

IEEE EMC SOCIETY

NEWSLETTER

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ROBERT D. GOLDBLUM, *Editor*

NIST, FCC Officials to be Honored by ACIL

ACIL, the national trade association representing independent scientific, engineering and testing firms, recently announced the recipients of its 1997 Public Service Award. Belinda L. Collins, Ph.D., Director of the Office of Standards Services at the National Institute of Standards and Technology, and Art Wall, Chief of the Customer Service Branch of the Federal Communications Commission's Office of Engineering and Technology, were presented their awards during ACIL's Ninth Annual Federal Issues Forum, Feb. 23 and 24, 1997 in Washington, D.C.

The Public Service Award recognizes government officials who have made significant contributions in areas important to the independent laboratory industry. Dr. Collins was recognized for her leadership of a public-private sector initiative to establish a comprehensive U.S. system for accrediting laboratories. The proposed system, called the National Council on Laboratory Accreditation (NACLA), would provide a mechanism for recognizing U.S. accrediting bodies that meet the accepted international standard for this activity. In doing so, NACLA will help to reduce the redundancy and excessive costs associated with U.S. laboratory accreditations today and will further the nation's global trading interests by establishing a central coordinating organization that can interface with counterpart organizations in other regions of the world.

Since 1994, Dr. Collins has co-chaired a private-public sector Laboratory Accreditation Working Group (LAWG) which laid the groundwork for the NACLA proposal by surveying the needs, problems and issues associated with accreditation

among the various stakeholders to the process, and which undertook the preliminary planning for a U.S. system.

Mr. Wall was invited to accept the Public Service Award on behalf of the FCC, which on June 19 instituted new procedures for approving personal computers and PC peripherals. The new rule includes laboratory accreditation requirements which serve as a model that can be used government-wide and internationally. It puts into place three elements that are important to U.S. independent laboratories.

First, it helps to ensure the integrity of test data by requiring all facilities — manufacturers' or independent laboratories — that test PC products for radio-frequency emissions and other technical requirements to be accredited. Second, rather than accredit laboratories directly, the FCC will recognize third-party programs so long as they are based on internationally-accepted accreditation criteria. The two accrediting bodies currently approved by the FCC are the NIST-run National Voluntary Laboratory Accreditation Program (NVLAP) and the private-sector American Association for Laboratory Accreditation (A2LA). Finally, the FCC will only recognize data produced by U.S.-based companies. Foreign laboratories will not be accredited unless the country in which the laboratory is located recognizes U.S. laboratory accreditations under a mutual recognition agreement (MRA).

Mr. Wall has also helped support U.S. laboratory views as the FCC's lead delegate to the U.S.-European mutual recognition agreement (MRA) negotiations aimed at facilitating trade in the areas of telecommunications, electronic, information technology and pharmaceutical products.

IEEE
ELECTROMAGNETIC
COMPATIBILITY
SOCIETY
NEWSLETTER

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Editorial

ROBERT D. GOLDBLUM
EDITOR

The EMC Cookbook

I have many great cookbooks on my shelf, but the best thing that I can make for dinner is reservations. It's not that the recipes themselves are difficult or incorrect, it's that little *innovation* or *art*

that is needed to make them work. A recipe can't smell or replace the individual skill of stirring the pot.

Alas, there are many EMC design cookbooks on my shelf, and many more in preparation stages. They prescribe the basic ingredients for many delicious EMC design recipes, which include gaskets, filters, grounding, box and cable shielding, etc. Some EMC chefs offer a quick fix, while others go to great lengths to explain how a filter or gasket works, when they should be used, and even computer codes to verify that the "stew" is simmering as it should. Twenty-five years ago, we called some of these recipes "application notes," and the EMC engineer who could apply all these fixes effectively had a "black art." But, today, cookbooks that include EM theory explain that Ohm's Law was indeed not repealed and that there is a technological basis for EMC design recipes.

The analysis methods of today are far more sophisticated than the basic recipe papers written by Garlington* and published in the Sprague Technical Paper 62-1. Some of the 1962 charts and figures in this 32-page document have a very familiar taste and their presentation looks very familiar. Today's recipes are so precise that they can predict an out-of-spec condition of, for instance, 17.62 dB whereas Garlington's old black magic might estimate 24 dB out-of-spec. (This is more than a 100% difference.) Notwithstanding the errors and uncertainties of the ultimate test, the solution is the proper application of a cable shield which provides a nominal shielding effectiveness of 60 dB. After you have been through this a dozen or so times, you sort of know what to do by simply asking a few questions and applying your bag of magic tricks. So, I'll have mine over light with a side order of ferrites. I still miss my old grid dip meter.

*Garlington's paper may be seen on <http://www.RBitem.com>

BACK ISSUES OF THE EMC SOCIETY NEWSLETTERS ON MICROFICHE

We still have a few sets of the uFiche copies of the back issues of the IEEE EMC Society Newsletters from the present to 1955, when it was called "Quasies and Peaks." The price is \$25.00 postpaid. Sets can be ordered from: Dr. Chester L. Smith, EMC Society Historian, 2 Jonathan Lane, Bedford, MA 01730.

IEEE EMCS Members Elected to Fellow Grade

The following members of the IEEE EMC Society have been elected to Fellow grade as of January 1, 1997. Congratulations to all!

Dr. H. Clark Bell
HF Plus
Chatsworth, CA

For advancements in synthesis techniques and development of new prototype networks for microwave filters.

Professor Dieter Koenig
Technical Univ. of Darmstadt
Institut fur
Hochspannungs-und
Messtechnik
Darmstadt, Germany

For contributions to the optimization and reliability of insulation technology and electrical engineering education.

Professor Karl Stephen Kunz
Penn State University
University Park, PA

For contributions to the application of the finite difference time domain method to electromagnetic scattering.

Mr. Zong Sha
Chinese Institute of
Electronics
Beijing, China

For technical leadership in radiowave-proagation research, practice and education.

Mr. Kenneth Roger
Siarkiewicz
Rome Laboratory
Rome, NY

For contributions to the development and promotion of general electromagnetic analysis models for military and civilian systems.

THE 1997 IEEE/EMC SYMPOSIUM



AUGUST 18-22

AUSTIN CONVENTION CENTER, AUSTIN, TEXAS

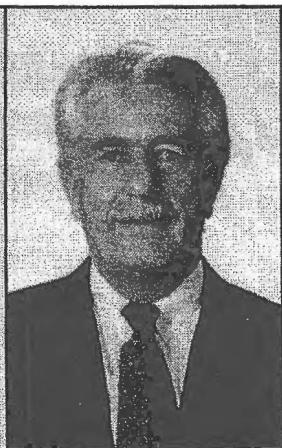
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BILL GJERTSON
PRESIDENT,
EMC SOCIETY

*The newsletter
you are now reading
continues to be a
great newsletter and
provides you, the
readers, with a
window into your
EMC Society and
its activities.*

A few months have passed since the last newsletter and it is time to reflect on an EMC year ending and on a new EMC year beginning. My emphasis in this newsletter is 1997 and how to make it your greatest EMC year. My focus will be on both involvement and contributions — Society-wise, Institute-wise, idea-wise, and technically.

The newsletter you are now reading continues to be a great newsletter and provides you, the readers, with a window into your EMC Society and its activities. Please use this media, or any other, to let us, your elected EMC Society Directors, and other committee volunteers know what is on your mind and how we can provide more service and benefits to you, the members. The E-mail, telephone, fax and mail are all acceptable methods for you to contribute ideas and suggestions for the EMC Society to consider. Another means of providing an input is through your direct or indirect participation in a committee. The list of committees is significant and covers many areas; perhaps one may be for you. This may be a way for you to participate, contribute and enjoy your EMC profession and/or activities.

The 1997 elected directors and officers are listed in the EMC Society home page and the names of numerous volunteers are listed in this very newsletter. Again, please take time to let us know what your thoughts are and what your reaction is to something we are doing. Actually, we would like you to become a part of the "we" we speak about.

During the November 1996 BoD meeting, the EMC Society Board of Directors, under the leadership of your Vice President and planning chair, Dan Hoolihan, elected to focus our efforts for 1997 on the short-term objectives we had identified in the EMC Society 1996-2001 Objectives. These objectives are based upon the IEEE goals (career enhancement, globalization, organizational involvement, products and services, and public responsibility). The EMCS Directors-at-Large and the 1997 Technical Directors discussed and re-engineered those 1997 EMCS objectives, and presented them as representing what this new year 1997 is all about and what is

Continued on page 6

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IEEE EMC Society Newsletter Publication Schedule

Publication Dates

May
August
November
February

Editorial Deadlines

March 15
June 15
September 15
December 15

Editorial Contributions for the May issue should be received by March 15.

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JANET O'NEIL
ASSOCIATE EDITOR

The third and final meeting of the EMC Society Board of Directors in 1996 was held on November 8 and 9 in conjunction with the IEEE TAB/RAB meetings held at the Marriott Marquis in Denver, Colorado.

Attending the Board meeting were officers President Bill Gjertson, Vice-President Dan Hoolihan, Treasurer Andrew Podgorski, Secretary Janet O'Neil, and Board members Don Sweeney, Joe Butler, Warren Kesselman, Kimball Williams, Len Carlson, Don Heirman, Bill Duff, Bob Hofmann, Todd Hubing, Norm Violette, Bill Ritenour, and Dick Ford. Board members absent included Franz Gisin, Bill McGinnis, Ferdy Mayer, Jim Muccioli, and Henry Ott. Guests in attendance included Andrew Drozd and Herb Zajac (who were recently elected to the Board for three year terms beginning in January 1997), V. Prasad Kodali, and Dr. Moto Kanda.

The meeting on November 8 at the Marriott Marquis was called to order by President Gjertson. Secretary O'Neil presented the minutes of the prior Board meetings in August which were approved as amended. Treasurer Andrew Podgorski distributed a report summarizing EMC Society financial activity. While the Society continues to enjoy robust financial health, anticipated overall income from EMCS activities is lower than budgeted for 1996. Therefore, the Board was cautioned to be frugal for the balance of the year. The Treasurer's report was accepted as presented.

Member Services

The Director for Member Services, Todd Hubing, next presented his report. He noted that Ray Adams, Chapters Coordinator, attended the November 1996 IEEE Sections Congress in Denver. Mr. Adams was impressed that over 600 people attended the conference, representing over 100 countries. From the Society case studies presented, Mr. Adams was pleased to advise that the EMC Society chapter activity was indeed impressive in comparison to many other Society chapters. Conference attendees identified increased and expanded usage of electronic communication as one of the top initiatives for the IEEE to address.

Scott Roleson, Chairman of the Distinguished Lecturer Program, presented two new nominees for the program; Jose Perini and Bill Ritenour were approved for three-year terms beginning January 1, 1997. Bill Duff, Chairman of the Fellows Search Committee, requested that Board members nominate

candidates for the Fellow grade. The deadline for nominations to Dr. Duff is March 15, 1997. Mr. Hubing noted that Steve Mullenix, Membership Committee Chairman, has created a new combined IEEE/EMC Society membership application to make it easy to join both the IEEE and the EMC Society at one time. He has also installed a new membership data base so it will be easier and quicker to receive information about our membership. Warren Kesselman, Chairman of the Nominations and Bylaws Committees, announced that a total of 804 ballots were returned to the IEEE for our recent EMCS Board election (some 20% of the membership voted). Regarding the Bylaws Committee, Mr. Kesselman noted that the bylaw change regarding the new Director-at-Large election process was printed in the EMCS Newsletter and will be effective in 1997.

Technical Services

The Director for Technical Services, Joe Butler, next presented his report. Don Heirman, chairman of the Standards Committee, reported on the recent committee meeting. Activity continues with changes and additions to the Policy and Procedures document and to the Operations Manual. The committee continues its effort to expand interest in Standards. They have aggressively contacted authors and members in IEEE Regions 8-10. An article was written for the EMCS Newsletter on subcommittee P1302 (which met prior to the Standards Committee meeting in Denver) and each Working Group chair was charged to seek their respective replacements should they no longer be able to act as chair. The budget for a three-hour seminar training video was approved. Standards were updated and coordination was established with other Standards Development Organizations.

Kimball Williams reported as Chairman of the Education and Student Activities Committee. Notable activities involved the NARTE, tutorials, and demonstrations committees; each committee is working on a program for the 1997 EMC Symposium in Austin. It was noted that NARTE has moved toward equalizing the EMC test questions between civilian and military. After many years, activity with CAEME has been terminated. The Education Committee will expand its plans for 1997 in order to address the goals and objectives of the EMCS Long-Range Plan.

As the new Technical Activities

Chairman, Kimball Williams reported that there will be a meeting of the TC chairmen at the 1997 EMC Symposium in Austin. A five-year plan will be developed for each TC and a generic policy and procedures document will be created. There will be a TC poster session at the 1998 EMC Symposium in Denver.

