IO.CT.CT X.CT CL.Exi.02

APLISENS

MANUFACTURING OF INDUSTRIAL MEASUREMENT
INSTRUMENTS AND AUTOMATION COMPONENTS

OPERATING MANUAL
(OPERATION AND MAINTENANCE INSTRUCTIONS)

INDUSTRIAL TEMPERATURE SENSORS
IN THE INTRINSICALLY SAFE HAZARD
type: **CT…, CT X…, CT CL**

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Symbols in use

Symbol	Definition
	Warning: Strictly follow the information in the manual to assure full safety and performance of this device.
	Note: Information of particular use for installation and operation of this device.
	Note: Information of particular use for installation and operation of this device in Exi version.
	Instructions on disposal of waste equipment.

BASIC REQUIREMENTS AND SAFE USE

- **The manufacturer shall not be liable for any damage resulting from incorrect installation, improper maintenance, misuse and/or deviations from intended use.**
- This device shall be installed by qualified personnel with authorisation for installation of electrical and pressure measuring equipment. The installers shall complete the installation procedure by following this Manual and all regulations and standards concerning the safety and EMC (electromagnetic compatibility) applicable to this installation type.
- Configure the device as required by its application. Incorrect configuration may result in faulty performance, leading to equipment damage or accidents.
- Pressure transducer installations may result in hazards to personnel from pressurised media if a leak occurs. Consider all applicable safety and protection requirements during installation, operation and inspections of this device.
- If the device malfunctions, disconnect it and return to the manufacturer or their authorised representative for repairs.

In order to minimise the risk of failure and resulting hazards to personnel, avoid installing this device in extremely unfavourable conditions where the following hazards occur:

- risk of mechanical impact, excessive shocks or vibration;
- excessive temperature variations;
- steam condensation, high dust levels or icing.

Installations of Exi versions must be carried out with extreme care and in compliance of relevant standards and regulations.

The manufacturer may modify this product (without reducing its performance of metrological parameters) without updating its relevant operation and maintenance instructions.

CONTENTS

1. Introduction

The subject of this Manual is intrinsically safe temperature sensors type **CT…, CT X…, CT CL**. This Manual includes the technical data, hints and guidelines for installation and operation of temperature sensors, as well as failure response procedures.

2. Intended use

Industrial temperature sensors in combination with suitable instruments enable remote measurement and recording of temperature of liquids, vapours, gases or dust in the range between –196^{o}C and 1100^{o}C.
Electrical thermometer sensors are intended for temperature measurement in industrial installations located in explosion hazard zones where the following is present: explosive mixtures of gases, vapours or mists of all explosion hazard classes, and of flammable dust of all temperature classes in all industrial sectors.
The CT..., CT X…, CT CL Exi temperature sensors can be operated in the explosion hazard zones identified by the intrinsic safety categories presented in Section 6.

3. Identification marks

The Exi sensors must be the name plate which read the following data:

a) the manufacturer's name and logo and the CT…, CT X..., CT CL sensor designation
b) the CE mark and the notified body number
c) the designation of explosion-proof design type and the certificate designation
d) input parameter values: Ui, Ii, Pi, Ci, and Li for resistance sensors or the Exi sensor version.
e) measurement range, output signal type and ambient temperature range Ta
f) year of manufacture
g) serial number
h) as prefix to CT: SPEC/ designation for the special version.

The name plate of a temperature sensor with a temperature transducer integrated in its head must also feature the transducer name after the I Exi or II Exi tag e.g. ATX-2.

The sensors prepared for DYI installation of the transducer in the head features an additional plate located inside of the head, which reads the following in Polish and English "Connect the leads to intrinsically safe transducers only" and the wiring connection diagram.

All other data is presented in the product information sheets for individual sensors.

4. Completion checklist

Apart from the product, the Exi sensor delivery also includes the following:

a) The Product Certificate, which is also the product warranty sheet
b) The Declaration of Conformity (issued on request)
c) A copy of the ATEX Certificate (issued on request)
d) The User's Manual designated "IO.CT.CT X.CT CL Exi.02" (issued on request)

The items (b), (c), and (d) are available at the website: www.aplisens.pl

5. Design

5.1. Nomenclature

– **Temperature sensor**: the complete measurement device comprised of the measuring insert, the shield and the terminal head.

– **Measuring insert**: an interchangeable sensor component comprised of the measuring element, i.e. a thermocouple or a measuring resistor. The measuring inserts are available as single inserts (with a single measuring circuit) or double inserts (with two measuring circuits), whereas the thermoelectric inserts have the measuring junction either isolated from the insert shield or coupled with the shield (depending on the version).

– **Shield**: an outer part of the temperature sensor, which is hermetically connected to the head and in direct physical contact with the measured medium.

– **Terminal head**: the sensor installation part intended to house e.g. a measuring insert with a terminal strip or, in the special version, a temperature transducer which transforms the resistance sensor or thermocouple signal into a standardised form, e.g. 4-20 mA.

The sensor measuring element is a thermometric resistor or a thermocouple. The element responds to the temperature changes of the medium in which the sensor is located. The temperature is measured by measuring the resistance or electromotive force (EMF) with a suitable measuring instrument.

The sensor design (only with the terminal head) enables interchangeable use of a terminal strip with a intrinsically safe measuring transducer, e.g. 4-20 mA; 0-20 mA; or 0-10V, which bears the manufacturer's Declaration of Conformity with the ATEX Directive 94/9/EC and the EC type examination certificate applicable to the relevant explosion hazard.

5.2. Description of design

The basic component of the sensor is a resistance or thermoelectric measuring insert housed in the outer shell. The insert terminals are housed inside of a head made of an aluminium alloy or of SS316 stainless steel. This sensor group outer shields feature various processing connections (threaded, slide clamps, flanges, etc.). The insert interior houses a thermoelectric resistor or a thermocouple which is connected to the outer terminals of the terminal strip or of a 4-20 mA transducer.

