Temperature head sensors for Hazardous Areas

PN-EN 60079-0, PN-EN 60079-11, PN-EN 50303, PN-EN 60079-26

Ex II 1/2 G D **Ex II 3 G D**
Ex II 2 G D **Ex I M1**

Hazardous Areas - Ex ia

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Edition 1.2017

Temperature head sensors for Hazardous Areas

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

	Ex	II	1	G	D
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	Gb
electrical devices explosion protected to EC standard					
type of explosion protection: intrinsically safe					
gas group					
temperature class					
EPL type of protection					

Kind of explosion protection for dusts:

	Ex	ia	IIIC	T85°C	Da
electrical devices explosion protected to EC standard					
type of explosion protection: intrinsically safe					
dust group					
max surface temperature					
EPL type of protection					

Destination to the ATEX Directive - mining industry.

	Ex	I	M1
mining			
category of apparatus			

Kind of protection:

	Ex	ia	I	Ma
electrical devices explosion protected to EC standard				
type of explosion protection: intrinsically safe				
mining				
EPL type of protection				

Inserts marking

Measuring insert	...	...	W	...	...	–	...	–	...	–	...	–	...	–	...	–	...	–	...	– Exi
Without transmitter	no designation																			
With transmitter	AP																			
Single	no designation																			
Double	2																			
Standard insert				1																
Mineral insulated insert				2																
RTD Pt					P															
Fe-CuNi; NiCr-NiAl					J; K															
Cu-CuNi; NiCrSi-NiSi					T; N **															
Thermowell diameter [mm] ***					3; 4,5; 6; 8															
Length L_w [mm]							245*													
RTD class									A, B*											
TC class									1, 2											
RTD wire connection for 1xPt100											2, 3, 4									
RTD wire connection for 2xPt100											2, 3									
RTD type													Pt100							
Hot junction types for TC											SO, SP, SOA									
Transmitter type															HRFX*					
Temperature range															(0 ÷ 100) °C*					
Intristically safe execution																				

* as agreed
** only mineral insulated insert ø6
*** d = 4,5 only as mineral insulated insert J and K
d = 8 performance W2 only for K
insert 2xPt100 diameter d<6 mm, have at the end of an additional symbol SP (see page 4-5)

Table 1. Temperature sensors marking:

Temperature sensors	...	...	T	...	...	...	Exi – ... – ... – ... – ... – ... – ... – ... – ... – ... – ... – ... – ...
Without transmitter With transmitter With two transmitters	**no designation** **AP**** **2AP*****						
Single Double		**no designation** **2**					
RTD Fe-CuNi; NiCr-NiAl Cu-CuNi; NiCrSi-NiSi PtRh10-Pt; PtRh13-Pt PtRh30-PtRh6			**OP** **TJ; TK** **TT; TN** **TS; TR** **TB**				
Without additional sheath:						**I-3****; I-4****; I-6; I-8**	
With additional sheath:						**GB-1; GN-1; T-1; SW-1; SW-2; P-1; SWT-1; SWG-1; GWN-5; C-2**	
Standard insert Mineral insulated insert						**1** **2**	
Connection head type: XE-DANA XE-DANAW XE-DAND XE-DANDW XE-BE							**S1** **W1** **S2** **W2** **N1**
Length L [mm]							**200***
Thermowell diameter d [mm]							**9**
Dimension of connecting element acc. to technical data							**PN40DN40B1***
RTD type Hot junction types for TC							**Pt100*** **SO, SP**, SOA***, SOB****
RTD class TC class							**A, B*** **1, 2, 3**
RTD wire connection (single) RTD wire connection (double)							**2, 3, 4** **2, 3**
Transmitter type							**FT2221Ex***
Temperature range							**(0 ÷ 150) °C***

* as agreed
** applies to single and double temperature sensors
*** applies to double temperature sensors
**** only mineral insulated insert
insert 2xPt100 diameter d<6 mm, have at the end of an additional symbol SP (see page 4-5)

