

KIMMEL GERKE



Bullets

Spring, 2002

Welcome to KGB...

And to this issue of our "personal communications" to our friends, clients, and colleagues about EMI issues, problems and solutions.

This KGB discusses "Military EMC," a topic of renewed interest these days. We have certainly seen that in our business, both in EMC training and EMC consulting.

Since both of us got our EMC start (over 30 years ago) with defense contractors, we are both very comfortable with this industry. However, some of you may be new to this area, due to job changes or your companies pursuing defense related projects. Thus, we thought it might be useful to share our EMC perspectives and experiences and perspectives about this important industry.

Unlike commercial EMC, military EMC has a very heavy systems emphasis. While much of the commercial EMC focus is on high speed circuit board design, the military focus is often on grounding, shielding, power, cables, and I/O interfaces. As a result, we've seen many commercial designers (and even commercial EMC consultants) struggle to prevent and solve military EMC problems. Although brief, we hope this provides you with some helpful insights.

As always, give us a call if we can help you with any of your EMI problems... military, commercial, medical, industrial, telecomm, automotive, and more...

Best Regards... Bill Kimmel, PE, and Daryl Gerke, PE

Please Requalify...

You can requalify at www.emiguru.com/register.htm, or you can send in the enclosed card if you received this by snail mail. Please include your E-MAIL address, plus your current regular mail address (home OK.)

We are in the process of converting to an electronic version of the KGB. It saves us money (our list is getting pretty big) and it lets you store them, or forward them to friends and colleagues. Thus, email will be the preferred medium, unless you specify regular US mail.

Current and back issues of the KGB are available at www.emiguru.com. *By the way, our KGB list is PRIVATE... it is never used by anyone else.*

Shows and Conferences...

Here are some shows and meetings we are involved with that may be of interest. Call us if you'd like more details.

IEEE EMC Symposium... August 19-23, 2002, in Minneapolis, MN. This is the first time this show has been held in the "Twin Cities." Daryl will give a one hour talk on "Designing for RF Immunity" as part of the Monday tutorial session. August is the ideal time of year to visit Minnesota... we hope to see you there.

Public EMC Courses...

Here are the cities for the Fall 2002 schedule for the EMC seminar series sponsored by Tektronix, and conducted by Kimmel Gerke Associates, Ltd. The exact dates have not been set yet, but watch our web site, www.emiguru.com, for more information.

- Denver, CO - September 2002
- Phoenix, AZ - September 2002
- Minneapolis, MN - October 2002
- Chicago, IL - October 2002
- Detroit - October 2002
- Seattle, WA - October 2002
- Santa Clara, CA - November 2002
- Los Angeles, CA - November 2002

We are planning a new format for the fall series, with updates (of course) containing the latest EMC information. *By the way, four or more from the same company qualify for a 10% discount.* These classes have been sponsored by Tektronix since 1993, and are very popular.

In-House EMC Courses...

Our on-site classes are also popular. Here are some recent classes we have done for clients:

- Design for EMC (2 days)
- Medical Design for EMC (2 days)
- EMC in Telecommunications (2 days)
- EMC in Vehicular Electronics (2 days)
- EMC in Military Systems (2 ½ days)
- EMC in Avionics Systems (2 days)
- Design for ESD (1 day)
- EMC in Systems (1 day)

We can customize to meet your special needs. Flat rate for up to 30 students, but with even a dozen students, an in-house class makes sense.

Focus on "Military EMC "...

We've seen a strong increase in our military EMC business in the past year. This is a change, as most of our work in recent years has been in the commercial, industrial, vehicular, and medical areas. Nevertheless, we have been involved with military EMC for over 30 years — in fact, that's how we got started with EMC.

Some of our clients are new to military EMC, due either to job changes or to their companies now pursuing defense contracts. That can lead to frustration and confusion, particularly when making adjustments from commercial to military projects. We've both seen several engineers struggle with this transition. Here are some comments and observations on dealing with military EMC issues.

First, there are many military environments. These can range from submarines to outer space, and from the desert to the arctic. These environments range from benign to harsh, and the products are usually low in volume and high in engineering efforts. (The infamous \$50 hammer may represent \$49 in special design/test efforts, and \$1 in actual materials - still often a "good deal" if the hammer must work in outer space or 5,000 feet beneath the sea.)

MIL-STD-461E, the key military EMC specification, addresses these multiple environments through a matrix of recommended requirements. The requirements for submarines are different than those for aircraft, etc. These requirements may vary among the different service branches as well. The overall goal it to anticipate the intended environment, and to provide tests that will assure operation in that environment.

