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EMC

IEEE EMC Society Newsletter

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IEEE

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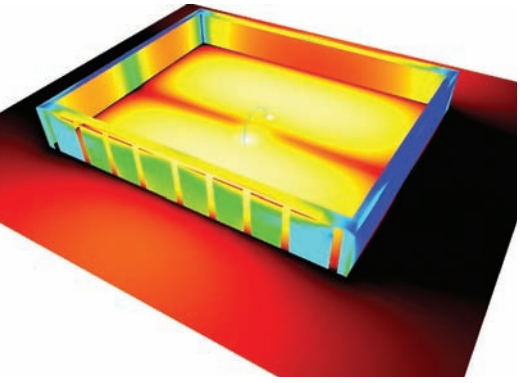

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CHANGING THE STANDARDS

Letter from the Editor

Newsletter Editor Janet O'Neil joins FIAT's Saint' Clair Nunes (left) and Rávisson Amaral Almeida (right) at the EMC Society outreach event in Brasilia, Brazil on April 4, 2011. The gentlemen attended to hear a full day of presentations on various EMC topics. See page 10 for more information on this successful event.

Welcome Kye Yak See! This issue features our new Technical Editor, Kye Yak See, of the Nanyang Technological University in Singapore. Dr. See brings a wealth of applied experience to the Practical Papers section of this Newsletter. He succeeds Flavio Canavero of the Polytechnic of Turin who served as the Newsletter's Technical Editor for several years. The EMC Society is indebted to Professor Canavero's service to the Newsletter as Technical Editor. You can learn more about our new Technical Editor on page 68.

Coincidentally, this issue starts and ends with a reference to the formal review IEEE conducts of its Societies every five years. In her President's Message starting on page 4, Francesca Maradei discusses the outcome of the EMC Society's review in February 2011. In his article on the IEEE Society on the Social Implications of Technology (SSIT) starting on page 93, Kimball Williams tells us why the IEEE initiated the five year review of all Societies. I think you will find this connection interesting.

In other interesting news, learn about Frank Leferink on page 30 and why I curtsied when I recently saw him at the Asia Pacific EMC conference in Korea. Dan Hoolihan provides a post earthquake report related to a past article he provided on the Museum of Communications in Tokyo, Japan (Spring 2010). One year later, it's gratifying to know an earthquake-resistant case worked and saved a technical treasure. Read about this treasure on page 44.

continued on page 84

FIELD OF INTEREST

The Field of Interest of the Electromagnetic Compatibility (EMC) Society involves engineering related to the electromagnetic environmental effects of systems to be compatible with itself and their intended operating environment. This includes: standards, measurement techniques and test procedures, instrumentation, equipment and systems characteristics, interference control techniques and components, education, computational analysis, and spectrum management, along with scientific, technical, industrial, professional or other activities that contribute to this field.

Newsletter Staff

IEEE EMC Society Newsletter Publication Schedule

Publication Dates	Editorial Deadlines	Advertising Deadlines
Summer	July 1	July 12
Fall	October 1	October 11
Winter	January 1	January 14
Spring	April 1	April 11

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President's Message

Francesca Maradei, President, IEEE EMC Society

This message is written while I am on the train back from Naples where I attended the IEEE Workshop on Signal Propagation on Interconnects. This workshop is sponsored by the IEEE Components, Packaging and Manufacturing Technology (CPMT) Society, and over the previous 14 editions it has certainly become a *forum of exchange* on the latest research and development in the field of interconnect modeling, simulation and measurement at chip, board, and package level. This was the first edition in which the IEEE EMC Society was involved as technical co-sponsor, and I hope that this cooperation will be strengthened in the future since the topics covered by this workshop certainly fit into our field of interest. I had the honor to give a welcome message on behalf of the EMC Society to the participants during the opening ceremony and to introduce the invited lecturer Moises Cases (of The Cases Group) who provided an interesting lecture on "Technical and Economical Challenges for Electronic Packaging."

Francesca Maradei with Flavio Canavero (left, member of SPI 2011 Standing Committee) and Antonio Maffucci (SPI 2011 Chairman) enjoying the coffee break.

The EMC Society Review

The EMC Society has successfully completed the periodically conducted five-year Society review on behalf of the IEEE Technical Activities Board (TAB) Society Review Committee (SRC). The SRC operates under TAB and ensures the continued technical leadership of the IEEE by developing procedures for the periodic review of TAB Societies and Councils and by conducting such reviews. The intent of the SRC is to listen, learn, discuss and comment with a view to helping Societies and Councils exchange best practices and better serve the profession. The reviews of IEEE Societies and Councils focus on the extent to which the Society/Council (S/C) is maintaining its vitality and technical leadership in its field of interest and is interacting appropriately with other entities. The main task of the SRC is to analyze the scope and structure of the various S/Cs in order to ensure that technical interest areas are fully covered in appropriate, effective and efficient ways.

As per the review schedule, Societies and Councils of the Technical Activities Board (TAB) are reviewed once every five years. The review process is based on a preliminary submission of a detailed report in which the Society provides input to the SRC as well as a face-to-face meeting. The report covers all aspects of the operation of the organizational unit, including finances, conferences, publications, governance, membership, etc., and is provided to the SRC one month or more prior to the SRC face-to-face meeting.

The face-to-face meeting with the SRC took place on February 17 in Miami, and I had the privilege to lead the EMC Society delegation that included our President-elect Ghery Pettit and our Vice-President for Standards, Don Heirman. We had a very interactive discussion in which the SRC has been very supportive. The whole review process was an instructive and enlightening experience which has been most helpful in broadening our view and vision of our Society and its activities.

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Don Heirman (far left), Francesca Maradei, Ghery Pettit and his wife Marilyn are shown enjoying dinner after the face-to-face meeting with the Society Review Committee.

Welcome to the participants at INTI in Buenos Aires on behalf of Edmundo Gatti (INTI), Francesca Maradei (EMC Society) and Gustavo Fano (Argentina EMC/AP Chapter chair).

Group photo of the speakers and organizers of the outreach event at INTI in Buenos Aires.

Enjoying Argentine food in Buenos Aires after the regional event at INTI are (clockwise from left) Perry Wilson, Janet O'Neil, Vince Rodriguez, John Estrada, Dennis Lewis, Kenny Kirchoff, Todd Hubing, Francesca Maradei and John Norgard.

The main comments received from the SRC are here summarized:

- The EMC Society is commended for its detailed Strategic Plan, and is encouraged to continue with an operational plan to implement its strategy.
- The Society has a thoughtful process for event technical co-sponsorship.
- Education is a serious focus for the Society, which runs a number of programs including a successful "Global EMC University Program." The Society should consider the possibility of expanding this initiative to include electronic dissemination.
- The Society has an active worldwide chapter program and provides its chapters with excellent support.
- The Society is in sound financial shape and is encouraged to identify initiatives to use some of its reserves.

The SRC has identified several best practices that will be presented at the next TAB meeting in June in order to provide an example to follow to other IEEE Societies. The EMC Society's best practices include having:

- A strategic plan for the Society
- A detailed procedure for technical co-sponsorship of conferences
- The Global EMC University Program
- An annual membership survey
- An effective chapter database – recommend to IEEE MGA
- A retreat for Chapter Chairs
- An online handbook for Chapter Chairs
- A Sections Coordinator and Sister Societies Committee
- A Technical Advisory Committee

Global Outreach Activities Continue

To increase its effectiveness, its visibility, and its relevance, the EMC Society continued in recent months its global outreach efforts with two regional events in Argentina and Brazil.

I was delighted to lead a delegation of the Board of Directors attending and participating in the one day event hosted at the Instituto Nacional de Tecnologia Electronica e Informatica (INTI) in Buenos Aires. The event on "Emerging Technologies in EMC" was organized by the EMC Society in cooperation with the local AP/EMC Argentina chapter and with iNARTE, and was attended by about

80 participants including people from both academia and industry. The interest in EMC in Region 9 is growing fast, and very high quality work was presented by members of the Board delegation, including Perry Wilson, Todd Hubing, John Norgard, and myself.

Unfortunately, I was not able to take part in the next outreach event in Brasilia that was hosted at Agência Nacional de Telecomunicações (ANATEL), but I can report that it was successful too.

I wish to thank Janet O'Neil for her excellent job in organizing, coordinating and publicizing the regional events in Buenos Aires and Brasilia. Without her hard dedication, they wouldn't have been so successful!

More information on the outreach efforts in both Argentina and Brazil may be found in the Chapter Chatter Column in this issue, starting on page 8.

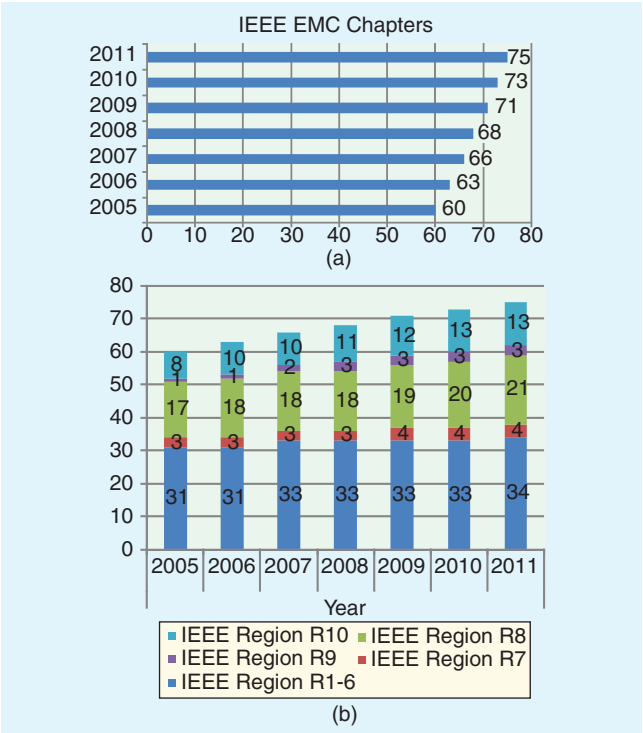
Welcome to Newly Formed EMC Chapters - Chapter Development Update

Since the beginning of the year, two new chapters have been approved:

- IEEE Syracuse Section joint AP/MTT/EMC chapter
- IEEE Serbia and Montenegro Section EMC chapter

Congratulations to the newly formed IEEE EMC Chapters!

Chapter development has been the focus of the EMC Society for many years, since it is believed (and has been proven valid) that healthy and active chapters form a great support for the Society as a whole, provide a resource for volunteers and most of all – provide a fundamental resource for the Society members.



EMC Society Chapter Growth: Total number (a) and distribution by region (b).

continued on page 47

Chapter Chatter

Todd Robinson, Associate Editor

Using ESD Guns to Settle Employee Disputes

We were young once, if not a little foolish
By Mike Violette

In the beginning of a company, work rules and policies don't always get well-defined. This is particularly true if you haven't held a real job yet and have no experience in organizational management. So it was with our early lab days and we've worked hard to improve (but some bad habits still exist: legacy, like a chipped tooth).

In the beginnings of commercial EMC, with the adoption of Docket 20780 (digging into a time capsule here), the landscape sprouted with labs. It was easier then; if you had a parking lot and fifty grand for a couple of antennas and a spectrum analyzer, you were in business.

So it was with us in the early days, and we froze our backsides in the snow in the winter and got wet when it rained and disassembled and dragged the antenna mast inside the building every night when we closed up because in the wild and reckless suburbs of Gaithersburg, one never could be too cautious. The weather was always a factor in this biz, as those with OATS know too well. And on the particular day in late August, the weather temporary broke the back of the local power distribution and we were left idle to gather in the front office and observe the lightning flashing and hard hail falling, dinging the ground and cars parked around our 3 m test site.

It was to be an electrically-charged day.

As I said, work rules were loose (*mea maxima culpa*) and our product safety/ESD test engineer "Vince", who liked to go barefoot in the summer (except when he was setting fire to products) leaned lazily against the metal frame of the front door, his shoeless feet (yes, OSHA, I know) on the damp carpet. The door was propped open to observe the full-fury of the late summer thunderstorm when suddenly lightning flashed a few hundred yards away. Vince yelped and jumped straight up, a victim of lightning ground currents and resultant "step voltage" (see: http://www.emcs.org/acstrial/newsletters/spring09/ChapterChatter.pdf). Vince stood at least 6'4" and when he leapt up, his head banged against the door closure mechanism. He howled again, landed and grabbed the top of his head.

"Scott", our FCC test guy, howled. Now Scott had the disposition of enjoying his job maybe too much, delighting in finding the odd spur that broke the FCC Class B limit; a bit sadistic, and a trait I've observed in more than one EMC engineer. Anyway, when Vince hit the ground again, bouncing, really, from the dual ignominy of the shock and the coup de tête, Scott doubled over in laughter.

Vince, not a happy camper, scowled and left the room, rubbing his pate.

Soon enough, the power came back. Vince put his shoes on and went back to the ESD testing that was interrupted when the juice went out. These were the days of the "IEC 801-2" specification, several years before CE Marking and all that good harmonization. ESD was a voluntary thing, but some manufacturers were aware that passing the test was a good idea.

Now, the Schaffner NSG 430 will always remain in my memory, fondly, as it was the first piece of test equipment that we acquired. This little beauty was built for a single purpose though: positive voltage, air discharge only (the notion of contact discharge hadn't been mid-wived by whatever committee was working it). Sixteen-point-five kilovolts of miniature lightning: it did the trick and it's still on a shelf, somewhere (we engineers loath to toss out any equipment, even when it's obsolete).

In any event, Vince and I were setting up to test a PC or something. The fog of time obscures all the small details. The NSG 430 was powered up and idling on the bench.

Scott, still in a state of reverie over Vince's double whammy a few minutes ago, was re-re-telling the story to Jane, who was trying to get some work done at her desk. He slapped her desk: "Hah, you should have seen it: Flash! Ow! Pow! YOW!"

Victor was now audibly growling as Scott came around the corner, beaming a big smile.

"Vince! How's your head? Hah! What hurts worse, your scalp or your feet? Hah hah! Did you see him jump, Mike?"

Vince, with the cool of The Stranger in High Plains Drifter, deftly hefted the NSG 430 as Scott approached, winding the knob on the ESD gun to maximum as Scott got within arms-length.

Vince's eyes flashed and locked onto Scott's, who suddenly froze. A coyote howled as the realization registered on Scott's face.

"Don't do it!"

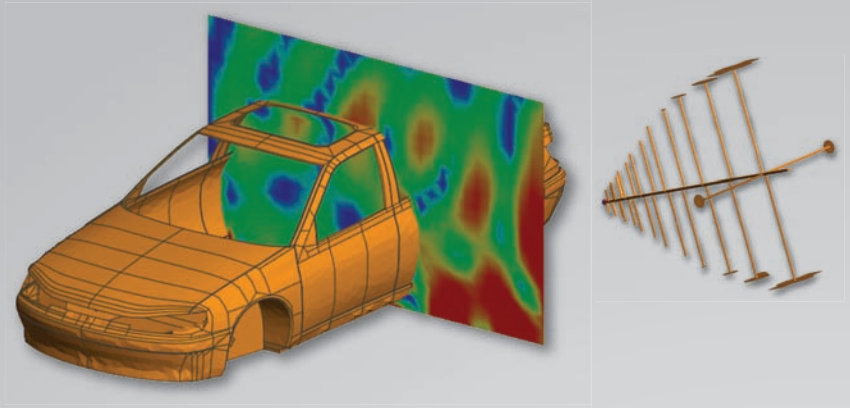
In an instant, Vince landed the tip of the gun onto Scott's left shoulder, pulled the trigger and unleashed a bucket of coulombs.

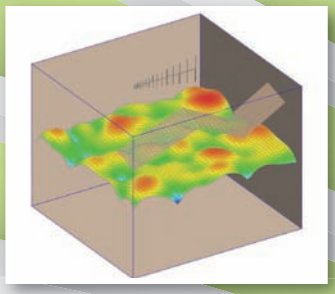
"YOW! D&MN! You did it! BZ&*@&T#E!"

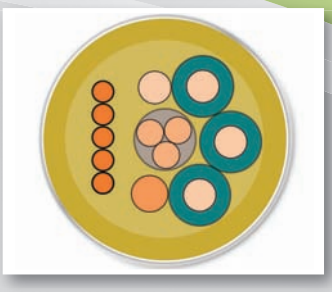
Score settled, Vince calmly blew the "smoke" from the barrel and holstered his weapon. Scott turned around, rubbing his shoulder and returned to his desk. He was quiet for the rest of the day and I enjoyed the peace that settles after a truce is struck.

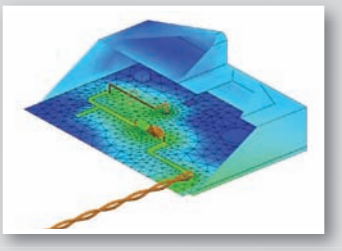
Since then, we have implemented various work-policies: wearing shoes is mandatory and we only allow the use of ESD guns on humans during certain training involving interns and only rarely on customers.

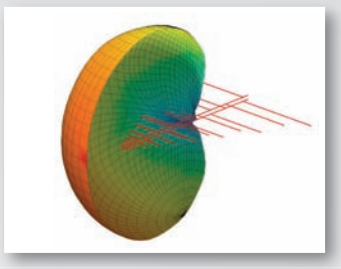
Covering a broad spectrum of your EMC simulation requirements

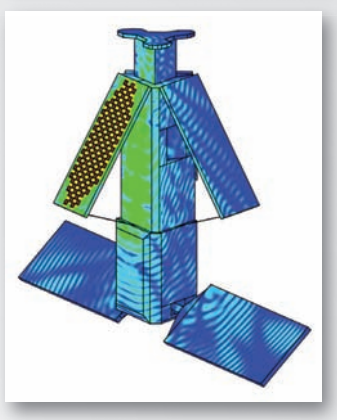












FEKO includes several computational methods, each optimised for different problem types, and hybridised for the efficient analysis of complex, low and high frequency problems. Special formulations, tools and interfaces are used for EMC analysis:

- shielding • coupling • cable analysis
- radiation • irradiation • near-fields
- fast frequency sweep • combined field and network analysis
- specific absorption rate (SAR) • test system design and analysis.

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Austria

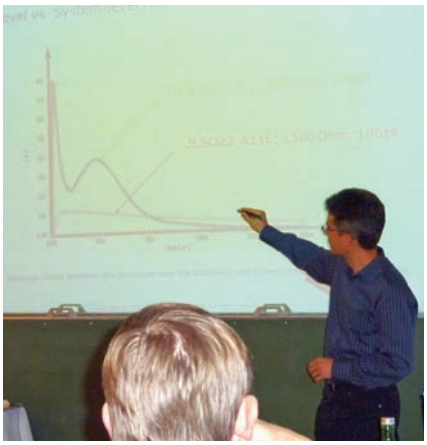
On October 28, 2010 the Austrian Chapter organized a technical meeting at the Johannes-Kepler University (JKU) Linz.

Gunter Winkler (Technical University Graz, Austria) and Bernd Deutschmann (Infineon Technologies AG, Munich, Germany) gave a presentation about the protection of electronic devices and systems against electrostatic discharges. Among all transient disturbances, ESD is still one of the most important reliability problems for the IC industry.

First, an overview of the typical sources and models for electrostatic discharges, such as Human Body Model (HBM), Machine Model (MM), and Charged Device Model (CDM) was given. The different ESD requirements at the IC- and the system-level were explained and discussed.

Commonly used protection elements such as a voltage dependent resistor (VDR), transient voltage suppressor (TVS), gas discharge tube, and RC filters were explained and analyzed in a live demonstration using ESD simulation with a gun ESD model. The attendees were able to see the differences in the responding and protection behavior of the demonstrated protection elements.

A very important topic, the right placement of the external protection elements on the PCB, concluded the 90 minute talk. After the presentation, the attendees used the opportunity for discussions during the coffee break.



Dr. Bernd Deutschmann (Infineon Technologies AG, Munich, Germany) explaining the differences between a system-level and an IC-level ESD pulse.

Brasilia

Several members of the IEEE EMC Society and members of the IEEE EMC Society Board of Directors traveled to Brasilia, the capital city of Brazil, following the EMC Society regional event in Buenos Aires (see page 12). Janet O'Neil, EMC Society Region 9 Event Coordinator, and André Kavaliéris Galvão of AK Telemedia organized a one day seminar on Monday, April 4, 2011 at the AGÊNCIA NACIONAL DE TELECOMUNICAÇÕES (ANATEL). Anatel is a government organization similar to the FCC in the United States. As such, it is a hub of activity for EMC, antenna and wireless technology in Brazil. The seminar was graciously hosted by Anatel's Maximiliano Salvadori Martinhão.

The IEEE EMC Society outreach event was held at Anatel in Brazil's capital city of Brasilia.

The topics presented included:

- **The Evolution of Complex Cavity Measurement Techniques from Precision Metrology Applications to Aircraft Electromagnetic Environment Assessments** *by Mr. Dennis Lewis, The Boeing Company, Seattle, Washington*
- **Current EMC Metrology Research at the National Institute of Standards and Technology (NIST)** *by Dr. Perry Wilson, NIST, Boulder, Colorado*
- **Half Power Beamwidth Measurements of Radiated Emission Antennas for EMC** *by Dr. Vicente Rodríguez, ETS-Lindgren, Cedar Park, Texas*
- **Tomographic Techniques (Microwave CAT Scans) for Detecting/Imaging Obsured Objects** *by Dr. Johannes Nordgaard, NASA/JSC, E3 Lab, Houston, Texas*
- **Concluding Remarks** by *Maximiliano Salvadori Martinhão, Anatel, Brasilia, Brazil*

Speaker Dennis Lewis noted electromagnetic reverberation chambers have been used for any years by the EMC community to measure the susceptibility and emissions for various electronic components and systems. His presentation described how these EMC tools were adapted as a metrology tool to generate precision electromagnetic fields used for field probe calibrations. The presentation also explained how these techniques were later applied to aircraft measurements to assess the aircraft electromagnetic environment, including wireless propagation and aircraft fuselage attenuation. He showed how, utilizing a precision network

BRASILIA PHOTOS BY JANET O'NEIL

Brasilia speakers and EMC seminar organizers included (front row from left) Perry Wilson of NIST, Maximiliano Salvadori Martinhão of Anatel, John Norgard of NASA, (back row from left) independent consultant Benjamim Galvão, Marcos de Souza Oliveira of Anatel, Vince Rodriguez of ETS-Lindgren, and Dennis Lewis of Boeing.

Attendees at the EMC seminar in Brasilia included (from left) Saint' Clair Nunes, Tom Mullineaux of Milmega, Rávisson Amaral Almeida, and Achim Gerstner of Rohde & Schwarz. The gentlemen in ties are with Fiat Automóveis S/A.

Anatel's administrative assistants tempted EMC seminar registration chair André Kavaliéris Galvão of AK Telemedia with many tasty desserts for the refreshment break.

The breaks during the EMC seminar in Brasilia encouraged networking amongst the attendees.

analyzer along with fiber optic port extenders, measurements of RF propagation from sources as varied as point source antennas to leaky coaxial antennas were obtained. These assessments were essential in the design and implementation of wireless systems on-board aircraft as well as ensuring aircraft system EMC.

Speaker John Norgard showed how enhanced remote sensing techniques are being developed to accurately detect and identify obscured objects. For example, microwave tomography is used to detect and image obscured objects. Tomograms (RF CAT Scans) of the obscured objects are formed using microwave spectral/temporal, spatial/angular, and orientation/polarization diversity. This imaging technique uses a distributed ring of sensors to detect radiated transmissions scattered from hidden objects. Three-dimensional imaging algorithms have been developed to detect, image, and characterize obscured objects. Ground Penetrating (GPEN), Building Penetrating (BPEN), and Foliage Penetrating (FOPEN) radars are used to irradiate the hidden objects. Distributed sensors are used to collect the tomographic data that are used to detect and image the objects. For examples, tomographic techniques are applied to find buried objects, targets under trees, and objects behind walls. Distributed transmitters and receivers, however, significantly increase unwanted mutual coupling and EM emissions that interfere with signal reception. Examples of objects behind walls and tunnel detection were presented.

Speaker Vince Rodriguez noted CISPR has recently required information on the half power beamwidth of emission

John Norgard of NASA in Houston spoke on tomographic techniques for detecting obsured objects at the EMC seminar in Brasilia.

Vladimar Barbosa, the Standardization Manager in the Certification Office of Anatel in Brasilia, gave a presentation directed at the EMC and antenna communities.

Professor Terada and his former student, Monique Cruvinel, enjoyed the EMC presentations at Anatel.

Professor Carlos Sartori, from the University of Sao Paulo and a former member of the EMC Society Board of Directors, joined Janet O'Neil of ETS-Lindgren at the EMC seminar in Brasilia.

measurement antennas. In his presentation, measured patterns for some of the most commonly used types of emission antennas were shown, including double-ridged horn, log periodic, biconical and hybrid type antennas. Dr. Rodriguez also discussed the effects of the near field and test set up on the half power beamwidth.

Speaker Perry Wilson updated the audience about a long standing research program in the Electromagnetics Division on metrology related to electromagnetic compatibly at the National Institute of Standards and Technology (NIST). His presentation briefly described some past highlights and then provided an overview of current research efforts. One focus area is field generation and measurement in high multipath environments, as simulated by a reverberation chamber. NIST is working on simulating repeatable multi-path environments over a wide range of K-factors for testing wireless devices, such as cell phones and MIMO systems. Reverberation chamber applications to material shielding measurements and to animal exposure studies were also mentioned. Recent NIST work on a quantum SI traceable field probe based on Rabi frequency measurements was also reviewed. The presentation concluded with a summary of NIST efforts in the areas of emergency responder communications and RFID standards.

Vladimar Barbosa, the Standardization Manager in the Certification Office of Anatel, also gave a presentation directed at the EMC and antenna communities. He talked about the "Antenna Regulatory Framework" in Brazil and efforts underway on IEEE Standard 149-1979: Test Procedures for Antennas. The increasing use of wireless devices has created a new set of challenges. He noted antennas traded and used in Brazil are based on international standards and are made in an open collaboration process with society; Brazil has adopted "International References" to establish minimum requirements for antennas. Anatel is permanently fostering the Brazilian Laboratory Infrastructure, with evaluation by Anatel or accreditation by INMETRO – the metrology laboratory of Brazil. He concluded his presentation by seeking collaboration with EMC and antenna engineers in achieving cost effective measurement techniques. This is most desirable for developing countries. Note: All Anatel's documents are available at www.anatel.gov.br

Some 50 engineers attended the conference from industry and academia. Many traveled from other parts of Brazil to attend the seminar. Lunch was provided in the Anatel cafeteria and generous refreshment buffets were available during the breaks. There was plenty of opportunity to network in the welcoming environment provided by Anatel. Thanks are due to Maximiliano Salvadori Martinhão for providing the Anatel auditorium for the EMC Society regional outreach event as well as to Hernan Urdiales of ETS-Lindgren, Benjamim Galvão, independent consultant, and André Kavaliéris Galvão of AK Telemedia, for their assistance in organizing this successful event.

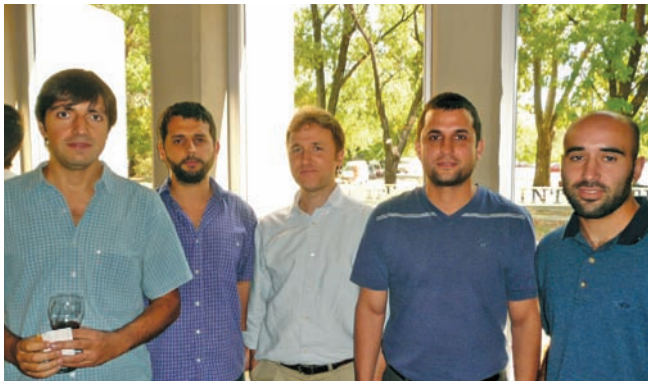
Buenos Aires

Gustavo Fano reports the Buenos Aires joint EMC and Antennas and Propagation (AP) Chapter organized a one day seminar on April 1, 2011 at the Instituto Nacional de Tecnología Industrial (INTI) in Buenos Aires, Argentina. The seminar's wonderful host, Edmundo Gatti, is the Director of the Electromagnetic Division at INTI, and was the first speaker of the event. He was followed by Francesca Maradei, President of the EMC

BUENOS AIRES PHOTOS BY JANET O'NEIL

John Norgard of NASA is shown at the entrance of the Instituto Nacional de Tecnología Industrial (INTI) of Argentina, site of the March 31 EMC regional event in Buenos Aires.

Hernan Sineiro of INVAP, Horacio Adolfo Benitez and Pablo Perri of INTI talked about EMC issues during a break in the technical program. INVAP is located in the Argentine region of Patagonia, in the beautiful town of San Carlos de Bariloche.



CONAE sent several of its best and brightest engineers to the EMC seminar at INTI, including (from left) Javier Pariani, Sebastian Chiocchetti, Pablo Marino, Dante Colantonio, and Santiago Spatolla.

Speakers and organizers of the EMC regional event gathered for a group photo, including (bottom row from left) Perry Wilson of NIST, Francesca Maradei of the University of Rome La Sapienza, Edmundo Gatti of INTI, Kenny Kirchoff of Boeing (center row from left) Todd Hubing of Clemson University, Dennis Lewis of Boeing, Hernan Sineiro of INVAP, Janet O'Neil of ETS-Lindgren, Gustavo Fano of Universidad Nacional de la Patagonia San Juan Bosco, (top row from left) Vince Rodriguez of ETS-Lindgren, Valentín Trainotti of the University of Buenos Aires, and John Norgard of NASA.

Society and Gustavo Fano, the Chair of the Argentina joint EMC/AP Chapter, who welcomed the attendees.

The seminar was a full day, from 9:00 am to 6:00 pm, with coffee breaks and a lunch buffet of typical Argentinean dishes. The weather was a sunny and comfortable 28 C degrees. The small fee for registration covered the refreshments and lunch expenses. The expert speakers were gracious and donated their time to speak to the audience of some 80 attendees from the universities, private companies, corporations and Government institutes of Argentina. We even attracted an attendee from nearby Uraguay! Everyone agreed it was a great event with a high calibar technical program that provided many opportunities to network with other Chapter members, the speakers and guests.

The agenda is sumarized as follows:

- **The Evolution of Complex Cavity Measurement Techniques from Precision Metrology Applications to Aircraft Electromagnetic Environment Assessments** *by Mr. Dennis Lewis, The Boeing Company, Seattle, Washington*
- **How to Define RE Requirements for Radiometer Instruments** *by Mr. Hernan Sineiro, INVAP, Bariloche, Rio Negro, Argentina*
- **Current EMC Metrology Research at the National Institute of Standards and Technology (NIST)** *by Dr. Perry Wilson, NIST, Boulder, Colorado*
- **Half Power Beamwidth Measurements of Radiated Emission Antennas for EMC** *by Dr. Vicente Rodríguez, ETS-Lindgren, Cedar Park, Texas*

The regional EMC event in Buenos Aires was a big success thanks to the efforts of the EMC/AP Joint Chapter Chair Gustavo Fano (far left) and Edmundo Gatti (second from right). Speaker Hernan Sineiro (second from left) and attendee Fernando Hernández (second from right) from Uruguay appreciated their efforts on the event. Ing. Professor Hernández travelled from the ORT University in Uruguay to attend the event. He works at Uruguay's URSEC, which is similar to the FCC in the US. URSEC is the institution for regulations in telecommunications and radio communications systems.

Bob Davis, IEEE EMC Society Membership VP, created the new EMC Society membership display which debuted at the Buenos Aires regional event.

IEEE EMC Society President Francesca Maradei prepares to start her presentation at the Buenos Aires regional event.

- **Mixed Analog/Digital Circuit Board Design and Layout for EMC** *by Dr. Todd Hubing, Clemson University, Clemson, South Carolina*
- **Tomographic Techniques (Microwave CAT Scans) for Detecting/Imaging Obsured Objects**
- *by Dr. Johannes Nordgaard, NASA/JSC, E3 Lab, Houston, Texas*
- **Numerical Simulations for EMC Compliance and Standard Development: A New Trend in European Standards** *by Dr. Francesca Maradei, Sapienza University, Rome, Italy*
- **Concluding Remarks** *by Edmundo Gatti, INTI, Buenos Aires, Argentina*

The day before this event, a one day seminar was organized by the Antenna Measurement Techniques Association (AMTA). Several of the EMC speakers also presented at the AMTA seminar. Following the AMTA seminar, we took a tour of the INTI facilities, including the ten meter semi-anechoic EMC chamber installed two years ago by ETS-Lindgren. The chamber featured impressive instrumentation by Rohde & Schwarz as well as special antennas for testing to the EMC standards required by the local industry.

For those interested in the presentations, these can be download from the INTI website: http://www.inti.gob.ar/electronicaeinformatica/emc/index.html

You can also see many photos of this regional event on the INTI site as well.

It was a pleasure for us to meet all the speakers in Buenos Aires at these events in order to promote the IEEE EMC Society and AMTA technical activities in our South America region.

The Buenos Aires regional event included a tour of the 10 meter EMC chamber at INTI. Some of the regional event attendees posed for a photo following the tour.

All registrants at the EMC seminar in Buenos Aires received a certificate of completion as a lasting memory of a great day of excellent technical presentations.

Speaker Roy Leventhal (standing far right) takes a question at the Chicago Chapter's February spring season kick-off meeting.

Many thanks to Mr. Alberto Lombardi of the Precision Electronica Company for handling the registration process and to Professor Valentin Trainotti and the people of the INTI for their support of this event!

Chicago

Jerry Meyerhoff, Secretary, reports that the Chicago IEEE EMC Chapter Spring 2011 season started February 16, kindly hosted by the IIT Rice/Wheaton campus, featuring Roy Leventhal of Leventhal Design & Communications. Roy's talk "EMI-EMC Theory and Troubleshooting" illustrated practical applications, using his recent real-world case-studies. In one situation, Roy recognized inconsistencies between measurements and expectations from fixes. Ultimately by refining the spectrum analyzer settings, he resolved multiple sources, each of which required individualized fixes. The 25 attendees came away with several valuable techniques for their own tool kits. His talk is available from the Chapter website.

On February 26, Chapter representatives Bob Hofmann and Jerry Meyerhoff exhibited at the 27th annual Dupage Area Engineers Week Expo at the IIT Rice/Wheaton campus. There, hundreds of junior and high school students and their parents visited many booths covering all the engineering disciplines. The Chapter's demonstrations included radio noise from common home appliances, shielding effectiveness and the ever popular static buildup from a Van DeGraff generator.

The March 16 meeting was hosted by the ITT Mt. Prospect campus with a pizza dinner supplied by the Chapter. Speaker Roger Swanberg of DLS addressed 32 attendees on the best practices of PC board design and layout. Roger skillfully led attendees between theory, practical details and analysis techniques, using design cases from his decades of experience. Roger urged attendees to "think like an electron!" i.e. visualize and then provide the path it needs to get back home.

On April 20 at the IIT Rice/Wheaton campus, the Chapter started with a Chicago-style Corky's Buffet, sponsored by Electronic Instrument Associates (EIA). Then Bob Hofmann spoke on ANSI C63® standards. Bob explained the standards development process and where changes were anticipated in the extensive documents. Bob shared examples of the detailed formal question and answer processes that helps users better understand the implementations. Attendees also enjoyed a few practical EMC problem solving "war stories" such as analyzing and mitigating emissions from a rural central office.

Chicago's spring session will peak with the 14th annual MiniSymposium on Tuesday, May 10 at the Itasca Country Club, again organized by Frank Krozel of EIA. Lee Hill of Silent will be the featured speaker delivering sessions with

Bob Hofmann demonstrates Van DeGraff static at the Chicago-Dupage Engineering Expo.

demonstrations on both Measurement Tools and Product Design. Tom Braxton of Shure will start the day with his popular Fundamentals talk. Lunch, 20 table-top exhibitors, EMC-opoly and prize raffle drawings will add to the excellent technical program.

Speaker Roger Swanberg emphasizes PCB floor planning at the Chicago Chapter's March meeting.

Bob Hofmann (left) receives a speaker's plaque from Chicago Chapter Chair Jack Black for his April ANSI C63® talk.

Please check the Chicago Chapter website at www.emcchicago.org for more information.

Milwaukee

On March 22, the Milwaukee EMC Chapter sponsored their 11th EMC Seminar. Registrations totaled 176 paid attendees along with a 33 tabletop exhibitors. Overall, 40 companies were represented at the EMC Seminar.

Our speaker was Dr. Todd Hubing from Clemson University. Dr. Hubing's lecture was titled "Printed Circuit Board Layout for EMC Suppression." Leading the way with the most attendees were GE Healthcare, Rockwell Automation, Johnson Controls, DRS Technologies and Magnetek. The luncheon, emceed by Milwaukee EMC Chapter Chair Jim Blaha, was held for 260 people. As with previous Chapter Chatter submittals on this event, the photos tell the story. Enjoy the photos of this very successful IEEE EMC Chapter event.

Australian EMC Symposium 2011

Symposium, Workshops, Tutorials, and Exhibition
9-11 November, 2011, Perth, Western Australia

The Electromagnetic Compatibility Society of Australia (EMCSA: www.emcsa.org.au), with technical co-sponsorship of the IEEE EMC Society, will organise its 10th Symposium from 9-11 November 2011 in Perth.

- **Technical presentations** of theoretical and practical nature: These talks show the progress in EMC related research and development in respect to prediction, planning, measurement and testing, as well as other topics of interest to the EMC community;
- **Workshops, tutorials and practical demonstrations**: This part is aimed at novices in the EMC arena who need a thorough introduction to the field, as well as at engineers who have to tackle a particular problem and need a reliable source of information;
- **A trade exhibition**: This component of the event puts on show the tools of the trade, be they software, test instruments, EMC relevant hardware such as filters, shielding etc., or testing and consulting services.

Visit the symposium website at **www.emcsa2011perth.org** for further information.

Dr. Todd Hubing of Clemson University starts the Milwaukee EMC Seminar with a full house of over 180 people in attendance.

Jamal Shafii (left) of Hamilton Sundstrand, the Rock River Valley EMC Chapter Chair, sizing up an IN Compliance shirt from Sharon Smith.

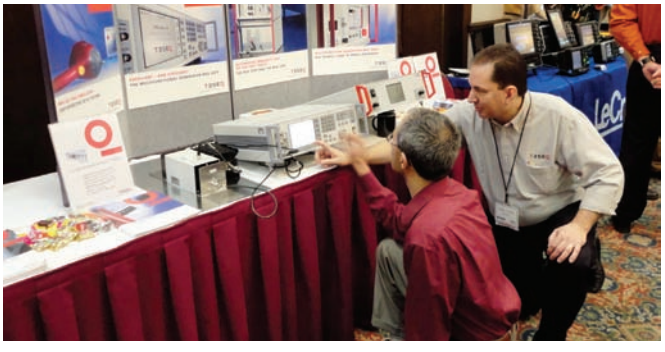
Dr. Hubing (left) enjoying the morning break with Mackenzie O'Connell (center) of ARC Technologies and Sharon Smith of IN Compliance magazine.

Ram Bhatia (left) of ABB Motor Drives congratulating Jim Blaha, Milwaukee EMC Chapter Chair, on another successful EMC Seminar.

Ken Boston (right) of LS Research digging into Ron Zimmerman's International Compliance EMC Lab, "Bowl of Mints."

Ping Lee (left) of Rockwell Automation enjoying the company of Dr. Hubing.

Renee Kamptner (right) of GE Healthcare playing catch with "TUV Earth Balls" from Ken Kamptner, also from GE Healthcare.



Abtin Spantman (left) of Danfoss Motor Drives being tutored by Randy Johnson of Teseq.

Mary Ellen Blaha and Jim Blaha catching a brief relaxing moment during the seminar.

Jerry Trepanier (left) of GE Healthcare and Don Koller of Rockwell Automation serving as technical advisors and envelop stuffers to the 2011 EMC Seminar Committee.

Jim Blaha was presented the IEEE Region 4 - 2010 MGA Achievement Award during lunch from Sylvia Wrate, DRS Technologies, and current 2011 IEEE Milwaukee Section Chairperson.

The team that pulled it all together (from left) - Don Koller (Rockwell Automation), Jerry Trepanier (GE Healthcare), Dr. Todd Hubing (with an honorary degree of MC - Master of Cheese), Jennifer Blaha (IEEE Comic Relief), Mary Ellen Blaha (IEEE Groupie), Jim Blaha (GE Healthcare and Chairperson) and Jessica Blaha (Data Base Specialist).

Joseph Majeski (left) of LeCroy Instrument provides one last presentation to Rodrigo Rodriguez of GE Healthcare.

Dr. Todd Hubing (left) and Jim Blaha – One last picture after a long day of managing over 200 engineers.

Nanjing

Professor Xiaowei Zhu, Chapter Secretary, reports that in April, several professors, including Professor Ke Wu from the University of Montreal, Professor Yang Hao from the Queen Mary University of London, and Professor Ke-Li Wu from the Chinese University of Hong Kong, made a visit to the Southeast University in Nanjing, China. During their stay in Nanjing, the IEEE MTT/AP/EMC Joint Nanjing Chapter invited

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A presentation on "Metamaterial Research" by Professor Yang Hao, Queen Mary University of London, was given at the Nanjing Chapter meeting.