Lastly, in RAC Chairman Leo Makowski's absence, Mr. Butler distributed the RAC report which included subcommittee reports by COMAR (Committee on Man and Radiation), ANSI C63, CISPR A & G & E, and NARTE. The committee continues to seek liaisons to act as EMCS representatives to the FCC, FDA, IEC (Product) and DoD DIESC, among others.

Communication Services

The Director for Communication Services, Len Carlson, reported for absent Board member Henry Ott, Symposia and Conference Chairman, that all is going well with the 1997 EMC Society Symposium in Austin. The financial books are being closed for the 1996 symposium in Santa Clara. Chet Smith continues his efforts with the CD ROM program. The committee has researched pricing, marketing, and distribution plans for the CD ROM disks. These will be available for sale in early 1997.

Regarding the EMCS Newsletter, Mr. Carlson announced that Bob Goldblum will retire as editor in mid-1997 and a new editor to take his place is being sought. The Board acknowledged the tremendous job Mr. Goldblum has done for many years as editor. Next, Moto Kanda, Transactions Editor, noted that the publication is set for a 575 page count in 1997. He also commended his associate editors for their fine jobs on the publication in 1996.

Professional Services

The Director for Professional Services, Norm Violette, next presented his report. Ferdy Mayer, International Activities Chairman, has possession of the EMC Society table-top display and will use this to promote IEEE membership at the EMC conference in Zurich, February 1997. PACE chairman

Al Mills reported that the September 1996 PACE Conference and Workshop he attended in Phoenix, Arizona was the "one of the best in recent years," partly due to the emphasis given to inviting a large number of young professionals. Lastly, Public Relations chairman Herb Zajac's showed a preliminary copy of the new EMCS PR video. This included footage taken during the Santa Clara symposium.

Long-range Plan

Dan Hoolihan, Vice President and custodian of the EMCS Long Range Plan reviewed each Service Directors' progress in addressing the plan. First, he distributed copies of the IEEE document entitled "Meeting Member Needs in the 21st Century — IEEE Strategies for the Future," thereby stressing that the Society is a membership-driven organization. The goals developed at the August 1996 Board meeting were summarized:

1. Promote EMC Awareness
2. Enhance and Expand EMC Education
3. Develop Applied EMC Practices
4. Increase Active Membership
5. Exploit Institute and Society Globalization
6. Formalize EMCS Leadership Development
7. Provide Career Enhancement.

Each of the four Service Directors (for Technical, Membership, Professional and Communication Services), outlined their respective goals for 1997 relative to the Long Range Plan. Mr. Hoolihan also proposed the idea of formalizing the Board's practice of two-year terms for officers and Service Directors, formally identifying the Vice-President position as President-Elect, and revising the EMCS Long Range Plan every other year. An ad hoc committee was appointed by President Gjertson to address this proposal. It was suggested that this committee review the effect of this proposal on the bylaws and review how this proposal relates to the TAB organizational chart of a "model Society." This chart was distributed at the TAB November 1996 meeting.

The Friday meeting adjourned for the day at 5:00 P.M. The Board

reconvened on Saturday, November 9 at 8:30 A.M. at the Adam's Mark Hotel.

Under Old Business on the agenda, the Board discussed the usage of electronic communication to expedite communication. Franz Gisin, who is the "Internet Chairman" (so called until a better title is found), was asked to provide training to the Board on the effective use of e-mail, the WWW, etc. Don Heirman and Herb Zajac volunteered to assist Franz with this training which will be held during the May 1997 Board meeting.

Under New Business on the agenda, the Board discussed the Board meetings for 1997. These were scheduled as follows:

February 21 in Zurich, Switzerland in conjunction with the EMC conference
May 5 in Boston
August 17 and 21 in Austin in conjunction with the EMC Symposium
November 8 in Atlanta, Georgia in conjunction with the IEEE TAB/RAB meetings.

The Board discussed plans for the Zurich meeting and the goal of using the venue to expose the Board and Standards Committee (who will also be meeting in Zurich prior to the Board meeting) to potential new international volunteers.

Next, President Gjertson introduced Barry Wallen, Chairman of the 1998 EMC Symposium in Denver. Mr. Wallen gave the Board a thorough presentation on committee activities to date. Mr. Wallen was commended for assembling an excellent committee for the symposium (notably including a prior Director of the EMC Society, Charlotte Tyson, and our own Transactions Editor, Moto Kanda). The Board was then led on a tour of the hotel, The Adam's Mark, in downtown Denver, which will be the symposium location.

Lastly, President Gjertson discussed the activities at the recent IEEE TAB/RAB meetings he attended. He distributed the 1997 and 1998 meeting dates for these committees and welcomed those interested to attend.

There being no further business, the meeting adjourned at 12:00 P.M.

challenging all of us. Some time was spent on planning for the Zurich Symposium, but the 1997 objectives were the focus of the group. We do intend to pursue those EMCS objectives in 1997 and hope you will contribute to them.

Our field, electromagnetic compatibility, provides an endless set of technical challenges which keeps us employed, challenges our technical expertise and provides numerous hours of real interesting enjoyment/entertainment. As you scan the technical literature and the upcoming symposiums and workshops, you can see numerous technical issues to which we as individual EMC professionals could contribute. Items that come to mind are EMC measurement uncertainty, consumer products, compliant EMC design, RF spectrum utilization, EMC standards, and numerous wireless products and EMC problems. I encourage each of you to select an issue and contribute. Again, get involved in the field of EMC technically, especially, if you find that more rewarding than IEEE volunteering. I believe that your 1997 will be an even better year if you make a technical contribution to our field. Then, of course, a paper could follow, which would increase peer interaction and hopefully your recognition, professionally and financially, by your employer and others.

When Wally Read (1996 IEEE President) spoke at a special EE Colloquium at the University of Washington in late 1996, his message ("The Changing Environment for Engineers in the Next Millennium") was the same: get involved, contribute, adapt, and increase your engineering prowess and technical skills. These are thoughts that will help us all enjoy our engineering careers by making technical contributions in 1997. Have a great year and I look forward to meeting more of you. Thank you for listening!

Michael Davis 1960-1996



The EMC community mourns the loss of Michael Davis, a senior E³ engineer for the Naval Air Systems Command Electromagnetics Competency, AIR-4.1.7, who was killed in a vehicular accident on October 13, 1996.

Mike began his career in Federal service with the Naval Sea Systems Command in 1981. In 1984, upon graduation with a BSEE from Tuskegee University, he began his EMC career in the EMC Branch of the Naval Air Test Center, Patuxent River. In September 1988, Mike joined

the NAVAIR E³ Branch as an E³ engineer where he managed the Air Launched Ordnance program under the Air Systems EMI Corrective Action Program (ASEMICAP) and all missile EMC programs as well. He chaired the EMCABs for the V-22 program and other assigned programs and headed the E³/Software Working Group. Mr. Davis was a NARTE-certified EMC Engineer and was in NAVAIR's Senior Executive Management Development Program. He was also attending the University of Maryland, enrolled in their Master's degree program in Systems Engineering Technology Management

During his years of employment at the Naval Air Systems Command, Mike received numerous awards, including the National Association of Radio and Telecommunications Engineers, Inc. (NARTE) Five Year Award, 1990; Ten Year Service Award, 1991; Superior Performance Award, 1991; Superior Performance Award, 1991, 1992, and 1994; Outstanding Performance Award, 1993, 1995, and 1996; Black Engineer of the Year Award 1994; Supervisory Excellence Program, 1994; Supervisory Development Program, 1995; Senior Executive Development Program, 1995; and an On-the-Spot Award, 1995.

The second son of Mrs. Ruby Esther Davis and the late James Esau Davis, Sr., Mike was born in Washington, D.C. on October 2, 1960. He attended Bunker Hill Elementary School and Bertie Backus Junior High School, both in Washington, D.C.; graduated from Bethune High School in Bethune, South Carolina, in June 1978; and matriculated at Tuskegee Institute in Tuskegee, Alabama, where he received his Bachelor of Science Degree, Electrical Engineering in May 1985.

Michael had a very strong sense of family. He was never too busy to help others, which was demonstrated by his love and service to his family, friends, and the community. In addition to his many hobbies, which included rifle-collecting, baseball and weightlifting, Mike was a Mason.

Mike is survived by his wife, Dr. Royance Vaughn Davis, their three sons, Michael Edward, Jr., Marquise Emmanuel, and Miles Emmett, all of Fort Washington, Maryland; and his mother, Ruby Esther Davis, Washington, D.C.

***Mr. Davis was a NARTE-
certified EMC Engineer and
was in NAVAIR's Senior
Executive Management
Development Program.***



TODD HUBING
ASSOCIATE EDITOR

Rolla, Missouri is not exactly a vast metropolis. We don't have skyscrapers or shopping malls. We don't have professional sports teams or a symphony orchestra. But we are the proud home of a relatively large engineering university. Because of this, Rolla has an unusually high percentage of engineers, which gives our town a rather unique personality.

Last week I walked into the barber shop to get a haircut. There was a heated discussion taking place. It seems that half the people in the shop were of the opinion that lightning rods reduce the probability of a strike by ionizing the surrounding air. The other half argued that lightning rods protect structures by shunting the current, but are ineffective at thwarting strikes. My contribution to the discussion was in direct conflict with the point of view of my barber. Now I have a haircut that makes me look like I was struck by lightning.

I should have known better! Last month they were arguing about whether decoupling capacitors should be connected to the pins of an active device or directly to the power and ground planes. Before that it was thyristors vs. metal oxide varistors. It's been three years since I've had a decent haircut!

We could really use a chapter of the IEEE EMC Society in Rolla. Chapter meetings allow EMC professionals to come together on a regular basis to discuss issues that are important to their profession. This type of technical interchange helps members to stay on top of new developments in their field.

I try to arrange to attend EMC chapter meetings in other cities whenever I am traveling on business. I've never been disappointed and I've never failed to learn something new. Best of all, I've never emerged from an IEEE EMC Society Chapter meeting with a bad haircut. (Unless, of course, I went in with one.)

If you live in a city that has an EMC Society Chapter, go to the meetings! There's no better way to keep up with the latest developments in your field. If you're traveling to another city with a local chapter, find out when their next meeting is and plan to attend. If you're passing through Rolla, Missouri, stop by the barber shop. You may even decide to get your hair cut while you're there. If you do, remember the words that people everywhere with good haircuts live by. "The barber is always right!"

Central New England

John Clarke reports that Isidor Straus of LLC was the speaker at the September meeting of the Central New England chapter. Mr. Straus's presentation was titled, "A Close Look at the New EC Power Line Harmonics Requirements." The speaker reviewed the history and applicability of the new power line harmonic requirements under the EMC directive. Design guidelines were provided on the basis of power supply current and conduction angle. These parameters can be measured easily with available equipment. Using this data it can be determined early in the design phase whether or not the new harmonic requirements will impose any problems.

Todd Hubing of the University of Missouri-Rolla was the speaker at the October meeting. Prof. Hubing's presentation was titled "An EMC Engineer's Guide to Electromagnetic Modeling Software." His presentation reviewed the various types of EM modeling software available commercially and over the internet. The purpose of the review was to help product developers and EMC engineers decide whether they could benefit from EM modeling software and which software packages were appropriate for particular applications. He also discussed EMC modeling strategies as they applied to real products under development or to existing products with EMC problems.

The November meeting featured Dr. Norman Violette, of Violette Engineering Corporation. Dr. Violette's presentation provided an overview of the transient generation phenomena, mechanisms by which transients couple into equipment, protection techniques and design strategies to minimize transient energy-induced failures. He also discussed the installation, characterization, and selection of protective devices and reviewed standards for transient immunity compliance.

China-Beijing

Gao Yougang reports that the Asia-Pacific Conference on Environmental Electromagnetics (CEEM '96) was held on November 5-7 in Xi'an, China. A total of 103 papers were received and 81 were accepted. One hundred and one delegates attended the meeting, with 61 Chinese and the rest from Japan, Korea, Canada, the USA, Singapore,

Russia and Hong Kong. The youngest delegate was only 24 years old (a doctoral candidate), while the oldest was more than 70 (a Japanese professor).

The conference was held at the Jian Guo Hotel. The conference began as Chairman Gao Yougang and Co-Chairman Shuichi Nitta gave greetings to all the delegates. Some congratulations were then given by several Chinese officials. Keynote speeches were given by Takeo Yoshino (Japan), Gary Wong (Canada) and Zhang Minggao (China).

