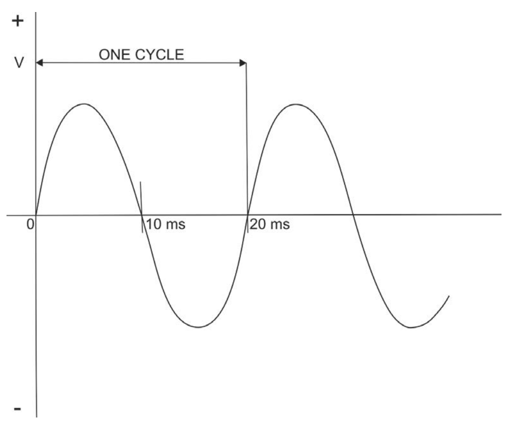
A SAFEhouse Guide to Type III Surge Protection for SANS 164 Products

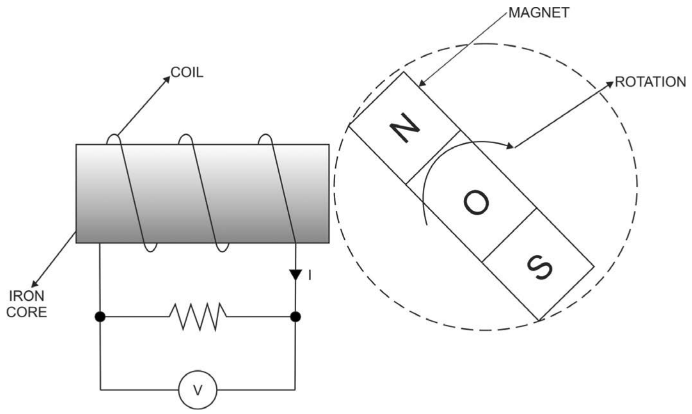
Increasingly, more products can be found on stores' DIY shelves that display 'lightning bolts' and claim, in bright red letters: 'surge protected'. What does this really mean, and what are the standards that apply to this type of product? This brochure offers an easy to follow explanation:

Introduction: What is our electrical supply about?

Our electrical supply – or power – is delivered to each installation by way of a voltage, which drives current in an electrical circuit. The product of these two parameters is called the wattage or power consumed by the appliance connected into the electric circuit. Simply put: voltage (volts – V) multiplied by current (amperes – I) is equal to power (watt – W). In South Africa, our national nominal voltage is fixed at 230 V +/- 10%.



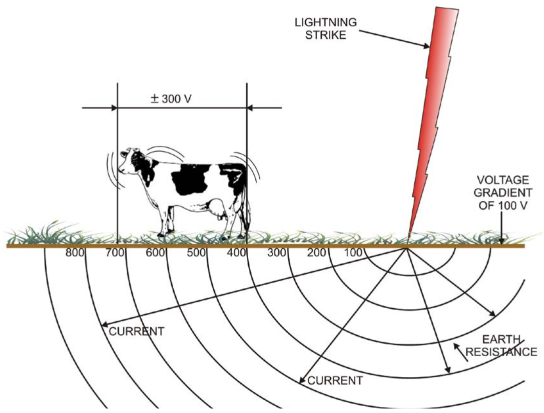
Another important characteristic of our voltage supply is that it is alternating and referred to as alternating current (ac) and fixed at 50 Herz (Hz) or cycles per second. This alternating voltage waveform completes a full cycle of between 0 and +230 V to 0 and -230 V and back to 0, fifty times in one second, or every 20 milliseconds (ms).



This type of waveform is obtained in a typical generator such as those used in Eskom power stations and the choice of alternating current instead of direct current (dc) is largely due to the fact that ac can be easily transformed into different voltages using the changing magnetic field that ac produces. In this simple example, the rotational speed of the magnet will determine the frequency of the alternating current and every time the north pole of the magnet passes the coil, it produces a positive voltage. When the south pole passes the coil, it produces a negative voltage.

What are surges, transients and impulses and what causes them?

