

Guide

Lightning and surge protection for Ex areas

Building Connections



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This guide is based on the currently known and valid rules and regulations, and on our experience.
The contents are not legally binding and make no claim to completeness.



1 Basic principles

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

Potentially explosive areas (Ex areas) are all those rooms and areas in which gases, vapours, mists or dusts, which 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. The system operator is responsible for the proper availability of the system!

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/Technical Rules for Hazardous Substances (TRGS) 727: Static electricity, electromagnetic waves or lightning strike

Parts 1 and 2 of TRBS 2153 and 2152 have the same content as those of TRGS 720/721 and 722.



EN 1127-1 states, 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 (MCR) 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 lightning 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 VDE 0185-305-3 (IEC/EN 62305-3), 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 potentially explosive areas – so-called Ex zones – the following rules must additionally be taken into account:

- IEC/EN 62305-3 – Appendix D
"Additional information for lightning protection systems for structure in potentially explosive areas"
- 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 air-termination systems in Ex zone 2 and Ex zone 22, taking Appendix D in IEC/EN 62305-3 into account.

With regard to the risk of ignition of a dangerous, potentially explosive atmosphere through a lightning strike, the Technical Rules for Hazardous Substances No. 509 refer to TRBS 2152 Part 3 Number 5.8. Appendix 1 of the TRGS lists individual details on the use and requirements of spark gaps in pipe lines, as well as detailed requirements on lightning and surge protection units according to IEC/EN 62305. Building sections containing tanks to store flammable liquids with an ignition point ≤ 55 °C and a volume of more than 3,000 litres must be protected against ignition risks from lightning strikes using suitable equipment. This also applies to above-ground tanks in the open air and underground tanks with flammable liquids with an ignition point of ≤ 55 °C, which are not completely surrounded by earth, masonry, concrete or multiples of these substances.

1.2 Assignment of the Ex zones

Potentially explosive areas are divided up into 3 zones according to the duration and frequency of the occurrence of potentially explosive atmospheres. These zones are always three-dimensional areas or a three-dimensional space.

A further subdivision of the potentially explosive areas makes a distinction between combustible gases and combustible dusts.

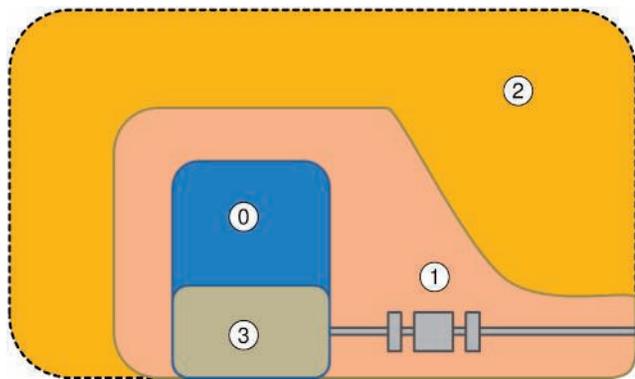
Intervals of the occurrence of potentially explosive atmospheres

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, > 1.000x	Greater than for Zone 1, > 3x/day	Longer than for Zone 1
Zone 1, Zone 21: Occasional formation of potentially explosive atmospheres	≥ 10x, < 1.000x	≥ 1x/month, < 3x/day	Longer than 0.5 hrs, shorter than 10 hrs
Zone 2, Zone 22: Normally no or short formation of potentially explosive atmospheres	≥ 1x, < 10x	≥ 1x/year, < 1x/month	Shorter than 0.5 hrs

Definition of Ex zones

Ex zones	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.

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, and the Hazardous Substances Ordinance. For the planning of lightning protection measures, these drawings must be reviewed before the planning and erection of the lightning protection system. According to GefStoffV 2015, the operator is required to compile this explosion protection document.



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

Example of assignment into Ex zones

Electrical devices may be used in different zones, depending on the device protection level EPL and device category.

Zone assignment of devices according to their category and/or protection level according to DIN EN 60079-14 (IEC 60079-14)

Zone	Equipment category	Equipment protection level EPL	Criteria
0 20	1G 1D	Ga Da	Very high safety requirements, explosion protection must be guaranteed even when errors rarely occur
1 21	1G, 2G 1D, 2D	Ga, Gb Da, Db	High safety requirements, explosion protection must be guaranteed when errors occur frequently
2 22	1G, 2G, 3G 1D, 2D, 3D	Ga, Db, Gc Da, Db, Dc	Normal safety requirements; when operated normally, the ignition sources that are expected to occur are avoided

Zone assignment example "gasses"

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 2014/34/EU for manufacturers and 99/92/EC for operators. The manufacturers' directive 2014/34/EU (ATEX) 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. In addition, the testing offices use regular audits with the manufacturers to ensure continuously guaranteed product quality.

