Issue No. 190 Summer 2001 ISSN 1089-0785 Janet O'Neil, Editor

http://www.emcs.org

EMC

IEEE EMC Society Newsletter

INSIDE:

President's Message

Joe Butler – President, EMC Society

Well, I hope this issue of our Newsletter finds you happily reflecting upon your experiences at our annual IEEE EMC Society International Symposium in Montreal, Quebec, Canada. As I write this column for the summer issue, Chairman Benoît Nadeau and his committee have been working very hard to ensure its success.

During June, the EMCS Board of Directors sent a delegation consisting of Board members Jose Perini, Elya Joffe, and Mark Montrose to represent the EMC Society as well as help conduct a technical workshop entitled, "EMC Aspects in the Analysis and Design of Printed Circuit Boards (PCB's)" at the IV International Symposium on Electromagnetic Compatibility and Electromagnetic Energy in St. Petersburg, Russia. Professor D.V. Puzankov, Chairman of the Organizing Committee, graciously embraced this workshop as a part of the symposium.

In parallel with the St. Petersburg symposium, the EMCS Board of Directors met in Minneapolis, Minnesota, site of the 2002 IEEE International Symposium on EMC. As a part of the meeting agenda, we were able to tour the Minneapolis Convention Center to inspect the meeting rooms and exhibition hall. The venue looks excellent from both an exhibitor as well as attendee perspective; for example, several of the nearby hotels are connected to the convention center by an elevated, enclosed walkway.

In case you haven't noticed, the EMCS has become a member of the IEEE Sensors Council, IEEE Intelligent Transportation Systems Council, as well as the IEEE Nanotechnology Committee, which itself is moving toward IEEE Council status. For those of you not familiar with an IEEE Council, it is an organization formed by the merger of two or more Societies and whose membership consists of members of those Societies. The EMCS, having recognized the potential relationship to EMCS activities, supports these three councils via appointed liaison personnel. Andrew Podgorski supports the Sensors Council, Mark Montrose and Dan Hoolihan support Nanotechnology, and Andy Drozd supports Intelligent Trans-portation Systems.

I should note that we recently decided not to pursue elevating our Newsletter to magazine status. The reasons for this are several. The recent financial analysis performed by the IEEE Technical Activities Board Financial Committee endorsed, in our view, not only excessive editorial and advertising commission fees, but also required that we raise EMC Society dues to $25 per person starting in 2002. However, I think one of the more important factors that convinced us not to proceed was the fact that in the intervening time from when this movement toward a magazine began to present day, the Newsletter has been significantly upgraded to more or less look like a magazine. The clincher was the fact that we have concluded that we can sell advertising space in the Newsletter. We shall start this activity as soon as policies can be developed and approved. In the interim, we are beginning to sell space for corporate advertising on our web page as well.

While we recently did vote to raise Society dues from $15 to $20 (our first increase since 1997) for 2002, we did so in order to meet recently mandated IEEE financial surplus guidelines. The IEEE continues to try and sort out its budgeting process and in the near term has elected to mandate surplus levels by organizing unit. At the recent TAB meetings in New Brunswick, New Jersey, there was much discussion on financial matters with the general feeling that the IEEE is finally moving towards more responsible fiscal practices in terms of balanced budgets. There will be more to come on this.

After the Montreal Symposium, the EMCS Board of Directors moves on to San Diego, California where we will convene on Tuesday, November 13th. At this meeting we will formally install Todd Hubing as President of the EMC Society, thank outgoing BOD members and welcome the newly elected members. Peter Staecker, IEEE Division IV Director, will attend our meeting as well.

I look forward to seeing and hearing from you. Feel free to call me at 781-939-4267 or send an e-mail to me at j.e.butler@ieee.org. **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 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.

Letter from the Editor

Janet O'Neil – Editor, EMC Society Newsletter

Our last issue of the EMC Society Newsletter was a record breaking 48 pages. It featured considerable contributions to the Chapter Chatter column, three practical papers, coverage of the Zurich and Brugge EMC conferences, an update on the hearing aid/cellular telephone ANSI C63.19 standard, and comments on the IEEE fiscal state of affairs by Division IV Director Peter Staecker. And, of course, our regular feature articles were included as well. All this information generated several letters to the Newsletter from our readers. I'd like to share these letters with you as follows this column and I encourage more readers to communicate with the Newsletter staff. It is always good to hear from you! Note in this issue that Bob Olsen, Associate Editor for Practical Papers specifically requests feedback on the article by Ed Bronaugh which appears on page 20. Please help us gather further information on the history of the Quasi-Peak detector.

The "table-top" season reached its height the first week in June when three separate EMC chapters held one-day shows. Clayton Paul is shown with EMC Newsletter Editor Janet O'Neil at the San Diego show. Dr. Paul spoke at the Oregon and SW Washington chapter event on June 4 and at the San Diego chapter event on June 8.

In early June, I was fortunate to attend three events sponsored by regional EMC chapters, including Portland, Seattle and San Diego. These events are featured in the Chapter Chatter column starting on page 5. It was great to see the local chapter members out in force for interesting technical programs and exhibits on the latest in EMC related products and services. If your local chapter has not held one of these events yet, feel free to contact me. As the Society's Regional EMC Conference Coordinator, I would be happy to help you and your Chapter organize a one-day event with a technical program and tabletop show.

You may recall that the last issue of the Newsletter was significant in that it marked the final issue containing the Chapter Chatter column by Associate Editor Todd Hubing. (As a result of his column, among other things, one reader contacted me to see if I really had the power to appoint the President of the EMC Society!) We published a call for volunteers to replace Todd in the last issue. Frankly, this did not generate the stampede of volunteers I had expected. Apparently, Todd's skill as a writer was rather intimidating to many people. Our new Associate Editor for Chapter Chatter took a different approach. Rather than submit samples of his writing to rival Todd's, he qualified himself by simply stating that since he has the same name, it's a natural for a Todd to replace a Todd. (I should have known not to open an e-mail with the subject "My Name is Also Todd.") So, quite literally, there you have it! Our new Associate Editor for Chapter Chatter is Todd Robinson of CKC Laboratories, located on Clouds Rest in tiny Mariposa, California. I am sure that in his low-ambient environment he will contribute some quite funny articles in the future. And, I bet they will be submitted on time! (Sorry, Mr. Hubing!) **EMC**

Letters to the Newsletter

April 18, 2001
Dear Art:

I'm a retired EMC engineer but have always had a great interest in field-wire coupling and have also implemented A. Smith's formulas into a series of BASIC programs when I was at Boeing. At this time, I also verified these by use of MOM codes. If your program were available, I would very much enjoy examining it, as you appear to have gone further than I in providing a good user interface.

I am surprised that so few young engineers appear to be involved with writing their own programs for applications like these. There was always a great deal of satisfaction for me in creating standalone programs to solve things like field-wire, wire-field and cable-cable coupling problems and today the expectations seem to be considerably different. It was always my opinion that if you don't really understand the methods used by an analytical program, the results are likely to be misleading. Nowadays with the widespread use of composites, it's a lot more difficult to apply the old formulas with confidence. I'd be interested to hear how you approach these kinds of problems.

Best wishes,

Roger Modeen
Senior EMC Consultant,
Kistler Aerospace
modeen@qwest.net

Editor's Note: This letter was sent to Art Glazar, author of the practical paper titled "A Software Implementation of TL Field-to-Cable Coupling Equations" which appeared in the Fall 2000 Newsletter. Mr. Glazar offered the software to readers who contacted him at aglazar@ieee.org. This practical paper generated the most correspondence to date to the Newsletter. Readers from all over the world requested this software. In response to Mr. Modeen's letter, Mr. Glazar advised that he had forwarded a copy of the software to Al Smith and he was very pleased. In his reply to Mr. Modeen, Mr. Glazar speculated that perhaps today's engineers have ready access to programs like MATHCAD, so that analytical solutions are easier to obtain than by programming.

May 3, 2001
Todd,

I have kept the most recent EMC Newsletter open at my desk with the box on Signal Return visible. I adopted the idea when talking to people over here about "signal ground." I really believe that this kind of clear definition helps a lot when dealing with different problems. In our department we also deal with power issues and then we of course use the notation of return current. In addition, one of the things I still remember from the textbook on electromagnetism we used at University 35 years ago is (my translation): "Currents of any significant magnitude only occur in closed loops." Please also forward to those concerned that I enjoy reading the Newsletter.

Best regards,

Arne Wallers, Senior Specialist Physical Properties Division Multi Service Networks, Access Networks
Infrastructure and Product Approvals
Ericsson Telecom AB, Stockholm
Telephone: +46 8 719 6636, Sweden
Cellular: +46 70 519 6636
Email: Arne.Wallers@ericsson.com

Editor's Note: This letter was sent in response to Todd Hubing's Chapter Chatter column that appeared in the Winter 2001 issue. This column included the popular "Tom Van Doren Song" and a discussion on "Signal Ground vs. Signal Return."

June 29, 2001
Dear Editor:

Todd Hubing requested that I send the Chapter Chatter input to you until you appoint his successor. I have been dealing with the Central New England (CNE) Chapter input since the mid 70s. As you know, Charlie Anderson was the Chapter Chatter Editor until Todd replaced him about nine years ago.

Sincerely,

John Clarke
jclarke805@mediaone.net

Editor's Note: We wish to acknowledge and commend Mr. Clarke for his contributions to the Newsletter over the past two decades.

June 11, 2001
Dear Editor:

I found the article on the cover of the last Newsletter (Spring 2001) of particular interest, especially since I have been involved in EMI signal measurement for over 40 years. Frankly, I also found the article to be rather amusing, since solutions to the problems discussed have been resolved and published years ago. It sort of reminds me of the joke about the conversion from cycles to Hertz.

The so-called beyond 1 GHz problem has in fact existed from 30 MHz, but no one in the EMC community wants to admit it. Thus, my reference to the cycle/Hertz conversion. Although there is ample reference to measurement uncertainty, such uncertainty applies only to signals that have been detected and can thus be measured. The real problem is one of omission, not detecting signals. There is ample evidence of the existence of this problem but, as I said, it is being ignored. However, as frequencies increase above 1 GHz, the beam width of DUT radiated signals can and does become much narrower. This exacerbates the already existing problem, thus the sudden realization that the problem exists. Fortunately, my paper "A Theory to Optimize the Detection of EMI Signal Measurement" published in the November 1989 issue of the IEEE Transactions on EMC, addresses, as the title suggests, the problem of EMI signal detection. The paper shows, among other things, that the problem is frequency independent. Most importantly, it provides the basis for a solution to the error of omission. In brief, the paper concludes that in the general case where the probability of detection is unknown, the only available solution to increase the probability of detection is to take a large number of sweeps. This, by the way, is why the solution lies with the use of a spectrum analyzer using a max hold positive peak detector function. There is still a need to provide measurement procedures to a total solution. Such procedures could be frequency dependent, since as I have said the problem becomes more severe at higher frequencies. It may be of further interest that the above referenced theory has been incorporated in the EMI Commercial Measurement Program, EMICMP, which is currently available for Anritsu spectrum analyzers. These programs provide a method of increasing the probability of signal detection, a method to optimize the measurement of individual signals, and an option to include measurement uncertainty in the measured data.

Anyway, the one thing I did not find in the article was an address for the author, Mr. Windler. My intention is to provide him with the solution to most of these problems.

Roger Southwick
rasouthwick@zianet.com

Editor's Note: This letter from Mr. Southwick was sent to the Newsletter and also on to Mr. Windler once his e-mail address was provided. Mr. Windler subsequently provided the following reply.

July 9, 2001
Hi Roger,

Thanks very much for your input. The symposium presentations were not covering "new ground" per se and were not advertised as new. Our standards are in need of updating in this area. The purpose of the special session Mr. Heirman organized was to review the status of the standards changes being developed and the issues to be addressed. I am the chairperson of one such activity. ANSI Accredited Standards Committee C63, Subcommittee 1, Working Group 1-13.2 is drafting requirements for test sites making measurements above 1 GHz. We would welcome your joining our working group if you are interested. I will try to find the paper you referred to in the IEEE archives. If you can, send a copy for me to share with the ANSI Working Group at next week's meeting.

Thanks again for your input.

Michael J. Windler, PE
Underwriters Laboratories, Inc.
International EMC & NEBS Services
E-mail: Michael.J.Windler@us.ul.com

July 1, 2001
Dear Editor,

I wish to comment upon Peter Staecker's article in the Spring 2001 EMC Society Newsletter. I've been an IEEE member for over 30 years and a very active EMC Society member for over 15 years. I served on our EMC Society's Board of Directors for much of that time. I was Society Treasurer from 1986 until 1994. I participated in formal IEEE administrative/financial training for two consecutive years. I've never met Peter, though I recall voting for him. Today, just prior to writing this, I had a fairly lengthy discussion with him regarding his article. I believe, after this discussion with him, that we agree on much more than we disagree. But having said that, his article still very much upsets me. Why?

I think the key issue is best illustrated by the lead sentence in his concluding remarks: "First, deficit budgeting is part of a plan to increase the value of our products and services to members, while remaining competitive in the marketplace." This statement can be interpreted differently from what I believe he meant: Increasing value by artificially pricing it. IEEE corporate decides to grow by pricing some new, or enlarged product line at an artificially low (subsidized) price. One possible example: I have IEEE insurance. I'm very happy with it. But a question: Is my insurance priced such that the total cost to IEEE of running this program is covered? After all, is it fair to require members, who don't want insurance, to pay for infrastructure costs to support my getting cheap insurance? What about our recent experience with book publishing? Our "closing" of our book-publishing endeavor seems to indicate that IEEE seriously underestimated the cost of publishing. Another example: Several years ago, IEEE artificially lowered their production/printing costs. They admitted that they did this to encourage Societies to have IEEE produce their newsletter. The tax paying, private firm we had been using was not able to compete with this artificially low price. We switched to IEEE. Now our Society seems committed to IEEE, though there is some question as to whether IEEE is competitive. Yes, our Newsletter is better than ever, but I wonder if it is only due to the volunteer editor's hard work and improved technology. Some Newsletter issues have been late and errors have been made in production. I could give a couple more examples, but I hope my point is made.

IEEE employees are very good people. I work closely with a number of them. It is not the individual's performance that I address. As Parkinson so eloquently described some 50 years ago, people systems constantly seek to grow (at a predictable rate of about 5% annually, I recall). Restraining and/or channeling that "need to grow" is a management job. Our Institute is a very complicated organization of Regions and Societies with Chapters and Sections with an equally complicated governance process. This complexity tends to disenfranchise the true customers (the average IEEE members). Anything that dis-empowers or alienates customers usually fosters bad management.

Cordially,

Richard (Dick) Ford
EMC4D@aol.com

July 10, 2001
Dear Editor:

In reference to Peter Staecker's article "Comments on the IEEE Fiscal State of Affairs", I am left with serious apprehension that the IEEE will never recover financially while it's on the path he has described. Mr. Staecker failed to mention that the IEEE was intending to tax the EMC Society over $100,000 per year to cover their shortfall, and probably are taxing many other groups and Societies 12% of their net assets, in order to cover their deficit budget. This, of course, limits the benefits that the Society can provide to its members. What I would like to have read is that the IEEE is re-organizing, changing some of the old guard, and restructuring "our business" just like any company of similar size in industry would do. They should be frequently revisiting their budget for 2001 and making additional cuts as necessary. If a comparable private company had a corporate infrastructure deficit of about 30 million dollars and a net loss of about 11 million dollars, there would be major changes in personnel, structure and policy. Unless there are significant attitude and other changes made, I fear for the viability of the insurance and other benefits which makes membership in the IEEE so worthwhile.

Sincerely,

Robert D Goldblum
IEEE Life Fellow
rgoldblum@RBitem.com

EMC

Chapter Chatter

Todd Robinson, Associate Editor

"OK, So My Name is Also *Todd*"

"Never volunteer for anything" would come to mind when the sergeant was looking for volunteers. Then, I would remind myself that I wouldn't be standing there in the first place had I not volunteered. So, here I go again. I volunteered to walk in the footsteps of Todd Hubing, our new EMC Society President-elect. He's a very funny guy who has been writing Chapter Chatter for nine years! What literary skills do I have in common with Todd Hubing, "the Will Rogers of EMC?" Well, my name is also Todd. Chief thought it was a good angle, so I volunteered.

My marching orders from j.n.oneil@ieee.org read, "Your first article is due in two weeks." The glory of my new position as Associate Editor faded quickly. I had to find something interesting to write about . . . fast. Something that, while not as funny as the last associate editor's poems, songs and plays, will at least keep a handful of readers amused and interested. Then, an idea came to me. Real stories. Reality entertainment is very popular these days. I won't have to make up any rhymes or sonnets!

The EMC business has a host of amusing, but true stories (past and present). Did you hear about the guys who worked on their tans by moving the EMC lab to the beach? What about the RF susceptible Porsche that couldn't seem to pass the Ham equipped Volvo? Or how about a shielded room barber shop? Have you heard about the fateful triangle between the (Ham operating) engineering student, the motorcycle policeman and the attractive, young lady? With the permission of the innocent (and sometimes guilty), I can share as many of these funny (but true) stories as "Chief" permits. Tune in for funny, nonfiction EMC stories in future issues of this Newsletter.

Austria

On May 22, a meeting was held at the Technical University of Graz, Styria. It was the second time that an Austria Chapter meeting took place in Graz. The presentation was about EMC On-Chip. Bernd Deutschmann of Austria Mikro Systeme International AG was the presenter. The presentation was followed by a very interesting discussion and by a nice social event. For information on upcoming meetings, please visit the Austria Chapter's website at http://ewh.ieee.org/r8/austria/Chapters/EMC/home.html

Central New England

John M. Clarke, Chair of the Central New England Chapter (CNEC) reports that they had their 5th and final meeting for the program year 2000/2001 on Wednesday, April 11. The speaker was H. Stephen Berger of TEM Consulting (email: sberger822@aol.com/phone (512) 657-6147) who spoke on the topic: "Interoperability and Band Crowding (Bluetooth IEEE 802.11) and Home RF: How do They Play Together?" The speaker noted that the popularity and effectiveness of wireless connectivity for voice and data communication is well established. Heavy demands are being made of a relatively limited spectrum space. Increasingly sophisticated equipment with growing bandwidth demands has resulted in concerns about band crowding and the interoperability of these diverse systems. The speaker discussed interoperability and band crowding issues that are the subject of two IEEE studies currently being conducted. IEEE 802.15.2 is a task group charged with investigating the interoperability issues between IEEE 802.11 and Bluetooth compliant products. The IEEE EMC Society Standards Development Committee and Spectrum Management Committee are monitoring the more general question of band crowding and what remedies may be available. The speaker reviewed the current findings of these studies, and the remedies being investigated. Mr. Berger is the current Chair of the IEEE EMC Standards Development Committee, President of AAES, and 1st Vice President of NARTE. He can be contacted for further information on this subject. The CNEC (Boston Section) Chapter Officers for 2001/2002 were previously nominated and elected at the April meeting, including Chairperson and Secretary: John Clarke, Co-Chair: John Luchini, and Vice-Chair: Boris Shusterman. The Chair may be contacted at phone (508) 362-7195 or e-mail: jclarke805@mediaone.net.

Chicago

Frank Krozel reports that the Year 2001 has been an active one for the Chicago Chapter. In January, Lucent hosted the meeting which included a technical presentation by Bob Hofmann of Lucent. Bob introduced the measurement uncertainty topic and explained how it is currently impacting EMC measurements. In February, Elite Electronic Engineering hosted the meeting at their lab. Ray Klouda presented the correlation process that is in place for the EMC Automotive Program (AEMCLAP) and their experiences with achieving correlation. In March, the meeting featured a presentation by Mike Hart of Quantum Change which he entitled "You Can't Always Blame the Software." Mike candidly discussed the ups and downs of automating EMC testing. He explained how automation requires patience and perseverance. In April, Mike Windler of UL presented "Measuring Antennas above 1 GHz." The

Photo by Ray Klouda

Tom Braxton (left) and Craig Dinsmore of Lucent attended the Chicago EMC Chapter "mini-symposium" on May 22.

Photo by Ray Klouda

Jason Lauer, Brian Mattson, Dianne Janega, and Mark Haynes (left to right) made for a strong showing from DLS Electronics at the Chicago Chapter event.

Photo by Ray Klouda

Gordon Ramsey of EMSCAN Corporation was a speaker at the Chicago Chapter mini-symposium and received a certificate for his efforts.

Photo by Ray Klouda

Jack Black of ZeCal is shown at left with Roger Swanberg of DLS Electronics. Roger was a speaker and received a certificate in recognition of his efforts.

Photo by Ray Klouda

Jack Black of ZeCal is shown at left with Rick Moritz of Systems Sensor just after Rick won one of the many prizes awarded by the Chicago Chapter in the exhibit area.

meeting was held at the UL facilities in Northbrook. He presented the latest work in the area of OATS evaluation and site attenuation measurements at frequencies above 1 GHz. In May, the chapter held its 3rd Annual Mini-Symposium at the Holiday Inn in Itasca. Over 100 people were in attendance and there were more than 20 vendor displays. We were very fortunate to have Doug Smith as the main presenter at the symposium. Other presenters included Tom Braxton of Lucent Technologies, Tom Moyer from Amplifier Research, Gordon Ramsey from EMSCAN, Claude Cesard from Schaffner, Craig Fanning from Elite Electronic Engineering, and Roger Swanberg of D.L.S. Electronics. At the awards banquet held in conjunction with the mini-symposium, presenters were given a certificate of appreciation for their contributions. This year's winners of our mystery game drawings were presented gift certificates as prizes. Members are encouraged to check our new website to keep up with the latest events planned for the chapter. The website is www.ewh.ieee.org/soc/emcs/chicago/.

Photo by Ray Klouda

Ida and Frank Krozel of Electronic Instrument Associates Central are shown relaxing during lunch. Frank was the principal organizer of the Chicago Chapter's mini-symposium and was lucky to have one moment to sit down during the busy day! Jim Blaha of LS Compliance is shown at right clapping in approval of Frank's efforts.

Israel

Moshe Netzer, newly elected Israel IEEE EMC Chapter Chairman, reports that a seminar was held on June 27 at a lovely place called Herzelya Pitoach which is North to Tel Aviv on the Mediterranean seashore. The instructor was Mr. Mark Montrose who is a past IEEE Distinguished Lecturer. He really did a very good job. Mark presented the topic "Signal Integrity and EMC Considerations in PCB Design" from 9:00 till 17:00 and there wasn't one dull moment. Many of the attendees evaluated Mark's seminar as informative and practical. The seminar was organized by both ILTAM (Israeli User's Association) and the Israel EMC Chapter. Although admission was not free, there were 170 attendees; among them 68 were IEEE members.

Photo by Ray Klouda

Ray Klouda of Elite Electronic Engineering and Andrea Spellman of Underwriters Laboratories Inc. in Northbrook, Illinois represented two exhibitors that supported the Chicago Chapter event. Ray is also the Chicago Chapter Secretary.

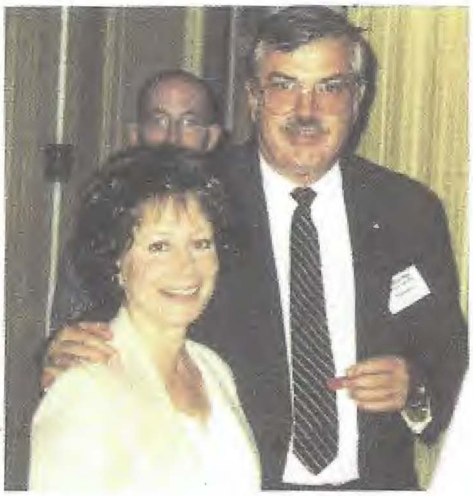


Photo by David Britton

Carol and Clayton Paul enjoyed their first ever visit to Portland. Clayton was the keynote speaker at the Chapter's one-day EMC event and spent the weekend exploring the city with his wife.

