Lightning and surge protection for potentially explosive (Ex) areas

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Table of content

1 Basic principles

Every year, explosions endanger people and systems around the world. Any company manufacturing, processing or storing combustible substances must expect possible explosions.

Application examples:

- Gas pressure regulation and measurement systems
- Pusher stations
- Pumping stations
- Fuel depots
- Natural gas storage facilities, natural gas compressor stations
- Petrol stations
- Refineries
- Biogas plants
- Production facilities of the chemicals and pharmaceuticals industry

Potentially explosive areas (Ex areas) are all those rooms and areas in which gases, vapours, mists or dusts that can form potentially explosive mixtures with air can collect to a hazardous level. Explosion protection will prevent damage to technical products, systems and other equipment.

Three factors must exist simultaneously for an explosion to occur:

- Combustible substance
- Oxygen
- Ignition source according to the Technical Rules for Operating Safety (TRBS) 2153: Static electricity, electromagnetic waves or lightning strike

If lightning strikes a potentially explosive atmosphere, then the atmosphere is always ignited. The strong heating of the arresting paths of the lightning can also trigger ignition. Starting at the lightning strike point, strong currents flow, which can cause sparks close to the impact point. Even without a direct lightning strike, induced voltages can cause damage to electrical devices, systems and components for measurement, control and regulation (MSR) technology and, in the worst case, can lead to an explosion.

For this reason, the three basic principles of explosion protection are:

- Avoid potentially explosive atmospheres
- Avoid any possibly effective source of ignition
- Limit possible explosion impacts to a reasonable level

1.1 Special requirements for lighting and surge protection in Ex areas

The lightning protection measures must be created in such a way that there are no melting and spray impacts. In a lightning protection system erected according to DIN EN 62305-3 (VDE 0185-305-3), the creation of ignitable sparks as well as interfering or damaging impacts on electrical systems through the impact of lightning need not be prevented in every case.

For this reason, when planning and running a lightning protection system through Ex zones, the following rules must additionally be taken into account:

- IEC/EN 62305-3 (VDE 0185-305-3) – Appendix D
  "Additional information for lightning protection systems for structures in areas with the risk of explosion"
- VDE 0185-305-3 – Supplement 2
  "Additional information for special building structures"

In Ex systems with Ex zone 2 and Ex zone 22, an Ex atmosphere will most likely only occur in rare, unforeseen circumstances. Therefore, it is possible to position interception systems in Ex zone 2 and Ex zone 22, taking Appendix D in IEC 62305-3 (VDE 0185-305-3) into account.

1.2 Assignment of the Ex zones

Potentially explosive areas are divided up into 6 zones according to the duration and frequency of the occurrence of Ex atmospheres. These zones are always three-dimensional areas or a three-dimensional space.

Lightning protection zone	Description
Zone 0	In Zone 0, in normal operation, a dangerous, potentially explosive atmosphere can form over longer periods or at regular intervals as a mixture of air or combustible gases, vapours or mist.
Zone 1	In Zone 1, in normal operation, an atmosphere can occasionally form as a mixture of air or combustible gases, vapours or mist.
Zone 2	In Zone 2, in normal operation, a potentially explosive atmosphere can normally not or only briefly form as a mixture of air or combustible gases, vapours or mist.
Zone 20	In Zone 20, in normal operation, a dangerous, potentially explosive atmosphere can form over longer periods or at regular intervals in the form of a cloud of combustible dust contained in the air.
Zone 21	In Zone 21, in normal operation, a dangerous, potentially explosive atmosphere can form occasionally in the form of a cloud of combustible dust contained in the air.
Zone 22	In Zone 22, in normal operation, a dangerous, potentially explosive atmosphere can normally not, or only briefly, form in the form of a cloud of combustible dust contained in the air.

