High Level Pulse Testing of Standard Telecom Interfaces

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Simple hardwire Telecom lines, entering buildings after running some distance exposed in the open, can act as antennas, coupling to high-level transient electromagnetic environments and bringing potentially harmful pulses into the building's Telecom circuit. Such EM environments include lightning and EMP (and accidental contact of the line with live powerlines). Because of this, it is standard to use protection at the building interface. The protection shorts out the line when the incident pulse gets too large, and then recovers when the pulse is gone. However, for too great a pulse, the protection device can burn-out, leaving a permanent short, and taking the line down until it is repaired. Although this protection is mainly designed for lightning, in this study we were concerned with narrower pulses. We performed laboratory tests in which standard Telecom interface hardware was injected with high-level (up to 70 kilovolts) narrow pulses. Additionally, to look at pulse-width variations, some tests were done with wider pulses (these up to 2.6 kilovolts). Some of the test results were as expected, while there were also some surprises. In the presentation, we will describe the laboratory tests, and summarize and interpret the results. The test consisted of 1290 shots, with pulse levels gradually stepped up, looking for break points.

The main pulser was a simple charged capacitor type, and could go up to 70 kilovolts. Its RC time constant was 750 nanoseconds (short-circuit FWHM pulse width of 520 nanoseconds), and the rise time was about 20 nanoseconds. The wider pulser tests were added as an afterthought, but proved very useful. Its pulser had a 6000 microseconds RC time constant (4200 microseconds FWHM). For comparison, some IEC standard test pulse widths are: EFT: 50 nanoseconds, CWG: 50 microseconds, and Telecom: 700 microseconds; generally with test levels up to 4 kilovolts.

The tests objects were standard protection interfaces and some sample Telecom user equipment. The protection circuit consists of a fuse and a shunting device, contained within a BET (Building Entrance Terminal). The BET is also where the building's external and internal wiring connect, typically on terminal blocks. The fuse is simply a length of thin wire, within the BET body. The shunt protectors are either solid state (avalanche diodes) or gas tubes, which short out when the voltage gets above a few hundred volts (we tested common 5-pin modules). The samples of Telecom equipment that were tested included a Telecom transformer (very common in many pieces of Telecom equipment), a phone/fax machine, and a modem in a PC.

First separate parts of the Telecom interface were tested, and then the full circuit. The fuse was tested by shorting it, to pass the maximum current. The BET was also tested in an open circuit mode - for maximum voltage. The fuse (designed for stopping very long pulses) could not be blown by our pulses (this was as expected). Ten different types of 5-pin shunt protectors were tested. As expected, none could be damaged, even up to 70 kV, by the narrower pulse, but some did blow out with the medium width pulse. Generally, the solid state devices were all damaged, but only some of the gas tube devices. However, some samples of gas tube devices were damaged at very low levels, but it was not the gas tube itself that suffered the damage.

Testing the transformer required more care, in that there is no obvious common mode path through a transformer. The results were that the medium width pulse caused damage at about the expected level, but for the narrower pulse, the damage level was much higher. These, and other results, will be discussed further in the presentation, including the importance of arcing. For very narrow pulses, the required damage level may be rather high (for example, if damage is caused by an integrated quantity, such as energy). For such high pulse levels, arcing in air gaps, either intentional or spurious, can be an important issue. The arcing can be protective, if it does not occur too deep down in the circuit.