For unique environments, the requirements may be "tailored." Test levels may be modified, or tests may be added or deleted. This often applies in spacecraft and avionics environments to accommodate special sensors or communications/navigation gear that may be on board.

One caveat - be sure you understand the requirements, and why they are being levied on your design. The best time to do this is during a proposal, NOT after you have signed the contract. In theory, the contracting agency (or prime contractor if you are a subcontractor) knows what they are asking for. In reality, this may or may not be true. We once had a case where a high level airborne RF immunity level was specified for a piece of land based equipment.

A KGB Bullet...

Here is a formula for the shielding effectiveness (SE) of a slot or opening in an enclosure:

$SE (dB) = 20 \log 150/(fD)$, where

f = frequency in MHz, and d = distance in meters

1 Ghz 1mm = 43dB 1cm = 23dB 10cm = 3dB

100 MHz 1mm = 63dB 1cm = 43dB 10cm = 23dB

Note: When a slot or opening exceeds 1/2 wavelength, you get ZERO dB ATTENUATION.

Fortunately, the cognizant EMC engineer for the prime contractor dropped the irrelevant requirement, much to the relief of our client.

Second, the relationship is contractual, not regulatory. This is a key difference between military EMC and commercial EMC. As we already mentioned, most military EMC requirements are application specific, and can be negotiated and/or tailored.

Furthermore, if you fail a test, you can often ask for a "waiver." In this case, you will need to demonstrate that the test "failure" will not have an adverse impact on overall system performance. For example, if you are 3 dB over the radiated emissions limits at 625 MHz, and nothing in the system uses 625 MHz, you may very well get the waiver. You certainly won't get that type of relief from the FCC or CE. In the commercial world, it is "meet it or else..."

Third, the focus is on systems, not individual elements like printed circuit boards. While high speed PCB design is all the rage in the commercial arena, military EMC often focuses on more mundane issues like grounding, shielding, power disturbances, lightning, and cables and connectors.

Many military designs are embedded controllers, and don't need GHz+ processors - but they do need good overall EMC systems design approaches. And while most military products still benefit from good PCB design techniques, military EMC success depends more on good EMC "teamwork" than on individual high speed "design stars."

Fourth, the cost of failure may be very high. Two key concepts are "mission criticality" and "personnel safety."

What is the cost if the mission fails? For a spacecraft, it might be many millions of dollars. For a aircraft or weapon system, it could mean loss of life. One of the more publicized "mission failures" in recent years during the Falklands war in South America. A British ship was sunk due to EMC problems between a satellite communications system and an antimissile tracking system.

A colleague put the safety issue in perspective some years ago when he said, "When we launch a missile, we can't reset if it decides to come back at us due to a glitch..." Always think about safety with military systems!

So what is the impact on design? MIL-STD-461 has four test categories : RE, RS, CE, CS. These terms stand for radiated emissions, radiated susceptibility, conducted emissions, and conducted susceptibility. Here are some comments on each of these categories.

RE/RS - The military radiated emissions requirements are typically between 10 and 1000 times (60 dB) more stringent than commercial requirements. The military radiated susceptibility requirements are typically between 1-100 times more severe, with special cases over 10,000 times (80 dB+) more severe than commercial requirements.

In addition, the military RE/RS limits cover a much wider



frequency range, often going down to 10 kHz and as high as 40 GHz (and beyond if needed.)

As a result, you should pay careful attention to shielding, cabling, and circuit board design. Typical design features include solid metal enclosures with gaskets, filtered I/O pins and shielded cables, and multi-layer circuit boards.

CE/CS - The military conducted emissions limits are also more stringent than commercial limits, and the military CS limits are generally much more severe.

As a result, you need to pay strict attention to all power (DC and AC), I/O interfaces, and grounding. Typical design features include multistage power filters (often operating up into the multi-GHz range) augmented by extensive transient protection. I/O lines often incorporate filtered connectors with full metal EMI backshells.

Special Effects - Some military programs include additional requirements for specialized threats such as HIRF (high intensity RF) and EMP (electromagnetic pulse) effects. These typically require additional design features.

In closing, we hope this has given you some useful insights into military EMC problems and solutions, particularly those of you "new" to military EMC. As we mentioned, we've been at this for years, and we "cut our teeth" on military EMC. If you need help with these issues, or any other EMC issues, please contact us at 1-888-EMI-GURU, or through our web site at www.emiguru.com.

