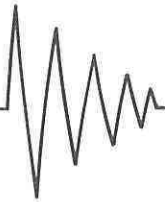


# KIMMEL GERKE



## Bullets



Summer, 1990  
Vol. 1, No. 4

### Welcome to KGB

And to the fourth issue of our "personal communications" to our friends and clients, complete with information to help you **identify, prevent, and fix** EMC problems.

**This issue focuses on power disturbances**, an area we believe is rapidly increasing as an EMI/EMC problem. Since most electronic systems are connected to commercial power, the power interface often becomes an unwanted gateway for interference to enter (and leave) a system. And even when systems are not power connected, power related electric and magnetic fields can cause problems in sensitive electronics, such as low level analog circuits or CRT displays.

A major problem we see is a lack of awareness to these problems, by equipment designers, installers, and even our colleagues in the EMI/EMC community. Hopefully, some of our comments and ideas will help you as you attack this problem area. Give us a call if you'll like some help with this, or any other EMI problem.

Best regards,

Daryl Gerke, PE, and Bill Kimmel, PE

### Pre-Register for EMC Event Now

If you're planning to attend the Fifth Annual Minnesota EMC Event, take a minute to fill out the enclosed registration card. **Remember, it's free if you pre-register, but it's \$25 at the door!**

We're excited about this year's show... new products, new information, new technical talks. We hope to see you there.

**P.S. To Our Out of Town Readers...** Come join us for up to three days, and attend our pre-Event seminars. While these are not free like the show, they can make your trip to Minnesota worthwhile. By the way, October in Minnesota is usually beautiful.

### Shows and Conferences

Here are some shows in which we'll be participating over the next several months. Give us a call if you'd like more information on any of these events.

**1990 International IEEE EMC Symposium...** The annual IEEE conference on interference, held August 21-23 at the Washington Hilton hotel, Washington, DC. Daryl and Paul Cook (AMADOR Corporation) will present a paper on "60 Hz Magnetic Field Susceptibility Tests of CRT Displays" on Wednesday, August 22, at 9 AM.

**MIPSYCON...** The Minnesota Power Systems Conference, held October 2-4 at the Earle Brown Center at the University of Minnesota- St. Paul Campus. Bill will present a paper titled "Electromagnetic Interference Aspects of Power Quality" at 1:30 PM on Tuesday, October 2.

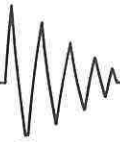
**EMC EXPO 1990...** An international conference sponsored by *EMC Technology* magazine, held October 17-19 in "Silicon Valley" at the San Mateo County Expo Center. Daryl and Bill will present a tutorial session titled "Twenty Common EMI Mistakes... and How to Avoid Them" on October 17.

**Fifth Annual Minnesota EMC Event...** The local (Twin Cities) EMC show of the year, co-sponsored by Amador and Kimmel Gerke Associates, held Thursday, October 25, 1990, at the Thunderbird Hotel in Bloomington, MN. Lots of new material for this year... free to preregistered attendees. Mark your calendar to attend.

### Thanks For Your Postcards

Thank you to all of you who returned the post cards from the last issue of KGB. We've updated our mail list, and should now have your correct address. Thanks also for your many kind comments... it's nice to hear that KGB is useful to you.

If any of your colleagues would like to receive KGB (it's free), just send us their name and address, or give us a call at 612-330-3728.



## PES Committee Meeting

The Power Quality Standards Coordinating Committee (SCC-22) held a meeting at the IEEE Power Engineering Society conference in Minneapolis on July 16. Daryl attended the meeting, representing the IEEE EMC society on this committee.

Highlights of the meeting included presentations by Harry Ruether of Sears (power quality and ESD standards that Sears suppliers must meet), Bill Moncrief of Georgia Power and Light (Power Quality Working Group), and several other leaders in the power quality area.

The goal of SCC-22 is to bring diverse viewpoints together within the IEEE, so that we can all better understand power disturbances and how to solve these problems.

## Attention Hams

Watch for our article titled "Amateur Radio Versus Microprocessors" in *BEAM*, a new ham radio magazine introduced in August 1990. This free (yes, free) ham radio magazine is published by Tom and Jo Chesworth, who also publish the EMI newsletter, *Electromagnetic News Report* (not free, but very worthwhile.) For more information on either publication, contact Tom or Jo in State College, Pennsylvania, at 814-466-6559.

