KIMMEL GERKE Bullets

MEMBER AMERICAN CONSULTING ENGINEERS COUNCIL

Fall, 1992
Vol. 4, No. 1

Welcome to KGB. . .

And to the fourth year of our "personal communications" to our friends, clients, and colleagues, as we discuss how to **identify, prevent, and fix EMI/EMC problems.**

This issue focuses on conductive coatings, and how to use them to solve EMI shielding problems. As more and more designers move to plastic enclosures, the need for good conductive coatings increases. Fortunately, even thin coatings can provide substantial EMI protection.

We'll discuss the pros and cons of several different processes, and we'll point out the potential problems areas. With care, 40-60 dB of shielding can be obtained with relatively thin coatings. This is often more than enough to solve many common EMI problems.

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

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

Thank You. . .

In August 1992, we celebrated five years in business as full-time EMI/EMC consulting engineers. (Our part-time consulting practice goes back to 1978. . . and our EMI experience goes back to the 1960s. . .)

Thanks to all of you. . .clients, colleagues, and friends. . .for your business and support.

ESD Alert. . .

As we move into the winter season, expect ESD problems to increase, due to lower humidity as air is heated. At 50% humidity, it is very difficult to charge a human to 2,000 volts: but at 5% humidity, a human can easily reach 10–12,000 volts or more.

Shows and Conferences. . .

Here are some shows and conferences that may be of interest. Call us 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 and Design Magazine.* A great show for both the newcomer and the EMI professional.

IEEE 1993 EMC 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.

Tektronix EMC Seminars. . .

Tektronix is now sponsoring our very popular *Designing For EMC* seminar. This is not just another EMC seminar, but rather **TWO DAYS FOCUSED ON DESIGN ISSUES** facing the designers of high performance electronics.

November 16-17	Wallingford, CT
November 19-20	Long Island, NY
December 7-8	San Francisco, CA
December 10-11	Portland, OR
January 11-12	Los Angeles, CA
January 14-15	San Diego, CA
February 8-9	Albuquerque, NM
March 8-9	Washington, DC
March 11-12	Woodbridge, NJ
April 19-20	Knoxville, TN
April 21-22	Pittsburgh, PA
May 17-18	St. Louis, MO
May 19-20	Chicago, IL
June 7-8	St. Paul, MN

This is a "nuts and bolts" seminar, filled with design oriented tools, tips, and techniques. TO RESERVE YOUR SPOT, CALL 1-800-426-2200, Ext. 181.

For QUESTIONS about this seminar, or FOR INFORMATION ON OUR SEVERAL IN-HOUSE SEMINARS, call us directly at 612-330-3728.

Kimmel Gerke Bullets is a newsletter on electromagnetic interference/compatibility (EMI/EMC).
Published by Kimmel Gerke Associates, Ltd., 1544 North Pascal, St. Paul, Minnesota 55108 (612) 330-3728.

Focus on Conductive Coatings. . .

According to one industry source, in 1980 less than half the electronic enclosures were made of plastic. By 1985, over two thirds were plastic. We estimate that today over 90% of the enclosures for commercial electronic equipment use plastic as part or all of an electronic enclosure.

Plastic offers many advantages for modern electronic systems. These include low cost, 50/60 Hz insulation, and aesthetics or style. Plastic, however, is transparent to electromagnetic energy, so absolutely no shielding is provided by plastic enclosures. (Unless the plastic is loaded with metal.)

Unfortunately, most electronic systems today need at least some shielding. It's commonly needed to contain energy to meet FCC or VDE emission requirements.

Shielding may also be needed to protect against external threats, such as strong electromagnetic fields from nearby hand held radios or cellular telephones, or against the fields caused by nearby electrostatic discharges. In this latter case, we've seen radiated ESD cause problems up to 20 feet away, a sneaky problem indeed.

Shielding needs. . . Fortunately, for most commercial applications a moderate amount of shielding will solve the problems. Unlike military designs which may need 100 dB or more of shielding, 40-60 dB is often more than enough. These numbers are well within the range of today's conductive coatings.

We've had very good results with several designs using conductive coatings on plastic to solve vexing EMI problems, and to meet both immunity and emission regulations.

A word of caution. . .While these thin coatings provide very adequate shielding levels for high frequency energy, they are transparent to low frequency (under 100 kHz) magnetic fields, such as those emanating from power supplies or CRT deflection circuits. In those cases, electrically thick materials with high permeability are needed.

Shielding materials. . . Let's look at the most popular processes available today. All of these will provide at least 40 dB of shielding *when properly applied.*

Conductive paints. . .The most popular EMI paints today are nickel or passivated copper. Both offer 40-60 dB of plane wave shielding with minimal fuss or expense. Silver paints can provide up to 80 dB, but are quite a bit more expensive.

Nickel paints are a favorite in the EMI world, due to nickel's superior corrosion resistance. Copper is becoming more popular now that non-oxidyzing copper paints are available. Graphite coatings are available, but due to their relatively high resistance, they do not offer much shielding. In our opinion, graphite is best suited as a static drain for ESD control, and not as an EMI shield.

