SensyTemp TSC400
Industrial thermometer

Measurement made easy

Additional Information
Additional documentation on SensyTemp TSC400 is available for download free of charge at www.abb.com/temperature. Alternatively simply scan this code:
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1 Safety

General information and instructions

These instructions are an important part of the product and must be retained for future reference.

Installation, commissioning, and maintenance of the product may only be performed by trained specialist personnel who have been authorized by the plant operator accordingly. The specialist personnel must have read and understood the manual and must comply with its instructions.

For additional information or if specific problems occur that are not discussed in these instructions, contact the manufacturer.

The content of these instructions is neither part of nor an amendment to any previous or existing agreement, promise or legal relationship.

Modifications and repairs to the product may only be performed if expressly permitted by these instructions.

Information and symbols on the product must be observed. These may not be removed and must be fully legible at all times.

The operating company must strictly observe the applicable national regulations relating to the installation, function testing, repair and maintenance of electrical products.

Warnings

The warnings in these instructions are structured as follows:

⚠️ DANGER

The signal word ‘DANGER’ indicates an imminent danger. Failure to observe this information will result in death or severe injury.

⚠️ WARNING

The signal word ‘WARNING’ indicates an imminent danger. Failure to observe this information may result in death or severe injury.

⚠️ CAUTION

The signal word ‘CAUTION’ indicates an imminent danger. Failure to observe this information may result in minor or moderate injury.

NOTICE

The signal word ‘NOTICE’ indicates possible material damage.

Note

‘Note’ indicates useful or important information about the product.
1 Safety

Intended use

The temperature sensors are used for measuring temperatures in a vast range of process applications. The device is designed for use exclusively within the values stated on the name plate and in the specifications (see Specifications in the operating instruction or data sheet).

- The permissible ambient temperature range may not be up-scaled or down-scaled.
- The IP rating must be observed during operation.
- For use in potentially explosive atmospheres, follow the respective guidelines.

Before using the devices with corrosive or abrasive measuring media, the owner must check the level of resistance of all wetted parts. ABB Automation Products GmbH will gladly support you in selecting the appropriate device, but cannot accept any liability in doing so.

The device has been designed for use exclusively within the technical limit values indicated on the identification plate and in the data sheets.

When using measuring media, please note the following items:

- Measuring media may only be used if, based on the state of the art or the operating experience of the user, it can be assured that the chemical and physical properties necessary for operational security of the materials of the wetted parts of the temperature sensor will not be adversely affected during the operating time.
- Media containing chloride in particular can cause corrosion damage to stainless steels which, although not visible externally, can damage wetted parts beyond repair and lead to the measuring medium escaping. It is the operator’s responsibility to check the suitability of these materials for the respective application.
- Measuring media with unknown properties or abrasive measuring media may only be used if the operator is able to perform regular and suitable tests to ensure the safe condition of the device.

Improper use

The following are considered to be instances of especially improper use of the device:

- For use as a climbing aid, for example for mounting purposes.
- For use as a bracket for external loads, for example as a support for piping, etc.
- Material application, for example by painting over the housing, name plate or welding/soldering on parts.
- Material removal, for example by spot drilling the housing.
Notes on data safety

This product is designed to be connected to and to communicate information and data via a network interface. It is operator’s sole responsibility to provide and continuously ensure a secure connection between the product and your network or any other network (as the case may be). Operator shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and / or theft of data or information. ABB Automation Products GmbH and its affiliates are not liable for damages and / or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and / or theft of data or information.

Warranty provisions

Using the device in a manner that does not fall within the scope of its intended use, disregarding this manual, using underqualified personnel, or making unauthorized alterations releases the manufacturer from liability for any resulting damage. This renders the manufacturer’s warranty null and void.

Manufacturer’s address

ABB Automation Products GmbH
Measurement & Analytics
Schillerstr. 72
32425 Minden
Germany
Tel: +49 571 830-0
Fax: +49 571 830-1806

Customer service center
Tel: +49 180 5 222 580
Email: automation.service@de.abb.com
2 Use in potentially explosive atmospheres

General
Special regulations must be observed in potentially explosive atmospheres as regards the power supply, signal inputs / outputs and ground connections. The information relating specifically to explosion protection that appears within the individual chapters must be observed.

All parts must be installed in accordance with the manufacturer's specifications, as well as relevant standards and regulations. For commissioning and operation, the respectively applicable regulations, especially for the protection of employees, should be complied with.

IP rating
The connection parts of the temperature sensor must be installed so that at least the IP rating of the type of protection used can be achieved.

Temperature classes
If the temperature sensor is identified with temperature class T6 only, the following will apply:
- If the existing explosive gas atmosphere is to be assigned a temperature class of T5, T4, T3, T2, or T1, the temperature sensors can be used at correspondingly higher process temperatures, according to the specifications of the temperature class.

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.

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:

<table>
<thead>
<tr>
<th>Electric values (up-scaled)</th>
<th>Electric values (not up-scaled)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ui (Input voltage)</td>
<td>Ii (Input current)</td>
</tr>
<tr>
<td>30 V</td>
<td>101 mA</td>
</tr>
<tr>
<td>25 V</td>
<td>158 mA</td>
</tr>
<tr>
<td>20 V</td>
<td>309 mA</td>
</tr>
</tbody>
</table>

Pi (Internal power) = max. 0.5 W
Li (Internal inductance) = 15 μH/m
Ci (Internal capacitance) = 280 pF/m

Note
For the internal power Pi of the sensor and the output power Po of the connected transmitter, the following must apply: Pi ≥ Po.
Likewise the following must apply: Ui ≥ Uo and Ii ≥ Io.

