

# KIMMEL GERKE



## Bullets

Summer  
2011

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

***This issue focuses on RF susceptibility, a rapidly increasing problem.*** We've dealt with a lot of these problems over the years. In fact, we were surprised we had not covered this topic in an earlier KGB.

This focus article also appears on our new blog at [www.emiguru.com](http://www.emiguru.com), and will appear shortly on our column at EE Times in the *Planet Analog* section. Thanks to the Internet, we are pleased to be able to share our ideas and information with a wider audience.

We are rapidly approaching 24 years in full time business. Thank you to everyone for your business and support. As always, give us a call if you need EMI help.

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

### FREE Copy of Useful Bits of Info...

Want your own copy "UBI," the little shirt pocket sized "cheat sheet" for EMI? Just e-mail [dgerke@emiguru.com](mailto:dgerke@emiguru.com), with your snail mail address, and we'll send you one.

### KGB Going All Electronic...

Starting in 2012, we're phasing out the print version of the KGB, and going all electronic. Saves trees & \$\$\$\$.

So, **PLEASE REQUALIFY with your E-MAIL address.** Since many company firewalls block outside messages, your HOME e-mail is welcome, and a good idea.

You can requalify on line at [www.emiguru.com](http://www.emiguru.com), or you can send in the enclosed card if you received this by snail mail. (Not necessary if you have signed up recently, or attended a seminar in the past year.)

If you provide your SNAIL MAIL, we'll drop you a post card if your e-mail bounces.

**Our Privacy Policy** – Our list is PRIVATE, we will not spam you. In addition to the new KGBs, we will also let you know about webinars or when we are holding a live class in your area.

### Shows & Conferences...

– **IEEE Symposium on EMC** – August 14-19, 2011 at the Convention Center in Long Beach, CA. Lots of good stuff for both EMC newcomers and old-timers - demos, tutorials, research papers, and EMC vendors. [www.emcs.org](http://www.emcs.org).

Daryl will be doing a presentation "So You Want to be a Consultant" in a special tutorial session on Friday. Bill will be doing a demonstration on "Shielding Effectiveness" as part of the regular show program (Tuesday Morning.)

Hope to see you there!

– **Minnesota EMC- Event** – September 20, 2011, at the Ramada Mall of America (formerly the Thunderbird) in Bloomington, MN. Three technical tracks, EMC vendors, and a delicious lunch. Bill Kimmel will be a presenter. For more information, go to [www.mnemcevent.com](http://www.mnemcevent.com).

### Public EMC Courses...

Here are the cities we have selected for the Fall 2011 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.

– **Portland, OR - September 28-29, 2011**  
Tektronix Campus - Beaverton, OR

– **Minneapolis, MN - October 10-11, 2011**  
Courtyard by Marriott - Roseville, MN

– **Chicago, IL - October 13-14, 2011**  
Holiday Inn Express - Downers Grove, IL

– **San Jose, CA - October 31-November 1, 2011**  
Courtyard by Marriott - San Jose Airport

– **Phoenix, AZ - November 7-8, 2011**  
Windmill Suites - Chandler, AZ

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.

Payment by Paypal, credit card, or check. Sorry, due to past bankruptcies and nonpayment, we can no longer accept purchase orders.

Call for discounts for multiple students (4 or more). For larger groups, (12 or more students,) it often makes sense to hold an in-house class. Call for details.

## **Focus on RFI Troubleshooting...**

RFI (radio frequency interference) is a rapidly increasing problem, thanks to the proliferation of wireless devices. These range from low power wi-fi and cell phone transmitters to high power radio/television broadcast transmitter to extremely high powered RADAR systems.

Mandatory RFI testing is now required for most electronics devices. Military and automotive devices have been subject to RS (Radiated Susceptibility) tests for years. More recently, commercial devices have been subject to RS testing for manufacturers seeking the CE mark in Europe.

As an aside, commercial testing has resulted in more robust products. Prior to 1996 (when CE testing became mandatory), we often saw RFI problems in the field. These were due to both broadcast transmitters (radio and television) and mobile transmitters (cell phones, hand held VHF/UHF transceivers, vehicular transmitters, etc.). Today, however, most RFI problems get caught at the design/test stage, prior to market release.

**RFI as an EMI source...** Transmitter power is not the sole issue, but rather a combination of power and proximity. The lowly cell phone a few inches away may cause more problems than the broadcast transmitter a mile away. The key parameter is the magnitude of the electromagnetic field at the recipient.

