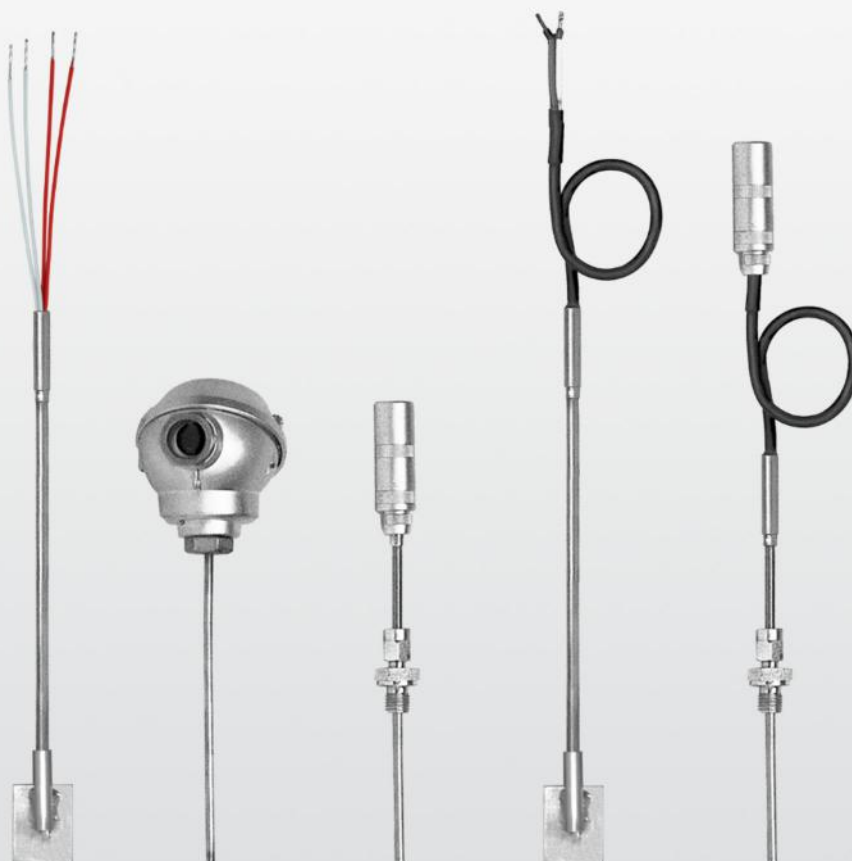


ABB MEASUREMENT & ANALYTICS | DATA SHEET

SensyTemp TSC400

Industrial thermometer



Measurement made easy

For plug-in connection

For screw-in connection

For surface measurement

Areas of application

- Universal application in general process engineering, tank and piping construction, mechanical and plant engineering

Electrical connections

- With compression fitting and fixed screw-in connection
- With weld-on plate for permanent surface measurement
- With molded part for tension clip mounting

Benefits

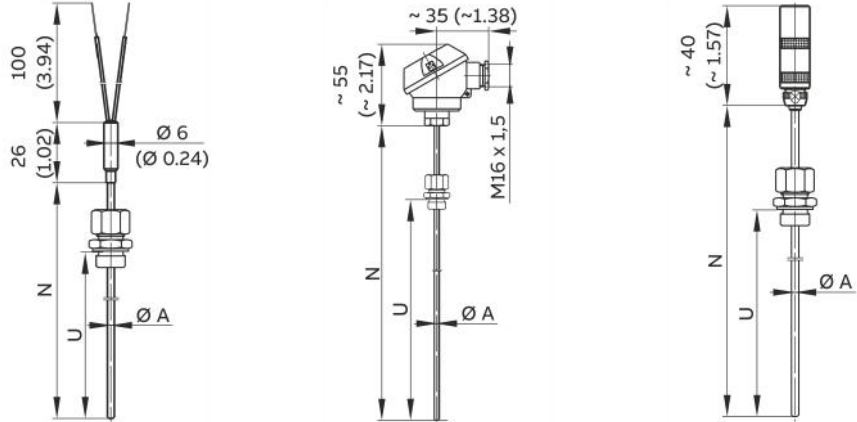
- Fastest possible measuring results through direct contact of the mineral insulated cable with the medium
- Widest application ranges through optimum sheath materials
- Subsequent installation possible by surface mounting
- Optimal usage due to a combination of mechanical and electrical interfaces
- Global approvals for explosion protection up to Zone 0

Overview of temperature sensors

Type TSC420, with direct electrical connection

Dimensions in mm (in)

U = Installation length
 N = Nominal length
 ØA = Diameter of the mineral insulated cable

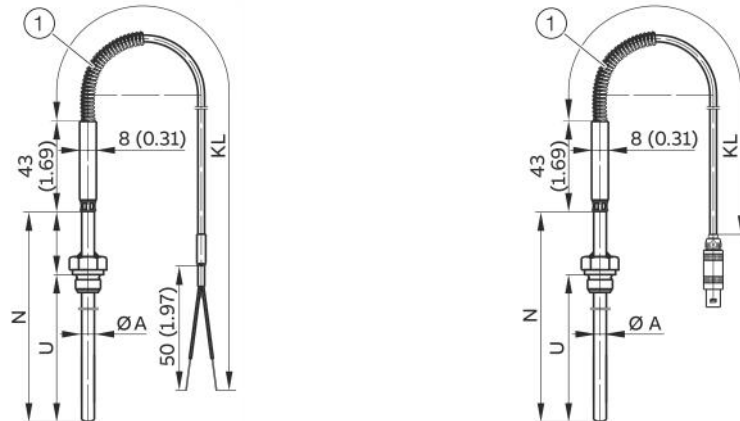


Electrical connection	Single and double thermocouples		
	Single Pt100 / 2-, 3-, or 4-wire		
Design	Double Pt100 / 2-, 3-, or 4-wire	Double Pt100 / 2-wire	Double Pt100 / 2- or 3-wire
	Bendable mineral insulated cable with sealing sleeve		
	Open cable ends, standard 100 mm (3.94 in) or customer-specific	Form F connecting head	Plug, socket

Type TSC430, with connection cable

Dimensions in mm (in)

U = Installation length
 N = Nominal length
 KL = Cable length
 ØA = Diameter of the mineral insulated cable



Electrical connection	Single and double thermocouples	
	Single Pt100 / 2-, 3-, or 4-wire	
Design	Double Pt100 / 2-, 3-, or 4-wire	Double Pt100 / 2- or 3-wire
	Bendable mineral insulated cable with sealing sleeve and optional anti-kink spring (1)	
	Open cable ends	Plug, socket

... Overview of temperature sensors

Selectable process connections

- Without process connection
- With fixed connection (please specify nominal length 'N' and installation length 'U')
- With movable connection (please specify nominal length 'N' only)
- With weld-on plate 25 x 25 x 3 mm (0.98 x 0.98 x 0.12 in) or 35 x 25 x 3 mm (1.38 x 0.98 x 0.12 in) for surface measurement
- With molded part for tension clip mounting
- Temperature sensor for use with or without thermowell

Installation instructions

The usual way of ensuring that thermal measurements are accurate is to comply with the minimum installation length of the temperature sensor. Ideally, in the case of pipelines, the sensor on a thermometer should be located in the center of the pipe. If this is not possible, both in the case of pipes and containers, a minimum installation length of 10- to 15-times the temperature sensor diameter is assumed to be sufficient.

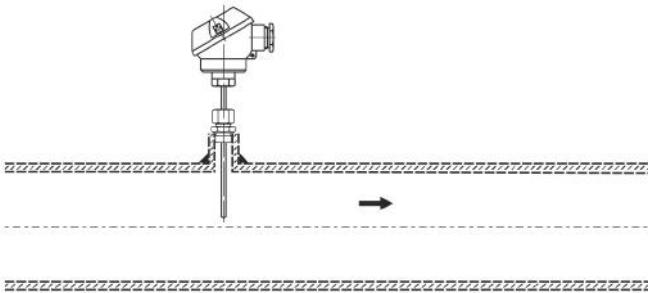


Figure 1: Recommended installation

Insufficient nominal diameter

In the case of pipelines with very small nominal diameters, installation inside an elbow pipe is recommended. The temperature sensor tip is set in opposition to the flow direction of the measuring medium. Also installing the temperature sensor with an adapter at an acute angle against the flow direction can also distort measurement results.

