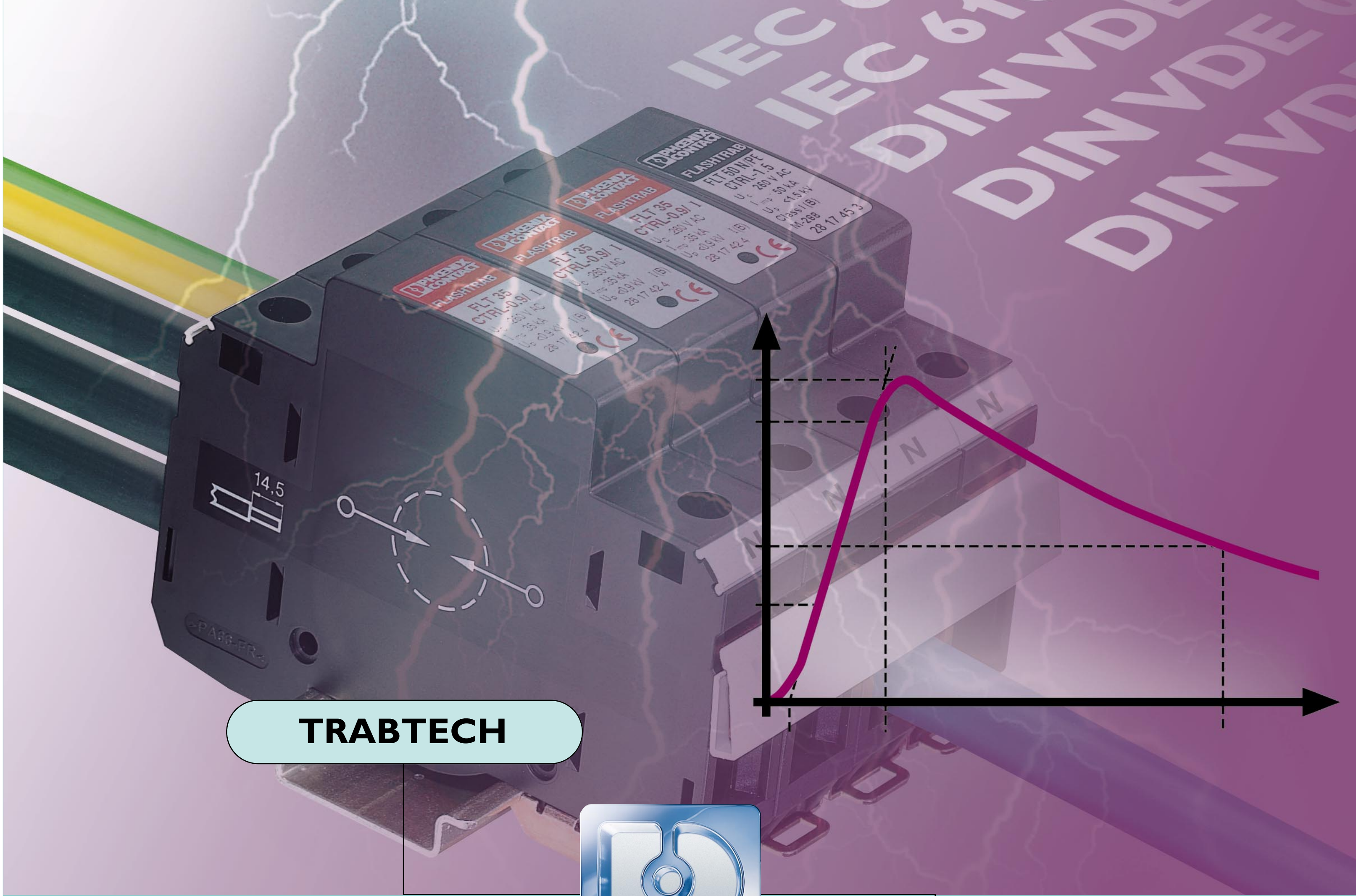

TRABTECH

Basics

PHOENIX CONTACT
INNOVATION IN INTERFACE

Author: Joachim Schimanski, Phoenix Contact

TRABTECH
The comprehensive surge voltage protection concept from Phoenix Contact

General

Surge voltages that occur as switching operations in electrical systems or from lightning discharges destroy or damage electronic equipment. Statistics of electrical insurers show that the frequency of damage from surge voltages doubles within three to four years for such systems. Although operators of electronic systems are compensated by their insurance company for damage to the hardware in most cases, software damage and system failure frequently remain uninsured with great financial burdens.

The more highly integrated electronic systems are, the less resistant they are to surge voltages. The frequency of damage is increasing as a result of this and because of the rapidly increasing number of sensitive electronic systems. Each circuit works with its own specific voltage. When a voltage increases beyond the upper tolerance limit, it becomes a surge voltage for the circuit. The transient voltages observed here are very short events in which many times the nominal voltage is reached.

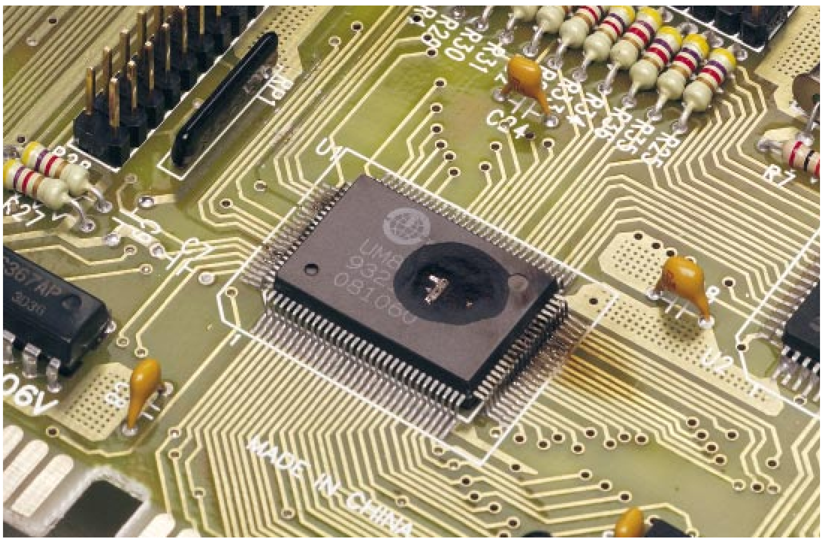

Fig. 1:
Highly integrated microelectronics: increasingly powerful, but also increasingly at risk from surge voltages.

In many cases, they damage the circuit and its components (power supply, load etc.). The extent of the damage largely depends on the dielectric strength of the components and – if you look at it further – on the energy that can be converted without damaging the circuit concerned.

For a circuit in which a 230 V AC relay is operated, a coupled transient voltage of 500 V that results e.g. from a switching operation at inductive loads is a surge voltage that hardly causes any damage; it does not even amount to 2.5 times the nominal voltage, and it only occurs in the µs range for a very short time.

The situation is different in a 5 V DC circuit that is linked to an IC. The identical coupled surge voltage here reaches 100 times the nominal voltage and definitely causes damage. The destruction resistance of an IC is less than that of a relay by several powers of ten **(Fig. 1)**. The transient surge voltages have very short ascent times of a few µs. They then drop relatively slowly again in the range of several 10 µs to several 100 µs.

To prevent these surge voltages from damaging sensitive electrical systems, the conductors in which such high voltages occur must be short-circuited with the equipotential bonding in a very short time.

During a surge arresting process, discharge currents of many thousand amperes can occur. At the same time, a protective module is often expected to limit the output voltage to a minimum despite the high discharge current. For this reason, components such as air spark gaps, gas-filled surge voltage arresters, varistors and suppressor diodes are available individually or in combined circuits in a protective module. This is sensible because each of the components has specific characteristics that differ according to:

- Surge arresting capacity,
- Operating behavior,
- Extinguishing behavior, and
- the voltage threshold.

The range of Phoenix Contact surge voltage arresters is presented under the name TRABTECH (**Tr**ansient **Ab**sorption **Tech**nology). A suitable protection module can be selected from the wide TRABTECH arrester range according to the respective application and the performance requirements for the surge voltage protection.

The surge voltage protection is an element of the entire technical field of electromagnetic compatibility (EMC).

Power supply

The protection of power supply systems must be configured selectively to be able to absorb long-term impulses with high amplitudes from lightning discharges and to attain a low residual voltage level. The lightning current arrester, FLASHTRAB is therefore used as the first stage of this protection if needed. This can discharge lightning currents up to 100 kA (10/350)µs. Various arresters are available for different requirements.
They mainly differ in their surge arresting capacity and size.

VALVETRAB is the second protection stage for reducing the voltage. This protective module has a surge arresting capacity of 40 kA (8/20) µs for once only or 20 kA (8/20) µs for repeated processes. It reduces the voltage to a value that is safe for a 230 V load in accordance with DIN VDE 0110 or IEC 60364-4-443.

As the third protection stage, a surge-voltage-protected ground contact socket, SOCKETTRAB, the adapter for ground contact sockets, MAINTRAB or other arresters for equipment protection are used directly before the equipment to be protected.

During installation, make sure that the individual surge arresters are arranged so that they are decoupled from each other. The decoupling can be achieved by interposing inductors or by using electronically triggered arresters. In this way, a weaker arrester is protected by a stronger arrester upstream.

MCR technology
(measurement and control systems)

Surge arresters such as MCR-PLUGTRAB, COMTRAB, and TERMITRAB are designed to protect interfaces in MCR circuits, which are considerably more sensitive to surge voltages than power supply systems are. The surge arresters for use in measurement circuits are scaled according to the voltage level and are for non-floating circuits as well as for floating circuits.

The basic circuit for MCR-PLUGTRAB is the indirect parallel circuit of a gas-filled surge voltage arrester and suppressor diodes. This makes it possible to attain a surge arresting capacity of 10 kA (8/20)µs with a very low and precise voltage threshold and a very short operating time. Depending on the application, varistors are also used additionally or as individual protective elements to protect these systems.

Especially user-friendly advantages of the MCR-PLUGTRAB components are their testability and impedance-neutral pluggability. The decoupling elements – inductors or resistors – are arranged in the base element and remain in the circuit regardless of whether the protective plug is plugged into the base element or not. This is especially important for measurement circuits. The protective elements are located in the plug and are not meshed, so that their function parameters can be easily tested at the plug pins in a measuring arrangement.

For this purpose, there is also a portable test set, the TRABTECH-TESTER.

Another testable element is COMTRAB. This arrester is wired parallel with LSA-PLUS disconnect and switching strips. When surge voltages occur, it discharges currents from each individual core to PE through coarse and fine protection elements that are decoupled from each other.

TERMITRAB is the smallest element in the entire range. It is a modular terminal block with an integrated surge voltage protection element, and it is designed as an output and input terminal block for MCR lines in control cabinets.

Data interfaces

Surge arresters for data processing equipment and systems differ from each other in their electric circuit as well as in their mechanical design.

DATATRAB is a surge voltage protection adapter that is inserted in the data line immediately before the equipment to be protected. In addition to the traditional basic circuits for TTY, V.24 and V.11, there are variants to protect interfaces in high-performance networks such as Ethernet or Token Ring.

Surge arresters for this application area are also available in a socket design with SUB-D, RJ (modular jack), and other connections.

COAXTRAB can be used to protect data processing systems as well as video systems (outdoor cameras).

For the arresters to function correctly, the equipotential bonding must be designed completely in accordance with the state of technology, and the installation must be in accordance with the valid regulations, standards, and norms for each site.

Causes and effects of surge voltages

Surge voltages occur during switching operations, electrostatic discharges and lightning current discharges. They couple into the electrical and electronic systems galvanically, inductively or capacitively through the connected lines for the power supply and the transmission of measured values or data.

Fig. 2 shows how a conductor loop is formed by the power supply and data line within a building. A conductor loop can also be formed with only two conductors of a data transmission line or with two conductors of a power supply line.

A surge voltage between an operating core and the ground potential is called "common mode voltage U_L" **(Fig. 3)**, and a surge voltage between two operating cores that are not grounded is called "normal mode voltage U_Q" **(Fig. 3)**.

The amount of an induced surge voltage increases along with the edge lengths of the induction loops.

When the first computer centers with mainframes went into operation, little or no thought had been given to the electromagnetic compatibility of the computers with the environment. This was also hardly necessary because the first generation of computers still had a

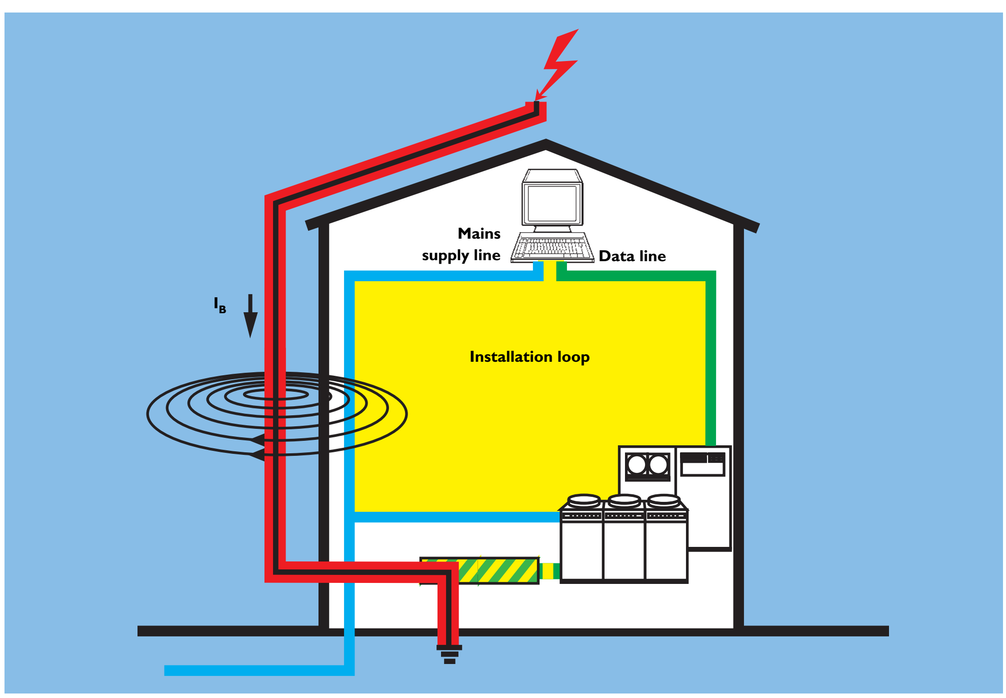

**Fig. 2:
Conductor loop from mains supply and data line**

very sturdy construction – in relation to possible interferences. From today's perspective, the computers had a very large volume but a relatively small capacity.

This large volume allowed a sufficient spacing or a sufficient insulation of two current-carrying lines or conducting paths inside the computer. Therefore, "flashovers" between two points with different electrical potentials were not expected.