Dr. Philip Meyler, Publishing Director, Cambridge University Press, gave a presentation on "Scientific Publishing" at the Nanjing Chapter meeting.

them to give technical talks to our professional and student members. The Chapter is very appreciative of the time that was taken by these gentlemen to share their expertise and knowledge.

Oregon and SW Washington

Alee Langford, Chapter Vice-Chair, reports that the Oregon and SW Washington Chapter started the year with Darren McCarthy of Tektronix discussing EMI diagnostics using real-time technologies. The following month, Bob Stern of Agilent presented the topic of "Quality Considerations in Selecting a Calibration Supplier." Bob Stern cautioned the attendees to carefully scrutinize the capabilities of a calibration lab before using them. In many cases, only the OEM can make adjustments to modern instruments because the adjustments are done electronically using proprietary algorithms. Good calibration labs will provide potential customers with "sample data" on similar instruments for you to assess prior to contracting them. The application of the accreditation agency's logo to the data is a key indicator that the measurements are traceable to SI.

Bob Scully of NASA during his March presentation to the Oregon-SW Washington Chapter on "EMI in Space."

Chapter Chair Mark Briggs (left) thanks Bob Stern of Agilent for presenting to the Oregon-SW Washington Chapter on the topic "Quality Considerations in Selecting a Calibration Supplier."

The Chapter welcomed Bob Scully of NASA in March to discuss EMI in space. Bob used a video from "*Forbidden Planet*" to illustrate how EMC is approached at times. We have the invisible monster and we throw lots of our "arsenal" at it. In some cases, we sacrifice someone to fix it to no avail. The current shuttle system is in its 36th year with a 10 year design! The latest project in EMC is the R2 robot system.

Mark Stefka (Distinguished EMC Lecturer) will present at the Chapter's April meeting with the topic of Automotive EMC. Meeting details and additional information can be found by visiting the Chapter website at http://ewh.ieee.org/r6/oregon/emc/

Darren McCarthy of Tektronix discussed EMI diagnostics using real-time technologies with the Oregon-SW Washington Chapter.

Ottawa

The EMC Ottawa Chapter reports that an IEEE technical presentation was hosted jointly by the Ottawa EMC Chapter and AP/MTT joint Chapter on June 21,

2010 from 3:00 PM to 5:00 PM. The speaker was Mr. Ghery S. Pettit. The topic was "Current and Upcoming EMC Standards for ITE and Multimedia Equipment." The event was held at FIDUS SYSTEMS Inc. (http://www.fidus.com/), a company specializing in high speed electronic product development. Pizza and soft drinks were served during the event.

Mr. Pettit is the EMC Regulatory Compliance Manager at Intel Corporation. He has been active in EMC and related subjects for the past 34 years, having previously worked for the US Navy, Martin Marietta Denver Aerospace and Tandem Computers. He is a member of a number of national and international standards development organizations and industry associations. He chairs ITI TC5 and CISPR SC I WG3. He was the Vice President for Conference Services of the IEEE EMC Society at the time of the presentation. He is an iNARTE Certified EMC Engineer. He holds an Amateur Extra class amateur radio license with the call N6TPT and is a private pilot.

Ghery's presentation discussed the basic organization of CISPR SC I, existing standards maintained by CISPR SC I and new multimedia equipment standards that are presently under development. CISPR SC I is responsible for the maintenance and generation of a family of EMC standards for multimedia equipment. In the past, CISPR SC I wrote and now maintains standards for broadcast receivers and ITE (information technology equipment).

Ghery Pettit (left) receives a gift from Qiubo Yi, the Vice-Chair of the Ottawa EMC Chapter, in appreciation of his excellent talk.

Phoenix

Brent Treadway reports that the first IEEE EMC Phoenix Chapter meeting of the 2011 season was held on February 15, 2011 at Garcia's Mexican Restaurant in Tempe, Arizona. Our speaker for the evening was Keith Peavler, Chief Engineer EMC for Honeywell Aerospace, who spoke on "Rod Antenna Grounding Issues for MIL-STD-461E and 461F." There have been various papers written on theoretical predictions of the active rod antenna in configurations conforming to MIL-STD-461E and 461F, specifically to the counterpoise grounding. While developing and qualifying a product for a military helicopter, the RE102 limits were exceeded within the 20-30 MHz region. Further investigation ensued including the collection of empirical data for both MIL-STD-461E and

PHOTO BY STEVE GERARD

Keith Peavler, Chief Engineer EMC of Honeywell Aerospace, shows a rapt Phoenix crowd the incredible difference in E field levels as measured with MIL-STD-461E and 461F test setups below 30 MHz.

PHOTO BY STEVE GERARD

Daryl Gerke (left) presents a copy of the Arizona Liar's Handbook to Dr. Vince Rodriguez as thanks for his presentation on antennas to the Phoenix Chapter.

PHOTO BY JERRY RAMIE

Dr. Bill Imes of Lockheed Martin delivered an excellent presentation to the Santa Clara Valley Chapter on grounding in space systems.

PHOTO BY JERRY RAMIE

John T. Tengdin, Senior Partner and Cofounder, OPUS Consulting Group, gave a presentation to the Santa Clara Chapter on "EMI in Electric Power Substations."

461F rod antenna configurations, while being referenced to a calibrated biconical antenna. To understand the issues behind using a rod antenna, Keith began by explaining the history of why the rod antenna was chosen, the distances that were picked for the measurement and the evolution of the Mil Spec to its current F revision. After many adjustments to his product to reduce the noise levels to no avail, he discovered the non repeatability of low frequency measurements when applying 461E. He described the empirical findings of his demonstration using the rod antenna and biconical in both the 461E and 461F configurations. He shared his results which showed improved measurement repeatability using the biconical down to 25 MHz and significant noise reduction when applying 461F. Keith was measuring 15dB lower at 25 MHz! He concluded by advising testing to 461F, but in the event that 461E is specified, then one should test using a biconical antenna.

The second IEEE EMC Phoenix Chapter meeting of the 2011 season was held in March when Dr. Vince Rodriguez of ETS-Lindgren spoke about "Antennas, Antenna Theory, Parameters and Antennas for EMC." Dr. Rodriguez is the Senior Principal Antenna Design Engineer and Antenna Product Manager for ETS-Lindgren in Cedar Park, Texas. Dr. Rodriguez began by breaking the antenna and antenna pattern into its parameters for easier evaluation and understanding. He defined the antenna and how it radiates, the antenna pattern, E and H planes, and both omni and directional antenna patterns. He introduced half power beam width, gain, antenna factor, and both types of polarization, circular and linear. He then applied these parameters to typical EMC antennas such as the coil and loop, monopole, dipole and horn. What was particularly interesting was the animated graphics of each of the radiating antennas and how their wave fronts impinged on aspects of the typical EMC test setup using a copper bench.

Santa Clara

On February 8, 2011, Bill Imes, Sr. Fellow, Lockheed Martin, gave a presentation to the Santa Clara Valley EMC Chapter on, "Grounding Application for Space Systems." Grounding considerations result in the interaction of power and signal applications in major aerospace systems. Dr. Imes' talk discussed the theoretical and practical basis for how to design aerospace ground systems (including test systems) that maximize the probability of success. Fundamental concepts of stray voltage generation, impedance, current flow path control vs. frequency, stray magnetic field limitation, safety, electrostatic discharge prevention (via grounding), and primary and secondary power grounding approaches were presented. Handling of grounding and reference systems for both analog and digital applications in system were addressed. Power boundary and isolation techniques (and how to achieve them), and prevention, limitation of common mode concerns were also discussed.

Bill Imes is a Lockheed Martin Senior Fellow. He has 46 years experience as a senior engineer, with 44 of those years spent at LM. Bill provides detailed technical support on complex issues to all facilities, all lines of business, and management. He has been significantly involved with most LM programs in Sunnyvale and has made contributions to numerous others in Space Systems (GPSIIR, GPB, Lunar Prospector, SIRTF, DMSP, FBM, AIA, HMI, HIRDLS, RM20), and elsewhere in the corporation (Aegis, JSF). His specialties include analog and digital electronics design and analysis, systems design and analysis, electromagnetic compatibility, signal integrity, power systems, and power electronics.

Bill has received numerous technical excellence awards, including the prestigious LM Nova Award (2007), and acted as a

consulting engineer to several companies outside LM developing space systems and aircraft hardware, biomedical equipment development, software development, and developing and delivering training. He is also an adjunct professor at Stanford University and San Jose State University. Bill has presented numerous papers and is the co-author of a book on EMC in switch mode power supplies. He holds a BSEE from Northwestern University and a MSIT from Carnegie Mellon University.

On April 12, 2011, John T. Tengdin, Senior Partner and Cofounder, OPUS Consulting Group gave a presentation to the Santa Clara Chapter on, "EMI in Electric Power Substations." His presentation covered these main points:

- How found? What events triggered the research?
- What failures occurred? Component damage? False trips?
- What IEEE PES protective relay standards evolved as a result?
- What's in IEEE 1613?
- How the IEEE PES Substations Committee WG C2 built on that history to create IEEE 1613-2003 in eleven months - from a blank page to a balloted "IEEE 1613 - Standard Environmental and Testing Requirements for Communication Networking Devices in Electric Power Substations."
- What was new then? Required serial and Ethernet communication (via copper and/or fiber - depending on the ports provided in the device) per prescribed communication profiles, and the added pass/fail criteria for loss of communication.
- What's new now - A PAR to extend the scope to "In Electric Power Facilities" and add a communication profile for communications via RF to be underway during each of the four transient tests, and - if necessary - tweeks to the pass/fail criteria.

John T. Tengdin, P.E (IEEE LF' 2007) received US Navy training as a radio technician, then served on the USS Kern (AOG-2) at the end of WWII. He graduated from Purdue University, West Lafayette, Indiana in 1949 with a BSEE degree (Power Major - Tau Beta Pi, Eta Kappa Nu). His post college employment experience began with Dayton Power and Light Company in their Cadet Engineering Program. That was interrupted by a recall to active duty in the U.S. Navy during the Korean War as an Electronic Technician. At NAS San Diego, he developed a jeep mounted radio relay unit that automatically linked communications between HF and VHF voice channels - for use during front line close air support, and improved the design during field tests in North Korea. Upon return to civilian life, he joined General Electric Company as a field service engineer, later as an application engineer serving electric utilities and their consulting engineering firms. He worked for GE's Computer Department for three years until it was sold to Honeywell Information Systems in Wellesley, Massachusetts where he worked for two years. He returned to GE in 1972 as Manager of Product Planning for GE's protective relay business located in Philadelphia, Pennsylvania. Under his direction, GE's PROBE Project installed a minicomputer (Varian V72) in

a Commonwealth Edison substation to explore the limits to pure digital solutions. In 1980, he was one of the founders of GE's Digital Systems Operation in King of Prussia, Pennsylvania. He began work as an independent consultant in 1986, and formed OPUS Publishing as a two man partnership specializing in substation automation and cyber security in 1999. It was the predecessor to OPUS Consulting Group, formed in 2007, where he is a Senior Partner and Co-Founder. He was one of the US members of IEC TC57 WG 10-11-12 that developed IEC 61850. He has received numerous awards from the PES Substations Committee and the PES Power System Relaying Committee for his work on technical papers and standards, and from the IEEE SA for rapid standard development. He chaired the IEEE PES Substations Committee Working Group C2 that developed IEEE 1613-2003 in eleven months. His 2007 Fellow citation was "for leadership in Ethernet local area network based protective relaying and control in electric power substations." He can be reached at j.t.tengdin@ieee.org.

SE Michigan

On June 17, 2010, Arnie Nielsen gave a great presentation on the "Basics of PCB Design" and working with component specifications for the Southeastern Michigan (SEM) EMC Society Chapter. His presentation covered both the history and present day technology. Arnie retired from Visteon-Ford in 2005 with over 35 years experience in a number of disciplines. Since retiring, he has been active consulting on electronic design and EMC for over 20 companies (including electric vehicles).

In his presentation, Arnie described test anomalies that should be taken seriously and showed how Ford has been able to speed up the EMC test cycle by putting components under duress. Arnie discussed Ford's chattering relay as a great way to see how components deal with spurious signals across the frequency spectrum.

Arnie talked about Power Spectral Density (PSD) calculations and the effect of the PSD on testing decisions. He examined the different characteristics of diodes and those waveforms; his slides on this point were very illuminating and are on the SEM website. Arnie involved the group in considering ESD failures. Some ESD events cause components to become vulnerable to other stress that would not normally cause failure. So he stressed the order of testing components.

Arnie Nielsen's presentation was amazing; check out our website at www.emcsociety.org to enjoy his slides and look at past meetings.

The Southeastern Michigan IEEE EMC Society Chapter on January 20, 2011 was graced as Kimball Williams spoke on "EMC Test Planning for Customers" or test plan planning. Kimball Williams is a Senior Manager at Denso Americas in Southfield, Michigan. He is the lead for the EMC laboratory. He obtained his BSEE degree at Lawrence Technological University in Southfield, Michigan. Kimball is well known in the industry as he has been involved in electromagnetics and EMC for over three decades.

Kimball spoke of the many pitfalls of testing handcrafted parts, too much solder, not enough solder, not made to manufacturing specifications. He said it was much better to wait for assembly line parts.

Kimball suggested telling the customer horror stories from the past to illustrate how much you need the customer's input. Explain to them that software may crash during testing and the results of a test, while the software is in soft recovery mode, may be very different from a standard test. It is very important, he said, to get the customer involved and to have ownership of the testing. He suggested involving the customer in a brain storming session to discover his or her goals.

Once the tests have evolved, the EMC test engineer should do a demo before running the test for the customer. Generate a test matrix for the customer that you will use with links to other records and relevant standards.

Kimball said once the testing starts, follow the plan. He suggested using tracking features of the test matrix. A lab should only deviate from the test plan with knowledge of the customers. Get records of their approvals. File everything. Kimball said to remember the customer owns the data and they can take all of it with them when the testing is finished.

On February 17, 2011, the Southeastern Michigan IEEE EMC Society Chapter welcomed Cyrous Rostamzadeh who presented, "ESD Behavior of Multi Layer Ceramic Capacitors." Cyrous Rostamzadeh is currently an EMC Technical Specialist at Robert Bosch LLC, in Plymouth, Michigan, where he has implemented an EMC design and analysis process to facilitate product compliance at a lower cost. For the past 14 years, he has been responsible for providing product design support and EMC interface to North American, Asian and European automotive markets. Prior to joining Bosch, he worked in various EMC, electromagnetic and analog electrical engineering occupations.

Cyrous Rostamzadeh received a B.Sc. in Physics from Imperial College of Science and Technology, University of London (England) and an MS in Electrical Engineering. He is a senior IEEE member. He is a NARTE certified EMC and Product Safety Engineer. He is an active member of the IEEE EMC TC-9 Computational Electromagnetics committee. He has given numerous EMC seminars and training courses to Bosch engineering associates. He has published extensively at IEEE EMC, IEEE PAC and URSI. Cyrous was an invited guest speaker at the European Space Agency (ESA) in Florence, Italy, March 2009.

Cyrous Rostamzadeh discussed the utilization of Multi Layered Ceramic Capacitors (MLCC) in small package geometries (0603) for the protection and mitigation of Electrostatic Discharge (ESD) for the automotive printed circuit board application, which is a major concern. He said that MLCC geometries have diminished dramatically in the past decade. In addition, the cost benefit and economic merit of their use for the PCB connector area in highly congested modules (pin density in excess of 200) is attractive and cannot be easily avoided. Nonetheless, the EMC engineering community and experienced PCB design experts have only concentrated in various optimization of PCB mounting schemes, thus developing "EMC guidelines." If the ESD protection of MLCC is sufficient for PCB mounting strategies or capacitor value and its voltage rating, then you are in for a big surprise after an ESD event or an event caused by high temperature. His presentation provided us with the fascinating overview of the pre-ESD versus post-ESD behavior of MLCC devices. The physics of the mitigation device and their interaction with ESD phenomena was illustrated.

The Southeastern Michigan IEEE EMC Society Chapter presented "Using Smith Charts to Represent Key Parameters of Interest in Addressing EMC Problem Solving" by Gowry and Vino Pathmanathan on March 17, 2011. Gowry Pathmanathan received her BSEE from the University of Peradeniya in

Sri Lanka and worked as an electrical engineer in the health sector. Gowry then came to the United States and received her MSEE in 2009 from Oakland University in Michigan. She worked for A123 as an electrical hardware engineer and is currently working as a system electrical engineer for CNC Onestop. Vino Pathmanathan received his BSEE in 1994 and his MSEE in 1996 from Wright State University in Dayton, Ohio. He worked for ITT as an automation engineer and then as a controls engineer, before becoming an EMC test engineer in 1998. Vino then worked for Valeo. He next was in charge of the TRW EMC lab. Vino is currently working for ESG Automotive as a Senior EMC Systems Engineer and as an EMC consultant. Vino's spare time is spent with the lovely and intelligent engineer, Mrs. Gowry Pathmanathan, and their son, Prathossh.

Vino and Gowry went over the invention of the Smith Chart, an incredible early calculator created by Phillip H. Smith in 1905. They discussed how it has evolved to date and helped engineering design and EMC. Their presentation demonstrated how to use the Smith Chart to represent key parameters of interest in addressing EMC problem solving. They covered the following:

- Black Magic Design of the Smith Chart calculator revealed
- What is the unity circle?
- Stability analysis
- Impedance
- Admittance
- Reflection coefficients
- Scattering parameters
- Noise figure circles
- Constant gain contours
- Region of unconditional stability

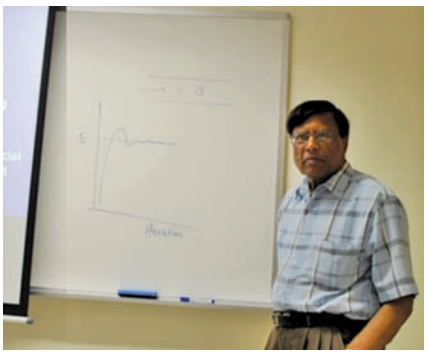
They discussed the many software packages available to plot the information on a Smith Chart (ex: Serenade and Smith 191). They showed and discussed the interpretation of data from the Smith Chart which requires a good understanding of AC theory and transmission line theory, both of which are prerequisites for an EMC and RF engineer.

Singapore

Richard Gao Xianke, Chapter Chair, reports that Singapore held the first 2011 administrative meeting on 8 February 2011. Dr. Richard Gao Xianke, Chapter Chair, hosted the meeting and summarized the annual report of Chapter activities in 2010. Dr. Chua Eng Kee, Chapter Treasurer, updated the financial report and balance of the year 2010. The

*Professor Lei Zhao from Xuzhou Normal University, China, delivered a technical talk at the A*STAR Institute of High Performance Computing, Singapore, on 10 March 2011.*

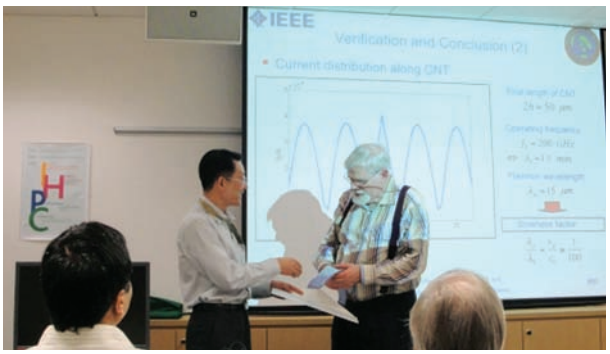
*Professor Lei Zhao is shown with Singapore EMC Chapter members (from right to left) Dr. Weijiang Zhao, Professor Lei Zhao, Dr. Richard Gao Xianke, and Dr. Liu Enxiao, at Infuse of A*STAR, Singapore, on 10 March 2011.*



Professor Raj Mittra from Pennsylvania State University, USA, delivered a technical talk at the Temasek Laboratories, NUS, Singapore, on 10 March 2011.

*Professor Peter Russer from Technical University Munich, Germany, delivered a technical talk at the A*STAR Institute of High Performance Computing, Singapore, on 21 March 2011.*

committee has passionately discussed the 2011 work plan, which includes organizing seminars/distinguished lectures, workshops, short courses, driving membership development, organizing Chapter social activities, sponsoring conferences, etc. On 28 January 2011, Professor Wen-Yan Yin, distinguished lecturer of the EMC Society from Zhejiang University, China, delivered a speech with the title of "Multiphysics Method for High-Power Electromagnetics." The DL talk took place at the Nanyang Technological University (NTU) with 34 attendees from universities, research institutes and industrial companies, 14 of which were IEEE members. On 10 February 2011, Chapter Chair, Dr. Richard Gao Xianke, attended the IEEE Singapore Section first general committee meeting at Suntec Singapore International Convention & Exhibition Centre. All general committee members discussed and reviewed the section reports for 2010. On 10 March 2011, Professor Lei Zhao from Xuzhou Normal University, China, delivered a technical talk entitled, "Research on Fast Assessment of Electromagnetic Exposure to Human Head by Mobile Phone," at A*STAR Institute of High Performance Computing, Singapore. There were a total of 12 attendees. Professor Raj Mittra from Pennsylvania State University, USA, presented two topics, "New Strategies in Computational Electromagnetics for Solving Real-World Problems" and "Some Recent Developments in Metamaterial-based Antennas, EMC/EMI, Plasmonics and Electromagnetic absorber Designs" in Singapore on 10 and 11 March 2011, respectively. The series talks were well attended with a total of 54 attendees, 25 of which were IEEE members. On 17 March 2011, Professor Natalia K. Nikolova from McMaster University, Canada, the distinguished lecturer of the IEEE Microwave Theory and Techniques (MTT) Society, delivered a technical talk entitled, "Microwave Near-field Imaging of Human Tissues: Hopes, Challenges, Outlook", at the National University of Singapore, Singapore. There were a total of 25 attendees, of which 12 were IEEE members. On 21 March 2011, Professor Peter Russer from Technical University Munich, Germany, another distinguished lecturer of the MTT Society, gave a speech entitled, "Nanoelectronics-based Integrated Antennas" at A*STAR Institute of High



Professor Peter Russer (right) appreciated a speaker gift of a tie with IEEE and EMC logos presented by Dr. Richard Gao Xianke, chair of the Singapore EMC Chapter.

Participants listened attentively at Professor Peter Russer's seminar on 21 March 2011 in Singapore.

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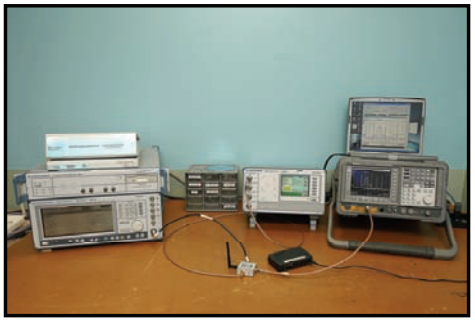

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Performance Computing, Singapore. The lecture had an overwhelming response which was attended by16 IEEE members and 17 guests.

Washington/Northern Virginia

The Washington/Northern Virginia EMC Society Winter Meeting was held on February 15, 2011 in the rumpus room at Washington Laboratories in Gaithersburg, Maryland.

The topic was, "Shielding Methodologies in Equipment Design" and featured a presentation by Praveen Pothapragada, Engineering Manager with Equipto. Mr. Pothapragada provided an overview of the challenges of shielding equipment assemblies against a variety of threats. The presentation covered the fundamentals of shielding mechanism, including the performance of shield materials against magnetic, E-field and plane wave sources and compromises in equipment (and how to mitigate them).

Equipto provided a demonstration cabinet that showed best-practices, including knife-edge finger stock doors, honeycombed ventilation panels, filtered I/O and power ports and a sturdy steel design that provides excellent attenuation across a wide frequency range. Proper selection and design can provide attenuation up to 10 GHz and higher. **EMC**

PHOTO BY DICK FORD

Praveen Pothapragada and Mike Violette (right) with Equipto Demonstration Cabinet.

2011 Chapter Chair Training Session & Dinner

Invitation to 2011 IEEE EMC Chapter Chair Training Session & Dinner

The IEEE EMC Society is pleased to wholeheartedly extend an invitation to all IEEE EMC Chapter Chairs to attend the Chapter Chair Training Session & Dinner taking place in conjunction with the 2011 IEEE International Symposium on EMC in Long Beach, California, during August 14-19 at the Long Beach Convention Center.

CHAPTER CHAIR TRAINING SESSION

Monday, August 15, 3:30 PM – 6:30 PM

The Training Session is intended to help Chapter Officers to be aware of the services provided to chapters by the IEEE and EMC Society.

Please note that this year the planned topics include a presentation delivered by an IEEE MGA Information Management Specialist on:

- Potential of **vTools.Meetings** and **vTools.Voting**
- Overview of the main features of **SAMIEEE** tool

CHAPTER CHAIR DINNER

Monday, August 15, 6:30 PM – 8:30 PM

This dinner is a chance for the Chapter Chairs or their representatives to gather and share what they have been doing for the past year.

Contact information:
EMC-S Chapter Coordinator,
Sergio A. Pignari,
sergio.pignari@polimi.it

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Professor Dr. Ir. Frank Leferink Appointed to Knight in the Order of Orange Nassau

Frank Leferink (center) receives his prestigious award from the Major of the County Westendorp as his wife Anne-Marie looks on.

On April 29, 2011, Professor Frank Leferink was appointed, on behalf of her Royal Highness Beatrix, Queen of The Netherlands, to Knight in the Order of Orange Nassau (*Ridder in de Orde van Oranje-Nassau*)

ORDE VAN
ORANJE-NASSAU

GOD ZIJ MET ONS

HARE MAJESTEIT DE KONINGIN
GROOTMEESTER VAN DE ORDE VAN ORANJE-NASSAU
HEEFT BIJ HAAR BESLUIT VAN
6 april 2011 nr. 11.000877
Franciscus Bernardus Johannes
LEFERINK
Geboren te Tubbergen, 21 april 1962
BENOEMD TOT
RIDDER
IN DE
ORDE VAN ORANJE-NASSAU

DE KANSELIER
DER NEDERLANDSE ORDEN.

He received the award for his hard work as a volunteer for various organizations, including the IEEE EMC Society and the conference steering committees for EMC Zurich, Asia Pacific EMC (APEMC) and EMC Europe. The award also recognized his service to professional organizations in the field of EMC in the Netherlands and abroad.

The Order of Orange-Nassau (Dutch: *Orde van Oranje-Nassau*) is a military and civil order of the Netherlands which was created on 4 April 1892 by the Queen regent Emma of the Netherlands, acting on behalf of her under-age daughter Queen Wilhelmina. The Order is a chivalry order open to "everyone who has earned special merits for society". These are people who deserve appreciation and recognition from society for the special way in which they have carried out their activities. The order is comparable with the Order of the British Empire in the UK.

Mr. and Mrs. Leferink are shown following the award ceremony, under the watchful eye of her Royal Highness Beatrix, Queen of The Netherlands, whose portrait hangs behind them.

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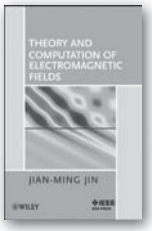
Theory and Computation of Electromagnetic Fields

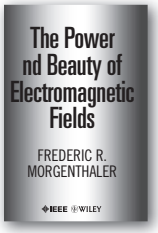


Jian-Ming Jin

9780470533598, Cloth, 600pp, $140.00, November 2010, Wiley-IEEE Press

Only one electromagnetics course is required for undergraduate students in most electrical engineering departments across the country, which leaves many students unprepared for the graduate course. This book serves as a textbook for both an entry-level graduate course on electromagnetics and an advanced-level graduate course on computational electromagnetics. No textbook is available for the advanced course; this book fills that void and presents electromagnetic theory in a systematic manner so that students can advance from the first course to the second without much difficulty. Accompanied by an instructor's guide, it covers both fundamental theories and advanced topics.

The Power and Beauty of Electromagnetic Fields

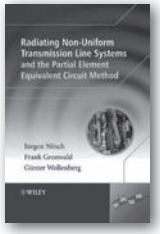


Frederic R. Morgenthaler

9781118057575, Cloth, 700pp, $135.00, June 2011, Wiley-IEEE Press

In this text, the author develops alternate representations of electromagnetic power and energy that differ from the familiar Maxwell-Poynting theorem values (S and W) - yet are fully equivalent. The particular choice focuses on features highly-localized power and energy components and emphasizes the circuit rather than the wave nature of theses quantities. Moreover, unlike the Poynting vector, this exact representation merges smoothly with well-known quasistatic approximations that have long been used to calculate power flows in both lumped and distributed circuits operating at low-frequencies.

Radiating Nonuniform Transmission-Line Systems and the Partial Element Equivalent Circuit Method



Prof. Dr. Juergen Nitsch, Dr. Frank Gronwald, Prof. Dr. Gunter Wollenberg

9780470845363, Cloth, 348pp, $130.00, December 2009, Wiley

Radiating Non-uniform Transmission Line Systems and the Partial Element Equivalent Circuit Method provides comprehensive coverage of both classical and non-parallel transmission line theory, surveying the most up-to-date research and current thinking in the field. The scope also spans EMC topology used to describe very complex systems by analyzing the EM interactions between the various components.

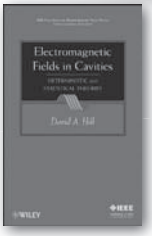
Inductance: Loop and Partial

Clayton R. Paul

9780470461884, Cloth, 379pp, $121.00, November 2009, Wiley-IEEE Press

This is an unprecedented text, thoroughly illuminating loop inductance as well as the increasingly important partial inductance, which are integral systems of understanding for the proper operation of high-speed digital systems. It fills a hole in the market and addresses industry-wide failure to adequately understand and calculate inductance, giving a badly needed refresher on magnetic fields. Written by a world-renowned leader and respected teacher in the field of Electromagnetics, this is a key text for graduate level engineering students, working engineers, and professionals engaged in electrical system scientific or research work.

Electromagnetic Fields in Cavities: Deterministic and Statistical Theories

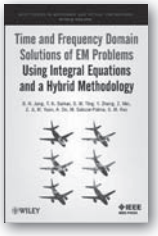


David A. Hill

9780470465905, Cloth, 280pp, $132.00, September 2009, Wiley-IEEE Press

The first book of its kind, Electromagnetic Fields in Cavities presents a unique combination of rigorous solutions to Maxwell's equations with conservation of energy to solve for the statistics of many quantities of interest: penetration into cavities (and shielding effectiveness), field strengths far from and close to cavity walls, and power received by antennas within cavities. Including all modes, rather than just the dominant mode, as well as wall losses and a special treatment of the current source region, the book is a valuable tool for researchers, practicing engineers, professors, and graduate students.

Time and Frequency Domain Solutions of EM Problems Using Integral Equations and a Hybrid Methodology



B. H. Jung, T. K. Sarkar, Y. Zhang, Z. Ji, M. Yuan, M. Salazar-Palma, S. M. Rao, S. W. Ting, Z. Mei, A. De

9780470487679, Cloth, 485pp, $89.95, October 2010, Wiley-IEEE Press

Numerical solutions of electromagnetic field problems is an area of paramount interest in academia, industry and government. This book provides a compendium of solution techniques dealing with integral equations arising in electromagnetic field problems in time and frequency domains. Written by leading researchers in the field, it documents the authors' unique space/time separation approach using Laguerre polynomials. Numerous examples that illustrate the various methodologies and user-friendly computer codes make this volume highly accessible for engineers, researchers, and scientists.

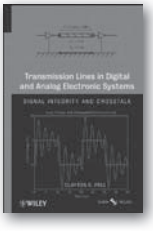
Parallel Solution of Integral Equation-Based EM Problems in the Frequency Domain

Y. Zhang, T. K. Sarkar

9780470405451, Cloth, 341pp, $105.00, June 2009, Wiley-IEEE Press

Method of Moments (MoM) remains one of the most powerful numerical methods of the past several decades and a powerful weapon for the solution of current complex Electromagnetic field problems. Parallel Solution of Integral Equation-Based EM Problems in the Frequency Domain provides complete coverage of parallel electromagnetic simulation techniques for Method of Moments. Presenting research that illustrates how to take the shortest route to highly efficient parallel electromagnetic (EM) code, this roadmap for computational code designers and chip designers demonstrates how to navigate through the multi-core advancements in chip design.

Transmission Lines in Digital and Analog Electronic Systems: Signal Integrity and Crosstalk



Clayton R. Paul

9780470592304, Cloth, 298pp, $99.95, August 2010, Wiley

This book grew out of the realization that most of today's EE and CpE graduates lack a critically important skill: the analysis of transmission lines. This text prepares readers for increasingly difficult design problems in a high-speed digital world, arming them with the basic though intricate knowledge they need to succeed.

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Completed Careers

Don Heirman, Associate Editor

Since the printing of the Winter 2011 issue of the EMC Newsletter, it saddens me to report that we lost two members of the EMC Society who passed away.

First, it is very sad for me personally to announce that our good colleague, **Professor Risaburo Sato**, has passed away. I had known him for over 30 years starting from the time he was on our EMC Society Board of Directors between 1979 and 1984. I, too, was on the Board at that time (it was called the Administrative Committee in those days).

In 1980 he almost single-handedly made the case for establishing the Tokyo EMC Chapter which was the first outside of Regions 1–7 of the IEEE. I was very pleased as that was the year I became president of the EMC Society and hence I was proud to be part of the support of this chapter formation.

I also remember his constant urging of having the first EMC Symposium to be held outside of the US and guess where - Tokyo in 1984. A highlight to me of the opening reception was Professor Sato singing and chanting as well as dancing to Japanese traditional music.

My personal memories of his support of EMC in Japan are lengthy including his membership on our EMC Society Standards Development Committee (simply called the standards committee at the time) for many years and his being instrumental in updating our Standard 187 on measuring emissions from TV receivers - a task that was performed by the Tokyo EMC chapter in record breaking time of a little over a month with his urging.

His energy and contributions for EMC in Japan is truly remarkable and in my book he is and will continue to be Mr. EMC of Japan. He will indeed be missed not only in Japan but worldwide.

Following is a tribute to Professor Sato that was composed by Takeo Yoshino with help from Professor Sato's students at Tohoku University in Sendai (where the Japan EMC symposium has been held in the past).

EMC Society member **Bob Howland** also passed away. One of his contributions was in the background supporting several careers in EMC of those that worked for him. To put this in perspective, I have asked Colin Brench to provide the tribute to his good friend and colleague. His tribute is encompassed in Bob's obituary which is later in this column.

Finally, we are also including a tribute to **Professor Ruediger Vahldieck** who passed away. Although he was not a member of the EMC Society, he was quite active in the IEEE's Microwave Theory and Techniques (MTT) Society and an enthusiastic leader of the EMC Zürich Symposium from 2003 to 2009 as well as many other international events. His IEEE activity was extraordinary in his being an IEEE Life Fellow, Chair of the Switzerland Section joint Chapter of the AP, MTT, and EMC Societies between 1999 and 2004, and a member at various times in six other IEEE Societies.

Among the many comments we received about his extraordinary contributions to the international EMC community was expressed by his friend, Erping Li, who led the first successful APEMC symposium with Professor Vahldieck, "He devoted tremendous efforts, not only to EMC-Zürich in Zürich, but also to EMC in Asia; he initiated the first EMC-Zürich outside of Europe, which was held in Singapore in 2006. He further assisted in establishing the Asia Pacific EMC (APEMC) conferences in 2007 and 2008, where he dedicated his efforts both in conference organising and technical papers, which made the APEMC conference one of the most highly regarded EMC conferences in the world. His efforts will be unforgettable."

Thank you to Wolfgang Hoefer for providing the following tribute to Professor Vahldieck, a man he remembers as "a prominent friend and protagonist of the EMC Society and the EMC community-at-large." Professor Hoefer first met Ruediger Vahldieck in 1984 when he joined Professor Hoefer's research group at the University of Ottawa as a postdoctoral fellow. Professor Vahldieck was laid to rest in Croatia, the native country of his spouse Zorka.

I would like to continue to solicit your support in helping me receive the names of EMC Society members that have recently passed away. You can either forward them directly to your local Chapter chair, or if you don't know who that is, you can forward the names to me directly (d.heirman@ieee.org) or a member of the Completed Careers Committee directly, including Bruce Archambeault, Don Sweeney, and Andy Drozd. See page 3 of this Newsletter or the EMC Society website (www.emcs.org) for contact information of these committee members.

Thank you in advance for your assistance as we honor EMC Society members who have completed their careers and made a difference in our careers.

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Risaburo Sato
1921–2011

In Memoriam of Risaburo Sato (M' SM' F'77 LM'92)

Professor Sato was born in Furukawa City on September 23, 1921. He received the B.S. and Doctor Degrees in electrical engineering from Tohoku University, Sendai, Japan in 1949, and 1952, respectively. Since 1949, he was positioned at Tohoku University as Associate Professor and as Professor from 1961 onwards. When he retired from Tohoku University in 1984, he was given the title Emeritus Professor of Tohoku University, and he moved to Tohoku Gakuin University, Sendai, Japan as Dean of Engineering Faculty until 1999, and given the Emeritus Professor at retirement at this University. He passed away on April 12, 2011 at his home in Sendai City.

His research areas were in very many fields such as transmission networks, microwave low noise circuits design, and antenna design with a notable example being the VHF TV transmission antenna that is at the top of the famous Tokyo Tower. All of these antenna designs were based on the latest EMC technologies. During his research activities, he strongly encouraged the start of EMC activities in Japan. Finally, the Institute of Electronics, Information and Communication Engineers of Japan (IEICE) established the first Special Committee for research on EMC (EMC-J) under his direction and leadership. In 1979, he became Chair of the EMC-J of IEICE. He also was an advisor of many communication companies and government activities as well as a member of the Japanese National Standard Committee concerned with the IEC (International Electrotechnical Commission) CISPR (International Special Committee on Radio Interference) international standards activities.

Based on the highly active research work on EMC in Japan, he urged having the IEEE international symposium on EMC in Japan sponsored by the IEEE EMC Society. Hence, in 1980 he made the great effort to first establish the Tokyo Chapter of the IEEE EMC Society. The EMC Society AdCom approved the establishment of the IEEE EMC Society Tokyo Chapter in response to his efforts on June 16, 1980. He was the first chairperson of the Tokyo Chapter which was then the first EMC Society chapter established outside the United States. During this period (1979–1984) he was elected as a member of the Board of Directors of the IEEE EMC Society and became the first Board member from Japan. In October 1984, the first Japanese International Symposium on EMC was held in Tokyo. It was sponsored by the IEICE and co-sponsored by the IEEE EMC Society and Tokyo Chapter. This symposium was the first EMC Symposium held in IEEE Region 10. The symposium was very successful with 558 attendees from 26 countries. This event is now held every five years.

In more recent times, Dr. Sato established a new IEEE EMC Society chapter in Sendai in December 2001. This was then the second EMC Society chapter in Japan. The activities of this chapter were immediately recognized with the chapter being awarded the Chapter of the Year Award at the 2003 IEEE EMC Society Symposium. This again is a tribute to Dr. Sato's vision of supporting EMC.

Other accolades and accomplishments continued for Dr. Sato. In particular, Dr. Sato was awarded the Best Paper Award of the Japanese IEE in 1955 and IEICE in 1979. In 1982, the IEEE MTT Society presented the 1982 Microwave Prize to him and his co-authors. He chaired the EMC Society Standard Committee P-187 (emission measurements from TV receivers) in 1986 and received two awards from the IEEE Standards Board: the Standards Board Award in 1990 and the Standards Board Medal in 1992. In 1997, he was decorated with the Order of the Rising Sun Gold Rays with Neck Ribbon by the Japanese Emperor for his distinguished service contributed to the development of Japanese electronics industries and leading electromagnetic noise reduction research and technology. He received the 2002 IEEE EMC Society Richard R. Stoddart Award and in 2006 he received the IEEE EMC Society Richard Schulz Transactions Prize Paper Award from the IEEE Electromagnetic Compatibility Society.

Dr. Sato was a distinguished research professor in the department of electronics and communication engineering at the Tohoku University and Tohoku Gakuin University in Sendai, Japan. He was an authority on a very wide range of EMC and industrial standards engineering in the world. His activities and contributions to the IEEE, especially the EMC Society, as well as to other Societies, cannot be expressed fully since they are so much and so far reaching.

Robert E. Howland
1938–2011

The following review of Bob's life was prepared by Colin Brench who worked for Bob. Colin had significant help in preparing this article from Bob's daughter – Linda Potter – as well as from many of his other friends in the EMC community. Bob will be remembered as a regular attendee of our annual EMC Society symposia and for his support of chapter events in the Northeast. But as this article will show, it was his encouragement of many EMC engineers to continue in our discipline that will be the lasting contribution.

Bob Howland, age 72 years, completed his career on April 21, 2011 after a brief illness. Bob was a long time member of the dB Society, a Senior Member of the IEEE/EMC Society, an iNARTE certified EMC Engineer, and was also a member of the Woodturners of Central New England and the Afghan Hound Rescue League of New England.

