Issue No. 192 Winter 2002 ISSN 1089-0785 Janet O'Neil, Editor

http://www.emcs.org

EMC

IEEE EMC Society Newsletter

INSIDE:

Donald R. Bush
Member, EMC Society Board of Directors, 1942 – 2001

Don Bush was born in Louisville, Kentucky in 1942. He passed away on December 19, 2001 after a courageous battle with cancer.

Don attended his first IEEE EMC Symposium in Washington DC in 1967 and his last in Montreal in 2001, where he received an Honorary Life Membership in the EMC Society and a Certificate of Technical Achievement for "Contributions to the Development of Spread Spectrum Clocking Technology." At the time, Don commented, "The Honorary Life Membership in the EMC Society is my most cherished award."

Upon graduation from the Speed Scientific School of the University of Louisville where he earned his BS and MS degrees in Electrical Engineering, Don started his career in the IBM Office Products Division (OPD) in Lexington, Kentucky. Some years later he met Clayton Paul, who had joined the faculty at the University of Kentucky. They were the only two members of the IEEE EMC Society in Kentucky and became life long friends.

Don got involved in ESD simulation and commercial product support in 1968. When the Federal Communications Commission (FCC) started looking at the interference potential of computers in the mid 1970's, the entire IBM EMC community was involved in studying this very critical issue. Don was involved in the EMI measurement and suppression of the consumer products of IBM. Virtually all of these products connected to 120 VAC outlets or were battery powered. Don led and originated several of the 120 V powerline conducted EMI studies, such as antenna proximity to Data Processing Systems. Over the years, IBM developed many internal EMC standards and design criteria, as did most other large companies. Don was named EMC coordinator and represented the low-end EMC issues in all corporate standards meetings.

Don was named Corporate Standards Project Authority for Electromagnetic

continued on page 33

"I first met Don Bush at the 1974 IEEE EMC Symposium in San Francisco. We were the only two from Lexington, Kentucky and prior to that I didn't know him. We became friends and colleagues as well as fishing 'buddies' from that point on for 27 years. Don was the most gifted experimentalist I knew. He could make measurement gear 'talk'. One of Don's quotes that influenced me considerably was: 'Anyone can construct a mathematical model and generate data. But if the predictions of your mathematical model do not match experimental data, either your model is worthless or your measurements are not done properly.' That caused me to blend experimental verification with my mathematical modeling. I learned a great deal about measurements from Don."

Clayton R. Paul
Sam Nunn Eminent Professor of Aerospace Engineering and
Professor of Electrical and Computer Engineering
School of Engineering
Mercer University
Macon, Georgia

Photos by Dick Ford

Don Bush was a Distinguished Lecturer for the EMC Society. In this capacity, he frequently traveled to various chapters of the EMC Society to present lectures on such topics as spread spectrum clocking technology. Mr. Bush won the EMC Society's "Certificate of Technical Achievement" at the 2001 IEEE International Symposium on EMC in Montreal for his contributions to the development of this technology. He will be remembered as a lively lecturer as evident in these photos.

There's a Better Choice for Anechoic Chambers – TDK.

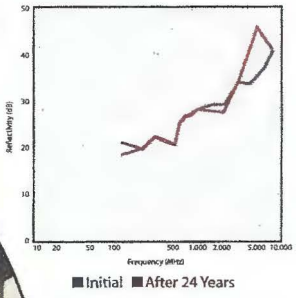
THE ORIGINAL HYBRID ABSORBER

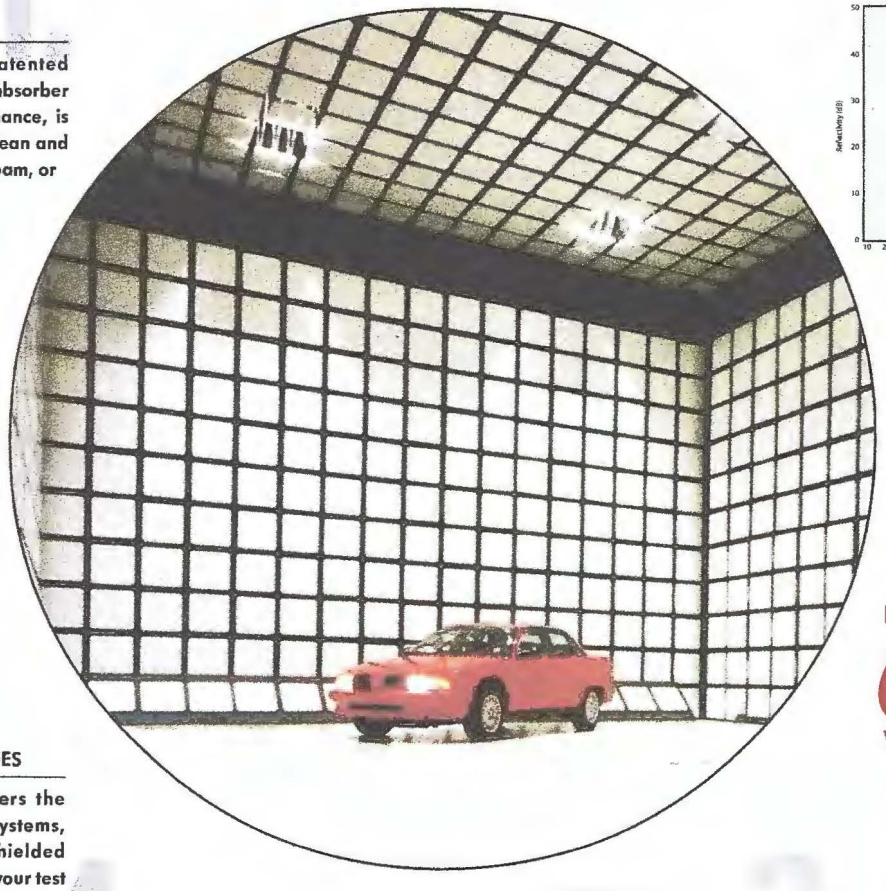
TDK chambers feature patented polystyrene and ferrite tile absorber that offers excellent performance, is mechanically stable, and is clean and safe—it will not dust carbon, foam, or fire retardant chemicals.

PROVEN LONG TERM PERFORMANCE

TDK polystyrene absorber features an exceptionally long working life—it meets the original spec after 24 years!

TDK Polystyrene Absorber Performance
(Initial vs. After 24 Years)





S SYSTEMS C CHAMBERS
A ANTENNAS SW SOFTWARE

www.tdkrfsolutions.com

TRUE TURNKEY FACILITIES

TDK RF Solutions also offers the automated EMI/EMS test systems, software, antennas, and shielded video camera systems to put your test facility to work. Designed, integrated, tested, and warranted with a single point of contact—TDK RF Solutions.

It makes great sense. And it makes TDK a better choice for your test facility.

For more information contact us at 512-258-9478 or chambers@tdkrf.com.

INSTALLATIONS
600+
WORLDWIDE

EXPERIENCE

TDK is an industry innovator and has more chamber installations than all other chamber suppliers combined. This experience translates into a better design for your facility—with no surprises.

TDK RF Solutions Inc.

1101 Cypress Creek Road, Cedar Park, Texas 78613 www.tdkrfsolutions.com

Letter from the Editor

Janet O'Neil
Editor, EMC Society Newsletter

Happy New Year!

Welcome to the first issue of the EMC Society Newsletter for 2002!

You will surely see a few changes in this Newsletter, most notably the addition of paid advertising. The EMC Society Board of Directors approved the addition of paid advertising in the Newsletter as a means to offset some of the expenses of this quarterly publication. Advertising was first personally solicited at the 2001 IEEE International Symposium on EMC in Montreal. Susan Schneiderman of IEEE Media, who handles the advertising for the Newsletter, walked the aisles in the exhibit hall from one end to the other to hand out media kits. She lined up commitments then and there for the full-page cover advertisements you see contained in this issue! We also placed ads to notify members of the availability to advertise in the 2002 issues of the *EMC Society Newsletter* in the Summer and Fall 2001 issues. Eventually, it is expected that advertising will completely underwrite the cost of publishing the Newsletter. The addition of advertising in the Newsletter also takes us one step further in the direction of becoming a full-fledged EMC magazine; this transition is one of the long-range goals of the EMC Society Board of Directors. If you or your company is interested in advertising in the *EMC Society Newsletter*, please contact Susan Schneiderman. Her contact information appears on page 3 under Newsletter Staff.

Speaking of page 3 and the "Newsletter Staff" box, some of you may have noticed a change in this issue in the listing of Associate Editors. Bob Olson is now the "Technical Editor" of the Newsletter. As the practical papers section of the Newsletter grew, it was only fitting that Bob's enhanced role in the publication of the Newsletter be recognized. We are very fortunate in having Bob's technical expertise supporting this publication. It helps the Board realize yet another long-range goal of the Newsletter/future magazine; that is, to be one of the premier technical EMC publications in the industry. We hope to attract and publish only the highest quality practical papers.

Sadly, this issue also features profiles of three esteemed members of the EMC Society who passed away last year. Don Bush was a fellow member of the EMC Society Board of Directors so I knew him quite well. I will always remember his ready laugh and soft-spoken manner. He was a true southern gentleman who will be sincerely missed by all who knew him. Likewise, Tom Doeppner and Seymour Krevsky were bastions of the IEEE on the east coast. I noted when reading the Chapter Chatter text in this issue for the Dallas EMC Chapter, that one of their long time members, Dick Troup, also passed away in 2001. Dick was one of my first customers when I sold RF power line filters. I was working for LectroMagnetics, Inc. (LMI) and Dick was working for Electrospace, based in Richardson, Texas. I was just out of college and was very nervous on my first sales calls. Dick always made me feel welcome and would treat me to a cup of coffee in his company cafeteria whenever I came to visit. I always appreciated his kind hospitality. The EMC Society lost some of its finest members in 2001.

If you have any comments on our new "look" for 2002, please send a letter to the Newsletter! **EMC**

Newsletter Staff

IEEE EMC Society Newsletter Publication Schedule

Publication Dates	*Editorial Deadlines*
August	July 1
November	October 1
February	January 1
May	April 1

IEEE EMC SOCIETY NEWSLETTER (ISSN 1089-0785) is published quarterly by the Electromagnetic Compatibility Society of the Institute of Electrical and Electronic Engineers, Inc., 3 Park Avenue, 17th Floor, New York, NY 10016-5997. One dollar ($1.00 USD) per member per year (included in the Society fee) for each member of the EMC Society. Periodicals postage paid at New York, NY and additional mailing offices. This newsletter is printed in the USA. Postmaster: Send address changes to IEEE EMC Society Newsletter to 445 Hoes Lane, Piscataway, NJ 08855.

President's Message

Todd Hubing
President, EMC Society

As I write my first President's Message for the Newsletter, I'm sitting at an airport gate in St. Louis. I missed my flight after waiting over an hour to pass through airport security. The world has changed in the past six months. Heightened security and concerns about terrorist attacks have caused all of us to rethink the way we do things. Countries around the world have declared a "war" against terrorism. EMC engineers will play an important role in this war.

As someone who has worked on the EM compatibility of commercial aircraft, I am reassured to know that the plane I will eventually be flying on is not susceptible to strong EM pulses or to the fields produced by most commercial or military radio transmitters. However, it is a little disconcerting to know that someone familiar with the plane and its electrical systems could easily build a transmitter capable of interfering with those systems. The same vulnerability can be found in helicopters, trucks, automobiles, communications networks and anything else controlled electronically.

The world has changed in the past six months. Heightened security and concerns about terrorist attacks have caused all of us to rethink the way we do things. Countries around the world have declared a "war" against terrorism. EMC engineers will play an important role in this war.

In the coming year, more EMC engineers will find themselves working on the design of systems that are less susceptible to intentional EM disturbances. This will require the development of new design methodologies, new measurement techniques and new test standards. The IEEE EMC Society will play a significant role in this effort. Stay tuned.

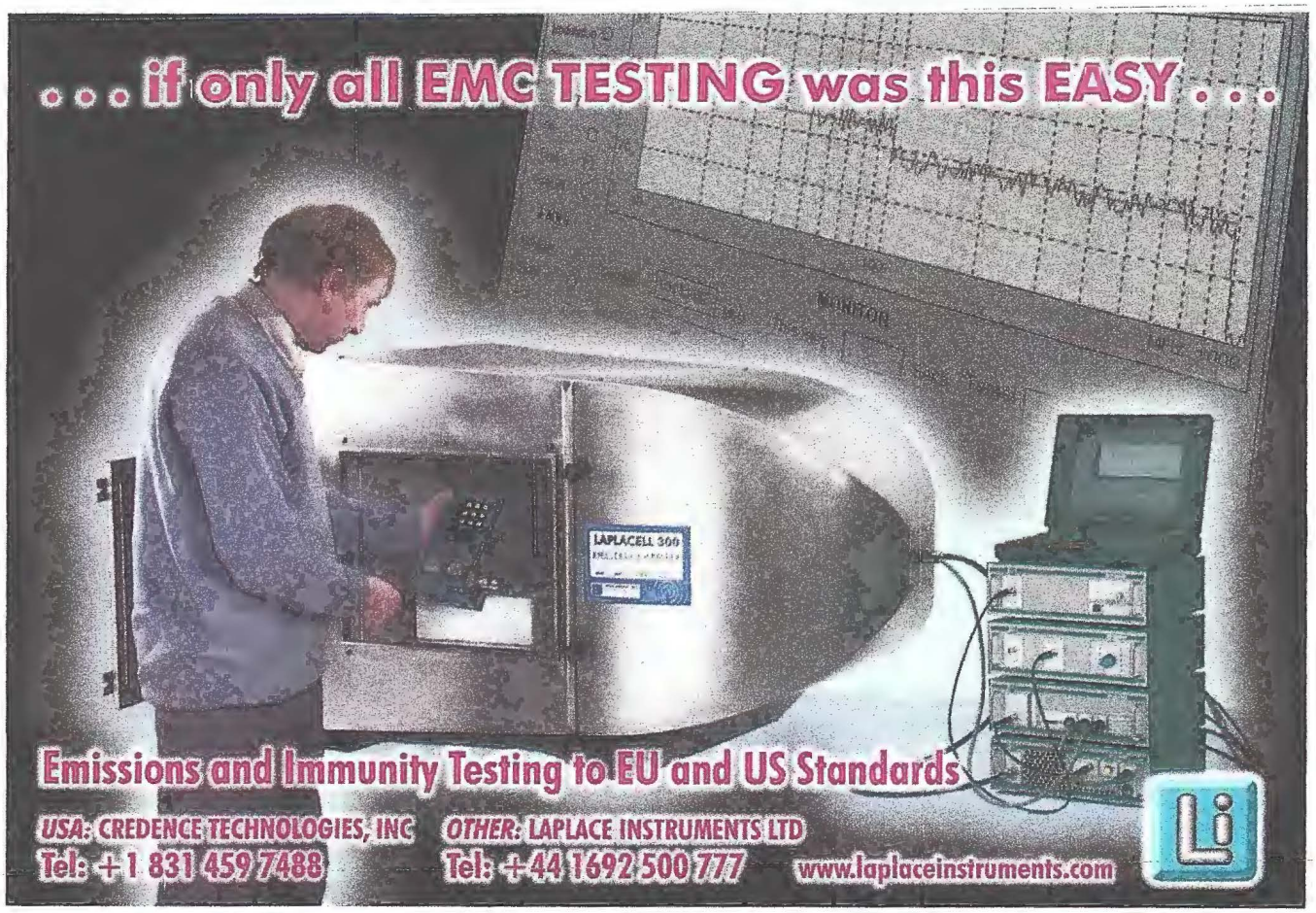
I want to take this opportunity to thank Joe Butler, the immediate past-president of the IEEE EMC Society. Joe worked hard for the Society during his two-year term and provided excellent leadership. Thanks largely to his efforts and the efforts of hundreds of other volunteers; the EMC Society is larger, more global, more organized and more productive than ever before. We're fulfilling our primary mission to serve the field of electromagnetic compatibility by sponsoring conferences, publications, standards and a wide variety of projects designed to inform, educate and promote communication between EMC engineers and the rest of the world.

You may have noticed that the newsletter is thicker, more colorful and has more technical content than it did just two years ago. Janet O'Neil, Bob Olsen and others have worked hard to produce a publication that is both informative and entertaining. Marcello D'Amore, Flavio Canavero and their team of editors have invested a great deal of effort to improve the value of the IEEE EMC Transactions to our members. They have implemented an electronic submission and review process that promises to significantly reduce publication delays without sacrificing the quality of the published papers.

If you've been to an annual IEEE EMC Symposium lately, you've undoubtedly noticed that this has become a major event. In addition to a strong technical papers program, the annual symposium offers a huge EMC exhibition, software and laboratory demonstrations, tutorials, workshops, live entertainment and the opportunity to meet and exchange ideas with over a thousand EMC professionals. Although many volunteers contribute to the ultimate success of any given symposium, Henry Ott and Barry Wallen are the people who ultimately ensure that things go smoothly year after year.

It's not possible to acknowledge everyone who devotes a significant fraction of his or her lives to the activities of the EMC Society in one Newsletter column. However, I've still got seven more to write as President, so I'll try to point out as many as I can in future columns.

On a final note, we were all saddened to learn of the passing of Don Bush in December. Don was a prominent member of the EMC community and a friend of mine since the days (many years ago) when we were both EMC engineers at IBM. Don contributed to the success of countless products and helped to educate many new EMC engineers. He was a kind person and will be missed by all who were privileged to know him. **EMC**



Chapter Chatter

Todd Robinson, Associate Editor

You Want Us to Test Where?
Or
Have Receiver, Will Travel
Or
"This Week We Meet Up With Our EMC Heroes Testing Somewhere in the Aegean Sea . . . "

An EMC testing project can be a major undertaking. For those visiting the EMC lab, the project can involve days of collecting functional EUT's, gathering support equipment, scheduling the necessary support personnel and possibly arranging for shipment and travel. For those operating the laboratory, preparing for test programs can also be a major undertaking. The process can involve gathering test equipment, preparing test fixtures, calibrating equipment, scheduling personnel, etc. The whole process can, at times, be a daunting undertaking. If an EMC test project ever becomes overwhelming for you, let the following story remind you of how good you have it.

In the early 1960's, NATO decided to start a missile test range in the Aegean Sea. Genistron, a Southern California EMC testing and filter manufacturing company, was contracted to perform an RF survey of the area. The NATO folks were rightfully concerned about supersonic missiles heading in the wrong direction due to RF interference. Genistron sent two survey teams to the Aegean: Team One to the Greek island of Crete and Team Two to the Greek Islands Santorini and Rodhos. Joe Fischer, now the CEO of Fischer Custom Communications, was a member of Team Two that was sent to Sanrorini and Rodhos. To reach the area of Santorini, where the RF survey was to take place, Team Two had to pack their sensitive test equipment 10 miles via mule train on a trail that traversed the side of an ancient volcano. If you have ever visited this island, or even if you have only seen pictures, you understand that this was an Indiana Jones type adventure. One piece of test equipment, along for the mule ride, was a (new at the time) Polarad 1 to 10 GHz receiver. Evidently, bad connectors often made this instrument somewhat unreliable for the Genistron engineers. During the perilous trip, mule and 1 to 10 GHz receiver suddenly parted company. After bouncing, sliding and rolling 30 feet down a rocky slope, the runaway receiver was retrieved and reloaded. According to Joe, the Polarad performed better than ever after the accident! After reaching the survey location, our heroes discovered that one of their most reliable pieces of test equipment had been damaged en route. The Stoddart MM10 had a broken control knob and their mission could not be accomplished without the instrument. Some have experienced the hassle of loosing an important test-set during lab time, but the EMC adventurers from Genistron couldn't use the cell phone and call "Equipment Rents R Us." One of the team's Greek guides hiked 20 miles to the nearest radio phone and ordered a replacement to the MM10, which had to be shipped from Los Angeles! Amazingly enough, the replacement arrived on Santorini within 48 hours. After overcoming the adversity on Santorini and also completing the survey on the Island of Rodhos, Team Two returned to Los Angeles after only 20 days. The next time you have to drive across town or even 100 miles into the hills to do EMC testing, be thankful that you don't have to travel by mule train to get there.

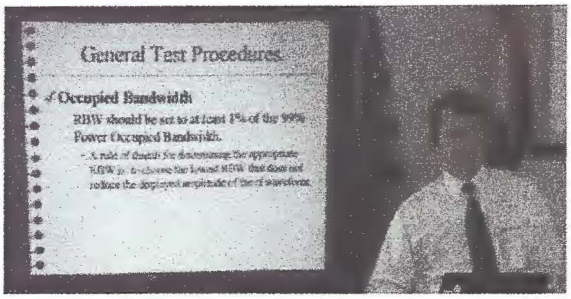
Central New England

The Central New England EMC Chapter meeting was held on Wednesday October 10th, 2001. The presentation described the new US Supplier's Declaration of Conformity (SDoC) process for certifying Telephone Terminal Equipment (TTE). The speaker was Larry K. Stillings, President, Compliance Worldwide, Inc., of Sandown, New Hampshire. Mr. Stilling shared that, on July 23, 2001, the Federal Communications Commission (FCC) formally privatized the Part 68 process for TTE certification. A new organization called the Administrative Council for Terminal Attachment (ACTA) now handles all TTE certification procedures with the exception of waivers. Mr. Stillings also explained the two new processes for how telephone terminal equipment may be approved, either by the use of a Telecommunications Certification Body (TCB) or through preparing an SDoC. The new labeling method for ACTA, filing requirements, and standards in development to cover new technologies were also discussed. 11 members and guests attended and the speaker responded to active participation and questions from the audience. Unfortunately, the meeting scheduled for November 1st had to be cancelled. The speaker was to have been Douglas C. Smith, Independent Consultant and Distinguished Lecturer (DL) for the EMC Society. We hope to reschedule this meeting in March, April or May 2002. We will also schedule a meeting with DL Colin Brench as the speaker around the same time in 2002. No other meetings are scheduled from December 2001 through February 2002. The Chapter avoids meetings in January because of possible winter storms in New England, and because

everyone is recovering from the Christmas and New Year holidays.

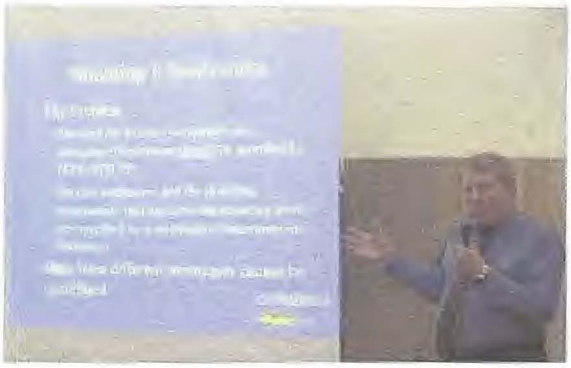
Dallas

Bill Paschetag, Secretary/Treasurer of the Dallas EMC Chapter, reports that 2001 was a very big year for the Chapter. They were honored to have presentations by three EMC Society Distinguished Lecturers, plus presentations by local EMC professionals. They also had their second annual war story session and plan to continue this at least once each year. The first monthly meeting of 2001 was held at KTL in Lewisville, Texas, on January 16th. Pizza and soft drinks were provided by KTL. The subject of the meeting was a presentation by Tom Tidwell, Manager, Wireless Test Group, KTL. Tom's topic was "EMC Issues in Low Power Wireless Systems." Being in the heart of the Telecom corridor, there was much interest in Tom's presentation. There were 34 attendees at the January meeting which included 17 IEEE members, 17 non-IEEE; there were 11 new attendees. The second meeting of 2001 was held at NTS in Plano, Texas, on February 26th. Pizza was provided by Byrt Scammel, Airep Electronics, and soft drinks were provided by Jim Abel, NTS. The subject of the meeting was a presentation by Doug Smith of D.C.Smith Consultants. Doug's topic was "Unusual Forms of ESD." Doug demonstrated potential interference from ESD produced by coins in a bag and from a standard office chair. A digital storage oscilloscope to display the voltage waveform of the ESD was provided by Harry Rosenberg of Agilent – with pick-up and delivery by Jim Abel and Bob Shoffstall of NTS. There were 32 attendees at the February meeting, 20 IEEE members,12 non-IEEE; there were 5 new attendees. The third month-



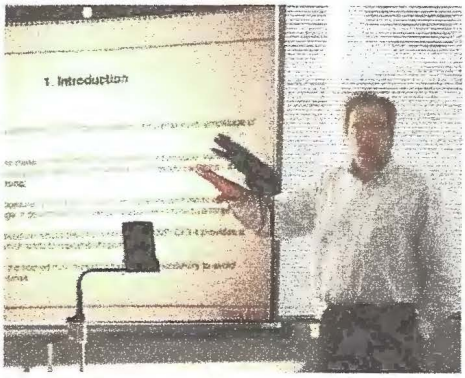
Tom Tidwell of KTL Wireless Test Group discusses measurement of occupied bandwidth at the January 2001 meeting of the Dallas EMC Chapter.

At the February 2001 meeting of the Dallas EMC Chapter, Doug Smith demonstrates that a plastic bag of coins can generate a significant level of ESD. NTS in Plano, Texas hosted the meeting.



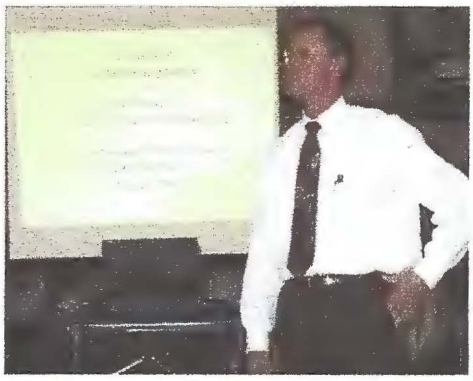
Joe Butler of the Chomerics Division of Parker Hannifin discusses some of the problems associated with shielding effectiveness measurements at the March 2001 meeting of the Dallas EMC Chapter.

ly meeting of 2001 was held at NTS in Plano, Texas, on March 20th. A Tex-Mex buffet was provided by Steve Kasachkoff of Chomerics, and soft drinks were provided by Jim Abel, NTS. The subject of the meeting was a presentation by Joe Butler, President of the IEEE EMC Society and Marketing Manager of the Chomerics Division of Parker-Hannifin. Joe's topic was "Why Don't We Have Shielding Effectiveness Standards?" There were 34 attendees at the March meeting, 16 IEEE members, 18 non-IEEE; there were 9 new attendees. The fourth monthly meeting of 2001 was held at NEMKO - Dallas, in Lewisville, Texas, on April 17th. A sandwich and fruit salad buffet and soft drinks were provided by NEMKO - Dallas. The meeting started with a welcome to NEMKO by Matt Fain, NEMKO Marketing Manager. The subject of the meeting was a presentation by Werner Schaefer of Cisco Systems in San Jose, California. Werner's topic was "Factors Determining Test Speed of Automated EMI Measurements." There were 20 attendees at the March meeting, 11 IEEE members, 9 non-IEEE; there were 2 new attendees. The fifth monthly meeting of 2001 was held at NTS in Plano on May 15th. Pizza and soft drinks were provided by NTS. The meeting started with a presentation to Jim Abel of NTS for an outstanding contribution to the EMC Society for the past year. Gary Shimko, Chairman of the Dallas Chapter of the IEEE/EMC Society, provided the presentation. It was also announced that Dick Troup, longtime Dallas area EMC professional, had passed away in his sleep the previous Thursday (May 10) following a prolonged illness. The subject of the May meeting was "War Stories" with Carl Irby as the monitor. Steve Juett provided the first War Story on the EMC challenges facing biomedical instrumenta-

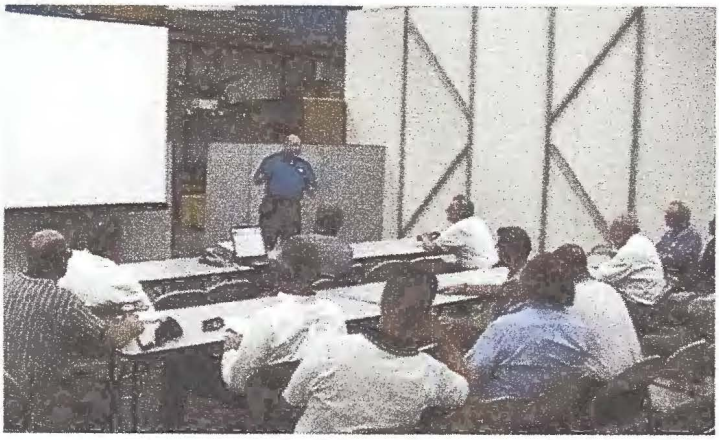


Werner Schaefer of Cisco Systems discusses some of the problems associated with automated EMC measurements at the April 2001 meeting of the Dallas EMC Chapter. NEMKO in Lewisville, Texas hosted the meeting.

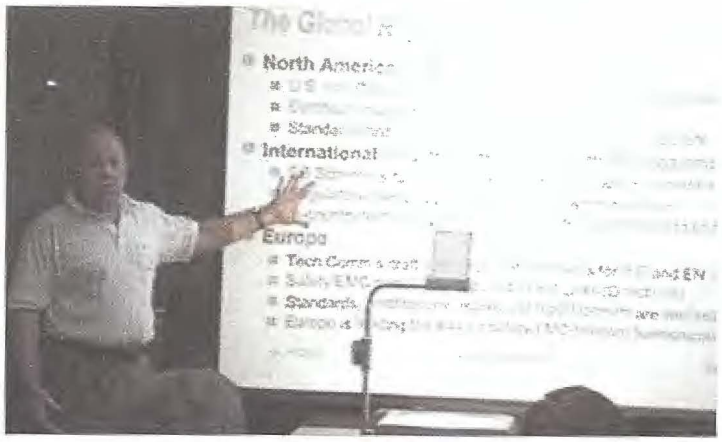
At the May 2001 meeting, Gary Shimko, Dallas EMC Chapter Chair (right), presents Jim Abel with an IEEE award for his outstanding contribution to the EMC Society for the year. NTS in Plano, Texas hosted the meeting.



Steve Juett, Director of Biomedical Engineering at Baylor Hospital in Dallas, discusses one of his two "war stories" at the Dallas EMC Chapter meeting in May.



Jim Press of NTS prepares to enlighten the attendees of the September Dallas EMC chapter meeting on the status of EMC requirements for Nuclear Power Plants.



