IM-Exi-GL01
(2009-12-01)

INSTRUCTION

MANUAL

Temperature head sensors for Hazardous Areas

II 1/2 G D **II 2 G D** **II 3 G D**

I M1

Intrinsically safe :

Ex ia

1. NOTES OF SAFETY

Intrinsically safe temperature sensors are designed to use in hazardous location both gas and dust atmospheres. If used incorrectly it is possible that application – related danger may arise.

Intrinsically safe sensors may be installed, connected, commissioned, operated and maintained by qualified and authorized person only, under strict observance of these application manual, any relevant standards, legal requirements, and where appropriate, the certificate.

2. APPLICATION

Temperature sensors are designed for temperature measurement in the industrial installations for measurement, signalization, monitoring, remote controlling in a range of industry branches, where hazardous areas of gas and dust occours.

Hazardous areas		Category to ATEX
Explosion atmosphere of gases, vaporous, mists	Zone 0	1G
	Zone 1	1G, 2G
	Zone 2	1G, 2G, 3G
Dust explosion atmosphere	Zone 20	1D
	Zone 21	1D, 2D
	Zone 22	1D, 2D, 3D

- **Destination to the ATEX Directive – non mining industry**

- non mining industry
- category of apparatus
- for gas hazardous areas
- for dust hazardous areas

Kind of explosion protection for gases, vaporous and mist: **Ex ia IIC T1**

- electrical devices explosion protected to EC standard
- type of explosion protection: intrinsically safe
- gas group
- temperature class

Kind of explosion protection for dusts: **Ex iaD 20/21 IP65 T100°C**

- electrical devices explosion protected to EC standard
- type of explosion protection: intrinsically safe
- zone
- protection degree (protection by enclosure)
- max surface temperature

Destination to the ATEX Directive – mining industry.

I M1

- mining
- category of apparatus

Kind of protection: **Ex ia I**

- electrical devices explosion protected to EC standard
- type of explosion protection: intrinsically safe
- mining

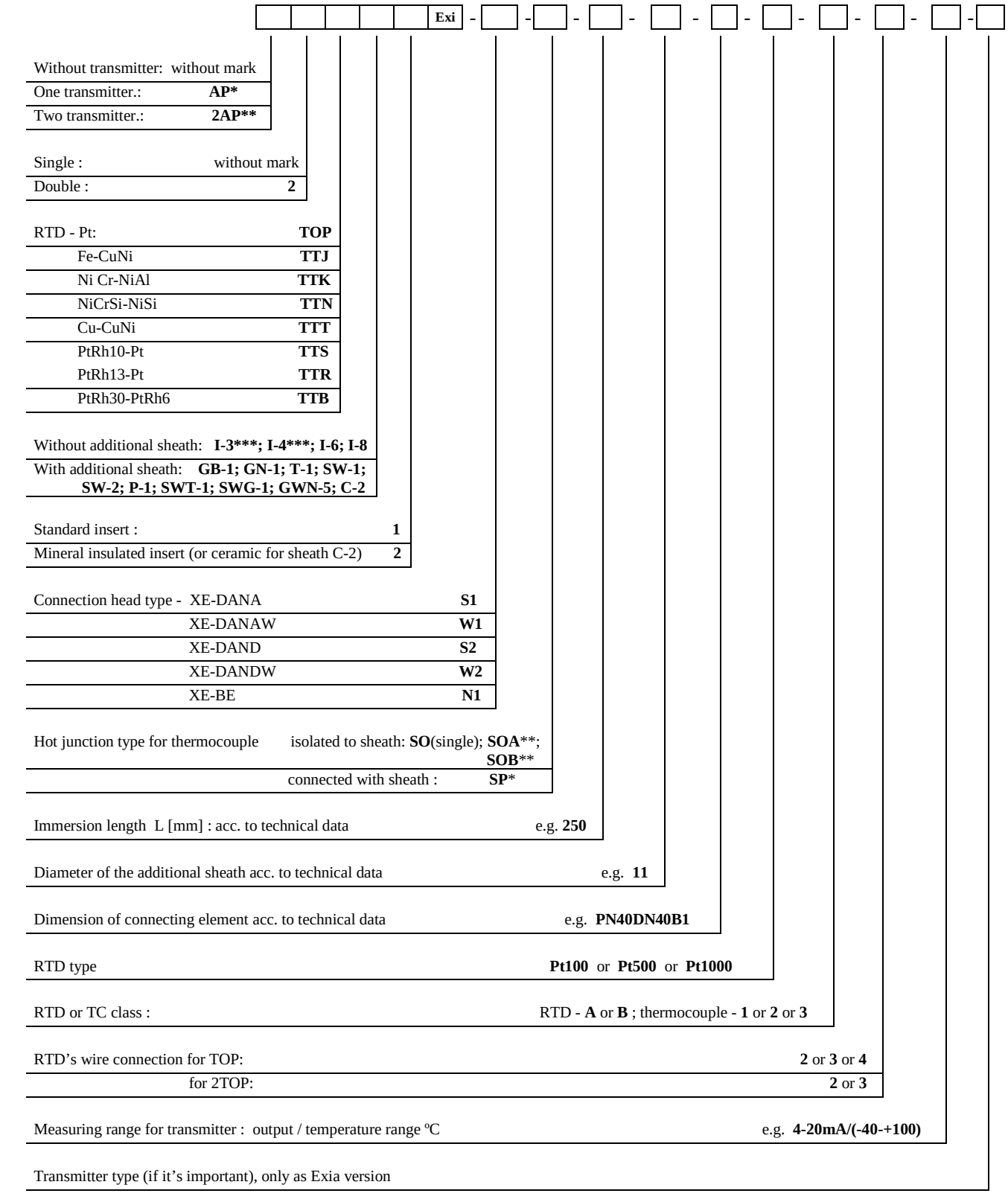
INSERTS MARKING:

