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EMC

IEEE EMC Society Newsletter

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EMC SOCIETY

Motohisa Kanda
September 10, 1943 – June 12, 2000

Motohisa Kanda was born September 10, 1943 in Kanagawa, Japan to Saburo and Sachiyo Kanda. Though mischievous, he was an inquisitive and dedicated student who plowed through an engineering bachelor's degree in 1966. As an undergraduate, he met Yoko Umeda at a YMCA camp. With the caring support of his family in Denver, he came to the University of Colorado and earned his Masters (1968) and Doctorate (1971) degrees. After many years of courtship, Motohisa finally convinced Yoko to get married in 1971. They moved to Boulder and began their lifelong journey as best friends and enjoyed doing everything together.

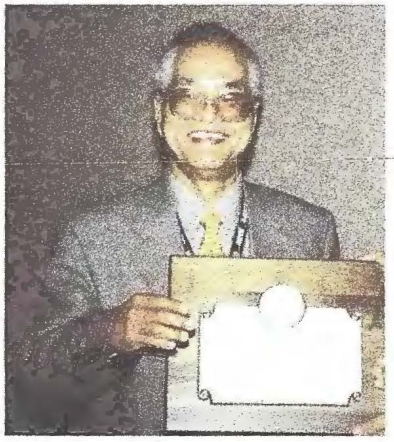
In 1971, Motohisa joined the Radio-Frequency Technology Division (formerly Electromagnetic Fields Division) at the National Institute of Standards and Technology (formerly National Bureau of Standards) and served as group leader of the Fields and Interference Group for 15 years. Concurrently, he also served as a professor adjoint in the Department of Computer Engineering at the University of Colorado.

Motohisa Kanda

He was an IEEE Fellow, Life Member of the EMC Society, and Editor-in-Chief of the IEEE Transactions on EMC for 12 years. As a leader of EMC research at NIST, he wrote over 100 archival papers, and contributed to numerous EMC books and ANSI and IEEE standards. He was a technical member, vice-chair and technical program/paper committee chair of the IEEE EMC Symposium in Denver (1981, 1989, 1998). He served as Vice-Chair (1994-1996) and as Chair (1997-2000) of International Commission A (Electromagnetic Metrology) of the International Union of Radio Science (URSI). He received two Bronze Medals (1981, 1992) and a Silver Medal (1989) from the US Department of Commerce. Awarded three Transactions on EMC Best Paper Awards (1982, 1989, 1992), he became an Honorary Life Member is 1996. He received the Laurence G. Cumming Award in 1999 and numerous other awards and certificates of appreciation from the IEEE and the Department of Commerce. Motohisa took part in evaluating research results for the IEEE Transactions on EMC. He improved the quality of EMC Society publications with participation in several technical advisory committees.

Above all, Motohisa was a kindhearted brother, devoted husband, and loving father. He was a compassionate person who cared deeply about his family and friends. He provided unconditional love, support and guidance. We miss him and will never forget the memories.

Editor's Note: Len Carlson, Vice-President for Communication Services, EMC Society Board of Directors, attended the memorial service for Motohisa Kanda on Saturday, June 24 in Boulder. The Kanda family shared this material at the service.



Moto Kanda received one of the EMC Society's highest awards at the 1999 IEEE International Symposium on EMC in Seattle.

As Editor of the IEEE's Transactions on EMC, Moto Kanda traveled the world seeking new and original material for the publication. On one such journey, he visited EMC'99 in Tokyo with his wife Yoko, left, and daughter Carol, center.

Remembering Dr. Moto Kanda

By Atsuya Maeda, PE

Moto Kanda enjoyed the company of the EMC Society Board of Directors and the Italian EMC community. He is shown at EMC '98 Roma with Board members Dick Ford (left) and Don Sweeney (center).

Kanda-san; not even in my wildest dreams did I think that you would depart this world so quickly. I still don't believe it. Little did I realize that I was listening to your dying words when I called you from the airport while transferring between planes in the U.S in May.

I first met Dr. Moto Kanda in July 1982 in Tokyo at a seminar on EMC/EMI measurement technology where Dr. Kanda was the teacher and I was the student. This meeting occurred during a turning point in my career when I was changing my specialty from measurement standards to EMC. I was employed by Matsushita Communication Industrial Co., Ltd., and chairman of the EIA Japan Industrial Measurements and Standards Research Committee, so I was able to be of some slight help in the planning of Dr. Kanda's first seminar in Japan.

Thus it can be said that I became the first disciple of Dr. Kanda. When I recall how I brazenly prevailed upon Dr. Kanda to read my first paper at the IEEE International Symposium on EMC in 1983 in Washington, D.C., because it was not possible for me to go to the U.S. at the scheduled time, I want to find a hole and crawl in. In 1989, I presented my own paper in Tokyo, but subsequently there were many times when I took advantage of Dr. Kanda's good nature to have him read a paper for me.

Dr. Kanda not only taught me, but by his everyday conduct he continually delivered the following message to the worldwide electronics industry:

The proposal and establishment of EMC standards and regulations, together with their interpretation and administration for application to products and furthermore technology to secure conformance of products to these standards, are extremely important concrete endeavors. However, it is imperative to advance the underlying basic technology and pay attention to the theoretical analysis that is the basis for this technology.

By his actions Dr. Kanda put his words into practice. One example is the Kansai Electronic Industry Development Center. A great debt is owed Dr. Kanda for suggesting the technical seminars that have been held starting from 1996. In the past all activity had centered around manufacturers, including studies for setting standards and countermeasures for products, but Dr. Kanda taught us that it is necessary to fully consider the basic technology and established these seminars to provide a forum for information exchange with leading specialists from universities. These seminars have continued since then, and will continue into the future in memory of Dr. Kanda.

All my memories related to Dr. Kanda are happy ones. We shared similar tastes in food and thus I enjoyed Dr. Kanda's company while we dined together many times.

At this point I would like to relate an anecdote about Dr. Kanda's great appetite for rice. Dr. Kanda created the opportunity for me to participate at EMC Roma. He told me that I would find it extremely informative because the quality of papers is always very high, so I began participating in 1996. It was my first visit to Rome and Dr. Kanda guided me to many interesting places during breaks in the program.

Breakfast at the Hotel Atlantico was served buffet style and the menu included rice so we both dashed off to heap some on our plates. However, this rice was not cooked in a manner palatable to Japanese persons; it was prepared so that it was still half raw with a hard core. Perhaps it was just a bad batch. But I thought it would be wasteful to leave it on my plate and persevered until I finished what I had taken. I looked to Dr. Kanda and saw that he had not only eaten all that was on his plate but had returned for a second helping. He proclaimed, "I must eat rice or I won't be strong." Japanese people often say this. The second day I passed on the rice, but Dr. Kanda piled a double portion on his plate and ate it all.

I learned a lesson from this experience and in 1998 I carried rice in vacuum packs with me from Japan. Each pack contains a single portion and tastes like freshly cooked rice after it has been reheated in a microwave cooker for one or two minutes. In the morning I brought several of these with me to the hotel dining room and asked the waiter to heat them in a microwave, but he turned down my request by saying they had no such instant machine (microwave). Dr. Kanda refused to give up and negotiated to have the rice warmed in a microwave at a convenience store on a street corner a short distance away. We finally had hot, delicious rice. The next morning he again had the hotel send somebody to the convenience store to warm the rice and we had a delicious breakfast.

My memories also include the time he found vacuum packs of tofu (from Japan) at a Korean store and the two of us became emotional while enjoying delicious tofu, and the flavor of the shrimp we ate on Capri.

I still find it impossible to comprehend that health-food devotee Dr. Kanda could die of stomach cancer. **EMC**

President's Message

Joe Butler – President, EMC Society

Many of you have already heard the sad news. EMC Society Board of Directors member and long time IEEE EMC Transactions editor, Moto Kanda, passed away on June 12, 2000 after a long battle with cancer. This is a sad story – Moto was a kind, caring person who worked very hard for our Society. Moto was global long before it was fashionable to do so. He was rigorous in his review of EMC technical material – protecting our EMC technical heritage from dilution. Moto will be missed by his family and friends as well as by the entire EMC Society.

As President of the EMC Society, it is my honor and duty to appoint someone to fill out the unexpired term of Moto Kanda on our Board of Directors. After some thoughtful introspection and consultation with trusted advisers, I have selected Carlos Sartori of Brazil to join the Board of Directors. As it turns out, Carlos had already been nominated and would have been placed on the ballot for our Board of Directors election for this year. I am very happy that Carlos has agreed to join us and by doing so becoming the first EMCS Board member from IEEE Region 9 (Latin America). Carlos's bio appears elsewhere in this newsletter. I look forward to working with Carlos on membership development in the region along with current board members Jose Perini and Todd Hubing.

The EMC Society Board of Directors held its second meeting of the year on June 9th in Montreal, Canada, the site of the 2001 International EMC Symposium. Besides addressing the normal business of the Society, this was an opportunity for the Board of Directors, the local Montreal EMC chapter, and the members of the 2001 symposium committee to get together and meet one another. To effect this, an informal reception was held which was followed by an interesting technical presentation on the use of decoupling capacitors on PC boards by EMCS Board Member Todd Hubing. Plans for the August 13 – 17, 2001 Montreal symposium are in full swing. The venue for the symposium, *the Palais des Congres de Montreal,* convention center, is a very large and attractive building that is easily accessible on foot from nearby hotels. Symposium Chair Benoît Nadeau and his committee have made much progress since the first part of this year.

While in Montreal for the Board of Directors meeting, EMCS President Butler managed to set aside time to sample Bonaparte, one of the fine French restaurants in town. Shown left to right are Barry Wallen, Janet O'Neil, Dan and Rosemary Hoolihan, Joe Butler and Todd Hubing.

As regards activities on the Board of Directors, we are moving ahead with the concept of offering paid advertising on our EMC Society website. This will be in the form of company logos that can be used to link directly with the respective company website. Issues remaining to be resolved involve legal and contractual terms. Website development among the Society technical commit-

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August	July 1
November	October 1
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Letter from the Editor

Janet O'Neil – Editor, EMC Society Newsletter

Newsletter Editor Janet O'Neil joined Barry Wallen (center) and Todd Hubing in Montreal, site of the June Board of Directors meeting.

In this issue, we reflect upon the loss of a treasured member of the EMC Society, **Motohisa Kanda**. I personally had the pleasure to know Moto over the years. His ready laugh and tremendous joie-de-vivre will never be forgotten. When I started as editor of this Newsletter, Moto always provided behind the scene encouragement and advice. We were fellow editors of the two EMC Society publications, the Transactions on EMC and the EMC Society Newsletter, respectively, and shared a warm camaraderie. Moto was always willing and able to provide invaluable introductions to the "movers and shakers" in the international EMC community. I have met many wonderful EMC colleagues over the years through Moto. From Moto I learned that the study of EMC goes hand-in-hand with good food, good company, and good sports (he loved tennis, especially playing with the Italians). Moto would magically make things "happen" and always laugh mischievously when acknowledged with thanks as the originator of something wonderful that he arranged. Never taking credit, and always modest, he was a most charming person. I am grateful to **Len Carlson** for providing material from his memorial service to share with our readers. I also thank **Atsuya Maeda** for sharing his personal reflections on Moto. Together with some of my favorite photos of Moto pictured in this Newsletter, I sincerely hope we have done justice to the life of a truly wonderful man.

This issue also marks the last time we will feature **Bob Rothenberg** as Associate Editor of Practical Papers. After many years, Bob is ready to move on. I cannot thank Bob publicly enough for his wonderful work with the practical papers. During Bob's association with the Newsletter, his column steadily grew to consistently feature two to three practical papers in each issue. Bob diligently worked with each author to ensure the material was presented correctly. His material was always submitted in a timely manner; a most important attribute in order to meet press deadlines. He was always a pleasure to work with and his talent for diplomacy was admirable. We are fortunate to have **Bob Olsen** of Washington State University assume Bob Rothenberg's position on the Newsletter. Bob Olsen's biography and photo are shown on page 19 of this Newsletter. Bob Olsen was highly recommended by several members of the EMC Society for this position. From his extensive background in EMC as evident in his biography, I am sure you will see why. So, thank you to Bob Rothenberg for your years of service to the Newsletter and welcome to Bob Olsen for accepting the challenge to be the new Associate Editor of Practical Papers effective with our next issue.

There are lots of new things going on in the EMC Society. I hope you'll take the time to read the Board of Directors Activities article (not just because I wrote it, ha!) in this issue, as you'll learn of the many varied tasks being undertaken by members of your Board of Directors. In Chapter Chatter, you'll be treated not only to **Todd Hubing**'s consistently humorous introduction, but be amazed by the extent of worldwide EMC activity carried on at the chapter level. In the EMC Standards Activity article, EMC industry luminaries **Warren Kesselman** and **Herb Mertel** have taken the time to reflect on the development of certain military standards. It's a wealth of historical knowledge. There are several new articles and material of interest in this issue, so sit back and enjoy reading. As always, if you have questions, comments, or suggestions about the Newsletter, please feel free to contact me. Don't forget, the next issue of the Newsletter will feature extensive coverage of the 2000 IEEE International Symposium on EMC in Washington, DC. Be on the look out for this in your mailbox this fall! **EMC**

Chapter Chatter

Todd Hubing, Associate Editor

Finally! I'm finally getting around to writing the Chapter Chatter column for the summer issue of the Newsletter. I confess, I'm two weeks late, but this time I've got a good excuse. I spent the last 3 weeks in Japan visiting Okayama University. They have a top-notch EMC Laboratory and I was there to learn more about the research they are doing in printed circuit board and VLSI EMC. While I was in Japan, I also had an opportunity to visit several EMC Laboratories in the Tokyo area where excellent research is being conducted. I was particularly impressed with work being done with high-resolution near-magnetic-field scanning, power-bus noise simulation and measurement of VLSI devices, and ultra-high-speed data buses on multi-layer printed circuit boards.

Prof. Ryuji Koga and Prof. Osami Wada of Okayama University were excellent hosts. They made sure my trip was both enjoyable and productive. My Japanese is not very good, but I did manage to pick up three Japanese words:

Kampai – "Let's drink this beer."

Arigato – "Thank you for the beer."

Kudasai – "More beer, please."

It's amazing how well one can get around in Japan with a vocabulary of three words. On occasions when I was exploring the city of Okayama on my own, I found that I was able to communicate with the people very effectively using exaggerated gestures and pantomime. The next time you see me at a conference, I'll be happy to show you a very effective way to ask for the location of the nearest restroom without using words.

The trip to Japan was enjoyable, but we also worked pretty hard, so I didn't have time to write my column while I was there. When I came back, I had three weeks worth of miscellaneous tasks to take care of. The most important task, of course, was to write the Chapter Chatter column for the summer issue of the EMC Society Newsletter. So obviously this was the first thing I did, right? Well, not exactly.

Photo by Osami Wada

Hubing-san, Oh-san, Wada-san and Watanabe-san discussing embedded capacitance in Tokyo - Kampai!

Let me explain the first rule in the Hubing School of Time Management: Do the least important things first. Why? Because, the most important things will always get done somehow. For example, suppose your list of things-to-do has three items:

1. Organize office
2. Write a Chapter Chatter column for the Newsletter
3. Have appendix removed before it bursts

Clearly these items do not have equal priority. The appendix is a life or death matter and therefore this task should be done last. After all, if you have the appendix taken care of first, you might not get around to the other tasks. However, even if you do the other tasks first, it is unlikely that you will decide you don't have time for the appendix.

See what I mean? The Hubing School of Time Management dictates that the office be organized first. Otherwise this will probably never happen. Next, the Chapter Chatter column can be written. After all, this item has a deadline. Finally, the appendix can be removed. No matter how much time was spent on the first two tasks, the third one will surely be completed.

This system is contrary to anything you are likely to learn in anyone else's time management course, but it works for me. I generally manage to meet deadlines and yet I don't neglect lower priority items.

If you are reading these words in the summer issue of the EMC Society Newsletter, then my column was received prior to the absolute-final-now-or-never deadline. Plus, I had a great time in Japan and my office looks really good. Now, if you will excuse me, I'm going to defragment my hard drive and then I'm off to the emergency room ....

Austria

Kurt Lamedschwandner, Chair of the Austria Chapter of the IEEE EMC Society reports that their meeting on June 29th featured a very interesting lecture by Prof. Hadrian, Technical University Vienna. The topic of his presentation was "Shielding of Rooms against Low-Frequency Electromagnetic Fields". After the lecture, the chapter held a nice social event in Vienna. This autumn, a meeting is planned in Graz, the second largest city in Austria.

Beijing

Gao Yougang, Chair of the Beijing Chapter, reports that the Second Asia-Pacific Conference on Environmental Electromagnetics – CEEM 2000 was held in Shanghai, China in May. It was co-sponsored by the China Institute of Communications, Beijing University of Posts and Telecommunications, The Institute of Electrical Engineers of Japan and the Institute of Electronics, Information, and Communication Engineers of Japan (IEICEJ). Both the IEEE EMC Society and the IEEE Communications Society were Technical Co-sponsors.

The Technical Program Committee received about 120 papers. 80% of these papers were accepted and published in the proceedings. The authors were from China, Japan, Korea, United States, Germany, Sweden, Switzerland, Italy, Poland, Finland, Singapore, and Thailand. More than 100 participants attended this conference. The Conference provided a forum to

The opening ceremony of CEEM 2000 Shanghai attracted several members of the regional EMC community including (L-R) Deng Zhenyin, Ye Peida, Song Zhiyuan, Gao Yougang, Shuichi Nitta, Yang Qianli, Zhang Weihua and Lin Jintong.

Prof. Yang Qianli made a short speech during the conference banquet.

Prof. Shuichi Nitta, Dr. Yu Defen, and Prof. Gao Yougang, (L-R) enjoyed the conference banquet. Dr. Defen was Vice-Chairman and Prof. Yougang was Chairman of the CEEM 2000 Organizing Committee.

exchange information on the progress of research and development in electromagnetic theory, antennas, wave propagation, electromagnetic environments, earthquakes, ESD, lightning and NEMP, bioeffects, and EMC-related areas. The exhibition held along with the conference featured manufacturers from China and other countries showing products of high quality. The conference was a huge success. The Third Conference on Environmental Electromagnetics will be held in Hangzhou, China in November 2003.

Dr. Li Shufang reports that a meeting of the Beijing chapter on May 22nd and 23rd featured IEEE EMC Society Distinguished Lecturer, Mark Montrose. Mark was invited to China by Prof. Gao Yougang. He gave an 8-hour lecture on "EMI and the PCB." That covered the fundamentals of signal integrity, fundamentals of EMC, basic EMC suppression concepts, bypassing and decoupling, trace routing, layer jumping using vias, crossing the barrier, and ESD protection. After his talk, there was an enthusiastic discussion about PCB design techniques. Mark answered many questions related to PCB design and layout. Thirty-one researchers attended the lecture from many famous universities, research institutes and companies such as Tsinghua University, Beijing University of Posts and Telecommunications, the Electronics Institute of China Scientific Academy and the Dongfang Telecommunications Company. Everyone who attended was interested in the topic and satisfied with the result.

