

# KIMMEL GERKE



## Bullets

Fall, 2002

### 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 in Space."** In the past few years, we've worked on several space projects. Some were defense related, and others were simply related to ongoing research. Thanks to advances in technology and NASA's emphasis on "faster/better/cheaper", there is a renewed interest in space electronics.

For many of us, space still excites the imagination. This is particularly true for those of us who grew up with names like Sputnik, Mercury, Gemini, and of course Apollo. As you might guess, however, space has it's own set of special EMC problems and concerns. In this article, we'll share some of our EMC perspectives and experiences on this exciting industry.

As always, give us a call if we can help you with any of your EMI problems... space, military, commercial, medical, industrial, telecomm, automotive, and more...

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

### Seasons Greetings...

Our sincere best wishes to you and your families this holiday season, and the best to you in 2003... Bill & Daryl

#### **EMC Winter Workshops 2003**

*Orlando, FL - February 3 - 6, 2003*

*San Diego, CA - February 11 - 14, 2003*

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

This year we offer our **NEW CLASS FORMAT**:

- Two Days on *EMC Grounding & Shielding*
- One Day on *EMC & Signal Integrity in PCBs*
- One Day on *EMC Troubleshooting*

Take only what you need to get up to speed on EMC.

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

### Shows and Conferences...

Here are some shows and meetings on EMC that may be of interest. Call us if you'd like more details.

- **EMC Zurich** - February 18-20, 2003 in Zurich, Switzerland.
- **EMV 2003 Augsburg** - April 1-3, 2003, Augsburg, Germany
- **IEEE International Symposium on EMC** May 11-16, 2003 in Istanbul, Turkey.
- **IEEE Symposium on EMC** - August 18-22, 2003 at the Hynes Convention Center in Boston, MA, USA.

### Public EMC Courses...

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

- **Orlando, FL** - February 3-4-5-6, 2003  
Four Points Sheraton Lakeside, Kissimmee, FL
- **San Diego, CA** - February 11-12-13-14, 2003  
Doubletree Club Hotel Circle, San Diego, CA
- **Dallas, TX** - March 10-11-12, 2003  
Radisson Hotel, Richardson, TX
- **Atlanta, GA** - March 25-26-27, 2003  
Courtyard Perimeter Center, Dunwoody, GA
- **Philadelphia, PA** - March 31-April 1-2, 2003  
Courtyard Hotel, Plymouth Meeting, PA
- **Washington, DC** - April 8-9-10, 2003  
Sheraton Columbia, Columbia, MD
- **Boston, MA** - April 29-30-May 1, 2003  
Courtyard Hotel, Westborough, MA
- **Long Island, NY** - May 5-6-7, 2003  
Courtyard MacArthur Airport, Ronkonkoma, NY
- **Newark, NJ** - May 13-14-15, 2003  
Hampton Inn, Somerset, NJ
- **Rochester, NY** - May 19-20-21, 2003  
Courtyard Rochester West, Greece, NY

**Our NEW CLASS FORMAT** is working out very well (see the box at the left for details.) *By the way, four or more students from the same company qualify for a 10% discount.* Also, if you have 10 or more students, it often makes sense to hold an in-house class. All classes are conducted by either Bill or Daryl.



## Focus on “EMC in Space”...

To paraphrase Star Trek, we have both “boldly gone to work on EMC problems” on several space related projects. As luck would have it, however, we never actually went on site. What a thrill that would have been! Nevertheless, these projects have been among the most interesting and challenging we have seen. Here are some comments and observations about “EMC in space.”

**First, there are several severe constraints.** These include weight, reliability, and harsh environments. Cost is also a factor, since NASA has replaced their old philosophy of “Reach for the stars” with “Better, faster, cheaper.”

- *Weight*- One rule of thumb is that it costs about \$10K/pound to put hardware into space. Thus, standard “earth” fixes like heavy shielding and cable ferrites are not practical.
- *Reliability*- Most space systems must work for several years. Obviously, on-site repairs are out of the question. But even a partial failure (such as degradation of a communications channel or a payload sensor) can have devastating effects on a mission.
- *Harsh Environments*- Both launch and operational environments can be extremely harsh. High RF levels may be present prior to and during launch, due to nearby radar and communications transmitters. Vibration and high G-forces are encountered during launch as well.

