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Technical Note

Tower Mounted Electronics Protection

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Summary

Protecting tower mounted electronics requires a protector at both ends of the feed cable.If coaxial cable is used, the protector should dc block the RF path, yet provide a separate, protected path for dc Voltage and control signals. If twisted pair data cables (CAT 5) are used, each pair should be protected in a differential and common mode at both ends.

Lightning transient protection for communication sites should be implemented in the following order of importance.

Tower and Site Grounding System Design and Implementation

Measurements: low frequency impedance, high frequency transient response

Data Cable Grounding, or…

Coaxial Cable Feeder Grounding

Shield grounding kits, grounding conductor size, geometry, length, and routing

Data Cable Protection, or…

Coaxial Cable Feeder Center Conductor Protection

Lightning Protectors (PolyPhaser)

Each of these topics are covered by other technical documents on the web site and are assumed to be understood and in place at a (virtual) tower site for this discussion.

Tower Mounted Equipment Protection

Lightning is a natural event with varying currents and rise times based on the inductance of the complete circuit to earth. The complete circuit includes the earth grounding system, system, the struck object, the ionized lightning channel’s ability to conduct current, and the cloud’s ability to rapidly migrate electrons to the cloud’s charge center. Each of these components can effect the rise time to 90% of peak current.

When lightning strikes the tower, an instantaneous peak voltage drop occurs from the tower top referenced to the site ground beneath it. This peak voltage can range upwards to well over a million Volts and is what drives current down the tower, coaxial cables, data lines, and tower light wiring. The peak current can be tens of thousands of Amps. Unless controlled by appropriate site configuration options, and properly sized and routed grounding conductors, current can pass through your equipment.

The tower top is no longer “ground” during the lightning event. The antenna and tower top electronics “grounds” all rise to the same peak Voltage as the tower. However the coaxial cable center conductor is isolated from the tower top “ground’ by the input/output circuitry of the tower mounted equipment. Whether it is a coaxial cable center conductor or data lines, the downward outbound conductors present a lower potential to the rapidly rising strike voltage (20-50 nanoseconds to peak). A strike will achieve whatever potential is required to force current down the outbound conductors.

The circuitry between the elevated potential tower “ground” in the tower mounted equipment and any isolated outbound conductor (e.g. coax cable center conductor) will be damaged or destroyed unless a lower impedance path from the elevated “ground” to the outbound conductor is established. This is what a tower top lightning protector does!

A non dc blocked protector (straight gas tube) at both ends of a coaxial cable, with a dc voltage riding on the rf, will allow more energy through the equipment input/output circuitry than an rf blocked, dc pass protector

Now that the tower mounted electronics is protected, what is to be done with the energy applied to the outbound coaxial cable center conductor from the low impedance path provided by the tower mounted protector? If there is a protector at the top of the cable, there must be a protector at the bottom to provide another low impedance path to the site ground for the energy switched to the center conductor by the top mounted protector!

Base Station Protection

Energy from the tower mounted equipment protector arrives at the base station as a fast rise time current pulse on the coax center conductor derived (mostly) from the gas tube turn on (~1µS delay) in the tower mounted protector. The shield potential at the base station, although arriving first, would be greatly reduced by proper bonding and grounding at the master ground bar.

This fast rise time current pulse comes to the Base Station on the center conductor, minus the coax feeder cable shield induced reverse current, plus downward propagation delayed “roll off” related to the velocity factor of the coaxial cable (capacitance through the dielectric and “unbalanced” inductances of the shield vs. center conductor x feeder length). Coaxial cable is a “low pass filter”.

The protector at the base station should be dc blocked in the rf path to minimize “let through” voltage, and effectively shunt the tower mounted protector’s current pulse through large circumference grounding conductors to a low impedance, fast transient response ground system. The protector’s dc circuit will clamp the equipment voltage just above its operating voltage on the protected side. Only an rf blocked, dc pass/protected coaxial protector accomplishes both. The lightning protector is the final component of a well thought out site design.

Shielded Data cables

Most coax cable protection principles are transferable to shielded data cables (STP). Since there are four balanced twisted pairs in a CAT5 cable, unbalanced inductances as in coaxial cables are unlikely. The data protector in the tower mounted equipment will “turn on” when the tower top elevates in potential referenced to the outbound data lines. We can assume that differential voltages will be minimal, but all eight conductors will carry a common current pulse applied by the tower mounted equipment protector during a lightning event. Unshielded CAT5 data cables (UTP) are not recommended for outdoor use.

Once again we have a potential driven current pulse on downward conductors. It is directed toward a fast transient response ground system by another data protector at the bottom of the data line. Data protectors come in many varieties. Each protector designed for a specific application. The data protectors at both ends of the same cable should be an exact match.

Please contact us for questions or further information on this topic.

Contact:

Tel: +1 (208) 635-6400
Email: sales@polyphaser.com

www.polyphaser.com