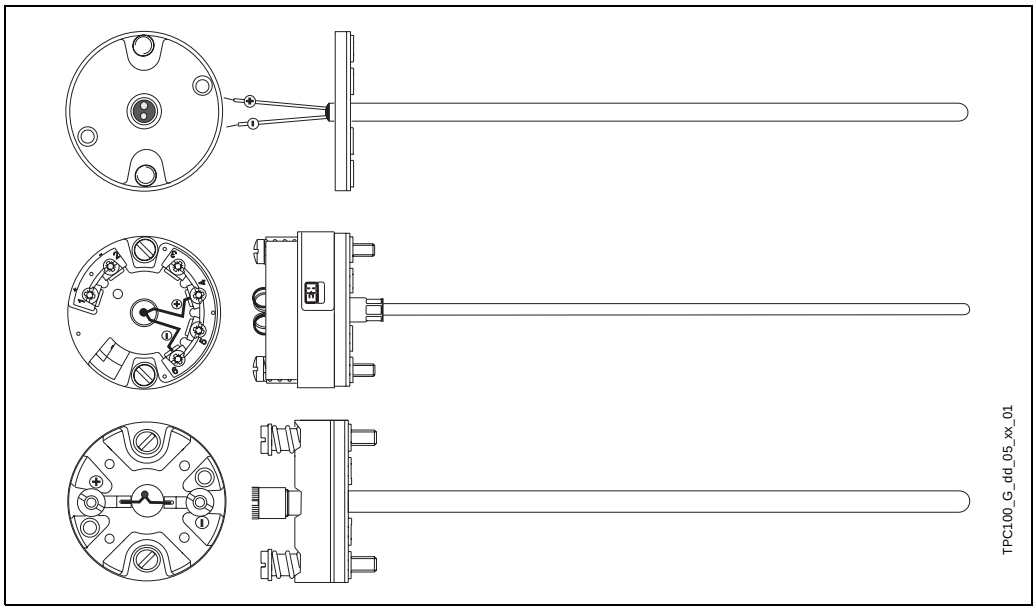

Fig. 1: Overall dimensions of the TPC 100

Material

Stem in SS 316L/1.4404 or Inconel 600®/2.4816, 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 correct head-mounted transmitter.
Endress+Hauser supplies “state-of-the-art” transmitters (the iTEMP® series) built in 2-wire technology and with 4…20 mA output signal, HART® or PROFIBUS-PA®. All of the transmitters can be easily programmed using a personal computer through the ReadWin® 2000 and FieldCare public domain softwares (for transmitters 4…20 mA and HART®), or the CommuWin II software (for PROFIBUS PA® transmitters). The HART® transmitters can also be programmed with the handheld operating module DXR 275 (Universal HART® Communicator).
In the case of PROFIBUS-PA® transmitters, E+H recommends the use of PROFIBUS® dedicated connectors. The Weidmüller type (Pg 13.5 - M12) is provided as a standard option. For detailed information about transmitters, please refer to the relevant documentation (refer to TI codes at the end of the document).
If a head-mounted transmitter is not employed, the sensor probe may be connected through the terminal block to a remote converter (i.e. DIN rail transmitter).

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 — 3 g peak / 10÷500 Hz

Accuracy

The tolerances set by the standard DIN EN 60584 and ANSI MC96.1 are the following:

Type of thermocouple	ANSI MC96.1				
	Class	Max deviation	Class	Max deviation	Cable colours
J (Fe-CuNi)	Standard	+/-2.2°C (0...293°C) +/-0.75% (293...750°C)	Special	+/-1.1°C (0...275°C) +/-0.4% (275...750°C)	+ black - red
K (NiCr-Ni)	Standard	+/-2.2°C (0...293°C) +/-0.75% (293...1250°C)	Special	+/-1.1°C (0...275°C) +/-0.4% (275...1250°C)	+ yellow - red

Type of thermocouple	DIN EN 60584				
	Class	Max deviation	Class	Max deviation	Cable colours
J (Fe-CuNi)	2	+/-2.5°C (-40...333°C) +/-0.0075 |t| (333...750°C)	1	+/-1.5°C (-40...375°C) +/-0.004 |t| (375...750°C)	+ black - white
K (NiCr-Ni)	2	+/-2.5°C (-40...333°C) +/-0.0075 |t| (333...1200°C)	1	+/-1.5°C (-40...375°C) +/-0.004 |t| (375...1000°C)	+ green - white

Note! ItI = absolute temperature value in °C

Table 1: Tolerances

Transmitter maximum error
See the corresponding documentation (codes at the end of the document).

