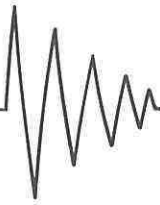


KIMMEL GERKE



Bullets



Spring, 1991
Vol. 2, No. 3

Welcome to KGB. . .

And to the seventh issue of our "personal communications" to our friends, clients, and colleagues. We have many new readers with this issue. . . welcome, and we hope all of you, new and old, find some ideas and information to help you **identify, prevent, and fix EMC problems.**

This issue focuses on Industrial Controls, and the EMC issues associated with *production lines, process control systems, oil and chemical refineries, medical instruments*, etc. We've seen an increasing number of these problems in the past year, which ranged from power disturbances and ESD causing glitches to radio transmitters shutting down entire systems.

If you're a *design engineer*, you want your equipment to survive in its increasingly rugged environment. . . if you're a *systems engineer*, you want to control that environment as much as you can. Although each discipline has its own "sphere of influence", both must work together to assure success. It's a matter of "design it right" and then "install it right."

We'd like to help you "do it right" for EMC. Give us a call, or stop by and see us one of the upcoming shows in Minneapolis, Santa Clara, or Orlando (see *Shows and Conferences*).

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

SEMINAR ON HIGH PERFORMANCE DESIGN

Not just another EMC seminar, but rather **TWO DAYS FOCUSED ON DESIGN ISSUES** facing designers of high performance electronics. Sponsored by Tektronix, and presented by Bill Kimmel of Kimmel Gerke Associates, Ltd.

What: High Performance Design Seminar

When: June 19-20 (Wednesday-Thursday)

Where: Tektronix, 2635 Long Lake Rd., Roseville, MN

Cost: \$750 per person

How to Register: Call 1-800-426-2200 Ext 181

Questions: Call Tektronix at 612-635-0520

This is a "nuts and bolts" seminar complete with demonstrations. If you've heard Bill speak, you know this will be filled with design-oriented information.

Shows and Conferences

Here are some shows in which we will be participating. Give us a call if you'd like more information on any of these events.

Midwest Electronics Expo. . . May 21-23 at the Minneapolis Convention Center (note new location). This is the largest electronics show in Minnesota, and is aimed at the general electronics community. We are exhibiting (Booth 1707), and chairing two EMC related sessions. (Dan Hoolihan of Amador will be chairing a third EMC session.) Don't miss these EMC technical sessions:

- *High Performance Design* — Bill Kimmel, chairman
- *Power Disturbances* — Daryl Gerke, chairman
- *European EMC Requirements* — Dan Hoolihan, chairman

Santa Clara Valley EMC 91. . . June 12-13, Santa Clara Convention Center, Santa Clara, California. We have a booth at this EMC colloquium/product exhibition, which is sponsored by the Santa Clara Valley IEEE EMC Society. If you are in the Santa Clara area, don't miss this show.

EMC-EXPO-91. . . June 25-27, at Walt Disney World Village, Buena Vista Palace Hotel, Orlando, Florida. Come down to Florida, and bring your family to Disney World! We'll be chairing the following sessions:

- *20 Common EMI Design Mistakes* — Bill Kimmel
- *Power Disturbances* — Daryl Gerke, chairman

Many registrations for this show already. . . sounds like it will be a good one to attend.

IEEE 1991 International Symposium on Electromagnetic Compatibility. . . August 13-15, at the Hyatt Cherry Hill, Cherry Hill, NJ. As usual, we'll be there. . . hope to see some of you there, too.

Sixth Annual Minnesota EMC EVENT. . . October 24, at the Thunderbird Hotel in Bloomington, MN. This is the local (Twin Cities) EMC show of the year, co-sponsored by Amador and Kimmel Gerke Associates. Lots of new material again this year. . . **FREE TO PREREGISTERED ATTENDEES.** Watch for more information, and mark you calendars to attend.

Focus on Industrial Controls . . .

Here are some observations and comments on common EMC problems with electronic industrial control equipment. With these systems, it's important to both "design it right" and then "install it right." We hope this helps.

EMC problems with industrial controls are aggravated by several factors. These include a **harsh electronic environment, mixed technologies** (analog, digital, relays, motors), and a **lack of uniform EMC guidelines**.

The **harsh environment** includes several key threats. The big three include **power disturbances**, (including high speed transients), **radio frequency interference** (hand held VHF radios can be a killer), and **electrostatic discharge** (a very real problem today). Two lesser threats are **power line magnetic fields** and **emissions**. We'll deal with each of these shortly.

Mixed technologies compound the problems, as the game is drastically changed. The old analog design rules (such as single point grounds) don't work with high speed digital systems, yet high speed design rules (such as multi-point grounds) can drive analog circuits crazy with ground loops. "Smart sensors" improve the signal/noise, yet are much more vulnerable to nearby radio transmitters. New "hybrid" approaches are needed — and only when we understand the problems can we prevent or fix them.