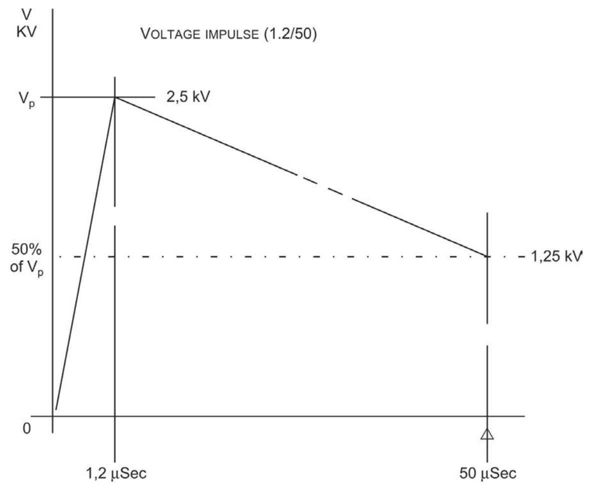
The inseparable phenomenon between electricity and magnetism is that whenever there is a change in current, a magnetic field is created and vice versa. Simply put, a fast and sudden change in current in one circuit can cause a fast and sudden change in voltage in another circuit adjacent to it.

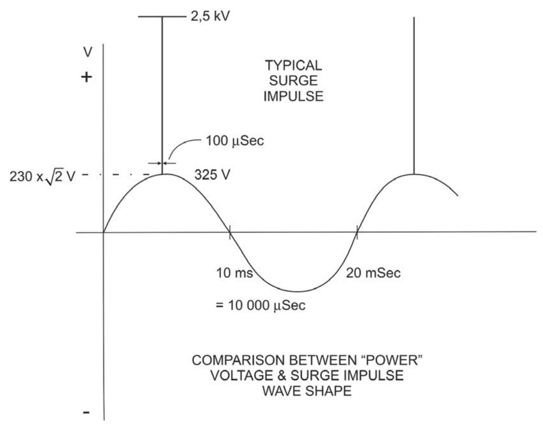


A surge is when the voltage or current increases suddenly to a value exceeding the rated value by a few percent (typically 10 to 20%) and falls back to normal in a few milliseconds (typically 20 to 30 ms). This is also referred to as a 'transient' and can be caused by switching power ON to un-energised transmission lines, during short circuits and arcing faults to earth. In the case shown, the voltage gradient between the front and back legs of the cow is high enough to electrocute the animal.

Spikes and impulses, however, are of high voltages (typically 1 to 5 kV) and of extremely short duration. These are usually caused by lightning strikes – in some cases, direct strikes onto the overhead lines (although this is quite rare) or to earth, and also cloud-to-cloud strikes where the spikes are caused in the overhead lines by the electromagnetic phenomenon described earlier.

Switching of loads ON and OFF, depending on which point on the voltage wave, also produces short duration spikes and these are the most common occurrences in our installations.





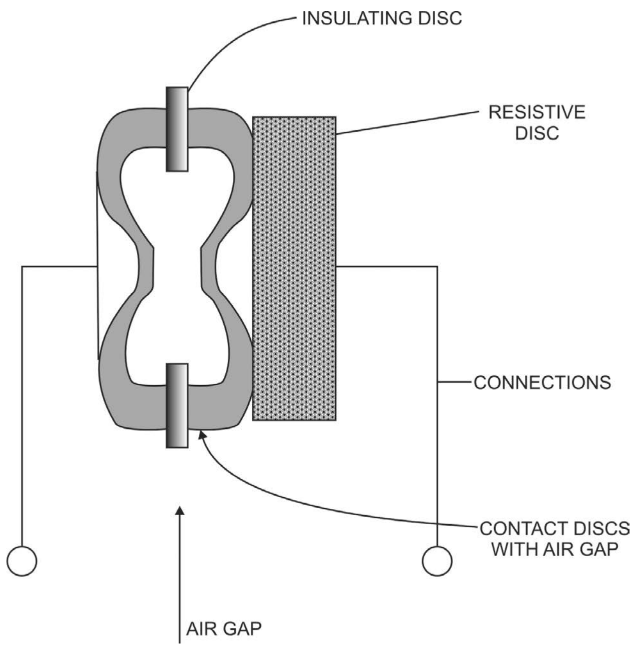
A typical voltage surge or spike has a peak of 2.5 kV with a 1.2 micro-second (1.2/1 000 000 of a second) rise time and a fall to 50 % of the peak value in 50 microseconds.

This spike, superimposed on our power frequency waveform, looks like a very thin needle rising to a peak more than 10 times the peak of our mains voltage. **These are the types of spikes that damage electronic equipment such as computers, printers and television sets.**

What is surge suppression all about?

