Protection of Control, Signal, and Data Points of Entry Against HEMP

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Abstract— This paper discusses the special case of using passive filter devices on control, signal, and data Points of Entry (PoE) for the protection of electrical or electronic equipment against HEMP. Much of the discussion about protection of electrical PoE's is focused on facility power filters. However, it should be recognized that control, signal, and data cabling is also of concern and should be attended to properly. This paper will review the requirements for protection against HEMP and briefly touch on IEMI protection as described in various standards. The paper examines the electrical and mechanical characteristics needed in order to effectively accomplish the task of protecting and also providing operational reliability and safety for control, signal, and data points of entry

I. INTRODUCTION

We begin by noting the signal and control protection requirements of military standard MIL-STD-188-125 and commercial standard IEC 61000-4-24. It should be pointed out that these standards are only concerned with HEMP and not with IEMI. Other standards such as MIL-STD-461 deal with the issue of interference, but not as an act of deliberate and malicious intent. IEC 61000-4-36 is a commercial standard that effectively deals with the IEMI threat. A new standard, IEC 61000-5-10, is a guide for the application of protective measures for HEMP and IEMI.

Filters must handle conducted threats but must be constructed in a way that maintain the RF shielding effectiveness of the protected space to which they are attached. As such, the design of these filters should follow established standards and practices. These filters must be designed, validated, and tested not only for the required protection, but also as part of an RF shielded system that must remain operational, reliable, and safe during an attack as well as during normal operations.

The electrical and mechanical characteristics such as the type of materials used, the filter topology, construction practices, testing, and final installation are of critical importance for an effective mitigation and protection of defense and commercial structures. And while power filters should be built following the requirements of one or more safety standards such as UL 1283 and IEC 60939, signal and control filters have no such requirements and a more general standard such as MIL-PRF-15733 could be used.

II. THE PROTECTION STANDARDS

A PoE is any place within a shielded structure where there is an opening for passing cables, materials, or persons. In this paper, we are concerned only with PoEs that require metallic cables or wires to pass information from the unprotected area to the protected area or vice versa. MIL-STD-188-125 establishes that any cables passing through the shield must be treated for an HEMP threat such as E1 and E2. E1 is a fast pulse characteristic of the detonation of a nuclear warhead in space. E2 is a slower pulse similar to lightning. In addition, MIL-STD-188-125 establishes that the HEMP protection shield should be 80 dB from 10 MHz to 1 GHz. This does not consider IEMI which can fall on the frequency range above 1 GHz. Fortunately, filters can easily be made to work for IEMI once the filter has been designed to take care of the E1 and E2 pulses. But MIL-STD-188-125 is considered to be a severe protection standard and used mainly for critical defense structures. IEC 61000-4-24 considers different levels of protection depending on the structure to be protected and the level of protection desired. The intent is to show that extreme protection is costly whereas perhaps in some cases, a short disruption of operations may be acceptable in exchange for a more cost effective solution.

III. DESIGN OF CONTROL, SIGNAL, AND DATA PROTECTION FILTERS

A. Electrical Features

All control, signal, and data filters used for HEMP/IEMI protection must have a voltage rating and current rating consistent with the source and load impedances they will be protecting. In addition, typical designs for HEMP include an input inductor and a fast acting semiconductor arrestor device. But control, signal, and data filters pose a unique design challenge that is not present in power filters. That is, these filters typically have a broader passband than power filters. This passband may be upset by the addition of delay inductors, allowing distortion of the signal or passage of HEMP frequencies. An even more unique problem is found with high speed data signals as the passband of these must be quite large.

B. Mechanical Features

The filters' enclosure material should be plated steel or stainless steel. This is necessary so that conducted and radiated currents do not pass into the filter and thus into the protected area, but rather get diverted to earth ground or reflected. The proper filter design should have at least one completely sealed compartment on the load side for effective mitigation of HEMP/IEMI of the protected area.

C. Filter Testing

Filters should be tested for safety according to the manufacturer's procedures or MIL-PRF-15733. The filter expected attenuation (insertion loss) should be in compliance with the protection requirements and tested per MIL-STD-220 or CISPR 17. In addition, the filters should be tested for their residual current performance during a simulated HEMP PCI event. PCI testing is done as design verification by a 3rd party, and typically not during production.