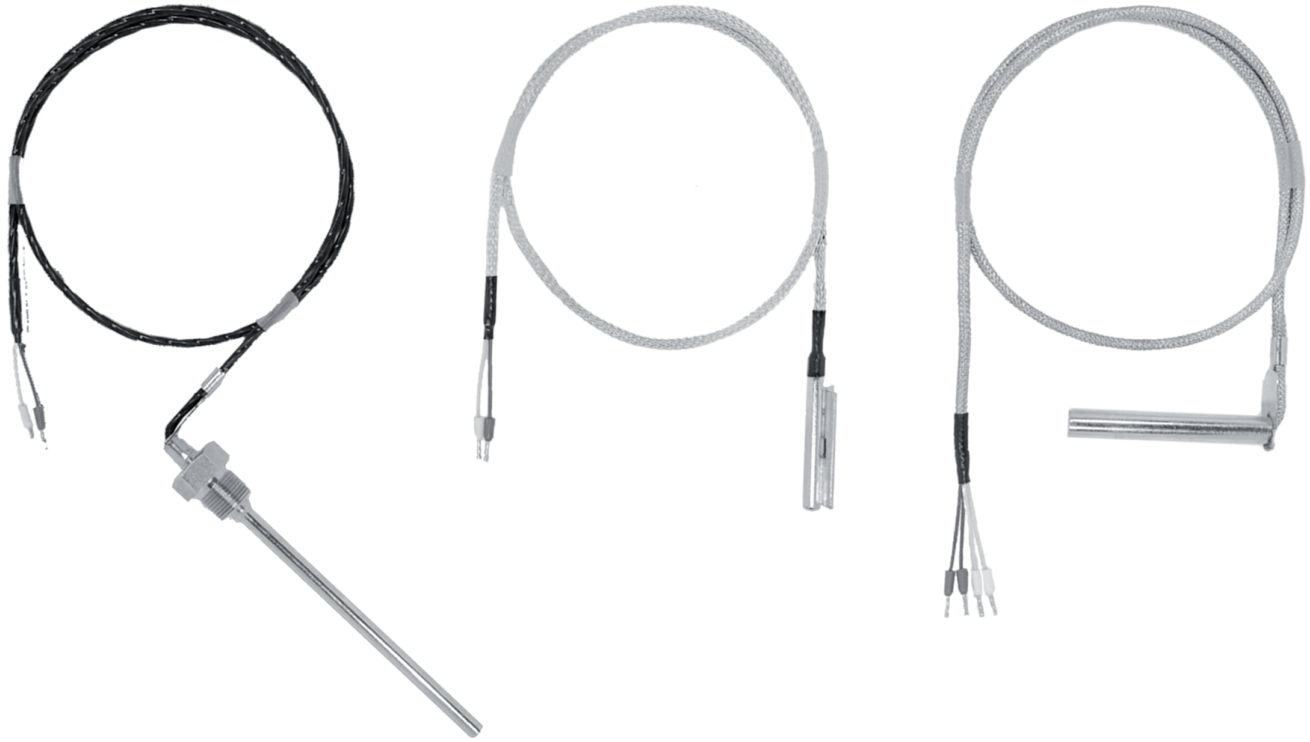
Temperature cable sensors for hazardous areas

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

II 2 G **II 3 G**
II 2 D **II 3 D**

Hazardous Areas - Ex ia



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Temperature cable 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.

Destination to the ATEX Directive

	Ex	II	1	G	D
non mining industry					
category of apparatus					
for gas hazardous areas					
for dust hazardous areas					

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

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					

Table 1. Temperature sensors marking:

Temperature sensor	...	T	...	...	Exi – ...	– ...	– ...	– ...	– ...	– ...	– ...	– ...	– ...
Single	no designation												
Double	2												
RTD Pt			OP										
Fe-CuNi; NiCr-NiAl			TJ; TK										
Cu-CuNi; NiCrSi-NiSi			TT; TN**										
Sheath to surface, with band				E-244									
Smooth sheath without threads, with sleeve				E-361									
Welded fitting with thread				E-361T									
With threaded welded				E-363									
With threaded swivel				E-365									
Thermowell length L [mm]					100*								
Thermowell diameter d [mm]						6*							
Conduit isolation: silicon							Si						
Conduit isolation: glass fibre, overbraided							Ws						
RTD type							Pt100*						
Hot juncion type for thermocouple							SO, SOA						
RTD class								A, B*					
TC class								1, 2					
RTD wire connection									2, 3, 4				
Thread size										M12x1,5*			
Conduit lenght L_p [m]											1,5m*		

