KIMMEL GERKE Bullets

Winter, 2001

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 "EMC Software", a topic of increasing interest. We certainly noticed this at the IEEE EMC symposium in Montreal last August, which included several papers and demonstrations on EMC software. We also receive questions on this issue in our public Tektronix sponsored classes (as a result, we now discuss this issue as a regular part of the design class.)

What many designers want is a software program that will tell them, with no uncertainty, whether their design will pass or fail an EMI requirement, and by precisely how much. Unfortunately, there is no such software panacea for EMI. We are beginning to see, however, some tools that might assist design and test personnel in the fight against EMI.

As always, give us a call if we can help you with any of your EMI problems, from "DC to daylight..."

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

Seasons Greetings...

Our sincere best wishes to you and your families this holiday season, and the best to you in 2002... *Bill & Daryl.*

EMC Winter Workshops 2002

Orlando, FL - February 4-7, 2002
San Diego, CA - February 11-14, 2002

Need a winter break, and some fun in the sun? Want to learn more about EMC design, systems, or trouble-shooting? Then join us in San Diego or Orlando in February for our "once a year" expanded seminar series, sponsored by Tektronix.

As we have done in the past, we have one day on systems, two days on design, and one day on troubleshooting. Take only what you need to get up to speed on EMC issues.

For more details, visit our website (*www.emiguru.com*) or call us toll free at 1-888-EMI-GURU. *(Inquire about special hotel rates if you reserve by January 1.)*

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.

Portable Design 2002... January 15, 2002, at the Santa Clara Marriott in Santa Clara, CA. Daryl will be doing a one day tutorial session on *"Dealing with EMI in Handheld Systems."*

IEEE EMC Symposium... August 19-23, 2002, in Minneapolis, MN. This is the first time this show has been held in the "Twin Cities." August is the ideal time of year to visit Minnesota… we hope to see you there.

EMI Courses...

Here is the first-half 2002 schedule of the popular seminar series sponsored by Tektronix, and conducted by Kimmel Gerke Associates, Ltd.

-Orlando, FL - February 4-7, 2002
-San Diego, CA - February 11-14, 2002
-Dallas, TX - February 25-27, 2002
-Research Triangle Park, NC - March 4-6, 2002
-Long Island, NY - March 11-13, 2002
-Somerset, NJ - March 18-20, 2002
-Baltimore, MD - April 8-10, 2002
-Boston, MA - April 22-24, 2002
-Rochester, NY - April 29, 30, May 1, 2002

These classes have been sponsored by Tektronix since 1993, and are very popular. If you have been to a recent class, you know that we also discuss *Signal Integrity* and *Power Quality* issues, and how these complement good EMI design. See our web site, *www.emiguru.com*, for more info. Please note that you can now register on-line.

EDN Designer's Guide to EMC...

Good news and bad news here. The good news is that the updated version or our popular guide (first published in 1994) is now available. The bad news is that it was not included as a free supplement to EDN Magazine.

We still think it is a good deal, even for $49.95. The update is in full color, and contains two new chapters plus the rest has been fully updated for new regulations, etc. Lot's of good practical ideas from Kimmel & Gerke. To get your copy, go to our web site *(www.emiguru.com)* and click on the icon for the EDN Magazine Designer's Guide.

Kimmel Gerke Bullets is a newsletter on electromagnetic interference/Compatibility (EMI/EMC).
Published by Kimmel Gerke Associates, Ltd., 300 Christine Lane, W. St. Paul, MN 55118 • 1-888-EMI-GURU • http://www.emiguru.com

Focus on "EMC Software"...

One thing we noticed at the IEEE Symposium in Montreal last August was the increased interest in EMC software.

PCB simulations were very popular. We particularly liked one software demonstration that showed standing waves on a circuit board. The animated PCB oscillations reminded us of the classic film clips of the Tacoma Narrows bridge failure many years ago. Thanks to the software simulations, one could readily imagine the electromagnetic energy "flying" off the boards.

Unfortunately, EMI software still does not do everything that designers would like it to do. What many engineers (and most managers) would like is software that would give EXACT emission levels or susceptibility thresholds, plus the EXACT cause of any problems. It should be very easy to use, and require absolutely no EMI knowledge to use. It should be inexpensive as well.

Frankly, we don't ever expect to see EMI software that meets all those "wants" we just described. The EMI area is filled with subtle problems, often caused by uncontrolled parameters that act in unpredictable ways. EMI is often like Winston Churchill's description of Russia — an enigma wrapped in a mystery wrapped in a riddle.

