

What transients are and why you need protection

The information provided in these introductory pages follows the requirements for transient overvoltage (surge) protection provided by both BS EN/IEC 62305 and the latest amendment of the IET Wiring Regulations 17th Edition, BS 7671:2008(+A1:2011).

Transient overvoltages

Transient overvoltages are short duration, high magnitude voltages peaks with fast rising edges, commonly referred to as surges. Often described as a "spike", transient voltages can reach up to 6000 V on a low-voltage consumer network, with no more than millisecond duration.

Lightning strikes are the most common source of extreme transient overvoltages where total outage of an unprotected system can occur with damage to cabling insulation through flashover potentially resulting in loss of life through fire and electric shock.

However, electrical and electronic equipment is also continually stressed by hundreds of transients that occur every day on the power supply network through switching operations of inductive loads such as air-conditioning units, lift motors and transformers.

Switching transients may also occur as a result of interrupting short-circuit currents (such as fuses blowing).

Although switching transients are of a lower magnitude than lightning transients, they occur more frequently and equipment failures unexpectedly occur often after a time delay; degradation of electronic components within the equipment is accelerated due to the continual stress caused by these switching transients.

Transient overvoltages, whether caused by lightning or by electrical switching, have similar effects: disruption (e.g. data loss, RCD tripping), degradation (reduced equipment lifespan), damage (outright equipment failure, particularly concerning for essential services such as fire and security alarm systems) and downtime - the biggest cost to any business such as lost productivity and product spoilage, staff overtime, delays to customers and sales lost to competitors.

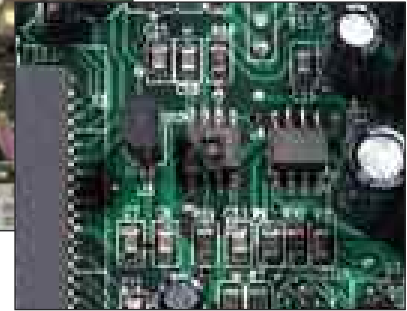
Protection against lightning and switching transients

BS EN/IEC 62305 takes account of protection measures on metallic service lines (typically power, signal and telecom lines) using transient overvoltage or surge protective devices (SPDs) against both direct lightning strikes as well as the more common indirect lightning strikes (often described as the secondary effects of lightning) and switching transients.

Standards such as BS EN 61643 series define the characteristics of lightning currents and voltages to enable reliable and repeatable testing of SPDs (as well as lightning protection components).



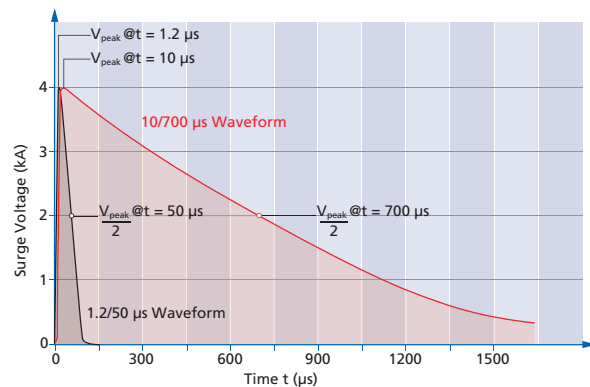
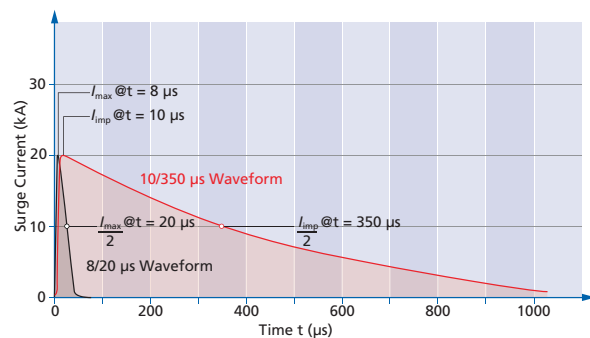
Transient overvoltage damage to the circuit board, left, is clear to see, but most damage is barely visible, as below.



Although these waveforms may differ from actual transients, the standardized forms are based upon years of observation and measurement (and in some cases simulation). In general they provide a fair approximation of the real world transient.

Transient waveforms have a fast rising edge and a longer tail. They are described through their peak value (or magnitude), rise time and their duration (or fall time). The duration is measured as the time taken for the test transient to decay to half its peak value.

The figures below illustrate the common current and voltage waveforms that are used to test SPDs for mains, signal and telecom lines.



Figures 1 & 2: The common current and voltage waveforms used to test SPDs for mains, signal and telecom lines



Lightning currents as a result of direct lightning strikes are represented by the simulated 10/350 μs waveform with a fast rise time and long decay that replicates the high energy content of direct lightning.

Direct lightning can inject partial lightning currents of the 10/350 μs waveform into a system where a structure with a structural Lightning Protection System (LPS) receives a direct strike (Source S1) or where lightning directly strikes an overhead service line (Source S3).

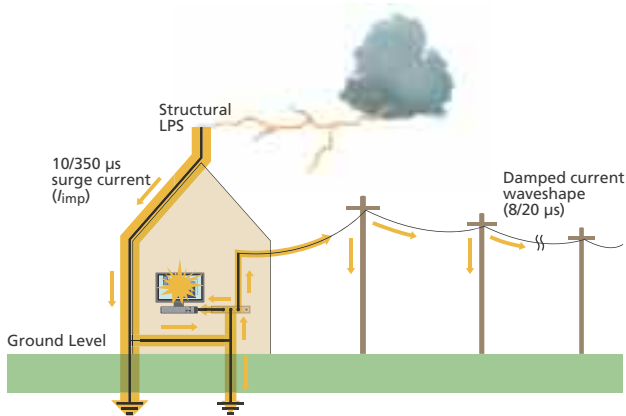


Figure 3: Illustration of lightning current flow from a direct strike to a structure (Source S1)

Remote or indirect lightning flashes near the structure (Source S2) or near a connected service to the structure (Source S4) of up to 1 km radius away (and hence far more common) are represented by the 8/20 μs waveform.