David Lobbeck of NEMKO Dallas discusses differences in regulatory requirements in the world marketplace at the November meeting of the Dallas EMC Chapter.

tion in hospitals. He presented very straightforward slides illustrating the situation. The FDA has no immunity requirements for biomedical instrumentation. Not surprisingly, the myriad of telemetry links and proliferation of personal computing devices and cellphones present challenges to medical equipment used to save lives, the sensitivities of which can be in microvolts! Mark Bushnell shared his war story of how his company sought to save money and time on a lightning certification by performing analysis instead of testing. After review by the certifying agency, the analysis was returned after some time for a more detailed simulation. Finally, after the agency approved the analysis, they required the test anyway. Neither time nor funding for the test was saved. Even though tools may exist to perform a simulation with high fidelity, sometimes the easiest approach is just to execute the test. Finally, Steve Juett provided another story from the biomedical arena — tracing down the source of an interference problem at the hospital to a local TV station trying out its HDTV band. It took some effort to get in touch with the right individual at the TV station to resolve the problem! The Dallas Chapter takes a three-month summer break with no meetings during June, July and August. Similar to an academic schedule, the regular September meeting is the start of the 2001-2002 year. The sixth monthly meeting of 2001 was held at NTS in Plano on September 18th. Pizza and soft drinks were provided by NTS. The subject of the meeting was "EMC Concerns For A Nuclear Power Plant" presented by Jim Press, Director of National EMC Operations, National Technical Systems (NTS). There were 18 attendees at the May meeting, 13 IEEE members, 5 non-IEEE; there was 1 new attendee. The seventh monthly meeting of 2001 was held at Intertek Testing Service (ITS) in Richardson, on October 16th. Pizza and soft drinks were provided by ITS. The subject of the meeting was "Current Status of the R&TTE Directive" presented by Bill Holz, Manager, Global Approval Management Services, ITS. The attendees were given a tour of the ITS facility. There were 23 attendees at the October meeting, 13 IEEE members, 10 non-IEEE; there were 2 new attendees. The eighth monthly meeting of 2001 was held at NEMKO Dallas (Lewisville), on November 20th. Sandwiches, fruit, cookies and soft drinks were provided by NEMKO. The subject of the meeting was "Global Market Access: Safety-EMC-Telecom Compliance" presented by David Lohbeck, General Manager for NEMKO Dallas. The attendees were given a tour of the NEMKO facility. There were 25 attendees at the November meeting, 14 IEEE members, 11 non-IEEE; there were 9 new attendees. This year's annual Holiday Social was held at Bennigan's Restaurant in Plano, Texas. Eleven persons attended, six IEEE members and five guests. Arrangements for the social were handled by Bob Shoffstall and Bob Stevens of National Technical Systems in Plano.

Professor Klaus Erich Pollmann, rector of the Otto-von-Guericke University (right) and Professor Juergen Nitsch (left) congratulated Heiko Haase (center) for his achievement. Professor Nitsch is a member of the IEEE EMC committee of the German Section.

France

The French chapter invited EMCS Distinguished Lecturer Professor Sabrina Sarto, of the University of Rome, "La Sapienza", to speak ar its meeting on December 17th, 2001. Professor Sarto presented a lecture titled "EM Performance of Composite Materials and Metalized Plastics for Industrial Applications." It was a very complete account of recent work on these topics, touching such different subjects as coating technology, modeling of composite panels, numerical issues in FDTD simulation etc., and illustrated by a variety of examples. Following the presentation by Professor Sarto, Dr. Ferdy Mayer presented "Composite Magnetic Materials and Anisotropy," where he pointed out promising directions for further research on wideband absorbers.

Germany

The annual general meeting of the IEEE German EMC Chapter took place November 21st in Frankfurt/Main. Chairman Professor Heyno Garbe from the University of Hannover welcomed 18 Chapter members and safely guided them through the agenda. Besides the more standard topics to be discussed, two points deserved special attention: First, everybody was happy to hear about the "2001 Chapter of the Year Award" that was given to the German EMC Chapter at the 2001 International Symposium on EMC in Montreal. Therefore, it was agreed to continue the many Chapter activities and good work. Second, in regard to the application of the German EMC Chapter to host the annual IEEE International Symposium on EMC in 2006, it was reported that all necessary preparations and requirements are met. It is planned to hold the Symposium in the historic city of Dresden which will celebrate its 800th anniversary that year. The final and, hopefully, positive decision of the Board of Directors to approve the application is expected in the spring 2002.

Israel

On November 25, 2001, the chapter conducted a special evening meeting with four presentations concerning "Selected Topics in EMC Engineering." The meeting was held in the headquarters of the Association of Engineers and Architects in Israel (AEAI), Tel Aviv. A total of 76 people attended the meeting, the majority of whom are members of the AEAI and the IEEE EMC Chapter in Israel. Chapter members and guesr experts prepared all the lectures, which were delivered during the three-hour meeting. The first two presentations were associated with potential adverse effects induced by utility lines EMI – stray current and electromagnetic fields. The next two presentations dealt with EMI effects generated from light trains (electrical trams) that are used in urban mass transportation, and design considerations of a static electricity grounding system. The specific presenta-

EMC Society Distinguished Lecturer Doug Smith (standing at far right) teaches the Melbourne, Florida EMC Chapter how to safeguard their computers from prying eyes at their December meeting.

The December meeting of the Melbourne EMC Chapter was held at the Indian River Brewing Company. Over 40 people attended the meeting, including students from the Florida Tech Student Chapter.

tion titles were: "Mutual Effects Between Utility Lines and Underground Pipes Located within the Right-of-Way," by Dr. Yavgeni Katz, Israel Electrical Company (IEC); "EMC and Safety Aspects of 400kV Electrical Power Lines," by Dr. Yosef Peker-IEC and Moshe Netzer – RAFAEL; "Potential EMI Effects of the Light Train in the Israel Metropolises," by Mr. Oren Hartal and Moshe Netzer – RAFAEL; and "Design Principals of ESD Grounding – By What is it Different from Safety Grounding?" by Dr. Boris Veprik-RAFAEL. The entire event was a great success as reported by all attendees.

Korea

Professor Dong Chul Park, the outgoing IEEE EMC Korea Chapter Chairman, reports that the newly elected officers took office on January 1, 2002. The new chairman and secretary are as follows: Chairman: Professor Dong Il Kim, Department of Radio Science and Engineering, Korea Maritime University (E-mail: dikim@kmaritime.ac.kr/ Phone: +82-51-410-4314), Secretary: Mr. Jong Hwa Kwon, Division of Radio Technology, Electronics and Telecommunications Research Institute (ETRI) (E-mail: hjkwon@etri.re.kr/ Phone: +82-42-860-6742).

Melbourne

The Melbourne Chapter held its December meeting at the Indian River Brewing Company. The highlight of the meeting was a lecture by Mr. Doug Smith, an Electromagnetic Compatibility Society Distinguished Lecturer. Doug's talk was titled: Computer Security for the Engineer, "The Knock in the Middle of the Night." Doug gave an entertaining lesson in personal computer security, showing us how prevalent the problem of hacker intrusion into home computers is and how we can protect ourselves from unauthorized access. Doug's presentation, which included many examples taken from his personal experience, left the audience with the unsettling realization that security of our home computers is a serious concern that requires us to take preventive measures. Prior to Doug's lecture, the crowd enjoyed pizza and cold drinks while mingling informally. The turnout for this meeting was very strong, with over 40 attendees. In addition to local EMCS members, we welcomed a large group of students from the Florida Tech Student Chapter, and visitors from the Canaveral, Daytona, and Orlando IEEE Sections. Participation at our events has increased steadily as the local EMC community and nearby IEEE groups have learned of our activities. Dennis Molly and Kathy Reinhart, officers with the Melbourne and Canaveral sections respectively, have been particularly helpful in spreading word of our Melbourne EMC chapter activities. Of course, most important to the success of our meetings is the availability of excellent speakers such as Doug Smith through the IEEE EMC Society Distinguished Lecturer Program.

Minneapolis-St. Paul

Curt Sponberg, Chair, reports that the Twin Cities chapter last held an official meeting in June, to coincide with the Board of Director's meeting in Minneapolis. In September, the annual EMC event drew about 75 people, members and non-members, for a one-day tabletop show and seminars. The local chapter will not meet again until the latter part of 2002 due to the planning of the 2002 IEEE Symposium on EMC in Minneapolis. Several chapter members are part of the local committee. So, many of us are actually meeting more than ever, at least until August!

Mohawk Valley

After a summer hiatus, the Mohawk Valley Joint EMC/Reliability Chapter held two meetings in November and December of 2001. Both meetings were conducted by Chapter Chair Irina Kasperovich of ANDRO Computational Solutions in Rome, New York. The November meeting featured EMC Society Distinguished Lecturer Doug Smith of D.C. Smith Consultants in Los Gatos, California who gave the talk: Computer Security for the Engineer, "The Knock in the Middle of the Night." In the talk, Doug covered some of the undesirable things that can happen to one's personal computer when surfing the Internet and how to avoid them. Screen shots from an attack on Doug's computer were shown. He demonstrated how the manufacturer of the laptop leaves it wide open to hackers so it can diagnose laptop problems remotely. During a recent trip made by Doug, that weakness was probed four times in two hours over a dialup by hackers! Doug has also shown using a recording of the electromagnetic emissions from his home computer as heard on a short-wave radio, that different computer activities, such a surfing the Internet and printing files, can definitely be identified audibly. This illus-

trates the critical nature of computer security and the methods unscrupulous individuals can use to directly or even remotely hack into a personal computer. We've all heard of the various methods of "sniffing" and extracting electromagnetic signals from mobile communications and computing devices. What is not always apparent is that this can be done using simple radio receivers. Some recent cases of "cyber-terrorism" have been observed where hackers use homemade sniffer probes and consumer radios to measure output signals from personal digital assistants (PDAs) and to decipher personal information. Doug provided the audience with a great deal of food for thought which was well received and appreciated.

The December meeting featured Andy Drozd of ANDRO Computational Solutions who presented the topic, Computational Electromagnetics (CEM): A Blend of Science and Art? In his presentation, Andy defined CEM as the blending of physics, computer science, mathematics, and electromagnetics engineering to solve sophisticated problems for simple-to-complex structures with associated electromagnetic boundary conditions. The various factors that force one to ask whether CEM modeling and simulation is both an art and a science were raised. For example, what are the various methods that engineers use to solve problems and how do they compare? What are the unique features of CEM methods and codes? This talk attempted to answer these and other questions using practical illustrations. The presentation was based on a chapter on computer modeling for EMC contributed by Andy for the textbook, *Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models*, 2nd Edition by V. Prasad Kodali. The presentation overviewed CEM methods focusing on several widely used techniques and their applicability without rigorously delving into the theory. Although CEM codes have their basis in Maxwell's equations of one form or another, their applicability and associated accuracies depend on the applied physics, numerical solver approach (full or partial wave, non-matrix, etc.), mathematical basis functions, canonical modeling primitives, inherent modeling limitations, built-in approximations, desired "observables" and so forth. Other factors such as analysis frequency and time or mesh discretization further *conspire* to affect accuracy, solution convergence, and overall validity of computer models. Concerns immediately arise when the results of predictions using one type of CEM code do not consistently agree with the results of other codes or against measurement benchmarks, begging the question, *"which is correct?"* Andy's familiarity with this topic is due to his work in the areas of CEM engineering research and development, multi-spectral information fusion, visualization, and collaborative engineering. He has over 26 years of experience in electrical and electromagnetic engineering, and more recently, in applying AI/expert system technologies to electromagnetic environment effects (E3) computer modeling and simulation. He is currently leading the development of a new IEEE standard and recommended practice for validating CEM computer models. Andy plans to give an encore presentation at the spring 2002 Mohawk Valley EMC/Reliability Chapter meeting and for the Winter meeting of the Rome Acade-

my of Sciences. The Chapter plans to invite at least two more Distinguished Lecturer Program speakers for the 2002 spring and fall meetings.

Nanjing

Wen Xun Zhang, Chapter Chair, reports that the Nanjing Chapter met on November 19th and November 26, 2001. The November 19th meeting was held to discuss chapter business. The meeting was attended by 9 IEEE members and 11 guests. During the meeting on November 26, two technical presentations were given. The first speaker was Da-Gang Fang of Nanjing University of Science and Technology who presented a paper entitled, "Optimized Design of Macrostrip Patch Array." The second speaker was Ru-Shan Chen of Nanjing University of Science and Technology who presented a paper entitled, "Vector FEM Techniques for 3-D Full Wave EM Problems." The technical presentations were well attended by 15 members and 44 guests.

Orange County

The Orange County Chapter met on October 24th at CKC Laboratories in Brea, California. Robert Tozier of CKC Laboratories has taken over the Chapter Chair position from Randy Flinders who will continue as Vice Chair. The Orange County Chapter welcomed Brett Robinson of Robinson's Enterprises, a Consulting and Engineering firm based in Chino, California. Mr. Robinson discussed the pros and cons of using COTS (circuit cards off the shelf) in "customer" driven designs, both commercial and military. For example, a manufacture elects to use an off the shelf video card with their FTN or TFT display. The initial assessment is, "great, it matches; very little design modifications are necessary, and the combination utilizes the latest technologies." However, the problem is that the entire system was not designed to meet the latest applicable EMC requirements (RTCA-DO160D, Mil-Std-461/462D, Mil-Std-810E/F, CISPR 22, FCC Class B, etc). The solution to these problems was discussed and included back plane design techniques, enclosure design, lightning protections via transorb utilization, custom designed compatible boards, shielding of cards, etc. We had a good turn-out of about 22 attendees. We expect to continue having the meetings at the new location of CKC Laboratories in Brea.

Brett Robinson of Robinson's Enterprises spoke at the October meeting of the Orange County EMC Chapter on the pros and cons of using COTS (circuit cards off the shelf).

Randy Flinders, immediate past chair of the Orange County EMC Chapter, takes a break at a recent chapter meeting. He's still a chapter officer though; currently he is lending his expertise as vice-chair of the chapter.

A crowd gathered at the October meeting of the Orange County EMC chapter held at CKC Laboratories in Brea, California.

Chip Fleury and Rhonda Saxson of TUV Product Service in San Diego attended the October meeting of the Orange County EMC Chapter.

Phoenix

Harry Gaul reports that the speaker at the October 4th, 2001 meeting was Garth D'Abreu of ETS-Lindgren in Austin, Texas. The topic of Garth's talk was "Reverberation Chambers: Design, Testing and Control, A Simplified Approach" which provided a good introduction to our Phoenix Chapter on the many uses of reverberation chambers. In this talk, we learned how reverberation chambers could be used to perform quick radiated emissions measurements. These chambers are often used for accurately measuring the shielding effectiveness of cables, gaskets, and conductive fabrics. One of the most exciting uses of these chambers is to perform radiated susceptibility testing that is very repeatable, even after disturbing the cable and EUT placement in a chamber. Garth explained that aluminum could be used for construction of reverberation chambers in order to minimize losses. But this comes at the expense of having resonant nodes at low frequency that are fairly narrow in bandwidth. This effect can easily be corrected by adding some portable absorbers to "de-Q" the room, but of course at the expense of higher losses. His talk was concluded with a demonstration of software that can be used for calibration and operation of reverberation chambers. Check out the Phoenix web site at http://www.ewh.ieee.org/r6/phoenix/phoenixemc/ for the latest schedule on upcoming meetings.

Photo by Steve Gerard

Daryl Gerke of Kimmel Gerke Associates (left) presents Garth D'Abreu of ETS-Lindgren with a jar of salsa in thanks for his thought provoking presentation on reverberation chambers to the Phoenix Chapter.

Rocky Mountain

The Rocky Mountain Chapter of the IEEE EMC Society held its 11th annual Regional EMC Symposium on Wednesday, October 3rd, 2001 at the Radisson Inn Greystone Castle in North Denver, Colorado. The annual symposium has been a key element of our Chapter program, which has focused on providing the regional technical community with valuable EMC training and education. Attendance at the event was relatively good, considering the date was in the shadow of the September 11 tragedy. A total of 123 members and guests participated in the symposium. The event included 20 exhibitors; with exhibits set up in the area where breakfast, breaks and lunch was provided for all attendees.

The technical program was expanded this year to include three parallel tracks to provide for a broad range of interests. The program included: Full day Tutorial on Fundamentals of EMC by Dr. Clayton Paul; Workshop sessions exploring selected topics presented by experts in the EMC field, including Dr. Eric Bogatin, T.J. Ritenour, Dr. Karl Bois and Dr. David Quint, Dr. Scott Bennett, and Doug Smith; Technical papers on current EMC topics by regional and national authors including: O. Buhler, C. Marrero, Dr. R. Johnk, Dr. Novotny, C. Weil, M. Taylor, T. O'Hara, H. Holden, Dr. E. Bogatin, R. Georgerian, R. Duffy, R. Perala, M. VanDenBergh, G. Senko, T. Robinson and S. Monroe.

The officers of the Rocky Mountain Chapter of the EMC Society wish to thank all who contributed to the success of this event. Special thanks to RMC Chapter members Charles Grasso and Tony O'Hara for work in coordinating the technical program and exhibitor arrangements. The complete symposium program, including exhibitors and technical program with presentation downloads, is available at http://www.ieee.org/rmcemc/.

The speakers at the Rocky Mountain EMC Chapter Symposium in October included, front row, left to right: Richard Georgerian, Carlos Marrero, and Charles Grasso. Back row, left to right: Bill Ritenour, David Quint, Clayton Paul, Robert Johnk, Happy Holden, Ron Duffy, Ron Perala, and Eric Bogatin.

During the table top show held in conjunction with the Rocky Mountain EMC Chapter Symposium in October, exhibitor Brad Brim of Ansoft (left) explains the uniqueness of Ansoft software to David Banas. Looking on are Drew Martin of Ansoft, (third from left) and Brian Gray (right).

San Diego

The San Diego Chapter finished a very successful year in 2001 with a pair of well-attended meetings featuring interesting topics and excellent speakers. November brought a great meeting with both EMC and safety offerings. This exciting, double-header featured Don Heirman of Don HEIRMAN Consultants and Dan Hoolihan of Hoolihan EMC Consulting presenting their informative "EMC Measurement Uncertainty—What is Certain and What is Not?" Coupled with Deborah Madsen of Underwriters Laboratories educating us on the subject of "Protection Against Electric Shock: UL 2601-1/IEC 60601-1 Insulation Diagrams," it made for a very full evening. The San Diego Chapter would like to thank the members of the EMCS Board of Directors that joined us for the meeting. They were in town for their last Board meeting of the year. It was a pleasure hosting them and we look forward to seeing them again soon. The San Diego chapter finished the year with a helpful and entertaining presentation from Dr. Brett D. Robinson of Robinson's Enterprises on the subject of "EMC Design and Test Considerations for Wireless Communication Products." This is a topic well suited to the San Diego area due to a local concentration of cell-phone and wireless communication companies. The San Diego Chapter looks forward to an even-better year in 2002 and they wish the same for the other EMCS chapters around the country and the world!

Seattle

The Seattle Chapter held a four-hour workshop, from 4:00 to 8:00 pm, in October at CKC Labs in Redmond. Chris Kendall of CKC Labs spoke at the "Design for Test and Immunity Workshop." The workshop was attended by a "sell out" crowd of 40 people (attendance was limited so the instruction could be interactive). All students received a certificate of completion signed by the instructor and the chapter provided dinner at the half way point of the workshop. The immunity part of the workshop covered such topics as grounding, bonding and shielding for immunity, design techniques for achieving required immunity, including system grounding, I/O cable shielding and shield termina-

John Stadille of Ball Aerospace (left), Lyle Luttrell of MaxOptix (center), and Jill Klancke of Harthun Associates (right) discuss shielding material applications during the exhibit hours of the Rocky Mountain EMC Chapter Symposium.

Dr. Clayton Paul kept the attention of the Rocky Mountain EMC audience for the full day tutorial held during the Rocky Mountain EMC Chapter Symposium in October.

Photo by Mark Frankfurth

It was a full house at TUV Product Service for the November meeting of the San Diego EMC Chapter.

Photo by Mark Frankfurth

Deborah Madsen of Underwriters Laboratories in Brea presented the informative "Protection Against Electric Shock: UL 2601-1/IEC 60601-1" to the San Diego EMC Chapter at its November meeting. She was part of their "double-header" program.

Photo by Mark Frankfurth

Don Heirman is shown presenting a lecture on measurement uncertainty to the San Diego EMC Chapter at their November meeting. Dan Hoolihan later joined Mr. Heirman as a lecturer on the topic.

tion, I/O filtering, PC board layout rules, PCB filtering rules, case shielding requirements, clamping methods, and RF common mode chokes. In addition, immunity analysis — transient and steady state, including the frequency domain transform of typical waveforms, radiated emissions levels and amount of cable voltage coupling was addressed. "Test Methods for Immunity" covered such topics related to EN61000-4-2 (IEC 1000-4-2, et al) such as ESD theory — how ESD is generated and basic physics that describe ESD including capacitance, impedance, charge, voltage, current, and power, radiated immunity, electrical fast transient burst and conducted immunity. Mr.

Photo by Stephen Slimac

It was a full house for the October Seattle EMC Chapter meeting. Andrew Price, Katie Molina and Pat Andre (standing L-R) of CKC Labs made their way through the crowd to distribute the speaker's notes for the "Design for Test and Immunity Workshop" presented by Chris Kendall.

Photo by Stephen Slimac

During the break, several people toured the laboratory at CKC Labs in Redmond, site of the October Seattle EMC Chapter meeting. Kimball Williams of Eaton Corporation (seated right) took advantage of a free chair to rest and finish his dinner.

Photo by Pat Andre

Some 40 people attended the November Seattle EMC Chapter meeting held at AT&T Wireless in Redmond. Franz entertained the crowd with his lively presentation, filled with his famous colorful graphics.

Photo by Pat Andre

Dennis Kringer of Techmaster Electronics (right) greeted speaker Franz Gisin at the November Seattle EMC Chapter meeting. Techmaster Electronics treated the chapter to an incredible barbecue dinner catered by Tony Roma's.

Photo by Stephen Slimac

There was a short break during the October workshop sponsored by the Seattle EMC Chapter with plenty of pizza for all.

Photo by Stephen Slimac

Chris Kendall received some local coffee as a Seattle memento following his presentation at the October Seattle EMC Chapter meeting.

Photo by Pat Andre

Janet O'Neil, Seattle EMC Chapter Chair, introduced speaker Franz Gisin of Sanmina in San Jose to the chapter at their November meeting.

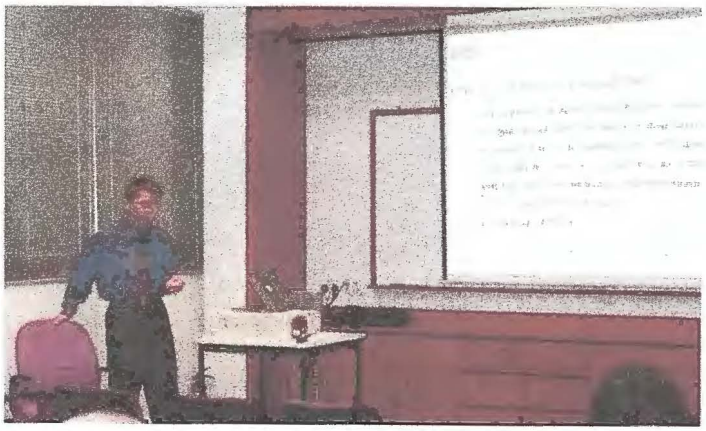
Kendall concluded his presentation with a review of some product specific variations of test methods, including EN55024, Information Technology Equipment, EN55103-2, Professional Audio and Video Equipment, EN61326, Test, Measurement and Instrumentation Equipment, IEC60601-1-2, Medical Devices, EN50130-4, Security Systems and ETS 300 683, Intentional Radiators. This October workshop was FREE to all who attended. It's part of the extended presentation format scheduled by the Seattle Chapter each fall. In November, the chapter was treated to an incredible graphics display with the lively presentation by Franz Gisin of Sanmina in San Jose. The psychadelic graphics reminded many of those in the audience of "lava lamps" from the 1960s. The title of the presentation was "How to Div Grad Kink and Curl Electrons Into Generating Unwanted Radiated Emis- sions." In fact, the presentation was so good that it was later formatted into an article and it appears in this Newsletter on page 25. Check it out for all the details of the material presented. The meeting was held at AT&T Wireless in Redmond. The excellent barbecue dinner before the meeting was provided courtesy of Techmaster Electronics. Over 40 chapter members and guests attended this presentation and many stayed well after the meeting to ask questions.

Singapore

There was a good turn out for the November meeting that the Singapore EMC Chapter held jointly with the Institute of High Performance Computing (IHPC, Singapore) who happened to be holding a seminar on "Electromagnetic Compatibility Simulation and Design." In all there was 30 attendees. Three presentations were featured during the meeting. The speakers were Dr. Chunfei Ye and Dr. Da-Ming Zhang of IHPC and Mr. Wee-Sing Chow of CET Technologies. The presentations covered various aspects of EMC simulation. Dr. Ye gave some useful insight into the role of various techniques and methods used in computational electromagnetics (CEM), such as the use of the Method of Moments or what was otherwise known as the Boundary Element Method in the frequency domain. With regards to simulations in the time domain, Dr. Ye explained the role of Finite Difference Time Domain and Finite Element Models with various Absorbing Boundary Conditions to free space with a finite computational volume. There was a brief introduction of the use of a Perfectly Matched Layer, Hidgon's operators and a few others. Several illustrations were presented by Dr. Ye dealing with the computation of the capacitance matrix for a wire bonded die in an IC package, radiated emission from PCB nets and several other applications of simulation.

Singapore EMC Chapter chair, Associate Professor See Kye Yak, provided the opening remarks at the November meeting.

Mr. Wee-Sing Chow showed an interesting example on the application of CEM tools for EMC modeling of a large-scale system integration project at the November meeting of the Singapore EMC Chapter.



A presentation was provided by Dr. Chunfei Ye on various numerical methods for CEM at the November meeting of the Singapore EMC Chapter.

Dr. Da-Ming Zhang gave a presentation on the design and modeling of reverberation chambers at the Singapore EMC Chapter's November meeting.

Dr. Ye spoke about the results from the use of simulation and presented many illustrations on field distributions in a computer chassis with many apertures as well as arrow charts on the power density functions in the microscopic scale for a via-hole in a printed circuit board. Mr. Chow's presentation was entitled "System EMC Engineering" and it was targeted at the application of CEM for large-scale system integration projects. The Naval Ship program and the Mass Rapid Transit (MRT) were cited as the examples of EMI/RFI modeling and simulation. The simulations were aimed to get a better understanding of the electromagnetic environment and the likely EMI phenomena for a given platform. The results provided the necessary quantitative risk assessment for possible EMI situations at system and equipment levels. Mr. Chow also spoke on the EMC management process throughout the entire project life cycle, in particular EMC requirements in areas of general equipment layout, earthing design, bonding implementation, cabling design and layout. This presentation introduced some installation guidelines and mitigation. Mr. Chow concluded his presentation with a theme based on the importance of EMC awareness and responsibilities among the different groups in an organization such as Purchasing, Assembly/Production, Installation and Maintenance, besides the leading design and test group in a typical project team structure. Dr. Zhang gave a presentation on the Experimental Design and Analytical Modeling of a Reverberation Chamber. The meeting was held at IHPC in the afternoon and IHPC had generously provided the attendees with refreshments during the break between presentations. The event was a unique opportunity for chapter members to mix with members of the industry, and many of them took time off from their busy schedules to attend.

Photo by Scott Lytle

Ed Bronaugh, Don Heirman and Dan Hoolihan (L-R) were the expert speakers featured at the October EMC Measurement Uncertainty Workshop hosted by the Southeastern Michigan Chapter.

Southeastern Michigan Chapter

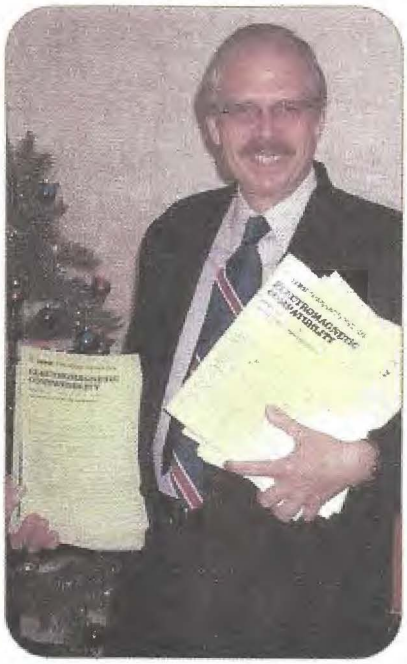
The Southeastern Michigan Chapter hosted an EMC Measurement Uncertainty Workshop on October 1 and 2, 2001. The workshop instructors were Ed Bronaugh, Don Heirman and Dan Hoolihan. The workshop covered uncertainty basics, distribution functions, calculations and associated guides and standards. Attendees were given software to calculate uncertainties of actual instrumentation from their test laboratories. The workshop was attended by 39 participants and was coordinated by Scott Lytle at the Yazaki North America facility in Canton, Michigan. A tour of the new Yazaki EMC Test Laboratory followed the workshop. The Southeastern Michigan Chapter is now planning their third annual EMC Fest to be held on April 22, 2002. Details can be found on the chapter website at http://www. emcsociety.org

continued on page 38

TRANSACTIONS ON EMC: BACK ISSUES WANTED!

There were many responses to the advertisement for a FREE complete set of the *Transactions on EMC* from 1982 to 2000 that appeared on page 8 of the Fall 2001 issue of the *EMC Society Newsletter*. This set was generously offered by past EMCS President, Bob Hofmann. If you have any past issues of the *Transactions on EMC* that you would like to share with others, please contact the following people who indicated that they would also pay for the shipping costs to receive free sets of the *Transactions on EMC*.

Shirley Chen, Shirley@quietek.com
Chang-yu Wu, changywu@us.ibm.com
Professor S. N. Shrivastava, shrinath@ece.iitkgp.ernet.in
Lieven Decrock, lieven.decrock@tycoelectronics.com



Eric Schumann was the first person to respond to the advertisement for a FREE complete set of the Transactions on EMC from 1982 to 2000. He is shown here with a partial set of the Transactions. Mr. Schumann commented that this was the "best holiday gift" he received in 2001.

10m, 5m, 3m, Compact Chambers,
And Shielded Enclosures

TEL: 203-866-5888
FAX: 203-866-6162

PANASHIELD INC.

www.panashield.com

Practical Papers, Articles and Application Notes

Bob Olsen, Associate Editor

In this issue you will find two practical papers and two letters that should be of interest to the EMC community. The first paper is entitled, "SE Measurement Comparison of a Conductive Plastic Modem Enclosure Employing GTEM cell or Mode-tuned Reverberation Chamber Methodology" by Y. J. Wang, W. J. Koh, C. K. Lee and Y.K. Tai of Singapore. In it, methods to evaluate conductive plastic shields similar to those described in the Summer 2001 Newsletter article by Sabrina Sarto et. al. are compared. It appears that interest in this type of enclosure is increasing. The second paper is entitled, "How to Div Grad Kink and Curl Electrons Into Generating Unwanted Radiated Emissions" by Franz Gisin and Zorica Pantic-Tanner. This paper was submitted in response to rave reviews from Franz's presentation of the material at the Seattle EMC Chapter meeting. I think that you will find the authors' discussion of the origin of radiation quite "illuminating." We hope to see more on this topic from the authors. Please contact the authors or me if you have some specific questions on this topic that have not yet been addressed. Finally, there are letters from Clayton Paul and Lex Van Duersen in response to my request for comments on Colin and Bronwyn Brench's article in last summer's issue on EMI Measurements and Modeling. I said then that I hoped this paper would be the beginning of a long conversation between those who primarily make measurements and those who primarily do numerical modeling. Lex and Clayton have responded with some very insightful comments. Enjoy these letters and feel free to add your two cents to the discussion.