**Second, there are several unique problems** that must be solved. These include “magnetic cleanliness”, surface charging, passive intermodulation (PIM), and the effects of ionizing radiation.

- *Magnetic cleanliness*- Magnetometers are often used for navigation. The earth’s magnetic field has been mapped in space, and thus can be used to aid navigation. The magnetic fields, however, are quite low and can be jammed by onboard magnetic fields from permanent magnets (both intentional and unintentional) or power currents. Special care must be taken to assure “magnetic cleanliness.”
- *Surface charging*- As a spacecraft orbits through space plasma, it is susceptible to surface charging. This phenomena can distort scientific data at low levels, and can cause damaging arcing at larger levels. This is similar to “earth-based” ESD, but at different levels of course.

### A KGB Bullet...

Need IEEE EMC standards? For \$280/year (single user) you have electronic access to a wide range of standards through the IEEE Standards Online. For details go to <http://standards.ieee.org/emc.html#emc>.

Need MIL standards? These are available FREE from <http://www.jsc.mil>. (Not really free - your tax dollars help pay for them - a very worthy service!)

- *Passive Intermodulation (PIM)*- Intermodulation can occur when multiple radio transmitters operate at the same time in the same vicinity, and when a local non-linearity is present to allow mixing products to be generated. This effect is well known on ships (often referred to as the “rusty bolt” effect) and VHF/UHF communications systems. Since most spacecraft have multiple transmitters and receivers, this can be a serious problem.

- *Ionizing radiation*- Spacecraft can be subjected to a continuous barrage of low level ionizing radiation. The effects are cumulative, and can limit the life of the onboard electronics. While not a common EMC problem, we still thought it best to include this.

**What about EMC requirements?** Most space requirements are based on MIL-STD-461, the key military EMC specification. The requirements are usually highly “tailored” for the specific system. Both the spacecraft and the payloads must be addressed as a system.

Test levels may be modified, or tests may be added or deleted. The objective is to identify and address specific EMC threats and vulnerabilities without over designing the system. (Remember the \$10/K pound launch cost.)

The EMC problems are challenging, to say the least. A strong systems approach is used — this is truly “rocket science”, not PC design. Entire modules are often purchased and integrated into the system. As result, a lot of attention is given to systems issues like grounding, shielding, power distribution, interfaces, and cables and connectors.

Printed circuit board design, all the rage in the commercial world, is often a secondary concern in space. You may not need or even want the latest high speed processor — the old “tried and true” is usually preferred over the “new and untested” technology. Furthermore, many of the spacecraft functions rely on embedded controllers. Thus, while PCB design is important, it is often only a small part of the overall EMC effort in space.

**So what is the design impact?** Here are some general comments regarding EMC design for space.

- *Radiated emissions/susceptibility*- Design approaches usually rely on a combination of filtering and shielding. When shielding is used, thin membranes like foil or cloth are employed to reduce weight.
- *Conducted emissions/susceptibility*- Design approaches include careful attention to the power distribution system. Filters, transient protectors, and special “low impedance” power bus designs are common.
- *Magnetic cleanliness*- Design approaches include identifying or eliminating magnetic field sources, or using magnetic field cancellation techniques. Power and signal grounding are critical as well. Due to weight constraints, magnetic shielding is not considered a practical solution.



- *Surface charging*- Design approaches include maintaining minimum surface impedance, and reducing differential charging with special grounding techniques.
- *PIM*- Design approaches include detailed frequency analysis and bonding techniques to assure that intermodulation products do not occur within the signal passband of intended onboard receiver frequencies.
- *Ionizing radiation*- Design approaches include selection of "rad-hard" components and technologies.

We hope this has given you some useful insights into space EMC problems and solutions. If you need help with these issues, or any other EMC issues, please contact us at toll free at 1-888-EMI-GURU, or through our web site at [www.emiguru.com](http://www.emiguru.com).