Induced surges from direct lightning flashes and switching sources are also represented by this waveform.

With a much shorter decay or fall time relative to the 10/350 μs waveform, the 8/20 μs waveform presents significantly less energy (for an equivalent peak current) but is still devastating enough to damage electrical and electronic equipment.

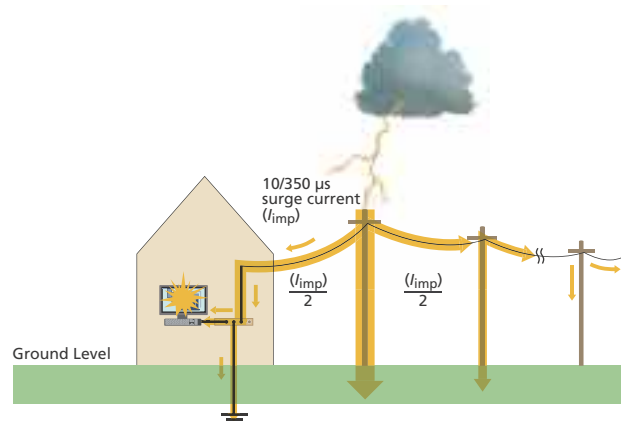


Figure 4: Illustration of lightning current flow from a direct strike to a nearby service (Source S3)

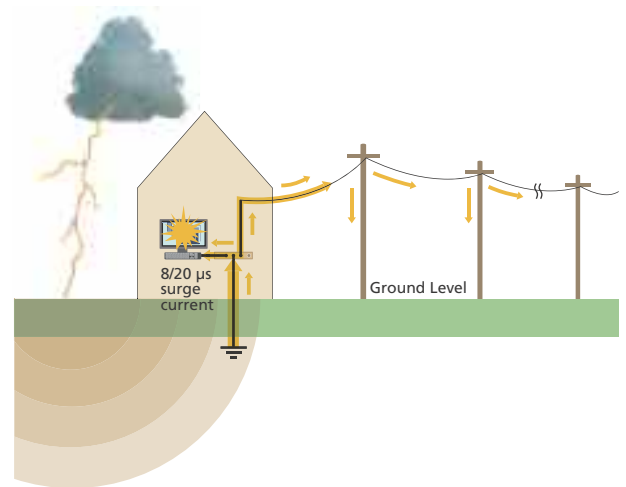


Figure 5: Illustration of lightning current flow from a direct strike near the structure (Source S2)

BS EN/IEC 62305-1 recognises that failure of internal systems (Damage Type D3) due to Lightning Electromagnetic Impulse (LEMP) is possible from all points of strike to the structure or service - direct or indirect (all Sources: S1, S2, S3 and S4).

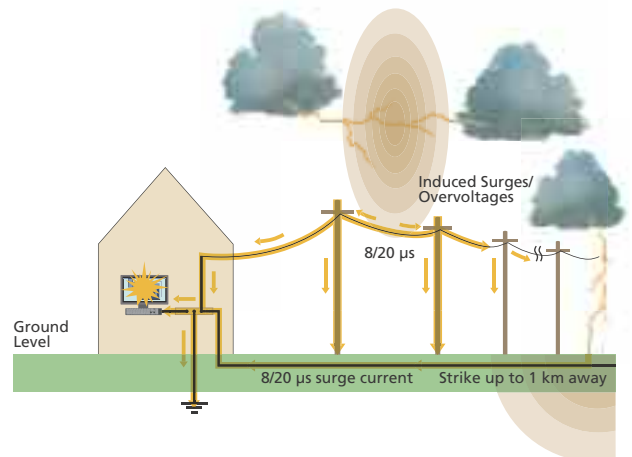


Figure 6: Illustration of lightning current flow from lightning flashes near connected services (Source S4)

To ensure continuous operation of critical systems even in the event of a direct strike, SPDs are essential and are suitably deployed, based on the source of surge and its intensity using the Lightning Protection Zones (LPZ) concept within BS EN/IEC 62305-4.

A series of zones is created within the structure according to the level of threat posed by the LEMP with each zone to have successively less exposure to the effects of lightning - for example LPZ 0_A (outside the structure) where the threat of lightning currents and fields is most severe being more onerous than LPZ 3 (within the structure) where the threat of lightning is considerably reduced such that electronics can be safely located within this zone.

What transients are and why you need protection

Figure 7 illustrates the basic LPZ concept defined by protection measures against LEMP as detailed in BS EN/IEC 62305-4.

Equipment is protected against both direct and indirect lightning strikes to the structure and connected services, through the use of Surge Protection Measures (SPM), formerly referred to as a LEMP Protection Measures System (LPMS).

To achieve this reduction in LEMP severity, from conducted surge currents and transient overvoltages, as well as radiated magnetic field effects, successive zones use a combination of shielding measures, bonding of incoming metallic services such as water and gas and the use of coordinated SPDs (further details can be found in the Furse Guide to BS EN 62305 Protection against Lightning).

Given that the live cores of metallic electrical services such as mains power, data and telecom cables cannot be bonded directly to earth wherever a line penetrates each LPZ, a suitable SPD is therefore needed.

The SPD's characteristics at the boundary of each given zone or installation location need to take account of the surge energy they are to be subject to as well as ensure the transient overvoltages are limited to safe levels for equipment within the respective zone.

