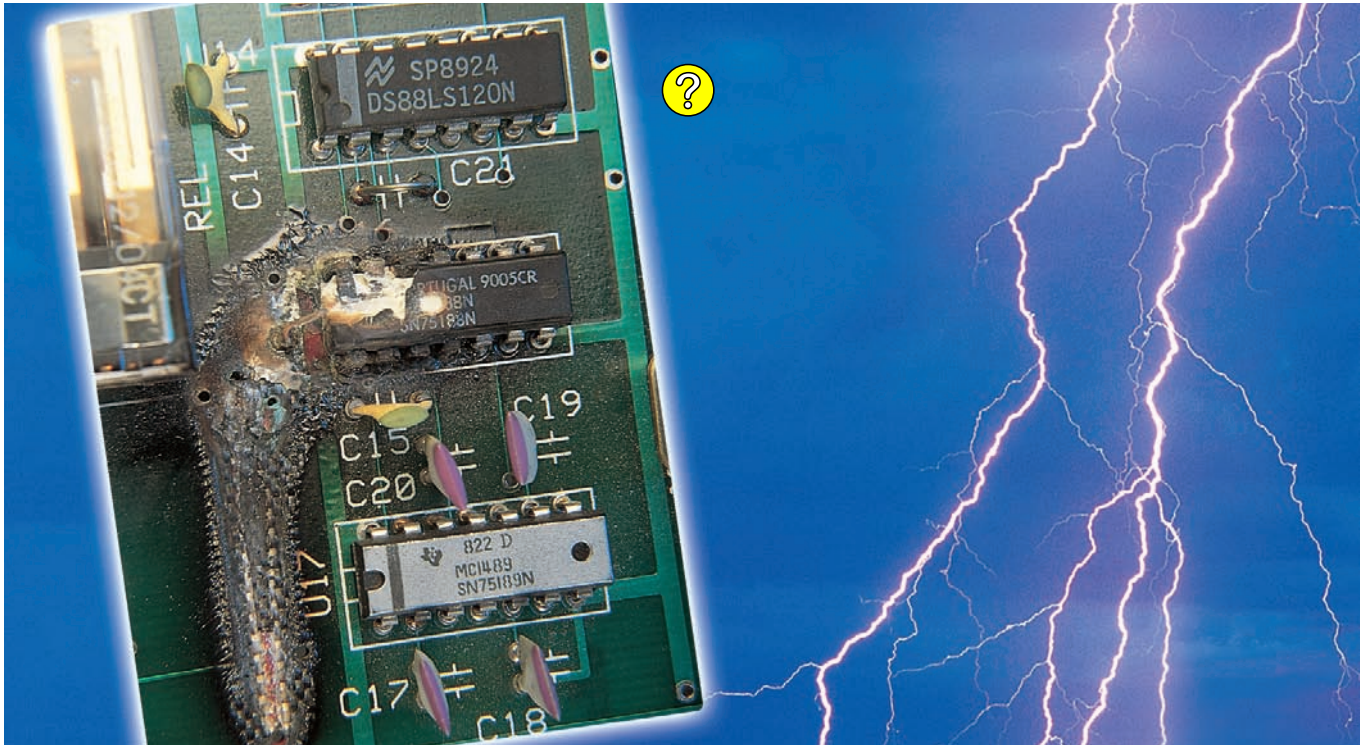




Future developments in the IEE Wiring Regulations (BS 7671:2008)

by Geoff Cronshaw

This article takes a closer look at the proposed new Section 534 (Surge Protection Devices) which it is expected may be included within a future amendment to BS 7671:2008. Section 534 contains requirements for the installation of surge protective devices (SPDs) to limit transient overvoltages where required by Section 443 of BS 7671:2008 or where otherwise specified by the designer. A risk assessment to BS EN 62305, Protection against Lightning also determines the need for SPDs. Surge protective components incorporated into appliances are not taken into account in 534.

Both lightning strikes and electrical switching can inject

what are called transient overvoltages into installations. Transient voltages are usually only a few micro seconds in duration. However their peak value can reach 6 kV. Normal electronic equipment cannot withstand this level of voltage.