Display maximum error 0.1% of the set span + 1 digit

Measurement range

The measurement ranges defined in standards are shown in table 2:

Type of thermocouple	DIN EN 60584	ANSI MC96.1
J	-40...750°C	0...750°C
K	-40...1200°C	0...1250°C

Table 2: Measurement ranges

Response time

Tests in water at 0.4 m/s (according to DIN EN 60751; temperature variation from 23 to 33°C):

	Diameter 3 mm		Diameter 6 mm	
Type of hot junction	t_{50}	t_{90}	t_{50}	t_{90}
grounded	0.8 s	2 s	2 s	5 s
insulated	1 s	2.5 s	2.5 s	7 s

Table 3: Response times

Insulation

Insulation resistance between terminals and probe sheath (according to DIN EN 60584, test voltage 500 V)
> 1GΩ at 25°C
> 5 MΩ at 500°C

Installation

The TPC 100 is normally mounted into thermometer assemblies where a thermocouple is required. The installation inside an assembly is very easy: it's enough to insert the TPC 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.
The TPC 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. 2).
For detailed information regarding adjustable process connections, as well as on ATEX-certified components (transmitter), please refer to the relevant documentation (see TI codes at the end of this document).

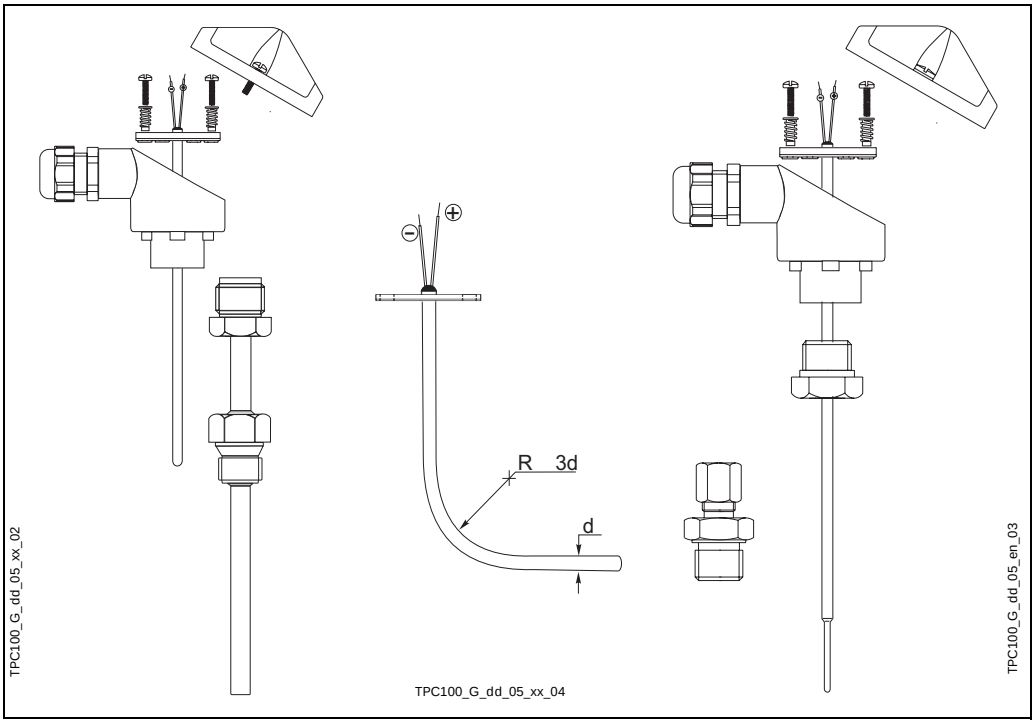

Fig. 2: General installation solutions: into an assembly with thermowell (right), possible bending of TPC 100 stem (center), direct measurement (left)

System components

Head transmitter

The head-mounted transmitters available are (also refer to the section “Electronics”):
- TMT 181 PCP 4…20 mA
- TMT 182 Smart HART®
- TMT 184 PROFIBUS-PA®.