* as agreed

** only as mineral insulated cable

Warning: sensors 2xPt100 diameter d < 6mm, have at the end of an additional symbol SP (see page 5)

3. Installation.

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

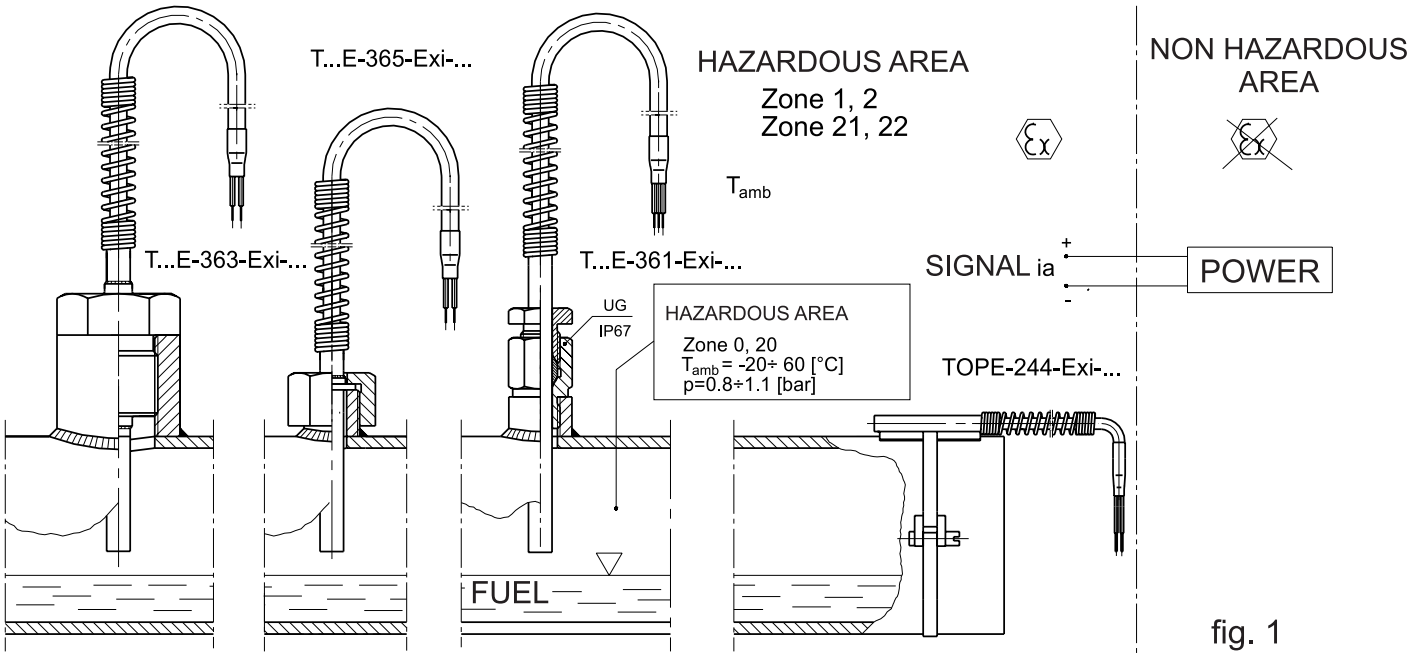


fig. 1

• measuring element in Zone 0 must be secured cover for wall thickness min. 1 mm

• 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.