3. Installation.

A) On the border of two Zones: 0 ; 20 and Zones: 1; 21, 2; 22

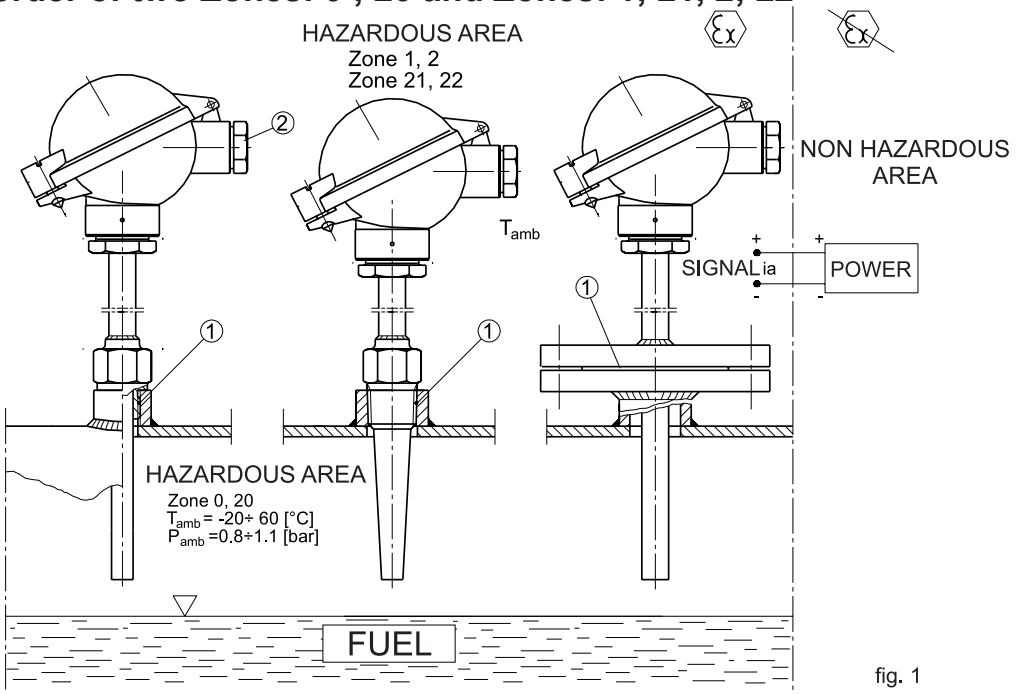


fig. 1

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 eb IIC, Ex ta IIIC 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.

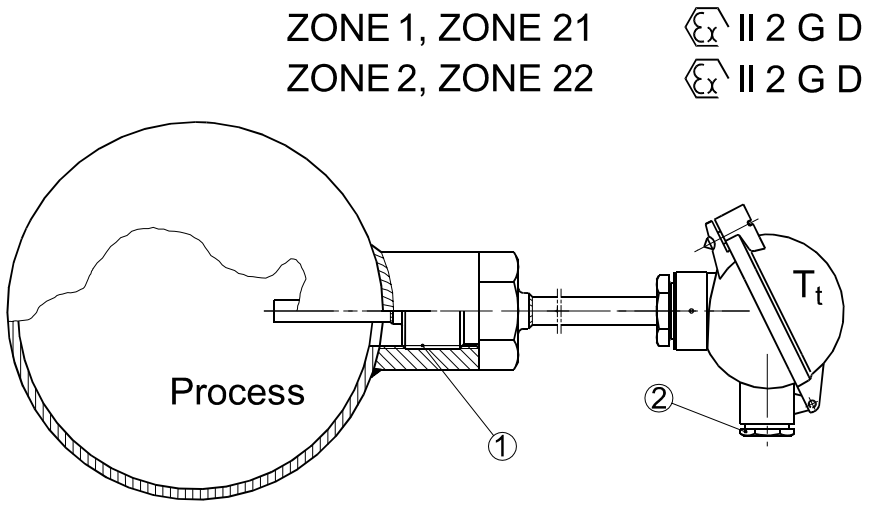


fig. 2

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 eb IIC, Ex ta IIIC suitable for cable diameter. IP min 65.