The optimist says the glass is half full. The pessimist says the glass is half empty. The engineer says the glass is twice as large as it needs to be. —*Author unknown*

Tired of Telemarketers???

Who isn't? Not exactly an EMI problem - but they could be classed as irritating "noise". In any event, the FCC and sister agency, the FTC, may be able to help. Here's how:

Unwanted telephone calls - The Federal Trade Commission is proposing to amend the Telemarketing Sales Rule, creating a national "do not call" registry. Naturally, telemarketers are fighting it, and the plan has a lot of loopholes. Still, it's a start. To comment, go to www.ftc.gov, or send an e-mail with comments to tsr@ftc.gov. Comments were due by April 15, but what the heck — drop them a line anyway. The more, the merrier...

Unwanted facsimiles - This one is even better. Our own FCC made unsolicited faxes illegal in 1991. Fines of over \$10,000 per unwanted fax have already been levied — don't you just love it? We've been sending unsolicited faxes to the FCC for action. For more info, go to www.fcc.gov, and search on "unsolicited fax." Now if we could just get some action on e-mail spam...

Book Reviews...

The Art of Electronics, by Horowitz and Hill. If you are involved with electronic design, you need this book. Sometimes called the "EE Bible", it covers a wide gamut of circuits and systems. Easy to read with lots of practical information — just the type of approach we appreciate. Second edition published in 1989, and reprinted in 1994. ISBN 0-521-3705-0. Price is about \$70, but worth it.

FFFFFFF...

In a recent EMI class, Gil Davis of General Dynamics came up with the "Seven F" slogan - *For Field Fixes Ferrites Fight Foul Frequencies*. (Groan...)

So here is the challenge — send us your literary EMI masterpieces, and we'll publish the printable ones.

Some Questions & Answers...

Here are some questions we recently received regarding shielded rooms.

Q. Will copper screening make a good screen room, or is the contact between individual wires too unreliable?

A. Copper screen will make a very good screen room. Many commercial rooms are made from copper screen, and work quite well. Typical problems are not with the individual wires, but rather with the seams, joints, penetrations (power & signal lines), and doors.

Q. How critical is earth grounding of the room?

A. Earth grounding is not critical from an EMI point (since the room is a Faraday cage), but it is VERY IMPORTANT from a SAFETY standpoint. Be sure to have a solid wire connection (typically #6 or larger) with clamps. The bonding connection should be installed so it cannot be undone. This "earth ground" connection is necessary to prevent shock hazard if the room becomes energized.

Q. Could you recommend any references on proper construction of a shielded room?

A. A good reference is the "*Architectural Electromagnetic Shielding Handbook*" by Leland Hemming (IEEE Press.) Keep in mind that room shielding is like building a water tank. The material usually works fine (even screen), but the big issues are to plug the holes and seal the joints.

EDN Designer's Guide to EMC...

The updated version of this popular guide (written entirely by Bill & Daryl) is available from Cahners Publishing. The update includes two new chapters, plus new regulatory information. Strongly recommended for anyone just starting out in EMC.

Cost is \$49.95, with quantity discounts. To order, go to our web site, www.emiguru.com, and click on the icon for the EDN Magazine Designer's Guide.



About Kimmel Gerke Associates...



DARYL GERKE, PE

We are a professional engineering consulting & training firm that specializes in *Electromagnetic Interference & Compatibility*, often referred to as "electronic noise." We share over 70 years of experience in the electronics industry. We are both degreed Electrical Engineers, Registered Professional Engineers (PE), and NARTE Certified EMC Engineers.



WILLIAM KIMMEL, PE

We both have extensive experience with the design, application, and installation of electronic equipment and systems subject to various EMC requirements (FCC, CE, FDA, SAE, DO-160, BELLCORE, MIL-STD-461, TEMPEST). We also have in-depth EMC troubleshooting experience, and extensive EMC training experience (over 250 classes). Give us a call to help with your EMC problems.

EMI-Toolkit (R) 2.0...

Check out the updated version of our popular *EMI-Toolkit*® software. The new version includes many useful features, plus an improved format. Comes on CD, and runs under Windows 95/98/NT/2000/XP. \$150 single user, \$750 for site license. Discounts apply for V1.0 users.

If you are heavy into the EMC standards, consider *EMI-Toolkit*® Plus. All the neat features of V2.0, plus additional information on most relevant EMC standards (MIL-STD-461, DO-160, FCC, CISPR, and more...)

For more information on either version, call us at 1-888-EMI-GURU, or e-mail bkimmel@emiguru.com*

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