

KIMMEL GERKE



Bullets



Fall, 1994
Vol. 5 No. 2

Welcome to KGB...

And to the second issue for 1994 of our "personal communications" to our friends, clients, and colleagues about EMI problems and solutions.

This issue focuses on embedded microcontrollers.

While most of the glory is with high speed designs (32/64 bit CISC and RISC devices running at 100 MIPs+), most of the design work today is still done with 4,8, and 16 bit devices which are buried as controllers in embedded systems.

Because so many of these systems are used in harsh environments (industrial, medical, automotive, etc.), extra attention must be given to EMI. We'll share both some ideas and some observations we've made as we've worked with many of you to help you to *identify, prevent, and fix your EMI problems* in your embedded control designs.

As always, give us a call if we can help you with any of your EMI problems.

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

MINNESOTA EMC EVENT...

Plan now to attend the *Ninth Annual Minnesota EMC Event...* once again held at the Thunderbird Hotel in Bloomington, MN... October 17-18-19 (Mon-Wed).

All events on Tuesday (October 18) are **FREE**... Trade Show Exhibits, **FREE LUNCH**, Technical Talks by Industry Experts, IEEE/EMC Meeting.

Join us Monday and Wednesday for in-depth seminars on *Grounding & Shielding, Design For EMC, ISO 9000, European EMC Certification, Medical Device Directive, and more.*

This show is sponsored by Kimmel Gerke Associates, AMADOR/TUV Product Service, and the Paul Bunyan Chapter of the Electronics Representatives Association (ERA). Hope to see you there!

Shows and Conferences...

Here are some shows and conferences in which we'll participate. Call if you want details on any of these.

Ninth Annual Minnesota EMC EVENT...

Tuesday, October 18, 1994, at the Thunderbird Hotel in Bloomington, MN. *Please note the date change... the show is on Tuesday, not Wednesday or Thursday as in the past.* Full day seminars will be offered before and after the show (Monday & Wednesday.)

Soft Ferrite User's Conference...

October 24-25, 1994, at the Westin Hotel O'Hare in Chicago, and sponsored by the *Magnetic Materials Producers Association*. Daryl will be presenting a paper on "High Frequency Modeling of EMI Ferrites," which reports on some original Kimmel Gerke research.

Medical Design & Manufacturing West 95 Conference...

January 9-13, 1995, at the Marriott Hotel in Anaheim, CA, and sponsored by *Medical Device and Diagnostics Industry* magazine.

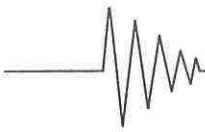
Daryl will present a tutorial on "Designing for EMI/EMC in Medical Devices", and Bill will present a paper on "Leakage Currents vs EMI - A Juggling Act." This year's show will include a full day on EMC issues - both tutorials and papers from several industry experts. In you are interested in medical EMI issues, you should attend this show.

EMC/ESD International...

January 29 - February 1, 1995, at the San Diego Convention Center in San Diego, CA. Sponsored by *EMC Test & Design Magazine*. Great show for the EMI newcomer, as well as the experts. Focus is on practical sessions.

Reprints... EDN Magazine's Designer's Guide to Electromagnetic Compatibility... now available...

Due to its popularity, this EMC guide (written entirely by us) is now available as a reprint. Call Kirsten Dumas at EDN Reprints (1-800-523-9654). Cost is \$19.95 + shipping. Quantity discounts.



Focus on Embedded Controllers..

Much has been written recently about EMI in high speed systems. Yet for every 32/64 bit processor used in a high performance computer, there are thousands of 4/8/16 bit processors used in more mundane roles, ranging from microwave ovens to vehicular controls, industrial controls, or medical devices.

As EMI consulting engineers, we've spent a lot of time working with the designers of embedded controllers. We've solved a lot of EMI problems, yet we continue to see a lot more. Here are some observations and ideas on how to deal with EMI in embedded control applications.

Some Key Issues...

Embedded controllers are often affected by several factors. These include severe **cost constraints**, **mixed technologies**, and **competitive markets**. All of these can have a severe impact on EMI designs and decisions.