B. Connection head and extension pipe in the zones: Z1, Z21, Z2, Z22, immersion part out of zone

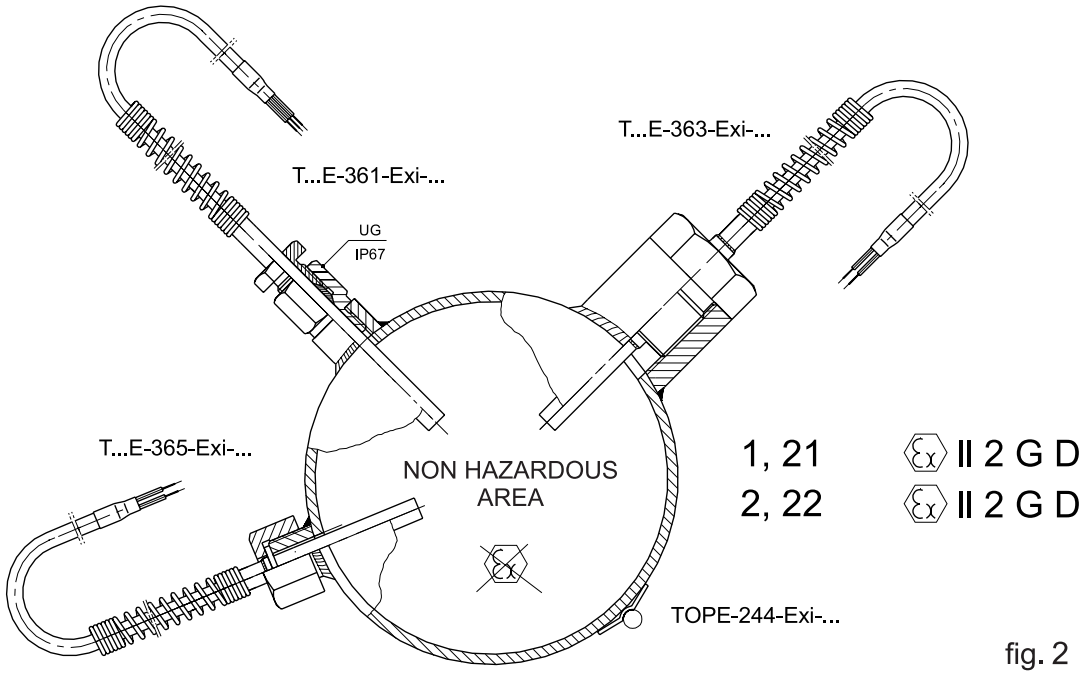


fig. 2

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.

Tightening moments for thread joints.

Tightening moments for thermowells and comperssion fittings	
Type of thred	**Max tightening [Nm]**
M6	2,9
M8	7
M10x1; G1/8	14
M12x1;G1/4	24
M14x1,5	38
M16x1,5; G3/8	58
M18x1,5	80
M20x1,5; G½, ½NPT	115
M24x1,5	200
M27x2; ¾, ¾NPT	275
M33x2; G1; 1NPT	506
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

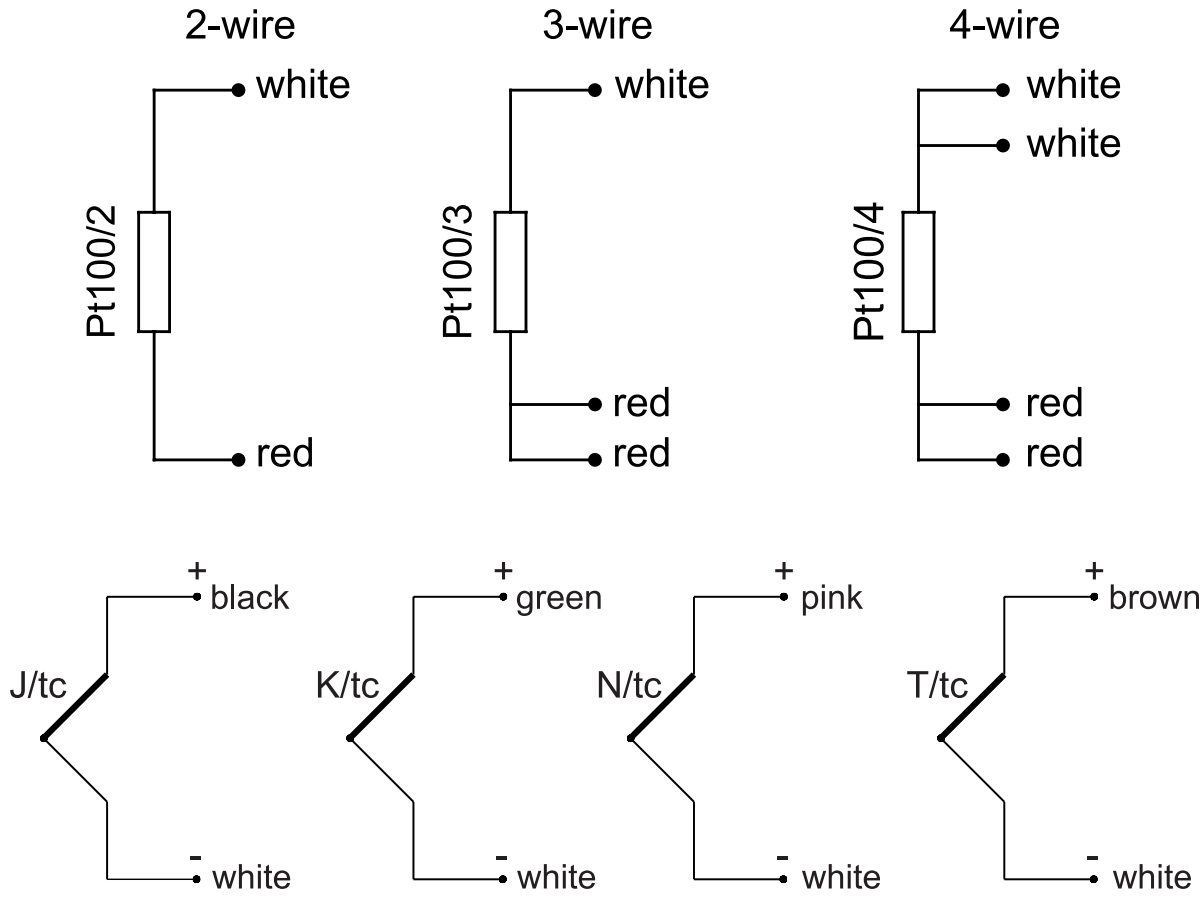
Sensor to connect to intrinsically safe circuit by cable according to project of electrical installation. The cable parameters C_L, L_L and L_i/R_i must be teken under consideration during accounting intrinsically safe circuit.