2 Solutions

2.1 Equipotential bonding systems

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

According to TRBS 2152 Part 3 and VDE 0185-305-3 (IEC/EN 62305-3), 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.

Supplementary Sheet 2 (IEC 62305-3) 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.

According to the (German) Equipment and Product Safety Act (GPSG), properties with potentially explosive areas require monitoring. In addition, GPSG regulates the protection of employees and third parties against hazards by making appropriate requirements of the operators. This states, amongst other things, that the erection and operation of the plant, the equipment and the materials must correspond to the state of the art.

According to the Ordinance on Industrial Safety and Health (BetrsichV) § 12, Paragraph 1, systems requiring monitoring must be mounted, installed and operated according to the latest standards. OBO can offer innovative solutions for this, which correspond to the current state of the art.

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 containers
- Balance pits and large outdoor filling systems
- Filling and emptying points (e.g. Big-Bag sacking, balances, sack handover)

2.1.1 Equipotential busbar EX PAS for Zone 1/21 and 2/22

The EX PAS equipotential busbar (equipotential busbar for potentially explosive areas) is used for lightning protection equipotential bonding according to VDE 0185-305-3 (IEC 62305-3) and protective/functional 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/EN 62561-1 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 2014/34/EU.

The EX PAS equipotential busbar is tested according to IEC/EN 62561-1 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 and IEC/EN 62305-3 in the Ex zones 1/21 and Ex zones 2/22. The EX PAS represents the current state of the art for equipotential busbars in Ex areas.

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
- Screws protected against self-loosening
- Made from corrosion-resistant material (stainless steel)
- Manufacturer and article labelling permanently attached



Equipotential busbar for zone 1/21 and 2/22 – EX PAS



Spark gap mounted on insulating sections

2.1.2 Ex spark gaps – EX ISG H

According to TRGS 507, electrical separating elements in potentially explosive areas must be bridged with spark gaps. The spark gaps must have a response surge voltage of 50% of the testing AC voltage of the insulating elements, although with a maximum of 2.5 kV.

The ATEX-certified OBO EX ISG H spark gap insulates the parts of the system against corrosion currents, fulfilling the requirements for the connection of lightning currents in potentially explosive areas according to IEC/EN 62561-3.

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

The OBO EX ISG H spark gap is certified according to the following directives for Zone 1/21 and 2/22:

- ATEX
- IECEx



Spark gap EX ISG H



Spark gap EX ISG H 350 2L



Spark gap EX ISG H 350



Spark gap EX ISG H KU

Selection of spark gaps in potentially explosive areas

Spark gaps	Item no.	EX labelling
EX ISG H 350	5240031	ATEX
EX ISG H	5240030	Ex II 2 G Ex db IIC T6 Gb
EX ISG H 350 2L	5240032	Ex II 2 D Ex tb IIIC T80 °C Db
EX ISG H KU	5240033	IECEX Ex db IIC T6 Gb Ex tb IIIC Db

OBO Ex spark gaps

As soon as the EX ISG H responds and conducts, the lightning current I_{imp} of up to 100 kA is run to the earth along a defined route. This arresting operation only takes a few microseconds. After the arresting operation, the EX ISG H returns to a standard, high-resistance state. The EX ISG H is low maintenance, as it is designed for a wide range of arresting operations.

Flanges and insulating pieces show a relatively low voltage resistance, which is usually in the range of a few kV. Class 1 insulating flanges have a testing AC voltage of U_{PW} of 5 kV and class 2 insulating flanges of 2.5 kV. In so doing, the technical rules GW 24 of DVGW require selection of the response surge voltage U_{as} of the spark gaps in such a way as to be $0.5 \times U_{PW}$. Thus, the OBO Ex spark gap, with an U_{rimp} of ≤ 1.25 kV, fulfils the requirements for all insulating flange classes according to IEC 62561-3. The same requirements are made in the European recommendation of Ceacor (European Committee for the study of corrosion and protection of pipes and pipeline systems).

When the spark gap has ignited, the pulse current causes a voltage drop U_L via the connection cables and the spark gap, whereby the connection technology has the greatest influence. Here, the maximum voltage drop should be smaller than the peak values of the testing AC voltage \hat{U}_{PW} . Class 1 insulating flanges have approx. 7 kV as the peak value.

