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Data_Link 2000

APPLICATION NOTE AN010

Lightning Protection

ZAP GAP

Summary

Lightning is caused by static electricity building up in the atmosphere to the level at which flash-over occurs. Discharges between clouds are spectacular, but not a major cause of damage. Discharges to ground, however, can release vast amounts of energy and cause extensive damage. Since these discharges take the path of least resistance, they are more prevalent on elevated, moist ground, and are attracted to high points such as masts.

Unfortunately, these are often the locations needed for telemetry systems, which often monitor reservoirs that are by necessity located on high ground. The aerials of radio outstations are particularly vulnerable. This document describes the precautions that can be taken to minimise the risk of damage.

Outline

A direct lightning strike discharges so much energy that it will destroy anything in its path. Far more extensive damage, however, is caused to electrical equipment in the surrounding area. A strike may discharge several million volts at over 100,000 amps, so induces considerable surges in any nearby conductors (both overhead and buried) by electro-magnetic induction. Conductors that are susceptible to these surges include telephone lines and cables to instruments such as level transducers in reservoirs. A nearby strike can induce surges of several thousand volts at several thousand amps, lasting for several microseconds, in these conductors.

One protection method is to deliberately discharge the static fields before they build up to flash-over levels, by providing lightning conductors fitted to masts. An aerial forms an effective lightning conductor, provided it is connected to ground. However, surge currents of several thousand amps can flow through it, and can easily damage radio equipment.

Equipment can be protected from both surge mechanisms by fitting surge protectors to the incoming lines. These work by diverting the surge to ground through components designed to pass very high currents for short periods. The voltage at which they clamp obviously must be higher than the normal signal levels on the lines, but lower than the level at which the equipment would be damaged.

Churchill Controls Ltd offer a range of surge suppressors to protect all input/output lines on telemetry systems, under the generic name ZapGap.

ZAP GAP

Suppression Components

The main component used in all surge protectors is the Gas Discharge Tube (GDT). A GDT is a sealed module filled with a rare gas at low pressure, with an integral 3-electrode spark gap. When the potential difference across any pair of electrodes reaches the breakdown voltage (~500V) a spark is generated which very rapidly heats the gas so it ionises. The ionised gas is highly conductive, so effectively shorts all electrodes together until the current flow drops to a level insufficient to maintain ionisation. A surge either leg of the line is therefore clamped to the breakdown voltage for the first few microseconds before dropping to less than 10V for surge currents of up to 20,000A.

Transient suppressor diodes can be used as secondary parallel protection to clamp surges to a defined voltage limit until the GDT ionises (and to clamp surges that fail to reach the breakdown voltage of the GDT). A small series resistance is needed to allow the line voltage to reach the GDT breakdown voltage. It should be noted that transient suppressor diodes have a relatively high capacitance, so cannot be used at radio frequencies.

Data Surge Protector

The 7210-xxyy Data Surge Protector (DSP) is designed for protecting telecommunication lines and transducer cables. It clamps the telemetry I/O lines to a voltage defined by 'xx', and inserts a series resistance 'yy' in each leg (e.g. 7210-2410 clamps at 24V, and has a resistance of 10Ω per leg). Each module protects 2 pairs of wires, and clamps both longitudinal surges (i.e. from either leg to ground) and differential surges (i.e. between the legs) to 'xx'. The pairs are isolated from each other, but share a common earth terminal. Each can therefore be used on 2 analogue inputs, 4 digital inputs or two 2-wire telephone lines.

The earth tab is a 6.3mm spade terminal, compatible with crimp connectors. Bus-bars are also available for linking the earth tabs on 2, 4 or 8 modules, to provide a common 6.3mm spade terminal (part number 7211-n).

The recommended clamp voltage/resistance for analogue and digital I/O is 24V/10Ω, although 48V/10Ω versions may also be used. Leased lines and private wires should be protected to 12V/5.0Ω.

Co-ax Surge Protector

The CSP Co-ax Surge Protector is designed to protect radio equipment from surges on aerials. It should be fitted to the TNC socket on the telemetry unit to protect it from surges induced on the aerial and the cable.

The earth connection is an M3 stud on the side of the unit.

Earthing

Surge protectors are very effective in protecting equipment against induced transients, ***provided they are correctly installed***. The most important aspect is the provision of a good earth to which the transient can be diverted. Figure 1 below graphically illustrates the potential problem caused by an incorrect installation. Figure 2 illustrates the correct method of installation.

This illustration correctly indicates that the integrity of the earth connection is irrelevant, provided there is no other path to earth. However, there will inevitably be other paths, via other equipment connected to the outstation, or ultimately by arcing. The earth connection should therefore be as low impedance as possible. Mains earth is not adequate, since it is only designed to take fault current of tens of amps.

Ideally the earth connection should be to a buried copper mat, or at least a substantial earth stake. The connecting cable should be at least 10mm2, and should be braid or copper strip to minimise its inductance.

Surge arrestors should be mounted close to the equipment being protected, but the cables should be kept apart to prevent electromagnetic coupling.

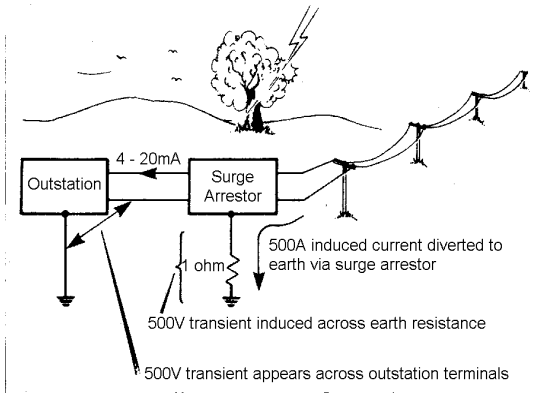

Figure 1 – Poor installation

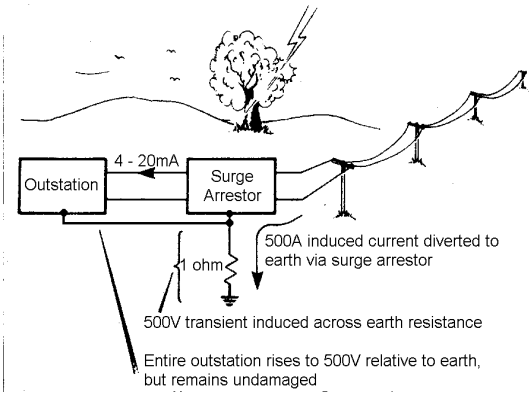

Figure 2 – Correct installation

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