The industrial unit of the CT..., CT X…, CT CL sensors features: a head or a grip, the shield with the processing connection, the measuring insert with the measuring elements and the terminal strip. The CT... temperature sensor with the head-mounted temperature transducer does not have a terminal strip, which is replaced by the said head-mounted temperature transducer, e.g. ATX-2, GIX22-2, or other. The transducer transforms the measuring sensor output into a unified output signal (4-20 mA). Table 4 shows a list of data for the transducer examples.

5.3. Sensor types

Table 1

Head-mounted temperature sensors for Group I *(labelling: IM1 Ex ia I Ma)*
CT...I6; I8; 8; 9; 11; GB 1; GN 1; G 1; T 1; SW; P1; U; UC; F; X; CL; Y
Head-mounted temperature sensors for Group II *(labelling: II 1/2G Ex ia IIC T6* Ga/Gb, II 1D Ex ia IIIC T75* Da)*
CT ... I4; I5; I6; I8; 8; 9; 11; GB 1, GB 2; GN 1, GN 2; G 1; T 1; SW; P1; U; UC; F; X; CL; Y; CT Z1
Wired temperature sensors for Group I and II *(labelling: IMI Ex ia I Ma, II ½ G Ex ia IIC T6* Ga/Gb, II 1D Ex ia IIICT75*Da)*
CT… L; GE1; E1; E2; E3; E4; E5; E6; E6/K; E7; E7/K; E8; E9; E10; 1068 + OG; R5; R6; S1; S2; S3; X

See the product information sheets for reference drawings of the sensors.

6. Intrinsic safety requirements and special requirements for use in explosion hazard zones

6.1. The sensors are manufactures in accordance with the following standards:

EN 60079-0:2012+A11:2013, EN 60079-11:2012, EN 50303:2000, and EN 60079-26:2007.

6.2. The sensors can be operated in the explosion hazard zones depending on the sensor version, i.e. in accordance with the issued explosion-proof design identification (marking):

I M1 Ex ia I Ma

or

II 1/2G Ex ia IIC T6..T1 Ga/Gb

II 1D Ex ia IIIC T75°C Da

KDB 06 ATEX 260X

T6-T1 is the sensor temperature class (for gases) or T75-the maximum surface temperature (for dusts) established in Sections 6.10.2 and 6.10.3, and in Notes 1 and 2.

The maximum surface temperature and / or sensor temperature class must be determined at the point of installation in accordance with the instructions. This temperature must not exceed:
- 450 ° C for I explosion group in case if the shield is not possible to collect pulverized coal or 150 ° C in the contrary case,
- head operation temperature and installed in the transmitter,
-self-ignition temperature of the surrounding explosive gas mixture device,
- 2/3 of the auto-ignition temperature of the cloud of dust, temperature sensor surface under a layer of dust must be below the ignition temperature of dust in accordance with EN 60079-14.

6.3. Sensor category and hazard zones category.

Sensor category 1/2G means that the sensor can be installed at border of hazard zones 0 and 1. The sensor's shields works in zone 0, and measuring part in zone 1.

6.4. The general instructions for connecting and operating the Exi sensors are shown in Section 8. The connections of the CT…, CT X…, and CT CL sensors shall conform to the rules and standards for intrinsically safe devices, and with the following standards:

EN 60079-14, Electrical apparatus for explosive gas atmospheres. Part 14: Electrical installations in hazardous areas (other than mining facilities). EN 60079-17, Electrical apparatus for explosive gas atmospheres. Part 17: Electrical installations inspection and maintenance.
The requirements for electrical installations in explosive gas atmospheres (i.e. hazardous areas) are defined in EN 60079-14
The electrical installations in explosive gas atmospheres shall first and foremost meet the requirements established in the Polish Regulation of the Ministry of Infrastructure of 12 April 2002 and 7 April 2004 concerning the technical requirements for buildings and locations thereof (Polish Journal of Laws issue 75/2002 item 690 and PJoL issue 109/2004 item 1156).
Place the wired sensor terminals in a terminal box providing a degree of protection at least. IP54 acc. to PN-EN 60529

6.5. Due to the construction material of the sensor head (light metal alloy with a high aluminium content), the user must assure that there is no risk of mechanical impact on the head at the installation site, which may result in the head failure. Use acid-resistant heads in locations exposed to mechanical impact.

6.6. The wiring connection method for the sensors is shown in Section 8.2

6.7. The wiring connection method for the head-mounted transducers is shown in Section 8.2

6.8. The sensors can be equipped with the ATX-2 or GIX-22-2 head-mounted temperature transducer, or other suitable working conditions intrinsically safe temperature transmitter.

The ATX-2 and GIX-22-2 head-mounted temperature transducers have the ATEX Certificate no. **ZELM 11**

ATEX 0452X. The explosion-proof safety has been assured by the intrinsically safe design of the transducers. The head-mounted temperature transducers bear the following identification:

II 1 G Ex ia IIC T6

T4≤75°C, T5≤70°C, T6≤55°C**.**

The permissible input and output parameters are listed in Section 6.9.

Note 1:

The intrinsically safe sensors meet the relevant safety requirements only when mated with intrinsically safe circuits of measurement instruments. The measuring circuits shall meet the requirements stated in the enclosed certificates. The sensors have the safety degree "ia" only when mated with intrinsically safe circuits with the safety degree "ia". If mated with the circuits with the safety degree "ib", the sensor's safety degree is also reduced to "ib".