Central New England

John Clarke, Chair of the Central New England Chapter, reports that Kevin P. Baldwin, of EMC Test Systems in Norwalk, CT, was the featured speaker at their April meeting. Mr. Baldwin spoke on "CASSPER, 'The Virtual Chamber' EMI Ambient Cancellation and Source Localization." The speaker provided a description and demonstration of the system. The CASSPER system effectively brings an open area test site (OATS) into the laboratory or onto the production floor, measures EMI and determines compliance at any loca-

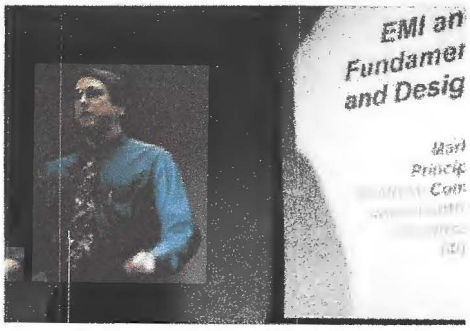
Prof. Trzaska and Dr. Hansen visited the exhibition area during the CEEM 2000 Shanghai conference.

On May 22-23, EMCS Distinguished Lecturer Mark Montrose spoke to the Beijing EMC Chapter at a meeting held at the Beijing University of Posts and Telecommunications.

tion. CASSPER is a new PC-based instrumentation system that records and isolates EUT signals of interest without the need for anechoic chambers. The system delivers true ambient cancellation and removes the guesswork in signal identification. The product's coherence measurement feature allows you to identify and locate sources of EMI noise including multiple sources at the same frequency. Twenty-two people were on hand for Mr. Baldwin's presentation.

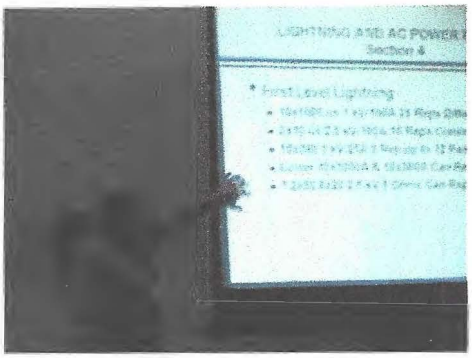
Denise Haley, of Agilent Technologies in Andover, MA, was the featured speaker at the May meeting. Her presentation was titled: "Overview of the European Union (EU) Radio Equipment and Telecommunications Terminal Equipment (R&TTE) Directive." Ms. Haley provided a comprehensive review and current status of the EU R&TTE Directive. Compliance to the Directive became mandatory on April 8, 2000 for all radio and telecommunications products being marketed in the EU. The speaker discussed the key elements of the Directive including scope, essential requirements, CE mark and other labeling specifications, and conformity assessment procedures. An up-to-date status of the Directive including references to recently published harmonized standards and member states' requirements were also covered, as well as a review of how one medical device manufacturer incorporated the Directive into their system.

CNEC EMCS Chapter Officers elected for 2000/2001: Chairperson and Secretary - John Clarke, Co-Chair-John Luchini, and Co-Vice Chairs - Lee Hill and Boris Shusterman.



Mark Montrose, EMCS Distinguished Lecturer, was guest speaker at the February meeting.

Mark Bushnell (Dallas EMC Chapter Chair), Mark Montrose (Distinguished Lecturer guest speaker at the February meeting), Chris Steidel (winner of the door prize) and Gary Shimko (Dallas EMC Chapter Vice Chair) enjoy some social time following the chapter meeting.



Jim Press presented information about Bellcore requirements at the March Dallas Chapter Meeting.

Dallas

The first meeting in 2000 of the Dallas EMC Chapter was held on January 18th at Intertek Testing Services, Richardson, Texas. The guest speaker was Bill Holz, ITS National Sales Manager, who spoke on "International Telecom Testing and Approvals". There were 23 in attendance (15 IEEE members).

The February 2000 Dallas EMC Chapter meeting was held on February 15th at Abbott Labs, Irving, Texas. The guest speaker was Distinguished Lecturer Mark Montrose, speaking on "EMI and the PCB - Fundamental Concepts and Design". There were 38 in attendance (16 IEEE members). A copy of Mark's second book, "EMC and the Printed Circuit Board", was given as a door prize to Chris Steidle, of Abbott Labs, holder of the winning ticket. No one claimed the second door prize, a gift certificate for a Don Heirman haircut at the Rolla Barber Shop.

The March 2000 Dallas EMC Chapter meeting was held on March 21st at National Technical Systems, Plano, Texas. The guest speaker was Mr. Jim Press, Chief Engineer, NTS, who spoke on Bellcore EMC requirements. There were 38 in attendance (16 IEEE members). NTS is in process of upgrading the Plano EMI Test Facility to add full Bellcore testing capability.

The April 2000 Dallas EMC Chapter meeting was held on April 18th at National Technical Systems, Plano, Texas. In April, instead of a guest speaker, the meeting was one of "EMC War Stories", moderated by Carl Irby (Bell Helicopter, Ft. Worth). There were 20 in attendance and almost everyone had at least one story to share, some had a few stories, and some are still talking.

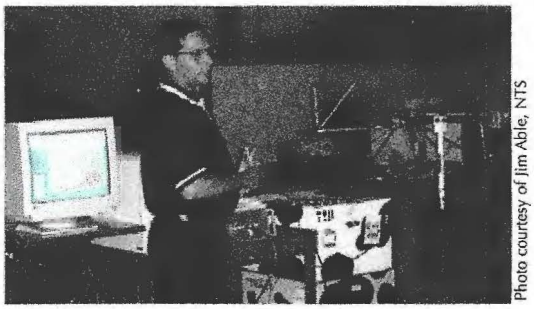


Photo courtesy of Jim Able, NTS

David Watkins demonstrates the new CASSPER product to the Dallas Chapter.

The May 2000 Dallas EMC Chapter meeting was held on May 16th at National Technical Systems, Plano, Texas (three months in a row for NTS). Our guest speaker was Mr. David Watkins, CASSPER Instrumentation Systems, Inc., Lake Forest, California. David first presented a description and history of the development of CASSPER and then demonstrated its capabilities. There were 25 in attendance (22 IEEE members). CASSPER utilizes two separate receiving "channels", one to measure the emission of the Unit-Under-Test plus ambient and the other to measure only the ambient; the system subtracts

Photo courtesy of Jim Able, NTS

Gary Shimko (2000-2001 Dallas Chapter Chair) presents the past Chapter Chairman's lapel pin to Mark Bushnell.

Ferdy Mayer (center) passes the torch as chairman of the French EMC Chapter. Dr. André Berthon (L) is the new Chairman and Dr. Yannick Beniguel is Vice-Chair (R).

the ambient, resulting in a measurement of only the EUT emission. The demo was quite impressive.

France

On May 29, 2000, in a French IEEE EMC Chapter board meeting, Prof. Ferdy Mayer confirmed his resignation as Chair. Dr. André Berthon has been nominated as new Chair and Dr. Yannick Beniguel will be the new Vice-Chair. Dr. Berthon has been the Chair of the EMC "Club" of the French Society of Electrical and Electronic Engineers (SEE). He is well positioned to encourage the development of the French IEEE EMC Chapter and to promote local cooperation with the SEE.

Germany

Frank Gronwald reports that during the summer term the German EMC Chapter held a couple of meetings at the University of Magdeburg. Each presentation was attended by more than 20 members and guests.

The first meeting was held May 18th. The presenter was Dr. Ira Kohlberg from Kohlberg Associates, USA. Before he started to talk about the effects of unwanted electromagnetic signals on information networks, there was a certain time delay because some transparencies were missing. Due to the excellent driving skills of Dr. Juergen Nitsch, they were retrieved from a hotel room quite quickly while the waiting audience was entertained by a spontaneous presentation by Heiko Haase on his approach towards a full-wave transmission line theory. With a complete set of transparencies at hand, Ira Kohlberg followed up and shared his many interesting ideas on how the influence of EM fields on information networks can be described in a proper framework. It was a true pleasure to listen to his explanations and comments. Mathematics played also a major role in the May 23rd presentation of Dr. Wilhelm Ochs from the Fraunhofer Institute INT, Euskirchen on high-to-low frequency conversion in nonlinear circuits. For specific configurations, he obtained closed form results and therefore succeeded in illustrating the physical mechanisms behind these nonlinear processes.

Photo by Frank Sabath

Shown touring the EMC facilities at the University of Magdeburg are (L-R) Dr. Sergey Tkachenko, Dr. Juergen Nitsch, Dr. Carl E. Baum and Dr. Guenter Wollenberg. Note the big smiles!

Offspring of the German EMC Chapter took the lead on June 8th and 20th when Roland Tiedemann and Alexander Sturm, respectively, presented their research results. Both of them work at the University of Dresden and will finish their Ph.D. theses within the next few months. Roland Tiedemann gave a thorough overview of the measurement of transfer impedance and transfer admittance by his ingenious current line method. Alexander Sturm used differential geometry to obtain a new method for the treatment of diffraction in EMC-related problems.

Finally, on June 13th, Dr. Carl E. Baum from the Air Force Research Laboratory at Kirtland, USA, was present to share his unmatched experience on the electromagnetic interaction with and scattering from systems and targets of interest. Focus was put on electromagnetic topology and the singularity expansion method. All questions were answered in detail. It was very nice to have Carl. E. Baum not only as a speaker at the Chapter meeting, but he also stayed with the EMC group of the University of Magdeburg for a full week. This allowed for more detailed interaction, especially with another leading EMC expert, Dr. Sergey Tkachenko, who joined the Magdeburgian EMC group in April 2000. The German EMC Chapter is very glad to have Sergey Tkachenko in its surroundings!

Dr. Frank Sabath informed us of two additional meetings in Germany. The German EMC Chapter held two meetings on the topic of "Impulse Radiating Antennas". On May 16th Dr. Dave Giri contributed as a speaker to a technical meeting at the armed forces scientific institute for protection technologies (WIS) in Munster, Germany. Dr. Giri shared his practical expertise in electromagnetism and gave a lecture on "Impulse Radiating Antennas". After the presentation the participants were invited to visit the laboratory of the EMP protection department.

A two-day workshop on "Impulse Radiating Antennas" was held on June 19-20 in Munster, Germany. More than 30 participants joined the meeting and listened to seven presentations related to

Photo by Frank Sabath

Dr. L. Schänzler head of the physics department, Dr. D. Giri distinguished speaker at the May meeting and Dr. F. Sabath.

Photo by Frank Sabath

Speakers and organizers of the workshop on IRAs. Shown from the left are Dr. F. Sabath, Professor G. Mönich, Dr. C. E. Baum, Dr. B. Staginnus (head of the WIS) and D. Nitsch.

ultra wideband coupling to electronics and impulse radiating. The speakers, among them Dr. C. E. Baum, Professor J. Nitsch and Professor H. Garbe, lead a host of challenging discussions. The presentations were on a high scientific level and provided an enjoyable atmosphere for discussion.

The organization of the workshop had been put into the hands of Dr. F. Sabath and D. Nitsch who are with the EMP protection department of the armed forces scientific institute for protection technologies. Professor H. Garbe, Chairmen of the German EMC Chapter, thanks the armed forces scientific institute for protection technologies for the organization and the admirable support of the June meeting.

Israel

The Israel IEEE EMC Chapter held its second chapter meeting of the year and the millennium. Elya Joffe, Chair of the Israel Chapter, reports that the meeting took place as a full day workshop on April 18, 2000. The title of the Workshop was: "EU EMC Directive Revisited, and Israeli EMC Legislation." It was devoted primarily to a discussion of the recent updates in the EU EMC Directive, standards, and a discussion on the future of Israeli EMC legislation and standardization. The workshop took place at the Israeli Institution of Standards. Twenty-four participants and members took part in the workshop. Approximately half the participants were IEEE Members. The guest speaker for the workshop was Mr. Diethard Moehr from Siemens, who is deeply involved in EMC standardization and legislation as Secretary of IEC TC-77.

A welcome address was presented by Mrs. Ziva Patir, CEO of the Israeli Institution of Standards. Three presentations were given: "Development Trends in Israel's EMC Standardization and Legislation", presented by Elya B. Joffe, Chapter Chair, EMCS Distinguished Lecturer and Chairman of Israel's TC-809 (EMC Standards); "Updates on the EU EMC Standardization and Legislation: Part 1 Basics of the EEC EMC Directive and Standards", Mr. Diethard Moehr, Siemens, Secretary of IEC TC-77; "Updates on the EU EMC Standardization and Legislation: Part 2 New Trends in the EEC EMC Directive and Standards", also by Mr. Dietahrd Moehr. This Workshop was a special opportunity to discuss developments in Israeli EMC legislation, and for that purpose, a "Q&A Forum" was held. The forum was lead by Mr. Moehr, Mr. Joffe and a special guest participant, Mr. Grisha Deutch, Commissioner for Standardization in the Israel Department of Trade and Industry.

The entire event was a very useful one, with its special importance being the fact that Israeli EMC standardization, currently voluntary, and in the midst of the legislation process, making them mandatory, was, for the first time, discussed in an open forum of users, standard developers and the legislation authorities. We believe that this meeting has helped to accelerate the EMC legislation process in Israel.

Melbourne Chapter

The Melbourne, Florida EMC Chapter held its first meeting of the year on April 25. The meeting took place at Rubicom Systems, Inc., an EMC test laboratory located in Melbourne. A total of 15 engineers attended the meeting, where cold drinks and pizza were served.

The meeting's host and guest speaker was Mr. Joe Barbee, president of Rubicom Systems. Joe delivered a presentation titled "Developing an Independent EMC Laboratory", which chronicled his 13 years of experience as the founder, owner, and operator of an EMC test lab for MIL-STD-461/462, DO-160, FCC and CE mark. Joe's talk was entertaining and informative as he discussed the very creative and resourceful means that were required to start and establish his business. For instance, Joe described how he developed the lab's capability by acquiring test equipment through barter, trading test time for used equipment. He also carefully planned facility and equipment purchases, investing company profits in new capability over time. Even though Rubicom is now firmly established, this economically sound philosophy has continued, and the lab has a locally renowned reputation for keeping customer costs low by vigilantly controlling operating costs. Joe and his associate, Alex Belardinelli, also described how important it is to work with their customers to achieve successful product EMC compliance. For instance, they often provide EMC engineering expertise to customers who don't have EMC engineers on staff. They told several entertaining tales of how they were able to help frantic customers through the careful application of ferrite beads, filters, and EMI gaskets.

After Joe's presentation, the meeting attendees casually lingered to discuss EMC activities in the Melbourne area. Now in its second year, the Chapter has realized its goal of providing a friendly forum for the sharing of ideas and experience within the Melbourne EMC community.

Photo by Ed Kirchner

Chapter Chair Bruce Crain (right) introduces the Melbourne Chapter's guest speaker and meeting host, Mr. Joe Barbee of Rubicom Systems, Inc.

Nanjing

At meetings on April 28th and 30th, Dr. Masayuki Fujise of the Communications Research Lab, Ministry of Post & Telecommunications - Japan, was the featured speaker. The title of his presentation was "Communications Technologies for Intelligent Transportation Systems." Part I was presented on the 28th and Part II was presented on the 30th. On May 18th, 33 people turned out to hear Xu-Chao Lan, of Xin-Lian Electronics Company, present a paper titled: "Application of Microwave Software to the CAD of Waveguide and Multi-Conductor Circuits."

A June 2nd meeting of the Nanjing chapter featured Prof. Ru-Shan Chen of the Nanjing Univ. of Science and Technology. His talk was titled, "Analysis of a Microwave Circulator Involving a Ferrite Ball." On June 15th, 58 people turned out to hear Professor Da-Gang Fang give a presentation titled, "Recent Progress of Numerical Techniques for Electromagnetics." Prof. Fang is also from the Nanjing Univ. of Science and Technology.

Phoenix

The Phoenix EMC Chapter held their last meeting of the season on May 18th, 2000. Bill Ritenour presented a well-received talk on printed wiring boards to about 30 attendees. His talk began "backwards" as he provided the various references for his talk including Henry Ott, Tom Van Doren, Bob Dockey, Clayton Paul, Todd Hubing, Howard Johnson and others. Bill reviewed the concept of PC board and cable resonance including the effects of ground plane inductance. The basis premise is that boards will resonate at frequencies associated with the board length equaling 1/2 wavelength or multiples thereof. Bill did an excellent job at recapping the concepts of common mode current generation and coupling. His notes are available for downloading at the Rocky Mountain EMC Chapter's web site.

The next meeting of the Phoenix chapter is planned for September 21, 2000 when Jack Opocensky of Polyphaser Inc. will be presenting a talk on lightning protection fundamentals. Check out our web site at *http://www.ewh.ieee.org/r6/phoenix/phoenixemc/* for the latest schedule on upcoming talks.

Rocky Mountain

Lyle Luttrell, Chair of the Rocky Mountain EMC Chapter, reports that their April Meeting was held at the Holiday Inn, Northglenn, CO, and was hosted by Schaffner. Following a light buffet, Tony O'Hara, Lartec Marketing, did a great stand-in for Mr. Joseph Heins, Schaffner, in a presentation on "Radiated Emissions and Immunity Testing: TEM Cells to Anechoic Chambers."

The presentation detailed current commercial, telecom and automotive radiated emissions and immunity requirements. The TEM Cell, GTEM Cell and anechoic chamber measurement environments with test equipment characteristics were defined including benefits and shortcomings. Specific attention was offered for EUT and associated cable configuration, typical setups, industry standard practices and pre-compliance versus compliance. The presentation concluded with an overview of conducted susceptibility per EN6 1000-4-6. The conducted methodology was discussed for both compliance to the standard and pre-compliance for radiated fields up to 1GHz. The presentation is available for download at the RMC website. Prior to the technical presentation, Jim West, Chairman of the Denver IEEE Section, visited our meeting and provided a short summary of IEEE activities. He talked to the group about the Denver Section activities with respect to the email list, pre-college, senior membership, college speakers, etc.

Photo by Harry Gaul

Daryl Gerke of Kimmel-Gerke Associates (r) presents Bill Ritenour of EMC Compliance LLC with a jar of salsa as thanks for his talk of "PWB's - Where the Noise Starts."

Our 2000 Regional Symposium on EMC was a great success! The 10th Annual Symposium was held May 23 at the Holiday Inn Northglenn, which again provided a good location for our program. The Technical Program was a full day with ten excellent papers, including our first student paper, and six tutorials. Technical Exhibits by 26 regional and national firms provided attendees with the opportunity to learn more about the latest products and services for EMC design and testing. Participation by the Colorado Product Safety Technical Committee helped round out the program. Our attendance of 126 matched that of 1999. Attendees, presenters and exhibitors agreed that this was an exceptional program for EMC and Product Safety professionals. The symposium included a continental breakfast and free buffet lunch for all registrants, sponsored by Criterion Technology, Chomerics, and TUV Product Service. Fortunately, the afternoon speakers were able to keep everyone awake after that lunch!

