Blockbuster Denver Symposium Issue!

IEEE EMC SOCIETY

N E W S L E T T E R

ISSUE NO. 179 FALL 1998 (ISSN 0164-7644) JANET O'NEIL, Edi

Past Presidents of the EMC Society

Photo by Dick Ford

Four Decades of EMC Society Presidents Attend IEEE EMC Symposium in Denver. Seated L-R: Don Clark (1988-89), Len Carlson (1986-87), Ed Bronaugh (1990-91), Gene Cory (1974-75), Bill Gjertson (1996-97), Ralph Showers (1960-61). Standing L-R: Dan Hoolihan (1998-99), Warren Kesselman (1994-95), Bob Hofmann (1992-93), Don Heirman (1980-81), Bill Duff (1982-83), Dick Schulz (1968).

The EMC Society will celebrate its 50th Anniversary in the year 2007. That may seem like a long way off, but the Board of Directors is already making plans to celebrate this occasion in a grand way. Those largely responsible for the attainment of a milestone such as this are the presidents of the EMC Society, especially past presidents Ralph Showers and Dick Schulz who guided the Society during its formative years. Sadly, Dick Schulz passed away shortly after this photo was taken. Many of us will remember Dick by the warm smile shown in this photo.

In August 1983, Len Thomas and the late Jim Hill, Fellows and Life Members of the IEEE EMC Society, wrote an article on the history of the EMC Society, entitled "A Brief Review of the Origin and Growth Statistics of the IEEE EMC Society" (volume EMC-25). This article, published in the *IEEE Transactions on EMC,* notes that the foundation of the Society was laid in Los Angeles, California, at meeting of radio-frequency engineers on February 23, 1956. There were many engineers at this meeting who represented such firms as AiResearch,

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Sprague, Stoddart Aircraft Radio, Douglas Aircraft, Filtron, Lockheed, and Northrop, to name a few. The steering committee appointed to formalize the functions and aims of this group of engineers were Prentice Tinney, Al Parker, Charles Ketteman and Fred Nichols. Just one year later, on February 27, 1957, six RFI engineers got together at the Armour Conference in Chicago and discussed a plan of organization for RFI engineers.

The article notes: "A. Zimbalatti, J. Lucyk, A. Ruzgis, S. Nellis, M. Kant, and H. Schwenk were the six who asked Fred Nichols, in his luncheon talk, to announce their plans to organize a group in the New York City area." They petitioned the Institute of Radio Engineers (IIRE) to establish a professional group on radio frequency interference. From these origins, the EMC Society as we know it was born. It's doubtful that this group of engineers in 1957 would have ever dreamed about the explosion in electronics that we see today. While the growth was originally spurred by government requirements, these days the growth continues from commercial requirements. Take a moment to visit with one of the past presidents at a future IEEE EMC symposium. Their wealth of knowledge will astound you.

Janet O'Neil
Editor

Editor's Note: A complete obituary on the life and times of Richard B. Schulz will appear in the next newsletter.

DAN HOOLIHAN
PRESIDENT,
EMC SOCIETY

Tempus Fugit

Time flies, as the Romans used to say. Since the last quarterly newsletter of the EMC Society, we have had two major symposiums in the EMC World. The first was, of course, the annual get together at IEEE 1998 International Symposium on EMC held in Denver, Colorado.The second one was EMC ROMA '98 in Rome, Italy.

Every general indication that we have seen highlights the fact that the Denver Symposium was very successful. There were over 2600 participants, almost 900 fully-paid registrants, and 185 exhibitors (occupying 250 booths). The technical sessions were well attended and the poster papers were quite successful as well.

The Board of Directors had a day-long meeting the Sunday before the symposium which was very productive and attended by a number of guests.

The "Board" also traveled to Italy in September to hold a meeting at the Rome Symposium. Members of the board participated in the opening session, various workshops during the week, and an "Introduction to the EMC Society Workshop" on Friday morning. The Symposium was held at the University of Rome, which is 500 years old, and it is surrounded by some of the ancient Roman ruins which are 2000 years old. The rather new technology of EMC Engineering seemed even newer in that historical and famous environment!

Gathering at the entrance to the University of Rome, "La Sapienza", are EMCS Board members Dan Hoolihan, Todd Hubing, Janet O'Neil and Don Heirman (L- R).

The next Board of Directors meeting will be held in New Brunswick, New Jersey; near the IEEE headquarters in Piscataway. The meeting is scheduled for Saturday, November 14, and guests (especially members of the EMC Society) are welcome to attend the meeting.

We will be attending the Tokyo Symposium in May of next year and having a BoD meeting at that time. We are attempting to hold one BoD meeting outside the United States to reflect the fact that 40% of our membership comes from outside the United States.

On a sadder note, we were sorry to hear that Richard B. Schulz had passed away as a result of a car accident in Oregon. Dick was a past president of the EMC Society (1968), a past editor of the EMC Society Transactions, and an IEEE EMC Society Fellow. He attended the most recent EMC Symposium in Denver and was part of the Past Presidents photo taken after the Thursday noon awards ceremony. Dick was always a gentleman and always easy to talk to while being full of information; especially historical information on the early days of the EMC Society. He will

be missed, both personally, and collectively by many EMC Society members.

Scenes from EMC '98 Roma

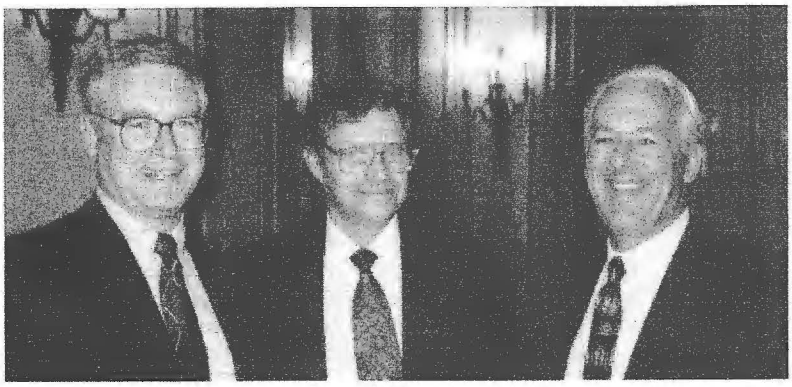

Photo by Janet O'Neil

(L-R) Dan Hoolihan of TUV Product Service caught up with Noel Sargent of the NASA Lewis Research Center and Dave Traver of Sony at the EMC '98 Roma banquet.

Photo by Janet O'Neil

Salvatore Celozzi of University of Rome "La Sapienza" and Todd Hubing of the University of Missouri-Rolla (L-R) form an interesting trio with an ancient bust at the EMC '98 Roma welcome cocktail party held at the Palazzo Barberini.

Photo by Janet O'Neil

Joe Butler (L) of Chomerics Division of Parker Hannifin, joined Bill Gjertson of Boeing and Marianne Gjertson at the EMC '98 Roma gala banquet. Bill and Marianne were intent on picking up some pointers at the Italian conference as they are Chairman of the IEEE 1999 Symposium on EMC, and Companion Events Chair, respectively.

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Scenes from EMC '98 Roma *continued*

Photo by Janet O'Neil

EMCS Board member Ferdy Mayer of LEAD is shown during his presentation at EMC '98 Roma on global EMC Society activities. Eight new IEEE EMC Society members were recruited during the conference.

Photo by Janet O'Neil

Professor D'Amore, Chairman of EMC '98 Roma, and Maria Sabrina Sarto, from the University of Rome "La Sapienza," organized an impromptu al fresco lunch for the Board during their visit to Rome.

Photo by Janet O'Neil

Dick Ford, Don Sweeney of DLS Electronic Systems, and Moto Kanda of NIST (L-R) are shown enjoying the Italian hospitality during their visit to EMC '98 Roma.

Photo by Janet O'Neil

The Board hosted a reception to informally meet the international attendees at EMC Roma '98. President Dan Hoolihan (C) discussed EMC in academia with Lorenz Jung (R) of the Technical University of Hamburg-Hasburg and Markus Petirsch (L) of the Universitat Karlsruhe.

Announcement

The United States National Committee to the IEC will host the 1999 CISPR and the TC77 meeting in San Diego, California from May 31 to June 12, 1999.

There are opportunities for manufacturers of EMC related products and services to exhibit their products to over 200 of the world's EMC experts.

Interested manufacturers may contact:
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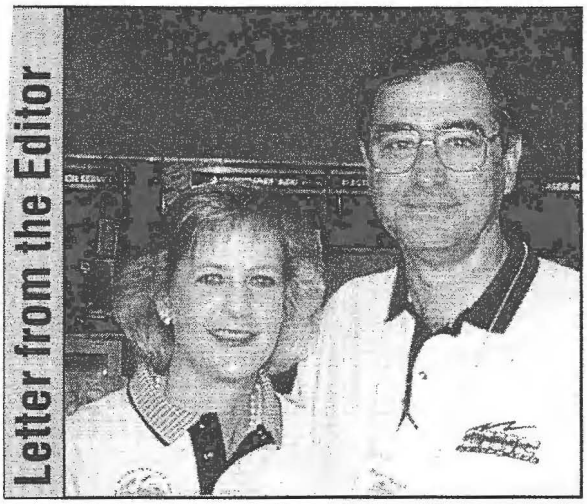
phone 760-741-3301, fax 760-741-5327
e-mail: hmertel@home.com

Letter from the Editor



Janet O'Neil, Editor, with Barry Wallen, Chairman of the IEEE 1998 International Symposium on EMC. Barry is with Criterion Technology.

BUCKING BRONCOS IN DENVER!

If you attended the IEEE 1998 International Symposium on EMC held in Denver, Colorado, you'll know that there was plenty of action in Denver! It wasn't just the bucking broncos supplying the action in Denver, but the over 2,600 people who attended the symposium. The weather in Denver was perfect during the symposium week and the symposium facilities were top notch. You'll read more about the highlights of the symposium in this newsletter. Don't miss the new article on the experiments presented in Denver by Andy Drozd. Since the experiments are becoming a "show within a show", so to speak, you'll want to know more about this increasingly popular part of the annual IEEE EMC symposia.

As I did last year at the Austin symposium, I traveled the exhibit halls, conference foyers, and social events in Denver with clipboard in hand to see what was new with our members. I picked up quite a bit of interesting news which I'd like to share with you.....

Allen Fischer of Fischer Custom Communications, missed his first symposium in years due to the arrival of his first born, daughter Emma Violet. Congratulations Allen and family!

Mike Bogusz of Nortel in Calgary, Canada, was overheard saying (and I quote), "I read the EMC Society Newsletter cover to cover!" **Bob Hofmann** was resting his weary feet one day. The day before, he climbed Mt. Maroon (14,200') in Colorado. Bob advised that he arrived early in Denver to "do some real work!" To date, Bob has scaled 50 of the 54 peaks in Colorado which are over 14,000' high. Now that's a lofty endeavor!

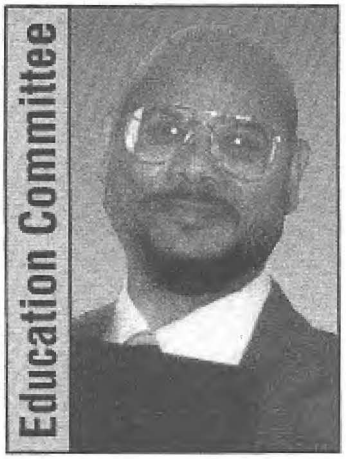
Steve Majkowski of Lucent Technologies spent two weeks prior to the symposium sightseeing. Highlights of his trip included a stop at a hotel dubbed the "Western White House" due to Teddy Roosevelt's frequent visits there when he was President. Steve also stopped to photograph Arches National Park in Utah and visited Pike's Peak. **Allan Woldow** advised that his visit to Denver was a sentimental one as he has two children who graduated with Master's degrees from the Colorado School of Mines. **Clayton Paul** looked very relaxed in Denver and no wonder, he's "retired" to a new home in Macon, Georgia where he has a four-acre fish pond. Speaking of new homes, **Scott Bennett** is building a new home near the "crowded" town of Carr, Colorado (total population is 35 people). For Brazilians, **Vanderlei Parro** and **Jose Carlos de Souza**, this was their first IEEE EMC symposium. It was hard not to miss these cosmopolitan attendees with their stylish attire. Finally, **Maria Sabrina Sarto**, a Researcher at the University of Rome, "La Sapienza", advised she had just received a Professorship at the University. She is the youngest female professor in electrical engineering in Italy.

With the EMC Society Newsletter, we have a new Associate Editor for Education.

After six years, Kimball Williams is stepping down. Maqsood Mohd, as the new Education Committee Chairman, will replace Kimball as the new Associate Editor for Education. Many thanks to Kimball for his contributions to the EMC Society Newsletter over the years.

In looking to the future, the IEEE 1999 International Symposium on EMC in Seattle, August 2-6, promises to be another great symposium. Keep in mind that in 1999 the symposium will be the FIRST week in August so plan on attending with your family. There's lots to do in Seattle and the weather is always perfect in August. The first week in August is also "Sea Fair" week which means there will also be lots of city sponsored fun activities. (It also means you need to book early for lodging and tours.) **Keep up to date with the Seattle symposium by visiting the web at http://www.seattleemc99.org**

See you there if not before!



Maqsood Mohd
ASSOCIATE EDITOR

As Kimball Williams has moved on to become the Vice President of Technical Activities, I have been entrusted with the challenging task of becoming the Chairman of the Education and Student Activities Committee. Some of you know me through the Fundamentals Workshop. I welcome you to join the Education and Student Activities Committee and help us enter into the 21st Century with well-founded EMC education. I would also like to thank Kimball Williams for leading the Education Committee during the last five years and making it a much more vibrant committee by taking on many new challenges such as the experimental demonstrations and tutorials.

Technology Literacy Counts!

Recently, I participated in an international workshop "Technological Literacy Counts!" The workshop was supported by the EMC-S. I had the opportunity to collaborate with 90 other workshop participants, engineers, and educators gathered to present suggestions and reach solutions for the enhancement of technological literacy for primary and secondary-level students worldwide. During the workshop sessions we focused on various technological literacy issues and made several recommendations. Some of the main recommendations were collaboration among engineering and education societies at all levels, provide knowledge as directly useable to educators (such as experiments, and tutorial material), and engineer-educator exchange programs. This was one of the most intensive two-day workshops I have ever attended. The recommendations are very closely related to the mission of our Committee - to present EMC education and learning materials to both the novice as well as the seasoned professional alike. (Please refer to the related article on page 13 of this newlsetter.)

Denver Symposium 1998:

The Denver Symposium for 1998 is now behind us; and it was the best yet for educating and enriching the EMC professional. The Denver Symposium Committee deserves thanks and appreciation for the job well done. At this symposium, the Education and Student Activities Committee achieved great success in several areas. In the following paragraphs I have highlighted some of the events that took place that you may find of interest.

Tutorials:

It was another landmark year for the Fundamentals Tutorials. Although the tutorials are primarily targeted for the entry level engineers in the EMC field, quite a few seasoned engineers can also enjoy brushing-up on concepts that they might not have used in a while. This year several noted experts from several organizations provided the tutorial material to help EMC concepts and to better design systems from an EMC point of view.

If attendance is any measure, the tutorials had an impressive attendance of more than 400 participants. The tutorial subcommittee is busy planning for another exciting and informative session during the Seattle Symposium. If you would like to propose a topic or a speaker for the Seattle Symposium, email your comments and ideas to mohd@eglin.af.mil.

Demonstrations:

Location, location, and location. Yes, indeed the location for experimental demonstrations during this year's symposium could not have been better. A series of EMC concepts demonstrated experimentally during the symposium was another effort by the Education and Student Activities Committee to educate the symposium attendees. For three main days of the symposium, more than 15 experts demonstrated EMC concepts that sometimes might be classified as abstract or black magic type. Many a happy souls were pleased to learn these concepts during these demonstrations. Their doubts changed into convincing beliefs.

Our thanks go to Andy Drozd and Larry Cohen for putting together the demonstration program. If you would like to demonstrate an experiment or demonstrate an EMC concept at the next symposium in Seattle, contact Andy at andro1@aol.com.

NARTE Activities:

As during the past several years, Dr. James Whalen conducted the workshop for engi-

neers and technicians who are preparing to take the National Association of Radio and Telecommunications Engineers (NARTE) examination to certify as EMC engineers and technicians. This year David Case assisted Dr. Whalen. David Case is co-chair of the NARTE subcommittee.

At the NARTE examination on Friday, 23 engineers and technicians sat for the exams. The word from NARTE is that 65% of the participants passed the exams. Our congratulations to all the successful applicants, and welcome to the ranks of certified NARTE professionals. Our thanks to Dr. James Whalen for championing the cause of "preparing for the NARTE exams," and his able co-host, David Case.

University Grant:

John Howard heads the university grant committee. This year his committee has been successful in finding a winner for this grant. The grant is provided to an institution that is on the verge of offering an EMC course. The grant money is used as seed money to start an EMC course as an established part of the curriculum in the Electrical Engineering department. The grant is open to all universities in the world. For more details contact John Howard at ???. This year's winning school is the University of Nevada at Reno.

The mission of the university grant committee is enhanced by adding the university survey tasks to its activities. The new name is the university subcommittee. If you would like to be a part of this committee, contact John Howard.

TC-7 and Student Activities:

Dr. William Croisant of TC-7 proposed a joint venture between the Education Committee and TC-7 in the form of a student design contest. The contest is to design an EMC solution as part of the design of a circuit. The details are being worked out. If you have an interest in fame and glory, then contact Bill at 217-373-7246 or email w-croisant@cecer.army.mil. This is an exciting area to be in. This effort has the potential of becoming the hallmark of how different technical committees, the industry, and the academia can work together.

Experiments Manual On-line:

Dr. Jim Drewniak is heading up this effort. The Experiment Manual published by the Education and Student Activities Committee is on the web site at: http://emclab2.ece.umr.edu/files/EMCman.pdf. If you have an Adobe Acrobat Reader, you can download the entire manual from this site. You can find it by going to the EMCS web page at http://www.emcs.org and choosing the "committees" link, then the "Education Committee" link, then the "EMC Experiments Manual" link.

Jim is looking for a volunteer who can do the follow-up work of soliciting and arranging the new experiments. If you are interested in broadening your career horizons, contact Jim or any other officers of the Education and Student Activities Committee.

Continuing Education Products:

Andy Drozd is the Chairperson of this subcommittee. This committee is an adjunct to the life-long learning committee. This committee is examining the development of products such as Introduction to Antennae, and Introduction to EMC.

Student Activities:

Mike Bogusz is the Chair of this subcommittee. The mission of this committee is to reach out and touch some students (in fact, all students). Primarily, the focus is on working with student chapters in four areas: The Awareness of EMC, Student Paper Contest, The President's Award, and the Design Contest.

Standards Education:

Dr. Vichate Ungivichian heads this committee. We are asking volunteers to join this committee or lead this committee and take it to new heights.

Education and Student Activities Officers:

Several changes occurred during the Denver Symposium. Contact any one of the following to become a part of the ongoing revolution in EMC engineering through education.

Vice Chair Andy Drozd
Chair – Student Activities Mike Bogusz
Chair – Demonstrations Andy Drozd
Vice Chair - Demonstrations Larry Cohen
Chair – Video Productions Dick Ford
Chair – University Committee John Howard
Chair – Experiments Manual II Jim Drewniak
Chair – Standards Education Vichate Ungivichian
Co-Chairs NARTE Jim Whalen, Dave Case
Chair – Nominations Bob Nelson
Secretary Bob Nelson
Chair – Life-Long Learning Kimball Williams
Chair – Continuing Education Andy Drozd

I would like to express my personal thanks and appreciation to each of these officers who tirelessly work throughout the year to bring the very best in EMC education materials, workshops, demonstrations, and tutorials to every symposium and to all the members of the EMC profession throughout the year.