6.9. Intrinsic safety parameters

Table 2

<table>
<tr><td>Single thermocouples:
Terminals: 1 – 2;
Double thermocouples:
Terminals: 1 – 2, 3 – 4;</td><td rowspan="2">Type sensors:

CT..., CT CL...: Ui=30V , Ii=101mA , Pi=750mW , Ci~0 , Li~0,

CT X...: Ui=30V, Ii=101mA , Pi=750mW,
Ci=280pF/m, Li=15µH/m
In the case of the sensors with 2 or more measuring elements, treat the sensor circuits as galvanically coupled in the object oriented analysis.</td></tr>
<tr><td>Two-wire single thermoresistors:
Terminals: 1 – 2;
Two-wire double thermoresistors:
Terminals: 1 – 2, 3 – 4;
Three-wire single thermoresistors:
Terminals: 1 – 2 – 3;
Three-wire double thermoresistors:
Terminals 1 – 2 – 3 and 4 – 5 – 6;
Four-wire single thermoresistors:
Terminals: 1 – 2 – 3 – 4;</td></tr>
<tr><td colspan="2">Head-mounted temperature transducer, type ATX-2 and GIX-22-2</td></tr>
<tr><td>Power terminals: 1(+), 2(-):</td><td>Ui=30V, Ii=100mA, Pi=750mW, Li~0, Ci~0.</td></tr>
<tr><td>Input terminals: 3+4+5+6:</td><td>Uo=9.6V, Io=4.5mA, Po=11mW, Lo=4.5mH, Co=709nF for IIC</td></tr>
<tr><td colspan="2">In the case of transducers other than type ATX-2 or GIX-22-2, see the limit parameters of Ui, Pi, Uo, Io, Po, Co, and Lo in the manual of the transducer.</td></tr>
</table>

6.10. Measurement of the sensor operating temperature Tp

6.10.1. The installation designer and user must assure that following the installation on-site the hottest of all sensor parts must not exceed the temperature class and the maximum surface temperature of flammable dust.

6.10.2. In the place of installation measure the temperature Tpp of the hottest spot on the connection surface, which can be in contact with the explosive gas atmosphere, and measure the head temperature Tpg. Determine Tpp and Tpg for the maximum temperatures of the medium and of the environment.
If the sensor has a transducer, add the head temperature Tpg to ΔTe=20K as the effect of additional heating with the electrical supply power in the failure state.
The higher value of Tpp and Tpg for the sensor without the transducer, or Tpp and (Tpg+20K) for the sensor with a transducer is the operating temperature Tp.

6.10.3. The transducer temperature class value T* for gases and the maximum surface temperature T* for flammable dust is derived as instructed in Notes 1 and 2 from Tp determined in Section 6.10.2.
1. Determine the sensor temperature class value T* for gases from the following relation:
T*≥Tp+5K for class T5..T6
T*≥Tp+10K for class T1..T4
2. The maximum sensor surface temperature T* in contact with the dust cloud must not exceed 2/3 of the minimum dust cloud ignition temperature T_{CL}.
T*≥Tp T*=2/3T_{CL}
3. The maximum sensor surface temperature T* for a dust layer 5 mm: T*≥Tp where T*≥=T_{5mm}-75K, T_{5mm} is the minimum ignition temperature of a 5 mm thick dust layer.
4. The maximum sensor surface temperature with deposition of coal dust shall not exceed 150ºC

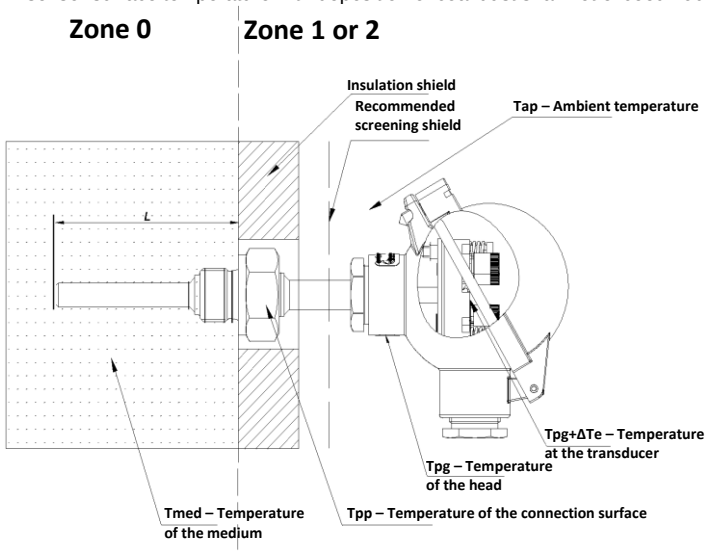


Fig. 1. Determination of the sensor surface temperature Tp (operating temperature) depending on the medium temperature and ambient temperature

6.10.4 The Shield temperature of measuring part of the sensor depending on the power provided by
Tob=Tp+Rthj·Pi
Tob – shield temperature

Tp- operating temperature of sensor
Rthj - The thermal resistance of the shield
Pi - the power input to sensor

Values of thermal resistance Rthj for different types of shields:

Sheathed insert ф 3 with a thin film resistor- 110 K/W
Sheathed insert ф 4,5 with a thin film resistor- 75 K/W
Sheathed insert ф 6 with a thin film resistor- 60 K/W
Shield ф6x1 with sheathed insert - 50 K/W
Shield ф8x1 with sheathed insert - 35 K/W
Shield ф9x1 with sheathed insert – 30 K/W
Shield ф10x1.5 with sheathed insert - 25 K/W

Note 2:

If the medium is heated above the ambient temperature, it is allowed to define the sensor temperature class or the maximum surface temperature class with Tp being the maximum medium temperature allowed in the given process. Hence it is not necessary to measure Tp.

Note 3:

When measuring the temperature of non-explosive media, the medium temperature can exceed the temperature class or the maximum surface temperature class of a given explosive mixture, provided that the medium heat will not heat any of the sensor surfaces installed in the gas or liquid vapour explosion hazard zone (where the surface is in contact with the explosive mixture) above the permissible value of Tp (see Section 6.10.2).

The installation designer is required to select the sensor type and mounting style that will keep the hottest sensor part temperatures below the given substance (gas/mist/vapour) temperature class in extreme operating conditions.