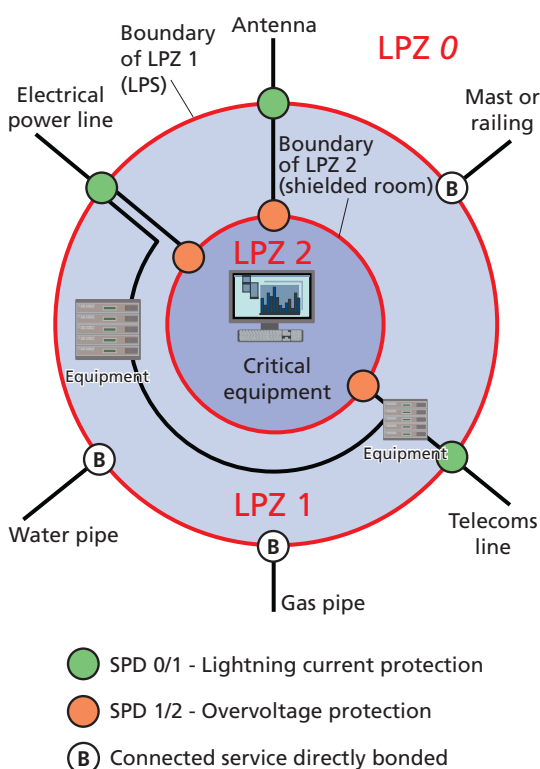


Figure 7: Basic LPZ concept - BS EN/IEC 62305-4

SPD location/LPZ boundary

| | LPZ 0/1 | LPZ 1/2 | LPZ 2/3 |
|---|--|---|---|
| Typical SPD installation point | Service Entrance (e.g. Main distribution board or telecom NTP) | Sub-distribution board or telecom PBX frame | Terminal Equipment (e.g. socket outlet) |
| Mains Test Class/SPD Type¹ | I/1 | II/2 | III/3 |
| Surge test waveform | 10/350 current | 8/20 current | Combination 8/20 current and 1.2/50 voltage |
| Typical peak test current (per mode) | 25 kA ² | 40 kA | 3 kA (with 6 kV) |
| Signal/Telecom Test Category¹ | D1 ³ | C2 ³ | C1 |
| Surge test waveform | 10/350 current | Combination 8/20 current and 1.2/50 voltage | Combination 8/20 current and 1.2/50 voltage |
| Typical peak test current (per mode) | 2.5 kA | 2 kA (with 4 kV) | 0.5 kA (with 1 kV) |

¹ Tests to BS EN 61643 series

² Peak current (per mode) for a 3 phase SPD to protect a TN-S mains system

³ Test category B2 10/700 voltage waveform (also within ITU-T standards) up to 4 kV peak also permissible

Table 1: Standardized test waveforms with peak currents used to test SPDs at each LPZ boundary

Table 1, above, details the standardized test waveforms with peak currents used to test SPDs typically located at each zone boundary.

Types of SPD

BS EN/IEC 62305 deals with the provision of SPDs to protect against both the effects of indirect lightning strikes and high-energy direct lightning strikes.

- Direct lightning strikes are protected by lightning current or equipotential bonding SPDs (Mains Type 1 SPDs & Signal/Telecom SPDs to Test Category D)
- Indirect lightning strikes and switching transients are protected by transient overvoltage SPDs (Mains Type 2 and Type 3 SPDs and Signal/Telecom SPDs to Test Category C)

Lightning current or equipotential bonding SPDs

Lightning current/equipotential bonding SPDs are designed to prevent dangerous sparking caused by flashover.

Flashover is caused when the extremely high voltages associated with a direct lightning strike breaks down cable insulation. This can occur between the structural LPS and electrical services and presents a potential fire hazard and risk from electric shock.



Transient overvoltage SPDs

Transient overvoltage SPDs are designed to protect electrical/electronic equipment from the secondary effects of indirect lightning and against switching transients. SPDs should be installed at sub-distribution boards and at equipment level for critical equipment.

BS EN/IEC 62305 refers to the correct application of lightning current and transient overvoltage SPDs as a coordinated set where the service entrance lightning current SPD handles the majority of surge energy and prevents flashover whilst the downstream transient overvoltage SPDs ensure equipment protection by sufficiently limiting the overvoltages.

For further information, please refer to the Furse Guide to BS EN 62305 Protection Against Lightning.

BS EN/IEC 62305-2 Risk Management is used to evaluate the required level of lightning protection measures necessary to lower the risk of damage to a particular structure, its contents and occupants to a defined tolerable level.

If the risk evaluation demands that a structural LPS is required, then lightning current or equipotential bonding SPDs are always required for any metallic electrical services entering the structure.

These SPDs are necessary to divert the partial lightning currents safely to earth and limit the transient overvoltage to prevent possible flashover.

They are therefore an integral part of the structural LPS and typically form the first part of a coordinated SPD set for effective protection of electronic equipment.

If the risk evaluation shows that a structural LPS is not required but there is an indirect risk, any electrical services feeding the structure via an overhead line will require lightning current SPDs typically installed at the service entrance, with coordinated transient overvoltage SPDs downstream to protect electronic equipment.

In order to provide effective protection, a transient overvoltage protector/SPD must:

- be compatible with the system it is protecting
- survive repeated transients
- have a low 'let-through' voltage, for all combinations of conductors (enhanced SPDs to BS EN 62305)
- not leave the user unprotected, at the end of its life, and
- be properly installed

IMPORTANT

The primary purpose of lightning current or equipotential bonding SPDs is to prevent dangerous sparking caused by flashover to protect against the loss of human life.

