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EMC

IEEE EMC Society Newsletter

INSIDE:

Special IEEE EMC Society Workshop Addresses Measurements Above 1 GHz and Associated Uncertainty

Michael J. Windler, Underwriters Laboratories Inc.
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Northbrook, IL USA

Everyday radiated emissions measurements above 1 GHz are being made on products. These measurements bring a unique set of challenges. The higher the frequency being measured, the narrower the beamwidth. This results in the signals being harder to find in the preliminary scans, harder to maximize, greater errors from ground plane imperfections, etc. Should these emissions be measured in an open area test site (OATS), anechoic room, reverberation chamber, or GTEM? What types of antennas are the most efficient and accurate? Should we use receivers or spectrum analyzers? What are the uncertainty contributions at these frequencies and test setups? All these questions and problems are part of the research underway to revise our measurement standards. They were also the topics of an exciting afternoon workshop by the IEEE EMC Society at the 14th International Zurich Symposium and Technical Exhibition on EMC February 20-22, 2001. The title of the workshop was "EMC Measurements Including those Above 1 GHz and Associated Uncertainty."

Photo by Janet O'Neil

Speakers at the IEEE EMC Society special workshop in Zurich included (front row left to right) Dr. Pierre Beeckman of Philips, Dennis Camell of NIST, Ed Bronaugh of EdB EMC Consultants, Ghery Pettit of Intel, (back row left to right) Bob Johnk of NIST, Mike Windler of UL, and Don Heirman of Don HEIRMAN Consultants.

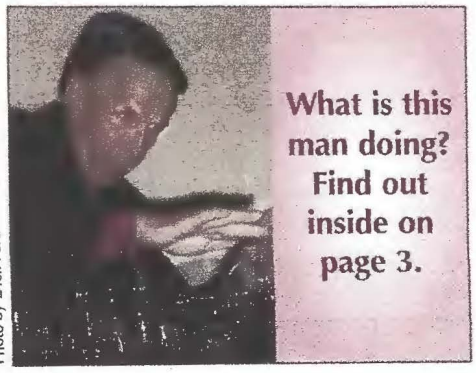

Photo by Dick Ford

What is this man doing? Find out inside on page 3.

The master of ceremonies for the afternoon was Don Heirman of Don HEIRMAN Consultants, Lincroft, New Jersey. This was only fitting since it was Don that proposed the afternoon workshop and coordinated the development of the papers and presentations.

Ed Bronaugh of EdB™ EMC Consultants, Austin, Texas, was the lead off speaker discussing measurement instrumentation used for measurements above 1 GHz. Ed's talk delved into a wide variety of instrumentation from spectrum analyzers and receivers to amplifiers and antennas. Proper pass band filters, high quality low loss cables and instrument settings were discussed in detail. Ed's review of the instrumentation issues was warmly received.

Next up on the workshop agenda was an article by Dennis Camell of the National Institute of Standards and Technology (NIST) RF Technology Division, in Boulder, Colorado, and Mike Windler of Underwriters Laboratories, in Northbrook, Illinois. They examined the issues and potential problems of various antennas used above 1 GHz. Dennis gave the presentation to a rapt audience. The presentation reviewed the current antenna requirements in ANSI, CISPR, and ETR. The plots of the principal plane patterns, beamwidths, cross polarization characteristics of various antennas including log periodic dipole arrays, double ridge horn standard and octave gain horns were presented.

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IEEE EMC Society Newsletter Publication Schedule

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

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President's Message

Joe Butler – President, EMC Society

Photo by Janet O'Neil

EMC Society President Joe Butler enjoyed the company of the Zurich EMC Symposium organizing committee during the Wednesday evening banquet. Shown left to right are Dr. Fred Tesche, Chair of the Technical Program Committee, Dr. Gabriel Meyer, Symposium Chairman, EMCS President Joe Butler, and Dr. Peter Leuthold, outgoing Symposium President.

Start thinking about Montreal, Canada and our upcoming International EMC Symposium the week of August 13th. By the time you get this Newsletter (yes it still is a Newsletter but it's looking a lot more like a magazine every issue), it will be time to make plans to join us in Montreal. The committee under Benoit Nadeau has done a great job to date of planning for this event. It should be a rewarding affair for all who attend.

I recently attended the 14th International Zurich Symposium and Technical Exhibition on Electromagnetic Compatibility, held from February 20 to 22, 2001. Although I have attended this event before, this was obviously my first time representing the EMC Society as President. I can't begin to thank the President of EMC Zurich '01, Professor Peter Leuthold, and Dr. Gabriel Meyer, Symposium Chairman, for their and the committee's hospitality during this event. It was made clear to me that the Zurich symposium committee very much appreciated the technical co-sponsorship provided by our Society. As usual, the event was very successful, once again retaining its reputation as one of the premier EMC symposia in the world. Besides the exposition, technical papers and the wonderful social events at this affair, I was also able to attend the conference Advisory Committee meeting. While discussing several aspects of the Zurich symposia dealing with the quality of technical papers, numbers of exhibitors, and participant representation by country, this meeting evolved into thoughts about the need for continuing discussions among the various national and international EMC symposia chairs. It's clear that the number of EMC symposia worldwide is increasing and hence the competition for technical papers and exhibitors inevitably results. With representatives from past or future symposia in Switzerland, Japan, United States, Israel, United Kingdom, Italy, Belgium, Poland, Germany, and Russia in attendance at this meeting, the discussion identified several common denominators, one of which being the request for technical co-sponsorship by the IEEE EMC Society. Since the EMC Society is engaged in dialogue with all of the above on symposia sponsorship issues, it was suggested that the Society start a series of co-operative discussions to minimize potential conflicts in the area of participant and technical paper as well as exhibitor solicitation. One area in particular that was addressed was the issue with the same or very similar technical papers being submitted to multiple symposia. This issue and others are ones on which the EMC Society Board of Directors will have more discussion.

I recognize that the "Call for Nominations" for the EMC Society Board of Directors went out with the last Newsletter with the deadline of May 31, 2001. However, I'd still like to mention the fact that we are seek-

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EMCS Newsletter Editor Janet O'Neil confers with IEEE publications colleague Marcello D'Amore, Editor of the Transactions on EMC, during the Zurich Symposium.

Letter from the Editor

Janet O'Neil – Editor, EMC Society Newsletter

I recall when I became editor of the EMC Society Newsletter that outgoing editor **Bob Goldblum** told me "Remember, you don't need to write a letter from the editor in every issue. You only need to write one when you have something to say." Well, in this issue, I have plenty to say! Here goes....

In February, I attended the 14th **International Zurich Symposium and Technical Exhibition on EMC** as a member of the EMC Society Board of Directors. I was impressed by the Symposium for many reasons. From attending the press conference held during the Symposium (I attended as the Editor of the EMCS Newsletter), I learned that over 600 people attended representing over 30 countries and all continents. Interestingly, according to the Symposium organizers, there were 94 people attending from Switzerland, a number which is decreasing, while there were 67 people from the USA, a number which is increasing. 200 papers were submitted of which 39% were rejected. Some 50 exhibitors of EMC related products and services participated. EMC modeling was one of the most significant topics at the Symposium. Four regular sessions and several other events at the symposium were devoted to recent technical developments in EMC testing and associated future global EMC standards. Emerging communication and information technologies with ever increasing channel bandwidths and clock frequencies above 1 GHz ensured that the special IEEE EMC Society workshop would be well attended (see cover story). At the Symposium Banquet, the program was very interesting and entertaining. Outgoing Zurich Symposium President **Peter Leuthold** acknowledged the past Presidents of the IEEE EMC Society who were present and thanked the EMC Society for its support of the Symposia over the years. Next year, at age 65, Professor Leuthold is retiring as Symposium President. He thanked the technical program chairs, including **Ralph Showers, Clayton R. Paul,** and **Fred Tesche** for their support over the years, noting "They are responsible for the high quality of the conference under the guidance of **Gabriel Meyer**." Several vendors were also acknowledged for supporting the Symposium over the years. Receiving awards for exhibiting continuously at the Symposium since 1981 were **Haefely Test, Rohde & Schwarz** (they were recognized as being one of the first exhibitors since 1977), **Schaffner EMV** and **Montena EMC**. President Leuthold oberved that the Zurich Symposium has come a long way since it was started by **Tomas Dvorak**. The incoming Zurich Symposium President, **Ruediger Vahldieck**, Chair for Field Theory with the Swiss Federal Institute of Technology Zurich, Laboratory for Electromagnetic Fields and Microwave Electronics, warmly recognized the leadership of Peter Leuthold. He presented Professor Leuthold with an ice-pick and plenty of rope so he could climb mountains next year during his retirement and "reach the top of the world." Following this glowing and sincere tribute to Professor Leuthold, the banquet attendees were entertained by a gentleman who played numerous songs on wine glasses (that's the photo on the cover of this Newsletter). It was a very special evening at the Dolder Grand Hotel and a special week at the 14th International Zurich Symposium and Technical Exhibition on EMC.

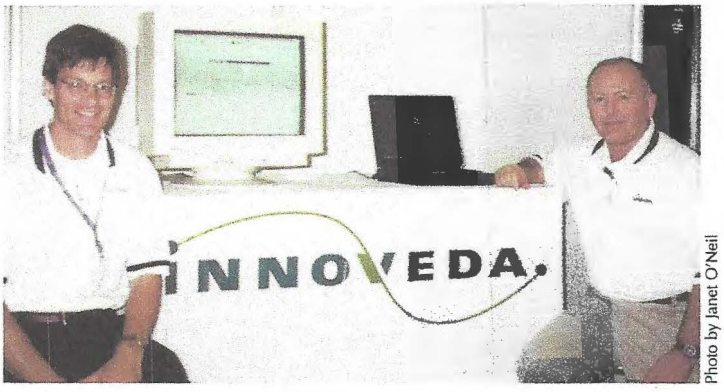

Photo by Janet O'Neil

Exhibitors in Zurich included the company Innoveda based in Camarillo, California. Staffing the Innoveda booth are Guy de Burgh and Gene Garat (L-R).

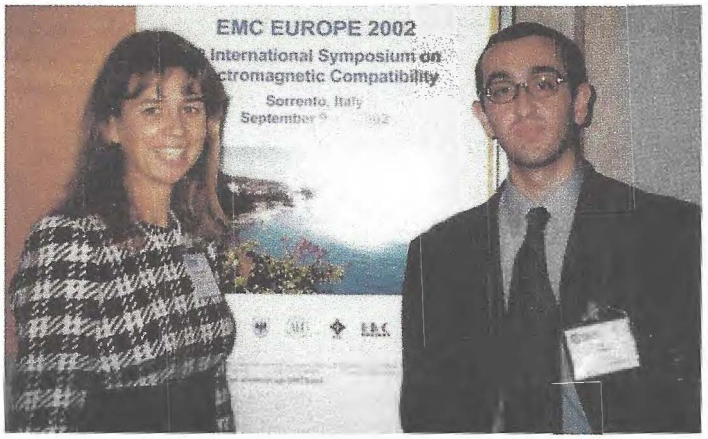

Photo by Janet O'Neil

When she wasn't presenting a paper in Zurich, Maria Sabrina Sarto of the University of Rome "La Sapienza" was busy promoting the EMC Europe 2002 conference in Sorrento, Italy. She encouraged Sergio Di Michele of Stork Screens B.V. in The Netherlands to attend this conference next year.

In March, I attended the **IEEE Panel of Editors Meeting** in San Diego, California as Editor of the

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Photo by Janet O'Neil

The Zurich Symposium attracted a global audience of EMC engineers including (L-R) Takeo Yoshino of the Fukui University of Technology, Radio Physics Research Lab, Yoshio Kami of the University of Electro-Communications, and Atsuya Maeda of A. Maeda Associates, Inc.

Photo by Janet O'Neil

Computer Simulation Technology (CST) presented an attractive booth and lively staff at the Zurich Symposium. Dr. Ralf Ehmann of CST GmbH, Dr. Emmanuel Leroux of CST Italy, and Tilmann Wittig of Darmstadt University of Technology in Germany, (L-R) enjoyed the booth traffic between the technical sessions.

EMC Society Newsletter. It was important to attend the meeting as this Newsletter will evolve into an official EMC Society magazine in 2002. Several key IEEE personnel who will be instrumental in helping our Society with this transition were at this meeting, including **Bob Smrek, Laura Pohl and Susan Schneiderman**. Over 150 IEEE Society Editors of Newsletters, Magazines and Transactions were present to learn about new policies, procedures, services, etc. In other words, we learned how to be more effective as editors. I also learned about recent developments with the IEEE Xplore web based "product". An advertisement for **Xplore** follows this column so you can learn more about this valuable product offering for IEEE members.

Lastly, I have to say something about **Todd Hubing**! ***Mr. Hubing is retiring from his post as Associate Editor for the Newsletter's popular Chapter Chatter column***! As the deadline for each issue of the Newsletter drew near, I'd worry just how late Todd would be in submitting his column. I always threatened that I would "fire" him, but he would submit such funny columns that I ended up in tears reading them. That is, they were tears from laughing so hard! So, I would forgive and forget until the scenario would play out with each subsequent issue. Well, I don't have Todd Hubing to kick around as Associate Editor anymore. That means I need to find another person to take my "kicks." While I conduct a search for someone to replace the irreplaceable Todd Hubing, please contact me if you or anyone you know might be interested in volunteering for this position. All you really need is the ability to meet deadlines and a good sense of humor. Please read Todd's last column in this Newsletter on page 6 for insight on what's basically required of the job. Then, if you are still interested, let me know. Seriously though, I have tremendously enjoyed reading Todd's column over the years and will miss his unique sense of humor. It's not often that I sit at my computer, read his Chapter Chatter opening column and bury my head in my hands while I wipe the tears away! Thanks Todd for the years of fun reading! **EMC**

Photo by Janet O'Neil

The EMCS Board of Directors hosted a cocktail party following the Zurich Symposium party. This provided an informal opportunity for former EMCS President and IEEE Division IV Director Bill Gjertson of Boeing and his wife Marianne to visit with the incoming Zurich Symposium President Ruediger Vahldieck (L-R). Professor Vahldieck is also the chairman of the Switzerland joint EMC, AP and MTT Chapter.

NOTICE: BYLAWS CHANGE

The EMC Society Board of Directors, at its February 2001 meeting, approved a Motion to add a new paragraph to Bylaws Section 4.0 Nomination and Election of the Board of Directors. IEEE has approved the amendment and it will become effective following distribution of this notice. The new paragraph follows:

"4.9 Unsuccessful candidates for the Board shall be notified by private letter from the President to the unsuccessful candidates. The letter shall contain the number of votes accumulated by the candidate and it shall also contain the minimum number of votes that were needed to be elected to the Board."

Chapter Chatter

Todd Hubing, Associate Editor

Photo by Janet O'Neil

Todd Hubing keeps good company at the Zurich Symposium. He's pictured at right with Dr. and Mrs. Fred Tesche. Dr. Tesche is Chair of the Zurich Technical Program Committee.

If the first Chapter Chatter column I had ever written had started with the letter 'A'; and if I started each column after that with the next consecutive letter in the alphabet (with 'Z' followed by 'A' again), I'd be starting this column with the letter 'I' for the second time. In other words, this is my 35th column. I've been doing this for almost nine years. It's been fun, but it's time for me to resign. Inevitably, a person who holds a job like this for too long starts to run out of new ideas. Instead of using words that are fresh, exciting and new, a writer may begin to use words that are not fresh, not exciting and not new. In rare cases, writers on the edge of sanity have been known to begin every sentence with the same letter. I need to quit before I reach that stage.

I hereby submit my last Chapter Chatter column for the IEEE EMC Society Newsletter. It would be prudent for me to mention at this point that the situations and characters in this column are fictional. In fact, any resemblance to actual people or events is entirely coincidental and can be attributed to a lack of originality on the part of the author.

I'm Retiring

Act I, Scene I

Setting: The suburban Seattle office of the Editor-in-Chief of a popular IEEE Society publication. Ace reporter, Todd Scarlett has been summoned for a brief meeting.

[Todd] What's up, Chief?

[Chief] Glad you could stop by.

[Todd] Sure, no problem. My office is only 1500 miles from here.

[Chief] Have a chair. Want some coffee?

[Todd] What is it with coffee around here? Everyone in Seattle seems to be selling or giving away coffee.

[Chief] Forget it. I'll get right to the point. You're fired!

[Todd] Fired! What for? I thought things were going well? People like the Chapter Chatter column.

[Chief] Correction, people *liked* the Chapter Chatter column. The latest reader survey results have just come in. It appears that there's too much chatter and not enough chapter.

[Todd] What do you mean?

[Chief] You know what I mean; poems, limericks, songs. What's that all about? People don't want to read that nonsense. They want facts!

[Todd] But Chief, I always report on the chapter activities.

[Chief] Sure, you tell everyone when meetings were held and who the speaker was, but our readers want to know more. Chapter meetings are much more than just technical presentations. Our readers want to know about the important things. What really transpired? Who was pulling the strings? People want to know who was there, what they wore, what was said, who exchanged business cards, and who left with whom.

[Todd] What they wore?

[Chief] Well, maybe not what they wore, but you get the idea.

[Todd] I can't deal in hearsay. This isn't a gossip column. I'm a reporter. I report the truth.

[Chief] The truth? You report the truth? Did you really defrag your hard drive before an emergency appendectomy? Do you think Washington D.C. is the country music capitol of the world? Did you dream about falling from an airplane with a Don Heirman haircut? Do you ...

[Todd] (*interrupting*) Ok, I get your point. But, I have a family to support. Where will I go? What will I do?

[Chief] Frankly, Scarlett, I don't give a... wait a second. Let me think. I do have one other opening. Would you be willing to write the President's Message?

[Todd] The President's Message? Doesn't the President write that?

[Chief] I'll arrange it.

[Todd] You'll arrange it? You can't arrange something like that!

[Chief] Don't bet on it. Now, as President you'll report directly to me. Your number one duty will be to write the President's Message and get it to me by the deadline. You'll also receive about 200 email messages per day.

[Todd] I don't know....

[Chief] Forget it. It's settled. You'll be the next President.

[Todd] Who will write the Chapter Chatter column?

[Chief] I'll initiate a worldwide search. Anyone who thinks they might want to write the column (and promises not to include any songs) will be considered for the position.

[Todd] You think it will be that easy to replace me?

[Chief] Shouldn't be too difficult. It's a pretty cushy job. Besides, they couldn't do any worse. The number of people reading Chapter Chatter has dropped significantly. According to the last survey, you were 2 percentage points behind "Calendar". You barely beat out "Mailing Label Area".

[Todd] I had no idea things had gotten that bad. Whose column was number one?

[Chief] Pat Buchanan's.

[Todd] Pat Buchanan! He doesn't even write a .... wait a minute! You didn't use a butterfly ballot for this reader survey did you?

[Chief] Well, yeah. How'd you guess?

Lights fade. Curtain closes.

Scene II

Setting: Rolla, Missouri office of Todd Scarlett, ace reporter. Todd is on the phone with Joe Boston, current President of the Society.

[Todd] So you say it's more like 300 email messages a day? I had no

idea.....Yes, that's right. Chief's letting me write one more Chapter Chatter Column. It's my chance to say goodbye to my three or four loyal readers.....No, she made it clear, no poems. .... Yeah, made me put it in writing and have it notarized. .... No, limericks count as poems. It says so in paragraph 8....[quiet chuckle] Definitely no songs. Paragraphs 15-17 exclusively prohibit any kind of song. Country, rock, Gregorian chants, if it's a song, it's prohibited..... Yeah, I know.....No, that won't work either. I can't describe dreams, offer to cut my hair, make fun of engineers, or print letters from non-existent people. .... Nope...No puzzles. No quizzes. No games. I can't write slogans, or cards or pretend to quote Dr. Suess. In fact, no two consecutive sentences are allowed to rhyme.... Yeah, it looks like this is going to be a relatively mundane column....What's that? ... A play? ...Let me check.. [thumbs quickly through a 4-page document] Why no, it never mentions plays....Thanks, Joe. I've got to go.

Lights fade. Curtain closes.

Austria

The first meeting of the year 2001 was held on the 25th of January at the Vienna University of Technology. Peter Mair (of Fronius Schweißmaschinen KG Austria) and Kurt Lamedschwandner were the presenters. The presentation was about harmonics and flicker. Their origin, measurement techniques, normative and design requirements for electronic appliances were discussed. The presentation was followed by a nice social event.

Juergen Nitsch (left), the head of the EMC group at the University of Magdeburg, and Hans-Georg Krauthaeuser (right), the principal experimental leader of this group, are very happy to show the brand new semi-anechoic chamber to Ulf Straehle (2nd from left) and Carl E. Baum (2nd from right). Ulf Straehle, former EMC expert of the German Ministry of Defense, always enjoys being in an academic environment!

Central New England

John Clarke reports that the speaker at the Chapter meeting on February 14 was Jim Conrad who is an independent EMC Consultant. Jim was formerly an EMC Manager for Agilent Technologies Healthcare Solutions Group located in Andover, Massachusetts. The Speaker presented an overview of International Electrotechnical Commission (IEC) Standard 60601-1-2; Second Edition, Electromagnetic Compatibility for Medical Electrical Equipment. This standard is currently under development by IEC and should be published as an IEC and European Norm later in 2001. The FDA is also planning to adopt IEC 60601-1-2 as soon as it is released. The electromagnetic emission and immunity requirements and test methods used to meet these requirements were also discussed. 17 members and guests attended the meeting, and the speaker responded to several specific questions from the audience.

Central & South Italy

Professor Salvatore Celozzi, Chair of the Central & South Italy Chapter, reports that the chapter hosted two very interesting seminars on March 12. The former Distinguished Lecturer, Dr. Elya Joffe, of KTM, Tel Aviv, gave both presentations. About 30 persons attended the event held in the ancient cloister of the Faculty of Engineering of the University of Rome "La Sapienza". Vice-Chair, Professor Antonio Orlandi, introduced the lecturer. Elya's first presentation was titled, "Transients - Protecting Components and Circuits." His second presentation was titled, "A Systematic Approach to Cable Design and Layout." Everybody was enthusiastic about the technical and scientific content and the outstanding way the presentations were given. Currently, the chapter is contributing to the promotion of a short course on EMC to be held in L'Aquila next July, organized by Professor Feliziani, and of the EMC'02 EUROPE conference, which will be held in Sorrento, Italy next September.

