

IEEE EMC SOCIETY

NEWSLETTER

ISSUE NO. 175

WINTER 1998

(ISSN 0164-7644)

JANET O'NEIL, Editor



Photo by Janet O'Neil

At the November Annual Board Dinner, outgoing EMC Society President Bill Gjertson (L) wishes newly elected President Dan Hoolihan (R) the best of luck in his new position.

EMC Society Leadership Changes Helm

At the November 1997 meeting of the EMC Society Board of Directors in Atlanta, elections were held for new officers of the Board. Dan Hoolihan was elected to assume the leadership helm as the new President of the IEEE EMC Society. Congratulations Dan!

To acquaint you with our new leader, Dan Hoolihan is presently the vice president for the Minnesota Operations of TUV Product Service, Inc., a firm specializing in conformity assessment of electronic products in the fields of electromagnetic compatibility (EMC), product safety, and ISO 9000 quality. Many of us also remember Dan as the co-founder and past chief operating officer of AMADOR Corporation (1984-1994). The famous t-

shirts with leaves of the four seasons which AMADOR distributed from its booth at the annual IEEE EMC Society symposia are a valuable collector's item now! Dan began his career in the EMC field as a manager/engineer with Control Data Corporation from 1969-1984.

Dan Hoolihan has been very active over the years with various professional organizations. He was previously the Vice President and Director of Member Services on the IEEE EMC Society Board of Directors. He is also a member of the Standards Committee of the EMC Society. His activities on the ANSI Accredited Standards Committee on EMC (C63 Committee) include being a member of the full committee, a member of the steering

IEEE ELECTROMAGNETIC COMPATIBILITY SOCIETY NEWSLETTER

INSIDE

EUGENE DANIEL KNOWLES
2

PRESIDENT'S MESSAGE
3

LETTER FROM THE EDITOR
4

CHAPTER CHATTER
5

JAMES PAUL MUCCIOLI
RECEIVES IEEE FELLOW AWARD
11

PRACTICAL PAPERS, ARTICLES
AND APPLICATION NOTES
12

DISTINGUISHED LECTURER
PROGRAM
13

EDUCATION COMMITTEE
14

DoD E³ ACTIVITIES
16

EMCABS
17

BOOK REVIEW
20

CALL FOR BOD NOMINATIONS
22

PERSONALITY PROFILE
24

EMCS BOARD OF DIRECTORS
ACTIVITIES
25

CALENDAR
31



IEEE
Networking the World™

committee of C63, chairman of Subcommittee 6 on Laboratory Accreditation and Conformity Assessment, and chairman of Subcommittee 8 on Medical Device Test Methods. Dan is a senior member of the Institute of Environmental Scientists and is a NARTE certified EMC engineer. This breadth of experience with other professional organizations will surely prove invaluable to the EMC Society. His formal education includes a Masters degree in Business Administration from the University of Minnesota, a MS in Physics from Louisiana State University, and a BA in Physics from St. John's University in Minnesota.

Dan has been married to Rosemary for 24 years. Rosemary is working on her MS degree in nursing. Dan has two daughters, Bridget (age 17) and Claire (age 14). His son Sam is a 19 year-old freshman at MIT. Dan's interests include boating, including taking his kids water-skiing, playing "500" cards, reading information on and playing the stock market, singing in the church choir, and walking/hiking.

The Board of Directors welcomes Dan as the new President and wishes him tremendous success during his two years of office. You'll find his first address to the membership in this Newsletter, page 3.

Those officers also elected at the November 1997 Board meeting for terms beginning January 1, 1998 are:

Vice-President, Standards:

Don Heirman

Vice-President, Member Services:

Todd Hubing

Vice-President, Technical Services:

Kimball Williams

Vice-President,

Communication Services: Len Carlson

Secretary: Janet O'Neil

Treasurer: Warren Kesselman

Congratulations to these officers!

— by Janet O'Neil



Eugene and Grace Knowles

Eugene Daniel Knowles Past President EMC Society 1921-1997

Eugene D. Knowles, IEEE/EMC-S Life Member, died Monday October 13, 1997 at his home in Renton, Washington. He was 76 years old. Gene was born July, 12, 1921, in San Francisco, California. During World War II, he served in the U. S. Navy as a Radio Technician and subsequently retired from the USN Reserve as a Lt. Commander. After graduating from the University of Washington in Electrical Engineering, he joined the Boeing Company in Seattle, Washington where he became an RFI/EMC Engineer. He retired from the Boeing Company on February 28, 1987. His many memberships included the IEEE and the Amateur Radio Society where he received a Technician Class License, N7EXC.

Gene encouraged Dr. Chester Smith, the General Chairperson of the 1985 EMC Symposium, to involve the American Radio Relay League in the Symposium. The ARRL was coping with interference phenomena from the days of Spark-Gap transmitters and had published several articles as early as 1927. The Amateur Radio Society has been an active participant in the EMC Society ever since.

Gene was very active in the IEEE and in particular the EMC Society where he was on the Board of Directors and served as the Society President from 1984 thru 1985. Gene was interested in many endeavors and collected many technical publications; so much so that when the EMC Society Historian was looking for a complete set of technical literature spanning the years of IRE PGRFI through the current EMC Society, Gene volunteered to give his collection for the generation of a CD-ROM. The 1997 EMC S CD-ROM containing 40 years of EMC Symposia papers including the Armour Conference Proceedings went on sale at the EMC Symposium in Austin, Texas.

Gene asked that the hard copies of all his technical collection be donated to Georgia Technical Research Institute in Atlanta, Georgia.

Gene is survived by his wife of 51 years, Grace Anna Knowles, four sons, two daughters, twenty three grandchildren and two great-grandchildren.

Gene used to say to some of us that we should go somewhere and "splice the main brace" once more.

— Len Carlson



**DAN HOOLIHAN
PRESIDENT,
EMC SOCIETY**

Greetings and Happy New Year!

I am pleased to be communicating with you via this President's column as your new EMC Society President. Operating under the new by-laws of the Society, you will be dealing with me as your President for both 1998 and 1999 as I will be enjoying a two-year term as your designated leader.

Congratulations are in order to outgoing President Bill Gjertson for his demonstrated administrative and leadership skills over the past two years. Good luck in his next IEEE volunteer assignment as Division IV Director Elect!

I would like to thank the outgoing Members of the Board: Bill Duff, Bill Ritenour, and Bill Gjertson for their excellent service to the Society over the past three years. (Apparently, our members thought we had too many "Bills" on the Board!) Our continuing members, re-elected to another three-year term, are Todd Hubing, Don Sweeney, and Kimball Williams.

Congratulations to all three for their past service and their continuing involvement!

Our new members of the Board, for 1998-2000, will be Henry Ott, Henry Benitez, Mark Montrose, Ferdy Mayer and Takeo Yoshino. My sincere congratulations to all five of the new Board Members.

Lastly, I must thank returning Treasurer Warren Kesselman and Secretary Janet O'Neil for their dedicated service over the years.

Our Board will have twenty members in 1998 as we added two members from outside the United States, Mr. Mayer and Mr. Yoshino, under our new by-law changes. Ferdy Mayer will be representing Region 9 and Takeo Yoshino will be representing Region 10 under our new emphasis on making the Board of Directors of the EMC Society more international in membership.

Continued on page 11

Newsletter Staff

Editor

Janet Nichols O'Neil
Lindgren RF Enclosures, Inc.
22117 NE 10th Place
Redmond, WA 98053
Tel: 425-868-2558 Fax: 425-868-0547
e-mail: j.n.oneil@ieee.org



Associate Editors

ABSTRACTS

William H. McGinnis
Sprint PCS
7400 Blanco Road, Suite 200
San Antonio, TX 78216
210-684-2455
fax: 210-348-0148
e-mail: w.mcginis@ieee.org

BOOK REVIEWS

Reinaldo Perez
c/o Lockheed Martin
MS: S8700, P.O. Box 179
Denver, CO 80201
303-977-5845
fax: 303-971-4306
e-mail: ray.j.perez@ast.lmco.com

J.L. Norman Violette
Violette Engineering Corp.
120 East Broad St., Ste. B
Falls Church, VA 22046
703-532-1355
fax: 703-538-3810
e-mail: eviolette@aol.com

CHAPTER CHATTER

Todd Hubing
Univ. of Missouri-Rolla
219 Electrical
Engineering Bldg.
Rolla, MO 65401
573-341-6069
fax: 573-341-4169
e-mail: t.hubing@ieee.org

DoD ACTIVITIES

Robert D. Goldblum
R&B Enterprises
20 Clipper Road
West Conshohocken,
PA 19428
610-825-1960
fax: 610-825-1684
e-mail: rgoldblum@RBitem.com

EMC PERSONALITY PROFILE

William G. Duff
Computer Sciences Corp.
Systems Engr. Div., Ste. 300
5501 Backlick Road
Springfield, VA 22151
703-914-8450
e-mail: w.duff@ieee.org

EMC STANDARDS ACTIVITIES

Donald N. Heirman
143 Jumping Brook Road
Lincroft, NJ 07738-1442
732-741-7723
fax: 732-530-5695
e-mail: d.heirman@worldnet.att.net

EMCS BoD ACTIVITIES

Janet Nichols O'Neil
Lindgren RF Enclosures, Inc.
22117 NE 10th Place
Redmond, WA 98053
Tel: 425-868-2558
Fax: 425-868-0547
e-mail: j.n.oneil@ieee.org

EMCS PHOTOGRAPHER

Dick Ford
6 Westcot Place
Falmouth, VA 22405
202-767-3440
fax: 202-404-4064
e-mail: dford@radar.nrl.navy.mil

EMCS EDUCATION COMMITTEE

Kimball Williams
Eaton Corporation
26201 Northwestern Highway
P.O. Box 766
Southfield, MI 48037
248-354-2845
fax: 248-354-2739
e-mail: k.williams@ieee.org

INTER-SOCIETY ACTIVITIES

Joseph E. Butler
Parker Chomerics
77 Dragon Ct.
Woburn, MA 01888
781-939-4267
fax: 781-938-5071
e-mail: jebmc@aol.com

PRACTICAL PAPERS, ARTICLES & APPLICATION NOTES

Bob Rothenberg
Parker Chomerics
77 Dragon Ct.
Woburn, MA 01888
781-939-4154
fax: 781-933-4318
e-mail: rothenberg@compuserve.com

IEEE EMC Society Newsletter Publication Schedule

Publication Dates

August
November
February
May

Editorial Deadlines

July 1
October 1
January 1
April 1

IEEE EMC SOCIETY NEWSLETTER is published quarterly by the Electromagnetic Compatibility Society of the Institute of Electrical and Electronic Engineers, Inc., 345 East 47th Street, New York, NY 10017. One dollar (\$1.00 USD) per member per year (included in the Society fee) for each member of the EMC Society. Periodicals postage paid at New York, NY and additional mailing offices. This newsletter is printed in the USA. Postmaster: Send address changes to IEEE EMC Society Newsletter to 446 Hoos Lane, Piscataway, NJ 08855.

© 1998 IEEE. Permission to copy without fee all or part of any material without a copyright notice is granted provided that the copies are not made or distributed for direct commercial advantage, and the title of the publication and its date appear on each copy. To copy material with a copyright notice requires specific permission. Please direct all inquiries or requests to IEEE Copyrights Office.



Janet O'Neil, Editor, with newly elected Board members Henry Benitez (L) and Mark Montrose (R).

Ringling in the New Year!

This year promises to be an exciting one! I don't know about you, but my phone has been ringing off the hook these days. I anticipated a slow January in a relatively quiet office. In fact, I

was looking forward to the quiet after a hectic holiday. This was not to be. Instead, I believe people have awoken after a long hibernation to encounter a robust economy. This has spurred tremendous activity. It's exciting!

It's also exciting that we have two new Board members in 1998 from the "younger" generation of EMC engineers. **Henry Benitez and Mark Montrose attended their first EMC Society Board of Directors meeting** last November in Atlanta, Georgia. I'm sure Henry and Mark will bring fresh, new ideas to the Board as they represent the younger EMC engineers in our Society.

We also have two new members of the Distinguished Lecturers Program and they are introduced in this Newsletter by the able **Chairman of the Distinguished Lecturers Program, Scott Roleson**, on Page 13.

Jim Muccioli recently received the IEEE Fellow Award. Congratulations Jim! We are formally acknowledging Jim on Page 11 of this Newsletter. Jim turns 39 on March 9. Could he be the youngest member of our Society to receive the Fellow Award? Speaking of awards, **now is the time to start considering nominations for awards to be given at the 1998 IEEE EMC Society Symposium in Denver.** Contact **Bill McGinnis, Awards Chairman**, for information on award categories and criteria for specific awards. Then, nominate that hard working volunteer you know that has contributed to the suc-

cess of the EMC Society. We need to hear from you! You may contact Bill McGinnis per the information on Page 3 of this Newsletter.

There are many regional conferences coming up in 1998 which may interest you. Please refer to the Calendar section of this Newsletter for more information. These conferences are an excellent way to sharpen your EMC skills and network with other EMC professionals. I hope to see you at one of these conferences during the year. Of course, **don't forget the 1998 IEEE EMC Society Symposium in Denver.** An advertisement for this symposium is found on Page 28 of this Newsletter.

I am also very excited to announce that **this Newsletter is now available electronically on the IEEE World Wide Web.** At the last Board meeting, the expenditure to provide each issue of the EMC Society Newsletter for 1998 on the web in the HTML format was approved! This was done to provide a better service to our international membership who do not always receive the Newsletter in a timely manner, if at all, via mail. Also, this enables other IEEE members, who are not members of the EMC Society and thus do not receive the Newsletter, to take a peek and learn about our activities. It is hoped that this will also recruit new members to the EMC Society. **Visit the EMC Society Newsletter on the EMC Society Home Page at http://www.emclab.umn.edu/ieee_emc/**

Lastly, we've confirmed for 1998 the companies who will support the Newsletter financially with their contributions to the **Institutional Listings** section. You'll find these companies on the back cover of the Newsletter. **Thank you for the corporate support!**

With all this activity, I'm sure you'll agree that 1998 promises to be a great year!

Well, gotta go, the phone's ringing!

Janet O'Neil



TODD HUBING
ASSOCIATE EDITOR

Very few college freshmen decide to study electrical engineering so that they can design kitchen appliances for a living. In order to stress the importance of high-frequency circuit design and EMC, I used to tell my students that they would have to be familiar with these subjects unless they planned to get a job designing toasters. A few years ago, in a previous Chapter Chatter column, I further speculated that within five years even toasters would be sophisticated high-speed microprocessor-controlled devices. Well, you can imagine my surprise and excitement when I saw an ad in the Rolla Daily News for a "smart" toaster with a "microchip" brain.

