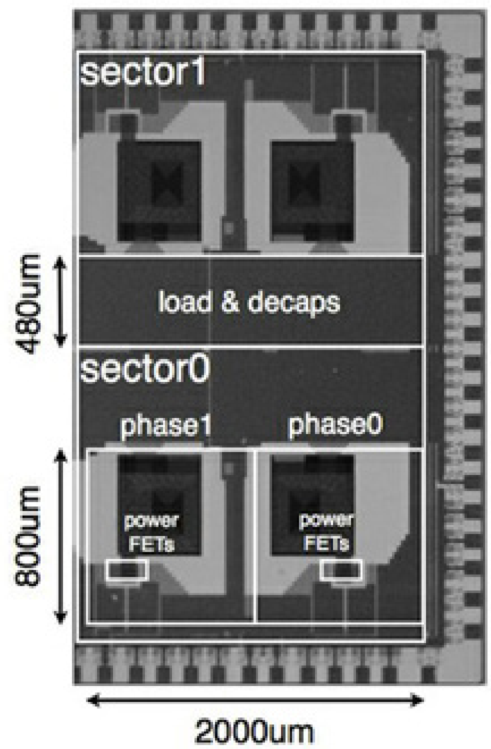
GROUNDING FOR ANTENNAS & TRANSMISSION LINES

Antenna Systems & Technology

It was a stormy night...
The importance of grounding.

It's nearly done. After all those months, weeks, days and nights of hard work, the wireless system is almost up and running. Tomorrow, the local telephone service provider will be bringing in the T1 lines, the wireless will be connected to the wire-line and the money will start to go on the plus side of the ledger instead of the negative.



Every possible means to have the best, most competitive, cost-efficient wireless system has been used. The best hardware, the best software, communications experts, tower experts, grounding experts - the works. New towers built when necessary and existing towers used wherever possible. In fact, even space on electric transmission line towers was purchased from the local electric utility. In other words, this is one state of the art system that will give you the edge.

But only if it all works.

Why wouldn't it work? Everything has been checked and re-cheeked, tested a zillion times. It's all perfect. But what about the high voltage protection? Towers - transmission line or otherwise - are a high voltage environment. And these can be pretty hostile places. One bad storm, a lightning strike, and thousands of dollars worth of equipment are gone. Not to mention those dreaded words: down time. That's why so much attention is given by grounding experts to install the most up-to-date equipment and shunt to ground any surge coming into the site, away from the equipment. That takes care of the enemy from outside, but what about the enemy from within? The strike that causes a surge to come up through the ground instead of coming in on the wire-line?

This type of surge is called a ground potential rise (GPR) and our purpose here is to explain what this is. how it can cause damage and how to protect against it, using high voltage wire-line isolation devices.

The basic premise behind the use of wire-line isolation devices in high voltage environments is simple: when phone service is required at a site that may be subject to high voltage surges, special protection measures are required by various national standards to ensure personnel safety and prevent damage to equipment. In classic W5 fashion, let's look at who needs to be aware of these special protection measures, what type of equipment is required to achieve this protection, where this equipment is installed, when should the equipment be installed and, most importantly, why it is required. So that, when the night docs grow dark and stormy, the network stays safe and reliable,

GROUND POTENTIAL RISE

As the old saying goes, "Know thine enemy." The "how's" and "whys" of GPR must first be understood, before designing and implementing a safe and effective protection scheme. In a nutshell, when a fault or lightning strike occurs and a current reaches a ground grid (like a tower site), (he result, according to Ohm's Law, is a potential rise. V equals R * I where I is the surge current, R is the impedance of the ground grid and V is the resulting potential rise.

If equipment is all tied to the same ground grid and is not referenced to any external ground, then it will not be damaged due to GPR. However, wire-line telecommunications, which are connected through equipment bonded to the tower site's ground grid, are also terminated to a Central Office (CO) by copper pairs. This CO is the remote earth, and the copper wire-line is a conductor lied between two ground planes. Therefore, a difference in potential between the two ground planes will cause a current to flow up from the ground at the tower site, through the equipment and out on to the wire-line. This is dangerous to personnel and can damage the site equipment.

Using an analogy, we can compare this situation to two glasses filled with water, one representing the ground plane at the tower site, the other, the ground plane at the CO. Imagine one glass up on a shelf and the other lower on the table. If there is no connection between the two, then no matter what happens to the water levels in the glasses (comparing variations in potential), no water will flow between the glasses (meaning no current will flow).

However, if the two glasses are connected by means of a straw (i.e. connecting the two ground planes by means of a copper phone line), then sudden increases in the water level of the first glass will mean that water will flow down the straw (i.e. current on the wire-line) to the second glass. Anything tied to that straw would get wet. In the same way, anything tied lo the wireline will see the current. The only way to prevent this is to put a barrier in the straw. This is what isolation devices do.

While proper grounding is essential and standard communication protection methods, used properly, are critical at these sites, they are unfortunately ineffective in protecting equipment from GPR. For example, shunting devices normally are placed at each end of a cable communication facility and are designed to direct foreign voltage impulses into a grounding system. During a GPR, these devices merely offer an additional path to remote ground reference and actually provide a path for current to flow in the reverse direction from which they were intended to operate. Thus, no matter how good standard protection devices are, equipment or cable facilities will become part of an electrical path between the GPR and remote ground. The only effective protection scheme against GPR is an isolation device.

The next step is defining what tools are available to help solve GPR problems. A series of field-proven national standards provide methods for protecting people and equipment from GPR. The most important and useful standards include:

- ANSI/IEEE Standard 487-1992 - Guide for the protection of wire-line communication facilities serving electric power stations;
- ANSI/IEEE Standard .167-1996- Recommended practice for determining the electric power station ground potential and induced voltage from a power fault;
- ANSI/IEEE Standard 80-1997 -Guide for safely in AC substation grounding;
- NFPA 70-lyyfi-National Electrical Code (NEC).

Although most of these standards address protection from GPR due to 60 Hz fault currents, lightning strike energy applications are basically the same when considering higher frequency impedance. Both currents generate a GPR and can potentially harm personnel and damage or destroy communication facilities.

The above standards define when high voltage interface (HVI) device is necessary for wire-line protection.   In general, an HVI should be installed when the calculated GPR is above 1,000 V peak asym-metrical, or the service performance objective (SPO) is for Class A, always requiring protection.

It should also he stressed that failure lo comply with national standards can have serious legal repercussions should a GPR incident cause injury to personnel or damage to property. Safely issues must be considered when designing and installing communication systems.

In summary, there are three issues that must be considered before a protection scheme can be designed and implemented:

Is the site a likely candidate for GPR? The answer is yes if a wire-line communication link enters a high voltage area or one that is prone to lightning.

What is the calculated level of GPR at this site? If it is evaluated at greater than 1,000 V peak asymmetrical, then high voltage isolation is required by