6.11. Special requirements for application

6.11.1. Determine the surface temperatures, the temperature classes and the operating temperature Tp as instructed in Sections 6.10.2 and 6.10.3.

6.11.2. Determine the maximum surface temperature at the device installation site. Consider the temperature of the measured medium, the ambient temperature and the power dissipated by the head-mounted transducer, if any.

6.11.3. The head temperature **Tpg** must not exceed the following values:

-40 to 75ºC for the head-mounted temperature transducer version;
-40 to 100ºC for the version without a head-mounted temperature transducer;
-50 to 150ºC for the special version without a head-mounted temperature transducer and with the silicon seal under the head cover.

6.11.4. The sensors with the measuring element galvanically coupled with the enclosure shall be feature an intrinsically safe power supply line with galvanic separation of the earth (ground).

6.11.5. The housing of the sensor designated CT Z1 ..., / intended for the explosion hazard Group II shall be the warning plate which reads: "Do not rub with dry cloth!".

(Rubbing with a dry cloth may cause a dangerous build-up of static electric charge!)

6.11.6. In the case of the sensors with the light metal alloy or plastic head (CT Z1… sensors), the user must assure that there is no risk of mechanical impact which may result in damage of the head. Use acid-resistant heads in locations exposed to mechanical impact.

6.11.7 The sensor designed for use in explosive atmospheres marked by category I M1 Ex ia I Ma have housing and heads made of stainless steel. In addition, the sensors have a cable wire in the armor with stainless steel.

7. Technical data

Common

Thermometric characteristics of the thermoelectric sensor	acc. to EN 60584-1:1995(IDT)
Thermocouples	acc. to EN 61515:1996(IDT)
Thermometric characteristics of the resistance sensor	acc. to EN 60751:2008 (IDT)
No. of measuring elements	1 or 2
Immersion depth	3000 mm maximum**
Degree of head integrity	IP65 acc. to EN 60529:1991(IDT) EN 60529:1991/A1:2000(IDT)
Equipment group EN 60079-0:2012	I or II
Explosion-proof device category EN 60079-0:2013	M1 or M2
Explosion-proof design type EN 60079-11:2012	ia
Explosive atmosphere type	
gas atmospheres	G EN 60079-0:2012+A11:2013 and EN 60079-11:2012
dust atmospheres	D EN 60079-0:2012+A11:2013 and EN 60079-11:2012
Dust atmosphere zone	20
Properties of vapours and gases, group II EN 60079-0:2012	II A; II B or II C
Temperature class EN 60079-0:2012	T6..T1 or T*
EPL EN 60079-26:2007	Ga; Gb; Da, Db

** The sensor temperature class depends on the measured medium temperature: in order to evaluate the heating of sensor elements, consider the installation conditions and the effect of heating / cooling by the measured medium.*
*** For sensors CTX maximum usable length is limited acceptable parameters Lo and Co of the measuring circuit, set designs:*
Co≥ capacity /m x cable length + compensation cable capacity;
Lo≥ inductance /m x cable length + compensation cable inductance
- capacity: 280 pF / m
- inductance: 15 µH / m
These parameters must be taken into account by using long wires shell, so that the resultant inductance and capacitance value does not exceed the limit values.
Standard length of compensating cable of the CT X TK sensor up to Lp=3 m

Application range	acc. to the product information sheets

Shield material acc. to the product information sheets

Operating conditions
see Sections 6.9 and 6.10.

Degree of enclosure protection

EN 60529; IP 66, 67

Materials

Head High-pressure cast of aluminium alloy or SS316 acid-resistant steel
Table 3 List of head examples

Aluminium heads

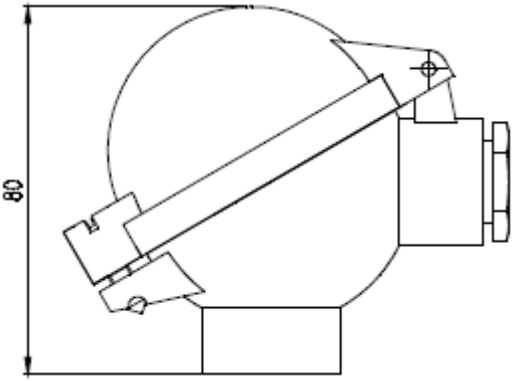


Fig. 2 NA head

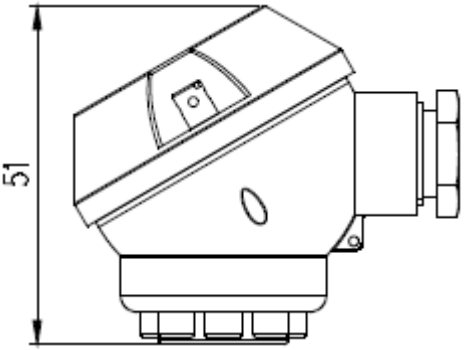


Fig. 3 MA head

Acid-resistant steel head

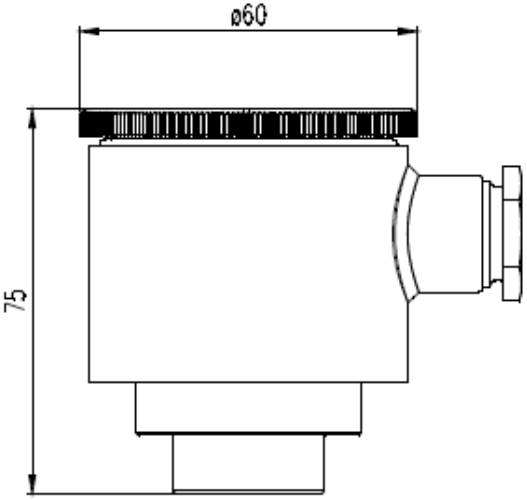


Fig. 4 KO head

Shields: materials, diameters and installation length (see Fig. 6)