We are already a two-toaster family. We have one toaster that we use infrequently and another (a gift) that is stowed somewhere in the deepest recesses of our kitchen cabinets. We didn't need another toaster, but I thought I'd stop by the local Wal-Mart and look at one. They had several "smart" toasters on display and I checked to see if any of them had FCC Compliance labels. They didn't. Of course, home appliances are exempt from FCC emission requirements, but I began to wonder if a smart toaster would interfere with nearby radio or television receivers. Fifteen minutes later, I was the proud owner of a new "smart" toaster.

As soon as I got it home, I plugged it in and used a portable FM radio to scan for signs of unintended EM emissions. I was surprised to find that there was absolutely no toaster-induced interference anywhere in the entire FM band. I threw the toaster in the car and took it to the laboratory. A quick scan revealed that other than a small amount of low-frequency broadband emissions, the toaster was dead quiet!

I pulled off the knobs, bent some metal tabs, and removed the plastic housing to reveal the tiny printed circuit board that housed the microchip "brain". With a few more snips and cuts, I was able to remove the board from the toaster and power it up on the bench. The "brain" was a small dot with 5 leads. Probing just above the surface of the dot and along the 5 leads confirmed that this was an analog device. The microchip "brain" was not a microprocessor at all. I'm still not sure exactly what it is, but clearly the design of this toaster did not re-

quire any special expertise in EMC or RF design. At least for now, students who skip the RF and EMC courses in the undergraduate EE curriculum can still find gainful employment as toaster designers.

But times are changing. Consumers are demanding more from their home appliances. Before long, knobs and dials will be obsolete.

Homeowners will tell their appliances what to do and the appliances will do it. Don't try to sell me a half-witted toaster with a 5-leaded brain. I want a toaster with the latest high-speed digital technology. I want a toaster with a fast RISC processor and gigabytes of RAM. I want a toaster that communicates with toast-making professionals via the Internet. I want a toaster that knows who I am, knows what I want, and knows how to make toast just the way I like it.

The toaster on our kitchen counter has a dial with numbers from 1 to 5. A higher setting is supposed to give you darker toast. I don't pay any attention to the setting because no two slices of toast ever come out the same. Our new "smart" toaster is supposed to be more consistent, but I can't really say for sure. These modern appliances are a lot easier to take apart than they are to put back together.

Central New England

John Clarke reports that the September meeting of the Central New England chapter was a joint meeting of the EMC and Product Safety Societies. The featured speaker was Wayne Hunter of GE Medical Systems in Milwaukee. The title of Wayne's presentation was "Electromedical Device EMC, Product Safety and the FDA GMP." The presentation provided information about EMC requirements for electromedical device manufacturers. EMC is now required for these devices under section 820.30 of the FDA Good Manufacturing Practices (GMP). GMP will require all electromedical manufacturers to provide information regarding the intended EMC environment as well as verification data for new products. The impact of the new FDA GMP on product safety was reviewed. The new GMP went into effect on June 1, 1997 with a transition period until June 1, 1998. This requirement directly affects finished device manufacturers and indirectly affects their



Photo by: John Clark

Wayne Hunter of GE Medical Systems (L) was the featured speaker at the Central New England Chapter's September meeting presided by Chapter Chairman Mirko Matejic (R).

subcontractors. Additional information was also presented in regard to FDA design controls included in section 820.30 of the code of Federal Regulations, Part 21. The question of changes that may be required in current CE marking and related issues was also discussed.

The December meeting featured Tim D'Arcangelis, an EMC Consultant from Oakdale, New York. Tim's topic was "RF Power Requirements For Radiated Immunity Testing." The presentation centered around the IEC 61000-4-3 standard as it imposes the most demanding radiated immunity test requirements. All other standards may be considered subsets of this comprehensive IEC test. The presentation discussed power amplifiers, the anechoic room, harmonic power, antenna performance, the fallacy of radiated immunity testing below 80 MHz and safety considerations. The written procedure for the standard is considered deficient and this can lead to gross testing errors.

Chicago

Steve Laya reports that the December meeting of the Chicago Chapter featured a "Comparison of TEM Cells, GTEM Cells and Anechoic Chambers" presented by Chase EMC. The presentation reviewed the benefits and limitations of these test environments. The Chicago chapter continues to have strong attendance at meetings. They have been experimenting with sending the meeting notices and meeting reminders using email. They have found that they can use email to remind everyone of the meetings a day or two in advance. Also, they plan to use email to inform the membership when a meeting needs to be cancelled due to weather or for other reasons. Contact mmartin@dlsemc.com to be added to the email list.

Germany

Markus Petirsch reports that there was a meeting of the

German IEEE EMC Chapter in Hannover on November 19th. The main topics of the chapter meeting were the reports of the chair and vice-chair, the reports of the Numerical Field Calculation Group and the Education Group, and the election of the chapter board.

The chairman, Dr. Sturm, thanked chapter members for their activities like the organization of symposia and presentations last year. The vice-chairman Prof. Garbe announced the success of the EMC Symposium in Guenzburg organized by the German IEEE EMC Chapter and the German VDE. In 1998, the German IEEE EMC Chapter will be a sponsor of a series of presentations planned for May and June at the University of Hannover. Prof. Mrozynski reported for the working group "Numerical Field Calculations" which created 14 configurations and problems to benchmark different calculation tools. The simulations of the numerical problems will be performed in small groups. Prof. ter Haseborg summarized the activity of the "Education" group. The main activities were restricted to locations near Hamburg last year. He suggested that similar activities be sponsored in other cities.

New board members were also elected at this meeting. The old chairman Dr. Sturm retired and is now the past-chairman. The chapter would like to thank Dr. Sturm for his activities. The new Chairman is Prof. Garbe. Prof. ter Haseborg was elected Vice-Chairman. The Educational Activities officer is now Dr. Dancau. The new Technical and Scientific Activities officer is Mr. Petirsch. Prof. Gonschorek was elected as Treasurer. The officers of the Work group for Standards are Mr. Harms and Mr. Moehr. Prof. Mrozynski was re-elected as officer for Numerical Field Calculations Workgroup and Dr. Dancau is the officer for the Education Workgroup.

Israel

November and December were very active months for the Israel EMC Chapter.

IEEE President, Dr. Charles (Chuck) Alexander, visited Israel by the invitation of Israel IEEE Section Chairman, Dr. Anthony Weiss. On November 17, a meeting of all IEEE Israel Section Officers and Chapter Chairmen with the IEEE President took place at the Tel-Aviv University. The next day, the Israel IEEE EMC Chapter sponsored a visit of the IEEE President, his wife and delegation to Telrad, a Hi-Tech Telecommunications Company, and a sponsor of the Israel IEEE EMC Chapter. The President and delegation were welcomed by the Vice President of International Marketing and later were met by the President of Telrad. Later, the President and delegation were invited to visit the super-modern production line, where many of its products, later found in telecommunication centers worldwide, are manufactured. Following the visit, a Certificate of Appreciation was presented to the President by the Israel IEEE EMC Chapter.



Photo by: Elya Joffe

Israel Chapter Officers (left to right) Eli Milshtein, Vice Chairman, Elya B. Joffe, Chairman, and Moshe Henig, Secretary, under the banner stating "Welcome to National Quality Week Activities, 14-19 September, 1997."

The December meeting was a full-day workshop on EMI Control Devices and Techniques sponsored by Telrad. Participation in the meeting was great!

There were over 80 attendees, of which over 30 were IEEE members.

Participants arrived from places as far as 100 km from Tel-Aviv.



Photo by: Elya Joffe

Dr. Alex Axelrod, Israel Chapter member, is shown demonstrating "Electrical Fast Transients/Bursts" at the Workshop held in the Israeli Institution of Standards.

After a short welcome by Chapter Chairman, Elya B. Joffe, a welcome address on behalf of Telrad was given by Mr. Reuven Rabinovitch, Vice President for Quality Management at Telrad. In his presentation, he highlighted the policy of Telrad to design EMC into its products, and thus the importance of familiarizing all design engineers in the company with EMI control techniques. This is exactly the objective of the EMC Chapter in Israel in holding such workshops - increasing the awareness of industry to the importance and benefits of EMI control "from the start".

Following the welcome address, elections for the Officers of the Chapter for the year 1998 took place. Elya B. Joffe was re-elected as Chapter Chair. Eli Milshtein was re-elected Vice-Chair. Moshe Henig was re-elected Secretary/Treasurer. Dr. Alex Axelrod was elected as the new Technical Activities Officer. Dr. Jacob Gavan was elected Student Activities Officer.

We wish good luck and success to all newly and re-elected officers, and look forward to yet another fruitful and active year.

Following the elections, a brief summary of the annual activities was presented by the Chairman, Elya Joffe, followed by an announcement of future activities in Israel and abroad. Special emphasis was placed on MELECON'98 and EUROEM'98 which will take place in Israel in 1998. After this introduction, the following technical presentations were given: "RFI Filter Connectors for Military and Commercial Applications", by Mr. Avi Inbar of Bar-Teck; "Active Power Line Filtering", by Mr. Nehemia Niv and Haim Neerman of Actil; "Combined E3 Mitigation/Protection", by Mr. Tino Nackson and Amir Cohen of Amtech; "EMC Considerations in Grounding Design on a Printed Circuit Board", by Dr. Alex Axelrod of EMI Test; "Lightning as a Source of RFI", by Dr. Itzhak Israeli of Lotan Engineering; "Analysis and Design of Transient Suppression Circuits using Pspice," by Mr. Moshe Shechter of Rafael/ADA; "From the Diary of a Clinic Engineer", by Dr. Alex Vilenski of Rambam Hospital; and "RFI Skirt in Cellular Systems", by Mr. David Peso of Telrad.

MELECON'98 (IEEE Mediterranean Electro-Technical Conference) will be held on May 18-20, 1998, in Tel-Aviv, Israel.

Chapter members were very busy in the last few months assisting in the review process of the abstracts and summaries which were submitted from many countries. Over 15 papers in the field of EMC were submitted, and eight were approved, from several countries, especially in Region 8.

The Chapter Officers held a Steering Committee meeting following the Chapter meeting at Telrad to discuss preparations for the IEEE International EMC Symposium to be held in Israel in May, 2003. An agreement has been reached with the National Committee of URSI, Commission E (EMC) to co-sponsor this Symposium. Additional Chapter meetings and activities are scheduled for 1998.

Information may be found on the Web Sites of the Israel IEEE Section: <http://www.eng.tau.ac.il/~ajw.ieee.html>. Again we encourage IEEE members from the Middle East, in particular from Egypt, Jordan and the Palestinian Authority (PA) who wish to participate in our activities, to contact the Israel EMC Chapter Chairman who will welcome all wholeheartedly.

Los Angeles

The Los Angeles Chapter had the pleasure of Dr. Lothar (Bud) Hoefft's company as he tutored some 35 attendees on the basics of shield transfer impedance at the January meeting. Bud is an independent EMC consultant and Certified EMC Engineer who resides in Albuquerque, NM. He presented the basics of shield transfer impedance and numerous measurements of everything from connector backshells to spiral wound shielded cables using vacuum deposited aluminum on mylar. He spoke of the effects of torque on connectors and how it affects shielding effectiveness—more torque, lower impedance.

Attendees came away with an understanding of the "characteristics" of a shield transfer impedance curve (i.e. what to look for—dc resistance, diffusion break frequency, and square root of frequency term). The talk lasted for 2-1/2 hours and most of the attendees were still interested at the end. The audience was given a chance to "escape" when the overhead projector light bulb burned out. Several EMC engineers rushed to correct the problem, but very few left!

Edna and her staff at The Lakes in El Segundo, where the meeting was held, whipped up wonderful teriyaki chicken and baked codfish dinners complete with all the fixings. Those who reserved early and showed up on time did not go hungry. We expected to lose a few attendees due to the "rain", but we actually ran out of food as several additional people showed up at the door. Fortunately, Edna whipped up something else to keep the late comers happy.

For information on the Los Angeles chapter, please contact Ray Adams at 310.662.7878 or e-mail at r.k.adams@ieee.org

Oregon (& SW Washington)

The Oregon and Southwest Washington Chapter is alive and well during its second year of existence. Officially, the chapter is within the jurisdiction of the Oregon Section, concentrated near the Portland metropolitan area, which extends to Southwest Washington. We have regular attendees and even an officer from SW Washington and hence our long chapter title.

The chapter has continued the enthusiasm from its inaugural year. Attendance at chapter meetings has consistently exceeded 30 people, with expectations that the membership will steadily increase as more people become aware of our existence. We have been fortunate to have had high caliber lecturers. Mr. Franz Gisin's "Fun with



Oregon EMC Chapter Meeting "Fun With Fourier" Lecture Series by Franz Gisin.

the Fourier Series" presentation on October 1 lived up to expectations. (I have included a picture for proof. Note that all eyes are focused on the presentation!!) On October 30, Mr. Art Wall from the FCC gave an update on US/EU Mutual Recognition Agreement details. Mr. Wall showed that even government representatives can have some fun as he not only partook in the chapter's Halloween Hat contest, but was the unanimous winner!!!

In November, Mr. Dan Hoolihan provided information on updates to the ISO/IEC Guide 25 lab accreditation guidelines. The presentation was very audience participative. In fact, things livened up even more during the question and answer period. It became apparent that what was important to this audience were the details of "how to pass an ISO/IEC Guide 25 EMC laboratory quality certification audit." Mr. Hoolihan came well prepared and pulled out a set of slides from his back pocket and proceeded speaking for an additional 30 minutes!

The chapter is excited about co-hosting a Vendor Exhibition on EMC Products and Services on June 29 in Portland, Oregon. The event will be held in conjunction with an Electromagnetic Compatibility (ANSI ASC C63) EMC Measurement Uncertainty Workshop and ANSI ASC



Note: All eyes focused on Mr. Franz Gisin's exciting presentation!

C63.4 Workshop on the Measurement of Radio-Noise Emissions sponsored by the US EMC Standards Corporation in cooperation with the American National Standards Institute, Accredited Standards Committee C63 (EMC). For those of you interested in these workshops, please sign up and come visit the beautiful Northwest June 29 - July 1. Contact Henry Benitez, Chapter Chairman, for more information at phone 503.627.1217 or e-mail at henry.w.benitez@tek.com

Ottawa

Gary Wong reports that the speaker at the December meeting of the Ottawa chapter was EMCS Distinguished Lecturer, Dr. Todd Hubing. The presentation was titled, "An EMC Engineer's Guide to Electromagnetic Modeling." Dr. Hubing presented an overview of various commercial and non-commercial software packages marketed to EMC engineers.