In the EMI world, we focus on the electric field magnitude. The field levels can be easily measured with suitable equipment. But here is a simple approximation that will get you in the right ball park for an initial assessment:

$E = (5.5 \sqrt{PA})/d$ , where

- E=Electric field in Volts/meter
- P=Transmitter power in Watts
- A=Antenna gain relative to isotropic
- d= Distance from transmitter antenna to victim in meters

This formula assumes a point source and a "far field", both valid for most RFI situations.

For example, a 1 watt radio at 1 meter with a relative gain of 1 (good assumptions for a hand held radio or cell phone) produces a field level of 5.5 Volts/meter. In fact, it is this model that results in the 3 Volt/meter and 10 Volt/meter limits for commercial equipment. Higher field levels reflect higher transmitter levels, such as the 200 Volt/meter limit common for many military/automotive environments.

### **KGB Bullet...** The *free space speed of light*

is almost exactly **one foot per nanosecond**. Wasn't that nice of the old English kings to choose the foot? On a **circuit board or in ribbon cable**, this decreases to about **six inches per nanosecond** due to the dielectric. This means it takes twice as long for a signal to travel the same distance compared to free space.

**RFI coupling paths...** Since radio transmitters work by electromagnetic radiation, the primary path is radiated. As "hidden antennas" are involved, physical dimensions count. For frequencies < 300 MHz, cables are the most likely. For frequencies > 300 MHz, everybody gets in the act -- circuit board traces, enclosure openings (slot antennas), and even components themselves.

A good rule of thumb is to assume any conductor greater than 1/20 wavelength long is a potential antenna. We've seen smaller antennas, but this criteria is widely used in the EMI community. This means six inches at 100 MHz, two inches at 300 MHz, and 3/4 inch at 1GHz.

Direct conduction is also possible, but less likely. Nevertheless, when troubleshooting an RFI problem, don't overlook this possibility. We've seen it happen.

**RFI recipients...** The primary RFI failure mode is rectification, but failure levels vary with circuit types. The more sensitive the circuit, the lower the thresholds. Here are some typical levels:

- Analog circuit - 0.1 to 1 V/m
- Power circuits - 1-10 V/m
- Digital circuits - 10-100 V/m

These are simple guides. As the saying goes, "Your mileage may vary..."

**Troubleshooting RFI problems...** If you fail an RFI test at the lab, you already have details -- frequency, amplitude, and failure mode. In you fail in the field, the picture is less clear. You may need to make some measurements, or to use approximations as described above.

### **Here are five quick RFI troubleshooting suggestions:**

- Remove cables to see if RF susceptibility changes. As an alternate, apply clamp on ferrites for frequencies above 30-50 MHz.
  - Wrap the unit under test in aluminum foil. This will show if shielding is adequate (or will help if UUT is unshielded.)
  - Harden critical circuits -- ferrites and 1000 pF capacitors very helpful at frequencies above 100 MHz. Apply to inputs, power, and even outputs.
  - At the systems/box level, troubleshooting best done in a shielded enclosure with suitable equipment. In a pinch, a hand held VHF/UHF radio can be useful. If testing in the field, keep transmissions short (1-2 seconds) on unused frequencies.
  - At the PCB level, a signal generator connected to a sniffer probe can also be helpful in "injecting" a signal at the component/trace level. Not new, this technique was used 50 years or more ago by those who repaired radios and televisions. It still works today.
- Give us a call if you need any EMC troubleshooting, training, or design help.

## From the Mailbox...

**Q: I read your article "Exploring Systems EMC in Medical Devices", and you say "make sure that all the members follow the 5:1 rule. What is the "5:1 rule"?**

**A:** The "5:1 rule" refers to the length-to-width ratio for bond straps. For example, if you have a five inch ground connection, the strap should be at least one inch wide.

This reduces the inductance by about 1/2 compared to a round wire. The inductance is important at frequencies above about 10 kHz.

The "5:1 rule" is widely used in military systems for bonding boxes and cabinets. In the commercial world, many of us prefer 3:1 (or less). This reduces the inductance to about 1/3. For high frequency grounding, fatter is better.