Germany

As the diligent Chapter Chatter reader might know, the German chapter frequently enjoys visits from Dr. Carl E. Baum. At the end of February, a few days after the 14th International Zurich Symposium on EMC, Dr. Baum stopped by the University of Magdeburg for a couple of days. His ability to ingeniously combine tough electromagnetic theory and real-life EMC problems was once again clearly demonstrated on February 28, when he presented a lecture series on "Transient Coupling- and Scattering-Phenomena". There were five talks on the program, ranging from careful considerations on the effects of different transient waveforms on electronic systems to the construction of switched oscillators as possible driving sources for

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antennas. When these talks were finished, about 20 German chapter members and guests, noticing no exhaustion of the speaker, kindly asked for more. And indeed, Dr. Baum found two more presentations, prepared and waiting in his briefcase. During this visit there was not only time to talk, there was also time to walk. Dr. Baum, in his position as the president of the Summa foundation, crisscrossed the campus of the University of Magdeburg and explored the facilities, focusing on lecture halls, cafeterias and scientific entertainment. The reason for this kind of research is quickly explained: supported by the German EMC chapter, EUROEM 2004, which will follow the AMEREM 2002 in Annapolis, will be hosted at the University of Magdeburg! Incidentally, during the tour, the EMC group at Magdeburg was glad to present to Dr. Baum its newly installed semi-anechoic chamber. With dimensions 21 m times 13 m times 9 m, it is the largest facility of its kind at a German university and is devoted to both academic and commercial EMC research. In connection with this facility, there are plans to offer EMC courses, consulting services, and measurement services related to EMC standards. These services are especially intended to support local industry in the region of the former East Germany.

Melbourne

Ed Kirchner, the newly elected Melbourne Chapter Chair.

The Melbourne chapter held its Spring 2001 meeting on March 7 at the Melbourne Airport Hilton. Leader Tech, Inc. of Tampa, Florida provided lunch for the 31 guests (a new attendance record for a Melbourne chapter meeting!) as well as the speaker, Darrell Yarbrough. Mr. Yarbrough discussed the design and application of Leader Tech's specialty circuit board shielding products — micro-can shields, one-piece can shields, two-piece fence/cover shields, and multi-cavity shields. This technology provides circuit board designers with a low-cost means to contain EMI at the board level. Special thanks to Tom Burton from Handy Tech in Orlando, Florida for helping to bring this seminar to fruition. The Melbourne chapter would like to congratulate the new slate of officers who were elected at the March meeting: Chair Ed Kirchner, Vice-Chair Chris Maginsky, Secretary Bruce Crain, and Treasurer Rick Botsford. All of the current officers work for Northrop Grumman Corporation in Melbourne, Florida, and the Melbourne chapter appreciates Northrop Grumman's continued support of the IEEE EMC Society.

A rather large and interested crowd was present to hear Bertram Chan of Foundry Networks speak at the Orange County Chapter's February meeting.

(Left to Right) Ed Nakauchi, Orange County Chapter Vice-Chair, speaker Bertram Chan, and Randy Flinders, Orange County Chapter Chair.

Orange County

The Orange County chapter welcomes its new Chairman, Rex Brucker of Emulex Corporation, to its board. The chapter's previous Chair, Randy Flinders, who has been the chapter's chair since May of 1998, will be assuming another position on the board and will still be active in chapter and EMC Society activities. Also, the Orange County chapter congratulates previous chair Randy Flinders for receiving the IEEE Orange County Section's "Distinguished Service Award". At its February meeting, the Orange County chapter welcomed Dr. Bertram K. C. Chan of Foundry Networks to give a presentation on "Effective Grounding and Shielding for GHz Processors and Beyond." Bert shared some great ideas with the crowd of almost 30 people. High-frequency design issues continue to be the most in-demand topic in the Orange County area, where manufacturers continue to move to increasingly faster clock speeds and data rates.

Oregon and SW Washington

Ali Elmi, Communications Director for the Oregon and South West Washington Chapter, reports that they started the year off in January with Mr. Jerry Ramie of Compliance Systems Corporation presenting "Emerging Standards for Europe". During the presentation, Mr. Ramie talked about how the "New Approach Directives" of the European Union mandate new and expanded testing for regulatory compliance for most electrical/electronic products. He mentioned that important changes were being made to the EMC Directive in 2001. These include changes to:

- EN61000-4-5 - Lightning Strike (Surge)
- EN61000-4-6 - Conducted RF Immunity
- EN61000-4-8 - 50 Hz Magnetic Fields
- EN61000-4-11 - Power Dips & Interrupts
- EN61000-3-2 – Power Harmonics
- EN61000-3-3 – Power Flicker
- EN55022:1998 – The "New CISPR" tests for ITE & Telecoms

Mr. Ramie went on to say that these expanded "European Norms" will impact your company's time-to-market and "windows of opportunity" if they are ignored, rather than managed. In February, Dr. Robert G. Olsen of the School of Electrical Engineering and Computer Science at Washington State University presented "Recent Developments in the ELF Electric

and Magnetic Field Health Effects Issue." During his presentation, Dr. Olsen gave an update on the extremely low frequency (ELF) electric and magnetic field health effects issue, with an emphasis on recent developments in the United States. He included information about the scientific consensus, the status of standard development, new field mitigation techniques, and several ongoing bioelectromagnetics research projects, including results from recent animal exposure studies as well as epidemiological studies of occupational exposure to magnetic fields and breast cancer, Altzheimers disease and arrhythmia-related cardiovascular disease. In March, Dr. Lynne Green of Innoveda, Inc. presented "PCB Layout for EMC and Signal Integrity." During her presentation, she discussed how layout is often treated as an "over-the-wall" step in the design process, where the electrical design is given to someone else for layout. However, today, as driver edge rates drop below 5 nsec, the tradeoffs made in placement and routing often make the difference between a "learning experience" and a functional design. She examined the interactions between system design and layout design, and the impact of layout choices on signal integrity and EMI performance, such as how the location of terminating components impacts SI and EMC performance. Guidelines for the prevention of signal integrity and EMI problems were also presented.

Phoenix

The Phoenix Chapter of the IEEE EMC Society held an election for officers for the 2001 calendar year. The three officers from the past year were re-elected unanimously including Terry Donohoe (Honeywell) as Chair, Daryl Gerke (Kimmel-Gerke Associates) as Vice-Chair, and Harry Gaul (Motorola) as Secretary/Treasurer. The speaker at the March 22nd meeting was a former IEEE EMC Society Distinguished Lecturer, Ron Brewer of Laird Technologies, formerly known as Instrument Specialties. The topic of Ron's talk was "EMC Systems Design," which covered the complete gamut from PCBs to cables to enclosure shielding. Starting with basic equations, Ron pointed out the key parameters to reducing emissions and susceptibility such as minimizing loop areas on PCBs and adding filtering and shielding. Additional concepts covered included using the slowest speed IC's consistent with operation and limiting the bandwidth with circuit suppression components. Ron explained that one must combine shielding with good PCB design in order to achieve a cost effective design. Ron also dispelled the myth that PCB power distribution is DC. Because of the high speed current pulses drawn by ICs, the power distribution needs to be thought of in RF terms with controlled impedances and critical capacitor placement. The final thought that Ron left us with is that of all the various commercial EMC requirements, the toughest ones to meet are radiated emissions and radiated susceptibility. Therefore, these critical areas must be addressed early in the design. Also, the radiated emissions tests should be performed first before the other tests because design iterations may be required. Check out the Phoenix web site at http://www.ewh.ieee.org/r6/phoenix/phoenixemc/ for the latest schedule of upcoming meetings.

Philadelphia

Michael Daniele, chair of the Philadelphia Chapter reports that they combined efforts with other working groups to present Mr. Courtney Yelle at the Philadelphia section meeting. Mr. Yelle is a retired naval aviator, who worked in the DOD industry for a number of years before becoming the Director of Consumer Protection and the Chief Sealer of the Weights and Measures Department for Bucks County Pennsylvania. His topic on "Self Defense Against New Millennium Scams and Flim Flams", was extremely informative as well as entertaining. He identified a number of scams that are perpetrated on the general public and offered solutions on how to guard against them as well as how to resolve injustices toward consumers. Mr. Yelle provided a wealth of printed matter and information as well as anecdotal material during his more than one-hour talk. Meeting guests were very responsive to his material and peppered the speaker with a plethora of questions regarding their own personal experiences and situations. Mr. Yelle was extremely knowledgeable and provided considerable useful information. The meeting guests were very pleased by the experience. The Philadelphia Chapter intends to bring in more speakers who are outside the mainstream of the IEEE community. Mr. Yelle set an excellent standard to follow.

Rocky Mountain

Lyle Luttrell reports that the February meeting of the Rocky Mountain chapter was a doubleheader with 24 members and guests at the National Institute for Standards and Technology (NIST) in Boulder. The first talk was titled, "PCB Emissions Scanning" and was presented by Tony O'Hara of Lartec Marketing. Tony gave a demonstration of the EMSCAN printed circuit board emissions measurement system. The presentation introduced the EMSCAN system, which uses an array of switched H-Field probes that allows close to real time spatial RF scans on PCB's. The second presentation was titled, "Identifying (and then avoiding) Errors in Signal Integrity Measurements." The speaker was Dr. Karl J. Bois of Hewlett Packard. This talk was part tutorial and part Q & A. Dr. Bois kicked off the tutorial portion of the meeting by reviewing some electronic history. The recent explosion in the Internet and high-speed signaling in particular means that the accurate characterization of signal path is now of very high concern to engineers. Traditionally the transmission line was short enough that lumped parameters models could be used with a high degree of accuracy. Some typical transmission line structures

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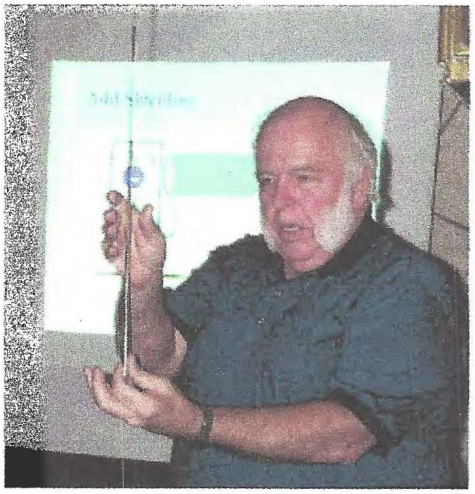

Photo by Steve Gerard

At the Phoenix March Chapter meeting, Ron Brewer of Laird Technologies explains how cable shields will act as quarter-wave antennas if inappropriately terminated.

were shown with their associated models. Problems concerning convergence issues were also discussed and S-parameters were introduced. After an all too short introduction into S-parameters, Dr. Bois then displayed some typical s-parameter responses for well-matched and poorly matched transmission lines - providing the audience with a sneak peak to the next portion of the talk, the VNA (Vector Network Analyzer). Dr. Bois then lifted the hood and gave us a peek into the internal functions of the VNA. A great deal of time was spent discussing and examining the central issue — the calibration of the VNA. Presentation materials are available for download from the chapter web page.

Photo by Stephen Stimac

Jerry Ramie of Compliance Systems, the speaker at the January meeting of the Seattle EMC Chapter, wows the audience with hand motions emphasizing the finer points of emerging EMC standards.

Photo by Stephen Stimac

Robert G. Olsen, of Washington State University in Pullman, took some time to answer questions on ELF electric and magnetic field health effects following his presentation to the Seattle EMC Chapter in February.

In March, the Chapter met at StorageTek Corporation in Louisville, where 28 people turned out to learn more about "The Basic Physics of Electromagnetics without Abstract Mathematics," presented by W. Scott Bennett. Scott wanted to present a different way of studying electromagnetic fields that can actually be applied to real life problems. The presentation kicked off with the basics: the sources of electromagnetic fields are electric currents. Although not a revelation to many, this was the cornerstone of his presentation development. In the entire talk, Scott never once mentioned voltage; rather the analysis was entirely based on an analysis of the current propagation along a transmission line. Indeed, Scott created some discussion when he presented the concept of +ve and -ve current on the same wire. Scott then graphically showed how currents along the transmission line are different (for different phases) and demonstrated how currents can double and subtract along the transmission line path. Having formed that basis, Scott then presented a new point source - the differential monopole. This is a simpler equivalent of the differential dipole - or Herzian dipole. Scott then developed the fields caused by that source using some basic EM theory and "high-school" math. Using the differential monopole, Scott showed that, in order to meet EMC requirements, the distances between equal and opposite point sources of a trace and its return should be minimized. This implies that the loop area is minimized and that the trace and its return have the same length so that they have the same number of point sources. The conclusion of the talk nicely rounded off the presentation. Scott did indeed show that one could use this new concept to analyze EM fields without knowing Maxwell's equations. Presentation materials are available for download from the chapter web page at http://www.ewh.ieee.org/r5/denver/rockymountainemc.

Seattle

Over 30 people attended the January 30 Seattle EMC Chapter meeting, including five people from Alpha Technologies who made the three-hour round trip drive from Bellingham to hear the topic "Emerging Standards for Europe" by Jerry Ramie of Compliance Systems Corporation in San Jose, California. The "New Approach Directives" of the European Union mandate new and expanded testing for regulatory compliance for most electrical/electronics products. Jerry explained in a novel way how these standards affect a vast array of products, some of which have not been subject to such rigorous testing in the past. The important changes to the EMC Directive and their impact on many products were discussed in the presentation. Jerry Ramie is a 20-year veteran of Regulatory Compliance, EMC, and RF/Microwave measurement instrumentation. In the early 1980's, he was a Field Sales Engineer with EATON Corp. This involved providing EMC Test Equipment and Systems, RF and Microwave Spectrum Analyzers, Synthesized Signal Generators, AC Products, Noise Figure Equipment, and Broadband Linear Amplifiers for Military and Commercial test installations. This background and experience was evident in his presentation as he confidently dis-

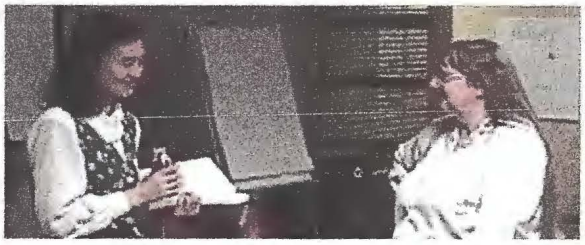

Photo by Stephen Stimac

Speaker Lynne Green of Innoveda (right) discussed signal integrity techniques with Lina Zhang of Interpoint following her presentation at the March Seattle Chapter meeting.

Photo by Stephen Stimac

Several Seattle EMC Chapter members got together for dinner prior to the March meeting, including Len Carlson (foreground left), Chapter Chair Janet O'Neil (2nd from right) and Dr. Lynne Green (far right).

Photo by Stephen Stimac

Todd Robinson and Ron Dulmage of CKC Labs chat with Joel LaChance of Microsoft (L-R) following the Seattle Chapter meeting. Note the famous dB clock invented by the late Al Parker of Solar Electronics in the background (see page 14 of this Newsletter for more information on Mr. Parker).

Photo by Stephen Stimac

(L-R) Leo Smale and Jeannie Olson of Kalmus have plenty to smile about. Their company was recently purchased by Amplifier Research (AR). Ken Shepherd of AR was on hand to make the announcement with them at the January Seattle Chapter meeting.

cussed the various EN test set-ups and procedures. Also at this meeting, locals Jeannie Olson and Leo Smale of Kalmus brought along a guest, Ken Shepherd of Amplifier Research (AR) in Souderton, Pennsylvania. Leo announced that AR just purchased Kalmus. That was big news!

Again, over 30 people attended the February 27 Seattle EMC Chapter meeting with Professor Bob Olsen from the School of Electrical Engineering and Computer Science at Washington State University, Pullman, Washington. The meeting was held at CKC Labs in Redmond. The hospitality of the folks at CKC Labs was stellar, as usual! Professor Olsen spoke on the topic "Recent Developments in the ELF Electric and Magnetic Field Health Effects Issue." The presentation included an update on the extremely low frequency (ELF) electric and magnetic field health effects issue (with an emphasis on recent developments in the United States). The review included information about the scientific consensus, the status of standard development, new field mitigation techniques and several ongoing bioelectromagnetics research projects. Professor Olsen shared the following quote from a recent column by Dave Barry of the Miami Herald entitled "College Students to Blame for the California Power Crisis." *"..... Nevertheless, Franklin had proved an important scientific point, which is that electricity originates inside clouds. There, it forms into lightning, which is attracted to the earth by golfers. After entering the ground, the electricity hardens into coal, which, when dug up by power companies and burned in big ovens called "generators," turns back into electricity, which is sent in the form of "volts" (also known as "watts," or "r.p.m." for short) through special wires with birds sitting on them to consumer's homes, where it is transformed by TV sets into commercials for beer, which passes through the consumers and back into the ground, thus completing what is known as a "circuit."* This generated a good chuckle during the meeting. For more information on the topic, Professor Olsen shared John Moulder's web sites for power line and cell phone research as follows:

Questions and Answers on the Connection Between Power Lines, Electrical Occupations and Cancer: http://www.mcw.edu/gcrc/cop/powerlines- cancer-FAQ/toc.html
FAQs about Cell Phone Base Antennas and Human Health:
http://www.mcw.edu/gcrc/cop/cell-phone-health-FAQ/toc.html
Static Electromagnetic Fields and Cancer FAQs: http://www.mcw.edu/gcrc/cop/static-fields- cancer-FAQ/toc.html

The Chapter had another great turn out at its meeting on March 27 with Dr. Lynne Green of Innoveda who spoke on the topic "Layout Constraints and Signal Integrity." The meeting was held at AT&T Wireless in Redmond. Prior to the meeting, several chapter members got together for a Seattle Chapter partially subsidized dinner at Thai Ginger in Redmond. Everyone loved the exotic seasonings in the several courses served. The speaker seemed to enjoy it too! Dr. Green presented an interesting tutorial on signal integrity as related to the layout of printed circuit boards. She gave lots of tips of what to do and not do when laying out a board based on her extensive experience with PCB design and layout. She bemoaned the fact that there is a real shortage of RF engineers these days and thus considerable training on signal integrity basics is required for "new hires". During the question and answer session following the one-hour presentation, a debate occurred between the term "signal integrity" and "electromagnetic compatibility." The argument was based upon the belief that these two terms are one and the same thing! Dr. Green has over 20 years of design experience, including I/O design at Duet Technologies and independent consulting in modeling and simulation, and is presently a high speed technical specialist in the High Speed Tools group at Innoveda. She earned the MSEE and Ph.D. degrees in Electrical Engineering at the University of Washington; thus the chapter drew on local talent as speakers for two consecutive months. The Chapter wishes to thank AT&T Wireless for allowing the chapter to meet in their excellent training facility.

The Chapter is actively promoting the June 4-6 Reverberation Chamber, Anechoic Chamber and OATS Users Meeting at the Hyatt Regency Hotel in Bellevue. The Seattle EMC Chapter is helping with the organization of this international EMC event. The Chapter is also helping promote the June 4 Oregon and SW Washington Chapter Colloquium and Exhibition with Dr. Clayton Paul and other speakers. This will be held at the Governor Hotel in Portland. Visit the IEEE Seattle Section website at www.ieee-seattle.org/ for more information about Seattle EMC Chapter activities.

continued on next page

The workshop organizers Carlos Sartori, J. R. Cardoso, and Denise Consonni, are shown during one of the sessions (head-table L-R).

Ray Findlay, the IEEE President, (in gray shirt on right) and IEEE South Brazil Section members at the luncheon meeting.

Carlos Sartori, Ray Findlay, and José Perini enjoyed the warm weather following the luncheon meeting in São Paulo (L-R).

South Brazil

The EMCS Chapter of the South Brazil Section has been formed! The effective date of the chapter formation is 29 December 2000, and Carlos Sartori was appointed as the Chapter Chair. In January, the first administrative meeting took place where planning activities for 2001 were proposed. After that, some technical events were held by the local Chapter: The first one, the "Brazilian Workshop on Biologic Effects due to Electro-magnetic Fields", organized in cooperation with other Brazilian Societies, was held on 26 and 27 March, in São Paulo. Secondly, taking advantage of the visit of Professor Perini to Brazil, two very interesting lectures were given on 30 March, at the Polytechnic School - University of São Paulo including: "An Alternative Way to Stir the Fields Inside a Mode Stirred Chamber", and "EMC Measurement Uncertainty – What is it?" There were 153, and 20 attendees, IEEE members and non-members, at these events, respectively. The Chapter also had the pleasure of taking part in a lunch on 18 March with the IEEE President, Ray Findlay, and several IEEE South Brazil members where very important points concerning general aspects of the IEEE Societies and the potential Brazil and Region 9 formation of new chapters were discussed. **EMC**

Professor Perini explained the mode stirring chamber concepts at the Polytechnic School - University of São Paulo.

Marcio Lobo, the IEEE South Brazil Section Chair, with the workshop organizers Denise Consonni, Carlos Sartori, and J. R. Cardoso (L-R).

AWARDS NOMINATIONS REQUESTED!

It's time to start thinking about nominations for awards to be presented at the Awards Luncheon held during the *2001 IEEE International Symposium on EMC*, August 13-17, 2001 in Montreal, Canada.

Consider nominating a fellow co-worker or others whose IEEE volunteer work deserves recognition! Visit the EMC Society web page at *www.emcs.org* to see the list of award categories, criteria for awards, and past award recipients.

Nominations must be submitted by July 1, 2001 to Henry Benitez, Awards Chairman, at phone 360-212-0471, henry_benitez@ hp.com.

2001 IEEE EMC Symposium

August 13-17, 2001

Montréal

It is with great pleasure that we ask you to come to our International Rendez-Vous for Electromagnetic Compatibility to be held on the 13th to 17th of August, 2001 at the Palais des Congrès in Montréal, Québec, Canada.

Summer in Montréal is a most beautiful setting for engineering professionals, their families and friends attending and participating in the 2001 IEEE EMC Symposium. The Symposium will include technical speakers, exhibits, and workshops.

You are invited to enjoy our unique city, fine dining and experience our renowned "joie de vivre".

We are looking forward to seeing you.

The 2001 IEEE EMC Committee

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EMC 2001
International Rendez-Vous
Montréal, Canada

Photographs: Tourisme Montréal

Al Parker, Well Known EMC Society Member, Dies at 87

"I received the sad news that Al Parker passed away recently. He was 87 years old. Al was certainly a pioneer in our industry. He was the first with the ancillary equipment - LISN's, current probes, etc. He was both extremely honest and moral, and didn't believe in overcharging, even though he may have had the only product to serve the need. Solar Electronics recently moved from its Hollywood location, which Al told me was on a verbal month-to-month lease for over 30 years. Until he became ill last December, he was the chief engineer who designed all of Solar's products. If you ever got a product that didn't meet spec, Al would replace it without any question. He was an icon of our industry that I will surely miss."
—Robert D. Goldblum, ITEM Publications

A.T. Parker was educated in St. Louis, Missouri. During World War II, while at Bendix Radio in Baltimore, he designed radio communications receivers and served as a Systems Engineer. He designed aircraft systems wiring for electronics aboard the American bombers that flew in that war. He also served as Manager of the Field Service Department.

