

KIMMEL GERKE *Bullets*

Winter, 1990
Vol. 1, No. 2

Welcome to KGB. . .

And to the second issue of our "personal communications" to our friends and clients. . . we hope you find some ideas and information that help you identify, prevent, or solve EMC problems.

This Issue Focuses On Architecture, and the EMC issues associated with buildings, facilities, and systems. With the proliferation of electronics in today's society, it's no surprise that EMC problems occur. Hand held radios upset computers, while those same computers jam nearby television receivers. Power disturbances upset sophisticated control systems, while the power supplies of those systems cause power line harmonic distortion. Distributed systems are knocked out by lightning induced ground shift, and electrostatic discharge causes problems for everyone.

Don White, the President of Interference Control Technologies, stated in the keynote address at EMC-Expo-86 that "By the year 2000, entire buildings will be unusable due to electromagnetic interference to electronic equipment..." We agree, except that it may not take until 2000. Sometimes we're surprised that systems work today.

Fortunately, these problems can be solved... some easily, some more difficult. Prevention is much better, and a lot less painful. But in either case we can help... just give us a call.

Best regards,

Daryl Gerke, PE, and Bill Kimmel, PE

American Consulting Engineers Council



The adjacent logo indicates we are members of ACEC, a nationwide professional organization made up of fully independent consulting engineering firms. ACEC has 140 member firms in Minnesota, and over 4400 firms in the United States. ACEC goals include "develop and follow professional conduct standards consistent with the ideals of the engineering profession", and "better serve the public interest."

A KGB Bullet. . .

Slots, or gaps in shielding, are a major source of shield leakages at high frequencies. A generally accepted criteria is to limit the slot lengths to 1/20 of a wavelength at the highest frequency of concern. The following table gives some maximum slot lengths, for both digital and transient signals.

tr	30 nsec	10 nsec	3 nsec	1 nsec*	0.3 nsec	0.1 nsec
Lcm	150 cm	50 cm	15 cm	5 cm	1.5 cm	0.5 cm
Lin	60 in	20 in	6 in	2 in	0.6 in	0.2 in

tr = rise/fall time in nanoseconds

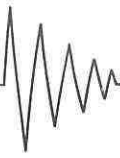
Lcm = maximum slot length in centimeters

Lin = maximum slot length in inches

* Use 1 nsec for electrostatic discharge

Subscription Information

We hope you enjoyed this issue. If you'd like to receive the KGB, drop us a line at Kimmel Gerke Associates, Ltd., 1544 N. Pascal, St. Paul, MN 55108. KGB is printed quarterly, and is FREE to qualified subscribers.



Focus on Architecture

Here are some observations and comments on five common threats faced by electronic equipment within the operational environment. As such, these often become "architectural" issues rather than "design" issues. The system may work fine on the bench, but fails when placed in an increasingly hostile electromagnetic environment.

Radio Frequency Interference...

This is a key threat to today's electronic systems, due to both the proliferation of radio transmitters, and to the lower immunity levels of modern solid state electronics. For example, a digital system with 1 nanosecond logic rise times has no inherent rejection from DC to over 300 MHz. With faster and faster systems, the "window of susceptibility" continues to open even wider.

As a rule of thumb, unprotected electronics fail when electric fields are in the 1-10 volt/meter range. In the absence of radios, ambient levels are typically below 0.1 volt/meter, so problems do not occur. Nearby transmitters, however, can easily cause fields in the 1-100 volt/meter range. Even low power handheld radios are a problem. . . a 1 watt radio at 1 meter distance has a field level of over 5 volts/meter. (See the "Bullet" in Vol 1 No 1 of KGB).

We've seen several cases of control system failures due to nearby hand held radios. We've also seen disturbances due to leakage from coaxial cable transmission lines - one in a hospital and one in a semiconductor fab.

The solutions include separation, shielding (equipment, cables, facility), and even limiting radio transmitter operation. But just being aware of this threat can be a big help.

Low Frequency Magnetic Fields...

This problem is starting to emerge, and we see an increasing number of complaints for "wavy" computer terminals. Usually, the display is very near a transformer or the building service entrance. Large currents result in large magnetic fields which can upset CRTs. These fields can also cause upsets to audio and instrumentation, such as "hum."