Mohawk Valley

The Mohawk Valley Section Joint EMC/Reliability Chapter officers held several meetings this past Spring to develop and implement plans to further revitalize the Chapter's activities and membership roster. Irina Kasperovich of ANDRO Computational Solutions in Rome, New York took over the helm as new Chapter Chair at the beginning of the year succeeding Andy Drozd who was chair for nearly three years prior to that. Under Irina's guidance, the Chapter's plans include: promoting membership development and involvement in Chapter activities targeting student members at local universities in Upstate, New York; periodically out-

Dave Britton of Hewlett Packard enjoyed the lunch buffet at the historic Governor Hotel in downtown Portland. Dave is the Oregon and SW Washington Chapter's Membership Chair and he also handled the program for the June 4 EMC event.

reaching to Section and Chapter members polling them on their topics of interest; and making additional use of the EMC Distinguished Lecturer (DL) Program. Andy Drozd, EMCS VP for Member Services, is working closely with the Chapter officers to accomplish these goals. The Chapter has already scheduled a DL talk in the Fall (guest speaker is Doug Smith) and another during November by Andy Drozd. Andy will talk on the topic of computer modeling and simulation for EMC based upon his recent work published in the IEEE Press textbook "Electrical Engineering Compatibility: Principles, Measurements, Technologies, and Computer Models" by Prasad V. Kodali.

Nanjing

Professor Jun-Fa Mao was the presiding officer of the Najing Chapter's meeting on June 11. The speaker was Professor Cam Nguyen of Texas A&M University who spoke on the topic "Some Recent Developments of Microwave and Millimeter-Wave Integrated Circuits and Systems for Sensing, Imaging, and Communication." 36 people attended this meeting. Najing Chapter Chair Professor Wen Xun Zhang presided over the June 18 meeting where speaker Professor Cam Nguyen repeated his previous presentation. Some 45 people attended this meeting. On June 22, Nai-Heng Yang presided at a chapter meeting featuring speaker Jia-Heng Qiu and

Photo by David Britton

Oregon and SW Washington Chapter Chairman Henry Benitez of Hewlett Packard took a break from the action during the Chapter's Colloquium and Exhibition on June 4. Elisabeth Satzger of Rohde & Schwarz kept him good company.

Bing-Fa He of the Nanjing Research Institute of Electronic Technology. This was a workshop on "Space-Fed Multibeam Phased Array Antenna" attended by 43 people.

Oregon and SW Washington

The Chapter concluded its technical program for the 2000/2001 year with an all-star event on Monday, June 4 at the Governor Hotel in downtown Portland. Some 100 people attended the technical presentations or exhibited with a tabletop display. The title of the event was "EMC 2001: Product Design and Compliance." Speakers included Clayton R. Paul of Mercer University in Georgia for the morning session on "The Fundamentals of EMC." In the afternoon, there were parallel sessions; one was devoted to several EMC topics such as "Design for Signal Integrity" by Scott McMorrow of Siqual and the other was devoted to Product Safety, also with several topics such as "Overview of the US System of Codes and Standards" by Jim Pierce of ETL SEMKO. The event organizers included Henry Benitez of Hewlett Packard who is also the Chapter Chairman, Charles Tohlen of Tektronix, Ali Elmi of Xerox, David Britton of Hewlett Packard, Ed Blakenship of Hewlett Packard, Janet O'Neil of ETS-Lindgren, and Dan Arnold of Underwriters Laboratories. Chapter members and friends who attended appreciated the nice venue for the displays and technical presenta-

Photo by Janet O'Neil

Crab season officially opened in the Pacific Northwest in early June as was evident by this visitor on top of the Governor Hotel in downtown Portland, site of the Oregon and SW Washington Chapter's colloquium and exhibition on Product Design and Compliance.

Photo by Janet O'Neil

Roxanne and Bob Dockey (he's with Hewlett Packard) enjoyed the "pre-party" on June 3 before the Oregon and SW Washington Chapter's one-day EMC event.

Photo by Janet O'Neil

Carol and Clayton Paul also visited with the Oregon and SW Washington Chapter officers, members and event organizers at the "pre-party" dinner. Dr. Paul was a speaker at the colloquium on June 4.

Photo by Janet O'Neil

Taking a break during the technical sessions at the June 4 EMC event were (from left) Gary Town, Sidney Chan, and Curry Moore of Hewlett Packard in Vancouver, Washington.

tions, the fine program presented, and the up to date information offered by the exhibitors of EMC related products and services.

Phoenix

Harry Gaul reports that the Phoenix chapter held their last meeting on May 15th with past IEEE EMC Society Distinguished Lecturer, Scott Roleson, from Hewlett Packard in Rancho Bernardo, California. The topic of Scott's talk was "EMC Bench Top Troubleshooting" which covered several proven techniques for locating emissions problems using "sniffer" probes, current probes, and directional couplers. In this talk, we learned that it is easier to locate emissions sources by using shielded magnetic field probes instead of electric field probes. The sources of magnetic fields include PC board loops, shield imperfections, and inductive components. Scott demonstrated an innovative technique using a sniffer probe, directional coupler, and a spectrum analyzer with a tracking generator. In essence, one searches in frequency to see where the power reflected from an enclosure's cavity is a minimum. This frequency corresponds to where the cavity is resonant and hence could be a problem if any clocks or data rates exist at the resonant frequency. Scott summarized his talk by saying, "Don't search for fixes but rather seek understanding." Bench top testing should be used to understand the physics of what's happening in the product. Then the design can be modified to address the phenomenon that's creating the emissions. Check out the Phoenix web site at

Photo by Janet O'Neil

The busy registration desk was ably manned by Ann and Charlie Tohlen (he's with Textronix), Ed Blankenship of Hewlett Packard and Dan Arnold of Underwriters Laboratories (from left to right). Dan was later nominated by the chapter to receive their first ever "Ironman" award for his tremendous efforts with the one-day event.

Photo by Janet O'Neil

Vendors supporting the Oregon and SW Washington Chapter's exhibition on June 4 included Rohde & Schwarz. Manning their booth is Achim Gerstner of R&S (center) with visitors Robert Hughes (left) and Wilson Cui of Intel.

Photo by Steve Gerard

Scott Roleson of Hewlett Packard displays a small H-field "sniffer" probe used for finding sources of radiated emissions.

At the May meeting of the Rocky Mountain Chapter, Dr. Eric Bogatin, Chief Technical Officer of Giga Test Labs, presented "Practical Analysis of Lossy Transmission Lines" to 37 chapter members and guests.

http://www.ewh.ieee.org/r6/phoenix/phoenixemc/ for the latest schedule on upcoming meetings.

Rocky Mountain Chapter

For the May meeting, Dr. Eric Bogatin, Chief Technical Officer of Giga Test Labs, presented "Practical Analysis of Lossy Transmission Lines" to thirty-seven chapter members and guests, including a dozen first-timers. In this talk, Eric "took the lid off" the mysteries of transmitting high frequency signals across back planes. The basic problem is that transmission lines begin to attenuate signals at high frequency, some more than others. In this lecture we looked at what design and material factors influence the signal losses and how to measure, model and simulate these effects. Eric started the talk with the obvious question - Why worry about lossy lines? The answer is that losses in the transmission line attenuate the signal resulting in collapse of the "eye diagram." After showing the frequency effects in the time domain, a frightening detail was presented - for high frequency signalling, 1ns rise time becomes a show-stopper. Eric then presented the physics behind the losses in a transmission line, both DC and AC, as well as some practical approximations for modelling the effects of the conductance and the resistance. The next part of the talk addressed the impact on signal integrity from the losses. Using clear and simple charts, Eric demonstrated how the amplitude of a clock is affected by varying dissipation factors and then postulated the obvious question - How does one measure the dissipation factor? In the last segment, Eric discussed how dissipation factors may be measured utilizing specialized equipment. Eric also discussed some surprising results of measurements of transmission lines including vias. In conclusion, the largest limiting factor of transmitting high frequency signals is the attenuation in the laminate. Accurate determination of the dissipation factor is vital for proper simulation of the effects. The slides for this presentation have been posted on the Giga Test Labs web site http://www.gigatest.com/. The Rocky Mountain Chapter will host a Regional Symposium and Table-Top Show on October 3. The event will feature multiple technical tracks including a Tutorial with Dr. Clayton Paul and workshops including Dr. Eric Bogatin, Doug Smith, and Bill Ritenour, in addition to the technical papers and exhibits. More information on the Symposium and other Rocky Mountain Chapter programs is available at http:// www. ieee.org/rmcemc/.

After the May meeting, speaker Dr. Eric Bogatin pauses with the Rocky Mountain Chapter officers Bob Reinhart, Lyle Luttrell, and Chas Grasso (left to right).

San Diego

The San Diego Chapter held a very successful one-day colloquium and exhibition titled "The Fundamentals of EMC" on Friday, June 8 at the Hilton San Diego/Del Mar. Even though the hotel was located just across the wide boulevard from the legendary Del Mar Racetrack, all the attendees stayed from the start to the finish of the great presentation by Clayton R. Paul, also a legend in the EMC community for his expertise. Some 100 people attended the event, chaired by Dave Bernardin of TUV Product Service. Paul Rostek of NCR Corporation ably handled the registration. San Diego EMC Chapter Chairman, Mark Frankfurth of Cymer was also on hand to lend his support. Dr. Paul spoke about EMC requirements for electronic systems, non-ideal behavior of components, signal spectra, crosstalk, shielding, radiated and conducted emissions and susceptibility and lastly, system design for EMC during his one-day presentation. He kept the topics lively and humorous with his quotes from Dave Barry and recollections about his

Photo by Janet O'Neil

Tabletop exhibitors Robert Tozier of CKC Labs (left) and Rob Hoffman of EMC Automation participated in the San Diego Chapter's EMC event on June 8.

Photo by Janet O'Neil

After a long day staffing his tabletop display, exhibitor Thomas Mullineaux of Ophir RF enjoys the cheese platter during the reception in San Diego.

Photo by Janet O'Neil

Abby Alejos of Parker Chomerics, Eugene Matarrese of Viasat, Henry Osgood of Haefely Test, and Paul Rostek of NCR (left to right) enjoyed the hazy sunshine of San Diego during a break in Clayton Paul's presentation.

Photo by Janet O'Neil

San Diego EMC Chapter Chairman Mark Frankfurth of Cymer (left) and Jim Knighten of NCR celebrate during the reception which concluded the San Diego Chapter's colloquium and exhibition. During the reception, Jim won the Palm Pilot raffle prize that was donated by ETS-Lindgren.

Photo by Janet O'Neil

Wendy May of Eclipse Shielding was an enthusiastic exhibitor at the tabletop show organized by the San Diego EMC Chapter.

early days in EMC. 18 exhibitors of EMC related products and services occupied the 20 tabletop spaces available, including three new tabletop show participants, Ophir RF and WEMS Electronics, both from the greater Los Angeles area, and Eclipse Shielding of Mission Viejo, California. At the reception following the technical presentation, many attendees lined up to have Dr. Paul personally sign his book "Introduction to Electromagnetic Compatibility" which was available for purchase on the event registration form. It was a great event according to Dr. Paul's wife Carol who especially enjoyed the authentic Mexican food served the night before. Carol advised that the Mexican food in Macon, Georgia (where she and Dr. Paul live) is no match to that offered in San Diego. Olé!

Photo by Janet O'Neil

That's the legendary Del Mar Racetrack in the background of this lunch gathering of Greg Viviano of Cymer (left) with Rhonda Saxson and Chip Fleury of TUV Product Service in San Diego. As EMC Lab manager, Chip closed the lab for the day and sent all his EMC engineers and technicians to the Clayton Paul tutorial entitled "The Fundamentals of EMC." Now that's supporting the chapter!

Photo by Janet O'Neil

Brian and Dave Bernardin visited with Bill Denke of Aurora Biosciences (left to right) over lunch during the San Diego Chapter's one-day tutorial and exhibition with Clayton R. Paul. Dave Bernardin chaired the one-day EMC event. Brian Bernardin had just graduated from Annapolis Naval Academy and took in the tutorial at his Dad's suggestion.

Photo by Janet O'Neil

The Seattle EMC Chapter organized a "table-top show" with exhibitors of EMC related products and services on the final day of the Users Meeting. Kent Madsen of Flextronics did "double duty" as he presented a paper titled "Reverberation Chambers for Mobile Phone Antenna Tests" and he staffed his company's tabletop display.

Photo by Janet O'Neil

A gala dinner was held the night before the tabletop show. Enjoying the fresh salmon offered were, from left, Heinrich Kunz of Schaffner EMC, Diethard Moehr of Siemens AG and Dan Hoolihan of Hoolihan EMC Consulting.

Photo by Janet O'Neil

Kevin Goldsmith of Defense Science and Technology, Air Operations Division, in South Australia is shown at left with Galen Koepke of NIST in Boulder, Colorado. Both men are well known for their expertise in and enthusiasm for reverberation chamber test methodology.

Photo by Janet O'Neil

Supporting the tabletop show were exhibitors (left to right) Casey Sullivan of Cascade Sales, Chris Toy of Laird Technologies, and Mack Davis of ETronic.

Photo by Janet O'Neil

The organizing committee of the 2001 Reverberation Chamber, Anechoic Chamber and OATS Users Meeting included, from left, Mike Hatfield of the Navy in Dahlgren, Heidi Scheuer of Underwriters Laboratories, Grant Erickson of Boeing Phantom Works EME, and Janet O'Neil of ETS-Lindgren.

Seattle

The Seattle Chapter April meeting featured speaker Dave Walen of the FAA. Over 30 chapter members enjoyed the presentation. The Chapter's Vice-Chairman, Pat Andre, gave a very humorous introduction of the speaker. Something about noting Mr. Walen's involvement in the various SAE, HIRF, EMC, CISPR, etc. committees and launching into an "EIEIO" song. (It must have been a long day for Pat, ha!) Nevertheless, the topic "Assessment of Recent Aircraft Lightning-Related Accidents" was presented by a very professional speaker with five years experience at the FAA plus 19 years experience at the Boeing Company. Mr. Walen discussed the weather conditions at the time of the accidents, the aircraft damage resulting from the lightning strikes, and the consequences to the aircraft, crew and passengers. He provided details on the aircraft design features that were affected by the lightning strikes and the changes that are required to prevent similar lightning strikes from causing future accidents. It was a riveting presentation, plus it was great to have local EMC talent present at the chapter meeting. Thanks are due to AT&T Wireless in Redmond for their generosity in providing pizza and soft

Photo by Janet O'Neil

The gala dinner provided a good opportunity for Users Meeting attendees, from left, Sandra Koppen and Theresa Salud of Lockheed Martin to visit with Diane Kempf of the Naval Air Warfare Center. Diane has attended all but one Users Meeting since the first one held in 1991.

Photo by Janet O'Neil

Chris Kendall of CKC Labs in Mariposa, California (left) made a surprise appearance during the Seattle Chapter's tabletop show. He visited with Fred Heather of the Navy at Patuxent River.

Photo by Janet O'Neil

A "Farewell Reception" was held in the tabletop show area. Mark Lamp of Sundstrand Aerospace enjoyed the elaborate buffet.

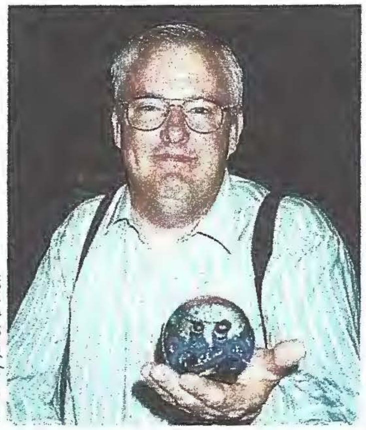


Photo by Janet O'Neil

Matt Wills of Cessna Aircraft displays the gift he received as winner of the Best Paper presented during the 2001 Reverberation Chamber, Anechoic Chamber and OATS Users Meeting. His paper was titled "A Different Antenna for the Mode-Stirred Chamber." The paperweight he received depicted an ocean scene that was hand crafted by a local Seattle artist.

Photo by Janet O'Neil

Amplifier Research was one of the exhibitor sponsors of the "Farewell Reception." They gave out "AR" hats during the reception to those who visited their booth. Shown from left are George Barth and Ken Shepherd of Amplifier Research with John Drapala and Rob Steinle of Boeing EMC Labs.

Photo by Stephen Stimac

Peter Shin of Ansoft was the speaker at the May joint meeting of the Seattle EMC and MTT/AP/EDS Chapters. He was thanked after the meeting by the respective Chapter Chairs, Tom Raschko (center) of Sea-Port Technical Sales who Chairs the MTT/AP/EDS Chapter and Janet O'Neil, Seattle EMC Chapter Chair.

Photo by Janet O'Neil

Relaxing towards the end of the three day Users Meeting in Seattle are, from left, Maurizio Migliaccio with the Universita di Cagliari in Italy, Heidi Scheuer of Underwriters Laboratories, John Ladbury of NIST, Ted Lehman of SARA, Inc. and Paolo Corona of the Naval University of Naples, Italy.

Photo by Janet O'Neil

The Southeastern Michigan Chapter sponsored a one-day EMC Fest 2001 on April 23. Attending the event were, from left, Scott Lytle of Yazaki North America, Richard Deppisch of NASA-Glenn Research Center and Noel Sargent of Analex. Yazaki sent a dozen engineers and technicians to the event. Now that's supporting the chapter!

Photo by Janet O'Neil

Kimball Williams of Eaton chaired EMC Fest 2001. His is shown at right with Igor Belokour of Visteon who won a raffle drawing.

Photo by Janet O'Neil

EMC Fest 2001 speaker Lee Hill managed a smile during pack-up time following the technical presentations. Lee conducted several real-time demonstrations of the material he presented which was appreciated by the attendees.

Photo by Janet O'Neil

IITRI supported the EMC Fest 2001 event by sending Seth Shapiro (left) and Rohit Vohra to man their tabletop display.

Photo by Janet O'Neil

There was a "tabletop" show during EMC Fest 2001 where exhibitors Sheryl and Jordy Bradley of J. Bradley Sales represented Fair-Rite products.

drinks for the April meeting. On May 17, the Seattle Chapter held a joint meeting with the IEEE MTT, EDS and AP Chapters. The speaker was Peter Shin of Ansoft who spoke on the topic: "Electrical Modeling of High Speed, High Density Packages." Thanks are due to the joint MTT, EDS and AP Chapter Chair, Tom Raschko of Sea-Port Technical Sales, who organized the meeting and whose chapter treated for the gourmet pizza. On Friday night May 18, several chapter officers and their spouses attended the IEEE Seattle Section Spring Banquet that was held at the Chateau Ste. Michelle Winery in Woodinville. It was a great banquet as always. An award was presented to Janet O'Neil for her efforts as Chair of the Seattle Chapter. Finally, on June 6, the Seattle Chapter organized an EMC "tabletop" show which was held at the Bellevue Hyatt in conjunction with the 2001 Reverberation Chamber, Anechoic Chamber and OATS Users Meeting. Over 20 exhibitors of EMC related products and services were on hand to educate the meeting attendees, some of whom travelled from as far as Australia and Sweden to attend the Meeting. Several chapter members joined the close to 70 meeting attendees during the "Farewell Reception" held in the tabletop area. This marked the close of the three-day

Those making EMC Fest 2001 happen included (front row left to right) speakers Lee Hill of Silent Solutions and Jim Muccioli of Jastech EMC Consulting, and event organizers (back row left to right) Janet O'Neil of ETS-Lindgren, Kimball Williams of Eaton, Scott Lytle of Yazaki North America, and Graeme Rogerson of Defiance. Not pictured is Mark Steffka of General Motors who helped with publications for the event.

meeting and the presentation of the "Best Paper Award." Everyone enjoyed the international cheese, jumbo shrimp cocktail, and fajitas buffet which was sponsored by Rohde& Schwarz, ETS-Lindgren, Schaffner EMC and Amplifier Research.

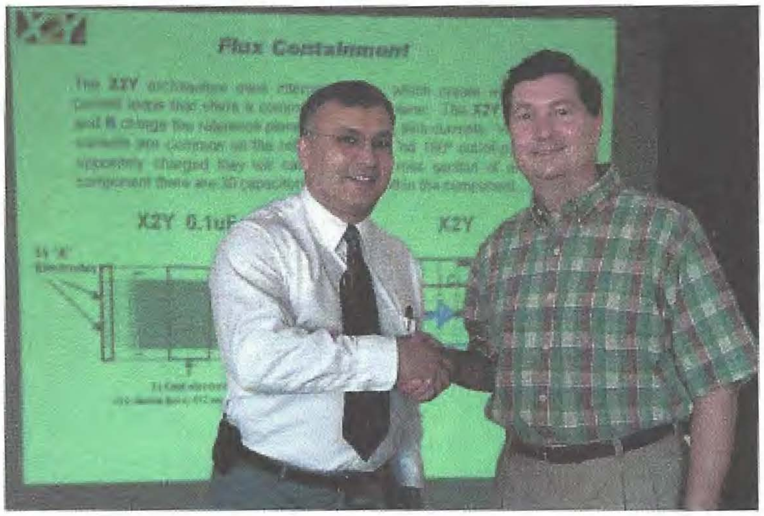


Photo by Dick Ford

Jim Muccioli of X2Y Attenuators was the speaker at the June meeting of the Twin Cities EMC Chapter. He is shown at left with the Twin Cities Chapter Chair Curt Sponberg of Medtronic.

Singapore

See Kye Yak reports that the Singapore EMC Chapter was officially formed in April 2001. The following members were nominated and successfully voted into office: Chairman: Professor See Kye Yak, Deputy Chairman: Dr. Li Er Ping, Secretary: Mr. Timothy Foo, and Treasurer: Mr. Sampath K.V.K. Chapter members include Professor Yeo Tat Soon, Mr. Tan Joo Huat, Dr. Roger Tay, Mr. Chow Wee Sin and Dr. Sam Chan.

Southeastern Michigan

Kimball Williams of Eaton chaired a super one-day event for the chapter which took place on Monday, April 23 at the Dearborn Inn in Dearborn, Michigan. The title of the event was "EMC Fest 2001: A Colloquium and Exhibition on Practical Control of Inductance and EMI in PCBs, Cables, Connectors and Motors." The speakers included the energetic Lee Hill of Silent Solutions of Amherst, New Hampshire, who spoke on the topics "Fundamentals of PCB Inductance" and "Designing for Minimum Inductance in PCBs" and the enthusiastic Jim Muccioli of Jastech EMC Consulting who presented "Fundamentals of Filtering" and "Real World Applications of Filtering." Some 20 exhibitors of EMC related products and services participated with tabletop displays in a ballroom which adjoined the technical presentation room. The exhibitors appreciated getting to know the approximately 80 registrants, many of whom are largely SAE members and thus do not attend the IEEE's annual EMC Symposium. Henry Ford built the Dearborn Inn in 1931 to use as his personal hotel for visitors who flew into his nearby private airport for business with Ford Motor Company. It provided a very suitable venue for the audience of largely automotive EMC engineers.

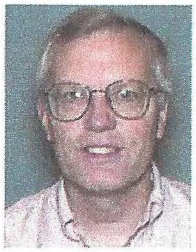
Toronto

The Toronto joint EMC and Radiation Chapter have sponsored several technical lectures in 2000 and 2001. Summaries of the lectures have been posted to the website www.tor.ieee.ca/ societies/electromag.htm. On March 27, 2000, Dr. Tapan Sarkar with the Department of Electrical Engineering and Computer Sciences at Syracuse University, New York, spoke on the topic "A Pragmatic Approach to Adaptive Antennas and Space Time Adaptive Processing (STAP)." Mark Montrose, Principal Consultant of Montrose Compliance Services, Inc. in Santa Clara, California spoke about "Fundamental Concept of Signal Integrity and EMC for Printed Circuit Boards" at their meeting on March 29, 2000. On July 5, 2000, Dr. Kamal Sarabandi, Associate Professor, Department of Electrical Engineering and Computer Science at the University of Michigan in Ann Arbor spoke on the topic "Radar Remote Sensing of Vegetation: A Tool for Monitoring Global Warming." On March 27, 2001, Michel Cuhaci, a Research Manager with the Advanced Antenna Technology Communication Research Centre (CRC) in Ottawa spoke on the topic "Satcom and Wireless Antenna Technology at Communications Research Centre." On June 1, 2001, the chapter heard Professor David R. Jackson of the Department of Electrical and Computer Engineering at the University of Houston, Texas speak on the topic "Microstrip Antennas with Reduced Surface-Wave and Lateral-Wave Excitation." All chapter meetings were held during the day at the University of Toronto. Attendance at the meetings ranged from 17 to 46 people.