The technical program is available at our web site, with many technical papers available for download. The site also includes links to exhibitors and sponsor web sites. The site address is *http://www.ewh.ieee.org/r5/denver/rockymountainemc/*. Thanks to everyone that made this symposium a great success! Special thanks to the symposium committee and helpers: Lyle Luttrell, Chas Grasso, Tony O'Hara, John Stadille, Bob Reinert, and Danny Odum.

The RMC June meeting was held at the StorageTek OATS, Louisville CO. A pizza supper was hosted by CASSPER Instrumentation Systems, and followed by a presentation and demonstration on "The CASSPER Ambient Cancellation Technology" by Dave Watkins, CASSPER Instrumentation Systems, Inc. CASSPER is a revolutionary new PC-based instrumentation system that records and isolates EUT signals of interest without the need for anechoic chambers. The system delivers true ambient cancellation and removes the guesswork in signal identification. The product's coherence measurement feature allows engineers to identify and locate sources of EMI noise, including multiple sources of the same frequency. This can save engineering time during the mitigation stage at the board, unit or system level. We were able to see

a demonstration of the system to localize signals on a PWB. The demonstration was halted by an exciting Rocky Mountain thunderstorm!

Singapore

In December 1999, members of the AP/MTT/EMC Society Chapter organized and hosted the Asia Pacific Microwave Conference in Singapore. The turnout was excellent with high-quality papers submitted. It was a huge success. In May, about 60 people turned out to hear Mark Montrose give a talk on "EMI and the PCB." Mr. Montrose is an IEEE EMC Society Distinguished Lecturer.

Photo by Stephen Stimac

Speaker Doug Smith (standing right) watches the teams assemble their probes at the May Seattle EMC Chapter meeting held at the Kalmus facility in Bothell.

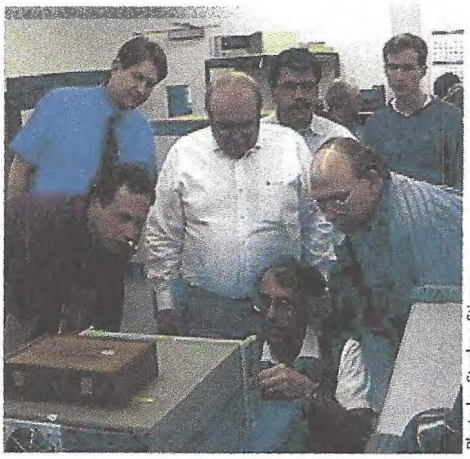


Photo by Stephen Stimac

While team members anxiously watch, Doug Smith (kneeling) checks the performance of a probe.

Saint Petersburg

Alexander Worshevsky reports that the first meeting of the new joint EMC/PE/AES/C chapter took place in Saint Petersburg, Russia on May 18th featuring the Chapter's EMCS "Angel" and Distinguished Lecturer, Elya Joffe. Elya gave an excellent lecture to the IEEE members and guests. The event was arranged in Scientists' House - the former Palace of the Tsar's brother near the famous Hermitage Museum. Participants could see the river Neva and Peter and Paul Fortress from the windows. In the first part of the meeting, Elya described IEEE EMCS activities. He provided IEEE membership application forms to guests and invited them to become EMCS members. Then Elya started his very interesting lecture on "EMC Case Histories and EMC Design in Systems." The participants asked many questions about technical details as well as global questions about information pollution on TV, radio and the Internet. EMCS member Professor Kostenko spoke about the importance of electromagnetic and information compatibility for humanity and raised the topic of Information Ecology Science for the struggle against information pollution. Elya answered all questions. Participants thanked him for the very informative presentation. They invited Elya to the National EMC Conference (September 2000) and other EMC events in Saint Petersburg.

Seattle

Janet O'Neil, Vice-Chair of the Seattle EMC Chapter, reports that the April and May Chapter meetings featured speakers from opposite ends of the country. In April, Maqsood Mohd came to Seattle from the Eglin AFB area in Florida. In May, Doug Smith visited the Chapter from his home base in Northern California.

On April 24, Dr. Maqsood A. Mohd spoke on the topic "Lightning Effects on Electronics and Humans." With the "Ph.D., NCE, Sverdrup Technology, Eglin AFB, Florida, Technical Fellow, EM Effects" following his name on the program, one knew an expert on the topic was present! The presentation began by describing lightning phenomenology and its direct and indirect effects. Several incredible photos of various lightning strikes were shown. The impact of direct and indirect effects on electronics systems and humans was discussed. Lastly, an indirect method to test for the lightning effects on an aircraft was discussed with an example. The presentation was an excellent and thorough overview of lightning to satisfy those new as well as familiar with the topic.

By popular demand, IEEE EMC Society Distinguished Lecturer Doug Smith returned to Seattle on May 16 to conduct his popular event "Build Your Own Probe." Doug conducted a special four-hour training where attendees learned to build their own probes on site under Mr. Smith's expert supervision. The training was held at the Kalmus facility in Bothell. Jeannie Olson and Leo Smale of Kalmus generously provided the workstations and tools. The chapter provided all the materials required to build the probes and dinner. The training was held from 4:00 pm to 8:00 pm, with a 45-minute dinner break. The evening began with a one-hour tutorial presentation on scope probes. This provided background information on signal integrity measurement using scope probes. Some of the pitfalls and limitations of probing were covered. Solutions to common measurement problems were provided. After the presentation and dinner break, materials were available for everyone to build their own 1 GHz passive 20X probe. Attendees broke into teams of two to build their probes. With a spectrum analyzer provided courtesy of the local Agilent Technologies representative and nearby CKC Labs, Doug evaluated the performance of the various probes. It was interesting to see how competitive the teams were during this evaluation

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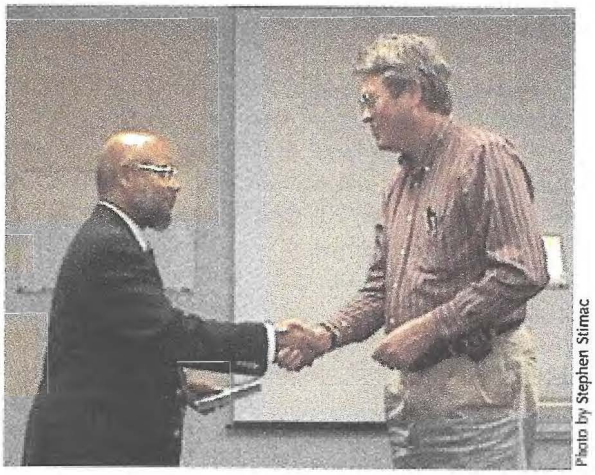

Photo by Stephen Stimac

Seattle EMC Chapter Chairman Ghery Pettit (R) presents speaker Maqsood Mohd with a gift following his presentation at the April meeting.

EMC Chapter Funds Scholarship Endowment for San Francisco State University

Santa Clara Valley Chapter Donates $16,000 to Promote EMC Education

By Franz Gisin, Santa Clara Valley Chapter Member

The Santa Clara Valley Chapter of the IEEE EMC Society recently donated $16,000 to create a scholarship endowment fund at San Francisco State University (SFSU). The interest from the endowment will be used to sponsor scholarships for outstanding electrical engineering students who are focusing their area of specialization in the fields of electromagnetic compatibility (EMC) and electromagnetics (EM). The Santa Clara Valley Chapter has always considered support of local educational institutions an important and integral part of its commitment to providing a high level of value to Chapter members and the engineering community at large. In the past, the chapter has funded the development of a dedicated EMC course that has been taught at both SFSU and other local universities. Students working in the SFSU Center of Applied Electromagnetics are encouraged to present results of their research at local Chapter meetings. With the addition of the scholarship, the Chapter hopes it will attract more students to the EMC field, thereby providing a new source of EMC engineers for Silicon Valley based high-tech companies.

The School of Engineering did not waste any time putting the endowment funds to good use. It awarded scholarships to three students: Monica Harrison, Bill Panos, and Sage Hsu. All three students are currently involved in EMC projects sponsored by the Center for Applied Electromagnetics. The Center, the only EMC/EM laboratory in the California State University School system, provides resources for theoretical and experimental studies in applied electromagnetics. It has state-of-the-art spectrum analyzers, network analyzers, immunity equipment, a shielded room, and a GTEM Cell for making precision radiated emission and immunity measurements. Analytical tools include SPICE, FEM, MOM, and FDTD 3-D full wave field solvers. The Center is equipped to perform research in a variety of disciplines including: electromagnetic compatibility (EMC); signal integrity (SI); high speed printed circuit board design; microwave transmission lines and waveguides; characterization of biomedical and biological samples; high frequency antenna design; and wireless communications devices.

Dr. Zorica Pantic-Tanner, Chair of the Santa Clara Valley EMC Chapter, (left) proudly delivers a check for $16,000 to Joy Morimoto, Senior Development Officer, Office of University Development, at San Francisco State University.

More information on the Santa Clara Valley Chapter of the EMC Society can be obtained at the web site: *http://www.scvemc.org*. More information on the SFSU Center for Applied Electromagnetics can be obtained at the web site *http://engineering.sfsu.edu/centers.html*.

IEEE SENSORS COUNCIL FORMED

The IEEE established the IEEE Sensors Council in 1999 for the purpose of creating a professional society focus for sensor activities. The Council has 26 member societies, with a combined membership of 260,000.

The Sensors Council's field of interest and activities are the theory, design and application of devices for sensing and transducing physical, chemical, and biological phenomena, with emphasis on the electronics and physics aspects of sensors and integrated sensor-actuators. The purpose of the Council is to advance and coordinate the work in the field of Sensors, and, as such, is exclusively scientific, literary and educational in character. The activity of the Council includes sponsoring Sensors related conferences and conference sessions, publishing appropriate periodicals, sponsoring IEEE Press publications, maintaining an IEEE Sensors website, and engaging in any other activity within its field of interest. The Council shall exist for the benefit of the member societies. Dr. John Vig, *J.Vig@ieee.org*, is the President of the Sensors Council.

Andrew Podgorski is the EMC Society Representative to the IEEE Sensors Council

The website of the IEEE Sensors Council is up and running, *http://www .ieee.org/sensors*. The next objective for the new Council is to launch the IEEE Sensors Journal. The field of interest statement of the journal reflects the variety of phenomena studied and includes mechanical, thermal, optical, magnetic, radiation, microwave, chemical, and biological sensors. Also of interest are packaging, interconnects, telemetry, characterization, noise, CAD, and, of course, applications. The IEEE Sensors Journal has a broader scope than many other IEEE publications. It gives it an opportunity to bring together a wide range of expertise thus favoring inter- and multi-disciplinary activities.

The inaugural issue of the IEEE Sensors Journal is scheduled for June 2001. It will consist of a collection of review papers covering a wide range of sensor technologies. A detailed call-for-papers, and other relevant information can be found on the Sensors Council website. The subscription price will be $19 per year for IEEE members, $10 for student members, and $395 for non-member (institutional) subscribers. Professor Vladimir Lumelsky, *vlumelsk@nsf.gov*, is the first Editor in Chief of the IEEE Sensors Journal.

The Sensors Council plans to co-sponsor conferences, and organize topical

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TC-9 Computational EMC

Modern Computer Capabilities Enhance Today's Electromagnetic Simulations

By Colin E. Brench

One aspect of computational modeling that is changing very rapidly is the capability of today's computers to run large, complex problems in very reasonable periods of time. Electromagnetic simulations have always been considered to require significant computer power and indeed there are many such problems that tax or even exceed the capabilities of today's largest computer systems. On the other side of the coin, there are problems that can now be solved quickly and efficiently on a typical notebook computer. These types of problems are probably the ones of most interest to the EMC engineer.

"Electromagnetic simulations have always been considered to require significant computer power. There are problems that can now be solved quickly and efficiently on a typical notebook computer."

In 1988, this author began using the Method of Moments code, MiniNEC, among other tools, to solve EMI problems. In order to handle the "large" problems of the day, it was necessary to modify the code to run on a Digital VAX computer so that advantage could be made of the 64 M of RAM available. This amount of RAM was infinitely more than what was available on a PC of the day and many times what was actually needed to solve the problem. A few years later an FDTD tool became available and more computer resources were needed. A few more fast processors, each with a few hundred megabytes of RAM available, seemed like heaven; many problems could be set up and would run over night.

In today's environment, processor speeds have greatly increased and available RAM runs to many gigabytes. Models using two gigabytes are not uncommon and two or three times this amount is by no means impossible. These large problems still run over night.

One basic truth to life is that demand will fill up all available resources! If 50 terabytes of RAM became available tomorrow, within a very short time problem complexity would increase to fill it. It is good to sit back and consider what is really needed from computational EMI modeling and what we can do comfortably on today's desktop or even notebook personal computers. This article is being typed upon a personal notebook computer which has a 450 MHz processor and 192M of RAM. This is pretty reasonable by today's standards and, apart from perhaps the available RAM, is by no means unusual. The RAM was increased to permit the execution of FDTD codes but, as the notebook is a working tool, the RAM is very cost effective. On a daily basis I can carry around enough compute power to solve serious electromagnetic problems.

How should this influence the way we approach EMI modeling? Engineers of all disciplines have perhaps three levels of detail to their design work. Starting off on the back of an envelope, they progress to further detailed calculations, and then where necessary to computer simulations. With the resources available today, EMI modeling can move more easily to the earlier stages of this process. In place of the pencil scribbling on a notepad over a cup of coffee, a quick model can be thrown together and run while a fresh pot is brewed.

So what types of EMI problems can be done quickly and easily on the present day PC? For radiation problems, the numerical electromagnetics code (NEC) is a well-proven tool and can provide a great deal of information in seconds for each frequency of interest. NEC can also be used to determine coupling between various arrays of conductors, this is perhaps of greater interest to the EMC engineer. The sizes of the matrices that can be solved by NEC are easily handled in the RAM of a typical PC. By way of comparison to NEC, even the resource hungry, Finite Difference Time Domain (FDTD) can run on a machine with easily obtained amounts of RAM. 64 M RAM will permit many problems to be tackled; add another 128 M and most EMC problems can be managed. The FDTD solution time is measured in minutes, perhaps an hour or so, rather than in seconds as for NEC. Despite the longer run times, FDTD is still a very effective tool for quick models.

Within the computational resource limits of NEC and FDTD, there are other tools that can be used for EMC purposes. The limitation to the uses of any tool is the imagination of those using it. Given the computer resources that we have now, it is time to get creative and find ways to most efficiently tackle our EMI design tasks.

We are still awaiting the personal computer that will permit us to solve the field distributions on very large, complex structures at high microwave frequencies. However, we have more than enough practical sized problems that will keep us busy while we are waiting.

"One basic truth to life is that demand will fill up all available resources! If 50 terabytes of RAM became available tomorrow, within a very short time problem complexity would increase to fill it."

In the meantime, if you have topics concerning computational electromagnetics as applied to EMC that you would like to see addressed in this column, at the EMC Symposium, or through some other medium, please contact the author at *colin.brench@compaq.com* **EMC**

Practical Papers, Articles and Application Notes

Bob Rothenberg, Associate Editor

Following are two very different types of papers concerning a common issue, grounding, and a third which presents a useful modeling tool for designers of digital communications systems. Professor Takeo Yoshino of Fukui University of Technology in Japan describes some unusual grounding problems encountered more than 40 years ago during an Antarctic research expedition, and resulting lessons learned which apply even to modern systems. Doug Smith, an independent consultant based in Los Gatos, CA, describes an interesting current probe which can be used to locate noisy circuit board grounds. Panagiotis Trakadas, currently working on his Ph.D. thesis at National Technical University of Athens (Greece), and Christos Capsalis, a Professor at NTUA, present an FDTD modeling approach that suggests the importance of considering non-uniformity of transmission line configuration when assessing the coupling effects of external EM fields.

EMCS members are encouraged to submit original papers and articles based on their own practical EMC experience for publication in this section of the Newsletter. Effective with the next issue, submittals should be forwarded to Bob Olsen at Washington State University (*olsen@eecs.wsu.edu*), who will take on the job of Associate Editor. I have been privileged to serve in this capacity for the past four years and have enjoyed working with the many authors who responded to our calls for papers. I have also greatly appreciated the strong support of Editor Janet O'Neil, who was especially active in recruiting and encouraging authors, and the production expertise of Robin Edwards and Andrea Watson, the IEEE Newsletter coordinators in Piscataway.

Oh No! Where's the Grounding Post?

(An Early Japanese Polar EMC Story)

By Takeo Yoshino

On 14 January 1959, two helicopters, as the first flight of the 3rd Japanese Antarctic Research Expedition (JARE), landed at Syowa Station with the aim of conducting geo-scientific research for the International Geophysical Year (IGY). Syowa Station had been uninhabited for one year. The research team immediately announced sensational news to the world: they found two living dogs that had survived through the whole winter in Antarctica without being fed.

As a member of this expedition, I started work on the resumption of the main power plant of this station. I participated in this party as a geo-scientist, as well as an electrical engineer. Soon, we set up a new diesel electric generator of 40 kW, 3 phase, 100 and 200V. After finishing the mechanical set up on the engine mounts, I was confused about how to connect the center point of the star circuit to a grounding post. The Syowa Station was built on rocks with very poor conductivity — eastern Antarctic pre-Cambrian Granuate (granite geneiss). The rock conductivity in this area was approximately 10^{-6} S/m.

I had to change the circuit connection of the generator output from star to delta in order to avoid the grounding problem, and this was just the beginning of a long struggle against numerous and serious EMC problems in our Antarctic expedition. For example, when the HF 1 kW output radio transmitter was keyed down, or the ionosphere bottom-side sounder (10 kW peak output, sweep frequency range from 0.5 MHz to 17MHz) was turned on every 15 minutes, the data recorded on high-sensitivity geophysical observation instruments in the station showed very strong electromagnetic interference based on the poor grounding condition.

During the whole austral autumn of 1959, I had to work everyday to solve these interference problems by trial and error. Finally, we reached a tentative best solution, although several issues still remained. Syowa Station was built on a small island named East Ongul Island. I extended a 600 m long and one square cm cable from the generator hut to the shore and terminated the cable with 2 m by 1 m copper plate, which was sunk into the sea water as the common mode grounding center after very hard work of thick sea ice boring.

I once again changed the generator wiring from delta back to star and connected the center point of the star circuit to the grounding cable connected to the sea water. This grounding approach, however, did not dramatically reduce the level of interference caused by the radio transmitters. The interference level was reduced by about 6 to 10 dB, but considerable interference still remained. Next, I extended the grounding cable from the generator hut to the radio communication hut and the ionosphere observatory hut, and connected the ground terminals of the radio transmitter and the ionosonde to the grounding cable. We found that this arrangement did not reduce interference levels encountered in magnetometers and other sensitive instruments.