TIGHTENING MOMENTS FOR THREAD JOINTS

Tightening moments for thermowells and comperssion fittings			
Type of thread		Max tightening [Nm]	
M20x1,5; G½; ½NPT		115	
M24x1,5		200	
M27x2; G ¾; ¾NPT		275	
M33x2; G1; 1NPT		506	
Tightening moments for screws of flange jonts			
Screw - nut	Class of screw	Class of nut	Max tightening moment for nut [Nm]
Screw M12x1,5 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.

Resistance sensors	Thermocouples
Maximal supply voltage: U_i= 45 V *	**Maximal output voltage:** U_o = 3 V
Maximal current: I_i = 26 mA *	**Maximal current:** Ii = 50 mA
Maximal strength: P_i = 150 mW *	**Maximal inductive:** Li = 0,3 µH / 1 m conduit
Maximal inductive: L_i = 0,3 µH / 1 m conduit	**Maximal capacity:** Ci = 0,25 nF / 1 m conduit
Maximal caacity: C_i = 0,25 nF / 1 m conduit	

* not applicable sensors 2xPt100 a diameter d<6mm, in additionaly marked letters **SP**, for which:

Maximal supply voltage: U_i= 10 V
Maximal current: I_i = 10 mA
Maximal strength: P_i = 100 mW

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 500 V insulation test, p.6.3.12 in accordance to standard 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 4 mm² in accordance to scheme below. Sensor enclosure can be grounded locally to the structure. When it is not sure that this metallic connectionn (by threaded connector of the sensor thermowell) is enough good, the sensor housing to be grounded by wire with cross section minimum 4 mm² in accordance to scheme below.

