IEEE ELECTROMAGNETIC COMPATIBILITY SOCIETY NEWSLETTER

ISSUE NO. 168 WINTER 1996 (ISSN 0164-7644) ROBERT D. GOLDBLUM, *Editor*

MESSAGE FROM THE PRESIDENT

BILL GJERTSON
PRESIDENT, EMC SOCIETY

At the November election meeting of the EMCS Board of Directors, I was elected as the 1996 president of our Society. I am very proud to have this position and will work to implement the wishes and desires of the Society's members. We have a 1996-2001 Strategic Plan for the EMC Society and will use it as a guideline to serve the members. Also, my critical mandate for the EMC Society is the result of the member survey conducted by the IEEE staff and is documented in their report. These two sets of inputs from the members will direct me in 1996. The four EMCS Technical Directors will execute and implement the objectives of the strategic plan and the member survey. I will guide these activities and maintain liaison with the Institute for support and information. It will be an exciting year for our Society as we continue to expand globally (approximately 30% of our members are currently outside the U.S.).

We will execute a number of initiatives via the Internet/ World Wide Web and ask all of you to assist us in these endeavors and join us as EMC volunteers. We are all volunteers and continually seek new ones. Non-members may also volunteer and explore areas for making contributions. We request your input; however, any and all help (e.g. committee work) is solicited. Many of our members (as indicated in the survey) are not working full-time in EMC and we also wish to solicit these individuals and ask their support in molding our organization to serve the part-time as well as the full-time EMC individuals. Many of our members are new to the EMC field and we encourage them to join our activities and help develop the appropriate Society response to this member segment. Another way to begin support/involvement of the EMC Society is through one of the local chapters (there are 42 EMC chapters worldwide). This can also expand potential participation in other EM-related Societies and the IEEE Sections. If you would like to contact the EMC Society officers or BoD members, you can get their telephone numbers from the World Wide Web page for the EMC Society or by calling me at (206) 773-3482. Another approach may be to attend our Board Meetings in 1996 or the 1996 EMC Symposium in Santa Clara, CA on August 18-24, 1996. The other Board of Directors meetings are as follows:

March 7 & 8, 1996 in Piscataway, NJ
(A Standards Training activity will be on March 5 & 6, 1996, also in Piscataway, NJ.)

November 3, 1996 in Denver, CO
(the site of the 1998 EMC Symposium)

To assist your planning, you may wish to contact your 1996 EMC Society Officers:

Dan Hoolihan	Vice President
Andrew Podgorski	Treasurer
Janet O'Neil	Secretary
Len Carlson	Director, Communications Services
Norm Violette	Director, Professional Services
Todd Hubing	Director, Member Services
Joe Butler	Director, Technical Services

Your support of the EMC Society and the EMC field is requested and you can make a difference in 1996. Just try it. It is also fun and rewarding.

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EDITORIAL

ROBERT D. GOLDBLUM
EDITOR

In my last few editorials, I have focused on five questions. One concentrated on military dependence on commercial EMC standards. No one addressed this issue, so I will offer a few comments on the subject.

Since Secretary Perry's memo ended the use of military standards for the military procurement of equipments and systems, the use of MIL-STD-461/462 has been on a case-by-case basis. That is to say, some services have approved waivers to use these standards since there are no equivalent commercial standards. In addition, the military has undertaken the task of examining commercial standards and comparing them to their needs, mostly as stated in MIL-STD-461D.

A DoD/Industry Committee is now functioning whose purpose is to make this comparison and to ultimately provide the guidance for EMI requirements in procurement to assure electromagnetic compatibility. Some requirements of commercial EMC standards may be acceptable to military needs. In other cases, there may be no alternative but to use and impose the military EMC requirements. If the military requirements of MIL-STD-461D are to be considered valid and real, then there can be no compromise other than using "equivalent commercial requirements." The acquisition of equipment which can only operate on a limited basis or not at all in a military electromagnetic environment is a waste of taxpayer dollars and doesn't make much sense. Thus, the use of MIL-STD-461/462 will prevail until there are acceptable alternatives.

When will the work of this Committee on EMC standards be completed? Probably never! Everything is in a state of change. New commercial EMC standards are being born several times a year and are usually based upon a new product category or proposed by a new governing body. Military needs are changing also, due partly to technological growth and partly to the great influx of commercial quality products placed in military electromagnetic environments and operating zones. With the present attitudes towards military standards, it is not likely that MIL-STD-461D will ever be revised on the scale that it has been in the past, even with the changes in EMC test technology. Some nonmilitary entity will have to step forward and provide the cohesive leadership required, not only to unify, but also to advance the state of the art consistent with technological advances.

Things would be much easier if there were a single EMC standard for all applications, military and commercial. The application of universal test methods, the use of common test equipment and facilities, and a single certification method would unify the EMC community. Such an EMC standard could be applicable on a worldwide basis.

What do you think?

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IEEE EMC SOCIETY NEWSLETTER PUBLICATION SCHEDULE

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TODD HUBING
ASSOCIATE EDITOR

"Nice tie! I like the way you've used copper gaskets and ferrite beads to make the eyes of Maxwell and Hertz pop out like that," was overheard at an EMC Society chapter meeting. Let's face it. EMC engineers are unique individuals. Our genius is rarely appreciated by product engineers, managers, or the general public. I was telling my family about EMC expert system software. I told them that it works and thinks like an EMC expert. My wife, who is acquainted with a few EMC experts, could not understand why anyone would want computer software that was forgetful, told bad jokes, and always took more time than expected to finish working. She has a point. Computers are fast, efficient and accurate thinking machines. EMC experts are not quite so fast or efficient. Computers always give the same answer to the same problem. EMC experts do not always appear to be quite so logical or consistent. Computers are highly valued and appreciated by the companies that employ them. EMC experts...(well, you get the picture).

Nevertheless, EMC is a field that does not lend itself well to fast, efficient, logical problem analysis. EMC experts are asked to answer vague questions like "Will my product radiate too much?" before the product has been fully designed. EMC experts must work with incomplete information to solve ill-defined problems.

Traditionally, computers have done a poor job of solving ill-defined problems. EMC experts, on the other hand, are pretty good at it. How do they do it? That's the question that must be answered before training a computer to think like an EMC expert. How does an EMC expert think? How is an EMC expert different from say... a circuit designer or a product manager? Do you think like an EMC expert? After extensive research into the knowledge base, attitudes, and behavior of recognized experts in EMC, I have developed the following 5-question quiz that can help you determine if you have what it takes to be an EMC expert.

Question 1: At 80 MHz, the FCC Class B limit for unintentional (digital) radiation sources is:
a. 100 microvolts per meter at 3 meters
b. 2 megawatts per meter squared
c. 50 ohms
d. 5 dB too low

Question 2: Decoupling capacitors in printed circuit board designs:
a. stabilize the power bus voltage
b. rectify the octagonals
c. provide transient protection for the active devices
d. add much-needed color

Question 3: Which of the following is a sure sign of trouble in a high speed digital design?
a. ground loops
b. Fruit Loops
c. missing components
d. all of the above

Question 4: The safest place to put your personal computer during a thunderstorm is:
a. in an aluminum canoe on a lake
b. in an overturned aluminum canoe on a lake
c. on your desk plugged into the phone and power lines
d. in an unattended suitcase at a major airport

Question 5: Which of the following is an important source of EMC-related information and a convenient way to keep in touch with other EMC professionals?
a. IEEE EMC Society chapter meetings and symposia
b. the internet
c. Star Trek conventions
d. watching "America's Most Wanted" on television

Finished? Let's add up your score.

The correct answer to Question 1 was a. If you chose a, give yourself 10 points. You don't get any points for choosing b or c. If you chose d however, you have the ability to come up with plausible answers even when you don't know what the answer is. If you chose d, wrote in your own answer, or did not answer, give yourself 100 points.

The answer to Question 2 is also a. Give yourself 10 more points for choosing a. If you guessed b, c, or d, or if you chose more than one answer, no answer, or wrote in your own answer, give yourself 100 points.

The best answer to Question 3 is b. If you find Fruit Loops in a digital design, expect trouble. The same applies for most other brands of dry cereal. Give yourself 10 points if you chose b. Ground loops and missing components do not necessarily indicate trouble. These answers sound good though (certainly better than Fruit Loops) so give yourself 100 points for choosing anything other than b.

Only an EMC engineer would consider putting a computer in or under a canoe on a lake or leave it unattended at the airport. Despite the possibility of lightning damage, the safest place for your computer (of the choices given) is on your desk. Give yourself 10 points for choosing c. Give yourself 100 points for choosing b, d or writing in your own answer.

Question 5 was a trick question (remember, I'm a professor). Both a and b are good answers. Chapter meetings, symposia and the internet are all excellent ways of keeping up to date. If you chose a or b, give yourself another 10 points. If you chose a and b, or any combination of answers that included both a and b, give yourself 100 points.

Now it's time to evaluate your score. Are you an EMC expert? A score of less than 40 or greater than 500 indicates that you either miscalculated or misunderstood the instructions. In either case, you should probably seek a career in upper-level management.

Continued

A score of 50 indicates that you are logical and well-informed. You are probably a whiz at solving EMC problems, but you may not get the recognition you deserve.

A score greater than 100 indicates that you have the ability to cloud the issue, break the rules, and make up the answers as you go. Anyone with a score greater than 100 clearly has the potential to be an outstanding EMC expert and a highly paid EMC consultant. If your score doesn't fall into any of the categories above or if you don't like your score, take the quiz again. EMC experts always reserve the right to change their answers.

Need to brush up on EMC for the next quiz? Whether you're already an EMC expert or not, attend your next local chapter meeting. You will make valuable contacts and keep up with new developments in your field. Besides, EMC Society chapter meetings are the one place where that new tie is sure to be appreciated!