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

Cable sensors connection diagram:



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 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 T_{amb} the hottest surface of the sensor will be surface of transmitter / connection head.

$$T_p < T_{amb}$$

Cable sensors.

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 ÷ 60°C	Enclosure from connector side UG, Fig. 3.
Category ⟨Ex⟩ II 2 G, ⟨Ex⟩ II 3 G				
• RTD • TC	-200°C ÷ T_{amb} -40°C ÷ T_{amb}	T6	-40 ÷ 60°C	Enclosure from connector side UG, Fig. 4.

* - 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. 3)

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

$$T_p < T_{amb}$$

Cable sensors.

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: TOPE-361T, TTJE-361T, TTKE-361T, TENT-361T, TTTE-361T,			-40÷60°C	• inner surface of the thermowell bottom • outer surface of the tip of measuring insert Fig. 4. • tip of measuring insert or Fig. 5a. • outer sheath of measuring insert behind compression fitting Fig. 5b.
With fibre conduit • RTD • TC J • TC K	 T_{amb} ÷ 400°C T_{amb} ÷ 400°C T_{amb} ÷ 400°C	 T1...T6 T1...T6 T1...T6		
With silicon conduit • RTD • TC J • TC K	 T_{amb} ÷ 180°C T_{amb} ÷ 180°C T_{amb} ÷ 180°C	 T3...T6 T3...T6 T3...T6		
• Sensor TOPE-361T • Sensor TTJE-361T • Sensor TTKE-361T • Sensor TTNE-361T • Sensor TTTE-361T	T_{amb} ÷ 550°C T_{amb} ÷ 700°C T_{amb} ÷ 1200°C T_{amb} ÷ 1300°C T_{amb} ÷ 300°C	T 550°C...T6 T 700°C...T6 T 1200°C...T6 T 1300°C...T6 T 300°C...T6		

1) without influence of ambient temperature T_{amb} 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 3.)