Nine sessions were arranged. The topics discussed included antenna theory, electromagnetic field theory and wave propagation, environmental and space electromagnetics, EMC and propagation models in communications, EMC measurement, lightning surge, ESD and EMP, earthquakes, immunity and susceptibility, and protection techniques. A visit to the figures of warriors and horses in the tomb of Qin Shi Huang and the Hua Qing Pool was arranged. Chairman Gao Yougang announced the successful close of the conference at the banquet on November 7th. CEEM '96 promoted the exchange of information concerning EM fields, strengthened friendship among researchers, and demonstrated the importance of enhancing exchange and cooperation of study in future work.

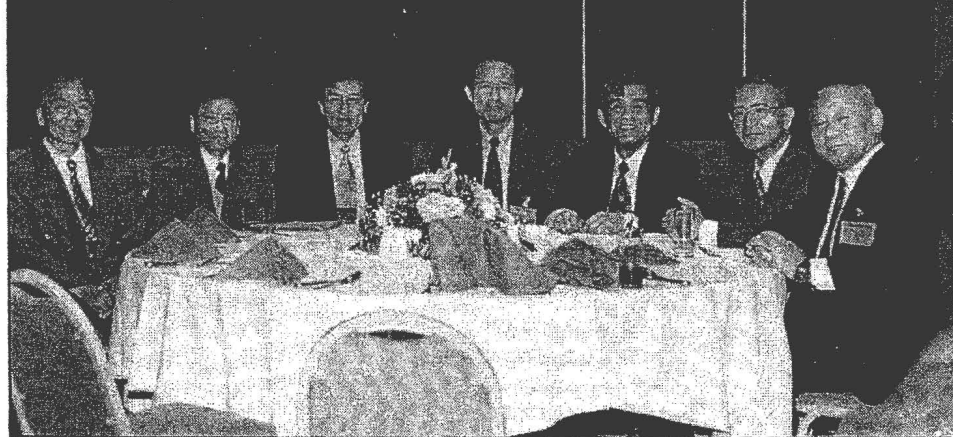
Twin Cities

Dan Hoolihan reports that Franz Gisin was the speaker at the October meeting of the Twin Cities chapter. Franz gave a presentation on the "Impact of Time and Voltage Windows on Transient Immunity Testing" to a full house, which included Dave Clark from Boston and John Smith from San Diego. The meeting was held at The Lido Cafe Italia in Roseville, Minnesota (a suburb of St. Paul) and was preceded by a social hour and a delicious Italian dinner.

Chicago

After the Twin Cities meeting, Franz Gisin continued on to Illinois to give a similar presentation to the Chicago

ASIA-PACIFIC CONFERENCE ON ENVIRONMENTAL ELECTROMAGNETICS CEEM'96



Attendees at the CEEM '96 banquet included (left to right) Prof. Gao Yougang (Conference General Chairman), Prof. Deng Zhengyin (General Secretary of CIC), Prof. Lin Jintong (Vice President of BUPT), Prof. Yang Quanli (Chairman of Technical Program Committee), Prof. S. Nitta (Conference Co-Chairman), Prof. Y. Miyazaki, and Prof. T. Yoshino.

chapter. This practice of "sharing" a distinguished lecturer with another chapter is an ideal way to attract qualified presenters to your chapter meetings. Distinguished lecturers can usually travel to two different chapter meetings in the same region on subsequent evenings and save enough on airfare so that the chapters do not have to pay any of the travel costs.

Pikes Peak

The Pikes Peak IEEE EMC Society chapter held their August meeting at DIGITAL on August 24th. Our hosts for the evening were Mike Nemeth and the Senior EMC Test Engineer for DIGITAL, Colorado Springs, Dennis Laurence. DIGITAL has a real nice EMC test facility here in town, complete with a small anechoic chamber for performing the European Community susceptibility testing, a shield room for performing conducted emissions and conducted susceptibility,

and an Open Area Test Site (OATS) for radiated emissions testing. We were even able to witness first hand one of the difficulties with using an OATS, since Pikes Peak once again favored us with a nice afternoon thunderstorm and shower during the entire meeting. The 3 meter and 10 meter sections of DIGITAL's OATS are, however, covered with a wooden A-frame structure. So once the lightning let up, we were able to check it out in relative comfort. The OATS extension for 30-meter testing (which, apparently was an old European requirement that is no longer required) extends beyond the A-frame. Thus, we just looked out at it and the rain and the puddles about the ground plane screening and thought about the joys of working on an uncovered OATS! A great big thanks for a wonderful tour goes out to Mike Nemeth and Dennis Laurence.

In other news, the Pikes Peak IEEE Section is now on the Web!

Correction

Please note that incorrect contact numbers were given for Elya Joffe, Israel IEEE EMC Chapter Chairman, in the Summer issue of the Newsletter. The correct numbers are as follows: Phone: 972-8-9272997; Fax: 972-8-9272524; Phone/Fax (home): 972-9-7657065

Thanks to the University of Colorado at Colorado Springs for providing the host services and to John Will for the initial effort in putting the home pages together and arranging the hosting with UCCS. Check us out at <http://www.uccs.edu/~ieec>. It is the intent that this home page be "your" home page with information about local activities, upcoming events, points of contact, local engineering jobs available and a place to post your resume if looking for work. Can't find your newsletter, and you know that there is a meeting coming up soon — check the home page, the info should be there. A word of caution, a substantial amount of work has gone into getting the home page started, but *much* more is needed to keep it going, updated, and timely. **WE NEED VOLUNTEERS TO HELP WITH THE MAINTENANCE OF THE HOME PAGE** or it will die. Please contact John Will at j.will@ieec.org or at 577-9700 if you are willing to help with the home page. Comments on what you like and don't like about the pages would also be appreciated.

Los Angeles

On November 11, the Los Angeles Chapter of the EMC Society was fortunate to cosponsor with the American National Standards Institute Accredited Standards Committee C63 a workshop on EMC measurement uncertainty. This workshop provided a unique opportunity for members of the EMC Society to interact with ANSI C63 members on this important issue. Some 60 people attended the one-day workshop which was held at the Radisson Plaza Hotel in Manhattan Beach. While the majority of workshop attendees were from California, there were a good many from the East Coast (Florida, Maryland, New York, Virginia and North Carolina to name a few states) and Eastern Canada (Ontario). Could it have been the mild Southern California

location in mid-November that attracted these East Coast attendees, OR, was it the stellar group of expert speakers who conducted the workshop? Of course, it was speakers Don Heirman of Lucent Technologies, Bell Labs Innovations, Dan Hoolihan of TUV Product Service and Ed Bronaugh of EdB EMC Consultants that drew the crowd! Actually, this workshop was a follow-up to the successful original workshop held in Baltimore, Maryland in April 1996. At that workshop, interest in the topic peaked and attendees indicated more time and attention was required to thoroughly address the issue of EMC measurement uncertainty. This comes as no surprise as the emphasis on uncertainty is being driven by a renewed importance for international conformity assessment and laboratory accreditation by recognized accreditation bodies. These bodies use ISO/IEC Guide 25, General Requirements for the Competence of Calibration and Testing Laboratories, as their principal document for evaluating a laboratory. Guide 25 specifically asks for an

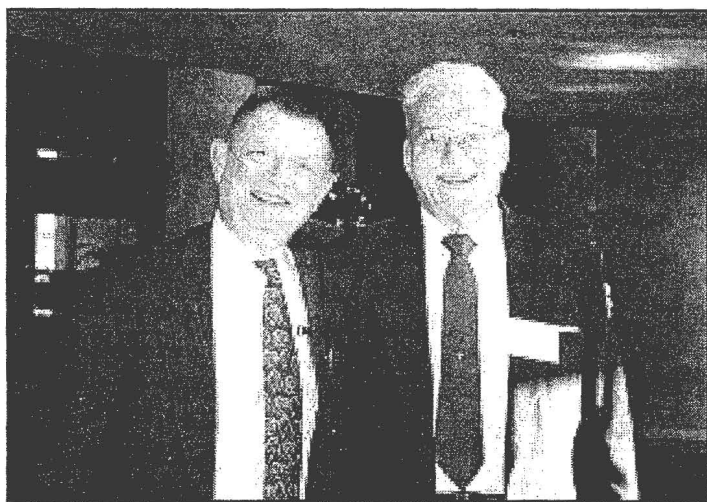
This practice of "sharing" a distinguished lecturer with another chapter is an ideal way to attract qualified presenters to your chapter meetings.

estimation of the measurement uncertainty associated with the instrumentation used and test procedures followed.

The workshop was broken into two parts: theory and practice. In the afternoon practice session, participants calculated their own instrumentation and measurement procedure uncertainties. They then learned how to combine these individual uncertainties to lead to an overall combined uncertainty which is reported to meet the Guide 25 requirements.

At the end of the day, it was unanimously agreed that more discussion was needed on this important topic. Thus, preliminary plans are to hold another EMC Measurement Uncertainty Workshop. The workshop is planned for the afternoon of 7 April continuing for the entire next day. By the way, the ACIL is also planning a workshop immediately following the uncertainty workshop at the same venue which now is planned to be at a hotel near O'Hare airport.

This will be sponsored again by the ANSI Accredited Standards Committee C63 in cooperation with the Chicago chapter of the EMC Society. For more information about the Chicago workshop, please contact the chairman of the Chicago chapter, Don Sweeney at phone (847) 537-6400 or Janet O'Neil (Arrangements Coordinator) at (206) 868-2558. Don Sweeney also has the information on the follow-on ACIL workshop.



EMC Measurement Uncertainty Workshop Speakers Don Heirman (L) and Ed Bronaugh (R) were happy to share their collective expert knowledge with the audience of ANSI and IEEE members.

Continued on next page

NEWS FLASH!!!! SAVE THE DATE!!!! The Los Angeles Chapter will hold a one-day tutorial entitled "Fundamentals in EMC" presented by IEEE Fellow, Dr. Clayton Paul from the University of Kentucky. Save the date of March 17, 1997 and plan to attend the tutorial which will be held at the Radisson Plaza Hotel in Manhattan Beach, California. The tutorial will draw extensively from Dr. Paul's widely read book, *Introduction to Electromagnetic Compatibility* (did you know this book has been translated into Japanese and Italian?). It is designed for the beginning EMC engineer or for those who could benefit from a "brush up" on their EMC skills. Don't miss out on this unique opportunity to see Dr. Paul on the West Coast! For more information, contact Peter Deal of Advanced Electromagnetics, Inc. at (310) 337-9425 or Janet O'Neil at (206) 868-2558. (NOTE: This tutorial will also be repeated in Santa Clara, California on Friday, March 21, 1997.)

Sweden

In October, the Sweden chapter elected the following new committee: Dag Bjorklof, of SEMKO AB is the new chair, Per-Olof Eriksson, of Enator Communications AB, is the new vice chair, and Mats Backstrom, of FOA3, is the new secretary. The meeting was held at FOA (National Defence Research Establishment) and was attended by 20 people. At the meeting there were two commercial presentations on computer-based analysis tools for EMC design at the PCB level. The first was made by Mr. Roland Sjostrom from Krets-Planering AB who presented the layout design tool, EMC Adviser, from Zuken-Redac. EMC Adviser is based on 20 pre-defined rules for design checking. The other commercial presentation was made by Mr. Per Viklund from DDE Sweden AB on the design tools UniSolve and SyntheSolve from UniCAD. UniSolve provides five analysis tools: emission, signal integrity, RF/I, thermal and reliability. Any of the modules can be used concurrently.

The meeting also included two presentations given by Dr. Mats Backstrom of FOA and a visit to FOA's new HPM facility. The first of these presentations was about a new center, Parallel and Scientific Computing Institute, which is a cooperation between the Royal Institute of Technology in Stockholm, Uppsala University and Swedish industry. One of the four programs deals with Computational Electromagnetics. So far, the research has concentrated on the use of FDTD methods to simulate electromagnetic phenomena in complex systems. The other presentation gave an overview of some of the HPM research at FOA, especially on recently developed methods to measure and calculate the transmission crosssection of apertures. Another subject was the angular and polarization dependence of equipment radiated susceptibility and its impact on RS testing in a mode-stirred chamber.

In June, the Sweden chapter also arranged a two-day EMC symposium on the topic, EM Immunity; Design and Testing. The meeting was attended by some 50 people. It included 15 talks and also visits to test facilities at Saab Military Aircraft and FMV (the Swedish Defence Material Administration).

IEEE Conference on Int'l EMC Standards

A one-day conference on "International Harmonization of EMC Standards, The Benefits to Industry" is scheduled for May 7, 1997 in Haifa, Israel. The conference will feature international representatives from the EMC community discussing the methods and benefits of harmonizing many international standards including NATO, MIL-STD-461/462, EC, and others. Speakers will represent several governments, including Germany, the U.S. and Israel. For program and additional information, contact the Conference Chairman, Elya B. Joffe, P.O. Box 264, Kafar Sava, 44102, Israel, Tel/Fax: 972-9-7657065.

