IEEE EMC SOCIETY

NEWSLETTER

ISSUE NO. 180 WINTER 1999 (ISSN 1089-0785) JANET O'NEIL, *Editor*

Richard B. Schulz May 21, 1920 to October 1, 1998

Richard B. Schulz

Richard B. (Dick) Schulz was born in Philadelphia. Dick earned the baccalaureate and masters degrees at the University of Pennsylvania, and worked on a doctorate. He was a research assistant at the University of Pennsylvania for four years. During that time he invented something on his own time, but the university claimed it. He left their employ on principle; he believed they were wrong. For Dick, money did not matter as much as virtue; and having the respect of his peers.

He then formed his own consulting company called Electro Search, working in the field of Electromagnetic Compatibility (EMC). He did quite a lot of work for the Federal Government. After some time, he sold his business and moved to Chicago where he worked for Armor Research Foundation for two years. Then in 1961, Boeing called him to Seattle to oversee the integrity of the electrical system in the first Boeing 747. Dick left Boeing and went to Southwest Research Institute in San Antonio, Texas, in 1970 where he worked in EMC research for about four years. He then went to the Electromagnetic Compatibility Analysis Center (ECAC) in Annapolis, Maryland, and worked there ten years. After leaving ECAC, he went to Xerox Corporation in Dallas, Texas, and worked there until the early 1990s. After retiring from Xerox, he worked part time for a small company in Dallas that had been started by a young man who had been at Xerox. He also stayed active in EMC standards work and writing and editing papers and books about EMC.

Dick served as editor of the IEEE Transactions on Electromagnetic Compatibility for 18 years. He wrote many papers and participated in the writing and editing of a number of books on EMC. He was a Life Fellow of the IEEE. He chaired the 1968 IEEE International Symposium on Electromagnetic Compatibility. He was also a former President of the EMC Society Board of Directors. He was considered one of the top EMC specialists in the world.

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INSIDE

IEEE
Networking the World

DAN HOOLIHAN
PRESIDENT, EMC SOCIETY

Here We Are In 1999

In the first issue of the EMC Society's Newsletter, I would like to wish all of you readers and members of the EMC Society a healthy and active 1999!

From our Society's perspective, the year is shaping-up to be a very busy and productive year in expanding our technical society's expertise and knowledge in the area of EMC Engineering. A number of major symposiums and expositions in EMC are planned around the world this year and I hope all our members can find one that is suitable for their attendance in terms of timing, financial considerations and geographical location.

Our EMC Society will be participating as a Technical Co-Sponsor in the 13th International Zurich Symposium and Technical Exhibition on EMC to be held in Zurich, Switzerland from February 16-18. (Technical Co-Sponsorship indicates direct and substantial involvement in the organization of the technical program but NO financial involvement.)

The EMC Society will have a membership booth there plus several board members will be in attendance; please stop by the booth and say hi to the Board members and other Society members that will be staffing the booth.

The next major symposium in which the EMC Society will be participating is EMC'99/Tokyo (May 17-21), the 4th International Symposium on EMC to be held in Japan (the previous symposiums were held in 1984, 1989, and 1994). The EMC Society will also be a Technical Co-Sponsor of this symposium. In addition, the Board of Directors of the EMC Society will be holding a regular meeting at this symposium on Friday, May 21. The purpose of this meeting is to make the BoD meetings more accessible to the members of our Society in Regions 7 through 10 where over 40% of our membership now resides. Japan is a key country in the IEEE Region 10 area which also includes China, India, Southeast Asia, Australia and New Zealand. As President of the EMC Society, I have been invited to give the keynote speech at EMC'99/Tokyo at the opening session on Tuesday morning.

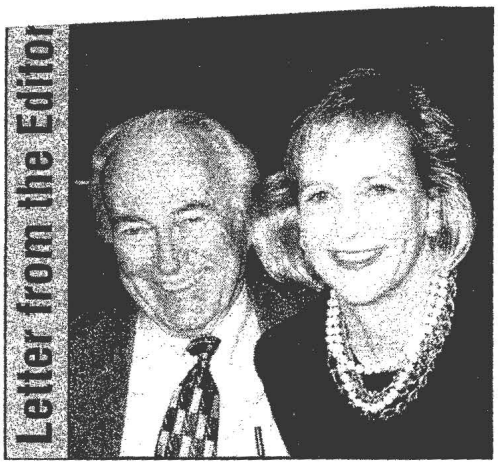
And, of course, the 1999 IEEE International Symposium on EMC, sponsored by the EMC Society of the IEEE, is scheduled for beautiful, downtown Seattle (Washington) from August 2-6. Put that on your travel and education schedule because it will be a top-notch event for professional, educational and cultural reasons.

I hope to see you at the symposiums mentioned or at a local chapter meeting. (I am trying to attend as many local meetings as I can consistent with my personal and business travel schedules.)

As always, I am available for comments, queries and puzzled looks at Phone 651-638-0250, FAX-651-638-0285 or e-mail at d.hoolihan@ieee.org.

Photo by Dick Ford

IEEE - Networking the World! EMC Society President Dan Hoolihan (L) is welcomed to EMC '98 Roma by Conference Chairman Professor D'Amore (R). This year, President Hoolihan will conduct similar trips to various EMC conferences worldwide to promote the IEEE and the EMC Society.



Len Carlson, Vice-President, Communication Services, and Janet O'Neil, Newsletter Editor, are shown at the annual dinner following the November Board of Directors meeting.

Letter From The Editor

We get mail! We've received many comments from our readers about the EMC Society Newsletter. One letter to the editor from Scott Bennett follows on page 4. One reader, Al Smith, requested that the directory of EMC Society Board members, Chapter Chairman, and Standing Committee Chairman be published in the Newsletter. You may find this directory on page 25. Thank you to Al for making this suggestion. Keep in mind that this directory is updated regularly and may be found on the EMC Society web page (www.emcs.org). Another reader, Bob Dockey, suggested we include information about becoming a Senior Member of the IEEE. This information is included on page 42. Lastly, one reader, Dave Bernardin, called in to say he appreciated the side shot photo of him which appeared in the last issue's article on the experiments at the Denver EMC Symposium. (See page 10 of the Fall 98 issue, that's Dave in the center foreground.) Apparently, Dave could now prove to his company that he actually attended the technical presentations during the symposium!

We have a new article on the Representative Advisory Committee (RAC) which was submitted by Dave Case, the Chairman of this Committee. See Page 22. Dave is taking over for Joe Butler who previously contributed as Associate Editor for Inter-Society Activities. I would like to thank Joe for his support over the years as an Associate Editor. Joe contributed to the EMC Society Newsletter for eight years! It's easy to understand why Joe would want to step down as Associate Editor. He was recently elected to the position of "President-Elect" by the EMC Society Board of Directors so he will be busy preparing for his role as our next EMC Society President. Also, Joe's position as a Marketing Manager for EMI shielding products at the Chomerics Division of Parker Hannifin keeps him busy and on the road. In fact, he will travel to the Pacific Northwest in March to speak to the Seattle and Oregon Chapters of the EMC Society. Welcome to Dave Case, Joe's capable replacement!

Lastly, I would like to call to your attention that there are several changes in EMC Society organization under Todd Hubing, Vice-President for Member Services. We have a new Awards Chair, Henry Benitez, a new Chapters Coordinator, Ghery Pettit, and a new Membership Committee Chair, Andy Drozd.

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Newsletter Staff

Editor

Janet Nichols O'Neil
Lindgren RF Enclosures, Inc.
22117 NE 10th Place
Redmond, WA 98053
Tel: 425-868-2558 Fax: 425-868-0547
e-mail: j.n.oneil@ieee.org

Associate Editors

ABSTRACTS
Professor Osamu Fujiwara
Dept. of Elec. & Comp. Engineering
Nagoya Institute of Technology
Gokiso-cho, Showa-ku, Nagoya
466-8555 Japan
+81-52-735-5421
fax: +81-52-735-5442
e-mail: fujiwara@odin.elcom.nitech.ac.jp

BOOK REVIEWS
Reinaldo Perez
c/o Lockheed Martin
MS: S8700, P.O. Box 179
Denver, CO 80201
303-977-5845
fax: 303-971-4306
e-mail: ray.j.perez@ast.lmco.com

J.L. Norman Violette
Violette Engineering Corp.
120 East Broad St., Ste. B
Falls Church, VA 22046
703-532-1355
fax: 703-538-3810
e-mail: enviolette@msn.com

CHAPTER CHATTER
Todd Hubing
Univ. of Missouri-Rolla
120 Emerson Electric Hall
Rolla, MO 65401
573-341-6069
fax: 573-341-4532
e-mail: t.hubing@ieee.org

DoD E^3 ACTIVITIES
Robert D. Goldblum
R&B Enterprises
20 Clipper Road
West Conshohocken,
PA 19428
610-825-1960
fax: 610-825-1684
e-mail: rgoldblum@RBitem.com

EMC PERSONALITY PROFILE
William G. Duff
Computer Sciences Corp.
Systems Engr. Div., Ste. 300
5501 Backlick Road
Springfield, VA 22151
703-914-8450
e-mail: w.duff@ieee.org

EMC STANDARDS ACTIVITIES
Donald N. Heirman
143 Jumping Brook Road
Lincroft, NJ 07738-1442
732-741-7723
fax: 732-530-5695
e-mail: d.heirman@worldnet.att.net

EMCS BoD ACTIVITIES
Janet Nichols O'Neil
Lindgren RF Enclosures, Inc.
22117 NE 10th Place
Redmond, WA 98053
Tel: 425-868-2558
Fax: 425-868-0547
e-mail: j.n.oneil@ieee.org

EMCS PHOTOGRAPHER
Dick Ford
6 Westcot Place
Falmouth, VA 22405
202-767-3440
fax: 202-404-4064
e-mail: dford@radar.nrl.navy.mil

EMCS EDUCATION COMMITTEE
Maqsood Mohd
Sverdrup Technology, Inc.
TEAS Group, Bldg. 260
P. O. Box 1935
Eglin AFB, FL 32542
850-729-6115
fax: 850-729-6377
e-mail: MOHD@eglin.af.mil

INTER-SOCIETY ACTIVITIES
David Case
Aironet Wireless Comm., Inc.
367 Ghent Road, Suite 300
P.O. Box 5292
Akron, OH 44333-0292
330-665-7396
fax: 330-665-7301
e-mail: dcase@aironet.com

PRACTICAL PAPERS, ARTICLES & APPLICATION NOTES
Bob Rothenberg
Technical Product Marketing
P.O. Box 551
Carlisle, MA 01741
978-369-2860
fax: 978-369-3581
e-mail: rothenberg@ieee.org

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Letters to the Editor:

Comments on Bennett Paper (Summer Issue)

To the Editor:

The paper by W. Scott Bennett ("Normalized Site Attenuation and Test Site Validation", Summer Issue No. 178) suggested that the vertical polarization normalized site attenuation (NSA) values in ANSI C63.4-1992 are in error by as much as 1.5 dB. The author failed to acknowledge that the NSA values in C63.4 are based on the radiation pattern of an ideal point dipole, whereas his calculations assume an isotropic radiation pattern.

Zhong Chen and Tim Harrington
EMC Test Systems

(Ed. Note: Additional comments by Zhong Chen and Tim Harrington are included in this issue's "Practical Papers, Articles and Application Notes" column.)

To the Editor:

The article by Bennett on "Normalized Site Attenuation and Test Site Validation" in the Summer issue of the IEEE EMC Society Newsletter contains a major error: He has neglected the angular dependence of the radiated field from a vertical electric dipole. He assumes that the fields at the Observation Point in his Fig. 1 are isotropic in the plane of the drawing.

While this is true for a horizontal electric dipole source, it is certainly not true for a vertical electric dipole. I think he will find complete agreement with the ANSI C63.4 values if he includes the appropiate term, proportional to the sine of the angle between the direction of the dipole and the direction of propagation.

There are some errors in the numbers given in C63.4 caused by neglecting the near field terms (which Bennett also neglects), but these are appreciable only near 30 MHz, as I point out in "Near-Field Corrections to Site Attenuation", IEEE Transactions on EMC, vol. 36, pp. 213-220, 1994.

David Gavenda
Physics Dept
University of Texas at Austin

Author's Response

To the Editor:

Normalized site attenuation (NSA) is defined in ANSI C63.4-1992 as follows:

Site attenuation divided by the antenna factors of the radiating and receiving antennas (all in linear units)

That is precisely equivalent to assuming uniformly radiating and receiving antennas both of which are free from near-field effects. And, that is precisely what was done to obtain the results given in my article.

W. Scott Bennett
Carr, Colorado

Back Up, Slow Down, and Think!

To the Editor:

I'm guilty, . . . you're guilty, . . . we're all guilty — guilty of not giving enough thought to the things we do. Many years ago, when I worked as a technician for IBM, everywhere you looked there were one-word signs that said "THINK!" Whether they still have those signs today, I do not know. However, it becomes clearer with every day that we need those THINK signs now more than we ever did. And, we need them everywhere! One recent example of that need is the failure of almost everybody's computers to distinguish the year 2000 from the year 1900. It is quite apparent to all of us, now, that "- - 00" could represent either 1900, or 2000 (or any of 98 other numbers, for that matter!). However, a few appropriately placed THINK signs might have made that apparent to computer software designers a lot earlier, and averted the problem.

Another example of our need to think has bothered me for many years. How often have you heard, or read (or said, or written) the words "current flow"? Those words are used over and over by almost all of us, even in well-respected books and journals. However, the words are seldom used correctly! Current, $i(t)$, is charge flow, $dq(t)/dt$. Current flow is the *propagation*, or *acceleration*, of current, di(t)/dt. Without any exception I am aware of, however, when someone says "a current flows", they *mean* "a current *exists*"! So, their words and the meaning intended are *not* the same. We all need to be much more precise. Otherwise, the words "teach", "learn", and "understand" will not have the meanings intended either.

More specific to EMC . . . a recent paper of mine on the radiations of small loops of current won third prize for best paper at an annual IEEE EMC Conference. However, shortly after rejoicing I realized that my analysis was incomplete and my prize-winning paper was incorrect! I had overlooked the reciprocal effects of their fields on the currents — something that should *never* be overlooked! Nevertheless, only a few people thought I was wrong, and not one said that a neglect of reciprocity was the reason. Typical of the reasons given was that some highly abstract mathematical equation was not satisfied. This example clearly shows that fundamentals are *not* getting the attention they should get, from *any* of us.

Two more recent papers of mine point a finger at every one of us who has worked in EMC for the last decade or so. Some of the numbers given in ANSI C63.4 are easily seen to be wrong, but we have all accepted them for more than 10 years! The values in error are those given for normalized site attenuation (NSA) with vertical polarization. *All* of those values given in that standard are in error — some by only 0.1 dB, but several by as much as 1.4 dB! That is very easily inferred from the definition of NSA and from the perpendicularity of an E-field and its H-field. The 10-year life span of those errors in a national standard again clearly illustrates a widespread need to pay much more attention to basic principles.

From each of the above examples, it should be obvious that we *all* need to BACK UP and give *much* more thought to fundamentals. We *all* need to SLOW DOWN in using mathematics that cloud, even *hide*, basic relationships that can and *should* be made obvious. And, we *all* need to THINK of how to *simplify* and *clarify* the things we do, so that we can maximize our own understanding, and facilitate the sharing of it with others.

Sincerely,
W. Scott Bennett
Carr, Colorado

TODD HUBING
ASSOCIATE EDITOR

Zero! Zip! Nada! That's how many EMC limericks I've received since my appeal in the last Chapter Chatter column. Ok, perhaps EMC engineers are not natural limerick writers. After all we're not poets, we're puzzle solvers. When we encounter a product with an EMC problem, we regard it as a challenge – a puzzle to be solved. Those of us that enjoy our work probably also enjoy solving other kinds of puzzles. Therefore, this issue's column is a puzzle. To solve it, cross out every word in the next paragraph that is the name of an EMC Society chapter city or country. Then, if you are a member of the IEEE EMC Society, circle the first word and every third word after that (skipping the words that have been crossed out). For example, applying this technique to the beginning of this column, the first three words circled would be Zero! That's EMC. Decode the message by reading the circled words in order including punctuation marks. If you are not a member of the IEEE EMC Society, then circle the second word and every third word after that (again, skipping crossed out words). Applying this technique to the beginning of this column, the first three words circled would be Zip! How limericks. Got it? If not read the instructions one more time. Here is the puzzle:

Too difficult? Here's a helpful hint. After crossing out the names of chapter cities and countries, each line has exactly 9 words in it. Still too difficult? Bring the puzzle to your next EMC Society chapter meeting. Chapter meetings are a great place to get help with all your EMC-related puzzles.

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Atlanta

Thanks to Bruce Crain, chair of the Atlanta chapter for submitting the following report.

The Atlanta chapter held a meeting on December 1, 1998 at the Lockheed Martin Aeronautical Systems (LMAS) facility in Marietta, Georgia. The speaker was Clayton Paul, who has recently joined the faculty of the Department of Electrical and Computer Engineering, Mercer University, Macon, Georgia. Dr. Paul presented "Crosstalk in Cables and Printed Circuit Boards" to a captivated audience. The presentation was interesting and enlightening to both the neophyte and "seasoned" EMC engineers in the audience. The Atlanta EMCS chapter is fortunate to have Dr. Paul as a member and we look forward to his participation in future chapter meetings.

It is with sadness that I inform you of the passing of Herb Zajac on November 11, 1998 after a 6-month battle with a brain tumor. Herb was the Vice Chairman of the Atlanta EMCS chapter and a member of the EMCS Board of Directors. Herb was a valued colleague and a trusted friend, especially to those of us at LMAS who worked with him daily. Our thoughts and prayers go out to his wife Linda, his daughters Wendy and Deanna and their husbands, and his 5 grandchildren.

Beijing

Prof. Gao Yougang, chair of the Beijing chapter of the IEEE EMC Society reports that the 1998 National Meeting on Electromagnetic Compatibility was held on September 22-24 in Nanjing, China. About 90 experts and scholars throughout the country attended the meeting. They were from universities, research institutes, factories, companies and departments all over the country.

The meeting was called to order at 9:00 am on September 22 by Prof. Gao Yougang, the president of the EMC Society of China. A round of introductions was made and Prof. Gao was invited to give a report on "EMC Technology in Communications and Computers in the 21st Century." Next Prof. Gao Benqing of the Beijing University of Science and Engineering presented his report. He noted that EMC technology is progressing rapidly in China. The last invited speaker, Prof. Cao Wei of the Nanjing Institute of Posts & Telecommunications gave a report on "The Environmental Pollution from Electromagnetic Radiation and Its Protection." After the invited talks were concluded, the remaining talks were divided into theoretical and engineering sessions.

The talk on "The 3D FDTD Modeling and Calculation for Crosstalk Coupling in Transmission Lines" presented by Prof. Gao Benqing attracted many scholars. His method models transmission lines directly and doesn't need to calculate the related impedances. Complete information about the electric and magnetic field coupling can be obtained to analyze the other characteristics of transmission lines.

Another popular talk was "Using Robot Mechanics to Calculate the 3D Field in the End-Windings of Large Generators" by Dr. Li Shufang. The reported method overcomes shortages in existing models by treating end-windings as many rectangular current elements, allowing the 3D distributed stator current in the end-windings to be modeled more accurately. The results have been used to design the hydraulic generator in the Three Gorge Hydraulic Power Station.

Following the above meeting, on September 25-26, the Meeting of the Foundation of Lightning and Electromagnetic Pulse (EMP) Sub-committee was held at the Nanjing Engineering College for Engineering Troops. Academic exchange activities were also carried out. Eight reports on lightning and electromagnetic pulse were presented. Among them were "The Numerical Calculation for High Power Microwaves" presented by research fellow, Chen Yusheng, and "The Engineering Protection for Nuclear Electromagnetic Pulse" presented by Prof. Zhou Bihua.

Thanks to the support of many experts and scholars from all over China, the two meetings above were very successful.

Central New England

John Clarke reports that Michael Hopkins of KeyTek was the speaker at their September meeting. Mr. Hopkins topic was "Harmonic and Flicker Analysis." This presentation provided manufacturers with a perspective pertaining to harmonic (IEC 61000-3-2) and flicker(IEC 61000-3-3) measurements, technical information about the tests, and test equipment needed. The speaker also discussed proposals for changes to the standards. This meeting was jointly sponsored with the North East Product Safety Society (NEPSS).

The October meeting featured Larry Stillings of Compliance Worldwide, who spoke on the subject of "Compliance vs. Compatibility with North American Digital Telecommunications Networks." The presentation discussed the recently harmonized FCC Part 68 and Industry Canada CS 03 rules for digital telecommunications interfaces covering T1, ISDN PRI, ISDN BRI, DDS and ADSL. An outline of the tests was also covered.

In November, Donald R. Bush of dBi Corporation, an EMC Society Distinguished Lecturer, presented "A Brief History of EMC Measurements." He discussed changes in both the technology and philosophy of EMC measurements that has taken place over the last 30 years. Some of the early experiences of the speaker and his colleagues were described.

Another EMC Society Distinguished Lecturer, Robert Dockey of Hewlett Packard, was the featured speaker at the December meeting. Mr. Dockey's presentation was entitled: "New Techniques for Reducing Printed Circuit Board Common-Mode Radiation." In 1993, Dockey discovered that a relatively small PCB with a solid ground-plane could also produce common-mode radiation. The speaker elaborated on these findings and described several methods that can be used to effectively mitigate the radiation mechanisms.

