Review of Susceptibility Data and Analysis Techniques in High-Power Electromagnetics

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The high-power electromagnetics community has tested many systems for failure due to illumination by electromagnetic waves. Failures are easily categorized as either upset or damage. Damage usually means physical damage to a component, but may mean sufficient change to the software or firmware of a system that the system will not function without repair. Upset is caused by interruption or confusion of data moving through a system or changes in stored data or programs that interrupts the function of the system until the programs and data are reloaded into the system. Upset occurs at lower energy or field levels than damage and is therefore more interesting to those trying to establish minimum threshold levels for failure as in weapon design.

The results of much of the susceptibility tests are withheld from the general public to discourage terrorist use of those data, but there is sufficient open publication to permit a discussion of the characteristics of the data (e.g., D. Nitsch, et al, IEEE Trans. EMC, 46, No. 3 August 2004). Thresholds for computers, for example, show large variation in upset thresholds for changes in center frequency, bandwidth, pulse repetition frequency, as well as with variations in test object configuration and composition. Understanding the trends and causal relationships in these data are critical to the long term goal of a predictive theory for failure due to EM illumination.

Analysis techniques for relating failure to the electromagnetic environment are usually based on 1) coupling analysis (Taylor and Giri, Taylor and Francis, 1994), statistical analysis of failure data (Ropiak, Gardner and Stoudt, ICEAA, Turin, 2005) or communications theory (Kohlberg and Gardner, Proc. ICEAA, Turin, 2001). None of these methods is complete, but each provides useful information about trends and required experiments. Further, each of the analysis techniques must agree with experiment when the experimental and analytical conditions are correctly matched. This paper summarizes the available failure data and the analysis techniques with emphasis on what is required to get to a useful predictive tool.