Fortunately the last issue, **lack of uniform guidelines**, is improving with the IEC 801.X specifications. These documents also form the basis for the impending European Community "immunity" requirements. Incidentally, the IEC 801.X series is titled "*Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment*," and they represent the real-world environment. Regardless of the legal issues, these guidelines are very good design goals.

Now let's look at each of the threats to control equipment in more detail.

Power Disturbances . . . Of all the possible types of power disturbances, the biggest problems for electronic systems are spikes/transients, sags/surges, and outages.

Digital circuits are most vulnerable to spikes (which can cause bits to flip) and sags/outages (which can cause loss of energy to run the system). Analog circuits are usually immune to the spikes, but sags/surges and power supply "noise" can cause undesired "modulation" of analog information.

Power conditioning can solve most of these problems, and is recommended for any critical control system. In addition, linear power supplies (not switchers) should be used to power sensitive analog circuits.

The guidelines of IEC 801.4 (and soon 801.5 and 801.6) can be helpful here. IEC 801.4 specifies an "electrically fast transient" (EFT) that simulates arcing and other high speed noise that plays havoc with computerized

systems. IEC 801.5 and 6 (still in draft form) are expected to add a slower "lightning based" transient plus "sag/surge" levels. See this issue's "Bullets" for some additional power guidelines.

Radio Frequency Interference . . . This is a very serious threat to control systems today, due to the proliferation of hand held VHF radios. We've seen numerous cases where entire systems were shut down due to one hand held radio. We've also seen disturbances due to leakage from coaxial cables carrying high levels of RF power.

As a rule of thumb, a 1 watt radio at 1 meter has an electric field of over 5 volts/meter. Thus, if you are a designer, a goal of 5-10 volts/meter is very realistic. Better to design in some hardening than have your equipment fail in the field.

If you're the designer, the guidelines of IEC 801.3 can be a big help, as they specify electric field levels of 1-10 volts/meter. If you're responsible for the systems, try separating cables, installing shields, and even limiting radio transmitter operation in critical areas.

Electrostatic discharge . . . This is also a big threat to modern electronic systems. And it no longer takes a "direct hit" to cause problems. . . the intense electromagnetic field from a nearby hit can easily upset a system.

An ESD event is very rapid, often 1-3 nanoseconds. At 1 nanosecond, the equivalent "bandwidth" is over 300 MHz, which means that good high frequency RF design techniques are also needed for ESD.

Don't assume that high humidity or lack of "shock" complaints means you don't have ESD problems. Humans can't feel anything less than about 2000 volts of ESD, yet equipment can and does fail at these levels, even in humid environments. We've repeatedly seen this in practice, with everyone claiming that "ESD can't be a problem" when, in fact, it is.

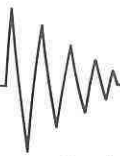
If you're the designer, your goals should be to meet IEC 801.2. If you're the systems engineer, try

continued . . .

A KGB Bullet . . .

Power disturbances are an increasing EMC problem. Here are some "power quality" standards. . .

- ANSI C84.1 — Steady state voltages for 60 Hz power
- ANSI/IEEE C62.41 — Surge voltages originating from lightning or switching transients (formerly IEEE STD 587)
- ANSI/IEEE C37.90 — Surge withstand test for relays
- IEEE 519 — Facility guidelines for power harmonics
- IEC 555-2 — Equipment guidelines for power harmonics
- IEC 801.4 — Defines the Electrically Fast Transient (EFT)
- NEPA 70 (National Electric Code) — Details safe electrical power wiring and grounding practices
- FIPS Publication 94 — Guidelines for electrical power wiring and grounding for data processing facilities
- IEEE 446 — Recommended power requirements for data processing equipment (the "Orange Book")



Focus on Industrial Controls. . . (continued)

preventing discharges with ionizers, conductive carpets, wrist straps, or touch-me pads. You still may not eliminate the problem, but you can often reduce occurrences by orders of magnitude.

Magnetic Fields. . . The main problems here are "wiggly" CRT displays, and "hum" in low level analog circuits. These can be sticky problems.

The preferred strategy is separation from sources such as transformers or power lines, since the fields decrease rapidly with distance. Shielding is usually ineffective, since copper or aluminum is virtually transparent to magnetic fields. Grounding and cable routing may help, but may also aggravate the problem. Don't be afraid to experiment here.

Emissions. . . In the US, process control equipment is exempt from FCC emission limits, which makes sense, since they only protect nearby television receivers anyway. Nevertheless, in Europe, the VDE emission limits apply.

A bigger emission problem with control equipment is interference to nearby radio communications equipment. Unfortunately, the FCC and VDE limits are woefully inadequate here, so if this problem occurs, it can be a very serious one. Separation, shielding, cable routing should all be tried. And don't overlook moving the radio receiver antenna — get it as far away from the "noise" source as you can.