Nevertheless, progress is being made. It does look like useful tools are starting to emerge. Here are some general comments on EMI software. Incidentally, we now include these comments in our EMI design classes.

Test Software... Most test equipment manufacturers offer EMI software to automate their equipment. The same software also typically provides data reduction, graphing, and archiving of the test data.

Most of this software is quite useful and mature. The test equipment manufacturers continue to update and improve their software all the time. When asked, we usually strongly recommend purchasing any EMC software that is available for your EMC test equipment. Of course, you also want to keep that software up to date as new versions are released.

PCB Design Software... There are two general categories for this type of software: analytical, and rules based. The former include software for Signal Integrity (SI), crosstalk (CT), and PCB radiated emissions. The latter include software that post-process layout/routing software for possible EMI problems, based on predetermined design rules.

A KGB Bullet...

As a first approximation, single layer wire wound inductors are good to about 50 MHz.

To refine this, you can use the following formula:

fo=200/sqrt (L)

fo resonant frequency in MHz

L=inductance in uH

For example, a 100 uH choke will typically become self-resonant at about 20 MHz.

Based on what we have seen, we have pretty good confidence in the SI/CT software. We are less optimistic about software that directly predicts PCB emissions. Remember, SI/CT problem levels are usually millivolts and milliamps. EMI problem levels are often microvolts and microamps for emissions, or kilovolts and amps for susceptibility. Also, EMI problems are often due to common mode issues, which can be very difficult to accurately predict and control.

We are also encouraged by the development of rules-based EMI software, which can quickly identify potential layout problems. This type of software, of course, is only as good as the inherent design rules, but much progress has been made in this area in recent years.

Systems Design Software... This type of EMI software often uses electromagnetic field modeling. There is still a lot of research & development in this area, so much of this software is still maturing.

This type of software if usually focused on very specific problems. As such, the electromagnetic field solvers may not be too useful for EMC unless you have a very specific problem worthy of in-depth modeling and analysis.

One type of RF systems software that is becoming more popular in the EMC community are the derivatives of the NEC codes for antenna analysis. These are quite mature, and antenna designers have been using these with good success for many years.

Summary... We hope this has given you some additional insight into the current state of EMC software, as we view it from our perspective as practicing EMC engineers "in the trenches." We are encouraged by the developments, but you still need to understand the underlying EMC problems.

These software packages are tools, not total solutions. It is like giving a carpenter a new saw — he or she still needs to know how to build houses.

Some Questions & Answers...

We often receive questions from our clients and class students, seeking to clarify key EMC design issues. Here are a few we have received in the past few months.

Q. I have a sensor with three wires: +V, ground, and output. Should I (1) twist the +V/ground together, (2) twist the output/ground together, or (3) twist all three leads together?

A. We recommend twisting all three leads together. You want both the signal and the voltage leads twisted with their respective return leads. Twisting all three assures that this happens.

Q. In your class, you talked about keeping the length/width ratio of ground straps low. You gave a guideline of less that 5:1, or better yet, 3:1. Does this apply only to threat frequencies above 10 kHz, or for all frequencies?

A. This guideline applies when threat frequencies are above 10 kHz, which is where inductance begins to predominate over resistance. At 5:1, the inductance is about half that of a

round wire, and at 3:1, the inductance is about 1/3 that of a round wire. That translates to 6dB & 10dB improvements. Note that at a 10:1 ratio (such as a one inch braid only ten inches long), the reduction is minimal, or no better than a round wire.

Q. You mentioned in class that crimped cable connectors often are too noisy for EMI measurements. Are the BNC connectors with a soldered terminal and screw clamp shield (as shown in the ARRL Radio Amateur Handbook) OK?

A. Yes, as long as the connection remains tight. The problem with a crimp connection is if it becomes loose. The combination of the soldered center terminal plus a screw clamp should work quite well.

By the way, even corrosion can cause a problem here. One of Daryl's personal "war stories" occurred a few years ago. He called the TV cable company to complain about lousy reception on several channels. The guy replied, "Oh, you have a bad cable connection. We'll send someone out to take a look at it." He went out and looked at the cable connections, and they looked OK . A couple of days later, the picture was fine on all channels. He went and looked again, and sure enough, the cable connectors had been changed. So even a veteran EMI engineer can be fooled by the first inspection.

> Learn from the mistakes of others. You can't live long enough to make them all yourself — *Author unknown*

Real Engineers...