Report on IEEE EMC Symposium Special Session Activities: EMC Experiment Demonstrations, From Denver To Seattle – Adding A New Dimension!

A Symposium Event Sponsored by the EMC Society Education Committee

By Andrew Drozd, Subcommittee Co-Chair on Experiment Demonstrations with Contributions by Larry Cohen

When I originally set out to prepare this article, I intended to write strictly about the Special Session demonstrations held at the Colorado Convention Center in Denver last August as part of the highly-successful 1998 IEEE International Symposium on EMC. As I began to write, I realized we had come a long way since Anaheim in 1992, the year we had seriously discussed launching this format as part of future IEEE EMC Society symposia. In retrospect, we experienced some growing pains, learned a great deal, accomplished much, and had some fun along the way. In this article then, I decided to cover a little history, a lot of perspective, highlight some of the added dimension that this session brings to our technical conferences, and provide a glimpse towards Seattle in 1999. I'll also indulge in some deserved name dropping, if you'll permit me.

Let's begin with a few perspectives. First, many of you may have noticed I was on hiatus doing other things for the past two years on behalf of the EMC Society and for my day job. In the meantime, I relinquished the responsibilities of Special Session Subcommittee Chair to Larry Cohen who readily and ably took charge, and did an excellent job to boot. Thanks Larry and the rest of the subcommittee for your continuing hard work and sacrifices!

Unfortunately, we were still amidst somewhat of an identity crisis. Something needed to be done about enhancing our visibility and defining our session's educational "spin" as part of the symposium program. Last year I decided to join forces with Larry for Denver to help achieve these goals.

I am elated to say we were successful in achieving our goals. The Special Session on EMC Experiment Demonstrations held in Denver last August was a tremendous success, in more ways than one! It was indeed an educational experience and something of a milestone considering the event's brief history.

Judging from the heavy traffic and the positive feedback from attendees in Denver, I think we definitely hit stride. This year's session was also a model to be followed for future symposia, but more on that later.

This was the sixth consecutive year that the Special Session was held under the sponsorship of the EMC Society Education Committee. This is an important milestone for several reasons. First, it is still a relatively-new format whose original purpose was not completely understood and as I said above, suffered something of an identity crisis at the beginning. We weren't sure at first if this was to be treated as an exhibit, a spin-off of the traditional technical paper sessions, or if it was to be something completely different.

I believe we have finally established something unique with the primary aim being EMC education, a goal which is in step with one of President Hoolihan's visions for promoting education throughout the EMC Society during his term. I believe the session has been achieving its fundamental EMC education goal while adding a "new dimension" to the tried and true symposium format. Credit is given to the founding fathers for their original vision. Much of the inspiration for this session is due to the ideas of Clayton Paul, Kimball Williams, Dick Ford, Henry Ott, and other veteran EMC Society members.

The session format has been embraced more widely each year as evidenced by the number of people who volunteer experiments and by the ever-growing attendance. This format provides a nice balance to the regular paper sessions, workshops, and exhibits. The session combines the features of an open-forum-type paper session, a hardware exhibit, and the dynamics of a workshop. The symposium committees have begun to recognize the importance of this session and our objectives, and have been giving the session the attention and visibility it deserves. This was especially evident in Denver as many of you who attended know.

For those unfamiliar with how this session is run, we arrange each year as part of the symposium to have available some of the most internationally recognized movers and shakers in the EMC community representing indus-

Photo by Ken Wyatt

Jack Meyer (c) demonstrates the use of "Ferrites for EMI Control".

Photo by Ken Wyatt

Jim Drewniak (far right) explains an important point during his demonstration on "Transmission Line Effects in PCB Design."

try, government, and academia. Their challenge is to demonstrate important EMC concepts through a series of interactive experiments run continuously over the three main days of the symposium. The operative word here is 'interactive', where onlookers are invited to directly participate in the experiments and ask plenty of questions. I believe this type of "hands-on" involvement is education at its finest. It's also a fun way to learn and occasionally provides a challenge or two to the presenters.

Past presenters by the way, have included: Ted Anderson, Jim Drewniak, Tom Van Doren, Dick Ford, Jasper Goedbloed, Kevin Goldsmith, Lee Hill, Todd Hubing, Mohammed Issa, Ken Javor, Tom Jerse, George Kunkel, Maqsood Mohd, Richard Mohr, Jim Muccioli, Mark Nave, John Norgard, Clayton Paul, Jose Perini, Bill Ritenour, Mike Seifert, Doug Smith, Norm Violette, Mike Violette, Don Weiner, James Whalen, and yours truly. So you can see that there is a wealth of experience, knowledge, and personality that comes into play here each year.

The experiments demonstrate EMC concepts and principles, phenomena and effects, and measurement methods - some of which invite controversy and debate (this is when it really gets interesting!). Experiments have demonstrated the effects of PC board radiation coupling; component-cable crosstalk; grounding and shielding strategies; spectral analysis techniques using test hardware; effective EMC test methods and practices; how EMC instrumentation is used to measure EMI at the device and component level; and how EMC standards play a vital role in achieving EMC as part of the measurement methodology. Fundamentally, the demonstrations are meant to show how in most cases, fairly simple test equipment and hardware can be used to study or quantify various electromagnetic phenomena and effects. The experiments vary daily and are intended for the journeyman EMC engineer as well as the experienced EMC technologist. EMC education early on in one's career is one important aspect. Promoting life-long learning is another. In any case, the constant goal of the session is one of educating our community.

Now, a little history and background. The Denver session experiments built upon the previous trials and successes of Dallas (1993), Chicago (1994), Atlanta (1995), Santa Clara (1996), and Austin (1997). Whereas 1993 was the "test drive" year, 1998 was the year we "bought the Cadillac" in terms of the session's highly-visible venue, technical content, and quality of presentations. Many thanks go to the Denver Symposium Committee (Barry Wallen, Charles Grasso, Bob Reinert, Tony O'Hara, and the rest) for giving us a spacious and attractive location in which to group the experiment stations along with receiving responsive, first-class service. Arranging for the Rocky Mountains as a backdrop was a nice touch.

Since the beginning, the experiments have been largely based on those documented in the Education Committee's "EMC Experiments Manual", Volume 1 originally compiled and reviewed by Clayton Paul and Henry Ott. Jim Drewniak of the University of Missouri-Rolla is currently compiling additional experiments for the Education Committee to generate Volume 2 of the manual.

Volume 1 can be downloaded from the web by referencing the URL ftp site address at http://emclab2.ece.umr.edu/files/EMCman.pdf.

This year, we reprised several popular experiments from the manual which were also showcased in previous years, as well as introduced a few new demonstrations. This year's experiments ran the gamut from measuring a signal's spectral properties using an oscilloscope and spectrum analyzer, to demonstrating the application of advanced infrared measurement systems for predicting corresponding electromagnetic field intensities, to challenging EMC regulatory standards using a rather novel shielded test fixture. We had a total of eighteen experiments and nineteen presenters. Several of the experiments were repeated over the course of the three days. Here's a rundown of the Denver demonstrations:

In the experiment titled "Transmission-Line Effects in PCB Design", Dr. James Drewniak of the University of Missouri-Rolla's EMC Laboratory illustrated how certain transmission-line effects such as reflection from resistive and reactive discontinuities that included parasitic interconnects, manifest themselves. Signal fan-out and distrib-

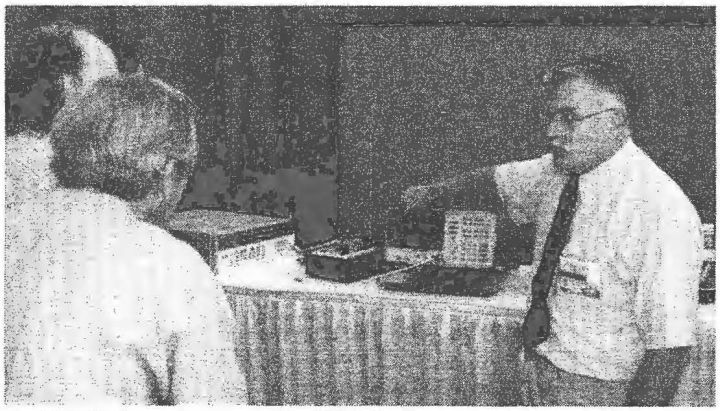


Photo by Ken Wyatt

Art Light is shown demonstrating "EMI Effects of Spread Spectrum Signals."

uted (reflection) versus lumped (ringing) effects were also demonstrated. Methods for developing equivalent circuit models and estimating the values of the parasitic parameters were shown.

The demonstration "EMI Effects of Spread Spectrum Signals" by Arthur Light of ITT Industries, Alexandria, VA showed the forms of spread spectrum (SS) transmissions and their effects in the electromagnetic environment. The demonstration also showed the apparent reduction of peak power by spreading the energy across a much larger frequency band for direct sequence spread spectrum (DSDD) and for frequency hopping spread spectrum (FHSS) signals.

Additionally, it demonstrated the increased potential for causing interference because of the much higher frequency occupancy. The demonstration then illustrated the differences in the types of interference caused by the two forms of SS transmissions.

In the experiment titled "Demonstrating Parasitics in Passive Components in a Line Impedance Stabilization Network (LISN)", Dr. James Whalen of the State University of New York at Buffalo showed how a spectrum analyzer and tracking generator were used to measure and display two insertion losses: (1) the insertion loss between the Equipment Under Test (EUT) and the spectrum analyzer used to measure the EUT noise voltage caused by the conducted emission current on the phase line; and (2) the insertion loss between the power grid and the spectrum analyzer used to measure the noise voltage caused by the power grid conducted emission current on the neutral line. Ideally, the former insertion loss should be 0dB which the measurements showed was nearly the case. The measurements indicated that the actual response was far from ideal with noticeable resonances and much lower attenuation characteristics observed. Professor Whalen also showed the results of computer simulations for an ideal LISN without parasitics and for a LISN with parasitics using PSPICE Evaluation Version 7.0. Some, but not all, of the observed behavior could be accounted for in the simulation. Dr. Whalen invited those who witnessed the demonstration and who have suggestions regarding the differences to email him at jjw@eng.buffalo.edu.

Photo by Ken Wyatt

Ken Javor enjoys a break during his demonstration "Rationale for Changing Conducted Emission Limits", or more appropriately titled, "A Better Way to Control Conducted Emissions?"

In "Barkhausen Effects", Dr. Theodore R. Anderson of the Naval Undersea Warfare Center Division Newport gave an experimental demonstration of this so-called effect by enabling the observer to actually hear the clicks produced by microscopic magnetic domain realignment from a loudspeaker. The Barkhausen EMI noise comes from sudden domain realignments brought about by an externally-changing magnetic field which cause inductive "kicks" in a coil connected to an amplifier and loudspeaker. Controlling Barkhausen noise is important for reducing noise in magnetic heads.

Photo by Ken Wyatt

It's standing room only near Bill Ritenour's demonstration on "Testing for Compliance to EN61000-4-2 (1995 - ESD)". Bill is shown on the far left.

The experiment "Surge Effects and Transient Suppression Techniques" demonstrated by Dr. J. L. Norman Violette of Voilette Engineering Corporation and Mike Violette reviewed surge phenomena and protection techniques. Lightning and AC power load anomalies create destructive surge energies that can harm equipment, if not properly protected. Several examples of surge coupling and prediction were presented, along with a live demonstration of the effects of surge energies on typical components (ka-boom! per the presenters). Protection techniques were demonstrated that included MOVs, filters, and hybrid suppressor arrangements.

In "Current Probe Demonstrations Including Phase Measurements", Doug C. Smith of Auspex Systems in Santa Clara, CA demonstrated both how current probes work and some interesting uses for them. One experiment showed how to extend the flat portion of a probe's frequency response to lower frequencies by terminating the probe with a lower resistance than for which it was designed. Other experiments showed relative phase measurements using a pair of matched probes.

"Ferrites for EMI Control" by Jack Meyer of Anteon Corporation in Fairfax, VA showed a simple method of measuring EMI voltages and currents inside an EUT.

Also shown were the advantages and potential problems of using ferrites to reduce conducted EMI problems. The test setup used a 2 MHz RF signal generator as a source of simulated EMI on a cable going through the EUT to a ground on the other side. An oscilloscope connected to a current probe and a high pass voltage probe were used to measure the resulting RF current and voltage inside the EUT. In one part of the demonstration, two physically identical, but electrically different ferrites were placed be-

Photo by Ken Wyatt

Doug Smith (R) reviews the finer points during "Current Probe Demonstrations Including Phase Measurements."

tween the source and the EUT to show the difference in reduction of EMI current and voltage inside the EUT, resulting from the frequency responses of the two different types of ferrite materials. In the second part of the demonstration, a ferrite was placed between the EUT and the point where the cable was grounded.

To the surprise of many, the current inside the EUT decreased just as before, but the voltage increased. The reason for this is that the increased impedance to ground caused more voltage to drop across the ferrite. One of Jack's closing statements was that if one puts a ferrite on a cable and the EMI at the EUT worsens, then it probably means that the ferrite was placed on the ground side of the EUT, rather than on the source side, and that the EMI problem inside the EUT is caused by high impedance or voltage coupling rather than by magnetic field or current coupling.

In "ESD Effects on Timing Circuits", Ahmad M. Fallah of Phoenix International Inc. and Dr. Bob Nelson of North Dakota State University in Fargo, ND examined the effect of ESD on a timing circuit. In the first case, an unprotected timing circuit was subjected to an ESD event. The performance and recovery of the circuit from the stresses caused by the ESD were then investigated. Next, a number of ESD countermeasures were added to the circuit to prevent and/or minimize the effect of the overstress on the circuit. In each case, the performance and recovery of the circuit was re-evaluated, thus illustrating the beneficial effects of using various ESD protection devices.

The experiment "Clock Separation as a Method of EMI Reduction" by Donald R. Bush of dBi Corporation in Winchester, KY showed that by slightly varying clock frequencies, one can reduce emissions from a product by 6 or more dB. If the clocks are varied by an amount that exceeds the receiver bandwidth of the measurement instrument, this will usually be the case.

In " Demonstration of Magnetic Field Shielding Techniques", Dr. Tom Van Doren of the University of Missouri-Rolla's EMC Laboratory explained and demonstrated the following shielding techniques: (1) self shielding produced by the signal current location, as in a twisted pair; (2) flux shunting using a high-permeability magnetic material; and (3) generating an opposing flux using induced eddy currents.

In "Rationale for Changing Conducted Emission Limits" or more appropriately titled "A Better Way to Control Conducted Emissions?", Ken Javor of EMC Compliance in Huntsville, AL demonstrated that radios (the victim protected by conducted emissions limits) are much more sensitive to common mode than to differential mode noise. Present practice is to measure vector sums and differences of these two noise types at each LISN port, and impose the same limit, regardless of noise type. Ken's experiment demonstrated a technique for separating the different modes, and showed that a limit for differential mode noise can be relaxed 20 dB from the limit for common mode noise.

Incidentally, Ken will be publishing an article on this subject which is anticipated for the Winter edition of the newsletter. Look for it as Ken's findings have significant implications to current industry product EMC compliance issues.

In "Crosstalk Between Parallel Current Loops", Pierre Beeckman of Philips Research Laboratories in Eindhoven, The Netherlands demonstrated an original experiment documented in a book on EMC written by our friend and colleague, Jasper Goedbloed. This experiment demonstrated that crosstalk between parallel current loops is a consequence of both the electric and magnetic field coupling between these loops. The experiment also demonstrated that: the load conditions in the loops determine the electric and magnetic field contributions to the crosstalk; near-end crosstalk effects, i.e. only crosstalk at the end near to the generator occurs when the loops are terminated in their characteristic impedance; the amount of crosstalk depends on the distance between the parallel loops, and may be reduced by an intermediate loop; unwanted resonance effects may occur when the electrical length of the intermediate loop is a fraction of the wavelength of the applied signal; and that grounding of a screen (shield) at only one end may lead to an increase in crosstalk.

The experiment "A Demonstration of How Electrostatic Discharge is Generated" by Dr. Maqsood Mohd of Sverdrup Technology at Eglin AFB, FL focused on the concepts of electrostatic materials and their charge development. The demonstration used a capacitor technique to store the charge and allow it to discharge through the air. The charge is developed sufficiently high to breakdown the air at a small area of a conductor. Finally, the experiment demonstrated the relationship between the accumulated charge and the area of accumulation for discharge to occur.

T. J. (Bill) Ritenour of EMC Compliance LLC in Boulder CO, demonstrated "Testing for Compliance to EN61000- 4-2 [1995] (ESD)." Bill showed what equipment is needed to conduct this test and how it is used in the mea-

surement procedure to verify compliance to the specified limits.

John Norgard of the University of Colorado at Colorado Springs demonstrated two separate experiments titled "Parasitic Effects in Circuit Elements" (based on an experiment originally devised by Clayton Paul) and "Infrared Images of Electromagnetic Fields (Aperture Coupling into a Cylinder)". The former demonstrated how the filtering effectiveness of capacitors can dramatically change as a function of lead lengths due to parasitic behavior at high frequencies. The latter experiment (developed in conjunction with Michael Seifert of the Air Force Research Laboratory, Rome Site) demonstrated an advanced test technique and fixture which establishes a relationship between infrared measured quantities and corresponding electromagnetic field intensities.

In "Spectrum of Non-Sinusoidal Signals," Dr. Jose Perini, professor emeritus of Syracuse University NY, demonstrated how changing waveform parameters such as duty cycle, pulsewidth, and risetime can drastically affect a signal's frequency spectrum. In this demonstration, a spectrum analyzer was used to display the spectra of several different non-sinusoidal waveforms. Displayed results were compared with computed results. The non-sinusoidal signals studied were: rectangular pulse, trapezoidal pulse, an AM modulated signal, and a phase (or frequency) modulated signal. It was shown that the rectangular pulse has a sinx/x spectral form. It was shown that by varying the duty cycle to 1/2, all the even harmonics are zero. For a duty cycle of 1/3, every third harmonic is zero, and so on. For the trapezoidal pulse with the same rise and fall times, the 20 dB/octave and 40 dB/octave breakpoints were shown. In the case of the AM modulated signal, both sidebands appeared and changed in amplitude as a function of the modulation index. For the phase (or frequency) modulated signal, the equation for the sidebands was shown along with a plot of the Bessel functions. It was shown that by changing the frequency deviation, the carrier signal completely disappears at the zeros of Jo (deviation). By changing the modulation frequency it is possible to see that the phase modulation signal requires a variable bandwidth.

Randal Vaughn of Motorola in Arlington, IL in conjunction with Lee Hill of Silent Solutions in Hollis, NH demonstrated the experiment "Clock Frequencies, Duty Cycle, and Low Pass Filtering". This was actually a series of experiments which showed the effect of high-frequency current paths, inductance, and gaps in PCB ground planes; and shield terminations, radiated emissions, common mode-current and pigtails.

Finally, Michael O. Hatfield of the Naval Surface Warfare Center Dahlgren Division demonstrated an experiment using a miniature mode stirred chamber.

The chamber was constructed with a partial screened glass front to allow one to visualize the mode-stirring process. This involved exciting three orthogonally-oriented, six-inch florescent tubes. The "dark bands" that traveled the length of the tubes showed the stirring of the modes. Random polarization was demonstrated when all three orthogonal tubes lit up.

Photo by Ken Wyatt

All eyes are on Jose Perini (far right) during his demonstration on "Spectrum of Non-Sinusoidal Signals."