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 Po with ABB transmitters

<table>
<thead>
<tr>
<th>Transmitter type</th>
<th>Po (mW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTH200, TTF200, TTR200 HART</td>
<td>≤ 29 mW*</td>
</tr>
<tr>
<td>TTH300, TTF300 HART</td>
<td>≤ 29 mW**</td>
</tr>
<tr>
<td>TTH300, TTF300 PA</td>
<td>≤ 38 mW</td>
</tr>
<tr>
<td>TTH300, TTF300 FF</td>
<td>≤ 38 mW</td>
</tr>
</tbody>
</table>

* as of HW-Rev. 1.12, previously Po ≤ 38 mW
** as of HW-Rev. 2.00, previously Po ≤ 38 mW

The type examination certificates for the corresponding transmitter types contain all further information necessary to verify intrinsic safety (Uo, Io, Po, Lo, Co, 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.

<table>
<thead>
<tr>
<th>Thermal resistance $R_{\text{th}}$</th>
<th>Diameter of the mineral insulated cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta t = 200 , \text{K/W} \times 0.038 , \text{W} = 7.6 , \text{K}$</td>
<td>&lt; 6 mm (0.24 in) ≥ 6 mm (0.24 in)</td>
</tr>
<tr>
<td>Resistance thermometer</td>
<td>200 K/W</td>
</tr>
<tr>
<td>Thermocouple</td>
<td>30 K/W</td>
</tr>
</tbody>
</table>

$K/W = \text{kelvin per watt}$

Temperature rise in the event of a fault
In the event of a fault, the temperature sensors will exhibit a temperature rise $\Delta t$ as appropriate for the applied power. This temperature rise $\Delta t$ 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 $\Delta t$ can be calculated using the following formula:

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

$\Delta t$ Temperature rise
$R_{\text{th}}$ Thermal resistance
$P_o$ Output power of an additional connected transmitter

Example:
Resistance thermometer diameter 3 mm (0.12 in):

$R_{\text{th}} = 200 \, \text{K/W}$

Temperature transmitter TTxx00 $P_o = 38 \, \text{mW}$, see also Output power $P_o$ with ABB transmitters on page 6.

$\Delta t = 200 \, \text{K/W} \times 0.038 \, \text{W} = 7.6 \, \text{K}$

Therefore, at transmitter output power $P_o = 38 \, \text{mW}$, the temperature rise in the event of a fault is approximately 8 K. This results in the following maximum possible process temperatures $T_{\text{medium}}$, as shown in Table Maximum process temperature $T_{\text{medium}}$ in Zone 0 and Zone 1 on page 7.

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 rise $\Delta t$ must be recalculated.

Maximum process temperature $T_{\text{medium}}$ 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 $T_{\text{medium}}$, 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 7.

<table>
<thead>
<tr>
<th>Temperature class</th>
<th>$-5 , \text{K}$</th>
<th>$-10 , \text{K}$</th>
<th>$T_{\text{medium}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 (450 °C (842 °F))</td>
<td>—</td>
<td>440 °C (824 °F)</td>
<td>432 °C (809.6 °F)</td>
</tr>
<tr>
<td>T2 (300 °C (572 °F))</td>
<td>—</td>
<td>290 °C (554 °F)</td>
<td>282 °C (539.6 °F)</td>
</tr>
<tr>
<td>T3 (200 °C (392 °F))</td>
<td>195 °C (383 °F)</td>
<td>—</td>
<td>187 °C (368.6 °F)</td>
</tr>
<tr>
<td>T4 (135 °C (275 °F))</td>
<td>130 °C (266 °F)</td>
<td>—</td>
<td>122 °C (251.6 °F)</td>
</tr>
<tr>
<td>T5 (100 °C (212 °F))</td>
<td>95 °C (203 °F)</td>
<td>—</td>
<td>87 °C (188.6 °F)</td>
</tr>
<tr>
<td>T6 (85 °C (185 °F))</td>
<td>80 °C (176 °F)</td>
<td>—</td>
<td>72 °C (161.6 °F)</td>
</tr>
</tbody>
</table>
... 2  Use in potentially explosive atmospheres

Mounting

Obligations of the owner
The installation, commissioning, maintenance and repair of devices in potentially explosive atmospheres must only be carried out by appropriately trained personnel. Works may be carried out only by persons, whose training has included instructions on different types of protection and installation techniques, concerned rules and regulations as well as general principles of zoning.

The installation, commissioning, maintenance and repair of devices in potentially explosive atmospheres must only be carried out by appropriately trained personnel. Works may be carried out only by persons, whose training has included instructions on different types of protection and installation techniques, concerned rules and regulations as well as general principles of zoning.

The person must possess the appropriate competences for the type of work to be conducted.

The safety instructions for electrical apparatus in potentially explosive areas must be in accordance with Directive 2014/34/EU (ATEX) and IEC 60079-14 (Installation of electrical equipment in potentially explosive areas).

