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1995 – 2025

SALTEK®

SOLUTION

Pipelines and Catodic Protection Stations

Lightning and overvoltage protection

Protection of pipelines against lightning and overvoltage effects

A properly designed and functioning protection against overvoltage effects should be an inherent part of all important industrial systems and technologies where the highest level of requirements is made on reliability, since a business interruption or loss of production could produce considerable financial losses but also have a serious bearing on the safety.

This, of course, applies generally to all sectors of industry, in particular the operation of pipelines (gas industry, oil refineries and oil industry), where a failure to the pipeline system and a leakage might cause not only a material damage, but also be harmful to the living environment. There are often whole regions and areas that depend on the delivery of the transported product, such as water. For this reason the design of the entire system should be reliable and insusceptible to any ambient effects, to ensure that compensations resulting from the interruption of deliveries and the related servicing costs are reduced to a minimum. Such costs are gradually increasing with the characteristic properties of the systems, such as the size of component parts, complicated handling, severe climatic conditions, difficult terrain, long distances, availability of operators etc. It is therefore evident that the pay-off period for initial investment to achieve highest possible failure-free operation of the system and overvoltage protection is very short compared to other areas of activity.

With the extension of pipelines it could be observed at many locations that the pipeline, if such is placed in the ground or water, is subject to increased appearance of corrosion and material degradation. Based on an extensive research of this phenomenon both passive protection started to be used on the pipeline to protect it from corrosion by applying various types of protective paints and coats, to ensure its reliable operation, but also active protection in form of **cathodic protection stations (CPS)**.

Cathodic protection stations protect the pipeline from the effects of alternating voltage on the piping by a generated AC/DC voltage. The system measures and compares voltages at the output of the cathodic protection power unit and a reference electrode and, if necessary, adjusts the level of the DC protective voltage introduced in the pipeline. The voltage then inhibits the appearance of corrosion on the pipeline. The cathodic protection stations consist of various electronic equipment, DC power supplies, sensors, communication lines, systems of remote status indication and various other elements. In such a way a comprehensive protection of the CPSs is ensured, which then are protected from failures and the effects of a prospective atmospheric or technological overvoltage, voltages induced from the parallel run of MV and HV power lines, or high-ohmic short circuits. A properly executed protection against impulse overvoltages minimizes the possibility of damaging the CPS and, consequently, prevents the occurrence of failures or constraints in the functionality of the cathodic protection installed at a specific section of the pipeline.

