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 technical specifications (see the “Specifications” chapter in the operating instructions or the data sheet).

- The maximum operating temperature must not be exceeded.
- The permissible ambient temperature must not be exceeded.
- The degree of protection must be observed.

Prior to using the devices with corrosive or abrasive media, the operator must check the level of resistance of all process-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 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.

Service address
Customer service center
Tel: +49 180 5 222 580
Mail: 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
By default, the temperature sensors are marked with the T6 temperature class. 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.

<table>
<thead>
<tr>
<th>Approval / Ex marking</th>
<th>Certificate</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATEX</td>
<td>PTB 01 ATEX 2200 X</td>
</tr>
<tr>
<td>II 1G Ex ia IIC T6 Ga</td>
<td></td>
</tr>
<tr>
<td>II 2G Ex ib IIC T6 Gb</td>
<td></td>
</tr>
<tr>
<td>IECEx</td>
<td>IECEx PTB 11.0111X</td>
</tr>
<tr>
<td>Ex ia IIC T6 Ga</td>
<td></td>
</tr>
<tr>
<td>GOST / EAC</td>
<td>Other Other</td>
</tr>
<tr>
<td>Ex ia</td>
<td></td>
</tr>
</tbody>
</table>

Industrial thermometers that conform to the requirements of both the type examination certificate for ATEX Ex i and Namur-specification NE 24, 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>$U_i$ (input voltage)</th>
<th>$I_i$ (input current)</th>
</tr>
</thead>
<tbody>
<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>

$P_i$ (internal power) = max. 0.5 W

$L_i$ (internal inductance) = 15 $\mu$H/m

$C_i$ (internal capacitance) = 280 pF/m

Note
The internal power $P_i$ corresponds to the output power $P_o$ of the connected transmitter.

Output power $P_o$ with ABB transmitters

<table>
<thead>
<tr>
<th>Transmitter type</th>
<th>$P_o$</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTxx00</td>
<td>$\leq$ 38 mW</td>
</tr>
</tbody>
</table>

The type examination certificates for the corresponding transmitters contain all further information necessary to verify intrinsic safety ($U_o$, $I_o$, $P_{oo}$, $L_o$, $C_o$ 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".
Use in potentially explosive atmospheres

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 $R_{th}$</th>
<th>Diameter of the mineral insulated cable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&lt; 6$ 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 = 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 with regard to the difference between process temperature and 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:

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

$\Delta t$  Temperature rise

$R_{th}$  Thermal resistance

$P_o$  Output power of an additional connected transmitter

Example:

Resistance thermometer diameter approx. 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 5.

$\Delta t = 200$ K/W $\times 0.038$ 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 possible process temperatures $T_{medium}$, as shown in Table **Maximum process temperature $T_{medium}$ in Zone 0** on page 6.

Maximum process temperature $T_{medium}$ in Zone 0

The surface temperature of Category 1 devices must not exceed 80 % of the ignition temperature of a flammable gas or liquid. 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 6.

<table>
<thead>
<tr>
<th>Temperature class</th>
<th>80 % of the ignition temperature</th>
<th>$T_{medium}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 (450 °C (842 °F))</td>
<td>360 °C (680 °F)</td>
<td>352 °C (665.5 °F)</td>
</tr>
<tr>
<td>T2 (300 °C (572 °F))</td>
<td>240 °C (464 °F)</td>
<td>232 °C (449.6 °F)</td>
</tr>
<tr>
<td>T3 (200 °C (392 °F))</td>
<td>160 °C (320 °F)</td>
<td>152 °C (305.6 °F)</td>
</tr>
<tr>
<td>T4 (135 °C (275 °F))</td>
<td>108 °C (226.4 °F)</td>
<td>100 °C (212 °F)</td>
</tr>
<tr>
<td>T5 (100 °C (212 °F))</td>
<td>80 °C (176 °F)</td>
<td>72 °C (161.6 °F)</td>
</tr>
<tr>
<td>T6 (85 °C (185 °F))</td>
<td>68 °C (154.4 °F)</td>
<td>60 °C (140 °F)</td>
</tr>
</tbody>
</table>