Central and Southern Italy

On December 7, a successful meeting of the Central and South Italy Chapter was held in Rome. The General Vice-Director of the Environment Ministry, Dr. Biondi, gave a Seminar on the new law (Nov. 1998) regulating the levels of electromagnetic field in the high frequency range (above 100 kHz) in Italy. These limits will be effective beginning in January 1999. Also, the evolving situation in the EC was presented and clarified. More than 100 people attended the conference. The 90-minute presentation was followed by many questions.

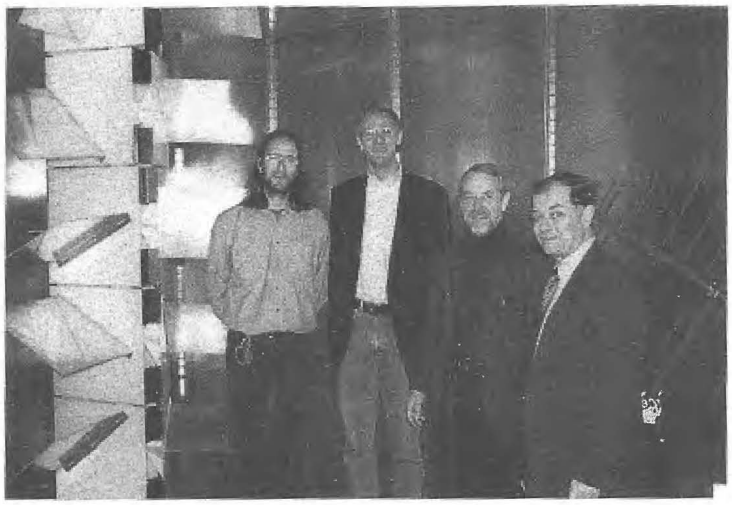
Chicago

The Fall meeting of the Chicago chapter included a presentation from Don Bush of dBi Corporation. Don is an IEEE EMC Society Distinguished Lecturer. He spoke to the group on International EMC Standards. He described how many of today's EMC specifications evolved out of the FCC and CISPR committees. His historical approach to EMC shed an interesting light on the roots of EMC. In the end, he noted the proliferation of EMC standards and requirements for products. He found one electronic typewriter with 20 emblems or marks! He challenged the EMC community to coordinate their efforts. He was also concerned about the value of EMC requirements. Are they applied unnecessarily? Are limits too restrictive? There seems to be a minimal number of EMC complaints. Does that indicate that the requirements are overkill or that they are doing what they were intended to do?

The executive committee met in December to discuss future plans. Work is continuing on the chapter website and plans are being made for the symposium to be held in Chicago in 2005. Plans are also underway for a one-day mini EMC symposium sometime soon. This symposium will be designed to provide an educational opportunity for many of the members and serve as a showcase for many of the EMC companies in the Chicago area. Contact Derek Walton, Tom Braxton, or Frank Krozel for further information.

Germany

The good atmosphere of a successful beginning was felt when members of the German EMC Chapter met at the University of Magdeburg, according to Dr. Frank Gronwald. There the recently established EMC group features a newly installed shielded room (7.9m x 6.7m x 3.8m) which will primarily be used as reverberation chamber. Moreover, a GTEM-cell (EMCO 5317) is expected to arrive in Magdeburg no later than March 1999. These circumstances were taken by Profs. Juergen Nitsch and Guenter Wollenberg as occasion to organize two seminars, which were held in December 1998. In the first one, Markus Petirsch shared his valuable experience on reverberation chambers. In the course of his research and measurements, he investigated the details and characteristics of the reverberation chamber at the University of Karlsruhe. Thus, in turn, the audience went through a thick pile of transparencies and gained a solid knowledge of his work.



The German EMC Chapter is increasingly interested in reverberation chamber test techniques. Principal investigator Hans-Georg Krauthaeuser, Markus Petirsch, Juergen Nitsch, and Guenter Wollenberg (left to right) are shown inspecting the new reverberation chamber at the University of Magdeburg.

The second talk, by Michael Koch from the University of Hannover, was devoted to electromagnetic field computation in GTEM-cells. Michael Koch presented the impressive results of his Ph.D. thesis where he connected exact analytical computations to experimental data and numerical simulations. In both cases the discussion did not cease at the end of the session but continued to late hours in the Italian restaurant around the university corner.

Mohawk Valley

The Mohawk Valley Section EMC Chapter held its last meeting of 1998 on December 3rd. Nearly thirty members and guests were in attendance for the luncheon meeting which had as a guest speaker Donald D. Weiner, IEEE Fellow and a professor at Syracuse University's Department of Electrical and Computer Engineering. Don's talk was on "Nonlinear Effects in EMC - The Impact on Spread Spectrum Communication Systems". The talk began with a brief review of communications receiver nonlinear effects such as harmonic generation, intermodulation, spurious responses, gain compression and desensitization. A baseband implementation of a nonlinear RF communications receiver was then presented. The impact of a soft nonlinearity in the RF amplifier of a discrete sequence spread spectrum receiver subjected to an interference environment was also discussed. It is noted that a good deal of Don's present research deals with the subject of signal processing in an interference environment including non-Gaussian noise. He has performed extensive work on the application of nonlinear systems analysis techniques and communications theory to EMC problems. He is most certainly a recognized leader in the combined areas of signal processing, communications and EMC.

Following the presentation by Don, Chapter Chair Andy Drozd announced that he would arrange for continued use of the EMC Distinguished Lecturer Program in 1999 and would periodically poll the Mohawk Valley mem-

bers about EMC topics of interest. Plans are also in progress to formally merge the Reliability Chapter under the EMC Chapter in 1999.

Oregon and Southwest Washington Chapter

The Oregon and Southwest Washington chapter has been very active. Chapter meetings or events have been held every month since September and will continue through June. Attendance averaged 50 people in October and November for guest speakers Chris Kendall and Dr. Howard Johnson respectively. In December, the chapter subsidized a Christmas dinner social at the Harborside restaurant overlooking Portland's Willamette river. The EMC related topic for the evening was "EMC Black Magic". Our guest speaker was a real magician who was able to make things disappear. It is yet to be seen whether he can really make "EMI" disappear! Regardless, everyone had a great time!

Dick Ford was the guest speaker in January. He gave an excellent presentation on Navy EMC excellence programs. February 17, the guest speaker will be Hans Peter-Bauer, from Rohde&Schwarz - Germany. He will discuss EMC measurement techniques. An EMC Colloquium and Vendor Exhibition will be held April 12 in Portland. The Colloquium was very successful in 1997. This year five speakers will be featured. Four of the speakers are members of the IEEE EMCS Board of Directors. For more information, contact Henry Benitez at 503-627-1217 or h.benitez@ieee.org.

Philadelphia

Michael Daniele reports that Dr. William Duff, a Senior Consulting Engineer with Computer Sciences Corporation, pre-

Photo by Henry Benitez

EMCS President Dan Hoolihan (L) has perfected the art of sleeping while standing up! Actually, President Hoolihan was in town to attend the Oregon and Southwest Washington EMC Chapter meeting in November with Dr. Howard Johnson (R). We caught him with his eyes closed! (Sorry Dan!)

Those spied enjoying a delicious three-course dinner at the Oregon and Southwest Washington EMC Chapter December Holiday Social are (L-R) Dan Arnold, Avis and Dan Horjus ("the Dans" are with Underwriters Laboratories), and Henry and Jackie Benitez. The popular Chapter Chairman Henry is with Tektronix.

Photo by Henry Benitez

A last minute room change was required at the November Oregon and Southwest Washington EMC Chapter meeting to accommodate the 48 attendees. Obviously the speaker, Dr. Howard Johnson (standing on the left), is quite popular in the Pacific Northwest. As such, he was invited to be a part of the "Fundamentals of EMC" tutorial on August 2 in conjunction with the 1999 IEEE International Symposium on EMC in Seattle.

Photo by Henry Benitez

Enjoying the Oregon and Southwest Washington EMC Chapter December Holiday Social at the Harborside Restaurant are Chapter Officers (L-R) Jerry Page of Northwest EMC, Charlie Tohlen of Tektronix and Dan Arnold of Underwriters Laboratories, Inc.

sented "Electromagnetic Interference (EMI): The Nemesis of Medical Electronics" at the IEEE Night Philadelphia Section Meeting, at the University of Pennsylvania on November 17, 1998. His presentation addressed the problems associated with EMI in medical electronics and identified methods and techniques that may be used to design medical electronic equipment for electromagnetic compatibility.

Phoenix

The Phoenix EMC Society Chapter has officially been resurrected from its dormant status much like the legendary bird. Many thanks go to Daryl Gerke of Kimmel Gerke Associates, Ltd. who has been instrumental in reorganizing the Phoenix chapter and reinstituting its status. Glen Gassaway of Motorola and Terry Donohoe of Honeywell were also ringleaders in getting the chapter going again. We have now had four meetings over the past year with some excellent speakers and an attendance averaging about 30 people.

Daryl was unable to line up a speaker for the fall meeting so he "volunteered" to present a talk that has been well received at several other EMC Society Chapters. The audience learned "How To Design To Fail FCC & CISPR In 20 Easy Steps", a tongue-in-cheek presentation that dealt with a number of serious EMC design problems. In this talk we learned of 20 ways to increase our radiated and conducted emissions including the concept of using the fastest clocks available and laying their circuit traces out to maximize the loop area!

The Phoenix EMC Society Chapter will be sponsoring an EMC Mini-Symposium on May 3, 1999 in the Phoenix area. The keynote speaker will be Henry Ott, a renowned expert in the field of EMC. There will also be about 10 to 30 exhibitors demonstrating their latest test equipment and EMC control products. The cost of the one-day symposium is expected to be about $125 for early registrations.

For information on the Phoenix EMC Society chapter, contact Mr. Daryl Gerke, phone (602) 755-0080 (dgerke@emiguru.com) or Mr. Harry Gaul, phone (602) 441-5321 (p19850@email.mot.com).

Pikes Peak

James Youngman reports that the Pikes Peak Chapter held two meetings during the fall of 1998. Mr. Dick Coulombe of INTERTest, a Colorado Springs product safety and EMC testing firm, provided an overview of general EMC emissions and immunity requirements for the US and European markets. INTERTest is the first (and only) independent organization which can provide such testing services for manufacturers in the Pikes Peaks region. The second meeting featured Mr. Neil Yosinski of Hewlett Packard, who gave a very interesting presentation on radiated emissions design, not from a purely technical perspective, but rather from an organizational "how-to" vantage. To ensure EMC success, the activities of many groups (management, electrical and mechanical engineering, PCB design, testing, etc.) must be effectively structured and managed.

Rocky Mountain

In October the Rocky Mountain Chapter welcomed Distinguished Lecturer Bob Dockey of Hewlett Packard to our meeting at NIST. Bob shared his EMC experience in a lively discussion of "New Techniques for Reducing Printed Circuit Board Common-Mode Radiation".

In December, the Chapter wrapped up the 1998 program with our Vendor Night and chapter elections. Chapter chair, Lyle Luttrell, reports that the turnout was good with a dozen vendors and over thirty society members, including EMC Society President Dan Hoolihan and the 1998 Symposium Chair Barry Wallen. Dan provided a summary of current international activities in the EMC Society, and Barry gave a recap of the 1998 EMC Symposium. The new chapter officers are:

Chairman – Lyle Luttrell (lluttrell@ieee.org)
Vice-chairman - Charles Grasso (chasgrasso@ieee.org)
Secretary - Bob Reinert (r.reinert@ieee.org)
Treasurer - John Stadille (jstadille@ball.com)

The 1999 Chapter program will focus on providing the regional technical community with more valuable EMC training and education. We are committed to providing industry with a program of solid technical content so that the cost of EMC can be reduced. Our program plans will be available at our NEW web site. The URL is: http://www.ewh.ieee.org/r5/denver/rockymountainemc/

The 1999 Rocky Mountain Chapter EMC Colloquium will be held in May; the date and program will be set soon.

Santa Clara Valley

The December meeting of the Santa Clara Valley chapter featured Neven Pischl of Bay Networks. Neven's topic was "A New Common-Mode Voltage Probe for Predicting EMI from Unshielded Differential-Pair Cables." His talk described a method for predicting EMI levels from unshielded differential twisted-pair cables using a common-mode voltage measurement.

EMCS Distinguished Lecturer, Don Bush, was the featured speaker at the January meeting. Over 100 people turned out to hear Don's presentation on "Spread Spectrum Clock Techniques."

Seattle

In October, the Seattle EMC Chapter held a special four-hour training from 4:00 pm to 8:00 pm in lieu of its traditional one hour evening meeting. The training was held at CKC Labs in Redmond. Chris Kendall of CKC Labs spoke on "EMC Emissions Measurements: Getting the Right Answer." The training included practical engineering and troubleshooting techniques while addressing conducted and radiated emissions. Demonstrations of the material presented were conducted in the lab for small groups. There was no fee

for the training and certificates of completion were provided. A 45-minute dinner break for complimentary pizza and soft drinks kept everyone fresh for the duration of the evening. Some 50 chapter members attended and took advantage of this unique EMC event. The chapter resolved to hold one training a year since this event was so popular.

In November, Dr. Howard Johnson spoke to the Seattle EMC Chapter on the topic, "Why Digital Designers Don't Believe in EMC." Based in Redmond, this "local hero" held the audience in a trance with his energetic, professional presentation. In fact, despite the fact that this was an evening meeting, chapter members wished that Dr. Johnson would have stayed and spoken longer!

Howard Johnson, Ph.D, is the author of High-Speed Digital Design: A Handbook of Black Magic (Prentice-Hall, 1993). One chapter member brought this book to the meeting for Dr. Johnson to personally autograph! Dr. Johnson explained that whether they recognize it or not, many engineers with a purely digital background have a difficult time dealing with EMC problems. In fact, the underlying, root cause of many of our present day difficulties with EMC is a matter of attitude: digital engineers don't believe in EMC.

Without intending any harm, our institutions, vendors, and managers have propagated five great misconceptions which prevent many, if not most, new digital designers from understanding EMC at any level, and in fact, from even believing in its existence. Dr. Johnson advised that the better you understand these five great misconceptions, the better equipped you will be to understand the point of view of many digital engineers, and to help them overcome the EMC difficulties they will inevitably face. He discussed these misconceptions and other issues of importance to both EMC and digital design engineers during his presentation.

Dr. Johnson will be participating as a speaker during the "Fundamentals of EMC" tutorial to be held on August 2, 1999 in conjunction with the 1999 IEEE International Symposium on Electromagnetic Compatibility in Seattle.

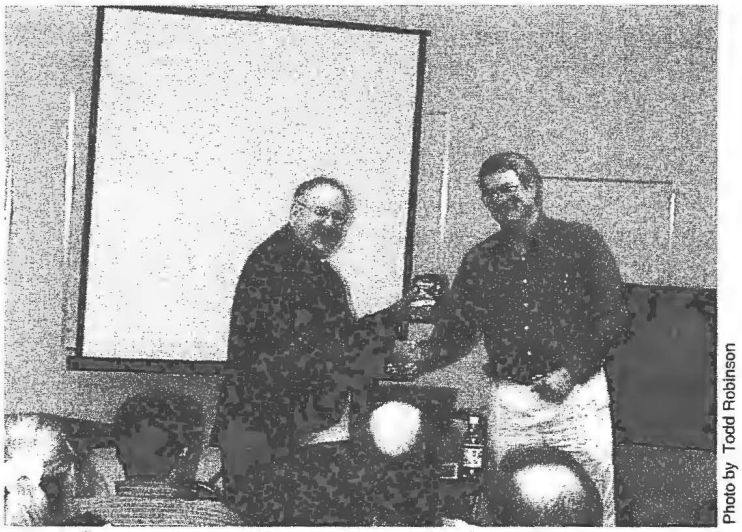


Photo by Todd Robinson

Chris Kendall (L) receives "payment" of one pound of "Seattle's Best" coffee from Chapter Chairman Ghery Pettit for his services as speaker at a special four-hour training held at the October Seattle EMC Chapter meeting. Chris donated his time and considerable talent to speak to the chapter on "EMC Emissions Measurements: Getting the Right Answer".

Photo by: Todd Robinson

Seattle EMC Chapter Chairman Ghery Pettit welcomes the crowd to the October Chapter meeting. After completing the four-hour EMC training, some 50 chapter members received a certificate signed by the instructor, Chris Kendall, and the Chapter Chairman.

Photo by Janet O'Neil

The November meeting of the Seattle EMC chapter featured speaker Howard Johnson (R). The topic "Why Digital Designers Don't Believe in EMC" enticed Erik Godo (L) of Boeing to attend his first EMC chapter meeting. Erik is the Chairman of the Seattle chapter of IEEE's Circuits and Systems Society.

Photo by Janet O'Neil

Howard Johnson speaks to a packed audience at the November Seattle EMC Chapter meeting. Some 45 people attended the meeting at CKC Labs and used every chair available!

Chapter members present at the meeting immediately marked their calendars to save the date for a future local presentation by Dr. Johnson.

The Seattle Chapter is also busy planning a special event to be held on August 1, 1999 at the Crowne Plaza Hotel in downtown Seattle. Clayton R. Paul will present a one day tutorial entitled "Introduction to Electromagnetic Compatibility." This event is designed for those new to EMC and it will be the perfect "prep class" for those attending the IEEE EMC Symposium the following week at the Washington State Convention and Trade Center in downtown Seattle. You can find more information about the tutorial, including a registration form, on the chapter's web page at http://home1.gte.net/joecool/ieee/. This event is expected to sell out so register early if you are interested in attending.

For more information about the Seattle EMC Chapter, visit the chapter's web page as noted above, or link to it from the EMC Society web page. Everyone is welcome at the chapter meetings! If you plan to be in the Seattle area, visit the web page and come to a meeting.

Invest in *YOUR* EMC Career by Attending EMC '99 in Oregon or Arizona

A Regional Colloquium & Exhibition on EMC Requirements and Design for Compliance. Sponsored by the local IEEE EMC Chapters!

Portland, Oregon	***Scottsdale, Arizona***
April 12, 1999	May 3, 1999
Double Tree Hotel	Double Tree Hotel
Columbia River	La Posada Resort
Colloquium Chairman:	Colloquium Chairman:
Henry Benitez	Daryl Gerke
(503) 627-1217	(602) 755-0080
henry.w.benitez@tek.com	dgerke@aol.com
Exhibits Chairman:	Exhibits Chairman:
Jerry Page	Janet O'Neil
(503) 537-0728	(425) 868-2558
jpage@nwemc.com	j.n.oneil@ieee.org

Each Colloquium features hands-on demonstrations, vendor table-top exhibits, and industry renowned speakers covering topics such as: Overview of EMC Requirements, PCB Design Techniques, Electrostatic Discharge, and more! Speakers in Arizona include Henry Ott, Dan Hoolihan, and Daryl Gerke. In Oregon, four members of the EMC Society Board of Directors will participate as speakers. Call the Chairman of each event to receive an advance program/registration form that details each program. Check out the LOW registration fees!

Letter from the Editor

continued from page 3

(Apparently, Todd did some arm-twisting following the last Board meeting to recruit members of the Board of Directors to fill these positions.) They are all dynamite fellows! Congratulations to these new leaders and kudos to Todd for his excellent delegating!

That's it for now. Thank you for your input and please keep up the phone calls, letters and e-mail!

ANNOUNCEMENT

Introducing Dave Traver, Recently Appointed to the EMC Society Board of Directors

Dave Traver is the newest member of the EMC Society Board of Directors. In accordance with EMC Society bylaws, as the unelected candidate with the most votes from the last election, he was appointed to fill the Board position vacated through the untimely passing of Herb Zajac.

David L. Traver (M'89) is Director of Quality Engineering at Sony Electronics Incorporated, San Diego, CA. He received his B.S degree in Business Management/Production from San Diego State University, his AS degree in Quality Technology from San Diego CC, and USN Avionics Electronics technical training.

Since 1985, Dave has been responsible for developing and maintaining the EMC measurement and compliance programs for several Consumer and ITE Product Design groups at Sony Electronics in San Diego.

His experience includes developing measurement techniques for both satellite and terrestrial Digital TV products, Computer Displays, and unique integrated ITE systems. Dave is in a unique position to see the integration of many new technologies, such as wireless telecom, HDTV, MPEG, DSS consumer products and specialized products and their EMC performance and compliance.

Dave has been a member of the IEEE EMCS Standards Committee since 1989 and is currently serving his 7th year as Secretary. He has directly supported P187 and P1140 standards and is actively seeking to develop a new working group to revise TV related standards 213 and 187 to prepare them for the digital environment.

Book Review: EMI/EMC Computational Modeling Handbook

by Bruce Archambeault, Omar M. Ramahi, and Colin Brench
Reviewed by
James L. Drewniak
Electromagnetic Compatibility Laboratory
University of Missouri-Rolla

Each of the authors of EMI/EMC Computational Modeling Handbook have a combination of many years of EMC (at IBM and Digital) as well as numerical electromagnetic modeling experience that results in a unique and useful presentation of this subject. As the authors remind the reader many times throughout, an EMC problem is minimally comprised of a noise source, unintended EMI antenna, and a parasitic path that couples energy from the noise source to the EMI antenna. The source is typically a high-speed digital IC, and the EMI antenna might be attached cables, or slots and apertures in a shielding enclosure. In practice, anticipating these two aspects of a potential EMI problem is much easier than the coupling path. The coupling path is related to layout features and may be parasitic inductance, capacitance, or a common impedance, and can be very difficult to anticipate at the design stage. Consequently, productively using numerical electromagnetic modeling to reduce EMI/EMC risk at the design stage can be challenging.

