furse

ABB

BS 7671 18th Edition wiring regulations

Furse overview

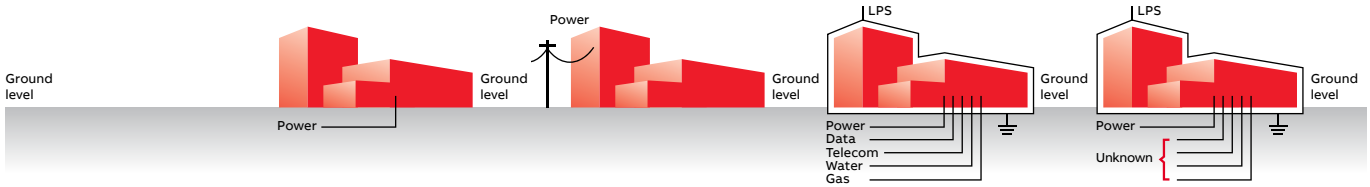
Transient overvoltage protection

Furse electronic systems protection

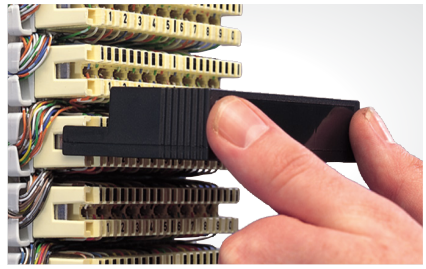
Enhanced solutions to BS EN 62305 / BS 7671

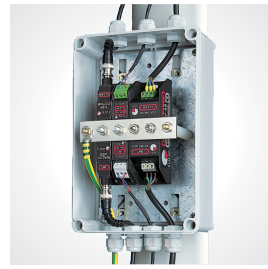
Furse Surge Protection devices are widely specified and offer industry-leading voltage protection levels to ensure the continuous operation of critical electronic systems, such as those found in data centres, hospitals and automated process control. Used with Furse data / telecom SPDs, they form part of a complete lightning protection solution.

Protection for 230/400 V TN-S or TN-C-S supplies

Supply type	Example 1	Example 2	Example 3	Example 4
	No external lighting protection sytem fitted	No external lighting protection sytem fitted	No external lighting protection sytem fitted	No external lighting protection sytem fitted
	Underground mains supply feed	Exposed overhead mains supply feed	Multiple connected metallic services	No. of services unknown
				
3 Phase 400 V Service entrance, after electricity meter (Main distribution board (MDB))	 ESP 415 D1 Series **OR**  ESP 415 M1 Series	 ESP415/II/TNS **OR**  ESP 415 M2 Series (for electronics located near MDB before SDB)	 ESP 415 D1 Series **OR**  ESP 415 M1 Series	 For LPL I & II ESP 415/I/TNS or ESP 415 M4 (for electronics located near MDB before SDB) **OR**  For LPL III & IV ESP 415/III/TNS or ESP 415 M2 (for electronics located near MDB before SDB)
3 Phase 400 V **1 Phase 230 V** Sub-distribution board (SDB) located >10 m from MDB feeding electronic equipment	 **OR**  For 3 Phase 400 V ESP 415 D1 Series, or ESP 414 M1 Series		 **OR**  For 1 Phase 230 V ESP 240 D1 Series, or ESP 240 M1 Series	
Critical terminal equipment located >10 m from SDB	 ESP MC ESP MC/TN/RJ11 ESP MC/Cat-5e (e.g. for servers)			

Protection for data signal and telecoms applications





Transient overvoltage protection
Introduction

Based on the IEC 60364 series, the 18th Edition of BS 7671 Wiring regulations covers the electrical installation of buildings including the use of surge protection.

The 18th Edition of BS 7671 applies to the design, erection and verification of electrical installations, and also to additions and alterations to existing installations. Existing installations that have been installed in accordance with earlier editions of BS 7671 may not comply with the 18th edition in every respect. This does not necessarily mean that they are unsafe for continued use or require upgrading.