Twin Cities

Dan Hoolihan, Program Chair for the Twin Cities Chapter, reports that the chapter has had two recent meetings. The latest one was held on June 14th at the Minneapolis Hyatt Regency Hotel in conjunction with the EMC Society Board of Directors meeting. The featured speaker was Jim Muccioli, an EMC consultant and a member of the Board of the EMC Society. Jim spoke on a topic of increased interest, "New X2Y Filter Technology Emerges as Single-Component Solution for Noise Suppression." He covered real world applications and test results of the technology. The physics principles behind the concept were discussed as well as the use of the technology in specialized signal-cable connectors. Approximately 25 people attended the luncheon presentation including several members of the Board of Directors who had arrived early for the Board meeting scheduled for the next day. The April meeting was held at the Thunderbird Hotel in Bloomington, Minnesota on Monday, April 30th. This was also a luncheon meeting and the guest speaker was Doug Smith, in his role as a Distinguished Lecturer of the EMC Society. About 30 people attended the talk where Doug spoke on a number of ESD phenomena that he has experienced in his many years in EMC. He had several interesting experiments that he performed to demonstrate his points. He also discussed the latest engineering standards being developed in the ESD areas including ANSI C63.16 and IEC 61000-4-2.

continued on page 46



Practical Papers, Articles and Application Notes

Bob Olsen, Associate Editor

In this issue you will find three practical papers that should be of interest to the EMC community. The first is by Colin and Bonnie Brench and is entitled, "EMI Measurements and Modeling – More Similar Than You'd Think!" I hope that this paper is the beginning of a long conversation between those who primarily make measurements and those who primarily do numerical modeling. It is my belief that the only reason you numerically model a system is to avoid doing one or more experiments. But, if you don't know exactly what experiment would produce the same results as your model and are not confident that your model will produce the same results, your modeling is not very informative. If, however, you are confident about the relationship between your model and an experiment, then numerical modeling can be very productive. I welcome all efforts to bring modeling and measurements together. Let's keep the conversation going. The second paper is an historical piece by Ed Bronaugh entitled "The Quasi-Peak Detector." Who in the EMC community has not used a Quasi-Peak detector? And yet, very few know why such a detector is used. You will find the answers to some of your questions here. Ed finishes his article with a set of questions to which he does not have answers. Perhaps we can collect contributions from some of you who have this information. Please write to us! The third paper is "An Innovative Shielding Concept for EMI Reduction" by Sabrina Sarto, Sergio DiMichele, Peter Leerkamp and Henk Thuis. The paper covers the practical side of making lightweight, inexpensive shields for small electronic devices. I think that we may find shields such at these appearing in devices that come to market shortly.

I must apologize for an inadvertent credit omission in the Winter 2001 issue of the Newsletter. The papers by Henk A. Klok and Diethard Hansen, respectively, were originally presented at the 2000 Wroclaw EMC Symposium. Certainly, EMC symposia such as the one in Wroclaw are an important source for the "Practical Papers" section of this Newsletter and should be acknowledged.

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.

EMI Measurements and Modeling – More Similar Than You'd Think!

Colin E. Brench

Compaq Computer Corporation
200 Forest Street
Marlborough, MA 01752
colin.brench@compaq.com

Bronwyn L. Brench

EMC Consultant
73 Crescent Street
Stow, MA 01775
bonnie.brench@usa.net

Abstract

Most EMC engineers are very familiar with working in a test lab, and devising experiments to help isolate the source of an emissions problem and a means of controlling it. However, give many of these same engineers access to sophisticated electromagnetic simulation software, and there would be a moment's silence before confusion sets in. Exactly the reverse applies to those tasked with the development of electromagnetics simulation tools. Offer them the opportunity to use a state-of-the-art measurement facility, and the same silence and confusion results. To be fair, there are more and more EMC engineers with a foot in both the hands-on measurement world and that of computational electromagnetics. It is the intent of this paper to help more engineers understand both sides of these still separate arts, particularly as the problems encountered developing a good EMI experiment are in fact very similar to those faced when creating EMI models.

Introduction

EMI measurements are made on a product after completion to evaluate whether or not that product's EM emissions are within specified limits. Measurements are also very beneficial during the development of a product, on component subsets of that product, to evaluate the behavior of a particular assembly. There are a number of reasons for the EMC engineer to develop special experiments but, at the root of them all, is the need to understand the physics behind a particular behavior. Such investigations are often done to evaluate the coupling paths between an RF energy source and a radiating element, for example, to gain an insight to the radiator itself or to determine specific parameters such as the magnitude and impedance of a particular source or the radiated field strength due to a particular configuration. Such detailed measurements are necessary to gain a full understanding of the product, and to quickly and efficiently bring that product to market.

EMI modeling is done for the same reason as the laboratory measurements, but with one additional critical driving factor – the absence of any real hardware. During the early stages of product development with nothing physically available to measure, the use of computer modeling is the only practical choice to evaluate an unknown structure.

Computer modeling of EMI problems requires creating a model that represents the key physical and electrical properties of the device of concern. The model must be prepared in a suitable way to provide input to the simulation software tool. In the context of this article, modeling refers to the complete process of model creation and the running of the simulation software.

Modeling can give an engineer a head start on the development of a computer system. With the concurrent design practices in industry today, it is often necessary to perform system level design work in parallel with the development of the components for that system. For example, a high performance computer system enclosure is designed, built, and waiting for the completion of the processor and other similar devices. Until all the pieces come together, the complete system cannot be measured; however, there are many details known for both the system and the processor from the early stages. Developing computer models of the processor and the system at this early stage can be essential in finalizing the EMC design quickly and in a cost effective manner. Modeling is an excellent way to gain an understanding of the electromagnetic behavior of individual parts of the system.

Given the fact that modeling and measurements are often being performed for the same reasons, it should not come as a surprise that the difficulties associated with both are also very similar. To put these issues into proper perspective, a variety of measurement concerns are examined, together with the equivalent modeling concerns. These concerns include:

- Effects of the surrounding environment
- Loading effects of the measurement probe
- Symmetry and in-phase reflection issues
- Comparison testing
- Source validity
- Uncertainty

Surrounding Environment

When making field strength measurements on an open field test site, there are some basic requirements that must be met such that the desired accuracy is obtained. One of these requirements is that there is a reflection free zone surrounding the device under test (DUT) and the test antenna. The minimum size of this zone is well defined in the measurement standards, and sized to ensure that any reflections from small objects at the edge of the zone will not cause significant errors in the measured field strength. However, if large or multiple objects are outside the defined reflection free zone, they can still influence field strength measurements. To this end, most test houses make the free zone significantly larger than called for by the standards. In reality, this practice works for most measurements, and the enlarged reflection free zone is given little further consideration other than to ensure that it is indeed kept clear. However, there always remains the risk that objects at the edge of the zone will impact measurements, thus causing errors.

The parallel to the reflection free zone in modeling is the use of absorbing boundary conditions (ABCs) that are required for volume-based modeling techniques, such as the Finite-Difference Time-Domain (FDTD) and Finite Elements Methods (FEM). In such techniques, the entire space of the problem is broken into small elements, and the fields for each element are computed. While free space is infinite, practical computer modeling requires the use of a finite computational domain, preferably as small as possible to minimize the size of the problem to be solved. ABCs of some kind are necessary to truncate the computational domain. As the ABCs are imperfect they have to be kept at a suitable distance from the other model elements and, so here again, if the domain is made too small, reflections errors can creep in.

ABCs are the mathematical equivalent of the absorbing materials used in a shielded room to make it into an anechoic chamber. Boundary conditions of this type are carefully crafted to minimize reflections from the edges of the computational domain. There are some foolproof ways of using ABCs; unfortunately, these all require significant amounts of additional volume to be included in the model. To create an efficient model, this additional volume must be minimized, so the use of the ABC that is part of a particular problem needs to be understood. Understanding is required of both the conditions that apply to the specific ABC, and the requirements for placing it sufficiently far from the model.

Some numerical techniques, such as the Boundary Element Method, better known in EMC circles as the Method of Moments (MoM), are surface-based rather than volume-based. These techniques typically solve for the currents on the surfaces of all conductors, do not utilize a computational domain, and thus free the user to construct a model without the need of an ABC. Inherent in the formulation of these surface-based techniques are the means to simulate the free space environment (within the Green's functions). In this case, the author of the code has the responsibility for setting the behavior of the simulation, rather than the code user.

Loading Effects of the Measurement Probe

Whenever a measurement is made, there is an understanding that the presence of the probe will in some way affect the measurement. A voltage probe will require the addition of a shunt impedance, and a field strength measurement made close to the DUT will have an effect on the calibration of the measurement antenna. Indeed, measurement antennas themselves can be considered as large field probes, and they are not immune from loading effects. Antennas will couple to all conductors nearby, including the test site ground plane, feed cable, and possibly also the DUT. The magnitude of these loading effects is understood and expected.

When modeling the DUT, the measurement probes have no physical existence, so there are no loading effects. This is an advantage when the goal of the model is to determine a field distribution, terminal impedance, or any other parameter that is adversely affected by loading. However, this can be a problem if there is a need to correlate the modeled results with those of a measurement. In this case, either the effective loading impedance or a model of the physical probe being used must be included.

The use of modeling to support EMC measurement methods is just beginning to have an impact. The measure of acceptability for an open field test site is site attenuation. In the early days of FCC testing, the reference to which all sites had to be compared was partly theoretical and partly empirical. The reason for this was understood, and is related to the direct coupling between antennas, particularly at the low frequencies of concern. However, as these effects could not be suitably calculated, the empirical model was needed. As test methods have developed, the inaccuracies in this early reference became more important, and good test sites would not always meet the requirements. Highly refined models for site attenuation are now possible through the use of computer modeling, and can account for the different results for a variety of antenna types.

Other practical applications of modeling of measurement configurations are becoming an important adjunct to measurement technology. As the position of an antenna is changed with respect to the test site ground plane, both in height and in polarization, its properties are subtly affected. A low horizontal antenna is very tightly coupled to the ground plane, and so its self-impedance changes. For the vertical case, the balance of the antenna is also upset. These changes add to the uncertainty of any measurements made by the antenna. The simple example of a 30 MHz tuned dipole located at different positions is modeled, and the results are shown in Table 1. Three cases are computed for the dipole: in free space, horizontally polarized at a height of 4 m above the ground plane, and vertically polarized with the lower tip of the dipole 25 cm above the ground plane. These latter two positions are those most likely to be used during real EMC measurements near 30 MHz. It is assumed for this example that the antenna is perfectly matched for the free space condition. The mismatch loss represents an uncertainty in the final field strength measurements.

Condition	Resistive Value (ohm)	Reactive Value (ohm)	Mismatch Loss (dB)
Free Space	71.0	+j 0.26	0.00
Horizontal	87.4	–j 13.00	0.95
Vertical	93.8	+j 0.26	1.29

*Table 1. 30 MHz Dipole Properties **

Feed Location (m)	Resistance (ohm)	Reactance (ohm)	Mismatch Loss (dB)
Antenna Alone	93.8	+j 0.26	1.29
1.0	37.8	+j 1.16	2.31
1.1	44.3	+j 8.80	1.78
1.2	50.6	+j 14.9	1.28
1.3	56.7	+j 14.9	0.82
1.4	62.7	+j 23.0	0.40
1.5	68.3	+j 25.4	0.02
1.6	73.7	+j 26.9	0.31
1.7	78.7	+j 27.0	0.60
1.8	83.3	+j 27.9	0.86
1.9	87.6	+j 27.5	1.09
2.0	91.4	+j 26.6	1.28

*Table 2. 30 MHz Dipole Properties with Feed Cable **

A similar effect can be observed when the antenna feed cable is parallel to the antenna polarization. If the cable is free to hang in different locations each time the antenna height is changed, yet another uncertainty is added to the measurement, as the cable coupling effects are free to vary differently each time. Table 2 shows the change in mismatch loss for a vertically polarized, 30 MHz tuned dipole. The dipole's lower tip is positioned 25 cm above the ground plane, and the feed cable position is moved in steps from 1.0 to 2.0 m away from the antenna element. It can be seen that an additional uncertainty is added into the measurement of field strength.

A diagram of the model used to compute the data in Table 2 is shown in Figure 1. It can be seen that the model is very simple, containing only three wire conductors, yet it provides data that supports improvements in practical EMI measurements. Many test laboratories include ferrite cores on antenna feed cables to break up the induced currents. The addition of these ferrite cores results in the minimizing of the variable mismatch losses. The data in Table 2 supports this practice and shows the improvements that can be expected. It should be noted that for a poorly matched antenna, the effects can be greater than for this simple example case.

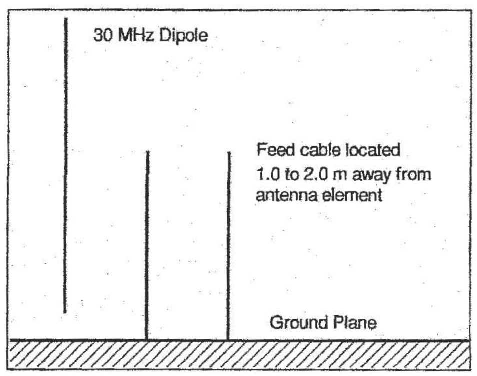


Figure 1. Wire Model of 30MHz Dipole with Feed Cable

* All of the antenna models used to create Tables 1 and 2 were prepared using MiniNEC, the personal computer version of the well known Numerical Electromagnetics Code (NEC).

Symmetry and In-Phase Reflection Issues

Through experience, it has been found that regular symmetrical shapes are not ideal for a variety of RF test facilities, including compact antenna ranges and EMI open field test sites. Compact antenna ranges are designed to simulate free space in a very short distance through the use of large reflector antennas. These reflectors are designed with angled edges to minimize large in-phase reflections. Rather than maintaining symmetry, EMC test sites are built with the antenna and turn table locations off axis with respect to the ground plane and any weather protection structure.

Exactly the same problems can arise when creating a model, and the same precautions are necessary; namely, ensuring that the main components are offset. These symmetry problems are due to the perfection associated with CAD tools. An ideal, physical box has perfectly orthogonal walls, but reality dictates that there are small imperfections in the construction. Many small details exist in a real box; these include draw angles, bowing, offsets for joining seams, and internal mounting brackets. These all limit the geometric perfection, and real material properties also add RF loss into the physical model. By comparison, a modeled box is often specified to be absolutely perfect in its geometry and to have a loss free nature. Typically, all the small details listed do not play a significant role in the EMC performance of the real box. Since they are not needed, they are not specifically included in the model; however, unless specified, a CAD tool will create a box that is perfect.

There are additional problems when modeling, similar to that of the perfect box. These problems are also due to the perfection possible with CAD tools. A good example of this CAD tool characteristic is the well-known attribute of any graphics interface – the ability to snap objects to a grid. This ensures that all elements in a model are perfectly aligned with respect to the x-, y-, and z-coordinates. As a result, all source elements will be perfectly aligned with other elements of the model. Similarly, when a source is specified, it will have pure polarization; while in reality, a noise source is rarely aligned exactly to the model coordinates, nor is it pure.

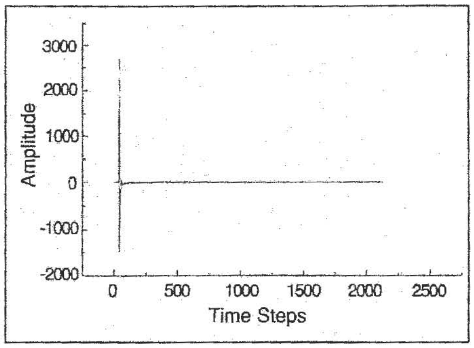


Figure 2. Impulse in Open Space

Either of these examples can completely eliminate any cross-polarized fields from existing in the model. This might not be a problem, but it is not unknown for a cross-polarized response to dominate in the overall EMI performance of a system. If these effects are critical, their lack can result in very misleading conclusions.

Perfect model geometries can also be a serious problem for simulation tools that function in the time-domain. Such codes effectively work by obtaining the impulse response of the structure being modeled, applying a stimulus, and letting the structure ring down to its quiescent state. With perfect geometries and parallel walls, it is quite possible for energy to become trapped, preventing the impulse response from dropping down to zero. To address this, some loss must be introduced.

Time-domain examples showing the impulse response in free space between two perfectly parallel walls and between two non-parallel walls are shown in Figures 2, 3, and 4 respectively. It can be seen how rapidly the non-parallel case settles compared to the case with parallel walls. It should be noted that this is not an enclosed space, just two parallel walls. The decrease in ringing time in Figures 3 and 4 is due to energy being reflected to the absorbing boundaries rather being trapped between them. These examples were prepared using a two-dimensional FDTD code.

Comparison Testing

Comparison testing, or comparing test A with test B (A-B tests), are frequently performed during EMC testing. These tests are of particular value when one part of a system is being changed. Rather than obtaining a full data set that identifies the entire system, an A-B test

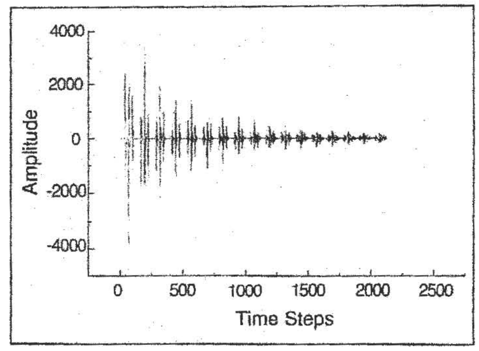


Figure 3. Impulse Response Between Two Parallel Walls

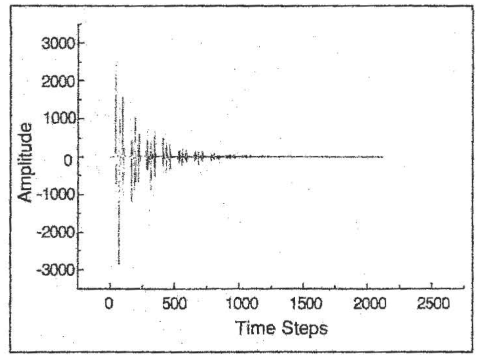


Figure 4. Impulse Response Between Two Non-Parallel Walls

more clearly identifies the characteristics of the specific part that has been changed. Comparison tests also have the advantage of minimizing the effect of errors; most errors will be present in both the A and B tests, and will cancel in the final comparison.

Modeling can also take advantage of the improved accuracy like that available in comparison testing. In fact, comparative simulations are highly recommended for those just beginning to model EMI problems, and to help offset the difficulties associated with accurate source definition.

Today, relatively few detailed models are created with the intention of predicting regulatory style measurement results; rather, the focus is on understanding some specific portion of a product's behavior. Topics of study may include coupling between different parts of a system or leakage through apertures. To determine coupling based on size and separation of the component parts, a series of models can be constructed, each with slightly different dimensions. By examining the differences in coupling between such models, trends can be seen and suitable isolation maintained in the design. This can be done analytically for simple shapes but, for complex geometries, the only suitable tools available are the computational ones. The shielding provided by different size apertures can be estimated from the traditional shielding effectiveness equations but, when the source is closely coupled to the shield and/or when there are other conductors closely coupled, the results of these equations are meaningless. Here again a series of models can be created, the results compared, and used to determine the effects of changing aperture shape and size for the given geometry.

Source Validity

When measuring a device for emissions, the real source is part of the system, and does not need to be defined separately. It is not an uncommon practice to determine the shielding performance of a box by inserting a source into the empty box; however, it is understood that the real source might well behave very differently. To obtain valid results for the shielding, it is necessary to try and emulate the real source that will be in the system. The key attributes of the source are impedance and size. As shielding is the ratio of field strengths with and without the shield present, the amplitude of the source is not critical as long as it is known. The source impedance is very important in the determination of how much energy couples into the box, while the physical size determines how tightly the source and box are coupled.

There is a strong temptation to use ideal sources when modeling, but this can lead to some very large errors. For example, a dipole having a real resonant frequency of around 700 MHz is modeled using NEC. The goal of this model is to show how the total radiated power varies with three separate source impedances over a wide frequency range. The results of this model are shown in Figure 5.

The plots in Figure 5 are scaled so that they fit on the same graph. It can be seen that the ideal current source provides very different results from either the voltage source or the practical source impedance. The maximum for the current source occurs at the full-wave resonance where the antenna impedance is

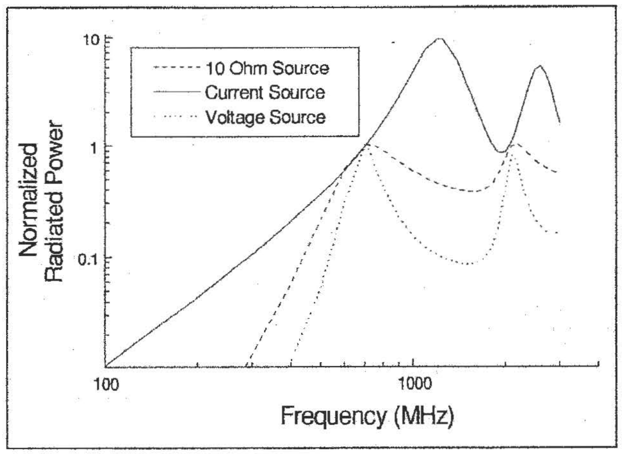


Figure 5. Radiated Power for a Dipole Antenna for Various Source Impedances

extremely high. In reality, it is extremely difficult to drive current into a full-wave dipole, and a minima would be expected rather than the peak. This minima can be clearly seen with both the voltage and practical source impedance.

For both measurements and modeling, an accurate representation of the noise source is critical if misleading results are to be avoided. One area of rapid growth for the use of EMI modeling is that of source modeling. The goal of these models is to provide accurate source information for system level computer models, and to support the need for building accurate physical models for experimental measurement work.

Uncertainty

It is understood by all engineers that their measurements are not perfect. There are calibration uncertainties with every part of a measurement including the instrumentation, test environment, and variations in the individual units being measured. A realistic evaluation of these uncertainties is essential to the proper interpretation of the data obtained. Indeed, one of the skills in making accurate measurements is to correctly devise the test set-up in such a way that uncertainties are minimized.

In addition to the basic uncertainties that exist, there is a further complicating factor, namely repeatability. When measuring a voltage in a well-defined structure, it is expected that the same data will be obtained with very close correlation each time the measurement is made. When the electric field strength is measured at a distance of 10 m from a system that includes many devices and interconnecting cables, the same degree of correlation is not expected. While it is expected that the amplitude of the field strength would be close, it would not be expected that the field maximum would be measured with the antenna at exactly the same elevation, and with the system under test rotated to the same angle, especially at higher frequencies.

It is equally understood by engineers familiar with modeling that the results obtained from modeling will have some uncertainty associated with them. There is, however, a major difference in the source of these uncertainties. Unlike a complex physical measurement, repeating a complex computer model will always produce exactly the same answer; the real question with the modeling results is whether or not the actual model is correct.

There is a degree of uncertainty associated with the use of any modeling technique. This uncertainty results from the approximation of the model geometry into a digitized form, and a similar formulation of the appropriate equations into a form that can be solved computationally. If the inputs to a modeling technique are uncertain, or inaccurate, then the results will be inaccurate. When properly used, the accuracy of modern computational techniques is usually very high, and may even be used within a particular code to estimate the error. Simulation uncertainty can be most easily evaluated by using another solution code that utilizes a totally different formulation.

There are, however, other sources of uncertainty that are of greater importance, and are much harder to evaluate. While it is easy to create an accurate representation of the physical geometry of a device; it is not as simple to include its exact electrical properties. This is simply because the information is seldom known. In a physical system, real components provide the source of the RF energy; in a model, this source information has to be properly included. If the source of emissions is not fully represented in both amplitude and impedance, and, if necessary, in its physical dimensions, significant errors may result. Computer results usually reflect the model being solved very accurately; the uncertainty comes from the degree of correlation between the computer model and the practical implementation of the DUT.

Summary

The practical differences and similarities between EMI lab work and modeling have been discussed, bringing these two worlds a little closer together. While there are clearly some differences in the challenges faced by the engineer in the lab and the one working in front of the computer, both rely on understanding the physics of the problem, and having the experience to get the job done. The information given in this paper is intended to help provide confidence that what is being measured or modeled is really what is wanted, and not some other aspect of the problem.