Tab. 1: Definition of Ex zones

Level of risk	Interval of occurrences of mixtures (annual)	Interval of occurrences of mixtures (differentiated)	Dwell times of the mixtures
Zone 0, Zone 20: Constant or frequent formation of potentially explosive atmospheres	Greater than for Zone 1, > 1,000 times	Greater than for Zone 1, > 3 times/day	Longer than for Zone 1
Zone 1, Zone 21: Occasional formation of potentially explosive atmospheres	≥ 10 times, < 1,000 times	≥ 1 time/month, < 3 times/day	Longer than 0.5 hrs, Shorter than 10 hrs
Zone 2, Zone 22: Normally no or short formation of potentially explosive atmospheres	≥ 1 time, < 10 times	≥ 1 time/year, < 1 time/month	Shorter than 0.5 hrs

Tab. 2: Intervals of the occurrence of potentially explosive atmospheres

The operator of a building specifies the appropriate potentially explosive areas, divides them up into zones and labels them in a diagram of the systems to be protected according to the Ordinance on Industrial Safety and Health. For the planning of lightning protection measures, these drawings must be reviewed before the planning and erection of the lightning protection system.

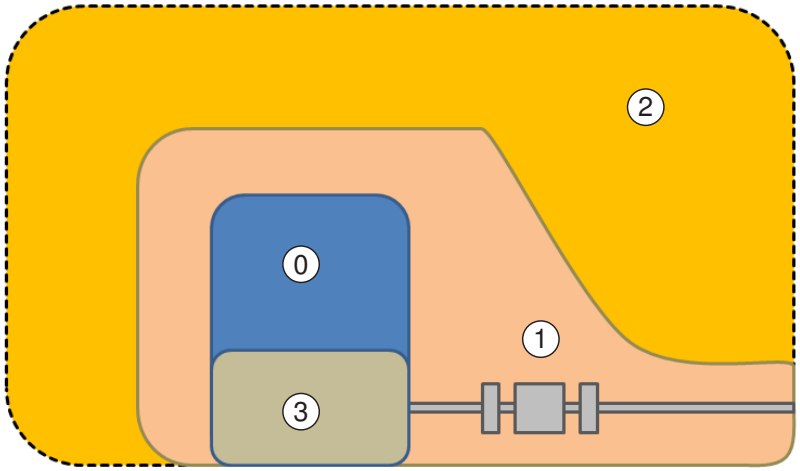

Abb. 1: Example of zone division for the gas Ex areas according to IEC 60079-10-1

Legend	
0	Zone 0
1	Zone 1
2	Zone 2
3	Combustible substance

1.3 ATEX guidelines

The EU ATEX directives regulate the requirements resulting from the use of devices and protection systems in potentially explosive areas. Due to increasing international economic intermeshing, major progress has been achieved in the standardisation of the explosion protection regulations.

In the European Union, the preconditions for complete standardisation were created in the directives 94/9/EC for manufacturers and 99/92/EC for operators. The manufacturers directive 94/9/EC (ATEX 95) regulates the requirements for the structure of explosion-protected devices and protection systems, by prescribing basic health and safety requirements.

Manufacturers of components for potentially explosive areas must obtain an approval for their products. The quality requirements for the production of resources without effective sources of ignition is very high. An approved test office will only certify the function of the components of a manufacturer after a comprehensive test, and will assign them into categories according to failure safety.

2 Solutions

2.1 Equipotential bonding systems

Systems in potentially explosive areas require equipotential bonding according to IEC 60079-14 (VDE 0165-1). All the bodies of electrically conductive parts must be connected to the equipotential bonding system. Secure equipotential bonding connections against self-loosening according to IEC 60079-14 (VDE 0165-1) and the Technical Rules for Operating Safety (TRBS) 2152 Part 3.

According to TRBS 2152 Part 3 and IEC 62305-3 (VDE 0185-305-3), the arresting paths of the lightning must be created in such a way that heating or ignitable sparks or spray sparks cannot become the ignition source of a potentially explosive atmosphere. OBO can offer innovative solutions for this.

