

Classification of potentially explosion hazardous areas			
Duration/year – for information only:	Continuous hazard More than 1000 hours /years	Occasional hazard Between 10 and 1000 hours/year	Hazard only during abnormal operating conditions Less than 10 hours/year
IEC CENELEC Europe	Zone 0 (gas) Zone 20 (dust)	Zone 1 (gas) Zone 21 (dust)	Zone 2 (gas), Zone 22 (dust)
North America	Division 1 (gas and dust)		Division 2 (gas and dust)

Gases			
Zone	Symbol	Category	Protection requirements
0		1 G required	2 independent means of protection
1		2 G required, 1 G possible	1 independent means of protection
2		3 G required 1 G, 2 G possible	normal operation

Dusts				
Zone	Zone (old)	Symbol	Category	Protection requirements
20	10		1 D required	2 independent means of protection
21			2 D required, 1 D possible	1 independent means of protection
22	11		3 D required 1 D, 2 D possible	normal operation

450 °C

300 °C

200 °C

135 °C

100 °C

85 °C

Ignition temperature and classification of combustible materials according to groups and temperature classes (I = mining areas susceptible to fire damp II = all other atmospheres)

Maximum surface temperature of apparatus

	T1	T2	T3	T4	T5	T6
I	Methane					
II A	Acetone Ethane Ethyl acetat Ammonium, Benzol (pure) Acetic acid Carbon monox. Methanol Propane Toluene	Ethyl alcohol i-Amylacetate n-Butane n-Butylalcohol	Gasolines Diesel fuel Aircraft fuel n-Hexane	Acetaldehyde Ethylene		
II B	City gas	Aethylene				
II C	Hydrogen	Acetylen*)				Carbon disulfide*)

*) no authorised regulations

Ignition Triangle

Sources of ignition

- hot surfaces
- flames and hot gases
- mechanical sparking
- electrical installations
- transient currents
- static electricity
- lightning, ultrasonic energy

Oxidizers:

- air (21 % oxygen)
- pure oxygen
- oxygen releasing compounds (e.g. potassium manganate)

Fuels (flammable substances):

Flammable concentrations of gases and dusts from liquids or solids which have the potential to ignite an explosive atmosphere.



Explosion protection conform to directive 94/9/EC (ATEX 95a, formerly 100a)

Marking of electrical equipment

Following an example of marking of intrinsically safe electrical equipment:

EEEx ia IIC T6
 temperature class
 explosion group
 type of protection (two independent means of protection) conform to European standard

Following an example of marking of associated apparatus:

[EEEx ia] IIC
 explosion group
 type of protection acc. to European standard
 associated apparatus

To date, the test certificate number of the test authority used to contain the generation number of the applicable standard to indicate the amendment status, e.g.:

PTB Nr. Ex-85.B.2128X
PTB Nr. Ex-85.2128 X
 authorised body
 explosion protected apparatus
 year of issue
 generation indicator
 serial certificate number
 special conditions

According to ATEX marking must be as follows:

PTB 97 ATEX 2128X
PTB 97 ATEX 2128 X
 authorised body
 year of issue
 accord. to 94/9/EC
 serial certificate number
 special conditions

Within the European Union the devices must meet the respective requirements. If the manufacturer fulfills these, he is permitted to affix the CE sign. The ATEX directive extends marking: the identification number of the notified body, which carried out the quality assurance system approval, is added to the CE sign.



For example, the test body of the TÜV Hannover uses the identification code 0044, the PTB in Braunschweig code 0102 and the Exam (BVS) in Bochum code 0158. Additionally, the year of production and the constructional level of safety must be contained in the device's marking. Marking of intrinsically safe apparatus according to ATEX would be as follows:

II 1 G
 explosion protected against gas, vapour and mist (D = dusts)
 very high safety level suited for zone 0 (two independent means of protection)
 all areas except mining (mining = I)

Associated equipment is identifiable by round brackets enclosing the device category:

II (1) G may not be installed in hazardous areas

When combined intrinsically safe equipment receives e.g. the following marking:

II 1 G EEEx ia IIC T6

Analogue to this is the complete marking of the associated apparatus:

II (1) G [EEEx ia] IIC

Marking of a related apparatus for application in zone 2:

II 3 G Ex nA nC [nL] IIC/IIB T4

Overview of Protection Types			
Symbol	Name	Standard	Comments
	General requirements	EN 60079-0	EN 60079-0 comprises general regulations on the construction and testing of electrical apparatus for use in explosion hazardous areas.
	Oil immersion (o)	EN 60079-6	Protection type „oil immersion“ implies that the electrical apparatus and its components are separated from the potentially explosive atmosphere by immersion in oil.
	Pressurised enclosure (p)	EN 60079-2	A protective gas, which is under overpressure, (min 0,5 mbar) encloses and separates the ignition source from the surrounding atmosphere.
	Sand filling (q)	EN 60079-5	The finely grained material encloses the ignition source. An electric arc generated in the inside of the housing must not be capable of igniting the potentially explosive atmosphere during normal operation.
	Flameproof enclosure (d)	EN 60079-1	In the event of an ignition within the enclosure, the housing must be able to withstand the pressure and prevent the ignition from propagating to the surrounding atmosphere.
	Increased safety (e)	EN 60079-7	This protection type (e) applies only to electrical equipment and its components which is incapable of generating dangerous sparks, electrical arcs or thermal effects during normal operation. The voltage rating of this type of equipment may not exceed 11 kV.
	Intrinsic safety (i)	EN 60079-11	The energy in the current circuit is limited to such an extent that sparks, electrical arcs or high temperatures cannot be generated.
	Non-sparking apparatus (nA)	EN 60079-15	Sparking is excluded. Clearances and creepage distances are determined. Maximum surface and component temperatures are limited. The protection degree of the housing has to be at least IP54/IP44. Area of application: zone 2.
	Sparking apparatus (nC)	EN 60079-15	The protection type (nC) applies to sparking equipment, in which contacts are appropriately protected by: - enclosed switching device - enclosed i.e. sealed equipment - hermetically sealed housing. Area of application: zone 2.
	Energy limited apparatus (nL)	EN 60079-15	In case of protection type (nL) current and voltage are limited. Internal and external inductivity and capacities are only allowed to have certain limit values. The maximum surface and component temperature is limited. Area of application: zone 2.
	Encapsulation (m)	EN 60079-18	Possible ignition sources are encapsulated in a potting material so that they are incapable of igniting an explosive atmosphere.
	Intrinsically safe electrical systems (i-SYST)	EN 60079-25	One distinguishes between two types: - certified intrinsically safe systems - non-certified intrinsically safe systems An intrinsically safe system is the approved assembly of interconnected electrical equipment (intrinsically safe and associated apparatus). It is documented accordingly in the system description.

Proof of intrinsic safety

According to EN 60079-14 a proof of intrinsic safety must be provided to confirm that the equipment which is interconnected within an assembly accords to the requirements of intrinsic safety. In this context there is a clear distinction between two basically different circuits:

1. a simple intrinsically safe circuit with a single associated apparatus and at least one intrinsically safe apparatus without additional supply
2. more than one associated apparatus which is capable of supplying electrical energy to the intrinsically safe circuit, not only during normal service but also in a fault condition.

Simple circuits

The first definition of a simple intrinsically safe circuit requires to observe all electrical limit values stated in the EC type examination certificate and the power characteristics. If these conditions are met, the user is entitled to keep a proof of intrinsic safety. Inductances and capacitances of the installed cables must be taken into account.

Intrinsic safety of a simple circuit is given, if the following conditions are met:

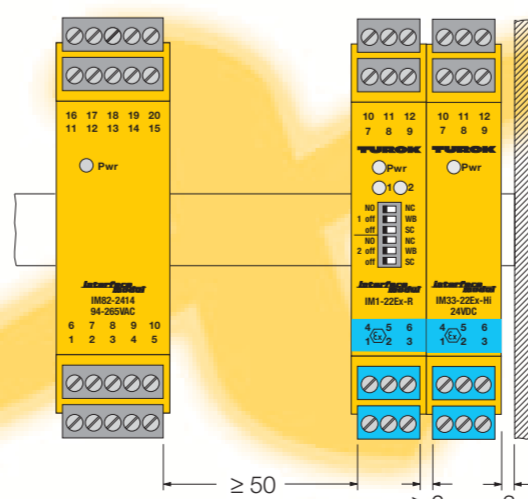
Associated apparatus	Condition	Intrinsically safe equipment + cable
U_0	\leq	U_i
I_0	\leq	I_i
P_0	\leq	P_i
L_0	\leq	$L_i + L_C$
C_0	\leq	$C_i + C_C$

The cable characteristics provided by the manufacturer should be used. Should these not be available, it is recommended to apply the following typical values (BASEEFA Newsletter no. 3, October 1980):
 $L_C = 1 \text{ mH/km}$
 $C_C = 110 \text{ nF/km}$

Connection of proximity switches to isolating switching amplifiers, or 2-wire transmitters to isolating transducers, or solenoid valves to a valve control module, can be considered as simple circuits.

General guidelines for the use of devices with intrinsically safe circuits

It is required to observe a safety distance of 3 mm (EN 60079-11, chapter 6.3, table 5) to earthed components, such as covers or side panels of mounting cabinets. A thread measure of 50 mm must be observed between intrinsically safe connections and non-safe connections.



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