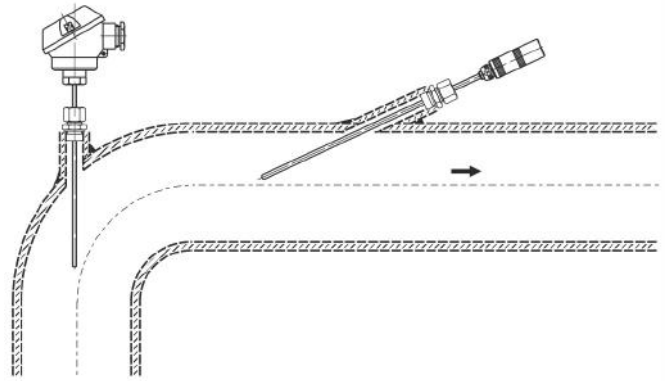


Figure 2: Installation with small nominal diameter

Specification

Resistance thermometer

The use of a mineral insulated cable and special sensors, including their installation, makes the vibration resistance of all SensyTemp TSC400 industrial thermometers very high. The peak-to-peak acceleration values of 30 m/sec² (3 g) for frequencies between 10 and 500 Hz (already defined in accordance with standard IEC 60751 for increased requirements) are exceeded by all industrial thermometers. The optimally suitable combination of measuring range, diameter, accuracy, and vibration resistance can be taken from the following tables.

Thin film resistor (TF) – Base design

	Meas. range	Vibration resistance
Class B	-50 to 400 °C (-58 to 752 °F)	100 m/sec ² (10 g) at 10 to 500 Hz
Class A	-30 to 300 °C (-22 to 572 °F)	
Class AA	0 to 100 °C (32 to 212 °F)	

	Single sensor			Double sensor		
	2-W	3-W	4-W	2-W	3-W	4-W
3.0 mm, class B	●	●	●			
3.0 mm, class A		●	●			
4.5 mm, class B	●	●	●			
4.5 mm, class A		●	●			
6.0 mm, class B	●	●	●	●	●	●
6.0 mm, class A		●	●		●	●
6.0 mm, class AA		●	●		●	●

Wire wound resistor (WW) – extended measuring range

	Meas. range	Vibration resistance
Class B	-196 to 600 °C (-320.8 to 1112 °F)	100 m/sec ² (10 g) at 10 to 500 Hz
Class A, single WW	-100 to 450 °C (-148 to 842 °F)	
Class A, double WW	0 to 250 °C (32 to 482 °F)	

	Single sensor			Double sensor		
	2-W	3-W	4-W	2-W	3-W	4-W
3.0 mm, class B	●	●	●	●	●	
3.0 mm, class A		●	●		●	
4.5 mm, class B	●	●	●	●	●	
4.5 mm, class A		●	●		●	
6.0 mm, class B	●	●	●	●	●	●
6.0 mm, class A		●	●		●	●

Accuracy classes of measurement resistors in accordance with IEC 60751

Both thin film resistors and wire wound resistors in accordance with IEC 60751 can be used across the entire range of application (also with increased accuracy class AA or class A). Subsequently, only the accuracy class of the temperature range used can remain valid.

Example: A sensor of class AA is used at 290 °C (554 °F). After this albeit brief application, class A applies for this sensor.

Thin film resistor (TF), built-in

Class B	$\Delta t = \pm (0.30 + 0.0050[t])$	-50 to 400 °C (-58 to 752 °F)
Class A	$\Delta t = \pm (0.15 + 0.0020[t])$	-30 to 300 °C (-22 to 572 °F)
Class AA	$\Delta t = \pm (0.10 + 0.0017[t])$	0 to 100 °C (32 to 212 °F)

Wire wound resistor (WW), built-in

Class B	$\Delta t = \pm (0.30 + 0.0050[t])$	-196 to 600 °C (-320.8 to 1112 °F)
Class A	$\Delta t = \pm (0.15 + 0.0020[t])$	-100 to 450 °C (-148 to 842 °F)

... Specification

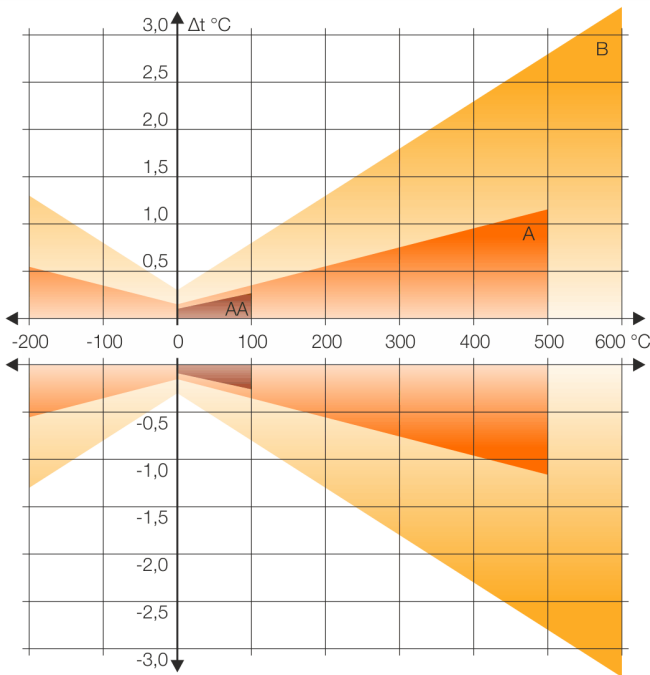


Figure 3: Graphical representation of accuracy classes

Measuring errors with two-wire circuits

The electric resistance of the copper inner conductor of the mineral insulated cable affects the measured value for two-wire circuits and must be taken into consideration.

Electric resistance depends on the diameter and length of the industrial thermometer.

If the error cannot be compensated metrologically, the following reference values shall apply:

Industrial thermometer diameter	Electric resistance / measured error
3.0 mm (0.12 in)	0.281 Ω/m / 0.7 °C/m
6.0 mm (0.24 in)	0.1 Ω/m / 0.25 °C/m

It is for this reason that ABB supplies three-wire / four-wire circuit temperature sensors as standard.

Length data for the temperature sensor tip

The following table shows the minimum immersion length, the temperature-sensitive length and the non-flexible length at the tip of the temperature sensor.

Design	Basic design	Extended measuring range
minimum immersion length	70 mm (2.8 in)	70 mm (2.8 in)
Temperature-sensitive length	7 mm (0.3 in)	50 mm (1.9 in)
Non-flexible length	30 mm (1.2 in)	60 mm (2.4 in)

Thermocouples

The accuracy classes of the thermocouples are in accordance with the IEC 60584 international standard. ABB also supplies in accordance with ANSI MC96.1 upon request.

Since the values of both standards differ only very slightly at low temperatures (up to approx. 300 °C), ABB recommends using thermocouples conforming to international standard IEC 60584. The tolerance specifications are presented in the table 'Accuracy classes in accordance with IEC 60584'

Version

Vibration-resistant up to 600 m/sec² (60 g)

	1 x K	2 x K	1 x J	2 x J	1 x N	2 x N	1 x E	2 x E
1.5 mm, class 2	●				●			
3.0 mm, class 2	●	●	●	●	●	●	●	●
3.0 mm, class 1	●	●	●	●	●	●	●	●
4.5 mm, class 2	●	●	●	●	●	●		
4.5 mm, class 1	●	●	●	●	●	●		
6.0 mm, class 2	●	●	●	●	●	●	●	●
6.0 mm, class 1	●	●	●	●	●	●	●	●

Note

Industrial thermometers with a diameter of 8 mm (0.31 in) are made up of a mineral insulated cable with a diameter of 6.0 mm (0.24 in) and a sleeve pressed onto the temperature sensor tip.