Numerical electromagnetic modeling is relatively mature, with many commercial codes available, and can result in good answers to well-defined problems. However, defining an EMI/EMC problem is in general an inexact art that typically requires both modeling as well as good EMC experience. The authors combine many years of industry EMC experience in shipping high-speed digital products, together with expertise that they have acquired in applying numerical modeling to product EMC design to provide the reader with valuable insight into productively using numerical modeling for EMC design.

The intended audience of the book is practicing engineers that may not be experts at numerical modeling, as well as more experienced modeling people that are seeking guidance on applying modeling to product design. I think that it is also an invaluable resource for graduate students that may be focusing on fundamental numerical modeling algorithms and issues to gain exposure to a new and growing area of application for these methods. The objectives of the book are to provide a rudimentary understanding of the common numerical electromagnetic modeling methods, and more significantly insight and guidance for incorporating them into the EMC design process. As such, the authors do not intend that it will be a comprehensive treatment on any particular numerical modeling method.

The book briefly reviews the basics of the three common numerical electromagnetic modeling methods, finite-difference time-domain (FDTD), finite element (FEM), and integral equation (method of moments MOM) formulations with some emphasis on FDTD. The critical issues in numerical modeling are determining the essential features that must be modeled, how to model them, and at what level of detail to result in a good and useful answer. In EMC design, ascertaining these very necessary details are typically difficult, and these are the issues on which the authors focus. The authors provide a good understanding of what can reasonably be expected and achieved in practical EMC design, basic modeling concepts, and how to use numerical modeling for understanding fundamental coupling physics, as well as for layout and design.

Chapter 1 is a brief introduction to EMI/EMC modeling, and the three common modeling methods. Chapter 2 is an overview of only the essential electromagnetic theory and basic "equations of motion" that are used later in the chapters on the individual modeling methods.

The three common, full-wave numerical electromagnetic modeling approaches, FDTD, MOM, and FEM are presented in Chapters 3, 4, and 5, respectively. In each case, only the essentials for acquiring a basic understanding of these methods are given. FDTD is a logical choice to present first since it is by far the easiest to understand of the three, as well as widely useful for EMI/EMC problems, and robust. The authors give the basics of the algorithm from a differential equation perspective, meshing, time-stepping, and absorbing boundaries. An alternative approach to understanding the basic algorithm is from the integral form of Maxwell's equations that I particularly like because it gives a clear understanding of the FDTD method in terms of the underlying physics. The reader is referred to one of the references (A. Taflove, Computational Electrodynamics: The FDTD Method).

The MOM is presented in Chapter 4. Complete volumes are devoted to this subject, and the technical literature is vast on the MOM and applications. In the spirit of their original objectives, the authors have presented this difficult subject in a simple and straight-forward manner with Pocklington's integral equation, i.e., MOM applied to wire geometries. The treatment is brief, and more-or-less one-dimesional, but adequate for a basic understanding. A further advantage of the choice in introducing MOM in this fashion is that a mature and commercially available MOM code (NEC) is largely wire-based.

The finite element method is presented in Chapter 5. The FEM presentation proceeds from a variational formulation and minimization of a quadratic functional, and may

leave an inexperienced reader confused. An alternative path to the final algorithm is via a weak formulation (see J.N. Reddy, An Introduction to the Finite Element Method). I like this approach because a one-dimensional formulation is easily understandable. The 2D overview of triangular patch basis functions presented in Chapter 5 does give the reader a feeling for the solution approximation and meshing.

Chapters 6, 7, and 8 are at the heart of this book. The consistent theme emphasized in these chapters is "what and where to model" for EMI/EMC design. The reader is left with a good understanding of what is achievable in applying numerical modeling to EMC design, and how to approach and construct models that can lead to useful results. The treatment is a reflection of the authors extensive experience using modeling in their own work at IBM and Digital. Chapter 6 discusses anticipating and modeling the EMI coupling, as well as the noise source. Guidance in choosing a suitable technique, FDTD, FEM, or MOM for particular types of problems is also given.

Chapter 7 discusses creation of EMI/EMC models and details a number of examples including common-mode radiation from cables being driven against a shielding enclosure, excitation of heatsinks by an IC, and apertures in a shield. Inherent in these examples is insight into how EMI/EMC modeling can be used in developing better designs. For example, one configuration discussed details the effects of coupling through a slot in an enclosure to an attached cable. Slots inevitably result in low-cost PC enclosures as a result of cost-effective attempts to seal unused expansion ports. The example demonstrates developing a model to understand the coupling effects between the source, aperture, and attached cable. The result is a clear indication that the EMI problem is dominated by the source coupling to the aperture and provides direction on where attention should be focused in mitigating this problem, i.e., a ferrite sleeve on the attached cable is a waste of a good part for this particular case.

Chapter 8 is a more detailed continuation of Chapter 7, and focuses specifically on examples of multi-stage modeling for PCB level coupling to perforations in a shielding enclosure and coupling to an attached cable, antenna impedance important for I/O filter design, test site modeling, and basic PCB level modeling. The PCB level modeling example demonstrates the use of numerical modeling for developing an understanding of fundamental EMI coupling physics. The geometries can be relatively simple, but the resulting design concepts are powerful. Practicing EMC engineers commonly draw general design conclusions based on their experience with prototype or production hardware. This hardware is complex, and it is easy to draw incorrect conclusions regarding fundamental noise and coupling processes in the trial-and-error process of shipping products. Numerical EMI/EMC modeling is a powerful tool for developing an understanding of fundamental concepts, and experienced EMC engineers are well-versed in translating these to design.

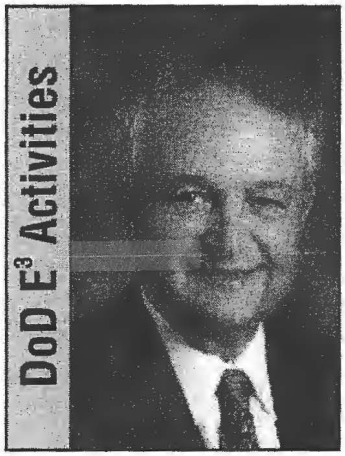
Chapter 9 discusses model validation that provides good insight for engineers not experienced with modeling. Some very helpful caution is given regarding comparing radiated EMI measurements on a functioning product that are inherently not well controllable, with modeling results. Chapter 10 is a brief over-view on geometries that are representative of high-speed digital design aspects that may be suitable for numerical modeling. From the perspective of a practicing EMC engineer, this provides direction on what can realistically be expected from numerical modeling, as well as problems on which to investigate and compare commercially available tools. From the standpoint of the numerical modeling community, these problems represent some goals for which to strive, i.e., demonstrating (in particular through well-controlled measurements) modeling approaches for problems of interest to practicing EMC engineers.

Overall, I found this to be a good book that achieves the author's stated goals very well, and I recommend it, in particular for practicing EMC engineers and numerical modelers. As I was reading the book and noting the aspects that I particularly liked or did not, I found that most of my criticisms were a matter of personal preference, and not fundamental disagreements with the treatment or presentation of topics. I would have liked to see more details in the examples that would allow the user to reproduce the author's results. While this is certainly more appropriate to research papers published in the referenced technical literature, it is important for those less experienced with modeling to initially have targets at which to shoot. Since the first author is taking a leading role in the EMC community through the IEEE EMC Society Technical Committee 9 (Computational Electromagnetics) in advancing the state of the art, and developing standard EMI/EMC modeling problems with proven results, a future addition might include this.

Application of numerical modeling in EMC design is relatively recent, and I consider this book the first stage of a "work in progress". The authors do not propose that this book is in any sense completed or concluded. I anticipate that this book will be updated and expanded periodically as the field progresses and grows.

Editor's Note: Many thanks to Jim Drewniak for providing this book review as a guest Associate Editor. Jim's experience in the field of EMI/EMC computational modeling is evident in this thorough book review and is surely appreciated by our readers. Jim may be reached at phone 573-341-4969 or email at drewniak@ee.umr.edu.

DoD E^3 Activities



BOB GOLDBLUM
ASSOCIATE EDITOR

If there is one good thing we can say about our Government, it is that it has a great deal of momentum. Thus, in spite of the significant number of key players who recently retired from the Government E^3 community, the EMC programs continue to move ahead without a hitch. One can keep up-to-date on the Government's latest DoD E^3 programs by attending the upcoming DoD Electromagnetic Environmental Effects Program Review scheduled for 23-25 March 1999 at the Colorado Springs Sheraton Hotel in Colorado Springs, CO. This Program was initiated six years ago to bring Government, industry E^3, and spectrum management personnel together to assess overall program progress and exchange technical information pertinent to E^3 and spectrum management related topics. Although most of the attendees are from the Government, industry is invited to participate. Government design engineers, system integrators, personnel involved in standards, innovators of specialized E^3 automated software tools, etc. can mingle freely with their Industry counterparts. This year's Program Review will feature guest speakers from the Office of the Secretary of Defense (OSD), Joint Staff, Service System Commands, Service Laboratories and private industry. Those interested in registering for the event should contact Mr. George Johnson, R & B Enterprises, 703-486-7023, E-mail: gjohnson@RBitem.com, for general hotel and conference information.

Progress is slow but steady in the MIL-STD-461 revision process. A draft of the "E" version is currently being circulated among Government personnel. When it is released after completion of the coordination process, the intention is to post it for public access on the Internet at that time. If the Committee does not need to deal with many technical comments, MIL-STD-461E should be released by early Summer 1999. For more information about the status of this standard, the point of contact is Mr. John Zentner at Wright Patterson Air Force Base, E-mail: zentnejc@asc-en.wpafb.af.mil.

The latest upgrade of DoD's Acquisition Streamlining and Standardization Information System (ASSIST) was activated on 1 October 1998. The DoD developed Assist capability as part of the Government's move to a paperless acquisition environment. Assist allows users to download full text PDF versions of military and federal specifications, standards, commercial item descriptions, qualified manufacturers and qualified parts lists. Assist can be accessed at web site http://assist.daps.mil. Users must register for Assist, but there is no charge for registration nor a charge to access documents.

The Government continues to publish its Joint E^3 Bulletin through the auspices of the Joint Spectrum Center. The January issue should be on line at www.jsc.mil or www.RBitem.com by the end of January.

Practical Papers, Articles and Application Notes

BOB ROTHENBERG
ASSOCIATE EDITOR

As you can see from the "Letters to the Editor" column in this issue, the Scott Bennett article in the Summer issue has been well read and debated. That's a good sign that this section of your Newsletter is serving its purpose of both informing and facilitating a dialogue within the EMC community.

Following are two papers which should be of interest to EMC engineers and practitioners. The first, by Ken Javor of EMC Compliance, presents a strong case for relaxation of the FCC and CISPR limits on differential mode conducted emissions. The second, by Zhong Chen and Tim Harrington of EMC Test Systems, expands on the points made in their Letter to the Editor concerning the Bennett paper and test site performance.

Comments from readers are welcome, either as a letter (or e-mail) to the editor or directly to the authors. To submit a practical paper or article for publication consideration, send it via fax, e-mail or snail mail to this Associate Editor. See page 3 for addresses and fax number.

Investigation into Radio Susceptibility to Power-Line Conducted Noise

by Ken Javor

ABSTRACT

Radio response to power-line conducted noise is described. Radios are evaluated as to their susceptibility to common mode (cm) and differential mode (dm) noise. Results are compared to traditional susceptibility evaluation techniques.

Radios are found to be more susceptible to cm than to dm noise. Significant differences between these responses (20 dB) suggest the efficacy of conducted emission (CE) procedures and limits which separately control cm and dm CE. Filter design to meet present day CE limits is more difficult and expensive than that required to simply protect radios.

Adoption of new standards which reflect real radio frequency interference will decrease cost of EMC compliance, with benefits resulting to the entire electronics marketplace. It has been estimated that the suggested changes could save $35 million annually in the personal computer industry.

1.0 BACKGROUND

Conducted emissions (CE) standards imposed by governmental authority protect AM radios from the effect of power-line rfi. Test frequency range, bandwidth, and quasi-peak detection all are tailored to protect reception of amplitude modulated radio signals.

1.1 CE CONTROL PROCEDURES

Conducted noise is measured between power conductor and ground. But the meaning of power conductor has changed over time. At the genesis of rfi control, power conductor meant phase or feeder, while ground meant both current return and power system reference — hence the line-to-ground topology of today's line impedance stabilization network (LISN). Early standards inserted a LISN between power conductor and return, with return being power source reference (Figure 1, left). Determination of AM radio susceptibility to power-line CE (to set CE limits on office and information technology equipment) was made using this topology. (CBEMA, 1977) Today, power conductor means a current carrying conductor, which includes neutral. Today's test inserts a LISN in each current-carrying conductor, each LISN bonded to power source reference (Figure 1, right). With this definition and configuration, CE appear not only between power conductor and ground, but also between different power conductors. CE standards, in accordance with tradition, control rfi measured between each current carrying conductor and ground (power system reference).

1.2 MODE-SPECIFIC CONDUCTED EMISSIONS

Conducted emissions flow in the paths shown in Figures 2 and 3. Figure 4 shows composite emissions (measured at LISN ports). Total rfi potentials measured at phase and neutral LISN ports are vector sums and differences of cm and dm CE, respectively.

In contrast, Figure 5 shows that an emission generating test sample connected to a single LISN inserted be-

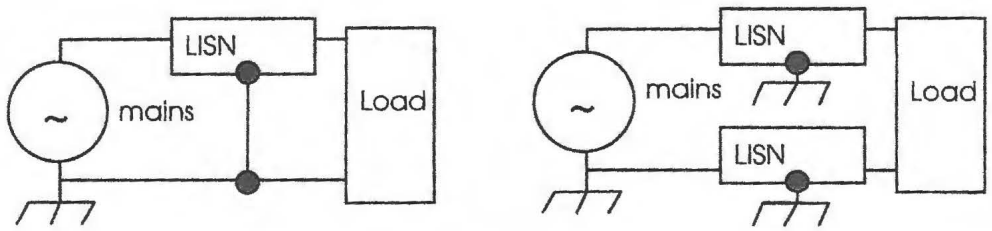


Figure 1: LISN placement and grounding, early (left) and present (right)

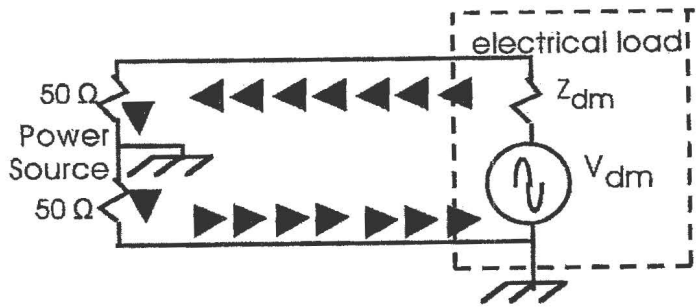


Figure 2: DM CE current

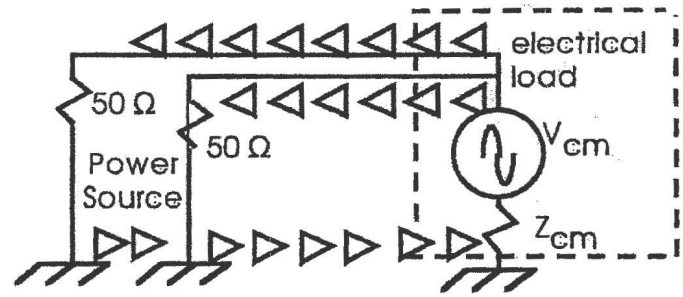


Figure 3: CM CE current

tween phase and neutral can only generate an emission potential between that same phase and neutral. It has but one CE degree of freedom, even though two separate noise sources still exist. Figure 4 is the modern practice, with a LISN connected between each current-carrying power conductor and power system reference. Two CE noise potentials are possible, line-to-ground, and line-to-line (i.e., two CE degrees of freedom). Note that:

1) Measured CE are a linear combination of two independent kinds of CE: line-to-ground, or common mode, and line-to-line, or differential mode.
2) Commercial radio receivers are provided only phase/neutral (no safety ground) power wiring, disabling any technique providing line-to-ground filter protection.

While present CE standards and test methods are *sufficient* to provide EMC in most cases, the above two observations led the author to question whether present standards and test methods are *completely necessary* to provide for EMC, or whether it might be important to consider radio CE susceptibility by modes when specifying control of conducted emissions. Tools exist to separate modes. Topetto, Nave and Paul realized that filter design to meet CE limits is optimized by designing to separately control each emission mode. Since compliance measurement techniques do not provide mode-specific CE data, attempts were made to invent circuits which can provide this information. Nave invented both differential and common mode rejection networks (DMRN/CMRN) and marketed them under the trade names LISNMATE/LISNMARK, respectively. Each network attenuates the unwanted mode by 50 dB.

1.3 EARLY CE CONTROL

Original CE control was based on radio and television local oscillator emanations as well as induction cooking ranges operating in the AM radio band. These were the only sources of AM band rf energy, hence CE control was imposed only on these products. Such control was exerted via use of two 5 µH LISNs, inserted in phase and neutral conductors, with ground reference. Frequency range extended from 300 kHz to 30 MHz.

In the late 1970s, a new source of rfi appeared: office/information technology equipment which utilized electrical switching techniques. Fourier spectra of such switching extended into radio bands. The Computer and Business Equipment Manufacturers' Association (CBEMA) initiated a program to quantify and recommend solutions. Results were documented in the CBEMA ESC5 report.

Victim radios were powered through a common impedance with culprit emitters (office/information technology equipment) and thresholds of interference (TOI) were established. These thresholds of interference were massaged into limits. Figure 6 shows the test set-up used to determine susceptibility of radio receivers to CW and pulsed CE. Victims were a selection of AM radios bought at typical consumer outlets. Common source impedance chosen was the traditional 5 µH LISN. Culprits were simulated by CW and pulse generators of 50 Ω source impedance, driving adjust-

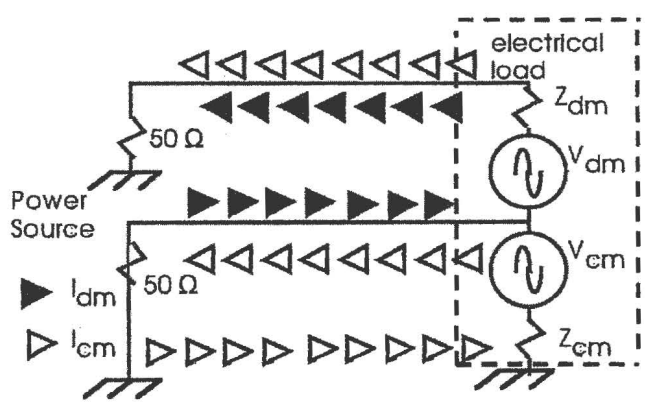


Figure 4: Composite cm/dm current in two-conductor above-ground power bus

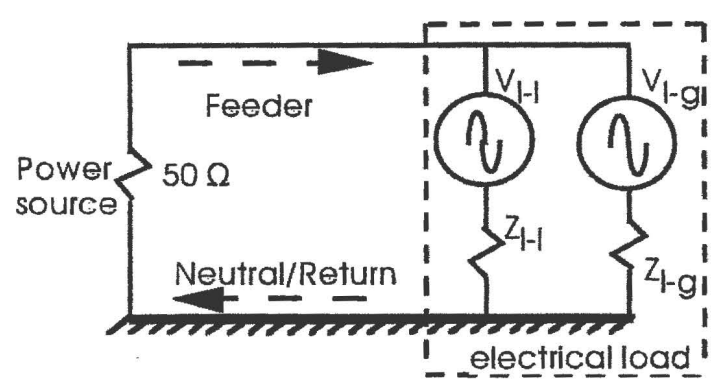


Figure 5: RFI noise sources with single power conductor above ground

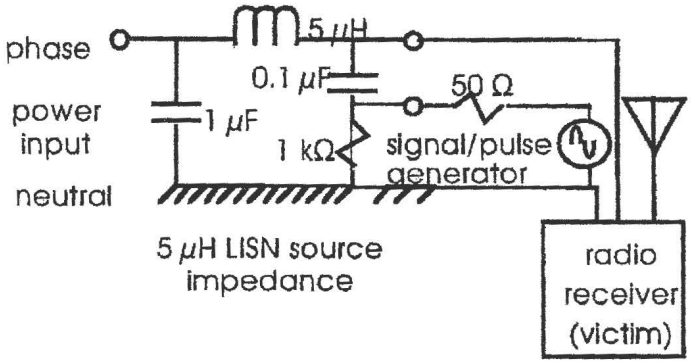


Figure 6: Limit determination for office equipment CE

able signal levels into the LISN port. TOIs thus determined were the basis for FCC limits.

In contrast to the TOI measurement technique, CBEMA recommended CE measurement techniques similar to the earlier Part 18 CE test set-up. The CBEMA report recommends a compliance technique utilizing a 50 μH, 50 Ω LISN in each current carrying power conductor. The report explicitly addresses the effect on radio TOI due to a second source of CE available when power bus configuration supplies an above-ground neutral. The CBEMA report assumes that the conducted voltage at which TOI occurs would decrease 6 dB, due to twice the amount of CE available with this measurement technique[1].

