KIMMEL GERKE Bullets

Fall, 1998

Welcome to KGB...

And to this issue of our "personal communications" to our friends, clients, and colleagues about EMI issues, problems and solutions.

This issue discusses transient protection. We've been seeing an increase in transient related EMC problems in the past few years. They are particularly difficult to troubleshoot, because by their very nature, they often "come and go" at random times.

The best approach is to design for transient protection, but often times it's necessary to add transient protection to installed systems. In either case, it's helpful to understand the "pros and cons" of different protectors, and when, where, and how to use them.

The European Community had made transients a priority, and incorporates transient testing on both power and selected signal interfaces. Other industries like military, vehicles, and industrial controls have done this for years.

As always, give us a call if we can help you with your EMI problems - transient or otherwise.

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

1999 EMC Winter Workshops

San Diego, CA February 1-4, 1999
Orlando, FL February 8-11, 1999

Need a winter break, and some fun in the sun? Want to learn more about EMC design, regulations, or troubleshooting? Then join us in Orlando or San Diego in February for our "once a year" expanded seminar series, sponsored by Tektronix.

Like last year, we've added a fourth day on regulations, in addition to the two days on design, and the one day on troubleshooting. Take only what you need to get up to speed on EMC issues.

See the insert for more details, or call us toll free at 1-888-EMI-GURU. *(Inqure about our special hotel rates if you reserve by January 1.)*

Shows and Conferences...

Here are some shows and meetings we are involved with that may be of interest. Call us if you'd like more details.

Arizona EMC Mini-Symposium ... May 3, 1999, in Mesa, Arizona. This popular one day session is sponsored by the IEEE EMC Society, and features several well known EMC speakers. The keynote speaker is Henry Ott, author of "Noise Reduction Techniques in Electronic Systems." Daryl will be one of the speakers as well. Nominal charge... Call for details... You do not need to be an IEEE member to attend.

IEEE International EMC Symposium... August 2-6, 1999, at the Washington State Trade & Convention Center in Seattle, WA. We'll both be there, of course.

Fourteenth Annual Minnesota EMC Event... Moved back to the fall for 1999. Combined day of training and exhibitions. Hard to believe we've been involved with this show for 14 years.

Electronic Communications...

Here are several ways of contacting us:

World Wide Web — Visit our "home page" at **http://www.emiguru.com.** You'll find back issues of the KGB *(Kimmel Gerke Bullets)*, plus other EMC related information.

Toll Free "888" Number... Please feel free to call us on our toll free number - **1-888-EMI-GURU.** This reaches our answering service in Minnesota, so please leave a message and we'll get back to you. For calls from outside the US, please use 651-330-3728 *(Note new area code.)*

E-Mail.. A preferred way of reaching us if you don't need a "real-time" answer. We both check our mail boxes regularly, and it works out well. Addresses are:
Bill Kimmel - *bkimmel@emiguru.com*
Daryl Gerke - *dgerke@emiguru.com*

Phone... You can also reach us directly the "old fashioned" way by telephone. These are direct lines to our offices, so if we're not in, just leave a message on the voice mail.
Bill Kimmel - MN - 651-457-3715 *(Note new area code.)*
Daryl Gerke - AZ - 602-755-0080

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Focus on Transients...

Transients are always "fun" to troubleshoot, because they are often so unpredictable. The best approach is to design for transients, but even that can be difficult without some advance knowledge.

Much effort has been spent over the years trying to understand and characterize many different transients in various environments. As a result, we have a number of specifications that include transients — military, vehicular, electrical switchyards, and of course the European Union requirements for the CE mark. These specifications can guide both our design approaches, and our "fix-it" approaches in the field.

Let's look at several different types of transients, and then explore the options for taming these "EMI rascals."

Different characteristics... Transients are varied, but key parameters are amplitude, speed (rise time), and duration.

Often times a particular transient is such a large threat that it acts like an umbrella for other transients. An example is lightning transients on power lines. If we can survive a simulated lightning transient, we can probably survive whole lot of other lesser transients on the power lines.

This has given rise to several "standard" transients. The big three for commercial and industrial equipment are *ESD* (electrostatic discharge), *EFT* (electrical fast transient) and *surge* (based on lightning.) These are embodied in standards such as EN61000-4-2, 4-4, 4-5, and IEEE C62.41. Let's look at each in detail.