Philadelphia

Richard Haynes of Richard Haynes Consultants was asked to give an after dinner talk at the October meeting of the Philadelphia chapter. The presentation was abstracted from the two popular courses: "Executive Summary: EMC/EMI/ESD Related to Corrosion and Materials Reliability Issues" and the more detailed technical course. The members were so interested in the subject matter that the talk had to be terminated after one and a half hours.

San Diego

The December meeting of the San Diego Chapter of the IEEE EMC Society featured Mr. Henry Osgood (Chapter Vice Chair) who discussed spectrum analyzer performance. This discussion was very well received by the local EMC members and presented an analysis of spectrum analyzer performance features and their relative merits in spectrum analyzer applications. The items covered included frequency and phase modulation, resolution issues, amplitude issues, display resolution, spectral purity, deviation accuracy, sensitivity, functions of a preselector, onscreen dynamic range and measurement error values.

Audience participation was encouraged and thought-provoking questions were entertained.

Seattle

Art Wall of the Federal Communications Commission (FCC), spoke at the October meeting on the "Status of the United States-European Union Mutual Recognition Agreement." The meeting was held on the evening of October 30, at a restaurant in downtown Bellevue, just east of Seattle. This being the night before Halloween, the chapter added a ghoulish air to the evening by providing Halloween candy on the tables and suitable decorations. In fact, the speaker surprised the audience by donning a crazy wig and witch's



Seattle Chapter speaker Art Wall of the FCC (C) enjoys a lighter moment with Northwest EMC's Jerry Page (L) and Kitty Tam (R). Northwest EMC sponsored the Halloween theme dinner prior to the presentation. Note the spider and web on Jerry's shoulder!

hat when he was introduced! Mr. Wall spoke about the current status of the United States-European Union Mutual Recognition Agreement (MRA). He elaborated on the steps being taken to implement the Agreement. Sectors covered included telecommunication equipment and electromagnetic compatibility, notably electrical safety, recreational craft, pharmaceutical GMP and medical devices. Mr. Wall also addressed the recent and proposed changes to the FCC equipment authorization program. Northwest EMC Inc. generously sponsored the cost of the dinner so a good time was had by all. Boo!

In November, Dan Hoolihan of TUV Product Service, New Brighton, Minnesota spoke on "A Comparison of the Third and Proposed Fourth Editions of ISO/IEC Guide 25: General Requirements for the Competence of Testing and Calibration." The Fourth Edition of ISO/IEC Guide 25 was circulated for review and comments the first half of 1997.



Hosts at the November Seattle Chapter meeting included Pat Andre (L) and Mark Darula (R) of CKC Labs in Redmond. Speaker Dan Hoolihan (C) is clearly enjoying his visit to the rainy Pacific Northwest!



Photo by: Janet O'Neil

Member Services Director Todd Hubing (R) actively promoted membership in the IEEE and EMC Society at the Wireless EMC Forum on October 27 and 28 in Dallas, Texas. This event was sponsored by the University of Oklahoma's Center for the Study of Wireless EMC. The program attracted representatives of the medical and automotive electronics industry, such as Poul Andersen of Chrysler (L) and Jim Polonis of the Southwest Research Institute (C).

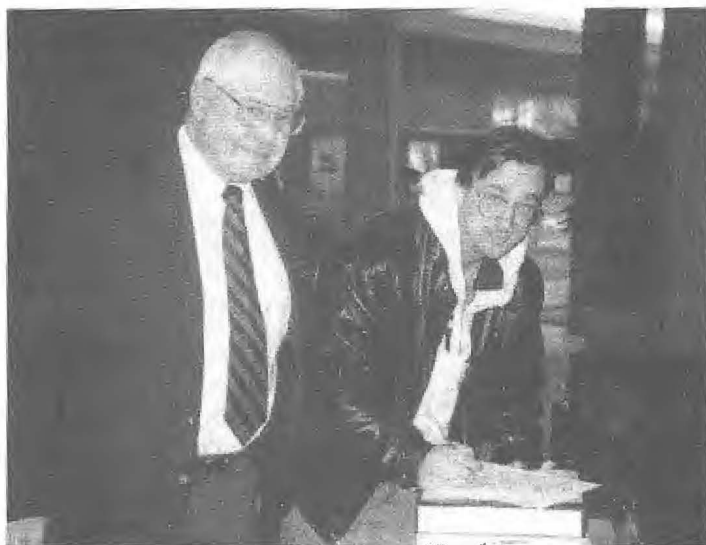


Photo by: Janet O'Neil

Washington Laboratories, Ltd. of the Washington DC/Northern Virginia Chapter lent administrative support to the EMC Measurement Uncertainty Workshop and ISO/IEC Guide 25 Workshop held on October 22-24 in Linthicum, Maryland. Signing in are Bill Lubitz (L) of Harley Davidson Motor Company and Richard Schmidt (R) of Yazaki North America.

Mr. Hoolihan's presentation compared and contrasted the 1990 third edition with the draft fourth edition. Paragraph by paragraph comparisons were made between the two versions of the Guide and differences/additions between the two editions were highlighted. Comments from reviewers of the 1997 draft were discussed. Implications on testing lab accreditation were emphasized. This evening meeting was held at CKC Labs in Redmond. CKC Labs and Lindgren RF Enclosures provided free pizza and soft drinks. It is still being debated among the chapter officers

if the free pizza or the excellent speaker was the bigger draw for this meeting. (Just kidding Dan!)

Southern Maryland

Wayne Devereux reports that during 1997, the Institute of Electrical and Electronics Engineers (IEEE) Southern Maryland Communications, Computers and Electromagnetic Compatibility (EMC) Chapter held 12 technical and business meetings, once every month of the year. The meetings were held regularly on the last Monday of every month, with dinner meetings held at the Roost restaurant on the 1st month of each quarter and brown-bag-lunch meetings held at Veda Incorporated on the 2nd and 3rd month of each quarter. Regular meeting notices were issued by postal mailings, e-mail and newspaper articles. All meetings in 1997 were very well attended throughout the year, averaging around 15 people for the dinner meetings to 35 people attending the lunchtime meetings, and increasing at each meeting throughout the year.

During 1997, our Chapter began to schedule IEEE Distinguished Lecturers for our 1st month of the quarter dinner meetings. For our October dinner meeting, Dr. Pasupathi Subrahmanyam, from Lucent Technologies, was scheduled to visit the Southern Maryland area to lecture on Embedded Systems. Unfortunately, our first Distinguished Lecturer had to cancel his arrival due to the flu, however, a business meeting was still conducted.

Future technical and business meetings for the first half-year of 1998 have already been planned by the Southern Maryland Communications, Computers and EMC Chapter. The regularity of a monthly meeting scheduled for the last Monday of each month will be continued. We are continuing to invite more IEEE Distinguished Lecturers to our dinner meetings in hopes we can increase our dinner meeting attendance. For more information, contact Mr. Fred Heather (heatherf%am3@mr.nawcad.navy.mil) or Mr. Wayne Devereux, phone (301) 863-4290 (wdevereux.paxr@veda.com).

Sweden

In November, the Sweden chapter re-elected the following committee: Dag Bjorklof, of SEMKO AB, is the chair; Per-Olof Eriksson, of Enator Communications AB, is the vice-chair; and Mats Backstrom, of FOA AB, is the secretary. During 1997, the Swedish chapter had three meetings. The topic of the April meeting at SEMKO EMC Center in Stockholm was "EMC and Medical Equipment." One presentation, given by Mr. Jan Welinder of the Swedish National Testing and Research Institute, was titled "Investigation of the Electromagnetic Environment in Hospitals." Another presentation, given by Mrs. Eva Clausson of Medtronic-Vingmed, was titled "Pacemakers and EMC".

A meeting was held in September at the University of Lund. The topic of this meeting was "Potential Biological Effects Due to Electromagnetic Fields." There were seven presentations representing Swedish authorities, scientists, and the telecommunication industry.

One of the representatives of the scientific community was Dr. Kjell Hansson-Mild of the National Institute for Working Life. His presentation was titled "Electrical Hypersensitivity - the Present Situation." From the industrial side, Mr. Christer Tomevik of Ericsson Radio Systems AB gave a presentation titled "Cellular Phones - Electromagnetic Exposure and Interference."

The third meeting of the year was held in November at ABB EMC Center in Vasteras. The topic of this meeting was "Power Electronics". An overview of the topic was given by Dr. Lars-Erik Juhlin of ABB Power Systems AB. Other subjects treated were EMC education and test standards.

Toronto

The December meeting of the Toronto chapter featured Prof. Todd Hubing of the University of Missouri-Rolla. The subject of Prof. Hubing's talk was "EMI Troubleshooting Techniques."



James Paul Muccioli Receives IEEE Fellow Award

James (Jim) Muccioli was elected to IEEE Fellow on January 1, 1998 for contributions to integrated circuit design practices to minimize electromagnetic interference. He was the only member of the EMC Society to be so honored this year. The award will be presented at the IEEE EMC Society Symposium in Denver, Colorado, August 24-28, 1998.

President's Message . . .

Continued from page 3

The entire Board, including the officers and executive committee, is looking forward to 1998. We ask for your inputs on EMC-related issues and we promise to do our best in serving the members of our Society. Our 1998 Board Meetings will be held in Seattle (Washington), Denver (Colorado), Rome (Italy), and Piscataway (New Jersey). Our Board meetings are open to all members and I invite you to consider attending one or more of our meetings. Note the Board meeting dates in the Calendar section of this Newsletter.

I would like to remind you that the IEEE 1998 International Symposium on EMC will be held in Denver from August 24-28. This is the high-point of the year for our EMC Society and I encourage you to begin planning on attending the event. For more information, contact the Denver Symposium Web Site at http://ball.com/aerospace/ieee_emc.html

It is an honor and a privilege to be leading the EMC Society. I look forward to meeting many of you over the next two years, either in person or via E-mail (dhoolihan@tuvps.com) or by phone (612-638-0250) or by FAX (612-638-0285).

We have been one of the fastest growing Societies in the IEEE over the past few years; I expect that growth-rate to continue as we charge forward into the 21st Century.

Dan Hoolihan
President, EMCS

Visit the EMC Society Homepage at:

http://www.emclab.umn.edu/ieee_emc/

For more information on:

- EMC Employment Opportunities
- Calendar Listings of Upcoming EMC Events
- NEW! This Newsletter is now available in the html format!!
- Additional EMCABS
- And much more!



BOB ROTHENBERG
ASSOCIATE EDITOR

This column is devoted to articles, papers or application notes which would be of interest to EMC practitioners as opposed to EMC academicians. Ideally, such papers should be about 1-3 Newsletter pages in length. If editing for length is required, it will only be with the author's concurrence. Please submit in double-spaced form, as hard copy, disk or e-mail (see page 3 for address, fax and e-mail info).

This issue's article on PCB signal integrity was written by Lee Hill of Silent Solutions (Hollis, NH). It is the first of a two-part series, which will be completed in the Spring issue.

Digital Clock Transmission Lines and Terminations on Printed Circuit Boards

by Lee Hill,
Silent Solutions (Hollis, NH)

Many EMC engineers spend a significant amount of time trying to reduce the levels of radiated EMI from digital electronics on the PC board. Harmonics from new high speed clock generating integrated circuits and their transmission lines usually comprise the dominant source of the high frequency (above 30 MHz) emissions that radiate from a system's cables and enclosure. Picking and adjusting the best termination strategy to control signal reflections at the ends of these transmission lines is often a balancing act between at least three signal integrity goals: 1) trying to maximize signal rise and fall times ("edge rates") to minimize high frequency content, 2) trying to minimize signal edge rates to ensure signal skew is within the overall system budget, and 3) trying to obtain monotonic (smooth-looking) signal edges to achieve clearly defined high and low voltage levels. In this application note, we will begin to take a look at the need for simple transmission line terminations per Figure 1 and their impact on signal integrity.

Most textbooks and vendor application notes tell us that we must consider using transmission line terminations when edge rates are fast and PCB traces that interconnect our circuits are long. To design a digital clock circuit with smooth edges we must know both: 1) how fast our edges will be and 2) how long the signal trace

will be to decide if transmission line terminations are necessary. If the following inequality is true, then we will judge that signal rise time is much less than the time it takes the signal to travel from source to load:

$$\frac{\tau_{\text{rise}}}{4} < \tau_{\text{propagation}} \quad \text{or} \quad \frac{\tau_{\text{rise}}}{4} < \frac{\text{trace length}}{\text{propagation velocity}}$$

Equation 1

For a fiberglass PC board with $\epsilon_r = 4.5$, use a propagation velocity of about 7.1 inches/nanosecond or 18 cm/nanosecond for outer (microstrip) signal layers, and 5.6 inches/nanosecond or 14 cm/nanosecond for inner (stripline) signal layers).

If we solve the inequality for trace length, we can easily find that a signal with a 100 nS edge can be routed over about 5 meters of PCB trace before we need to worry about using termination components. If the signal edge rate is reduced to 1 nS however, then we must use a termination for traces that are greater than about 5 centimeters in length.

Equation #1 tells us the relationship between how much time the signal requires to reach full value versus the time it takes the signal to travel all the way down the transmission line. If the signal edge is "very" fast as compared with the time required for the signal to travel from source to load, then we will find that: 1) the pulse reaches full value before it can get to the end of the line, 2) the voltage and current on the trace are a function of position, that

is, if we look at the signal trace on the PC board with an oscilloscope, we can expect to see different looking waveforms when we put our 'scope probes between points A and B versus points C and D and 3) the ratio of the magnitude of the total voltage on the trace to the total current

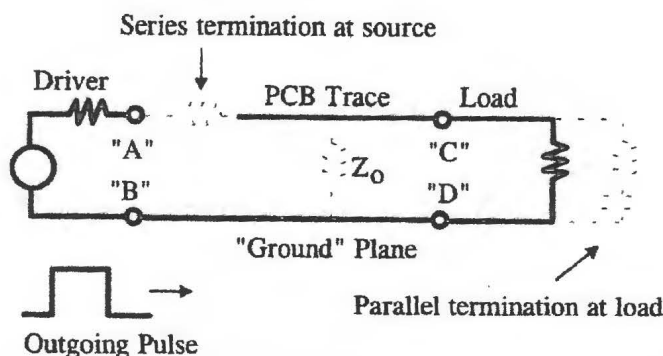


Figure 1: Simple PC board circuit model.