A key update in the 18th Edition relates to Sections 443 and 534, which concern protection of electrical and electronic systems against transient overvoltages, either as a result of atmospheric origin (lightning) or electrical switching events.

Essentially, the 18th Edition requires all new electrical system designs and installations, as well as alterations and additions to existing installations, to be assessed against transient overvoltage risk and, where necessary, protected using appropriate protection measures (in the form of SPDs).

Within BS 7671:

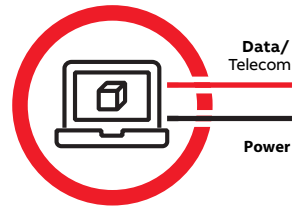
- **Section 443** defines the criteria for risk assessment against transient overvoltages, considering the supply to the structure, risk factors and rated impulse voltages of equipment
- **Section 534** details the selection and installation of SPDs for effective transient overvoltage protection, including SPD Type, performance and coordination

Readers of this guide should be mindful of the need to protect all incoming metallic service lines against the risk of transient overvoltages.

BS 7671 provides focussed guidance for the assessment and protection of electrical and electronic equipment intended to be installed on AC mains power supplies.

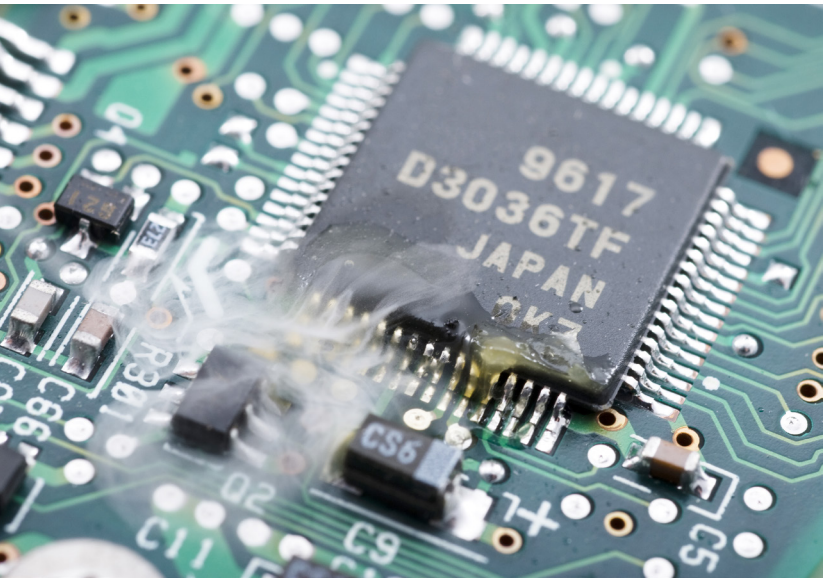
In order to observe the Lightning Protection Zone LPZ concept within BS 7671 and BS EN 62305, all other incoming metallic service lines, such as data, signal and telecommunications lines, are also a potential route through which transient overvoltages to damage equipment. As such all such lines will require appropriate SPDs.

BS 7671 clearly points the reader back to BS EN 62305 and BS EN 61643 for specific guidance. This is covered extensively in the Furse guide to BS EN 62305 Protection Against Lightning.



IMPORTANT:
Equipment is ONLY protected against transient overvoltages if all incoming / outgoing mains and data lines have protection fitted.

The need for transient overvoltage protection



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Why is transient overvoltage protection so important?
Transient overvoltages are short duration surges in voltage between two or more conductors (L-PE, L-N or N-PE), which can reach up to 6 kV on 230 Vac power lines, and generally result from:

- Atmospheric origin (lightning activity through resistive or inductive coupling (see Figures 02 & 03), and/or
- Electrical switching of inductive loads

Transient overvoltages significantly damage and degrade electronic systems. Outright damage to sensitive electronic systems, such as computers etc, occurs when transient overvoltages between L-PE or N-PE exceed the withstand voltage of the electrical equipment (i.e. above 1.5 kV for Category I equipment to BS 7671 Table 443.2).