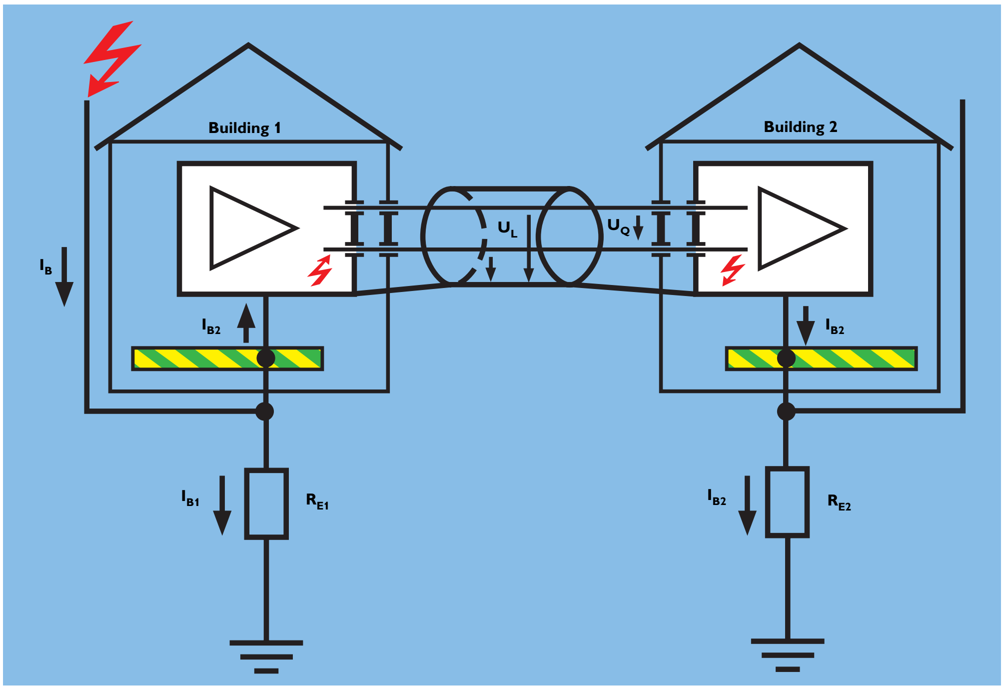

Fig. 3: Common mode volt. and normal mode voltage

Flashovers due to high potential differences do not occur in the normal operation of a system but as a result of surge voltages coupling from external interference sources.

In the meantime, computer technology has advanced so much that the same memory size and computing speed that was found in a room-sized computer many years ago is now achieved with a PC including peripherals that are also miniaturized. It is therefore understandable that in such a PC, large distances no longer exist between two conductor paths on a p.c.b. The surge voltages that can couple from external interference sources still have the same high values as a few decades ago.

Since the dielectric strength between two points with different electrical potentials decreases when the distance becomes smaller, modern computers are no longer able to function without interference and damage unless measures such as interference and surge voltage protection are implemented.

Fortunately, very few operators of computer centers or other sensitive electronic equipment still believe that they have sufficient protection from an "outdoor lightning protection system".

Apart from the fact that lightning protection systems have to be completed with an indoor lightning protection in accordance with DIN VDE 0185 Part 100 or IEC 61024 to be functional, an outdoor lightning protection system also causes EMC problems for the electrical equipment inside the building. When lightning surge currents are intercepted and discharged by the lightning protection system, electromagnetic interferences occur that cause surge voltages to couple into data lines and conductor loops on the p.c.b.s of electrical equipment. Interferences are coupled to conductor loops in the same way when lightning strikes into the ground through the natural lightning current channel in the general vicinity of an electronic system **(Fig. 4)**.

All lines that run parallel and diagonally to the lightning current path are influenced in this way. Couplings of several 1000 V into the power supply or data lines to a computer are not unusual. Surge voltages are not only caused by lightning discharges, though. Whenever a current changes very quickly, surge voltages will be produced in the connected electrical lines according to Faraday's law. This can happen, for example, with switching operations and short circuits in power installations or with electrostatic discharges. In these cases, one must also reckon with very high surge voltages that can destroy the electronics.

Danger from surge voltages normally does not announce its arrival. There are, however, indications that a system is not sufficiently protected from interferences. One indication could be, for example, when the electronics "drop out" at a given time for no reason or interferences continually occur during a particular season of the year, on a particular day of the week, or always at the same time of day. In such a case, measures should be immediately implemented to protect the affected system.

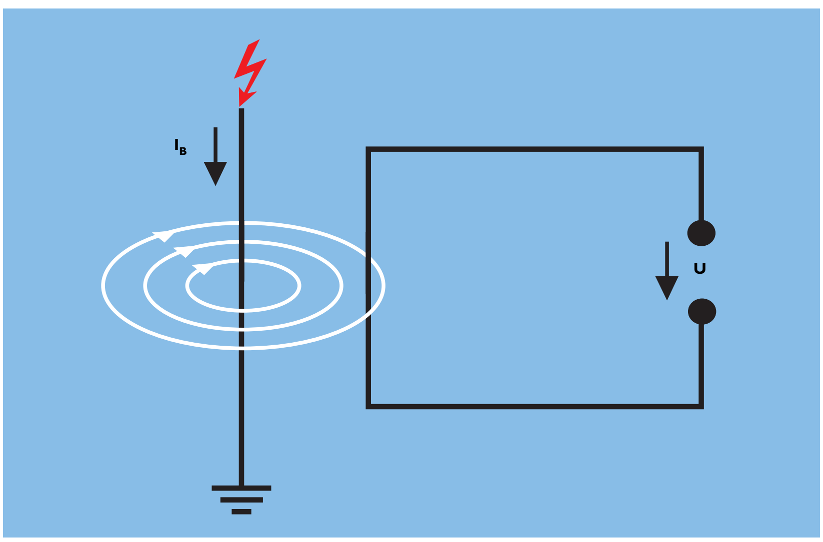

Fig. 4: Coupling of lightning currents in a conductor loop

Primary and secondary measures against surge voltages

There are two basic possibilities for creating an efficient surge voltage protection:

- absolute potential separation, which must be done in such a way that no more interference is possible
- or a consistent equipotential bonding between all active and passive system components

Both of these, the potential separation as well as the equipotential bonding, can only function if they are fully implemented. An absolute potential separation, which also has to withstand an inductive and capacitive interference, is practically impossible.

Complete equipotential bonding requires the inclusion of all active conductors such as power supply and data lines, for example. This requires surge voltage arresters that produce a short circuit between two points with different potentials. This short circuit functions as a "predetermined breaking point" for a very short time when surge voltages occur.

During normal operation, these arresters can be treated as open switches that do not influence the power circuit. The short circuit is generated within nanoseconds and only maintained for a period of microseconds depending on the duration of the surge voltage.

The fuse of the circuit only operates in rare cases, and then it is generally only due to line follow currents from low-impedance current sources – proof that fuses are not suitable for the tasks of surge voltage protection.

Primary measures against surge voltages are shielding, grounding, equipotential bonding, and separate installation of lines that may interfere with each other. These measures include improving the EMC characteristics of electrical installations as well as using an uninterruptible power supply (UPS).

Ideal conditions in accordance with the above-mentioned primary measures cannot be produced in practice. It is therefore also necessary to install surge voltage arresters if surge voltages might couple. The use of surge voltage arresters is considered a secondary measure against surge voltages. Such surge voltage arresters reduce the transients to a safe level for the electronic systems. The arresters are able to discharge the surge currents often and also with a high frequency.

The surge voltages discussed here as well as the discharge surge currents occur as transients.

Ensuring surge voltage protection when planning

It is best to begin with the surge voltage protection as early as the planning stage, when it is possible to minimize the costs of an effective protection concept the most.

The correct functioning of the surge arresters requires a complete equipotential bonding that has a corresponding connection to the grounding system and is designed according to the valid standards. The grounding system should be created in the very first building phase during the excavation and foundation work. For this reason, it must be taken into account in the construction planning.

The environment of the sensitive electrical and electronic systems must be divided into EMC protection zones. These protection zones must be determined according to the dielectric strength of the systems that are operated inside (see also the chapter "The installation of arresters").

Equipment and systems with approximately the same dielectric strength should be kept together in the same place and arranged in a common EMC protection zone, or a common EMC protection zone should be formed around these systems and equipment.

"Comprehensive surge voltage protection" means that an effective protection concept always takes into account all interfaces of the incoming or outgoing circuits of an electrical or electronic system. The use of protective modules that conform to the system prevents destructive surge voltages from reaching the sensitive interfaces of electrical and electronic systems.

A surge arrester has electric circuits and uses familiar components: air spark gap, gas-filled surge voltage arrester, varistor and suppressor diode. Between one and three of these component types are used in an arrester.

The word "arrester" already indicates that something is arrested or stopped here. What is stopped are the currents that result when a surge voltage connects with the existing complex resistance "X". The arresters are not responsible for converting electrical energy (e.g. into warmth). They are the "gate" for discharging the currents to ground.

The most important factor for the remaining residual voltage of a current path in relation to ground is therefore a low resistance (a low impedance) of the entire discharge path, thus of the arrester and the connected down conductors. Since this path runs over the equipotential bonding of the affected building, the objective is to keep the resistance of the equipotential bonding low.

The surge voltages are transient events and thus concern the discharge of high-frequency currents. This means that it is not the ohmic but the inductive resistance that is of primary importance. According to Faraday's law

$$\hat{u} = L \bullet di/dt$$

when surge currents are discharged to the ground potential, surge voltages are produced again.

$\hat{u}$ = Voltage along the conductor in V
L = Inductivity in H
di/dt = Increase in the current

The inductive resistance can only be influenced by changing the length of the cable or by connecting cables in parallel. For this reason, a mesh-shaped equipotential bonding that is as finely meshed as possible is the best technical solution to keep the total impedance of the discharge path and thus the residual voltage low.

One generally distinguishes between line, star and mesh-shaped equipotential bondings. In the case of an existing building, a line-shaped equipotential bonding will have to suffice in most cases.

However, it is sometimes possible to achieve a star-shaped equipotential bonding by laying additional equipotential bonding cables. A mesh-shaped equipotential bonding can only be implemented in places where corresponding measures have already been taken in the building planning phase.

Different protection requirements

The necessary surge voltage protection for the power supply and data lines is basically divided into three protection stages.

Lightning current arresters, surge voltage arresters, and equipment protection are needed for the power supply.

Interfaces in the area of data, telecommunications, and MCR technology are significantly more sensitive than the power supply input of terminal equipment. Fine protection for the data interfaces is therefore urgently necessary.

The first protection stage for the power supply is created with a lightning current arrester either at the entrance to the building, in the main distribution or in the meter board.

Since the remaining residual voltage is still too high for the downstream system areas, further protection stages have to

Fig. 5: MAINS-PRINTRAB universal equipment protection for installation in cable ducts or flush-type installations

Fig. 6: Arrester for protection in data lines

be installed depending on the definition of the protection area. In downstream distributions, such as floor distribution boards or the connection boxes of large electronic systems, surge voltage arresters should be installed as the second protection stage. As the third stage of equipment protection, surge voltage arresters must be used immediately before the equipment. A normal grounding outlet, for example, can be replaced by a grounding outlet with integrated surge voltage protection or an equipment protection that can be adapted to each range of sockets/switches **(Fig. 5)**. In addition, arresters are available in many other designs such as plug-in adapters, socket strips or modules for rail mounting.

Arresters for applications in data lines have to fulfill the electrical and mechanical requirements of the corresponding interface.

Examples of such arresters are shown in **Fig. 6**. They contain matching coarse protection elements and fine protection elements. The decoupling resistors that are necessary for the commutation are contained in the circuits of the arresters. These arresters are installed in the particular protection area at the entrance of the data line.

In contrast to the parallel connection of the arresters in the power supply, the surge voltage protection for MCR systems and data processing equipment is connected to the transmission line in series. The corresponding arresters must therefore be installed on both sides, at the transmitter as well as at the receiver of data.

After the equipment and systems with the same protection requirement have been arranged together in an EMC protection zone, all of the electrical connections that enter into the protection zone are connected to arresters that allow a residual voltage level in accordance with this protection requirement. In addition – as already mentioned as a basic prerequisite – an equipotential bonding must be created between all conductive connections within each protection area.

Structure and functioning of arresters

In surge voltage protection for power supplies, one distinguishes between:

- lightning current arresters (class B/class I)
- surge voltage arresters (class C, class II) and
- arresters as equipment protection (class D, class III)

Lightning current arresters have the strongest protection element – a spark gap – which allows them to control discharge surge currents, e.g. occurring from direct lightning strikes.

Encapsulated lightning current arresters (see sectional drawing **Fig. 7**) and lightning current arresters are used as an open spark gap. **Fig. 8** shows the arc chopping technology of an open spark gap. In addition to the surge arresting capacity of a lightning current arrester, the level of the line follow current (short circuit current from the current source) that an arrester can quench by itself without operating a fuse is also especially important. Diverging electrodes (spark horns) such as those shown in the sectional drawings of the two arresters **(Fig. 7 and Fig. 8)** provide very good prerequisites for quenching the line follow current.

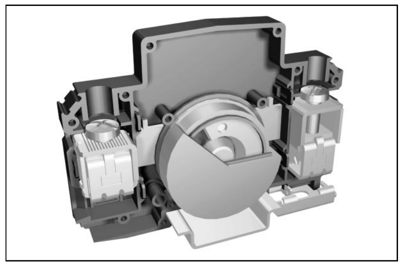

Fig. 7: Sectional drawing of encapsulated spark gap

Surge voltage arresters for installation in main distributions or subdistributions have powerful varistors as surge arresting components.

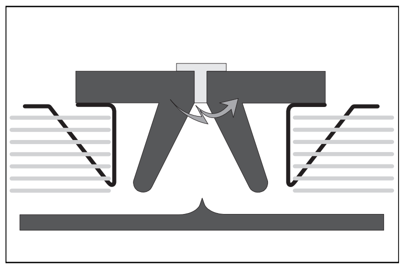

Fig. 8: Sectional view of open spark gap

Combination circuits of varistors and gas-filled surge voltage arresters are used in equipment protection arresters. The gas-filled surge voltage arresters are in series with the varistors and are connected between L and PE or N and PE. According to various national and international standards, varistors that are operated in powerful circuits must be permanently checked for temperature increases, i.e. for the flowing of leakage currents. For this reason, varistors for the protection of power supplies are always equipped with thermal fuses.

Arresters for equipment protection are placed immediately before the volume/equipment to be protected.

To effectively protect the power

supply from surge voltages with coordinated arresters, it is necessary to position lightning current arresters, surge voltage arresters and equipment protection decoupled from each other. Lightning current arresters and surge voltage arresters are connected parallel to the power supply lines, i.e. between the phase conductor and ground. This prevents the power supply from being interrupted in the case of a fault in this arrester or in the fuse immediately upstream.

Fixed minimum conductor lengths must be observed between the arresters of the various protection stages. The distance between lightning current arresters with an operating voltage of approx. 4 kV and surge voltage arresters in the power supply should not be less than 10 m. The conductor should cover a distance of at least 5 m between the surge voltage arrester and the equipment protection. The required decoupling lengths are given in **Fig. 9**. If the conductor path is affected by surge currents, a voltage is built up in the conductors due to the self-inductance. The sum of this voltage and the arrester threshold voltage, e.g. of a surge voltage arrester, results in the necessary operating voltage for the arrester in the upstream protection stage, e.g. a lightning current arrester. In this way, the discharge current commutes from the weaker arrester to the more powerful arrester. If the spark gap has been triggered in the lightning current arrester, it takes over the surge current completely. The discharge current is commuted in the same way as described later in "Combined protective circuits".

The energetic coordination between the surge voltage arrester and the lightning current arrester can be implemented in a particularly advantageous way with electronically controlled spark gaps. The technology that is used is called AEC and is described in the chapter "Interaction of the installation of the surge voltage protection in the power supply" on Page 17.

In addition to the protection for power supplies, protection must also be supplied in data, MCR and antenna lines. Surge voltage arresters for these applications usually have multi-stage protective circuits with components of various capacities and different protection levels.