Comply with the applicable regulations for the protection of employees to ensure safe operation.

General

When installing the temperature sensor, observe the following points:

- Avoid impermissible increases in the ambient temperature by making sure that equipment is at a sufficient distance from system components with excessively high temperatures.
- Heat dissipation by means of unrestricted air circulation must be guaranteed.
- You must avoid up-scaling the maximum permissible ambient temperature as per the approved temperature class.
- Compliance with the Ex temperature classes must be guaranteed through suited measures.

Note

- It is essential that you guarantee compliance with the type examination certificates for the equipment, including the documents associated with these.
- The temperature sensors must be included in the potential equalization.

### Installation instructions

#### Type of protection intrinsic safety up to Zone 0

<table>
<thead>
<tr>
<th>Ex marking</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 0, 1, 2</td>
<td>TSC4x0-A1</td>
</tr>
<tr>
<td>ATEX II 1 G Ex ia IIC T6…T1 Ga</td>
<td></td>
</tr>
</tbody>
</table>

When implementing in Zone 0, the use of aluminum connection heads is not permitted. Moreover, no additional specific information needs to be observed for mechanical installation.

#### Type of protection intrinsic safety up to Zone 1

<table>
<thead>
<tr>
<th>Ex marking</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zones 1, 2</td>
<td>TSC4x0-A2</td>
</tr>
<tr>
<td>ATEX II 2 G Ex ib IIC T6…T1 Gb</td>
<td></td>
</tr>
</tbody>
</table>

No additional specific information needs to be observed for mechanical installation.
Electrical connections

Grounding
If, for functional reasons, the intrinsically safe circuit needs to be grounded by means of a connection to the potential equalization of the installation, it may only be grounded at one point.
For reinforced connection cables, the mineral insulated cable of the temperature sensor must be connected with the potential equalization of the installation.

Intrinsic safety proof
If the temperature sensors are operated in an intrinsically safe circuit, proof that the interconnection is intrinsically safe must be provided in accordance with DIN VDE 0165/Part 1 (EN 60079-25 and IEC 60079-25).
The supply isolators / distributed control system (DCS) inputs must feature intrinsically safe input protection circuits to eliminate hazards (spark formation).
In order to provide proof of intrinsic safety, the electrical limit value must be used as the basis for the EC-type examination certificates for the equipment (devices); this includes the capacitance and inductance values of the cables.
Proof of intrinsic safety is said to have been provided if the following conditions are fulfilled when a comparison is carried out in relation to the limit values of the equipment:

<table>
<thead>
<tr>
<th>Transmitter (intrinsically safe equipment)</th>
<th>Supply isolator / DCS input (related equipment)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( U_i \geqslant U_o )</td>
</tr>
<tr>
<td></td>
<td>( I_i \geqslant I_o )</td>
</tr>
<tr>
<td></td>
<td>( P_i \geqslant P_o )</td>
</tr>
<tr>
<td></td>
<td>( L_i + L_c ) (cable) \leqslant L_o</td>
</tr>
<tr>
<td></td>
<td>( C_i + C_c ) (cable) \leqslant C_o</td>
</tr>
</tbody>
</table>

Electrical connection notice
Only certified transmitters with the maximum values specified in the operating instruction may be connected to the temperature sensors.
Observe the following points when connecting to the temperature transmitter:
- If two transmitters are used for two intrinsically safe circuits, the sum of the values may not up-scale the maximum values specified in the operating instruction.
- The temperature sensor must feature appropriate input protection circuits to eliminate hazards (spark formation).
- An intrinsic safety installation check must be performed. For this purpose, the electric limit values must be used as the basis for the type examination certificates for the equipment (devices); this includes the capacitance and inductance values of the connection leads.

The temperature sensor can be installed in a huge variety of industrial locations. Plants with explosion protection (Ex plants) are divided into zones, meaning that they also require a wide range of instruments. Different certificates are required for these depending on the region. The temperature sensor must be instrumented by the user in accordance with the valid Ex standards.

Note
Ex relevant specifications must be taken from the applicable type examination certificates and other relevant certificates that apply in each case.
... 2  Use in potentially explosive atmospheres

... Electrical connections

Type of protection intrinsic safety up to Zone 0

<table>
<thead>
<tr>
<th>Ex marking</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 0, 1, 2</td>
<td>TSC4x0-A1</td>
</tr>
</tbody>
</table>

ATEX II 1 G Ex ia IIC T6...T1 Ga

In the case of the intrinsic safety type of protection, only one measuring element may be connected in Zone 0 if two measuring elements are being used (e.g. 2 x Pt100).

The internal wiring in TTF300 transmitters enables two sensor elements to be connected, as both elements are integrated into the same intrinsically safe sensor circuit.

For the Zone 0 version, only one intrinsically safe sensor measurement circuit may be used.

