

KIMMEL GERKE



Bullets

Winter
2012

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 Power Disturbances. It's not just about power supplies or transient protectors anymore. Worrying about DC or 60 Hz is no longer adequate -- now we must consider "DC to daylight" on the power lines.

The recent IEEE EMC symposium held a dedicated day long session on *EMC and the Smart Grid*, with rapidly emerging EMI concerns in the mid-frequency range. The addition of sophisticated electronics to the power grid opens up a whole new set of EMI issues. As some wag said, this is where *Megawatts meet Megahertz*.

Happy Holidays, and all the best to you and your families now and in 2012! 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, with your snail mail address, and we'll send you one.

EMC Winter Workshops 2012

San Diego, CA - February 7-8-9, 2012

Orlando, FL - February 13-14-15, 2012

Need a winter break, and some fun in the sun? Want to learn more about EMC design or troubleshooting? Then join us in San Diego or Orlando for our annual *EMC Winter Workshops*.

In addition to our regular *Design for EMC* class (2 days), you can attend our *EMC Troubleshooting* class (1 day).

The troubleshooting class is offered ONLY at these locations, as an optional extension to the two day class.

If you have already attended a two day class, you are welcome to join us for this additional day.

For more details, visit our website (www.emiguru.com) or call us toll free at 1-888-EMI-GURU. (Inquire about our special hotel rates in Orlando.)

Public EMC Courses...

Here are the cities for the Winter/Spring 2012 schedule for the EMC seminar series co-hosted by Tektronix and Kimmel Gerke Associates, Ltd. The first two are fixed -- exact dates for the rest are TBD.

– San Diego, CA - February 22-23-24, 2011

Arrow Electronics Inc., San Diego, CA

– Orlando, FL - February 7-8-9, 2011

Maingate Lakeside Resort, Kissimmee, FL
(Formerly Best Western Lakeside)

We're still working on the following classes.

– Dallas, TX - March 2012

– Atlanta, GA - March 2012

– Washington, DC - March 2012

– Boston, MA - April, 2012

– Syracuse, NY - May, 2012

– New Jersey - May 2012

For more information on any of these locations, please visit our web site, www.emiguru.com, or leave a message toll-free at 1-888-EMI-GURU and we'll call you back.

Payment by Paypal, credit card, or check. Due to bankruptcies, we regret we can no longer accept POs.

Discounts apply 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.

Change in Plans...

In the last issue, we announced we were going all electronic on the KGB. But since about half of you get the KGB by snail mail, we decided to rescind that decision.

We'll keep the KGB, but we plan to add an on-line "mini-KGB". So if you want to save a tree and/or get the interim newsletters, you can sign up at our website (www.emiguru.com) or just send your e-mail to Bill at bkimmel@emiguru.com.

EE-Times Column...

We now have a monthly column based on our blog in the *Planet Analog* section of *EE-Times*. We're told it is doing well, and is quite popular. Just Google "*EE-Times EMC Basics*" and we should pop up. Enjoy...

Focus on Power Disturbances...

We've worked on a wide range of power related EMI problems over the years, ranging from simple power supplies to nuclear power plants. In fact, we have seen a dramatic increase in these problems in the last few years. The most recent concern is EMI and the "Smart Grid."

In this issue, we'll look at this convergence of technologies, and what it means to those of us who deal with EMI on a regular basis. This is not necessarily a bad thing -- rather, it may represent an opportunity for the future. Here are some thoughts and comments from our EMI perspective.

Culture Clash -- Let us start off with an anecdote. Several years ago, a friend (electronics engineer) who worked for our local power utility, pointed out an interesting "cultural problem" that he had encountered.

His comments were the result of Daryl saying, "From an EMI view, there is little difference between DC and 60 Hz -- it is all very slow." His response was, "Don't ever say that to a power engineer. Remember, you can't put DC through a transformer."

But then he added, "I made the same mistake when I started with the power company. My background is electronics, and they hired me to work on SCADA systems. After joining the utility, I soon realized we were often not on the same page -- it was a different culture."

He continued, "As EEs, we all go to school together and study many of the same subjects. But after graduation, our careers take us in different directions. Within a few years, our perspectives and even language are different."

"For example, for power engineers, 60 Hz is their world. The tenth harmonic (600 Hz) is high frequency. They also deal with megaWatts, kiloVolts, and megaAmps. We electronic engineers work with much wider frequency ranges (DC to daylight), but our amplitudes are often much smaller -- milliAmps, microVolts, and milliWatts."