EMC '97

A Colloquium and Exhibition on Pre-Compliance EMC Testing Problems and Solutions will be held on April 14, 1997, in Portland, Oregon (Hotel to be Determined). Featured industry renowned speakers include Henry Ott, Bill Ritenour, Steve Jensen, Scott Roleson, Henry Benitez, and Ken Javor. Topics will include an overview of EMC requirements, PCB design techniques, conducted and radiated emissions, conducted and radiated immunity, and electrostatic discharge. For further information contact Henry Benitez, Colloquium Chairman, phone: 503.627.1217, e-mail: henry@banyan.bv.tek.com; or Janet O'Neil, Colloquium Vice-Chairman, phone 206.868.2558, e-mail: j.n.oneil@ieee.org

1997 NIST Meeting

The '97 Mode-Stirred Chamber, Anechoic Chamber, and OATS Users Meeting will be held April 28- May 2, 1997 at the Lion Square Lodge and Conference Center, Vail, CO. Hosted by the Fields and Interference Metrology Group of the National Institute of Standards and Technology, the meeting will include tutorial sessions on measurement uncertainty analysis. Short papers and presentations on the design, construction, evaluation, analysis and/or use of mode-stirred chambers, anechoic chambers, and OATS are requested. Submissions can be sent no later than March 21, 1997, to Galen Koepke, NIST-M/S 813.07, 325 Broadway, Boulder, CO 80303. Phone: (303) 497-5766; Fax: (303) 497-6665; e-mail: koepke@boulder.nist.gov



KIMBALL WILLIAMS
ASSOCIATE EDITOR

What is "lifelong learning"?

We all know about keeping up with technical developments, new materials and techniques. But is this what is meant by lifelong learning? Is just keeping current in your field of specialization what lifelong learning is all about?

Most of us believe that humanity is more than a collection of organized chemicals, who's reasons for existence are self-preservation and species propagation. This belief implies that we are multidimensional creatures, that exist simultaneously on many levels. There are physical, mental, emotional and spiritual aspects to the human condition that must be recognized, and exercised, on a regular basis.

At one time, a classical university education was supposed to train the student to live a full life, and after graduation, if he or she was plucky, lucky, and persistent, they might find a suitable job. But, no matter what kind of employment or life station they achieved, they should be equipped with the balanced skills to live life to the fullest. We still see some remnant of this philosophy in our "core courses" which include the humanities. Often I see these humanities touted as unnecessary evils in a technical education context. This is a shortsighted attitude at best, and at worst, downright dangerous for our students. We must teach our students to communicate with others, and to know something of literature, music, the arts and all the rest. Otherwise, they run the risk of finding themselves with a "good job" and no life!

Within the context of the classical education was also the concept of a focus, a specialty within the general curricula which allowed the student to pursue specific interests. Some specialties became common stepping stones to further studies toward particular career choices. A degree in history might preface studies for the law. Science might start a young doctor on her or his way toward medical school. But, in no case was the general education sacrificed in favor of the specific subject. The goal of a "well rounded" student was held to be sacrosanct.

Lou Gotlieb of "The Lime Lighters" prefaced one of that group's songs with

"Remember our motto here at camp: Clean Mind, Clean Body. Take your pick!" The joke was not wasted on his audience. Most of us realize the mind-body link and strive to keep a wise balance between the two.

Balancing Act

The thrust of Mr. Gotlieb's joke was recognizing our sometimes myopic attitude toward a multifaceted life which tends to suggest an either-or position. The obvious answer is "both, and." A healthy mind in a weak body will suffer, as will the healthy body controlled by a dull mind. However, the implication goes much further. As creatures with a multidimensional existence, we must maintain some quantum of balance between all the facets of our existence if we are to truly prosper and achieve our full potential.

Yet some of us, (most of us?) tend to fall into the traps we set for ourselves by a limited, yet still demanding life style. Our family, friends, church and job tend to spill over the available time in our lives. What happened to all our plans to learn another language, write that novel, read all the classics or take up an instrument? It was not planned that our circle of daily or weekly activities consume us completely: we never intended for this to happen. It just did! Is this bad? Is this a problem? Perhaps.

Elementary Juggling

If we accept the premise that we are multidimensional creatures, then it is incumbent on us to devote time to maintaining each of our aspects on a regular basis. If some are over-emphasized at the expense of others, then we have dropped one of the juggling balls. This is what we are trying to avoid. Why regular? Can't we just do it once and have it done (whatever 'it' happens to be)?

When I taught classical guitar, I had one student that found the discipline of practice so onerous that one day he asked, "When I learn to play well, can I stop practicing?" I told him that the only way he would learn to play well was to first learn to love to practice. It was several months later that he "caught fire" as the expression goes. His parents also

told me that his grades improved about the same time. He had learned a most valuable lesson, and was wisely applying it to the rest of his life.

We can never be truly adept at any aspect of our lives until we have converted the drudgery of regular practice into the joy of playing. The analogy seems to apply everywhere I have tried it. Yes, it takes time and effort to make this conversion complete. But, it should happen, indeed it must happen, if we are ever to be truly successful. I believe this so strongly that one of our laboratory precepts is "If you are not having fun, something is wrong. Find out what and change it!"

Scope

Fred Bauer, Chairman of CISPR/D once told me that he had never seen an engineer dismissed for technical incompetence. But, he had seen many fall by the way because they could not write, or speak well enough. Apparently they had learned, and kept up with, the technical disciplines, but somehow missed the need to balance their technical knowledge with the ability to communicate. Fred's point was that the complete engineer required at least a modicum of verbal skills to even succeed as an engineer.

Is this the only other aspect of learning that we need to consider? OK, you read the paper, listen to the news broadcasts and try to keep abreast of most current affairs. Is this enough? It used to be common to refer to some people as "well read." By this, it was meant that they explored literature from the classics through contemporary authors in many genres and perhaps in several languages.

Does education stop with literature or with the mental skills? Shouldn't we include sports, dance, music, the arts in general, as well as science outside of our technical specialization. What about philosophy, history, theology,

politics, economics, crafts, etc.? Wouldn't all of these qualify in a complete definition of the content of lifelong learning? Of course.

Does any subject have more importance than another? Within the context of a particular person at a particular time, perhaps. But, in general, I would say no. Pursuing any avenue of learning helps keep the mind open and receptive and growing. Does this mean always taking formal classes? Certainly not!

I know several people who are actively pursuing self-directed studies. Some are reading or researching particular subjects in technology (biologically-fed fuel cells) or literature (French love poetry). One is exploring various forms of martial arts, (primarily a physical activity, although with rather high mental content). Another is collecting folk music of the Great Lakes Maritime tradition.

Renaissance Man

What we have been describing is generally referred to as the characteristics of a "Renaissance Man." The Renaissance Man is a person with "broad intellectual and cultural interests encompassing the full spectrum of available knowledge." Sounds ambitious. It is! But, what is the alternative?

We must teach our students to communicate with others, and to know something of literature, music, the arts and all the rest. Otherwise, they run the risk of finding themselves with a "good job" and no life!

We all can probably name people that fit the old epitaph "Died at 30, Buried at 60." This person would be the antithesis of the Renaissance Man. But, have we ever deduced what could cause such a tragic waste of a life?

My guess would be that this person became a one-dimensional person. They became someone to whom one aspect of their life became the 'be all and end all' of their existence to the exclusion of all else. When this happens, a tragic transformation can occur. Neglect any single factor in the equation of your life only at the peril of your entire life's meaning and purpose.

We seem to have arrived at the definition of lifelong learning that we began our search for at the start. Lifelong learning is the continuous, balanced pursuit of knowledge in all areas of human existence.

Lifelong learning:

How long should it be?

Does lifelong learning really mean what it says, "lifelong"? Why not? Is there any fundamental reason why we should not continue to learn throughout our entire lives? What is the natural limit to learning? Death! Is the converse also true? Is the natural result of continual learning a longer life? Think of those people you have known who maintained their curiosity and thirst for knowledge late into their lives. Aren't these the people who we find are still excited about life and still going strong when their contemporaries are wasting away in front of a TV set? It may not be that these people live longer lives, but it appears that they may live life longer.

How long should you continue to learn? The question begs the next question.

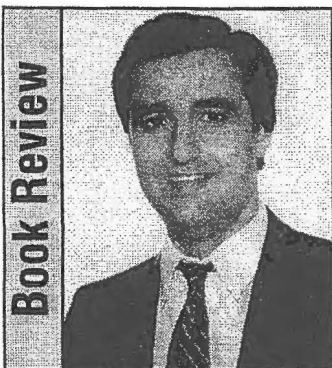
How long should a life be?

Are you ready to die?

Yes?!

Then it is time to stop learning.

Otherwise, how are your studies coming along?



REINALDO PEREZ
ASSOCIATE EDITOR

ELECTROMAGNETIC COMPATIBILITY IN POWER ELECTRONICS

By Laszlo Tihanyi

**Butterworth & Heinemann,
1995**

378 pages

**Special thanks to J.K.Eckert
of J.K.Eckert & Company who
provided a copy of this book.**

Even over 20 years ago when EMI was not a predominant issue of concern in electronic components, assemblies, and subsystems, and where analog components and early digital designs were the dominant players in the electronic scene; electromagnetic interference issues in power electronics was already a threat. This book provides a good overview of the most important factors that electronic power designers must deal with when addressing electromagnetic interference in their designs.

The book is developed into twelve chapters followed by a reference section. The first two chapters briefly treat an introduction to the subject and the history of EMC standards efforts, although mostly from the European point of view. The technical work of the book does not really start until Chapter 3, which comprises a brief description of electromagnetic noise, (called "disturbances" by author) classified into three groups: by frequency content, by character, and by transmission mode. Concerning frequency content, the conducted radio frequency of interest ranges from 150 kHz to 30 MHz. A description of the differences between narrowband and broadband follows. Concerning character content, disturbances are classified as broadband noise, impulse or transients. Chapter 4 is devoted to conducted EMI measurements. The concepts of common-mode and differential-mode currents are discussed. This is followed by a description of EMI measuring instruments such as EMI receivers, spectrum analyzers, and measurement techniques such as peak, effective rms, quasi-peak, measuring interference voltage in both differential- and common-mode (with the use of LISNs), and measuring interference current using the current probe. The concepts of measurement bandwidth and coherent emissions are also discussed. Some basic terminology in conducted EMI is also covered. The chapter ends with a brief description of measuring EMI for consumer appliances and impulse-like EMI.

Chapter 5 specifically addresses EMI for power electronic equipment. The chapter covers EMI noise produced by rectifiers, power transistors, controlled rectifier circuits, and switching power supplies. The chapter ends with the subject of spectra of pulsed signals (both periodic and aperiodic) which is typical material found in other EMC books.

Graphical approaches for drawing an EMI spectrum of pulsed signals are also discussed. Chapter 6 starts with an introduction to EMI filter elements and terminology. Typical network theory is used to introduce the concept of insertion loss. High frequency effects (non-ideal behavior) on capacitors are addressed, including specific capacitor behavior such as electrolytic, paper, ceramic, and feedthrough. A good section on choke coils follows in this chapter, including the calculation of the inductance of various coil arrangements and the effect of parasitic capacitances. The chapter ends with a study of ferrite beads and ferrite cores.

Noise suppression is the subject of Chapter 7. The main emphasis is on noise suppression in relay systems, the use of RC snubbers in power semiconductors, shielded transformers, and capacitor filters. The role of heat sink in EMI generation (due to parasitics) is detailed. Chapters 8 and 9 are probably the most important chapters in the book in this reviewer's opinion. Chapter 8 deals with EMI filter selection and measurements and Chapter 9 covers EMI filter design. In Chapter 8 the concept of insertion loss is discussed in terms of cascaded parameters, and basic circuit configurations are reviewed (π , T, multi-stage). The author addresses the very common scenario of using filters in load impedance mismatch conditions, as well as the use of multi-stage filter configurations to improve filter performance (i.e., good insertion loss over a desired frequency range). EMI power-line filter configurations with common-mode choke coils are also discussed. The chapter ends with some review of insertion loss test methods.

Chapter 9 introduces some basic insertion loss equations (and graphical approaches) for designing LC and π EMI filters terminated by resistive (only) sources and loads. The method is extended to multistage filters. Finally, the design methods are applied to mismatch impedance conditions where worst-case insertion loss problems resulting from the placement of a mismatched EMI filter can be diminished by the use of RC and RL matching networks on both sides of the filter. The chapter ends with a view of high frequency effects (resonance effects) of EMI filters and the use of dissipative methods to reduce them.

Continued on next page

Chapter 10 addresses testing for power-line susceptibility, such as the use of surge voltages in AC power lines and a review of the IEC (European) test specifications, test procedures, and standards. Chapter 11 addresses reduction techniques for internal EMI. This is again a typical chapter found in other EMC books and covers common impedance coupling, capacitive and inductive coupling, shielding, wiring layout, and PCB design considerations. Chapter 12 covers the issue of calculating the energy content of transient noise through the use of Laplace transforms. The Laplace transform is preceded by first finding the transfer function of the circuit under consideration (the circuit, of course, can include the EMI filter). The Laplace transform is then calculated and its spectrum drawn. From the spectrum the chapter shows how to do the energy calculation.

