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NEIL, Editor



Dan Hoolihan, President EMC Society, (left) spoke at the April meeting of the EMC Chapter in Sweden. The meeting was held at ETL SEMKO in Stockholm. Things got "exciting" following the meeting when the inventor of the first ESD gun, Lars-Olov Johansson (center), presented a few of his "toys" to Dan and fellow chapter member Dag Bjorklof. President Hoolihan actively supports EMC chapter activity whenever possible during business travel for his company, TUV Product Service.

Nurturing Chapters

The first half of 1999 is already over and that means, among other things, that I am three-quarters of the way through my two-year presidential term for the EMC Society. I would like to take this opportunity to talk about our EMC Society Chapters that are scattered around the world.

To begin with, you should know that there are approximately 300 Sections within the IEEE and about 350,000 members worldwide in the IEEE. There are about 1200 chapters of Technical Societies or, as you mathematical wizards have already figured out, about 4 chapters per section. The EMC Society has 46 Chapters on the books; that represents about 4% of the total of 1200 chapters.

The 46 EMCS chapters are split in the following manner; 29 in the United States and 17 in Regions 7 -10 (outside

the United States). There are 3 chapters in Canada (Region 7), 8 chapters in Region 8 (Europe and Middle East), no chapters in Region 9, and 6 Chapters in Region 10 (Pacific Rim countries).

So much for the statistics. The point of this message is that not all the Chapters are as healthy as we would like to see them. The minimum requirement to maintain a Chapter is to have two meetings a year and submit an appropriate report to the Section on those two meetings. In addition, most Societies (EMC included) like to be copied on the chapter reports so that they can be reviewed by the Membership Vice-President and his chapter coordi-

continued on page 4

ELECTRONIC
COMPATIBILITY
NEWSLETTER

INSIDE

PRESIDENT'S MESSAGE

1

LETTER FROM THE EDITOR

2

BOOK REVIEW

5

CHAPTER CHATTER

7

PRACTICAL PAPERS, ARTICLES
AND APPLICATION NOTES:

MEASUREMENT TECHNIQUES
FOR THE EMI EVALUATION OF
VLSI DEVICES

17

COMMENT ON JAVOR'S
"INVESTIGATION INTO RADIO
SUSCEPTIBILITY TO POWER-LINE
CONDUCTED NOISE"

20

PERSONALITY PROFILE

24

EMC BOARD OF DIRECTORS
ACTIVITIES

25

THIRD MILLENNIUM MEDALS
WILL CREATE THOUSANDS OF
CELEBRATIONS

29

DIVISION IV DIRECTOR-ELECT
CANDIDATE POSITION PAPERS

29

EMCABS

32

CALENDAR

35



IEEE

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Janet O'Neil, Editor, enjoyed meeting Professor Shuichi Nitta, Chairman of EMC '99 Tokyo in Japan recently.

Out and About

One of the things I enjoy most about my job is getting out and about. I enjoy traveling to various EMC conferences and seminars in the US and abroad to meet new EMC engineers and to learn what they do to further EMC engineering. The common denominator I find at every conference, no matter the location or the topic, is the enthusiasm exhibited by EMC engineers for their work. EMC may be frustrating, but more often it's a challenge. It's the challenge and the desire to learn more that prompts the organization of many conferences and consequently, the presentation of many great papers.

That said, in April I attended the Society of Automotive Engineers (SAE's) EMC TopTec in Novi, Michigan. This conference attracted a largely local group of EMC engineers, some 85% of whom do not attend the annual IEEE EMC Symposia. This was their opportunity to learn more about automotive EMC and they eagerly took advantage of the situation. Several EMC Society members, including Poul Andersen of DaimlerChrysler, are also members of the SAE and they were very active in putting together the diverse technical program. As automobiles become increasingly more computerized, the need for good EMC design and test practices increases as well. Cars just aren't what they used to be!

I also managed to take in EMC '99 Tokyo this past May. Over 400 people attended this conference from 19 countries. There were 196 general papers and 20 invited papers. This issue of the EMC Society Newsletter includes many photos from the conference, details of the EMC Society Board of Directors meeting held at the conference (see page 25), and abstracts from several of the papers presented at the conference (see page 32). From your review of this material, I'm sure you'll agree this was a top-notch EMC conference.

In June, I also happened to attend the 1999 Mode-Stirred Chamber, Anechoic Chamber, and OATS Users meeting in Northbrook, Illinois. Like the conference in Japan, this event attracted a very international group of EMC engineers. However, unlike the conference in Japan, the papers presented at this meet-

ing were very specialized. It was also a smaller, high intensity group, which led to tremendous, on-going interaction between the attendees and the presenters. A few photos from this Users meeting are included herein.

Of course, increasing the awareness and study of EMC just doesn't "happen." It takes enthusiastic, go-getters to organize EMC conferences and dedicated, talented engineers to write and present the papers. One such go-getter is Professor Shuichi Nitta, of the Tokyo University of Agriculture and Technology, and Chairman of EMC '99 Tokyo, whom I



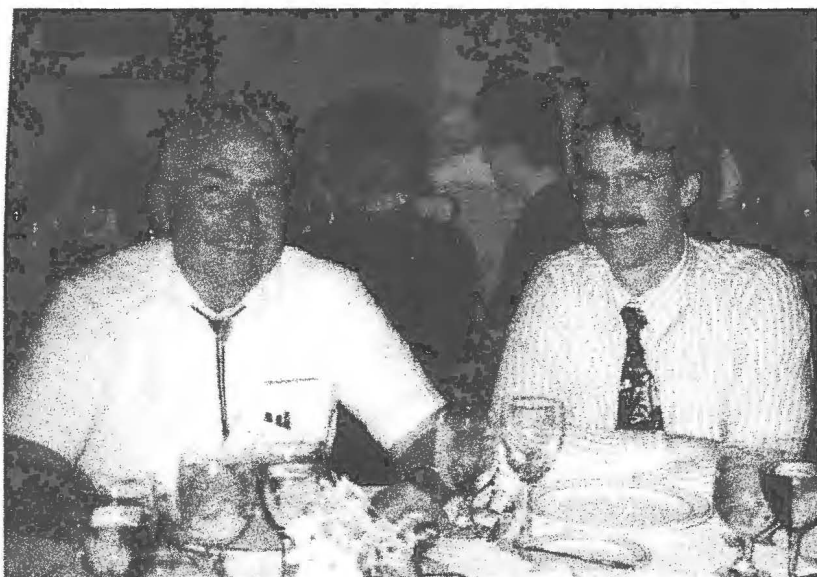
Photo by Janet O'Neil

At the 1999 Mode-Stirred Chamber, Anechoic Chamber and OATS Users Meeting in Northbrook, Illinois, several "movers and shakers" convened, including Mike Hatfield (L) of the Naval Surface Warfare Center in Dahlgren, Virginia, and Olof Lundun of FOA in Sweden. Mr. Lundun received the "Best Paper Award" at the conference.



Photo by Janet O'Neil

Lunches during the Users Meeting provided an opportunity for the international attendees to get to know one another. (L-R) Luk Arnaut of the National Physical Laboratory in the United Kingdom used his lunch hour to meet Sam Newman of Micro Sales and John Ladbury of NIST.



At the Users Meeting dinner party, Gus Freyer (L) of the Northeast Consortium for Engineering Education shared his expertise in EMC with Dan Horjus of Underwriters Laboratories in Camas, Washington.

had the pleasure to meet in Japan. One such dedicated, talented EMC engineer is Bob Dockey of Hewlett Packard in Vancouver, Washington who was recognized by the Academy of Electrical Engineering of the University of Missouri-Rolla for his outstanding contributions to the profession of electrical engineering and for leadership in his community and profession. Bob is a graduate of the University of Missouri-Rolla class of 1970. He is also a Distinguished Lecturer of the EMC Society. As a member of the Seattle EMC chapter, I was fortunate to hear Bob speak to the chapter last year.

For the ultimate "out and about" experience, nothing beats the annual IEEE EMC Symposia! The 1999 IEEE International Symposium on Electromagnetic Compatibility in Seattle will be featured in the next issue of the EMC Society Newsletter. Check it out! Also, be sure to put the 2000 IEEE International Symposium on Electromagnetic Compatibility in Washington DC on your calendar for next year. The dates are August 21-25, 2000. See you there!



GE Medical Systems in Milwaukee turned up in force at the Users Meeting. (L-R) Keith Griffiths, Bruce Fiorani and Jerry Itzenheiser appreciated hearing the papers presented by EMC experts.

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The Users Meeting concluded with an impromptu, light-hearted "awards" presentation. Receiving hat awards from UL were (L-R) Kevin Goldsmith of the Defense Science and Technology Organization in Australia. He received the award for "coming the farthest" to attend the meeting. Paolo Corona with the Naval University of Naples in Italy received the award for "asking the most questions" during the meeting and Olof Lundun of the FOA received an award to commemorate his "best paper".



Bob Dockey of Hewlett-Packard in Vancouver, Washington (left) was honored recently by the University of Missouri-Rolla, Academy of Electrical Engineering. He was joined at the April presentation ceremony in Rolla by Professor Todd Hubing.



The Users Meeting in Northbrook included a tour of the ten meter chamber at Underwriters Laboratories. UL's John Niklewicz (in suspenders) presented a paper at the conference and then conducted a tour of the chamber.

President's Message

Continued from page 1

nator. We have a number of Chapters that are either not making that minimum requirement or are barely making the minimum requirement.

The Board of Directors of the EMC Society has instituted programs over the years to help the local Chapters. These programs include the Distinguished Lecturer Program, the Angel program, and special incentives to Board members to visit local chapters. We still don't see the level of activity in a number of chapters that we would like to see, despite these board incentives, so we are asking for ideas from the members.

What would you like to see to stimulate local chapters of the EMC Society? What do local chapters need to grow

strong? How can the Board nurture chapters? Send your ideas to me at d.hoolihan@ieee.org or FAX 651-638-0285.

Over the past few years, I have had the pleasure of visiting a number of chapters and participating in local meetings; this includes Portland (twice), Seattle, Phoenix, San Diego (twice), Los Angeles, Central Texas, Chicago, Rocky Mountain, Santa Clara Valley, and Sweden. (I, of course, also remain active in my own local chapter here in the Twin Cities of Minneapolis/St. Paul - Minnesota). It is always interesting to meet the grass-root members of our EMC Society and to participate in their local programs.

Regardless of your Chapter's level of activity, I hope to see you all in Seattle the first week of August for the Annual IEEE International Symposium on EMC. The local organizing committee has been working diligently for months on the Symposium and they are promising us a great symposium plus sunny skies the entire week we are in Seattle!



J.L. NORMAN VIOLETTE
ASSOCIATE EDITOR

**Wireless
Communications
Design Handbook
Volume I: Space
(Interference: Aspects of
Noise, Interference, and
Environmental Concerns)**

Author: Dr. Reinaldo Perez
Spacecraft Design
Jet Propulsion Laboratory
California Institute of
Technology

Academic Press, San Diego,
CA 1998

Introduction

This book is part of a three-volume series that "cover introductory and advanced concepts in interference analysis and mitigation for wireless personal communications." The first volume provides a generalized description of launch vehicles including several satellite systems being built for worldwide access to personal communication services, such as Iridium, Globalstar, Teledesic, and Odyssey systems. Concepts of LEO, MEO, and GEO orbits used by these satellite systems are also presented.

Chapter 1 - Introduction to Satellite Systems and Personal Wireless Communications

The multiple uses of satellite systems (navigation, surveillance, communications, broadcast applications, etc.) are briefly described. The basic spacecraft structural and power distribution requirements are described and illustrated. The attitude and articulation control subsystem (AACS) that assures that the spacecraft is placed in a precise orbital location and maintains the required attitude is described. Other subsystems presented as introduction include command and data handling, thermal, and propulsion control, and a variety of mechanical devices, instruments, and sensors. Payload functions and electrical connections for signal and power distribution are described briefly.

Overviews of personal and mobile satellite communications provides descriptions and illustrations of satellite communications networks including descriptions of launch vehicles and launch scenarios. The advantages and disadvantages of geostationary earth orbits (GEO) and low earth orbits (LEO) are described.

Chapter 2 - Aerodynamics of Satellites for Mobile Systems

Fundamental concepts of space mechanics are presented to help understand the inner workings of the attitude and articulation control (guidance) subsystem (AACS). Chapter sections describe the two-body central force motion; orbital determination; Keplerian (circular, elliptical, parabolic, and hyperbolic) orbits; and satellite earth area coverage. Descriptions of orbital terminology conclude the chapter.

Chapter 3 - Attitude Control and Navigation

This chapter contains detailed descriptions of space concepts and subsystems and asso-

ciated basic electronic circuits. The techniques and subsystems that essentially control the attitude and stabilization of a satellite are described. The physical principles and electrical functional block diagrams of a satellite AACS and sun sensors are presented and illustrated.

Oscillation problems and possible solutions in sun-sensor operational amplifier circuits are described. Grounding techniques for proper operational amplifier performance are illustrated.

The physical principles of momentum/reaction wheels that add stability against distorting torques, absorb cyclic torques, and transfer momentum to the satellite body are described and the drive electronics functionally illustrated. The noise problems generated in these reaction wheel assemblies are introduced and addressed in more detail later in the book. Noise generation and suppression in motor drive circuits are described and illustrated.

Other topics developed include intrinsic noise in operational amplifiers; a description of the physical principles of a star camera and associated noise concerns; noise in amplifier circuits; spectral (Fourier) representation of digital waveforms; simple electromagnetic noise coupling; descriptions of common-mode and differential-mode currents; satellite inertial measurement unit (IMU); noise issues in analog-to-digital (A/D) converters; noise concerns in high-speed A/D converters; noise figure in op-amps; total noise output; proper power supply decoupling in op-amps; and fundamentals of op-amp grounding.

Chapter 4 - Satellite Power Subsystems and Noise in Power Electronics

This chapter addresses the various elements of satellite power systems including: solar energy and power; solar cells and radiation; solar arrays; the space environment and radiation damage to solar cells; noise in switching-mode power supplies (SMPS), including input noise, input ripple noise, input inrush current limit, conducted interference, and sources of interference generated in the SMPS including EMI from diodes, silicon-controlled rectifiers, and power transistors. Interference paths in SMPS are described and illustrated. A section is provided on a study in the proper design of grounding for SMPS converters in printed circuit

boards (PCBs). This includes transient effects in SMPSs, and proper grounding to suppress these transient effects. Energy storage (batteries) and battery charging and power control are described. Stresses on satellite power systems due to wide temperature variations are described.

Chapter 5 - Command and Data Handling Subsystem

This (C&DH) subsystem provides communications to and from the spacecraft. A brief overview is presented of satellite command C&DH systems including requirements for such a system with block diagrams provided to illustrate parts of the system. Fundamentals of modulation theory and coding are presented. Worst-case analysis guidelines are included for analog and digital design with examples of use in C&DH subsystems. Details of factors affecting propagation delays are addressed including timing analysis. Noise issues in satellite telecommunications subsystems are addressed, including uplink/downlink models.

Chapter 6 - Noise Representations in Transponders and Multiple Access

Detailed developments are provided on transponder functions. Included are descriptions of travelling wave tube amplifiers (TWTAs), intermodulation distortion, and multiple access techniques in satellites (TDMA, CDMA, FDMA).

Chapter 7 - Satellite Antennas

Some fundamentals of antenna theory are presented which provide basic concepts useful for understanding more specific satellite antenna developments that follow. Antenna basics presented include near-field and far-field concepts, antenna gain, power relationships, electromagnetic wave propagation, antenna factor, and antenna interference coupling model. Satellite antenna concepts include satellite coverage area, phased array antennas, lens and reflector antennas, feed systems, pulse-forming networks, unfurlable antennas, and multibeam frequency reuse in mobile communications.