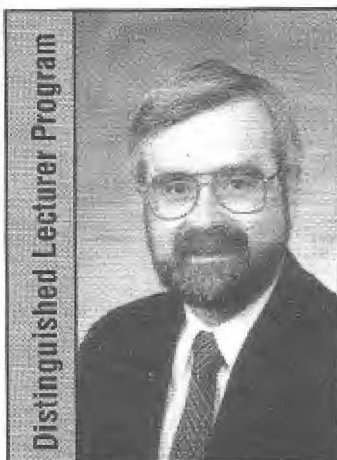
IV/I on the trace must be expressed in terms of a characteristic impedance, Z_0 . If we find these three conditions to be true, either through math or by observation, then we may say that transmission line behavior exists, and that conventional lumped element theory is inadequate to explain what we see on the oscilloscope. We will have to use appropriate terminations to achieve good signal integrity in such cases.

If we find that the inequality in equation #1 is not valid, then the signal rise time is very "slow", and/or the trace is very short. In such cases, we can say in contrast that: 1) the pulse does not "travel" down the line, but rather the entire line is a single node and has a single unique voltage and current throughout its length, 2) voltage and current now are *not* a function of position; our scope probe will display the same signal regardless of where we place it along the trace, and 3) circuit and voltage currents are determined primarily by source and load impedances, and are minimally affected by trace characteristic impedance. If we find these three conditions to be true, then we may say that a lumped element circuit with resistors, capacitors, and inductors is good enough to describe what happens on the signal trace. We may decide that no termination components will be necessary to achieve good signal integrity.

In the next part of this article, we will look at transmission line reflections and how termination components are used to control them.



Lee Hill may be contacted at
Silent Solutions EMC Consulting
603.465.3920
e-mail: noiseless@aol.com



SCOTT ROLESON
CHAIRMAN

New Distinguished Lecturers Start Their Terms

by Scott Roleson

Chairman EMCS Distinguished Lecturer Program

Donald Bush and Robert Dockey recently began their terms as the newest Distinguished Lecturers of the EMC Society, replacing Dr. Todd Hubing and Franz Gisin whose terms expired on December 31 of last year. Don and Bob join the other two EMCS Distinguished Lecturers, Dr. Jose Perini and Bill Ritenour, who are midway through their two year terms.

Don Bush has over 27 years experience in EMC. He is currently an EMC Consultant after retiring as a Senior Engineer from Lexmark International, where he was responsible for worldwide EMC compliance. He is co-inventor of a proprietary spread-spectrum clock technology, and provided EMC guidance and consultation on several IBM products. He has written or co-authored 11 published technical papers on various aspects of EMC, is a Registered Professional Engineer in the state of Kentucky, and is a NARTE certified EMC engineer. He is a member of Sigma Tau, Tau Beta Pi, and is a Senior member of the IEEE.



Don Bush

Bob Dockey also has over 27 years experience in EMC and Tempest engineering. He is currently EMC Engineering Manager at Hewlett-Packard's Vancouver (Washington) Division, where he is responsible for a group of 11 EMC engineers and technicians, a 10 meter open area test site, and both 3 and 10 meter semi-anechoic chambers. Published papers include one on "Asymmetrical Mode Radiation from Multi-Layer Printed Circuit Boards," and he co-authored another on "New Techniques for Reducing PCB Common Mode Radiation." Bob is a NARTE certified EMC engineer.



Bob Dockey

The EMC Society's Distinguished Lecturer program provides speakers for Society chapter meetings and similar functions. Each speaker typically can offer one of several presentations on various electromagnetic compatibility topics. Speakers may present a maximum of six talks each year under this program. Distinguished Lecturers are appointed by the Board of Directors to two year terms. Currently the EMC Society has four speakers, two each on alternating terms.

The Society reimburses speakers for their approved traveling expenses up to a recommended limit of \$750 per US engagement, or up to \$1000 per overseas engagement with advance approval. Whenever possible, hosting chapters are encouraged to absorb some part of the cost, such as providing local transportation for the speaker, paying his hotel bill, or providing his meals.

For more information about the EMCS Distinguished Lecturer Program, see our Web site at URL http://www.emclab.umn.edu/ieee_emc/lectur.html, or contact the Program Chairman, Scott Roleson, at +1-619-655-4809 or via e-mail to scott@sdd.hp.com



KIMBALL WILLIAMS
ASSOCIATE EDITOR

IEEE EMC-S Education Committee

A Learning Organization

There has been much said about the advantages of learning, and the advantages that accrue to an organization when its members learn. There are a few assumptions that are often made, and occasionally stated, about what this learning is all about, and specifically what topics make 'appropriate' learning for the benefit of the organization. One source suggested that the only valid learning, from the organization's point of view, was learning that related directly to the worker's assigned tasks. Fiddle sticks!

Learning for Learning's Sake

From a practical standpoint, it makes little sense to attempt to dictate what is an 'appropriate' subject for learning, even within the apparent narrow confines of a technical discipline. Those subjects that we tout as 'hot' within a technology today become old news when the winds of change shift slightly one way or another. How could we predict what subject will be the pivotal element in a new approach to tomorrow's questions? Simple; we can't.

So, how are we to direct our learning for maximum benefit for ourselves and for our organization? Some subjects are clearly important to technological success. The basics and a few targeted specialty courses are obvious but, after that,...what next? I submit that beyond those already mentioned, anything we study is a good subject. Literally, ANYTHING!

So...Study what Interests You

"Yeah? How will basket weaving help my electronics?"

First of all, you were probably lead to the subject by some innate talent or curiosity, otherwise why were you interested in the first place? Second, there might be some skill or ability that is demonstrated by those practicing the craft that you can gain and profit by making your own. Third, you might perceive some aspect of the skill that is just beyond your current understanding, and with a little work you could master. Fourth, at some level, you might recognize that the subject contains the germ of another way of approaching a problem in a completely different discipline that may give you an 'edge' to cutting through to the

heart of some problem. Since we started with 'basket weaving', lets just explore that for a minute. Some elements of complex thinking and manipulating the environment are evident in that 'simple' skill. Lets look at a few:

- Increased awareness of patterns, how they repeat, how they evolve, how they can be altered to effect differences in form and appearance.
- Heightened perception of depth, volume, texture and color.
- Awareness of the limits and strengths of materials, flexibility, stiffness, twisting and bending and breaking levels.

And if all that were not enough, if you do it right, when you are done, you have a basket as well.

A Work Out in the Mental Gym

Think a moment about what we are accomplishing with our learning process. In a way it is mental exercise. If we use the analog of bodily exercise, perhaps we can shed some light here. If we go to a gym to 'work out', we probably engage in a variety of exercise types. The objective is to maintain strength, improve flexibility, range of motion and stamina. With that in mind, we wouldn't want to only work on one exercise, every time, all the time. In fact, it is the variety that does the most good.

The same can be said of our mental exercise (learning) experiences. First of all, lets maintain our strengths. In other words, review the basics. Then let us improve our flexibility, say, with a subject that we only know slightly, but want to know better. Now, let's expand our range of motion with something completely new and outside our previous experience. Finally, attack one of those topics which we find difficult and frustrating to help us build up our ability to stay at a job and get it done, no matter what.

Notice that with the exception of the first subject, the basics, the rest of the topics have no constraints at all. Even the basics will be different for each individual. But, the rest of the topics only need to 'flex', 'stretch', 'move', and 'challenge'. When the

subject being studied fulfills those needs, it is exercising our mental muscles and helps us to maintain and/or grow.

Fundamentals, Fundamentals, Fundamentals....

Is there anyone who knows his subject so well that he cannot benefit from a review of the basics? And once you know your basics well enough, who cannot benefit from practice? Athletes and musicians know this and use it. Pablo Cassals often said that he had to teach his hands the C Major scale again every morning. Runners don't start a marathon race by running, they start by stretching and flexing. Have you considered reviewing your Fourier and Laplace transforms lately?

Don't Get Stuck

In the forward to Al Chung-liang Huang's book, "Embrace Tiger, Return to Mountain", he speaks of an ex-pupil visiting and complaining "...you have changed this...". The reply was "Yes, of course; I move on and beyond..., and how did you get stuck back then and there?" The lesson is, unless you are helping move the subject forward and opening new approaches, you need to occasionally review what you were taught and see if there are better ways of doing it that have been developed while you were away.

If it has been a while since you actively studied a subject with a master, it is a good idea to revisit a class, or attend a lecture, or a symposium on the subject to find out what has developed recently that may help you in your work. Yeah, the basics are the basics, but better methods of getting to the answer are always surfacing. It makes sense to find out about them when you have a chance. I suspect that this is one reason why Maqsood Mohd's EMC fundamental tutorials are so popular with 'senior' EMC engineers at the annual EMC Society symposia.

And, to Really Make it Stick...

I recently saw data regarding how much of a class content is retained by students given differing levels of class participation. To restate it again:

- 20% Lecture only.
- 40% Perform as an exercise.
- 70% Apply it directly in your work.
- 90% Teach it to someone else right away.

Obviously the jump from 20 to 40 percent is why we do homework for a class. If we can find immediate practical use we can reach the 70 percent mark. But, best of all is returning from a learning experience and finding someone to whom you can teach what you've learned.

I believe that I have mentioned in the past that teaching is like magic. You can give away all you have, and still have it all, and it gets clearer in the process. Plus you have the extra benefit of having more people understand what you just taught. It's wonderful!

Follow Your Nose

Again, let me state this as clearly as I can. Study what interests you. "Follow your nose" as the old adage states. You have a natural compass in your gut that can lead you to

what you need, can use, can benefit from. It is there to help and guide you. Trust it! Your natural inclinations will not lead you astray.

This is not to say that you, or anyone else, may be able to tell what the subject that you are interested in today will have for you that will benefit you tomorrow. The path will not always be clearly marked. But it will be clearly felt. I am reminded of the question that foreign travelers in Tibet are greeted with on the road: "Which of the great paths are you following?" The question was not referring to the road they were walking on that day, but to the spiritual journey that Tibetans assumed everyone was taking in life. They believe that there were many 'paths'; Buddhism, Tao, Christianity, Mohadism, Shinto, etc.... They also knew that they all lead to the same place, enlightenment. For the Tibetan, since all paths lead to the same place, all are equally honored.

With your studies also, expect that all paths will eventually lead to enlightenment. If you are learning what you are interested in, then you are on the right path for you.

Learning that Benefits All

So the individual within an organization is learning and growing. How does that help the organization? Earlier I mentioned that one of the objectives of learning is increased flexibility and range. That ability to adjust to new conditions, situations, and requirements helps the individual in the organization accept and adapt to change. If it becomes necessary to sustain a mental drive to a solution for the organization, a staff with increased mental stamina has what it takes to continue the effort when others would have given up. When the individual adapts, he learns new approaches and skills and inevitability passes them on to the rest of the organization. His success becomes the organization's success. They all win!

"Get a Life"

When we get to the end of all this discussion, what have we been able to conclude? I submit that point one is that learning anything serves the same function for the mind as muscular exercise serves for the body. Neglect either at your peril.

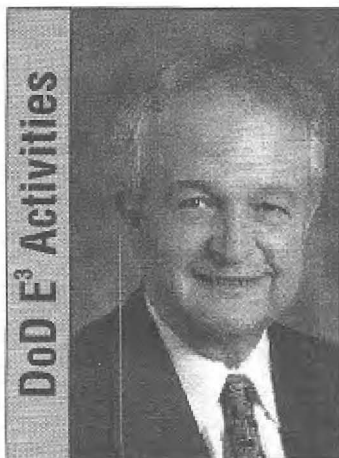
Second, that no one can predict what subject will benefit the individual, more than the individual themselves. And, since the organization as a whole has no more insight into the future than any of the individuals that make it up, the choice of what to study is best left to the individual.

Finally, any learning, no matter how divergent it appears to be to the goals of the organization, will eventually benefit the organization as the individual learns, grows and evolves. In the slang of a few years ago, as your learning benefits you, you "get a life" in that you are walking your own 'path' to enlightenment.

"May we both work together with great energy."

"May our study be thorough and fruitful."

From the "Vedas"



BOB GOLDBLUM
ASSOCIATE EDITOR

As I reported in my initial article, which appeared in the Summer 1997 issue of the EMCS Newsletter, the Joint Spectrum Center (JSC) is, among other things, the lead DoD Standardization Activity for EMC standards. Since a great deal of effort has been placed on the area of harmonization of military and civilian E3 standards over the past two years, I thought that I would devote this article to it, specifically the role and activities of the Defense Industry EMC Standards Committee (DIESC).

In accordance with the policy established by the June 94 memo of then Secretary of Defense Perry, the DoD started a program to maximize the use of commercial equipment (CI) and non-development items (NDI). As a result, the DoD was forced to evaluate the commercial E3 standards which these equipments are usually required to meet. For example, since the Federal Communications Commission (FCC) is only concerned with controlling conducted and radiated emissions over a limited frequency spectrum, it did not provide much of a challenge in terms of a comparison to the MIL-STD-461D/462D requirements usually called out in military equipment procurement specifications. The European Norms (ENs) developed under the auspices of the International Electrotechnical Commission (IEC) offered a wide range of differing EMI control and test requirements which lend themselves to comparisons with MIL-STD-461D/462D requirements and test procedures. Considering that most American products are designed to be shipped to Europe and must meet the European EMC requirements, the DIESC focused on comparing the MIL-STD-461/462 EMC requirements with the IEC requirements as well as other industry standards to determine whether or not the commercial requirements were suitable for military applications. These comparisons were based upon the application, the test methodology, test instrumentation and the test limits of the requirements.

The DIESC is co-chaired by Mr. Stephen Caine, JSC Director of Plans and Programs, and Dr. Ralph Showers, chairman of the American National Standards Committee C-63. Membership on this Committee is diverse, with government representatives from the Army, Air Force, Navy,

Defense Special Weapons Agency, Joint Spectrum Center and NASA. Industry representation was from the SAE AE-4, EIA G-46, NEMA, and the IEEE, ANSC-63.

The committee realized that the military environments were very severe, with some radiated susceptibility criteria exceeding the MIL-STD-461 level of 200 V/m by as much as 20 dB or more. Thus, it was assumed that some of the limits in the IEC requirements would not meet the needs of the DoD. On the other hand, if the test methods were satisfactory, there could be some harmonization between the two sets. Ad hoc committees were set up to study each of the MIL-STD-461 requirements and to compare them to the related industry requirements.

Studies were performed, reports were prepared and discussions concerning the results were conducted during the DIESC Committee meetings. This work is still ongoing and is expected to be completed by June 98.

The results of this effort will be twofold. First, an Acquisition Guidance Handbook for DoD Procuring Activities will be prepared for use as a reference when purchasing commercial equipment and determining its suitability for use in military applications and environments. The handbook will show comparisons between applicable commercial and MIL-STD-461/2 requirements. A draft of the Acquisition Guidance Handbook will be circulated to limited DoD activities in early 1998.

