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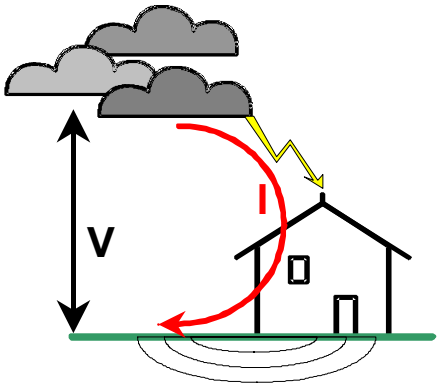
Lightning and Surge Protection



Background

Lightning is a natural phenomena occurring when a large static voltage potential exists between clouds in the sky and the earth below. When the potential difference rises to a very high value an electrical energy discharge (lightning strike) occurs between the sky and the earth. This discharge results in a current path being established between the two points and will often include any conductor that helps to bridge the gap such as trees, buildings or other structures.

When the current path is established the resulting current flow will be extremely high, perhaps as much as 5000 amps. This current flows through whatever impedance there is in the route taken by the lightning strike and will produce large potential differences across relatively small impedances. For example if there is a 0.1 ohm resistance and 5000 amps there will be 500 volts developed across the resistance.

Although the voltage and current levels during a lightning strike are very high the time duration is extremely short. The period of the discharge is only a few milliseconds. This means that the actual power transferred is relatively small - perhaps as little as a 100 watts. In extremely intense tropical storms this could rise to about 1000 watts.

Whenever electrical equipment is located in a region where lightning strikes are likely to occur it is prudent to include protection for the equipment against these energy discharges. Electronic equipment is particularly vulnerable and where it is connected using long cables any discharge into the area around these cables is likely to induce currents in the cables. A direct strike onto the equipment itself will almost certainly damage the equipment as the protection devices available have a limited capability. Some of the effects of a direct strike may be protected against by using lightning diverters, these often take the form of conductor rods specifically designed to provide a lower impedance discharge route for the current. In electronic terms these diverters are semiconductor devices used to route the energy away from the sensitive circuits.

Effect of Lightning Energy Surges

The result of energy surges such as lightning or heavy current flows in cables is to create a magnetic and electrical field which, in turn, induces currents and voltages in any nearby cables. The surge energy is distributed throughout the conductive materials near the source or current path of the energy. These induced energy flows are dependent on the coupling effects between the source and affected parts of the system.

If the induced currents are excessive they may produce voltage levels above those which the attached equipment can tolerate when the currents flow in the detector circuits. For this reason additional components are added to act as diverters for the induced signals.

There is virtually no protection possible against a direct primary strike of the lightning itself onto the equipment or cables connected to the equipment. Such an event will almost certainly destroy part of the system. For this reason critical plants in vulnerable areas often have arrays of conductor rods on the outskirts of the site.

Protecting Against Lightning

One very important factor to consider in any protection scheme is that the lightning induced current has to be able to flow to ground. The primary strike relies on dissipation to ground and any secondary currents should also have a suitable path back to ground. Grounding of equipment therefore plays a key role in protection.

The effect of the induced currents can be greatly reduced if the impedance through which they flow is small, that is if the resistance of the circuits is small.

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Modern electronic circuits operate at low voltages and currents to minimise the power consumed, so keeping down the heat generated in the hardware. Conventional diverter protection circuits use discharge tubes but these are sometimes not suitable as the striking voltage of the tube is above the acceptable limits for the electronic circuits. More recent designs of diverter circuits employ Transorb and Varistor devices. These use special semiconductors that change their impedance characteristics as the applied voltage increases.

Actuator Protection

The lightning arrestor has a voltage that it will clamp the strike voltage down to. The lightning suppression module Rotork offer is rated at 510V RMS (Root Mean Square or 675VDC) with a peak transient current of 6500 amps and a transient of 8/20 microseconds. When the surge current comes to the arrestor, the arrestor passes the current (up to 6500A) and prevents the voltage from rising above a certain level. The voltage will rise because the current passes through the resistance of the arrestor. The voltage specified (510V RMS or 675 VDC) is the clamping voltage above which the arrestor will not allow the voltage to rise provided the current remains below 6500 amps. A sinusoidal voltage with a RMS of 510V will have a peak of 675VDC.

The lightening suppression module protects the actuator from electrical surges due to lightening strikes on the supply power cables. The Rotork design and build device is located in the electrical terminal cover of the actuator and does not protect against strikes directly on the actuator or pipeline - in these situations the ground connection is designed to deal with the surge. As standard, Rotork actuators meet the immunity requirements of BS EN61326:1997, A1:1998 Industrial Environment.

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