Chapter 8 - Space Environment and Interference

Concepts of space physics are introduced that describe the natural electromagnetic environment encountered by orbiting spacecraft. The presence of plasmas that result in spacecraft charging is briefly described. Typical environmental parameters encountered at geosynchronous altitudes, and those encountered during auroral activity in low-altitude polar orbits, are presented. The effects of electron energy, and other factors due to spacecraft charging, are described. The author suggests assuming that the spacecraft be visualized as a Langmuir probe, used in laboratory plasma experiments, in order to facilitate understanding spacecraft charging. The remainder of the chapter provides additional descriptions of charging environments and charging currents, differential charging, surface potential differences, and arcing (electrostatic discharge, or ESD). The latter discharging is the primary mechanism by which charging disturbs spacecraft. Methods and models are provided to analyze the coupling of the discharge transient to the spacecraft structure and cables. A recommended analysis approach is illustrated. Parameters and threshold levels for component/circuit upset and damage are provided.

References and Index:

A list of References and an Index are included.

General Evaluation

The book is well-written by a knowledgeable author. This Volume I provides an excellent, easy-to-read introduction to space communication systems. It can be used by itself for an introductory course at the college undergraduate level and as a ready-reference for practicing engineers. It also leads to Volumes II and III for more details on space communication techniques.



IEEE/ABET Seek Evaluators for Accreditation Programs



The IEEE Educational Activities Board seeks engineering professionals from industrial, government, and academic sectors to serve as program evaluators for accrediting engineering and engineering technology programs at U.S. universities. Nominations will be accepted through 1 November 1999.

The IEEE members selected will attend a one-day training seminar on the IEEE/ABET accreditation process, the first of which to take place at the June 2000 ASEE convention in Saint Louis. The IEEE and ABET, through their pool of trained program evaluators, will be able to visit engineering and engineering technology departments across the country. Evaluation sessions take place each fall and generally run for two to three days. "Participation in the accreditation process for IEEE/ABET engineering programs is a major responsibility," said Rae Toscano, manager of IEEE EAB Administration. "Service as a program evaluator provides IEEE members with the opportunity to contribute to the achievement of high quality educational standards in engineering programs."

Nomination packages are available from: Accreditation Administrator, IEEE Educational Activities, 445 Hoes Lane, Piscataway, NJ. 08855-1331; accreditation@ieee.org



TODD HUBING
ASSOCIATE EDITOR

Bigger companies with EMC departments often publish a set of EMC design rules for their product designers. Design rules can be a good thing, but there is a tendency to rely on them too heavily and sometimes incredibly poor design decisions are made in an attempt to comply with out-dated or just-plain-bad design rules.

As a case in point, the other day I came across the following EMC design rule in a corporate policy document on printed circuit board designs: "High-speed traces should not cross over gaps in a round plane." Is this really a problem? How many circuit board designs employ round planes? This is a clear case of some well-intentioned EMC engineer making a simple observation and then drawing a grossly incorrect conclusion.

How many times have you seen this happen? For example, someone has an intractable radiated EMI problem. They work for days trying dozens of fixes. Finally somebody speculates that a "widget" is the source of the EMI. A ferrite is placed on the widget cable and the problem is solved. Everyone is happy and the problem solver is a hero. However the story does not end there. Somewhere is our hero's mind a new fact is stored: "Widgets radiate." And somewhere in the corporate database a new EMI design rule is registered: "Widget cables should have ferrites." It doesn't matter that widgets are low-speed devices with passive components. Evidence that widgets don't radiate is dismissed by our hero, because it is contrary to experience. Lessons learned by experience outlast, and generally overrule, lessons learned from a textbook.

Maybe that's the way it should be, but it is important to remember that lessons learned by experience can be wrong. People do not always draw the correct conclusions based on their experiences. This is particularly true when the experience is an EMI test marathon and the primary goal is to fix the product rather than to understand the problem.

Which brings us back to the rule about traces crossing gaps in a round plane. This is evidently a rule based on someone's experience. They may have observed that their boards with traces crossing gaps in rectangular planes did not have EMI problems. On the other hand, boards with traces crossing over a gap in a round plane may have radiated significantly. A design rule was born.

Nevertheless, modeling of this phenomenon reveals that the shape of the plane should have very little effect on the EMI. True, the size and shape of the plane affect the resonances. It's possible for a change in the plane's shape to have an effect on EMI due to alignment of clock and resonant frequencies. However, there is no reason to believe that round planes (in general) should be any worse than planes with other shapes.

This rule should be scrapped. In fact, all design rules based on experience that cannot be justified using thoughtfully constructed and experimentally validated models should be scrapped. Companies are spending too much money doing stupid things like putting ferrites on widget cables and avoiding round planes. Unsubstantiated and out-of-date EMC rules-of-thumb are robbing our world economy of billions of dollars every year! It's time to take a stand. EMC engineers of the world unite! Just say NO to unvalidated design rules! Show me the model!

[Note: Of course, it's possible that the rule I saw was a misprint. Perhaps it was supposed to say, "High-speed traces should not cross over gaps in a 'ground' plane." In that case, never mind.]

Central New England

John Clarke reports that the April meeting of the Central New England chapter featured "A Review of Taiwan's BCIQ EMC Approval Process CNS 13438" presented by Peter Boers, US National Committee, Technical Advisory Group for CISPR/G. The speaker provided a brief overview of the implementation schedule of CNS 13438 and the change in agency name from BCIQ to BSMI. His presentation was followed by a discussion of the differences between this standard and CISPR 22.

The May meeting featured James Press of National Technical Systems, who gave a presentation titled: "Overview of Lightning and Other Transient Phenomena." The presentation provided an overview of the physics of lightning and the composite waveforms used to simulate the effects of lightning. The speaker described commercial FAA, military, and telecommunication requirements for lightning hardness. The following specifications were addressed: ANSIC62.41, EN61000-4-5, SAE-AE4L, DO-160 and GR-1089-CORE.

CNEC Officers Elected for 1999/2000 were: Chairperson and Secretary - John Clarke, Vice Chair - John Luchini, and Vice Chair - Lee Hill.

Central and Southern Italy

Prof. Salvatore Celozzi reports that the Central & Southern Italy chapter hosted two very interesting presentations on June 4th. The presentations were given by Distinguished Lecturer, Dr. Elya Joffe, of KTM, Tel Aviv. About 25 persons attended the high-level presentations in the ancient cloister of the Faculty of Engineering of the University of Rome "La Sapienza".

Elya's lectures were respectively on "Grounding and Grounding Implementation in PCBs" and on "High-Speed Transmission Lines in PCBs". He got the attention of the audience not only with many examples from the real world but also by means of very funny stories (both EMC-related and otherwise!). At the end, everybody was enthusiastic about the content and the way the presentations were given.



Elya Joffe giving a presentation to the Central and Southern Italy Chapter.

The Chapter also contributed to the promotion of a two-day meeting on "EMC-related safety issues in transportation systems" hosted by the University of L'Aquila and organized by professors M. Feliziani and R. De Leo. The meeting was held on June 23 and 24.

Chicago

Ray Klouda reports that this spring has been exciting for the Chicago EMC Chapter. Antenna Calibration Methods were discussed at their March meeting which was held at Underwriters Laboratories in Northbrook. Mike Howard of Liberty Labs and Dale Sventanoff of Lindgren RF Enclosures presented their thoughts regarding the latest improvements in the field of antenna calibrations. By far the



Rod Foley of EIA and Carla Robinson of 3COM at the registration table.



Roosevelt Nesmith of Patterson, Belknap, Webb and Tyler presenting Legal Issues in EMC.



Tom Braxton (left) receives his award for his contributions to the Chicago chapter from our chair Derek Walton (far right).

highlight of this spring was their first Chicago Chapter EMC Mini Symposium that was held May 24 at the Holiday Inn in Itasca. Over 100 people attended this event. Twenty-two companies exhibited. This one-day extravaganza featured "Legal Issues in EMC" presented by Marshall Miller of Baise, Miller, and Feer and Roosevelt Nesmith of Patterson, Belknap, Webb and Tyler. These two gentlemen gave a riveting account of EMC liability issues that are beginning to surface in the courts and things that EMC engineers need to consider. The program was rounded off with presentations including "Introduction to EMC" presented by Tom Braxton of Lucent Technologies and Derek Walton of LF Research, "Significance of Laboratory Accreditations" presented by Mirko Matejic of Foxboro Co. and "EMC Testing Issues" presented by Pat Malloy of Amplifier Research and Dr. Mike Foegelle of ETS. A special award was presented to Tom Braxton of Lucent Technologies at our awards banquet to honor Tom for his contributions and dedication to the Chicago Chapter. His efforts are much appreciated. Two drawings were held at the conclusion of the symposium. Carla Robinson of 3COM presented a 3COM Palm Pilot to Joe Khammyvong. An HP meter went to Ken Pagenkopf. The event was a tremendous success. Many positive comments were received.



Carla Robinson presents the grand prize to Joe Khammyvong.



Frank Krozel of Electronic Instrument Associates (left) and Tom Braxton of Lucent Technologies in the exhibit area.

Germany

The German Chapter will hold its annual meeting in Frankfurt, VDE Haus, Stresemannallee on November 17th, 1999 at 10:00am. Please confirm your participation via e-mail to hey.no.garbe@ieee.org.

Israel

The Israeli IEEE EMC Chapter held its first chapter meeting of 1999 in Haifa. This was the first time ever that a Chapter meeting was held in Haifa, in the North of Israel.

The meeting - a full day workshop on EMI from Circuits to Systems, was held jointly with the Israel Association of Engineers and Architects (AEAI) and was hosted by them in their facilities. Many thanks to Dr. Josef Pecker, a member of the Chapter and the Society, for his dedicated assistance in the organization of the Meeting. Special thanks also to our "Angel" for providing the "Angel" support for refreshments and a light lunch for the participants.

Participation in the meeting was great! Over 60 attendees, most of whom were IEEE members. Others have requested application forms for the IEEE and the EMC Society, and we hope to see them as members, soon.

After a short welcome by the EMC Chapter Chair, Elya B. Joffe, a welcome address on behalf of AEAI was given by Mr. Dror Ken-Dror, Chairman of the Electronics and Electrical Engineering Society of the AEAI in Haifa.

Following the welcome address, elections for 1999 officers were held. The following people were elected: Chairman - Elya B. Joffe, Vice Chairman - Moshe Netzer, Secretary - Eli Recht, Student Activities - Prof. Jacob Gavan, Technical Activities - Dr. Alex Axelrod. Good luck to the elected officers, and thanks to the retiring officers.

Following the elections, the following technical presentations were given:

- 1) "An Investigation of a Capacitive Coupling Problem", Mr. Yossi Dahan, RAFAEL
- 2) "Interference due to Electrostatic Discharge, and Solutions in Industry (with Demonstrations)", Mr. Eyal Zadok, The Israel Laboratory for Electrostatic Electricity
- 3) "The Problems Emerging from Harmonics on AC Power Distribution Systems and their Solutions", Mr. Moshe Sherman, Consultant
- 4) "Attenuation provided by Meshes and Conductive Plating", Dr. Gershon Friedlander, RAFAEL
- 5) "Tactical Models for the Design of High Speed Printed Circuit Boards", Dr. Moshe Merzer, RAFAEL
- 6) "Electrophobia", Mr. Moshe Netzer, RAFAEL
- 7) "MIL-STD-464 - A System-Level EMC Standard", Mr. Elya B. Joffe, KTM Project Engineering, Ltd.

On July 4-5, 1999, two full day tutorials on High Speed Digital Design of PCBs were held in Tel-Aviv, in conjunction with ILTAM (the Israeli Consortium of High Technology Users in Electronics). The tutorials were presented by Dr. Istvan Novak of Sun Microsystems.



The Israel EMC Chapter recently elected new officers, including (R-L) Eli Recht, Secretary, Moshe Netzer, Vice Chair (returning to office after a sabbatical), Elya B. Joffe, Chapter Chairman (again!), and a "New Chapter Member" (holding the inevitable IEEE registration form which was just completed).

Over 140 participants turned out for the first day to hear presentations on "First Order Effects on PCBs," "Second Order Effects on PCBs," and "Power Distribution Systems on High Speed PCBs."

On the second day, a smaller group of interested parties attended a more "cozy" session with Dr. Novak for the discussion of High Speed Design and Analysis Tools. Many, many thanks to Dr. Novak, who agreed to come to Israel, for 2 days only, including the 4th of July, for this special seminar.

Responses to the "Request for Proposal" (RFP) for selection of the organizing company for the 2003 Symposium were received in November. The selected company is ORTRA. ORTRA is extremely experienced in the organization of IEEE Symposia, and assisted in the organization of the 1992 IEEE Regional Symposium on EMC, which took place in Tel-Aviv, Israel.

Sponsorship (or participation) has been approved already by the IEEE EMC Society, IEEE Region 8, IEEE Israel Section, Israel IEEE EMC Chapter, and the Israel URSI National Committee. Future reports will continuously update the activities and preparations for this great and exciting event. Stay Tuned!!!

Additional Chapter meetings and activities are scheduled for 1999. Information on them may be found in the Web Sites of the Israel IEEE Section at <http://www.eng.tau.ac.il/~ajw/ieee.html>.

The Israel EMC Chapter wishes to extend a welcoming hand to all colleagues, EMC engineers and engineers in related fields, from our neighboring countries, in particular Jordan, Egypt, and the PA, and invite them all to hold joint activities, conference meetings, etc. In particular, the Israel Chapter invites engineers from our neighboring countries to participate in our chapter meetings, and will hold such meetings in English for the benefit of our guests.

Orange County

On June 24th, the Orange County chapter welcomed Steve Watkins and Mike Morino of Cassper Instrumentation Systems, along with Ed Nakauchi of SARA Inc. to the June Chapter meeting. The trio demonstrated CIS's newest system, a two-channel spectrum-analyzer-like system, which has the ability to simultaneously and synchronously make two RF measurements. The system's amazing ability to identify and cancel out ambient signals was demonstrated, along with the unit's unique capability to localize and even pinpoint the source of EMI within a circuit design. These features are made possible by a combining the latest in EMI receiver design and cutting edge DSP technology. The presentation was well received, with even the most seasoned of EMI engineers walking away from the presentation very impressed. Although a smaller than usual meeting, with 16 attendees, the presentation ended up being one of the most exciting of the year.

This fall The Orange County Chapter of the IEEE EMC Society is hosting EMCFest '99, a one-day tutorial featuring



Stephen Watkins of CIS, Ed Nakauchi of Sara Inc., and Mike Morino of CIS with the CASSPER System (left to right).

some of the top speakers in the EMC community. Scheduled speakers include Dr. Howard Johnson, Mr. Lee Hill, and Mr. Daryl Gerke. Topics to be presented include High Speed Digital Design for EMC, Standards Activity, and EMC Troubleshooting Techniques. Vendors from the EMC community will also be on hand with the latest information on EMC mitigation products and

test equipment. For more information, please contact Randy Flinders at (714) 513-8012 or r.flinders@ieee.org.

Oregon and S.W. Washington

[Thanks to Henry Benitez, chair of the Oregon Chapter for submitting the following report.]

Summertime is here and we are ready to enjoy it. We had great speakers at our monthly chapter meetings and events all year long. Chapter speakers included Bob Dockey, Chris Kendall, Dr. Howard Johnson, Dick Ford, Hans-Peter Bauer, Joe Butler, Ken Javor, and Jose Perini. The April EMC '99 Oregon Colloquium was a grand success once again. Vendor participation was excellent and has been a major contribution to these local events. Colloquium speakers included Henry Benitez, Greg Kiemel, Don Bush, Mark Montrose, and Doug Smith.

