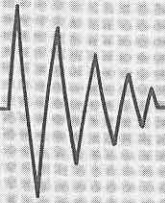


# KIMMEL GERKE



## Bullets



Winter, 1993  
Vol. 4, No. 2

### Welcome to KGB. . .

And to another issue of our personal communications to our friends, clients, and colleagues concerned about EMI/EMC issues.

This quarter's KGB focuses on lightning, and some of the ways it can cause EMI problems. Lightning itself is often not the key issue — rather, it's the disagreement on the "best" grounding and transient protection methods that cause problems. This becomes acute as we mix technologies and industries, such as radios, computers, and telecommunications.

We'll examine the lightning phenomena and associated EMI coupling modes, and then we'll give you some suggestions on how to deal with this critical EMI issue.

Give us a call if we can help you with any of your EMI problems, lightning or otherwise.

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

### Tektronix EMI Seminars. . .

We've just completed several of our Tektronix sponsored seminars on *Designing for EMC*, with very favorable reviews. It's two days focused on design issues facing the designers of sophisticated high performance equipment.

These are planned throughout the US, so one may be coming your way. Please note that the schedule printed in the last issue has changed. . . call us at 612-330-3728 for information on the next seminar in your area.

We'll be in Phoenix and Washington, D.C. in March, followed by Dallas and Portland in April.

### Shows and Conferences. . .

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

**EMC/ESD International** . . . April 28-30, 1993, in Denver, Colorado, and sponsored by *EMC Test & Design Magazine*. A great show for both the newcomer and the EMI professional. We'll be there doing two sessions:

- *ESD Design Tutorial (April 27, before the show)*
- *Twelve Offbeat Problems (April 28)*

Hope to see you there.

**IEEE 1993 Symposium** . . . August 9-13, 1993 in Dallas, Texas. Technical Sessions, plus three days of exhibits. Sponsored by the IEEE EMC Society, it's always a good show to attend.

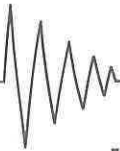
### EMI-Toolkit™

*A New and Unique Concept in EMI Software*

**EMI-Toolkit™** is a collection of over thirty of our favorite EMI formulas, graphs, and tables that we use on a regular basis as EMI consulting engineers. They help us assess and evaluate problems, and provide quick approximations to common EMI problems. These proven tools are now available to you as an easy to use Windows (3.1) program.

- **Estimators** — Used to Calculate & Predict Levels
- **Selectors** — Used to help choose components
- **Tables** — Containing Common Values
- **Conversions** — Used to convert units and values
- **Limits & Regulations** — FCC, VDE, CISPR
- **Reference Data** — Useful Facts & Figures

**EMI-Toolkit™** is like having an EMI reference handbook (or perhaps even an EMI consultant) right at your fingertips. Only \$100 for single user copy or \$500 for a single-site/single-network copy. A corporate wide license is also available. Call 612/330-3728 for more details or to order.



## Focus on Lightning. . .

Many of you, particularly equipment designers, may not consider lightning a "real" EMI problem like emissions, ESD, or RFI issues. As EMC engineers, however, we've seen an increased interest and concern over the effects of lightning on electronic equipment, particularly at the systems and facilities levels.

In this issue of the KGB, we'll look at how Mother Nature's version of electrostatic discharge (ESD) affects electronic systems, and we'll share some ideas with you on how to control those effects.

We've recently dealt with some interesting lightning problems associated with "911" emergency systems. These combine radios, telephones, and computers into a integrated system where high reliability can literally be a matter of "life or death." Since most radio systems use large outside antennas, an eventual direct lightning hit is almost assured.

A key issue we continually see is different vendor philosophies on power, grounding, and cabling. As a result, hybrid approaches are often needed. As with so many EMI problems, it's often a matter of just getting everyone on the same wavelength.

**Multiple lightning effects.** . . Like electrostatic discharge, lightning can affect systems in several ways. All of these must be considered in designing or troubleshooting a system where lightning is suspect.

**Direct hit.** . . This obviously results in damage (or worse) when nature unleashes 100,000 amps or more of current in fraction of a second. Anything in the current path is likely to be destroyed, unless a very low impedance path can be maintained.

This is the goal of a building lightning protection system, which assumes that sooner or later, lightning *will* strike the structure. The objective is to provide a controlled, low impedance path to earth for the lightning current. Most of us leave these details to the lightning protection specialists.

**Power upsets.** . . This effect can also result in damage to unprotected equipment, as lightning induced transients reach equipment through the power mains. Years of power studies have shown that power disturbances on building wiring can reach levels of about 6000 volts or 2000 amps, with risetimes of 1-10 microseconds and lasting 20-50 microseconds.

These levels have been codified in specifications such as IEEE C62.41 or IEC 801.5. Incidentally, most

systems are not expected to operate "glitch free" through these tests, and many are not even expected to survive the full force of these transients. For some systems, success is simply not bursting into flames!

**Ground shift.** . . This is a more subtle effect of lightning that often results in seemingly mysterious equipment upsets or failures. Voltage gradients of many thousands of volts can be developed at some distance from an actual lightning hit, as the lightning currents are dispersed in less than perfect grounds.

This ground surge travels through earth and facility grounds like an electronic tidal wave, and can destroy anything not properly grounded or protected. This includes non-power circuits, such as I/O or LAN interfaces. It can even kill, and is the reason many people or animals have died due to a nearby (but not actually direct) lightning hit.

This is the basis for building ground rings, ground windows, and even ground planes. The objective is to stabilize the ground impedance, to minimize the voltage gradients due to the transient currents.

**Electromagnetic Field Coupling.** . . A fourth major effect of lightning are the large transient electric and magnetic fields. These can be particularly vexing in metal frame buildings, as transient currents in the structure induce noise into power and signal wiring.