- Real Engineers consider themselves well dressed if their socks match.
- Real Engineers buy their spouses a set of matched screwdrivers for their birthday.
- Real Engineers know the second law of thermodynamics, but not their own shirt size
- Real Engineers wear mustaches or beards for "efficiency" and not because they are lazy.
- Real Engineers know the "ABC's of Infrared" from A to B.
- Real Engineers will make four sets of drawings (with seven revisions) before making a bird bath.
- Real Engineers briefcases contain a Philips screwdriver, a copy of "Quantum Physics", and half a sandwich.
- Real Engineers rotate their tires for laughs.
- Real Engineers repair their own cameras, telephones, televisions, watches, and automatic transmissions.
- Real Engineers don't find any of the above funny.

-Sent to us by e-mail from an obvious non-engineer.

EMC Resources from Kimmel Gerke...

In addition to consulting and public classes, we also offer other resources that may help you address EMC problems. These include software, books, and in-house training.

Software... *EMI-Toolkit®* Version 2.0. This update includes many useful features, plus an improved format. Comes on CD, and runs under Windows 95/98/NT/2000. $150 single user, $750 for site license.

EMI-Toolkit® Plus includes additional summary information on most relevant EMI standards. For more details on either version, call 1-888-EMI-GURU, or email *bkimmel@emiguru.com*.

Books... In addition to writing well over 100 technical articles, we have written three books that may be of interest. All emphasize practical "nuts and bolts" approaches to help you identify, prevent, and fix your EMI problems.

EDN Magazine Designer's Guide to EMC... The long awaited update to our original 1994 supplement in EDN Magazine. The update includes two new chapters, plus new regulatory information. We're told several companies bought the original version in quantity, and then gave them to their design engineers. Neat idea, we thought.

Only $49.95 each, with quantity discounts. To order go to our web site, *www.emiguru.com*, and click on the icon for the EDN Designer's Guide. You can also go directly to *www.EDNmag.com*.

EMC Suppression Handbook... You get this book free when you attend one of our classes. But even if you can't make it to a class, you can still get your own copy of the little red book with the great EMI war stories.

Only $25 plus shipping. To order, contact Seven Mountains Scientific at 814-466-6559, or *www.7ms.com*.

Electromagnetic Compatibility in Medical Equipment... Published in 1995 as a joint project by the IEEE and medical publisher Interpharm Press.

Price varies. It appears the IEEE no longer stocks this book, but it is available at the Seven Mountains Scientific EMC Bookstore (*www.7ms.com*), Interpharm, or by special order at *amazon.com*. ISBN 0-935184-80-5.

In-House Training... Our on-site EMC classes are very popular. Here are several standard classes we offer:

- *Design for EMC (2 days)*
- *Systems Grounding & Shielding (1 day)*
- *Medical Design for EMC (2 days)*
- *EMC in Telecommunications (2 days)*
- *EMC in Vehicular Electronics (2 days)*

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

About Kimmel Gerke Associates...

We are often asked to give a quick description of what we do and who we are. If you are asked by someone needing EMI help, here are several key points about KGA...

Point I... We are a two-man electrical engineering firm that specializes in consulting & training on EMI/EMC (electromagnetic interference and compatibility) issues. These include five areas:

- -Regulatory Compliance (Emissions, immunity, FCC, CISPR, IEC, CE, MIL-STD-461, DO-160, SAE, etc.)
- -Radio Frequency Interference - (RFI)
- -Electrostatic Discharge -(ESD)
- -Power Disturbances - (Transients, magnetic fields, etc.)
- -Self Compatibility - (Signal Integrity, Analog, etc.)

Point II... We serve many industries, and our support ranges from circuit boards to complete systems. We've helped clients in the following areas:

- Computers (PCs to supercomputers)
- Industrial Controls (Individual controls to full systems)
- Vehicular (Planes, trains, automobiles, farm machinery)
- Medical (Diagnostic, clinical, patient connected)
- Telecommunications (Small and large systems)
- Military (MIL-STD-461, TEMPEST, EMP, etc.)
- Architecture (Shielded rooms, lightning, power)

Point III... We are Registered Professional Engineers (PE) and NARTE Certified EMC and ESD engineers. Between us, we have over 70 years of industry experience.

Point IV... We are not a test lab - our emphasis is on EMC design, troubleshooting, and training. While we are knowledgeable on key EMC tests and regulations, our focus is on design/systems issues, and how to identify, prevent, and fix EMI problems.

Point V... We are an independent consulting firm with no outside affiliations. Our advice and recommendations are free from any bias or other business concerns.

Please feel free to pass our name along to your colleagues. Your referrals are always sincerely appreciated.

Kimmel Gerke Associates, Ltd.
300 Christine Lane
W. St. Paul, MN 55118

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