Accuracy classes in accordance with IEC 60584, DIN 43710 and ANSI MC96.1

IEC 60584			
Type	Class (CL)	Temperature range	Maximum measuring error
K (NiCr-Ni)	2	-40 to 333 °C (-40 to 631.4 °F)	± 2.5 °C (± 4.5 °F)
		333 to 1200 °C (631.4 to 2192 °F)	±0.0075 x [t]
N (NiCrSi-NiSi)	1	-40 to 375 °C (-40 to 707 °F)	± 1.5 °C (± 2.7 °F)
		375 to 1000 °C (707 to 1832 °F)	±0.004 x [t]
J (Fe-CuNi)	2	-40 to 333 °C (-40 to 631.4 °F)	± 2.5 °C (± 4.5 °F)
		333 to 750 °C (631.4 to 1382 °F)	±0.0075 x [t]
	1	-40 to 375 °C (-40 to 707 °F)	± 1.5 °C (± 2.7 °F)
		375 to 750 °C (707 to 1382 °F)	±0.004 x [t]
E (NiCr-CuNi)	2	-40 to 333 °C (-40 to 631.4 °F)	± 2.5 °C (± 4.5 °F)
		333 to 900 °C (631.4 to 1652 °F)	±0.0075 x [t]
	1	-40 to 375 °C (-40 to 707 °F)	± 1.5 °C (± 2.7 °F)
		375 to 800 °C (707 to 1472 °F)	±0.004 x [t]

... Specification

ANSI MC 96.1			
Type	Class (CL)	Temperature range	Maximum measuring error
K (NiCr-Ni), N (NiCrSi-NiSi)	Standard	0 to 293 °C (32 to 559.4 °F)	± 2.2 °C (± 3.96 °F)
		293 to 1250 °C (559.4 to 2282 °F)	$\pm 0.0075 \times [t]$
	Special	0 to 275 °C (32 to 527 °F)	± 1.1 °C (± 1.98 °F)
		275 to 1250 °C (527 to 2282 °F)	$\pm 0.004 \times [t]$
J (Fe-CuNi)	Standard	0 to 293 °C (32 to 559.4 °F)	± 2.2 °C (± 3.96 °F)
		293 to 750 °C (559.4 to 1382 °F)	$\pm 0.0075 \times [t]$
	Special	0 to 275 °C (32 to 527 °F)	± 1.1 °C (± 1.98 °F)
		275 to 750 °C (527 to 1382 °F)	$\pm 0.004 \times [t]$

Length data for the temperature sensor tip

The following table shows the temperature-sensitive length, the minimum immersion length, and the non-flexible length at the tip of the temperature sensor.

Basic design

minimum immersion length	70 mm (2.8 in)
Temperature-sensitive length	7 mm (0.3 in)
Non-flexible length	30 mm (1.2 in)

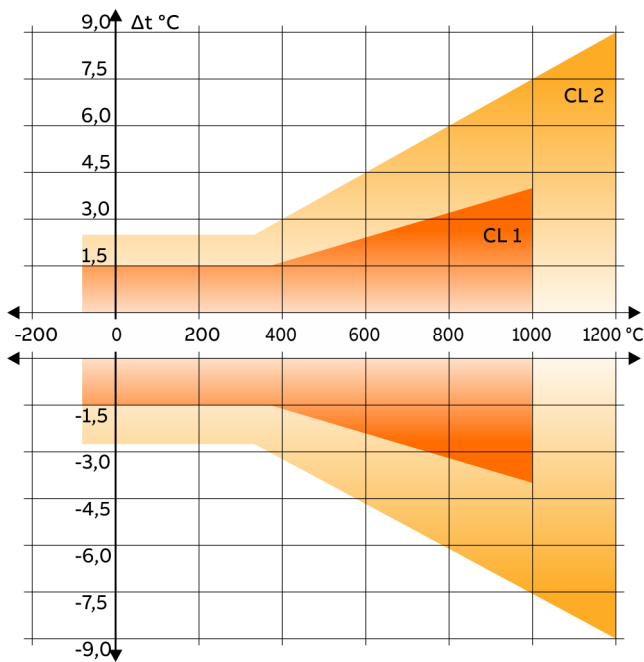


Figure 4: Graphical representation of accuracy classes using type K and N in accordance with IEC 60584 as examples. See tables for other types.

Resistance thermometers and thermocouples

Insulation resistance of measuring inset

The insulation resistance is measured between the outer sheath and measuring loop. If there are two measuring loops, the insulation resistance between both measuring loops is also measured.

Thanks to a special process used during manufacturing, ABB measuring insets can boast outstanding insulation values even at high temperatures.

Insulation resistance R_{iso}

$\geq 500 \text{ M}\Omega$ with a ambient temperature range from 15 to 35 °C (59 to 95 °F)

Air humidity

< 80 %

Permissible ambient temperature at the closure of the mineral insulated cable

Design	Ambient temperature
Standard	-40 to 120 °C (-40 to 248 °F)
Optional	-56 to 200 °C (-68.8 to 392 °F)

In type TSC430, the temperature limits of the connection cables used should also be considered. See **Connection cable for the resistance thermometer** on page 14 and **Connection cables for thermocouples** on page 16.

Response times in accordance with IEC 60751 and IEC 60584

Ø Temperature sensor	Water 0.4 m/s		Air 3 m/s	
	$t_{0,5}$	$t_{0,9}$	$t_{0,5}$	$t_{0,9}$
Resistance thermometer				
3.0 mm (0.12 in)	1.5	4.5	15.0	50.0
4.5 mm (0.18 in)	2.5	6.3	24.7	75.5
6.0 mm (0.24 in)	4.0	9.7	43.5	105.0
Thermocouples				
1.5 mm (0.06 in)	0.7	1.8	12.4	38.6
3.0 mm (0.12 in)	0.8	2.1	14.5	44.5
4.5 mm (0.18 in)	1.8	5.4	24.8	67.6
6.0 mm (0.24 in)	3.0	7.5	38.6	98.5

Maximum permissible operating temperature

Depending on the sensor type and material selected, the lower temperature value in each case applies.

Sensor types	Maximum operating temperature
Thin film resistor (TF)	400 °C (752 °F)
Wire wound resistor (WW)	600 °C (1112 °F)
Type K and N thermocouples	1200 °C (2192 °F)
Type J thermocouples	750 °C (1382 °F)
Type E thermocouples	900 °C (1652 °F)
Materials	
Stainless steel 1.4404 (ASTM 316L)	800 °C (1472 °F)
Stainless steel 1.4571 (ASTM 316Ti)	800 °C (1472 °F)
NiCr alloy 2.4816 (Inconel 600)	1100 °C (2012 °F)

The maximum operating temperatures and pressures specified are maximum values and do not take into consideration process-related stress.

The effects of viscosity, flow rate, pressure, and temperature in the process usually cause these values to drop.

Transport temperature / Storage temperature

-20 to 70 °C (-4 to 158 °F)

Process connections

Process connections – screwed connections

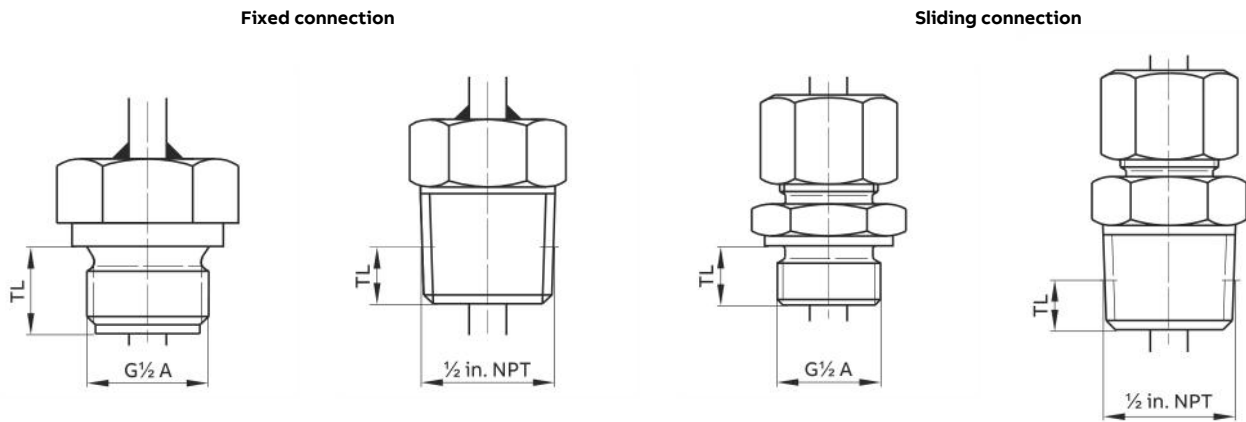


Figure 1: Screw connections types (examples)

