

# KIMMEL GERKE



## Bullets

Summer, 2003

### 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 what we call "CONC", or the "cost of non-compliance."** As engineers, cost is always a factor, whether we like it or not. For example, anyone can build the world's best washing machine for a million dollars. The real challenge is to build a highly reliable washing machine that pleases customers, and that can sell for a couple of hundred dollars and still make a decent profit.

One issue that often drives up engineering costs is the compliance with regulations, such as those for EMI/EMC. The earlier in the design process EMI/EMC is addressed, the better. Fixing problems at the end of a project (when most EMC tests are done) can be expensive and frustrating. Even more expensive is fixing a problem in the field, which can mean product recalls or sending out field personnel. As the old saying goes, "For the want of a nail, a horse was lost... for the want of a horse, the battle was lost..."

Our advice — don't CONC yourself out. We'll look at the CONC factors in several industries, and share our perspectives. As always, if we can help you with any of your EMI problems... from designs to disasters... give us a call at 1-888-EMI-GURU.

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

### **EMC Winter Workshops 2004** Orlando, FL – San Diego, CA

Even though it may be hot outside right now, winter will still be here in six months. It's not too soon to start thinking about a winter break, and a chance to learn more about EMC systems, design, and troubleshooting.

This is the only time we offer the one day EMC Troubleshooting Workshop, so even if you have attended our other classes (*Grounding & Shielding* or *EMC & Signal Integrity in PCBs*), you still have a good reason for some midwinter fun in the sun. Of course, you can always attend all four days for an *EMC refresher*. Watch [www.emiguru.com](http://www.emiguru.com) for details.

### 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 18-22, 2003, at the Hynes Convention Center in Boston, MA. We will be there, of course. Daryl will present a tutorial session on Monday on *EMC Systems Engineering*, and both Bill and Daryl will chair technical sessions on Tuesday.

– **Power Line Interference Workshop...** September 15-16, 2003 at the Airport Ramada Inn in Spokane, WA. This will include presentations by Marv Loftness, author of the *AC Power Interference Handbook* (see our book review.)

### Public EMC Seminars...

Here are the cities for the Fall 2003 schedule for the EMC/SI seminar series co-sponsored by Tektronix and Kimmel Gerke Associates, Ltd. For more information, visit our web site at [www.emiguru.com](http://www.emiguru.com).

– **Portland, OR - September 8-9-10, 2003**

– Tektronix Campus Bldg. 38, Beaverton, OR

– **Denver, CO - September 15-16-17, 2003**

– Courtyard by Marriott, Louisville, CO

– **Chicago, IL - September 29-30-October 1, 2003**

– Hampton Inn, Schaumburg, IL

– **Minneapolis, MN - October 6-7-8, 2003**

– Hampton Inn, Bloomington, MN

– **Detroit - October 13-14-15, 2003**

– Hotel Baronette, Novi, MI

– **Lincoln, NE - October 22-23-24, 2003**

– Nebraska Center for Excellence in Electronics

– **Los Angeles, CA - November 5-6-7, 2003**

– Hacienda Hotel at LAX, El Segundo, CA

– **San Jose, CA - November 10-11-12, 2003**

– Hampton Inn & Suites, San Jose, CA

– **Phoenix, AZ - November 17-18-19, 2003**

– Embassy Suites, Tempe, AZ

By the way, four or more from the same company qualify for a 10% discount. These classes are also available in-house – if you have 10 or more students, it often makes sense to hold an in-house class. For more information, visit our web site, [www.emiguru.com](http://www.emiguru.com), or give us a call at 1-888-EMI-GURU. You may also now register on-line at [www.emiguru.com](http://www.emiguru.com).



## Focus on “Cost of Non-Compliance”...

It has been said that engineering is a marriage of science and economics. Cost is always a factor, from design to manufacturing to support in the field. Engineering decisions are routinely made based on both technical and economic trade-offs. To be blunt, if our companies don't profit, they don't stay in business.

So it is in the world of EMC engineering. As most of you know, we regularly argue for addressing EMC early in the design process. We are big believers in “pre-compliance” engineering tests, and allowing for contingent components (ferrites, filters, etc.) It's all about managing risk. We've even coined a term — CONC — or “cost of non compliance” to focus attention on these issues.

**Four key factors** – We've identified four key CONC factors. The obvious ones include *component costs* (ferrites, capacitors, filters, shields, etc.) and test costs (to validate the design). Less obvious, but often more important are *failure costs* (recalls, lawsuits, etc.) or *lost opportunity costs* (being late to market). All of these factors should be considered when it comes to EMC.