In 1947, he joined Stoddart Aircraft Radio Company in Hollywood, Cali-fornia. As Chief Engineer, he designed and supervised the design of Radio Interference and Field Intensity Receivers on Navy contracts. These receivers were the first to be designed specifically for measuring what is now called electromagnetic interference (EMI).

In 1957, Mr. Parker joined with the late Fred Nichols and the late Jerry Rothhammer in organizing the first technical group devoted to Radio Interference, which at that time was considered a "black art". They named themselves the Professional Group on Radio Frequency Interference (PGRFI). Several years later, this group became the nucleus of the EMC Society of the IEEE.

In 1960, he started his own company called Solar Electronics in Hollywood. In 1962, he began designing and supplying ancillary test items for use in EMI laboratories. These items include spike generators, audio sources, current probes, injection probes, LISN's and many other useful devices. New products are always under development. The company is well known throughout the world, with sales offices in more than twenty countries. The integrity of the staff and the quality of the products have earned the company an enviable reputation and are truly Mr. Parker's legacy. **EMC**

Editor's Note: The Editor wishes to thank the Parker family for providing the above information. Al Parker was a well-liked and much admired member of the IEEE EMC Society Los Angeles Chapter, of which your Editor was a long time member. At the Chapter's table top shows, he would often donate one of his famous dB clocks to be raffled as a prize. We've included some information on the dB clock he designed. You can see he was a creative and original EMC engineer. He was also a gentleman whose ready smile will be sorely missed by all who had the pleasure of knowing him.

Practical Papers, Articles and Application Notes

Bob Olsen, Associate Editor

In this issue you will find three practical papers that should be of interest to the EMC community. The first is a summary by Michael Windler of the discussions from the Zurich workshop entitled, "EMC Measurements Including Those Above 1 GHz and Associated Uncertainties." You will find it featured on the cover of this issue. Those of you who are now required to make such high frequency measurements will be interested in these discussions. The second paper was written by Eisuke Hanada and several others and is at the opposite end of the frequency spectrum. It is about the potential effect on sensitive medical equipment of high DC magnetic fields due to residual magnetization in the structural steel of a hospital. This is a source of interference that could easily be overlooked. The third, by Frank Leferink and Wim van Etten, was originally presented at the EMC Symposium in Brugge and was deemed to be of sufficient interest to publish in this Newsletter. It concerns the design of reverberation chambers that have increased field homogeneity and field strength, the "Holy Grail" of EMC chamber design.

The purpose of this section is to disseminate practical information to the EMC community. In some cases the material is entirely original. In others, the material is not new but has been made either more understandable or accessible to the community. In others, the material has been previously presented at a conference but has been deemed especially worthy of wider dissemination. Readers wishing to share such information with colleagues in the EMC community are encouraged to submit papers or application notes for this section of the Newsletter. See page 2 for my e-mail, FAX and real mail address. While all material will be reviewed prior to acceptance, the criteria are different from those of *The Transactions on EMC* papers. Specifically, while it is not necessary that the paper be archival, it is necessary that the paper be useful and of interest to readers of the *EMC Society Newsletter*.

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

Possibility of Electromagnetic Interference with Electronic Medical Equipment by Residual Magnetization in a Building with a Steel Structure

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Abstract

Electromagnetic interference (EMI) with electronic medical equipment is a problem of increasing concern. Although there is the possibility of EMI by a static magnetic field, no safety standards for electronic medical equipment have been formulated. We measured the magnetic flux density of our hospital building, which is constructed with a steel frame. We also investigated EMI with a digital electrocardiograph, an analog electroencephalograph, and four types of monitor displays.

Strong magnetic flux density, exceeding 200μT, was observed at the welds of deck plates, at the piping holes of metal deck plates, and at the welds of metallic ornaments hanging from the deck plates. Magnetic flux density changes greatly with slight differences of probe location. EMI was observed on a CRT, but not on a LCD, a color TFT, a PDP, or the medical equipment.

In this study, a static magnetic field was confirmed to cause EMI with a CRT, which is an integral part of some electronic medical equipment. Hospitals would benefit from residual magnetic field measurement to protect patients from EMI. De-magnetizing or magnetic shielding would help prevent EMI.

Keywords: electromagnetic interference, static magnetic field, residual magnetization, electronic medical equipment, display monitor

I. Introduction

Electromagnetic interference (EMI) with electronic medical equipment is a problem of increasing concern. EMI by electromagnetic field radiation (radio waves) has been reported [1-3]. Compatibility and immunity standards for electronic medical equipment against radiated electromagnetic fields have been issued internationally [4]. However, there are no reports of EMI by a static magnetic field. Although the possibility of EMI with electronic medical equipment, such as an artificial-heart pacemaker, by static magnetic fields has been reported [5], no safety standards for electronic medical equipment have been formulated.

In this study, we investigated EMI by static magnetic fields by measuring residual magnetization at electric welds, possible sources of static magnetic fields, in our steel structured hospital building.

II. Methods

A. Magnetic flux density measurement

A new building at Kyushu University Hospital has 11 above ground floors and one basement floor. The steel framing had been completed, and the interior finish work was being done at the time of testing. We measured magnetic flux

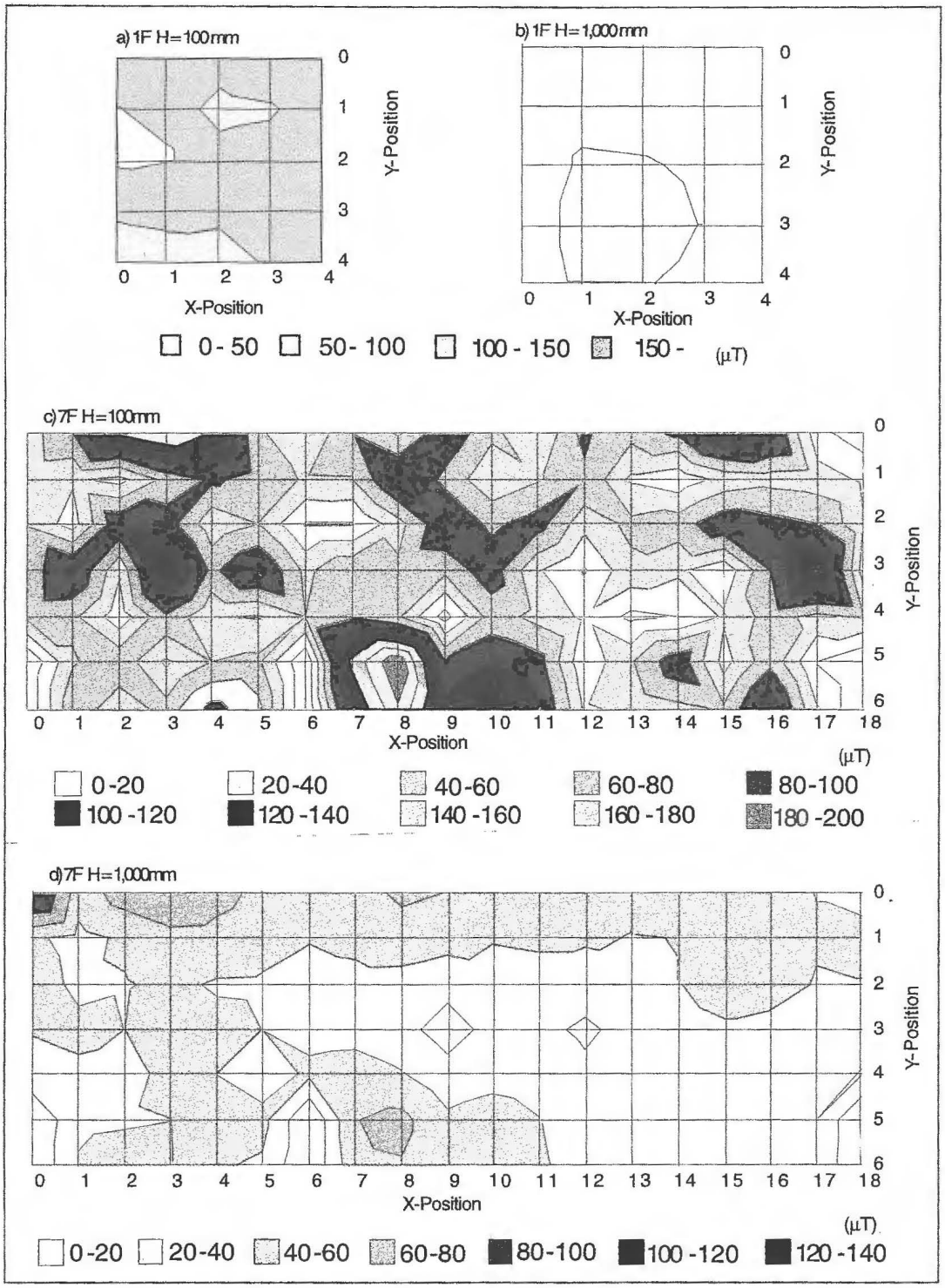

Fig.1. Magnetic flux density distribution

a) 100 mm above the floor in the emergency treatment room (1F)

b) 1,000 mm above the floor in the emergency treatment room (1F)

c) 100 mm above the floor in the Neurosurgery ICU (7F)

d) 1,000 mm above the floor in the Neurosurgery ICU (7F)

density in the emergency treatment room, intensive care unit, coronary care unit, and recovery rooms, rooms in which a number of pieces of electronic medical equipment would be installed. Magnetic flux density measurement was done 100 mm and 1,000 mm above the floor at each corner of a 1 m grid drawn on the floor of each room measured.

A Gauss meter (HM-320, MTI Co.) and a 3-axis probe (attachment HM-320, MTI Co.) were used. A 3-axis probe with a Gauss meter can measure the magnetic flux density in 3 axial directions simultaneously using the magnetic dispatch system. The measurable range of the Gauss meter is from -200μT to +200μT. Accuracy is 100 nT for each direction.

The magnetic flux density *Fe* at each point measured was calculated by the following equation (1).

$$Fe = \sqrt{Fx^2 + Fy^2 + Fz^2} \quad (1)$$

where, *Fx, Fy, Fz* are the magnetic flux densities obtained by the Gauss meter for the three directions.

Measurement was done on a holiday when there was no construction activity. The weather was cloudy.

B. Observation of electronic medical equipment and monitor displays

At each point of highest magnetic flux density measurement, we determined if EMI occurred with a digital electrocardiograph (ECG-9020, Nihon Kohden Co. Ltd.) including a monochrome liquid-crystal-display (LCD) monitor [6], and with an analog electroencephalograph (EEG-7414, Nihon Kohden Co. Ltd.). The electrocardiograph was placed on the floor when testing, and a person acting as a patient lay on a plastic bench 400 mm from the floor. The electroencephalograph was on a wagon at a height of 1,000 mm with the same person sitting on the plastic bench during testing.

For both pieces of electronic medical equipment, a skilled clinical engineer carefully attached sensors to the person. Sensor noise was decreased to the minimum. Both the electrocardiograph and the electroencephalograph were electrically grounded to reduce noise from the exchange power supply to a minimum.

We tested whether or not color distortion would arise in a television cath-

ode-ray tube (CRT) display by playing a video tape from a television with a built-in video player. We also tested 2 digital patient monitors (M3000A and M1205A, Agilent Technologies Ltd.) with color liquid crystal displays that used thin-film transistors (TFT) monitor [7]. Each monitor was operated in test mode. A 42-inch plasma display panel (PDP) [8] (Flexscan P4260, Eizo) attached to a personal computer and a digital patient monitor were also tested. A mono-color image, a picture image, and animation were displayed, and distortion and color change on the display were observed by three persons. These observations were done at the point of highest magnetization in the emergency operation room on the first floor and in a recovery room on the seventh floor.

(Unit: μT)

rooms	floor	Magnetic flux density (H=100 mm)	Magnetic flux density (H=1000 mm)
emergency treatment room	1F	214.5	77.8
ICU, CCU	3F	-	86.8
surgical operation room	3F	-	138.6
common patient bedroom	5F	65.9	83.8
neurosurgical ICU	7F	210.6	110.6
recovery room	11F	130.5	112.1

Table 1. Maximum magnetic flux density at each observation point

III. Result

A. Magnetic flux density measurement

Two examples of measurement results are shown in Fig. 1. Values on the X and Y axes show the distance of the measurement point from the wall, and the value on the Z axis shows the magnetic flux density. Magnetic flux density changes greatly with slight differences of probe location. Especially strong magnetic flux density was observed at the welds of deck plates, the piping holes of metal deck plates, and the welds of metallic ornaments hanging from the deck plates. Strong magnetic flux density was also observed close to the following points; aluminum sash frame to metallic wall structure welds, the welds of steel girders to each other, and welds of the metal frames in partition walls.

The maximum magnetic flux density observed at each measurement point is shown in Table 1. Strong magnetic flux density was observed on every floor. The magnetic flux density exceeded the range of the Gauss meter at 100 mm above the first and seventh floors. The magnetic flux density 100 mm above the floor was higher than at 1,000 mm above the floor at most of measurement points. For example (see Figs. 1c and 1d), the maximum magnetic flux density measured in the recovery room on the seventh floor was 210.6 μT at 100 mm above the floor and 110.6 μT at 1,000 mm above the floor.

B. Observation of medical equipment and displays

No EMI was observed with the electrocardiograph or the electroencephalograph. No noise was observed on either piece of equipment. Monochrome LCD, TFT monitor, and PDP showed no distortion or color change. However, color change was observed in the television CRT at measurement points where strong magnetic flux density was observed. The color change was different as the position of the television changed. For example, blue on the CRT became red or green with very slight differences in the location of the television. The color change was not seen over the whole screen, but was partially changed or parts of the screen changed with changes of location. The color change lessened as the television was moved to higher positions.

IV. Discussion

Because of the strong magnetic flux measured, it was expected that the electroencephalograph placed 1,000 mm above floor and the electrocardiograph placed on the floor would experience EMI. However, no EMI was observed for either.

For the electrocardiograph, since the direction of the magnetism was fixed in the static magnetic field, the magnetism filter (de-gauss filter) possibly protected it from EMI. For the electroencephalograph, the pen driver coils, which tend to be easily interfered with by magnetism, were in a position 1,000 mm above the floor, a sufficient distance to fully protect it from EMI from the weak magnetic flux density found 100 mm from the weld.

EMI with the CRT was observed, but none was observed with the LCD. The direction of CRT beams is changed by magnetic power from two magnetism deviation coils. The beams make a fluorescent material luminous. Therefore, when magnetic flux density is strong, magnetism is forced in a direction different from that of the magnetism deviation coil, and color change or distortion appears. The liquid-crystal elements of an LCD would not change direction unless very powerful magnetism was radiated. The source of light for the monochrome LCD used in the observation was external light reflected in a mirror in the back of the screen. A LCD does not use a deviation coil. Theoretically, LCDs should be little influenced by magnetism.

In the case of static magnetic fields, magnetic flux density is in inverse proportion to the square of the distance from a magnetized point. Therefore, it is possible to prevent EMI by keeping electronic medical equipment away from the magnetized weld. When equipment cannot be placed far enough from a weld, de-magnetization [9-10] or shielding may be necessary. De-magnetization can negate the magnetic energy by emitting the same volume of magnetic energy in a reverse direction to

Less than 100 μT (1G)		Less than 500 μT (5G)
Pet Scanners		Cardiac pacemakers
CT Scanners		Neurostimulators
Ultrasound		Biostimulation devices
Lithotriptors		
Nuclear Cameras		
Video displays		
Color TV		
Electron microscopes		
Image intensifiers		

Table 2. Equipment typically susceptible to various static magnetic field levels as reported by GE Medical Systems

every magnetized point, after investigation of magnetic energy and its direction. However, when there are large numbers of magnetized welds, de-magnetization requires much time. Magnetic shielding, such as highly permeable materials, permalloy, silicon plate, and amorphous metal can be used to protect electronic medical equipment from magnetism. However, highly permeable materials are expensive. One standard for safe performance in cases where magnetic flux density is over 80μT (0.8 G), the standard for CRT [11], is placement from 100 mm to 300 mm above the floor. This is considered the lowest safe installation height for general electronic medical equipment. GE Medical Systems has published a Proximity Limit Chart for their MRI systems that indicates equipment typically susceptible to various static magnetic field intensities. Examples are shown in Table 2.

V. Conclusion

In this study, a static magnetic field was confirmed to be the cause of EMI with a CRT, which is an integral part of some electronic medical equipment. The residual magnetization of welds in a hospital should not be overlooked. Near the electric welds of steel frames and deck plates, strong residual magnetic flux density, which may produce EMI with electronic medical equipment, was found. Therefore, it would be beneficial for hospitals to do residual magnetic-field measurement and to place electronic medical equipment away from strongly magnetized points when strong magnetic fields are found. De-magnetization or magnetic shielding would be helpful for the prevention of EMI.

Acknowledgement

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Generating an EMC Test Field Using a Vibrating Intrinsic Reverberation Chamber

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Abstract: The impact of the geometry of a reverberation chamber, as used for electromagnetic compatibility testing, on spatial uniformity, isotropicity and quality factor are described. A new reverberation chamber with varying angles between walls, floor and ceiling and with vibrating walls is presented. Inside this Vibrating Intrinsic Reverberation Chamber (VIRC) a diffuse, statistically uniform electromagnetic field is created without the use of a mechanical, rotating, mode stirrer. Test results obtained in the VIRC are presented.

Introduction

Reverberation chambers have grown in popularity for electromagnetic immunity (EMI) testing in the last decade. A reverberation chamber generally consists of a rectangular test room with metal walls and a mode stirrer, usually in the form of a large paddle, near the ceiling of the chamber. The equipment under test (EUT) is placed in the chamber and exposed to an electromagnetic field while the stirrer slowly revolves. The average response of the EUT to the field is found by integrating the response over the time period of one revolution of the stirrer. The metal walls of the chamber allow a large field to be built up inside the chamber. The EUT is therefore exposed to a high field level consisting of several different polarizations [1,2,3,4].

In classic electromagnetic immunity testing, tests are performed in a well defined, non-random environment such as a transverse electromagnetic cell or an anechoic chamber. In these deterministic environments the distribution and the polarization of the fields are invariant with time because the operational principles of these methods rely on a single dominant mode of propagation. A reverberation chamber does not give a deterministic field but provides an electromagnetic environment which is

- spatially uniform, i.e. the energy density in the chamber is uniform everywhere
- isotropic, i.e. the energy flow in all directions is the same and
- randomly polarised, i.e. the phase, and thus polarisation, between all waves is random.

These requirements are fulfilled if there are a large number of eigenmodes in the chamber, which is the case above a certain

frequency. Furthermore the degeneracy, i.e. how many modes coincide at a certain frequency, and mode separation is an important parameter.

The main advantage of reverberation chambers is that inside such a chamber it is possible to generate high field strength using modest power sources. Therefore we need a high quality factor Q.

These aspects will be discussed in the next paragraph.

Reverberation Chamber Properties

Mode Separation

The analysis of chamber resonators requires solution of Maxwell's equations subject to the boundary conditions of the chamber walls. For simple geometrical shapes such solutions may be found by superposing incident and reflected travelling waves for the corresponding guides to produce standing waves. For nonseparable geometries ray analysis instead of modal analysis is needed. With the available calculation power this technique is not converging and thus not available. A thorough theoretical discussion about the determination of resonant modes for several chamber geometries can be found in [5, 6]. The mode separation for

- cubical
- rectangular (l=5.55m, w=4.44m and h=3.33m)
- circular
- isosceles right-triangular
- $\pi/3$ right-triangular and
- equilateral-triangular

chambers with *equal* volume is presented graphically in Figure 1. In this figure every resonance frequency (~mode) is presented as a vertical line. If adjacent resonance frequencies are within 1 MHz bandwidth then the vertical line is extended by a horizontal line. If resonance frequencies are separated uniformly in the frequency range then less vertical lines are visible. From the results in Figure 1 we can conclude that the 543-rectangular chamber gives the best mode separation

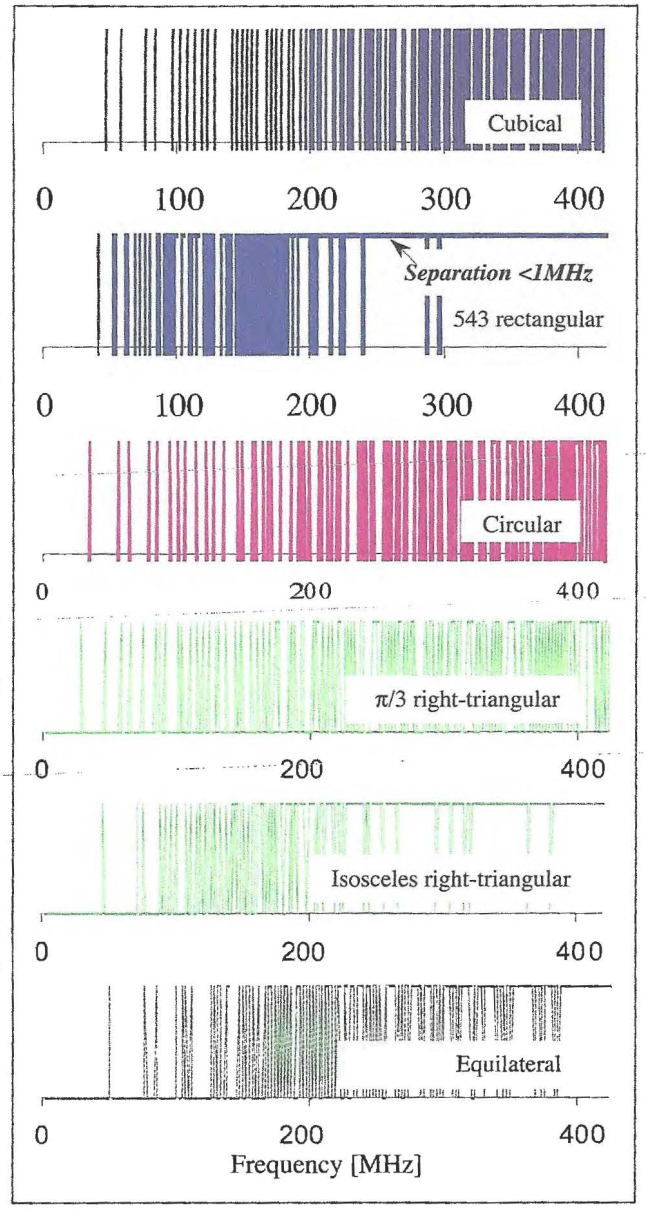

Figure 1. Mode separation for different chambers

Mode Number

Our main objective for EMI testing is a high level of spatial uniformity and isotropicity. This can be achieved if the resonance frequencies are spread over the frequency range. Another measure for this spreading is the smoothness of the mode number function. The mode number function is the cumulative number of modes versus frequency N(f) , which is actually a discontinuous function. It can be obtained by mode counting. A smooth approximation can be calculated by observing that the wavenumber equation [7] is actually an ellipsoidal equation [6]. The volume of this ellipsoid is

$$V = \frac{4}{3}\pi \; lwh\left(\frac{2f}{c}\right)^3 \qquad (1)$$

where only the modes inside the ellipsoid can be used.