Reasons for the development of overvoltage at the cathodic protection stations

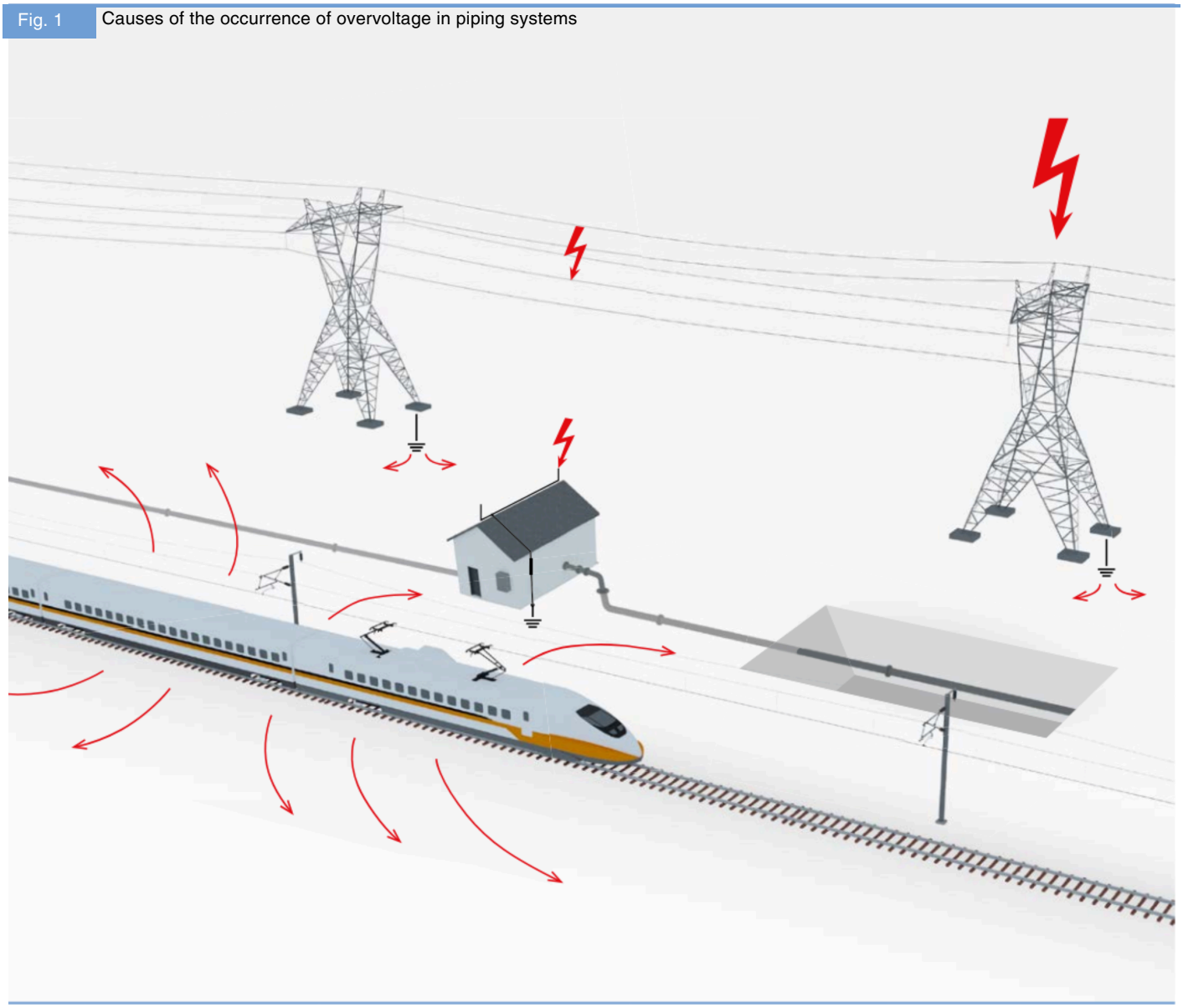
There are usually at least three different lines introduced into a cathodic protection station:

- LV power supply line
- circuits belonging to the cathodic protection (pipeline, anodes)
- circuit of the reference electrode

The power supply inlet is often a source of overvoltage, in particular if the power connection is an overhead line, taken out from the transformer mounted on a power-transmission pole, from where the lightning currents can be conducted into the station. Switching and atmospheric impulse-type overvoltage from MV/HV power distributions, containing HF components, penetrates into the CPS via the capacity of power supply transformer, and thus the LV underground cabling of the power supply connection. From the point of view of electric power the greatest problem is a **direct lightning strike into the protected pipeline.** The high voltage gradient around the pipeline presents a danger to all circuits connected to the electrodes in the ground. A similar situation arises if the **lightning strike occurs near the cathodic station**, in which case the impulse voltage level increases due to the scattering of the lightning current in the ground.

The consequence are various potentials arising on the respective metallic structures in the ground (piping, anode, reference electrode, ground wire for grounding the power supply mains, and lightning conductors belonging to the building object protection). The voltage difference between the potentials attains dangerous values for circuits installed at the CPS. The same situation arises if the **lightning strikes the lightning conductor protecting the object** in which the CPS is installed: in the process of spreading the lightning current generates various voltages at the inlets to the earthed parts and the electrodes (piping, PEN conductor, anode, reference electrode, etc.). Any **short-circuit current occurring during earth faults on a MV/HV power line or electric traction running in parallel with the pipeline** generates induced currents in the nearby pipelines. However, the greatest danger is hidden in currents that flow (through the earth) into the piping during a short-circuit on an overhead power line with a low-impedance earthed node (this applies typically to the TN and TT networks). Keeping to adequate distance of the earthing system to the piping is often a problem, in particular in urbanized areas. The course of over-voltage then depends on the short-circuit current flowing through the system considered.