Bob was born in Schenectady, New York in 1938, and graduated from Union college, Schenectady, in 1963 with a BSEE. Bob then went into the U.S. Air Force. After his return, Bob settled in Massachusetts where, in 1975, he joined Digital Equipment Corporation (DEC), where he worked for nearly 22 years. Initially Bob worked as a design engineer for mass storage systems, but this was the early days of the development of Part 15 of the FCC Rules, and he turned his skills to EMC issues. Over the next several years, DEC replaced many products with newer compliant versions and, as an EMC Engineer,

Bob worked on multiple computers and computer related products. Of particular note was the PRO series of DEC PCs that were based upon the PDP-11 microprocessor. It was through his work on these PCs that lead Bob to achieving Consultant Engineer status at DEC, a position restricted to those few who demonstrate exceptional technical skill. In the role of Manager and Consultant Engineer, he was responsible for many products based on the VAX technology, including workstations, servers, and networking devices.

Bob also started a successful, company-wide discussion group for the purpose of sharing technology and ideas. This group served as a model that has been continued by Bob's DEC colleagues who have moved on to other companies. After DEC, Bob worked for Bay Networks and Nortel, and for his own consulting business, dBH Consulting. He had just started working for Avaya, Inc., as their Regulatory Consultant Engineer, when he became ill.

Despite Bob's considerable technical expertise, those who worked with him remember him most for his cheerful demeanor and his ability to encourage and mentor all those around him. There was definitely a 'je ne sais quoi' about Bob that quietly inspired. He was not arrogant when discussing or debating; he had no qualms in sharing his knowledge. He fostered aspiring to a high goal, but never pushed to share any of the limelight for teaching or inspiring. A couple of typical stories follow.

I first met Bob when I was a young engineer, just out of college by about two months. He was on a business trip to meet my manager and team in California, and was introduced to me as a Principal Engineer with a long successful career at DEC, etc., etc. As one can imagine, I was a bit intimidated, still being new to the profession and barely proficient enough to spell "RF probe", let alone use one. Our collective group toured the facility and afterward met in a conference room. Just by circumstance, I sat between Bob and my own manager. The discussion started with round-table introductions. There was a VP of this, Director of that, Director again, Manager 1, and Manager 2. When they got to me, I gave my name followed with a title of, "Just an engineer." Bob followed with, "I'm Bob Howland, just an engineer"; and so started the framework for the rest of the engineering staff to complete the introductions. This was a very simple gesture but, in electing to use this humble footnote, he suddenly became approachable. He had been a mentor and fast friend ever since.

It was Bob Howland who hired me into the EMC group at DEC in 1986. I had been working for a small company where I was the only EMC engineer, so I had had no basis by which I could compare my limited experiences. I felt very much a tenderfoot in this field. I found Bob to be an unusually supportive, knowledgeable, and encouraging manager. He very quickly noted my past experience with antennas and my curiosity about how they are used in EMC measurements; he promptly encouraged me to make this a study, which in turn led to my becoming involved in EMC Standards work. As a result of Bob's encouragement, I have been working and contributing in the Standards groups for over 30 years.

When Bob and I met up throughout the years at IEEE events, he would always make me smile and laugh a lot! His general cheerfulness and the ability to put people at ease and pull people together was typical of Bob; a rare trait in a competitive world.

Bob is survived by his wife of 48 years, Patricia; a son and daughter, Scott and Linda; a sister, four grandchildren, and several nieces and nephews. We will all miss him.

Rüdiger Vahldieck
1951–2011

Rüdiger Vahldieck of Zürich, Switzerland, passed away on 21 March 2011 at age 59 after a long and valiant fight with brain cancer. He leaves behind his wife Zorka and his daughter Masha, who were at his bedside.

Rüdiger was born in Heiligenhafen, Germany, on 8 July 1951. He received the Dipl.-Ing. and Dr.-Ing. degrees, both in Electrical Engineering, from the University of Bremen, Germany, in 1980 and 1983, respectively. From 1980 to 1983 he was a Research Assistant at the Microwave Department of the University of Bremen, where he was engaged in computer aided design of millimeter wave integrated circuits. From 1984 to 1986 he was a Postdoctoral Fellow in the Department of Electrical Engineering, University of Ottawa, Canada. In 1986 he joined the Department of Electrical and Computer Engineering, University of Victoria, Canada, where he became a Full Professor in 1991. During the Fall and Spring of 1992/93 he was a Visiting Scientist with the Ferdinand Braun Institut für Hochfrequenztechnik, Berlin, Germany. In 1996 he accepted the position of Professor of Field Theory at the Eidgenössische Technische Hochschule (ETH) Zürich (Swiss Federal Institute of Technology), first as Leader of the Field Theory Group and subsequently, in 2003, as Head of the Department of Field Theory and Microwave Electronics (IFH). In 2005, he became President of the Research Foundation for Mobile Communications and was elected Head of the Department of Information Technology and Electrical Engineering (D-ITET) of ETH Zürich, a position he held at the time when the sudden onset of his grave illness brutally ended his career. Nevertheless, he continued to devote his waning energy to the well being of his family, his institute, his students and his colleagues until he was no longer able to do so. He leaves a rich legacy of scientific discovery, technical innovation, engineering education, and service to the profession.

Professor Vahldieck has been the President and General Chairman of the International Zürich Symposium on Electromagnetic Compatibility (EMC Zürich) from 2003 to 2009, and was General Chair of the 2006 and 2008 APEMC/EMC Zürich in Singapore and 2007 EMC Zürich in Munich. Concurrently he was a Scientist in Residence at the Institute of High Performance Computing in Singapore where he initiated and oversaw several innovative research projects in microwave electronics and plasmonics. He tirelessly served the IEEE in key leadership roles, notably as a reviewer of several IEEE journals, Associate Editor and Editor in Chief of the IEEE Microwave and Wireless Components Letters (2004–2006), Member of the MTT 15 Technical Committee on Field Theory, Chair of IMS TPSC Committee 3, and Chair of the Swiss Joint IEEE MTT, AP, and EMC Societies Chapter. He has been a member of IEEE since

1985, became a Fellow in 1999, and received several outstanding publication awards. He rarely missed an IMS event during the past twenty five years, regularly contributing innovative-papers, workshop presentations and special sessions each year.

Rüdiger was a passionate sailor and spent whatever time he could find on his sailboat with his family and friends. He often mentioned that when the time had come to retire from his many professional responsibilities and to hand over the reins to the next generation, he would weigh anchor and sail the seas. He now has departed on his final voyage, leaving behind his loved ones, friends, students, research associates and colleagues to remember him fondly.

Carl Baum
1940–2010

Colleagues and Friends Remember Carl Baum

After the announcement of Carl Baum's passing, your Completed Careers Associate Editor asked for personal thoughts about Carl and what he meant to our EMC community as well as other technically related fields. There were several that stepped forward to give a portrait of Carl. We start with the remembrances of a close friend, John Norgard. Other comments follow John's wonderful description of a true genius. You can get the sense of the vastness of his contributions by looking at but one of his projects by visiting this link: http://www.ece.unm.edu/summa/notes/trestle.html

John Norgard Remembers a Close Colleague

I was in Brussels when I heard about Carl's stroke. From the first few e-mails I received, it seemed that he was getting better, and I had hoped for a complete recovery. It was especially disappointing then to hear that his health had deteriorated and he had died. I was deeply saddened by the news. We have now lost a truly great theoretical genius in our field of Electromagnetics.

Carl was a special friend of mine and a colleague since our PhD Graduate School days together at Caltech. I am sure you can imagine what it must have been like to have had numerous classes with Carl, who knew more than the professors ever did. It is hard to imagine anyone with a greater intellect, knowledge, and experience than Carl had. Carl didn't learn anything new at Caltech; he knew it all before he came there. After graduating, Carl went back to Kirtland AFB and I went back to Georgia Tech. He didn't seem to mind my calling him "Kaptain Karl from Kirtland" while in school together.

Despite his eccentricity, he was always very kind, considerate, and encouraging to me, especially when I was a Visiting Professor at the AFRL/PRS with him in Albuquerque. Technically, he was always very patient with me when he was explaining his many new and advanced ideas to me. He didn't seem to mind my asking him numerous technical questions, for which he always had the answers, supported by several technical references and/or books in his extensive library. His library was actually mentally in his head, not physically in his office, he never had to stop to lookup any reference material for me. I wonder what will happen to his library now. Personally, when I was in Albuquerque, he would often invite me over to his apartment for dinner (that meant going out for dinner and drinks!) followed by a beautiful piano concert by him.

I always thought that Carl was very humble (most of the time, that is!) and that he never got very excited about the many awards that he had received over the years, until I noticed his excitement over receiving the IEEE Electromagnetics (EM) Award at the 2007 IEEE International Symposium on EMC, our 50th Anniversary Meeting in Hawaii. I was on the EM Award Selection Committee, and with the help of Glenn Smith and Tapan Sarkar, we were instrumental in convincing the panel that Carl should get the award that year. I also chaired a special EM Award Session for Carl at the EMC conference, where he presented a very comprehensive review paper on Transmission Line Theory, in his typical way of two simultaneous, hand-written, overhead projector slides. Later that evening, I was sitting with Carl at the Awards Banquet and could not help but notice his excitement when he was officially presented the EM Award. He really enjoyed the notoriety of winning that prestigious award, which he should have, since it is our highest IEEE award in the EM area. He stood up and looked around the room with his head held high and I noted that he really enjoyed the moment! I was very pleased for him, too.

It was a privilege to know Carl personally as one of his Caltech classmates and to read his papers and to study his Interaction Notes; and, later, it was truly a greater privilege to become one of his colleagues and friends.

Carl was also noted for his distinctive "laugh", which I can still hear echoing down the halls! I, with all of you I am sure, will certainly miss Carl and his laugh. He was truly a brilliant guy!

Larry Cohen Remembers Carl

I can add some humorous experiences concerning Carl.

- About 10 years ago Carl came to meet with my boss Eric Mokole. Eric had to go to a meeting and requested that I spend some time with Carl until he came back. Before I could say one word, Carl was lecturing me on how many EMC engineers were not well prepared in the basics of electromagnetic theory. This lecture lasted an hour and I learned a lot about my own strengths and weaknesses.
- During the EMC Zurich 97 Symposium (I think it was 1997) my friend Dianne went up to Carl who was sitting by himself and said to him, "I understand that you know all about electromagnetic theory. Carl replied " Well, I know a few things"

Nigel Carter Adds a Challenge to Come Up with Words

I have to admit I can't think of anything that would be suitable for an obituary at the moment.

Don Sweeney Recalls Carl's Experiments and Even His Music

I met Carl at a lightning conference in 1979 or 1980. It seems that half of the papers started out, "Carl was walking through our lab and said, XYZ. I'm here to present the work I have done, based on his comments."

A funny story was also part of the conference. One person had presented a technique where one could measure the relative intensity of a lightning strike. It was to take a 20 cent audio tape, put a 1000 Hz tone on it for a few feet and then pull the tape out perpendicular through a plastic pipe. The tip of the pipe was placed next to a ground wire. When the lightning struck, the magnetic fields from the current passing down the wire would demagnetize the tape to a length related to the intensity. You simply listen to the tape and the length of time the tone was missing on the tape was related to the current intensity.

They had tens of thousands of these monitors distributed throughout the US. When Carl heard the presentation, he could not comprehend the inaccuracy of such a measurement. He stated he could measure the current to the nano-amp. Carl had millions to buy equipment. The person with the tape only had a few thousand.

I listened to some of his music today and wish I could hear more.

May he rest in peace!

Elya Joffe Notes Carl's Unrest Even Now

I can hardly believe it. Interestingly, while I was teaching a course here in Singapore today, I had quoted a saying of Carl regarding grounding ("ground is an interference distribution system"), not knowing that Carl had passed away.

I will remember him not only as a top notch scientist, a "cedar of Lebanon" of the EMC Society, but also as a friendly person, always smiling and happy (especially with beer in one - or both - of his hands), and as a great talent in music. He actually sent me CDs as well as the notes of his compositions.

My he rest in peace (although, knowing Carl, he would probably find that quite boring...).

In deep in sorrow for our loss…

Please Let Us Know

I would like to continue to solicit your support in helping me receive the names of EMC Society members that have recently passed away. You can either forward them directly to your local Chapter chair, or if you don't know who that is, you can forward the names to me (d.heirman@ieee.org) or any other committee member which can be found on the EMC Society web page (www.emcs.org) and by clicking on the "Committees" button in the left column. Thank you in advance for your assistance as we honor EMC Society members who have completed their careers.

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EMC Personality Profile

Frank Sabath, Associate Editor

Introducing Franz Schlagenhaufer

With this personality profile, I would like to stay in the Asia Pacific Region (IEEE Region 10) and to bring a colleague to your attention whose professional biography is characterized by international activities. The person I would like to introduce is Franz Schlagenhaufer. Members of the IEEE EMC Society might know him as a Distinguished Lecturer on EMC topics and as an organizer of EMC events in Australia. Some might know that his native country is Germany and he tries to be present at the German national EMC conference.

Franz Schlagenhaufer started his engineering career in Bavaria by studying Electrical Engineering at the Technical University Munich. After graduating with the diploma degree he changed his workplace from Bavaria to the North Sea Coast and joined the Hamburg University of Technology (TU Hamburg-Harburg). He received his Ph.D. degree in Electrical Engineering from the Hamburg University of Technology in 1994. He stayed for two more years (1994–1996) in Hamburg and worked as the manager of an EMC laboratory. Franz left Hamburg and Germany and joined a small consulting company in Melbourne, Australia as technical manager in 1996. In 2000, after four years in industry, he returned to the academic world as Senior Research Fellow and Associate Professor at The University of Western Australia, Perth. Since 2010, he is with the International Centre for Radio Astronomy Research (ICRAR) at Curtin University, also in Perth.

Franz' first brush with EMC came during his final year project, without him noticing. His topic was measuring very fast transients in SF_6-insulated high voltage switches (transients with rise times as short as 1 ns and amplitudes as high as 700 kV); interference between these transients and the measurement set-up were, not surprisingly, a challenge. Since then, his focus has shifted several times between EMC measurements and numerical modelling and simulation. His Ph.D. project, 'Coupling of electromagnetic pulses to multi-conductor transmission lines with non-linear terminations' was based on numerical modelling and simulations, with some measurements thrown in for validation purposes. His time as a Ph.D. student under the supervision of Professor Hermann Singer provided Franz with a solid theoretical knowledge of electromagnetics and numerical modelling.

His first job after receiving the Ph.D. was to set up and manage an EMC laboratory for the government owned Microelectronic Application Centre Hamburg (MAZ Hamburg GmbH). At the time, Franz knew little about running an EMC test lab, not to mention establishing one from scratch. With the invaluable support of Professor Karl-Heinz Gonschorek, he took on this challenge of selecting and procuring test equipment, familiarising himself with standard test procedures, and the day-to-day business of running a lab. He had also his first brush with quality systems when obtaining formal accreditation from the German Accreditation Council (DAR).

A small simulation job for an Australian shipyard, done by one of his EMC engineers, would then have a big impact on his life. The client's contact person started his own consulting company in Melbourne, Australia, and Franz decided that was a good opportunity for a sea change. Not that he considered moving from Hamburg, Germany to Melbourne, Australia to be a big deal – a much bigger step had been the move from Bavaria to Hamburg. But to leave the safety of a successful lab for the unknown of a small start-up company could be seen as

Measurements on a fishing vessel.

Franz Schlagenhaufer relaxing after taking measurements on a fishing vessel.

a risk. The next four years, 1996–1999, saw Franz in Melbourne as the technical manager of EMCSI Pty Ltd, where he was involved in EM simulations for Navy projects in Australia, Singapore and Germany. And again EMC regulation caught up with him. Australia had just introduced the EMC Framework, and EMCSI Pty Ltd was to become Australia's first Competent Body for product assessment.

During all this time in industry, Franz had kept close contact to the academic world, mainly the Hamburg University of Technology and Dresden University of Technology. By the end of 1999, he felt it was time to return to academia, and the offer of a new position as Senior Research Fellow for EMC at The University of Western Australia in Perth came just at the right time.

In 2000, he joined the Telecommunications, Electronics and Networking group at The University of Western Australia in Perth, which was later transformed into the Western Australian Telecommunications Research Institute (WATRI). His research topics were the investigation of shielding enclosures, in particular the effect of slots on the shielding effectiveness, the near field/far field conversion of measured data based on genetic algorithms, and assessment procedures for lighting systems. His teaching duties covered electromagnetic theory and EMC, and the supervision of Ph.D. and master students. Besides the academic and research part of his work, he also liked to stay involved with industry, was active in national and international standardisation, and delivered numerous EMC seminars.

Franz Schlagenhaufer giving a talk to the Shanghai EMC Chapter.

Since 2010, he has found a new task at Curtin University, still in Perth, with the International Centre for Radio Astronomy Research (ICRAR). Western Australia has dedicated a large block of land to radio astronomy, the Murchison Radio Astronomy Observatory, about 700 km north-east of Perth, where currently two major telescopes are being built: 36 dish antennas forming the Australian Square Kilometre Array Pathfinder project, and the 8192 dipole antennas for the Murchison Widefield Array project. This site is also shortlisted as the potential location of the Square Kilometre Array. ICRAR is one of the institutions supporting these radio astronomy activities, and protection from RF interference is a major concern for sensitive radio telescopes. Derivation of limit values, tailoring of test procedures, and providing the means to perform these tests are important to guarantee that the radio astronomers' own equipment is not disturbing the radio quietness of the site. Besides EMC problems, a difficulty for Franz, as an EMC engineer, is to understand the language of radio astronomers.

Franz joined the IEEE in 1994 and is now a senior member. He is serving the IEEE EMC Society as Region 10 Regional Conference Coordinator and has served a two year term as Distinguished Lecturer in 2007/2008, a role that brought him to South America, Eastern Europe and China. He is also active in the Australian EMC Society, has the status of an accredited Inspection Body for EMC (Competent Body) and electromagnetic modelling, and acts occasionally as a technical assessor for NATA, the Australian accreditation body.

Since graduating from the Technical University Munich more than 20 years ago, Franz has tried to keep a balance between theoretical and practical work. He believes that one can't trust either simulation or measurement results, if they can't be interpreted based on electromagnetic theory. He also believes that academics have the right to live in an ivory tower - as long is this tower has doors and windows, and there is some engagement with the 'real' world. **EMC**

EMC Society History

Daniel D. Hoolihan, Associate Editor,
Chair of the EMC Society History Committee

Introduction to the EMC Society History Section

For this Newsletter, we have three articles on EMC Society History.

The initial article focuses on the "EMC Society Newsletter Review," where we look at Newsletters from 50 years ago, 25 years ago, and 10 years ago. The highlights of the Newsletters are repeated for your reading pleasure.

The second article is another look at a special museum in Tokyo, Japan. This museum was visited by the author in March of 2010 and this second article covers two new additions to the museum plus some news on how it survived the March 2011 Japanese earthquake.

The third article is a reprint of the second *Quasies and Peaks* newsletter from April of 1955. This newsletter preceded the EMC Society Newsletter and was edited and published by Rexford Daniels in the 1955–1958 timeframe. The reprint is of the entire Newsletter for our readers' interest and for historical archiving purposes.

EMC

EMC Society Newsletter Articles 50–25–10 Years Ago

Fifty Years Ago – May 1961 – Newsletter Number 16 Institute of Radio Engineers (IRE) – Professional Group on Radio Frequency Interference

The cover story of this issue highlighted the officers of the Professional Group on Radio Frequency Interference (PGRFI). They included Harold Dinger as Chairman, Rexford Daniels as Vice-Chairman, Zigmund Grobowski as Secretary, and Herman Garlan as Treasurer. Other members of the Administrative Committee included Robert Fairweather, Leonard Milton, Otmar Schreiber, Leonard Thomas, John Egli, Hal Gauper, Richard Schulz, Sam Burruano, Henry Randall, Ralph Showers, and William Pakala.

Page 2 of the Newsletter had a short announcement titled "Don White Associates Formed in Bethesda, Maryland." The article went on to say "Donald R. J. White, formerly vice-president of Frederick Research Corporation, has formed his own technical consulting firm under the name of Don White Associates at 7306 Honeywell Lane, Bethesda, Maryland. The new firm specializes in the solution of system problems associated with increasingly complex military and industrial plans and operations and will emphasize radio frequency interference prediction and control. Jack McShulskis, also formerly of Frederick Research Corp., is associated with the above firm.

A second article on Page 2 was titled "FCC Amends Part 18." It stated "Effective April 30, 1961; *Form 724 – Certificate of Compliance – Industrial, Scientific, and Medical Equipment;* is approved for use in certifying ISM equipment and *Part 18 – Industrial, Scientific, and Medical Service* is thereby amended. Form 724 is available from the Commission's office in Washington, DC or from any of its Engineering Field Offices.

Outstanding changes included the following: "The certification required in Part III of FCC Form 724 shall be executed by an engineer skilled in making and interpreting field strength measurements. The Commission may require such engineers to furnish proof of their qualifications."

Another article in the Newsletter was titled "New Empire Devices, Inc. Products." The article went on to say "Empire Devices, Inc., Amsterdam, New York, very kindly listed, at the Institute of Radio Engineers (IRE) show, their new products for Radio Frequency Interference control. The products included (1) Tuning Unit, 14 KC to 150 KC, Cat. No. T-X/NF-105, (2) Corner Reflector Antenna, Model RD-105, (3) Rejection filters from150 KC to 400 MC, (4) Clamp-On Probe, Model CP-105, (5) Antenna, a single log periodic antenna to be used to cover the entire frequency range from 1.0 to 10.0 KMC, (6) Standard Antenna Set, Model SA-301 10 KC to 30 MC, Correlation with National Bureau of Standards (NBS) standard field to within 1% of any frequency in the above frequency range, and (7) Attenuator Selection Chart showing average power dissipation from Direct Current to 10 KMC of 1 to 50 watts.

The Editor of the Newsletter was Rexford Daniels.

25 Years Ago – IEEE Electromagnetic Compatibility Society Newsletter – Issue No. 129 – Spring 1986

"A Message from San Diego – EMC/1986" was the lead story in the Newsletter. It went on to say "The 1986 EMC Symposium promises to be the most significant EMC technology event of the year. The technical program is being coordinated by Ed Skomal and Joe Fischer. The Exhibits chairman is Jerry Rothhammer. The Arrangements chairman is Bill Johnson. The Chairman was Herb Mertel and the Vice-Chairman was George Ufen. The symposium will be held at the San Diego Town & Country Convention Center."

The Newsletter contained a report on the Board of Directors meeting held in Anaheim, California on February 5, 1986. Newly-elected officers included Len Carlson as President, Donald Clark as Vice-President, L. Gilda Haskins as Secretary, and Dick Ford as Treasurer. Technical Directors were Bob Haislmaier for Communication Services, Fred Nichols for Member Services, Ed Bronaugh for Technical Services and Bob Brook for Professional Services.

There was a one-page obituary notice for William Elmer Pakala, 1901–1985. He was a Founder of the IRE Professional Group on Radio Frequency Interference (the precursor to the IEEE EMC Society), a Life Fellow of the IEEE, and a member of the Board of Directors of the EMC Society from 1959–1964.

The EMC personality profiled was Leonard Carlson and the Personality Profile Associate Editor was William G. Duff.

The practical paper in the Newsletter was written by Anatoly Tsaliovich and was titled "LISN Design Affects Low-Frequency Conducted Emission Measurement Results." Anatoly worked for AT&T Information Systems in Holmdel, New Jersey. The summary and recommendations of the article were:

1) When performing conducted emission testing per VDE regulations, it may be necessary to apply a correction factor to account for the insertion loss of the LISN coupling circuit in the frequency range below 150 kHz.
2) The correction factor value depends on the values of coupling capacitors used in the LISN coupling network design. The frequency characteristics of the correction factor may be calculated using the formulas (1), (3), and (4).
3) In some LISN designs, a special coupling network is used, which makes the use of a correction factor unnecessary. The EMC measurement engineer should verify if any corrections are needed when making CE tests below 150 kHz. A review of the LISN manufacturer's schematic should provide the necessary information with which to base such a judgment. A check with the appropriate regulatory agency is also suggested.

The Editor of the Newsletter was Bob Goldblum.

Ten Years Ago – IEEE EMC Society Newsletter – Issue No. 189 – Spring 2001

"Special IEEE EMC Society Workshop Addresses Measurements Above 1 GHz and Associated Uncertainty" by Michael J. Windler was the cover story article for this issue of the Newsletter. The article explained the various topics that were covered by the special Workshop, sponsored by the IEEE EMC Society, at the 14th International Zurich Symposium and Technical Exposition on EMC held on February 20–22, 2001. A picture on the front page displayed the distinguished speakers including Dr. Pierre Beeckman, Dennis Camell, Ed Bronaugh, Ghery Pettit, Bob Johnk, Don Heirman, and Michael Windler.

The Chapter Chatter Associate Editor, Todd Hubing, resigned in this issue after 35 articles over a period of nine years. After starting every sentence in the first paragraph of his "good-by" column with an "I" – he concludes "In rare cases, writers on the edge of sanity have been known to begin every sentence with the same letter. I need to quit before I reach that stage." His farewell column includes a one-act, two-scene play that wraps up his clever column for this issue and concludes his service to the Society as Associate Editor for the Chapter Chatter column as he moves on to the next "stage" of his life.

The Newsletter also highlighted the passing of Al Parker, a well-known EMC Society member, at the age of 87. In the 1940s and 1950s, he designed Radio Interference and Field Intensity Receivers for Stoddart Aircraft Radio Company under a series of Navy contracts. In 1957, he was one of the original Founders of the Professional Group on Radio Frequency Interference in the Institute of Radio Engineers. In 1960, he formed his own company, Solar Electronics, which designed and manufactured ancillary equipment for EMC laboratories such as spike generators, audio sources, LISNs and similar equipment. He also designed a "dB Clock" that clearly showed the relationship between dBs and linear numbers. He guaranteed that the clock (which had no electronic parts) was "EMI-free!"

The Personality Profile was done on Salvatore Celozzi from Italy. He earned his Ph.D. from the University of Rome "La Sapienza." His doctor's thesis was on the direct time-domain analysis of multiconductor line networks. He has been an IEEE member since 1991 and he was an Associate Editor of the IEEE Transactions on Electromagnetic Compatibility from 1995–2000. The Personality Profile Associate Editor was Bill Duff.

Peter Staecker, Division IV Director, had an article in the Newsletter titled "Comments on the IEEE Fiscal State of Affairs." This article was needed in order to understand the fact that the IEEE incurred a deficit of 10.9 Million Dollars in Calendar Year 2000, primarily because of the stock market downturn. The deficit was covered by transferring money from the reserves of the Societies and Councils of the IEEE.

The Editor of the Newsletter was Janet O'Neil.

EMC

Additional Information on the Museum of Communications in Tokyo, Japan

In the Spring 2010 issue of the EMC Society Newsletter (Issue No. 225), we published an article on my visit (Associate Editor Hoolihan) to the UEC Museum of Communications in Tokyo, Japan on March 27, 2010. This article is an update on the Museum including a post-earthquake report.

When I visited the Museum in March of 2010, the Museum was waiting for the delivery of a special tube from Sweden. The tube was delivered from Sweden in early 2011; it is on loan from the Teknisa Museet Sweden (Technical Museum of Sweden) in Stockholm, Sweden. The tube is called the Lieben Tube. The tube is now on display in a special, very-strong and anti-earthquake display case in Room 7 of the Museum.

The Lieben Tube is a mercury-vapor filled triode. The tube was invented by Austria in 1906 and, during World War I, the tube was used in the battlefield as a repeater amplifier for the wired telephone system of the German Army. There are only two of the Lieben Tubes in existence today.

In 1906, three Austrians – Robert von Lieben, Eugene Reisz, and Sigmund Strauss – developed the mercury-vapor filled triode. In 1912, a German company began to produce the Lieben Tube; the company was AEG-Telefunken. But, the Lieben Tube was very unstable and its critical characteristics were variable due to the anomaly of the mercury-vapor. Also, the Lieben Tube had a short life which made it impractical to use in real work. So, it was replaced by tubes that were of a high-vacuum design.

The structure of the Lieben Tube was unique; its two large glass tubes are connected at the center as shown in the accompanying photos. An aluminum grid plate with holes "like a lotus flower" joins the two glass tubes to each other.

An anode is located in the upper tube and it is structured as a narrow spiral coil with 2 mm diameter aluminum wire. The cathode is located in the lower tube and it consists of a platinum ribbon coated with an oxide material. The cathode is structured like a cage with folded ribbons with an oxide coating (BaO and CaO) on the ribbon facing outwards.

A small glass vessel is fitted at the bottom of the lower tube; it has an amalgam that releases the mercury vapor.

The tube is approximately 30 cm long with a 10 cm diameter. The cathode (filament) is operated at 30 volts at about 2 amps. The anode voltage is 200 volts DC with a current of 10–11 milliamps DC. The mercury vapor pressure is 0.01 mm Hg. The amplitude factor is mu = 33, the operating temperature is 15–30 degrees Centigrade, and the useful lifetime was between 1000 and 3000 hours.

The Good News is that the Earthquake-Resistant Case for the Lieben Tube Worked Exactly as Designed and the March Earthquake (magnitude 9) in Japan did not do Any Damage to the Lieben Tube!

The Lieben Tube on display at the Museum of Communications in Tokyo, Japan.

The display of the photomultiplier tube for nuetrino detection at the Museum of Communications in Japan is signed by its inventor, Professor Masatoshi Koshiba of the University of Tokyo. Professor Koshiba was awarded the Nobel Prize for Physics in 2002 for research accomplished using this tube.

A photomultiplier tube for nuetrino detection used at the world famous Kamiokande Observatory in Nagaon, Japan.

The Museum in Tokyo has also added a Photomultiplier tube for Neutrino Detection. This tube was used at the world famous Kamiokande Observatory in Nagano, Japan. The tube is classified as an extremely low-noise super-high sensitivity photoelectric cell with extreme high-gain photomultiplier.

Kamiokande Observatory of ICPR of the University of Tokyo was built for the research and verification of nucleon decay phenomena. The observatory is located at Kamioka City in the Nagano prefecture of Japan.

The observatory was built with a huge cylindrical tank filled with 3000 tons of super-pure water; the tank was built 1000 meters below ground level. The inside surface of the tank is covered with 11,000 of the extremely sensitive photomultiplier tubes for detection of very weak fluorescent light emitted by the nucleon decay after a collision with a high-speed neutrino. The photomultiplier tube is designed to be similar in style to a 20 inch CRT which was developed and made by Hamamatsu Photonics Co. in Hamamatsu, Japan.

The entire project was developed and directed by Emeritus Professor Masatoshi Koshiba of the University of Tokyo; it was initiated in 1983. On the 23rd of February in 1987, the project detected the world's first detection of light due to a collision of a neutrino with the water. It is believed the neutrino came from the Super Nova of the Great Magellan Nebula (SN1987A).

Professor Koshiba was awarded the Nobel Prize for physics in 2002 for this detection result. The tube in the museum is autographed by Professor Koshiba.

EMC

Quasies and Peaks – The Precursor to the EMC Society Newsletter

As explained in the last IEEE EMC Newsletter, there existed an informal Newsletter before the start of the Institute of Radio Engineers (IRE) Professional Group on Radio Frequency Interference (PGRFI) in 1957. The Newsletter was edited by Rexford Daniels and 18 editions were published between 1955 and 1958.

Again, for purposes of historical preservation and for the interesting articles, we will be reproducing these *Quasies and Peaks* Newsletters in the IEEE EMC Newsletter over the next 17 issues.

Quasies and Peaks – April 1955 – Interference Testing and Research Laboratory, Inc.; 150 Causeway Street, Boston 14, Massachusetts

EDITORIAL

The Symposium on Spurious Radiation – at the IRE Convention – dealt mostly with broad governmental and industrial problems and responsibilities. It was pointed out by several speakers, that many of the problems involved were more of a managerial than engineering nature; hence, in the future, an increasing number of questions would have to be settled by 'presidents' of companies as well as by their Chief Engineers.

It was felt that, to reach the ultimate objectives which would be necessary for a practical program of interference reduction, there would have to be dual responsibilities between sources of interference – and equipment being interfered with; as well as new classes of controls. It was considered impractical to place the full responsibility on transmitters of spurious radiation when, in many instances, improved receivers might be a part of the solution. Also, some means of certification of apparatus, which could not be licensed, might have to be considered. These questions would require a close co-operation between the FCC and industry.

Possibly the most important statement, which was made engineering-wise, was made by Mr. G. C. W. Browne, Controller of Telecommunications, Department of Transportation,

SUPPRESSION OF INDUCTIVE INTERFERENCE

Circular No.	Title	Pages	Charts
SII-10-1	Commutators of Motors and Generators	1	
SII-10-2	DC Relays (Street Car)	2	
SII-10-4	Railway Crossing Signals	1	
SII-10-7	Flashing Electric Signs	2	
SII-10-8	Small Lighting Plants	2	
SII-10-9	Oil Burning Furnaces	2	
SII-10-13	Mercury Arc Rectifiers	1	
SII-10-16	Care of Commutators and Brushes	2	
SII-10-27	Luminous Tube Signs	2	
SII-10-29	The Control of Interference from Industrial, Scientific, and Medical Apparatus	3	
SII-10-30	Small Electrical Apparatus	2	
SII-10-34	Frequency Stabilized Diathermy Units and Suppressors	3	
SII-10-36	Short Leads of Capacitors	2	1
SII-10-39	Survey of Broadcast Interference from Household Appliances	15	9
SII-10-40	Large DC Generators	1	
SII-10-42	Suppressors for Fluorescent Lighting	3	
SII-10-43	Shielding	16	
SII-10-44	High Frequency Stabilized Arc Welders	9	1
SII-10-45	Elevators	4	
SII-10-46	Suppression Capacitors for Television	2	
SII-10-47	Variation of Field Strength with Distance	12	16
SII-10-48	Antenna Factor	2	1

Canada, in his talk "Control of Radio Interference in Canada." In discussing the problems of applying and administering the limits now in force in Canada, he said:

"As we all are aware, the practical application of such limits tends to be rather complex and we feel therefore that every effort must be made to simplify procedures as much as possible. Measurement of radiation at VHF frequencies tends to be affected by a number of variables which are difficult to control, and serious consideration is being given to relying, initially at least, on measurements of conducted noise only, which are much more manageable and easy to make. This, of course, would apply only to appliances and possibly to TV receiver interference. Such measurements of conducted noise from TV receivers would include measurements with the antenna terminals grounded."

National Conference on Aeronautical Electronics to hold Radio Interference Session, Dayton, Ohio, May 10, 1955

The National Conference on Aeronautical Electronics; presented by the Dayton Section of the IRE and the Professional Group of Aeronautical and Navigational Electronics, and participated in by The Institute of Aeronautical Sciences; will hold a Radio Interference Session at the Engineers Club, Dayton, Ohio, on May 10, 1955.

Subjects and Speakers are as follows:

- *Low-Impedance Gaskets for Radio-Frequency Applications*; V. Pulsifer, A. J. Hoehn – Armour Foundation.
- *Measurement of Interference Fields About Aircraft*; J. R. Stahmann – Lightning and Transients Research Institute.
- *Radio Interference Control in Aircraft*; A. L. Albin, J. E. McManus – Armour Research Foundation.
- *A Study of Interference Between Messages from Independent Multiple Sources on a Single Channel*; Lt. B. Buchanan – Cambridge Research center, USAF.
- *Study of Noise Reduction by Feedback in Ultra-High Frequency Amplifiers*; A. B. Glenn – Radio Corporation of America.

Military Will Probe Spurious Radiations from Electronics, April, 1955

On page 7 of **Electronics**, April 1955, is a discussion of the Armour Research Foundation's recent Conference. Excerpts are as follows:

"Increasing use of the radio spectrum has aggravated the problem of interference. Both government and industry have stepped up progress to reduce spurious radiation…."

"Results of the study (Armour) will be used to provide recommendations for a long-range program of research and development and to furnish guidance on measures which can be affected immediately to improve field operation and maintenance."

"Cost – Interference control has become a significant part of the defense program. John W. Klotz of the Department of Defense, in an address before the symposium on radio interference reduction at Illinois Institute of Technology, pointed out that every area of equipment development has become involved in some phase of the interference problem to insure that the equipment will operate effectively. He said that the Department of Defense estimates its annual support of the interference control program to be in excess of $200 million."

"Last year one piece of radar equipment required a $2-million program of interference control to make it operate properly in its equipment environments. The control program extends to fields such as power generators, x-ray machines, lighting fixtures, office machines, etc."

NEWS ITEM

From Danton Walker's column, London, March 15, 1955:

"Parliament is studying a bill that would require anyone operating any machine (hair dryer, vacuum cleaner, etc.) that might interfere with television or radio reception to get a "suppressor" to eliminate any distortion of programs."

NEW BOOK

NOISE, by Albert van der Ziol, Prentice Hall, Inc.; 1954, 450 pp., $10.35.

Some chapter headings: Noise Measurements, Tube Noise at Low Frequencies, Tube Noise at High Frequencies, Practical Low-Noise Circuits, Excess Noise in Semiconductors and Vacuum Tubes, Noise in Feedback Circuits.

New Theory for Formation of Thunderstorm Electricity

Bernard Vonnegut, Arthur D. Little, Inc., Cambridge, Massachusetts has advanced a new theory for formation of thunderstorm electricity. A short write-up explaining the theory appears on page 184 of **Electronics,** April, 1955.

New ASEA List of Military Specifications and Standards

The Armed Services Electro-Standards Agency, Fort Monmouth, NJ has brought out ASEA List No. 100, Issue No. 37, 1 March 1955. This list covers those specifications, standards, and other publications prepared by the Armed Services Electro-Standards Agency and pertaining to electro-standard parts, materials, and processes.

New Shielded Transformer

Electro-Search, 4337 N. 5th Street, Philadelphia 40, Pennsylvania has brought out a completely shielded transformer which performs any normal transformer function at power frequencies but rejects the higher audio and radio frequencies with an insertion loss of over 100 dB from 100 kc to 1800 mc when measured in a 50-ohm system.

Pertinent Notes Concerning Interference

We are pleased to include, with this issue, a copy of "Pertinent Notes Concerning Interference" prepared by Mr. C. R. Billheimer, of Code 837, BuShips, Navy Department.

What Interest is There in Forming a Technical Group?

We have been asked by several readers to sound out those in this field as to their interest in forming some sort of technical group, or Society, which would act as a focal point for exchange of information and technical matters. Have you any suggestions?

Bibliography

Requests for copies of the following Circulars should be addressed to Controller of Telecommunications, Department of Transport, Ottawa, Canada, and are available free of charge.

EMC

President's Message

continued from page 7

As a result of the Society's efforts, significant chapter growth was observed in the last five years, as presented in the following charts. Today, the EMC Society has 75 active and healthy chapters worldwide, a half of which are located outside the United States.

Looking Forward to Long Beach in August

By the time you read this article, our 2011 IEEE International Symposium on EMC in Long Beach, California will be at hand. As usual, this symposium will provide us all with education, information exchange, networking and just plain social and entertainment opportunities. Don't miss the chance to keep yourself updated with the latest research outcomes and products as well as the opportunity to meet old friends, and make new ones! For more information, visit www.emc2011.org

Board of Directors Meetings

The next EMC Society Board of Directors (BoD) meeting is scheduled on August 14 and 18, in Long Beach, California, in conjunction with the 2011 IEEE International Symposium on EMC. As usual, besides the technical program and the exhibition, the Symposium week offers a variety of committee meetings. I remind you that all meetings of the EMC Society Board of Directors and its committees are open. Any members who want to attend will be most welcome. This could be your opportunity to take a look at the manner in which our Society is run and become familiar with the activities of our committees. You may find it interesting enough to make you want to get involved with the committee's activity or even to run for the Board of Directors during its next election.

Call for Volunteers

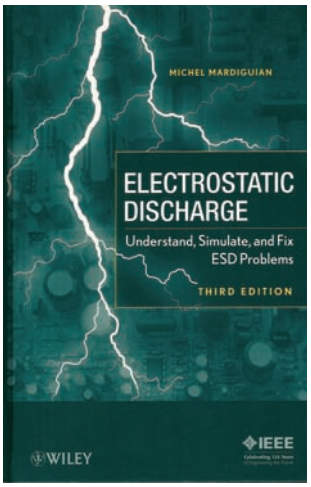
The success of our Society is possible thanks to many fine volunteers who have contributed unselfishly of their time and talent. As the Society evolves, and new initiatives emerge, we are always in need of volunteers. Please, give serious consideration to becoming involved in our broad and challenging goals and objectives. The full list of committees can be found on our website at http://www.ewh.ieee.org/soc/emcs/directors.html

I look forward to working with all of you who join the volunteers of the Society in helping achieve the set of our goals for the benefit of us all. For making a suggestion, comment, or just for dropping a friendly note, please do not hesitate to e-mail me at: fr.maradei@ieee.org **EMC**

Book Review

Antonio Orlandi, Associate Editor

Title: ELECTROSTATIC DISCHARGE – Understand, Simulate, and Fix ESD Problems. Third Edition
Author: Michel Mardiguian
Publisher: John Wiley, 2009
ISBN: 978-0-470-39704-6



This book has reached its third edition. The first and second editions have been out of print since the year 2000 and only a few lucky readers can benefit from their contents. The third edition, now published by a major publisher, makes the book available to a larger number of readers who will appreciate this methodic step-by-step attack of electrostatic discharge (ESD) problems.