Surge suppression is about diverting the surge spikes – either between the neutral and live conductors or between live and the protective earth conductor. However, this must be done in such a way that the mains voltage is not affected during this process and it must be done safely.

Typical components that do this are 'gapped arrestors' and 'metal oxide varistors' (MOV).



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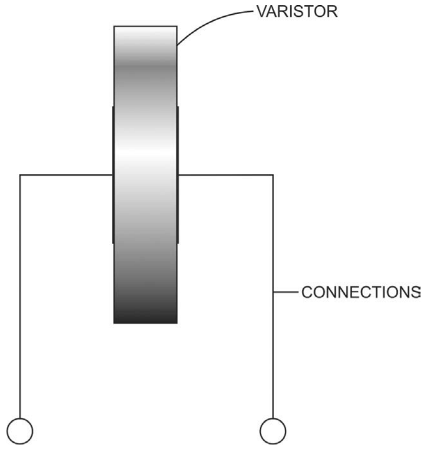
Gapped arrestors are generally used in Type I arrestors for HV power lines. Because of the air gap there is almost no current flow between the terminals. The breakdown voltage across an air gap is around 3 kV per mm (under specified conditions), at which point an arc is struck in the air gap. The resistive disc then controls the current flow through the arc, till the voltage drops to a value below the breakdown level.



MOV arrestors are used in Type II and Type III arrestors and since this varistor is connected directly to the terminals, a small current flows continuously between them. As the voltage increases, the current also increases slightly until, at breakdown, a sudden and high current flows through the disc and persists until the voltage drops to a value below the breakdown level.

It must, however, be borne in mind that whilst these devices are diverting surges, behind the HV line or LV installation there may be several thousands of amperes waiting to be delivered into a low resistance circuit, such as that which may be caused by this delicate diversion of unwanted surges. It is this 50 Hz current that can damage the line or installation as it has to pass through the overcurrent protection circuits, thereby increasing the risk, under extreme conditions, of damage or failure.

What are the applicable standards for surge protected products?

Three standards and one compulsory specification are applicable and interlinked for both the installation and the products. These are:

SANS 10142-1	The SA National Standard for the wiring of premises	Specifies the types of surge protection products and circuits for the wiring of fixed installations.
SANS 61643-11	The SA National Standard for low-voltage surge protective devices.	Comprehensive specification covering all aspects of the physical and performance requirements of surge protection devices.

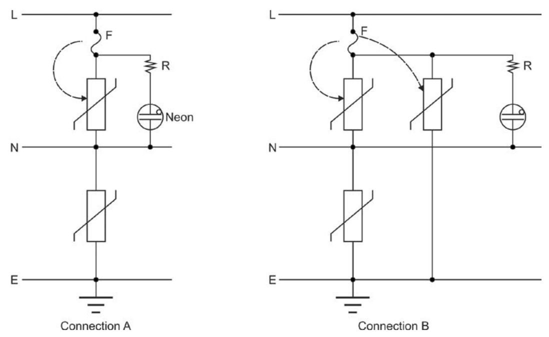
SANS 164-0	The SA National Standard for plug and socket outlet systems for household and similar purposes for use in South Africa Part 0: General and safety requirements	The first of seven parts that specify national plug and socket outlet configurations legally applied in South Africa. Part 0 covers the requirements for surge protected plugs and socket outlets.

VC8008	The SA Compulsory Specification for plugs, socket-outlets and socket-outlet adaptors	Legislation issued under Government Gazette No 33763 of 19 November 2010: making the compliance with SANS 164-0 a mandatory requirement for the selling and distribution of these products.

For SANS 164 products, which include all the commonly known plugs and sockets, cord extension sets and plug-in adaptors in use in South Africa; SANS 164-0 has the following applicable clause …

4.1.6 – Surge protective devices (SPDs) incorporated in a plug, in an adaptor or in a portable socket outlet shall comply with the requirements of SANS 61643-11. The SPD shall be a Class III device (a metal-oxide varistor or a silicon device) and shall incorporate a thermal disconnector that functions in series with its live connection. The internal connection of SPDs within a plug, an adaptor or a portable socket-outlet shall be such that the SPDs will provide both common mode and differential mode surge protection. An indicator shall be provided to indicate whether the SPD is operational.

