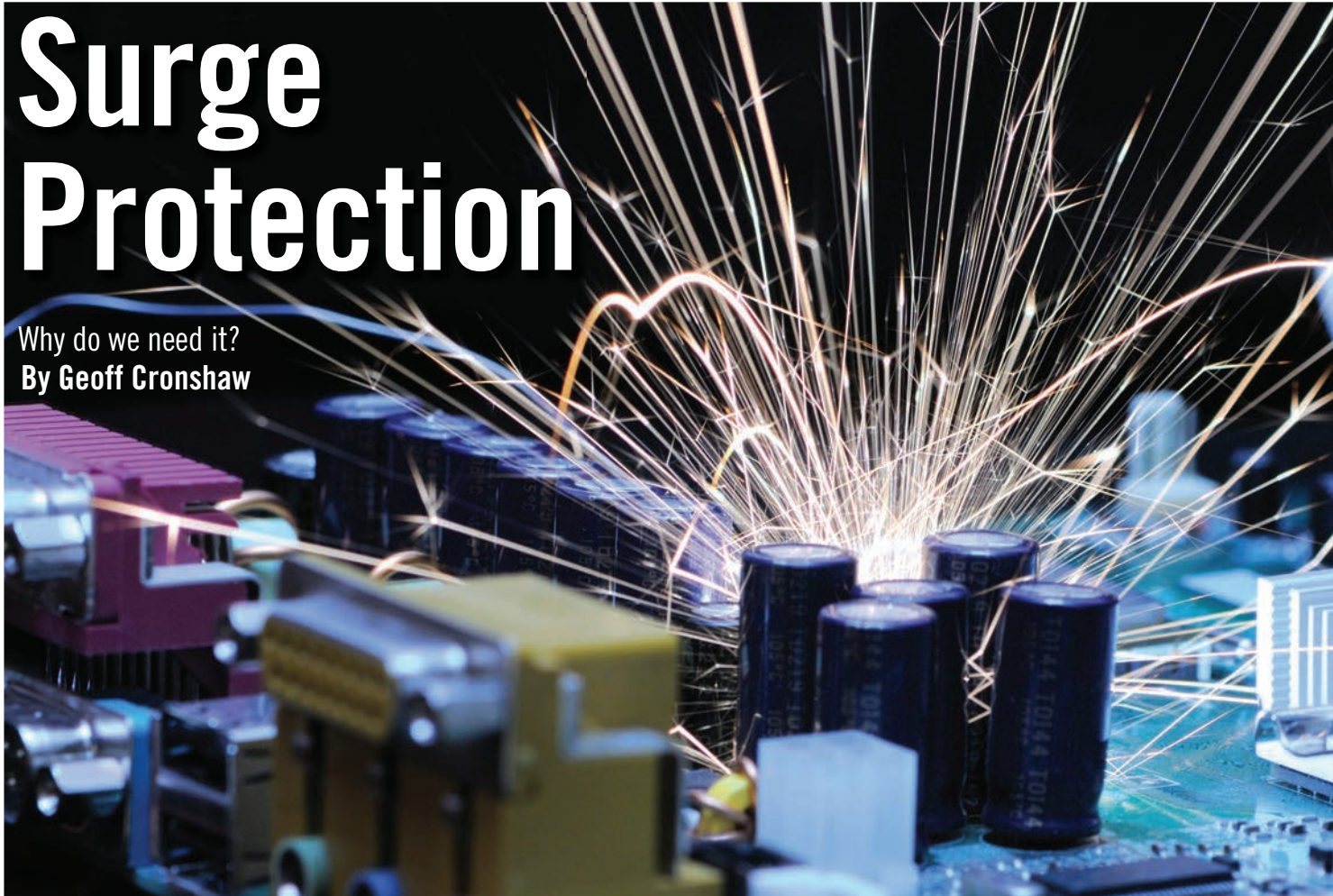


Surge Protection

Why do we need it?
By Geoff Cronshaw



MORE AND MORE sensitive electronic equipment such as computers, electronic process controls, telecommunications systems and point-of-sale terminal equipment is in use as time goes by. Society is now heavily reliant on the continuous and efficient running of such systems. Electronic equipment today is much smaller and less energy from transients is required to damage this equipment.

Proposed new section 534

This is the second of two articles specifically on the proposed new Section 534 – Selection and erection of surge protection devices (SPDs) which is planned for inclusion in Amendment number 1 of BS 7671:2008. Note: The article is based on the draft for public comment and therefore

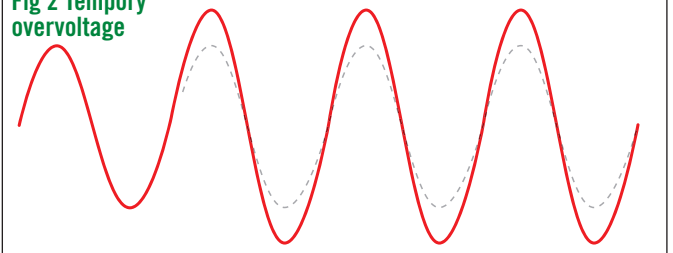
the actual requirements may change.