1.4 STUDY PURPOSE AND SCOPE

This last assumption was studied and is challenged by the author. It appears reasonable as long as the second source of rfi is held to be identical to the first. Equation set 1 models the CBEMA assumption.

$$\text{TOI single LISN (dB}\mu\text{V)} \sim V_{measured} \qquad \text{Eq. 1-1}$$

$$\text{TOI two LISN (dB}\mu\text{V)} \sim \frac{1}{2} \cdot V_{measured} \qquad \text{Eq. 1-2}$$

However, the two-LISN technique measures two different types of CE, cm and dm. What is measured at each LISN port is a linear combination of these two noise components. An accurate mathematical analogy is that cm and dm noise components are two basis sets which together span the space of measurable line-to-ground CE. Equation set 2 models the author's assumption.

$$\text{LISN 1 (dB}\mu\text{V)} \sim (V_{cm} + V_{dm}) \qquad \text{Eq. 2-1}$$

$$\text{LISN 2 (dB}\mu\text{V)} \sim (V_{cm} - V_{dm}) \qquad \text{Eq. 2-2}$$

$$\text{TOI}_{\text{author's model}} \text{ (dB}\mu\text{V)} \sim (\alpha V_{cm} + \beta V_{dm}) \qquad \text{Eq. 2-3}$$

With the model of 2-3, the CBEMA assumption is only valid if $\alpha \approx \beta$. If this is not the case, as the author suspected, then it makes sense to control CE by modes, with the degree of strictness proportional to the ratio of α to β (i.e., cm to dm susceptibility).

Over 30 radios were tested. They varied greatly in price, performance, and purpose. What all 30 radios had in common were a linear power supply and a two wire (phase and neutral, no green or safety wire) ac power input. These two common characteristics impact performance (vis a vis power line rf noise) as follows.

Linear power supplies draw 60 Hz and/or 120 Hz current waveform. Since ac power source impedance is very low, there is no need to provide local dm low impedance energy storage, as for an SMPS. Filtering consists of enough capacity on power supply secondary to prevent objectionable 60/120 Hz ripple from entering audio stage. This type of filtering can be performed with electrolytics, which are poor filters at radio frequencies. Inspection of the tested radios revealed not a single case of rfi-specific filtering.

Lack of a case ground obviates any attempt at line-to-ground filtering — which is effective against cm CE. This single factor is the clue that radios might be expected to be more susceptible to cm than dm CE. Although dm filtering is only that residual level obtained fortuitously from ripple filters, it at least exists.

These comments are not a condemnation of present practices. In particular, cm filtering would be problematical even with a case ground. Some radios utilize their power cord as an FM antenna rather than provide a collapsible rod or antenna port (alarm clock types). Effective filtering of AM band rfi while passing FM signals is not economical in such inexpensive devices.

A full report (see References) describes a well- controlled test, including test set-up and procedures for empirically determining the $\frac{\alpha}{\beta}$ ratio. This portion is only summarized briefly herein. The last part of the full report demonstrates benefits resulting from CE control by modes.

2.0 CHARACTERIZING RADIO SUSCEPTIBILITY TO CM AND DM CE

TOI is measured under controlled conditions, with noise injection mode the only variation. Several parameters are controlled to assure test validity. Parameters requiring control and control implementation, as well as detailed test procedures, are described in the referenced report. Figure 7 is a schematic of the test set-up. A device dubbed SMIN (selectable mode noise injection network) generated pure cm and dm signals. It consisted of a Y-splitter and transformer, with a switch changing the sense of the transformer windings. This device provided over 46 dB of alternate mode rejection in the AM band.

3.0 TEST RESULTS

3.1 Threshold of Interference Survey Results

Figure 8 portrays raw TOI measurements for all radios tested. A fairly consistent differential is evident between cm and dm TOI. In general, cm TOI is slightly below

[1] CBEMA, 1977, ESC5 Report, paragraph 5.6.2, p. 5-24, 5-25

CBEMA TOI[2]. The Figure 8 data supports the study conclusion but is not overly instructive. A normalization is enlightening. Original CBEMA ESC5 testing likely resulted in a similar scatter plot, but a single limit of 48 dBμV was derived.[3] If the Figure 8 CBEMA test results are normalized to 48 dBμV, and a normalization factor for each radio is then applied to both cm and dm TOI, Figure 9 emerges. Scatter reduction in Figure 9 allows for mode-unique limit setting by statistical methods. Figure 9 is rather busy; Figure 10 shows statistically derived means and standard deviations vs. FCC/CISPR limits as a function of frequency in the AM band.[4] Figure 10 demonstrates two important conclusions. First, dm CE limits can be easily set near 70 dBμV, a relaxation of 22/14 dB relative to FCC/CISPR Class B limits, respectively. Also, not only is there more than a 20 dB difference between mean cm and dm TOI, but there exists more than a 10 dB difference between one standard deviation below the dm mean, and one standard deviation above the cm mean. Mode-specific TOI differences are statistically significant.

3.1.1 OTHER ISSUES

The above analysis compares measured CBEMA TOI and uses individual differences from 48 dBμV to adjust cm and dm TOI. This raises questions of linearity of TOI with changes in broadcast/rfi level. Testing demonstrated a high degree of linearity (see Figures 11 and 12) over a 50 dB change in radio input signal level.

Another factor requiring control as a source of error is any effect on TOI due to tuned frequency. Most, but not all radios in Figure 8 were tested at a mid-band frequency near 1 MHz. To quantify the effect, if any, of tuned frequency on TOI, several radios had their (cm and dm) TOIs measured at three frequencies, low-,

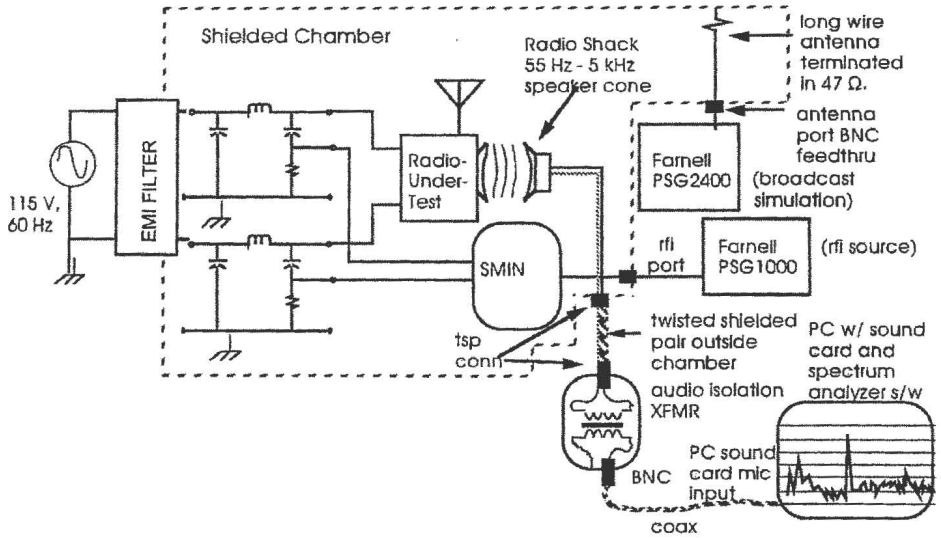


Figure 7: Radio TOI determination test set-up

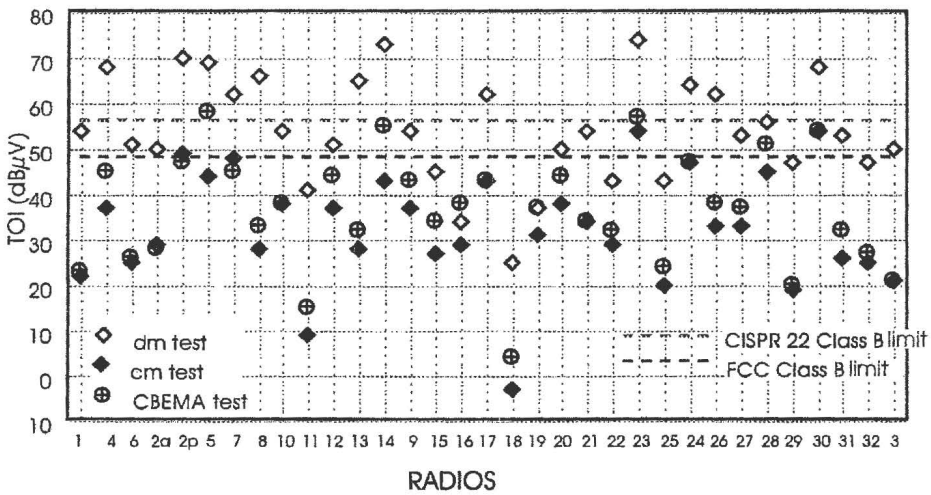


Figure 8: TOI of AM radios with broadcast reception at 10 dB $\frac{s+n}{n}$

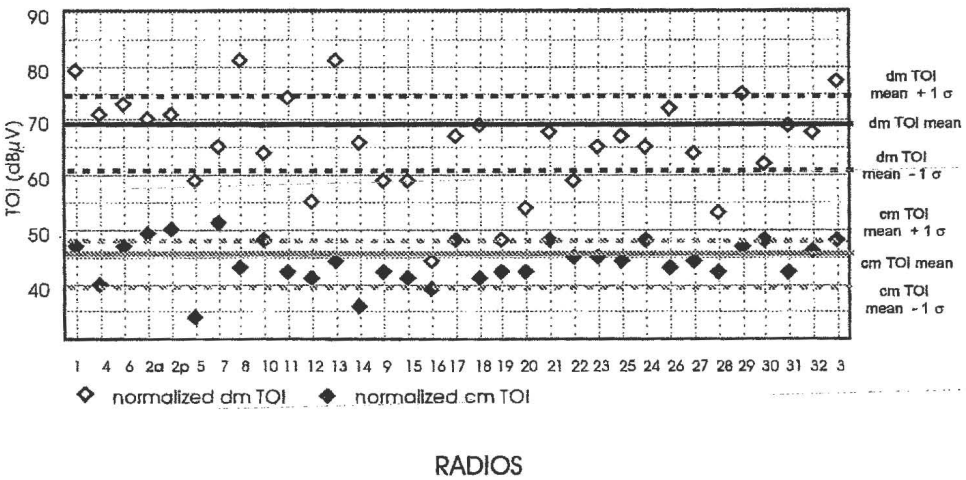


Figure 9: TOIs of Figure 8 with CBEMA TOI normalized to 48 dBμV

[2] CBEMA TOI is that measured per the original CBEMA investigation, using one LISN.

[3] Author's conjecture; CBEMA ESC5 report does not include such test data.

[4] One (European model) radio operating below 530kHz was tested. Its LW band performance was identical to its MW performance, which was comparable with other radios tested.

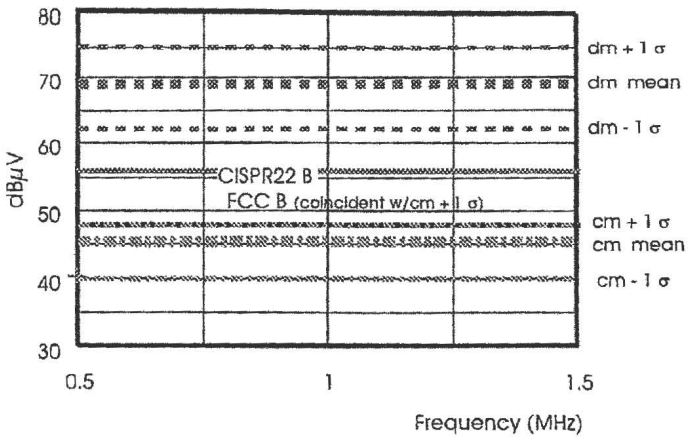


Figure 10: Statistical means/standard deviations vs. commercial CE limits

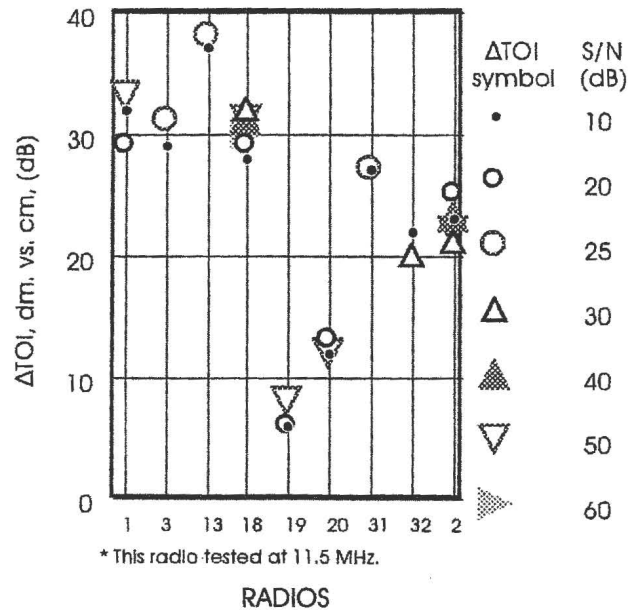


Figure 11: CM/DM TOI ratio linearity vs. received signal strength

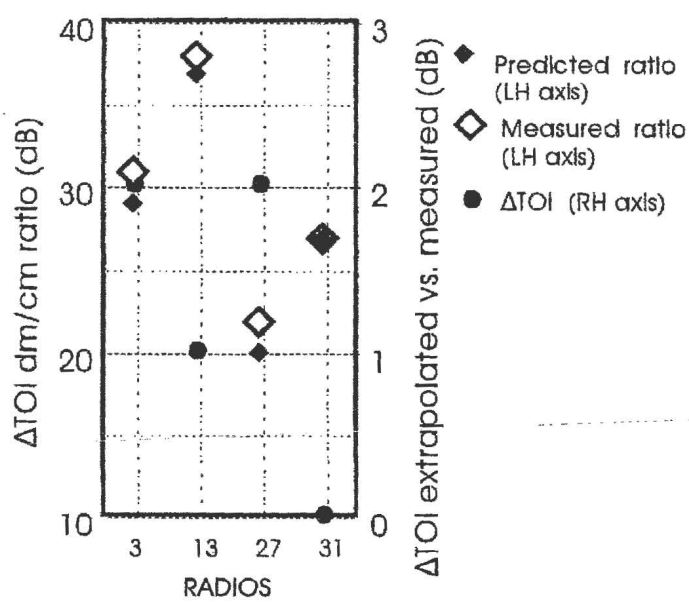


Figure 12: Predicted vs. measured dm/cm ΔTOI

mid-, high-band (Figure 13). Effect of tuned frequency is random, and does not affect test validity or conclusion.

Testing using a broadband noise source (low repetition pulsed) showed the same 20 dB disparity in response to dm vs. cm power-line conducted noise.

4.0 RAMIFICATIONS OF CE CONTROL BY MODES: DECREASED COST OF RFI FILTER

As stated in the introductory paragraphs, present day CE control has proved *sufficient* to protect AM band receivers. The issue raised in this article is whether present CE control is *totally necessary*. Results presented in Section 3 argue for relaxation of dm CE limits, while maintaining cm control at levels presently levied by the FCC. However, the value of such "tinkering" with present limits and methods of control has yet to be demonstrated. Admittedly, new mode-specific CE control complicates compliance testing; a payoff in less costly filter design must more than offset this complication.

It is more complicated and expensive to filter dm emissions than cm for an off-line supply. *Therefore, if for cost reduction purposes one were to pick a single CE mode for limit relaxation, the mode selected would be differential. Fortunately, in preceding sections, it is precisely that mode's limit which was found suitable for relaxation.*

It has been estimated that on a global scale, the PC industry could save $35 million annually by relaxing the dm limit to 68 dBμV, while maintaining the cm limit at the present 48 dBμV[5].

5.0 CONCLUSION/RECOMMENDATION

Response of over thirty radio receivers to power-line conducted noise was evaluated as to their susceptibility to common and differential mode noise.

Radios are much more susceptible to common mode than to differential mode noise. 20 dB differences between these responses strongly suggest the efficacy of procedures and limits which separately control cm and dm conducted emissions.

This work suggests that new standards be adopted which reflect real radio rfi susceptibility. Such regulatory action would decrease the cost of EMC compliance, with benefits resulting to both electronics manufacturers and consumers.

5.1 ACKNOWLEDGEMENTS

The author expresses gratitude to the following engineers for their invaluable assistance: Mr. Mark Nave of EMC Services designed the selectable mode rejection network (SMIN) per the author's specification. The SMIN was at the very heart of the test method. Mr. Nave also offered many helpful suggestions over the course of the study. Mr. Charles Grasso of Storage-Tek and Mr. Vincent Greb of

[5] This is an unofficial estimate by a major U. S. PC manufacturer.

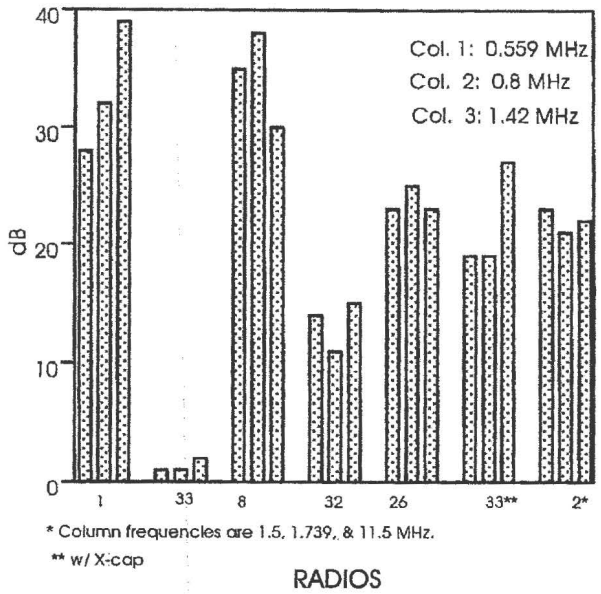
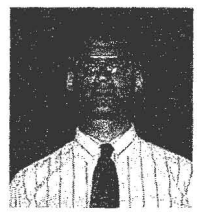


Figure 13: Cm/dm ΔTOI variation vs. radio tuned frequency

EMC Integrity provided insight into rf filter design cost factors. Mr. Duane Driver assisted with test fixture design/build and in running radio TOI tests.

6.0 REFERENCES

Javor, Ken. *"Investigation Into the Susceptibility of Radio Receivers to Power-Line Conducted Noise"* EMC Compliance, P.O. Box 14161, Huntsville, AL, 1998.



Ken Javor is founder of EMC Compliance in Huntsville, AL, and author of "Introduction to the Control of Electromagnetic Interference, A Guide to Understanding, Applying, and Tailoring EMI Limits and Test Methods" (1993). He can be reached during working hours at Sverdrup Technology, Inc., (256) 971-9527. His e-mail address is ken.javor@hsv.sverdrup.com.

Comment on Bennett's "Normalized Site Attenuation and Test Site Validation" [1]

by Zhong Chen and Tim Harrington

ANSI C63.4 NSA is based on the derivation in [2], where the E_D^{max} concept was introduced. E_D^{max} is the maximum electric field in $d^B\mu V/m$ over the height scan of a half-wave dipole receive antenna from 1 pW of transmitted power. The subsequent NSA derivation is based on a point dipole with a sinusoidal pattern in the plane containing the dipole, and an isotropic pattern in the perpendicular plane. In fact, when a sinusoid radiation pattern is included in the vertical polarization equation of [1], the original C63.4 NSA equation is obtained.

In [1], the vertical polarization direct and reflected magnetic fields are

$$H_d(t) = \frac{|H_1|}{d}\cos(\omega t),$$

$$H_r(t) = \rho_H \frac{|H_1|}{r}\cos(\omega(t-(r-d)/c)),$$

With the point dipole vertical radiation pattern, these become

$$H_d(t) = \frac{|H_1|}{d}\cos(\omega t)F(\Theta_1)\sin(\theta_1),$$

$$H_r(t) = \rho_H \frac{|H_1|}{r}\cos(\omega(t-(r-d)/c))F(\Theta_2)\sin(\theta_2),$$

where the notation of [2] is used with the directivity pattern of an electrically short dipole, and , account for the angular dependence of the non-isotropic pattern. By simple trigonometry, $\sin(\theta_1) = h/d$, and $\sin(\theta_2) = h/r$. Thus,

$$H_d(t) = \frac{|H_1|h^2}{d^3}\cos(\omega t),$$

$$H_r(t) = \rho_H \frac{|H_1|h^2}{r^3}\cos(\omega(t-(r-d)/c)).$$

The total H field at the observation point is then given by

$$H_{obs}(t) = |H_1|[\frac{h^2}{d^3}\cos(\omega t) + \rho_H \frac{h^2}{r^3}\cos(\omega(t-(r-d)/c))],$$

The magnitude of $H_{obs}(t)$ is given by

$$|H_{obs}| = |H_1|h^2\sqrt{\frac{1}{d^6} + \rho_H \frac{2}{d^3r^3}\cos(2\pi(r-d)/\lambda)) + \frac{1}{r^6}}.$$

Using ρ_H=1 for H-field reflection coefficient, the power density attenuation from source to receiving antenna is

$$\frac{|H_1|^2}{|H_{obs}|^2} = \frac{1}{h^2\sqrt{\frac{1}{d^6} + \frac{2}{d^3r^3}\cos(2\pi(r-d)/\lambda)) + \frac{1}{r^6}}} = \frac{d^3r^3}{h^2\sqrt{r^6 + 2d^3r^3\cos(2\pi(r-d)/\lambda)) + d^6}},$$

and multiplying by $(\frac{R_c\lambda}{Z_0})^2$ yields the NSA. This agrees with the results of ANSI C63.4.