		W			/..	-		-		-		-		-		-		-	Exi

Without transmitter: without mark.		
With transmitter:	**AP**	
Single :	without marking	
Double :	**2**	
Standard insert	**1**	
Mineral insulated insert	**2**	
RTD - Pt:	**P**	
Fe-CuNi	**J**	
Ni Cr-NiAl	**K**	
NiCrSi-NiSi *	**N**	
Cu-CuNi	**T**	
Diameter of the sheath d [mm]**	**3; 4,5; 6, 8**	
Length L [mm] :	e.g. **405**	
RTD type	**Pt100**, **Pt500** or **Pt1000**	
RTD or TC class:	RTD - **A** or **B** ; thermocouple - **1** or **2**	
RTD's wire connection for TOP	**2** or **3** or **4**	
for 2TOP	**2** or **3**	
Hot junction type for thermocouple	isolated to sheath:	**SO**(single); **SOA** or **SOB**(double)
	connected with sheath:	**SP**
Measuring range for transmitter : output / temperature range ºC	e.g. **4-20mA/(-40-+100)**	
Transmitter type (if it's important), only as Exia version		

* only as mineral insulated insert ø6
** d=4,5 only as mineral insulated insert for J and K
d=8 performance W2 only for K

TEMPERATURE SENSORS MARKING:



* concern single and double temperature sensors
** concern double temperature sensors
*** concern sensors with mineral insulated insert only

3. INSTALLATION

A. ON THE BORDER OF TWO ZONES: 0; 20 and ZONES: 1; 21, 2; 22

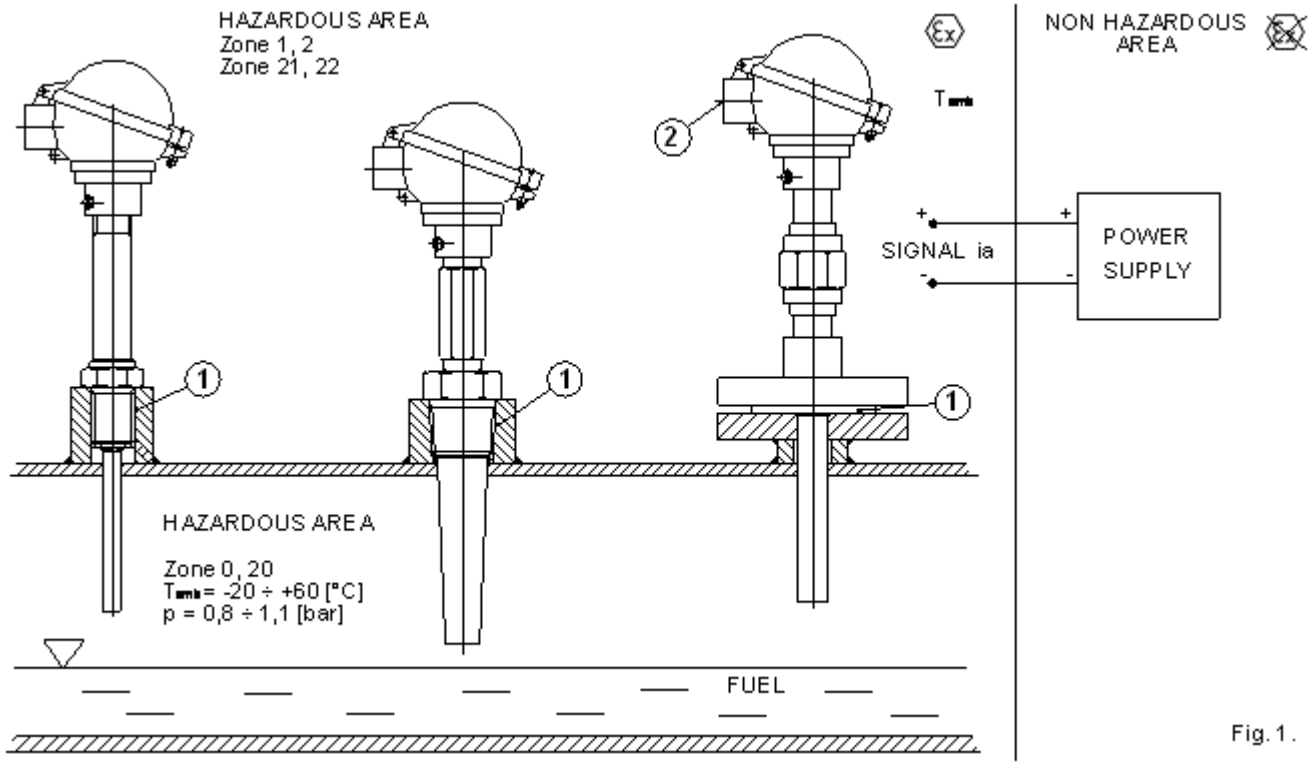
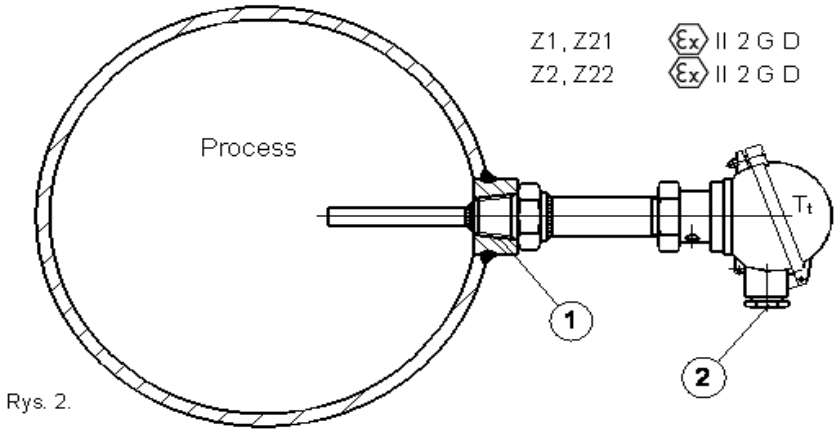


