HIDDEN DANGERS:
HOW TO PROTECT YOUR INSTALLATIONS EFFECTIVELY

How ACI provides the answer to your industrial challenges

Protection against voltage: in the world of electrical engineering, surge protective devices (SPDs) are indispensable. They protect vulnerable technologies from the fatal effects of overvoltages, which can be caused by both natural phenomena, such as lightning strikes, and industrial processes. Especially today, in an age in which automation and digitalization are constantly on the rise, the protection of critical systems – particularly in the manufacturing industry – is becoming increasingly important.

But first things first: not all overvoltages are the same. After all, they can be caused by a variety of factors. From atmospheric conditions to switching processes within industrial plants: voltage peaks are potentially devastating and can damage or even destroy sensitive devices in a fraction of a second.

SPDS – THE PROTECTIVE SHIELD FOR YOUR ELECTRONICS

SPDs are the backbone of any reliable surge protection system. Equipped with cutting-edge technologies, these devices are precisely designed to guarantee comprehensive safety even under extreme conditions. In particular, the use of triggered spark gaps in SPDs – known for their exceptional ability to safely channel high pulse currents – protects grid stability.

This has not only proved itself in practice. It also fulfils demanding international standards such as IEC 61643-11 and DIN EN 61643-11, which guarantee the highest safety standards and reliable performance. As Problem solvers, DEHN shows you exactly how this works with its technological solutions.

HOW MODERN SPDS PROTECT YOUR PLANT SUSTAINABLY

DEHN is setting new standards with its new Advanced Circuit Interruption (ACI) technology. The special feature of the integrated switch/ spark gap combination in ACI eliminates the need for a separate device fuse, similar to CI products with integrated fuses. However, the decisive advantage of ACI lies in the special switch/spark gap combination, which offers additional safety and performance features (read more about the technological details on pages 7 and 8). ACI thus avoids possible errors that can occur when selecting and dimensioning a backup fuse.

In this information sheet, you will not only learn about the advantages of modern SPDs – such as DEHN ACI technology – but we will also provide detailed practical examples and scenarios to show you the importance of surge protection in various application areas. As always, it is about finding the right balance. On the following pages you will find a combination of theoretical knowledge and practical application, enriched with facts and figures on the subject of surge protection for modern installations.

Rethinking surge protection with ACI

Choosing the right SPD and integrating it correctly into an electrical system minimises the risk of downtimes and expensive repairs. This is particularly true in an industrial context, where harsh conditions often prevail and the probability of surges is high. In terms of operational safety and productivity, the correct selection and installation of SPDs – adapted to the specific requirements and ambient conditions – is essential for these objectives.

RISKS DUE TO GRID-RELATED VOLTAGE FLUCTUATIONS, DEFECTS AND LIGHTNING STRIKES

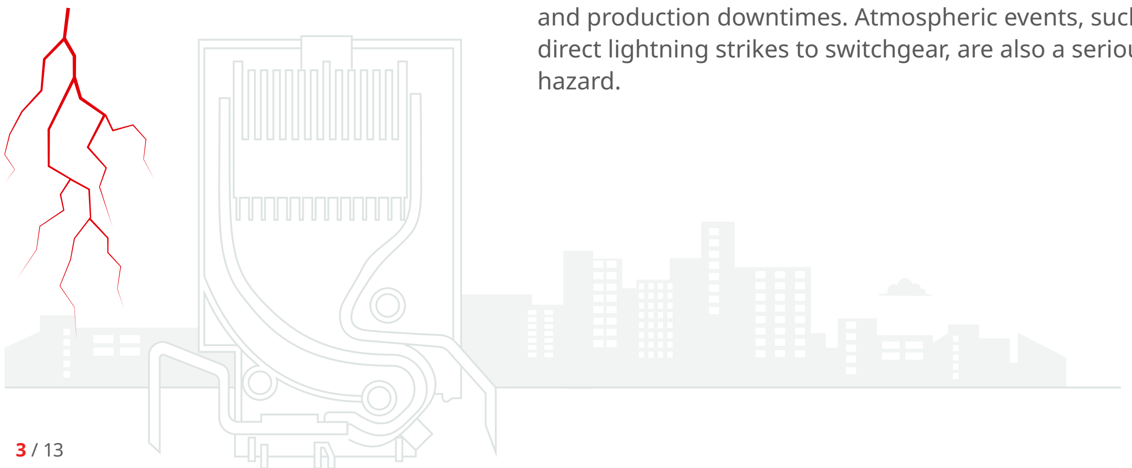
With the increasing automation, visualisation and remote control of devices and systems, their sensitivity to transient overvoltages is also increasing. It is therefore crucial that the surge protective devices used in switchgear cabinets for industrial applications guarantee an appropriate level of protection and reliably safeguard connected devices and systems from voltage peaks.