The book has been defined as "the most thorough and concise treatment of the broad ESD continuum that is available" and, after a careful reading, I cannot disagree; in less than 300 pages the author delivers a trusted coverage of the ESD phenomenon also incorporating recent technological advances that have taken place in recent years in the engineering community.

As needed, formulas and equivalent circuits help to quantify the values of voltages and currents involved in ESD. At the same time, to help with troubleshooting, many ESD case histories are provided.

The book is divided into six chapters and eight appendices.

Chapter 1 is my favorite. It discusses the physics of the discharge phenomenon. It describes ESD starting from its influencing parameters and how humans and furniture play a significant role in determining the electromagnetic characteristics of the ESD waveform.

Chapter 2 addresses the analysis of the effects of ESD on electronics. It starts with looking at the generation of direct and indirect discharges on electronic components. Then the analysis of the coupling mechanisms of ESD as pulsed into the victim's circuitry is developed with the aim to identify the response of the victim circuit and the possible types of errors. This is a mandatory previous step. It will be the base of the diagnostic techniques discussed in chapter 4.

Chapter 3 illustrates the relevant ESD specifications: from IEC 61000-4-2 to MIL STD 1541. In this chapter the author discusses their contents and applicability. A specific paragraph is dedicated to the EIA/JEDEC test methods and to the immunity requirements for space systems and automobile electronics.

Chapter 4 reviews diagnostics and testing. The industrial experience of the author takes the reader by the hand through three important topics:

1) how the ESD simulators work and how to use and interpret their results
2) the fundamentals of ESD test setup and test routine
3) the diagnostics' concepts (such as the *Error per Discharge* concept and the *Forced Crash* method) and their use during design and development

Chapter 5 offers a thorough discussion on the design strategies for a robust and reliable ESD immunity. Although not openly declared, the author uses a bottom-up logical approach. He starts by discussing ESD protection at the component level, then passing to the PCB level, up to the internal wiring and mechanical packaging level. The discussion then addresses the ESD protection by box shielding and envelope design, taking into account the presence of the external cables. The paragraph on non-metalized plastic boxes is very factual and useful.

The last chapter (chapter 6) is a collection of seven ESD case studies. Each one is presented and well conceptualized. Then the solution (the fix of the problem) is presented and discussed.

Eight appendixes enrich the book. They deal with some very specific and actual ESD related issues such as the ESD protection of chips and microcontrollers, the prediction of ESD damage at the semiconductor junction level, the fatigue phenomenon during repeated ESD testing, as well as examples of SPICE modeling of ESD coupling effects and time-to-frequency domain conversion formulas for single transient ESD waveforms.

As I mentioned at the beginning, one of the strong points of this book is its conciseness; a few well written sentences, with the help of clear pictures, are very effective in transferring the relevant concepts.

In my opinion *Electrostatic Discharge* is essential reading for all EMC engineers and electronic designers who want to avoid component failures, no trouble found incidents, and random errors. I would also recommend the reading of chapters 1, 2 and 6 to students and instructors of EMC courses at the graduate level.

EMC

WANTED: EMC Books to Review!

Dear IEEE EMC Society Members,

The "Book Review" columns that are published in the EMC Newsletter are a great treasure for all of us. They give us the possibility to be informed of the existence and contents of published books that are of interest in the wide range of topics covered by our common technical and scientific interest: Electromagnetic Compatibility.

The large number of books published on EMC related topics per year makes it impossible for a mortal Associate Editor to be acquainted of all of them. Because of this, I wish to ask you for your help.

Please contact me if you:

- Have read a technical book that you consider worthy to be shared with members of our community
- Have noticed a book that could be of interest to the IEEE EMC Society members
- Are an author of a technical book on EMC related issues

Please indicate the author(s), the book title, the publisher, the ISBN and a brief description and/or your comments on why you feel the book should be considered for review in the EMC Newsletter.

This will help me very much in considering books for review and hopefully increase the number of book reviews made available to our community.

Thank you in advance for your help and time!

Antonio Orlandi
Book Review Associate Editor
antonio.orlandi@univaq.it

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The IEEE Technology Management Council provides tools to enhance your career and organizational effectiveness. We can keep you current with managerial, business, and entrepreneurial thinking whether you are an executive, an aspiring manager, a technical professional, or student.

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Francesca Maradei
IEEE EMC Society President (2010-2011)

A Message from the EMC Society Technical Advisory Committee Chair

By Bruce Archambeault

The Technical Program for the 2011 IEEE International Symposium on EMC in Long Beach, California will have something for everyone — from the novice EMC engineer to the advanced practitioner. The technical papers have enjoyed a reputation for extremely high quality in the past years, and EMC 2011 will be no different!

In fact, I am excited and pleased to announce that the EMC 2011 Symposium will have guest speakers who are the top leaders in their respective fields. This is a unique opportunity to see these technical giants in person!

- Henry Ott will teach the fundamentals of EMC based on his award-winning book, *Electromagnetic Compatibility Engineering*

- Dr. Howard Johnson will organize a special session on Signal Integrity

Technical papers will cover a wide range of topics including EMC Measurements, EMI Control, Computational Electromagnetics, Signal Integrity, High Power Electromagnetics, EMC Management, Electromagnetic Environments, as well as the newest technical topic areas for the EMC Society: Nanotechnology, Engineered Materials, and Smart Grid.

Remember, for the latest research in EMC – visit us in Long Beach!

Long Beach Convention Center

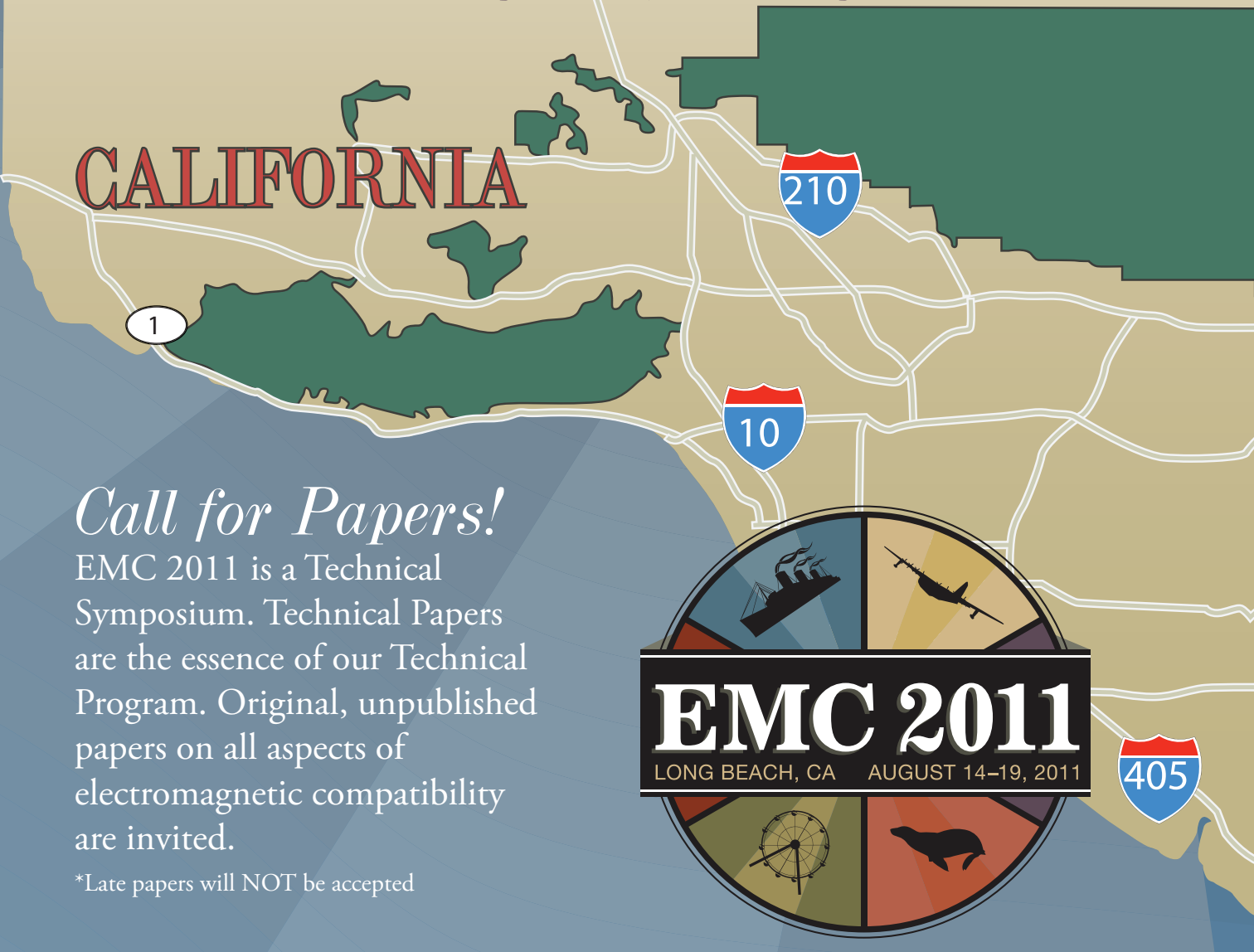
The Long Beach Convention & Entertainment Center is a spectacular multi-purpose complex - one of the few waterfront facilities nationwide - featuring more than 400,000 square feet of flexible exhibit and meeting space, two theaters, an arena and 34 meeting rooms. The glass concourse and lobby offer expansive views of the scenic harbor and downtown skyline.

Located in the heart of downtown Long Beach, the Center is within walking distance to first-class accommodations, shopping, dining, attractions, sightseeing along picturesque bays and 5 1/2 miles of sandy beach.

Harmonizing WAVES for EMC

2011 IEEE International Symposium on Electromagnetic Compatibility

August 14-19, 2011 • Long Beach Convention Center



Call for Papers!

EMC 2011 is a Technical Symposium. Technical Papers are the essence of our Technical Program. Original, unpublished papers on all aspects of electromagnetic compatibility are invited.

*Late papers will NOT be accepted

Important Dates

- *Preliminary Full Paper Manuscript:* November 1, 2010 - January 15, 2011
- *Acceptance Notification:* March 15, 2011
- *Final Paper and Workshop/Tutorial Material Due:* May 1, 2011

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Practical Papers, Articles and Application Notes

Kye Yak See, Technical Editor

Hello, I am Kye Yak, your new Technical Editor of the IEEE EMC Society Newsletter. It is both my honour and pleasure to have the opportunity to work with Janet O'Neil, the Editor-in-Chief, and the entire editorial team to serve the EMC community through this Newsletter. I would like to thank my predecessor, Professor Flavio Canavero, for his meticulous effort to solicit many wonderful articles during his term of running this column. He has made this column so successful that I can only hope to be able to match his results.

The key factor for the continuous success of this column requires your active participation and I encourage you to submit practical and interesting manuscripts to share with our EMC community. While all material will be reviewed prior to acceptance, it is not necessary that the paper be original or archival; it is only necessary that the paper be useful and of interest to readers of the Newsletter. I have a relatively smooth start for the current issue as the first two articles are the result of Professor Canavero's efforts; he invited the authors to contribute the articles and conducted the review process.

The first paper "Shielded Cable Transfer Impedance Measurements; Microwave Range 1 GHz–10 GHz" by B. Démoulin and L. Koné, is the conclusion of the three-part series on the measurement of the transfer impedance of shielded cables. The measurement of transfer impedance is not new, but to measure it correctly with repeatable results requires a proper test jig and experience. In the previous parts 1 and 2 of this series, the authors shared their many years of experience in the measurement of the transfer impedance of shielded coaxial cables up to 1 GHz. In this concluding part 3 of the series, they address the challenges faced in transfer impedance measurements up to 10 GHz. They propose a reverberation chamber measurement setup where the shielding attenuation of a shielded cable can be estimated with good confidence through the conversion from the measured transfer impedance results.

The second paper is contributed by Edmund K. Miller; it is entitled "Time-Domain Computation of Loop Inductance." For those of you (including myself) who were using Numerical Electromagnetics Code (NEC) for your wire antenna modeling many years ago, Dr. Miller is no stranger to us. He contributed significantly to the development of NEC, which led to him receiving a Certificate of Achievement Award from the IEEE EMC Society. Most of us are very familiar with the concept of partial inductance and how it can be used to obtain the loop inductance of arbitrary geometry. Dr. Miller proposes an alternative way to obtain the inductance of any arbitrary wire loop numerically using a time-domain computer model called the "Thin-Wire Time Domain" (TWTD) model. TWTD is usually employed for modeling wire antennas excited by impulsive voltage for their transient behavior and this paper extends TWTD to obtain the inductance of wire loops.

Professor Clayton R. Paul contributed the third paper, "The Remarkable Inverse Distance-Squared Law." You may wonder why many physical laws had their distance precisely squared. In this paper, Professor Paul shares his insights by examining the interesting relationship between the physical laws and their mathematical formulations. Some examples are shown to illustrate his observation on the famous inverse distance-squared law in both the law of gravity and Coulomb's law.

In conclusion, I hope you enjoy reading these papers and I welcome your suggestions and comments. With your active participation and with the help of independent reviewers, I really hope to be able to provide a great variety of enjoyable and informative papers. Feel free to communicate with me, preferably by email at ekysee@ntu.edu.sg.

Shielded Cable Transfer Impedance Measurements in the Microwave Range of 1 GHz to 10 GHz

B. Démoulin, L. Koné, lamine.kone@univ-lille1.fr
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I. Introduction

In the previous articles [1], [2], we have described the setup of test benches for the measurement of the transfer impedance of shielded coaxial cables. We have demonstrated that, at frequencies lower than 100 MHz, a conventional triaxial setup is sufficient to make this kind of measurements. The only restrictions of its use concern practical tests performed on shielded cables with high electromagnetic immunity. In this case, it is not

unusual to come across transfer impedances the absolute value of which falls below the $\mu\Omega$/m. Under these conditions, the voltages of very small amplitude measured at the extremities of the test cables can be seriously perturbed by the radiation of the triaxial setup. Some adjustments were proposed with the aim of protecting the measurements from interference risks [1].

Keeping in mind that 1-m long cable samples fit very well for measurements of transfer impedances below 100 MHz, we demonstrated that in order to cover a frequency range up to 1 GHz it is necessary to reduce the cables length. Indeed, as the wavelength gets near or below the test tube dimension, propagation phenomena give rise to systematic measurement errors. In order to reduce this inconvenience, the dimension of the shield subject to the currents injected through the setup must be reduced to approximately 10 cm. Thus, this physical constraint calls for a total revision of the concept of measurement setup of transfer impedances itself.

The analysis performed in [2] mainly concerned two methods respectively based on the the wire injection method and the shield discontinuity method in a triaxial setup. Despite this improvement, the measurements reveal that at frequencies close to or superior to the GHz range, the previous methods generate new errors, this time due to the approximation of the TEM propagation. Indeed, be it the classic triaxial setup, the wire injection method or the shield discontinuity method, the transfer impedance measurement setup is based on the theory of transmission lines whose validity domain is necessarily dependent on the hypothesis of TEM signal propagation.

In order to extend the transfer impedance measurement to the microwave range, here assumed to cover the 1 GHz–10 GHz bandwidth, at the beginning of the 80's we have started to characterize the cables shielding attenuation through practical measures performed in shielded anechoic chambers. The cables, connected at both extremities to a matched load and to a spectrum analyzer installed outside the chamber, were submitted to an electromagnetic field generated by a large bandwidth antenna. This antenna, placed at 3 m distance from the cable, produces on it a local irradiation quite close to a plane-wave. The measure of the voltage amplitude gathered on the spectrum analyzer provides a clue on the attenuation generated by the cable shield. This rather simple process nevertheless presents three main difficulties. The measures will be hardly repeatable on account of the uncertainty of the radiation diagram of the cable under test connected to the load and to the receiver through high-immunity coaxial cables. The physical contribution of the junction cables considerably influences the voltage amplitude induced on the shielding outer surface. As it is almost impossible to impose a repeatable setup configuration by means of a standard, the uncertainty becomes unacceptable. The second difficulty lies in the search for an objective reference magnitude, in the view of the shielding attenuation expressed as the ratio between two physical quantities having dimensions of voltage or power. Neither the electromagnetic field measured with a sensor, nor the power induced on a receiving antenna installed in the chamber could supply this reference. Their measures are still too dependent both on the position of the sensor and on that of the receiving antenna with respect to the transmitting antenna. They therefore do not account for viable indicators. Finally, we have to turn the shield attenuation in transfer impedance in order to compare the measurements with the results achieved below 1 GHz. The direct measurement of the induced current on the outer shield surface could solve this issue, but it will cause huge uncertainties generated by the current collector and its connection with the outside receiver. This procedure was then abandoned.

During the same period, progress made in understanding reverberation chambers allowed to use them to measure shielded cables attenuation [4]. As we will remind in section 1, the fields generated within reverberation chambers, submitted to different methods, offer interesting ways of producing repeatable attenuation measures through shielded cables or connectors. In fact, thanks to the oversizing of chambers in relation to wavelenght, the objects installed in cavities with high conductive walls gain isotropic electromagnetic behaviour. This means that they are characterized by the absence of defined directivity and polarisation. Moreover, mode stirring provides uniform average amplitude of the field throughout the whole chamber. However, the average amplitude is associated to a standard deviation that becomes constant for operating frequencies of the fields situated above a minimum value defined by the chamber dimensions. The isotropic and uniformity properties of the fields allow using the power received on an antenna installed in any place in the chamber to measure the reference level. So it becomes possible to evaluate the shielding attenuation by means of a ratio between the power received on the spectrum analyzer connected to the cable end, and the reference power captured on a broadband receiving antenna. Other advantages related to the properties of cables immersed in a reverberation chamber were added. Indeed, according to the statistics of the random data collected within a reverberation room, we have established analytical formulas which yield, through a very simple calculation, the conversion of the shielding attenuation into the transfer impedance [12].

This third article will thus be entirely devoted to the description of protocols which lead to measuring the shielding attenuation in mode stirring reverberation chambers. This conversion, given in terms of transfer impedance, will be demonstrated and then illustrated by means of examples. Section 1 will be devoted to remind us the properties of reverberation chambers. It will also include the description of the installation of shielded cables (or the connectors) in preparation for the measurement of the shielding attenuation. The reader who wants to go deeper in the physical issues can refer to specialized articles on reverberation chambers. Section 2 concerns the description of the protocols adopted to measure the attenuation of shielded cables. Section 3 will mainly address the conversion of the shielding attenuation into transfer impedance and vice-versa. Section 4 deals with the chambers calibration in view of determining their natural uncertainty margin and comparing transfer impedances taken from measures with a standard based on theory. Section 5 will show the results of different measurement performed on samples of shielded cables.

2. Description and Physical Features of the Mode Stirring Reverberation Chambers

Properties

Reverberation chambers (RC) of rectangular shape are made up of plane-parallel shielded surrounding walls working on so called either resonant modes or eigenmodes of high order. In

fact, let us consider a completely empty chamber except for an emitting antenna which does not change the electromagnetic properties of the chamber at all. Under such ≪ideal≫ conditions, electromagnetic theory shows that the chamber resonates at frequencies f_{mnp} determined by the following expression:

$$f_{mnp} = \frac{c}{2}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2 + \left(\frac{p}{d}\right)^2} \quad (1)$$

In this formula, c represents the speed of light, the value of which we will set at 3×10^8 m/s, while a, b and d are the dimensions of the cavity. The parameters m, n, p represent positive integer numbers, the value of which determines the order of the resonant modes. Thus, the *fundamental resonant mode* or *the first eigenmode* corresponds to a particular choice of m, n, p providing the lowest frequency value f_{mnp} for which we can have a non-null field inside the chamber. So, in a chamber having dimensions $a = 1.9$ m, $b = 2.5$ m, $d = 2.8$ m, the fundamental resonant mode is given by the following values $m = 0$, $n = 1$, $p = 1$. Under these conditions the expression (1) anticipates a fundamental resonant mode at 80.4 MHz.

The cavity excitation at a resonant mode is represented by a standing wave whose amplitude variation in space is expressed with sinusoidal laws. It can be shown that the sinusoid period is inversely proportional to the values of m, n, p relative to f_{mnp}. As a consequence, when the triplet gets much higher than unity, the periodical amplitude fluctuations of the field inside the cavity becomes spatially very dense. The chamber is then said to be working in an *overmode condition*, judging from the wavelength λ_{mnp} corresponding to the source frequency f_{mnp}:

$$\lambda_{mnp} = \frac{c}{f_{mnp}} \quad (2)$$

Once the excitation of the *overmode condition* is reached, it can be shown that all the metallic objects in the chamber significantly influence the field distribution. The presence of the emission antenna itself provides such a perturbation, but so do other objects such as the mode stirrer shown in Figure 1. Under these conditions we realize that the presence of metallic objects moves the field distribution away from the initial sinusoidal law. The field becomes a stochastic process, the amplitude distribution of which behaves randomly distributed within the room. Measurements and theoretical simulations of reverberation chambers indicate that we can associate known probability distributions to the electric (or magnetic) field data. Moreover, we can demonstrate that the mode stirrer rotation can produce new sets of random data in an almost independent way. The only condition required to observe this phenomenon is that the angular spacing of the mode stirrer progressive positions be over a threshold fixed by uncorrelation criteria for the electromagnetic field.

We can then associate average amplitude with a standard deviation to the fields or to other physical data such as currents, voltages, power. A reverberation chamber properly calibrated implies that the average amplitude is independent from the position of an observer moving in a certain chamber working volume. Under these preliminary conditions, the average amplitude is associated to an uncertainty whose value equally follows a stationary behavior. In practical terms, this means that the uncertainty is independent from the chamber volume and from the physical nature of its content.

The minimum frequency from which the reverberation chamber acquires its remarkable properties depends on the characteristics of the mode stirrer and on the dimensions of the chamber setting the fundamental resonance. The frequency threshold which determines its functioning is called lowest usable frequency (LUF) or starting frequency. It is represented by the symbol f_s, which is in general approximately 5 or 6 times greater than the fundamental resonant frequency of the empty chamber. In the above example, this threshold is located between 400 and 480 MHz.

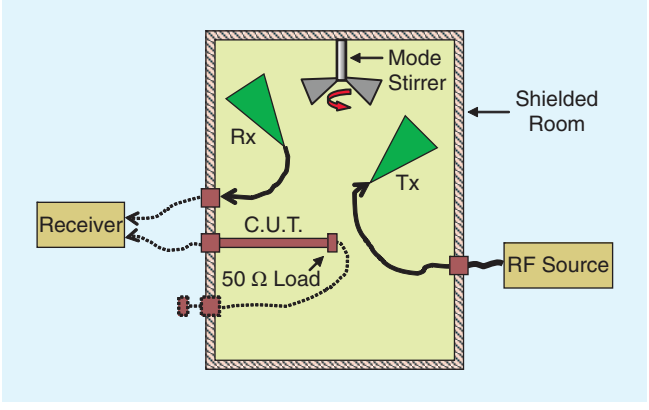

Fig. 1. Arrangement of the reverberation room to perform transfer impedance measurements.

Description

The emitting antenna Tx and the receiving broadband antenna Rx will be arranged in order to reduce their direct coupling as much as possible. The mutual coupling reduction can be eased by directive antennas of the log-periodic or horn types. However, experience tells us that some acceptable results can also be obtained with the help of antennas made up of conductors arranged at around 10 cm from the metallic walls of the chamber. The conductors so arranged form radiating transmission lines, one end of which is connected onto the broadband radio frequency source and the other end to a matched load.

With two identical antennas, the emitting one placed on one of the walls and the receiving one on the opposing wall, we can reduce their mutual coupling by a large amount. These reduced-size antennas are matched for a frequency range which goes from a hundred MHz to around 10 GHz. In exchange, their poor efficiency is balanced by the natural increase of the amplitude of standing waves produced by the chamber.

The mode stirrer, made up of metallic blades and set into rotation by an external electrical motor, is located on the top wall, but other arrangements are also possible. The control of the angular position of the mode stirrer will be set via software. The emitting source and the receiver will be placed outside the chamber. We can use a conventional generator and spectrum analyzer, but the two functions can be combined by employing a network analyzer. The installation of the cables under test (C.U.T.) requires a direct connection to the external receiver as well as a connection to a matched load placed in the chamber or connected to an external load. The discussion on which arrangement may be chosen will be undertaken in Section 5 by describing some measurement examples in RCs.

Figure 2 adds more details to the installation of cables under test of a dimension ΔL close to 10 cm. The sample so configured will be extended at the extremities by two pieces of high-immunity shielded coaxial cables. The dimensions of these additional cables must be bigger than the wavelength required by the lowest frequency found during measurements. For example, for 1 GHz, corresponding to a wavelength of 30 cm, the dimensions will be at least the double of λ, which is larger than 60 cm. It has to be remarked that the sample of the cable under test ΔL will be placed in a zone where the average amplitude of the field is statistically uniform. Studies of reverberation chambers show that this condition is satisfied when the distance from metallic walls is at least larger than a quarter wavelength. Thus, for a minimum frequency of 1 GHz, with a distance of 7.5 cm between the walls, the field uniformity is achieved. More details about the reverberating chambers may be found in [7], [10], and [11].

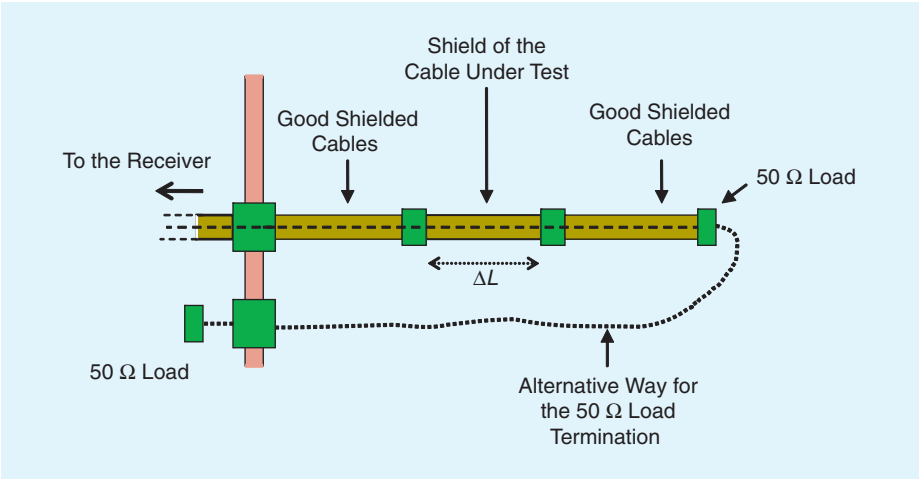

Fig. 2. Details of the Cable Under Test arrangement.

3. Method for the Measurement of Shielding Attenuation of a Cable Sample

The shielding attenuation measurement of the C.U.T, as described in the previous section assumes that the average amplitude of the field inside the chamber meets statistic uniformity criteria. A preliminary calibration of the chamber, for which we will mention the principle in Section 4, is suggested. In compliance with this condition and with the installation criteria described in the previous section, the attenuation measurement consists of two stages which aim at estimating the average power captured at the C.U.T.'s end. The term ≪estimate≫ is better suited than the term ≪determination≫ since the measurements are performed on a limited number of data, however sufficiently large and set by the minimum angular step of the mode stirrer.

Estimate of the Reference Average Power

On the whole frequency range explored in testing, we proceed by measuring a reference power P_r, collected on the receiver connected to the Rx antenna. During the measurement, the emission power sent to the Tx antenna can either be kept unmodified or not, according to the frequency function. Such power data will in any case be stored in order to perform the second step of the attenuation test.

For each frequency sample, we perform a rotation of the mode stirrer so as to capture N power samples $(P_r)_i$. The index i identifies any sample from this group N, uniformly distributed. From this measure we estimate the average amplitude $<P_r>$ of the reference power, as:

$$<P_r> = \frac{1}{N}\sum_{i=1}^{N}(P_r)_i \qquad (3)$$

The value N of samples must satisfy the condition of large numbers, that is to say the set N contains an adequate quantity of statistically independent data. In order to fix this number we recommend referring both to the international standards such as IEC 61000-4-3 and to specialized literature on reverberation chambers [10], [11].

Estimate of the Power Collected on the Cable Under Test

We repeat the previous protocol with the end of the C.U.T. connected to the receiver. This time the Rx antenna is connected to a 50 Ω load, similar to the input impedance of the receiver. On the N positions of the mode stirrer we measure the power $(P_c)_i$ collected at the cable's termination, as done before, and we estimate the average power:

$$<P_c> = \frac{1}{N}\sum_{i=1}^{N}(P_c)_i \qquad (4)$$

It ought to be noted that in the second stage, the power level injected on the Tx antenna must be exactly equal to the level memorized in the previous stage for every frequency sample. It follows that we turn either to a logarithmic or to a linear representation and the attenuation A given by the shielded cable sample will be expressed through the following formula:

$$\hat{A}_{\text{lin}} = \frac{<P_c>}{<P_r>} \quad \hat{A}_{\text{dB}} = 10\log\left(\frac{<P_c>}{<P_r>}\right) \qquad (5)$$

The sign ^ placed on top of the symbol A reminds us that the measure comes from a random process. In fact, each average estimation, as indicated in (4), is affected by an uncertainty defined by the law of large numbers. If the chamber was calibrated according to the protocol mentioned in section 4, the uncertainty should be independent from the chamber volume and the nature of its content.

In order to keep the quality coefficient of the chamber (Q factor) unchanged during the collection of power P_c by the cable under test, the receiving antenna will be connected to a load impedance similar to the input impedance of the receiver, usually 50 Ω. Without this precaution, the field amplitude

might be more or less modified, and this translates into a systematic error.

4. Shielding Attenuation and Transfer Impedance Conversion

This section comprises two parts, one devoted to explaining the physical properties of wire-like objects submitted to the electromagnetic field randomly generated into a reverberation chamber. The second part is devoted to describing the protocols which help us converting the screening attenuation into transfer impedance.

Behaviour of Wire-Like Conductors Immersed into a Reverberation Chamber

Figure 3 represents an electric monopole connected to an infinite perfectly conducting plate with load impedance Z_L. In this figure, $E_z(x, y, z)$ represents the electric field in the chamber, with polarization parallel to the monopole.

It can be proved that, in a properly calibrated chamber, $E_z(x, y, z)$ behaves like a random variable. The probability distribution of the real and imaginary components follow the Gaussian distribution. Let's consider in the meantime the field E_z in any point of the surface where the monopole in Figure 3 will be placed, namely $E_z(0, 0, z)$ with $0 < z < L_0$. Whenever the wavelenght is much lower than L_0, the projection of the field E_z on the monopole behaves exactly as a random variable, and the same will be for the induced current $I_M(z)$. It can be demonstrated that the variables E_z and $I_M(z)$ obey the ergodicity principle. That is to say, an observer set in any point of the monopole observes, as a consequence of stirrer rotation, that the amplitude of the random variables E_z and $I_M(z)$ follow a distribution of probalibity similar to that observed if he moves along the *oz* direction of Figure 3.

In order to ease the rest of this presentation, we will think the field distribution in the chamber as due to the combination of a large number of waves converging towards the object under test [5], [10], [11]. The analysis of how a reverberation chamber physically works shows us that we can reproduce the random variable E_z as a superposition of a large number of plane waves N_w having constant amplitude E_w whose incidence angles Ω_n, polarisation angles η_n and the phase angle ϕ_n are distributed according to a uniform distribution, that is

$$E_z = \sum_{n=1}^{N_W} (E_w)_n \qquad (6)$$

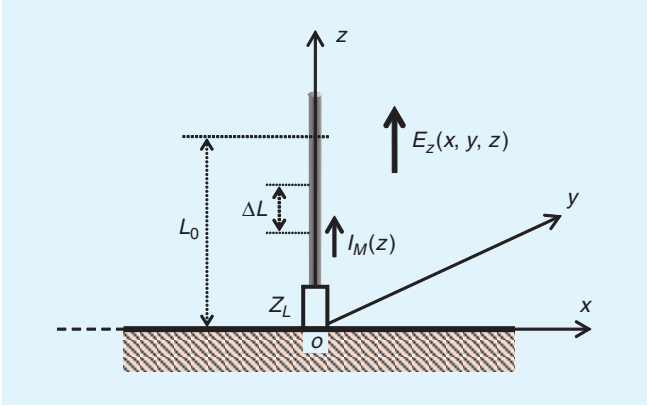

Fig. 3. Outer surface of the cable under test behaves like a short circuited electric monopole.

In the above formula, the symbol $(E_w)_n$ represents one of the N_w plane waves of constant amplitude E_w, while E_z refers to the entire random set.

We know that when a measurement is performed on the load impedance Z_L connected to the base of the monopole of Figure 3, the average power $<P_r>$ collected on N_S positions of the mode stirrer will be expressed as:

$$<P_r> = \frac{1}{N_S} \sum_{i=1}^{N_S} (P_r)_i \qquad (7)$$

In this relation, $(P_r)_i$ is equal to the power captured for any angular position θ_i of the mode stirrer.

If we perform N_S independent realizations of the variable E_z, according to (6), it can be shown that the average power collected on Z_L for such N_S realizations can be expressed with the following formula [11]:

$$<P_r> = \frac{E_w^2}{Z_w} <S_e> \quad \text{where} \quad Z_w = \sqrt{\frac{\mu_0}{\varepsilon_0}} \cong 377\,\Omega \qquad (8)$$

In the above expression, E_w represents the amplitude of the fictitious plane waves, Z_w the plane wave impedance given by the square root of the ratio between the magnetic permeability of vacuum μ_0 and the electric permittivity of vacuum ε_0, whereas the term $< S_e >$ is equal to the estimated average effective area of the monopole. This quantity is related to the N_S plane wave samples considered above. Knowing that the expression (8) can also be written

$$<P_r> = Z_w <I_M^2> \qquad (9)$$

the term $<I_M^2>$ represents the mean square amplitude estimate of the current I_M induced on the monopole for the previous N_S plane waves configurations. If we apply this argument to the cables under test, the extremity of which opposite to the chamber wall is left in open circuit, namely without the link marked by the dotted line in Figure 2, the current I_S induced on the shielding is thus similar to the current induced on the monopole in Figure 3 short circuited to the base, being $Z_L = 0$.

As the dimensions L_0 of the monopole or of the cable under test exceed the wavelenght, and if we assume a constant value for the average amplitude of the field in the chamber, the average square values of I_M and I_S calculated on N_S plane wave realizations or N_S positions of the mode stirrer finally converge to identical values, hence:

$$L_0 >> \lambda \quad \text{and} \quad E_w = \text{const} \rightarrow <I_M^2> = <I_S^2> \qquad (10)$$

If P_c represents the power collected on the extremity of the cable under test (C.U.T.), the formula becomes:

$$<P_c> = \frac{E_w^2}{Z_w} <S_e'> \quad \text{with} \quad <S_e'> \ll <S_e> \qquad (11)$$

This equation can be rephrased after the insertion of the term $<I_S^2>$ introduced in (10) and of an impedance term Zw' which remains to be determined.

$$<P_c> = Z_w' <I_S^2> \qquad (12)$$

As we know that the sections situated on either side of the sample under test have a dimension larger than the wavelength λ, but the dimension ΔL of the shielding under test remains smaller than λ, $< P_c >$ can be written:

$$<P_c> = \frac{1|Z_t|^2}{2\ Z_c}(\Delta L)^2\ <I_S^2> \quad \text{where} \quad Z_L' = Z_c \quad (13)$$

In this formula, the term Z_t represents the transfer impedance of the cable under test, whereas the term Z_c means that the cable's load impedance Z_L is matched to its own characteristic impedance Z_c.

Thus, we can determine the link between the shielding attenuation measure, as it is defined by the formula (5), and the transfer impedance.

Physical Principle of the Conversion of Shielding Attenuation into Transfer Impedance

As long as the dimension of the receiving antenna used for measuring power is larger than the wavelenght, the average power $<P_r>$ will be equal to the power collected on load impedance Z_L on the monopole in Figure 3. Consequently, if we take the ratio between (13) and (9), the result is very similar to the shielding attenuation described in (5), hence:

$$\frac{<P_c>}{<P_r>} = \frac{1\,|Z_t|^2}{2Z_cZ_w}(\Delta L)^2\frac{<I_S^2>}{<I_M^2>} = \hat{A}_{\text{lin}} \quad (14)$$

Using the mean square estimate of the current amplitude as expressed in (10), we will easily find the conversion formula we were looking for:

$$|\hat{Z}_t| = \frac{\sqrt{2Z_cZ_w}}{\Delta L}\hat{A}_{\text{lin}} \quad (15)$$

When the attenuation is expressed in dB, the above equation becomes:

$$|\hat{Z}_t| = \frac{\sqrt{2Z_cZ_w}}{\Delta L}10^{+0.05\hat{A}_{\text{dB}}} \quad (16)$$

The sign ^ placed on top of the symbol Z_t means that the determination of the transfer impedance is necessarily affected by the uncertainty related to the estimation of A_{lin} or A_{dB}. It's worth remembering that the terms Z_c and Z_w which appear in those formulas represent in turn the characteristic impedance of the cable under test (C.U.T.) and the impedance of the plane wave defined in (8). Some details about the transfer impedance conversion may be found in standard IEC 61196-1-4 or in [11].

5. Determination of the Uncertainty Margin and Calibration of the Transfer Impedance Measurement

In this section we will first of all examine the calibration procedure of the intrinsic margin of error in a reverberation chamber. In determining this parameter we will stick to standard specifications. Then we will perform the actual calibration of the transfer impedance, by using a shielded sample with a single small aperture as described in a previous paper [2].

Margin of Error Calibration

Let us now verify, by using an appropriate measurement procedure, that the electromagnetic field amplitude, as it is distributed in the reverberation room, is statistically uniform. In order to perform repeatable measures it is essential to adhere to this condition. By reproducible measures we mean data, of shielding attenuation or transfer impedance, extracted from measurements whose results are independent from the chamber's volume. We will only mention the physical principle of the calibration procedure, while readers wishing to have more details will need to refer to reverberation chambers regulations as found in standard IEC-61000-4-3 or to specific literature [10], [11].

Figure 4 offers a representation of the chamber specifically configured for calibrating the margin of error on the working volume edges delimited by the parallelepiped drawn within the chamber with a dotted line. Using a field sensor which delivers the absolute amplitude of the three cartesian components E_{xyz}, we estimate, on each of the 8 points A, B, C, D, E, F, G, H, the field's average amplitude collected on N_S angular positions of the stirrer:

$$<(|E_x|)_A> = \frac{1}{N_S}\sum_{i=1}^{N_S}(|E_x|)_i \quad (17)$$

We will repeat this average estimate on all 24 combined configurations of position and polarization, hence:

$$<E> = \frac{1}{24}[<(|E_{xyz}|)_A> + <(|E_{xyz}|)_B> + \ldots <(|E_{xyz}|)_H>] \quad (18)$$

According to the notation in (18), we will write:

$$<(|E_{xyz}|)_A> = <(|E_x|)_A> + <(|E_y|)_A> + <(|E_z|)_A> \quad (19)$$

Then we will estimate the variance as:

$$<\sigma_E^2> = \frac{1}{24}[[(E_x)_A - <E>]^2 + \ldots [(E_z)_H - <E>]^2] \quad (20)$$

Expression (20) will be computed for each polarization x, y, z of the sensor and at each corner point A, B, C, D, E, F, G, H of the working volume [11].

After correcting the bias error, we get to the variance adopted for calculating the standard deviation of the field σ_E, [11].

$$\hat{\sigma}_E^2 = \frac{24}{24-1}<\sigma_E^2> \rightarrow \hat{\sigma}_E = \sqrt{\hat{\sigma}_E^2} \quad (21)$$

If S_σ indicates the ration between the relative standard deviation and the estimate of the average amplitude, we will have:

$$S_\sigma = \frac{<E> + \hat{\sigma}_E}{<E>} \quad \text{or} \quad (S_\sigma)_{\text{dB}} = 20\log(S_\sigma) \quad (22)$$

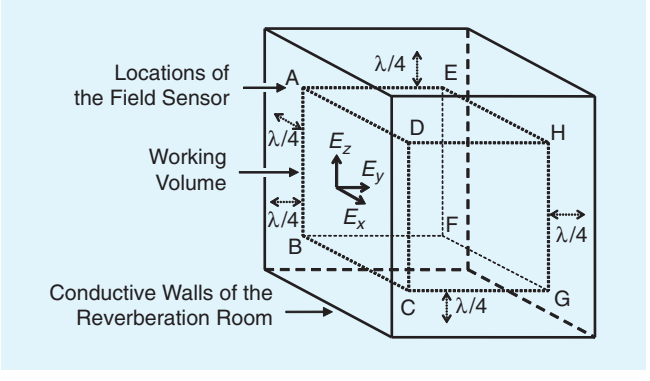

Fig. 4. View of the reverberation room to perform the field uniformity test at 8 corners of the working volume as drawn with thin dotted lines.

