Basics of explosion protection

Directives and standards

Development of directives

Up to the end of 1975, only national regulations covering the field of explosion protection existed in the individual European states. On 18 December 1975, the first framework directive for above ground explosion protection came into effect, and became applicable in the member states of the European Union: Directive 76/117/EEC.

By 1990 Directive 76/117/EEC had been modified several times. This directive referred to the characteristics and structure of the equipment at issue and was directly related to standards which applied exclusively to electrical equipment and explosion protection (except mining). As national regulations were still in force, the free transport of goods was still restricted.

At the beginning of 1994, the "Framework Directive 94/9/EC of the European Parliament and Council of 23 March 1994 on the approximation of laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres" was passed. This directive refers to the "Single European Act" of 1985 in accordance with Article 100a of the First Treaty for Establishing the European Community in the version of February 7, 1992. "ATEX 100a" is the standard abbreviation (ATEX derived from the French term "atmosphère explosible"). Besides Article 100a, there are other articles that have not been transposed in directives. In TURCK catalogs, the term ATEX always refers to the regulations pertaining to ATEX 100a.

The ATEX 100a Directive was integrated into national laws in the individual Member States of the EU, such as in Germany, with the Gerätesicherheitsgesetz (§11 GSGV - Equipment Safety Law) – since 1 December 2011, Produktsicherheitsgesetz (§34 ProdSG – Product Safety Law) – and the Explosionsschutzverordnung ExVO (11. ProdSV - Explosion Protection Ordinance).

The validity of the previous regulations for explosion protection expired on 30.06.2003. ATEX 100a came into force on 1 July 2003, and was superseded by ATEX 95a.

Efforts to harmonize explosion protection regulations worldwide led to the creation of IEC 60079. The aim here is to enable the free movement of goods worldwide. The IECEx scheme specifying approval requirements for equipment was first of all defined for this purpose. This also stipulates the provision of a quality management system which is binding for the manufacturer.

Installation and operation of electrical equipment in hazardous areas – standards and regulations

The following persons are involved in the installation, acceptance and operation of electrical equipment:

- The legislator responsible for industrial supervision, trade organizations, TÜV and experts as supervisory authorities.
- All plant personnel are required to act responsibly and observe precautionary measures such as smoking restrictions and work regulations during the servicing and operation of electrical equipment located in the hazardous area.
- Plant builders who must meet safety requirements according to EN 60079-14, (RL 1999/92/EC), ATEX 137.
- The manufacturers of components subject to construction requirements set forth by IEC/EN 60079 and ATEX 95a (RL 94/9/EC).

EN 60079-14 and DIN VDE 0165 – Installation of electrical equipment in explosion hazardous areas

The DIN VDE 0165 standard includes the safety requirements that must be observed (e.g. classification of explosion hazardous areas into zones, temperature classes, cable routing, requirements for the installation of electrical devices in zones 0, 1 and 2, many specific provisions). Unlike the standards described above, which are primarily for manufacturers, this standard applies to plant builders, operators and test personnel.

The rules for the interconnection are based on the installation requirements of IEC 60079-14 and EN 60079-14. These stipulate that the safety-related maximum values of the input and output parameters of the equipment must be compared in order to assess if the interconnection of several devices with intrinsically safe circuits complies with the requirements of intrinsic safety.

Ordinance on Industrial Safety and Health – (BetrSichV)

The industrial safety ordinance BetrSichV governs the health and safety aspects of the provision of work equipment and its use at work. Furthermore BetrSichV regulates the operation of equipment requiring supervision and the organization of occupational health and safety precautions.

ATEX 137 – Directive for plant operators

The 1999/92/EC Directive of the European Parliament and Council, dated 16 December 1999, describes the minimum health and safety requirements for improving the health and safety of employees exposed to the potential hazards of a potentially explosive atmosphere (previously ATEX 118, now ATEX 137). The directive is aimed at plant operators and employers and stipulates the requirements to be observed. These include the assessment of the risks resulting from a potentially explosive atmosphere, the classification of areas exposed to potentially explosive atmospheres, and the keeping of an explosion protection document.

The explosion protection ordinance – ExVO (11. ProdSV)

The explosion protection ordinance – ExVO (11. ProdSV) regulates the placing on the market of devices, protective systems and components intended for use in potentially explosive atmospheres and is the German transposition of the Directive 94/9/EC. The ordinance describes the essential health and safety requirements and mandatory conformity assessment procedures. The explosion protection ordinance is therefore mainly aimed at manufacturers of devices, maintenance, test and sales personnel.

Like Directive 94/9/EC, the explosion protection ordinance excludes the following equipment from its scope. The following is an extract of exceptions: medical devices, explosive substances, or unstable chemicals, personal protective equipment, seagoing vessels, offshore systems and products for military.

EN 60079-0 – Electrical equipment for explosive atmospheres, general requirements

EN 60079-0 lays down general requirements for the design and testing of electrical equipment required for the hazardous area. The following standards of the EN 60079 series describe the technical implementation of different protection types:

- Flameproof enclosure (EN 60079-1)
- Pressurized enclosure (EN 60079-2)
- Powder filling (EN 60079-5)
- Oil immersion (EN 60079-6)
- Increased safety(EN 60079-7)
- Intrinsic safety (EN 60079-11)
- Protection type n (EN 60079-15)
- Encapsulation(EN 60079-18)
- Intrinsically safe electrical systems (EN 60079-25)
- Optical radiation (EN 60079-28)

EN 60079-11 – Intrinsic safety “i”

Apart from the „intrinsic safety“ ignition protection, all methods of protection attempt to “contain” an explosion on the inside of the housing and to prevent the penetration of an ignitable gaseous mixture.

Protection with “intrinsic safety” is based on a different approach: It limits the electrical energy in a circuit to such an extent, that increased temperatures, sparks or arcs are incapable of generating the energy needed to ignite a potentially explosive atmosphere.

Due to the limitation of electrical energy, these circuits are mainly suited for use in the field of measuring, control and instrumentation and offer some considerable advantages compared to other protection types. An intrinsically safe circuit can therefore be maintained or connected under live conditions without the need for a hot work permit; the easy-to-use systems are also economical thanks to the use of inexpensive components. Last but not least, there are also many suppliers of components with protection type “i”.

Definition of terms

Explosion

By an explosion is meant an exothermic reaction of material (gas, vapor, mist or dust) that takes place at a very high speed of reaction. The risk of an explosion exists wherever there is the probability of an explosive atmosphere. This is possible wherever dust, flammable gases or liquids are manufactured, processed, transported or stored. Such hazardous atmospheres can be present for instance in chemical industries, gas stations, refineries, power plants, paint shops, vehicles, sewage plants, grain mills, airports, grain silos and filling plants.

Explosion hazards

Explosion hazards only exist in locations

- in which ignitable concentrations of flammable substances can exist under normal operating conditions or in the event of faults, and when these conditions provide the probability that a dangerous substance to air mixture is enough to form an explosive mixture;
- where the explosive or ignitable mixtures can come in contact with a source of ignition and continue to burn after ignition.

Explosive mixture (generic term)

An explosive mixture is a mixture of gases or vapors, mists or dusts, capable of propagating a reaction after ignition.

Potentially explosive atmosphere

A potentially explosive atmosphere contains gases, vapors, mists or dusts mixed with air, as well as the usual filler materials that can explode spontaneously under atmospheric conditions (see also ‘Explosive mixture’). This can occur wherever dust, flammable gases or liquids are manufactured, processed, transported or stored.

Potentially explosive atmosphere (hazardous)

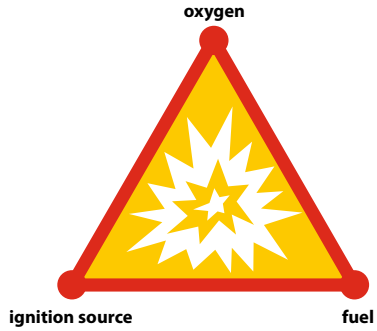
A hazardous explosive atmosphere is a mixture containing concentrations of flammable gases or vapors that, when ignited, can cause damage to persons directly or indirectly through an explosion (see also ‘Hazardous explosive atmosphere’).

Hazardous area

A hazardous area is an area in which there is a risk of explosion, i.e. a hazardous explosive atmosphere can occur due to local operating conditions. Such hazardous atmospheres can be present for instance in chemical industries, gas stations, refineries, power plants, paint shops, vehicles, sewage plants, grain mills, airports, grain silos and filling plants.

Ignition triangle

An ignition is only possible if three factors are present at the same time:



Possible ignition sources:
- hot surfaces
- flames and hot gases
- mechanically generated sparks
- electrical installations
- transient currents
- static electricity
- lightning, ultrasonic energy…

Oxidizers:
- air (21 % oxygen)
- pure oxygen
- oxygen releasing compounds (potassium permanganate etc.)

Combustible substances:
- Gases and dusts arising from flammable liquids and solid materials and present in the correct concentration for an explosion.

Explosive limits

A mixture is only explosive if the concentration is within certain material specific limits. These limits are called the upper and lower explosion limits and are listed in appropriate tables.

Flash-point

The flash-point is the lowest temperature at which a liquid releases sufficient vapors that can be ignited when close to an energy source and extinguished when the energy source is removed.