Fig. 1 Causes of the occurrence of overvoltage in piping systems

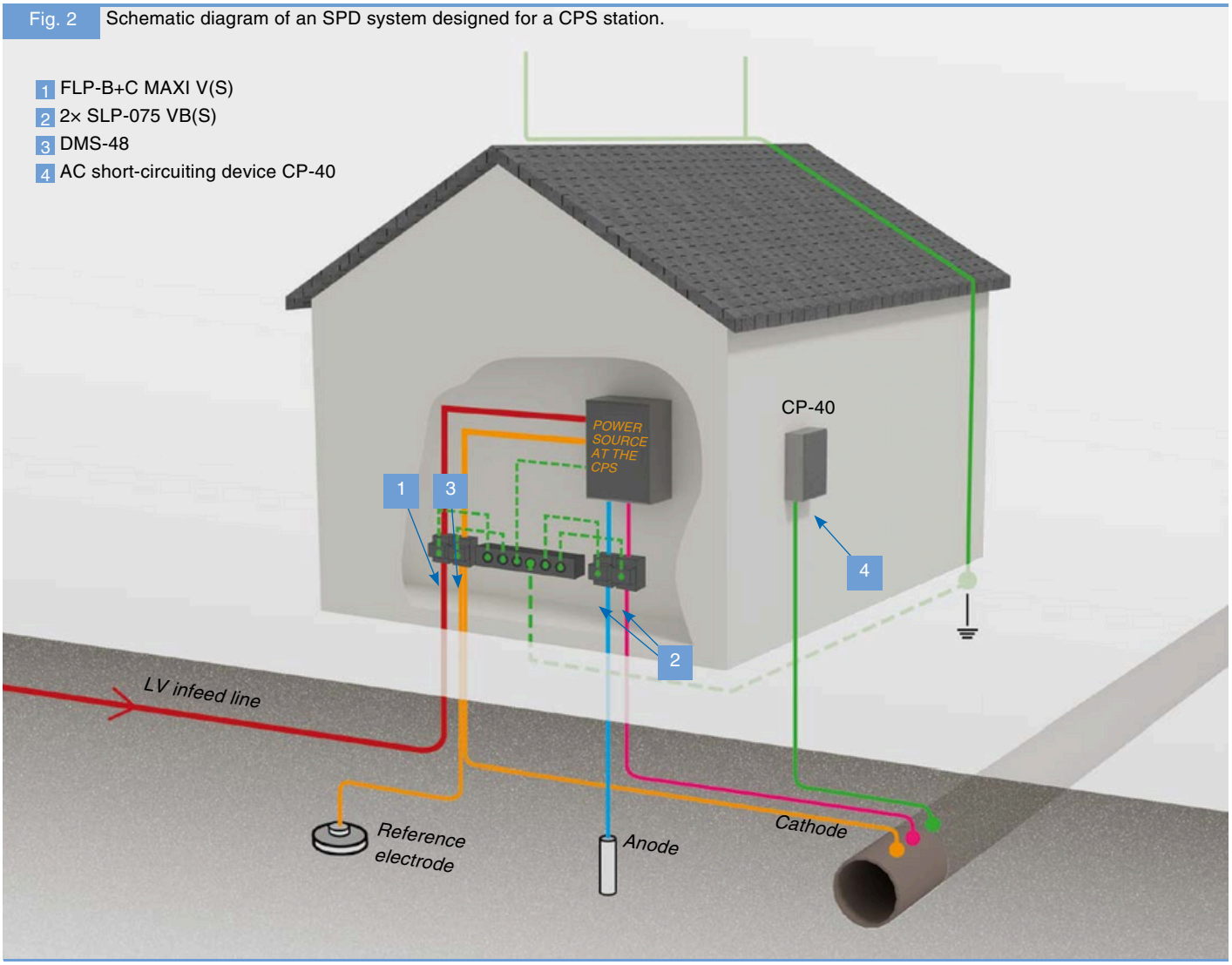


Protecting the power source of the cathodic corrosion protection

Protection against voltage spikes (impulse-type overvoltages) **at the input of a LV power line** stems from the bonding principle aimed at the prevention of occurrence of different electric potential that might impair the power source during either direct or a nearby lightning strike, which is similar to the design of surge protection in residential buildings. This is why all the inputs into a power source at the CPS should be equipped with lightning stroke arresters and surge protection devices (SPDs) of the **FLP-B+C MAXI V** series (SPD type1 and 2). The advantages lie in their very low (and safe) voltage level of U ≤ 1.5 kV which ensures that the