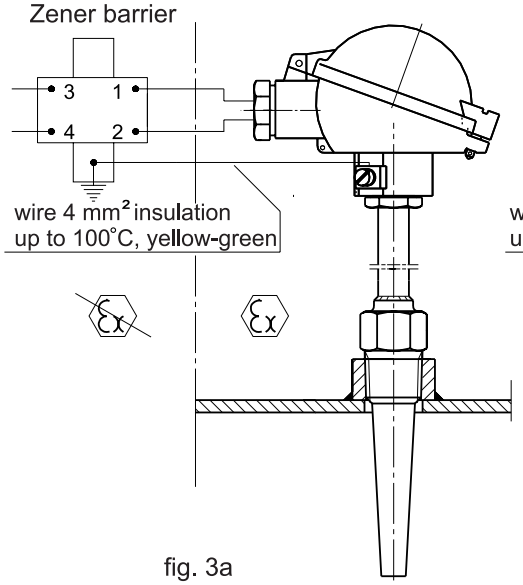


fig. 3a

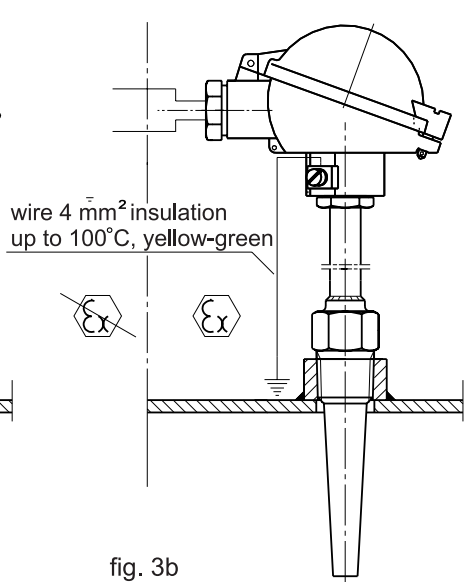
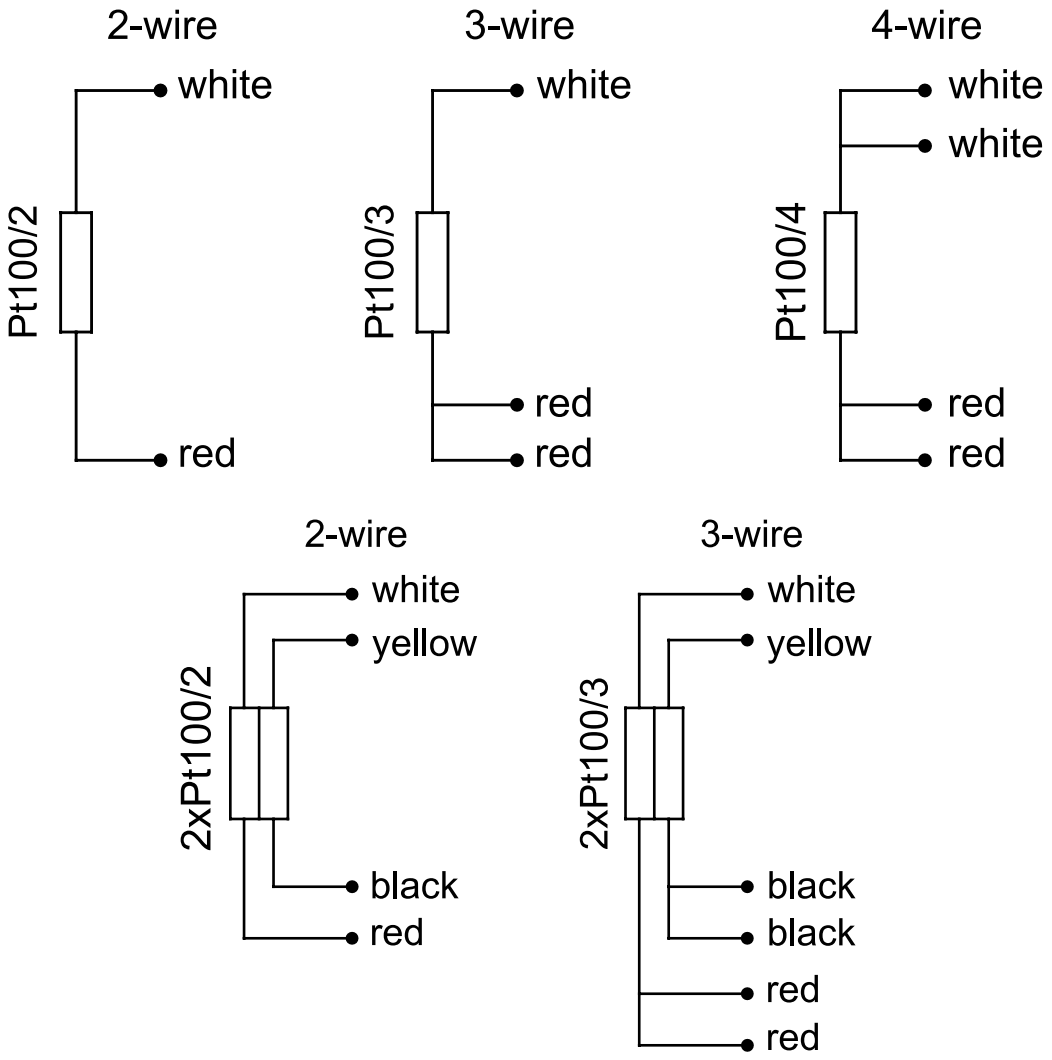