Primary and secondary explosion protection

Primary and secondary explosion protection measures are used to prevent explosions.

Primary explosion protection

Primary explosion protection consists of measures with which the formation of a hazardous atmosphere can be prevented:
- Avoiding the use of flammable liquids
- Increasing the flash point
- Limiting the concentration
- Natural and technical ventilation
- Monitoring the concentration…

(see also 'Secondary explosion protection')

Secondary explosion protection

Secondary explosion protection consists of measures with which the ignition of a hazardous atmosphere is prevented. For this purpose the electrical equipment is designed so that
- the equipment does not form an effective ignition source and the combining of ignition source and potentially explosive atmosphere is prevented.
- the penetration of ignition into the surrounding explosive atmosphere is prevented.

(see also 'Primary explosion protection')

Electrical equipment featuring ignition protection class „Intrinsic Safety" (IEC/EN 60079-11)

Intrinsically safe and associated electrical equipment

By "intrinsic safety" is meant the reduction of energy in an intrinsically safe circuit so that a thermal effect or spark is incapable of igniting a potentially explosive atmosphere under specified test conditions.

TURCK devices for use in explosion hazardous locations comply with protection type "intrinsic safety". The devices are categorized as intrinsically safe equipment and associated equipment. This distinction is clearly indicated by the marking of the devices (see section „Marking of equipment"). Intrinsically safe electrical equipment consists of devices that are provided exclusively with intrinsically safe circuits. They can be installed directly in the explosion hazardous area provided that the necessary requirements are observed (example: an approved NAMUR sensor in accordance with EN 60947-5-6 or transmitter).

Associated equipment is equipment that incorporates non-intrinsically safe circuits as well as intrinsically safe circuits. Intrinsically safe equipment may be connected to associated equipment, provided that all essential conditions for this kind of interconnected assembly are fulfilled. For example, an isolating switching amplifier is classed as associated equipment and the connected NAMUR sensor as intrinsically safe equipment.

Associated equipment must be installed outside of the Ex area or must be protected additionally by means of another protection type, e.g. flameproof enclosure or pressurized enclosure. A number of TURCK devices are approved for zone 2, enabling the installation of a device in the Ex area. All TURCK devices with intrinsically safe circuits (such as the interface module types) are classified as associated equipment.

Simple electrical equipment

Simple components and simple equipment that do not generate or store more than 1.5 V, 0.1 A and 25 mW do not require a test certificate and are classified as "simple electrical equipment" (e.g. thermocouples). This equipment is defined in the standard EN 60079-14.

Categories

Intrinsically safe and associated electrical equipment are subdivided into three categories according to EN 60079-11. The subdivision is based on the fault probability in the intrinsically safe circuit in conjunction with the possibility of ignition.

Category ia

Category "ia" indicates that the electrical equipment should not be able to ignite a dangerous mixture during normal operation, in the event of a single fault, and in the event of any combination of two faults. Intrinsic safety must be maintained when two independent faults occur at the same time. Components of any equipment of category "ia" that are susceptible to faults must therefore be available in triplicate.

Category ib

Category "ib" states that no ignition must occur in normal operation in the event of a fault. The intrinsic safety must be ensured in the event of a fault. A fault could be the failure of a safety-relevant component. With category ib equipment, safety-related components must therefore be provided in duplicate.

Category ic

Category "ic" denotes that no ignition must occur in normal operation. From 2011 this protection type replaces protection "nL" for use in zone 2. The benefits of intrinsically safe circuits are thus also available in this zone.

Ignition protection class n (EN 60079-15)

Devices with ignition protection class "n" must only be installed in zone 2 or 22. The devices must not provide any ignition sources in normal operation; no maintenance must be carried out during the operation. This must be ensured by means of suitable marking and mechanical locking.

Groups and temperature classes

Electrical equipment for use in explosion hazardous areas is classified into groups and classes based on the likelihood of an explosion hazard. This is of special importance in terms of safety and financial considerations because it determines the requirements that must be met by the electrical equipment. The division into groups is based on the location where the equipment is going to be used:

- Group I classified equipment may be used in mines susceptible to firedamp and must conform to EN 60079 and additional mining standards (e.g. EN 50303).
- Group II classified equipment may not be used in mining applications susceptible to firedamp but in all other explosion hazardous areas.

Group II classified equipment is used in all explosion hazardous areas except mining applications susceptible to firedamp. However, group II devices must be further classified depending on the application area in which they are used and the different flammable substances and ignition energy involved. A further subdivision of group II is therefore necessary and also useful for financial reasons.

The subdivision of group II equipment is based on the different ignition energy of the flammable materials. The different groups are classified by capital letters in ascending alphabetical order according to the hazard risk of the associated materials. Materials belonging to group C require less ignition energy than Group A materials. (see Tab. 1)

	T1	T2	T3	T4	T5	T6
I	methane					
II A	acetone, ethane, ethyl acetate, ammonia, benzene, acetic acid, carbon monoxide, methanol, propane, toluene	ethyl alcohol, i-amyl acetate, n-butane, n-butyl alcohol,	benzines, diesel fuel, aviation fuels, fuel oils, n-hexane	acetaldehyde, ethyl aether		
II B	town gas (coal gas)	ethylene*)				
II C	hydrogen	ethylene*)				carbon disulfide*)

*) no authorized regulations available

Tab. 1: Division of flammable materials – groups and temperature classes

Temperature class

The temperature class is the maximum permissible surface temperature of a device. The explosion protected apparatus can also be approved for several temperature classes – depending on technical and financial considerations.

Depending on the protection type the lowest possible temperature class is thus usually achieved with relatively extensive technical effort and accordingly high expense. The effort required for "intrinsic safety" is relatively low in comparison. Only intrinsically safe equipment that is installed directly in the explosion hazardous area requires a temperature class. The specification of a temperature class for associated equipment is not required.

Ignition temperature

The ignition temperature (defined as the temperature at which a mixture is susceptible to ignition in the course of a defined test procedure) is directly related to the temperature class. The temperature class indicates the maximum surface temperature of the electrical equipment and must be lower than the ignition temperature of the flammable material in order to prevent an ignition. (see Tab. 2)

IEC/EN NEC 505-10 temperature class	Maximum surface temperature of the equipment (°C)	Ignition temperatures of the flammable material (°C)
T1	450	>450
T2	300	>300 ≤ 450
	280	>280 ≤ 300
	260	> 260 ≤ 280
	230	> 230 ≤ 260
	215	> 215 ≤ 230
T3	200	> 200 ≤ 300
	180	> 180 ≤ 200
	165	> 165 ≤ 180
	160	> 160 ≤ 165
T4	135	> 135 ≤ 200
	120	> 120 ≤ 135
T5	100	> 100 ≤ 135
T6	85	> 85 ≤ 100

Tab. 2: Temperature classes with maximum permissible surface temperatures and ignition temperatures

Device groups and equipment categories according to ATEX

The ATEX device marking directive specifies an unambiguous marking for the application range and the design safety level of a device. EN 60079-11 also provides detailed information on how the protection measures were implemented and which applications are permitted and uses similar terms, but the information provided by EN 60079-11 and ATEX may be essentially different.

The first criterion of the ATEX Directive is the device group. Like the groups described above, the different groups are defined and described according to their place of use:

- Device group I: for mining underground with a potential hazard due to firedamp and/or combustible dusts
- Device group II: for all other locations in which a potentially explosive atmosphere exists

The second feature is the equipment category and describes the achieved safety level of a device:

- Equipment category 1: Very high level of safety; there are two independent protection measures; the device is also protected from ignition in the event of rare device faults
- Equipment category 2: high level of safety; there is a protection measure to ensure that the device is protected from ignition in the event faults that are frequent or are normally expected
- Equipment category 3: Normal safety; the device is protected from ignition in normal operation.

Devices classified as Group I (firedamp) use the prefix M, e.g. M1, in addition to the category classification.

The third feature is the Substance group which characterizes the application of devices in particular atmospheres:

- Substance group G: Explosion protection in potentially explosive atmospheres due to gases, vapor or mists (G: Gas)
- Substance group D: Explosion protection in potentially explosive atmospheres due to dusts (D: Dust)

The device marking also determines whether the device is associated equipment or intrinsically safe equipment. If it is associated equipment, the equipment category is placed in round brackets, e.g. II (1) G.

Equipment protection level (EPL)

Devices are classified according to their potential hazard. According to IEC 60079-0 the following equipment protection levels are defined for gas and dust explosion protection:

Gas explosion protection

EPL Ga:
- Device with very high protection level
- The device does not constitute a potential source of ignition when used for its intended purpose and when subject to faults which cannot necessarily be expected on a regular basis

EPL Gb:
- Device with high protection level
- The device does not constitute a potential source of ignition when used for its intended purpose and when subject to faults which cannot necessarily be expected on a regular basis

EPL Gc:
- Device with increased protection level
- The device does not constitute a potential source of ignition when used for its intended purpose
- The device is provided with additional protection, to prevent an ignition source with regularly expected faults.