After many trial-and-error steps, I put a new sea ground plane into another ice hole, which was separated by 400 m from the common mode grounding point for the power plant, and extended this new grounding cable to a new radio hut and ionosphere observatory. Finally, I connected the grounding post of the RF antenna circuit to this grounding cable. A dramatic improvement was achieved. Today, this ground system, which was separated from the common mode grounding line, is called the normal mode grounding line.

After my work on the grounding problem in the third (1959) expedition, later Japanese Antarctic research expeditions did not attempt any further improvements in the field of EMC techniques. In 1976, I returned to Syowa Station again, as the leader of the 17th Japanese Antarctic Expedition, and I faced another new interference problem during the construction of an inland station. We had a plan to extend the upper atmosphere multi-point observation network around Syowa Station. As a part of this network, we selected a new observation site located 300 km southeast of Syowa Station. We called this site "Mizuho" Station.

The Mizuho Station was built on the snow surface of the 2200 m thick Antarctic ice sheet. The electrical characteristics of the Antarctic ice sheet are as follows: the dielectric constant is 1.05 at the surface and 3.8-3.95 at a depth of 150 m from the bottom of the ice sheet, and its conductivity is 10^{-7} S/m or less.

The internal structure of the ice sheet is Polycrystalline, including high pressure air cells. This situation is quite similar to the grounding condition of space satellites. We set a diesel engine generator in the hole of an ice tunnel. The hole sunk deeper and deeper year by year with new snow accumulation.

After rebuilding the station, we had to solve two large difficulties. The first was an unbelievably great natural electrostatic charging and discharging phenomenon. The meteorological conditions at Mizuho Station are as follows: the average temperature is -20°C in summer and -50 to -60°C in winter; relative humidity is 1 to 6 % (water vapor) throughout the year; wind velocity is between 10 m/s and 30 m/s from the southeast.

The noise level of electrostatic charge started and quickly reached to over-scale of receiver's "S" meter and finally made a strong electric discharge sound somewhat like a lightning strike. The noise level then returned to normal, but increased again soon thereafter. We found that the noise showed a good synchronization to snow cloud packet drifting. Outside, there was always a katabatic wind blowing at 10 m/s to 30 m/s, and very dry, tiny snow powders were carried by this wind. Gusty wind brought a mass of snow cloud, producing a large amount of electric charge. Electrostatic noise started to increase with the approach of a snow cloud and continued to increase during the passing of strong drifting snow mass until a discharge took place, like a lightning strike. During the passing of the drifting snow, this charging-discharging took place several times, and the noise stopped shortly after the snow clouds passed.

In order to reduce the build-up of electrostatic charge, we tried to bury all metallic materials completely under the snow surface. By this method, we obtained a perfectly successful result in decreasing the electrostatic noise. If any portion of metallic material became exposed outside the snow surface, strong electrostatic charging would come back quickly. So we buried all metallic materials, including HF and riometer antennas, under the snow, and the all-sky camera and exhaust pipe of the generator were covered by a thick plastic board.

The second difficulty was the ground system of this station. When the radio transmitter (50W) was keyed down, all the observation equipment and sensitive coupling electric facilities experienced heavy interference. The power cable between the generator and the observation cabins ran beside and across the cabin wall. All the equipment was connected to this power cable through the capacitive coupling. We connected grounding points of all the equipment and machines with a thick power cable, and this cable was extended about 40 m, where we built a counter-poise consisting of 20 radial wires, each 20 m long. This counter-poise was set at 0.5 m under the snow surface. After the setting of the counter-poise, we connected common mode grounding cable to the center of the counter-poise. This counter-poise type grounding system worked perfectly to eliminate the natural and man-made noise in our base. It could work as both common mode and normal mode ground. The RF system, including antennas and sensors, was also connected to this ground as single point grounding, and we obtained very satisfactory results.

When we were faced with strong interference at Syowa Station in the third expedition in 1959, the results of our improvements were very similar to the modern system. Of course, we had not known of this new technique at that time. I applied this grounding technique later in the design of rocket and satellite instrumentation, after leaving the Antarctic. And I have encountered several similar cases of noise and interference reduction technologies in rocket, balloon, and satellite experiments in Japan. The experience obtained at least 30 years ago in grounding and interference reduction is still of great use in my EMC work even today.

Takeo Yoshino is a professor at Fukui University of Technology in Japan. He is a Life Member of IEEE, and a member of the Board of Directors of the IEEE EMC Society. Professor Yoshino was chairman of the IEEE EMC-S Tokyo chapter from 1990 to 1994. For details on his very interesting career and achievements, see "Personality Profile" in the Fall 1999 EMCS Newsletter (pages 32-33).

A Resistive Current Probe

by Douglas C. Smith

Although the object in Figure 1 does not look like a current probe, it is. The current is measured by a resistor network covered by heat shrink tubing. Before describing how it works and its uses, let's review a simple model of a coaxial cable.

A coaxial cable can be simply modeled for this discussion in two parts for frequencies above a few hundred kilohertz. First is the cable's input impedance. If a cable with a 50 Ohm characteristic impedance is connected to a 50 Ohm load, in this case the input to a measurement instrument, then the input impedance into the opposite end of the cable is just 50 Ohms. And, everything that is happening *inside* the cable can be replaced, approximately, by a 50 Ohm resistor connected between where the center conductor and shield connections were. Because skin effect makes the inside surface of the shield a different world electrically than the outside surface of the shield, the outer surface of the shield must be included in our model as a thick wire. So, for the purposes of this discussion, a 50 Ohm coaxial cable can be modeled as a 50 Ohm resistor in series with a thick wire (the shield) connected to the chassis of the measuring instrument.

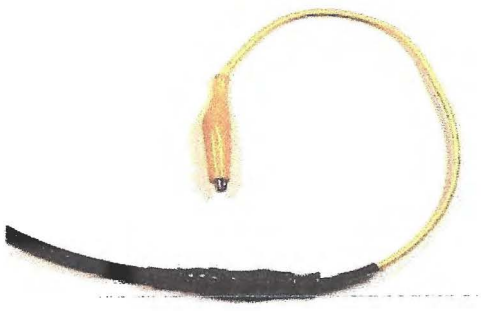

Figure 1. A Current Probe?

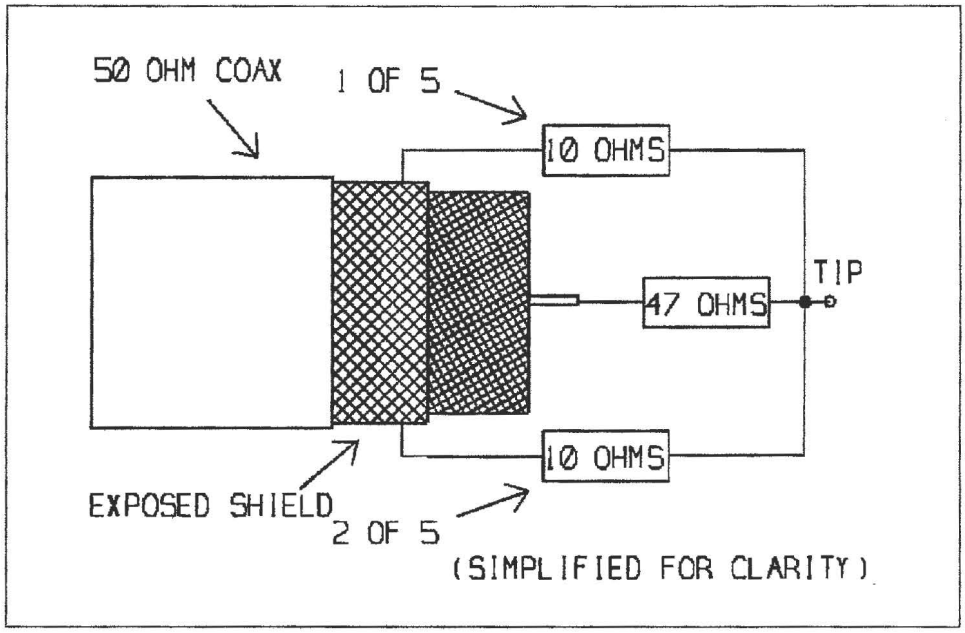

Figure 2. Side View of Current Probe {1}

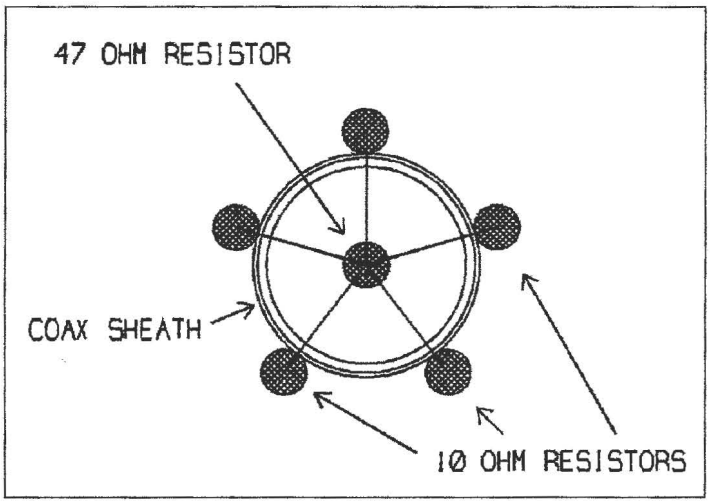

Figure 3. End View of Current Probe {1}

Now, on to the details of the resistive current probe. Figures 2 and 3 show the construction details. First, the jacket of the cable is stripped to expose the shield and the center conductor as shown in Figure 2. A 47 Ohm resistor connects the center conductor to the probe tip and five 10 Ohm resistors are connected from the tip back to the shield. The 10 Ohm resistors should be equally spaced around the circumference of the cable as shown in Figure 3. Carbon composition resistors are ideal for this use if available. These resistors form a 2 Ohm resistor of reasonably low inductance.

Figure 4 shows the equivalent circuit of the current probe. The input impedance of the coaxial cable is replaced by a 50 Ohm resistor, the 10 Ohm resistors are shown as a single 2 Ohm resistor, and the outer surface of the cable shield is shown as a wire. The junction of the 50 Ohm and 47 Ohm resistors is the node where the center conductor connects to the 47 Ohm resistor.

The circuit operates as follows. Assume one Ampere of current is flowing from the probe tip through the resistor network to the measuring instrument chassis on the cable shield. That current will generate approximately 2 Volts across the 2 Ohm resistor (actually 1.96 Volts if the other two resistors are taken into account). Approximately one half of that voltage, about 1 Volt (actually 1.01 Volts), is developed across the 50 Ohm input to the cable and delivered to the measuring instrument. Thus the transfer impedance of this current probe is about 1 Ohm, that is it gives an output of 1 Volt for a current of 1 Ampere. Structures of similar design have been used to measure currents in numerous applications. One is the target used in IEC 61000-4-2 to calibrate the current waveform of an ESD simulator.

In *A New Type of Furniture ESD and Its Implications*, delivered at the 1993 EOS/ESD Symposium, this probe was used to measure the induced current in a wire due to emissions from a nearby ESD event. The one Ohm transfer impedance of the probe allows the scope vertical scale to be converted directly from Volts to Amperes. For this application, a wire was attached to the probe tip as shown in Figure 5 to form an antenna. Used in this way, the probe makes a great ESD event detector in that it gives a reading of the current flowing on the wire as a result of EMI radiated from the ESD event.

But there is another use for this probe, that of finding noisy areas of ground on a circuit board or in a system. Only 10 to 20 microamps of current above 30 MHz flowing on a cable at one frequency may cause radiated emissions to exceed required Class A limits. If the probe is connected to a spectrum analyzer through a high pass filter and protection network, to protect the input of the spectrum analyzer, it can be used to probe various areas of ground on a circuit board in a system. Also recommended is a 0.01 uF DC blocking cap in series with the tip, in case the tip is touched to a power node by accident. When touched to the board ground, it delivers a signal to the spectrum analyzer that is the amount of high frequency current flowing on the wire.

The probe is touched to the circuit board ground in many areas of the cir-

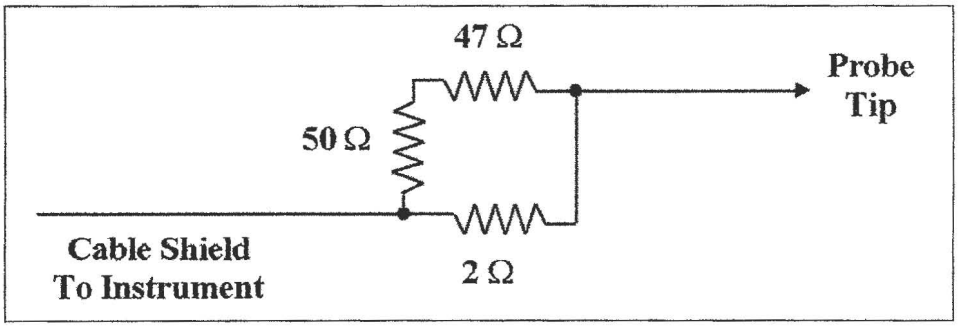

Figure 4. Equivalent Circuit of Current Probe

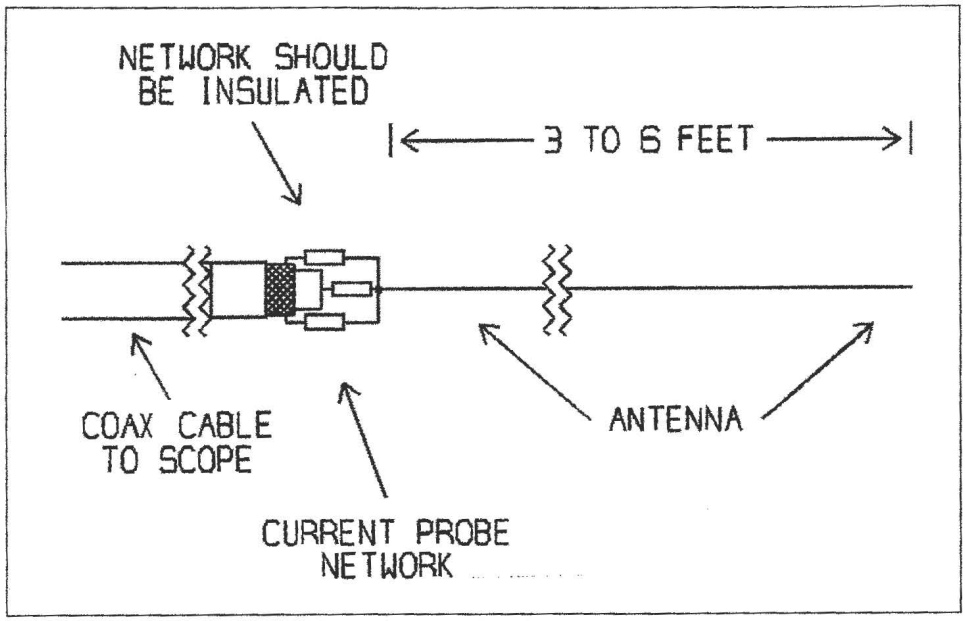

Figure 5. Using a Resistor Current Probe to Detect and Characterize Radiation from an ESD Event [1]

cuit board, especially in the neighborhood of connectors. It can even be plugged into ground pins of connectors. Anywhere on the board ground that the output of the probe exceeds a few tens of microamps at one frequency is a dangerous place to have a cable connected to. A cable attached to this point may also carry the current and cause an emissions problem. Depending on the length and what is at the end of the cable, the current may flow at a different frequency (harmonic of a system clock), but there is a real possibility of a problem.

The probe and its resistor network could be built into a test probe of the type used on multimeters for ease of use. Built with standard film resistors, the probe should work to about 300 MHz (just the region where cable radiation is usually a problem). For higher frequencies, resistors with lower inductance are needed. One approach would be to use ten 20 Ohm resistors to lower the effective inductance although resistor physical size becomes an issue.

Another possibility is to use one or more disk resistors in parallel to make a 2 Ohm resistor. The disk resistor(s) could be mounted on top of the 47 Ohm resistor with the perimeter of the disk resistor(s) connected 360 degrees via copper tape to the shield of the coaxial cable. The probe could be made from 20 cm of semi-rigid coaxial cable with a BNC or SMA connector on one end and the 47 Ohm and disk resistor(s) at the the other end. This would extend the usable frequency well beyond the ~300 MHz that the construction described in Figures 1, 2, and 3 achieves.

It's not a highly accurate way of predicting emissions problems or the best way to measure ESD events, but simple tools like this can make troubleshooting a circuit easier. I highly recommend it be included in the lab toolbox.

[1] From "A New Type of Furniture ESD and Its Implications," Douglas C. Smith, 1993 EOS/ESD Symposium Proceedings, pp. 3-7.

Doug Smith retired from AT&T Bell Labs in 1996, after more than 25 years. From 1996 to April 2000 he was Manager of EMC Development and Test at Auspex Systems. Mr. Smith is currently an independent consultant, specializing in high frequency measurements, circuit/system design and verification, switching power supply noise and specifications, EMC, and immunity to transient noise. He is a Senior Member of the IEEE and a member of the IEEE EMC Society Board of Directors. He may be contacted at doug@dsmith.org (or tel: 408-356-4186). His website URL is www.dsmith.org. **EMC**

Time-Domain Response of Non-Uniform Transmission Lines

By Panagiotis Trakadas and Christos Capsalis

Introduction

In the past, extensive study has been made on the theoretical modeling and experimental validation of the parameters influencing the response of a transmission line (TL) illuminated by external electromagnetic waves or lumped voltage sources along the length of its conductors. Summarizing these parameters, one can mainly state: the per-unit-length losses of TL, the length of TL compared to the wavelength of the excitation waveform, the behavior of non-linear termination loads, the presence of lossy earth, etc. According to the specific configuration of the problem, numerical as well as analytical models have been introduced in the literature, both in time and frequency domain. One of the most commonly used models is the Finite Difference Time Domain (FDTD) technique. This technique has become popular due to its versatility and the ability to incorporate several modifications related to the configuration of the problem. In this paper, we highlight the alterations observed on the far-end induced voltage of the TL, associated with the non-uniformity of the TL.

Modern Trends and Applications

It is of great importance to note that the study of the behavior of the induced voltage of TLs in the time domain is very interesting, especially in modern broadband communication systems using Direct Sequence Code Division Multiple Access (DS-CDMA). When the transmitters in such a system operate close to each other, the emissions from one transmitter influences the TL circuit driving the front end of the other, and this fact gives rise to intersymbol interference. As the orthogonali-

ty of the pseudo-random sequences in DS-CDMA is prerequisite, the induced voltage will probably alter this substantial property. On the other hand, the operation of TLs in the presence of an external E/M wave may probably result in data asymmetry. The use of an FDTD model for simulation purposes in such cases offers a great advantage in the EMC design of modern wireless communication systems. A comprehensive analysis of such phenomena will be presented in a future paper.