In order to protect electronic equipment and ensure the continual operation of systems, transient overvoltage SPDs are required. BS EN/IEC 62305-4 specifically states that "a lightning protection system which only employs equipotential bonding SPDs provides no effective protection against failure of sensitive electrical or electronic systems."

| | Protectors for mains supplies | | Protectors for data lines | | |
|-------------------------------|-------------------------------|--------------------|---------------------------|--------------------|----------------------------|
| | Parallel protectors | In-line protectors | Low frequency protectors | Network protectors | Radio frequency protectors |
| Nominal operating voltage | ✓ | ✓ | ✓ | ✓ | ✓ |
| Maximum operating voltage | ✓ | ✓ | ✓ | ✓ | ✓ |
| Leakage current | ✓ | ✓ | ✓ | ✓ | ✓ |
| Nominal current rating | X | ✓ | ✓ | ✓ | ✓ |
| Max continuous current rating | X | ✓ | ✓ | ✓ | ✓ |
| In-line impedance | X | ✓ | ✓ | ✓ | ✓ |
| Shunt capacitance | X | X | X | ✓ | ✓ |
| Bandwidth | X | X | ✓ | ✓ | ✓ |
| Voltage standing wave ratio | X | X | X | ✓ | ✓ |

Table 2: General indication of system impairments, of which manufacturers of transient overvoltage protectors should provide details

How to get effective protection

Compatibility

The protector must not interfere with the system's normal operation:

- mains power supply SPDs should not disrupt the normal power supply such as creating follow current that could blow supply fuses, or cause high leakage currents to earth
- SPDs for data communication, signal and telephone lines should not impair or restrict the systems' data or signal transmission

Survival

It is vital that the protector is capable of surviving the worst case transients expected at its installation point/LPZ boundary.

More importantly, since lightning is a multiple event, the protector must be able to withstand repeated transients.

The highest surge currents occur at the service entrance (boundary LPZ 0_A to LPZ 1). For buildings with a structural LPS, the lightning current SPD could be subject to as high as 25 kA 10/350 μ s surge currents per mode on a 3-phase TN-S/TN-C-S mains system (up to 2.5 kA 10/350 μ s per mode on a signal or telecom line) for a worst-case lightning strike of 200,000 A.

However, this 200 kA level of lightning current itself is extremely rare (approx. 1% probability of occurring) and the peak current the SPD would be subject to further assumes that a structure is only fed with one metallic service.

Almost all structures have several metallic services connected to them such as gas, water, mains, data & telecoms.

Each service shares a portion of the lightning current when the protected building receives a strike, greatly reducing the overall current seen by any single service, and as such any SPD fitted to the electric service lines.

Transient overvoltages caused by the secondary effects of lightning are considerably more common (lightning flash near a connected service up to 1 km away from the structure) and therefore are unlikely to have currents exceeding 10 kA 8/20 μ s.

Let-through voltage

The larger the transient overvoltage, the greater the risk of flashover, equipment interference, physical damage and hence system downtime.

Therefore, the transient overvoltage let through the protector (also known as the voltage protection level U_p of the SPD) should be as low as possible and certainly lower than the level at which flashover, interference or component degradation may occur.

Transient overvoltages can exist between any pair of conductors:

- phase to neutral, phase to earth and neutral to earth on mains power supplies
- line to line and line(s) to earth on data communication, signal and telephone lines

Thus, a good protector (enhanced SPDs to BS EN 62305) must have a low let-through voltage between every pair of conductors.

Enhanced performance SPDs - SPD*

BS EN 62305-2 details the application of improved performance SPDs to further lower the risk from damage.

The lower the sparkover voltage, the lower the chance of flashover causing insulation breakdown, electric shock and fire.

SPDs that offer lower let-through voltages further reduce the risks of injury to living beings, physical damage as well as failure and malfunction of internal systems.

All Furse ESP protectors offer such superior protection and are termed as enhanced performance SPDs (SPD*) in line with BS EN 62305.

Enhanced SPDs can also satisfy more than one test class/category by handling both high-energy partial lightning currents of 10/350 μ s waveshape whilst offering very low let-through voltages.

Such enhanced SPDs may be suitable for changing a lightning protection zone from LPZ 0_A right through to LPZ 3 at a single boundary or installation point.

As such they provide both technical and economic advantages over standard SPDs.

End of life

When an SPD comes to the end of its working life it should not leave equipment unprotected.

Thus in-line protectors should take the line out of commission, preventing subsequent transients from damaging equipment.

SPDs for data communication, signal and telephone lines and protectors for low current mains power supplies are usually in-line devices.

Where SPDs are installed at mains power distribution boards it is usually unacceptable for these to suddenly fail, cutting the power supply.

Consequently, to prevent equipment being left unprotected, the SPD should have a clear pre end-of-life warning, which allows plenty of time for it to be replaced.



Installation

The performance of SPDs is heavily dependent upon their correct installation. Thus, it is vital that SPDs are supplied with clear installation instructions.

The following is intended to supplement the detailed guidance given with each product in order to give a general overview of installation.

This should not be viewed as a substitute for the Installation Instructions supplied with the SPD. Copies of these are available separately on request.

Installing parallel connected SPDs for mains power supplies:

- SPDs should be installed very close to the power supply to be protected, either within the distribution panel or directly alongside of it (in an enclosure to the required IP rating)
- Connections between the SPD and phase(s), neutral and earth of the supply should be kept very short (ideally 25 cm or less, but no more than 50 cm)
- SPD performance is further enhanced by tightly binding connecting leads together (simply using cable ties or similar), over their entire length
- For safety and convenient means of isolation, the phase/live connecting leads should be suitably fused using HRC fuses or switchfuse, MCB or MCCB

Installing in-line SPDs for data, signal, telephone or power:

- SPDs are usually installed between where cabling enters or leaves buildings and the equipment being protected (or actually within its control panel)
- The installation position should be close to the system's earth star point (usually the mains power earth) to enable a short and direct connection to earth
- In-line, or series, connected SPDs generally have connections marked line and clean.
The line end of the SPD should be connected to the incoming or "dirty" line (from where the transient is expected).
The clean end of the SPD should be connected to the line or cable feeding the equipment
- Cables connected to the SPD's clean end should never be routed next to dirty line cables or the SPD's earth bond
- Unless ready-boxed, SPDs should be installed within an existing cabinet/cubicle or in an enclosure to the required IP rating

Note: further information on the satisfactory installation of SPDs on mains power supplies, to meet the requirements of IET Wiring Regulations 17th Edition, BS 7671:2008(+A1:2011),

How to apply protection

Transient overvoltages are conducted into the sensitive circuitry of electronic equipment on power and data communication, signal and telephone lines. Protection is recommended for:

- all cables which enter or leave the building (except fibre optic)
- the power supply local to important equipment
- electronic equipment outside the main building(s)

Protect incoming and outgoing electrical services

Lightning strikes between clouds or to ground (and objects upon it) can cause transient overvoltages to be coupled on to electrical cables, and hence into the sensitive electronic equipment connected to them.

