EMC+SIPI Symposium Shares Valuable Tutorials Virtually

by Kevin Parmenter, Chair, and James Spangler, Co-chair, PSMA Safety and Compliance Committee

Each year the IEEE EMC Society holds its annual conference devoted to electromagnetic compatibility, signal integrity and power integrity. This conference, or symposium, offers both R&D type paper presentations as are common at most IEEE conferences as well as a heavy dose of tutorials and other instructional sessions devoted to professional training. It also hosts an exhibition of vendors providing products relevant to engineers working in this field.

As is the case with many events, the IEEE EMC + SIPI Symposium is going virtual this year with all presentations being given online. As a result, in lieu of the traditional one-week format, conference sessions have been spread out over the course of a month, from August 3rd through the 28th. This virtual format could be a boon for many attendees as it allows individuals to attend more sessions live. Nevertheless, the conference is so large that you cannot attend every presentation live. So the IEEE EMC Society has made a special provision for people who register to attend sessions they missed, by viewing them on-demand from September 1-30, 2020. Also note that conference proceedings are available after registration, downloadable in a 721 MB, .zip file format.

As the symposium is on-going as this is being written, Kevin and I are both in the process of attending this symposium. This article contains our overview of the week one sessions with my (Jim's) comments on the sessions I have personally attended. We'll be writing more about this symposium in a subsequent article. But in the meantime, we highly recommend you consult the schedule at a glance to get a fuller picture of the conference's scope as well as the final program, which goes into greater detail. For those who'd like to attend, you can view the conference rates and register here, or go directly to the registration page.

Week One Highlights

As noted above, this is a review of the first week of EMC + SIPI, which ran Tuesday, August 4 through Thursday August 6. We'll provide abstracts for all the morning sessions, both those I have attended, as well as the overlapping sessions I did not attend. In addition, we'll list titles for the afternoon sessions. The sessions mentioned here were those we found particularly interesting, but there are still more interesting sessions listed in the program. Space does not allow us to list them all here.

For the sessions I have attended, I'll also list the individual papers given in those sessions along with my comments about them. Note that the abstracts and paper titles have been italicized to distinguish them from my comments. Also note that the PDF of the session is listed as (# xxx-xxxx) which than can be found in the download zip unpack file for workshops. The session papers were not easily linked.

Tuesday Morning Workshop

W1_TU_AM_A, "Fundamentals of EMC – Part 1," 8:45 am to 12:00 pm

Session abstract: This tutorial provides an overview of many of the major topics that need to be considered when designing an electronic product or system to meet signal and power integrity (SIPI) and electromagnetic compatibility (EMC) requirements. The tutorial will present foundational ideas from physics and mathematics and will demonstrate engineering approaches to help attendees successfully design, evaluate, diagnose, and/or solve electromagnetic interference (EMI) problems. The main objective of this tutorial is to provide a learning opportunity for those new to EMC as well as a review of the basics for those who already have EMC experience.

Papers in this session:

1. *Inductance and Capacitance, Session # 001-3394, Bruce Archambeault, Missouri University of Science and Technology, Raleigh, NC, USA*

For this presentation, Bruce gave a review of inductors including loops of wire and various loops. There is no inductance until there is a return path or a complete loop for current to return. The return current can be direct ac or dc, or radiated. This is very important for radiation and loop antennas. Various equations are given for different configurations. Self inductance, mutual inductance, and partial inductance concepts are reviewed. The high frequency and low frequency return path is shown for pc board.

A capacitance review was also presented. Pc-board vias were discussed along with the inductance associated with the pc board lead connections. A stray inductance table was presented for the various surface-mount sizes of capacitors that use vias for interconnections. The idea of parallel pc board traces and the capacitance was also presented.

2. *Crosstalk, Session # 002-3210, Eric Bogatin, Teledyne LeCroy, University of Colorado Boulder, Longmont, CO, USA*

Electric fields (E) and magnetic fields (B) as related to pc-board layout and crosstalk between traces were reviewed and presented. The presentation noted that a free download for signals on a pc board is available at www.bethesignal.com and https://www.bethesignal.com/bogatin/vrpw3012-yoshi-animationscrosstalkp-1070.html. Demos were given of the company's software. Of particular interest was the case where a bus of parallel lines is transmitted. If digital signals are present next to analog traces the analog signal can have noise.