Mathematical Model

Under the assumption of TEM mode propagation along the line, its behavior can be described in terms of circuit-theory parameters. Consider a TL of z-directed, total length L and x-directed distance of separation between the conductors equal to d, terminated in resistive loads R_S, R_L. The mathematical representation of TL excited by an external electromagnetic wave with angle of incidence θ, consists of a system of two coupled integro-differential equations written as:

(1a)

$$\frac{\partial}{\partial z}V(z,t)+l\frac{\partial}{\partial t}I(z,t)=V_F(z,t)=\frac{\partial}{\partial t}B_N(z,t)=-\frac{\partial}{\partial z}E_T(z,t)+E_L(z,t)$$

(1b)

$$\frac{\partial}{\partial z}I(z,t)+c\frac{\partial}{\partial t}V(z,t)=I_F(z,t)=-c\frac{\partial}{\partial t}E_T(z,t)$$

where $V(z,t)$,$I(z,t)$ is the line voltage and current, respectively, l, c is the per-unit-length inductance and capacitance of the lossless TL (r=g=0), and finally, E_T, E_L are the components of the incident electric field vector.

The FDTD technique seeks to approximate the derivatives in equation (1) with regard to the discrete solution points defined by spatial and temporal cells. For this purpose, the length of TL is divided into K sections of length Δz, and the total time of coupling phenomenon observation is divided into N sections of Δt. According to this notation, the line voltage and current can be formulated as written below:

(2a)

$$V_k^n=V\left((k-1)\cdot\Delta z,n\cdot\Delta t\right)$$

(2b)

$$I_k^n=I\left((k-1/2)\cdot\Delta z,n\cdot\Delta t\right)$$

Additionally, the forcing functions can be expressed in a similar form.

As it can be readily seen from equations (2), we interlace the voltage and current points in order to insure second-order accuracy of the discretization. Finally, the terminal conditions are implemented into FDTD code by:

(3a)

$$I_S^n=-\frac{V_1^n}{R_S}$$

(3b)

$$I_L^n=\frac{V_{KTot+1}^n}{R_L}$$

By applying the concept of FDTD technique into equations (1), the final form can be written as:

(4a)

$$V_1^{n+1}=\frac{1}{1+\frac{\Delta t}{c\Delta zR_S}}\cdot\left\{\left(1-\frac{\Delta t}{c\Delta zR_S}\right)V_1^n-\frac{2\cdot\Delta t}{c\Delta z}I_1^{n+1/2}-\left(E_{T,1}^{n+1}-E_{T,1}^n\right)\right\}$$

(4b)

$$V_k^{n+1}=V_k^n-\frac{\Delta t}{c\cdot\Delta z}\cdot\left(I_k^{n+1/2}-I_{k-1}^{n+1/2}\right)-\left(E_{T,k}^{n+1}-E_{T,k}^n\right)$$

(4c)

$$V_{KTot+1}^{n+1}=\frac{1}{1+\frac{\Delta t}{c\Delta zR_L}}\cdot\left\{\left(1-\frac{\Delta t}{c\Delta zR_L}\right)V_{KTot+1}^n+\frac{2\cdot\Delta t}{c\Delta z}I_{KTot}^{n+1/2}-\left(E_{T,KTot+1}^{n+1}-E_{T,KTot+1}^n\right)\right\}$$

(4d)

$$I_k^{n+3/2}=I_k^{n+1/2}-\frac{\Delta t}{l\cdot\Delta z}\cdot\left(V_{k+1}^{n+1}-V_k^{n+1}\right)-\frac{\Delta t}{l\cdot\Delta z}\cdot\left(E_{T,k+1}^{n+1}-E_{T,k}^{n+1}\right)+\frac{\Delta t}{2\cdot l}\cdot\left(E_{L,k}^{n+3/2}-E_{L,k}^{n+1/2}\right)$$

The above equations can be solved in a "bootstrapping" fashion. At each time step n, the voltages along the line are computed in terms of the previous voltage and current values. Afterwards, the currents along the line are evaluated for the next temporal cell. This procedure ends when time reaches the total time of observation. In order to insure stability of this leapfrog scheme, the following condition must be fulfilled:

(5)

$$N\geq K\cdot\frac{u\cdot Final\ Solution\ Time}{TL\ Length}$$

known as the Courant condition, where u is the speed of light.

Numerical Results

In the majority of previously published studies, the per-unit-length inductance and capacitance is considered of constant value; that is the case of uniform TL. In our study, the height of the upper conductor, d, is a function of z. In order to show the

Parameter	Symbol	Value
TL Length	L	30m
Radius of the conductor	α	1.5mm
Termination Loads	R_S, R_L	150Ω
Incident E/M Wave	E^{inc}	$e^{-4\cdot10^6 t}-e^{-4.76\cdot10^8 t}$ V/m
Angle of Incidence	θ	45°

Table 1. Common TL Characteristics

discrepancies observed in the induced voltage, due to non-uniformity of the TL, we will compare five TL configurations of similar geometrical and excitation characteristics. In Table 1, the common characteristics of all TLs under study are presented.

Moreover, in Table 2, the function of $d=d(z)$ for each TL is listed.

TL Number	d(z) (in cm)
#1 (uniform)	30
#2 (ascending 1)	10+1.33z
#3 (ascending 2)	25+0.83z
#4 (descending 1)	50-1.33z
#5 (descending 2)	50-0.83z

Table 2. Inclination of TLs

In Figure 1, the induced voltage at the far-end is depicted for the line configurations. Although the lines under study are quite similar to each other, the variations between their voltages are large. This is due to two main reasons: The first one is related to the strong dependency of the voltage response to the inductance and capacitance. In other words, each spatial cell Δz results in different values of l, c. On the other hand, the external E/M wave travels more or less time (depending on the configuration of the line) to impinge the non-uniform line. Thus, the time interval needed for the wave to impinge the line between two successive spatial cells is not constant, as in the case of a uniform TL.

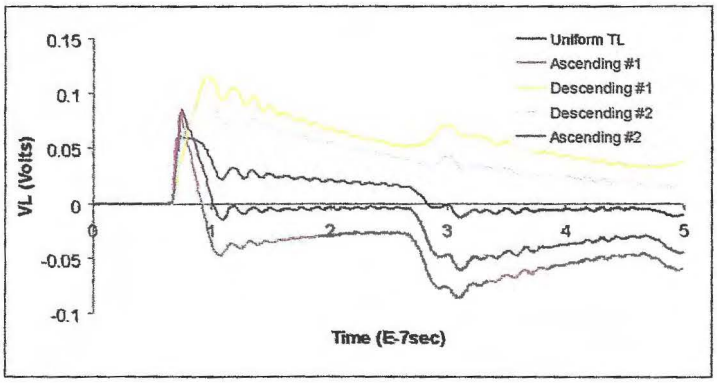

Figure 1. Transient Response of five similar TL configurations

Due to the versatile nature of FDTD code, the excitation waveform can be chosen to be sequential rectangular pulses on a carrier frequency and thus describe the interference caused in digital communication systems.

Conclusion

The important conclusion arising from this work is that an additional parameter must be taken into account when dealing with the coupling phenomenon present when a TL is illuminated by an external electromagnetic wave; that is the non-uniformity of the line configuration. It was shown that slight inclinations of the conductors could result in great alterations in the voltage response of the line. From a designer's point of view, this property can be used as a useful tool in the design of immune TL configurations by choosing the proper inclination, termination loads and other geometrical characteristics of the line.

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[1] F. M. Tesche, M. V. Ianoz, T. Karlsson, EMC Analysis Methods and Computational Models, Wiley, New York, 1994.

[2] C. R. Paul, Analysis of Multiconductor Transmission Lines, Wiley, New York, 1994. **EMC**

Panagiotis Trakadas *received his Diploma of Electrical and Computer Engineering and the M.E. Degree from National Technical University of Athens, in 1997. He is currently working towards his Ph.D. thesis at NTUA. His research interests include time-domain techniques and computational modeling of MTL problems and OATS performance. He is a student member of the IEEE EMC and AP Societies.*

Christos Capsalis *is currently a Professor at the National Technical University of Athens and Director of its Wireless Communications Laboratory. He has organized post-graduate courses in EMC at NTUA and at local companies. His current research activities include wireless and satellite communication systems and EMC.*

Bob Olsen Becomes New Associate Editor for Practical Papers

Robert G. Olsen received the BS degree in electrical engineering from Rutgers University in 1968 and the MS and Ph.D. degrees in electrical engineering from the University of Colorado, Boulder in 1970 and 1974 respectively. He presently serves as Boeing Distinguished Professor of Electrical Engineering at Washington State University (WSU) in Pullman, WA. During his service at WSU he has been a visiting scientist at GTE Laboratories in Waltham, MA, at ABB Corporate Research in Västerås, Sweden, and at the Electric Power Research Institute in Palo Alto, CA and a Visiting Professor at the Technical University of Denmark. Prior to WSU he worked for Radio WOR in New York City and the Westinghouse Georesearch Laboratory in Boulder, CO. Prof. Olsen has published more than 65 refereed journal articles on topics that include electromagnetic interference from power lines, the electromagnetic environment of power lines, low frequency electromagnetic shielding, electromagnetic compatibility, antenna theory and electromagnetic scattering. The National Science Foundation, the Electric Power Research Institute, the Office of Naval Research, Boeing, the Bonneville Power Administration and several utilities have sponsored his work. In addition to his research, he has served as a consultant on a number of low frequency EMC issues. He is a Fellow of the IEEE and presently serves as chair of the IEEE Power Engineering Society Corona Effects Fields Working Group, as Associate Editor of the *IEEE Transactions on Electromagnetic Compatibility*, as US National Committee representative to the

Continued on page 26

Book Review

Reviewed by Reinaldo Perez

Title: Electromagnetic Shielding Handbook for Wired and Wireless EMC Applications

Author: Anatoly Tsaliovich
Publisher: Kluwer Academic Publishers, 1999

Anatoly's entire career has been in the shielding business. Some of the first things that I learned about shielding, I learned from him through his papers. This book is a very well researched book (just as his other book in cable shielding was) and shows Anatoly's expertise on the subject. I personally will use this book as a reference any time I need information about the subject of shielding.

The final chapter in the book is titled, "This Brave New World of Electromagnetic Shielding." It summarizes some developments in the electromagnetic shielding industry. Some of these developments are old principles with new applications, others are more innovative.

There are nine chapters in the book, the last chapter being an appendix. The book covers many aspects of electromagnetic shielding problems and, as the title indicates, these problems are tailored to those found in wired and wireless equipment. The book starts from fundamental ideas on the subject of electromagnetic compatibility and progresses to electromagnetic coupling mechanisms and shield parameters. Techniques for identification, evaluation, and measurements of shielding are discussed. Typical shielding subjects such a cables, interconnections, enclosures, PCB and circuit hardening techniques, shield terminations and grounding are also addressed. Many of the aspects of shielding in the book are discussed at the system level. The study of shielding is very much related to the electromagnetic compatibility approach, antenna models, crosstalk theory, and general system analysis. Anatoly combines all of the methodologies of signal propagation, electromagnetic coupling analysis, field theory, and circuit theory, with a treatment of shielding which accounts for common and differential transmission mode EMI effects and the use of optimization theory for system design concerning shielding. The book emphasizes both theory and the more practical aspects of electromagnetic shield design, evaluation, and application in the system. The book leads the reader from the most general ideas of electromagnetic compatibility to electromagnetic energy coupling and transfer mechanisms in shielded circuits to design and selection methods of optimal shields which are effective.

The first chapter title "Introduction to System EMI and EMC" gives a review of the fundamental definitions of EMI and EMC, addressing electronic system problems in the interference environment, the role of system elements and interconnections. In this chapter the discussion concentrates on ideas to be used in further analysis of electromagnetic shielding in the following chapters. The concepts of electronic system EMI synthesis and analysis are applied to develop the principles of electronic system and system element EMC performance to generate models of electromagnetic emissions and immunity. Chapter 2 presents the fundamentals of electromagnetic shielding as one of the most important interference mitigation techniques. The chapter discusses the effects of electromagnetic shielding as they relate to system level applications and outlines the fundamental mathematical principles of shielding. The specifics of and differences between various electromagnetic shielding effectiveness definitions and parameters are discussed. A comprehensive approach to electromagnetic shielding is introduced as well as some models. Chapter 3 is titled "Transfer Parameters of Electromagnetic Shields and Enclosures." The chapter introduces differential parameters which characterize energy transfer across the shield. The electrical and mathematical models are developed, addressing the shield performance both as a shield and as a high frequency conductor. The analysis extends over the most popular shield designs: homogeneous and non-homogeneous, single and multi-layer, foil and mesh, apertures, serve and spiral tapes, braid, magnetic and non-magnetic, linear and non-linear materials. Energy transfer is considered in such applications as cables, ground and power planes in PCB, shelves, shielded rooms, and electromagnetic gaskets. Chapter 4 addresses the shield-to-external and shield-to-internal field coupling, the interaction of the coupling and transfer function, as well as the impact of the shield on coupling between shielded circuits and lines. The chapter addresses induction, near field and far field coupling scenarios. However, the concept of close, near, and far field are largely dependent upon the geometry and physical properties of the particular interferers and propagation media, even for the same rate of signal variations.

Chapter 5 addresses shielding effectiveness for EMI protection. It makes use of the comprehensive shielding system model to assemble the shield transfer and coupling functions into the respective figures of merit in order to evaluate shielding effectiveness in important practical applications. It addresses such subjects as the shielding effectiveness of product enclosures, architectural structures, and mobile objects, the crosstalk attenuation between shielded lines, printed circuit board traces, and cables, and the rationale, specifics, and problems of shielding system grounding and termination. The presented factual data, test results, and

examples enhance the understanding of complex shielding problems and provide useful reference material. In Chapter 6, measurement techniques for shielding are addressed. The chapter starts with a discussion on shielding measurement philosophies. The particular measurement techniques and their practical implementations are discussed from basic principles. The importance of and techniques for shield to shield measuring equipment calibration are emphasized.

Chapter 7 is titled "Shielding Engineering" and addresses practical aspects important to shielding design, manufacturing, and utilization. First, low and high level shielding models are formulated and reviewed. At the low level, the bypass shield model clarifies the roles of shield imperfections, connectors, gaskets, and ground loops in the shield EMC performance. At the high level, the concept of shielding system topology is considered. Shield performance modeling and optimization are illustrated with practical examples. The final chapter in the book is titled, "This Brave New World of Electromagnetic Shielding." It summarizes some developments in the electromagnetic shielding industry. Some of these developments are old principles with new applications, others are more innovative. The final chapter is an appendix that provides a reference background in electromagnetic and circuit theory. The chapter also addresses numerical methods and techniques in solving shielding problems.

The book is the result of Anatoly's 30 years experience in the area of shielding and is highly recommended to those EMC engineers who are interested in the subject. **EMC**

IEEE Press: You Can Be an Author!

By Mark Montrose

Why Be an Author?

As the new liaison to the IEEE Press from the EMC Society, and author of three best selling IEEE Press books, it is my pleasure to describe this important position within the EMC Society, and to encourage one to become an author.

IEEE Press publishes 30% of the world's engineering text and reference books. The focus of IEEE Press is to provide the highest quality of technical information in a variety of engineering disciplines. Most publishers focus on a specific market, or target a unique group of authors (i.e., university professors). Other publishers have thousands of books in their inventory that makes it difficult to ascertain if a specific title or subject exist. IEEE Press sells books worldwide. In addition, the staff at IEEE Press provides an incredible amount of support to the author during the development and publication cycle. An IEEE Press author never has to spend personal funds to publish! One must choose a publisher that provides the greatest amount of benefit to the author and audience, with the widest exposure possible for the sale of products.

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Mark Montrose
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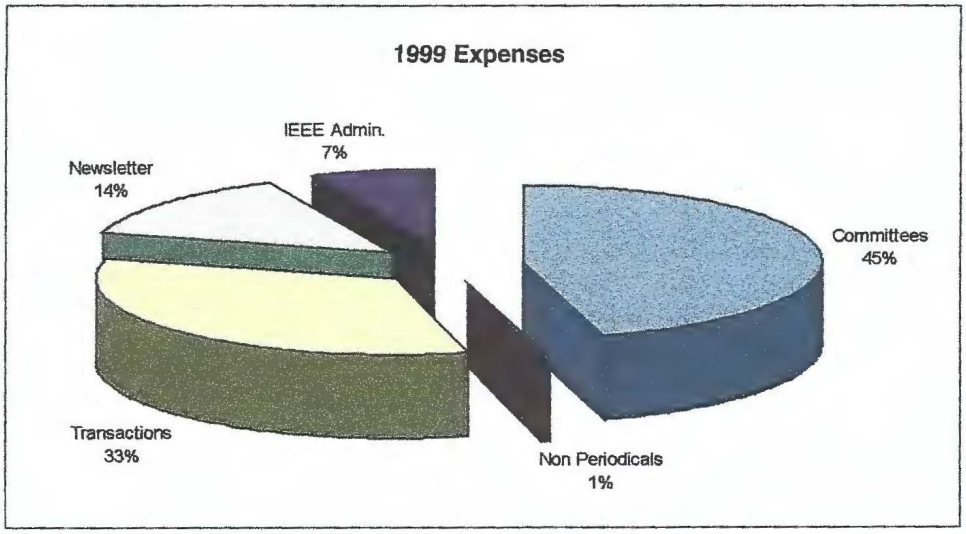
WHERE DO MY DUES GO?

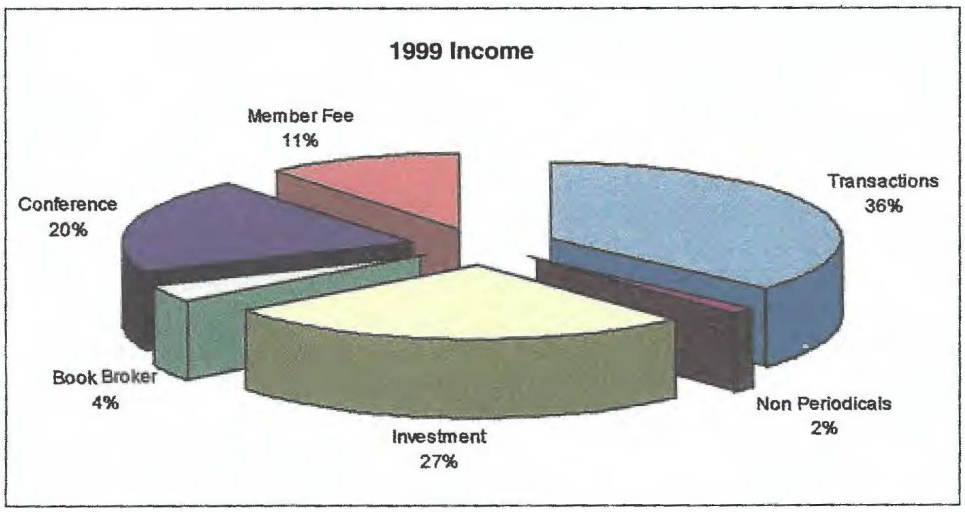
By Warren Kesselman, Treasurer, EMC Society Board of Directors

Recently, an EMC Society member suggested that a financial summary be included in the Newsletter to enlighten the membership on Society operational costs and let them know "what happens to their membership dues".