As I mentioned at the beginning, I considered the level of support and cooperation for this year's event to be a model for future symposia. The Denver symposium committee clearly appreciated the importance of this session and supported our planning efforts from the very beginning. Our appreciation also goes out to each of the presenters for a job very well done.

We also owe a debt of gratitude to many supporters behind the scenes, in particular, the individuals and companies who worked very hard to get us state-of-the-art test equipment and materials to support the experiments.

These included all of the oscilloscopes, spectrum and network analyzers, function generators, meters and probes, etc. that many of you saw set-up at the experiment stations. I cannot conclude this article without expressing thanks specifically to the following people for their help in getting us the equipment we needed:

Hewlett-Packard:

Jan Brown and Dennis Handlon of Santa Rosa, CA; Ken Wyatt and Barbara Martin of Colorado Springs, CO; Kevin McMenamin of Baltimore, MD; Merrilee McMurray, Support Administrator, T&M Consignment Hub.

Tektronix, Rohde & Schwartz, and Advantest:

Mark Klein of Albany, NY; Tabb Warsinske of Denver, CO; Henry Benitez, Cliff Morgan and Peggy Rogers of Beaverton, OR.

Fluke Corporation

Hilton Hammond and Irene Geyer of Everett, WA.

Because of their efforts, it was a win-win situation overall. We not only gained an appreciation for their equipments' capabilities, but also saw how the equipment is used to perform EMC-type measurements. I again encourage you to contact these individuals for guidance in the selection of EMC test equipment for your needs. They are a group of true professionals who know their hardware and who are willing to work with you.

This brings me to next year's Special Session in Seattle and some closing comments. We have already begun planning the session and have a partial list of experiments tentatively lined up. We plan to expand the number of experiments to as many as 26 or so with up to 6 experiments each in the morning and afternoon of the three days. If you have ideas for an experiment and want to have it considered, please feel free to contact Larry Cohen [(202) 404-7726, cohen@radar.nrl.navy.mil] or me [(315) 337-4396, andro1@aol.com] to discuss your ideas. Also, periodically visit the official Seattle 1999 IEEE International Symposium on EMC web site to find out more about the upcoming conference and session agendas. The site will also provide a list of experiment topics being considered. We look forward to your input.

Thanks for your time! Next stop - Seattle!!

Editor's Note: Many thanks to Ken Wyatt of Hewlett-Packard in Colorado Springs, CO for supplying the photos of the experiments to accompany this article.

Engineers and Educators Collaborate to Reach Solutions for Technological Literacy Enhancements

by Arthur Winston

BALTIMORE, MD, October 14, 1998 - One hundred engineers and educators gathered on October 9-10, 1998, at the Harbor Court Hotel, in Baltimore, MD to collaborate and reach solutions for the enhancements of technological literacy for primary- and secondary-level students worldwide. The educators and engineers were part of the Technological Literacy Counts! (TLC) workshop sponsored by the IEEE (The Institute of Electrical and Electronics Engineers, Inc.).

The delegates represented a cross section of math, science, and technology teachers; school administrators; curriculum developers; practicing engineers and other engineering professionals; technological literacy advocates; and community leaders from the United States and other countries. During the workshop sessions, the delegates focused on the following technological literacy issues:

- definition of technological literacy
- the processes involved in technological learning
- the effects of technological changes on the society
- the initiatives necessary to promote technological literacy

"When we began organizing this workshop, we knew that we wouldn't be able to solve the issue of technological literacy in one sitting," says Arthur Winston, Ph.D., Vice President of IEEE Educational Activities. "Our goal in bringing these individuals together, was to put the issue on the table, let them discuss it, present their suggestions and solutions, so a global TLC network can be established."

The objective of this workshop was to open communication lines between engineers and teachers for a high-quality primary and secondary math, science, and technology education. "We hope that these 100 people will go back to their communities and convey the message about the importance of technological literacy for the future of our society," adds Dr. Winston.

The TLC workshop is designed to serve as a forerunner for future events related to the issue of technological literacy. For more information on how to become involved in promoting technological literacy among pre-college students, please contact Barbara Coburn, IEEE Educational Activities, 445 Hoes Lane, Piscataway, NJ 08854; Phone: 732.562.5498; Fax: 732.981.1686; E-mail: b.coburn@ieee.org.

This workshop was supported by Baltimore Gas and Electric Company; Ford Motor Company; S.U.N.Y. Binghamton; University of Texas at Austin; IEEE Educational Activities Board; IEEE Regional Activities Board; IEEE United States Activities; IEEE Foundation; and the following IEEE Societies: Communications Society; Education Society; Electromagnetic Compatibility Society; Electron Devices Society; Engineering in Medicine and Biology Society; Power Electronics Society; Power Engineering Society; Systems, Man and Cybernetics Society; Ultrasonics, Ferroelectrics Society; and Vehicular Technology Society.

The IEEE is the world's largest technical professional society, serving the interests of more than 320,000 members in the information and electrotechnology communities in approximately 150 countries. In keeping with its "Networking the World" slogan, the IEEE helps to foster technological innovation, enable members' careers and promote community worldwide.

Arthur Winston is the IEEE Vice President for Educational Activities, as well as a Fellow of the IEEE. He completed his undergraduate work at the University of Toronto, Toronto, Canada and received his Ph.D. from MIT, Cambridge, Massachusetts. He is the Senior Associate Director of the Gordon Institute of the Graduate School of Arts and Sciences, Tufts University, Boston, MA. He is a Research Professor, Electrical Engineering and Computer Science at Tufts. Dr. Winston received the IEEE Educational Activities Board Major Educational Innovation Award based on his work in developing and establishing the Gordon Institute program.

TODD HUBING
ASSOCIATE EDITOR

You know how sometimes your mind wanders and it's hard to focus so you jump from one idea to another and you can't seem to complete a thought so you have to ... um.... I'm having one of those days, so this column is kind of a hodge-podge of thoughts and observations.

The 1998 IEEE EMC Symposium in Denver was incredible. There were more than 2600 attendees, yet everything appeared to run very smoothly. Barry Wallen and his committee put on a great show and the technical program was excellent. If you were unable to attend, but you are a member of the IEEE EMC Society, you will get a copy of the two-volume symposium record in the mail. Be sure to review it. There's a lot of exciting progress being made that is (or should be) affecting the way EMC engineers do business.

I also had an opportunity to attend EMC'98 in Rome, Italy this year. This was another excellent technical meeting. Professor D'Amore and his colleagues at the University of Rome "La Sapienza" and the University of L'Aquila did a great job of organizing this symposium. There is a lot of good work being done in Italy and throughout Europe, particularly in the area of computer modeling techniques applied to EMC problems.

Limericks! Have you noticed that most limericks are about sex? Have you noticed that sex is incredibly popular around the world? We can only conclude that limericks must be great advertising! We need to start writing EMC limericks if we are ever going to get our message out. Here's one:

There once was a man from Nantucket
Who slept in a very large bucket.
'Twas lucky for him
He grounded the rim
For one stormy night lightning struck it.

Or, how about:

A woman from Europe's Community
Saw an EMI-fix opportunity.
She built her box
With optical clocks,
Now her big problem's immunity.

If you've got an EMC limerick, send it in! We'll put them on the EMC Society web site. They're not difficult to write. In fact, I'm thinking of asking that all future chapter activities be submitted to the newsletter in limerick form.

Greeting Cards! The holiday season is almost upon us. Have you got holiday greeting cards for your EMC co-workers? It's hard to find EMC-specific greeting cards in the Hallmark store, but if you make your own cards you can personalize your message. Here's an example of the type of holiday greeting card I would like to receive:

Season's Greetings! Season's Greetings!
Cancel all your status meetings
Deck the lab with copper coils
Ferrite beads and shiny foils

May your wit and perseverance
Squelch all EM interference
May your products be compliant
And your Christmas bonus giant.

Of course, if you're the department manager and your card is for the company's senior EMC engineer, you might want to personalize it a little more:

All throughout the corporation
You have got a reputation
I hear all the people say
You're an EMC gourmet

When there is a complication
You address the situation
Taking steps without delay
You make problems go away

Now we have a situation
With our new configuration
You'll be working Christmas day
Hope it's happy anyway.

Here's a card I wrote for a company product manager:

Your new product is astounding
But it lacks sufficient grounding
You have wires where you need straps
You need more decoupling caps

There are unused inputs floating
Cracks in your conductive coating
And the way you've gapped your plane
Makes me wonder if you're sane

Though your product's really crappy
Hope your Holiday is happy!

Whether or not your products are passing, I hope you have a great holiday season!

Baltimore

Many thanks to Vil Arafiles for submitting the following report of the activities of the Baltimore chapter.

The Baltimore-Annapolis EMCS Chapter conducted two technical meetings for 1998 at the Fort Meade Officer's Club, Mapes Road, Fort Meade, Maryland. The first meeting was on April 7, 1998, where Mr. Jerry Hodges, Technical Director of the Joint Spectrum Center presented a paper on "Spectrum Related Changes." He provided data relating to the real cost of the much publicized spectrum auction by the government. While it is true that the auction resulted in bids totaling billions, the cost of replacing or modifying government equipment to move out of the affected frequencies were estimated to be from two to five times the auction revenues. A total of 21 members attended the dinner and presentation.

A second technical meeting was held September 8, 1998, with Mr. John Osburn, Principal Scientist for EMC Test Systems presenting a tutorial paper on "EMC Antennas and Characteristics". Mr. Osburn covered and explained the characteristics of antennas that are important in the EMC field. For instance, the relationships between receive and transmit antenna factors and how these terms relate to classical antennas and propagation equations. Attendees welcomed the presentation positively and at least four requested IEEE membership applications.

During the last meeting, the chapter members resolved to provide full support to the IEEE 2000 International Symposium on Electromagnetic Compatibility in Washington, D.C. We will be assisting Dr. William Duff, the Chairman of the Year 2000 EMC Symposium. This item was presented by the Chapter Vice Chair to the September 14, 1998 IEEE Baltimore Section Executive Committee meeting. The section agreed to provide full cooperation and support to this effort.

Central New England

The Central New England chapter organized an EMC Technology session for the ELECTRO 98 Conference held in Boston on June 9-10,1998. The session was organized and co-chaired by John Luchini and John Clarke. Nine papers were presented by the following speakers: "Noise Filtering on Cables" by Lee Hill of Silent Solutions, "Follow These 18 Rules for Better EMC Design" by Jon Curtis of Laboratory for EMC, Safety, NEBS, SEMI-S2 and Telecom, "EMC Testing: For Some, It's Mandatory-Why Not Do it the Most Cost-Effective Way and Get Some Added Benefits as Well?" by Michael Hopkins of KeyTek, "Radiated Immunity Testing: Avoiding Costly Errors and Investments" by Tim D'Arcangelis of Antenna Research Associates, Inc. "Measurement of Potential Magnetic Field Interference with Implanted Cardiovascular Defibrillators or Pacemakers" by J Robert Ashley, "Power Lines, Cancer, and Errors in Engineering Physics" by J Robert Ashley, "The European Union Machinery Directive 89/392/EEC: Removing the Mystery" by Jill Geppert of TUV Product Service/TUV Management Service, "Understanding the EMI Requirements of Bellcore's GR-1089 Nebs Generic Requirement Specific Specification" by Greg Sperun of Bellcore, and "Mutual Recognition Agreement (MRA) with the USA and EU: Background and Current Status" by Butch Sarma of Technology International Inc.

Photo by Henry Benitez

Bob Dockey of Hewlett-Packard in Vancouver, WA is shown demonstrating new techniques to reduce PCB common mode radiation at the Oregon and SW Washington September Chapter meeting.

Orange County

The May meeting of the Orange County Chapter of the EMC Society featured Donald Bush of dBi Corporation speaking about PCB Design. Mr. Bush presented many helpful hints on proper printed circuit board design. His insights were well received by the more than twenty attendees.

At the July meeting, Chris Kendall of CKC Labs spoke on WorldWide EMC Regulations. Chris was kind enough to stop by on one of his many visits to his Brea test site. This is a topic of increasing concern for more and more EMC engineers with companies putting more emphasis on serving a global marketplace. Chris described the policies and procedures for meeting EMC requirements in many of the major countries such as Australia, Taiwan, South Korea, Hong Kong, etc. It was a very informative and interesting topic as determined by the excellent attendance of over twenty-five attendees.

The chapter meetings are fast becoming noted for the fine buffet that Randy Flinders arranges each time. Anyone hungry for another shark-kabob! Kudos are to be extended to Randy Flinders, Dan Modi and Ed Nakauchi for reviving the Orange County Chapter after a hibernation of about two years. Meetings are normally held on the second Thursday of every other month.

Oregon and SW Washington Chapter

The EMC chapter is running a strong program again this year. No chapter meetings were held during July and August. Instead in July we supported the Oregon Section Summer Cruise (which was wonderful once again!). In August we had excellent local turnout to the EMC Society International Symposium held in Denver, Colorado. Next year it will be held in Seattle, Washington.

Our recently elected officers are:

Chairman - Henry Benitez
Vice Chairman - Ed Blankenship
Secretary - Charlie Tohlen
Treasurer - Dan Arnold
Communications Director - Nora Xiao
Membership Services Director - Jerry Page

Bob Dockey from Hewlett Packard jump started our Fall program September 30th with an exciting talk on "New Techniques for Reducing Printed Circuit Board Common-Mode Radiation". The Buster's Bar-B-Que provided at the meeting was of course a big hit as well. We held a 4 hour free EMC Design workshop with Chris Kendall on October 27 in Vancouver, Washington. This was an excellent value and a good way to entice more SW Washington participants. (Don't worry Ghery, we are not encroaching on the Seattle chapter territory!). For our November chapter meeting, we have Dr. Howard Johnson to speak on "Why Digital Designers Don't Believe in EMC!" The Oregon & SW Washington Chapter and Seattle chapter are once again coordinating monthly chapter meetings. This has been a great way to reduce the costs for speakers and be most efficient with speaker schedules. The two chapters have also been alternating EMC Colloquium events each year. Portland will have another Colloquium in April 1999. The exact date and program will be set soon.

Jackie Benitez and Henry Benitez at the Oregon Section Summer Cruise

Henry Benitez of Tektronix, David Campbell (Portland Spirit Captain), and Bruce Brunstad of Tektronix.

Rocky Mountain

Thanks to Barry Wallen, Chair of the 1998 IEEE EMC Symposium Committee, for submitting the following report.

The Rocky Mountain Chapter had a very successful Chapter meeting in August. We invited about 2600 guests and all of them showed up. We are of course talking about the 1998 EMC Symposium held in Denver. By all accounts it was a very well received event. I would like to thank all of

Photo by Henry Benitez

The IEEE Inter-Chapter Dinner Cruise was well attended by Oregon and SW Washington chapter members. The Keynote speaker was the President of IEEE USA.

the attendees, our faithful exhibitors, volunteers, and most of all the Denver Symposium Committee for making this a great event.

Seattle

In August, the Chapter held a summer social event at Northwest EMC's new open area test site in Sultan, WA. While Sultan may seem "out in the boonies" to you, in fact it's just 60 minutes north of Seattle. Northwest EMC treated the chapter members and their families to an outdoor barbecue picnic with all the trimmings. The mouthwatering steak was especially memorable! A tour of a facility was also available for those not interested in playing Frisbee or enjoying the afternoon sunshine.

In September, the Chapter hosted EMC Society Distinguished Lecturer Bob Dockey. Bob's presentation was entitled "Reducing Printed Circuit Board Common-Mode Radiation." Bob proposed several methods which can be used to effectively mitigate the common mode radiation mechanisms associated with printed circuit boards. As the EMC Engineering Group Manager at Hewlett-Packard in Vancouver, Washington, with over 25 years experience in EMC, Bob was certainly well versed on the topic. The day following the presentation, it was unseasonably sunny and warm in the Pacific Northwest so Bob spent a morning at the famous Pike's Place Market in downtown Seattle. He marveled at the "flying fish" (see for yourself when you visit Seattle next year for the 1999 IEEE International Symposium on EMC) and then traveled to Portland where he was a speaker at that chapter's meeting that night.

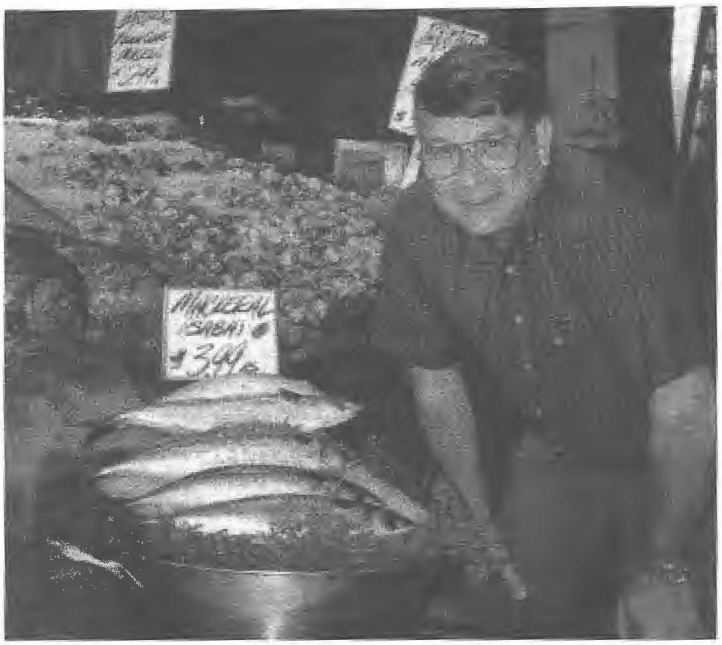


Photo by Janet O'Neil

There's something fishy about this photo! That's Bob Dockey checking out the fresh fish at the Pike Place Market in Seattle the day following his presentation at the Seattle EMC Chapter meeting.

Photo by Janet O'Neil

While at the Pike Place Market, Bob Dockey stopped to buy fresh flowers for his wife. (What a guy!)

Southeastern Michigan

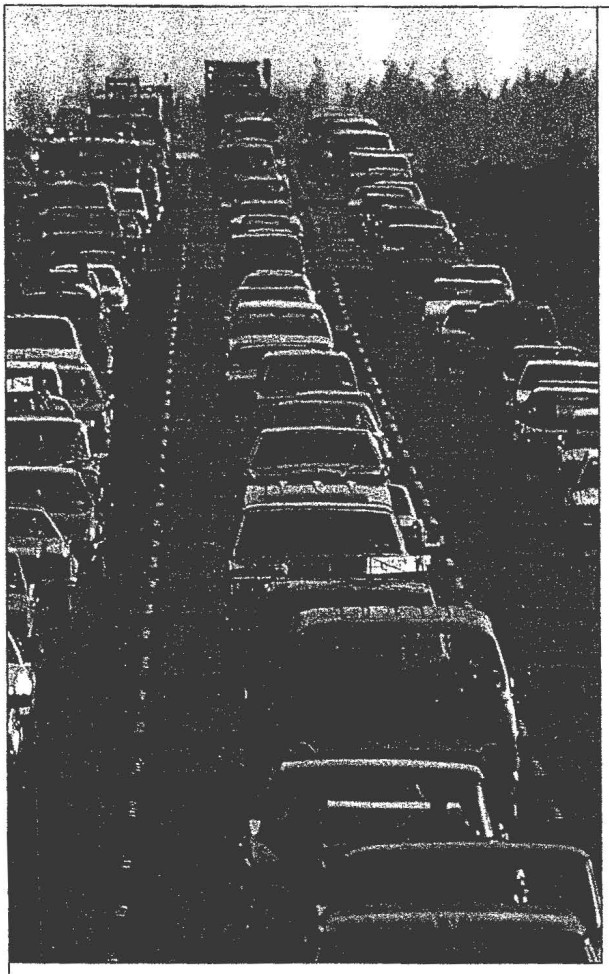
Kimball Williams reports that Dr. J. C. (Jim) McDade of Eaton Vorad in San Diego was the featured speaker at the July meeting of the Southeastern Michigan chapter. "EMC Concerns in Automotive Radar" was the topic of the meeting, which was held at the Eaton Corporation Innovation Center.