Dust explosion protection

EPL Da
- Device with very high protection level
- The device does not constitute a potential source of ignition when used for its intended purpose and when subject to faults which cannot necessarily be expected on a regular basis

EPL Db:
- Device with high protection level
- The device does not constitute a potential source of ignition when used for its intended purpose and when subject to faults which cannot necessarily be expected on a regular basis

EPL Dc:
- Device with increased protection level
- The device does not constitute a potential source of ignition when used for its intended purpose
- The device is provided with additional protection, to prevent an ignition source with regularly expected faults.

EPL and zones

Devices with a higher protection level can be use in applications with lower protection levels. Devices approved for zone 0 can also be used in zone 1 and devices for zone 20 in zone 21.

Equipment protection level	Zone
Ga	0
Gb	1
Gc	2
Da	20
Db	21
Dc	22

Zone classification

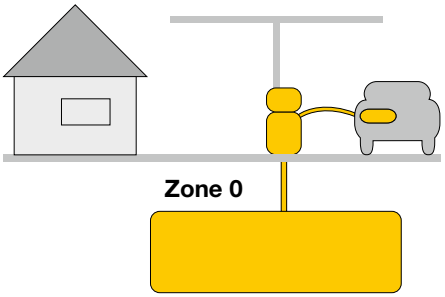
In accordance with EN 60079-10 and EN 1127-1, hazardous areas are classified into zones for flammable gases, vapors, fumes and combustible dusts. The classification is based on the likelihood that a hazardous explosive atmosphere can occur. The ATEX Directive has re-defined the zone divisions. The different definitions are listed as follows.

Classification according to
- Zone 0, 1 and 2 for gases, vapors and mists
- Zone 20, 21 and 22 for dusts

Zone classification for gases

Zone 0

Zone 0 consists of areas in which a hazardous explosive atmosphere is present continuously or frequently. The definition has been extended with the term "frequently" in the ATEX Directive. The example shows a gas station with the areas of zone 0.

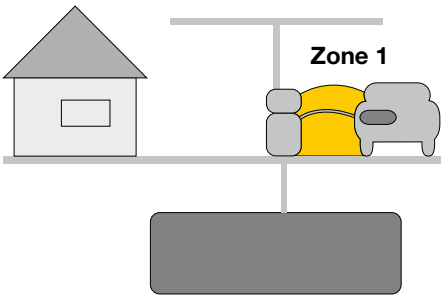


All equipment designed for use in zone 0 must meet category "ia" of equipment category 1 and must not contain any open switch contacts. Galvanic isolation between intrinsically safe and non-intrinsically safe equipment is recommended. If the intrinsically safe circuit has to be grounded for functional reasons, this must be implemented outside of zone 0, however, as close as possible to it. The devices must also be approved for gas group IIA, IIB and IIC.

Zone 1

Zone 1 consists of areas in which a hazardous explosive atmosphere is present occasionally. No change has been made here by the ATEX Directive. The example shows zone 1 is present during refueling in the area of the gas pump.

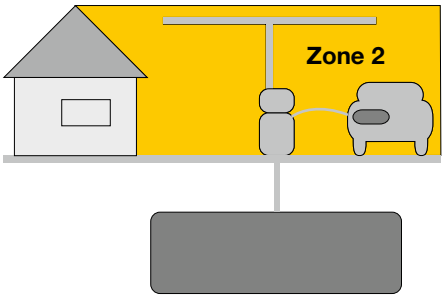
In industrial plants zone 1 is normally present in the following areas:
- in the close vicinity of zone 0
- in the area surrounding inspection openings
- in the area of filling and draining equipment
- inside equipment.



Zone 1 requires equipment category 2 and an approval of devices in group IIA, IIB or IIC, at least in category "ib".

Zone 2

Zone 2 consists of areas in which a hazardous or potentially explosive atmosphere is rarely present and for a short time. According to the ATEX Directive, the definition states that the presence of a potentially explosive atmosphere is not expected, and if so only rarely and for a short period. In industrial applications this includes the following examples:
- Areas near zones 0 and 1
- Areas near flange seals where standard flat seals are used
- Areas near pipelines in closed rooms



A test certificate from a test authority is not required for use in zone 2 as is compulsory in zone 0 and zone 1. Devices must comply with category 3. The equipment must meet the following criteria (EN 60079-15):

- restricted breathing enclosures (10 K overtemperature only)
- sealed enclosures (various test methods and requirements)
- simple pressurized enclosure (like "p" without purging)
- limited energy (intrinsic safety without safety factor)
- encapsulated switching devices (simple "pressurized enclosure")
- lower requirements for equipment in zone 1, e.g.
- clearance and creepage distances
- housing impact test
- plastic materials
- construction of lampholders and starters

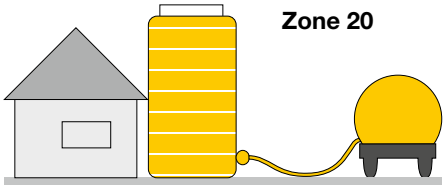
Use of devices in Zone 0 to 2

The intrinsically safe and associated equipment used in Zone 0 to 2 (gases, vapors) must comply at least with the requirements stipulated for the zone at the location where the intrinsically safe equipment is used. If the equipment meets higher requirements, operation is obviously permitted. The national regulations apply to THE interconnected assembly and installation of devices. (For this refer to the information stated under General Notes for the User on the Use of Equipment with Intrinsically Safe Circuits).

Zone classification for combustible dusts and fibers

Zone 20

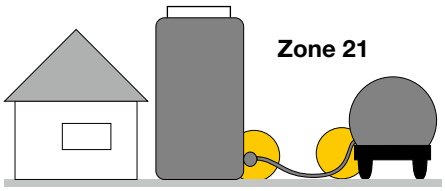
According to the ATEX Directive, zone 20 is an area in which during normal operation, a potentially explosive atmosphere in the form of a dust cloud can occur continuously or for long periods or frequently. Dust deposits in a known or excessive thickness can be formed. Dust deposits alone do not form a zone 20. Normally these conditions can only be present inside containers, pipes, apparatus etc.



Areas in which dust deposits are present but dust clouds are not present permanently or for long periods or frequently are not assigned to this zone.

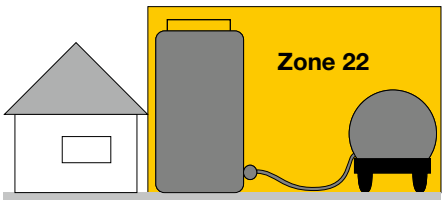
Zone 21 and zone 22

Zone 21:
Zone 21 is an area in which a potentially explosive atmosphere in the form of a dust cloud can occur occasionally during normal operation. Dust deposits or layers of combustible dust will usually be present.



These can include areas in the close vicinity of filling or dust extraction stations, where dust deposits form and potentially explosive concentrations of flammable dust mixed with air may occur during normal operation.

Zone 22:
Zone 22 is an area in which it is unlikely that a potentially explosive atmosphere in the form of a dust cloud occurs during normal operation. However if such an atmosphere does occur, then only for a short period, or as a result of dust accumulation or layers of combustible dust.



This includes areas in the vicinity of equipment containing dust which can escape due to leakage and where dust deposits can build up (e.g. mills from which dust is released and accumulates).

Use of devices in Zone 20 to 22

National regulations (EN 60079-14/EN 61241-14) must be applied to the selection, installation and maintenance of devices in the area where flammable dust is present. Intrinsically safe devices installed in zone 20 to 22 must therefore have the appropriate approval. Associated equipment, on the other hand, does not require an approval for flammable dusts, and an approval for gases and vapor is sufficient. It is only necessary to ensure that the limit values of intrinsic safety of the EC type examination certificate are met for an interconnected assembly. In this case the intrinsically safe device can then be marked for example as II 1 D and the associated equipment as II (1) G. To prevent misunderstandings, it is standard practice to use the marking II (1) G, II (1) D.

The special requirements for dust protection must be observed for the installation. For example, simple equipment for use in zones 20 to 22 must have an approval, whereas this is not necessary for simple equipment used in zones 0 to 2.

Marking of equipment

Device marking according to CENELEC regulations

Equipment for explosion protected areas must be clearly marked. There are two different types of marking.
According to CENELEC, marking of equipment conforming to EN 60079-0/…-11 must provide the following information:

- Manufacturer's name or trademark
- Type designation
- Serial number
- Test authority
- Ex symbol
- Ignition category code (e.g. "ia")
- If special conditions must be observed: the "X" after the certificate number.