These problems can be sticky ones. Separation is usually quite effective, since the magnetic fields decrease rapidly with distance. Shielding, however, is often ineffective, and if used must be ferrous. . . copper or aluminum are virtually transparent to power line magnetic fields. Grounding and cable routing may help, but may also actually aggravate the problem.

We are planning some research and further investigations in this area, which we'll report here.

Power Disturbances...

Of all the possible types of power disturbances, two cause the most problems for electronic systems. . . sags and spikes. Sags result in insufficient

energy to run the system, and spikes cause false triggering of digital systems.

Fortunately, sags and spikes are relatively easy to remedy, with add-on power conditioning. An entire industry has developed around mitigating these problems. Incidentally, the problems are usually internally generated. . . one recent study showed that over 85% of the disturbances were generated within the facility.

Harmonic distortion is another problem, only in this case the computers are the source, rather than the victim. While most electronic systems are immune to this problem, the transformers, wiring, and distribution systems are often severely stressed. Due to this problem, the National Electrical Code no longer allows derating of neutrals for power circuits feeding electronic systems.

Electrostatic Discharge...

Modern electronic systems are very susceptible to this environmental threat. And it no longer takes a "direct discharge" to cause a problem... the intense electromagnetic fields resulting from a *nearby* discharge can easily upset a system. And the faster the system, the more susceptible it is to this type of problem.

These intense fields are the result of a very rapid discharge... often 1 to 3 nanoseconds. At 1 nanosecond, the equivalent "bandwidth" is over 300 MHz, which means that VHF/UHF shielding and grounding techniques are required. (See the "Bullet" in Vol 1 No 1 of KGB.)

One of the best architectural techniques is to prevent the discharges, with humidity, ionizers, conductive carpets, wrist straps or touch-me pads. By "bleeding" off the charge before a discharge occurs, most equipment problems can be eliminated. In any event, the rate of occurrences can often be reduced by orders of magnitude.

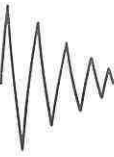
Mitigation techniques to deal with the actual discharges include high frequency shielding, add-on transient suppression, and high frequency grounding.

Lightning. . .

The adverse effects of lightning on electrical systems and power interfaces are well understood. Standards such as IEEE C62.41 (formerly IEEE-STD-587) simulate "worst case" lightning transients on the power lines, and transient protection devices are readily available to solve these problems.

Lightning, however, causes other failures with electronic systems. First, a large shift in "ground" potential can occur near a lightning hit, due to lightning currents dispersing in the earth. In distributed systems, these potentials can easily reach 10kv-100kv, enough to "blow out" interface circuits. Second, the large magnetic fields associated with a lightning hit may also cause problems. In both cases,

(continued on next page)



Focus on Architecture. . . (continued)

grounding is crucial. Ground grids are often used to lower the impedance (and thus the voltage) between equipment, and single point grounds are often used to eliminate "ground loops." Since grounding also plays a crucial role in safety, *ground systems must be carefully designed... they can not be left to chance.*

Local area networks pose special lightning problems... often shields are isolated (grounded at one end only) in single point ground systems to maintain the grounding scheme... yet this makes the system very vulnerable to radio frequency interference and electrostatic discharge. "Hybrid grounds" or fiber optics may be needed.

A KGB Bullet . . .

Crosstalk between wires or cables can become a serious problem when the common length of the wires/traces/cables approaches the "risetime length" of a transient or switched signal. In free space or for "loose wiring" this is about 1 foot per nanosecond; in circuit boards or "tight" cables, this drops to about 0.6 foot per nanosecond due to the dielectric. The following table gives a first approximation for crosstalk as a potential problem.

t - nsec	1	3	10	30	100	300	1000
Lfs-feet	1	3	10	30	100	300	1000
Lpcb-ft	0.6	1.8	6	18	60	180	600

t = rise/fall time in nanoseconds (use shortest time)
Lfs = risetime length in free space or loose cable
Lpcb = risetime length on circuit board or tight cable

EMC Event a Success

The **Fourth Annual EMC EVENT**, held in late October, was a big success. Over 180 attended this one day show, visiting 26 exhibitors and attending the 20 technical sessions. Very favorable comments on this year's show. . . thank you to all of you who attended!