The TMT 181 is a PCP programmable transmitter (see fig. 3).
The TMT 182 output consists of 4…20 mA and HART® superimposed signals.
For the TMT 184 (see fig. 4), with PROFIBUS-PA® output signal, the communication address may be set via software or via mechanical dip-switch. The customer may specify the configuration desired during the order phase.

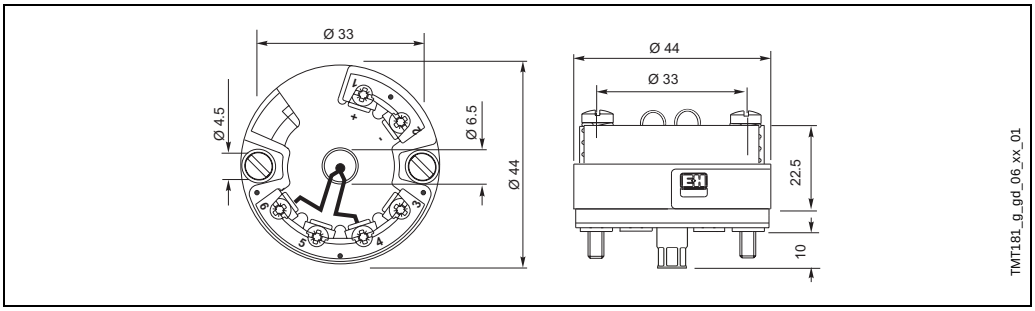

Fig. 3: TMT 181, 182

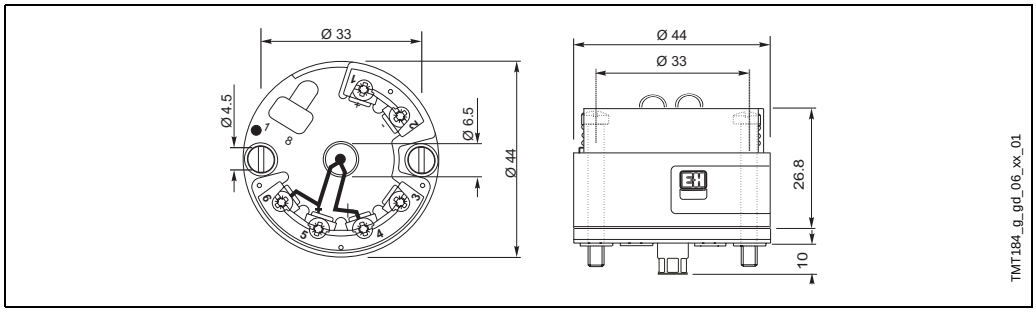

Fig. 4: TMT 184

Probe

The TPC 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.
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).
Standard lengths moreover, facilitate the exchangeability of inserts in standard length thermowells.

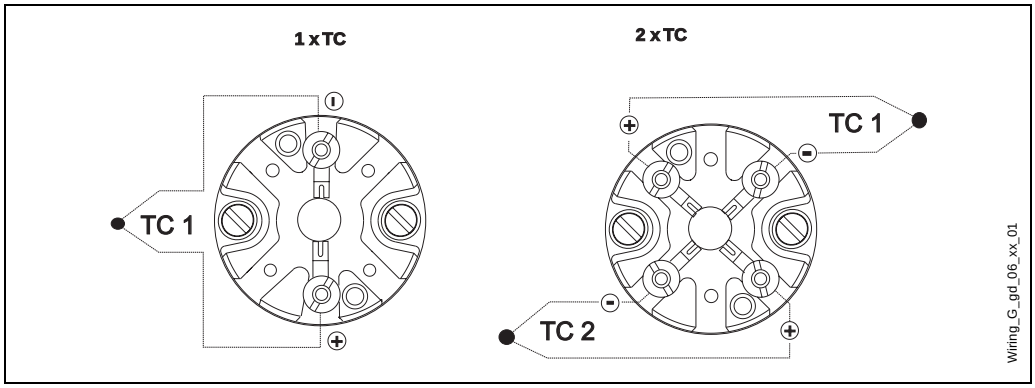

Fig. 5: Standard wiring diagrams (terminal block)