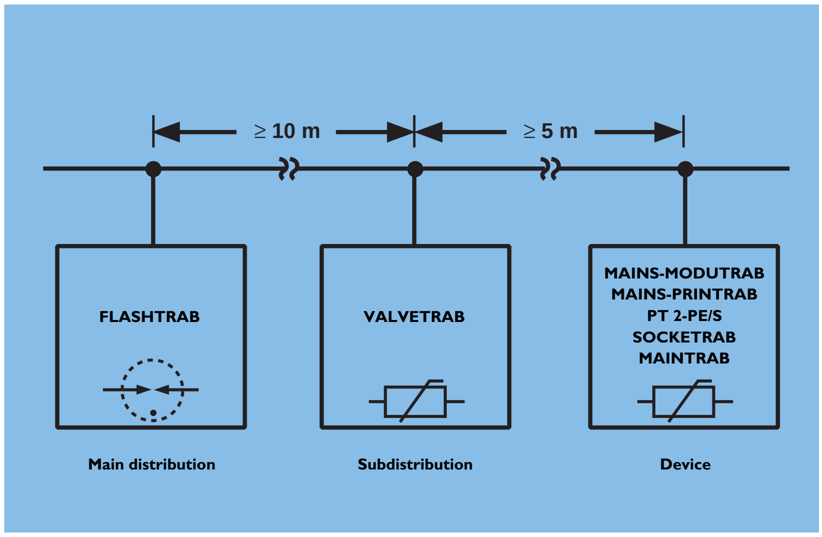

Fig. 9: Cable as a decoupling element

Components for multi-stage protective circuits

1. Surge voltage arresters filled with inert gas

Surge voltage arresters filled with inert gas (gas-filled surge arresters) are used as a coarse protection element. The most commonly used types can discharge transient currents up to 10 kA (8/20)µs **(Fig.10a).**

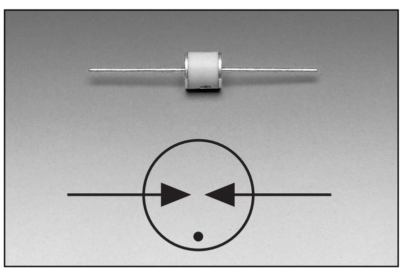

Fig. 10a: Gas-filled surge arrester

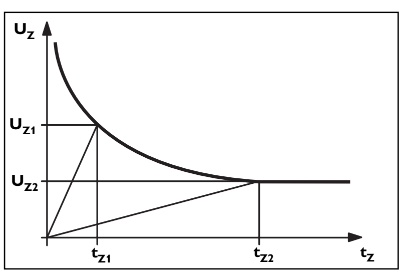

Fig. 10b: Charact. curve of a gas-filled surge arrester

Larger discharge currents are also not to be expected in such data lines; the connected cables have relatively small cross-sections that often have no more current carrying capacity for the transients.

The gas-filled surge arrester, which has operating times in the mean nanosecond range and has already been used in the telecommunications field for several decades, not only has advantages though. One disadvantage is the time-dependent ignition behavior. **(Fig. 10b)**

Transients with long ascent times (e.g. du/dt ≈ 100 V/s) intersect the characteristic ignition curve in the area that almost runs parallel to the time axis. A protection level that is roughly as high as the nominal voltage of the gas-filled surge arrester is therefore to be expected. Especially fast transients, however, intersect the characteristic ignition curve at a point at which the voltage can be ten times the amount of the nominal voltage of the gas-filled surge arrester. In the case of 90 V, the smallest nominal voltage of a gas-filled surge arrester, this fact would still signify a residual voltage of 900 V.

A further disadvantage is that line follow currents may occur. If the gas-filled surge arrester has ignited, a low-impedance circuit with voltages over 24 V in particular is able to maintain the short circuit, which is actually only desired for a few microseconds, throughout the gas-filled surge arrester. As a result, the gas-filled surge arrester would explode within fractions of a second. In surge voltage protection circuits where gas-filled surge arresters are used, it is therefore necessary to connect a safety fuse upstream that interrupts the circuit for a very short time.

2. Varistors

The use of varistors causes the remaining residual current to decrease further after the high currents have been discharged. **(Fig. 11a and Fig. 11b)**.

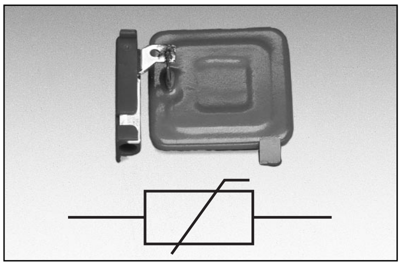

Fig. 11a: Varistor

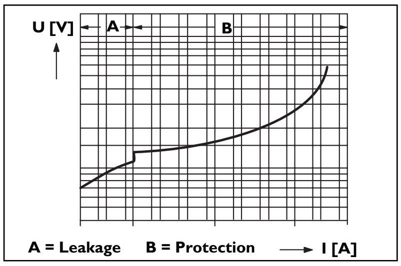

Fig. 11a: Characteristic curve of a varistor

Varistors that are approximately the same size of a gas-filled surge arrester are not able to discharge such high currents. However, they react faster, with operating times in the low nanosecond range, and do not have the problem with line follow currents. In protective circuits for MCR circuits, varistors are used in the medium protection stage with discharge currents of around 2.5 kA to 5 kA (8/20) µs. These varistors, however, have larger dimensions than the gas-filled surge arresters with 10 kA (8/20) µs discharge current.

More important disadvantages are the aging of varistors and the relatively high capacity. Aging refers to the failure of diode elements within the varistor. Since the pn transitions cause a short circuit in most cases when an overload occurs, a varistor will begin to draw leakage currents depending on the frequency of its loading. These leakage currents can cause distorted measurement data in measurement circuits and – particularly in the case of circuits in the power supply - a high rise in temperature.

The high capacitances of varistors rule out their use in data transmission lines with high frequencies in many cases. Together with the inductance of the conductor, these capacitances form a low pass, which then causes a great damping of the signals. However, at frequencies up to around 30 kHz, this damping is almost meaningless.

3. Suppressor diodes

Due to the low dielectric strength of sensitive electronic circuits, the protection level that is achieved with a medium protection element is still frequently too high. For this reason, a further stage – the fine protection – has to be included in the protective circuit.

Suppressor diodes that react very fast are used as a fine protection element **(Fig. 12a and Fig. 12b)**.

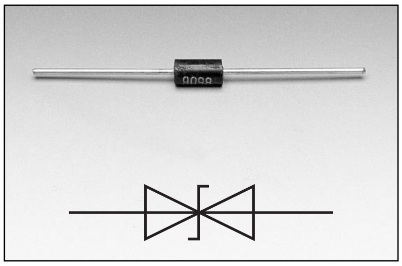

Fig. 12a: Suppressor diode

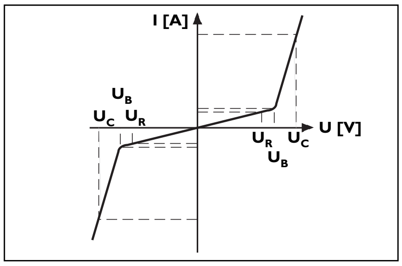

Fig. 12b: Characteristic curve of a suppressor diode

The operating times extend into the picosecond range. The voltage threshold, which is around 1.8 times the nominal voltage, is also advantageous.

Nevertheless, these diodes also have disadvantages: the low current carrying capacity and the relatively high capacitance. In the case of nominal voltages of 5 V DC, the maximum discharge current is around 600 A; with special diodes, it can even be up to 900 A (8/20)µs. Higher nominal voltages only allow currents of a few 10 A.

Suppressor diodes also have a self-capacitance. This increases with a decreasing nominal voltage. In connection with the inductance of the connected cables, a low pass is formed here as well. Depending on the signal frequency of the connected circuit, the low pass has a damping effect on the data transmission.

Combined protective circuits

The aim is obviously to exploit the advantages of the individual components – gas-filled surge arrester, varistor, suppressor diode – and eliminate the disadvantages. To do this, indirect parallel circuits of these components are used with decoupling impedances. Such a circuit, which can be found in specialist literature as well as information material on the Phoenix TRABTECH arrester range, is shown in **Fig. 13**.

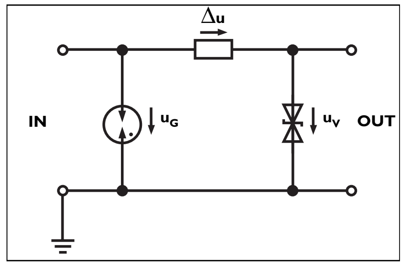

Fig. 13: Block diagram of an arrester

When a surge voltage occurs, the suppressor diode operates first as the fastest component. The circuit is designed so that when the amplitude increases, the discharge current commutes to the upstream discharge path, i.e. to the gas-filled surge arrester, before the suppressor diode can be destroyed.

$$u_V + \Delta u \geq u_G$$

u_V	Voltage over the suppressor diode
Δu	Differential voltage over the decoupling inductance
u_G	Operating voltage of the gas-filled surge arrester

If the discharge current remains smaller, then the gas-filled surge arrester does not operate.

This circuit provides the advantages of fast operating surge arresters with a low voltage threshold as well as a high surge arresting capacity at the same time. The disadvantages of overloading the suppressor diode and frequent disconnection of the circuit by the fuse when a line follow current occurs have been eliminated.

Circuits for higher frequencies also use ohmic resistors as decoupling impedances and work with low-capacity bridge circuits.

In the case of surge arresters that are to be connected in series, such as in measured-value and data processing, the input and output of the protection module are marked with the words “IN” and “OUT”. During installation, make sure that “IN” points in the direction from which the surge voltage is expected. The cables to the volume to be protected are connected on the “OUT” side.

Designs with numerous advantages

The entire protective circuit is then arranged in a housing that provides the user with numerous advantages for installation and maintenance. Such advantages are:

- Two-part design consisting of base element and connection plug. If the surge arresting elements in the plug are overloaded, they can be replaced without interrupting the circuit.
- The component can be conveniently tested with a special test device to prevent lengthy laboratory tests.
- Arrangement of the decoupling impedances in the base to keep the measuring circuits impedance-neutral even during the test process or during replacement.
- Polarization of the plugs and base elements to prevent confusion of "IN" and "OUT".
- Use of a grounding foot that simultaneously creates the connection to the ground potential during installation.

A surge arrester that combines these and other advantages and can be used for measurement or information processing circuits depending on the internal circuitry is shown in **Fig. 14**. The distinguishing feature of other surge arrester designs is that they use the same physical connection technology as the equipment to be protected. This is generally the case, for example, with surge arresters that are inserted in the cable like an adapter. Surge arresters with familiar plug connectors are shown in **Fig. 6**.

Comprehensive surge voltage protection concept

The first step in planning a protection concept is to determine all the devices and areas of the system that need to be protected. This is followed by an evaluation of the protection level required by the devices. A comprehensive surge voltage protection concept can only be achieved when all of the electrical circuits that enter a surge voltage protection zone, such as

- power supply lines
- lines of measurement and control systems
- network/data lines
- telecommunications transmission lines
- antenna lines from transceiver systems

are included in the equipotential bonding by connecting suitable surge arresters. For this purpose, a protective circuit must be mentally laid in accordance with **Fig. 15** around the entire volume to be protected.

The area within the protective circuit is planned so that it is not possible for surge voltages to couple from outside, and different electrical circuits such as e.g. power supply and data lines are also not able to influence each other within this area.

It would thus be possible to use floor duct installation with grounded metal frames instead of window duct installation in plastic ducts. Power supply and data lines must be laid shielded from each other in separate ducts.

After all electrical circuits that enter or leave this surge voltage protection zone have been led through suitable surge voltage arresters, all conductive parts such as pipelines, for example, are also connected to the equipotential bonding.

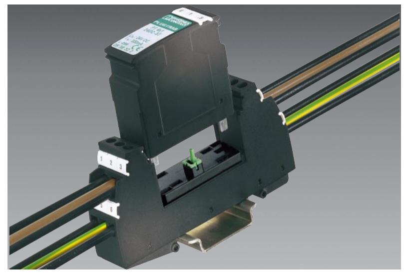

Fig. 14:
MCR-PLUGTRAB

Depending on how soon the surge voltage protection concept can be integrated in the building and electrical planning phase, such a surge voltage protection zone can affect an entire building, a room, part of a room or only a single computer. If only a single computer, perhaps even one working in isolated operation, is to be protected, it is not economical to extend the surge voltage protection zone to an entire room or a building. A subsequent expansion of the electronic systems should, however, be taken into account from the beginning.

In practice, two steps have proven to be advantageous for planning and installing surge voltage protection:

1. Select the surge arresters according to the dielectric strength of the electrical and electronic systems.
2. Determine the correct installation site by dividing the entire volume in need of protection into surge voltage protection zones.

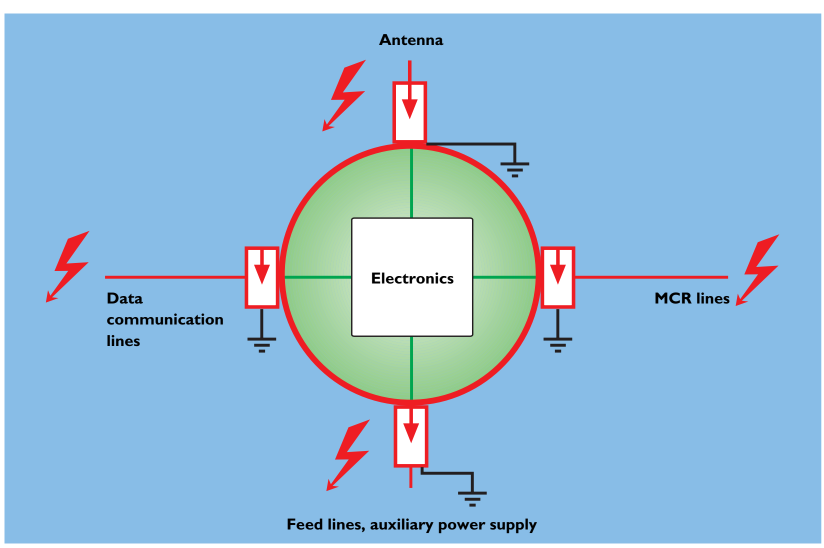

Fig. 15:
Efficient protective circuit

Conductor-PE voltage in V	Rated surge voltage in V (1.2/50) Surge voltage classes acc. to DIN VDE 0110/1			
	I	II	III	IV
50	330	500	800	1500
100	500	800	1500	2500
150	800	1500	2500	4000
300	1500	2500	4000	6000
600	2500	4000	6000	8000
1000	4000	6000	8000	12000

Fig. 16:
Impulse withstand voltage according to DIN VDE 0110

Selection of the surge arresters

For power supply systems, the values for the impulse withstand voltage of the insulation are given in DIN VDE 0110 (Table, **Fig. 16**). Nominal voltages in stages up to 1000 V are divided into surge voltage categories I to IV. Each surge voltage category is assigned a dielectric strength according to the nominal voltage.

Fig. 17:
VALVETRAB VAL-MS

The nominal voltage here is based on the voltage between the phase conductor and PE. For 230/400 V three-phase systems, this means that the conductor-PE voltage of 300 V should be used to assign the rated surge voltage. It is then interesting to note that terminal equipment in the power supply still has to have a dielectric strength of 1500 V. When creating a surge voltage protection concept, it is therefore completely sufficient to orient oneself according to a residual voltage of approx. 1000 V at the input of the equipment, while taking into account a respectful distance to these 1500 V. This is also the reason why a so-called fine protection, which limits the surge voltages to values of around 2 x U_N, is not necessary in the 230/400 V power supply.