Areas of application could include:

- Chemicals industry
- Paint shops
- Oil and gas industry
- Fuel depots
- Gas pressure regulation and measurement systems (GDRM systems)
- Liquefied gas storage container
- Balance pits and large outdoor filling systems
- Filling and emptying points (e.g. big-bag sacking, balances, sack handover)

2.1.1 Equipotential busbars for Zone 1, Zone 21, Zone 2 and Zone 22

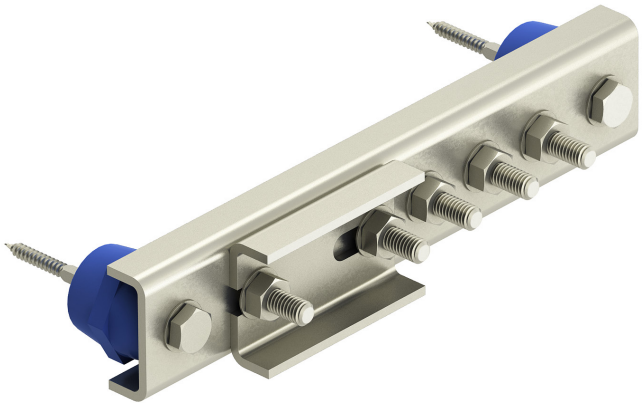

Abb. 2: Equipotential busbar EX PAS

Type	Item number
EX PAS 5	5015265
EX PAS 10	5015270

IEC 62305-3 Supplementary sheet 2 (VDE 0185-305-3 Supplementary sheet 2) requires that connections of lightning protection systems in potentially explosive areas are created in such a way that no ignitable sparks are created when the lightning current passes through.

The EX PAS equipotential busbar (equipotential busbar for potentially explosive areas) is used for lightning protection equipotential bonding according to IEC 62305-3 (VDE 0185-305-3) and protective/function equipotential bonding according to DIN VDE 0100 Part 410/540.

The lack of ignition sparks in an explosive atmosphere has been tested according to IEC 62561-1 (VDE 0185-561-1) according to the most demanding explosion group, IIC, with a potentially explosive gas mixture and a lightning current of up to 75 kA. It can thus be used in all explosion groups, even in the explosion groups IIB and IIA. As the EX PAS equipotential busbar does not possess its own potential source of ignition, it does not come under the European directive 94/9/EC.

The EX PAS equipotential busbar is tested according to IEC 62561-1 (VDE 0185-561-1) in Class H for high loads and is suitable for indoor and outdoor applications.

Thanks to the patented design, the equipotential busbar can be used in a system according to IEC 60079-14 (VDE 0165 Part 1) and IEC 62305-3 (VDE 0185-305-3) in the Ex zones 1/21 and Ex zones 2/22.

The EX PAS equipotential busbar for potentially explosive areas possesses the following properties:

- Suitable for all explosion groups and use in Ex zones 1/21 and 2/22
- Free of ignition sparks with a lightning current of up to 75 kA
- Tested according to Class H for high loads
- Protected against self-loosening
- Made from corrosion-resistant material (stainless steel)

2.1.2 Ex spark gaps

The ATEX-certified OBO Parex spark gap insulates the parts of the system against corrosion currents, fulfilling the requirements for the connection of lightning currents in potentially explosive areas.

To avoid arcing to insulating pieces in Ex areas, the use of Ex-approved spark gaps is required.