Given the complexity of the EMC design and measurements, no one approach can be, or should be, relied upon exclusively to provide a full understanding. When supporting data is gathered from a variety of sources, an engineer can have greater confidence that it is both reliable and valid. Computer models and measurements can be used synergistically to provide insight to a particular issue, and they can be used in a complementary manner to ensure the validity and applicability.

Once the basic operation of an EMI modeling tool is understood, EMC engineers will find themselves in a very familiar world. This is a world where all experiments, both physical and simulated, must be carefully evaluated to ensure they are both valid and accurate; and where all results are treated only as a very good guide as to what is happening, rather than the final answer. Most importantly, it is a world that will continue to provide the EMC engineer with surprises and new challenges.

Biographical Notes

Colin Brench *has been working for Digital Equipment Corp., now Compaq Computer Corporation, for 15 years, where he is a Principal Member of the Technical Staff. He has responsibility for EMC product design, and the development of EMC modeling capabilities in the High Performance Server Division. Colin has been active in the area of antennas and EMC since the early 1970's. Colin is a co-author of the book,* *__EMI/EMC Computational Modeling Handbook__* *(Kluwer Academic, 1998), and has authored over 20 technical papers and articles. In addition, he holds eight patents for various methods of EMI control. He is a NARTE certified EMC Engineer, a member of the IEEE EMC Society, and is active in the TC-9 and ANSI ASC C63 SC-1 committees. In March of this year, Colin was appointed a Distingushed Lecturer for the IEEE EMC Society.*

Bronwyn Brench *has run an EMC engineering consulting business since 1982. Her responsibilities include the management and operation of the business, and the reviewing and editing of technical papers, articles, and educational materials used for EMC training. Her latest project was technical reviewer and editor for the second edition of the book,* *__EMI/EMC Computational Modeling Handbook__* *(Kluwer Academic) due out in August 2001.*

Bronwyn, in addition to being an at-home mother of two children, aged 14 and 16, with all that entails, has been working in the engineering field since 1976. She is a NARTE certified EMC Engineer, and is author of 13 technical papers and articles in the fields of EMC and photovoltaic systems. **EMC**

The Quasi-Peak Detector

By Edwin L. Bronaugh, ANSI ASC C63 Historian

Many modern EMC practitioners have asked how the Quasi-Peak detector came about. In this article, I will attempt to provide some historical answers to this question. But first, some EMC history may be appropriate. The science of EMC started out in the 1920s and 1930s as an effort to solve problems with what would later be called RIV (radio influence voltage) and RIF (radio influence field-strength).[1] In those days, this "science" dealt entirely with "noises" which interfered with radio broadcast reception and the reception of government and licensed commercial services.

Quoting from [1], "Almost from the beginning of radio broadcasting, the electric utility companies were faced with problems of radio noise. In 1924 the National Electric Light Association appointed a committee to study the subject. The manufacturers of electric power equipment had encountered similar problems, and in 1930, a subcommittee of the NEMA Codes and Standards Committee was set up. The following year, the EEI-NEMA-RMA[2] Joint Coordination Committee on Radio Reception was organized."

The EMC efforts addressed mostly unintentionally generated man-made radio noises such as noise from power lines (probably corona and leakage noise), switching transients, electric motor commutator sparking, automobile ignition noise, etc., and some natural phenomena such as atmospheric noise and signal fading. In those days, these efforts were far from a science because the phenomena of concern were not well understood, and solutions for the interference problems were often considered akin to "black magic." The instruments used in those days were relatively simple radio broadcast and communications receivers sometimes accompanied by an external audio frequency voltmeter to provide a somewhat less subjective notion of the amount of radio-noise being received.

[1] We did not get around to calling it radio frequency interference (RFI) until much later, and then much, much later we started calling the science Electromagnetic Compatibility (EMC).

[2] Edison Electric Institute, National Electrical Manufacturers Association, and Radio Manufacturers Association.

During this time, the CISPR[3] had been organized and undertook to develop a method of voltage measurement in the frequency range from 150 kHz to 1605 kHz. To develop the method and an instrument, an assessment of interference related to its effect on the reception of sound broadcasting was needed. As mentioned above, much of the interference was impulsive in nature and its effect increased with increasing repetition rate in a way that was shown to be approximated by a quasi-peak detector circuit with appropriate time constants. During this development, engineers and scientists from both Europe and North America were involved in the CISPR, since it was an international organization.

In the 1930s, a board of listeners was formed to decide what characteristics of a radio disturbance caused annoying interference, and the degree of annoyance, for listeners to radio broadcast (sound) reception. The broadcast receiver of the day received signals in the LF or MF bands, and had an IF bandwidth of between 8 kHz and 10 kHz. The desired signal was a carrier with voice or music amplitude modulation. Using a radio broadcast receiver equipped with an audio output voltmeter, the board of listeners rated the annoyance of the interference with its audio output and its particular pulse repetition frequency. Each member of the board of listeners was said to have worked independently, so that the results would be statistically useful. Out of this study came the specifications for the quasi-peak (QP) detector used in the first CISPR Radio-Noise Meter. When radio broadcasting was extended into the HF band, the frequency range of the CISPR Radio-Noise Meter was extended upward from 1605 kHz to 30 MHz. Since the later radio broadcasting services to be protected had about the same characteristics as the earlier ones, the QP detector from the early CISPR Radio-Noise Meter was retained, and did a good job predicting the interference effects of radio disturbances. CISPR Publication 1 was the specification for this radio-noise meter.

The CISPR has extended the quasi-peak technique to a much broader range of frequencies over the years. Currently, CISPR radio-noise meters use the QP detector from 9 kHz to 1 GHz; and, there is discussion of extending it into the GHz frequency range. I have not read anything that indicates that the QP detector, even with different bandwidths and time constants, is really appropriate to measure interference to radio and television broadcasting and radio communications above 30 MHz. As far as I can tell, there was no formal "board of listeners or viewers" to decide that some form of QP detector appropriately predicted the interference effect of various radio disturbances to the radio services operating above 30 MHz. But, right or wrong, quoting from [2], "Instruments using the quasi-peak detector still remain as the basic reference for determining compliance with CISPR limits."

This has been a short historical sketch of the QP detector. Many technical and historical questions remain unanswered. I am therefore extending this invitation to any readers out there who can add to it. Perhaps we can finally put together a really good history of the QP detector and archive it so it won't get lost, again. Some questions that were asked by an anonymous reviewer deserve answers, but require much research. They are (in no particular order):

1) Who actually designed the first QP detector and why QP?
2) For many years CISPR QP and ANSI QP were different. How did this happen and why was the ANSI QP dumped in favor of the CISPR QP?
3) How were the charge and discharge time constants selected for the first QP detectors and why were they changed over the years? How was the bandwidth selected? [Note: the 9 kHz bandwidth was the prevalent bandwidth of radio receivers for sound broadcast reception at the time. EdB]
4) The dynamic range of the first CISPR meters was less than 15 dB, whereas the first Stoddart meters had a dynamic range of 40 dB. Why did the CISPR meter have this limitation and how did Stoddart get around it?
5) Who put together this first board of listeners? What were they asked to do and what meters with what detectors were used in this work? Was the QP detector really designed as a result of this work?
6) When CISPR extended the QP technique to a broader range of frequencies, how did they come up with the time constants in this meter since they are not the same as the time constants for the lower frequency meter?
7) What about the T&D Committee of the IEEE PES "board of listeners" that evaluated TV reception in the presence of power line interference several years ago?
8) With the proliferation of communication systems, one could easily ask if any single detector can adequately predict the interference effect of all the various disturbances on all the various communications systems.

Bibliography

[1] ASA[4] C63.4-1963, *American Standard Methods of Measurement of Radio-Noise Voltage and Radio-Noise Field Strength 0.015 to 25 Megacycles/ Second Low-Voltage Electric Equipment and Nonelectric Equipment*, p. 3.

[2] CISPR Publication 16:1987, *C.I.S.P.R. specification for radio interference measuring apparatus and measurement methods*, Second Edition, pp. 13 & 15.

[3] E. L. Bronaugh, "Introduction to Electromagnetic Compatibility: Review, History and Trends," *Proceedings of the 17th Electrical/ Electronics Insulation Conference*, IEEE EIS, NEMA and ICWA, Boston, MA, Sept. 30 - Oct. 3, 1985, p. 177.

[4] E. L. Bronaugh and W. S. Lambdin, *Electromagnetic Interference Test Methodology and Procedures*, Vol. 6, Handbook series on Electromagnetic Interference and Compatibility, Interference Technologies, Inc., State Route 625, P.O. Box D, Gainesville, VA 22065, U.S.A., 1988, pp. 1.22-1.24 & 3.35-3.38.

[5] ANSI C63.4-1981, *American National Standard Methods of Measurement of*

[3] CISPR is an abbreviation made up of the initials of the French for "International Special Committee on Radio-Interference."

[4] American Standards Association, Inc., forerunner of the American National Standards Institute, Inc. (ANSI).

Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 10 kHz to 1000 MHz, p. 3.

[6] CISPR Publication 7:1969, *Recommendations of the C.I.S.P.R.*, Amendment No. 1:1973; and supplements. CISPR Publications 7A:1973, *First supplement*; and, 7B:1975, *Second supplement*.

[7] CISPR Publication 8:1969, *Reports and Study Questions of the C.I.S.P.R.*, Amendment No. 1:1973; and supplements. CISPR 8A:1973, *First supplement*; CISPR 8B:1975, *Second supplement*, Amendment No. 1:1980; CISPR 8C:1980, *Third supplement*; and, CISPR 8D:1982, *Fourth supplement*.

Biographical Notes

Edwin L. (Ed) Bronaugh *is a Life Fellow of the IEEE and an Honorary Life Member of the EMC Society. He has often served on the EMC Society Board of Directors, and is a past president of the Society. He is also a distinguished lecturer on EMC topics. He is a member of the EMC Standards Committee and represents the IEEE on ANSI-Accredited Standards Committee C63; of which he is Vice Chairman. He is a member of the US Technical Advisory Groups for CISPR, CISPR/A and CISPR/I. The EMC Society has awarded him several of its highest awards including the Richard R. Stoddart Award, the Lawrence G. Cumming Award and the Standards Medallion, and the IEEE Third Millennium Medal in 2000. He has authored a book on EMI measurements and authored over 150 papers in professional meetings and publications. He is a senior member of the National Association of Radio and Telecommunications Engineers (Certified EMC Engineer). He is listed in Who's Who in America, Who's Who in the World, Who's Who in Science and Engineering, Who's Who in the South and Southwest, and Men of Achievement. Mr. Bronaugh is Principal of EdB EMC Consultants, an independent EMC consulting firm. Previously, he was Lead Engineer for Siemens for Hardware Design Assurance at Siemens Communication Devices, Austin, Texas, Vice President for Engineering at the Electro-Mechanics Company, Technical Director of Electro-Metrics, and Manager of EMC Research at Southwest Research Institute. He may be reached at ed.bronaugh@ieee.org.* **EMC**

An Innovative Shielding Concept for EMI Reduction

Maria Sabrina Sarto[1], Sergio Di Michele[2], Peter Leerkamp[2], Henk Thuis[2]

[1] *University of Rome "La Sapienza",*
Dept. of Electrical Engineering, via Eudossiana 18,
00184 Rome, Italy
e-mail: sarto@elettrica.ing.uniroma1.it

[2] *Stork Screens B.V.,*
Raamstraat 1-3,
5831 AT Boxmeer, The Netherlands
e-mail: peter.leerkamp@stork.com

I. Introduction

The design and realization of lightweight shields to reduce radiated emissions and electromagnetic interference (EMI) with sensitive electronic apparatus and systems is a challenge for electromagnetic compatibility (EMC) engineers.

Techniques that are currently used to improve the shielding performances of light materials such as plastics and composites are: the insertion of conducting meshes in the substrate [1, 2], the use of conducting additives and fillers prior to injection molding [3, 4] and the use of conducting coatings [5-8]. Among these techniques the use of conducting coatings allows the realization of lightweight shields.

The purpose of this paper is to demonstrate that thin coatings of conducting material, having thickness of a few micrometers, can provide good shielding performances in the radio-frequency range, up to a few gigahertz. The deposition of such coatings on polycarbonate foils leads to a new concept of lightweight thermoformable shield, which can be used to reduce EMI from and against printed circuit boards (PCBs) in electronic devices.

Applications of the innovative shielding concept are in different fields, when the requirement of light weight is a stringent constraint in the design of the shields. Examples are: portable electronic devices (PEDs) such as cellular phones, walk-talkies, portable radios and CDs, equipment to be used or installed onboard aircraft, on satellites, etc..

II. The Thermoformed Shield

A. The production process

The new shield is made by a polycarbonate foil having the thickness of 125 μm, which is coated by a 50-nm thick layer of nickel and a 5 μm-thick layer of tin, as sketched in Fig.1.

The choice of the polycarbonate as substrate is suggested by its thermoforming properties. Moreover, among thermoplastics, it presents a relative high molding temperature (approximately 200°C).

The choice of tin was suggested by its mechanical properties. Tin is a very ductile metal, and is also characterized by good resistance against corrosion and aging. The 5μm-thick layer of tin is realized by electroplating. Such technique allows the manufacturing of very compact coatings, is rather inexpensive and fast, and is suitable for deposition of coatings over wide-surfaces. One limitation of the technique is that it can be applied to realize only metallic coatings over conductive substrates: therefore the tin-layer cannot be deposited by electroplating directly on the polycarbonate foil.

In order to overcome such limitation, a thin layer of nickel, having the thickness of only 50 nm, is deposited first on the polycarbonate substrate by DC magnetron sputtering. The magnetron sputtering technique is a vacuum deposition technique which has the advantage, with respect to electroplating, of allowing the realization of conductive coatings, on both metallic and non-metallic substrates. It also allows the realization of very compact coatings, and permits a fine control of the thickness growth of the film. However, the DC magnetron sputtering has two main drawbacks: it is only suitable for very thin coatings (with thickness not higher than 1 μm); and it is also generally more expensive than electroplating.

The choice of nickel was suggested by its chemical properties: in particular, it is not subjected to oxidation and it does not react with tin or polycarbonate. Moreover, it has good adhesion properties on plastic substrates.

The thickness of 50 nm was the minimum one resulting from the compromise of reducing the sputtering deposition time, and of realizing a conductive substrate which is able to guarantee correct deposition of the tin layer by electroplating.

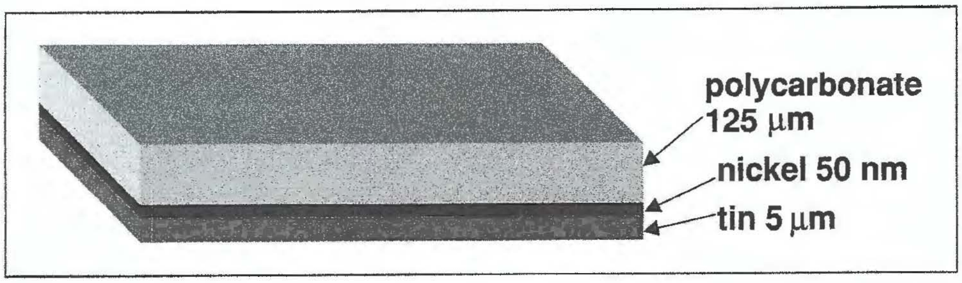


Figure 1. Sketch of the three-layer shield.

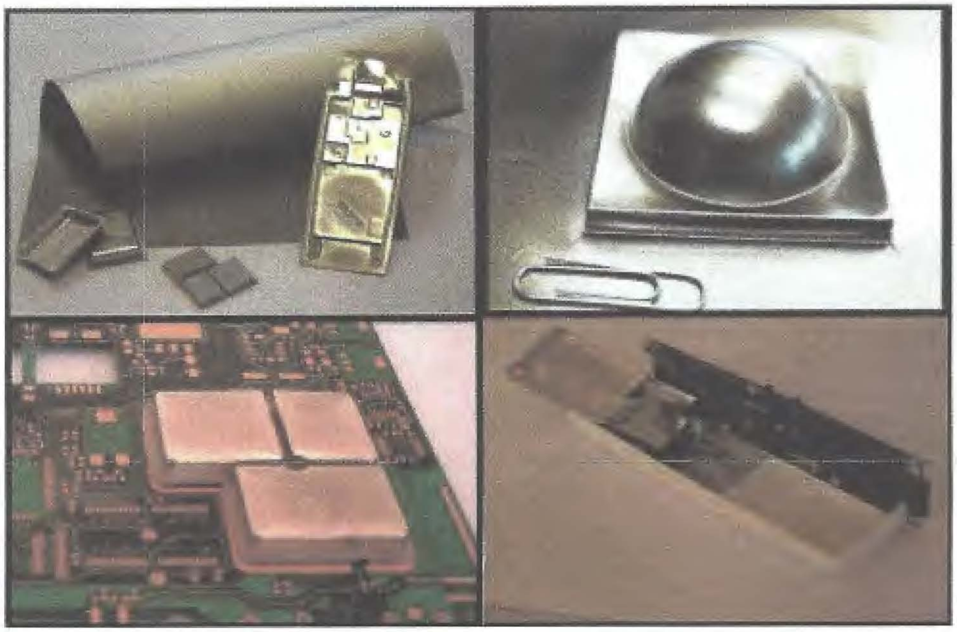


Figure 2. Examples of thermoformed shields.

Finally the metalized foil is thermoformed at the temperature of 200°C to realize lightweight shielding covers and caps, having whatever shape. Figure 2 shows some examples of lightweight shields.

Mechanical, chemical and aging tests have been performed in order to characterize: the thickness profile of the metallic layers after thermoforming; the adhesion and abrasion properties of the coating, the electrical conductivity before and after exposure to a damp environment and the effect of aging on the metallic layers [9].

B. The EM tests

The shielding performances of planar and 3-D samples of metalized polycarbonate foils before and after thermoforming have been tested experimentally in a wide frequency range, and considering different set-ups.

1) ***The planar samples.*** The planar samples before thermoforming have been tested by using the standard ASTM 4935D set-up [10]. The ASTM 4935-D test method is probably one of the most used and reliable way to characterize the shielding performances of planar samples. It provides the shielding effectiveness of the material against a TEM wave in a coaxial cable, in the frequency range from about 30 MHz to a few gigahertz. These frequency limits are not exact but are based on the decreasing of displacement currents due to decreased capacitive coupling at lower frequencies, and on overmoding (i.e. excitation of modes other than the TEM) at higher frequencies.

The test set-up, sketched in Fig.3, is composed by: the bi-directional network vector analyzer, the 50-Ω-coaxial waveguide, the load test specimen and the reference one and double shielded coaxial cables. The two parts of the TEM coaxial waveguide are not electrically connected, but are coupled through the sample. The SE in decibels of the sample under test (load specimen) is defined by:

$$SE_{\mathrm{dB}} = 20 \log \frac{S_{21}^{ref}}{S_{21}^{load}} = S_{21,\mathrm{dB}}^{ref} - S_{21,\mathrm{dB}}^{load} \qquad (1)$$

in which S_{21}^{ref} is the transmission coefficient measured when the reference sample is mounted inside the waveguide, and S_{21}^{load} is the transmission coefficient measured with the load sample. Such a test procedure allows one to cancel the effect of the contact resistance between the sample and the metallic waveguide; therefore, it is very important that the surfaces of both the reference and load specimens are properly treated before the test.

Even though this method allows a high accuracy and reproducibility of the measurements, it has two main drawbacks: it can be used to test only planar samples and the frequency range is limited between about 30 MHz and 1.5 GHz, in order for the cell to work in the TEM mode.

Three different thicknesses of the tin layer have been considered (i.e. 3 μm, 5 μm, 7 μm) in order to assess the influence on the shielding effectiveness (SE) of the coating thickness. The measured data are reported in Fig.4: the average SE in the

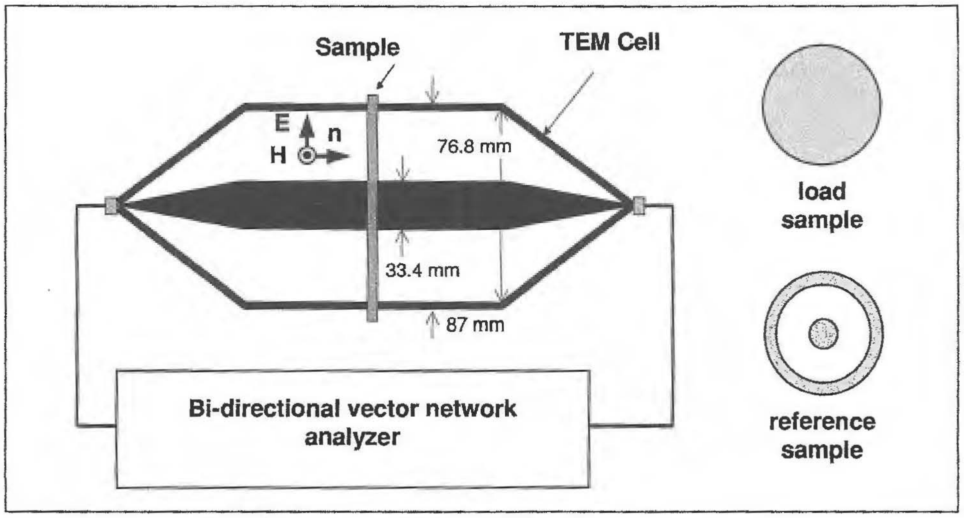


Figure 3. Schematic representation of test set-up for the SE measurement of planar samples, with the load and reference specimens.

considered frequency-range is about 72.5 dB for the shield with the 3 μm-thick-coating, nearly 79 dB for the sample with the 5 μm-thick-coating, and 80.5 dB for the shield with the 7 μm-thick-coating.

The obtained results are in good agreement with the values of the SE that are calculated by applying the theoretical expressions valid for a multilayered panel illuminated by a plane wave [9,11]. Table I shows the values of electrical conductivity, relative permittivity, relative permeability, and thickness of tin, nickel and polycarbonate used in the simulations.

The obtained numerical and experimental results are summarized in Table II, where the average values of SE_{dB}, in the frequency range from 30 MHz to 1.5 GHz, are reported. As an example, Fig.5 shows the measured and computed frequency spectra of SE_{dB} for the planar sample with the 5 μm-thick layer of tin.

It should be observed that numerical experiments have also demonstrated that the effect on the SE of the presence of the polycarbonate foil is absolutely negligible in the considered frequency range, due to the high resistivity and small thickness. Moreover, the presence of the nickel layer affects the SE_{dB} of less than 1 dB, because it is thin compared with the tin one.

Therefore, theoretical analyses are carried out in order to ascertain the influence on the SE of the EM-wave reflection and absorption phenomena as regards a single layer of tin, illuminated by a TEM plane wave in the frequency range up to 1.5 GHz.

For a single layer indefinite shield, SE_{dB} can be expressed in the following form [12]:

$$SE_{dB} = R_{dB} + A_{dB} + B_{dB} \tag{1}$$

in which:

$$R_{dB} = 20 \cdot \log_{10} \left| \frac{(\eta_0 + \eta)^2}{4\eta_0 \eta} \right| \cong 168 + 10 \cdot \log_{10} \left(\frac{\sigma}{\sigma_{Cu}} \cdot \frac{1}{\mu_r f} \right) \tag{2}$$

is the reflection coefficient at the air/metal interface,

$$A_{dB} = 20 \cdot \log_{10} \left| e^{\gamma d} \right| \cong 131.4 d \left(\frac{\sigma}{\sigma_{Cu}} \mu_r f \right)^{1/2} \tag{3}$$

is the absorption coefficient, and

$$B_{dB} = 20 \cdot \log_{10} \left| 1 - \left(\frac{\eta_0 - \eta}{\eta_0 + \eta} \right)^2 e^{-2\gamma d} \right| \tag{4}$$

is the coefficient accounting for the multiple reflections inside the shield [N.B.: the approximate expressions are only valid using SI-Units (International System of Units)]. In eqs.(2), (3) and (4), d is the shield thickness, μr the relative

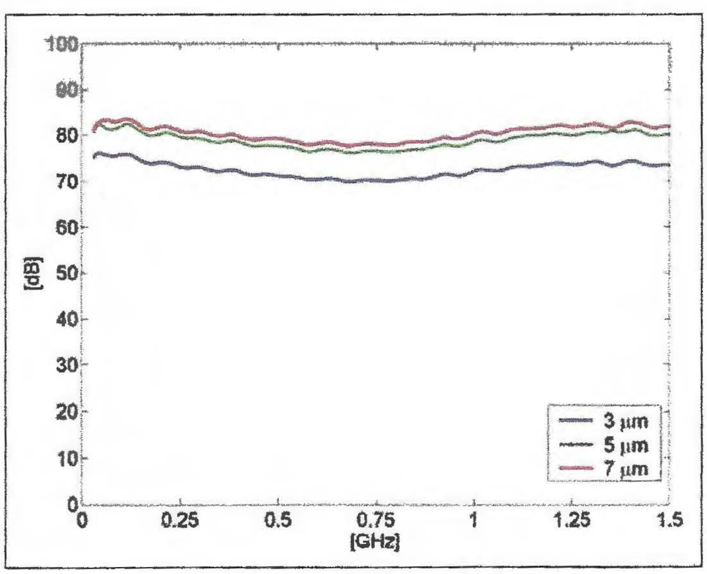


Figure 4. Frequency spectra of the measured SE of planar samples having thickness of the tin layer of 3 μm, 5 μm, 7 μm.