At our May Chapter meeting, Jose Perini and Ken Javor gave excellent presentations on RF conducted immunity and RF fields immunity techniques. The gentlemen added excitement to the meeting by sparring one another on the issue of correlatability between the two methods when evaluating long cables in the frequency range below 80 MHz. The views of both speakers were quite valid and very well respected. We considered the debate a draw!

We started off this summer with an EMC Summer Social on July 26. We had 70 people join our picnic! In July we will help the Oregon IEEE Section celebrate via a "Portland Spirit" cruise on the Willamette river. 200 IEEE affiliates are expected! In August we expect to show up in numbers to the Seattle '99 EMC Symposium.

Included are pictures of the EMC '99 Oregon Colloquium, recent chapter meetings and the EMC Summer Social Picnic.



Charlie Tohlen of Tektronix (L) prepares his hot dog at the Oregon summer social while Jerry Page of Northwest EMC promotes the IEEE EMC Symposium in Seattle. Who else would take an advance program to a picnic?!



Oregon Chapter member Orv Olson (standing) attended the summer social with his wife and eight of his 18 grandchildren - all future EMC engineers!



At the March meeting of the Oregon Chapter, Joe Butler (L) of the Chomerics Division of Parker Hannifin, spoke on shielding effectiveness and standards. He is joined by Chapter Chairman Henry Benitez of Tektronix.



Conversations at the Oregon summer social included the chapter officer wives suggesting that they organize next year's picnic.



The amusement park at the Oregon chapter summer social brought out the "kid" in several members, including Chapter Chairman, Henry Benitez of Tektronix. Go Henry go!



Speakers Jose Perini and Ken Javor shake hands after an extensive debate over the correlatability of two test methods at the May Oregon Chapter meeting. The Chapter called it an exciting "draw."



Dave Crawford of Tektronix (L) suggests adding liquid oxygen to the charcoal at the June summer social organized by the Oregon chapter.



The Oregon Chapter held an EMC Colloquium and Exhibition on April 12 in Portland. At the pre-party for out-of-towners, speakers Don Bush (L) of dBi Corporation in Winchester, Kentucky and Doug Smith of Auspex Systems in Santa Clara, California, catch up on the latest.



The speakers at the Portland EMC Colloquium included (L-R) Greg Kiemel of Northwest EMC, Mark Montrose of Montrose Compliance Services, Don Bush of dBi Corporation, Henry Benitez of Tektronix, and Doug Smith of Auspex Systems.



The registration crew is shown hard at work at the Portland EMC Colloquium. The able assistants seated behind the table are (L-R) Dan Arnold of Underwriters Laboratories, Charlie Tohlen and Jamie Moritz, both of Tektronix. Standing is Ann Tohlen who helped her husband at the Colloquium.

Phoenix

The Phoenix Chapter of the IEEE EMC Society sponsored a one-day colloquium on EMC at the Double Tree La Posada Resort in Scottsdale, Arizona on May 3, 1999. Six world-renowned experts in EMC presented talks and answered questions on EMC requirements, electrostatic discharge, circuit board layout, testing and troubleshooting techniques. These experts included Dan Hoolihan, the president of the IEEE EMC Society, and Henry Ott, the keynote speaker for the event. Many of the people that attended the colloquium never get to attend the EMC Society's annual IEEE EMC symposium so this event provided them with a good source of education. Twenty-seven vendors offered exhibits of their products and fielded questions from over 80 attendees. This provided an excellent opportunity for local EMC engineers and technicians to learn about the latest in test equipment, EMC control products, and EMC prediction software.

Six invited technical papers were presented during the one-day colloquium. Dan Hoolihan, TUV Product Service, provided an overview of EMC requirements. This talk was beneficial to both the novices and the experts in the audience. Especially enlightening was the explanation of the how the new European Union RTT&E Directive will allow manufacturers of radio transmitters to self-declare to harmonized standards without the need for a Notified Body. This apparently caught the FCC by surprise since they didn't think the EU was going to take such a liberal approach.

Bill Ritenour, EMC Compliance LLC, provided an excellent tutorial on ESD including a discussion of the various standards and information on mitigation techniques. Bill also put on an ESD demonstration during the reception that followed the talks.

Scott Roleson, Hewlett-Packard Company, shared his techniques to evaluate emissions from products without the need for expensive shield rooms or open area test sites. The attendees enjoyed his analogy of finding the optimum set of EMI fixes to that of fixing the leaks on a tin can while blind-folded. You don't know which areas are just dents and



Enjoying the Phoenix chapter hospitality poolside at the DoubleTree La Posada Resort are Leo Smale of Kalmus, Mark Prchlik of BMI, and Mike Hoen of Honeywell.

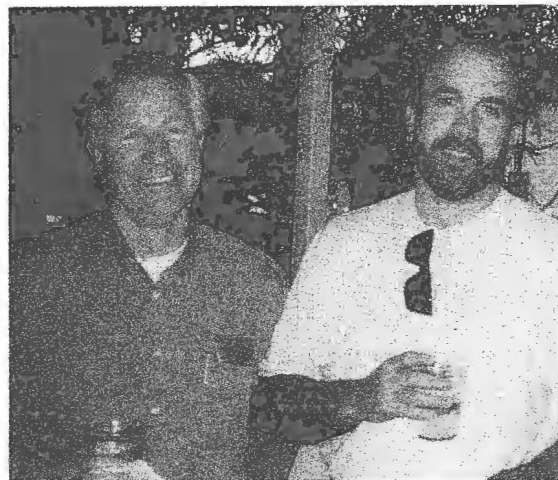


Photo by Janet O'Neil

The Phoenix Chapter sponsored EMC '99: A Colloquium and Exhibition on EMC Pre-Compliance Testing Problems and Solutions. Shown at the pre-party for out-of-towners before the event are Dave Bernardin of TUV Product Service in San Diego and Dean Ghizzone of Northwest EMC in Newberg, Oregon.

which are real holes. Therefore, you keep adding fixes until the can stops leaking and then remove them one at a time until only the necessary fixes are left.

Henry Ott provided empirical data on the inductance of ground planes and contrasted his data with that of some theoretical work by Holloway and Kuester. We learned that the ground plane is low inductance except where the current bunches together near the board via. His empirical data showed that the inductance of the ground plane approaches that of a single trace (about 5 to 10 nH/cm) when within a centimeter or so of the via. Henry also demonstrated that small holes have a negligible effect but slots can be a major contributor to ground plane inductance.

Daryl Gerke, Kimmel Gerke Associates, provided some excellent techniques on troubleshooting conducted and radiated immunity problems. He explained that you must first diagnose the problem by gathering and critiquing data using differential diagnosis as is done in the medical field. Then diagnostic tests are performed as appropriate such as using an ESD gun or mobile and hand held radios to determine the coupling means for the problem. Finally, appropriate fixes are tried and the tests are repeated to verify that the fix is effective.

Bill Kimmel, Kimmel Gerke Associates, enlightened us with troubleshooting techniques for radiated and conducted emissions. Bill recommended to work from the outside in by starting with external cables and shields and progressing inside to internal cables, grounding and the circuit boards. Bill also echoed Scott's suggestion to leave all fixes in until the goal is achieved. Then the fixes can be removed one by one.

The Phoenix Chapter of the EMC Society would like to thank all of the speakers, the vendors, the chapter officers, and the attendees for making this a very successful event. A very special thanks needs to go to Janet O'Neil, Lindgren RF Enclosures, for her exceptional work on coordinating the event.



Photo by Janet O'Neil

The organizing committee for EMC '99 Arizona included (L-R), Harry Gaul of Motorola, Treasurer, Janet O'Neil of Lindgren RF Enclosures, Vice-Chair, Terry Donohoe of Honeywell, Registrar, and Daryl Gerke of Kimmel Gerke Associates, Chair.



Photo by Janet O'Neil

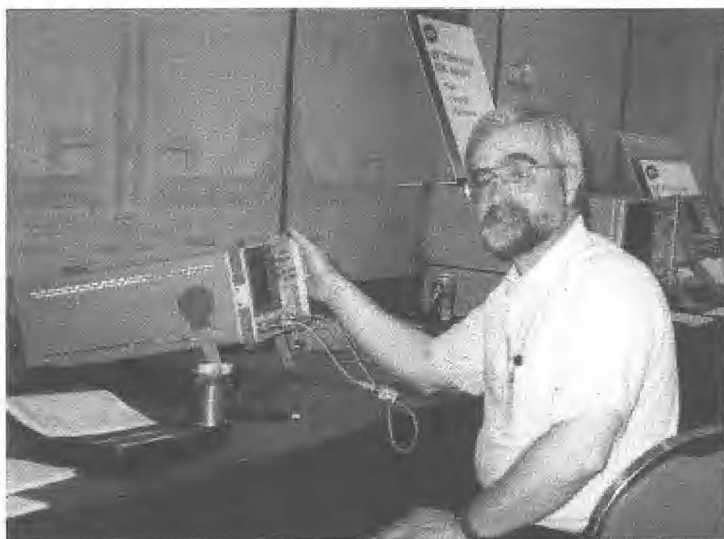
The luncheon held during EMC '99 Arizona was outside on the resort's patio. Who would have thought on May 3 that the temperatures would drop to the low 60s? Shivering are (L-R) Todd Robinson of CKC Labs, Tom Lindgren of BF Goodrich Aerospace, and Vladimir Kraz of Credence Technologies.



It's an all-star line-up of speakers that contributed to the success of EMC '99 Arizona. Seated (L-R) are speakers Bill Ritenour of EMC Compliance LLC and Scott Roleson of Hewlett-Packard. Standing (L-R) are speakers Dan Hoolihan of TUV Product Service, Henry Ott of Henry Ott Consultants, Bill Kimmel and Daryl Gerke, of Kimmel Gerke Associates.



Demonstrations of the material presented during EMC '99 Arizona were held during the reception following the technical program. Bill Kimmel (L) attracted an audience for his demonstration on conducted emissions troubleshooting techniques.



The ever-popular Scott Roleson readied his demonstration on bench-top radiated emissions test techniques just prior to the EMC '99 Arizona reception.

Rocky Mountain

[Thanks to Lyle Luttrell for sending in this report from the Rocky Mountain Chapter.]

We knew the topic of PCB Design would be popular; we were pleasantly surprised that we underestimated the response we would have for our April 21 program on "PCB Design Techniques for Signal Integrity and EMC Compliance". Following a pizza lunch sponsored by TUV Product Service, 71 people filled the meeting room at StorageTek in Louisville, CO for a very interactive four hour session with EMC Society Distinguished Lecturer Mark Montrose of Montrose Compliance Services! Thanks to Mark, we have a better understanding of the linkage of signal integrity and Electromagnetic Compatibility, and many of the issues that the design team needs to consider with the trends of today's technology.

Mark introduced the subject of signal integrity, which is a concern for logic designers, and its relationship to the field of EMC. The PCB designer, EMC engineer, and other design team members have a common goal of ensuring that a functional product is developed for corporate revenue. Signal integrity is a complex issue, and is hard to understand or analyze without advanced engineering education, experience or expensive simulation tools, however the fundamentals are closely related to EMC. While signal integrity is a time domain issue, EMC engineers typically deal with the frequency domain.

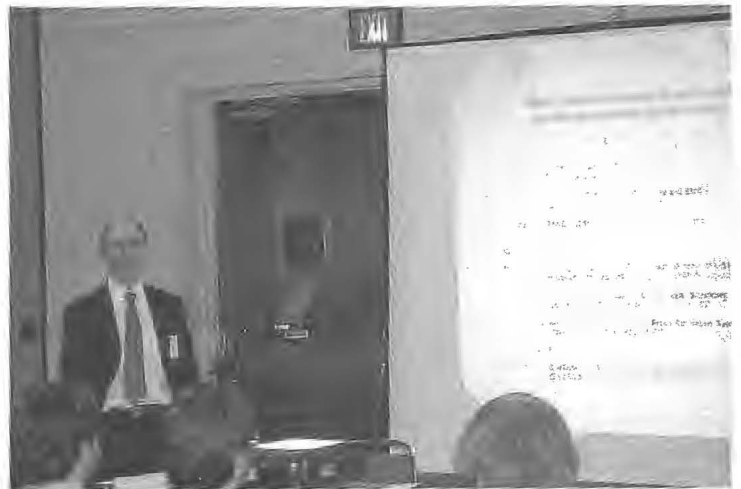
Mark's presentation helped EMC engineers gain knowledge for understanding complex digital designs, related to EMC compliance, along with signal integrity for high-speed, high technology systems. He also raised an awareness of the mechanisms of how EMI is created and propagated within a PCB to help us understand control principles. Mark discussed basic printed circuit board concepts in both the time and frequency domains; this format allowed engineers to understand fundamental concepts and techniques that can be incorporated during the design and layout of a PCB for both signal integrity and EMC compliance. Finally, Mark provided a sampling of design and layout techniques that have a proven track record of success, providing attendees with some valuable information to use on their next project.

Our 1999 Regional Symposium on EMC held May 18th at the Holiday Inn Northglenn was a great success! The Holiday Inn provided an excellent venue for our expanded program. The Technical Program, expanded to a full day event, featured ten papers of exceptional quality. The Workshops and Tutorials included five presentations and technical exhibits by twenty-seven regional and national firms provided attendees with the opportunity to check out the latest products and services for EMC design and testing. Participation by the Colorado Product Safety Technical Committee helped round out the program.

Our attendance of 125 was more than double the event attendance of recent years. Attendees, presenters and exhibitors agreed that this was an exceptional program of



Rocky Mountain Chapter officers welcome Mark Montrose to StorageTek. Left-right are Vice chair Charles Grasso of StorageTek, Chapter Chair Lyle Luttrell of Breece Hill Technologies, Lecturer Mark Montrose of Montrose Compliance Services and Secretary Bob Reinert of StorageTek.



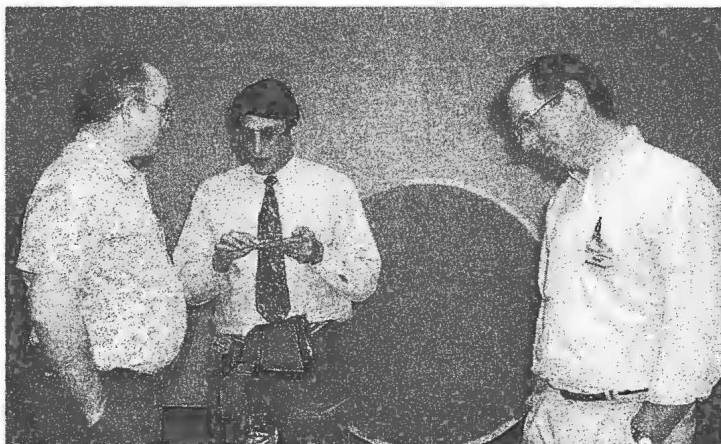
Technical Program Chair Bob German of German Training & Consulting welcomes attendees to the EMC technical session at the Rocky Mountain Chapter's Regional EMC Symposium.



Reid Gardner of Hewlett Packard, Dr. Chris Holloway of ITS/Dept. of Commerce and Barry Wallen of Criterion Technology help themselves to the terrific buffet lunch at the Rocky Mountain Chapter's Regional EMC Symposium.



Chapter Chair Lyle Luttrell of Breece Hill Technologies, right, welcomes Bob Cresswell of Criterion Technology to IEEE EMC Society membership. Bob was one of several new members to join IEEE during the Rocky Mountain Chapter's Regional EMC symposium.



Mark Montrose, center, provides insight on a technical problem with H. Holmes, StorageTek and Brent DeWitt, Datex-Ohmeda at the April meeting of the Rocky Mountain Chapter.



