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ELECTROMAGNETIC COMPATIBILITY

2014

EMC SYMPOSIUM GUIDE

AUGUST 3-8 RALEIGH, NC

YOUR COMPREHENSIVE GUIDE TO THE IEEE
INTERNATIONAL SYMPOSIUM ON EMC

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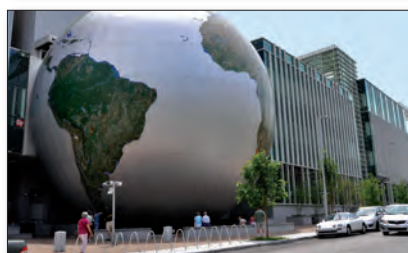
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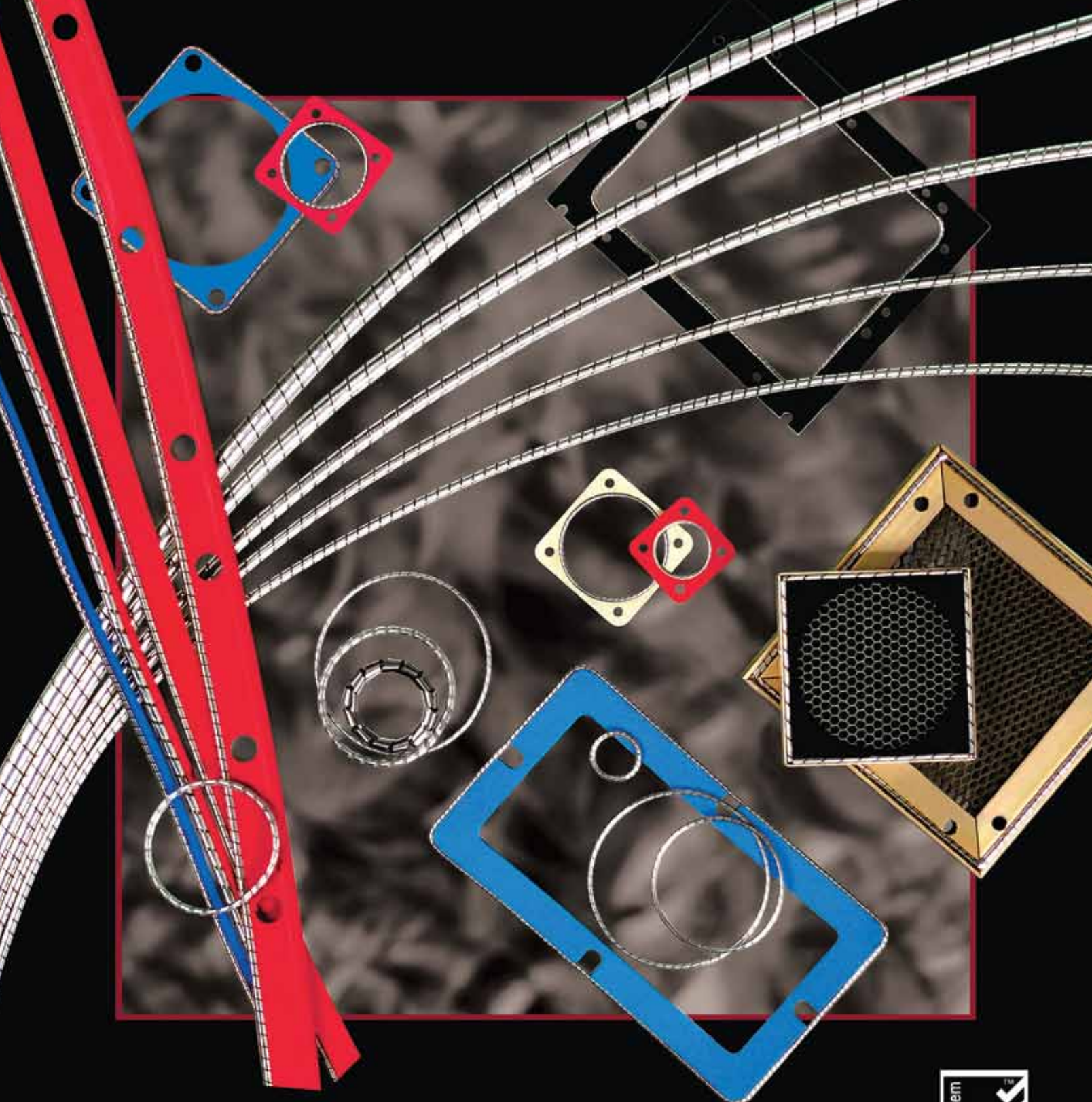
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ARE Y'ALL READY FOR SOMETHING A LITTLE DIFFERENT? This year we have a number of exciting new events planned! The embedded Signal and Power Integrity Conference has brought in a record number of technical papers in

this very timely subject area. The renowned, Henry Ott will be presenting the Keynote Speech to discuss the evolution of EMC Engineering. We'll have a Special Event to honor those famous (infamous?) Maxwell's Equations. And of course, we'll have

the high quality technical papers, workshops/tutorials and special sessions that you have come to expect over the years!

I would like to welcome you to the 2014 IEEE International Symposium on Electromagnetic Compatibility in Raleigh, North Carolina. I would also like to extend a welcome to the Eastern NC Section of the IEEE and to our local Electromagnetic Compatibility Society Chapter.

The Symposium Organizing Committee has planned and designed the 2014 EMC Symposium with the goal of ensuring the most enriching technical and professional networking opportunities possible through multiple exhibits, technical programs, companion programs, and social events. We have prepared three days of top-rated, peer-reviewed technical papers presented by experts in multi-track sessions and two days of practical workshops and tutorials, experiments and demonstrations presented by industry professionals. In addition to the number of regular sessions, special sessions and workshop/tutorial sessions on 'standard EMC' and Signal/Power Integrity, there will be papers on emerging wireless technology, nanotechnology, information security and many more topics! Also included are collateral industry meetings and a full exhibit hall to learn about the latest offerings in EMC products and services. Make sure to visit the booths of our new exhibitors.

You will have the opportunity to experience the cultural element of North Carolina at our Welcome Reception at the Duke Energy Center for the Performing Arts. This stunning venue is a short walk from the host hotels and convention center. Our evening will feature live entertainment, and a distinct 'taste' of the South while you mingle and chat with friends and colleagues. If you are musically inclined, you might want to show off your talent in the Engineer Talent Showcase. Or, if you enjoy biking, don't miss the second annual Team EMC Bike ride. In addition, in the evening of August 7th, we have organized a tour of IBM's largest 10 meter EMC Test chamber with unique power, cooling and weight requirements for large main frame servers. There is certainly something new for everyone, regardless of your interests within the broad EMC world.

We are very pleased you decided to join us for EMC 2014 in Raleigh to enjoy the networking, education, special events, and hospitality of North Carolina at its finest!

Welcome!

Bruce Archambeault

Bruce Archambeault

General Chairman
2014 IEEE International EMC Symposium

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RALEIGH, NC
AUGUST 3-8, 2014

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WELCOME TO RALEIGH AND THE 2014 IEEE SYMPOSIUM on Electromagnetic Compatibility. This Symposium Overview is designed to give you a day-by-day summary of the technical, social, and educational programs available to attendees of the IEEE EMC Symposium and their families. Use it to plan your days and nights and get the maximum benefit of five days plus of non-stop immersion in everything EMC.*

SUNDAY, AUG.3

- 8:00 am – 6:00 pm
- Exhibitor Move-In

MONDAY, AUG.4

- 8:00 am – 6:00 pm
- Exhibitor Move-In

MORNING WORKSHOP & TUTORIALS PROGRAM

- 8:30 a.m. – 12:00 p.m.
- **MO-AM-1** Fundamentals of EMC
- **MO-AM-2** Understanding the Importance of Bore Sight Antenna Measurements

- **MO-AM-3** Smart Grid EMC Update
- **MO-AM-4** EMC Issues for Unmanned Aircraft Systems
- **MO-AM-5** Nanotechnology Applied to EMC

AFTERNOON WORKSHOP & TUTORIALS PROGRAM

- 1:30-5:30pm
- **MO-PM-1** Fundamentals of EMC
- **MO-PM-2** Application of Reverberation Chambers
- **MO-PM-3** Introduction to Medical EMC
- **MO-PM-4** Recent Developments in EMC for Emerging Wireless Technologies
- **MO-PM-5** Using CEM Modeling to Understand the Underlying Physics in EMC Problems

TUESDAY, AUG.5

- 9:00 am – 5:00 pm
- Exhibit Hall Open

MORNING WORKSHOP & TUTORIALS PROGRAM

- 10:30 a.m. – 12:00 p.m.
- **TU-AM-1 TC2** EMC Measurements
- **TU-AM-2 TC6** Spectrum Management
- **TU-AM-3 TC11** Nanotechnology and Advanced Materials
- **TU-AM-5-SIPI** SI/PI Design and Modeling for 3D Integration
- **TU-AM-6-SIPI** SI/PI Advanced Noise/Jitter Modeling and Analysis

AFTERNOON WORKSHOP & TUTORIALS PROGRAM

- 1:30-5:30pm
- **TU-PM-1 TC9** Applications of Numerical Modeling

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○ TU-PM-2 TC4 EMI Systems

○ TU-PM-3 Special Session: SC4 Radio-Frequency Interference and Wireless EMC

○ TU-PM-4 Special Session: TC11 Nanotechnology in EMC

○ TU-PM-5-SIPI Special Session Numerical Methods for Signal and Power Integrity

○ TU-PM-6-SIPI SI/PI High Speed Interconnect Design and Analysis I

WEDNESDAY, AUG. 6

● 9:00 am – 5:00 pm

○ Exhibit Hall Open

MORNING WORKSHOP & TUTORIALS PROGRAM

● 8:30 a.m. – 12:00 p.m.

○ WED-AM-1 TC4 Cables & Connectors

○ WED-AM-2 TC2 Measurement - Immunity

○ WED-AM-3 TC9 Statistical Analysis & Model Validation

○ WED-AM-4 TC7 Low Frequency EMC

○ WED-AM-5-SIPI SI/PI GHz Power Integrity Design

○ WED-AM-6-SIPI SI/PI Co-Design and Co-Simulations

○ WED-AM-7 Poster Session

AFTERNOON WORKSHOP & TUTORIALS PROGRAM

● 1:30-5:30pm

○ WED-PM-1 Special Event Celebrating the 150th Anniversary of Maxwell's Equations

○ WED-PM-2 TC4 PCB EMC

○ WED-PM-3 TC5 High Power EM Including Intentional EMI, ESD and Lightning

○ WED-PM-4 SC4 Wireless EMC

○ WED-PM-5 TC5 High Power EM Including Intentional EMI, ESD and Lightning

○ WED-PM-6-SIPI SI/PI High Speed Interconnect Design and Analysis II

THURSDAY, AUG. 7

● 9:00 am – 1:00 pm

○ Exhibit Hall Open

● 1:00 pm – 6:00 pm

○ Exhibit Hall Move Out

MORNING WORKSHOP & TUTORIALS PROGRAM

● 8:30 a.m. – 1:00 p.m.

○ TH-AM-1 TC2 Antennas

- **TH-AM-2 Special Session: TC9 & TC10**
Large Scale Modeling for Signal and Power Integrity
- **TH-AM-3 Special Session: TC5** EM
Information Leakage
- **TH-AM-4 TC9** Reverb Chambers
& Complex Cavities
- **TH-AM-5A-SIPI** SI/PI Package/PCB
Material Characterization
- **TH-AM-6-SIPI** SI/PI On-Chip and
Off-Chip Power Integrity Issues
and Design

AFTERNOON WORKSHOP & TUTORIALS PROGRAM

- **2:30-5:30pm**
- **TH-PM-1 TC9** Numerical Modeling
Approaches
- **TH-PM-2 TC2** TEM & Reverb
Measurements
- **TH-PM-3 TC1** Business and
Management Concerns in EMC
- **TH-PM-5-SIPI** SI/PI Channel Emulation
- **TH-PM-6-SIPI** SI/PI High Speed
Interconnect Design and Analysis IV

FRIDAY, AUG. 8

- **8:00 am – Noon**
- **Exhibit Hall Move Out**

MORNING WORKSHOP & TUTORIALS PROGRAM

- **8:30 a.m. – 12:00 p.m.**
- **FR-AM-1** Basic EMC Measurements
- **FR-AM-2** EMC for Space Applications
- **FR-AM-3** EMC Consultant's Toolkit
- **FR-AM-4** Time Domain Site VSWR
(sVSWR) Method above 1 GHz and
Correlations to CISPR sVSWR
- **FR-AM-5** Introduction to Spectrum
Engineering

AFTERNOON WORKSHOP & TUTORIALS PROGRAM

- **1:30-5:30pm**
- **FR-PM-1** Electromagnetic Time
Reversal with Emphasis on Lightning
and Fault Detection
- **FR-PM-2** Details of the First Practical
Method for Risk-Managing EMC
(i.e. achieving EMC for Functional Safety)
- **FR-PM-3** Understanding Recent EMC
Standards from the IEEE
- **FR-PM-4** System Level Approaches to
Design and Test for EMI Control
- **FR-PM-5** Introduction to Spectrum
Engineering

Move-out must be completed by 12:00 pm, Friday, August 8, 2014.

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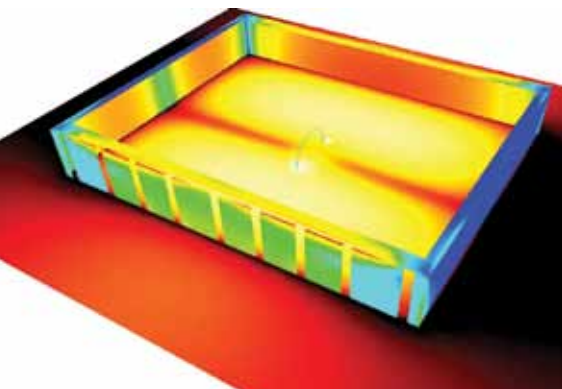
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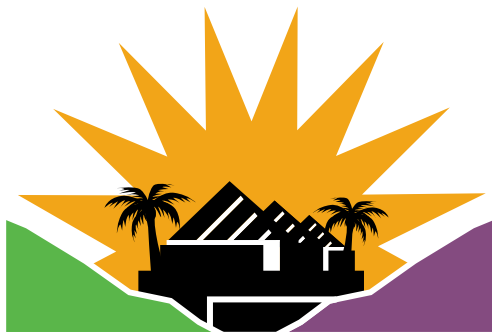
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- High Power Electromagnetics
- Electromagnetic Environments
- EMC Management
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 - High-speed channel characterization and modeling
 - Signal/power integrity co-design and co-simulation
 - 3D IC and 3D packaging
 - Measurement techniques
 - Jitter, equalization, BER
- Theme Topic II - EMC for Emerging Technologies
 - Wireless EMC
 - Radio-Frequency Interference
 - Smart Grid EMC
 - Nano-Materials and Silicon Photonics
 - Unmanned Aircraft Systems EMC
- Theme Topic III - Space EMC

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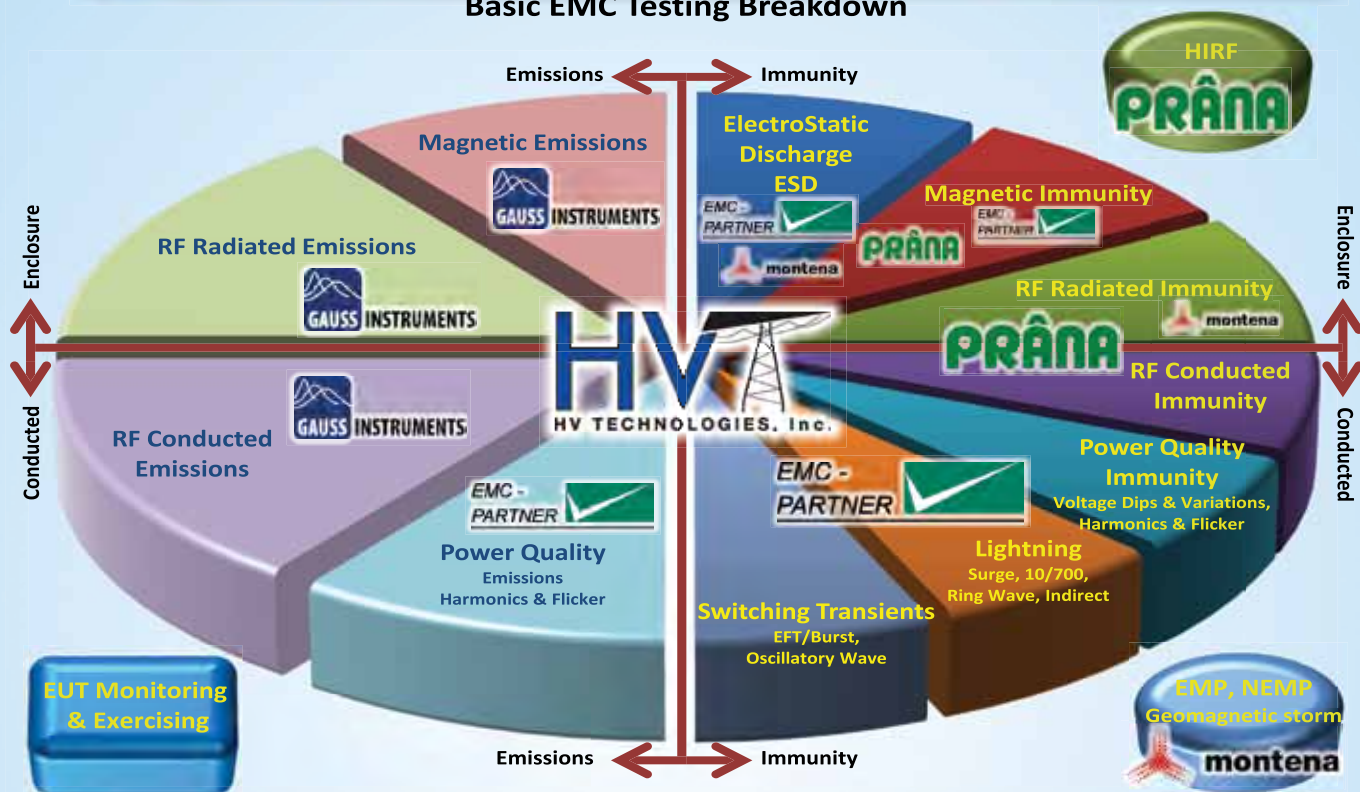
A.H. Systems

SUN	7 am	8 am	9 am	10 am	11 am	Noon	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm	
MONDAY		Exhibitor Set Up												
	7 am	8 am	9 am	10 am	11 am	Noon	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm	
	Companion Suite Open													
		Exhibitor Set Up												
						Lunch								
		Workshops & Tutorials					Workshops & Tutorials							
		SI/ PI Workshops & Tutorials					SI/ PI Workshops & Tutorials							
		Global University					Global University							
					Historic Raleigh Trolley Tour									
TUESDAY											Chapter Chair Training/ Dinner (to 9)			
	7 am	8 am	9 am	10 am	11 am	Noon	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm	
	Companion Suite Open													
			Exhibit Hall Open											
					Technical Papers		Technical Paper Sessions							
		Global University					Global University							
					Experiments and Demos		Experiments and Demos							
				Break		Lunch			Break					
	Team EMC Bike Tour							Youth Tech Prog.			Welcome Reception			
					Epicurean Inspiration - Carolina Style					8:30-10 EMC Young Professionals Social Gathering				
WEDNESDAY	7 am	8 am	9 am	10 am	11 am	Noon	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm	
	Companion Suite Open													
			Exhibit Hall Open											
			Technical Paper Sessions					Technical Paper Sessions						
		Global University					Global University							
			Experiments and Demos				Experiments and Demos							
				Break		Lunch			Break					
								Youth Tech Prog.						
					DURHAM'S PIVOT: From Tobacco Road to City of Medicine						Gala Event (to 9:30)			
	THURSDAY	7 am	8 am	9 am	10 am	11 am	Noon	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm
Companion Suite Open														
			Exhibit Hall Open				Exhibit Hall Move Out							
			Technical Paper Sessions					Technical Paper Sessions						
		Global University					Global University							
			Experiments and Demos											
Team EMC Bike Ride					Awards Luncheon									
				North Carolina Pottery Artist Tour						Board Meeting (to 9:30)				
				Break		Lunch			Break					
FRIDAY		7 am	8 am	9 am	10 am	11 am	Noon	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm
	Companion Suite Open													
		Exhibit Hall Move Out												
		Workshops & Tutorials					Workshops & Tutorials							
				Break		Lunch			Break					
				"For the Art Lovers...."										

Have Some EMC Pie

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Basic EMC Testing Breakdown



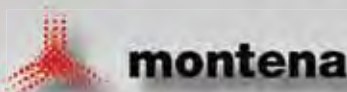
Transient and Impulse Generators

ESD, EFT, Surge, 10/700, Ring Wave, DOW, Common Mode, Harmonics and Flicker, DO-160 Indirect lighting, MIL-STD: CS106, CS115, CS116; Requirements up to 144kV, 100kA



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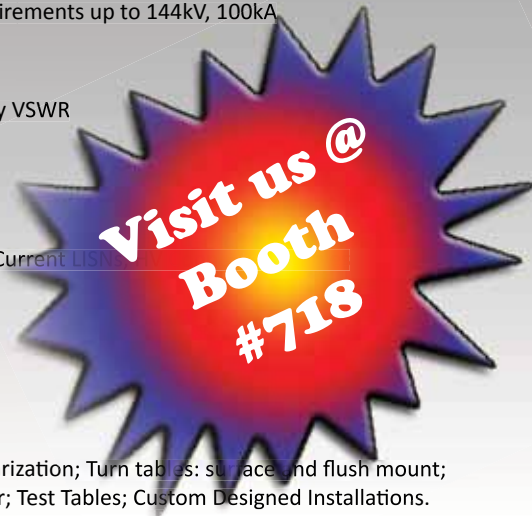
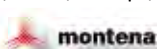
Turn Tables and Positioners

Antenna Masts and Stands: electric or pneumatic polarization; Turn tables: surface and flush mount; Dynamometers; Field Probe Positioner; Cable slide bar; Test Tables; Custom Designed Installations.



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MONDAY INCLUDES*

WORKSHOPS/TUTORIALS

- >> Fundamentals of EMC
- >> Understanding the Importance of Bore Sight Antenna Measurements
- >> Smart Grid EMC Update
- >> EMC Issues for Unmanned Aircraft Systems
- >> Nanotechnology Applied to EMC
- >> Fundamentals of EMC
- >> Application of Reverberation Chambers
- >> Introduction to Medical EMC
- >> Recent Developments in EMC for Emerging Wireless Technologies
- >> Using CEM Modeling to Understand the Underlying Physics in EMC Problems

OTHER EVENTS

- >> Technical Committee Meetings
- >> iNARTE Examinations Preparation Tutorial (Page 56)
- >> Global University (Page 58)
- >> Chapter Chairs Training Session and Dinner

EXHIBITOR SET UP

Fundamentals of EMC Sponsored by ESAC

Format: Full-day Tutorial – MO-AM-1 and MO-PM-1 8:30 AM-Noon Rm 305 A&B

Chair: Mark Steffka, University of Michigan – Dearborn, Dearborn, Michigan, USA

Abstract

This tutorial is an introduction and overview of many of the major topics that need to be considered when designing a component or system for EMC. The tutorial will present the foundational physics and provide an overview of the significance and relevant mathematics that need to be understood to successfully evaluate, diagnose, and solve EMC issues. After the background material is covered, specific examples of the application of the theory will be discussed by sessions on printed circuit board (PCB) design, important considerations in immunity/susceptibility, signal integrity (SI), power integrity (PI), and the tutorial will conclude with an introduction to modelling for EMC.

Planned Speakers and Topics

8:30 AM - 8:45 AM

What is EMC (And Why is it Important)?

Mark Steffka, University of Michigan – Dearborn, Dearborn, Michigan, USA

Basic introduction to EMC, conducted/radiated testing, emissions and immunity, and standards used by different industries.

8:45 AM - 9:45 AM

Basic EM and the Source of Emissions

Lee Hill, Silent Solutions, LLC, Amherst, New Hampshire, USA

Topics to be covered: Maxwell's equations, Ampere's law, Faraday's law, and how it defines inductance; current flows in path of least impedance; boundary conditions and how this requires electric fields to be zero on perfect electric conductors; skin effect; harmonic content of digital signals; how wavelength and 'antenna' length are related.

9:45 AM - 10:00 AM

System Level Grounding Overview

Todd Hubing, Clemson University, South Carolina, USA

Topics to be covered: What is a ground? What is its purpose(s)? Ground versus current return paths. Practical grounding issues – bonding, corrosion control, current levels, sizing, etc. Grounding and circuits – PCBs, digital, analog, RF, power supplies. Grounding for systems – automotive, aerospace, and naval vehicles.

10:30 AM - 11:00 AM

Shielding

Todd Hubing, Clemson University, South Carolina, USA

Topics to be covered: An introduction to the theory of shielding; absorption and reflection loss, the difference between electric and magnetic field shielding in the near field and shielding in the far-field; the influence of apertures and holes on shielding effectiveness; shielding materials, gaskets, and enclosures, effective and ineffective techniques of implementing a shield.

11:00 AM - 11:45 AM

Immunity/Susceptibility

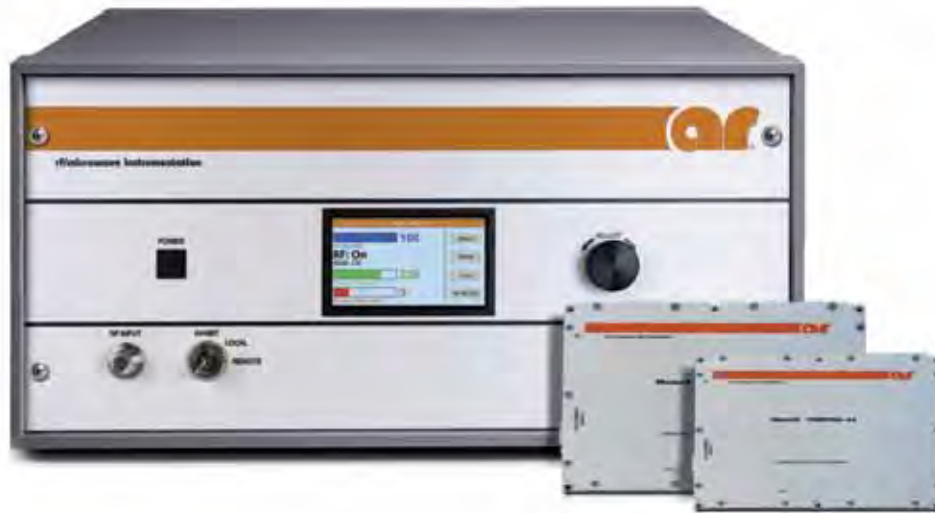
Randy Jost, Ball Aerospace and Technologies Corporation, Westminster, Colorado, USA

Topics to be covered: Description, cause, and effects of RF and transient immunity issues; suppression, shielding, and other mitigation strategies, nature and effects of electrostatic discharge (ESD).

* All events are subject to change. Check www.emc2014.org and the Registration Area daily for updates

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Understanding the Importance of Bore Sight Antenna Measurements

Format: Half-day Tutorial — MO-AM-2

8:30AM-Noon Rm 306 A&B

Chair: Vince Rodriguez, ETS-Lindgren, Cedar Park, Texas, USA

Co-chair: Janet O'Neil, ETS-Lindgren, Cedar Park, Texas, USA

Abstract

Although "bore sighting" is a term that does not appear in standards or in FCC directives, the words "cone of radiation" do. What does this term mean? Are bore sight measurements required for testing above 1 GHz? Why? Are there alternatives to continuous bore sighting?