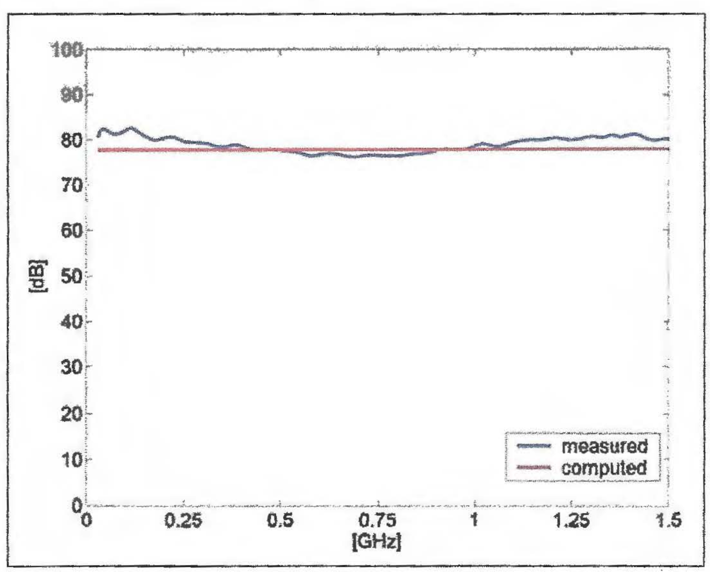


Figure 5. Frequency spectra of the measured and computed SEdB of the planar sample having thickness of the tin layer of 5 μm.

magnetic permeability of the shield, f the frequency, $\sigma_{Cu}=5.8\cdot10^7$ S/m the electrical conductivity of copper, η_0 the free-space impedance, γ and η are respectively:

$$\gamma = \sqrt{j\omega\mu \cdot (\sigma + j\omega\varepsilon)}$$
$$\eta = \sqrt{\frac{j\omega\mu}{\sigma + j\omega\varepsilon}} \qquad (5)$$

where σ is the electrical conductivity; ε and μ are the electrical permittivity and the magnetic permeability of the material realizing the shield; ω is the angular velocity.

Table III reports the values of R_{dB}, A_{dB} and B_{dB} for the tin layer alone, considering the different thicknesses of 3 μm, 5 μm, 7 μm, at the frequencies of 100 MHz, 1 GHz, and 1.5 GHz. Notice that in all cases the reflection phenomenon plays a dominant role in the EM shielding. However, for frequencies higher than 1.5 GHz, the absorption coefficient becomes more and more important since it grows up as the root of f.

2) ***The thermoformed shield.*** The SE of the thermoformed shield has been tested in the anechoic chamber of the National Aerospace Laboratories (NLR) in The Netherlands. To this purpose the simple cover, having the geometrical configuration sketched in Fig.6, is used. The tin layer has a thickness of 5 μm.

Both far field and near field test configurations have been considered. In the far field set-up the incident plane wave is produced by a horn antenna in the frequency range from 1 GHz to 2 GHz, located at 1.5 m far from the shield. In the near-field set-up a small loop antenna is printed on a board and supplied with power through an amplifier in the frequency range from 1 GHz to 2 GHz. The experimental configurations are sketched in Figs. 7 (a) and (b).

In order to assure a good contact between the borders of the shield and the reference ground, the shield is pressed against the brass plate by means of a pressing device which is made entirely of polyacrylate, so that it is expected that its influence on the experimental results is negligible.

The measurements are made on different samples in order to verify the repeatability of the results. In fact, the measurement is affected by uncertainty due to several aspects: resonances inside the anechoic chamber, coupling between the near-field source and the shield, and dynamic range of the measurements limited by the quality of the room.

The frequency spectra obtained by the average of several SE measurements made on different samples having the same characteristics, in the far and near-field test set-ups, are reported in Fig. 8(a). The corresponding standard deviations are shown in Fig. 8(b).

It can be observed that in the far-field tests the measured mean varies from about 63 dB at 1 GHz to nearly 70 dB at 2 GHz. The corresponding standard deviation is 1 dB - 1.5 dB from 1.2 GHz to 1.8 GHz; higher values of standard deviation at the boundaries of the investigated frequency range are probably due to the worst performances of the radiating and receiving antennas nearby 1 GHz and 2 GHz.

In the near-field configuration, the SE of the shielding caps is reduced by about 5 dB - 10 dB with respect to the far field set-up. Moreover, it is noted that the near-field measurements are much more noisy than the far-field ones, and that the standard deviation is higher (between 2 dB and 7 dB): this behavior is probably due to the combined effects of the mismatching between the amplifier and the radiating loop antenna, and loop resonances.

Finally, the sensitivity of the SE against variation of the angular position ϑ of the receiving antenna in the near field set-up is analyzed (Fig. 7(b)). The obtained experimental data are reported in Fig. 9: the zero-degree configuration corresponds to the case in which the magnetic loop and the receiving antenna axes are parallel. In the test, the distance between the shielding box and the receiving antenna is kept constant. It is interesting to note that in the high frequency range the SE is weakly influenced by the position of the receiving antenna. At frequencies lower than 1.4

	thickness [μm]	*conductivity* [S/m]	*relative permittivity* ϵ_r	*relative permeability* μ_r
tin	3, 5, 7	$8\cdot10^6$	1	1
nickel	0.050	$1.56\cdot10^6$	1	1
polycarbonate	125	10^{-14}	2.93	1

Table I. Electrical conductivity, relative permittivity, relative permeability, and thickness of the tin, nickel and polycarbonate layers.

tin thickness [μm]	*measured* $SE_{dB,av}$ [dB]	*calculated* $SE_{dB,av}$ [dB]
3	72.48	73.40
5	78.92	77.81
7	80.35	80.94

Table II. Measured (ASTM 4935D) and calculated SEdB of the three-layer planar sample for different values of the tin-thickness. Average values in the frequency range from 30 MHz to 1.5 GHz.

frequency [MHz]	R_{dB} [dB]	A_{dB} [dB] 3 μm	A_{dB} [dB] 5 μm	A_{dB} [dB] 7 μm	B_{dB} [dB] 3 μm	B_{dB} [dB] 5 μm	B_{dB} [dB] 7 μm
100	79.54	1.46	2.44	3.42	-7.89	-4.43	-2.48
1000	69.54	4.63	7.72	10.80	-1.05	0.41	0.56
1500	67.78	5.67	9.45	13.23	-0.31	0.58	0.40

Table III. Calculated reflection, absorption, and multiple-reflection coefficients of a single layer of tin (s=8◊106 S/m), for different values of thickness.

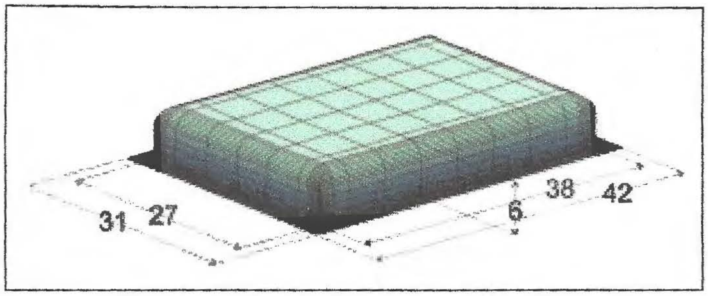


Figure 6. Sketch of the shielding cover used in the far-field and near-field tests inside the anechoic chamber (dimensions in mm).

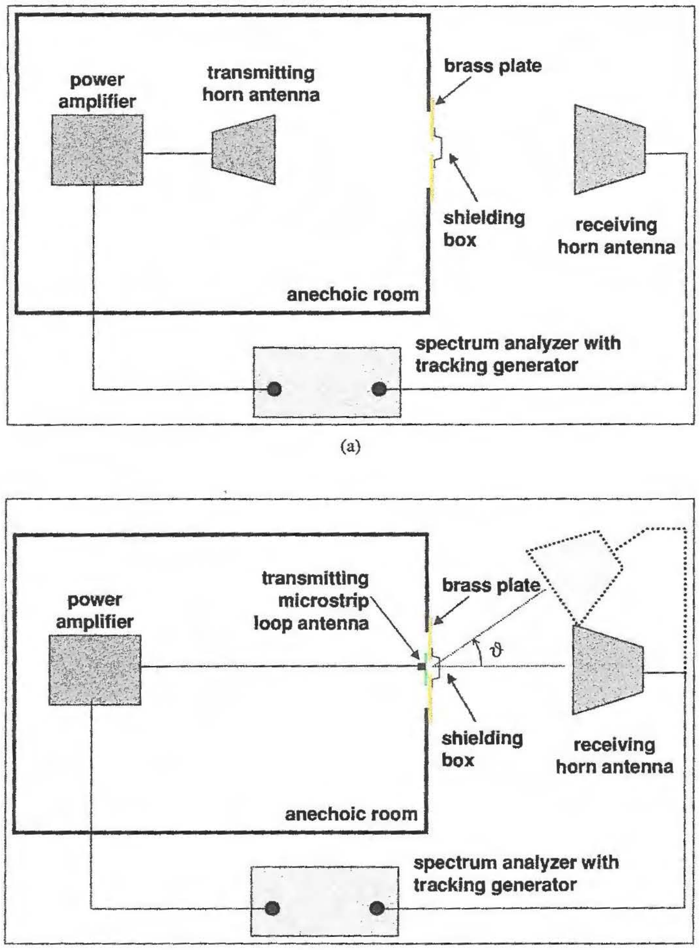


Figure 7. Schematic configuration of the test-set up for the far-field (a) and near-field (b) measurements.

GHz the $\vartheta = 0°$ configuration represents the worst case as regards the SE. In fact, for higher values of ϑ the coupling between the loop source and the receiving antenna through the aperture is weak.

III. Conclusions

An innovative concept of lightweight shield is described. The proposed shield is made by a thermoformed polycarbonate foil, which is coated by a thin layer of tin before thermoforming. Due to the great formability of polycarbonate and to the good ductility of tin, the shielding foil can be used to realize

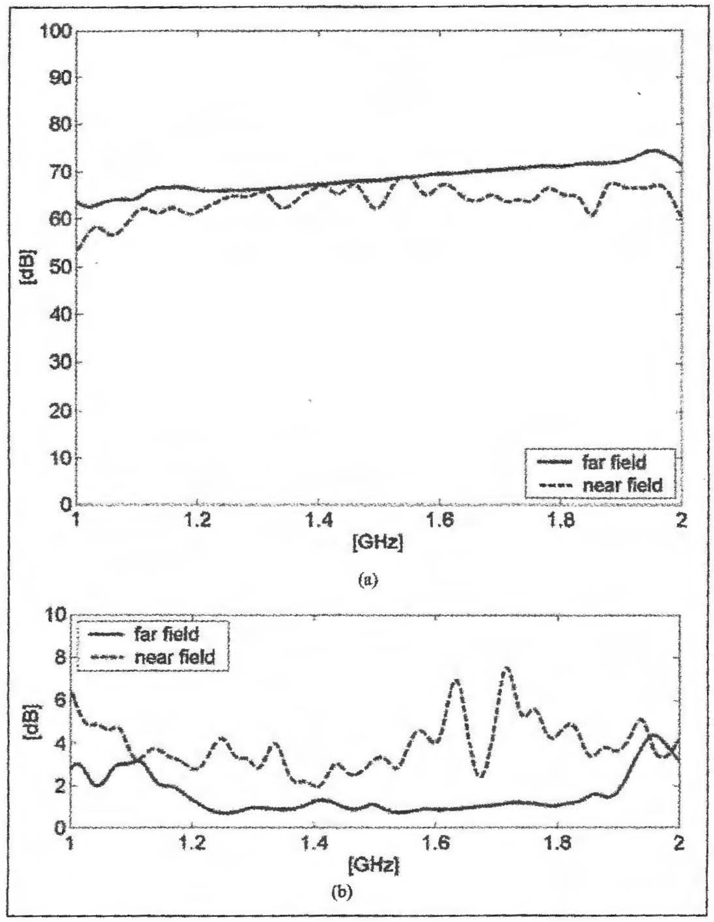


Figure 8. Frequency spectra of the SE measured in the Far-field and Near-field tests: (a) mean and (b) standard deviation among different measurements made on several cover shields having the same characteristics.

covers and caps, having different shapes, to be mounted on PCBs in order to reduce EMI and radiated emissions.

It is demonstrated that a metallic coating of only 5 µm of tin can provide an average shielding effectiveness against plane wave of about 79 dB in the frequency-range from 30 MHz up to 1.5 GHz. Such performance is motivated by the fact that in the considered frequency range the shielding phenomenon is dominated by reflection of the EM wave at the air-coating interface: for instance at 1.5 GHz the percent ratio between the reflection coefficient (R_{dB}) and the shielding effectiveness (SE_{dB}) is 87%, whereas the percent ratios between the absorption coefficient (A_{dB}) and the multiple reflection coefficient (B_{dB}) and SE_{dB} are 12% and 1%, respectively. Therefore it can be concluded that even very thin layers of conducting material are able to produce a strong attenuation of the incident field.

Near field and far field measurements performed in an anechoic chamber, in the frequency range from 1 GHz to 2 GHz, have demonstrated that the average SE of the thermoformed shields varies between 60 dB – 75 dB in spite of the non-uniform thickness distribution produced by the thermoforming process. Nevertheless, it should be highlighted that such values of shielding effectiveness are obtained as regards shields without seams or apertures, and that the metallic coating is continuous over the surface of the polycarbonate foil.

The developed shielding covers have been designed to be mounted on PCBs inside cellular phones. The main advantages of the proposed solution are the low cost of production and installation, and the light weight.

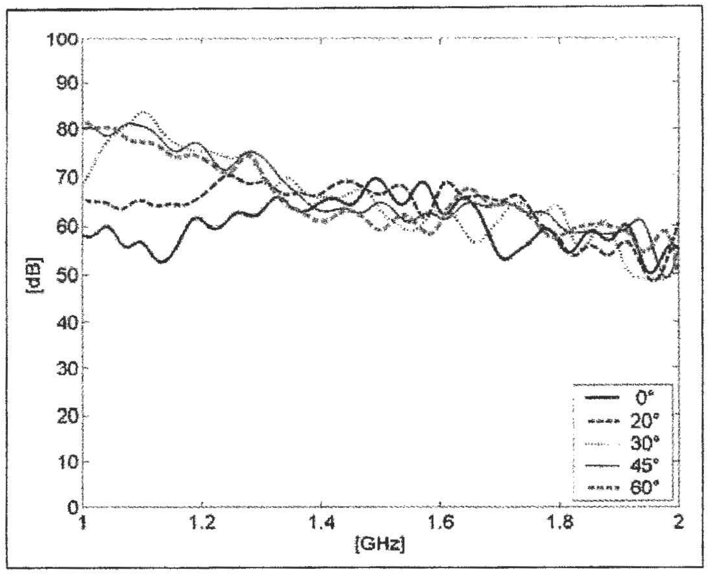


Figure 9. Frequency spectra of the SE measured in the near-field test, with respect to different angular positions of the receiving antenna.

References

1. J.A. Catrysse, "Comparative study of different combinations of metalized non-woven shielding materials and an insulating substrate, for use as shielding envelopes and small shielding boxes", Proc. EMC'96 ROMA, *International Symposium on EMC*, Rome, Italy, Sept. 17-20, 1996, pp.562-568.
2. P. Burton, "Joining of two technologies: wire mesh & plastic to produce shielded plastic enclosures", Proc. *IEEE 1999 International Symposium on EMC*, Seattle, USA, Aug.2-6, 1999, pp.586-589.
3. J. Catrysse, C. Borgmans, "Comparative testing of enclosures made from conductive plastics concerning their ESD behaviour", Proc. 11th *International Zurich Symposium and Technical Exhibition* on EMC, Zurich, Switzerland, March 7-9, 1995, paper 118R3, pp.623-628.
4. F. Grabner, J. Weiss, "Development of flexible materials suitable for shielding electromagnetic waves over a wide range of frequencies", ITEM UPDATE 2000, pg. 46-52.
5. M.S. Sarto, E. Caluri, F. Sarto, F. Nanni, "Enhancement of composite material shielding effectiveness by ion beam sputtering deposition of thin films", *EMC Europe 2000 Brugge, 4th International Symposium on EMC*, Brugge, Belgium, Sept. 11-15, 2000, Vol. 1, pp.483-488.
6. B. C. Jackson, T. W. Bleeks, "Performance characteristics of conductive coatings for EMI control", ITEM 1999, pg.125.
7. J.A. Catrysse, "Comparative study of different combinations of metalized flexible shielding materials under mechanical stress", Proc. 12th *International Zurich Symposium and Technical Exhibition on EMC*, Zurich, Switzerland, Feb. 18-20, 1997, paper 44H3, pp.235-238.
8. D.S. Dixon, J. Masi, "Thin coating can provide significant shielding against low frequency EMF/magnetic fields", Proc. *1998 IEEE International Symposium on EMC*, Aug. 24-28, 1998, pp.1035-1040.
9. M.S. Sarto, S. Di Michele, P. Leerkamp, "Electromagnetic performances of innovative lightweight shields to reduce radiated emissions from PCBs", submitted to IEEE Trans. on EMC (April 2001).
10. ASTM D4935-99 "Standard test method for measuring the electromagnetic shielding effectiveness of planar materials".
11. M. S. Sarto, "A matrix surface impedance formulation for the analysis of EM-interactions to finite laminated composite slabs", Proc. *1996 IEEE International Symposium on EMC*, S. Clara (CA), August 23-27, 1996, pp.168-173.
12. C. R. Paul, "Introduction to Electromagnetic Compatibility", New York, Wiley, 1992.

Biographical Notes

Maria Sabrina Sarto received the Ph.D. in Electrical Engineering in 1997, and since 1998 has been Associate Professor of Electrical Engineering at the University of Rome "La Sapienza", where she teaches the course of "Basic Electrical Engineering" for the degree in Aerospace Engineering, and is the head of the EMC Laboratory of the Department of Electrical Engineering. Professor Sarto is the author of more than 70 technical and scientific papers published in International Journals and in the Proceedings of International Symposia, covering several EMC topics. In particular, her research interests include susceptibility and radiated emission of transmission line networks, electromagnetic characterization of composite materials and thin films, lightning interaction to aircraft, and numerical modeling. She received the Best Paper Award at the 1993 IEEE International Symposium on EMC, in Dallas, Texas, the President's Memorial Awards in 1996 and 1997, the 1997 Best Transactions on EMC Paper Award, and the Best Poster Paper Presentation Award during the International Symposium EMC EUROPE 2000 in Brugge. She is Associate Editor of the IEEE Transactions on Electromag-netic Compatibility, a member of the TC9 Committee on numerical modeling in EMC, and of the IEEE STD 299 working group. Professor Sarto is a Senior Member of the IEEE and a Distinguished Lecturer of IEEE EMC Society.

Sergio Di Michele was born in Campobasso, Italy, in 1976. He received his degree in Electrical Engineering in 2000 from the "University of Rome – La Sapienza". In November 2000 he joined Stork Screens as a researcher. His research activities are focused on electromagnetic shielding, in particular on the shielding properties of composite materials.

***Peter Leerkamp** graduated in Physical Chemistry at the University of Leiden, the Netherlands. For more than ten years he worked at Stork Screens in the field of research and development; his main topics being sputtering, electroplating, electroforming and photo-etching. Now he works in the New Business Development department of Stork Screens, focusing on market introduction and market acceptance processes of new products in the market.*

***Henk Thuis** received his Ph.D. in Molecular Physics at the University of Nijmegen, the Netherlands. In 1980 he joined the Stork Group, where he still works. During these years he dealt with product development and was product manager for digital engraving and printing products in the textile market; since 1999 he is involved in the development of shielding products at Stork Screens.* **EMC**

Senior Member Update

Congratulations to the following EMC Society members recently elected to IEEE Senior Member Grade!

Bruce B. Willard, Long Island, New York
Francois Le Chevalier, France
Irene Zambettakis, France
Francisco Medina Mena, Spain
Hsing-Yi Chen, Taipei
Jan Luiken ter Haseborg, Hamburg, Germany
Andreas C. Cangellaris, Urbana, Illinois
Gilles Y. Delisle, Quebec, Canada
David Dixon, Newport, Rhode Island
Randy L. Haupt, Reno, Nevada

If you have been in professional practice for 10 years, you may be eligible for Senior Membership, the highest grade of membership for which an individual may apply. New Senior members receive a wood and bronze plaque and a credit certificate for up to US $25 for a new IEEE Society membership. In addition, upon request, a letter will be sent to employers recognizing the new status. And, during the IEEE's "Nominate a Senior Member Initiative", the EMC Society will be awarded US $10 for each successful Senior Member nomination made through December 31, 2001. For more information on Senior Member status, visit http://www.ieee.org/membership/grades_cats.html#SENIORMEM. To apply for Senior Member status, fill out an application at http://www.ieee.org/organizations/rab/md/smelev.htm.

2002 IEEE International Symposium on Electromagnetic Compatibility

by Dan Hoolihan, Steering Committee Chairman

The 2002 IEEE International Symposium on EMC will be held in Minneapolis, Minnesota in the middle of the United States in August of 2002. The exact dates are August 19-23; a whole week (Monday through Friday) of EMC technical papers, EMC exhibits, workshops, and social events!

The slogan for the 2002 EMC Symposium is "Superior EMC" alongside the largest body (surface-area) of fresh water in the world – Lake Superior. We encourage you to come to the largest EMC Symposium in the world and "drink" from the fountains of knowledge that will be present. We expect to have a superior event due to the outstanding people attending and presenting papers.

The 2002 EMC Symposium will be held in the Minneapolis Convention Center in "downtown" Minneapolis. The main hotel will be the Minneapolis Hyatt Regency; located about one block from the Convention Center. The airport of interest is the Minneapolis-St. Paul International Airport which is a short taxi or shuttle ride away from the Minneapolis downtown-area.

The Convention Center is large and modern; it can handle all the vendor/exhibitor booths normally associated with the IEEE EMC Symposium with room to spare! In parallel, it has many fine rooms for the technical sessions; the rooms are capable of handling anywhere from 50 to 250+ people at any one time.

We will have some fun also. We are planning some wonderful social events including tours of the Mall of America (the largest indoor shopping mall in the United States), the river city of Stillwater on the scenic St. Croix River (the boundary line between the states of Minnesota and Wisconsin), a longer one-day trip to the port city of Duluth (located on Lake Superior), and many other half day events for any and all age groups.

In addition to access to Lake Superior, Minnesota has over 10,000 fresh water lakes known for their fishing and recreational potential. Maybe a short fishing trip would be appropriate for you on your visit to Minnesota!

August is a warm month in Minnesota; we normally have highs of 80 degrees Fahrenheit during the day and lows of 60 degrees F. at night. It has never snowed in Minneapolis in August! Bring your swimsuits and shorts! You will have a great time cavorting in the lakes of Minnesota.