Equipment damage leads to unexpected failures and expensive downtime, or risk of fire/electric shock due to flashover, if insulation breaks down.

Degradation of electronic systems, however, begins at much lower overvoltage levels and can cause data losses, intermittent outages and shorter equipment lifetimes (see Figure 04).

Where continuous operation of electronic systems is critical, for example in hospitals, banking and most public services, degradation must be avoidedby ensuring these transient overvoltages, which occur between L-N, are limited below the impulse immunity of equipment. This can be calculated as twice the peak operating voltage of the electrical system, if unknown (i.e. approximately 715 V for 230 V systems).

Protection against transient overvoltages can be achieved through installation of a coordinated set of SPDs at appropriate points in the electrical system, in line with BS 7671 Section 534 and the guidance provided in this publication.

Selecting SPDs with lower (i.e. better) voltage protection levels (U_p) is a critical factor, especially where continuous usage of electronic equipment is essential.

Resistive coupling (see Figure 02)
Resistively coupled transients are caused by differences in potential between two connected earths. Energy from ground strikes flows away through the path of least resistance, and increases the potential in local earths, cabling and electronic circuitry. Where these are linked to separate earths by a metallic service line, the potential is shared, creating transient overvoltages as the current attempts to flow.

Inductive coupling (see Figure 03)
Inductively coupled transients are caused by electromagnetic pick-up.

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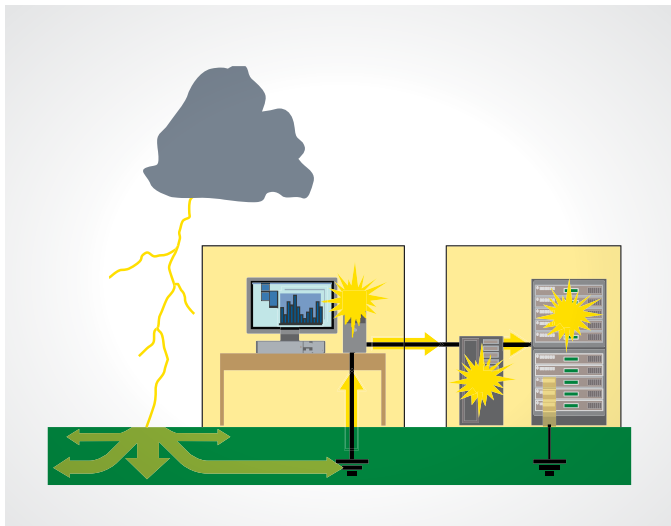

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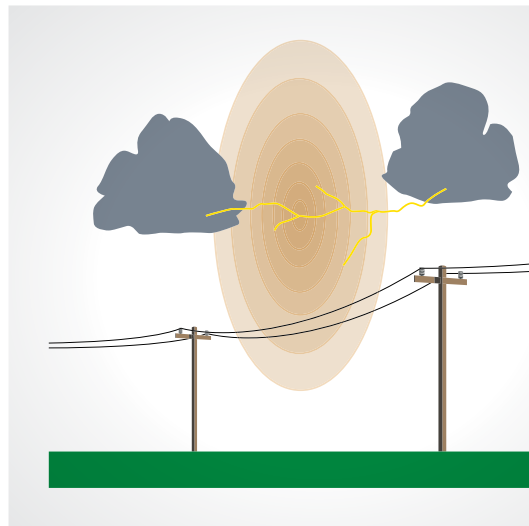

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01 Transient overvoltages significantly damage and degrade electronic systems.
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02 Resistive coupling – Resistively coupled transients are caused by differences in potential between two connected earths.
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03 Inductive coupling – Inductively coupled transients are caused by electromagnetic pick-up.