The answers to these questions and reasoning will be reviewed in this tutorial, including an explanation of the impact of antenna beam widths on measurements. An EMC regulatory expert for a global company will explain why these measurements are important in their EMC labs worldwide. Attendees will learn about an accreditation body's interpretation and expectations of EMC lab assessors when reviewing the bore sighting technique (and clauses in the standard) during the on-site assessment. An antenna manufacturer will share how numerical simulations may be used to show how above certain frequencies, which are dependent on the electrical size of the EUT, bore sighting is a necessity in order to get an accurate measurement of the highest field radiated by the EUT. This presentation will review basic EM theory to look at the possible radiation patterns of EUT's at different frequencies and then illustrate the radiation of these over a ground plane in the presence of directional antennas. A member of CISPR/A will share his investigative work related to the issue of keeping the antenna in the EUT's "cone of radiation" and issues related to height scanning of antennas above 1 GHz.

Planned Speakers and Topics

Why Bore Sight Antennas?

Ghery Pettit, Intel, Dupont, Washington, USA

Bore Sighting Antenna Measurements from the Assessor's Perspective

Brad Moore, National Voluntary Laboratory Accreditation Program (NVLAP), Gaithersburg, Maryland, USA

Say it with Pictures: Using Numerical Simulations to Demonstrate the Importance of Bore Sighting in EMC Measurements

Vince Rodriguez, ETS-Lindgren, Cedar Park, Texas, USA

Investigating the EUT Cone of Radiation Above 1 GHz

Drew Frana, IBM Corporation, Member CISPR/A, Rochester, Minnesota, USA

Smart Grid EMC Update Sponsored by TC1

Format: Half-day Tutorial — MO-AM-3

8:30AM-Noon Rm 303

Chair: Don Heirman, Don HEIRMAN Consultants, Lincroft, New Jersey, USA

Abstract

Smart Grid EMC is so pervasive that almost all that are involved in devices and systems that are part of the Smart Grid (SG) will need to see the bigger picture of the acceptance of EMC considerations. The primary issue involves the immunity of products that are connected to the power grid. This tutorial will provide the status of several key organizations and activities as they continue to strongly recommend that EMC must be considered to ensure the proper operation of SG devices in the RF environment where they will be installed. The speakers are all involved directly in EMC aspects of the Smart Grid internationally and are willing to answer questions on their presentations.

Planned Speakers and Topics

8:30 AM - 9:15 AM

New Smart Grid Interoperability Panel (SGIP 2.0)

Don Heirman, Don HEIRMAN Consultants, Lincroft, New Jersey, USA

9:15 AM - 10:00 AM

SGIP Electromagnetic Issues Working Group Activity

Galen Koepke, National Institute of Standards and Technology, Boulder, Colorado, USA

10:30 AM - 11:00 AM

Smart Grid EMC Standards Harmonization

Jerry Ramie, Arc Technical Resources, San Jose, California, USA

11:00-11:45 AM

Immunity for Power Station and Substation Environments

Bill Radasky, Metatech, Galetta, California, USA

11:45 AM - Noon

International view of Smart Grid EMC Needs/Activity

Don Heirman, Don HEIRMAN Consultants, Lincroft, New Jersey, USA

EMC Issues for Unmanned Aircraft Systems Sponsored by SC6

Format: Half-day Tutorial — MO-AM-4

8:30AM-Noon Rm 306 C

Chair: Chuck Bunting, Oklahoma State University, Stillwater, Oklahoma, USA,

Abstract

This tutorial will focus on identifying EMC issues which hinder the full potential for widespread civilian use of unmanned aircraft systems (UAS). Operational and design barriers include the desirability of rapidly

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reconfigurable avionics systems that do not require full system recertification, and the adaptation of general aviation EMC standards for UAS applications. Integration of various commercially available systems (COTS) on a UAS platform creates interesting EMC issues and inter-operability between systems needs to be ensured for proper operation of UAS. Issues related to modeling UAS will also be discussed. It is designed for both academics and people from industry who will be involved in UAS operations and system design.

Planned Speakers and Topics

Overview of EMC Issues for Unmanned Aircraft Systems

Chuck Bunting, Oklahoma State University, Stillwater, Oklahoma, USA
Vignesh Rajamani, Oklahoma State University, Stillwater, Oklahoma, USA

On Numerical Modeling of EMC Problems for UAVs

C. J. Reddy, EM Software and Systems (USA) Inc, Hampton, Virginia, USA

Electromagnetic Analysis of Installed Antenna Performance on a UAV and Assessment of Co-site Interference

David Johns, CST of America, Inc., Boston, Massachusetts, USA

Electromagnetic Compatibility of UAVs and Sensors

Sarah A. Seguin, University of Kansas, Lawrence, Kansas, USA

Stochastic Characterization of Electromagnetic Vulnerability for Unmanned Aircraft Systems Digital Avionics: A Statistical Electromagnetics Approach

Andy Drozd and Irina Kasperovich, ANDRO Computational Solutions, LLC, Rome, New York, USA
Chuck Bunting and Vignesh Rajamani, Oklahoma State University, Stillwater, Oklahoma, USA

An overview of UAS standards development

Chuck Bunting, Oklahoma State University, Stillwater, Oklahoma, USA

The Tutorial is intended to introduce EMC engineers and researchers to nanoscience and nanotechnology showing how fundamental EMC topics (like measurements, transmission line, shielding and protection) should be "revisited" at nanoscale. It will present new materials, devices and processes for EMC applications, with particular attention to theoretical modeling approaches, simulation methods, and experimental characterization techniques. It will provide participants with opportunities for professional development and the chance to gain a better understanding of nanotechnology and its implications in EMC issues. The Tutorial will contribute to the development of a debate on the state-of-art as well as on future research possibilities.

Planned Speakers and Topics

Introduction to Nano-EMC

Alessio Tamburrano, Research Center on Nanotechnology Applied to Engineering, Sapienza University of Rome, Rome, Italy

Broadband Metrology at the Nano-Scale

T. Mitch Wallis, Atif Imtiaz, Joel Weber, Sam Berweger, Kevin Coakley, and Pavel Kabos, National Institute of Standards and Technology (NIST), Boulder, Colorado, USA

Graphene Interconnects for the End of the Roadmap CMOS and Beyond-CMOS Nanoelectronics

Vachan Kumar and Azad Naeemi, Georgia Institute of Technology, Atlanta, GA, USA
Shaloo Rakheja, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA

Modeling and Fabrication of Graphene-Polymer Nanocomposites for Electromagnetic Shielding and Radar Absorbing Materials

A. G. D'Aloia, A. Tamburrano, and M. S. Sarto, Research Center on Nanotechnology Applied to Engineering, Sapienza University of Rome, Rome, Italy

Frequency Dispersion of Magnetic Composites and Nanocomposites

Marina Y. Koledintseva, Missouri University of Science and Technology, Rolla, Missouri, USA
Konstantin N. Rozanov, Russian Academy of Sciences, Russia

Nanotechnology Applied to EMC

Sponsored by TC11

Format: Half-day Tutorial — MO-AM-5

8:30AM-Noon Rm 302 C

Chair: Alessio Tamburrano, Sapienza University of Rome, Rome, Italy

Abstract

Nanotechnology is the engineering of functional systems at the molecular and atomic scale and represents a technological revolution that is shaking scientific academia, industries, and almost all areas of society. Nanotechnology has the potential to develop many novel materials and devices with a vast range of applications. Over the last ten years several studies have been focused on carbon nanotubes, graphene nanoribbons, nanostructured multifunctional materials, and single/multi-phase composites filled with nanoparticles. The outstanding performance and capabilities of these novel materials have demonstrated a great effect in different EMC applications: signal integrity of electrical nano-interconnects and nano-vias for high speed electronics, multifunctional electromagnetic shields, lightweight and high performance radar absorbing materials, just to mention some examples.

Fundamentals of EMC

Format: Full-day Tutorial — MO-AM-1 and MO-PM-1

1:30AM-5:30PM Rm 305 A&B

Chair: Mark Steffka, University of Michigan — Dearborn, Dearborn, Michigan, USA

See MO-AM-1 for description

Planned Speakers and Topics

1:30 PM - 2:30 PM

Introduction to Modeling Techniques

Sam Connor, IBM Corporation, Research Triangle Park, North Carolina, USA

Topics to be covered: Overview of the common modeling techniques and which types of problems they are best suited to analyze.

2:30 PM - 3:00 PM**Power Integrity**

Jim Drewniak, Missouri University of Science and Technology, Rolla, Missouri, USA

Topics to be covered: The impact of parasitics on the performance of decoupling capacitors; placement of decoupling capacitors depending on the board stack-up and the required frequency of performance; embedded capacitance and the effects of distance between ICs and buried capacitance layers; time domain delivery of charge versus magnitude only frequency domain analysis.

3:30 PM - 4:15 PM**Signal Integrity**

Jun Fan, Missouri University of Science and Technology, Rolla, Missouri, USA

Topics to be covered: Transmission lines; crosstalk and coupling, differential and common-mode signaling and the effects of differential signal channel mis-matching; transmission line parasitics; resonance, ringing, and rounding; channel analysis (eye diagrams, bit-error rate, jitter, equalization).

4:15 PM - 5:15 PM**PCB Design**

Bruce Archambeault, Missouri University of Science and Technology, Rolla, Missouri, USA and IBM, Research Triangle Park, North Carolina, USA

Topics to be covered: A brief introduction to the main concepts behind good EMC design of PCBs, with special emphasis on control of the current return path (while minimizing coupling to antennas, control of signal transition times, etc.); decoupling for EMI and SI, methods to improve the design of PCBs; typical pitfalls.

Application of Reverberation Chambers

Format: Half-day Tutorial — MO-PM-3

1:30AM-5:30PM Rm 303

Chair: Vignesh Rajamani, Oklahoma State University, Stillwater, Oklahoma, USA

Abstract

This tutorial will provide an introduction to recent applications of reverberation chambers. It is intended to provide EMC engineers who are interested in applying reverberation chambers to various measurement issues and the extension of reverberation chambers to solve a variety of EMC problems. This half-day tutorial provides a brief overview of Reverb Chamber (RC) theory, followed by recent applications of RCs. The tutorial material will be updated to reflect recent research results and implications. The format will be a conference presentation style (lecture) followed by questions moderated by the chairman. It is designed for both academics and people from industry who will be involved in radiated emission or immunity testing of commercial or military systems using reverberation chambers and will be valuable to personnel evaluating the use of reverberation chambers as a complement to or replacement for other types of radiated test facilities and for personnel who are trying to use statistical methods to characterize electromagnetic environments.

Planned Speakers and Topics**Introduction — Rationale for RC Testing**

Vignesh Rajamani, Oklahoma State University (OSU), Stillwater, Oklahoma, USA

Overview of Reverberation Chamber Theory

Chuck Bunting, Oklahoma State University (OSU), Stillwater, Oklahoma, USA

Using Reverberation Chambers for Broadband (4G/LTE) Immunity Testing on Devices

J. Ladbury and J. Coder, National Institute of Science and Technology (NIST), Boulder, Colorado, USA

Measuring Intrinsic Material Shielding Effectiveness Using Coupled Reverberant Cavities

Greg Tait, Naval Surface Warfare Center, Dahlgren, Virginia, USA

Complex Cavity Measurement Techniques for Precision Metrology Applications and Aircraft/Vehicle Electromagnetic Environment Assessments

Dennis Lewis, Boeing, Seattle, Washington, USA

Wireless Device Testing in Reverberation Chambers

Garth D'Abreu, ETS Lindgren, Cedar Park, Texas, USA

Introduction to Medical EMC

Format: Half-day Tutorial — MO-PM-3

1:30AM-5:30PM Rm 306 C

Chair: Darryl Ray, Darryl Ray EMC Consulting, Carlsbad, California, USA

Abstract

This tutorial will describe medical EMC testing requirements and the special issues associated with pacemakers and neurostimulators, describe the new requirements for EMC Risk Management and how to comply with them and provide a view of FDA regulations.

Worldwide, EMC of medical devices is regulated differently from that of all other types of equipment, and for reasons of patient safety, medical devices may have to comply with very low leakage current requirements that preclude some of the usual EM mitigation design techniques. IEC/ANSI/AMIEE/EN 60601-1-2, the mandatory EMC standard for medical devices, includes a requirement to manage all safety risks that could foreseeably be caused by errors, malfunctions and faults caused by EM disturbances. Medical devices are the first in the world required to comply with an EMC risk management standard, a requirement that is poorly understood at present but will soon become the norm for safety-related and safety-critical equipment of all types. These items will be discussed.

Trends in medical wireless technologies and key strategies that product developers can use to successfully address the EMC regulatory requirements for their wireless medical devices will be detailed. Medical devices have benefited from the explosion of new wireless technologies. The desire for greater patient mobility dictate "cable replacement" strategies such as Bluetooth® and Wifi® on many medical devices. Remote patient monitoring is highly desired for multiple reasons. These issues are interesting to all EMC engineers, and will be of practical utility to many, whatever industries they work in.

Planned Speakers and Topics**Basics of Medical EMC & IEC 60601-1-2, 4th Edition**

Darryl Ray, Darryl Ray EMC Consulting, Carlsbad, California, USA

Testing Considerations

Harald Buchwald, CSA Group Europe, Strasskirchen, Germany

EMC Aspects for Implantable Devices

Curt Sponberg, Medtronic, Minneapolis, Minnesota, USA

Testing for Wireless Medical Devices

Greg Kiemel, Northwest EMC, Hillsboro, Oregon, USA

Risk Management

Keith Armstrong, Cheery Clough Consulting, Brocton, UK

An FDA Perspective on EMC of Medical Devices

Jeff Silberberg, FDA, Silver Spring, Maryland, USA

Recent Developments in EMC for Emerging Wireless Technologies

Sponsored by SC4

Format: Half-day Tutorial — MO-PM-4**1:30AM-5:30PM Rm 306 A&B****Co-chairs:** Yihong Qi, DBJ Tech, Waterloo, Ontario, Canada

Janet O'Neil, ETS-Lindgren, Cedar Park, Texas, USA

Garth D'Abreu, ETS-Lindgren, Cedar Park, Texas, USA

Jun Fan, Missouri University of Science and Technology,
Rolla, Missouri, USA**Abstract**

With the continuous development of wireless technologies and their tight integration with various electronic/computer/communication devices, EMC issues, at both the system and the intra-system levels, become increasingly important. This tutorial, sponsored by SC4 EMC for Emerging Wireless Technologies, will provide an overview of the issues and challenges, as well as the recent developments in modeling, measurements, test practices, and standards. Planned topics include interference from digital to wireless, noise mitigation (EMC design) through system planning, wireless performance testing methodologies, anechoic and reverberation chambers in wireless testing.

Planned Speakers and Topics**Wireless Interference: Real Life Impact and Solution Strategies**

Harry Skinner, Intel, Hillsboro, Oregon, USA

Whole Vehicle Testing for EMC with Complex Wireless Technologies in Base Models

Garth D'Abreu, ETS-Lindgren, Cedar Park, Texas, USA

Radiated Two Stage Method for MIMO Throughput Test Demystify

Kefeng Liu, General Test System Inc., Shenzhen, China

Green Communications for Future Cellular Networks

Corbett Rowell, China Mobile, Beijing, China

Wireless Security

Guang Gong, University of Waterloo, Waterloo, Ontario, Canada

PIM Influence on Wireless Network

Gao Feng, China Mobile, Beijing, China

Using CEM Modeling to Understand the Underlying Physics in EMC Problems

Sponsored by TC9

Format: Half-day Tutorial — MO-PM-5**1:30PM-5:30PM Rm 302 C****Co-chairs:** David P. Johns, CST of America Inc., Boston, Mass., USAAlbert E. Ruehli, Missouri University of Science and Technology,
Rolla, Missouri, USA**Abstract**

This tutorial is intended to help engineers understand the underlying physics behind EMC/EMI problems by applying CEM modeling techniques and visualizing/interpreting current return paths, E/H fields and power flow. It will focus on relatively simple benchmark problems but these may be extrapolated to more realistic/complex cases. Different EMC coupling mechanisms will be simulated and guidelines on how to identify the type of coupling from the results discussed.

One of the outcomes of the tutorial is to equip engineers with simple tests and techniques to check that modeling codes are simulating the physics correctly for certain classes of EMC/EMI problems. This will include modeling aspects such as choosing an excitation type or port, material definitions, boundaries and other settings/parameters. The testing of simulation results against expected trends associated with the underlying physics will be discussed. The tutorial will provide guidelines for selecting different methods for various types of EMC/EMI problems

Planned Speakers and Topics**1:30 PM****Using Modeling Tools to Understand Radiation from Multi-PC Systems with High Speed Connectors**B. Archambeault^{1,2}, M. Halligan¹, X. Tian¹, and S. Connor²,

(1) Missouri University of Science and Technology, Rolla, Missouri, USA, (2) IBM, Research Triangle Park, North Carolina, USA

2:15 PM**Low-Frequency Magnetic Field Shielding and Physics for Shielding Enclosures**

James L. Drewniak, Missouri University of Science and Technology, Rolla, Missouri, USA

3:30 PM**Combining Electromagnetic Field Simulation and Physics Based Models**

David P. Johns, CST of America Inc., Boston, Mass., USA

4:15 PM**Partitioning Systems into Smaller Sub-Systems for EM/Circuit Modeling**

A. E. Ruehli, D. P. Johns and K. Shringarpure, Missouri University of Science and Technology, Rolla, Missouri, USA

TUESDAY INCLUDES*

WORKSHOPS/TUTORIALS

- >> EMC Measurements
- >> Spectrum Management
- >> Nanotechnology and Advanced Materials
- >> Design and Modeling for 3D Integration
- >> Advanced Noise/Jitter Modeling and Analysis
- >> Applications of Numerical Modeling
- >> EMI Systems
- >> Radio-Frequency Interference and Wireless EMC
- >> Nanotechnology in EMC
- >> Numerical Methods for Signal and Power Integrity
- >> High Speed Interconnect Design and Analysis I

EXPERIMENTS AND DEMONSTRATIONS

- >> Computer Modeling and Simulation Demonstrations
- >> Hardware Experiments & Demonstrations (Page 54)

OTHER EVENTS

- >> Global University (Page 58)
- >> Technical Paper Sessions
- >> Youth Technical Program

EXHIBIT HALL OPEN

*All events are subject to change. Check www.emc2014.org and the Registration Area daily for updates

EMC Measurements

TU-AM-1 TC2 10:30AM - Noon Rm 305A&B

Chair: H. Robert Hofmann, Hofmann EMC Engineering

Planned Speakers and Topics

10:30 AM

A System to Measure Out-of-Band Noise of IEEE 802.11b/g/a/n/ac Transmitter Signals in Cellular Frequency Bands with Noise Calibration

Chun-Hao Hsu and Heng-Yu Jian, Wireless LAN/ RF Engineering, Broadcom Corp., San Diego, CA

11:00 AM

Application of Emission Source Microscopy Technique to EMI Source Localization above 5 GHz

Pratik Maheshwari¹, Victor Khilkevich¹, David Pommerenke¹, Hamed Kajbaf² and Jin Min², (1) Electrical and Computer Engineering, EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Amber Precision Instruments, Sunnyvale, CA

11:30 AM

Design and Implementation of Conducted Emission Reference Source

Dongsheng Zhao¹, George Teunisse¹ and Frank Leferink², (1) Dutch Metrology Institute, Delft, Netherlands, (2) University of Twente, Enschede, Netherlands

Spectrum Management

TU-AM-2 TC6 10:30 AM - 11:30 PM Rm 306A&B

Chair: Karen Dyberg, Raytheon Integrated Defense Systems, Sudbury, Mass. USA

Planned Speakers and Topics

10:30 AM

On Modeling Wireless Radio-Frequency Energy Propagation in Below-Deck Ship Spaces ** Finalist for Best EMC Paper Award

Gregory Tait and Carl Hager, NSWC Dahlgren, Dahlgren, VA

11:00 AM

On Intermittent OFDM Transmitter Saturation and Radar System Performance ** Finalist for Best EMC Paper Award

Brian Cordill and Sarah Seguin, Electrical Engineering and Computer Science (EECS), University of Kansas, Lawrence, KS

Nanotechnology and Advanced Materials

TU-AM-3 TC11 10:30 AM - 12:00 PM Rm 306C

Chairs: Alessio Tamburrano, Sapienza University of Rome and Emmanuel Decrossas, California Institute of Technology

Planned Speakers and Topics

10:30 AM

Crosstalk Analysis in Graphene MTLs

Rodolfo Araneo¹, Giampiero Lovat¹, Salvatore Celozzi¹ and Paolo Burghignoli², (1) Department of Astronautical, Electrical, and Energetic Engineering, Electrical Division, Sapienza University of Rome, Roma, Italy, (2) D.I.E.T. - Sapienza University of Rome, Rome, Italy

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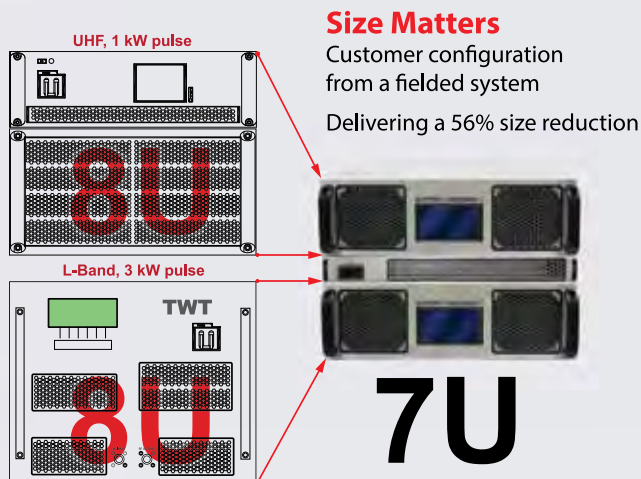
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SKU 1191	100 W	2500 - 6000 MHz	8 x 6.5 x 1"



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11:00 AM**Evaluation of a Surface Equivalent Model in the Case of Conductive Reinforced Composite Sheets****** Finalist for Best Student EMC Paper Award**

Ammar Kader^{1,2}, Marco Klingler¹, Tristan Dubois² and Genevieve Duchamp²,

(1) PSA Peugeot Citroën, Vélizy Villacoublay, France,

(2) Univ. Bordeaux, IMS UMR CNRS 5218, Talence, France

11:30 AM**Nanocrescent Antenna as a Transceiver for Optical Communication Systems**

Islam Hashem, Department of Engineering Mathematics and Physics, Faculty of Engineering, Cairo University, Cairo, Egypt; Department of Physics, School of Sciences and Engineering, American University in Cairo, Cairo, Egypt, Nadia Rafat, Department of Engineering Mathematics and Physics, Faculty of Engineering, Cairo University, Giza, Egypt and Ezzeldin Soliman, Department of Physics, School of Sciences and Engineering, American University in Cairo, New Cairo, Egypt

Design and Modeling for 3D Integration

TU-AM-5-SIPI SI/PI 10:30 AM - 12:00 PM Rm 302B

Chairs: Antonio Orlandi, University of L'Aquila and Madhavan Swaminathan, Georgia Tech

Planned Speakers and Topics**10:30 AM****Timing Analysis for Wide IO Memory Interface Applications with Silicon Interposer**

Karthik Chandrasekar, Dan Oh and Arif Rahman, Altera Corporation, San Jose, CA

11:00 AM**Electrical Modeling and Study of Sidewall Roughness of Through Silicon Vias in 3D Integration**

M. Amimul Ehsan¹, Yang Yi¹, and Zhen Zhou², (1) University of Missouri at Kansas City, Kansas City, MO, (2) Research Lab on Photonic Technology, Intel Corp., Santa Clara, CA

11:30 AM**Electromagnetic Simulation of 3D Stacked ICs: Full Model vs. S-parameter Cascaded Based Model**

Stefano Piersanti¹, Francesco de Paulis¹, Antonio Ciccomancini², Madhavan Swaminathan³ and Antonio Orlandi¹, (1) Industrial and Information Engineering and Economics, University of L'Aquila, L'Aquila, Italy, (2) CST of America, Framingham, MA, (3) Georgia Tech, Atlanta, GA

Advanced Noise/Jitter Modeling and Analysis

TU-AM-6-SIPI SI/PI 10:30 AM - 12:00 PM Rm 302C

Chairs: Dan Oh, Altera Corporation and Jim Nadolny,

Planned Speakers and Topics**10:30 AM****Jitter Induced Voltage Noise in Clock Channels**

Fangyi Rao, Agilent Technologies, Santa Clara, CA and Sammy Hindi, Juniper Networks, Sunnyvale, CA

11:00 AM**Analytical Jitter Estimation of Two-Stage Output Buffers with Supply Voltage Fluctuations**

Eunkyeong Park¹, Hyungsoo Kim², Kwansu Shon² and Jinguook Kim¹, (1) Ulsan National Institute of Science and Technology, Ulsan, South Korea, (2) SK hynix, Icheon, South Korea

11:30 AM**On-Chip Voltage Regulator Module (VRM) Effect on PowerGround Noise and Jitter at High-Speed Output Buffer**

Heegon Kim¹, Changwook Yoon², Brice Achkir³, Jinguook Kim⁴, Joungho Kim¹, and Jun Fan², (1) KAIST, Daejeon, South Korea, (2) The EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (3) Cisco Systems, Inc., San Jose, CA, (4) Ulsan National Institute of Science and Technology, Ulsan, South Korea

Applications of Numerical Modeling

TU-PM-1 TC9 1:30 PM - 5:30 PM Rm 305A&B

Chairs: Samuel Connor, IBM Corporation and Venkatesh Seetharam, Avago Technologies

Planned Speakers and Topics**1:30 PM****EMC Model of Low Voltage DC Motor**

Irina Oganezova^{1,2}, Rob Kado³, Badri Khvitia¹, Zviad Kuchadze¹, Anna Gheonjian^{1,2} and Roman Jobava^{1,2}, (1) EMCoS Ltd., Tbilisi, Georgia, (2) Tbilisi State University, Tbilisi, Georgia, (3) Electromagnetic Compatibility, Chrysler, Auburn Hills, MI

2:00 PM**A Global Approach to TD Shielding Problems**

Salvatore Celozzi, Rodolfo Araneo and Giampiero Lovat, Sapienza University of Rome, Rome, Italy

2:30 PM**A New and Easy Approach to Create BCI Models**

Irina Oganezova^{1,2}, Xavier Bunlon³, Anna Gheonjian¹, Imad Chahine², Badri Khvitia² and Roman Jobava², (1) Tbilisi State University, Tbilisi, Georgia, (2) EMCoS Ltd., Tbilisi, Georgia, (3) Technocentre Renault, Guyancourt, France

3:00-3:30 PM Break**RALEIGH FACTS**

Raleigh is often referred to as the "City of Oaks" for its many oak trees, which line the streets in the heart of the city.