Design	Material	Thread	Mineral insulated cable [Ø mm (in)]	Length of engaged thread (TL) [mm (in)]	Compression fitting
Fixed connection	Stainless steel	M8 x 1	3.0 (0.12)	6.5 (0.26)	–
		$G\frac{1}{4} A$	3.0 / 4.5 / 6.0	12.0 (0.47)	–
		$G\frac{1}{2} A$	(0.12 / 0.18 / 0.24)	14.0 (0.55)	–
		$\frac{1}{4} \text{ in NPT}$		5.08 (0.20)	–
		$\frac{1}{2} \text{ in NPT}$		8.12 (0.32)	–
Sliding connection	Stainless steel	M8 x 1	3.0 (0.12)	6.5 (0.26)	PTFE or VA
		$G\frac{1}{4} A$	3.0 / 4.5 / 6.0	12.0 (0.47)	PTFE or VA
		$G\frac{1}{2} A$	(0.12 / 0.18 / 0.24)	14.0 (0.55)	PTFE or VA
		$\frac{1}{4} \text{ in NPT}$		5.08 (0.20)	PTFE or VA
		$\frac{1}{2} \text{ in NPT}$		8.12 (0.32)	PTFE or VA

Note

In the version with fixed connection, the link between the connection and the mineral insulated cable is established using hard-soldering. The process connections for mineral insulated cables with a diameter of 6 mm (0.24 in) and 8 mm (0.31 in) are identical.

Process connections for surface thermometers

Molded part for clip mounting

All dimensions in mm (in)

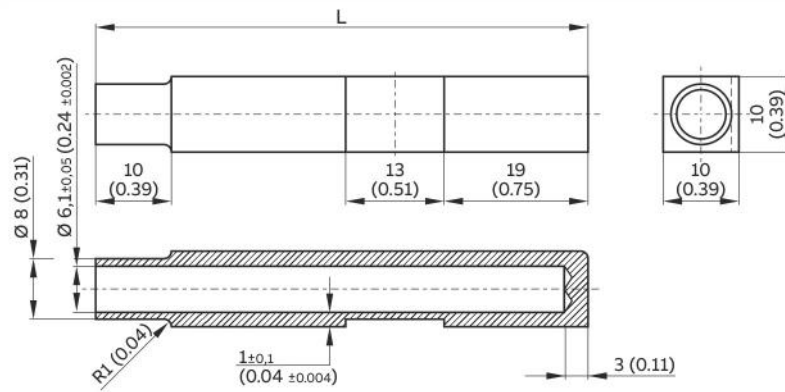
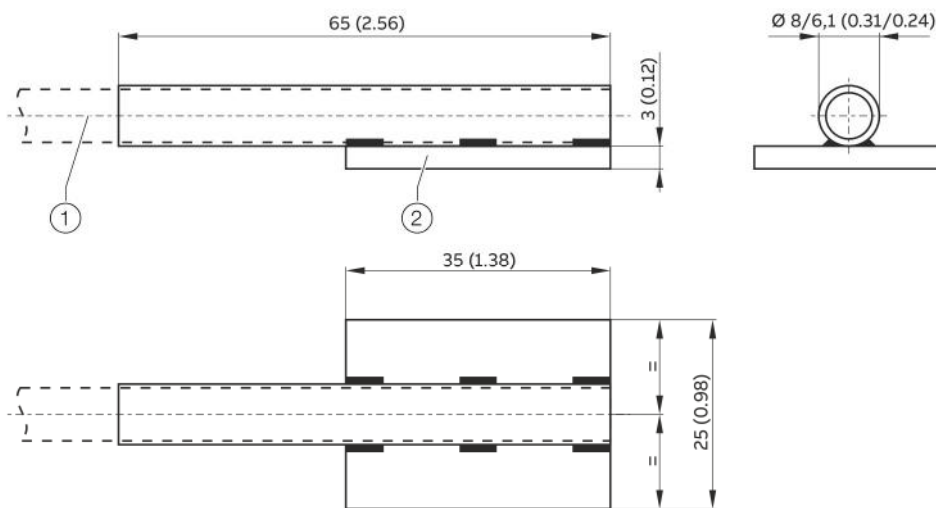


Figure 5: Molded part for clamp collars up to 500 mm (19.68 in), other versions available on request

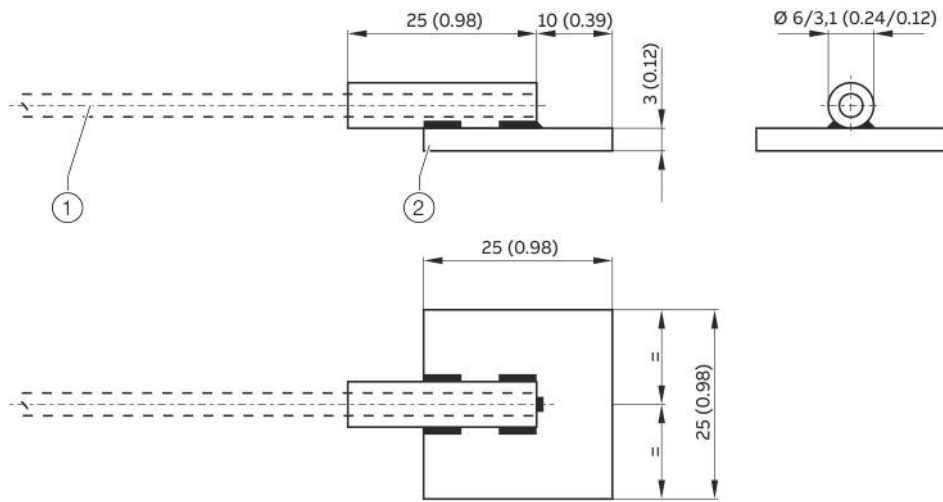


① Industrial thermometer

② Material: Stainless steel 1.4571 (ASTM 316Ti)

Figure 6: Weld-on plate for resistance thermometer, all dimensions in mm (in)

... Process connections

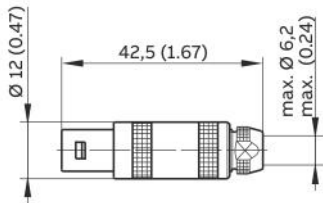
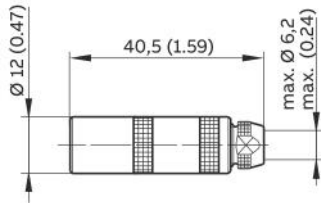


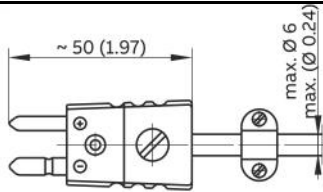
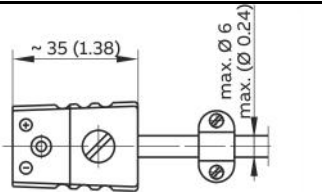
① Industrial thermometer

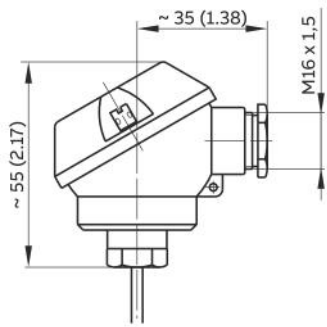
② Material: NiCr alloy 2.4816 (Inconel 600)

Figure 7: Weld-on plate for thermocouples, all dimensions in mm (in)

Electrical connections

	Lemo plug size 1S	Lemo socket size 1S
Dimensions in mm (in)		
Type	FFA	PCA
Chassis	Nickel-plated brass, gold-plated brass contacts, PEEK isolator, maximum 6 contacts	
IP rating	IP 54	
Maximum ambient temperature	200 °C (392 °F)	

	Thermocouple – standard plug	Thermocouple – standard socket
Dimensions in mm (in)		
Type	Standard	
Material	Plastic	
Maximum ambient temperature	200 °C (392 °F)	

	Form F connecting head	Functions of the connection head
Dimensions in mm (in)		<ul style="list-style-type: none"> • Housing of a coupler connector • Protection of the terminal compartment against environmental influence
Chassis	Aluminum epoxide coating, loose cover,	Ambient temperature The ambient temperature on the Form F connection head can be between -40 and 120 °C (-40 to 248 °F). The most commonly used cable gland is suited for a temperature range of -20 to 100 °C (-4 to 212 °F). For temperatures outside this range, an appropriate cable gland can be installed.
IP rating	IP 65	
Maximum ambient temperature	120 °C (248 °F)	

... Electrical connections

Connection cable for the resistance thermometer

Note

The specified outside diameters of the connection cable are batch-dependent and should be treated as guideline values. The color coding of the wires for the resistance thermometer is in accordance with IEC 60751. See also 'Electrical connections' in the operating instruction OI/TSC400.