Fig. 1.

(1) - Minimum IP67. Parallel threads must be sealed by gasket on the collar. Taper threads must be sealed by teflon tape or other sealing material (e.g. LOCTITE). Flange joint with gasket.

(2) - Cable glands ATEX Ex e II G or D, suitable for cable diameter. IP min 65.

B. CONNECTION HEAD AND EXTENSION PIPE IN THE ZONES: Z1, Z21, Z2, Z22, IMMERSION PART OUT OF ZONE



Rys. 2.

① - Sealed thread, to ensure tightness from measuring process. Parallel threads to be sealed on the collar. Taper threads to be sealed by teflon tape or sealing material (e.g. LOCTITE). Flange joint with gasket.

② - Cable glands ATEX Ex e II G or II D suitable for cable diameter. IP min 65.

TIGHTENING MOMENTS FOR THREAD JOINTS

Tightening moments for thermowells and compression fittings			
Type of thread			Max tightening moment [Nm]
M20×1,5; G ½; ½NPT			115
M24×1,5			200
M27×2; G¾; ¾NPT			275
M33×2; G1; 1NPT			506
Tightening moments for screws of flange joints			
Screw - nut	Class of screw	Class of nut	Max tightening moment for nut [Nm]
Screw M12×1,5 with steel nut, zinc-plated	5.8	5	50
	8.8	8	90
	10.9	10	125
	12.9	12	150
Tightening moment for press caps of threaded compression fittings (sensor fixing)			
Type of compression fitting			Max tightening moment [Nm]
UG-3			275
UG-8			375

4. ELECTRICAL CONNECTION TO THE INTRINSICALLY SAFE CIRCUIT

A) CONNECTION OF SENSOR WITHOUT TRANSMITTER

a) Supply and signal connection

Sensor to connect to intrinsically safe circuit by cable according to project of electrical installation. The cable parameters C_L, L_L and L_i/R_i must be taken under consideration during accounting intrinsically safe circuit.

Maximal supply voltage: U_i = 10V
Maximal current: I_i =10 mA for Pt100; : I_i =3 mA for Pt1000, Pt500
Maximal strength: P_i =100mW
Maximal inductive: L_i= 0,3µH / 1m conduit
Maximal capacity: C_i= 0,25nF / 1m conduit

Sensor grounding

All type of sensors equipped with exchangeable measuring insert do not meet requirements of insulation distance according to p.6.3.1 and Table 5., and the failure to comply with the 500V insulation test, p.6.3.12 in accordance to standard PN-EN 60079-11. These means that it is regarded as being permanently earthed. Enclosure of this sensors must be grounded to Zener's barrier grounding terminal by wire with cross section minimum 4mm^2 in accordance to scheme below. Sensor enclosure can be grounded locally to the structure. When it is not sure that this metallic connection (by threaded connector of the sensor thermowell) is enough good, the sensor housing to be grounded by wire with cross section minimum 4mm^2 in accordance to scheme below.

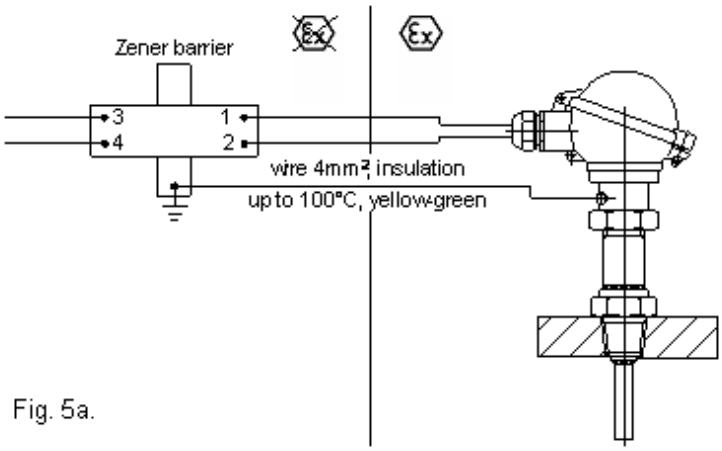


Fig. 5a.