3:30 PM**Modeling Electromagnetic Radiation at High-Density PCB/Connector Interfaces****** Finalist for Best Student EMC Paper Award**

Xinxin Tian¹, Matthew Halligan², Xiao Li², Kiyeong Kim³, Hung-Chuan Chen⁴, Samuel Connor⁵, Bruce Archambeault⁵, Michael Cracraft⁶, Albert Ruehli² and James Drewniak², (1) Huazhong University of Science and Technology, Wuhan, China, (2) Missouri S&T EMC Lab, Rolla, MO, (3) Korea Advanced Institute of Science and Technology (KAIST), Daejeon, South Korea, (4) Graduate Institute of Communication Engineering, National Taiwan University, Taipei, Taiwan, (5) Systems & Technology Group, IBM Corporation, RTP, NC, (6) Systems & Technology Group, IBM Corporation, Poughkeepsie, NY

4:00 PM**Estimating the Radiated Emissions and Received Waveforms from Coupled Microstrip Lines with Unipolar Signaling**

David Norte, RICOH and ITT Technical Institute, Westminster, CO

4:30 PM**Using Scaling Approach to Estimate MRI RF Field Induced Heating for Small Medical Implants**

Dawei Li, Jianfeng Zheng and Ji Chen, Department of Electrical and Computer Engineering, University of Houston, Houston, TX

5:00 PM**MRI Heating Reduction for External Fixation Devices Using Absorption Material**

Xin Huang, Jianfeng Zheng and Ji Chen, Department of Electrical and Computer Engineering, University of Houston, Houston, TX

EMI Systems

TU-PM-2 TC4 1:30 PM - 5:30 PM Rm 306A&B

Chair: Ross Carlton, National Instruments

Planned Speakers and Topics

1:30 PM**Software-related EMI Behavior of Embedded Microcontroller**

Shih-Yi Yuan¹, Wei-yen Chung¹, Cheng-Chang Chang² and Chiu-Kuo Chang², (1) Department of Communication Engineering, Feng Chia University, Taichung, Taiwan, (2) Bureau of Standards, Metrology and Inspection, M.O.E.A, Taipei, Taiwan

2:00 PM**Model-Based Analysis of Screw Locations to Reduce Radiation from a PCB-Chassis Structure**

Hiroki Funato¹, Takashi Suga¹ and Michihiko Suhara², (1)Yokohama Research Lab, Hitachi, Ltd., Yokohama, Japan, (2) Department of Electrical and Electronic Engineering, Tokyo Metropolitan University, Hachioji, Japan

2:30 PM**Correlating the High-Frequency Shielding Performance of 'On-Board' Gaskets when Measured using a Stripline or Reverberation Room Method**

Davy Pissoot¹, Bart Boesman¹, Johan Catrysse², Tim Claeys¹ and Jason Pitteman¹, (1) Electrical Engineering Technology, KU Leuven, Ostend, Belgium, (2) Electrical Engineering, KU Leuven, Leuven, Belgium

3:00-3:30 PM Break**3:30 PM****Electromagnetic Shielding Effectiveness of Non-magnetic Metal Coated Non-woven Fabric Noise Suppressor**

Sho Muroga¹, Masahiro Yamaguchi², Tomoya Tanaka³, Chie Okamura³, Shin-ichi Okajima⁴ and Kazufumi Kato⁴, (1) Electromagnetic Engineering, Tohoku University, Sendai, Japan, (2) Dept. of Electrical and Communication Engineering, Tohoku University, Sendai, Japan, (3) Asahi Kasei Fibers Corporation, Osaka, Japan, (4) Asahi Kasei Fibers Corporation, Sendai, Japan

4:00 PM**Reducing Emissions from an AC-DC-AC Converter to Improve Power Delivery Network Behavior**

Petre-Marian Nicolae¹, Ileana-Diana Nicolae¹, George Mihai, and Ion Patru², (1) University of Craiova, Craiova / Dolj County, Romania, (2) ICMET, Craiova, Romania

4:30 PM**Operational Field Coupled ESD Susceptibility of Magnetic Sensor IC's in Automotive Applications****** Finalist for Best EMC Paper Award**

Cyrous Rostamzadeh, Bosch, Plymouth, MI, Rob Kado, Electromagnetic Compatibility, Chrysler, Auburn Hills, MI and Kimball Williams, Dearborn, MI

5:00 PM**EMI Mitigation with Lossy Material at 10 GHz**

Xiangyang Jiao¹, Pratik Maheshwari¹, Victor Khilkevich¹, Paul Dixon², Yoeri Arien³, Alpesh Bhobe⁴, Jing Li¹, Xiao Li¹, David Pommerenke¹, James Drewniak¹, Hamed Kajbaf¹⁰ and Jin Min⁵, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Laird Technologies, Randolph, MA, (3) Laird Technologies, Geel, Belgium, (4) EMC Design & Simulations, Cisco Systems, Inc., San Jose, CA, (5) Amber Precision Instruments, Sunnyvale, CA

Radio-Frequency Interference and Wireless EMC

TU-PM-3 Special Session: SC4 1:30 PM - 5:30 PM Rm 306C

Chairs: Jun Fan, Missouri University of Science and Technology and Yihong Qi, DBJ Technologies

Planned Speakers and Topics

1:30 PM**WiFi-based Location Services Attack on Dual-band Hardware**

Jun Liang Feng and Guang Gong, University of Waterloo, Waterloo, ON, Canada

2:00 PM**Mitigation Techniques for RFI Due to Broadband Noise**

Harry Skinner¹, Eduardo Alban¹, Soji Sajuyigbe¹, Alberto Alcocer² and Rodrigo Camacho², (1) Intel Labs, Intel Corporation, Hillsboro, OR, (2) Intel Labs, Intel Corporation, Guadalajara, Mexico

2:30 PM**A Study of Antenna Efficiency and MRI Compatibility of Cardiac Stent**

Dawei Li, Xin Huang and Ji Chen, Department of Electrical and Computer Engineering, University of Houston, Houston, TX

3:00-3:30 PM Break**3:30 PM****Electromagnetic Interference and Radiation from Wireless Power Transfer Systems**

Jonghoon Kim¹, Hongseok Kim¹, Chiuk Song¹, In-Myoung Kim², Young-il Kim³ and Joungho Kim¹, (1) KAIST, Daejeon, South Korea, (2) EnerCons Tech, Seoul, South Korea

4:00 PM**New Spread Spectrum Clocking Techniques (for Improved Compatibility with Cellular and Wireless Subsystems)**

Dawson Kesling, Intel Corporation, Folsom, CA and Harry Skinner, Intel Labs, Intel Corporation, Hillsboro, OR

Nanotechnology in EMC

TU-PM-4 Special Session: TC11 1:30 PM - 5:30 PM Rm 303

Chairs: Alessio Tamburrano, Sapienza University of Rome and Emmanuel Decrossas, California Institute of Technology

Planned Speakers and Topics

1:30 PM**Time-Domain Shielding Effectiveness of Planar Conductive Nanoscreens**

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Giampiero Lovat, Rodolfo Araneo and Salvatore Celozzi, Department of Astronautical, Electrical, and Energetic Engineering, Electrical Division, Sapienza University of Rome, Rome, Italy

2:00 PM**RF Shielding Performance of Thin Flexible Graphene Nanoplatelets-Based Papers**

Alessio Tamburrano, Licia Paliotta, Andrea Rinaldi, Giovanni De Bellis and Maria Sabrina Sarto, Sapienza University of Rome, Rome, Italy

2:30 PM**System Level Analysis and Benchmarking of Graphene Interconnects for Low-Power Applications**

Vachan Kumar¹, Ramy Nashed¹, Kevin Brenner², Romeil Sandhu² and Azad Naeemi¹, (1) Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, (2) Harper Laboratories, LLC, Atlanta, GA

3:00-3:30 PM Break**3:30 PM****Modeling of Carbon Nanotubes - Metal Contact Losses in Electronic Devices**

Asmaa Elkadi and Samir M. El-Ghazaly, Electrical Engineering, University of Arkansas, Fayetteville, AR

Numerical Methods for Signal and Power Integrity

TU-PM-5-SIPI Special Session 1:30 PM - 5:30 PM Rm 302B

Chairs: Albert Ruehli, Giulio Antonini, University of L'Aquila and Dale Becker, IBM

Planned Speakers and Topics

1:30 PM**Distributive Radiation Characterization Based on the PEEC Method**

Ying S. Cao¹, Li Jun Jiang¹, and Albert E. Ruehli², (1) University of Hong Kong, Hong Kong, (2) Missouri University of Science and Technology, Rolla, MO

2:00 PM**Efficient Stochastic Transient Analysis of High-Speed Passive Distributed Networks using Loewner Matrix Based Macromodels**

Md. Aminul Haque Talukder¹, Muhammad Kabir¹, Sourajeet Roy² and Roni Khazaka¹, (1) McGill University, Montreal, QC, Canada, (2) Colorado State University, Fort Collins, CO

2:30 PM**Broadband Full-wave Frequency Domain PEEC Solver Using Effective Scaling and Preconditioning for SIPI Models**

Giulio Antonini¹, Daniele Romano¹, Mauro Bandinelli², Alessandro Mori², and Gianmarco Sammarone², (1) University of L'Aquila, L'Aquila, Italy, (2) Ingegneria dei Sistemi S.p.A, Pisa, Italy

3:00-3:30 PM Break

3:30 PM**On Finding the Optimal Number of Decoupling Capacitors by Minimizing the Equivalent Inductance of the PCB PDN****** Finalist for Best Student SI/PI Paper Award**

Ketan Shringarpure¹, Biyao Zhao¹, Leihao Wei², Bruce Archambeault³, Albert Ruehli¹, Michael Cracraft⁴, Matteo Cocchini⁴, Edward Wheeler², Jun Fan¹ and James Drewniak¹, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Electrical and Computer Engineering, Rose-Hulman Institute of Technology, Terre Haute, IN, (3) Systems & Technology Group, IBM Corporation, RTP, NC, (4) Systems & Technology Group, IBM Corporation, Poughkeepsie, NY

4:00 PM**An Efficient Hybrid Boundary-Integral and Finite-Element Method for Signal Integrity Analysis of Multiple Vias Sharing an Anti-Pad in an Infinitely-Large Plate Pair**

YaoJiang Zhang, EMC Laboratory, Missouri University of Science and Technology, Rolla, MO

4:30 PM**Robust SPICE Circuit Generation Using Scattering Parameters**

Jose Schutt-Aine, Electrical and Computer Engineering, University of Illinois, Urbana, IL

5:00 PM**Optimization of Microstrip-to-Via Transition for High-Speed Differential Signaling on Printed Circuit Boards by Suppression of the Parasitic Modes in Shared Antipads**

Xiaomin Duan¹, Andreas Hardock², Ivan Ndip¹, Christian Schuster² and Klaus-Dieter Lang¹, (1) Fraunhofer IZM, Berlin, Germany, (2) Institute of Electromagnetic Theory, Technische Universität Hamburg-Harburg, Hamburg, Germany

Michael Cracraft¹, Samuel Connor² and Bruce Archambeault², (1) Systems & Technology Group, IBM Corporation, Poughkeepsie, NY, (2) Systems & Technology Group, IBM Corporation, RTP, NC

3:00-3:30 PM Break**3:30 PM****Fast Prediction of Radiation from High-Speed/High-Density Connectors**

Hung-Chuan Chen¹, Samuel Connor², Bruce Archambeault² and Tzong-Lin Wu¹, (1) Graduate Institute of Communication Engineering, Taipei, Taiwan, (2) Systems & Technology Group, IBM Corporation, RTP, NC

4:00 PM**Ground Guard Structure to Reduce the Crosstalk Noise and Electromagnetic Interference (EMI) in Vertical Probe Card for Wafer-level Testing**

Eunjung Lee¹, Manho Lee¹, Jonghoon. J Kim¹, Mijoo Kim¹, Jonghoon Kim¹, Joungho Kim¹, Il Kim², Jeongkeun Park², Younghoon Joo², Yoonhee Bang² and Seungki Nam³, (1) KAIST, Daejeon, South Korea, (2) Will Technology, Suwon, South Korea, (3) Samsung Electronics, Hwasung, South Korea

4:30 PM**Modeling of Multiple Vias with a Shared Anti-pad in an Irregular Plate Pair using Domain Decomposition Approach**

YaoJiang Zhang¹, Xiaoxiong Gu², Liehui Ren¹, Dazhao Liu¹ and Jun Fan¹, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) IBM Research, Yorktown Heights, NY

5:00 PM**A Mass-Matrix Based Frequency-Domain Finite-Element Method Accelerated by a Reduced Eigenspace Method for Circuit Modeling**

Jianfang Zhu, Intel, Hillsboro, OR, Duo Chen, Intel Corporation, Santa Clara, CA, Qing He, Oracle Corporation USA, Santa Clara, CA and Dan Jiao, Electrical and Computer Engineering, Purdue University, West Lafayette, IN

High Speed Interconnect Design and Analysis I

TU-PM-6-SIPI SI/PI 1:30 PM - 5:30 PM Rm 302C

Chairs: Antonio Orlandi, University of L'Aquila and Francesco de Paulis, University of L'Aquila

1:30 PM**Time-Domain Mutual Coupling Between Power-Ground Structures ** Finalist for Best SI/PI Paper Award**

Martin Stumpf, SIX Research Center, Brno University of Technology, Brno, Czech Republic

2:00 PM**Standalone Removable EBG-Based Common Mode Filter for High Speed Differential Signaling**

Francesco de Paulis¹, Hilmi Nisanci², Danilo Di Febo¹, Antonio Orlandi¹, Samuel Connor³, Michael Cracraft⁴ and Bruce Archambeault³, (1) Industrial and Information Engineering and Economics, University of L'Aquila, L'Aquila, Italy, (2) Electrical and Electronics Engineering, Sakarya University, Sakarya, Turkey, (3) Systems & Technology Group, IBM Corporation, RTP, NC, (4) Systems & Technology Group, IBM Corporation, Poughkeepsie, NY

2:30 PM**Unintended Effects of Asymmetric Return Vias and Via Array Design for Reduced Mode Conversion**

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YEARS SPENT IN THE AREA: 1

ATTRACTION YOU WOULD RECOMMEND TO A FIRST TIME VISITOR:

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MUST HAVE SOUVENIR: Some kind of Western attire

RALEIGH'S BEST KEPT SECRET:

Deep River Brewing Company's Watermelon Lager

BEST VIEW: Duke University - more specifically the Chapel on campus

WEDNESDAY INCLUDES*

WORKSHOPS/TUTORIALS

- >> Cables & Connectors
- >> Measurement - Immunity
- >> Statistical Analysis & Model Validation
- >> Low Frequency EMC
- >> GHz Power Integrity Design
- >> Co-Design and Co-Simulations
- >> Poster Session
- >> Special Event Celebrating the 150th Anniversary of Maxwell's Equations
- >> PCB EMC
- >> High Power EM Including Intentional EMI, ESD and Lightning
- >> Wireless EMC
- >> Full Link Modeling and Design Optimization
- >> High Speed Interconnect Design and Analysis II

EXPERIMENTS AND DEMONSTRATIONS

- >> Computer Modeling and Simulation Demonstrations
- >> Hardware Experiments & Demonstrations (Page 54)

OTHER EVENTS

- >> Global University (Page 58)
- >> Youth Technical Program

EXHIBIT HALL OPEN

Cables & Connectors

WED-AM-1 TC4 8:30 AM - 10:00 AM Rm 305AB

Chair: Phil Berger, Missouri University of Science and Technology

Planned Speakers and Topics

8:30AM

MTL Modeling of Spacecraft Harness Cable Assemblies

Nicolas Mora¹, Farhad Rachidi¹, Patrice Pelissou² and Axel Junge³, (1) EMC Lab, Swiss Federal Institute of Technology in Lausanne (EPFL), Lausanne, Switzerland, (2) EMC Section, Astrium Satellites, Toulouse, France, (3) EMC Section, European Space Agency - ESTEC, Noordwijk, Netherlands

9:00 AM

Measurement-based Models for Crosstalk within a Connector Shell

Guanghua Li¹, Jungping He¹, Gary Hess², Robert Hoeckele², Pete Jalbert², Thomas Van Doren¹ and Daryl Beetner¹, (1) Missouri University of Science and Technology, Rolla, MO, (2) Hamilton Sundstrand, Windsor Locks, CT

9:30 AM

A Method to Quantify the Coupling Between DVI and HDMI Connectors

Abhishek Patnaik¹, YaoJiang Zhang¹, Soumya De¹, David Pommerenke¹, Chen Wang² and Charles Jackson², (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) NVIDIA, Inc., Santa Clara, CA

Measurement - Immunity

WED-AM-2 TC2 8:30 AM - 10:00 AM Rm 306AB

Chair: Tom Fagan, Raytheon, Tucson, AZ, USA

Planned Speakers and Topics

8:30 AM

Considerations When Characterizing a Device's Susceptibility to Broadband Signals: A Case Study

Jason Coder¹, John Ladbury¹ and David Hunter², (1) RF Fields, National Institute of Standards and Technology, Boulder, CO, (2) CableLabs, Louisville, CO

9:00 AM

An Ethernet Cable Discharge Event (CDE) Test and Measurement System

Wei Huang¹, Viswa Pilla², Jerry Tichenor¹, David Pommerenke², Giorgi Maghlakelidze² and Pratik Maheshwari², (1) R&D Center, ESDEMC Technology LLC, Rolla, MO, (2) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO

9:30 AM

Assessment of Challenges Faced by Test Laboratories that Perform Bench Level Automotive Electrical and Electromagnetic Compatibility Validation Testing

Lawrence Banasky Jr., Electromagnetic Compatibility, Ford Motor Company, Dearborn, MI

*All events are subject to change. Check www.emc2014.org and the Registration Area daily for updates

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Statistical Analysis & Model Validation

WED-AM-3 TC9 8:30 AM - 10:00 AM Rm 306C

Chairs: Alistair Duffy, De Montfort University and Andy Drozd, ANDRO Computational Solutions, LLC

Planned Speakers and Topics

8:30 AM

Statistical Analysis in EMC using Dimension Reduction Methods

Dave Thomas, Oluwabukola Oke, and Christopher Smartt, The University of Nottingham, Nottingham, United Kingdom

9:00 AM

Statistical Performance Comparison between the FSV and the FS-NMI index

Marco Azpurua¹, Eduardo Paez¹, Ricardo Jauregui², Xileidys Parra¹, and Ferran Silva², Polytechnic University of Catalonia, Barcelona, Spain, (1) Instituto de Ingeniería, Caracas, Venezuela, (2) Universitat Politècnica de Catalunya, Barcelona, Spain

9:30 AM

Measurement Uncertainty Propagation through the Feature Selective Validation Method

Marco Azpurua¹, Eduardo Paez¹, and Ricardo Jauregui², (1) Instituto de Ingeniería, Caracas, Venezuela, (2) Universitat Politècnica de Catalunya, Barcelona, Spain

Low Frequency EMC

WED-AM-4 TC7 8:30 AM - 10:00 AM Rm 303

Chairs: Magnus Olofsson, Elforsk - Swedish Electrical Utilities' R & D Company and John Maas, IBM Corporation

Planned Speakers and Topics

8:30 AM

Common-mode Voltage due to Asymmetry in Inductive Power Transfer Systems

James McLean and Robert Sutton, TDK R&D Corp., Cedar Park, TX

9:00 AM

A Common-Mode Active Filter in a Compact Package for a Switching Mode Power Supply

Dongil Shin¹, Sungnam Kim², Geunseok Jeong², Jaesu Park², Joungwook Park², Ki Jin Han¹ and Jinguok Kim¹, (1) Ulsan National Institute of Science and Technology, Ulsan, South Korea, (2) LG Electronics, Pyeongtaek, South Korea

SI/PI GHz Power Integrity Design

WED-AM-5-SIPI

8:30 AM - 10:00 AM Rm 302B

Chairs: A. Ege Engin, San Diego State University and Zhiping Yang, Apple Computer

Planned Speakers and Topics

8:30 AM

Optimized Virtual Ground Fence for Power Delivery Filtering of Mixed-signal Systems

Mohammad Ali Khorrami, University of Arkansas, Fayetteville, AR

9:00 AM

"Open-Stub Electromagnetic Bandgap" Structures Loaded with Capacitive Transmission Line Segments for Bandgap Frequency Control

Yoshiaki Kasahara, Central Research Labs, NEC Corporation, Tokyo, Japan and Hiroshi Toyao, NEC Corporation, Tokyo, Japan

9:30 AM

Miniaturized and Bandwidth-Enhanced Multilayer 1-D EBG Structure for Power Noise Suppression

Chi-Kai Shen¹, Tzong-Lin Wu¹, Chung-Hao (Joseph) Chen², and Dong-ho Han², (1) National Taiwan University, Taipei, Taiwan, (2) Intel Architecture Group, Hillsboro, OR

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SI/PI Co-Design and Co-Simulations

WED-AM-6-SIPI 8:30 AM - 10:00 AM Rm 302C

Chairs: Antonio Ciccimancini, CST of America
and Qing He, Oracle Corporation

Planned Speakers and Topics

8:30 AM

Switching Voltage Regulator Noise Coupling to Connector Signal Pins through Near Field Radiation

Gong Ouyang¹, Kai Xiao¹, Pengchong Li², Wei Xu³, Jiangqi He³, Jin Fang¹, Oliver Tian⁴, Xiaoning Ye⁵, Yinglei Ren⁶ and Yuan-liang Li⁷, (1) Intel Corp., Dupont, WA, (2) High-end Server R&D Department, Inspur Electronic Information Industry Co., Ltd, Beijing, China, (3) Intel Corporation, Chandler, AZ, (4) Intel Corp, Shanghai, China, (5) Intel Corporation, Hillsboro, OR, (6) Intel Asia-Pacific Research and Development Ltd., Shanghai, China, (7) Intel Corporation, Taipei, Taiwan

9:00 AM

In-Depth Study of Simultaneous Switching Noise Patterns for Different Signaling Topologies

Kundan Chand, and Dan Oh, Altera Corporation, San Jose, CA

9:30 AM

VR Noise Analysis and Reduction in Printed Circuit Board Designs

Yinglei Ren¹, Wei Shen¹, and Kai Xiao², (1) Intel Asia-Pacific Research and Development Ltd., Shanghai, China, (2) Intel Corp, DuPont, WA

Poster Session

WED-AM-7 10:30 AM - 12:00 PM

Planned Speakers and Topics

Crosstalk Study of High Speed On-Package Interconnects for Multi-Chip Packaging Technology

Bok Eng Cheah¹, Jackson Kong¹, Khang Choong Yong¹, Louis Lo², and Po Yin Yaw³, (1) Intel Corporation, Penang, Malaysia, (2) Intel Corporation, Folsom, CA (3) NCS Information Systems Sdn Bhd, Penang, Malaysia

Study on Simulation of Lightning Electromagnetic Field

Yazhou Chen^{1,2} and Haojiang Wan², (1) University of Florida, Gainesville, FL, (2) Shijiazhuang Mechanical Engineering College, Shijiazhuang, China

Applications of Flexible AC Transmissions System (FACTS) Technology in SmartGrid and Its EMC Impact

Qin Yu, Alcatel-Lucent, Dublin, OH

Electrostatic Discharge (ESD) Effects on Wireless Power Transfer using Magnetic Resonance Coupling

Sukjin Kim, KAIST, Daejeon, South Korea

MIMO Channel Capacity Based on Reverberation Chamber

Zhuming Zhou, Guizhen Lu and Dongdong Zeng, The Communication University of China, Beijing, China

Practical De-embedding Solution for PoP Devices using a Transfer Function Methodology

Gerardo Romo Luevano, Power & Signal Integrity Group, Qualcomm Technologies, Inc., San Diego, CA

An Efficient Eye Diagram Generation Method for Jitter Analysis in High Speed Links

Yang Wu, Cisco Systems, Shanghai, China

Influence of Cable Routing for Indoor Multi-System Omnidirectional Antenna Horizontal Pattern Ripple Measurement

Feng Gao, China Mobile Design Institute, Beijing, China, Lei Zhou, Xidian University, Xi'an, China, Yan Zhao, CETC No.7 Research Institute, Guangzhou, China, Yihong Qi, DBJ Technologies, Zhuhai, China, Runhong Shan, Copyright Protection Center of China, Beijing, China and Yang Hu, CETC No.7 Research Institute CARES Calibration and Testing Laboratory, Guangzhou, China

A New Jitter Decomposition Method Design

Chunchun Sui^{1,2}, Ting Zhu², Christopher Cheng² and Daryl Beetner¹, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Hewlett-Packard Company, Fremont, CA

The Application of High Impedance Surface for Noise Reduction Inside the Package

Xing-Chang Wei¹, Xin Wei¹, Yong-Sheng Li¹, Jian-Bo Zhang¹, Gao-Le Dai², and Er-Ping Li¹, (1) Zhejiang University, Hangzhou, China, (2) Ningbo Institute of Materials Technology & Engineering, Ningbo, China

Signal Integrity Optimization of MLVDS-based Multi-master Instrument Bus

Kaichen Song¹, Caixia Li¹, Lingyun Ye¹, Ayonga Hereid² and Bin Chen¹, (1) College of Biomedical Engineering & Instrument Science, Zhejiang University, Hangzhou, China, (2) Department of Mechanical Engineering, Texas A&M University, College Station, TX

Theoretical Analysis of Limiting Factors for Distributed MIMO System

Yanjie Dong, Beijing University of Posts and Telecommunications, Beijing, China

Modeling and Analysis of Lightning Surge Overvoltage and Induced Electromagnetic Field for HV Semi-Composite Transmission Tower

Youpeng Huangfu, Shuhong Wang, Xi Tao, Song Wang, Bin Yang, Guolin Wang and Yuxi Zhang, State Key Laboratory of Electrical Insulation and Power Equipment, Faculty of Electrical Engineering, Xi'an Jiaotong University, Xi'an, China

Simulation and Analysis of Power Frequency Electric Field for Building Close to Power Transmission Lines

Bin Yang, Shuhong Wang, Qiang Wang, Han Du and Youpeng Huangfu, State Key Laboratory of Electrical Insulation and Power Equipment, Faculty of Electrical Engineering, Xi'an Jiaotong University, Xi'an, China

Simple D Flip-flop Behavioral Model of ESD Immunity for use in the IES10605 Standard

Guangyao Shen¹, Victor Khilkevich¹, Sen Yang¹, David Pommerenke¹, Hermann Aichele², Dirk Eichel² and Christoph Keller², (1) EMC Lab, Missouri University of Science and Technology, Rolla, MO, (2) Robert Bosch GmbH, Stuttgart, Germany

Virtual Ground Fence Options for Shielding Power Plane Noise

A. Ege Engin and Jesse Bowman, San Diego State University, San Diego, CA

Monitoring Transistor Degradation in Power Inverters Through Pole Shifts

J. Hunter Hayes and Todd Hubing, Department of Electrical and Computer Engineering, Clemson University, Clemson, SC

Analysis of PDN in Glass, Silicon Interposer and PCB

Youngwoo Kim¹, Kiyeong Kim¹, Jonghyun Cho¹, Jounggho Kim¹, Venky Sundaram¹ and Rao Tummala², (1) KAIST, Daejeon, South Korea, (2) Georgia Institute of Technology, Atlanta, GA

Numerical Analysis of Glass-Weave Effects for Printed Circuit Board ** Finalist for Best Student SI/PI Paper Award

Xinxin Tian¹, YaoJiang Zhang², Jane Lim³, Kelvin Qiu³, Rick Brooks³, Ji Zhang³ and Jun Fan², (1) Huazhong University of Science and Technology, Wuhan, China, (2) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (3) Cisco Systems, Inc, San Jose, CA

A Novel Microwave Network Analysis Method on Transient Response of Power Delivery Network

Chunlei Guo, Intel Corp., Folsom, CA and Jiangqi He, Intel Corporation, Chandler, AZ

Noise Transfer from Receiver to Transmitter Circuits of Transceivers through Power Supply Network (PDN)

Janani Chandrasekhar and Yujeong Shim, Altera Corporation, San Jose, CA

On the Optimization of the Return Current Paths of Signal Vias in High-Speed Interposers and PCBs using the M3 Approach

Ivan Ndip, RF & Smart Sensor Systems, Fraunhofer IZM, Berlin, Germany

Evaluation of Radiated Emissions from Multi-port Integrated Connector Modules (ICM) by S-parameters

Hongmei Fan¹, Jianquan Lou¹, Hailong Zhang¹, Jinghan Yu¹, Alpesh Bhobe², Feng Ji¹, Dewen Xu¹, Wenbin Ma¹ and Xinyi Hu¹, (1) Cisco Systems (China) R&D Co., Ltd., Shanghai, China, (2) EMC Design & Simulations, Cisco Systems, Inc., San Jose, CA

Complex Valued Neural Network Modelling of the Balun of a Biconical Antenna

Alessio Bonci, Carlo Carobbi and Antonio Luchetta, Department of Information Engineering, Università degli Studi di Firenze, Florence, Italy

and quantum worlds of physics. A man who touched nearly every corner of natural philosophy (the study of nature), James reconciled the properties of light, heat and electromagnetic radiation. His equations ultimately formed a crucial link in the chain that brought Sir Isaac Newton and Albert Einstein together. Einstein noted that, "One scientific epoch ended and another began with James Clerk Maxwell." Speakers include former IEEE MTT Society Distinguished Lecturer, Dr. James C. Rautio, and IEEE EMC Society President, Dr. Robert Scully. View presentation abstracts and speaker bios on line at www.emc2014.org/program/special-events.