Automotive Radar engineers must execute their designs within limits imposed by both the FCC and the Society of Automotive Engineers (SAE). The former deals with the ability of the equipment to operate without interference among co-existing electronics systems. The latter is concerned with the ability of the equipment to continue to operate in a severe electromagnetic environment. The FCC has allocated frequency slots within the electromagnetic spectrum with limits on the power that may be radiated.

These restrictions set limits on the level of performance of the radar systems that can affect their effectiveness as collision warning systems (CWS) or automatic cruise control (ACC) systems. The author discussed the impact of FCC limits on system design. He also talked about interference problems with actual systems and the means by which they were mitigated.

The Road to a New Job Can Be a Long One.

Fortunately, We Have a Shortcut...



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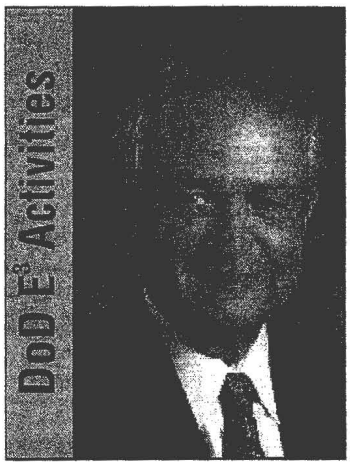


BOB GOLDBLUM
ASSOCIATE EDITOR

It was heartening and reassuring to meet so many of EMCS members at the recent Symposium in Denver who expressed their appreciation of the DoD activities article which appears in the EMCS Newsletter. There is certainly a great deal of focus on the commercial aspects of EMC dealing with computer products, EU and FCC requirements, including accreditation. However, there is still a significant percentage of our membership who deal with military procurements and equipment which must operate in military environments. I wish to express my thanks to all those who expressed their appreciation for this column.

The major activities occurring within DoD E^3 circles at the present time deal with personnel rather than standards activities. Mr. Stephen Caine, Director, Plans & Programs for the Joint Spectrum Center, has retired. Mr. Caine has been the driver and creator of many major EMC programs including the current activities to revise MIL-STD- 461/462, the development of the Defense/Industry EMC Committee, and the sponsorship of many other programs both within the Department of Defense and NATO. He has sponsored the JSC E^3 Bulletin for many years and initiated the annual DoD E^3 Program Review and Conference. It is surely hoped that the retirement of Mr. Caine will not signify the end of these progressive programs, as well as others which are still on the drawing board. Mr. William Lenzi will assume the responsibilities as the head of the JSC E^3 Division. The position for Director, Plans & Programs will be filled later this year. We all wish Mr. Caine success in his retirement and hope that somehow his legacy will be continued.

At the same time, Mr. Anthony Iacono has resigned as the Branch Head for NAVAIR's EMC organization. Mr. Iacono has spent nearly his entire career in avionics EMC matters. He has been an avid supporter of both the NVLAP accreditation and the NARTE certification programs for EMC personnel. He has also sponsored many other avionics-related programs both in conjunction with the Air Force and with NATO. As anticipated, Mr. Iacono will be replaced by Mr. Matthew Grenis.

Mr. David Cofield has retired recently from the Army Communications Electronics Command (CECOM) at Fort Monmouth, NJ. Mr. Cofield was a member of the MIL-STD-461 Committee and a significant resource in the Army's EMC community. Additionally, Mr. Dennis Baseley, who formerly headed the EMC organization for the Air Force Aeronautical Systems Center in Wright-Patterson Air Force Base, has transferred to another organization. Mr. Baseley also was very active in the MIL-STD-461/462 revision process, as well as many EMC activities conducted by the Air Force. Approximately two months ago, Mr. Jerry Hodges, Technical Director of the Joint Spectrum Center, retired from Government service.

These and other personnel changes within the DoD E^3 community could have a major impact, depending upon the effectiveness of their replacements. Although we often blame the lack of programs due to funding, it is the personnel in charge who aggressively seek the funding appropriations for EMC programs. Thus, the replacement personnel have major challenges ahead while the DoD EMC community stands by and watches.

In spite of these personnel changes, ongoing activities continue. The MIL-STD-461E draft is being electronically circulated to review organizations within the DoD and industry for comment and review. Formal publication of the document, at which point it will be applicable on all new procurements, is expected to occur early in 1999.

To keep updated on Government activities, interested parties may subscribe to the *JSC E^3 Bulletin.* Applications can be found on *www.RBitem.com.*

Scenes from the 1998 IEEE International Symposium on EMC held in Denver, Colorado

Photo by Janet O'Neil

Always ready with a smile is friendly Bret Lenmark of Instrument Specialties.

Photo by Dick Ford

Crowds gather to take the bus from the Convention Center to one of the many nearby hotels which catered to the symposium attendees.

Photo by Dick Ford

Friends reunite in the companions hospitality suite. Geri Bronaugh (L) gives Edith Clark (R) a big welcome hug.

Photo by Janet O'Neil

Unanimously voted the couple "Most Likely to Succeed" are Barry and Marti Wallen.

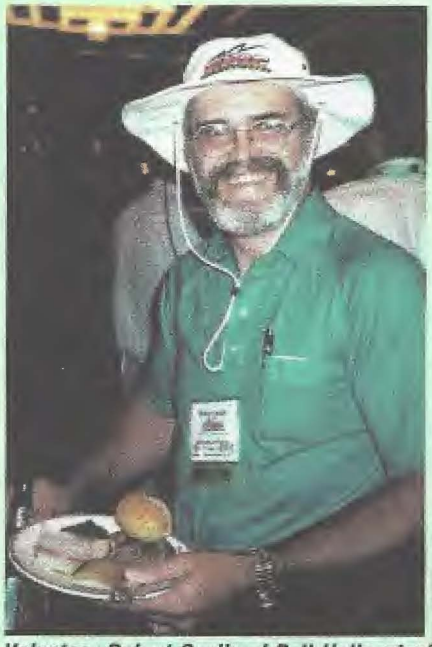


Photo by Dick Ford

Volunteer Robert Scully of Bell Helicopter/ Textron enjoys the welcome reception on Tuesday night.

Photo by Dick Ford

Dan Hoolihan (L) congratulates Salvatore Celozzi of the University of Rome "La Sapienza" (R), author of the Best Symposium Paper Award.

Photo by Janet O'Neil

The Denver symposium committee were always hard at work, but they made it look effortless! Barry Wallen of Criterion Technology, John Stadille of Ball Aerospace and Technologies, and Richard Georgerian of Exabyte (L-R) are the picture of calm.

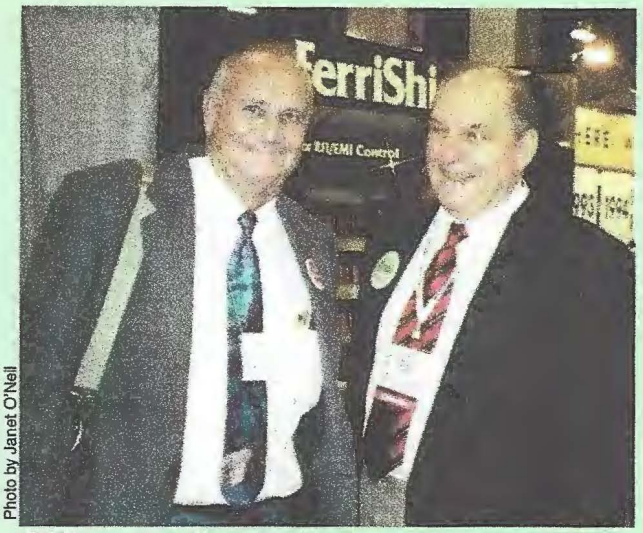


Photo by Janet O'Neil

Bill Kimmel (L) of Kimmel Gerke enjoys a lighter moment in the exhibit area with Tom Chesworth (R) of Seven Mountains Scientific.

Photo by Janet O'Neil

The Italians celebrate during the Awards Luncheon, with good reason! Salvatore Celozzi (standing) won the Best Symposium Paper Award, while Antonio Orlandi and Giulio Antonini (seated on right) won the Best Transactions Paper Award (co-authored with S. Cristine - not pictured). Maria Sabrina Sarto and Professor D'Amore (seated on the left) join in the celebrations.

Photo by Janet O'Neil

The "Chrysler Contingency" wait patiently for the IMAX show on Mount Everest at the symposium gala event. That's Kevin Slattery, Terry North and Jim Muccioli (L-R).

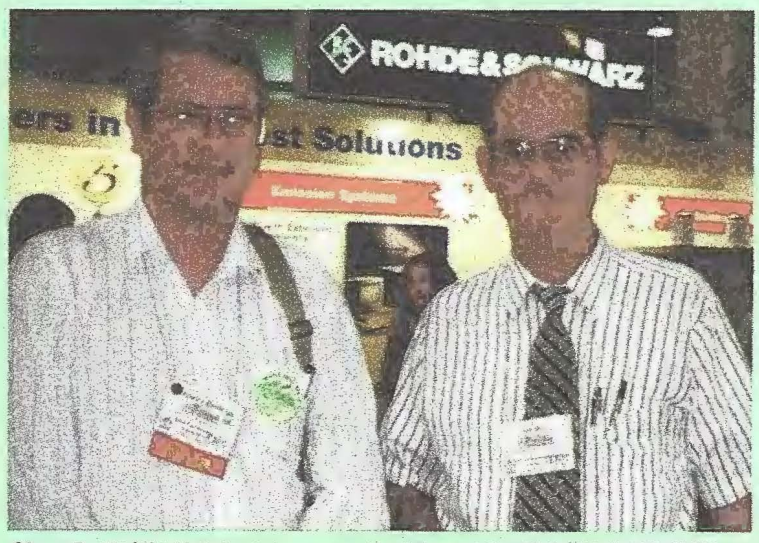


Photo by Janet O'Neil

Ghery Pettit (L) of Intel catches up on the latest at the FCC with Art Wall (R).

Photo by Dick Ford

Beaming Jim Muccioli (C) receives his Fellow Award from Bill Duff (R) and Dan Hoolihan (L).

Photo by Dick Ford

The IEEE EMC Society Membership Booth was ably manned once again in Denver by Flo Haislmaier. Her capable assistant was Mike Hatfield of the Naval Surface Warfare Center in Dahlgren.

Photo by Janet O'Neil

It's a reunion of one-time former employees at LectroMagnetics, Bill Giacone, John O'Brien and Peter Deal (L-R). Bill is now with Lindgren RF Enclosures, John is with WEMS Electronics, and Peter is with Advanced ElectroMagnetics.

Photo by Dick Fordi

At the Awards Luncheon, Janet O'Neil catches up with Beijing EMC Chapter Chairman, Prof. Gao Yougang.

Photo by Dick Ford

Dan Hoolihan (L) congratulates Giulio Antonini (R) of the University of Rome "La Sapienza," a co-author of the Best Transactions Paper Award.

Photo by Dick Ford

The energy filled the room at the Denver Museum of Natural History, site of the symposium gala event, "Dining with Dinosaurs".

Photo by Dick Ford

Talk about sticking your neck out! A rare example at the Denver Museum of Natural History.

Photo by Janet O'Neil

Hans Mellberg of Mellberg Inc., Dale Guthrie of Sunol Sciences and Wally Pilat of Trace Laboratories(L-R) discuss business in Dale's booth.

Photo by Dick Ford

Dan Hoolihan (L) congratulates Antonio Orlandi (R) of the University of L'Aquila, Italy, a co-author of the Best Transactions Paper Award.

Photo by Janet O'Neil

Last year's Austin symposium chairman, John Osburn (L), clearly enjoys not being in charge in Denver. He shares his enthusiasm with Colin Brench of Compaq (R).

Photo by Janet O'Neil

Getting the "Royal Treatment" in Denver are Jeannie Olson of Kalmus and Mike Windler of UL.

Photo by Janet O'Neil

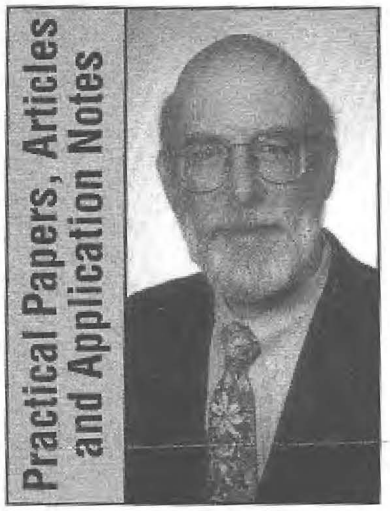
Joe Weibler (L) and Bill Curran Sr. of Lindgren RF Enclosures pause at a break in the booth traffic during the symposium exhibit hours.

Photo by Dick Ford

Jim Whalen (R) of the State University of New York at Buffalo is shown receiving a Certificate of Achievement from Dan Hoolihan (L).

Photo by Janet O'Neil

(L-R) Franz Gisin of Silicon Graphics, Bob Howland of Bay Networks and Moto Kanda of NIST pause in the registration area.



BOB ROTHENBERG
ASSOCIATE EDITOR

This section of the Newsletter is intended to provide EMC practitioners with an outlet for sharing knowledge or perspective gained from experience. To submit an article for consideration, send it via fax, e-mail or real mail to this Associate Editor. See page 3 for addresses and fax number.

The following two articles should be of interest to EMCS members. Herb Mertel describes a verification test program carried out at Oklahoma City Hospital to determine whether the procedures of ANSI C63.18 are simple and practical. Mark Montrose provides some fundamental EMC concepts relating to routing clock traces on printed circuit boards, based on material extracted from two books he has authored: *Printed Circuit Board Design Techniques for EMC Compliance* (IEEE Press, 1996) and *EMC and the Printed Circuit Board — Design, Theory and Layout Made Simple* (to be published in 1999).

Reader feedback is welcome, either as a letter (or e-mail) to the Editor or directly to the authors.

Verifying ANSI C63.18, Immunity of Medical Devices to Portable Transmitters (up to 8 W)

by Herbert Mertel

On May 21, 1998, twelve biomedical engineers from various hospitals participated in a workshop to determine whether the methods given in ANSI C63.18 are easily usable. The work was performed at the University Hospital in Oklahoma City. The workshop was preceded by a one day seminar explaining the procedures of C63.18 at the Center for the Study of Wireless Devices, located at the Oklahoma University in Norman, Oklahoma.

The instructors included Sean Boyd, FDA Winchester Engineering and Analytical Center; Don Heirman, Don HEIRMAN Consultants; Herbert Mertel, Mertel Associates; and Jeffrey Silberberg, FDA Center for Radiological Health. The seminar was guided by Dr. Hank Grant and his able staff from the Center for the Study of Wireless Devices.

The testing was performed on the vacant 9th floor of the University Hospital. The testing configuration is shown in Figure 1. An additional item was added: Sean Boyd brought along a Holaday E-Field sensor for up to 2 GHz. The probe was held over the EUT by a participant. This device proved very valuable since it reads out directly in V/m. Consequently, we could measure the field around the EUT whereas C63.18 provides only an estimate of the field strength on the basis of the rated output of the portable transmitter. The field was estimated on the basis of the dipole equation. In general, this was conservative. The measured field strength was always lower than estimated by up to 10 dB!!

Several medical devices were evaluated with various transmitters. The cellular phones were operated at maximum rated power by a maintenance code provided by the Center. The procedure was as follows: at the specified distance (3 m), the transmitter was held at the normal operating height of 1.7 m, polarization was changed from vertical to horizontal, then the transmitter was held at 1 m, and the transmitter operator approached the EUT up to 0.25 m from the EUT while continuously changing the polarization by rotating the transmitter by 90 degrees.

The test was performed with both vertical and horizontal polarization while the transmitter was modulated with normal speech. No susceptibility problems were observed with the 600 mW cellular phones. The operating pressure of a ventilator was changed with an 8 W transmitter and a field of 5 V/m. No patient-connected devices, such as medical telemetry or infusion

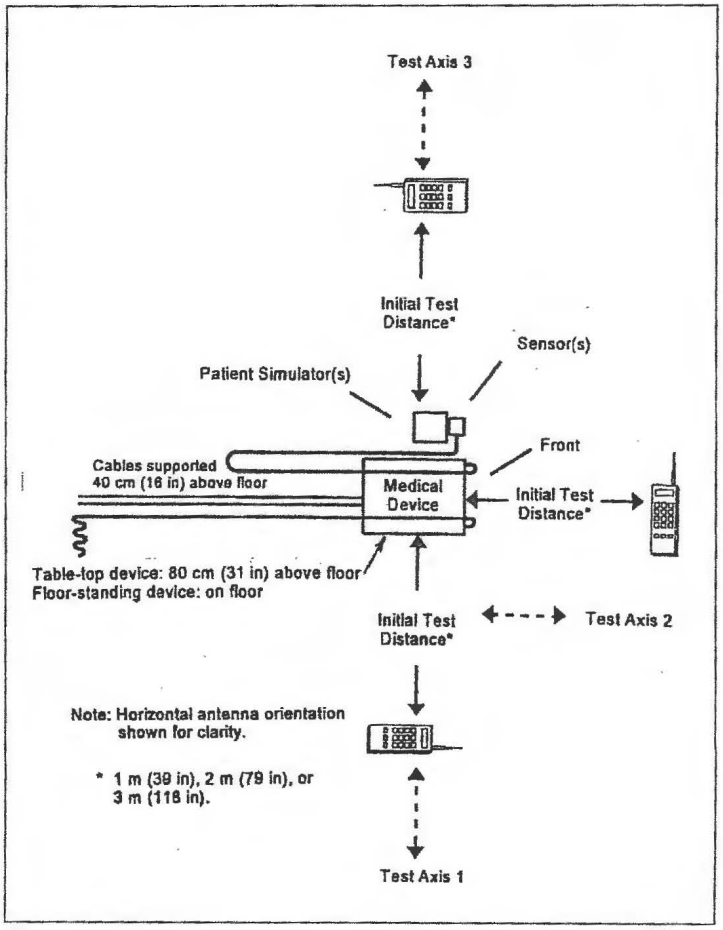


Figure 1

pumps, were tested. Such devices will be evaluated during the next verification test.

The biomedical engineers participating in the test believe that the writers of C63.18 were overly concerned with the protection of the equipment (i.e. "no damage"). They would like the standard to start the test at the closest distance to the equipment, which can be on top of the equipment. They are confident of being able to fix any damage that might result.

The test also demonstrated that it is imperative to add an E-field indicating device to the test setup, such as a spectrum analyzer with a probe/antenna or an E-field sensor. Most transmitters will have an output that is lower than predicted; therefore, it is important to determine the field strength during the test. For more rapid evaluation of a medical device's susceptibility, the standard should be changed to an initial test distance of 0.1 meter from the front and rear of the device. At present, no testing at the rear of the device is required.

The C63.18 standard is intended for the use of biomedical engineers who do not have a shielded anechoic chamber available and who want do some quick evaluation of a medical device's immunity to the small portable transmitters in general use. Therefore, this workshop was a valuable experience for the writers of the standard. The findings will be incorporated in a planned revision of the standard.

The writers of the standard are indebted to the staff of the Center for the Study of Wireless Devices for having arranged the seminar and workshop.

