First Thoughts on a Standard for Future HPEM Immunity Tests

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***Abstract*— Since high power electromagnetic (HPEM) threats to electric devices had been emerging, various attempts were made to classify the threat parameters and to settle on a standard for testing devices. Today, additional sources of high power interference signals are available, with a wide range of bandwidths and frequency coverage. This paper will provide first ideas to tackle the problem of classifying those new threats, and propose new test procedures that cover he whole range of threats with a reasonable number of tests.**

Keywords- HPEM standardization, HPEM sources

I. Introduction

For a first classification of new threats, we follow [1], dividing the possible threat range into four classes according to their characteristic bandwidths: Narrow-, Meso-, Sub-Hyper-, and Hyperband. We propose to classify Sub-Hyper- and Hyperband as one class and to add the nuclear electromagnetic pulse (NEMP) as a single category due to its unique characteristics.

Since we discuss immunity testing in this paper, our goal is to expose a device under test (DUT) to a worst-case environment, e.g., a high power microwave (HPM) signal with a center frequency which can couple into the DUT, a damped sinus signal, an ultra wide band pulse, and a NEMP. After passing an immunity test with adequate threat levels, the DUT can be admitted to work in the real world.

To guarantee an effective test, a minimum field level must be defined. Based on statistical analysis of the susceptibility of electronic devices we estimate the minimum field level needed for disturbance of a DUT at approximately 20 kV/m. An exception must be made for narrowband HPM signals (with interference visible at 10 kV/m), see below.

Alternatively, the maximum field magnitude that available sources can generate at the locus of the DUT was estimated, under the assumption that bulky, powerful threat systems (e.g., JOLT [2]) cannot be operated unnoticed at close distances, whereas low-power miniature systems (e.g., can sources [3]) can be deployed close to the DUT.

Again, a realistic estimation results in a magnitude of 25 kV/m, approximately. The parameters for this estimation and, even more important, additional safety margins to guarantee a robust test are still under intense discussion.

II. Parameters for Threat Classes

A. High Power Microwave Signals

Sinusoidal and quasi-sinusoidal signals can be characterized by center frequency f_C, magnitude (≈10 kV/m) and damping factor. The chosen f_C will decisively effect the coupling.

B. Damped Sinus (DS) Signals

DS signals combine a high power density with limited bandwidths; DUTs will be damaged by the injected power. Additional coupling paths (e.g., through attached power and data cables) should be taken into account. Since tunable DS sources are not yet available, we propose to define a threat corridor in frequency domain from 100 - 1000 MHz, that can be covered with a broadband source at fixed center frequency.

C. Nuclear Electromagnetic Pulses

Several immunity test procedures deal with NEMPs already. The main difference to the other threats discussed here is the higher power and energy content of the signal.

D. Ultra Wideband (UWB) Signals

For characterizing UWB signals, we assume that this class can be defined by a double exponential pulse. Assuming that a critical UWB pulse, compared to a NEMP, contains the same energy with a ten times larger bandwidth, the rise time t_{rise} is the most important parameter for a standard UWB pulse:

$$t_{\text{rise, UWB}} \leq 250 \text{ ps}, \text{ and } t_{\text{rise, UWB}} \leq 0{,}1 \; t_{\text{rise, NEMP}} .$$

III. Discussion

Since this vast range of possible threats a priori allows for many possible classifications, we wish to engage in an active discussion of our approach.

References

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