Planned Speakers and Topics**1:30 PM****The Life of James Clerk Maxwell**

James C. Rautio, Sonnet Software, North Syracuse, NY, USA

3:00 PM Break**3:30 PM****The Acceptance of Maxwell's Equations, Æthereal Waves Make History**

James C. Rautio, Sonnet Software, North Syracuse, NY, USA

4:30 PM**Maxwell's Legacy: The Heart and Soul of the EMC Discipline**

Bob Scully, National Aeronautics and Space Administration (NASA) Space Center, Houston, TX, USA

PCB EMC**WED-PM-2 TC4 1:30 PM - 5:30 PM Rm 306A&B**

Chair: John Kraemer, Rockwell Collins

Planned Speakers and Topics**1:30 PM****Modulation of 1 MHz Clock with Low Frequency (LF) Signals to Analyze Common-Mode Radiation from Printed Circuit Boards**

Cyrous Rostamzadeh, Bosch, Plymouth, MI and Mark Steffka, Powertrain Electromagnetic Compatibility Engineering, General Motors, Milford, MI

2:00 PM**Impact of Clock Net Routing on EMC Emissions Performance of Automotive Electronic Modules**

Stiliyan Filipov¹, Aaron Lutz², Krzysztof Russa², Scott Mee², Chakrapani Nandyala³, and Aneliya Hadzhikrasteva¹, (1) Johnson Controls Inc., Sofia, Bulgaria, (2) Johnson Controls Inc., Holland, MI, (3) Johnson Controls Inc., Pune, India

2:30 PM**A Method for Compensating Imbalance Component of Asymmetrical Differential-Paired Lines Due to Turnoff Point for SI and EMI Performances**

Yoshiki Kayano¹, Masashi Ohkoshi¹, and Hiroshi Inoue², (1) Akita University, Akita, Japan, (2) The Open University of Japan, Akita, Japan

3:00-3:30 PM Break**Special Event Celebrating the 150th Anniversary of Maxwell's Equations****WED-PM-1 1:30 PM - 5:30 PM Rm 305A&B**

Chairs: Janet O'Neil, ETS-Lindgren, Cedar Park, TX, USA and Bob Scully, National Aeronautics and Space Administration (NASA) Space Center, Houston, TX, USA.

James Clerk Maxwell (1831 – 1879) was a man of prodigious and singular gifts, of insight, curiosity and determination. His equations, developed 150 years ago, describe the link between the classical

3:30 PM**Investigating a Guard Trace Ring to Suppress the Crosstalk due to a Clock Trace on a Power Electronics DSP Control Board**

Jun Xu and Shuo Wang, Electrical and Computer Engineering, University of Texas at San Antonio, San Antonio, TX

4:00 PM**PCB Structures for Common Mode Suppression on Differential Microstrip Lines ** Finalist for Best Student EMC Paper Award**

Qian Liu¹, Shuai Xu², and David Pommerenke¹, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO (2) Huawei Technologies Co., Ltd., Shenzhen, China

High Power EM Including Intentional EMI, ESD and Lightning

WED-PM-3 TC5 1:30 PM - 5:30 PM Rm 306C

Chairs: William Radasky, Metatech Corporation and Michael McInerney, US Army Corp of Engineers

Planned Speakers and Topics

1:30 PM**AC Harmonics Effects on Small External Power Supplies (Wall Warts)**

Edward Savage and William Radasky, Metatech Corporation, Goleta, CA

2:00 PM**Influence of Software Effects on the Susceptibility of Ethernet Connections**

Matthias Kreitlow¹, Heyno Garbe² and Frank Sabath¹, (1) Bundeswehr Research Institute for Protective Technologies and NBC Protection, Munster, Germany (2) Institute of Electrical Engineering and Measurement Technology, Leibniz Universität Hannover, Hannover, Germany

2:30 PM**Susceptibility of Notebook Computers to HPM**

Yuichiro Murata, Advanced Technology R&D Center, Mitsubishi Electric Corporation, Amagasaki, Japan

3:00-3:30 PM Break**3:30 PM****The Electric Field at the Surface of a Cylindrical Monopole ** Finalist for Best EMC Paper Award**

William Price and Benjamin Andros, The Boeing Company, Seattle, WA

4:00 PM**Efficient Calculation of ESD Inductive Coupling on a Conductor Loop Using PEEC Method**

Junsik Park¹, John Lee², Byongsu Seol² and Jinguook Kim¹, (1) Ulsan National Institute of Science and Technology, Ulsan, South Korea, (2) Samsung Electronics, Gyeonggi-do, South Korea

4:30 PM**Simplified Techniques for Treating the Ocean-Land Interface for Geomagnetically Induced Electric Fields**

James Gilbert, Metatech Corporation, Goleta, CA

5:00 PM**Transient Grounding Characteristics of a Wind Turbine Foundation with Grounding Wires and Plates**

Kazuo Yamamoto, Chubu University, Kasugai, Japan

Wireless EMC

WED-PM-4 SC4 1:30 PM - 5:30 PM Rm 303

Chairs: Alpesh Bhohe, Cisco Systems, Inc. and Wilson Wu, Shenzhen Sunway Communication Co., Ltd.

Planned Speakers and Topics

1:30 PM**Radiation Physics and EMI Coupling Path Determination for Optical Links ** Finalist for Best Student EMC Paper Award**

Jing Li¹, Sukhjinder Toor², Alpesh Bhohe², James Drewniak¹ and Jun Fan¹, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Cisco Systems, Inc., San Jose, CA

2:00 PM**The Impact of Near-field Scanning Size on the Accuracy of Far-Field Estimation**

Xiao Ren¹, Pratik Maheshwari¹, Yao-Jiang Zhang¹, Victor Khilkevich¹, Jun Fan¹, Yan Zhou², Yadong Bai² and Xuequan Yu², (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Huawei Technologies Co., Ltd, Shenzhen, China

2:30 PM**Reliable Wi-Fi Communication in EMC Critical Multipath Propagation Environment Using Phased Array Antennas**

Helge Fielitz and Jan Luiken ter Haseborg, Institute of Measurement Technology and EMC, Hamburg University of Technology, Hamburg, Germany

3:00-3:30 PM Break**3:30 PM****Conducted-Emission Modeling for a High-Speed ECL Clock Buffer**

Shuai Jin¹, YaoJiang Zhang¹, Yan Zhou², Yadong Bai², Xuequan Yu² and Jun Fan¹, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Huawei Technologies Co. Ltd, Shenzhen, China

4:00 PM**De-Embedding Method to Accurately Measure High-Frequency Impedance of an O-Shape Spring Contact**

Qiaolei Huang¹, Jing Li¹, Joe Zhou², Wilson Wu², Yihong Qi³ and Jun Fan¹, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Shenzhen Sunway Communication Co., Ltd., Shenzhen, China, (3) DBJ Technologies, Zhuhai, China

4:30 PM**Physical Layer Phase Encryption for Combating the Traffic Analysis Attack ** Finalist for Best EMC Paper Award**

Fei Huo and Guang Gong, University of Waterloo, Waterloo, ON, Canada

5:00 PM**Far-field Radiation Estimation from Near-field Measurements and Image Theory**

Jingnan Pan, Xu Gao, YaoJiang Zhang and Jun Fan, EMC Laboratory, Missouri University of Science and Technology, Rolla, MO

SI/PI Full Link Modeling and Design Optimization

WED-PM-5-SIPI 1:30 PM - 5:30 PM Rm 302B

Chairs: Chunfei Ye, Intel Corp. and Changwook Yoon, Missouri University of Science and Technology

Planned Speakers and Topics

1:30 PM

Additional Coupling for Far End Crosstalk Cancellation in Server Interconnects

Raul Enriquez¹, César Méndez Ruiz², Kai Xiao³, Gong Ouyang³, and Beomtaek Lee⁴, (1) Intel, Guadalajara, Mexico, (2) Intel Corporation, Tlaquepaque, Mexico, (3) Intel Corp, DuPont, WA, (4) Intel Corporation, Santa Clara, CA

2:00 PM

PCB Via to Trace Return Loss Optimization for >25Gbps Serial Links

Ji Zhang, Jane Lim, Wei Yao, Kelvin Qiu and Rick Brooks, Cisco Systems, Inc, San Jose, CA

2:30 PM

Package Technology Evaluation and Optimization for High-Speed Applications

Louis Lo, Intel Corporation, Folsom, CA and Bok Eng Cheah, Intel Corporation, Penang, Malaysia

3:00-3:30 PM Break

3:30 PM

Impedance Transparency Design for PCI-Express Gen 3 SerDes Channel on HDI PCBs

Jue Chen and Bidyut Sen, Cisco Systems, Inc, San Jose, CA

4:00 PM

Interconnect Impedance Optimization for High Speed IO up to 12 Gbps under HVM Condition

Xinjun Zhang¹, Chunfei Ye², Ming Wei¹, Weifeng Shu¹ and Xiaoning Ye³, (1) CPD, Intel Asia Pacific Research and DeveloPMent Ltd, Shanghai, China, (2) IAG, Intel Co., DuPont, WA, (3) Intel Corporation, Hillsboro, OR

4:30 PM

Proximity Effects Between Striplines and Vias

Young Kwark¹, Renato Rimolo-Donadio², Christian Baks¹, Sebastian Muller³ and Christian Schuster³, (1) IBM Research, Yorktown Heights, NY, (2) Electronics Engineering Department, Costa Rica Institute of Technology (ITCR), Cartago, Costa Rica, (3) Technische Universität Hamburg-Harburg (TUHH), Hamburg, Germany

5:00 PM

An Exercise in Applying Channel Operating Margin (COM) for 10GBASE-KR Channel Design

Brandon Gore and Richard Mellitz, Intel Corporation, Columbia, SC

SI/PI High Speed Interconnect Design and Analysis II

WED-PM-6-SIPI 1:30 PM - 5:30 PM Rm 302C

Chairs: Er-Ping Li, Zhejiang University and Antonio Ciccomancini, CST of America

Planned Speakers and Topics

1:30 PM

Design Criteria of Automatic Fixture Removal (AFR) for Asymmetric Fixture De-embedding

Changwook Yoon¹, Tsiklauri Mikheil¹, Mikhail Zvonkin¹, Alex Razmadze², Aman Aflaki², Jingoook Kim³, Bill Chen⁴, Jun Fan¹ and James Drewniak¹, (1) EMC Lab, Missouri University of Science and Technology, Rolla, MO, (2) Altera Corporation, San Jose, CA, (3) Ulsan National Institute of Science and Technology, Ulsan, South Korea, (4) Yangtze Delta Region Institute of Tsinghua University, Beijing, China

2:00 PM

De-embedding Techniques for Transmission Lines: An Application to Measurements of On-Chip Coplanar Traces

Nicholas Erickson¹, Xu Gao¹, Jun Fan¹, Siming Pan² and Brice Achkir², (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Cisco Systems, Inc., San Jose, CA

2:30 PM

High-Speed Differential IO Crosstalk - The Impact of Phase, Bit Rate, Jitter and Equalization

Chunfei Ye, Intel Corp., DuPont, WA

3:00-3:30 PM Break

3:30 PM

Impact on Signal Integrity of Interconnect Variabilities

Paolo Manfredi¹, Dries Vande Ginste², Daniël De Zutter² and Flavio Canavero¹, (1) Department of Electronics and Telecommunications, Politecnico di Torino, Turin, Italy, (2) Department of Information Technology, Ghent University, Ghent, Belgium

4:00 PM

DC Blocking Capacitor Design and Optimization for High Speed Signalling

Weifeng Shu¹, Chunfei Ye², Dan Liu¹, Xiaoning Ye³, Enrique Lopez⁴ and Xinjun Zhang¹, (1) Intel Asia Pacific Research and DeveloPMent Ltd, Shanghai, China, (2) Intel Corp., DuPont, WA, (3) Intel Corporation, Hillsboro, OR, (4) Intel Corp., Tlaquepaque, Mexico

4:30 PM

Stochastic Modeling of a High-Speed Signal Channel by Polynomial Chaos Method

Yansheng Wang¹, Alex Razmadze², Timothy Lu², YaoJiang Zhang¹, Jun Fan¹ and Ji Chen³, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Altera Corporation, San Jose, CA, (3) University of Houston, Houston, TX

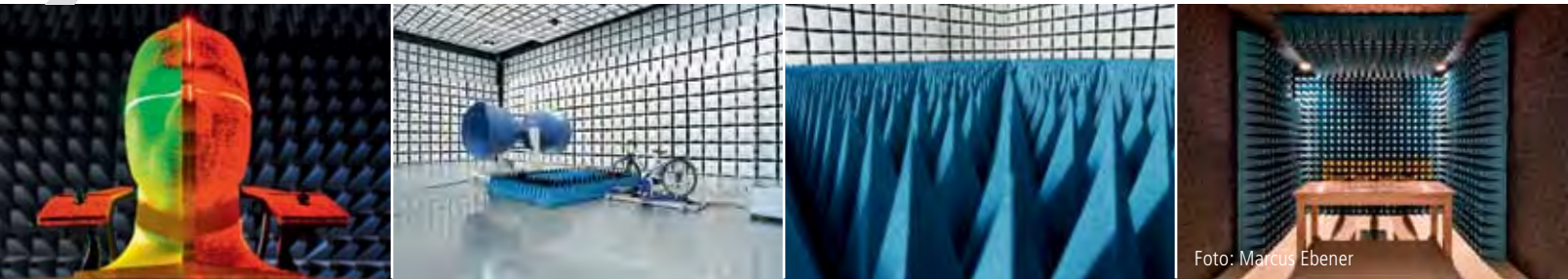
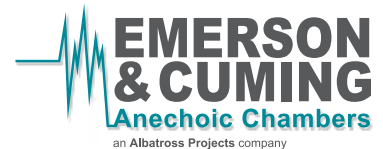


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THURSDAY INCLUDES*

WORKSHOPS/TUTORIALS

- >> Antennas
- >> Large Scale Modeling for Signal and Power Integrity
- >> EM Information Leakage
- >> Reverb Chambers & Complex Cavities
- >> Package/PCB Material Characterization
- >> High Speed Interconnect Design and Analysis III
- >> On-Chip and Off-Chip Power Integrity Issues and Design
- >> Numerical Modeling Approaches
- >> TEM & Reverb Measurements
- >> Business and Management Concerns in EMC
- >> Channel Emulation
- >> High Speed Interconnect Design and Analysis IV

EXPERIMENTS AND DEMONSTRATIONS

- >> Computer Modeling and Simulation Demonstrations
- >> Hardware Experiments & Demonstrations (Page 54)

OTHER EVENTS

- >> Global University (Page 58)
- >> IEEE EMC Society Board of Director's Meeting

EXHIBIT HALL OPEN EXHIBIT HALL MOVE OUT

*All events are subject to change. Check www.emc2014.org and the Registration Area daily for updates

Antennas

TH-AM-1 TC2 8:30 AM - 12:00 PM Rm 305A&B

Chair: Don Heirman, Don Heirman Consultants

Planned Speakers and Topics

8:30 AM

A Substitution Method for Antenna Calibration by the Use of Broadband Antenna (30 to 1000 MHz)

Mitsunobu Samoto¹, Nobuhito Samoto¹, Hiroyuki Shimanoe¹, Ikuo Makino¹ and Kazuo Shimada², (1) Liberty Labs Asia, Inc., Yokohama, Japan, (2) ETS-Lindgren Japan, Edogawa-ku, Japan

9:00 AM

Optical Tracking Based EM-field Probing System for EMC Near Field Manual Scanning

Hui He, Pratik Maheshwari, and David Pommerenke, EMC Laboratory, Missouri University of Science and Technology, Rolla, MO

9:30 AM

Broadband Measurement of Near-Fields for Predicting Far-Fields for EMC Applications

Prasanna Padmanabhan^{1,2}, Keith Hardin³ and William Smith¹, (1) University of Kentucky, Lexington, KY, (2) Delcross Technologies, Champaign, IL, (3) Lexmark International, Inc., Lexington, KY

10:00-10:30 AM Break

10:30 AM

Coupling Path Visualization using a Movable Scatterer

Sen Yang, Pratik Maheshwari, Victor Khilkevich and David Pommerenke, EMC Laboratory, Missouri University of Science and Technology, Rolla, MO

Large Scale Modeling for Signal and Power Integrity

TH-AM-2 Special Session: TC9 & TC10 8:30 AM - 12:00 PM Rm 306A&B

Chairs: Kai Xiao, Intel Corp and Duo Chen, Intel Corporation

Planned Speakers and Topics

8:30 AM

Checking PCB Design Electrically for PI/SI Issues

Kai Xiao¹, Thonas Su², Jimmy Hsu², Weifeng Shu³, Xiaoning Ye⁴ and Yuan-liang Li², (1) Intel Corp, DuPont, WA, (2) DCSG, Intel Corp, Taipei, Taiwan, (3) Intel Asia Pacific Research and Development Ltd, Shanghai, China, (4) Intel Corporation, Hillsboro, OR

9:00 AM

Mobile-oriented CPS (Chip-Package-System) Integrated Power Integrity Techniques at Early Chip Design Stage

Youngsoo Lee¹, Kyoungchoul Koo² and Woncheol Baek², (1) Samsung Electronics, Seoul, South Korea, (2) Samsung Electronics, Yong-in, South Korea

9:30 AM

Direct Finite-Element Solver of Linear Complexity for System-Level Signal and Power Integrity Co-Analysis

Bangda Zhou and Dan Jiao, Purdue University, West Lafayette, IN

10:00-10:30 AM Break

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10:30 AM**Post-layout PCB Check and Simulations for Signal Integrity**Jiang Li, Cadence. Design Systems, San Jose, CA and
Yingzhi Wu, Cadence Design Systems, Shanghai, China**11:00 AM****Wavelet Compression for Signal Integrity Analysis**

Jianfang Zhu and Adam Norman, Intel Corporation, Hillsboro, OR

EM Information Leakage

TH-AM-3 Special Session: TC5 8:30 AM - 12:00 PM Rm 306C**Planned Speakers and Topics****8:30 AM****Precisely Timed IEMI Fault Injection Synchronized with EM Information Leakage**

Yuichi Hayashi, Naofumi Homma, Takaaki Mizuki, Takafumi Aoki and Hideaki Sone; Tohoku University, Sendai, Japan

9:00 AM**Development of Human Resources in Hardware Security through Practical Information Technology Education Program**Naofumi Homma¹, Yu-ichi Hayashi¹, Toshihiro Katashita² and Hideaki Sone¹, (1) Tohoku University, Sendai, Japan, (2) AIST, Tsukuba, Japan**9:30 AM****Integrated-Circuit Countermeasures Against Information Leakage Through EM Radiation**Noriyuki Miura¹, Daisuke Fujimoto¹, Yu-ichi Hayashi², Naofumi Homma², Takafumi Aoki² and Makoto Nagata¹, (1) Kobe University, Kobe, Japan, (2) Tohoku University, Sendai, Japan**10:00-10:30 AM Break****10:30 AM****Software and Hardware Co-Verification for Privacy-Enhanced Passive UHF RFID Tag**

Yang Li, Toshiaki Nakasone and Kazuo Sakiyama, The University of Electro-Communications, Tokyo, Japan

11:00 AM**Investigation in Burst Pulse Injection Method for Fault Based Cryptanalysis**Kengo Iokibe¹, Kazuhiro Maeshima¹, Tetsushi Watanabe², Hiroto Kagotani¹, Yoshitaka Toyota¹ and Yasuyuki Nogami¹, (1) Okayama University, Okayama, Japan, (2) Industrial Technology Center of Okayama Prefecture, Okayama, Japan**11:30 AM****Hardware/Software Co-Design Flavors of Elliptic Curve Scalar Multiplication**

Josep Balasch, Benedikt Gierlichs, Kimmo Järvinen and Ingrid Verbauwhede, KU Leuven, ESAT/COSIC, Leuven, Belgium

Reverb Chambers & Complex Cavities

TH-AM-4 TC9 8:30 AM - 12:00 PM Rm 303**Chairs:** Vignesh Rajamani, Oklahoma State University and James West, Oklahoma State University**Planned Speakers and Topics****8:30 AM****A Hybrid Approach to Calculate Mean Response and Variance in a Reverberant Environment**Robin S. Langley^{1,2}, Andrea Barbarulo^{1,3} and Louis Kovalevsky^{1,3}, (1) University of Cambridge, Cambridge, United Kingdom, (2) Wave6, San Diego, CA, (3) Structural Acoustics Ltd, Cambridge, United Kingdom**9:00 AM****Dependence of Reverberation Chamber Performance on Distributed Losses: A Numerical Study**Gabriele Gradoni¹, Valter Mariani Primiani² and Franco Moglie², (1) The University of Nottingham, Nottingham, United Kingdom, (2) Università Politecnica delle Marche, Ancona, Italy**9:30 AM****Simulation of Stirred Fields within a Reverberation Chamber Using a Refined Spectral-Domain-Factorization Moment Method**

JAMES West, Vignesh Rajamani and Chuck Bunting, Oklahoma State University, Stillwater, OK

10:00-10:30 AM Break**10:30 AM****Search for Limits of Complex Cavity Model by Progressive Simplification**

Florent Todeschini, AIRBUS Defense & Space, Les Mureaux, France

11:00 AM**Random Coupling Model for Interconnected Wireless Environments**Gabriele Gradoni¹, Thomas Antonsen Jr.², Steven Anlage² and Edward Ott², (1) The University of Nottingham, Nottingham, United Kingdom, (2) University of Maryland, College Park, MD

SI/PI Package/PCB Material Characterization

TH-AM-5A-SIPI SI/PI 8:30 AM - 10:00 AM Rm 302B**Chairs:** Xiaoning Ye, Intel Corporation and Brice Achkir, Cisco Systems, Inc.**Planned Speakers and Topics****8:30 AM****Effective Roughness Dielectric in a PCB: Measurement and Full-wave Simulation Verification****** Finalist for Best SI/PI Paper Award**Marina Koledintseva¹, Tracey Vincent², Antonio Ciccomancini² and Scott Hinaga³, (1) Missouri University of Science and Technology, Rolla, MO, (2) CST of America, Framingham, MA, (3) PCB Technology Group, Cisco Systems, San Jose, CA

9:00 AM**Modelling Jitter Induced by Fibre Weave Effect in PCB Dielectrics**

Chudy Nwachukwu, Isola USA Corp, Chandler, AZ

9:30 AM**Characterization of PCB Dielectric Properties using Two Striplines on the Same Board**Lei Hua¹, Bichen Chen¹, Shuai Jin¹, Marina Koledintseva¹, Jane Lim², Kelvin Qiu², Rick Brooks², Ji Zhang², Ketan Shringarpure¹ and Jun Fan¹, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Cisco Systems, Inc, San Jose, CA**10:00-10:30 AM Break**

SI/PI High Speed Interconnect Design and Analysis III

TH-AM-5b-SIPI 10:30 AM - 12:00 PM Rm 302B

Chairs: Brice Achkir, Cisco Systems, Inc. and Dan Oh, Altera Corporation

Planned Speakers and Topics

10:30 AM**An Accurate, Robust and Intuitive Technique to Detect Causality Violations in Broadband Frequency Measurements****** Finalist for Best SI/PI Paper Award**

Piero Triverio, University of Toronto, Toronto, ON, Canada

11:00 AM**SI-PI Cosimulation Analysis of Dual Referencing and VSS-Referencing Memory Bus**

Mauro Lai, Intel Corp., Dupont, WA, Krishna Srinivasan, Intel Corp, Chandler, AZ, Ritochit Chakraborty, Intel Corp, Hillsboro, OR and Madhumitha Seshadhri, Intel Corp, DuPont, WA

11:30 AM**A Jitter Equalization Technique for Minimizing Supply Noise Induced Jitter in High Speed Serial Links**

Yujeong Shim and Dan Oh, Altera Corporation, San Jose, CA

SI/PI On-Chip and Off-Chip Power Integrity Issues and Design

TH-AM-6-SIPI 8:30 AM - 12:00 PM Rm 302C

Chairs: Dale Becker, IBM and Young Kwark, IBM Research

Planned Speakers and Topics

8:30 AM**Power Integrity Analysis for Core Timing Models****** Finalist for Best SI/PI Paper Award**

Dan Oh and Yujeong Shim, Altera, San Jose, CA

9:00 AM**Effect of Narrow Power Fills on PCB PDN Noise**Ketan Shringarpure¹, Biyao Zhao¹, Bruce Archambeault², Albert Ruehli¹, JAMES Drewniak¹ and Jun Fan¹, (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Systems & Technology Group, IBM Corporation, RTP, NC**9:30 AM****Optimization of PCB PDN Design using Enhanced VRM Model**Guang Chen¹, Zhiwei Liu², Mostafa Shabban³, Ahmed Abou-Alfotouh² and Dan Oh¹, (1) Altera Corp., San Jose, CA, (2) Altera Corp, HAMpton, NJ, (3) Altera Corp., Aswan, Egypt**10:00-10:30 AM Break****10:30 AM****Electrical Characterization of Bump-less High Speed Channel on Silicon, Organic and Glass Interposer**Hyunsuk Lee¹, Heegon Kim¹, Kiyeong Kim¹, Daniel Hyunsuk Jung¹, Jonghoon. J Kim¹, Sumin Choi¹, Jaemin Lim¹, Joungho Kim¹, Hyungsoo Kim² and Kunwoo Park², (1) KAIST, Daejeon, South Korea, (2) SK hynix, Icheon, South Korea**11:00 AM****Switching Voltage Regulator Modeling and its Applications in Power Delivery Design**Wei Xu¹, Jin Fang², Jiangqi He¹ and Tae Kim¹, (1) Intel Corporation, Chandler, AZ, (2) Intel Corporation, Dupont, WA**11:30 AM****Accelerating the Large-Scale Simulation of Power Distribution Networks by Using the Multi-GPU LIM**

Yuta Inoue and Hideki Asai, Shizuoka Univ., Hamamatsu, Japan

Numerical Modeling Approaches

TH-PM-1 TC9 2:30 PM - 5:30 PM Rm 305A&B

Chairs: Alan Roden, The Aerospace Corporation, Chantilly, Virginia, USA, and Albert Ruehli, Missouri University of Science and Technology, Rolla, Missouri, USA

Planned Speakers and Topics

2:30 PM**Parallel Power Grid Analysis Using Distributed Direct Linear Solver**

Qing He, William Au, Alexander Korobkov and Subramanian Venkateswaran, Oracle Corporation USA, Santa Clara, CA

3:00 PM**Uncertainty Quantification of EM/Circuit Systems Using Stochastic Polynomial Chaos Method****** Finalist for Best Student EMC Paper Award**

Ping Li and Li Jun Jiang, The University of Hong Kong, Hong Kong

3:30-4:00 PM Break**4:00 PM****An Active Thevenin Equivalent Network Approach to EMI/EMC Problems**

Jeffery Williams, Larry Bacon, Michael Walker and Erik Zeek, Sandia National Laboratories, Albuquerque, NM

4:30 PM**A Wigner Function Approach for Describing the Radiation of Complex Sources**