voltage levels on equipment connected close to the SPD will also be safe, and also the leakage current, which means a zero energy intensity in day-to-day operations.

The **protection of the output of a power source at the cathodic corrosion protection station** (the anode and cathode circuits) shall use two pcs of the **SLP-075 VB/1** SPD (also available in the “S” version with remote indication of the SPD state), one for the positive and one for the negative poles. The circuit of the ref- erence electrode will be equipped with a special **DMS-48** SPD with the function of conducted current.

Fig. 2 Schematic diagram of an SPD system designed for a CPS station.



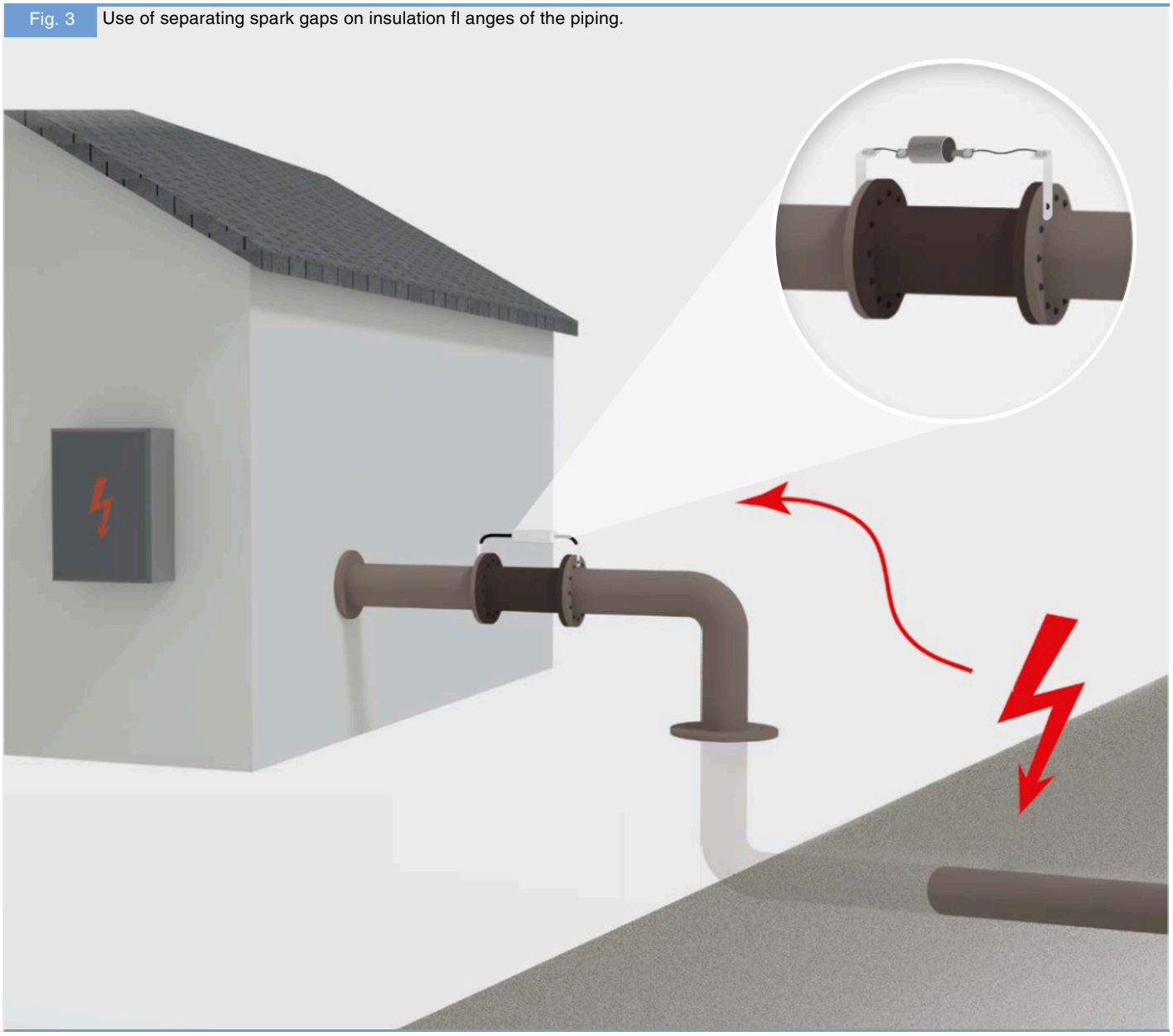
Protection of piping incl. equipment serving to protect the piping against the occurrence of undesirable AC voltages