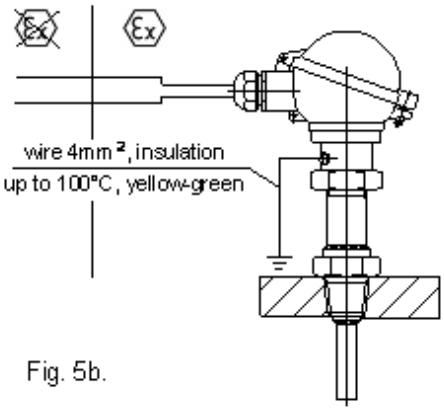
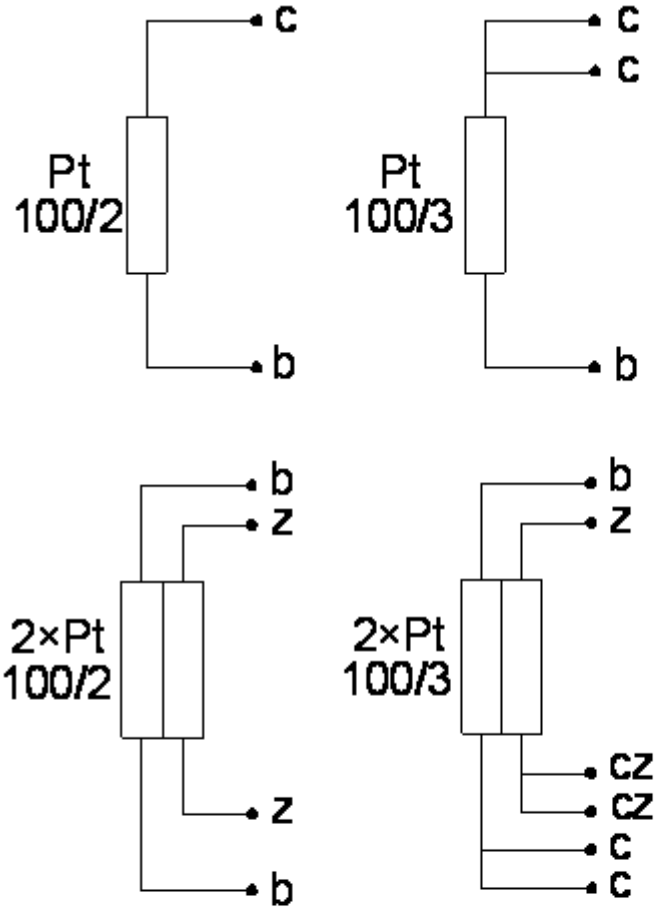


Fig. 5b.

RTD's CONNECTION DIAGRAM



Legend:
b – white
c – red
cz – black
z - green

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All bellow transmitters are circuits galvanic isolated. On request sensor can be equipped with other types of ATEX approved transmitters with or not circuits galvanic isolator.

Technical data of transmitter used exchangeable in the sensors

Parameter		FlexTop 2211	FlexTop 2221	FlexTop 2231	IPAQ-HX	dTRANS T01 956555	dTRANS T01 956556
Output signal		4...20 mA	4...20 mA	4...20 mA	4...20 mA	4...20 mA	4...20 mA
Supply voltage		6,5...30 VDC	8...30 VDC	9...17,5 VDC	8...30 VDC	8...30 VDC	10...30 VDC
Burden resistance [Kohm]		$R_{obc} = \frac{U - 6{,}5\ V}{23\ mA}$	$R_{obc} = \frac{U - 12\ V}{23\ mA}$		$R_{obc} = \frac{U - 8\ V}{22\ mA}$	$R_{obc} = \frac{U - 8\ V}{0{,}022\ A}$	$R_{obc} = \frac{U - 8\ V}{22\ mA}$
Max internal voltage U_i		T 30 VDC	T 30 VDC	T 17,5 VDC	T 30 VDC	T 30 VDC	T 30 VDC
Max internal current I_i		100 mA	100 mA	215 mA	T 100 mA	T 100 mA	T 100 mA
Max internal power P_i		0,75 W	0,75 W	2 W	T 900 mW	T 750 mW	T 750 mW
Internal capacitance L_i		T 15 µH	T 15 µH	10 µH	~ 0 mH	~ 0	~ 0
Internal inductance C_i		T 5 nF	T 5 nF	2 nF	~ 0 nF	~ 0	~ 0
Circuit galvanic isolation	**U**	T 30 VDC	T 30 VDC	T 20 VDC	1500 VAC / 1 min	3,75 kV / 50 Hz	3,75 kV / 50 Hz
	I	T 0,1 A	T 0,1 A	T 100 mA			
	P	T 0,75 W	T 0,75 W	T 0,75 W			
Temperature class for ☒ II 1 G	**T1...T6**	$-40 < T_{amb} < 50°C$	$-40 < T_{amb} < 50°C$	$-40 < T_{amb} < 50°C$	$-40 < T_{amb} < 50°C$	$-20 < T_{amb} < 40°C$	$-20 < T_{amb} < 40°C$
	T1...T5	$-40 < T_{amb} < 85°C$	$-40 < T_{amb} < 85°C$	$-40 < T_{amb} < 85°C$	$-40 < T_{amb} < 65°C$	$-20 < T_{amb} < 50°C$	$-20 < T_{amb} < 50°C$
	T1...T4				$-40 < T_{amb} < 85°C$	$-20 < T_{amb} < 60°C$	$-20 < T_{amb} < 60°C$
Temperature class for ☒ II 2 G ☒ II 3 G	**T1...T6**					$-40 < T_{amb} < 55°C$	$-40 < T_{amb} < 55°C$
	T1...T5					$-40 < T_{amb} < 70°C$	$-40 < T_{amb} < 70°C$
	T1...T4					$-40 < T_{amb} < 85°C$	$-40 < T_{amb} < 85°C$
Communication way		-	Hart HCF	Profibus PA ver. 3.0 DPV 1	-	-	Hart
Explosion protection concept		Intrinsically safe Ex ia II C T5/T6 ☒ II 1 GD	Intrinsically safe Ex ia II C T5/T6 ☒ II 1 GD	Intrinsically safe Ex ia II C T5/T6 ☒ II 1 GD	Intrinsically safe Ex ia II C T4/T5/T6 ☒ II 1 GD	Intrinsically safe Ex ia II C T4/T5/T6 ☒ II 1 G	Intrinsically safe Ex ia II C T4/T5/T6 ☒ II 1 G ☒ II 2 G
ATEX Certificate		TUV 07 ATEX 347150 X	TUV 07 ATEX 347151 X	TUV 07 ATEX 347152 X	Demko 02 ATEX 132033 X	ZELM 99 ATEX 0018 X	PTB 01 ATEX 2124