Besides the response range, the EX ISG H has a defined lower blocking range. Interfering earth currents or close parallel high-voltage routes can, for example, induce permanent 50 Hz AC voltages into the pipeline segments. To prevent the EX ISG H from igniting every time – and, in consequence, influencing the KKS system (cathodic corrosion protection system) – a so-called 50 Hz withstand AC voltage U_{WAC} is defined and must be maintained. Here, DVGW GW 24 recommends: ≤ 250 V, 50 Hz. This safety-relevant requirement is fulfilled by the OBO Ex spark gap.

The 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.

Product characteristics of the spark gap EX ISG H

The EX ISG H implements state-of-the-art technologies and innovations:

- Solvent-free, environmentally friendly material
- Modern machining technology from the automotive sector
- Chemical resistance
- Resistance to oils and extreme temperature variations
- Halogen-free
- UV-stable, weatherproof
- Ignition protection type/device protection level: Pressure-resistant encapsulation/"db" for gases, protection through housing/"td" for dusts
- Resistant to salt water
- Highest testing Class H in accordance with IEC 62561-3
- Tested connection technology Class H according to IEC 62561-1
- Suitable for all explosion groups and use in Ex zones 1/21 and 2/22

Ex spark gap accessories

Designation	Art.-Nr.
Connection cable AL EX ISG 100	5240102
Connection cable AL EX ISG 200	5240104
Connection cable AL EX ISG 300	5240106
Connection clamp, flat M10	5240360
Connection clamp, flat M12	5240362
Connection clamp, flat M10	5240366
Connection clamp, flat M20	5240370
Connection clamp, flat M24	5240374
Connection clamp, angled M10	5240380
Connection clamp, angled M12	5240382
Connection clamp, angled M16	5240386
Connection clamp, angled M20	5240390
Connection clamp, angled M24	5240394



Connection cable AL EX ISG 100



Connection clamp, flat M10



Connection clamp, angled M10

2.1.3 Earthing pipe clamp EX BES for Zone 1/21 and 2/22

Previously, connections for equipotential bonding and lightning protection equipotential bonding in potentially explosive areas had to be welded or have threaded sleeves. This is very complex and cost-intensive. The use of clips is only approved if the freedom from ignition sparks has been proven for lightning surge currents.

The lack of ignition sparks of the EX BES earthing pipe clamp in an explosive atmosphere has been tested according to VDE 0185-561-1 (IEC 62561-1) according to the most demanding explosion group, IIC, with a potentially explosive gas mixture. It can thus be used in all explosion groups, even in the explosion groups IIB and IIA. As the EX BES earthing pipe clamp does not possess its own potential source of ignition, it does not come under the European Directive 2014/34/EU.

The independently certified OBO earthing pipe clamp, for use in potentially explosive areas according to VDE 0165 Part 1 (IEC 60079-14) with the Ex zones 1/21 and 2/22, represents the current state of the art for earthing pipe clamps in potentially explosive areas.

The EX BES possesses the following characteristics:

- Suitable for all explosion groups and use in Ex zones 1/21 and 2/22
- Only one clip type for all pipe diameters up to 500 mm
- Mounting with only one tightening strap
- Safe electrical contacting
- Clip element insulated from contact element
- Ignition spark-free, for example with 50 kA (10/350) pulse current
- For equalising temperature-related material expansions
- UV-stabilised and weatherproof
- Easy mounting: Max. tightening torque cannot be exceeded due to a mechanical locking system
- Tested according to Class H for high loads
- Screws protected against self-loosening
- For indoor and outdoor applications
- Manufacturer, type and article labelling permanently attached
- With 2 labelling panels

The following connection options are available for the EX BES:

- Round conductor made of Cu, St/tZn, Al, stainless steel with a diameter of \varnothing 8/10 mm or fine/multi-wire conductors made of copper with a cross-section of 16 to 35 mm², with compression cable lug made of E-Cu (DIN 46235)
- Flat conductor made of copper with minimum dimensions 20 x 2.5 mm, with a drill hole of diameter \varnothing 10.5 mm

Due to the tested freedom from ignition sparks, the EX BES on strip steel represents the current state of the art for connections able to carry lightning current free of ignition sparks to the ring equipotential bonding in buildings.



Strip Earthing clamp for Zone 1/21 and 2/22 EX BES

2.2 Surge protection for data and MCR systems – MDP-EX and FDB

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 arrestors.