Our local steering committee, in conjunction with the IEEE Conference Services experts, is already hard at work planning the symposium. We look forward to having you join us in lovely Minneapolis, Minnesota for a "superior" event. **EMC**

All photos by Dick Ford

Three New Distinguished Lecturers Begin Terms in 2001

By Lee Hill, Chairman, Distinguished Lecturer Program

Colin Brench, Dr. Sabrina Sarto, and Dr. Bud Hoeft recently began their two-year terms as the newest Distinguished Lecturers (DLs) of the IEEE EMC Society. They replace Michel Mardiguian, Elya Joffe, and Mark Montrose whose terms expired on December 31 of last year. Our other two DLs, Doug Smith and Werner Schaefer, will complete their two-year terms in December.

Before introducing Colin, Sabrina, and Bud, I want to acknowledge the contributions of Michel, Elya and Mark over the past two years. During their terms, they had to endure many days away from home and family on "planes, trains, and automobiles" in order to give presentations all over the Unites States, Asia, and Europe. The Distinguished Lecturer Program depends upon knowledgeable volunteers with lecture topics that can spark an audience with humor and unique information. A big thank you to our retiring DLs and to our new expert speakers.

Here are our new Distinguished Lecturers:

Colin Brench is currently a Principal Member of the Technical Staff at Compaq Computer Corporation in the High Performance Server Business Unit. His responsibilities include EMC design and development of EMI modeling tools. Colin has been awarded eight patents for various EMI control techniques and has published over 30 technical articles. He is co-author of the "EMI/EMC Computational Modeling Handbook" and teaches regular short courses on EMC topics. Colin has been an active member of the IEEE EMC Society, Technical Committee 9 (EMCS TC9), since its inception in 1994 and provides regular updates on TC9 activities to the IEEE EMC Society Newsletter. Colin is a member of the IEEE EMC Society, ANSI C63.1, and the dB Society. He has chaired the reference antenna working group of ANSI C63.1 and is a past member of the Applied Computational Mathematics Society (ACES). You can reach Colin at colin.brench@compaq.com, telephone 1-508-467-4454.

Dr. Bud Hoeft received a B.S. and M.S. in physics from the University of Wisconsin and a PhD in physics and biophysics from Pennsylvania State University. In 1979, he completed a 25-year R&D career in the US Air Force working on acoustical noise control, bionics, nuclear weapon simulation, pulse power technology and international R&D coordination. He joined BDM, where he was primarily concerned with helping designers build and test systems that are hardened to electromagnetic effects. In 1994, he retired from BDM and became a private consultant. Dr. Hoeft is a NARTE Certified EMC Engineer. He has presented numerous papers and tutorials on shielding and electromagnetic effects at IEEE-EMC, NEM, Zurich-EMC, Wroclaw-EMC, IEE-EMC, Lightning and IICIT symposia. You can reach Bud at bud.hoeft@ieee.org, telephone 1-505-298-2065

Maria Sabrina Sarto received the Ph.D. in Electrical Engineering in 1997, and since 1998 has been Associate Professor of Electrical Engineering at the University of Rome "La Sapienza", where she teaches the course of "Basic Electrical Engineering" for the degree in Aerospace Engineering, and is the head of the EMC Laboratory of the Department of Electrical Engineering. As far as I know, Professor Sarto is the first female Distinguished Lecturer in the history of the IEEE EMC Society! She is the author of more than 70 technical and scientific papers published in international journals and in the proceedings of international symposia, covering several EMC topics. In particular, her research interests include susceptibility and radiated emission of transmission line networks, electromagnetic characterization of composite materials and thin films, lightning interaction to aircraft and numerical modeling. Sabrina has received many prestigious awards including the IEEE EMC Society's Best Paper Award at the 1993 IEEE International Symposium on EMC, the President's Memorial Scholarship Award in 1996 and 1997, and the Best Poster Paper Presentation Award at the International EMC Symposium "EUROPE 2000", in Brugge. She is an Associate Editor of the IEEE Transactions on Electromagnetic Compatibility, a member of the TC9 Committee on numerical modeling in EMC and of the IEEE STD 299 working group. Professor Sarto is Senior Member of IEEE. You can reach Sabrina at sarto@elettrica.ing.uniroma1.it, telephone +3906 44 585 543.

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 pre-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 can also contact me at 1-603-578-1842 x203, or via email at LHill@silent-solutions.com **EMC**

Personality Profile

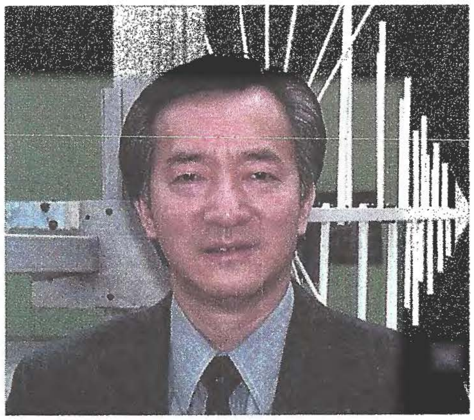
Bill Duff, Associate Editor

Introducing Kwok Soohoo

Kwok Soohoo was born in China in 1950 and spent his childhood in Hong Kong. He came to the U.S. when he was 15 years old. After adjusting to the cultural shock and receiving a crash course in English, he completed high school and went on to college at Fordham University majoring in Physics. He graduated in 1972 with a BS degree and then went to graduate school at Columbia University, studying Geophysics. His goal was to obtain a PhD and enter a career in mining engineering or oil exploration; however, his summer job at IBM turned out to be a fork in the road. The challenge and opportunity of designing multi-million dollar computers lured him away from Geophysics.

He joined IBM in 1973 in the Field Engineering Division in New York City servicing large system accounts in midtown Manhattan. He was working full time while attending Columbia University part time taking classes in Geophysics and Computer Science. In 1975, he joined IBM Poughkeepsie's Large System Development Laboratory as a logic designer working on the System 370 family of computers. He spent the next three years designing and supporting channel subsystem and attached processors for the state of the art largest single imaged commercial systems. Next he spent one year traveling worldwide while providing system and manufacturing support dealing with critical situation resolutions.

In 1979, he was exposed to the world of EMC when he was assigned to support a system that was going through the German VDE EMI certification testing. He met Dr.Chang-Yu Wu, founder of the Poughkeepsie EMC Laboratory, and was intrigued and fascinated by the challenges facing the EMC engineers. This turned out to be a crucial career turning point in Kwok's life. He accepted an offer to work in the EMC department where he has spent the last 22 years mastering the art of EMC while trying to keep pace with the explosive growth of computer technology.



His colleague Dr. Wu offered a humorous explanation why EMC is still an art rather than science: "To the neophytes EMC stands for Electromagnetic Compatibility, to the seasoned engineers EMC stands for Even More Confused, and to veteran experts EMC stands for Ever More Confused." In other words, the more we learn about EMC, the more awareness we gain about the missing puzzle pieces of our knowledge gaps. Seriously, at the moment even the world's fastest supercomputer does not have sufficient resources to totally model and accurately predict the EMI emission from a small personal computer due to the number of variables and complex interactions involved.

Kwok is a Senior Engineer currently responsible for the P-Series and Z-Series large computing system/server EMC developments; over the past 22 years he has worked on every S/370, S/390 and Power Parallel IBM system developed in Poughkeepsie. Some of the more famous computers include the 9076 Deep Blue Supercomputer that defeated the Russian Chess Champion Gary Karparov and the current number one ranked supercomputer in the world "the ASCI White" installed at Lawrence Livermore Laboratory in New Mexico. Thanks to Kwok's conscientious efforts, corporate America can sleep better knowing that their systems were designed with years of proven expertise and experience.

To round out his background in computer hardware design, Kwok recently went back to school and acquired an MS degree in Electrical Engineering from Union College.

Kwok is very active in both IEEE EMC Symposia and annual DoD E3 Conferences. He has presented paper(s) every year for the last four years either in domestic or international EMC symposia. He gave a talk on EMC at the Northern CaoTung University in Beijing at the invitation of Professor Zhang, Linchang (1997 International IEEE EMC Symposium Chairman in Beijing and Chairman of the Beijing IEEE Executive Committee). He also served as a Member of the Technical Committee for the 1997 International EMC Symposium in Beijing, China; CEEM 2000 (Second Asia-Pacific Conference on Environmental Electromagnetics) in Shanghai; and in addition he chaired two technical sessions in the Washington DC International IEEE EMC Symposium last year. He has also accepted an invitation from Professor Gao Yougang (Chairman) to serve on the Technical Committee for the 2002 International EMC Symposium in Beijing.

Kwok is an IEEE Senior Member and has also earned a senior grade as a NARTE-Certified EMC and ESD Control Engineer. With all the denial of service attacks waged on the Internet, Kwok is very much interested in assessing the threats of electronic terrorism. Dr. William Radasky, Chairman of the IEC Sub-Committee SC77C on High Power Electromagnetic Phenomena, invited him to attend the briefing in Switzerland, as an industry observer, this past February. By gathering the facts and understanding the reality and nature of the threats he can then provide proper guidance for the future system design in a proactive manner.

On a personal note, Kwok Soohoo is married and has two children. His wife Fanny is a programming consultant at IBM. Their major challenge is trying to figure out ways of raising money to pay for their daughters' tuition. His older daughter Stephanie graduated from MIT last year and is currently enrolled in New York Medical College. His other daughter is Christina who will be a senior this fall. She is studying Biochemistry at Harvard with a goal of obtaining a PhD in the field of genetics. Kwok Soohoo may be reached at ksoohoo@us.ibm.com. **EMC**

EMC Standards Activities

Don Heirman, Associate Editor

The Standards Development Committee (SDCom) of the EMC Society develops and maintains EMC test and measurement standards for use by US and international companies and organizations. These standards apply to situations that vary from site surveys to the determination of the immunity and emission properties of equipment and systems. MIL-STD-220A was developed in 1952 by the US Department of Defense for evaluation of the performance of communication filters under known source and load impedances. While there is no comparable standard for the evaluation of installed power line filters which encounter widely varying source and load impedances, MIL-STD-220A is still often used for characterizing power line filter behavior even though documented evidence shows that the results could be very misleading. Working Group P1560 is seeking to rectify this long-standing problem with standard P1560 which addresses the RF characteristics of such filters in typical load and source impedances. You are encouraged to provide Kermit Phipps and his working group with your opinions, recommendations and assistance as this work is proceeding to completion. The following article describes the issues being addressed in P1560.

Development of a Standardized Method for Measuring Power Line Filter Performance under Realistic Conditions

by Kermit O. Phipps, Member – IEEE EMC Society and Standards Association

Purpose of Proposed IEEE Standard P1560

EMI/RFI facility filters specified to typical 100 dB levels are used in government and commercial installations to prevent unwanted signals on power lines. The common standard used to measure filter insertion loss (synonymous for matched impedance attenuation, typically 50 ohms) is MIL-STD-220A. Because MIL-STD-220A was developed for matched impedance communication systems to test mobile radio filter suppression capacitors in 1952, it is often considered unrealistic for mismatched source and load impedance found in almost all power applications. Since then, other standards and methods have been discussed and developed that attempt to model "real world" attenuation by requiring varying source and load impedance. As Figure 1 illustrates, the MIL-STD-220A method gives a much different expected value for attenuation than the proposed new method.

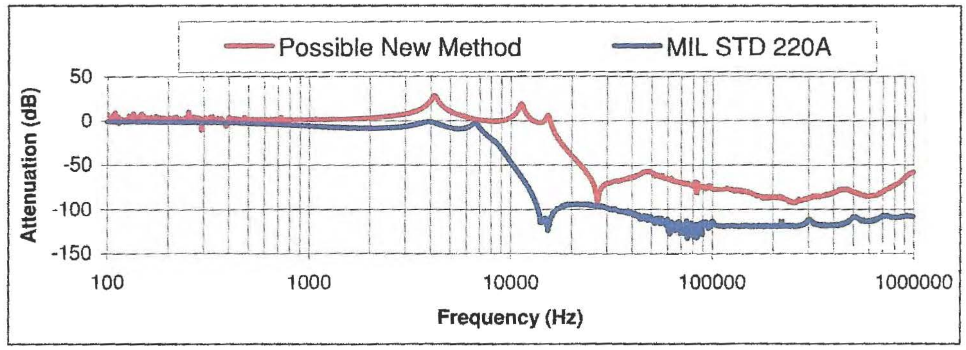


Figure 1. Generic 50 Amp filter measured using MIL-STD-220A and Realistic Method at 30 Amp loading.

To date, however, none of the other measuring methods have replaced MIL-STD-220A. The proposed new standard supports the continued use of the much-beleaguered matched impedance test above 10 MHz. Additionally, the standard addresses power quality issues and critical RF performance factors below 10 MHz for realistic load and source impedances.

Working Group Efforts

Currently the P1560 Working Group is engaged in evaluating filter standards and methods of filter characterization. These efforts are directed at bringing about standardized test methods for the effective measurement and specification of facility power line filters. After conducting a literature search and reviewing several existing standards and methods, the following key areas are being addressed:

1. Effectiveness of LISNs below 100 kHz as a Source Impedance
2. Standardized AC Source Impedance
3. Standardized Load Impedances and Nonlinear Load Characteristics
4. Waveshape Quality Measurements Under Nonlinear Loading
5. AC Filters used in DC Applications
6. Matched Impedance Measurements above 10 MHz
7. Extended Range from 100 Hz to 40 GHz Techniques
8. Repeatable and Standardized Current Injection Test Methods

The Working Group is considering all the possible variables that current standards often do not recognize. Figure 2 illustrates the situation where two different loads are tested at the same rms value of current.

As can be seen, the load characteristic is very important. Figure 3 illustrates a gain instead of attenuation across the filter band because of differences in source impedance.

To date, the P1560 Working Group has developed a "strawman" document. This draft is intended to help the group recognize the shortcomings and pitfalls of test methods as they are worked out addressing each issue listed above before the issuance of a first draft.

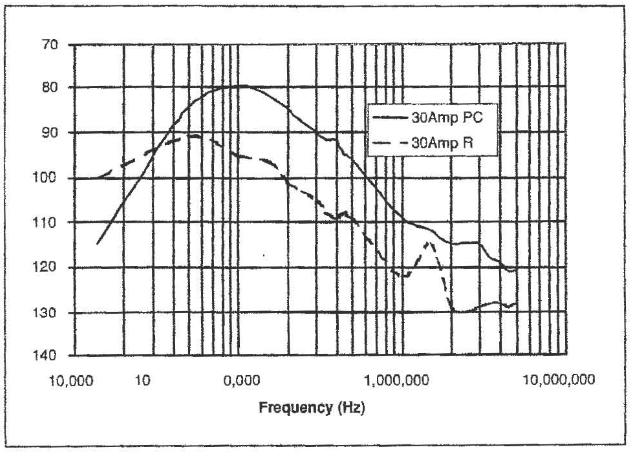


Figure 2. Measurement results for linear and nonlinear loading with the same rms current value.

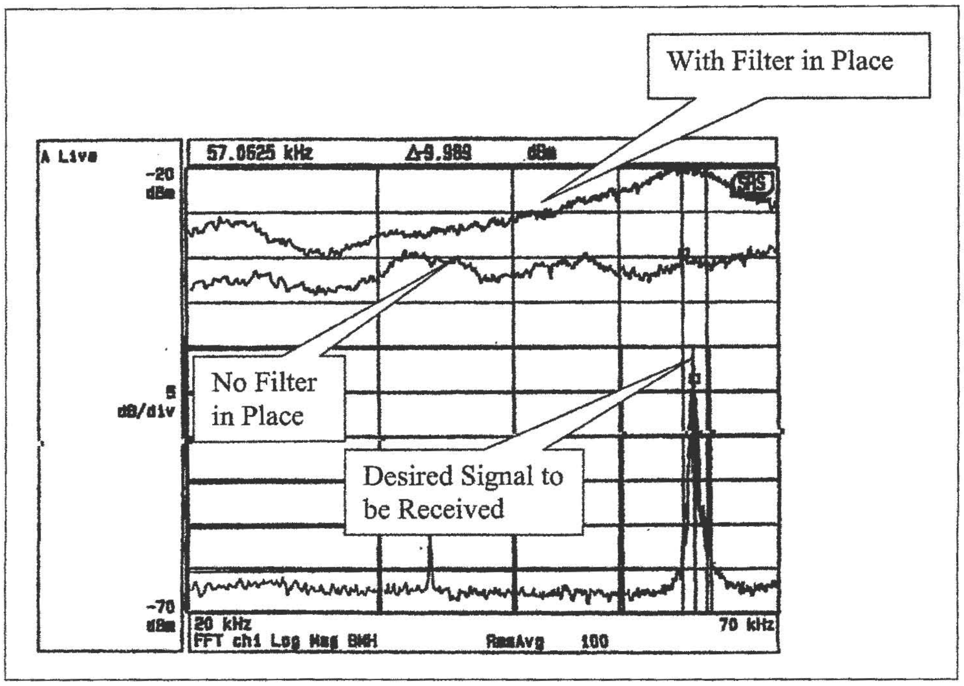


Figure 3. Filter gain across attenuation band, approximately 10 dB amplification of noise.

Volunteers

The P1560 Working Group is still currently open for membership for anyone interested in contributing. The group meets officially once a year at the IEEE EMC Symposium. All activities and issues are coordinated by e-mail. We only ask that you:

1. Participate actively.
2. Respond to e-mail requests.
3. Attend at least one official meeting a year.

If you would like to contribute to this activity, please do not hesitate to let KPhipps@EPRI-PEAC.com know.

Bibliography

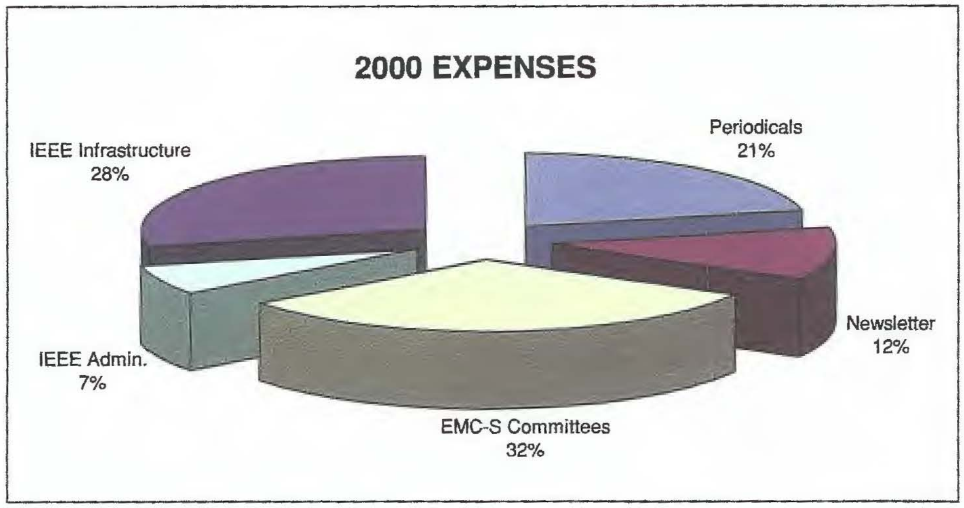
1. A. Tucker, *100/0.1 Ohm Filter Terminations and Other Extreme-Valued Affects*, 1989 International Symposium on EMC, 8-10 Sept., 1989, Nagoya, Japan, p. 828-833, Vol. 2
2. H. Weidmann and W. J. McMartin, *Two Worst-Case Insertion Loss Test Methods for Passive Power-Line Interference Filters*, IEEE January 11, 1968.
3. Heinze M. Schlicke, *Assuredly Effective Filters*, IEEE Transactions on Electromagnetic Compatibility, Vol. EMC-18, No. 3 June 1976.
4. J.R. Fischer et al., *Evaluating Filters In Situ Under Heavy Load Currents and Normal Working Impedances*, presented at the IEEE Electromagnetic Compatibility Symposium, Washington, D.C., July 1967.
5. Robert E. Hassett, *EMI Filter Characteristics and Measurement Techniques*, Interference Technology Engineers' Master (ITEM) 1997.
6. S. Eisbruck and F. Giordano, *A Survey of Power-Line Filter Measurement Techniques*, IEEE Transactions on Electromagnetic Compatibility, Vol. EMC-10, No. 2 June 1968.

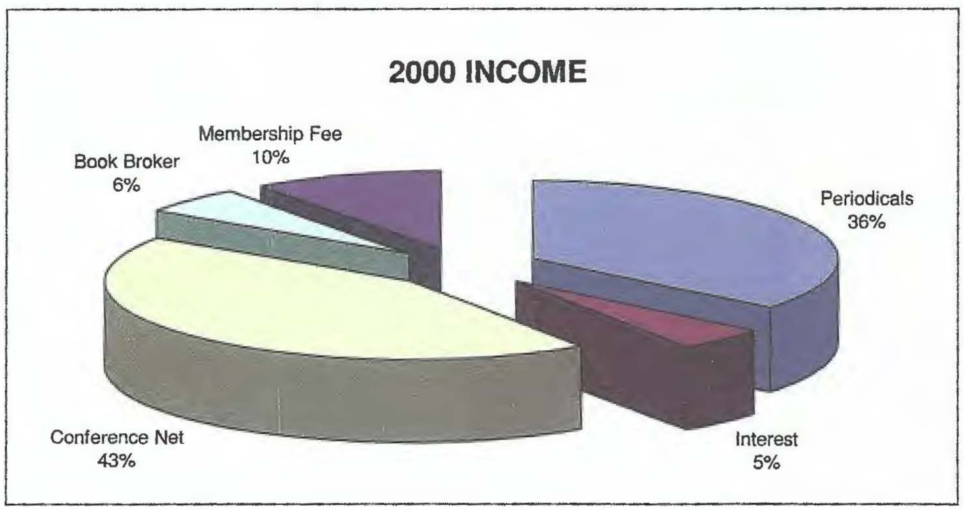
Kermit O. Phipps is the Senior Power Quality Technician at EPRI PEAC Corporation, a power quality engineering services and consulting firm, located in Knoxville, Tennessee. He has over twenty years of experience in electronics, ranging from discrete component-level troubleshooting to analog/digital system design. As a Manual Electronic Warfare Test and Component Specialist in the U. S. Air Force, he was awarded the Air Force Accommodation Medal for his expertise and work with the validation of the Central Air Data Computer Automated Test System for the F/FB-111 aircraft. For the past ten years, Mr. Phipps has conducted tests and evaluations of equipment performance in accordance with standards of ANSI/IEEE, IEC, U.S. Military, and UL, as well as with the EPRI System Compatibility Protocols. Mr. Phipps has conducted a number of power quality training sessions and numerous field investigations relating to EMI, EMF and Power Quality. He may be reached at KPhipps@ EPRI-PEAC.com **EMC**

Year 2000 EMC Society Financial Summary

by Warren Kesselman, Treasurer, EMC Society

IEEE's post audit report on EMC's 2000 financial operations indicates the Society's net for the year was a surplus of $104,000. The Society's 2000 expenses (excluding symposium finances that are administered by the individual symposium's Treasurer) were $545,000. Of that total, periodical production and distribution costs were $116,000; Committee expenses were $173,000; the Newsletter cost $63,000 to print and distribute; IEEE administrative support costs totaled $38,000; and, the Society's share of IEEE's infrastructure deficit was $155,000. Income from periodical sales was $237,000; symposia net surplus was $282,000; the IEEE Book Broker program net was $36,000; member fees provided $64,000; and, interest on the short-term investment funds was $30,000. The long-term investment return was 1.03%. The charts below give a pictorial view of the above information. **EMC**





Board of Directors Activities

Minneapolis, Minnesota
Friday, June 15, 2001

At a meeting at IEEE headquarters, Dick Ford, Steering Committee Treasurer for the 2000 IEEE International Symposium on Electromagnetic Compatibility, turned in the Treasurer's books for the IEEE required audit. Dick Ford is shown (left to right) with Pete Curtis, IEEE CMS Finance Administrator, Emily Cummings, IEEE Operations Auditor, Ken Maze, Director, Audit Operations and Sameer Qureshi, IEEE Operations Audit Intern. This Symposium set records for total attendance (3003) and for total conference revenues ($1.14M). The surplus generated was within 1% of the budget estimate ($190K). Mr. Ford presented a financial report on the symposium at the June Board meeting.