Cost constraints mean that even a few cents can spell the difference between financial success or failure. This is particularly acute in embedded controllers used in automotive or telecomm applications. The EMC solutions must be cost effective and "good enough", but they can not be overdesigned.

Mixed technologies compound the problem. Many embedded control systems also include sensitive analog circuits, noisy relays, and multiple interfaces to a harsh outside world. Self compatibility and immunity to external threats are serious issues.

Competitive markets mean that "time to market" is crucial, and product recalls can be deadly. You need to "get it right" the first time. This will become even more critical in 1996, when the European Union EMC directives become mandatory. *Remember, after 1995 virtually ALL embedded control designs sold in Europe will be subject to the same EMC rules as those now applied to computer systems.*

Some EMC solutions...

Here are some thoughts and ideas on how to identify and prevent EMC problems in embedded control systems at the design stage.

One caveat. While EMI emissions are the big concern with high speed computers, embedded control systems are usually much more concerned with susceptibility to ESD, RFI, and power disturbances. Internal self compatibility is also a big issue. Thus, your EMC design approach must focus on hardening against external and internal threats.

EMC at the Micro-Controller level...

Many system designers would like push the problem

back to the chip designers. Why not incorporate suppression or hardening at the IC level, and be done with it?

In fact, many chip vendors are addressing these issues and are starting to market "EMI quiet" devices. But even the best chip design can be undone by a poor board design. The embedded control system designer still has the most control over the problem.

EMC at the Circuit Board Level...

This is still the area where the most effective EMC results can be achieved. Fortunately, many of the solutions are inexpensive, or even free, when done early in the design. These include careful board layout, routing, and placement of components.

Pay attention to the most critical circuits. In our experience, 95% of the problems are caused by 5% of the circuits. Special attention should be given to I/O, resets, interrupts, control lines, and clocks. All of these are vulnerable to both internal and external threats. The clocks are also a critical for emissions.

Don't "throw the design over the wall" to the PCB layout group. Rather, stay involved with the design. Most good EMC designs are the result of the design engineer and the PCB layout specialist working together as a team.

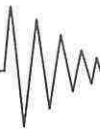
One technique we've used with good success in embedded control designs is what we've dubbed *Micro-Island*. The microcontroller (and any other high speed circuits) are placed over a separate ground plane, with all traces to/from the island isolated through ferrites and capacitors. This method is particularly effective with two-layer circuit boards.

EMC at the I/O Level...

Since the I/O connects to the outside world, EMC attention here is mandatory. The tradeoff is often between I/O filtering or cable shielding. For low speed systems, filtering is usually more cost effective. In many cases, this can be done with minimal expense on the PCB. Fiber optics may change this for the better in the future.

A KGB Bullet...

A widely used criteria for treating traces as transmission lines (which require terminations) is when the round trip transit time is equal to the pulse rise or fall time. For circuit boards, this can be approximated by $L=3t$, where L is the length in inches, and t , is the rise time in nanoseconds. For example, a pulse with a 1 nanosecond edge rate should be terminated when the trace length exceeds 3 inches; 2 nanoseconds @ 6 inches, etc.



EMC at the Module Level...

Although shielding is considered expensive, don't overlook this approach. Often times it is cheaper to shield and filter a module, than it is to fully harden a circuit board. This is particularly true for high level threats.

Good shielding need not be expensive. We often refer to the television tuner as a good example of cheap shielding done well. A simple interlocked metal enclosure and a few filters can do wonders.

EMC at the Software Level...

While not strictly an EMC technique, don't overlook this possibility, as even a few lines of code can provide a lot of "noise tolerance." The objective is to catch any errors, and then to gracefully recover. (We wrote an "award winning" paper on this subject several years ago. Call if you'd like a copy.)

Summary...

We hope this has helped provide some insights into EMC in embedded controllers. Give us a call if you need more help.

I don't make jokes. I just watch the government and report the facts.

— Will Rogers —

E-Mail Address...