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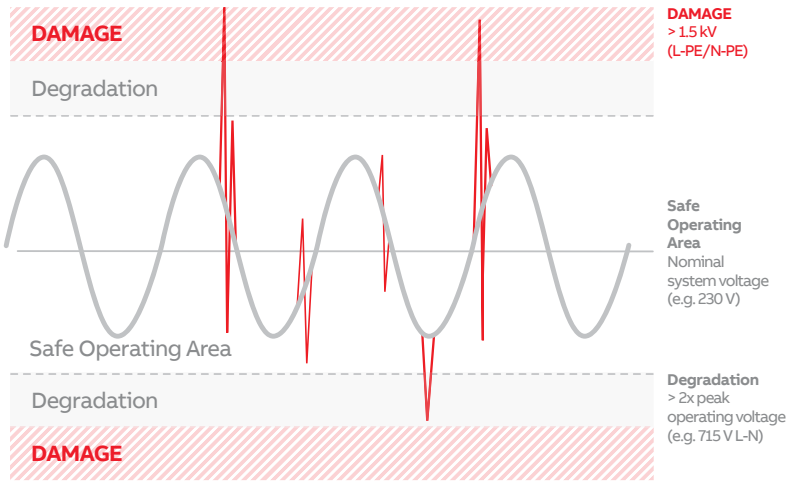

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04 Equipment risk – Degradation of electronic systems begins at lower transient overvoltage levels and affects critical electronic systems whenever the impulse immunity of the equipment is compromised.

A lightning discharge gives rise to an electromagnetic field. If metallic services, such as overhead power lines, pass through this field a voltage will be picked up by, or induced on to, the line.

Equipment risk (see Figure 04)
Degradation of electronic systems begins at lower transient overvoltage levels and affects critical electronic systems whenever the impulse immunity of the equipment is compromised.

Damage occurs when a transient overvoltage exceeds the withstand voltage of electrical and electronic equipment.

Selection of SPDs to BS 7671

The scope of Section 534 of BS 7671 is to achieve overvoltage limitation within AC power systems to obtain insulation coordination, in line with Section 443, and other standards, including BS EN 62305-4.

Overvoltage limitiation is achieved through installation of SPDs as per the recommendations in Section 534 (for AC power systems), and BS EN 62305-4 (for other power and data, signal or telecommunications lines).

Selection of SPDs should achieve the limitation of transient overvoltages of atmospheric origin, and protection against transient overvoltages caused by direct lightning strikes or lightning strikes in the vicinity of a building protected by a structural Lightning Protection System LPS.

SPD selection
SPDs should be selected according to the following requirements:
- Voltage protection level (U_p)
- Continuous operating voltage (U_c)
- Temporary overvoltages (U_{TOV})
- Nominal discharge current (I_{inspd}) and impulse current (I_{imp})
- Prospective fault current and the follow current interrupt rating

The most important aspect in SPD selection is its voltage protection level (U_p). The SPD's voltage protection level (U_p) must be lower than the rated impulse voltage (U_w) of protected electrical equipment (defined within Table 443.2), or for continuous operation of critical equipment, its impulse immunity.

Where unknown, impulse immunity can be calculated as twice the peak operating voltage of the electrical system (i.e. approximately 715 V for 230 V systems).