On an operational expense basis, the answer is that member fees only pay about 17% of your Society's yearly costs. In 1999, Society expenses (excluding symposium finances that are administered by the individual symposium's Treasurer) were approximately $368,000. The cost to produce and distribute the EMC Transactions was $122,000; Newsletter costs were $52,000; Society committee expenses totaled $169,000; and, IEEE administration costs were $25,000. Other than member fees ($64,000 in 1999), Society income is derived from the sale of its intellectual property, conference surpluses, and return on investments. In 1999, technical literature sales provided $90,000 net income. Investment income was $157,000 and surpluses from the 1997 and 1998 conferences totaled $121,000. Without investment and conference income, 1999 operations would have ended with a $57,000 deficit. The percentage distribution of 1999 income and expenses is shown in the pie charts that accompany this article.

Warren Kesselman





Over the past several years, income from investments and symposia (currently about a million-dollar venture) has enabled your Society to "grow" a reserve fund to the level suggested by IEEE for a financially sound Society. On January 1, 2000, the market value of the EMC Society's long-term investment was $788,989.56. (As a historical note, your Society, due to a symposium deficit, had to borrow money for a few years in the 1970s to pay expenses.)

What does your $15 EMC Society membership dues buy? The combined production and distribution costs for the Transactions, Newsletter and a copy of the symposium record, if you are not an attendee, is about $60 per member. One might view the annual fee as being equivalent to a 75% membership discount on products received. If the "Transactions on EMC" nonmember subscription rate ($225) is used for comparison, the "value" of an EMC Society membership is in excess of $250. **EMC**

EMC Standards Activities

by Don Heirman, Associate Editor

This article appears as a result of a new initiative by the Standards Education and Training Committee (SETCom), chaired by Hugh Denny. The charter of SETCom is twofold; namely 1) seek to better train working groups and working group chairs so as to facilitate acceptance of a standard by the IEEE Nescom and Revcom after it has been prepared by the working groups, and 2) provide an education forum for the broader EMC community on various EMC standards, both civilian and military. In pursuit of this second goal, the following article was prepared by EMC community luminaries Warren Kesselman and Herb Mertel. If you have material you would like to contribute for publication in this Newsletter that provides educational and historical background on EMC standards, please contact Hugh Denny via e-mail at hugh.denny@gtri.gatech.edu

The History of Military EMC Specifications

By Warren Kesselman, IEEE and Herbert Mertel, IEEE

1 The Early Years - Control of Ignition interference

The US military first encountered Radio Frequency Interference (RFI) some time prior to World War I when a radio was first installed on a vehicle. However, little is known about early efforts to address RFI problems until the early 1930s. The IRE (Institute of Radio Engineers) 1932 Proceedings included a paper on electrical interference in car radios.[1] The first military specification was published by the US Army Signal Corps in 1934 as SCL-49 entitled "Electrical Shielding and Radio Power Supply in Vehicles". That document "protected" radio receivers from interference by requiring shielding of the vehicle ignition system, regulator and generator. The requirement was simply that the vehicle operation not "disturb" radio reception. With the increased use of mobile radio communications, it became apparent SCL-49 was inadequate. In 1942 it was superseded by specification 71-1303, "Vehicular Radio Noise Suppression" that addressed (in addition to shielding) the use of filters, by-pass capacitors, resistor-suppressors, bonding, grounding and proper wire routing. This specification also defined an instrumentation system and a limit. During the 1940s military standards were principally concerned with RFI suppression components for internal combustion engines and electrical machinery.[2] In 1945 a joint Army-Navy (Air Force not yet "born") standard JAN-I-225 entitled "Interference Measurement, Radio, Methods of, 150 Kilocycles to 20 Megacycles (For components and complete assemblies) was issued.[3] Then in 1947, AN-I-40 established limits for aircraft systems. [4]

The subsequent succession of military EMC specifications closely follows the evolution of our electrotechnology. Initially, military specification limits for radio frequency interference were established to protect the minimum usable field strength on board vehicles for land, sea, and air. As more sensitive equipment was developed, susceptibility (immunity) limits were established. With the space age came the concept of electromagnetic compatibility within small platform systems and also between platforms. As a consequence, the equipment and system specifications became more general to include all types of electrical and electronic equipment that require application of EMC techniques during the design, development, production, installation, and operational states.

2 1950 - 1965: A Proliferation of Interference and Susceptibility Specs

In the 1950s and up to 1965, each major military agency imposed its own electromagnetic interference (EMI)/ EMC specification in the procurement of electronic systems and equipment. For instance, the Air Force used MIL-I-6181 and MIL-I-26600, the Navy used MIL-I-16910, and the Army used MIL-I-11748 and MIL-E-55301(EL). These specifications limited the amount of conducted and radiated EMI emissions and set susceptibility levels which systems and equipment must reject. The specifications also set forth the test configurations and techniques needed to demonstrate compliance with the requirements therein.

The existence and application of different EMC specifications for each service caused quite a dilemma. They were significantly different from each other, so that when a component was designed to meet one specification, it usually had to be redesigned and tested to meet another. The frequency ranges covered were different and the limits for overlapping frequencies varied. More significantly, each specification required the use of different test equipment, making it quite expensive for an organization to be fully equipped to test to all EMC specifications.

The problem was compounded by additional specifications for specific systems, such as Minuteman AFBSD-62-87 initiated by the Boeing Company; GSFCS-523-P-7 prepared by Genisco under contract from Goddard Space Flight Center for Aerospace Ground Equipment (AGE); and those issued by technical centers, such as MSFC-SPEC-279 issued by the Marshall Space Flight Center and MIL-STD-1541 issued by the USAF/SAMSO. It became obvious that there was a need to limit these different specifications and the generation of one unified standard to serve all government and military agencies.

The first attempt to issue a specification which would be acceptable to all branches of the government was the publication of MIL-STD-826 in January 1964. This document presented a new set of limits. However, this effort was ill-fated and MIL-STD-826 was used only by the USAF. [5,6]

3 1967: MIL-STD-461 Arrives on the Scene

In 1960 [7] the US Department of Defense (DoD) enacted a comprehensive Defense Radio Frequency Compatibility Program (later renamed Electromagnetic Compatibility Program) that focused the Military Services R&D programs "to provide a means whereby electromagnetic compatibility should be 'built into' military communications-electronics equipment in the research and development stage". In 1966, EMC personnel of the three military departments jointly drafted standards addressing the interference reduction needs of the entire Department of Defense.

That effort culminated in 1967 in the issuance of Military Standards 461, 462 and 463. As a result, approximately 20 basic and subsidiary specifications were superseded. The 461 document focused on requirements and the 462 standard prescribed measurement methodology. Definitions and acronyms were contained in 463.

Considerable revision was required and MIL-STD-461A was issued in August 1968. MIL-STD-461 was accepted by the joint services and was also used by many other countries. Eventually, the different military agencies (Army, Air Force, and Navy) found many items to their dissatisfaction, and thus many revisions were issued by each of the three services until 1989. The most noted difference was the "Pink Copy" issued by the Army.

4 1990 - 2000: Military EMC Specifications Mature

An effort was started in 1990 by the Tri-Service EMC Committee to prepare an updated MIL-STD-461 and MIL-STD-462. MIL-STD-463 was withdrawn and definitions were referenced in American National Standards Institute (ANSI) C63.14 "Standard Dictionary for Technologies of Electromagnetic Compatibility (EMC), Electromagnetic Pulse (EMP) and Electrostatic Discharge (ESD)". [8,9]

Since the 1970s EMC personnel of the US Army, Navy and Air Force have periodically met and upgraded MIL-STD-461 and 462. The latest revision (1999) consolidated the two standards (Limits and Measurement Methods) into one standard: MIL-STD-461E "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment". This latest edition is an "interface" standard of requirements to provide reasonable assurance (during development) that a system, subsystem or equipment will be compatible with its anticipated electromagnetic environment. [8]

The most significant changes in MIL-STD-461D/-462D and the subsequent MIL-STD-461E as compared with the previous MIL-STD-461C are as follows:

- Broadband emission tests are deleted.
- Measurement (6 dB) bandwidths are specified.
- Radio frequency (RF) susceptibility scan times are specified.
- The 50 Σ line impedance stabilization network (LISN) is used for conducted emission.
- Test setup calibration is required.
- Absorber in shielded room is specified.
- Bulk cable injection is specified.
- Conducted emission measurements stop at 10 MHz.
- Explanatory appendices were added to MIL-STD-461D and MIL-STD-462D.
- Receiver susceptibility tests must be defined for each procurement.
- MIL-STD-463 was canceled. American National Standards Institute (ANSI) C63.14 is referenced for definitions.

The most valuable sections of these two specifications and of MIL-STD-461E are the appendices, which give the technical rationale for the limits and measurement procedures. These appendices should be read first because the material gives the logic behind the requirements. Although it is not customary that military specifications are accredited to an author; the appendices of MIL-STD-461D/-462D as well as of -461E are accredited to one of the main contributors of the -461D and -461E re-write: Mr. John Zentner of the Air Force Systems Division of Wright-Patterson Air Force Base.

The technical work was completed in November 1992. The two documents were published in January 1993 as MIL-STD-461 and MIL-STD-462D [6, 7]. The work for MIL-STD-461E was completed in 1999. The basic concepts of 461 standards were adopted by several non-US military organizations and also influenced national and international standardization efforts

5 Progress and Future of Military EMC specifications

Thus, over the past seven decades, US Military EMC Standards have evolved from a simple beginning to keep pace with the "technology explosion" and the resultant complex electromagnetic environment. The MIL-STD-461 D requirements (limits) and MIL-STD-462D test methods as well as the new "Interface Standard" MIL-STD-461E were developed by approximately 15 U.S. government and industry experts during the 1990 to 1999 time period under the leadership of Mr. Stephen Caine, USN/SPAWAR, retired.

However, the development of EMC specifications is never finished since the technology requiring compatibility constantly changes. Since 1998, the Defense/Industry E3 Standards Committee has been trying to find a compromise between the (1) Policy of DOD to use commercial EMC standards whenever possible and (2) the use of MIL-STD-461E. The work is continuing at the time when this paper was prepared (May, 2000). However, the work to-date seems to indicate that there is very limited overlap of the military vs. the commercial EMC requirements. The EMC requirements of the military pertain to small metallic platforms with unique requirements that are different from the commercial needs.

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[7] Memorandum from the Acting Secretary of Defense to the Secretaries of the Army, Navy and Air Force. Subject - Radio Frequency Compatibility with attachment: "Radio Frequency Compatibility Program, dated 9 June 1960."

[8] Military Standard (1993). "Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility," MIL-STD-461D. Available from Naval Publications and Forms Center, Attention: NPODS, 700 Robbins Avenue, Philadelphia, PA 19111-5093.

[9] Military Standard (1993). "Measurement of Electromagnetic Interference Characteristics," MIL-STD-462D. (Companion document to MIL-STD461 D.)

[10] Military Standard (1999). "DoD Interface Standard, Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility", MIL-STD-461E **EMC**

Personality Profile

Bill Duff, Associate Editor

Introducing... Elya Bernard Joffe from Israel

In this issue, we travel to Israel, to present the personality profile of Elya Joffe. Elya is a member of the Joffe family, one of the largest families in the Hebrew people. Rumors claim that the family is descended from King David.

Elya Joffe received his B.Sc.EE degree in 1982 from the Ben-Gurion University of the Negev in Be'er-Sheva, Israel. His studies, which he completed within two years and a half, took place while he was still with the Israel Air Force, and focused on communication and radiating systems. It appears from that early time he was preparing for a career in Electromagnetic Effects.

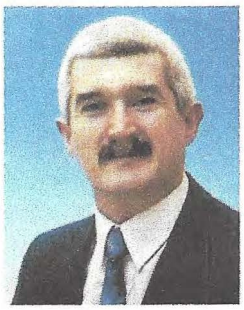
During his studies, Elya joined the IEEE, and participated in the First Mediterranean Electrotechnical Conference (MELECON'81), in Israel, where he presented his first Symposium paper.

Upon graduation in 1982, he returned to full service in the Engineering Division of the Israel Air Force, where he obtained the degree of Captain.

During that time, Elya was first introduced to EMC. His first mentor was Mr. Jack Moe, a well-known expert in the EMC Community (and up to these very days – a good friend of his). Thanks to Jack's encouragement and willingness to discuss and explain technical aspects, Elya's future was being "carved on the rock". EMC was "love at first sight".

During his service in the IAF, Elya was preparing to make EMC his career, taking courses, reading books and participating in several EMC Symposia. His first EMC Symposium was the 1986 IEEE International Symposium on EMC in San-Diego. Thereafter, he participated in most of the annual IEEE EMC Symposia and others.

In 1987, Elya was discharged from the IAF, and joined KTM Project Engineering, a privately owned consulting company, and was assigned to the IRRS (Israel Radio Relay Station) project, better known as the "Voice of America" Station in Israel. His responsibilities covered the study and investigation of the potential electromagnetic effects of the planned broadcast station (one of the largest of its kind in the world), transmissions on people, fauna and flora, communication systems and aircraft. Many studies carried out then could still be considered innovative today - especially those associated with the investigation of aircraft ("iron birds") fuselage shielding effectiveness in the short-wave frequency band as well as EMR effects on living birds. Measurement techniques developed by Elya and his Team have been the topic of several papers presented at various EMC Symposia.



Elya Bernard Joffe

Up to these very days, one of Elya's primary fields of interest is that associated with field to aircraft interactions, particularly Short Wave (HF) interactions.

During his work for the Project, Elya joined the Society of Automotive Engineers (SAE), and became an active member of the SAE-AE/4-R Committee (HIRF). This enabled him to contribute his experience from his studies to the development of the HIRF requirements generated in the Committee.

After the termination of the Project, in 1992 Elya extended his consulting in EMC to government and industry in Israel, and became one of the leading consultants in Israel in the field of EMC. His activities extend from circuit (and below) to systems (and above). He also extended his activities to EMC Education and training, in Israel and abroad, where he teaches multiple EMC and EMC-related public and in-house courses.

Elya was first introduced to the EMC Society and joined it during his service in the Air Force. Naturally he joined the IEEE EMC Chapter in Israel in 1986, and soon became the Chapter Secretary/ Treasurer. New as he was in the Society, he already outlined his aspirations to contribute to the Society, and to the EMC Community in a global scale. In 1990, Elya was elected to the Senior Member grade of IEEE. In 1992, while acting as Secretary of the Israel IEEE EMC Chapter, Elya and Mr. Rafi Rubinstein, then the Chapter Chairman, organized the 1992 IEEE Regional Symposium on EMC, of which Elya was the Technical Chairman. In 1995, Elya was elected Chairman of the Israel IEEE EMC Chapter. Since his appointment as Chapter Chairman, the Chapter membership increased by 20dB (from 20 members, approximately, to 200 and more today).

Elya was determined to get the Israel Chapter "on the global map", and, therefore, one of his first activities as Chapter Chairman was to "cash the cheque" from the EMC-S, and petition to hold the 2003 IEEE International Symposium on EMC in Tel-Aviv, Israel. That proposal being approved, Elya was elected as chairman of that Symposium, "the first after 2000 years," as commonly said in Israel.

In 1998, Elya was elected to the IEEE EMC Society Board of Directors (BoD) for the term 1999-2001. It is interesting to note that he is the first Israeli Member on the BoD. It is noteworthy that the Israel EMC Chapter was also the first EMC Chapter outside the USA. Elya now serves the Society as the Chairman of the IEEE EMC Society Standards Advisory and Coordination Committee (SACCom) and as Chairman of the IEEE EMC Society Region 8 Membership Committee and, naturally, also as the "Angel" of the Region 8 Chapters.

Elya is very active in the annual EMC symposia, and has presented over 30 papers on EMC at various EMC symposia worldwide. He also serves as a member of the international committees of several EMC Symposia worldwide (e.g., EMC'97 Beijing, EMC'99 Tokyo, and others).

Elya is an Associate Editor of the IEEE Transactions on Electromagnetic Compatibility (EMC) and was a reviewer of several EMC books which were published by the IEEE Press. He is also a demanded speaker on EMC topics in Israel and abroad, and serves as a Distinguished Lecturer of the EMC Society for the years 1999-2000.

Elya's interest in EMC Standardization led him to the position of Chairman of the Israel Technical Committee on EMC in the Israel

Institution of Standards, where he is currently leading the effort of standards development and regulation in Israel. He is also a member of other technical committees, particularly the Lightning Protection Experts Committee.

He is a registered Professional Engineer and a NARTE-Certified EMC and ESD Control Engineer. He is also a member of the dB Society.

Elya is a recipient of the Third Millenium Medal of the IEEE. He is also listed in the 14th Edition (1997) of "Who's Who in the World".

His favorite hobby and pastime is ... IEEE, to which he devotes many, many hours of his day (and nights). He also enjoys the reading of historical novels and fiction.

Elya enjoys traveling, especially with his family, and takes advantage of the annual trips to the IEEE EMC Symposia to explore different regions of the USA and other regions of the world. He is, therefore, always accompanied to the IEEE EMC Symposia by his wife, Anat, and daughter, Tami-Lee. Incidentally, Tami-Lee, has "attended", since her birth in 1988, all EMC Symposia, with the exception of the 1991 Symposium. Elya says she is undergoing her "on job training" in EMC.

And finally from past to future. From the troubled yet so promising region – the Middle East, where the Israel Chapter resides as the only IEEE EMC Society Chapter, Elya also has a vision: A vision of EMC cooperation between EMC engineers in Israel and in the neighboring countries. His aspirations are to open the Israel Chapter to EMC engineers, and particularly to EMC Society members from the Region. His motto is EMC for Peace and Peace for EMC. Would that not be the accomplishment of the IEEE's goals: The understanding of the electrical and electronic phenomena and their application for the benefit of Society and mankind in general, and to the improvement of it's quality of life?

Elya Joffe may be reached at *eb.joffe@ieee.org*. **EMC**

President's Message

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tees is progressing as well as that of the EMC Society Standards Committee. Soon it will be possible to easily access information about Society technical committee activities and EMC standards development.

One of the major thrusts on the Board of Directors this year, besides concern over globalization, is that of EMC Society chapter support. Last month, Henry Benitez reported on his activities at the IEEE Chapter Coordinators retreat. The board has supported several other initiatives in this area. Janet O'Neil has promoted the highly successful concept of Regional Colloquia in various cities, including Portland, OR, Phoenix, AZ, Dearborn, MI, and Orange County, CA, among others. The scenario consists of a one day technical session track comprised of high quality speakers along with continental breakfast, lunch and an after hours reception with the speakers. Financial gain is realized by charging a modest registration fee and a modest tabletop booth rental fee to several EMC product vendors. Ghery Pettit, Chapter Coor-dinator, has developed a chapter chair reflector so as to allow chapter chairs to electtonically post information to share with other chapters. Todd Hubing continues to let his budgeted expenditures for Distinguished Lecturers run at full power. EMCS Board members are being encouraged to visit local chapters in the course of their normal business travels. Takeo Yoshino, Todd Hubing, Jose Perini are all actively pursuing new EMCS chapter development in IEEE Regions 9 and 10 (Latin America and Asia Pacific). On October 1, 2000, I plan to participate in an IEEE Divisions I & IV Region 8 Chapters meeting to be held in Paris, France. These two IEEE Divisions encompass some 12 Societies while Region 8 includes Europe and the Middle East. We remain committed to supporting the development and the growth of EMC Society Chapters worldwide.