B) CONNECTION OF SENSOR WITH TRANSMITTER

! Sensor to connect to intrinsically safe circuit by cable according to project of electrical installation. The cable parameters C_L, L_L and L_i/R_i must be taken under consideration during accounting intrinsically safe circuit.

! **Each transmitter's data sheet includes diagrams. It is attached with sensor documentation.**

! The transmitter must be supplied via intrinsically supply unit direct or via Zener barrier.

! The transmitter without galvanic isolator must be supplied by intrinsically safe supply unit via Zener barrier placed outside hazardous areas.

5. **TEMPERATURE CLASS OF THE SENSOR –** gas potential explosive atmosphere G.

Temperature class of the apparatus determine its the hottest surface, which can appear during normal operation, it means temperature measurement of the process in the measuring range.

Because sensor manufacturer is not able foreseen actually operation condition of the sensor, on the data sheets and certificate was declared temperature class responding top temperature declared measuring range regardless influence of ambient T_{amb} and self-heating T_e temperature.

Actually maximum surface temperature and responding temperature class of sensor working on the object can be lower than declared by sensor producer in accordance to Table 1. in the standard EN 60079-0.

The hottest sensor surface can be surface of electronic transmitter, connection heads or surfaces around sensing element (RTD, TC).

If process temperature T_p is lower than ambient temperature T_{amb} the hottest surface of the sensor will be surface of transmitter / connection head.

$$\mathbf{T_p < T_{amb}}$$

SENSORS WITHOUT TRANSMITTERS

Sensor type	Measuring range	Range of temperature class	Ambient temperature T_{amb}	The hottest surface in the most disadvantageous conditions T_S
Category Ex II 1/2 G				
All types	-20 ÷ 60 °C	T6	-40 ÷ 75°C	Connection head, Fig.16.
Category Ex II 2 G, Ex II 3 G				
•RTD •TC	-200°C ÷ T_{amb} -40°C ÷ T_{amb}	T6	-40 ÷ 75°C	Connection head, Fig.17.

SENSOR WITH TRANSMITTER

Sensor type	Measuring range	Range of temperature class	Ambient temperature T_{amb}	The hottest surface in the most disadvantageous conditions T_S
Category Ex II 1/2 G				
All types	-20 ÷ 60 °C	T4 ÷ T6 depends on temperature class	-40 ÷ Tx°C with transmitters	Connection head, Fig. 16.

Category Ex II 2 G, Ex II 3 G				
•RTD •TC	-200°C ÷ T_{amb} -40°C ÷ T_{amb}	T4 ÷ T6	-40 ÷ Tx°C with transmitters [2)]	Connection head, Fig. 17.

Tx – maximal temperature T_{amb} for temperature class for type of used transmitter – see Table page 8 with the technical data of used transmitters in the sensors.

If process temperature T_p is higher than ambient temperature T_{amb} the sensor surface will be heated by process temperature T_p and ambient temperature T_{amb}. In case of sensors working in the explosion atmospheres when $T_p > T_{amb}$ the hottest places of the sensor are:

- bottom of the thermowell – inner surface has contact with explosive gas mixture,
- the tip of the measuring insert – outer surface has contact with explosive gas mixture.