Electromagnetic News Report . . .

Here is a resource that may be of interest, particularly if you have EMC responsibility for your company. This detailed newsletter on EMI/EMC is published six times a year, and typically runs 30 pages. No, it's not free, but we still think it's a good deal at \$53/year (\$68 overseas). For more details, call Tom or Jo Chesworth in Boalsburg, Pennsylvania, at 814-466-6559. (Subscribe and you can follow the popular *EMC Notebook* series by Bill Kimmel.)

IEC 555-2 spec on Power Line Harmonics. . .

Switching mode power supplies and other "non-linear" loads can result in high power harmonics and a reduced power factor. One solution to this increasing problem is to incorporate power factor correction (PFC) into the design.

Soon, Europe will require this preventative measure, via the IEC Specification 555-2. By June 1994, all power supplies exceeding 500 watts will need to meet this spec. There are four categories — B and C are for portable tools and lighting equipment, while A and D are dependent on the type of input.

If you're designing equipment for the European market, you should address this requirement now — don't wait until 1994.

Fame For Fifteen Minutes. . .

To paraphrase Andy Warhol, each of us should be famous for fifteen minutes. Thanks to the *New York Times*, we've had our fifteen minutes of glory.

The story was about **magnetic fields from CRTs**, and quoted our recently released **test reports on CRT "glare shields."** While some wild claims have been made, we found no low frequency (ELF/VLF) magnetic field shielding from any of the shields we tested. This research project was sponsored by the Optical Coating Laboratory, Inc. (OCLI) of Santa Rosa, California. For copies of the reports, call 1-800-OCLI (6254).

Analog Microcontroller Symposium . . .

It was a pleasure meeting many of you during this recent event, held in six cities across the US in April. During this half day session, three different views were given on microcontroller design: **Jim Williams (Staff Scientist from Linear Technology)** discussed high performance analog design; **Charly Gullett (Microcontroller Specialist from Intel)** discussed analog/digital microcontrollers; and **Daryl Gerke (EMC Specialist from Kimmel Gerke Associates Ltd.)** discussed common EMC issues that plague microcontrollers.

We had a great time, and it was quite a success. If you missed this event, two more are planned for Los Angeles and Santa Clara. For more information call Charly Gullett (Intel-Phoenix) at 602-554-5006. And if you need EMI/EMC help, of course, give us a call in St. Paul, Minnesota, at 612-330-3728.

Call For Speakers. . .

Let us know if you'd like to speak at this year's MINNESOTA EMC EVENT. We're looking for one-half hour presentations on regulatory compliance, electrostatic discharge, power, shielding, high speed digital design, radio frequency interference, etc. Give us a call at 612-330-3728 for more details. . . *please call by June 1.*

A KGB Bullet. . .

Worried about magnetic fields from nearby wiring?

Here are two formulas for quick predictions:

$$B = 2I/d/D^2 \text{ (balanced transmission lines, ROMEX, etc.)}$$

$$B = 2I/D \text{ (single conductor or "unbalanced" lines)}$$

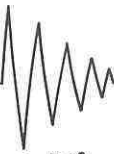
Where B = magnetic field in milliGauss

I = current in amps

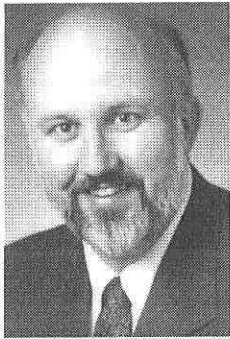
d = wire-to-wire spacing in meters

D = distance from wire/transmission line in meters

Remember, 10 milliGauss is enough to upset a video terminal. (See our paper *60 Hz Magnetic Field Susceptibility Tests of CRT Displays*, International IEEE EMC Symposium, August 1990, Washington, DC.)



About Kimmel Gerke Associates, Ltd.



DARYL GERKE, PE

We're a professional engineering consulting firm that specializes in ELECTROMAGNETIC COMPATIBILITY, a broad area of electrical engineering that deals with electronic interference, or noise. We share almost fifty years of experience in the electronics industry. We're both degreed Electrical Engineers, and we are both Registered Professional Engineers.



WILLIAM KIMMEL, PE

We both have experience with the design, applications, and installation of electronic systems subject to government EMC (FCC, VDE, MIL-STD-461) and TEMPEST requirements. We both have experience solving operational EMC problems with a wide range of equipment. We'd be glad to help you with your EMC problems, fixes, design support, test support, or training needs.

Design Reviews . . .

An increasing number of our clients now include **EMC Design Reviews** as part of the design process. They have discovered that the earlier you address EMC issues, the more options you have, and the lower the costs.

We'd like to help you prevent EMI/EMC problems in your projects. The best time for a design review is right at the start, when you have the most flexibility. And remember, \$5K at design time can easily save \$50K in retest and rework at the end of a project. Call us for more details.

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