To protect the electronic equipment inside a building, all cables that enter or leave the building must be protected. Cables leaving the building can also provide a route back into the building for transients.

For each building protect incoming/outgoing:

- mains power supplies (including UPS supplies)
- data communication and local area network cables
- signal, control, instrumentation and alarm lines
- CCTV, satellite, TV and antenna cables
- telephone and telemetry lines

Protect the power supply locally to important equipment

In addition to installing protection on the mains power supply as it enters/leaves the building, protection should also be installed locally to important equipment. Protection at the main LV (low voltage) incomer(s) is necessary to prevent large transients from entering the building's power distribution system, where they could have farreaching effects.

However, where the cable run to equipment exceeds 10 metres (to BS 7671 Clause 534.2.3.1.1), transient overvoltages may appear on the mains after the protector at the main LV incomer. These transients can result from:

- the electrical switching of large inductive loads within the building
- a lightning strike to the building - as lightning currents flow through down conductors transient overvoltages can be induced on to nearby power cables
- the natural inductance and capacitance of long cable runs, 'amplifying' the voltage 'let-through' the protector at the main LV incomer

Additionally, local protection guards against the possibility of a supply which enters/leaves the building being overlooked and left unprotected.

When & where to protect

Protect data lines locally

Generally, the biggest risk to data, signal, telecom and network wiring is associated with cables that enter and leave the building.

These should always be protected. However, data cables within a building can additionally have transients induced on to them when loops between data and power cables “pick up” voltages from the magnetic field caused by a lightning strike.

As part of the overall SPM, BS EN/IEC 62305 advocates the use of metal in the structure, and a Faraday cage lightning protection system to help exclude magnetic fields.

Cable management practices eliminate loops by routing data and power cables along the same general path.

In these cases, the need for local data line protection is minimal. However, where these steps are not possible, data line protection, local to the equipment requiring protection, should be considered.

Protect electronic equipment outside the building

Onsite or field-based electronic equipment with mains power, data communication, video, signal or telephone line inputs will need to be protected against transient overvoltages. It may be helpful to think of each equipment cabinet or cubicle as a separate building with incoming/outgoing cables to be protected.

Complementary techniques

As well as the use of transient overvoltage protectors, BS EN/IEC 62305 outlines additional protection techniques (e.g. shielding measures), which can be used to help reduce the transient threat as part of the overall SPM.

These are described further in the Furse Guide to BS EN 62305 Protection Against Lightning. Where these can be used, principally on new build or refurbishment projects, they need to be supported by the use of SPDs.



Special product development

Whilst this catalogue focuses on our standard product range which meets a wide variety of applications, on occasion a customer will have a special requirement which needs transient overvoltage protection.

In these circumstances we have the technical capability in-house to design and propose a specific solution to meet the customer's special requirement.

Following our proposal, technical and performance parameters of the SPD can be finalised, and the special product manufactured to order.

Special products completed to date include:

- Low-current supply protection to industrial microwave ovens
- Media distribution protection (TV/Radio/DAB on 19" rack)
- Integrated photovoltaic inverter protection
- Overvoltage disconnect for battery-charger installations within substations

For more information about special product development, or to discuss a particular project, please contact us.

Common terminology and definitions

The following common terminologies, as recognised by BS EN/IEC 61643, are used throughout SPD specifications in order to aid correct selection and are defined as follows:

Nominal Voltage U_o is the phase to neutral AC RMS voltage of the mains system (derived from the nominal system voltage) for which the SPD is designed. U_o is the voltage by which the power system is designated - e.g. 230 V.

Maximum Continuous Operating Voltage U_c is the maximum RMS voltage that may be continuously applied to the SPD's mode of protection e.g. phase to neutral mode. This is equivalent to the SPD's rated peak voltage.

Temporary Overvoltage U_T is the stated test value of momentary voltage increase or overvoltage that the power SPD must withstand safely for a defined time.

Temporary overvoltages, typically lasting up to several seconds, usually originate from switching operations or wiring faults (for example, sudden load rejection, single-phase faults) as well as mains abnormalities such as ferro-resonance effects and harmonics.

Impulse Current I_{imp} is defined by three parameters, a current peak with a charge and a specific energy typically simulated with the 10/350 μ s waveform to represent partial lightning currents.

This waveform is used, with peak I_{imp} current value stated, for the mains Type 1 SPD Class I test and typically for data/telecom SPD Test Category D.

Nominal Discharge Current I_n is a defined nominal peak current value through the SPD, with an 8/20 μ s current waveshape. This is used for classification of mains SPDs (Class II test) and also for preconditioning of SPDs in Class I and Class II tests. (Note: within BS 7671, I_n is referred to as I_{nspd}).

Maximum Discharge Current I_{max} is the peak current value through the SPD, with an 8/20 μ s waveshape. I_{max} is declared for mains Type 2 SPDs in accordance to the test sequence of the Class II operating duty test. In general, I_{max} is greater than I_n .

Combined Impulse Test with Open Circuit Voltage U_{oc} is a hybrid 1.2/50 μ s voltage test combined with an 8/20 μ s current.

The test is performed using a combination wave generator where its open circuit voltage is defined as U_{oc} , typically 6 kV 1.2/50 μ s for the mains Class III test and up to 4 kV 1.2/50 μ s for signal/telecom Test Category C.

With an impedance of 2 Ω , the generator also produces a peak short circuit current (sometimes referred to as I_{sc}) at half the value of U_{oc} (3 kA 8/20 μ s for the mains Class III test and up to 2 kA 8/20 μ s for signal/telecom Test Category C).

With both voltage and current test waveforms, the combined impulse test is designed to stress all technologies used within SPDs.