Tab.3: Zone classification – Equipment categories

Zone classification	Likelihood of an explosive atmosphere	Compliance with safety requirements by	Requirements fulfilled by:		
			Equipment group	Related equipment category	Additional equipment category
Zone 0 (gas, …) Zone 20 (dust)	Continuously, for long periods or frequently	2 independent means of protection	II	1G (for gas, ...)	–
			III	1D (for dust)	
Zone 1 Zone 21	Occasionally	1 independent means of protection	II	2 G	1
			III	2 D	
Zone 2 Zone 22	Unlikely or infrequently - for a short period only	Normal operation	II	3 G	1 or 2
			III	3 D	

- Group with the appropriate subdivision (e.g. IIC)
- Temperature class or maximum surface temperature (for group II devices)
- Entry of test authority with date and consecutive number
- Equipment protection level (e.g. "Ga")

An intrinsically safe device is marked as follows:

Ex ia IIC T6 Ga	
Ex	Complies with explosion protection regulations
ia	Protection type (Category)
IIC	Explosion group
T6	Temperature class
Ga	Equipment protection level

Associated equipment for example is marked as follows:

[Ex ia Ga] IIC	
Ex	Complies with explosion protection regulations
Ia	Protection type (Category)
IIC	Explosion group
Ga	Equipment protection level

Marking in accordance with the ATEX Directive

According to the ATEX Directive, the certificate number of the EC type examination certificate must have the following type of marking:

PTB 97 ATEX 2128X	
PTB	Authorized body
97	Test year
ATEX	In accordance with 94/9/EC Directive
2128	Consec. no. of the certificate
X	Special conditions

Within the European Union the devices must meet the relevant requirements. If the manufacturer fulfills these, he is permitted to affix the CE mark with the identification number of the notified body, which carried out the quality assurance system approval.

CE 0102

The test authority TÜV Hannover has the ID number 0044, EXAM (BVS) Bochum 0158 and PTB in Braunschweig 0102.

The marking of the device must also indicate the year of production and the constructional level of safety acc. to ATEX.

For intrinsically safe devices the marking would be:

II 1 G	
II	All areas except mining
1	Suitable for a very high level of safety for zone 0
G	Explosion protected against gas, vapor and mist

With associated equipment, the equipment category is placed in round brackets:

II (1) G	
II	All areas except mining
(1)	Must not be installed in the explosion hazardous area
G	Explosion protected against gas, vapor and mist

Manufacturer obligations

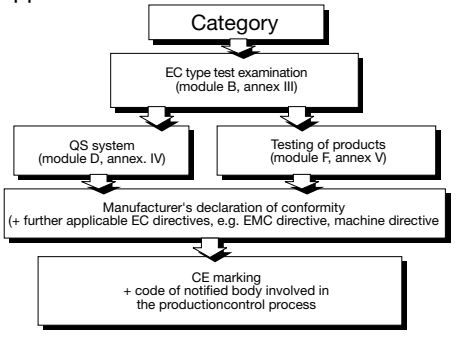
Conformity certificates of the manufacturer and EC type examination certificate of a certification body

A test authority must examine and certify that the devices are suited for use in explosion hazardous areas and comply with the relevant regulations and standards. For this the manufacturer submits a test sample to the test authority. The testy authority then issues the test report which is passed on to a certification body. The certification body decides on the basis of the test report whether an EC type examination certificate is issued. The test and certification bodies in the EC are registered centrally.

The type examination certificate contains all relevant explosion protection data for devices of zone 0 and zone 1. This certificate is kept exclusively with the manufacturer of the device. The manufacturer provides operating instructions for his device containing the relevant explosion protection data. The manufacturer also certifies with his conformity declaration that the defined standards and directives have been observed. These two documents are required by the user for the documentation of his installation.

CE marking procedures

Devices for use in explosion hazardous areas are provided with the CE marking and the identification code of the testing authority. The procedure for issuing the CE marking is clearly defined and depends on the equipment category. The example shown for equipment category 1 illustrates the highest safety level and the applicable annexes of the 94/9/EC Directive are also shown.

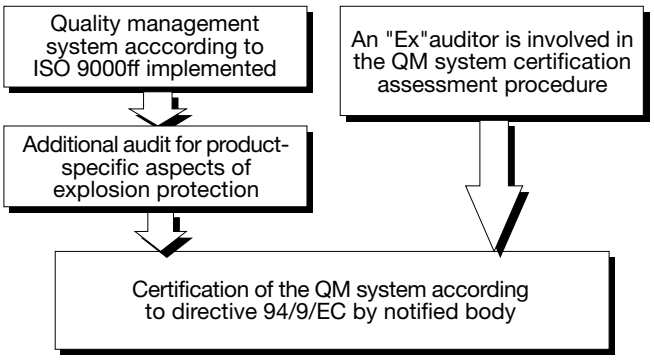


Different annexes apply to the various equipment categories.

QA system approval

The manufacturer of category 1 and 2 intrinsically safe devices must have an approved quality management system. The approval is designed to ensure that manufacturers produce their devices in accordance with the type examination certificate and that the relevant safety regulations are observed. The system approval is carried out by an approved body. This can be achieved in two ways.

Approval can be achieved directly within the scope of certification according to ISO 9000ff. Approval of those fields associated with explosion protection is accomplished in cooperation with an expert from the approval body. If the ISO certificate has already been granted, it is possible to certify those parts relating to explosion protection subsequently within the scope of an additional audit. The following illustration shows both methods.



TURCK's manufacturing sites for explosion protected devices are certified according to ISO 9001 and have a QA system approval.

General guidelines on the use of devices with intrinsically safe circuits

The relevant national regulations and standards are the basis for the use of devices with intrinsically safe circuits. These must be strictly observed and followed. The user is obliged to keep up-to-date with the latest revisions. The following guidelines relate to the ATEX (94/9/EC) Directive of the member states of the European Union, especially to the field of explosion protection in areas exposed to hazards by gas.

If the device is classified as an associated apparatus equipped with intrinsically safe and non-intrinsically safe circuits, it may not be installed in explosion hazardous areas. Intrinsically safe devices located in the hazardous area can only be connected to the intrinsically safe circuits. With the TURCK devices, the intrinsically safe connections are provided with a blue marking.

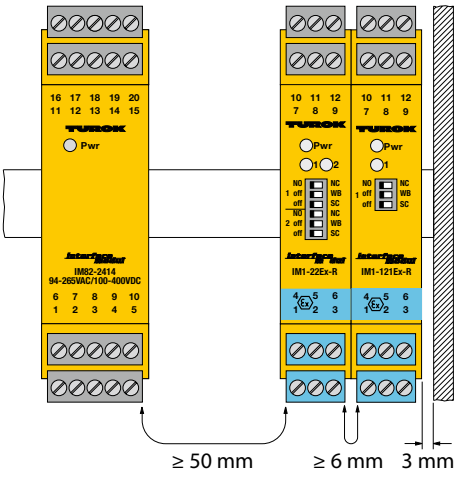
When interconnecting devices within such an assembly, the "Verification of intrinsic safety" must be completed without fail (EN 60079-14: 2004, chap. 12.2.5). This examines whether all data related to explosion protection of the different devices can be operated together. Verification must take into account the internal capacitances and inductances of the cable used. Please refer to the separate section "Verification of intrinsic safety".

Intrinsically safe circuits must never be connected to non-intrinsically safe circuits. A single operation may result in critical protective devices being destroyed without the user noticing anything. A function test does not provide the satisfactory information to determine this. The use of equipment with intrinsically safe circuits connected to non-intrinsically safe circuits is no longer permissible in explosion protection applications.

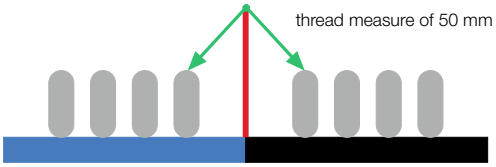
The installation of intrinsically safe circuits, mounting to external connections, cable characteristics and cable installation must comply with the relevant regulations. Cables and terminals with intrinsically safe circuits must be marked and separated from non-intrinsically safe circuits or provided with appropriate isolation (> 1500 VAC).

The following is an extract of the requirements according to EN 60079-14:

- protection against external electrical or magnetic fields (e.g. power current cables)
- prevent conductor splicing of fine wires using ferrules
- min. cross section (also for single wires of a conductor): 0.1 mm
- protection from damage (mechanical, chemical, thermic…)
- armoring, metal cladding, shielding of cables and lines
- no common use of single-core cables for intrinsically and non-intrinsically safe circuits in one line
- separate fault assessment when using multi-core cables and lines
- when marking cables by color, light-blue must be used



Either a partition must be used between intrinsically safe and non-intrinsically safe connections so that the minimum clearance is 50 mm (thread measure), or each connection must be covered individually and securely with a sleeve so that no part of the connection is exposed.



A thread measure is the distance between the circuits around a partition. This is necessary because it is possible to work with live intrinsically safe circuits; when disconnected, these circuits must therefore not come into contact accidentally with any non-intrinsically safe connectors. This distance is however only required for external connections which can be accessed by the user. The minimum distance between two intrinsically safe circuits must be 6 mm and the separation from other (grounded) metal parts must be 3 mm.

Approval becomes invalid if the device is repaired, altered or opened by a person other than the manufacturer or an expert unless the specific instructions for the device explicitly permit such interventions. Only in this way is the required technical information

about the protection measures available, and is it possible to ensure that the device continues to comply with the regulations. Visible changes to the housing, such has brown-black colorations caused by heat, holes or deformations indicate a serious fault. The device must be switched off immediately and examined. If necessary, the connected devices must also be examined.

The inspection of a device with regard to all relevant aspects of explosion protection may only be carried out by an expert or the manufacturer. Operation of the device is only permitted within the specified limits. For example, the supply voltage may never exceed the maximum rating, and the temperature range during operation must be strictly observed.