Table 4 List of shield examples

Shield type	Shield			Shield material	Connection type
	D [mm]	Lo [mm]	l [mm]		
OG2.11	10, 11, 12, 15 or other	per order		15HM, 10H2M, 316Lss or other	G1/2, G3/4, G1 1/2" NPT, 3/4" NPT M18x1.5, M20x1.5 M24x1.5, M27x2 or other
SW2	24h7	140, 200 or other	65	15HM, 10H2M, 316Lss or other	-
SW2T	24h7	100, 160, or other	65	15HM, 10H2M, 316Lss or other	-
T1	10, 11, 12, 15 or other	per order		15HM, 10H2M, 316Lss or other	Flanged: PN, DIN, ANSI G3/4" connection or other

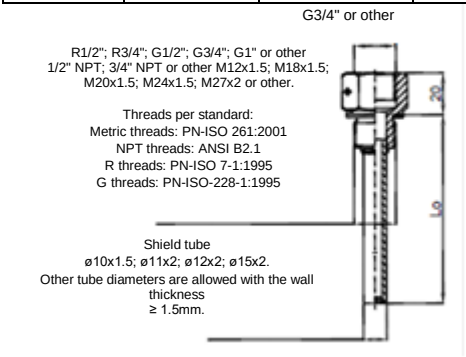


Fig. 6a. OG2.11 shield

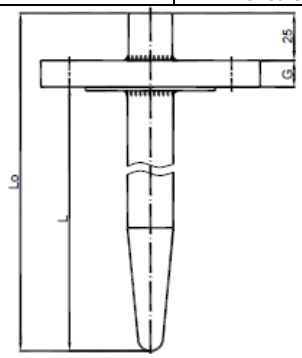


Fig. 6b. SW2T shield

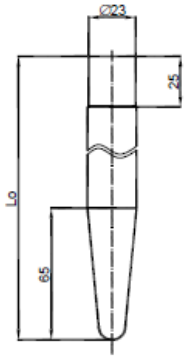


Fig. 6c. SW2 shield

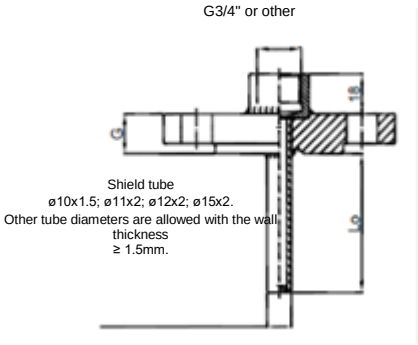


Fig. 6d. T1 shield

Fig. 6 List of shield examples See the product information sheets for more shield types.

7.1. Intrinsically safe head-mounted temperature transducers

Table 5

	Transducer type					
Parameter	ATX-2			GIX22-2		
Output signal	4-20 mA			4-20 mA		
Supply voltage	8…30 V DC			8…30 V DC		
Load resistance	Ro[kΩ]≤(Uz-8V)/22 mA			Ro[kΩ]≤(Uz-8V)/22 mA		
Explosion-proof design type	Intrinsically safe			Intrinsically safe		
Sensor break or shorting	≥21 mA or ≤3.5 mA opto-electronic adjustable			≥21 mA or ≤3.5 mA opto-electronic adjustable		
Minimum measurement range length	10°C			10°C for Pt, Ni 50°C for J, L, U, T, E, K, N 500°C for S, R, B		
Intrinsic error	Pt100: Pt100: Pt500: Pt500: Pt1000: Pt1000: Ni100:	-100 to 200°C -200 to 850°C -100 to 200°C -200 to 250°C -100 to 200°C -100 to 250°C -60 to 250°C	±0.2°C ±0.4°C ±0.2°C ±0.4°C ±0.2°C ±0.4°C ±0.2°C	±0.5°C ±0.5°C ±0.5°C ±0.5°C ±1°C ±2°C ±2°C ±2°C	Over Over Over Over Over Over Over Over	-200°C -150°C -140°C -100°C +20°C +50°C +400°C
Temperature change error	±0.05%/10°C			±0.05%/10°C		
Supply voltage change error	±0.01%/V			±0.01%/V		
Ambient temperature	-40...75°C			-40...75°C		
Permissible input parameters (terminals 1, 2)	Ui=30V, Ii=100mA, Pi=750mW, Ci~0, Li~0					
Permissible output parameters (terminals 3, 4, 5, 6)	mW, Co=709nF, Lo=4.5mH for IIC, Co=1300nF, Lo=8.5mH for IIB					
Transducers from other manufacturers: see the relevant operating manual for the permissible parameters.						

8. Installation

8.1. Mechanical installation of sensors

Install the sensor in the orientation required by the measurement site, the sensor outer shield type, the measured medium, etc. Install the sensor by following the installation examples shown in Figures 1 to 3 and the following general guidelines and notes.

1. Install the sensor in a relatively accessible location that permits easy maintenance and replacement of the measuring insert
2. Install the sensors with large installation length, especially for high temperature measurements, in the vertical orientation or as vertically as possible. If horizontal installation is required, use supports for the shield, which will protect the shield from bending under its own weight.
3. Install the sensor in the pipeline so that the heat-sensitive part of the sensor, i.e. its hot junction (thermometric resistor) is aligned with the pipeline centre line.
4. Do the following to eliminate or minimise the measurement error from changes in the thermal field distribution causes by the sensor within the measured medium:
   - whenever possible, use sensors with larger installation lengths to obtain a good ratio of the immersed shield length to the external shield length (e.g. install the sensor at an oblique angle, or in an elbow for the best result);
   - install thermal insulation on the sensor parts outside of the measurement area (note, however, that the temperature of the head which houses the transducer must not exceed the permissible limits);
   - when measuring the temperatures in pipelines with low flow rates (especially gas pipelines), reduce the pipeline inner diameter at the sensor location (to increase the flow rate).
5. If the external part of the sensor is directly exposed to heat radiation which may increase the head temperature over the limit, use protective screens.