According to DIN VDE 0110, a dielectric strength of 2500 V is required between the terminal equipment and the subdistribution. This requirement is met by installing a surge voltage arrester in the subdistribution as the second protection stage. **Fig. 17** shows a surge arrester that fits the given space and installation conditions in the distribution in every respect.

To discharge the high currents, which could result from a lightning strike for example, lightning current arresters are installed in the main distribution or in the incoming supply system in the building. The lightning current equipotential bonding is also carried out in this area.

In accordance with DIN VDE 0110, only a residual voltage of 4000 V may exist between the main distribution and the subdistribution. The surge arrester must be selected accordingly and in respect to the expected discharge currents.

Fig. 18 shows the dielectric strengths according to DIN VDE 0110 from the incoming building supply to the terminal equipment and the site of the surge arresters to be installed.

A similar table for data processing and data transmission equipment as well as for MCR systems does not exist in the regulations. When selecting the surge arresters for the surge voltage protection of MCR systems, one should therefore observe the manufacturer's information regarding dielectric strengths. Since the European EMC law has gone into effect, these values can be

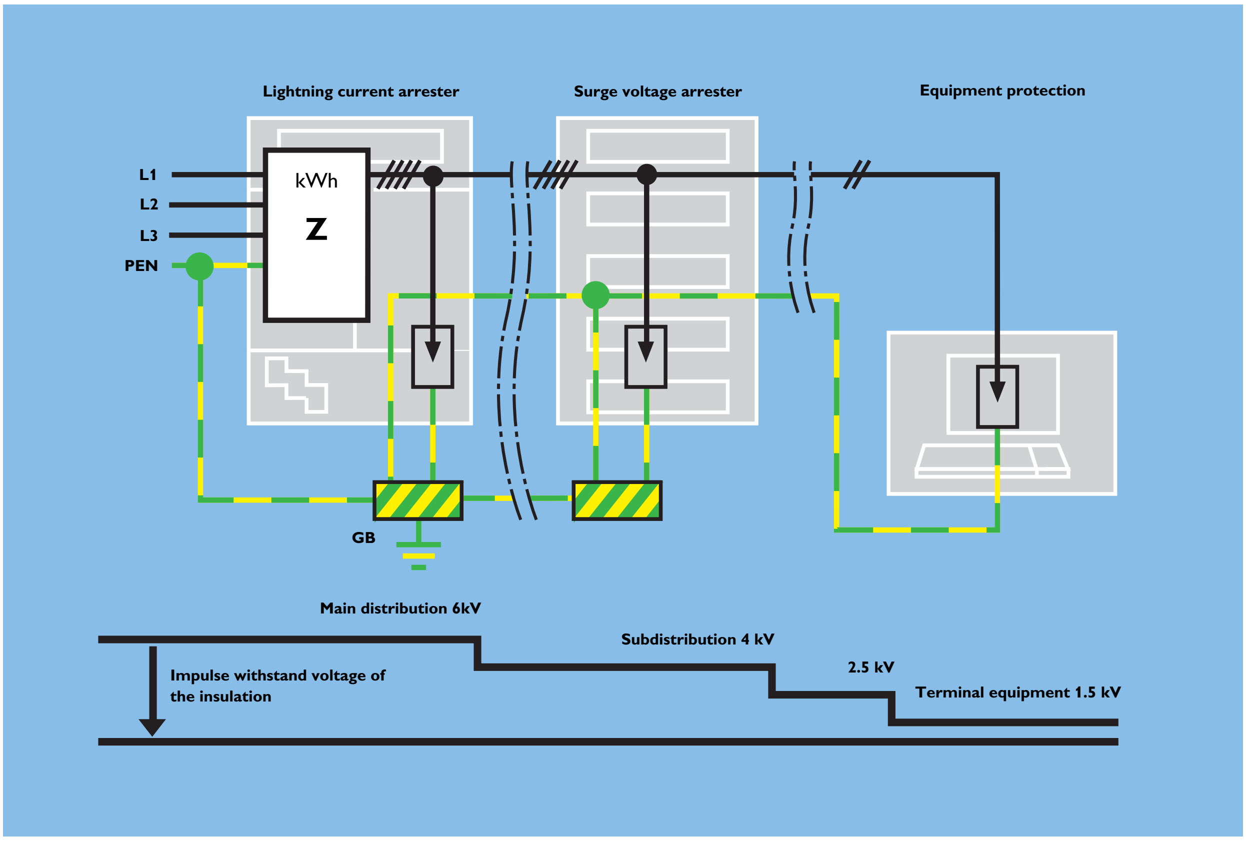

Fig. 18:
Insulation coordination acc. to DIN VDE 0110/Part 1

determined relatively easily, since the manufacturers of electronic equipment are required to adhere to minimum dielectric strengths according to IEC 61000-4-5.

However, not only the dielectric strengths are interesting for selecting surge arresters for MCR systems. Very decisive factors for the subsequent installation are the physical connection conditions (plug connections, terminal blocks), the possibilities for mounting (mountable on DIN rails, adapters) and also the current carrying capacity of the surge arrester as well as the transmission frequencies.

In regard to the necessary operational safety, the circuits of EEx ia systems are considered to be especially sensitive. Above all the total inductance and the total capacitance of such circuits, incl. all corresponding electrical equipment, must not exceed set limit values. For this reason, the values of the inner capacitance C and the inductance L of surge voltage arresters that are to be used to protect EEx circuits must be taken into account. The installation then takes place in accordance with DIN VDE 0165 and DIN VDE 0170/0171 or the national regulations of other countries or international regulations (EN 50020). The electrical planning is simplified considerably when a surge arrester is used that already fulfills these requirements, as shown in **Fig. 19** (EX(I)-PLUGTRAB).

The surge arrester contains a protective circuit according to **Fig. 20**, which fulfills all the requirements of the standard.

It is considerably easier to select surge voltage arresters for the data processing area than planners and installation technicians of these systems think.

The Phoenix TRABTECH range offers a wide selection of surge arresters that are already adapted to the electrical and physical conditions of all common data transmission interfaces. It is therefore only necessary to determine the interface that is used and to select the corresponding surge arrester from the interface matrix in the catalog.

The user does not need to take into account the pin assignments, mechanical connection conditions, transmission frequencies, voltages and currents. These values were all taken into account in the development of the surge arrester. Examples of surge arresters for standardized interfaces that already contain currents, frequencies, and dielectric strengths are shown by **Fig. 6**.

Fig. 19: Two-conductor protection for 2 EEx ia circuits

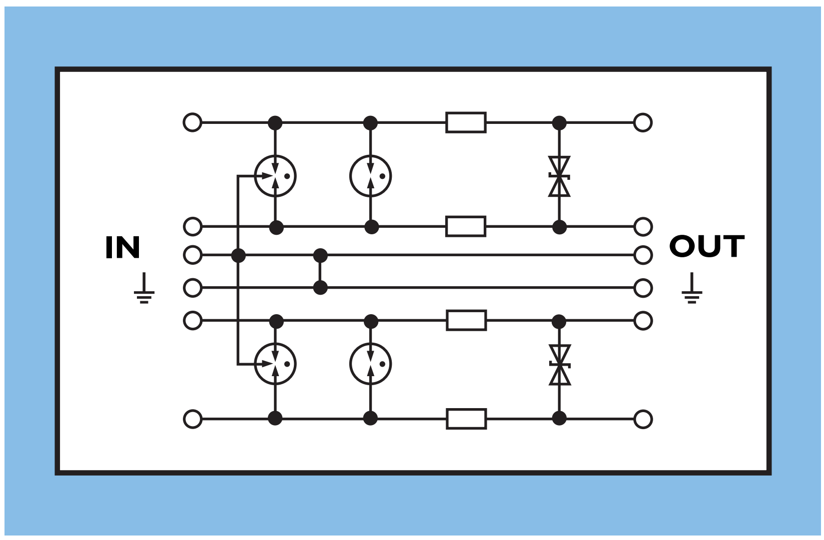

Fig. 20: Circuit PT 2xEX(I)-24DC

The installation of surge arresters

After the correct surge arresters have been selected, it is necessary to determine the most favorable installation site for the protective effect and the volume to be protected. It has been shown that the best way to do this is to divide the volume to be protected into four EMC protection zones 0-3:

Zone 0:
- Outside of the building; direct lightning strikes; no shielding against LEMP; (lightning protection zone)

Zone 1
- Inside the building; powerful transients from: switching operations (SEMP), partial lightning currents (surge voltage protection zone 1)

Zone 2:
- Inside the building; less powerful transients from: switching operations (SEMP), electrostatic discharges (ESD); (surge voltage protection zone 2)

Zone 3:
- Inside the building; no generation of transient currents and voltages over the interference limit; shielding and separate laying of circuits that could influence each other; (surge voltage protection zone 3)

0 refers to the area of the strongest electromagnetic interference – a direct lightning strike is possible here – and 3 refers to a room in which no more interference over the destruction limit of even sensitive equipment and systems can occur.

The areas 1 and 2 are located inbetween, according to the dielectric strengths of the electrical equipment and systems installed there and their resulting resistance to electromagnetic interferences.

The system to be protected can be divided into EMC protection zones by developing a concept according to **Fig. 21**.

The main equipotential bonding is created at the transition from the surge voltage protection stage 0 to 1.

All electrical connections and conductive connections that enter this surge voltage protection zone are brought to the same potential by connecting them to the equipotential bonding bar. Active conductors of power supplies, data transmission systems and MCR equipment are placed directly on the grounding busbar (GB) through spark gaps or gas-filled surge voltage arresters and passive conductive connections (PE, water line etc.).

According to DIN VDE 0100 Part 540, the water line may only be used as a "natural" grounder under special circumstances, but it must be included in the equipotential bonding. Outside of Germany, the applicable national regulations must be observed.

In the EMC protection zone 2, you should proceed in the same way and contact all the above-mentioned connections on the local sub-grounding busbar. Passive, conductive parts are connected directly. The active conductors must be included in the equipotential bonding with surge voltage protection devices. The sub-GB must be connected to the main-GB in the EMC protection zone 1 in the shortest and most direct way.

A sub-GB must also be installed at the transition to the EMC protection zone 3. The equipotential bonding is created in the same way as described previously.

In **Fig. 21**, the water line does not extend into the EMC protection zone 3. It is therefore not included in the equipotential bonding of this protection zone.

The active conductors of the power supply are also connected to the equipotential bonding with varistor-based surge voltage protective equipment in the EMC protection zone 3; data lines and MCR lines, however, require a narrowly limiting protection using suppressor diodes in most cases.

An equipotential bonding line is used to create the shortest possible connection to the grounding busbar in the surge voltage protection zone 1 as well as to other sub-grounding busbars. In this way, a mesh-shaped equipotential bonding is created.

In practice, a two- or three-stage surge voltage protection for MCR and data interfaces is almost always realized with a combined protective circuit in a surge arrester directly at the entrance to the surge voltage protection zone for technical installation reasons. This eliminates the gradual reduction of the surge voltage in the EMC protection zones 1 and 2. Within the EMC protection zone 3, power supply lines and information lines are then laid separately from each other or shielded.

If electronic systems connected through data lines do not need as much protection, these feed lines must be laid separately from the other data lines or shielded.

This concept automatically leads to the correct place to install the surge arresters. All electrical equipment and systems must then be placed in the EMC protection zone that they require. In this case, it does not matter whether a protection zone is created around an entire room or only around a single device.

All EMC protection zones 1-3 can occur several times. From an economical point of view, it is wise to design the concept so that as many devices and systems as possible with the same protection requirement can be arranged in a protection zone. Such a successful surge voltage concept can only be achieved if it is already taken into account in the planning phase (see chapter "Ensuring surge voltage protection when planning").

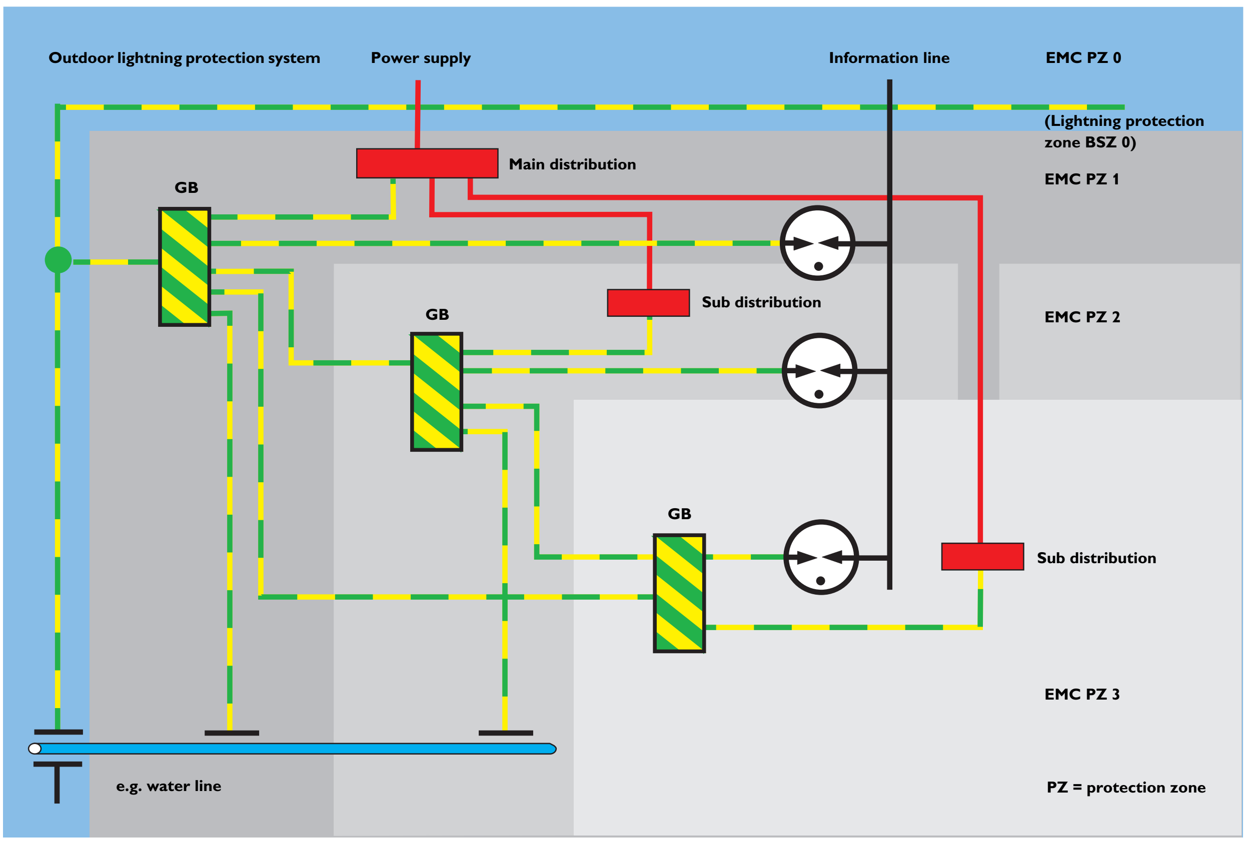

Fig. 21: Division and realization of surge voltage protection zones

Installation instructions

1. Protection in the power supply

1.1 Lightning current arrester FLASHTRAB

The connection of a lightning current arrester is shown in **Fig. 22** using the FLASHTRAB FLT 35-260 as an example. During installation, please note the following:

1. FLASHTRAB is arranged parallel, i.e. between the phase conductor (or neutral conductor) and the equipotential bonding, in the power supply. This means that operating current does not flow through the FLASHTRAB. **Fig. 22** gives information on the general installation conditions. The installation instructions for lightning current arresters and surge voltage protection equipment in different types of power supplies depending on the type of grounding **(Fig. 23 to 26)** must also be observed.