Maximum process temperature $T_{medium}$ in Zone 1

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

<table>
<thead>
<tr>
<th>Temperature class</th>
<th>$-5$ K</th>
<th>$-10$ K</th>
<th>$T_{medium}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 (450 °C (842 °F))</td>
<td>440 °C (824 °F)</td>
<td>432 °C (809.6 °F)</td>
<td></td>
</tr>
<tr>
<td>T2 (300 °C (572 °F))</td>
<td>290 °C (554 °F)</td>
<td>282 °C (539.6 °F)</td>
<td></td>
</tr>
<tr>
<td>T3 (200 °C (392 °F))</td>
<td>195 °C (383 °F)</td>
<td>187 °C (368.6 °F)</td>
<td></td>
</tr>
<tr>
<td>T4 (135 °C (275 °F))</td>
<td>130 °C (266 °F)</td>
<td>122 °C (251.6 °F)</td>
<td></td>
</tr>
<tr>
<td>T5 (100 °C (212 °F))</td>
<td>95 °C (203 °F)</td>
<td>87 °C (188.6 °F)</td>
<td></td>
</tr>
<tr>
<td>T6 (85 °C (185 °F))</td>
<td>80 °C (176 °F)</td>
<td>72 °C (161.6 °F)</td>
<td></td>
</tr>
</tbody>
</table>
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 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/EC (ATEX) and IEC60079-14 (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 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 Gb</td>
<td></td>
</tr>
</tbody>
</table>

No additional specific information needs to be observed for mechanical installation.
... 2  Use in potentially explosive atmospheres

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></td>
</tr>
<tr>
<td></td>
<td>$U_i \geq U_o$</td>
</tr>
<tr>
<td></td>
<td>$I_i \geq I_o$</td>
</tr>
<tr>
<td></td>
<td>$P_i \geq P_o$</td>
</tr>
<tr>
<td></td>
<td>$L_i + L_c$ (cable) $\leq L_o$</td>
</tr>
<tr>
<td></td>
<td>$C_i + C_c$ (cable) $\leq C_o$</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.

Figure 1: Intrinsic safety installation check
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 Ga</td>
<td></td>
</tr>
</tbody>
</table>

For the intrinsic safety type of protection, only one sensor element may be connected in Zone 0 with double sensor elements, 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.

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.

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 Gb</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: Interconnection
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.

The typical failure rates of the temperature sensors listed below are taken from the literature. They are distinguished by fault type (break, short-circuit, drift), vibration requirements at the installation location (low stress / high stress) and type of connection between the measuring point and temperature transmitter (close coupled / extension wire).

Typical failure rates

<table>
<thead>
<tr>
<th>Temperature sensor</th>
<th>Fault type</th>
<th>low stress</th>
<th>high stress</th>
<th>low stress</th>
<th>high stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>close coupled</td>
<td>close coupled</td>
<td>extension wire</td>
<td>extension wire</td>
</tr>
<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 thermometer</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></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 resistance thermometer</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></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.

Notices regarding functional safety of the TTx300 and TTx200 temperature transmitters can be found in the SIL safety instructions. The failure rates of the combination of transmitter and temperature sensor are listed there as well.
4 Product identification

Name plate

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

Notice
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.

Figure 4: Name plate TSC420 (example)

5 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.

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.
Include the return form once it has been properly filled out (see appendix in operating instructions) with the device.
According to 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 4 for nearest service location.
6 Installation

General information

Note
When using the device in potentially explosive atmospheres, note the additional temperature data in chapter Use in potentially explosive atmospheres on page 5!

- 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.

![Image: Recommended installation]

Figure 6: 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.

![Image: Installation with small nominal diameter]

Figure 7: Installation with small nominal diameter

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 17 and Connection cables for thermocouples on page 19.
... 6 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](image1)

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](image2)