Confidence is the feeling you have before you understand the situation.   
--Author Unknown

## Application Note...

Recently, several of our class attendees were unable to locate a copy of the Intel Application Note (*AP711-EMI Design Techniques for Microcontrollers in Automotive Applications*) that we helped write a few years ago. Apparently it is out of print. Don't worry — we have a PDF version available. If you need a copy, e-mail your request to Daryl at [dgerke@emiguru.com](mailto:dgerke@emiguru.com).

## Engineering Rules...

Several of you accepted our challenge in the last KGB to share your favorite "engineering rules." Here are some of the responses:

- If nothing changes, nothing changes. (Lisa Nutter)
- Every resistor a pot, every hole a slot... and a cap in the right place will solve the problem. (Bob Hazen got this from a friend.)
- You should always know what is happening in your circuit at all times — there is no "magic" in there. (Rick West, from a favorite professor.)
- You can't reason with unreasonable people. (Kenneth Friend.)
- EMI is what you have when you don't have EMC. (ibid.)

## KGA Fifteen Years in Business...

How time flies! In October, we celebrated our 15 year anniversary. As some of you know, our first day in full time practice was the day the stock market crashed in 1987. No, we don't think we caused the crash, but that event was certainly sobering for the first day in business.

Since then, we've done several hundred EMC projects in 40 states and 9 foreign countries. The two furthest were Perth, Australia (Bill) and Kuwait City, Kuwait (Daryl - just a few months before the Iraq invasion.) THANKS to all of you for your support and business these past 15 years!

## Book Reviews...

**MECL Designer's Handbook**, by William Blood.

One of the original authoritative texts on high speed digital design. First published by Motorola in 1980, and now republished by ON Semiconductor. Best of all, it is FREE. Available in both PDF and hard copy formats. Go to [www.onsemi.com](http://www.onsemi.com) and request HB205/D.

**Harry Potter and the Sorcerer's Stone**,

by J.K. Rowling. This is the first book in a series on Black Magic - essential reading for all EMI practitioners. You won't be able to solve your EMI problems after reading this book, but at least you will know what evil lurks out there. ISBN 0590353403, or ask your kids or grandkids for a copy.

## EMC Periodicals...

Here are some specialized publications on EMC that you may find of interest.

**Compliance Engineering**, CE Magazine, Cannon Communications, 11444 W. Olympic Blvd., Los Angeles, CA 90064, 310-445-4200. Annual Reference Guide plus quarterly updates. General interest regulatory issues, including EMC. FREE. Visit [www.ce-mag.com](http://www.ce-mag.com)

**ITEM (Interference Technology Engineers' Master)** Hem Publications, 3 Union Hill Rd., West Conshohocken, PA 19428, 610-834-0400. Annual Reference Guide plus quarterly updates. Reference material for design and regulatory requirements. FREE. Visit [www.rbitem.com](http://www.rbitem.com).

**Conformity**, Curtis- Strauss, 531 King Street #6, Littleton, MA 01460, 978-486-0888. Annual Reference Guide plus quarterly updates. FREE. Visit [www.conformity.com](http://www.conformity.com).

**Electromagnetic News Report (ENR)**, Seven Mountains Scientific, PO Box 650, Boalsburg, PA 16827, 814-466-6559. Newsletter on EMC issues, with strong flavor on international regulatory issues. Bi-monthly. Subscription, about \$70/year. Visit [www.7ms.com](http://www.7ms.com).

**IEEE Transactions on Electromagnetic Compatibility**, IEEE. Monthly. Highly analytical. Subscription with IEEE EMC Society membership. (We actually find more practical articles on EMI in the IEEE Industry Applications Society Transactions.) Visit [www.emcs.org](http://www.emcs.org).

**KGB Newsletter**, Kimmel Gerke Associates Ltd (You are reading it!!!) Highly authoritative quarterly newsletter by industry leaders. (No false modesty here...) FREE. Also available for download at [www.emiguru.com](http://www.emiguru.com).

## E-Mail Versions of the KGB...

Many of you already receive the KGB by e-mail. Thanks... that obviously saves us \$\$\$, and makes it easy for you to archive or forward the KGBs. If you do not receive the KGB by e-mail, you can sign up at [www.emiguru.com](http://www.emiguru.com). By the way, our mail lists (both e-mail and snail-mail) are private, so you don't need to worry about spam from us.

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