Overvoltages, also known as “surges“ and “transients“, can occur in microseconds and severely damage or even destroy appliances and electrical installations. Without appropriate protection, devastating damage can occur, which can impair system availability and quickly result in high costs due to production losses, material replacement and production downtimes. Atmospheric events, such as direct lightning strikes to switchgear, are also a serious hazard.

MORE THAN TWO BILLION LIGHTNING STRIKES WORLDWIDE – IN 2023 ALONE

A total of 2,102,170,206 lightning strikes occurred worldwide in 2023 – and the trend is rising. This was recently summarised in the Vaisala Xweather Annual Lightning Report. According to the report, thunderstorms and associated lightning strikes were the most costly natural disaster in 2023. The resulting downtimes at industrial plants led to correspondingly high costs.

But regardless of whether natural influences, grid-related overvoltages or defective protective devices are involved, the following generally applies: if machines break down unexpectedly, companies suffer massive financial losses. The hourly costs for system failures quickly exceed the 100,000 dollar mark – the equivalent of more than 90,000 euros. The range between different industry sectors is high: from the equivalent of almost 36,000 euros for fast-moving consumer goods to 1.84 million euros in the automotive sector. This was calculated by the software provider Senseye together with Siemens. You can find out more about outage scenarios on page 4.



Surge protection for the energy revolution

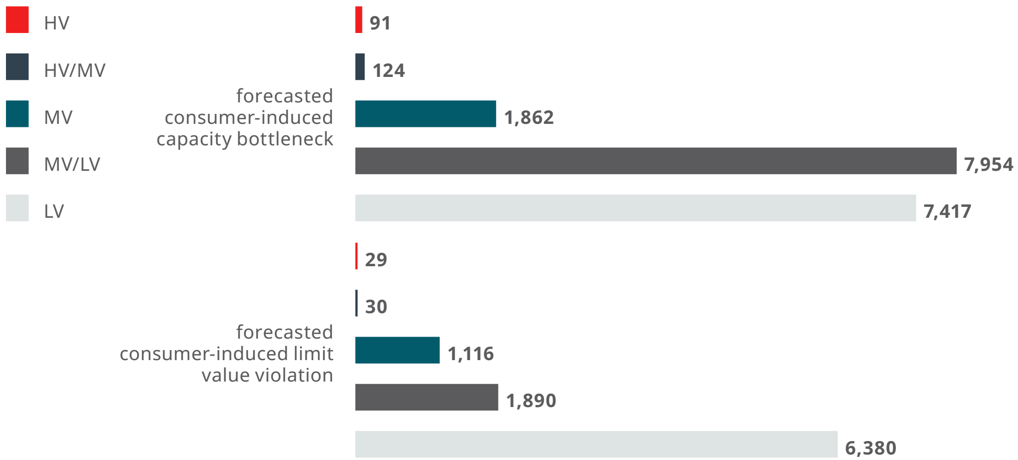
In the times of the energy transition, when the expansion of renewable energy sources such as wind and solar energy is playing an ever greater role, protection against voltage problems and surges is becoming increasingly important. While switching to clean energy sources undoubtedly has a positive impact on the environment, it also harbours challenges for the stability and security of the power grid.

CAPACITY BOTTLENECKS AND LIMIT VIOLATIONS IN THE POWER GRID

To date, Germany has stood out with the highest quality in terms of electrical power supply. However, some companies in Bavaria are reporting a greater demand for power quality and potential impairments. In the "Report on the State and Expansion of the Distribution Grids", the German Federal Network Agency states that "66 of the 82 distribution grid operators surveyed" are pushing for an expansion of the power grid due to potential surges.

