A guide to Lightning Transients

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Lightning Transients

The major mechanisms by which lightning produces surge voltages are the following:

- A direct lightning strike to an external circuit (outdoor) injecting high currents producing voltages by either flowing through earth resistance or flowing through the impedance of the existing circuit.
- An indirect lightning strike (i.e. a strike between or within clouds or to nearby objects which produces electromagnetic fields) that induces voltages/currents on the conductors outside and/or inside a building.
- Lightning earth current flow resulting from nearby direct-to-earth discharges coupling into the common earth paths of the earthing system of the installation.

Transient Suppression Devices

The ideal transient suppression device would be an open circuit at normal voltages, would conduct without delay at some slight voltage above normal, would not allow the voltage to increase during the clamping period, would handle unlimited currents and power, would revert back to an open circuit when the stress has gone, and would never wear out.

At the time this is written, there is no single transient suppression device that approaches this ideal for all the stress conditions. Hence, at present efficient transient protection requires the use of a number of devices, carefully selected to compliment each other and thus cover the full range of voltage and current stress conditions.

Line Filter, Transient Suppressor Combinations

If inductors are used, it is expedient to provide additional filtering in the transient suppressor circuit at the same time. This will help to reject line-borne noise and filter out power supply generated noise. Also, the winding resistance and inductance can provide the necessary series impedance to limit transient current for efficient transient suppression. Consequently, transient suppression is often combined with the EMI noise filtering circuits typically required with switch mode power supplies.

Metal Oxide Varistors (MOVs, Voltage-Dependant Resistors)

As the name implies, varistors (MOVs) display a voltage-dependant resistance characteristic. At voltages below the turnover voltage, these devices have high resistance and little circuit loading. When the terminal voltage exceeds the turnover voltage, the resistance decreases rapidly and increasing current flows in the shunt-connected varistor.

The major advantages of the varistor are its low cost and its relatively high transient energy absorption capability. The major disadvantages are progressive degradation of the device with repetitive stress and a relatively large slope resistance.

Gas-Filled Surge Arresters

Much larger transient currents can be handled by the various gas-discharge suppressor devices. In such suppressors, two or more electrodes are accurately spaced within a sealed high pressure inert gas environment. When the striking voltage of the gas tube is exceeded, an ionized glow discharge is first developed between the electrodes. As the current increases, an arc discharge is produced, providing low impedance path between all internal electrodes.

When it strikes, the gas arrester effectively short circuits the supply, with only a small voltage being maintained across the electrodes. Because of the low internal dissipation in this mode, a relatively small device can carry currents of many thousand amperes. With this type of suppressor, protection is provided not so much by the energy dissipated within the device itself, but by the device’s short circuit actions. This forces the transient energy to be dissipated in the series resistance of the supply line and filter.

A disadvantage of the gas arrester is it’s relatively slow response to an overvoltage stress.

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