Herb Mertel is an EMC consultant with Mertel Associates, P.O. Box 300752, Escondido, CA 92030 (e-mail: hmertel@home.com).

EMC Suppression Concepts for Printed Circuit Boards

Routing Clock Traces

by Mark I. Montrose

This article discusses how to route traces on a printed circuit board (PCB), along with proper component placement. We must be concerned with both the time domain (functionality), and frequency domain (EMI) of any product design. The discussion is applicable to single-sided, double-sided, and multilayer designs.

Oscillators, associated components, and clock traces account for a significant amount of the RF energy generated within a PCB. A clock circuit is defined as the functional area that physically contains the oscillator and/or its buffers, drivers, and associated components, both active and passive. RF energy is observed related to both the rise and fall time of signal transitions, and the fundamental clock frequency of active components. To determine the highest RF spectral distribution of energy typically observed, Equation 1 is used. This equation does not take into account harmonics of the primary frequency.

$$f\,max = \frac{1}{\pi * t_r} \qquad \text{(Eq. 1)}$$

where f_{max} = maximum generated RF frequency, and t_r = edge rate in ns (use the faster value of either the rise or fall time).

For example, a 2 ns edge rate, typical of common clock drivers and components, can be expected to radiate significant RF energy up to 160 MHz, falling off rapidly above that frequency. The possible significant RF spectrum is $10f_{max}$ or 1.6 GHz, which includes the harmonic content of the main frequency component.

Clock and periodic signal traces should always be ***manually*** routed before any other action occurs. Following successful manual routing of clocks and sensitive or high-threat traces rich in RF energy, the rest of the PCB can be routed by automatic means.

Component Placement

Locate clock generation components near the center of the PCB, or adjacent to a mechanical ground stitch location (to chassis ground), rather than along the perimeter of the board or near the I/O section. If the clock trace goes off the board to a daughter card, ribbon cable, or interconnect, locate the clock circuit some distance from this interconnect, but not so far away as to make the interconnect trace electrically long. *Terminate* the clock trace directly at the connector, whether an interconnect is present or not. It is imperative that this be comprised of a single point-to-point connection. Termination of clock lines where a trace crosses a boundary (connector) guarantees signal quality and improves functional performance. Without termination, a clock trace can act as a monopole antenna when no interconnect, or load, is provided. In addition, proper termination of transmission lines helps suppress common-mode induced RF currents from coupling into other areas susceptible to RF corruption. Install oscillators and

crystals directly on the PCB rather than using sockets. Sockets add lead length inductance (LdI/dt). Lead length inductance allows ground noise voltage to be created across the transmission line. Ground noise voltage is developed because there may exist a difference in voltage potential between two circuits, caused by inductance in the circuit. Ground noise voltage in turn generates common-mode RF currents, which can radiate, or couple, into susceptible areas.

Trace Lengths

Locate components that use clocks or periodic signals to achieve the shortest, straight-line path possible (minimal Manhattan length) between two points, with no vias in the trace route, if possible. Ground vias, if required, are discussed later in this article. Each via adds approximately 1-3 nH inductance to the trace route. Inductance in a trace can cause both signal quality concerns (time domain) and potential RF emissions (frequency domain). The total inductance within a trace is added to the sums of all via inductances. The faster the edge rate of the clock signal, the more this design rule becomes mandatory. If a periodic signal, or clock trace, must traverse from one routing plane to another, this transition should occur only at a component lead at 0V, or ground reference, not anywhere else. The reason for making the transition adjacent to a component lead is to allow RF return current to easily make a layer transition jump. Try for a maximum of two vias per route, one at the source, and one at the load, if a stripline configuration is provided.

The old directive to *"keep clock lines short"* will always be valid. The longer the trace, the greater the probability that RF currents will be produced, and more spectral distribution of RF energy created. Clock traces must be terminated to reduce ringing (enhance signal integrity), and to prevent the creation of avoidable RF currents. Improperly terminated clock signals might also degrade the signal to the point of being non-functional, depending on frequency of operation and logic family provided.

Determining Electrically Long Trace Lengths

How do we determine if a trace is electrically long? Typical velocity of propagation of a signal in a trace is 60% of the speed of light. From this, calculate the maximum permissible unterminated line length (Eq. 2). This equation is valid when the two-way propagation delay (source-load-source) is greater than, or equal to, the signal rise time. This length is for round trip distance. *The one way length, from source to load, is 1/2 the value of Lmax.*

$$L_{max} = \frac{tr}{2\,t'_{pd}} \qquad \text{(Eq. 2)}$$

where tr = edge rate of the signal transition (ns); t'_{pd} = propagation delay of 1 cm of line (ns); and L_{max} = maximum round trip distance of the routed trace (centimeters).

When dealing with transmission lines, a PCB designer needs a general rule-of-thumb *during component placement,* that allows quick determination of whether a trace route can be considered electrically long. A simple calculation is available with almost absolute accuracy. When determining if a trace is electrically long, think in the time domain, as the propagation speed of the signal is based exclusive on the permittivity, or dielectric constant of the planar material.

To simplify (Eq. 2), there are two basic equations for determining maximum electrical routed length before termination is required. These equations, (Eq. 3 and 4), take into account conversion from units of feet to cm and include the propagation delay, t_{pd}. For FR-4 material, with a dielectric constant of 4.6, the flight time of a signal routed microstrip is t_{pd} = 1.72 ns/ft and for stripline t_{pd} = 2.2 ns/ft. If the routed trace length is greater than L_{max}, both signal functionality and EMI concerns exist.

$L_{max} = 9\ t_r$ *(for microstrip topology - in cm.)* (Eq. 3)

$L_{max} = 3.5\ t_r$ *(for microstrip topology - in inches)*

$L_{max} = 7\ t_r$ *(for stripline topology - in cm.)* (Eq. 4)

$L_{max} = 2.75\ t_r$ *(for microstrip topology - in inches)*

For example, if a signal edge is 2 ns, the maximum unterminated trace length for routed microstrip is $L_{max}=9\ t_r=18$ *cm (7").* When this same clock trace is routed stripline, the maximum unterminated trace length of this 2 ns signal edge is now: $L_{max}=7t_r=14$ *cm (5.5").*

For materials with a dielectric constant other than 4.6, the propagation delay of a signal within a trace will differ. To use a different dielectric constant value, (Eq. 5) is presented.

$$L_{max} = x\left(a/t_{pd}\right) \qquad \text{(Eq. 5)}$$

where: a=30.5 (for cm) or 12 (for inches); and x=0.5 (converts transmission line to one way path). The equations for propagation delay of a signal are $t_{pd} = 1.107\sqrt{0.475\varepsilon_r + 0.67}$ for microstrip, and $t_{pd} = 1.017\sqrt{\varepsilon_r}$ for stripline, with ε_r the dielectric constant of the material at the frequency of operation. For example, if ε_r=4.1, L_{max}=8.9 cm (3.5 in.) for microstrip, and 6.9 cm (2.7 in.) for stripline.

If a trace is longer than L_{max}, termination is required, as signal integrity concerns, reflections and ringing may occur. Ringing generated by an impedance mismatch in an electrically long trace may also make the circuit non-functional, and could create common-mode RF currents within the trace. (The signal of interest is usually differential mode.) Even with optimal termination, a finite amount of RF current will exist in the trace due to the potential difference between the source and load circuit.

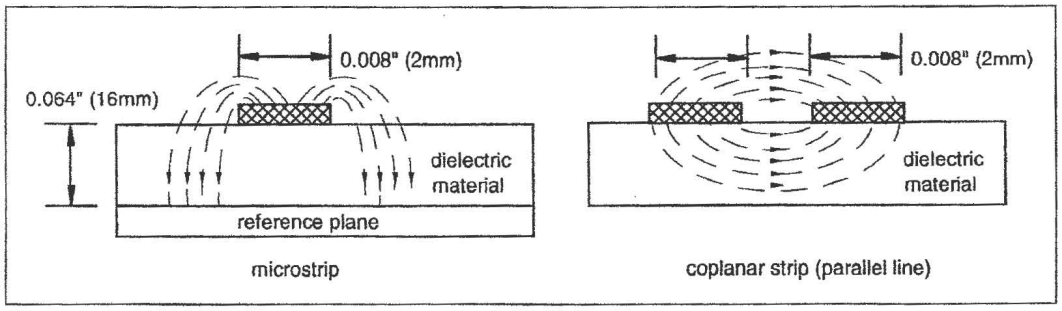


Figure 1. Field distribution for microstrip and coplanar strips

For every signal, a time domain reflection occurs. It takes a finite time for a signal to travel from source-to-load, and then return from load-to-source. An electrically long trace is a trace that allows the one way (source-to-load) propagation delay to exceed 1/2 the clock cycle. If a second clock signal (edge transition) occurs before the reflection of the original signal returns to the source, signal integrity problems occur. Depending on the phasing of the reflection, overshoot or undershoot may develop, which affects signal integrity. Signal degradation is a concern if the edge time of the signal constitutes a significant percentage of the propagation time between the device load intervals. Proper termination prevents ringing and reflections from occurring, thus enhancing signal functionality.

Routing Layers for Clock Traces

When designing any PCB, one must take into consideration several major concerns. These concerns relate to optimal signal integrity along with EMC compliance.

1. Creating a transmission line with proper terminations for all critical traces.
2. Minimizing inductance within the transmission line structure.
3. Providing a return path for RF currents using the lowest impedance path possible. (Refer to Issue No. 173, Spring, 1997 of this newsletter for a discussion of RF return currents.)

For single- and double-sided PCBs, it is virtually impossible to create an optimal transmission line. The impedance of a typical trace on a single- or double-sided PCB is 110 to 135 ohms. When used in a 50 ohm circuit, this impedance mismatch may cause the system to become non-functional, especially if the system clock is greater than 10 MHz, or clock edges are faster than 5 ns. In addition, an optimal RF return path may not be present in a

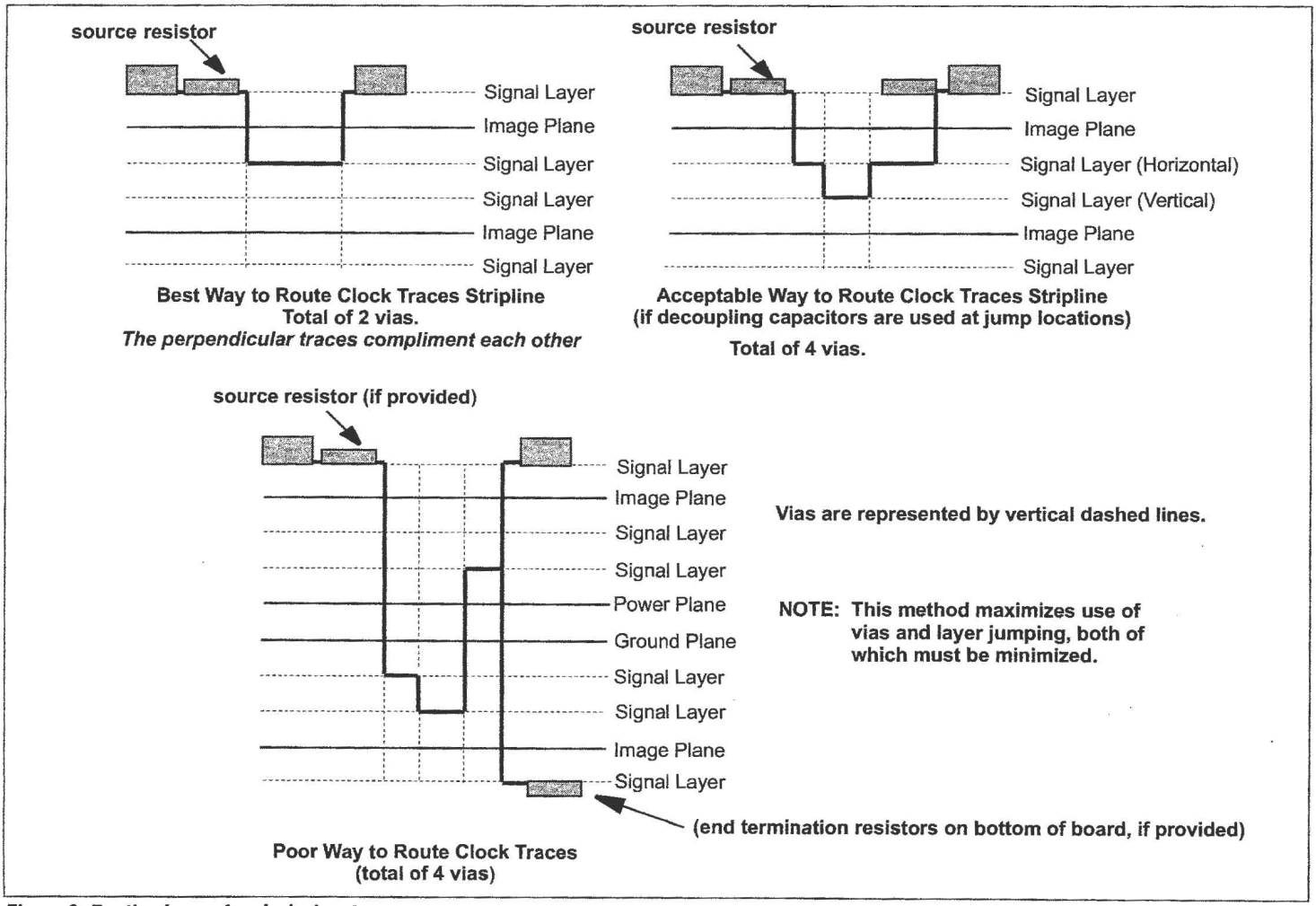


Figure 2. Routing layers for clock signals

single-sided design, whereas in a double-sided assembly, the distance between the trace and the RF return path is excessively large, typically 0.16 cm (0.062").

RF flux present on a trace is generally observed at a distance that is equal to the width of the trace. RF flux from a 0.008" trace will couple easily to an image plane that is 0.008" away, instead of a plane 0.062" away. Because of the current density distribution of RF flux, related to a RF return path, use of single- or double-sided PCBs is not recommended for any high-speed design. Figure 1 illustrates RF field distribution for microstrip traces. For a double-sided PCB, RF flux must travel through a dielectric material to find the RF return path. If a trace at 0V potential is routed adjacent to the clock trace on a single-side design (coplanar configuration), the trace becomes the RF return path. There is no simple technique for routing single- and double-sided PCBs that are EMI compliant due to: lack of an optimal RF return path, high trace impedance, and lack of a proper transmission line. Although use of a simple stackup assignment is cost effective, additional cost will probably be required through use of shielding or containment of internally created RF energy. It is generally cheaper to add a power and ground plane to a PCB, than to rely on secondary shielding methods.

For multilayer designs, clocks and periodic signals must be routed adjacent to a solid plane, *preferably at ground or 0V potential*. A plane must not be floating or isolated. This is true for both routing layers, "x" axis and "y" axis (also identified as the horizontal or vertical routing planes). When selecting routing layers, the designer must be concerned with which layers to use for trace routing, jumping between designated layers, and maintaining constant trace impedance.

Figure 2 shows an example of how to optimally route clock traces on different layers, assuming a multilayer stackup. The following design guidelines are suggested:

1. A solid (image) plane is located adjacent to the routing plane, or signal trace. Minimize routed trace length while maintaining constant trace impedance of the transmission line. If series termination is provided, connect the resistor directly to the output pin of the component. After the resistor, place a via to the internal stripline layer(s). The use of ground planes is preferred over use of voltage planes for the following reason: Voltage planes generally contain switching noise injected by components into the power distribution system. The voltage plane may disrupt the RF return path or cause common-mode coupling of switching noise into the RF return path.

2. Do not route clock or sensitive traces on the outer layers of a multilayer board, if a six or more layer stackup is provided. The outer layers of the PCB should be reserved for large signal busses and I/O circuitry. Functionality and signal quality of these traces could be corrupted by routing high-threat signals microstrip. When routing traces between layers, there will be a change in the characteristic impedance of the trace, as the trace relates to a reference plane (impedance control), thus affecting performance and possibly causing signal degradation.

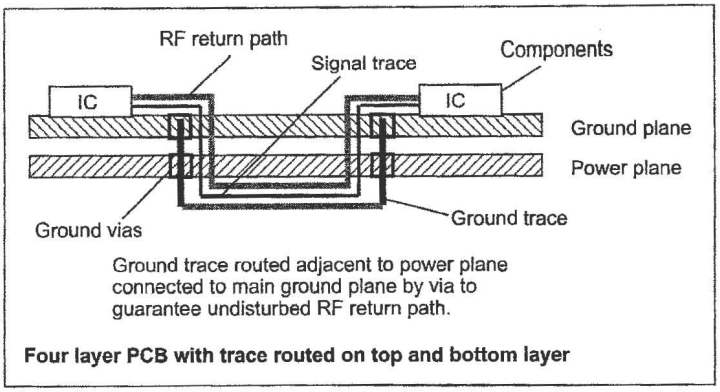


Figure 3. Using a ground trace on a four-layer stackup

If the design maintains constant trace impedance, provides for an optimal RF return path, and minimizes or eliminates use of vias (reduce inductance), the trace will not radiate any more than a coax.

Layer Jumping (Use of Ground Vias)

When routing clocks or high-threat signals, it is common practice to via the trace between routing planes (e.g., x-axis) and then via this same trace to another plane (e.g., y-axis) from source to load. This is shown in the poor routing method of Figure 2. It is generally assumed that if each and every trace is routed adjacent to an image plane, or RF return path, there will exist tight RF coupling (flux cancellation) of common-mode RF currents along the entire route. In reality, this assumption is incorrect.

When a jump is made from a horizontal to a vertical routing layer, the RF return current *cannot* make this jump. This is because a discontinuity occurs in the trace route by the via. The RF return current must now find an alternate, low inductance (impedance) path to complete its return. A suitable alternate path usually does not exist when jumping a trace between layers. To minimize creation of EMI and crosstalk, due to layer jumping, the following design techniques have been found to be effective:

- Route all clock and high-threat signal traces on only one routing layer. This means that both "x" and "y" axis routes are in the same plane.
- Verify that a solid 0V reference, or ground plane, is adjacent to the routing layer with no discontinuities in the route, e.g., plane cuts or moats.
- If a via must be used for routing a sensitive, high-threat, or clock signal trace between horizontal and vertical routing layers, incorporate corresponding ground vias at each and every via location where the axis jump occurs.

A ground via is a via that is placed directly adjacent to each signal route via at one trace width distance away. Ground vias can only by used when there are multiple ground planes in the PCB. This via must connect all ground planes together. Ground vias guarantee that a constant RF return path is adjacent to a signal route, thus providing a mechanism for optimal flux cancellation. The ground pin of a component makes an excellent ground via.

For a four-layer PCB, with one voltage plane and one ground plane, how is a constant RF return path provided when a ground via cannot be used? To maintain a constant return path for RF currents, the 0V reference plane must be allowed to act as the primary return path. When the trace must route against the power plane, use of a ground trace is required, with vias at both ends of the ground trace routed parallel, and adjacent, to the signal trace tied to the 0V reference plane. Using this configuration, a constant RF return path can now be maintained, as detailed in Figure 3.

Summary

The important concept for routing traces with periodic signals is to provide a properly terminated, impedance controlled signal route adjacent to an RF return image plane. This image plane provides for flux cancellation of RF common-mode currents, and allows the trace to function as a coaxial transmission line. Ground vias allow the RF return path to be undisturbed along the entire trace route. If multiple ground planes are not provided, a ground trace must be used on the routing plane adjacent to the signal trace to assure a constant, undisturbed RF return path.

Mark Montrose can be contacted via telephone at (408) 247-5715, or via e-mail at mmontros@ix.netcom.com.