Type of protection intrinsic safety up to Zone 1

<table>
<thead>
<tr>
<th>Ex marking</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zones 1, 2</td>
<td>TSC4x0-A2</td>
</tr>
</tbody>
</table>

ATEX II 2 G Ex ib IIC T6...T1 Gb

Ex area Zone 1, 2 Safe area

A Sensor
B Sensor connection leads
C TSC4x0 electrical connection
D Transmitter, Ex ia/ib type of protection

Figure 2: Interconnection

The transmitter must always have an Ex ia type of protection (Category 1G) design to enable it to be used in Zone 0.
3 Functional safety (SIL)

The following notes should be observed to calculate the safety integrity level (SIL) of the combination of a temperature sensor SensyTemp TSC400 with an SIL-certified transmitter – e.g. The ABB TTFx00 temperature transmitter for field installation.

Failure rates of temperature sensors
The failure rates of the temperature sensor are included in the calculation of the safety integrity level (SIL) of a thermometer with temperature transmitter and sensor in a safety-related application in accordance with IEC 61508.

Typical failure rates

<table>
<thead>
<tr>
<th>Temperature sensor</th>
<th>Fault type</th>
<th>low stress close coupled</th>
<th>high stress close coupled</th>
<th>low stress extension wire</th>
<th>high stress extension wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermocouple</td>
<td>Wire break</td>
<td>95 FIT</td>
<td>1900 FIT</td>
<td>900 FIT</td>
<td>18000 FIT</td>
</tr>
<tr>
<td></td>
<td>Short circuit</td>
<td>4 FIT</td>
<td>80 FIT</td>
<td>50 FIT</td>
<td>1000 FIT</td>
</tr>
<tr>
<td></td>
<td>Drift</td>
<td>1 FIT</td>
<td>20 FIT</td>
<td>50 FIT</td>
<td>1000 FIT</td>
</tr>
<tr>
<td>Four-wire resistance</td>
<td>Wire break</td>
<td>41.5 FIT</td>
<td>830 FIT</td>
<td>410 FIT</td>
<td>8200 FIT</td>
</tr>
<tr>
<td>thermometer</td>
<td>Short circuit</td>
<td>2.5 FIT</td>
<td>50 FIT</td>
<td>20 FIT</td>
<td>400 FIT</td>
</tr>
<tr>
<td></td>
<td>Drift</td>
<td>6 FIT</td>
<td>120 FIT</td>
<td>70 FIT</td>
<td>1400 FIT</td>
</tr>
<tr>
<td>Two-wire / three-wire</td>
<td>Wire break</td>
<td>37.92 FIT</td>
<td>758.5 FIT</td>
<td>370.5 FIT</td>
<td>7410 FIT</td>
</tr>
<tr>
<td>resistance thermometer</td>
<td>Short circuit</td>
<td>1.44 FIT</td>
<td>28.8 FIT</td>
<td>9.5 FIT</td>
<td>190 FIT</td>
</tr>
<tr>
<td></td>
<td>Drift</td>
<td>8.64 FIT</td>
<td>172.8 FIT</td>
<td>95 FIT</td>
<td>1900 FIT</td>
</tr>
</tbody>
</table>

Note: 1 FIT is 1 failure per 10^9 hours.

Information on the functional safety of the TTx300 and TTx200 temperature transmitters can be found in the corresponding SIL-Safety Manual.
4 General description

**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

<table>
<thead>
<tr>
<th>Single and double thermocouples</th>
<th>Single Pt100 / 2-, 3-, or 4-wire</th>
<th>Double Pt100 / 2-, 3-, or 4-wire</th>
<th>Double Pt100 / 2-wire</th>
<th>Double Pt100 / 2- or 3-wire</th>
</tr>
</thead>
</table>

Design

<table>
<thead>
<tr>
<th>Bendable mineral insulated cable with sealing sleeve</th>
<th>Open cable ends, standard 100 mm (3.94 in) or customer-specific</th>
<th>Form F connecting head</th>
<th>Plug, socket</th>
</tr>
</thead>
</table>

**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

<table>
<thead>
<tr>
<th>Single and double thermocouples</th>
<th>Single Pt100 / 2-, 3-, or 4-wire</th>
<th>Double Pt100 / 2-, 3-, or 4-wire</th>
<th>Double Pt100 / 2-wire</th>
<th>Double Pt100 / 2- or 3-wire</th>
</tr>
</thead>
</table>

Design

<table>
<thead>
<tr>
<th>Bendable mineral insulated cable with sealing sleeve and optional anti-kink spring</th>
<th>Open cable ends</th>
<th>Plug, socket</th>
</tr>
</thead>
</table>

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
5 Product identification

Name plate

Note
The name plates displayed are examples. The device identification plates affixed to the device can differ from this representation.

Note
The values specified on the name plate are maximum values and do not take process-related stress into consideration. This should be taken into consideration when working with the instruments.

6 Transport and storage

Inspection
Check the devices immediately after unpacking for possible damage that may have occurred from improper transport. Details of any damage that has occurred in transit must be recorded on the transport documents. All claims for damages must be submitted to the shipper without delay and before installation.

Transporting the device
Observe the following instructions:
- Do not expose the device to humidity during transport. Pack the device accordingly.
- Pack the device so that it is protected against vibrations during transport, for example, by using air-cushioned packing.

Storing the device
Bear the following points in mind when storing devices:
- Store the device in its original packaging in a dry and dust-free location.
- Observe the permitted ambient conditions for transport and storage.
- Avoid storing the device in direct sunlight.
- In principle, the devices may be stored for an unlimited period. However, the warranty conditions stipulated in the order confirmation of the supplier apply.