Voltage Protection Level U_p is the key parameter that characterizes the performance of the SPD in limiting the transient overvoltage across its terminals. A low protection level value (also known as let-through voltage) is therefore particularly critical for the effective protection and continued operation of electronic equipment.

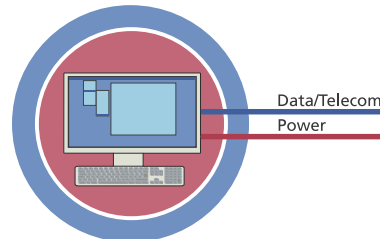
The peak voltage protection level U_p is declared when the SPD is tested with its stated nominal discharge current I_n (or the peak current (I_{peak}) of I_{imp}) and is also declared when the SPD is subject to combined impulse test (mains Class III test for Type 3 SPDs) as well as data/telecom Test Categories C and B.

Simplified product selection

Simplified product selection

All Furse ESP products are designed to provide simple system integration whilst achieving highest levels of effective protection against transients.

Tested in line with the BS EN 61643 standards series, ESP protection can be selected and applied to BS EN 62305 and BS 7671 easily using the SPD product application tables and data sheets. Key product and application features are represented using the following symbols:



WARNING Equipment is **ONLY** protected if all incoming lines have protection fitted



Lightning Protection Zone (LPZ) details the boundary (to BS EN/IEC 62305-4) or installation point of the SPD. For example, LPZ $O_A \rightarrow 3$ signifies that the SPD can be installed at the service entrance boundary and create an immediate LPZ 3 suitable for protecting electronic equipment close to the SPD installation.

Equipment further downstream of this location may require additional protection, against switching transients for example.



Mains Test Type defines the Type of mains SPD (BS EN 61643 Type 1, 2, 3 or I, II, III to IEC 61643) tested with the respective test Class I (high energy 10/350 μ s current waveform), II (8/20 μ s current waveform) or III (combined 8/20 μ s current and 1.2/50 μ s voltage waveform) from the BS EN/IEC 61643 series.

Where more than one Type is stated (for combined, enhanced Type SPDs), the SPD has been tested to each respective test Class, with the results detailed on its transient performance specification.



Signal/Telecom Test Category indicates the Test Categories (as defined in BS EN/IEC 61643 series) that SPDs for signal and telecom systems have been subject to, with the results detailed on the transient performance specification.

Test Category D is a high-energy test typically using the 10/350 μ s current waveform. Test Category C is a fast rate of rise test using the 1.2/50 μ s voltage waveform combined with 8/20 μ s current waveform. Test Category B is a slow rate of rise test using the 10/700 μ s waveform, also used within ITU standards. Enhanced SPDs tested with categories D, C and B can offer up to LPZ $O_A \rightarrow 3$ protection.



Common Mode signifies that the SPD specifically offers protection on conductors with respect to earth. For a mains system, this would be between phases and earth or neutral and earth. For a data/telecom line this would be between signal line(s) to earth.

Common mode surges can result in flashover if the insulation withstand voltage of connected wiring or equipment is exceeded. Flashover could lead to dangerous sparking potentially causing fire or electric shock risks. Equipotentially bonding Type 1 mains SPDs or Test Cat D tested signal/telecom SPDs reduce the risk of flashover by limiting common mode surges.



Full Mode means that the SPD protects in all possible modes; common mode (live conductors with respect to earth) and differential mode (between live conductors). For example, full mode mains SPDs offer protection between phase(s) to earth, phase(s) to neutral and neutral to earth. Whilst common mode protection ensures flashover is prevented, differential mode protection is critical to ensure sensitive electronics are protected as well as operational during surge activity.



Enhanced SPDs (SPD* within BS EN 62305 series) have lower (better) let-through voltage or protection levels (U_p) and therefore further reduce the risk of injury to living beings, physical damage and failure of internal electronic systems.

Enhanced Type 1 mains SPDs (for a 230/400 V system) should have a protection level U_p of no more than 1600 V whilst Type 2 and Type 3 mains SPDs should have a protection level U_p of no more than 600 V in all modes when tested in accordance with BS EN 61643 series. Enhanced signal/telecom SPDs should typically have a protection level U_p no more than twice the peak operating voltage of the protected system.



Status Indication for mains wire-in power distribution SPDs is essential as they are installed in parallel or shunt with the supply and as such could potentially leave the system unprotected should the SPD fail. 3-way status indication of the SPD's condition provides simple and clear visual inspection and further provides advanced pre-failure warning such that the system is never unprotected. Furthermore warning of potentially fatal neutral to earth faults due to incorrect earthing and wiring faults for example is provided with additional flashing indication.



Remote Indication is an innovative feature that further optimizes mains wire-in SPD protection. A parallel or shunt installed SPD has additive let-through voltage because of its connecting leads that need to be kept as short as possible - ideally no more than 25 cm. Often an SPD cannot be mounted in its optimum position without compromising the visibility of its status indication.

Innovative remote status indication displays overcome this by allowing the SPD to be mounted with short connecting leads with the separate status display being conveniently mounted in a visible position such as the front of a power distribution cabinet providing convenient and effective equipment protection.

ACTIVE
VOLT-FREE
CONTACT

Active Volt-free Contact is an essential addition to the visual 3-way status indication.

The changeover volt-free contact is simply connected or linked to an existing building management system, buzzer or light and should the SPD have a pre-failure condition, this would be remotely indicated - particularly important for remote installations where the building management system would be connected to a telecom modem.

Active contacts further enable the SPD to also conveniently warn of phase loss from a power failure or blown fuse.



Intelligent Display iD is an innovation from Furse that encompasses existing features of 3-way SPD status indication with Neutral to Earth voltage warning but through clear easy to read text on an illuminated LCD display.

Often SPDs should be mounted on their side in order to facilitate short connecting leads for better protection levels but as this compromises the position and appearance of the status indication, it is not widely practiced.

Also available in a remote display option, the iD feature enhances mains wire-in SPD installation as the status indication text can easily be rotated (in 90° steps, clockwise) at the push of a button to aid good installation practice.