Intrinsically safe circuits with galvanic isolation - as is the case with TURCK devices - should not be grounded unless absolutely necessary from a functional point of view. Circuits without galvanic isolation, e.g. Zener barriers, always require grounding. The relevant grounding regulations are laid down in EN 60079-14. The grounding of a circuit in zone 0 is not necessary. If grounding is necessary for functional reasons, then it must be carried out in close proximity to zone 0.

Prior to every commissioning or after any change of the device interconnection within the assembly, it must be ensured that all applicable regulations, directives and framework directives are met, that all safety regulations are fulfilled and that the device is functioning properly. Only then is operation permitted.

Mounting and connection of the device should only be carried out by qualified and trained staff familiar with the relevant national and international regulations of explosion protection to ensure correct operation. Only in this way can it be ensured that the system is always in the required safe condition.

The operator of a system is responsible for its proper working order, and must ensure that it is supervised continuously, that necessary maintenance and work is carried out immediately, and that the relevant safety measures are implemented. If necessary, a system must be tested at least every three years.

Verification of intrinsic safety

EN 60079-14 stipulates that the intrinsic safety of interconnected devices must be verified. There are two basic types of circuits:

- First case: Simple intrinsically safe circuit with only one associated apparatus and at least one intrinsically safe apparatus without further supply
- Second case: Several associated apparatus which can supply electrical energy to the intrinsically safe circuit in normal operation and in the event of a fault.

Simple circuit

In the first case of a simple intrinsically safe circuit, only the electrical limit values from the type examination certificates and the rating values have to be examined for the verification of intrinsic safety. The inductance and capacitance values of the cables used must also be taken into account here. The intrinsic safety of a simple current circuit is verified if the limit values examined meet the following requirements:

Associated equipment	Conditions	Intrinsically safe device + cable
U_0	≤	U_I
I_0	≤	I_I
P_0	≤	P_I
L_0	≥	$L_I + L_C$
C_0	≥	$C_I + C_C$

This applies to circuits with:
- A non-linear output characteristic of the associated equipment and (at the same time)
- Exclusive occurrence of distributed reactances.

If massed reactances are present and the associated equipment has linear limitation, a check must be made whether:
- C_0 1 % of C_I
- L_0 1 % of L_I
-

As soon as one of the two conditions is fulfilled, the percentage of C_0 and L_0 must be reduced by half. (so-called 50 % rule).

Example: Verification of intrinsic safety

Associated equipment: Designation	Type	Manufacturer	Test certificate no.	Expl. group	U_0 [V]	I_0 [mA]	P_0 [mW]	L_0 [mH]	C_0 [µF]
Isolating switching amplifier	IM1-22EX-R	TURCK	TÜV D4 ATEX 2553	[Ex ia Ga] IIC	9.6	11.0	26.0	1.0	1.1

Intrinsically safe equipment: No.	Designation	Type	Manufacturer	Test certificate no.	Expl. group	U_i [V]	I_i [mA]	P_i [mW]	L_i [µH]	C_i [nF]
1	Proximity switch	BIM-INT-Y1X	TURCK	KEMA 01 ATEX 1264 X	EEx ia IIC T6	20.0	60.0	80.0	150.0	150.0
2	Proximity switch	BI1-EG05-Y1	TURCK	KEMA 02 ATEX 1090 X	Ex ia IIC T6	20.0	60.0	130.0	150.0	150.0

⇒	Cable inductances and capacitances: (Manufactures spec. or $L_c = 1$ mH/km. $C_c = 110$ nF/km)	Total cable length: 130 m	0.13	14.3
	Total inductances and capacitances: (ΣL_i and ΣC_i)		150.13	164.3
	Intrinsic safety is achieved if all conditions are fulfilled: $U_0 \leq Ui$ $I_0 \leq Ii$ $P_0 \leq Pi$ $L_0 \geq \Sigma L_i$ $C_0 \geq \Sigma C_i$			

The manufacturer's specifications must be observed for the cables. If these specifications are not available, the following values can be assumed (according to EN 60017-14, Part 12.2.2.2.): 200 pF/m and 1 mH/m or 30 µH/Ω.
If the value P_0 of the associated equipment is not stated, a linear characteristic must be present. From this P_0 can be calculated by $P_0 = ¼ \times I_0 \times U_0$.

The connection of proximity switches to isolating switching amplifiers, two-wire transmitters to isolating transducers or solenoid valves to valve control modules can be regarded as examples of simple circuits. The conformance certificate and the EC type examination certificate contain different indices for the limit values. In this description only the indices according to EN 60079-14 are used. The index 0 here stands for maximum limit data that can be output and I for the maximum limit data that can supplied.
Standardized documents should be used for the intrinsic safety verification in order to ensure greater clarity. Besides the date and the name of the issuer, the document should also contain the circuit designation or number.

Interconnection/assembly of several devices

The second case considers the interconnection of several active associated apparatus. The electrical limit values of the EC type examination certificate must not in this case be used as proof of intrinsic safety. This procedure is fundamentally different to the first case. This considers a new assembly based on the interconnection of the individual associated apparatus into a single assembly with new limit values. This kind of interconnected assembly is then always assigned to category "ib", even if all the individual apparatus are assigned to category "ia". The use of such an assembly for zone 0 is therefore not permitted. A detailed description of the interconnection and assembly of several devices is beyond the scope of this introduction. The related calculation methods and an example are contained in annexes A and B of EN 60079-14. The ignition curves of IEC 60079-11 are also required for this. These ignition curves are also contained in EN 50020.

A special procedure must be observed when interconnecting associated equipment that does not have linear characteristics throughout. This is described in detail in EN 60079-25.

Applicability of approvals

Scope of approvals/national approvals

Equipment that conforms to the ATEX Directive can be freely traded, installed and operated in the member states of the European Union.

ATEX approval is recognized in Switzerland although this country is not a member of the EU. An approval by the SEV is no longer required if the customer is provided with the necessary documentation. This includes the operating instructions of the device, the type examination certificate, the CE declaration and the certificate of the manufacturer's Ex audit.

Many states worldwide require their own national approval of the equipment. TURCK devices are therefore often provided with approvals for different states. National approvals are required, for example, in the USA, Canada, China, Japan, Australia or the CIS countries. Other countries accept the issued approvals of other states. For this reason, knowledge of national regulations is essential.

In many countries, approvals are only issued for a limited period. When purchasing a device it should therefore be ensured that the time limit for the approval was renewed. Further operation is accepted in many countries if an approval elapses after the installation.

The ATEX approval and the approvals in the USA and Canada are not time limited.

Approvals available on the internet

Current overview of approvals

The approvals of all TURCK devices are available on the Internet and can be downloaded directly from the TURCK website: www.turck.com

Glossary

Terms and explanations

Active metal part

Active metal parts are conductors or conductive components that carry an electrical voltage during operation.

Actuator

An actuator, such as a control valve for example, is a device that converts electrical control signals into mechanical motion.

Address

The address is on a network, a numerical identification that is needed to identify the participants, e.g. the hardware address of a field bus (MAC address) or the IP address of a host (PC).

Addressing

Addressing describes the assignment and setting of an address, e.g. for a station in a network.

Alarm output

A detected error resulted in the shutdown of the corresponding output. The alarm output remains on as long as the input circuit monitoring does not detect any faults. If a fault occurs in a circuit, the alarm output switches off (see also 'Common alarm output').

Alarm output (interface technology)

Electrical output that is set to LOW in the event of an error.

Analog

Representation of a signal with continuous, interruption-free history.

Analog output

The analog output signal of the device is used for the continuous output of a measured variable. The format of an analog signal is for example 0/4 … 20 mA or 0/2 … 10 V.

Analog signal

An analog signal is an electrical signal that can continuously take on any infinitely variable value between a minimum and maximum value (see also 'Digital signal'). For analog signals, the value x of the physical size (such as a voltage) is also mapped as physical size. Thus there is an analogous correlation between the physical unit and the value representing it.

Application area (Ex devices)

The application areas for Ex devices are:
- The areas in the explosion hazardous zones themselves
- The areas outside of the explosion hazardous zones

ARP

ARP (Address Resolution Protocol) is used to assign hardware addresses (MAC IDs) worldwide to the IP address of the network stations. The assignments are managed in internal tables (AR tables).

ATEX

The abbreviation for "Atmosphère explosible" stands for the EC Framework Directive 94/9/EC, which refers to the "single European Act" under Article 100a of the EU. The corresponding national regulations for explosion protection were adopted from the ATEX 100a.

Attenuating element

Attenuating elements consist of a special material and serve for the damping of sensors.

Backplane

A backplane is a mounting plate which provides slots for taking module cards.

Baud

Baud is a unit for the transmission speed. One baud corresponds to the transfer of one step/signal change per second. If one bit is transferred per step, the baud rate is identical to the transfer rate in bits per second, if a step is transferred in 0.2 s, the baud rate is 5.

Baud rate

See Baud

Bidirectional

Bidirectional means that the data and signals are transmitted at the same time from point to point in both directions.

Burden

The burden defines the maximum value of the resistance on an analog output. This value consists of the load of the connected device and the cable resistance.

Bus

A bus collects and transmits data and control information between different components such as CPU, memory and I/O level following a defined protocol. A bus can be composed of a number of parallel cables for data transfer, addressing, control and power supply.

Bus cycle time

The bus cycle time is the time required by a master to serve all stations of a bus system once, i.e. to write the corresponding outputs and read the inputs.

