

# KIMMEL GERKE



## Bullets

Summer 2007

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

***This KGB focuses on diagnosing EMI problems...*** an essential element of EMI troubleshooting, a topic we first addressed in 1993. Based on several recent consultations, we decided to discuss this important topic again.

This time, we'll focus on the diagnosis, or trying to understand the root cause of a problem. Too often fixes are tried without really thinking about the problem first. We'll borrow some concepts from the medical profession, such as "differential diagnosis" and "hunting for Zebras."

We hope you enjoy this issue of the KGB. As always, give us a call if we can help you out diagnose—and fix—your EMI problems.

*Best Regards*

*Daryl Gerke, PE, and Bill Kimmel, PE*

### EMI Suppression Handbook...

The little red book with the great EMI war stories (with diagnoses) 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 web site at [www.7ms.com](http://www.7ms.com).

### EDN Magazine Designer's Guide for EMC

Although no longer offered by Cahner's Publications, we are now publishing this classic design guide—written entirely by Kimmel and Gerke, and updated in 2001. (Cahner's graciously returned the copyright to us.)

To order a copy, visit our web site at [www.emiguru.com](http://www.emiguru.com). This is virtually identical to the original—even the color. The price, however, is less—only \$25 (+ \$4 S&H) instead of \$50. Better yet—attend one of our EMC classes, and receive your own copy FREE with the class.

We also have special pricing for multiple copies, so you can equip ALL your engineers with this practical EMC guide. (Several companies have already done this.)

For more details, visit [www.emiguru.com](http://www.emiguru.com), or give us a call (toll free) 1-888-EMI-GURU.

### Public EMC Courses...

Here are the cities we have selected for the Fall 2007 EMC seminar series co-hosted by Tektronix and Kimmel Gerke Associates, Ltd. We've been doing these popular seminars since 1992, and have provided practical EMC training to thousands of your colleagues.

**-Lincoln, NE - September 12-13, 2007**

NCEE Labs - Lincoln, NE

**-Denver, CO - September 17-18, 2007**

Courtyard by Marriott - Louisville, CO

**-Portland, OR - September 24-25, 2007**

Tektronix Campus - Beaverton, OR

**-Chicago, IL - October 1-2, 2007**

Hampton Inn - Schaumburg, IL

**-Minneapolis, MN - October 4-5, 2007**

Courtyard by Marriott - Roseville, MN

**-San Jose, CA - October 9-10, 2007**

Courtyard by Marriott - San Jose Airport

**-Detroit, MI - October 29-30, 2007**

Hotel Baronette - Novi, MI

**-Phoenix, AZ - November 5-6, 2007**

Windmill Suites - Chandler, AZ

**-Los Angeles, CA - November 8-9, 2007**

Courtyard by Marriott - Irvine, CA

For more information, please visit our web site, [www.emiguru.com](http://www.emiguru.com), or call 1-888-EMI-GURU. Please note you can also register on-line, using our secure registration.

### In-House EMC Courses...

If you have 12 or more students, an in-house class often makes sense. Furthermore, we can tailor the in-house classes for your specific needs - *military, commercial, medical, automotive, industrial, telecom, and more*. We can address *design, systems, and troubleshooting issues*.

Most in-house classes run two days, but some opt for a third day for more details. You supply the meeting space... we supply the materials and instructor (either Bill or Daryl.) FLAT RATE for up to 30 students.

### 20 Year Anniversary...

In October, we will celebrate 20 years as **FULL TIME EMC** consulting engineers. The first day in business was the day the market crashed in 1987 (we don't think we caused the crash???)

**THANKS** to all of you who have contributed to our success.



## Focus on Diagnosing EMI Problems...

As consulting engineers, we spend much of our time troubleshooting EMI problems. Often times we are called in after many "fixes" have been tried. Too often, these fixes have been applied without first diagnosing the underlying problem. As the medical profession says, "Prescription without diagnosis is malpractice."

In fact, we can learn a lot about diagnosis from our professional medical colleagues. We've had several interesting discussions with doctors, including one chance meeting (on an airplane) with a wise old teaching doctor from the Mayo clinic.

We often share these insights with clients at the start of a troubleshooting session, to get everyone thinking about the possible root cause(s) of the problem. Here are some of those ideas.

**Differential Diagnosis** – This is a formal methodology used in medicine to diagnose diseases. The goal is to narrow the range of possibilities by "ruling in" the most likely causes, and "ruling out" the least likely causes.

In your mind, you are trying to create two lists: "most likely" and "least likely." This process can be dynamic – as you gain additional information, you may start moving items back and forth between these lists. Incidentally, you never throw out any possibility, but you do consider the odds as you assess the symptoms and probabilities.

The method is not foolproof, and is much like being a detective. In fact, the Arthur Conan Doyle (MD) is often considered the "father" of differential diagnosis. Dr. Doyle based his famous character, Sherlock Holmes, on one of his professors in medical school who was considered an excellent diagnostician.