ESD... Based on a human generated discharge. A very fast transient, with typical rise times are 1 nanosecond or less, and with a peak voltages of 15+kV and peak currents of 10+ amps. Fortunately the duration is short, in the tens of nanoseconds, so the total energy is relatively low. Not enough to harm humans, but certainly enough to upset or even destroy sensitive electronic components.

ESD can enter a system from many points — power ports, signal ports, or even switches or keyboards — anywhere a human can possibly touch. And even the electromagnetic fields from a nearby event can cause problems, which has given rise to the "indirect" ESD test procedures.

EFT... Based on a "showering arc" due to opening switches or relays serving inductive loads, often resulting in multiple arcs at the contacts. A little slower and lower than ESD, with typical 5 nanosecond rise times and peak voltages in the 3-6 kV range. Still, this can be cause serious upsets with modern electronic systems.

The primary entry point for EFT is the power interface, with signal lines as a secondary port. The latter is usually only a concern if long cables are attached, which allows possible crosstalk between power and signal cables.

Lightning... Based on the residual surge that makes it past the external power company protection and into the facility wiring. This is a relatively slow, but very large transient. Much empirical data has been gathered over the years, which has resulted in the "standard" 1.2x50 usec voltage waveform, and the 8x20 usec current waveform. The upper limits are 6000 Volts/2000 Amps (IEEE C62.41), although the Europeans provide for lower levels.

Like EFT, the primary entry port is power, with signal lines with long cables a secondary port. Lightning can also enter antenna terminals on radio systems with 100kA+ levels, but this is beyond the scope of this article. Needless to say, that calls for drastic protection measures.

Other "popular" transients... Several other standard transients have been developed, such as CS06 or CS114 for MIL-STD-461, and the infamous "load dump" for vehicles. The latter is kind of like lightning, and it is the nastiest of vehicle power transients.

Preventing or fixing problems... The usual strategy is to install shunt protection across critical input lines, either power or signal. There are three popular types, each with pros and cons. The secret is to use the right protector for a given application.

Arc Devices... The slowest (often requiring many tens of nanoseconds) but the most robust, since they actually "short" the transient. As a result, they don't dissipate much power internally, but rather reflect it. Fine for lightning and many garden variety power transients, these are usually not fast enough for ESD or EFT transients.

MOVs... The "Metal Oxide Varistor" is a workhorse for lightning and other power transients. These "clamp" rather than "short" transients, so they must dissipate the excess energy in the device. Like arc devices, MOVs are generally not fast enough for ESD or EFT. One exception is surface mount MOVs for signal lines, that operate very fast due to their small size. A caution on MOVs... they can "wear out" with use... fine for commercial products, but often not such a good idea for high reliability systems.

Silicon Devices... These are the fastest of the bunch, often clamping in less than a nanosecond. In these devices, it's very important to keep lead lengths short,

A KGB BULLET...

Here is some advice from Howard Johnson, PhD, that appeared in a recent EDN Magazine column:

> "If you want 20 dB (or more) of reflected wave attenuation, use a stub delay that will not exceed more than one sixth of the rase time, a very good low-inductance package, and an accurate, low inductance non etched metal film resistor."

Dr. Johnson is the author of *High Speed Digital Design: A Handbook of Black Magic*, one of our favorite books.

to minimize inductance. Like MOVs, they "clamp" and thus dissipate excess energy in the device. A popular type of silicon protector is the "Transzorb™", which has a large junction and can really take a beating.

Where to "ground"... The best is to connect the shunt protector to chassis, rather than signal ground, to divert the transient currents rather than dump them into the signal ground. Keep the leads short to limit the inductance.

If no external chassis is available, then consider adding series impedance to help limit currents. For ESD and EFT, a 100 ohm resistor or small ferrite is often enough. For lightning, try a wire wound choke of 10-100 uH.

In summary... We hope this quick tour has given some insights and appreciation on dealing with transients. A key point is to use the right type of device for the job.

Some Humor...

A very busy consultant (EMC???) once had a plumbing problem. Rather than fix it himself, he called in a plumber. The plumber did something simple, and was done in ten minutes.

Presented with a bill for $150, the consultant questioned why the charge was so high.