Bus system

A bus system describes the totality of all units that communicate with one another via a bus. Serial bus systems transfer the information serially via a common line; parallel bus systems consist of several parallel lines on which data, address or control information is transferred in parallel.

Cable compensation

With temperature measurements a so-called cable compensation may be required, depending on the measuring process (e.g. Pt100 in 2-wire circuits). With resistance thermometers, the resistance value of the incoming cable must be taken into account with 2-wire circuits; this resistance value is determined with cable compensation and can thus be compensated. Otherwise unwanted corruptions of the measuring result may occur.

Cable resistance

The cable resistance is the resistance value of a complete cable (feed and return cables).

Capacitive coupling

A capacitive (electrical) coupling occurs between conductors located on different potentials. This can cause interference. Possible causes of a capacitive coupling are signal cables, contactors routed in parallel and static discharges.

Coding element

A coding element is an element consisting of two sections, which is used for the unique assignment of the electronic and base module in the TURCK BL20 and BL67 I/O systems.

Cold junction compensation

A thermocouple consists of two wires of different metals, connected at one end to a measuring point. On the two open ends of the thermocouple (= cold junction) a voltage can be measured which is determined by the different electron density of the wires, as well as by the temperature difference between the measuring point and cold junction. Thus, a thermocouple measures not absolute temperature at the measuring point, but the differential temperature between the measuring point and the cold junction. Since the voltage is usually measured at ambient temperature, the measured voltage value is too low by the amount which corresponds to the voltage of the ambient temperature. Therefore, the so-called "cold junction compensation" is carried out to determine the value for the absolute temperature at the measuring point. To do so, temperature at the cold junction must either be kept constant - as in the past by an ice bath with constant 0 °C ("cold junction") - or the temperature of the cold junction must additionally be measured as a reference point.

Common alarm output

A detected error resulted in the shutdown of the corresponding output. As long as the error monitoring detects no errors, the alarm output is switched on. When an error occurs in a circuit, the alarm output switches off (see also alarm output).

Common potential

Common potential means that the reference potential of control and working circuit (input and output circuit) are electrically connected.

Configure

Is the systematic arrangement of the modules of a station.

Current consumption

The current consumption defines the current that is used for the power supply of the device. For sensors with switching output the power consumption is indicated without load.

DeviceNet™

DeviceNet™ is a standard open bus system based on CAN (Controller Area Network) and is standardized in EN 50325. It is widely used in the USA and Asia.

DHCP

Dynamic Host Configuration Protocol - DHCP is a client-server protocol for the allocation of IP addresses and other parameters. It is used for the dynamic and automatic configuration of terminal devices.

Digital

Representation of a value by a series of characters that are assigned to the value to be represented (e.g. a voltage) according to a

code. Examples of digital representation: binary 0 and 1, decimal by the digits 0 through 9 and alphanumeric digits - and letter combinations.

Digital output

A digital output provides on/off signals depending on the values that are determined during a continuous measuring process. Digital outputs are normally implemented with PNP or NPN transistors or with an electromechanical relay.

Digital signals

For digital signals, the value of the physical quantity x of a voltage for example, is not represented as a physical size, but encoded in characters of any kind, such as in binary digit combinations. There is thus no analogous correlation between the physical unit and the output value. Basis of the digital process is the collection and analysis of abstract strings corresponding to a physical value such as a voltage.

DIN

DIN is the mark for the collective work of the Deutsches Institut für Normung e. V., a central body for normative and standardization work in Germany.

Drop-off time

The drop-off time defines the time required for a signal to change its signal level from 90% to 10 % (see also 'Rise time').

DTM

DTM stands for Device Type Manager and defines the application-independent driver for computer-programmable and communication devices within a defined FDT frame application such as PACT*ware*™. The DTM includes among others:
- User interface for the device
- Device logic and parameterization

EC Declaration of Conformity

With the EC Declaration of Conformity the manufacturer of a device certifies legally binding, that the device complies with the relevant European Directives. The manufacturer must ensure this by appropriate manufacturing and testing.

EC type examination certificate

The EC type examination certificate is issued by a certified testing laboratory and contains the technical data of a device or values at which the device may be operated. The EC type examination certificate also states any "special conditions" for the use of the device as well as the basic safety and health regulations.

Efficiency

The efficiency is generally the ratio between output power (effective power) and input power.

ElexV - Ordinance for electrical installations in hazardous rooms (old) /areas (new)

ElexV is applicable in Germany and is aimed at those responsible for the technological causes of the formation of explosive mixtures. The former ElexV of 1980 related to European regulations on explosion protection of industrial electrical equipment. This "old" version constituted the legal basis for almost the entire field of explosion protection of electrical equipment. By defining explosion hazardous areas and especially by dividing these into specific zones, ElexV gained major importance as a virtual standard for explosion protection measures. Since the introduction of the ATEX Directive in 1996 a lot has changed. Definitions relating to the non-electrical aspects of new electrical equipment are now covered by the new "Explosion Protection Ordinance" (ExVO). The "new" 1996 version of the ElexV refers only to those parts which have not yet been transposed into national regulations.

EMC

By electromagnetic compatibility (EMC) is meant the ability of an electrical device to operate satisfactorily in an electromagnetic environment without adversely affecting or being adversely affected by other electrical equipment.

EN

Abbreviation for "European Norm"

Equipment, electrical

Electrical equipment is an object that is used for the generation, conversion, transfer, distribution or application of electrical energy, such as sensors, cables, machines, control devices.

ESD

Electrostatic Discharge – ESD is the abbreviation for electrostatic discharge, and describes the balancing of electrical charge between two differently charged materials.

EtherCAT®

EtherCAT® is an Ethernet-based standard bus system with a master/slave architecture for fast applications and time-sensitive industrial applications, and is standardized in compliance with IEC 61158, IEC 61784 and ISO 15745-4. It offers the cyclical transmission of I/O data and acyclical transmission of requested data such as parameters, diagnostics and device identification data.

EtherNet/IP™

EtherNet/IP is an open Ethernet standard for industrial networks standardized to IEC 61158. It is mainly used in America and offers the connection to server-based office functions such as email clients or web servers.

External inductance

By external inductance is meant those inductances that have an effect outside of an Ex device, such as in a cable.

ExVO

Explosion Protection Regulation

Fault current

Output current in the event of a wire break or short-circuit in the input circuit, selectable between 0 mA or > 21.5 mA

FDT

FDT stands for Field Device Tool and describes the interface definition between the specific device DTMs used and the frame application (such as PACT*ware*™). The FDT includes:
- A standard user environment for all DTMs

- User management
- Management of the used DTMs
- Network configuration

Field device

In automation, devices that are installed outside of the control cabinet, e.g. a NAMUR sensor, are called field devices.

Field supply

Power supply for the field devices and the signal voltage

FM (Approval)

Factory Mutual - certification and test lab for North American approvals for the Ex and non-Ex area (see also UL)

Force mode

The Force mode of a software makes it possible to "force" specific variables on input and output modules in order to create specific plant states.

Frequency

The frequency f is the number of vibrations per second and can be calculated as the reciprocal of the period (T = 1/f). The SI unit of frequency is the Hertz (1/s). Often, as well other units are used such as 1/min.

Function code

The function codes are used in the Modbus fieldbus to control the type and method of access to the devices. The function codes are incorporated and contained in the Modbus data telegram, including commands for reading and writing input and output data.

Galvanic isolation

Electric circuits are separated by means of a transformer such as an optocoupler.

GND

GND – Abbreviation for "Ground" (see Mass)

HART®

HART® stands for "Highway Addressable Remote Transducer" and consists of digital communication via a common data bus. The data transfer is implemented according to the Bell 202 standard by means Frequency Shift Keying (FSK). The low-frequency analog signal is superimposed with a high frequency oscillation (± 0.5 mA). A digital "1" is represented with a frequency of 1.2 kHz (1200 Hz) and a "0" with the frequency 2.2 kHz (2200 Hz).

Hexadecimal

Number system with the base 16. The sequence begins with 0 to 9 and continues with the letters A, B, C, D, E and F.

Hysteresis

The hysteresis is the difference between the switch-on and the switch-off point.

Hysteresis (limit value monitoring)

With switching outputs: Difference between switch-on and switch-off point. To avoid fluttering of an output, the two switching points can be set to different values. If the switch-off point is higher than the switch-on point, the exceedance of a limit value is monitored. If the switch-on point is higher than the switch-off point, the undercutting of a limit value monitored. The difference between the values is application-specific and should take into account the regular fluctuations in the measured value.

I/O

Abbreviation for "Input/ Output"

I/P converter

An I/P converter converts a current signal on the input side (0/4…20 mA) to a pressure on (e.g. 0.5…4 bar) on the output side.

IECEx

International Electrotechnical Commission System for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres.

