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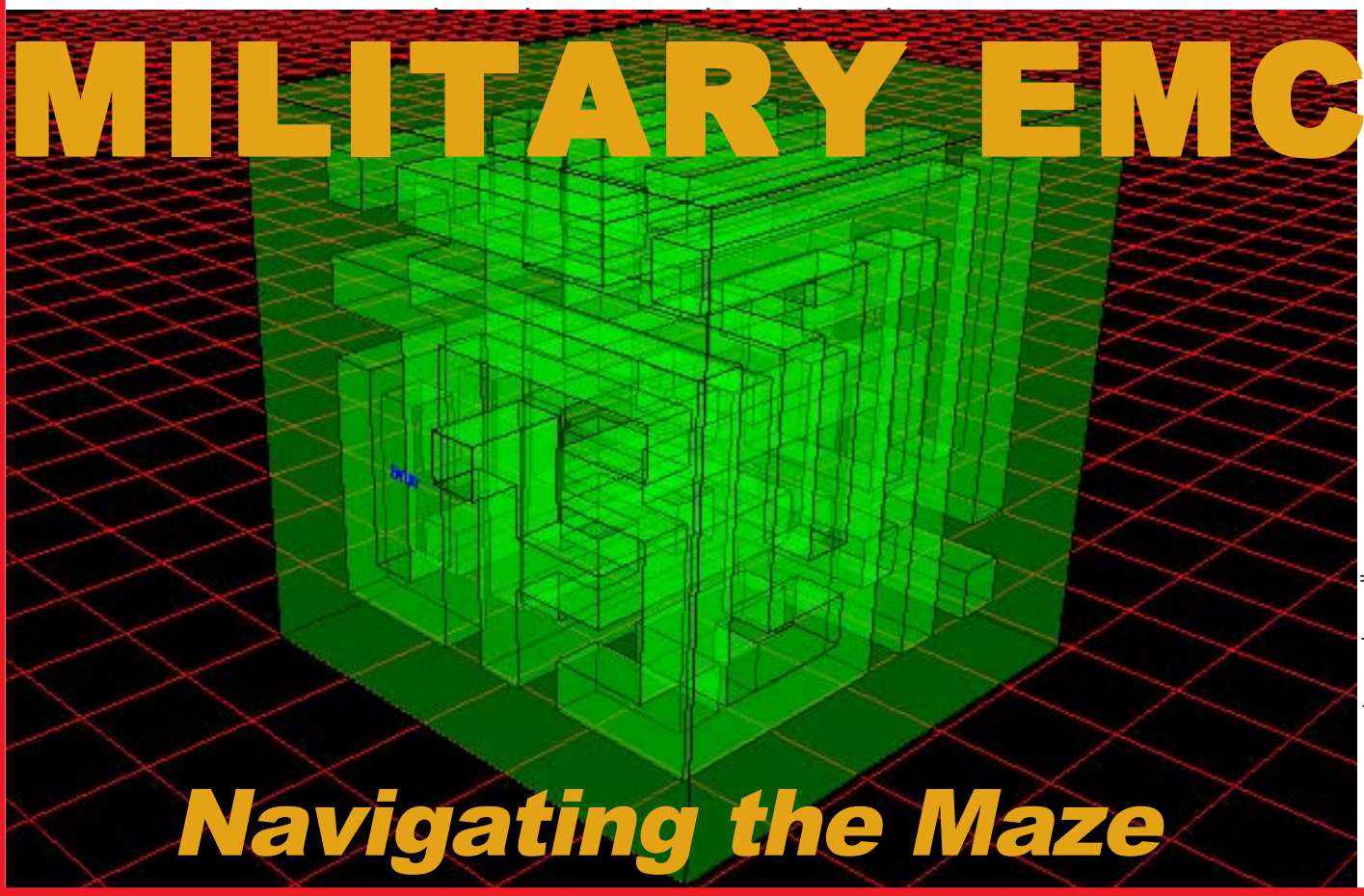
MILITARY EMC



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Navigating the Maze

There is a major swing back to military EMC after a funding drought lasting a decade. New military projects are being funded, and that means lots of new EMC work. On the other hand, commercial EMC remains decidedly on the slow side, waiting for the economic recovery. Accordingly, some EMC professionals are "crossing over" to work on military EMC projects, where they are finding a significantly different way of doing business.

A Different Approach to EMC Engineering

This article is dedicated to the EMC engineer new to the military EMC end of the business. We'll look at both the technical and management aspects of developing and delivering military systems. Tougher limits are only a small part of the differences. There is also a tendency to treat EMC from a systems point of view, with much more formality in the process.

More Stringent Requirements

MIL-STD-461E: *"DOD Interface Standard Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment"* was published on August 20, 1999 and consolidates MIL-STD-461D and MIL-STD-462D into one Standard—Military Standard 461E.

It was intended that the application of MIL-STD 461E be tailored to the particular needs of the equipment or system to which it is applied. The requirements, then, vary with the application. Depending on the environment in which the equipment or system is intended to operate, EMC requirements may be more stringent than for a non-military counterpart.

For example, emission limits can be 30 dB lower than for their commercial counterparts. Susceptibility (or immunity) levels, can run between 10 to 200 v/m, depending on the environment to which the equipment or system may be exposed. Shipboard aircraft may encounter even higher levels-perhaps exceeding 10 KV/m for equipment exposed to shipboard radar.

