

EMI/EMC Computational Modeling for Real-World Engineering Problems

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Course Description

The world of EMI/EMC compliance has become much more important than ever before, due to the higher speed electronics in lower cost packages. The 'old ways' of best-guess design practices, and then fix the EMI problems after the product is built is not acceptable in today's market place. Designs must be cost effective, and must pass regulatory requirements the first time through the design cycle.

The old rules-of-thumb *cannot* be relied upon to ensure success. There is a new set of tools available to the EMI/EMC engineer, which allows a more accurate estimation of the EMI/EMC effects of a system, before that system is ever built. While the technology is not available today to completely analyze the entire system with a signal model, separate parts of the system can be successfully modeled and accurate results be obtained.

This seminar provides a complete assessment of the various modeling techniques available today, and more importantly, provides a number of detailed examples of how-to create models for a wide variety of disciplines. Radiated emissions, radiated susceptibility and ESD are all discussed and demonstrated against real-world problems. Validation of modeling techniques and modeling codes are discussed, as well as standard modeling problems to allow engineers a more complete evaluation against potential vendor software packages. The seminar focuses heavily on practical, real-world problems, and provides the students with the ability to begin to do EMC modeling and simulation on their own.

Intended Audience

This course is intended for:

- Working EMI/EMC engineers who are interested in using the latest state-of-the-art tools to help meet product cost and schedule requirements.
- Working Signal Integrity and Design engineers who are interested in expanding the types of analysis tools they currently use to include EMC simulations to help meet product cost and schedule requirements.
- Managers and engineers who are interested in obtaining a better understanding of EMI/EMC computational modeling so they can better evaluate which commercially available software tool would best suit their needs.
- Developers of EMI/EMC simulations software who would like a clearer understanding of the real-world types of problems facing their customers.

Objectives

Students will learn a basic understanding of all the popular EM full-wave modeling techniques, and when to use which technique. More importantly, students will learn how to break real-world EMC problems into something that can be simulated with today's technology. Just as importantly, students will learn how to validate their models to insure the correct result.

Course Materials

All registered participants will receive a copy of all the transparencies used in the presentations and a copy of the book, "EMI/EMC Computational Modeling Handbook", Second Edition, by B. Archambeault, O. Ramahi, C. Brench, Kluwer Academic Publishers, 2001.

For More Information Contact

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Introduction to EMC Modeling Seminar Outline

Introduction

- *Introduction to EMI/EMC Computational Modeling*
- *Why is EMI Modeling Important?*
- *EMI Modeling State-of-the-Art*
- *Tool Box Approach*
- *Range of Modeling Approaches*
 - Rule checking
 - Differential Current Emissions
 - Quasi-Static
 - Full-Wave
 - Magic
- *Brief Description of EMI Modeling Techniques*
 - Finite-Difference Time-Domain (FDTD)
 - Method of Moments (MoM)
 - Finite Element Method (FEM)
 - Transmission Line Method (TLM)
 - Partial Element Equivalent Circuit (PEEC)
- *Other uses for Electromagnetics Modeling*

- *Using Quasi-static and Signal Integrity Tools for EMC Modeling Applications*
 - Limitations of Quasi-static techniques
 - Using circuit based modeling for EMC applications
 - SI tools can be very useful for EMC optimization

The Method of Moments Technique

- *Linear Operators*
- *Pocklington Integral Equation*
- *MoM Development*
 - Matrix construction
 - Basis and Testing Functions
 - Matrix Solution

The Finite-Difference Time Domain Method

- *Basic Formulation*
 - Two-Dimensional FDTD
 - Three-Dimensional FDTD
 - Modeling Primary Sources in FDTD
- *Factors Affecting FDTD Simulation*
 - Numerical Dispersion and Anisotropy
 - Mesh Truncation Techniques
- *Field Extension*
- *FDTD Simulation Errors*

The Finite Element Method

- *Variational Forms*
- *Construction of Finite Elements*
 - Creating the Finite Element Matrix
 - Matrix Assembly
 - Matrix Solution
- *Solving the Two-dimensional Helmholtz Wave Equation*
 - Variational Form for the Helmholtz Equation
 - Radiation Boundary Condition
 - Field Extension
- *Numerical Considerations*

Other Methods

- *TLM*
- *PEEC*
- *Multipole techniques*

Preparation for Modeling

- *The EMI/EMC Problem*
- *Overview of Modeling*
 - Two and Three Dimensional Models
 - Quasi-Static Techniques
 - Full Wave Techniques
 - Time Domain Techniques
 - Frequency Domain Techniques
- *Strengths and Weaknesses of Each Computational Technique*
- *Elements of an EMI/EMC Model*
 - Sources
 - Model Geometry
 - Completing the Problem Space - ABCs
- *Model Goals*
 - Defining Goals
 - Desired Results
 - Problem Geometry
 - Graphics
- *How to Approach EMI/EMC Modeling*
 - Idealized Models
 - Isolated Models
- *Multistage Modeling*

EMI/EMC Model Validation

- *Model Validation Introduction*
- *Computational Technique Validation*
- *Individual Software Code Implementation Validation*
- *EMI/EMC Model Validation using Measurements*
- *EMI/EMC Model Validation using Intermediate Results*

Standard EMI/EMC Problems for Software Evaluation

- *General Principles*
- *Standard Problems*
 - IEEE/EMC Society Standard Problems
 - ACES & IEEE/EMC Society Special Challenge Problems

Creating Practical Real-World Models

This section provides a number of different examples to help students understand how to break a real-world problem into realistic models, and how to create models that will provide useful information. The following examples, and others, will each be discussed in detail.

- *Shielding Effectiveness*
- *Emissions from a Microstrip*
- *Decoupling PCB Power/Ground Planes*
- *IC Packaging Effects*
- *Multi-Stage Modeling*
- *Coupling to Cables, etc*
- *Aircraft Navigation antenna susceptibility to On-board Personal Electronic Devices*
- *Medical Electronics Sensor susceptibility to Near-by Cellular phone emissions*
- *Unshielded telephone susceptibility to RF Fields*
- *ESD Susceptibility of personal laptop computers*
- *EMC Test site evaluation (OATS, Semi-anechoic room, GTEM, Reverb Chamber)*

Commercially Available Software Tools

This section provides a list of commercially available EMC simulation software. A discussion of the strengths and weaknesses of each software package is presented.

Summary/Questions