Atmospheric events

Lightning is the visible discharge of static electricity. The current contained within a lightning strike varies considerably with the atmospheric conditions. Associated with this sudden discharge of current is a magnetic field that surrounds the lightning perpendicular to the direction of travel. Lightning can impress a voltage onto a low voltage power network (or any metallic

service) in a number of different ways: resistively, inductively or capacitively

Switching events

Generally, any switching operation, fault initiation, interruption, etc., in an electrical installation is followed by a transient phenomenon in which overvoltages can occur. The sudden change in the system can initiate damped oscillations with high frequencies (determined by the resonant frequencies of the network), until the system is stabilised to its new steady state. The magnitude of the switching overvoltages depends on several parameters, such as the type of circuit, the kind of switching

operation (closing, opening, restriking), the loads and the protection device. In most cases, the maximum overvoltage is up to twice the amplitude of the system voltage but higher values can occur, especially when switching inductive loads (motors, transformers) or capacitive loads or even resistive loads connected very near to the terminals of a supply transformer. Also, interruption of short-circuit currents can cause high overvoltages. If current chopping occurs, relatively high energy can be stored in inductive loads and oscillations can occur on the load side of the opening switch or protective device. As detailed within BS EN 62305

“Protection against lightning”, surges present a risk of dangerous sparking or flashover leading to possible fire and electric shock hazards. Surges also present risk of disruption, degradation and damage to electrical and electronic equipment leading to costly system downtime.

Surge Protection Devices

A surge protective device (SPD) is a device that is intended to limit transient over voltages and divert damaging surge current away from sensitive equipment. SPDs must have the necessary capability to deal with the current levels and durations involved in the surges to be expected at their point of installation.



Installation of a surge protective device

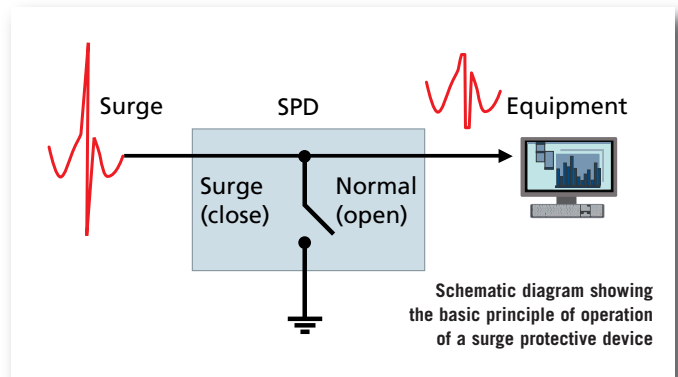
SPDs can operate in one of two ways, based on the component technologies within them. One way is as a voltage switching device where under normal conditions, the

device is an open circuit. However at a certain threshold voltage the SPD conducts and diverts the current through it. It has two states ON and OFF, hence the name of voltage switching. Air gap technology is an example of a voltage switching device.

Another way is as a voltage limiting device. Voltage limiting type SPDs again present an open circuit under normal circuit conditions. When an over voltage is detected the device begins to conduct, dropping its resistance dramatically such that the overvoltage is limited and the surge current is diverted away from the protected equipment. Metal Oxide Varistors (MOVs) are a common example of voltage limiting devices. Advanced SPDs often utilise hybrid technologies combining voltage switching with voltage limiting components.

Selection of SPDs

Section 534 contains requirements for the selection of SPDs in order to ensure that the correct type of SPD is installed at the correct position within an installation. Typically, Type 1 SPDs are used at the origin of the installation, Type 2 SPDs are used at distribution boards and Type 3 SPDs are used near terminal equipment. Combined Type SPDs are classified with more than one



Type, e.g. Type 1+2, Type 2+3. Type 1 SPDs are only used where there is a risk of direct lightning current.

Section 534 advises that in selecting an SPD, the key parameter is its limiting voltage performance (protection level U_p) during the expected surge event. The SPD energy withstand (e.g. I_{imp}) also needs to be sufficient for its location within the installation. An SPD with a low protection level will ensure adequate protection of the equipment, while an SPD with a high energy withstand may only result in a longer operating life. All SPDs are to comply with BS EN 61643.

Connection of SPDs

Section 534 contains a number of requirements for the Connection of SPDs depending on the type of supply and system earthing.

BS 7671:2008 lists five types of earthing system:

TN-S, TN-C-S, TT, TN-C, and IT.

T = Earth (from the French word *Terre*)

N = Neutral

S = Separate

C = Combined

I = Isolated (The source of an IT system is either connected to earth through a deliberately introduced earthing impedance or is isolated from Earth. All exposed-conductive-parts of an installation are connected to an earth electrode.)

When designing an electrical installation, one of the first things to determine is the type of earthing system. The distributor will be able to provide this information.

The system will either be TN-S, TN-C-S (PME) or TT for a low voltage supply given in accordance with the Electricity Safety, Quality and Continuity Regulations 2002. This is because TN-C requires an exemption from the Electricity Safety, Quality and Continuity



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Regulations, and an IT system is not permitted for a low voltage public supply in the UK because the source is not directly earthed. Therefore TN-C and IT systems are both very uncommon in the UK.