Tutorial and Workshop presenters at the Rocky Mountain Chapter's Regional EMC Symposium: Front row: Eric Lord, David Novotny, Charles Grasso, Otto Buhler, Ron Duffy. Rear: Bob Johnk, Chris Holloway, Ed Reilly, Monrad Monsen, Ray Perez, Greg Rigden, Bob German.

value to EMC and Product Safety professionals. The symposium included a continental breakfast and superb buffet lunch for all registrants, sponsored by Fischer Custom Communications, National Technical Systems, Chomerics,

Amplifier Research, and EMC Test Systems. We did not hear from anyone who left hungry after that lunch!

A complete technical program is available at our web site, with many technical papers available for download.

The site also includes links to exhibitors and sponsor web sites. The site address is <http://www.ewh.ieee.org/r5/denver/rockymountainemc>.

Thanks to everyone that made this a great success! Special thanks to symposium committee and helpers: Lyle Luttrell, Chas Grasso, Bob German, Tony O'Hara, John Stadille, Bob Reinert, Danny Odum, Bill Bryant, and Richard Georgerian.

In other news, the Rocky Mountain EMC Society Chapter was selected as the 1999 recipient of the Society Chapter of the Year award by the IEEE Denver Section. The award recognizes the outstanding services provided by the Chapter to its membership. Lyle Luttrell, chapter chair, attended the Denver Awards Banquet on May 19 to accept the award, which includes an engraved plaque and an honorarium of \$100 for the chapter.

The Rocky Mountain Chapter web site is regularly updated with information on past and future programs with links to other sites of interest for EMC engineers. Our meeting program will resume in September; as meeting information is available it will be published first on our Chapter web site <http://www.ewh.ieee.org/r5/denver/rockymountainemc>.

San Diego Chapter

The San Diego Chapter held a meeting & BBQ on June 16th. Dave Bernardin, chapter chair, reports that they had a great BBQ at the Hewlett-Packard office on Aero Drive. Steak and salmon were served with potato salad, chips and cold drinks. There were three terrific speakers from CASSPER Instrumentation Systems, Inc. Mr. Stephen Watkins CEO/President, Mr. Mike Marino, Vice President Engineering and Mr. Ed Nakauchi, EMC Consultant SARA, gave a presentation on "EMI Ambient Cancellation and Source Localization Technology."

Santa Clara Valley

Mark Montrose reports that the Santa Clara Valley Chapter concluded its 1998-1999 season with two presentations prior to the annual summer break. With a large attendance at the April 13th meeting, Dr. Gary Haussmann of Silicon Graphics Inc., discussed "Solving Real World EMC Problems Using FDTD Modeling Code." An analysis of how the FDTD modeling technique can be effectively used to solve real world EMC problems was presented. Applications ranged from time-domain signal integrity problems, commonly found in high speed circuit design, to the more traditional frequency-domain EMC problems associated with enclosure and printed circuit board resonances, radiation through apertures, and crosstalk.

The May meeting has always been a special one for the chapter, as election of officers occur for the following year. In addition, it has become an annual event for Dr. Zorica Pantic-Tanner, Director of the School of Engineering, San Francisco State University (SFSU) to have students present results of ongoing research projects in EMC and signal integrity (SI). The university has received numerous equipment donations from industry, along with student research grants that have been put to excellent use. EMC concepts have been

integrated throughout the EE curriculum, and expanded laboratory capabilities have given students the opportunity to pursue a high caliber of EMC and SI research. Topics presented include the study in time/frequency domain analysis of PCB crosstalk, minimization of signal integrity waveform distortion using transmission line terminations, and radiated field coupling into shielded enclosures with apertures.

Seattle

The chapter took the month of April "off" and did not hold a meeting as chapter members were encouraged to travel to Portland to support the regional EMC colloquium held there on April 12.

On May 25, the chapter reconvened at the Hyatt Hotel in Bellevue to hear two distinguished speakers, Dr. Jose Perini and Mr. Ken Javor. The speakers presented differing viewpoints on the validity of substituting conducted immunity (CI) approaches for traditional radiated immunity (RI) techniques. Both Dr. Perini and Mr. Javor have investigated and published results on this topic over the last decade.

Dr. Perini's analytical work and numerical simulations conclusively demonstrated the following:

1. Conducted and injected measurements can only be made equivalent at specified ports of a linear reciprocal EUT. This rules out most EUTs with the exception of cables.
2. All injected sources have to be coherent, that is, they are generated by a single generator. This is self-evident since in the radiated test all sources come from the same incident field.
3. The equivalence is true only if the correct injected voltages or currents are used.
4. The voltage sources are determined by leaving the ports open and measuring the open circuit voltage induced by a low level radiated field:
5. The current sources are determined by short-circuiting the ports and measuring the short circuit current induced by the same low-level radiated field.
6. The injected voltages and currents have to bear the correct amplitudes and phases measured in 4 and 5.
7. If these conditions are met, then the voltages and currents at any arbitrary loads placed at the ports will be identical for both tests.
8. Nothing can be said on the voltages and currents induced elsewhere in the EUT. In fact, there is no reason to expect them to be equal since both tests are not electromagnetically the same.
9. For the case of cables, if the correct injected sources are used, the measurements are equivalent at the ports irrespective of the cable length. The voltages and currents elsewhere in the cable differ by over 30 dB in the simulation presented.

continued on page 22



BOB ROTHENBERG
ASSOCIATE EDITOR

Two practical papers are presented in this issue. The first, by Kevin Slattery of DaimlerChrysler, provides descriptions and comparisons of three measurement techniques for VLSI emissions. The second, by EMC consulting engineer Michel Mardiguian, consists of comments on the article by Ken Javor published in Issue No.180 (Winter 1999).

Members of the IEEE EMC Society are encouraged to submit practical papers and articles for publication in this section of the Newsletter. Maximum length is approximately 1500 words plus 6-8 figures. Submissions may be transmitted via e-mail, fax or snail mail. See addresses on page 3.

Comments from readers are also welcome, either as a letter (or e-mail) to the editor or directly to the authors.

Measurement Techniques for the EMI Evaluation of VLSI Devices

K.P. Slattery
DaimlerChrysler

At the heart of almost every EMI/EMC problem is what to do about the source of emissions. These emissions may be causing problems in the surrounding environment through direct radiated interference; they may be showing themselves indirectly through emissions emanating from the module harness; or they may show themselves by creating functional problems within the module circuitry itself. In all cases, the designer needs a method for identifying and then characterizing these emissions. This paper describes three methods for accomplishing this. It is concerned primarily with emissions generated by VLSI devices such as microprocessors, ASICs and other large scale devices that use high speed clocks. Two of the methods to be described are essentially similar, but differ in the frequency range that they address. The third method is complementary to the first two in that, once having characterized the spectrum of concern, the designer can use this method to investigate the geometry of the emissions at the device package and die level.

The Fischer mini-TEM cell has been available for some time now, and has seen use both by end users of VLSI devices, and by manufacturers of the devices. The frequency range is 10 kHz to 1.5 GHz. The device is described in SAE 1752/3, and in [1]. The basic idea is that the device to be measured is attached to a multi-layer PC board with the device on the side interior to the cell, and all supporting circuitry on the flip side, outside the cell. Because the device can now be considered a part of the cell structure, the device itself does not, to any appreciable degree, perturb the field structure within the cell. One then obtains quite good spectral measurements that can be correlated with OATS and anechoic measurements.

The Lindgren OmniCell is a GTEM structure constructed to perform a measurement similar to the Fischer cell. The Lindgren cell extends the range of the measurement to 7-8 GHz, for correlatable measurements, and to 16 GHz for comparative measurements.

The DaimlerChrysler Surface Scan is a technique for scanning a VLSI device at the

package and the die level. Both the magnetic and the electric near fields can be measured. For magnetic measurements, a simple loop fashioned from rigid coax is used and oriented in two orthogonal directions, the resulting data are then combined to arrive at the total magnetic near field. The electric probe is a truncated rigid coax. Both probes are placed to within 100-200 μm of the surface of the device to be measured. 10,000 scan points are typically accumulated at each frequency of interest. This results in scan steps of approximately 70-100 μm . Structural resolution has been determined to be on the order of 100-200 μm . While this cannot resolve individual transistors, it does offer a means for scanning and characterizing functional areas within the device, such as PLL, CPU, memory, A/D, etc. Additionally, the Vdd/Vss topology and related emissions can be measured.

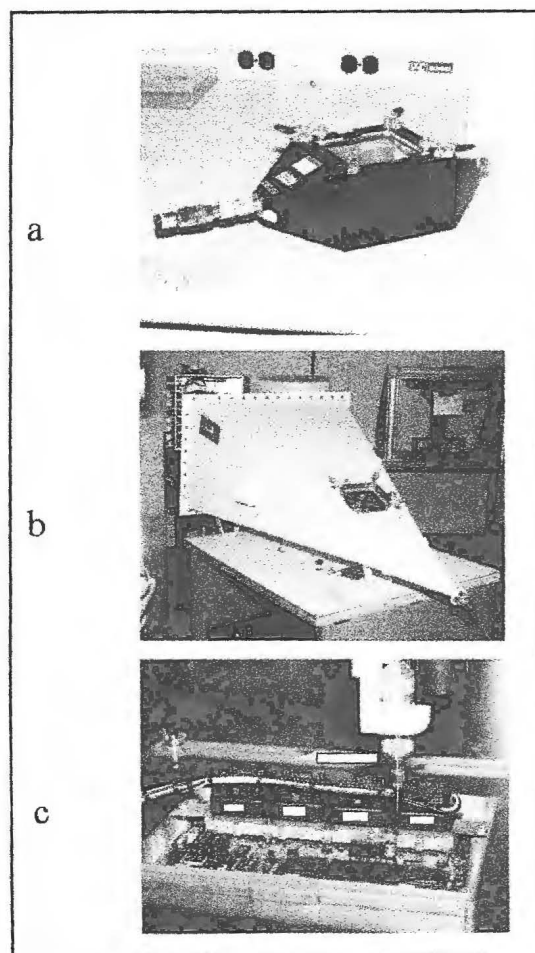


Figure 1. a) Fischer mini-TEM cell b) Lindgren OmniCell c) DaimlerChrysler Surface Scan.

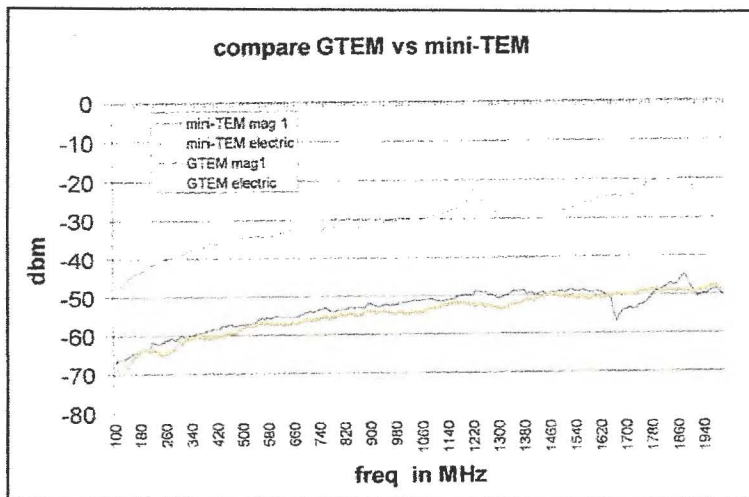


Figure 2. A comparison of the mini-TEM and the GTEM, 100-2000 MHz, electric and magnetic field.

Figure 1 shows the three devices that will be discussed. Figure 2 shows a set of measurements taken in both the mini-TEM and the OmniCell GTEM. The measurements were made using an electrically small electric monopole, and an electrically small magnetic loop. Observation of the resulting plots shows that both devices have a linear response through the range of measurement. However, the GTEM is clearly more monotonic than is the mini-TEM above 1200 MHz. Equally obvious is that either device can be used in the range 100-1200 MHz without any fear of one device giving a set of data different from the other device.

Figure 3 shows the measured data, using the same electric and magnetic probes, for the GTEM through 10 GHz. The GTEM is seen to be monotonic through approximately 7 GHz, after which the response levels off and then starts decreasing. This effect is assumed (at present) to be due to wall losses in the GTEM becoming predominant. However, it should be noted that the magnetic and electric fields maintain a reasonably constant relationship until 8 GHz.

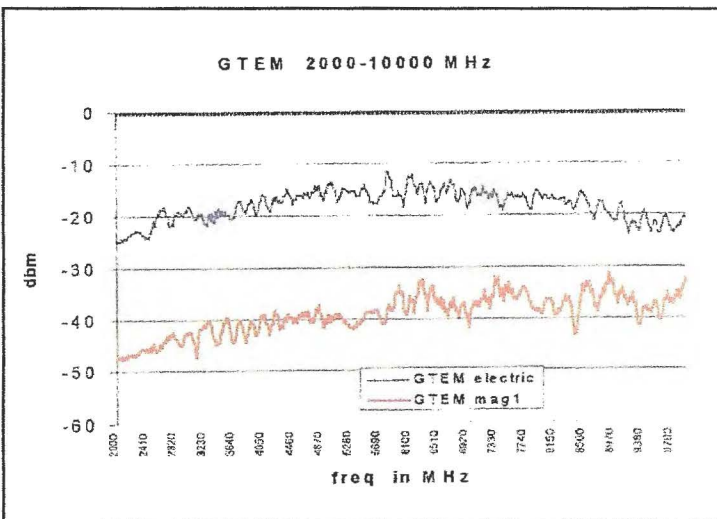


Figure 3. The GTEM, over the range 2000-10000 MHz, electric and magnetic field.

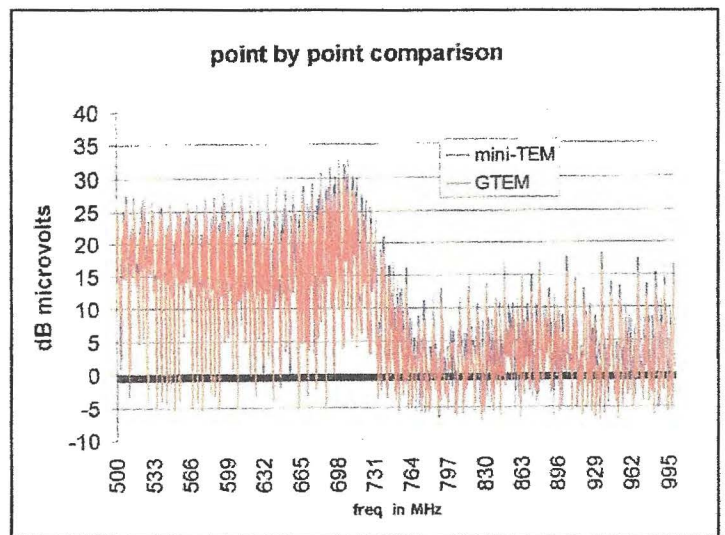


Figure 4. A comparison of measurements taken from a 16 bit microcontroller, operating at 16 MHz, mounted on a BGA.

Figure 4 is a comparison of measurements made in the GTEM, and in the mini-TEM, of a 16 bit microcontroller running at 16 MHz, over the range 500-1000 MHz. Because of the density of spectral components it is difficult to do a point by point comparison of the results. Figure 5 is a plot of the same data sets, but the spectrums have been smoothed using a 16 point moving average.

As Figure 5 shows, both devices give approximately the same response. The interested reader is directed to [2], [3] where the mini-TEM cell is discussed in greater detail, and a better appreciation of the cell's applications can be gained.

The plots in Figures 6 and 7 show the Daimler-Chrysler Surface Scan images from the same 16 bit microcontroller that was measured in the GTEM and in the mini-TEM cell, scanned at 32 MHz (Figure 6) and 80 MHz (Figure 7).