In this article, we'll look at the CONC for a range of industries. We'll share our insights and suggestions, based on our many years as EMC consulting engineers working in each of these industries. Incidentally, it is important to keep these differences in mind if you switch industries – the focus is often quite different.

**Commercial** – Most commercial products are produced in high volume, and are very price and market sensitive. Thus, the main commercial CONC factors are *component costs*, and *lost opportunity costs*. For certain products, *failure costs* may be important if recalls are involved, or if failures result in tarnishing the company's image. *Test costs* are usually not a major factor in the overall program budget.

For commercial products, we advocate EMC design reviews as the circuit boards and packaging are developed. These should be supported by “pre-compliance” EMC tests to uncover problems as early as possible. If market timing is important, we usually suggest a slightly conservative design approach that can be optimized and cost-reduced after production begins. Better to be in the marketplace with a product that costs a little bit more, than not be in the marketplace at all!

### A KGB Bullet...

Interested in automotive EMC? Here is a link to an ARRL (American Radio Relay League) web page that has some details, plus links to automotive sites by DaimlerChrysler, Ford, General Motors, and more.

[www.arrl.org/tis/info.rifcar.html](http://www.arrl.org/tis/info.rifcar.html)

The ARRL is an amateur radio organization, and publishes *QST* magazine and many useful handbooks.

**Industrial/Telecomm** – Most products in these sectors are produced in moderate volumes (although some may be high) and usually are not as price sensitive as commercial products. High reliability is important, and the markets can be quite competitive. Thus, the main industrial/commercial CONC factors are *failure costs* and *opportunity costs*. *Component costs* and *tests costs* are secondary concerns.

Due to reliability concerns, we usually recommend strong I/O protection (filters and transient protectors) and emphasize immunity issues (ESD, RF interference, power disturbances.) We often recommend going beyond the immunity protection minimums required for CE marking, particularly for ESD. For a \$100,000 system, it is better to spend an extra dollar or two on parts than to spend \$10,000 to repair installed equipment in the field.

**Medical** – Most medical products are similar to the industrial/telecomm products (moderate volume, moderate price sensitivity) but with an added twist — very high to extremely high reliability requirements. As a result, the failure costs are usually the primary CONC factor driving medical EMC designs.

There are key differences between patient connected equipment, and lab/diagnostic equipment. The former have additional safety constraints due to leakage current limitations. This often puts severe design constraints on filter designs. Immunity is also crucial, particularly for devices where failures could be life threatening, such as monitors or ventilators. Analog circuits are common in medical designs, and are particularly vulnerable to RF. The good news is that few well placed parts go a long way.

We like to be involved very early in the design with medical devices, particularly if they are patient connected. Since the medical industry is highly regulated, we often need to deal with detailed requirements provided by the FDA (US) or Medical Device Directives (Europe.)

**Automotive** – Most automotive designs are extremely cost sensitive, are produced in extremely high volumes, and must work under extremely harsh conditions. Safety and reliability are also key concerns. As a result, *component costs* and *failure costs* are their main concerns.

A variation of the automotive market is the vehicular machinery market (farm equipment, heavy trucks, road construction, etc.) In those cases, the volumes are lower which relieves the price pressure a bit. They are still driven, however, by the failure costs.

For any vehicular products, both immunity and emissions are important. Due to cost sensitivities, we often recommend “place-holders” on circuit boards for additional components (ferrites, capacitors, etc.) to be added as needed. Special design techniques may be needed for two layer boards. Fortunately, due to the potential payback, time and money can be spent on engineering and testing.



**Military/Avionics** – Most military products and systems (and their near relatives, avionics designs) are produced in low volumes and have very high reliability requirements. Testing can be extensive, particularly for the military market. As a result, the driving CONC factors here are the *test costs* and *failure costs*.

We've seen clients work for many months (and spend hundreds of thousands of dollars) on military EMC tests. Even so, these costs may pale in comparison to contractual penalty clauses, which can easily reach into the millions..

We like to get involved early in these projects, and then work with the design team during the design process. Fortunately, the military has a lot of EMC experience, and has had proven procedures (such as EMC Control Plans and Test Plans) in place for many years. Military EMC focuses on systems engineering, rather than just design issues.

We hope this has give you some insight on the true costs of EMC. As a parting comment, *don't CONC yourself out!*

As always, give us a call if we can help you with your EMC problems in any of these areas.