CENTRAL NEW ENGLAND

John Clarke, chair of the Central New England chapter, faxed me the following update of their activities through the end of 1995. Thanks, John.

Colin Brench, of Digital Equipment Corporation, was the speaker at the October meeting. His talk was titled "Practical Computational Electromagnetics." Colin discussed the availability of computational electromagnetic codes that provide the EMC engineer with a range of new tools for evaluating EM emissions from computer products. His presentation went through the EMC design process for a hypothetical product, from VLSI device to complete system.

The November meeting featured Michael Hopkins, of Thermo Voltek. His presentation was titled "The EMC Directive, What Does It Mean to a U.S. Manufacturer?" His talk discussed the various issues regarding compliance with the European EMC Directive, the required tests and methods of compliance with the directive.

Penny A. Caran, the CEO of Technology International Inc., gave a presentation on "New Developments in the Regulatory Demands of the European Union and their Impact on U.S. Business" at the December meeting. Many aspects of the EMC directive are still open to wide interpretation by members of the European Community, leading to confusion and costly delays for manufacturers and importers/exporters. This session addressed those topics and provided answers to how manufacturers can certify their products using the various routes to compliance, while avoiding delays and deflecting costly challenges to product certification.

ISRAEL

Many thanks to Elya B. Joffe for providing us with this update of the Israeli Chapter activities.

The Israeli Chapter held a one-day workshop on the topic of the EMC and TTE Directives of the EEC and their implications in the telecommunications industry. This workshop, which took place in November, was attended by over 70 members and guests from all over Israel. The large attendance was not surprising, as the workshop took place only about six weeks before the EMC Directive became mandatory throughout the EEC.

The workshop was hosted by TELRAD, the Israeli Telecommunications Company. Its primary objective was to present and discuss the technical and organizational implications of the directives. There were presentations with a special emphasis on the EEC EMC and TTE directives and the EEC Harmonized Standards. Additional topics included ESD, ESD control, and the FCC Part 68 EMC requirement. Many thanks to TELRAD for the outstanding facilities and organization of this event.

The Israeli Chapter is taking seriously its commitment to enlarging the membership. Five new members have joined the IEEE and EMCS since our report in the last newsletter. This was primarily a direct result of our first chapter meeting in 1995. Additional colleagues have requested, received and a few have already mailed their applications to IEEE. In a way, it

Continued

PHOTO COURTESY OF ELYA JOFFE

Attendees at the last meeting of the Israeli Chapter include (l to r): Dr. Jacob Gavan, recently elected Fellow of the IEEE, Boaz Vigdor, Telrad, Eli Avital, Telrad, Elya B. Joffe, Israel EMC Chapter Chairman, Moshe Netzer, Israel EMC Chapter Vice-Chairman, Oren Hartal, Israel EMC Chapter Immediate Past-Chairman, and Moshe Henig, Israel EMC Chapter Secretary.

could be said that we are losing all of our guests because... they all join!

Since the EMCS BoD has approved the Israeli Chapter's petition to hold the 2003 IEEE International Symposium on EMC in Israel, work has begun to organize this event. An executive committee has been formed to begin planning this meeting, which is only 7 years away.

We would like to encourage IEEE EMCS members from the Middle East, in particular from Egypt and Jordan, to become active in the organization of the 2003 Symposium. Those who wish to participate should contact the Israel IEEE EMC Chapter Chair, who will welcome them wholeheartedly.

LOS ANGELES

Once again, I would like to thank Janet O'Neil for keeping us up-to-date on the activities of the Los Angeles chapter. Janet's natural writing style and sense of humor make the Los Angeles chapter report one of the highlights of this column.

The Los Angeles chapter concluded its fall program with two interesting speakers: Bill Ritenour of Storage Technology Corporation in Louisville, Colorado and Lee Hill of Silent Solutions in Pepperell, Massachusetts.

Bill Ritenour, a member of the EMC Society Board of Directors, spoke on "ESD Basics" at the October meeting. Bill Ritenour, noted for his humor and lively presentation style, did not disappoint the audience. Bill expertly launched into his presentation to a captive audience of some 40-plus engineers, including a fellow ESD guru, Bill Rhoades of Xerox. (The Bills kept each other honest throughout the presentation!) He reviewed the basic theory associated with ESD and how it affects operating products, e.g. what causes ESD and how ESD can cause operational "halts." His hints on how to design products to mitigate against the effects of ESD were especially well-received. He also showed how small and large products can be tested for ESD immunity (susceptibility). The presentation also included a discussion on the explanation of ESD phenomena, the relationship of ESD phenomena to electric and magnetic fields, as well as to common mode effects, circuitry and systems. Of course, the "hot topic" of European Union standards and guidelines as related to ESD was discussed at the conclusion of the presentation. Noted for being exceptionally courteous to their speakers, the Los Angeles chapter officers escorted Bill to a nearby bookstore on the way back to the hotel so Bill could unwind after the presentation with a good book. The title of Bill's selection? *Get Shorty!!* Bill Ritenour may be reached at 303/673-7096.

Lee Hill was the featured November speaker and his presentation was entitled "Impact of PWB Ground Plane Gaps on Inductance and Radiated EMI." Lee is a Distinguished Lecturer of the EMC Society and his presentation did not disappoint the more than 30 engineers who attended the meeting. He noted that previous work in literature has demonstrated that the presence of common mode on the external cables of electronic equipment is often the primary source of radiated EMI frequencies above 30 MHz. In an attempt to reduce the magnitude of these currents to yield products that exhibit low levels of radiated EMI, many engineers have implemented segmented, "gapped" and/or narrow width ground plane geometries in multilayer printed wire board (PWB) designs. Lee's presentation reviewed the results of recent research and experiments in order to explore and develop a better understanding of the inductance and common mode voltages introduced by such geometries. Incidentally, you may be interested to know that Lee earned his MSEE degree from the University of Missouri at Rolla, an institution which boasts a rapidly growing EMC Laboratory and Research Center recognized and supported by industry and the National Science Foundation. Lee Hill may be reached at 508/433-0515.

As always, Los Angeles chapter chairman Ray Adams at TRW welcomes any comments about chapter activities. Ray may be contacted at 310/813-7152 or by e-mail at ray_adams@qmail4.sp.trw.com. Ray, and Janet O'Neil at Lindgren RF Enclosures are busy these days co-chairing an upcoming one-day event entitled "EMC'96: A Colloquium and Exhibition on Pre-Compliance Testing Problems and Solutions." This event is sponsored by the Los Angeles, Orange County and San Diego chapters of the EMC Society. It will be held on Monday, April 1, 1996 in Southern California, near the Los Angeles International Airport. Speakers for the series of practical tutorials and demos include Henry Ott, Herb Mertel, Bill Parker, Steven Jensen, Bill Rhoades, Bill Ritenour, Scott Roleson and Joe Fischer. Advance registration by March 1 is $50.00 for IEEE members, $60.00 for non-members, including continental breakfast, lunch, Happy Hour reception and the Colloquium notebook. For more information on this event contact Ray as above or Janet at 310/348-9665, fax 310/348-9683. Save the date of April 1, 1996 and plan to attend!

NANJING

The information below was collected by Wen Xun Zhang and forwarded to me by Dave Staggs.

The September meeting of the Joint Nanjing Chapter featured two speakers. The first speaker was Dian Cheng Wang, from the Nanjing Research Institute of Electronic Technology, who gave a presentation titled "Engineering Analysis of Waveguides." The second speaker was Xiao Hua Yun, from the Nanjing University of Science and Technology, who spoke on "Advanced Techniques of Frequency Synthesis."

Three papers were presented in two sessions in October. Shan Jie Zhang, of Nanjing University, presented two of the papers. Both of these papers dealt with the subject of numerical computation. The third paper was presented by Wen Xun Zhang, of Southeast University, and was titled "Review on Progress of Research and Development in Antennas."

In November, Wen Xun Zhang, the chapter chair, made a presentation describing the organization and structure of the IEEE.

DIVISION IV REPORT

ROLF H. JANSEN

ELECTROMAGNETICS & RADIATION

Although previously described as a Division not leading the pack in transnational membership with its Societies, in 1995 Division IV participated in one of the major initiatives within IEEE to develop a foothold in Eastern Europe (EE) and the Former Soviet Union (FSU). This initiative started originally as a joint activity of the Microwave Theory and Techniques Society and the Electron Device Society and is now growing into a joint effort of Division IV and Division I with its incoming Director Mike Adler. As a result of this cooperation, six new chapters were established in the EE/FSU region by the end of 1995, and 4 to 5 more in other parts of Region 8 and in Region 10 have been set up or are close to being formed. Antennas and Propagation have been encouraged to join in, making use of their natural links of technical interest. Further, the EMC Society is a natural contender to benefit from the synergies of this process. With a continuation and consolidation plan at hand already for 1996, it is very likely that there with be four more chapters created in EE/FSU by the middle of the coming year under the umbrella of the mentioned initiative.

Working as a Division Director, the first year of my term of office gave me a lot of insight into the globalization process within the Institute and the organizational structures engaged in it. Serving in parallel as a member of the RAB/TAB Transnational Committee brought me into direct contact with other initiatives and groups involved in the development of transnational membership and in the improvement of services for this IEEE community outside of the U.S. Last but not least, sitting together in the Board of Directors of Regions 8 to 10 provided the necessary cross links with RAB and the procedures and committees installed there to pursue similar goals.