**Hunting for Zebras** – In engineering, as in medicine, most common problems are due to common causes. As technical people, however, we all love a good juicy problem, so we often try to complicate things right from the start.

Medical students are taught "If you hear the sound of hoofbeats, look for horses, not zebras." (Unless you're in Africa, of course.) The same advice holds true for EMI issues – most problems have simple causes and simple solutions, if we just take the time to understand what the problem is in the first place.

### A KGB Bullet...Application Note

We still get requests for the Intel Application Note (AP-711 - EMI Design Technique for Microcontrollers in Automotive Applications) that we helped write some years back. The general concepts still apply today to a wide range of embedded controller applications.

We have a PDF version, so if you need a copy, just e-mail Daryl at [dgerke@emiguru.com](mailto:dgerke@emiguru.com)

Troubleshooting is often a process of elimination. After "ruling out" the more common causes, you may in fact be left with the less likely causes. In fact, we may now be looking for "zebras," which is the term the medical profession uses for those oddball and obscure problems that are so popular on the TV shows. In the real world, however, make sure you have eliminated the horses and the donkeys, before you go chasing the zebras.

**"Gross vs. Microscopic" diagnoses** – This concept came from a hospital pathologist. Many years ago, we helped him automate his pathology lab. No, not an EMI problem – he just needed to track several thousand tissue samples per month as they progressed through the lab.

He explained that they employ two levels of diagnosis. At the first level (gross), a preliminary diagnosis is made based on a simple visual inspection of a tissue sample. At the second level (microscopic), a more detailed diagnosis is made after examining the tissue sample under a microscope.

Sometimes the two do not agree. In that case, the second diagnosis is usually followed, as it is based on more details. Alternately, additional testing may be recommended to reconcile the differences.

EMI diagnosis can be similar. As consultants, we are often pressed to make a preliminary (gross) diagnosis of the problem. With additional test data, however, that initial diagnosis may change. When that happens, management often wants to know why it has changed. That is why we like to alert clients to the possibility of a change in diagnosis in the first place.

**Establish a minimal configuration** – Ever wonder why the doctor wants you to remove your clothes? No, it's not to snoop – doctors see bodies and body parts all the time. Rather, it is to get things down to the "bare essentials."

We like to do the same with EMI troubleshooting. Rather than work on a fully configured system, try for the absolute minimum. If possible, remove all unnecessary cables and peripherals, and power down unneeded circuits and subsystems.

For example, for emissions, we often start with just a power cable. If the unit under test is capable of battery operation, we remove the power cables as well. If it fails, no need to go further until the initial problem is fixed.

For susceptibility, a minimal software configuration may also help. This can be coupled with a simple indicator, such as a blinking LED to indicate "heartbeat."

Once the simple configurations are working, then one can slowly add features such as cables and peripherals. Of course, when you are finally ready to test for compliance, you will need a fully functional configuration, running the actual system software. But for initial troubleshooting, simpler is definitely better, and easier to work with.



**Standardize the test environment** – One final thought – establish a standard and repeatable test environment. In the medical world, the surgeons follow standard procedures in the Operating Room. In the EMI world, we should strive for similar standards.

This means paying attention to placement of cables, peripherals, and the unit under test. We often recommend developing a test fixture, which could be as simple as a piece of plywood with cable ties and an outline of the UUT. Be sure to photograph and document the test configuration, so you can repeat the setup in the future.

**In conclusion** – We hope our comments have proved useful. For more details, see Chapter 14 (Troubleshooting: EMI in the Trenches) of the *EDN Designer's Guide*, or the Fall 1993 copy of the KGB (back issues available on [www.emiguru.com](http://www.emiguru.com).) Or call us to help you with your EMI troubleshooting problems. And one final piece of advice... *Diagnose First... Then Try Fixes*

*Today is a gift – that is why it is called "the present."  
–Author unknown*

## Some Points to Ponder...

– Give a person a fish, and you feed him or her for a day. Teach a person to use the Internet, and they won't bother you for weeks.

– Some people are like a Slinky... not really good for anything, but you still can't help but smile when you shove them down the stairs.

– All of us could take a lesson from the weather. It pays absolutely no attention to criticism.

– Why does a slight tax increase cost you two hundred dollars, and a substantial tax cut saves you thirty cents?

– In the 60s, people took LSD to make the world weird. Now the world is weird, and people take Prozac to make it appear normal.

– We know exactly where one cow with Mad Cow Disease is located among the millions of cows in America, but we haven't got a clue as to where thousands of illegal immigrants or potential terrorists are located. (Hmmm... maybe we should put the Department of Agriculture in charge of immigration and homeland security.)