2. For subsequent maintenance work and a greater availability of the power supply, the lightning current arrester FLASHTRAB should be installed with an additional back-up fuse F2 that guarantees an overcurrent discrimination to F1. This is considered to be fulfilled for safety fuses according to DIN VDE 0636 if the rated current values for F2 to F1 are in the ratio 1:1.6; in other words, F1 must be dimensioned two fusing stages greater than F2. If F2 blows due to disproportionately high line follow currents, the equipment will still be operational through F1. Due to the surge strength of fuses, it is usually not sensible to select an F2 that is less than 63 A. If F2 has operated, FLASHTRAB will be switched off, cancelling the protection for the cable in question. Consequently, we recommend that this be monitored in conjunction with a signaling device in case F2 blows.

3. The values of the maximum permissible back-up fuse (F2) and the connection cross-sections are documented in the Phoenix catalog part "TRABTECH".

4. FLASHTRAB should be arranged directly at the incoming supply system of the building. It is recommended to install the lightning current arrester before the meter. Installation in the sealed area requires the permission of the responsible local public utility company.

5. When open lightning current arresters operate, emissions are blown out of the rear housing wall of the surge arrester through the spark gaps around the arcing chambers. To ensure that this process does not cause short circuits on bare and live conductors/parts, and to prevent the ignition of any inflammable materials, a distance of 10 cm must be observed between such surge arresters and the parts/materials mentioned. This distance can also be substituted by an enclosure/shield with non-flammable and non-conductive materials.

Mutually live, bare parts, e.g. busbars, that are routed within the blow-out area of open spark gaps, must be safe-guarded by suitable disconnect bridges to prevent a flashover due to ionized air.

6. If FLASHTRAB is arranged separately outside of distributions, then only tested and approved housings from Phoenix Contact that withstand the resulting pressure during the surge arresting process may be used.

7. For use in intermediate meters, the VDEW guideline "Surge voltage protection equipment of the requirement class B in main power supply systems" must be observed. Most FLASHTRABs can be used in 50 Hz and 60 Hz AC and three-phase networks that have a maximum operating voltage of 440 V between the phase conductor and ground.

When installed in TT systems, lightning current arresters and surge voltage arresters (before residual-current-operated circuit breakers, of course) must be arranged in a "3+1" circuit. This means that either a FLASHTRAB or a VALVETRAB is connected from each phase to N. This group of three is also connected from N to PE via a residual surge current spark gap **(Fig. 25)**.

The residual surge current spark gaps are characterized by a high surge current

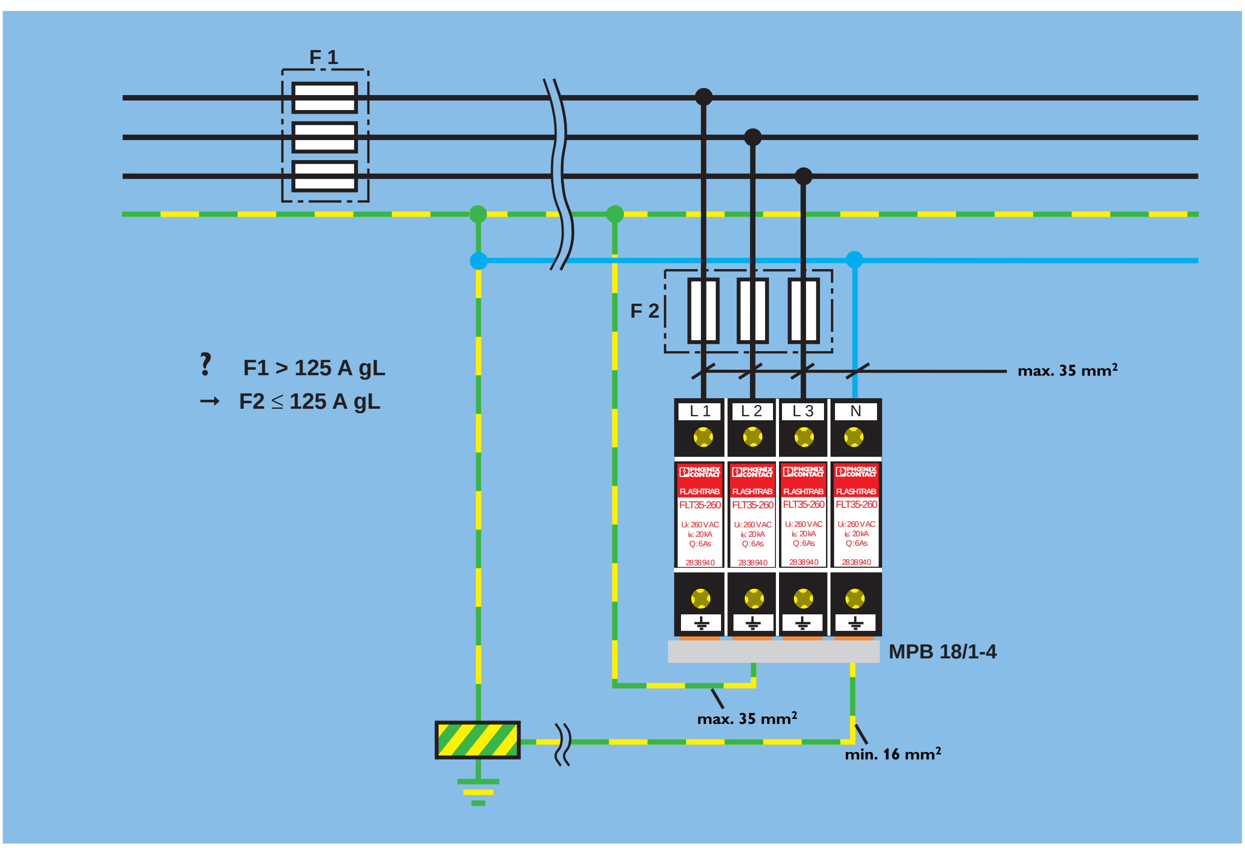

Fig. 22: FLASHTRAB FLT 35-260 in the TN-C-S system

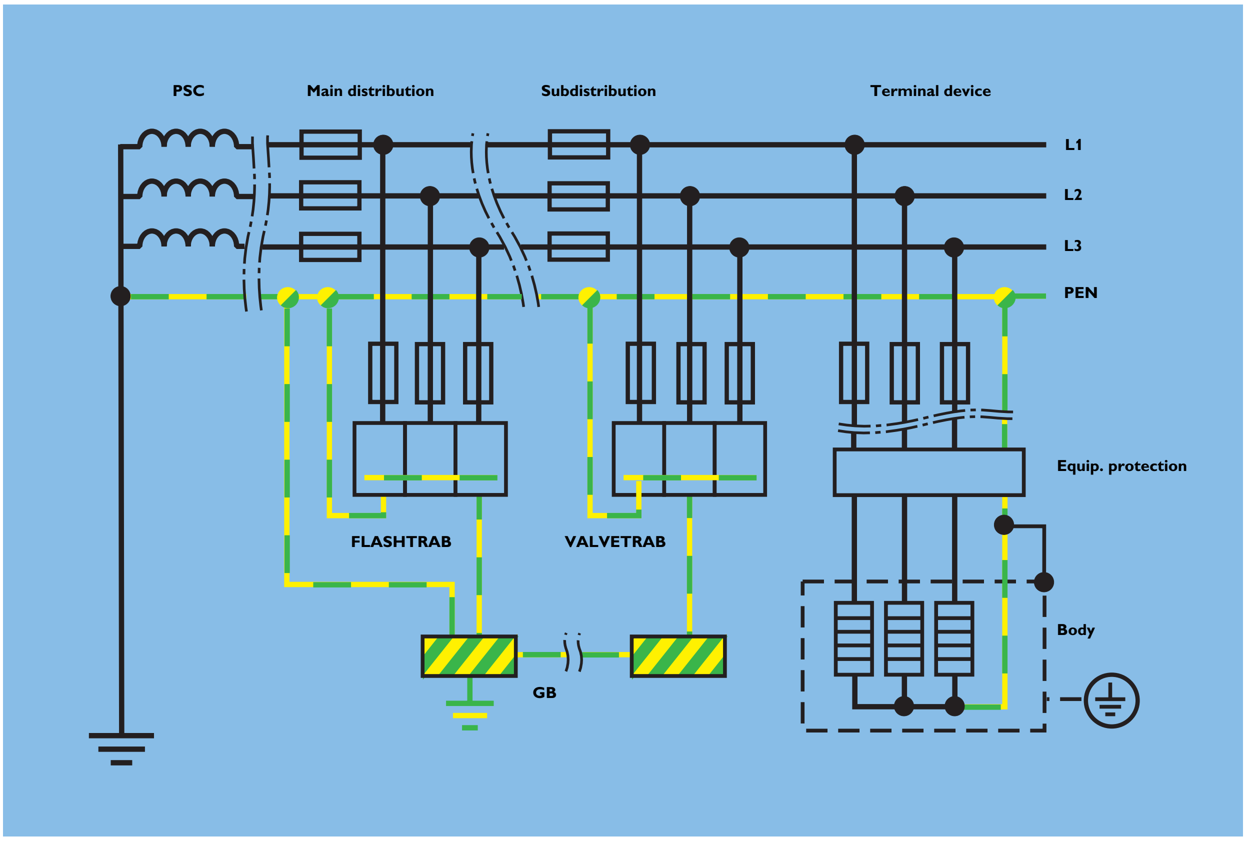

Fig. 23:
TN-C system with PEN conductor, (> 6 mm²) (classical TN system)

arresting capacity. However, they are not able to quench high line follow currents by themselves – which is also not necessary in this application.

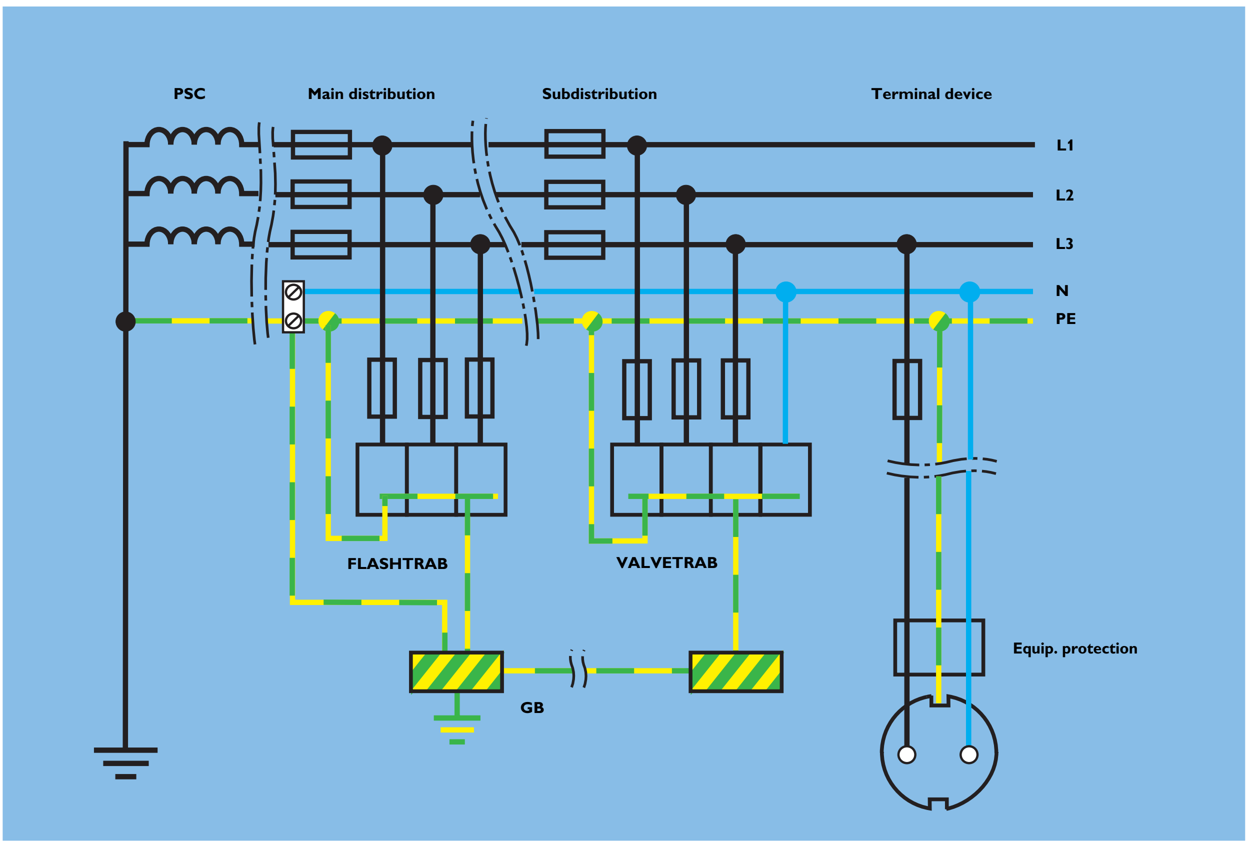

Fig. 24:
TN-C-S system with PEN cond. and separate N/PE cond. (modern TN system)

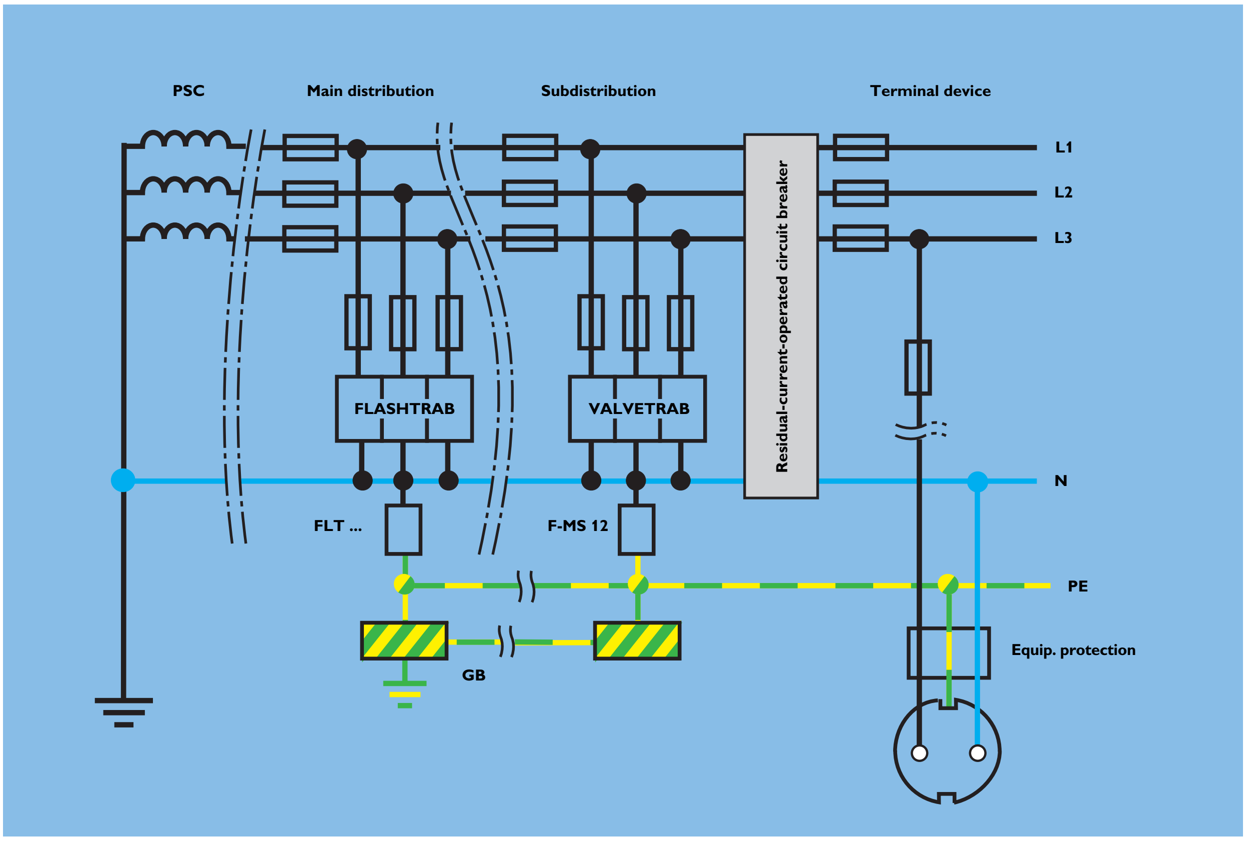

Fig. 25:
TT system with rccb as protective equipment

1.2 Surge voltage arrester for power supply systems VALVETRAB VAL-MS/ME

1. VAL-MS/ME is connected in parallel, i.e. between the phase conductor or neutral conductor and PE, to the power supply system **(Fig. 27)**.