In these cases, careful cable routing is necessary. Even metal structures like water pipes or ventilation ducts can cause problems during a lightning hit.

**Mitigation Techniques.** . . Lightning control is best applied at all levels of equipment usage — facilities, system, and the equipment itself.

At the **facilities level**, "primary" transient protection should be included at the power service entrance, plus on any other data/telephone/radio cables entering or leaving the building. Grounding halos,

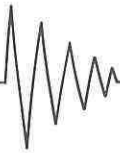
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### A KGB Bullet. . .

Have you ever wondered what electrical current levels can cause a shock? Here are some guidelines:

AC Current(60 Hz)	DC Current	Effects
0-1 ma	0-4 ma	Perception
1-4	4-15	Reaction
4-21	15-80	Let-Go Current
21-40	80-160	Muscular Inhibition
40-100	160-300	Respiratory Block
Over 100	Over 300	Usually Fatal

— Source: MIL-HDBK-419



## Focus on Lightning . . .

*continued*

grounding windows, and signal reference grids can be used to stabilize the ground impedance and minimize ground loop effects. Cable routing and shielding should also be considered, and not just left to chance.

At the **systems level**, "secondary" transient protection should be included on power and critical signal interfaces. Faraday shielded isolation transformers and filters offer additional power protection. Uninterruptible Power Systems (UPS) should be considered for critical loads, like computers and security systems. Local "ground windows" can help control unwanted potential shift between different systems like telephones and computers.

At the **equipment level**, MOVs (metal oxide varistors) and Tranzorbs (zener devices) offer additional power and signal transient protection. For critical equipment, we recommend protecting every interface, not just the input power. Optical isolators or fiber optics are very useful in controlling ground shift effects. Fiber optics is also very good at controlling unwanted cable problems.

An overriding concern in all of this is human safety. We can never violate safety standards, such as UL or the National Electrical Codes, even if it might "improve" our equipment operation. We also need to need to think how our systems will act in both "steady state" and "transient" conditions — a 60 Hz approach is not enough when lightning is involved.

*There is nothing wrong with the younger generation that becoming taxpayers won't cure.*  
— Author Unknown

## Test Lab Tidbits . . .

Liberty Labs (Iowa) now offers antenna calibration and automotive immunity testing. Contact Mike Howard at 712-764-2199. Ask Mike about his EMC BBS as well.

Northwest EMC Inc. (Oregon) now offers full service commercial, military, and medical emission and immunity testing. Contact Dean Ghizzone (former Tektronix EMC engineer) at 503-537-0728.

## EMI Software . . .

We're proud to announce our new EMI software package, the *EMI-Toolkit™*. This is a collection of formulas and information that we find useful as EMC consulting engineers. We've put these together in a useful Windows (3.1) based package for \$100.

This is *not* a test automation package, nor is it a CAD or EMI prediction package. Rather, it's more like a "smart" EMI reference book. We think this is a new and unique concept for EMI software. Call for a brochure at 612-330-3728. (Got your own Windows application? We've got an ace programmer — call.)

## Engineering Foil Tape Shielding Kit . . .

The Electrical Specialties Division of 3M recently introduced a new product kit containing a full line of 3M foil shielding tapes. Like the very popular ferrite kits, it's great for prototyping and troubleshooting. Cost \$67. Call 1-800-328-1368.

## Book Reviews . . .

*High Frequency Measurements and Noise in Electronic Circuits*, DC Smith, published by Van Nostrand Reinhold. Highly practical information on how to make accurate signal and noise measurements, and a very welcome addition to our own libraries. Well written and easy to read.

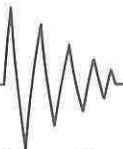
*Introduction To Electromagnetic Compatibility*, Clayton Paul, published by Wiley. Written as a text book, this book offers a comprehensive blend of theory and applications. Lots of formulas with derivations. Well written and a solid reference.

**A KGB Bullet . . .**

Here are some European EMI Standards that will become mandatory in January 1996. (Some are still in draft form, but are very likely to be ratified.)

Product Family	Emissions	Immunity
Household Appliances	EN55014	EN 50082-1
Fluorescent Lamps	EN55015	EN 50082-1
Receivers	EN55013	EN 55020
Computers	EN55022	EN 50082-1
Mains Signaling	EN50065-1	EN50082-1
ISM Equipment	EN55011	EN50082-2

— Source: *EMC Test & Design*, Nov/Dec 92, page 49



## Design Reviews . . .

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

For a single product, a review typically runs a day or two depending on the complexity. We'll sit down with your design team, and go over all EMI aspects of your design, including circuit board design and layout, input/output, power supply, interconnections and cables, and mechanical packaging. We won't dictate terms, either — we'll give you the options, but the final decisions are yours.

The best time for a design review is near the start of a project. Just before or during the PCB layout is ideal, as most of the concepts are solid at this point. (A note to military designers — you need to involve us in the *proposal* stage — that's when many of your key design decisions are made.) **Remember — \$5K at design time can easily save \$50K in retest and rework at the end of a project.** Call us for more details.

### Kimmel Gerke Associates, Ltd.

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

## ESD Articles . . .

We've published several articles and papers on electrostatic discharge as an EMI problem. Give us a call (612-330-3728) if you'd like any of these:

- *ESD: Miniature Lightning*, Inside Line, Sept. 1988
- *Electrostatic Discharge as an EMI Issue*, RF Design Magazine, Nov. 1988
- *EMC Notebook: ESD*, Electromagnetic News Report, Sept. 1989
- *ESD — The Season is Here*, Inside Line, Oct. 1991
- *ESD Season is Coming*, Electromagnetic News Report, Nov. 1991

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