## E-mail vs. Snail Mail...

Most of you now receive the KGB by e-mail, which makes it easy for you to archive or forward (and which also saves a few trees and postage). We do get quite a few returns, however, due to bad addresses or company firewalls.

As a fallback, we then send the KGB by snail mail. *If you want to receive the KGB by e-mail, please contact Bill at [bkimmel@emiguru.com](mailto:bkimmel@emiguru.com) – we will do the rest.* By the way, our mail lists (both e-mail and snail mail) are PRIVATE.

## Book Reviews...

If you are an amateur radio (ham) operator, you are already well aware of the many publications by the American Radio Relay League (ARRL.) Here are three that should be in any EMC engineer's library. To order, go to [www.arrl.org](http://www.arrl.org).

– **The ARRL RFI Book (Second Edition)** – Primary emphasis on RF immunity from nearby radio transmitters, but also addresses emissions from sources that may interfere with radio receivers. Practical and easy to understand. Revised 2007. \$29.95, ISBN 0-87259-989-2.

– **AC Power Interference Handbook**, by Marv Loftness. Focuses on broadband noise from power lines and other power related sources. Great guide – we've used Marv's methods in our practice. Revised 2007. \$34.95, ISBN 0-87259-110-3.

– **The RSGB Guide to EMC**, by Robin Page-Jones. Learn how they address radio related EMC problems "across the pond" in the UK. 1998, published by the Radio Society of Great Britain. \$34.95, ISBN 1-872309-48-8.

## From the E-Mail Bag...

Here is a question we recently received that may be of interest to others: *We plan on implementing the "power patch" you discuss in your classes. We will flood the area under a DSP device with 3.3V. Should we use one ferrite bead to feed the power patch, or four (one at each corner?)*

The short answer is that one bead is preferred. That gives you four times the impedance of four parallel beads. Just be sure the ferrite bead is rated to handle the load current. Also, be sure you have adequate decoupling capacitance on the DSP side of the ferrite.

Here are some more details for those not familiar with the "power patch". For power isolation on noisy loads (CPUs, DSPs, clock drivers, etc.), it often helps to provide additional isolation through a ferrite bead. If the noisy device has multiple power leads, designers often create an isolated "island" in the power plane. The power pins are connected to the "island", and one ferrite provides the isolation between the device power and the main power plane. The drawback is cutting the power plane.

An alternate approach is to provide a separate "island" in the signal routing layer. This provides two advantages: first, it eliminates cuts in the power plane, and second, it prevents trace routing under the noisy device. We've had a number of our clients use this approach with good success.

If you are using two layer boards, a similar approach can be used. A plane is established on one layer, and the power and signal leads are isolated with ferrite beads. We refer to this two layer approach as "Micro-Island." It is very useful for embedded controllers, and when properly done, can yield results similar to a multi-layer board.



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 key 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.)

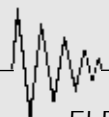
**Point II...** We are Registered Professional Engineers (PE) and NARTE Certified EMC and ESD engineers. **Between us, we have over 80 years of industry experience.**

**Point III...** We are not a test lab—**our emphasis is on EMC design, troubleshooting, and training.** While we are knowledgeable on EMC tests and regulations (and regularly witness EMC testing for our clients), our primary focus is on design/systems issues, and **how to identify, prevent, and fix EMI problems.**

**Point IV...** We serve many industries, and our support ranges from circuit boards to complete systems.

- **Military/Aero** (MIL-STD-461, TEMPEST, EMP, etc.)
- **Avionics** (DO-160, MIL-STD-461, etc.)
- **Computers** (FCC, EU, PCs to supercomputers)
- **Industrial Controls** (Individual controls to full systems)
- **Vehicular** (SAE, automobiles, farm machinery, etc.)
- **Medical** (FDA, diagnostic, clinical, patient connected)
- **Telecommunications** (BELLCORE 1089, etc.)
- **Facilities** (Shielded rooms, lightning, power)
- **Site Surveys** (RF, magnetic fields, mitigation help)

**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.**



KIMMEL GERKE ASSOCIATES, LTD.  
EMC Consulting Engineers

**DESIGN & TROUBLESHOOTING  
ELECTRONIC INTERFERENCE CONTROL**

- **EMI Design and Systems Consulting**
  - Regulations – Emissions – RFI – ESD – Power Disturbances
- **EMI Seminars**
  - Design – Systems – Troubleshooting – Custom
- **EMI-Toolkit®**
  - An EMI Software "Reference Handbook"

Daryl Gerke, PE • 2538 W. Monterey • Mesa, AZ 85202  
William Kimmel, PE • 628 LeVander Way • S. St. Paul, MN 55075  
1-888-EMI-GURU • [www.emiguru.com](http://www.emiguru.com)



**FIRST CLASS  
MAIL**

Kimmel Gerke Associates, Ltd.  
628 LeVander Way  
S. St. Paul, MN 55075  
1-888-EMI-GURU