Benoît Nadeau, Sylvie Fafard and Joe Butler (L-R) pause during a tour of the Palais des Congrés de Montreal, site of the 2001 IEEE International Symposium on EMC in Montreal, Quebec, Canada. Ms. Fafard conducted the tour of the modern convention center.

If you have any questions, comments or suggestions, please feel free to call or write me at my workplace: Chomerics, Division of Parker Hannifin Co., 77 Dragon Court, Woburn, MA 01888, 781-939-4267 or e-mail me at *j.e.butler@ieee.org*. **EMC**

Bob Olsen

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Conférence Internationale des Grands Réseaux Électriques á Haute Tension (CIGRE) Study Committee 36 (Electromagnetic Compatibility) and a member of the Electric Power Research Institute EMF Science Advisory Committee. Past appointments include chair of the IEEE Power Engineering Society AC Fields Working Group, Associate Editor of Radio Science and membership on the National Research Council Committee to evaluate the U.S. Navy's Extremely Low Frequency Communications System Ecological Monitoring Program. He also has been on the international steering committee for EMC Roma 96, EMC Roma 98 and EMC Europe 2000. **EMC**

Sensor's Council

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symposia and sessions at related domestic and international meetings. The Sensors Council will have an exhibition booth at the Eurosensors, The 14th European Conference on Solid-State Transducers, to be held 27-30 August 2000, in Copenhagen, Denmark. The Sensors Council will also be represented at the forthcoming SensorsExpo, September 19-21, 2000 in Detroit.

EMC Society Board of Directors member Dr. Andrew Podgorski is the EMC Society Representative to the Sensor Council. For more information, please contact Dr. Podgorski at *a.podgorski@ieee.org*. **EMC**

Board of Directors Activities

Montreal, Canada
Friday, June 9, 2000

Call to Order

President Butler called the June 9, 2000 meeting of the EMC Society Board of Directors to order at 8:30 am. A round of introductions was made. Board members present included H. Benitez, D. Bush, J. Butler, L. Carlson, T. Chesworth, L. Cohen, A. Drozd, F. Heather, D. Hoolihan, T. Hubing, E. Joffe, W. Kesselman, D. Millard, M. Montrose, J. O'Neil, H. Ott, J. Perini, G. Pettit, A. Podgorski, D. Sweeney, K. Williams and T. Yoshino. Board members absent included M. Kanda, F. Mayer, D. Heirman and D. Smith. Guests present included B. Wallen, H. Denny, R. Ford, R. Carstensen, B. Nadeau and W. Duff. The meeting agenda was approved as presented.

President's Report

President Butler introduced Russ Carstensen who was present to address the NARTE MOU. Mr. Carstensen distributed a copy of the draft MOU for the Board to review. (This was discussed later in the meeting.) President Butler also advised that Henry Benitez would be soliciting nominations for awards to be presented at the Washington DC symposium. He encouraged the Board to consider nominating a peer for an award. Mr. Butler noted that there is a surplus of IEEE EMC Society CDs as well as Seattle Symposium Records. He solicited volunteers to sit on an ad hoc committee to determine what to do with this material. Todd Hubing, Dave Millard, Don Bush and Hugh Denny volunteered to sit on this committee. The committee was requested to present a report via e-mail by July 31, 2000.

Treasurer's Report

Treasurer Warren Kesselman distributed his report that included the 2000 Operations Summary from January 1 to April 30. Current cash reserves as of April 30 were $465,350. The long-term investment market value as of April 30 was $808,500. The Board approved the 2001 budget for Committee and Other expenses of $312,100 for the EMC Society. President Butler requested that Mr. Kesselman present a detailed financial report for the next meeting showing a comparison between YTD actual versus YTD budget figures.

Photo by Janet O'Neil

The EMC Society Board of Directors hosted a reception and dinner for the members of the Montreal EMC Chapter. Christian Dube, Vice-Chairman of the steering committee for the 2001 IEEE International Symposium on EMC in Montreal, (left) joined Harriett and Henry Ott, Vice-President for Conference Services, during the reception.

Secretary's Report

Secretary Janet O'Neil presented the minutes from the Board meeting on March 24, 2000 for review. Changes were required. The Board approved the minutes as amended.

Membership Services Report

Todd Hubing, Vice-President for Membership Services, presented his report. Henry Benitez reported on Awards. The Society is now soliciting nominations for awards to be presented at the Washington DC symposium. Mr. Benitez listed the names of the candidates to receive awards and briefly explained why the people were so nominated. Ghery Pettit reported on Chapter Activities and advised that there is now a list server created in order to communicate to all chapter chairmen. The address is *emc-chapter-chairs@ieee.org*. He has used this to communicate to the chapter chairmen regarding the awards luncheon in Washington DC. Dick Ford reported for Video Productions. He showed the recently produced video of Clayton Paul performing an experiment at the Seattle EMC Symposium. The video is approximately eight minutes long. The intent of the committee is to film additional experiments in order to compile a video library of demonstrations. Mr. Ford also advised that the membership survey is now being conducted by the IEEE. It will be completed by the August 2000 symposium in Washington DC. Results will be presented by the IEEE at the August 2000 Board meeting. Any follow up activity required for the survey will be done between the August and November Board meetings. Mr. Ford will make the concluding report on the survey at the November Board meeting. Regarding Membership, Andy Drozd reported that he has ordered all the IEEE materials necessary for the EMCS booth in Washington DC. The booth itself will be shipped to the symposium. Elya Joffe reported as EMC Region 8 Membership Committee Chairman. He will take the EMCS membership booth to various Region 8 EMC conferences this year, including the Wroclaw symposium, the Millennium Workshop in Greece, and the Brugge conference. Jose Perini reported on EMC activities in Region 9. He has been to Brazil and notes that there is increasing EMC activity there. A chapter is in development in San Paulo and a regional EMC conference is being planned there for 2001. There is also activity in the southern part of Brazil. In Argentina and Mexico, EMC activity is also increasing. Mr. Perini plans to visit these countries to foster the development of EMC. Mr. Hubing then introduced Takeo Yoshino who recently accepted the position of EMC Region 10 Membership Committee Chairman. Mr. Yoshino advised that some of the countries in Region 10 have little industry involvement in EMC. Australia has shown interest in forming an EMC chapter, for example. Mr. Millard advised that there is EMC activity in India and he has contacts there that he will pass along to Mr. Yoshino. The Board discussed the issue of potential IEEE EMCS members in Regions 8-10 not joining due to the relatively high cost of membership dues. President Butler advised that the IEEE Technical Activities Board (TAB) is addressing this issue now. He will report on the status of developing IEEE policy in this regard at the August meeting. Mr. Hubing requested that if any Board mem-

Photo by Janet O'Neil

The reception was held in "Les Voutes" (The Vaults) of the Intercontinental Hotel, site of the Board of Directors meeting in historic "Old Montreal". The vaults date back to the early 19th century. Some maintain that the vaults date back to the 18th century fortification walls that encircled the old city of Montreal. Enjoying the unique ambiance are Elya Joffe, Janet Nichols, and Takeo Yoshino.

bers are attending international EMC conferences, that they let the appropriate Region 8, 9 or 10 chair know so that outreach efforts may be coordinated. If Board members are attending US EMC conferences, they should contact Mr. Drozd. Bill Duff next reported that he has received three Fellow Award applications this year. The awards will be presented at the Washington DC symposium. Tom Chesworth was recently appointed chair of the Fellows Search Committee. Todd Hubing reported for Lee Hill, chair of the Distinguished Lecturer (DL) program. DL activity is at an all-time high and the budget for this year in June is close to being fully allocated. There have been more trips overseas by the DLs. He thanked Elya Joffe and Mark Montrose for their support as DLs who have traveled overseas. Lastly, Dan Hoolihan presented his report as chair of the Nominations and Bylaws Committee. He advised that the Call for Board nominations was printed in the Winter 2000 EMC Society Newsletter. There is a total of 12 candidates, including seven candidates from Regions 1-6, one candidate each from Regions 9 and 10, and two candidates from Region 8. This is the first time a member from Region 9 has been included on the ballot. There is no candidate from Region 7.

Standards Services

Elya Joffe reported on Standards activities in the absence of Don Heirman, Vice-President of Standards. It was noted that the webpage 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 Committee (SACCom) chaired by Mr. Joffe and the Standards Development Committee (SDCom) chaired by Steve Berger. Each committee met prior to the Board meeting. Regarding the SDCom, all standards are currently active. However, Standard 140 must be reaffirmed by October of this year. A PAR for the update of 187 has been submitted to IEEE REVCOM. The revision will expand the standard to address digital television systems as well as analog systems. Regarding SETCom, a workshop has been scheduled for Monday afternoon, August 21 during the DC EMC Symposium. Speakers include Don Heirman, Sue Vogel of the IEEE, and Hugh Denny. Articles on standards will be a regular feature of the EMCS Newsletter. Regarding SACCom, a new liaison has joined the committee from IEC TC46 (copper cables, EMC test methods). A proposal for liaison with CENELEC TC210 has been received. An additional liaison is being negotiated with ISO WG for Space Systems EMC standards. At their recent meeting, various representatives present reported on EMC activity in their respective areas.

Conference Services

Henry Ott, Vice President for Conference Services, presented his report. Mr. Ott made two announcements. First, that he was pleased to report that the Montreal EMC Symposium Committee has made great strides in becoming an effective committee. Second, he advised that Janet O'Neil has assumed the responsibility of Exhibitor Liaison in place of Glen Watkins. Mr. Ott then turned the floor over to Barr Wallen, Symposia Committee Chair, wh summarized activity of recent symposia The Board approved the audit report o the Denver 1998 Symposium whicl showed a net surplus of $96,847. In reference to the Seattle 1999 Symposium, the expected surplus is $291,888.95, this represents a 29% surplus. The IEEE audit of the symposium is now underway. Chairman Bill Duff presented a report on the Washington DC 2000 Symposium. Regarding the 2001 Montreal Symposium, Benoît Nadeau, Chairman, presented his report. Since April they have had four committee meetings and have developed a time line for the symposium actions required. They have contracted with a local firm to be their show managers. There will be multiple hotels serving the symposium attendees. The symposium website is under development and is expected to debut in one month. Electronic registration will be available on site. Regarding the Minneapolis 2002 Symposium, Dan Hoolihan advised that their committee will present a preliminary budget for approval at the August Board meeting. Regarding the Boston 2003 Symposium, Mr. Wallen advised that the symposium chairman, Mirko Matejic, is requesting a $20,000 advance. Mr. Wallen and his committee are evaluating this request. Elya Joffe, Chairman of the Israel 2003 Symposium, advised that the preliminary budget for this event will be presented at the next Board meeting. His committee has conducted consider-

Photo by Janet O'Neil

Also enjoying the reception are Montreal EMC Chapter members (L-R) Pierre-Marie Wecowski, of Nortel Networks, Jean-Jacques Laurin, Professor at École Polytechnique of Montréal, Zhongfang Jin, Doctorate Student at École Polytechnique of Montréal and EMC Society Board member Andrew Podgorski, ASR Technologies. Professor Laurin and Dr. Podgorski are members of the steering committee for the Montreal EMC symposium serving as Technical Papers Chair and as Treasurer, respectively.

able international advertising to promote this event. They are trying to have various international committees, such as TC-77 and CISPR, meet in Israel in conjunction with their symposium to build attendance. Regarding various symposia issues, Mr. Wallen reviewed the issuance of the "Call for Papers", the timeframe for sending them out, reviewing these, etc. Sending out the call for papers in April, roughly 16 months prior to the symposium, for example, will give the membership more time to respond and add more time to review the papers. The current time frame is too tight for meeting the advance program print deadlines. The Board approved mailing the call for papers in April prior to the following year's symposia. Mr. Wallen will report at the August Board meeting on the status of the ad hoc committee of the symposia task force, formerly chaired by John Osburn. Janet O'Neil reported on regional EMC conferences. Several conferences have been held by EMCS chapters this spring. Basically, the chapters enjoy hosting these regional conferences as they provide funds for future chapter activities and they also provide EMC education to their members. The participating vendors appreciate the low cost and effective way of meeting new potential customers. However, the vendors have requested more coordination of scheduling these one-day conferences so that two do not fall on the same date or are scheduled too close in time. These regional conferences will be discussed at the Chapter Chairmen's luncheon in Washington DC. Global EMC Symposia Coordinator Chairman Elya Joffe advised that this newly created committee's task is to represent and promote the interests of the EMCS at non-US, non-EMCS organized EMC symposia. The membership booth will be present at these conferences.

Communication Services

Len Carlson, Vice-President for Communications Services, reported in the absence of Moto Kanda, Transactions Editor. Mr. Kanda has resigned his position effective June 1, 2000. Marcello D'Amore of the University of Rome, "La Sapienza", was approved as the new editor of the Transactions on EMC. Professor D'Amore has assigned a managing editor, Flavio Canavero, to assist him with the publication. Newsletter editor Janet O'Neil advised efforts continue to "fatten up" the Newsletter with more practical papers and articles of interest to the membership. Ms. O'Neil advised that she had attended the IEEE Panel of Editors meeting in Newark on April 7 and 8. She met many fellow editors of IEEE Society magazines and newsletters. It was a good educational experience. Mark Montrose presented his report as IEEE press liaison. Royalties paid to the EMCS through this program amounted to $5,587.54 in 1999. On Mr. Montrose's behalf, Hugh Denny attended the IEEE Press Editorial Board meeting in Savannah, GA on June 2-3, 2000. "General Interest" books remain the biggest sellers. Public Relations Chair Henry Benitez reported that they are planning a chapter information packet that would help to promote chapter development and the formation of new chapters. It was clarified that the material that was once included in the chapter chairman handbook is now included on the Society's website. Thus, Mr. Benitez and his committee will develop a new product for chapters. EMCS webmaster Andy Drozd reported on his recent activity with the EMCS website. He is working with the IEEE to develop a website advertising policy. The hosting of the website is still in process to transfer this from the University of Missouri, Rolla to the IEEE. The IEEE hosting of the website will be provided at no charge. The issue of including a counter on the website to determine the number of "hits" received daily was discussed. Several vendors have signed up for advertising on the EMC Society website. Mr. Drozd will follow up on the issues raised during the discussion as the policy is developed. Regarding the individual TC websites, Mr. Drozd is continuing his work to review and evaluate the sites to ensure that they present a consistent look and information.

Photo by Janet O'Neil

Joining the Board for dinner are Montreal EMC Chapter members Elise Lin and Mark de Payrebrune of EMS Technologies Canada, the Space Division of EMS Technologies headquartered in Atlanta. Elise and Mark are dubbed the "The EMC Couple" as they work together looking after the EMC aspects of the RADARSAT-2 satellite program and, yes, also happen to be married.

Technical Services

Kimball Williams, Vice-President for Technical Services, presented his report. He relayed the report of Maqsood Mohd, Chair of the Education Committee. The committee received a good response to the Student Paper Contest to be held during the Washington DC symposium. It will be difficult to determine the winner.

Photo by Janet O'Neil

Following dinner, Board member Todd Hubing was the featured speaker at the Montreal EMC Chapter meeting. Todd enthusiastically discussed embedded capacitance. Following the meeting, Montreal EMC Chapter Chairman, Benoît Nadeau, Conformity Group Manager at Matrox, (right) joined Barry Wallen, EMC Symposia Committee Chairman, (center) and Bill Duff for some "symposia talk". Mr. Duff is the chairman of the steering committee for the 2000 IEEE International Symposium on EMC in Washington DC while Mr. Nadeau is the chairman of the steering committee for the 2001 IEEE International Symposium on EMC in Montreal.

They are planning on 20 experiments this year at the symposium over Tuesday-Thursday of the symposium week. Next year they will formalize the experiments process by developing a "Call for Experiments." Regarding the video production committee, they have produced the eight-minute Clayton Paul experiment video. Mr. Williams would like to see this distributed to all IEEE student chapters globally. The Student Design Contest is reviewing the four entries they have received. The University Grant committee received three requests from various universities. The Grant will be awarded at the Washington DC symposium. Chairman Andrew Podgorski presented the Technical Activities Committee (TAC) report. The TAC Matrix has not been changed since it was distributed at the March Board meeting. Several of the TCs are preparing special tutorials for the Washington DC symposium. TC-8 is slowly moving towards becoming an independent society. Mr. Butler advised that he has not received any formal request from TC-8 to assist them or support them in this effort. Until the Society is approached officially by TC-8, Mr. Butler does not recommend taking any action on this. He requested that Mr. Podgorski stay abreast of their continuing activity, however. Regarding the request for a special TC-10 on Signal Integrity, President Butler advised that the consensus of the Executive Committee was not to create a special TC-10, but rather to expand the scope of TC-4 to include signal integrity. He requested that Mr. Podgorski revise the mission statement for TC-4 to accomplish this plan. Mr. Williams advised that Dave Case, the Representative Advisory Committee (RAC) Chairman, has organized a special RAC session, entitled "Testing and RF Hazards" for the Washington DC symposium. Russ Carstensen, Executive Director of NARTE, discussed the MOU between his organization and the EMCS. Basically, NARTE wishes to formalize its relationship with the IEEE EMCS such that the EMCS is the official "body of knowledge" for technical matters relating to EMC. The Board requested some changes be made to the document, including a request that the document also be reviewed by legal counsel (including IEEE lawyers) before it is brought before the Board in August. President Butler requested that Mr. Williams and Mr. Carstensen clarify some of the issues regarding the NARTE exam questions raised at the meeting. Mr. Williams reported that the effort with the NANO Technology Council is evolving slowy, but progress will continue to be monitored. Mr. Williams closed his report by briefing reviewing the budget of the Vice-Presidency of Technical Services.

Old Business

Regarding the IEEE Sensors Council, Mr. Podgorski advised that they have reached a formal agreement. He will present a report on this via an article in the Newsletter (see page 12 of this Newsletter).

New Business

Regarding the Brugge conference, Mr. Butler informally polled the Board to see who was planning to attend this conference. In Focus Corporation has been approached for a donation of an LCD projector for Board activities. Mr. Butler would like to see the Board have access to this technology for meetings and chapter activities. Mr. Butler advised that there is an IEEE Region 8 and Division I and IV Chapter Chairs meeting in Paris, France on October 1, 2000. Regarding Awards, Mr. Benitez presented the slate of potential award recipients. The Board will electronically vote upon the slates presented. Regarding the spring Board meeting for 2001, Mr. Hoolihan suggested holding the meeting in Minneapolis so that the Board could tour the 2002 symposium facilities.