These images are comprised of 10,000 scan points taken over the surface of the entire BGA package, 17 mm by 27 mm, with the probe at a distance of 150 μ m. The peaks have been truncated to better show some of the underlying detail. Notice the differences between the mag-

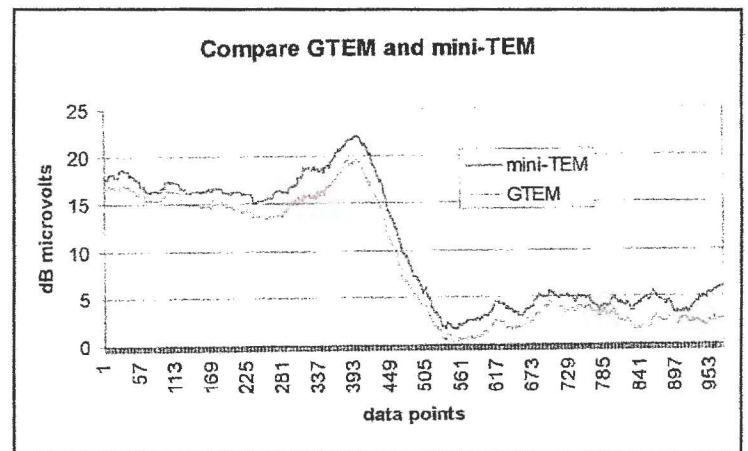


Figure 5. Same measurement as Figure 4. The data has been smoothed with a moving average taken every 16 data points for better comparison.

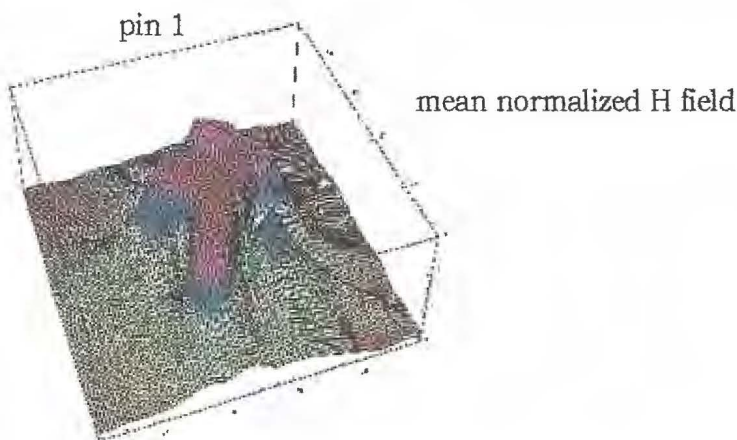
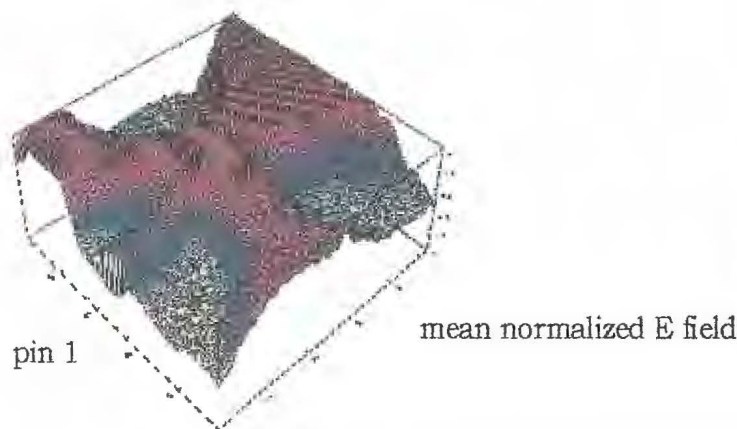


Figure 6. Surface Scan images of a 16 bit microcontroller, operating at 16 MHz, scanned over the entire BGA package at 32 MHz, magnetic and electric near field.

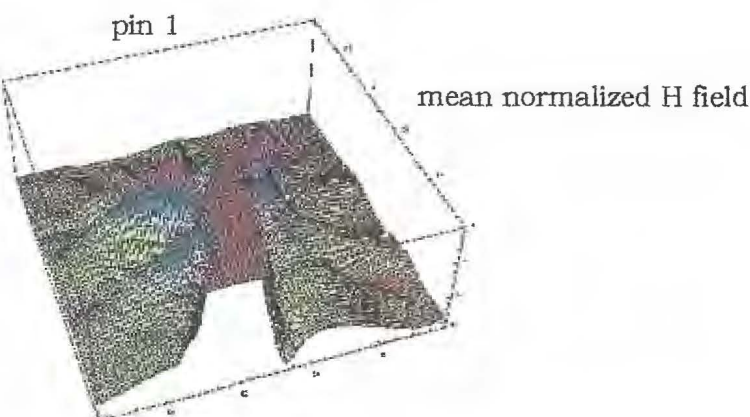
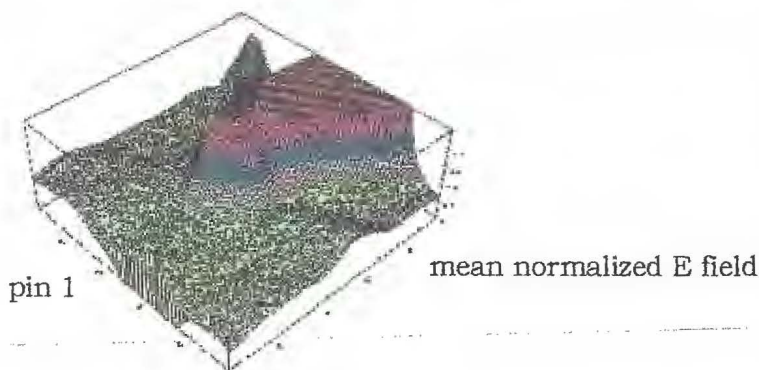


Figure 7. Surface Scan images of a 16 bit microcontroller operating at 16 MHz, scanned over the entire BGA package at 80 MHz, magnetic and electric near field.

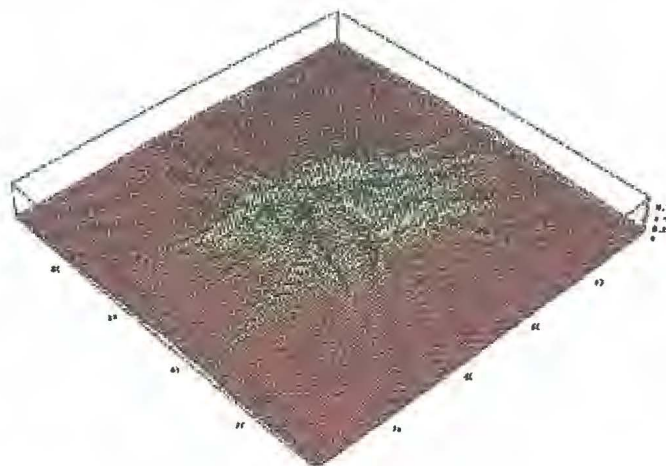


Figure 8. Second derivative of the magnetic field over the 16-bit processor BGA, at 64 MHz.

netic and electric field distributions at the two frequencies shown. Clearly, the current distributions within the device are markedly different as a function of frequency.

Figure 8 shows some of the image processing that can be done with the data array generated with Surface Scan. We have taken the discrete array of the measured magnetic field at 64 MHz, imported it to Mathematica, a commercial software package, and generated a continuous function of two variables. We then differentiated this function, arriving at a secondary function related to the magnetic density over the VLSI device. This is shown in the figure. Using this method, further detail within the package, and deep within the die, can be seen. For instance, certain Vdd and Vss pin pairs can be seen to be more pronounced than others. Using this technique on a different device, and working with the manufacturer, we were able to reduce the module level emissions by 8-10 dB by rearranging the functional floorplan and modifying the power and ground feed to the digital core of the device.

Summary

By working at the VLSI device level to reduce system and module level EMI, the designer can have a large economic impact on the EMC of a product. By characterizing and mapping the emissions from the dominant source in a module, the EMC engineer may be able to identify and thereby mitigate EMI at the package and die level. By reducing the EMI at the source, EMC fixes introduced at the PCB level may be eliminated, thereby reducing the manufacturing cost and easing the manufacturability of a product.

References

- [1] Investigation of the Theoretical Basis for Using a 1 GHz TEM Cell to Evaluate the Radiated Emissions from Integrated Circuits, Muccioli, North, Slattery, 1996 IEEE International Symposium on EMC, Santa Clara, CA
- [2] Measuring the Radiated Emissions From a Family of Microprocessors Using a GHz TEM Cell, Slattery, Muccioli, North, IEEE Transactions on EMC, May 1999, Volume 41, Number 2
- [3] Characterization of the RF Emissions from a Family of Microprocessors Using a GHz TEM Cell, Muccioli, North, Slattery, 1997 IEEE International Symposium on EMC, Austin, Texas



Kevin Slattery is responsible for Module EMC analysis and testing at DaimlerChrysler Electronics in Huntsville, Alabama. Previously, Mr. Slattery spent 14 years at the Stanford Linear Accelerator Center, designing high speed timing electronics and particle transport systems. He can be reached via e-mail at kslattery@aol.com

Comment on Javor's "Investigation into Radio Susceptibility to Power-Line Conducted Noise"¹

by Michel Mardiguian

Ken Javor's paper is interesting in many respects. If nothing else, it is an example of what a good engineering attitude should be: don't rest on acquired ground just because it was established 25 years ago as a standard; question it periodically and ask if the premises are still valid. Then, only if it survives a thorough re-check, keep using it.

However, in this case, I must disagree with Javor on his interpretation of the CBEMA study² which was the essential foundation for CISPR 22, hence FCC, emissions limits on computing equipment. Javor assumes that, back in 1977, power line CE investigations and modeling were made considering that power return and power earthing reference were a same conductor, such as a one-LISN configuration would represent actual installations. This is not correct. Looking at Figure 5.7 and paragraph 5.6.2 of the CBEMA study, it shows that the "ungrounded neutral" case was taken into account as well, resulting in a 6 dB reinforcement of the limit (see Table 7.1 of CBEMA study). Accordingly, as noted by Javor, the CE setup for single phase (Figure 10.8 of CBEMA) clearly has the two LISNs, as it is practiced today, 25 years later.

The issue remains that CBEMA regarded this as a case for reinforcing the limit, not relaxing it. Let us examine this. Assume, for instance, that the TDI (Threshold for Audible Interference) was found as: $V_{T(50\Omega)} = 1\text{mV}$ with a

single LISN type of audio survey (Figure 1). This means that the receiver was, for frequencies below 1 MHz (we are in an AM broadcast scenario), more heavily attacked by Differential Mode (DM) injection than by Common Mode (CM) injection.

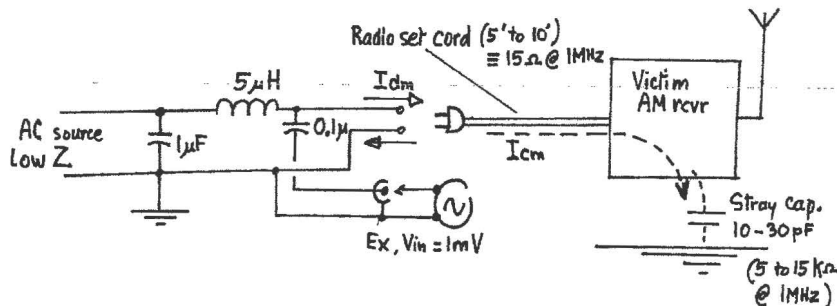


Figure 1. Typical set-up for evaluating TDI.

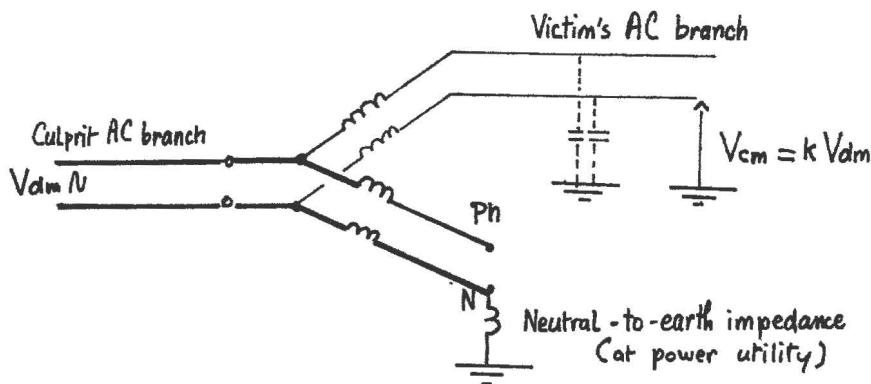


Figure 2. DM voltage to CM Voltage conversion along AC distribution.

tion. (The CM loop impedance is quite high at these frequencies, with a floating AC receiver, i.e., less CM current for a given LISN-injected voltage.) However, the DM current path is easily trapped at the receiver AC input by the simple power supply filtering circuit, while the CM current path is uncontrolled, returning by the parasitic capacitance of the radio set PCB to ground and likely doing more harm. The assumption in the CBEMA study was that *if the same noise had been injected in phase opposition on line 1 (Ph) and 2 (N), the radio would have seen 2 x Vr*.

If the EMI source is a high-Z one (i.e., typically CM, below a MHz), Vr1 and Vr2 are equal, but not out-of-phase, and the victim receiver sees only Vr through a high-Z path. If the EMI source is a low-Z one (as typically DM), the two voltages will indeed add up. This is why the -6 dB adjustment was made.

I think that the real danger, not spelled out in the CBEMA study but certainly implicitly thought of, is that of mode conversion in the utility wiring (urban power distribution inside buildings), where a purely DM-originated noise creates, after some distance, a CM component. Power distribution schemes, especially in Europe, exhibit large variance. Some are using *Impedant* or *Isolated Neutral* schemes whereas the Neutral point at the step-down utility transformer is not grounded, causing a mode conversion (Figure 2) with an efficiency which can be greater than -20 dB. Thus, the 20dB derating factor proposed by Javor may not be safe, after all.

Another aspect is a statistical one: it is not sure that the radio sets which are in the upper percentiles of the Vdm TOI (dm mean + 1σ) are the same ones which have the highest Vcm TDI (cm mean + 1σ). If we allow for Murphy, the prudent approach would be to consider that a certain percentage of Javor's radio set population had TOI which were a mix of (cm mean + 1σ) and (dm mean - 1σ). In this case, the relaxation for DM-only emissions could probably be of 10 dB (instead of 20), which is still substantial in frequency regions where dBs are expensive to get. Notice that the CISPR 22B limit shown in Javor's Figures 8 and 10 is wrong; since we are dealing with NB EMI, the average limit of 46 dBμV (close to FCC) should be considered, and not the 56 dBμV quasi-peak limit, as shown.

Finally, another critical aspect not specifically addressed by Javor, but clearly foreseen by CBEMA, CISPR and FCC, was that the conducted limit does not simply protect receivers from power-cord-injected RFI. It also protects from *power line radiated RF noise*, received by the radio set aerial (ferrite coil antenna for AM). It is not clear in the experiment how much of an effect this played, but I suspect that being in a shielded room, the radiating portion of the power line was short. In actual situations, in the near field of a long wire from a perfectly conductive ground, the radiated H field amounts to:

$$H(A/m) = I / 2\pi R \quad (\text{Eq. 1})$$

Taking the existing CISPR limit of 46dBμV, converted into CM current via the two LISN in parallel, we get:

$$I(\text{limit}) = 46 \text{ dB}\mu\text{V} - 28 \text{ dB}\Omega = 18 \text{ dB}\mu\text{A}, \text{ or } 9\mu\text{A}$$

Setting 9μA for I in Eq. 1 produces at 3 cm (Class B distance): $H \approx 0.5\mu\text{A/m}$.

Translated artificially into an equivalent E field, using 377Ω, we get 181μV/m or 45 dBμV/m. The lowest protected useful field in the CBEMA study was 48 dBμV/m, quite close, and this is no mere coincidence.