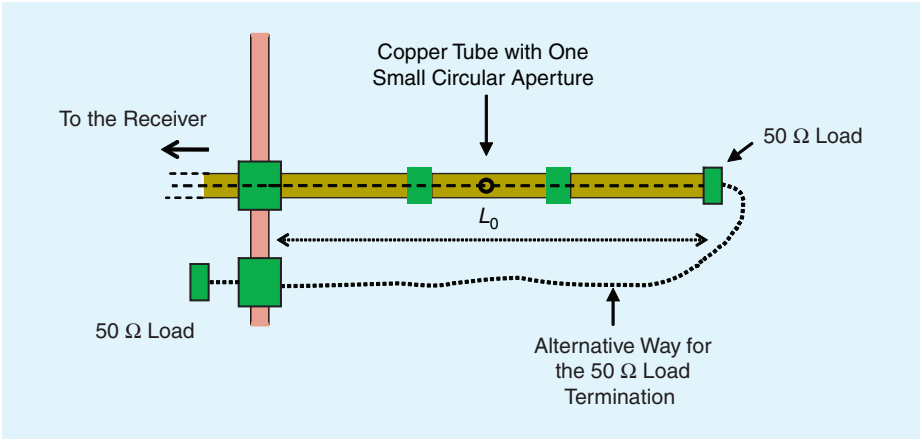

Fig. 5. Coaxial cable with one small aperture used for the relative calibration in reverberation room. The total length L_0 must be oversized in respect of the wavelength, $L_0 >> \lambda$.

A chamber complying with the statistical uniformity criteria of the field as set by the standards, will have to show, at the time of the calibration, a relative standard deviation S_σ or (S_σ) dB lower or at most equal to a normalized margin gap. This condition has to be verified for the entire frequency range explored while measuring the shielding attenuation.

A reverberation chamber satisfying the requirement of the normalized margin gap must in principle provide a uniform average field within the working volume delimited by the dotted lines in Figure 4. We ought to remember that the boundaries of the working volume are placed at a minimum distance from the chamber walls that is equal or larger than a quarter of the wavelength. If we take a look at Figure 1, we see that the device under test will not be entirely contained in the working volume, as the connection(s) made with the external receiver (and load) will experience a non-uniform field area situated near the walls. Nevertheless, as the total dimension L_0 of the device under test is larger than the wavelength, it can be proved that this imperfection does not influence the quality and reproducibility of the measures. The most important criterion requires that the position of the cable shielding of dimension ΔL is well fit into the working volume.

The uniformity calibration of the field is optional, since this procedure is generally carried out periodically by chambers' maintenance teams or exceptionally when tests on bulky or electromagnetically absorbing objects are carried out. The cables or the connectors interested by shielding attenuation measurements do not belong in this frame.

Since we are dealing with relative measurements, the calibration of the error margin is less important than for tests of immunity, susceptibility, or radiated emissions. However, if in doubt, performing the error margin test allows us to better identify the lowest usable frequency (LUF) of the chamber. The empirical rule set for the LUF is, that f_s must be 4 or 5 times the frequency of the fundamental mode of the empty chamber.

Transfer Impedance Measurement Calibration

The procedure adopts a coaxial sample with a small aperture. Let us remind you that the physical principle of this device has to a large extent been explained in a previous paper [2].

The sample will be connected at both extremities to two samples of high-immunity coaxial cables. In Figure 5 the installation details in relation to the chamber's metallic walls are given.

The calibration consists in providing the measurement of the screening attenuation described in Section 2. Then we go on to the conversion of the attenuation into transfer impedance through formulas (15) and (16). These expressions, valid for a uniformly distributed coupling, will yet have to be transformed for the isolated coupling given by the sample aperture in Figure 5. In this case, the transfer impedance will be identified by the symbol Z_{t0} and the term ΔL will be deleted, hence:

$$|\hat{Z}_{t0}| = \sqrt{2Z_c Z_w}\,\hat{A}_{\text{lin}} \quad |\hat{Z}_{t0}| = \sqrt{2Z_c Z_w}\,10^{+0.05\hat{A}_{\text{dB}}} \qquad (23)$$

At the frequencies considered, and with reference to [2], we know that Z_{t0} assumes the following approximate value:

$$Z_{t0} \cong j\,L_{t0}\omega \qquad (24)$$

In this formula, L_{t0} represents the transfer inductance of the sample. The calculations performed in [2] allow us to evaluate the theoretical value of Z_{t0} dependent on the diameter D of the sample tube and the diameter d of the aperture. The calibration procedure involves comparing the theoretical curve calculated by (24) with the Z_{t0} experimental curve derived from the shielding attenuation measure, thanks to the transformations drawn from (23).

6. Examples of Measurements Carried Out in Reverberating Chamber

Measurements involve in turn a calibration sample including a small circular aperture and a single braid coaxial cable sample, bearing the commercial reference RG-58. The tests will be performed in a reverberation room having 6.5 m × 4 m × 2.8 m dimensions and 72 m^3 volume, the fundamental mode of which (first eigenmode) is located at 40 MHz and with a lowest usable frequency (LUF) f_s at around 200 MHz. The transmitting antenna Tx, as well as the receiving antenna used to measure the reference power, is of log-periodic type up to a 3 GHz, while from 3 GHz to 10 GHz we use a wideband horn antenna.

Measurements Performed on a Calibration Sample

The calibration sample is made up of a brass tube having an external diameter of 12 mm and a 1 mm thickness. This tube forms a coaxial pipe, the characteristic impedance of which is very close to 50 Ω. On the shielding surface an aperture of diameter d of 5 mm is made, in order to produce the electromagnetic coupling described in [2] and [3].

The test sample is placed in the chamber according to the setup described in Figure 5. The tests have shown that the

conductor link (marked with a dotted line on this figure) has no influence provided that the frequency exceeds f_s, which is 200 MHz. Figure 6 shows different curves which allow us to find the transfer impedance of the sample from the shielding attenuation by means of the conversion rules described in detail in section 3.

The green curve of Figure 6 provides the evolution of the transfer impedance extracted from (23). The frequencies explored by the measurement range from 30 MHz to 10 GHz, and the dashed vertical line sets the LUF of the chamber. Consequently, only the part of the curve situated above f_s is currently usable. Nonetheless, examining the trends on either side of f_s gives us interesting comments on the physical behavior of a reverberation chamber. In fact, at frequencies close to 40 MHz, we can observe an important amplitude fluctuation of Z_t, linked to the chamber's fundamental resonance, predicted by (1) to be positioned at 40 MHz. From 40 MHz to 200 MHz, the fluctuations decrease but remain important, and this seems to prove that the statistical properties of the field distribution in the chamber are not completely acquired. On the other hand, above 200 MHz the uncertainty margin is reduced and becomes stationary, thus proving that the chamber conforms to the expected behavior.

The blue curve of Figure 6 refers to the theoretical characteristic deducted from (24) in which the transfer inductance L_t is computed thanks to expression (19) of [2] and reminded below:

$$L_t = \frac{\mu_0 \, \alpha_m}{\pi^2 \, D^2} \tag{25}$$

Knowing that for a circular opening the magnetic polarizability α_m is expressed by

$$\alpha_m = \frac{d^3}{6} \tag{26}$$

the theoretical transfer inductance of the sample tube takes a value of 1.8 10^{-2} nH.

The red curve of Figure 6 corresponds to the transfer impedance as deduced from the measurements by means of the shielding discontinuity method described in [2].

By comparing these results we see a very satisfactory correspondence within the range 200 MHz to 1 GHz. By contrast, above 1 GHz the transfer impedance derived from the shielding attenuation measurement in the reverberation chamber, shows a rise which is higher than the linear law with frequency as predicted by (24). The reasons behind this gap are still not clear. We consider the possible contribution of the three phenomena. Indeed, the transfer inductance as it is presented in (25) is calculated under the hypothesis of the transmission line theory. This means that L_t represents a mutual coupling coefficient between a transmission line external to the test tube and the coaxial line to the test structure itself [6]. On the other hand, the approach adopted in section 3 to convert the shielding attenuation into transfer impedance outclasses the concept of mutual coupling.

Certainly, in this argument it is accepted that the power collected on the calibration sample is connected to the quadratic norm of the current induced on the shielding outer surface by means of a proportionality factor which is similar to the transfer impedance. This point deserves to be considered in depth. On the other hand, it is possible that the rise observed from 1 GHz is stimulated by a physical evolution of coupling phenomena

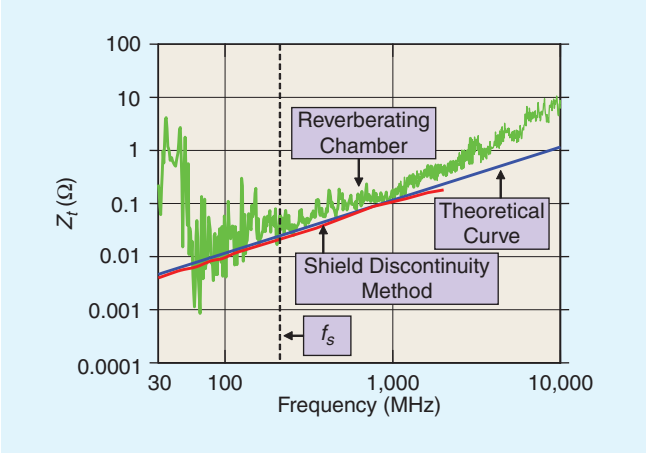

Fig. 6. *Measurements carried out on a calibration sample with one small aperture (green curve) in a reverberation chamber. The measurements are compared with the theoretical curve of transfer impedance (blue curve) and other measurements performed with the shield discontinuity method on measurement setup (red curve).*

already present below 1 GHz, the contribution of which might become crucial in the microwave frequency range.

In a theoretical work in 1993, F. Broydé [8] has introduced five coupling modes for electromagnetic fields which operate on a shielded cable. Certain phenomena assume the concept of mutual coupling like the transfer impedance and the transfer admittance as used by the transmission lines theory. Others are manifestly unrelated to this context, in particular the couplings introduced by the magnetic field component perpendicular to the aperture or parallel to the longitudinal axis of the sample. Finally, a third physical cause might come from a direct electromagnetic coupling due to the far-field radiation of the aperture made on the calibration sample shield.

In order to have a better understanding, let us use reciprocity with the source connected to one extremity of the sample, while the other extremity is matched at 50 Ω. Under these conditions, the electromagnetic field radiated outside of the sample is the result of the superposition of two phenomena. A direct field due to radiation of the equivalent magnetic dipole of the aperture, and an indirect field coming from the radiation of the current induced by the aperture in close proximity and flowing on the outer surface of the cable shield. This current must in principle match with the concept of transfer impedance introduced in section 3, where the conversion protocol was illustrated. Y. Bouri [9] has recently shown that above 1 GHz the indirect coupling mostly appears at the sample resonance, while outside of such frequencies, it is the direct coupling which controls the cable radiation. A thorough analysis of these phenomena applied to the current measurement setup will undoubtedly allow us to strengthen our interpretation.

Measures Performed on a Single Braid Shielded Cable

The curves presented in figure 7 provide us with the transfer impedance characteristics measured on a cable sample RG-58 of a dimension ΔL reduced to 10 cm. The installation of the sample was carried out in accordance with the specifications in figure 2, as before; with the device extremity left open. In the

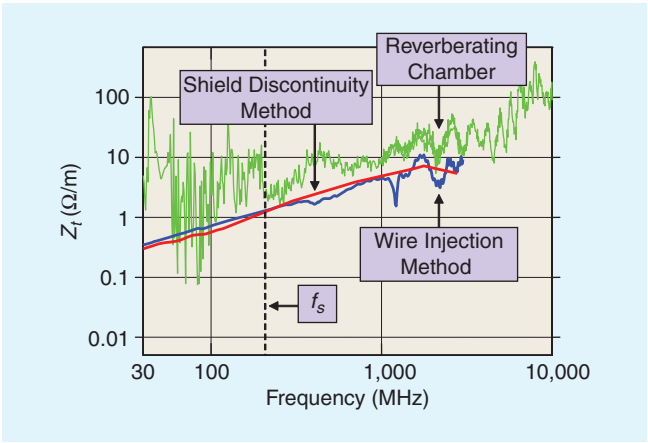

Fig. 7. *Example of measurements carried out with a single braid cable of 10 cm in length, in a reverberation room (green curve), with the shield discontinuity method (red curve) and wire injection method (blue curve).*

working area located above 200 MHz we can observe various amplitude fluctuations, the origin of which can be related to a combination of propagation phenomena or to leaks created by the connectors installed at the sample extremities.

As for the comparison between the measures performed on this sample by means of the shielding discontinuity method (red curve) and those performed through the injection wire method (blue curve), the frequency behaviour appears to agree when the transfer impedance amplitude obtained in the reverberation chamber is appreciably larger.

It is possible that the overestimation of the transfer impedance comes from leaks located at the level of the connectors at the sample extremities. Undeniably, contrary to usual test benches, reverberation chamber tests stress the connectors, and more specifically their back shell, with an electromagnetic field of the same level as that applied to the shielding under test. Moreover, as we have noticed for the open sample, we witness a slope change in the transfer impedance curve. This phenomenon starts at a frequency of 3 GHz.

In order to complete the previous results, the curve drawn in figure 8 represents the evolution of the shielding attenuation measured in a reverberation chamber on a RG-58 1 meter cable sample. In accordance with the definition reported in the right hand expression of (5), the curve's vertical axis is expressed in dB.

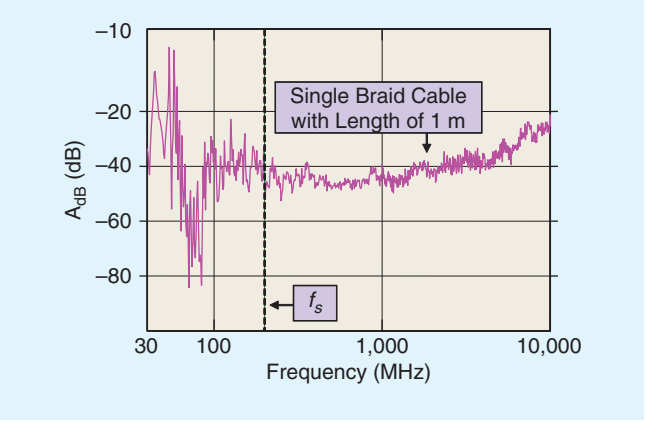

Fig. 8. *RG-58 single braid coaxial cable measurement of the shield attenuation as given in equation (5).*

As in the case of the previously shown curves, the attenuation characteristic very clearly highlights the reverberation chamber behaviour as it depends on whether it is located below or above f_s. In the first case the excessive amplitude of fluctuations corresponds to the mode stirrer's imperfections. Inversely, above f_s, the fluctuations are included in the uncertainty provided by the uniform statistics generated by the mode stirrer. The uncertainty must then stay within the gauge determined by the calibration procedure described in the previous section.

As far as the conversion of this curve into transfer impedance is concerned, things are more complex than on a 10 cm sample. In fact, at the lowest usable frequency of 200 MHz, the wavelength is comparable to the sample length of 1 meter and at higher frequencies this sample clearly gets oversized in relation to the wavelength. Under these conditions, the current distribution I_S on the shielding outer surface behaves as a random variable to which we can add the average value $I_{S\,av}$.

If we then bring into play the phase differences generated by propagation along the cable, the voltage collected at each matched extremities can be written as:

$$V_c = \frac{1}{2}|Z_t|\frac{1-e^{-jk_2\Delta L}}{jk_2}I_{S\,av} \tag{27}$$

In this expression, the wave number k_2 is connected to the propagation speed v_2 inside to the cable and to the angular frequency by means of the well known formula:

$$k_2 = \frac{\omega}{v_2} \tag{28}$$

The expression (27) immediately shows that the collected voltage will be at its maximum for those frequencies which satisfy the condition:

$$\left(e^{jk_2\Delta L}\right)_{\omega_n} = -1 \rightarrow |V_c|_{\max i} = \frac{|Z_t|}{k_2}I_{S\,av} \tag{29}$$

Knowing that when we measure the attenuation in a reverberation chamber we obtain the average amplitude of the power collected on the sample during a mode stirrer rotation, the largest amplitudes generated by propagation phenomena will be confused with the measurements uncertainty margins. Consequently, when the cable gets oversized in relation to the wavelength, it is advisable to correct (15) and (16) by removing the term ΔL and by weighting with the factor $k_2/2$, that is:

$$|\hat{Z}_t| \cong \frac{k_2}{2}\sqrt{2Z_cZ_w}\,\hat{A}_{\text{lin}} \tag{30}$$

$$|\hat{Z}_t| \cong \frac{k_2}{2}\sqrt{2Z_cZ_w}\,10^{+0.05\hat{A}_{\text{dB}}} \tag{31}$$

At a close examination, the curve in figure 8, at 200 MHz and 1 GHz frequencies, reveals attenuations which are almost identical and close to −48 dB. Knowing that the propagation speed inside the cable is close to $v_2 = 2.10^8$ m/s, after having applied the correction in (31), at 200 MHz and 1 GHz we find transfer impedances of 2.4 Ω/m and 12 Ω/m, respectively. These values are then very close to the measures performed on the 10 cm sample without correction. If the shielded cable transfer impedance continuously evolves following a law proportional to the frequency, an analysis of (30) and (31) shows that the shielding

attenuation must be kept independent of frequency. Actually, the curve in figure 8 shows a rise above 1 GHz which seems to strengthen the hypothesis of an additional leakage due to the extremities connectors.

Before closing this section, it is worth indicating that above a few GHz the attenuation introduced by the cables connecting the samples to the instruments must be corrected.

7. Conclusion

In a previous paper [2] we have illustrated that the use of test benches based on coupled transmission lines becomes ineffective above 1 GHz. As far as frequencies significantly higher than 10 GHz are concerned, we know that extending the concept of transfer impedance to this domain is still the subject matter of fundamental questions and that is thus premature to extend its use to the whole microwave spectrum. Consequently, if we limit the extent of these conclusions to the 1 GHz–10 GHz range, the paper proves that the properties of mode stirring reverberation chambers offer interesting perspectives for the measurement of the attenuation provided by shielded cables or connectors. The issue discussed at length in the paper deals with the conversion of the shielding attenuation into a measure consistent with the transfer impedance. In section 3 it has been proven, thanks to the fields' statistical properties due to mode stirring, that the power data collected at the sample extremities are correlated to the shielding attenuation by means of a physical parameter comparable to a cable (or a connector's) transfer impedance.

In this intent, it is thus possible to calibrate the measurements by means of a sample made up of a tubular shielding fitted with a small aperture. Knowing that the transfer impedance of this device evolves through a law proportional to frequency, different tests will allow us to understand the transfer impedance behavior when the sample is irradiated by the field generated within a reverberation chamber.

From the experimental analysis detailed in section 5, we can observe that the transfer impedance measures compared to the measured values and then estimated on the test bench are fully consistent between 200 MHz and 1 GHz. The lower limit, set at 200 MHz for the minimum usable chamber frequency, allows us to observe an upper limit located around 1 GHz and characterized by an unexplained rise on the transfer impedance. Some hypotheses were formulated in order to find rational explanations to this phenomenon. One involves the legitimacy of the concept of transfer impedance when it comes to practical measures on the illumination of electromagnetic fields. Indeed, the sample's transfer impedance as it is expressed by the law proportional to the frequency drawn in (24) is not an extension of the properties of mutual inductances adopted in the transmission lines theory. It will not be surprising then if they turn out to be inaccurate in the context of practical measures of field illumination. We can also involve the contribution of other couplings generated through leakage by the azimuthal magnetic field taken into consideration only in order to set the reference formula (24). We mainly think about the influence that the other components of the magnetic field as well as the electric field exert on coupling. To these physical causes some other artifacts can be added, which are generated by parasitic couplings occurring on the sample connectors exposed to the field surrounding the chamber.

As for the other tests performed on a cable sample made up of a single braid shielding which has shown a similar behavior, we can say that a lot of work has still to be done in order to understand the concept of transfer impedance in the microwaves domain.

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Biography

Bernard Démoulin *was born in 1946. He received his Ph.D. degree in 1981 and until 2008 was the head of the EMC group at the IEMN-TELICE Laboratory. He is presently professor emeritus at the University of Lille, France. His domain of expertise is mainly related to the effect of electromagnetic coupling through cables, transfer impedance measurement and the study of mode stirred reverberation chambers. He is a senior member of the French Society of Electrical Engineers (SEE) and a corresponding member of URSI.*

Lamine Koné *was born in 1956. He received his Ph.D. degree in 1989. Since 1990, he has been working as an engineer at the IEMN-TELICE laboratory at the University of Lille, France. His domain of expertise deals with EMC measurements, especially involving the transfer impedance on shielded cables or connectors and tests carried out in mode stirred reverberation chambers.*

Time-Domain Computation of Loop inductance

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Abstract – The use of a time-domain code for modeling the electromagnetic behavior of thin wires is shown to provide an alternate way to obtain the DC inductance of wire loops. It involves computing the constant current that flows around a loop when an excitation whose time integral is non-zero is used to excite the loop as an antenna and the high-frequency energy has radiated away. Results from the time-domain model are found to agree within 0.1% of analytical values.

Index Terms – Loop inductance, time-domain electromagnetics, inductance, thin-wire loops, moment-method modeling

1. Introduction

An interesting recent article [1] described the concept of partial inductance and demonstrated how it can be used to obtain the inductance of loops of arbitrary geometry. Specific examples were given for the self inductance of square and triangular loops and shown to agree with previously derived results [2].

The purpose of this brief discussion is to show how the DC inductance of arbitrary wire loops can be obtained numerically using a time-domain computer model. The model, TWTD (Thin-Wire Time Domain) [3], is based on the time-dependent Maxwell Equations. TWTD is usually employed for modeling wire radiators and scatterers excited by impulsive voltages or plane waves to obtain their transient behavior or wide-band frequency response. But TWTD also provides an alternate approach for obtaining the inductance of wire loops. This can be done by exciting a candidate loop by a voltage whose time integral is nonzero and computing the current as a function of time until it reaches a constant value, Io, around the loop.

The TWTD model is briefly described in Section 2 below. The computational approach for obtaining loop inductance follows in Section 3, with numerical results for a variety of loop geometries included in Section 4.

2. The Thin-Wire Time-Domain (TWTD) Computer Model

One version of a time-domain integral equation for a wire object in free space has the form [3]

$$\hat{\mathbf{s}}\cdot\mathbf{E}^{ex}(s,t)=\frac{\mu_0}{4\pi}\int_{C(r)}\left(\frac{\hat{\mathbf{s}}\cdot\hat{\mathbf{s}}'}{R}\frac{\partial I(s',t')}{\partial t'}+\left[\frac{c\mathbf{s}\cdot\mathbf{R}}{R^2}\right]\left[\frac{\partial I(s',t')}{\partial s'}-\frac{c}{R}Q(s',t')\right]\right)ds' \quad (1a)$$

with

$$Q(s',t')=-\int_{-\infty}^{t'}\frac{\partial I(s',t')}{\partial s'}dt' \quad (1b)$$

and where $I(s',t')$ and $Q(s,t)$ are the unknown current and the charge density at space location s' and the "retarded time" $t'=R/c$, c is the speed of light in the medium and **R** is the vector distance between the source at s' and observation point at s. Also c and μ_0 are the speed of light in, and magnetic permeability of, free space and the exciting electric field is $\mathbf{E}^{ex}(s,t)$. The unknown current and charge density on the wire can be found as the solution of an initial-value problem via a time-stepping procedure using the method of moments [3].

The TWTD model employs a nine-term polynomial basis, up to and including quadratic space-time variation and delta-weight functions to satisfy the integral equation (1). It has been well-validated by many users, one of which [4] used the inductance of a circular loop for this purpose. Since the results presented in Section 4 serve to further validate TWTD, no additional validation examples are included here.

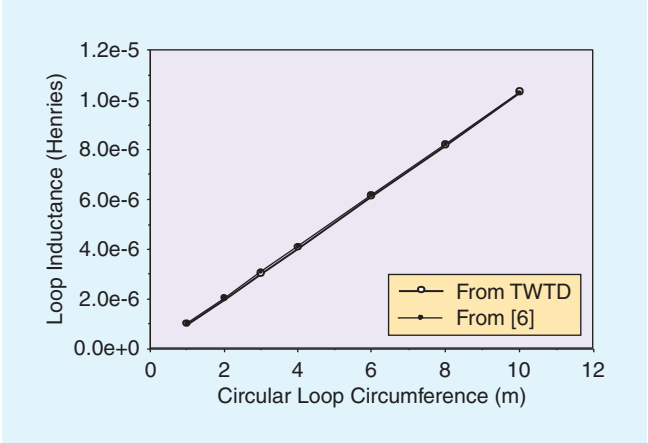

Fig. 1. The inductance of a circular loop as a function of its circumference as obtained from TWTD and Eq (6).

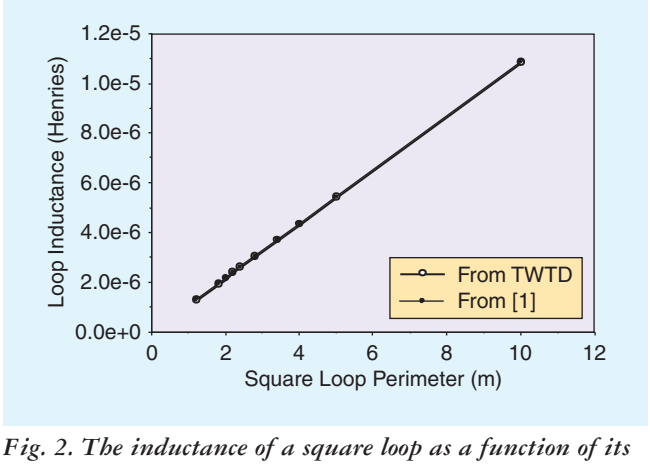

Fig. 2. The inductance of a square loop as a function of its perimeter length as obtained from TWTD and Eq. (14) of reference {1}.

3. Obtaining Loop Inductance Using TWTD

A Gaussian-pulse voltage is a convenient and effective excitation for use in time-domain modeling [3]. It is given by

$$V(t) = V_0 e^{[-A(t-T)]^2} \tag{2}$$

where V_0 is the voltage maximum, A is a width parameter, t is the time and T is the time at which the maximum voltage occurs. For the computations that follow, these parameters had the values:

$$Vo = 1\text{–}V,$$

$$A = 4.2 \times 10^8 \text{ sec}^{-1},$$

and

$$T = 1.5 \times 10^{-8} \text{ sec}.$$

For a loop whose low-frequency inductance is L, he constant current I_O is then given by [4]

$$I_O = \frac{1}{L}\int_{-\infty}^{\infty} V(t)dt \tag{3}$$

which results from integrating the defining equation for a loop. Using (2) in (3) we then find

$$I_O = \frac{\pi^{1/2}}{AL}. \tag{4}$$

For the examples that follow a constant current around the loop was typically reached in 1,000 or fewer time steps of the time-domain solution.

Thus, the inductance from the late-time TWTD current is simply obtained as

$$L = \frac{\pi^{1/2}}{AI_o}. \tag{5}$$

which was the test used previously in [4] as a validation check on the TWTD model itself.

4. Numerical Results for Loop Inductance from TWTD

Three of the loop geometries that are modeled here, circular, square and triangular loops, assumed to be perfect electric conductors, have analytical expressions for their inductance. For the circle it is [6]

$$L_{circle} = r_{loop}\,\mu_o\left[\text{In}\left(\frac{8r_{loop}}{r_{wire}}\right) - 2\right] \tag{6}$$

with the loop and wire radii denoted by r_{loop} and r_{wire}. For the square and triangle the inductances are given respectively by [1]

$$L_{square} = \frac{2\mu_o h_{side}}{\pi}\left[\text{In}\left(\frac{h_{side}}{r_{wire}}\right) - 0.774\right] \tag{7}$$

and

$$L_{triangle} = 3\frac{\mu_o}{2\pi}h_{side}\left[\text{In}\left(\frac{2h_{side}}{r_{wire}}\right) - 1.405\right] \tag{8}$$

with the side length of the square and triangle given by h_{side}. The results that follow were obtained from TWTD models that used 20 spatial samples, or segments, per meter. For simplicity, the wire radius was scaled to maintain a fixed ratio between the loop radius and side length in the above expressions. For the circle $r_{wire} = 2\pi r_{loop}/10^3$. For the square and triangle $r_{wire} = l_{side}/50$.

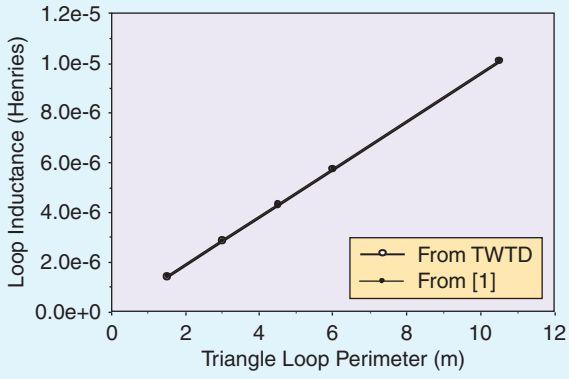

Fig. 3. The inductance of a triangle loop as a function of its perimeter length as obtained from TWTD and Eq. (19) of reference {1}.

This results in the inductance for all three loops varying linearly with the loop size, as is shown in Figs. 1–3. The agreement between the TWTD values and the analytical results is within 0.1% or so. This outcome serves primarily to validate the use of TWTD for obtaining the inductance of a loop, as the analytical expressions have been independently validated.

Three other loop configurations were also modeled. The first is a square loop 0.3-m on a side having a wire radius of 6×10^{-4} m and bent into a V shape. The inductance of this loop is shown as a function of the angle in degrees between the two

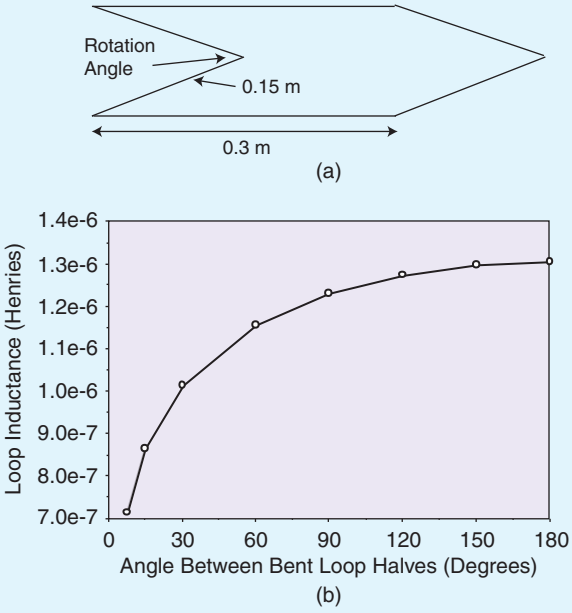

Fig. 4. (a) A square loop bent into a V-shape. (b) The inductance of the bent loop as a function of the rotation angle obtained using TWTD.

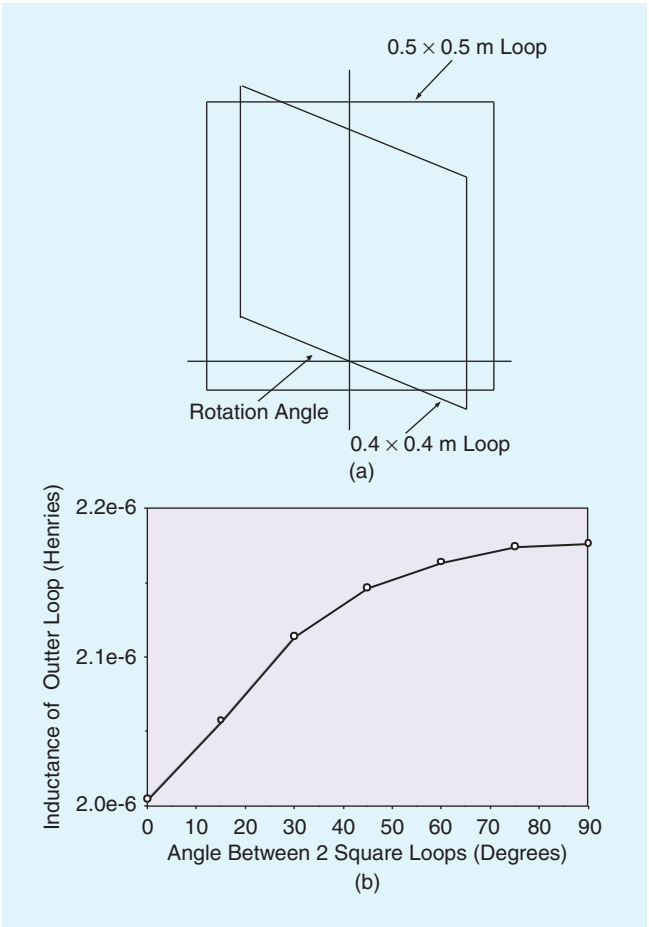

Fig. 5. (a) An inner loop rotated from the plane of a larger outer loop.(b) The inductance of the outer loop as a function of the rotation angle of the inner loop from their common plane at 0 degrees obtained using TWTD.

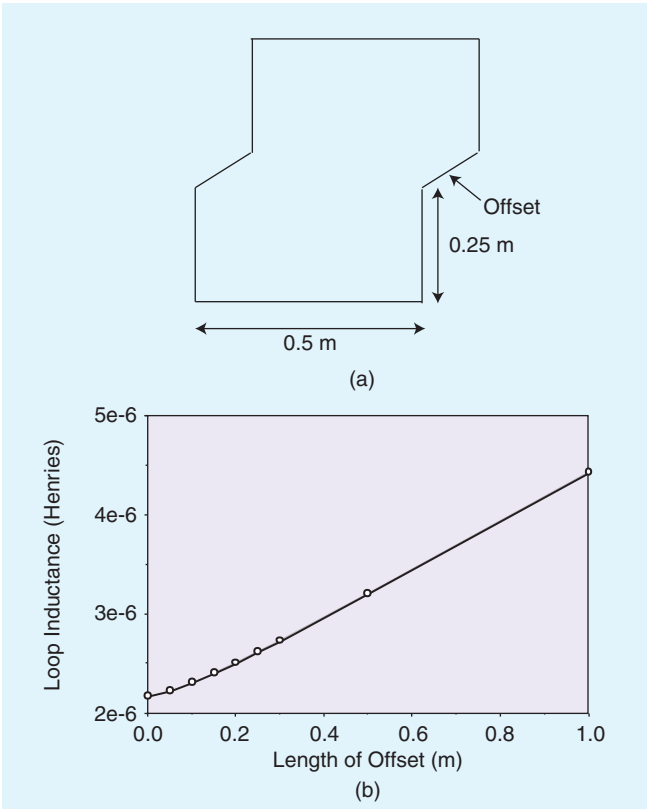

Fig. 6. The inductance of the offset loop as a function of the offset length obtained using TWTD. (a) An offset loop.

halves of the loop in Fig. 4. The inductance of the bent loop is seen to vary over a range of nearly 2:1 over the 172.5-degree variation of the included angle.

Another loop arrangement consisted of two square loops 0.5 and 0.4-m on a side with wire radii of 10^{-3}-m and having a common center. The loops are concentric when co-planar with the inductance of the larger, outer loop determined as a function of the rotation angle of the inner loop relative to it. The result of this variation is shown in Fig. 5, varying by a little less than 10% as the inner loop varies from co-planar to orthogonal relative to the outer loop.

The last example shown here is for a square loop that is initially 0.5-m on a side and wire radii of 10^{-3}-m. Its inductance is determined from TWTD as the upper half of the loop is systematically offset from the lower half while remaining joined to it by two orthogonal wires. The result for this experiment is shown in Fig. 6 where the inductance varies by more than 2:1 up to the maximum offset of 1-m, essentially increasing in proportion to the offset, essentially as might be expected from Eq. (7).

5. Concluding Comments

A possibly unanticipated use of an electromagnetics, time-domain computer model, TWTD, has been demonstrated here for determining the DC inductance of wire loops of fairly arbitrary geometry. Application of a Gaussian voltage pulse to excite the loop as an antenna results in a constant current around the loop after the higher frequency energy has radiated away. This constant current provides a straightforward way to then determine the inductance, the current being inversely proportional to it. While an analytical formula is preferable when available, the TWTD approach represents an independent way to obtain the inductance of a given loop as well as to confirm the validity of an analytical result. Furthermore, a more general time-domain model, e.g. FDTD, that permits a more complex electromagnetic environment to be handled, could be employed for printed circuit boards and other configurations that involve dielectric media.

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Biography

Edmund K. Miller *earned his Ph.D. in Electrical Engineering at the University of Michigan. Dr. E. K. Miller has held a variety of government, academic and industrial positions. These include 15 years at Lawrence Livermore National Laboratory and over four years at Los Alamos National Laboratory from which he retired as a Group Leader in 1993. His academic experience includes holding a position as Regents-Distinguished Professor at Kansas University and as Stocker Visiting Professor at Ohio University. Dr. Miller has served as an Antennas and Propagation (AP) Distinguished Lecturer, and wrote the column "PCs for AP and Other EM Reflections" from 1984 to 2000. He received (with others) a Certificate of Achievement from the IEEE Electromagnetic Compatibility Society for Contributions to Development of NEC (Numerical Electromagnetics Code) and was a recipient (with others) in 1989 of the best paper award given by the Education Society for "Computer Movies for Education."*

He served as Editor or Associate Editor of IEEE Potentials Magazine from 1985 to 2005 for which he wrote a regular column "On the Job," and in connection with which he was a member of the IEEE Technical Activities Advisory Committee of the Education Activities Board and a member of the IEEE Student Activities Committee. Dr. Miller has lectured at numerous short courses in various venues, such as Applied Computational Electromagnetics Society (ACES), AP-S, MTT-S and local IEEE chapter/section meetings, and at NATO Lecture Series and Advanced Study Institutes.

Dr. Miller edited the book "Time-Domain Measurements in Electromagnetics", Van Nostrand Reinhold, New York, NY, 1986 and was co-editor of the IEEE Press book Computational Electromagnetics: Frequency-Domain Moment Methods, 1991. He was organizer and first President of the Applied Computational Electromagnetics Society (ACES) for which he also served two terms on the Board of Directors. He served a term as Chairman of Commission A of US URSI and is or has been a member of Commissions B, C, and F, has been on the TPC for the URSI Electromagnetic Theory Symposia in 1992 and 2001, and was elected as a member of the US delegation to several URSI General Assemblies. He is a Life Fellow of IEEE from which he received the IEEE Third Millennium Medal in 2000 and is a Fellow of ACES. His research interests include scientific visualization, model-based parameter estimation, the physics of electromagnetic radiation, validation of computational software, and numerical modeling about which he has published more than 150 articles and book chapters. **EMC**

The Remarkable Inverse Distance-Squared Law

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Abstract – Numerous fundamental physical laws depend on inverse distance as distance squared. The reason for why this distance must be PRECISELY SQUARED is examined.

I. Physical Laws That Depend on Inverse Separation Distance Squared

A large number of physical laws depend on inverse distance squared as $1/R^2$: NOT $1/R^{1.999}$, NOT $1/R^{2.001}$, etc. There is a reason why this precise squared integer power of the distance in these laws is required. This reason will be explained.

Perhaps the most famous inverse distance-squared law is the law of gravity where the force exerted on one body by the presence of a nearby body varies as the product of the masses of the two bodies and as the inverse of the square of the distance R between them: $1/R^2$. Another of the inverse distance-squared laws in electromagnetics is that of Coulomb's law for the vector force exerted by one stationary point charge on another nearby stationary point charge [1]:

$$\mathbf{F} = \frac{1}{4\pi\,\varepsilon_0}\frac{Q_1\,Q_2}{R^2}\mathbf{a}_R$$

as illustrated in Fig. 1 where $\mathbf{a}_R$ is a unit vector on a line between the charges and pointing away from the charges if the charges have the same sign.

The electric field produced by a stationary point charge is obtained by dividing out the second charge in Coulomb's law which remains an inverse distance-squared law as shown in Fig. 2:

$$\mathbf{E} = \frac{\mathbf{F}}{q} = \frac{Q}{4\pi\,\varepsilon_0 R^2}\mathbf{a}_R$$

The corresponding law for determining the magnetic field due to a linear, DC differential current element is the Biot-Savart law [1]:

$$d\mathbf{B} = \frac{\mu_0\,I}{4\pi\,R^2}d\mathbf{l}\times\mathbf{a}_R$$

which is illustrated in Fig. 3.

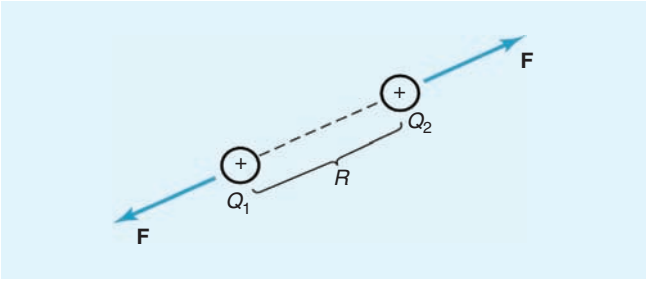

Fig. 1. Coulomb's law for two stationary point charges.

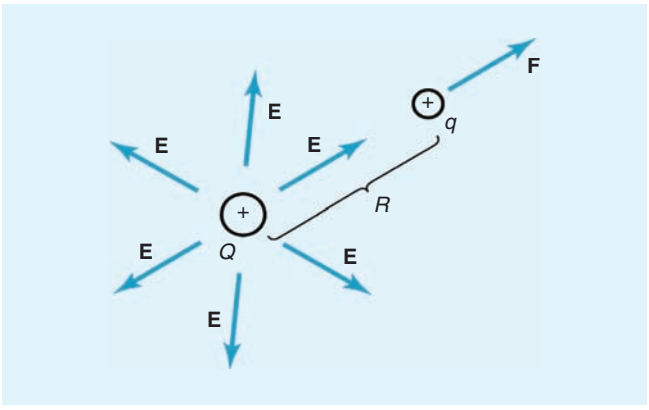

Fig. 2. Electric field of a point charge.