The second result will be an ongoing series of recommendations to the ISO, IEC, and other standards authorities on how the differences between the military standards and the commercial standards can be resolved to reflect a more universally-acceptable set of standards. This effort could signify the first step towards a worldwide EMC standard (a concept which I have long championed).

The work performed by DIESC is both timely and comprehensive and will be shared with the rest of the EMC community in an appropriate manner. With the additions of Korean, Australian, and other national EMC regulations, the work of DIESC could be perpetual.

I would like to remind those interested in DoD E3 activities that a Joint E3 Bulle-

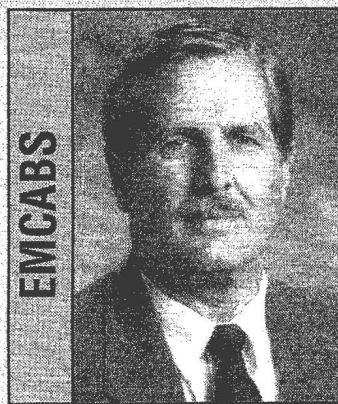
tin is available at no charge. Subscription applications can be obtained on www.RBitem.com. All applications are subject to approval by Mr. Marcus Shellman of the Joint Spectrum Center (JSC/J52) (shellman@jsc.mil).

The DoD is also planning its annual E3 conference, officially referred to as the DoD E3 Program Review at the Omni Rosen Hotel in Orlando, Florida, from April 6 -10, 1998. Service meetings will be conducted on Monday, April 6. The DoD E3 program reviews will take place on Tuesday through Thursday, April 7-9, and will include a tour of the NASA facilities at the Kennedy Space Center.

Specific topics to be addressed include modeling, simulation, data bases and international programs. A half-day session will be designated to specifically address E3 issues during the acquisition process. This session is a must for program managers, acquisition managers and their E3 staffs. Additional information, available at www.jsc.mil and www.RBitem.com, will also be published in the Joint E3 Bulletin. The complete program will be mailed to the Joint E3 Bulletin subscribers. Information can also be found on the referenced web sites.

In my next article, I will focus on the results of the DoD E3 Program Review and other aspects of the DoD Joint E3 Program being implemented by the JSC. I will also provide a status report on DIESC activities. Readers are invited to send their comments to me at the address shown on page 3 of this Newsletter.

Written inquiries are preferred over telephone calls. Let's keep in touch.



WILLIAM H. MCGINNIS
ASSOCIATE EDITOR

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

EMCAB COMMITTEE

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

"HOW CAN I GET A COPY OF AN ABSTRACTED ARTICLE?"

Engineering college/university libraries, public libraries, company or corporate libraries, National Technical Information Services (NTIS), or the Defense Technical Information Center (DTIC) are all possible sources for copies of abstracted articles or papers. If the library you visit does not own the source document, the librarian can probably request the material or a copy from another library through interlibrary loan, or for a small fee, order it from NTIS or DTIC. Recently it became clear that EMCABs were more timely than publications which were being listed in data files. Therefore, additional information will be included, when available, to assist in obtaining desired articles or papers. Examples are: IEEE, SAE, ISBN, and Library of Congress identification numbers.

Also, the steering staffs of the Japan Technical Group and the EMC Japan Tokyo Chapter have offered to act as a central point for requests of papers abstracted here. Most of the papers will be available in Japanese only. Abstracts of papers from EMC Japan will be clearly identified. 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: sfujiwara@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 my attention at my address shown on page 3 of this Newsletter. 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.

TIME QUANTITY ONE-CYCLE CONTROL FOR POWER-FACTOR CORRECTORS

Z. Lai, K. M. Smedley, Y. Ma
Department of Electrical and Computer Engineering,
University of California, Irvine, CA
IEEE Transactions on Power Electronics Vol. 12, No. 2,
March 1997, pp. 369-375

EMCABS: 01-2-98

Abstract: The use of dc-dc converters for active input current shaping is documented in the references. The method disclosed has advantages of operation at a constant switching frequency and a simpler control than previously described ac-dc converters.

The one-cycle control technique is adopted in a boost converter to modulate the pulse width. The result is a power supply that presents a resistive input resistance to the line and substantially reduces total harmonic distortion to less than 3%.

Index Terms: Switching converters, power factor correction, harmonic reduction

ANTENNA ARRANGEMENTS FOR BROADBAND EMI ANTENNA CALIBRATION

Takuya Nagai, Akira Sugiura, Yukio Yamanaka, and Takashi Iwasaki
EMC-Japan meeting at Kikai-Shinko-Kaikan, Tokyo
July 17, 1997, EMCJ97-26

EMCABS: 02-2-98

Abstract: To improve the accuracy of antenna calibration for broadband EMI antennas, theoretical and experimental studies are made on possible causes of the calibration errors. The accuracy is found to be seriously affected by (1) the uniformity of the field in which an antenna under calibration is immersed, (2) the directivity of the antenna in the vertical plane, (3) the directivity in the horizontal plane, (4) the mutual coupling between the transmit and receive antennas, and (5) ambient noise. Taking these error factors into consideration, the most appropriate antenna arrangements are determined to achieve antenna calibration with an accuracy of better than 0.5 dB at 300 MHz. *Index terms:* Antenna calibration, EMI antenna, biconical antenna, log-periodic dipole array antenna, directivity, moment method

INPUT IMPEDANCE OF EQUIPMENT HOUSING WITH AN APERTURE FOR EMI ESTIMATION INSIDE THE HOUSING

Yusuke Hamada, Hiroaki Kogure, Hideki Nakano, Kohji Koshiji, and Eimei Syu
EMC-Japan meeting at Kikai-Shinko-Kaikan, Tokyo
July 17, 1997, EMCJ97-29

EMCABS: 03-2-98

Abstract: Resonant modes inside equipment housing with an aperture are analyzed by TLM method for EMI estimation inside the housing. The analyzed resonant frequencies agree well with the measured frequencies. Ideal cavity without aperture has an infinite number of resonant modes. However, some modes of them in the housing with an aperture are disappeared by existence of the aperture. This means that resonant modes excited through the aperture can be specified under consideration of dimension and position of the aperture. The input impedance of the housing inside through the aperture is also analyzed by TLM method, since the input impedance is indispensable for the magnitude estimation.

Index terms: Equipment housing, aperture, TLM method, resonant mode, EMC

COMMENTS ON EPIDEMIOLOGIC PAPERS RELATED TO CHILDHOOD LEUKEMIA AND MAGNETIC FIELDS OF POWER LINES (PART 2)

Yoshifumi Amemiya
EMC-Japan meeting at Kikai-Shinko-Kaikan, Tokyo
July 17, 1997, EMCJ97-33

EMCABS: 04-2-98

Abstract: The Swedish investigation of epidemiology, which has been carried out on cancers in children residing near high-voltage power lines in and around Stockholm County during 1960-1985, shows us the conclusion that there is significant association between the historical magnetic fields calculated and childhood cancer. Employing its data of the stratum-specific analyses, we can find out the following facts on cases associated with the magnetic fields: none in children diagnosed 1960-74 in and around Stockholm County; ones, diagnosed 1975-85 only around its County. They show that the association is not consistent in the periods and areas considered. Therefore, the association is not a causal relation, and the conclusion which suggests that the same association is to be observed everywhere is not valid.

Index terms: Magnetic field, childhood leukemia, cancer, Karolinska, epidemiology, National Academy of Sciences

AN IMPROVEMENT OF INPUT PROPERTIES IN A SLOT-COUPLED MICROSTRIP ANTENNA WITH A PARASITIC STRIP

Kohichi Ozaki, Manabu Yamamoto, and Kiyohiko Itoh
EMC-Japan meeting at Hokkaido University, Hokkaido
September 26, 1997, EMCJ97-34

EMCABS: 05-2-98

Abstract: In a slot coupled microstrip antenna with a triplate line feed, the parallel plate mode can be successfully suppressed when the antenna is operated at the series resonant frequency of the radiating patch. However, the antenna has low input resistance in this case. In this report, we perform analytical considerations on the input properties of the antenna to achieve high input resistance at the series resonant frequency. Numerical results indicate that input resistance is decreased because of the inductive effect due to the slot. Then we propose the use of a parasitic strip to cancel the inductive effect and confirm the increase of the resistance.

Index terms: Slot-coupled microstrip antenna, triplate line, parallel plate mode, series resonant frequency, parasitic strip

A MAGNETIC PROBE WITH MULTILAYER STRUCTURE FOR HIGH SPATIAL RESOLUTION

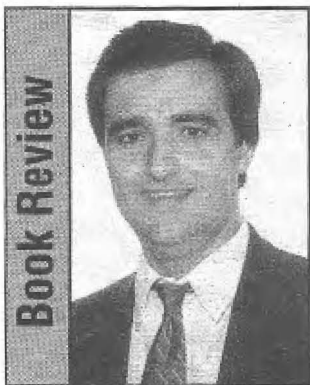
Naoya Tamaki, Norio Masuda, and Masahiro Yamaguchi
EMC-Japan meeting at Hokkaido University, Hokkaido
September 26, 1997, EMCJ97-36

EMCABS: 06-2-98

Abstract: This paper describes a shielded loop probe with multilayer structure for high spatial resolution to measure magnetic fields near a trace on surface of printed circuit boards (PCBs). The probe is fabricated with four layer PCBs. According to replacing a coaxial cable of the conventional probe by a strip line, it can acquire smaller loop size and shorter distance between the probe and the trace in comparison with the conventional probe. The spatial resolution is evaluated by measuring magnetic field distribution above the trace. It is indicated that the probe has over twice spatial resolution than the conventional probe.

Index terms: PCB, magnetic fields, high spatial resolution, multilayer structure, shielded loop probe

<p>HF-UHF BAND ELECTROMAGNETIC MEASUREMENTS USING MULTI-LAYER PRINTED WIRING BOARD Sin Yabukami, Masahiro Yamaguchi, and Kenichi Arai EMC-Japan meeting at Hokkaido University, Hokkaido September 26, 1997, EMCJ97-37</p> <p><i>Abstract:</i> We have developed new microstrip line type pick up coil and shielded loop type coil, which are planar type pickup coil using by multi layer printed wiring board technique. Magnetic thin film permeability can be measured from 1MHz-3.5GHz range to take into account of electric field and impedance matching. We developed electromagnetic noise mapping system using by shielded loop type coil array. High resolution (0.1mm) and vector detection can be realized.</p> <p><i>Index terms:</i> Microstrip, shielded loop, magnetic thin film permeability, electromagnetic noise.</p>	<p>EMCABS: 07-2-98</p>	<p>EVALUATION OF APPLICABILITY FOR SEMI-ANECHOIC CHAMBER AS TEST SITE ABOVE 1GHZ Yoshinobu Hayashi, Takashi Shinozuka, Yasuo Hashimoto, and Risaburo Sato EMC-Japan meeting at Hokkaido University, Hokkaido September 26, 1997, EMCJ97-49</p> <p><i>Abstract:</i> Requirements of test site for EMI measurement above 1GHz are now under consideration. Only free-space condition comes to an agreement. The users of semi-anechoic chambers currently used below a semi-anechoic chamber, and then investigated the requirements to realize a free-space condition by covering the electromagnetic absorbers for widths greater than the first Fresnel zone are installed on the floor of the current semi-anechoic chamber, free-space conditions are satisfied within a precision level of 2dB for horizontal polarized waves and 2.5dB for vertical polarized waves.</p> <p><i>Index terms:</i> Measuring test site, semi-anechoic chamber, free space condition, height pattern site attenuation above 1GHz, electromagnetic absorbers</p>	<p>EMCABS: 10-2-98</p>
<p>STUDY ON RADIO ABSORPTIVE MATERIAL USING GRAPHITIZED CARBON Fumio Sakamoto, Yoshio Nikawa, and Masaru Chino EMC-Japan meeting at Hokkaido University, Hokkaido September 26, 1997, EMCJ97-42</p> <p><i>Abstract:</i> Radio absorptive materials in microwave and millimeter wave frequencies, which can be used for the hazardous EM radiation circumstances, have been studied. For the measuring frequencies from 40 MHz to 40 GHz, the materials dispersed graphitized carbon in silicone rubber are discussed. For the single layer radio absorptive materials, it is found that good absorptive characteristics can be obtained as long as narrow frequency band. Also, for the two layer radio absorptive materials, it is found that absorptive bandwidth can be obtained wider than that obtained for single layer radio absorptive materials.</p> <p><i>Index terms:</i> Complex permittivity, radio absorptive, graphitized carbon</p>	<p>EMCABS: 08-2-98</p>	<p>TWO-DIMENSIONAL AND HIGH-RESOLUTION NEAR FIELD NOISE MAPPING SYSTEM M.yamaguchi, S. Yabukami, K.Nakada, K.I. Arai, A. Itagaki, K. Itagaki, N. Saito, K. Fuda, M. Watanabe, H. Takahashi, T. Tamogami, and Y. Sakurada EMC-Japan meeting at Akita University, Akita October 27, 1997, EMCJ97-52</p> <p><i>Abstract:</i> We developed near field noise mapping system by using shielded loop type coil array. High resolution (0.1mm) and Two-dimensional magnetic field vector detection can be realized. We demonstrated the noise map of Loop antenna, microstrip line and printed wiring board of personal computer.</p> <p><i>Index terms:</i> Shielded loop, near field electromagnetic noise, high resolution, vector measurement</p>	<p>EMCABS: 11-2-98</p>
<p>DEVELOPMENT OF PHANTOMS AS A HUMAN MODEL AT MICROWAVE FREQUENCY Lira Hamada, Rong Wang, Yoshinobu Okano, Kazuyuki Sato, Keiichi Matsumura, and Koichi Ito EMC-Japan meeting at Hokkaido University, Hokkaido September 26, 1997, EMCJ97-43</p> <p><i>Abstract:</i> A lot of phantoms have been proposed as the human model for experimental evaluation of the effect between the human body and electromagnetic fields around. In this report, phantoms in two types are introduced as the human model realizing the same permittivity as biological tissue. First, the solid phantom for a model of human is described. Next, the characteristics of the liquid phantom composed of water and silicone emulsion have been introduced.</p> <p><i>Index terms:</i> Human model, phantom, complex permittivity, specific absorption rate</p>	<p>EMCABS: 09-2-98</p>	<p>FDTD COMPUTATION OF TEMPERATURE-RISE IN THE HUMAN HEAD DURING DAILY USE OF PORTABLE TELEPHONES Jianqing Wang, and Osamu Fujiwara EMC-Japan meeting at Akita University, Akita October 27, 1997, EMCJ97-60</p> <p><i>Abstract:</i> In this paper, temperature-rises in the human head for portable telephones were computed with an anatomically based head model. The specific absorption rate (SAR) in the human head was determined using the finite difference time-domain (FDTD) method, while a bioheat equation, which takes into account various heat exchange mechanisms such as heat conduction, blood flow and electromagnetic (EM) heating, was numerically solved also using the FDTD method. Computed results show that, for an uncontrolled environment, application of the ANSI/IEEE safety guidelines restricting the one-gram-averaged peak SAR to 1.6 W/kg results in maximum temperature-rises in the brain of 0.05 degrees centigrade at 900 MHz and 0.06 degrees centigrade at 1.5 GHz, and application of the ICNIRP/Japan safety guidelines restricting the ten-gram-averaged peak SAR to 2 W/kg results in maximum temperature-rises in the brain of 0.10 degrees centigrade at 900 MHz and 0.11 degrees centigrade at 1.5 GHz.</p> <p><i>Index terms:</i> Biological effects, SAR, temperature-rise, portable telephone, anatomically based head model, FDTD computation</p>	<p>EMCABS: 12-2-98</p>



RAY PEREZ
ASSOCIATE EDITOR

High Speed Digital Design: A Handbook of Black Magic

*Authors: Drs. Howard W. Johnson and
Martin Graham*

Publisher: Prentice Hall, 1993

Reviewer: R. Perez

The main objective of book reviews in the EMCS Newsletter is to let our readers know of the main features or salient points of EMC related books that have recently been published. Rarely, do we go back and review a book that has been published several years ago, because the normal thinking is that the book is already familiar to many of our readers. However, when I personally believe that a book is unique enough (and EMC related) to provide good material to those beginning in the EMC field, I "dust-off" such books from my personal library and will submit one to our editor as a review candidate.