Submission of material to the Practical Papers section of the Newsletter is encouraged. While all material will be reviewed prior to acceptance, the criteria are different from those of Transactions papers. Specifically, while it is not necessary that the paper be original or archival, it is necessary that the paper be correct, useful and of interest to readers of the Newsletter.

Comments from readers concerning these papers are welcome, either as a letter (or e-mail) to the Associate Editor or directly to the authors.

SE Measurement Comparison of a Conductive Plastic Modem Enclosure Employing GTEM cell or Mode-tuned Reverberation Chamber Methodology

Y. J. Wang[1], W. J. Koh[1], C. K. Lee[2] and Y. K. Tai[1]

[1] *DSO National Laboratories, Singapore*
20 Science Park Drive, Singapore 118230
Email: wyajun@dso.org.sg

[2] *Nanyang Technological University, Singapore*
Nanyang Avenue, Singapore 639798
Email: ecklee@ntu.edu.sg

Abstract: The paper presents two methodologies for performing shielding effectiveness measurements of a USB modem enclosure shielded by conductive plastic material, by the aid of either a GTEM cell or a mode-tuned mini-reverberation chamber with two orthogonal and mechanical stirrers. The measurement set-ups and underlying mechanisms are described. Both shielding effectiveness measurement results using different facilities are evaluated and discussed. The methodology by the use of the reverberation chamber is proven to be preferable for assessing the shielding effectiveness of the shielding enclosure.
Key Words: SE, GTEM cell, reverberation chamber, conductive plastics, and EMC

1. Introduction

The rapid development and widespread proliferation of sophisticated electronic equipment, such as wireless communications, information technologies, and military industries, have accelerated interest in electromagnetic compatibility (EMC). One of major factors in achieving conformant EMC requirements is electromagnetic interference (EMI) shielding. Enclosing a circuitry in a shielding enclosure is a good way to control radiated emissions and improve immunity or reduce susceptibility to external EMI. Traditional shielding is based on the use of metal materials with well-understood electromagnetic properties. However, driven by economics, miniaturization and complexity, metals are increasingly replaced by conductive thermoplastics or composite materials for housing both commercial electronic equipment [1], such as computers and telecommunications, and military applications, such as spacecraft, aircraft, naval, transportation, and construction structures.

The conductive thermoplastic enclosures provide designers with lighter weight, lower cost, greater flexibility, more complex designs and more aesthetic appeal when compared with metallic counterpart [2], [3]. Most common thermoplastics available for shielding bases include polycarbonate (PC), acrylonitrile butadienestyrene (ABS), polystyrene, nylon, poly phenylene oxide, polypropylen and maleated polystyrene copolymer. The key conductive coating processes applied to the thermoplastic substrates can be electroless coatings, electrolytic coating, conductive spraying, and vacuum metallizing, etc.

In general, both insertion loss and twin antenna techniques are employed in industry to assess shielding effectiveness (SE) of the conductive thermoplastic enclosure [4]. The insertion loss tech-

nique is widely used by manufacturers when evaluating the material shielding performance, while the twin antenna technique is utilized to assess the shielding effectiveness of an enclosure itself. The SE measurement methodology using a mode-tuned or mode-stirred reverberation chamber has been increasingly generating lots of interest recently [8]. Numerous test standards on the SE measurements of conductive materials or enclosures have been established, which result in the application of hybrid techniques to various shielding products. Some SE measurement techniques available to date are inclusive of ASTM 4935/89, ASTM ES7-83 dual chamber test fixture, MIL-STD-285, VG 95373, TEM-T cell, circular coaxial transmission line holders, dual TEM for near-field SE measurement, transfer impedance approach, time-domain approach, complex permittivity approach, and apertured TEM cell in a reverberation chamber [5]-[7].

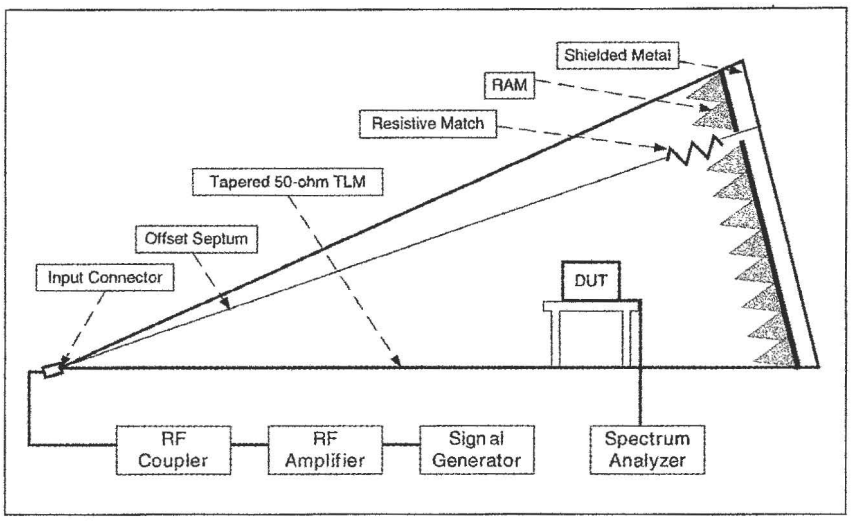


Figure 1. SE Measurement Set-up Using a GTEM Cell.

The use of a mode-tuned or mode-stirred reverberation chamber for performing EMC measurements, such as shielding effectiveness evaluations and radiated susceptibility testing of equipment and subsystems, has become accepted practically. The concept used in the reverberation chamber is to excite available electromagnetic wave propagation modes to set up variable standing wave patterns in the chamber. The electromagnetic (EM) fields inside the chamber are regarded as statistically isotropic, randomly polarised, and uniformly homogenous within an acceptable uncertainty and confidence limit. The reverberation chamber method is cost-effective and time-efficient compared to some other conventional testing methods [11]-[13]. Extensive interest in introducing the reverberation chamber measurement technique into various standards has led to the attempt to develop performance-based criteria for reverberation chambers. These standards include IEC 61000-4-21, IEC 61000-4-3 (Annex), MIL-STD-461E, MIL-STD-1344A, EIA-364-66A, RTCA/DO-160D, SAE J1113/27, GM-9120P, CISPR 16-1, CISPR 16-2, FAA HIRF user guides, etc.

In this paper, a SE measurement methodology using a GTEM (gigahertz transverse electromagnetic mode) cell is employed initially to quantitatively evaluate the SE of a stylish modem enclosure made of conductive plastic material, within the frequency range of interest. Another novel SE measurement methodology by the aid of a mode-tuned mini-reverberation chamber with two orthogonal and mechanical stirrers is also proposed. Both results are compared and discussed.

The studied device under test (DUT) is a commercially available USB (universal serial bus) modem with a stingray-shaped appearance. Its maximum external dimensions are around 17cm×13cm×4cm. There is no complete perforation except some shallow holes simulating the stingray skin in the plastic top-cover of the modem, while several holes are perforated in the plastic bottom-cover of the modem, which are mainly used for the top-bottom closure purpose and are adequately sealed with a conductive gasket ring. The internal conductive parts of both the top-cover and the bottom-cover of the modem are specially designed such that they can be properly linked to the ground planes of both sides of the printed circuit board (PCB). No inner gasket is installed between the top-cover and the bottom-cover of the modem.

2. Shielding Effectiveness Measurement Set-ups

2.1. GTEM Cell

A GTEM cell is a single-taper development of an asymmetrical TEM (transverse electromagnetic mode) cell with an offset septum plate for increased working volume. It has a current load connected to the septum and distributed wave termination in the form of RAM (radio absorbent material) wall at the end of the enclosing taper. It may be viewed as a careful combination of aspects of a TEM cell and an anechoic chamber. The SE measurement made with a GTEM cell [9] is based on the use of coaxial transmission lines supporting TEM mode propagation: the DUT is placed between the tapered coaxial lines and is immersed in an almost uniform plane-wave field.

The experimental set-up is shown in Fig.1. The source of RF (radio frequency) signal generator feeds the input of the GTEM cell via RF amplifier and RF coupler. The function of the RF coupler is to make sure that the injected power into the GTEM cell is stable throughout the measurements. A properly designed monopole antenna is placed within the modem shielding enclosure after removing its internal circuitry. The monopole is supported by some tiny nonconductive substrate to avoid touching the inner conductive layer of the enclosure material. All the connecting cables with high SE are chosen to avoid externally ambient EMI; the coaxial cable linking the monopole and the outlet of the GTEM cell is properly shielded with film copper to minimize possible EM coupling from the plane wave. The monopole requires adequate grounding connection to the internal conductive layer of the modem enclosure to ensure accurate results. The appropriate positioning of the monopole with respect to the field polarization of the plane wave is essential to the acquisition of SE measurement data.

The ability of a shield to screen out EM fields is defined quantitatively in MIL-STD-285 [10] as the attenuation or the ratio of the received power on both sides of the shield when it is illuminated by EM radiation. Similarly, in the case of SE measurement of a shielding enclosure, the shielding effectiveness can be expressed as

$$SE = 10 \log \frac{P_1}{P_2} \quad (1)$$

Or

$$SE = 20\log\frac{E_1}{E_2} \qquad (2)$$

Where P_1, E_1 and P_2, E_2 are the received powers and electric field strengths of the receiving monopole antenna without and with the modem enclosure, respectively. It is well known that SE measurement result of a practical enclosure is widely influenced by the enclosure material, material thickness, enclosure shape, field incidence, and functional apertures, unintentional leakage, seams and joints, etc.

The measurement procedure using this methodology demands the initial received power measurements without the enclosure and the received power measurements with the enclosure, within the frequency range of interest. Three different enclosure orientations are studied to cover possible polarizations and directions of the EM coupling into the enclosure: enclosure top-cover normally facing the GTEM RF inlet, enclosure bottom-cover normally facing the GTEM RF inlet, and enclosure side horizontally facing the GTEM RF inlet.

2.2. Mini-reverberation Chamber

The mode-tuned mini-reverberation chamber applied in the course of the SE measurement has the dimensions of 113.6cm (length)×77.0cm(width)×54.5cm(height). The LUF (lowest usable frequency) of the chamber was determined to be around 0.74GHz; the field uniformity within the frequency of interest satisfies the specific requirements proposed by IEC standards (IEC-61000-4-3 or IEC-61000-4-21). The reverberation chamber itself is a shielded rectangular enclosure made of aluminium material. A rectangular door cut in the chamber top is of double-layer structure: one layer of transparent wire-meshed conductive plastic sheet above the lower layer of removable aluminium sheet. High quality finger gaskets are lined evenly along the door perimeters to avoid radiation leakage when the door is closed. The door is sealed shut during measurements by the use of a series of forth latches surrounding the four sides of the door. There are totally two orthogonal Z-shaped stirrers (rotating paddle wheels) inside the chamber, which are mutually at right angles. The vertical stirrer reaches from the floor to the ceiling of the chamber, while the horizontal stirrer is parallel to the width edge of the chamber at the opposite top. The extended lengths of the vertical stirrer and the horizontal one are 48.0cm and 60.0cm, respectively. Both have the same width of 12.0cm.

The schematic of the SE measurement is plotted in Fig. 2. A small horn antenna, attached to a RF amplifier and RF generator, is placed nearby the corner of the chamber to transmit RF signal into the chamber. A monopole antenna, identical to the one used in the GTEM cell methodology, is utilised to detect the received power. A step motor assembly, which is operated by a laptop with a GPIB port, is connected to both stirrers. The rotations of both stirrers are controlled by a specific operating program developed in the laptop.

A spectrum analyzer is used to collect data at discrete sampling frequencies, which are spaced at 0.25GHz interval. The receiving monopole will monitor the received powers to the spectrum analyzer, which are then recorded into the same laptop by the aid of some instrumental measurement software. With these collected raw data, the software will go through a series of post-processing calculations. A three-axis isotropic E-probe is used as a reference antenna to ensure the same field strength inside the chamber in two cases with and without the modem enclosure immersed. Due to the loading effect of the modem enclosure, it is essential to increase the RF power injected to the chamber appropriately, based on the calibration results obtained by the E-probe.

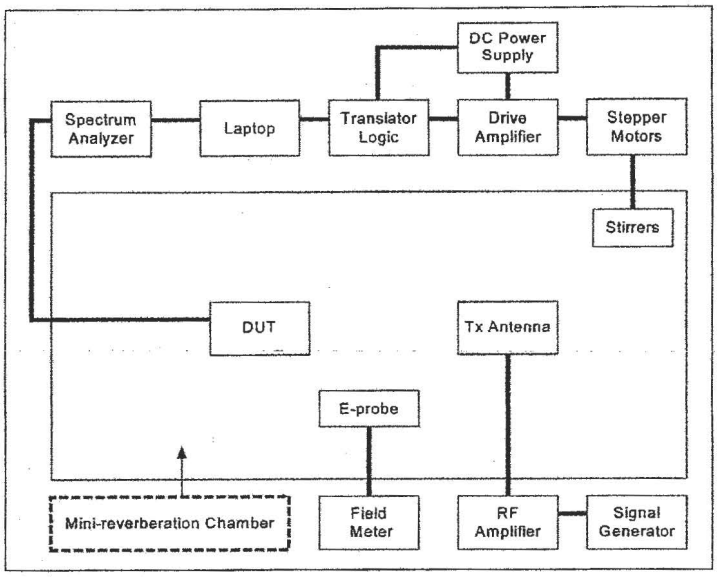


Figure 2. SE Measurement Set-up Employing Mini-reverberation Chamber Methodology.

3. Results and Analyses

Fig.3 compares the SE measurement results of the USB modem shielding enclosure by using two different methodologies. The frequency band was limited to 0.1GHz - 1.0GHz in the GTEM cell methodology due to the facility constrains. The frequency band for the mini-chamber was chosen to be 0.5GHz - 1.0GHz. Since the LUF of the chamber was originally designed to be around 0.74GHz, the field uniformity at much lower frequencies than the LUF is supposed to be unacceptable for practical applications [12].

Three different orientations of the modem enclosure were investigated due to the vertical polarization of the plane wave in the GTEM cell: the top-cover, bottom-cover and wide side of the enclosure normally facing the GTEM power inlet, respectively. Similarly, three orthogonal orientations of the modem enclosure were also tested in the case of the mini-reverberation chamber methodology, the average received power of all the three orientations at one specific frequency was used for the SE post-processing.

It can be seen that big fluctuations of SE measurement results are obvious in the GTEM methodology, within the frequency range of interest, as shown in Fig.3. The SE variation with the enclosure top-cover facing the GTEM RF power inlet is similar to that with the enclosure bottom-cover facing the GTEM RF power inlet except at few frequencies. This may be due to the quasi-symmetrical structure and the similar material characteristics of both the top and bottom of the modem

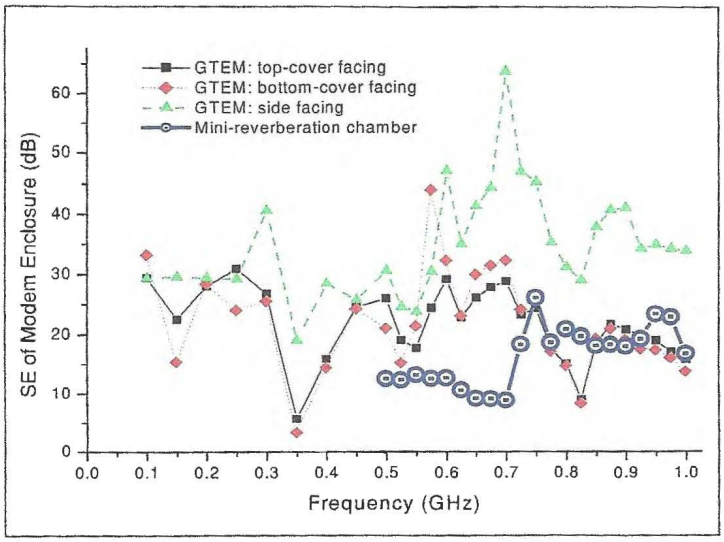


Fig.3. Comparison of SE Measurement Results for Two Different Methodologies.

enclosure. The SE results with the enclosure side facing the GTEM RF power inlet show better performance compared to the above two cases, which may be associated with the perfect contact between the peripheral conductive parts of both the top and bottom enclosure covers. Most of the SE values in the GTEM methodology are within the range of 20 - 40dB, while the poorest SE at 0.35GHz and 0.825GHz might be related to the enclosure resonant modes.

In the mini-reverberation chamber methodology, the SE results are relatively more stabile compared to the GTEM methodology. Two additional important aspects are observed. Firstly, the SE values within the frequency range of 0.5GHz - 0.725GHz are apparently lower compared to those within the frequency range from 0.75GHz to 1.0GHz; there are big differences (up to 20dB) in the SE measurements by using the GTEM cell or the mini-reverberation chamber set-ups at the frequency range of 0.5GHz – 0.725GHz. This is principally due to the LUF, i.e. 0.74GHz, of the mini-reverberation chamber, where lower mode density and non-uniform field strengths will exist under evanescent modes. The discrepancy suggests that the mini-reverberation chamber will not be suitable for frequencies lower than the LUF of 0.74GHz. On the contrary, this phenomenon could be regarded as the possible verification of the LUF of the chamber. In the second aspect, the dynamic range of the SE results is limited to about 18 - 27dB from 0.75GHz to 1.0GHz, which is close to that measured applying the GTEM methodology except at the possible enclosure resonant frequencies. The mini-reverberation chamber methodology may imply the worst case for the SE measurements, as the EM coupling into the enclosure are highly due to the random polarization within the chamber.

It should be noted that the correlation between the SE results using the two different methods is not investigated. As the radiation conditions in the GTEM cell are not satisfied everywhere, the presence of the DUT enclosure would modify the field distribution and polarization and introduce the loading effect. Therefore, great attention should be paid to the use of Formula (1) or (2) for the SE calculation in the case of the GTEM methodology. As for the loading effect of the DUT enclosure, one could increase the input RF power accordingly by introducing and monitoring a small sensor inside the GTEM cell. The similar problem occurs in the mini-reverberation chamber methodology, where a three-axis isotropic E-probe, as shown in Fig. 2, is applied as a reference antenna to ensure the same field strength within the chamber with or without the DUT enclosure immersed.

4. Conclusions

Two methodologies, employing either a GTEM cell or a mode-tuned mini-reverberation chamber, for experimentally measuring the shielding effectiveness of a USB modem, made of conductive plastic material, have been presented and compared. In the case of the enclosure SE measurement within the frequency range of interest, the reverberation chamber method offers better testing repeatability, more stable outcome, more aspect angles and significant time-effectiveness over the GTEM cell counterpart.

Acknowledgements

The first author would like to recognize L. S. Lam of DSO National Laboratories, Singapore for her valuable assistance in the course of the shielding effectiveness measurements.

References

1. B. C. Jackson and G. Shawhan, "Current Review of the Performance Characteristics of Conductive Coatings for EMI Control", *Proceedings of 1998 IEEE International Symposium on EMC*, vol.1, pp. 567-572.
2. H. Rahman, P. K. Saha, J. Dowling, and T. Curran, "Shielding Effectiveness Measurement Techniques for Various Materials Used for EMI Shielding", *IEE Colloquium on Screening of Connectors*, pp. 9/1-9/6.
3. R. D. Semidi, J. Pintelon, G. Spildooren, and S. Criel, "Practical Experience with the Shielding Effectiveness of Small Coated Plastic Boxes", *Proceedings of 2001 IEEE International Symposium on EMC*, vol. 3, pp. 245-260.
4. A. Ogunsola, "A Test Programme for the Shielding Effectiveness Evaluation of Conductive Plastic Enclosures", *Proceedings of 2000 IEEE International Symposium on EMC*, pp. 851-854.
5. B. A. Kinningham and D. M. Yenni, "Test Methods for Electromagnetic Shielding Materials", *Proceedings of 1988 IEEE International Symposium on EMC*, pp. 223-230.
6. P. F. Wilson, M. T. Ma, and J. W. Adams, "Techniques for Measuring the Electromagnetic Shielding Effectiveness of Materials: Part I-Far-field Source Simulation", *IEEE Transactions on EMC*, vol. 30, No. 3, Aug. 1988, pp. 239-250.
7. P. F. Wilson and M. T. Ma, "Techniques for Measuring the Electromagnetic Shielding Effectiveness of Materials: Part II-Near-field Source Simulation", *IEEE Transactions on EMC*, vol. 30, No. 3, Aug. 1988, pp. 251-259.
8. M. O. Hatfield, "Shielding Effectiveness Measurements Using Mode-stirred Chambers: a Comparison of Two Approaches", *IEEE Transactions on EMC*, vol. 30, No. 3, Aug. 1988, pp. 229-238.

EMC Fest 2002

A Colloquium and Exhibition on Designing for EMC Immunity & Reverberation Chambers

Monday, April 22, 2002

Dearborn Inn
Dearborn, Michigan

7:30 am-8:30 am Registration & Continental Breakfast
8:30 am-5:00 pm Technical Sessions
5:00 pm-6:30 pm Reception, Exhibits & Demonstrations

Featuring
Industry Renowned Speakers:
Chris Kendall & Mike Hatfield
The focus of this colloquium will be on
Design Considerations for EMC Immunity in Electronic Modules
and
Using Reverberation Chambers for EMC Testing

Registration Fees
$150 Prior to April 1
$175 after April 1 and at the door
Non-IEEE attendees, add $30

ATTENDANCE IS LIMITED
***** Register Early *****

Fees include one copy of the colloquium record, a continental breakfast, "networking" lunch and "Happy Hour" reception immediately following the Technical Sessions.

PLUS! Hands on participation during the demos. Vendor tabletop exhibits of the latest EMC related products and services.

For further information:
Kimball Williams, Chairman
248-354-2845, e-mail: k.williams@ieee.org
Janet O'Neil, Vice-Chair Exhibits:
425-868-2558, e-mail: j.n.oneil@ieee.org

Home page: http://www.emcsociety.org/
Register On-Line!

Sponsored by the Southeastern Michigan Chapter of the IEEE EMC Society

9. A. Manara, "Measurement of Material Shielding Effectiveness Using a Dual TEM Cell and Vector Network Analyzer", *IEEE Transactions on EMC*, vol. 38, No. 3, Aug. 1996, pp. 327-333.
10. MIL-STD-285, "Method of Attenuation Measurement for Enclosures Electromagnetic Shielding for Electronic Test Purposes", 1956.
11. G. J. Freyer and M. O. Hatfield, "An Introduction to Reverberation Chambers for Radiated Emission/Immunity Testing", *ITEM* 1998, pp. 86-95.
12. M. L. Crawford and G. H. Koepke, "Design, Evaluation, and Use of Reverberation Chamber for Performing Electromagnetic Susceptibility/Vulnerability Measurements", *NBS Technical Note 1092*, Apr. 1986.
13. K. Goldsmith, "Reverberation Chambers-What Are They?" *IEEE EMC Society Newsletter,* Fall 1999.

Biographical Notes

Ya Jun Wang (M'02) was born in Ningbo, Zhejiang, P.R. China. He received B. Sc. (Best Hons) from Physics Department of Xiamen University, P. R. China in 1992, and M. Eng. (by research) in electrical & electronic engineering from Nanyang Technological University, Singapore in 2000.

From 1992 to 1998 he was an electrical engineer/a senior electrical engineer and assistant to General Manager at China Import and Export Commodities Inspection Bureau (CCIB), Fujian, P.R. China. Since November 2000, he has been working with DSO (Defence Science Organisation) National Laboratories, Singapore as a member of technical staff and an EMC (electromagnetic compatibility) engineer. He is an NARTE-certified EMC engineer and a committee member of IEEE Singapore EMC chapter for year 2002. Some areas of his interest are devoted to microstrip antennas, mobile antennas, numerical methods, computational electromagnetics, test chambers, EMC protection and measurement techniques.

Wee Jin Koh (M'90) was born on May 13, 1957 in Singapore. He received his B.Sc. from UMIST, UK in 1979, M. Sc. from Naval Postgraduate School, California USA in 1987 and PhD from Ohio State University, Ohio USA in 1995, all in electrical engineering.

He has been working at DSO National Laboratories since 1981. He worked as an EMC engineer from 1982 to 1985, and headed an EMC Group from 1987 to 1991. He was appointed Head of Research in EM in 95 and became Head of EM Centre in 1999. His area of interest is in RCS and EMC.

Ching Kwang Lee was born in Malaysia. He received his B.Sc. and PhD degrees from the University of Kent at Canterbury, United Kingdom, in 1982 and 1987 respectively.

He was a research fellow in the areas of microwave antenna majoring in frequency selective surface, at the above university between 1988 and 1990. He joined the Electro-Optic Group, Division of Radiophysics (now renamed as Telecommunications and Industrial Physics), and Commonwealth Scientific Industrial Research Organisation (CSIRO) in Australia as a research scientist from Oct. 1990 to Jul. 1991 working on near field range. He is currently an associate professor in the school of Electrical and Electronic Engineering, Nanyang Technological University, Singapore. His research interests include frequency selective surface, microstrip antenna and electromagnetic inverse scattering.

Yeow Kwang Tai was born in Singapore. He received his B. Eng. (Hons) in Electrical Engineering (telecommunication) from the University of Edinburgh, UK in 1998. He has been working at DSO National laboratories, Singapore as a Member of Technical Staff since his graduation. His specialisation includes reverberation chamber characterisation, radio frequency interference and field to cable coupling.

How to Div Grad Kink and Curl Electrons Into Generating Unwanted Radiated Emissions

Franz Gisin, Senior Member IEEE, and Dr. Zorica Pantic-Tanner, Senior Member IEEE

Introduction

Anyone who has spent any length of time wandering around within the EMC discipline, will, on occasion, take time out to pause and reflect on exactly what it is about pushing electrons around on conducting materials that causes them to generate propagating electromagnetic waves in their wake. We know structure size plays an important role. Antennas and enclosure apertures excited at their natural resonant frequencies radiate at higher levels. If we dig a bit deeper into what is actually going on we notice size, especially length, does not always equate to higher emission levels. Anyone who has tried to debug a failing product on an Open Area Test Site (OATS) quickly discovers simply moving cables around, without appreciably changing their length, can also be used to reduce emission levels, a physical fact that can be quite frustrating when emission levels at "minimum" orientation are comfortably below the applicable regulatory agency limit while emissions at "maximum" orientation rocket to embarrassingly high levels.

Analytical expressions for the total radiation from a simple dipole antenna show more radiation occurs at the ends and the middle of a dipole than uniformly along its entire length [1], [2], [3]. Figure 1 shows one frame from an FDTD animation of a dipole excited by a single pulse, graphically portraying the power magnitude of the electromagnetic field, |E×H|, around the dipole right after the pulse reached the ends of the dipole [4]. The "puffs" of increased radiation from the ends of the dipole can clearly be seen.

If radiation along the dipole is not uniform, then we should not be surprised if it is also true for other shapes, in which case we must ask ourselves what intrinsic qualities inherent in the shape of a structure causes electrons in some areas to generate higher levels of electromagnetic radiation than others.

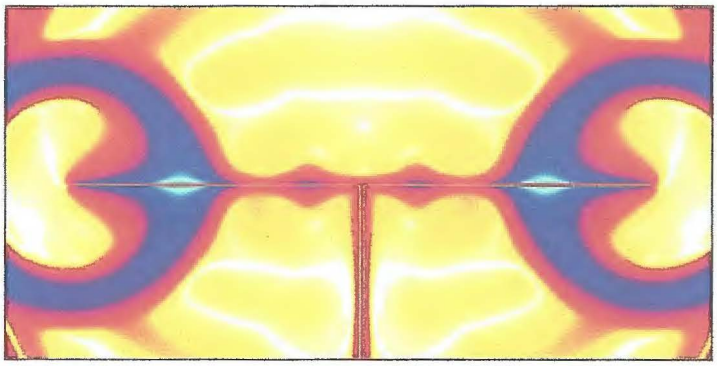


Figure 1: Radiation from the ends of a dipole antenna

Maxwell's Equations

The differential form of Maxwell's equations are shown in (1) through (4). Equations (1) and (2) are Gauss's law for electric and magnetic fields, (3) is Ampere's original circuit law with an added displacement current term, $\partial D/\partial t$, describing, for example, how alternating current behaves when it flows between the plates of a capacitor, and (4) is Faraday's law.

$$\nabla \mathbf{D} = \rho_v \tag{1}$$

$$\nabla \mathbf{B} = 0 \tag{2}$$

$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t} \tag{3}$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \tag{4}$$

Associated with the four Maxwell equations are the three constitutive relationships relating the two field quantities, **E**, and **H**, with three field densities, **D**, **B**, and **J**.

$$\mathbf{D} = \varepsilon \mathbf{E} \quad \mathbf{B} = \mu \mathbf{H} \quad \mathbf{J} = \sigma \mathbf{E} \tag{5}$$

Since most of us do not work with Maxwell's equations on a daily basis, a quick overview of the mathematical notation used in (1) through (4) will help strengthen our intuitive understanding of the physics behind undesired radiation. In the Cartesian coordinate system, the del differential operator is defined as

$$\nabla = \frac{\partial}{\partial x}\mathbf{a}_x + \frac{\partial}{\partial y}\mathbf{a}_y + \frac{\partial}{\partial z}\mathbf{a}_z \tag{6}$$

Applying the del operator to different electromagnetic field quantities tells us how the fields behave in space. If we combine the del operator with the vector dot product and then apply it to a vector, we get the divergence, or div, of that vector. For example, applying this combination to the displacement flux density, **D**, results in Gauss's law for electric fields.

$$\text{div } \mathbf{D} = \nabla \mathbf{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z} = q_v \tag{7}$$

From (7) we can see that Gauss's law relates a spatial property of the electric field at a point, its divergence $\nabla \bullet \mathbf{D}$, to a known quantity, the charge density q_v, at that point. How much the electric field diverges from a point is dependent on the amount of charge located at that point.

If we combine the del operator with the vector cross product and again apply it to a vector, we get the curl of that vector. Applying this combination to the electric field, we get Faraday's law.