Split ground planes were also presented. There are reasons for wanting a split ground plane but also complications. But as this talk discussed, there are techniques to minimize the undesired effects.

3. *Transmission Lines and Basic Signal Integrity, Session # 003-3211, Xiaoning Ye, Intel Corporation, Beaverton, OR, USA.*

Signal Integrity data for high speed IO over interconnections between pc boards was presented with various systems: USB, UDB2, USB3, USB 3.1, etc. This data included signal delays that occur at the receiver for a 5-in. and 8-in. pc board traces. Delays are 500 ps (2 Gbit/sec), while at 20 Gbit/sec rates, 1 bit can be 50 ps.

Data rates can often be distorted and these need to be error corrected. Vias in the pc board can also cause reflections because of the mismatch in the transmission line characteristic. The pc board material must be considered in some applications where there is high speed data due to the mismatch.

The last section of this presentation was a discussion of the various "eye diagrams" for digital signals. For those involved with USB interfaces used in vehicles, this is critical along with CAN signals used in vehicle automotive modules.

4. *PCB Decoupling on Multi-Layer PCBs for Power Integrity Design, Session # 004-3212, James Drewniak[1], Biyao Zhao[1], Shuang Liang[1], Siqi Bai[1], Xiaolu Zhu[1], Samuel Connor[2], Matteo Cocchini[2], Dale Becker[2], Michael Cracraft[2], Brice Achkir[3], Stephen Scearce[3], Quinn Gaumer[3], Albert Ruehli[1], Chulsoon Hwang[1] 1. Missouri University of Science and Technology, Rolla, MO, USA; 2. IBM Corp., Rochester, MN, USA; 3. Cisco Systems, Inc., Morrisville, NC, USA*

This presentation was mainly a review of multilayer pc boards and IC interconnects. Vias play an important role in radiation and transmission line characteristics. The transmission line effects for signal integrity were discussed. Also discussed was the mounting of decoupling SMT capacitors with a layer for the return path.

Along with the session just described, there were two other sessions being held at the same time:

W1_TU_AM_B, "Introduction to EMI Modeling Techniques," 8:45 am - 12:00 pm

Session Abstract: This tutorial will provide an introduction to commonly used numerical EMC modeling techniques without the need for detailed math. Practicing modelers will also benefit from learning the fundamentals of modeling techniques they are currently not using. Each technique will be presented along with its strengths and weaknesses, so engineers can decide which techniques are appropriate for their types of problems.

W1_TU_AM_C, "Smart Grid Support and EMC Issues," 8:45 am - 12:00 pm

Session Abstract: The Smart Grid (SG) continues to be a hot topic worldwide. As SG interest and installations continue to rise, so does the EMC work needed to keep the grid operating. This tutorial will review the contribution of a key SG EMC working group in the US. The focus will be on their 2019 activity as SG devices were exposed to the electromagnetic environment where the grid traverses and is terminated. The tutorial will also give specific examples of the immunity testing needed for Smart devices used in power station and substation environments, as well as a review of the effects on conducted emissions of the SG operation. The tutorial will also place in perspective the EMC work still needed to be done to make EMC an integral part of the SG activity/operation. Finally, the tutorial will present links for free webinars on the extent/severity of EMC

problems, test setups needed to perform immunity tests, and what to consider in planning long-term EMC applications as the SG ages.

The Tuesday morning sessions were followed by three afternoon sessions:

1. *Power Integrity and Analysis and Design: session TC-10*
2. *Computational Modeling: session TC-9*
3. *Emissions and Reverberation Chambers: session TC-2*

Wednesday Morning Workshop

W1_WE_AM_A "Fundamentals of EMC – Part 2," 8:45 am - 12:00 pm

Session Abstract: This tutorial is an overview of many of the major topics that should be considered when designing an electronic product or system to meet SIPI and EMC requirements. The tutorial will present foundational ideas from physics and mathematics and will demonstrate engineering approaches to help attendees successfully design, evaluate, diagnose, and/or solve electromagnetic interoperability problems. The primary objective of this tutorial is to provide a learning opportunity for those who are new to EMC as well as provide a review of the basics for those who already have EMC experience.

Papers in this session:

1. *Grounding, Session # 032-3213, Todd Hubing, Clemson University and Learn EMC, Stoughton, WI, USA*

This was a review of pc board grounding and system ground. This covers pc boards with large ground planes below a digital integrated circuit. Various return path techniques are discussed: single point grounding, star grounding, and multipoint grounding.