In this article we take a closer look at transients compared with other forms of electrical disturbance, the different types of surge protection devices, and the selection and installation of surge protection devices.

Transient overvoltages

Both lightning strikes and electrical switching can inject what are called transient

Fig 2 Temporary overvoltage

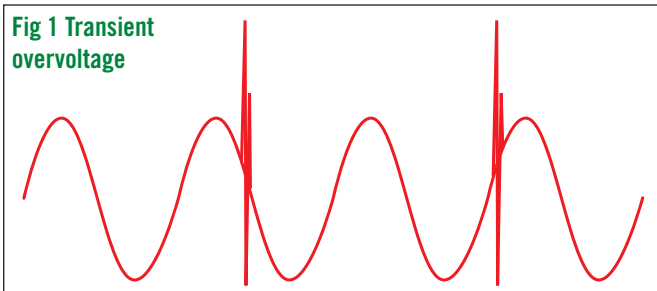


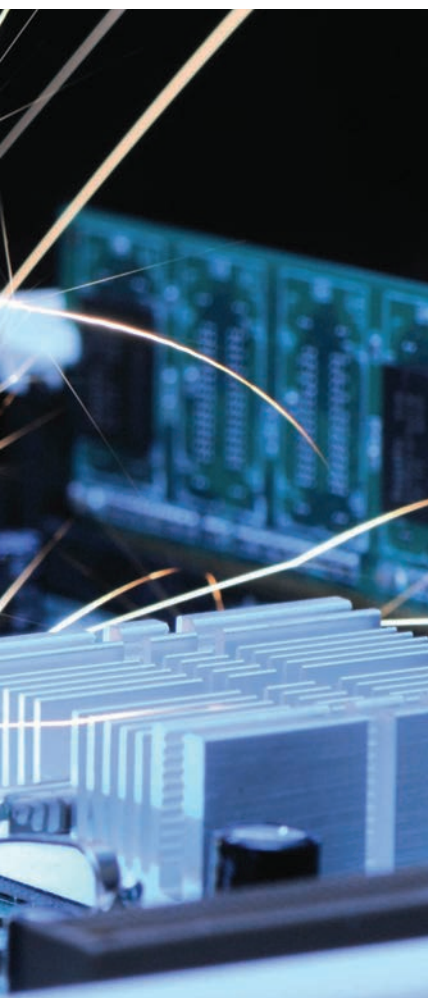
overvoltages into an installation. Transient voltages are usually only a few micro seconds in duration. However their peak value can reach 6kV. Normal electronic equipment cannot withstand

this level of voltage. An example of a transient overvoltage is shown below.

Other forms of electrical disturbance include temporary overvoltages, which are not transients and can last a few seconds but are usually at a much lower voltage. A temporary overvoltage is considered to be any voltage greater than the nominal voltage (U_0) plus 10%, see Fig 2. The permitted tolerance is +10%/-6% which gives a permitted voltage range of

Fig 1 Transient overvoltage





216.2-253V. Temporary overvoltages are often caused by HV switching and fault clearing operations on the HV network.

In comparison, harmonics are a steady-state disturbance compared with short-term transient overvoltages. Harmonics are generally caused by non-linear loads such as switched mode power supplies of computers and discharge lighting see Fig 3. Regulations 523.6.1 and 523.6.3 of the 17th edition recognise the effect of triple

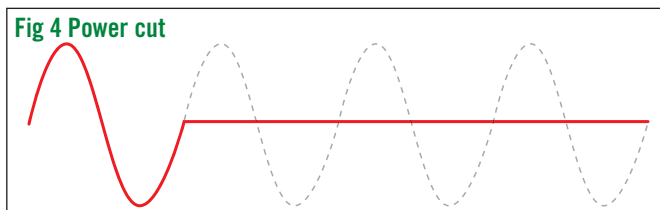
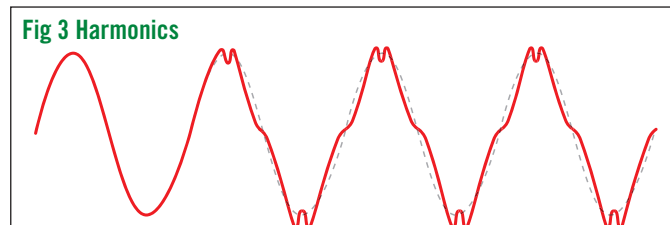
harmonic currents in the neutral conductor and the need to take account of it. In electrical installations there is a particular problem in three-phase circuits.

The third and other triple harmonics combine in the neutral to give a neutral current that has a magnitude equal to the sum of the third harmonic content of each phase. The heating effect of this neutral current could raise the temperature of the cable above its rated value and damage the cable.

Power-cuts or blackouts as shown in Fig 4 are total breaks in the supply.