And with good reason. According to the report: "For the entire grid, 17,448 line sections or substations with consumption-related capacity bottlenecks and 9,445 line sections or substations with consumption-related limit value violations are expected in 5 years."

Forecasted consumer-induced capacity bottlenecks and limit value violations
Number of line sections/substations



Source: Bundesnetzagentur

HV=High voltage, MV=Medium voltage, LV=Low voltage

The grid operators are assuming a significant increase in consumption-related capacity bottlenecks and limit value violations. Renewable energy generation ultimately leads to new grid parameters that conventional protection systems are often no longer able to take sufficiently into account. An effective solution must therefore not only be technically sophisticated, but also easy to install and maintain, even by less qualified personnel.

TARGETED DETECTION AND DISCHARGE OF SURGES

Effective surge protection is essential to minimise the risks of uncontrolled fluctuations. An important component is the installation of discharge systems that effectively protect connected equipment. This includes, for example, the use of lightning conductors and surge protective devices at the interfaces between the public power grid and the consumer systems.

Modern surge protective devices, such as those offered by DEHN, rely on innovative technologies such as ACI technology. This technology makes surge protection even more reliable. Find out more about the advanced ACI technology and how DEHN is setting new standards in surge protection on our website.

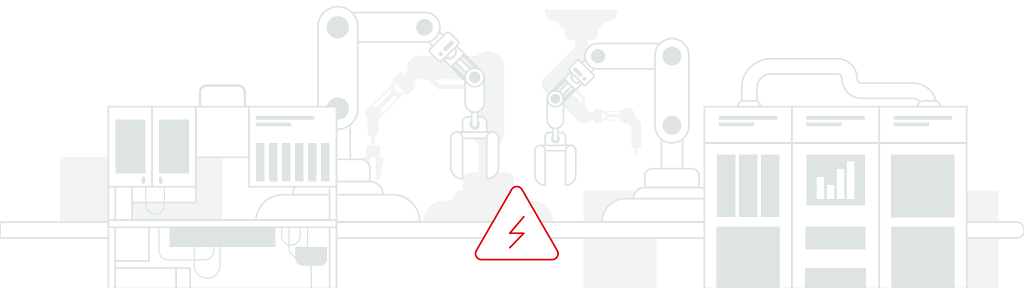
Production stoppage due to inadequate surge protection

A typical workday in a manufacturing plant. Machines are running at full speed to achieve the daily production targets. Suddenly, a thunderstorm breaks out and lightning strikes near the plant. This leads to an overvoltage in the power grid.

The production facility is not adequately protected against overvoltage because the installed surge protective devices are outdated or insufficiently dimensioned. Within seconds, the overvoltage leads to a total failure of the facility. This can end up very costly and quickly jeopardise the company's existence (see page 4).

THE DIRECT CONSEQUENCES:

- **Power failure:** the company is abruptly disconnected from the power supply. Machines and production facilities come to a standstill, computers and other electronic devices switch off. The operation comes to a standstill.
- **Damage to devices:** the current peaks caused by the overvoltage damage sensitive electronic devices and control systems. Repairing or replacing these devices is costly and time-consuming.
- **Production losses:** every production standstill leads to considerable financial losses. Orders cannot be fulfilled on time, resulting in contractual penalties.



THE INDIRECT CONSEQUENCES:

- **Reputational damage:** the unreliability of the power supply and the resulting production losses harm the company's reputation. Customers and business partners doubt the company' s ability to deliver reliably.
- **Additional costs:** in addition to the direct repair costs, further costs arise from the utilisation of emergency power generators, the hiring of external specialists to rectify faults and the possible loss of perishable goods.
- **Safety risks:** abrupt machine shutdown can pose safety risks for employees. Emergency protocols must be triggered to prevent injuries or accidents.
- **Insurance issues:** the damage leads to lengthy negotiations with the insurance company to clarify the coverage of the damage. Insurance policies often do not cover all the costs incurred, which further increases the financial burden.

All this could be prevented with modern surge protection: The use of DEHN's ACI technology solves specific problems that conventional surge protective devices cannot handle. ACI products offer greater reliability and durability and are particularly advantageous in low-voltage main distribution boards or transformer stations.