2. If F1 fuses exceeding 125 A gL are used on the supply side, VALVETRAB MS/ME requires an additional back-up fuse F2 ≤ 125 A gL to be connected upstream. The blowing of this fuse leads to the disconnection of VALVETRAB MS/ME. In this case the protective effect is eliminated. Consequently, we recommend that this be monitored in conjunction with a signaling device in case F2 blows.

3. The connecting terminal blocks of VAL-MS/ME are designed for max. 25 mm^2 fine strand or 35 mm^2 multi-

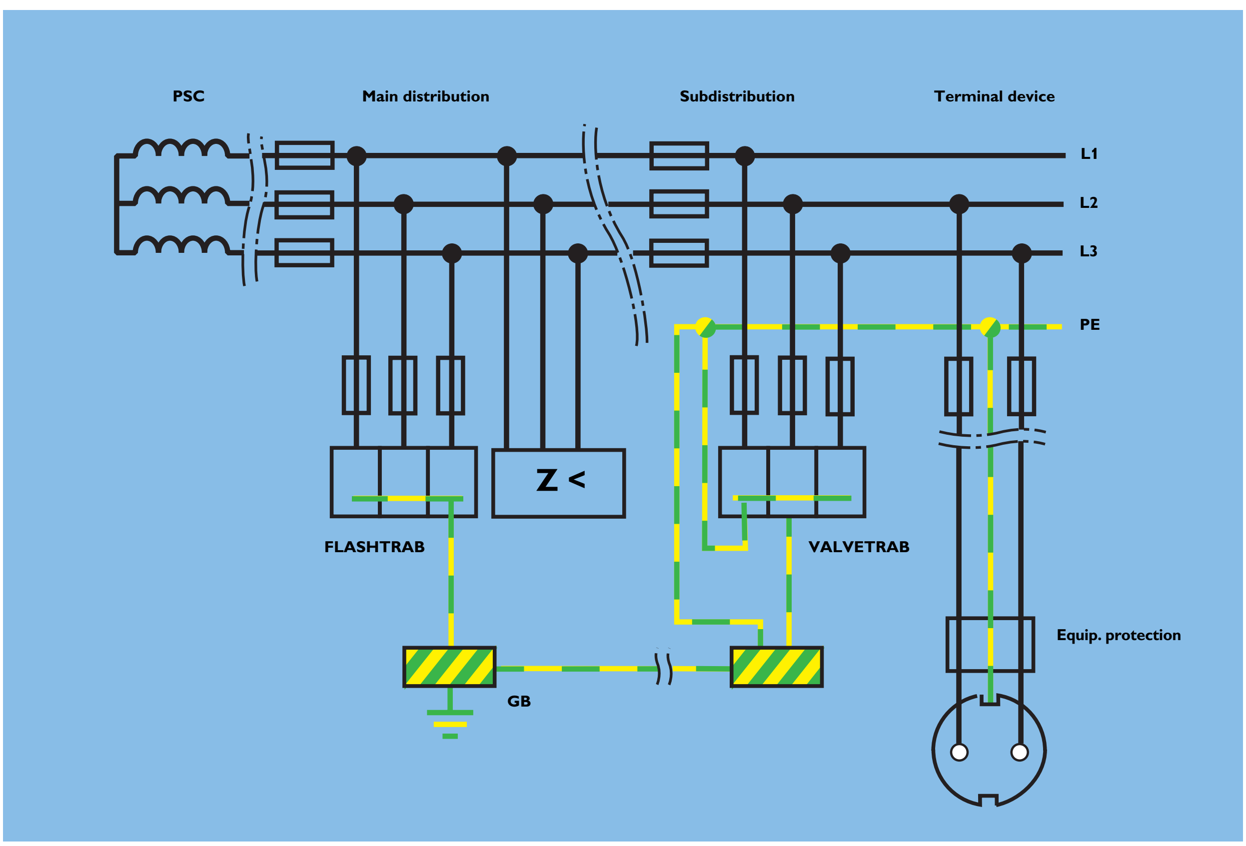

Fig. 26:
IT system with insulation monitoring equipment (protection line system)

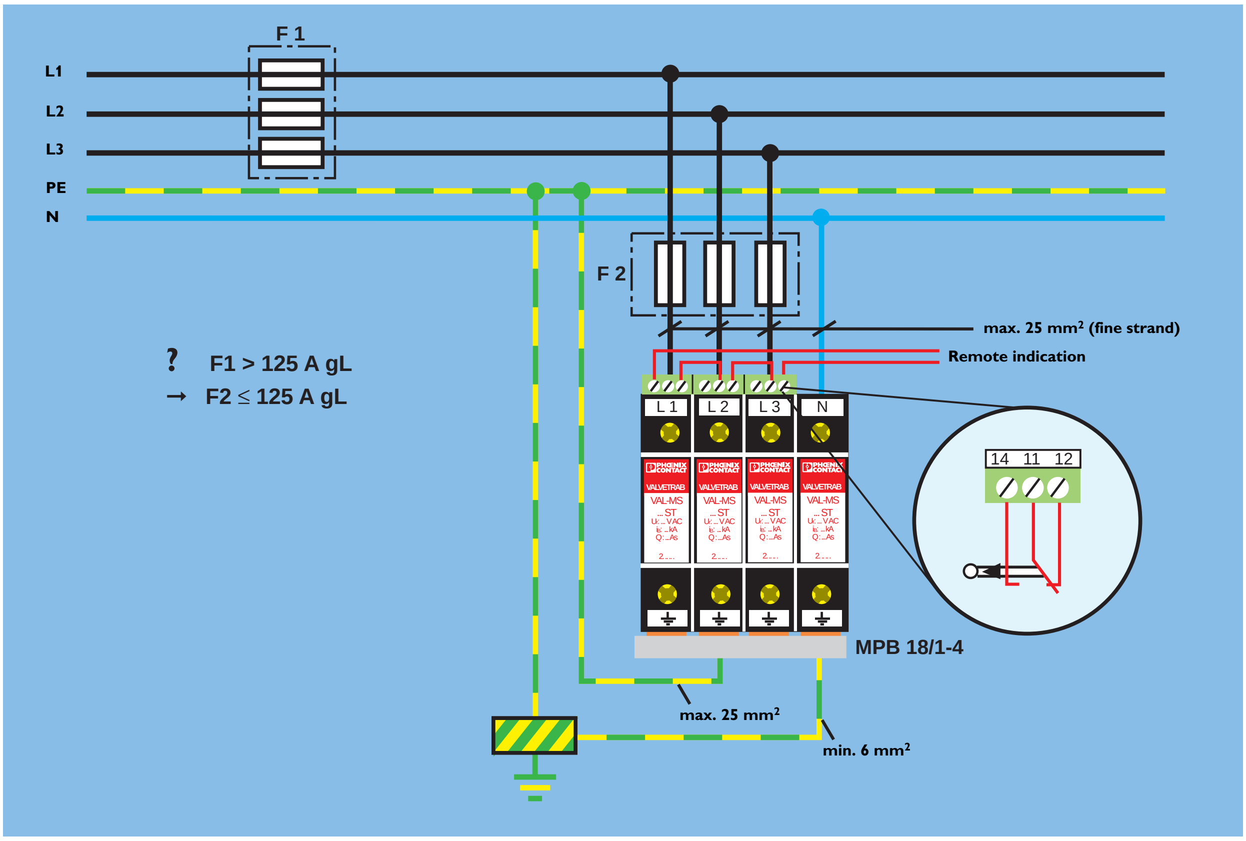

Fig. 27:
Installation of VALVETRAB

strand. The connection cross-sections result from the switch-off conditions according to VDE 0100, depending on the back-up fuse used. They are at least 6 mm².

4. In the TN-C system (PEN conductor), VAL-MS/ME must only be installed for L1, L2 and L3.

5. It is possible to install VAL-MS/ME in the main distribution as well as in the subdistribution. The VAL-MS/ME is installed in the main distribution when no lightning current arrester is planned for the system to be protected because of a low risk to the system to be protected or when a lightning current arrester has already been placed before the meter. When it is installed in the subdistribution, VAL-MS/ME forms the second protection stage.

6. When the alternatively available VAL-MS/ME with remote indicator contacts (PDT) is used, the disconnection of the protection element can be signalized externally.

Fig. 28:
Surge arrester block VAL... 3+1

7. VAL-MS/ME is used in DC and AC networks with maximum operating voltages up to the rated surge arrester voltage (see catalog).

8. For the "3+1 circuit" that is required in TT power supply systems, the Phoenix Contact range of TRABTECH surge voltage arrester products offers a prewired, easy to install solution in VAL...3+1 **(Fig. 28)**. The "3+1" circuit and thus this surge arrester block as well can also be advantageously used in TN-S power supply systems.

1.3 Equipment protection

The equipment protection, which reduces the remaining residual voltage further and additionally limits the normal mode voltage, can be created using surge arresters with various designs and connection conditions from the Phoenix TRABTECH range.

The equipment protection is generally connected in series to the power supply. The surge arresters are designed so that the surge arresting components are arranged between the phase conductor or neutral conductor and ground (PE) as well as between the active cores L and N.

When surge arresters are connected in series for the equipment protection, the maximum operating currents must be observed.

1.4 Interaction of the installation of the surge voltage protection in the power supply

The conductor lengths given in **Fig. 9** are valid for the distances of the surge arresters in the conductor path between the lightning current arrester, surge voltage arrester and equipment protection. A lightning current arrester alone is not sufficient in any case. It is necessary to install at least a second protection stage that is realized with surge voltage arresters in the same or the following distribution. If a 10 m conductor path does not exist between the lightning current arrester and the surge voltage arrester, the triggered FLASHTRAB FLT...CTRL lightning current arresters **(Fig. 29)** offer an ideal solution from a technical and economical point of view. Using the FLT...CTRL makes it possible to connect the lightning current arrester and the surge voltage arrester in parallel directly without any conductor spacing. The technology of this connection is called AEC (**A**ctive **E**nergy **C**ontrol). This considerably improves the interaction of the surge

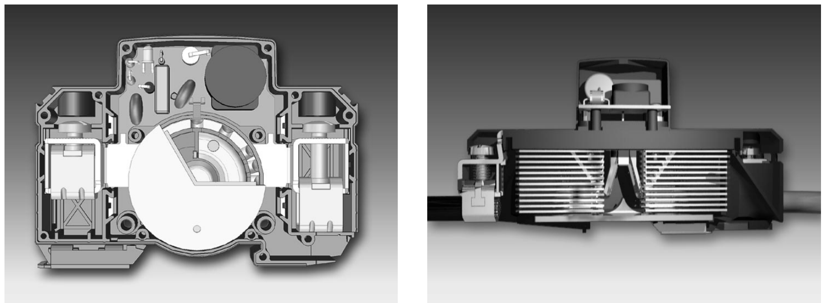

Fig. 29:
FLT 35 CTRL and FLT PLUS CTRL

arresters in comparison to coordinating the surge arresters using the required conductor lengths. The switching diagram is shown in **Fig. 30**.

Lightning current arresters and surge voltage arresters can also be coordinated in very small spaces in the usual way using the L-TRAB decoupling coils. This increases the space requirements and limits the operating current, though.

If the equipment to be protected (volume to be protected) is more than 5 m away from the feed distribution or if smaller residual voltages require more protection, additional equipment protection must be provided. The decoupling between the surge voltage arrester in the distribution and the equipment protection must then be provided by a conductor path of at least 5 m or by an additional decoupling inductance such as L-TRAB.

In addition to the conductor entry of the PE conductor in the power supply, which is present to begin with, it is necessary to create an equipotential bonding between the subdistributions – in the case of industrial plants up to the volume to be protected. For this reason, each subdistribution should have a grounding busbar that is connected with all other grounding busbars via a separate equipotential bonding conductor system and via the PE to connect the surge voltage arresters. The equipotential bonding system should be meshed, in other words have a low impedance. The equipotential bonding cables must be laid with at least 6 mm² Cu.

1.5 Interaction with residual-current-operated circuit breakers

The electrical installation equipment industry has provided surge-proof residual-current-operated circuit breakers for several years. The use of such residual-current-operated circuit breakers is a basic prerequisite for an installation with surge voltage arresters.

Surge voltage arresters must always be placed before residual-current-operated circuit breakers, as seen from the direction of the current supply. In this way, the surge current is discharged to ground before the residual-current-operated circuit breaker. This minimizes the triggering of the circuit breaker and damage.

If residual-current-operated circuit breakers have biconnect terminal blocks, such as the surge voltage arrester VAL-MS/ME does, an easy-to-wire and cost-saving installation can be realized with suitable bridge systems.

2. Protection of MCR systems

2.1 All surge arresters that contain multi-stage protective circuits and are added to the electric circuit in series are marked with the words "IN" and "OUT"**(Fig. 20)**. "IN" is always the unprotected side and points in the direction from which the surge voltage is expected.

The protected side "OUT" points to the volume to be protected (see also the chapter "Combined protective circuits").