Switching events

As mentioned in a previous article, generally any switching operation, fault initiation or interruption 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.

Inductive circuits

The instantaneous voltage that appears across an inductor is given by

$$v = L \frac{di}{dt}$$

Where,

v = the instantaneous voltage across the inductor

L = the inductance in Henrys

$\frac{di}{dt}$ = instantaneous rate of current change expressed in units of amps per second.

Atmospheric events

The current contained within a lightning strike varies considerably with the atmospheric conditions. However it is understood that values of 200 kA are possible. 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 in a number of different ways. Resistively, inductively or capacitively. A lightning strike direct to ground, overhead lines or building protection lattice will inject a huge amount of charge which flows, in the form of current, away from the point of injection. As it passes along its routes, potential differences are created and if the routes coincide with building structures or cabling then these voltages are seen within

the installation. In addition the magnetic field associated with a lightning strike can induce a voltage in any metallic structure the magnetic flux cuts. Also, if a building is struck, it is the objective of the lightning rod and conductor tape to pass the current to ground to help protect the structure from physical damage. However the current flowing through the tape will generate its own magnetic field which can induce transients within the buildings cabling system.

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.

SPD operation.

The proposed new Section 534 contains requirements for the installation of SPDs to limit transient overvoltages where required by Section 443 of BS 7671:2008 or where otherwise specified by the designer.

An SPD is a device that is intended to limit transient overvoltages 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. All SPDs are to comply with BS EN 61643. ►

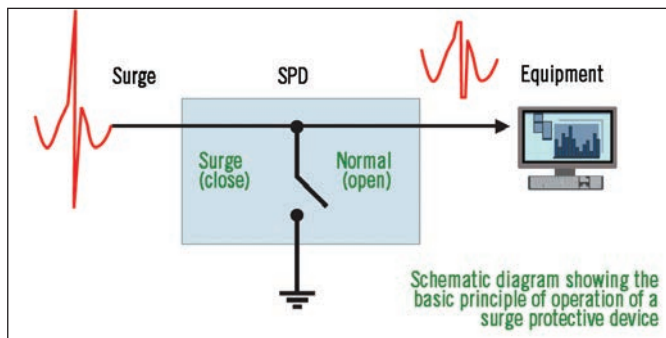


Fig 5 When an overvoltage is detected the SPD begins to conduct

◀ As mentioned in a previous article, 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. Spark gaps, gas discharge tubes, thyristors (silicon controlled rectifiers), and triacs are examples of voltage switching devices.

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

All SPDs are to comply with BS EN 61643. 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.

Standards such as BS EN 61643 series (components for low-voltage surge protective devices) define the characteristics of lightning and voltages to enable reliable and repeatable testing of SPDs (as well as lightning protection components). Although these waveforms may differ from actual transients, the standardised forms are based upon years of observation and measurement (and in some cases simulation). They provide a fair approximation of the real-world transient.

The most important aspect in selecting an SPD is its voltage limiting performance during the expected surge event – this parameter is the SPD's protection level U_p , also known in industry as the SPD's let-through voltage. An SPD with a low limiting voltage or lower (hence better) protection level reduces the risk of flashover causing insulation breakdown and associated hazards (fire or electric shock) as well ensure adequate protection of the equipment.

It should also be noted that selecting an SPD with a lower value U_p (compared to the equipment's damage threshold

or withstand level UW) results in a lower stress to the equipment which may result not just in a lower probability of damage, but also a longer operating life. As such, the risk assessment within BS EN 62305 defines SPDs with low voltage protection levels U_p as enhanced SPDs.

According to BS EN 62305, Type 1 enhanced SPDs should have a protection level U_p (or let-through voltage) no more than 1600 V whilst Type 2 and Type 3 SPDs should have a protection level U_p no more than 600 V when tested in accordance with BS EN 61643 series.

Given that transients can be present between all conductors or modes (for example line to earth, line to neutral and neutral to earth) it is important to ensure good protection level U_p in all such modes.

Connection of SPDs

One important point to note is that in order to gain maximum protection the supply conductors of the SPD shall be kept as short as possible, to minimise additive inductive voltage drops across the conductors.

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

SPD installation in conjunction with RCDs

Clause 534.2.6 of Section 534 is concerned with SPDs and their installation with respect to RCDs. It is ideal to install SPDs on the supply side of the RCD as this prevents the RCD from tripping during a surge event. Where this is not possible and SPDs are installed on the load side of an RCD transients could therefore trip the RCD. In this situation, 534 recommends the use of RCDs which are resistant to surge currents of up to 3 kA.

SPD status indication.

SPD status indication needs 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.

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 is expected to be included in amendment number 1 of BS 7671:2008 depending on the decision of the National Wiring Regulations Committee (JPEL/64). The first amendment to BS 7671:2008 is expected to be issued on the 1st July 2011 and planned to come into effect on the 1st January 2012 subject to the decision of the National Committee.

Acknowledgements

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