KIMMEL GERKE Bullets

Summer, 1996

Welcome to KGB...

And to the mid-1996 issue of our "personal communications" to our friends, clients, and colleagues about EMI issues, problems and solutions.

This issue focuses on cables and connectors. Even though they appear to be simple passive parts of the system (it's only wire, right?), cables and connectors are very important players in the battle against EMI.

One problem is that cables often have the longest physical dimensions of any part of the system. As such, they act as "hidden antennas" to both radiate and receive EMI.

We often refer to cables as the "EMI antenna farm". As a first estimate, we usually assume that radiated problems between 30 MHz and 300 MHz are cable related. (At frequencies above 300 MHz, we still suspect cables, but other things like slots and even circuit board dimensions become suspect too.)

As always, give us a call if we can help you out.

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

ADDRESS & PHONE NUMBER CHANGES

Please note that our business address has changed. The new corporate address is:

Kimmel Gerke Associates, Ltd.
300 Christine Lane
West St. Paul, MN 55118
1-888-EMI-GURU (Toll Free)
612-330-3728

This change occurred due to Daryl's move to Arizona (see details inside.) Please send any address changes to the above address.

We've also added a toll free number. This rings to our answering service, so please leave a message and we'll return your call as soon as we can. Remember, you can also reach us by EMAIL at: *bkimmel@emiguru.com and dgerke@aol.com.*

Shows and Conferences...

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

IEEE EMC Symposium... August 19-23, 1996, at the Santa Clara Convention Center in Santa Clara, CA. We'll be there, of course! Hope to see many of you there, too. Should be a very good show.

Medical Design & Manufacturing Midwest 96 Conference... October 30-31, 1996, at the Minneapolis Convention Center in Minneapolis, MN, and sponsored by *Medical Devices and Diagnostics Industry* magazine.

Bill will chair an EMC session, which is the first time an EMC session has been presented at an MD&M show in Minnesota.

Medical Design & Manufacturing West 97 Conference... February 11-13, 1997, at the Anaheim Convention Center in Anaheim, California, and sponsored by *Medical Devices and Diagnostics Industry* magazine.

No firm plans on technical papers at this time, but we will be there. Bill is chairing a session on EMC in medical devices and systems, always a popular subject at this conference.

Twelfth Annual Minnesota EMC Event...
Tuesday-Wednesday, April 22-23, 1997, in Bloomington, Minnesota. *Remember, the EMC Event has moved from the fall to the spring.* One day exhibition, plus one day of technical seminars. Watch for more details in a future issue of the KGB.

Reprints... EDN Magazine's *Designer's Guide to Electromagnetic Compatibility...*

We're told this EMC design guide (written entirely by us) is still a popular item. *For your copy, call Cahners Reprint Services at 1-800-523-9654.* Only $ 19.95+ shipping.

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Focus on Cables & Connectors...

For many designers, cables and connectors are an afterthought. After all, they just connect things together, right? But cables and connectors are major entry and exit points for EMI into and out of electronic systems. They act as "hidden antennas" for radiated energy, and "hidden conduits" for conducted energy.

In fact, cables and connectors are so important, they are the often the first things we check out when troubleshooting EMI problems in a system. Here are a few thoughts on cable and connector design for EMI.

Trade off shielding for filtering. If you don't filter I/O interfaces, then you must assume that the highest frequencies inside the unit will end up on the cable wires. (Or you must assume the cables will intercept the highest frequencies and bring them into the unit.)

Just because that RS-232 interface is only operating in the kilobaud range doesn't stop higher frequencies from hitching a "free ride" on the cables. We've solved many radiated problems (emissions and immunity) by adding simple filters to interfaces that were only supposed to carry "slow" or "low frequency" signals.

The alternate to filtering the cables is shielding the cables. We generally prefer to filter slower cables, since it's usually more cost effective and easier to maintain EMI integrity.

Ground the cable shield. If you do decide to use shielded cables, then the immediate question becomes how best to ground the cable shield. The correct method depends on both threat frequencies and circuit impedance levels.