And if you are an active ham, look for Daryl (KØFBF) on 10,12,15,17 or 20 meters.

## European Community Update

The European Community (EC) is an organization of 12 European countries which have agreed to remove trade barriers to form one common market. This market will consist of 320 million people, which exceeds the US market by 100 million.

Common EMI standards will apply in all member countries, **including immunity tests for ESD, RF fields, and power disturbances.** These are in addition to the emission tests, similar to today's VDE/FCC limits.

These new European standards will be enforced January 1992 . . . which means **if you are designing equipment today for Europe, you must consider these requirements now. . . not in 1992!** (By the way, we believe companies that are compliant in 1992 will enjoy a distinct competitive advantage.)

## Courses Available

If you'd like instruction on how to design and/or install your equipment for EMI compliance (FCC, VDE) or immunity (ESD, power, RF, etc), we can help with one, two, three, or four-day classes. Available either "off the shelf" or "custom designed".

If you need to train five or more people, an in-plant class can probably save you money. And since the class is taught by an experienced EMI consultant and instructor, you get practical up-to-date knowledge, not a lot of theory. Call us at 612-330-3728 for details and pricing.

## Book Reviews

With winter not too far off, the ESD season will again be upon us. Here are three books that we like. . .

**Electrostatic Discharge — Understand, Simulate and Fix ESD Problems**, by Michel Mardiguian. A classic work on ESD, written by one of the world's experts. Emphasis on designing, diagnosing, and testing for ESD on electronic systems. Published in 1986 and available from Interference Control Technologies.

**ESD**, by Warren Boxleitner. Published in 1989 by the IEEE Press, this is also a well written text that also deals with ESD at the systems level. Warren is the VP of engineering at Keytek, and a recognized authority on ESD.

**ESD From A to Z**, by John Kolyer and Donald Watson. This text deals with ESD at the chip and equipment manufacturing level, and not at the equipment level. Includes recommendations on how to set up an ESD control program in your manufacturing area. Published in 1990 by Van Nostrand Reinhold.

### A KGB Bullet

When dealing with magnetic fields, several common units are used, including ampere-turns, Tesla, dB picoTesla, Gauss, and milliGauss. Ampere turns is a unit for the H field (magnetic intensity) while Tesla and Gauss are units for the B field (flux density.) B and H are related by  $\mu$ , the permeability. The following table gives some common examples for air or free space:

				dB
MilliGauss	Gauss	Ampere-turns	$\mu$ Tesla	PicoTesla
1	0.001	0.08	0.1	100
10	0.01	0.8	1	120
100	0.1	8	10	140
1000	1	80	100	160
10,000	10	800	1000	180
100,000	100	8000	10,000	200

## Recent Projects

Our experience goes far beyond dealing with traditional EMI issues, such as FCC, VDE and MIL-STD-461. Here are some recent projects on which we have assisted our clients. . .

**Design reviews** — high speed digital systems

**Medical products** — ESD and RF susceptibility

**Automotive products** — emissions, MIL-STD-461, ESD

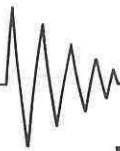
**Military products** — MIL-STD-461, TEMPEST

**Facilities** — magnetic & electric field measurements, shield room design, power disturbances

**R&D projects** — shielding effectiveness, emissions, magnetic field susceptibility

**Training** — FCC/VDE, susceptibility, ESD, systems installations

Give us a call if we can help you. All inquiries and projects are treated in a confidential manner.



## Focus on Power Disturbances

Power disturbances are often the orphans of the EMI world. The equipment designer blames the power company, and the power company blames the installer. Meanwhile, it is often the user who is "fouling his/her own nest" by polluting the local power. One recent study showed that 85% of the power problems were due to this local pollution.

Rather than point the finger, we all need to work together to prevent and solve these problems. As design engineers, we need to build in more protection against these problems. As systems engineers, we need to better understand how to install modern equipment to minimize these problems. Here are some comments and recommendations, with an emphasis on how power disturbances affect modern electronic equipment.

**Conducted disturbances** — Although there are many types of disturbances that can be conducted via the power system, two types cause most of the problems with electronic equipment. These are **sags** (long term drops in line voltage) and **spikes** (short term transients). The sags cause power supplies to fail, due to lack of energy, while the spikes cause false triggering of digital circuits. **Both issues must be addressed**—not just one or the other, as some vendors would have you believe.