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. The products MDP-EX and FDB have been tested and certified according to the current standards for intrinsically safe measurement and bus systems (Ex (i) systems):

- EN 60079-0:2012+A11:2013 – General requirements
- EN 60079-11:2012 – Intrinsic safety "i"
- EN 60079-25:2010 – Intrinsically safe systems

The OBO products MDP-EX and FDB thus fulfil the testing requirements for intrinsically safe systems and do not need to comply with IEC 60079-26. They only represent alternative testing methods for products that cannot be tested according to Part 25. The products also fulfil the ATEX directive 2014/34/EU.

With a high arresting capacity of 10 kA, they offer optimum protection for two to four-pole measurement and control applications. Different voltage variants offer a wide range of applications.

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 of 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 aggressive atmospheres are no problem. The intrinsic safety of the Petrol Field Protector has been independently tested and certified.

Type	Item no.	Ex certificate
MDP-4 D-5-EX	5098412	BVS 11 ATEX E 131 X EX II 2(1) G Ex ia [iaGa] IIC T4 Gb
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 [iaGa] IIC T6...T4 Gb
FDB-3 24-M	5098382	
FDB-2 24-N	5098390	
FDB-3 24-N	5098392	

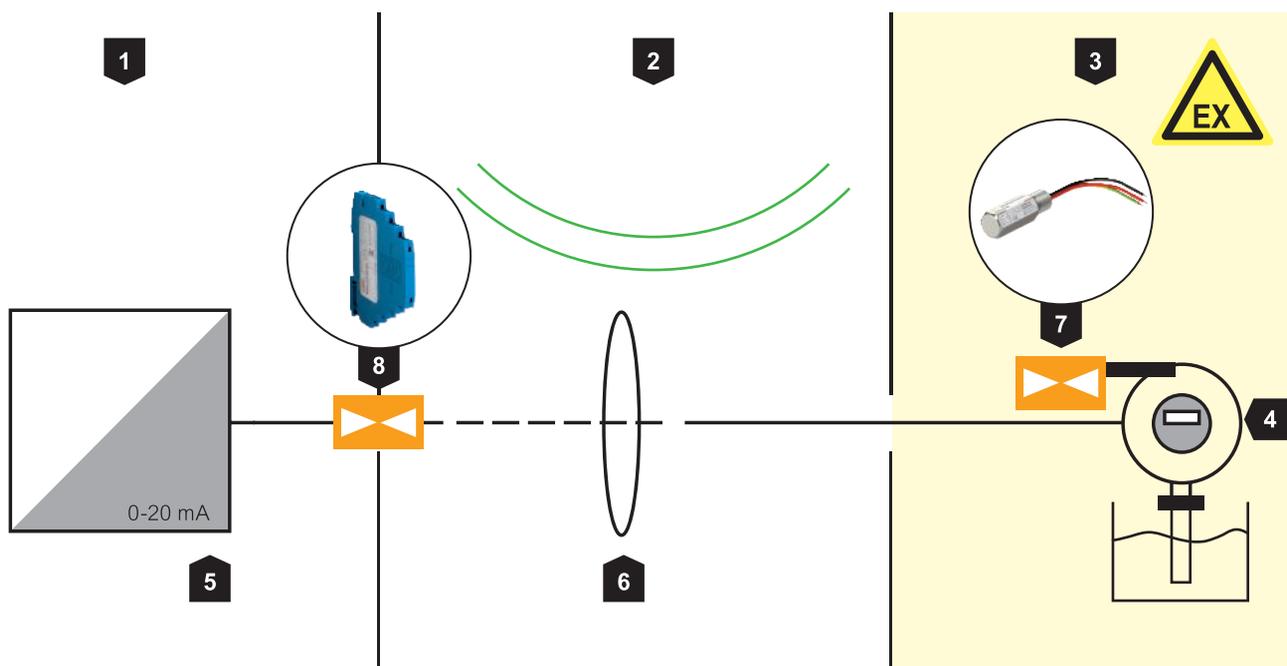
Ex-certified SPDs



Lightning barrier MDP-4 D-5-EX



Petrol Field Protector FDB-2 24-M



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

Application example – protection of a measurement/control signal line in an ex area

According to VDE 0170-7 (IEC 60079-11), an intrinsically safe electrical resource is an electrical resource, in which all the power circuits are intrinsically safe. The corresponding electrical resource, which contains both intrinsically safe and non-intrinsically safe circuits, is structured in such a way that the non-intrinsically safe circuits cannot influence the intrinsically safe circuits.