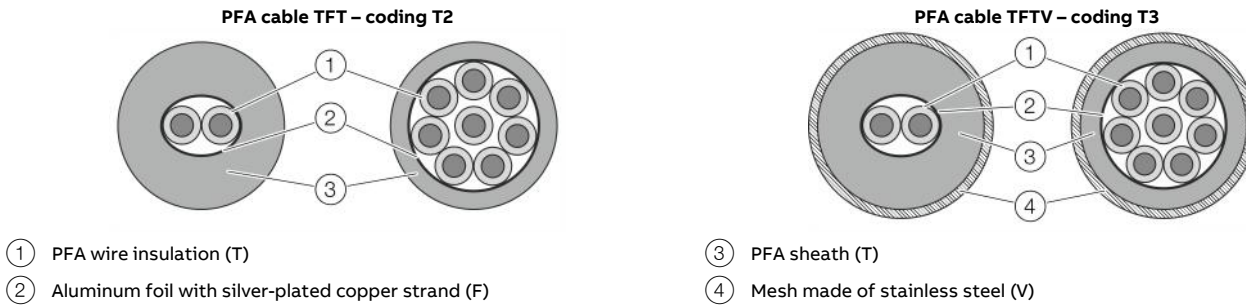


Figure 8: PFA cable

Design	Design	Sensor design
PFA cable TFT – coding T2	<p>General: Stranded wire, wire material: solid copper Temperature resistance of the insulation: -200 to 200 °C (-328 to 392 °F)</p> <p>Up to 4 wires: Outside diameter: approx. 4.8 mm (0.19 in), conductor cross-section: 0.75 mm²</p> <p>From 6 wires: Outside diameter: approx. 4.5 mm (0.18 in), conductor cross-section: 0.22 mm²</p>	1 x Pt100 / 2-w. – coding P1 1 x Pt100 / 3-w. – coding P2 1 x Pt100 / 4-w. – coding P3 2 x Pt100 / 2-w. – coding P4 2 x Pt100 / 3-w. – coding P5 2 x Pt100 / 4-w. – coding P6
PFA cable TFTV – coding T3	<p>General: Stranded wire, wire material: solid copper Temperature resistance of the insulation: -200 to 200 °C (-328 to 392 °F)</p> <p>Up to 4 wires: Outside diameter: approx. 4.0 mm (0.16 in), conductor cross-section: 0.22 mm²</p> <p>From 6 wires: Outside diameter: approx. 5.5 mm (0.22 in), conductor cross-section: 0.22 mm²</p>	

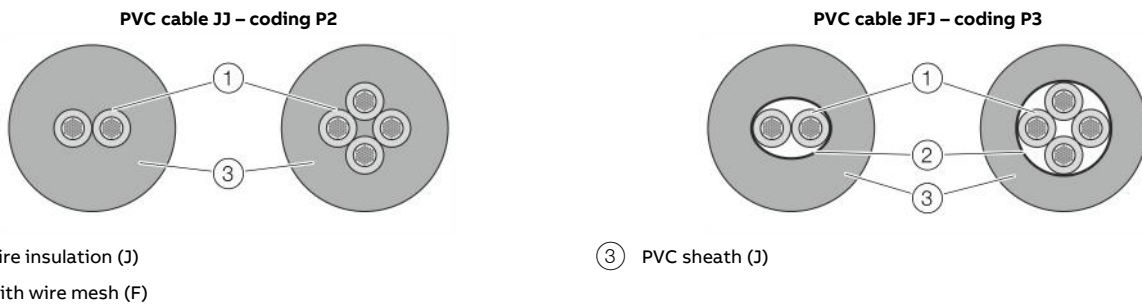


Figure 9: PVC cable

Design	Design	Sensor design
PVC cable JJ – coding P2	Outside diameter approx. 5.5 mm (0.22 in)	1 x Pt100 / 2-w. – coding P1
	Conductor cross-section: 0.22 mm ² , Wire material: copper strand	1 x Pt100 / 3-w. – coding P2
	Temperature resistance of the insulation: -20 to 105 °C (-4 to 221 °F)	1 x Pt100 / 4-w. – coding P3
PVC cable JFJ – coding P3	Outside diameter approx. 5.5 mm (0.22 in)	2 x Pt100 / 2-w. – coding P4
	Conductor cross-section: 0.50 mm ² , Wire material: copper strand	
	Temperature resistance of the insulation: -10 to 105 °C (14 to 221 °F)	

... Electrical connections

Connection cables for thermocouples

Note

The specified outside diameters of the connection cable are batch-dependent and should be treated as guideline values.

Type	Class of upper/lower deviation		Application temperature range
	Class 1	Class 2	
JX	± 85 µV (± 1.5 °C (34.7 °F))	–	–25 to 200 °C (-13 to 392 °F)
EX	± 120 µV (± 1.5 °C (34.7 °F))	–	–25 to 200 °C (-13 to 392 °F)
NX	± 60 µV (± 1.5 °C (34.7 °F))	–	–25 to 200 °C (-13 to 392 °F)
KCA	–	± 100 µV (± 2.5 °C (36.5 °F))	0 °C to 150 °C (32 to 302 °F):

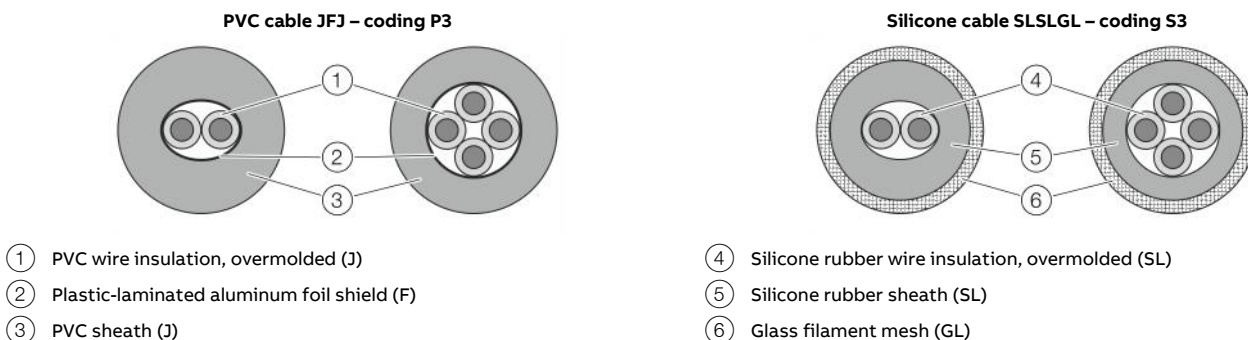
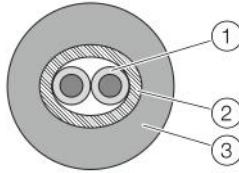


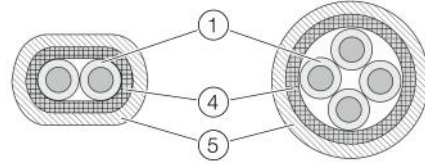
Figure 10: PVC and silicone cable

Design	Design	Sensor design
PVC cable JFJ – coding P3	General: Stranded wire, conductor cross-section: 0.22 mm ² , Temperature resistance of the insulation: –10 to 105 °C (14 to 221 °F)	1 x JX – coding J1 2 x JX – coding J2
	Type JX: Outside diameter up to 4 wires approx. 5.8 mm (0.23 in)	
	Type KCA: Outside diameter up to 4 wires approx. 5.0 mm (0.20 in)	1 x KCA – coding K1 2 x KCA – coding K2
Silicone cable SLSLGL – coding S3	Stranded wire, conductor cross-section: 0.22 mm ² , Temperature resistance of the insulation: –200 to 200 °C (–328 to 392 °F)	1 x KCA – coding K1 2 x KCA – coding K2
	Outside diameter up to 2 wires approx. 4.7 mm (0.19 in)	
	Outside diameter up to 4 wires approx. 5.5 mm (0.22 in)	