It can be noted that *TE* and *TM* modes of the same order have identical resonance frequencies. Such modes with different field patterns but the same resonant frequency are known as degenerate modes. This has to be considered in mode counting. Therefore the total number of modes in a rectangular chamber is approximately[6]

$$N_h(f) = \frac{8}{3}\pi \; lwh\left(\frac{f}{c}\right)^3 \qquad (2)$$

which is equal to Weyl's formula [4], where $V=lwh$ is the volume of a cavity of general shape.

The more degeneracy the chamber, the less smooth is the cumulative mode number function, and the less spatial uniformity and isotropicity. The number of modes for several chambers has been obtained by mode counting. The most interesting chambers are

- a cubic shaped chamber with $l=w=h$=4.35m compared to
- a 543-rectangular shaped chamber with equal volume, dimensions l=5.55m, w=4.44m and h=3.33m.

The cumulative number of modes for the rectangular and cubic shaped chamber are drawn with the theoretical Weyl curve in Figure 2.

Comparing the two chambers the 543-rectangular shaped chamber has lesser deviation from the smoothed Weyl curve than the cubic shaped chamber. This supports again the idea that for mode separation the dimensions of a chamber should be disassociated.

Quality Factor

The quality factor Q of a chamber is defined as the stored energy U in the chamber divided by the power P_d that must be injected into the chamber, multiplied by the angular frequency, $\omega=2\pi f$, of operation:

$$Q = \frac{\omega U}{P_d} \qquad (3)$$

Four types of loss, decreasing the quality factor, have been denoted: the loss due to power dissipated in the walls,

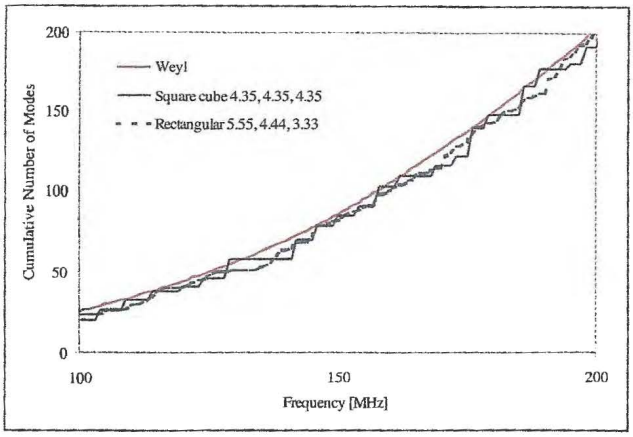

Figure 2. Cumulative number of modes for a rectangular and cubic shaped chamber and the Weyl curve

the loss due to power absorbing objects in the chamber, the leakage through apertures and the loss due to the power dissipated in the loads of receiving antennas [8]. From these loss mechanisms the wall loss is usually dominant and the only loss type applicable when comparing different chambers [7]. If we assume furthermore that a highly conducting chamber is used then the quality factor reduces to the more widely and more general expression for the first-order Q [7,9]:

$$Q = \frac{3V}{2\delta S} = \frac{3}{2\delta}\frac{V}{S} \qquad (4)$$

where: V volume [m3]
S surface [m2]
δ skindepth [m]
μ_r relative permeability of wall

Our objective for EMI testing is to create a high quality factor Q resulting in a high field strength, besides the requirements for spatial uniformity and isotropicity. This can be achieved by minimising the surface S of the chamber for a given volume V. It has been shown [5] that the quality factor is maximised for a spherical chamber, compared to cubical, rectangular, circular and triangular shaped chambers. On the other hand, a spherical chamber results in the poorest spatial uniformity because the field will be focussed in the center of the chamber [5, 7].

A good compromise with respect to mode separation and quality factor could be a rectangular shaped chamber.

Mode Modification Techniques

A reverberation chamber should yield in a high spatial uniformity and isotropicity. Chambers with fixed boundary conditions cannot fulfil these requirements, at least not below a minimum frequency.

Mode modification techniques have been investigated in the past such as:

- rectangular chamber with wall angle irregularities: the intrinsic reverberation chamber (IRC) [10]
- wall irregularities, such as the phase reflection gratings [11, 12], Schroeder diffusers [13] or corrugated walls [14]
- mode tuning or stirring (the classic mode stirred chamber) and
- moving wall [15]

These mode modification techniques are drawn in Figures 3, 4, 5, 6 and 7.

The IRC has never been tested in practical applications. The phase reflection gratings, Schroedinger diffusers and corrugated walls have been proven to improve the spatial uniformity of the field inside the chamber. The moving wall has been analysed but cannot be built in a practical sense.

In the next paragraph a new reverberation chamber is presented which is an optimisation of all known techniques for improved spatial uniformity and isotropicity without a decrease in quality factor.

Vibrating Intrinsic Reverberation Chamber (VIRC)

It has been shown that the variation of the boundary conditions deviate the reso-

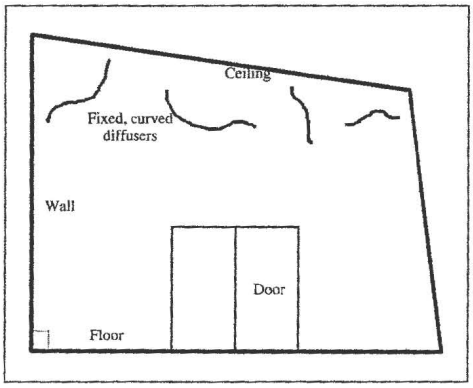

Figure 3. The Intrinsic Reverberation Chamber [10]

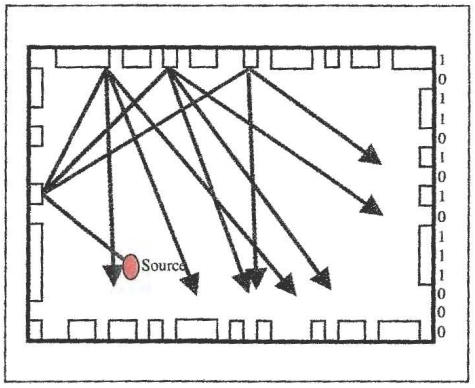

Figure 4. Phase reflection gratings [11,12]

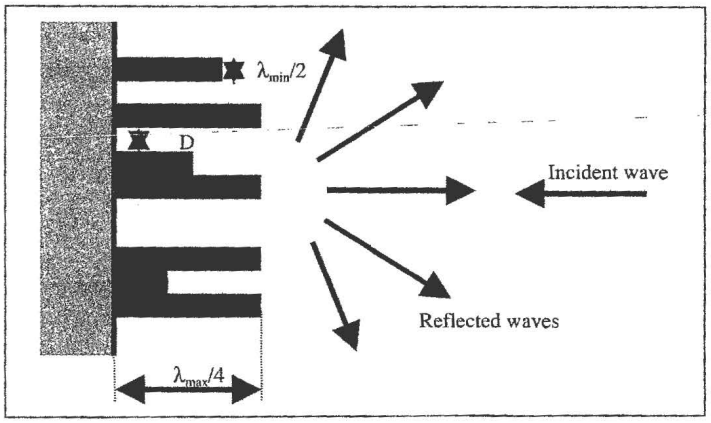

Figure 5. Principle of Schroedinger diffusers [13]

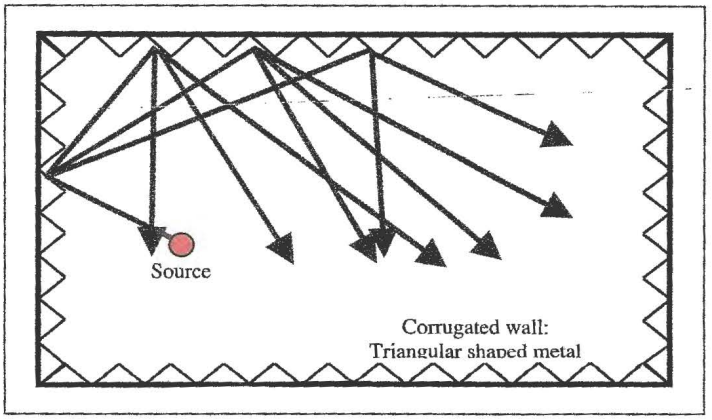

Figure 6. Corrugated walls [14]

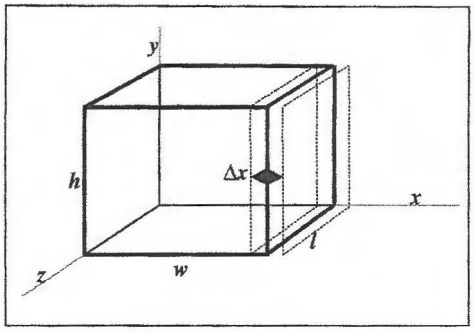

Figure 7. Moving wall [15]

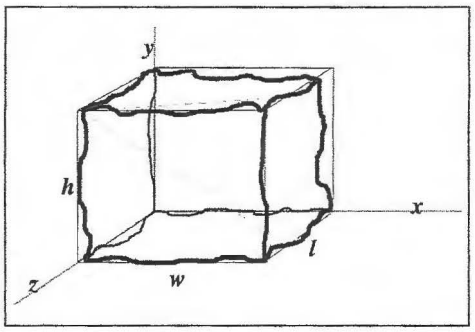

Figure 8. The VIRC: a flexible tent with irregularly shaped walls

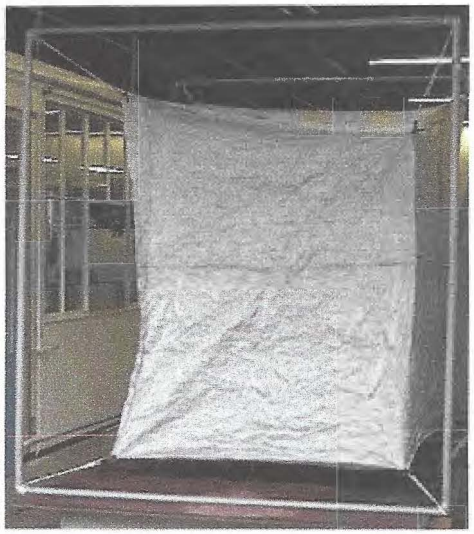

Figure 9. The VIRC hanging in strings

nant behaviour of a reverberation chamber. For proper mode separation we need asymmetric structures. On the other hand, circular structures result in focussing of rays and thus degrade the spatial uniformity. Wall irregularities and wall-floor angle irregularities show that the spatial uniformity and isotropicity can be improved.

By changing all angles of the wall-floor-ceiling of a reverberation room at a high rate compared to the classic mode stirrer in mode stirred reverberation chambers we can use all beneficial effects. This technique is called Vibrating Intrinsic Reverberation Chamber (VIRC) and drawn schematically in Figure 8.

The VIRC is a reverberation chamber where the walls are made of flexible conducting material. It is mounted in a rigid structure and connected to that structure via flexible rubber strings, as shown in Figure 9. By moving one or more ridges or one or more walls the modal structure inside the chamber is changed. Because the resonance frequency shift is much larger compared to what is possible with a classic mode stirrer, the frequency range of the chamber is extended to lower frequencies compared to classic (mode stirred) reverberation chambers with equal dimensions. Note the natural corrugation of the flexible walls in Figure 9 which is beneficial for the spatial uniformity too. Another advantage is that the flexible chamber can be erected inside a standard anechoic chamber where the EUT has been installed for standard EMI tests. Because all measuring equipment is already available inside a laboratory there is no need for costly test set-up changes. Furthermore the VIRC does not need extra space inside the laboratory: it can be folded and put away fast. The most important advantage of the flexible structure of the VIRC is that it can be installed in-situ.

Experimental Characterisation of a Reverberation Chamber

Numerous experiments could be carried out to characterise a reverberation chamber. Some of them are:

- Resonance frequency variation (Δf)
  The change in resonance frequency provides an indication of the 'stirring efficiency' of the VIRC
- Voltage Standing Wave Ratio (VSWR)
  The VSWR indicates at what frequency the maximum energy transfer can be achieved.
- Stirring Ratio (SR)
  The stirring ratio indicates the effectiveness of a stirring mechanism. If the stirring ratio would be small then the boundary conditions are changed only slightly, and the spatial uniformity is poor.
- Power Density Function (PDF)
  By comparison of the experimental PDF with the theoretical PDF the quality of the chamber can be found: if the experimental PDF is equal to the theoretical PDF then the accuracy of a prediction is very high.
- Cumulative Density Function (CDF)

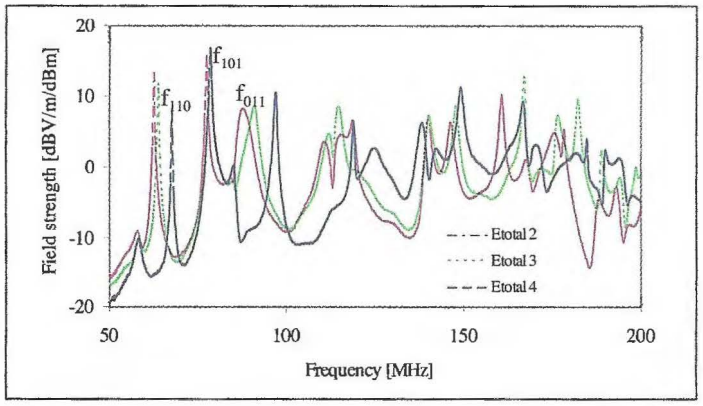

Figure 10. Total electric field strength as function of the frequency for VIRC position 2, 3 and 4

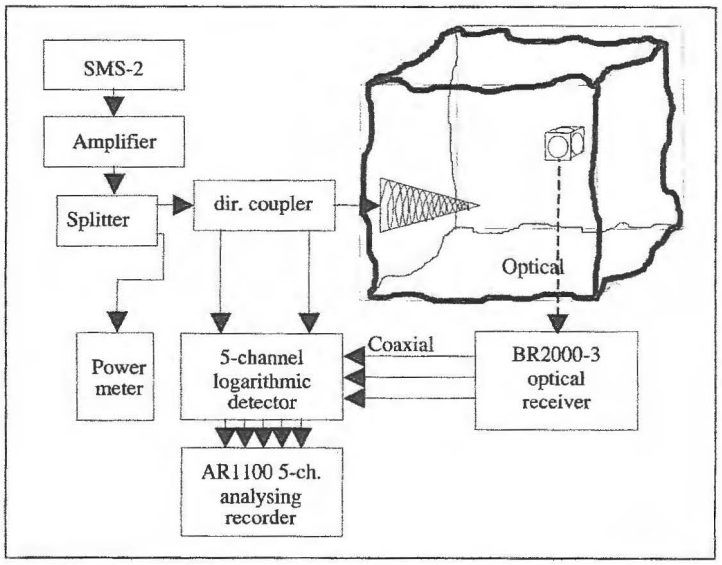

Figure 11. Test set-up for measuring the field strength inside the VIRC as function of change in boundary conditions

Via the CDF a comparison of PDFs for different frequencies is facilitated.

- Spatial Field Uniformity (SFU)
  The SFU gives the ability to generate an isotropic, randomly polarised field which is stochastic equal in the whole volume of the chamber.
- Quality Factor (Q)
  The chamber quality factor Q determines the efficiency of the chamber in relation to the power needed for generating a specific field strength.

Measurements have been carried out in a conventional MSC and the VIRC. Results of the Δf, VSWR, SR, PDF, CDF and Q have been presented in [16, 17]. In this paper only some results of the frequency variation and the power density function are shown.

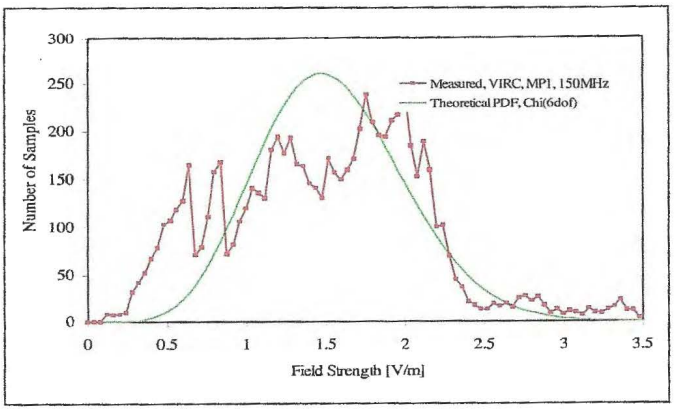

Figure 12. PDF for 150 MHz

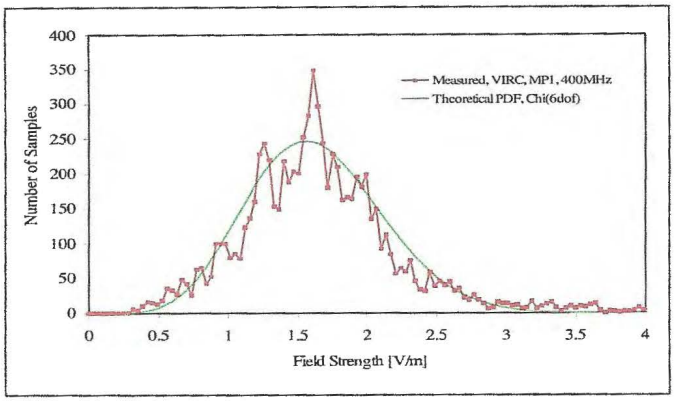

Figure 13. PDF for 400 MHz

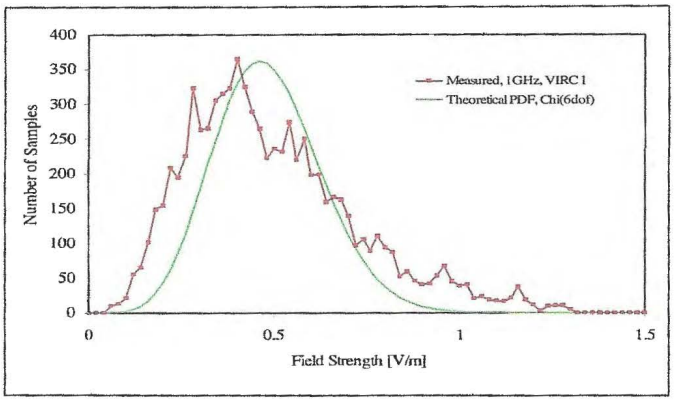

Figure 14. PDF for 1 GHz

Resonance Frequency Variation

The field strength in the three orthogonal directions was measured inside the VIRC as function of the frequency.

An electromagnetic field was generated inside the VIRC by a log-spiral antenna (150 MHz-1 GHz). The antenna was activated by the output of the tracking generator of the Rohde&Schwarz ESS measuring receiver. The field strength inside the VIRC has been measured using the Thomson-CSF ET2003 three-dimensional E-field sensor. The output signal of the sensor was fed to the optical receiver via an optical fibre. The output voltage level of the optical receiver was measured by the ESS measuring receiver for the three axes of the field.

In Figure 10 the total electric field strength between 50 MHz and 200 MHz has been drawn for the situation that the VIRC was at three fixed positions (position 2, 3 and 4), i.e. *not* vibrating. The resonance frequency variation due to the changed VIRC positions is quite large, upped 10 MHz for the f_{011} mode, while the resonance frequency variation in the MSC is only a few MHz [17]

Probability Density Function

The electric field strength has been measured in the three orthogonal directions while the boundary conditions were changing; i.e. the VIRC was vibrating. The movements were random: three persons were independently moving the VIRC. The test set-up was as drawn in Figure 11. Measurements have been performed using a sample time of 1 ms for a signal frequency of 150 MHz decreasing to 0.1 ms for a signal frequency of 1 GHz.

For every frequency 4000 samples have been recorded. The samples were recorded simultaneously for the incident and reflected power and the field strength for every axis, giving a total of 5 channels with 4000 samples. To obtain the probability density function the measured absolute value of the electric field strengths in the three directions were normalized. The samples of the total electric field strength have been sorted from the minimum field strength to the maximum field strength. This yields the experimental probability density function (PDF), as shown in Figures 12 through 14 for 150 MHz, 400 MHz and 1 GHz respectively.

The theory of the stochastic behaviour of reverberation chambers is described in detail in [7]. In [7, 18] it is shown that the magnitude of the electric field strength in any direction is X (Chi) distributed with two degrees of freedom, or Rayleigh distributed. This is based on the assumption that there is no direct path between the transmitting antenna and receiving sensor. If there is a direct path between the antenna and sensor then the Rayleigh distribution has to be modified resulting in the Rayleigh-Rice distribution. This distribution results in a longer tail for the total electric field strength distribution.

From the comparison between measured and theoretical PDF in figures 12, 13 and 14 we can observe that the measured PDF at 1 GHz has a longer tail than the theoretical PDF. Because the dimension of the VIRC was small with respect to the transmitting antenna, the longer tail could be caused by a direct transmission path between transmitting antenna and field strength sensor.

Visualisation of the Spatial Uniformity

In the VIRC three fluorescent tubes

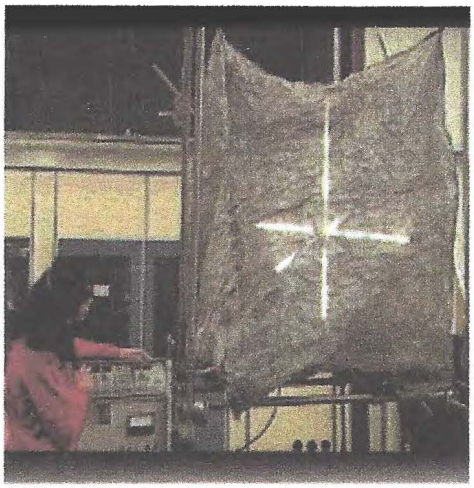

Figure 15. Three fluorescent tube lights in the VIRC, at 3 GHz and 50 W injected power.

Figure 17. Due to the vibration of the walls the light intensity is constant over the volume of the VIRC.