In this complex organizational environment, it became very obvious to me that I would have to work as a Division Director on enhancing the coordination of the many disconnected structures and activities dealing with Transnational Activities and Globalization within the IEEE. This will help all Societies in Division IV and beyond to achieve their transnational goals. As a specific step, the development of a model (organizational structure, interaction and guidelines) that shall serve as a vehicle for transnational activities for the IEEE Societies was brought on the way by myself within the RAB/TAB TC. In the relatively short term, the Magnetics Society and the Society for Nuclear and Plasma Sciences could benefit from this with their membership potential in the EE/FSU region. In the joint effort conducted by Divisions I and IV, the model will be modified and optimized to be truly applicable to all IEEE Societies.

During the second year of my term of office as Division Director, I shall try to link my transnational activities with an initiative in educational activities, conforming with my statement of candidacy. Improving the quality of engineering education is an important topic presently in Europe, where the IEEE could also play its role of technical leadership and step out of the U.S. to contribute educational program definition as a global promoter of high standards. A first brainstorming session on this topic was already conducted together with Jerry Yeargan, the incoming Vice President of Educational Activities. I look forward to another exciting year of service. Thanks to all of you in Division IV and beyond for your support.

SECTIONS CONGRESS '96

DAVE STAGGS
EMCS CHAPTER COORDINATOR

On November 1 through 6, 1996 in Denver, Colorado there will be a Sections Congress consisting of section chairs as well as chapter representatives from all ten regions of the IEEE.

The focus of this meeting is first, to learn how to utilize the resources of the IEEE to maximize the section chairs' effectiveness as IEEE volunteer leaders. Second, the Congress is the one major meeting sponsored by the IEEE which brings together the Institute's grass-roots leadership so that they can share ideas, concerns and solutions. Workshop and tutorial sessions will be held on section operations, section activities, and the technical and professional aspects of the IEEE. The Congress is also a forum where the section chairs and other local leaders speak as the collective voice of IEEE membership, expressing ideas, raising issues and generating recommendations about how the Institute can better serve its members, both now and in the future.

The discussion topics were developed from a survey sent to all section chairs in October, 1994. The topics will pertain to all local leaders and their entities, so chapter chairs and other chapter representatives are encouraged and invited to attend. The recommendations produced at this Sections Congress will have major impact on the plans made by the IEEE leadership for the future of the Institute.

Sections Congress 96 (SC'96) is a function of the Regional Activities Board (RAB). For more information, please contact Carol Coffey, Manager, Regional Projects and Staff Coordinator, SC'96; 908-562-5512, fax: 908-463-9359, e-mail: c.coffey@ieee.org.

KIMBALL WILLIAMS
ASSOCIATE EDITOR

STUDENT CHAPTERS

One of the continuing issues that turns up in discussions among chapter and section officers is the question of how to maintain the interest of students in the IEEE. One possible solution, which may also provide benefits to the chapter or section as well, is to arrange with the section's student activities chair to provide speakers for the student chapter meetings from the section members at large and from the EMC chapter in particular.

Over the last few years I have managed to speak to student chapters and student groups at seven different colleges and universities (with several repeat performances). In all cases, the students seemed to be interested in hearing from a working engineer. They have spent a lot of time learning skills that they hope to put to use in the work place and they appreciate the view of someone who is actually in the field, using the tools that they are honing.

SECTION STUDENT ACTIVITIES

Every section's student activities chair could look through the listing of officers for the different societies within his section with the idea that each one of these officers could (or should) be a potential speaker for every student chapter within the section. Any engineer who has been working for more than three months has work experiences, opinions, war stories and suggestions that will probably keep a group of students spellbound for at least a half hour to three quarters of an hour. On one occasion I simply described what EMC is about, and something of my work, and started answering questions. The questions went on for an hour and a half!

TALKING TO STUDENTS

At what level should you address a group of students? Use the same level that you would use with any group of diverse engineers. The only difference will be the level of experience which will range from none for students with no work experience, to possibly more experience than you may have for students who are cross training or taking continuing education classes. In all cases, the approach to a student group will be the same as you would have to any other group a student group will be the same as you would have to any other group of professionals.

What topics interest students? The same things that would interest a group of engineers are of interest to the students. It is beneficial to keep in mind that members of the audience (students) are already thinking like engineers. There is no need to coddle or talk down to a group of IEEE students. By the same token, there is no need to snow them with technical jargon. Talk about what you know, about your specialty, about your experiences. Treat a student presentation in the same way you would treat a presentation for any non-EMC group of engineers and you should not go wrong.

What do students want to hear about that would be different from an audience of general engineers? There are a few additional topics that might be of interest to students that would differ from a homogeneous group of engineers. When I give a general talk on EMC to students, I try to give them some feel for the employment opportunities in the field, and how EMC work differs from or is the same as other forms of electrical engineering like product development or field service. I also try to open their eyes to the importance of standards in the work place as both a help to the definition of a new design and a guide to what a real world environment will be for the product.

In addition, I make a point of emphasizing how their association with the IEEE can be of benefit to their work on a technical level. Particularly, I point out how a short series of phone calls can put them in touch with the technical expert in any electrical or electronic discipline, anywhere in the world. Or, if they find a standard confusing or difficult to interpret, an INTERNET message can get clarification of the document's content directly from the author.

HOW DO I INITIATE A PROGRAM?

First, decide on what topic you would like to speak. Make it something that you are excited about and that you know well. Work up an outline of the areas that you would like to cover within the topic. Based upon your outline, look for material that would make good overhead projection sheets or 35-mm slides. For this you will probably want to seek out pictures, figures, diagrams or drawings that get the point across. Remember, 1 picture = 1000 words.

Flesh out the visual aids with word slides to emphasize the points you want to speak about. The words should be close to your outline form; bullet statements instead of phrases. Remember, this is not to be what you are going to say, but only the essence of what you are driving at. One general rule is to have no more than 9 words on a single slide.

Put it all together and try it out. Give the talk to your bathroom mirror. Then to your dog. Finally, try it on your spouse or significant other. If you can stand to look at the material and your delivery in the mirror, if your dog will listen to you all the way through and if your spouse doesn't

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EMC'96 COLLOQUIUM & EXHIBITION

The Los Angeles, Orange County and San Diego chapters of the IEEE Electromagnetic (EMC) Society have organized a one-day EMC event entitled: "EMC'96: A Colloquium and Exhibition on Pre-Compliance Testing Problems and Solutions." The objective of the colloquium is to present the EMC or design engineer with an overview of pertinent EMC requirements, low-cost troubleshooting techniques, and sample mitigation techniques. The overview will be applicable to engineers working in commercial or military environments. A major emphasis will be European Union (EU) requirements. Hands-on participation will be available during the demonstrations following the colloquium and vendor tabletops will display the latest EMC-related products.

The colloquium will feature industry-renowned Henry Ott, Herb Mertel, Joe Fischer, Steve Jensen, Bill Parker, Scott Roleson, Bill Ritenour and Bill Rhoades. A "networking" lunch will enable attendees to informally discuss scheduled topics with the speakers. Attendees will also have an opportunity to visit with vendors, speakers and other attendees at the Happy Hour reception immediately following the colloquium.

"EMC'96: A Colloquium and Exhibition on Pre-Compliance Testing Problems and Solutions" will be held on Monday, April 1, 1996 at the Radisson Plaza Hotel located in Manhattan Beach, California, just three miles south of the Los Angeles International Airport. Registration fees are $50.00 in advance (prior to March 1) and $100.00 at the door. Registration fees include a continental breakfast, lunch, two reception drink tickets and the colloquium program. Registration begins at 7:30 A.M. followed by the first presentation at 8:30 A.M. The last presentation will conclude at 5:00 pm followed by the Happy Hour reception with

Continued on page 11

EMC SOCIETY CHAIRPERSON'S LUNCHEON

The EMC Society Chapter Chairperson's Luncheon in Atlanta at the 1995 International Symposium on EMC was very successful. We had a total of 22 Chapters represented (15 U.S. and 7 foreign). This is almost double the number of chapters represented at last year's luncheon. Many members of the Board of Directors were also present. Each chapter representative was given an opportunity to report on chapter activities of the last year.

This year's number of EMC chapters has grown from 40 to 42 (27 U.S. chapters and 15 non-U.S. chapters). The additions this year have been the Beijing, China chapter and the Taipei, Taiwan chapter. We now have two chapters in China, the Beijing chapter and the Nanjing chapter.

PHOTO COURTESY OF DICK FORD

Luncheon attendees. Front row (l to r): Kimball Williams (USA), Fred Heather (USA), Ferdy Meyer (France), Maqsood Mohn (USA), Paul Watson (USA). Middle Row (l to r): Joseph Calabria, Gao Yougang (China), George Trejo (USA), Ray Adams (USA), Steve Stegner (USA), Jean-Jacques Laurin (Canada), Gus Freyer (USA). Back Row (l to r): Don Sweeney (USA), Tim Peterson (USA), Elya Joffe (Israel), Franz Gisin (USA), Peter Landgren (Sweden), Bill Kimmel (USA), PJ Mondon (USA).

J. L. NORMAN VIOLETTE
ASSOCIATE EDITOR

PRINTED CIRCUIT BOARD DESIGN TECHNIQUES for EMC COMPLIANCE

by Mark I. Montrose

IEEE Press on Electronics Technology
445 Hoes Lane
Piscataway, NJ 08855-1331

Published under the Sponsorship of the IEEE Electromagnetic Compatibility Society
ISBN 0-7803-1131-0
1996
$49.95

The Preface states the intent and objectives of this book: "To assist in printed circuit board design and layout, with the intent of meeting North American and international EMC compliance requirements." The intended audience consists of engineers who design analog, digital, system-level electronic products and use printed circuit boards. This includes engineers involved in electrical and mechanical design, CAD/CAE, production, test, and manufacturing of electronic products.