fig. 3b

RTD connection diagram



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

Parameter		FlexTop 2211	FlexTop 2221	FlexTop 2231	IPAQ-HX	dTRANS T01 707015	dTRANS T01 707016	Technical data of transmitter used exchangeable in the sensors
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	11,5÷30 VDC	
Burden resistance [Kohm]		R_{obc}=(U - 6,5 V)/23 mA	R_{obc}=(U-12 V)/23 mA	–	R_{obc}=(U-8 V)/22 mA	R_{obc}=(U-8 V)/0.022 A	R_{obc}=(U-10 V)/22 mA	
Max internal voltage U_i		30 VDC	30 VDC	17,5 VDC	30 VDC	30 VDC	30 VDC	
Max internal current I_i		100 mA	100 mA	215 mA	100 mA	100 mA	100 mA	
Max internal power P_i		0,75 W	0,75 W	2 W	900 mW	750 mW	750 mW	
Internal capacitance L_i		15 µH	15 µH	10 µH	~ 0 mH	~ 0	~ 0	
Internal induktance C_i		5 nF	5 nF	2 nF	~ 0 nF	~ 0	~ 0	
Circuit galvanic izolation	U	30 V DC	30 V DC	20 V DC	1500 VAC / 1 min	3,75 kV / 50 Hz	2,00 kV / 50 Hz	
	I	0,1 A	0,1 A	100 mA	–	–	–	
	P	0,75 W	0,75 W	0,75 W	–	–	–	
Temperature class for Ex II 1 G	T1...T6	$-40 < T_{amb} < 50°C$	$-40 < T_{amb} < 50°C$	$-40 < T_{amb} < 60°C$	$-40 < T_{amb} < 50°C$	$-20 < T_{amb} < 40°C$	$-20 < T_{amb} < 40°C$	
	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 Ex II 2 G Ex 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 IIC T5/T6 ⟨Ex⟩ II 1G	Intrinsically safe Ex ia IIC T5/T6 ⟨Ex⟩ II 1G	Intrinsically safe Ex ia IIC T5/T6 ⟨Ex⟩ II 1G	Intrinsically safe Ex ia IIC T5/T6 ⟨Ex⟩ II 1G	Intrinsically safe Ex ia IIC T5/T6 ⟨Ex⟩ II 1G	Intrinsically safe Ex ia IIC T5/T6 ⟨Ex⟩ II 1G	
ATEX Certificate		TÜV 07 ATEX 347151X	TÜV 07 ATEX 347151X	TÜV 07 ATEX 347152X	Demko 02 ATEX 132033X	ZELM 99 ATEX 0018X	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 Tamb and self-heating Te 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 Tamb the hottest surface of the sensor will be surface of transmitter / connection head.

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

Temperature class for sensors without transmitter will be T6, and for sensors with transmitter is dependent on the temperature class for the transmitter.

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 ½G				
All types with thermowell having a wall thickness min. 1 mm	-20÷60°C	T6	-40÷60°C	Connection head Fig. 4
Category ⟨Ex⟩ II 2 G, ⟨Ex⟩ II 3 G				
• RTD • TC	-200°C ÷ T_{amb} -40°C ÷ T_{amb}	T6	-40÷60°C	Connection head Fig. 5

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 ½G				
All types with thermowell having a wall thickness min. 1 mm	-20÷60 °C	T4 + T6 depends on transmitters temperature class	-40÷60°C	Connection head Fig. 4
Category ⟨Ex⟩ II 2 G, ⟨Ex⟩ II 3 G				
• RTD • TC	-200°C ÷ T_{amb} -40°C ÷ T_{amb}	T4 + T6	-40÷60°C	Connection head Fig. 5

* - max temperature T_{amb} for temperature class may be higher (up to 75°C) while reducing the current parameters - marking SP (see p. 4A, page. 5)

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	Ambient temperature* T_{amb}	The hottest surface in the most disadvantageous conditions T_s
Category ⟨Ex⟩ II 2 G, ⟨Ex⟩ II 3 G				
All sensors type except: TOPGB, TOPI, TTJI, TTKI, PTTKI APTOPGB, APTOPI, APTTJL, 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÷60°C	• inner surface of the thermowell bottom • outer surface of the tip of measuring insert Fig. 5. • tip of measuring insert or Fig. 6a. • outer sheath of measuring insert behind compression fitting Fig. 6b.
• Sensor TOPGB, APTOPGB • Sensor TOPI, APTOPI • Sensor TTJI, APTTJI • Sensor TTKI, APTTKI • Sensor PTTKI, APTTKI • 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		• tip of measuring insert or Fig 6a • outer sheath of measuring insert behind compression fitting Fig. 6b