This book is recommended for those involved in either power-line EMI filter design or power electronics design with a view to controlling EMI. Since this book is not a book on power electronics (but only about EMI from such assemblies), readers who are new to the field of power electronics are advised to look at the references below to get a complete picture. The references below deal more with design and analysis but the EMI material is limited.

Additional references

Power Electronics, Converters, Applications, and Design, 2nd Edition, Ned Mohan, Tore M. Undeland, and William P. Robbins, John Wiley and Sons, 1995.

SPICE for Power Electronics and Electrical Power, Muhammad H. Rashid, Prentice Hall Inc., 1993.

Power Electronics Converter Harmonics: Multiple Methods for Clean Power, Derek A. Paice, IEEE Press, 1995.



**J.L. NORMAN
VILOETTE
ASSOCIATE EDITOR**

CABLE SHIELDING FOR ELECTROMAGNETIC COMPATIBILITY

**By Anatoly Tsaliovich
Van Nostrand Reinhold
1995**

An alternate title for this book could be: "Everything I Wanted to Know About Cable Shielding and Found in Anatoly's Book." As the title indicates, this is, by intention, a highly specialized publication. Practicing EMC engineers are fully aware of the "antenna" characteristics of cables in a radiated electromagnetic (EM) field environment both from an emission and immunity (susceptibility) standpoint. The author has addressed the issue of cable shielding in depth.

The preface gives historical perspective of EM cable shielding is presented dating back to the mid-to-late 1800's. The thrust of this book as stated is to provide: "...information on electronic cable shield design, utilization, and evaluation techniques, as they pertain to electromagnetic compatibility." A brief outline of each of the book's six chapters also appears in the Preface. A useful explanation is given of the book's two-tier format, where "theory at the background" presentations are provided as supplementary material to the book's main body. The intention is to provide in-depth theoretical and mathematical material in addition to practical information. Reading the Preface is recommended to facilitate a better understanding of the book's material.

Chapter 1, Electronic Cable in an EMI Environment, provides a general introduction to EMI, including sources, typical frequency spectra, emissions and immunity, units used to express quantitative levels (dBs), an introduction to the role of cable shielding, and system-level EMI. The contribution of cables to EMI is described, including cables as radiators of EMI (differential and common modes), and descriptions of cables as antennas, including illustrations of typical antenna radiation patterns. Time and frequency domain presentations of signals are described with basic Fourier transform mathematical techniques developed. EMC modeling techniques for cables are outlined with illustrations. The material in this chapter provides a basis of EMI/EMC concepts used in the other parts of the book.

Chapter 2, Understanding Cable Shielding, presents cable shielding as one of several listed EMI mitigating techniques. Questions pertaining to cable shielding are addressed, and include: What will be the effectiveness of cable shielding? What kind of shield should I use, how should it be terminated, and what will be the effect on system performance? Time and frequency domain cable crosstalk is developed for different cable grounding configurations. The effects of balancing, grounding, and shielding on cable radiated emissions are illustrated, as is the importance of shielding for ESD control. The problem of finding a unique definition for

“shielding” is discussed. Transmission line concepts and basic mathematical developments applied to shielding theory are presented. A refresher section is included of Maxwell’s equations and circuit theory leading to applications to describe cable performance. The chapter ends with a look at transmission line vs. plane wave shielding models, including model constraints. Five ingredients/steps are presented regarding shielding phenomena.

Chapter 3, Transfer Parameters of Cable Shields, introduces the concept of transfer function as a measure or figure of merit for shield performance. The transfer impedance of a shield is defined, developed, and illustrated. The author also develops what he defines as universal transfer parameters to describe cable shield performance in terms of energy transfer or diffusion across or through a cable shield. Mathematical models are developed in terms of electrical parameters including electric and magnetic fields, shield dc resistance, currents, voltages, and impedances. An electromagnetic theory of solid, homogeneous shielding tubes is developed, followed by transfer parameters for this configuration. Transfer impedances are illustrated for practical tubular shields, including longitudinally applied tape cable shields, foil shields, mesh shields, spiral shields, braided shields, and multilayer (homogeneous and nonhomogeneous) shields. An appreciation of field and circuit mathematical developments is required to understand this chapter.

In Chapter 4, Electromagnetic Coupling and Shielding, the author asserts that the coupling of electromagnetic fields to cable shields is “...among the most important topics in cable shielding.” It is also considered “...among the most confusing and challenging.” The role of the cable shield is developed and considered to be a system circuit element. The treatment of shielding-related phenomena is developed as: “...manifestations and transformations of various coupling mechanisms.” The author repeats the five basic ingredients/steps presented in Chapter 2 to build a system model of cable

shielding performance. A statement that needs clarification: “... from the system shielding effectiveness, which is affected by the shield ability to generate (?) the EMI currents and voltages.” A shield is passive and not a “generator.” (page 233).

On page 245, equation (4.9b), applied in a dielectric (e.g., in free space propagation, frequency domain): $\text{curl } H = j\omega\epsilon E$ (displacement current), which is not zero. The two paragraphs following the equations on page 245, and Equations (4.11) and (4.12) on page 246 correctly state and apply the relationship between H and E fields in a dielectric.

Electrostatic and magnetostatic shielding are discussed, along with a detailed presentation of shielding for crosstalk protection. Shielding performance curves for various cable configurations are provided with a section on transient response of cable shielding. An illustration of shield terminations is included.

Chapter 5, Measurement Techniques and Apparatus: the Tools of the Trade, opens with the truism, The proof of the shielding is in testing. The conditions that may be imposed on shielding test procedures in industrial and research applications are presented. A road map to cable shielding measurements is provided. A development describes EMI testing in open-area test sites (OATS) and in an absorber-lined chamber (ALC). Deriving the system-level, cable under test (CUT) “absolute” shielding effectiveness (SE) can be accomplished by testing a system, first with a particular cable unshielded, and second, with the cable shielded, and then taking the difference between the two sets of measurements as a determination of cable SE. This procedure yields the SE of the cable for the specific system. This procedure can be repeated to determine the SE for another cable or a combination of cables. The author warns of disadvantages of this procedure.

Other measurement environments and techniques are described including the use of TEM and GTEM cells, mode-stirred chambers, Helmholtz coils for magnetic field immunity, absorbing clamp setups, and other techniques.

Chapter 6, Cable Shield Engineering, “takes off” to present what happens when it is decided that a cable shield will be used. Fundamental concepts are presented of cable shield specification and design, with a system approach to shielding engineering.

Alternative approaches to cable shielding are presented, including an assessment of the relative cost implications. Evaluating these alternatives is recommended from a system point of view before making a commitment. Examples are included. Cable shield design options and requirements and objectives are illustrated in two box diagrams. Several other sets of design curves (e.g., transfer impedances and cost for several cable types) are provided. A section addresses performance stability and reliability of cable shields.

The uses of intentionally “leaky” shields and “plastic” shields are described. The uses are described for ferromagnetic absorptive materials for shield construction, such as ferrite-elastomers. The concepts and applications of superconductive and chiral shields are introduced as new approaches to cable shielding.

A General Evaluation

The value of this book lies in its in-depth, specialized, thorough, and detailed presentation of the topics covered. It definitely leads the reader to think about cable shielding from a multifaceted system approach. The reader interested in detailed, comprehensive material on the subject of cable shielding will certainly find it here. This approach also encompasses a dilemma: too much detail and repetition in some areas for the reader who wants to reach a quick approach to solve a practical cable shielding solution.

The book is recommended for reference to any EMC, electrical, and electronic system design engineer who seeks more than trivial information regarding cable system shielding.

This book is available for \$69.95 from the publisher, Chapman & Hall, or from R&B Enterprises, 20 Clipper Rd., W. Conshohocken, PA 19428. (610)825-1960. Fax: (610)825-1684.



BOB ROTHENBERG
ASSOCIATE EDITOR

As announced in the last issue of the Newsletter, the "Practical Papers" feature is being resurrected. Short articles, papers or application notes of interest to practicing EMC engineers and technicians are needed for this feature. Submit drafts, preferably in the range of 750-1500 words, to me at Parker-Chomerics, 77 Dragon Court, Woburn, MA 01888 (or e-mail to 104362.2415@compuserve.com).

The following is the first in a series of articles that will present fundamental EMC concepts related to printed circuit boards. It is extracted from Printed Circuit Board Design Techniques for EMC Compliance, by Mark I. Montrose, IEEE Press, 1996. While not a theoretically rigorous approach to understanding and predicting EMI on PCBs, it is certainly a different approach which this editor feels should be useful to practicing EMC engineers and PCB designers.



**MARK I.
MONTROSE**

How EMI is Created Within a Printed Circuit Board (Made Simple) Mark I. Montrose

In today's international marketplace, products must conform to a host of regulations, standards and requirements mandated by government agencies, private standards organizations, or voluntary councils. Mandatory compliance requirements exist for North America, the European Union (EU), and numerous countries worldwide. These requirements relate to electromagnetic compatibility (EMC) and product safety. It is more cost-effective to design EMC suppression into a printed circuit board (PCB) than to rely upon containment measures. Top covers, filler panels, I/O adapter brackets, and the like can be removed or damaged by the end user. Sometimes these items are not designed or manufactured correctly. A system must maintain compliance to EMC standards for the life of the product. Containment cannot be relied upon for lifetime protection, whereas suppression is always there.

Three elements must be present for EMI to exist: a noise source, a propagation path, and a susceptor. Noise sources on a PCB relate to clock generation circuits, component radiation within a plastic package, incorrect

trace routing, electrically long trace lengths, poor impedance control, internal cable interconnects, and the like. A propagation path refers to the medium that carries the RF energy, such as free space or cabling. A susceptor is the device which receives the harmful interference. If one of the three elements is removed, EMI cannot exist. It therefore becomes the designer's task to determine which is the easiest to eliminate. The designer has no control over the susceptor. Suppression affects noise source, and is the easier of the two to implement.

A product must be designed for two levels of performance: one to minimize RF energy exiting (emissions), and the other to minimize the amount of RF energy entering the enclosure (susceptibility or immunity). When dealing with emissions, the general rule of thumb is: The higher the frequency, the greater the likelihood of a radiated coupling path; the lower the frequency, the greater the likelihood of a conducted coupling path.

There are five major considerations in EMI analysis (referred to as "FAT-ID" by Bill Kimmel and Daryl Gerke):

1. Frequency. Where in the frequency spectrum is the problem observed?
2. Amplitude. How strong is the source energy level, and how great is its potential to cause harmful interference?
3. Time. Is the problem continuous (clock signals), or does it exist only during certain cycles of operation (i.e., disk drive write operation)?
4. Impedance. What is the impedance of both the source and receptor units and the impedance of the transfer mechanism between the two?
5. Dimension. For transmission of RF currents to exist, an antenna is needed. The physical dimensions that exist, based on trace length or slots within an enclosure, determine what particular frequencies are most likely to be radiated from a product.

How does RF energy get created within a PCB? Maxwell's four equations describe the relationship of electric and magnetic fields and are derived from Ampere's Law, Faraday's Law, and two from Gauss's Law. These equations describe the field strength and current density within a closed loop boundary environment. However, for our purpose, detailed knowledge of Maxwell is not a prerequisite for understanding how EMI exists within a PCB.

To overly simplify Maxwell, we relate his four equations to Ohms law. The presentation that follows is a simplified concept that allows one to visualize Maxwell in terms that are easy to understand. Although not mathematically perfect, this presentation concept is useful in presenting Maxwell to non-EMC engineers or those with minimal exposure to circuit board EMI suppression concepts and EMC theory.

Ohms Law	Maxwell Made Simple
$V = I * R$	$V_{rf} = I_{rf} * Z$

where

V = voltage

I = current

R = resistance

Z = impedance ($R + j\omega L$)

rf = radio frequency energy

To associate Maxwell Made Simple to Ohms Law, if RF current exists in a PCB trace, which has a “fixed impedance value,” an RF voltage will be created that is proportional to that RF current. Notice that in the electromagnetics model, R is replaced by Z, a complex number that contains both resistance (real component) and inductance (L - complex component). Capacitance is not a concern in this equation. Each and every trace has a finite inductance value. Trace inductance is only one of the reasons why RF energy is created within a PCB. Even the lead bond wires that connect a silicon die to its mounting pad may be sufficiently long to cause RF energy to exist. Traces routed on a board can be highly inductive, especially traces that are electrically long. Electrically long traces are those that are physically long in routed length such that the round-trip propagation delayed signal on the trace does not return to the source driver before the next edge triggered event occurs.