Several of you have sent us Internet E-mail recently via Comuser, but now we have even easier method. You can contact us via the Internet through America On-Line at dgerke@aol.com.

EMI Winter Getaway ...

Need a winter break? Want to learn more about EMI design and troubleshooting? Then join us in Phoenix or Orlando this winter for one of our expanded three day seminars with Tektronix. In addition to two days on EMI design, we'll host an optional third day on EMI troubleshooting. Held in a roundtable format, we'll discuss how to diagnose and solve common EMI problems, complete with practical case studies.

This is a repeat of last year's popular Getaway. It's a chance to learn more about EMI, plus enjoy some fun in the sun. (You must take the seminar to attend the workshop. If you've already taken one of our EMI seminars, call for special arrangements.) Fee is still \$750 for two days, and \$1000 for all three days, which includes materials, lunches, and refreshments. Call us at 612-330-3728 for more details.

Book Reviews...

Here are several books we've found helpful when chasing down power transient problems:

Protection of Electronic Circuits from Overvoltages, by Ronald Standler, published by Wiley-Interscience, 1989. Discusses various transient threats, protective components, and test techniques. Good practical rules and strategies on protecting electronic circuits.

Electrical Transients in Power Systems, by Allan Greenwood, published by Wiley-Interscience, 1991. Emphasis is on transient behavior in electrical utility and industrial power systems. Includes a section on case studies.

Handbook of Power Signatures, by Alexander McEachren, published by Basic Measuring Instruments, 1988. A very useful collection of power faults, with causes, symptoms, and solutions. Actual traces of power disturbances make it easy to use.

Chicago EMC Symposium a success...

The 1994 IEEE EMC Symposium was a winner. Well attended, well planned, and well executed. We noticed an increase in practical presentations and papers, which we think is welcome and overdue.

Lots of interest in the European EMC Directives, and on EMI in medical devices. We attended the special sessions on those topics, and found them interesting.

EMI Test & Measurement Software...

In our last issue, we mentioned that our friend and colleague Bob Swarts was available to help set up EMI software. (Bob is a former Tektronix spectrum analyzer guru who is now on his own.)

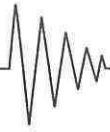
Bob has just released an EMI software package for the Tektronix 27XX spectrum analyzers, and it looks very nice. For more information, call Bob Swarts in Oregon at 503-662-3931.

A KGB Bullet...

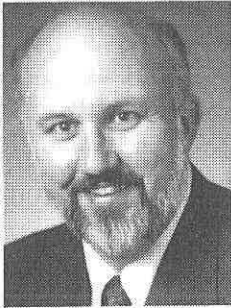
Here is a source for EMC and safety standards that we have found useful:

Document Center
1504 Industrial Way #9
Belmont, CA 94002
415-591-7600

They can supply documents from IEC, UL, ANSI, IEEE, ISO, and more. They have given us good service and quick response.



About Kimmel Gerke Associates, Ltd.



DARYL GERKE, PE

We're a professional engineering consulting firm that specializes in ELECTROMAGNETIC COMPATABILITY, a broad area of electrical engineering that deals with electronic 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.

EMI-Toolkit® Software...

We continue to deliver copies of our unique EMI software, and we've had good comments from users. Thanks again to all of you who have ordered it.

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. It's like having an EMI reference book (or perhaps even an EMI consultant) right at your fingertips.

Only \$100 for a single user copy. Network and site licenses also available. Call for our brochure.



KIMMEL GERKE ASSOCIATES, LTD.
EMC Consulting Engineers

DESIGN SPECIALISTS
ELECTRONIC INTERFERENCE CONTROL

- **EMI Design and Systems Consulting**
– Regulations – Emissions – RFI – ESD
– Power Disturbances
- **EMI Seminars**
– Design – Systems – Troubleshooting – Custom
- **EMI Toolkit®**
An EMI Software "Reference Handbook"

Daryl Gerke, PE William Kimmel, PE
1544 N Pascal • St. Paul, MN 55108 • 612/330-3728

Kimmel Gerke Associates, Ltd.

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

FIRST CLASS MAIL