His comments changed our thinking about EMI and power problems. It's like living on the border between Germany and France. Although neighbors, the languages and cultures are different. So it is with power disturbances in general, and the Smart Grid in particular. We'll all need to work together for future success.

KGB Bullet... 60 Hz Electrocution Hazards

Here are some guidelines we found in a recent article.

- Tingling sensation - 500 μ A
- Painful shock, inability to let go - 10 mA
- Ventricular fibrillation, may cause death - 35 mA

The bottom line -- if you can feel a 60 Hz shock, you are getting into dangerous territory. Please be careful!

Divide and Conquer - When dealing with power problems, we find it useful to divide things by frequency. (This division also works well for grounding.) Although arbitrary, we use these three ranges:

- **DC to 10 kHz** - Parasitics are minimal, and circuits and components usually behave as expected. This is the realm of AC/DC power and audio.

- **10 kHz to 1 MHz** - Parasitic inductance and capacitance start to affect things. This is the realm of power electronics (switch mode power supplies, variable speed drives, etc.) and the Smart Grid. Conducted emissions and conducted susceptibility start becoming problematic.

- **Above 1 MHz** - Transmission-line and antenna effects, along with parasitic capacitance/inductance. This is the world of RF, where radiated emissions and susceptibility become problematic, and everything eventually becomes an antenna.

It helps to look at power electronics in these three ranges. We often use the following default frequencies:

- 60 Hz for the low range
- 1 MHz for the medium range
- 100 MHz for the high range.

This is like looking at something under a microscope with different levels of magnification. When evaluated this way, the problems and their solutions often become apparent.

Incidentally, for transients, we often use about 1 MHz for lightning and other generic transients, and 60 MHz for the EFT (Electrically Fast Transient). These are based on the equivalent frequencies of the transient risetimes.

Power Quality - This is a term you need to know when dealing with power disturbances. Widely used at the utility/facility level, it refers primarily to low frequency disturbances such as sags, surges, outages, and longer duration (lower frequency) transients.

The term is important in the "power culture." If you call your power utility and ask for EMI help, you may not get anywhere. But if you ask for Power Quality help, you may even get directed to a special engineering group.

Regulatory Issues - A big problem with the Smart Grid is the lack of commercial EMC regulations in the 2 kHz-150 kHz range. The power line harmonic requirements address frequencies up to about 2 kHz, and the radiated emissions requirements address frequencies above 150 kHz. EMC committees are starting to address this gap, but are still in the early stages for developing requirements.

This gap does not exist with military EMC requirements. Depending on the platform, MIL-STD-461 addresses conducted emissions and conducted susceptibility down to 30 Hz. In addition, special Power Quality requirements often apply to the various military platforms.



Fixing the problems - The different frequency ranges require different design approaches and fixes. Multiple solutions may be needed, as one size does not fit all cases.

-DC to 10 kHz - Voltage regulators & transient protectors. Filters usually not practical at these frequencies. Gas tube and MOV devices fine for transients, but must be sized to handle the excess transient energy. Isolation transformers can also be helpful for grounding issues.

-10 kHz to 1 MHz - Filters become practical. Single stage differential mode filters prevail. Common mode isolation can be handled with shielded isolation transformers. Gas tubes and MOVs still suitable for transient protection.

-Above 1 MHz - Multistage filters, both differential mode and common mode. Ultra-shielded isolation transformers can often extend their range to about 10 MHz. High speed transient protectors, such as Zeners diodes and Tranzorbs, may become necessary.

Note that for frequencies above 1 MHz, location and mounting of components also becomes critical. As the frequencies increase even more, shields, filters, grounding, and lead lengths all become intertwined.

We hope this has helped clarify this increasingly important aspect of EMC. And perhaps it will help you cross the cultural barriers between power and electronics. As always, give us a call if we can help.

Coming Next Year...

Watch our web site for new developments. We will soon have an on-line vendor directory, and are planning some more webinars. Be sure to check out our blog, which is also mirrored at EE Times.

Finally, come join us at an EMC class when we are in your vicinity. Better yet, have us do an in-house class to get everyone up to speed on good EMC design techniques.

-- Good EMC design does what you want it to do.
-- Poor EMC design doesn't do what you want it to do, and does what you don't want it to do.