1) without influence of ambient temperature T_{tmb} and self-heating T_p

*- max temperaure T_{amb} for temperature class may be higher (up to 75°C). While reducing the current paramaters - marking SP (see p. 4A, page 5.)

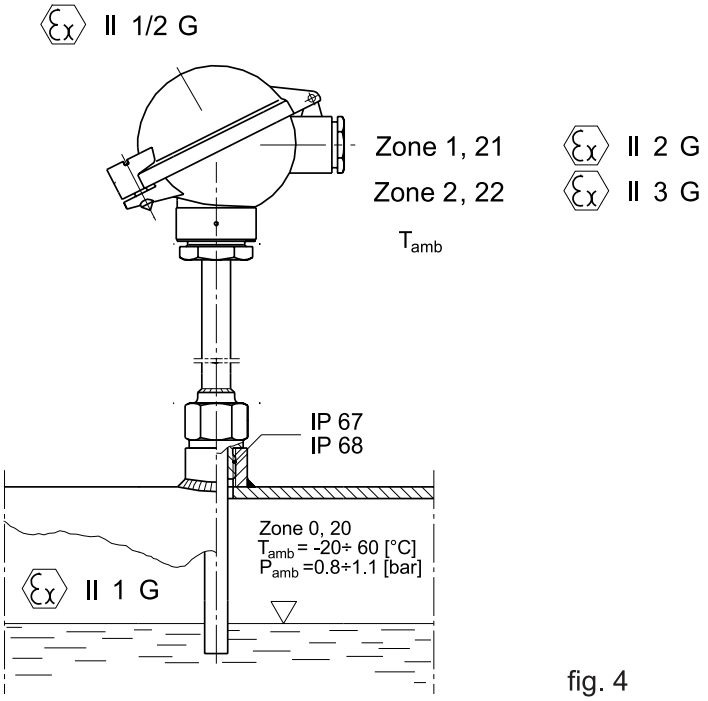


fig. 4

! For sensors working on Zone 0 / Zone 1 border the temperature class of the sensor is T6.