Ambient conditions
The ambient conditions for the transport and storage of the device correspond to the ambient conditions for operation of the device. Adhere to the device data sheet!

Returning devices
For the return of devices, follow the instructions in Maintenance / Repair on page 23.
7 Installation

General information

Note
When using the device in potentially explosive atmospheres, note the additional temperature data in **Use in potentially explosive atmospheres** on page 6!

- The temperature sensors (thermocouple, resistance thermometer) must be brought into maximum contact with the medium to be measured.
- The IP rating will no longer apply in the event of damage to the connection head or the threads, gaskets or cable glands on the connection head.
- The connection leads must be firmly connected to the terminals.
- The correct polarity must be ensured in the case of thermocouples.
- In the case of resistance thermometers, take note of whether a two-, three-, or four-wire circuit type is being used.
- When installing temperature sensors in existing thermowells, make sure that the measuring inset can be inserted easily. If this is not the case, the inside of the thermowell will need to be cleaned.
- The temperature sensor must be firmly and securely installed in a way that conforms to the requirements of the application process.
- Please take note of the sensor and circuit type specified.
- After clamping the connection leads using a suited tool (screwdriver, wrench), you must make sure that the connection heads are securely closed and sealed again. When doing this, make sure that the sealing rings of the connection heads are clean and undamaged.

Cable glands

SensyTemp TSC420 temperature sensors are supplied with a M16 x 1.5 cable gland.

Approved cable glands are used as appropriate for temperature sensors with Ex certification. If used correctly, these cable glands can help achieve an IP rating of at least IP 54 for the SensyTemp TSC420.

Alternatively, the temperature sensors are available without a cable gland, but with a M16 x 1.5 thread. In this case, the user must take suited measures to make sure that the required IP rating is achieved.

With this option it is also necessary to ensure that the measures taken satisfy the Ex relevant specifications and standards, and approvals for the relevant temperature sensors (e.g. Ex-certificate PTB 01 ATEX 2200 X for Ex ia type of protection).

In practice, you may find the specified IP rating can no longer be achieved if certain cables and lines are used in conjunction with the cable gland.

Deviations from the test conditions as set out in the IEC 60529 standard must be checked. Check the cables' concentricity, transposition, external hardness, sheath, and surface roughness.

Requirements for achieving the IP rating

- Only use cable glands in the specified clamping area.
- When using very soft cable types, do not use them in the lower clamping area.
- Only use round cables or cables with a slightly oval-shaped cross section.
- Frequent opening / closing of the cable glands is possible but may have a negative effect on the IP rating.
- If cables are demonstrating pronounced cold flow behavior, the cable glands will need to be retightened.
- Cables with VA wire mesh require special cable glands.
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.

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.

Permissible ambient temperature at the closure of the mineral insulated cable

<table>
<thead>
<tr>
<th>Design</th>
<th>Ambient temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>−40 to 120 °C (−40 to 248 °F)</td>
</tr>
<tr>
<td>Optional</td>
<td>−56 to 200 °C (−68.8 to 392 °F)</td>
</tr>
</tbody>
</table>

In type TSC430, the temperature limits of the connection cables used should also be considered. See Connection cable for the resistance thermometer on page 19 and Connection cables for thermocouples on page 21.
... 7 Installation

Process connections for surface thermometers

**NOTICE**

Damage to the temperature sensor by the welding process.
- To avoid damage to the temperature sensor, the permissible maximum operating temperature of the temperature sensor (see data sheet) must not be up-scaled throughout the welding process.

For a Pt100 thin film resistor of accuracy class B, this is for example 400 °C (752 °F).

Apply the weld-on plate in such a way to guarantee good heat conductivity between the temperature sensor and the process.

![Diagram of weld-on plate for resistance thermometer](image)

1. Industrial thermometer
2. Material: Stainless steel 1.4571 (ASTM 316Ti)

Figure 8: Weld-on plate for resistance thermometer, all dimensions in mm (in)

![Diagram of weld-on plate for thermocouples](image)

1. Industrial thermometer
2. Material: NiCr alloy 2.4816 (Inconel 600)

Figure 9: Weld-on plate for thermocouples, all dimensions in mm (in)
Electrical connections

Safety instructions for electrical installation

The electrical connection may only be established by authorized specialist personnel.

Notices on electrical connection in this instruction must be observed; otherwise, electric safety and the IP-rating may be adversely affected.

Safe isolation of electric circuits which are dangerous if touched is only guaranteed when the connected devices fulfill the requirements of EN 61140 (basic requirements for secure separation).

To ensure safe isolation, install supply lines so that they are separate from electrical circuits which are dangerous if touched, or implement additional isolation measures for them.