Chapter 1 presents the goals of EMC based upon both major aspects of EMC: emissions and susceptibility. It states that "the information presented in this volume is focused on non-EMC engineers who design and lay out printed circuit boards...." It also states that EMC engineers will find the information helpful as well. The mathematical analysis is kept to a minimum and an applied electromagnetics background is not required. Applications of known successful "hands-on" techniques are presented based on fundamental concepts applicable to all electronic products. A list of definitions is provided and a discussion is presented on EMC and printed circuit boards.

The non-ideal natures and effects of common passive components (wires, R, L, and C) are described under "hidden schematics." The elements of an EMI problem (source, receptor, coupling path) and an approach to a solution based on these conceptual elements is presented. Five major considerations in EMI analysis are suggested and enumerated: frequency, amplitude, time, impedance, and dimensions.

Regulatory requirements for North America (U.S. and Canada) and other countries (worldwide, but basically European) are described briefly.

In Chapter 2, Printed Circuit Board Basics, descriptions are presented of the components, layouts, and functions that are commonly found in PCB configurations: number of layers, power and ground planes, traces, routing (stripline and microstrip), layer stackup for multilayer boards. Layout and routing detail guidelines are suggested for 2, 4, 6, 8, and 10-layer boards.

A concept called the "20-H" rule is introduced as a means to minimize radiation due to fringing between power and ground planes on PCBs with operating very-high-speed logic. Examples are provided of this 20-H rule (the definition of which is attributed in this book to W. Michael King).

Grounding methods are also addressed in this chapter, covering single-point (SPG) and multipoint (MPG) grounding configurations. Admittedly, "grounding" topics can generate discussions that strain relations between friends. The book does not make clear the necessity for a robust zero-volt, equipotential, signal reference, commonly referred to as "ground," which is always needed for proper system design. Some clarification is needed about mixing or not mixing of SPGs and MPGs (which is done in practice). Also, the statement that SPGs are "... occasionally found in extremely high-frequency circuits and systems" needs clarification. The important problem of ground lead inductance is discussed.

Some terminology misconceptions: The author refers to electromagnetic (EM) fields "radiating RF currents" (pages 26, 32). It is the other way around: currents produce (radiate) EM fields! Also, the term ground sources (page 32) is misleading. Electrical sources produce voltages and current, not grounds.

Section 2.5, Image Planes, introduces the concept of image planes to reduce emissions but it is difficult to follow. The last paragraph on page 34 is misleading for two reasons: the E-field is not the sum of two currents, although the currents are the sources of the field; and as stated, one could interpret the author as saying that the common mode and differential mode are the same (again, both equal to the "sum" of two currents, I1 and I2 as depicted in Figure 2.19). The reader is advised to refer to Reference [2] (German, Ott, and Paul) for a clearer development of the image plane concept. Partitioning or placement of components in PCB layouts and multipoint grounding are also discussed and illustrated.

Logic Families covers the selection of different technologies for specific applications. A question of terminology: the concept of edge rate needs to be clarified as being more than a time interval in nanoseconds (ns). The illustration shown in the book as edge "rate" (page 42) is generally understood as rise time. Edge rate is usually a rate of voltage or current change per unit time (volts/ns, amperes/ns) along the leading and/or trailing edge of a digital pulse. Another statement to clarify on page 43 (bottom): "When

Continued

the edge rate of a signal increases, (e.g., from 2 ns to 1 ns), a quadruple amount of dI/dt flowing into the capacitive loads occurs." What is a "quadruple amount of dI/dt"?

Chapter 3, Bypassing and Decoupling, presents the need for decoupling capacitors. A discussion is provided on basic resonance phenomena associated with passive (RLC) elements. The important concept of self-resonance of decoupling capacitors is discussed along with capacitor value selection and calculation, lead length inductance, and placement. The equation for parallel C, series RL resonance in Figure 3.4 on page 50, is incorrect.

Chapter 4, Clock Circuits, develops the importance and effects of clock circuit placement, localized ground planes, impedance control, and propagation delay. Also included are the effects of capacitive loading, decoupling, trace lengths, trace termination and impedance matching, trace geometry and separation, routing layers, and vias. The problem of crosstalk and its avoidance is presented.

Chapter 5, Interconnects and I/O, discusses a major concern regarding the impact of interconnections on EMI. The location of I/O circuitry on PCBs is described. Methods of isolating these circuits are described to prevent internal coupling. I/O data line filtering and grounding techniques are presented. Other topics discussed in this chapter include LANs, video interfaces, and audio circuitry. The chapter concludes with a section on energy hazard protection (fusing) and creepage and clearance distances for safety consideration.

In Chapter 6, Electrostatic Discharge Protection, the basics of the ESD threat introduce the reader to this short chapter. The ESD spectrum is briefly described and four PCB failure modes due to ESD are described. Design techniques proposed for PCB protection include spark gaps, high-voltage capacitors, transorbs, LC filters, minimizing circuit loop areas, and guard bands.

Chapter 7, Backplanes and Daughter Cards, explains the concerns associated with the design of these packages including trace impedance, construction, trace termination, signal routing, crosstalk, and trace length. The author refers to the application of the techniques developed in the earlier chapters with a discussion of some unique aspects for backplanes and daughter cards, such as longer trace lengths (transmission line effects). Proposed layouts and construction methods are described.

Chapter 8, Additional Design Techniques, describes the potential problem of traces turning a sharp corner. Ferrite device selection and heatsink grounding are discussed with some illustrations provided. Other topics in this chapter include discussions on lithium battery circuit safety, and considerations regarding BNC connectors. A section titled "FILM" presents techniques for the designer to monitor the PCB assembly process to ascertain signal integrity and EMI performance. Topics include the application of "test coupons," layer stackup windows (with stackup details), and test points for analyzing signal integrity of critical nets.

Appendix A provides a summary of design techniques based essentially on the material in the previous chapters. This also provides a useful design checklist. Appendix B summarizes international EMI specification limits supported by tables and graphical illustrations. A bibliography followed by an index completes the book.

The author presents an awareness and useful checklist of concepts, techniques, and actions required in the design of PCBs. Admittedly, an author can only include so much between two covers. The book is recommended for reference by designers of PCBs. Some topics may require the use of supplementary material as provided in the references and bibliography.

EMCS EDUCATION COMMITTEE . . .
Continued from page 7

fall asleep or turn on the TV, you are ready to try it out on your co-workers. Notice that this part of the exercise isn't about content, but delivery. The best topic and supporting graphics will bore anyone if presented poorly. If you can maintain interest in what you are saying with an effective style, then, and only then, are you ready to have your colleagues listen to the technical side of your presentation.

FINDING YOUR AUDIENCE

Last of all, contact your section's student activities chair,whose business it is to maintain contacts with all the university student chapters in the section. Let it beknown that you are ready, willing and able to provide talks to the IEEE student chapters and ask for assistance in making arrangements with the student chapter officers. Chances are that the chair has been looking for you!

"But what do if someone asks me to do a presentation on EMC on very short notice?" This happens to most of us at one time or another. Fortunately, the Outline and Abstracts Subcommittee of the EMC Education Committee is currently finishing building a generic EMC presentation with slide, overhead and video support materials. The package is scheduled to be ready for presentation to the Board of Directors for approval at the Santa Clara Symposium in August, 1996. Shortly after the Symposium we should have copies ready for distribution to the membership.

Meanwhile, if you have materials that you believe would be helpful in fleshing out the presentation package, such as a good illustration, picture, slide or view graph image, please send it to me so that we can consider it for inclusion with the rest of the material we are gathering. As always I can be reached using the contact information on the inside of the front cover of the newsletter.

EMC'96 COLLOQUIUM & EXHIBITION . . .
Continued from page 8

demonstrations relevant to the presented material from 5:00 to 7:00 P.M. The Radisson Plaza Hotel features a challenging nine-hole golf course and offers a specially reduced guest room rate for colloquium attendees.

Further information may be obtained from Colloquium Co-chairs Ray Adams at TRW (310)813-7152, or Janet O'Neil at Lindgren RF Enclosures, (310) 973-8757. The colloquium e-mail address is ray_adams@qmail4.sp.trw.com and a 24-hour hotline is available at 310-348-9665. Guest room reservations should be made directly with the Radisson Plaza Hotel LAX at 310-546-7511 or 800-333-3333.

IEEE CEFC '96

The Seventh Biennial IEEE Conference on ElectromagnetiC Field Computation will be held at Culture Hotel in Okayama, Japan, March 18-20, 1996.

The aim of the IEEE CEFC is to present recent developments in the design and analysis of low and high frequency electromagnetic devices. Emphasis is on practical applications and specific problems related to the numerical computation of electromagnetic fields. Given the rapidity of developments in the field, contributions are to be significant and original. Topics of interest include static and quasi-static fields, wave propagation, material modeling, coupled problems, optimization, numerical techniques, software methodology and applications in various areas. The conference will feature oral and poster presentaions.

For more information contact K. Fujiwara or K. Muramatsu, Dept. of Electrical and Electronic Engineering, Okayama University, 53-1-1 Tsushima, Okayama 700,. Japan, Tel:+81-86-251-8114, Fax: +81-86-253-9522, e-mail: cefc@eplab.elec.okayama-u.ac.jp

PERSONALITY PROFILE

BILL GJERTSON

WILLIAM G. DUFF
ASSOCIATE EDITOR

Bill Gjertson, the 1996 EMC Society's President, is a practicing EMC engineer with the Boeing Company. He is a veteran of the Korean War, earned a B.S. in Physics and Mathematics from Wisconsin State University in 1960, and has 35 years of experience in the aerospace industry at Boeing, UNISYS and LTV. Bill has been married to Marianne Helgeson for over 40 years. They have three married children, Jill, Jo, and Geoff, and four grandchildren.

