Mitigating overvoltage and overcurrent risks in communication networks

White Paper
Executive Summary

Fast-growing network demands are placing ever-greater strain on the advanced communications systems that increasingly support voice, video and data transmissions. What’s more, deployment of electronics further into the network has resulted in miniaturization (and higher integration density), which means reduced electrical strength of components. Both of these trends may result in greater risk of overvoltage and overcurrent, making overvoltage protection significantly more important over the past years.

All about overvoltage

**Overvoltage** - interference caused by electrical energy disturbances in communication lines - is undoubtedly the primary cause of faults. The term ‘overvoltage’ may conjure up images of vast amounts of energy being released during thunderstorms. However, even seemingly harmless static discharges can seriously affect signal transmission - or even paralyze entire networks. Overvoltage in supply lines for centrally controlled process management and control systems can even result in millions worth of damage, or even to irrecoverable losses.

Overvoltage in communication networks is usually the result of electromagnetic interference, equalizing currents between different earth potentials or network short circuits. This is caused by switching operations on neighboring lines, the indirect effect of lightning or natural forces, or by human error. The direct effect of lightning on distribution equipment is an exception, because this type of equipment is usually installed indoors or in enclosures. The massive amount of energy involved in direct lightning strikes requires separate protection concepts and structural measures.

Damaged or destroyed equipment also introduces high costs as a result of downtime. These may cost many times more than the direct damage. According to insurance industry data, indirect influences are responsible for 95% of the damage as a result of atmospheric discharges.

Networks located kilometers away from the site of impact can be damaged.

Interference by one of the following phenomena is usually the cause of damage to or destruction of communication systems:

- Lightning strikes
- Indirect lightning impact
- Electromagnetic interference
- Inductive or capacitive effects
- Electrostatic discharge
- Contact with live power lines

These conditions often represent a high degree of danger to human life.
Applying protection measures

Although the various forms of overvoltage have basically been the same for many years, their causes and effects are subject to change. Overvoltage is not only caused by reproducible interferences, but also by randomly occurring impulses. Generally, reproducible excess voltages caused, for example, by capacitive or inductive switching, are easy to localize and suppress. However, efficient protection against excess voltages caused by non-reproducible interferences is harder to achieve. A range of standards and recommendations can be adopted with a view to causes, duration and injection of such interferences into the system.

Wherever communication lines are distributed and connected, protection systems are introduced. Overvoltage protection fulfills several requirements, depending on the type of installation to be protected. In conventional switching equipment, overvoltage protection is mainly used to protect people. In highly sensitive electronic switching equipment installations, however, comprehensive protection measures are necessary in order to protect people as well as the valuable installation itself.

Overvoltage protection devices consist of components or protective circuits that limit interference to permissible values. Overvoltage protection devices must be adapted to regional and local requirements. These requirements include operating conditions on the line and protection requirements that result from the specific application area.

Graded protective circuits with secondary protection elements should be used for incoming circuits on the exchange side and for terminal equipment (telephone, fax, modem). After all, in addition to personnel safety, sensitive electronic systems also require protection. High voltage protection is usually sufficient for the line. If active components are installed in a cross-connection cabinet, graded protective circuits are also recommended.

Costs and benefits for the user

When selecting overvoltage protection modules, the cost-to-benefit ratio is key. The cost of installing protection modules is clearly offset by the increased availability of the communication network and lower repair costs. By carefully selecting equipment, network operators can minimize costs while realizing maximum economic efficiency of equipment. The extent of protection measures is based on requirements and specifications from the network operator or equipment manufacturer. To protect personnel, applicable standards and regulations for setting up and operating telecommunications networks must also be observed.
Operating conditions

Protection system design needs to meet the requirements of copper-based connection and distribution systems. In most applications, the protection modules are electrically equivalent; however, their contact and protection behavior is not necessarily compatible.

**Basic differentiators include:**

- Operating behavior of the system to be protected
- Overvoltage protection requirements (electrical and mechanical), for example requirements facing the permissible impulse current or the permissible AC discharge current. The network operator's specifications must be observed when designing the protection modules.
- The LSA-PLUS® Series 2 blocks and for LSA-PLUS® HD180.
- Requirements for protection for a single pair, or an entire module

Furthermore, protection equipment and systems must be designed to meet the needs of the following network conditions:

Before the planning phase, requirements for the protection system must be examined together with the operating conditions. An over-designed protection system rarely leads to damage but does impact the economic efficiency of the equipment. Over-designed protection also means higher repair costs and poses a personnel risk.