Plug connector and connection head

<table>
<thead>
<tr>
<th>Lemo plug size 1S</th>
<th>Lemo socket size 1S</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions in mm (in)</strong></td>
<td></td>
</tr>
<tr>
<td><img src="image1" alt="Lemo plug size 1S" /></td>
<td><img src="image2" alt="Lemo socket size 1S" /></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>FFA</td>
<td>PCA</td>
</tr>
<tr>
<td><strong>Chassis</strong></td>
<td></td>
</tr>
<tr>
<td>Nickel-plated brass, gold-plated brass contacts, PEEK isolator, maximum 6 contacts</td>
<td></td>
</tr>
<tr>
<td><strong>IP rating</strong></td>
<td></td>
</tr>
<tr>
<td>IP 54</td>
<td></td>
</tr>
<tr>
<td><strong>Maximum ambient temperature</strong></td>
<td></td>
</tr>
<tr>
<td>200 °C (392 °F)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thermocouple – standard plug</th>
<th>Thermocouple – standard socket</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions in mm (in)</strong></td>
<td></td>
</tr>
<tr>
<td><img src="image3" alt="Thermocouple – standard plug" /></td>
<td><img src="image4" alt="Thermocouple – standard socket" /></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td></td>
</tr>
<tr>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td><strong>Maximum ambient temperature</strong></td>
<td></td>
</tr>
<tr>
<td>200 °C (392 °F)</td>
<td></td>
</tr>
</tbody>
</table>

Form F connecting head

<table>
<thead>
<tr>
<th><strong>Dimensions in mm (in)</strong></th>
<th><strong>Functions of the connection head</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Form F connecting head" /></td>
<td></td>
</tr>
<tr>
<td><strong>Chassis</strong></td>
<td>Housing of a coupler connector</td>
</tr>
<tr>
<td>Aluminum epoxide coating, loose cover, M18 x 1,5</td>
<td>Protection of the terminal compartment against</td>
</tr>
<tr>
<td></td>
<td>environmental influence</td>
</tr>
<tr>
<td><strong>IP rating</strong></td>
<td></td>
</tr>
<tr>
<td>IP 65</td>
<td></td>
</tr>
<tr>
<td><strong>Maximum ambient temperature</strong></td>
<td></td>
</tr>
<tr>
<td>120 °C (248 °F)</td>
<td></td>
</tr>
</tbody>
</table>

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.
... 7 Installation

... Electrical connections

Electrical connections

---

**Electrical connections and color coding of resistance thermometers in accordance with IEC 60751**

**Single sensor**

<table>
<thead>
<tr>
<th>Two-wire circuit</th>
<th>Three-wire circuit</th>
<th>Four-wire circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- **R** Red
- **W** White

---

**Electrical connections and color coding of resistance thermometers in accordance with IEC 60751**

**Double sensor**

<table>
<thead>
<tr>
<th>Two-wire circuit</th>
<th>Three-wire circuit</th>
<th>Four-wire circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="Diagram" /></td>
<td><img src="image5" alt="Diagram" /></td>
<td><img src="image6" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- **R** Red
- **Y** Yellow
- **B** Black
- **W** White

---

**Electrical connections of thermocouples in accordance with IEC 60584**

<table>
<thead>
<tr>
<th>Single sensor</th>
<th>Double sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7" alt="Diagram" /></td>
<td><img src="image8" alt="Diagram" /></td>
</tr>
</tbody>
</table>
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.

Note
The color coding of the wires for the resistance thermometer is in accordance with IEC 60751. See Electrical connections on page 18.

![Connection cable drawings](image)

**Figure 10: PFA cable**

<table>
<thead>
<tr>
<th>Design</th>
<th>Design</th>
<th>Sensor design</th>
</tr>
</thead>
</table>
| PFA cable TFT – coding T2 | **General:** Stranded wire, wire material: solid copper  
Temperature resistance of the insulation: −200 to 200 °C (−328 to 392 °F)  
**Up to 4 wires:**  
Outside diameter: approx. 4.8 mm (0.19 in), conductor cross-section: 0.75 mm²  
**From 6 wires:**  
Outside diameter: approx. 4.5 mm (0.18 in), conductor cross-section: 0.22 mm² | 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 | **General:** Stranded wire, wire material: solid copper  
Temperature resistance of the insulation: −200 to 200 °C (−328 to 392 °F)  
**Up to 4 wires:**  
Outside diameter: approx. 4.0 mm (0.16 in), conductor cross-section: 0.22 mm²  
**From 6 wires:**  
Outside diameter: approx. 5.5 mm (0.22 in), conductor cross-section: 0.22 mm² |
### 7 Installation

#### Electrical connections

![PVC cable JJ – coding P2](image1)

1. PVC wire insulation (J)
2. Film with wire mesh (F)
3. PVC sheath (J)

![PVC cable JFJ – coding P3](image2)

<table>
<thead>
<tr>
<th>Design</th>
<th>Design</th>
<th>Sensor design</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC cable JJ – coding</td>
<td>Outside diameter approx. 5.5 mm (0.22 in)</td>
<td>1 x Pt100 / 2-w. – coding P1</td>
</tr>
<tr>
<td>P2</td>
<td>Conductor cross-section: 0.22 mm², Wire material: copper strand</td>
<td>1 x Pt100 / 3-w. – coding P2</td>
</tr>
<tr>
<td></td>
<td>Temperature resistance of the insulation: −20 to 105 °C (−4 to 221 °F)</td>
<td>1 x Pt100 / 4-w. – coding P3</td>
</tr>
<tr>
<td>PVC cable JFJ – coding</td>
<td>Outside diameter approx. 5.5 mm (0.22 in)</td>
<td>2 x Pt100 / 2-w. – coding P4</td>
</tr>
<tr>
<td>P3</td>
<td>Conductor cross-section: 0.50 mm², Wire material: copper strand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature resistance of the insulation: −10 to 105 °C (14 to 221 °F)</td>
<td></td>
</tr>
</tbody>
</table>
Connection cables for thermocouples