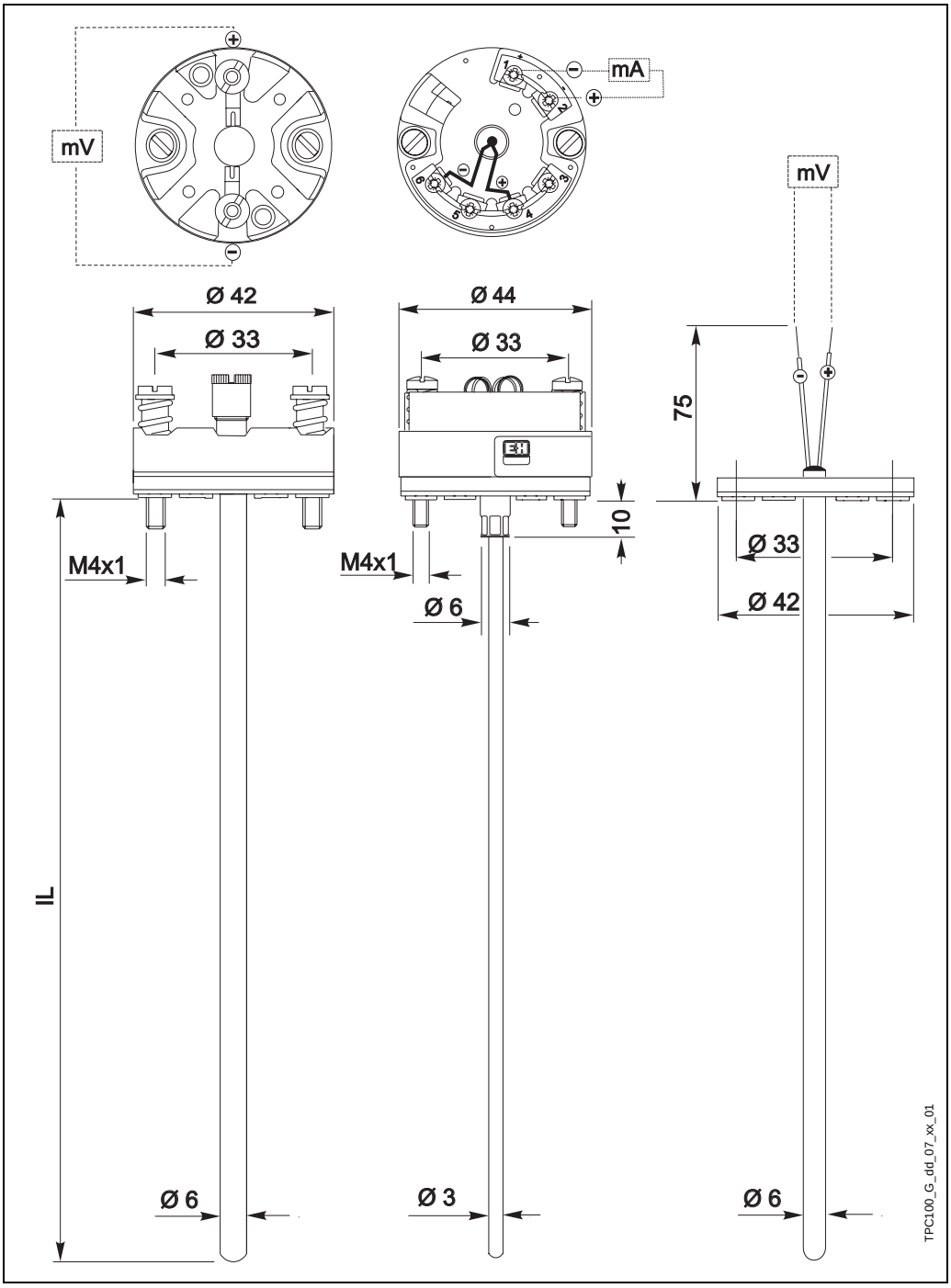

Fig. 6: Different types of TPC 100

Certificates & Approvals

PED approval

The Pressure Equipment Directive (97/23/CE) is respected. As paragraph 2.1 of article 1 is not applicable to these types of instruments, the CE mark is not requested for the TPC 100 destined for general use.

Test report

Regarding testing and calibration, the "inspection test report" consists of a declaration of conformity with the essential points of standard DIN EN 60584/ANSI MC96.1.