Gabriele Gradoni, Stephen Creagh and Gregor Tanner,
The University of Nottingham, Nottingham, United Kingdom

5:00 PM**Locally Stabilized Explicit Method for Fast Transient Analysis of Inhomogeneously-Meshed Plane Structures**

Tadatoshi Sekine, and Hideki Asai, Shizuoka University,
HAMAMatsu, Japan

TEM & Reverb Measurements

TH-PM-2 TC2 2:30 PM - 5:30 PM Rm 306A&B

Chair: Galen Koepke, NIST, Colorado Springs, Colorado, USA

Planned Speakers and Topics

2:30 PM**A Methodology to Generate a Time-varying Wave Impedance inside a TEM Cell ** Finalist for Best Student EMC Paper Award**

Guanghua Li, Venkata Anand Kishore Prabhala,
Abhinav Rakeshkumar Saxena, Qian Wang, David Pommerenke
and Pratik Maheshwari, EMC Laboratory, Missouri University of
Science and Technology, Rolla, MO

3:00 PM**Enhanced Estimates of Field Distribution's Uncertainty Contribution for TEM Waveguides**

David Hamann and Heyno Garbe, Institute of Electrical
Engineering and Measurement Technology, Leibniz Universität
Hannover, Hannover, Germany

3:30-4:00 PM Break**4:00 PM****Over-the-Air Performance Testing of a Real 4G LTE Base Station in a Reverberation Chamber**

Massimo Barazzetta¹, Davide Micheli², Franco Moglie³ and
Valter Mariani Primiani³, (1) Nokia Solutions and Networks
Italia, Cassina de' Pecchi, Italy, (2) TELECOM Italia, Rome, Italy,
(3) Dept. Information Engineering, Università Politecnica delle
Marche, Ancona, Italy

4:30 PM**Effectiveness of Absorbing Materials on Reducing Electromagnetic Emissions from Cavities Measured Using a Nested Reverberation Chamber Approach**

**** Finalist for Best Student EMC Paper Award**

Logan Washbourne¹, Vignesh Rajamani¹, Chuck Bunting¹,
James West¹, Bruce Archambeault² and Samuel Connor²,
(1) Oklahoma State University, Stillwater, OK, (3) Systems &
Technology Group, IBM Corporation, RTP, NC

Business and Management Concerns in EMC

TH-PM-3 TC1 2:30 PM - 5:30 PM Rm 306C

Chair: Doug Kramer, ETS-Lindgren, Austin, Texas, USA

Planned Speakers and Topics

2:30 PM**ITE EMC Requirements in BRIC Countries**

Mark Maynard, Marketing and Business Development, SIEMIC,
Inc., Milpitas, CA

3:00 PM**Demographics of Bench Level Automotive Electrical and Electromagnetic Compatibility Validation Test Laboratories**

Lawrence Banasky Jr., Electromagnetic Compatibility, Ford
Motor Company, Dearborn, MI

3:30-4:00 PM Break**4:00 PM****Part 2: Dealing with Complexities of Worldwide Regulatory Compliance; Beginning with EMC**

David Staggs, Hunt, TX

4:30 PM**Why Few (If Any) Medical Devices Comply with Their EMC Standard, and What Can Be Done About It**

Keith Armstrong, Cherry Clough Consultants Ltd, Stafford,
United Kingdom

5:00 PM**Size of Devices to be Measured at 3 m**

**** Finalist for Best EMC Paper Award**

Andy Griffin, Corporate Compliance, Cisco Systems Inc,
San Jose, CA

Channel Emulation

TH-PM-5-SIPI SI/PI 2:30 PM - 5:30 PM Rm 302B

Chairs: Zhiping Yang, Apple Computer and Michael Cracraft,
IBM Corporation

Planned Speakers and Topics

2:30 PM**Electro - Mechanical Structures for Channel Emulation**

Satyajeet Shinde¹, Sen Yang¹, Nicholas Erickson¹,
David Pommerenke¹, Douglas White², Chong Ding²,
Stephen Scarce² and Yaochao Yang², (1) EMC Laboratory,
Missouri University of Science and Technology, Rolla, MO, (2)
Cisco Systems, Inc., San Jose, CA

3:00 PM**Emulation of Lossy Channel Using a Low Loss Channel with Added Lossy Dielectric Material**

Wei Qian¹, Guanghua Li¹, Pratik Maheshwari¹, Chong Ding²,
Douglas White², Stephen Scarce², Yaochao Yang²,
Victor Khilkevich¹ and David Pommerenke¹, (1) EMC Laboratory,
Missouri University of Science and Technology, Rolla, MO, (2)
Cisco Systems, Inc., San Jose, CA

3:30-4:00 PM Break**4:00 PM****Implementation of a 18 GHz Bandwidth Channel Emulator Using FIR Filter**

Abhishek Patnaik¹, Atieh Talebzadeh¹, Tsiklauri Mikheil¹,
David Pommerenke¹, Chong Ding², Stephen Scarce²,

Douglas White² and Yaochao Yang², (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (3) Cisco Systems, Inc., San Jose, CA

4:30 PM

Designing A 3D Printing Based Channel Emulator

**** Finalist for Best SI/PI Paper Award**

**** Finalist for Best Student SI/PI Paper Award**

Xiangyang Jiao¹, Hui He¹, Guanghua Li¹, David Pommerenke¹, Wei Qian¹, Guangyao Shen¹, Chong Ding², Douglas White², Stephen Searce² and Yaochao Yang², (1) EMC Laboratory, Missouri University of Science and Technology, Rolla, MO, (2) Cisco Systems, Inc., San Jose, CA

Mikheil Tsiklauri¹, Mikhail Zvonkin¹, Jun Fan¹, JAMES Drewniak¹, Alexander Razmadze², and Bill Chen³, (1) EMC Laboratory, Missouri University of Science & Technology, Rolla, MO, (2) Altera Corporation, San Jose, CA, (3) Yangtze Delta Region Institute of Tsinghua University, Beijing, China

3:00 PM

Signal Integrity Optimization by Suppressing Resonance of Multi-Port Transfer Function in Multi-Interconnect Systems

Xingming Li¹, Shanqing Hu¹, Kye Yak See² and Yi Deng³, (1) Beijing Institute of Technology, Beijing, China, (2) Nanyang Technological University, Singapore, Singapore, (3) Virginia Polytechnic Institute and State University, Arlington, VA

3:30-4:00 PM Break

4:00 PM

Simulation Models for Signal Integrity Analyses Extracted from Computed Tomography Scans – A Case Study for High-Speed Interconnects

Jürgen Hillebrand¹, Sven Simon² and Steffen Kieß¹, (1) University of Stuttgart, Stuttgart, Germany, (2) Institute of Parallel and Distributed Systems, Stuttgart, Germany

4:30 PM

NEXT and FEXT Characteristics and Suppressions in Dense 25 Gbps+ Backplane Vias

Peerouz Amleshi and Cong Gao, Molex Inc, Lisle, IL

High Speed Interconnect Design and Analysis IV

TH-PM-6-SIPI SI/PI 2:30 PM - 5:30 PM Rm 302C

Chairs: Venkatesh Seetharam, Avago Technologies and Olena Zhu, Intel Corporation

Planned Speakers and Topics

2:30 PM

Causality and Delay and Physics in Real Systems



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WORKSHOPS/TUTORIALS

- >> Basic EMC Measurements
- >> EMC for Space Applications
- >> EMC Consultant's Toolkit
- >> Time Domain Site VSWR (sVSWR)
Method above 1 GHz and Correlations
to CISPR sVSWR
- >> Introduction to Spectrum Engineering
- >> Electromagnetic Time Reversal
with Emphasis on Lightning
and Fault Detection
- >> Details of the First Practical Method
for Risk-Managing EMC (or Achieving
EMC for Functional Safety)
- >> Understanding Recent EMC Standards
from the IEEE
- >> System Level Approaches to Design
and Test for EMI Control
- >> Introduction to Spectrum Engineering

OTHER EVENTS

- >> iNARTE Examinations
Preparation Tutorial (Page 56)

EXHIBITOR MOVE OUT

Basic EMC Measurements Sponsored by TC2

Format: Half-day Tutorial — FR-AM-1 8:30AM-Noon Rm 306 C

Chair: Don Heirman, Don Heirman Consultants, Lincroft, New Jersey, USA

Abstract

This tutorial will be an introduction to product immunity testing to comply with basic EMC immunity measurements methods for a wide range of products. Included will be a description of the latest test sites and their validation requirements and construction review. The latest activity in national and international standards related to EMC immunity measurements and application will also be presented as time allows. Where appropriate, attendees will be asked questions as to what they learned and have an opportunity for extended questioning of the speakers' subjects at the end of the session.

Planned Speakers and Topics

8:30 - 9:15 AM

Basic Measurement Facilities, Methods and Associated Errors

Don Heirman, Don HEIRMAN Consultants, Lincroft, New Jersey, USA

9:15 - 10:00 AM

**IEC Approach to Immunity Test Methods Using
the Application of Continuous RF Disturbances**

John Maas, IBM Corporation, Frostbite Falls, Minnesota, USA

10:30 - 11:15 AM

IEC View of Transient Immunity Testing

Thomas E. Braxton, Shure Incorporated, Niles, Illinois, USA

11:15 AM - NOON

High Power Electromagnetics Test Facilities and Measurement Methods

Bill Radasky, Metatech, Goleta, California, USA

EMC for Space Applications

Format: Half-day Tutorial — FR-AM-2 8:30AM-Noon Rm 306 A&B

Co-chairs: John McCloskey, NASA/Goddard Space Flight Center, Greenbelt, Maryland, USA

Albert Whittlesey, Jet Propulsion Laboratory, Pasadena, California, USA

Abstract

Achieving electromagnetic compatibility is challenging for any product or system in any environment. When a product or system is deployed into space, the designer faces additional challenges that are generally not a concern for ground-based equipment. This tutorial will discuss some of these challenges and techniques for addressing them.

Planned Speakers and Topics

Proper Cable Construction and Shielding Termination Techniques

Robert C. Scully, NASA Johnson Space Center, Houston, Texas, USA

Proper Flowdown and Tailoring of Requirements for a Given Platform

Pablo S. Narvaez, Jet Propulsion Laboratory, Pasadena, California, USA

Space Charging and Electrostatic Discharge

Albert C. Whittlesey, Jet Propulsion Laboratory, Pasadena, California, USA

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EMC in Space - Lessons Learned

John C. McCloskey, NASA/Goddard Space Flight Center,
Greenbelt, Maryland, USA

Integrated Use of CAE/CEM tools for EMI/EMC/RF Analysis and Mission Requirements Verification

Paul R. Edwards, NASA Kennedy Space Center, Florida, USA

Simple Statistical Model to Quantify Maximum Expected EMC in Spacecraft and Avionics Boxes

Dawn H. Trout, NASA Kennedy Space Center, Florida, USA
Paul Bremner, Sonelite Inc., Del Mar, California, USA

EMC Consultant's Toolkit

Format: Half-day Tutorial – FR-AM-3

8:30AM-Noon Rm 302 C

Chair: Jerry Meyerhoff, JDM Labs LLC, Buffalo Grove, Illinois, USA

Abstract

As more engineering and design firms outsource and reduce staff, more qualified EMC engineers are finding themselves “homeless.” As well, there are hundreds of companies that do not have the resources to hire a full-time EMC engineer. The purpose of this tutorial is to provide an introduction to the technical, business and marketing skills to interested EMC engineers so that they can successfully locate, market and provide effective services to these companies at a fair profit and with job satisfaction.

Topics to be addressed include practical tools and skills in the following areas—marketing and self-promotion, acquiring low-cost equipment, developing a troubleshooting kit using new and low-cost DIY tools and probes, how to use social media marketing, such as LinkedIn, to bring in business, networking practices, advertising, setting up your office, pricing your services, tracking your time, quickly assessing the client's issues, best business practices, how to present yourself professionally, tax and legal obligations as well as contracts and non-disclosure agreements. Presenters' own experiences and case histories in business, along with a panel Q and A will insure covering the needs and concerns of the audience.

Planned Speakers and Topics

Positioning Yourself

Jerry Meyerhoff, JDM Labs LLC, Buffalo Grove, Illinois, USA

Networking, Branding and Providing Customer Value

Kenneth Wyatt, Wyatt Technical Services LLC, Woodland Park, Colorado, USA

Presenting Yourself Professionally

Patrick André, André Consulting Inc, Bothell, Washington, USA

Acquiring Test Equipment and Developing a Low-Cost EMC Troubleshooting Kit

Patrick André, André Consulting Inc, Bothell, Washington, USA
and Kenneth Wyatt, Wyatt Technical Services LLC,
Woodland Park, Colorado, USA

Winning Financially Successful Contracts Without Frightening Customers Away

Keith Armstrong, Cherry Clough Consultants, Stafford,
Staffordshire, United Kingdom

Panel Discussion

Audience Q&A with all Presenters

Time Domain Site VSWR (sVSWR) Method above 1 GHz and Correlations to CISPR sVSWR

Format: Half-day Tutorial -- FR-AM-4

8:30AM-Noon Rm 305 A&B

Co-chairs: Zhong Chen, ETS-Lindgren, Cedar Park, Texas, USA
Janet O'Neil, ETS-Lindgren, Cedar Park, Texas, USA

Abstract

This tutorial covers the recent advances in the theory and measurements of the time domain site VSWR (sVSWR) method. Time domain sVSWR measures the antenna responses between a user-defined receive antenna and an omni-directional transmit antenna. It uses the time domain transformation of the vector frequency domain data to separate the direct antenna response from the reflections in a chamber. The sVSWR can then be calculated from that data. The test setups of the time domain sVSWR method, including the antenna height, locations, and polarizations closely resemble those in the CISPR method. Recent measurements have shown that the time domain sVSWR method results are closely correlated to the CISPR method results. Background information on the development of the method will be presented, as well as actual data collected from several labs showing the sVSWR using both the time domain and the CISPR methods. Extensive data analyses will be presented showing the benefits of the time domain sVSWR method, including faster testing (1/6th of the test time), better repeatability, greater accuracy in determining defects, and lower measurement uncertainties. The time domain sVSWR method is expected to be included in the latest draft version of the ANSI C63.25 standard.

Planned Speakers and Topics

Considerations of using Time Domain Methods to Improve Site Qualifications above 1 GHz

Bob Johnk, Technical Leader at Institute for Telecommunication Sciences (NTIA/ITS), Boulder, Colorado, USA

Time-Domain Performance Metrics in Anchoic Chambers

Dr. Bob Johnk, Institute for Telecommunication Sciences (NTIA/ITS), Boulder, Colorado, USA

Evolution of Time Domain Site VSWR and using Statistical Metrics to Evaluate Sites above 1 GHz

Zhong Chen, ETS-Lindgren, ANSI ASC C63® Subcommittee 1 chairperson and ANSI C63.25 working group member, Cedar Park, Texas, USA

Correlation and Empirical Validation of the Time Domain Methods

Dean Ghizzone and Greg Kiemel, Northwest EMC, ANSI C63.25 working group members. Hillsboro, Oregon, USA

Experiences with Time-Domain sVSWR Calibration Method to Evaluate 3 Meter Chamber

John Fessler, Lexmark International, Lexington, Kentucky, USA

Statistical vs. Deterministic Methods for Evaluating Complex Electromagnetic Environments

Dennis Lewis, Boeing, Seattle, Washington, USA

Introduction to Spectrum Engineering

Sponsored by TC6

Format: Full-day Tutorial -- FR-AM-5 and FR-PM-5

8:30AM-Noon Rm 303

Co-chairs: Karen Dyberg, TC6 Chair, Raytheon Integrated Defense Systems, Sudbury, Massachusetts, USA
Sarah Seguin, TC6 Secretary, The University of Kansas, Lawrence, Kansas, USA

Abstract

The Electromagnetic Spectrum is a finite resource and its use is rapidly expanding for both military and commercial use. Access to unencumbered spectrum has been, and continues to be, critical to many government and commercial systems. Many frequency bands within the spectrum are already congested and the challenge of efficiently managing the deployment of new systems and technologies will continue to become more complex. In order to efficiently utilize limited spectral resources, systems will need to become more efficient with their use and resilient to the effects of EMI. System designers will have to recognize that in-band and adjacent-band usage by other systems may require creative filtering and RF system design techniques in order to mitigate potential interference. Potential regulatory changes for both U.S. domestic and international domains are also a harbinger of change for spectrum engineering and management.

This tutorial introduces the EMC community to the subject of Spectrum Engineering, Spectrum Management, and their combined relationship to EMC. The objectives of EMC engineers and those who work in spectrum-related fields is the same; to enable electronic systems to perform their functions in the intended environment without causing or suffering unacceptable interference.

Planned Speakers and Topics

8:30 AM — 8:40 AM

Introduction

Karen Dyberg, Raytheon Integrated Defense Systems, Sudbury, Massachusetts, USA

8:40 AM — 9:25 AM

What is Spectrum?

Randy J. Jost, Ball Aerospace and Technologies Corporation, Westminster, Colorado, USA

9:25 AM — 10:00 AM

The History of Regulation

Brian Farmer, EMC Management, Sterling, Virginia, USA

10:30 AM — Noon

An Engineer's Overview with Respect to System Design

Tom Fagan, Raytheon Missile Systems, Tucson, Arizona, USA

Electromagnetic Time Reversal with Emphasis on Lightning and Fault Detection

Sponsored by TC5

Format: Full-day Tutorial -- FR-PM-1

1:30PM-5:30PM Rm 306 C

Co-chairs: Marcos Rubenstein, University of Applied Sciences Western Switzerland Institute for Information and Communication

Technologies, Yverdon-les-Bains, Switzerland
Farhad Rachidi, Institute of Technology, Lausanne, Switzerland

Abstract

The localization of the sources of electromagnetic radiation has numerous practical applications in electrical engineering and, in particular, the localization of the source of perturbations is important in electromagnetic compatibility. Classical localization methods applied to lightning and fault location include the well-known direction finding techniques, difference in time of arrival, peak-amplitude methods, interferometry, and time-domain reflectometry (the latter is only applicable to fault location). A technique known as "time-reversal", originally used in acoustics by Fink and co-workers has been proposed for the location of electromagnetic sources and, specifically, for lightning and for fault location in electric energy transmission and distribution networks. Time reversal is based on the invariance of physical laws under a $t \rightarrow -t$ transformation.

In this tutorial, we will present 1) an introduction to the main source location techniques used in lightning and fault location, 2) the physical basis for electromagnetic time reversal, 3) the application of time reversal to lightning location, and 4) the application of time reversal to fault location. The potential advantages and disadvantages with respect to classical location techniques will be discussed.

Planned Speakers and Topics

Electromagnetic Time Reversal with Emphasis on Lightning and Fault Detection: Introduction to Classical Location Techniques Part I

Marcos Rubinstein, Institute for Information and Communication Technologies, Yverdon-les-bains, Switzerland

Electromagnetic Time Reversal with Emphasis on Lightning and Fault Detection: Introduction to Classical Location Techniques Part II

Farhad Rachidi, Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, Marcos Rubinstein, Institute for Information and Communication Technologies, Yverdon-les-bains, Switzerland

Electromagnetic Time Reversal with Emphasis on Lightning and Fault Detection: Introduction to Classical Location Techniques Part III

Marcos Rubinstein, Institute for Information and Communication Technologies, Yverdon-les-bains, Switzerland

Electromagnetic Time Reversal with Emphasis on Lightning and Fault Detection: Introduction to Classical Location Techniques Part IV

Marcos Rubinstein, Institute for Information and Communication Technologies, Yverdon-les-bains, Switzerland

RALEIGH FACTS

Andrew Johnson, seventeenth President of the United States, was born in Raleigh.

Details of the First Practical Method for Risk-Managing EMC (or Achieving EMC for Functional Safety)

Sponsored by TC1

Format: Half-day Workshop -- FR-PM-2

1:30PM-5:30PM Rm 306 A&B

Chair: Keith Armstrong, Cherry Clough Consultants Ltd,
Chair of the IEEE EMC Society TC-1's Special Committee on the Risk
Management of EMC, Brocton, Stafford, United Kingdom

Abstract

Where safety risks can be increased by the effects of EMI on electronic equipment, EMC must be risk-managed for the full lifetime of the equipment/system/installation concerned, and so must take into account all aging, wear, corrosion, faults and misuse. Risks of death are only acceptable at levels below a 0.1% (1000ppm) per person per year, with most levels being set at or below 1ppm per person per year. A consequence of the above is that no affordable time/cost of EMC immunity testing, at any test levels, can provide the necessary design confidence required by the relevant safety standards. Where the future EM environment is unknown (as it usually is), the traditional approach (e.g. as used by the

military) is to use very rugged high-specification EM mitigation, designed to meet or exceed all possible environmental issues (shock, vibration, humidity, salt spray, temperature, EM disturbances, etc.). However, this 'big grey box' approach can be too large, heavy or costly for many modern safety-critical systems, especially (for example) in road/air transportation, portable medical devices, mobile life-support equipment, etc. The new approach described in this workshop is the first practical alternative to the very rugged high-specification EM mitigation approach and adds little to size, weight and cost.

Planned Speakers and Topics

Introduction to the Risk-Management of EMC, An Increasingly Important Topic

Jeffrey L Silberberg, Food and Drug Administration/Center for Devices and Radiological Health, Silver Spring, Maryland, USA

General Overview of Approaches: The 'Big Grey Box' or the New Method

Keith Armstrong, Cherry Clough Consultants Ltd, Brocton, Stafford, United Kingdom

Developments in All Related IEC Standards

Keith Armstrong, Cherry Clough Consultants Ltd, Brocton, Stafford, United Kingdom

Special Challenges for Medical EMC Standard IEC 60601-1-2

Jeffrey L Silberberg, Food and Drug Administration/Center for Devices and Radiological Health, Silver Spring, Maryland, USA

Discussions of the Detailed Design Techniques and Measures for Increasing Resilience Against EMI, Using the New Practical Method

Keith Armstrong, Cherry Clough Consultants Ltd, Brocton, Stafford, United Kingdom

Overall Discussions, Q&A

Chaired by Jeffrey L Silberberg, Food and Drug Administration/Center for Devices and Radiological Health, Silver Spring, Maryland, USA

Technical Summary and Conclusions

Keith Armstrong, Cherry Clough Consultants Ltd, Brocton, Stafford, United Kingdom

Understanding Recent EMC Standards from the IEEE

Sponsored by SDECom

Format: Half-day Tutorial -- FR-PM-3

1:30PM-5:30PM Rm 302 C

Chair: Alistair Duffy, School of Engineering and Sustainable Development, De Montfort University, The Gateway, Leicester, United Kingdom

Abstract

The development of Standards is an important way for a society such as the EMC Society to demonstrate the impact that the work of our members has on the profession as a whole. Similarly, it is a way for the Society to curate some of the most influential and novel research and development performed by our members.

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The society has a broad portfolio of standards that has probably one of the highest standards-per-member ratio of any IEEE Society. This portfolio has been recently expanded by four very different standards but which all have interest and appeal across a broad range of membership. This workshop addresses a number of objectives:

1. Provide the Symposium attendees with an overview of these standards.
2. Allow the attendees to interact with members of the development working groups for a better understanding of those standards.
3. Update the attendees on current and planned standards development work, providing an opportunity for them to volunteer to contribute if they would like to do so.
4. Discuss the Society's approach to the development of standards and suggestions for future standardization activities.

Planned Speakers and Topics

Introduction - Understanding Recent EMC Standards from the IEEE

Alistair P. Duffy, De Montfort University, Leicester, UK

Standard Technique for Shielding Effectiveness Measurement of "Small" Enclosures: IEEE P299.1-2013

A. G. D'Aloia

IEEE 1309 Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9 kHz to 40 GHz.

Zhong Chen, ETS-Lindgren, Cedar Park, Texas, USA, and Domenico Festa, IBD, Chiari, Italy

IEEE 1642 Recommended Practice for Protecting Public Accessible Computer Systems from Intentional EMI

William Radasky, Metatech Corporation, Goleta, California, USA

Current and Emerging EMC Standardization Projects

Alistair P. Duffy, De Montfort University, Leicester UK

The Process of Standardization in the EMC Society (Including a Comparison with other Standardization Bodies)

Don Heirman, Don Heirman Consultants, Lincroft, New Jersey, USA

System Level Approaches to Design and Test for EMI Control

Sponsored by TC4

Format: Half-day Tutorial -- FR-PM-4

1:30PM-5:30PM Rm 305 A&B

Co-chairs: Karen Burnham, Sierra Nevada Corp., Denver, Colorado, USA

John G. Kraemer, Rockwell Collins, Inc., Cedar Rapids, Iowa, USA

Abstract

EMI and EMC are of critical concern at the box, sub-system, and system levels when it comes to building complex systems. Even when a component is designed right and has passed testing, attention must be given to integrating multiple components into a larger system. This tutorial will address design and test approaches for ensuring that multiple components can be integrated in a way that minimizes EMI concerns.

Planned Speakers and Topics

Military Control of Electromagnetic Interference, WWII to Present

Ken Javor, EMC Compliance, Huntsville, Alabama, USA

Systems Level Perspectives for E3 and EMI Control

Dr. Timothy J. McDonald, Electro Magnetic Applications, Denver, Colorado, USA

EMC Design Considerations for High-speed Interfaces in Defense/Aerospace Systems

John G Kraemer, Rockwell Collins, Cedar Rapids, Iowa, USA

"Ground" in Space

Dr. Robert C. Scully, NASA Johnson Space Center, Houston, Texas, USA

Introduction to Spectrum Engineering

Sponsored by TC6

Format: Full-day Tutorial -- FR-AM -5 and FR-PM-5

1:30PM-5:30PM Rm 303

Co-chairs: Karen Dyberg, TC6 Chair, Raytheon Integrated Defense Systems, Sudbury, Massachusetts, USA

Sarah Seguin, TC6 Secretary, The University of Kansas, Lawrence, Kansas, USA

See FR-AM-5 for description

1:30 PM – 2:15 PM

Spectrum Monitoring

Bill E. Wangard, Rohde and Schwarz USA, Inc., Kildeer, Illinois, USA
Sarah Seguin, The University of Kansas, Lawrence, Kansas, USA

2:15 PM – 3:00 PM

The Current State of Spectrum Usage

Larry Cohen, Naval Research Laboratory, Gaithersburg, Maryland, USA

3:30 PM – 5:00 PM

Spectrum Efficiency Advances

John Stine, The MITRE Corporation, McLean, Virginia, USA

SI/PI Workshops and Tutorials

FOR THE FIRST TIME EVER there will be an embedded conference within the IEEE International EMC Symposium: the 2014 IEEE International Conference on Signal and Power Integrity (SI/PI 2014). One registration will allow access to both the EMC and SI/PI technical programs. As high-speed designs continue to evolve, signal and power integrity (SI/PI) and other EMC problems are becoming more tightly related. This conference provides a unique opportunity for attendees to exchange ideas and share experiences relevant to today's high-speed designs. The standalone technical program of this embedded SI/PI conference includes: regular technical sessions and special sessions from Tuesday to Thursday, as well as workshops and tutorials on Monday and Friday.

SI/PI 2014 TECHNICAL PAPERS

Technical papers will be provided Tuesday through Thursday in two or more parallel sessions. This is the first IEEE International Conference on Signal and Power Integrity, and a large number of paper submissions have been received and will be incorporated into this year's symposium (over 40% of all the papers received are SI/PI related). We are very excited to present outstanding technical sessions that reflect the latest research and technology advancements from industry, academia, and government related to signal and power integrity. One best paper award and one best student paper award for Signal and Power Integrity will be selected, and the finalists for the awards will be announced in the final program. The technical papers will be given in two formats: oral presentation sessions and poster paper sessions.

PRESENTATION OF PAPERS SESSIONS

The Technical Papers Sessions presentations are oral briefings on a digital projector in a theatre-style room setup. The Session Chair will moderate the meeting between speaker presentations and questions and answers with the attendees and speakers.