2. *Filters, Session # 032-3214, Frank Leferink, University of Twente, Enshede, Netherlands*

This was another paper that reviewed the LISN and common-mode and differential-mode currents with CISPR 17. The various filters for power lines were summarized. A three-phase EMI filter was given with a single-stage and two-stage filtering with mismatch of the various filters.

3. *Radiated Electric and Magnetic Field Emissions Shielding Mitigations, Session # 032-3215, 71 pages, Pablo Narvaez, NASA Jet Propulsion Laboratory, Pasadena, CA, USA*

In this talk, a very complete review of magnetic and electric field shielding was presented. Shielding techniques with incident, reflected fields and transmitted fields were given with examples. Surface resistivity along with Ohms per square were reviewed as these are important for shielding.

4. *Conducted Emissions, Lee Hill, Silent Solutions LLC & GmbH, Worcester Polytechnic Institute (WPI), Amherst, NH, USA, contact Lee Hill @ lhill@silent-solution.com for slides.*

Lee discussed the EN 55011 and EN 55022 standards in addition to the MIL STD-461 standard. The ANSI C63.4 standard for LISN's was reviewed. There is insufficient space here to adequately review this presentation.

5. *Radiated Emissions, Session # 032-3217, Cheung-Wei Lam, Apple Inc., Cupertino, CA, USA*

Lam from Apple reviewed noise sources and how they affect the system. Different noise sources with their EMI signatures were talked about. The different paths of radiated and line conducted noise were reviewed. Time was spent reviewing ground plane discontinuities or slots that cause radiated emissions.

The other two sessions held on Wednesday morning were:

W1_WE_AM_B "Lessons Learned Creating Reliable Computational Models for EMC," 8:45 am - 12:00 pm

Session Abstract: This tutorial will expose the attendees to the lessons learned by several industry experts over the years, the goal being for them to benefit from the sometimes painful learning experiences of the presenters. Computational tools are very powerful and invaluable to the modern design engineer, but there is still an art to using them effectively. In all disciplines, hindsight is perfect, and this opportunity to learn from others will be an

excellent resource. This tutorial will not only show lessons learned but also provide fundamental ways of thinking through their models to better ensure success.

W1_WE_AM_C "Learn EMC Techniques NOW!" 8:45 am - 12:00 pm

Session Abstract: "Learn EMC Techniques NOW!" enables the audience to have the resources to effectively continue to learn about electromagnetic issues and see the ways the issues can occur with improper design techniques. The tutorial enables participants to have practical electromagnetic resources to use immediately, including showing the attendees how to make their own low-cost near field probes to use in their labs and providing probing techniques to debug noise issues. The overall purpose of the tutorial is to provide tools for participants to solve their electromagnetic issues and provide resources for further exploration.

The Wednesday morning sessions were followed by two afternoon sessions:

1. *Interference Control Methods, TC-4*
2. *RFI Issues and 5G Measurements I, TC-12*

Thursday Morning Workshop

W1_TH_AM_B "Basic EMC Measurements," 8:45 am - 12:00 pm

Session Abstract: There continue to be those entering the EMC field who are performing measurement activity for both emissions and immunity. In addition, there are practitioners who want to get a second opinion to support what they are doing. They are all least familiar with basic EMC immunity measurements methods that cover a wide range of electromagnetic phenomena. This tutorial will cover both emissions and immunity by highlighting the latest amendment to a major multimedia emissions standard and a selection of immunity testing standards for transients that are more difficult to implement. The transient discussion will also delve into signals that are high power in a very short time. Also included is a description of emission and immunity test sites, the sites that are becoming popular, and their validation requirements, as well as an overview of test setups in these facilities. Where appropriate and if time permits, attendees will be asked questions as to what they have learned and will be given an opportunity to question the speakers at a panel discussion at the end of the session.

The other two sessions held at the same time included:

W1_TH_AM_A, "Lightning Phenomenology and Salient Parameters for Engineering," 8:45 am - 12:00 pm

Session Abstract: Lightning is a source of electromagnetic interference and damage to transmission lines, wind turbines, photovoltaics, buildings, electronic circuits, and even nuclear power plants. It is also the cause of human and livestock fatalities as well as forest and household fires. Lightning is also frequently responsible for airport delays due to hazardous conditions during fueling, baggage handling, tug operations, and other services. In spite if this non-exhaustive list of nefarious effects, much of the current knowledge of the lightning phenomenon remains unknown to a large portion of EMC engineers. The objective of this tutorial is to familiarize the audience with this important phenomenon and the most important parameters responsible for its deleterious effects.