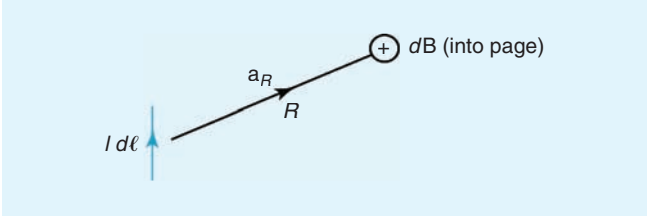

Fig. 3. The Biot-Savart law.

Note that this is also an inverse distance-squared law. The differential magnetic field, $d\mathbf{B}$, is perpendicular to the plane containing the differential current and the vector *from* the current *to* the point where the field is to be determined. Its direction is determined according to the right-hand rule. Hence the magnetic field forms closed loops in the circumferential direction around the current, I, that produced it.

II. Vector Mathematical Principles

The key to why the inverse distance, $1/R^2$, in the many physical laws must be precisely squared and not some other approximately square law power of distance such as $1/R^{1.999}$ or $1/R^{2.001}$ depends on the vector mathematics involved. All vector problems require a coordinate system. A useful coordinate system in electromagnetics problems is the spherical coordinate system shown in Fig. 4 which also shows the differential surfaces [1]. Each differential surface is perpendicular to the coordinate axis. For example, ds_r is a differential surface that is perpendicular to the radial distance from the origin of the coordinate system, r.

The physical electromagnetics laws are frequently used in integrals over a *closed* surface s for the purposes of determining the *net flux* of the law *out of (leaving) the closed surface* (much like light flux through a window) as

$$\text{Flux of the Law } \textit{out of} \text{ the closed surface } s = \oint_S \textbf{Law} \bullet d\mathbf{s}$$

This is referred to as a *surface integral* and represents the summation of the products of the differential surfaces, ds, and the components of the vector Law that are *perpendicular to (leaving) the closed surface*. Note in Fig. 4 that the differential surface through which the flux of the Law penetrates and *flows away from the origin of the coordinate system* is

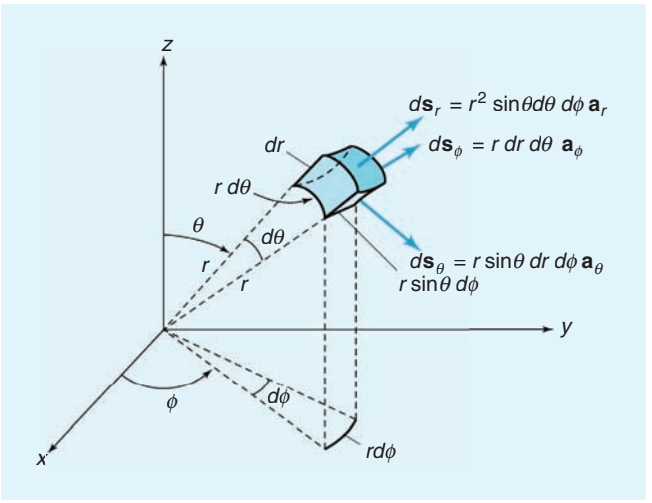

Fig. 4. The differential surfaces in a spherical coordinate system.

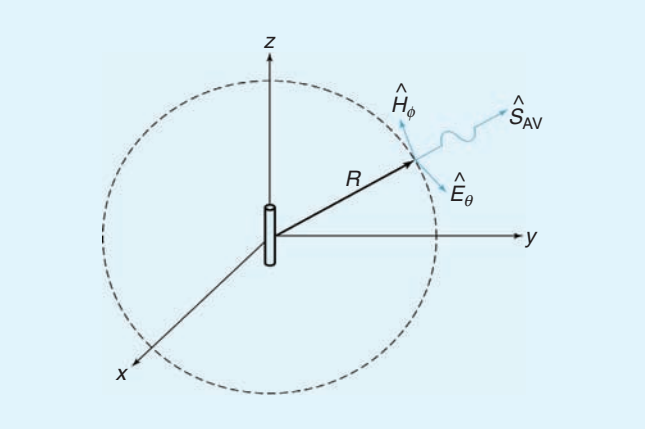

Fig. 5. Computation of the radiated power from an antenna.

$$ds_r = r^2 \sin\theta\, d\theta\, d\phi$$

which involves the *square of the distance from the origin of the coordinate system*. Observe that neither of the other differential surfaces, ds_ϕ and ds_θ, are distance squared.

III. Examples Where The Inverse Square Distance Must Be Present In The Law or The Result Would Make No Sense

An important example that shows the need for the inverse distance-squared law is the computation of the total average power radiated into space by an antenna as shown in Fig. 5.

Surround the antenna by a closed, spherical surface of radius R. The total power radiated by the antenna is the power *out of* the closed surface. The time-varying radiated electric field $\left(\frac{V}{m}\right)$ and radiated magnetic field $\left(\frac{A}{m}\right)$ in the *far field* of the antenna both depend on the distance from the origin of the coordinate system as $1/R$ [1]. Hence the *power density* in the radiated wave is dependent on $1/R^2$:

$$S_{AS} \propto \frac{1}{R^2} \quad \frac{W}{m^2}$$

and is directed in the radial direction. The surface integral for computing the *total* average power radiating into space from the antenna through *any closed surface that encloses the antenna* becomes:

$$P_{AV} = \oiint_S S_{AV} \bullet d\mathbf{s}$$

$$= \oiint_S S_{AV} \underbrace{R^2 \sin\theta \, d\theta \, d\phi}_{ds_r}$$

Therefore the $1/R^2$ in S_{AV} and the R^2 in the differential surface *cancel* and the integrand is *independent* of R. Hence the total power radiated into space (never to return),P_{AV}, would be a constant independent of the size or shape of the closed surface! If this cancellation of R^2 were not the case, the integrand of the integral would be a function of R and *we could change the radius of the closed surface thereby changing the total power radiated from the antenna.* But the total average power radiated into space by an antenna *must be a constant*! Hence the absence of the complete cancellation of R would make absolutely NO SENSE! In order for the power of R^2 in the differential surface, ds_r to cancel, the power of R^2 in S_{AV} must be precisely 2.000000$\cdots$. Powers of approximately 2 such as 1.999 and 2.001 in S_{AV} will not work since these will not cancel with the R^2 in the differential surface, and this fact is a vector algebra property and is not approximatable.

There are several other cases that show this dependence on the inverse-square law. First consider Gauss' law for the electric field [1]. Gauss' law provides that *if we perform a surface integral of the electric field over a closed surface that surrounds some charge, we would obtain as the result the net positive charge contained within that closed surface irrespective of the shape of the closed surface so long as the surface is closed*:

$$\oiint_S \mathbf{D} \bullet d\mathbf{s} = Q_{\text{enclosed}}$$

as illustrated in Fig. 6 where $\mathbf{D} = \varepsilon_0 \mathbf{E}$ and ε_0 is the permittivity of free space. Electric field lines that begin on a positive charge must end on a corresponding negative charge as illustrated in Fig. 6. Hence electric field lines that begin on positive charge within the closed surface must terminate on corresponding negative charge which exists either within the closed surface or outside it. If the negative charge exists within the closed surface, the associated field line does not penetrate the closed surface. If the associated negative charge exists outside the closed surface, the associated field line must *penetrate* the closed surface.

For example, consider a point charge shown in Fig. 7. Placing a sphere of radius r around the charge, the net flux out of the closed surface is obtained with a surface integral as

$$\int_{\phi=0}^{2\pi} \int_{\theta=0}^{\pi} \varepsilon_0 \frac{Q}{4\pi\varepsilon_0 r^2} \underbrace{r^2 \sin\theta \, d\theta \, d\phi}_{ds_r}$$

$$= \int_{\phi=0}^{2\pi} \int_{\theta=0}^{\pi} \frac{Q}{4\pi} \sin\theta \, d\theta \, d\phi = Q$$

Hence the $1/r^2$ in $\mathbf{D}$ (or $\mathbf{E}$) *cancels* the r^2 in ds and the result would be *independent of the size of the enclosing sphere which makes sense*. If this cancellation did not occur, i.e., the integrand did not contain $1/r^2$ in $\mathbf{D}$ (or $\mathbf{E}$) and r^2 in $d\mathbf{s}$, the flux of the result (the charge contained within the sphere, Q) *would be different for different sizes of the sphere* (dependent on r) which does not make sense!

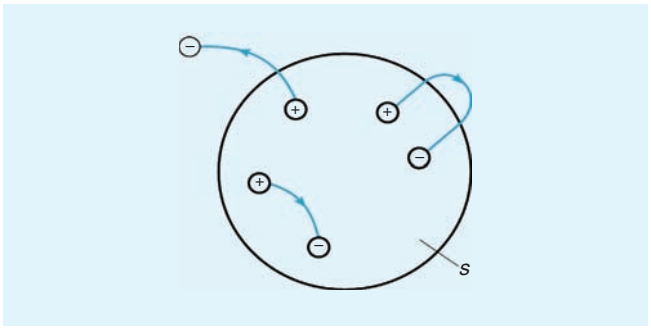

Fig. 6. Gauss' law for the electric field.

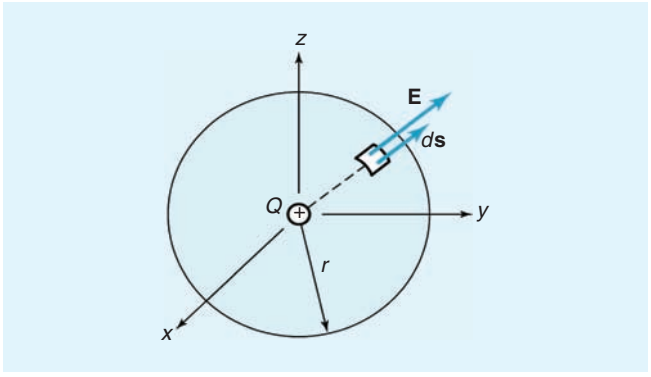

Fig. 7. Electric field of a point charge.

The corresponding law for the magnetic field is Gauss' law for the magnetic field as illustrated in Fig. 8 [1]. Gauss' law provides that a surface integral of the magnetic field over any closed surface yields a result of zero:

$$\oiint_S \mathbf{B} \bullet d\mathbf{s} = 0$$

Hence all magnetic field lines must form *closed loops* or, in other words, unlike the electric field due to a stationary charge, there are no known sources or sinks of the magnetic field. As we saw earlier, the DC magnetic field $\mathbf{B}$ depends on distance as $1/R^2$ as does the electric field both of which completely cancel the R^2

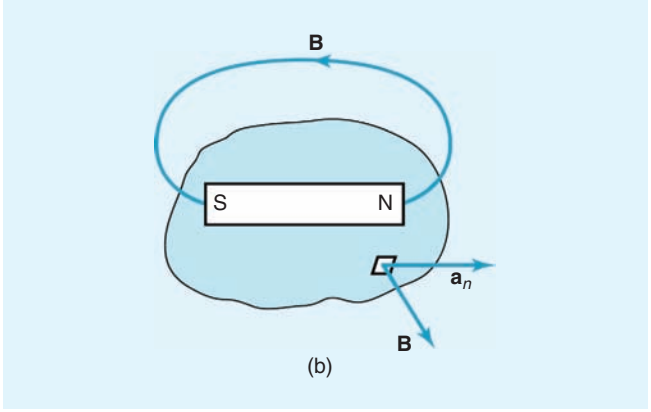

Fig. 8. Gauss' law for the magnetic field.

in ds_r. The result would be *independent of the size or shape of the enclosing surface which makes sense*.

If the law being considered did not contain the inverse squared-distance, $1/R^2$, it would not cancel the R^2 in the differential surface ds_r on the closed surface and the result would not be *independent* of the size of the closed surface which would again make no sense. A power of R of other than exactly two, $2.000000\cdots$, such as 1.999 or 2.001 would also not provide cancellation and would also not make any sense.

IV. Summary

Since I started studying science and, in particular electromagnetics, some 48 years ago I was always profoundly impressed at how the physical laws and their mathematical formulations are so precise and none are arbitrary. These are examples of that observation. It also seems to indicate that the creation of this universe was not accidental or random but was the result of planning by some higher power.

Reference

[1] C.R. Paul, *Electromagnetics for Engineers: with applications to digital systems and electromagnetic interference*, John Wiley, NY, 2004.

Biography

Clayton R. Paul *received the B.S. degree from The Citadel, Charleston, SC, in 1963, the M.S. degree from Georgia Institute of Technology, Atlanta, GA, in 1964, and the Ph.D. degree from Purdue University, Lafayette, IN, in 1970, all in Electrical Engineering. He is an Emeritus Professor of Electrical Engineering at the University of Kentucky where he was a member of the faculty in the Department of Electrical Engineering for 27 years retiring in 1998. Since 1998 he has been the Sam Nunn Eminent Professor of Aerospace Systems Engineering and a Professor of Electrical and Computer Engineering in the Department of Electrical and Computer Engineering at Mercer University in Macon, GA. He has published numerous papers on the results of his research in the Electromagnetic Compatibility (EMC) of electronic systems and given numerous invited presentations. He has also published 18 textbooks and Chapters in four handbooks. Dr. Paul is a Life Fellow of the Institute of Electrical and Electronics Engineers (IEEE) and is an Honorary Life Member of the IEEE EMC Society. He was awarded the IEEE Electromagnetics Award in 2005 and the IEEE Undergraduate Teaching Award in 2007.* **EMC**

Introducing Kye Yak See (SM'02)

Dr. See obtained his B. Eng from the National University of Singapore in 1986. From 1986 to 1994, he held various senior technical and management positions in the electronic industries in Singapore, the United Kingdom and Hong Kong. In 1994, he was awarded a scholarship by the Nanyang Technological University (NTU) to pursue his Ph.D. at Imperial College, United Kingdom. He joined NTU as a faculty member after obtaining his Ph.D. in 1997.

He is currently an Associate Professor of the School of Electrical and Electronic Engineering. He also holds the concurrent appointments of Deputy Head of the Division of Circuits and Systems and Director of Electromagnetic Effects Research Laboratory (EMERL).

He has co-authored three books and has published close to 90 refereed international journal and conference publications in the areas of EMC, signal integrity and computational electromagnetics. He is a senior member of IEEE, the founding chair of the IEEE EMC Society Singapore Chapter and a member of the Technical Committee on EMC. He was the Organizing Committee Chair for the 2006 EMC Zurich Symposium and the 2008 Asia Pacific EMC Conference. He was also one of the invited international speakers for the "Global EMC University" at the 2007 and 2008 IEEE International EMC Symposiums in the USA.

He looks forward to meeting authors of potential practical papers for this Newsletter at the EMC Europe 2011 Symposium over September 26–30.

Design Tips

Bruce Archambeault, Associate Editor

Welcome to Design Tips! It is well known that high speed signal traces should not cross a split in the nearest ground-reference plane. However, due to PCB cost/space constraints, we are often forced to route such traces adjacent to power layers, where various power islands exist. If a high speed trace travels from the region of one power island to another, it effectively crosses a split in the nearest reference plane. In this Design Tip, Professor Jun Fan with the Missouri University of Science and Technology discusses how to estimate the impact of this crossing on crosstalk between two traces.

Please send me your most useful design tip for consideration in this section. Ideas should not be limited by anything other than your imagination! Please send these submissions to bruce.arch@ieee.org. I'll look forward to receiving many "Design Tips!" Please also let me know if you have any comments or suggestions for this section, or comments on the Design Tips articles.

Crosstalk Estimation for Stripline Traces Crossing a Split

By Jun Fan, Missouri University of Science and Technology, jfan@mst.edu

In practical printed circuit board (PCB) designs, it is common to split power/ground planes into islands, area fills, or plane portions. Consequently, it may be inevitable to route signal traces crossing a split due to ever-increasing circuit density in design. As a well-known EMC rule of thumb, these traces could potentially cause signal integrity and EMI consequences, and are usually not recommended in practice. One exception is probably the stripline case where only one of the two reference planes is gapped. The hypothesis is that the good reference plane will provide a well-controlled return path, and the discontinuity in the other reference plane has a negligible effect. Studies have demonstrated that these stripline traces do achieve good signal transmission. However, additional crosstalk could be introduced due to the split-crossing. Further, the split could be excited, resulting in potential EMI issues. In this article, we will focus our discussion on crosstalk.

Let's look at an example test structure shown in Fig. 1. In this 3-layer structure, two stripline traces are placed in the middle layer. The top layer is partitioned into two parts by a split, while the bottom layer is a solid ground plane. The crosstalk between these two traces is investigated in both the frequency and the time domains.

It is found that the crosstalk between the two stripline traces is a function of the distance between them [1], which agrees with our intuition. For example, Fig. 2 shows the |S31| results in the frequency domain, which represent the near-end crosstalk (NEXT). We can clearly observe the trend in the figure where d is the trace-to-trace separation (in this example, the other geometrical parameters are a = 100 mm, b = 80 mm, s = 40 mm, t = 1 mm, β = 90°, w = 135 μm, h = 370 μm, and ε_r = 4.35). Furthermore, it is noticeable that the curves can be divided into two categories and they have different shapes. This can be explained as two coupling mechanisms, direct trace-to-trace coupling and split-related coupling, existing in this kind of geometries.

Let's then decompose the two crosstalk components. The direct trace-to-trace crosstalk can be well estimated using the multi-conductor transmission-line theories assuming both the reference planes are solid. The split-related crosstalk is obtained by subtracting the direct trace-to-trace coupling from the overall

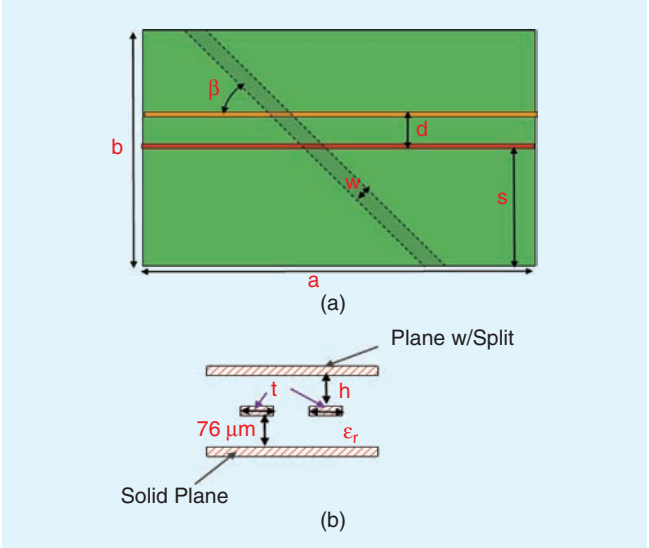

Fig. 1. Geometry under study. (a) Top view (b) Cross section view.

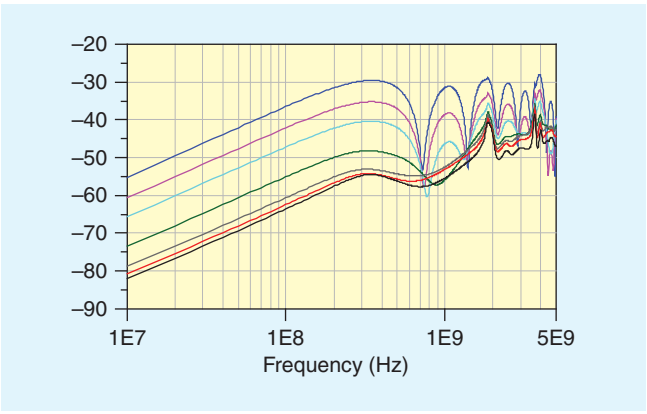

Fig. 2. $|S_{31}|$ as a function of trace-to-trace separation.

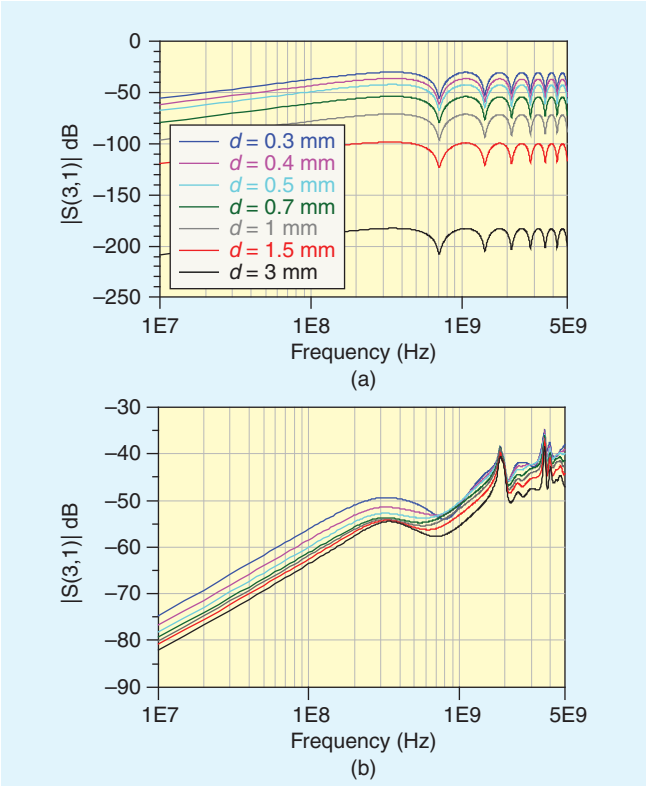

Fig. 3. Two crosstalk mechanisms. (a) $|S_{31}|$ due to direct trace-to-trace coupling (b) $|S_{31}|$ due to split-related coupling.

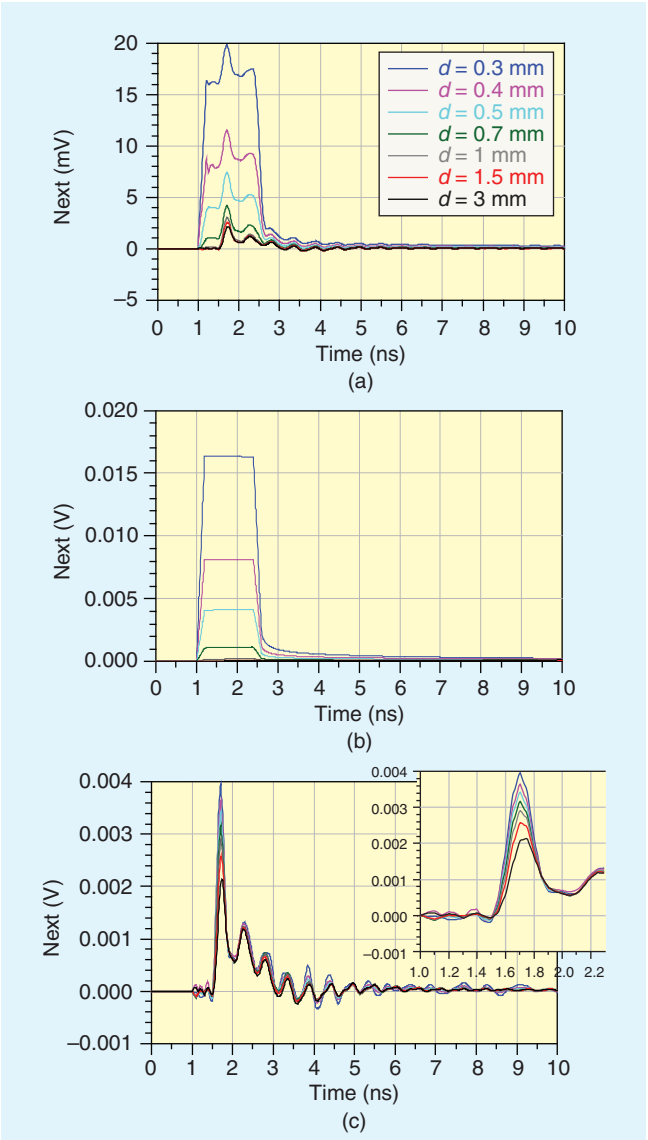

Fig. 4. NEXT as a function of trace-to-trace separation. (a) Overall NEXT (b) NEXT due to direct trace-to-trace coupling (c) NEXT due to split-related coupling.

crosstalk. The two resulting components are shown in Fig. 3. It can be clearly seen that, when d is smaller than 0.7 mm, the overall S_{31} magnitude is dominated by the direct trace-to-trace coupling and it increases drastically when d decreases. When d is greater than 0.7 mm, the split-related coupling becomes the dominant noise-coupling mechanism. In these cases, the S_{31} magnitude does not change with d as significantly as in the cases when the trace-to-trace coupling dominates. The resonances shown in Fig. 3(a) are related to the trace length, and the resonances shown in Fig. 3(c) are related to the split length.

The same decomposition procedure can be applied to the NEXT waveforms in the time domain as well. The corresponding results are shown in Fig. 4, where the rise time of the aggressor voltage is 200 ps and both traces are matched at the ends. It can be seen that the direct trace-to-trace coupling decreases quickly as d increases. The split-related NEXT waveform is a single sharp pulse with multiple oscillations. The oscillations are caused by the split-associated resonances. As d increases, the split-related crosstalk decreases too, but not as significantly as the direct trace-to-trace coupling.

By investigating the two crosstalk mechanisms, we can conclude that split-crossing does contribute additional crosstalk among the stripline traces even though one of their reference planes is ideal. Our study shows that we can draw similar conclusions for the FEXT and the NEXT, although only the NEXT results are discussed here for brevity. The split-related crosstalk is relatively weak, but it is not a strong function of the trace-to-trace separation. When two traces are closely located, the crosstalk between them is dominated by the direct trace-to-trace coupling. Otherwise, it is dominated by the split-related coupling. The dimensions of the split contribute to the

resonances in the frequency domain and oscillations in the time domain, which could become a trouble maker for sensitive signals when the aggressor signal has large spectral components at these resonant frequencies.

Using this effective decomposition technique, we can further study the split-related crosstalk as a function of various geometrical dimensions. In addition to the trace-to-trace separation, the trace-to-split-plane distance and the rise/fall time of the aggressor signal are found to be the other two dominant factors. When the traces move closer to the split plane (h decreases), both the NEXT and FEXT magnitudes increase. This makes sense since, as h decreases, more return current flows in the split plane, resulting in a higher level of split-related crosstalk. The split-related crosstalk also increases with the decrease of the rise/fall time of the aggressor signal. And this increase is more significant when the rise/fall time is smaller. The other geometrical parameters, such as the split length b, the aggressor-to-board-edge distance s, the split width w, the split-trace angle β, the trace width t, and the dielectric constant ε_r, do not play significant roles in the split-related crosstalk.

Lastly, but certainly not the least, what happens when there are multiple aggressors? Fortunately, our study shows that superposition holds. In other words, if multiple traces cross a split, the overall crosstalk voltage on the victim line can be estimated simply by adding up the crosstalk from each individual aggressor. This implies that using differential signaling can effectively reduce the split-related crosstalk, although the cancellation will not be complete due to the asymmetry of the geometry.

Reference

[1] S. Wu, M. Herndon, H. Shi, B. Cornelius, and J. Fan, "Crosstalk among multiple stripline traces crossing a split," *DesignCon 2011*, Santa Clara, CA, January 31–February 3, 2011.

STAY TUNED!

"By investigating the two crosstalk mechanisms, we can conclude that split-crossing does contribute additional crosstalk among the stripline traces even though one of their reference planes is ideal. Our study shows that we can draw similar conclusions for the FEXT and the NEXT, although only the NEXT results are discussed here for brevity." **The FEXT results will be discussed in the next, Summer 2011, issue of the EMC Newsletter. Stay tuned!**

7th Asia-Pacific International Conference on Lightning and Technical Exhibition will be held in Chengdu, from Tuesday, November 1 through Friday, November 4, 2011. The conference Chairman is Prof. He Jinliang from Tsinghua University, China.

This event will address the lightning community of the Asian-Pacific region and its link to the world and at the same time enhance the communication among atmospheric electricity, lightning physics and protection fields. Chengdu has been selected to host the APL 2011, which has a long history of 2500 years, and is world famous historical city with rich culture, natural & historical landmarks, such as Sichuan cuisine, Giant Panda Habitat, Dufu's Thatched Cottage, Mount Emei, Leshan Giant Buddha, and Jiuzaigou.

So come and join the APL 2011 in Chengdu! We will offer a rich scientific program of highest quality with invited speakers from all over the world and provide a broad forum of exchange for both academia and industry.

The conference will cover the entire scope of atmospheric electricity, lightning physics and protection. Prospective authors are invited to submit original papers on their latest research results. We also solicit proposals for special sessions, industrial forum, workshops and tutorials.

For further information, *please contact:* Dr. Zhanqing YU apl2011@tsinghua.edu.cn
For Exhibition, please contact: Dr. Jun HU, hjun@tsinghua.edu.cn

Preliminary paper submissions (At least 4 pages)	**June 15, 2011**
Notification of acceptance	**July 31, 2011**
Final paper submission	**Aug. 31, 2011**
Details on the conference websites:	**www.apl2011.org**

EMC Standards Activity

Don Heirman, Associate Editor

Standards Meetings in March in Fort Lauderdale – Much to Report!

We had another Fort Lauderdale visit after our EMC Society symposium last August 2010 for the EMC Society Board series at the end of March 2011. Our standards meetings are always most of the day before the Board meeting and this was no exception.

In addition to the usual progress reporting on our standards activity in the Standards Development Committee (SDCom), the Standards Advisory and Coordination Committee (SACCom) held a meeting led by its new Chairman—John Norgard (NASA). He replaced Werner Schaefer who we again thank for his work to revitalize the committee in the past year. Don Heirman will remain as SACCom secretary.

We start by highlighting the SDCom meeting reports on each of our EMC Society standards. The full title is found on the EMC Society web site under http://grouper.ieee.org/groups/emc/emc/ieee_emcs_-_sdcom_mainpage.htm

Here is a short progress report as of March 2011:

- **Industrial, Scientific and Medical (ISM) on site measurements (Std. 139):** Current. Resolution of reaffirmation comments in progress.
- **TV emission measurements (HDTV) (Std. 187):** Current until 2013, but consensus was that it needs updating for digital TV. Resolution of reaffirmation comments in progress.
- **Shielding Effectiveness (large rooms) (Std. 299):** Current, reaffirmation ballot to be initiated.
- **Shielding Effectiveness of small enclosures (less than 2 m maximum dimension) (P299.1):** Par extended to 2012. Draft was approved by SDCom 3/28/2011 as being ready for sponsor ballot.
- **Land mobile emissions (Std. 377):** Current until 2013.
- **EM site survey (Std. 473):** Project turned over to TC3. TC3 will hold a web meeting to finalize proposed PAR and to gather all existing text. SDCom secretary will work with TC3 and continue to monitor closely.
- **Field disturbance sensors (Std. 475):** Current. Want to apply below 300 MHz. Reaffirmation ballot next step.
- **RF absorber evaluation (Std. 1128):** Current. Interest in work up to 18 GHz. Resolution of reaffirmation comments in progress.
- **VDT emissions (Std. 1140):** Current. Interest in applying to plasma displays. Will solicit interest through EMC Society Newsletter.
- **Gasket characterization (Std. 1302):** Current until 2013.
- **Probe calibration (Std. 1309):** PAR extended to 2012. Text was approved to go to sponsor ballot.
- **RF filter performance (P1560):** Current. Resolution of reaffirmation comments in progress.
- **Computational EM (P1597.1):** Current until 2014.
- **Computational EM practices (P1597.2):** Current until 2015.
- **Intentional EMI to computers (P1642):** PAR extended to end of 2011. Text was approved to go to sponsor ballot.
- **Line replaceable module testing for product compliance (P1688):** Conversion of document to IEEE template complete. Working group has outlined an aggressive schedule. PAR extended to 2012. Expect to be in ballot in 2011.
- **EMC testing of Broadband Access Powerline Communications Equipment (Std. 1775):** SDCom voted to withdraw as co-sponsor. Accepted by IEEE staff; standard published.
- **Power Line Harmonics (P1836/P1837):** Policy and Procedure for working group approved. First face-to-face meeting in April. Over 50 people on working group.
- **Software Defined Radio (SDR) interference and coexistence (P1900 series):** SCC-41 was reorganized under Communications Society sponsorship. SDCom interested in participating as sponsor and investigating possibilities.
- **Smart Grid interoperability (P2030):** Sponsored by SCC21. EMC Society/SDCom actively engaged
- **Power-line noise complaints (PXXXX):** Discussions with Power and Energy Society (PES) being planned.

The SACCom meeting followed the SDCom meeting. John Norgard and Don Heirman are working on further invigorating the committee interactions by having each non-EMC Society standards organization present a list of their EMC standards and compare them to the list of SDCom standards for two reasons:

1) To see if there is possible joint work between these committees and SDCom
2) With approval, possible use of portions of the non-EMC Society standards in our SDCom work and vice versa.

The full background on the committee is found on http://grouper.ieee.org/groups/emc/emc/ieee_emcs_-_saccom_mainpage.html

EMC Europe 2011
26-30 September, York

International Steering Committee Board of Chairmen:

J L ter Haseborg, Chairman (Germany)
H Garbe, Vice-Chairman (Germany)
M D'Amore (Italy)
J Catrysse (Belgium)
A P J van Deursen (The Netherlands)
M Feliziani (Italy)
F Silva (Spain)
N Uzunoglu (Greece)
T W Wieckowski (Poland)

Local Organising Committee:

A C Marvin, Chairman
C Christopoulos, Vice-Chairman
J F Dawson
L Dawson
C Marshman
D W P Thomas
A Nothofer
S Greedy

Important Dates:

17 January 2011:
Preliminary Paper Submission.

1 March 2011:
Proposals for Workshops, Tutorials and Special Sessions.

1 March 2011:
Experimental and Practical Demonstrations.

8 April 2011:
Notification of Acceptance

9 May 2011:
Submission of Final Paper

The Conference:

EMC Europe is the pre-eminent EMC Conference in Europe and will be held at the University of York in the UK in 2011. We wish to invite and encourage all those working in electromagnetic compatibility to participate in this prestigious event in 2011.

EMC research and conferences in Europe have a long tradition. From the series of independent EMC conferences based in Wroclaw, Zurich and Rome running every second year, has now emerged EMC Europe which will be organised every year in a European city to provide an international forum for the exchange of technical information on EMC. The 2010 EMC Europe Conference was in Wroclaw and in 2011 it will be at York.

Technical Scope:

Authors are invited to submit original contributions on all aspects of EMC. Only full papers 4-6 pages in length, in IEEE, format, will be considered by the deadlines shown below. In addition, Workshop, Tutorial and other Special sessions will be organised to provide up-to-date practical help to those new to the subject or requiring an update, as well as to address in more depth topical subjects. Normal preliminary paper submission should be done electronically through the EMC Europe 2011 website (www.emceurope2011.york.ac.uk).

Proposals for Workshops, Tutorials and Special sessions will be coordinated by Dr D W P Thomas and the experimental and other practical presentations by Dr Angela Nothofer. There will be a technical exhibition held in parallel with the conference coordinated by Mr Chris Marshman. Sponsorship opportunities will also be available. Conference registration will be done at www.emceurope2011.york.ac.uk where further details will become available in due course.

All queries to: conference@emceurope2011.york.ac.uk

The Organisers aim at making this a technically rewarding conference and your stay in the historic city of York a very pleasant one.

A C Marvin, University of York
C Christopoulos, University of Nottingham

http://www.emceurope2011.york.ac.uk

EMC EUROPE 2011
YORK, UK

What follows is the current list of SACCom representatives:

Confirmed SACCom Representatives
(As of March 5, 2010)

Representative	Represented Committee
Sargent, Noel	ISO TC20 SC14
Lukash, James	AIAA S-121-2009
Petersen, Ron	IEEE SCC-39 (ICES)
Peterson, Ron	IEC TC106
Smith, Doug	Electrostatic Discharge Society
Heirman, Don	AAMI
Heirman, Don	IEC CISPR/A
Pettit, Ghery	IEC CISPR/I
Pettit, Ghery	ITI TC5
Moy, Kin	ISO TC22/SC3/WG3
Williams, Kimball	IEEE Vehicular Technology Society
Williams, Kimball	Society of Automotive Engineers
Hurst, Bill	Federal Communications Commission
Brumbaugh, David	SAE AE4
Hoolihan, Dan	IEC CISPR/B
Jones, Brian	CENELEC TC210
Schaefer, Werner	IEC CISPR/H

John sent out messages to all these members asking not only confirmation of their continued interest in staying on the committee, but to send back a list of EMC related standards that their organization has.

This was quite enlightening as many of the above organizations had dozens of EMC related standards. For example, the SAE AE4 committee had 42 EMC related standards! Here is the start of their list provided to give you an idea of what is happening in this committee.

Partial list of the 42 SAE AE4 EMC Standards

The following standards are available at:

http://standards.sae.org/automotive/electrical-electronics-avionics/emc/standards/

- **J1113_198708 Electromagnetic Susceptibility Measurement Procedures for Vehicle Components (Except Aircraft) (Cancelled Aug 1987) 1987-08-19**
- **Cancelled J1113/1_200610 Electromagnetic Compatibility Measurement Procedures and Limits for Components of Vehicles, Boats (up to 15 m), and Machines (Except Aircraft) (16.6 Hz to 18 GHz) 2006-10-13**
- **Revised J1113/11_200706 Immunity to Conducted Transients on Power Leads 2007-06-25**
- **Revised J1113/12_200608 Electrical Interference by Conduction and Coupling - Capacitive and Inductive Coupling via Lines Other than Supply Lines 2006-08-30**
- **Revised J1113/13_200411 Electromagnetic Compatibility Measurement Procedure for Vehicle Components-Part 13: Immunity to Electrostatic Discharge 2004-11-03**
- **Revised J1113/2_201008 Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components (Except Aircraft) - Conducted Immunity, 15 Hz to 250 kHz - All Leads (Cancelled Aug 2010) 2010-08-06**
- **Cancelled J1113/21_200510 Electromagnetic Compatibility Measurement Procedure for Vehicle Components – Part 21: Immunity to Electromagnetic Fields, 30 MHz to 18 GHz, Absorber-Lined Chamber 2005-10-06 Revised**

We have a standards meeting for everybody at the symposium! We especially invite you to attend the Monday morning Standards Meeting on 15 August 2011 at the Long Beach Convention Center. SDCom, SACCom and our SETCom (Standards Education and Training Committee) will meet in sequence. Consult your EMC 2011 advance program or www.emc2011.org for the room location and timing.

See you in Long Beach! **EMC**

The EMC Standards Committees will meet at the Long Beach Convention Center during the 2011 IEEE International Symposium on EMC – PLEASE JOIN US! See www.emc2011.org for the list of Standards Committee meetings with room locations, dates and times.

Call for Participants for EMC Society Smart Grid Activity

In the Winter 2011 issue of the EMC Newsletter, we asked for volunteers interested in working on EMC aspects of the SmartGrid that our Society can bring to the table. The article identified that there is now a special committee (Special Committee 1 - SC1) reporting to the Technical Advisory Committee of the EMC Society. Details of the committee are contained on the EMC Society web site: http://ewh.ieee.org/soc/emcs/committees/sc01/index.html

We had inquires from a few readers and there were some joining SC1. But we need more volunteers to review the EMC literature that is being written on EMC requirements for SmartGrid, offer new suggestions on applications, suggest possible standards areas, in addition to the usual immunity basic standards in the IEC (International Electrotechnical Commission), and in other areas.

To further generate interest in this work, SC1 is sponsoring a special tutorial on the subject on Monday afternoon, 15 August

IEEE
Advancing Technology for Humanity

IEEE COMCAS 2011

The International IEEE Conference on Microwaves, Communications, Antennas and Electronic Systems

Hilton Hotel, Tel Aviv, Israel, November 7-9, 2011

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Deadline for summaries is June 25th, 2011!

- A 3 day International Professional IEEE Conference
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The International IEEE COMCAS 2011 continues the tradition of providing a multidisciplinary forum for the exchange of ideas in the areas of Microwaves, Communications, Antennas, Solid State integrated Circuits, EMC, Electron Devices, Radar and Electronic Systems engineering. The conference will take place on November 7-9, 2011 at the Hilton Tel Aviv Hotel, Israel.

Tel Aviv is a cosmopolitan city situated on the Mediterranean coast; a city that inspires visitors with its unique energetic atmosphere, majestic beauty, lively beaches, rich culture and vibrant nightlife.

The venue will be exciting and enjoyable with many opportunities for networking, candid exchange of ideas and a strong sense of community. A diverse assembly of researchers, engineers and scientists will be invited to present their ideas and discuss new results, providing a unique opportunity for attendees to view a variety of interesting and innovative technologies.

Keynotes speakers will be **Mr. Russell Ellwanger**, CEO at TowerJazz who had been awarded in 2010 the High Tech CEO of the Year Award by the Forum of the Israeli Management Center and **Prof. Richard Gitlin**, from the University of South Florida, who is a member of the US National Academy of Engineering, a Fellow of the IEEE, and a Bell Laboratories Fellow. The titles of their talks are "Formulas for Growth" and "Wireless Directions For the 21st Century" respectively.