Special attention is also to be given to the possibility of damaging the CPS power source by dangerous electrical potentials resulting from **AC voltages induced from MV/HV power lines or railway traction lines.** This induced voltage is a great problem which prevents proper operation of the CPS source and results in the a.m. piping corrosion, reduction of the piping´s service life and higher consumption of electric power at the CPS. Since two types of voltage appear at the same time during the occurrence of the situation described above, i.e. a DC voltage from CPS which we need to protect the piping, and AC parasitic induced voltage, it is rather difficult to eliminate the latter one without significantly influencing the course of DC voltage from the CPS, especially when there is no a possibility of direct earthing of the piping due to the usage of cathodic protection. So it is preferable to complete the once designed protection of CPS on the basis of SPDs with the **CP-40 short-circuiting AC device** which also is used as a replacement for the formerly used „KIRK“ or “DOC” solutions. The CP-40 is a maintenance-free equipment, easily to be installed, which minimizes the servicing costs. In case of occurrence of an induced AC voltage the circuit interconnects the piping for a short period of time with the earthing system, drains the induced AC voltage from the piping, but acts as if the DC polarization voltage generated by the CPS power source would not be there, i.e. it does not infl uence the operation of the power source. CP-40 also significantly reduces the power consumption of the CPC by optimizing the level of generated DC current, hence reducing significantly the total operation costs by up to 80 percent. Thanks to its sophisticated design and the used high-performance spark gap the CP-40 provides also an efficient protection of the CPS from atmospheric effects (lightning) arriving from the piping, along with its capability to derive lightning currents of up to 100 kA (10/350 µs). This characteristic may find its usage also for the elimination of stray currents acting on the piping as a result of passing by trains or locomotives in cases when the pipeline is laid e.g. in a gravely subsoil. The AC CP-40 short-circuiting device is offered in two basic versions – under the designation of **CP-40-K2** for mounting into a distribution board, or under the designation of **CP-40-BOX** for mounting on the outer surface of a distribution board with IP65 protection degree.

The use of isolating spark gaps on insulation fl anges of the piping

As has been pointed out, a large problem for the operation of a CPS is the **direct lightning strike into the protected piping.** After the impact the lightning current spreads along the piping (to a distance of up to several kilometres) up until the point where either the CPS or an insulation part or fl ange is connected. The latter two are mounted in the piping to separate the sections protected by cathodic protection, having their own earthing system. The large difference in potentials, subsequently arisen between either sides of the flange, may cause insulation breakdown and malfunction of the cathodic protection on either of the affected sections of the piping. The interconnection of the parts enlisted is done by **ISG –** a special, high-performance, gas insulated isolating spark gaps. If a difference in potentials arises on the piping, or if one section of the piping is affected by a direct lightning strike, the spark gap makes sure that the potentials between the sections equal, by protecting in such a way the insulation between either of the metallic parts from electrical breakthrough. On pipelines serving for the transport of dangerous energy media such as gas or crude oil, special versions of spark gaps, intended for use in explosive environments (the so called Ex with the ATEX certificate), with type designation of **ISG...H Ex** have to be used. Another area of application for the isolating spark gaps are the pipeline inspection stations, where the whole system is to be equalized in terms of electric potentials, in order to prevent the occurrence of insulation breakthrough or flashover if the pipeline is used for the transport of dangerous raw materials. This is achieved by earthing the piping indirectly via ISG (Ex) connected to the main bonding system of the station. In case a difference between electrical potentials arises between the piping sections, which is also the case for a direct lightning strike into the building, the potential equalization takes place through that specific protective element.