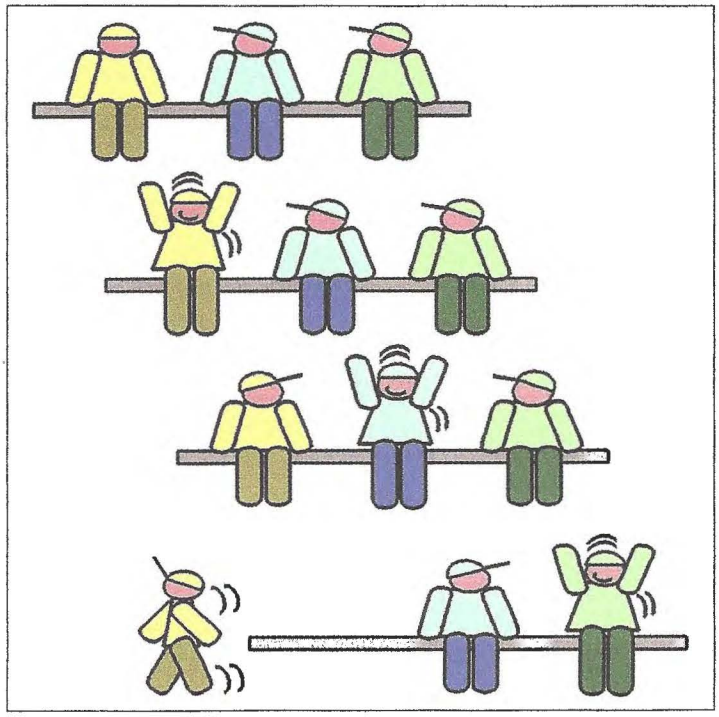


Figure 2: Spectator Wave Motion

$$\text{curl}\ \mathbf{E} = \nabla \times \mathbf{E} = \begin{vmatrix} \hat{\mathbf{a}}_x & \hat{\mathbf{a}}_y & \hat{\mathbf{a}}_z \\ \partial/\partial x & \partial/\partial y & \partial/\partial x \\ E_x & E_y & E_z \end{vmatrix} = -\frac{\partial \mathbf{B}}{\partial t} \tag{8}$$

From (8) we can see that Faraday's law also relates a spatial property of the electric field at a point, the curl of the electric field $\nabla \times \mathbf{E}$, to the time rate of change of magnetic field occurring at that point.

We can use the del operator to define other spatial relationships. For example, we can define the Laplacian of the electric field, $\nabla^2 \mathbf{E}$, as the gradient (grad) of the divergence of **E** minus the curl of the curl of **E**.

$$\begin{aligned} \nabla^2 \mathbf{E} &= \nabla(\nabla \bullet \mathbf{E}) - \nabla \times (\nabla \times \mathbf{E}) \\ &= \frac{\partial^2 E_x}{\partial x^2}\mathbf{a}_x + \frac{\partial^2 E_y}{\partial y^2}\mathbf{a}_y + \frac{\partial^2 E_z}{\partial z^2}\mathbf{a}_z \end{aligned} \tag{9}$$

What is important to keep in mind is not the detailed mathematical manipulations required to come up with expressions such as (9), but the fact that expressions containing the del operator, ∇, describe some aspect of the spatial characteristics of electric and magnetic fields at a point in space. If we confine ourselves to regions of space where the materials properties, ε, μ, and σ, are linear, isotropic, and homogenous - an assumption we can confidently apply to our case where good conductors are surrounded by air - we can take the first two relationships of (5), substitute them into (3) and (4), and after some crafty mathematical thrashing about that includes (9), we arrive at the following three elegant equations [3].

$$\nabla^2 \mathbf{E} - \mu\varepsilon \frac{\partial^2 \mathbf{E}}{\partial t^2} = \mu \frac{\partial \mathbf{J}}{\partial t} \tag{10}$$

$$\nabla \times \mathbf{H} = \varepsilon \frac{\partial \mathbf{E}}{\partial t} \tag{11}$$

$$\nabla \times \mathbf{E} = -\mu \frac{\partial \mathbf{H}}{\partial t} \tag{12}$$

From (10) we can see that a time varying current, **J**, creates a distortion in the electric field, **E**, (e.g. an electric field that varies both in time and space) around the current carrying conductor. In the region of space around the wire, we can set the conduction current in (3) to zero, in which case (3) can be expressed as (11). Once a time varying electric field is created, then (11) says a distortion in the magnetic field is also created, which in turn creates a distortion in the electric field (12). Equation (10) is the governing equation that describes how a distortion in the electromagnetic field is launched, while (11) and (12) describe how this distortion propagates through space. If the current, **J**, does not vary in time, for example when there is no current flowing or the current is flowing at a constant (DC) rate, then no time varying distortions are created in the electric field, and no propagating electromagnetic field is created. Since current is defined as the velocity of charge, the derivative of the current is equal to the acceleration of charge. Equations (10) through (12) basically state that whenever we have acceleration of charge, we create propagating electromagnetic fields.

An analogous process occurs in all physical waves, even the spectator "waves" so popular at sporting events. Referring to Figure 2, a "source" spectator launches a wave by standing up and then sitting back down. The spectator sitting beside the source decides to do the same, and also stands up and sits back down. The third spectator, sitting beside the second spectator, also decides to participate. The process continues on, and the "wave" starts propagating down the bleachers. Once the wave is launched, the "source" spectator is no longer needed. He/she can leave to go buy another soft drink or hot dog, and the wave will continue unimpeded. We should note that neither the electromagnetic wave or the spectator wave, travel at infinite velocity, both waves exhibit time retardation.

Once the source of the electromagnetic wave, the accelerating charges that form the basis for the time varying current **J**, launch the wave in accordance with (10), the wave continues on its own volition in accordance with (11) and (12). The charge, no longer needed to maintain the outwardly propagating wave, can then concentrate on other things, like heating up the wire.

Electric Fields Around a Positive Charge

While (10) through (12) make sense from a conceptual point of view, they tell us little about what the distortion we created in the electromagnetic field looks like. To find out exactly what is happening, we can study the electric field around a collection of stationary charge, briefly accelerate the charge to a DC current level, wait for a short period of time to let the distortion propagate outward a bit into space, and then decompose the

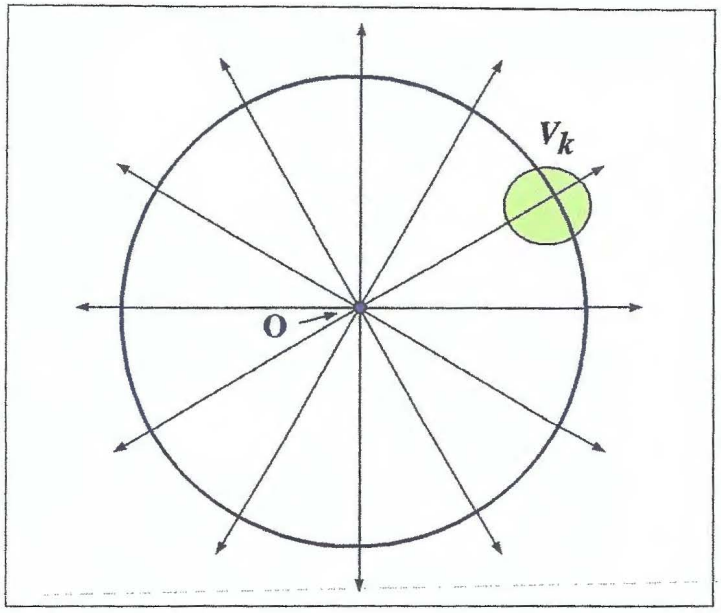


Figure 3: Electric lines of flux around a point charge

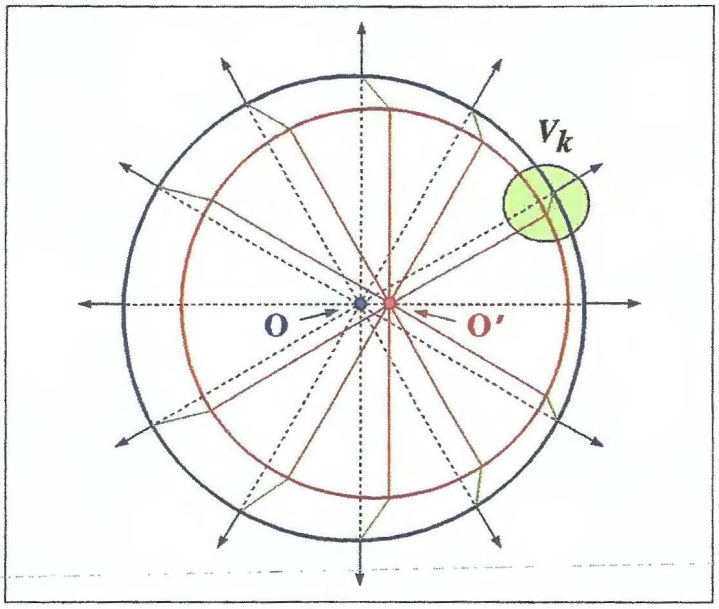


Figure 4: Field line kink due to accelerating charge

distortion into vector components tangential and normal to the direction of propagation.

Figure 3 shows a cross section of a sphere surrounding the charge centered at the origin, O. Lines of electric flux emanate radially outward from the charge. The lines of electric flux only show vector direction, not magnitude. They show the path a small positive test charge would follow if we placed it in the field and then let it go. Within the engineering world, a variety of methods are used to indicate magnitude, including varying either the length or the thickness of the vector line in proportion to its magnitude. In our case the spacing between the lines of flux is used to represent the magnitude of the electric flux density, **D**. As we approach the charge, the lines of flux come closer together and the magnitude of the flux density, **D**, increases. As we move away from the charge, the lines of flux spread farther apart and the magnitude of **D** decreases.

By taking Gauss's law (1), integrating both sides over the entire volume of the sphere, and then applying the divergence theorem, we find the flux density, **D**, and electric field, **E**, are equal to [5].

$$\mathbf{D} = \frac{q}{4\pi r^2}\hat{\mathbf{a}}_r \qquad \mathbf{E} = \frac{\mathbf{D}}{\varepsilon} = \frac{q}{4\pi\varepsilon r^2}\hat{\mathbf{a}}_r \tag{13}$$

From (13) we can see the electric field also varies with increasing/decreasing distance from the source.

Restrictions on Lines of Flux

There are several other subtle points we need to address with respect to lines of flux. Gauss's law (1) states that at points where charge exists, the divergence of **D** is not zero. Geometrically this means lines of flux either start (if the net charge density is positive at the point of interest) or end (if the net charge density is negative).

At the center, O, $\nabla\bullet\mathbf{D} \neq 0$, charge is present AND lines of flux line start from that point. Conversely, at points where $\nabla\bullet\mathbf{D} = 0$, no charge is present AND no flux lines start from or terminate at that point. In region V_k, no charge exists, and hence field lines passing through this region must be continuous.

Kinks in the Electric Field

We are now ready to see what happens to the electric field when we briefly accelerate our collection of charge. Referring to Figure 4, at time $t = 0$, our charge is at rest at position, O, and the flux lines emanating from the charge are identical to the lines of flux shown in Figure 4. Shortly thereafter, we apply an acceleration, a, for a brief period of time, Δt, bringing the charge velocity up to $v = a\Delta t$. Now the lines of flux start from point O' instead of O. It takes a finite amount of time for the position of the new flux lines to propagate outward – they cannot go faster than the speed of light.

On the outwardly propagating "wave-front", for example in volume V_k, we are in a region with no charge, and Gauss's law requires the flux lines be continuous across the wave-front. The

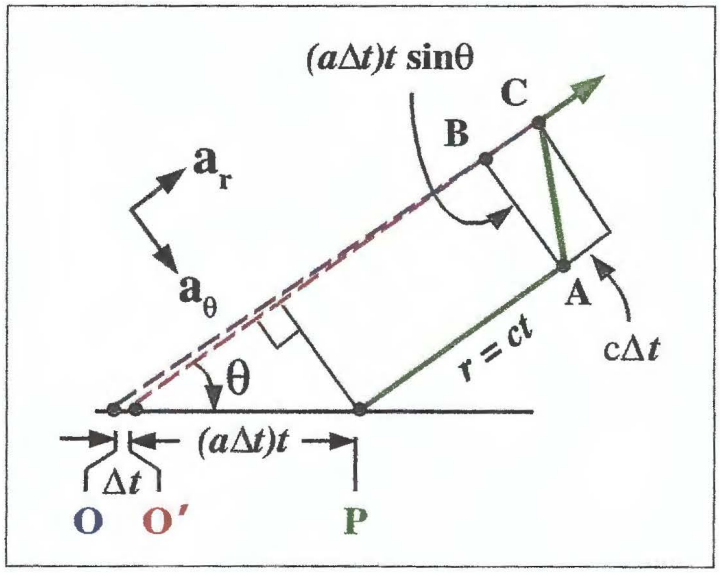


Figure 5: Kink detail

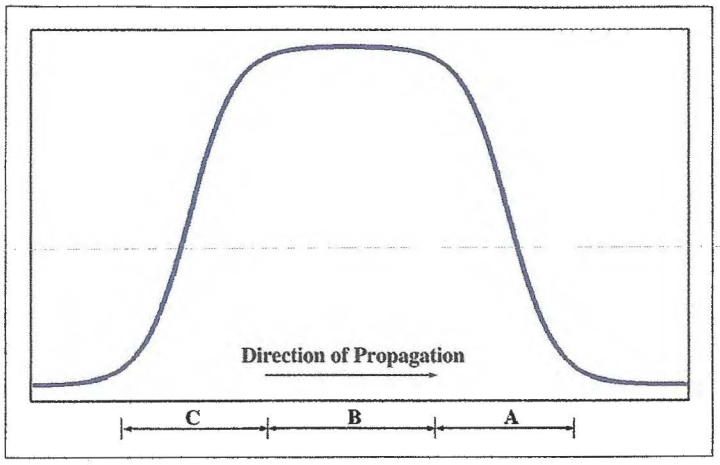


Figure 6: A propagating digital pulse

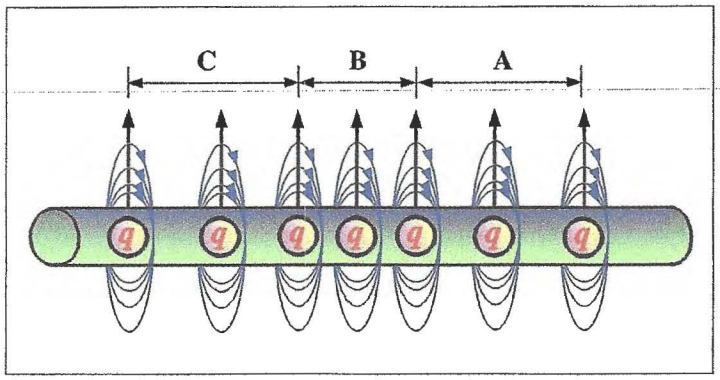


Figure 7: E and H fields around a digital pulse

only way this condition can hold is if the lines of flux are kinked. Since the electric flux density, D, and its associated electric field, E, are both defined in terms of the electric lines of flux, they too end up being kinked. We can therefore conclude accelerating charge creates a kink in the electric field, E.

Note the kinks are not constant on the wave-front – they change with respect to angle.

Referring to Figure 5, if we now wait for a short period of time, t, to let the kink propagate outwards a bit, the charge will have moved to the right by a distance $vt = (a\Delta t)t$ to point P.

The field lines due to the charge must still remain connected, and so we still have a kink, although it is now a bit larger. In the limiting case, where $\Delta t \rightarrow 0$, distance OP $\approx$ O'P $\approx vt = (a\Delta t)t$, and the normal component of the electric field kink, $\mathbf{E}_\theta$, is proportional to distance AB $= (a\Delta t)t \sin\theta$. The tangential component of the kink, $\mathbf{E}_r$, is proportional to distance BC $= c\Delta t$. Taking the ratio of these two electric field components, we get

$$\frac{E_\theta}{E_r} = \frac{AB}{BC} = \frac{(a\Delta t)t\sin\theta}{c\Delta t} = \frac{at\sin\theta}{c} \qquad (14)$$

Substituting (11) for $\mathbf{E}_r$ in (17), and noting that the distance PA $= r = ct$, we finally obtain the tangential and normal components of the electric field kink.

$$\mathbf{E}_r = \frac{q}{4\pi\varepsilon_0 r^2}\mathbf{a}_r \qquad (15)$$

$$\mathbf{E}_{\acute{e}} = \frac{qa\sin\theta}{4\pi\varepsilon_0 c^2 r}\mathbf{a}_{\acute{e}} \qquad (16)$$

This is another good point to pause and reflect on exactly what these two equations mean from a physical standpoint. We see from (15) and (16) that the radial component of the electric field kink, E_r, decreases as the square of the distance, $1/r^2$, while the normal component, E_θ, decreases linearly with distance, $1/r$. Far away from the source only the normal component of the kink remains. From (16) the magnitude of E_θ is proportional to the rate of charge acceleration, a. Because current is defined as the velocity of charge, $I = dq/dt$, acceleration of charge occurs whenever we generate a time-varying current, $dI/dt = d^2q/dt^2 \neq 0$. These results are also in agreement with (10).

The magnitude of $\mathbf{E}_\theta$ is dependent $\sin\theta$. From Figure 5, maximum radiation occurs at points perpendicular to the direction of charge motion, minimum magnitudes occur at points in line with charge motion. This angular dependence explains why broadside radiation from a resonant dipole antenna is maximum while end-fire radiation is minimum.

And finally, we should keep in mind that (14) through (16) assumes the electron velocity, also known as the conduction drift velocity, is much less than the speed of light. For most conductors, such as copper, steel, and aluminum, this holds true. Convection electrons, inside a particle accelerator for example, can travel significantly faster, and then the relativistic forms of these expressions must be used [6].

Charge Acceleration on a Wire Segment

Now let's take a look at what happens when a digital logic device launches a pulse down a conductor towards a load. The pulse can be divided into three distinct regions. During the logical zero to one transition, region A in Figure 6, current increases, and charge accelerates. During the logical high level, region B, a constant current is flowing, and no charge acceleration takes place. And finally, during the logical one to zero transition, region C, charge deaccelerates.

Referring to Figure 7, we can see during the leading and trailing edges of the digital pulse (regions A and C), the spacing between the lines of electric flux change. The electric flux density, D, and its associated electric field, E, both change with time, creating a kink in the electric field. During the logical high level, however, the spacing between the electric lines of flux remain constant, no kinks are created in the electric field.

Figure 8 shows three frames from an FDTD simulation where a source launches a current pulse into a horizontal wire. The simulation supports this geometrical interpretation. Notice that as the pulse propagates down the wire towards the right, the two kinks, one due to the leading edge of the pulse, region A, the other due to the trailing edge of the pulse, region C, propagate radially outward from the location of the source.

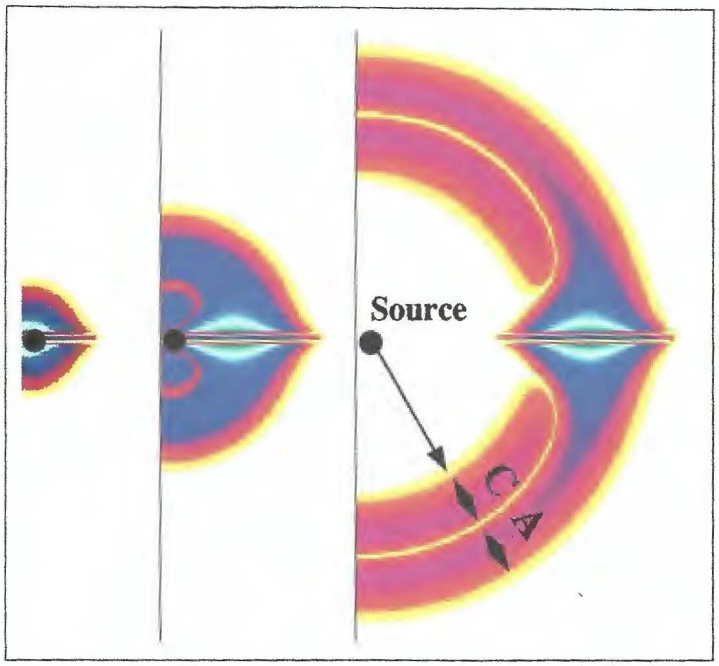


Figure 8: Propagation of a digital pulse kink-pair

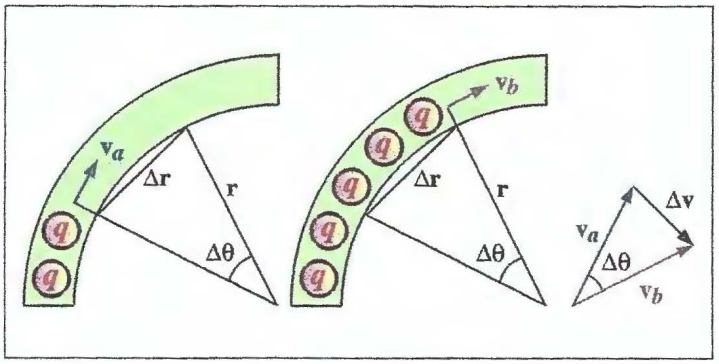


Figure 9: Propagation around a conductor bend

If we look closely at Figure 7, we also see the magnetic flux density changing during the logical transitions (e.g. the magnetic lines of flux come closer together during the leading edge of our pulse, and moving farther apart during the trailing edge). This does not surprise us since we know from (11) and (12) that propagating fields contain coupled electric and magnetic field components.

Bends in Conductors

We also need to ask ourselves what happens when the leading or trailing edge of our propagating digital pulse encounters a bend in the conductor.

Referring to Figure 9, the leading edge of our digital pulse propagates down the wire with velocity, v. At time ta, the velocity is va, and a bit later, at time tb, the velocity is vb. The magnitude of the velocity, v, remains the same, just the direction changes. The acceleration, a, is defined as the time rate of change of velocity

$$\mathbf{a} = \frac{\mathbf{v}_b - \mathbf{v}_a}{t_b - t_a} = \frac{\Delta \mathbf{v}}{\Delta t} \tag{17}$$

From geometry, we can see that

$$\frac{\Delta v}{v_a} = \frac{\Delta v}{v_b} = \frac{\Delta r}{r} \quad \Rightarrow \quad \Delta v = \frac{v \Delta r}{r} \tag{18}$$

Substituting (17) into (18) and taking the limit we get

$$a = \frac{\Delta v}{\Delta t} = \frac{v}{r}\frac{\Delta r}{\Delta t} \Rightarrow \lim_{\Delta t \to 0} \frac{\Delta r}{\Delta t} = v \Rightarrow a = \frac{v^2}{r} \tag{19}$$

From (19) we can see that another region where charge can accelerate is around conductor bends. A smaller bend radius increases the acceleration of charge, and produces a correspondingly larger kink in the electromagnetic field.

To reduce radiation from printed circuit boards, trace right angle bends can replaced by two 45 degree bends or bends with a smooth continuous radius. Figure 10 shows an example of how this is accomplished as traces are routed through a connector via field.

Figure 11 shows a serpentined delay line with rounded ends to minimize radiation from the bends.

Impedance Mismatches

We know from transmission line theory that terminating a transmission line into an impedance not equal to its characteristic impedance produces a reflection. As a result, a portion of the charge associated with the pulse must de-accelerate until they come to a complete stop, turn around, and then accelerate back towards the source. Impedance mismatches are also locations where charge acceleration can take place. No wonder the ends of the dipole radiate so efficiently.

Figures 12 shows a cross section of a printed circuit board card edge connector from an FDTD simulation. The printed circuit board is located in the lower right corner of Figure 13. On the left are the shielded twisted pair cables. In the center are the mated sections of the two connector halves.

Figure 13 graphically shows the results of the FDTD simulation when a single digital pulse propagates through the connector. As can be seen from Figure 13, a significant number of kinks propagate outward from each bend in the connector structure.

Summary of Potential EMC Problem Areas

Whenever charge accelerates, time/spatially varying kinks are created in the electric field surrounding the region where the charge is being accelerated in accordance with (10).

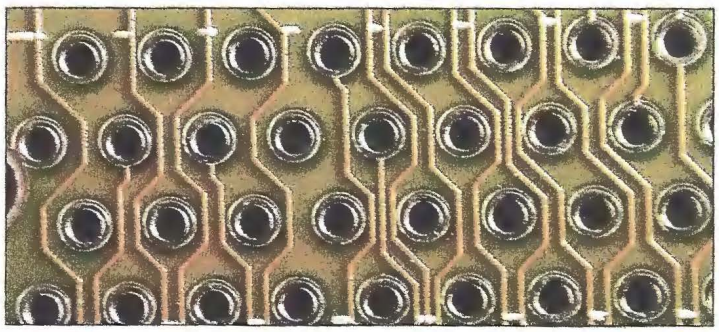


Figure 10: 45 degree trace routing through via fields

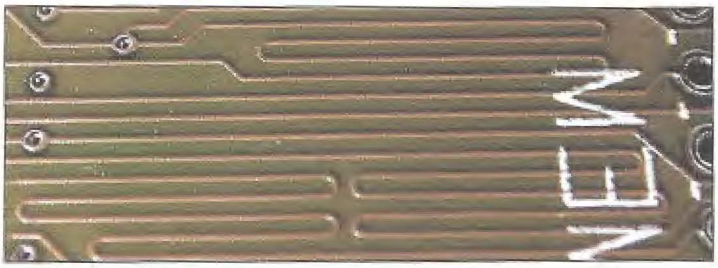


Figure 11: Serpentine delay lines

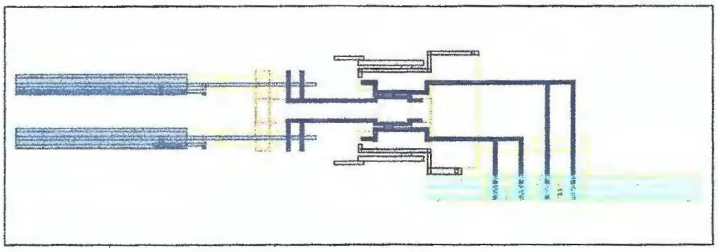


Figure 12: Cross section of card edge connector

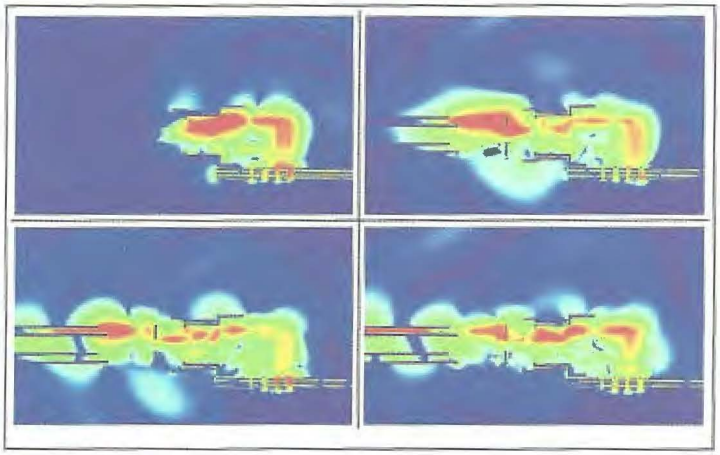


Figure 13: Simulation of PCB edge connector

$$\nabla^2 \mathbf{E} - \mu\varepsilon \frac{\partial^2 \mathbf{E}}{\partial t^2} = \mu \frac{\partial \mathbf{J}}{\partial t} \tag{10}$$

The kink in the electric field produces a propagating electromagnetic field in accordance with the coupled curl equations

$$\nabla \times \mathbf{H} = \varepsilon \frac{\partial \mathbf{D}}{\partial t} \tag{11}$$

$$\nabla \times \mathbf{E} = -\mu \frac{\partial \mathbf{H}}{\partial t} \tag{12}$$

Locations where charge acceleration is enhances include sources, bends with small radius of curvature, and locations in transmission line structures where a constant impedance is not maintained.

References

[1] G. S. Smith, T. H. Hertel, "On the Transient Radiation of Energy from Simple Current Distributions and Linear Antennas," *IEEE Antennas and Propagation Magazine*, pp. 49-62; Vol. 43, No 3, June 2001.

[2] E. K. Miller, "An Exploration of Radiation Physics in Electromagnetics", *13th Annual Review of Progress in Applied Computational Electromagnetics*, pp.240-247; Vol. 1, ACES Conference Proceedings, March 1997.

[3] S. Cloude, "An Introduction to Electromagnetic Wave Propagation and Antennas, Springer-Verlag, 1995.

[4] The LC FDTD code used to generate the animations used in this paper is available at *http://lc.cray.com.*

[5] M. N. O. Sadiku, "Elements of Electromagnetics", 3rd Edition, Oxford University Press, 2001.

[6] J. Tessman, J. T. Finnell, "Electric Field of an Accelerating Charge", Journal of Applied Physics, Vol 30, June 1966.

Author Biographies

Franz Gisin *is Manager of EMC and Signal Integrity Design at Sanmina-SCI. He has been active in the EMC field for over 25 years, and has published numerous articles in trade journals and EMC Symposia. His current research interests focus on EMC and signal integrity issues associated with high speed PCB interconnects. He has served as a Secretary, Treasurer, Vice Chair, and Chair of the Santa Clara Valley Chapter of the IEEE EMC Society. He is a past IEEE EMC Society Distinguished Lecturer, and past member of the IEEE EMC Society Board of Directors. Currently he is vice-chair of TC-10, Signal Integrity, and Steering Committee Chair of the 2004 IEEE International EMC Symposium, Santa Clara, CA. He received his BS(EE) from the University of Idaho in 1972, and his MS(Applied Math) from Santa Clara University in 1986.*

Dr. Zorica Pantic-Tanner *is Founding Dean of the College of Engineering at the University of Texas at San Antonio (UTSA). Prior to joining UTSA she was Director of the school of Engineering at San Francisco State University (SFSU). Pantic-Tanner's research and teaching interests are in the areas of Electromagnetic Field Theory, Applied Electromagnetics and Electromagnetic Compatibility (EMC). She has published more than 80 papers in refereed journals and conference proceedings. Dr. Pantic-Tanner received her B.S., M.S., and Ph.D. degrees in Electrical Engineering from the University of Nish in Yugoslavia in 1975, 1978, and 1982, respectively. In 1984 she was awarded a Fulbright Scholarship for postdoctoral research in the area of Applied Electromagnetics at the Electromagnetics & Communications Lab of the University of Illinois at Urbana. Dr. Pantic-Tanner is a Senior Member of the IEEE, a member of the IEEE EMC Board of Directors, International EMC Education Committee, University EMC Grant Committee, Vice-Chair of the IEEE International EMC Numerical Modeling Committee, and Technical Program Chair for the 2004 IEEE International Symposium on EMC. She also belongs to the IEEE Women in Engineering Association, IEEE EMB Society, ASEE, SWE, and AHEE.*

Comments on EMI Measurements and Modeling

I read the article by Colin and Bronwyn Brench in the Practical Papers, Articles and Application Notes in the Summer 2001 issue of the EMC Newsletter. It rekindled some thoughts I have had about the issue of modeling versus experimentation. I realize that Colin and Bronwyn were addressing modeling in the context of modern Computational Electromagnetics Modeling (CEM) by numerical solution of Maxwell's equations as represented by Method of Moments (MOM), Finite Element Method (FEM), Finite-Difference Time-Domain (FDTD), and the like but I think the definition and concept of modeling should be broadened. The other part of their article that struck a chord with me is that they bring up the issue of what seems to be a longstanding divide between "modelers" and "experimentalists". This creates an artificial division between practitioners of EMC that is unfortunate and results in a form of "distrust" between the two camps. I would like to address both issues in order to bring us closer together.