Abb. 3: Parex spark gap

The OBO Parex spark gap is certified according to the following directives:

- ATEX
- DNV Inmetro
- IECEx

2.1.2.1 Application example gas pressure regulation and measuring system

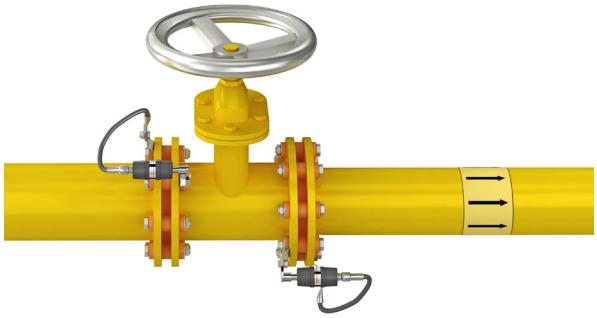

Abb. 4: Parex spark gap mounted on insulating sections

Parex spark gaps (type)	Item number
480 180	5240034
480 250	5240077
480 350	5240069

Tab. 3: Usable spark gaps

Afk recommendation no. 5 of the DVGB e.V. working group (German Technical and Scientific Association for Gas and Water) explains the coordinated use of Ex spark gaps on insulating flanges using examples and detailed calculations.

2.2 Surge protection for data and MSR systems

All the active conductors run in from outside of the energy, information and MCR technology must be included in the equipotential bonding with type 1 or D1 lightning arresters. Surge protection in potentially explosive areas is an important topic. It is important here to protect costly measuring technology against the influence of surge voltages through atmospheric discharge.

OBO lightning barriers of type MDP are tested for intrinsic safety (ia) and are independently certified. With a high arresting capacity of 10 kA, they offer optimum protection for four-pole measurement and control applications. Different voltage variants offer a wide range of applications.

Type	Item number	Figure	Ex certificate
MDP-4 D-5-EX	5098412		BVS 11 ATEX E 131 X Ex II 2(1) G Ex ia IIC T4
MDP-4 D-24-EX	5098432		
MDP-4 D-48-EX	5098452		
FDB-2 24-M	5098380		BVS 10 ATEX E 048 Ex II 2(1) G Ex ia IIC T6
FDB-3 24-M	5098382		
FDB-2 24-N	5098390		
FDB-3 24-N	5098392		

Tab. 4: Ex-certified SPDs

With the Petrol Field Protector, OBO can offer a surge protection device to protect sensors in potentially explosive areas. The Petrol Field Protector permits two- or three-pole protection for all kinds of sensors.

The protection device can be fastened directly on the sensor and wired in using the appropriate metric or NPT thread. The robust stainless steel housing means that even aggressive atmospheres are no problem.

The intrinsic safety of the Petrol Field Protector has been independently tested and certified.