PFA cable TCUT – coding T2



PFA cable TGLV – coding T4



- ① PFA wire insulation, overmolded (T)
- ② Tinned mesh (CU)
- ③ PFA sheath, overmolded (T)

- ④ Glass filament mesh (GL)
- ⑤ Mesh made of stainless steel (V)

Figure 11: PFA cable

Design	Design	Sensor design
PFA cable TCUT – coding T2	Stranded wire, conductor cross-section: 0.22 mm ² Temperature resistance of the insulation: -200 to 200 °C (-328 to 392 °F) Outside diameter approx. 3.0 mm (0.12 in)	1 x NX – coding N1
PFA cable TGLV – coding T4	<p>General:</p> With single thermocouple: parallel wire With double thermocouple: stranded wire Conductor cross-section: 0.22 mm ² Temperature resistance of the insulation: -200 to 200 °C (-328 to 392 °F)	1 x JX – coding J1 2 x JX – coding J2
	<p>Type JX:</p> Outside diameter with 2 wires (oval conductor): approx. 3.3 mm x 2.0 mm (0.13 x 0.08 in) Outside diameter up to 4 wires approx. 3.7 mm (0.15 in)	1 x KCA – coding K1 2 x KCA – coding K2
	<p>Type KCA:</p> Outside diameter with 2 wires (oval conductor): approx. 3.3 mm x 2.0 mm (0.13 x 0.08 in) Outside diameter up to 4 wires approx. 3.7 mm (0.15 in)	1 x EX – coding E1 2 x EX – coding E2
	<p>Type NX:</p> Outside diameter up to 4 wires approx. 3.5 mm (0.14 in)	
	<p>Type EX:</p> Outside diameter up to 4 wires approx. 3.4 mm (0.13 in)	

Use in potentially explosive atmospheres

Intrinsic safety type of protection approvals (Ex i)

The SensyTemp TSC400 temperature sensors are equipped with the following approvals.

ATEX approvals are valid throughout the EU and in Switzerland, IECEx approvals are recognized internationally.

The device has the following approvals (examination certificates):

- ATEX Ex i, PTB 01 ATEX 2200 X
- IECEx Ex i, IECEx PTB 11.0111 X

A list of applied standards including the output data with which the device is in conformity can be found in the (EC type) examination certificate.

Additional approvals available for the TSC400 temperature sensor are available on request.

Industrial thermometers that conform to the requirements of both the type examination certificate for ATEX 'Ex i' and NAMUR-specification NE24, are available on request.

Electrical data

All of the values listed below are valid assuming that an additional transmitter has been connected.

The following electric values must not be up-scaled:

U_i (input voltage)	I_i (input current)
30 V	101 mA
25 V	158 mA
20 V	309 mA

P_i (internal power) = max. 0.5 W

L_i (internal inductance) = 15 μ H/m

C_i (internal capacitance) = 280 pF/m

Note

For the internal power P_i of the sensor and the output power P_o of the connected transmitter, the following must apply: $P_i \geq P_o$.

Likewise the following must apply: $U_i \geq U_o$ and $I_i \geq I_o$.

The output values of a connected transmitter, both when mounting in the connection head and when mounting in the field, must not up-scale these electric values. The output values of ABB temperature transmitters (TTx300 and TTx200) are below these maximum values.

Output power P_o with ABB transmitters

Transmitter type	P_o
TTxx00	≤ 38 mW

The type examination certificates for the corresponding transmitters contain all further information necessary to verify intrinsic safety (U_o , I_o , P_{o0} , L_o , C_o etc.).

Note

Temperature sensors for use in Zone 0 may only contain an intrinsically safe circuit and may only be connected to declared intrinsically safe circuits with type of protection 'Ex ia'.

Temperature data

Thermal resistance

The thermal resistances for mineral insulated cables are listed in the following table.

The values are specified under 'gas with a flow velocity of 0 m/s' conditions.

Thermal resistance R_{th} $\Delta t = 200$ K/W \times 0.038 W = 7.6 K	Diameter of the mineral insulated cable	
	< 6 mm (0.24 in)	≥ 6 mm (0.24 in)
Resistance thermometer	200 K/W	84 K/W
Thermocouple	30 K/W	30 K/W

K/W = kelvin per watt

Temperature rise in the event of a fault

In the event of a fault, the temperature sensors will exhibit a temperature rise Δt as appropriate for the applied power. This temperature rise Δt must be taken into account when determining the maximum process temperature for each temperature class.

Note

In the event of a fault (short-circuit), the dynamic short-circuit current that occurs in the measurement circuit for a matter of milliseconds is not relevant with regard to temperature rise.

The temperature rise Δt can be calculated using the following formula:

$$\Delta t = R_{th} \times P_o [K / W \times W]$$

Δt	Temperature rise
R _{th}	Thermal resistance
P _o	Output power of an additional connected transmitter

Example:

Resistance thermometer diameter 3 mm (0.12 in):
 R_{th} = 200 K/W
 Temperature transmitter TTxx00 P_o = 38 mW, see also **Output power Po with ABB transmitters** on page 18.

Δt = 200 K/W x 0.038 W = 7.6 K

Therefore, at transmitter output power P_o = 38 mW, the temperature rise in the event of a fault is approximately 8 K. This results in the following maximum process temperatures T_{medium}, as shown in Table **Maximum process temperature Tmedium in Zone 0 and Zone 1** on page 19.

Note

For a higher output power P_o as 38 mW in case of failure, but also for a generally higher output power of a connected transmitter as 38 mW, the temperature increase Δt must be recalculated.

Maximum process temperature T_{medium} in Zone 0 and Zone 1

To calculate the temperature classes for T3, T4, T5 and T6, deduct 5 K in each instance from the maximum surface temperature; for T1 and T2, deduct 10 K in each instance from this surface temperature.

For temperature T_{medium}, the temperature rise in the event of a fault of 8 K as calculated as an example in **Temperature rise in the event of a fault** on page 19.

Temperature class	-5 K	-10 K	T _{medium}
T1 (450 °C (842 °F))	—	440 °C (824 °F)	432 °C (809.6 °F)
T2 (300 °C (572 °F))	—	290 °C (554 °F)	282 °C (539.6 °F)
T3 (200 °C (392 °F))	195 °C (383 °F)	—	187 °C (368.6 °F)
T4 (135 °C (275 °F))	130 °C (266 °F)	—	122 °C (251.6 °F)
T5 (100 °C (212 °F))	95 °C (203 °F)	—	87 °C (188.6 °F)
T6 (85 °C (185 °F))	80 °C (176 °F)	—	72 °C (161.6 °F)

Tests and certificates

In order to increase the safety and accuracy of the process, ABB offers various mechanical and electrical tests. The results are confirmed with certificates in accordance with EN 10204.

Certificates

- Declaration of compliance 2.1 for order conformity
- Inspection certificate 3.1 for the following tests:
 - Material certificate for the MI-Cable
 - Visual, dimensional and function checks of the temperature sensor
 - Reference measurement for temperature sensor

For measurements requiring extremely high accuracy, ABB offers a calibration of the temperature sensor in its own DAkkS-calibration laboratory.

With a DAkkS-calibration, a separate calibration certificate is provided for each temperature sensor.

To obtain meaningful measurement results, the following minimum lengths of the mineral insulated cable should be adhered to:

Temperature range	Recommended minimum lengths
For very low temperatures below -70 °C (-94 °F)	300 mm (11.81 in)
For low to medium temperatures	100 to 150 mm (3.94 to 5.91 in)
For temperatures above 500 °C (932 °F)	300 to 400 mm (11.81 to 15.75 in)

Greater lengths allow additional measurement methods and simplify the measuring process. If you require any further information, please contact your local ABB partner.

In case of a reference measurements and DAkkS-calibration, the individual sensor characteristic of the temperature sensor can also be calculated and a suitable transmitter can be accordingly programmed using a freestyle characteristic. The measuring accuracy of the temperature sensor can be considerably improved by adjusting the transmitter to the sensor characteristics. To this end, the measurement must be conducted with at least three temperatures.

Ordering Information

NOTE

Order codes cannot be combined at will. Your ABB partner will be happy to answer any questions you might have regarding installation feasibility. All documentation, declarations of conformity, and certificates are available in ABB's download area.