Back to Maxwell, a moving electrical charge in a trace generates an electric current which creates a magnetic field. Magnetic fields created by this moving electrical charge are also identified as magnetic lines of flux. Magnetic lines of flux can easily be visualized using the Right Hand Rule, shown in Figure 1. To observe this rule, place your right hand into a loose fist with your thumb pointing straight out. Current flow is in the direction of the thumb (upwards), simulating current flowing in a wire or PCB trace. Your curved fingers encircle the wire point in the direction of the magnetic field, or lines of magnetic flux. This magnetic flux creates a transverse electromagnetic field, commonly called the electric field. The mathematical relationship between magnetic and electric fields is beyond the scope of this article. RF emissions are a combination of both magnetic and electric fields. These fields will exit the PCB structure by either radiated or conductive means.

Notice that the magnetic field travels around a closed loop boundary. In a PCB, RF currents are generated by a source driver and transferred to a load through a trace. RF currents must return to their source (Ampere’s Law) through a ground return system. As a result, a current loop is

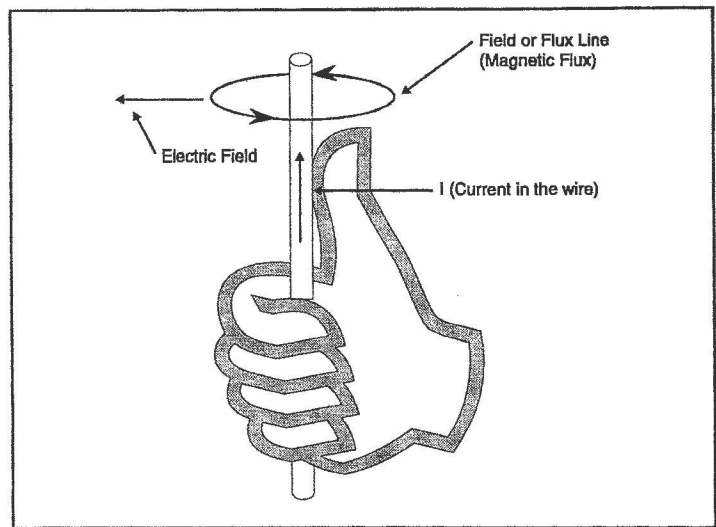


Figure 1.

developed. This loop does not have to be circular, and often is a convoluted shape. Since we have now created a closed loop within the ground return system, a magnetic field is developed. This magnetic field creates a radiated electric field. Magnetic fields are typically observed with loop antennas in the near field ($<\lambda/4$ of the frequency present), while electric fields are observed in the far field ($>\lambda/4$).

Another simplified explanation of how RF exists within a PCB is depicted in Figure 2. Here we see a circuit in both the time and frequency domain. For the time domain circuit, a ground return structure allows the circuit to operate as designed. For the equivalent frequency domain circuit, if a low impedance, direct line path from load to source does not exist, such as a slot in a ground plane or no ground return structure, the RF current return must find its way back home like the time domain circuit. According to Kirchhoff’s and Ampere’s law, a closed loop circuit must exist if the circuit is to work. Without a closed circuit, the signal would never make it from source to load. When the switch is closed, the circuit is complete, and ac or dc current flows (time domain). In the frequency domain, replace the time domain current (ac/dc) with RF current. The RF return path from load to source must also exist or the circuit would not work. Hence, a PCB structure in both time and frequency domain must conform to Maxwell’s equations, and Kirchhoff and Ampere’s law.

Return currents travel through the power supply return system, generally a ground trace or ground plane. When RF return current travels from load to source through a planar structure, this path is commonly called an image plane or image return path. It is desirable to have the return path located as close as physically possible to the routed trace. Because there is a finite, physical distance between the trace and RF current return path, flux coupling will approach, but not quite reach 100 percent. A small amount of differential mode RF current will not be captured by the return plane. This finite amount of leftover RF current is a primary cause of EMI within the PCB.

Knowing one reason why RF energy exists within a PCB (generation of magnetic lines of flux from a trace), it becomes

the designer's job to prevent this unwanted energy. The process of removing unwanted RF currents is called flux cancellation. Flux cancellation is one of the most important PCB design and layout requirements for RF suppression. The PCB must be designed for use in the frequency domain in addition to the time domain. Regardless of how well a PCB is designed, both magnetic and electric fields will always exist. If the flux is canceled out, EMI cannot exist. It's that simple!

How do is flux canceled? This is easier said than done. Future issues of this series will discuss techniques available to the design engineer. Some of these techniques include, but are not limited to:

- Proper stack-up assignment and impedance control for multilayer boards
- Routing a clock trace adjacent to a ground plane (multilayer PCB) or use of a ground or guard trace (single- and double-sided boards)
- Canceling magnetic flux, created internal to a component's package, into the ground reference system to reduce component radiation
- Carefully choosing logic families to minimize RF spectral distribution from component and trace radiation (use of slower edge rate devices)
- Reducing RF currents on traces by reducing the RF voltage (drive level)

from a clock generation circuit, i.e., TTL vs. CMOS

- Reducing ground noise voltage in the power and ground plane structure
- Providing sufficient decoupling for components that consume power when all device pins switch simultaneously under maximum capacitive load
- Proper termination of clock and signal traces to prevent ringing, overshoot and undershoot (enhance signal quality)
- Use of data line filters and common-mode chokes on selected nets
- Proper use of bypass (not decoupling) capacitors when external I/O cables are provided
- Providing a grounded heat sink for components that radiate large amounts of common-mode RF energy internal to the package

As seen in the above list, existence of magnetic flux is only part of the reason EMI is created in a PCB. Other major area of concern are: existence of common-mode (CM) and differential-mode (DM) currents between circuits and I/O cables; ground loops creating a magnetic field structure; component radiation; and impedance mismatches.

Future articles will examine other aspects of PCBs and their relationship to EMC compliance, along with suppression design techniques and concepts.

Senate Bill 2050

On August 2, 1996, Senator Feingold (Wisconsin) introduced a bill to amend the Communications Act of 1934 to authorize states to regulate interference with radio frequencies. The Bill was as follows:

"Section 1: Authority of States to Regulate Radio Frequency Interference Section 3 02 of the Communications Act of 193 4 (47 U. S. C. 3 02) is amended by adding at the end the following: (e) Where radio frequency interference to home electronic equipment is caused by a CB radio station through the use of a transmitter or amplifier that is not authorized for use by a CB radio station pursuant to Commission rules, the State, county, municipal, or other local government shall not be preempted from exercising its police powers to resolve the interference by prohibiting the use of such unauthorized equipment or by imposing fines or other monetary sanctions. For purpose of this subsection, home electronic equipment includes, but is not limited to, television receivers, radio receivers, stereo components or systems, video cassette recorders, audio recorders, loud speakers, telephone equipment and other electronic devices normally used in the home. Any action taken by the State, county, municipal, or local government shall not preclude concurrent action by the Commission. Nothing in this subsection shall be construed to diminish the Commission's exclusive jurisdiction over radio frequency interference in any matter outside the scope of this subsection."

The bill was read twice and referred to the Committee on Commerce, Science and Transportation. We thank Sandy Rotter (E-mail: 70441.571@CompuServe.COM) for bringing this to our attention.

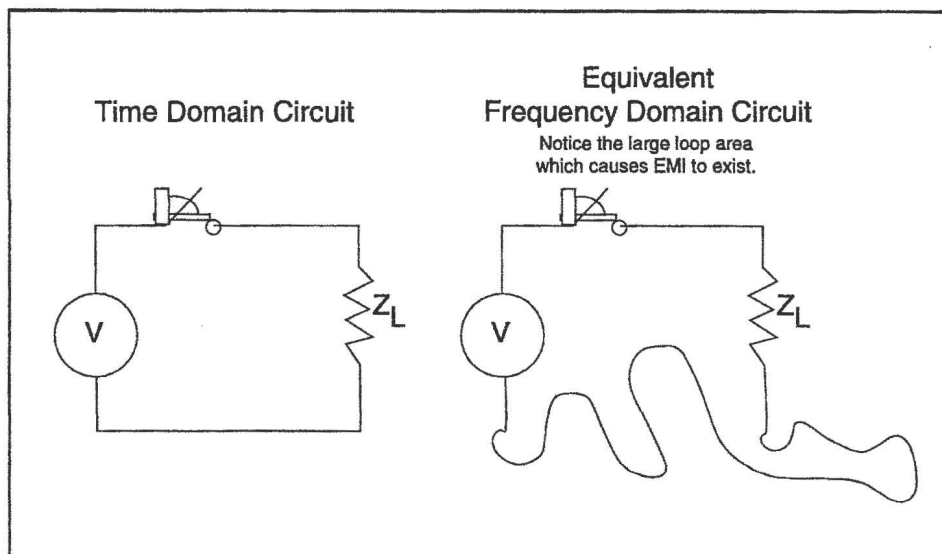


Figure 2.



WILLIAM G. DUFF
ASSOCIATE EDITOR

Kenneth Siarkiewicz graduated from the University of Detroit in 1965 with a Bachelor of Science in Engineering and from the University of Michigan in Ann Arbor in 1966 with a Master's Degree in electrical engineering. He also earned a Master of Arts in Pastoral Theology from St. Mary-of-the-Woods College in Indiana. He has worked at the Rome Laboratory (formerly the Rome Air Development Center) since 1962, when he started as a cooperative student working on antenna pattern measurement technology.

From 1966 to 1970, Ken contributed in various development programs to advancing the state-of-the-art in antenna measurement technology for antennas mounted on aircraft and ground-based phased array surveillance systems.

The objective was to better characterize near-field effects and coupling among antennas and to the mounting structure.

Since 1971 Ken has been in the forefront of the computational electromagnetics (CEM) arena, especially as it is applied to the analysis of antenna performance and EMC in the presence of nearby structures, whether an aircraft fuselage or other antennas. He directed the major Air Force program which resulted in the first seamless electromagnetic hybridization of three CEM formulations, the GEMACS computer code. It is still used by each of the three Services for antenna integration on ground, ship, and aircraft platforms, and is continuously enhanced by each of the Services.

Ken continues to lead the CEM technical program at Rome as it applies to antenna radiation and system-level EMC. This includes research and development of tools which utilize CAD descriptions of the platforms, layered models of antennas, and the development of a unique test bed to carefully collect validation data for the CEM codes. Other areas include the parallelization of CEM codes and the use of rule-based AI technology for the development of effective and efficient CEM models.

Since 1993, Ken has led a project at Rome which will develop an Integrated Computational Environment (ICE) for product development and acquisition. ICE leverages off a program which is administered through NRL. ICE will allow numerous engineering disciplines to interact and share data. It recognizes that EMC is affected not only by electromagnetics but also by the structural, thermal, and circuit phenomena associated with a system.

Ken has authored or coauthored over 40 papers and has had two of them reprinted in books published by SCEEE and the IEEE Press. He has presented numerous briefings to various professional organizations, and he has been an invited speaker on the use of CEM for system-level EMC analysis. Ken is a member of Eta Kappa Nu, Tau Beta Pi, ACES, a member of the Technical Review Committee for the OSD Joint Service Electronics Program (JSEP), a member of the Interservice Antenna Group (ISAG), and a member on the Government Executive Committee of the Electromagnetic Code Consortium (EMCC).

Over the years he has received numerous performance, achievement, and Special Act or Special Service awards from the Air Force, DoD, and NATO. In 1984 he received a Certificate of Recognition from the IEEE EMC Society for the development of mathematical modeling for EMC analysis. He received the Rome Laboratory's prestigious Harry Davis Award in 1993 for his work in CEM. He received an IEEE Region 1 Award in 1994 for leadership in state-of-the-art CEM and computer-aided tools for the EM posture of DoD and civilian RF systems. In 1996, Ken was named Rome Laboratory Fellow for his pioneering work in CEM. Also in 1996 he was named IEEE Fellow for his contributions in improving the quality assurance of military and civilian systems through the development and promotion of computer modeling.

Ken is active in his local church. He is an avid fan of Sherlock Holmes and Tolkien's *Lord of the Rings*. He and his wife Emilie, a computer scientist at the Rome Laboratory, are in the process of restoring their 1916 Arts and Crafts Style house. She is a nationally recognized member of the Daughters of the American Revolution (DAR) and is responsible for the development and maintenance of the DAR Web Page.



KENNETH SIARKIEWICZ

Since 1993, Ken has led a project at Rome which will develop an Integrated Computational Environment (ICE) for product development and acquisition.

No Adverse Effects Seen from Exposure to EM Fields

No clear, convincing evidence exists to show that residential exposures to electric and magnetic fields (EMFs) are a threat to human health, a committee of the National Research Council has concluded in a new report. After examining more than 500 studies spanning 17 years of research, the committee said there is no conclusive evidence that electromagnetic fields play a role in the development of cancer, reproductive and developmental abnormalities, or learning and behavioral problems.