Regular maintenance and inspection of the surge protection systems ensures that they function effectively in an emergency. A backup system, consisting of battery packs or emergency power generators, can also minimise the effects of a power outage. Whichever way you look at it, surge protection is an investment in the future security and stability of your company.

Shortlink:

ACI Technology

Precise planning helps – even with surge protection

Renewable energy generation leads to new grid parameters that conventional protection systems are often no longer able to take sufficiently into account. New contexts require new measures, so good planning and dimensioning of surge protection systems in industrial plants are essential for their ability to survive. And it all starts with a detailed analysis of the specific grid and operating conditions.

WHAT TO LOOK OUT FOR:

- **Determine the surge risks:** it is important to identify the main sources of surges, such as lightning strikes, switching operations and short circuits. This analysis helps with the selection of the right SPD types and their placement.
- **Select suitable SPDs:** based on the risks identified, SPDs are selected that meet the specific requirements of the system. Type 1 SPDs are installed at the building entrance to divert lightning currents, while Type 2 and Type 3 SPDs are used in sub-distribution boards and near terminal equipment to protect against switching overvoltages and smaller overvoltages. You can find more details on the following page.
- **Coordinate protection levels effectively:** careful coordination of the various protection levels is necessary to ensure different levels of protection. This minimises the load on the downstream devices and increases the overall effectiveness of the surge protection system.
- **Dimension cables and fuses correctly:** the cable cross-sections and fuses must be dimensioned so that they can safely carry the currents discharged by the SPDs. This also includes consideration of the maximum permissible cable lengths in accordance with the relevant standards, such as DIN VDE 0100-534 and IEC 60364-5-53.
- **Last but not least:** integration into the overall system. SPDs should be integrated into the electrical system in such a way that they are easily accessible and can be replaced quickly in the event of a failure.

What you need to know about the different types of surge protective devices (SPDs)

We now know that surge protective devices (SPDs) are crucial for protecting industrial facilities from the damaging effects of surges. We explained on the first few pages that they are caused by switching operations, short circuits or lightning strikes. Now it's time to go into more detail. What types of SPDs are there, and for what specific applications and protection requirements have they been developed?

TYPE 1 SPDS – THE FIRST LINE OF DEFENCE

Type 1 SPDs are designed to divert lightning currents and are mainly installed at the entrance point into the building. They protect against direct lightning strikes and the extremely high energy associated with them. These devices often use spark gap technologies that are characterised by their high performance and robustness.

Spark gaps can dissipate high pulse currents and are leakage-current- free during normal operation, which increases their durability and stability. Type 1 SPDs are ideal for use in industrial plants and large buildings, where they act as the first line of protection against lightning strikes. A powerful Type 1 spark-gap based arrester acts like a wave breaker, reducing the penetrating energy to a significantly lower level. This protects the electrical installation and reduces the load on downstream Type 2 or Type 3 arresters, which extends their service life. Further information can be found at „DEHN Basic-Technologies".

TYPE 2 SPDS – TECHNOLOGY THAT PROTECTS

Type 2 SPDs offer mid-level protection and are typically used in subdistribution boards. They protect against overvoltages caused by switching operations or indirect lightning strikes. These devices are capable of handling moderate energy levels and provide protection for more sensitive electronic devices and systems. Type 2 SPDs are critical for ensuring business continuity and preventing failures in industrial and commercial applications.

TYPE 3 SPDS – FINE-GRAINED SECURITY

Type 3 SPDs offer the most precise protection and are installed close to the end devices. They are designed to dissipate low overvoltages that have not been completely eliminated by the upstream SPDs. These devices protect sensitive electronics such as computers, telecommunications equipment and other critical systems in industrial plants. Type 3 SPDs are particularly important in areas where even minor overvoltages can cause considerable damage.

COMBINATIONS AND MODULAR SYSTEMS

The advantages for you? DEHN offers devices that combine all three protection levels (Type 1 + 2 + 3). That saves on space. On top of that, thanks to ACI, you can confidently dispense with the backup fuse. This gives you more space, which is often scarce in complex systems. The DEHNventil ACI arrester unites all three types of protection levels and combines them with ACI technology.