… and is accompanied by the following circuit diagrams:



F = thermal disconnector

Common mode:

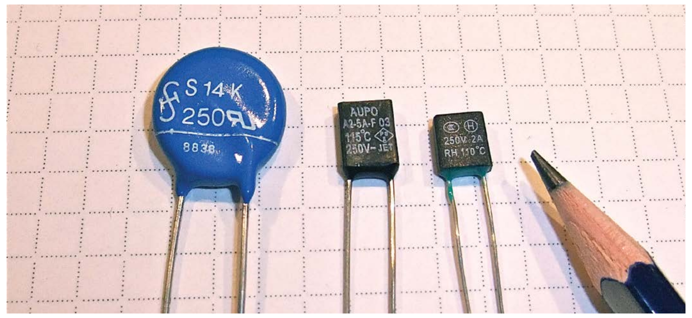
The MOV connected between L & E and/or between N & E.

Differential mode:

MOV connected between L & N.

The most appropriate connection is that shown in 'Connection B' of the standard.

Why the thermal disconnector?



The thermal disconnector is a crucial component in the surge protection circuit as it prevents a fire developing within the MOV assembly after it has absorbed repetitive surges over its lifetime.

The zinc oxide material in the MOV acts as a diode and, under normal voltages, it conducts a very small current of a few micro-amperes. However, after many surges, small 'holes' develop within the structure and the current gradually increases where at around 1 milliampere, the heating effect raises the temperature of the device to levels where the epoxy coating can ignite. The thermal fuse, which is assembled in intimate contact with the MOV, protects it by interrupting the current when a temperature of 100 °C has been exceeded. Usually, a neon or LED indicator lamp is connected in the protection circuit in order to show whether the MOV is functional or not. Once the indicator is OFF, the surge protection function has been disabled.

What required markings should be shown on a surge protected product and what do they mean?

According to the standard SANS 61643, there are several markings specified for the MOV itself, which are generally applied to the MOV components, usually in the form of a catalogue number and the MOV operating voltage. However, as far as SANS 164-0 is concerned, there are three items of information that are required to be visible to the user:

- **Surge category: Type III or the [T3] symbol**
  - Type III: As explained above, these devices are installed to reduce the overvoltage at the terminals of sensitive equipment. Their current discharge capacity is very limited. Consequently, they should be used in conjunction with Type II devices fitted to the main distribution board. A Type III device is tested with a combined high voltage and high current wave.
- **Open circuit voltage (surge): U_{oc} = Value in kV**
  - **U_{oc}:** The open circuit voltage of the combined (surge) wave denotes the high voltage level of the surge that can be safely absorbed by the protection circuit. The higher this value the greater the capacity of the protection circuit's ability to handle surges. Generally, a level of 2.5 kV or more is recommended.
- **Voltage protection level: U_p = Value in kV**
  - **U_p:** Denotes the voltage protection level or the residual voltage that the equipment connected to it is exposed to, after having diverted the surge pulse.
  - The lower this value, the better protection is offered to the equipment being protected. Generally, a level of 1 kV or less is recommended.
  - **In addition, at the indicator lamp, the legend: 'If lit – surge protection on' (or words to that effect).**

What should a user look for to ensure the product is compliant and safe?

- Look for the markings as listed above.
- Look for certification marks such as the SABS mark or VDE.
- Look for the test specification marking: 'Tested to SANS or IEC 61643-11'.
- Look for the SAFEhouse logo. It is a supplier's commitment to providing only safe products and services.
- If the product does not display 'Tested to SANS 61643-11' be cautious. Try to determine when the Letter of Authority (LOA) was issued by the National Regulator for Compulsory Specifications (NRCS).
- If the approval was issued before 2012, the product **may not be fitted with a thermal fuse and can become a fire hazard.**
- Read any product information and/or instruction leaflet carefully to understand the product's capability and possible limitations. Surge protection products limit the surges but cannot eliminate all of them. If there is no literature with the product or if such information appears to be sketchy – be very careful.

What should purchasers look for to ensure adequate protection for the entire installation?

- Check whether the distribution board is fitted with surge suppression.
- If not, ask an electrician for a quote to fit Type II surge arrestors and get them installed before the seasonal storms.

For a list of reputable local suppliers or for technical information on these products, please contact:

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Suppliers you can trust

Tel: +27 11 396 8140 info@safehousesa.co.za

www.safehousesa.co.za