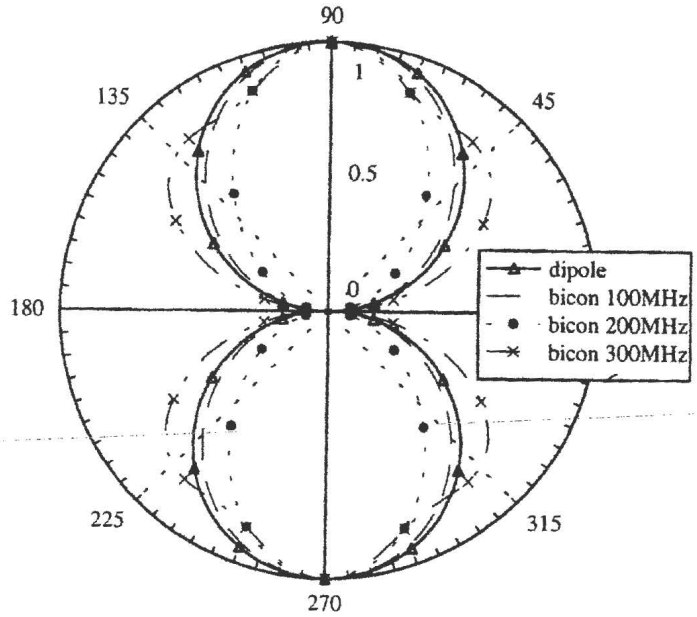


Figure 1. Numerically modeled (MoM) radiation pattern of a biconical antenna compared with a point dipole pattern.

An additional question is which is more accurate for simulating a real measurement situation with a typical EMC antenna: the point dipole or an isotropic source radiation pattern? For most EMC antennas, such as biconical or log-periodic dipole array antennas, [2] shows relatively good agreement between theory and measurements using the dipole pattern. It is clear that a vertical dipole pattern approximates the pattern of a low gain antenna better than does an isotropic source. Thus the results in C63.4 are likely to have smaller errors. However, this does not mean the NSA formulation in [2] and C63.4 does not contain errors. In fact, Figure 1 (from [3]) shows that a typical biconical (dimension defined by MIL-STD-461-1964) radiation pattern can deviate from a dipole pattern significantly when the biconical antenna becomes electrically large.

The C63.4 NSA formulation is a very simplified theoretical approach. In addition to the radiation pattern errors, the presence of a ground plane strongly affects antenna performance [3]. Although [2] and C63.4 include considerations of mutual coupling between transmit and receive antennas (and their images) for half-wave tuned dipoles, corrections for broadband antennas are not included but are needed.

[1] W. S. Bennett, "Normalized site attenuation and test site validation," *IEEE EMC Society Newsletter*, no. 178, pp. 10-12, Summer 1998.

[2] A. A. Smith, R. F. German, and J. B. Pate, "Calculation of site attenuation from antenna factors," *IEEE Trans. Electromag. Compat.*, vol. EMC-24, no. 3, pp. 301-316, Aug. 1982.

[3] Z. Chen, and M. Foegelle, "A numerical investigation of ground plane effects on biconical antenna factor," *IEEE Intl. Symp. EMC*, Denver, CO, 1998.

Zhong Chen and Tim Harrington are both with EMC Test Systems in Austin, Texas. They can be reached at (800) 253-3761 or via e-mail at zhong.chen@emctest.com or tim.harrington@emctest.com.

NOTICE: Constitution And Bylaws Changes

The EMC Society Board of Directors, at its November 1998 meeting, approved several editorial and clarification changes to both the Constitution and the Bylaws.

1. In Constitution Article V, Section 6, the word "insure" was changed to "ensure".
2. In Constitution Article VII, Section 1, the word "international" was added in the first sentence and in the second sentence "national" was changed to "international".
3. Bylaws clause 2.6 was rewritten to improve the grammar. The content was not changed. The modified clause reads as follows: "Special Membership: Retired members, those who are unemployed due to involuntary termination of employment and who are seeking reemployment, and those whose annual income falls below the minimum income level in his/her region may become special members with special reduced fees as described in IEEE Bylaw 109."
4. In Bylaws clause 9.1, the sentence "The last meeting of the calendar year shall be the "annual meeting of the Board of Directors" was added to the first paragraph.
5. In Bylaws clause 9.1, the words "or by electronic means" were added in the second paragraph after the words "or by mail".
6. In Bylaws clause 9.2, the second sentence ("The symposium shall be held, when at all possible, in the fall of the year.") was deleted in its entirety.

The changes to the Bylaws will become effective 30 days following publication of this notice.

The Constitutional changes will become effective 30 days after publication of this notice unless ten percent of the Society members object within that period. Objections must be in writing and sent to the Society Secretary. (Janet O'Neil, Lindgren RF Enclosures, Inc., 22117 NE 10th Place, Redmond, WA 98053.)

Inter-Society Activities: RAC Report

David A. Case NCE
Chairman

The Representative Advisory Committee (RAC) will host a special session at the 1999 IEEE International Symposium on Electromagnetic Compatibility in Seattle, Washington. In response to the increased use of wireless devices, the session will be geared for those with interest in the requirements for Radio Type Approval and EMC requirements.

The special session is entitled "EMC and Type Approval for Wireless Devices." This session will address US and some international regulatory requirements for wireless devices such as cell phones, wireless LAN and PCS devices. Invited speakers for this session include Greg Czumak of the FCC Labs in Columbia, Maryland and Steve Dillingham of RFI Labs in the UK. Look for the session in your Seattle Symposium Advance Program or visit the Symposium web page at www.seattleemc99.org for the complete listing of the technical program. Then, mark the session's date and time in your calendar and plan to attend.

RAC is formulating plans to offer and sponsor this exact same session at next year's Wireless Symposium which will be held in late February 2000 on the West Coast (exact date and location still pending). It is RAC's intention to participate in this event so that the EMC Society can share its knowledge on this topic while learning from others. This exchange of information on EMC between related entities is what RAC is all about!

EMC Society Membership In The IEEE Intelligent Transportation Systems (ITS) Technical Council

Andy Drozd
EMC Society Senior Representative on the ITS Technical Council

New Year's Day marked the birth of the IEEE's newest entity dedicated to studying technical issues and solving sophisticated problems on a global scale associated with the Intelligent Transportation Systems (ITS) initiative. The Technical Activities Board (TAB) of the 320,000+ IEEE members voted to transform the TAB Ad Hoc Committee on ITS into a permanent entity, the new ITS Council, which officially began operations as of 1 January 1999.

The EMC Society is one of a number of other IEEE societies that joined the Ad Hoc Committee in 1997 and continued on during the committee's recent transition to technical council status. To provide some background on what the ITS Council is all about and the EMC Society's role, submitted for your approval below is an excerpt of a recently issued press release announcing the establishment of the IEEE ITS Council. This is followed by a brief overview of our participation in the ITS Council.

The ITS Council press release was sent to all IEEE transactions and newsletter editors, and to the editors of leading ITS-related publications such as Inside ITS, ITS World, The Intelligent Highway, ITS America News, ITS International, ICDN Newsletter, GPS World, Traffic Technology International, etc. The excerpt is as follows:

"The ITS Council joins the ranks of 37 other societies and councils within IEEE. The purpose of the Council is to advance and coordinate scientific, literary and educational work in the field of ITS throughout IEEE and the larger ITS community. The ITS Council's field of interest includes the theoretical, experimental and operational aspects of electrical and electronics engineering and information technologies as applied to all intelligent transportation efforts.

Membership. Eighteen societies with interests in the field of ITS are already members of the ITS Council. That's more than half the total number of IEEE Societies. The ITS Council's founding members include the following:

Aerospace & Electronic Systems
Antennas & Propagation
Communications
Computer
Consumer Electronics
Control Systems
Electromagnetic Compatibility
Electron Devices
Industrial Electronics
Instrumentation & Measurement
Microwave Theory & Techniques
Power Electronics
Professional Communication
Reliability
Robotics & Automation
Signal Processing
Systems, Man & Cybernetics
Vehicular Technology

Each member society appoints two representatives to the Council. The society representatives bring a broad spectrum of backgrounds from large corporations, consulting firms, academia, and trade associations.

Conferences. The Council continues a series of IEEE ITS conferences that was launched with ITSC '97. Held November 1997 in Boston, the first conference drew close to 500 engineers from corporations and governments around the world. The focus of this and future ITSC conferences is on cutting-edge electronics technologies and their applications for ITS. Tokyo is the site of the next ITSC conference in October 1999. Plans for ITSC 2000 in Detroit are also well along.

The ITS Council will be governed by a president, vice president, secretary and treasurer elected annually by the society representatives. In the transitional year (1999), the officers are:

President: Dr. Umit Ozguner, Ohio State University
Vice President: Dr. Ichiro Masaki
Secretary: Ms. Emily Sopensky, The Iris Company
Treasurer: Dr. Richard Klafter, Temple University

Publications. The first issue of the ITS Council's quarterly journal, IEEE Transactions on Intelligent Transportation Systems, is scheduled for March 2000. Dr. Chelsea C. White, III, Director of the ITS Research Center of Excellence at the University of Michigan, is slated to become Editor of the Transactions. White was the first chair of the predecessor IEEE ITS Ad Hoc Committee when it was organized in 1993. A call for papers will be posted at the Council's website: www.ewh.ieee.org/tc/its.

An electronic newsletter for the TAB ITS Council is planned to start soon with Dr. Alberto Broggi (University of Pavia, Italy) as editor."

And now, a little about our involvement as a member society. First, there are two individuals who collectively represent the EMC Society and are able to vote on ITS matters brought before the council. These are J. L. Norman Violette and yours truly. In particular, our responsibilities and contributions are concerned with:

- Standards development
- Affecting technology insertion, measurement, safety, and modeling & simulation issues
- Contributing solutions to technology integration impacts and related logistical issues
- Reconciling the various society-infrastructure and EMC aspects of ITS
- Influencing the overall ITS technology, and policies and procedures related to the execution of ITS Council-related activities for the mutual benefit of the EMC Society, the ITS Council, and the overall ITS initiative(s).

The EMC Society looks forward to a long and meaningful association with the ITS Council in the coming years. The council and its activities allow the EMC Society to play a major technical and policy role in virtually all ITS technologies and applications as they pertain to EMC on a broad, international scale. We hope to positively shape the overall direction of the council, and to help solve some challenging technical problems along the way.

I will periodically report on the progress of this activity to the membership.

If you have any questions or comments in the meantime, please contact me at (315) 337-4396 or via email at andro1@aol.com.

Contributor's Note: Many thanks to Robert L. French, IEEE ITS Council Publicity Chair, for supplying much of the background material contained in this article.

In Memorial

Herb Zajac

Herb Zajac passed away in November 1998 after a brief battle with cancer. He was an electromagnetic compatibility engineer throughout his professional career. He became intrigued with RF while serving in the military. He earned his BSEE degree and began his career at Sprague Electronics. He was largely responsible for the growth of the RF shielded room business and the shielding effectiveness discipline. He worked at Litton Industries prior to spending a good part of his career at Tektronix, Inc in Portland, Oregon. Herb was hired at Tektronix in the mid 70s as their EMC laboratory manager. While his managerial responsibilities increased to include environmental and product safety aspects of product compliance, he was always an EMC engineer at heart. After a 15 year career at Tektronix, Herb continued work in the EMC field at Electromagnetic Engineering, Hamilton Engineering, and Boeing in Seattle, Washington. He was last employed at Lockheed-Martin in Georgia.

Herb was elected to the IEEE Electromagnetic Compatibility Society Board of Directors in 1996. He served as Public Relations Director. Herb will be missed by the EMC community and friends.

Award Nominations Requested!

It's time to start thinking about nominations for awards to be presented at the Awards Luncheon held at the 1999 IEEE International Symposium on Electromagnetic Compatibility, August 2-6, 1999 in Seattle, Washington.

Consider nominating a fellow co-worker or others whose IEEE volunteer work deserves recognition! Visit the EMC Society web page at www.emcs.org to see the list of award categories and past recipients.

Nominations must be submitted by May 1, 1999 to Henry Benitez, Awards Chairman, at phone 503-627-1217 or e-mail at henry.w.benitez@tek.com

IEEE EMC Society President's Memorial Award

Nominations are invited for a worthy student who qualifies for the IEEE EMC Society President's Memorial Award. This award was established in 1992 to link the Society's past, present, and future. The award is given in honor of a deceased, eminent member of the EMC Society through scholarship support for graduate study.

The award is a $1000 scholarship and a certificate. In addition, the award winner will be reimbursed for reasonable travel expenses, not to exceed $1000, to receive the award in person at the annual IEEE EMC Symposium August 2-6, 1999 in Seattle, Washington.

Each eligible candidate must be an active Student or higher grade Member of the IEEE EMC Society. The candidate must also be enrolled in or be formally accepted for full-time study pursuing an M.S. or Ph.D. degree, with a demonstrated commitment to the field of EMC.

Each candidate must be endorsed by at least three (3) individuals (two EMC Society members and one previous or present college instructor) who can address the candidate's technical proficiency and career intentions.

Prioritized criteria are commitment to EMC followed by technical excellence.

The deadline for award nominations is May 1, 1999.

Nominations should be sent to:

Todd Hubing
Vice-President - Member Services, EMCS
120 Emerson Electric Hall
University of Missouri-Rolla
Rolla, MO 65401
Phone: (573) 341-6069
Fax: (573) 341-4532
E-mail: t.hubing@ieee.org

The EMC Society encourages contributions to the President's Memorial Award fund from industry, private and corporate, for future scholarships.

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Warren Kesselman
Treasurer, EMCS
31 Hope Road
Tinton Falls, NJ 07724-3009
Phone: (732) 842 3207
Fax: (732) 530 9710
E-mail: w.kesselman@ieee.org

For more information on this and all of the EMC Society's awards, visit the EMC Society's web page at http://www.emcs.org.

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DISTINGUISHED LECTURERS

J Perini (12/98)
T Ritenour (12/98)
E Joffe (12/99)
M Mardiguian (12/99)
M Montrose (12/99)

The IEEE EMC Society Chapters and Chapter Chairs

January 1999 Directory

ALBUQUERQUE
Joint AP/MTT
Term: 1-1-96, 12-31-96
Donald McLemore
(505) 889-7009
email: mclemore-abq1@kaman.com
ANGEL: Bill McGinnis

ATLANTA
Joint IM
Term: 8-13-95, ?
Bruce Crain
1250 Rockcrest Drive
Marietta, GA 30062
(770) 494-7411 (work)
(770) 494-3182(fax)
email: brcrain@mar.lmco.com
ANGEL: Ghery Pettit

AUSTRIA
Term:
Dr Dipl Ing Heinrich Garn
Austrian Research Center
Seibersdorf
Forschungszentrum Seibersdorf
A-2444 Seibersdorf Austria
43 2254 780 2800
43 2254 74060 (fax)
ANGEL: Ferdy Mayer

BALTIMORE
Term: 7-1-98, 6-30-99
Ted Harwood
185 Admiral Cochrane Drive
Annapolis, MD 21401
410-573-7365 - work
410-573-7344 - fax
harwoodt@jsc.com
ANGEL: Dick Ford

BEIJING
Term: 11-1-92, 12-31-95
Gao, You-gang
Beijing University
Ports & Telecommunications
Beijing 100088 China
2013388-2451 (work)
(8610) 62281774 (fax)
E-Mail: faoffice@bupt.edu.cn
ANGEL: Gene Cory

BOSTON (CNEC)
Term: 6/98, 6/99
John Clarke
24 Althea Drive
Yarmouthport, MA 02675
508 362-7195 - phone
jclarke805@aol.com
ANGEL: Joe Butler

CENTRAL TEXAS
9/1/98 - 8/31/99
Eric Lifsey
National Instruments
Tel: 512-683-8474
Fax: 512-683-8641
e-mail: eric.lifsey@natinst.com
Angel: Bill McGinnis

CHICAGO
Term: 4-1-98, 4-1-99
Derek N. Walton
12790 Route 76,
Poplar Grove, IL 61065
815 547 3467 - Home
815 637 3729 - Work
email: lfresearch@aol.com
ANGEL: Bob Hofmann

DALLAS/FORT WORTH
Term: 6-30-97, 6-30-99
Mark E. Bushnell
2814 Capella Circle
Garland, TX 75044-6228
Office: 903.457.6375
Fax: 903.457.7640
email: M.Bushnell@ieee.org
ANGEL: Bill McGinnis

FRANCE
Term: 1-1-92, 12-31-93
Prof Ferdy Mayer
President LEAD
12 avenue de la Republique
94700 Maisons-Alfort
France
1-49-77-9400 (phone)
1-49-77-9813 (fax)
ANGEL: Ferdy Mayer

GERMANY
Term: 11-1-97; 10/31/00
Prof. Dr. Ing. Heyno Garbe
University of Hannover
Appelstrasse 9 A
D-30167 Hannover Germany
(05 11) 7 62-37 60 - phone
(05 11) 7 62-39 17 - fax
email: garbe@geml.uni-hannover.de
email: Heyno.Garbe@ieee.org
ANGEL: Ferdy Mayer

HOUSTON
Joint AP,MTT
Term: 1-1-91, 12-31-91
Jeff Williams
University of Houston
University Park
Dept of EE
Houston TX 77004
713-743-4455 (phone)
713-743-4444 (fax)
email: jwilliams@uh.edu
ANGEL: Bill McGinnis

ISRAEL
Term: 1-1-98, 12-31-98
Elya B. Joffe
KTM Project Eng., Ltd.
P. O. Box 264
KFAR Sava 94102, Israel
011-972-8-9272997 (work)
011-972-9-7657065 (home & fax)
011-972-8-9272524 (fax)
email: ebj@netvision.net.il
ANGEL: Ghery Pettit

ITALY (Central and South Italy)
Term: 11/1/97-10/31/98
Salvatore Celozzi
Electrical Eng. Dept.
University of Rome "La Sapienza"
via Eudossiana, 18
00184 Rome Italy
tel: +396 44585520
fax: +396 4883235
e-mail:celozzi@elettrica.ing.uniroma1.it
ANGEL: Ghery Pettit

LONG ISLAND/NEW YORK
Term: 6-30-92, 12-31-96
Bob Berkovits
P.O. Box 496
Huntington NY 11743-0496
516-346-7782 (work)
516-346-7823 (fax)
516-754-4095 (home)
ANGEL: Ghery Pettit

LOS ANGELES
Term: 9-1-93, 12-31-99
Ray Adams Hughes Space &
Communciations
P.O. Box 92919
Los Angeles, CA 90009
Mail Station: SC/S25/C372
Phone: 310.662.7878
Fax: 310.416.3088
rkadams@mail.hac.com
ANGEL: Ghery Pettit

MOHAWK VALLEY
Term: 12-31-97, 12-31-99
Andrew L. Drozd
Andro Consulting services
P.O. Box 543
Rome, New York 13442-0543
(315) 337-4396 - Work
(315) 337-4396 - Fax
andro1@aol.com
ANGEL: Ghery Pettit

MONTREAL
Term: 9-1-97, 8-31-99
Benoit Nadeau
Matrox
1055, boul. St-Regis
Dorval, Quebec, Canada H9P 2T4
(514) 822-6000 ext. 2475 - phone
(514) 822-6275 - fax
email: bnadeau@matrox.com
ANGEL: Ghery Pettit

NANJING Joint: AP/MTT
Term: 1-1-97, 12-31-98
Prof. Wen Xun Zhang
22-1001
2nd Suo-Jin-Cun
Nanjing Jiangs 210042
P.R. China
(86) 25 5414002 - Home
(86) 25 3792648 - Work
(86) 25 5414002 - Fax
email: wxzhang@seu.edu.cn
ANGEL: Ghery Pettit

NEW JERSEY COAST
Joint AP, VT
9-1-94; 9-31-96
Robert A Ziegler
Bellcore
331 Newman Springs Rd, MS 3Z-339
Red Bank NJ 07701
732-758-3057 (work)
732-758-4371 (fax)
email: zeigler@bellcore.com
ANGEL:Don Heirman

NORTHWEST FLORIDA
Term: 7-1-92, 6-30-97
Dr Maqsood A Mohd
4462 Parkwood Square
Niceville FL 32578
850-729-6115 (phone)
850-729-6377 (fax)
email: mohd@eglin.af.mil
ANGEL: Bill McGinnis

ORANGE COUNTY
Term: 8-1-98, 7-30-99
Randall Flinders
Emulex Corporation
3535 Harbor Blvd
Costa Mesa CA 92626-1437
714-513-8012 (phone)
714-513-8265 (fax)
email: r.flinders@ieee.org
ANGEL: Ghery Pettit

OREGON & S.W. WASHINGTON
Term: 8-1-96, 7-1-99
Henry Benitez
Tektronix, Inc.
M/S 19-045
13500 S. W. Karl Braun Dr.
Beaverton, OR 97077-0001
503-627-1217 (phone)
503-627-1311 (fax)
e-mail: henry.w.benitez@tek.com
ANGEL: Janet O'Neil

OTTAWA
Term: 12-10-97, 12-18-98
Pablo Garcia
NORTEL
PO Box 3511, Station C
Ottawa, Ontario Canada K1Y 4H7
(613)763-4959 (phone)
(613)763-8091 (fax)
email: p.garcia@ieee.org
ANGEL: Ghery Pettit