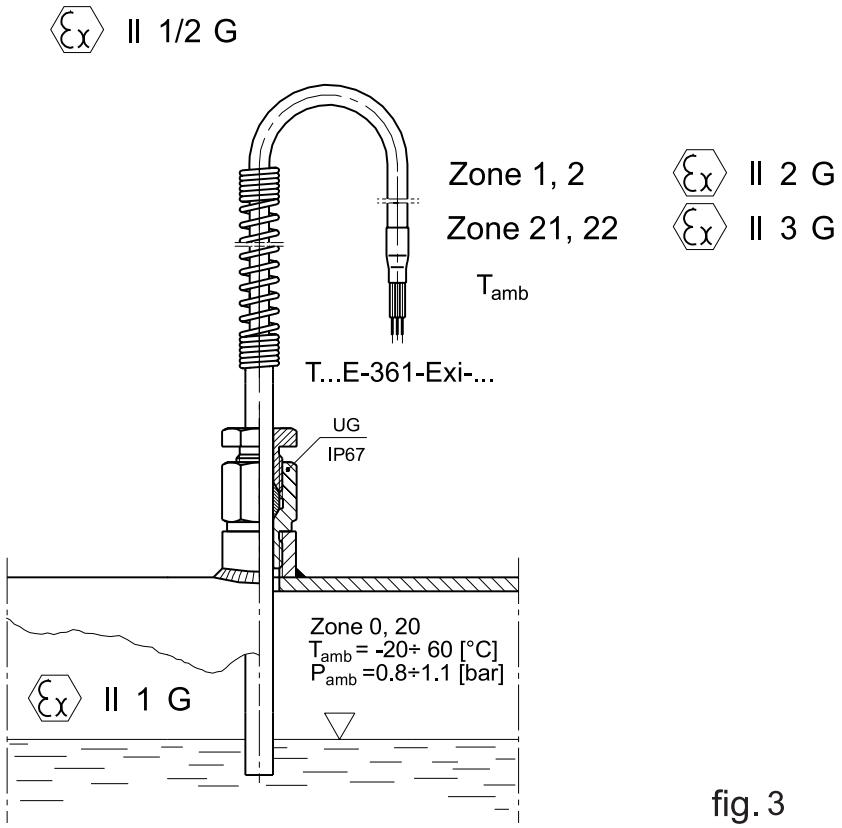


fig. 3

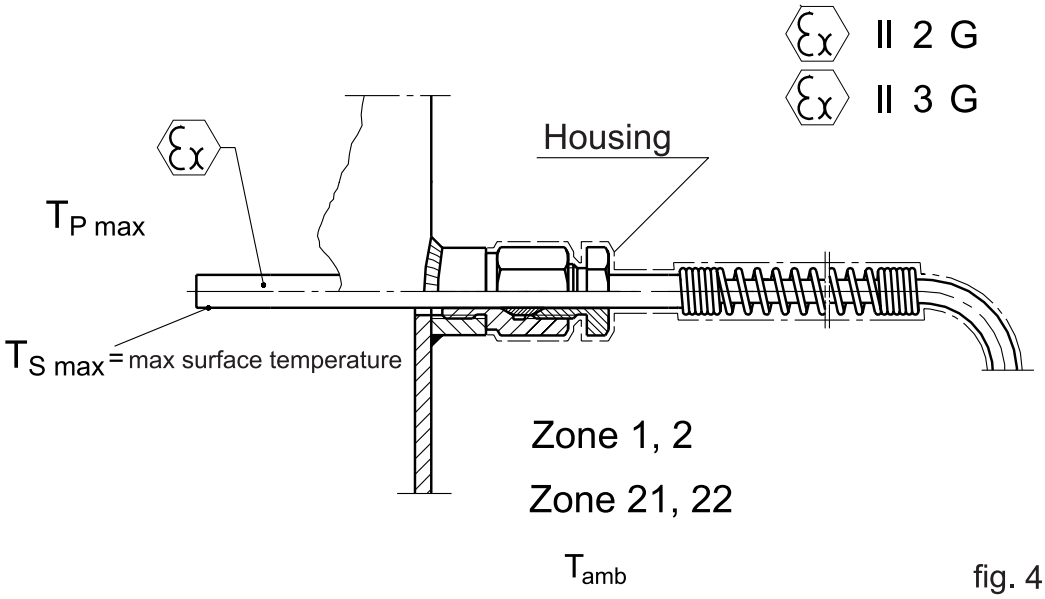


fig. 4

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

! For all sensors except TOPE-361T, TTJE-361T, TTKE-361T, TTNE-361T, TTTE-361T the max process temperature T_{pmax} must not be higher than the temperature of temperature class for surrounding explosive mixture.