Ignition category

The EN 60079 (IEC 60079) standard stipulates general requirements for the design and testing of electrical equipment required for the hazardous area:

- Oil immersion "o" (EN / IEC 60079-6)
- Pressurized enclosure "p" (EN /IEC 60079-2)
- Powder filling "q" (EN / IEC 60079-5)
- Flameproof enclosure "d" (EN / IEC 60079-1)
- Increased safety "e" (EN / IEC 60079-7)
- Intrinsic safety "i" (EN / IEC 60079-11)
- Non-sparking equipment "nA" (EN / IEC 60079-15)
- Sparking equipment "nC" , "nR" (EN / IEC 60079-15)
- Encapsulation "m" (EN / IEC 60079-18)
- Optical radiation "o" (EN / IEC 60079-28)
- Intrinsically safe electrical systems "i-SYST" (EN / IEC 60079-25)

(see also the section 'Basics of explosion protection')

Impedance

The impedance (also: apparent resistance) is the resistance, which a device or a circuit of several devices has for an alternating current of a specific frequency. The size of the impedance is therefore not constant in relation to the different frequency values. This is due to the fact that the impedance also consists of a reactive resistance as well as the pure ohmic resistance (active resistance).

Inductance

The inductance is an electrical property of a current-carrying conductor or other component, to build a magnetic field due to a change in the electrical current, which counteracts the power change.

Inductive coupling

Inductive (magnetic) coupling occurs between two current carrying conductors. The magnetic field caused by the currents induces a voltage that can cause interference. Transformers, motors, power supply cables routed in parallel and HF signal cables are typical sources of interference.

Input circuit monitoring

The input circuit monitoring monitors the connected loop. For analog signals, usually the 4…20 mA signal is used (example: wire breakage I < 3.6 mA; Short circuits I > 21.5 mA). The NAMUR working group makes recommendations on the threshold. NAMUR sensors offer line monitoring for digital signals. Sensors compliant with EN 60947-5-6 (NAMUR) have an impedance of < 400 Ω in a non-operational state and otherwise have a maximum impedance that ensures a minimum current of > 0.05 mA. These limit values can be used for detecting wire breaks and/or short-circuits in the control circuit of switching amplifiers.

Input delay

The input delay specifies the time required by a device (e.g. a valve control module) to provide the output signal after a signal is present at the input.

Input frequency

The input frequency is the maximum rate that must be applied to the input of the unit or that can be measured.

Input lock time

During the input lock-out time pulses at the sensor input of the interface device are suppressed for the set time.

Input resistance

The input resistance is present at the input of a device and loads the voltage source present at the input.

Insulation resistance

By insulation resistance is meant the ohmic resistance between electrical conductors or to ground potential.

Internal inductance

The value of the internal inductance must be taken into account when verifying intrinsic safety. The internal inductance of associated equipment reduces the connectable value. The internal inductance of an intrinsically safe apparatus reduces the usable cable length. The 50% rule should be applied if the intrinsically safe equipment also has an internal capacitance in addition to the internal inductance. This rule is applicable as soon as both reactances are more than 1 % of the connectible reactances. If this is the case, the connectible reactances are reduced by 50 %, i.e. the usable cable length is reduced.

Intrinsic safety

"Intrinsic safety i" is a protection type for the hazardous area that is described by the EN 60079-11 standard. The electrical energy of a device here is limited so that it cannot cause ignition in a potentially explosive atmosphere (see also the section "Basics of explosion protection").

IP protocol

IP protocol (Internet protocol) – a network protocol wide-spread in computer networks and used in the context of the TCP/IP protocol family to communicate data packets. The protocol aims to assemble data packages (formatting and fragmentation) to units, to address the data packages (addressing), and to convey (routing) in a connectionless packet-oriented network.

Limit frequency

The limit or cutoff frequency defines the maximum or minimum value of the frequency that can or should be processed. To ensure interference immunity, an upstream filter is installed in the pulse inputs of rotational speed monitors. Input frequencies that are above the limit frequency of this filter can no longer be processed by the speed monitoring device.

Line monitoring

TURCK interface devices with cable monitoring are used to monitor the input circuit for short-circuits and wire breaks (see also 'Input circuit monitoring').

Linearity deviation

Indicated by sensors with an analog output. Permitted deviation of the output signal from an ideal linear output characteristic as a % of the full scale value of the output signal.

Load resistance

The load resistance is the electrical resistance, by which a power and signal source is loaded.

Loop-powered

Loop-powered devices are fed from the signal and do not require a separate power supply.

LSB

LSB stands for Least Significant Bit; and represents the lowest value of a digital bit string.

MAC ID

The MAC ID (Media Access Control Identification) is the unchangeable, globally unique physical address of a network component. The MAC address is used for communication in Ethernet networks.

Mass

Mass is a common reference potential for conductive components.

Measurement deviation

Is the deviation of a value according to DIN 1319-1:1995 obtained from the measurements of the true value of the measurand.

Measuring accuracy

The closeness of the measured value to the nominal value (see also Measurement deviation).

Measuring range

Indicated by sensors with analog output. It is the size of the range in which the output signal is changed.

Millivolt signals

One thousandth of a volt

Modbus TCP

Modbus TCP is an open Ethernet standard with a client/server architecture for industrial automation that is standardized in IEC 61158. Modbus communication is implemented with function codes that are incorporated in the data telegram. For data transmission in Ethernet-TCP/IP networks, Modbus TCP uses the Transport Control protocol (TCP) for the transfer of the Modbus application protocol.

Module bus (TURCK BL stations and modules)

The internal bus of a BL20 or BL67 station is called the module bus. The module bus is independent of the fieldbus. The BL20 and BL67 modules communicate via the module bus with the gateway.

MSB

MSB stands for „Most significant bit"; in a digital signal of a specific length, the bit that represents the highest value.

Multiprotocol Ethernet

The Ethernet multiprotocol describes a special function of I/O modules that enables the modules to be used in any of the three Ethernet systems PROFINET, Modbus TCP or EtherNet/IP™. The Ethernet multiprotocol modules detect the protocol used automatically by listening to the communication traffic during the startup phase.

NAMUR

International Association of automation technology users of the process industry.

Ni100

Temperature-dependent resistor to DIN 43760, consisting of nickel; less expensive than Pt100 resistors. The temperature coefficient of a nickel resistance thermometer is virtually 2 × greater than that of a platinum resistance thermometer.

No-load voltage

The open circuit voltage is the voltage on the output side if no load is connected.

Nominal voltage

The nominal or rated voltage specified by the manufacturer for the normal operation of a device.

Normally closed operation

Normally closed operation is present when the output (e.g. of an isolating switching amplifier) is active when the contact is open or with an activated NAMUR sensor.

Normally open operation

Normally open operation is present when the output (such as of an isolating switching amplifier) is active when the contact is closed or with a non-activated inductive NAMUR sensor.

On signal (1 signal)

The On signal defines the signal level (e.g. in Volts) required by a device to detect the input pulse (e.g. 5…30 V – see also 'Zero signal').

Operational safety Ordinance (BetrSichV)

The Operational Safety Ordinance (BetrSichV) is the German implementation of the work equipment directive 89/655/EEC [1], later replaced by Directive 2009/104/EC [2], and regulates in Germany the provision of work equipment by the employer, the use of work equipment by workers at work, as well as the monitoring of systems within the meaning of the occupational health and safety.

Output current

The output current is the current that a device can provide at the output circuit.

Output function (see also „Electrical designs")

Typical output functions are: NAMUR: Normalized output signal in accordance with EN 60947-5-6 NO contact (NO): The output is open when the sensor is non-activated and closed when the sensor is activated. Normally closed (NC): The output is closed when the sensor is non-activated and open when the sensor is activated. Complementary/Antivalent (two-way contact): One of the two outputs is closed in the non-activated state and the other output is closed in the activated state. Analog output: The output supplies a normalized output signal (0/4…20 mA or 0/2…10 V).

Output power

The output power is the power that a device can provide at the output circuit, such as a valve control module for the associated valve controlled (see also 'Switching capacity').

Output voltage

The output voltage is the voltage that a device can provide at the output circuit.

Overhead

In data communication, overhead stands for all information additional to the user data that has to be transferred or stored. This includes headers in the data packets, routing data or a check code that a receiver has sent back to the transmitter, in order to confirm correct data transmission.

PACT*ware*™

PACT*ware*™ stands for "Process Automation Configuration Tool" and is an open and manufacturer-independent operator interface for the plant-wide operation of devices, systems and communication components. The connection between the PACT*ware*™ operator interface and the specific device DTM is implemented via an FDT interface. PACT*ware*™ enables the devices of an installation to be configured and operated simply, quickly and efficiently, as well as diagnosed if required.

Parameterization

Parameterization denotes the setting of parameters to specific values, e.g. the device type, format and length data, as well as the number of inputs and outputs in the configuration software of a fieldbus master.

Passive metal part

Passive metal parts are conductive elements that are not energized during (normal) operation, but may become energized in the event of a fault.

Period duration measuring process

With the rotational speed monitors, the time between two successive input pulses is measured directly and compared with the internally defined reference time. This measuring principle also enables acceptable reaction times in applications with relatively large pulse intervals.

Ping

PING - acronym for "Packet INternet Gopher"; A command, with which the accessibility of target stations in networks can be tested. For this, a PING signal is sent to the destination station and checked whether and in what period of time the expected "echo" comes back.

PLC

A programmable logic controller is a device for the digital control and regulation of machinery or equipment. The program sequences are edited cyclicly or acyclicly in the PLC in event-oriented manner.