**Q: I took your seminar a few years ago. We built a video & audio decoder device housed in a metal box with two microcontrollers, several switching power supplies, and an FCC certified Wi-Fi module. The Wi-Fi module connects to a commercially available antenna that is mounted through the box top.**

**Does this whole set up need to go through an accredited lab and then to TCB for FCC Part 15? Can we make our own measurements and keep them on file?**

**A:** Since you have embedded microcontrollers and a switching power supply, you'll still need to do the Part 15 testing as you normally would for "unintentional radiators." You can do your own measurements and keep these on file.

Regarding the Wi-Fi, you are OK with the FCC certified module, as long as you use the antenna it was tested with, and make no modifications to the module (increase power, etc.) Product labeling needs to include the information on the Wi-Fi module as well. (Confirmed with a test lab.)

There are very few personal problems that cannot be solved through a suitable application of high explosives.  
-- Scott Adams, creator of Dilbert

## Some Engineering Humor...

Three engineers are traveling together:  
a mechanical engineer, an electrical engineer,  
and a software engineer. Their car breaks down.  
-- The mechanical engineer says: "Must be the engine."  
-- The electrical engineer says: "Maybe it's a dead battery".  
-- The software engineer says: "Let's all get out and get back in again, and see if that fixes it." And it does!

## EE Web Interviews...

Curious how Bill and Daryl got started in EMC? Or engineering, for that matter? All that, and more here:

-- [www.eeweb.com/spotlight/interview-with-bill-kimmel](http://www.eeweb.com/spotlight/interview-with-bill-kimmel).  
-- [www.eeweb.com/spotlight/interview-with-daryl-gerke](http://www.eeweb.com/spotlight/interview-with-daryl-gerke)  
We were honored to be selected for these interviews.

## Book Review...

**ARRL Amateur Radio Handbook (2011)**, published by the American Radio Relay League. If you are a radio ham, you probably already own this book (or an earlier edition.)

Filled with practical nuts and bolts information on RF issues, inducing RF interference. Well written -- you don't need to be an EE to understand it. Includes a CD ROM. ISBN 978-0-87259-095-3. \$49 at [arrl.org](http://arrl.org) or [amazon.com](http://amazon.com).

## Kimmel Gerke Webinars...

Our webinar program is now under way. We did one in February, and another in May. So far, so good, although we are still learning to use the GoToWebinar system.

Based on the initial results, we plan to continue. Our goal is to offer focused topics that we don't cover in depth (or at all) in our public EMC seminars.

Since there are webinar costs and since these will contain new original material, there will be a nominal charge (\$99) per seat, or a max of \$495 per location. So watch them by yourself, or grab a conference room and make this a "lunch and learn" with your colleagues.

The next planned webinar is on spectrum analyzer use for EMI. It will cover topics like setting bandwidths, spans, etc. and will include "tricks of the trade." Date yet TBD, so watch our web site for schedule and details.

If you have a topic you would like to see, drop us a line at [bkimmel@emiguru.com](mailto:bkimmel@emiguru.com), or [dgerke@emiguru.com](mailto:dgerke@emiguru.com).

## In-House EMC Courses...

Want more depth than a webinar? Can't make it to a public seminar? Have a dozen or more attendees? Then check out our In-house EMC courses done at your facility.

Our on-site classes are very popular. Here are some examples of dedicated classes we have done for clients:

- Design for EMC (2 days)
- EMC Grounding & Shielding (2 days)
- EMC in Military Systems (2 ½ days - 3 days)
- EMC in Avionics Systems (2 days)
- EMC in Medical Devices (2 days)
- EMC in Vehicular Electronics (2 days)
- EMC and Signal Integrity in PCBs (1 day)
- EMC for Mechanical Engineers (1 day)

We can customize to meet your special needs. Flat rate for up to 30 students. Call 888-EMI-GURU for more information on an in-house class at your facility.

## In Memory...

We regret to report the passing of Bob Pease, 70, friend and well known analog guru. Tragically, Bob died in an auto accident in June when returning from the funeral of his good friend Jim Williams, another analog guru. The engineering world will miss both of these great minds.

## **Kimmel Gerke Associates, Ltd.**

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**FIRST CLASS  
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 **Kimmel Gerke Associates, Ltd.**

**Summer 2011**

### **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 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 iNARTE 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** (GR-1089, etc.)
- **Facilities** (Shielded rooms, lightning, power)
- **Site Surveys** (RF, magnetic fields, mitigation help)
- **Legal Support** (Patent help, expert witness)

**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**

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