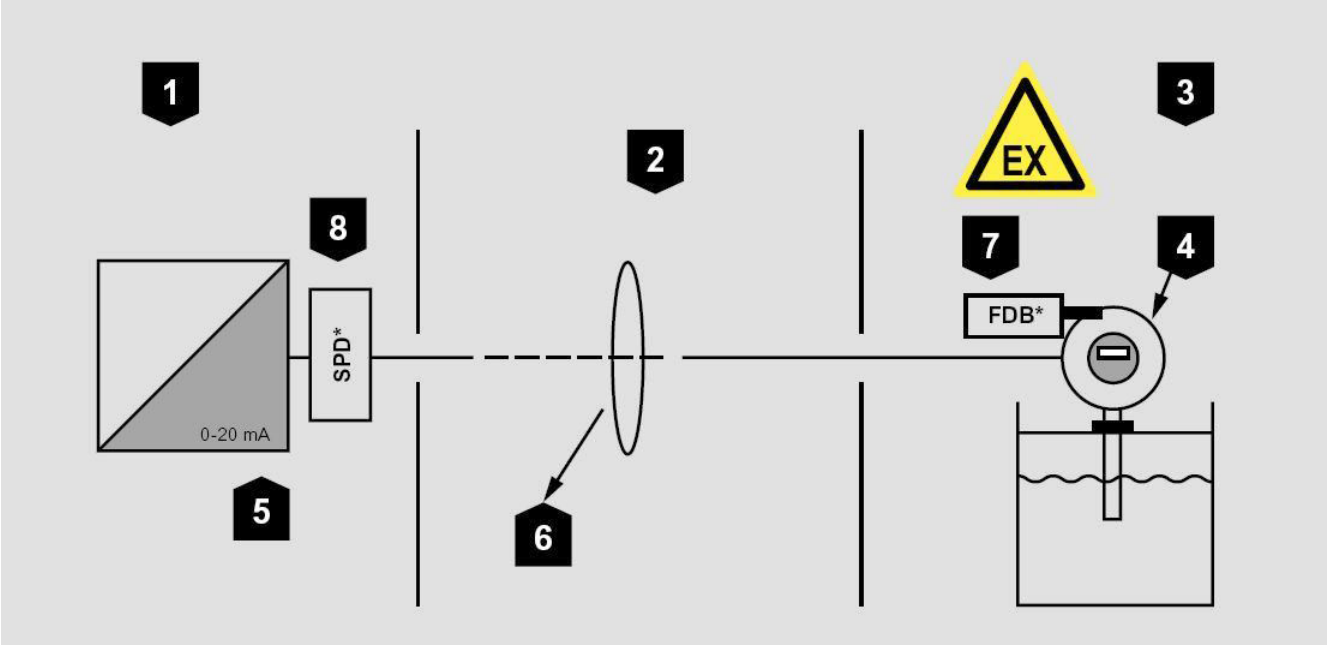

Abb. 5: Connection diagram for MDP and FDB in Ex area

Legend	
1	Protected side
2	Field
3	Ex area
4	Protected sensor
5	Signal source
6	Coupling
7	Surge protection device on sensor (e.g. FDB)
8	Surge protection device in front of the signal source (e.g. MDP)

Typical MDP and FDB interfaces are:

- Profibus PA
- (0)4 - 20 mA
- RS232/RS485
- Foundation Fieldbus

You can find additional information on MSR systems (including MSR selection aid) at http://obo.eu/mdpfdb

2.3 External lightning protection with high-voltage-resistant, insulated down-conductor

The OBO isCon® down-conductor prevents direct arcing between the down-conductor and the building to be protected. After the first potential connection behind the connection element, the isCon® down-conductor reflects an equivalent separation distance of up to 0.75 metres in the air and up to 1.5 metres in solid substances according to IEC 62305-3 (VDE 0185-305-3). This means that installation is possible directly on metallic and electrical structures.

Abb. 6: isCon® down-conductor on interception rod in Ex area

The OBO isCon® down-conductor has been tested according to the following directives:

– ATEX
– IECEx

Abb. 7: Wall and pipe mounting: Internally routed isCon® down-conductor in interception rod in biogas plant

In Ex zones 1 and 21, after the first potential connection, the OBO isCon® down-conductor should be connected at regular distances (0.5 metres) using a metallic cable bracket (e.g. isCon H VA or PAE) to the equipotential bonding. If there is a lightning strike, the equipotential bonding must not carry lightning current and must be in the protection angle of the lightning protection system.

OBO can offer the right interception and down-conductor system for every application. Chimneys, antenna masts, ventilation pipes, tanks and similar parts of the system can be protected using the OBO isCon® system with separated and insulated interception rods.

Type	Item number
isCon 750 SW, length 25 m	5408002
isCon 750 SW, length 100 m	5408004
isCon 750 SW, length 250 m	5408006
isCon 750 LGR, length 25 m	5407995
isCon 750 LGR, length 100 m	5407997
isCon stripper 2	5408012
isCon connect	5408022
isCon PAE	5408036

3 Literature index:

- IEC 62305-1 (VDE 0185-305-1) – General principles
- IEC 62305-2 (VDE 0185-305-2) – Risk management
- IEC 62305-3 (VDE 0185-305-3) – Protection of buildings and humans
- IEC 62305-4 (VDE 0185-305-4) – Electrical and electronic systems within structures
- TRBS 2152
- TRBS 2153
- IEC 600074-14 (VDE 0165 Part 1)
- AfK recommendation no. 5
- Ordinance on Industrial Safety and Health (BetrSichV)
- BGR 104

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