SensyTemp TSC420

Base model	TSC420	XX	XX	XX	XX	XX	XX	XX	XX	XX
TSC420 Screw-in thermometer with direct electrical connection										
Explosion Protection Certification										
Without explosion protection		Y0								
Intrinsic Safety ATEX II 1 G Ex ia IIC T6...T1 Ga, Zone 0		A1								
Intrinsic Safety ATEX II 2 G Ex ib IIC T6...T1 Gb, Zone 1		A2								
Intrinsic Safety IECEx ia IIC T6...T1 Ga, Zone 0		H1								
NEPSI Intrinsic Safety type of protection: Ex ia IIC T6 Ga		S1								
Mounting Type										
Without fitting			F0							
Fixed connection			F1							
Compression fitting, clamp ring material PTFE			F2							
Compression fitting, clamp ring material stainless steel			F3							
Weld-on pad 25 mm x 25 mm x 3 mm (for Thermocouple)			W2							
Weld-on pad 35 mm x 25 mm x 3 mm (for Pt100)			W3							
Clamping adapter (please define clip separately)			C1							
Others			Z9							
Sensor Type and Wiring										
1 x Pt100, two-wire circuit				P1						
1 x Pt100, three-wire circuit				P2						
1 x Pt100, four-wire circuit				P3						
2 x Pt100, two-wire circuit				P4						
2 x Pt100, three-wire circuit				P5						
2 x Pt100, four-wire circuit				P6						
1 x Type K (NiCr-NiAl)				K1						
2 x Type K (NiCr-NiAl)				K2						
1 x Type J (Fe-CuNi)				J1						
2 x Type J (Fe-CuNi)				J2						
1 x Type N (NiCrSi-NiSi)				N1						
2 x Type N (NiCrSi-NiSi)				N2						
1 x Type E (NiCr-CuNi)				E1						
2 x Type E (NiCr-CuNi)				E2						
Others				Z9						

... Ordering Information

SensyTemp TSC420	XX	XX	XX	XX	XX	XX
Sensor / Accuracy Class						
Wire Wound, Accuracy Class B, IEC 60751, Range -196 to 600 °C (-321 to 1112 °F)	B2					
Wire Wound, Double, Accuracy Class A, IEC 60751, Range 0 to 250 °C (32 to 482 °F)	D2					
Wire Wound, Accuracy Class A, IEC 60751, Range -100 to 450 °C (-148 to 842 °F)	D1					
Thin Film, Accuracy Class B, IEC 60751, Range -50 to 400 °C (-58 to 752 °F)	S5					
Thin Film, Accuracy Class A, IEC 60751, Range -30 to 300 °C (-22 to 572 °F)	S1					
Thin Film, Accuracy Class AA, IEC 60751, Range 0 to 100 °C (32 to 212 °F)	S3					
Thermocouple, Accuracy Class 2, IEC 60584	T2					
Thermocouple, Accuracy Class 1, IEC 60584	T1					
Others	Z9					
Mineral Insulated Cable Diameter						
1,5 mm		C2				
3,0 mm		D3				
4,5 mm		C5				
6,0 mm		D6				
6,0 mm, tip with sleeve 8.0 mm		H8				
Others		Z9				
Mineral Insulated Cable Material						
Stainless steel 316Ti (1.4571)				S1		
Stainless steel 316L (1.4404)				S2		
Inconel Alloy 600 (2.4816)				J1		
Others				Z9		
Process Connection Type						
Without					Y0	
Parallel thread M8 x 1					M1	
Parallel thread G ¼ A					G1	
Parallel thread G ½ A					G2	
Tapered thread ¼ in. NPT					N1	
Tapered thread ½ in. NPT					N2	
Others					Z9	

SensyTemp TSC420	XX	XX
Electrical Connetion		
Head type F / aluminium	C7	
Open wires, length 100 mm (4 in.), standard length	C1	
Open wires, customer specific length	C8	
Thermocouple-plug, size: standard	C3	
Thermocouple-socket, size: standard	C4	
Lemo-plug, size: 1S	C5	
Lemo-socket, size: 1S	C6	
Others	Z9	
Length Unit of Measure		
Millimeter (mm)		U1
Inches (in.)		U3

SensyTemp TSC420	XX	XX	XX
Certificates			
Inspection certificate according EN 10204-3.1, material monitoring for wetted parts	C2		
Declaration of compliance according EN 10204-2.1, with the order	C4		
Inspection certificate according EN 10204-3.1, visual, dimensional and functional test	C6		
Inspection certificate according EN 10204-3.1, sensor calibration, single RTD	CD		
Inspection certificate according EN 10204-3.1, sensor calibration, double RTD	CE		
Inspection certificate according EN 10204-3.1, sensor calibration, single thermocouple	CF		
Inspection certificate according EN 10204-3.1, sensor calibration, double thermocouple	CG		
DAkkS sensor calibration, single RTD, separate calibration certificate per thermometer	CH		
DAkkS sensor calibration, double RTD, separate calibration certificate per thermometer	CJ		
DAkkS sensor calibration, single thermocouple, separate calibration certificate per thermometer	CK		
DAkkS sensor calibration, double thermocouple, separate calibration certificate per thermometer	CL		
Number of Calibration Test Points			
1 point		P1	
2 points		P2	
3 points		P3	
4 points		P4	
5 points		P5	

... Ordering Information

SensyTemp TSC420	XX	XX	XX	XX	XX
Temperatures for Sensor Calibration					
Standard calibration: 0 °C (32 °F)	V1				
Standard calibration: 100 °C (212 °F)	V2				
Standard calibration: 400 °C (752 °F)	V3				
Standard calibration: 0 °C and 100 °C (32 °F and 212 °F)	V4				
Standard calibration: 0 °C and 400 °C (32 °F and 752 °F)	V5				
Standard calibration: 0 °C, 100 °C and 200 °C (32 °F, 212 °F and 392 °F)	V7				
Standard calibration: 0 °C, 200 °C and 400 °C (32 °F, 392 °F and 752 °F)	V8				
Standard calibration: Customer specific temperatures	V6				
DAkKS calibration: 0 °C (32 °F)	D1				
DAkKS calibration: 100 °C (212 °F)	D2				
DAkKS calibration: 400 °C (752 °F)	D3				
DAkKS calibration: 0 °C and 100 °C (32 °F and 212 °F)	D4				
DAkKS calibration: 0 °C and 400 °C (32 °F and 752 °F)	D5				
DAkKS calibration: 0 °C, 100 °C and 200 °C (32 °F, 212 °F and 392 °F)	D7				
DAkKS calibration: 0 °C, 200 °C and 400 °C (32 °F, 392 °F and 752 °F)	D8				
DAkKS calibration: Customer specific temperatures	D6				
Pipe Clamp					
Clamping diameter 20 mm up to 40 mm		S1			
Clamping diameter 40 mm up to 60 mm		S2			
Clamping diameter 60 mm up to 80 mm		S3			
Clamping diameter 80 mm up to 100 mm		S4			
Clamping diameter 100 mm up to 120 mm		S5			
Clamping diameter 120 mm up to 140 mm		S6			
Clamping diameter 140 mm up to 160 mm		S7			
Clamping diameter 160 mm up to 180 mm		S8			
Clamping diameter 180 mm up to 200 mm		S9			
Clamping diameter more than 200 mm		SZ			
Other Options					
Hot junction grounded			J1		
Mineral insulated cable sealed, up to 200 °C (392 °F)			J6		
Documentation Language					
German				M1	
English				M5	
Language package Western Europe / Scandinavia (Languages: DE, EN, DA, ES, FR, IT, NL, PT, FI, SV)				MW	
Language package Eastern Europe (Languages: DE, EL, CS, ET, LV, LT, HU, PL, SK, SL, RO, BG)				ME	
Additional TAG Plate					
Stainless steel plate with TAG no., lasered					T1