The thing that distinguishes the EMC discipline from other traditional Electrical Engineering disciplines such as antenna designers, microwave circuit designers, etc. is that the nonideal aspects of a system cannot be avoided or designed out of the system. For example, parasitic effects are one of the dominant effects that determine how a practical system behaves from an EMC standpoint. Granted microwave circuit designers have to consider these parasitic effects but, for the most part, these are known beforehand and can be incorporated into their simulations which give highly accurate correlation with measured results. But for the EMC practitioner, the nonideal aspects that must be confronted are not something we can design around but are a "given" that we have little control over. Assymetries in the physical system tend to cause common-mode currents. In EMC these common-mode currents are often the critical aspect in determining the radiated emissions from a product. In the operation of a microwave circuit, these common-mode currents are present but their effect is dominated by the desired or differential-mode currents in the functional performance of the device. Common-mode currents are extremely difficult to predict, whereas differential-mode currents are predictable with considerably more accuracy and repeatability. These nonideal aspects make modeling of EMC systems much more difficult and imprecise, and it's a fact that we must expect and live with. It's also an aspect of EMC that initially intrigued me and continues to stimulate my interest in the discipline.

I think the concept of "modeling" and "experimentation" are a matter of degree. I firmly believe that all of us in EMC should consider ourselves as being both modelers and experimentalists. For example, a board designer whose responsibility is the +5V power distribution does a lot of Ohm's law "modeling". Another example is sizing a bypass capacitor to divert a 100MHz noise signal from a cable where it would have radiated and caused radiated emissions problems. In determining the proper value of that bypass capacitor we shouldn't use a value of capacitor that "seems right" but should calculate a value of capacitance that will give, say, a 1 ohm impedance at 100MHz. This is modeling although not as detailed as what Colin and Bronwyn were discussing. I always tell my students that you must "do the numbers". On the other hand, we all at one time or another perform experiments. These also range in degree. For example, final testing of a product for compliance requires a great deal of skill if we expect to get valid data. My good friend, the late Don Bush, was the most gifted experimentalist I know. He could make measurement gear "talk". Being a ham radio enthusiast, he also was very skilled in constructing test jigs and making measurements that gave reliable results, i.e., what he was measuring was indeed the desired item rather than some other variable that was corrupted by test probes, etc. In order to understand the basic mechanisms responsible for radiated and conducted emissions, he and I constructed many simple experiments. These experiments were not made on complete systems such as a laser printer but were simple items such as a pair of lands on a printed circuit board driven by a canned DIP oscillator. A great deal of what I understand about these basic phenomena came from what we learned from those simple experiments. But he and I did not stop there, we always constructed mathematical models (generally only simple models were needed because of the simple nature of the experiment) so that we could ascertain whether the "predictions" of the model matched the experimental results. We certainly didn't expect 100% accuracy, but 3dB error was sufficient to indicate that our understanding was in the "ballpark". Don used to say that "Anyone can construct a mathematical model and generate data. But if the predictions of your mathematical model do not match experimental data either your model is worthless or your measurements are not done properly." Once you can get both to agree within a reasonable degree you can study the mathematical model you developed and be assured that it will tell you what is really going on. I grant that this kind of experimentation/modeling is not of the same degree as comparing measured data from an entire system to a computer simulation of the entire system (which is not feasible today and probably won't be in the future). But it is a combination of experimentation and modeling to understand what factors influence the basic phenomenon. I strongly believe that all of us involved in EMC should combine modeling and experimentation to some degree, and so we should not divide into two camps. We should respect the skills and abilities of modelers and experimentalists even though we are more proficient in one aspect and not so proficient in the other. It's a matter of degree.

And finally, there are simple problems and there are difficult problems. We should all be aware of this difference. For example, in today's digital systems having GHz clock rates and picosecond rise/fall times, factors such as interconnect lands that were inconsequential in systems twenty years ago are critical today. The modeling of these factors becomes more complicated and there is nothing we can do about it. Kirchhoff's laws become invalid for structures that are electrically large (i.e., a significant portion of a wavelength), and numerical

solution of Maxwell's equations (or an appropriate approximation of them such as the solution of the transmission line equations) is the only way to generate data that matches the physical world. We have no choice. For example, a pair of lands on a FR4 printed circuit board (PCB) that are 10cm in length (about 4 inches) will have a propagation delay of about 0.6ns or 600ps. Twenty years ago with clock speeds in the tens of MHz these interconnect delays were inconsequential; the propagation delay through the gates was the only concern. In today's high-speed designs this delay caused by the interconnect lands is becoming extremely important. For simple problems where the structure is electrically small, we do not need to utilize the sophisticated full wave models; simple models will do. The key thing here is to be aware of when a model of simple sophistication and detail is adequate and to use it. But when a simple model is invalid, recognize that a sophisticated model must be used and use it (or get a person skilled in its use such as Colin to use it properly for you).

This cooperation and trust between modelers and experimentalists is increasingly needed in today's digital system designs and more so in the future. We should respect each other's skills. In our earlier association, Don was the more skilled at experimentation and I tended to do the modeling. But as we worked together, I learned from him and he learned from me. We increased our proficiency in each other's primary area of expertise. We should respect each other's primary skills and make use of them. We're all in this together and will increasingly need each other's skills in the future. We cannot continue to progress in successful EMC design without this cooperation and respect for each other's primary skills.

Clayton R. Paul
School of Engineering
Mercer University
1400 Coleman Avenue
Macon, GA 31207

The summer issue of the EMC newsletter started, as we may hope, a series on practical papers. The first discussion had an interesting subject, the comparison of measurements results and calculations; the latter often called a numerical model (NM). To the points brought forward by the authors, one could only add a few.

All numerical modeling is based on a theory. Maxwell's equations have been formulated to describe experiments in electricity and magnetism carried out earlier in the 18th and 19th century. The validity of the theory was shortly after its appearance beautifully demonstrated by Herz's radiation experiments. Since that time, the electromagnetic theory is generally accepted as a highly accurate description of the physical EM phenomena in the macroscopic world. The equations are simple to write down; their full solution is a formidable task except for a free space or other simple boundary conditions.

EM models build on an approximation of Maxwell's theory. The computing power increases steadily, as does the complexity of systems one wishes to analyze: chips, PCB's or large installations. Ultimately, the model that fits within limits of time and budget and is accurate enough for the goals set, is the one that will be preferred mostly. But the limits of validity for the approximations should be carefully and constantly regarded. For instance, at power frequencies a grounding electrode in the soil can be described by a current distribution determined by the soil resistivity. As the system becomes larger or the frequency increases, inductance cannot be neglected anymore. A similar situation occurs in the steadily faster microprocessors. Also, induction phenomena have to be taken into account added to the usual RC transmissions lines.

A good model is able to predict, perhaps a posteriori, the outcome of an experiment; practical circumstances should reflect the model boundary conditions. But for many 'real world' problems, the circumstances of the experiment may be less known. For instance, in safety grounding or lightning protection, the amount of known buried conductors depends on the good bookkeeping of an installation throughout its lifetime. If other parties bury their metal contraptions nearby, this will influence the envisaged safety, either in a positive or in a negative way. Modifications of an existing installation, ageing and corrosion affect even the known conductors. In such a case, NM may provide us with the sensitivity of the safety with respect to uncertainty in or degradation of the installation. But in the case of lightning protection of a critical installation, e.g. a nuclear power plant, a real measurement on the actual installation would be useful to convince ourselves and others, until sufficient experience has been gained to trust the next installation without further tests.

Such a sensitivity analysis can be quite sobering. The EMI coupling of PCBs often shows sharply peaked resonances. Minor changes in the NM parameters shift the calculated resonance frequencies. If the PCB circuits operate near a resonance, large differences may occur between NM and the measured EMI, and perhaps also between various measured samples.

Many EMC solutions for acute industrial problems have to be given without any time for modeling, not to mention a full analysis. This 'fire brigade' type of activity is quite common for EMC consultants. Apparently, a fast mental picture is possible for the behavior of currents that guides one effectively to EMC solutions. Modeling, even afterwards, is very useful to extend this mental database.

It is sometimes advocated to compare the results of various NM codes, to find out whichever suits better. Such enterprise is certainly useful to enhance the quality of the codes. However, a carefully designed experiment requires as much diligence as modeling, but a different experience. So the effort of the authors to combine NM and measurements should really be appreciated. After all, the modeling is carried out to make a real piece of electronics work.

Lex van Deursen
Department of Electrical Engineering
Eindhoven University of Technology
5600 MB Eindhoven
The Netherlands

EMC

Donald R. Bush

continued from page 1

Susceptibility in 1985, and held this post until 1991, when IBM decided to spin off what had become the PC printer and typewriter division. Lexmark was born. Don was a Senior Engineer and technical team leader of the Lexmark EMC laboratory. He held a patent on Spread Spectrum Clock Generation, which was assigned to Lexmark International.

Don retired from IBM/Lexmark in 1996 and founded dBi Corporation which provided EMC services such as seminars, EMI/EMC measurements, and design consultation. He was a registered professional engineer and a NARTE certified EMC engineer. He was elected to the IEEE EMC Society Board of Directors for a three-year term beginning in 1999.

Don is survived by his wife Sandra, three children, and three grandchildren. **EMC**

Photo by Janet O'Neil

Don Bush enjoyed his membership in the dB Society. He regularly attended their annual "picnic" along with his wife Sandy. They are shown here at the dB Society's French themed picnic in Montreal, Canada in August 2001.

In Memoriam

Thomas W. Doeppner, Active Member of the Washington, DC/Northern Virginia EMC Chapter

Thomas W. Doeppner

The Washington, DC/Northern Virginia Chapter of the IEEE EMC Society has lost one of its most respected members. Thomas W. Doeppner, who was 81 years old, died December 1, 2001 at the Mount Vernon Nursing home in Alexandria, Virginia. He had Alzheimer's disease.

Tom was born in Germany and lived in the Netherlands before coming to the United States in 1939. He graduated from Kansas State University with a degree in electrical engineering before entering the Army in 1944. Tom was commissioned the next year and served with World War II occupational forces in Germany.

He served in Japan during the Korean War and later taught ROTC courses at the University of California at Berkeley where he received a master's degree in electrical engineering. Tom was also stationed in Taiwan and graduated from the Command and General Staff College at Fort Leavenworth, Kansas. He was assigned to the Advanced Research Projects Agency (ARPA) in Vietnam and at the Pentagon before retiring from active duty as Chief of the Army Electronics Directorate with the Army General Staff. He was a colonel when he retired and his military decorations included the Legion of Honor and two Bronze Stars.

After retiring from active duty, Colonel Doeppner was a manager at General Research Corporation from 1973 to 1985 and then taught at the Defense Systems Management College at Fort Belvoir before retiring again in 1988.

Tom was a Fellow of the IEEE. The Citation on his Fellow Award was for "Leadership in advancing electromagnetic compatibility in the design, development, and operation of military telecommunication systems." He received numerous other IEEE awards including the IEEE Centennial Metal, Washington, DC and National Capital Area Council Patron Awards, and the IEEE USAB Professional Leadership Award.

The "old timers" in the EMC Society may remember that Tom was active in several IEEE International EMC Symposia. He held the positions of Publications Chairman in 1976, Vice Chairman in 1983 and General Chairman in 1990. Tom was also Chairman of the Washington, DC/Northern Virginia Chapter of the EMC Society in 1975/76. In addition to his IEEE EMC activities, Tom was very active in the Washington, DC Section and the National Capital Area Council.

Tom is survived by his wife Marjorie; two sons Thomas Jr. and Ronald; and three grandchildren. He will be missed by all who knew him.

Seymour Krevsky, Former New Jersey Section Chair

Seymour Krevsky, IEEE Senior Member, died June 5, 2001. He was 80 years old. Mr. Krevsky earned bachelor's and master's degrees from the Newark College of Engineering in Newark, New Jersey. He worked with the Signal Corps Engineering Labs, RCA and US Army Communications Systems Agency.

He was active in the IEEE and other engineering associations. Mr. Krevsky was chair of the then New Jersey Section from 1972 to 1973. He edited the 1984 *IEEE Centennial History* and the *IEEE Engineering Management Society* newsletters. He also held executive positions in the Antennas and Propagation, Vehicular Technology and Electromagnetic Compatibility Society Chapters. He was the Assistant Treasurer for the EMC Society from 1986 to 1991. He published over a dozen technical papers on topics ranging from filter and antenna design to global communication systems in IEEE Transactions and Symposia Proceedings.

He is survived by his wife, two daughters, and two grandsons. **EMC**

Introducing Members Newly Elected to the EMC Society Board of Directors

The following members began a three-year term on the Board effective January 1, 2002. Abbreviated biographies of these members are shown below.

Ron Brewer

Ron Brewer is Vice President, EMC/Technical Services for Laird Technologies, Delaware Water Gap, Pennsylvania. Laird Technologies is the world's largest RF gasket manufacturer, and resulted from the merger of Instrument Specialties (ISC) and Advanced Performance Materials (APM). He has been with the company for 19 years. Ron is responsible for technical planning, coordination, and consulting for the EMC/technical services organization and works in conjunction with the Pennsylvania based World Compliance Center (WCC), which he established in 1983. The WCC was one of the first non-European EMC test and consulting facilities in the USA to receive European Competent Body endorsement.

Ron is a NARTE certified EMC/ESD engineer and has worked full time in the EMC/ESD/TEMPEST engineering field for over 30 years. His specialty is EMC Systems Design. He serves on three EMC technical committees, has published numerous papers on EMC design for systems, PCB EMC design, and Shielding. Ron is the inventor/co-inventor of 13 EMC/TEMPEST related devices and circuits and has four patents in the EMC field. He also has an interest in ham radio, and holds an FCC Extra Class license KE3TH. An internationally recognized EMC authority, Ron has made over 260 EMC technical presentations in 29 countries worldwide and was named Distinguished Lecturer by the IEEE EMC Society. Ron did both his undergraduate and graduate work in Engineering Science and in Physics at the University of Michigan, Ann Arbor.

E. Thomas Chesworth

Dr. E. Thomas Chesworth is a registered professional engineer with a Ph.D. in Physics and two other degrees from Pennsylvania State University. He has more than 30 years experience in EMC at Penn State's Radio Astronomy Laboratory, HRB-Singer, Inc., Locus, Inc. and, since 1979, his own consulting firm, Seven Mountains Scientific, Inc. He is a NARTE certified EMC engineer and a technical expert for the National Institute of Standards and Technology's NVLAP program, assessing EMC testing laboratories to perform measurements to FCC Part 15, FCC Part 68, IEC 61000-4-x and MIL-STD-461/462. As a technical expert in EMC for the United Nations Industrial Development Organization (UNIDO), he helped to establish the central EMC facility and taught EMC seminars at SAMEER in Madras, India. He is a Senior Member of the IEEE. He is also technical editor of the bimonthly EMC magazine, *Electromagnetic News Report*, and author of more than 40 technical articles in other journals.

Elya B. Joffe

Elya B. Joffe (M'80-SM'90) graduated with a BSEE from the Ben Gurion University in Beer-Sheva, Israel, in 1981. Elya is the Vice-President of Engineering for K.T.M. Project Engineering, an engineering consulting company, located in Israel. Elya has been involved in EMC design, development and engineering since 1981. He is currently active as an EMC consulting specialist in the EMC design of commercial and military systems, from circuits to platforms and large-scale installations and facilities. His work covers EMC, EMP and Lightning Protection design, as well as numerical modeling for solution of EMC Problems. He is also well known in Israel and abroad for his activities in EMC training, as an author and instructor of several courses on Electromagnetic Compatibility worldwide. Elya is a Senior Member of IEEE, a member of the IEEE EMC Society and the Immediate Past Chairman of the Israel IEEE EMC Chapter (having served for 5 years). Under his leadership, activities of the Chapter have increased as well as have participation in its meetings. Elya served as a member and of the IEEE EMC Society Board of Directors (BoD) during the term 1999-2001. In addition to his being a member at-large, Elya also serves the Board (and the Society) as the Region 8 Membership and Chapter Coordinator and as the "Angel" of the Region 8 Chapters. In this capacity, he supported the start-up of two new Region 8 (the fastest growing region in the IEEE) EMC Chapters, in Russia and Turkey. Elya is also a member of the EMCS Education Committee and of the EMCS Standards Development Committee (SDCom). In particular, he is the chairman of the Working Group for the revision of IEEE STD 473 (Practices for Conducting Electromagnetic Site Surveys). Elya has authored and co-authored over 30 papers in EMC and EMC-related topics, both in the IEEE Transactions on EMC, as well as in the IEEE EMC Society and other EMC Symposia proceedings. Elya is a past Associate Editor of the IEEE Transactions on EMC and serves as a reviewer of various EMC books, for IEEE Press and others. He is also the General Chairman of the 2003 IEEE International Symposium on EMC, which will take place in Tel-Aviv, Israel. He is active in EMC Standardization, in

the development of Israeli EMC Standards as Chairman of the Israeli National EMC Standards Committee for EMC, and member of several expert committees for human exposure and for lightning protection. Elya is a NARTE-Certified EMC and ESD Control Engineer and a member of the dB Society.

John Norgard

Dr. John Norgard received a BSEE degree from Georgia Tech in 1966 (as a cooperative student with the Charleston Naval Shipyard). He received MS and PhD degrees in applied physics from Caltech in 1967 and 1969, respectively. During this time, he was an associate engineer with NASA's Jet Propulsion Laboratory. In 1970, he was a Post-Doctoral Fellow at the University of Oslo and worked for the Norwegian Defense Research Institute and the Auroral Observatory. From 1970 to 1985 he was a professor in the School of Electrical Engineering at Georgia Tech and consulted for the Bell Telephone Laboratories. Since 1985, he has been a professor in the Department of Electrical & Computer Engineering at the University of Colorado at Colorado Springs and works part time for the Mission Research Corporation, JAYCOR, NavSys, and Sequel. Professor Norgard received the Chancellor's Award, the Outstanding Research Award, and the HKN Teaching Award at the University of Colorado. He also received the PE Society Award for Outstanding Accomplishments in Research at Georgia Tech. He was the EMC Atlanta Chapter Chairman while at Georgia Tech. He has served on numerous technical program committees for APS, MTT, EMC, and URSI and on several steering committees for MTT, EMC, and AMTA. He has been the Interim Dean of the EAS College, the Acting Chairman and Associate Chairman of the ECE Department, and the Chairman of the MAE Department at the University of Colorado. He is the Director of the Electromagnetics Laboratory and the Microwave Anechoic Chamber. He has been a Visiting Professor at the US Air Force Academy and the Tel-Aviv University. He was an AFOSR Fellow at AFRL/RRS (Rome Lab) and an IPA at AFRL/PRS (Phillips Lab). Dr. Norgard is a Fellow of the IEEE (for Infrared Metrology), an Associate Editor of the IEEE/EMC Transactions (on Antennas), the Chairman of Commission A (Metrology) of URSI, a member of the Board of Physics and Astronomy for the National Academy of Sciences, and a Registered Professional Engineer in Georgia and Colorado. He has served as the panel chair of the National Science Foundation Graduate Fellowship Program in Engineering. His interests include applied computational electromagnetics, plasmas, lightning, EMP, multipair transmission lines, high field emission, coupling problems (EMC, EMI, EMS/V), EM numerical code verification, time domain metrology, anechoic chamber measurement techniques, and infrared thermography and holography. He has obtained numerous grants and has published over 100 papers in these areas.

Zorica Pantic-Tanner

Zorica Pantic-Tanner is Founding Dean of the College of Engineering at the University of Texas at San Antonio (UTSA), one of the 11 women engineering deans in the US. She spearheads the growing efforts toward research, including development of Ph.D. programs and a new $83-million building. She serves on the Texas Engineering and Technology Consortium for development of a high-tech workforce and on the Brooks Development Authority that manages the Brooks Technology & Business Park, a partnership project between the City of San Antonio and Brooks AFB.

Before joining UTSA, Dr. Pantic-Tanner was Director of the School of Engineering and Computer Science at San Francisco State University (SFSU) from 1997-2001. Under her leadership, the engineering programs had improved in quality and for the first time tanked among the top 50 in the US News Best Undergraduate Programs. She worked with the California State University Engineering Deans on the California Strategic Workforce Initiative that resulted in a $10 million grant for the California State Universities, and played a crucial role on the $480,000 Pathways Project to establish upper division engineering courses at Cañada Community College in Redwood City. She enhanced the SFSU engineering graduate program by strengthening the environmental engineering area and introducing the wireless communications area. Under the sponsorship of the IEEE EMC Society, and using a major National Science Foundation grant and donations from Silicon Valley companies, she developed a Center for Applied Electromagnetics; the only center on the West Coast that supports undergraduate EMC education and research.

Dr. Pantic-Tanner received her B.S., M.S., and Ph.D. degrees in Electrical Engineering from the University of Nish in Yugoslavia in 1975, 1978, and 1982, respectively. From 1984 to 1989 she was a Fulbright Fellow in the Electromagnetics & Communications Lab at the University of Illinois-at Urbana-Champaign. In 1989, she joined the SFSU School of Engineering as an Associate Professor and she was promoted to Full Professor in 1995.

Dr. Pantic-Tanner's research and teaching interests are in the area of Applied Electromagnetics. She has published more than 80 papers in refereed journals and conference proceedings on topics ranging from analysis and design of microwave circuits and printed circuit boards to electromagnetic interference and optical properties of biological macromolecules such as proteins.

Dr. Pantic-Tanner is a Senior IEEE Member and served as an officer of the Santa Clara Valley Chapter of the IEEE EMC Society from 1996-2000 (Secretary, Treasurer, Vice Chair and Chair). She is currently a member of the EMCS Education Committee, University Grant Committee, Vice-Chair of the EMC Numerical Modeling Committee (TC-9), Technical Program Committee member for the 2002 IEEE Antennas and Propagation Symposium, and Technical Program Committee chair for the upcoming 2004 IEEE International Symposium on EMC. She also belongs to the IEEE Women in Engineering Association and IEEE EMB Society. Dr. Pantic-Tanner is active in the American Society for Engineering Education (ASEE) and has served on the Board of Directors of the ASEE Pacific South West Section. She also belongs to the American

Association for Higher Education (AAHE) and AHEE Women's Caucus.

Ghery S. Pettit

Ghery S. Pettit, NCE, is a Senior Member of the IEEE and has been a member of the IEEE EMC Society since 1977. He received the BSEE degree from Washington State University in 1975. He has been employed full time in EMC and related matters for 26 years with the U.S. Navy, Martin Marietta Aerospace (Denver), Tandem Computers and Intel Corporation. He presently is the Corporate EMC Engineer in the Corporate Product Regulations department at Intel. In this position he serves as the corporate focal point for EMC regulations issues. He is the past Chairman of the Seattle Chapter of the IEEE EMC Society, is a member of the Board of Directors of the IEEE EMC Society and is the EMC expert on the Board on Assessment of NIST Programs under the National Research Council. He is a member of the U.S. National Committee for the IEC / Technical Advisory Group (TAG) for CISPR Subcommittee I, is a member of CISPR Subcommittee I WG2, WG3 and WG4 and is the Chairman of the Information Technology Industry Council's EMC technical committee (TC5). Mr. Pettit has written seven technical papers and articles for publication, is a member of the dB Society, is a NARTE Certified EMC Engineer with the Accredited Test Laboratory Engineer Endorsement and holds an Amateur Extra class amateur radio license (N6TPT). Most recently, he was appointed as the EMC Society's Assistant Vice-President for Communication Services.

Kimball Williams

Kimball Williams is a principal EMC engineer for Eaton Corporation at the Eaton Engineering and Research Center in Southfield, Michigan where he directs the technical operation of its Electromagnetic Environmental Effects laboratory. He holds a BSEE degree from Lawrence Technological University in Southfield, Michigan and is pursuing a master's degree through the National Technical University. His professional EMC Society experience includes the following: member of the IEEE EMC Society Board of Directors and VP of Technical Services, member of the IEEE EMC Society Standards Committee, member of the IEEE Education Activities Board - Continuing Education Committee, Past Chair of the IEEE EMC-S Education Committee, Past Chair of the IEEE EMC-S Technical Advisory Committee, and Secretary/ Treasurer of the South Eastern Michigan Chapter of the IEEE EMC-S. In addition, he is a National Association of Radio and Telecommunications Engineers (NARTE) certified EMC engineer and a member of the Board for NARTE. He is a member of the SAE EMI and EMR Committees as well as a member of the US Technical Advisory Groups to CISPR and ISO. He is also an amateur radio operator (N8FNC), scuba diver and private pilot.

We wish the newly elcted members of the Board of Directors success and thank all candidates for their willingness to serve and for permitting their names to be included on the ballot. **EMC**

Two New Distinguished Lecturers for 2002-2003

By Lee Hill, Chairman of the EMCS Distinguished Lecturer Committee

Dr. Keith Hardin and Dr. Cheung-Wei Lam have recently begun their two-year terms as the newest Distinguished Lecturers (DLs) of the IEEE EMC Society. They replace Doug Smith and Werner Schaefer whose terms expired on December 31, 2001. Our other three DLs, Dr. Maria Sabrina Sarto, Dr. Bud Hoeft, and Colin Brench continue their terms through December of 2002.

Before introducing Dr. Hardin and Dr. Lam, I want to acknowledge the contributions of Doug and Werner over the past two years. During their terms, they volunteered to spend days away from home and family in planes, cars, and shuttle busses in order to give presentations all over the Unites States and Europe. The Distinguished Lecturer Program depends upon these bright and learned volunteers who can make an EMC Society Chapter meeting or special event a very entertaining and educational experience. Please join me in thanking our retiring DLs, and welcoming our new expert speakers.

Here are our new Distinguished Lecturers for 2002-2003. Please feel free to contact them directly by phone or email to discuss hosting them at your next chapter meeting, university class, or other special event.

Dr. Keith Hardin is currently a Senior Technical Staff Member and Technical Team Leader in the EMC Department of Lexmark International in Lexington, Kentucky. In this role, Keith is responsible for overseeing all technical aspects of Lexmark's EMC product development and test activities. He has been involved with product design and EMC at Lexmark and its former parent company IBM since 1981.

Keith received his M.S. and B.S. in Electrical Engineering from the University of Louisville in Kentucky. He received his PhD in Electrical Engineering from the University of Kentucky where he studied under the tutelage of Dr. Clayton Paul. He is a prolific author and inventor who has published 20 technical publications in peer reviewed journals and international symposia. He holds seven US patents in the field of EMC. He is a NARTE certified EMC engineer and a registered professional engineer in the state of Kentucky. In 2001, he received the IEEE EMC Society's Certificate of Technical Achievement for contributions to the development of spread spectrum clocking technology.

Keith is prepared to give sevetal favorite lectures on EMC including *Spread Spectrum Clock Generation (SSCG)*, *Two-Layer PCB Design for EMC*, and *Radiated and Conducted Emission Debug Techniques*. You may contact him at khardin@lexmark.com, telephone (859) 232-7797.

Dr. Cheung-Wei Lam is currently a Senior EMC Engineer at Apple Computer, where he has implemented an EMC design and analysis process to facilitate on-time compliance at lower cost. At Apple, he is also engaged in IC, PCB and system level EMC R&D. Prior to joining Apple, he was a Co-Founder and Principal Engineer of Transcendent Design Technology. In addition to Transcendent, he has worked in Viewlogic's Advancement Development Group (formerly Quad Design Technology). During his years in the EDA industry, he has played key roles in the design and development of EMC, signal integrity and ground bounce analysis software tools. From 1988 to 1993, he was with the MIT Research Laboratory of Electronics, where his focus was on modeling of high-speed interconnects and superconducting transmission lines.

Dr. Lam received the B.S. degree in electronics from the Chinese University of Hong Kong, and the S.M. and PhD degrees in electrical engineering and computer science ftom MIT.

Dr. Lam has served on the IEEE EMC/S TC-9 Computational EMC committee and the SAE EMC Modeling Task Force committee. He has given numerous papers, seminars, workshops, tutorials, and training courses on various EMC and signal integrity topics in the US, Europe and Japan. He was a co-recipient of the best paper award at the 1996 IEEE International Symposium on EMC. He is listed in Who's Who in Science and Engineering, Who's Who in America, and Who's Who in the World.

Dr. Lam is prepared to give several EMC design related lectures including *Obtaining Benefit from EMC Analysis Tools*, *Signal Integrity Design versus Radiated Emission Control*, *Transmission Lines: Beyond the Basics*, and *PCB Layout: Dos and Don'ts*. You can reach him at (408) 974 0769, or via email at lam@apple.com. **EMC**

The EMC Society's Distinguished Lecturer Program provides speakers for Society chapter meetings and similar functions. Each Distinguished Lecturer (DL) usually can offer one of several pre-prepared presentations on various EMC topics. DLs are appointed by the EMC Society Board of Directors to two-year terms. Currently the Society has five speakers serving on alternating terms.

Distinguished Lecturers may give up to six talks per year under the Program, which reimburses the DL for their approved traveling expenses up to a recommended limit of $750 USD per US engagement, or $1000 USD for international engagements. To provide as many opportunities to as many members as possible, the Society encourages hosting chapters whenever possible to absorb some part of the speaker's costs, such as by providing or paying for local transportation, meals, and lodging.

For more information about the EMC Society's Distinguished Lecturer Program, visit our Web site at http://www.emcs.org/lectur.html. You may also contact Lee Hill at 1-603-578-1842 x203, or via email at LHill@silent-solutions.com.

Chapter Chatter

continued from page 18

Toronto

Ramesh Abhari, Chair of the IEEE Toronto Electromagnetics and Radiation (MTT-S/AP-S/EMC-S) joint chapter, reports that they enjoyed a meeting and technical presentation on October 26, 2001. The lecture, given by Dr. Amir Mortazawi, was entitled: "Quasi-Optical and Extended Resonance Power Combining Structures." Dr. Mortazawi is an Associate Professor in the Department of Electrical Engineering and Computer Science at the University of Michigan in Ann Arbor, Michigan. The well-attended meeting was held in the Medical Sciences Building at the University of Toronto. **EMC**

2007: The EMC Society's 50th Anniversary

by Daniel D. Hoolihan

The EMC Society will be celebrating its 50th anniversary as an IEEE Society in 2007.

The Board of Directors of the EMC Society has formed an ad hoc committee to begin planning for the anniversary. The members of the 50th Anniversary Committee are Dan Hoolihan (Chair), Henry Ott, Warren Kesselman, Herb Mertel, Len Carlson and Elya Joffe.