We are pleased to welcome this year **Prof. Moshe Kam**, IEEE President; **Prof. Magdalena Salazar Palma**, AP-S President and **Dr. Richard Snyder**, MTT-S President among our distinguished guests.

On both a professional and personal level, we have something for everyone and we look forward to welcoming you in Tel Aviv. **Please join us for the 3rd Annual IEEE COMCAS 2011.**

The technical program will be complemented with a Technical Exhibition, offering attendees from industry, academia and government a unique opportunity to network with relevant companies, vendors and technologies from Israel and abroad.

The official language of the Conference is English.

Important Deadlines:

Summary Submission: 25 June 2011
Early Bird Registration: 31 August 2011
Final Manuscript Submission:15 September 2011

Conference Chairman: **Shmuel Auster** TPC Co-Chairmen: **Barry Perlman, Roger Pollard**

For further information on the conference and the exhibition, please visit: www.comcas.org

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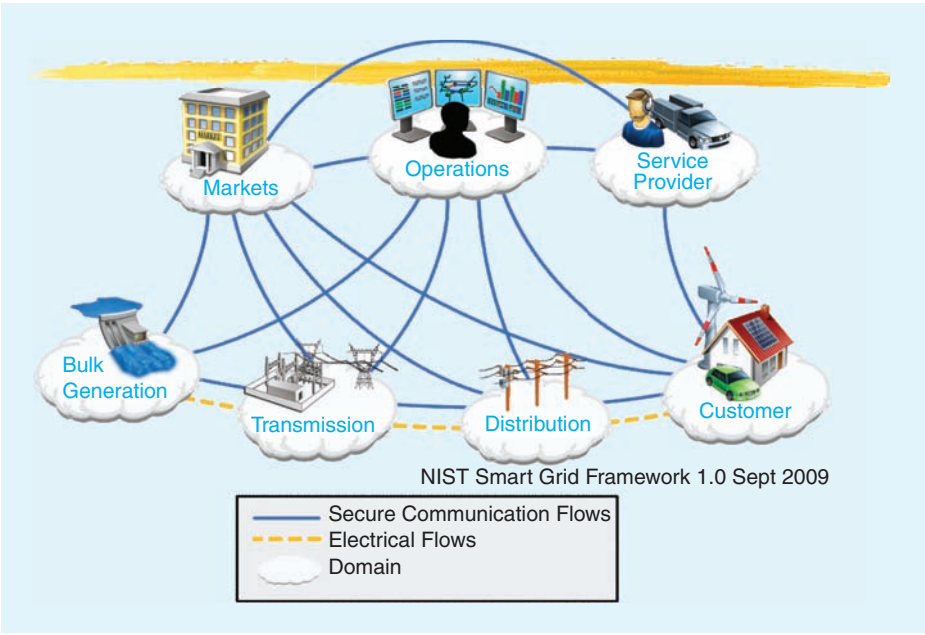

at the Long Beach Convention Center as part of the 2011 IEEE International Symposium on EMC. (See the EMC 2011 final program for the room number.) The tutorial subject is "EMC Aspects of SmartGrid". It will present the application of EMC in supporting the design of a workable SmartGrid system that interoperates in the RF environment where it will be deployed. It will also review the primary EMC standards work being done around the world to identify applicable EMC standards that need to be taken into account for a robust SmartGrid system on the power delivery side as well as the power customer side of the SmartGrid meter mounted on the power customer building.

Topics will be as follows along with the speakers that will make these presentations:

1) *Introduction of Worldwide Efforts to Deal with SmartGrid with Emphasis on EMC*
   Don Heirman, Don HEIRMAN Consultants
2) *EMC Aspects of the Utility Side of the SmartGrid*
   John T. Tengdin, OPUS Consulting Group
3) *Overview of NIST activities and the Activities of the SmartGrid Interoperability Panel (SGIP) Working Group on EM Interoperability Issues (EMIIWG)*
   Galen Koepke, National Institute of Standards and Technology
4) *Smart Grid Activities in Europe with Emphasis on EMC*
   Magnus Olofsson, Swedish National Electric Safety Board
5) *High Power EM Concerns with SmartGrid*
   Bill Radasky, Metatech

For those of you with an interest in the subject, please try to attend this session and the SC1 meeting which is on Monday evening at 5:30 pm. See the EMC 2011 advance and final programs for the meeting room number at the Long Beach Convention Center.

Finally, to restate what is on the web site, the charter is as follows:

Special Committee 1 – Charter

This special committee is concerned with coordinating the EMC Society activity on providing EMC principles for those organizations and associated documentation and specifications that address the efficient use of the AC power grid including the control of power entering a house or building. Such control may be from a meter at the point of power entry into these facilities to control incorporated into appliances and other electronic devices in these facilities. Such controllers may be sources of undesirable RF emissions and at the same time vulnerable to the RF environment which speaks to the need for EMC. It is expected that the coordination aspect of this special committee will involve several EMC Society Technical Committees, including, with special membership by the EMC Society Standards Development Committee (SDCom):

TC 2: EMC Measurements
TC 3: EM Environments
TC 4: EMC Design
TC 5: High Power EM
TC 9: Computational EM

What are needed now are EMC Society members who can bring their EMC expertise to bear on the subject. So we are asking for volunteers to join the special committee. What is the job? The following discusses how to get started with our committee.

Interested in Joining?

If you are an IEEE EMC Society member and would like to join this special committee, please contact one of the SC 1 officers with your name and IEEE membership number. The committee primarily will communicate electronically and using teleconferencing. It will also meet face to face as needed and at the annual IEEE EMC Symposium.

Contact Information

Please contact the chair Don Heirman on d.heirman@ieee.org and the secretary Kermit Phipps on kphipps@epri.org

Don't wait as this activity is moving ahead with a lot of energy and pacing. Our interest is in a successful SmartGrid (SG) system. We have indicated already that for the SG to have interoperability you need to first operate—and that will require proper EMC design! **EMC**

EMC Society Standards Travel Grant Now Available!

At the November 2010 EMC Society Board of Directors meeting, the Board unanimously approved the implementation of a special grant that was received from a donor. The Grant is to partially help EMC Society members to actively participate in EMC Society standards development and attend regular meetings of the EMC Society Standards Development Committee (SDCom), the Standards Advisory and Coordination Committee (SACCom) and the Standards Education Committee (SETCom).

The EMC Society will administer the Grant by providing proper oversight of delegated duties to a Standards Travel Grant Committee (Committee). The Committee shall be formed by the EMC Society Vice President (VP) for Standards and be comprised of the chairmen of the SDCom, SETCom and the SACCom. The Chair of the Committee shall either be the EMC Society VP for Standards or the Chair of the Standards Development Committee (SDCom). In addition to these positions, the present VP for Standards (Don Heirman) has named John Norgard (past VP for Standards) to assist him in operating the committee. The following are key excerpts of the travel grant text.

Eligibility and Selection

Grant recipients must be members in good standing of EMC Society standards committees or EMC Society standards working groups. Good standing means those that are current, paid members of the EMC Society.

The selection process shall comply with procedures and regulations established in IEEE governing documents, particularly with IEEE Policy 4.4 on Awards Limitations.

The Committee shall establish and implement a procedure for the selection of the Grant recipients. Consideration must be given to the financial need and the active participation of the applicant in the standards process and development.

The travel grant request form is available from the VP for Standards – Don Heirman – who can be contacted on d.heirman@ieee.org or John Norgard who is facilitating the process. John is on j.norgard@ieee.org.

Recipients shall be selected when, in the judgment of the Committee, suitable candidates are available and request travel reimbursement. If suitable candidates are not available or have not requested reimbursement, the Committee can recommend no funding to be issued in that year. Voting will be under the leadership of the EMC Society Vice President for Standards and the outcome will be on the majority consensus of the committee.

Schedule

The selection of Grant recipients will be considered twice each year. The timing of requests for travel reimbursement will be annually at the end of the calendar year for those meetings to be held the following year. There may be other meetings that are planned such as Working Group (WG) meetings during the year. In this case, request to the Standards Travel Grant Committee for funding shall be no less than 30 days in advance of the meeting. Any requests that do not follow this timeline shall not be granted. Those receiving funding will be notified in a manner coordinated by the VP for Standards.

Travel Reimbursement

Grant recipients shall receive travel reimbursement for expenses associated with traveling to and participating in EMC Society standards meetings. Each Grant recipient may receive no more than two travel reimbursements within a calendar year.

Travel reimbursement shall be limited to 80% of the total cost of the trip but in no case will the reimbursement exceed $2,000 USD per trip. Eligible expenses include: economy class transportation (air, ground, or rail), accommodations, meals, and travel visas.

Travel reimbursements to multiple individuals may be given each year with a maximum annual distribution of $4000 USD from the fund.

No reimbursements shall be given to support participation in EMC Society standards meetings associated with the EMC Society annual symposium.

Presentation

Recipients selected to receive travel reimbursements shall be notified prior to the related meeting deadline, in time to make travel arrangements and to seek any necessary complimentary support from their employers or other sources of funding.

Summary

The EMC Society appreciates the opportunity for advancing the standards activity of the Society via the implementation of the travel grant. If there are any questions, please contact Don Heirman at d.heirman@ieee.org.

EMC

NEW for 2011!

Interlab Comparisons and Data Reduction plus Emission Measurements (ANSI C63.4), Antenna Calibration (ANSI C63.5) and Time Domain (TD) Applications

EMC 2011
LONG BEACH, CA AUGUST 14–19, 2011

This workshop is presented now in four parts over a two and a half day period: (1) Introduction to interlab emission measurement comparisons and requisite data reduction, (2) Review of the 2009 edition of ANSI C63.4 (now accepted by the FCC for use), (3) Review of the 2006 edition of C63.5 and the changes proposed for the expected 2012 edition and (4) Application of TD for test site validation and antenna calibration. The workshops are designed to increase your understanding of these standards, the TD approach and the importance of interlab comparisons (ILC) as it applies to emission measurements and how to analyze results to improve lab test accuracy. For the C63.4 workshop, there will be an analysis of the test site validation including using the CISPR S-VSWR method or arranging absorber material on the ground plane. The C63.5 workshop will lead the user through the document, highlighting which technique should be used based on the type of antenna being calibrated. This is essential to ensure that the right antenna factor is obtained, especially when validating semi-anechoic chambers. The proposed application of the same TD method to validating test sites and antenna calibrations will also be presented in real time using the ten meter semi-anechoic chamber at Northwest EMC. Group problem solving will be a highlight of all four workshops. **Visit www.c63.org for more information.**

In the ILC workshop, you will learn:

- Elements of ISO 17025, Clause 5.9
- Collecting/analyzing data
- Setting control limits/uncertainty
- Computing/presenting results
- Lab experience with comparisons

In the C63.4 workshop, you will learn:

- Emission measurement procedures
- Regulatory implications
- Test facility and instrumentation requirements
- Test arrangements and configurations

In the C63.5 workshop, you will learn:

- General test conditions
- Appropriate measurement geometry
- Application of standard site method
- Rationale for geometry specific correction factors for biconicals
- Measurement uncertainty guidelines
- Changes proposed for 2012 edition

In the TD workshop, you will learn:

- Application for site validation
- Application for antenna calibration
- Tips on using TD instrumentation in a ten meter semi-anechoic chamber

Support Material

- A complete lecture notebook
- FCC handouts and references

Who Should Attend

- Product Managers and Developers
- EMC Engineers and test technicians
- Regulatory Compliance Managers
- Test Instrumentation Developers
- Calibration labs/technicians
- Accreditation bodies
- Lab quality assessors
- Test instrumentation and chamber manufacturers
- Data reduction analysts

Host Hotel

Hilton Orange County/Costa Mesa
3050 Bristol St., Costa Mesa, CA 92626

"ANSI C63" Group Rate: $99 plus tax for reservations made by July 1, 2011
Phone: +1 714-540-7000

Date and Location

August 11 and 12: Host Hotel - Hilton
August 13: Northwest EMC in Irvine

Expert Instructors

Workshops feature industry leaders and ANSI C63® members, including Don Heirman, Workshop Director, (Don HEIRMAN Consultants), Bob Hofmann (Hofmann EMC), Greg Kiemel (Northwest EMC), Harry Hodes (Acme Testing Co.), Dennis Camell (NIST), Victor Kuczynski (Vican Electronics) and Zhong Chen (ETS-Lindgren)

Fee Includes

Lecture notebook, continental breakfast, lunch, breaks, completion certificate, and transportation on August 13 to/from the Host Hotel and Northwest EMC. Fee does NOT include draft or published standards.

Agenda

Interlab Comparison
August 11: Class: 1:00 to 5:00 pm

ANSI C63.4:
August 12: Registration: 8:30 am
Class: 9:00 am to 5:00 pm

ANSI C63.5 and Time Domain:
August 13: Registration: 8:30 am
Class: 9:00 am to 5:00 pm

Registration Form
Telephone: 425-868-2558

Contact: Janet O'Neil
j.n.oneil@ieee.org

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Email_____
Credit Card (check one): MC_____Visa_____Amex_____
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Check or Credit Card Number must accompany registration.

Make check payable to **U.S. EMC Standards Corporation** in U.S. dollars drawn on a U.S. bank. Mail to:
Janet O'Neil, ETS-Lindgren
22316 Northeast 19th Street, Sammamish, WA 98074

Interlab Comparison Workshop only - August 11 (PM)	
By June 30*:	$200 USD _____
C63.4 Workshop only - August 12	
By June 30*:	$500 USD _____
C63.5/TD Workshop only - August 13	
By June 30*:	$500 USD _____
All three workshops	
By June 30*:	$1000 USD _____
Add $200 if after June 30	$200 USD _____
Add'l copy of both workshop notebooks**	$150 USD each _____
	***Total USD $_____

NOTE: You are not registered until you receive confirmation

*Please do not mail after 30 June. **Order by June 30 for pickup at the workshop. ***A discount applies to ASC C63® paid members: contact Janet O'Neil for this special offer and pricing.

The organizing committee reserves the right to substitute speakers, modify the program (or lecture notes), restrict attendance or to cancel the workshop(s). In the event the workshop(s) is/are cancelled, registration fees will be refunded. No refunds will be made to individuals who cancel after July 1. Substitutions are allowed. Workshops without a minimum of 15 attendees signed up by 1 July 2011 will be cancelled and registration fees returned. It is suggested that you book refundable travel arrangements as appropriate if workshop(s) is/(are) cancelled.

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EMC SOCIETY

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6th Symposium on Environmental Electromagnetic Compatibility (EEMC 2011)

in conjunction with the 19th International Conference **SoftCOM 2011**

September 15-17, Split – Adriatic coast, Croatia

Authors are invited to submit their high-quality papers representing the original results in all areas of EMC in communications.
Accepted and presented papers will be published in the Conference Proceedings and indexed in the IEEE Xplore and Inspec.

Topics of interest include, but are not limited to:

* *Sources of Electromagnetic Interference*
* *Antennas for Mobile Communications*
* *Shields for Mobile Units and other Protective Measures*
* *Lightning*
* *Grounding*
* *Electromagnetic Field Dosimetry*
* *Propagation Through Biological Media*
* *Biological Effects of Electromagnetic Fields*
* *Electromagnetic Stimulation of Human Tissue*
* *Electromagnetic Modeling of Human Body*
* *Electromagnetic Interference with Medical Devices*
* *Advanced Numerical Modeling*
* *Regulatory Activities and Safety Trends*

IMPORTANT DATES

Complete manuscript due	June 01, 2011
Notification of acceptance	July 15, 2011
Camera-ready manuscript	Sept. 01, 2011

More information on: www.fesb.hr/softcom

Conference Secretary: *Josko Rradic (softcom@fesb.hr)*

Authors of the selected papers will be invited to submit extended version of their manuscripts for possible publication in the Journal of Communications Software and Systems (JCOMSS).

JOURNAL OF COMMUNICATIONS SOFTWARE AND SYSTEMS
www.ccis.hr/jcomss

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EMCABS

EMC Abstracts

Osamu Fujiwara, Associate Editor

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

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

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

EMCABS: 01-05-2011

BROADBAND PERMEABILITY MEASUREMENT METHOD FOR FERRITES AT ANY MAGNETIZATION STATE: DIRECT PROBLEM

Jorge E. Lezaca, Patrick Qu´eff´elec, and Alexis Chevalier
Lab-STICC UMR 3192, European University of Brittany, University of Brest, Brest, France
Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp.148–151.

Abstract: A data processing program based on a full-wave electromagnetic (EM) analysis of a non-reciprocal transmission line partially filled with a ferrite sample is presented. A predictive permeability tensor model is introduced in the Maxwell equations to allow the program to work at any magnetization state. The dispersion diagram for the first significant modes inside the ferrite loaded region of the line is obtained. The presence of magneto static modes generated by magnetized ferrite inside the line is verified. Using a mode matching technique, the theoretical scattering parameters (S-parameters) of the non-reciprocal transmission line are calculated. The analysis is validated by the comparison between the calculated S-parameters with those obtained with a FEM based EM simulator and the measurements at limit cases.

Index terms: Ferrite, permeability, measurement method.

EMCABS: 02-05-2011

PRECISE CHARACTERIZATION AND DESIGN OF COMPOSITE ABSORBERS FOR WIDEBAND MICROWAVE APPLICATIONS

Anjali Sharma, Nahid Rahman, Mahmut Obol, Mohammed Afsar
High Frequency Materials Measurement and Information Centre, Dept. of Electrical and Computer Engineering, Tufts University, Medford, MA-02155, USA
Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 160–163.

Abstract: This paper presents a novel measurement, characterization, and design procedure for practical broadband absorbers. A multi-layer absorber ideally suited to broadband communication applications has been designed, optimized and analyzed. A newly developed and precise transmission-reflection (T/R) based waveguide measurement technique has been used to determine the frequency dependent complex permeability and permittivity of a variety of dielectric and magnetic absorbers in the microwave spectra. These materials have been accurately characterized for the first time across eight frequency bands from 2 to 40 GHz. The constitutive parameters have then been analyzed to design a 2-18 GHz multi-layer composite structure that offers minimum

specular reflection and maximum absorption of electromagnetic energy across the bandwidth. To verify the absorption performance in wideband applications, the multi-layer structure has been inserted in the lossy cavity of a 2-arm Archimedean spiral antenna and simulated for its radiation patterns. The optimal thicknesses of each absorbing layer have been determined for this specific broadband application. Finally, the reflection properties of the composite structure have been experimentally verified using the T/R measurement technique.
Index terms: Composite absorber, wideband, measurement method.

EMCABS: 03-05-2011

SIMPLIFIED METHOD FOR MEASURING SAR BY USING PHANTOM COMPOSED OF WAVE ABSORBER

Tan Watanabe, Naobumi Michishita, Yoshihide Yamada
Department of Electrical and Electronic Engineering, National Defense Academy, Japan

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 216–219.

Abstract: A simplified method for measuring the specific absorption rate (SAR) is required in order to limit the spatial average SAR for mobile devices in Japan. In this paper, a simplified SAR measurement method involving the use of a flat plane lightweight phantom composed of a radio wave absorber is proposed. The utility of the lightweight phantom and the feasibility of using the proposed measurement method along with the lightweight phantom are verified. Finally, the peak spatial average SAR is estimated by using the proposed measurement method.

Index terms: SAR, mobile device, measuring method.

EMCABS: 04-05-2011

SAR COMPUTATION IN A REAL-SIZED CAR: MULTI-EXPOSURE SCENARIOS

Louis-Ray Harris, Maxim Zhadobov, and Ronan Sauleau
Institute of Electronics and Telecommunications of Rennes (IETR), Rennes, France

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 224–227.

Abstract: In this study, investigations have been carried out into the variation of whole-body averaged SAR values for four humans (one driver + three passengers) inside a realistic realized car. Transmitting devices used in the simulations had multiple frequencies making it a multi-exposure environment. These devices (e.g. Bluetooth, Universal Mobile Telecommunications System (UMTS) and WiMAX) use differing operating frequencies and can be used in semi-echoic environments such as cars, trains, planes, etc. Results showed that the whole-body averaged SAR is below exposure limits provided by international standards and guidelines when there is one of each transmitter present. The results also show the whole-body averaged SAR when two active transmitters are simultaneously in use. Computed values are shown to be within the ICNIRP recommended limits.

Index terms: SAR, multi-exposure, car.

EMCABS: 05-05-2011

EFFECT OF VIA STUBS ON THE TRL CALIBRATION TECHNIQUE FOR MEASUREMENT OF EMBEDDED MULTILAYER STRUCTURES

Miroslav Kotzev, Heinz-Dietrich Brüns, and Christian Schuster
Institut für Theoretische Elektrotechnik, Technische Universität Hamburg-Harburg, Hamburg, Germany

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 248–251.

Abstract: In this paper the effect of access via stubs on the Thru-Reflect-Line (TRL) calibration for de-embedding of multilayer printed circuit board structures is analyzed. For this purpose a dedicated calibration board with single ended TRL standards containing broadband signal launches for measurement of embedded (internal) printed circuit board (PCB) structures such as striplines and vias (plated through holes) was designed. First results from the extracted signal launch S-parameters in the bandwidth from 40 MHz to 40 GHz using two-tier calibration techniques are shown and corroborated using full-wave 3-D FEM solver models. It was found that the access via stubs represent highly resonant structures that act as short circuits at their quarter wavelength frequency (and odd multiples thereof). As a consequence, the TRL algorithm fails at these frequencies and the calibration cannot be accomplished. Several mitigation strategies such as using recessed probing or backdrilling are discussed and their extension of calibration bandwidth is quantified.

Index terms: PCB, TRL, calibration, via stubs.

EMCABS: 06-05-2011

INTER-CHIP AND INTRA-CHIP PULSED SIGNAL TRANSFER BETWEEN TRANSMITTING AND RECEIVING LOOPS IN WIRELESS INTERCONNECT CONFIGURATIONS

+ Loan E. Lager, and ++ Adrianus T. de Hoop
+ IRCTR, Delft University of Technology, Delft, the Netherlands
++ Laboratory of Electromagnetic Research, Delft University of Technology, Delft, the Netherlands

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 577–580.

Abstract: The pulsed signal transfer between transmitting and receiving loops employed for inter-chip and intra-chip wireless interconnects in integrated circuit devices is investigated. A computational model, based on the electromagnetic reciprocity theorem of the time-convolution type, is developed. The transmitter loop excitation is modeled as a causal, unipolar pulse characterized by its pulse amplitude, its pulse rise time and its pulse time width. Analytic expressions are provided for the generator voltage in the equivalent Th´evenin circuit describing the performance of the receiver loop in its dependence on its location relative to the transmitter loop. Due to the intricate radiation behavior of the coupling magnetic field, the received signal is in an intricate manner related to the signal to be transferred. Numerical examples illustrate the complexity of the phenomena involved.

Index terms: Wireless interconnector, inter-chip, signal transfer.

EMCABS: 07-05-2011

APPLICATION OF TRANSIENT ELECTROMAGNETIC FIELD SIMULATION WITH FINITE ELEMENTS

M.H. Vogel, H. Songoro, M.H. Commens
ANSYS, Inc., Pittsburgh, PA, USA

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 581–584.

Abstract: This paper presents a full-wave 3D electromagnetic transient simulation method developed around an unstructured finite-element mesh. In such an unstructured mesh, the elements have a range of sizes and orientations such that, rather than forming a regular grid, they conform to the geometry of the model, respecting all its details. This paper discusses the method and presents some examples of applications.

Index terms: Numerical method, FEM, transient, EMP pulse.

EMCABS: 08-05-2011

MEASUREMENT MAGNETIC FIELD LEVEL OF RADIATED EMISSIONS FROM MILITARY EQUIPMENT

Rafał Przesmycki, Leszek Nowosielski, Marian Wnuk, Roman Kubacki
Faculty of Electronics, Military University of Technology, Warsaw, Poland

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 1285–1288.

Abstract: This paper addresses problems of electromagnetic compatibility of military equipment. Its goal is to present a sample application of position and methodology of measurements concerning the measurement level of magnetic induction of interference in the frequency range from 30 Hz to 100 KHz, generated by equipment, sets of devices and such components as feeder cables, control, signal, aerial and connection cables(ducts) between components of military equipment sets. The procedure can also be used with reference to basic operating frequency of sonars, industrial devices, scientific and medical equipment. The procedure cannot be used with reference to emission directly from antennas and emission at the basic frequency of radio communication transmitters. The paper presents the methodology of measurements and description of position for measuring the magnetic induction level of interference in the frequency range from 30 Hz to 100 kHz according to the RE101 procedure of the MIL-STD-461E standard. The goal of research is to obtain measurement data essential for assessment of compatibility of tested equipment or sets of devices with requirements included in the defense standard MIL-STD-461E. The above mentioned position is used for conducting research in the Laboratory of Electromagnetic Compatibility, Faculty of Electronics, Military University of Technology, which has accreditation granted by the Polish Accreditation Centre.

Index terms: Radiated emission, magnetic field, military equipment.

EMCABS: 09-05-2011

DESIGN OPTIMIZATION OF AUTOMOTIVE ELECTRONIC CONTROL UNIT USING THE ANALYSIS OF COMMON-MODE CURRENT BY FAST ELECTROMAGNETIC FIELD SOLVER

+ Yuji Okazaki, + Masaki Unno, ++ Takanori Uno, and + Hideki Asai
+ Graduate School of Engineering, Shizuoka University, Hamamatsu-shi, Japan.
++ DENSO CORPORATION, Kariya-shi, 448-8661 Japan

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 1289–1292.

Abstract: In this paper, the authors propose an optimization system based on the fast electromagnetic field solver and met heuristics for reducing electromagnetic interference (EMI) on an electronic control unit (ECU). They adopt simulated annealing (SA), genetic algorithm (GA) and taboo search (TS) to seek optimal solutions, and the finite difference time domain (FDTD) method with general purpose computing on a graphic processing unit (GPGPU) to analyze electromagnetic fields. Therefore, the proposed system can determine the adequate combination of the values of discrete circuit components and the width of layout patterns on a printed circuit board (PCB) efficiently and practically, to reduce EMI caused by the common-mode current. Finally, the authors apply the proposed system to an example circuit to verify the validity and efficiency of the system.

Index terms: Automotive, EMI, common mode current.

EMCABS: 10-05-2011

EFFECT OF NONLINEAR PORT IMPEDANCES ON DISTRIBUTED PASSIVE INTERMODULATION IN PRINTED LINES

Alexey Shitvov, Dmitry Zelenchuk, Alexander Schuchinsky
The Institute of Electronics, Communications and Information Technology (ECIT), Queen's University Belfast, Belfast, UK

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 1293–1296.

Abstract: The effect of weak nonlinear terminations on the distributed passive intermodulation (PIM) generation in printed transmission lines has been investigated. The phenomenology based on the nonlinear transmission line model developed in the previous work has been generalized by introducing the new nonlinear boundary conditions. The developed model has been verified experimentally with the loose end connectors emulating weak nonlinear source/load impedances. Comparison of the measurement and simulation results has proved that the presented model enables an accurate evaluation of the effect of the lumped nonlinearities on the distributed PIM generation in printed circuits.

Index terms: PCB, transmission line, intermodulation distortion.

EMCABS: 11-05-2011

INTERACTION OF LOW FREQUENCY MAGNETIC FIELDS WITH THIN 3D SHEETS OF COMBINED RESISTIVE AND MAGNETIC PROPERTIES

+ R. Jobava, + A. Gheonjian, + D. Karkashadze, and ++ J. Hippeli
+ Electrical and Electronics Engineering Department, Tbilisi State University, Tbilisi, Georgia
++ AUDI AG, Ingolstadt, Germany

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 1309–1212.

Abstract: The subject of this paper is numerical modeling of thin 3D sheets with combined resistive and magnetic properties, exposed by low frequency magnetic fields. Incorporating

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reduction of thickness of sheet into Maxwell equations leads to approximate boundary conditions, written for tangential electric and magnetic fields of free space. These fields are represented only by vector potential, which is calculated based on single and double layer currents, located on the interface surface. Resulting equations are solved via Method of Moments. Numerical simulations are compared with semi-analytic solutions for thin plate and for spherical shell, as well as with measurement data. As an application, radiation from a supply cable in the presence of a metallic surface and shield is considered.
Index terms: Low frequency, shielding, interaction.

EMCABS: 12-05-2011

DESIGN OF WEARABLE COMMUNICATION DEVICE FOR BODY PROTECTION FROM EM WAVE USING THE EBG STRUCTURE
Sang il Kwak, Dong-Uk Sim, Jong Hwa Kwon and Hyung Do Choi
Radio Technology Research Department, ETRI (Electronics and Telecommunications Research Institute), Daejeon, Korea

Proceedings of the 40th European Microwave Conference, 28–30 September, 2010, Paris, France, pp. 1433–1436.
Abstract: This paper presents a wearable communication device for body protection from electromagnetic waves using an electromagnetic bandgap (EBG) structure at a WCDMA band. Since wearable wireless communication devices are used in the proximity or contact of the human body, a health risk from electromagnetic fields generated by body worn devices is important. The EBG structures can suppress the propagation of surface current and act as a perfect magnetic conductor. Thus, it is capable of preventing an undesired electromagnetic wave from the wireless communication devices. The proposed wearable communication device has the PIFA with the EBG structure at a WCDMA band, frequency generator for the SAR testing and a dielectric case. It is similar to a watch phone worn on the human wrist. Simulation and experimental results demonstrate S parameter, radiation pattern and the SAR value of the proposed structure.
Index terms: Wearable device, SAR, EBG.

EMC

Letter from the Editor

continued from page 3

We honor several prominent members of the IEEE and EMC Society who passed away since our last issue starting on page 32. I knew each of these members and appreciate the effort of Don Heirman and his colleagues to pay them the tribute they deserve. Risaburo Sato, featured on our cover, was truly the "Father of EMC" in Japan. From my earliest days in EMC, I recall the respect he commanded from his peers when he would enter the room. Always humble and modest, despite his tremendous accomplishments in EMC, he was a pleasure to know.

There can never be another Risaburo Sato, Rudi Vahldieck, Bob Howland and Carl Baum who have all completed their careers. The ability to cross paths with gentlemen such as these makes membership in the IEEE and EMC Society rewarding. May their souls rest in peace.

EMC

Following the EMC Society outreach event in Brasilia, the speakers took a "field trip" to the National Institute of Metrology, Normalization and Industrial Quality (INMETRO), the metrology lab of Brazil. INMERTO is located in Xerem, Brazil. Facilitating the tour of this progressive facility were (from left), Benjamim Galvão (independent consultant), Edson Afonso of INMETRO and André Kavaliéris Galvão of AK Telemedia. Benjamim and André were instrumental to the success of the EMC Society outreach event in Brasilia.

EMC Society Board of Directors Activities

The Hyatt Regency Hotel, Fort Lauderdale, Florida
March 29–30, 2011

The President's Opening Remarks

President Maradei called the meeting to order at 9:00 am. A round of introductions was made. Board members present included B. Archambeault, H. Benitez, C. Bunting, R. Davis, A. Duffy, R. Ford, D. Heirman, T. Hubing, E. Joffe, R. Koga, F. Maradei, J. Norgard, M. Oliver, J. O'Neil, G. Pettit, R. Scully, D. Sweeney, K. Williams, P. Wilson, and T. Yoshino. Absent were Board members L. Cohen, D. Hoolihan, J. LaSalle, A. Marvin, and V. Roje. F. Heather was present as a guest.

President Maradei reviewed Board meeting protocol, the IEEE code of ethics, and upcoming activities. She reminded Board members of the material on the Board FTP site and asked that everyone remember to review this prior to the Board meetings. Ms. Maradei welcomed the new Board members present and thanked them for their interest in the Board activities.

Consent Agenda

The agenda was presented for review. The consent agenda included approval of several motions as well as the March 2011 meeting agenda, the November 2010 Board meeting minutes, inclusion of financial policy in the EMC-S's OP&P manual, approval of the non-IEEE member subscription fee price list in accordance with the recommended price as determined by IEEE for 2012, approval of the 2012 *Transactions on EMC* page count not to exceed 1,200 pages, approval of the optional member *Transactions on EMC* (print copy) fee of $20 in accordance with recommended prices as determined by IEEE for 2012 (no change from 2011), approval of the 2012 membership fee of $30 (no change from previous year), approval to replace the present GOLD representative (Andrés Pavas) with Caroline Chan, approval of the names for the Certificate of Recognition and Certificate of Appreciation awards. A few motions were pulled from the consent agenda and moved to the regular agenda for discussion later in the meeting. The Board then approved the consent agenda. The approved November 2010 Board minutes will be posted to the EMC Society website.

Treasurer's Report

In the absence of John LaSalle, Ms. Maradei presented his report on EMC Society finances. Mr. LaSalle attended an IEEE Finance Workshop recently. IEEE Operations are strong and this will impact spending from Society reserves. The year-to-date actual is a net $403,500; this is considerably higher than the planned budget of $18,400. The Society had a large positive variance over the budget; key line items impacting this variance included:

- The 1900 Committee/Other account came in $56,000 below budget
- Periodicals income was ~$50,000 above the budget
- Conference proceedings income ($130,000) was distributed in FM13 to all S/Cs
- Includes EMC-S share of market fluctuation, reserves spending and the pension adjustment (FASB 158) which amounts to ~$135,700

As of the end of January, the EMC Society is operating at a net-positive $102,300 and is currently tracking towards an overall net-positive budget of $23,100.

The Board approved the preliminary Officer, Committee, and Other budgeted expenses not to exceed $257,000 (in accordance with the EMC-27 1900 account line items) and to

PHOTOS BY JANET O'NEIL

Don Heirman of Don HEIRMAN Consultants, Kermit Phipps of EPRI and Ghery Pettit of Intel (from left) visit during a break at the Board meeting in Fort Lauderdale, Florida.

Elya Joffe of KTM Project Engineering presents a report on the EMC Society Constitution and Bylaws during the Board of Directors meeting on March 29.

allow the EMC-S FinCom to make the appropriate adjustments in order to assure a balanced budget.

President's Report

Ms. Maradei presented her report. She asked John Norgard to speak about the passing of Carl Baum, recipient of the 2007 IEEE Electromagnetics Award. She asked for a moment of silence in respect for Dr. Baum's passing and in recognition of the devastation in Japan due to the earthquake and tsunami. Takeo Yoshino then gave a presentation summarizing the devastation in Japan and in particular the problems associated with the damage to the nuclear reactor.

Ms. Maradei reviewed the activity of the Excom meeting held the previous evening. The meeting addressed administrative points including the agenda review, motions to be presented, etc. All items discussed are included on the meeting agenda.

Regarding Global Outreach, Ms. Maradei noted the two upcoming Regional Events - in Buenos Aires (April 1, 2011) and Brasilia (April 4, 2011). She will attend and give a presentation at the Buenos Aires event and she plans to attend the Asia Pacific EMC Week in Jeju Korea, from May 16–19, 2011.

Regarding the November IEEE TAB meetings, she confirmed IEEE has approved the transition of the EMC Newsletter to a Magazine. The launch of the EMC Magazine is January 2012. The 5-year EMC Society review took place last February 17 during the IEEE TAB Meeting Series in Miami, 15–20 February 2011. A report will be coming shortly from the IEEE.

Regarding the status of electronic motions made since the last Board meeting in November, three motions were approved for EMC-S technical co-sponsorship of the following conferences: COMCAS 2011, APL 2011 and SoftCom/EEEMC 2011.

Past President's Report

Elya Joffe presented his report. He addressed all motions, including the four motions that were moved from the Consent Agenda to this part of the agenda. The Board approved the following amendment to Section 11.1 of the IEEE Electromagnetic Compatibility Society (EMC-27) Bylaws as follows, to say: *"11.1 The Excom shall make such rules and regulations as from time to time it may deem proper for its own Governance as documented in the Society's Operations, Policy and Procedure Manual."* The Board approved the following amendment to Section 3.0 of the IEEE Electromagnetic Compatibility Society (EMC-27) Bylaws as follows, to say *"3.0 Board of Directors: The Board of Directors shall consist of Directors-at-Large and Executive Directors with vote plus elected and appointed Ex-officio Directors without vote. A majority of the voting members of the Board of Directors shall constitute a quorum. All voting members shall have an equal vote."* The Board approved incorporation of the EMC-S Financial Policy, now maintained on the EMC-S web site, at URL http://www.emcs.org/financial-policy.html and any amendment thereafter, in the IEEE Electromagnetic Compatibility Society (EMC-27) Handbook Operations, Policy and Procedure Manual as Appendix S. Amendments to the EMC-S Financial Policy shall thereafter automatically amend Appendix S accordingly.

Member Services Report

Bob Davis, Vice-President for Member Services, presented his report. He asked Bruce Archambeault to lead off with the awards committee presentation. Mr. Archambeault presented the list of major awards and candidates for each award. The Board then reviewed and approved several awards which will be presented at EMC 2011 in Long Beach, California. The balance of the awards that will be presented at EMC 2011 will be determined by the various committees, such as the best symposium paper award, etc. New Awards Committee Chair Mike Oliver reported TAB has approved the changes to the Presidents Memorial Award cash amounts as approved at the last Board meeting. The request for the new EMC Society Award for Excellence in Continuing EMC Engineering Education has been submitted to IEEE and will be presented to the TAB ARC at their next meeting.

On membership, Bob Davis advised seven members have been elevated from member to senior member this year since January 2011. Current membership is at 4,007 (with affiliates) a decrease of 34 members or 0.8 % since this time last year. EMC Society Student membership is down 12.9% from this time last year to 61 student members. The new EMC Society marketing brochure is completed. The plan is to initially print 1,000 brochures, upload the brochure to the EMC-S website and upload a special down-loadable PDF version of the brochure for printing. Also, three new, tradeshow type displays

Bruce Archambeault of IBM, Henry Benitez of ElectroMagnetic Investigations, John Norgard of NASA, and Chuck Bunting of Oklahoma State University (from left) enjoy the lunch break.

Mike Oliver (center) of MAJR Products was selected by Visit Pittsburgh as Pittsburgh's Convention & Meetings Partner of the Year. Ghery Pettit (left) and Todd Hubing of Clemson University congratulated Mike on this recognition.

were purchased in December 2010, including two larger pop-up type displays for regional events in the US and Region 10 and one smaller display for regional outreach events, such as the ones coming up in Argentina and Brazil (Region 9) in April. The new EMC-S brochures will be distributed at these Region 9 events as well.

Bruce Archambeault reported on the Distinguished Lecturer (DL) program. The DLs for 2010–2011 include Dr. Giulio Antonini, Mark Steffka, and Dr. Omar Ramahi. The DLs for 2011–2012 include Jerry Ramie, Jerry Meyerhoff, Professor Wen-Yan Yin, and Chuck Bunting. The report includes financial data on the program as well as the number of presentations/trips per DL. A list of the current topics presented as part of the video DL library is included in his report.

Bruce Archambeault noted three Respected Speaker Bureau (RSB) talks have been presented to date in 2011. The current speaker list includes Colin Brench, Alistair Duffy, Jim Drewniak, Tzong-Lin Wu, Cheung-Wei Lam, Eric Bogatin, Werner Schaefer, David Pommerenke, Bruce Archambeault, Elya B. Joffe, Jun Fan and Chris Holloway.

Frank Sabath provided a detailed report for Region 8. Currently there are 1,113 active members, 167 members are in arrears (e.g. a member who has not paid the membership fee) and there are 175 inactive members. A breakdown of the number of members at the various membership levels is included in his report. Mr. Sabath has sent emails to members in arrears to remind them to renew their IEEE membership and provide information on suspension of membership. During this process he learned that some members had problems with payment via credit card, of which he advised Bob Davis.

Takeo Yoshino reported on Region 10 activity. New China and India Membership Coordinators were appointed to allow the EMC Society to provide a focus of membership and chapter growth in these countries. Er Ping Li was appointed in China and Dr. Subbarao was appointed in India.

Bob Scully (left) of NASA and Fred Heather of the Naval Air Station at Patuxent River caught on their respective EMC test challenges during a break in the Board meeting.

Chapter Coordinator Sergio Pignari reports there are now 74 chapters. The top regions for chapters includes Regions 1-6 with 34 Chapters, Region 7 with four Chapters, Region 8 with 20 Chapters, Region 9 with three Chapters and Region 10 with 13 Chapters. He noted the request to form a Joint Society Syracuse Section AP03/EMC27/MTT17 Chapter obtained the final approval from IEEE in early March 2011. His report outlines activity for potential new chapters. For Long Beach at EMC 2011, the training session contents have been re-arranged. Part

Members of the Board pose for a photo following the Board meeting, including (from left) Ryuji Koga of Okayama University, Kermit Phipps, Todd Hubing, Francesca Maradei of the University of Rome "La Sapienza", Don Sweeney of DLS Electronic Systems, Bob Davis of Lockheed Martin, and Chuck Bunting.

of the formal session material will be posted on the EMC Society website. Mr. Pignari has completed a review and update of the Chapter Chair Directory. The Chapter awards will be presented as announced at the March Board meeting.