Potential equalization

Potential equalization consists of all measures taken to equalize differences in electrical potential between the chassis of electrical equipment, the ground and external conductive components.

Potential-free

The reference potentials of control and power circuits (input and output circuit) are said to be potential-free when they are galvanically isolated from each other.

Power consumption

The power consumption defines the value that the device itself converts.

PROFIBUS-DP

PROFIBUS-DP (Process Field Bus for Decentralized Peripherals) is one of the most widely used standard bus systems in automation technology, standardized according to EN 50170. It is used for the fast, serial control of remote field devices by the central controller with cyclic data exchange.

PROFINET

PROFINET is an open Ethernet standard based on PROFIBUS and standardized in IEC 61158 and IEC 61784 for the connection of decentralized devices to a controller. It offers cyclical and acyclical data exchange based on a provider - consumer model.

Protection rating

Protection class according to IEC/EN 60529 and DIN 40050-9, defines the protection of the enclosure against contact with and ingress of foreign matters and humidity. The customary protection classes of TURCK products are:

- IP20: Protection against solid foreign objects with Ø > 50 mm; no protection against water (use only in the control cabinet)
- IP65: Full protection against dust and hose water
- IP67: Full protection against dust and short submersion in water
- IP69K: Full protection against dust and high-pressure/steam-jet cleaning

Protective conductor

A protective conductor is primarily used to offer protection against fatal shock currents and must discharge a fault current for at least a short time. Protective earth/ground conductors are represented by the abbreviation PE/PG (protective earth/ground). The PE/PG for insulated conductors and cables must have a yellow-green marking over the entire length.

Pt100

Pt100 resistors are used for the industrial temperature measurement. In the IEC 751, the basic values can be found for platinum resistors. The measuring range is from -200 °C to +850 °C; common is the range -100 °C to +600 °C for standard resistors. A Pt100 can be connected in 2, 3 or 4-wire technology to a transmitter.

Pulse

Pulses are voltages or currents that exist over a "short" period. For monitoring rotational speed, the signals of a NAMUR sensor are used as input pulses for the rotational speed monitor.

Pulse output

The pulse output (transistor output) provides the input pulse signal (e.g. with a rotational speed monitor) for other processing units.

Pulse time

The pulse time is the period in which a pulse is present.

Rated voltage

The rated voltage is the highest permissible supply voltage of a device (in normal operation).

Reference ground

The reference ground is the potential of the ground in the vicinity of the grounding equipment. Unlike the ground, which always has a potential of zero, the reference ground can have a different potential than zero.

Reference potential

The reference potential is the potential from which the voltages of all connected circuits are considered and/or measured.

Repeater

A repeater is a device that is used in data cables to electrically amplify and refresh the signals to be transferred. This enables data to be transported over large distances.

Response time

A bus system response time is the time interval between sending a read request and the receipt of a reply. The reaction time in relation to an input module is the time between the occurrence of a signal change at the module input and the output of the signal change to the bus system.

Ring memory

A ring memory stores data continuously in a certain period of time, and overrides the data after a given amount of time to reclaim the space for new data. This process is inevitably best illustrated graphically in a ring form, thus the name of this technology.

Ripple

Irregularities in the DC voltage may occur after the VAC mains voltage is rectified to a VDC voltage (due to the original sinusoidal wave of the mains voltage). The remaining wave troughs can be compensated ("smoothed") by means of a capacitor connected in parallel to the load or a coil connected in series to the load. The remaining AC component after smoothing is called the ripple or hum voltage. A 10 % ripple (peak-peak) of the supply voltage is normally tolerated.

Rise time

The rise time defines the time required for a signal to change its signal level from 10% to 90 % (see also 'Drop-off time').

RS485

RS485 (EIA-485) is a serial (bus) interface according to EIA standard for fast, wired data transmission at high data rates.

RS485-IS

Standard RS485 with reduced, adapted intrinsically safe IS signal levels

Segment coupler

The segment coupler is used to adapt the standard RS485 signal to an intrinsically safe RS485-IS signal. The signal is transferred via copper cables. The repeater functionality of the segment coupler ensures that the amplitude and phase of the signal are regenerated; thus preventing any losses in signal strength and quality.

Serial

With serial data transmission, digital data is transmitted sequentially – bit by bit – via a cable. Standardized serial interfaces are available for the serial transfer of digital data.

Shield

A shield is the term given to the electrically conductive covering of cables, housings and cabinets that prevents the formation of electrical or magnetic fields in order to ensure the proper functioning of an electrical system and improve electromagnetic compatibility (see also "Shielding").

Shielding

Shielding describes the entirety of all measures to protect sensitive electronic components or lines against interference through magnetic or electrical fields (see also „Shield").

Short circuit proof

A short circuit proof apparatus resists the thermal and dynamic stresses that can occur at its place of installation due to a short circuit.

Short-circuit

A short circuit is a conductive connection between two or several points in a circuit that are normally energized. The fault current circuit has no effective resistance.

Short-circuit current

The short-circuit current defines the value of the current present in the event of a short-circuit.

Short-circuit detection

Several TURCK interface devices, such as isolating switching amplifiers, are provided with short-circuit monitoring in the input circuit (see also 'Input circuit monitoring' and 'Short-circuit threshold').

Short-circuit threshold

The short-circuit threshold is the value at which a device, such as an isolating switching amplifier, detects a short-circuit in the input circuit.

SIL

SIL stands for Safety Integrity Level. The IEC 62061, IEC 61508 and IEC 61511 standards offer methods of making probabilistic risk assessments of safety circuits. These standards define four safety levels (SIL level) which describe the measures required for the mitigation of risk in installation sections.

Simultaneity factor

The simultaneity factor indicates how many channels can be operated simultaneously with nominal load.

Start-up time delay

Adjustable time for bridging the startup phase, e.g. of a drive in which the alarms are switched off.

Station

A station is a functional unit or assembly, which consists of several components.

Supply voltage

The supply voltage is the voltage that a device requires for trouble-free operation.

Supply voltage range

The supply voltage range is the range between the minimum and maximum value that a device requires to ensure a power supply.

Switch-off delay

Adjustable time by which the switching of the output can be delayed (see also 'Switch-on delay').

Switch-off threshold/Switch-off point

A switch-off point is exceeded or falls below a set value.

Switch-on threshold

The switch-on threshold defines the signal level at which a switch-on is initiated, e.g. by means of a limit value relay.

Switching capacity

The switching capacity is the power that an electrical device can switch safely.

Switching current

The switching current is the current that an electrical device can safely switch.

Switching frequency (interface devices)

The switching frequency indicates the number of status changes per second.

Switching frequency (max.)

The max. switching frequency of a device indicates how many changes of the switching state are possible within a second.

Switching voltage

The switching voltage is the voltage that an electrical device can safely switch.

TCP

TCP (Transmission Control Protocol) is a connection-oriented transport protocol that ensures secure and fault-free data transport based on the Internet protocol and a special fault detection mechanism (e.g. acknowledgment of telegrams, time monitoring of telegrams).

Temperature classes

Equipment for the hazardous area is classified into temperature classes. This specifies the maximum permissible surface temperature of an apparatus. The explosion protected apparatus can also be approved for several temperature classes – depending on technical and financial considerations.

Terminal cross-section

The cross-section of the connection cables of a device

Terminating resistor

A terminating resistor (terminator) is used in a network at the beginning and the end of a bus line in order to prevent disturbing signal reflections.

Test voltage

The test voltage is the voltage used for testing the insulation resistance (see also 'Insulation resistance').

Thermocouples

Thermocouples are used for industrial temperature measuring. The most common types are type B, E, J, K, L, N, R, S and T thermocouples. Depending on type, thermocouples can be used for temperature ranges from -270…1800 °C.

Topology

In networks, the topology denotes the arrangement and connection of network components (stations, nodes). Network components can be connected in different ways Point-to-point connections (such as star, ring and hybrid topology) as well as point to multipoint connections (bus and cell topology).

Transmitter

Transmitters are devices that convert signals into a different, mostly normalized signal (e.g. transducer).

Trigger event

A trigger event is normally the triggering of an event, such as the exceeding of a limit value, on account of which, for example, the write process to a ring memory is stopped.

UDP

UDP (User Datagram Protocol) is a connectionless, unsecured transport protocol for exchanging data between different participants in a network.

UL

Underwriters Laboratories – certification and test lab for North American approvals for the Ex and non-Ex area (see also FM)

Unidirectional

Unidirectional means that the data and signals are transmitted from point to point in one direction only.

Voltage drop

In electrical engineering, the voltage drop is a potential difference which exists between two terminal points of a resistor through which current flows, for example, the voltage across a switched output of a device.

Window function

The power-good range is set with the window function. The user defines the switch range by means of an upper and lower window limit.

Wire-break

A wire break occurs when a cable is interrupted in a closed electrical circuit (see also 'Input circuit monitoring').

Wire-break threshold

Sensors according to EN 60947-5-6 ensure a minimum flow of 0.05 mA This current is used for detecting wire breaks and represents the wire-break threshold.

Zero signal (0 signal)

A "zero signal" is the signal level (e.g. in Volts) that a device requires to detect the input pulse as a zero signal (e.g. 0…3 V) (see also 'On signal').