Introducing Members Newly Elected to the EMC Society Board of Directors

The following members will begin a three year term on the Board effective January 1, 1999. Abbreviated biographies of these gentlemen are shown below.

Don Bush worked in or managed the EMC lab at IBM Lexington, KY, from 1965 until its acquisition by Lexmark International in 1991. He worked for Lexmark from this date until March, 1996. At this time founded dBi Corporation and continued in the EMC profession (art?).

Mr. Bush received the Bachelor of Electrical Engineering and Master of Electrical Engineering Degrees from the University of Louisville, is a registered professional engineer, and a NARTE certified EMC engineer. He has authored and presented eleven papers on EMC subjects, and holds one patent. His company, dBi, is an A2LA accredited EMC test lab.

E. Thomas Chesworth is President of Seven Mountains Scientific, Inc., an EMC consulting and publishing company he founded in 1979. He received his Bachelor of Science in meteorology in 1960, Master of Science in physics in 1969, and Doctor of Philosophy in physics in 1974, all from Pennsylvania State University.

Dr. Chesworth is a Registered Professional Engineer in the Commonwealth of Pennsylvania (1977), a NARTE-Certified EMC Engineer, and a Technical EMC Expert for the National Institute of Standards and Technology (NIST) and the United Nations Industrial Development Organization (UNIDO). He has been an EMC assessor for NIST's NVLAP since 1989 and a technical consultant to numerous companies on EMC projects, electromagnetic shielding and other electromagnetic effects. He is a Technical Editor of *Electromagnetic News Report, FCC News Report, Advance Battery Technology*, and *Advanced Fuel Cell Technology*. Dr. Chesworth has published more than 40 technical papers and has designed and built various electronic devices, including instruments for time-of-flight mass spectrometry, a computer-controlled synchroscope driver, and a chamber for aerosol levitation in vacuum. He worked in EMC at HRB-Singer, Inc. from 1966 to 1970 and was a Staff Physicist with LOCUS, Inc. from 1975-1979.

Elya B. Joffe was born in Johannesburg, South Africa.

He received his education in Electrical Engineering from the Ben-Gurion University of the Negev in Be'er-Sheva, Israel.

With over 15 years of experience in government and industry, in EMC/E^3 (Electro-

magnetic Compatibility/Electromagnetic Environmental Effects), Mr. Joffe's expertise ranges from interference control from circuit through systems to platforms. His work covers EMC, EMP and Lightning Protection design, as well as numerical modeling for the solution of EMC problems. Mr. Joffe is the VP of Engineering of K.T.M. Project Engineering, Ltd and works as an EMC Engineering Specialist.

Mr. Joffe is well known in Israel and abroad for his activities in EMC training and education, as an author and instructor of various courses on Electromagnetic Compatibility and related topics. Mr. Joffe has authored and co-authored over 35 papers in EMC and EMC-related topics. Mr. Joffe is a Registered Professional Engineer and a NARTE Certified EMC and ESD Control Engineer.

David P. Millard is a Principal Research Engineer and Chief of the Electromagnetics and Antennas Division, Sensors and Electromagnetic Applications Laboratory, Georgia Tech Research Institute (GTRI), Georgia Institute of Technology, Atlanta, Georgia. He received a Bachelor of Science in Electrical Engineering and a Master of Science in Electrical Engineering from Virginia Polytechnic Institute and State University in 1973 and 1974, respectively. He also pursued work toward a Doctor of Philosophy in Electrical Engineering at the Georgia Institute of Technology from 1981-1986. Mr. Millard is a member of AFCEA, a Registered Professional Engineer and a NARTE Certified EMC Engineer. He has published over 15 articles and symposium papers and 36 major reports. He was a co-author of the IEEE video, VC51 "Getting Rid of Interference," 3 December 1991.

Mr. Millard has enjoyed an 18 year career in electromagnetic compatibility (EMC) at GTRI where he started as a Research Engineer II in 1980, was promotion to Principal Research Engineer in 1991, and was appointed to his current position as Division Chief in 1995. He currently manages a diverse group of antenna and electromagnetic environmental effects (E3) engineers with Projects in the division covering all aspects of antenna design and E3.

Ghery S. Pettit is a Senior EMC Engineer with Intel Corporation in DuPont, Washington. He received the Bachelor of Science Degree in Electrical Engineering from Washington State University in 1975 and has taken numerous courses in EMC and related subjects since then.

Mr. Pettit began his EMC career as a field TEMPEST test engineer for the U.S. Navy in 1976. He was employed by Martin Marietta Denver Aerospace from 1979 to 1983, performing EMC and TEMPEST design and analysis on MX and other projects. From 1983 to 1995 Mr. Pettit worked for Tandem Computers, providing EMC design, analysis, troubleshooting and testing support for various products. During that time he designed and built both a 30 meter open area test site and a 10 meter RF semi-anechoic chamber and served as Tandem's representative to the CBEMA ESC-5 committee (now ITI TC-5). Since 1995 he has been employed by Intel Corporation, providing EMC support for various groups, including desktop PCs. While at Intel he has built two EMC laboratories, one in Hillsboro, Oregon and the other in DuPont, Washington. He has written 6 papers for publication/presentation. Mr. Pettit is a NARTE Certified EMC Engineer, a member of the dB Society and is a Technical Advisor in the area of EMC to the American Radio Relay League (ARRL). He presently serves as Intel's representative to the ITI TC-5 committee and is a member of the USNC to the IEC / CISPR SC G Technical Advisory Group.

Douglas C. Smith is Manager EMC Development and Test at Auspex Systems, in Santa Clara, CA.

Mr. Smith held an FCC First Class Radiotelephone license by age 16 and a General Class amateur radio license at age 12. He received a B.E.E.E. degree from Vanderbilt University in 1969 and an M.S.E.E. degree from the California Institute of Technology in 1970. In 1970, he joined AT&T Bell Laboratories as a Member of the Technical Staff. He retired in 1996 as a Distinguished Member of the Technical Staff. Currently he is Manager of EMC Development and Test at Auspex Systems, a maker of high performance network servers.

He has been involved with FCC Part 68 testing and design, telephone system analog and digital design, IC design, and computer simulation of circuits. He has been granted over 15 patents, several on measurement apparatus.

Mr. Smith has lectured internationally at Universities, technical symposia, and at public and private seminars on high frequency measurements, circuit design, ESD, and EMC. He has published over two dozen technical papers and articles in these fields and is author of the book *High Frequency Measurements and Noise in Electronic Circuits*. Mr Smith is currently working on his second book which will be published in 1999.

We wish the newly elected members of the Board of Directors success and thank all candidates for their willingness to serve and for permitting their names to be included on the ballot.

JOE BUTLER
ASSOCIATE EDITOR

Last year the EMCS Board of Directors (BOD) voted to establish the position of Vice President, for Standards. When this change was made the BOD also voted to split the Representative Advisory Committee (RAC) into two entities - the RAC and the Standards Advisory Committee (SAC). The original RAC was a committee which fell organizationally under the Director, now VP, of Technical Services. The RAC was the committte which provided the technical liaisons between the EMCS and many different IEEE and non IEEE entities. The entities consisted of both standards developing committees, e.g., ANSI, SAE, etc. as well as others, e.g., IEEE Committee on Man and Radiation, NARTE, etc. With the establishment of this new office of VP Standards, the original was split into the RAC and SAC with the obvious division of liaisons. Bob Hofmann has recently agreed to chair the SAC, while David Case has agreed to chair the RAC.

Joe Butler

COMMITTEE ON MAN AND RADIATION (COMAR)

Dan Hoolihan
SAC Representative

The Technical Information Statement (TIS) on "Radio Frequency Interference with Medical Devices" was published in the May/June 1998 issue of the Engineering in Medicine and Biology (EMB) magazine. Another position paper on health effects from cellular phone use is being developed. This position statement will replace a similar paper issued by COMAR in 1992. COMAR is soliciting input, both pro and con, as to the possible biological effects resulting from exposure to electromagnetic radiation at cellular phone frequencies. Input from experts in the field as to the existence of published papers in this area would be appreciated. COMAR will use the Michaelson and Elson article in the second Edition of the CRC Handbook of Biological Effects of Electromagnetic Fields as a good review of the literature up until 1992.

Other TIS to be reviewed by COMAR include: "Human Exposure to Radio-Frequency Fields from Police Radars" (May 1992); "Human Exposure to Radio-Frequency Fields from Portable and Mobile Telephones and Other Communications Devices" (December 1992); "Human Exposure to RF Emissions from Cellular Radio Base Station Antennas" (May 1992); "The Safety of Electromagnetic Pulse Simulators" (May 1992); and the "Health Aspects of Exposure to Electromagnetic Fields from RF Sealers and Dielectric Heaters" (May 1992).

ESD ASSOCIATION

T. J. (Bill) Ritenour
SAC Representative

There is nothing new to report with respect to general ESD Association activity. However, a lot of activity that is of interest to EMC practitioners is presently occurring with respect to a cooperative effort between the ESD Association and ANSI C63.16 in their efforts to each create a new standard:

The ESD Association is creating a completely new test standard for measuring ESD wave shapes that eliminates the bandwidth artifacts, and hopefully the unintended near field test set emissions of the present test method in IEC/EN 61000-4-2.

ANSI is creating an up-to-date ESD test *standard* to replace the ANSI 1993 Test *Guideline* (C63.16) that includes all the newly discovered electromagnetic effects revealed during the ESD Association's test efforts (sub nanosecond rise times, unwanted rise time artifacts, etc.). In addition, the ANSI subcommittee is creating a simpler approach to perform statistically based tests than that offered in the ANSI 1993 Test Guideline (C63.16); as well as incorporating the European Union style approach to product families such as household appliances.

ANSI C63

Don Heirman
SAC Representative

Review and contribution to the following topics via IEEE EMCS members of C63 is requested:

C63.18 (On-site Measurement of Medical Device Immunity to transceivers)

C63.17 (Measurement Methods for Unlicensed Personal Communication Services)

C63.14 (EMC Definitions)

C63.5 (Antenna Calibration)
C63 has several active subcommittees that have their own projects in support of maintenance of C63 standards as well as new material to add to new or existing C63 standards. C63 ballots to approve or modify the submission of work by its subcommittees.
At the last meeting in Minneapolis in June, the following activities were reported:
Proposed revision to C63.4 to cover TEM devices and revisions to more closely harmonize with CISPR Pub 22 Measurements above 1 GHz
Revision to C63.13 on EMI filter design
Reaffirmation of C63.12 on limit setting
Work with the military tri-services to cite civilian standards instead of current military standards
Status of submitting CISPR Pubs 11 and 14 as C63 standards
Providing NARTE with certification exam questions on commercial standards
Liaison with ESD Association with C63.16 working group

CISPR A

Don Heirman
SAC Representative

CISPR A met in Frankfurt, Germany, in July, 1998. Major activity included discussion of draft documents on the following topics which will be included in CISPR Pub 16 Parts 1, 2, and 3 all under revision (Part 3 will be a new document comprised of reports and miscellaneous topics).
Accounting for measurement uncertainty when determining compliance with a limit
Antenna calibration
Radiated measurements and limits above 1 GHz
Limits of intermodulation effects
Devices for measuring signal lines
Calibration of insertion loss of artificial mains networks
Amendment of receiver selectivity curve
Use of an artificial mains network as a voltage probe
Emission measurements in the presence of ambient signals
Automated emission measurements
New work on capacitive voltage probes
Amplitude probability distribution measurement equipment
Emission measurements in fully anechoic chambers
Emission measurements using TEM devices
Uniform measurement arrangement for emission and immunity testing
Measurement of EUTs in-situ
Use of stirred mode reverberating chambers

CISPR B

Dan Hoolihan
SAC Representative

I attended a CISPR B Technical Advisory Group Meeting in Washington, DC on May 13, 1998. Highlights of the meeting involved:
1) A proposal by the U.S. for a new work item proposal for CISPR B to open the 61.25 GHz frequency band (ISM band) for communications use.
2) A final draft international standard, amending CISPR 11, will be out by the end of 1998 changing the radiated emission measurement distance for Class A equipment from 30 meters to 10 meters.
3) Karl Nebbia, the chair of CISPR B TAG for the U.S., resigned his position. No one has been selected to fill the position.

CISPR E

Don Heirman
SAC Representative

Both CISPR Pubs 13 and 20 are under total revision.
A new working group has been started to deal with measurements of emissions and immunity from digital TV receivers. Issues to be addressed by the new WG include:
Specification of the wanted TV signal
Performance criteria
Measurement method
Extent of EUT to be included
Analysis of where requirements belong:
CISPR 13 versus CISPR 22 (ITE)
and CISPR 20 versus CISPR 24 (ITE)

CISPR G

Don Heirman
SAC Representative

CISPR G met in Germany in July, 1998
Major activity included discussions of draft documents on the following topics (modifications to CISPR Pubs 22 and 24):
Expansion of scope to include to include ITE with a function of radio transmission and reception
Limits above 1 GHz
User installation testing
Use of ferrite clamps and tubes on a radiation test site
Operating conditions of visual display units
Measurement of telecom port emissions below 30 MHz
Conducted emission measurements for telecom terminal equipment
Generic cable setup for measuring emissions and immunity of local area networks

RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA)

Erik Borgstrom
SAC Representative

RTCA/DO-160D, *Environmental Conditions and Test Procedures for Airborne Equipment* was published in August 97. About half of this document deals with EMC requirements.

Since the publication of DO-160D, Special Committee 135 (the committee that writes DO-160) has been meeting to work on the expected and promised Change Notice 1. Change Notice 1 will be a complete revision of Section 20, *RF Susceptibility (Radiated and Conducted)*.

There will be two major changes in Section 20:

1. The maximum Radiated Susceptibility test level will be increased more than ten fold to a maximum test level of 7200 Volts/meter.
2. The Mode-Stirred Chamber test method, which was added in DO-160D, will be revised completely to bring it up to the "state-of-the-art" and to try to bring it in line with international standards under development.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) D09.12.14 ELECTROMAGNETIC SHIELDING

Drew Peregrim
SAC Representative

The ASTM D09-12.14 meeting was held on Tuesday, March 24, 1998. Three standards have been moved up the ballot chain: Transfer Impedance test method, Environmental Degradation of RF Joints test method, and the Slot Aperture Radiated test method. These standards will be voted on in the next 6 months, and could be standards by December. (I am crossing my fingers). Modifications to the ASTM Planar Test method are complete, and the revised standard will be sent in for ballot by the next meeting.

The next shielding effectiveness committee meeting will be held between October 19-21, 1998 at the Marriott and Omni Hotels in Norfolk, VA.

ETSI TC ERM EMC

Ronald Storrs
SAC Representative

1. Radio Communications EMC Standards

All standards for radio communications equipment in the initial work program attached to EU mandate BC-T-353 are either published or in the ETSI approval process. The following three standards will complete the public inquiry stage shortly:

EN 301 090. EMC standard for Maritime Radiotelephone watch receiver, operating on 2182 kHz. The public inquiry ends 3-13-98.

EN 301 011. EMC standard for narrow band Direct (NBDP), NAVTEX receivers operating on the Maritime mobile service. Public inquiry ends 3-13-98.

EN 300 342-3. EMC standard for GSM 900 MHz and DCS 1800 MHz, Base station radio and ancillary equipment and repeaters meeting phase two GSM requirements. Public inquiry ends 2-27-98.

It is intended to hold a resolution meeting for the above standards in May 1998. It is planned to submit the above three standards to TC ERM at its June 1998 meeting for approval to move forward into the ETSI voting process.

ETS 300 339 (the general EMC standard for radio communications equipment) has started its ETSI vote.

2. Fixed Network Telecommunications EMC Standards

EN 300 386-2 passed the ETSI vote with 100% approval. It is now being forwarded to the EU Commission for publication in the OJ.

2.1 Proposal for the further processing of EN 300 386-2 and ETS 300 386-1.

ETS 300 386-1 will not be offered to the EU Commission as a harmonized standard. A modified ETS 300 386-1 will be developed as a non-regulatory ETS dealing with quality aspects for fixed network equipment.

3. Compatibility requirements for equipment interfacing with cables supporting wideband services.

ETSI is in the process of investigating the problems which are arising from the application of wideband services in copper access networks. There is consensus that standards need to be developed to minimize interference problems due to crosstalk between different broadband services.

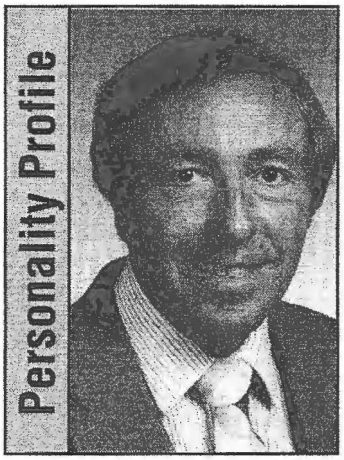
SAE EMI STANDARDS TC AND SAE EMR STANDARDS TC

Ed Bronaugh
SAC Representative

Work continues on updating the several land vehicle EMC standards. A standard on GTEM applications to Automotive EMC is being readied. The EMI TC is the US Advisory group for ISO TC22 WG 3. Part of its ongoing efforts is the coordination of US and ISO automotive standards.

The EMR TC is the US TAG for CISPR/D. It has ongoing efforts to coordinate US and IEC/CISPR automotive EMC standards.

Because of the cost of maintaining membership in the SAE standards operation and US TAG for CISPR/D, and the fact that the division of Siemens for which I work has no automotive interest, I cannot maintain membership in the committee. I therefore request to be replaced as the Representative of the EMC Standards Committee to the SAE Land Vehicle EMC Standards Technical Committees.



DR. WILLIAM G. DUFF
ASSOCIATE EDITOR

John Windell started his career with The Boeing Company as a Student Engineer in June 1956. His first exposure to Radio Frequency Interference, as it was known then, was helping to reduce data from the FAA Certification testing of the 707 aircraft in 1958. The following summer he received further exposure to RFI by calculating transmitter to receiver coupling on the BOMARC missile. In December 1959, following completion of his graduate course work, he began full time employment in the RFI Technical Staff. His first assignment was to plan and support conduct of the MIL-I-6051 qualification test of the BOMARC B missile. He has continued to work in the EME area throughout his 40-year career with Boeing.

John participated in the early development of computer modeling and analysis of EMC coupling at the system level by directing a subcontracted effort to calculate both antenna to antenna and cable to cable coupling of the BOMARC missile and, subsequently the Minuteman Launch Facility. Many of the techniques developed in that code are still used in the present IEMCAP. He then was assigned to lead the EMC system qualification testing of the Minuteman system. He and his colleagues developed the "circuit sensitization" approach to demonstrating EMI safety margins and successfully applied it to full system testing at Vandenberg Air Force Base. In 1970, John was asked to lead the EMC program for the AWACS aircraft and he was promoted into management in 1973. He has subsequently managed the EMC programs for the Inertial Upper Stage booster, a classified space program, the V-22 OSPREY aircraft and is currently working on the International Space Station. John will be retiring from Boeing in January 1999.

John was appointed as the Boeing representative to the Electronic Industries Association G-46 EMC Committee in 1975 and was elected Committee chairman in 1988. As G-46 chairman, he has attempted to foster greater coordination between the various industry committees and between industry and Government, particularly the DoD. He has regularly attended meetings of the SAE AE-4 and ANSI C-63 committees to maintain communication with those groups. He has participated in numerous DoD sponsored activities and has been a member of the DoD/Industry E3 Standards Committee since its inception.

John Windell

John is a member of the IEEE and the EMC Society but has limited his participation due to the demands of the G-46 activities. He served as a volunteer at both the 1977 and 1988 EMC Symposia in Seattle and has participated in panel discussions and as a Session Chairman at other EMC Symposia. John is the Technical Papers Chairman for the 1999 EMC Symposium in Seattle.