References

- [1] K. Javor, "Investigation into Radio Susceptibility to Power-Line Conducted Noise," IEEE EMC Society Newsletter, no. 180, pp. 15-20, Winter 1998.
- [2] CBEMA ESC-5 Subcommittee Report: "Limits and Measurement of EM Emanations from EDP and Office Equipment," May 1977.



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Chapter Chatter

Continued from page 16

Photo by Janet O'Neil



The Seattle Chapter treated its members to two outstanding speakers AND a delicious three-course meal at the May meeting. What a way to close out the regular monthly program of meetings from September through May! Celebrating the intellectual and culinary feast are (L-R) speaker Jose Perini, Kitty Tam, Leo Smale, and speaker Ken Javor. Kitty represented Northwest EMC while Leo represented Kalmus, the two companies who generously sponsored the dinner.

10. The simulation shows that even if the cable is $2/3$ rd of a wavelength the statement o of 9 is true.
11. The simulation shows that for cables of the order of $1/15$ th of wavelength then the results are within 5 dB everywhere in the cable.
12. In light of all these difficulties, it is suggested that for the cases where radiated tests are not physically possible or difficult to apply, an injected test be specified and appropriate limits be derived for it. Using the radiated test limits, arbitrarily, without any solid justification, is not appropriate or wise.

Mr. Javor stated that when cables are electrically long there is no way to inject a conducted signal in such a way as to replicate the precise pattern of standing waves induced by a radiated field. He also stated that such a degree of accuracy was unnecessary. Mr. Javor made the following points:

1. The conducted simulation was best at frequencies where the cable-under-test (CUT) was electrically short, and a lumped element technique was an accurate simulation of field-to-wire coupling. Mr. Javor presented test data showing good agreement between RI and CI techniques at low frequencies.
2. The substitution of CI for RI techniques is absolutely necessary when the CUT is both a) electrically short, and b) the CUT is shorter than the cable in the final installation.
3. The concept of substituting one test for another does not require absolute equivalence, but rather that the substitute test provides a worst case bound on the results that would have been obtained from the original test.

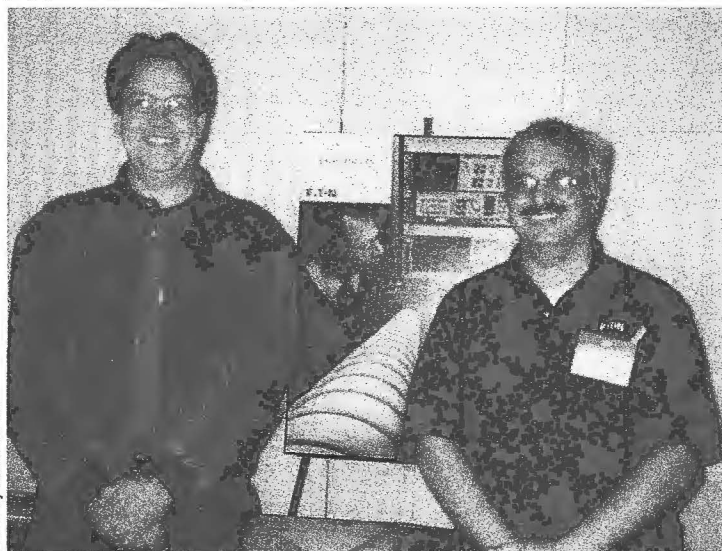
Mr. Javor's position is that there has to be a linkage between the CI and RI tests since the CI test is a means for demonstrating compatibility with an electromagnetic field environment.

This was the first time a chapter meeting featured two speakers who presented different perspectives on the same topic. It was quite a spirited and thought provoking evening! The format is highly recommended to other chapters.

The Seattle chapter wisely decided to cancel the traditional summer social meeting as the chapter officers and several chapter members would be "knee-deep" in planning a slightly larger summer social - the 1999 IEEE International Symposium on Electromagnetic Compatibility in downtown Seattle.

Southeastern Michigan

Photo by Janet O'Neil



Southeastern Michigan Chapter members attended the April 26-27 SAE TopTec on Automotive EMC in Novi, Michigan. Scott Lytle and Mario Mifsud manned the Eaton table top display. Can you spot EMCS Board member Kimball Williams in this photo?

Photo by Janet O'Neil



EMC Society member Poul Andersen of DaimlerChrysler and Kin Moy of Delphi Automotive Systems/Packard Electric were part of the organizing team for the SAE's only technical conference devoted exclusively to EMC.



Tom Volpe of Retlif Testing Laboratories supported the SAE TopTec on EMC. Janet O'Neil dropped by his table top display to see what's new with EMC automotive testing.

Sweden

Stellan Stenmark, Secretary of the Sweden chapter reports that the topic of their April meeting was *EMC -reliability, a necessity for vehicle technology*. The meeting was held at Volvo in Gothenburg and it was attended by more than 40 people. After ordinary proceedings, the attendees had the honor of listening to Dan Hoolihan, President of the IEEE EMC Society.

Dan talked about the IEEE and the EMC Society in particular. He gave a very interesting historical review of the organization from the start at 1884 with AIEE to the IEEE organization of today with a number of Regions and Societies. After lunch, Dan presented the status of the new proposal for ISO Guide 25.

Hakan Berg of Volvo Car Corporation presented *EMC Aspects of Future Vehicle Electronics*. His presentation provided an overview of the complexity of future vehicle technology. It also highlighted the challenge of intrasystem EMC.

Bjorn Bergqvist of Volvo Car Corporation presented *The Car - A Society in Miniature*. His presentation gave ev-



EMC Society President Dan Hoolihan attended the meeting held by the Sweden Chapter of the EMC Society. He is welcomed at the meeting by the current chapter officers including (left to right) Stellan Stenmark, Per-Olof Eriksson, Jan Carlsson, and Dag Bjorklof.

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Jonas Bergqvist of Saab Automobile AB gave a presentation on *EMC Experiences with the Implementation of the CAN-Bus*. After defining a CAN Bus he provided an overview of the application in a Saab 9-5 and also showed the physical layer implementation. The EMC approach was given particular attention and design and validation requirements were presented. A simulation method for stub analysis was discussed and a detailed description of the EMC/ESD filter design was given.

Dag Bjorklof, chair of the EMC Sweden chapter, gave a presentation on *Some Experiences with Round Robin Tests* and summarized the meeting. Special thanks go out to the host, Volvo Car Corporation, and to Daniel Hoolihan.

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DR. WILLIAM G. DUFF
ASSOCIATE EDITOR

Dawn Trout started her EMC career at NASA's Marshall Space Flight Center (MSFC) in Huntsville, Alabama in 1989. MSFC is the NASA center for propulsion, space transportation, micro-gravity research and optics. During the first year she designed and developed a power supply using SPICE based modeling to examine the EMI characteristics of power supplies. This provided her with a foundation for future EMC work.

After supporting NASA Shuttle-based payloads in the electromagnetic compatibility area, Dawn took the lead NASA EMC role for Space Station Module development in Huntsville. This offered a variety of challenges, especially in the areas of identifying and verifying critical circuits (circuits whose failure to operate properly could cause loss of life or loss of the vehicle).

In 1993, Dawn authored the EMC Design and Prediction Techniques Section of the MSFC EMC Design and Interference Control Handbook. This handbook includes design, analysis, and trouble-shooting techniques to aid electrical engineers to meet the NASA EMI requirements. Dawn and her co-authors (Tony Clark, Matt McCollum, and Ken Javor) received the NASA Research and Technology Award for this effort. She and her teammates are still using the laboratory developed during this activity to work on specialized EMI testing procedures for NASA programs.

After the Space Station Freedom was re-designed into the International Space Station (ISS) which included Russia as a partner, Dawn was the principal negotiator with Russia for the EMC area. This work included performing detailed analytical comparisons of the Russian and US standards, developing test techniques to model the Russian power system and writing and performing EMC procedures so that US payloads could fly on the Mir. This work evolved into negotiations of the EMC requirements for the Russian Segment of ISS and the system level integration analysis and testing. Dawn also performed testing on Russian coatings to assess their bonding conductivity for Space Station interfaces. In addition,



Dawn Trout

she is the lead for developing EMC requirements and analysis for ISS payloads. In 1996, Dawn received the NASA Medal for Exceptional Achievement.

In 1998, she became the team leader for the Electromagnetic Environmental Effects group at MSFC. In this role, she led a team of civil servant and contractor engineers in the areas of EMC, Spacecraft charging, and Lightning for MSFC and NASA programs.

Dawn is currently the lead of an International Organization for Standardization (ISO) standard, "Space Systems – Electromagnetic Compatibility Requirements." She and her co-leader, Noel Sargent, lead international meetings with representatives from France, Italy, Japan, Russia, Germany, China, the European Space Agency, and the IEC. Also, Dawn is the NASA Liaison in a related activity, the DoD and Industry E3 Standardization Committee, which evaluates commercial standards and makes recommendations about their use on military platforms.

Dawn is active in the NASA Space Environments and Effects (SEE) program managed by Steve Pearson at MSFC. This program is dedicated to developing technologies in the environments area that are needed for future space systems. Dawn has developed concepts and led contracts in the areas of critical circuit verification processes, spread spectrum EMI test techniques, power-line transient test techniques and most recently developing analytical transfer functions for commercial versus military test techniques.

In July of this year she will transfer to Kennedy Space Center at Cape Canaveral, Florida where she will continue her EMC career at the Expendable Launch Vehicle Office. Dawn will also continue her work with the ISO standard and remain active in the SEE program.

Dawn began her education in the nursing field at the Methodist Hospital School of Nursing becoming a registered nurse in 1985. She worked as a nurse while going to school under the Herff Engineering Scholarship for her Electrical Engineering Degree

at Memphis State University. She graduated Summa Cum Laude with the Engineering Department Dean's award in 1989. Dawn continued her education at the University of Alabama in Huntsville while working for NASA and received a Masters Degree in Engineering with a Major in Electromagnetics in 1995. Her thesis was the "Relationship between induced currents from bulk current injection techniques versus radiated electromagnetic field illumination." In April of 1999, she completed the NARTE exam and became NARTE certified.

Dawn is a member of the IEEE and the EMC Society. She has participated in several EMC Symposia and presented a paper related to bulk current injection (BCI). The IEEE EMC Symposia have allowed her to establish multi-

national contacts that have been crucial in the development of the ISO standard. She has also been active in side committee meetings at the IEEE EMC Symposia, such as the G-46 committee. She has taken advantage of multiple training opportunities offered by the IEEE in the Huntsville area and plans to become an active member in the Florida area.

Dawn and her husband are looking forward to Florida sunshine and beaches. They enjoy warm weather activities such as swimming, running, boating and biking, as well as a yearly trip to the Rocky Mountains for snow skiing.

Dawn says she will sincerely miss her teammates at MSFC.

Board of Directors Activities

Board Meeting, Friday, May 21, 1999

Chuo University Surugadai-Kinen-Kan Memorial Hall, Tokyo, Japan

Call to Order

President Hoolihan called the meeting to order at 1:00 pm. He welcomed everyone to Japan. A round of introductions was made. Board members present included Dan Hoolihan, Janet O'Neil, Len Carlson, Todd Hubing, Don Heirman, Kimball Williams, Bill Gjertson, Joe Butler, Andy Drozd, Tom Chesworth, Dick Ford, Henry Benitez, Mark Montrose, Don Sweeney, Dave Traver, Takeo Yoshino, Elya Joffe, David Millard, Don Bush, Ghery Pettit, and Doug Smith. Absent Board members were Warren Kesselman, Norm Violette, Henry Ott, Ferdy Mayer and Bill McGinnis. Guests included Gao You-gang and Shuichi Nitta. The agenda was presented and approved as modified.

President's Report

President Hoolihan reported on the various Board activities during the week, including the demonstrations arranged by Andy Drozd and the technical workshops presented by Henry Benitez and Mark Montrose. The Board hosted reception was well attended and resulted in many new acquaintances for Board members with the international EMC community. President Hoolihan thanked Professor Yoshino for his assistance with all arrangements for the reception and the Board during the EMC conference.

President Hoolihan reviewed the results of the Executive Committee meeting on Tuesday, May 18. The Board meeting schedule was determined for the year 2000. Doug Smith and Elya Joffe volunteered to speak to the chapters during any chapter meeting scheduled in conjunction with the Board meetings. Don Heirman advised that there would



Photo by Dick Ford

During the reception the EMC Society Board of Directors hosted in Tokyo, President Dan Hoolihan had the opportunity to informally socialize with the Chairman of the EMC '99 Tokyo conference, Professor Nitta (L) and Professor Takeo Yoshino (R), EMC Society Board member.



Photo by Dick Ford

The demonstrations provided a unique opportunity for EMC Society Board members to interact with international EMC engineers who attended EMC '99 Tokyo. Elya Joffe, Y. Fukumoto, Henry Benitez and K. Takahashi (front, left to right) found that the EMC "language" is truly universal.



Professor Hokama, President of Chuo University, delivered the EMC '99 Tokyo welcome address.

be a four-hour Standards Committee meeting prior to the Board meetings scheduled in the year 2000.

Regarding the IEEE Millennium Awards, President Hoolihan advised that the EMC Society is entitled to 17 awards. The deadline for the award submittals is October 1. Send any comments or criteria ideas for recipients of these awards to President Hoolihan. More information about the awards and criteria, etc.

may be found by visiting the following IEEE Web Page: mmedalsnom.txt@ieee.org.

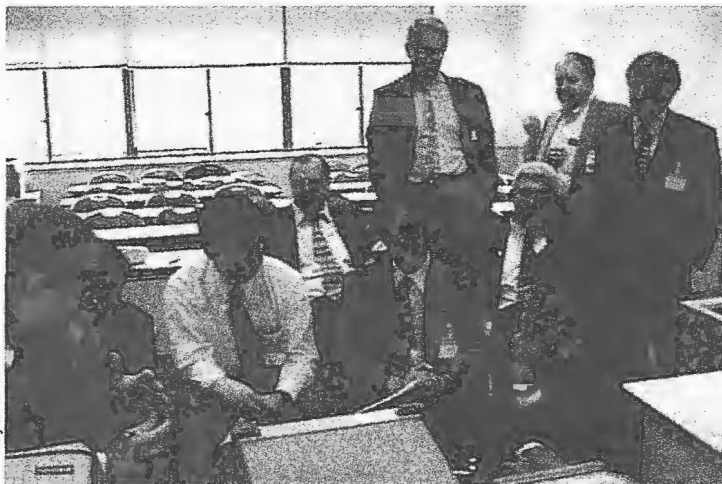
Treasurer's Report

President Hoolihan presented the Treasurer's Report in the absence of Treasurer Warren Kesselman. The 2000 budget meets the IEEE guidelines to show a projected increase in surplus of 3%. For the EMCS, this equates to a net surplus of \$148K. The 2000 budget will be formally approved at the August Board meeting.

A new EMCS "Travel Policy" was discussed wherein Directors and Officers residing in IEEE Regions 8, 9, or 10, may be granted a subsidy equal to 80% of reasonable total costs for transportation, lodging, associated EMC conference registration, and food expenditures to attend Board meetings held in IEEE regions other than the region where they live. Directors and officers residing in IEEE Regions 1 through 7 may be granted a similar subsidy to attend Board meetings in Regions 8, 9 or 10. This policy will be invoked on a trial use basis starting with the August 1999 Board meeting and ending in December 2000. The Board then determined an implementation and exclusion policy to apply to the "Travel Policy."