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

<table>
<thead>
<tr>
<th>Type</th>
<th>Class of upper/lower deviation</th>
<th>Application temperature range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 1</td>
<td>Class 2</td>
</tr>
<tr>
<td>JX</td>
<td>± 85 μV (± 1.5 °C (34.7 °F))</td>
<td>–</td>
</tr>
<tr>
<td>EX</td>
<td>± 120 μV (± 1.5 °C (34.7 °F))</td>
<td>–</td>
</tr>
<tr>
<td>NX</td>
<td>± 60 μV (± 1.5 °C (34.7 °F))</td>
<td>–</td>
</tr>
<tr>
<td>KCA</td>
<td>–</td>
<td>± 100 μV (± 2.5 °C (36.5 °F))</td>
</tr>
</tbody>
</table>

Figure 12: PVC and silicone cable

1. PVC wire insulation, overmolded (J)
2. Plastic-laminated aluminum foil shield (F)
3. PVC sheath (J)
4. Silicone rubber wire insulation, overmolded (SL)
5. Silicone rubber sheath (SL)
6. Glass filament mesh (GL)

<table>
<thead>
<tr>
<th>Design</th>
<th>Design</th>
<th>Sensor design</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC cable JFJ – coding P3</td>
<td>General: Stranded wire, conductor cross-section: 0.22 mm², Temperature resistance of the insulation: −10 to 105 °C (14 to 221 °F)</td>
<td>1 x JX – coding J1</td>
</tr>
<tr>
<td>Type JX:</td>
<td>Outside diameter up to 4 wires approx. 5.8 mm (0.23 in)</td>
<td>1 x JX – coding J1</td>
</tr>
<tr>
<td>Type KCA:</td>
<td>Outside diameter up to 4 wires approx. 5.0 mm (0.20 in)</td>
<td>2 x JX – coding J2</td>
</tr>
<tr>
<td>Silicone cable SLSLGL – coding S3</td>
<td>Stranded wire, conductor cross-section: 0.22 mm², Temperature resistance of the insulation: −200 to 200 °C (−328 to 392 °F)</td>
<td>1 x KCA – coding K1</td>
</tr>
<tr>
<td>Outside diameter up to 2 wires approx. 4.7 mm (0.19 in)</td>
<td>2 x KCA – coding K2</td>
<td></td>
</tr>
<tr>
<td>Outside diameter up to 4 wires approx. 5.5 mm (0.22 in)</td>
<td>1 x KCA – coding K1</td>
<td></td>
</tr>
<tr>
<td>2 x KCA – coding K2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 7 Installation

#### Electrical connections

**PFA cable TCUT – coding T2**
- **1.** PFA wire insulation, overmolded (T)
- **2.** Tinned mesh (CU)
- **3.** PFA sheath, overmolded (T)

**PFA cable TGLV – coding T4**
- **4.** Glass filament mesh (GL)
- **5.** Mesh made of stainless steel (V)

![Diagram of PFA cable TCUT](image1)
![Diagram of PFA cable TGLV](image2)

*Figure 13: PFA cable*

<table>
<thead>
<tr>
<th>Design</th>
<th>Design</th>
<th>Sensor design</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFA cable TCUT – coding T2</td>
<td><strong>Stranded wire, conductor cross-section: 0.22 mm²</strong></td>
<td>1 x NX – coding N1</td>
</tr>
<tr>
<td></td>
<td>Temperature resistance of the insulation: −200 to 200 °C (−328 to 392 °F)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside diameter approx. 3.0 mm (0.12 in)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>General:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>With single thermocouple: parallel wire</td>
<td>1 x JX – coding J1</td>
</tr>
<tr>
<td></td>
<td>With double thermocouple: stranded wire</td>
<td>2 x JX – coding J2</td>
</tr>
<tr>
<td></td>
<td>Conductor cross-section: 0.22 mm²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature resistance of the insulation: −200 to 200 °C (−328 to 392 °F)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside diameter with 2 wires (oval conductor): approx. 3.3 mm x 2.0 mm (0.13 x 0.08 in)</td>
<td>1 x NX – coding N1</td>
</tr>
<tr>
<td></td>
<td>Outside diameter up to 4 wires approx. 3.7 mm (0.15 in)</td>
<td>2 x NX – coding N2</td>
</tr>
<tr>
<td></td>
<td><strong>Type JX:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside diameter with 2 wires (oval conductor): approx. 3.3 mm x 2.0 mm (0.13 x 0.08 in)</td>
<td>1 x JX – coding J1</td>
</tr>
<tr>
<td></td>
<td>Outside diameter up to 4 wires approx. 3.7 mm (0.15 in)</td>
<td>2 x JX – coding J2</td>
</tr>
<tr>
<td></td>
<td><strong>Type KCA:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside diameter with 2 wires (oval conductor): approx. 3.3 mm x 2.0 mm (0.13 x 0.08 in)</td>
<td>1 x KCA – coding K1</td>
</tr>
<tr>
<td></td>
<td>Outside diameter up to 4 wires approx. 3.7 mm (0.15 in)</td>
<td>2 x KCA – coding K2</td>
</tr>
<tr>
<td></td>
<td><strong>Type NX:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside diameter up to 4 wires approx. 3.5 mm (0.14 in)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Type EX:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outside diameter up to 4 wires approx. 3.4 mm (0.13 in)</td>
<td></td>
</tr>
</tbody>
</table>
8 Commissioning

Safety instructions for operation
Before switching on the device, make sure that your installation complies with the environmental conditions listed in the chapter “Technical Data” or on the data sheet. If there is a chance that safe operation is no longer possible, take the device out of operation and secure it against unintended startup.