Bill grew up in Wisconsin on a dairy farm, is of Norwegian ancestry, and has taken part in all athletics at the high school, college and industrial levels. He continues to run, hike, ski, bike and utilize nautilus equipment.

Bill enjoys EMC work, travelling, dining out and hiking the mountains of the Northwest. Marianne enjoys the same activities and is usually at his side. However, she is an independent character, interior design consultant, Registered Nurse, mother and grandmother. Bill and Marianne have lived in 24 homes in their 40 years together (Kwajalein M.I. during Sprint and Spartan live-intercept testing was their most interesting residence). Their travels have included Japan, the Philippines, Taiwan, Hong Kong, Australia, New Zealand, Norway, Mexico, Canada and all 50 states.

Other EMC engineering assignments have taken Bill to Moscow, Prudhoe Bay, Adak, Shemiya, Wake Island, St. John's, Newfoundland, Flin Flon, Canada, Bermuda, China Lake, Vandenberg AFB, Camp Irwin, Guam, Yuma, and numerous other test sites.

Bill is currently a Boeing Senior Principal Engineer on the Sea Launch and Comanche Project. Prior to this assignment, Bill worked on a number of Boeing Programs (V-22, F-22, Space Station and Airborne Laser). He has 35 years of experience in electromagnetic effects and electromagnetic systems engineering, design, analysis and test since his B.S. degree. He also completed graduate work at the University of Hawaii, University of Alabama-Huntsville and Wisconsin State University.

Bill is a senior member of the IEEE, the 1996 President of the EMC Society, and was the 1994-1995 Vice-President of the EMC Society. He is a member of the 1992-1997 EMC Society Board of Directors, a member of the AIAA (American Institute of Aeronautics and Astronautics), AFCEA (American Forces Communication Electronics Association), ADPA (American Defense Preparedness Association), AHA (American Helicopter Association) and a NARTE certified EMC Engineer (EMC-000468-NE). Bill has authored numerous papers on EMC, EM, HPM (High Power Microwave), MMW (MilliMeter Wave) and EMP.

HEALTH EFFECTS OF EMF FIELDS

The IEEE Spectrum reported that a U.S. congressionally mandated advisory panel, the National Council on Radiation Protection and Measurements, said it had concluded a 10-year study that some health effects linked to electromagnetic fields appear real and steps are warranted to reduce exposure to them. The announcement was made in August. The panel, chaired by Ross Adey of the Veterans Administration Hospital in Loma Linda, CA, recommends that housing not be built under high-voltage transmission lines and that day-care centers, schools and playgrounds not be built where ambient 60-Hz magnetic lines exceed 0.2 microtesla. (Source: *IEEE Spectrum*, October 1995.)

12TH INT'L ZURICH SYMPOSIUM & TECHNICAL EXHIBIT ON EMC

ZURICH SWITZERLAND
FEBRUARY 18-20, 1997

A call for papers for Zurich EMC has been issued. The deadline for submittal is July 1, 1996. For more information, contact the Symposium Chairman, Dr. Gabriel Meyer, ETH Zentrum-IKT, CH-8092 Zurich, Switzerland. Phone: (..411) 632 27 90, fax: (..411) 632 12 09, e-mail: gmeyer@nari.ee.ethz.ch, http://www.ee.ethz.ch/

Prospective authors, exhibitors and attendees should note that the date of the symposium has been shifted from the usual early March to the latter part of February.

EMCABS

WILLIAM H. McGINNIS
ASSOCIATE EDITOR

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

EMCAB COMMITTEE
Mike Crawford, Consultant
Bob Hunter, Consultant
Professor Fujiwara, Nagoya Institute of Technology
Sha Fei, EMC Research Section, N. Jiatong Univ., Beijing, China
Ferdy Mayer, L.E.A.D., Maisons, Alfort, France
Perry Wilson, EMC Baden, Ltd., Switzerland
Heinrich Garn, Austrian Research Center

"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 or papers. If the library you visit does not own the source document, the librarian can probably request the material or a copy from another library through interlibrary loan, or for a small fee, order it from NTIS or DTIC. Recently it became clear that EMCABs were more timely than publications which were being listed in data files. Therefore, additional information will be included, when available, to assist in obtaining desired articles or papers. Examples are: IEEE, SAE, ISBN, and Library of Congress identification numbers.

Also, the steering staffs of the Japan Technical Group and the EMC-J Tokyo chapter have offered to act as a central point for requests of papers abstracted here. Most of the papers will be available in Japanese only. Abstracts of papers from EMC-J will be clearly identified. The steering staff will assist in routing your request to the author(s) but will not translate the papers. The contact person is Professor Osamu Fujiwara, Department of Electrical and Computer Engineering, Nagoya Institute of Technology, Gokiso-Cho, Showa-ku, Nagoya 466, Japan. e-mail: fujiwara@odin.elcom.nitech.ac.jp

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

As the EMC Society becomes more international, we will be adding additional worldwide abstractors who will be reviewing articles and papers in many languages. We will continue to set up these informal cooperation networks to assist members in getting the information or contacting the author(s). The library at Southwest Research Institute, 6220 Culebra Road, San Antonio, Texas, 78228-0510 has agreed to catalog, shelve, and have available for interlibrary loans proceedings from symposia and meetings which are donated to the library. Any such donations can be sent to me at the above address and I will review them for suitable articles and then forward them to the SWRI library. 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.

ON THE METHOD FOR MEASURING COMPLEX DIELECTRIC CONSTANT USING SMALL CAVITY WITH EXTERNAL ELEMENT

EMCABS: 01-02-96

Ki-Chai Kim and Kazunori Uchida
EMC-Japan meeting at Kikai-Shinko-Kaikan, Tokyo
July 20, 1995,EMCJ95-27

Abstract: This paper presents the method for measuring complex dielectric constants of dielectric materials from measured driving point impedances. The proposed method is to use an input impedance of an electrically small cavity and an external element used to form a sensitivity control. The method of moments with Galerkin's procedure is used to determine the input impedance of the cavity. In this paper, Muller's method is used to find the complex dielectric constant from the measured driving point impedance as the inverse algorithm.

Index terms: Dielectric constant, small cavity, external reactance, driving point impedance

ANALYSIS OF LOCAL VALUES OF SAR IN A HEAD INSIDE MRI ANTENNA

EMCABS: 02-02-96

Hisaaki Ochi, Etsuji Yamamoto and Kunio Sawaya
EMC-Japan meeting at Kikai-Shinko-Kaikan, Tokyo,
July 20, 1995,EMCJ95-28

Abstract: Analysis of the local values of the specific absorption rate (SAR) is described using a realistic head model exposed by the electromagnetic field generated by an MRI antenna used for brain imaging. It is shown that the SAR of the eyeball is strongly affected by the position of the feed point of the antenna, whereas the sensitivity of the antenna is almost independent of the feed point. Moreover, the safety of the MRI antenna used for brain imaging is discussed based on the local values of the SAR.

Index terms: MRI, antenna, head model, local values of SAR

SHIELDING EVALUATION METHOD FOR MICROWAVE AND MILLIMETER WAVE

EMCABS: 03-02-96

Kennichi Hatakeyama, Hitoshi Togawa, NEC Corporation, and Tokin Corporation
EMC-Japan meeting at Kyoto University
Sept. 20, 1995,EMCJ95-29

Abstract: The basic shielding evaluation is to measure the power transmitting through a test material which is placed to block propagation in the transmission line. A coaxial line or a metallic waveguide is usually used as transmission line at frequencies below several GHz. However, their cross sections are too small in the millimeter wave range to measure the shielding materials inside. A metal parallel-plate-guide with a dielectric slab sandwiched between the plates is examined instead of conventional coaxial lines and waveguides, and the measurement results are discussed.

Index terms: Electromagnetic shielding, millimeter wave, electromagnetic absorber

SAR CALCULATION OF ELLIPTICAL CYLINDRICAL HUMAN MODEL ACCOMPANIED BY DIELECTRIC LOSSY SHIELD

EMCABS: 04-02-96

Wataru Tshchida and Osamu Hashimoto
EMC-Japan meeting at Kyoto University
Sept. 20, 1995,EMCJ95-30

Abstract: In this paper, we present calculations of whole average specific absorption rate (SAR) and local SAR of dielectric cylindrical human model with elliptical cross section. We discuss a shielding effect of dielectric lossy wave resonance that occurs between the human model and the dielectric material, and the local SAR increases on the particular combination of the thickness of dielectric material, the distance between the human model and material, and its permittivity. Also, we compare two different methods of SAR calculation which are Point Matching method and Moment method, for the case without shielding, and conclude that the Moment method is more suitable for analyzing a cylindrical human model whose cross section is a very deformed elliptic shape.

Index terms: Shielding effect, SAR, moment method

THE FDTD ANALYSIS ON PERMITTIVITY MEASUREMENT WITH TE101 RECTANGULAR CAVITY RESONATOR

EMCABS: 05-02-96

Takumi Abe, Motonari Funakoshi and Osamu Hashimoto
EMC-Japan meeting at Kyoto University
Sept. 20, 1995,EMCJ95-31

Abstract: We present a possible suggestion of a way to measure a permittivity without cutting a sample material by means of the rectangular cavity resonator. The theoretical discussion on the possibility is made in this paper, based on the time variation and the resonance frequency of the electromagnetic field inside cavity which is calculated by the FDTD method. The material permittivity estimated from the resonance frequency has a reasonable agreement with the theoretical one within an error of a few percent. The present result suggests a possibility for further application of the permittivity estimation which does not require any processing of the material.