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>Dimensions in mm (in.)</td>
<td>Dimensions in mm (in.)</td>
</tr>
<tr>
<td>Ø 12 (0.47)</td>
<td>Ø 12 (0.47)</td>
</tr>
<tr>
<td>42,5 (1.67)</td>
<td>40,5 (1.59)</td>
</tr>
<tr>
<td>max. Ø 6,2 max. (Ø 0.24)</td>
<td>max. Ø 6,2 max. (Ø 0.24)</td>
</tr>
<tr>
<td>Type</td>
<td>FFA</td>
</tr>
<tr>
<td>Housing</td>
<td>Nickel-plated brass, gold-plated brass contacts, PEEK isolator, maximum 6 contacts</td>
</tr>
<tr>
<td>IP rating</td>
<td>IP 54</td>
</tr>
<tr>
<td>Maximum ambient temperature</td>
<td>200 °C (392 °F)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thermocouple – standard plug</th>
<th>Thermocouple – standard socket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions in mm (in.)</td>
<td>Dimensions in mm (in.)</td>
</tr>
<tr>
<td>~ 50 (1.97)</td>
<td>~ 35 (1.38)</td>
</tr>
<tr>
<td>max. Ø 6 max. (0.24)</td>
<td>max. Ø 6 max. (0.24)</td>
</tr>
<tr>
<td>Design</td>
<td>Standard</td>
</tr>
<tr>
<td>Material</td>
<td>Plastic</td>
</tr>
<tr>
<td>Maximum ambient temperature</td>
<td>200 °C (392 °F)</td>
</tr>
</tbody>
</table>

Form F connecting head

<table>
<thead>
<tr>
<th>Dimensions in mm (in.)</th>
<th>Functions of the connection head</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ 55 (2.17)</td>
<td>- Mounting of a coupler connector</td>
</tr>
<tr>
<td>M16 x 1,5</td>
<td>- Protection of the terminal compartment against environmental influence</td>
</tr>
<tr>
<td>Housing</td>
<td>Aluminum epoxide coating, loose cover,</td>
</tr>
<tr>
<td>IP rating</td>
<td>IP 65</td>
</tr>
<tr>
<td>Maximum ambient temperature</td>
<td>120 °C (248 °F)</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.
... 6  Installation

... Electrical connections

Electrical connections

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

Single sensor

<table>
<thead>
<tr>
<th>2-W</th>
<th>3-W</th>
<th>4-W</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
<td><img src="image3.png" 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>2-W</th>
<th>3-W</th>
<th>4-W</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4.png" alt="Diagram" /></td>
<td><img src="image5.png" alt="Diagram" /></td>
<td><img src="image6.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

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

Electrical connections of thermocouples in accordance with IEC 60584

Single sensor

![Diagram](image7.png)

Double sensor

![Diagram](image8.png)
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 16.

![Diagram of PFA cable TFT – coding T2 and PFA cable TFTV – coding T3]

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

Figure 10: PFA cable

1. PFA wire insulation (T)
2. Aluminum foil with silver-plated copper strand (F)
3. PFA sheath (T)
4. Mesh made of stainless steel (V)
6 Installation

Electrical connections

Table 11: PVC cable

<table>
<thead>
<tr>
<th>Design</th>
<th>Design Details</th>
<th>Sensor design</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC cable JJ – coding P2</td>
<td>Outside diameter approx. 5.5 mm (0.22 in.)</td>
<td>1 x Pt100 / 2-w. – coding P1</td>
</tr>
<tr>
<td></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 P3</td>
<td>Outside diameter approx. 5.5 mm (0.22 in.)</td>
<td>2 x Pt100 / 2-w. – coding P4</td>
</tr>
<tr>
<td></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. Silicone rubber wire insulation, overmolded (SL)
4. Silicone rubber sheath (SL)
5. Glass filament mesh (GL)
6 Installation

Electrical connections

PFA cable TCUT – coding T2

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

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>Stranded wire, conductor cross-section: 0.22 mm²</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>PFA cable TGLV – coding T4</td>
<td>General:</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>1 x KCA – coding K1</td>
</tr>
<tr>
<td></td>
<td>Temperature resistance of the insulation: ~200 to 200 °C (~328 to 392 °F)</td>
<td>2 x KCA – coding K2</td>
</tr>
<tr>
<td></td>
<td>Type JX:</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>Type KCA:</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 EX – coding E1</td>
</tr>
<tr>
<td></td>
<td>Outside diameter up to 4 wires approx. 3.7 mm (0.15 in.)</td>
<td>2 x EX – coding E2</td>
</tr>
<tr>
<td></td>
<td>Type NX:</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>Type EX:</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>
7 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.

8 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.

9 Additional documents

Note
All documentation, declarations of conformity, and certificates are available in ABB's download area. www.abb.com/temperature

Trademarks

@ Inconel is a registered trademark of Special Metals Corporation
10 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:
Company:
Address:
Contact person: Telephone:
Fax: Email:

Device details:
Type: Serial no.:
Reason for the return/description of the defect:

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