General
In the case of a corresponding order, the device is ready for operation after mounting and installing the connections.

Checks prior to commissioning
The following points must be checked before commissioning the device:
- The proper mounting and sealing of thermowells or protective sleeves. This especially applies when used as a separating element for Zone 0.
- The potential equalization line must be connected.
- The electric specifications must comply with the specified Ex relevant values.
- The electrical connection and mounting must be performed professionally in accordance with Installation and Electrical connections.

9 Maintenance / Repair

⚠️ WARNING
Risk of explosion!
Faulty temperature sensors may not be repaired by the operator.
Any repair may only be performed in the production plant or by workshops authorized by ABB.

The industrial thermometers do not require any maintenance if they are used as intended under normal operating conditions. No on-site repair or replacement of electronic parts by the user is required.

Returning devices
Use the original packaging or a secure transport container of an appropriate type if you need to return the device for repair or recalibration purposes.
Fill out the return form (see Return form on page 25) and include this with the device.
In accordance with the EU Directive governing hazardous materials, the owner of hazardous waste is responsible for its disposal or must observe the following regulations for shipping purposes:
All devices delivered to ABB must be free from any hazardous materials (acids, alkalis, solvents, etc.).

Please contact Customer Center Service acc. to page 5 for nearest service location.
10 Recycling and disposal

Dismounting

**WARNING**

**Risk of injury due to process conditions.**

The process conditions, for example high pressures and temperatures, toxic and aggressive measuring media, can give rise to hazards when dismantling the device.

- If necessary, wear suited personal protective equipment during disassembly.
- Before disassembly, make sure that the process conditions do not pose any safety risks.
- Depressurize and empty the device / piping, allow to cool and purge if necessary.

Bear the following points in mind when dismantling the device:

- Switch off the power supply.
- Disconnect electrical connections.
- Allow the device / piping to cool and depressurize and empty. Collect any escaping medium and dispose of it in accordance with environmental guidelines.
- Use suited tools to disassemble the device, taking the weight of the device into consideration.
- If the device is to be used at another location, the device should preferably be packaged in its original packing so that it cannot be damaged.
- Observe the notices in Returning devices on page 13.

Disposal

**Note**

Products that are marked with the adjacent symbol may not be disposed of as unsorted municipal waste (domestic waste).

They should be disposed of through separate collection of electric and electronic devices.

This product and its packaging are manufactured from materials that can be recycled by specialist recycling companies.

Bear the following points in mind when disposing of them:

- As of 8/15/2018, this product will be under the open scope of the WEEE Directive 2012/19/EU and relevant national laws (for example, ElektroG - Electrical Equipment Act - in Germany).
- The product must be supplied to a specialist recycling company. Do not use municipal waste collection points. These may be used for privately used products only in accordance with WEEE Directive 2012/19/EU.
- If there is no possibility to dispose of the old equipment properly, our Service can take care of its pick-up and disposal for a fee.

11 Specification

**Note**

The device data sheet is available in the ABB download area at www.abb.com/temperature.

12 Declaration of conformity

**Note**

Declarations of conformity of the device are available in the download area of ABB at www.abb.com/temperature. In addition, these are also included with the device in case of ATEX-certified devices.

Trademarks

Inconel is a registered trademark of Special Metals Corporation
# 13 Appendix

## Return form

### Statement on the contamination of devices and components

Repair and/or maintenance work will only be performed on devices and components if a statement form has been completed and submitted. Otherwise, the device/component returned may be rejected. This statement form may only be completed and signed by authorized specialist personnel employed by the operator.

### Customer details:

<table>
<thead>
<tr>
<th>Company:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
<td></td>
</tr>
<tr>
<td>Contact person:</td>
<td>Telephone:</td>
</tr>
<tr>
<td>Fax:</td>
<td>Email:</td>
</tr>
</tbody>
</table>

### Device details:

<table>
<thead>
<tr>
<th>Type:</th>
<th>Serial no.:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reason for the return/description of the defect:</td>
<td></td>
</tr>
</tbody>
</table>

### Was this device used in conjunction with substances which pose a threat or risk to health?

- [ ] Yes  
- [ ] No  

If yes, which type of contamination (please place an X next to the applicable items):

- [ ] biological  
- [ ] corrosive / irritating  
- [ ] combustible (highly / extremely combustible)

- [ ] toxic  
- [ ] explosive  
- [ ] other toxic substances  
- [ ] radioactive

### Which substances have come into contact with the device?

1.  
2.  
3.  

We hereby state that the devices/components shipped have been cleaned and are free from any dangerous or poisonous substances.

| Town/city, date | Signature and company stamp |
Notes
Notes