This book was published in 1993 by an electronic digital designer in the industry for electronic designers. It is mostly a practical book, but theory, practical approaches and solutions are mixed in a unique way so as to make this book an excellent one in the art of teaching electronic design for built-in immunity to noise and interference. The material itself is not new, but the format when this book was published in 1993 is indeed new.

This book is highly recommended for those involved in analog and digital design (specially digital). If you call yourself an EMC engineer this book also is of great value to you and it would be an excellent companion to those more traditional EMC books that you may already have in your library.

Finally, this book is reviewed for the sake of those thousands of electronic engineers entering the job market who are at least aware of the importance of noise control in their future designs. This book should be of great benefit.

From a broad point of view, the book is divided into 12 chapters and three appendices. The first three chapters introduce analog circuit terminology, the high speed properties of logic gates, and standard high speed measurements techniques, respectively. The first three chapters form the fundamentals of this book and are very important in every serious consideration of high speed logic de-

sign. The remaining chapters (four through 12), each treat a specialized subject in high speed logic design. Appendix A collects highlights from each section and each chapter of the book, listing the most important ideas and concepts presented. The author thinks that it can be used as a check list for system design or as an index to the text when facing a difficult problem. Appendix B details the mathematical assumptions behind various forms of rise time measurements. This section helps relate results given in this book to other sources and standards of nomenclatures.

Appendix C lists a series of standard formulas used in the book and their MathCad implementation.

Chapter one's title is called "Fundamentals" and it addresses how passive circuit elements affect signal propagation interactions (ringing and reflections) between signals (or crosstalk) and interactions with the natural world (electromagnetic interference). The author begins the chapter with a study of high speed digital design and relationships among frequency, time, and distance. The empirical formulation of knee frequency is derived and the role of such frequency in the flat frequency response and the processing of short time events in digital circuits is discussed. The chapter also discusses the difference between lumped and distributed systems and the fact that the response of any system of conductors to an incoming signal depends on whether the system is smaller than the effective length of the fastest electrical feature in the signal. Four kinds of parasitic reactances are reviewed which are typical of high speed digital circuits: capacitance, inductance, mutual capacitance, and mutual inductance. The author provides diagnostic rules to instantly characterize which kind of reactance is present in the device under question. Two good sections in chapter one are the discussion of mutual capacitance among two circuits and the relation of mutual capacitance to crosstalk as well as mutual inductance and its role in crosstalk. These discussions are done in the time domain with examples and measurements. Chapter two addresses the high speed properties of logic gates.

All logic families exhibit trade off among power, speed, and packaging and this chapter looks at these issues in great detail. The chapter covers the study of power consumption of high speed logic circuits in the four main categories: input power, internal dissipation, drive circuit dissipation, and outer power delivered to the load (quiescent power is also introduced briefly). Many examples are discussed and numerous handy simple formulas are derived which I personally found very useful when deriving the need for "power budgets" in my PCB designs. The important subject of logic speed is also covered in chapter two. Theoretical digital logic designs focus on the propagation delay of logic gates. Practical problems in high frequency, however, often depend solely upon a more subtle specification: the minimum output switching time. Faster switching times cause proportional increases in problems with return currents, crosstalk, and ringing that are independent of propagation delay. Logic families having minimum switching times much faster than the propagation delays suffer unnecessary penalty in system design because the device packaging, board layout and connectors must accommodate fast switching times while the logic timing benefits only from propagation delay. The chapter effectively discusses the two distinct mechanisms which can cause problems in fast switching times IC: effects created by sudden changes in voltage and effects created by sudden changes in current. The very important and related subject of voltage margin is generously discussed also. One of the most important sections in the book is the last section of chapter two where a thorough review of the subject of packaging is given. This is even more important in these days where the number of packaging schemes is growing greatly to accommodate even more faster ICs and the fact that packages at high logic speeds suffer from problems with lead inductance, lead capacitance, and heat dissipation.

Chapter three deals with the limitations of scientific instruments in making digital measurements. This chapter describes not only real world problems in making accurate measurements with the oscilloscope, but provides a great deal of examples, tips, cautions, and formulas that make this chapter extremely useful (it has been for this reviewer). If you are an EMC engineer that works frequently with compliance testing, this chapter should be a good companion for you and should be put together in a binder with those chapters, that you probably already have, dealing with measurements in the frequency domain using the spectrum analyzer. Chapter four addresses the analysis of transmission lines in the time domain. The chapter compares the use of transmission lines in logic circuits versus the old method of point to point wiring. Transmission lines provide less distortion, less radiation, and less crosstalk; the price paid, of course, is that more driving power is needed. The chapter compares and gives examples of signal distortions, radiation and crosstalk problems arising from point to point wiring, and the benefits when compared to the use of transmission lines. The material covered con-

cerning transmission lines is typical of that covered in other electromagnetic books such as the infinite uniform transmission line, the low-loss transmission line, skin effect, frequency response in the skin effect region, and dielectric effects (including losses). Any combination of practical source and local impedances connected to a real transmission line will degrade its performance. This degradation may be slight or it may be devastating, depending upon the particular source and local impedances used with the transmission line. Therefore, in chapter four considerable attention is paid to the effects of source and local impedances in such topics as reflections, end and source terminations, settling time in poorly terminated lines, high and low source impedance with unterminated lines, capacitive loading, uniform loaded lines, and right angle bendings. The chapter ends with a good discussion on the different relationships between impedances and propagation delays.

In chapter five, it is noted that ground and power planes in high speed digital systems perform three critical functions: provide stable reference voltages for exchanging digital signals, distribute power to all logic devices, and control crosstalk between signals.

The first approach is to assume short traces for which lumped analysis and mutual inductance is appropriate, later the traces are treated as long lines where separate coupling into its forward and reverse parts are applied. The chapter ends with summary rules for designing good printed circuit board layer stacks for the control of crosstalk. The author outlines a handy group of empirical formulas that are reasonably accurate and several measurement exercises and examples are outlined. Chapter six addresses the very important subject of terminations. This chapter has also been very useful to this reviewer. When a line is such that cable length exceeds about one sixth of the electrical length of a rising edge, the cable needs terminations. Without terminations, reflections at either end of a long cable renders signal transmission impossible. When a line is short it may still need terminations if it is driving capacitive loads. This chapter addresses three main topics: comparison of ends versus series terminations, selection of appropriate terminating resistors, and crosstalk among terminating components. Chapter seven covers vias. The term via commonly refers to a hole in a printed circuit board. A via can be used for mounting a through-hole component or for routing traces between layers. The only difference, from our point of view, is that during assembly a through hole has one leg of a component soldered into it, while a trace routing via remains empty. The chapter covers mechanical properties of vias, capacitance and inductance of vias and current return and its relation to vias.

The very important subject of power distribution in digital systems is discussed in chapter eight. This chapter describes how power systems provide stable voltage references and distribute power. The need and pitfalls encountered in providing a stable voltage reference is discussed with examples in the chapter. Power "rules" are outlined

for the designer. Power distribution problems encountered in the process of supplying uniform voltage are also discussed in this chapter. Topics such as resistance, inductance of distribution wiring and board level filtering using bypass capacitances are discussed in good detail. Procedures for using bypass capacitance arrays are discussed as well as procedures for using bypass capacitance in different design scenarios. A very novel chapter is chapter nine, which discusses the subject of connectors. Chapter nine examines connector properties which are important in high speed digital design. After reading this chapter, you will know what properties are important in your application and how to test a connector system. The primary electrical factors discussed concerning high performance in connectors are: how connectors create crosstalk (a mutual inductance effect), how series inductance slows down signal propagation and creates electromagnetic interference, and how parasitic capacitance slows down signal propagation. The chapter provides many illustrations and examples. The chapter ends with the resolution of EMI problems in connectors using filtering and shielding. Chapter 10 is an extension of chapter nine, but specifically addresses ribbon cables. The term ribbon cable refers to any cable having multiple conductors bound together in a flat wide strip. Ribbon cable wiring always runs parallel to each other at precisely controlled separations. The chapter covers ribbon cable signal propagation and ribbon cable crosstalk. Formulas and measurement techniques are provided. The chapter ends with proper design of ribbon cable connectors.

Chapters 11 and 12 cover clock distribution and clock generation respectively. Not only are clocks the fastest signals, but they are also the most heavily loaded. Clocks connect to every flip flop in a system, while individual data wires fan out to only a few devices each. Chapter 11 provides special attention to clocks. The chapter examines clock drivers, special clock routing rules, and peculiar circuits used to improve the distribution of clock signals. The very basic but extremely important subjects of time margins and clock skew are discussed first. This material is followed by a discussion on the usage of low impedance drivers and low impedance distribution lines. Brief introductions are provided concerning source termination of multiple clocked lines and how to control crosstalk in clock lines. A fairly good discussion on delay adjustments for eliminating clock skew is also provided in the chapter. Chapter 11 ends with methods for canceling parasitic capacitances of clock repeaters. Chapter 12 covers clock oscillators. Standard industry practice has shifted from designing oscillators to specifying oscillators. Chapter 12 focuses on how to properly specify and use oscillators and crystals; this includes frequency specifications, allowed operating conditions, electrical and mechanical manufacturing issues and reliability. Finally, the subject of clock jitters (deviations of clock output transitions from their ideal position, mostly caused by amplified noise) is discussed in good detail.

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, mail and e-mail communications. Nominees must be full members of the IEEE and members of the EMC Society. Elected Directors must serve a three-year term starting January 1, 1999. Attendance at the last meeting of the 1998 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:

Bill Gjertson
Boeing Information, Space Defense Systems
P. O. Box 3999; M/S: 8H-10
Seattle, WA 98124
Telephone: (253) 773-3482
Fax: (253) 773-4173

Submissions must be postmarked no later than May 31, 1998. Information can be obtained from Mr. Gjertson 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, 1999.

MEMBER'S NAME (PRINT)

SIGNATURE

MEMBERSHIP NUMBER

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____



DR. WILLIAM G. DUFF
ASSOCIATE EDITOR

William Eugene Cory (Gene) served in the US Navy from April 1945 to July 1946 where he attended Captain "Eddy's" Radar Technician Course. He graduated from Texas A&M with a Bachelor of Science in Electrical Engineering in January 1950. In September 1959, Gene received the Master of Science in Engineering from the University of California at Los Angeles. He has completed additional studies in Mathematics and Economics at Trinity University in San Antonio. In June 1950, he applied for and received a direct commission as a 2nd Lieutenant in the U.S. Air Force. He retired as a Major after completing 20 years of satisfactory military service, mostly in a reserve capacity.

In January 1950, he joined the U.S.A.F. Security Service, where he conducted analyses of secure communications requirements of major Air Force Commands and designed special equipment. He also served as a project officer on what is now known as Tempest, including serving on the JECE committee tasked to establish national Tempest policy. He also served on the Tri-Service committee on IFF problems. In 1952, he was promoted to Chief, Ciphony and Cifax Division. Gene received a Special Service award and had one patent application filed, which was declassified and issued in 1981.

In 1957, Gene took a position as Electronic Systems Engineer with Lockheed Aircraft Company at Burbank, California. He was responsible for communications, navigation and identification on the advanced weapons development team. Programs that Gene worked on included CNI preliminary design on Airborne Early Warning, Anti-Submarine Warfare, Interceptor and Fighter-Bomber weapons systems. He transferred to Lockheed in Marietta, Georgia as an Aircraft Development Engineer Specialist. Programs included a Bomber-Navigator Trainer using the Lockheed Jet Star and a Lockheed version of the Army Mohawk.

In 1959, Gene returned to San Antonio, where he joined Southwest Research Institute (SWRI) as a Senior Research Engineer. He was promoted to Manager, Communications Section in 1961, Director, Electronic Systems Department in 1965, and Vice



President, Electronic Systems Research Division in 1972. Responsibilities included technical, management and promotion of R&D in the fields of Automation, Bioengineering, Communications, Data Systems, Electromagnetic Compatibility, and Earth Sciences. Gene retired from SWRI in 1989.

He is presently managing his own company, Cory Consulting, where he provides consulting services in research management, electromagnetic compatibility and electromagnetic bioeffects.

Gene has received seven patents and authored nineteen papers and numerous technical reports, many on EMC subjects.

He has had the privilege of serving the IEEE and EMC Society in over 50 capacities including: Member, IEEE Board of Directors; Director, IEEE Region 5; President, IEEE EMC Society; Member, IEEE EMC Society Board of Directors; General Chairman, 1975 IEEE EMC Symposium; Organizer and Director, MIDCON. He has also served on the National Research Council's Electromagnetic Pulse Environment Committee, the National Research Council's Electronics and Electrical Engineering Panel, Board of Assessment of the National Institute of Standards and Technology, and the USAF Aeronautical Systems Division's Advisory Group on Pave PAWS Electro-Explosive Device Safety.