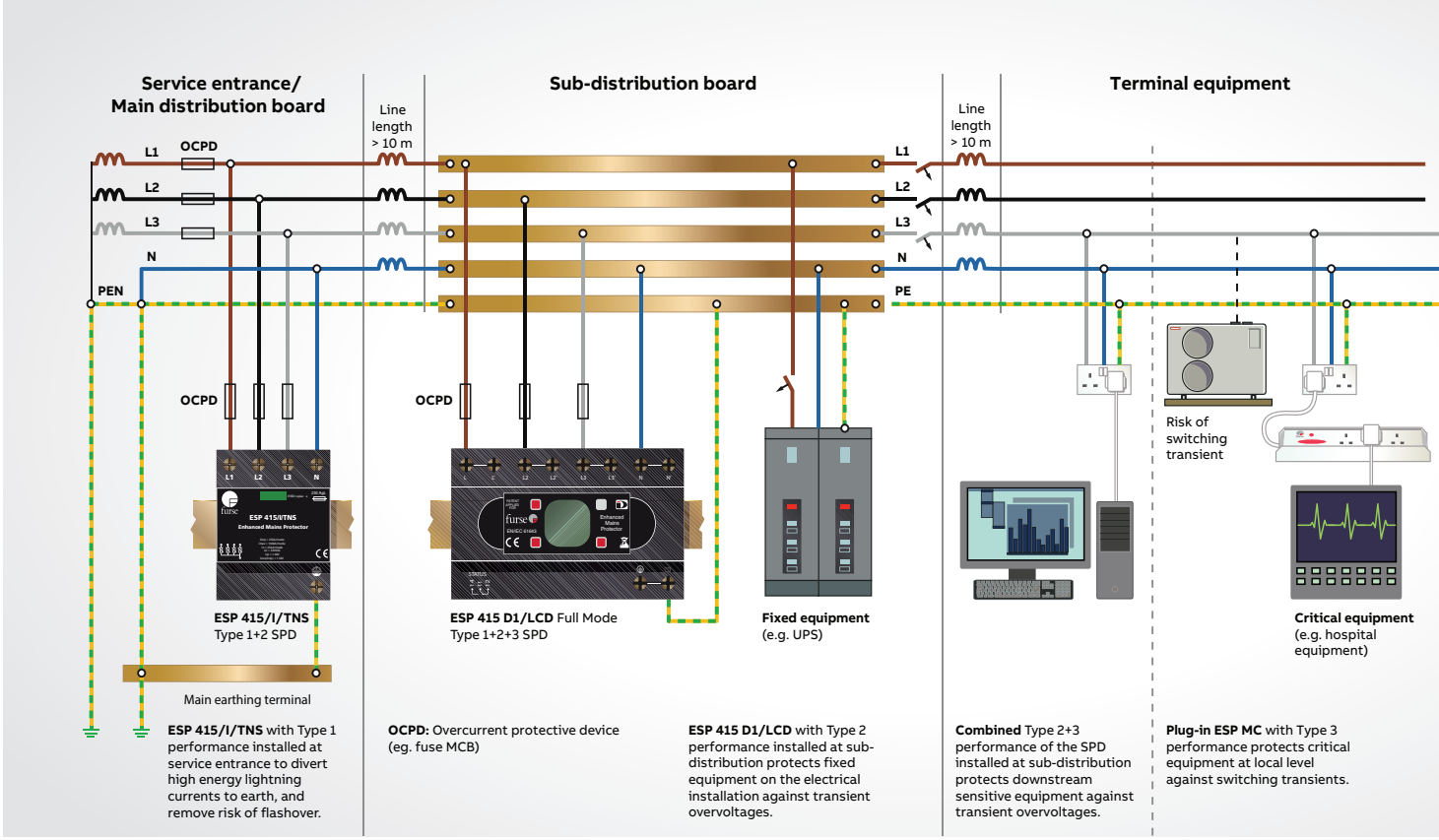
Non-critical equipment connected to a 230/400 V fixed electrical installation (e.g. a UPS system) would require protection by an SPD with a U_p lower than Category II rated impulse voltage (2.5 kV). Sensitive equipment, such as laptops and PCs, would require additional SPD protection to Category I rated impulse voltage (1.5 kV).

These figures should be considered as achieving a minimal level of protection. SPDs with lower voltage protection levels (U_p) offer much better protection, by:
- Reducing risk from additive inductive voltages on the SPD's connecting leads
- Reducing risk from voltage oscillations downstream which could reach up to twice the SPD's UP at the equipment terminals
- Keeping equipment stress to a minimum, as well as improving operating lifetime

In essence, an enhanced SPD (SPD* to BS EN 62305) would best meet the selection criteria, as such SPDs offer voltage protection levels (U_p) considerably lower than equipment's damage thresholds and thereby are more effective in achieving a protective state.