The best defenses here are to install transient protection devices (MOVs, zeners, arc devices) for spikes, and regulation devices or dedicated power circuits for electronic equipment to protect against sags.

**Harmonics—an emerging problem** — Although electronic systems are not generally affected by harmonic distortion, they are a major cause of this problem. The problem is not due to the electronics, but rather the power supplies. The victims, in this case, are often adjacent motors, transformers, and even facility wiring.

Power supplies represent "non-linear" loads to the power distribution system. The worst offenders are switched-mode power supplies, which take "gulps" of current at the cycle peak, rather than over the entire sine wave. This non-sinusoidal current results in current harmonics, and eventually voltage distortion as well. These harmonics can cause overheating of transformers, motors, and even neutral lines. The latter has resulted in changes to the 1990 National Electrical Code for circuits supplying "non-linear loads."

The best line of defense here is to be sure that proper wiring practices are followed, which include issues like proper sizing of power/neutral wires, and derating of transformers. The "old ways" are no longer adequate.

**RFI on Power Lines** — In addition to providing a conductive path for low frequency disturbances, the power lines can also act as unwilling "antennas" for

high frequency energy. Internal sources of this energy can be power supply harmonics (previous paragraph), or other energy coupled to/through the power supplies, such as microprocessor clocks.

This high frequency radiation can become a factor as low as 1 MHz, and it is definitely a factor in the 10 to 50 MHz range. In fact, this is one reason why the FCC and VDE do conducted measurements up to 30 MHz, and then switch to radiated measurements from 30 MHz to 1 GHz.

Keep in mind that these same "power line antennas" can collect unwanted external energy (hand held radios, land mobile transmitters) and deliver that energy to your system, creating susceptibility problems as well.

The best defense here is to use filters, which can range from simple bypass capacitors to complete multi-stage power line filters. Filtering should be used both inside and outside the equipment. Filters are best placed at "barrier" or transition points, such as at the equipment power entry, output of power supplies, and power entry points to printed circuit boards.

**Magnetic Fields** — Like harmonic distortion, this too is a rapidly emerging problem. Much attention is being given to the possible health and biological effects of low frequency magnetic fields, which may or may not prove to even be a problem. Thanks to one author about to make a lot of money on his book, this has become the latest "crisis" for the non-technical media types.

Nevertheless, magnetic fields do cause problems with electronic equipment. Field intensities of 10-100 milliGauss can, and do, cause CRT displays to "wave." These fields can be from internal electronics, or external power wiring. We did some research on this, which will be presented at the IEEE EMC Symposium in August 1990. Call us if you'd like copy of our paper.

This is a tough area to defend against. Wire twisting can be effective, but shielding is very difficult.

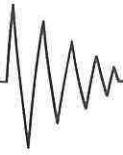
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### A KGB Bullet

The inductive reactance of wiring exceeds the wiring resistance at surprisingly low frequencies. Here are some values for one meter of wiring for several common wire sizes:

Wire size	R	L	Z(60Hz)	Z(1 k)	Z(10 K)	Z(100 K)
AWG 2	520uΩ	1.1uΩ	670uΩ	7.1mΩ	71mΩ	710mΩ
12	5.3mΩ	1.3uΩ	5.3mΩ	10.mΩ	86mΩ	860mΩ
22	54 mΩ	1.6uΩ	54 mΩ	54 mΩ	113mΩ	1Ω

Note that above 10 KHz (the upper end of the audio range) the impedances are almost independent of wire size.



## Focus on Power Disturbances. . . (continued)

Aluminum won't work at all at 60 Hz; steel or highly permeable (and expensive) mu-metals are needed. The best approach here is to design equipment to minimize the effects of magnetic fields.

**Summary** — This is just a quick overview of power disturbances, and how they affect (or are affected by) modern electronic equipment. Although not very glorious, we think power disturbances will be a major EMI issue in the 1990s.

The Europeans are addressing this issue now, and will add power transient and surge testing to their 1992 immunity requirements (IEC 801.4 for transients, IEC 801.5 for surges). The IEEE is updating IEEE C62.41 (formerly IEEE-STD-587) with the final draft being circulated for approval (it will include new transients, similar to IEC 801.4). And the IEEE "Emerald Book" continues to progress, which will provide specific power guidelines for installing electronic systems.

As mentioned earlier, we all need to pull together to prevent and solve these problems - designers, installers, utilities, and architects/engineers. Give us a call if you need help.

## 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.

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