If life were fair, Elvis would be alive, and all the impersonators would be dead. — *Johnny Carson*

### **Did you know???**

- Donkeys kill more people annually than plane crashes.
- You burn more calories sleeping than watching television.
- Oak trees do not produce acorns until they are fifty.
- The first product to have a bar code was Wrigley's gum.
- A Boeing 747's wing span is longer than the Wright brother's first flight.
- Venus is the only planet that rotates clockwise.
- The plastic things on shoelace ends are called aglets.
- A duck's quack doesn't echo, and nobody knows why.
- Barbie's full name is Barbara Millicent Roberts.
- Walt Disney was afraid of mice.

*(Thanks to Jerry Ramie, ARC Technical Resources)*

### **Emergency Current Probe...**

During a recent radiated emissions troubleshooting case, it became apparent a current probe would be helpful to make some cable current measurements. Since one was not available, we wound four turns of wire through a clamp-on ferrite, and then clamped this "probe" on the cables.

When connected to a spectrum analyzer, the emergency probe worked fine. While it was not calibrated, we were able to make comparative measurements and thus isolate and identify a problem cable.

### **Book Review...**

**AC Power Interference Handbook – 2nd Edition**, by Marv Loftness. This EMC gem is filled with practical insights and information on the causes, effects, locating, and correction of power-line interference. For many years, Marv was an "RFI Investigator" for a major power utility, and even invented several instruments to locate these problems. Power utility personnel and radio amateurs will find this book particularly useful. ISBN 0-9653760-3-6, published by Percival Technology and distributed by the American Radio Relay League ([www.arrl.org](http://www.arrl.org).)

### **Application Note...**

We still get requests for the Intel Application Note (AP-711 - *EMI Design Techniques for Microcontrollers in Automotive Applications*) that we helped write several years ago. Apparently it can be hard to find. Don't worry, as we have a PDF version available. Just e-mail your request to [dgerke@emiguru.com](mailto:dgerke@emiguru.com).

### **In House EMC Courses...**

Our on-site classes continue to be popular. Here are some of the past classes we have done for clients:

- Design for EMC (2 days)
- EMC in Military Systems (2 ½ days)
- EMC in Avionics Systems (2 days)
- EMC in Telecommunications (2 days)
- Automotive EMC (1 day and 2 days)
- Medical Design for EMC (2 days)
- EMC in Industrial Controls (2 days)
- EMC Grounding & Shielding (2 days)
- EMC and Signal Integrity in PCBs (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 often makes sense. Many clients combine a class with one or two days of "design reviews" to help solve immediate problems. Call 1-888-EMI-GURU for pricing and details.

### **Need Technical Writing Help???**

Most of you know us as EMC/Signal Integrity engineers, but we also have experience with technical writing. We've written three books, over 300 technical articles and reports, and our own newsletter, the KGB (now over 10 years old). Some of you have even had us write applications notes and articles for you, but we have hesitated to pursue these activities due to limited resources.

We now have an alliance with eContentWorks, a firm that specializes in producing technical articles and related collateral. Founded by Jack Shandle, former chief editor of *Electronic Design* and founder of *Chip-Center ezine*, Jack has a team of experienced tech writers on-call. We are his "EMC/Signal Integrity" specialists. If you need EMC/SI writing, give us a call. (For general tech writing, please contact Jack directly at [jshandle@e-contentworks.com](mailto:jshandle@e-contentworks.com).)



### How to Contact Us...

**Telephone...** Toll free or direct...

- Answering Service - 888-EMI-GURU (Toll Free)
- Bill Kimmel - 651-457-3715 (Minnesota Office)
- Daryl Gerke - 480-755-0080 (Arizona Office)

**E-Mail...** A preferred way of reaching us, if you don't need a "real time" answer. Addresses are:

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**Snail Mail...** If you need to mail or Fed-X something...

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**Web Site...** Please visit our web site ([www.emiguru.com](http://www.emiguru.com)) for class schedules, back issues of the KGB, and other useful EMI stuff. We've also included detailed information on our firm, such as our consulting and training brochures.

#### EMI Suppression Handbook...

The little red book with the great EMI war stories, written by us, and edited by our good friend, Dr. Tom Chesworth. Only \$25 plus shipping. To order, contact Seven Mountains Scientific at 814-466-6559, or visit their secure web site at [www.7ms.com](http://www.7ms.com).

### EMI-Toolkit® 2.0...

Want a bunch of useful EMI information at your fingertips? Then check out our popular software package. Includes tables, calculators, frequency assignments, and more.

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...)

Both V2.0 and 2.0 Plus come on CD, and run under Windows 95/98/NT/2000/XP. V2.0 is \$150 for single users, \$750 for site licenses. (V2.0 Plus is higher.) Discounts apply if you are a V1.0 user.

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