Concern about the health effects from EMFs arose in 1979 when researchers showed that children living close to high concentrations of certain types of electrical wires were 1.5 times more likely to develop leukemia. Because it is difficult, time-consuming, and expensive to measure electric fields in a home over a long period of time, researchers relied on a substitute to estimate the levels of electromagnetic fields to which residents may have been exposed. Using factors such as the size of wires going past the home and distance between the home and power lines, researchers estimated the fields inside.

The Research Council committee's report says that studies in the aggregate show a weak but statistically significant correlation between the incidence of childhood leukemia, which is rare, and wire configurations. It never has been demonstrated that this apparent association was caused by exposure to electromagnetic fields, however. Outside wiring correlates poorly with measurements of actual fields inside the home, in that it accounts for only a fraction of the fields inside. Scientists have tried unsuccessfully to link leukemia to EMFs by measuring fields inside of homes of children who had the disease. The results "have been inconsistent and contradictory and do not constitute reliable evidence of an association," the report says.

The weak link shown between proximity to power lines and childhood leukemia may be the result of factors other than magnetic fields that are common to houses with the types of external wiring identified with the disease. These possible factors include a home's proximity to high traffic density, local air quality, and construction features of older homes that fall into this category, the committee said.

This article was excerpted from a congressionally requested study by the National Research Council sponsored by the U.S. Department of Energy. The National Research Council is a private, non-profit institution that provides science and technology advice under a congressional charter. Copies of Possible Health Effects of Exposure to Residential Electric and Magnetic Fields are available from the National Academy Press. 1-800-624-6242.

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, 1998. Attendance at the last meeting of the 1997 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, 1997. 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, 1998.

MEMBER'S NAME (PRINT)	SIGNATURE	MEMBERSHIP NUMBER
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EMC Harmonization: DC Style

IEEE EMC Society
DC/Northern Virginia

The Washington DC/Northern Virginia Chapter of the IEEE EMC Society will be sponsoring a one-day regional conference and exhibit on May 1, 1997, at the McLean Hilton in Northern Virginia.

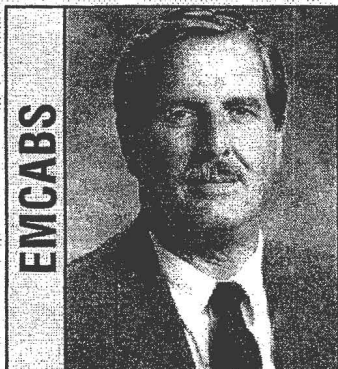
Theme. The theme of the conference is EMC Harmonization: DC Style – Government/Military/Commercial. The show will provide a forum for information on the ongoing evolution of EMC. Numerous changes in the regulatory, specification and marketplace are forcing rethinking of the EMC programs and approaches in a wide segment of the electronics community.

EMC Harmonization: DC Style will address these changes, provide a forum for discussion and create an opportunity for attendees to increase their awareness of EMC and view new products for the EMC community. Technical discussions will focus on cross-pollinating EMC activities in the industrial, military and government communities.

Topics. The list of technical topics includes new trends in EMC regulations and specifications, development of EMC testing methods and techniques, dealing with EMC problems in equipment and systems, and other regulatory aspects facing the equipment provided.

The Show. The show will provide two or more concurrent technical tutorials for the attendees to choose from with EMC industry leaders and government representatives leading the sessions. The exhibit area will feature EMC product and services providers. Demonstration areas will also be available to display specific equipment capabilities.

For more information on exhibit and sponsorship opportunities or attendance at the conference, please contact the IEEE/EMC Society of DC and Northern Virginia, c/o Washington Labs, 7560 Lindbergh Dr., Gaithersburg, MD 20879, 301-417-0220.



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
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Sha Fei, EMC Research Section,
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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.

THE EUROPEAN PRE-STANDARD ENV 50166 "HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS " IN PERSPECTIVE

Barnabas Kunsch

Austrian Research Centre Seibersdorf, A-2444 Seibersdorf, Austria

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume I, September 17-20, 1996, Rome, Italy, Pages 1-6

EMCABS: 01-02-97

Abstract: This paper describes the protection concept of the ENV 50166 for human exposure to electromagnetic fields and compares its limit values with those of other relevant regulations.

Index terms: Bioeffects, RF exposure, electromagnetic fields

FEASIBILITY OF USING FDTD TO MODEL FIELDS FROM PCS IN A HOSPITAL ENVIRONMENT

Michal Okoniewski, Maria A. Stuchly and Stan S. Stuchly

Dept. of Electrical and Computer Engineering, University of Victoria, Victoria, BC, V8W 3P6, Canada

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility

Volume I, September 17-20, 1996, Rome, Italy, Pages 200-203

Abstract: Proliferation of personal communications services (PCS), particularly devices such as cellular telephones, has raised concerns about possible electromagnetic interference (EMI) with medical devices including those used on the human body or implanted. While several methods can be used for computations of electromagnetic fields for EMI evaluation, the efficiency, flexibility and ability to account for the presence of the human body make the finite-difference time-domain technique a very attractive tool for addressing the problem. We apply this technique with several recently introduced improvements to model electromagnetic fields in the 900 MHz band in a typical hospital room with a patient on a bed and a cellular telephone model located at a distant and proximal (about 1 m from the patient) locations. We also model the electric field and power dissipated for a person in the room and in free space, and compare the results. Maps of the induced electric fields around and on the patient's body surface as well as inside the body are obtained. They are intended to be used for assessment of potential interference with critical medical devices.

Index terms: modeling, RF exposure, FDTD, PCS

EMCABS: 04-02-97**SAR EVALUATIONS FOR AN ANATOMICALLY-BASED MODEL OF THE HUMAN HEAD GENERATED BY DIFFERENT TYPES OF CELLULAR PHONES**

A. Schiavoni, G. Richiardi, and P. Bielli

GSELT- Centro Studi E. Laboratori Telecomunicazioni S.p.A., Via G. Reiss Romoli 274, 10148, Torino, Italia

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume I, September 17-20, 1996, Rome, Italy, Pages: 182-187

EMCABS: 02-02-97

Abstract: An analysis of the SAR (Specific Absorption Rate) distribution is obtained into the human head radiated by different types of cellular phones. The geometry of the cellular phone is described by means of a pre-processing system, developed in-house, that, starting from a graphical representation obtained by means of a mechanical Computer Aided Design (CAD) tool, generates all necessary data for the electromagnetic elaboration with the Finite Difference Time Domain (FDTD) technique. The human head is defined by means of a Magnetic Resonance (MR) images recognized by tissues and organs. The recognition process is performed with neural network techniques and is validated with the help of neurophysiologists. Results show the SAR distribution into the head due to different types of hand-held phones at 900.0 MHz, the evaluation of the SAR into the tissues/organs. The FDTD code had been validated experimentally.

Index terms: SAR, bioeffects, FDTD

WIDEBAND NOISE AND SPECTRUM ENGINEERING

E. Fournier, C. Vadier, M. Robillard, and A. Azoulay

CNET/PAB/RGF/RTC, 38-40 rue du general Leclerc, 92131

Issy Les Moulineaux, France

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume I, September 17-20, 1996, Rome, Italy, Pages 253-257

EMCABS: 05-02-97

Abstract: Wideband noise is more and more often found to be the dominant mechanism of interference in compatibility studies carried out between radio communication systems, in particular, mobile systems. In this paper, we will review all definition and regulatory provisions applying to the wideband noise and the physical origins of such a phenomenon. Examples of compatibility studies, including a statistical approach, will enable illustration of spectrum engineering issues which have arisen in various bodies and the kind of analysis which have been performed in each case for solving these issues.

Index terms: Wideband noise, GSM, digital communications

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS PRODUCED BY PERSONAL MOBILE TELEPHONES

S. Caorsi, (1) and G.L. Gragnani, A. Massa, M. Pastorino, M. Raffetto (2)

(1) Department of Electronics, University of Pavia, Via Abbiategrasso 209, 27100 Pavia, Italy and (2)

Department of Biophysical and Electronic Engineering, University of Genoa, Via Opera Pia 11A, 16145, Genova, Italy

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume I, September 17-20, 1996, Rome, Italy, Pages: 188-193

EMCABS: 03-02-97

Abstract: The knowledge of the electromagnetic source and of the complex dielectric permittivity distributions of a model of the human head does not allow the exact evaluation of the field strength and of the power disposition inside a particular head, as a consequence of the differences between the model considered and the actual head. The problem is even worse considering that each person has a different head configuration. In order to point out this difficulty we consider some simple models of the human head and, by modifying some dielectric or geometric parameters, we show that the computed electromagnetic field can have big variations. On the basis of these results, we suggest an alternative way to predict the internal field, i.e., the use of a microwave-imaging technique. In particular, a probabilistic approach to the solution of the complete nonlinear formation of the related inverse scattering problem is considered.

Index terms: RF exposure, electromagnetic fields, modeling

ELECTROMAGNETIC COMPATIBILITY CONSIDERATIONS OF SS-CDMA AND FDM/FM RADIO SYSTEMS

M. Dukic and Z. Dobrosavljevic

Faculty of Electrical Engineering, Dept. of Communications, Belgrade, Yugoslavia

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume I, September 17-20, 1996, Rome, Italy, Pages 258-261

EMCABS: 06-02-97

Abstract: This paper presents the preliminary results of the analysis of electromagnetic compatibility (EMC) of existing FDM/FM radio systems and the new personal mobile communication systems, sharing the same frequency band, using direct sequence spread spectrum with code division multiple access techniques (SS-CDMA). The effect of the SS-CDMA system on the FDM/FM radio systems is expressed through the normalized interference noise power at the FDM/FM system output. The result of this analysis is a simple approximation formula for a quick estimation of the interference noise power.

Index terms: Spread spectrum, CDMA, FDM/FM

SHIELDING PERFORMANCE OF ENCLOSURES AGAINST NEAR FIELD SOURCES**EMCABS: 07-02-97**

Salvatore Celozzi and Maria Sabrina Sarto
 Dept. Of Electrical Engineering, University of Rome "La Sapienza," via Eudossiana 18, 00184 Rome, Italy
 Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility
 Volume I, September 17-20, 1996, Rome, Italy, Pages 273-278

Abstract: A finite element-based method to evaluate shielding of metallic enclosures against near field sources is presented. The method relies on the introduction of new boundary conditions on the internal surfaces of the enclosure itself. These new boundary conditions are expressed in terms of equivalent near-field source distributions and of equivalent near-field source distributions and of equivalent wave impedance (admittance) distributions along the removed edges in analogy with Thevenin (Norton) approach in circuit theory. Also the presence of apertures is accounted for by imposing adequate boundary conditions.

Index terms: Shielding, FE/FD, modeling

A CRITIQUE OF THE EMC DIRECTIVE**EMCABS: 08-02-97**

Tim Williams
 Elmac Services, Quarry Lane, Chichester, PO19 2PQ, UK
 Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility
 Volume I, September 17-20, 1996, Rome, Italy; Pages: 339-344

Abstract: This paper discusses the EMC Directive 89/336/EEC in the experience gained in the application to date. This experience is analyzed to indicate areas of possible improvement. A review of the purpose and salient features of the Directive is offered. Three broad areas of perceived deficiencies are discussed.

1. General implementation of the Directive.
2. Availability and applicability of standards.
3. Use of the Technical Construction File route.

Particular illustrations of the issues are provided.

EMC SPECIFICATIONS IN THE AUTOMOTIVE INDUSTRY**EMCABS: 09-02-97**

A. Guarina (1), M. Gerotto (2), G. Nicocia (3), B. Audone (4), and A. Lamp
 1. Magneti Marelli, 2. SEPA, 3. IVECO, 4. GF-Sistemi Avionici, and
 organizations in Torino, Italy
 Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility
 Volume I, September 17-20, 1996, Rome, Italy, Pages 345-350

Abstract: A survey of existing EMC specifications in the automotive industry is carried out outlining points of convergence and disagreements taking also into account the aims that the EMC specifications try to achieve. There are two major areas of concern: internal EMC and external EMC. Internal EMC is a functional problem; external EMC regards the environment: it is in the interest of the human community to avoid electromagnetic pollution.