PRESENTATION OF POSTER SESSION PAPERS

For the Poster Paper Sessions, the authors will be available for one hour to present and discuss their papers. Afterwards, the posters will be moved to another location for further review by those who may be interested. To provide prominence to the poster session papers, no technical paper oral presentations will be scheduled during that one hour session.

SI/PI 2014 SPECIAL SESSIONS

There will be two special sessions in the embedded conference. Special sessions cover more focused topics in the areas that are beginning to be developed or are of particular interest to the attendees. The invited speakers are well-known experts, and the topics reflect the latest and greatest results in the specific areas. Special session papers, although invited, are reviewed using the same criteria as regular papers to ensure the high quality of the technical program.

Numerical Methods for Signal and Power Integrity

Sponsored by IEEE EMC Society TC10

Large Scale Modeling for Signal and Power Integrity

Sponsored by IEEE EMC Society TC9 and TC10

MONDAY

Introduction to SI/PI Modeling and Design

Format: Half-day Tutorial 8:30AM-Noon Rm TBD

Co-chairs: A. Ege Engin, San Diego State University, San Diego, California, USA

Antonio Ciccomancini, CST of America, Boston, Massachusetts, USA

Abstract

As the clock frequencies for off-chip signals approach 20 GHz and beyond, maintaining signal and power integrity are becoming major issues to design a computer system that can actually support such speed. This tutorial will cover fundamentals of modeling, simulation, and design techniques to ensure signal and power integrity.

The list of topics covered in this tutorial can be summarized as:

- SI/PI modeling techniques: Modeling of frequency-dependent parameters due to skin effect and dielectric loss; modeling of transmission line return currents and return path discontinuity; modeling of power distribution networks; glass-weave effect; EM simulation techniques for SI/PI; ensuring causality and passivity in simulations.
- SI/PI design techniques: Design approaches including crosstalk mitigation methods, equalization methods, and eye estimation methods; exploitation of CAE (Computer-Aided Engineering) technology and the future trends in SI/PI design.

Primary audience and secondary audience being targeted:

Signal integrity and EMC engineers, package and PCB layout designers.

Planned Speakers and Topics

1. High-Speed Channel Design Considering Loss, ISI, Equalizer, and Eye Diagram

Joungho Kim, Korea Advanced Institute of Science and Technology, Seoul, Republic of Korea

2. SI/PI/EMI Issues and Exploitation of CAE in High-Speed Electronic Design

Hideki Asai, Shizuoka University & SESAME Technology Inc., Shizuoka, Japan

3. Modeling and Optimization of Bond Wire Interconnects for High-speed Applications using the M3-Approach

Ivan Ndiip, Fraunhofer IZM, Germany

4. EM Modeling of High-Speed Interconnects for Signal Integrity Analysis

Antonio Ciccomancini, CST of America, Boston, Massachusetts, USA

5. Equivalent Circuit Modeling Approaches for SI/PI Analysis

A. Ege Engin, San Diego State University, San Diego, California, USA

Advanced Topics in Signal and Power Integrity - Achieving 25 Gb/s to 100 Gb/s

Format: Half-day Workshop 1:30PM-5:30PM Rm TBD

Co-chairs: Dale Becker, IBM Corporation, Poughkeepsie, New York, USA
Xiaoning Ye, Intel Corporation, Hillsboro, Oregon, USA

Abstract

The challenges of high-speed channel system design require the electrical engineer to understand signal integrity, power integrity and EMC and make the appropriate decisions so that all electrical constraints are met. The growth of bandwidth demand on our systems is resulting in a rapidly increasing operating bit rate of the data channels. This session gives a survey of the broad range of challenges the signal and power integrity engineers face in designing high speed links at 25 Gb/s and faster. This workshop offers leading edge engineers presenting the design of transmit and receive circuits, development of standards, design of channel components, modeling and measurement of interconnect, and the impact of jitter and non-linear impact on the performance of channels in the 25 Gb/s to 100 Gb/s operating range.

Planned Speakers and Topics

1. Emerging IEEE 100 Gb/s Ethernet Standards - Unification of Transmitter, Receiver, and Channels Specification

Richard Mellitz, Intel, Columbia, South Carolina, USA

The 100 Gb/s Ethernet over backplanes and copper cables project needed to support wide and diverse markets allowing for platform topology tradeoffs. Lingered from 10 Gb/s Ethernet was the desire to be able to support 1 meter of backplane with 2 connectors. This presented a number of challenges such as insertion losses spread over the marketplace of 5 dB to 47 dB die to die. A tight budget was required to manage tradeoff decisions involving crosstalk and reflection which are manifests of board and connector choices.

This talk through will describe the channel specification which is computed as a channel operating margin (COM). COM is essentially a signal-to-noise ratio statistically computed from the channel single bit response and the reference minimum signaling architecture. The relation to chip jitter, CDR, packages, die termination, and silicon noise are all described. A goal for the receiver compliance was to enable testing with a real product channel and use of a chip's transmitter. The unified channel budget is illustrated with the utilization of COM and transmitter specifications for receiver compliance testing.

The project faced the challenge cascading of packages and for cables, module boards, to arbitrary set of channel s-parameters. A new efficient method for describing transmission lines was developed for this task which will be explained.

2. Low Power and High Density 56Gb/s Links for Next Generation Systems

Mounir Meghelli, IBM Research, Yorktown Heights, New York, USA

On-off keying modulation format (e.g. NRZ) may not be the best option for 56Gb/s I/Os for next generation systems. The majority of the NRZ signal power resides in a bandwidth equal to half the bit rate (i.e. 28GHz at 56Gb/s), with significant energy at the half bit rate frequency. In the context of limited device speed improvement from silicon technology scaling, transferring signal energy at such a high frequency is quite demanding for the integrated circuit components. Equally a limiting factor, the insertion loss of printed circuit board

(PCB) copper traces is not scaling as fast as the demand for higher speeds, even considering the lowest loss dielectric materials deemed as manufacturable at a reasonable cost increase. Signaling schemes with better spectral efficiency such as n-level amplitude modulation (PAMn, n>2), or more advanced digital modulation schemes can be used, but at the cost of increased circuit complexity and power.

3. Analysis of Non-Linear Effects in Serial Links

Wendem Beyene, Rambus, Los Altos, California, USA

The linearity assumption in link analysis does not hold anymore as current transmitters and receivers get more complicated. For example, high-speed transmitters and receivers often incorporate equalization blocks that have multiple stages and feedbacks. This change in non-linearity is not only limited to serial links. In LVSTL mobile memory interface, the pull-up and pull-down devices are also highly nonlinear. In this talk, the impact of nonlinearity and the limitations of linear link analysis to predict system performance are reviewed. Approaches based on multilinear theory are presented to handle weakly nonlinear links.

4. Power Integrity Challenges for Next Generation High-Speed Signalings

Dan Oh, Altera, San Jose, California, USA

In recent years, high-speed interface designs have mostly focused on signal quality. As a result, advanced signal conditioning methods have been well developed in order to address signal quality. Emerging new challenges in high-speed system designs is jitter due to power noise. This tutorial briefly reviews the modern signaling trends and challenges. It then presents the unique supply noise induced jitter challenges for different signaling schemes used for various digital systems, such as 2.5/3D integrations, parallel/memory buses, core clock distribution, and serial links. As an example, supply noise issues and solutions for the next-generation serial links are considered in detail.

5. Measurement Challenges for Package Model Verification - Is Measurement Still the Gold Standard?

Young Kwark, IBM Research, Yorktown Heights, New York, USA

Measurements, especially those made using the precision calibration and de-embedding algorithms available for vector network analyzers, have constituted the gold standard against which full wave simulations were compared. This was due to several factors: lack of precise knowledge of dielectric properties, difficulty in modeling of interfacial phenomena such as surface roughness, and the increasing computation resource required to model at short wavelengths for ever larger physical structures. As data rates push past 28Gb/s, increasing measurement uncertainties due to decreasing dynamic range, increasing uncertainty in correlation between calibration/de-embedding vs D.U.T. structures, and increasing equipment and fixturing expense make experimental verification of simulation results more problematic. This talk will address some of these challenges and suggest possible future strategies to address them.

6. Channel Component Design for 56 Gb/s

Peerouz Amleshi, Molex Corporation, Lisle, Illinois, USA

As the Datacom industry has expressed a need for serial data rates higher than today's 28 Gb/s for chip-to-module I/O interconnects, feasibility studies on single lane 56Gb/s links have recently begun. Once the feasibility of 56 Gb/s transceiver chips, modulation techniques, and interconnect components is established, the standard bodies will proceed to define the channel performance requirements to guarantee acceptable transmissions.

In our study, we consider a 56 Gb/s backplane system consisting of two chip module cards (MC), two backplane connectors, and a corresponding backplane (BP). Signals originating from one MC flow within a connector and route through the BP to the other connector

and MC. For this BP system, we investigate the high-speed effects of the channel components on the overall channel characteristics such as: transmission loss, loss resonances, and impedance discontinuities. Assuming a suitable signaling scheme, we attempt to determine the high-speed design requirements for each individual channel component in order to obtain high quality 56 Gb/s channel operations.

7. SI Interconnect Modeling Challenges at 56 Gb/s and Common Mistakes

Steve Pytel, ANSYS, Columbia, South Carolina, USA

During this 30 minute tutorial an overview of challenges associated with routing SerDes at 56 Gb/s will be discussed. The focus will be to understand limitations and commonly encountered mistakes that happen with electrical models used in circuit simulators. We will discuss several important techniques that are commonly available within the industry which help minimize modeling mistakes. These techniques will include dielectric loss handling, surface roughness impact, passivity and causality of reduced order models produced by EM field solvers for use with system simulations in the time domain.

FRIDAY

Essential Principles of Jitter

Format: Half-day Tutorial 8:30AM-Noon Rm TBD

Co-Chairs: Eric Bogatin, Teledyne LeCroy Front Range Signal Integrity Lab, Longmont, Colorado, USA
Alan Blankman, Teledyne LeCroy Corporate Headquarters, Chestnut Ridge, New York, USA

Abstract

All high speed serial links will have bit errors due to jitter. It is absolutely unavoidable. The challenge is to engineer the channel design to keep these bit errors at an acceptable level. This means understanding the root cause of jitter and fixing the problem at the source. What makes this complicated is that the clock is embedded in the data and the channel can dramatically distort the signal quality at the receiver. These factors make jitter analysis very subtle.

This tutorial will start at the ground level and illustrate what jitter is, what its various components are, their root cause and signature, and how the various sources of jitter can interact. We will look at features in the TX and RX and the interconnect that contribute to jitter and some of the design guidelines that will help minimize their problems. We will show how to estimate the bit error ratio based on the magnitude of the jitter. Finally, we show practical examples of how to separate the types of jitter from real measurements to help identify the root cause and from measurements of only a few million bits, how to extrapolate to very tiny bit error ratios. Attendees will leave the tutorial with a firm understanding of the essential principles of jitter, so they will be up to speed and apply these principles to their daily engineering activities.

Planned Speakers and Topics

Eric Bogatin, Teledyne LeCroy Front Range Signal Integrity Lab, Longmont, Colorado, USA
Alan Blankman, Teledyne LeCroy Corporate Headquarters, Chestnut Ridge, New York, USA

Session 1: What is Jitter

- Clock jitter and do we care
- Clock and data patterns
- The time interval error (TIE)
- Analysis of jitter: TIE trends, histograms
- Type of jitter: ISI, DCD, periodic, random

Session 2: Analysis of Jitter

- Signature and figures of merit of ISI jitter
- Signature and figures of merit of DCD jitter
- Signature and figures of merit of periodic jitter
- Signature and figures of merit of random jitter
- Playing together: interactions of the various types of jitter
- Total jitter and estimating bit error ratio

Session 3: Practical Analysis of Jitter

- Measuring jitter with a scope
- Decomposition and separating DCD and ISI jitter
- Decomposition and separating periodic jitter
- Decomposition and separating random jitter
- How to avoid common artifacts
- Examples of USB and PCIe busses

RALEIGH FACTS

Raleigh is the largest city in the Research Triangle, a region in the Piedmont of North Carolina anchored by North Carolina State University, Duke University, University of North Carolina at Chapel Hill, and the cities of Raleigh, Durham, the town of Cary and the town of Chapel Hill respectively. The area also includes the well-known Research Triangle Park, home to numerous high-tech companies and enterprises.

Technical Committee (TC) Meetings play an important role in the overall success of the EMC Society by promoting activities in their fields and providing expert knowledge and assistance to generate and review technical papers, organize and operate sessions at symposia, generate and develop standards, and evaluate the state of the art in EMC science. All meetings are open to everyone; join them for breakfast, a break, lunch, or dinner. Listen to the discussions and learn what they are working on. Join your peers who volunteer to make EMC better. Just by attending, you can be part of the solution and the future of EMC!

Technical Committee 1: EMC Management

This committee is concerned with the development and dissemination of Best Practices and Methodologies for the successful leadership, supervision and guidance of EMC related activities. These Best Practices and Methodologies shall be structured so as to provide assistance to all managers, and engineers. Appropriate and convenient tools shall serve as a foundation to these Best Practices and Methodologies.

Technical Committee 2: EMC Measurements

This committee is concerned with the measurement and instrumentation requirements in EMC standards and procedures and how they are interpreted. Also concerned with the adequacy of measurement procedures and measurement instrumentation specifications for radiated and conducted emission and susceptibility tests and the rationale for performance limits for these tests.

Technical Committee 3: Electromagnetic Environment

This committee is to encourage research in the following areas: electromagnetic environment (EME), development of standards for EME measurement and characterization, natural and man-made sources of electromagnetic environment that comprise this environment, effects of noise (unwanted portions of EME) on systems performance, effects of international civil and military standards intended to control man-made intentional and unintentional emissions of electromagnetic energy.

Technical Committee 4: EMI Control

This committee is concerned with design, analysis, and modeling techniques useful in suppressing interference or eliminating it at its source. Bonding, grounding, shielding, and filtering are within the jurisdiction of this committee. These activities span efforts at the system, subsystem, and unit levels.

Technical Committee 5: High Power Electromagnetics

This committee is concerned with the effects and protection methods for electronic equipment and systems for all types of high power electromagnetic environments. These environments include electromagnetic pulse (EMP), intentional EMI environments (i.e., narrowband and wideband), lightning electromagnetic currents and fields, electrostatic discharge and geomagnetic storms. In addition this committee deals with the commercial data security issue through electromagnetic information leakage activities. Interactions with subsystems, systems and platforms are included.

Technical Committee 6: Spectrum Management

This committee is concerned with the analysis, design, and measurement techniques for intentional RF transmitting and receiving equipment to prevent interference and promote efficient spectrum use through technology and operational based approaches, such as software design, dynamic spectral allocation, waveform control, as well as frequency coordination and management procedures.

Technical Committee 7: Low Frequency EMC

This committee is concerned with low-frequency EMC including Power Quality in electric power systems. The committee is focusing on application of fundamental EMC concepts also to low frequency conducted disturbances. EMC in power systems is expected to be increasingly important. This is due to increased use of electronics in renewables, electric vehicles, energy efficient technologies and Smart Grid applications.

Technical Committee 9: Computational Electromagnetics

This committee is concerned with broad aspects of Applied Computational Electromagnetic techniques which can be used to model electromagnetic interaction phenomena in circuits, devices, and systems. The primary focus is with the identification of the modeling methods that can be applied to interference (EMC) phenomena, their validation and delineating the practical limits of their applicability. Included are low and high frequency spectral-domain techniques and time-domain methods.

Technical Committee 10: Signal and Power Integrity

This committee is concerned with the design, analysis, simulation, modeling and measurement techniques useful in maintaining the quality of electrical signals. These activities encompass all aspects of signal integrity from the integrated circuit level to the system level.

Technical Committee 11: Nanotechnology

The newest technical topic area for the EMC Society, the topics include carbon nanotubes, composite materials, and other measurements, design, and analysis applications.

Special Committee 1: Smart Grid

This special committee is concerned with coordination of 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 and in some cases exiting a house or building.

Special Committee 4: EMC for Emerging Wireless Technologies

This committee is concerned with the design, analysis, modeling and measurement for interference control and mitigation in emerging wireless products. The committee encourages researches including but not limited to the following areas: EMC-based system architecture design and system planning, strategic EMC performance budgeting and distribution, new system interface requirements and new system integration methods, intra-system coupling path analysis, modeling and validation, new EMC evaluation/measurement methods and standards for components/devices, Innovative component designs with integrated EMC functionalities, new EMC material requirements, applications and evaluation methods, and interdisciplinary issues involving EMC, audio, mechanical, and thermal designs.

Special Committee 5: Power Electronics EMC

This committee is concerned with power electronics converters EMI/EMC issues. These are mainly, converters that use switching frequency schemes to control the output parameters, such as voltage and current. These converters, including inverters, can be found as interface between the raw power and the electrical grid to provide the end-user with the desired operating power. Applications can range from grid-connected PV systems, wind farms, automotive, aerospace, and communication systems.

Special Committee 6: Unmanned Aircraft Systems EMC

This committee is concerned with design, testing, modeling/simulation required for system level EMC for unmanned aircraft systems that will be engaged in all-weather autonomous single and cooperative flight. Special emphasis is on spectrum management on intra and inter-system interactions (platform integration), mission specific data security and bandwidth requirements, and robust performance in the presence of high intensity radiated fields (HIRF). Engagement in the development of standards will be a key role of this special committee.

COMPUTER MODELING AND SIMULATION DEMONSTRATIONS

TUESDAY, AUGUST 5 - 10:00 AM — NOON

Topic: Using Simulated EMC Instruments to Develop, Edit, and Validate EMC Test Routines

Presenter: Joe Tannehill, ETS-Lindgren, Austin, TX, USA

Abstract: Automating the EMC test process has the benefits of improving measurement accuracy and repeatability while also increasing test throughput. EMC testing is complex and requires multiple instruments to work in unison so that data gathered is coherently assembled to determine compliance of a device under test.

Integrity of the test setup is typically done with system checks where a known signal is injected at some point in the system and compared with expected results. This approach is great for validating the entire hardware/software signal chain. Using virtual instruments, the software side of the system can be validated before assembling the instrumentation. This is a significant time saver and allows for scenario testing without tying up test equipment and chamber time.

This demonstration will show how instrument simulation can be used to setup system checks as well as validate actual EMC emissions and immunity tests.

TUESDAY, AUGUST 5 — 2:00 PM — 4:00 PM

Topic: Simultaneous Measurement and Simulation of Induced Pin Transients on a Typical Aerospace Shielded Cable Harness

Presenter: Jennifer Kitaygorsky and Timothy McDonald, Electro Magnetic Applications, Inc., Lakewood, CO, USA

Abstract: One of the challenges of electromagnetic modeling on systems (aircraft, vehicles, wind turbines, etc.) is understanding the induced transients on individual pins. It is reasonably straightforward to model the currents that are induced on overall cable bundles. However, it is the current and voltage on inner conductors that often matters to system designers.

The geometry is not very simple. There can be branches of cables, multiple shield levels, and multiple conductors in a bundle that can complicate this effort. One approach to simulating this system is a modified finite-difference time domain solution of the telegrapher's equations with special considerations for junctions and boundaries.

In this demonstration, we will provide a "live" demonstration of a measurement of the transient coupled to the inner pins of a typical aerospace cable. Simultaneously, we will describe how to set up a simulation of the same system. The audience will learn about both measurement and simulation techniques and see how well the two match up.

WEDNESDAY, AUGUST 6 - 9:00 AM — 11:00 AM

Topic: Field-Circuit Co-Simulation of ESD impacts on Electronic Devices

Presenter: Bo (Rodger) Zhao, Wave Computation Technologies, Inc.

Abstract: ESD (electrostatic discharge), the sudden and momentary electric current that flows between two objects at different electrical potentials, causes equipment failure and network downtime, thus causing production losses of multiple billions of dollars annually. From portable consumer electronics to industrial-automation, process-control systems, and military and aerospace applications, every electronics manufacturer must consider ESD during equipment design.

ESD testing is a mandatory step but also a money-burning stage. It is nice to use CAE (computer aided engineering) tools to predict the behaviors on computer screen rather than seeing a failure device burned down. However, modeling and simulating such a process is challenging due to its multi-physics and multi-scale nature. In this talk, we will review the state-of-the-art solutions on simulating ESD problems and demonstrate its capability on solving ESD problems for electronic devices.

WEDNESDAY, AUGUST 6 — 2:00 PM — 4:00 PM

Topic: EMI/EMC Analysis for High-Speed Digital Design

Presenter: Colin Warwick, Agilent EEs of EDA, Andover, MA, USA

Abstract: Even at today's high data rates, it is now possible to analyze EMI/EMC behavior and mitigate their effects before prototypes are built, using computational electromagnetics (CEM). In this demo, we will compare simulation with industry regulatory standards such as FCC and CISPR. Examples will include chassis, housings, cables, and connectors.

Topic: Channel Modeling and Analysis for Signal Integrity in High-Speed Digital Designs

Presenter: James L. Drewniak, Missouri University of Science and Technology, Rolla, MO, USA

Abstract: High-speed layouts on printed circuit boards for multi-gigabit signals require careful layout and analysis of the channel performance to ensure the specification for bit-error-rate is met. The physical layout of the channel is broken down into its constituent parts from transmitter to receiver including all routing geometry features. Each block in the routing is characterized in terms of S-parameters, and an end-to-end model of cascaded S-parameter blocks is assembled to model the layout. Eye patterns can then be generated from PRBS sequences. Equalization can be applied if the specified eye pattern mask is not achieved. Breaking down layout for modeling will be shown in this demonstration, and construction of a channel model from cross-sectional analysis for printed circuit transmission-lines, and other S-parameter blocks. Pre- and de-emphasis will be shown, as well as equalization for improving the eye pattern and bit-error-rate for lossy channels.

THURSDAY, AUGUST 7 - 9:00 AM — 11:00 AM

Topic: The Virtual EMC Testbench

Presenter: Jim DeLap, ANSYS, Inc., Burlington, MA

Abstract: Typically, electromagnetic modeling of entire systems is not performed for the purpose of EMC compliance. Using a combination of 0d through 3d models, entire products can be modeled from an electromagnetic perspective. Additionally, coupling the physical model to mechanical and fluid dynamic solvers allow the tradeoffs between electromagnetic, acoustic, and thermal domains.

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HARDWARE EXPERIMENTS & DEMONSTRATIONS

TUESDAY, AUGUST 5 - 10:00 AM — NOON

Topic: Demonstration of Differential Pair Signaling to Show the Effects of Asymmetry, Skew, Interconnects, Stubs, and Loose Coupling.

Presenters: Bill Spence and Ben Appold, Gentex Corp, Zeeland, MI, USA

Abstract: Demonstration of Differential Pair Signaling to Show the Effects of Asymmetry, Skew, Interconnects, Stubs, and Loose Coupling.

Topic: Effects of "Pigtails" on Shield Terminations

Presenter: John McCloskey, NASA/Goddard Space Flight Center, Greenbelt, MD, USA

Abstract: The effectiveness of a shield on a cable assembly is largely determined by the implementation of its terminations to its respective connectors/backshells. From an EMC perspective, the proper termination provides a connection that maintains 360-degree coverage of all of the signal conductors. However, many cable designs continue to implement shield-to-connector/backshell terminations with a wire. This type of termination, which is commonly called a "pigtail," adds undesired impedance to the termination and compromises the effectiveness of the shield.

In this demonstration, the shielding effectiveness will be measured on cables that implement "pigtail" terminations of varying lengths. The shielding effectiveness will also be measured on a cable that implements proper 360-degree terminations. The results will be compared to demonstrate: 1) the 360-degree termination is more effective than any the pigtail terminations, and 2) for the pigtail terminations, the shielding effectiveness degrades as the pigtail length increases.

TUESDAY, AUGUST 5 — 2:00 PM — 4:00 PM**Topic:** Inductive Effects in Cables**Presenter:** Jerry Meyerhof, JDM Labs LLC, Buffalo Grove, Illinois, USA**Abstract:**

The laboratory objective : Understand the practical implementation details of "cables" or "transmission lines" which are critical to EMC performance, as used between modules/units, across systems and within Printed Circuit Boards (PCBs).

Demonstrated Observations:

- 1) Signal currents follow the path of least impedance.
- 2) Cable geometry effects and self-shielding.
- 3) Conversion mechanisms between differential and common mode signal propagation.
- 4) Impact of cable mechanical end termination geometry such as "pigtail" connections.
- 5) Use of Common-Mode Chokes.

Analyze and Predict the observed effects

Another element of the presentation is to talk about the tasks involved in getting an educational lab to work, much like the Chris Semanson article in our EMCS magazine and his own demos in past years.

Topic: LTE Interference from Consumer Devices**Presenters:** Paul Densizowski, Bill Wangard, and Darren McCarthy, Rohde & Schwarz, Columbia, MD, USA

Abstract: Over-the-air interference to LTE devices is often caused by spurious or unintentional emissions from consumer devices. This presentation explains the most common causes of this type of interference and demonstrates how they can be identified, quantified, and located using portable instruments in the field.

WEDNESDAY, AUGUST 6 - 9:00AM — 11:00 AM**Topic:** The Role of the Shield of Magnetic Field Probes**Presenter:** Carlo Carobbi, University of Florence, Firenze, Italy

Abstract: Magnetic field loop probes are usually provided with a shield in order to increase electric field rejection. In textbooks such a shield is presented as an example of a "selective" shield because the electric field is selectively shielded whereas the magnetic field is not perturbed. This interpretation of the role of the shield is correct if the thickness t of the shield is small with respect to the skin depth δ (i.e. for a frequency lower than tens of kilohertz).

However, as surprising as it may seem at first sight, when $\delta < t$ the current flowing along the outer surface of the shield is, in the usual shielded loop designs, the same as that flowing through the inner conductor of the shield which, in turn is the same (but opposite) as that flowing along the inner surface of the shield.

Simple experiments can be setup in order to demonstrate that if the cut of the shield is moved from the center position then a significant common mode current arises at frequencies where the loop probe size is small with respect to wavelength (i.e. in its usual frequency range of operation). This demonstrates that a properly designed shield is actually a balun.

Topic: [Louann Devine's Experiment]**Presenter:** Louann Devine, Shure Corporation**Abstract:** TBD**Topic:** Troubleshooting EMI with Near Field Probes and VSWR Bridges**Presenter:** Arturo Mediano, University of Zaragoza, Zaragoza, Spain

Abstract: Discover how to use a Voltage Standing Wave Ratio (VSWR) bridge, a near field probe and a spectrum analyzer to find resonances in your electronic components, circuits, cables, PC boards, enclosures, etc. This technique is so powerful!!!!

A Voltage Standing Wave Ratio (VSWR) bridge is a device used by RF/MW engineers to discern between forward and reflected waves in transmission lines.

The bridge provides a sample from coupling to electric field and other to magnetic field in the line. They are summed resulting in addition in the forward orientation and subtraction in the reflected orientation.

The VSWR Bridge has three ports labelled as RFin (RF input port), RFout (RF output port) to be connected to the Device Under Test (DUT) and Coupled (Reflected signal from DUT).

We can use a typical EMI/EMC near field probe (NFP) to obtain an excellent design and troubleshooting tool.

Holding the NFP near a component, circuit, system, cable, PC board, structure, etc., while sweeping with the spectrum analyzer frequency in a range of interest, and there is a resonance, some part of the incident energy will be absorbed at that frequency and a "dip" will appear in the screen (part of the tracking generator output is being absorbed in the resonant system).

You can use this technique in a broad range of applications in EMI/EMC fields finding structural resonances in shields or cables, looking for resonances in PC board traces, etc.

In this experiment for EMC 2014, the basics for this technique will be explained and some real experiments will be developed to demonstrate its usefulness.