Why you should rely on DEHN either way

As a technological leader in the field of lightning and surge protection, DEHN introduced a genuine innovation back in 2009 with the development of an arrester with an integrated backup fuse. This technology not only reduces the complexity of the installation, but also eliminates frequently occurring problems with dimensioning and compliance with the prescribed connection length.

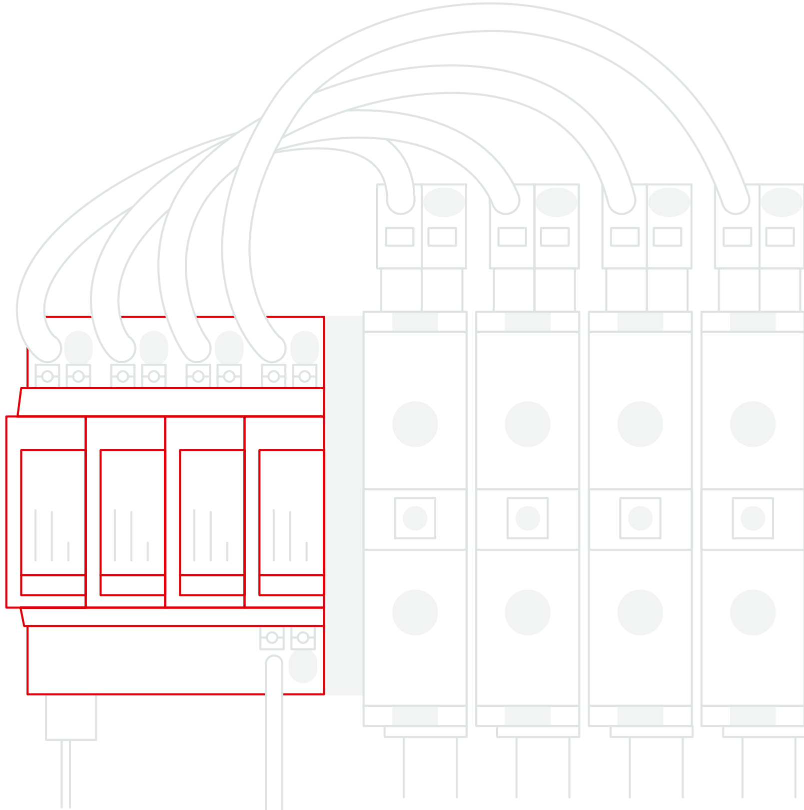
The absence of external backup fuses significantly simplifies planning and installation, which is particularly advantageous in complex systems. DEHN's latest development, ACI technology, goes one step further. It integrates a switch/spark gap combination into the surge protective device, which significantly increases reaction speed and reliability, especially in the event of a fault.

COMPACT DESIGN, HIGH IMMUNITY

This reduces the load on the connected cables and enables a more compact design. ACI technology also improves selectivity and extends the service life of the protective components thanks to their high immunity to interference. This is because ACI arresters do not allow any leakage currents to earth. This makes them much more durable and increases system safety.

But let's take another step back. With conventional SPDs, the electrical consultant is responsible for the backup fuse. And it must be correctly dimensioned. If the backup fuse is too small, it will trip as soon as lightning current flows through it. Conversely, if the rating of the backup fuse is too high, the SPD might be destroyed.

The fact that the arrester backup fuse for system protection must be selective doesn't make it any easier. Another problem is the overall cable length: in accordance with VDE 0100-534 (IEC 60364-5-53), it may be a maximum of 0.5 metres. What sounds simple can become a real challenge as a longer cable length reduces the protection level. DEHN has the right solution for all these challenges.



ACI provides effective protection – thanks to a special switch/spark gap combination

ACI technology solves several problems at once. Instead of a conventional fuse, DEHN has integrated a special switch/spark gap combination into the surge protective device. This is how it works: in the event of a surge, the impulse is only conducted at the narrowest point, which is always sufficiently dimensioned, and the resulting electric arc is not fed into the arcing chamber.