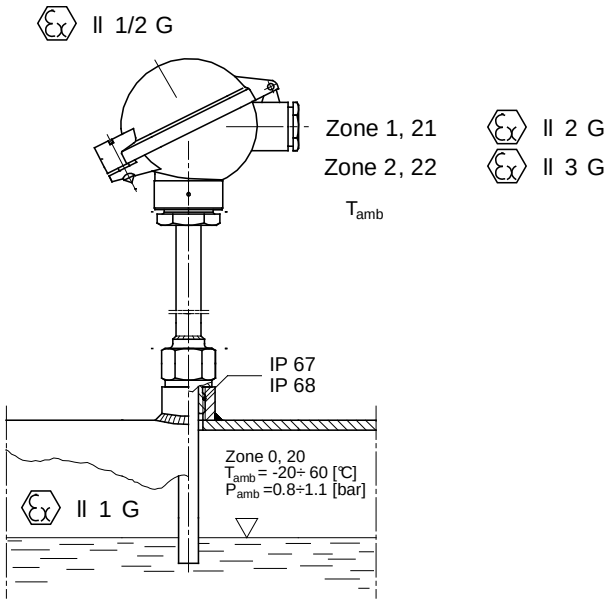
$$\mathbf{T_p > T_{amb}}$$

SENSORS WITHOUT TRANSMITTER, SENSORS WITH TRANSMITTER

Sensor type	Measuring range [1)]	Range of temperature class	Ambitne temperature T_{amb}	The hottest surface in the most disadventageous conditions T_S
Category ⟨Ex⟩ II 2 G, ⟨Ex⟩ II 3 G				
All sensor type except: TOPGB, TOPI, TTJI, TTKI, PTTKI APTOPGB, APTOPI, APTTJI, APTTKI, APPTTKI • RTD • TC J • TC K	 T_{amb} ÷ 450°C T_{amb} ÷ 450°C T_{amb} ÷ 450°C	 T1...T6 T1...T6 T1...T6	-40 ÷ 75°C without transmitters -40 ÷ Tx°C with transmitter	• inner surface of the thermowell bottom • outer surface of the tip of measuring insert Fig. 17.
• Sensor TOPGB, APTOPGB • Sensor TOPI, APTOPI • Sensor TTJI, APTTJI • Sensor TTKI, APTTKI • Sensor PTTKI, APPTTKI • Sensor TT(RSB)C, APTT(RSB)C	T_{amb} ÷ 135°C T_{amb} ÷ 600°C T_{amb} ÷ 700°C T_{amb} ÷ 800°C T_{amb} ÷ 1200°C T_{amb} ÷ 1600°C	T4...T6 T 600°C...T6 T 700°C...T6 T 800°C...T6 T 1200°C...T6 T 1600°C...T6	-40 ÷ 75°C without transmitters -40 ÷ Tx°C with teansmitter	• tip of measuring insert or Fig. 18a • outer sheath of measuring insert behind compression fitting Fig. 18b

[1)] without influence of ambient temperature T_{amb} and self-heating T_e

Tx – max temperature T_{amb} for temperature class for type of used transmitter – see Table page 8. With the technical data of used transmitters in the sensors.



! For sensors working on Zone0 / Zone 1 border the temperature class of the sensor is T6

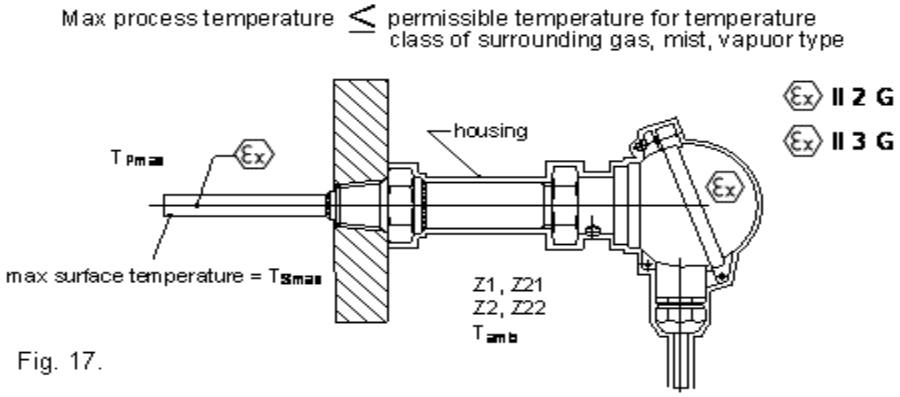


Fig. 17.

! For all sensors except TOPI, TTJI, TTKI, PTTKI, APTOPI, APTTJI, APTTKI, APPTTKI the max process temperature T_{pmax} must not be higher than the temperature of temperature class for surrounding explosive mixture.