Compared to standard SPDs, enhanced SPDs offer both technical and economic advantages:
- Combined equipotential bonding and transient overvoltage protection (Type 1+2 & Type 1+2+3)
- Full mode (common and differential mode) protection, essential to safeguard sensitive electronic equipment from all types of transient overvoltage - lightning & switching and
- Effective SPD coordination within a single unit versus installation of multiple standard Type SPDs to protect terminal equipment

***As per BS EN 62305, all SPDs installed to meet the requirements of BS 7671 shall conform to the product and testing standards (BS EN 61643 series).**



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Enhanced total solution

Compliance to BS EN 62305/BS 7671

05 Typical installation on a 230/400 V TN-C-S/TN-S system, using Furse SPDs, to meet the requirements of BS 7671.

BS 7671 Section 534 focuses guidance on selection and installation of SPDs to limit transient overvoltages on the AC power supply.

Enhanced Total Solution
Compliance to BS EN 62305 / BS 7671
BS 7671 Section 443 states that, transient overvoltages transmitted by the supply distribution system are not significantly attenuated downstream in most installations BS 7671 Section 534 therefore recommends that SPDs are installed at key locations in the electrical system:

- As close as practicable to the origin of the installation (usually in the main distribution board after the meter)
- As close as practicable to sensitive equipment (sub-distribution level), and local to critical equipment

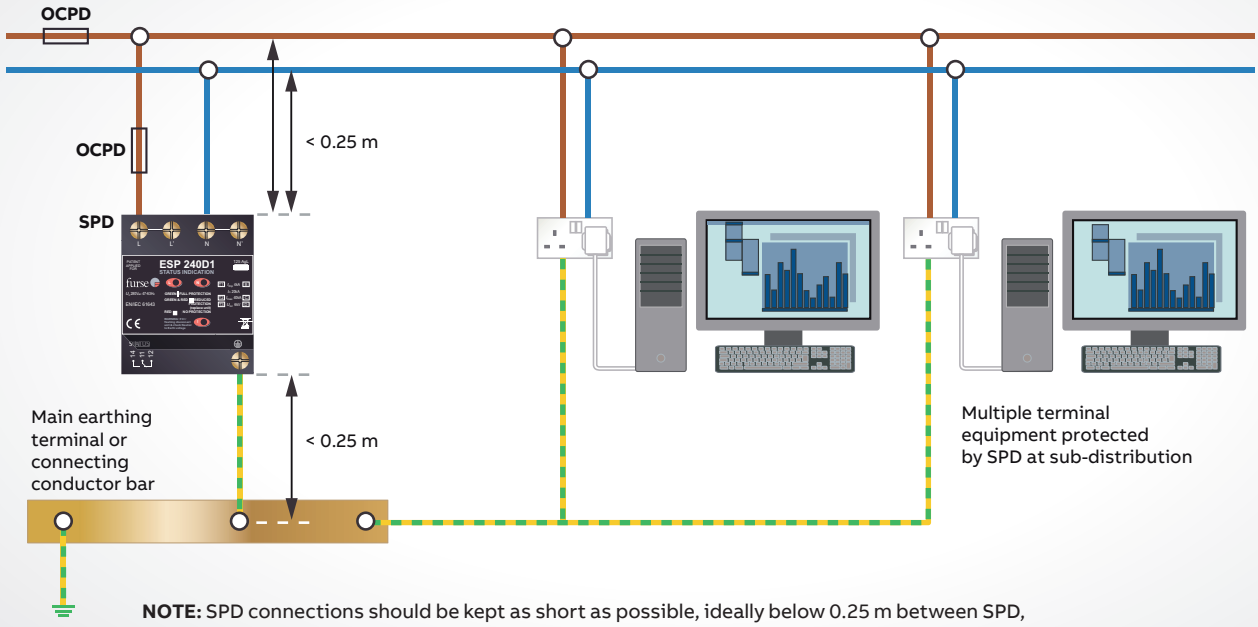
Figure 05 shows a typical installation on a 230/400 V TN-CS/TN-S system using Furse SPDs, to meet the requirements of BS 7671. The illustration demonstrates how effective protection comprises a service entrance SPD to divert high energy lightning currents to earth, followed by coordinated downstream SPDs at appropriate points to protect sensitive and critical equipment.