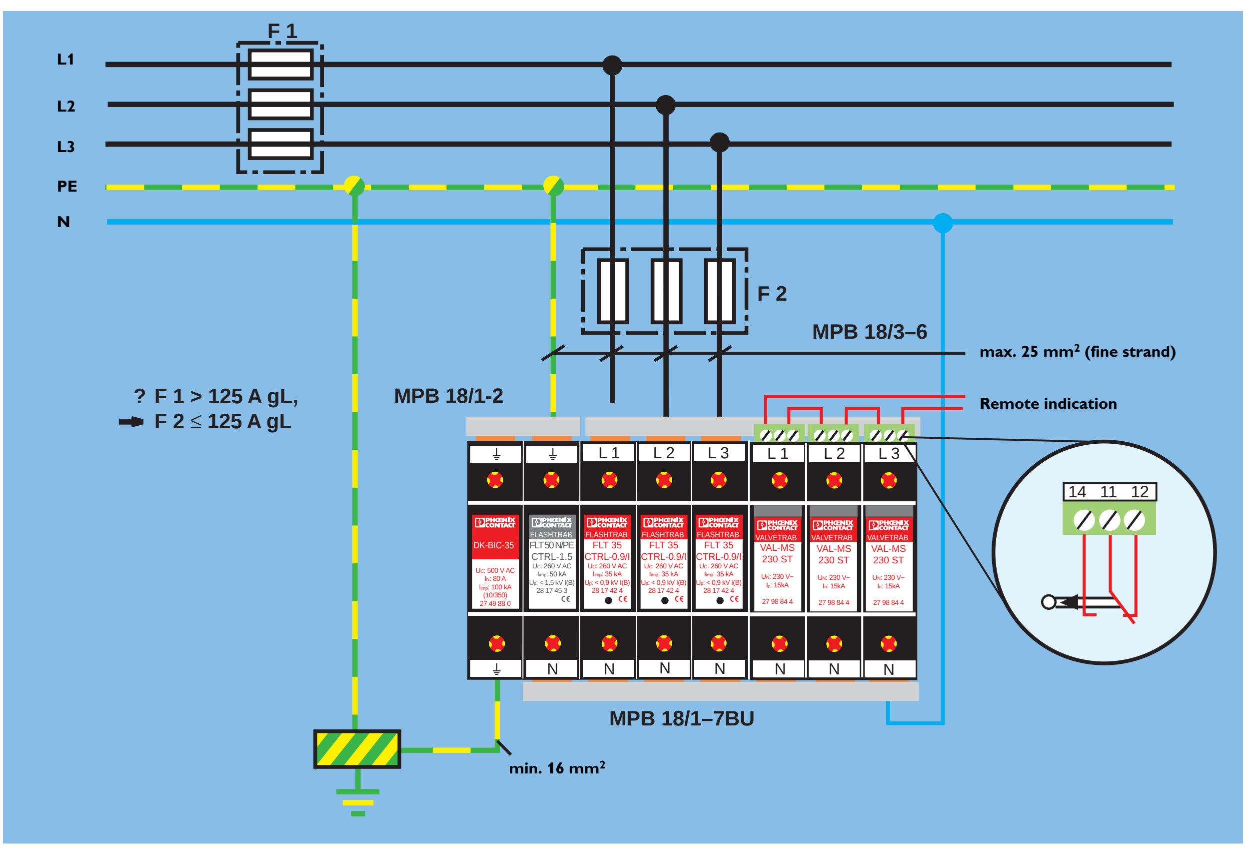

Fig. 30:
Coordinated inst. of FLASHTRAB and VALVETRAB with AEC technology

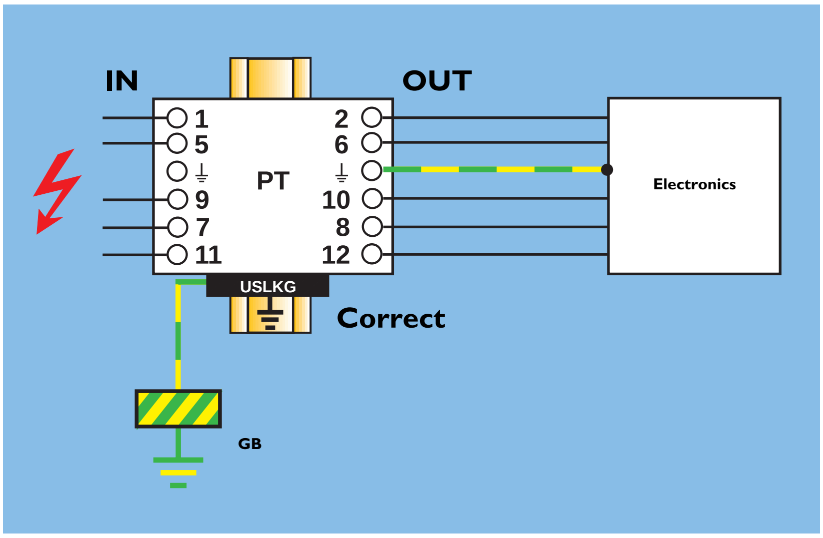

Fig. 31:
PE/GB connection
Correct

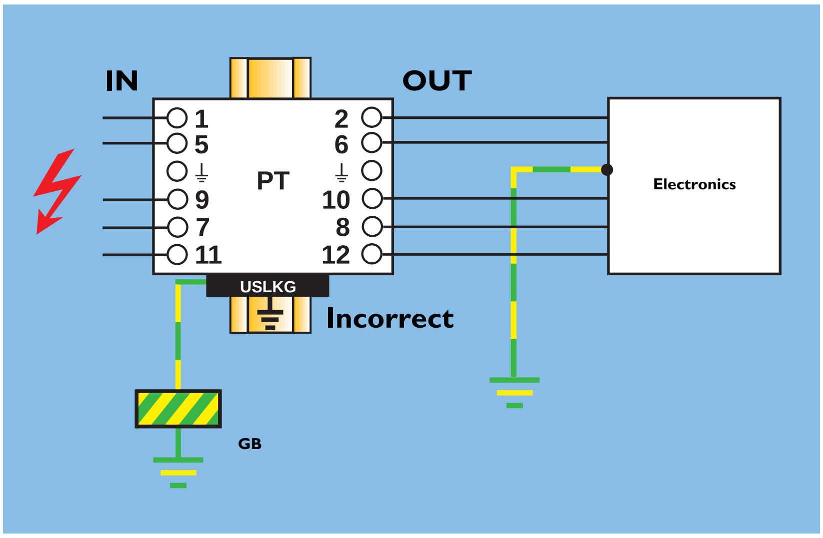

Fig. 32:
PE/GB connection
incorrect

2.2 The surge arresters for MCR circuits must be selected from 5 V DC on up for different nominal voltages in the TRABTECH catalog. When voltage signals are transmitted, the nominal voltage of the surge arrester depends on the amount of the voltage signal.

In current loops (e.g. 4-20 mA), the actual voltage that occurs depends on the total resistance of the circuit. This resistance is often referred to as the load "R_B". The voltage according to which the surge arrester should be selected then results from:

$$U = R_B \bullet 20 \text{ mA}$$

If this formula yields a value that is not a nominal voltage value of the offered surge arrester, the surge arrester with the next highest nominal voltage should be selected. In this case, it is also possible to convert the nominal voltage values from AC to DC (point 2.3).

2.3 Phoenix surge voltage arresters are divided into AC (alternating current) and DC (direct current) modules. The type of the module determines the circuit for the surge arrester. Modules of the same type only differ in the operating voltages and protection levels. Since the modules used are suitable for AC as well as DC, it is often possible and sensible to use an AC module instead of a DC module and vice versa. The values for the AC and DC nominal voltage only differ in the peak factor.

$$U_{nominal} = \sqrt{2} \bullet U_{rms}$$

A 24 V AC surge arrester can therefore also be used in systems up to 34 V DC, or a 24 V DC surge arrester can be used in measuring circuits up to 17 V AC.

2.4 The required protective effect can only be obtained when the PE/GB connection of the volume to be protected is directly connected with the base point or earthing point of the surge arrester. **Fig. 31** shows the correct connection.

Attention: If the protective equipment and the volume to be protected are connected as shown in **Fig. 32**, the path of the discharge current to GB will yield another surge voltage as a common mode voltage, in accordance with the formula:

$$u = L \bullet di/dt$$

This voltage would then be led to the electronics through the separate ground connection.

2.5 Gas-filled surge voltage arresters can only interrupt current to a limited extent by themselves. If the surge arrester is triggered with a nominal voltage of ≥ 12 V DC and nominal currents of ≥ 100 mA, excessive follow currents can be expected. In such circuits, a safety fuse must be connected upstream from the surge arrester as a quenching aid.

The nominal current for this fuse depends on the maximum operating current carrying capacity of the surge arrester.

3. Protection of data systems

The selection and installation of surge voltage protection equipment for data systems is relatively simple. The

Fig. 33:
Surge voltage arrester
for Ethernet interface

protective equipment already takes into account all the requirements for the data transmission system. It must be selected from the TRABTECH catalog in accordance with the interface specifications and added to the cable in series.

3.1 Surge arresters that contain a multi-stage protective circuit and are added to the electric circuit in series are marked with the words “IN” and “OUT” **(Fig. 20)**. “IN” is always the unprotected side and points in the direction from which the surge voltage is expected. The protected side “OUT” points towards the volume to be protected. (see also the chapter “Combined protective circuits”).

3.2 Surge arresters in adapter designs, which are used to protect floating interfaces, have a single-stranded ground conductor that is directly connected to the protective circuit in many cases. This cable, which is shown in **Fig. 33** on a surge arrester for Ethernet networks, is 1.5 m long when delivered.

When the surge arrester is installed, the grounding line should be shortened until it can be placed directly on the ground potential without detours. A practical feature is the connection to the grounded chassis of the volume to be protected.

3.3 When protection for the power supply is combined with data interface protection, the mesh of the equipotential bonding should be closed by connecting all grounding connections immediately before the volume to be protected.

The common connection of DATATRAB and MAINS-PRINTRAB is shown in **Fig. 34** as an example.

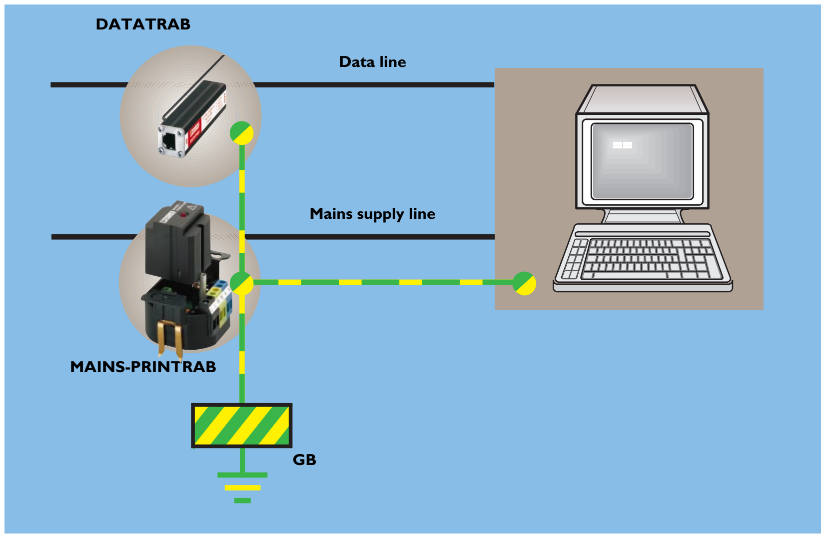

Fig. 34:
Equip. protection for the data interface and power supply with DATATRAB and PRINTRAB

Examples of the installation of surge voltage arresters

On this page and the following ones, **Fig. 35-39** show five connections of MCR and data systems together with surge voltage arresters. These often occur in practice and can be used repeatedly in this configuration.

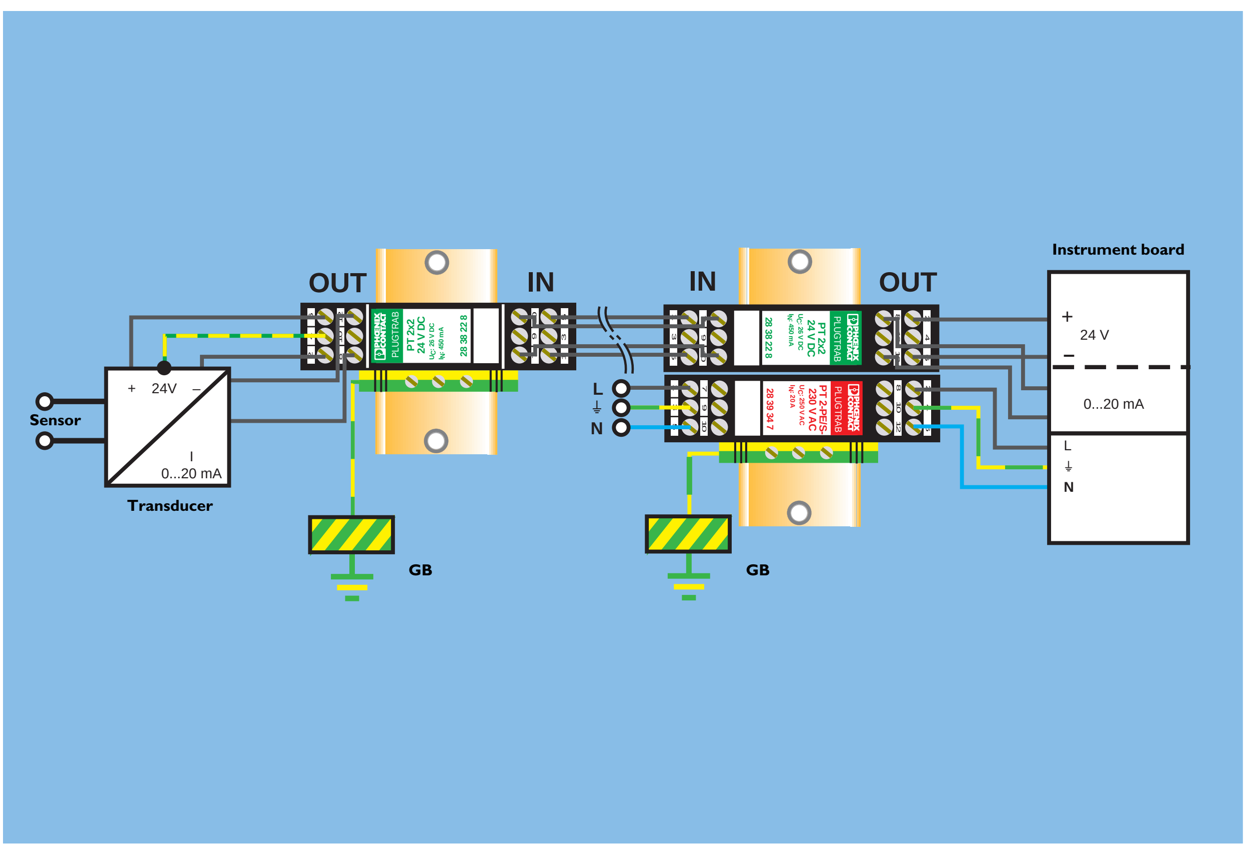

Fig. 35:
Protection of an analog measurement

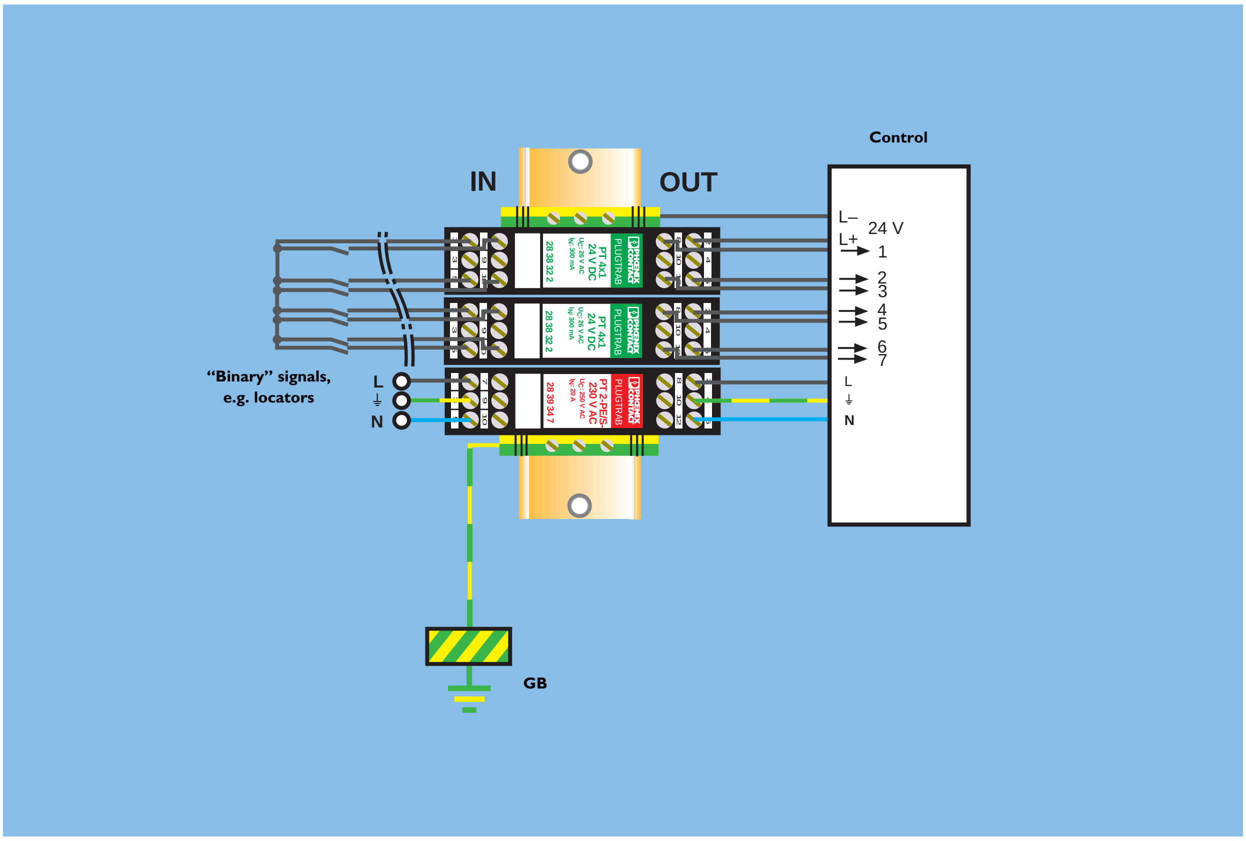

Fig. 36:
Protection of a binary signal input, reference potential (negative pole grounded)