Member Services

Todd Hubing, Vice-President for Member Services, presented his report. He advised that Scott Roleson would like to retire as Chairman of the Distinguished Lecturer (DL) program. Anyone interested in this position should contact Mr. Hubing. The newly elected DLs are Mark Montrose, Michel Mardiguan, and Elya Joffe. Andy Drozd presented a brief report on the IEEE Membership Development Retreat that he attended in February. Mr. Hubing moved to eliminate the International Committee and establish membership committees for IEEE Regions 8, 9 and 10, each having its own chairman. Regarding PACE, Bill McGinnis is the new PACE chairman. He will attend the annual PACE meeting this year and will report at a future Board meeting. Dick Ford spoke about the survey committee. He advised that \$10K is required to budget for a survey per the advice of the IEEE's Henry Shein. This will be performed during the year 2000 and will



Thanks to the efforts of EMC Society Board members Andy Drozd and Dave Traver, among others, the EMC Society organized the popular EMC demonstrations during EMC '99 Tokyo. Shown viewing the action are (front row left to right) Don Bush, K. Takahashi, T. Watanabe, T. Chiyojima, and Y. Fukumoto. Seated behind are E. Baum and Elya Joffe. Standing are M. Stecher, D. Hansen, and G. Mryzynski who all traveled from Germany to attend the conference.



Rosemary and Dan Hoolihan really got around on the Tokyo subways during their visit to EMC '99 Tokyo.



The EMC '99 Tokyo committee held a banquet at the Grand Palace Hotel for the conference attendees. The tables were laden with a variety of delicious, traditional Japanese dishes. Conference attendees await the presentation by the conference chairman, Professor Nitta.

be budgeted accordingly. Mr. Ford requested suggestions for survey promotional items. Regarding the Constitution and By-laws, Bill Gjertson presented a summary report. As Chairman of the Nominations Committee, his committee has a slate of 12 names for the ballot for new Board member positions for the years 2000-2002. Mr. Gjertson advised that there are three ways for a name to be included on the ballot for the EMC Board of Directors as follows: 1. Nominated by the Board or the Chapter Chairman, 2. Petition for nomination using the 15 signatures required, or 3. Be slated by the Nominating Committee (only item 2 requires the 15 signatures). The cost for the ballot was reviewed. President Hoolihan requested that Mr. Hubing budget for electronic balloting for the year 2000. Michael Adler's outreach letter detailing the IEEE's goal of increasing the number of chapters globally, starting with Region 8, was reviewed. Mr. Adler states in the letter, "I believe local activities are a key benefit of IEEE membership and if we expand our base I believe we will also expand our membership." Regarding Awards, Mr. Hubing made a motion to present the 1999 President's Memorial Award in memory of Dick Schulz. This was seconded and approved. The IEEE approved the Board's request to increase the award amount to \$2,000.

Communication Services

Len Carlson, Vice-President for Communication Services presented his report. Janet O'Neil, Newsletter Editor, discussed the Newsletter in general and requested the Board's assistance in encouraging members to contribute practical papers for inclusion in the Newsletter. Andy Drozd, Web Master, presented a report. He is attempting to coordinate all the Society WebPages and set standards/establish guidelines for commercial issues (i.e. corporate logos). Moto Kanda, Transactions Editor, will have a special issue this year on EMC in Germany. This follows what he did last year with his special issue on EMC in Italy (covering lightning). Next year, he will have a special issue on



Photo by Janet O'Neil

The EMC Society Board of Directors held a reception during the EMC '99 Tokyo conference to "network" with the international EMC community. Board member Elya Joffe (L) is shown with Diethard and Rosemary Moehr. Mr. Moehr of Siemens AG in Germany is the secretary of IEC TC-77 (EMC).

EMC in Japan. Henry Ott, Symposia Chairman, submitted a report, which was presented in his absence by Len Carlson. This included several motions related to EMC symposia activity. Bill Gjertson, Chairman of the 1999 EMC Symposium, gave a brief report. Dick Ford reported for Bill Duff, Chairman of the 2000 EMC Symposium. The Symposium Committee wants to increase student attendance and has plans in place to do this. Extensive media coverage is also planned. Elya Joffe reported briefly on the Israel Symposium in 2003. A brochure for the symposium venue, the David Inter-Continental Hotel, was distributed. Joe Butler reported on the 2003 conference in Boston. He advised that the hotel and venue have been selected. The Hynes Center will house the exhibits.

Standards

Standards Vice-President Don Heirman presented his report. He reviewed the activity related to standards during meetings held in Japan. There were 22 people at the meeting so international representation was present. Complete elections will be held at the Seattle Symposium.



Photo by Janet O'Neil

Diethard Hansen of Euro EMC Service in Germany visited with Lih Fang Chew of Schlegel Systems in Rochester, New York during the Board reception in Tokyo.



Photo by Janet O'Neil

At the Board's reception in Tokyo, Carsten Probol of the Dresden University of Technology in Germany (L) is shown discussing an EMC theory with Jan Adolfsson of SEMKO AB in Sweden.



The Transactions on EMC Editor, Moto Kanda, attended EMC '99 Tokyo with his wife, Yoko, and his daughter, Carol. Mr. Kanda appreciates interacting with the global EMC community in order to attract good papers for the Transactions.



At the EMC '99 Tokyo banquet, Dan Hoolihan shared a Japanese beer with past EMC Society Board member Dr. Risaburo Sato. Dr. Sato was a "special member" of the conference organizing committee.

Technical Services

Kimball Williams, Vice-President for Technical Services, presented his report. He discussed the symposium paper review process in detail. New procedures for this process are being explored. He would like the Board members to review this new process, which includes electronically reviewing the papers. Reviewing the papers electronically can reduce the review process by up to 30 days, which can be required for distributing material via regular mail. RAC will be holding a special session on wireless EMC during the Seattle Symposium. Mr. Williams' report also includes the VP Technical Services budget through the year 2006.

Secretary's Report

Secretary Janet O'Neil presented the minutes from the last Board meeting held in November 1998. There was one correction to add the name of Tom Chesworth under "Members Absent" on the cover page of the minutes. The minutes were approved as amended. Next, the action items from the current and previous meetings were reviewed.



EMCS Board member Dave Traver pauses near the entrance to the EMC '99 Tokyo venue, Chuo University, Surugadai Memorial Hall. The azaleas were in full bloom in Japan during the conference. Just a hint of these beautiful flowers is visible in the lower left of this photo.

There being no further business, the meeting was adjourned at 5:10 pm.

Janet O'Neil

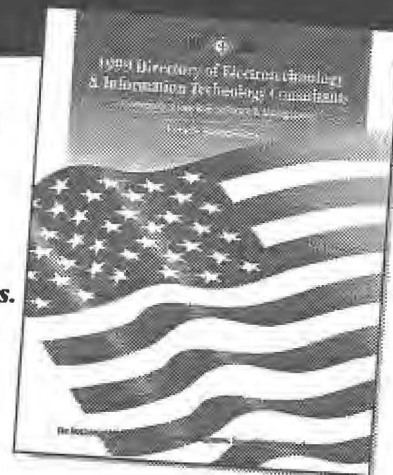
Secretary, EMC Society Board of Directors

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Honors from one's peers are always sweeter. The IEEE Third Millennium Medals — presented in the year 2000 with nominations now open — are such a sweet celebration.

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World renowned sculptor Gladys Gunzer created the medals. Her work includes the 1984 IEEE Centennial Medal and the 1980 Winter Olympics Medallions.

The design will include a world map symbolizing the global nature of the IEEE and the words "In Celebration of the Third Millennium." Each award is customized with the recipient's name.

"I would like to see hundreds of celebrations next year, each one honoring special members while marking a special year," said IEEE President-elect Bruce Eisenstein. He has called upon sections, societies and major boards to nominate their most deserving members to receive this prestigious award.

Letters were sent out to the societies, sections and major boards and it is now up to them to decide who among their peers should receive this honor. "The reaction I've gotten is very positive," said Eisenstein.

The criteria for members to be named a Third Millennium Medal recipient includes outstanding contribu-

tions to a section, community, chapter, area of technology or outstanding contributions to their board. Eisenstein said he favors a more open criteria to enable each entity to decide for themselves who should be selected. "It's hard to dictate from the top what would be good for everyone," he said. Each entity will use their own awards processes to name nominees.

The number of awards allotted to the societies and sections is based on its population, excluding students and associate members. (Each of the six boards will be given five medals.) This allows each entity to receive a proportionate amount of awards. Also, the Awards Department has established a database that will track, among other things, whether the same member is nominated twice and further ensure equitable distribution.

The IEEE Centennial Medals were presented in 1984 to 1,984 members to commemorate the 100th anniversary of the IEEE's earliest predecessor society, the American Institute of Electrical Engineers in 1884. In 1984 the Institute had a little over 260,000 members. Today, the Institute boasts a membership of over 335,000 members and 3,000 medals will be given out.

One of the few differences with the Third Millennium Medals is that this time the sections, societies and major boards are asked to keep in mind the GOLD members, the future of the IEEE, when making their selections.

The nominating group must submit a form to IEEE Awards/Fellows Activities by 1 Oct.

Why I Need Your Vote This Fall

By Harold L. Flescher
Division IV Director-Elect Candidate

I believe that it is incumbent on people who run for office to state clearly why they are running and exactly what they would do if elected, rather than mouth the usual uncontroversial, semi-meaningless statements concerning motherhood and apple pie. First the what, then the why.

The most important issue facing IEEE today is how we bring our vision of globalization to reality. Globalization means that IEEE membership in every country consists of a substantial percentage of each country's electrotechnologists, people for whom dues must both provide value and be affordable. Past volunteer and staff activities have focused on increasing the value of membership without lowering its cost. This has produced benefits like free virus-scanned e-mail aliases and substantially enhanced financial advantage programs. Yet our penetration of our market is low,

even in the more wealthy countries. Although our membership is rising slowly, we have a large turn-over each year indicating that many members don't see adequate value for their dues. While we must continue to find new ways to add value for our members we must also look for ways to make membership more affordable for everyone, everywhere. To do that we must do two things.

First we must go through our expenses with a fine-tooth comb, eliminating activities that don't provide substantial value. As a member of the Ad Hoc Financial Committee that did this for the Technical Activities Board (TAB) in 1995, we cut 3.6% out of our budget without no-



Harold L. Flescher

ticeable effect. This year we completed another similar activity, cutting our expenses by almost another 3% without noticeable effect. Identical activities must be carried out by all IEEE entities. After being elected to the TAB Administrative Committee and elected chair of the TAB Liaison Council, I put motions in front of TAB to eliminate both of these entities (as well as my jobs) because it was clear that these entities did not add enough value to justify their expenses. Their absence has not affected TAB's effectiveness or usefulness. There will be difficult decisions to make in order to cut expenses, but they must be made for our future success. I am committed to making this happen.

The second thing we must do is drive down the cost of membership. This can be done by unbundling our services; by not having membership dues include everything they do today. We must determine which of our current services are absolutely core to membership, services our members and the organization want and need, and set our dues at a level that will pay for those services. Members can select any additional services they both want and find cost-effective. That is the way membership in IEEE technical societies works; one doesn't have to join any society but may join as many as desired. I believe that we can lower our basic dues to 50% or less of the current level, and I believe that this would mean that IEEE would gain many more members as a result. It worked with students when we cut their dues in 1998, resulting in a 21% increase in student memberships.

Wouldn't unbundling create an end to some services? Perhaps, but not if members perceive that they are getting value for money from those services. If members don't perceive value, then why is the IEEE continuing these activities? Let me use IEEE-USA as an example. Some say that were membership in IEEE-USA voluntary, too few people would join to keep it as a viable activity. Let's ask that question differently: were IEEE-USA dues voluntary, what would be necessary for American IEEE members to happily pay the \$24 they are currently assessed? Those of us who live in the USA generally feel that we need national representation. So the real trick is to make IEEE-USA responsive to us, its customers, by providing services we value. Unbundling dues would not mean an end to entity services but a new beginning for membership sensitive and supportive IEEE entities.

Doing these things won't be easy. They will require hard work, difficult decisions, and a well thought out and rigorous transition plan for implementation, but they must be done if we are to attain our stated vision and continue the successful progress of IEEE.

Now, *why*? I feel very strongly that the program I advocate would be in the best interest of electrotechnologists world-wide and the IEEE. A stronger IEEE can help us for the future. My background in industry says that my proposals are feasible and achievable. I ask for your support and your vote to begin this journey. Thanks!

Connectivity = Membership Satisfaction

by Peter Staecker
Division IV Director-Elect Candidate

Statement: *As a working engineer in a global electronics company, I have experienced the cultures of the engineering workplace and the demands it places upon the individual contributor and technical leader to continue learning while adding value to the company. These demands exist at all levels within any organization, including IEEE. The challenge to IEEE is to offer information and interaction to ALL its members as quickly as the communications technology infrastructure allows.*

I have had the opportunity to serve the MTT Society in areas that affect its global membership - in Meetings and Symposia, Publications, and Awards - and am still active in all three areas. I understand the needs for, and challenges of, rapid communication.

My primary goal is to facilitate global connectivity among the membership, by enabling and communicating best practices among the Societies of Division IV and of the Institute.

I look forward to sharing the results of these efforts with you.

Membership Satisfaction

(Why Join IEEE?): *The manner in which information is provided and the facility with which we access it (connectivity) will transform the way we live in the next decade. Learning, career paths, technical achievements, and volunteer efforts, all of which are components of membership satisfaction, will be profoundly impacted. How can we give members a competitive edge in their profession, career, or volunteer activities? I think the answer lies in access to technical information (connectivity) in its many forms (face-to-face, hard-copy, or electronic; real-time or archival), and making the tools and data readily accessible to our membership as quickly as the technology allows. (This vision drives*



Peter Staecker

growth. Cost-cutting serves a useful support activity, but is not a vision.) Here are some examples:

Accessibility of archival technical information to Society membership. Many of the methods and techniques captured in the archival journals of the MTT Society are of permanent value. Because of the recent efforts by an individual MTT member, MTT's entire set of Transactions (1952-1999) is now available to IEEE members as a 22 disk CDROM set (<http://www.mtt.org/pub/cdrom.html>).

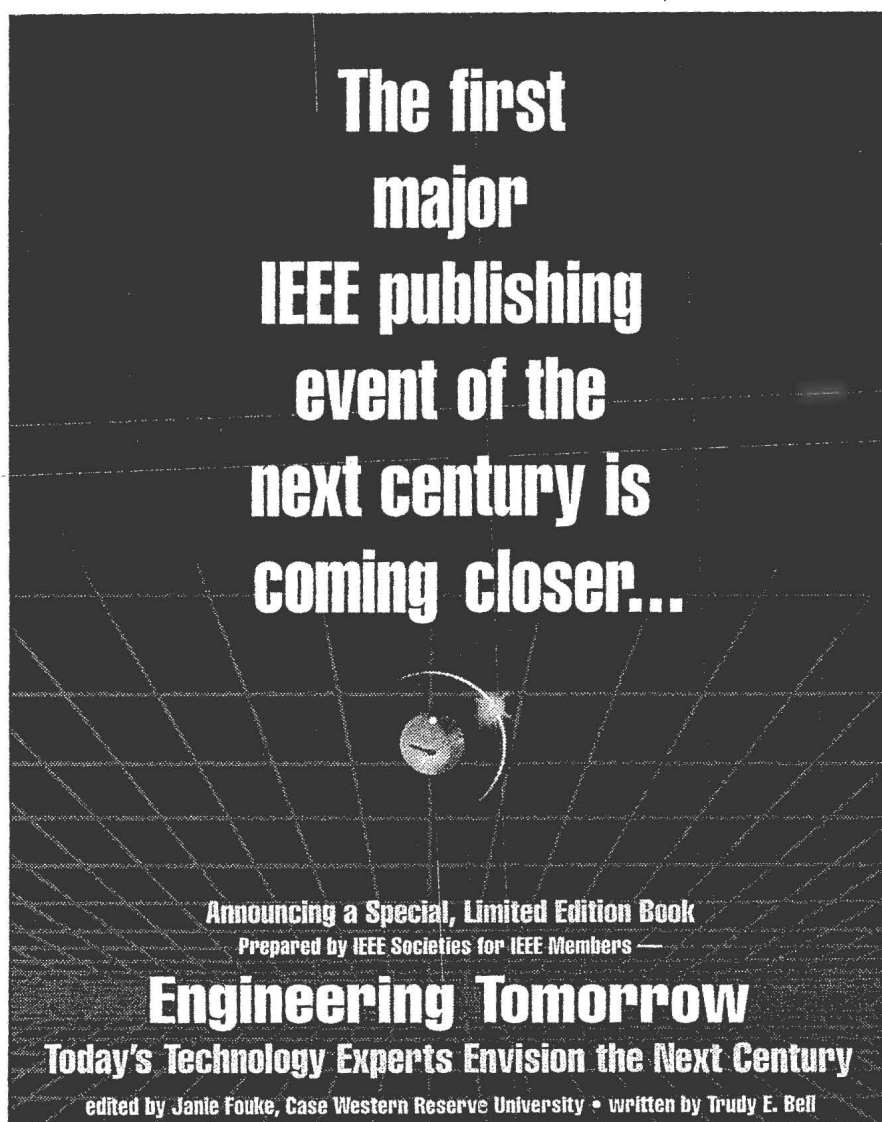
Rapid and timely review of papers for large conferences. MTT is embarking on electronic submission and review of paper summaries (task: distribute 800 – 1000 summaries among a 250 person international Technical Program Committee) for its upcoming International Microwave Symposium in June 2000. This exercise will be easier to implement because of the lessons and successes of AP, MAG, and NPS Conference Committees who have completed similar efforts.