For problem frequencies below 10 kHz (audio), the preferred approach is to ground one only one end of the shield. This it to prevent "ground loop" coupling from the cable shield to the inner wires. This is particularly important for preventing 60 Hz coupling into low level/high impedance circuits used in audio or instrumentation systems.

Unfortunately, this is exactly the wrong thing to do for high frequency threats. *For most RF situations (above 10 kHz), the preferred approach is to ground both ends of the cable shield, to minimize coupling at the open end due to standing wave effects.* So what do you do if both threats exist? You can ground one end with a small capacitor (1,000-10,000 pf typical) or you can use two shields — one grounded on one end, and the other grounded on both ends. In the latter case, the shields must be insulated from each other.

One more case where both ends must be grounded is the low frequency/low impedance case, where magnetic fields are the major culprit. In this case, the strategy is to minimize "loop size" by providing an adjacent return path for noise currents. This is often necessary in electrical sub-stations, where large 60 Hz magnetic fields exist due to the high current levels. Most of the time, however, single point grounding at low frequencies is the preferred approach.

Use Care With Connector Terminations. This is extremely important for shielded cables with EMI threats above about 1 MHz. Poor joints (or worse, "pigtail" connections from the shield to the connector) are a leading cause EMI-induced failures on shielded cables. We've seen 20 dB increases in emissions, and 10 fold reductions in ESD immunity due to poor connections. (Remember, with a 1 nsec edge rate, ESD is a 300 MHz EMI problem.)

To maintain high frequency cable shield integrity, you need a circumferential bond between the cable shield and the connector shell. In addition, you need full metal-to-metal between the mating connectors.

Finally, you need a solid connector-to-chassis connection. One problem we often see here is with chassis connectors that overlap connector cutouts. The imprecise fit creates a slot that very effectively couples high frequency energy directly to/from the cable shield. Think in terms of a garden hose —you need a very tight connection at the faucet, or else it leaks.

What About The Cable Shield Itself? Yes, this is a valid concern, but only after you have addressed the connector termination issues. For frequencies below about 10 MHz, most cable shielding materials behave about the same, and provide very respectable amounts of shielding. For frequencies above about 10 MHz, however, the cable construction becomes important. Loose single braids become increasingly leaky, so above 10 MHz, you may need high density braid shields. Double braids work very well here, as do braid over mylar cable shields. For high frequencies, both shields should be connected together.

In summary, remember cables are very important in the battle against EMI. They can not be left to chance, but must be properly designed from the start.

A KGB BULLET...

"As a rule of thumb, most sensitive loads can tolerate sags of about 20% below and swells to about 10% above nominal AC voltage. Keep in mind that this applies to the nominal AC voltage. If you have a nominal 120V rms branch circuit that is actually delivering 105V rms at the load, even a 5% sag can cause problems".

—Alex McEachern, BMI (EC&M Magazine)

EMC Newsgroup Forms...

Martin Rowe, editor of *Test & Measurement World* magazine, advises that there is a new Internet newsgroup for discussing EMC compliance issues. The group is known as *sci.engr.electrical.compliance*. For more information, contact Martin at *m.rowe@ieee.org*.

A Simple RFI Failure Forcer...

Most of us have used handheld radios (CB, VHF, UHF) at one time or another to pinpoint RF interference problems.

David Sterrett of Picturetel uses another method that lets him zero in on susceptible circuits right at the circuit board level. It's the small handheld transmitter on a key chain used for popular remote controlled car alarms. It operates at mW levels in the 300 MHz range, and uses AM, making it a slick RFI tester.

As David said in a recent EMail "These transmitters are CHEEEEP and readily available... and good for board level troubleshooting." (Thanks, David.)

The surest sign that intelligent life exists in the universe is that it has never tried to contact us.

Calvin & Hobbs (Bill Waterson)

World Wide Web...

If you haven't already done so, you are invited to visit our "home page" at ***http://www.emiguru.com***. You'll find back issues of the *KGB (Kimmel Gerke Bullets)*, plus an assortment of other EMC related information. This includes a bibliography of EMC books and periodicals, plus other "useful bits of information."