"That's what I charge," replied the plumber.

The consultant asked "How can you justify such a charge? You are charging $900 an hour. I'm a consultant, and even I don't charge that much."

The plumber replied, "Neither did I when I was a consultant."

Did you thank an engineer today?

These are from a recent ad that appeared in the Long Island, NY, based Newdsay, and reprinted in EE Times:

Did you Thank an Engineer Today?

Why? Because without engineers you would:

-Spend your life in the dark.
-Go to work by stagecoach.
-Walk up all stairs.
-Know how to handle horses.
-Use Pony Express for your urgent mail.
-Use sailing ships to cross the ocean.
-Have no idea what a telephone, radio, or X-ray is.
-Buy ice by the cake, etc.

The ad finished by saying it was sponsored by the "New York and Long Island Chapter of the IEEE Power Engineering Society and Industry Applications Society. A group of dedicated professionals improving the quality of life." We say "Thanks" to our engineering colleagues in New York for printing this, and "Thanks" to all of you who work so hard making the world a little bit better for all of us.

Book Reviews...

We have three books to review this issue - two on EMC, and one we found of "unique interest..."

EMI Suppression Handbook... by yours truly, Bill Kimmel and Daryl Gerke, and edited by our Associate, Dr. Tom Chesworth of Seven Mountains Scientific. This is a collection of articles written over the past ten years for Electromagnetic News Report. The book includes short articles and "war stories" on various aspects of EMC. To order, see the inserted flyer, or see *www.7ms.com*. For only $20+ shipping, we thinks it's a deal (of course.)

EMC and the Printed Circuit Board... by Mark Montrose, and published by the IEEE Press, 1998. This book addresses the design engineering aspects of printed circuit boards, and supplements his earlier book, *Printed Circuit Board Design Techniques for EMC Compliance*, which focused on PCB layout. Call 1-800-678-IEEE, or 732-981-0060 outside the US and Canada.

How to Drive into ACCIDENTS... and How NOT To... by our friend Bob Pease, author of EDN Magazine's very popular *Troubleshooting Analog Circuits* and the *Pease Porridge* column in *Electronic Design*. Although not an EMC book, it's a survival guide for drivers, written in Bob's famous irreverent style. Buy one for your teen age drivers, or read it yourself. Cost is $22, including shipping. For info, see www.transtronix.com, or write Bob at 682H Miramar Ave., San Francisco, CA 94112.

> "When you sit with a nice girl for two hours, you think it's only a minute. But when you sit on a hot stove for a minute, you think it's two hours. That's relativity."
>
> -Albert Einstein

Harmonic Standards are Coming...

Although no mandatory standards exits in the US for power line harmonics, there is change in the wind. The US Social Security Administration has a proposed policy on harmonic limits for new "Information Technology Equipment" to be acquired by the SSA. They propose to implement new technical standards over a three year period. The concern is for potentially serious power problems, such as overheating neutrals and transformers. For more info, see *http://ssa.gov/oag/oag2.htm.*

—Our thanks to Scott Roleson, PE, for the update.

A KGB Bullet...

Here is some advice from Mark Mays of Fluke Corp. regarding snubber circuits:

"For most AC coils, a 33 kOhm resistor connected in series with an 0.047 uF capacitor can be connected across each AC relay and contactor coil. For DC coils, use a reverse based diode across the coil to achieve similar results."

(Power Quality Assurrance Magazine, Sept. 1998)

On-site EMC Classes...

Our in-house EMC classes continue to be very popular. Here are several standard classes we've done:

-Design for EMC (2 days)
-Systems EMC/Grounding & Shielding (2 days)
-Medical Design for EMC (2 days)
-EMC in Telecommunications (2 days)
-EMC Troubleshooting (1/2 to 1 day)
-Understanding EMC Regulations (1 day)

We can also custom tailor classes to your needs as well. For example, we recently did a class that was "half design/half systems", and we've done several that included the "troubleshooting workshop."

If you have 12 or more, in-house classes become quite cost effective. We regularly update our materials based on our experience as active EMC consulting engineers, so you get the latest practical information. Call 1-888-EMI-GURU.

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

This popular EMC design guide (written entirely by us) is still available. For your copy, call Cahners Reprint Services at 1-800-523-9654. Only $ 19.95+ shipping.

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