The EMC Society was formed in 1957 as the Professional Group on Radio Frequency Interference, which was part of the Institute of Radio Engineers in New Jersey. Some of the original founders were Ralph Showers, Warren Kesselman, Fred Nichols, Harold Schwenk, Herman Garlan, Leonard W. Thomas, Sr., and Anthony Zimbalatti.

The 1982 issue of the EMC Society Transactions was devoted to the history of the first 25 years of the EMC Society. It makes for very interesting reading!

One of the key decisions to be made by the committee is the location of the 2007 IEEE International Symposium on EMC. (This decision will, of course, be subject to the review and approval of the EMCS's Board of Directors.) Initial suggestions for the location have included Hawaii (because it is the 50th state of the United States), Las Vegas (because it is easy to travel to and has lots of convention space), Orlando (because of Disney World), and San Diego (because of its convention facilities and its great weather and location).

One of the key decisions to be made by the committee is the location of the 2007 IEEE International Symposium on EMC.

We are asking the readers of this Newsletter to submit additional suggestions for the location of the 2007 Symposium to Dan Hoolihan at hoolihan@emcxpert.com. Please include a short summary of why you think your recommendation would be the best choice for the EMC symposium location. The Board of Directors would like to make a preliminary choice of location by their November 2002 meeting.

Other preliminary ideas for the 50th anniversary include a gold commemorative coin, a special issue of the Transactions on EMC which will cover the second 25 years of the EMC Society, unique and different activities at the 2007 EMC Symposium, cooperative activities with the IEEE History Center, special Newsletter editions, essays by distinguished EMC personnel, including some of the original founders, inducements to other IEEE members to join the EMC Society, CD-ROMs of symposium records and transactions and additional items to be thought of and revealed as the Committee meets over the next five years. If you have some unique thoughts on celebratory ideas, please send them to Dan Hoolihan at hoolihan@emcxpert.com or any of the committee members.

We plan on making the 50th anniversary celebration of the EMC Society a major series of events. We welcome your ideas and your participation. Please contact any committee member with your ideas and suggestions.

Remember, 2007 is only a short five years away! **EMC**

AUGUST 19-23, 2002 | www.2002-ieee-emc.org

Join your colleagues at the **2002 IEEE International Symposium on Electromagnetic Compatibility**. The **Superior EMC Conference in Minneapolis, Minnesota** is building itself to be the best Symposium in years! While in Minneapolis, **enjoy the beauty, landscape and local activities** that have made Minnesota an exciting destination.

2002 IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY

EMC Personality Profile

Bill Duff, Associate Editor

Introducing Bill Lenzi

Bill Lenzi was born and raised in Sharon, Pennsylvania. He graduated from Youngstown University in 1965 with a Bachelor of Science Degree in Physics. In 1965, Bill entered the US Army as an Ordnance Officer. He attended the Missile Maintenance Officer's Course at Redstone Arsenal, Alabama and graduated in 1966. After graduation from the Officer's Course, Bill was assigned as a training instructor in the Nike Hercules High Power Acquisition Radar and Radar Simulator Branch at Redstone Arsenal. Subsequently, he was assigned as a training supervisor for the same branch.

In August 1968, Bill joined the Naval Surface Weapons Center (NSWC) at Dahlgren, Virginia as a Physicist in the Hazards of Electromagnetic Radiation to Ordnance (HERO) Program. In 1971, he began investigating spurious responses in avionics and ground support equipment that were occurring aboard aircraft carriers. Bill determined these phenomena were created by shipboard radar and communication transmitters and presented his findings to the Naval Air (NAVAIR) Systems Command. This action led to the establishment of NAVAIR's Electromagnetic Vulnerability (EMV/ EMC intersystem) test program. In 1983, Bill was assigned as Head of Systems EM Effects Branch, F52, at NSWC, Dahlgren Division. In 1992, Bill Lenzi began addressing the problems associated with tri-service, joint operations on board Navy ships.

Bill Lenzi

From 1992 to 1997 Bill was on detail from NSWC serving as the Program Manager for the Joint Spectrum Center's Joint-Service Ordnance Electromagnetic Environmental Effects (E3) Program. In July of 1997, Bill joined the Joint Spectrum Center to lead efforts to develop and manage the Joint-Service Ordnance E3 Program. In April of 1999, Bill was assigned duties as Chief of the E3 Engineering Division at the Joint Spectrum Center. His current duties include managing the DoD Joint E3 Program.

Bill was a presenter at the 2000 IEEE Symposium on EMC in Washington, DC. His topics were "Ordnance Use in Future Joint Operations" and "Incorporating E3 and Spectrum Certification in Acquisitions."

Bill is married to the former Merry Ellen (Ellie) Cochran from Hermitage, Pennsylvania and they have four children. His son Billy is an electronic engineer at the Naval Surface Warfare Center, Dahlgren and his son Mark won two Olympic medals in 3-meter springboard diving: Gold in 1992 and Bronze in 1996. Bill's hobbies include fishing, golfing, and hunting. **EMC**

COMMENTS WANTED ON IEEE STANDARD 1128

IEEE STANDARD 1128 (Recommended Practice for RF Absorber Performance Evaluation in the Range 30 MHz to 5 GHz) is due for reaffirmation in 2003. If you have any comments, suggestions, or corrections, please send them to jperini @ieee.org prior to the end of August 2002 so that they can be included in the reaffirmation process.

EMC Standards Activities

Don Heirman, Associate Editor

This article is another in the series of calls for experts to assist in maintaining currency of our EMCS standards. This particular standard is especially important since it addresses calibration of probes and sensors well into the GHz range where there is increased emphasis for product compliance. Such compliance can be aided by using these probes during exploratory investigations of emissions from these products. Not only do we need volunteers, but we also need to be sure that they represent a balance of interested parties including those who are immediately affected by the standard such as probe manufacturers and users. I hope that after you read the following article by John Kraemer, you will send him an email announcing your availability to help in this important task.

Revision of IEEE Standard 1309: IEEE Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, From 9 kHz to 40 GHz

by John G. Kraemer PE, Member – Standards Development Committee

A. IEEE Standard 1309 – 1996 at a Glance

IEEE STD 1309 provides calibration methods for electromagnetic (EM) field sensors and field probes, excluding antennas per se, for the frequency range of 9 kHz to 40 GHz. It was published in 1996 as a new standard authored by a committee consisting of several probe and sensor manufacturers and users of EM field probes and sensors, as well as those with a general interest in the subject area. Per IEEE procedures, the standard is due for reaffirmation or start of revision in 2001. The IEEE EMC Standards Development Committee recently approved a project authorization request to revise the standard.

B. Overview of IEEE Standard 1309

EM field sensors are defined as electrically small, passive devices used for measuring electric and magnetic fields with minimum perturbation of the field being measured. Unlike antennas, they are designed to extract minimum energy from the field. EM field probes, by definition, consist of one or more field sensors and interfacing electronics (e.g. diodes, resistors, amplifiers) to provide an indication of field strength.

Field probes and sensors are used in two principle areas: 1) radiated EM effects immunity testing under popular standards such as MIL-STD-461E, DO-160D, and IEC 61000-4-3, and 2) radiation hazard measurements, such as those applicable to ANSI C95.3. They are also used to characterize transient fields such as those produced by ESD and lightning.

STD 1309 provides three calibration methods for EM field probes and sensors: calibration using a transfer standard, calibration using calculated field strengths, and calibration using a primary standard (reference) sensor. Most of the standard is devoted to calibration using calculated field strengths; it provides methods for creating standard electric and magnetic fields for sensor and probe calibration and provides direction on probe orientation in the field.

Per STD 1309, calibration shall address the characteristics of amplitude response, frequency response, accuracy (uncertainty), linearity, and isotropy. Additionally, the calibration may address response time, time constant, and response to modulation characteristics. Procedures for each of these measurements are included in the standard.

The number of calibration measurements made and which are quantized into various "grades" of calibration for each applicable characteristic, depends upon the probe or sensor design, the manufacturer's specification, and the needs of the user. The standard provides descriptions of the various "grades" of calibration for each characteristic to aid in the specification of a calibration.

Although most of the standard's text is dedicated to frequency domain calibration, methods are provided for time (transient) domain calibration. Included are methods to generate standard transient fields used for time calibration.

C. Why Revision?

As with almost any new standard, the first few years of use will bring about ideas for improvement. Areas of improvement, and hence expanded usefulness to the EMC community, may include the addition of characteristics to measure that

NOTICE: IEEE STANDARD 140 WITHDRAWN

At its December 2001 Board Meeting, the IEEE Standards Association withdrew IEEE-STD-140-1990 (R1995) "IEEE Recommended Practice for Minimization of Interference from Radio-Frequency Heating Equipment." Persons wishing to obtain a photocopy of the last version of the standard should go to http://standards.ieee.org or call 1-800-678-IEEE.

may be applicable to one or more probe/sensor type, more direction on determining measurement uncertainty, or maybe an informative annex explaining how a particular calibration characteristic relates to a specific application of a field probe (e.g. burst peak measurement).

Several EM field probe and sensor developers and general interest EMC practitioners have expressed interest in adding descriptions of new probes types to the standard. This may prompt the need to include new acceptable methods of field generation and calibration. Currently, the standard includes the TEM cell, Helmholtz coil, open-ended waveguides and pyramidal horn antennas as preferred methods of field generation for frequency domain calibration.

Most importantly, the revision process will provide a wide opportunity for probe and sensor users, manufacturers, and general interest parties to provide constructive feedback and participate in the making of changes to this relatively new standard as part of an active working group.

D. Call for Volunteers

Do you have an interest in participating on the IEEE STD 1309 revision working group? If you are a user or manufacturer of EM field probes and/or sensors, or if you have a general interest in this area and would like to be part of this activity, please let us know. We currently plan to have our first working group meeting the week of August 19, 2002, in conjunction with the IEEE EMC Symposium in Minneapolis.

Our goal is to maintain a useful, up-to-date standard.

For more information, please contact John Kraemer at: jgkraeme@rockwellcollins.com.

John G. Kraemer is a principal EMI/EMC engineer at Rockwell Collins, Cedar Rapids, Iowa. His responsibilities include EMI/EMC design leadership and analysis on defense/aerospace communication, navigation, and cockpit display products. He also leads company-wide EMI/EMC training programs and has recently produced an in-house interactive computer based training course covering the design of aircraft equipment for EMI control. With over 19 years of EMI, EMC, TEMPEST and signal analysis experience, he is also teaching a new graduate level course on EMC for Iowa State University. He is the chairman of the committee that developed IEEE STD 1309, is a registered professional engineer in the State of Iowa, and is a NARTE certified EMC engineer. He may be contacted at jgkraeme@rockwellcollins.com. **EMC**

Call for BoD Nominations

Nominations are now being accepted for candidates for the IEEE EMC Society Board of Directors. In accordance with the Bylaws, nominations may be made by petition or by the Nominations Committee. Petitions shall carry a minimum of 15 names of Society members in good standing (dues paid), excluding those of students. Nominees should possess professional stature and significant technical skills in electromagnetic compatibility. They must have adequate financial support outside the Society and have the approval of their organizations or employers to actively participate. Duties include attendance at three of four Board meetings a year and participation on committees, both of which require telephone, fax, mail and e-mail communications. Nominees must be full members of the IEEE and members of the EMC Society. Elected Directors must serve a three-year term starting January 1, 2003. Attendance at the last meeting of the 2002 year is also desirable. No member can serve more than two consecutive three-year terms, including partial terms. All nominees are required to submit a biographical summary to the Nominations Chairman for inclusion on the ballot. The summary must not exceed a one-half typewritten page and must be in the following format:

First paragraph Name, title, place of employment, educational background

Second paragraph Technical and professional experience

Third paragraph IEEE service and activities including offices, committees, etc.

Please submit petitions and biographical summaries to the Nominations Chairman:

Joe Butler
Parker Chomerics
77 Dragon Court
Woburn, MA 01888
phone: 781.939.4267
fax: 781.939.4213
jbutler@parker.com

Submissions must be postmarked no later than May 31, 2002. Information can be obtained from Mr. Butler or any member of the BoD.

NOMINATION PETITION
ELECTROMAGNETIC COMPATIBILITY SOCIETY
BOARD OF DIRECTORS

(Nomination guidelines given on preceding page.)

I. NOMINEE'S NAME: _____

MEMBERSHIP NUMBER: _____

ADDRESS: _____

_____

_____

PHONE: _____

II. BIOGRAPHICAL SUMMARY: Attach Typed Copy

III. SIGNATURES: (Minimum of 15 names.) We, the undersigned, all of whom are current IEEE Electromagnetic Compatibility Society (EMCS) members in good standing, nominate the above-mentioned person to serve on the EMCS BoD for a three-year term beginning January 1, 2003.

MEMBER'S NAME (PRINT)	SIGNATURE	MEMBERSHIP NUMBER
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

Book Review

Reinaldo Perez, Associate Editor

EMI/EMC Computational Modeling Handbook, 2nd edition, 311 pp.
Authors: Bruce Archambeault, Colin Brench, and Omar M. Ramahi
Publisher: Kluwer Academic Publishers, 2001

There are many books in computational electromagnetics, but this book specializes in the usage of computational electromagnetics for EMC problems. Most EMC/EMI engineers come from the testing world (where EMC actually got started with the nascence of testing requirements and standards) and some come from the abstract world of electromagnetic theory. Both groups have learned to apply what they know to the often-misunderstood concepts of EMC and EMI, but the complexities of EMI problems have rendered the analytical approaches to the solution of interference and compliance problems very difficult to implement.

Now comes to the rescue the art of computational electromagnetics. For years, such computational techniques have been used for different types of EMI problems with different degrees of success (unless you understand the EMI problem, you can't model it properly). This book serves as a bridge for those in the EMC world who want to learn about modeling of EMI problems via computational electromagnetics (CEM). It may also be useful to the experienced CEM modeler who wants to know about the EMI world. The book is introductory in the level of difficulty and light in the mathematics. The purpose of the book is to teach the art of modeling for EMI rather than detail the CEM techniques.

The book is divided into 11 chapters. Chapters 4, 5, and 6 deal with the most commonly used CEM techniques such as FDTD, Method of Moments, and FEM, respectively. The rest of the book (Chapters 7 through 11), deals with the application aspects of EMC. The first three chapters are introductory in nature. For the experienced CEM modeler who wants to know about the applicability of CEM to EMI, I suggest starting with Chapter 1 and proceeding with Chapters 7 through 11. For the EMC engineer who is starting to learn CEM, a cursory reading of the book from Chapters 1 through 11 is recommended.

Chapter 1 introduces the reader to the basic principles of EMI and what is the state of the art in EMI modeling. The "tool box" approach, as described in the chapter, allows the EMC engineer to look at an EMI problem and choose the appropriate CEM tool (FDTD, MoM, or FEM) to analyze the situation. The choice of the appropriate CEM tool requires some intuition and experience. A successful modeler is one who has an intuition of what is the nature of the interference/compliance problem and one that has some experience on what each CEM is capable of delivering for that particular situation. The chapter ends with a brief description of FDTD, MoM, and FEM. Chapter 2 introduces the reader to the basic concepts of electromagnetic theory and eases the reader into the CEM techniques resulting from the manipulation of the mathematics embedded in Maxwell equations.

The introduction to CEM techniques starts with Chapter 3 where the FDTD method is discussed. The chapter is devoted to the details of FDTD. Two and three dimensional FDTD are discussed, with the emphasis of course on the 3D approach as outlined by the Yee cell. The chapter covers the modeling of radiation sources and the inherited dispersion issues that are part of every FDTD modeling approach. The chapter ends with mesh truncation techniques and the sources of FDTD modeling errors. Chapter 4 covers the method of moments which is used less in EMI analysis than FDTD, mostly because it is more complex mathematically, mostly used for surface currents, and more complex when using inhomogeneous media. Therefore, from the EMI point of view, only those problems in EMI where there is a need to calculate current distributions (e.g antenna emissions problems) does the method of moments provide an advantage. The material discussed in Chapter 4 is for the method of moments of perfectly conducting surfaces. Chapter 5 addresses the finite element method. The chapters covers the basic principles of FEM, such as creating the finite element matrix, matrix assembly, matrix solution and the solution of a two-dimensional Helmholz equation.

Chapter 6 prepares the reader for the world of EMI modeling. The first aspect of this is the consideration of how modeling tools can be used. Depending upon the frequency range and the physical size of the device to be modeled, quasi-static or full wave tools may be more appropriate. If the geometry of the problems permits it, two-dimensional models may be used to avoid the model complexity and higher computer resources necessary for full three-dimensional models. If detailed frequency responses are desired, the use of time domain tools is advantageous, as a wide bandwidth is modeled with a single run instead of multiple runs that are required with frequency domain methods. Therefore, it is up to the reader to weigh the pros and cons of the main CEM techniques for a given EMI problem based upon the data available for the problem and what is really wanted as a solution.

Chapter 7 presents the steps required to create practical EMC models for different computational techniques. In addition, examples of practical problems are presented to illustrate the use of modeling and to show some of the most critical areas. Good geometries are important to the construction of models, especially if such geometries are well defined. However, it is always important to realize that EMI models are often unusual in their needs and applications, and often require further attention to make sure the problems being solved are the ones of interest, and not those from a perfect model.

Every modeling task has its own priorities and criteria and the creation of EMI models can often be a difficult process. However, a guide to the steps needed to prepare for modeling, using the three

main CEM techniques, is provided in the next chapter. Chapter 8 covers a wide range of modeling topics of interest to EMC engineers. Multiple stage models can be used when several sections are electromagnetically separable, and the modeling techniques can be varied to allow each individual stage to be optimized. Test sites can be evaluated before construction to show effects of changes to typical recommendations. Antennas and other measuring probes can be modeled as part of the evaluation process or as a method to allow their effects to be included in the overall results. Chapter 9 talks about the EMI modeling validation and the usage of different techniques, depending upon which is most appropriate. Validation is important in order to ensure the correctness of the model and help understand the basic physics behind the model. Measurements can be used to validate modeling results, but extreme care must be used to ensure the model correctly simulates the measurements made.

Chapter 10 covers standard EMI/EMC modeling problems. A set of well defined and designed modeling problems can be used as test beds for new software and it can serve as an important tool in the process of selecting an appropriate modeling technique. Taking time to consider the actual uses for such software and creating suitable problems is the key to getting the most value from such problems. The objective is to have a problem that is not only representative of the challenges of an EMC engineer, but also one that is not so complex that the answers can not be verified. Several examples are shown in the chapter that can be used as standard EMI modeling problems. These benchmark problems can be used to evaluate present and future modeling tools that may show up in the market. The last chapter in the book, Chapter 11, addresses advanced modeling techniques. The chapter describes the PEEC and TLM modeling techniques. These techniques are relatively new to EMC modeling activities, but can be extremely useful for certain EMC modeling applications. The PEEC technique is an equivalent circuit technique much more suitable than SPICE. PEEC is a full wave simulation tool because it does include the propagation delay. It is suited for EMC problems that include lumped circuit elements, such as power/ground plane decoupling, including capacitors, via inductance, and other printed circuit board related EMI problems. PEEC is also very suitable to interface directly with traditional quasi-static TEM based signal integrity tools to provide the full wave part of the problem for traces running over splits in their ground-reference planes, or traces with connectors between boards. The TLM converts the electromagnetic problem into a series of transmission lines. It is similar in some aspects to the FDTD, however, there is the ability of TLM to have the voltage and currents in each node located at the same point in space. This is an advantage when changing cell size or modeling very thin objects. **EMC**

Still More Comments on the IEEE Fiscal State of Affairs

Peter Staecker, Divison IV Director (p.staecker@ieee.org)

December 2001

Fiscal matters continue to dominate the activity horizon in Piscataway, so it is appropriate to once more review the following challenges for fiscal improvement mentioned in this column back in March, 2001:

1. Selection and management of initiative programs within the Institute
2. Periodic review of the Corporate Infrastructure activities
3. A closer look at (read "simplification of") the complicated set of business rules that are required to support the many offerings of the Societies and Councils
4. A financial model that more properly allocates expenses among users

As of December, there is additional progress to report on these challenges, which, recall, are being put in place for 2002 and beyond.

1. Initiative Programs

An adhoc committee of the Board of Directors has been looking closely at initiative spending throughout the year. Necessary expenditures such as information technology [IT] and revitalization initiatives with revenue payoffs such as *IEEE Spectrum* are continuing. IT alone accounts for over half of the total continuing initiative budget for 2002. Other initiatives, better suited for oversight within organizational unit operating budgets, have been dropped or absorbed. After a year of activity, it is clear that there is more work to do on initiative selection, review, and sunsetting. Hopefully, these items will be addressed in 2002.

2. Infrastructure Cost Distribution within TAB

The 2002 budget distributes infrastructure costs to TAB and the other organizational units (RAB, P2SB, EAB, SA, IEEE-USA) in accordance with the financial model proposed by the Overhead Administrative Recovery Committee (OARC). TAB is now developing a distribution method for passing these costs to the Society/Council users. Briefly, infrastructure activities support the IEEE business "engine", including our growing portfolio of electronic products, and an increasingly complex business (perhaps too complex...see discussion below).

The OARC proposal allocates the cost of *direct* core functions by use in the following categories:

- Controllers
- Payroll
- Human Resources
- Business Administration
- Member Services
- Application Processing
- Procurement
- IT-Common

- IT-Membership
- IT-Financial

And allocates the cost of *indirect* corporate and other core functions through algorithms specific to TAB:

- IP Revenue Sharing
- Elimination of the TAB allotment from Member Dues
- First 6% of Investment Returns on Reserves

Based on target budgets for 2002, the list above sums to around $15M for Societies and Councils, excluding any investment returns. The Infrastructure Task Force looked at a number of distribution algorithms, including one based only on Reserves; a *Blended* method, which added the concept of IP revenue sharing (yes, you may call it a tax); the *Principles* method, which attempts to link Society/Council *activity* to each allocation item (except for those designated as initial conditions by the OARC); and a *Simplified* method, a variation of the *Principles* method. The tables at right (based on the same target budgets) show how the total bill is divided among the activity metrics (Table 1), and how the bill would be calculated for an individual Society/Council (Table 2).

	Method		
Metric	**Blended**	**Principles**	**Simplified**
Reserves	69.8%	20.6%	39.7%
Pkg Revenue	30.2%	16.5%	16.5%
Membership	-	33.1%	19.1%
Use (expense)	-	24.2%	19.1%
Exec Offices	-	5.6%	5.6%
Total	100%	100%	100%

Table 1: Percentage of the Total Bill Based Upon the Given Metric

		Method		
Metric	**Unit**	**Blended**	**Principles**	**Simplified**
Reserves	%	20.3%	6%	11.5%
Pkg Revenue	%	75.1%	40%	40%
Membership	$/member-	-	$20.55	$11.10
Use (expense)	% of expenses-	-	10.6%	8.4%
Exec Offices	$/head-		$8,371	$8.371

Table 2: Society/Council Bill Estimator

These tables give two completely different, but complementary, views of the infrastructure bill: Table 1 shows how the percentage of each of the five components of the bill vary among the methods proposed, while Table 2 shows how the bill for a particular Society/Counil would be calculated. In Table 2, for example, using the Principles method, the bill for your Society would consist of 6% of your Society/Council reserves, 40% of your Society's package revenue, a charge of $20.55 per Society member, 10.6% of your Society expenses, and $8.371K per staff head in Society Executive Offices in Piscataway. Important note: These numbers are from the challenge budget to TAB from last May, and are for illustrative purposes only. In the interim, a number of cost-cutting and revenue enhancing activities from other OUs have been inserted into the 2002 budget. These will change the entries in the two tables, and will improve the Society/Council financial picture.

At its November meeting, the voting members of TAB, in a straw poll, agreed that the *Principles* method seemed to have the features linking metrics to use/activity that lead to good business practices, and also shared the opinion of the Task Force that this algorithm could cause short term financial hardship for a small number of Societies/Councils. Accordingly, the Task Force was tasked to consider *rescue plans* to be used on an as-needed basis, and will report back in February.

In summary, IEEE and TAB have made substantial progress on the issue of how to *DISTRIBUTE* Infrastructure costs, so that the next step will be to focus on the issue of how to *REDUCE* them. Stay tuned.

3. Business Rule Complexity

The Societies and Councils can save as much as $3M/year by simplifying the following areas: Institute, Society, and student Membership pricing, publication pricing, payment options, additional information requests, and the solicitation process. A spread sheet summarizing the options for 2001 Products (a 27 option by 270 product matrix, spreading over six legal size pages in five point type) was shown to illustrate the tangled web that we the Societies/Councils have woven. In November, the Infrastructure Oversight Committee (IOC) requested the BoD to authorize RAB and TAB to investigate business rule changes to realize savings in a *minimum feature* alternative, and the motion was passed. What would it be like if each Society had the same membership fee? Etc, etc. Keeping it simple will save money! You will probably be hearing about this through TAB shortly.

4. Financial Model and the Budget Update

The Board approved the OARC's recommendations for use with the 2002 Budget process at its July meeting, and the philosophy of *pay-by-the-drink* is now being driven down to the Society/Council level by efforts such as those by TAB's Infrastructure Task Force. Mentioned above, but worth repeating: this will allow us to identify the costs of doing business, and is a necessary step in the process of reducing those costs.

In November, the usual time for the IEEE BoD to approve the budget for the following year, the proposed budget still showed a shortfall of $1.7M. The BoD decided that the 2002 budget process will be continued until February, charging IEEE FinCom and Staff to balance the budget to net zero using only dividends and interest as a source of income. Other returns on our investment portfolio are budgeted at zero percent. The anticipated planned spending of reserves (which would have reduced Society/Council

continued on page 58

Board of Directors Activities

San Diego, California
November 13, 2001

Photo by Chery Pettit

Dick Ford, Bruce Crain and Todd Hubing (L-R) relax after the adjournment of the November EMC Society Board of Directors meeting.

THE PRESIDENT'S OPENING REMARKS

President-elect Todd Hubing called the meeting to order at 8:30 am. He advised that President Joe Butler was not able to attend this meeting. He welcomed John Norgard, newly elected Board member, and Peter Staecker, IEEE Division IV Director. A round of introductions was made. Board members present included H. Benitez, L. Carlson, B. Crain, A. Drozd, R. Ford, F. Heather, D. Heirman, D. Hoolihan, T. Hubing, E. Joffe, D. Millard, M. Montrose, J. Norgard, J. O'Neil, H. Ott, J. Perini, G. Pettit, C. Sartori, K. Williams, and T. Yoshino. Board members absent included J. Butler, D. Bush, T. Chesworth, L. Cohen, W. Kesselman, J. Muccioli, A. Podgorski, and D. Smith. Guests present included H. Denny, J. Fischer, B. Nadeau; P. Staecker, and B. Wallen. The agenda was approved as presented.

TREASURER'S REPORT

Mr. Hubing advised that Treasurer Warren Kesselman's flight to San Diego yesterday was cancelled due to the airline accident outside New York. Therefore, he was not able to attend the meeting. In his absence, Mr. Hubing distributed his report. IEEE's 30 September 2001 financial reports indicate that the EMC Society's 2001 cumulative surplus was $173.8K.

SECRETARY'S REPORT

The minutes from the Board meeting on June 15, 2001 were reviewed. A few changes were required. The minutes were approved as amended.

DIVISION IV DIRECTOR'S REPORT

Todd Hubing introduced Peter Staecker, IEEE Division IV Director, who then presented a report on the IEEE current state of financial affairs. Mr. Staecker advised that IEEE is a $200M business. Reserves in 2000 were approximately $120 million. He reviewed the roles of the major boards within the IEEE, (TAB, TAB and EAB) and the IEEE corporate infrastructure, including the cost of doing business. The IEEE budget versus actual numbers for the years 1996 to 2001 were reviewed. Starting in 1998, the actuals were more than budgeted. Basically, the IEEE started out in 1996 spending to improve services offered by the IEEE to its members. The cost for these services had been covered by the excellent returns from investments. However, starting in 1998, the investment returns did not cover the expenses and thus the deficit grew. The IEEE staff is working hard now to reduce costs. At the start of 2000, the net IEEE losses had eliminated corporate reserves. Thus, the question arose of how to pay for IEEE business costs, including paying for a $27 million dollar deficit budget. The initial 2002 budget proposal (dated May 1, 2001) was reviewed. The Findlay Financial Model was reviewed. This budget is named after Ray Findlay who chaired the IEEE committee that created this budget. The TAB Infrastructure Cost Distribution was reviewed. Methods under consideration include addressing reserves, membership, expenses, package revenue and the executive offices. The IEEE staff level was discussed over the years from 1996 to 2002. For 2002, Mr. Staecker reviewed what qualifies a financially successful society, including the surplus/member ratio, surplus/reserves, and expenses/member. The EMC Society has good numbers in these categories. Mr. Staecker summarized his report by advising that all costs need to be continually monitored and we need to question all assumptions regarding expenses.

CONFERENCE SERVICES

Henry Ott, Vice President for Conference Services, presented his report. Regarding the 2000 Washington DC symposium, the IEEE has completed the audit. The surplus was $189,000. Mr. Ott then called upon Barry Wallen, Chair of the International Symposia Committee. Mr. Wallen introduced Benoit Nadeau, chairman of the 2001 IEEE International Symposium on EMC in Montreal. Mr. Nadeau presented an overview of the Montreal symposium. The total number of attendees was 1,706; of which 486 were full registrations, 296 non-members, 247 exhibitors, exhibitor free passes were 262. The balance was companions. Out of the 296 non-members, three were session chairs and 46 were speakers. The registration distribution was then reviewed by country. Regarding the exhibition, there were 163 exhibitors occupying 250 booths, which generated a net income of $557,190 USD. Most of this income was generated early by booth sales at the previous year's symposium. There are a few outstanding bills to be reconciled, and reports to be filed, including a tax rebate report, to close the books on the symposium. The symposium expense and income budgets were reviewed. The patron program generated a net income of $57,000 USD. Mr. Ott complimented Mr. Nadeau and his committee for doing an excellent job in organizing the Montreal symposium. He brought it to the Board's attention that the committee has already submitted a 75 page final report on the symposium. Barry Wallen then reviewed the status of future symposia as follows: 2002 Minneapolis: Chair Dan Hoolihan reported that all is going well

with this symposium. The symposium website address is www.2002-ieee-emc.org; 2003 Boston: Jon Curtis of Curtis-Strauss is the new chairman for the 2003 Boston Symposium Steering Committee. They have contracted with IEEE Conference Management Services to run this symposium. All of the hotels are within walking distance of the Heinz Auditorium where the symposium will be held; 2003 Tel Aviv: Elya Joffe presented a report on this symposium. He reported that the symposium is on track with all milestones; 2005 Chicago: Derek Walton has stepped down as Chair of this Symposium. Tom Braxton was approved as the new Chair of the 2005 Symposium steering committee; and lastly, 2006 Location to be Determined: There are three proposals for locations for this symposium, including Singapore, Portland and Dresden (Germany). Mr. Wallen advised that the potential impact on the revenue from exhibitors at these locations needs to be considered. Mr. Ott then called upon Henry Benitez to present a proposal from the Portland chapter to host the 2006 symposium. Mr. Benitez reviewed the convention center capabilities, the hotels available nearby, and transportation to the city of Portland. The proposed steering committee was identified. In summary, Mr. Benitez emphasized that the Oregon and SW Washington chapter is very strong and has been for years. They have eight officers and are supported heavily by industry in the area, including Hewlett Packard, Intel, In Focus, and Tektronix, among other companies. Mr. Ott then addressed the Board and reviewed the three potential symposium locations for the year 2006. He presented viewgraphs, which stated the pros and cons of each city. The Board planned to confirm the 2006 Symposium location at its February 2002 Board meeting. Regarding the symposium in the year 2007, which is the 50th anniversary of the EMC Society, Mr. Ott suggested that San Diego be considered as a location for this symposium. San Diego has a relatively new convention center on the waterfront. It opened in 1989. There are many attractions nearby. A Hyatt Regency Hotel is located one block from the convention center and the Marriott Hotel is located adjacent to the convention center. Janet O'Neil then presented her report as

Photo by Dick Ford

A long-range planning session was held the day after the November 13 Board meeting in San Diego. Board members informally met to brainstorm and strategize about future EMCS activities, including symposia, awards, and technical programs, among other topics.