Installation takes place after the distribution equipment has been set up. Retrofitting existing equipment is, in most cases, not a problem if LSA-PLUS® Series 2 blocks and for LSA-PLUS® HD180 systems are installed.

Aside from the electrical characteristics, the conditions of the interface with the distributor system and the housing dimensions (if necessary) must be taken into consideration at the earliest possible stage. The following protection modules are available for the LSA-PLUS® Series 2 blocks and for LSA-PLUS® HD180.

**Selection**

Regardless of the series and circuit used, all overvoltage protection components rely on the same working principle: excessive voltages are discharged to earth. Depending on the component, the energy consumption of the protection device is relatively low. One precondition for this is the protection component's low-resistance earthing.

In line with signal potentials, a distinction is made between three-point and five-point protection. For connection modules, only three-point protection is possible. Five-point protection (components in the signal path) is recommended for use with switching modules. Once the protective plug is removed, the contact in the module is open and possible faults cannot make their way to the downstream network. Five-point protection can also be implemented using disconnection modules.

**ComProtect offers a choice of protective circuits:**

- Three-point protection: pure overvoltage protection (high-voltage or secondary protection)
- Five-point protection: overvoltage protection combined with current protection
- Five-point protection: graded protection (high-voltage and secondary protection with current protection)

Components designed for single-pair protection provide a safe and reliable solution in LSA-PLUS® Series 2 blocks and for LSA-PLUS® HD180 distribution systems. These components
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Operating conditions

3-point protection
Subscriber side System side
1
2
3
Over-voltage protection

5-point protection
Subscriber side Current protection System side
1
2
3
4
5
High-voltage protection
Fine protection
Current protection

Fig 4

also offer advantages over multiple-pair protection magazines for eight- and/or ten-pair modules. When a single-pair protection plug is removed, this does not leave the entire module (all eight or ten pairs) unprotected. Partial or combined equipping of the modules is also possible. Because of their small dimensions, the most convenient protection plugs also offer the option of switching and jumpering with protection components in place. All protection functions thus remain guaranteed at all times for both the communication equipment and maintenance personnel.

Advantages of protection magazines for eight and ten pairs are mainly a result of the fast set up and lower installation costs of a protection panel. When necessary, protection magazines for LSA-PLUS® Series 2 blocks and for LSA-PLUS® HD180 can be installed in the distributor in combination with ComProtect components.

Operating voltage/technical data

The operating voltage of the system to be protected determines the protection plug’s voltage class. The protection device must not be triggered during normal operation as this would not only destroy the protective circuit, but would also lead to interruption in signal transmission. The highest possible voltage class should be selected for the protection plug – at least above the maximum voltage possible during operation (maximum operating voltage including tolerance). The upper limit for selecting the protection plug’s voltage class is determined by the maximum protection level permitted (the maximum input voltage that would not damage the downstream system components should overvoltage occur). The selection of components and switching configurations determines other electrical parameters for protective circuits. Properly designed and specified overvoltage protection components have a serviceable life of several decades and require no additional maintenance. CommScope recommends that the nominal DC spark-over voltage of installed protection components be tested regularly. For safety reasons, the arrestors should be replaced if the protective circuit has been subjected to impulse current.
Fail-safe

Protective circuits with an integrated fail-safe feature are highly recommended. Components for overvoltage protection are usually designed only for pulse-shaped loads. Therefore, if permanent overloads are possible (for example mains contact), a safe short-circuit to earth must be ensured. Overloaded or overheated protection components would not only lose their protection function, they could cause fire or an explosion, leading to considerable damage and expense.

Choosing wisely

The mechanical interface where the protection components is going to be installed must be taken into account. CommScope offers a large number of complete magazine solutions and flexible single-pair protection plugs. Our product portfolio offers several levels of protection with extended features that have a direct influence on the severity of the network downtime and the associated commercial loss. Of course, we are more than happy to share our decades of network design experience to help you map your precise requirements and potential future needs, and select the best possible combination of components and services.

- Basic protection plugs
- Intermediate protection plugs
- Advanced protection plugs
- Maintenance-free advanced protection plugs

The solution for overvoltage protection includes a broad range of performance classes as well as various options for installation in Access Network structures.

Please check our latest overview of the ComProtect product family available [here](#).

CommScope pushes the boundaries of communications technology with game-changing ideas and ground-breaking discoveries that spark profound human achievement. We collaborate with our customers and partners to design, create and build the world’s most advanced networks. It is our passion and commitment to identify the next opportunity and realize a better tomorrow.

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