WEDNESDAY, AUGUST 6 — 2:00 PM — 4:00 PM**Topic:** Demonstration of a Representative 2kW Inductive Power Transfer System**Presenters:** James McLean, Donnie Gray, Robert Sutton, TDK R&D Corp, Cedar Park, TX, USA

Abstract: A functional, representative, 150 kHz, 2 kW inductive power transfer (IPT) system is demonstrated. In particular, the nature of the extraneous electromagnetic field in the immediate vicinity of the inductive couplers is explored using a number of diverse magnetic and electric field probes.

The time-domain rotation of the instantaneous magnetic and electric field vectors due to the relative phase of the primary and secondary currents is demonstrated. Also, errors due to the averaging of magnetic flux density by finite-sized loop probes are quantified and the extremely intense magnetic field at the surface of the magnetic cores of the couplers is accurately measured with a very small loop probe.

The effects of hard-switched rectification followed by low-pass filtering on the extraneous electromagnetic field are demonstrated using high-fidelity, time domain electric field, magnetic field, and current probes with a multi-channel sampling oscilloscope.

This demonstration is repeated for different low-pass filter topologies and different RF matching network topologies demonstrating the effect of system topology on the extraneous field. Finally, the electrostatically induced, common-mode voltage with respect to ground on the electrostatic shield of the secondary is explored and it is shown that despite the slightly non-conservative nature of the near electric field, a nearly unique value of potential can be measured on the shield.

Topic: Optimization Method of ESD Testing**Presenter:** Makoto Sugihashi, Noise Laboratory Co., Ltd., Kanagawa, Japan

Abstract: Only air discharges exist in the real field. But ESD testing requires contact discharges also due to repeatability reason. Since the actual ESD events and simulated ESD are different, it is important that the following steps shall be taken.

- 1) know about the actual ESD events
- 2) understand the purpose of an applicable ESD test standard
- 3) understand the differences in the characteristics of the actual ESD events and simulated ESD
- 4) perform ESD testing

This presentation covers a description of the actual ESD events and electronic equipment responses to the contact and air discharges. Contact discharges are applied to the metallic enclosure of the Equipment under test (EUT), generating a potential difference and surface current. The discharge in inactive gas of the high voltage relay is stable. On the other hand air discharges are intended to be applied to an internal metallic part of the EUT through a non-metallic part of the EUT. As air discharges are actuated by an air gap, they are affected by the humidity and approach speed of the ESD gun. ESD testing generates radiated electromagnetic fields, which are different between the contact and air discharges. Also presented is an experiment to measure the voltage and current in the actual ESD test set-up, showing measured ESD waveforms vary depending on the EUT shape and current return path.

THURSDAY, AUGUST 7 - 9:00 AM — 11:00 AM**Topic:** Measuring Cable Resonance**Presenter:** Ken Wyatt, Wyatt Technical Services, Woodland Park, CO, USA

Abstract: Product power and I/O cables tend to resonate at their half-wavelength frequency, if harmonic common-mode currents are allowed to flow on them. This usually causes peaking of harmonic energy in the EMI profile of the product under test. A low-cost method for measuring resonance will be demonstrated and discussions of quarter-wave and half-wave resonance conditions, as well as proper cable termination and common-mode currents will be included.

Topic: By Listening, Engineers Understand EMI Sources**Presenter:** Arturo Mediano, University of Zaragoza, Zaragoza, Spain

Abstract: EMI troubleshooting is considered black magic. You need some special eyes to "see" the sources and some special "thinking" to find fixes but, do you know EMI sources can "speak"?

In this demo you will see some experiments with noise sources to understand how you can "listen and understand" them using near field probes. Funny and practical.



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RALEIGH FACTS

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and established by a state as the seat of state government.**

iNARTE Program at EMC 2014 Technical Program

Monday, August 4

Learn more about iNARTE Certifications

This workshop is recommended for anyone interested in learning more about iNARTE certifications. During this workshop, you will learn more about the following iNARTE certification programs:

- **EMC Engineer and Technician**
- **EMC Design Engineer**
- **Wireless Device Certification Professional**

You will have an opportunity to ask questions regarding application and examination for these programs, as well as an opportunity to take a practice test.

Register to take the exams for all or any of these certification programs by visiting: <http://www.narte.org/h/examregform.asp>. Identify your testing location using the "Special Event Location" feature on this site.

Friday, August 8

The iNARTE Certification Examinations for the following programs will be held at the Symposium from 8:00 AM to 5:00 PM.

- **EMC Engineer and Technician**
- **EMC Design Engineer**
- **Wireless Device Certification Professional**

If you attend The Global EMC University lectures, this is an opportunity to validate your knowledge and experience by becoming iNARTE Certified. You may take the Examination at the Symposium and apply for the certification later, or apply now and register for the exam by visiting www.narte.com

More Information on iNARTE Certifications

The iNARTE EMC certification is an international program that recognizes engineers and technicians practicing in the EMC fields to include bonding, shielding, grounding, EMI prediction, EMI analysis, conducted and radiated interference, lightning protection and more. Learn more about the EMC program at: <http://www.narte.org/h/emc.asp>

The iNARTE EMC Design Engineer certification is an international program that recognizes engineers practicing in EMC fields whose main responsibilities consist of designing electronic circuits, components, sub systems, and equipment to ensure EMC compliance. Learn more about the EMC Design Engineer program at: <http://www.narte.org/h/emcdesignengineer.asp>.

The iNARTE Wireless Device Certification Professional (WDCP) certification is a new program that recognizes professionals who are skilled and knowledgeable of the global regulatory requirements applicable to the wide range of Wireless Devices now being introduced to market segments. Learn more about the WDCP program at: <http://www.narte.org/h/wdcp.asp>.

ANSI C63® Workshops

Emission Measurements

(New 2014 Edition of ANSI C63.4), and Time Domain
(TD) Applications (draft ANSI C63.25)
(Visit www.c63.org for more information)

This combined workshop is presented in two parts over a two day period.

Topics Covered Include:

- (1) review of the new 2014 edition of ANSI C63.4 and
- (2) application of Time Domain (TD) measurements for test site validation and antenna calibration.

These workshops are designed to increase your understanding of the new C63.4 standard and the TD approach. For the C63.4 workshop, there will be an analysis of the test site validation including using the CISPR SVSWR method above 1 GHz, requirements for hybrid antenna use, test setup requirements and many other changes. Application of time domain methods to validating test sites will also be presented along with a demonstration on its use. As time permits, attendees will get a chance to apply what they learned via problem solving and/or participating in the real-time time domain demonstration.

In the C63.4 workshop, you will learn:

- RF emission measurement procedures
- National and international regulatory implications
- Test facility and instrumentation requirements
- Equipment test arrangements and configurations

In the Time Domain (C63.25 draft) workshop, you will learn:

- Application for site validation
- Application for antenna calibration

Support material provided

- A complete lecture flash drive
- FCC handouts and references

Who Should Attend

Those responsible for determining compliance with FCC Rules and Regulations (and CISPR 22), including:

- Product managers and developers
- EMC engineers and test technicians
- Regulatory compliance managers

- Test instrumentation developers
- Those using and calibrating antennas in making radiated emission compliance measurements
- Calibration technicians
- Calibration and measurement accreditation bodies
- Lab quality assessors
- Test instrumentation and chamber manufacturers

Expert Instructors

Workshops feature leading industry experts and ANSI C63® members, including Don Heirman, Workshop Director, (Don HEIRMAN Consultants), Bob Hofmann (Hofmann EMC Engineering), and Zhong Chen (ETS-Lindgren)

Dates and Location

August 1-2, 2014

Raleigh (North Carolina) Marriott City Center Hotel.
See www.emc2014.org for hotel info and to reserve your hotel room.

Fee Includes

Complete lecture flash drive, continental breakfast, lunch, breaks, and completion certificate. Fee does NOT include copies of the draft or published standards. Fee does NOT include hotel accommodations.

Agenda

ANSI C63.4: All day August 1 and morning only of August 2

Aug. 1 Registration: 8:30 am

Class: 9:00 am to 5:00 pm

Aug. 2 Class: 9:00 am to 12:00 pm

Time Domain:

Afternoon only on

Aug. 2 Registration: 12:30 pm

Class: 1:00 pm to 5:00 pm

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 canceled, registration fees will be refunded. No refunds will be made to individuals who cancel after July 10. Substitutions are allowed. Workshops without a minimum of 12 attendees signed up by 1 July 2014 will be cancelled and registration fees returned. It is suggested that you book refundable travel arrangements as appropriate if workshop(s) is/(are) cancelled

GLOBAL EMC UNIVERSITY was first offered at the 2007 IEEE EMC Symposium in Honolulu to provide advanced education on a variety of topics that are an important part of EMC engineering. The overwhelming response to this program caused the EMC Society to add it to the technical program every year since 2007. It has continued to receive high praise from those who attend. This year, the Board of Directors voted to name the Global University in honor of Clayton R. Paul, who dedicated his career to EMC education and was instrumental in setting up the initial Global University. We are pleased to be able to offer Global University once again at the 2014 IEEE International EMC Symposium in Raleigh, North Carolina.

This year's Global University is approximately 20 hours of instruction on basic EMC and SI/PI related topics that are run in parallel with the traditional technical sessions at the symposium. Students are encouraged to participate in symposium workshops, exhibits and other activities when they are not in class. Classes are taught by an international panel of educators, who have been selected for this program based on their reputation for excellence in areas of practical importance to EMC engineers and their demonstrated ability to communicate effectively with students who are new to the field.

GLOBAL UNIVERSITY SCHEDULE

MONDAY, AUGUST 4

- **Welcome and Introduction**

Antonio Orlandi, University of L'Aquila

- **Transmission Lines: Frequency-Domain and Crosswalk**

Farhad Rachidi, Swiss Federal Institute of Technology (EPFL)

- **Radiated Emissions and EMC Standards**

Lee Hill, Silent Solutions, LLC

- **Conducted Emissions and Power Supply Filters**

Mark A. Steffka, University of Michigan - Dearborn

- **Grounding**

Elya Joffe, KTM Project Engineering

TUESDAY, AUGUST 5

- **Keynote Lecture**

Henry Ott, Henry Ott Consultants

- **Overview of EMC Test Facilities**

Chuck Bunting, Oklahoma State University

WEDNESDAY, AUGUST 6

- **Introduction to Signal Integrity**

Eric Bogatin, Teledyne LeCroy Front Range Signal Integrity Lab

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• **Introduction to Power Integrity**

James Drewniak, Missouri University of Science and Technology

THURSDAY, AUGUST 7

• **Electrostatic Discharge**

David Pommerenke, Missouri University of Science and Technology

• **EMC for Wireless Devices**

Jun Fan, Missouri University of Science and Technology

OTHER INFORMATION

WHO IS IT FOR:

Engineers, technicians and professionals who have been in EMC and SI/PI at least 5 years or more.

OVERALL OBJECTIVE:

To provide an in-depth exposure to the concepts and skills that are necessary to be successful in EMC and SI/PI.

PREREQUISITES:

Engineering or Technology Degree with Electrical Theory A certificate of completion will be provided to students who have signed in and signed out each day thereby confirming 100% attendance at all lectures. Continuing Education Units (CEUs) will be assigned to this course.

REGISTRATION:

A 5-Day symposium registration is required in addition to the Global University fee for these special classes. Attendance is limited, and early registration for Global University is strongly recommended.

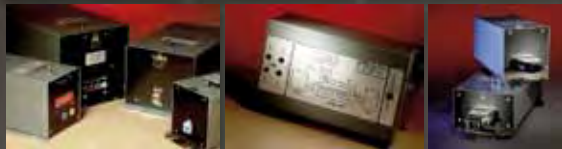
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NOTE:

You must be paid in full by July 7 to receive the Advanced rates.



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AR RF/Microwave Instrumentation
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V Technical Textiles, Inc./Shieldex U.S.

ANECHOIC MATERIALS

Dutch Microwave Absorber Solutions
ETS-Lindgren
Fair-Rite Products Corp.
Leader Tech, Inc.
Universal Shielding Corp.

ANTENNAS

A.H. Systems, Inc.
Com-Power Corporation
TDK Corporation

ANTENNA MASTS

ETS-Lindgren
Innco Systems GmbH
Rohde & Schwarz, Inc.

AUTOMOTIVE TESTING

EM TEST USA
National Technical Systems
TESEQ, Inc.

BICONICAL ANTENNAS

A.H. Systems, Inc.
National Technical Systems
TESEQ, Inc.

BOARD LEVEL SHIELDS

Laird Technologies
Leader Tech, Inc.
Schlegel Electronic Materials Inc.
Tech-Etch, Inc.

BOOKS/PUBLICATIONS, EMI/EMC RELATED

ENR / Seven Mountains Scientific
EspressoEngineering.tv
Evaluation Engineering
IN Compliance Magazine
ITEM Publications / Interference Technology
Microwave Journal
Safety & EMC Magazine

BROADBAND EMI DETECTORS

Advanced Test Equipment Rentals
Agilent Technologies, Inc.
ETS-Lindgren

CABLES & CONNECTORS

Andro Computational SolutionsCanada
Applied EM Technology & EMS-PLUS
Filconn Inc.
Laird Technologies
Quell Corp.
Würth Electronics Midcom Inc.

CALIBRATION SERVICES

A.H. Systems, Inc.
Advanced Test Equipment Rentals
EM TEST USA.
Fischer Custom Communications, Inc.
National Technical Systems
Northwest EMC Inc.
Pearson Electronics Inc.
Techmaster Electronics, Inc.
TESEQ, Inc.

CERTIFICATION SERVICES

EM TEST USA.
iNARTE
National Technical Systems

COAXIAL FILTER CONNECTORS

Amphenol Canada
Curtis Industries/Filter Networks

COMPUTER-AIDED ANALYSIS SERVICES

CST of America, Inc.
Delcross Technologies, LLC
ETS-Lindgren
National Technical Systems

CONDUCTIVE CLOTH

ARC Technologies, Inc.
Leader Tech, Inc.
V Technical Textiles, Inc./Shieldex U.S.

CONDUCTIVE MATERIALS

ARC Technologies, Inc.
Dexmet Corporation
Intermark (USA) Inc.
Schlegel Electronic Materials Inc.

CONDUCTIVE TAPES

Leader Tech, Inc.

CONSULTANTS

EMCOS Consulting and Software
ETS-Lindgren
EM Software & Systems – FEKO
ITEM Publications / Interference Technology
Leader Tech, Inc.
Montrose Compliance Services
Pearson Electronics Inc.

CURRENT PROBES

A.H. Systems, Inc.
Advanced Test Equipment Rentals
Fischer Custom Communications, Inc.
Rohde & Schwarz, Inc.
TESEQ, Inc.

DESIGN SOFTWARE

AR RF / Microwave Instrumentation
CST of America, Inc.
EM Software & Systems – FEKO

DIE CUT SHIELDING MATERIAL

Leader Tech, Inc.
Spira Manufacturing Corp.
Tech-Etch, Inc.

DIRECT LIGHTNING TESTING

National Technical Systems

E-FIELD ANTENNAS

A.H. Systems, Inc.
Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
Rohde & Schwarz, Inc.

EMI GASKETS

Laird Technologies
Leader Tech, Inc.
Spira Manufacturing Corp.
Tech-Etch, Inc.
V Technical Textiles, Inc./Shieldex U.S.

EMI RECEIVERS

Advanced Test Equipment Rentals
Agilent Technologies, Inc.
AR RF / Microwave Instrumentation
ETS-Lindgren
HV Technologies Inc.
Rohde & Schwarz, Inc.
TESEQ, Inc.

EMI TEST ANTENNAS

A.H. Systems, Inc.
Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
ETS-Lindgren
Rohde & Schwarz, Inc.

EMISSIONS TESTING

National Technical Systems
Nemko USA
Retlif Testing Laboratories

EMP/LIGHTNING EFFECTS TESTING

Elite Electronic Engineering Inc.
National Technical Systems
TESEQ, Inc.

EMP GENERATORS

EM TEST USA
EMC Partner AG
Fischer Custom Communications, Inc.
HV Technologies Inc.

EMP SIMULATORS

Advanced Test Equipment Rentals
EM TEST USA
Fischer Custom Communications, Inc.
HV Technologies Inc.

ESD GENERATORS

Advanced Test Equipment Rentals
EM TEST USA
EMC Partner AG
Fischer Custom Communications, Inc.
HV Technologies Inc.
TESEQ, Inc.

EUROPEAN CERTIFICATION TESTING

National Technical Systems
TUV Rheinland of North America

FACILITIES & SHIELDED ENCLOSURE SERVICES

ETS-Lindgren
Universal Shielding Corp.
V Technical Textiles, Inc./Shieldex U.S.

FCC PARTS 15 & 18 TESTING

Elite Electronic Engineering Inc.
National Technical Systems
Washington Laboratories, Ltd

FCC PART 68 TESTING

Advanced Test Equipment Rentals
EM TEST USA
National Technical Systems
Washington Laboratories, Ltd

FEED-THROUGH FILTERS

Amphenol Canada
Curtis Industries/ Filter Networks
EMI Filter Company
Quell Corp.
Tri-Mag, Inc.

FERRITE BEADS & CORES

Fair-Rite Products Corp.
Leader Tech, Inc.
MAJR Products

FERRITE SUPPRESSION COMPONENTS

ARC Technologies, Inc.
Fair-Rite Products Corp.
Intermark (USA) Inc.
Leader Tech, Inc.

FIBER OPTIC CABLES/SYSTEMS

Advanced Test Equipment Rentals
Fischer Custom Communications, Inc.
HV Technologies Inc.
Michigan Scientific Corp.

FIELD INTENSITY METERS

Advanced Test Equipment Rentals
ETS-Lindgren

FILTER ARRAYS

Curtis Industries/ Filter Networks
Quell Corp.

FILTER CAPACITORS

API Technology-Spectrum Control
Curtis Industries/ Filter Networks
EMI Filter Company
Quell Corp.

FILTER CHOKES

Curtis Industries/ Filter Networks
Fair-Rite Products Corp.
Schurter, Inc.

FILTER COILS

Curtis Industries/ Filter Networks
Schurter, Inc.

FILTER CONNECTORS

Amphenol Canada
API Technology-Spectrum Control

FILTER MODULES

Curtis Industries/ Filter Networks
Schurter, Inc.

FILTER PINS/PIN CONNECTORS

EMI Filter Company
Quell Corp.

FILTERED POWER ENTRY MODULES

Americor
API Technology-Spectrum Control
Curtis Industries/ Filter Networks
Schurter, Inc.
Tri-Mag, Inc.
V Technical Textiles, Inc./Shieldex U.S.

FILTERS

Americor
Amphenol Canada
Curtis Industries / Filter Networks
EMI Filter Company
Souriau PA&E
WEMS Electronics

GTEM CELLS

Fischer Custom Communications, Inc.
Rohde & Schwarz, Inc.

H FIELD ANTENNAS

A.H. Systems, Inc.
AR RF / Microwave Instrumentation
EM TEST USA.
Rohde & Schwarz, Inc.

HELMHOLTZ COILS

ETS-Lindgren
Fischer Custom Communications, Inc.

HONEYCOMB SHIELDING

Leader Tech, Inc.
Spira Manufacturing Corp.
Tech-Etch, Inc.
V Technical Textiles, Inc./Shieldex U.S.

HORN ANTENNAS

A.H. Systems, Inc.
Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
ETS-Lindgren
HV Technologies Inc.
Rohde & Schwarz, Inc.
TESEQ, Inc.

IMMUNITY TESTING

A.H. Systems, Inc.
EM TEST USA.
National Technical Systems
Nemko USA
Retlif Testing Laboratories
TESEQ, Inc.

IMPULSE GENERATORS

Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
EM TEST USA
EMC Partner AG
HV Technologies Inc.
TESEQ, Inc.

INDUCED CURRENT METERS & PROBES

AR RF / Microwave Instrumentation
ETS-Lindgren

INDUCTORS

Curtis Industries/ Filter Networks
Schurter, Inc.

INTERFERENCE GENERATORS

Advanced Test Equipment Rentals
EMC Partner AG
EM TEST USA.

ISOTROPIC FIELD SENSORS

ETS-Lindgren

LIGHTNING GENERATORS

Advanced Test Equipment Rentals
EM TEST USA
EMC Partner AG
Fischer Custom Communications, Inc.
HV Technologies Inc.

LIGHTNING SIMULATORS

Advanced Test Equipment Rentals
EM TEST USA
Fischer Custom Communications, Inc.
HV Technologies Inc.

LIGHTNING STRIKE TESTING

National Technical Systems
Retlif Testing Laboratories

LINE IMPEDANCE STABILIZATION NETWORKS (LISNS/PLISNS)

Fischer Custom Communications, Inc.
TESEQ, Inc.

LOG PERIODIC ANTENNAS

A.H. Systems, Inc.
Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
Rohde & Schwarz, Inc.

MAGNETIC FIELD PROBES/METERS

AR RF / Microwave Instrumentation
ETS-Lindgren
Fischer Custom Communications, Inc.
Rohde & Schwarz, Inc.

MAGNETIC SHIELDING GASKETS

Spira Manufacturing Corp.

MICROWAVE ABSORBERS

ARC Technologies, Inc.
Dutch Microwave Absorber Solutions
Laird Technologies
Leader Tech, Inc.

MICROWAVE FILTERS

EMI Filter Company
V Technical Textiles, Inc./Shieldex U.S.

MICROWAVE POWER AMPLIFIERS

Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
HV Technologies Inc.
Ophir RF
R&K Company Limited
Rohde & Schwarz, Inc.

MIL-STD 188/125 TESTING

National Technical Systems

MIL-STD 461/462 TESTING

National Technical Systems

MOBILE SHIELDED ROOMS

Advanced Test Equipment Rentals

MONOPOLE ANTENNAS

Rohde & Schwarz, Inc.

MRI SHIELDING

ETS-Lindgren
Leader Tech, Inc.
Panashield
Universal Shielding Corp.
V Technical Textiles, Inc./Shieldex U.S.

NAVLAP / A2LA APPROVED TESTING

National Technical Systems
Northwest EMC Inc.

NETWORK ANALYZERS

Agilent Technologies, Inc.

PARALLEL PLATE LINE TEST SET

ETS-Lindgren
Fischer Custom Communications, Inc.
Rohde & Schwarz, Inc.

PORTABLE TEST EQUIPMENT

A.H. Systems, Inc.
Advanced Test Equipment Rentals

POWER LINE FILTERS

Curtis Industries/ Filter Networks
Schurter, Inc.
V Technical Textiles, Inc./Shieldex U.S.

PRINTED CIRCUIT BOARD FILTERS

Curtis Industries/ Filter Networks
Schurter, Inc.
Tri-Mag, Inc.

PRODUCT SAFETY TESTING

National Technical Systems
Nemko USA
Retlif Testing Laboratories

RADIATION HAZARD METERS/PROBES

Advanced Test Equipment Rentals
ETS-Lindgren

RETROFIT FILTERS & CONNECTORS

Amphenol Canada
Curtis Industries/ Filter Networks
Quell Corp.
Schurter, Inc.
V Technical Textiles, Inc./Shieldex U.S.

RF POWER AMPLIFIERS

Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
HV Technologies Inc.
Ophir RF
R&K Company Limited
TESEQ, Inc.
Rohde & Schwarz, Inc.

RF POWER METERS

AR RF / Microwave Instrumentation
ETS-Lindgren
Rohde & Schwarz, Inc.

RF SHIELDING GASKETS

Spira Manufacturing Corp.
Tech-Etch, Inc.

RF SHIELDING MATERIAL

Dexmet Corporation
Spira Manufacturing Corp.
Tech-Etch, Inc.
V Technical Textiles, Inc./Shieldex U.S.

RS03<200 V/METER TESTING

Elite Electronic Engineering Inc.
National Technical Systems

RTCA DO-160 TESTING

National Technical Systems
Retlif Testing Laboratories

SCIF DESIGN, CONSTRUCTION, & MAINTENANCE

ETS-Lindgren

SHIELDED AIR FILTERS

ETS-Lindgren
Leader Tech, Inc.
Spira Manufacturing Corp.
Tech-Etch, Inc.

SHIELDED BUILDINGS

Advanced Test Equipment Rentals
ETS-Lindgren
V Technical Textiles, Inc./Shieldex U.S.

SHIELDED COMPONENTS

Schurter, Inc.
Spira Manufacturing Corp.
Tech-Etch, Inc.

SHIELDED DOORS

ETS-Lindgren
Panashield
V Technical Textiles, Inc./Shieldex U.S.

SHIELDED FANS

ETS-Lindgren
Leader Tech, Inc.
Spira Manufacturing Corp.
Tech-Etch, Inc.

SHIELDED ROOM FILTERS

ETS-Lindgren
Panashield
V Technical Textiles, Inc./Shieldex U.S.

SHIELDED ROOMS

Advanced Test Equipment Rentals
Applied Electromagnetic Technology
Braden Shielding Systems
ETS-Lindgren
Panashield

SHIELDED ROOMS/ACCESSORIES

Leader Tech, Inc.
National Technical Systems
V Technical Textiles, Inc./Shieldex U.S.

SHIELDED ROOMS / LEAK DETECTORS

ETS-Lindgren

SHIELDING

Intermark (USA) Inc.
Metal Textiles Corp.
Panashield
Quell Corp.

SHIELDING EFFECTIVENESS TESTING

ETS-Lindgren
Leader Tech, Inc.
National Technical Systems
Retlif Testing Laboratories

SHIELDING, MAGNETIC FIELD

Spira Manufacturing Corp.

SIGNAL GENERATORS

Advanced Test Equipment Rentals
Agilent Technologies, Inc.
AR RF / Microwave Instrumentation
Rohde & Schwarz, Inc.

SIGNAL LINE FILTERS

Curtis Industries/ Filter Networks
EMI Filter Company
ETS-Lindgren
V Technical Textiles, Inc./Shieldex U.S.

SITE ATTENUATION TESTING

ETS-Lindgren
National Technical Systems

SITE SURVEY SERVICES

ETS-Lindgren
National Technical Systems

SOFTWARE, EMI/EMC RELATED

ANSYS, Inc. (Ansoft Products)
Delcross Technologies, LLC
Detectus (Interfax)
Electro-Magnetic Applications, Inc.
EM Software & Systems (USA) - FEKO
EMSCAN
Moss Bay EDA
NEXIO
Techcelerant

SOLID-STATE AMPLIFIERS

AR RF / Microwave Instrumentation
HV Technologies Inc.
R&K Company Limited
Rohde & Schwarz, Inc.

SPECTRUM ANALYZERS

Agilent Technologies, Inc.
Rohde & Schwarz, Inc.

STANDARDS TRANSLATIONS

ANDRO Computational Solutions, LLC

STATIC CONTROL MATERIALS & EQUIPMENT

Advanced Test Equipment Rentals

SUPPRESSORS

Fair-Rite Products Corp.
Fischer Custom Communications, Inc.

TELCORDIA TESTING

National Technical Systems

TELECOMMUNICATIONS TEST NETWORKS

Advanced Test Equipment Rentals
Agilent Technologies, Inc.
Ophir RF

TEM CELLS

Advanced Test Equipment Rentals
ETS-Lindgren
Fischer Custom Communications, Inc.
Rohde & Schwarz, Inc.
TESEQ, Inc.

TEMPEST TESTING/ TEST EQUIPMENT

A.H. Systems, Inc.
Advanced Test Equipment Rentals
Curtis Industries/ Filter Networks
Fischer Custom Communications, Inc.
National Technical Systems
Rohde & Schwarz, Inc.
Shinpei Corporation of America (Noiseken)

TEST ACCESSORIES

A.H. Systems, Inc.
Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
EM TEST USA
ETS-Lindgren
Fischer Custom Communications, Inc.
Inco Systems GmbH
Ophir RF
Rohde & Schwarz, Inc.
TESEQ, Inc.