Gene has received many awards, including the IEEE Fellow Award for "contributions in the fields of electromagnetic compatibility and systems analyses", the IEEE EMC Society Lawrence C. Cummings Award for "outstanding service to the EMC Society as President, Committee Chairman, and a member of the Board of Directors", and the IEEE EMC Society Richard B. Stoddard Award for "contributions to the low frequency near-field measurement technology for the evaluation of the effects of electromagnetic energy on the environment."

Gene and his wife Doris have a son, Bill, and a daughter, Karen, and three grandchildren. They enjoy attending theater performances and World Affairs Council lectures and travelling. Gene's hobbies include chess, stamp collecting and science fiction.

EMCS Board of Directors Activities

Janet O'Neil

The fourth and final meeting of the EMC Society Board of Directors in 1997 was held on Saturday, November 8 in conjunction with the IEEE TAB/RAB meetings held at the Marriott Marquis Hotel in Atlanta, Georgia.

Attending the Board meeting were officers President Bill Gjertson, Vice-President Dan Hoolihan, Treasurer Warren Kesselman, Secretary Janet O'Neil, and Board members Don Sweeney, Joe Butler, Andrew Podgorski, Kimball Williams, Len Carlson, Bill Duff, Bob Hofmann, Todd Hubing, Norm Violette, Bill Ritenour, Herb Zajac, Jim Muccioli, Andy Drozd and Dick Ford. Board members absent included Don Heirman, Franz Gisin, and Bill McGinnis. Guests in attendance included Henry Benitez and Mark Montrose (who were recently elected to the Board for three year terms beginning in January 1998), Barry Wallen, Hugh Denny, Bruce Crain, Steve Berger, Dave Traver, and John Osburn.

The meeting was called to order at 8:30 am by Vice President Hoolihan. (President Gjertson was unavailable for the morning of the meeting due to a conflict with a TAB meeting.) A round of introductions was made. Secretary O'Neil presented the minutes of the prior Board meetings in August which were approved as amended. Treasurer Warren Kesselman distributed a report summarizing EMC Society financial activity. The 1997 operating summary (as of September 30, 1997) showed an income of \$237K with expenses of \$249K. Net worth of the Society as of September 30, 1997 is \$568K. The value of the Society's long term investments has steadily risen since June 1996. The Treasurer's report was accepted as presented.

The Director for Member Services, Todd Hubing, next presented his report. He noted that Ray Adams, Chapters Coordinator, reports that there is a new Central and South Italy Chap-

ter chaired by S. Celozzi with A. Orlandi as Vice-Chairman.

Keith Galbraith is attempting to set up a new chapter in the Binghamton, New York area. Scott Roleson, Chairman of the Distinguished Lecturer Program, is working on a proposal to establish a new program in Europe. This proposal will be presented at the next Board meeting. Gene Cory is the new Chairman of the Fellows Search Committee, replacing Bill Duff. Mr. Hubing noted that Steve Mullenix, Membership Committee Chairman, received word from the IEEE that membership in the EMC Society currently totals 5,243. This represents a 4% growth in membership since August 1996. Warren Kesselman, Chairman of the Nominations and Bylaws Committees, announced that a total of 908 ballots were returned to the IEEE for the recent EMC/S Board election (some 20% of the membership voted). The results of the ballot indicated three Board members were re-elected (Hubing, Sweeney, and Williams) and the newly elected Board members included Henry Ott, Mark Montrose, and Henry Benitez from the USA. Also elected to represent the international membership per a recent by-laws change were Ferdy Mayer (France) and Takeo Yoshino (Japan).

The Director for Communication Services, Len Carlson, next presented his report. He introduced Ms. Michael Ann Ellis, Ms. Roseann Cary, and Mr. James Howard of IEEE Travel and Conference Management Services.



Past, Present and Future IEEE Division IV Directors are pictured at the dinner following the Board of Directors meeting in Atlanta, Georgia. Len Carlson (L) was the "past," Bill Duff (C) is the "present," and Bill Gjertson (R) is the "future" Division IV Director.

Photo by Janet O'Neil

Ms. Ellis was invited to give a 45 minute presentation on her department's capabilities in handling the annual EMC/S symposia. Concern has been expressed by regional symposia committees that the EMC/S symposia are getting too large to be run effectively entirely with volunteers. The Board is thus exploring options available with having the IEEE handle all or a portion of the administrative functions of the symposia. Following the IEEE presentation, John Osburn, Chairman of the Austin 1997 Symposium, gave a report summarizing activity in Austin. The Board thanked Mr. Osburn and his committee for a job well done in Austin. Barry Wallen, Chairman of the Denver 1998 Symposium, followed with a report on activity to date for the upcoming symposium. Mr. Carlson reported that Chet Smith continues his efforts with the CD ROM program. Sales of the CD ROMs were strong at the Austin Symposium and the non-member pricing was effective in recruiting new members. Regarding the EMC/S Newsletter, editor Janet O'Neil distributed a report indicating that more practical papers will be solicited for publishing in 1998. The Board approved the distribution of the Newsletter electroni-



Photo by Janet O'Neil

Atlanta resident and former EMC Society President Don Clark of the Georgia Tech Research Institute and his wife Edith joined the Board at their November dinner.

cally in 1998. The Newsletter will be available in the html format on the EMC Society Web Page starting with the first issue in 1998. Moto Kanda, Transactions Editor, reports that the publication is budgeted for four regular issues and one special issue in 1998. Some fifteen authors have been secured for a special issue on lightning for publication in the summer/fall of 1998. Mr. Carlson presented a proposal to publish an EMC Society magazine similar to that published by the IEEE Antennas and Propagation Society. The Board supported this proposal and encouraged Mr. Carlson to proceed with this effort.

Following the lunch break, Warren Kesselman, Nominations Chairman, presented the nominations slate for the 1998 Board of Directors officers. Those elected included: Dan Hoolihan, President, Don Heirman, Vice-President Standards, Todd Hubing, Vice-President Member Services, Kimball Williams, Vice-President Technical Services, Len Carlson, Vice-President Communication Services, Janet O'Neil, Secretary, and Warren Kesselman, Treasurer.

Joe Butler chaired an ad hoc committee which studied the reorganization of the Board and the creation of the new Vice-President positions. He

Vice-President Standards include a new committee entitled Standards Advisory Committee (SAC) consisting of the following RAC committees: CISPR A, CISPR B, CISPR E, CISPR G, ANSI C63, SAE Automotive EMI and EMR, SAE AE-4, ESD Association, EIA G-46&Commercial, RTCA, ASTM D09.12.14, ASTM E06.53, ESTI TC ERM, CENELEC WG1 SC 110 & 210A, IEC TC 77 WG3, IEEE Metric Policy, and ISO TC 22 SC3 WG3. The SSIT committee will be placed under Vice-President Technical Services as part of the RAC. The Board accepted the recommendations of the ad-hoc committee. Further, the Board requested that Mr. Butler continue to study the need for committee reorganization as part of the long range planning process. Mr. Butler agreed to chair an ad hoc committee formed for this purpose.

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 two

presented his committee report which recommended that the Survey, International Committee and PACE Coordinator committees be placed under the Vice-President of Member Services. The Public Relations committee will be placed under the Vice-President Communication Services. The committees to be placed under the

international EMC conferences in 1998. PACE chairman Al Mills proposed having a special PACE session at the national EMC/S symposia with invited speakers. The Board requested that Mr. Mills formalize this proposal for presentation at the next Board meeting. Lastly, Public Relations chairman Herb Zajac advised that the new EMC/S promotional video is now available in VHS, PAL and SECAM formats.

The Director for Technical Services, Joe Butler, next presented his report. Mr. Butler reported for Don Heirman, chairman of the Standards Committee, who was unable to attend the Board meeting. At the Standards Committee meetings held in August during the Austin symposium, 27 people attended the first meeting devoted to organization, policy and procedures and general Standards Committee operations. 18 people attended the second meeting which concentrated on the current status of standards. Mr. Heirman is encouraged by this interest in the Standards Committee. Kimball Williams reported as Chairman of the Education Committee. Notable activities involved the NARTE, Tutorials, and Demonstrations committees; each committee prepared a program for the 1997 EMC Symposium in Austin and is planning a program for the 1998 EMC Symposium in Denver. Due to the growth in attendance at the tutorials, there are plans to allow for 300 to 400 participants at the tutorials held



Photo by Janet O'Neil

Elizabeth and Andrew Podgorski of Ottawa, Canada particularly enjoyed the relatively warm Atlanta climate in November during the Board of Directors activities. Mr. Podgorski is the new Technical Activities Committee (TAC) Chairman.

in conjunction with the Denver 1998 Symposium. Chicago Chapter member Don Sweeney will present the 1997 University Grant Award at the November chapter meeting to Dr. Vincent P. McGinn of the Northern Illinois University in DeKalb, Illinois. The Standards Education Committee is considering organizing a workshop for the Seattle 1999 Symposium which will provide an introduction to standards with an overview of the standards community, an introduction to the standards process and updates on where the major standards are moving.

Mr. Williams summarized his report by noting that the Education Committee is committed to implementing a program of planned officer progression throughout all the Education Committee subcommittees. A rewrite of the committee policy and procedures is now in progress. In the review of the Technical Activities Committee (TAC), the Board agreed to expand the focus of TC-7 (Nonsinusoidal Fields) to include materials. 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.

As the EMC/S representative to COMAR, Dan Hoolihan requested that the EMC/S agree to be a reviewing source for the National Science Foundation's reports on non-ionizing radiation. The Board agreed to assist as necessary.

Dan Hoolihan, Vice President and custodian of the EMC/S Long Range Plan, reviewed each Service Directors' progress in addressing the plan. First, he distributed copies of the 1996-2000 EMC Society Plan (Revision dated November 4, 1997). He requested that the newly elected Vice Presidents incorporate three year budgets into this plan. The goals of the plan address career enhancement, globalization, organizational improvement, products and services, and public responsibility.

Under Old Business on the agenda, the Board discussed the TAB Intelligent Transportation Systems Ad Hoc Committee per the report of Andy Drozd. Mr. Drozd attended one of their committee meetings in June 1997. The committee is attempting to become a technical council within the IEEE and is soliciting Society memberships for a fee. Mr. Drozd agreed to work with the Chairman of this committee to see how the EMC/S can best contribute to their efforts as well as be assured that there is minimal risk associated with any financial commitments. He will attend their next meeting in February 1998 and will report his findings at the next Board meeting.

Under New Business on the agenda, the Board discussed the Board meetings for 1998. These were proposed and subsequently scheduled as follows: April 27 in Seattle, Washington, August 23 in Denver, Colorado in conjunction with the IEEE EMC Symposium, September 18 in Rome, Italy in conjunction with the EMC'98 Roma conference, and November 14 in Pis-

cataway, New Jersey in conjunction with the IEEE TAB/RAB meetings.

Lastly, President Gjertson discussed the activities at the recent IEEE TAB/RAB meetings he attended. He distributed the 1998 and 1999 TAB meeting dates and welcomed those interested to attend. This being the last meeting under President Gjertson, the gavel was officially passed to the newly elected President, Dan Hoolihan. The Board then gave Mr. Gjertson a round of applause for a successful two year term as President of the EMC Society.

There being no further business, the meeting adjourned at 5:00 pm.

Later that evening, the Board held their traditional November dinner at Anthony's restaurant in the Buckhead area of Atlanta. The new Board members were "officially" welcomed at this dinner while the outgoing Board members were "officially" thanked for their years of service to the Board. The Board also celebrated the election of its new officers for 1998.

A Colloquium and Exhibition | **EMC '98**

Product Compliance Understanding the Fundamentals

Monday, June 1, 1998

Westin Santa Clara, CA

Technical Program Covers:

Fundamentals of EMC

Leading Edge EMC Design Guidelines

EMC/Product Safety/Telecom

Regulatory Issues

Pre-Compliance EMC Testing Techniques

Product and Test Equipment Vendors

For further information:

Franz Gizin, Chair (650) 933-8789

Ken Renda, Vice Chair (408) 742-5135

Jay Gaertner, Exhibits, (408) 773-8871

John Shetler, Registration, (408) 738-2888, Ext. 5817

Web site: <http://www.scvemc.org/emc98>

Sponsored by the Santa Clara Valley Chapter IEEE EMC Society

1998 IEEE

INTERNATIONAL
SYMPOSIUM ON
ELECTROMAGNETIC
COMPATIBILITY



August 24-28, 1998

Denver Convention Center

& Adam's Mark Hotel
Denver, Colorado USA

We would like to invite you to the
1998 IEEE EMC Symposium
and Technical Exposition
to be held in Denver, Colorado.



NOT *just* a symposium...
think of *it* as your summer
vacation GETAWAY.



EXPERIENCE THE MILE HIGH CITY
Electro-Magnetic Colorado

In addition to Symposium activities, Denver provides a wealth of other activities and recreational opportunities in the Rocky Mountains of Colorado. Denver enjoys over 300 days of sunshine each year; more annual hours of sun than San Diego or Miami, and the summertime humidity averages only 35%. While you're here take advantage of the opportunity to hear the technical presentations, see the many exhibits, and roam the Mile High City.

Denver has an array of cultural, educational and recreational opportunities available. Professional sports, particularly football, baseball, basketball and hockey attract avid fans. Denver was just announced *Sports Capital, USA* for 1997, listed by The Sporting News.

Art museums, musical and theatrical productions abound right in the city. The Performing Arts Complex (PLEX) is the second largest in the nation with eight theaters seating over 9,000 people. Offering everything from symphonies to Broadway

productions like *Sunset Boulevard*. The Museum of Natural History is the fifth largest in the nation, and the Denver Zoo ranks among our country's top ten with over 3,500 animals.