Exhibitor Liaison. The revised policy which addressed the gray areas in the exhibitor "points system" was sent out for review to an unofficial "exhibitor advisory committee" for comment/critique. Once their comments are received back, IEEE's legal department will review this revised policy. Then, the material will be posted to the EMCS website along with the updated point allocation grid (which needs to be updated). The "exhibitor advisory committee" is small, represents long time and brand new exhibitors, large companies and small companies, so there is balanced representation. Future considerations for the Exhibitor Liaison include the points to be awarded in 2003 to exhibitors who exhibit in Boston and/or Tel Aviv and also the institutionalization of the program advertising/sponsorship component of each symposium committee. This latter effort is on going. Janet O'Neil then presented her report as Regional Conferences chair. There are five regional EMC chapter tabletop shows scheduled to date for early 2002. The dates and locations will be noted in the calendar section of the EMC Society Newsletter. A future tabletop show is in the initial planning stages for June 2002 in Florida. This will address military EMC and is being organized with the assistance of Maqsood Mohd and the Melbourne EMC chapter. Mr. Ott then advised that Jose Perini would be the new Global Symposia Coordinator. The outgoing Global Symposia Coordinator, Elya Joffe, advised that the document "How to Obtain EMC Symposium Sponsorship" has been reviewed by the Board and is close to being ready to being posted to the EMCS website. Mr. Ott advised that he has received requests for EMC Society co-sponsorship from the following symposia steering committees: EMC Workshop in Rhodes, Greece, October 7-11, 2002 and EMC Conference (5th annual event) in St. Petersburg, Russia, June 2003. The Board approved the EMC Society as a technical co-sponsor of the EMC Workshop in Rhodes, Greece on October 7-11, 2002. The Board declined the request of the St. Petersburg, Russia EMC conference steering committee.

COMMUNICATION SERVICES

Len Carlson, Vice-President for Communication Services, verbally presented his report. In the absence of Professor Marcello D'Amore, Transactions Editor-in-Chief, Len Carlson advised that the Transactions budget would be overrun this year since the page count for 2001 has been exceeded. Newsletter Editor Janet O'Neil verbally reported that the current issue (Summer 2001) is 48 pages and contains three practical papers, including one by ANSI ASC C63 historian Ed Bronaugh on the quasi-peak detector. The issue includes an announcement regarding advertising in the 2002 issues of the Newsletter. The Distinguished Lecturers for 2001 are introduced with photos and bios. EMCS Treasurer Warren Kesselman

submitted an article on the year 2000 EMCS financial summary. Chapter Chatter has a strong showing in this issue. The Fall 2001 issue will focus on the Montreal symposium and is expected to exceed 48 pages in length. Mark Montrose then presented his report as IEEE press liaison. He advised that he attended the meeting of the IEEE Press Board held on September 28-29 in New Brunswick, New Jersey. Representatives from both Wiley and IEEE Press presented an overview of their partnership. Specific assignments as detailed in the MOU (valid for three years) were discussed. The Mission Statement was examined and revised. His report included a list of the books currently sponsored by EMCS and potential books for EMCS sponsorship. Andy Drozd next presented his report as the EMCS Webmaster. He advised that the committee has made numerous updates to the Society home page, including adding a link to the 2002 Minneapolis EMC symposium website. There are currently three advertisers for the EMCS website and two more companies have expressed interest. Doug Smith is supporting the committee by checking the web hit counter, and exploring various security issues related to the website. The committee is maintaining the website on a regular basis and they are looking at hiring a firm to create a new "look" for the site and make it more attractive and professional. He attended the EMCS Panel of Webmasters meeting in Montreal during the symposium week. The group will prepare a "Web Page Summary Guideline" to provide essential information on how to develop and properly maintain web pages in accordance with IEEE policies and procedures. Web page templates are being developed. Funding to support future website development and maintenance needs to be considered by the Board. There was no report on Public Relations in the absence of committee chair Tom Chesworth.

MEMBER SERVICES REPORT

Andy Drozd, Vice-President for Membership Services, presented his report. Bruce Crain advised that he submitted an article on the Membership booth activity during the Montreal symposium for publication in the EMC Society Newsletter. He has followed up with those who applied for a Senior Member upgrade at the Montreal symposium. "Solutions for Today's Innovators" is a new IEEE ad to promote membership. It was suggested that this ad be run in the EMCS Newsletter. Andy Drozd reported for Lee Hill, chair of the Distinguished Lecturer (DL) program. The Board approved the appointment of Dr. Keith Hardin of Lexmark and Dr. Cheung-Wei Lam of Apple Computer as EMCS Distinguished Lecturers for the 2002-2003 term.

Photo by Janet O'Neil

Henry Ott of Henry Ott Consultants (left) visited with John Norgard who was attending his first Board of Directors meeting as a newly elected Board member.

Henry Benitez then reported on Awards. This committee is following up on the cash awards due to the Montreal award recipients. There was a delay this year in issuing these checks due to a turn over in personnel at IEEE. Next year, you can submit an award entirely on line and there will be no need to download it, complete it and snail mail a hard copy to IEEE. Ghery Pettit next reported on Chapter Activities. During 2001, he noted that an inquiry has been received from Australia and Romania about forming new chapters; the new Benelux chapter was approved in October; a new chairman was named for the Israel chapter (Moshe Netzer); in Malaysia, the Antennas and Propagation chapter added Microwave Theory and Techniques and EMC to create a joint chapter; and in Singapore, the EMC group has broken off from a joint AP, MTT and EMC chapter to form a separate EMC chapter. Elya Joffe reported on Region 8 activities. Since the Montreal symposium, there have not been any EMC symposia in this region. He visited Russia and the chapter there recently and promoted IEEE membership. He also informed the chapter about our Senior member program. In Israel, he has sent the chapter information about the Senior member program via e-mail. He reviewed the new chapter activity in Region 8. He maintains contact with the chairmen of these newly formed, or forming, chapters. Mr. Joffe concluded his report with a dis-

Photo by Janet O'Neil

Dan Hoolihan of Hoolihan EMC Consulting, Takeo Yoshino of the Awara Space Radio Observatory, Fukui University of Technology and Hugh Denny (L-R) enjoyed the mild climate of San Diego during a break in the meeting of the EMC Society Board of Directors.

cussion on proactive membership initiatives, including a regional chapter chairmen meeting in addition to the annual EMC symposium chapter chairman's luncheon, special free material from the EMC Society, including CDs of symposia proceedings, etc. Jose Perini then reported on Region 9 activities. He advised that there is not much EMC activity in Argentina right now due to the poor economic climate. However, there is much activity in Brazil and the newly formed Sao Paulo EMC chapter will be organizing a two-day EMC conference in November 2002. Carlos Sartori will chair this event. Mr. Sartori advised that he would coordinate his efforts with Janet O'Neil so that a tabletop show can be held in conjunction with the technical program. Takeo Yoshino reported on EMC activity in Region 10. There are several EMC conferences being organized in his region, including the international EMC Japan 2004. There will be an international EMC conference in Bangkok, Thailand on July 25-27, 2002. The Korea-Japan AP/EMC/EMT joint conference was held in Korea on September 10-11, 2001. Regarding Nominations and Bylaws, Dan Hoolihan advised that the newly elected members to the Board include: Ghery Pettit, Ron Brewer, Zorica Panic-Tanner, Elya Joffe, Tom Chesworth, John Norgard and Kimball Williams. This election resulted in a tie for the sixth place position on the Board. The EMCS bylaws do not address what to do in a tie election. Thus, both members who tied were allotted a spot on the Board. Mr. Hoolihan will prepare a proposal to revise the bylaws to address this situation. Outgoing Board members this year include Doug Smith, Don Bush, and Dave Millard. Approximately 18% of the EMCS membership returned a ballot. Mr. Drozd reported for Bill Duff that six Fellow nominations were received this year. The awards will be presented next year. The committee does not expect any significant activity until next summer. Dick Ford discussed the Annual Symposium Survey. He presented a spreadsheet, which showed the results of the some 100 completed surveys which were returned. The survey results were compared over a six-year window, from the Santa Clara (1996) to the Montreal (2001) symposia. He is planning a major revision to the survey for next year. There will be a new give-away for those who complete the survey. The survey fill rate has gone from 75% to 60% over the years. This decrease will be rectified in next year's survey. Regarding his report as the Society's photographer, he distributed copies of photos taken during the Montreal symposium. Several of these are on the Montreal symposium website. Many of the exhibitors wanted photos taken of their booths this year. This was in dramatic contrast to last year's symposium where very few exhibitors wanted photos taken of their booths. There was no report submitted by the PACE chair, Bill McGinnis.

Photo by Janet O'Neil

Dave Bernardin of TUV Product Service (left) received the IEEE EMC Society "Certificate of Acknowledgement" award for his contributions to the San Diego EMC 2001 Tutorial and Exhibition. Henry Benitez of Hewlett Packard, EMCS Awards Chairman, (center) presented the award at the November annual dinner. EMCS President-elect Todd Hubing of the University of Missouri at Rolla was on hand to offer congratulations.

TECHNICAL SERVICES

Kimball Williams, Vice President for Technical Services, presented his report. There are new chairmen of Technical Committees TC-3, TC-4, and TC-9. The Board approved the appointment of these new chairmen, including Don Gilliland of IBM for TC-3, Robert Scully of NASA for TC-4 and Chris Holloway of NIST for TC-9. The Board approved the revised TC-4 charter as presented. Regarding TC-8 (Product Safety), Mark Montrose advised that the committee has developed a business and marketing plan. This was submitted to Mary Ward Callahan of the IEEE for review. The committee expects the IEEE to approve their request to be a separate, new society in February 2002. The technical committees expect to review many papers for the Minneapolis symposium. Mr. Williams relayed the Education Committee report for chair Maqsood Mohd. He reported that the fundamentals tutorial is being planned for the Minneapolis symposium. The experiments demonstrations for next year's symposium have been solicited in the EMCS Newsletter. The modeling demonstrations are still being worked on and developed since they are very new. They were presented for the first time at the Montreal symposium. The student paper and student design contests for the Minneapolis symposium are being promoted now. Mr. Williams advised that RAC Chair Dave Case reports that they will hold their traditional RAC/SACCom luncheon at the Minneapolis EMC Symposium. They are seeking an appropriate speaker for a special RAC session to be held during the symposium. Mark

Photo by Janet O'Neil

The Board's annual November dinner often includes long time volunteers to the IEEE EMC Society, such as Joe and Virginia Fischer of Fischer Custom Communications and Herb and Jill Mertel of Mertel Associates (L-R). It's just one way the Board can thank these volunteer for their valuable contributions to the Society.

Photo by Janet O'Neil

Board member Ghery Pettit of Intel (standing) enjoyed catching up with Scott Roleson of Hewlett Packard and his guest Linda Emsley at the November annual dinner. Scott was the chairman of the Society's Distinguished Lecturer program for many years.

Montrose then reported that he attended the Nano Technology symposium in Maui, Hawaii. Circuits and systems are being taken to the electron level. There will be a meeting of the Intelligent Transportation Systems Council, which Mark Montrose will also attend as a representative of the EMC Society. The quality of the technical papers was excellent. Student participation was very good. He also distributed a report regarding the ITS (Intelligent Transportation Systems) conference he attended as a representative of the EMC Society. This meeting was held on August 25-29 in Oakland, California. 225 of the 280 papers submitted were presented at this conference. There were 230 paid attendees. This was strictly a technical conference; there were no exhibitors. Mr. Montrose spoke with representatives from other societies to discuss their participation in the new Product Safety Society, cross promoting the respective conferences, recruiting new members, etc.

STANDARDS SERVICES

Don Heirman, Vice-President of Standards, presented his report. It was noted that the webpage (http://www.ewh.ieee.org/soc/emcs/) for EMC Standards is now operational thanks to the work of Andy Drozd. Standards activity is currently at an all time high and covers three major areas: The Standards Education and Training Committee (SETCom) chaired by Hugh Denny, the Standards Advisory and Coordination Committee (SACCom) chaired by Elya Joffe and the Standards Development Committee (SDCom) chaired by Stephen Berger. Mr. Heirman, reporting for Stephen Berger, advised that the SDCom meeting was held on Monday, 12 November at The Grande Colonial Hotel in La Jolla, California. Eight members of the committee were present. There were two visitors. Hence there was a quorum. The overall result of the meeting is that all EMC standards are current. The subject/titles for each standard number to follow were listed. SDCom revisions are now underway on Standards 187, 473, 1302, and 1309. New standards are the subjects of PARs 1530, 1560 and 1597. SDCom voted to retire Standard 140. A notice to this effect will be printed in the EMCS Newsletter to provide the community an opportunity for comment. STD-377 is being evaluated for potential reaffirmation or withdrawal. Recommendations have been solicited from the SAE and from automotive radio manufacturers who at this point have expressed a desire to retain the document. PAR 1530 continues to encounter delays in timely completion. The SDCom decided to see if Joe Butler would act as an "angel" to see if this development effort can be expedited. Andy Drozd is nearing completion of tailored website templates for the VP for Standards, the SDCom, the SETCom, and the SACCom. The template developed by David Case for the RAC is being used as the basis for the Standards Web Site. An article on PAR 1597 by Andy Drozd appeared in the Fall 2001 issue of the EMCS Newsletter. John Kraemer will prepare the next Newsletter article on Standard 1309 and the need for experts for the next revision. Hugh Denny, SETCom Chair, reported that another workshop session on EMC Standards is planned for next year's symposium in Minneapolis. Several options were discussed for shifting the thrust of the workshop to broaden the appeal to Symposium attendees. The topics for this workshop will be coordinated with Elya Joffe, the SACCom chair. Topics considered include description of active standards in SDCom as well as those from liaison representatives in SACCom. The other thrust of SETCom, i.e. increasing public awareness of EMC standards, continues by submitting *EMC Society Newsletter* articles and working with the IEEE Standards Association staff via our EMCS liaison. Elya Joffe, the SACCom chairman, advised that they held their quarterly meeting as part of the VP for Standards series of meetings in conjunction with EMCS Board meetings on November 12, 2001. A total of 10 attendees were present, including six members and four guests. During the meeting, lively discussions were held relating to measurement techniques as implemented by CISPR 22 (Information Technology Equipment Emission Measurements) versus those in ANSI C63.4. Another point of interest was the possible involvement of the EMCS SDCom and SACCom in biological hazard measurements related to EM fields especially from cellular telephones. SACCom has existing liaisons with IEEE Standards Coordinating Committees SCC 28 and 34, which have standards activity on RF hazard levels and

Photo by Janet O'Neil

Los Angeles EMC Chapter Chair, Ray Adams of Hughes Space and Communications, is shown with his wife Sylvia and Bruce Crain of Northrop Grumann (L-R) at the November annual dinner. Bruce is the Society's Membership Chair.

Patti and Dave Traver attended the November annual dinner to visit with the EMCS Board members. Dave is with Sony Electronics in San Diego and he was Secretary of the EMCS Standards Committee for many years.

cell phone specific absorption rate (SAR) measurements, respectively. This issue will be a matter for discussion in a future SDCom meeting where interest was expressed to consider possible future involvement. The committee has received status reports on the EMC standards activity in their member organizations in a regular manner prior to each meeting. These reports are distributed to the membership and interested parties in the format of "compilation of reports." SACCom is continuously searching for representatives from new EMC standardization organizations, in order to increase the exchange of information among them. Regarding SDCom, Mr. Heirman noted that SDCom Chair Stephen Berger is now chairing the new IEEE Standards Association voting equipment standard 1583. The SDCom is providing coordination and support to this project, which includes a liaison with the Federal Election Commission. This is a very high profile effort being undertaken by the EMC Society. In fact, it is anticipated that the PAR 1583 will be moved to a proposed Standards Coordinating Committee (SCC). It is expected that the IEEE SA Standards Board at its December meeting will approve this SCC. An article on this voting equipment standard effort was the lead story in a recent issue of the *IEEE Institute* and is on the IEEE home page.

OLD BUSINESS

Regarding the dissemination of EMCS material, Andy Drozd spoke about the motion he submitted electronically about the policy regarding distribution of the excess EMC symposia CDs, programs, etc. He also asked IEEE to review the motion and they had comments regarding legal implications of the distribution of this material. Mr. Drozd would like to incorporate these comments into a new policy and have IEEE review this.

NEW BUSINESS

The following items were discussed under New Business:

EMCS Administrator: Dan Hoolihan discussed the role of Warren Kesselman as the EMC Society's paid administrator and our on-site representative at IEEE in Piscataway. The Board approved the appointment of Warren Kesselman as the EMC Society Administrator for 2002.

EMCS Board Meeting Schedule in 2002: Todd Hubing advised that the following dates have been set for the Board meetings in 2002, including February 13 in Tempe, Arizona, May 31 in Boston, Massachusetts, August 18 and 22 in Minneapolis and Sunday, November 24 in Sao Paulo, Brazil. There will also be a one and a half to two day EMC workshop sponsored by the Sao Paulo EMC Chapter in conjunction with the November Board meeting. A tabletop EMC exhibition will also be organized. Carlos Sartori will chair this wotkshop and he is working with Janet O'Neil on the arrangements and exhibits. The speakers for the workshop will include Board members as well as members of the Sao Paulo EMC chapter.

Planning Session: Mr. Hubing discussed the planning session for the following day, November 14. He discussed the format of the session and some of the agenda topics, including our awards program, our technical cosponsorship policy for global EMC symposia, membership initiatives and overall EMCS Board organization. There will be four tables with one of these topics assigned per table. Board members are invited to sit at the table whose topic most interests them. The planning session will be from 8:00 am to 12:00 pm.

ACTION ITEM REVIEW

President-elect Todd Hubing reviewed the action items discussed during the meeting. Dan Hoolihan then reviewed the electronic balloting research he has undertaken to date with Joe Butler. The EMC Society has done considerable work on this and other Societies are soliciting us for input on how this works.

NEXT MEETING

The next meeting of the EMCS Board of Directors will be on Wednesday, February 13 in Tempe, Arizona from 8:30 am to 5:00 pm. There being no further business, the meeting then adjourned at 5:00 pm.

Submitted by:

Janet O'Neil
Secretary, EMC Society
Board of Directors

EMC

ADVERTISER'S INDEX

The Advertisers Index contained in this issue is compiled as a service to our readers and advertisers: the publisher is not liable for errors or omissions although every effort is made to ensure its accuracy. Be sure to let our advertisers know you found them through the *IEEE EMC Newsletter.*

THE 2003 IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY (EMC)

Tel Aviv, Israel, May 11-16, 2003

http://www.ortra.com/emc2003/

Call For Papers

Dear Colleagues and Fellow EMC Engineers, Shalom from Israel,

We are delighted to announce the 2003 IEEE International Symposium on EMC to be held in Tel-Aviv, Israel on May 11–16, 2003. Workshops, tutorials, "Birds of a Feather" panels and special invited sessions will be organized on stimulating topics. The Symposium will be accompanied by a technical exhibition.

Paper Submission

Prospective authors are invited to submit, by **July 15, 2002** abstract and preliminary manuscripts in English, either electronically, via e-mail or by regular mail. The official language is English. For detailed instructions on paper submission please visit the Symposium's official web site at **http://www.ortra.com/emc2003.**

Technical Exhibition

The Symposium will be accompanied by a technical exhibition on EMC. Prospective exhibitors are invited to order a Exhibitor's Kit from the Symposium Secretariat for exhibition space, constructed stands, showcases, mural display areas and advertisement space in conference publications. We expect exciting new product launches and exhibitor events during the Symposium. Do not miss this unique opportunity!

Tel-Aviv - one of Israel's largest cities, is a thriving vibrant metropolitan that never sleeps! Often nicknamed in Israel "The Non Stop City". As an exciting and cosmopolitan mix of leisure activities, Tel-Aviv offers something for everyone – to be fully enjoyed in the ideal Mediterranean climate. Outdoor cafes, ethnic restaurants and cultural centers will compete for your attention with historic sites, open oriental markets and of course the Mediterranean coast and its golden beaches.

The Symposium will take place in the David Intercontinental Hotel, featuring Israel's largest Convention Center and Banqueting facility and ideally situated on the seafront, opposite the buzzing beachfront promenade.

FOR FURTHER INFORMATION PLEASE CONTACT THE SYMPOSIUM SECRETARIAT:

ORTRA Ltd.

1 Nirim Street, P.O. Box 9352, 61092 Tel-Aviv, Israel

Tel: +972-3-6384444 Fax: +972-3-6384455 e-mail: emc2003@ortra.co.il

OR VISIT OUR WEB SITE AT:

Web site: http://www.ortra.com/emc2003

Association of Engineers and Architects in Israel (AEAI)

Institute of Electrical Engineers (IEE)

International Union of Radio Science (URSI) Commission E

EMCABS

EMC Abstracts

Osamu Fujiwara, Associate Editor

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

EMCAB COMMITTEE

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

"How Can I Get a Copy of an Abstracted Article?"

Engineering college/university libraries, public libraries, company or corporate libraries, National Technical Information Services (NTIS), or the Defense Technical Information Center (DTIC) are all possible sources for copies of abstracted articles of papers. If the library you visit does not own the source document, the librarian can probably request the material or a copy from another library through interlibrary loan, or for a small fee, you can 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.

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. **EMC**

EMCABS: 01-2-2002

CORRELATION OF TEST FACILITIES FOR RADIATED EMISSION MEASUREMENTS USING A SPHERICAL DIPOLE RADIATOR: OATS, FULLY ANECHOIC CHAMBER AND GTEM CELL

Tae-Weon Kang+, Joo-Gwang Lee+ and Hyo-Tae Kim++
+Electromagnetics Group, Division of Electromagnetic Metrology, Korea Research Institute of Standards and Science, P. O. Box 102, Yusong, Taejon 305-600, Republic of Korea
++Department of Electrical Engineering, Pohand University of Science and Technology, Pohang, Kyoungbuk 790-784, Republic of Korea

Proceedings of Korea-Japan AP/EMC/EMT Joint Conference, Taejon, Korea, September 10-11, 2001, pp.98-102.

Abstract: The correlation of test facilities for radiated emission measurements are considered in the frequency range of 30 to 1000 MHz. The facilities considered are an open area test site (OATS), a fully anechoic chamber (FAC) and a gigahertz-TEM (GTEM) cell, and only vertically polarized case is taken into account. A spherical dipole radiator (SDR) is employed as a reference emitter. Results show that the correlation of the three test facilities agrees within +-4.7 dB and +-5.7 dB for 3 m and 10 m distances, respectively.
Index terms: Correlation, radiated emission, open area test site, GTEM cell, fully anechoic chamber.

EMCABS: 02-2-2002

SAR REDUCED EFFECT OF THE FERRITE BEAD INSIDE OF THE CELLULAR PHONE ANTENNA

Yun'n M'young Gimm, Ki Hwea Kim and Seung Bae Lee
Dept. of Electronics Engineering, Dankook University

Proceedings of Korea-Japan AP/EMC/EMT Joint Conference, Taejon, Korea, September 10-11, 2001, pp.200-205.

Abstract: We are proposing a new mobile phone antenna, which has a specially manufactured Mn-Zn cylindrical ferrite bead inside of the helical coil of the antenna. The extended antenna radiation patterns and the spatial peak SAR averaged over 1 gram simulated tissue with and without the ferrite bead insertion were measured at 824 MHz. The results show that the ferrite bead resulted in a SAR reduction of about 20%, and a reflection coefficient increase of about 7% for the extended antenna. The applicability of this scheme to the antenna mass production is quite feasible.
Index terms: Mobile phone, antenna, ferrite bead, SAR reduction.

EMCABS: 03-2-2002

RESOLUTION IMPROVEMENT OF E-FIELD PROBE USING A SIGNAL PROCESSING TECHNIQUE

Hiroshi Hirayama and Yoshio Kami
The University of Electro-Communications, 1-5-1 Chofugaoka, Chofu-shi, Tokyo 182-8585, Japan

Proceedings of Korea-Japan AP/EMC/EMT Joint Conference, Taejon, Korea, September 10-11, 2001, pp.206-209.

Abstract: This report describes a new method to improve resolution of an E-field probe with a signal processing technique without hardware modification. In order to reduce an emission from a PCB, for example, it is useful to study near field distribution. Most conventional methods have obtained the distribution of E-field strength by scanning an E-field probe [1] and

multiplying its antenna factor by the output voltage. However, the method has the following disadvantages: 1) a correlation between near E/M field distribution and the probe output voltage has not been proved, 2) not enough resolution for a latest small schematic can be obtained. In this report, we propose a new method, which makes it possible to overcome these problems by using a de-convolution technique with E-probe's spatial responses. Experimental results show that the proposed method has a capability to distinguish two near null points, which cannot be separated with a conventional method.
Index terms: Convolution, model for E-field, measurement and de-convolution.

EMCABS: 04-2-2002

EFFECT OF GROUNDING ON LIGHTNING-INDUCED VOLTAGES OF TELECOMMUNICATION SUBSCRIBER CABLE

Jae Cheol Ju+ and Dong Chul Park++
+Dept. of Electronic Eng., Chungnam Nat'l Univ., Daejeon, Korea
++Dept. of Radio Science and Eng., Chungnam Nat'l Univ., Daejeon, Korea
Proceedings of Korea-Japan AP/EMC/EMT Joint Conference, Taejon, Korea, September 10-11, 2001, pp.210-213.

Abstract: The lightning-induced voltages on a telecommunication subscriber cable with multipoint grounding both on a cable shield and on an overhead ground wire are discussed. The shielding effectiveness due to multipoint grounding is affected by ground position, cable length, grounding resistance, and amplitude and wave shapes of lightning electromagnetic fields. In this paper, the characteristics of lightning-induced voltages between cable shield and twisted-pair wires inside are calculated by using the FDTD method. The shielding effect by changing the grounding position of the cable shield and the overhead ground wire is also examined. A finitely conducting ground plane is taken into account in both lightning electromagnetic field calculations and surge propagation along the cable shield for a practical simulation.
Index terms: Telecommunication subscriber cable, lightning-induced voltage, grounding effect, FDTD analysis.

EMCABS: 05-2-2002

DEVELOPMENT OF WIDE-BAND FERRITE FIN ELECTROMAGNETIC WAVE ABSORBER PANEL WITH VARIOUS SURFACE LAYERS

Toshihiro Yamane+, Shigeo Numata+, Tetsuya Mizumoto++ and Yoshiyuki Naito++
+Shimizu Corporation, Engineering R&D Department, Institute of Technology, 3-4-17, Etchujima, Koto-ku, Tokyo 135-8530, Japan
++Tokyo Institute of Technology, 2-12-1, Ookayama, Meguro-ku, Tokyo 152-0033, Japan
Proceedings of Korea-Japan AP/EMC/EMT Joint Conference, Taejon, Korea, September 10-11, 2001, pp.234-237.

Abstract: In Japan, television ghost caused by tall buildings becomes a problem to be solved [1]. The area where severe ghost is observed can be remarkably reduced by suppressing reflection due to the building walls <-14dB [2]. Most absorbers currently used are narrow band types for either VHF or UHF band. Absorbers are expected to suppress reflection in a wide frequency range, since both VHF and UHF bands are used for TV broadcasting in Japanese urban area. We have developed single layer ferrite grid absorbers as wide band absorbers, which are often used in RF anechoic chambers [3]. The grid absorber works for both vertically and horizontally polarized waves. Vertical fin structure is sufficient to absorb a horizontally polarized wave [4], which is often used as a TV broadcasting radio wave in the Japanese urban area. In this paper, the ferrite fin structure is used for an absorber on the TV ghost problem. For tall building walls, PC (Precast Concrete) curtain walls are often used to shorten the construction period. The PC curtain walls consist of the building materials. This paper describes development of a wide band absorber panel as a PC curtain wall using the ferrite fin with various surface layers. The absorber panels are designed by taking into account building materials located in front of the ferrite fin. The characteristics are measured using mock-ups of the absorber panel.
Index terms: TV ghost problem, electromagnetic wave absorber, ferrite fin absorber panel, measurement.

EMCABS: 06-2-2002

DESIGN OF CUTTING CONE SHAPED AND HEMISPHERE SHAPE-ADDED FERRITE ABSORBER

Dong Il Kim, June Young Son and Jae Young Bae
Dept. of Radio Sciences & Engineering, Korea Maritime University
Proceedings of Korea-Japan AP/EMC/EMT Joint Conference, Taejon, Korea, September 10-11, 2001, pp.238-241.

Abstract: Due to the progress of the electronic industry and radio communication technologies, mankind enjoys an abundant life. On the other hand, serious social problems such as EMI by unnecessary electromagnetic (EM) waves occur due to the increased use of electromagnetic waves. Therefore, the organizations such as CISPR, FCC, ANSI, etc., have provided the standard of the EM wave environment for the countermeasure of the EMC. The absorption ability of EM wave absorber has required more than 20 dB, and the bandwidth has been required through 30 MHz to 1,000 MHz for satisfying the international standards about an anechoic chamber for EMI/EMS measurement. From November of 1998, however, CISPR has accepted the extended frequency band from 1 GHz to 18 GHz additionally in the bandwidth of EMI measurement [1]. In this paper, we proposed the hemisphere shape-added absorber on the cutting cone-shape in order to satisfy the above requirements and carried out broadband design using the equivalent material constants method. Furthermore, the experiments were carried out over the frequency band from 30 MHz to 3 GHz, and the validity of the proposed design theory was confirmed.
Index terms: EMI measurement, cutting cone shaped and hemisphere shape-added ferrite absorber, broadband design, experiment.