CURRENT
RATING
4 A

Current Rating indicates the maximum continuous current rating of in-line SPDs for data communication, signal and telephone lines.

The SPD's quoted maximum continuous current rating should always exceed the peak running current of the protected system to ensure normal system operation is not impaired.

Damage, through overheating, would result if its quoted current rating were exceeded.

LOW IN-LINE
RESISTANCE
1 Ω

Low In-line Resistance states the resistance value in Ohms (Ω) per line of SPDs for data communication, signal and telephone lines.

A low in-line resistance is desirable; particularly for systems with high running currents in order to reduce any voltage drops across the SPD and ensure normal system operation is not impaired.

Consideration should be made for additional SPDs installed on the same line to protect connected equipment at each end of the line (e.g. CCTV camera and connected monitoring equipment) as the in-line resistance of each SPD is introduced into the system.

REPLACEABLE
PROTECTION
MODULE

Replaceable Protection Module indicates that the SPD component providing protection can be easily removed and replaced following end-of-life with an appropriate replacement module, saving on reinstallation time and protector cost.

The replaceable module includes a quick release mechanism allowing partial removal, which facilitates line commissioning and maintenance.

LED
OPTIONAL
INDICATION

LED Optional Indication is an additional feature where an SPD can be supplied with an integral LED which indicates performance or fault when installed in low current DC power applications.

This enables rapid assessment and replacement of SPDs in situations where a considerable number of SPDs are installed.

HIGH
BANDWIDTH

High Bandwidth SPDs ensure the full system frequency range of transmission signals, for protected data communication, signal and telephone lines, is not impaired.

Signal frequencies outside the stated SPD bandwidth may potentially be distorted causing information loss or corruption.

As the SPD should accommodate the characteristics of the protected system, the stated SPD bandwidth (typically quoted for a 50 Ω system) should always exceed the protected system's bandwidth.

BX
IP66

BX IP is an International Protection (IP) rating (to BS EN/IEC 60529) for ready-boxed (BX) SPDs typically used in dusty and damp environments.

The IP rating system (also interpreted as "Ingress Protection") classifies the degrees of protection provided against the intrusion of solid objects (including body parts like hands and fingers), dust, accidental contact and water in electrical enclosures. For example, an IP66 rated enclosure provides no ingress of dust and therefore complete protection against contact as well as against water projected in powerful jets against the enclosure from any direction with no harmful effects.

Unboxed SPDs should be installed within distribution panels/cabinets or within external enclosures to the required IP rating (such as the Furse weatherproof WBX enclosure range).

ULTRA SLIM
7 mm
WIDTH

Ultra Slim 7 mm Width highlights the Slim Line feature of our new ESP SL range which permits installation in tight spaces, or multiple installation where a high number of lines require protection.

ATEX/IEC
APPROVED

ATEX/IECex Approved indicates that this SPD has undergone the relevant testing and approval process defined by ATEX/IECex, and has proven suitable for use in the hazardous environment as defined on the SPD datasheet.

We've described in the ESP introduction how protection should be installed on all cables which enter or leave the building (except fibre optic), the power supply local to important equipment and electronic equipment outside the main building(s). With the aid of the illustration we can see how this might be applied in practice.

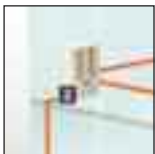
Protect incoming and outgoing electrical services

We'll start by considering the main (office) building in isolation.

Incoming mains power supplies



Install protection on the incoming mains power supply at the incoming distribution board(s).



If, as in this example, there are any other power supplies entering the building install protection on these near where they enter the building.

Outgoing mains power supplies



Outgoing supplies can provide transient overvoltages with a route back into the building's power distribution system.



Install protection on supplies to other buildings. (Note how, if correctly positioned, the protector at the incoming distribution board (1), also protects against transients from the outgoing supply to the UPS building).

Install protection on outgoing supplies to site services, such as CCTV systems and site lighting.

Protect all incoming/outgoing data communication, signal and telephone lines (unless fibre optic).

Telephone lines



Incoming telephone lines and extensions that leave the building have protectors installed on them at the PBX's distribution frame.



In our example, there is a direct (i.e. not via the PBX) telephone line to an alarm panel, which also needs protecting.

Data & signal lines



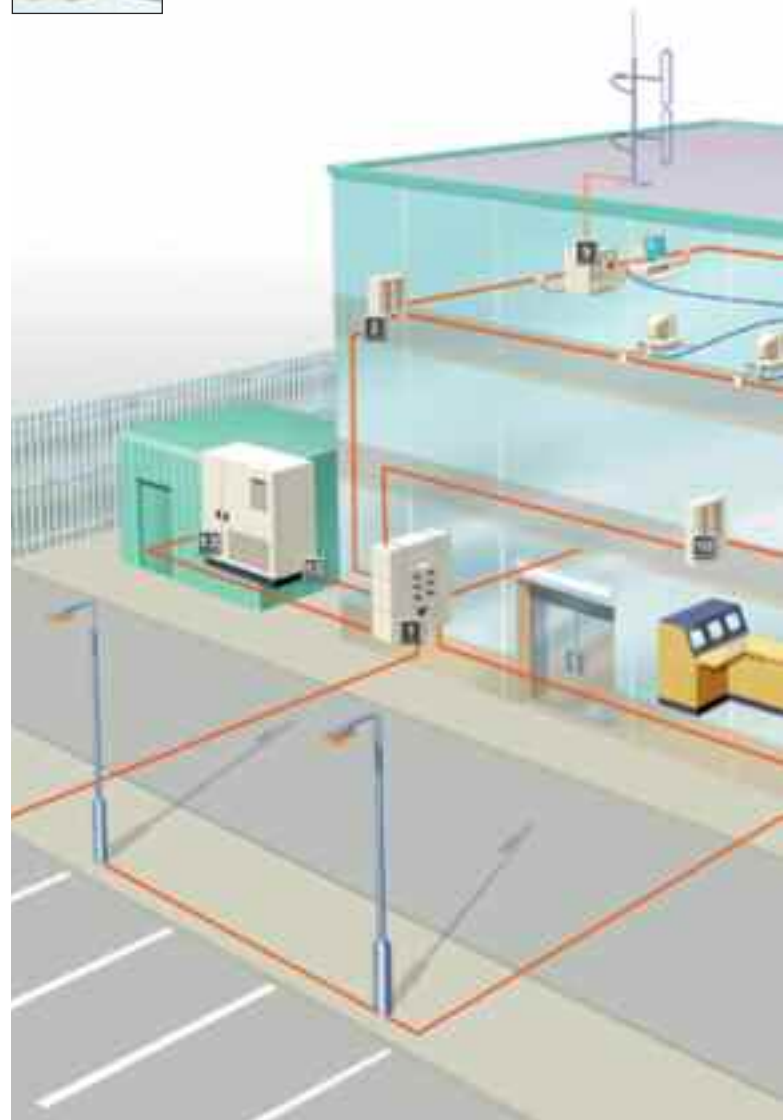
Protectors are installed on CCTV video cables from outdoor cameras to prevent damage to the control desk.