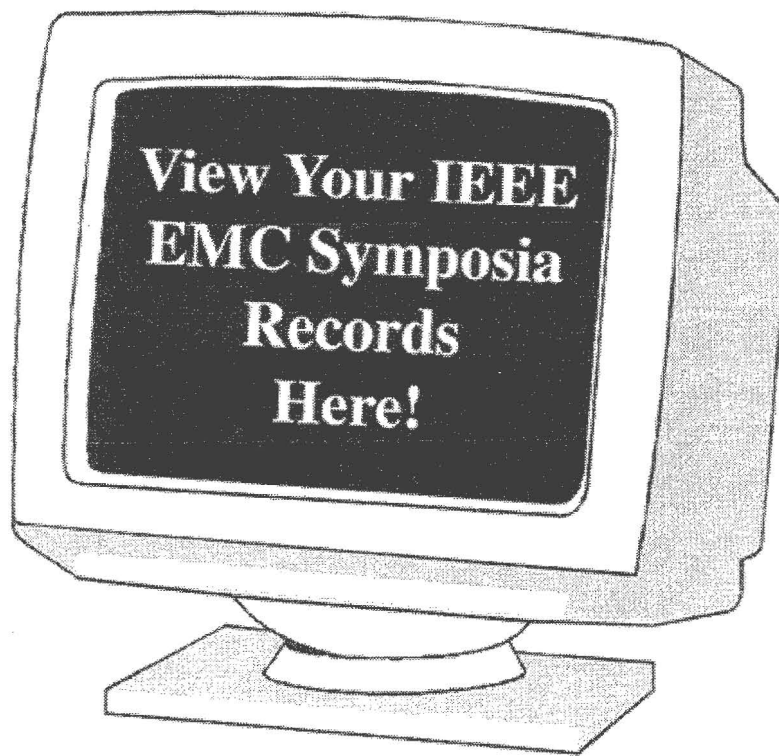
Denver is an energetic city who loves the outdoors, hosting the nation's largest park system, with over 200 parks, and over 200 miles of biking and jogging trails within the city limits. Many more lie in the surrounding mountain areas. For the golfing enthusiast, try a round at one of over 70 courses in the Denver metro area.

Colorado has two national parks, six national monuments, eleven national forests and 40 state parks in the nearby Rocky Mountains. This creates a vast outdoor playground for rafting, ballooning, hiking, camping, fishing and more. The adventures continue with hundreds of miles of offroad trails. Many of which lead to historic sites, and old ghost towns. All this and more under a spectacular Colorado blue sky! Think of it as more than *just* a symposium.

Come join us in August and enjoy our beautiful State of Colorado.
1998 IEEE International Symposium on Electromagnetic Compatibility

Barry Wallen, Chairman • P.O. Box 399 Louisville, Colorado 80027-0399

For More Information Contact Our WEB Site at http://www.ball.com/aerospace/ieee_emc.html
or E-Mail Us at reinerb@louisville.stortek.com

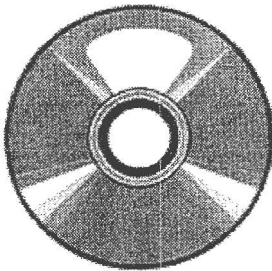


40 Years for 40 Bucks!

40 years of IEEE EMC Society Symposia Records
now available on CD-ROM

Get your Copy While Supplies Last!

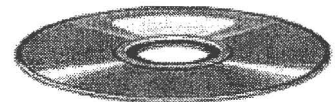
To Order: Contact AMC Applied Microimage



Phone: 781.893.7863

Fax: 781.893.0084

Email: amc@bx.com



Price for members is \$40USD. Price for non-members is \$200USD.

Does not include shipping and handling. You must supply your IEEE member number to receive the member price. Limit two sets per customer. MasterCard, Visa, and checks accepted.

Use the handy order form on back and order today!

CD ROM DISC ORDER FORM

_____ Yes! I would like to order the 40 Years of IEEE EMC Society Symposia Records
from 1955 to 1995 on CD-ROM

Name: _____

IEEE Membership Number: _____

Daytime Phone Number: _____

Ship To Address: _____

IEEE Member Price* \$40.00 USD

Non-Member Price \$200.00 USD

Please complete the following:

_____ CD-ROMs @ \$ _____ each = \$ _____
Quantity Unit Price Total Price**

*Limit TWO Sets Per Member - You Must Supply Your IEEE Member Number to Receive the Discounted Price of \$40.00

****For mail orders, the additional charge for shipping and handling is \$9.95 USD for US distribution and \$15.95 USD for foreign distribution. \$1.50 USD will be added for multiple sets in the same package.**

Please indicate the method of payment:

Master Card: _____
 Account Number _____ Expiration Date _____

VISA:

	Account Number	Expiration Date
--	----------------	-----------------

Signature: _____

FAX THIS FORM TO 781-893-0084 (USA)

EMC Related Conferences & Symposia

1998

April 6 - 8

Sponsored by the US EMC Standards Corporation in cooperation with the American National Standards Institute, Accredited Standards Committee C63 - Electromagnetic Compatibility (ANSI ASC C63)
EMC MEASUREMENT UNCERTAINTY WORKSHOP AND ISO/IEC GUIDE 25 WORKSHOP
 The Westin Hotel, Santa Clara, CA
 Janet O'Neil 425.868.2558

April 6 - 10

DoD E³ PROGRAM REVIEW AND CONFERENCE
 Omni Rosen Hotel, Orlando, FL
 Registration: George Johnson
 Tel: 703.486.7023, Fax: 703.486.2659
 E-mail: gjohnson@RBitem.com

April 28, Seattle, WA

April 30, Los Angeles, CA
 Sponsored by the Los Angeles and Seattle Chapter of the IEEE EMC Society
ONE DAY TUTORIAL AND EXHIBITION WITH HENRY OTT on "The Ten Most Common EMC Design Problems & Their Solutions" PLUS "EMC Diagnostic Techniques"
 Seattle Contact: Janet O'Neil, 425.868.2558
 Los Angeles Contact: Ray Adams, 310.662.7878

June 1

Sponsored by the Santa Clara Valley EMC Chapter
SCV EMC '98: ONE DAY EMC COLLOQUIUM AND EXHIBITION on "Product Compliance: Understanding the Fundamentals" (see the advertisement on page 27 of this newsletter)
 The Westin Hotel, Santa Clara, CA
 Franz Gisin 650.933.8789

June 2

Sponsored by Don HEIRMAN Consultants
INTERNATIONAL EMC LIMITS AND METHODS OF MEASUREMENT FOR INFORMATION TECHNOLOGY EQUIPMENT (CISPR 22/CISPR 24)
 The Westin Hotel, Santa Clara, CA
 Janet O'Neil, 425.868.2558

June 9-11

Sponsored by the Electronic Representatives Association (ERA) and the IEEE with the cooperation of the EMC Society
IEEE NEPCON EAST/ELECTRO '98
 Bayside Exposition Center
 Boston, MA

For information about attending or exhibiting, call 1.800.467.5656 or fax 203.840.9656

June 14-19

11TH INTERNATIONAL CONFERENCE ON HIGH-POWER ELECTROMAGNETICS: EUROEM '98
 Tel Aviv, Israel
 The Secretariat Euroem '98
 Tel: 972.3.5140000
 Fax: 972.3.5140077
 e-mail: euroem98@kenes.com

June 15-19

Organized by the Naval Surface Warfare Center, Dahlgren Division, at their facilities in Dahlgren, VA
REVERBERATION CHAMBER TESTING THEORY/EXPERIMENT SHORT COURSE
 Mike Hatfield
 540.653.3451
 e-mail: mhatfie@nswc.navy.mil

June 23-25

Organized by The Association of Polish Electrical Engineers, The Wroclaw Technical University, and The Institute of Telecommunications
14th INTERNATIONAL WROCLAW SYMPOSIUM AND EXHIBITION ON ELECTROMAGNETIC COMPATIBILITY
 Wroclaw, Poland
 Mr. W. Moron
 Tel: +4871.728812
 Fax: +4871.729375
 E-mail: il.wroc.pl www.emc98.wroc.pl

June 29 - July 1

Sponsored by the US EMC Standards Corporation in cooperation with the American National Standards Institute, Accredited Standards Committee C63 - Electromagnetic Compatibility (ANSI ASC C63)
EMC MEASUREMENT UNCERTAINTY WORKSHOP AND ANSI ASC C63.4 WORKSHOP ON THE MEASUREMENT OF RADIO-NOISE EMISSIONS
 Includes Vendor Exhibition on EMC Products and Services on June 29
 Portland, OR
 The Governor Hotel
 Henry Benitez 503.627.1217
 E-mail: henry.w.benitez@tek.com

June 29

Sponsored by the Washington DC/Northern Virginia Chapter of the IEEE EMC Society
EMC HARMONIZATION CONFERENCE
 The Ritz-Carlton Hotel
 McLean, VA
 Leo Makowski, 703.494.1900
 E-mail: haefely_trench_usa@compuserve.com

August 3-5

Sponsored by The Canadian Radiation Society and AK Electromagnetique Inc.
FIRST INTERNATIONAL SYMPOSIUM ON POWER LINE TO MICROWAVE RADIATION

Montreal, Quebec, Canada
 Dr. David Smith
 Tel: 514.620.3717
 Fax: 514.267.1144
 E-mail: kumar@colba.net

August 21 - 22

Sponsored by the US EMC Standards Corporation in cooperation with the American National Standards Institute, Accredited Standards Committee C63 - Electromagnetic Compatibility (ANSI ASC C63)
C63.4 WORKSHOP ON THE MEASUREMENT OF RADIO-NOISE EMISSIONS
 Denver, CO (in conjunction with IEEE EMC Symposium)
 Adams Mark Hotel
 Janet O'Neil, 425.868.2558

September 14-18

Organized by the Faculty of Engineering University of Rome "La Sapienza" Rome, Italy
EMC '98 ROMA: INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY
 Daniela Fioramonti
 Tel: +39.2.777901
 Fax: +39.2.798817
 E-Mail: conferencesaei@aei.it

Week of October 5

MODE-STIRRED, ANECHOIC CHAMBER, AND OATS USERS MEETING
 Air Force Research Lab Rome, NY
 Raymond W. Tucker, Jr.
 315.330.3884
 E-mail: tuckerr@rl.af.mil

IEEE Administrative Meetings 1998

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

April 27

EMC Society Board of Directors
 Westin Hotel
 Seattle, WA

August 23

EMC Society Board of Directors
 Adams Mark Hotel
 Denver, CO

September 18

EMC Society Board of Directors
 Rome, Italy

November 14

EMC Society Board of Directors
 New Brunswick, NJ

EMCS Cooperating Symposia

U.K.: Biannually, even years, in September
 Zurich: Biannually, odd years, in March
 Wroclaw: Biannually, even years, in June

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

AMPLIFIER RESEARCH

160 School House Road, Souderton, PA 18964-9990 USA
Telephone (215) 723-8181 Fax (215) 723-5688 Website: www.ar-amps.com
Broadband RF power amplifiers, 1 W to 50 kW, dc to 40 GHz; Antennas and accessories for RF susceptibility testing; broadband E-field monitors and interference generators for IEC/ISO applications.

CKC LABORATORIES, INC.

Seven Locations in California, Oregon, and Washington
Toll Free (800) 500-4EMC Fax (209) 742-6133 e-mail: ckclabs@ckc.com
Worldwide EMC-compliance testing, design consultation and seminar services, DAR EN45001 and A2LA Accredited. Visit our Website at <http://www.ckc.com>

EMCO

P.O. Box 80589, Austin, TX 78708-0589 USA
Telephone (512) 835-4684 Fax (512) 835-4729
Essentials for EMC Testing: Antennas, Towers, Turntables, Current Probes, CDNs, Broadband E-field Sensors, GTEM™ Cells, TEM Cells, LISNs and Accessories

FAIR-RITE PRODUCTS CORPORATION

One Commercial Row, Wallkill, NY 12589
Telephone (914) 895-2055 Fax (914) 895-2629 e-mail: ferrites@fair-rite.com Website: <http://www.fair-rite.com>
Ferrite Cores for EMI Suppression, Bead-On-Leads, Surface Mount Beads, Multi-Hole Connector Blocks, and Tile Absorbers.

LINDGREN RF ENCLOSURES, INC.

400 High Grove Blvd., Glendale Heights, IL 60139
Telephone (630) 307-7200 Fax (630) 307-7571 e-mail: lrfe@interserv.com Website: www.LindgrenRF.com
EMI/RFI Shielded Rooms; RF Shielded Doors and Components; Anechoic Chambers and Absorber Materials; High Performance Power, Signal, Data and Telecomm Line Filters from ELMAG Division (561) 881-9292

PATTON & ASSOCIATES

1600 West Manzanita Drive, Prescott, AZ 86303-6121
Telephone (520) 771-2900 Fax (520) 771-2990 e-mail: patton@patton-assoc.com Website: <http://www.patton-assoc.com/>
Patton & Associates consult in the design, test, regulatory type approval and market entry of telecommunications terminal equipment worldwide.

RANTEC

P.O. Box 80589, Austin, TX 78708-0589 USA
Telephone (512) 835-4684 Fax (512) 339-4517
Shielded Rooms and Anechoic Chambers, High-performance RF & EMC Absorbers

RAY PROOF LTD. (A Lindgren Company)

Boulton Road, Pin Green Ind. Area, Stevenage, Herts. SG1 4TH, U.K.
Telephone +44 (0) 1438 730700 Fax +44 (0) 1438 730750 e-mail: sales@linray.co.uk www.rayproof.demon.co.uk
EMI/RFI Shielded Rooms; Anechoic Chambers; Shielded Doors and Components; High Performance Power, Signal, Data and Telecomm Line Filters; EMP Filter Systems; Fiber Optic CCTV and Communication Systems

SCHAFFNER EMC, INC.

9B Fadem Road, Springfield, NJ 07081
Telephone (973) 379-7778 or (800) 367-5566 Fax (973) 379-1151 <http://www.schaffner.com>
EMC Filters, EMC Immunity Test Instruments, Automatic Test Systems for EMC and Power Supply Testing

TEXAS SPECTRUM ELECTRONICS, INC.

9110 Autobahn Dr., Dallas, TX 75237
Telephone (972) 296-3699 Fax (972) 296-7881 Website: www.Sales@texspec.com
Custom EMI Filters, Miniature EMI Filters, Telecom Power Filters, Filter Arrays, and Filter Suppressor Networks.
Distributor of Plastic Insulation Materials (Heat Shrink) and Wiring Accessories.

WEINSCHTEL, BRUNO ASSOCIATES

42 Cessna Court, Gaithersburg, MD 20879 USA
Telephone (301) 948-8342 Fax (301) 869-9783
Attenuators, Fixed Terminations, 5-1000 (av.) W average/10 KW Pk. Power Cont. Var. 0-4 GHz, 1-40 GHz; Power Splitters 0-18 GHz

06014849 27N 1
EDWIN L BRUNAUGH
10210 PRISM DR
AUSTIN TX 78726-1364

An Institutional Listing recognizes contributions to support the publication of the IEEE EMC SOCIETY NEWSLETTER and the IEEE TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY. Minimum rates are \$500.00 for four consecutive issues of each publication during one calendar year (each publication is distributed quarterly). The above Institutional Listings represent those contracted for 1998. Institutional Listings for 1999 will be solicited in December 1998. No agency fee is granted for soliciting such contributions. For inquiries related to institutional listings, please contact Janet O'Neil, Editor, phone 425.868.2558, e-mail j.n.oneil@ieee.org.