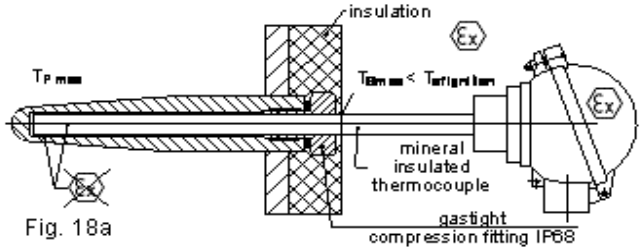


Fig. 18a

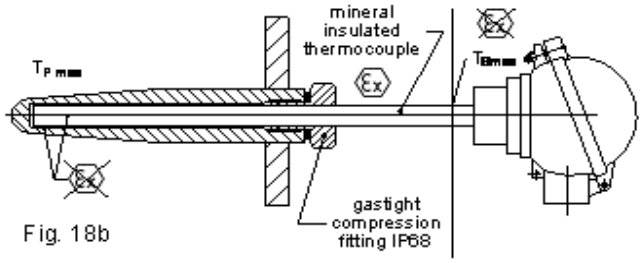


Fig. 18b

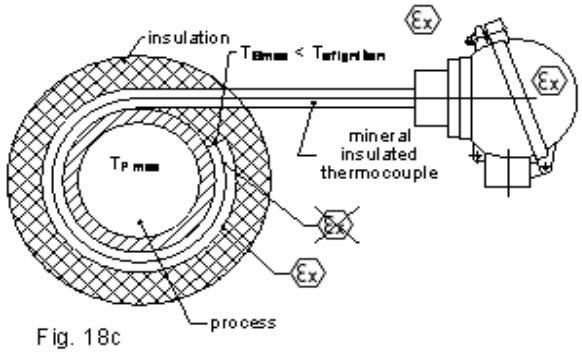


Fig. 18c

$T_{pmax} \leq$ T1...T6

! For sensors TOPI, TTJI, TTKI, PTTKI, APTOPI, APTTJI, APTTKI, APPTTKI the max process temperature T_{pmax} can be higher than class temperature for present explosion mixture under condition, that conduiting heat and radiation heat from temperature process T_p do not worm none sensor surface exposed to explosion atmosphere higher than ignition temperature of the explosive mixture.

$T_p >$ T°C...T6
$T_{Smax} <$ T°C...T6

! Designer of the installation is responsible for such sensor type choosing and way his installation so as to after sensor installation during extremal working conditions temperature of the hottest surface will be lower than temperature of class temperature for surrounding gas, mist, vaporous type.

6. MAXIMAL PERMISSIBLE SURFACE TEMPERATURE OF THE SENSOR – dust explosive atmosphere D.

Maximal surface temperature of the sensor can be reached during operation in extreme conditions. Because tightness of the sensor is IP6X (dusttight enclosure) dust must not ingress inside and this concerns outside surface of the sensor.
If process temperature T_p is higher than ambient temperature T_{amb} sensor surfaces will be wormed by process temperature T_p, ambient temperature T_{amb} and self-heating T_e.

Maximum surface temperature of the sensor having contact with explosive dust mixture must not excced 2/3 self-inflamination temperature of dust cloud or 75K lower from self-ignition temperature of dust layer thickness up to 5mm (p. 6.1 and 6.2 EN 50281-1-2).

Example of maximum surface temperature of hot parts of the sensor for choosen type of dusts

Dust	Self-inflamation temperature °C layer cloud		Minimum inflamation energy (cloud) [mJ]	Minimum explosion concentration (cloud) [g/m^3]	$T_{Smax} = T_{5mm} - 75K$	$T_{Smax} = 2/3\ T_{Cl}$
	T_{5mm}	T_{Cl}				
Agricultural dust						
Cellulose	270	480	80	55	195	300
Cocoa	240	510	100	75	165	320
Corn starch	-	380	30	40	-	253
Cork	210	460	35	35	135	306
Dextrin						
Flour / wheat	440	440	60	50	365	293
Malt	250	400	35	55	175	266
Milk powder	200	490	50	50	125	326
Peanuts (husks)	210	460	50	45	135	306
Rice	450	510	100	85	375	340
Soya (flour)	340	550	100	60	265	366
Starch (wheat)	380	400	25	25	305	266
Unprocessed cotton	520	-	100	190	445	-
Wheat (bulk)	220	500	60	65	145	333
Wood / pine (sawdust)	260	470	40	35	185	313
Sugar	400	370	30	45	325	246
Chemicals dust						
Asphalt	550	510	40	35	475	340
Bituminous coal	180	610	30	50	105	406
Carbon black	900	no infla-mmation	-	-	825	-
Charcoal	180	530	20	140	105	353
Coal (anthracite)	-	730	100	65	-	486
Graphite	580	no infla-mmation	-	-	505	-
Lignite	200	450	30	30	125	300
Reference coal (Pittsburgh)	170	610	60	55	95	406
Smoke black	-	730	-	-	-	486
Tar	-	630	25	45	-	420
Metallic dust						
Aluminium flakes (*)	400÷900	600÷700	10÷100	40÷60	325÷825	400÷466
Cadmium	250	570	4 000	-	250	380

Copper	-	900	-	-	-	600
Manganese	240	460	305	125	165	306
Silicon	950	780	96	160	21	520
Titanium	510	330	25	45	435	220
Zinc	540	690	960	460	465	460
Plastics, rubber						
A.B.S. (Acrylonitrile Butadiene Styrene)	-	480	20	25	-	320
Carboxymethylcellulose	310	460	140	60	235	306
Cellulose acetate	-	420	15	40	-	280
Ethylcellulose	350	370	10	25	275	246
Flameproof polyurethane foam	390	550	flame in presence of hot surface		315	366
Ground polystyrene	-	560	40	15	-	373

In case other type of dusts has not been mentioned in the above table T_{Smax} shall be evaluated on the base relevant standards and scores of testing.