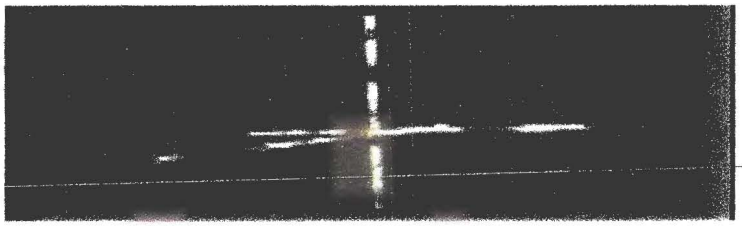

Figure 16. Detail of Figure 16. Note the difference in light intensity ~> field intensity.

are fixed in three orthogonal directions [18]. A field in the VIRC is generated by means of a generator tuned at approximately 3 GHz and an amplifier with an output level of approximately 50 W. Due to the fields inside the VIRC the lights are glowing; bright at the point with a high field strength and dimmed at places with low field strength, as shown in Figure 15. The difference in intensity can be seen in more detail in Figure 16. By moving the VIRC the field structure is changed. This results in the time-averaged constant light intensity as shown in Figure 17.

Conclusion

A new type of reverberation chamber to create a spatial uniform and isotropic electromagnetic field is the Vibrating Intrinsic Reverberation Chamber (VIRC). It makes an optimal use of geometry variations.

Several measurements have been performed within the VIRC and some results have been presented. It was shown that the VIRC can even change the lowest resonance frequency by more than 10 MHz. The experimental PDF shows good resemblance with the theoretical PDF. The spatial distribution of the electromagnetic fields inside the VIRC has been demonstrated.

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Frank Leferink finished his studies in electrical engineering in 1984. Since then he has been an employee of Thales Naval Systems (formerly Thomson-CSF) in the Netherlands. Thales is the largest defense industry outside the US. Mr. Leferink is responsible for the EMC activities within Thales Netherlands. He initiates technology studies and is involved in EMI consultancy, research and engineering tests in the Environmental Competence Center of Thales Netherlands. This unit of 20 employees offers consultancy and performs tests for Thales and external customers in the field of mechanical, climatological and electrical environments. Mr. Leferink is president of the Dutch EMC-ESD Society, a group of 200 EMC and ESD professionals. He is also active as a professor of EMC at the University of Twente. He teaches a course on EMC and initiated and leads several related studies. His main interests are radiated electromagnetic fields generated by printed circuit boards and special test techniques. He introduced TEM cells with more than one septum, dual polarization and was also the first who applied ferrite absorbers in TEM cells. The vibrating reverberation chamber is another new technique. **EMC**

President's Message

continued from page 2

ing to identify individuals worldwide who would be interested in working on a number of Society initiatives. Note that the key word in the last sentence was "working". In that vein, if you are interested in getting involved at the Society/Board of Directors level, we'd like to hear from you. I know many of you have tended to shy away from running for election to the Board of Directors, fearing you do not have the worldwide "name recognition" to get elected. Well to be honest about it, this fear is somewhat real, but a course of action to take to address it would be to first get involved on a committee in areas such as standards, education, membership, or symposia. We are always looking for a few good men or women. We especially need more international representation on several committees. Please consider it as a means of getting more familiar with the Society as well as an avenue for you to meet many more international EMC contacts.

Finally, as you can't help but notice the relatively rapid decline in the high technology marketplace, I hope you're not affected by the increasing number of staff reductions I have been reading about since the first of this year. I doubt that the eventual/inevitable "coming back to earth" of the "dot.com" companies that last year seemed to grow so rapidly in size in both people and capitalization affected many EMC engineers. This is especially true, since many of these companies had not yet developed any products to sell. However, many of the cutbacks earlier this year were in the high technology sector. As I write this column, it would appear that EMC engineers have avoided much of the fallout, but as the slowdown continues, who knows. This is where involvement in your local EMC Chapter meetings can help you. Professional networking has consistently been shown to offer the highest probability for finding a job. Please take advantage of your EMC Society, both at the local level as well as at the international level via our web site, www.emcs.org, or via our international symposium. Looking forward to seeing and hearing from you – call me at 781-939-4267 or e-mail me at j.e.butler@ieee.org. **EMC**

Inter-Society Activities

Mentoring EMC Engineers

By David A. Case NCE, RAC Chairman

Education has always been a key in EMC and a very important key. More and more I find myself in situations where I must do impromptu training even when I am not planning on it. Sometimes it is fun, other times it is annoying. As the field of EMC expands, the greater need for training as our ranks grow.

One thing I have noticed is that some of the basic skill sets are not actually being taught. For example, last year while at a test lab that was qualifying one of our radios, the tester observed that we had a failing frequency below 100 MHz. However, he was surprised when I explained it was channel three audio and was not our product. Since I did not know the ambient of the test lab, how could I know it was an ambient? I explained that when you work in RF, you learn at what frequencies the various services operate in so as to avoid problems. He was more surprised when I proved that I was correct by locking on the signal and demodulating it to hear the audio. It seemed no one had taught him to do that before.

> *"We need to review our skill sets and determine not only what skill sets we need to pass on to those who work for us, or eventually will occupy our chairs, but what tricks can we teach them. In other words, teach the tricks that make an average test engineer an above average tester, or an exceptional compliance engineer."*

Basically what is required is mentoring. My own skill set was greatly enhanced by having worked with, or even now working with, skilled practitioners in the field whose breadth of knowledge covers areas in which I am not as well versed.

We need to review our skill sets and determine not only what skill sets we need to pass on to those who work for us, or eventually will occupy our chairs, but what tricks can we teach them. In other words, teach the tricks that make an average test engineer an above average tester, or an exceptional compliance engineer.

We need to teach beyond the FCC rulebook. I have seen too many cases where people quote or misquote the FCC rules because they do not see a specific reference in them - even though the specific information may very well be available in an FCC docket, updated rule making release, public notice, or interpretation by the FCC.

The EMC Society plays a key role in this and as members we all do. The EMC Society provides not only an excellent forum for technical presentations on everything from standards to wireless issues, it also provides a social forum where one can meet fellow engineers and have fun. Whether at special sessions, workshops, regular sessions, or chapter meetings, we provide a fun learning atmosphere for the seasoned veteran or the new comer.

The Representative Advisory Committee (RAC) is helping with this effort by reaching out to the various industry groups involved in issues that involve EMC or wireless matters in order to provide an avenue for helping those needing compliance issues addressed.

This year the RAC will be sponsoring a Special Session on wireless issues at the 2001 IEEE International Symposium on EMC in Montreal. We will discuss Bluetooth, ultra-wide band technology, SAR/MPE and TCB issues.

However, for the first time in a number of years I will not be attending this year's EMC Symposium in Montreal. This is due the fact I will be awaiting the arrival of the stork that week. My Vice-Chair, Steve Berger, will host the Special RAC Session this year. Also at this year's Symposium, the RAC committee will again participate in the RAC/SACCom (Standards Advisory and Coordination Committee) jointly organized luncheon. This year, Elya Joffe as the SACCom Chair will host this event. As usual, RAC and SACCom members are welcome to attend along with the EMC Society Board of Directors and both the 2001 and 2002 symposium steering committees.

See you in 2002. **EMC**

Board of Directors Activities

Zurich, Switzerland
Friday, February 23, 2001

CALL TO ORDER

President Butler called the meeting to order at 9:00 am. A round of introductions was made. Board members present included H. Benitez, D. Bush, J. Butler, L. Carlson, L. Cohen, B. Crain, A. Drozd, R. Ford, D. Heirman, D. Hoolihan, T. Hubing, E. Joffe, D. Millard, M. Montrose, J. O'Neil, J. Perini, G. Pettit, A. Podgorski, C. Sartori, D. Smith, K. Williams, and T. Yoshino. Board members absent included T. Chesworth, F. Heather, W. Kesselman, J. Muccioli, and H. Ott. Guests present included E. Bronaugh, W. Gjertson, G. Meyer, G. Mays, and R. Vahldieck. Mr. Butler thanked Dr. Gabriel Meyer for making the arrangements for the Board meeting in Zurich. The agenda was then presented. Several items were added to the agenda. The agenda was approved as amended.

TREASURER'S REPORT

Treasurer Warren Kesselman's report showed an estimate that the EMC Society's net operational surplus for 2000 will be in the order of $60,000. The Society remains financially sound with an estimated million dollar net worth.

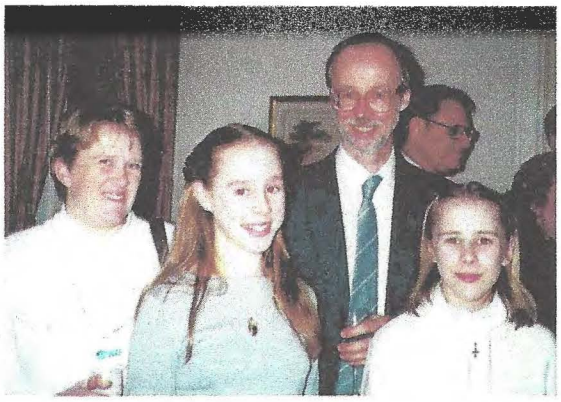

Photo by Janet O'Neil

Mr. and Mrs. Martin Alexander (he is with the National Physical Laboratory in the United Kingdom) brought their daughters Eleanor and Catherine (L-R) to the Board party following the Zurich Symposium.

SECRETARY'S REPORT

Secretary Janet O'Neil presented the minutes from the Board meeting on November 16, 2000 for review. The minutes were approved as amended.

VICE PRESIDENT'S REPORT OVERVIEW

President Butler requested that each Vice President provide an overview of their respective activities for the benefit of the meeting guests present.

Andy Drozd, Vice-President for Member Services, provided an overview of the activities under his Vice-Presidency. He noted that there are approximately 5,237 members in the EMC Society. He showed a list of EMC related conferences in IEEE Regions 7-10 in 2001 and discussed the Distinguished Lecturer and Angel programs. One of the goals for 2001 is to reinvigorate some of the inactive existing EMC chapters. Also, they would like to outreach/recruit new members and thereby create new EMC chapters. There is new chapter activity in Belgium, Brazil, Mexico, Wroclaw, Romania, and Georgia (Russia). There is an active chapter now in Turkey. The newest chapter to join the EMC Society is based in Singapore. Expected EMC Society membership growth outside the USA is estimated at 5-10%.

Len Carlson, Vice-President for Communication Services, provided an overview of the activities under his Vice-Presidency. One key goal to be realized in 2002 is the publication of the new EMC Society magazine. Janet O'Neil will be the managing editor and Bob Olsen will be the technical editor. The Transactions on EMC has a new editor, Marcello D'Amore, and he is reorganizing the structure of associate editors and reviewers in order to expedite the review and publication process. Regarding the internet, Andy Drozd as the EMCS webmaster, has made tremendous progress in posting material to the website, keeping material on the site updated and current, and he has developed the paid advertising program for EMC vendors for the website. The History Committee, while currently inactive, has in the past published the CDs containing the 40 years of EMCS symposia records. This committee will work with the EMCS 50th Anniversary Committee to prepare a special celebratory event in 2007. Future tasks of the History Committee currently under consideration include placing back issues of the Transactions on EMC on CDs. The IEEE Press Liaison also falls under this Vice-Presidency. EMCS books are published with a percentage of sales being returned to the EMCS.

Janet O'Neil reported in the absence of Henry Ott, Vice-President for Conference Services. She provided an overview of the activities under his Vice-Presidency. This includes the International Conference Committee

Photo by Janet O'Neil

Barry Wallen of TUV Product Service and Bruce Crain of Northrop Grumman (L-R) attended the EMCS hosted cocktail party following the Zurich Symposium. Mr. Wallen reports to the EMCS Board of Directors as the Society's Chairman of the International Conference Committee. Mr. Crain recently began his three-year term as a member of the Board.

Photo by Janet O'Neil

Mr. and Mrs. Roland Danieli enjoyed the "calm" (the Board party) after the "storm" that was the Zurich Symposium. Erika Danieli was in charge of the social program while Roland handled the local arrangements. This kept them very busy!

chaired by Barry Wallen, the Exhibitor Liaison (Janet O'Neil), the Global Symposium Coordinator (Elya Joffe) and the Regional Symposia Coordinator (Janet O'Neil). Mr. Wallen oversees the activities of the annual IEEE International Symposia on EMC. The Exhibitor Liaison is the consistent EMCS representative from year to year who works with the vendors participating in the annual IEEE International Symposia on EMC. The Global Symposium Coordinator works with the non-IEEE EMCS organized EMC symposia/conferences worldwide to orchestrate cooperation and co-sponsorship with the EMCS. Finally, the Regional Symposia Coordinator works directly with the EMCS chapters to organize one-day EMC conferences which are regional, i.e. local to the host chapter.

Don Heirman, Vice-President for Standards Services, provided an overview of the activities under his Vice-Presidency. This includes the Standards Education and Training Committee (SETCom) chaired by Hugh Denny, the Standards Advisory and Coordination Committee (SACCom) chaired by Elya Joffe and the Standards Development Committee (SDCom) chaired by Steve Berger. They try to work with the IEC, CISPR and other international EMC organizations in order to maintain EMCS representation worldwide on various standards making committees. They educate and train EMCS members and others about writing and developing standards. They publish standards. The IEEE Standards website is very active and easily accessible for purchasing and downloading EMC standards on-line (http://standards.ieee.org).

Kimball William, Vice-President for Technical Services, provided an overview of the activities under his Vice-Presidency. The vision of Technical Services is to promote the growth of the worldwide EMC technical community for the benefit of all mankind. He focused on three main subcommittees and how they carry out this vision: the Education and Student Activities Committee chaired by Maqsood Mohd, the Representative Advisory Committee (RAC) chaired by Dave Case, and the Technical Advisory Committee (TAC) chaired by Andrew Podgorski. The Education and Student Activities Committee's goal is to establish an awareness of EMC fundamentals throughout industry and academia. They also attempt to enhance EMC education through the development of improved education techniques, materials, opportunities and communications. RAC provides a communications linkage between the EMCS Board of Directors and other non-standards bodies within the larger EMC community. TAC promotes the technical advancement of the IEEE EMC Society as a whole.

WELCOME REMARKS BY NEW ZURICH SYMPOSIUM PRESIDENT

President Butler welcomed the new Zurich Symposium President, Dr. Ruedigues Vahldieck. Dr. Vahldieck thanked the Board for holding their meeting in Zurich in conjunction with the Symposium. He talked about some of the challenges facing the Zurich Symposium organizing committee as they enter the new millennium. Some of the challenges include "competition" from other EMC conferences in Europe and globally, as well as a decline in the number of exhibitors present due to the consolidation of companies. Nevertheless, Dr. Vahldieck is optimistic about the Zurich Symposium on EMC retaining its reputation as having the premier technical program. As a bit of background, he noted that his interests involve antennas and propagation, and microwave theory and techniques. President Butler thanked Dr. Vahldieck for taking the time to attend the Board meeting.

LONG RANGE PLANNING

Todd Hubing, EMCS President-Elect, spoke about the Long Range Planning for the Board of Directors. He asked, "Why are we doing what we do?" He quizzed the Board on its mission statement. He stressed the importance of serving our EMCS membership. The Long Range Planning initiatives are threefold: 1) Globalization, 2) Organization and 3) Technical Activities. These three items will be addressed further at future Board meetings.

MEMBER SERVICES REPORT

Andy Drozd presented the report of Membership Services. He advised that the Society will have two booths at the Montreal EMC Symposium and the booth will have a new banner. Currently there are 5,237 active members of the EMC Society and 869 members in arrears. Mr. Drozd then reported for Lee Hill, chair of the DL program. Two new lecturers were proposed for the 2001-2002 term. Their respective resumes and lecture topics were circulated to the Board. The Board approved Colin Brench and Maria Sabrina Sarto as Distinguished Lecturers for 2001-2002. Mr. Brench and Ms. Sarto will replace DLs Werner Schaeffer and Doug Smith whose terms expire at the end of this year. Henry Benitez reported on Awards. The awards nomination process needs to be revised. Don Sweeney previously volunteered to create a template for each award category. The award nominations forms were created and will be used this year. Mr. Benitez presented the new timeline for the awards process. He advised that there would be a new balloting process. Regarding Chapter Activities, Ghery Pettit advised that efforts continue in establishing new EMC chapters in Georgia and Singapore. The Georgia chapter is a "self proclaimed" chapter and efforts are underway to correct their status. He reported on the Haislmaier Angel Fund policy wherein chapters may request $500 USD once yearly to support chapter activities. He presented a formal policy on this. The Board approved adopting this "Angel Fund Policy Proposal"

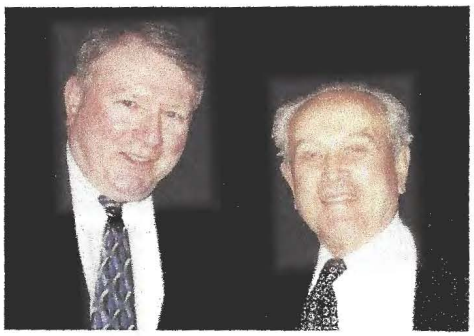

Photo by Janet O'Neil

EMCS President Joe Butler visited with Tomas Dvorak, Zurich Symposium Honorary Chairman, during the Board party on Thursday evening of the Zurich Symposium week. The next day, bright and early, President Butler ran the EMCS Board of Directors meeting held at the Federal Institute of Technology Zurich (ETHZ).

as presented by Mr. Pettit. Regarding International Chapter relations, Mr. Drozd invited Graham Mays to address the Board. Mr. Mays is Secretary of the UK EMC Chapter. He reviewed the trouble their chapter is having communicating with the IEEE. They have requested the status of EMC Society members in their region from IEEE, but have not received a response to date. Mr. Drozd volunteered to obtain this information from the IEEE. Elya Joffe reported on Region 8 activity. He staffed the EMCS membership booth in Zurich during the conference. Seven new members were recruited. Future activity in Region 8 during 2001 includes participation in the St. Petersburg EMC Symposium on June 19-22, and the International Conference on Electromagnetics in Advanced Applications in Torino, Italy from September 10-14. New chapter activity is underway in Turkey (active), Belgium (in process of petition), Greece (delayed due to personal constraints of the founding chair), and Georgia (the former USSR, is being reviewed due to their "self proclaimed" status). In presenting the Region 9 report, Jose Perini advised that he has arranged to visit four cities in Brazil this spring. He will also visit Mexico City in conjunction with this trip to Brazil. He is working with Elya Joffe on a special IEEE EMCS workshop to be held during the St. Petersburg Symposium. Takeo Yoshino reported on EMC activity in Region 10. He showed a map of China that outlined the areas of EMC activity, including Beijing, Shanghai, Nanjing, Wuhan, Shenzhen, and Chendu. The area of Shenzhen is developing the most quickly with growth in industry and electronics. The number of members in each area was reported on the map. He noted that the incomes of these EMC engineers are very low as outlined in his report and this must be taken into account when recruiting new members. Dan Hoolihan reported on Nominations and Bylaws. The "Call for Nominations" will be included in the Winter 2001 issue of the EMC Society Newsletter. He expects to have a well-rounded slate of candidates for the EMC Society Board of Directors for this year's ballot. Regarding the Bylaws, Mr. Hoolihan advised that the previous Board approved Bylaws change regarding the scheduled dates for the Director-at-large election cycle will appear in the Winter 2001 Newsletter as required by the IEEE. Lastly, regarding the Fellows Search Committee, Mr. Drozd advised that last year two Fellow candidates, Donald R. Pflug and Daniel J. Kenneally, were elected to the grade of Fellow.

Photo by Dick Ford

EMCS Board members Jose Perini and Carlos Sartori (from far left) enjoy the ambiance of the Board party. They are joined by Mr. and Mrs. Takeo Yoshino (third from left and far right) and Mr. and Mrs. Peter Leuthold.

COMMUNICATION SERVICES

Len Carlson, Vice-President for Communication Services, presented a proposal for the new EMCS magazine. This responds to the TAB questions he received. The first issue of the magazine will be issued in February 2002. It will replace the existing EMC Society Newsletter. The proposal outlines the scope of the magazine, intended audience, and production details, among other items. Mr. Carlson reported for Professor Marcello D'Amore, Transactions Editor-in-Chief. He discussed the IEEE's publication service for electronic review of papers called the "Manuscript Central Pilot Program." It is hoped that this service will expedite the time from paper submittal to publication in the Transactions on EMC. The program appears to be very promising for the editors of Transactions within the various IEEE Societies. Newsletter Editor Janet O'Neil reported that the practical paper in the Fall 2000 issue by Art Glazar titled "A Software Implementation of TL Field-to-Cable Coupling Equations" has generated the greatest number of letters to the editor to date. Comments continue to come in. Regarding the Winter 2001 issue, this is 44 pages and includes an article by our COMAR representative Dan Hoolihan on the issue of cell phones and human health. There are two practical papers by non-US authors that were originally presented at the Wroclaw EMC Symposium. The issue also includes profiles of the newly elected Board members, the call for Board nominations, and the announcement of the proposed bylaws change among other articles. The Institutional Listings on the back cover were updated for 2001. Mark Montrose presented his report as IEEE press liaison. The IEEE is nearing the end of negotiations with John Wiley and Sons, New York, to enter into a publishing partnership. Production responsibilities would be transferred from IEEE Press to Wiley, while the IEEE would continue to work with authors and editors to generate proposals and develop manuscripts. The goal of the alliance is to increase the audience for the IEEE books, while reducing IEEE costs in order to ensure the financial viability of the program. The IEEE Press recently released the EMCS sponsored book "Engineering Electromagnetic Compatibility", 2nd edition, by Kodali. Revenue figures for the program for the year 2000 will be available shortly. EMCS Webmaster Andy Drozd presented his report detailing updates to the EMCS website. New web pages for the RAC and Education Committee were forwarded to the respective committee webmasters and secretaries for review and comment. The web advertising policy is fully operational and advertisers are being solicited. Mr. Drozd wrote an article on Webmaster activity for the Fall 2000 issue of the EMCS Newsletter.

STANDARDS SERVICES

Don Heirman, Vice-President of Standards presented his report as a Power Point presentation. It was noted that the webpage (http://standards.ieee.org) for EMC Standards is now operational.