Fig. 3 Use of separating spark gaps on insulation fl anges of the piping.



Recommended products for protection of pipelines

Lightning current arresters and surge arresters (SPD Type 1 and 2) FLP-B+C MAXI

High-performance combined lightning stroke current arresters and surge protectors, for installation at the feed-in points of LV power dis- tributions. Protection against the effects of overvoltage during direct or indirect lightning strike. Combination of varistor and sparking gap, connected in series. Zero leakage current, zero follow current.

- Removable module
- Visual status indication
- Possibility of blocking the module
- Remote status indication as an option (S)
- Up ≤ 1,5 kV

Type	Connection	Suitable for networks	U_c	I_{imp} (10/350 µs)	I_n (8/20 µs)	I_{max} (8/20 µs)	Remote status indication	Ordering number
FLP-B+C MAXI V/1+1	1+1	TT	275 V AC	25 kA	30 kA	60 kA	no	A05095
FLP-B+C MAXI VS/1+1	1+1	TT	275 V AC	25 kA	30 kA	60 kA	yes	A03783
FLP-B+C MAXI V/2	2+0	TN-S	275 V AC	25 kA	30 kA	60 kA	no	A05092
FLP-B+C MAXI VS/2	2+0	TN-S	275 V AC	25 kA	30 kA	60 kA	yes	A03784
FLP-B+C MAXI V/3	3+0	TN-C	275 V AC	25 kA	30 kA	60 kA	no	A05093
FLP-B+C MAXI VS/3	3+0	TN-C	275 V AC	25 kA	30 kA	60 kA	yes	A03570
FLP-B+C MAXI V/3+1	3+1	TT	275 V AC	25 kA	30 kA	60 kA	no	A05096
FLP-B+C MAXI VS/3+1	3+1	TT	275 V AC	25 kA	30 kA	60 kA	yes	A03572
FLP-B+C MAXI V/4	4+0	TN-S	275 V AC	25 kA	30 kA	60 kA	no	A05094
FLP-B+C MAXI VS/4	4+0	TN-S	275 V AC	25 kA	30 kA	60 kA	yes	A03571

Surge arresters (SPD Type 2) SLP-075 VB

To be connected to the output of cathodic protection power source, to protect a device against induced overvoltages (surge voltages) during a lightning strike, or as a first protection stage of measuring circuits. Suitable for use in networks with fluctuating voltage. Combination varistor + sparking gap connected in series. Zero leakage current, zero follow current.

- Removable module
- Visual status indication
- Possibility of blocking the module
- Remote status indication as an option (S)

Type	Connection	Suitable for networks	U_c	I_n (8/20 µs)	I_{max} (8/20 µs)	Remote status indication	Ordering number
SLP-075 VB/1	1+0	TN	75 V AC	15kA	25 kA	no	A02155
SLP-075 VB/1 S	1+0	TN	75 V AC	15 kA	25 kA	yes	A07052

DMS Surge protective device

A special two-stage surge protective device with a resistance against conducted AC voltages and a limitation of through-flow current. Intended to be used for the protection of measuring and control systems, security systems, fire alarm systems, etc., in particular the protection of measuring loops against pulse overvoltages in systems running over a long distance with electrical power lines.