At the end of the surge protective device's service life, the fault and short-circuit currents are immediately channelled into the arcing chamber. The current is interrupted without interactions and selectively to small system fuses. On top of that, the process in the ACI spark gap is much faster than when the wire melts in a fuse. This puts less strain on the connected cable in the event of a short-circuit and the cross-section can be significantly smaller – 16 mm^2 for Type 1 and 6 mm^2 for Type 2. This saves material costs and enables easier installation thanks to smaller conductor radiuses.

In addition, the elimination of the backup fuse simplifies the necessary selectivity analysis during system planning. But now let's take another look at it ...

THE BENEFITS OF ACI TECHNOLOGY:

- **Reliable dimensioning:** The integrated switch/spark gap combination is precisely adapted to the arrester. This means: no arrester backup fuse, no errors in dimensioning, and optimised system availability.
- **Standard-compliant:** According to DIN VDE 0100-534 (IEC 60364-5-53), the total length of all cables between the connection points of the SPD assembly must not exceed 0.5 metres. Due to the integrated switch/spark gaps in our ACI arresters, you save one cable. This makes it easier to comply with the maximum length.
- **Space-saving:** Type 1 and Type 2 arresters with ACI technology from DEHN have an overcurrent protection module integrated directly in the arrester. This means that the otherwise necessary external backup fuse and the requisite fuse disconnector are no longer required. This saves valuable installation space in the switchgear cabinet.
- **Convenient:** The compact system solution provides maximum flexibility during installation. The particularly small connection cross-sectional area of just 6 mm^2 (Type 2) or 16 mm^2 Cu (Type 1) enables shorter wiring paths. No separate arrester backup fuse is necessary - this saves wiring material, time, and money.
- **Durable:** The technical properties of the ACI modules are particularly resistant to system faults or tolerance fluctuations and therefore offer long-term protection for your systems. They are also characterised by their TOV withstand and the prevention of leakage currents, which further increases their service life.
- **Reliable:** ACI modules are particularly durable and interrupt even smaller shortcircuit currents in the shortest possible time thanks to the integrated switch/spark gap combination. This makes ACI arresters extremely reliable protection modules compared to conventional fuse solutions and reduces the downtime of your system – maximum system availability.

DEHN

ACI – Innovations that last

The info paper shows that DEHN's ACI technology revolutionises surge protection and offers an efficient, safe, and reliable solution for modern industrial installations. With its ability to protect sensitive devices from the devastating effects of overvoltages, ACI technology is particularly important in times of increasing use of renewable energies and the new grid parameters associated with this. Finally, let's take another look at the innovations in ACI technology:

- **Integration of spark gaps:** ACI technology combines modern spark gaps with additional protection mechanisms, resulting in higher performance and reliability. This combination enables better selectivity and extends the service life of the protective components.

- **Reduction of mains follow currents:** Thanks to the efficient spark gap technology, no or only very low mains follow currents occur after a discharge process. This improves coordination with upstream fuses and circuit-breakers.

Safety, modularity, flexibility, intelligent technology, and easy handling are just some of the advantages of ACI technology. On top of that, it's future-proof. In a world where the protection of critical systems is becoming increasingly important, it offers a futureproof solution that meets the high demands of modern industrial plants.

By combining high performance, simple installation and comprehensive protection, ACI technology helps to increase operational reliability and minimise the costs of unplanned downtime.

Investing in advanced surge protection systems, such as ACI technology, is an investment in the future security and stability of your company. With DEHN as your partner, you can be sure that your systems are optimally protected – today and in the future.

DEHN offers customised protection concepts

As the energy revolution progresses and the use of renewable energies increases, the requirements for surge protection will continue to rise. Through continuous innovation and adaptation to new network parameters, DEHN will continue to develop customised protection concepts in the future to ensure the operational safety and efficiency of electrical systems.

The integration of smart technologies and a focus on simple handling and maintenance will play a central role in this. Invest in ACI technology to optimally protect your systems for the years to come and benefit from the latest developments in surge protection.
Relax. It's DEHN ACI.

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Surge Protection
Lightning Protection / Earthing
Safety Equipment
DEHN protects.

DEHN SE
Hans-Dehn-Str.1
Postfach 1640
92306 Neumarkt, Germany

Tel +49 9181 906-0
Fax +49 9181 906-1100
info@dehn.de
www.dehn-international.com