Standards activity covers three major areas: The Standards Education and Training Committee (SETCom) chaired by Hugh Denny, the Standards Advisory and Coordination Committee (SACCom) chaired by Elya Joffe and the Standards Development Committee (SDCom) chaired by Steve Berger. SDCom has 14 active projects and standards. There is special attention being paid to the new wireless LAN activity including Bluetooth and IEEE 802.11 standards. SETCom has 6 members now and is finishing up the plans for their second workshop on the development of standards at the Montreal Symposium. Regarding SACCom, Elya Joffe presented his report. The committee activities are "on track". Three new members have joined the committee including Ron Petersen, Chair of SCC 34 (SAR measurements), Arnold Greenspan, Chair of SCC 20, and Dave Baron, Chair of SCC 28 (Dosimetry). The website for SACCom is active and populated regularly with data emerging from the activities of the Committee. All three standards committees are meeting in March in Hilton Head, South Carolina in conjunction with two meetings: the IEEE Standards Association Standards Board series of meetings and the IEEE 802 committee meeting. Steve Berger gave a special presentation at the 802.11 meeting to foster coordination efforts on EMC aspects of 802.11 usage. It was well received. Mr. Heirman reported that he appointed Steve Berger to the IEEE Standards Association Standards Board new standards committee (NesCom) which is responsible for recommending approval of project authorization requests (PARs).

CONFERENCE SERVICES

Barry Wallen, International Conference Committee Chair, reported in the absence of Henry Ott, Vice President for Conference Services. He called on the various Symposia representatives in attendance at the meeting to present their respective reports as follows: 2001 Montreal: Andrew Podgorski, Treasurer of the Montreal Symposium Steering Committee, relayed the report of Benoit Nadeau, Chairman. The technical program is largely defined with four parallel sessions. 82% of the papers submitted were accepted. 200 booths have been sold to date. The advance program is now being prepared. Ads for the symposium have been included in five industry trade magazines. The committee is sending promotional material to all the IEEE EMC regional events scheduled for early 2001. The symposium website (www.2001emcmtl.org) is being used extensively to make available useful information on the Symposium and Montreal. There is also a family page of selected activities for people coming to Montreal with children; 2002 Minneapolis: Dan Hoolihan reported that the symposium will be held at the Minneapolis Convention Center with the main hotel, the Hyatt Regency, being located across the street. The Board will meet at the Hyatt in June and will take a tour of the hotel and convention center while in town. He showed a preview of their website home page; 2003 Boston: No report was available; 2003 Israel: Elya Joffe reported that this Symposium will take place May 11-16. The "Call for Papers" will be distributed in the Montreal 2001 Symposium Record. They will have a promotion booth in Montreal. The Symposium website is www.ortra.com/emc2003. It is updated regularly; 2004: Santa Clara: Mr. Wallen reported that Franz Gisin advised they are having difficulty getting reasonable hotel rates in the Silicon Valley for the Symposium week. This is their major concern at this time; 2005: Chicago: No report was available; 2006: Mr. Wallen reported that the location for the Symposium in 2006 has not been determined to date. The EMC Society has been approached by the German EMC Chapter to hold the Symposium in Germany. The Board will make a decision on this in November 2001. If the location of Germany were approved, there would not be a Symposium in the USA in 2006. Next, Global Symposia Coordinator Elya Joffe reported that the EMC Society organized a successful special workshop in Zurich titled "EMC Measurements Including Those Above 1 GHz and Associated Uncertainty." The Chairman was Don Heirman; Ed Bronaugh was the Co-Chairman. The IEEE EMCS will organize a special workshop for presentation at the St. Petersburg Symposium in June. This will be a two-part workshop on the topics of "PCB Design Techniques" and "EMC Measurements." The EMC Society has agreed to be a technical co-sponsor with the EMC conference in Torino, Italy from September 10-14, 2001. The EMCS has also agreed to technically co-sponsor the 3rd International Beijing EMC Symposium May 21-24, 2002, as well as the EMC Europe 2002 Symposium in Sorrento, Italy, September 9-13. In order to avoid misunderstandings such as those that can occur with the misuse of the EMCS logo and name, Mr. Joffe prepared a draft document titled "How to Obtain IEEE EMCS Co-Sponsorship." He requested comments from the Board on this document.

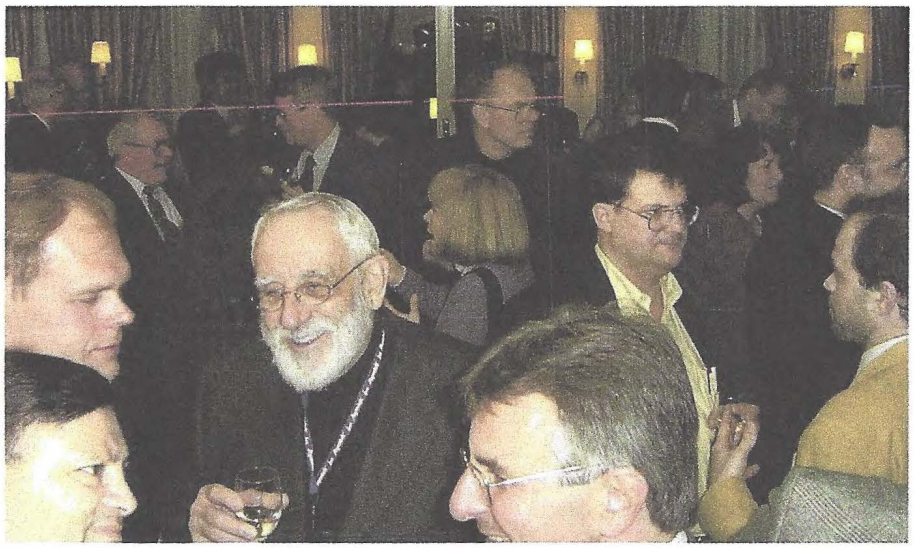

Photo by Dick Ford

Lothar "Bud" Hoeft, an EMC Consultant from Albuquerque, New Mexico (bearded gentleman in the center) attended the Zurich Symposium and enjoyed getting lost in the crowd at the Board's party.

TECHNICAL SERVICES

Kimball Williams, Vice President for Technical Services, presented his report. The Technical Committees are considering having papers reviewed electronically in the future. A detailed review of this plan was included in his report. The goal is to provide a rapid document turn around with confirmation to everyone involved. It also allows the reviewers to provide direct input with rapid reviews. The problem lies with finding the talent needed to create a programming system not currently available in the EMCS. The Antennas and Propagation Society is currently working with commercial software, for example. The Technical Activities Committee will create an interim manual system for now and will conduct a cost/benefit study by March 15. Regarding the Education and Student Activities Committee, Maqsood Mohd's report advised that the Best Student Design Competition Award is being formalized and paperwork is being prepared for submission to the IEEE headquarters. The cash award will be the same as the Best Student Paper Award.

OLD BUSINESS

The following topics were addressed under Old Business:

TC-8/PRODUCT SAFETY SOCIETY ACTIVITIES – Mark Montrose reports that this group is very active and has a large database of a few thousand members. They have scheduled a special workshop at the Montreal Symposium. They have a full time Webmaster. It was suggested that the EMCS site be linked to the Product Safety site www.ewh.ieee.org/soc/emcs/pstc/. (Subsequent to the meeting, this link was established.)

TC-10 ACTIVITIES – Mark Montrose advised that the special workshop on signal integrity that they have planned for the Montreal Symposium was approved.

IEEE WORKSHOP ON NEW AND EMERGING TECHNOLOGIES – Dan Hoolihan reported that he attended this workshop held at Rutgers University on January 18 and 19, 2001. Five key topics were covered during the workshop: Photonics, Wireless Technologies, New Materials, Systems-on-Chip, and Nanotechnologies. The speakers were varied and talented, representing industry, academia, and government. Mr. Hoolihan noted that EMC and EMI were mentioned specifically only four times during the two-day workshop. The first two times EMI was mentioned was in the Wireless Technologies section of the workshop; the first time happened when the speaker recommended, "using low power base stations to prevent interference problems." The second occurrence was the statement a few minutes later in the workshop that "metal covers on RF modules are good for EMI/RFI shielding." The third mention of EMI occurred with the topic of Time Difference of Arrival (TDOA) in Wireless where it was mentioned that "most cellular systems are not range or gain limited; they are interference limited." The fourth incident was in regards to "Smart Antenna Technologies." It was stated, "steerable antennas reduce electromagnetic interference." (A steerable antenna is basically an antenna that can change its principal focus of direction.) One of the questions raised at the workshop was "What should the IEEE's strategy be for new Technologies?" No clear answers were provided. It was thought, however, that more cooperation between the individual societies in the IEEE will be necessary to address some of these new and emerging technologies. (A complete report on this workshop is available from Mr. Hoolihan via e-mail to d.hoolihan @ieee.org)

NARTE MOU – President Butler advised that IEEE's legal department is reviewing this document and the review should be completed shortly. He will send the document to the Board after he has received it from the IEEE.

50th ANNIVERSARY COMMITTEE – Dan Hoolihan, Chair of this committee, advised that activity has been relatively quiet. The committee will work in earnest once the 2006 symposium location has been determined. The committee is investigating having a special anniversary IEEE Transactions on EMC issue as well as a special EMCS Magazine issue. Any suggestions related to the 50th Anniversary of the IEEE EMC Society to occur in 2007 should be directed to Mr. Hoolihan.

BYLAWS – Dan Hoolihan revisited the discussion tabled at the last Board meeting regarding advising candidates for election to the Board of Directors about the voting results. The Board approved adding the following new paragraph to the existing Bylaws: 4.9 Unsuccessful candidates for the Board shall be notified by private letter from the President to the unsuccessful candidates. The letter shall contain the number of votes accumulated by the candidate and it shall also contain the minimum number of votes that were needed to be elected to the Board.

NEW BUSINESS

The following topics were addressed under New Business:

REVIEW OF IEEE SURVEY OF EMCS – Dick Ford discussed the survey. He noted the survey definition of an "active" member which is basically a member who does something for the Society and one who attends three or more chapter meetings a year. He would like to relook at the survey in terms of defining a new set of "quality" members in order to determine at what age we can influence growth in membership. We can also look at "lapsed" members and maybe regain them. Mr. Ford will send a copy of the official EMCS survey to any Board member who sends him an e-mail so requesting this document.

IEEE MEMBERSHIP DEVELOPMENT RETREAT – President Butler advised that Bruce Crain and Andy Drozd will attend this event and will report back to the Board on their findings.

2001 SOCIETIES WEB-ED WORKSHOP – President Butler advised that Maqsood Mohd and Andy Drozd will attend this event and will report back to the Board on their findings.

IEEE WIRELESS WORKING GROUP – President Butler advised that Don Heirman volunteered to be the EMCS representative to this newly formed group.

IEEE TRANSACTIONS ON MOBILE COMPUTING – President Butler advised

that the IEEE has received an overwhelming response to this special Transactions. Several Societies are participating as either a "key" or "technical sponsor" (the latter requiring no significant time contribution in terms of providing qualified editors and authors). The Board approved having the EMC Society be a technical sponsor on the IEEE Transactions on Mobile Computing.

IEEE NOMINATE A SENIOR MEMBER PROGRAM – Andy Drozd advised that the IEEE's program regarding nominating Senior Members has been very successful and will continue through 2001. The EMCS will receive $10 for each member who is elevated to the Senior Member grade. The elevated member will receive a plaque celebrating his/her elevation and a $25 certificate good towards joining a new Society.

FUNDING FOR ELECTRONIC PAPER REVIEW – Kimball Williams discussed the problems associated with electronic paper review including the lack of software available for this purpose. The MTT and AP Societies as well as the Zurich symposium committee have partial software packages for electronic paper review. He will study what's available and will report back to the Excom by March 15. The current estimate for this program is $45,000 for year one, plus $1,000 / year thereafter for maintenance. The Technical Activities Committee expects to review papers electronically for the 2002 IEEE EMC Symposium. Papers will be reviewed via e-mail in the interim until the software is ready.

STUDENT DESIGN AWARD – Kimball Williams discussed the new Best Student Design Award. The Board approved equating the cash prize for the Best Student Design Award with the Best Student Paper Award.

USE OF EMCS LOGO – Todd Hubing led a discussion on the use of the EMCS logo. He presented a proposed policy for adoption by the Board. The Board approved adopting this policy, provided it is reviewed and approved by IEEE's legal department, and grandfathering is allowed in 2001 regional EMCS colloquia.

DISTRIBUTION OF EXCESS EMCS MATERIAL – Andy Drozd distributed a report on the excess EMCS material, including CDs, Symposia records, etc. The Board was asked to provide comments to Mr. Drozd.

MEETING SCHEDULE FOR 2002 – Todd Hubing led a discussion on the schedule of Board meetings for next year. After much discussion, the board approved having the February 2002 meeting a full Board meeting and not just an Excom meeting. The date of February 13, 2002 was selected. The location will be in Tempe, Arizona, site of the TAB meetings. Further discussion on future meetings in 2002 was postponed until the June Board meeting.

ACTION ITEM REVIEW

President Butler reviewed the action items discussed during the meeting.

ADJOURNMENT

There being no further business, the meeting then adjourned at 4:55 pm.

Janet O'Neil
Secretary
EMC Society Board of Directors
EMC

EMC Zurich 2001 — An Overview

by Franz Schlagenhaufer
The University of Western Australia

In February of every odd-numbered year many EMC experts go on a pilgrimage to the EMC Symposium in Zurich, Switzerland. This year about 600 participants gathered there to attend over 130 presentations, workshops, tutorials and industry fora and, equally important, discuss the current research activities and latest results during the coffee breaks or throughout the evenings in Zurich's restaurants and pubs. (After all, the word 'Symposium' originates from the Greek meaning 'having a drink together'.)

Since 1975 this EMC symposium is held biennially in Europe, since 1981 at the Federal Institute of Technology (Eidgenoessische Technische Hochschule) in Zurich. An EMC event in Germany just three weeks later dropped the number of exhibitors in Zurich this time; however, the quality of the presentations was not affected. The program committee rejected about 1/3 of the submitted papers, and this tough selection process ensured the high scientific standard of the symposium.

Participants and presenters came from all continents, with the exception of Antarctica, and most aspects of EMC were covered. In 19 sessions, topics from Biological Effects to High Power Electromagnetics and Lightning, to Transients and Transmission Lines, to Measurement Techniques and EMC in Networks to Computer Codes and Validation were covered. Test Chambers and Cells and Reverberation Chambers were addressed in two sessions, as was EMC on chip-level.

EMC is not a new science, and many problems in achieving an electromagnetic compatible environment are quite well understood. The solution of these problems is, however, still a challenging task and there is plenty of work ahead.

Looking for the ultimate test site continues with OATS, anechoic chambers, various test cells and reverberation chambers all having their place in EMC testing. Computer simulation has made enormous progress in the last decade and was the subject in several sessions. The trend here is the combination of different techniques in hybrid methods.

It was again a successful EMC event, enjoyed by all the experts interested in the more scientific aspects of the area. Many of them are certainly looking forward to February 2003, to the next pilgrimage to Zurich. **EMC**

Personality Profile

Bill Duff, Associate Editor

Photo by Dick Ford

EMCS President Joe Butler presents a "Certificate of Recognition" to Salvatore Celozzi for his contributions to Technical Committee 9 on Computational Electromagnetics. Mr. Celozzi received the award at the 2000 IEEE International Symposium on EMC in Washington, DC.

Salvatore Celozzi was born in Rome, Italy, in 1964. With the goal of receiving a sound theoretical basis, he began pursuing a Physics degree, then, after two years, changed to Electrical Engineering, getting the degree cum laude in 1988, from the University of Rome "La Sapienza". His thesis was on signal transmission on multiconductor power cable networks. During his first two years at the University, he had the privilege to be a student of Professor Luciano De Vito, an outstanding educator and mathematician, whose impressive lectures he has never forgotten.

In those years, an academic career became an attractive alternative to the professional activity of his father and grandfather, who were both electrical engineers. After the degree, he spent 15 months in the Army Corps of Engineering as a lieutenant assigned to the wire-guided missiles section.

He started to collaborate with professors Mauro Feliziani and Marcello D'Amore. Then he got his Ph. D. degree in Electrical Engineering. His doctors thesis was on the direct time-domain analysis of multiconductor line networks. In that period he became indebted and grateful to professor George Costache and Dr. Fred Tesche, for their kind availability and willingness to assist a young, inexperienced and broken-English-speaking researcher.

Salvatore won the competition to become Researcher in 1991 and since the academic year 1989-90 he has been involved in teaching activities for the courses of Electrotechnics for degrees in Electrical, Avionic and Environmental Engineering. In 1998 he became associate professor of Electrotechnics, at the Department of Electrical Engineering of the University of Rome "La Sapienza".

Initially, his research activity was addressed to the development of accurate simulation models of multiconductor cables and finite element codes for the solution of EMC problems. Then, he started to consider shielding his main interest, according to his

Four EMC Truths

I. All electrical things are EMC suffering.
II. Electromagnetic fields are the cause of EMC suffering.
III. Freedom of EMC suffering consists in the complete extinguishing of EM fields.
IV. SHIELDING constitutes one method for reducing EM fields.

He thinks that his major contributions to shielding theory have been the evaluation of the shielding effectiveness in IEEE 299 loop-to-loop configuration in exact form, putting in evidence the limits and the errors of the analogy with transmission lines (the paper was presented in 1998 at the IEEE Symposium held in Denver and won the Best Paper Award), and the time domain analysis of ferromagnetic shields under near field excitation, modelling hysteresis.

Also of some interest has been the explanation of the reasons why it may happen that, at power frequency, aluminium is more effective than high permeability materials (the paper was given at the International Symposium on High Voltage Engineering in 1997 and was awarded as Best Paper for the EMC sub-topic).

He has published nearly 70 papers, most of them in reviewed journals or in proceedings of international conferences, and two books of exercises of Electrotechnics, written in collaboration with professors Andreotti, Fabricatore and Verolino, all belonging to the University of Naples Federico II.

During the years Salvatore has participated in a number of EMC research projects coordinated by professor D'Amore, in collaboration with either academic and/or industrial partners. Now he is involved in two projects concerning the mitigation of EMI inside the Parliament Building and the simulation of the electromagnetic pollution due to the high-speed railway system under construction in Italy.

Salvatore has been an IEEE member since 1991 and he is now a Senior Member. His IEEE memberships include the EMC, Antennas and Propagation and Magnetics Societies. He founded the EMC Chapter of Central and South Italy Section in 1997, serving as Chair since then. In 2000, at the IEEE Symposium held in Washington D. C., he was awarded a Certificate of Recognition for his contribution to the activities of the TC-9 Technical Committee on Computational Electromagnetics. He also chaired sessions at the Austin (1997), Denver (1998) and Seattle (1999) IEEE International EMC Symposia, and is a member of TC-4.

In the past, from 1995 to 2000, he served as Associate Editor of the IEEE Transactions on Electromagnetic Compatibility for papers related to shielding, because of the reciprocal esteem and friendship with the Editor-in-Chief, the late Dr. Motohisa Kanda.

He is Vice-Chairman of the International Symposium EMC EUROPE 2002, to be held in Sorrento, Southern Italy, on September 9-13, 2002.

Salvatore is happily married to Michela, Judge of the Military Court. They enjoy travelling around the world and listening to classic music (Beethoven, Schubert and Brahms are their favourite composers). Salvatore may be reached at celozzi@elettrica.ing.uniroma1.it **EMC**

Reporting from... "EMC Europe 2000", Brugge

By Elya Joffe, EMC Society Global Symposia Coordinator

In September 2000, several hundred EMC specialists were focused on their traditional trip – to the Biannual EMC Europe Symposium, which took place this year in the beautiful historical city of Brugge, Belgium. After running that symposium successfully for three times in Rome (remember – "EMC Roma 94/96/98" organized by Prof. M. D'Amore), the Symposium was relocated to Brugge for the year 2000.

The Symposium took place between September 11-15, 2000, in the old "Hospital St. John" in the center of the medieval town of Brugge, which, in the 15th Century was the international business center of Europe.

The excellent, high quality technical program featured 160 papers selected out of 266 papers submitted for review. Some special sessions and workshops also took place. Especially noteworthy is the keynote address presented by the Distinguished keynote speaker, Mr. Diethard Mohr, Secretary of IEC TC-77, on the topic: "IEC TC-77 EMC – the 'United Nations of EMC."

The Technical Program of the Symposium featured 17 oral sessions, nine poster sessions, six tutorials and nine workshops. A very diverse Program offered "something for everyone", from chip and PCB levels up to railways, power systems and environmental effects.

378 participants from 40 Countries gathered in Brugge to attend Symposium. This was, therefore, a truly international Symposium; of course European nationals mainly attended it, but participants from the USA and many other countries were not scarce.

The Symposium provided wonderful opportunities, not only for engineering presentations but also for a social "get together." There was also a wonderful social program organized by the Organizing Committee, including a cocktail followed by a boat sail on the canals in the Brugge "old town". This was surely a very different perspective of the ancient city. However, possibly the most impressive of all, was the dinner that took place in the ancient City Hall, where a first class dinner was served while bands of musicians further increased harmony with their pleasant music.

The EMC Society of the IEEE was proud to be a technical co-sponsor of the Symposium, and a distinguished delegation of the EMC Society attended the Symposium, headed by EMCS President Joe Butler, Past President Bill Gjertson and several other members.

The EMCS was also represented visually with the Membership Booth which was placed in the exhibit area.

Many thanks and congratulations to Professor Johan Catrysse, Symposium General Chairman, and to his Organizing Committee for yet another pleasant and successful EMC event which was thoroughly enjoyed by all attendees. Also thanks to the international steering committee and the reviewing board under the chairmanship of Professor D'Amore.

I hope to see you in September 2002 during the next Europe EMC Symposium in Sorrento (Italy), which will be organized by Professor M. Feliziani. **EMC**

The "Welcome Cocktail" was held in the central open area of the medieval City Hall building prior to the Symposium Banquet.

The Symposium Banquet featured a candlelight dinner in the old City Hall of Brugge.

The "Welcome Cocktail" was offered by the town of Brugge. Professor Johan Catrysse, Symposium Chairman, and his wife are shown enjoying a local "delicatesse," Straffe Hendrik, which was brewed locally. Mrs. Catrysse organized the Symposium social program.

The best poster paper was awarded to a research group from the University of Rome "La Sapienza." Professor Catrysse presented the award to Professor D'Amore and Dr. V. Vulpi from the University of Rome "La Sapienza" (shown left to right).

The best oral paper was awarded to a research group composed of the Universities of York and Nottingham. Professor Catrysse and Professor D'Amore presented the award to Dr. John Dawson from the EMC Research Group of the University of York (shown left to right). Both oral and poster paper awards were sponsored by Bekaert Fibres Technologies and are original lithographs of Brugge by the local artist Bosschaert.

EMC Standards Activities

Don Heirman, Associate Editor

EMC standards activity can be found in various international and national organizations. For example, in the United States the American National Standards Institute (ANSI) accredits very active standards development organizations such as Accredited Standards Committee C63 (EMC) which publish under the ANSI logo.