Index terms: Cavity resonator, permittivity measurement, FDTD

A STUDY ON TWISTED PAIR CABLE COUPLING FOR FAST TRANSIENT BURST NOISE

EMCABS: 06-02-96

Yoshihiko Namba, Jon Duerr and Kazuhisa Yoshida
EMC-Japan meeting at Kyoto University
Sept. 20, 1995,EMCJ95-34

Abstract: This paper examines the near-end induced voltage on a UTP (Unshielded Twisted Pair) cable, such as in frequency used for information transfer, when disturbance waveform similar to that of IEC 801-4 is present on an adjacent cable running parallel to it. It is shown that the near-end induced voltage is largely independent of the coupled length of the cables. That is to say, the UTP cable coupling can be analyzed by the parallel transmission line theory. The calculated results and those measured are discussed in this paper, and also it is described that the simplified cable coupling model can be used for UTP. From these results, it is suggested that further work could establish suitable suppression methods for transient interference.

Index terms: Unshielded twisted cable, transient noise, induced voltage, near-end cross talk

NATIONAL PROCESS FOR SUPPORTING FEDERAL RESEARCH AND DEVELOPMENT

(Source: National Research Council News, Office of News and Public Information, 2101 Constitution Avenue, N.W., Washington, D.C. 20418, (202) 334-2138)

Federal policy-makers need to adopt a new way of budgeting the funding for science and technology if the United States is to remain the world leader in research and development during a time of severe fiscal constraints, says a congressionally requested report by a joint committee of the National Academies of Sciences and Engineering and the Institute of Medicine. This new approach would include combining the many disjointed pieces of federal science and technology funding into a single budget picture, funding the best projects and people, and cutting ineffective or outdated activities to free funds for important new opportunities.

The first step, the committee said, is for the federal government to calculate more accurately its funding for science and technology. Federal research and development (R&D) expenditures currently are reported as being more than $70 billion annually. However, the committee says this figure is misleading since almost half is spent on activities - such as establishing production lines and developing operational systems for new aircraft and weapons systems - that do not involve the creation of new knowledge or technologies. Because these activities focus on existing technologies, they do not conform to the usual meaning of R&D and, though very important, they should not be included when evaluating the vitality and effectiveness of federal R&D. Leaving them out provides the true federal science and technology (FS&T) budget of $35 billion to $40 billion.

The federal government should use this FS&T figure as part of a much more coherent budgeting process, the committee said. Today the research and development budget is simply an aggregation of agency budgets; it is not considered an integrated whole by either the executive or legislative branches. Today, when major cutbacks are likely, the different pieces of the FS&T budget need to be fitted together into an overall picture of spending that shows how cuts in one program or department will affect other areas. The President should present to Congress a comprehensive annual FS&T budget that discusses areas of increased and reduced emphasis, says the report. This FS&T budget should be considered as a whole at the beginning of the congressional budget process before it is divided among the appropriations subcommittees. Federal departments and agencies, in turn, should make their funding decisions based on criteria that follow those used by the President and the Congress. Such a process would allow trade-offs to be made across agencies, programs, and research institutions, freeing funds for new initiatives by reducing or ending projects that have become a lower priority or for which there are better alternatives.

In general, the report says, the federal government should use key principles in making FS&T budget decisions: preference should be given to funding projects and people rather than institutions, thereby promoting the quality and flexibility of research. Competitive merit review should be the basis for allocating funds, except when the purpose or nature of the work make even-handed competition unfeasible. Competitive merit review has been largely responsible for the remarkable quality, productivity, and originality of U.S. science and technology. R&D capacity should remain associated with the agencies whose missions require it. The resulting pluralism of agencies and research institutions fosters creativity, cross-fertilization, and flexibility. The committee noted that a more coherent budgeting process along with a more competitive distribution of funds can accomplish more than establishing a federal Department of Science. The committee's recommended process integrates the entire federal budget for science and technology rather than only the smaller fraction envisaged for a Department of Science.

Academic research generally should receive priority for funding. Although university-based research is not presumed to always be of higher quality than that conducted elsewhere, it has three distinctive advantages that argue for giving it preference. First, it allows agencies the flexibility to easily shift funding when priorities change. Second, it provides quality control through grant competition and rigorous peer review. Finally, by linking research to education, funding R&D projects at colleges and universities reaps the added benefit of simultaneously supporting the training of the nation's succeeding generations of scientists and engineers.

The federal government should encourage, but not directly fund, private-sector technology development, with two exceptions: in pursuit of the government's own missions - such as weapons development or space flight - or where government participation is essential for the development of new enabling, or broadly applicable, technologies.

Existing federal laboratories should undergo renewed scrutiny, with the possibility of redirecting or eliminating resources when mission requirements have diminished or if external reviewers deem them less effective than other alternatives. The federal laboratories, which now account for nearly 40 percent of the FS&T budget, have played a vital role in the nation's science and technology enterprise. There remain superb federal laboratories whose unique contributions to their agency's mission should not be diminished, the committee said.

The study was requested by the Senate Appropriations Committee in October 1994. It was funded by the National Institutes of Health with additional funds from the Department of Defense, the National Science Foundation, and the National Research Council.

The National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine are private, non-profit institutions that provide science, technology, and health policy advice under a congressional charter. The National Research Council is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering.

A GENERAL CHARACTERISTIC OF ATMOSPHERICAL ELECTROMAGNETIC WAVE ANOMALY AS AN EARTHQUAKE PRECURSOR

EMCABS: 07-02-96

Masayasu Hata, Xuejun Tian and Seiji Yabashi
EMC-Japan meeting at Kyoto University
Sept. 20, 1995,EMCJ95-36

Abstract: For the six recent earthquakes (M>5) taken at four locations, the received abnormalities were spectrum analyzed by Wavelet technique and showed that they were caused by electromagnetic fields of very low frequency components of several hour periods, which are coming up from microcrackin of deep plate and disturbing the D-layer ionosphere to scatter tropical thunder radiation at the ELF band. As a model which explains well the electromagnetic precursors, we propose a "Two-Stage Fracture" model of the deep plate earthquakes. Through studies of electromagnetic wave (EMW) characteristics which are transmitted in the earth's crust, we discuss the EMW precursor of earthquakes directly above its epicenter as opposed to the deep plate earthquakes.

Index terms: Atmospherical EM, thunder radiation, ionosphere scattering, earthquake prediction

CHARACTERISTICS OF EM WAVE RADIATION BY EM MOVEMENT IN THE EARTH'S CRUST

EMCABS: 08-02-96

Xuejun Tian and Masayasu Hata
EMC-Japan meeting at Kyoto University
Sept. 20, 1995,EMCJ95-37

Abstract: EM wave radiated from EM dipole in the earth's crust which results from micro cracking and stresses of the earth's crust attenuates very largely through passing the sea or the crust of large conductivity. And the level of EM becomes low as the depth of the dipole. However, an EM wave whose cycle is long as some hours, almost direct current, can penetrate sea water of 5km in depth. In this paper, EM propagation of sea water and the earth's crust is theoretically discussed.

Index terms: Super low frequency EM, Fourier transformation, radiation dipole, lossy media, earthquake prediction

EFFECT OF THE FERRITE TILES' GAP ON FERRITE ELECTROMAGNETIC WAVE ABSORBER

EMCABS: 09-02-96

Hiroki Anzai, Yoshiyuki Naito, Tetsuya Mizumoto, Michiharu Takahashi
EMC-Japan meeting at Iwate University,
Oct. 20, 1995,EMCJ95-38, MW95-82

Abstract: The gap between ferrite tiles degrades the characteristics of ferrite electromagnetic wave absorbers at low frequency. The problem is serious when the tiles' gaps affect the site attenuation of an anechoic chamber constructed with ferrite tiles. The effect of gaps on proposed ferrite grid tiles is discussed. It becomes clear that the degradation of reflectivity due to the air gap in the grid ferrite absorber is less compared to the conventional plate ferrite tile absorber. Also, we investigated the effect of inserting ferrite powder into the gap to upgrade the properties of the ferrite tiles with the gaps.

Index terms: Electromagnetic wave absorber, ferrite tile, gap, grid ferrite, plate ferrite, ferrite powder

AN ANALYSIS OF LOAD EFFECT PRODUCED BY EMI FERRITE CORE ATTACHMENT

EMCABS: 10-02-96

Takeshi Ichikawa and Osamu Fujiwara
EMC-Japan meeting at Iwate University,
Oct. 20, 1995,EMCJ95-39, MW95-83

Abstract: Ferrite cores are commonly used to suppress the electromagnetic noise emitted from digital information equipment, and also to improve the immunity level against the noise. This is largely because the impedance of the portion attached by the ferrite core increases with frequencies resulting from reduction of the high frequency current flowing on that portion. The mechanism, however, is not being theoretically elucidated in relation to the core dimension and material. This paper analyzes the high frequency impedance of the lead produced by the ferrite core attachment, thereby showing the equivalent circuit for the load effect. The dimension design method is given for effectively enhancing the resistive impedance per unit core length. Measurement of the vector impedance is also made to validate the equivalent circuit derived here.

Index terms: Ferrite core, load effect, analysis, core dimension design, measurement

AN OPTOELECTRIC MODULATOR USING A METAL STRIP GRATING ON A SILICON PLATE FOR MILLIMETER AND SUBMILLIMETER WAVELENGTHS

EMCABS: 11-02-96

Jongsuck Bae, Hiroyuki Mazaki and Koji Mizuno
EMC-Japan meeting at Iwate University,
Oct. 20, 1995,EMCJ95-47, MW95-91

Abstract: An optoelectric modulator using a metal strip grating on a silicon plate with an external electric field between the metal strips has been developed as a quasi-optical component for millimeter and submillimeter wavelengths. The external electric field quickly sweeps out photo excited carriers in the silicon plate and consequently increases modulation speed. The experimental results obtained from 52 GHz to 60 GHz show that with inductive metal strip modulators, the maximum modulation frequency can be increased from 13 kHz to 250kHz by applying only 15 volts between the metal strips.