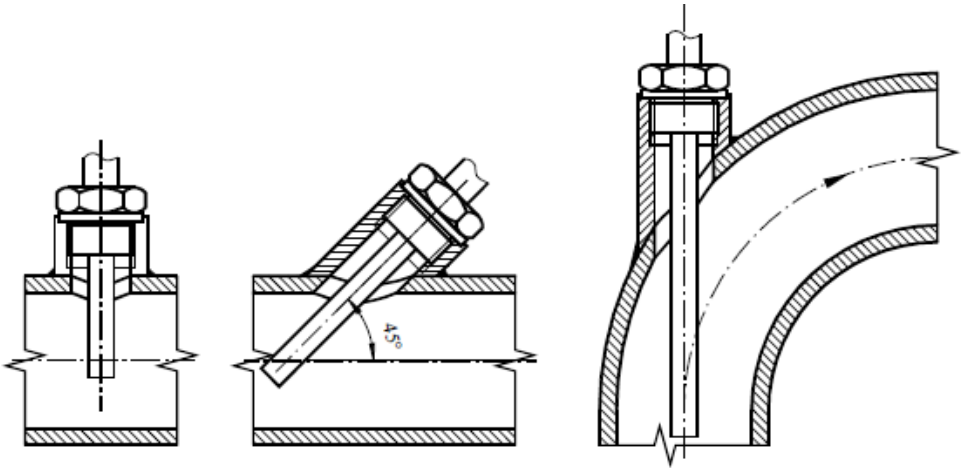


Fig. 7. Installation examples of the sensors with the G, GN and GB shields

When installing the sensor in high pressure systems, the installation must be extremely careful and adopt suitable precautions for corrosive, explosive and all other media of hazard to the personnel. The SW1 and SW2 pressure shields can only be welded by suitably licensed personnel.

Table 6 Tightening torques of the sensor shields and cleats with threaded connection with the installation

Thread type	Maximum tightening torque [Nm]
M20x1.5; G1/2"; 1/2 NPT	115
M24×1.5	200
M27×2; G¾; ¾ NPT	275
M33×2; G1; 1 NPT	506

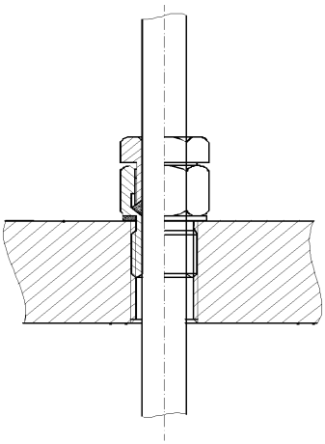


Fig. 8. Example of an installation of a sensor with the I guard and a straight connection

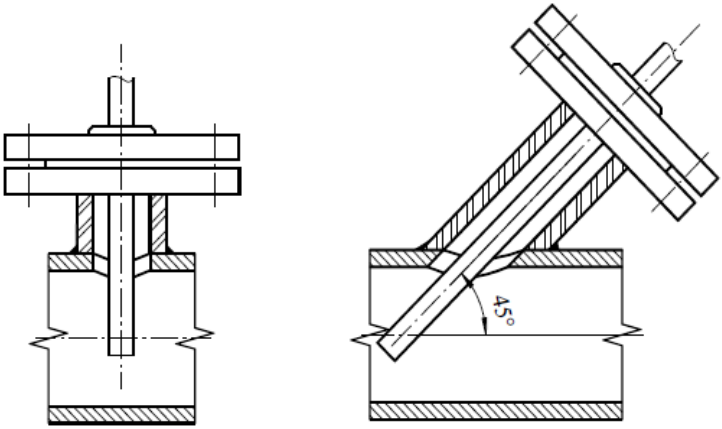


Fig. 9. Examples of installation of sensors with the T guard.

Straight threads shall be sealed with a flanged gasket.
Taper threads shall be sealed with a Teflon tape or a special sealant (e.g. Loctite brand).
Flanged connection with a gasket.

8.2. Electrical wiring installation of sensors in explosion hazard zones

8.2.1 Attempt to make the electrical connections and operate the sensor only once you have read and understood this Manual. Connect the sensor wiring in accordance with the connection diagram in Fig. 8. The sensors in explosion hazard zones can only be wired by personnel with the necessary expertise and experience.

8.2.2. The sensors with the head-mounted temperature transducers shall be powered at the voltage in Table 5 (24 V DC nominal) supplied from intrinsically safe power supply units. The user remains solely responsible for providing power supply in accordance with these requirements.

8.2.3 The wiring can be routed as buried directly in the ground or in cable ducts. The wiring and cables can be routed in steel protective tubes on structures and building walls, except for routing on relief surfaces, fire partitions and flame-proof protections, e.g. flame screens. This also applies to other types of installations, e.g. remote engineering wiring, signal transmission lines, lighting arrestor systems, etc.
The cables and wiring can be continuously routed in explosive gas atmospheres, except for zone 0 and zone 20. The cables and wiring routed through
explosion hazard zones shall be protected against ingress into the zones in the same way as the cable cores and wires used in the zones.
The penetrations of cables and wires through walls and floors shall be protected against mechanical damage and sealed with flame-retardant compounds of extremely good thermal insulating properties.
There are commercially available sealing materials which are organic solvent free, flame-arresting and halogen-free, as well as prefabricated penetration units and ready-to-use penetrations, e.g.:
- mineral wool cable penetrations;
- flame-proof foam cable penetrations;
- flame-proof mortar;
- flexible penetration fittings;
- penetrations for single wires and wiring bundles with racks and seals made of mineral wool panels.