TEST EQUIPMENT, LEASING & RENTAL

A.H. Systems, Inc.
Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
EM TEST USA
TESEQ, Inc.

TEST EQUIPMENT, REPAIR & CALIBRATION

Advanced Test Equipment Rentals
Agilent Technologies, Inc.
ETS-Lindgren
Fischer Custom Communications, Inc.
Tektronix, Inc.
TESEQ, Inc.

TEST INSTRUMENTATION

A.H. Systems, Inc.
EMI Instrumentation
Haefely EMC

HV Technologies Inc.
Pearson Electronics Inc.
Rohde & Schwarz, Inc.
Thermo Fisher Scientific

TESTING

A.H. Systems, Inc.
DNB Engineering, Inc.
Empower RF Systems, Inc.
Intertek
NAVAIR
Nemko USA Inc.
NEXIO
Northwest EMC Inc.
Qualtest
Retlif Testing Laboratories
RF Exposure Lab LLC
TUV Rheinland of North America, Inc.
Washington Laboratories, Ltd

TESTING LABORATORIES

D.L.S. Electronics Systems Inc.
Elite Electronic Engineering Inc.
Liberty Labs Inc.-World Cal Inc.
National Technical Systems
Northwest EMC Inc.
Retlif Testing Laboratories

TRAINING, SEMINARS, & WORKSHOPS

A2LA
CST of America, Inc.
Delcross Technologies, LLC
EM TEST USA.
Kimmel Gerke Associates, Ltd.
Leader Tech, Inc.
TESEQ, Inc.

TRANSIENT DETECTION & MEASURING EQUIPMENT

Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
Transient Specialists, Inc.

TRANSIENT GENERATORS

Advanced Test Equipment Rentals
AR RF / Microwave Instrumentation
EM TEST USA
EMC Partner AG
Fischer Custom Communications, Inc.
Haefely EMC
TESEQ, Inc.
Transient Specialists, Inc.

TRAVELING WAVE TUBE AMPLIFIERS

AR RF / Microwave Instrumentation

VOLTAGE PROBES

Advanced Test Equipment Rentals
Fischer Custom Communications, Inc.
Haefely EMC
Rohde & Schwarz, Inc.

Companion Program

WELCOME GUESTS, SPOUSES, CHILDREN, FRIENDS AND FAMILY to the 2014 International Symposium on EMC in Raleigh, North Carolina! We have activities planned that will make your visit enjoyable.

The Companion Club is your chance to meet new people and catch up with old friends. You may register for the Companion Club as a part of the technical attendee's registration, or separately. Prices for Companion Club registration are \$85 in advance and \$110 after July 7th for adults, and \$40 in advance and \$60 after July 7th for the Junior Companion Club.

We have five specially arranged Tours for you to get out and see the Raleigh area. If you register for the Companion Club, you may sign up for any of these tours right in your own registration. Otherwise, a tour may be purchased through the technical attendee's registration; there will be a drop down space to add your name.

Join your technical attendee at any of our Social Events for more fun and to meet more people. We have special prices for companions under the age 18. Tickets to the Welcome Reception, a great networking time for all, are included in all Companion Club registrations. The Wednesday night Gala is also a fun event, and companions are invited to register for this event separately in their Companion Club or technical attendee's registration.

For the younger crowd, our ever popular Youth Technical Program is back once again to amaze all companions and guests aged 8 to 19. This program will again be free of charge, but please register early to be assured a project kit. Registration for each young person can be made either through your own Companion Club registration or the technical attendee's registration.

We look forward to seeing you in Raleigh!

Sue Archambeault and Judy Rohrbaugh
Companion Program & Hospitality Co-Chairs

Monday, August 4 HISTORIC RALEIGH TROLLEY TOUR

Departs 11:00 AM and returns 3:00 PM

Cost: \$62 before July 7, 2014, \$77 after July 7, 2014

Explore a city once described on a CBS documentary as a "charming historic city with a modern get-up and go". Now more than ever this vibrant city continues to surprise visitors with its southern hospitality and cosmopolitan culture.

Enjoy a driving tour with sites such as a Southern antebellum plantation house, the elegant Governor's Mansion, a charming Victorian neighborhood, the birthplace of a President, the North Carolina State Capitol and beautiful gardens.

We will stop at the Mordecai House & Gardens for a private tour. The Mordecai House is the oldest residence in Raleigh on its original foundation. The property is representative of the plantations that once dominated the local landscape. At one time the house was the seat of one of the largest farms in Wake

County, encompassing more than 5,000 acres. The oldest portion of the home was built about 1785 by Joel Lane for his son Henry. Seven years later, Joel Lane sold 1,000 acres immediately south of the house to the state as the site of the new capital city of Raleigh.

The city abounds with history, culture, modernism, with interesting things to see and do!

INCLUSIONS:

- Private Trolley Transportation
- Professional Licensed & Insured guide throughout
- Iced Water available for guests
- Docent lead tour of Mordecai House & Gardens
- Lunch at 18 Seaboard

Tuesday, August 5

EPICUREAN INSPIRATION CAROLINA STYLE!

Departs 11:00 AM and returns 4:00 PM

Cost: \$69 before July 7, 2014, \$84 after July 7, 2014

Take the opportunity to experience what goes on behind the scene in a commercial kitchen environment. As our chef is preparing a dish he will walk you through the process and explain why certain things are done in the kitchen. As the chef interacts with guests we welcome you to enjoy a tasting especially prepared for your group. Once the chef has completed his demonstration we invite you to ask questions that you may not normally have an opportunity to ask a chef.

After your kitchen lesson and tasting are complete the next stop is at "The Pit". The Pit proudly continues the tradition of BBQ by serving authentic whole-hog, pit-cooked barbecue in downtown Raleigh's warehouse district. A celebration of all of the great culinary offerings of the Old North State, The Pit has made a name for itself as the destination

for the state's signature cuisine. The pigs used to produce the barbecue are raised in North Carolina using free-range farming practices, and the freshest of the state's bountiful produce is featured in the starters, sides and desserts.

After a taste of BBQ from The Pit we invite you to step into Raleigh's very own chocolate factory, Videri. Take a short stroll across the street to Videri Chocolate Factory to see how chocolate is made. The doors are open to everyone curious about the process and flavor of hand-made bean-to-bar chocolate. Videri sources every ingredient to ensure a high quality, responsible chocolate for all to enjoy.

INCLUSIONS:

- Private deluxe transportation to all locations Local food tour guide on transportation
- BBQ samples from The Pit
- Tour & tasting at Chef's Academy
- Tour and tasting of Videri Chocolate Factory
- Time to shop at Videri
- Iced Water available for guests

Wednesday, August 6

DURHAM'S PIVOT: From Tobacco Road to City of Medicine

Departs 11:00 AM and returns 4:00 PM

Cost: \$81 before July 7, 2014, \$96 after July 7, 2014

How did a sleepy town at a railroad depot turn into the mecca of tobacco named "The Bull City" then reverse course 180 degrees and rise again as the "City of Medicine"? The historic tour of Durham is one of the most extraordinary stories you never heard.

In 1865, 17 days after Lee surrendered his army at Appomattox, Union General Sherman and Confederate General Johnston negotiated the largest troop surrender of the Civil War at Bennett Place. While 150,000 blue and grey troops awaited details of surrender, they enjoyed the local



"bright leaf" variety of tobacco. Post war those men wanted more. The orders for that smooth tobacco began rolling in and a mega industry arose overnight.

Our tour begins at the American Tobacco Campus and Brightleaf Square – both formerly warehouses of the tobacco empire – where we learn about the industry, the Duke family that consolidated it and the huge sums of money that flowed into the city during that segment of history. These one-time factories are now part of the vibrant Durham culture where people dine in the restaurants, shop in boutiques, listen to community concerts and even start up high-tech companies. You'll experience the vibe where old and new collide.

Next, a guided driving tour of downtown Durham shows us where tobacco industry employees spent their hard earned wages leading to the creation of a thriving black middle class of shop owners, banks, an insurance company and much more; dubbed "Black Wall Street".

The money tobacco brought to the local economy helped build many institutions that drive today's local economy, such as Duke University. Originally Trinity College, the school once planned to move its campus to Raleigh until Washington Duke outbid them and together with Julian S. Carr, enticed the college to relocate to Durham in 1892. We'll tour the striking neo-Gothic campus and see North Carolina's second most visited tourist attraction, the amazing Duke Chapel.

Ironically, Duke University has become a nationally recognized medical hub bringing the tale full circle from war to tobacco to the science and medical research Companion Program based economy that drives present-day Durham.

INCLUSIONS:

- Private transportation
- Professional step-on guide throughout
- Walking tours of Duke Chapel
- Delicious lunch at Piazza Italia in Brightleaf Square
- Iced Water available for guests

Thursday, August 7 NORTH CAROLINA POTTERY ARTIST TOUR 1 2

Departs 10:00 AM and returns 3:00 PM

Cost: \$76 before July 7, 2014
\$91 after July 7, 2014

The tradition of thousands of visitors who come to Seagrove area each year to enjoy and buy pottery still thrives. To get a good overview of the history, traditions and techniques of pottery we will first stop at the North Carolina Pottery Center for a tour and opportunity to stroll for 20 minutes.

Beth Gore: After spending several years on the "fringes" of the creative process; teaching children, doing potter bookwork, and glazing pieces thrown by her husband, Beth is making time to hand build with clay. A favorite of Beth's; the organic, asymmetrical, often serendipitous forms that start with a simple slab of clay. The cool feel of clay in one's hands and the joy of manipulating it toward the idea in one's mind is restful and therapeutic.



Ben Owen III: A gentleman and successor to generations of famous potters. One might think he would continue to make products just as his fore fathers, but that is only partly true. Yes, he makes each by hand, using a salt glaze, in a ground hog kiln BUT after traveling the world his art is also influenced by modern techniques and has been displayed in public spaces from the Ritz Carlton Japan to The Umstead's five star hotel here in the Triangle.

Jugtown Pottery: Opened in 1917, a critical part of the history of Seagrove, this family operation creates authentic work. We'll make another stop to see, experience and possibly buy works to enjoy. Jugtown is listed in the National Register of Historic Places and has a museum with examples of early area pots as well as the Jugtown story told through pottery. David Stuempfle Pottery: In order to round out our visit, our last stop is not related to generations of potters before but migrated here after traveling the world and learning techniques from different cultures.

INCLUSIONS:

- Private deluxe transportation (based on 5 hours & max of 32 passengers)
- Professional Licensed & Insured guide throughout
- Guided visit to the North Carolina Pottery Center
- Four artist's studio/workshop tours
- Delicious gourmet box lunch
- Iced Water available for guests

Friday, August 8, 2014 FOR THE ART LOVERS...

Departs 10:00 AM and returns 3:00 PM

Cost: \$97 before July 7, 2014
\$112 after July 7, 2014

We invite you to experience the art world up-close and personal with an opportunity to walk through one of Raleigh's art studios - home to several artists. Watch local artists hard at work in their own studio and see a master piece come together.

Enjoy lunch at the NC Museum of Art's very own restaurant - Iris. While enjoying your afternoon lunch you'll find that you are not in just any ordinary restaurant. Iris is an experience all in itself. The setting; the art and the food all will be enjoyed by every guest. Following lunch take a moment or two to enjoy some of the works of art that hang in our Art Museum.

After lunch we invite you to view not only the permanent exhibit but also the visiting exhibit currently on display.

INCLUSIONS:

- Private deluxe transportation to all locations
- Tour of Artspace and artist's studios with time to talk with artist
- Delicious gourmet lunch NC Museum of Art Iris Restaurant
- Self-guided tour of NC Museum of Art
- Admission to current exhibit hosted by NC Museum of Art
- Iced Water available for guests



Social Events

Welcome Reception

Tuesday, August 5

6:00 PM – 8:00 PM

Come join us for a Southern Hospitality Culinary experience at the Duke Energy Center for the Performing Arts. We will have food and beverage that represents North Carolina and the different styles of barbeque and other culinary items that have made the state of North Carolina so unique. Enjoy the open foyer both inside and outside of the Duke Energy Center for the Performing Arts; the Center is within walking distance to our host hotels (Marriott City Center and the Sheraton).

One ticket to this event is included in all 5-Day technical registrations and the Companion Program registration. All others may purchase a ticket to the Welcome Reception as an add-on to your registration.

- **An Adult Reception Ticket price:** \$65 (\$75 after July 7, 2014)
- **A Junior (Age 8 to 17, inclusive) Reception Ticket is:** \$25 (\$35 after July 7, 2014)
- **Children under age 8 are free, but must be accompanied by a registered adult.**

Gala Event

Wednesday, August 6

6:30 PM – 9:30 PM

The Raleigh Convention Center will be the location of the Gala Event. We will have entertainment and southern hospitality cuisine for all to enjoy. The

Raleigh Convention Center is located across the street from our host hotels (Marriott City Center and the Sheraton). One ticket to this event is included in all 5-Day technical registrations EXCEPT student registrations. This is a change from last year, made to keep student registration costs down. Extra tickets to the Gala may be purchased as an add-on to your registration.

- **An Adult Gala Ticket is:** \$80 (\$90 after July 7, 2014)
- **A Junior (Age 8 to 17, inclusive) Gala Ticket is:** \$35 (\$45 after July 7, 2014)
- **Children under age 8 are free, but must be accompanied by a registered adult.**

EMC Young Professionals Party

Tuesday, August 5

8:30 PM – 10:00 PM

(after the Tuesday Welcome Reception)

Join us at Coglin's for a social gathering, karaoke and corn holes game.

EMC YP will have a table to provide you with information and a raffle ticket. Only EMC YP eligible members can receive a raffle ticket, so your chance of winning is high! Look for us by the registration desk.

Raffle Schedule:

- At Coglin's during the Social.
- At the Standards Presentation in the Chancellor Room at the Raleigh Marriott Center.

EMC YP Members or Eligible Members Only

Awards Luncheon

Thursday, August 7

12:30 PM – 2:00 PM

The Awards Luncheon will be held at The Raleigh Convention Center. The Awards Luncheon will be the last formal opportunity to gather and network with families and EMC professionals from academia, industry, government, military, and retired sectors. The event will start off with a catered sit-down meal. Afterwards, the EMC Society will take time to recognize members and non-members for their contribution to the Society and for professional excellence.

One ticket to this event is included in all 5-Day technical registrations. All others may purchase a ticket to the Awards Luncheon as an add-on to their registration.

- **An Adult Awards Luncheon ticket is:** \$45 (\$50 after July 7, 2014)
- **A Junior (Age 8 to 17, inclusive) Awards Luncheon ticket is:** \$20 (\$25 after July 7, 2014)
- **Children under age 8 are free, but must be accompanied by a registered adult.**

Anticipated Awards

- Best EMC 2014 Symposium Paper
- Best SI/PI 2014 Symposium Paper
- Best EMC 2014 Student Paper
- Best SI/PI 2014 Student Paper
- Special Service
- Richard R. Stoddart Award for Outstanding Performance
- Lawrence G. Cumming Award for Outstanding Service
- President's Memorial Award 2nd Year Extension
- President's Memorial Award
- Technical Achievement Award
- Honorary Life Member Award
- Certificate of Appreciation
- Certificate of Acknowledgement
- Certificate of Recognition
- Hall of Fame
- Sustained Service
- Symposium Chair Award

Chapter Chair Training Session and Dinner

Monday, August 4

6:00 PM – 9:00 PM

The Chapter Chair Training Session provides a forum for providing focused training to the Chapter Chairs, provides the Chapter Chairs with the opportunity to discuss their chapter issues and get group feedback, gives the Chapter Chairs the opportunity to meet other Chapter Chairs from around the world and for the Chapter Coordinator to disseminate important information from IEEE headquarters and the EMC Society Board of Directors.

A Social Session will precede the Dinner, to give the Chapter Chairs the opportunity to socialize with the other Chapter Chairs and their Angels.

The Dinner will be served at the end of the Social Session. Besides a great meal, each Chapter Chair or their representatives will have the opportunity to share what their chapter has been doing for the past year. After the Dinner, an interactive brainstorming session will conclude the meeting. This session is intended to exchange information and new ideas for effective chapter management, as well as to discuss best practices and suggestions for future development and growth of the EMC chapters.

This is a free event open to Chapter Chairs or their representatives. Please check with your Chapter Chair, as you can be that representative for your chapter if your Chapter Chair cannot attend this event.

Founders and Past-Presidents Luncheon

Wednesday, August 6

12:00 PM – 1:30 PM

The Founders and Past-Presidents Luncheon will be held at the convention center. The Luncheon is open to the Founders of the EMC Society, Past-Presidents of the EMC Society, current members of the Board of Directors, and students. The luncheon is a chance for the old and the new to mix, exchanging experiences of the past, challenges of the future, and learning about the EMC profession. A



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sit down lunch is provided. When making your reservation, please indicate that you plan to attend so there will be seating and food for you.

Exhibition Hall Tour

Thursday, August 7

10:00 AM - 11:30 AM

A tour of the Exhibition Hall is offered free of charge to companions and families. This is a guided tour of selected exhibit booths and provides an overview of EMC technologies and products. The purpose of the tour is to present an overview of the

symposium to participants who do not have a technical background in EMC. The Exhibition Hall tour will begin at the main entrance of the exhibit hall.

Team EMC 1

Meeting place: 7am @ Raleigh Convention Center, outside the Registration Area on the Salisbury Street side. The ride will depart from the Convention Center and proceed to the bike trails.

Interested in exploring some of Raleigh on bike with your fellow EMCS members? The second annual Team EMC bike ride is scheduled

for Thursday, August 7th. Please join us for a leisurely morning ride to get some exercise and to experience part of the city in a refreshing way. This year we will host two levels of escorted riding: leisure and performance.

A Team EMC jersey will be included for 1st-time participants on a first come first serve basis, while quantities last. If you received a jersey last year in Denver, please don't forget to bring it with you. We will provide bike rental information (approximate price: \$50/day). Mountain Bike to High Performance Road Bikes are available. It is the responsibility of the rider to arrange the rental. Please plan on renting the bike the

night before the ride since the bike shop doesn't open until 10:00 AM. You will need to provide the type of bike you want and size (or your height if you don't know). If you have a cycling helmet, it is recommended that you bring it as quantities are limited. If you want to use your bike shoes and need clipless pedals you can bring your own. Please sign up early to ensure availability. You are also welcome to bring your own bike. To sign up, contact Ray Adams at r.k.adams@ieee.org or (310) 387-7201. We are putting together the bike rental information, route information and logistics.

Restaurants

**SYMPOSIUM TRIPS
ARE EXPENSIVE,
IS THERE ANYTHING
CHEAP TO EAT?**

Beasley's Chicken & Honey

Southern, American

237 S. Wilmington St.
Raleigh, NC 27601
t: 919-322-0127
w: <http://ac-restaurants.com/beasleys/>
\$5-15

Big Ed's City Market

**Breakfast, Sandwiches,
Southern**

220 Wolfe St., City Market
Raleigh, NC 27601
t: 919-836-9909
w: <http://www.bigedscitymarket.com/>
\$5-10

Café Carolina and Bakery

Café, Breakfast, Sandwiches

150 Fayetteville St., Wells Fargo Center
Raleigh, NC 27601
t: 919-834-9117
w: <http://cafecarolina.com/>
\$5-15

Chuck's

Burgers, Late-Night Dining

237 S. Wilmington St.
Raleigh, NC 27601
t: 919-322-0126
w: <http://ac-restaurants.com/chucks/>
\$10-15

Clyde Cooper's Barbecue 1

Barbecue, Sandwiches

109 E. Davie St.
Raleigh, NC 27601
t: 919-832-7614
w: <http://clydecoopersbbq.com/>
\$10-15

Humble Pie

**Small Plates, Brunch,
Contemporary**

317 S. Harrington St.
Raleigh, NC 27603
t: 919-829-9222
w: <http://humblepierestaurant.com/>
\$10-15

Mantra Indian Cuisine & Bar

Indian

116 N. West St., Suite 100
Raleigh, NC 27603
t: 919-833-2823
w: <http://www.mantraraleigh.com/>
\$10-20

Moonlight Pizza Company

Pizza, Sandwiches

615 W. Morgan St.
Raleigh, NC 27603
t: 919-755-9133
w: <http://www.moonlightpizza.com/>
\$10-20

Oakwood Café

Latin/South American, Cuban

300 E. Edenton St.
Raleigh, NC 27601
t: 919-929-5994
w: <http://oakwoodcaferaleigh.com/>
\$10-20

The Pit 2

Barbecue, Farm-to-Table

328 W. Davie St.
Raleigh, NC 27601
t: 919-829-1212
w: <http://www.thepit-raleigh.com/>
\$10-20

The Raleigh Times Bar

**American, Burgers,
Fish and Chips**

14 E. Hargett St.
Raleigh, NC 27601
t: 919-833-0999
http://www.raleightimesbar.com/
\$10-15

Snoopy's Hot Dogs

Hot Dogs, Sandwiches, Burgers

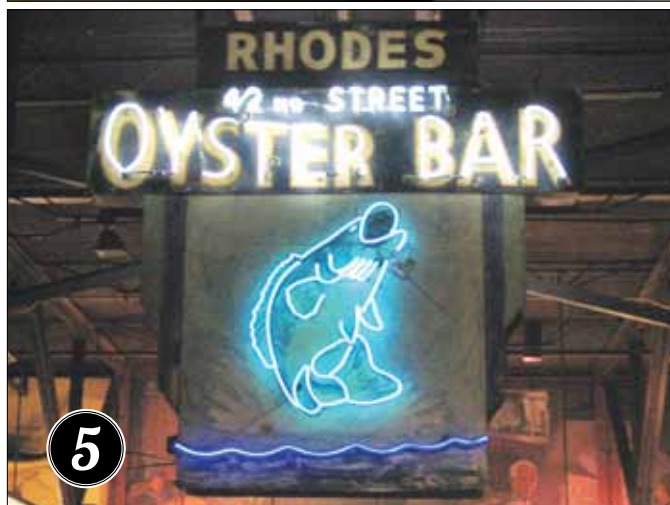
600 Hillsborough St.
Raleigh, NC 27603
t: 919-839-2176
w: <http://www.snoopys.com/>
\$5-10

Sushi Blues Café

Japanese, Sushi

301 Glenwood Ave.
Raleigh, NC 27603
t: 919-664-8061
w: <http://www.sushibluescafe.com/>
\$15-20





LOOKS GOOD BUT
I'M TRYING TO
IMPRESS MY CLIENT!

19 Seaboard

Seafood, Contemporary

18 Seaboard Ave.
Raleigh, NC 27604
t: 919-861-4318
w: <http://www.18seaboard.com/index.html>
\$20-30

Buku

Brunch, Tapas, Asian Fusion

110 E. Davie St.
Raleigh, NC 27601
t: 919-834-6963
w: <http://bukuraleigh.com/buku/>
\$10-30

Caffe Luna

Italian, Mediterranean

136 E. Hargett St.
Raleigh, NC 27601
t: 919-832-6090
w: <http://www.cafeluna.com/>
\$15-20

Centro

Mexican

106 S. Wilmington St.
Raleigh, NC 27601
t: 919-835-3593
w: <http://www.centroraleigh.com/>
\$10-20

Poole's Downtown Diner

Bistro, Contemporary,
Farm-to-Table

426 S. McDowell St.
Raleigh, NC 27601
t: 919-832-4477
w: <http://ac-restaurants.com/pooles/>
\$10-30

Sitti 3

Lebanese

137 S. Wilmington St.
Raleigh, NC 27601
w: <http://www.sitti-raleigh.com/index1.php>
\$15-25

I MEAN I REALLY
WANT TO IMPRESS
MY CLIENT!

42nd Street Oyster Bar and Seafood Grill

4 5

Seafood, Steak

508 W. Jones St.
Raleigh, NC 27603
t: 919-831-2811
w: <http://www.42ndstoysterbar.com/>
\$20-35

Bloomsbury Bistro

509 W. Whitaker Mill Road, Suite 101
Raleigh, NC 27608
t: 919-834-9011
w: <http://bloomsburybistro.com/bistro.restaurant.raleigh/>
\$25-30

Mo's Diner

Contemporary, Farm-to-Table

306 E. Hargett St.
Raleigh, NC 27601
w: <http://www.mosdiner.net/>
\$20-40

Second Empire

330 Hillsborough St.
Raleigh, NC 27603
t: 919-829-3663
w: <http://www.second-empire.com/>
\$25-35

Attractions



North Carolina Museum of Art 1

2110 Blue Ridge Road
Raleigh, NC 27607
t: 919-839-6262
w: <http://www.ncartmuseum.org/>

Recently renovated as part of a three-year expansion project, the North Carolina Museum of Art (NCMA) offers a permanent collection spanning more than 5,000 years, a variety of special exhibits and public programs, outdoor gardens showcasing large-scale sculpture and an amphitheater that hosts an annual summer concert and movie series. The surrounding campus is home to the nation's largest art museum park featuring 164-acres of trails and parkland containing major works of art.

City Market

214 East Martin St.
Raleigh, NC 27601
w: <http://citymarketraleigh.com/>

Built in 1915, the city's first farmer's market has evolved while remaining close to its roots. The towering red brick City Market is home to several dozen shops and boutiques carrying everything from Tibetan prayer flags to local artwork and organic cotton T-shirts. Visitors can also visit the weekend farmer's market or grab a bite to eat at any number of restaurants, including local favorite Big Ed's restaurant or Rum Runners Dueling Piano Bar and Dance Club.

North Carolina Museum of History 4

5 E. Edenton St.
Raleigh, NC 27601
t: 919-807-7850
w: <http://www.ncdcr.gov/ncmoh/Home.aspx>

Explore North Carolina's past through exhibits highlighting the state's military and agricultural background, art and famous historical figures. Learn about the history of NASCAR racing, walk through the original workshop for firearms designer David Marshall "Carbine" Williams and view previously unseen original battle flags from the Civil War.

North Carolina Museum of Natural Sciences 5

11 W. Jones St.
Raleigh, NC 27601
t: 919-707-9800
w: <http://naturalsciences.org/>

The Southeast's largest natural history museum features nine difference exhibit halls filled with an array of walk-through dioramas and interactive features. Dinosaur-lovers will have a chance to view the towering acrocanthosaurus skeleton located in the main lobby and meet Willo, the most complete thescelosaurus ever found, while the Mountains to the Sea exhibit will entice those interested in nature with its live plants and animals and two-story waterfall. Temporary exhibits cover everything from the Titanic to the rainforest.

North Carolina State Capitol ③

1 E. Edenton Street
Raleigh, NC 27601
W: <http://www.ncstatecapitol.org/>

Built in 1840, the North Carolina State Capitol is one of the best-preserved examples of Greek Revival architecture. While the building originally housed the entire state government, today it serves as the offices of the governor and lieutenant governor. Visitors are welcome to take a free self-guided tour through the rotunda, the old legislative chambers and the antique library.



Historic Oak View County Park

4028 Carya Drive
Raleigh, NC 27610
W: <http://www.wakegov.com/parks/oakview/pages/default.aspx>

Historic Oak View County Park is a 19th-century historic farmstead located seven miles east of downtown. The Greek Revival-style farmhouse was built in 1855 by the Williams family, who grew cotton on the surrounding land using slave labor. Visitors can tour a number of historic buildings on the property or visit the Farm History Center, a museum and visitor's center with a variety of permanent and temporary exhibits on North Carolina's agricultural development.



Pullen Park

408 Ashe Ave.
Raleigh, NC 27606
W: <http://www.raleighnc.gov/parks/content/ParksRec/Articles/Parks/Pullen.html>

Founded in 1887, Pullen Park is the first public park in North Carolina, offering a wide range of recreational activities including amusement rides, tennis courts, sports fields and picnic areas. Raleigh's Theatre in the Park, Arts Center and Aquatic Center are also all located in Pullen Park.



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