Albert Alexander, EMC Engineer

Some Engineering Humor...

Here are some important conversion factors:

- 1 million microphones = 1 megaphone
- 1 million bicycles = 2 megacycles
- 10 rations = 1 decoration
- 100 rations = 1 C-ration
- 10 millipedes = 1 centipede
- 10 cards = 1 decacards
- 2 monograms = 1 diagram
- 8 nickels = 2 paradigms
- 2 wharves = 1 paradox

Hope these prove useful...

Book Review...

Handbook of Power Signatures, by Alexander McEachern (1988). Originally reviewed in 1994, but worth mentioning again. A very useful collection of power disturbances plots, with causes, symptoms, and solutions.

Alex is the founder of BMI and currently the president of the Power Standards Laboratory. Alex recently gave a great talk on the Smart Grid at a Phoenix EMC Society Chapter. The book is out of print, but look for it on e-Bay.

From the Mailbox...

Q: In Chapter 3 of the *EDN Designer's Guide to EMC* you state that anything less than 20% relative humidity (RH) should cause you to suspect ESD. Why 20%?

A: Numerous published ESD test results show that as the humidity increases, the static voltage resulting from triboelectric charging increases. The theory is that as the humidity increases, leakage current increases as the surface impedance decreases. Thus, at higher humidity levels it is harder to generate and sustain higher voltages.

Here are some examples from one published test:

-Walking across floor-12kV@20% RH-250V@80% RH

-Arising from foam seat-18kV@20%RH-1.5kV@80%RH

As you can see, the peak voltage is much lower at higher humidity levels. Other studies have shown the voltage also decays much faster at higher humidity levels.

As a result of these studies, many of us in the EMI/ESD business use low humidity as due for ESD problems in the field. There is nothing magic about 20% -- we simply chose that to be consistent with other published guidelines.

In-House EMC Courses... Can't make it to a public seminar? Have a dozen or more attendees? Then check into our in-house EMC courses.

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 1/2 days - 3 days)
- EMC in Avionics Systems (2 days)
- EMC in Medical Devices (2 days)
- EMC in Vehicular Electronics (2 days)

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

In Memory...

We regret to report the passing of Terry Donohoe, 53, a good friend to both of us, and well known in the DO-160/ avionics EMC community. Terry died December 10 in a plane crash west of Phoenix AZ due to an apparent controls failure. We will miss his technical contributions and his great sense of humor.

Kimmel Gerke Associates, Ltd.

628 LeVander Way
S. St. Paul, MN 55075

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Kimmel Gerke Associates, Ltd.

Winter 2012

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:

- Bill Kimmel - bkimmel@emiguru.com
- Daryl Gerke - dgerke@emiguru.com

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

- Bill Kimmel, 628 LeVander Way, So. St. Paul, MN 55075
- Daryl Gerke, 2538 W. Monterey, Mesa, AZ 85202

Web Site... Please visit our web site (www.emiguru.com) for class schedules, back issues of the KGB, and other useful EMI stuff. We've also included detailed info on our services, both consulting and training.

EDN Designer's Guide to EMC...

Written entirely by Kimmel Gerke Associates. First published in 1994, and updated in 2001 (three new chapters.) Now available -- *at a reduced price* -- directly from Kimmel Gerke Associates.

Order on-line at www.emiguru.com, for \$29 US, or \$45 overseas (includes shipping.) Call for special pricing on multiple copies. *Attend a class and get a FREE copy of this book.*

Visit Our Web Site... As mentioned earlier, we'll soon be adding more features. Here is a quick summary of what is currently available.

- *EDN Designer's Guide to EMC* - Order on-line (\$\$).
- *E-Book* - The out-of-print "EMI Suppression Handbook" available for download. (\$\$).
- *EMI-Toolkit (TM) Software* - Available for download (\$\$)
- *Past KGB's* - All 20 years now in PDF files (FREE)
- *EMI Bibliography* - (FREE)
- *Blog* - Our thought and comments on EMI issues (FREE)
- *Seminars and Webinars* - Select topics (\$\$ & FREE)

All of these are part of our ongoing educational efforts to share our EMI knowledge and experience (over 80 years between us.) Please visit us at www.emiguru.com.



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Daryl Gerke, PE • 2538 W. Monterey • Mesa, AZ 85202
William Kimmel, PE • 628 LeVander Way • S. St. Paul, MN 55075
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