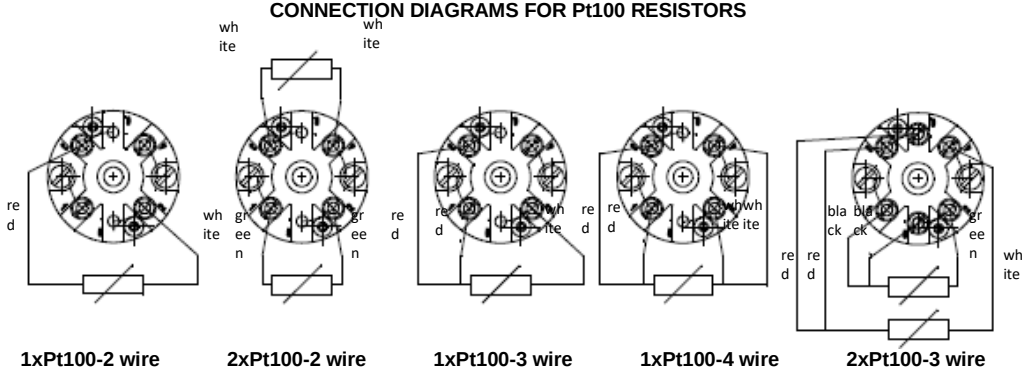
8.2.4 Route signal transmission lines with twisted pairs. Protect the wiring and cables (especially of intrinsically safe types) from electromagnetic fields and electrostatic effects, direct lightning strike, mechanical damage and all other hazards which may result in damage and/or initiate an explosion or fire.

8.2.5 When making electrical connections, note that the cable type and size must match the cable gland size. Use shielded or unshielded cables without armour, with a composite structure and circular cross-section, in elastomeric braids (e.g. plasticised granulated PVC) and which do not absorb water (see Table 7).
The head-mounted sensors with the NA, B, DA, DAW and KO heads feature standard M20x1.5 cable glands. The MA heads feature the M16x1.5 cable glands which ensure IP 65. The glands allow tight and secure fastening of connection leads in the diameter size range from 4 to 12.5 mm (MA: from 3 to 6 mm). The heads can be supplied with IP 68 glands on custom order, rated at the maximum pressure of 5 or 10 bar and cable sizes from 5 to 14 mm (MA: from 3 to 6 mm). All sensor parts are factory tightened to the torque values which guarantee the declared
degree of protection. When installing the sensor on site, once the sensor has been connected to the intrinsically safe system, do the following:

- standard glands: use a wrench (24 mm or other matching size) to tighten the gland nut so that the gland seal tightly holds the cable. Pull the cable by hand to check that the cable is tightly held by the gland. If the gland hold is too weak retighten the nut. Tightening torque: 6 Nm. Tighten the cover screw with a screwdriver by hand (maximum tightening torque: 2.2 Nm).

CAUTION! Proper tightening torque of the cable gland nut and the cover screw is especially important for sensors intended for operation in explosive dust atmospheres.
The integrity of an IP6X enclosure is the essential explosion-proof measure.

CONNECTION DIAGRAMS FOR Pt100 RESISTORS



1xPt100-2 wire **2xPt100-2 wire** **1xPt100-3 wire** **1xPt100-4 wire** **2xPt100-3 wire**

Fig. 10 Sensor electrical connection diagrams

Route and fasten the cable without any mechanical stress. Tighten the cable gland and the enclosure cover. Form the signal wire run directly upstream of the gland in a drip loop with its lowest point below the wire entry to the gland to prevent running of condensate towards the gland.

Place the wired sensor terminals in a terminal box rated at IP54.

8.3. Wiring

Follow these rules as a minimum when building the electrical installation:

- make wire connections and branches only inside of explosion-proof device enclosures (i.e. terminal boxes) and inside of explosion-proof electrical fittings;
- the wiring and cables must have outer coatings made of flame-arresting and halogen-free materials (see Table 7);
- explosion-proof devices, wires and fittings shall be selected and protected to prevent overheating during operation;
- the installations shall be protected from: overvoltage, shorting, overloading and electrocution hazards.

Table 7. Selected insulating and coating materials

Acronym	Chemical designation	Operating temperature, °C	Flammability	Oxygen ratio, % O2	Calorific value MJ/kg	Halogen content
PVC	Plasticised polyvinyl chloride	-30 to 70	sg	23 - 42	17 - 25	yes
PVC	Heat-resistant polyvinyl chloride	-25 to 105	sg	24 - 42	16 - 20	yes
PE	Insulating polyethylene	-50 to 100	flammable	N/A	N/A	no
VPE	Virgin polyethylene	N/A		22	42 - 44	no
LDPE	Low-density polyethylene	-50 to 70	flammable	22	42 - 44	no
PUR	Polyurethane	-40 to 100	sg	20 - 26	20 - 26	yes
PI, PA	Polyamide	-40 to 110	flammable	22	27 - 31	yes
PFA	Perfluoroalkoxy	-190 to 260	sg	> 95	5	yes
PP	Polypropylene	-50 to 110	flammable	22	42 - 44	no
PTFE	Teflon	-190 to 260	sg	> 95	5	yes
PEEK	Polyether ether ketone	N/A	N/A	N/A	N/A	N/A
ETFE	Ethylene tetrafluoroethylene	-100 to 150	sg	30 - 35	14	yes
FEP	Fluorinated ethylene propylene	-100 to 200	sg	> 95	5	yes
TPE-O	Thermoplastic polyester elastomere	-40 to 120	flammable	< 29	20 - 25	no
TPE-P	Thermoplastic polyester elastomere	-70 to 125	flammable	< 25	23 - 28	no
TPE-S	Thermoplastic polyester elastomere	-75 to 140	flammable	N/A	N/A	N/A
FRHF	Polyolefin plastic	-30 to 90	sg	N/A	N/A	no
FRNC	Non-corrosive fire-resistatnt rubber composite	N/A	N/A	N/A	N/A	N/A
SI	Silicone rubber	-6 to 180	flame-retardant	25 - 35	17 - 19	no
EWA	Ethylene vinyl acetate	-30 to 125	flammable	22	19 - 23	no
FEP	Fluorinated ethylene propylene	-100 to 205	sg	> 95	5	no
	sg - self-extinguishing					
	N/A - no data available					

8.4. Installation of intrinsically safe transducers

The head-mounted sensors (e.g. MA, NA, B, DA, DAW, KO) can have the terminal strip replaced with an intrinsically safe transducer with the output signal e.g. 4-20 mA, which has the Declaration of Conformity with the Directive ATEX 94/9/EC.