EMC GOLD representative Caroline Chan notes in her report that she has communicated with Bob Davis, Elya Joffe, William Somerville (GOLD Representative) on when/how to promote GOLD EMC. The target is to bring awareness to the eligible members in the IEEE EMC Society - how GOLD can help them and vice versa. An announcement of IEEE GOLD EMC activities at Long Beach was sent to the GOLD e-Newsletter on March 16, 2011 for publication. A Facebook (IEEE GOLD EMC keyword) and email address GOLDEMC@gmail.com have been created. The report details GOLD activity planned for EMC 2011 in Long Beach.

Henry Benitez reported as the Sections Coordinator. Plans underway include providing Mexico Section liaison support in order to encourage chapter development in Mexico in coordination with efforts provided by Maria Alejandra Mora. He will continue to develop good relations with the Region 9 Director and solicit support for EMC-S Chapter or Joint Chapter formations in that region. Mr. Benitez will participate in the upcoming Sections Congress in San Francisco. He is coordinating with the Santa Clara Valley Chapter regarding a possible EMC Society tabletop display at this year's Congress.

Conference Services

Bruce Archambeault presented his report. For EMC 2010 in Fort Lauderdale, the financial books have not been closed. The audit needs to be scheduled. The approximate surplus is 19.3%.

Regarding EMC 2011 in Long Beach, Mr. Archambeault noted 182 papers were submitted for review. Approximately 85% of the papers were accepted with required and suggested changes. On the Workshop/Tutorials, 19 half day sessions were accepted. Four special sessions were accepted.

The Board approved the EMC 2011 Committee to allow exhibitors to provide alcoholic beverages during the last two hours of exhibit time on Tuesday of the Symposium week. Exhibitors will be responsible for paying the conference center caterer directly (not through EMC 2011 committee) and all alcohol served must be served by conference center caterer personnel.

Regarding EMC 2012 in Pittsburgh, the committee will change the symposium URL to emc2012.ISEMC.org since emc2012.org was not available. Conference Direct was selected for conference management. Mr. Archambeault was pleased to announce Mike Oliver was selected by Visit Pittsburgh as Pittsburgh's Convention & Meetings Partner of the Year.

Mr. Archambeault discussed the cooperation between the EMC Society and the EMC 2015 symposium in Dresden. Details of the cooperation are outlined in the report. The Board approved the cooperation between EMC 2015 and EMC Europe as presented.

Regarding EMC 2015 (USA location), Mr. Archambeault advised Washington DC did not work out and there may be a possible bid by the Santa Clara EMC Chapter to organize this symposium. On EMC 2016 in Ottawa, the committee is negotiating with the convention center.

Regarding Technical Co-Sponsorship requests received since the last Board meeting, the Technical Advisory Committee (TAC) recommended and the Board confirmed approval for SOFTCOM 2011 and APL 2011. TAC also recommends approval for the EMC Society of Australia conference – EMC-SA. The Board approved Technical Co-Sponsorship for EMC-SA 2011.

Edmundo Gatti of the Instituto Nacional de Tecnología Industrial (INTI) received a special book from Perry Wilson of NIST as Pablo Perri of INTI, Hernan Urdiales of ETS-Lindgren and Hector Eduardo Petronacci of INTI (from left) look on. INTI is the metrology lab of Argentina. The book was titled "Plane-Wave Scattering-Matrix Theory of Antennas and Antenna-Antenna Interactions" by David M. Kerns and featured the National Bureau of Standards (NBS) Monograph 162. Mr. Gatti was a "guest worker" at NBS in Boulder, Colorado between October 1980 and January 1981; coincidentally, the book was issued in June 1981. The book provides the foundation of near-field antenna metrology.

The Board approved an EMC-S policy that will require all EMC-S technically co-sponsored conference Memorandums of Understanding to include the requirement that all papers must be presented in order to be submitted to IEEE *Xplore.*

Mr. Archambeault concluded his report by discussing issues with the symposium paper review software. The Society needs to find a new system as support for the current system is not timely. The TAC is looking at commercial systems.

Communication Services

Perry Wilson, Vice-President for Communication Services, presented his report.

Newsletter Editor Janet O'Neil reported on Newsletter finances for the Fall 2010 issue. The 112 page issue cost $19,261 for the printing and mailing of 4,776 copies. There were 14 advertisers in the issue (up from nine in the last issue) that generated $17,850 in billed ad revenue, of which the EMC Society received a net of $9,818. The spreadsheet included in her report shows the revenues and expenses for all four Newsletter issues produced in 2010. The Winter 2010 issue is still in production. There is quite a bit of new material with bylaws changes, call for Board nominations, summary of last Board election process, and the introduction of new Board members. The Associate Editor for History, Dan Hoolihan, is suggesting a reprint of all 18 issues of "Quasies and Peaks" (Q&P, the "original" newsletter of the EMC Society – then called the Institute of Radio Engineers Professional Group on Radio Frequency Interference) over the next 18 issues of the Newsletter. This issue of the EMC Newsletter includes the first, March 1955 issue of Q&P. This is the last issue for Flavio Canavero, as he will retire as the Newsletter's Technical Editor. Professor Kye Yak See of the Nanyang Technical University in Singapore will replace him as the Technical Editor effective with the Spring 2011 issue. Ms. O'Neil recognized Professor Canavero for the tremendous work he has done over the past several years as Technical Editor. He has also worked with Kye Yak See on the last few issues to ensure a successful transition.

The Society's proposal to transition from a Newsletter to a Magazine was formally approved by IEEE TAB at its November 2010 meeting. The new publication will launch with the Winter 2012 issue. Financially, the EMC Society has an initial investment to make in the first year of magazine publication (2012) which at this time is a not to exceed amount of $40K. Over 3–5 years, the magazine will be a break even proposition as there is increased revenue from subscriptions, downloads from Xplore, and revenue from being part of the IEEE all periodicals collection. The expenses include the cost to be on Xplore as well as promotion costs. Ms. O'Neil concluded her report in presenting a summary of the financial impact of the Newsletter to Magazine transition over the next three years.

Mr. Wilson reported for Professor Heyno Garbe, the Editor-in-Chief of the *Transactions on EMC*. He is starting the second year of his three year term. There are currently 20 Associate Editors with a resource of some 200–300 reviewers, of which 100 are active in any given year. The Advisory Committee includes six members. In 2010, all issues were mailed on time. There is a slight backlog at present due to the 2010 special issue. Professor Garbe has requested a 1200 page budget for 2012. On future special issues, in 2011 the topic is "Applications of Nanotechnology in EMC" with guest editors Marcello D'Amore and Sabrina Sarto. In 2012 the topic is "The Impact of High Altitude Electromagnetic Pulse (HEMP) on the Civil Infrastructures" with guest editor Bill Radasky. In 2013 the topic is "Model Validation and EMC" with guest editors Bruce Archambeault, Alistair Duffy and others. A luncheon will be held once again at the symposium in Long Beach to thank the Associate Editors for their service. Professor Garbe's report includes detailed information on current Transactions activity.

Dan Hoolihan, Chair of the EMC Society's History Committee, reports the committee continues publication of "look back" articles in the EMC Newsletter. Bill Duff has donated old EMC test equipment, which is currently stored in Mr. Hoolihan's garage. Digitizing older copies of the EMC Newsletter is still being pursued with the IEEE.

On the EMC Society website, Todd Hubing reported several routine updates have been made to committee, chapter, conference, and awards web pages. Job listings (PDs) have been added to the Board of Directors page. A major revision of the website's appearance is still planned although funding for this activity was cut from $10k to $0.9k for 2011. A link to proposed changes to the constitution and bylaws has been added to the main page.

Standards Services

Don Heirman, Vice-President for Standards, presented his report.

On the Standards Development Committee (SDCom) activity, Mr. Heirman reported for chair Andy Drozd. He reviewed the status of each standard in his report. He advised IEEE accepted SDCom's withdrawal as co-sponsor of Std. 1775. A small group formed to write an article for IEEE Spectrum or the EMC Newsletter and to draft recommended changes in SA Standards Board procedures. Final revisions to the SDCom Policies & Procedures document are underway; this will be sent to AudCom for review. He summarized Long Range Planning strategy and reviewed the link to the EMC-S SC1 committee on SmartGrid. Mr. Heirman reviewed the intent and description

Gustavo Fano (left) of the Universidad Nacional de la Patagonia San Juan Bosco is the chair of the joint IEEE APS/EMC chapter in Buenos Aires, Argentina. He was a big help to Janet O'Neil of ETS-Lindgren in organizing the successful EMC regional event there.

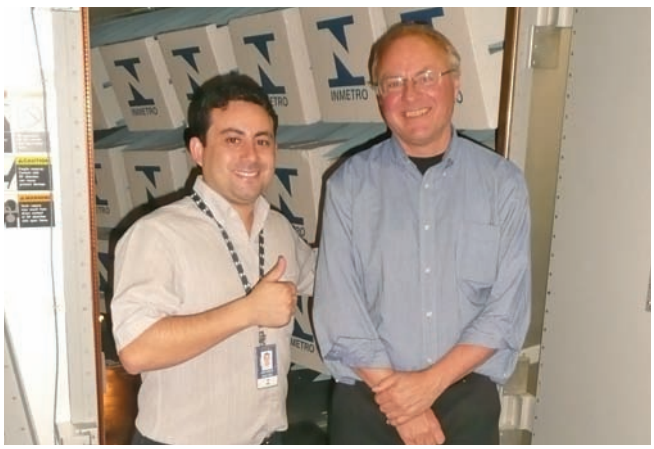
of the new Standards Travel Grant. Information on this will be published in the Spring 2011 EMC Newsletter.

John Norgard has assumed chairmanship of the Standards Advisory and Coordination Committee (SACCom), with Don Heirman remaining as secretary. The committee is reorganizing activity to show EMC standards by non-EMC-S organizations that can be useful to EMC-S standards work. The goal is to explore possible joint work and using material from each other's work (with approval) to leverage each organization's expertise. The report includes a list of the SACCom members and their respective work on EMC related standards with non EMC-S organizations. For the SAE AE4 committee, there are 42 EMC related standards. Examples of SACCom member activity with these non EMC-S standards organizations are included in the report.

Technical Services

Bob Scully, Vice President for Technical Services, presented his report.

Regarding the Education and Student Activities Committee (ESAC), Mr. Scully noted that technical coordination between stakeholders for educational initiatives continues to be a problem with the ESAC. A policy is needed to establish who is responsible for what, and what individual roles are with regard to input and oversight. ESAC perceives its role as primarily being for the development of EMC education in academia, with professional education considered as a legacy role, but not a target area of interest. Mr. Scully recommends a group be formed, comprising membership from ESAC, TAC, and the BoD, to deliberate on this and propose a solution at the next BoD meeting to establish an unambiguous guiding authority for professional technical educational activities within the EMC-S that will enable the ESAC to carry forward its educational initiatives without further inhibition. A new group is being formed to propose a solution to the ambiguity of its relationship with the EMC Global University, the leadership track, PACE, etc. Chuck Bunting, Kimball Williams, Bruce Archambeault and Elya Joffe volunteered to be part of the new group studying this. The group will be chaired by Bob Scully.



Perry Wilson of NIST (right) visited with Juan Carlos Mateus Sánchez of the National Institute of Metrology, Normalization and Industrial Quality (INMETRO), the metrology lab of Brazil. Dr. Wilson was in Brazil to present at the EMC regional event and stopped by INMETRO to learn more about their capabilities.

Technical Advisory Committee (TAC) Chair Bruce Archambeault noted the committee held a telecom on March 7. Future meetings in 2011 include May 14 at the Missouri University of Science and Technology, in August during the EMC symposium and a telecom will be held on October 11. The report outlines the activity for the EMC 2011 paper, workshops/tutorials and special session reviews. Issues with the paper review software used are outlined in the report.

Bob Scully reiterated that TAC has used the same paper review system as last year, and is experiencing the same frustrations this year with lack of attention to needed actions, changes, and so forth. While TAC has been using this system for free for some years now, it's time to look for alternative systems. The EMC-S requires, at present, a review system that accommodates a second round of reviews, and an off-the-shelf solution does not exist. Mr. Scully advised he will chair a task force committee to make a proposal to the Board on purchasing new software for the paper review process. Bruce Archambeault, Francesca Maradei, Don Heirman, Perry Wilson, Todd Hubing, Fred Heather, and Alistair Duffy volunteered to be members of this task force.

Mr. Archambeault noted that Kermit Phipps has resigned as TAC secretary and a replacement is being sought.

Suspension of Meeting

Ms. Maradei suspended the meeting at 5:45 pm. The meeting will continue on Wednesday morning, March 30 at 9:00 am.

Continuation of meeting on Wednesday, March 30, 2011

Call To Order

President Maradei called the meeting to order at 9:00 am.

Strategic Planning Update

Ghery Pettit talked about strategic planning. He summarized the five strategic goals of the EMC Society, including A. Provide products of value to EMC researchers and practitioners managed by Perry Wilson, VP Communications; B. Global technology presence, visibility and excellence managed by Bruce Archambeault, VP Conferences; C. Engage young professionals in the EMC Society managed by Bob Scully, VP Technical Services; D. Improve EMC-S membership development and retention managed by Bob Davis, VP Member Services; and E. Enhance community collaboration managed by Don Heirman, VP Standards. The next strategic planning meeting will be held at the November Board meeting.

New Initiatives

New Membership - Bob Davis presented a motion related to new memberships in the EMC Society. The Board approved the use of EMC Society reserves, in the amount of $20,000 per year, for up to 3 years renewable annually, to use for offering a limited number of free IEEE and EMC memberships at IEEE EMC symposia, free IEEE EMC memberships at domestic and international EMC regional symposia, free IEEE EMC membership at technically co-sponsored symposia and free e-memberships at international EMC regional symposia.

Symposium Finance Tool – The Board approved Bruce Archambeault's suggestion to investigate the feasibility of creating a standard accounting tool (such as Quick Books) for use by all EMC-S symposia using funds from the EMC-S surplus. A maximum of $4,000 may be used to purchase software licenses and contract help to set up an initial system.

Paper Review Software – Bob Scully revisited the issues with the paper review software noted earlier in his VP Technical Services Report as well as in Bruce Archambeault's TAC Report. The Board approved $10,000 of funding sourced from the new initiative pool to support the acquisition process of suitably designed and tailored software for EMC-S Symposium paper review activities.

Angel Training

Bob Davis reported for Chapter Coordinator Sergio Pignari on the Angel Program. He conducted a "refresher course" on the program and the Board member responsibilities as Angels. The Chapter Angels serve as liaisons between the Board of Directors and the Chapters on all matters relating to Chapter Activities. They should employ a proactive approach in their Chapter support activities. Angels can determine Chapters under their responsibility by looking at the list of Chapters and Chapter Chairs, posted on the EMC-S website: http://www.ewh.ieee.org/soc/emcs/chapters/chapter1.html. The goal is for Chapter Angels to act as "coaches" or "mentors" to the Chapters to better improve their activities. The report includes a list of the Chapters worldwide and their assigned Angel. The website link also includes the Angel Manual for more information.

Board of Directors Forum and Document Archive

Bruce Archambeault led a discussion on the new Board Forum available on line. The Forum has three main purposes: 1. Allows discussion threads, 2. Facilitates email to Board members and 3. Serves as a document repository of important documents for all to access. Mr. Archambeault acknowledged the efforts of Jun Fan in setting up this Forum for the Board.

Old Business

The following items were reviewed under Old Business:

Boston Globe Article – Francesca Maradei thanked Dick Ford for his work on the letter refuting the claims in the Boston Globe article on the use of cell phones on planes. She commented that she never received a response from the Boston Globe in reply to the EMC Society letter. Dick advised he has finished with his scope of work and has disbanded the committee formed to support this work.

Newsletter to Magazine Transition – Perry Wilson reviewed the three year financial forecast for the transition from an IEEE Newsletter to Magazine presented earlier in his report. Following discussion, the Board approved the transition of the EMC Newsletter to a Magazine in 2012.

New Business/Additional Items

The following items were reviewed under New Business:

Board A/V Equipment – The Board approved the purchase of a new notebook computer (with MS Office 2010, and Anti Virus program) and shipping container in an amount not to exceed $2,100 for use at the August 2011 Board meeting and beyond.

IEEE Sections (and Societies) Congress – Elya Joffe discussed the upcoming Sections Congress to be held over August 19–22, 2011 in San Francisco, California. This year's tri-annual event is the 10th IEEE Sections Congress. It provides an opportunity for IEEE representatives from all over the world to participate in an event which provides them with the tools and training to assist their unit in focusing their activities solely on the member and increase members' participation in IEEE activities. The Sections Congress is the one major meeting which brings together the IEEE's grassroots leadership so that they can share ideas, concerns and solutions. The report outlines the schedule for the congress this year and details activities that will take place, including a new poster paper session.

iNARTE and RABQSA – Kimball Williams discussed the new partnership between these two organizations. iNARTE had been exploring an offer from RABQSA in the form of a strategic alliance to enhance the capabilities of both organizations. RABQSA is an international certification agency based in Sydney, Australia that offers professional certifications in many technical disciplines that complement the iNARTE portfolio. This alignment is expected to give iNARTE the capacity to expand in several areas where its Board has long hoped to grow, but was limited by manpower and funding from stepping in that direction.

Board Meeting Dates for 2012–2013 – Ghery Pettit discussed future Board meeting dates and locations. The dates are tentative at this time. When confirmed, these will be announced in the EMC Newsletter.

Summary of Financial Impact of Approved Motions

Elya Joffe provided a financial summary of the motions approved at the meeting.

Action Item Review

Secretary O'Neil reviewed the action items discussed during the meeting. An updated, consolidated list of action items will be sent to the Board following the meeting.

Closing Remarks

Francesca Maradei thanked everyone for attending and contributing to the Board meeting.

The meeting adjourned at 12:15 pm.

Submitted by:

Janet O'Neil
Secretary, EMC Society Board of Directors
EMC

2012 Asia-Pacific EMC Week

May 21 - 24, 2012, Singapore

www.apemc2012.org

APEMC Singapore 2012

EMC SOCIETY

IEEE

Call for Papers

2012 Asia-Pacific International Symposium on Electromagnetic Compatibility in Singapore

After the resounding success of 2006 EMC-Zurich in Singapore, 2008 APEMC Singapore, 2010 APEMC Beijing and 2011 APEMC Korea, it was decided to hold the **2012 Asia-Pacific EMC Symposium in Singapore** from May 21 to 24, 2012. The event will continue in the spirit of APEMC and at the same time address the EMC community of the Asia-Pacific region and its link to the world.

So come and join the 2012 Asia Pacific Week in Singapore! We will offer a rich scientific program of highest quality with invited speakers from all over the world and provide a broad forum of exchange both for academia and industry alike.

The Symposium will cover the entire scope of electromagnetic compatibility. Prospective authors are invited to submit original papers on their latest research results.

Symposium Topics

- EMC Management
- EMC Measurement Techniques
- Lightning
- Electromagnetic Environment
- High Power EMC
- Power System EMC
- System-Level EMC and PCB EMC
- 3D integration EMC
- Electronic Packaging and Integration EMC
- IC EMC
- Communication EMC
- Computational Electromagnetics
- Nanotechnology in EMC
- Microwave Electronics and Components
- Semiconductor EMC
- Bio-Medical Electromagnetics
- EMC Material

Important Dates

Proposals for special /focused sessions & Proposals for workshops and tutorials	**Oct. 25, 2011**
Preliminary paper submissions (4 pages)	**Dec. 15, 2011**
Notification of acceptance	**Feb. 05, 2012**
Final paper submission	**Mar. 15, 2012**

Symposium website:

www.apemc2012.org

IEEE EMC SOCIETY NUS National University of Singapore NANYANG TECHNOLOGICAL UNIVERSITY

The IEEE Society on Social Implications of Technology (SSIT)

By Kimball Williams, Past President of the IEEE EMC Society

The Society for the Social Implications of Technology (SSIT) has been a part of my IEEE life since I first met Bob Brook, a past director of the EMC Society as well as a past officer of the SSIT, and one of my first mentors in both EMC technology and in the EMC Society. Bob encouraged me to look beyond the technical aspects of our technology and see the human and social interactions that resulted from our "purely" technical decisions. When I joined the IEEE and EMC Society 27 years ago, Bob was the 'liaison' between the SSIT and the EMC Society. With his passing a few years ago, the torch was passed to me. The alignment between SSIT and the EMC Society is a natural one in that the fundamental aspects of EMC have always had a 'human' aspect. This is obvious in our Standards that are often written to "protect" some other human activity from inadvertent disruption due to interactions with electromagnetic fields. The EMC Society maintains a close liaison between its Board of Directors and the SSIT to this day, and we follow and encourage its activities whenever and wherever we can. The following article is an introduction to the SSIT and provides an example of EMC Society support and encouragement. It is summarized from the IEEE SSIT website and extracted from "Notes for a History of the IEEE Society on Social Implications of Technology" by Karl D. Stephan, SSIT/T&S 25th Anniversary Issue.

Overview

The Society on Social Implications of Technology (SSIT) of the Institute of Electrical and Electronics Engineers (IEEE) currently has about 2,000 members worldwide. The scope of the Society includes such issues as environmental, health and safety implications of technology; engineering ethics and professional responsibility; history of electrotechnology; technical expertise and public policy; peace technology; and social issues related to energy, information technology and telecommunications.

This Society focuses on the impact of technology on society, including both positive and negative effects, the impact of society on the engineering profession, the history of the societal aspects of electrotechnology, and professional, social and economic responsibility in the practice of engineering and its related technology.

SSIT publishes a quarterly journal, IEEE Technology and Society Magazine, and sponsors periodic conferences entitled "The International Symposium on Technology and Society (ISTAS)." Membership in SSIT is open to all IEEE members and student members. Affiliate membership in SSIT is available to persons who are not members of the IEEE.

Extracts from "Notes for a History of the IEEE Society on Social Implications of Technology" by Karl D. Stephan

On a warm April day in 1955, three men walked up to the porch of 112 Mercer Street in Princeton, New Jersey. One of them was Victor Paschkis, a Vienna-born professor of mechanical engineering at Columbia University. Seven years earlier, Paschkis, a Quaker, had talked with the Quaker chaplain at Columbia about the incredible dangers of wars fought with advanced technologies such as nuclear and biological weapons. That talk had moved Paschkis to found the Society for Social Responsibility in Science in 1948. Now, he and two other officers of his organization were about to meet with their most famous member, Albert Einstein, to work on an open letter calling for scientists around the world to refrain from using their knowledge for war. Bertrand Russell and Dr. Einstein were already in the process of issuing a similar declaration and in the last month of his life, he and Russell issued the Russell-Einstein Declaration calling for the governments of the world to find peaceful means to settle their disputes.

Committee on Social Responsibility in Engineering

In the 1960s, Paschkis's anti-war stance became less unusual as the highly divisive Vietnam War dragged on. A small but growing minority, including a few engineers, vocally opposed the war for a variety of reasons. In 1969, electrical engineers Mal Benjamin and Stephen Unger impressed by Paschkis's example, decided to do something similar within the Institute of Electrical and Electronics Engineers (IEEE).

Around 1971, the plan was to become a "technical group" (the equivalent of today's Society) within IEEE. Unger recalls that the requirement for starting such a group was to gather signatures of at least one hundred IEEE members. The drive that Unger and his colleagues mounted produced over eight hundred names. Discussions with the IEEE President and other officials led to the decision to form a TAB Committee on Social Implications of Technology (CSIT), rather than a technical group. By 1972, CSIT was up and running, although its administrative structure was somewhat unusual. By the rules of its founding, the vice-chairman of TAB also chaired CSIT, and only the vice-chairman of CSIT could be elected by its members. This gave the TAB officer some control over CSIT's activities, which allayed concerns about CSIT's possible behavior.

CSIT's Stormy Decade

In late 1972, the Vietnam War continued to provoke protests and controversy. In connection with a large IEEE meeting called INTERCON '73 to be held the following March, members of CSIT wanted to sponsor "a session 'Conversion to a Peacetime Economy,' a workshop on 'The Engineer and Military Technology,' and an 'Open Forum'." The IEEE convention manager turned them down. Frank Stoller, who was listed in the minutes as the "Chairman, Working Group on IEEE Activists," protested that "his attempts to work within 'the IEEE system' had produced only frustration and that by design, not by accident." Eventually, IEEE Executive Director Donald Fink did allocate some space in the meeting's hotel for CSIT activities, but in an out-of-the-way location.

One of the landmark achievements of CSIT in its early years was its involvement in the BART case. This case involved three engineers working on the design of San Francisco's Bay Area Rapid Transit system. Believing (with justification) that the electronic design of certain safety-critical components was inadequate, they approached a member of BART's board of directors after their own managers refused to pursue the matter, and the board member made their concerns public. Then the engineers were fired. Later investigation fully validated the engineers' concerns after the automatic train control system failed on October 2, 1972 and a BART train overshot its station and plowed into the barricade beyond it. In 1974, CSIT was instrumental in persuading the IEEE to file amicus curiae brief in the engineers' civil suit against BART. This was one of the first times that a professional engineering organization of IEEE's stature had intervened on the side of engineers in such a public manner.

CSIT's efforts to free Enrique Kirberg, a Chilean university rector imprisoned by the Pinochet regime in 1975, eventually led to the IEEE Member Conduct Committee, which eventually took over the task of dealing with ethics cases that CSIT had handled previously.

In 1978, the Committee decided to establish a monetary award for outstanding service in the public interest. The first recipients of this award were Max Blankenzee, Robert Bruder, and Holger Hjortzvang, the three engineers who went public in the BART case. A year later, a computer engineer named Virginia Edgerton received the award for her efforts to bring attention to a potentially hazardous defect in the New York City police emergency dispatch software system. In 1985, the award was renamed the Carl Barus Award for Outstanding Service in the Public Interest in his honor.

From the start, most CSIT members wanted their organization to be a Society within IEEE, and accepted committee status only as a compromise. Eventually, the limitations of CSIT's committee structure became a serious hindrance to the organization. Although CSIT published a newsletter which was sent to a mailing list numbering around 2,000, it collected no dues. For this and other reasons, in 1980 CSIT members mounted another petition drive, collected over 600 signatures, and requested that the IEEE grant them Society status.

SSIT's Early Years

One of the most important changes that took place when CSIT became SSIT was the transformation of the CSIT Newsletter into the IEEE Technology and Society (T&S) Magazine. In the early 1980s, the new Society continued to take part in engineering ethics controversies to the extent possible. However, the IEEE as a whole became more reluctant to engage in actions in support of individual engineers who were trying to uphold the principles of the IEEE ethics code, even to the extent of giving them informal advice.

While SSIT did not sponsor a stand-alone conference on its own until 1991, in 1984 President Jeff Bogumil worked with the Society of Photo-optical Instrumentation Engineers (SPIE) to sponsor a conference called "Electro-culture '84." Held on May 1 and 2, 1984, it featured a well-attended session on "Weapons in Space" concerned with the controversial Strategic Defense Initiative ("Star Wars") proposals that were then in the news.

Another controversy that took many of those involved by surprise began with the publication of the June 1989 issue of T&S. The magazine's editor, Robert J. Whelchel, had received for review an article by an independent scholar named Rachel Maines on an aspect of the history of technology that pertained to women. T&S editors had published historical articles in the past, and this particular subject unquestionably had social implications. Whelchel sent it out for review, the reviews were positive, and when subscribers opened their issues of T&S in the summer of 1989, they found Maines' article on page 3, entitled "Socially Camouflaged Technologies: The Case of the Electromechanical Vibrator."

Maines' research in the Bakken Library of Electricity in Life had uncovered the surprisingly long and complex history of a device the appearance of which causes movies to receive at least a PG rating even today. While T&S carried many other articles of more lasting importance in that period, it is safe to say that what came to be called "the vibrator article" attracted the most attention, much of it unfavorable. Joe Herkert, the present editor of T&S, recalls that five years after the article appeared, during a job interview he met a prominent IEEE volunteer whose first words to him were, "I want you to know, I think that vibrator article was a disgrace!" Herkert got the job anyway. Terri Bookman, who was then a staff editor for IEEE Transactions, recalls that the article made something of a stir even within her office.

Norm Balabanian, SSIT President, attended a TAB meeting in the Fall of 1989. When someone brought up the fact of the vibrator article's appearance in an IEEE publication, Balabanian recalls that many of the Society presidents "went ballistic." The minutes of the SSIT Adcom meeting of March 17, 1990 record that "at the previous TAB Meeting their upset at the 'Vibrator' article' in T& S resulted in the decision to review all Societies every 5 years". These reviews got under way the following year, and, not surprisingly, SSIT was one of the first Societies selected for review. Ron Kline, a historian of science and technology at Cornell and SSIT President in 1991–1992, recalls that the review, which he conducted with Vice-President Christine Nielsen, managed to satisfy IEEE that SSIT was in fact doing a creditable job of scholarly and professional service to the technical community. TAB has continued this practice of five-year reviews with every Society and has found it to be a valuable exercise in promoting best practices within the IEEE.

1990s: SSIT and ISTAS

The first conference to be called the International Symposium on Technology and Society (ISTAS) was held at the Ryerson

Polytechnic Institute in Toronto, Canada, on June 21–22, 1991. Subtitled "Preparing for a Sustainable Society," it was chaired by SSIT member Walter Zessner. ISTAS has since become one of SSIT's most important ongoing activities. Typical attendance figures range from 40 to over 100, and the conference has been held at a wide variety of venues both in the U. S. and abroad.

In addition to providing a forum where people from many disciplines can come together to discuss wide-ranging topics about technology and society, ISTAS conferences have helped to recruit many SSIT leaders. Unlike most technically-focused IEEE Societies, whose scopes match the primary professional expertise of their members, SSIT draws its members from an eclectic variety of specializations, as well as from professions outside engineering such as political science, science and technology studies, law, medicine, public policy, and history. In the course of interviews for this article, I asked several present and former officers of the organization how each became involved in SSIT. In nearly every case, there was a personal connection, often forged at an Adcom meeting or ISTAS conference, between those who were already active in the organization and the newcomer.

SSIT Since 2000

Around 2001, IEEE as a whole found itself in fiscal difficulties, which impacted SSIT's financial situation as well. SSIT has never had more than about 2,500 members, which makes it one of the smallest IEEE Societies. IEEE is structured financially so that there is only an indirect relationship between membership figures, dues, and the amount of revenue under a given Society's control. In addition to rather modest income from dues, SSIT receives an increasing proportion of its revenues from its share of charges that libraries and other institutional users pay for receiving print and electronic publications from IEEE. Changes recently made in the way this income is allocated within IEEE threaten to reduce SSIT's revenues to the point that its fiscal stability may again be in doubt in the future.

In 2005, for the first time, three members of SSIT were named IEEE Fellows for their professional activities in the area of technology and society. (For many years, SSIT has counted several new Fellows annually in its membership, but their Fellow status had been conferred through other Societies.) In 2005, this prestigious honor was awarded to Luis Kun, Michael Loui, and Swamy Laxminarayan. Kun, a professor at the U.S. National Defense University, was honored for his contributions to health care infrastructure. Loui, a professor at the University of Illinois Urbana-Champaign and current chair of the SSIT Publications Committee, was cited for his leadership in the teaching of engineering ethics. Swamy Laxminarayan's award was for his work in the social and ethical implications of biomedical engineering. Sadly, Swamy passed away shortly after receiving his award. SSIT's increasing participation in the Fellows nomination process may contribute to greater awareness and recognition of the organization within IEEE in years to come.

Especially in recent years, SSIT has reached out to other Societies and entities within IEEE to co-sponsor conferences and other activities of mutual interest. Past SSIT President Brian O'Connell points out that SSIT co-sponsored the April 2–4, 2004, conference "The Hydrogen Economy: Its Impact on the Future of Electricity" with three other IEEE Societies: Power Electronics, Industry Applications, and Power Engineering. Other cooperative work has been undertaken with the Oceanic Engineering Society, the Product Safety Engineering Society, and the Computer Society. On the regional level, there are numerous active SSIT Chapters both in the U. S. and abroad, and through connections with IEEE's Regional Activities Board (RAB), SSIT officers have benefited SSIT Chapter members through visits and other support. As awareness of ethical and social implications of new technologies rises, it will make sense for more technically focused Societies to participate in further collaborative ventures with SSIT.

Future Directions

In principle, every member of IEEE should find something of interest in the activities of SSIT, since it is hard to think of a technology without social implications. But the same factor that makes SSIT such an interesting mix of people with various technical and professional backgrounds also means that SSIT membership is usually not the primary reason that professionals join IEEE. Besides this difference between SSIT and most other IEEE Societies, there is a basic philosophical difference as well, at least according to some.

SSIT has made more contributions to the critical-science camp than to the technological-optimism camp. SSIT's traditional role is as the "loyal opposition" to the technical-progress mentality, which is often the underlying philosophical foundation for nearly everything the rest of the IEEE does. There is tremendous interest in the IEEE at large in the social implications and context of technology, and SSIT could play a much larger role if the Society can figure out a way to reach this larger audience. As awareness of ethical and social implications of new technologies rises, it will make sense for more technically focused Societies to participate in further collaborative ventures with SSIT.

The most impressive aspect of the SSIT is the passion that its founders, officers, and members bring to the matters they study, write about, and act on. "Engineering" and "passion" are words not often found in the same sentence, but found in a high percentage of SSIT members. IEEE functions mostly through the efforts of volunteers, most volunteers see their IEEE activities as at least indirectly connected with their own professional advancement. But, involvement in SSIT is not a guaranteed way to advance your career! I hope SSIT members will make the best of what the organization has done in the past an inspiration to do even better in the future. **EMC**

8th International Workshop on Electromagnetic Compatibility of Integrated Circuits

EMC Compo 2011

November 6 - 9, 2011, Dubrovnik, *Croatia*
www.emccompo2011.org

CALL FOR PAPERS

"EMC-Aware Design from IC to System Level"

The achievements in terms of operating frequency and integration of semiconductor technology are constantly creating new challenges in EMC, power and signal integrity, which must necessarily be addressed at both the integrated circuit and system level. Keeping up-to-date is of paramount importance to be successful in this field. Following earlier EMC Compo events, the International Workshop **EMC Compo 2011** is a place to be for exchange of the latest research achievements and experience in IC-level EMC up to application on a PCB. This workshop is addressed to researchers from industry and academia as for tool providers and equipment suppliers in these fields.

The workshop event is focused on emission and susceptibility as well as power and signal integrity issues of digital, analogue and mixed-signal integrated circuits. The most recent advances in simulation and measurement techniques, modelling, standards, tools, design, design flows and verification methodologies will be discussed. A Technical Exhibition will provide tool providers, equipment manufacturers and suppliers an opportunity to display their products, services and to discuss them with potential clients.

Highlights

- **Tutorials** by **distinguished experts** in the field of EMC of ICs is organized on: Wednesday, November 9th
- A **panel discussion** on Tuesday, November 8th followed by a social event/dinner in the evening
- **Key-note presentations** in opening sessions on Monday, November 7th, and Tuesday, November 8th
- A **PhD seminar** will be organized on Sunday afternoon, November 6th.
  PhD students conducting research in EMC of ICs are invited to present their work at this event.
- **Best paper** and **best student paper** awards

Main Topics

- Measurement and modelling of IC susceptibility
- Measurement and modelling of IC emission
- EMC issues in System-on-Chip
- EMC issues in System-in-Package (SiP)
- EMC issues in smart power ICs
- EMC of ICs in wireless communications
- EMC of ICs for biomedical applications
- Materials for improved EMC of ICs
- Signal Integrity and Power Integrity on PCB-level
- EMC-aware IC design and guidelines
- EMC-driven IC/PCB co-design
- Tools to handle EMC at IC-level
- Computational Electromagnetics for IC-level EMC
- Harsh environment effects on IC-level EMC
- Long-term electromagnetic robustness of ICs
- Extending EMC standards and regulations up to 6 GHz
- Modern EMC education on IC-level EMC

Paper Submission

Complete papers should be written in English and submitted in PDF format (max. 6 pages including title, 100-word abstract, illustrations and references). The contributions should be submitted electronically through the website: ***www.emccompo2011.org***, where further information on paper preparation is available.

Deadline for paper submission: May 16th, 2011
Notification of acceptance: July 10th, 2011
Final Paper due date: September 19th, 2011

Workshop Venue

Dubrovnik, a city renowned for its beauty, is situated in the southern part of Croatia. The Old City of Dubrovnik, founded in the 7th century, with its rich cultural and historical monuments is included in the UNESCO World Heritage List. One of the lovely features of Dubrovnik is that one can make a tour of its churches, monasteries, museums, palaces and city walls on foot. EMC Compo 2011 is hosted by the Centre for Advanced Academic Studies, which is very close to the Old City and guarantees warm atmosphere for participants.

Contacts and Information

More location and organization details can be found on the workshop website: **www.emcompo2011.org**
For further information do not hesitate to contact the organizing committee at **info@emccompo2011.org**

Calendar

EMC Related Conferences & Symposia

2011

August 11–13
ANSI C63® Workshops
Held in conjunction with the 2011 IEEE International Symposium on EMC
Hilton Costa Mesa Hotel (August 11–12)
Northwest EMC (August 13)
Irvine, California
Janet O'Neil
425.868.2558
www.c63.org
(See ad page 78)

September 15–17
SoftCOM 2011
The 19th International Conference on Software, Telecommunications and Computer Networks
Split, Croatia
www.fesb.hr/SOFTCOM
(See ad page 79)

September 26–30
EMC Europe 2011
University of York
York, United Kingdom
www.emceurope.org/2011
(See ad page 73)

October 16–21
AMTA 2011
The 33rd Annual Meeting of the Antenna Measurement Techniques Association (AMTA)
The Inverness Hotel and Conference Center
Englewood, Colorado
www.amta2011.org

November 1–4
APL 2011
7th Asia-Pacific International Conference on Lightning
Chengdu, China
www.apl2011.org
(See ad page 71)

November 6–9
EMC Compo 2011
8th International Workshop on Electro-Magnetic Compatibility of Integrated Circuits: "EMC-Aware Design from IC to System Level"
Center for Advanced Academic Studies
Dubrovnik, Croatia
www.emccompo2011.org
(See ad page 96)

November 7–9
COMCAS 2011—The International IEEE Conference on Microwaves, Communications, Antennas and Electronic Systems
Hilton Hotel
Tel Aviv, Israel
www.comcas.org
(See ad page 75)

November 9–11
The 10th EMC Society of Australia Symposium
Bentley Technology Park Function Centre
Perth, Australia
Franz Schlagenhaufer
Phone +61 8 9266 9473
Email: franz.schlagenhaufer@ieee.org
www.emcsa2011perth.org
(See ad page 16)

2012

May 21–24
Asia Pacific EMC Symposium
Singapore
www.apemc2012.org
(See ad page 92)

EMCS Annual Symposia Schedule

2011 **August 14–19 Long Beach, California**
Ray Adams, 310.303.3300
(See ad pages 50–51)

2012 **August 6–10 Pittsburgh, Pennsylvania**
Mike Oliver, 814.763.3211

2013 **August 5–9 Denver, Colorado**
Danny Odum, 303.693.1778

2014 **August 3–7 Raleigh, North Carolina**
Bruce Archambeault,
919.486.0120

2015 **August 17–21 Dresden, Germany**
Hans Georg Krauthäuser,
+49 (0)351.463.33357
hans_georg.krauthaeuser@tu-dresden.de

2016 **July 25–29 Ottawa, Canada**
Qiubo Ye, 613.998.2769

IEEE EMC Board of Directors and Standards Committee Meetings

Please note the Standards committee meetings of the IEEE EMC Society are held the day prior to the EMC Board meetings listed below. All Standards committee meetings are open to anyone with an interest in EMC standards. To attend a Standards committee meeting at one of the locations below, contact Don Heirman at d.heirman@ieee.org. Board meetings are also open to those interested in the administration of the EMC Society. For information on the Board meetings, contact Janet O'Neil, 425.868.2558, j.n.oneil@ieee.org. Your involvement is welcome!

August 14 and 18, 2011
Long Beach, California

November 15–17, 2011
IEEE Headquarters
Piscataway, New Jersey

EMC Chapter Colloquium and Exhibition "Table-Top Shows"

2011

There are no table-top shows scheduled to date for the balance of 2011. Check the EMC Society website "Calendar of Events" at the bottom of the home page monthly to see if any new table-top shows have been scheduled.

If you would like to add your name to the list of exhibitors to receive direct announcements in advance of these upcoming tabletop shows, please send an e-mail to j.n.oneil@ieee.org

Please Note: For more information, IEEE-sponsored and co-sponsored symposia can be found at the following page: http://www.ieee.org/conferencesearch/. Enter the symposium name, time frame, and/or other pertinent information (partial information is also acceptable) to search for a particular symposium.

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TWTAs for EMC applications

1.0 -18.0 GHz up to 1000 W CW (10 kW available over select bands)

18.0-40.0 GHz up to 150 W (2.0 kW over select bands)

40.0 – 50.0 GHz up to 80 W

Full Pulsed Amplifier Suites to 8 kW (megawatts pulsed power capability)

Meet the new automotive and military EMC standards with CPI high-powered TWT amplifiers.

EMC facilities worldwide depend on CPI amplifiers for superior performance, reliability, and quality. CPI has a proven track record of consistent performance, service, and support. For EMC testing, CPI is the only manufacturer of both the TWT and the amplifier, ensuring quality designs and smooth operation. CW and pulsed amplifiers are available from 1 to 95 GHz, with power levels exceeding 2 kW over selected frequencies.

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