New system frequency ranges may be much wider at both the low and high frequency end. Consequently, a multi-layered approach utilizing several EMC control techniques may be necessary to achieve compatibility.

Designers and testers will need to review the actual requirements levied on a given equipment or system before a planned approach can be established.

It is important to remember that while tailoring of MIL-STD 461E is encouraged, the tailoring must be appropriate to the application. If not, it is important to revise the tailoring early, before manufacturing, to avoid costly rework.

Containment Or Suppression?

A point has been raised that military EMC people don't pay any attention to circuit board design - they only work at the box level. There is a definite truth to this observation, but the practice is not without justification.

The fact of the matter is that only a select set of EMC problems can be solved by circuit design—another set will respond better (and less expensively) to containment.

Containment includes high quality shielding and box level filtering. EMC enclosures must have minimal openings or slots. As a minimum, service access and connection points will need EMI gasketing held in-place with closely spaced screws.

Cable shields will need 360 degree wrap, without pigtail connections.

Filters will be needed on all unshielded lines, including power and ground wires. Feed-through filter connectors are a good (but expensive) solution.

Continued . . .

MILITARY EMC continued...

Military enclosures need to be pretty rugged for reasons other than EMI—shock, vibration and environmental factors (rain or, worse yet, salt spray and stack gasses). Maintaining the structural integrity of a ruggedized enclosure can impact the application of both internal circuit design and external EMC controls.

Once the need for shielding and filtering has been determined, circuit board design plays a supporting role. With the establishment of a good shield, circuit design techniques can have greater impact on the overall EMC performance of a system.

Application of basic EMC and signal integrity principles at the circuit board and interconnect level would ease the load on the shielding requirements and probably result in avoidance of some elusive internal gremlins, as well. Our observation is that there are a lot of boards in use that could have had 10 to 20 dB lower emissions—enough to make the difference between pass and fail in many cases.

EMC Documentation

Military EMC programs will require that the supplier prepare three major documents; the EMC Control Plan, the EMC Test Plan and the EMC Test Report. The following paragraphs explain what these documents contain.

1. The EMC Control Plan:

The EMC Control Plan defines how the EMC requirements are to be met. The contract should define the environment in which the equipment or system will operate. The EMC Control Plan then defines the problem, the levels, the vulnerabilities, and any expected sensitivities.

The plan defines the steps anticipated to overcome the vulnerabilities. It defines the development organization, and how the appropriate steps will be taken, and how the EMC team expects to identify and resolve problems in a timely fashion.

The EMC Control Plan serves two purposes. One, it shows the customer that you have your arms around the problem and have a reasonable probability of delivering the goods. Two, it serves as a design guideline to the design team, so that they know how to proceed. Clearly, the EMC design approach needs to be a cooperative effort with the electrical and mechanical design teams.

The EMC Control Plan will be prepared early in the beginning design stages, before any design details have been worked out—so it will need to be amended as the design progresses.

2. The EMC Test Plan

The EMC Test Plan defines how the equipment will be tested. Military EMC tests will be tailored to the particular system. The tests should be conducted to simulate the installation as closely as possible, notably including grounding and cable routing.

All questions of technical approach and disagreements on test methodology need to be resolved before actual testing begins.

3. The EMC Test Report

The EMC Test Report documents the results of the testing. In the ideal world, this would simply be a tabulation of the resulting test data, with a summary indicating that all requirements had been met or exceeded. In practice, deviations from the requirements are very common. In such a case, it is important for the customer to know that requirements were not met—and why.

This isn't to say that a deficient product is being delivered. It is simply facing the physical facts of life. In the early stages of a military design, requirements may not be well defined, or may change. It is typical to err on the conservative side—on the principle that it is easier to relax requirements later on than it is to increase them.

For example, emissions in excess of the requirements at a particular frequency won't be bothersome if no communications equipment or radar intermediate frequencies will be operating in the product performance range.

After all, the goal is to build a system that works, and there is no reason to increase the cost or delay delivery in order to correct a "problem" that doesn't exist in the anticipated working, operational environment. So you may be able to get some of the requirements waived, but it is still important to know just what levels you have achieved to support your thesis for waiver.

Major System Design Reviews

In addition to internal design reviews, you may be participating in several major system design reviews, especially including the Preliminary Design Review (PDR) and Critical Design Review (CDR). The design reviews aren't limited to just EMC, of course. You may be amazed at the number of participants in these reviews.

> "THE CHALLENGE TO EMC ENGINEERS IS TO DELIVER A SYSTEM WHICH WILL OPERATE TO ITS FULL DESIGN POTENTIAL IN AN EVER-CHANGING COMBAT ENVIRONMENT."

The Preliminary Design Review occurs early in the program, shortly after submission of the EMC Control Plan. Here is where the players, including the customers and other suppliers, get together and review each other's plans. The purpose of the design review is to get everything on the table so that potential problems can be identified and resolved in a timely fashion.

The Critical Design Review occurs later in the design stage. This is where everyone tells each other how they are going to build it. This is the last chance to catch any problems before manufacturing commences.

Summary

Military projects employ a formal program approach. Military systems can be complex because of "battle-hardening" requirements.

The cost of system failure is much higher, so the military customer takes an active role in development throughout the system design, build planning and acceptance testing.

The challenge to EMC engineers is to deliver a military system which will operate to its full potential in an ever-changing combat environment. Ω