- Installation straight in front of the equipment to be protected
- The line part is severed from the protective earth with a surge diverter (floating)

Type	Location	No. of lines	U_C	I_L	In (C2)	$U_{P(C3)}$ wire-PE	Floating	Ordering number
DMS-24	ST 2+3	1	33 V DC	0.06 A	5 kA	450 V	yes	A06596
DMS-48	ST 2+3	1	56 V DC	0.06 A	5 kA	450 V	yes	A06597

CP-40 – AC short-circuiting device

The CP-40 eliminates negative effects of induced AC voltage acting on the cathodic protection power supplies. It has no an effect on the operation of the power supply itself, but short circuits all AC voltages do earth, except for currents with 10 kHz frequency, which are used for finding out leakage currents. The highest long-lasting AC current the CP-40 is able to short circuit to earth is 40 A. The device integrates also a surge protective device and lightning protection for currents rising to up to 100 kA (10/350 µs).

- Protection of CPS from atmospheric effects coming from the piping side
- Elimination of harmful effects caused by induced AC voltage in the piping
- No effects on the DC current and the functioning of cathodic protection
- Significant reduction of power consumption by the CPS
- Maintenance-free equipment

Type	Mounting	U_{max}	I_A	I_{max}	I_L	I_n	I_{imp}	Protection degree	Ordering number
CP-40-BOX	wall mounting	18 V DC	40 A AC	400 A AC	≤ 1 mA	10 × 100 kA	100 kA	IP 65	A05346
CP-40-K2	into K2 box	18 V DC	40 A AC	400 A AC	≤ 1 mA	10 × 100 kA	100 kA	IP 00	A03761

Isolating spark gaps ISG and ISG EX

Isolating spark gap to equalize potentials and establishing a bridge between insulated flanges and insulated piping connections on piping systems with cathodic protection. Another usage the isolating spark gaps may find is the indirect connection of an external lightning protection system to another metallic structures installed nearby, or indirect connection of isolated conductive parts, where direct connection is not allowed to be used due to operational reasons.

- Very low rated DC withstand voltage
- Different connection possibilities
- Different versions for explosive environments (Ex) – in stainless steel housing
- Isolation resistance ≥ 100 MΩ
- Products of N and H classification classes

Type	Into Ex environment	Connection via	I_{imp} (10/350 µs)	U_{rimp}	U_{WAC}	U_{WDC}	Calssification	Ordering number
ISG -A100	no	connecting pins	100 kA	5 kV	2,5 kV	-	class H	A03590
ISG-50	no	screws	50 kA	0,9 kV	0,035 kV	0,05 kV	class N	A04086
ISG-100	no	screws	50 kA	0,95 kV	0,07 kV	0,1 kV	class N	A04078
ISG-500	no	screws	100 kA	1,5 kV	0,35 kV	0,5 kV	class H	A04127
ISGC-50	no	cables	50 kA	0,9 kV	0,035 kV	0,05 kV	class N	A05365
ISGC-100	no	cables	50 kA	0,95 kV	0,07 kV	0,1 kV	class N	A05366
ISGC-500	no	cables	100 kA	1,5 kV	0,35 kV	0,5 kV	class H	A05368
ISGO-500	no	cable / screw	100 kA	1,5 kV	0,35 kV	0,5 kV	class H	A05518
ISG-50H Ex	yes	screws	100 kA	0,9 kV	0,035 kV	0,05 kV	class H	A04131
ISG-100H Ex	yes	screws	100 kA	0,95 kV	0,07 kV	0,1 kV	class H	A04132
ISG-500H Ex	yes	screws	100 kA	1,5 kV	0,35 kV	0,5 kV	class H	A04109
ISGC-50h Ex	yes	cables	100 kA	0,9 kV	0,035 kV	0,05 kV	class H	A04128
ISGC-100H Ex	yes	cables	100 kA	0,95 kV	0,07 kV	0,1 kV	class H	A04129
ISGC-500H Ex	yes	cables	100 kA	1,5 kV	0,35 kV	0,5 kV	class H	A04120
ISGO-50H Ex	yes	cable / screw	100 kA	0,9 kV	0,035 kV	0,05 kV	class H	A06142
ISGO-100H Ex	yes	cable / screw	100 kA	0,95 kV	0,07 kV	0,1 kV	class H	A06143
ISGO-500H Ex	yes	cable / screw	100 kA	1,5 kV	0,35 kV	0,5 kV	class H	A05514

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