SensyTemp TSC430

Base model	TSC430	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
TSC430 Sheathed cable thermometer with connection cable											
Explosion Protection Certification											
Without explosion protection		Y0									
Intrinsic Safety ATEX II 1 G Ex ia IIC T6...T1 Ga, Zone 0		A1									
Intrinsic Safety ATEX II 2 G Ex ib IIC T6...T1 Gb, Zone 1		A2									
Intrinsic Safety IECEx ia IIC T6...T1 Ga, Zone 0		H1									
NEPSI Intrinsic Safety type of protection: Ex ia IIC T6 Ga		S1									
Mounting Type											
Without fitting			F0								
Fixed connection			F1								
Compression fitting, clamp ring material PTFE			F2								
Compression fitting, clamp ring material stainless steel			F3								
Weld-on pad 25 mm x 25 mm x 3 mm (for Thermocouple)			W2								
Weld-on pad 35 mm x 25 mm x 3 mm (for Pt100)			W3								
Clamping adapter (please define clip separately)			C1								
Others			Z9								
Sensor Type and Wiring											
1 x Pt100, 2-wire				P1							
1 x Pt100, 3-wire				P2							
1 x Pt100, 4-wire				P3							
2 x Pt100, 2-wire				P4							
2 x Pt100, 3-wire				P5							
2 x Pt100, 4-wire				P6							
1 x Type K (NiCr-NiAl)				K1							
2 x Type K (NiCr-NiAl)				K2							
1 x Type J (Fe-CuNi)				J1							
2 x Type J (Fe-CuNi)				J2							
1 x Type N (NiCrSi-NiSi)				N1							
2 x Type N (NiCrSi-NiSi)				N2							
1 x Type E (NiCr-CuNi)				E1							
2 x Type E (NiCr-CuNi)				E2							
Others				Z9							

... Ordering Information

Main ordering information SensyTemp TSC430	XX	XX	XX	XX	XX
Sensor / Accuracy Class					
Wire Wound, Accuracy Class B, IEC 60751, Range -196 to 600 °C (-321 to 1112 °F)	B2				
Wire Wound, Double, Accuracy Class A, IEC 60751, Range 0 to 250 °C (32 to 482 °F)	D2				
Wire Wound, Accuracy Class A, IEC 60751, Range -100 to 450 °C (-148 to 842 °F)	D1				
Thin Film, Accuracy Class B, IEC 60751, Range -50 to 400 °C (-58 to 752 °F)	S5				
Thin Film, Accuracy Class A, IEC 60751, Range -30 to 300 °C (-22 to 572 °F)	S1				
Thin Film, Accuracy Class AA, IEC 60751, Range 0 to 100 °C (32 to 212 °F)	S3				
Thermocouple, Accuracy Class 2, IEC 60584	T2				
Thermocouple, Accuracy Class 1, IEC 60584	T1				
Others	Z9				
Mineral Insulated Cable Diameter					
1,5 mm		C2			
3,0 mm		D3			
4,5 mm		C5			
6,0 mm		D6			
6,0 mm, tip with sleeve 8.0 mm		H8			
Others		Z9			
Mineral Insulated Cable Material					
Stainless steel 316Ti (1.4571)			S1		
Stainless steel 316L (1.4404)			S2		
Inconel Alloy 600 (2.4816)			J1		
Others			Z9		
Process Connection Type					
Without				Y0	
Parallel thread M8 x 1				M1	
Parallel thread G 1/4 A				G1	
Parallel thread G 1/2 A				G2	
Tapered thread 1/4 in. NPT				N1	
Tapered thread 1/2 in. NPT				N2	
Others				Z9	
Electrical Connetion					
Open wires					C2
Thermocouple-plug, size: standard					C3
Thermocouple-socket, size: standard					C4
Lemo-plug, size: 1S					C5
Lemo-socket, size: 1S					C6
Others					Z9

Main ordering information SensyTemp TSC430		XX	XX
Connection Cable Type			
JJ (PVC / PVC), up to 105 °C (221 °F)		P2	
JFJ(PVC/Alu Foil with additional tinned wire 0,50 mm/PVC), up to 105 °C (221 °F)		P3	
SLSLGL (silicone / silicone / glas fibre) up to 200°C (392 °F)		S3	
TFT (PFA / Alu Foil / PFA), up to 200 °C (392 °F)		T2	
TFTV (PFA / Alu Foil / PFA / SST wire braid), up to 200 °C (392 °F)		T3	
TGLV (PFA / Glas fibre / SST wire braid), up to 200 °C (392 °F)		T4	
Others		Z9	
Length Unit of Measure			
Millimeter (mm)			U1
Inches (in.)			U3

Additional ordering information

SensyTemp TSC430		XX	XX
Certificates			
Inspection certificate according EN 10204-3.1, material monitoring for wetted parts		C2	
Declaration of compliance according EN 10204-2.1, with the order		C4	
Inspection certificate according EN 10204-3.1, visual, dimensional and functional test		C6	
Inspection certificate according EN 10204-3.1, sensor calibration, single RTD		CD	
Inspection certificate according EN 10204-3.1, sensor calibration, double RTD		CE	
Inspection certificate according EN 10204-3.1, sensor calibration, single thermocouple		CF	
Inspection certificate according EN 10204-3.1, sensor calibration, double thermocouple		CG	
DAkKS sensor calibration, single RTD, calibration certificate per thermometer		CH	
DAkKS sensor calibration, double RTD, calibration certificate per thermometer		CJ	
DAkKS sensor calibration, single thermocouple, calibration certificate per thermometer		CK	
DAkKS sensor calibration, double thermocouple, calibration certificate per thermometer		CL	
Number of Calibration Test Points			
1 point			P1
2 points			P2
3 points			P3
4 points			P4
5 points			P5

... Ordering Information

SensyTemp TSC430	XX	XX	XX	XX	XX
Temperatures for Sensor Calibration					
Standard calibration: 0 °C (32 °F)	V1				
Standard calibration: 100 °C (212 °F)	V2				
Standard calibration: 400 °C (752 °F)	V3				
Standard calibration: 0 °C and 100 °C (32 °F and 212 °F)	V4				
Standard calibration: 0 °C and 400 °C (32 °F and 752 °F)	V5				
Standard calibration: 0 °C, 100 °C and 200 °C (32 °F, 212 °F and 392 °F)	V7				
Standard calibration: 0 °C, 200 °C and 400 °C (32 °F, 392 °F and 752 °F)	V8				
Standard calibration: Customer specific temperatures	V6				
DAkkS calibration: 0 °C (32 °F)	D1				
DAkkS calibration: 100 °C (212 °F)	D2				
DAkkS calibration: 400 °C (752 °F)	D3				
DAkkS calibration: 0 °C and 100 °C (32 °F and 212 °F)	D4				
DAkkS calibration: 0 °C and 400 °C (32 °F and 752 °F)	D5				
DAkkS calibration: 0 °C, 100 °C and 200 °C (32 °F, 212 °F and 392 °F)	D7				
DAkkS calibration: 0 °C, 200 °C and 400 °C (32 °F, 392 °F and 752 °F)	D8				
DAkkS calibration: customer specific temperatures	D6				
Pipe Clamp					
without		S0			
Clamping diameter 20 mm up to 40 mm		S1			
Clamping diameter 40 mm up to 60 mm		S2			
Clamping diameter 60 mm up to 80 mm		S3			
Clamping diameter 80 mm up to 100 mm		S4			
Clamping diameter 100 mm up to 120 mm		S5			
Clamping diameter 120 mm up to 140 mm		S6			
Clamping diameter 140 mm up to 160 mm		S7			
Clamping diameter 160 mm up to 180 mm		S8			
Clamping diameter 180 mm up to 200 mm		S9			
Clamping diameter more than 200 mm		SZ			
Other Options					
Hot junction grounded			J1		
Mineral insulated cable, sealed, up to 200 °C (392 °F)			J6		
Anti-kink spring for connecting cable			J8		
Documentation Language					
German				M1	
English				M5	
Language package Western Europe / Scandinavia (Languages: DE, EN, DA, ES, FR, IT, NL, PT, FI, SV)				MW	
Language package Eastern Europe (Languages: DE, EL, CS, ET, LV, LT, HU, PL, SK, SL, RO, BG)				ME	
Additional TAG Plate					
Stainless steel plate with TAG no.					T1

Accessories

Accessories	Order code
TSC400 Commissioning Instruction, German	3KXT121400R4403
TSC400 Commissioning Instruction, English	3KXT121400R4401
TSC400 Commissioning Instruction, Language package Western Europe / Scandinavia	3KXT121400R4493
TSC400 Commissioning Instruction, Language package Eastern Europe	3KXT121400R4494



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Sales



Service



ABB Measurement & Analytics

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For more product information, visit:

www.abb.com/temperature

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