John received the BSEE degree in June 1958 and the MSEE degree in March 1961, both from the University of Washington. He is a member of Phi Beta Kappa, Tau Beta Pi and Sigma Xi. John and his wife Ellen live in Bellevue, Washington and have two daughters, Jonella and Julie who live in the same city. They enjoy attending symphony and theater performances, Husky football games and travelling. John's hobbies include gardening, coin collecting and reading.

J.L. NORMAN VIOLETTE
ASSOCIATE EDITOR

Radio Frequency Principles and Applications The Generation, Propagation, and Reception of Signals and Noise
by
Albert A. Smith, Jr., Fellow IEEE
IEEE Press

This 219-page book provides a ready- reference for the understanding and application of the basic laws of electromagnetics to RF technology. It is intended that the material in this book can be extended to application areas such as EMC, RF wave propagation, antennas, the description of the RF environment, wireless communications, transmission lines, and microwave circuits and systems. The seven-chapter organization starts with static field concepts and progresses to more specific applications of time-varying fields as follows.

Chapter 1 Static Fields and Sources

The well-known concepts of static electric and magnetic fields are presented, including Coulomb's Law, electric flux and flux density, Gauss's Law, conservation of energy, potential difference, fields from line and surface charges, line current, static magnetic fields and the Biot-Savart Law, magnetic flux and flux density, Ampere's Law, Lorentz force, and field units.

Chapter 2 Time-Varying Fields

The fundamental laws that govern time-varying fields are described and illustrated. This includes Faraday's Law, Maxwell's Equations in regions with field sources and source-free regions. These equations are also presented for the special case of sinusoidal time variation (frequency domain), and field boundary conditions. The situation of a plane wave incident on a conducting half space is used to illustrate wave impedance, diffusion and skin depth. Shielding effectiveness is illustrated as transmission through a metal sheet.

Equations for the fields radiated from a short dipole and a small loop are provided along with the definitions of near-field (Fresnel) and far-field (Fraunhofer) regions described.

NOTE: On page 35 (in the text and in Figure 2.17), the microwave oven frequency should be 2.45 GHz (not 24.50 MHz). The other calculations in Figure 2.17 follow for a frequency of 2.45 GHz.

Wave impedance is defined for the far-field and near-field regions as a function of distance from the wave source. This is followed by the concept of power density and hazardous radiation.

Chapter 3 Propagation

This chapter defines and discusses radio wave propagation as: "...the transfer of energy by electromagnetic radiation at radio frequencies." The various modes of radio wave propagation depend on: "... the path geometry, the frequency, and the electrical properties and the temporal variability of the earth's surface, the atmosphere, the troposphere, and the ionosphere." Propagation is described for free space, ground wave over plane earth, propagation over a perfectly conducting plane, attenuation of electromagnetic fields by buildings, and edge diffraction. The Rayleigh surface roughness criterion is presented.

Chapter 4 Antennas

The important characteristics of transmitting and receiving antennas are reviewed. This includes the typical antenna parameters: impedance, resistance, radiation resistance, loss resistance, antenna reactance, antenna effective length, antenna factor, gain, directivity, efficiency, etc. The relationships between the antenna parameters are presented in several sections including the property of reciprocity. Types of receiving antennas are described along with antenna calibration.

Chapter 5 The RF Environment

The electromagnetic noise environment limits the performance of all communication systems. The parameters or measures commonly used to describe electromagnetic noise are described, including noise field power, spectral density, field strength, noise factors, etc. System noise factor and receiving system available noise power are described. The determination of receiver sensitivity and noise figure is illustrated. Extraterrestrial, atmospheric, man-made, and power-line conducted noise are described. The effects of the earth's electric and magnetic fields are described.

Chapter 6 Waveforms and Spectral Analysis

Signal classification as either energy or power signals is described. The development of signal spectral density using the Fourier transform is presented. The impulse bandwidth is defined and spectral developments are presented for a rectangular

and a trapezoidal pulse. The Fourier series is illustrated for representing periodic waveforms in the frequency domain.

Chapter 7 Transmission Lines

Two-conductor transmission line theory is reviewed. Examples of common transmission line configurations are presented. Conditions for the support of the TEM mode of propagation are presented. The two-conductor model is provided from which distributed parameters, propagation constant, and characteristic impedance are developed. Ideal (lossless) and lossy lines are described. Line reflection and transmission coefficients are generally described. Solutions are developed for the line operation for the sinusoidal steady-state, including the concept of line termination and the VSWR. Excitation of lines by external fields is described along with radiation from transmission lines.

The book ends with Appendices of (A) Physical Constants, (B) Electrical Units, (C) Wave Relations, (D) Math Identities, (E) Vector Operators, (F) Frequency Bands, and an Index. References are included at the end of each chapter for further study.

In general, the book provides a well-organized, concise reference for reviewing electromagnetic (EM) concepts and applications for the electrical engineer who has taken a typical undergraduate course (or two) in EM theory. It can also serve as a reference for students and instructors currently involved in EM curricula.

Board of Directors Activities

Call to Order

President Hoolihan called the August 23,1998 meeting of the EMC Society Board of Directors to order at 9:00 am. A round of introductions was made. Board members present included Dan Hoolihan, Janet O'Neil, Warren Kesselman, Len Carlson, Todd Hubing, Don Heirman, Kimball Williams, Bill Gjertson, Franz Gisin, Bob Hofmann, Jim Muccioli, Andrew Podgorski, Joe Butler, Andy Drozd, Dick Ford, Bill McGinnis, Norm Violette, Henry Benitez, Ferdy Mayer, Mark Montrose, Don Sweeney, and Takeo Yoshino. Absent Board members were Herb Zajac and Henry Ott.

Photo by Dick Ford

The 1998 EMC Society Board of Directors at the IEEE 1998 Symposium on EMC in Denver. Seated L-R, Janet O'Neil, Warren Kesselman, Todd Hubing, Len Carlson, Dan Hoolihan, Don Heirman, Kimball Williams. Center L-R, Andy Drozd, Henry Benitez, Franz Gisin, Takeo Yoshino, Andrew Podgorski, and Norm Violette. Back Row L-R: Dick Ford, Don Sweeney, Joe Butler, Bob Hofmann, Bill Gjertson, Bill McGinnis, Mark Montrose. (Not pictured: Jim Muccioli, Ferdy Mayer, Henry Ott, Herb Zajac)

Secretary's Report

Secretary Janet O'Neil presented the minutes from the previous Board meeting on April 27, 1998. The minutes were amended and approved.

Treasurer's Report

Treasurer Warren Kesselman distributed his report. President Hoolihan noted that this report projects an EMC Society budget surplus of $85,000 which is the first time in three years that the Society has projected a surplus. The "1999 Initiatives" budget line item increases were reviewed as follows. Joe Butler, representing Long Range Planning, addressed the $10,000 requested for the global membership expansion. This is to promote EMC membership in South America. Don Heirman addressed the request for $5,000 to support EMC public relations and marketing efforts at the CISPR meeting to be held in 1999 in San Diego. Len Carlson addressed the $5,000 request for the IEEE History Center. President Hoolihan noted that the IEEE Foundation would match the dollar amount that each Society donates for this effort. Kimball Williams ad-

dressed the $6,000 request for EMC representation on IEEE councils. This will partially fund travel for Andrew Podgorski and Andy Drozd for travel to IEEE TAB meetings in 1999 to represent the Society at the Intelligent Transportation Systems and Sensors Councils, respectively. Joe Butler addressed the $10,000 proposal for a paid Society administrator (EMCS liaison to IEEE headquarters).

Denver Symposium Committee Report

President Hoolihan introduced Barry Wallen, the Chairman of the Denver EMC Symposium. Mr. Wallen presented an oral report on symposium activities. President Hoolihan also requested that Barry Wallen attend the November EMCS Board meeting in Piscataway, New Jersey to present a final report on the Denver symposium.

Member Services Report

Todd Hubing, Vice-President for Member Services, presented his report. Regarding Awards, Bill McGinnis reported that a total of 31 awards will be presented at the Thursday Awards Luncheon. On Chapter Activities, Mr. Hubing advised that Ray Adams will not be able to attend the Chapter Chairman's Luncheon this year. He reported that Seattle will receive the Most Improved Chapter Award and Central Texas will receive the Chapter of the Year Award. Membership retention and recruitment was discussed. Member benefits such as the Financial Advantage Program, the EMC Society Newsletter, Transactions on EMC, and others were discussed. Outreach programs such as the IEEE EMC Society membership booth and Board members making presentations or participating in the technical program at foreign EMC conferences were also discussed. The Board agreed to set up a committee to address membership retention. Dick Ford will chair the committee with members to include Bob Goldblum and Don Heirman.

Regarding International Activities, Ferdy Mayer reported on activities at the EMCS membership booth which was present at the Wroclaw EMC symposium in June. Several new members were recruited. Mr. Mayer will also staff the EMCS membership booth in Rome at EMC Roma '98. Mr. Hubing advised that Al Mills has retired as Chairman of the PACE program. Mr. Hubing is seeking a replacement for Mr. Mills. Anyone interested in assuming this position is encouraged to contact Mr. Hubing. Dick Ford advised that this is the fourth year he will distribute a survey at the annual EMC symposia. He solicited survey questions from Janet O'Neil regarding the Newsletter and from Kimball Williams regarding the Education Committee and Technical Services. Regarding membership, Steve Mullenix will staff the EMCS membership booth in Denver along with Flo Haislmaier and Ginger Sanchez (from the IEEE). They will support CD ROM sales and recruit new members. According to the IEEE, EMCS membership numbers 8,693, but this number is questionable since it is a significant increase from the 5,605 members shown in the IEEE database in April 1998. Regarding the Fellows Search Committee, Bill Duff reported that Jim Muccioli would receive his Fellow Award at the Awards Luncheon. Gene Cory will be taking over as chair of the Fellows Search Committee. Todd Hubing reported for Scott Roleson, chair of the Distinguished Lecturer program. Mr. Roleson prepared a report concerning the search for a European DL candidate. A slate of four DL candidates for the two open positions starting in 1999 will be presented to the Board for approval at the November Board meeting. Bob Brook presented a report on the IEEE Membership Development Conference held in February 1998. Highlights of the conference involved the legislative efforts of the IEEE in promoting portable pensions. Also noteworthy is the review of membership breakdown by category and location. Student membership increased 10.9%, which is attributed to a decrease in student dues. Most of the growth in student members comes from outside the US. There are now 36 societies in the IEEE, however, only 50% of the membership belong to one of the societies. The IEEE estimates that there are 4-6 million people in the world that are eligible for IEEE membership. Membership growth in the US in 1997 was 7% and the non-US growth was 15%. Bill Gjertson, Nominations and Elections Chair, reported that the ballots were sent out in early August. The slate for 1999 Board of Directors positions included nine names.

Technical Services

Kimball Williams, Vice-President of Technical Services, presented his report. This included the Education Committee report which summarized the various subcommittees and their respective activities planned during the Denver symposium. The Life Long Learning subcommittee prepared a review of the IEEE Entrepreneurial Skills videotape seminar that is sponsored by the IEEE Foundation. Dick Ford requested a copy of this tape for the EMCS videotape library. An agenda of the 24 experiments organized by Experiments subcommittee chairs Larry Cohen and Andrew Drozd was reviewed in the report. Regarding the Technical Activities Committee, Chairman Andrew Podgorski plans to submit a quarterly report to the EMCS Newsletter to encourage participation in the TAC activities. He also plans to post material on the EMCS web page. It was suggested that in addition to material on TAC, material on the Standards Committee should also be included. Mr. Podgorski's report included a TAC Matrix that shows a status report of the technical committees. The scope and charter of each TC is included as well as the roster for each TC chairman. Kimball Williams submitted a report concerning the reorganization of TC-1 (EMC Management). Mr. Williams will chair the TC-1 meeting in Denver. Also, Mr. Williams noted that Louis Libelo was asked to step down as chairman of TC-5 (High Power

Electromagnetics) due to the lack of activity. The Board authorized the TAC and Standards Committee to establish their own respective web pages subject to the approval of Len Carlson and the "Internet Committee". Andy Drozd presented a report on the Intelligent Transportation Systems Council. TAB has given $75,000 as "seed" money to establish future conferences and other activities. There are 19 member Societies in this Council who equally share financial involvement. Mr. Drozd recommended the appointment of a "junior" EMCS representative to the Council to assist him with representing EMCS interests. Regarding the Representative Advisory Committee (RAC), Chairman Dave Case presented a report. Mr. Case recently replaced Leo Makowski as the new RAC chairman.

Standards

Don Heirman, Vice-President for Standards Services, summarized the first year of the reorganization of the Standards Committee and EMCS Board of Directors. His area of responsibilities covers two major areas: the Standards Advisory Committee (SAC) and the Standards Committee. SAC includes 14 representative liaisons that are also working on EMC standards. This includes liaisons to CISPR, ANSI, SAE, EIA, ISO and the ESD Association, among others. Joe Butler, the interim chair of SAC, gave a brief report. Among the goals of the Standards Committee are global/international coordination, policy and procedures, education/training, electronic communications/balloting (including the future addition of chat rooms to discuss standards on line), and liaisons with RAC/SAC/technical committees, to name a few. During the symposium committee meeting, the Standards Committee will work to get ready for the IEEE audit and further revise the Operations Manual. Three standards have been approved (299, 1128, and 1302) in the last four months. Elections are planned for late fall. The committee is preparing their presentation for the EMC '98 Roma conference. They will update their five-year plan and continue their thrust for increased international participation. Bob Hofmann agreed to take over the chairmanship of SAC, replacing Joe Butler. Mr. Heirman acknowledged and thanked Mr. Butler for his work as interim chair of SAC. Concluding his report, Mr. Heirman noted that the EMC Standards Compendium would soon be on-line through the IEEE. This will be a password-protected site.

Communication Services

Len Carlson, Vice-President for Communication Services, distributed his report. This includes a response to an action item on the definition of "poster paper" and "regular paper" as well as information about OPeRA (IEEE's On-line Periodicals and Research Area). Moto Kanda, Transactions on EMC Editor, reported that the special issue on lightning will have 15 papers and will be published in November. Mr. Kanda also proposed a special issue on reverberation chambers for publication in 2000. EMCS Newsletter editor Janet O'Neil advised that Summer Edition was mailed in early August. 400 extra copies were ordered and these will be distributed from the EMCS membership booth in Denver. Favorable comments have been received about the recent publication of practical papers, especially concerning the article on digital EMC by Dr. Howard Johnson. The EMC logo will be incorporated into the cover of the newsletter next year. The new EMCS web page address will be prominently advertised in the next issue. Regarding the History Committee, Mr. Carlson reported for Chet Smith about the Memorandum of Understanding (MOU) outlining the relationship between the EMCS and Applied Microimage, the producers of the CD-ROMs. An ad for the CD-ROMs appeared in the summer issues of IEEE's Spectrum Magazine and yielded sales that exceeded the cost of the ads. Some 4000 CD-ROMs remain in inventory. CD-ROMs will be sold from the membership booth in Denver and will be included as a line item on the registration form for the Seattle symposium in 1999. It is hoped that the convenience of purchasing the CD-ROM with symposium registration will increase sales. Mr. Carlson also reported for Henry Ott, Symposia and Conferences Committee Chairman. Bill Duff discussed the EMC Washington DC symposium in 2000. There is concern about the limited amount of exhibit space available and the committee is considering changing the size of the booth space offered to exhibitors. The budget for the 2000 IEEE EMCS Symposium Budget was presented and approved. The Board approved the formation of a committee to advise the 2000 Washington DC committee on the use of different contracting firms to provide services for the symposium. Bill Duff, Dick Ford, John Osburn, Bill Gjertson and Barry Wallen were suggested as members of this committee to be chaired by Henry Ott. Bill Gjertson presented information on the 1999 Seattle symposium. The committee has secured the services of IEEE Travel and Conference Management Services (ITCMS) to manage the symposium. The committee has transferred the exhibit area from the Westin Hotel to the Seattle Convention Center since the Westin could not offer enough space for the projected number of exhibitors. Thus, the Westin is now the headquarters hotel for social functions and committee meetings, but the Convention Center will be the location for the exhibit space and the technical presentations. President Hoolihan appointed an ad hoc committee to address the issue of the institutionalization of the EMCS symposia process. He would like to see this chaired by John Osburn with the members being Jim Muccioli, Bill Gjertson, Barry Wallen, Bob Hofmann, Hugh Denny and Bill Duff. Hugh Denny gave a brief report concerning the IEEE Press. Mark Montrose will complete a second book on PCBs that will follow up on his first book published by the IEEE Press. Mr. Denny will have a report on the IEEE Press ac-

tivities in Denver (i.e. how many books were sold, etc.) for the November Board meeting.

EMC '98 Roma

President Hoolihan briefly addressed the Board activities in Rome during the EMC '98 Roma conference. There will be technical presentations by a few Board members and an informal, Board-hosted reception.

Long Range Planning

Joe Butler distributed the report of long range planning. He discussed the idea of the EMCS hiring a paid administrator to manage the interests of the EMC Society at the IEEE. He would like to include $10K in the annual budget for this purpose. The Board approved this and formed a committee to make recommendations on the job description, compensation, and candidates for the position. Mr. Butler discussed the goal of increasing EMCS membership in Region 9 (South America) in line with our long-range plan to become an increasingly global organization. The EMCS has been solicited to participate in an EMC conference in Brazil. Jose Perini is involved in this conference. The Board agreed to continue targeting Region 9 for increased membership and the request of $10,000 to be added to the membership committee budget for this purpose. Mr. Butler advised that he was not able to prepare a report on recommendations for computer software for the Board. This will be addressed in the future.

The following item was discussed under "Unfinished Business":

EMCS Handbook

Bob Hofmann distributed copies of the EMCS Handbook concerning Procedures, Policy, Constitution and Bylaws. It was suggested that this handbook be posted on the EMCS webpage. Board members were requested to review this document and forward any comments to Mr. Hofmann. Once all comments are resolved, the handbook will be posted to the web page.

The following items were discussed under "New Business":

1999 EMC Symposium in Tokyo

Takeo Yoshino provided information on the EMC conference in Tokyo, Japan on May 17-21, 1999. He also distributed the call for papers. President Hoolihan will present the keynote speech at the opening session of the conference on May 18.

1999 EMC Symposium in Zurich

President Hoolihan advised that there would be an EMCS membership booth at Zurich which will be coordinated by Member Services. The Board will not be travelling to Zurich; instead, the Board selected the Tokyo EMC symposium as the location for the 1999 non-US Board meeting.

IEEE Procedures on Meetings, Conferences and Symposia

President Hoolihan advised that the IEEE has had a change in policy on the use of sponsorship, etc. in referring to participation in various conferences and symposia. These changes mandate a review of all existing agreements with currently scheduled EMCS symposia.

IEEE Market Study

The income stream from Transactions on EMC is being threatened by the increasing use of electronic media. The Board discussed ways to address this trend.

IEEE History Center

The Board approved allocating $5,000 for the purpose of including the EMC Society in the proposed new IEEE History Center. The expenditure of these funds would require prior Board review and approval. Len Carlson suggested that a representative from the History Center attend the November Board meeting in Piscataway and present a report on the benefits for EMCS members from participating in the History Center.

EMC Society 50th Anniversary

President Hoolihan noted that the 50th anniversary of the EMC Society would occur in 2007. President Hoolihan would like the Board to consider the significance of the EMC symposium location that year. Any proposals for 2007 should be forwarded to President Hoolihan.