Index terms: Modulator, optical control, metal strip grating, quasi-optics

OUTPUT POWER OF EVEN HARMONIC MODULATOR

EMCABS: 12-02-96

Kenji Itoh, Kenji Kawakami, Mitsuhiro Shimozawa and Akio Iida
EMC-Japan meeting at Iwate University,
Oct. 20, 1995,EMCJ95-49, MW95-93

Abstract: Transmitters employing RF quadrature modulators have advantages of small size and low cost by reduction of IF circuits. So, applications for digital radio transmission systems are considered. In such a system quadrature modulators require high vector accuracy for good bit error rate and low distortion level for narrow bandwidth. An even harmonic modulator with an anti parallel diode pair (APDP) has high suppression of carrier leakage which is one of vector error components. But there were no discussions about distortion characteristics of the even harmonic modulator. In this report, we discuss output power and distortion characteristics of the even harmonic modulator by analytical approaches. APDP's DC characteristics are expressed as linear, and APDP's current caused by local oscillator and modulation signal and its Fourier coefficient are indicated by analysis. Furthermore, the Fourier coefficient is expressed in a series form and it indicated 3rd order distortion of the modulator. Finally, experimental results in X-band indicate the same dependence with the analysis.

Index terms: Quadrature modulator, vector error, 3rd order distortion, diode

NARTE ACTIVITIES AT THE 1995 IEEE EMC SYMPOSIUM

JAMES WHALEN

A half-day workshop on "Preparing for the NARTE Exam" was conducted on Monday afternoon during the EMC Society Symposium in Atlanta. Approximately 35 attendees participated. This workshop was intended for EMC engineers who were preparing for the NARTE EMC Credentials Certification Exam. It was similar to Workshop W8, which was given at the 1993 EMC Symposium in Dallas, and Workshop WS2D, which was given at the 1994 EMC Symposium at Chicago.

Those taking the practice exam used their favorite reference books. The three references most often used by the NARTE EMC Exam Committee are:

1. IEEE Dictionary of Standard Electrical and Electronic Terms
2. ITT Reference Data for Radio Engineers (6th or 7th edition)
3. MIL-STD-461C and MIL-STD-462

A single copy of each of these three references was available at the workshop for participants to borrow.

I was the Workshop Coordinator for this workshop. Dave Case, who is on the NARTE Board of Directors, was Assistant Workshop Coordinator. Please contact me directly on any items related to the Monday workshop. My telephone number, fax number, and e-mail address are:

Dr. James J. Whalen
State University of New York at Buffalo
Tel: (716) 645-2422, Ext. 1210, 2124
Fax: (716) 645-5964 & (716) 645-3659
E-mail: jjw@ubvms.cc.buffalo.edu

On Friday, the NARTE EMC Certification Exam was conducted from 8:30 AM to 5:00 PM. The number of EMC engineers who took the exam was 26, which may have been the largest number ever to sit for the Exam at one site. The number who passed was 23.

It is believed that the combination of the Monday workshop "Preparing for the NARTE Exam" and the Friday Narte EMC Certification Exam worked very well for all involved. We are planning to do a repeat performance at the 1996 IEEE EMC Symposium at Santa Clara.

For information on the NARTE exam, please contact:

Ms. Susan Stillwell
NARTE Inc.
P.O. Box 678
Medway, MA 02053
Tel: (508) 533-8333
Fax: (508) 533-3815

Additional information on the NARTE EMC Exam is given in the paper "The NARTE EMC Credentials Certification Examination," by James J. Whalen, 1993 International Symposium on Electromagnetic Compatibility Record, pp. 5-9, IEEE Publication No. 93CH3310-0, IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

PHOTO COURTESY OF DICK FORD

Seated at the front table (l to r) are Matha Veladecasilla and Dillard Gilmore; middle table (l to r): David Stienkamp, Adam Odak; rear table (l to r): John Fessler, Melissa Gluck.

BASIC PROBLEMS OF EMC TEST SITE (13) - SPECIFICATION OF RADIO DISTURBANCE LIMIT BASED ON FREE SPACES

EMCABS: 13-02-96

Shigekazu Shibuya, Haruo Ishizuka, Toshio Kinoshita, Hideya Ando, Akinori Kameshima, and Takashi Suzuki

EMC-Japan meeting at Nigata Institute of Technology, Nov. 16, 1995,EMCJ95-51

Abstract: Although limit values for the radio disturbance (EMI) of information technology equipment (ITE) have been given in the revised recommendation of CISPR 22 (193), they give a difference in the order of 10 to 20 dB, depending on the mounting height of ITE, measurement distance and polarization. For example it is almost impossible to find a correlation between "3-m method: semi-anechoic chamber (with a metallic floor)" and "10-m method; CISPR type open free site." This can be settled easily through defining the radio disturbance limit within a free space and using a free space type site (opened or perfect anechoic chamber). The EMS test, the EMI measurement in 1 GHz or higher, etc. have so far presupposed the use of the free space type site and therefore revision of the specifications presently used is indispensable to insure consistency with them. This paper explains that an error in converting the radio disturbance limits in CISPR 22 (1993) is attributed to an error in the technical basis of the FCC OST 55 (1982) and it has been used without correction.

Index terms: EMC, test site, basic problem free space, radio disturbance, limit value

DEPOLARIZATION PROPERTIES OF LAYERED CHIRAL MEDIA WITH APPLICATION TO DESIGN OF POLARIZATION TRANSFORMERS

EMCABS: 14-02-96

Atsushi Kusunoki and Mitsuru Tanaka

EMC-Japan meeting at Nigata Institute of Technology
Nov. 17, 1995,EMCJ95-57

Abstract: Depolarization properties of layered chiral media, which are composed of nonreciprocal or reciprocal chiral layers, are presented. Noting that the electromagnetic field inside a chiral layer is expressed as a sum of left-and right- circularly polarized plane waves, one may obtain the electric field components of the reflected and transmitted waves. The cross- and co-polarized powers and the Stokes parameters of the reflected and transmitted waves are computed for the incident plane wave of perpendicular polarization. Numerical results demonstrate novel depolarization properties of the layered chiral media with application to the design of efficient polarization transformation filters active at the optical, millimeter wave, and microwave regions.

Index terms: Layered chiral media, cross-polarized power, co-polarized power, the Stokes parameters

A STUDY ON A METHOD FOR CHANGING OF MATCHING FREQUENCY CHARACTERISTICS BY MAGNETIZED COMBINATION FERRITE ABSORBER

EMCABS: 15-02-96

Atsushi Maeda and Youji Kotsuka

EMC-Japan meeting at Nigata Institute of Technology
Nov. 17, 1995,EMCJ95-58

Abstract: Conventional ferrite materials have had basically only one matching frequency region determined by their thickness and material properties. So we propose a new method making use of magnetized combination ferrite absorber for the purpose of establishment of a procedure for making broad matching frequency changes. Then using this method, characteristics of the matching frequency can be changed greatly.

Index terms: Changing of matching frequency, magnetized ferrite, combination ferrite

ANALYSIS OF MATCHING CHARACTERISTICS OF A MULTI-LAYERED CHIRAL MEDIUM MIXED WITH A MAGNETIC MATERIAL

EMCABS: 16-02-96

Youji Kotsuka and Hirishi Wakita

EMC-Japan meeting at Nigata Institute of Technology
Nov. 17, 1995,EMCJ95-59

Abstract: We proposed a new type EM wave absorber which is constructed of a chiral medium mixed with a ferrite material. And it is clarified that a chiral absorber can make the desired matching frequency change, if it is composed of a multi-layered structure.

Index terms: Chiral medium, multi-layered, EM wave absorber, matching characteristics

ON UNDESIRED RADIATION FROM SUBSURFACE RADAR

EMCABS: 17-02-96

Toshifumi Moriyama, Yoshio Yamaguchi, Hiroyoshi Yamada, and Takeo Abe

EMC-Japan meeting at Nigata Institute of Technology
Nov. 17, 1995,EMCJ95-63

Abstract: In recent years, various subsurface radars have been investigated. The requirement for subsurface radar is the ability of high resolution and the detection of deep objects underground. Therefore, the radar must use high power with wide-band spectrum. However, all of the wave radiated from the radar does not necessarily penetrate underground, resulting in undesired radiation into the free space. In order to detect deep objects and reduce undesired radiation to free space, this report discusses the position and structure of a horn antenna based on the FD-TD method.

Index terms: Subsurface radar, undesired radiation, FD-TD method

RADIATION CHARACTERISTIC OF ELF, VLF ELECTROMAGNETIC FIELD FROM VDT'S

EMCABS: 18-02-96

Koichi Furuta, Akira Haga, Koichi Oonuma and Risaburou Sato

EMC-Japan meeting at Gifu University
Dec.15, 1995,EMCJ95-71

Abstract: In recent years there has been considerable attention concerning emissions from video display terminals (VDT's). The VDT's which contain a cathode ray tube (CRT), by the nature of their operation, have associated very low frequency magnetic, electric, and electrostatic fields. Most of us sit closely to our VDT's, thus we have concern that the very low frequency emissions are hazardous to our health. This paper describes the measurement results of electric and magnetic fields from VDT's on the basis of procedures of IEEE EMC Standard 1140 1994.