Chapter meetings, local technical conferences, and visits by distinguished lecturers. Global connectivity takes on quite different meanings depending on where you live. Communications infrastructure does not exist in some countries or is prohibitively expensive in others. A Region 8 (including Europe, countries of the Former Soviet Union (FSU), Middle East, and Africa) colleague relates that a 100kB transmission in Ukraine costs the receiver US\$ 5, a sizeable fraction of a professional's monthly salary. In Eastern Europe and FSU, therefore, *global connectivity* addresses, at least for the moment, very basic networking needs: chapter meetings, local technical conferences, and visits by distinguished lecturers. Membership growth is booming, but needs the basic IEEE infrastructure to flourish.

Aside: Financial support and action at the local level addressed this issue in a decisive manner when the growth prospects and fragility of technical communities in this area of the world were first recognized. In late 1993, MTT, ED, and later AP, joined forces to subsidize chapter and membership growth in countries of Eastern Europe and the FSU. By the end of 1996, 12 Joint Chapters in FSU countries had been established, with membership dues for 154 Members subsidized. As a result, in 1998, Region 8 was the fastest growing Region, not only in terms of MTT membership, but also in technical events such as conferences, workshops, lectures and educational activities

Communicating the Process (the Task of the Division Director): The Societies are a rich source of practices that enhance Membership satisfaction. Implemented *locally*, as they are today, these practices are quick and effective. Modifications gained by sharing and interacting with other Societies will yield improvements and lead to *best practices*. The Division Director should serve as a clearing house for reporting continuous improvement in membership satisfaction, by reporting his own personal activities in this area as well as those of the Societies. He should be responsive to inputs from individual Members.

Improvements in information access and interaction (connectivity) will change our lives in the next decade. If elected your Division Director, I will work with the Committees of TAB, the Societies of Division IV, and the Institute to identify, modify, and deploy best practices in these areas to keep pace with rapid technology improvements for the benefit of the membership.



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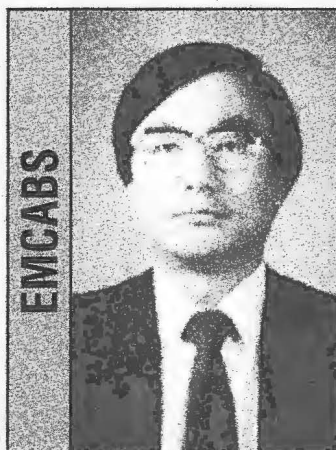
EMC Symposium

SEATTLE, WA

The reviews are in!

*Look for our upcoming issue of IEEE EMC
Society Newsletter recapping this year's
Symposium in Seattle, Washington.*

A Great Show in Seattle
Complete Reviews
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A Look Ahead



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

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"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.

A DESIGN METHOD OF DECOUPLING CIRCUITS FOR A DIGITAL PCB TO REDUCE HIGH FREQUENCY CURRENT ON POWER AND GROUND PLANES

Y. Fukumoto* e-mail: fukumoto@isl.mei.co.jp, S. Nakamura**, O. Wada** and R. Koga**

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Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.9-12

Abstract: This paper describes a design technique of decoupling circuits that can reduce high frequency current rushing into power/ground planes of a digital PCB. In this technique, IC is modeled as a current source of high frequency, and a parameter that represents the effect of the high frequency current reduction is derived. Then, by using the parameter, a design procedure to obtain the optimal bypass capacitor and the decoupling inductor is shown. Furthermore, validity of this modeling is shown by experimental study.

Index terms: Printed circuit board, emission, decoupling circuit.

EMCABS: 01-08-99

A METHOD TO EVALUATE ELECTRIC FIELDS INDUCTION OF OVERHEAD LINES AND SUBSTATION'S EQUIPMENT IN HUMANS

G. Ala, P. Buccheri and M. Inzerillo,

e-mail: m.inzerillo@dielectricslab.diepa.unipa.it, Palermo University, Palermo, Italy

Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.161-164

Abstract: In this paper a method to accurately simulate the human body under a high voltage overhead line or in proximity to substation's equipment is proposed, in order to evaluate the electric field and currents on the human body surface. Based on the charge simulation and Maxwell sub-areas methods, the computer program developed allows consideration of complex systems, including three-dimensional multiple overhead lines, bus-bar system, grounding wires, supporting lattice towers and metallic elements as reinforcing bars.

Index terms: Biological effect, overhead line, substation's equipment, electric field induction.

EMCABS: 04-08-99

CHARACTERIZATION OF PRINTED CIRCUIT BOARDS INCLUDING MAGNETIC FILM USING FINITE ELEMENT ANALYSIS

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and Y. Saito*** e-mail: cortial@ccrl-nece.technopark.gmd.de

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Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.13-16

Abstract: A method to evaluate the characteristics of printed circuit boards containing magnetic films is proposed. By means of electromagnetic field distribution computed from a combined finite element method and strategic dual image method, the equivalent circuit parameters R, L, C are determined. The employed methodology which accounts for eddy currents, displacement currents and hysteresis is detailed in case of 2D axisymmetric problems. Then two simple PCB configurations are investigated. The results clearly show that the NiZn ferrite composite material included in one PCB reduces EMI efficiently.

Index terms: Printed circuit board, emission, magnetic film, finite element method.

EMCABS: 02-08-99

MICROWAVE ABSORPTION PROPERTIES OF M-TYPE HEXAGONAL FERRITE COMPOSITE SHEET

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** Tohoku University, Sendai 980-8579, Japan

Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.420-423

Abstract: The microwave absorption properties of M-type hexagonal ferrite BaFe₁₂-x (Ti_{0.5}Mn_{0.5})_x O₁₉ composite have been investigated. An optimized TiMn substituted ferrite composite exhibited a wide absorption bandwidth nearly double that of conventional spinel ferrite composites in the X-band for both normal and 30 degree oblique incidence. The composite sheet exhibited exactly the expected absorption characteristics and this demonstrated the advantage of utilizing the ferrimagnetic resonance of M-type hexagonal ferrite for microwave absorbers.

Index terms: Microwave absorber, hexagonal ferrite, composite sheet.

EMCABS: 05-08-99

A NOVEL PHYSICALLY-BASED PSPICE-COMPATIBLE-MODEL FOR COMMON-MODE-CHOKES

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Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.33-36

Dresden University of Technology, D-01062 Dresden, Germany

Abstract: In this paper a new physically based PSPICE-compatible model for common-mode chokes for the prediction of EMI-filter size and insertion loss is presented. Skin-effect inside the winding and the non-linear characteristic of core materials can be considered. The model parameters can be obtained from the winding and the core geometry. The accuracy of the model is demonstrated for a typical EMI-filter in a high frequency switched mode power supply.

Index terms: Common-mode choke, EMI-filter, PSPICE.

EMCABS: 03-08-99

NEAR- & FAR-FIELDS TEST SYSTEM OF PORTABLE RADIOS EMI TO ELECTRONIC DEVICES

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Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.472-475

Abstract: A new EMI (ElectroMagnetic Interference) test system to estimate the immunity of electronic devices is proposed. This system directly exposes the devices to the near- and far-fields generated by a dipole antenna and/or actual mobile phone. In addition, an in-vitro experimental system for pacemaker EMI investigation is introduced. This method uses the antenna input power and the distance between the antenna and device-under-test as the test parameters instead of E-field strength. The transmitting signal properties of present mobile phones in Japan (800MHz- and 1.5GHz-PDC, 1.9GHz-PHS, etc.,) are clarified to analyze EMI due to mobile radio wave exposure. A practical test procedure is also described. The summarized experimental results of EMI tests conducted on 228 pacemakers and 499 medical devices are shown to confirm the fact that the proposed system is indispensable for the EMI assessment of mobile phones.

Index terms: Portable radio, EMI, test system, medical device.

EMCABS: 06-08-99

SUPPRESSION OF TV-GHOSTS CAUSED BY SUSPENSION BRIDGE USING A WAVE ABSORBER

T. Aoyagi, A. Nishikata and Y. Shimizu,

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Tokyo Institute of Technology, Tokyo 152-8552, Japan

Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.488-491

Abstract: A vertically-polarized electromagnetic wave is strongly scattered by the hanger ropes of a large suspension bridge. Sometimes this causes TV-ghost problems. This TV-ghost problem was theoretically calculated. Then, cylindrical wave absorbers constructed from a combination of dielectric and magnetic material were designed to suppress the scattering. This paper theoretically shows that using this absorber decreases the TV-ghost problem.

Index terms: Suspension bridge, TV-ghost, cylindrical wave absorber.

EMCABS: 07-08-99

FDTD MODELING OF EMI ANTENNAS

M. Tanaka, W. Cui, X. Luo, J.L. Drewniak, T.H. Hubing,

T.P. VanDoren and R.E. Dubroff

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Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.560-563

Abstract: The FDTD (Finite-Difference Time-Domain) method is used for modeling EMI antenna geometries to anticipate EMI problems in high-speed digital designs. FDTD is well-suited to modeling large-scale geometries such as cables that might be driven against PCB ground planes as a result of a noise voltage that appears at the connector. Three specific cases are addressed herein including a simple cable driven against a PCB ground, coupling between a high-speed digital and I/O line that drives a cable against the PCB, and the finite impedance of the PCB reference plane that results in an effective noise source that drives the PCB ground against the cable. The FDTD modeling is compared with measurements. Guidelines for coupling to I/O lines, and a keep-out distance around the board periphery for high-speed digital lines can then be developed.

Index terms: Printed circuit board, radiated emission, EMI antenna, FDTD modeling.

EMCABS: 10-08-99

A NEW DUAL-COAXIAL-TEM CELL

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Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.528-531

Abstract: Previously, different configurations of TEM cells, chambers and transmission-line holders were used to determine the intrinsic shielding effectiveness (SE) of materials e.g. conductive plastics. In this contribution, a new dual-coaxial-TEM cell is presented which allows to measure the SE of materials, determine the influence of apertures and test analytical and numerical computation methods. The mechanical and electrical structure is described and the calculation of the electromagnetic coupling is verified by the results of measurements. In addition to the worst-case examination of structures (the electric field is perpendicular to the surface of the test-sample), the dual-coaxial-TEM cell provides a wide frequency range and high dynamic.

Index terms: Shielding effectiveness, dual-coaxial-TEM cell, properties.

EMCABS: 08-08-99

VERTICAL RISER EFFECTS OF A FINITE-LENGTH TRANSMISSION LINE

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The University of Electro-Communications, Tokyo 182-8585, Japan

Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.642-645

Abstract: Electromagnetic effects due to vertical risers of a finite-length transmission line are studied on a view point of a circuit concept. Those effects can be taken into account in an expression of modified telegrapher's equations. From a set of solutions to the equations, a new chain matrix is obtained. As a result of the effects, resonance frequencies are discussed using scattering parameters S₂₁ and S₁₁. The effectiveness of this theory is confirmed by comparison between the measured and the computed.

Index terms: Transmission line, riser effect, circuit concept.

EMCABS: 11-08-99

STUDY OF RADIATED EMISSIONS FROM PCB WITH NARROW GROUND PLANE

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Nanyang Technological University, Singapore

Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.552-555

Abstract: Printed circuit boards (PCB) with narrow ground plane microstrip structure (PCBNGP) find many applications in electronic equipment. In this paper, various PCBNGP with different parameters were fabricated and their radiation was measured. It was found that narrow ground plane increases radiation and common-mode current is the main source of radiation. From the method of moments, it was found that the PCB structure asymmetry is the main source of the common-mode current. By treating the reference point (at infinity) as a conductor, multiconductor transmission line model was developed to simulate radiation from PCBNGP and several factors affecting the radiation were extracted.

Index terms: Printed circuit board, radiated emission, common-mode current, method of moment.

EMCABS: 09-08-99

A STUDY OF CROSSTALK APPLIED TO ULTRA-HIGH-SPEED PARALLEL LOSSY MICROSTRIP AND STRIP LINES WITH SHIELDING EFFECTIVENESS

S. Malisuwan and V. Ungvichian,

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Proceedings of 1999 International Symposium on Electromagnetic Compatibility, Tokyo, Japan, May 17-21, 1999, pp.742-745

Abstract: Several researchers have reported that in some cases the crosstalk in the lossless ultra-high-speed parallel microstrip transmission lines does not necessary reduce by increasing the spacing in between the two lines. In this study, the substrate loss parameters which are dielectric and conductor are include in the calculation. Furthermore, the influence of a near-by cover plate which provides shielding is also considered. The technique used to calculate the crosstalk is based upon accurate wide-range closed form expressions for the frequency-dependent parameters in conjunction with a linear system theory and Fourier theory. The simulations using Gaussian pulses with different widths as input source have indicated that the crosstalk decreases non-monotonically for certain s/h and pulse-width of less than 20 picoseconds. Also the crosstalk can be reduced further by using a cover plate mounted sufficiently close to the transmission lines.

Index terms: Crosstalk, microstrip transmission line, substrate loss, simulation.

EMCABS: 12-08-99

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Randy Flinders, 714.513.8012
r.flinders@ieee.org

October 11-12

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November 2-4

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

November 8-9

C63.18 WORKSHOP: RF
TRANSMITTER EFFECTS ON
MEDICAL DEVICES
Walter Reed Memorial Hospital in the
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Herb Mertel, 760-741-3301
hmertel@home.com

December 2-8

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2000

May 3-7

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September 11-15

EUROPEAN EMC SYMPOSIUM
(formerly EMC ROMA)
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Fax: (059) 70.42.15
e-mail: johan.catrysse@kh.khbo.be

July 5-14

PROGRESS IN
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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

- 2000 Washington, DC
August 21-25
Washington Hilton
Bill Duff
703.914.8450
- 2001 Montreal, Canada
Montreal Convention Center
Christian Dube
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- 2002 Minneapolis/St. Paul
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Dan Hoolihan
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- 2003 Tel-Aviv, Israel
(International IEEE)
May 11-16
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- 2004 Santa Clara, CA
Franz Gisin
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- 2005 Chicago, IL
Bob Hofmann
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IEEE EMC Society Board Of Directors Meetings

(For information on all meetings,
contact Janet O'Neil, 425-868-2558)

November 19-20, 1999
Washington DC

March 24, 2000
Phoenix, Arizona

June 19, 2000
Montreal, Canada

August 20 and 24, 2000
Washington DC

November 16, 2000
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