THE PRESIDENT'S OPENING REMARKS

President Butler called the meeting to order at 9:00 am. A round of introductions was made. Board members present included H. Benitez, J. Butler, L. Carlson, T. Chesworth, L. Cohen, B. Crain, A. Drozd, R. Ford, F. Heather, D. Heirman, D. Hoolihan, T. Hubing, W. Kesselman, D. Millard, M. Montrose, J. Muccioli, J. O'Neil, H. Ott, J. Perini, G. Pettit, C. Sartori, K. Williams, and T. Yoshino. Board members absent included D. Bush, E. Joffe, A. Podgorski, and D. Smith. Guests present included V. Feuerstein, R. Schlentz, and M. Volk. President Butler welcomed Vita Feuerstein of IEEE Conference Management Services (she will be working on the 2002 IEEE International Symposium on EMC in Minneapolis) and Robert Schlentz of the Minneapolis EMC Symposium Steering Committee. The agenda was then distributed. The agenda was approved as presented.

TREASURER'S REPORT

Treasurer Warren Kesselman reported that the EMC Society's net operational surplus for 2000 was $103,900. The Society remains financially sound with an estimated million dollar net worth. Regarding the budget for 2002, President Butler noted that we raised the dues last year to $20 per member. The dues were raised in part to support the new magazine initiative. However, in the IEEE's revised proposal for the magazine, several costs were increased substantially. Thus, the new magazine initiative will be postponed. President Butler recommended keeping the dues increase of $20 though so as to support the IEEE's newly imposed infrastructure charges. The Board approved a 2002 budget for the EMC Society with the following parameters: Member dues $20, Transactions budget based upon five issues or 600 pages, Nonmember subscription rate of $255 and a net surplus of $94,400. A commission was formed to look at options for the EMC Society to continue its association with the IEEE. Dick Ford will chair this with members being Larry Cohen, Jose Perini and Ghery Pettit.

SECRETARY'S REPORT

Secretary O'Neil presented the minutes from the Board meeting on February 23, 2001 in Zurich for review. The minutes were approved with one amendment.

STANDARDS SERVICES

Don Heirman, Vice-President of Standards presented his report. It was noted that the webpage (http://www.standards.ieee.org) for EMC Standards is now operational. Standards activity 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 Steve Berger. SDCom is the most active committee. They are looking at standards involving high definition and digital television. Two new standards P-1530 and P-1560 are proceeding in their development. They are branching out of worrying about immunity and looking at matters of public concern. The website has more information about SDCom activity. Mr. Heirman reported that he appointed Steve Berger to the IEEE Standards Association Standards Board new standards committee (NesCom) which is responsible for recommending approval of project authorization requests (PARs). The SETCom will hold a special workshop session on "Processes and Procedures for the Development of EMC Standards" during the IEEE EMC Symposium in Montreal. Regarding the


Photo by Janet O'Neil

During the June meeting of the IEEE EMC Society Board of Directors, a tour was conducted of the Minneapolis Convention Center, site of the 2002 IEEE International Symposium on EMC. Board members accompanied Jody Geiselhart, Sales Manager for the Minneapolis Convention Center, (center foreground) on a tour of the spacious facility.

SACCom activities, Mr. Heirman's report included a status report from Chair Elya Joffe. This included an update of CISPR activity and the work of the IEEE Standards Coordinating Committee 34 on cellular phone measurements.

COMMUNICATION SERVICES

Len Carlson, Vice-President for Communication Services, presented his report. He reported for Professor Marcello D'Amore, Transactions Editor-in-Chief. There will be a special issue on printed circuit boards (PCBs) as well as a special issue on the late Transactions editor, Moto Kanda. The special issue on PCBs will be published in November 2001 with Flavio Canaverio as guest editor. The special issue in honor of Moto Kanda will be published in February 2002 with guest editors being Chris Holloway and Perry Wilson. Professor D'Amore is also processing a proposal from Professor Gavan of Israel to do a new special issue about EMC problems due to antenna co-site. Regarding the selection process to identify the best paper from the 2000 Transactions on EMC, Professor D'Amore has received nominations from eight of his associate editors. He has organized a special session to be held during the Montreal symposium which addresses the Transactions on EMC. All Board members are invited to attend this session. Flavio Canaverio, the Managing Editor of the Transactions on EMC, is evaluating the electronic handling of Transactions papers using the IEEE Manuscript Central procedures. They hope to have this electronic submission and reviewing of the papers fully implemented by the end of this September. The announcement about electronic processing will be published in the August issue of Transactions. Regarding the Newsletter, Editor Janet O'Neil verbally reported that the last issue (Spring 2001) was 48 pages, a record length for the Newsletter. It featured a cover story about the IEEE EMCS organized special session in Zurich, coverage of the Zurich and Brugge EMC conferences (of which the EMCS was a technical co-sponsor), three practical papers, a standards activity article on ANSI ASC C63 document C63.19, and an article by Division IV Director Peter Staecker on the IEEE fiscal state of affairs. Several letters to the Newsletter were received as a result of these articles. They will be published in the next Newsletter. The Spring 2001 issue marked the last article by Associate Editor for Chapter Chatter, Todd Hubing. Ms. O'Neil publicly acknowledged and thanked Mr. Hubing for his years of service as an Associate Editor. Plans are now underway to continue the publication as a Newsletter, not a magazine, in accordance with the Board's recent direction. Advertising will be solicited for the Newsletter and will appear in the first issue published in 2002. The IEEE media department will handle the advertising efforts. Mark Montrose next presented his report as IEEE press liaison. The IEEE has completed negotiations with John Wiley and Sons, New York, to enter into a publishing partnership. The IEEE Press was running at a deficit and this publishing relationship will help them control costs. Royalty payments to authors and EMCS will remain unchanged at this time. Royalties received for the calendar year 2000 were $6,786.73. EMCS Webmaster Andy Drozd then presented his report. Most of the recent activity concerns TC-2, 5 and 8. TC-8 (Product Safety) has an alternate site and the EMCS site forwards viewers to their alternate site. New pages have been made for the RAC. The Education Committee is being approached to provide information on their activities so they can have a site. Regarding advertising on the website, two new companies have indicated interest in advertising. Mr. Drozd discussed costs involved in upgrading the website by professional outside firms. The Board approved establishing an annual budget under Communication Services starting in FY 02 to support web page activities (development, update and maintenance) across all EMCS technical committees (TCs 1-10) including Education and Student Activities, RAC, Standards, and Web Manager committees. The initial budget projections for FY 02 may become part of an out-of-cycle "New Initiative and Operational Necessities" request coordinated through the EMCS Treasurer. Mr. Drozd advised that he attended the IEEE sponsored web education workshop on April 20-22 in Alexandria, Virginia. The IEEE presented various new technologies available via the web, such as the "Hot Lava" capabilities. Mr. Drozd's report includes the 2001 IEEE Technical Societies Web Education Meeting Report. Public Relations Chair Tom Chesworth presented a report titled "Proactive Media-Based Introduction to Benefits of EMC Society Membership." He would like to reach more people outside the EMC Society and IEEE to tell them who we are and what we do. He suggested placing ads in the EMC related trade magazines, attending related trade shows and having material distributed on the EMC Society and/or performing a popular demonstration related to EMC. It was suggested that this material be posted to the EMCS website so members can review and comment upon this. Bruce Crain, Andy Drozd, Fred Heather, Dick Ford and Mark Montrose volunteered to

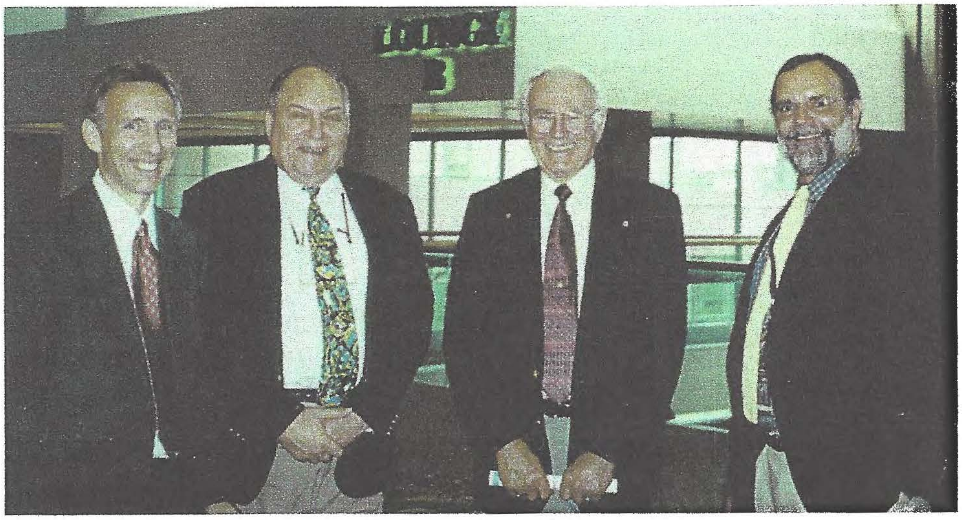


Photo by Janet O'Neil

EMCS Board members, Todd Hubing of the University of Missouri at Rolla, Tom Chesworth of Seven Mountains Scientific, Len Carlson of NW Emetek Services, and Dave Millard of the Georgia Tech Research Institute (from left) agreed that the Minneapolis Convention Center would be an ideal site for the 2002 EMC Symposium.

help Mr. Chesworth on a committee he formed to address public relations.

MEMBER SERVICES REPORT

Andy Drozd, Vice-President for Membership Services presented his report. Currently there are 4,830 active members of the EMC Society, a slight decrease from 2000. He introduced Bruce Crain who will be in charge of setting up the membership booth at our annual symposia. Mr. Crain advised that we will have two booths at the Montreal EMC Symposium and the booth will have a new banner. Mr. Crain also discussed plans for increasing senior membership levels in the EMC Society. He presented a detailed report on the Senior Membership. Andy Drozd next reported for Lee Hill, chair of the Distinguished Lecturer program. Two new lecturers, Colin Brench and Maria Sabrina Sarto, were approved for the 2001-2002 term. The Board approved Lothar "Bud" Hoeft as the third Distinguished Lecturer for the 2001-2002 term. Henry Benitez reported on Awards. The awards nomination process is now available via the EMCS website. The awards will be presented as a two-part event at the Montreal symposium. Some of the lesser awards will be presented the night before the awards luncheon. During the awards luncheon, a video will be shown of the awards presented the previous night. He presented a schedule for submitting awards. The candidates for the various awards to be presented in Montreal were reviewed. Ghery Pettit presented the report for Chapter Activities. He noted that the German chapter has a request in for Angel funds. Angel funds were distributed to the Central and South Italy EMC chapter. A new EMC chapter in Romania is in the process of formation headed by Dr. Andrei Marinescu. There is interest in Australia for forming an IEEE EMC Chapter. The Milwaukee EMC chapter was added to the chapter roster. The chapter chair is James Blaha. Mr. Joffe's report for Region 8 activities was distributed. In Mr. Joffe's absence, Mr. Drozd noted that seven new IEEE EMC Society members were recruited at the EMCS membership booth in Zurich. The EMCS international membership booth will be present at the St. Petersburg, Russia, International Symposium on EMC June 19-22, 2001. The EMCS will be a technical co-sponsor of this symposium as well as the EMC Europe 2002 conference in Sorrento, Italy and the International Conference on Electromagnetics in Advanced Applications (ICEAA-01) in Torino, Italy. Potential new EMC chapter development is underway in Belgium, Romania, Greece, Georgia (Russia) and Australia. Regarding the Region 9 report, Jose Perini advised that he had visited Mexico City and four cities in Brazil this spring. He was impressed with the well-organized IEEE membership in Mexico. There were over 54 student chapters with over 40 members on average per chapter. Carlos Sartori assisted Mr. Perini with his visit to Brazil. This country too is very fertile ground for recruiting new EMC Society members. Mr. Perini gave sevetal presentations on this trip including one on "Radiated and Injected Measurements – When are They Equivalent?" and "Measurement Uncertainty – What is it?" He is working with Elya Joffe on a special IEEE EMCS workshop to be held during the St. Petersburg Symposium. Takeo Yoshino reported on EMC activity in Region 10. He has been in contact with two new potential chapters in India and Australia, respectively. Mr. Drozd is working on preparing a SAMIeee list of EMC members in Region 10 (excluding Japan) for Dr. Yoshino in an effort to identify the most appropriate contacts to pursue in this region for chapter formation. Concerning Nominations and Bylaws, Dan Hoolihan advised there were no changes required for the bylaws. The "Call for Nominations" was printed in the Winter 2001 issue of the EMC Society Newsletter. To date, six nominations have been received. Mr. Hoolihan has requested that Board members encourage others to be considered as candidates for the Board of Directors. Regarding the Fellows Search Committee, Mr. Drozd advised that last year two Fellow candidates, Donald R. Pflug and Daniel J. Kenneally, were elected to the grade of Fellow. Their awards will be presented at the Montreal EMC Symposium. Bill McGinnis's PACE report was distributed to the Board. The main thrust for 2001 for IEEE-USA is to improve communications with and training of PACE representatives for an integrated fast response network. The PACE committee has doubled in size. Mr. McGinnis has asked Kimball Williams to join the committee as Vice-Chair and he has accepted. This should complement the EMCS Education Committee's Life Long Learning activity. Lastly, Dick Ford distributed copies of the survey which will be distributed at the Montreal EMC symposium. The EMCS experiments video was shown during the break. Mr. Ford requested comments and feedback on the video.

TECHNICAL SERVICES

Kimball Williams, Vice President for Technical Services, presented his report. He advised that the Technical Committees are attempting to pursue meetings on line. The formation of a new TC-10 on Signal Integrity is underway. The Product Safety Committee (TC-8) continues its evolution into its own IEEE Society. Andy Drozd and David Southworth are working to encourage more use of our web pages to communicate within the elements of EMCS. The symposia electronic paper review system is moving towards a cooperative implementation in conjunction with TC9 and the IEEE A&P and MTT Societies. Mark Montrose next reported on his efforts to promote TC-10. Formation of the committee will be finalized at the Montreal EMC Symposium. TC-10 has organized a half-day workshop during the symposium. Mr. Montrose will chair this workshop that was designed for those interested in signal integrity and EMC aspects related to advances within the semiconductor industry. Officers for the TC-10 are being finalized. Mr. Montrose also reported on TC-8 efforts for the Montreal EMC Symposium. TC-8 reviewed 13 papers. They have organized a half-day product safety workshop for Montreal to be chaired by Dan Modi. Murlin Marks and Jack Burns will chair a special session on product safety during the Montreal Symposium. Maqsood Mohd's report on the activities of the Education Committee was reviewed. The experiments manual will soon be posted to the website. Larry Cohen spoke on the new model for the demonstrations. Now the demonstrations include software modeling. There are approximately 15 modeling and simulation demonstrations planned for the Montreal EMC Symposium that focus on computer analysis applications for EMC using canonical-type problems. There will also be some 20-24 hardware demonstrations planned at the Symposium. Approximately 30-40% of the Symposium demonstrations will be new this year. Regarding the Student Design Competition, 37 kits have been requested from seven different countries. This is very encouraging. The University Grant program was expanded last year to include non-US universities. The NARTE Exam will be conducted on the Friday following the symposium, with the review on the Monday of the symposium week. Concluding the report of Technical Services, Mr. Williams discussed the report of the Representative Advisory Committee (RAC). Chair Dave Case reports that they have organized their traditional RAC/SACCom luncheon at the Montreal EMC Symposium. The RAC report included a budget review and cost reduction efforts. There will not be any special RAC sponsored special session at the Montreal EMC Symposium.

Photo by Janet O'Neil

The convention center featured a "Holiday Show" on the exhibitor floor. Board members Andy Drozd of Andro Consulting Services and Jim Muccioli of Jastech EMC Consulting (foreground left to right) are shown amidst the Christmas trees and various holiday themed items on display. Henry Ott of Henry Ott Consultants is shown at rear, left, surveying the scene in his role as the Society's Vice-President for Conferences.

CONFERENCE SERVICES

Henry Ott, Vice President for Conference Services presented his report. This addresses the increasing commercialism of the symposia. He also advised that there are various committees associated with the EMC Society who are holding meetings during the annual symposia. The Board approved the requirement that an EMC Society Vice-President approve a committee's request for a free meeting room during the annual symposia. President Butler noted that a task force has been formed to address the inconsistencies in symposia policy and the "institutionalizing" of more components of the symposia. Henry Ott will chair the task force with members being Don Heirman, Hugh Denny, Barry Wallen, Kimball Williams and Janet O'Neil. Mr. Ott then called upon Barry Wallen, Chair of the International Symposia Committee. Mr. Wallen reported on the various upcoming symposia as follows: 2000 Washington DC: The audit should be completed by the IEEE in August. The projected surplus is expected to be approximately $189,000; 2001 Montreal: The committee has already repaid the loan they received from the EMC Society. It was noted that the Montreal committee obtained the copy of the Zurich symposium mailing list and will use this to promote the Montreal symposium. To date there are 160 exhibitors with 266 booths sold. 85% of the room block at the Wyndham hotel has been filled. 383 registrations have been received to date. They are undertaking a strong e-mail campaign to build attendance; 2002 Minneapolis: Dan Hoolihan led a tour of the Minneapolis Convention Center, site of the 2002 IEEE International Symposium on EMC. The host hotel, the Hyatt Regency, is located across the street and is connected to the convention center by a covered skyway. Mr. Hoolihan advised that the symposium website address is www.2002-ieee-emc.org; 2003 Boston: Mirko Matejic has stepped down as Chairman of the 2003 Boston Symposium Steering Committee. Jon Curtis of Curtis-Strauss was proposed by the committee as the new steering committee chairman. The Board approved this appointment; 2006: Mr. Ott reported that the location for the Symposium in 2006 has not been determined to date. The EMC Society has been approached by

Photo by Janet O'Neil

Barry Wallen (left) and Erik Borgstrom (right) of TUV Product Service join Dan Hoolihan of Hoolihan EMC Consulting (center) for the tour of the Minneapolis Convention Center. Mr. Wallen is the Society's International Conference Chairman, Mr. Hoolihan is Chairman of the 2002 Symposium Steering Committee, and Mr. Borgstrom will handle publicity for the 2002 Symposium.

the German and Eastern North Carolina EMC Chapters to hold the Symposium in their respective areas. Mr. Ott encourages any chapters interested in holding the 2006 symposium in their respective cities to present a proposal at the August Board meeting. The Board will make a decision on where to hold the 2006 Symposium in November 2001. Larry Cohen advised that the AMEREM 2002 conference on high power electromagnetics would be held on June 3-7, 2002 in Annapolis, MD. He advised that a request was received for the EMC Society to be a technical co-sponsor of this conference. TC-5 supports this proposal. The Board could not make a decision on this request based upon the limited information received. Mr. Cohen will prepare some more information on this conference for a presentation to the Board at the next meeting. Mr. Ott then presented Chairman Elya Joffe's report as the Global Symposia Coordinator. Regarding recent global activities, the report notes that the Zurich conference special session organized by Don Heirman and Ed Bronaugh on measurements above 1 GHz and associated uncertainty was well received and attended by some 100 people. Future global activities include the EMC conference in St. Petersburg this June where the EMCS will hold a special session on "EMC Aspects in the Analysis and Design of Printed Circuit Boards" and on "Techniques and Facilities for EMC Measurements." The International Conference on Electromagnetics in Advance Applications will take place in Torino, Italy this fall. The EMCS will be a technical co-sponsor of the following future global EMC symposia: EMC 2002 Beijing, EMC Europe 2002 Sorrento, and EMC 2002 Wroclaw. Mr. Joffe's report covers recent activity on the 2003 IEEE International Symposium on EMC in Tel Aviv. The symposium is on track and is following the master schedule as planned. A document has been prepared which is titled "How to Obtain EMCS Co-Sponsorship" so that organizers of global EMC conferences can understand in advance how to approach the Board to obtain co-sponsorship. Janet O'Neil presented her report as Exhibitor Liaison. She advised that she has fielded several calls from exhibitors and has worked with the Montreal conference management representative on various exhibitor issues. Ms. O'Neil noted that the exhibitor point policy and rules will be posted to the EMCS website in addition to the actual point system grid which is currently posted. The agenda is being prepared for the exhibitor's breakfast in Montreal. Ms. O'Neil next reported on regional conferences. There were five technical conferences and tabletop shows sponsored by regional EMC chapters during the spring, including the Chicago, Southeastern Michigan, Portland, Seattle, and San Diego chapters. These events were well attended and will be featured in the Chapter Chatter column. Andy Drozd and Warren Kesselman organized the shipment of IEEE and EMC Society membership and promotional material to each of these chapter events. Ms. O'Neil acknowledged in particular the outstanding job Clayton Paul did in promoting membership in the IEEE at the chapter events at which he was a speaker. There are no plans for such tabletop shows in the summer and one is planned to date by the Rocky Mountain Chapter for October 3, 2001.

OLD BUSINESS

There was no Old Business to discuss.

NEW BUSINESS

The following items were discussed under new business:

DISTRIBUTION OF EXCESS EMCS MATERIAL – Andy Drozd distributed a report on the excess EMCS material, including CDs, Symposia records, etc. that is currently in storage.

MEETING SCHEDULE FOR 2002 – EMCS President-Elect Todd Hubing proposed the following meeting schedule for 2002:

- February 13 in Tempe, AZ
- May 31 in Boston, MA
- August 18 and 22, in Minneapolis, MN
- November in Sao Paulo, Brazil (date to be determined)

ACTION ITEM REVIEW

President Butler reviewed the action items discussed during the meeting.

ADJOURNMENT

There being no further business, the meeting then adjourned at 5:03 pm.

Janet O'Neil
Secretary
EMC Society Board of Directors
EMC

Book Review

Reinaldo Perez, Associate Editor

Book: Electromagnetic Field Measurements in the Near Field
Author: Hubert Trzaska
Publisher: Noble Publishing, 2001, 216 pages

Measurements are an essential part of EMC and I thought this book could be of use to many of us. Though most EMC standards address measurements in the far field, it turns out that many of the diagnostics done in EMC and other disciplines (e.g antennas, radars, etc.) is done in the near field. I have come across other texts that deal with EM measurements in the near field but this is a new book that addresses such near field measurements from a general approach.

The book is divided into ten chapters and their titles are as follows: Chapter 1: Introduction, Chapter 2: The Principles of Near Field EMF Measurements, Chapter 3: EMF Measurements Methods, Chapter 4: Electric Field Measurements, Chapter 5: Magnetic Field Measurement, Chapter 6: Power Density Measurements, Chapter 7: Directional Pattern Synthesis, Chapter 8: Other Factors Limiting Measurements Accuracy, Chapter 9: Photonic EMF Measurements, and Chapter 10: Final Comments.

EMF measurements in the far field (fraunhofer zone) are one of the less accurate measurements of physical quantities. Hazardous exposure to EMF requires field measurements in the primary and secondary field sources as well as fields disturbed by the presence of materials and the transmission media. The attention of this book is in the near field (fresnel region). The near field conditions cause further degradation of the near field EMF measurements accuracy as compared to those in the far field. These difficulties bring frustration to the designers of EMF measurement equipment. The problem with EMF standards is to address the accuracy of field measurements. According to the author, the accuracy of a good EMF standard does not exceed +/- 5%. The book is devoted to the specific problems of EMF measurements in the near field and to the analysis of the main factors limiting the measurement accuracy, especially in the near field. Chapter 1 addresses the numeric limits and frequencies in some of the known standards. Chapter 2 provides essential information for practical metrology, including a brief summary of the near field properties as well as the basic equations and formulas related to fields generated by simple radiating sources.

In order to determine the best method for EMF measurement in the near field, it is first necessary to determine which quantities best characterize the field. These quantities will then be the subject of measurements. Chapter 3 addresses the measurements of E, H and S in the near field. From the point of view of shielding, absorbing, or EMF attenuating materials, investigations of the E, H and S measurements are sufficient. For protection from unwanted EMF, the measurement of specific absorption rate (SAR) is added to the needed measurements. The SAR is calculated based on temperature rise measurements. The chapter also addresses the measurements of induced currents in the body. Electric field measurements are discussed in Chapter 4. The basic method of electric field measurements, within a wide frequency range, involves the use of a charge induction in a body illuminated by the field. Field averaging by a measuring antenna is discussed in the chapter and error of E-field measurement resulting from averaging of the measured field by the measuring antenna is calculated. The possibility of the field spatial distribution measurement, especially under conditions of multipath propagation and interference, and the measurement of the maximal and minimal magnitudes of the field strength requires the use of probes equipped with antennas whose sizes are much less than the wavelengths. Dipoles are normally used for such measurements and the measurement error versus Kh of the dipole antenna is calculated. It is important to know the precise frequency response of E-field measuring probes. In order to achieve this, the schematic representation of an E-field probe is studied (for low and high frequencies), as well as the schematic representation of such probes with different types of filtering. Chapter 4 also addresses the interactions of the measuring antenna and the field source and the sources of errors that such interactions introduce. This work is also extended to include errors from antenna input impedance changes. The chapter also addresses the changes to the probe's directional pattern. The magnitudes of the calculated directional pattern irregularities versus Kh are presented. This consideration is related to the electrical length of the dipoles, which is of special concern when resonant antennas are used (for shorter antennas, the error vanishes). The chapter ends with comparison of E-field probes.

