Effects of High Power Electromagnetic Radiation on Electronic Systems

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To better understand the effects of high power EM (HPEM) effects on electrical systems, there is a need for determining the EM field thresholds at which upsets or failures in electrical systems can occur. Conventional EMC compliance testing does not provide information on such thresholds, since this type of test only proves that the equipment under test (EUT) will not fail when exposed to a specied or mandated EM field level.

A common frequency that is found in both industrial and household locations is 2.4 GHz. Many types of consumer goods are exposed to this intermittent CW environment, and such signals arise from cell phones, Bluetooth appliances, microwave ovens and other unlicensed radiators. To obtain the upset and damage thresholds for common commercial electronics at this frequency, Clemson University has undertaken an experimental effort to test to failure a variety of commercial equipment. The testing was conducted in an anechoic chamber with a magnetron source from a commercial microwave oven feeding an S-band pyramidal horn through a section of WR340 waveguide. This test was similar to one conducted earlier by Kaelin and Giri (see D. V. Giri, High-Power Electromagnetic Radiators: Nonlethal Weapons and Other Applications, Harvard Press, Nov. 2004), which showed damaging effects of EM field at this frequency, but did not examine upset or failure thresholds.

For the Clemson testing, a commercial H-field probe was used to measure the three H-field components at various locations within the chamber, which enabled us to characterize the EM field environment experienced by the EUT. Unfortunately, the probe had a maximum H-field measurement capability of about 2.1 A/m (800 V/m) and consequently, field points close to the horn could not be measured directly. To estimate the EM field environment near the antenna, a near-field pyramidal horn model was developed and the field strengths at these test locations were inferred from a measurement of the field farther away, where the probe could function safely.

The results of the computational model and its experimental standardization are presented as are the testing methodology and the test observations. The effects of HPEM on several everyday electrical systems are described.