Electroless deposition. . .This process has become quite popular in the personal computer industry. The plastic is first etched with an oxidizing solution which creates micro-pores in the plastic. When the plastic is dipped in a copper or nickel solution, a thin layer of metal adheres to the porous surface. The resulting metal layer is tight, continuous, and consistent, yielding a good EMI shield.

Like paints, nickel and copper are the most common materials. Some vendors provide an undercoat of copper for high conductivity, followed by an overcoat of nickel for corrosion protection. Such combinations hold up very well in salt spray tests, and should do well in corrosive environments. Shielding of 60 to 80 dB is achievable.

A KGB Bullet. . .

Ever wonder just how good hose connectors are? Here are some guidelines for upper frequency limits. . .

UHF – 300 MHz
BNC – 1 GHz
TNC – 10 GHz+
N – 10 GHz
SMA – 26 GHz

Source: *UHF/Microwave Experimenters Handbook* (See our Book Reviews section.)

Focus on Conductive Coatings. . .
continued

Vacuum deposition. . .In this process, a metallic film is deposited by evaporating the metal in a high vacuum. The process has been used for years to make decorative plastics, such as automotive parts. In recent years, the vacuum deposition vendors have moved into the EMI arena with good success.

Aluminum is a popular metal for this process, and the resulting metal coat is hard and uniform. We tested samples of this process, and saw 60-80 dB shielding levels. Independent tests have shown that vacuum deposition can degrade in highly corrosive environments. It is very cost effective, however, and is popular for consumer items like computers and cellular telephones.

Problem areas. . .Like any high frequency shield, the biggest problems are with seams and other openings, and with penetrations. Tight fitting joints are mandatory, and may require EMI gaskets. All penetrations must be filtered and/or bonded to the shielding surface through low impedance connections. Follow the rules, though, and the conductive coated plastics can be very effective in the battle against EMI.

Two reports available. . .Two of our clients have made several of our test reports on their thin film products available to the public. One is on vacuum deposition *(Vacuum Platers Inc.)*, and the others are on CRT glare shields (Optical Coating Laboratories Inc.). Call us for more information on how to obtain these free reports.

Anaheim EMC Show a Big Success. . .

The 1992 IEEE EMC Society show was a winner, with over 1600 attendees from 23 countries, and over 100 exhibitors. It was a well-planned and well-executed show.

Our observation. . .the mood was upbeat at the show. Since EMC is involved with new products and designs, maybe this is a good leading indicator for the electronics business.

Our Apoligies. . . to Doug Smith of DC Smith Consultants, who graciously donated a *Bullet* on ESD *(volts per inch)* for the last issue. We made a mistake in the example. . .the error was ours, not Doug's. ***The correct version is shown at the right.***

Back Issues of the KGB. . .

We have a limited number of back issues of the KGBs available. A complete set (all 13 issues) is $25, which includes postage and a 3-ring binder (where you can keep future copies, too). Individual copies available for $2 each. Call 612-330-3728.

When I was a boy I was told that anyone could become President. I'm beginning to believe it.
— Clarence Darrow

Book Reviews. . .

Here are some books from the Amateur Radio community that may be of interest:

Radio Frequency Interference: How to Find It and Fix It, published by the American Radio Relay League (ARRL). Published in 1991, this book is a steal for $15. . .filled with practical nuts and bolts information on RFI.

UHF/Microwave Experimenters Manual, also published by the ARRL. Published in 1990, this book is also a good value at $20. . . lots of information on radiation safety, high frequency component behavior, and more.

Interference Handbook, by William Nelson, published in 1981 by Radio Publications Inc. Mr. Nelson is a former RFI investigator for Southern California Edison, and offers practical advice for power related EMI/RFI. Cost is about $10, and a good value.

Radio/TV Interference — Sources and Solutions, by Frank Hughes, published 1989 by Tiare Publications. Simple but practical. Cost about $9.

A KGB Bullet. . . *corrected*

When dealing with transients such as ESD, it can be helpful to compute wire lengths in terms of *volts per inch* Here's how to do it. . .

$V = L\ di/dt$, which becomes $V = Li/tr$

For L = 20 nh/inch (typical wire inductance)
i = 10 amps (typical peak ESD current)
tr = 1 nsec (typical ESD rise time)
V = 200 volts per inch.

Thus, if you have a ½ inch lead to ground, ESD will generate a peak voltage of 100 volts across that ground lead. A good reason to keep your leads short!

(Thanks to Doug Smith, DC Smith Consultants)

About Kimmel Gerke Associates, Ltd.

DARYL GERKE, PE

We're a professional engineering consulting firm that specializes in ELECTROMAGNETIC 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'd be glad to help you with your EMC problems, fixes, design support, test support, or training needs.

Magnetic Field Articles. . .

We've published several articles and papers on magnetic fields and "wiggly" CRTs. Give us a call (612-330-3728) if you'd like any of these articles:

- ***60 Hz Magnetic Field Susceptibility Tests of CRT Displays,*** 1990 IEEE EMC Symposium
- ***Power Line Magnetic Fields and CRTs: An Emerging Power Problem,*** 1991 EMC-EXPO
- ***Power Line Magnetic Fields and Computer Video Displays,*** 1992 ITEM

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