EMCS Representation on Councils

The Board agreed to increase the RAC budget by $6,000 to fund travel for two Board members to attend the Intelligent Transportation Systems and Sensors Council meetings in 1999 which will be held in conjunction with the IEEE TAB meetings.

1999 Budget

Treasurer Warren Kesselman presented the 1999 budget, which shows a net surplus of $54,300. The budget was approved as presented.

1999 Board Meetings

President Hoolihan discussed the proposed EMCS Board meeting dates and locations for 1999.

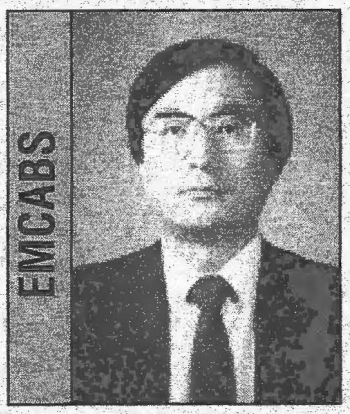
Secretary Janet O'Neil then reviewed the action items assigned during the meeting. There being no further business, the meeting then adjourned at 4:40 pm.

Janet O'Neil
Secretary, EMC Society Board of Directors

In Memoriam

Chris Kuyatt, Acting Executive Director for the NIST Visiting Committee on Advanced Technology, passed away on Saturday, September 12 after a brief battle with cancer. Dr. Kuyatt joined the National Bureau of Standards in 1960 as a physicist in the Electron Physics section. In 1978, Dr. Kuyatt became Chief of the newly-formed NIST Radiation Physics Division. From 1979-1991, he held the position of Director, Center for Radiation Research.

EMC Society members will remember Chris for his contributions to EMC measurement uncertainty, and his work as one of the authors of NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results" in particular.



OSAMU FUJIWARA
ASSOCIATE EDITOR

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

EMCAB COMMITTEE
Bob Hunter, Consultant
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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, order it from NTIS or DTIC. Recently it became clear that EMCABs were more timely than publications which were being listed in data files. Therefore, additional information will be included, when available, to assist in obtaining desired articles or papers. Examples are: IEEE, SAE, ISBN, and Library of Congress identification numbers.

Also, the steering staffs of the Japan Technical Group and the EMC Japan Tokyo Chapter have offered to act as a central point for requests of papers abstracted here. Most of the papers will be available in Japanese only. Abstracts of papers from EMC Japan will be clearly identified. As a member of the steering staff, I will assist in routing your request to the author(s) but will not translate the papers.

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

As the EMC Society becomes more international, we will be adding additional worldwide abstractors who will be reviewing articles and papers in many languages. We will continue to set up these informal cooperation networks to assist members in getting the information or contacting the author(s). 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.

SITE ATTENUATION CHARACTERISTICS OF FULLY ANECHOIC CHAMBER USING FOAMED FERRITE AS NEW ABSORBING MATERIAL

EMCABS: 01-11-98

Masamitsu Tokuda+, Kazuo Simada++ and Hiroshi Ishii++
Kyushu Institute of Technology
++Riken Eletech Corporation
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.181-184

Abstract: Fully anechoic chamber using a foamed ferrite as a new absorbing material, which thickness is only about 10 cm, has been developed. It is confirmed that the normalized site attenuation in free pace is within plus-minus 4dB to the theoretical value on the frequency range of 30 MHz to 18 GHz. It is revealed that the emission measurement in free space condition can be realized in a small space.

Index terms: Fully anechoic chamber, foamed ferrites, site attenuation, emission measurement.

PRODUCTION METHODS AND CHARACTERISTICS OF FOAMED FERRITE AS NEW ABSORBING MATERIAL OF ANECHOIC CHAMBER

EMCABS: 02-11-98

Toshikastu Hayashi, Sigeo Inoue, Yukio Nakanouchi,
Kazuo Simada, Hiroyosi Ishii and Masamitsu Tokuda,
Riken Corporation, Rikenelectech Corporation
Kyushu Institute of Technology
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.189-192
Abstract: In this study, we proposed a wide frequency range RF absorber which shows superior absorbing characteristics at the microwave band, by means of combining ferrite tile absorbers with RF absorbers made of pyramidally foamed, formed and sintered ferrite powders. In the new absorber, while the absorbing property of the ferrite tile absorber at a low frequency range is maintained, an absorbing property of 20 dB or over at a high frequency range up to 10 GHz is achieved. The height of the pyramid of the new absorber is only 10 cm, which is advantageous for use in anechoic chambers. In addition, when a carbon pyramidal absorber approximately 30 cm high is added, the absorber can be used even at a higher frequency range; it showed an absorbing property of 30 dB or over at 1 GHz - 20 Ghz.
Index terms: Anechoic chamber, RF absorber, foamed ferrites, production method, absorbing properties.

EXPERIMENTAL ANALYSIS ON ELF MAGNETIC FIELD ATTENUATION OF SHIELDED CYLINDERS

EMCABS: 03-11-98

Yeon-Choon Chung, Byung-Chil Woo and Min-Su Choi
Electromagnetic Metrology Div., Korea Res. Inst. of Std. & Sci.
Jong-Hwa Kwon and Dong-Chul Park
Dept. of Radio Sci. & Eng., Chungnam National Univ.
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.193-196

Abstract: The construction of magnetic shielding measurement system and the experimental analysis of magnetic field attenuation of the shielded cylinders are presented. Measurement system was constructed using a Helmholtz coil system in accordance with ASTM-A698M-92. Generated field uniformity was less than 5% within 403 cm3 volume, and magnetic shielding effectiveness of less than 50 dB can be measured in the frequency range up to 10 kHz. The variation of magnetic shielding effectiveness was investigated by changing the magnetic flux density, test frequency, and physical size of the shielded cylinder made with 3% SiFe and magnetic amorphous ribbon.

Index terms: Magnetic shielding, ELF, Helmholtz coil system, shielding effectiveness, experiment.

SHIELDING EFFECT OF POROUS CARBON MATERIAL "WOOD CERAMICS"

EMCABS: 04-11-98

Yukio Hotta, Mitsuharu Sato and Hitoshi Togawa,
Tokin Corporation,
Shuichi Nitta,
Tokyo University of Agriculture and Technology
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.197-200

Abstract: The measured results of electromagnetic shielding effect of porous carbon material wood ceramics, which is currently being studied for practical commodity application, are discussed. The electromagnetic shielding effect or permittivity vs frequency characteristics for different sintering temperatures are studied and it is found that wood ceramics permittivity increases as sintering temperature becomes high. This means that conductivity of high-temperature sintered wood ceramics is getting low. In this paper, electromagnetic shielding effect of wood ceramics sintered at 800 Centigrade against near field and far field are studied. To obtain the shielding effect at near field and far field, ADVANTEST method and TEM cell method are used respectively.

Index terms: Wood ceramics, electromagnetic shielding effect, measurement.

ALTERATIONS OF SEMI-ANECHOIC CHAMBER TO REALIZE THE FREE SPACE CONDITION

EMCABS: 05-11-98

+Yoshinobu Hayashi, Takashi Shinozuka and Risaburo Sato
Electromagnetic Compatibility Research Laboratories Co., Ltd.
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.201-204
Abstract: Free space condition is required of test site at EMI measurement above 1 GHz. The users of semi-anechoic chambers currently used below 1 GHz take notice of the applicability to use them above 1 GHz. We measured conventional chamber of 3 m and 10 m method and investigated the requirements to realize free space condition, for example the requirement of covering the floor with electromagnetic absorbers in the range from 1 GHz to 6 GHz. We already reported the evaluated result by height pattern measurement. This time, we measured the horizontal distance characteristics of the electromagnetic field strength, compared them with theoretical values of characteristics. In the result, it was found that free space condition is satisfied within an accuracy of 3 dB for both horizontal and vertical polarization in a chamber of 3 m method with considerations for around the receiving antenna. It was also found that this result was same as result of height pattern measurement.
Index terms: EMI measurement, semi-anechoic chamber, horizontal distance characteristics, free space condition.

ELECTROMAGNETIC SCATTERING CHARACTERISTICS OF CONCRETE BUILOINGS IN MOBILE RADIO WAVE PROPAGATION CHANNEL

EMCABS: 06-11-98

Yasumitsu Miyazaki+ and Paul Selormey
Toyohashi University of Technology
Department of Information and Computer Sciences
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.205-208

Abstract: Detailed characterization of radio propagation channel is a major requirement for successful design of mobile communication systems. In this paper, mobile radio channel characterization process based on the FDTD method is presented. The merits and demerits of the currently used methods, namely impulse-response method and ray-tracing methods are briefly considered, and the total field formulation of the FDTD method is discussed.

Index terms: Mobile communication systems, concrete building, electromagnetic scattering, FDTD simulation.

SHIELDING PERFORMANCE EVALUATION OF TWO IMAGE PLANES CONFIGURATION — EMCABS: 07-11-98

J.S. Kim, H.J. Lee, and N. Kim
+Electronics and Telecommunications Research Institute
++Chungbuk University
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.209-212

Abstract: The use of image planes is an effective method to reduce the radiated emissions from a printed circuit board(PCB). This paper deals with the influence of image planes on the radiation from PCB. The shielding performance of multi-layers of image planes of finite width and length is analyzed by the method of moments based on the triangular surface patch model. It is demonstrated that proper triangulation should be made so as to take two basis functions in the boundary triangles of the surface.

Index terms: Printed circuit board, radiated emission, shielding performance, method of moment.

EFFECTS OF FERRITE SHEET ATTACHED TO PORTABLE TELEPHONE ON SPATIAL PEAK SAR REDUCTION — EMCABS: 08-11-98

+Jianqing Wang and Osamu Fujiwara
Department of Electrical and Computer Engineering, Nagoya Institute of Technology
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.213-216
Abstract: Although the authors have previously proposed a ferrite sheet attached to a portable telephone to reduce the spatial peak specific absorption rate (SAR) in the human head, the dependence of material properties of ferrite sheet on the SAR reduction effects is still unclear. In this paper, a quantitative relationship between the complex permeability of ferrite sheet and the reduction effect of spatial peak SAR is derived through the finite-difference time-domain (FDTD) analysis. It is found that the SAR reduction effect increases with increasing of the real part of the complex permeability and decreasing of the imaginary part. A maximum reduction of spatial peak SAR may exceed 30% at 900 MHz, and no degradations in the maximum antenna radiation directions are observed for both the horizontal and vertical planes. Moreover, the antenna radiation efficiency increases slightly when is large because the decreased quantity of the power absorbed by the human head is larger than that dissipated and reflected by the ferrite sheet.
Index terms: Portable telephone, spatial SAR, ferrite sheet attachment, SAR reduction effect, FDTD analysis.

CALCULATION OF HIGHER ORDER MODE CUTOFF FREQUENCIES IN 50 OHM ASYMMETRIC TEM CELLS BY GALERKIN METHOD — EMCABS: 09-11-98

J.H. Yun, K.Y. Cho and H.J. Lee
Electronics and Telecommunications Research Institute
J.K. Kim
Department of Electronics Engineering, Chungang University
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.217- 220

Abstract: The authors propose the half mode boundaries to solve not only the higher order mode cutoff frequencies of symmetric TEM cells but also those of asymmetric TEM cells. It is shown that the measured resonant frequencies of a designed asymmetric TEM cell agreed well with the predicted results by the Galerkin method (GM).

Index terms: Crawford's TEM cells, higher order mode cutoff frequencies, Galerkin method, calculation, measurement.

LONG-TERM TEST RESULTS OF ELECTROMAGNETIC INTERFERENCE FROM A 765 KV TEST LINE — EMCABS: 10-11-98

Hee-Sung Ahn, Sung-Ho Myoung, and Kwang-Ho Yang
Korea Electrotechnology Research Institute
Jeong-Boo Kim, Dong-Il Lee,and Koo-Yong Shin
Korea Electric Power Research Institute,
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.225-230

Abstract: This paper presents the results of long-term electromagnetic interference measurements (EMI) on one of the first conductor bundle tested at the Kochang 765 kV Project. The instrumentation and the facilities are also described in brief. This test line can be energized at line voltages up to 830 kV line-to-line. The measurements described in this paper were conducted on a bundle of 6 x 3.04 cm diameter conductors (Cardinal). The analysis of the data shows that the 6-Cardinal conductor bundle meets the radio and television interference guidelines of the Korea Electric Power Corporation (KEPCO).

Index terms: EMI, radio interference, television interference, test line, corona, extra high voltage

RESPONSES OF SPECTRUM ANALYZERS TO PULSIVE AND GAUSSIAN NOISE INPUTS — EMCABS: 11-11-98

Yukiko Yamanaka and Akira Sugiura
Communications Research Labolatory, Ministry of Posts and Telecommunications, Japan
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.239-242

Abstract: Three different spectrum analyzers currently available were investigated with special interest in their IF frequency selectivities, impulse responses, and Gaussian noise responses. It was concluded that, due to the variation in the frequency selectivities, disagreement arose over EMI measurement results obtained with different spectrum analyzers. The maximum differences in the impulse and Gaussian responses of various analyzers were observed to reach 6.4 dB and 3.5 dB respectively, when the analyzers were adjusted for a nominal RBW of 1 MHz. Frequency selectivities such as 6-dB band width should be standardized clearly in order to measure EM disturbance with good accuracy and reproducibility.

Index terms: EMI measurement, spectrum analyzer, impulsive/gausian noise response, measurement.

EVALUATION OF UNCERTAINTY FOR SITE ATTENUATION MEASUREMENTS — EMCABS: 12-11-98

Akira Sugiura+, Kunimasa Koike, Akira Ohtani, and Hiroshi Masuzawa
Communications Research Laboratory, MPT
Proceedings of 1998 Korea-Japan AP/EMC/EMT Joint Conference, Pusan, Korea, September 3-5, 1998, pp.247-250

Abstract: This paper briefly reviewed recent CISPR activities related to the validation of a test site used for EMI antenna calibration. Following the CISPR draft specification, site attenuation was measured at a CRL site, which proved excellent agreement between experimental and theoretical values. In addition, various uncertainty components associated with the above measurement were analyzed using the moment method. The expanded total uncertainty varies widely depending on the frequency, but it was estimated to be max. 0.33 dB, as listed in Table 3.

Index terms: EMI antenna calibration, test site validation, site attenuation measurement, uncertainty.

Calendar

EMC Related Conferences & Symposia

1999

February 16-18
Sponsored by the IEEE Switzerland EMC Chapter
13TH INTERNATIONAL ZURICH SYMPOSIUM AND TECHNICAL EXHIBITION ON EMC
Zurich, Switzerland
Dr. Gabriel Meyer, +411.632.27.90
e-mail: gmeyer@nari.ee.ethz.ch
Http://www.nari.ee.ethz.ch/emc/

March 23-25
Sponsored by the IEEE
EMV '99: International Exhibition (with Workshops) on EMC
Messe Dusseldorf, Germany
Organized by: MESAGO
http://www.mesago.de
e-mail: dunja@mesago.de

April 26-28
Sponsored by the SAE
TOPTEC ON EMC
Technical Conference and Exhibition
The Novi Hilton, Novi, MI
Kevin Perry, 724-772-8569
e-mail: kperry@sae.org

May 3
Sponsored by the Phoenix Chapter of the EMC Society
EMC '98: A COLLOQUIUM AND EXHIBITION ON PRE-COMPLIANCE EMC TESTING PROBLEMS AND SOLUTIONS
Featuring Keynote Speaker Henry Ott
Mesa, AZ
Daryl Gerke, 602.755.0080
e-mail: dgerke@aol.com

May 17-19
Sponsored by Wessex Institute of Technology, UK and the University of Toronto, Canada
ELECTROSOFT 99 - Software for Electrical Engineering
Seville, Spain
Liz Kerr, +44(0)1703 293223
fax: +44(0)1703 292853
e-mail: liz@wessex.ac.uk
Http://www.wessex.ac.uk

May 17-21
Co-Sponsored by the IEEE EMC Society - Tokyo Chapter
EMC '99 TOKYO
Chuo University
Tokyo, Japan
Prof. Noboru, +81.426.65.1441
e-mail: sch@cs.takushoku-u.ac.jp
Http://www.cs.takushoku-u.ac.jp/is/emc99/

June (exact date to be advised)
MODE-STIRRED, ANECHOIC CHAMBER, AND OATS USERS MEETING - New Location, New Date (Originally scheduled in October 1998)
Underwriters Laboratories
Northbrook, IL
Mike Caruso, 847-272-8800 x41534
e-mail: carusomi@ul.com

June 22-24
Sponsored by the SAE
INTERNATIONAL CONFERENCE ON LIGHTNING AND STATIC ELECTRICITY
Toulouse, France
Jim Brahney, fax 724-776-1830

September 13-17
Sponsored by the IEEE
INTERNATIONAL CONFERENCE ON EMC IN ADVANCED APPLICATIONS (ICEAA 99)
Torino, Italy
http://www.polito.it/iceaa99

November 1-4
Sponsored by the IEEE Beijing Section and others
1999 INTERNATIONAL CONFERENCE ON COMPUTATIONAL EMC AND ITS APPLICATIONS (ICCEA'99)
Beijing, China
http://www.cie-china.org/iccea-99.htm

November 2-4
EMC ASIA 99: 2nd INTERNATIONAL EXHIBITION (WITH WORKSHOPS) ON EMC
Westin Stamford and Westin Plaza
Singapore
http://www.mesago.de

December 2-8
Sponsored by the IEEE and others
6TH INTERNATIONAL CONFERENCE AND WORKSHOP ON EMI AND EMC: EMC for Optimal Spectrum Utilization
New Delhi, India
S. Mukhopadhyay
e-mail: mukho@xm.doe.ernet.in

IEEE Administrative Meetings 1999

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

May 21
EMC Society Board of Directors
Tokyo, Japan

August 1 and 5
EMC Society Board of Directors
Seattle, WA

November 19 and 20
EMC Society Board of Directors
Washington DC

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

1999 Tokyo, Japan
May 17-21
S. Nitta
E-Mail: nitta@cc.tuat.ac.jp

1999 Seattle, WA
August 2-6
Westin Hotel
Bill Gjertson
425.393.2557
E-mail: w.gjertson@ieee.org

2000 Washington, DC
August 21-25
Washington Hilton
Bill Duff
703.914.8450

2001 Montreal, Canada
Montreal Convention Center
Christian Dube
514.653.6674

2002 Minneapolis/St. Paul
Hyatt Regency, Minneapolis
Dan Hoolihan
651.638.0250
E-Mail: dhoolihan@tuvps.com

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
650.933.8789

2005 Chicago, IL
Bob Hofmann
630.979.3627

The IEEE EMCS Newsletter welcomes contributions to this calendar page. Please send information to:
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Institutional Listings

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

AMPLIFIER RESEARCH

160 School House Road, Souderton, PA 18964-9990 USA
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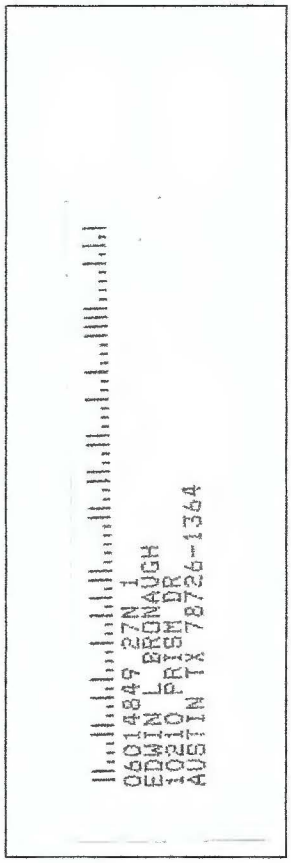

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