Further details

Maintenance

The TPC 100 does not require specific maintenance.

Delivery time

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

Ordering information

Product structure

TPC100-	Safety (Ex) certification
	A — No Ex certification required

		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
	AW	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 M.I. insert
		1	3 mm inset diameter
		2	6 mm inset diameter

				Terminal type or built-in transmitter
			F	Flying leads
			C	Ceramic terminal block
			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
			T	TMT182-B HART® ATEX, 2-wire, isolated, programmable from ... to ... °C
			S	TMT184-A Profibus-PA®, 2-wire, programmable from ... to ... °C
			V	TMT184-B Profibus-PA® ATEX, 2-wire, programmable from ... to ... °C
			Y	Special version

					TC type, accuracy, sheath matereial
				A	1xTC type K, cl. 1/spc, Inconel 600®/2.4816
				B	2xTC type K, cl. 1/spc, Inconel 600®/2.4816
				E	1xTC type J, cl. 1/spc, SS 316L/1.4404
				F	2xTC type J, cl. 1/spc, SS 316L/1.4404
				Y	Special version

						TC reference standard, hot junction type
					1	EN 60584 std., hot junction ungrounded
					2	EN 60584 std., hot junction grounded
					3	ANSI MC96.1, hot junction ungrounded
					4	ANSI MC96.1, hot junction grounded
					9	Special version

							Tests on the inset
						0	Tests not required
						1	Inspection test report on sensor
						2	Inspection test report on loop TC + transmitter
						Y	Special version

								Additional options
							0	Additional options not required
							9	Special version

TPC100-									Complete order code

Sales structure

THT1	Model and version of the head transmitter						
	F11	TMT181-A	PCP	2-wire, isolated	programmable	from...to...°C	
	F21	TMT181-B	PCP	ATEX	2-wire, isolated	programmable	from...to...°C
	F22	TMT181-C	PCP	FM IS	2-wire, isolated	programmable	from...to...°C
	F23	TMT181-D	PCP	CSA	2-wire, isolated	programmable	from...to...°C
	F24	TMT181-E	PCP	ATEX II3G EEx-nA	2-wire, isolated	programmable	from...to...°C
	F25	TMT181-F	PCP	ATEX II3D	2-wire, isolated	programmable	from...to...°C
	L11	TMT182-A	HART®	2-wire, isolated	programmable	from...to...°C	
	L21	TMT182-B	HART®	ATEX	2-wire, isolated	programmable	from...to...°C
	L22	TMT182-C	HART®	FM IS	2-wire, isolated	programmable	from...to...°C
	L23	TMT182-D	HART®	CSA	2-wire, isolated	programmable	from...to...°C
	L24	TMT182-E	HART®	ATEX II3G EEx-nA	2-wire, isolated	programmable	from...to...°C
	L25	TMT182-F	HART®	ATEX II3D	2-wire, isolated	programmable	from...to...°C
	K11	TMT184-A	PROFIBUS-PA®	2-wire, isolated	programmable	from...to...°C	
	K21	TMT184-B	PROFIBUS-PA®	ATEX	2-wire, isolated	programmable	from...to...°C
	K22	TMT184-C	PROFIBUS-PA®	FM IS	2-wire, isolated	programmable	from...to...°C
	K23	TMT184-D	PROFIBUS-PA®	CSA	2-wire, isolated	programmable	from...to...°C
	K24	TMT184-E	PROFIBUS-PA®	ATEX II3G EEx-nA	2-wire, isolated	programmable	from...to...°C
	K25	TMT184-F	PROFIBUS-PA®	ATEX II3D	2-wire, isolated	programmable	from...to...°C
	YYY	Special transmitter					

		Application and services
	1	Assembled into position
	9	Special version

THT1-			Complete order code

Supplementary documentation

❑ Thermocouple thermometers Omnigrad TSC - General information	TI 090T/02/en
❑ Terminal housings - Omnigrad TA 20	TI 072T/02/en
❑ TI 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
❑ 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

Endress+Hauser GmbH+Co. KG
Instruments International
P.O. Box 2222
D-79574 Weil am Rhein
Germany

Tel. +49 7621 975 02
Fax +49 7621 975 345
http://www.endress.com
info@ii.endress.com

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