According to VDE 0165 Part 1 (IEC 60079-14) and VDE 0170-10-1 (IEC 60079-25), surge protection devices must fulfil the following requirements:

- Minimum arresting capacity of 10 pulses of 10 kA (8/20)
- Protection of the cables between the SPD and operating device against lightning strikes
- Leakage current < 10 µA
- Insulation resistance > 500 V (conductor-protective conductor)
- Corresponds to the device category ia, ib or ic
- Taking the L0 and C0 values into account

MDP-EX/FDB labelling and areas of use: II 2(1)G Ex ia [ia Ga] IIC T6...T4 Gb

The surge arrestors may be installed in potentially explosive areas which require Category 2 devices (2G) (Zone 1/2). The intrinsically safe circuits/sensor circuits may be run in areas requiring Category 1 devices (1G) (Zone 0).

Both product ranges are also tested for applications in process technology such as the Profibus PA/DP and Foundation Fieldbus.

Typical MDP-EX and FDB interfaces are:

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

You can find additional information on MCR systems (including MCR selection aid) in the OBO lightning protection guide (item no. 9131970).



isCon® conductor on air-termination rod in Ex area

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

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

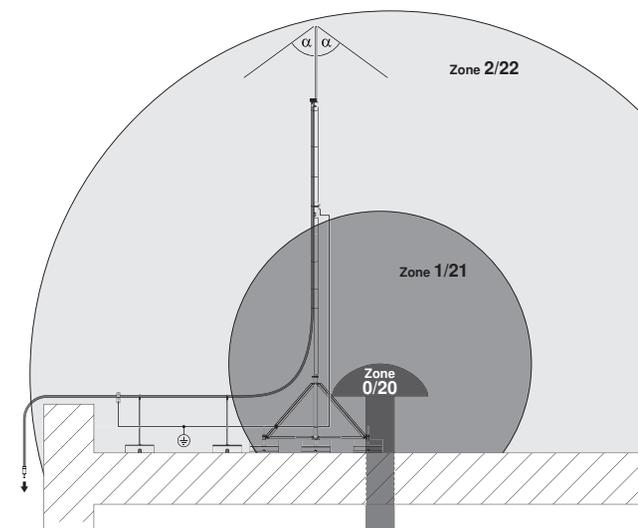
The OBO isCon® Pro+ conductor has been tested independently according to the ATEX directive. OBO manufacturer's declarations can be found at www.obo-bettermann.com.

In Ex zones 1 and 21, after the first potential connection, the OBO isCon® Pro+ 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 air-termination and 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 isolated air-termination rods.

Type	Item no.
isCon Pro+75 SW, length 25 m	5408002
isCon Pro+75 SW, length 100 m	5408004
isCon Pro+75 SW, length 250 m	5408006
isCon Pro+75 GR, length 25 m	5407995
isCon Pro+75 GR, length 100 m	5407997
isCon stripper 2	5408012
isCon connect	5408022
isCon PAE	5408036

OBO isCon® Pro+ systems



Example of the installation of the isCon® Pro+ system in the Ex zones of a potentially explosive area

2.4 Earthing systems

In potentially explosive areas, type B according to VDE 0185-305-3 (IEC/EN 62305-3) is recommended for earthing systems. In this special application, the arresting resistance must be as low as possible and may not reach 10 Ohm. With the "Earthing systems" module, the OBO Construct online tool makes efficient support available for project planning and documentation of type B (ring and foundation earth electrodes) and type A (earth rods) earthing systems.

3 Literature index

- VDE 0185-305-1 (IEC 62305-1) – General principles
- VDE 0185-305-2 (IEC 62305-2) – Risk management
- VDE 0185-305-3 (IEC 62305-3) – Protection of buildings and humans
- VDE 0185-305-4 (IEC 62305-4) – Electrical and electronic systems within structures
- VDE 0185-561-3 (IEC 62561-3) – Requirements for spark gaps
- VDE 0185-56+1-3 (IEC 62561-1) – Requirements for lightning protection connection components
- TRBS 2152/2153
- IEC 60079-25 (VDE 0170-1-6)
- IEC 60074-14 (VDE 0165 Part 1)
- IEC 60079-25 (VDE 0170-1-6)
- AfK recommendation no. 5
- Ordinance on Industrial Safety and Health (BetrSichV)
- BGR 104
- TRGS 509
- DVGW GW 24
- GefStoffV 2015
- OBO Construct Earthing
- OBO Lightning protection guide

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