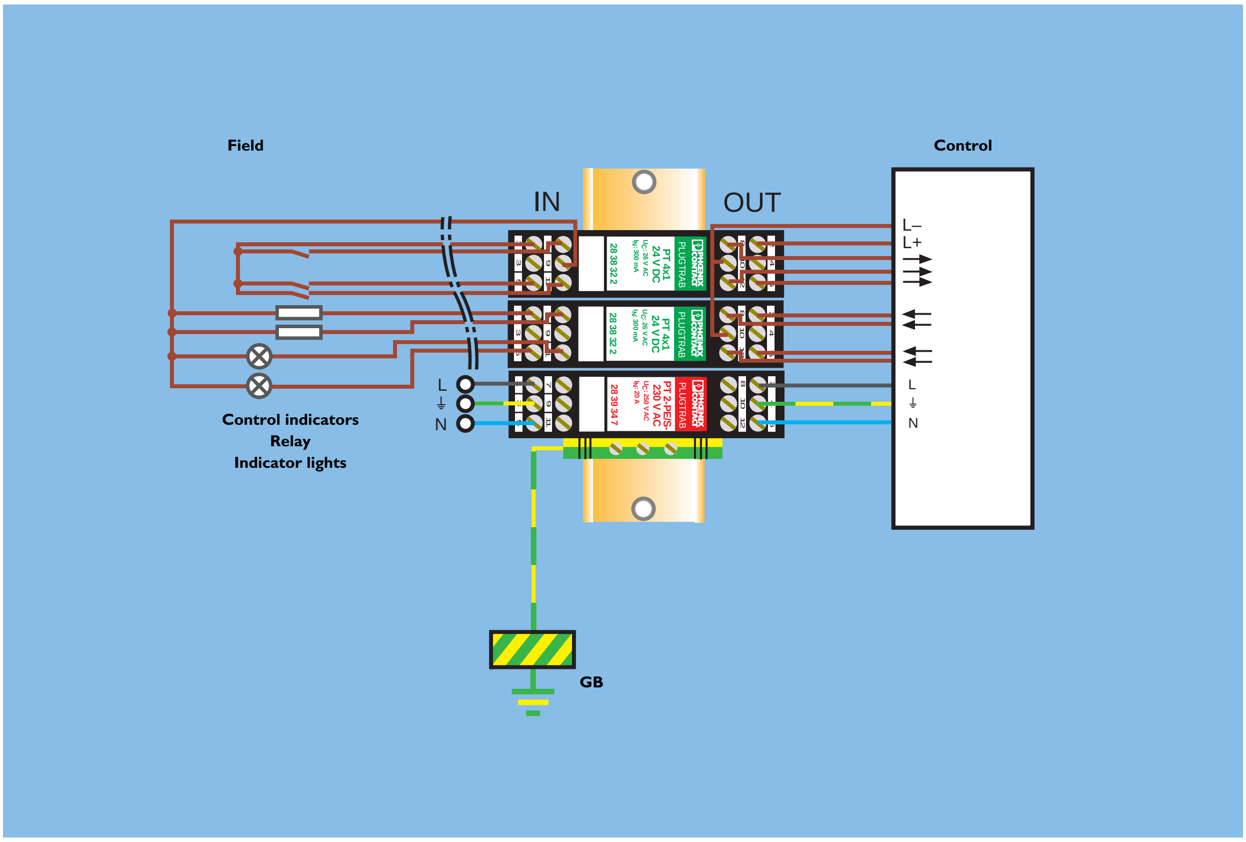

Fig. 37:
Protection of a binary signal input incl. actuator circuit, floating

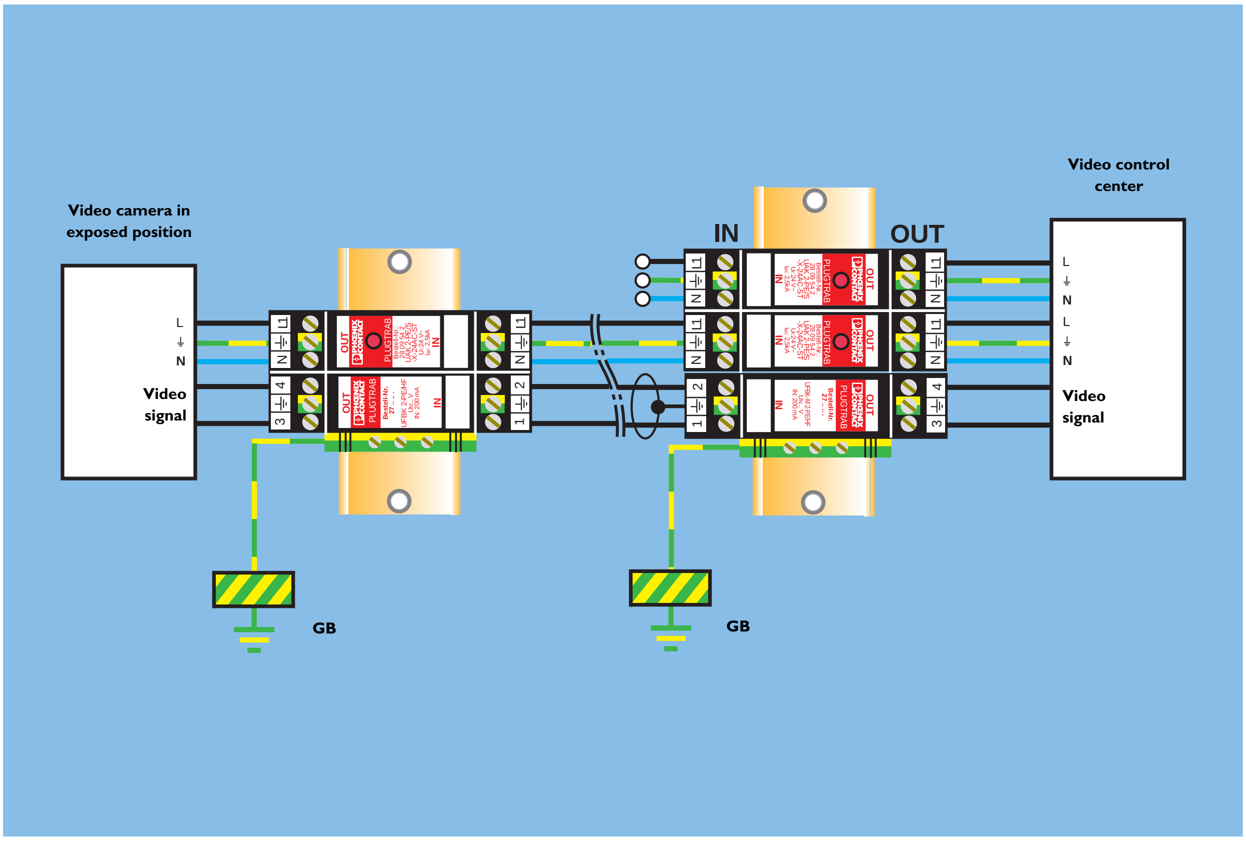

Fig. 38: Prot. of video signals in 2-wire technology; with UFBK-M and UAK surge arresters

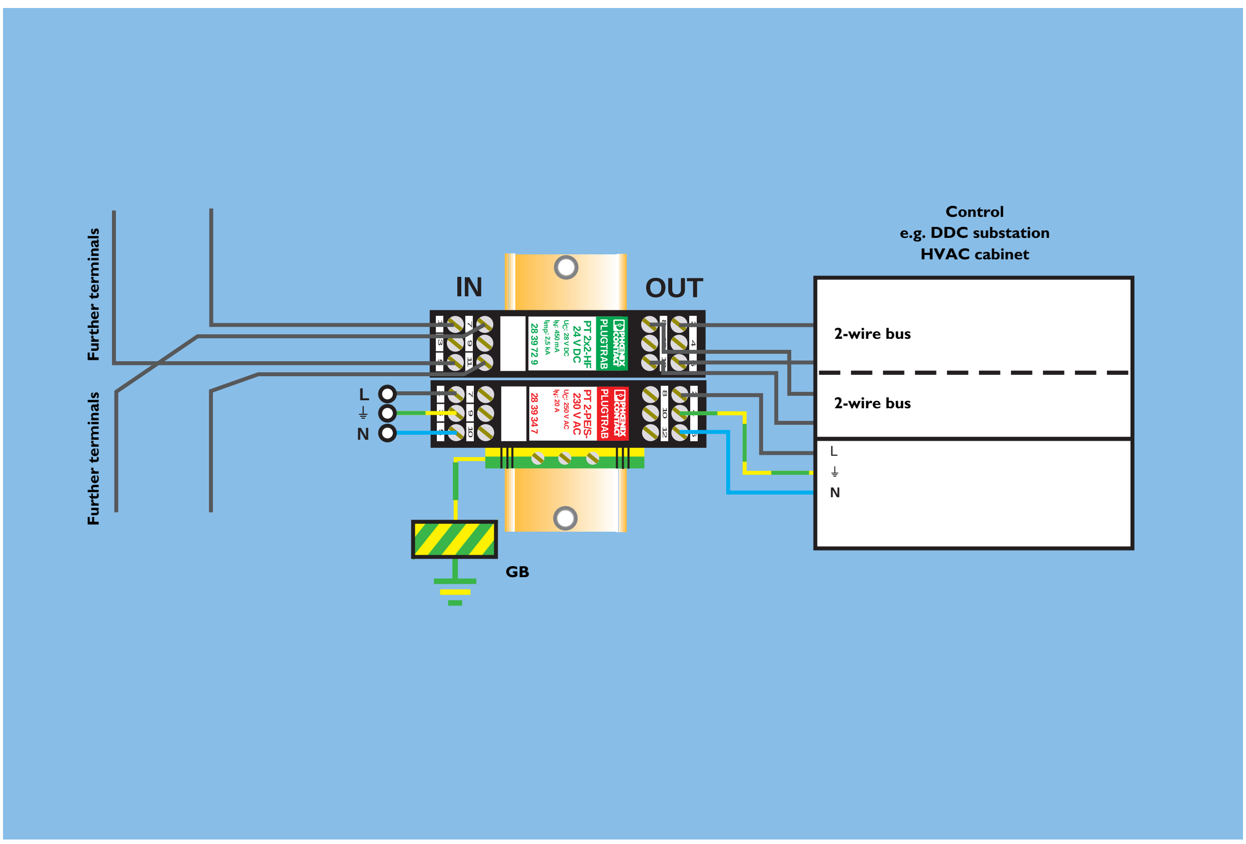

Fig. 39: Protection of a data transmission

Final notes

This document gives practical information for planning surge voltage protection concepts and selecting and installing surge arresters. It relates basic theoretical and practical knowledge on the topic of surge voltage protection. It is important to note that even a very good surge voltage protection concept that has been adapted to the applications can only be used successfully if it is installed correctly and in accordance with the standards.

Bibliography:

Standards:
IEC 61024
IEC 61643
DIN VDE 0100 Part 443
DIN VDE 0100 Part 534
DIN VDE 0100 Part 540
DIN VDE 0110
DIN VDE 0185 Part 1, 2, 100
DIN VDE 0190
DIN VDE 0675 Part 6
DIN VDE 0800 Part 2
DIN VDE 0843 Part 1, 2
DIN VDE 0845 Part 1

Publications:

[1] Schimanski, J. "Überspannungsschutz – Theorie und Praxis"
Hüthig GmbH, 1996

[2] Schimanski, J.; Scheibe, K. "Praktische Erfahrungen mit Blitzschutzableitern"
ICLP, 1998 Birmingham

[3] Schimanski, J.; Wolff, G, "Niederspannungsverbrauchanlagen"
ETZ, 5/99

[4] Wolff, G. "Überspannungsschutz im Vorzählerbereich"
EVU-Betriebspraxis, 7-8/99

[5] Danowsky, V. "Gekapselte Funkenstrecken"
de, 22/99

[6] Wetter, M.; Scheibe, K.; Schimanski, J. "Lebensdaueruntersuchungen an elektronisch gezündeten Blitzstromableitern"
3. VDE/ABB Blitzschutztagung, 1999 Neu-Ulm

[7] Hausmann, R.; Scheibe, K. "Überspannungsschutz für Antennanlagen"
EMC-Kompendium, 2000

[8] Danowsky, V; Wolff, G. "Überspannungsschutz"
EMC Journal, 1/00

[9] Welzel, F. "Überspannungsschutz in der MSR-Technik"
elektroAutomation, 1-2/00

[10] Schimanski, J.; Scheibe, K.; Wetter, M. "Coordination of varistors"
ICLP, 2000 Rhodos

[11] Wetter, M.; Scheibe, K.; Schimanski, J. "Comparison of 3-stage and 2-stage overvoltage protection concepts for power supplies" **ICLP**, 2000 Rhodos

[12] Wetter, M. "Überspannungsschutz & Blitzstromableiter"
ep, 7/00

[13] Danowsky, V. "Praxisgerechte Schutzkonzepte"
de, 18/00

[14] Schimanski, J. "Überspannungsschutz Klasse B"
VDE-Jahrbuch Elektrotechnik 2001

Fax

Please send me the following information:

- ❑ Catalog — TRABTECH – Surge Voltage Protection
- ❑ Info — Surge Voltage Protection for the Power Supply
- ❑ Info — Surge Voltage Protection for Information Technology
- ❑ Info — Surge Voltage Protection for Measurement and Control Technology
- ❑ Software — TRABTECH-Select
Planning aid for surge voltage protection concepts
- ❑ Please give me a call and arrange a date for a meeting

Requests and suggestions:

Name

Company

Department

Position

Address/P.O. Box

Postal Code/City

Phone

Fax

e-mail

TNR 5131327/1.0-30.06.01 Printed in Germany

Phoenix Contact GmbH & Co. KG
P.O. Box 1341 · D-32819 Blomberg
Fax: ++49/52 35/32 10 99
Phone: ++49/52 35/3 00
http://www.phoenixcontact.com

PHOENIX CONTACT
INNOVATION IN INTERFACE