EMCABS: 07-2-2002

AN EXPERIMENTAL STUDY OF A LAMBDA/4 WAVE ABSORBER USING FSS FOR TWO FREQUENCIES

Akihiko Itou+, Kouji Wada++ and Osamu Hashimoto++
+Technical Research Institute, TOPPAN PRINTING CO., LTD., 4-2-3 Takanodai-minami, Sugito-machi, Kita-katushika-gun, Saitama 345-8508, Japan
++College of Science and Engineering, Aoyama Gakuin University, 6-16-1 Chitosedai, Setagaya-ku, Tokyo 157-8572, Japan
Proceedings of Korea-Japan AP/EMC/EMT Joint Conference, Taejon, Korea, September 10-11, 2001, pp.242-245.

Abstract: Technologies of a frequency selective surface (FSS) are of considerable practical concern for good frequency-selection in recent complicated frequency bands [1]. We previously studied basic characteristics of the FSS and their application to a single-layer lambda/4 wave absorber. To the author's knowledge, there are no studies of the lambda/4 wave absorber using the FSS for consisting of the reflection film. We consider that the shielding characteristics with the frequency-selection of the presented wave absorber can be obtained as well as the realization of the absorption characteristics with the frequency selection [2]. First, basic operations of the FSS are examined experimentally. Second, a lambda/4 wave absorber using the FSS is proposed, fabricated and measured. In this study, two types of new wave absorbers using the FSS are proposed, which are fabricated by double absorption films and double FSS films, respectively. Moreover, the design of the double absorption films type wave absorber can be performed by point matching method. As for the design of the double FSS films type wave absorber, the classical design of the single-layer absorber is applied.
Index terms: Electromagnetic wave absorber, frequency selective surface (FSS), lambda/4 wave FSS absorber, measurement.

EMCABS: 08-2-2002

RADIO ELECTRO-MAGNETIC COMPATIBILITY AND APPLICATION OF HIGH-TC SUPERCONDUCTING TECHNOLOGY

Toshio Nojima, Yoshiaki Tarusawa and Shoichi Narahashi
Radio Environment Technology Research Laboratories, NTTDoCoMo Inc., 3-5 Hikarino-oka, Yokosuka-shi, 239-8536, Japan
Proceedings of 2001 Asia-Pacific Microwave Conference, Taipei, Taiwan, December 3-6, 2001, pp.1000-1003.

Abstract: Recent research and development activities on measurement technologies and countermeasures for establishing the electromagnetic compatibility (EMC) of mobile radio equipment with electronic devices and biological safety issues are introduced. EMC studies of medical devices are focused on, and SAR measurement technologies for mobile radios are discussed. Moreover, a cryogenic receiver front end using high temperature super-conducting filter for mobile base stations is proposed as a promising technology that allows the transmission power of mobile communication systems to be lowered, a desirable result with regard to EMC.
Index terms: EMC, mobile radio equipment, medical devices, SAR measurement, high temperature super-conducting filter.

EMCABS: 09-2-2002

A SIMPLE METHOD FOR PREDICTING COMMON-MODE RADIATION FROM A CABLE ATTACHED TO A CONDUCTING ENCLOSURE

Jianqing Wang+, Osamu Fujiwara+ and Kohji Sasabe++
+Nagoya Institute of Technology, Gokiso-cho, Showa-ku, Nagoya 466-8555, Japan
++Matsushita Electric Works, Ltd., 1048, Kadoma, Osaka 571-8686, Japan
Proceedings of 2001 Asia-Pacific Microwave Conference, Taipei, Taiwan, December 3-6, 2001, pp.1119-1122.

Abstract: Common-mode (CM) radiation from a cable attached to a conducting enclosure is typically a dipole-type antenna structure, in which an equivalent noise voltage source located at the connector excites the attached cable against the enclosure to produce radiated emissions. A simple method for predicting the CM radiation from the cable/enclosure structure was proposed in this paper. The method combines an equivalent dipole approximation with sinusoidal current distribution and CM current measurement at a specified location on the cable. The predicted resonance frequencies and CM radiation levels were validated with engineering accuracy, i.e., within 30 MHz and 6 dB, respectively, from the measured and FDTD-modeled results in the frequencies above 130 MHz.
Index terms: Conducting enclosure, attached cable, common-mode radiation, prediction, equivalent dipole approximation, FDTD calculation, measurement.

EMCABS: 10-2-2002

AN IMPROVEMENT OF FIELD UNIFORMITY OF REVERBERATION CHAMBER BY THE VARIANCE OF DIFFUSER VOLUME RATIO

Jong-Chel Yun, Joong-Geun Rhee, Ph. D. and Sam-Young Chung
Dept. of Electronic Eng. Hanyang University
Proceedings of 2001 Asia-Pacific Microwave Conference, Taipei, Taiwan, December 3-6, 2001, pp.1119-1122.

Abstract: A conventional reverberation chamber is a rectangular structure including mode-stirrers or mode-tuned stirrers to obtain the field uniformity inside the chamber. In this paper, we used Schroeder diffusers to obtain field uniformity of a rectangular reverberation chamber, and field uniformity characteristics were investigated with the condition of a diffuser volume ratio of 0.9, 1.35, and 1.8 % of the total rectangular empty volume. The Finite-Difference Time-Domain (FDTD) simulation method was used to analyze the field homogeneous characteristics of these reverberation chambers.
Index terms: Reverberation chamber, field uniformity, Schroeder diffusers, FDTD simulation.

EMCABS: 11-2-2002

COMPOSITE EFFECTS OF REFLECTIONS AND GROUND BOUNCE FOR SIGNAL VIAS IN MULTI-LAYER ENVIRONMENT

Sheng-Mou Lin and Ruey-Beei Wu
Dept. of Electrical Engineering and Graduate Institute of Communication Engineering, National Taiwan University, Taipei, Taiwan, 10617, R.O.C.
Proceedings of 2001 Asia-Pacific Microwave Conference, Taipei, Taiwan, December 3-6, 2001, pp.1127-1130.

Abstract: The signal propagating down the vias in a multi-layer environment will suffer from composite effects of reflected noise by via discontinuity and ground bounce between power/ground planes. An equivalent circuit modeling is proposed to simulate these effects, which consists of transmission line for signal line, lumped inductance and capacitance for via discontinuity, and two-dimensional fields solver for the region between power and ground planes. Simulations are performed for a four-layer structure and three different cases are considered to characterize both effects. Results show that the via discontinuity is dominant for reflected noise in the early time response, while the ground bounce is dominant in the late time response.
Index terms: Multi-layer environment, via, ground bounce, equivalent circuit modeling, simulation.

Still More Comments on the IEEE Fiscal State of Affairs

continued from page 47

reserves by approximately $4.1M in the beginning of the year) reported in June has been reduced to zero through additional cost savings at headquarters in core functions (infrastructure), continuing initiatives, staff compensation, travel expenses, and by recognizing only the most certain aspect of investment income, dividends and interest. Here is the significant sound bite: *No budgeted depletion of reserves for 2002.* Operating net has improved by nearly $22M over 2001, and it has taken an effort from every part of the Institute to achieve this goal.

Discussion

Financial focus has been intense during 2001, and processes are being implemented or studied which will make our volunteer organization fiscally stronger in the years to come. The details of OARC's blueprint for itemizing and distributing the costs of IEEE infrastructure are in place. The next step, reducing the costs, has already started. My email address is at the top of this column. I welcome your thoughts. **EMC**

EMCABS

continued from page 57

EMCABS: 12-2-2002

EMI INDUCED BY THE SIMULTANEOUS SWITCHING NOISE ON THE PARTITIONED DC PLANES
J. N. Hwang, J. J. Lin and Tzong-Lin Wu
EMC Laboratory, Department of Electrical Engineering, National Sun Yat-sen University, Kaohsiung 804, Taiwan
Proceedings of 2001 Asia-Pacific Microwave Conference, Taipei, Taiwan, December 3-6, 2001, pp.1135-1138.

Abstract: Based on the FDTD modeling approach, the bridging effect of the isolation moat on the EMI caused by simultaneous switching noise is investigated. We find that isolating the noise source by the slits (or moats) is effective to eliminate the EMI, but bridges connecting between two sides of the slits will significantly degrade the effect of EMI protection. The measured and modeled results of the EMI strength at 3m are compared and they are quite consistent.
Index terms: Switching noise, EMI, partitioned DC planes, isolation moat, FDTD modeling, measurement. **EMC**

All photos by Sabrina Sarto

The grooming of a future EMCABS contributor! Alessio Morucci is shown at three-and-a-half months. His mother is Maria Sabrina Sarto, a long-time member of the EMCABS committee. Alessio looks forward to reviewing papers for publication in the EMCABS column one day.

IEEE Press – Wiley Partnership

By Mark Montrose, EMCS Liaison to the IEEE Press and Press Authors

Last year, IEEE Press and Wiley entered into a partnership that now provides a wealth of benefits not only for IEEE members, but also for anyone wishing to purchase a technical book within any field of engineering. The reason for the partnership provides a financial benefit to both companies. IEEE, as an entity, has had financial problems as detailed in past *EMCS Newsletters*. The cost of book preparation (copy-edit, composition, typesetting), printing, warehousing, managing inventories and tax consequences were extensive. Technical books do not sell in large numbers, like books written by Stephen King. Therefore, the profit margin for technical publishers is not great. By off-loading this aspect of the publication arena, IEEE Press can focus on maintaining high-quality manuscripts while retaining the best authors within their particular field of specialty, thus benefiting the engineering community worldwide.

To briefly describe the partnership, the following is presented in bullet format.

Summary of operations: IEEE Press (Staff of five, one office)

- Seek new authors and topics.
- Solicit proposals and write contracts.
- Guide authors through the development and review process.
- Develop manuscripts along with peer review.
- Deliver finished manuscript to Wiley.
- Assist in marketing.
- Maintain no inventory or warehousing expenses.

Summary of operations: Wiley (Staff of thousands, offices world-wide)

- Produce, manufacture, market, sell and distribute titles exclusively.
- Administer author and series editor royalties.
- Contribute titles to be marketed through imprint.
- Maintain all the inventory and associated warehousing expenses.

Most of the books published by IEEE Press were transferred to Wiley last year. Those not chosen for adoption have been sold to other companies or removed from inventory. All new books, and those that go through another round of printing (to replenish inventories), will have both IEEE Press and Wiley logos imprinted on the front cover as well as on the inside, known as front cover page. IEEE Press retains the copyright for all Press authors.

Why Publish with IEEE Press/Wiley?

Authors come from all areas of the engineering profession: academic, research laboratory, production, the consultant's office, and managerial suites, to name a few. Some authors only publish technical papers or teach professional seminars or short courses. All are experts in their field and share a commitment to providing timely, practical, effective information to help readers solve work-related problems.

- *Visibility and Prestige.* IEEE Press and Wiley have published some of the greatest names in the profession, and are known for timely, authoritative, practical books.
- *Friendlier, Professional Folks!* The staff at IEEE Press and Wiley is able to provide personalized assistance, making the job of writing a book easy.
- *Higher Quality Books.* IEEE Press and Wiley are committed to publishing the best books in all fields of engineering, working with each author to determine what assistance they may offer during preparation of the manuscript and the production steps needed to turn an author's vision into reality.
- *IEEE Press/Wiley Sells Books!* As the largest professional society for electrical and computer engineers, this partnership offers unrivaled access to the engineering community internationally. They are an effective multi-channel promoter of books.

If one desires to be an author, or desires additional information, contact me at "m.montrose@ieee.org." **EMC**

Inter-Society Activities

By David A. Case NCE, RAC Chair

Representative Advisory Committee (RAC)

I still get an occasional question on what exactly is RAC and what does it do. RAC is the Representative Advisory Committee. This committee acts a liaison forum for non-IEEE groups that deal with or are concerned with EMC issues. It provides a link for these organizations to the Board of the IEEE EMC Society.

RAC has sponsored a special session at the last several EMC symposia. For example, during the last two years, RAC special sessions have dealt with wireless issues from certification to SAR and MPE issues. Last year's session was chaired in my absence by my Vice Chair, Steve Berger, and Bill Graff. RAC is currently investigating hosting a session at the next symposium.

Currently the RAC has 13 organizations as part of the group. A few of the groups that are RAC members are shown below:

AAES: The Association of Access Engineering Specialists. This organization was formed under the umbrella of NARTE to deal with the requirements of section 256 of the 1996 Telecommunications Act. This organization addresses the access issues of telecommunications for the disabled. Those interested in these issues can obtain more information from the NARTE website.

ACIL EMC: American Council of Independent Laboratories. The ACIL EMC group is made up of EMC Society members who belong to ACIL. The group deals with various EMC issues from the point of view of ACIL members. Information can be obtained from the ACIL web site at www.acil.org

NARTE: The National Association of Radio and Telecommunication Engineers, Inc. is a non-profit organization that specializes in certification. Currently NARTE certifies engineers and technicians in the fields of EMC, ESD Control, Telecommunications, and now Unlicensed Wireless Systems Installers. NARTE recently signed an MOU with the IEEE EMC Society and one with the American Radio Relay League (ARRL). Further information can be obtained from the NARTE web site at www.narte.org.

USCEL: The United States Council of EMC Labs is open to any test lab, manufacturer, or consultant interested in addressing worldwide EMC issues. Originally USCEL's mission was dealing with European Union (EU) issues only, but currently they write technical opinions addressing various EU issues and have addressed non-EU issues. For further information on USCEL, you can check the website www.uscel.org

TCB Council: The Telecommunication Certified Body (TCB) Council is the organization that addresses TCB issues and concerns. The organization has two levels of membership, TCB and Associate members. Full TCB membership is open to any designated TCB. The associate membership is open to any company or entity interested in the TCB program. The council sponsors several training sessions each year conducted by the FCC or the TCB trainers on such topics as spread spectrum testing, SAR testing, and overview of the FCC rules. As an associate member, you can participate in the TCB meetings that generally provide additional chances to meet with the FCC. For information on the council, you can access the web site at www.tcbc.org

RAC will be hosting next year's RAC /SAC luncheon at the 2002 IEEE International Symposium on EMC in Minneapolis. I look forward to seeing you there! **EMC**

Calendar

EMC Related Conferences & Symposia

2002

May 12-15
Sponsored by the IEEE Computer Society - Test Technology Technical Council and by the IEEE Components, Packaging and Manufacturing Technology Society
6th IEEE Workshop on Signal Propagation on Interconnects
Convention Center "Il Ciocco"
Castelvecchio (Pisa), Italy
http://www.tet.uni-hannover.de/SPI

May 21-24
Sponsored by the Chinese Institute of Electronics (CIE)
2002 International Symposium and Technical Exhibition on EMC
Beijing, China
Professor Liu, Dayong
Phone: +8610.68283463
Fax: +8610.68283458
E-mail: dyliu@public.bta.net.cn
http://www.cie-china.org/emc2002/

June 3-7
AMEREM 2002
(combined conferences for High Power Electromagnetics, Ultra-WideBand Short-Pulse Electromagnetics and Unexploded Ordnance Detection and Range Remediation)
US Naval Academy
Annapolis, MD
Terence Wieting, 202.767.2101
Terence.wieting@nrl.navy.mil
http://www.AMEREM.org

June 25-28
16th International Wroclaw Symposium and Exhibition on EMC
Wroclaw, Poland
Professor W. Moron
Phone: +4871-348-3051
Fax: +4971-372-8878
E-mail: emc@il.wroc.pl
http://www.emc.wroc.pl

September 9-13
Organized by the Associazione Elettrotecnica ed Elettronica Italiana, the University of Rome "La Sapienza", the University of L'Aquila, the University of Naples "Federico II"
EMC Europe 2002
Sorrento, Italy
Massimo Iandolo
Phone: +39.02.77790-218/230
Fax: +39.02.798817
E-mail: emceurope2002@aei.it

October 7-11
Technically Co-Sponsored by the IEEE EMC Society
2nd International Workshop on "Biological Effects of Electromagnetic Fields"
Rhodes, Greece
Ms. Kety Apostolou
Workshop Secretary
Conf2002@imm.demokritos.gr
http://imm.ariadne-t.gr/bioeffects
http://www.uoi.gr/conf_sem/bioeffects

November 3-8
AMTA 2002: 24th Annual Meeting and Symposium
Sponsored by the Antenna Measurement Techniques Association (AMTA)
Cleveland, OH
Sally Kronk, 614.888.2700 x218
Sally.kronk@lintek.aeroflex.com
http://www.amta.org

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

2002	Minneapolis/St. Paul Hyatt Regency, Minneapolis Dan Hoolihan 651.213.0966 E-Mail: d.hoolihan@ieee.org
2003	Tel-Aviv, Israel (International IEEE) Elya Joffe Fax: 972.9.765.7065 E-Mail: emc2003@ortra.co.il
2003	Boston, MA Sheraton Boston Jon Curtis 978.486.8880
2004	Santa Clara, CA Franz Gisin 408.495.3783
2005	Chicago, IL Tom Braxton 630.759.8674

IEEE EMC Society Board of Directors Meetings

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

May 31, 2002
Boston, Massachusetts

August 18 and 22, 2002
Minneapolis, Minnesota
(in conjunction with the IEEE EMC Symposium)

November 24, 2002
Sao Paulo, Brazil

IEEE EMC Chapter Colloquium and Exhibition "Table-Top Shows"

April 22, 2002
Southeastern Michigan Chapter, Automotive EMC
Contact: Kimball Williams, 248.354.2845
E-mail: k.williams@ieee.org
(See ad on page 24)

May 21, 2002
Chicago Chapter, 4th Annual Chicago EMC Mini-Symposium
Contact: Frank Krozel, 630.924.1600
(See ad on page 60)

COMING IN 2002!

The IEEE EMC Society Newsletter will include advertising beginning with the March 2002 issue. Impact this hard-to-reach audience in their own Society publication. For further information on product and recruitment advertising, call your local sales office.

IEEE EMC Society Newsletter Advertising Sales Offices
445 Hoes Lane, P. O. Box 1331 Piscataway NJ 08855-1331
www.ieee.org/organizations/pubs/magazines

Susan E. Schneiderman
Business Development Manager
732-562-3946; Fax: 732-981-1855
ss.ieeemedia@ieee.org

Product Advertising
Mid-Atlantic
Dawn Becker
732-772-0160; Fax: 732-772-0161
db.ieeemedia@ieee.org
NY, CT, NJ, PA, DE, MD, DC, KY, WV

New England/Eastern Canada
Jody Estabrook
978-244-0192; Fax: 978-244-0103
je.ieeemedia@ieee.org
ME, VT, NH, MA, RI. CANADA: Nova Scotia, Prince Edward Island, Newfoundland New Brunswick, Quebec

Southeast
William Bentz, Greg Maddock, Sarah Wiley
404-256-3800; Fax: 404-255-7942
bb.ieeemedia@ieee.org
gm.ieeemedia@ieee.org
sh.ieeemedia@ieee.org
VA, NC, SC, TN, AL, GA, MS, FL

Midwest/Central Canada
David Kovacs
847-705-6867; Fax:: 847-705-6878
dk.ieeemedia@ieeed.org
IL, IN, IA, KS, MI, MN, MS, NE, ND, SD ND,OH, WI. CANADA: Ontario, Manitoba

Southwest/Mountain States
Royce House
713-668-1007; Fax: 713-668-1176
rh.ieeemedia@ieee.org
AR, AZ, LA, TX, OK, NM, CO, UT

So. California/Nevada/Hawaii
Marshall Rubin
818-888-2407; Fax: 818-888-4907
mr.ieeemedia@ieee.org
NV, HI, CA 93400 & below

Northwest/Western Canada
John Gibbs, Lisa Downing
415-929-7619; Fax: 415-775-3776
jg.ieeemedia@ieee.org
AK, ID, MT, WY, OR, WA, CA 93401 & above. CANADA: British Columbia, Alberta, Saskatchewan

Europe/Africa/Middle East
Gerry Rhoades Brown
44 (0) 1932 564999; Fax: 44 (0) 1932 564998
grb.ieeemedia@ieee.org
Europe, Africa, Middle East

Far East/Pacific Rim
German Tajiri
81-42 501 9551; Fax: 81-42 501 9552
gt.ieeemedia@ieee.org
Asia, Far East, Pacific Rim, Australia, New Zealand

Marion Delaney
Advertising Sales Director
212-419-7766; Fax 212-419-7589
md.ieeemedia@ieee.org

Recruitment Advertising
Mid-Atlantic
Lisa Rinaldo
732-772-0160; Fax: 732-772-0161
ieeemediasales10@earthlink.net
NY, CT, NJ, PA, DE, MD, DC, KY, WV

New England/Eastern Canada
Barbara J. Lynch
401-738-6237; Fax: 401-739-7970
bl.ieeemedia@ieee.org
ME, VT, NH, MA, RI. CANADA: Nova Scotia, Prince Edward Island, Newfoundland, New Brunswick, Quebec

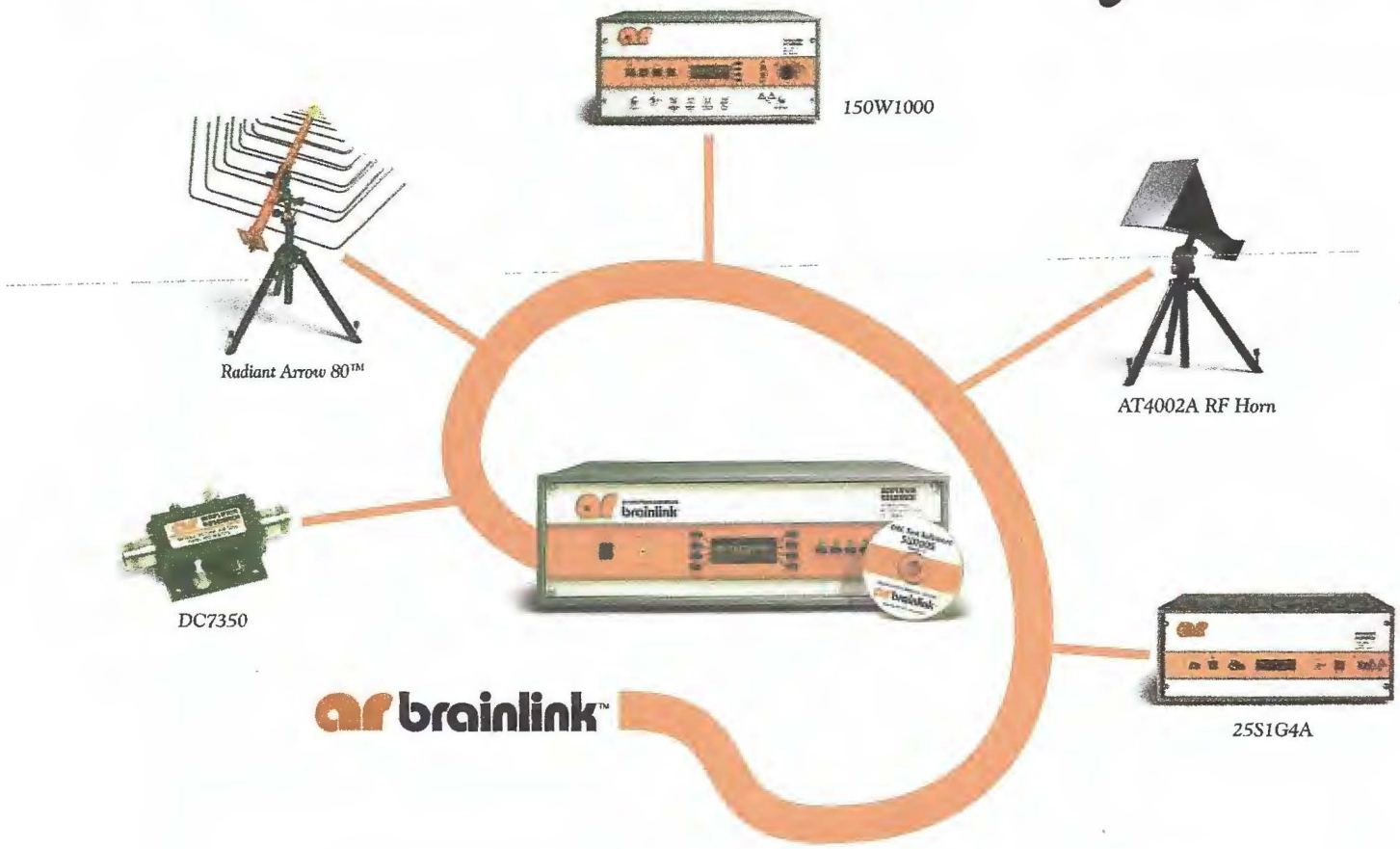
Southeast
William Bentz, Greg Maddock, Sarah Wiley
404-256-3800; Fax: 404-255-7942
bb.ieeemeida@ieee.org
gm.ieeemedia@ieee.org
sh.ieeemedia@ieee.org
VA. NC, SC, TN, AL, GA, MS, FL

Midwest/Central Canada/Texas
Tom Wilcoxen, Steven Loerch
847-498-4520; Fax: 847-498-5911
tw.ieeemedia@ieee.org; sl.ieeemedia@ieee.org
AR, LA, TX, OK, IL, IN, IA, KS, MI, MN, NE, SD, OH, WI. CANADA: Ontario, Manitoba

So. California/Southwest/Mountain States
Karin Altonaga
714-974-0555; Fax: 714-974-6853
ka.ieeemedia@ieee.org
AZ, CO, UT, NM, HI, NV, CA 93400 & below

Northwest/Western Canada
Mary Tonon
415-431-5333; Fax: 415-431-5335
mt.ieeemedia@ieee.org
AK, ID, MT, WY, OR, WA, CA 93401 & above. CANADA: British Columbia, Alberta Saskatchewan

It Takes A Brainlink To Build A Better System.



Now, AR can solve your most challenging test problems with a complete, fully integrated system. All the components work together, under the direction of our SC 1000 System Controller and our proprietary software. Together, they act as "The Brain," coordinating and supervising multiple RF test instruments.

The system arrives fully configured and ready to go, out of the box. You save time & money upfront. Lab tests are quicker & easier. Plus, you have one source to turn to for service and support. The one source that backs every component of every system with the "Mark of Performance" and the strongest guarantee in the industry. It doesn't take a superior brain to see the benefits behind an AR Brainlink™ system.

Find out more on the web at **www.amplifiers.com**

World Class Mark of Performance

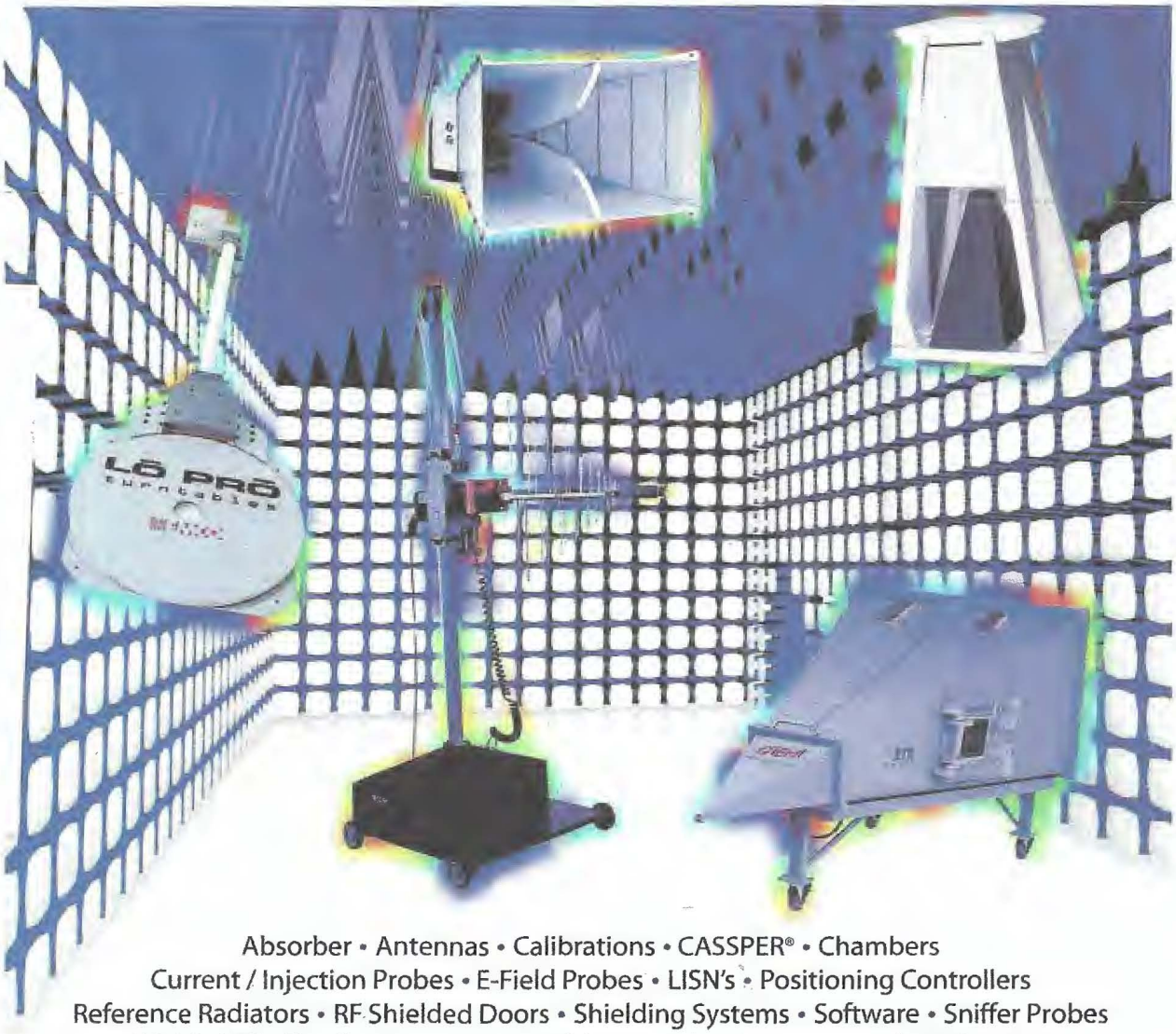
ISO 9001 Certified

ar® AMPLIFIER® RESEARCH

The Force Behind The Field.

USA 215-723-8181 or 800-933-8181 for an applications engineer.
In Europe, call EMV– Munich: 89-614-1710 • London: 01908-566556 • Paris: 1-64-61-63-29 • Amsterdam: 31-172-423-003

Total Solution, Single Source™



Absorber • Antennas • Calibrations • CASSPER® • Chambers
Current / Injection Probes • E-Field Probes • LISN's • Positioning Controllers
Reference Radiators • RF Shielded Doors • Shielding Systems • Software • Sniffer Probes
TEM & GTEM!™ Cells • Towers • Turntables • Turnkey Systems • and Much More!

Everything you need for EMC testing from one company!

www.ets-lindgren.com

ETS·LINDGREN™
An ESCO Technologies Company

USA +1.512.531.6400 UK + 44.(0)1438.730700 Finland +358.2.8383.300 Singapore +65.536.7078