T_{pmax} < T1...T6

fig. 5a

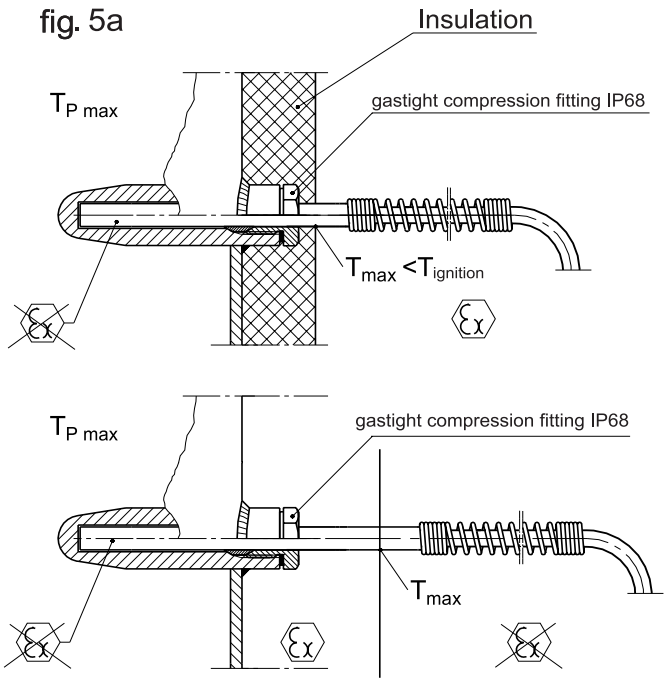


fig. 5b

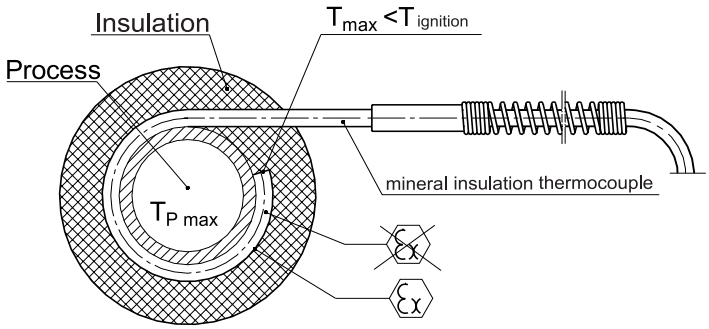


fig. 5c

! For sensors TOPE-361T, TTJE-361T, TTKE-361T, TTNE-361T, TTTE-361T the max process temperature T_{pmax} can be higher than class temperature for present xplosion 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.

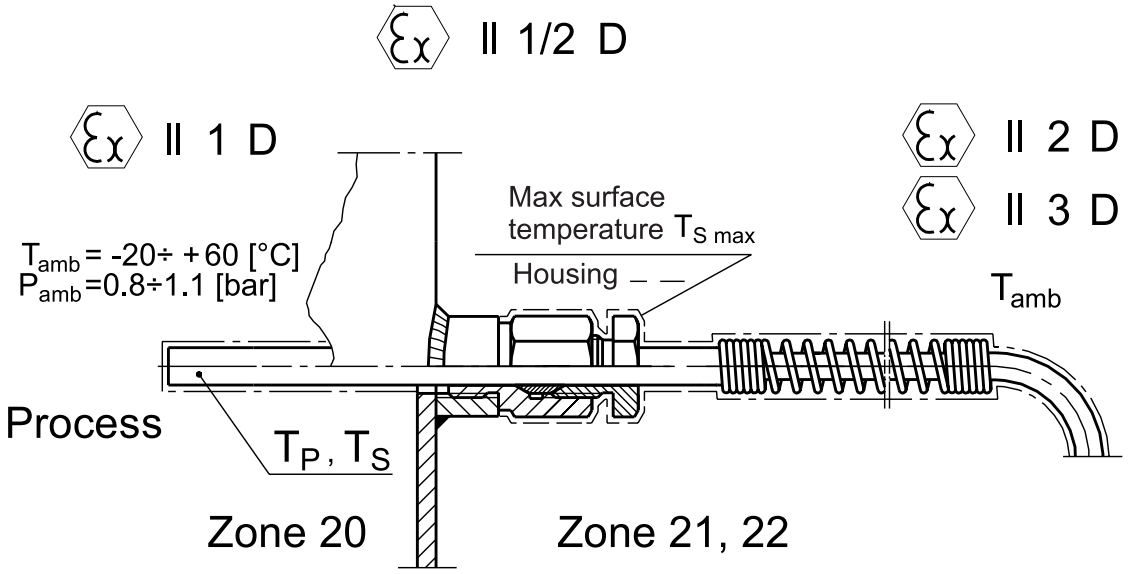
Maximal surface temperature of the sensor can be reached during operation in extreme conditions. Because tightness of the sensor is IP6X (dusttight enclosure) dust must not ingress inside and this concerns outside surface of the sensor.
If process temperature T_p is higher than ambient temperature T_{amb} sensor surfaces will be wormed by process temperature T_p , ambient temperature T_{amb} and self-heating Te. 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 information	-	-	825	-
Charcoal	180	530	20	140	19105	353
Coal (anthracite)	-	730	100	65	-	486