Following is an article by Stephen Berger, IEEE EMC Society Standards Development Committee Chairman and ANSI ASC C63 Subcommittee 8 (Medical EMC) committee member. This article summarizes the issues related to hearing aid and cellular telephone electromagnetic compatibility which recently resulted in the finalizing of ANSI Standard C63.19 which provides for testing both the cellular phone and the hearing aid for EMC. The work was sponsored and conducted by Subcommittee 8 of ASC C63. I'd like to thank Mr. Berger for taking the time to share his efforts in the development of this new standard with our readers.

Also, please note the announcement included in the shaded box within this column. The IEEE EMC Society Standards Education and Training Committee (SETCom) is once again holding its popular Workshop Session at this year's 2001 IEEE International Symposium on EMC in Montreal. It is also advertised in the Advance Program for the Montreal Symposium. Don't miss it! This is an ideal forum for those who are interested in volunteering to work on the development of new standards or revisions to existing standards. Visit informally with the seasoned professionals including the IEEE Standards Association staff that make these standards available and viable to our industry. I look forward to seeing you there.

ANSI C63.19 HEARING AID/CELLULAR TELEPHONE COMPATIBILITY

H. Stephen Berger
TEM Consulting

INTRODUCTION

Early in 1996 the FCC called together a Summit between the hearing industry, the wireless industry and consumers to resolve the compatibility issue between hearing aids and cellular phones. Digital technology cellular phones were then just being introduced in the US. An interference problem with hearing aids had been discovered and a group of concerned consumer groups petitioned the FCC. The new digital telephones caused many hearing aids to "buzz" due to their RF transmission. In their petition the consumer groups asked the FCC to deal with the problem and assure that people with hearing aids would have the same ability to use these new technologies as everyone else.

As a result of the discussions held in the Hearing Aid Summit it was decided that a technical standard was needed which would identify a solution and develop tests to show that a hearing aid and cellular phone were compatible. In the spring of 1996 ANSI ASC C63 (EMC) formed task group for C63.19 to develop a measurement standard for hearing aid compatibility with wireless communications devices. The goal was to develop a set of parameters and tests that would evaluate and predict the compatibility of hearing aids with cellular phones. In January 2001 the task group completed their work and ANSI C63.19 was approved by C63[1]. At the time of this article, C63.19 is in the last stages of being processed as an American National Standards Institute (ANSI) national standard.

The challenges presented to the task group were formidable. In order to accomplish this task several significant technical issues had to be faced. The effort required to complete this project ultimately came to include 5 research projects, and over 90 engineers from 50 different companies and organizations including the Federal Communications Commission (FCC)[2] and Food and Drug Administration (FDA) working together.

THE PROBLEM

The essence of the problem is that the RF energy transmitted by a cellular phone is received by the circuitry in hearing aids. Once the energy is in the hearing aid it may be audio rectified across some non-linear junction, resulting in a "buzz" of different types depending on the modulation used by the cellular phone. Significant effort has been invested in understanding and addressing this issue. This mechanism of interference is well known. The challenge in this case is that hearing aid wearers want to be able to use cellular phones. This means that the hearing aid must be located well into the near-field region of the transmitting antenna. Accordingly an evaluation of the immunity of the hearing aid must be of that immunity in the near-field environment, not the usual far field test used for immunity testing. These near fields can be an order of magnitude or larger than the "standard" immunity test field.

A second challenge faced is that, in the near-field, the fields from a wireless device are highly variable in intensity and field impedance. The quantification of the environment in which a hearing aid must operate presents a significant challenge. Movements of only a centimeter can produce significant changes in the field magnitude or impedance.

A third challenge is presented by the presence of the hearing aid wearer. The human tissue in the head and hand has a very significant influence on the field generated by the cellular phone. The question of how to properly account for this field deformation when evaluating a hearing aid's immunity presents special challenges.

[1] The same problem was being addressed in Australia and later in Europe. See references 2-4, 6-8 and 13.

[2] A standard for Hearing Aid Compatibility (HAC) in corded phones had been developed by EIA and incorporated into the FCC rules for Part 68. However, this solution is not effective for cellular phones for several reasons, the most prominent is that it does not address the interference problem. See references 1, 5 and 11.

A fourth challenge is that many hearing aids are equipped with a magnetic coupling mode, called the TeleCoil (t-coil) mode, in addition to the primary audio coupling mode. Testing for compatibility in this mode has its own set of challenges. For example, in this mode there is the possibility of RF interference and in addition electronic noise in the kHz region adds a second, independent, source of interference with the desired reception.

A fifth problem is that the actual annoying effects produced by the use of the cellular phone is highly dependent on the hear impairment of the user as to what is really "heard".

The measurement techniques developed for ANSI C63.19 allow the accurate evaluation of the system performance of a hearing aid used with the new generation of cellular phones or other wireless communications device. The resulting tests present new test methodology for near-field evaluation of system immunity. This addition brings a valuable evaluation tool to compliment the more mature far-field evaluation techniques, which are available.

Workshop Session on the Development of IEEE Standards

A repeat of the popular Workshop Session on the development and adoption of standards given at the 2000 IEEE International Symposium on EMC in Washington, DC will be held this year on Monday, August 13, during the 2001 IEEE International Symposium on EMC in Montreal. Topics to be addressed include IEEE requirements on standards development; computer-based tools now available to support working groups and others working on the development of new standards or on the revision of existing standards; suggestions for managing working group meetings and activities; and personal perspectives of current and recent working group chairs. All persons who are currently members of IEEE EMC standards working groups or anyone who is interested in learning more about standards development activities, whether IEEE or others, are invited to attend. Check the Advance Program for the 2001 IEEE International Symposium on EMC in Montreal for the location of this Workshop Session. Be sure to register for this informative Workshop Session when you send in your Advance Registration. Questions? Comments? Please contact Hugh Denny, EMCS Standards Education and Training Committee (SETCom) Chairman, at phone 404-633-9363, e-mail: hugh.denny@gtri.gatech.edu

QUANTIFICATION OF THE OBJECTIVE

The objective of the wireless hearing aid compatibility effort is to provide for good system performance between hearing aids and wireless devices. This section discusses the logic by which this objective is parameterized and target values are assigned to those constituent parameters.

The first step is to normalize the test for normal speech. 65 dB SPL (sound pressure level referenced to 20 μPascals) is a nominal value often assigned to normal speech. For the purposes of this discussion, the complexities of frequency differences within the audio frequency band will be disregarded. So, for any given frequency in the audio frequency band a level of 65 dB SPL is assumed to deliver normal speech. A hearing aid increases this nominal level by some gain factor in order to compensate for the user's hearing loss. Other processing may be involved, such as noise cancellation or automatic gain control. However, at any given point in time a hearing aid may be assumed to receive an input signal, nominally at 65 dB SPL, and deliver to the user a signal of (65 + G) dB SPL, where G is the gain at the frequency of interest.[3]

In order to normalize the hearing aid parameters the standard related all parameters to an equivalent input. So the interference measured at the hearing aid output has the gain of the hearing aid subtracted from it. The result is the sound level, which if presented to the input of the hearing aid would produce the measured output. In this way the variances of gain between hearing aids is normalized out of the measurement.

In order to be intelligible the signal delivered to the user must have an acceptable signal to noise or signal to interference ratio. Three performance categories have come to be commonly used, which may be characterized as: usable in an emergency, acceptable for normal use, and excellent performance. Various research studies[4] have indicated that a speech to interference ratio of 20-26 dB is acceptable for normal use. A 10 dB degradation, to a range of 10-16 dB, yields a system which could be characterized as usable in an emergency but inadequate for regular use. Alternatively, an improvement of 10 dB, to a range of 30-36 dB, yields an excellent performance level, where there is little discernible noise or interference. Taking 20 dB signal to interference as a nominal target performance criterion results in a 45 dB SPL, input related, level for interference. Equivalent target parameters may be derived for the other performance categories.

The target performance is then parameterized and allocated between the system components, the phone and hearing aid. The picture is further complicated by the fact that this equipment operates within the near-field region of the phone's antenna and body. Yet further complication is created by the field perturbation from the user's head and hand and other nearby objects. Setting these complications aside for the moment, a general division must be made between the E and H field performance of the hearing aid. So target immunity for both the E and H field must be set for the hearing aid. These immunity targets must be coordinated for both near-field E and H field of the radiating device, in the area controlled for the use of the hearing aid. Hence, when phones pro-

continued on next page

[3] This work assumes hearing aid performance is consistent with the standards for that industry. See references 9-10 and 12.

[4] The three primary North American Studies have been performed by Dr. Schlegel and the University of Oklahoma Center for the Study of Wireless EMC, Dr. Levitt of CUNY with Dr. Harkin of Gaulludet University and Dr. Killion of Etomotic Research. The research focus and protocol of each study was different. However, the conclusions of these studies have shown remarkable consistency on the fundamental issues involved.

ACOUSTIC MODE (Microphone Mode)	MAGNETIC MODE (T-Coil Mode)
Adequate acoustic volume.	Adequate magnetic field intensity.
Low background noise.	Acceptable magnetic signal to noise ratio.
Coordinated RF emissions and immunity.	Coordinated RF emissions and immunity.

Table 1. Operational Requirements

vide fields at or below the emission limits and hearing aids exhibit immunities at or above the immunity targets the required audio performance will be delivered.

Next, the t-coil coupling mode must be dealt with. In this mode a hearing aid receives its signal not by a microphone but through an inductive pickup coil. The intended magnetic signal for the t-coil is that produced by the audio signal driving the phone receiver element or some other inductive circuit element. In the ideal case a hearing aid delivers the same audio level whether in audio or t-coil mode. Going back to the 65 dB SPL level for normal speech, some magnetic field emission level may be assigned to it. The hearing aid in t-coil mode receives this signal inductively and amplifies it to the same (65 +G) dB SPL level which it would deliver if the user were using the microphone mode. The intended advantage of this system is that any audio background noise is not received and so the user receives a better signal.

However, in the case of a cellular phone there is a lot of electronics in the handset, unlike landline corded-phone handsets. The electronics also emits magnetic fields from the currents in the circuitry. These emissions are received as noise to the intended audio signal. In order to deliver the desired performance two criterion must be met. First the user of a hearing aid in t-coil mode should receive a signal of (65+G) dB SPL for a normal speech level emission. Second that signal should have a noise component of no more than (45+G) dB SPL. In paramaterizing this, the phone must deliver a magnetic field of the intended audio signal within a defined target window. The hearing aid is then responsible for receiving this signal and amplifying it to the intended (65+G) dB SPL level.

Orientation effects further complicate this picture. If the hearing aid's inductive coil is cross polarized to the field then a significant loss of reception will result. This must be left for the user to adjust for optimum reception.

In the t-coil mode there are two distinct noise sources. The currents in the phone's circuits will create magnetic emissions in the audio frequency band used by the intended signal. Secondly, the RF fields may be audio rectified within the t-coil circuits exactly as they are for the microphone mode. The combined effect of these independent interference sources must be below the (45+G) dB SPL level.

In order to achieve the desired target performance for t-coil mode a number of parameters must be met by the hearing aid involved. For the cellular phone a magnetic emission must be delivered which is within some defined relationship to its acoustic output. Further, this signal must have an intended signal to interference ratio of 21 dB or better. The change from a 20 to a 21 dB target allows for the addition of RF interference noise. Other partitions, which sum to the same 20 dB, final performance figure are possible. The phone must also provide RF E and H fields below set levels in the area intended for use by the hearing aid.

The hearing aid must then receive and amplify the magnetic field, provided by the phone, to the same level it would the matching acoustic signal. It must not add any significant noise to the signal from its own circuitry. In addition, it must provide an immunity to the RF E and H fields such that the signal received at 21 dB signal to interference is delivered at the desired 20 dB quality level.

In summary then, in order for a hearing aid and cellular phone to operate as desired the requirements listed in Table 1 must be met.

From these requirements the following parameters must be observed for wireless phones and hearing aids to deliver the desired system performance:

In the Acoustic Mode:

1. Cellular phones must provide an area for hearing aid use at or below established E and H field limits.
2. Hearing aids must provide RF immunity at or above the established RF E and H field levels.

In the T-Coil Mode:

1. Cellular phones must provide an audio frequency magnetic field emission of the intended signal in an established relationship to its acoustic signal.
2. The cellular phone's magnetic field signal must have an acceptable signal to interference ratio, for the audio frequency signal.
3. The cellular phone's magnetic field and the hearing aid's inductive coil must be properly aligned for maximum reception.
4. Cellular phones must provide an area for hearing aid use at or below established RF E and H field limits.
5. Hearing aids must provide RF immunity, in t-coil mode, at or above the established RF E and H field levels.

MEASUREMENT REQUIREMENTS

These parameters result in the need for five measurements in order to assure that the intended performance will be achieved. These measurements are:

1. Measurement of the cellular phone's RF E and H fields in an area prescribed for hearing aid use.
2. Measurement of a hearing aid's immunity to both RF E and H field emissions, in both acoustic and t-coil mode.
3. Measurement of the cellular phone's audio frequency magnetic field emission level.
4. Measurement of the cellular phone's audio frequency magnetic field emission signal to noise ratio.
5. Measurement of the equivalence of the hearing aid's t-coil mode gain to its acoustic gain.
6. Measurement of the hearing aid's delivered signal to noise ratio, in t-coil mode.

TELEPHONE RF EMISSIONS TESTING

ANSI C63.19 controls an area 5 cm square for use by a hearing aid (See Figure 1). This area is defined as being 1 cm from the surface of the phone, over the area of the receiver. Specifically it begins at the top edge of the body of the phone and comes down over the receiver

area of the phone. It is centered, left to right, about the centerline of the phone. The field strength in this area is to be scanned using near-field probes for both the E and H field. Because the area is deep within the near-field of the antenna, sharp field gradients are common. Field variations of over 100 V/m can be found within this 5 cm square area. Hence, it is vital that careful scans of the entire area be made to accurately assess the peak field potential.

The concern in assessing these fields is the interference potential of the emissions. Therefore, it is the peak field value which is of interest with the cellular phones operating at their maximum power. Probes and their supporting instrumentation system must be capable of fast response. For example, in TDMA (Time Domain Multiple Access) cellular phone protocols a unit transmits in a specified time slot. It is common for the transmitter to function only one eighth of the time. So for a 600 milliwatt system the average power transmitted will be 75 milliwatts. For this reason probes which use diode detection are preferred. Even with these systems it is common to perform averages either in the A/D conversion process or at other locations in the instrumentation software. For the purpose of assessing the interference potential the peak reading is the required value.

HEARING AID RF IMMUNITY MEASUREMENTS

In considering the immunity of a hearing aid to RF emissions the near-field immunity is of interest. The standard measures the immunity using a resonant half-wave dipole tuned to the center of the cellular phone bands.

The near-field test is performed by feeding a resonant dipole, tuned to the prescribed frequency with a specified amount of power. The hearing aid being evaluated is tested near the center and tip of the dipole. The fields produced by the dipole are predominately H field near the junction of the dipole and predominately E field near the tip of either element. So by exposing a hearing aid to the field near the dipole junction and to the area near the tip both an H and E field immunity test is performed. In order to achieve good repeatability great

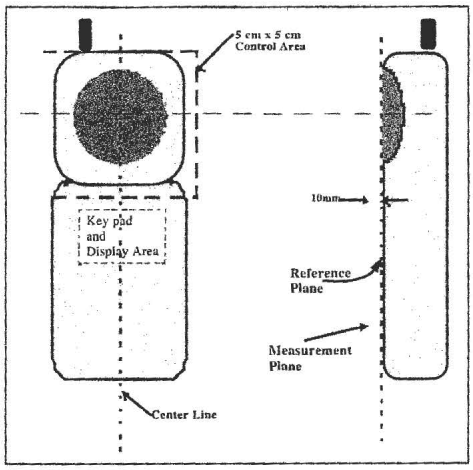

Figure 1. Control Area for Hearing Aid Use

care must be taken to control the spatial parameters involved. The region, which contains the peak emission within 10%, is less than 1 cm in any direction. In the direction tangential to the dipole the peak field falls off by more than 10% with a very few millimeters. Because of this sensitivity to location, a mechanical fixture allowing small movements is required during the tests.

AUDIO FREQUENCY EMISSIONS TESTING

Standard measurement techniques for the audio frequency magnetic emission of landline corded phones have existed for some time. FCC Part 68 sets for the required limits for these signals and EIA RS-504 and IEEE 1027 set forth the specific measurement procedures. However, these procedures, while helpful, are not sufficient for the situation with wireless telephones. The levels established for landline corded telephones are not appropriate for the technologies being used for wireless devices. Three major factors must be considered in addition to the factors involved in testing landline corded phones for FCC Part 68 hearing aid compatibility compliance. First, the RF transmission of the phone may affect the test equipment being used and create inaccuracies in the testing. This is often circumvented by redirecting the RF to an auxiliary antenna port on the telephone under test. However, even in this case the residual RF leakage can produce fields of 30 V/m or more in the region very close to the phone. The test procedure used must assure that any RF, including any residual RF, does not affect the test.

The second major issue is the question of signal quality. With landline corded phones it is assumed that there is not a significant possibility of noise emissions adding to the intended audio magnetic emission. So if a magnetic field of the required amplitude is measured it is assumed that this signal is produced by, and carries, the acoustic signal being delivered by the telephone receiver. This is not the case with cellular phones. Battery current surges, keyboard scanning and display currents can produce significant emissions of their own which will add noise to a t-coil mode hearing aid. It is important to measure first the emission level without signal, which is the noise level from these other sources. Then the signal is introduced at its intended level and the measurement is remade. The second measurement is a signal plus noise measurement. Thus a signal plus noise to noise assessment of signal quality may be made. The division being made is that the telephone must deliver an audio frequency magnetic emission with an acceptable signal plus noise to noise figure. The hearing aid must then deliver this signal to the user without adding significant additional noise to it, either from its own circuitry or, more probably, by audio rectification of RF emissions.

The third consideration is the assurance that the telephone's mode of operation during the test is truly representative of its normal operating mode. The advanced signal processing algorithms used in cellular telephones often will treat a test signal in a very different manner than an actual voice signal. This will be discussed more fully in a separate section below. However, the simple test signals which are fully adequate for landline corded phones are not effective in cellular telephones. For example, currently it is most common to induce a test signal at a specified voltage onto the tip and ring (signal) lines to a landline corded telephone being tested. The signal path from that point is sufficiently standard that the acoustic signal emitted from the phone is reasonably determined. So for the magnetic field test the test signal is put onto the telephone lines and the magnetic field at the phone handset receiver is measured. An alternative, which does not assume this fixed relationship between input and

continued on next page

acoustic output, calls for the receiver output to be established at a specified volume. Then the magnetic field is measured. Thus the relationship being sought is a fixed relationship between the acoustic output and the magnetic field output. Care must still be taken to assure that the test signal being used has the cellular phone's various gain and other settings at similar levels to those created by an actual voice signal.

SUMMARY

The ever-increasing use of electronics creates defacto systems that must operate acceptably. However, these systems may not be under the control of a single company or even a single industry. The case discussed here of cellular telephones and hearing aids is a case in point. There is a societal desire and a commitment from both the cellular telephone and hearing aid industries that these devices operate well together. ANSI C63.19 was developed by both industries to provide the requirements and validating tests required to make that commitment a realized reality in the marketplace.

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Stephen Berger *is president of TEM Consulting, an engineering services and consulting firm, located in Austin, Texas. He was co-chair of the ANSI C63.19 committee with Tom Victorian of Starke Labs. Mr. Berger has worked in EMC (Electromagnetic Compatibility), RF Safety and Disability related issues for 20 years. He has served on two federal advisory committees, the Telecommunications Access Advisory Committee, in 1996, and the Electronic and Information Technology Advisory Committee, in 1999. Currently he is:*

- *Chair of the IEEE EMC Society Standards Development Committee*
- *1st Vice-President of NARTE (National Association of Radio and Telecommunications Engineers) and*
- *President of AAES (Association of Access Engineering Specialists).*

He has written numerous technical papers and holds several patents in the area of EMC and Access technology. He may be reached at stephen.berger@ieee.org. **EMC**

Comments on the IEEE Fiscal State of Affairs

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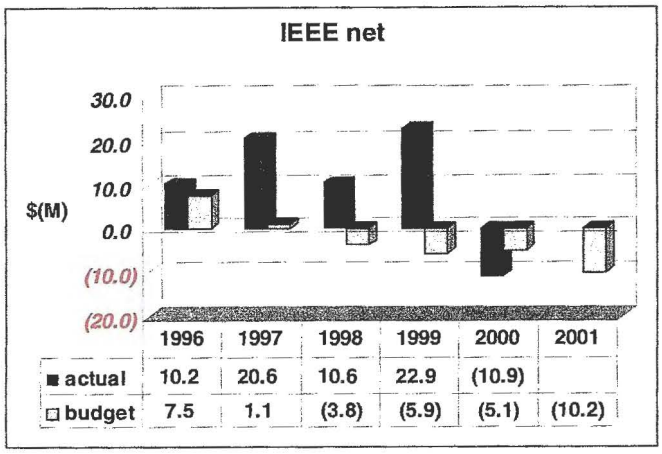
Last year (2000) was for many the end of a long merry ride for personal (and corporate) investments. As we await the statistical data to see whether indeed the stock market icon has changed from bull to bear, it is appropriate to review the state of IEEE finances. The following reviews the IEEE financial picture for the year 2000, and also gives history and a look forward. The elements of the budgeting process are discussed, and examples of *infrastructure* and *initiative* projects: investments in "our business" are described. Although the detail may be most meaningful for volunteers deeply involved in financial matters of the Institute, the overview is relevant to all.

Y2K

For the year 2000, the IEEE incurred a deficit of $10.9M, due primarily to lower than budgeted investment returns. The deficit was comprised of a Society/Council (S/C) operating surplus of $12.3M, other operating unit (OU) surpluses of $3.7M, and a corporate infrastructure deficit of -$26.9M. The corporate infrastructure shortfall of $-26.9M was partially offset by corporate reserves of $10.7M, leaving $16.2M to be covered by a reduction in reserves (apportioned as follows: S/C reserves ($15.0M) and other unit reserves ($1.2M)). The Societies and Councils therefore earned an operating surplus of $12.3M and incurred a reserve reduction of $15.M, resulting in a net hit to the 1999 S/C reserves of $2.7M. The final formula used for reserve depletion (across the entire Institute) was something like 12%. S/C reserves at 1999 end were $109.1M. If you followed the above, then for an instant at end of 2000, S/C reserves grew to $121.4M (because of their operating surplus for the year). S/C reserves were then reduced by $15M to $106.4M to get rid of the Institute shortfall and balance the books.