See Section 6 for designation of explosion-proof design and intrinsic safety parameters.

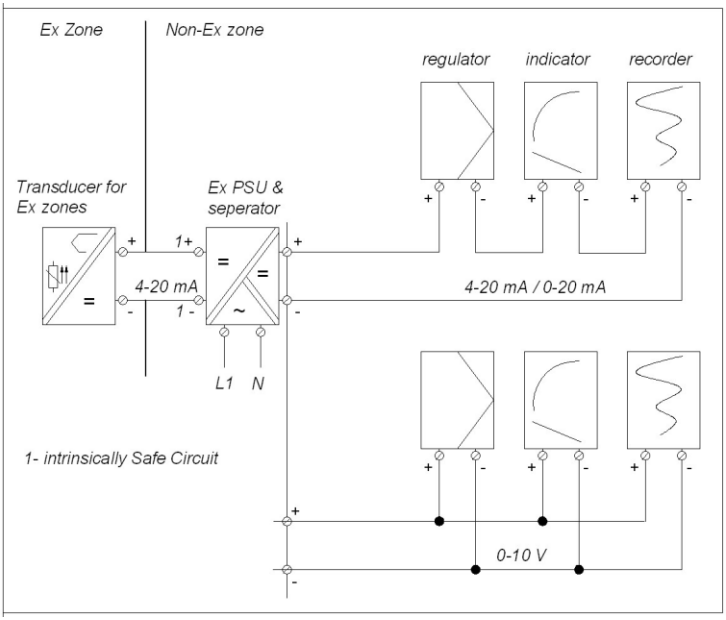


Fig. 11 Wiring connection diagram for the ATX2, GIX-22-2 and other intrinsically safe transducers

The measuring transducers housed in the sensor heads are two-wire systems where the power line is the measuring line with the standard signal of

4-20 mA.

The line which connects the sensor to the mated instruments (e.g. meter, regulator, etc.) and to the PSU shall be made of copper wires with the cross-section between 0.5 and 1.5 mm^2, according to the diagrams in Fig. 11 and Fig. 12 herein, and in accordance with the low-voltage electrical installation regulations and any guidelines in the manuals for the mated instruments.

The PSU can supply power to one or more sensors. The common source can supply power to various types of sensors (both resistance and thermoelectric), see Fig. 12, if the intrinsic safety requirements are met.

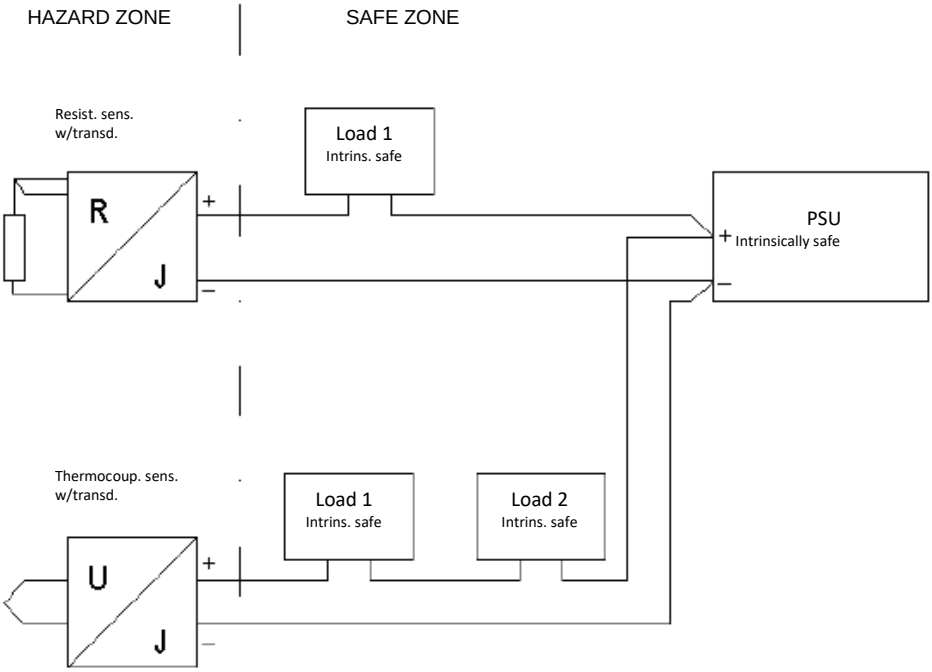


Fig. 12 Example of two sensors connected to a common PSU

Caution!
The customer may install an intrinsically safe transducer directly in the intrinsically safe sensor head if the following requirements are met:

- **the transducer power supply shall be intrinsically safe;**
- **the ambient and operating temperatures shall meet the designation and the certificate for the transducer types T4/T5/T6;**
- **the supplied sensor features a measuring insert without the terminal strip and the lead outs prepared for installing the transducer;**
- **the transducer installed by the customer shall be intrinsically safe.**

THE CUSTOMER / USER SHALL BE SOLELY RESPONSIBLE FOR THE CONNECTION.

9. Warranty

The manufacturer grants commercial warranty for the sensor provided that its operation shall meet the requirements defined in the product information sheets and this Manual.

The warranty terms and conditions are specified in the relevant warranty sheets and available at: www.aplisens.pl.

10. Storage and transport

Keep the sensors in sheltered rooms with the temperature and humidity within the permissible limits specified in Section 6.1.13.

Transport the product in closed vehicles. The maximum acceleration of transport containers shall be 20m/s^2. Do not toss or throw the containers with the sensors inside.