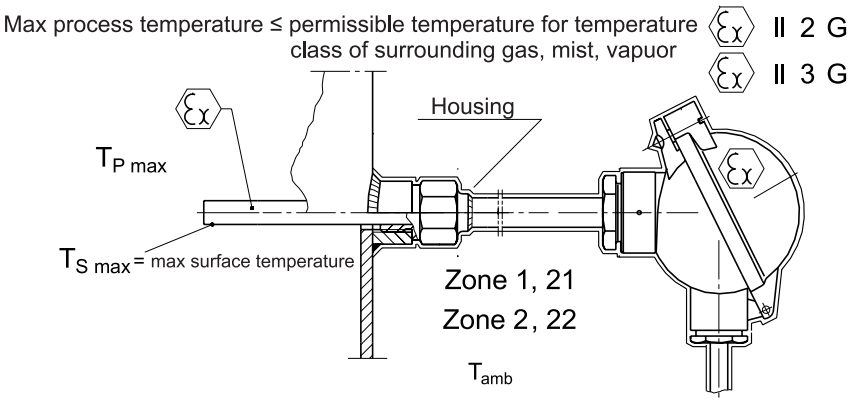


fig. 5

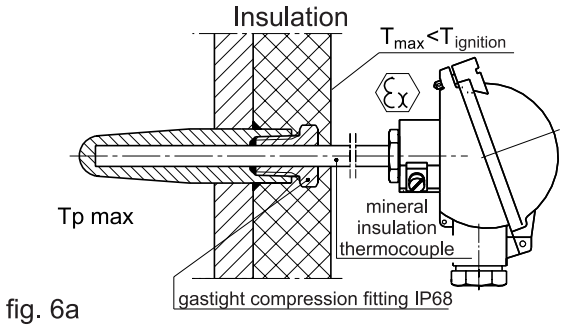


fig. 6a

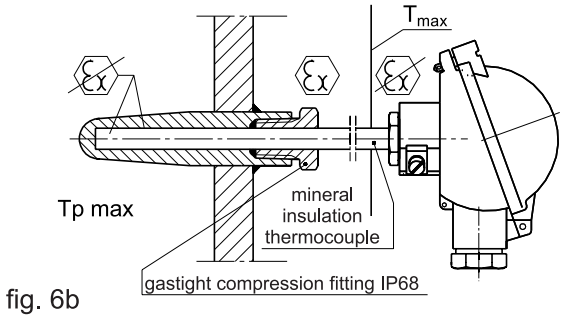


fig. 6b

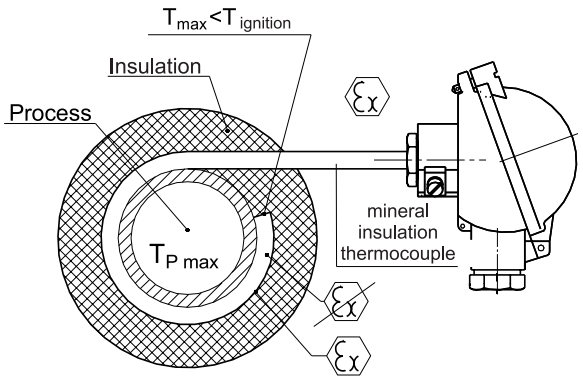


fig. 6c

! 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.

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

! For sensors TOPI, TTJI, TTKI, PTTKI, APTOPI, APTTJI, APTTKI, APPTTKI, APTT(RSB)C, 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.

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

! 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 ⅔ self-inflamination temperature of dust cloud or 75K lower from self-ignition temperature of dust layer thickness up to 5 mm (EN 60079-0).

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

Dust	Self-inflamination temp. °C layer cloud		Minimum inflamation energy (cloud) [mJ]	Minimum explosion concentration (cloud) [g/m³]	$T_{smax}=T_{smin}-75K$	$T_{smax}=2/3\ T_{cL}$
	T_{smax}	T_{Cl}				
Agricultural dust						
Cellulose	270	480	80	55	195	300
Cocoa	240	510	100	75	165	320
Corn strach	-	380	30	40	-	253
Cork	210	460	35	35	135	306
Dextrin						
Flour/wheat	44	440	60	50	365	293
Malt	250	400	35	55	175	266
Milk powder	250	490	50	50	125	326
Peanuts (husks)	200	460	50	45	135	306
Rice	450	510	100	85	375	340
PhtalRice	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						
Asphalt	550	510	40	35	475	340
Bituminous coal	180	610	30	50	105	406

Carbon black	900	no inflammation	-	-	825	-
Charcoal	180	530	20	140	19105	353
Coal (anthracite)	-	730	100	65	-	486
Graphite	580	no inflammation	-	-	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	4000	-	250	380
Copper	-	900	-	-	-	600
Manganese	240	460	305	125	165	306
Silicon	950	80	96	160	21	520
Titanium	510	330	25	45	435	220
Uranium	100	20	45	60	25	13
Zinc	540	690	960	460	465	460
Plastics, rubber						
A.B.S. (Acryloitrile Butadiene Styrene)	-	480	20	25		320
Carboxymethylcellulose	310	460	140	60		306
Cellulose acetate	-	420	15	40		280
Ethylcellulose	350	370	10	25		246
Flameproof polyurethane foam	390	550	flame in presence of hot surface			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.