Index terms: VDT, low frequency, electric and magnetic field, Bioeffects

1995 PACE CONFERENCE

A.H. MILLS

Over 230 people, including members of the IEEE Board of Directors, members of the United States Activities Board, PACE representatives from sections, councils, regions, divisions and societies and guests, attended the 1995 PACE Conference and Workshop in Cedar Rapids, Iowa during the Labor Day weekend. The theme of this year's conference was "Making a Difference."

Plenary sessions were held at the start of each morning and afternoon period. The five plenary sessions were entitled Difference Makers, Establishing an IEEE Grassroots Role in National Technology Policy, In Pursuit of a Resilient Career, IEEE Organizational Improvement, and PACE Hot Issues Panel: Immigration. After each plenary session, workshops were conducted on various issues such as global competitiveness, K through 12 education, e-mail, jobs, IR&D policy issues, retirement concerns, age discrimination, legislative and regulatory matters impacting our careers such as the recent telecommunication policy, and the state legislation of the registration of EEs as it impacts consultants.

The IEEE organizational improvements issue was a "hot" item since it has a major impact on the United States Activities Board. USAB has the mandate to look after the professional needs of the U.S. members. The organization improvement task force of the IEEE Strategic Planning Committee was given the task of developing models for the reorganization of the volunteer structure of IEEE. A description of these models appeared in the June 1995 issue of the Institute. Under the present schedule the Board of Directors was to vote at the December meeting on a model for reorganization of the IEEE.

PACE representatives of the Regions and Divisions/Societies met on two occasions to review activities of the past year and to discuss possible PACE projects for the next year. The 1996 PACE Conference is scheduled to be held in Phoenix, AZ during the Labor Day weekend.

CALL FOR BoD NOMINATIONS

Nominations are now being accepted for candidates for the IEEE EMC Society Board of Directors. In accordance with the Bylaws, nominations may be made by petition or by the Nominations Committee. Petitions shall carry a minimum of 15 names of Society members in good standing (dues paid), excluding those of students. Nominees should possess professional stature and significant technical skills in electromagnetic compatibility. They must have adequate financial support outside the Society and have the approval of their organizations or employers to actively participate. Duties include attendance at three or four Board meetings a year and participation on committees, both of which require telephone, fax and mail communications. Nominees must be full members of the IEEE and members of the EMC Society. Elected Directors must serve a three-year term starting January 1, 1997. Attendance at the last meeting of the 1996 year is also desirable. No member can serve more than two consecutive three-year terms, including partial terms. All nominees are required to submit a biographical summary to the Nominations Chairman for inclusion on the ballot. The summary must not exceed a one-half typewritten page and must be in the following format:

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

Please submit petitions and biographical summaries to the Nominations Chairman:

Warren Kesselman
31 Hope Road
Tinton Falls, NJ 07724-3009 USA
Telephone: (908) 842-3207
Fax: (908) 530-9710

Submissions must be postmarked no later than May 30, 1996.

Information can be obtained from Mr. Kesselman or any member of the BoD.

NOMINATION PETITION
ELECTROMAGNETIC COMPATIBILITY SOCIETY
BOARD OF DIRECTORS
(Nomination guidelines given on facing page.)

I. NOMINEE'S NAME: _____

MEMBERSHIP NUMBER: _____

ADDRESS: _____

_____

_____

PHONE: _____

II. BIOGRAPHICAL SUMMARY: Attach Typed Copy

III. SIGNATURES: (Minimum of 15 names) We, the undersigned, all of whom are current IEEE Electromagnetic Compatibility Society (EMCS) members in good standing, nominate the above-mentioned person to serve on the EMCS BoD for a three-year term beginning January 1, 1997.

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

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The Santa Clara Valley Chapter of the IEEE EMC Society proudly hosts
The IEEE 1996 International Symposium on Electromagnetic Compatibility

IEEE EMC'96

EMC: Silicon to Systems

August 19-23, 1996
Santa Clara Convention Center - Santa Clara California

This conference is tailored for the practicing EMC engineer, design/test engineers, technicians, and managers who must ensure their products meet changing global compliance requirements. Technical sessions will feature expert speakers covering fundamentals through advanced level issues of EMC, product standards and regulations. Demonstrations will illustrate practical EMC design and test topics. State-of-the-art exhibits will feature the latest equipment and services from more than 120 suppliers. Workshops will be presented on Monday and Friday of the symposium week to complement the technical program. A full registration includes; admission to all technical sessions, workshops, exhibits, demonstrations, the symposium record and several fantastic social events. Don't miss this one!

Technical Sessions

- PC Board Layout for EMC
- EMC Troubleshooting
- EMC Emissions Measurements
- Shielding and Cable Design
- EMC Component Issues
- Compliance Standards Review
- Compliance Management
- IC Level EMI Mitigation
- EU (European Union) Issues
- CE Mark EMC Requirements

Additional information regarding the symposium including a complete on-line Advance Program can be found on our Web page at:

http://reality.sgi.com/csp/emc96

or send e-mail to our mailbot at:

emc96@olympus.engr.sgi.com

Exhibits

- EMC Components
- EMC Test Equipment
- EMC Test Facilities
- Consulting Services
- EU Competent Bodies
- IEEE Info. & Registration

Workshops

- Fundamentals of EMC
- EMC Testing
- Product Safety
- EU EMC Directive
- Numerical Techniques
- Ferrite Materials
- NARTE Exam Review

Fee Schedule

	*Advance**	*Walk In*
Full registration IEEE Members	$195	$225
Full Registration Non IEEE Member	$250	$275
One Day Registration IEEE member	$75	$90
One Day Registration non IEEE member	$90	$105
Workshop (Monday or Friday)	$50	$50
Additional Symposium Record**	$35	$35
Exhibits Only	$15	$15

** Advance registration must be received by July 31, 1996*
*** Non IEEE member price is $50*

Demonstrations

- Crosstalk
- EMC Troubleshooting
- Time/Freq. Component Response
- Immunity Testing
- Transient Suppression
- Signal Spectra

IEEE

EMC: SILICON TO SYSTEMS
SILICON VALLEY, 1996

EMC SOCIETY

Correspondence
IEEE EMC'96
P.O. Box 2102
Cupertino, CA 95015-2102

Registration
Ray Mascia
415-933-1299
email:raym@engr.sgi.com

Exhibits
Jay Gaertner
408-773-8871
email: jgaert7214@aol.com

General Information
David Hanttula
415-933-1071
email:hanttula@engr.sgi.com

IEEE EMC '96 INFORMATION AVAILABLE

The EMC '96 committee is in the process of putting the advance program, hotel and registration forms on the Web. We believe that this will be an improvement in getting timely information to EMCS members. Conserving natural resources and minimizing costs are additional benefits. Base information is currently available and the preparation of the advance program is underway. Target date for the advance program and registration forms is February 1, 1996. The WWW address is http://reality.sgi.com/csp/emc96. For those without WWW access the e-mail address is emc96@olympus.engr. sgi.com. The e-mail mailbox will automatically return the file.

PIERS 1997 CALL FOR PAPERS

The Progress in Electromagnetics Research Symposium (PIERS 1997) will be organized by the Telecommunications Research Centre at the City University of Hong Kong on January 6-9, 1997, on the campus of the City University of Hong Kong in Kowloon, Hong Kong.

PIERS provides an international forum for reporting progress and recent advances in the modern development of electromagnetic theory and its new exciting applications. A one-page abstract must be received by May 1, 1996. Abstract(s) and inquiries should be directed to: Prof. K.F. Lee, University of Toledo, Toledo, OH 43606-3390. Tel: (419)841-6024. Fax: (419) 537-2915. E-mail: klee@uoft02.utoledo.edu (for participants from the United States and Canada), or Dr. K.M. Luk, City University of Hong Kong, Kowloon, Hong Kong. Tel: (852)2788 7352. Fax: (852)2788 7791. E-mail: eekmluk@cityu.edu.hk (for participants from other countries).

EMCS SYMPOSIA SCHEDULE

1996 Santa Clara, CA: August 19-23
IEEE-EMC Symposium
Santa Clara Convention Center
Westin Hotel
Chair: David Hanttula
Silicon Graphics
(415)933-1071
FAX: (415)962-9439
e-mail:
emc96@olympus.engr.sgi.com
Web: http://reality.sgi.com/csp/emc96/index

1997 Austin, TX: August 18-22
Austin Convention Center
Hyatt Hotel
John Osburn
(512)835-4684

1998 Denver, CO: August 9-14
Radisson Hotel
T.J. Ritenour
(303)673-7096

1999 Seattle, WA: August 2-6
Westin Hotel
Bill Gjertson
(215)591-6478

2000 Washington, DC
Washington Hilton
Bill Duff
(703)914-8450

2001 Montreal, Canada
Montreal Convention Center
Christian Dubé
(514)633-9679

2002 Minneapolis/St. Paul
Dan Hoolihan
(612)638-0250

EMCS COOPERATING SYMPOSIA

1996 **AMEREM (NEM)**, May 21-27
Albuquerque, NM
1997 Shenzhen, China: May 21-23
1999 Japan: May 15-17
UK: Biannually, even years, in September
Zurich: Biannually, odd years.
Wroclaw: Biannually, even years, in June.

CALENDAR 1996

February 13-19
IEEE BoD SERIES I
Le Meridien Hotel
San Diego, CA
Julie Cozin: (908)562-3984

February 14-17
TAB MEETING
Le Meridien Hotel
San Diego, CA
Paula Dunne
(908)562-3919

June 18-19
EAB COMMITTEES and BOARD MEETING
Westin Mont Royal
Montreal, Canada
Rae Toscano
(908) 562-5482

June 20
PUB BOARD MEETING
Westin Mont Royal
Montreal, Canada
Rob Colburn
(908)562-3972

June 19-22
TAB MEETING
Westin Mont Royal
Montreal, Canada
Paula Dunne
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