We've already begun on next year's conference. The **Fifth Annual EMC EVENT** will be held Thursday, October 25, 1990, at the Thunderbird Hotel in Bloomington, Minnesota. Mark your calendars to attend.

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

A new twist for next year are two full day seminars preceding the conference, on Tuesday and Wednesday. Dan Hoolihan (AMADOR) and Bill Kimmel (Kimmel Gerke Associates) will present their popular "EMC for Digital Designers" and "Electrostatic Discharge" seminars. These are optional and at a charge. . . **please note**, however, **that the EMC EVENT itself remains a FREE ONE DAY SHOW.**

Speaking of free. . . it is the exhibitors who pay for this show, and the good folks of AMADOR and Kimmel Gerke Associates who organize and sponsor it. Please support these exhibitors, and let them (and us) know when you've gained good ideas or learned about new products through the EMC EVENT.

Shows and Conferences

In addition to co-sponsoring the MINNESOTA EMC EVENT, we are also involved in several other shows and conferences. Quite often, we are able to provide a unique perspective on EMC problems and solutions. Here are some upcoming shows in which we'll participate.

Midwest Engineers Conference and Exposition. . . This show is aimed at dispersing information within the Professional Engineering community in Minnesota. We're leading a session titled "Electronic Interference Control - From Microchips to Megamalls", on Wednesday, February 7, at 8:30 AM at the Minneapolis Convention Center.

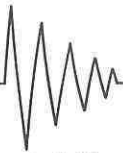
Second National Power Quality Conference For End Use Applications. . . Sponsored by EPRI and the Edison Electric Institute, this conference is aimed at the users of electric power. We're giving a presentation on "EMI Aspects of Power Quality", on Friday, March 23, at the San Francisco Airport Hilton.

Midwest EXPO. . . This is the largest electronics show in Minnesota, and is aimed at the general technical community. We're supporting two IEEE sponsored sessions on EMC and on Power Disturbances. Stop by and see us at Booth # 652, May 15-17, at the St. Paul Civic Center. More details later.

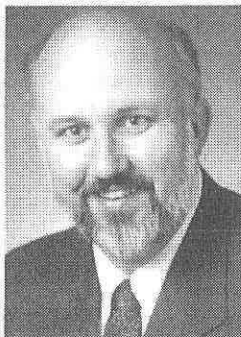
Join the IEEE EMC Society

If you are involved with EMC issues, consider joining the IEEE EMC Society. You don't need to be an expert. . . just interested in EMC.

Although one of the smallest of the IEEE societies, the EMC Society is quite active. Most cities have local chapters that sponsor technical meetings throughout the year. . . a good chance to learn and meet others in the field. And the annual IEEE EMC Symposium is the place to see new products and hear about new developments. . . this year it's in Washington, D.C., August 21-22-23. Hope to see you there.



About Kimmel Gerke Associates, Ltd.



DARYL GERKE, PE

We're a professional engineering consulting firm that specializes in ELECTRO-MAGNETIC 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 both have lectured and published on ESD, EMI, EMP, and related issues. We'd be glad to help you with your EMC problems,

fixes, design support, test support, or training needs.

Expert Witness Help Available . . .

Although we hope you and your products don't end up in court, we might be able to help if they do. We've both had experience as "expert witnesses", and although it's not a central part of our business, we do offer that as part of our services as consulting engineers.

We are both Registered Professional Engineers, which is almost mandatory in this area. In addition, Daryl holds a Master Electrician's License and an FCC Commercial License, two additional credentials useful in this area.

KIMMEL GERKE ASSOCIATES, LTD.

Electrical Engineering Consultants

SPECIALISTS IN ELECTRONIC INTERFERENCE CONTROL

Noise, Transients, and Electrostatic Discharge
FCC, VDE, MIL-STD, EMI/EMC, EMP
New designs and retrofits

Experienced in power, communications,
and computers

Daryl Gerke, PE

William Kimmel, PE

1544 North Pascal • St. Paul, MN 55108 • 612-330-3728

Kimmel Gerke Associates, Ltd.

1544 North Pascal
St. Paul, MN USA 55108
612-330-3728