PHILADELPHIA
Term: 10-01-93, 10-01-94
Michael Daniele
CSC 1301 Virginia Drive
Suite 100
Fort Washington PA 19034
215-542-5409 (work)
215-283-2507 (fax)
email: Mdaniele@csc.com
ANGEL: Ghery Pettit

PHOENIX
Joint MTT, AP, ED, LEO
Term: 1-1-97; 12-31-97
Milt Crane
5201 N. Saddle Rock Dr.
Phoenix, AZ 85018
Home: 840-1171
Email: mcrane@imap2.asu.edu
ANGEL: Daryl Gerke

PIKES PEAK
Term: 10-10-96; 10-10-97
Jim Youngman
Omnipoint Corporation
1365 Garden of the Gods Road
Colorado Springs, CO 80907
phone: (719) 548 1201
email: j.a.youngman@ieee.org
ANGEL: Ghery Pettit

ROCKY MOUNTAIN
Term: 1-1-99; 12-31-99
Lyle Luttrell
Regulatory Agent/Component Engineer
Breece Hill Technologies
phone: 303-664-8286
fax: 303-449-1027
lluttrell@ieee.org
ANGEL: Henry Ott

SAN DIEGO
Term 1-1-97, 12-31-97
Dave Bernardin
TUV Product Service
10040 Mesa Rim Rd.
San Diego, CA 92121
(619) 546-3999 (work)
(619) 546 0364 (fax)
email: d.a.bernardin@ieee.org
ANGEL: Ghery Pettit

SANTA CLARA VALLEY
Term: 7-1-98, 6-30-99
Geoffrey Day
Lockheed-Martin
Phone: (408) 756-9919
FAX: (408) 756-6550
Email: geoff.day@lmco.com
ANGEL: Janet O'Neil

SEATTLE
Term: 7-1-98, 6-30-99
Ghery S. Pettit
Intel Corporation DP2-303
2800 Center Drive
DuPont, WA 98327
(253) 371-5515 (voice)
(253) 371-5690 (fax)
g.pettit@ieee.org
ANGEL: Leonard Carlson

SINGAPORE
Joint AP, MTT
Term: 1-6-93, 1-6-94
Prof Leong Mook Seung
EE Dept/ Nat'l University of Singapore
10 Kent Ridge Crescent
Singapore 0511
ANGEL: Ghery Pettit

SOUTHEASTERN MICHIGAN
Term: 1-1-96, 12-31-96
Dennis Barberi
1567 Eason
Waterford, MI 48328
810-825-8854 - Work
810-825-4013 - Fax
email: barberi@gdls.com
ANGEL: Kimball Williams

SOUTHERN MARYLAND
Term: 7-93, 12-94
Frederick W Heather
202 Bob's Court
Lexington Park MD 20653
301-737-0303 (work)
301-737-0305 (fax)
301-863-5782(home)
ANGEL: Bill Duff

SWEDEN
Term: 10-23-96, 10-23-97
Dag Bjorklof
SEMKO AB
P.O. Box 1103
S-164 22 Kista, Sweden
46-8-7500455 (work)
46-8-7500475 (fax)
ANGEL: Ferdy Mayer

SWITZERLAND
Term: 1-1-91, 12-31-93
W Zengle
Swiss Federal Institute of Technology
High Voltage Engineering Group
ETH Zentrum - CH
8092 Zurich Switzerland
41-1-256-2776 (phone)
41-1-261-5212 (fax)
ANGEL: Ferdy Mayer

TAIWAN
Term: 11-95, 12-31-96
Song-Tsuen Peng
National Chiao Tung University
Dept. of Comm. Eng.
1001 Ta Hsueh Road
Hsinchu 30050 Taiwan
ANGEL: Ghery Pettit

TOKYO
Term: 1-1-97, 12-31-97
Dr. Shuichi Nitta
Prof. Tokyo Univ. of Agri. & Tech.
2 24-16 Nakacho Koganei
Tokyo 184 JAPAN
+81-423-88-7096 (phone)
+81-423-27-6692 (fax)
ANGEL: Ghery Pettit

TORONTO, ONTARIO (CANADA)
Dr T Emilie Van Deventer
113 Annette St #303
Toronto Ontario M6P1N8
416-978-0803 (work)
416-978-7423 (fax) email:
Emilie@Waves.Toronot.EDU
ANGEL: Ghery Pettit

TWIN CITIES
Term: 1-1-98, 12-31-98
Roger Kuhn
3M
410 E. Fillmore Ave.
St. Paul, MN 55144
612-778-6279 (work)
612-778-6252 (fax)
rdkuhn1@mmm.com
ANGEL: Dan Hoolihan

UNITED KINGDOM & REPUBLIC OF IRELAND
Term: 11-92, 11-93
Martin Green
International Interference Technology
The Corner House
Stainswick Lane
Shrivenham, Swindon,
England SN6 8DX
44 793 782059 (work)
44 793 782059 (home)
44 1793 782 310 (fax)
ANGEL: Ferdy Mayer

WASHINGTON/NORTHERN VIRGINIA
Term: 7-1-97, 6-30-98
Lawrence Cohen
11521 Sullnick Way
Gaithersburg, MD 20878-1032
202-404-7726 - phone
ANGEL: Dick Ford

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(please send all corrections to Todd Hubing at t.hubing@ieee.org)

Arafiles, Virgilio (Vil)
9542 Westwood Drive
Ellicott City, MD 21042-3728
Work Phone: 301-688-6276
Home Phone: 410-465-0502
Fax: 301-688-0056
vparafiles@aol.com

Benitez, Henry
Tektronix, Inc.
M/S 19-045
13500 S. W. Karl Braun Dr.
Beaverton, OR 97077-0001
503-627-1217 (phone)
503-627-1311 (Fax)
henry.w.benitez@tek.com

Berger, H S (Steve)
Siemens Business Com.
2205 Grand Ave Pkwy
Austin TX 78728
512 990 6147 - Work
512 990 6335 - Fax
sberger822@aol.com

Bogusz, Michael
EMC/Radio Engineer
Wireless Networks Calgary
Northern Telecom Limited
2924 11th Street N.E.
Calgary, Alberta
T2E 7L7 Canada
Phone: (403) 232-4797
Fax: (403) 232-4813
e-mail: mike_bogusz@nt.com

Bronaugh, Edwin L
EdB EMC Consultants
10210 Prism Dr
Austin TX 78726-1364
512 258 6687 - Work
512 258 6982 - Fax
Edwin.Bronaugh@siemenscom.com

Brook, Robert H
9 Ruey Place
Plainview NY 11803
516 938 6991 - Home/Work
516 938 4363 - Fax
rbrook@worldnet.att.net

Bush, Donald R.
131 French Ave.
Winchester, KY 40391-2520
606-744-8659 - phone
606-737-0747 - fax
dbush@ieee.org

Butler, Joseph E
Parker Chomerics
77 Dragon Court
Woburn MA 01888
781 939 4267 - Work
781 938 5071 - Fax
978 468 0080 - Home
jbutler@parker.com

Carlson, B Leonard
NW Emetek Services
516 W Snoq. River Rd SE
Carnation WA 98014
425 222 5268 - Home
425 222 5268 - Fax
l.carlson@ieee.org

Case, David
Aironet Wireless Comm., Inc.
367 Ghent Road, Suite 300
P.O. Box 5292
Akron, OH 44333-0292
330-665-7396 - Work
330-665-7301 - Fax
dcase@aironet.com

Clarke, John
24 Althea Drive
Yarmouthport MA 02675
508 362 7195
JClarke805@aol.com

Chesworth, Thomas E.
7 Mountains Scientific Inc.
P.O. BOX 650
Boalsburg, PA 16827-0651
814-466-6559 - phone
814-4662777 - fax
sevmtnsci@aol.com

Chubukjain, Arto
Industry Canada
300 Slater Street, Room 1859C
Ottawa Ontario Canada K1A 0C8
613 990 4717 - Work
613 991 3961 - Fax
Chubukjian.Arto@ic.gc.ca

Cohen, Lawrence
Naval Research Laboratory
Search Radar Div Code 53326
4555 Overlook Drive
Washington, DC 20375
(202) 404 7726 - Work
(202) 767 6172 - Fax

Cory, William E (Gene)
4135 High Sierra
San Antonio TX 78228
210 736 0714 - Home
210 522 3396 - Fax
gcory@swri.edu

Dawson, Dr W Kenneth
TRIUMF
4004 Westbrook Mall
Vancover British Columbia
Canada V6T 2A3
604 222 1047 - Work
604 222 8325 - Fax
K.Dawson@ieee.org

Denny, Hugh W
2528 LaVista Rd
Decatur GA 30033
404 894 3522 - Work
404 894 7358 - Fax
404 633 9363 - Home
hugh.denny@gtri.gatech.edu

Drewniak, James L.
Department of Electrical Engineering
University of Missouri-Rolla
Rolla, MO 65401
(573) 341-4969 - Work
(573) 341-4169 - Fax
drewniak@ee.umr.edu

Drozd, Andrew
Andro Consulting Services
P.O. Box 543
Rome, New York 13442-0543
(315) 337-4396 - phone/fax
andro1@aol.com

Duff, Dr William G
Computer Sciences Corp
5501 Backlick Rd, Suite 300
Springfield VA 22151
703 914 8450 - Work
703 914 8499 - Fax
703 250 2409 - Home
w.duff@ieee.org

Fenical, Gary
Instruments Specialties Co
PO Box A
Delaware Water Gap PA
18327-0136
717 424 8510
717 421 4227 - Fax

Ford, Richard T
6 Westcot Place
Falmouth VA 22405
540 371 4008 - Home
202 767 3440 - work
202 404 4064 - Fax
dford@radar.nrl.navy.mil

Gjertson, William G
Boeing Information, Space &
Defense Systems
PO Box 3999, MS: 8H-10
Seattle WA 98124
425 393 2557 - Work
253 773 4173- Fax
206 448 8675 - Home
w.gjertson@ieee.org

Heirman, Donald N
Don HEIRMAN Consultants
143 Jumping Brook Rd
Lincroft NJ 07738-1442
732 741 7723 - Work
732 530 5695 - Fax
d.heirman@worldnet.att.net

Hill, Lee
Silent Solutions
20 Patch Road
Hollis, NH 03049
603 465 3920 - Work
603 465 3921 - FAX
noiseless@aol.com

Hoeft, Lothar O. (Bud)
9013 Haines Ave., NE
Albuquerque, NM 87112
505 298 2065 - Phone
505 848 5120 - Fax
budhoeft@rt66.com

Hofmann, H R (Bob)
Lucent Technologies
Room 2B-220
2000 N Naperville Rd
Naperville IL 60566
630 979 3627 - Work
630 979 5755 - Fax
630 355 2440 - Home
hrhofmann@lucent.com

Hoolihan, Daniel D
TÜV Product Service
1775 Old Hwy 8 NW
New Brighton MN 55112-1891
651 638 0250 - Work
651 638 0285 - Fax
651 257 2074 - Home
dhoolihan@tuvps.com

Howard, John B.
EMC Consultant
1632 Grosbeak Avenue
Sunnyvale, CA 94087 U.S.A.
(408) 736-2514 (Work)
(408) 739-1461 (Fax)
jhoward@emcguru.com

Hubing, Todd
120 Emerson Electric Hall
University of Missouri-Rolla
Rolla MO 65401
573 341 6069 - Work
573 341 4532 - Fax
t.hubing@ieee.org

Joffe, Elya B.
P.O. BOX 264
Kfar-Sava 44102, Israel
+972-9-7657065 - phone
+972-9-7657065 - fax
eb.joffe@ieee.org

Johnson, W F
Hamilton Engineering Inc
2108 SW 152nd St
Seattle WA 98166
206 244 0952 - Work
206 243 0598 - Fax
206 931 0372 - Home

Kanda, Dr Motohisa
Electromagnetic Field Div
NIST
M/S 813.07
325 S Broadway
Boulder CO 80303
303 497 5320 - Work
303 497 6665 - Fax
mkanda@boulder.nist.gov

Kesselman, Warren A
31 Hope Rd
Tinton Falls NJ 07724-3009
732 842 3207 - Home
732 530 9710 - Fax
w.kesselman@ieee.org

Kraemer, John G.
Rockwell Collins
M/S 106-183
350 Collins Road, NE
Cedar Rapids, IA 52498
319 295 4681 - Work
319 373 0125 - Home
319 395 5429 - Fax
jgkraeme@collins.rockwell.com

Libelo, Dr. Louis F
US Army Research Lab
2800 Powder Mill Road
Adelphi, Maryland 20783
Phone: (301) 394-0782
FAX: (301) 394-2525
llibelo@emsc5.arl.mil

Marks, Murlin
Underwriters Laboratories
1655 Scott Blvd
Santa Clara, CA 95051
408 985 2400 - phone
408 556 6037 - fax
marksm@ul.com

Mayer, Prof Ferdy
President LEAD
12 avenue de la Republique
94700 Maison-Alfort
France
1 49 77 9400 - Work
1 49 77 9813 - Fax
FerdyMayerLEADFrance@compuserve.com

McGinnis, William
Alexander Utility Engineering, Inc.
975 W. Bitters Rd
San Antonio, TX 78216
210 496 3200 - work
210 494 9987 - fax
210 684 2455 - Home
wmcginnis@ieee.org

Millard, David P.
Georgia Tech Research Institute (GTRI)
Georgia Institute of Technology
Atlanta, Georgia 30332-0852
770 528 7600 - work
770 528 3187 - fax
David.Millard@GTRI.GaTech.Edu

Mohd, Maqsood A. Dr.
Sverdrup Technology, Inc.
TEAS Group
Bldg. 260
P.O. Box 1935
Eglin Air Force Base, FL 32542
850 678 2001, Ext. 6115 - work
850 729 6377 - fax
MOHD@eglin.af.mil

Mohr, Richard
8 York Ct
Northport, NY 11768
516) 754 1142 - Work
516) 754 1142 - Fax
rjmohr5@juno.com

Montrose, Mark I.
Montrose Compliance Services, Inc.
2353 Mission Glen Dr.
Santa Clara, CA 95051-1214
(408) 247-5715 - Home and Fax
mmontros@ix.netcom.com

Osburn, John
EMC Test Systems, L.P.
Austin TX 78767
512 835 4684 ext. 669 - Work
512 339 4517 - Fax
john.osburn@emctest.com

O'Neil, Janet
Lindgren RF Enclosures, Inc.
425 868 2558 - Work
425 868 0547 - Fax
j.n.oneil@ieee.org

Ott, Henry W
Henry Ott Consultants
48 Baker Rd
Livingston NJ 07039
973 992 1793 - Work
973 533 1442 - Fax
hott@idt.net

Perini, Jose
May-Sept Residence:
34 Chardonnway
Ogdensburg, NY 13669-4221
315 393 4277 - phone
Oct-April Residence:
5207 South Atlantic Ave, Apt. 1221
New Smyrna Beach, FL 32169-4558
904 426 5546 - phone
jperini@syr.edu

Pettit, Ghery S.
Intel Corporation DP2-303
2800 Center Drive
DuPont, WA 98327
253 371 5515 - voice
253 371 5690 - fax
g.pettit@ieee.org

Podgorski, Dr Andrew
332 Crestview Road
Ottawa Ontario K1H 5G8 Canada
613 737 2026 - Work
613 737 3098 - Fax
613 737 6405 - home
a.podgorski@ieee.org

Roleson, Scott
Hewlett Packard
MS 8-90
16399 W Bernardo Dr
San Diego CA 92127-1899
619 655 4809 - Work
619 655 5931 - Fax
scott@sdd.hp.com

Sato, Risaburo
Dean Faculty of Eng
Tohuku Gakuin University
13-1 Chuo 1-Chome
Tagajo City Miyaga Pref
985 Japan
022 368 1115 - Work
022 368 7070 - Fax

Smith, Chester
Harvey Consultants Inc
2 Jonathan Lane
Bedford MA 01730-1848
781 275 0598 - Home
781 280 0281 - Fax

Smith, Douglas C.
Auspex Systems
127 Wheeler Ave.
Los Gatos, CA 95030-6246
408-566-2157 - work
408-358-3799 - fax
d.c.smith@ieee.org

Svetanoff, D.
Lindgren R.F. Enclosures, Inc.
400 High Grove Blvd.
Glendale Heights, IL 60139
630 307 7200 ext. 1054 - Work
630 307 7571 - Fax
svetanof@mc.net

Sweeney, Donald L
DLS Electronic Systems, Inc.
1250 Peterson Dr
Wheeling IL 60090
847 537 6400 - Work
847 537 6488 - Fax
847 724 3044 - Home
dsweeney@dlsemc.com

Takagi, Tasuku
Dept. of Engineering
Nihon Univ. at Kohriyama
Fukushima, Japan

Traver, Dave
Sony, M/S 3295
16450 W Bernardo Dr
San Diego CA 92129-1898
619 673 2601 - Work
619 674 5967 - Fax
David_Traver@ccmail.sgo.sony.com

Ungvichian, Vichate
Florida Atlantic University
Electrical Engineering Dept.
777 Glades Road
Boca Raton, FL 33431
561 367 3465 - work
561 367 2336 - fax
ungvich@acc.fau.edu

Violette, J.L. Norman
Violette Engineering Corp
6927 Tyndale Street
McLean,VA 22101
Tel (703) 506-0528
FAX (703) 506-0549
enviolette@msn.com

Wallen, Barry
Criterion Technology
1350 County Road 16
P.O. Box 387
Rollinsville, CO 80474
Phone: (303) 682-6600
FAX: (303) 682-6672
bwallen@criteriontech.com

Watkins, Glen
EMCO
2205 Kramer Ln
Austin TX 78758
512 835 4684 - Work
512-835-4729 - Fax
512 892 2345 - Home
glen.watkins@emctest.com

Whalen, James
State University of New York
Bonner Hall - Room 215B
Buffalo, NY 14260 U.S.A.
(716) 645-2422, ext. 1210 (Work)
(716) 645-5964 (Fax)
jjw@ubvms.cc.buffalo.edu

Williams, Kimball
Eaton Corporation
PO Box 766
26201 Northwestern Hwy
Southfield MI 48037-0766
248 354 2845 - Work
248 208 2018 - Fax
k.williams@ieee.org

Yoshino, Takeo
Fukui University of Technology
The Radio Physics Research Lab
2-36-22 Zempukuji, Suginamiku
Tokyo, Japan, 1670041
81-3-3397-5577 - phone/fax
yoshinot@nisiq.net

You-Gang, Gao
Beijing University
Ports & Telecommunications
Beijing 100088 China
2013388-2451 (work)
(8610) 62281774 (fax)
E-Mail: faoffice@bupt.edu.cn

This directory is updated frequently. The most recent version is on the web at http://www.emcs.org/chairs.html.

Please send all corrections to Todd Hubing at t.hubing@ieee.org

EMC Fellow Awards

The following members of the EMC Society were elected IEEE Fellows on January 1, 1999. Congratulations to these outstanding individuals!

Stanislaw Grzybowski of Mississippi State University, Mississippi, Tennessee. *For contributions to the evaluation of insulation performance of transmission and distribution lines.*

Oren Byrl Kesler of Raytheon Systems Company, McKinney, Texas. *For contributions to the theory and practice of antennas and sensors.*

Said El-Sayed Ismail El-Khamy of Alexandria University, Alexandria, Egypt. *For contributions to signaling techniques for propagation through natural media.*

Wen Xun Zhang of Southeast University, Nanjing, China. *For developments in electromagnetics including antennas, waveguides and scattering.*

WEDDING deciBELLS

Photo by Don Heirman

Mr. and Mrs. Henry Ott at their wedding on October 11, 1998 in New Jersey. Henry is a member of the EMC Society Board of Directors.

Former EMC Society Board Member Bob Hofmann is the handsome "Father-of-the-Bride" at the wedding of his daughter, Susan, on June 20, 1998. Susan married Kevin Slater in Good Hope, Illinois.

DR. WILLIAM G. DUFF
ASSOCIATE EDITOR

Introducing Antonio Orlandi.....

Antonio Orlandi is an Associate Professor of Electrical Engineering at the Department of Electrical Engineering at the University of L'Aquila in Italy.

Antonio describes L'Aquila as "a nice town in between the mountains called Appennini in the district of Abruzzi."

Antonio became involved in EMC during his Laurea thesis on electromagnetic coupling effects on cables under the guidance of Professor M. D'Amore at the University of Roma "La Sapienza". The enthusiasm of his tutor on EMC steered his research interests on this subject. After two years at the University of Roma "La Sapienza", he accepted the position of Assistant Professor at the University of L'Aquila. With Professor S.Cristina (now at the University of Roma) and Associate Professor Orlandi at the helm, the EMC activities in L'Aquila started to grow as did the number of members of the EMC group (now including Professor M. Feliziani, Dr. Buccella and Dr. Antonini). In particular, Antonio has concentrated his efforts into developing the EMC Laboratory of the Department, now a valued facility for research and teaching activities.

In the last ten years, Antonio has spent at least two months every summer in the United States, studying and collaborating in different universities and engineering institutions. He has been a "Visiting Scientist" at the Radiation Laboratory at M.I.T. in 1991 and 1993, and a "Visiting Engineer" at the Kaman Science Corp. (Santa Monica, CA) in 1992. Antonio credits the summers he spent at two

leading EMC universities, the University of Kentucky and the University of Missouri-Rolla, with providing a fundamental role in his EMC education. In addition, he appreciates the relationships he developed at these universities and institutions, saying "I have made a lot of wonderful friends in the United States."