The Broader Picture

What about past history and looking forward? The actual net revenue for the Institute has been positive for the four years prior to 2000, as shown above. For the past three years, the IEEE has elected to invest in its infrastructure, budgeting for a deficit in each year. Why? As with any business, we can elect to increase our reserves, or we can invest in methods and tools, allowing us to grow and/or compete more effectively. Prudence demands a balance between these two courses, and a figure-of-merit to guide strategy is the ratio of reserves to annual operating expenses (R/E). If this ratio is greater than 0.5, IEEE's financial partners are happy.



	1996	1997	1998	1999	2000	2001
■ actual	10.2	20.6	10.6	22.9	(10.9)	
□ budget	7.5	1.1	(3.8)	(5.9)	(5.1)	(10.2)

As can be seen from the first figure, the deficit budgets planned for the years 1998-2001 were obscured by net positive actual surpluses due to the remarkable performance of the stock market in the 1990's. Over this serendipitous period of time, investments in IEEE infrastructure and initiatives were made, AND Institute reserves rose. Then came the year 2000, and the markets abruptly tanked. For the year 2000, the IEEE investment portfolio continued to beat its benchmarks, with a 1% gain against a 4.5% drop in the properly weighted market index. Had the budgeted investment return of 9% been realized, Y2K would have shown a net surplus; in fact the deficit for 2000 is the first since 1994.

A note on the timing of the budget: The budget process closes toward the end of the previous year but begins a full year earlier. The 9% investment return forecast for 2000 looked pretty conservative when locked in a year earlier; even in the middle of 2000, bullish optimism for 2001 prevailed, and the forecast for investment return was maintained at 9% for 2001. With our R/E guideline of 0.5 looking a bit at risk for 2001, a number of actions have been taken, or are in progress:

- The BoD cut $5M from 2001 IEEE initiative spending at the December 2000 Board meeting.
- Together, the BoD and TAB are developing comprehensive guidelines for initiative selection and tracking.
- Staff and volunteers are studying plans for increasing revenue and reducing cost for 2001.
- The recommended 2002 budget has a reduced investment return estimate (presently targeted at the 3% level).
- TAB and BoD are looking VERY closely at initiative and infrastructure spending for 2002.

These course corrections to drive towards a net zero budget for future budgeting cycles are being put in place as the investment market bears growl more loudly.

Investing in Our Business and in the Market

While all will agree that extended periods of expenses greater than revenue lead to bankruptcy, guidelines for annual budgeting (in addition to the R/E

continued on next page

metric, above) include environmental issues such as how we position ourselves to deal with the competitive environment, specifically, our business infrastructure, and our ability to manage our investment and spending portfolios.

An obvious component of our competitive environment is the publication activity. (Number of archival publications, conference proceedings, magazines, press books, and standards.) The 1999 ISI Citation Report ratifies the high quality of IEEE's technical publications, showing nine IEEE journals in the top ten Electrical and Electronics Engineering. In our marketing niche of the publishing business, first-ranked (sales) Elsevier Science, $864M sales are an order of magnitude larger than IEEE, in ninth place. With sales volume comes the need for new products and innovation. Information technology with properly designed electronic access is the key to capturing future markets. A great deal of Institute volunteer and staff effort is presently being directed at projects such as IEEE Xplore, IEL, business alliances with other publishers, online periodicals subscriptions, improvements in the sales and marketing force, and the revitalization of Spectrum. The funding for these efforts has come from IEEE infrastructure projects and initiatives (approved by the volunteers of our Publications, Products, and Services Board [P2SB]), and returns on these investments are already being realized. The publications activity is a perfect example of an IEEE "business," which demonstrates that a thoughtful injection of venture capital can lead to competitive strength and growth in the publishing marketplace.

Similar initiatives and infrastructure expenses exist in other parts of the Institute. Two visible examples of efforts in Member Services are On-Line Renewal (over 100,000 members renewed online this year at http://www.ieee.org/membership/), and free IEEE email alias services – with automatic virus checking at http://eleccomm.ieee.org/. (It has saved me more than once, and the price is right!) The 1999 infrastructure expense line of $38M represents 20% of total IEEE expenses for the year. This is a sizable fraction of the Institute budget, and it is important that the constituent programs be executed and reviewed properly, hence the actions by TAB and the BoD mentioned above.

Finally, a few additional words on the management of IEEE investments: we employ the services of professional investment groups to manage a weighted portfolio among four asset classes (the fixed asset class is managed internally). Performance over the last five years has been very good, and ranks within the top 11% of managed funds with similar asset classes.

Some Concluding Remarks

First, deficit budgeting is part of a plan to increase the value of our products and services to members, while remaining competitive in its marketplace. We have had a down year as far as our investment portfolio is concerned, and may have another. If so, reserves will decrease again. We will still be financially healthy.

Second, my sense is that we run the business of IEEE well. The heroes in this exercise are the volunteers and staff who work together to plot the future of products and services. IEEE can compete with much more heavily capitalized competitors because of its dedicated and intelligent volunteer base. There are some wrinkles to be worked out, such as:

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

Third, I am happy to report that these important issues are on the table at TAB and the Board of Directors. We will make progress as long as we keep the communication lines open.

My personal interests in IEEE activities have expanded since last year. I have been trying to find ways to contribute to Publications, Products and Services (P2SB), particularly in areas of electronic products, and am also working on an Initiative Review Committee and Audit Committee of the BoD, which has given me a crash course in Institute finances.

At the February TAB meeting, the Division IV Directors met for dinner, and we started a discussion on TAB/BoD issues. Since then, I have received some pretty frank assessments of the performance of the BoD. My personal goal is to continue this dialog with all of you over the next two years, and bring TAB and the Board closer together. The dinners will continue, as will these reports. I have begun to make plans to attend your next round of AdCom/BoD meetings, and look forward to continuing the discussion. My email address is at the top of this column. Let me know your thoughts. **EMC**

EMCABS

EMC Abstracts

Osamu Fujiwara,
Associate Editor

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

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

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

The abstracts of papers from EMC Japan are now available on the web-site: http://www.tc.knct.ac.jp/EMCJ/index-e.html, which has been provided by the IEICE EMC Japan Technical Committee and the EMC-S Japan Chapter with the aid of Professor Yoshifumi Shimoshio, Kumamoto National College of Technology. Most of the papers are available in Japanese only, while the abstracts are clearly identified. In each abstract the author's address or e-mail is given below the article title. You can directly contact the author(s) of your interested article and request the copy. In case you cannot reach the author(s), please feel free to contact Prof. Shimoshio via e-mail at *yshimo@tc.knct.ac.jp* He will assist in routing your request to the author(s), but he will not translate the papers.

As the EMC Society becomes more international, we will be adding additional worldwide abstractors who will be reviewing articles and papers in many languages. We will continue to set up these informal cooperation networks to assist members in getting the information or contacting the author(s). We are particularly interested in symposium proceedings which have not been available for review in the past. Thank you for any assistance you can give to expand the EMCS knowledge base. **EMC**

EMCABS: 01-5-2001

EXPERIMENTAL SENSITIVITY ANALYSIS OF THE SCATTERING PARAMETERS OF WIRE HARNESSES FOR FREQUENCY-DOMAIN MODELLING

Marcello D'Amore and Maria Sabrina Sarto
University of Rome "La Sapienza", Department of Electrical Engineering, via Eudossiana 18, 00184 Rome, Italy

Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 16D1, pp.81-86.

Abstract: An experimental study is carried out in order to assess the sensitivity of the scattering parameters of conductor pairs inside a complex cable bundle against variations of the harness composition, of the height above the ground plane, of the load condition of surrounding bundles. The influence of either the metallic overall-screen or the insulating sheath is also analyzed. The analysis is carried out by considering a typical bundle used on board aircraft. Useful indications for the definition of simulation models for the evaluation of the per-unit length external parameters of complex harnesses are derived.

Index terms: Wire harness, scattering parameter, sensitivity, aircraft.

EMCABS: 02-5-2001

COUPLING OF INHOMOGENEOUS FIELDS INTO AN AUTOMOTIVE CABLE HARNESS WITH ARBITRARY TERMINATIONS

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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 17D2, pp. 87-92.

Abstract: Electronic equipment in automobiles can be exposed to very high field strengths. The cable harness is, from the EMC point of view, the most critical part of an automobile. A direct computation of the terminal voltages of the cable harness with a 3D field solver is nearly impossible due to the different structure sizes of wires and car bodies. A new hybrid method based on Transmission Line (TL) theory, the Method of Moments (MoM), and circuit simulation programs was developed to calculate the coupling of inhomogeneous fields into non-uniform transmission lines, terminated with arbitrary non-linear circuits. Selected examples show the applicability of the method.

Index terms: Coupling, automobile, cable harness, transmission line theory, method of moment.

EMCABS: 03-5-2001

HUMAN-GENERATED ESD: INVESTIGATION ON THE DIRECT DISCHARGE TO A VICTIM

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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 38G5, pp. 193-198.

Abstract: The ESD directly applied to some classes of victims has carefully been investigated. A diakoptic theory-based HBM, combined with an available PSPICE routine, has methodically been adopted to reproduce the discharging phase. Specifically, the influence of the human posture, the non-linear behavior of the arc and a metallic intruder are discussed with a certain degree of detail. The victims under

examination are grounded and classified as deprived of, or conversely presenting, substantial stray capacitance. In addition, the practical case of off-chip protected integrated circuit has been selected as a representative example.
Index terms: Electrostatic discharge (ESD), human-generated ESD, direct discharge, human body model, integrated circuit.

EMCABS: 04-5-2001

TIME DOMAIN ANALYSIS OF LOSSY MULTICONDUCTOR TRANSMISSION LINES
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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 42H2, pp. 217-222.
Abstract: Multiconductor transmission lines (MTL) and their analysis have been subject to numerous investigations for many years. The combination of MTL solutions with the CPU power of current computers allowing the treatment of hundreds of coupled conductors extends the class of problems to which this method can be applied. This paper gives a brief introduction of the theory how to adopt Bergeron's method to the treatment of multiconductor and field excited transmission lines. This is followed by a number of examples: the calculation of characteristic impedances of transmission lines, the calculation of field excited multiconductor lines, and the investigation of the coupling through a plane of finite conductivity.
Index terms: Multiconductor transmission line, field excited transmission line, coupling, characteristic impedance, Bergeron's method.

EMCABS: 05-5-2001

A MODEL FOR A FINITE LENGTH TRANSMISSION LINE CONSIDERING SKIN AND RADIATION EFFECTS
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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 44H4, pp. 229-234.
Abstract: Widening of the frequency range for the analysis of distributed systems is a characteristic feature for modern EMC problems. The developed techniques permit one to take into consideration radiation effects, but do not allow regarding skin and proximity effects and, in particular, an additional attenuation caused by these effects. On the other hand, the methods that take into account skin and proximity effects do not allow the treatment of radiating systems. The authors propose an approach based on the generalized system of the telegrapher's equations permitting one to consider more exactly skin and proximity effects and with a simultaneous approximate consideration of the electromagnetic energy radiation. The structure of the equivalent circuit modeling transmission line radiation is defined from a rigorous solution of the "canonical" problem for a two-wire line, but its equivalent parameters are determined in such a way that the mathematical model represents the performance of real systems. The experimental results are compared with those calculated for the simplest system.
Index terms: Transmission line, skin effect, proximity effect, radiation, equivalent circuit modeling.

EMCABS: 06-5-2001

FULL –WAVE TRANSMISSION-LINE THEORY (FWTLT) FOR THE ANALYSIS OF THREE-DIMENSIONAL WIRE LIKE STRUCTURES
Heiko Haase and Jurgen Nitsch
Institute for Fundamental Electrical Engineering and EMC, Otto-von-Guericke University, Magdeburg, Germany
Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 45H5, pp. 235-240.
Abstract: This paper presents a generalized transmission-line theory which is useful to describe the wave propagation along as well as the field coupling to almost arbitrary three-dimensional wire structures. In contrast to the classical transmission-line theory, this new theory is a full-wave description based upon generalized telegraphers equations. Whereas the mathematical structure of these equations is preserved, the coefficients (the per unit length parameters) are redefined in order to represent the intrinsic behavior of the wire structure. Due to the full-wave description, all EM phenomena, e.g., radiation, are taken into account. Measurements as well as MoM simulations were performed to validate the predicted data.
Index terms: Full wave transmission-line theory, three-dimensional wire structure, coupling, radiation, complex line parameters.

EMCABS: 07-5-2001

ANALYTICAL MODELLING OF RADIATED EMISSION FROM LONG BUS-LINES IN CMOS ICS
J.R. Bergervoet
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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 52I5, pp. 275-280.
Abstract: A new, closed-form analytical expression is derived for the influence of the substrate on the transmission line parameters, taking into account capacitive, resistive and inductive coupling. This is used in a multi-transmission line model for the EMC properties of a digital bus-line in an IC (epi-type, with highly doped substrate). The influence of the substrate on cross-talk and on radiated emission levels is demonstrated. It is shown that for long bus-lines, the emission directly from the chip can reach levels comparable to the CISPR radiated emission limit.
Index terms: Radiated emission, cross-talk, CMOS, bus-line, transmission line parameter.

EMCABS: 08-5-2001

A HIGH FREQUENCY MODEL OF CURRENT PROBES FOR INJECTION PURPOSES
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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 71K8, pp. 379-384.
Abstract: The paper presents a method for the modeling of current probes, used in injection applications, up to 1 GHz. It is based on the determination of the S matrix of the probe thought of as a three port network. The probe parameters are recovered by some measurements when it clamps a standard line, whose characteristics are theoretically known. The results pertaining to the signal injected on a line using this model are compared with measurements and with the results obtained by a simplified probe model, based on a series transformer.
Index terms: Current probe, modeling, injection application, S Matrix.

EMCABS: 09-5-2001

CHARACTERIZATION OF PRINTED CIRCUIT BOARD TRANSMISSION LINES AT DATA RATES ABOVE 1 GB/S USING TIME DOMAIN CHARACTERISTICS DERIVED FROM FREQUENCY DOMAIN MEASUREMENTS

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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 95O1, pp. 509-514.

Abstract: High data rate differential transmission line characteristics were examined on printed circuit test boards fabricated from five different board materials. Two areas of primary concern were signal loss and common-mode signal generation. Frequency domain characteristics were studied by means of mixed-mode s-parameters with time domain behavior derived from them. Impedance profiles versus distance along the transmission line were generated. Time domain eye patterns were generated by convolving the time domain impulse response of SDD21 with a repetitive bit pattern. The frequency domain measurement technique was found to be well suited to cost-effective characterization. At data rates above 1 Gb/s, dielectric losses can have a significant effect on the distance that a differential signal may be propagated.

Index terms: Printed circuit board, common-mode, time domain analysis, giga-hertz range, dielectric loss.

EMCABS: 10-5-2001

CALCULATION OF SELF AND MUTUAL INDUCTANCES ASSOCIATED WITH VIAS IN A DC POWER BUS STRUCTURE FROM A CIRCUIT EXTRACTION APPROACH BASED ON A MIXED-POTENTIAL INTEGRAL

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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 97O3, pp. 521-526.

Abstract: Inductances associated with vias are critical in printed circuit board DC power bus and SMT decoupling designs. Many issues, such as decoupling capacitor effectiveness, local decoupling, etc., involve the characterization of interconnect vias. A procedure was developed to extract lumped element values for the DC power bus structures with vias from the equivalent circuit model extracted from a first principles formulation. Although the capacitance model for the power and ground planes is valid only at low frequencies, via inductances dominate into the giga-hertz range. The extracted inductance values were used to estimate decoupling effects, and good agreement was achieved compared with full-wave modeling.

Index terms: Printed circuit board, power bus, inductance, via, giga-hertz range.

EMCABS: 11-5-2001

A QUALITATIVE ANALYSIS APPROACH FOR AN EXTERNALLY EXCITED TRANSMISSION LINE

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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 110P9, pp. 589-594.

Abstract: Fuzzy inference abilities were implemented to electromagnetic problems for the first time by the authors. After very successful results of applying the developed fuzzy modeling method to input impedance of a general monopole antenna and general transmission line, in this article we apply the proposed method to make a qualitative model for coupling of an extetnal wave to a transmission line to show the abilities of the proposed method in EMC problems. It is shown that because of using a novel point of view and parameters, the system may be analyzed and modeled by simply using a fuzzy inference system based on new parameters.

Index terms: Electromagnetic interference, transmission line, fuzzy modeling, coupling, external field.

EMCABS: 12-5-2001

REVERBERATING CHAMBERS AND ABSORBERS

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Proceedings of 14th International Zurich Symposium on EMC, Switzerland, Feb. 20-22, 2001, 118R1, pp. 631-634.

Abstract: A study regarding the role of absorbing materials within a reverberating chamber is presented. In particular, it examines the influence of absorbers in modifying the structure and the level of the electromagnetic field within a reverberating chamber. The study is based upon a novel generalized stochastic approach to the field within the reverberating chamber and a set of experiments conducted at the Istituto Universitario Navale (IUN) reverberating chamber facility. Such results show that it is possible to generate a field which is characteristic of urban environments. As a consequence, it is proven that the reverberating chamber is acceptable to properly test electronic devices meant to operate in urban environments.

Index terms: Reverberation chamber, absorbing material, urban environment, stochastic approach.

Special Workshop

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Dennis also collaborated with colleagues, notably Dr. Robert Johnk of NIST and Ken Hall of the Hewlett-Packard Company, in Roseville, California, in presenting a paper on exploring test site performance using a double ridge horn. Thanks to their efforts, the audience learned that using the traditional normalized site attenuation methods would result in virtually any site complying! Even with a sheet of steel just a few meters to the side of a measurement path, no reflections were detected. This research clearly demonstrated the need for more analysis to develop a meaningful site qualification procedure that is representative of the measurement process.

If one thing is certain, it is that Ed Bronaugh's talk on measurement instrumentation uncertainties was educational. Influence quantities of receiver versus spectrum analyzer configurations were compared. Different antennas, measurement environments and cable types were also contrasted with respect to measurement uncertainty. Ed summed it all up nicely!

The current state of affairs with draft international standards on measurement uncertainty being developed in the International Special Committee on Radio Interference (CISPR) was thoroughly reviewed by Don Heirman. Don's insights were excellent, as you might have guessed. The extensive activities of both CISPR and the US Accredited Standards Committee C63 working groups were reviewed in detail. Radiated emission measurement uncertainty proposals under consideration by both organizations were examined. The international efforts to create practical requirements for measurements above 1 GHz and the associated uncertainties are indeed far-reaching.

Uncertainties were sure to come up again as Pierre Beeckman of Philips Research in the Netherlands took the stage. Pierre provided an overview of the contributions to uncertainty from the equipment under test and the test setup requirements in standards.

The lack of guidance in the current standards contributes to uncertainty by not providing enough guidance in test setups, cable manipulation, etc. Pierre's presentation tied together the issues of calibration, errors, and instrumentation uncertainty from Ed's presentation on uncertainty.

The closing speaker for the afternoon workshop was Ghery Pettit of Intel in Dupont, Washington. Ghery discussed the nature of emissions from products that occur above 1 GHz. Proper measurement of spread spectrum clock signals utilized in computers and telecommunications equipment was reviewed. Some of the practical difficulties of finding millimeter wavelength emissions during preliminary scans in an OATS environment were also considered.

Instrumentation, antenna selection, instrumentation uncertainties, site qualifications, set-up uncertainties, standards developments, and the complexities of practical measurements are a lot to cover in one afternoon. The IEEE EMC Society special workshop in Zurich covered them all. It was a big hit with over 100 people in attendance! Yet more work is being done. Research is underway under the auspices of ANSI Accredited Standards Committee C63 and CISPR Subcommittee A to develop a practical way of evaluating a test site for reflections. Beamwidths of products and antennas are being studied to determine the feasibly of using reverberation chamber test techniques and establishing emissions measurements in terms of radiated power. The practical frequency limit to manually pre-scanning products is also under consideration. With all this work underway, you can expect more interesting and educational presentations to come from the IEEE EMC Society.

For further reading, the presentation slides used for this special IEEE EMC Society workshop are included in the Zurich Symposium proceedings – view the website for ordering information on http://www.emc-zurich.ch/ or contact Dr. Gabriel Meyer at gmeyer@nari.ee.ethz.ch. Those interested in pursuing this topic further are encouraged to join the Working Groups in ANSI ASC C63 Subcommittee 1 on "Measurement Techniques and Methods." Visit the website http://www.C63.org for more information. Or, consider joining the Technical Advisory Groups in your respective countries for CISPR. Visit the website http://www.iec.ch which provides information on CISPR activities.

***Michael J. Windler** is an Associate Managing Engineer responsible for the operation of the EMC laboratory of Underwriters Laboratories Inc. in Northbrook, Illinois. Mr. Windler is an active member of the American National Standards Institute Accredited Standards Committee C63 (ANSI ASC C63). In addition, he is a member of the ANSI ASC C63 Subcommittee 1 on "Measurement Techniques and Methods" as well as Subcommittee 6 on "Laboratory Accreditation." Mr. Windler is also the chairman of the ANSI ASC C63 working group 1-13.2 on "Requirements for Sites Operating above 1 GHz." He was also a principal researcher in the development of correction factors for biconical antennas under working group 1-15.6. He earned a BSEE from the University of Wisconsin and an MBA from Northwestern University.* **EMC**

Calendar

EMC Related Conferences & Symposia

2001

June 19-22
IV International Symposium on EMC and Electromagnetic Ecology
St. Petersburg State Electrotechnical University "LETI" Russia
Prof. D.V. Puzankov, Chairman
Phone: +812.346.46.37
Michel Ianoz, Vice-Chairman
Phone: +4121.6932664
E-mail: michel.ianoz@epfl.ch
emc2001@eltech.ru
http://www.eltech.ru/EMC2001

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

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

2002

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

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

EMCS Cooperating Symposia

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

EMCS Symposia Schedule

2001 Montreal, Canada
Montreal Convention Center
Benoît Nadeau
514.822.6000 x2475

2002 Minneapolis/St. Paul
Hyatt Regency, Minneapolis
Dan Hoolihan
651.213.0966
E-Mail: d.hoolihan@ieee.org

2003 Tel-Aviv, Israel
(International IEEE)
Elya Joffe
Fax: 972.9.765.7065

2003 Boston, MA
Sheraton Boston
Mirko Matejic
508.549.3185

2004 Santa Clara, CA
Franz Gisin
408.495.3783

2005 Chicago, IL
Derek Walton
815.637.3729

IEEE EMC Society Board of Directors Meetings

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

August 12, 2001
Montreal, Canada

November 13, 2001
San Diego, California

February 13, 2002
Tempe, Arizona

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

Please note that there are no EMC Chapter table-top shows scheduled for the months of June-September, 2001. The Chapters will support the Montreal EMC Symposium in August. Check future issues of this Newsletter for Fall 2001 scheduled table-top shows. *See ad page 25.*

http://www.emcs.org

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