ESTIMATES OF THE NEAR FIELD EM ENVIRONMENT OF A PYRAMIDAL HORN ANTENNA, WITH APPLICATIONS TO VULNERABILITY TESTING OF COMMON ELECTRICAL APPLIANCES

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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 specified 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, and this provided information as to 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 antenns, 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.

This presentation concentrates not on the measurement program and results, but on the computational model used to characterize the excitation EM field in the near-field region of the horn. The model uses the equivalence theorem with an assumed TE10 field distribution over the horn aperture. Close to the antenna, the usual Fresnel and Fraunhoffer approximations cannot be invoked, and the 2-dimensional aperture field integration must be performed numerically. This procedure yields both the on-axis and off-axis fields. In this presentation, we describe the computational model and compare the results with other near-field calculations reported elsewhere in the literature.