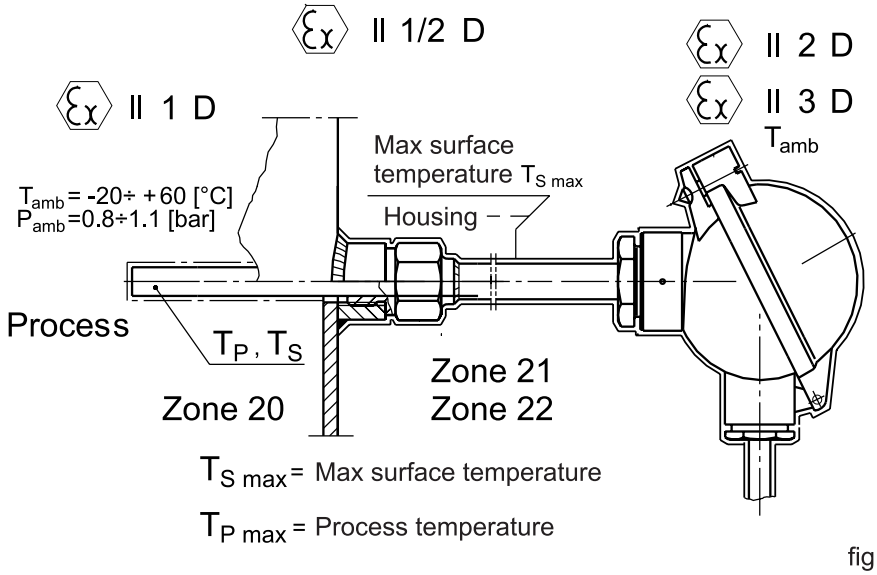


fig. 7

! 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.

$T_{Smax} < \min(⅔\ T_{Cl}; T_{5mm} - 75K)$ for particular dust type

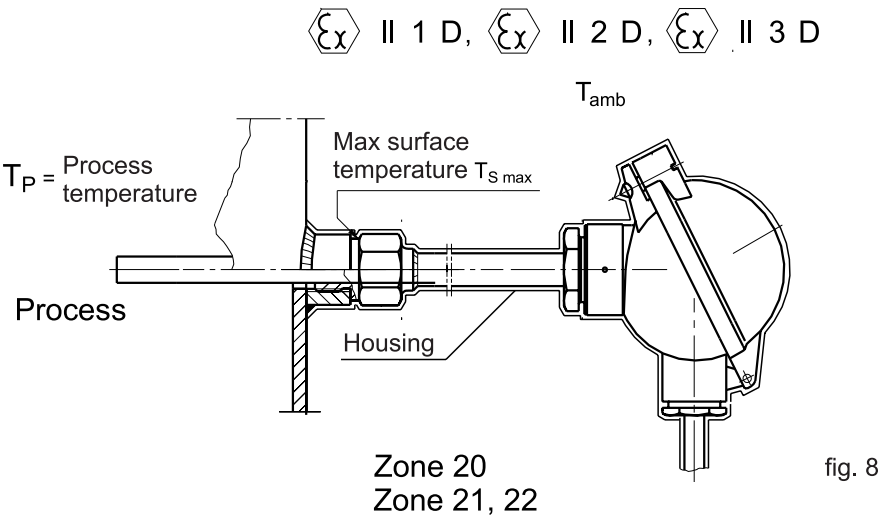


fig. 8

! 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.

$T_{Smax} < \min (⅔\ TCl; T_{5mm} - 75K)$ 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 ⅔ of dust cloud self-inflammation temperature TCl or dust layer self-inflamination temperature T_{5mm} – 75K.**

Other cases of using sensor and adequate conditions are given by standard EN 60079-0.

7. Environmental conditions.

- Ambient temperature depend on sensor type acc. to Table page 9-10.
- 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 Ex eb IIC approved, or standard design

• for sensor intended for use in potencially dust D explosive Ex ta IIIC 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 II Ex ia IIIC 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