Action Item Review

Secretary Janet O'Neil reviewed the action items assigned during the meeting and those open from previous meetings.

There being no further business, the meeting then adjourned at 5:40 pm. EMC

Janet O'Neil
Secretary, EMC Society Board of Directors

Chapter Chatter

continued from page 11

process! It was a fun hands-on event for the chapter. Many thanks to Kalmus for providing their facility for the evening and for arranging the delicious, spicy (whew!) dinner.

Before breaking for the summer months, the Chapter elected new officers for 2000/2001. Newly elected were Janet O'Neil of ETS-Lindgren as Chairman and Pat Andre of CKC Labs as Vice-Chairman. Reelected were Stephen Stimac as Secretary and Kitty Tam of Northwest EMC as Treasurer. Outgoing Chairman Ghery Pettit of Intel was applauded for his leadership of the chapter for the past three years.

Vienna

Professor Hadrian demonstrates the shielding effectiveness of materials to members of the Vienna Chapter.

The 20 Greatest Engineering Achievements of the 20th Century

Include 13 from IEEE technologies.

1. Electrification 2. Automobile 3. Airplane 4. Safe and abundant water **5. Electronics 6. Radio and Television** 7. Agricultural Mechanization **8. Computers 9. Telephone 10. Air Conditioning and Refrigeration** 11. Interstate Highways **12. Space Exploration 13. Internet 14. Imaging Technologies** **15. Household Appliances 16. Health Technologies** 17. Petroleum and Gas Technologies **18. Laser and Fiber Optics 19. Nuclear Technologies** 20. High-Performance Materials

"If anything shines as an example of how engineering has changed the world during the 20th century, it is clearly the power that we use in our homes and businesses. What I really hoped to do was shamelessly use this occasion to remind you of the breadth, and the depth, and the importance of engineering as a whole to human existence, human progress, and human happiness."

- NEIL ARMSTRONG, Astronaut & Engineer
National Press Club, Washington, DC, 22 February 2000

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 authorís 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.

EMCABS: 01-8-200(

MICROWAVE TESTING OF A COMPUTER: A REPRESENTATIVE EXAMPLE OF THE SUSCEPTIBITY OF COMMERCIAl SYSTEM

Seow, T S*, Yeo, P C*, Jansson, L**, Backstrom, M**
* DSO National Laboratories, Singapore
** FOA Defence Research Establishment, Sweden

Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.14

Abstract: The paper describes the Low Power Microwave Test Methodology and the test result of microwave susceptibility measurement on commercial PCs. In this research, we carried out two types of measurement on the PC. They are as follows: Shielding Effectiveness (SE) of the PC in Reverberation Chamber and Low Power Microwave (LPM) Susceptibility Testing. For the SE measurement of the PC, it was performed in the FOA'S Reverberation Chamber. The chamber size is 5.1 m x 2.46 m x 3 m. The Reverberation Chamber consists of two stirrers, one rotating vertically and the other horizontally. The field inside the computer was measured using two short monopole probes of length 4 mm. Such probe is constructed from a semi-rigid cable with the inner conductor exposed at the end. In the LPM susceptibility testing, the PC was broken down into seven sub-systems. Each subsystem was tested using the same test parameters (E-field = 100/200 V/m, CW, Horizontal and Vertical Polarization). The objective of this measurement is to determine the PC sub-systems under microwave radiation. Preliminary investigation has shown that most of the sub-systems were more susceptible to low frequency than high frequency microwave radiation. It was also observed that field level of 200 V/m was unable to damage the PC (only caused degradation). The most susceptible sub-system was the Video Monitor and least susceptible was the Hard Disk.

Index terms: Microwave susceptibility, shielding effectiveness, reverberation chamber.

EMCABS: 02-8-2000

RADIATED EMP SUSCEPTIBILITY TESTING OF COTS ELECTRONICS

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* Defense Threat Reduction Agency, USA
** JAYCOR, USA
*** Defense Threat Reduction Agency,

Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.19

Abstract: There is a requirement to use commercial electronics in United States military systems to the extent practical. As a consequence, commercial electronics are finding their way onto the modern battlefield. In addition, critical civilian infrastructure systems are becoming more reliant on electronic components. Thus, in both the commercial and military sectors, there is increasing interest in the capability of Commercial-Off-The-Shelf (COTS) electronics to operate during and after exposure to high-altitude electromagnetic pulse (HEMP) environments. The capability of modern commercial electronics to operate through HEMP environments is largely unknown. Therefore, the Defense Threat Reduction Agency initiated a program to test COTS subsystems and to populate an immunity data-base using the results. Several commercial electronic components, configured as operating subsystems, were exposed to simulated HEMP fields in the laboratory. Operation during and after exposure was monitored, and immunity/susceptibility levels determined. The results of this COTS equipment testing show that COTS components configured as operating subsystems have upset and damaged susceptibility levels below the peak HEMP fields that can be experienced on the battlefield. Upset was observed below 1 kV/m and damage in the range of 4 kV/m. Field coupling to interconnecting cables caused the anomalous response. Immunity levels should be considered at least a factor of 2 below the corresponding susceptibility levels. Thus, there is risk that mission functions dependent on these COTS subsystems will be degraded upon exposure to HEMP fields if the subsystems are deployed without HEMP protection.

Index terms: EMP, susceptibility, high-altitude electromagnetic pulse.

EMCABS: 03-8-2000

RADIO-FREQUENCY SUSCEPTIBILITY EXPERIMENTS USING A MODEL 5317 GTEM CELL

Coburn, W*, Berry, M* and Turner, T*
* U.S.Army Research Laboratory, USA

Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.26

Abstract: This report describes an experimental method to determine the susceptibility of an electronic system when exposed to a rectangular pulse-modulated RF carrier. Radio frequency (RF) effecrs experiments were conducted in a model 5317 gigahertz transverse electromagnetic (GTEM!) cell, supplied, installed, and certified by the Electro-Mechanics Company. The results, presented in terms of a normalized power density required to induce an adverse effect, demonstrate consistent trends in the measured susceptibility levels. The system susceptibility depends on the modulation waveform, and the measured data can be used to estimate system vulnerabilities to pulse-modulated signals. The test samples were in a powered and operational state in the GTEM! cell and exposed to pulse modulated signals with RF carrier frequencies in the range of 1 to 2 GHz. The threshold level for system susceptibility was found to depend on the pulse modulation and the RF carrier frequency. The critical modulation parameter is identified to be the pulse repetition rate to provide the optimum side-frequency components in the transmitted spectrum. To account for the experimental repeatability and uncertain engagement geometries, we include a factor of two margin (i.e., 3 dB) in the susceptibility threshold level. For pulse-modulated signals, we find that this system is susceptible when exposed to sufficient average power density. The results can be used to establish an upper bound on the HPM susceptibility of this electronic system. (GTEM! is a registered trademark of the Electro-Mechanics Company.)

Index terms: RF susceptibility, GTEM cell, pulse modulated signal.

EMCABS: 04-8-2000

GENERAL TRANSMISSION-LINE MODEL OF SHIELDED CABLES: APPLICATION TO EM COUPLING AND EM EMISSION

Parmantier, J P*, Issac, F*, Bertyikm, S* and Boulay, F*
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Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.32

Abstract: To represent EM coupling on shielded cables it is common to introduce the concept of transfer impedance and transfer admittance. Generally, the derivation of the coupling response of a shielded cable is performed in two steps, solving two problems separately. First, the response of the shield is determined by calculating external currents and external voltages. Then, they are used to derive the distributed equivalent voltage generators, and current generators, on the inner wires. The expression of those generators is fully correct but the decomposition in two independent domains requires an important assumption that may be easily forgotten: the shield must be short-circuited at both ends. However, in the general case, the connecrions of the shields at the ends determine the performance of the shielding. Therefore, the knowledge of the equivalent generators is not sufficient and mutual coupling terms between the shields and the inner wires may become more relevant than the transfer parameters through the shields. The objective of the talk is to present a general model of a multi-shield/multi-conductor cable enabling one to account for EM coupling and EM emission at the same time, whatever the connections at the ends of the shields are. Such a model has been already applied at ONERA for a long time and is still improved but up to now, we did not have the opportunity to devote a paper to demonstrate all its advantages.

Index terms: Shielded cable, multi-conductor transmission line, EM coupling, EM emission.

EMCABS: 05-8-2000

NONUNIFORM TRANSMISSION LINES AND A STATISTICAL ANALYSIS OF CABLE HARNESS

Steinmetz, T* and Nitsch, J*
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Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.32

Abstract: Modern complex systems like cars or aircraft contain miles of cables. These cables connect various electrical sensors and actors that work on a low energetic level. Knowledge of the electromagnetic behavior of such a system already in the design phase would help to ensure the electromagnetic compatibility of the entire system. If the disturbances on the cables are known, then the separate circuits of the system could appropriately be hardened. An effective method to treat such problems is the electromagnetic topology in conjunction with the transmission line theory. However, in real systems the cable geometry often does not meet the basic assumptions of the transmission line theory. In many cases the cables are non-uniform lines. Therefore a method is presenred which allows one to treat non-uniform lines in a network code. This method is based on the product integral, which is the solution of a system of ordinary linear differential equations with non-constant coefficients. Many calculations of randomly generated tube geometries have to be completed to estimate maximum and minimal bounds for the scattering or propagation parameters. The disturbances on the cables of the system can roughly be estimated wirh these results. Also a calculation of the statistical distribution of the disturbances on the cables is possible using the resulting scattering or propagation parameters of the randomly generated tubes in the BLT-equation.

Index terms: Non-uniform transmission line, electromagnetic disturbances, cable harness, statistical analysis.

EMCABS: 06-8-2000

AN OPTICAL APPROACH TO DETERMINE THE STATISTICAL FEATURES OF THE FIELD DISTRIBUTION IN MODE STIRRED REVERBERATION CHAMBER

Baranowki, S*, Kone, L* and Demoulin, B*
*Universite des Sciences et Technologies de Lille, France

Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.57

Abstract: Mode stirred reverberation chambers are suitable tools for electromagnetic compatibility measurements, especially to carry out immunity tests and radiated field measurements. Theoretical simulation of the field distribution inside these oversized cavities are today considered, in order to improve the mode stirred methods and to characterize the electromagnetic coupling phenomena introduced by the devices under test. At high frequency range, we can consider that the sizes of the reverberation chamber are large compared to the wavelength. In these conditions an optical approach may be used to predict the field distribution in the room. Then, the electromagnetic field at any point within the cavity may be considered as the sum of the incident wave merging from the source antenna and the multiple reflections occurring on the walls of the room. Paths and amplitude of the reflected waves are equivalent to the radiation of N shifted images of the antenna source weighted by the reflection parameters of the walls. Due to the high conductivity of the walls, the reflection parameters are closed to one, then a too large number of images is required to reach a numerical convergence. However, the model aimed in this paper not to find exactly the field amplitude in the room, but rather to test the efficiency of the mode stirred methods. The proposed simulation will consist in using the statistical feature of the field distribution.

Index terms: Reverberation chamber, mode stirred method, field distribution, statistical simulation.

EMCABS: 07-8-2000

FDTD COMPUTATION MODELING FOR ELECTROMAGNETIC FIELDS DUE TO ELECTROSTATIC DISCHARGE BETWEEN CHARGED METALS

Fujiwara, O*
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Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.58

Abstract: The electromagnetic fields due to electrostatic discharge (ESD) between charged metals have wide-band frequency spectra up to the microwave region, which often give a fatal shock to high-tech information devices. Such electromagnetic interference is known to be significantly affected by the metals, whereas the effect is not being well understood. In this paper a FDTD (finite-difference time-domain) modeling was investigated to compute the ESD fields in conjunction with a spark current and a

spark voltage both theoretically derived from the Rompe-Weizel spark resistance formula. The effect of the metal on rhe ESD fields was numerically examined with respect to their size. Comparison was made between the FDTD computation and the analysis based on the previously proposed dipole model. A simple experiment by the spark between metal balls was also conducted to validate the computation modeling.

Index terms: Metal, electrostatic discharge, spark-resistance formula, FDTD modeling.

EMCABS: 08-8-2000

TIME-DOMAIN COUPLING RESPONSES FOR CROSSING TRANSMISSION LINES

Kami, Yoshio*

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Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.58

Abstract: A model of two transmission lines of different heights crossing each other is seen in various line systems such as communication lines, power lines, multi-layer printed circuit boards, etc. In digital circuit boards, crosstalk is a serious topic according as working voltage becomes low. Coupling or crosstalk between two transmission lines of finite length crossing at right angles is investigated in time domain. The time-domain coupling voltages are measured under some conditions and then the coupling mechanism are studied from the experimental results. We consider a system of two transmission lines crossing each other at right angles; two thin wire lines are set at different heights above a ground plane of aluminum. Two lines are assumed to be inherently of transverse electromagnetic (TEM) mode. The coupling of non-parallel transmission lines has been studied on a basis of circuit concept. There are essentially two coupling mechanism, i.e., electric- and magnetic-field couplings caused by TEM fields and those by currents on risers supporting the wire line of finite-length transmission line.

Index terms: Crossing transmission lines, time-domain response, measurement, coupling mechanism.

EMCABS: 09-8-2000

COMPACT SENSORS FOR TIME-DOMAIN MEASUREMENTS

Tyo,S* and Buchenauer, J**

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**Los Alamos National Labs NIS-9, USA

Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.66

Abstract: High-quality measurements of ultra-wideband (UWB) electromagnetic fields are difficult to make because of the limited bandwidth of sensors, transmission channels, and measurement devices. Numerous techniques have been developed to deconvolve the response of the measurement system in order to accurately reconstruct the incident signal. A number of sensors have been introduced that utilize loaded and unloaded monopole and TEM horn antennas in order to achieve a flat impulse response over a reasonable frequency range. In contrast to frequency-domain processing, where temporal signals are converted to the Fourier domain for deconvolution before being converted back to the time domain for presentation, true time-domain processing involves no Fourier processing. In this paper techniques are presented that have been designed to be used strictly in the time domain, and the benefits and limitations are discussed.

Index terms: Ultra-wideband electromagnetic fields, time-domain measurement, sensor, deconvolution.

EMCABS:10-8-2000

COMPARISON BETWEEN SAR DISTRIBUTIONS INSIDE LOSSY DIELECTRIC MATERIAL RADIATED BY A STRAIGHT DIPOLE AND A HELICAL ANTENNA

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Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.73

Abstract: In the present contribution we show the results obtained evaluating the SAR distribution inside a dielectric cube, placed in the near field of a straight dipole and a normal mode helical antenna of dimensions typical of the commonly used radiating structures in cellular phones, at the operating frequency of 1710 MHz. A hybrid Method MoMTD/FDTD was applied to solve the electromagneric problem; in particular the radiating antennas are studied by MoM and the field inside a complex penetrable object is evaluated by FDTD. Concerning the SAR distributions inside the cube, we can observe that, as expected, for the case of the helix it is concentrated in a region smaller than that of the straight dipole case. The maximum value of SAR (normalized to 1W of radiated power) we found inside the cube for dipole antenna is SARmaxA=13.38 W/Kg. For the helix we found SARmaxB=6.58W/Kg that is lower than that obtained for the straight dipole.

Index terms: Cellular phone, SAR, straight dipole, helical antenna, MoM/FDTD method.

EMCABS: 11-8-2000

CONTRIBUTION OF EARTHING CONDUCTORS TO CURRENT REDUCTION FACTOR OF THREE-CORE CABLE LINE

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Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.85

Abstract: Earthing conductors are often laid together with cables in the same cable trench. Cable sheets and earthing conductors represent a system of passive conductors. They are mostly connected to the earthing grid of incidental substations in making a common earthing system. In case of phase-to-ground short circuit, fault currents in the earthing system as well as through the ground occur. These currents are a consequence of both electromagnetic coupling and potential of earthing grid. Currents caused by electromagnetic coupling in the system of passive conductors may be represented by an adequate current reduction factor. This reduction factor has an important role at solving numerous tasks from the EMC area. This paper shows calculation of the current reduction factor of a three-core cable line and arbitrary number of earthing conductors laid in a common cable trench. An adequate mathematical model is presented. A quasi-steady-state treatment is used because it deals with sinus alternate values. Geophysical features of the cable route are taken into account. An appertaining equation system in a matrix form is derived, by which current and voltage state in the system of passive conductors is described.

Index terms: Earthing conductors, three-core cable line, cutrent reduction factor, quasi-steady-state analysis.

EMCABS: 12-8-2000

HIGH FREQUENCY ELECTROMAGNETIC FIELD COUPLING TO UNIFORM AND NONUNIFORM LINES: AN ASYMPTOTIC APPROACH

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Book of Abstracts, EUROEM 2000 Euro Electromagnetics, Edinburgh, Scotland, May 30-June 2, 2000, P.85

Abstract: The necessity to analyze the interaction of high-frequency electromagnetic field with transmission lines arises in many problems of electromagnetic compatibility. To solve such problem, the transmission line (TL) approximation is not applicable for rhe general case of a finite line. Additionally, the presence of non-uniformities, such as line bends, makes the use of the TL approximation more questionable. Therefore, the solution of the problem is found in general by solving numerically the Pocklington's equation. We propose in this study an asymptotic approach, which is based on the fact that in the regions of the wire sufficiently far from non-uniformities (such as terminal loads, line bends, etc.), the influence of the currents in these parts is negligible. Using this approach, it is possible to express analytically the induced current along the asymptotic region of the line as the sum of three terms: a forced-response wave which corresponds to the solution of nonhomogeneous Pocklington's equation for the case of an infinitely long wire, and two positive and negative traveling waves (with unknown coefficients) corresponding to the solution of the homogeneous Pocklington's equation.

Index terms: Transmission lines, coupling, Pocklington's equation, asymptotic analysis.

Calendar

EMC Related Conferences & Symposia

2000

September 11-15
EUROPEAN EMC SYMPOSIUM
(formerly EMC ROMA)
Brugge, Belgium
Prof. Johan Catrysse
Fax: (059) 70.42.15
e-mail: *johan.catrysse@kh.khbo.be*
http://www.ti.kviv.be/conf/emc2000.htm

October 4-6
Presented by US West and
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Michael Hatfield
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October 17-20
Co-Sponsored by the IEEE
MILLENIUM WORKSHOP ON
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Creta Maris Hotel
Heraklion, Crete, Greece
Prof. Peter Stavroulakis, General
Program Chair
Fax: +30.1.6532910
millenium@ariadne-t.gr
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October 23
Sponsored by the Eastern North
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A ONE DAY EXHIBITION AND
TUTORIAL ON "THE
FUNDAMENTALS OF EMC"
by Dr. Clayton R. Paul
The Radisson Governors Inn
Research Triangle Park, NC
Jim Marley, 919.549.1408
james.r.marley@us.ul.com

2001

February 20-22
Sponsored by the Swiss Electrotechnical
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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 Bob Hofmann 630.979.3627

IEEE EMC Society Board of Directors Meetings

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

November 16, 2000
Tampa Bay, Florida

February 23, 2001
Zurich, Switzerland

http://www.emcs.org

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