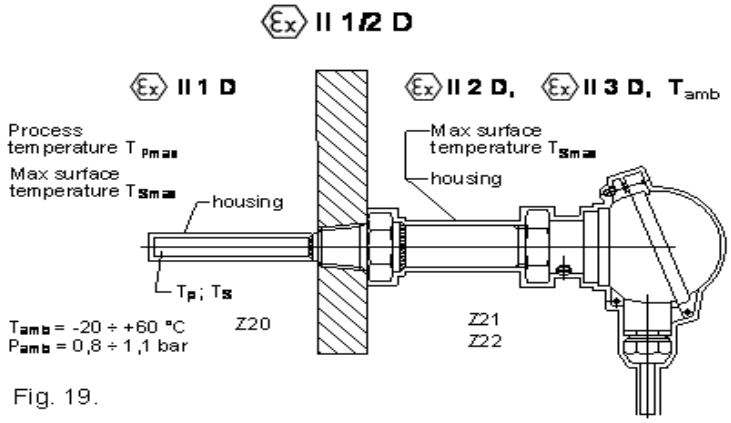


Fig. 19.

! In case of dust explosive atmosphere exists in both side of the process wall and process temperature $T_p > T_{amb}$, maximum surface temperature T_{Smax} occours on the immersion part of the sensor exposed to the process.

T_{Smax} < min(2/3 T_{Cl}; T_{5mm} – 75K) for particular dust type

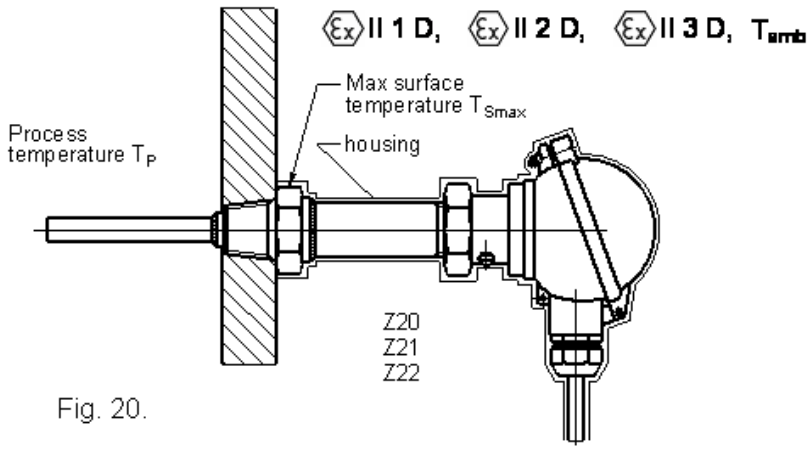


Fig. 20.

! In case of dust explosive atmosphere exists higher up installation fitting and process temperature $T_p > T_{amb}$, maximum surface temperature T_{Smax} occours on the sensor parts behind the wall of the process

T_{Smax} < min (2/3 T_{Cl}; T_{5mm} – 75K) for particular dust type

! Designer of the installation is responsible for such sensor choosing and way his installation so as to after sensor installation during extremal working conditions, temperature the hottest surface will not be higher than 2/3 of dust cloud self-inflamination temperature T_{Cl} or dust layer self-inflamination temperature T_{5mm} – 75K.

Other cases of using sensor and adequate conditions are given by standard PN-EN 60241-0.

7. ENVIRONMENTAL CONDITIONS

- Ambient temperature depend on sensor type acc. to Table page 10, 11.
- Humidity max 80%,
- Sensors are destined to use indoor and outdoor location.

8. TIGHTNESS. IP DEGREE

Ordered in Limatherm Sensor, sensor can be equipped with appropriate cable gland:
- for sensor intended for use in potentially gas G explosive atmospheres Exe II G approved, or standard design
- for sensor intended for use in potencially dust D explosive Exe tD A21 approved.

All cable glands are pointed out by Limatherm Sensor, so as to include foreseen to use cable diameter.

In case ordering a sensor without cable gland, fitter is obliged to mount certified cable gland for destination of sensor (G or D atmospheres).

All parts of the sensors are assembled using tightening moment which ensure comply declared IP degree rating. During sensor installation on the object, after electrical connection to the intrinsically safe circuit shall:

- standard cable glands
  using wrench (AF = 24mm or other appropriate) tighten the press cup of cable gland so as to seal ring closelly pressed the cable. Check by hand possibility of draw out cable from cable gland. In case of cable moving use the wrench once more. Tightening moment max 14 Nm.

- ATEX approved cable glands
  Handling shall be done in accordance with gland producer's manual.

- Using screwdriver tighten by hand cover screw. Tightening moment max 2,2 Nm.

! Tightening with appropriate moment of cable gland press cup and cover screw is especially important in the sensor intended for use in potential dust D explosive atmospheres.

Housing tightness rating IP6X is the base way to ensure dust explosion protection.

! Do not open connection head cover of the sensor marked Ex II iD during operation in the presence dust cloud or when dust is stored on the connection head.

9. DOCUMENTS

To the each sensor is enclosed:

- Instruction manual for sensor,
- Instruction manual for cable gland ATEX approved,
- Data sheet for transmitter
- Warranty,
- Declaration of conformity.