Index terms: Automotive EMC, EMC specifications

ANALYSIS OF COUPLING PHENOMENA BETWEEN A FLAT CONDUCTOR AND A THICK WALL APERTURE**EMCABS: 10-02-97**

K. A. Karatheodorou, D. I. Kaklamani and N.K. Uzunoglu
 Institute of Communications and Computer Systems, Dept of E. & CE, National Technical University of Athens, 9 Iroon Polytechniou St., GR-15773, Zografou, Athens, GREECE
 Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility
 Volume I, September 17-20, 1996, Rome, Italy, Pages 363-367

Abstract: In order to counter various electromagnetic compatibility problems, a semi-analytical approach is developed to compute the coupling phenomena between a current source and a thick wall aperture. Fields in the region of the thick wall and aperture are expanded in terms of canonical wave solutions. The current distribution on the conductor surfaces is described in terms of superposition of pulse functions. The boundary conditions on the aperture surfaces and on the conductor carrying currents, excited by an external source, are satisfied by using a point-matching technique. In order to reduce the numerical cost, analytical techniques are employed to calculate the matrix of the system. Numerical implementation concepts and preliminary results are discussed.

Index terms: Mathematical analysis, signal coupling

AN EFFICIENT ALGORITHM FOR THE TREATMENT OF MULTIPLE FREQUENCIES WITH THE METHOD OF MOMENTS**EMCABS: 11-02-97**

Gernot Hoyler and Rolf Unbehauen
 Universitat Erlangen-Nurnberg, Lehrstuhl fur Allgemeine und Theoretische Elektrotechnik, Cauerstr. 7, 91058 Erlangen, Germany
 Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility
 Volume I, September 17-20, 1996, Rome, Italy, Pages 368-371

Abstract: In a method of moments computation, one must set up and solve linear systems at each frequency of interest. Since solving a system at a single frequency can be a very time-consuming process, performing moment method computations over wide frequency ranges can require vast amounts of CPU time. We present an efficient algorithm where the impedance matrix is factorized only once and then used as a preconditioner in the iterative solutions of all further linear systems. Examples show that significant time savings can be obtained compared to treating each frequency individually with the method of moments.

Index terms: Modeling, SEM, FFS algorithm

NEW PERSPECTIVE IN BROAD BAND SENSORS CALIBRATION**EMCABS: 12-02-97**

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 Via Marradi, 114-57126 Livorno, Italy, and 2. C.I.S.A.M., Dept. Of Defense, S. Piero a Grado, 56100 Pisa, Italy
 Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility
 Volume I, September 17-20, 1996, Rome, Italy, Pages: 411-415

Abstract: A GTEM cell characterization in the frequency range below 1 GHz is presented in order to investigate its capability in broadband sensors calibration. VSWR, electric field uniformity, etc., are measured and their values compared to specifications. A compact broadband electric field sensor is used to assess consistency and repeatability of measurements and comparisons between field strength values evaluated by this sensor, independently calibrated by the manufacturer and GTEM data are displayed. The optimum position of the sensor inside the test volume is investigated. In order to optimize test time and repeatability, an ad hoc software fit to drive all used implementation is implemented. Preliminary results of electric field uniformity in the frequency range over 1 GHz are shown. Finally, a critical evaluation of GTEM performances is presented and suggestions are given to improve its reliability.

Index terms: Broadband sensor calibration, GTEM

IMPACT OF RADIATED EMISSIONS STANDARDS ON DIGITAL RADIO RECEIVER PERFORMANCE**EMCABS: 13-02-97**

Peter F. Snumgaard

National Defence Research Establishment, Dept. Of Command and Control Warfare Technology, S-581 11 Linköping, Sweden

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages: 445-449

Abstract: This paper discusses the impact of radiated emissions standards on the performance of digital radio receivers. A simple methodology to drive the Bit Error Probability (BEP) for a digital radio receiver with a colocated unintended interference source is presented, together with a discussion of the difficulties involved in these kinds of estimations. Special attention is paid to so-called stealth radio applications where a low signal to noise ratio is required. A comparison is made between the EC Euronorm EN 55022 for commercial equipment and typical military requirements, MIL-STD-461D. This comparison is motivated by the fact that reduced defense budgets, in combination with rapid technological advances in civilian informational technology, open the possibility for an increased use of civilian technology in the armed forces.

Index terms: Radiated Emissions, EN 55022, MIL-STD-461D

MEASUREMENT AND CALCULATION OF PROPAGATION LOSSES IN A CONCRETE BUILDING AT 1.5 GHz**EMCABS: 14-02-97**

Jong-Chwen Wang and Hsing-Yi Chen

Dept of EE, Yuan-Ze Inst. of Technology, Nei-Li, Taoyuan Shian, Taiwan 32026

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages: 461-465

Abstract: The geometric theory of diffraction (GTD) method was used to calculate the propagation losses in a concrete building at 1.5 GHz. The seven-story building is constructed of reinforced concrete slabs and walls, wooden doors at the front and back of the building, and glass windows on each floor. To simplify calculations and make assumptions, the other stories of the building, except the first floor, were excluded for the simulations. In the simulations, the glass windows, wooden doors, concrete slabs, and concrete walls of the first story of the building were modeled by 66 lossy dielectric plates. The propagation losses obtained by the GTD method were found in the range of 223 to 52 dB. It was found that the measurement data had good agreement with the simulation results obtained with the GTD method.

Index terms: Building propagation losses, GTD, modeling

IMPROVING CHANNEL ISOLATION OF MICROWAVE DIPLEXERS**EMCABS: 15-02-97**

B. Milovanovic and Ana Vukovic

Electronic faculty, Beogradska 14, 18 000 Nis, Yugoslavia

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages 491-495

Abstract: An approach for improving channel isolation of microwave planar diplexers by modeling series LC resonant circuits in the shunt branches of constituent lowpass filters using stepped impedance resonators is proposed in this paper. An exact design procedure for the three-stepped impedance resonators is presented. In addition, improved characteristic of the trial microwave SSS diplexer for channels (0-4) and (4-8) GHz is given.

Index terms: Diplexer design, stepped impedance resonators

SENSITIVITY OF HUMANS TO LOW-FREQUENCY MAGNETIC FIELDS**EMCABS: 16-02-97**

Betz, H.D., Oettinger, W.P., Berg, H., Kulzer, R. (1) Schandry,

R., Leopold, Ch. (2); and Titschler, J. (3)

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Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages: 517-522

Abstract: We have constructed an arrangement to expose humans to weak and well-defined VLF magnetic-field pulses (sferics) in order to search for corresponding alterations in the (Fourier-transformed) electroencephalogram (EEG) of both specially and randomly selected individuals. As stimulus we reproduced the magnetic field components of sferics which were previously recorded with high-precision VLF receiving stations, newly developed for the measurement of true waveforms in the range from 1 to 200 kHz.

Index terms: Bioeffects, VLF, magnetic fields

ELECTROMAGNETIC FIELD COUPLING TO SHIELDED CABLES: METHODOLOGY AND EXPERIMENTAL VALIDATIONS**EMCABS: 17-02-97**

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Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages 532-537

Abstract: The coupling of electromagnetic fields inside shielded cables is an important issue in EMC applications, in which the transfer impedance represents one of the main parameters. The paper discusses the last analytical expressions which have been developed for the transfer impedance of braided cables. A general approach for the determination of the internal response of a shielded cable to an external electromagnetic excitation is presented in the frequency domain using the BLT equations. Then, an equivalent time domain form of the BLT equations is presented for the case of a lossless line.

Index terms: Transfer impedance, cable coupling, BLT equations

MEASURING METHODS AND MEASURING SETUPS FOR THE CHARACTERIZATION OF SHIELDING MATERIALS UNDER DIFFERENT CONDITIONS**EMCABS: 18-02-97**

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Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages 562-568

Abstract: The characterization of shielding materials under different measuring conditions is still a difficult topic. In this paper, some measuring methods are discussed which allow the characterization of shielding materials under different conditions. In the first part, the basic concept of both TEM-t and H-t cells will be discussed. In the second part, typical electromagnetic behavior of shielding will be treated under both plane wave and near field magnetic conditions, showing the different parameters which are dominant under each field condition.

Index terms: Shielding effectiveness, TEM-t cells, H-t cells

A MORE EFFICIENT ADAPTED FINITE-DIFFERENCE METHOD APPLIED TO MODELING CROSSTALK PROBLEMS BETWEEN PRINTED CIRCUIT BOARD TRACKS

EMCABS: 19-02-97

John Kelly (1) and Tom Sorensen (2)

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Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages 672-677

Abstract: One of the major areas of interest in the area of electromagnetic compatibility (EMC) modeling is the modeling of electromagnetic coupling between printed circuit board (PCB) tracks. The non-homogeneity of many PCB geometries means that numerical methods must be used for the calculations of these coupling parameters. Conventional numerical methods for calculating electromagnetic coupling parameters are extremely demanding in terms of computation time. In this paper, an adapted version of the finite-difference method (FDM), a widely used numerical method, is proposed. Results obtained using the adapted FDM show good agreement with those obtained using the conventional FDM and other methods, while achieving the anticipated reduction in time with respect to the conventional FDM.

Index terms: Finite-difference method, modeling, PCB coupling

SIMPLE MEASUREMENT OF THE TRANSFER IMPEDANCE OF A CONNECTOR

EMCABS: 20-02-97

F.B.M. van Horck, A.P.J. van Deursen, P.C.T. van der Laan, (1) and B.L.F. Paagman (2)

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Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages 733 - 737

Abstract: A small and inexpensive workbench setup is developed to determine the transfer impedance of shielded connectors. The primary incentive was the need for a fast, simple, accurate, and sensitive method to judge changes in prototypes of small shielded twin lead telecommunications connectors, which are to be combined to large arrays on printed circuit boards. The injected current is directly measured by a sensor integrated in the setup. Presented are measurements of the transfer impedance of a special coaxial cable with a small hole in the solid shield.

Index terms: Transfer impedance, cable shielding

SHIELDING OF A COIL BY A FERROMAGNETIC DISC

EMCABS: 21-02-97

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Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages 828 - 833

Abstract: A rotation-symmetric system consists of a conducting ferromagnetic disc and an exciting coil which leads a low-frequency alternating current. For the calculation of the disc's shielding properties we solve its eddy current problem with the help of two coupled boundary integral equations written for the vector potential. The integrals are evaluated by applying the Gaussian method, and by using polynomials of high order for the approximation of the unknown functions at the disc's surface. In the case of a nonconductive disc the problem can be described by a single integral equation of the second kind. Diagrams display the dependency of the shielding effectiveness on the disc's diameter, thickness, conductivity and permeability.

Index terms: modeling, ferromagnetic shielding

OPTIMAL PHASE REFLECTION GRATINGS AND THE EFFECT ON FIELDS IN A MODE STIRRED CHAMBER

EMCABS: 22-02-97

J. Clegg, A.C. Marvin, J.A.S. Angus, and J.F. Dawson

Department of Electronics, University of York, England

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages 867- 872

Abstract: A method is introduced which uses phase reflection gratings on walls of a reverberant screened room in order to increase the mode density. A measure is described which predicts how well each grating succeeds in scattering energy. It is shown that there is a correlation between the measurement and mode density, and an optimal sequence is found using the measurement. The effect of a grating on the directions of the fields inside the chamber are investigated by examining the time domain response to an impulsive excitation. Experiments are described which compare three alternative methods: mode stirring, the use of grating, and the use of stirring together with a grating. It is shown that the grating used in conjunction with stirring is the best of these three methods.

Index terms: mode stirring, radiated immunity, radiated emissions

A NOVEL TECHNIQUE FOR DAMPING SCREENED ROOM RESONANCE

EMCABS: 23-02-97

N. Izzat, G.S. Hilton, C.J. Railton, I.J. Craddock and R.J. Butler
Dept. Of E&EE, University of Bristol, Merchant Venturers Building,
Bristol, UK

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy, Pages 873 - 878

Abstract: Radiated emission measurements in screened rooms suffer from measurement repeatability problems due to the excitation of room resonances. A possible solution to this problem is damping the electromagnetic fields in the room through the introduction of small amounts of absorber. The present contribution considers the use of resistive sheets for this purpose. Results from a finite difference time domain model for an example screened room show that a screened room error in the range of +/- 5 dB to +/- 10 dB may be achieved using minimal layouts of resistive sheets.

Index terms: FDTD, radiated emissions, measurements

INVESTIGATION OF RESONANCE EFFECTS IN GTEM-CELL 1750

EMCABS: 24-02-97

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Cottbus, Germany

Proceedings of EMC'96 ROMA, International Symposium on Electromagnetic Compatibility Volume II, September 17-20, 1996, Rome, Italy ; Pages: 879 - 883

Abstract: GTEM-cells are used for testing electrical devices for EMC. They are getting more and more accepted by international standards. Most papers yet published describe the electromagnetic field only on limited surfaces within the recommended test volume. In this paper the electromagnetic field within the whole test volume of the GTEM-cell 1750 will be under consideration. The electric field is both calculated and measured and the received data is compared in order to find out whether cell resonances could influence the field level versus frequency. The investigation is of practical interest as the accuracy of measurements in GTEM-cell might get worse due to resonances.

Index terms: GTEM, electrical field measurements

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