Chapter 5 is very similar to Chapter 4 in its approach as it addresses magnetic field measurements. This chapter discusses probe properties for RF magnetic field measurements and in particular, the factors limiting measurement accuracy. The approach is limited to a probe consisting of a circular loop antenna loaded with a detector of a shaped frequency response. The majority of the presented estimations are fully applicable for hall-cell probes, magneto-optic probes, magneto-diode probes, and for other designs, especially when considering the averaging of the measured field upon the surface of the measuring antenna. As was done in Chapter 4, the frequency response of the probe is modeled using circuit analysis by representing the probe in its electrical schematic representation. The error in the accuracy of the measurement is made as a function of the distance between the source of radiation and the antenna. The effect of antenna input impedance is also addressed in the calculations.

Power density measurements are discussed in Chapter 6. The power density measurements in the near field (especially in proximity to electrically small sources) using the electric or magnetic field measurement is burdened with an error whose value is dependent upon the type and the structure of the source and the measured EMF component as well as the distance between the source and a point of observation. Based upon error measurements as a function of kR, as well as assuming the smallest distances from a field source in which the measurements should be performed, it is possible to estimate the minimal frequency at which the measurement may be applied without the necessity of using additional correction factors (because of the deterministic character of the error, the factors may be analytically estimated for a known source type, measured EMF component, propagation geometry and distance). Widely applied methods of the electromagnetic power density measurement are presented and analyzed in this chapter. The considerations are purely theoretical in character and they are concerned with the fields' relations only. The source of the accuracy limitation of the measurement (error of the method) is demonstrated in the chapter and the magnitude of the error for different combinations of source and measured is estimated. Then, a certain improvement of the accuracy, as a result of simultaneous measurements of E and H fields, and calculation of an arithmetical or geometrical mean is proposed. Chapter 7 addresses the detailed considerations of the polarization problem resulting from the need to understand and apply the omni-directional probes as well as their design and construction. These needs are the result of: the specificity of the polarization intricacies, especially in the near field; the necessity of understanding the polarization phenomena in order to select optimal procedures when measurements are planned and for interpretation of their results; and the development of the ability to select an appropriate probe and meter for specific measurements conditions.

In the previous chapter, the most typical and frequent factors limiting EMF measurement accuracy were discussed. They resulted mainly from the type of antenna applied in the EMF probe, its size, and mutual coupling between the antenna and the radiation source. In Chapter 8, a brief discussion is presented on the influence of thermal drift upon the probe parameters, the role of its dynamic characteristics, and the deformation of the measured field by a person performing the measurements, the meter, resonant phenomena, and other factors.

Chapter 9 addresses the issue of photonic measurements. There is considerable literature devoted to the field of opto electronics elements use as sensors for a variety of physical measurements. Several publications discuss the use of opto electronic transducers for EMF measurements. The principle of a photonic transducer may be conveyed to the modulation of an optical beam and the subject of the modulation may be the signal's phase (which is a function of the light velocity of propagation in an electro-optic medium), its frequency, amplitude or polarization. The type of modulation as well as that of the electro-optic crystal is selected in such a way as to obtain the device's maximal sensitivity. Sensitivity is still a measure issue with optical detectors. In Chapter 9, two approaches are followed; the direct interaction of the measured field onto the electro-optical crystal, and a voltage induced by the field in an auxiliary antenna (playing the role of the measured field concentrator) impressed to the modulator. Apart from technological differences, the factors limiting measurement accuracy are, in the case of the photonic probes, similar or identical to those discussed in Chapter 8.

Chapter 10 is dedicated to some final comments by the author. Again, this is a new and useful book which I recommend. **EMC**

Additional Comments on the IEEE Fiscal State of Affairs

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

Concluding remarks of my last article on the general financial state of health of the Institute as of the end of March included the following challenges for fiscal improvement:

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 May, there is progress to report on these challenges:

Overhead Administration Recovery (OAR)

More than another new name for another new financial model, OAR addresses point 4 above head-on. The OAR Committee, chaired by President-elect Ray Findlay, proposed guidelines based on the premise that all organizational units contribute value to IEEE. With the objective of finding long term solutions, the proposed model:

- Links direct costs associated with revenue to the appropriate revenue streams, wherever possible. This is the famous *pay-by-the-drink* philosophy.
- Redirects a portion of revenues to cover administrative (indirect) costs.

You may say that this exercise is simply re-arranging the deck chairs on the Titanic, since it does not create any new revenue. By transferring the oversight of the cost of doing business to the proper OU's, however, this model will encourage and facilitate cost reductions by the responsible organizations. While the details of this cost linkage/allocation are still being hammered out, the guideline of point 3 above will be observed, so that we do not create additional costs due to tracking overhead. The OAR committee also proposed increasing revenues, by means of:

- An Institute-wide membership dues increase.
- Price increases of products to more appropriate levels.

Which brings us to the second action:

Balancing the Budget

A false sense of security regarding our reserves has evolved over the past few years, during which substantial market gains in our investment portfolio have obscured the fact that our revenues (net of investments) are exceeded by our expenses. For the year 2002 (the present budget cycle), our starting position is not pleasant. With the pre-May assumptions in place, the Institute budget net for 2002 will be a whopping $28M NEGATIVE, if one assumes a zero net return on investment. The IEEE Executive Director and staff were tasked with producing a budget that achieves a zero impact to reserves, with less dependence on investment gains, and minimal reductions in member services. The plan was presented to ExCom on May 5, and consists of the following challenges to the Operations Budget:

a. A reduction in core functions (direct and indirect charges to OU's) and continuing IEEE initiatives. Cost savings: $3.5M
b. Reduction in staff compensation. Cost savings: $2.1M.
c. Member service reductions. Cost savings: $150K
d. Net revenue enhancements in Publications, Products, and Services (P2SB). Net: $1.35M
e. Net revenue enhancements in other major Boards (EAB, RAB, IEEE-USA, Standards Association). Net: $1M
f. Net revenue enhancements in TAB and Societies. Net: $3.5M
g. IEEE dues and packaged products revenues increases. Net: $4.1M

There is much detail behind a-g, and that detail will be discussed at length and with larger audiences. Net budget improvements from these items for 2002 amount to ~$16M.

Separate from the Operations Budget, the Investment Budget for 2002 will assume a 6% return, historically mediocre, and slightly less than the real rate of return of the S&P composite index dating back to 1871. 5% is a more appropriate number to use, as it is consistent with university and endowment spending rules, but is a bit too draconian to implement as early as 2002. Budgets for 2003 and beyond will incorporate this lower level of spending, however, so that an investment return of 5% or greater will add positive numbers to the reserves for that year. Doing the math, the 6% investment return assumption yields an additional $12M for 2002, yielding the net zero goal. Whew! But don't forget, these challenges are on top of other pre-May cost-cutting measures, which already had reduced initiatives and core functions.

Discussion

A financial business model and a balanced budget are being implemented for 2002. TAB-related business rule simplification dialogue will continue this year, with implementation scheduled for 2002, and financial return for 2003. By the time you read this, the governing body of your Society or Council will have had its marching orders passed down from TAB on how to meet the cost savings and revenue enhancements of items a and f, above. Having just returned from my Society's AdCom meeting, where a project (initiated by me) previously approved was cut, I understand the unpleasantness this situation creates. The good news is that a zero net budget at the IEEE level means that Society reserve accounts do not deteriorate over the long term, pay-by-the-drink encourages responsible business infrastructure investment, and adoption of a 5% spending rule is the first step in assuring the long-term growth of IEEE reserves.

My email address is at the top of this column. Let me know your thoughts. **EMC**

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: 01-8-2001

SPECTRUM MANAGEMENT, PRICING, AND EFFICIENCY CONTROL IN BROAD-BAND WIRELESS COMMUNICATIONS

Cengiz Evci and Bernard Fino
Alcatel, 75008 Paris, France, now with Evolium, a joint venture of Alcatel and Fujitsu, 78138 Velizy, France; CNAM, 75003 Paris, France, respectively

Proceedings of the IEEE, Vol.89, No.1, January 2001, pp. 105-115.

Abstract: Increasing demands for communications spectrum require new methods of spectrum management. This paper provides an overview of some important issues, including regulatory considerations. The allocation process, technical progress and trends in spectrum pricing are reviewed. Also of concern is the problem of spectrum efficiency (getting more out of a limited resource). The 20 sharing of bands is also reviewed in light of recent developments, e.g., Bluetooth. Some 20 pricing concepts are applied to CDMA and TDMA systems.
Index terms: Spectrum management, propagation issues, technical issues, spectral efficiency, 20 spectrum pricing.

EMCABS: 02-8-2001

SOME ELECTROMAGNETIC ASPECTS OF CORELESS PCB TRANSFORMERS

S. Y. (Ron) Hui, S. C. Tang, and Henry Shu-hung Chung
Department of Electronic Engineering, City University of Hong Kong, Kowloon, Hong Kong

IEEE Transactions on Power Electronics, Vol. 15, No. 4, July 2000, pp. 805-810.

Abstract: In previous papers, the authors resolved several doubts about the use of coreless PCB transformers. In this paper, the authors investigate the radiation from the loop antennas formed by such transformers using antenna theory, field simulation and measurements. Measurements made on circuits described in the paper confirm the theory that coreless PCB transformers do not produce significant radiation in typical applications. The authors point out that the radiation from PWB traces in such circuits provides most of the measured radiated field.
Index terms: Coreless PCB Transformers, Power Supplies, radiation from coreless PCB transformers, field simulation, field measurement.

EMCABS: 03-8-2001

A REALIZATION OF TRANSPARENT WAVE ABSORBER USING RESISTIVE-FILM AT X-BAND FOR OBLIQUE INCIDENT

Masahiro Hanazawa, Osamu Hashimoto, and Hidetoshi Ebara
College of Science and Engineering, Aoyama Gakuin University, 6-16-1 Chitosedai, Setagaya-ku, Tokyo, 157-8572 Japan

The Transactions of the Institute of Electronics, Information and Communication Engineers B, Vol. J83-B, No. 2, February 2000, pp. 245-251.

Abstract: We already realized the transparent wave absorber for angle using resistive-film at 1 GHz, 10 GHz and 60 GHz. The necessity of the transparent wave absorber for oblique is high because electromagnetic waves do not always incite the wave absorber vertically. In this paper, we try to realize the transparent wave absorber using resistive-film with angle characteristic at X-band frequency. As a result, we confirm

that the realization of the transparent wave absorber for TE-wave which has absorption of more than 20 dB at 0-40[deg.], and also that the absorption of transparent wave absorber for TM-wave which has the absorption of more than 20 dB at 0-30[deg.] These types of wave absorbers will be used as a wall because the thickness is about 5.3-5.6[mm].

Index terms: Transparent wave absorber, X-band, angle characteristics, resistive-film.

EMCABS: 04-8-2001

A STUDY ON THE SMALLER DOOR SEAL STRUCTURE OF A MICROWAVE OVEN USING THE FDTD METHOD

Yusuke Kusawa+, Osamu Hashimoto+, and Minoru Makida++

+Aoyama Gakuin University, 6-16-1 Chitosedai, Setagaya-ku, Tokyo, 157-8572 Japan

++SHARP, 3-1-72 Kitakamei-cho, Yao-shi, 581-0066 Japan

The Transactions of the Institute of Electronics, Information and Communication Engineers B, Vol. J83-B, No. 4, April 2000, pp. 544-553.

Abstract: In this paper, SE (shielding effectiveness) of the choke groove whose depth dimension was reduced to a half scale compared to the conventional one was examined oscillating the more real leakage wave that includes the higher modes using the FDTD method. First, the optimum dimensions of the 2-dim cross-section groove were calculated on TEM mode so that the calculation time can be minimized. And then the 3-dim groove model with the periodic slits was analyzed using the optimum data from 2-dim analysis. Also the groove combined with a lossy material, which is used secondary to compensate the SE decrease, was examined, too. The propriety of the analytical results was confirmed experimentally because the SE level of the manufactured choke was about 31 dB.

Index terms: Microwave oven, door seal, lossy material, shielding effectiveness, FDTD.

EMCABS: 05-8-2001

SIMULATION OF TRANSMISSION WAVES THROUGH MULTI LAYERED THIN CONDUCTING SHEETS BY FDTD METHOD

Toru Fukasawa, Hiroyuki Ohmine, Isamu Chiba, and Yonehiko Sunahara

Information Technology R & D Center, Mitsubishi Electric Corporation, Kamakura-shi, 247-8501 Japan

The Transactions of the Institute of Electronics, Information and Communication Engineers B, Vol. J83-B, No. 5, May 2000, pp. 711-719.

Abstract: The shield material is frequently made of multi-layered thin conductor films. To estimate the shielding effect by the FDTD method directly, the cell size must be as small as the thickness of the conductor films. Because the size of the shield material is much greater than that of conductor thickness, the number of cells increases significantly. In this paper, a resistance sheet that has the same transmission coefficient as that of multi-layered conductor films is proposed as a sub-cell method in FDTD. It becomes possible to simulate an accurate transmission coefficient without an increase in the number of cells.

Index terms: FD-TD, sub-cell method, multi-layered structure, transmission coefficient.

EMCABS: 06-8-2001

DOSIMETRY ANALYSIS AND SAFETY EVALUATION OF REALISTIC HEAD MODELS FOR PORTABLE TELEPHONES

Osamu Fujiwara, Takahiro Joukou, and Jianqing Wang

Faculty of Engineering, Nagoya Institute of Technology, Nagoya-shi, 466-8555 Japan

The Transactions of the Institute of Electronics, Information and Communication Engineers B, Vol. J83-B, No. 5, May 2000, pp. 720-725.

Abstract: This paper evaluated the dosimetries in five kinds of our developed realistic human head models simulating an adult through an infant for portable telephones. The FDTD (finite-difference time-domain) method was used to compute both the SAR (Specific Absorption Rate) and temperature rise. As a result, we found that the peak SARs averaged over any one-gram of tissue exceeded the guideline value (1.6 W/kg) being specified in ANSI/IEEE C95.1-1992, while the ten-gram peak SARs do not exceed the ICNIRP/Japan specified value (2 W/kg). The peak temperature-rise, however, was found to be less than 0.2 degrees centigrade on the head surface. On the other hand, we also found that the temperature rises at the hypothalamus increase with reducing the head size, which are less than 0.003 degrees for the adult-size model and also 0.05 degrees for the infant-size head model. The above temperature rises are significantly lower than the threshold value (0.3 degrees) causing body-temperature regulating action, which implies that the present portable telephones produce no heat stress, even though the localized peak SAR exceeds the specified guideline value.

Index terms: Portable telephone, biological effects, partial-body absorption guidelines, realistic head models, dosimetry.

EMCABS: 07-8-2001

TIME-DOMAIN ANALYSIS OF THE ARC VOLTAGE AND ELECTROMAGNETIC NOISE CAUSED FROM OPENING ARC DISCHARGE BETWEEN THE C AND CU CONTACT

Toshiaki Koizumi+,++, Kumio Takahashi+, Yasuo Ebara++, Hideaki Sone++, and Yosiaki Nemoto++

+Research Dept. 1, Research & Development Laboratory, Hitachi Koki Corporation, Hitachinaka-shi, 312-8502 Japan

++Graduated School of Information Science, Tohoku University, Sendai-shi, 980-8579, Japan

The Transactions of the Institute of Electronics, Information and Communication Engineers B, Vol. J83-B, No. 7, July 2000, pp. 1027-1033.

Abstract: A pair of brushes is commonly fixed symmetrically in a small commutator motor. Arc discharge between the brush and commutator causes EM (electromagnetic) noise. Arc discharges simultaneously occur at both brushes with different current polarities. One of the current polarities is Cu (cathode) that means the current direction from the brush to the commutator, and another is the opposite direction denoted by C (cathode). This paper shows the characteristics of the opening arc voltage and EM noise with opening arc discharge of each current polarity between Cu-C electrodes at DC40 V, 2 A with load inductance 0.8 mH. It was found that maximum EM noise level at every operation of Cu (cathode) was about 20 dB higher than that of C (cathode), and maximum EM noise was observed at the arc extinction for Cu (cathode) while it was in the middle of arc duration for C (cathode). The gradient of the

+++Communications Research Laboratory, M.P.T., Koganei-shi, 184-8795 Japan
The Transactions of the Institute of Electronics, Information and Communication Engineers B, Vol. J83-B, No. 12, December 2000, pp. 1739-1746.
Abstract: Biconical antennas are commonly used for radiated EMI measurements in the frequency range of 30 to 300 MHz. Therefore, antenna calibration is theoretically investigated for biconical antennas by using the moment method. It is found that at frequencies below 70 MHz, adverse effects on the calibration are mainly caused by strong mutual coupling between transmit antenna and a reference dipole antenna. On the other hand, at higher frequencies, abrupt changes in the electric field impinging on a biconical antenna produce serious errors in the antenna calibration. Based on these error analyses, appropriate antenna separation distance is deter mined which is required for marking calibration of a biconi cal antenna with an accuracy of 0.1 dB. In addition, EMI mea surement errors caused by the use of a biconical antenna ar investigated assuming an EUT as a radiating point source. I is found that measurement results obtained with a biconica antenna agree well with those measured using a standarc dipole antenna within about 1.0 dB. However, the differences in the results are greater in the vertical polarization measurement than in the horizontal polarization measurement, particularly in the case of 3m-antenna separation. Finally, it is found that the use of free-space antenna factors could reduce the differences in measurement results.
Index terms: EMI measurements, EMC, biconical antenna, antenna calibration. **EMC**

Chapter Chatter

continued from page 14

United Kingdom and Republic of Ireland

The Chapter holds four to six meetings each year at a variety of venues such as Osborne House, which was Queen Victoria's home, and onboard the 1860's warship HMS Warrior at Portsmouth dockyard. The series last year culminated in EMC Society Distinguished Lecturer Doug Smith's very well received afternoon lecture at King's College London on "High Frequency Measurements." Some meetings are jointly held with various Compliance Associations that are regional business "self help" groups and speakers are often provided by the Chapter. At the March meeting, Brian Jones covered the EU EMC Directive SLIM Initiative and David Mawdsley spoke on OATS measurements. In June, an excellent meeting on Earthing and Lighting was held at Bletchley Park, the World War II secret code breaking heritage centre. Keith Armstrong spoke on "Earthing for EMC and Lightning Protection for Apparatus and Installations." John Hardwick and Tim Bowly then continued the lightning protection and testing theme for aerospace systems. After lunch all enjoyed a guided tour of the site. Checkout the forthcoming event information at http://www.ieee.org.uk/emc.html. **EMC**

Photo by John Duerr

Members of the UK&RI Chapter Committee are shown with speaker Doug Smith at King's College London. Back Row (L-R), Charles Turner our host at KCL, Dave Atkins from Astrium, Graham Mays of DERA, Martin Green of Technology International, Jon Duerr of Mitsubishi, Tony Swainson, Consultant. Seated (L-R), Doug Smith of D.C. Smith Consultants and Roy Ediss of Philips Semiconductors.

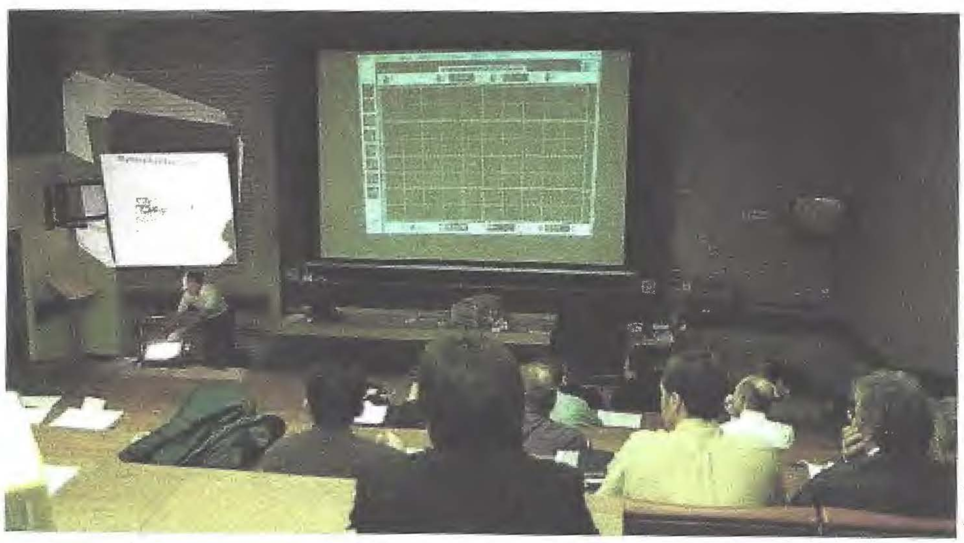


Photo by John Duerr

Doug Smith was the speaker at the last meeting of 2000 held by the United Kingdom and Republic of Ireland Chapter. He spoke on "High Frequency Measurements" and is shown in action in the lower left of this photo.

Calendar

EMC Related Conferences & Symposia

2001

October 21-26
Sponsored by the Antenna Measurement Techniques Association (AMTA)
AMTA Annual Symposium
Denver, CO
Mike Francis
Phone: 303.497.5973
francis@boulder.nist.gov
http://www.amta.org/AMTA2001

October 28-30
Sponsored by the IEEE
IEEE-NANO 2001
Maui, Hawaii
Professor Toshio Fukuda, General Co-Chair
Phone: +81.52.789.4478
Fax: +81.52.789.3115
E-mail: Fukuda@mein.nagoya-u.ac.jp
Dr. Robert D. Shull, General Co-Chair
Phone: 301.975.6035
Fax: 301.975.4553
E-mail: Shull@nist.gov
http://www.mein.nagoya-u.ac.jp/IEEE-NANO

December 3-7
Five Day Reverberation Chamber Course (with Experiments)
NSWC Dahlgren, Virginia
Mike Hatfield
Phone: 540.653.3451
E-mail: HatfieldMO@NSWC.navy.mil
http://www.egginc.com/dahlgren

2002

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 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

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
2003	Boston, MA Sheraton Boston Jon Curtis 978.486.8880
2004	Santa Clara, CA Franz Gisin 408.495.3783
2005	Chicago, IL Derek Walton 815.637.3729

IEEE EMC Society Board of Directors Meetings

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

November 13, 2001
San Diego, California
February 13, 2002
Tempe, Arizona
May 31, 2002
Boston, Massachusetts
August 18 and 22, 2002
Minneapolis, Minnesota (in conjunction with the IEEE EMC Symposium)

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

October 3, 2001
Rocky Mountain EMC Chapter
Contact: Lyle Luttrell, lluttrell@ieee.org
(see ad on page 41)

http://www.emcs.org

This newsletter is online!
Visit the web page address above and click on the "Newsletter" button.

Institutional Listings

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

An Institutional Listing recognizes contributions to support the publication of the IEEE EMC SOCIETY NEWSLETTER and the IEEE TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY. Minimum rates are $500.00 for four consecutive issues of each publication during one calendar year (each publication is distributed quarterly). The above Institutional Listings represent those contracted for 2001. Institutional Listings for 2002 will be solicited in December 2001. No agency fee is granted for soliciting such contributions. For inquiries related to Insitutional Listings, please contact Janet O'Neil, Editor, phone 425.868.2558, e-mail j.n.oneil@ieee.org.

Mailing Label Area

********************************* 3-DIGIT 077
00607093 27N 308888 B0008
WARREN A KESSELMAN
TINTON FALLS
31 HOPE RD
EATONTOWN NJ 07724-3009