Of course, we've also included general information on Kimmel Gerke Associates, including capabilities and copies of our brochures on training and consulting. Please feel free to pass the address along to others who might be interested in EMC issues.

New Toll Free "888" Number...

If you need our help, please feel free to call us on our toll free number, 1-888-EMI-GURU (1-888-364-4878). This reaches our answering service in St. Paul, Minnesota, so please leave a message and we'll get back to you.

For calls from outside the US or Canada, you should continue to use 612-330-3728.

Extra EMC help...

As mentioned in the last KGB, we've made arrangements with two professional colleagues for additional EMC support. Since then, several of you have had the chance to work with our very capable associates.

Dr. Tom Chesworth, PE, is a "practical PhD" with many years of EMC experience. He is very proficient in detailed EMC analysis as well. Tom and his wife Jo reside in State College, PA.

Bill Ritenour has 30+ years of industry EMC experience. Bill is also practical and knowledgeable about ESD, EMI, and European EMC Regulations. Bill and his wife Roma reside in Boulder, CO.

We are pleased to have both Tom and Bill helping us and our clients solve EMC problems. Our goal is to continue to provide you with timely EMC support.

Daryl Moves to Arizona...

By mid-July, Daryl will be relocated in sunny Mesa, Arizona. No, this isn't "retirement" — just part of a long term plan to get away from the snow and cold. Nor does this mean the "end" of Kimmel Gerke Associates — rather, we like to think of it as our first "expansion" outside of Minnesota.

Seriously, our goal is minimal disruption to our clients. We'll still both be serving clients with consulting and training all across the country, and we'll both back up each other when needed.

Since Mary Gerke does the bookkeeping and billing, invoices and payments will be processed through the Arizona office. Address changes should be sent to Sharon Kimmel at the Minnesota office. (Please note the corporate address change on page 1 of the KGB.)

A KGB Bullet...

Here are two application notes of EMC interest from the folks at AMD:

-High Speed Board Design Techniques
(# 16356 - pub 1992)

-Minimization of Ground Bounce Through Output Edge Rate Control
(# 10181 - pub 1988)

To order, call the AMD Literature Department at 1-800-222-9323. *(Thanks to Scott Roleson, PE)*

About Kimmel Gerke Associates. . .

Often we are asked to give a quick description of what we do. If you are asked by someone needing EMC help, here are six key points about KGA. . .

Key Point I . . .We are a two-man **electrical engineering firm that specializes in electromagnetic interference and compatibility (EMI/EMC) issues.** These include five areas:

- **Regulatory Compliance** (FCC, CISPR, IEC, MIL-STD 461, etc.)
- **Radio Frequency Interference** (Communications systems)
- **Electrostatic Discharge** (ESD)
- **Power Disturbances** (Transients, magnetic fields, etc.)
- **Self-compatibility** (High speed digital, analog, etc.)

Key Point II . . .We are Registered Professional Engineers (PE) and NARTE Certified EMC Engineers. Between us, we have **over 60 years of industry experience.**

Key Point III . . .We are not a test lab — **our emphasis is on EMC design and troubleshooting.** While we are knowledgable about key EMC tests and regulations, our focus is on design issues, and how to identify, prevent, and fix EMC problems. **This includes training as well as engineering help.**

Key Point IV . . .**We serve many industries,** and our support ranges from individual equipment to large systems. We've helped clients in the following areas:

- **Computers** (PCs to supercomputers)
- **Industrial Controls** (Individual controls to full systems)
- **Vehicular** (Automotive, railroad, avionics)
- **Medical** (Diagnostic, clinical, patient connected)
- **Telecommunications** (Small and large system
- **Military** (MIL-STD-461, EMP, TEMPEST, etc.)
- **Architecture** (Sheilded rooms, lightning, power)

Key Point V . . .We are an independent firm with no outside affiliations. **Our advice and recommendations are free from any bias or other business concerns.**

Key Point VI . . . **All client projects are treated in complete confidence.** Unlike many other consulting firms, you won't even see our clients named in our brochure.

Please give us a call if we can help you with your EMI/EMC problems or training needs. **And please pass our name along to your colleagues. Your referrals are always sincerely appreciated.**

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