A protector is installed at the network hub to protect it from transients on the between building data link.



Equipment such as our RF receiver, with antenna (or satellite) links will also need protecting.



Protect the power supply locally to important equipment

Within the building transient overvoltages can be injected on to the mains power supply (downstream of the protector at the incomer). Consequently, protectors should be installed close to important pieces of equipment.



Protection is installed on the local distribution board feeding the servers and network hub. (Note how the top floor PC network and RF receiver is protected by the protector on the distribution board (2)).



The telephone PBX is protected locally by a plug-in protector.

Protect electronic equipment outside the building

Electronic equipment outside the main building in ancillary buildings, on site or in the field should also be protected.



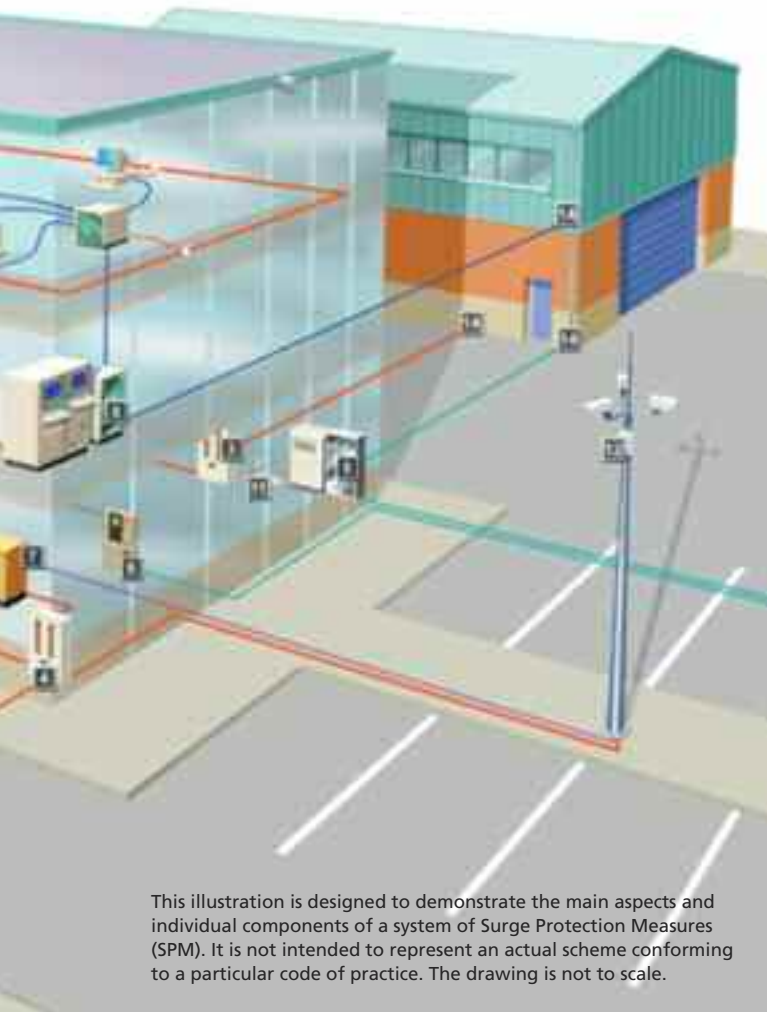
Protect outdoor CCTV cameras with protectors on the power supply, and video cable (and, if relevant, telemetry control line).



If the UPS is housed in a separate building with a separate earth, incoming and outgoing supplies will need to be protected. This is because most modern UPS systems contain electronics that make them vulnerable to being disabled by transient overvoltages. To prevent transient overvoltage damage to the UPS it must have a protector installed on both its input and output (outgoing the building). A protector will also need to be installed on the power supply into the main building (2).



Protection is also installed on mains power, data communication and telephone lines entering the neighbouring building. Additional protection (not shown) may be required within this building (whether it's a computer-controlled warehouse or automated manufacturing operation with PLCs, drives and computer controls).



This illustration is designed to demonstrate the main aspects and individual components of a system of Surge Protection Measures (SPM). It is not intended to represent an actual scheme conforming to a particular code of practice. The drawing is not to scale.

Product selector

- (1) Mains wire-in protectors
- (2) Mains wire-in protectors
- (3) Mains wire-in protectors
- (4) Mains wire-in protectors
- (5) PBX telephone/ISDN line protection
- (6) Plug-in telephone line protection, or Wire-in telephone line protection
- (7) CCTV video protectors
- (8) Computer network protector
- (9) RF signal protector
- (10) Mains wire-in protector
- (11) Plug-in mains protector
- (12) Protectors for low current mains power supplies, CCTV video and telemetry lines
- (13) Mains wire-in protectors
- (14) Mains wire-in protectors
Computer network protector
PBX telephone/ISDN line protection