Antonio is a senior member of the IEEE, Vice-Chairman of the Central and South Italy Section IEEE EMC Chapter, Associate Editor of the IEEE Transactions on EMC, member of the IEEE EMCS Technical Committee-9 (Computational EMC) and member of the EMCS Education Committee where he is coordinating the EMC University Survey.

Antonio and his wife Antonia are expecting their first baby, due in October.

In his spare time (which will be limited come October!), he likes to ski, play tennis and soccer.

Board of Directors Activities

Board Meeting, Saturday, November 14, 1998
New Brunswick, New Jersey

Call to Order

President Hoolihan called the final Board meeting of 1998 to order at 8:30 am. He asked for a moment of silence for Herb Zajac who recently passed away from an illness. Herb had been a member of the EMC Society Board of Directors for the past few years. Also, Dick Schulz recently passed away as a result of injuries sustained from a car accident. Dick was a previous long-term editor of the IEEE Transactions on EMC. There was a moment of silence for these two gentlemen.

A round of introductions was made. Board members present included Dan Hoolihan, Janet O'Neil, Warren Kesselman, Len Carlson, Todd Hubing, Don Heirman, Kimball Williams, Bill Gjertson, Henry Ott, Bob Hofmann, Andrew Podgorski, Joe Butler, Andy Drozd, Dick Ford, Norm Violette, Henry Benitez, Ferdy Mayer, Mark Montrose, Don Sweeney, and Takeo Yoshino. Newly elected Board members included Elya Joffe, David Millard, Don Bush, Ghery Pettit, and Doug Smith. Absent Board members were Jim Muccioli, Franz Gisin, and Bill McGinnis. Guests included Barry Wallen and Maqsood Mohd. The agenda was presented and approved as modified.

Secretary's Report

Secretary Janet O'Neil presented the minutes from the last Board meeting in Rome on September 18, 1998. The minutes were approved as presented.

Treasurer's Report

Warren Kesselman presented the treasurer's report. He advised that the Society's 1998 financial outlook is good. As of October 30th, the Society has a $207,900 surplus and the net worth on September 30th was $930,770.

President's Report

President Hoolihan commented upon the TAB meetings held this week. The IEEE has hired a series of consultants to help "modernize" the IEEE to update its logo and to "brand" the look of IEEE publications so there is a consistent look. A proposal was also submitted to limit the return on investments to Societies from both short and long term returns to just short term returns. Regarding the 1999 EMC Symposium in Zurich, President Hoolihan advised that he would attend to present a short introduction to the IEEE and EMC Society.

Member Services

Todd Hubing, Vice-President for Member Services, presented his report. He noted that the request to increase the cash awards for the President's Memorial and the Stoddart Awards has been forwarded to the IEEE for approval. Mr. Hubing expects to receive the approval in time to become effective for the August 1999 Awards Luncheon. Nominations for 1999 awards should be submitted to Mr. Hubing by the May 1999 Board meeting. The award nominations will be voted upon at the May 1999 Board meeting. The Board requested that the citations for each award recipient be included in the lunch program for the Seattle Awards Luncheon. Mr. Hubing advised that a description of each award as well as a list of past award recipients is available now on the EMC Society web page. Regarding the Distinguished Lecturer Program, Scott Roleson has a list of five candidates for the three open positions. Information on these candidates will be circulated to the Board electronically. Mr. Hubing discussed membership numbers for the EMC Society. The current membership is 5,560 active members. The position of PACE coordinator is still open since the retirement of Al Mills. Ferdy Mayer will man the membership booth in Zurich. Don Bush and Don Heirman volunteered to help staff the membership booth. Bob Hofmann reported on changes to the EMC Society Constitution and Bylaws. Dick Ford distributed a photo album of the Denver symposium activities, which was then presented to Barry Wallen, Chairman of the 1998 IEEE International Symposium on EMC. He presented a list of the EMI related videos in his library. Mr. Ford discussed the survey. The bias on the survey has been corrected, but the return has been low. The Board agreed to conduct a formal, scientific survey on the EMCS in 2001. The 1999 symposium survey will be divided into two parts; one for members and one for nonmembers. Mr. Ford requested that any suggested changes to the survey questions be sent to him electronically (EMC4D@aol.com).


Photo by Janet O'Neil

(L-R) Don Heirman of Don HEIRMAN Consultants raises a toast to outgoing Board member Bob Hofmann of Lucent Technologies while Andrew and Elizabeth Podgorski look on. Dr. Andrew Podgorski is with ASR Technologies.

Technical Services

Kimball Williams, Vice-President for Technical Services, distributed his report. He introduced Maqsood Mohd, Chairman of the Education Committee. Mr. Mohd re-

Photo by Janet O'Neil

Joining in the annual November Board dinner celebrations are (L-R) Norm Violette of Violette Engineering Corp., Mark Montrose of Montrose Compliance Services, Inc., and Elya Joffe of KTM Project Engineering Ltd.

ported that the Student Paper contest for the Seattle symposium in 1999 was well publicized and resulted in 17 papers being submitted. An additional four papers were received after the deadline and were rejected. Mr. Mohd reported on the Technological Literacy Counts Workshop he recently attended. He was very impressed with the quality and content of the workshop. President Hoolihan advised that the EMC Society financially supported this workshop. Work continues with the experiments subcommittee to repeat their successful efforts in Denver in Seattle. The committee would like to hold a student design contest in conjunction with the 2000 symposium, but there are problems developing the contest. Mr. Mohd solicited suggestions from the Board to put this in place. Regarding the Technical Activities Committee (TAC), Chairman Andrew Podgorski distributed his report. He discussed the TAC web page currently under construction. Mr. Podgorski also reported on the paper review process for the EMCS symposia. Mr. Williams concluded his report with a review of the Technical Services budget. This projects out to the year 2006.

Standards

Don Heirman, Vice-President for Standards, presented a report on Standards. Activity continues with the three subcommittees: 1. Standards Development Committee (SDCom), 2. Standards Education/Training Committee (SETCom), and 3. Standards Advisory and Coordination Committee (SACCom). He reviewed the organizational chart of the VP for Standards Organization. The committee has developed with the IEEE a password protected site for the on-line review of standards electronically. The committee has effectively worked towards being a truly international committee. All three above subcommittees typically meet prior to a regularly scheduled Board meeting. Mr. Heirman invited anyone with an interest in the activities of these subcommittees to attend their meetings. In mid-December, the collection of 37 EMC related standards will be on line for individual subscriptions.

Communication Sersvices

Len Carlson, Vice-President for Communication Services, presented his report. He welcomed Emerson Pugh, Chairman of the IEEE History Center, who reported on the activities of the History Center. The goal of the Center is to document and promote engineering achievements. The Center's endowment market value as of December 1997 is $3.65 million. The History Center is located on Rutgers campus in New Jersey. Graduate students work part time at the center. The History Center publishes a newsletter. The History Center web page address is www.ieee.org/history_center. Their phone number is 732-932-1066. The EMC Society pledged to contribute a total of $15,000 over three years to fund the Center. Bill Gjertson, Chairman of the 1999 IEEE International Symposium on EMC to be held in Seattle, Washington, August 2-6, then presented his report. The Board discussed the registration fees for IEEE members and nonmembers. The Board also discussed the distribution of the conference record via printed matter and/or CD-ROM. Barry Wallen, Chairman of the 1998 IEEE International Symposium, presented a report. The net surplus is estimated to be $119,000. There were 2,093 total advance registrations and 494 on-site registrations. There were 184 exhibitors occupying 262 booths. Close to 5,000 total room nights were booked at the four hotels used during the symposium week. Takeo Yoshino reported on the 1999 EMC Conference in Tokyo, Japan, May 17-21. He suggested a hotel for the Board and reviewed surface travel logistics between the airport/hotel/conference site. Len Carlson introduced Fran Zappulla, IEEE Publications Staff Director, who supervises the OPeRA program (On-Line Periodicals and Research Area). Ms. Zappulla gave a presentation on the OPeRA program. When they began the program in 1996, they had 12 journals on line. Currently, they have 38 journals on line. A direct mail piece promoting the OPeRA program will be sent to the entire membership in the near future. They are monitoring the "hit rates" of their site and usage is up 50% since the program's inception in 1996. The demo site is located at http://opera.ieee.org/opdemo The Board agreed to participate in the IEEE on-line periodicals research area (OPeRA) beginning in the year 1999 and to fund the program $12,500. The Transactions on EMC are to

Photo by Janet O'Neil

Todd Hubing of the University of Missouri at Rolla (L) and Andy Drozd of Andro Consulting Services (C) welcome new Board member Doug Smith of Auspex Systems (R).

Photo by Janet O'Neil

(L-R) Joe Butler of the Chomerics Division of Parker Hannifin celebrates the results of the Board election of officers. Joe is the new President-Elect for the EMC Society. Fellow Board members offering congratulations to Joe are Takeo Yoshino of the Fukui University of Technology (Radio Physics Research Lab), Kimball Williams of Eaton, and Henry Benitez of Tektronix.

remain on the database indefinitely. The Board formed a committee to evaluate the dissemination of all the EMC Society published material (Newsletter, Transactions, Symposia Records) and to make a recommendation on the most cost effective way to distribute this material. Henry Ott, Chairman of the Symposia Committee, presented his report. He suggested a revision to the EMCS Policy on Exhibitors Booth Assignment. The Board reaffirmed and clarified their commitment to the 2003 IEEE International Symposium on EMC in Israel. The Board will authorize use of the EMC Society name for their conference, but will not provide financial resources. Bill Duff, Chairman of the 2000 IEEE International Symposium on EMC in Washington DC, presented a report. There is room for 254 8' x 10' exhibit booths plus 60 tabletop displays. Mr. Duff feels the Hilton Hotel at 1919 Connecticut Ave. will meet the needs of the symposium. This is the hotel where the symposium was held in 1990. He showed a video walk-through of the hotel meeting and exhibit space which Dick Ford prepared. There are several large hotels nearby for overflow guestrooms. Janet O'Neil presented a brief report as Newsletter Editor.

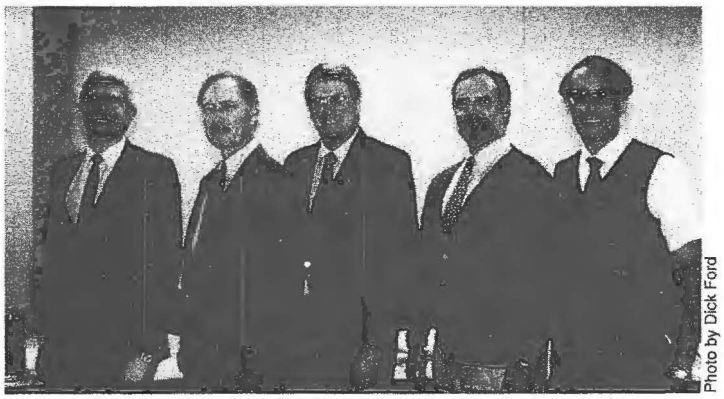

Photo by Dick Ford

Newly Elected Board Members attending their first Board meeting in November are (L-R) Elya Joffe of KTM Project Engineering Ltd., Don Bush of dBi Corporation, Ghery Pettit of Intel, David Millard of the Georgia Tech Research Institute, and Doug Smith of Auspex Systems.

Long Range Planning

Joe Butler presented the Planning Committee report. He suggested, and the Board approved, that the EMC Society accept the job description for a part-time paid administrator as outlined in his report. The Board accepted Mr. Butler's recommendation that Warren Kesselman be hired for the paid administrator position. Mr. Butler strongly recommended that all BOD members upgrade to Windows'95/Office '97 software, but when sending attachments, these be sent in Word 6.0.

Nominations

Warren Kesselman handled the officer nominations in the absence of Bill Gjertson who was required to attend a training at the TAB meeting.

The election results follow:

President-Elect: Joe Butler was the successful candidate for a one-year term beginning 1999.

Treasurer: Warren Kesselman was the successful candidate for a two-year term beginning 1999.

Secretary: Janet O'Neil was elected Secretary by acclamation for a two-year term beginning 1999.

Vice-President for Communications: Len Carlson was the successful candidate for a two-year term beginning 1999.

Vice-President for Member Services: Todd Hubing was the successful candidate for a two-year term beginning 1999.

Vice-President for Standards: Don Heirman was the successful candidate for a two-year term beginning 1999.

Vice-President for Technical Services: Kimball Williams was the successful candidate for a two-year term beginning 1999.

New Business

President Hoolihan advised that there is a vacancy on the Board due to the death of Herb Zajac. In the recent Board elections, the next runner-up with the most votes who was not elected was Dave Traver. The Board approved President Hoolihan's recommendation that Dave Traver be selected as the new Board member to fill the vacancy.

50th Anniversary of the EMC Society

President Hoolihan requested that the Board start considering what the Society should do to recognize the anniversary in 2007.

1999 Board Meeting Schedule

President Hoolihan set the Board meeting schedule for 1999.

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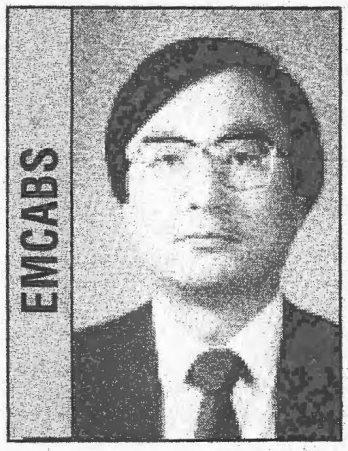

OSAMU FUJIWARA
ASSOCIATE EDITOR

Following are abstracts of papers from previous EMC symposia, related conferences, meetings and publications.

EMCAB COMMITTEE

Bob Hunter, Consultant
r.d.hunter@ieee.com
Sha Fei, EMC Research Section, Northern Jiatong University, Beijing, China
emclab@center.njtu.edu.cn
Ferdy Mayer, L.E.A.D., Maisons, Alfort France
FerdyMayerLEADFrance@compuserve.com
Maria Sabrina Sarto, Department of Electrical Engineering, University of Rome, Italy
sarto@elettrica.ing.uniroma1.it

"HOW CAN I GET A COPY OF AN ABSTRACTED ARTICLE?"

Engineering college/university libraries, public libraries, company or corporate libraries, National Technical Information Services (NTIS), or the Defense Technical Information Center (DTIC) are all possible sources for copies of abstracted articles of papers. If the library you visit does not own the source document, the librarian can probably request the material or a copy from another library through interlibrary loan, or for a small fee, order it from NTIS or DTIC. Recently it became clear that EMCABs were more timely than publications which were being listed in data files. Therefore, additional information will be included, when available, to assist in obtaining desired articles or papers. Examples are: IEEE, SAE, ISBN, and Library of Congress identification numbers.

Also, the steering staffs of the Japan Technical Group and the EMC Japan Tokyo Chapter have offered to act as a central point for requests of papers abstracted here. Most of the papers will be available in Japanese only. Abstracts of papers from EMC Japan will be clearly identified. As a member of the steering staff, I will assist in routing your request to the author(s) but will not translate the papers.

Some of the Chinese papers are not available in English. Professor Sha Fei, EMC Research Section, Northern Jiatong University, has offered his time and assistance in routing requests for papers to appropriate author(s). He is not furnishing a translation service.

As the EMC Society becomes more international, we will be adding additional worldwide abstractors who will be reviewing articles and papers in many languages. We will continue to set up these informal cooperation networks to assist members in getting the information or contacting the author(s). We are particularly interested in symposium proceedings which have not been available for review in the past. Thank you for any assistance you can give to expand the EMCS knowledge base.

EMCABS: 01-2-99

A FAMILY OF LOW EMI UNITY POWER FACTOR CONVERTERS
Marinus van der Berg and Jan A. Ferreira
Industrial Electronic Technology, Energy Laboratory, Rand Afrikaans University, 2004 Auckland Park, South Africa, and Delft University of Technology, 2600 GA Delft, The Netherlands
IEEE Transactions on Power Electronics, vol.13, no.3, May 1998, pp.547-555

Abstract: A new family of converter (ac-dc) circuits is presented. The family of circuits uses soft switching and high input power factor to meet both conducted EMI and harmonics requirements. Detailed analyses are supported by test results that show a conducted emissions improvement of 5-10 dB microvolt over hard switching circuits of similar type.

Index terms: ZVS resonant converters, power factor correction, harmonics reduction, conducted emissions reduction

EMCABS: 02-2-99

FREQUENCY COORDINATION BETWEEN CDMA AND NON-CDMA SYSTEMS
Samir Soliman and Charles Wheatly
QUALCOMM, Inc., San Diego, CA (USA)
Proceedings of the 1995 IEEE MTT-S Symposium on Technologies for Wireless Applications, Vancouver, BC, Canada, February 20-23, 1995, pp. 79-87

Abstract: This paper investigates cochannel and adjacent channel interference between CDMA and non-CDMA systems. Mitigation indicates a frequency separation of at least 870 kHz will prevent non-CDMA subscriber stations from interfering with CDMA base stations. In cases where the services share the band, a guard zone with path loss of 144 dB seems to suffice. Noise Figures and Coordination are recommended for minimizing interference.

Index terms: EMC for CDMA systems, spectrum management, frequency coordination, noise figure, guard band, guard zone

FAST EMC ANALYSIS FOR PRINTED CIRCUIT BOARDS USING AN EQUIVALENT-WIRE METHOD OF MOMENTS

EMCABS: 03-2-99

M.Leone, H.Bruns and H.Singer
Technical University Hamburg-Harbug
21079 Hamburg, Germany
Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.7-12

Abstract: The EMC analysis of printed circuit boards (PCBs) with the method of moments combined with an equivalent wire model offers the advantages of small modeling effort and short computation time. Being a full-wave method, it includes all electromagnetic phenomena encountered in modern printed circuit boards, e.g. transmission line effects, reflection, and mutual trace coupling, for arbitrary complex nets. This simplifying approach which has been recently used for the prediction of radiated emissions is further investigated giving validity ranges and error estimations. An extension for the treatment of large trace widths and the accurate computation of radiated fields using appropriate Green's functions, including vertical currents within the PCB substrate is presented. Validation by more rigorous analysis examples indicates the broad range of practical application.

Index terms: Printed circuit board, radiated emission, method of moments, analysis

THE USE OF AN ACTIVE TEST BOARD TO VALIDATE A METHOD THAT PREDICTS DIFFERENTIAL MODE RADIATED EMISSIONS FROM PRINTED CIRCUIT BOARDS

EMCABS: 04-2-99

Emmanuel Leroux[1], Andrea Giuliano[1], Garla Giachino[1], Ronald De Smedt[2], Jan De Moerloose[2], Willem Temmerman[2], Paolo Fogliati[3], Piero Belforte3) and Bernard Demoulin[4]
1) High Design Technology, Corso Trapani 16, 10139 Torino, Italy, 2) Alcatel Bell Telephone, Francis Wellesplein 1, B-2018 Antwerpen, Belgium, 3) CSELT, Via Reiss Romoli 2274, 10148 Torino, Italy, 4) University of Lille, 59655 Villeneuve d'ascq, France
Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.28-32

Abstract: The design of new Printed Circuit Boards (PCBs) could be conveniently supported by the use of a fast and reliable estimations tool of the Radiated Emissions (RE). In this paper an active test board is used to validate a method aimed at predicting RE due to differential mode currents on PCB traces. The method takes into account effects of dielectric layer in the field calculation and does not need to discretise traces in short segments. It can simulate all traces of a PCB in a reasonable computation time. The simulation results are compared with measurements in a semi-anechoic chamber in far field. Radiation from the routed power net, on board batteries holders is put in evidence though measurement in near field. The paper shows the importance of modeling of components and of taking into account all couplings in the measurement set-up when comparing RE results. The method validated in this paper is included in the Telecom Hardware Robustness Inspection System (THRIS) for evaluation of telecom hardware.