Selecting appropriate SPDs
SPDs are classified by Type within BS 7671 following the criteria established in BS EN 62305.

Where a building includes a structural LPS, or connected overhead metallic services at risk from a direct lightning strike, equipotential bonding SPDs (Type 1 or Combined Type 1+2) must be installed at the service entrance, to remove risk of flashover.

Installation of Type 1 SPDs alone however does not provide protection to electronic systems. Transient overvoltage SPDs (Type 2 and Type 3, or Combined Type 1+2+3 and Type 2+3) should therefore be installed downstream of the service entrance.These SPDs further protect against those transient overvoltages caused by indirect lightning (via resistive or inductive coupling) and electrical switching of inductive loads.

Combined Type SPDs (such as the Furse ESP D1 Series and ESP M1/M2/M4 Series) significantly simplify the SPD selection process, whether installing at the service entrance or downstream in the electrical system.



NOTE: SPD connections should be kept as short as possible, ideally below 0.25 m between SPD, live conductors & earth, but in any case not more than 0.5 m, to reduce risk of additive inductive voltage drops across the conductors.

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06 Total lead length for SPDs installed in parallel.

Installation of SPDs to BS 7671

Critical length of connecting conductors
An installed SPD will always present a higher let through voltage to equipment compared with the voltage protection level (U_p) stated on a manufacturer's data sheet, due to additive inductive voltage drops across the conductors on the SPD's connecting leads.

Therefore, for maximum transient overvoltage protection the SPDs connecting conductors must be kept as short as possible.

BS 7671 defines that for SPDs installed in parallel (shunt), the total lead length between line conductors, protective conductor and SPD preferably should not exceed 0.5 m and never exceed 1 m. See Figure 06 for example.

For SPDs installed in-line (series), the lead length between the protective conductor and SPD preferably should not exceed 0.5 m and never exceed 1 m.

Best practice
Poor installation can significantly reduce effectiveness of SPDs. Therefore, keeping connecting leads as short as possible is vital to maximise performance, and minimise additive inductive voltages.

Best practice cabling techniques, such as binding together connecting leads over as much of their length as possible, using cable ties or spiral wrap, is highly effective in cancelling inductance.

The combination of an SPD with low voltage protection level (U_p), and short, tightly bound connecting leads ensure optimised installation to the requirements of BS 7671.

Cross-sectional area of connecting conductors
For SPDs connecting at the origin of the installation (service entrance) BS 7671 requires the minimum cross-sectional area size of SPDs connecting leads (copper or equivalent) to PE/live conductors respectively to be:
- 16 mm²/6 mm² for Type 1 SPDs
- 6 mm²/2.5 mm² for Type 2 SPDs

These cross-sectional area values are based on the surge current that these SPD connecting leads need to handle, not the supply current.

However, in the event of a short circuit, for example due to the end of life condition of the SPD, the connecting leads to the SPD would need to be protected by a suitable Overcurrent Protective Device (OCPD).

Fault protection
BS 7671 defines requirements to ensure that fault protection shall remain effective in the protected installation even in the case of failure of SPDs.

Therefore an SPD needs to be protected against short circuits through the use of an appropriate OCPD capable of eliminating the short-circuit. In effect, the SPD should have a dedicated OCPD installed in-line on its connecting leads, ensuring that this OCPD to the SPD discriminates with the upstream OCPD of the main supply.

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