Therefore, for example, Section 534 requires that SPDs at or near the origin of the installation (if there is a direct connection between the neutral conductor and the protective conductor at or near the origin) shall be connected between each line conductor and the protective conductor/main earthing terminal which ever is the shorter distance.

Clause 534.2.3 of the proposed Section 534 selection of Surge Protective Devices (SPDs)

Clause 534.2.3 requires that SPDs shall be selected in accordance with the following requirements:

- voltage protection level (Up)
- continuous operating voltage (Uc)
- temporary overvoltages (TOVs)
- nominal discharge current (Inspd) and impulse current (Iimp)
- prospective fault current and the follow current interrupt rating

Co-ordination of SPDs

Occasionally it may be required to limit the voltage to the protected equipment to an even lower value. In this case two SPDs are used in a co-ordinated approach to minimise the let-through voltage.

Protection against overcurrent and consequences of SPDs end of life

Clause 534.2.4 has requirements for the protection against SPD short-circuits by Overload Circuit Protective Devices.

Fault protection integrity

Clause 534.2.5 has

requirements to ensure that fault protection, shall remain effective in the protected installation even in case of failures of SPDs.

SPD installation in conjunction with RCDs

An RCD is a protective device used to automatically disconnect the electrical supply when an imbalance is detected between live conductors. In the case of a single-phase circuit, the device monitors the difference in currents between the line and neutral conductors. If a line to earth fault develops, a portion of the line conductor current will not return through the neutral conductor. The device monitors this difference, operates and disconnects the circuit when the residual current reaches a preset limit, the residual operating current ($I_{\Delta n}$). An RCD on its own does not provide protection against overcurrents. Overcurrent protection is provided by a fuse or a circuit-breaker. However, combined RCD and circuit-breakers are available and are designated RCBOs. Unwanted tripping of RCDs can occur when a protective conductor current or leakage current causes unnecessary operation of the RCD. An RCD must be so selected and the electrical circuits so subdivided that any protective conductor current that may be expected to occur during normal operation of the connected load(s) will be unlikely to cause unnecessary tripping of the device.

Discrimination: Where two, or more, RCDs are connected in series, discrimination must be provided, if necessary, to prevent danger. During a fault, discrimination will be achieved when the device electrically nearest to the fault operates and does not affect other upstream devices.

Discrimination will be achieved when 'S' (Selective) types are used in conjunction with downstream general type RCDs. The 'S' type has a built-in time delay and provides discrimination by simply ignoring the fault for a set period of time allowing more sensitive downstream devices to operate and remove the fault. For example, when two RCDs are connected in series, to provide discrimination, the first RCD should be an 'S' type. RCDs with built in time delays should not be used to provide personal protection.

Clause 534.2.6 of Section 534 is concerned with ensuring that the correct type of RCD is selected in conjunction with the correct type of SPD. Where SPDs are installed on the load side of an RCD, the operation of the SPD could potentially cause the RCD to operate unless it is of the S type. Where SPDs are installed on the supply side of an RCD the operation of the SPD will not affect the RCD.

Clause 534.2.6 states:

Where SPDs are installed in accordance with 534.2.1 and are on the load side of a residual current device, an RCD with or without time delay, but having an immunity to surge currents of at least 3kA 8/20, shall be used.

NOTE 1: *S-type RCDs satisfy this requirement.*

NOTE 2: *In the case of surge current higher than 3 kA 8/20, the RCD may trip causing interruption of the power supply.*

SPD status indication

Section 534 requires indication to be provided by a status indicator local to the SPD itself and/or remote, that the SPD no longer provides (or provides limited) overvoltage protection.

Critical length of connecting conductors

To gain maximum protection the supply conductors shall be

kept as short as possible, to minimise additive inductive voltage drops across the conductors. Current loops shall be avoided. Clause 534.2.9 has specific requirements on conductor lengths.

Cross-section of connecting conductors

Clause 534.2.10 states:

The connecting conductors of SPDs shall either:

- have a cross-sectional area of not less than 4 mm² copper (or equivalent) if the cross-sectional area of the line conductors is greater than or equal to 4 mm², or
- have a cross-sectional area not less than that of the line conductors, where the line conductors have a cross-sectional area less than 4 mm².

Where there is a structural lightning protection system, the minimum cross-sectional area for Type 1 SPDs shall be 16 mm² copper, or equivalent.

Further information

Important: this article is only intended as a brief summary of possible forthcoming requirements in BS 7671. Persons involved in this area should seek specialist advice. For further information on the installation of surge protective devices see HD 60364-5-534.

Conclusion

Section 534 may or may not be included in amendment number 1 of BS 7671:2008 depending on the decision of the National Wiring Regulations Committee (JPEL/64). A future amendment to the IEE Wiring Regulation (BS 7671:2008) is expected during 2011.

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