W1_TH_AM_C "Conformity Assessment Topics for EMC Laboratories," 8:45 am - 12:00 pm

This tutorial addresses the topic of conformity assessment, which enables buyers, sellers, consumers, and regulators to have confidence that products sourced in the global market meet the specific requirements. It is the demonstration that specified requirements relating to a product, process, system, person, or body are fulfilled. Mutual Recognition Agreements (or arrangements) (MRAs) are government-to-government trade facilitating measures aimed at a global approach to conformity assessment. Standards are interwoven into all aspects of these activities and can have a major impact on the outcome of a conformity assessment program. Conformity assessment activities form a vital link between standards (which define necessary characteristics or requirements) and the products themselves. This session is intended to provide an overview of the US participation in telecom mutual recognition agreements, and to explore the conformity assessment system that underpins the agreements. Additionally, we will provide an update on key regulatory matters related to the EU Radio Equipment and EMC Directives.

These were followed by three afternoon sessions:

1. *High-Speed Bus/Link Design, TC-10*
2. *ESD: Touchscreens, Software, and Protection, TC-5*
3. *Special Problems Concerning EMC at Low Frequency, TC-7*

Summary

The conference was excellent and I look forward to attending weeks 2, 3, and 4. Since I was not able to attend all the presentations, I am looking forward to attending the recorded sessions which will be made available on demand September 1-30. I recommend that you download the final program and look at the presenters and also review the presentations prior to the broadcast of the scheduled presentations.

In the Spotlight on Safety & Compliance column in the September issue of this newsletter, additional presentations will be reviewed.

About the Authors

Kevin Parmenter is an IEEE Senior Member and has over 20 years of experience in the electronics and semiconductor industry. Kevin is currently director of Field Applications Engineering North America for Taiwan Semiconductor. Previously he was vice president of applications engineering in the U.S.A. for Excelsys, an Advanced Energy company; director of Advanced Technical Marketing for Digital Power Products at Exar; and led global product applications engineering and new product definition for Freescale Semiconductors AMPD - Analog, Mixed Signal and Power Division.

Prior to that, Kevin worked for Fairchild Semiconductor in the Americas as senior director of field applications engineering and held various technical and management positions with increasing responsibility at ON Semiconductor and in the Motorola Semiconductor Products Sector. Kevin also led an applications engineering team for the start-up Primarion.

Kevin serves on the board of directors of the PSMA (Power Sources Manufacturers Association) and was the general chair of APEC 2009 (the IEEE Applied Power Electronics Conference.) Kevin has also had design engineering experience in the medical electronics and military electronics fields. He holds a BSEE and BS in Business Administration, is a member of the IEEE, and holds an Amateur Extra class FCC license (call sign KG5Q) as well as an FCC Commercial Radiotelephone License.

Jim Spangler is a Life Member of the IEEE with over 40 years of electronics design experience and is president of Spangler Prototype Inc. (SPI). His power electronics engineering consulting firm's priority is helping companies to place products into production, assisting them to pass government regulations and agency standards such as UL, FCC, ANSI, IES, and the IEC.

For many years, he worked as a field applications engineer (FAE) for Motorola Semiconductor, On Semiconductor, Cirrus Logic, and Active Semiconductor, assisting customers in using semiconductors. He published numerous application notes and conference papers at a variety of conferences: APEC, ECCE, IAS, and PCIM. Topics included power factor correction, lighting, and automotive applications. As a FAE, he traveled internationally giving switch-mode power supply seminars in Australia, Hong Kong, Taiwan, Korea, Japan, Mexico, and Canada.

Jim has a master's degree from Northern Illinois University (NIU) and was a PhD candidate at Illinois Institute of Technology (IIT). He taught senior and first-level graduate student classes: Survey of Power Electronics, Fields and Waves, and Electronic Engineering at IIT and Midwest College of Engineering. Jim is a member of the IEEE: IAS, PELS, PES; the Illuminating Engineering Society (IES), and the Power Sources Manufacturers Association (PSMA) where he is co-chair of the Safety and Compliance Committee.

For further reading on power supply-related safety and compliance issues, see How2Power's special section on Power Supply Safety and Compliance.