Index terms: Active test board, printed circuit board, radiated emission, differential mode current

EVALUATION OF SAR AND TEMPERATURE DISTRIBUTION IN SUBJECTS EXPOSED IN THE FAR-FIELD OF RADIATING RADIO FREQUENCY SOURCES

EMCABS: 05-2-99

P.Bernardi, M.Cavagnaro, S.Pisa and E.Piuzzi, University of Rome "La Sapienza", Department of Electronic Engineering, Via Eudossiana 18, 00184 Rome, Italy
Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.190-193
Abstract: In this work. a subject exposed to the far field of RF broadcasting sources has been considered. The incident field has been supposed to be a plane wave of variable frequency from 20 to 900. In a previous work, we have shown that in particular situations, SAR evaluation is not sufficient to establish if a given exposure is safe from a thermal point of view. In fact, heating is strongly influenced not only by the power dissipated in a certain volume of tissue and by the way in which absorption is distributed in the volume, but also by the thermal characteristics of the tissues and the heat exchanges. For this reason in this work we have solved both the electromagnetic and the thermal problem. In particular, the FDTD method has been used for computing the electromagnetic field distribution inside the exposed body, while an explicit finite difference formulation of the Bio-Heat equation has been adopted for computing the temperature increase. Thc obtained results have shown that thermal analysis gives a more complete information on the exposure hazard than SAR analysis alone.
Index terms: RF broadcasting source, biological hazard, SAR, temperature distribution, FDTD analysis

ASYMMETRICAL NOISE IMMUNITY FLIP-FLOP FOR THE USE OF FAIL-SAFE COMPONENT

EMCABS: 06-2-99

Tsuneo Tsukagoshi[1], Shuichi Nitta[2], Atsuo Mutoh[2] and Shigeru Kaneko[2]
1) EMC Technical Center, NEC Corporation, 4-1-1 Miyazaki, Kawasaki, Kanagawa, 216-8555 Japan. 2) Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology, 2-24-16 Naka-cho, Koganei, Tokyo, 184-0012 Japan
Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.219-224
Abstract: Generally, in digital circuits, it is uncertain whether its output changes to H or L for malfunction due to noise on power supply line. This makes it difficult to design the fail-safe system of a digital circuit in practical applications. In this paper, asymmetrical noise immunity Flip-Flop whose noise immunity on Vcc from H to L is different from L to H is proposed. It is shown that asymmetrical noise immunity characteristics can be intentionally realized by applying unbalanced ODF to two transistors which compose the Flip-Flop circuit. Design method to realize an asymmetrical noise immunity Flip-Flop is also shown.
Index terms: Digital circuit, flip-flop, asymmetrical noise immunity

ASSESSMENT OF THE SHIELDING EFFECTIVENESS OF A REAL ENCLOSURE

EMCABS: 07-2-99

Ronald De Smedt[1], Jan De Moerloose[1], Steven Criel[1], Daniel De Zutter[2], Frank Olyslager[2], Eric Laermans[2], Ward Wallyn[2] and Norbert Lietaert[3]
1) Alcatel Telecom, EMC Research, Francis Wellesplein 1, B-2018 Antwerpen, Belgium,
2) Univefslty of Gent, Department of Information Technology, St.-Pietersnieuwstraat 41, B-9000 Gent, Belgium. 3) BARCO NV, Research & Development Department, Th. Sevenslaan 106, B-8500 Kortrijk, Belgiüm
Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.248-253
Abstract: We determine the shielding effectiveness (SE) of a real enclosure: a commercial, shielded 19" rack, with a complicated structure. We use simple, equivalent circuits to approximate the SE of multiple apertures and grids. To assess the SE of a complex shield, we first identify all possible points of leakage and simulate the belonging SE with the above simple and quick analysis method. By comparing and ranking the results, we are able to locate the most critical parts of the shield and to determine the total SE. A good agreement with measured results is obtained.
Index terms: Shielding effectiveness, multiple apertures, equivalent circuit approximation, measurement

TRANSIENT ANALYSIS OF THE ELECTROMAGNETIC FIELD IN SEIELDED ENCLOSURE CONFIGURATION BY THE MIXED FD/WE-TD METHOD

EMCABS: 08-2-99

F.Maradei, Department of Electrical Engineering, University of Rome "La Sapienza", Via Eudossiana 18, 00184 Rome, Italy

Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.322-327

Abstract: The mixed finite difference/Whitney elements time domain (FD/WE-TD) method is applied to the analysis of transient electromagnetic field in complex configurations such as enclosure with aperture. The mixed FD/WE-TD method consists in discretizing the region in two parts composed respectively by structured and unstructured elements and leads to an explicit-implicit solution scheme. In the structured mesh Yee's algorithm is applied to solve Maxwell's curl equations while in the unstructured mesh the Whitney elements-time domain method is applied to solve the wave equation. The method is very powerful since it permits to overcome some of the main limitations of the basic FDTD method, such as staircase in modeling of curved boundaries and uniform space discretization, without a significant increase of the computational cost. The procedure is tested in canonical configurations and then applied to the analysis of the electromagnetic field in shielded enclosure with aperture configurations.

Index terms: Enclosure with aperture, transient field analysis, mixed finite-difference/Whitney elements time domain method

MICROWAVE FIELD-TO-WIRE COUPLING MEASUREMENT

EMCABS: 09-2-99

S.Silfverskiold1), M.Backstrom2) and J.Loren2)
1) National Deference College, P.O.Box 27805, S-115 93 Stockholm, Sweden
2) FOA Deference Research Establishment, P.O.Box 1165, S-581 11 Linkoping, Sweden

Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.452-457

Abstract: Knowledge of antenna receiving properties of wires and cables is essential in the analysis of susceptibility of electronic systems to microwave radiation. This paper presents measurements of receiving parameters for basic wire geometries. Directional properties of realized gain, receiving cross section and of effective antenna length for the wires are presented. The impact of measured directivity effects of the order of 15 dB on radiated susceptibility testing in anechoic and mode-stirred chambers is discussed.

Index terms: Wire geometries, field-to-wire coupling measurement, radiated susceptibility testing, mode-stirred chambers

NEW FINDING METHOD OF RADIATED EMISSION SOURCES UTILIZING CISPR EMISSION MEASUREMENT SYSTEM

EMCABS: 10-2-99

Yasuhiro Ishida1), Kazuo Murakawa2), Kouji Yamashita3) and Masamitsu Tokuda3)
1) Fukuoka Industrial Technology Center, 3-6-1 Nortimatsu, Yahatanishi-ku, Kitakyushu-shi, 807-0831 Japan, 2) NTT Co. Ltd., 3-9-11 Midori-cho, Musashino-shi, 180-8585 Japan
3) Kyushu Institute of Technology, 1-1 Sensui-cho, Tobata-ku, Kitakyushu-shi, 804-8550 Japan

Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.500-504

Abstract: New emission sources finding method, which uses only amplitude data without phase, applying the discrete singularity method is proposed. The position estimation deviation between the estimated and the given current positions is less than 0.2m and the amplitude estimation deviation is less than 1.6 dB when spherical dipole antennas are used as ideal emission sources. Consequently, it is revealed that the finding method can be applied to find emission sources on equipment under test at CISPR emission measurement.

Index terms: CISPR emission measurement, radiated source finding, discrete singularity method

ESD RESPONSE OF LINEAR SYSTEMS USING ONLY SCALAR CW MEASUREMENTS

EMCABS: 11-2-99

G.Cerri, R.De Leo and V.Mariani Primiani
Dipartimento di Elettronica ed Automatica, Universita di Ancona, Italy

Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.637-640

Abstract: The goal of this paper is to state a procedure that enables one to estimate the behavior of a linear system excited by non-sinusoidal sources (for example ESD), making use of CW measurements of its transfer function amplitude by low cost scalar instrumentation. The method, based on the synthesis of the transfer function by means of proper elementary structures, is efficient, simple and gives an upper bound of the system response in the time domain. Numerical results are validated by measurements in several cases, where the response to an ESD is recovered for coupled PCB traces and enclosures with apertures.

Index terms: ESD, linear system response, scalar CW measurement, synthesis of transfer function

MODELING AND EXPERIMENTAL ACTIVITY ABOUT THE COUPLING OF ESD THROUGH THE GROUNDING SYSTEM

EMCABS: 12-2-99

Marco Angeli[1], Ermanno Cardelli[1] and Bernardo Tellini[2]
1) Instituto di Energetica, Universita di Perugia, Via G. Duranti, 06125 Perugia, Italy, 2) Dipartimento di Sistemi Elettrici e Automazione, Universita di Pisa, Via Diotisalvi 2, 56126 Pisa, Italy

Proceedings of International Symposium on Electromagnetic Compatibility, Rome, Italy, September 14-18, 1998, pp.652-657

Abstract: In this paper we report some results dealing with our investigation about the role played by the grounding system in the coupling between an electrostatic discharge (ESD) event and a possible victim component or system. This investigation has been made with two connected scientific activities. The numerical modeling and simulation of the system (ESD + grounding + victim) has been made by means of a suitable application of the Finite-Difference in Time Domain (FDTD) technique. This numerical technique has been studied in particular in order to well simulate the ESD source in complex geometries, where there are interconnection conductors that pass through the boundary of the investigated region and reach far grounding systems. The experimental activity has been carried out in order either to check the numerical procedure or to measure the interference conducted via the grounding system to possible susceptible electronic devices. The practical problems encountered and solved during this experimental activity are presented and discussed in the paper. Preliminary results applied to radial or meshed grounding systems seem to prove the effectiveness and the accuracy of the numerical modelling technique proposed. Finally, some quantitative and qualitative considerations about the level of the interference produced and of the coupling degree vs. the position of the ESD and the configuration of the grounding system are reported.

Index terms: ESD, coupling through grounding system, FDTD analysis, experiment

Richard B. Schulz
continued from page 1

Dick loved to play bridge. He was an excellent player and was a Life Master. Other people liked to play bridge with him, not just because he was good, but because he did not take himself or the game too seriously. He liked to dance. He was an amateur radio operator. In 1940 he put together a TV set and invited neighbors to see the TV picture on the tiny CRT. Dick built a house by the ocean in the mid 1960s when he lived in Seattle. He was a man of many talents. He did the plumbing, wiring, paneling, and kitchen; all on weekends.

Dick was handicapped by multiple sclerosis, but he never let it keep him from accomplishing anything he wanted to do. He was a man of unwavering faith in God; but he did not talk it, he just lived it with integrity, faithfulness, kindness, patience, and peace.

By Ed Bronaugh

Memorial contributions may be made to the Multiple Sclerosis Society, 8750 N. Central Expressway, Dallas, Texas, 75231.

Editors Note: My colleague at Lindgren, Dale Svetanoff, as Chairman of the IEEE Working Group on P299, recalled his last committee meeting held in Denver in conjunction with the IEEE EMC Symposium. Dick Schulz attended this meeting. I'd like to share Dale's recollection with you and thank Dale for providing this.

"Those of us who attended the Friday meeting in Denver will surely recall Dick Schulz's presentation on a non-RF method of determining shielding performance of small enclosures by using DC (or low frequency AC) resistance measured across some portion of the enclosure. As stated at that meeting, Dick's name can be found on the ORIGINAL 299, dating from 1969. His input on the history of 299, along with remarks from fellow "originals" Ed Bronaugh and Jim Klouda, clarified many issues for us "newer" folks during technical deliberations of the previous Working Group. Dick was Chairman of the IEEE Working Group on P299 until July 1995. He was most helpful to me in those early days of my chairmanship, for I had lots of reading and understanding to do in order to better comprehend the task at hand. Dick was both an excellent engineer and a gentleman. The EMC world will miss Dick Schulz."

Call for BoD Nominations

EMC SOCIETY

IEEE

Nominations are now being accepted for candidates for the IEEE EMC Society Board of Directors. In accordance with the Bylaws, nominations may be made by petition or by the Nominations Committee. Petitions shall carry a minimum of 15 names of Society members in good standing (dues paid), excluding those of students. Nominees should possess professional stature and significant technical skills in electromagnetic compatibility. They must have adequate financial support outside the Society and have the approval of their organizations or employers to actively participate. Duties include attendance at three or four Board meetings a year and participation on committees, both of which require telephone, fax, mail and e-mail communications. Nominees must be full members of the IEEE and members of the EMC Society. Elected Directors must serve a three-year term starting January 1, 2000. Attendance at the last meeting of the 1999 year is also desirable. No member can serve more than two consecutive three-year terms, including partial terms. All nominees are required to submit a biographical summary to the Nominations Chairman for inclusion on the ballot. The summary must not exceed a one-half typewritten page and must be in the following format:

First paragraph	Name, title, place of employment, educational background
Second paragraph	Technical and professional experience
Third paragraph	IEEE service and activities including offices, committees, etc.

Please submit petitions and biographical summaries to the Nominations Chairman:

Bill Gjertson
Boeing Information, Space and Defense Systems
P. O. Box 3999; M/S: 8H-10
Seattle, WA 98124
Telephone: (425) 393-2557
Fax: (253) 773-4173

Submissions must be postmarked no later than May 31, 1999. Information can be obtained from Mr. Gjertson or any member of the BoD.

NOMINATION PETITION
ELECTROMAGNETIC COMPATIBILITY SOCIETY
BOARD OF DIRECTORS

(Nomination guidelines given on facing page.)

I. NOMINEE'S NAME: _____

MEMBERSHIP NUMBER: _____

ADDRESS: _____

_____

_____

PHONE: _____

II. BIOGRAPHICAL SUMMARY: Attach Typed Copy

III. SIGNATURES: (Minimum of 15 names). We, the undersigned, all of whom are current IEEE Electromagnetic Compatibility Society (EMCS) members in good standing, nominate the above-mentioned person to serve on the EMCS BoD for a three-year term beginning January 1, 2000.

MEMBER'S NAME (PRINT)	SIGNATURE	MEMBERSHIP NUMBER
1.		
2.		
3.		
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IEEE BEEEP OCTOBER 1998

Become a Senior Member of the IEEE

Those interested in upgrading to Sr. Membership should note that forms are now available online by sending e-mail to the address "senior-member-forms@ieee.org" An automatic response usually takes less than a minute and includes the condensed electronic version of the application form, which may also be used for the three recommendations which are required. They are also available via anonymous ftp at ftp://ftp.ieee.org/info/rab/senior-member-forms.

This should make the process much easier to complete now. Full instructions are available on the forms. All forms should be submitted to senior-member@ieee.org or may be printed and mailed in to IEEE in the standard manner. Those interested in locating three Sr. Member or higher members for references can also contact Mike Garretson via e-mail at m.garretson@ieee.org. Membership in IEEE is at its highest level ever and the number of people elevated to Sr. Membership is also at its highest level ever.

Congratulations to the following members of the EMC Society who were elected to Senior Member grade on December 1, 1998:

William C. Johnson, Columbia, South Carolina
Melinda J. Piket-May, Denver, Colorado
Mook-Seng Leong, Singapore

CALL FOR PAPERS!

The next meeting of the Mode-Stirred, Anechoic Chamber, and OATS Users will be held June 7-9, 1999 at the Underwriters Laboratories (UL) facility in Northbrook, Illinois (near Chicago). Papers are solicited which address reverberation chamber, anechoic chamber and OATS test methodology. Abstracts should be submitted via e-mail to Mike Hatfield at HatfieldMO@NSWC.NAVY.MIL no later than April 1.

NEW PROGRAM! This June meeting will begin on Monday afternoon, June 7 with an optional half-day tutorial/workshop on reverberation chamber statistics by the well-known industry expert, Gus Freyer. Tuesday, June 8 will feature a full day of technical presentations. On Wednesday, June 9, the full day's technical program will include a tour of the extensive UL EMC Test Facility. The program will also include a Tuesday evening dinner party where the recipient of the "Best Paper Award" will be announced.

VENDOR LIBRARY: Vendors of EMC related products and services are invited to submit their literature for inclusion in a "Vendor Library" which will be available to all attendees during the three day meeting. Contact Janet O'Neil for more information, phone 425-868-2558, e-mail j.n.oneil@ieee.org.

REGISTRATION: Registration fees are $125 by April 15, $175 by May 15 and $200.00 thereafter and at the door. Registration fees include a copy of the technical notes, continental breakfast, afternoon refreshments, and the Tuesday evening dinner party. (Lunch will be on your own in the UL cafeteria.) Hotel recommendations in the area will be provided upon request. Contact Mike Caruso of UL, phone 847-272-8800 x41534, e-mail carusomi@ul.com to receive more information regarding registration.

Board of Directors Activities

continued from page 36

Public Relations Video

Dick Ford showed a public relations EMC video which had been developed by Herb Zajac.

Don Heirman suggested that the video be distributed subject to the video review and marketing committee recommendations. Henry Benitez will chair the video review and marketing committee of Len Carlson, Elya Joffe, Dick Ford, and Kimball Williams.

Secretary Janet O'Neil then reviewed the action items assigned during the meeting.

Hearing no further business, the meeting adjourned at 5:45 pm.

Janet O'Neil
Secretary, EMC Society Board of Directors

Calendar

EMC Related Conferences & Symposia

1999

March 23-25
Sponsored by the IEEE
EMV '99: International Exhibition (with Workshops) on EMC
Messe Dusseldorf, Germany
Organized by: MESAGO
http://www.mesago.de
e-mail: dunja@mesago.de

April 12 (see ad page 11)
Sponsored by the Oregon Chapter of the EMC Society
A COLLOQUIUM AND EXHIBITION ON EMC REQUIREMENTS AND DESIGN FOR COMPLIANCE
The DoubleTree Hotel on the Columbia River Portland, OR
Henry Benitez, 503.627.1217
e-mail: henry.w.benitez@tek.com

April 26-28
Sponsored by the SAE
TOPTEC ON EMC
Technical Conference and Exhibition
The Novi Hilton, Novi, MI
Kevin Perry, 724-772-8569
e-mail: kperry@sae.org

May 3 (see ad page 11)
Sponsored by the Phoenix Chapter of the EMC Society
EMC '99: A COLLOQUIUM AND EXHIBITION ON PRE-COMPLIANCE EMC TESTING PROBLEMS AND SOLUTIONS
Featuring Keynote Speaker Henry Ott
La Posada Resort, Scottsdale, AZ
Daryl Gerke, 602.755.0080
e-mail: dgerke@aol.com

May 17-19
Sponsored by Wessex Institute of Technology, UK and the University of Toronto, Canada
ELECTROSOFT 99 - Software for Electrical Engineering
Seville, Spain
Liz Kerr, +44(0)1703 293223
fax: +44(0)1703 292853
e-mail: liz@wessex.ac.uk
Http://www.wessex.ac.uk

May 17-21
Co-Sponsored by the IEEE EMC Society - Tokyo Chapter
EMC '99 TOKYO
Chuo University
Tokyo, Japan
Prof. Noboru, +81.426.65.1441
e-mail: sch@cs.takushoku-u.ac.jp
Http://www.cs.takushoku-u.ac.jp/is/emc99/

June 7-9 (see ad page 42)
MODE-STIRRED, ANECHOIC CHAMBER, AND OATS USERS MEETING - New Location, New Date (Originally scheduled in October 1998)
Underwriters Laboratories
Northbrook, IL
Mike Caruso, 847-272-8800 x41534
e-mail: carusomi@ul.com

June 22-24
Sponsored by the SAE
INTERNATIONAL CONFERENCE ON LIGHTNING AND STATIC ELECTRICITY
Toulouse, France
Jim Brahney, fax 724-776-1830

July 12-13
Sponsored by York EMC Services and IEE
EMC YORK '99
The University of York, United Kingdom
Chris Marshman
e-mail: cam@yes.york.ac.uk

August 1
Sponsored by the Seattle Chapter of the EMC Society
INTRODUCTION TO ELECTROMAGNETIC COMPATIBILITY: A One Day Tutorial by Clayton R. Paul
The Crowne Plaza Hotel
Seattle, WA
Desire'e Patterson, 360.595.2785
Register on-line at:
www.acmetesting.com

September 13-17
Sponsored by the IEEE
INTERNATIONAL CONFERENCE ON EMC IN ADVANCED APPLICATIONS (ICEAA 99)
Torino, Italy
http://www.polito.it/iceaa99

November 1-4
Sponsored by the IEEE Beijing Section and others
1999 INTERNATIONAL CONFERENCE ON COMPUTATIONAL EMC AND ITS APPLICATIONS (ICCEA'99)
Beijing, China
http://www.cie-china.org/iccea-99.htm

November 2-4
EMC ASIA 99: 2nd INTERNATIONAL EXHIBITION (WITH WORKSHOPS) ON EMC
Westin Stamford and Westin Plaza
Singapore
http://www.mesago.de

December 2-8
Sponsored by the IEEE and others
6TH INTERNATIONAL CONFERENCE AND WORKSHOP ON EMI AND EMC: EMC for Optimal Spectrum Utilization
New Delhi, India
S. Mukhopadhyay
e-mail: mukho@xm.doe.ernet.in

2000

May 4-6
Co-Sponsored by the IEEE Communications Society SECOND ASIA-PACIFIC CONFERENCE ON ENVIRONMENTAL EMC - CEEM '2000
Shanghai, China
Prof. Gao Yougang
Fax: +86.10.6228.1774
e-mail: faoffice@bupt.edu.cn

IEEE Administrative Meetings 1999

(For information on all meetings, contact Janet O'Neil, 425.868.2558)

May 21
EMC Society Board of Directors
Tokyo, Japan

August 1 and 5
EMC Society Board of Directors
Seattle, WA

November 19 and 20
EMC Society Board of Directors
Washington DC

EMCS Cooperating Symposia

U.K.: Biannually, even years, in September
Zurich: Biannually, odd years, in February
Wroclaw: Biannually, even years, in June

EMCS Symposia Schedule

1999 Tokyo, Japan
May 17-21
S. Nitta
E-Mail: nitta@cc.tuat.ac.jp

1999 Seattle, WA
August 2-6
Westin Hotel
Bill Gjertson
425.393.2557
E-mail: w.gjertson@ieee.org

2000 Washington, DC
August 21-25
Washington Hilton
Bill Duff
703.914.8450

2001 Montreal, Canada
Montreal Convention Center
Christian Dube
514.653.6674

2002 Minneapolis/St. Paul
Hyatt Regency, Minneapolis
Dan Hoolihan
651.638.0250
E-Mail: dhoolihan@tuvps.com

2003 Tel-Aviv, Israel
(International IEEE)
Elya Joffe
Fax: 972.9.765.7065

2003 Boston, MA
Sheraton Boston
Mirko Matejic
508.549.3185

2004 Santa Clara, CA
Franz Gisin
650.933.8789

2005 Chicago, IL
Bob Hofmann
630.979.3627

Institutional Listings

The IEEE Electromagnetic Compatibility Society is grateful for the assistance given by the firms listed below and invites application for Institutional Listings from other firms interested in the electromagnetic compatibility field.

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