Graphite	580	no inflammation	-	-	505	-
Liguite	200	450	30	30	125	300
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
Copper	-	900	-	-	-	600
Electrolytic chromium	400	580	40	230	325	386
Ground aluminium (*)	460÷900	550÷700	50÷120	45÷120	389÷600	475÷466
Ground magnesium	430	560	40	30	355	373
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
Coumarin - indene resin	-	550	10	15		366
Ethylcellulose	350	370	10	25		246
Flameproof polyurethane foam	390	550	flame in presence of hot surface			366
Formic melamine-aldehyde resin	-	810	320	85	-	540
Formic phebol-aldehyde resin	-	580	15	25	-	386
Ground alkyl resin	270	500	120	155	195	333
Ground formic urea-aldehyde resin	-	460	80	85	-	306
Ground polystyrene	-	560	40	15	-	373
Methylcellulose	340	360	-	30	265	240
Methyl polymethacrylate	-	480	20	30	-	320
Non-flameproof polyurethane foam	440	510	20	30	365	340
Nylon (hexamethylene polyadipamied)	430	500	20	30	355	333
(*) Depending on size grading and manufacture process						

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.



$T_{S\,max}$ = Max surface temperature

$T_{P\,max}$ = Process temperature

fig. 6

! 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_{Sma}x occours on the immersion part of the sensor exposed to the process.

T_{Smax} < min(⅔ T_{Cl}; T_5 mm – 75K) for particular dust type

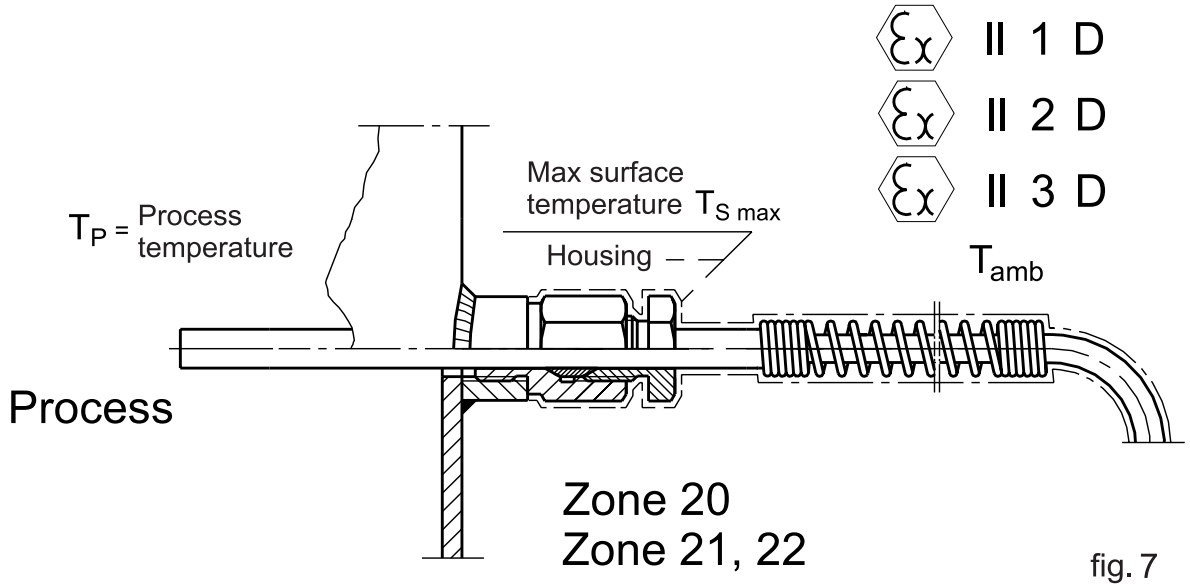


fig. 7

! 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 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 ⅔ of dust cloud self-inflamination 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 5.
- Humidity max 95%, for sensors with silicone conduit, max 45% for sensors with glass fibre + stainless wire.
- Sensors are destined to use indoor and outdoor location. IP degree IP65/00.

8. Documents.

To the each sensor is enclosed:

- Instruction manual for sensor,
- Warranty,
- Declaration of conformity.