Introduction to EMC – Fundamental Concepts
(One Day Seminar)

Introduction

The field of EMC is considered to be *Black Magic* by those who do not understanding electromagnetics. In reality, one can solve some of the most complex aspects of EMC by understanding fundamental or basic concepts. A brief overview on EMC is presented. Fundamental areas include basic electromagnetic theory, signal development and propagation, grounding methodologies, transmission line theory, printed circuit board basics, and an introduction to system level testing.

Course Objective

This course examines the following topics, which covers most of the field of introductory EMC engineering. Regardless how many years one has been working within the field of EMC, a fundamental course will provide significant value. A senior engineer tends to solve simple problems using complex analysis. A refresher course in the basics will allow one to visualize problem areas differently and to provide guidance on new approaches toward achieving compliance quickly.

1. Introduction to the Field of Electromagnetic Compatibility
2. Signal Spectra and Waveforms.
3. Basic Electromagnetic Theory
4. Electrostatic Fields (a.k.a. ESD or electrostatic discharge)
5. Grounding and 0V-Referencing
6. Common Impedance Coupling
7. Non-Ideal Behavior of Components
8. Fundamentals of Signal Integrity
9. Printed Circuit Board Basics
10. Simple Test Facilities

Who Should Attend

This course is an introduction to the field of EMC engineering. The target audience is those responsible for management of a regulatory compliance department or supervising engineers working in the field. Mathematical concepts are kept to a bare minimum (simple algebra), where needed. In addition, *practicing* design engineers of all disciplines, regulatory compliance engineers, EMC consultants and PCB designers will significantly benefit from this refresher course. No formal training in electronic theory is required. Concepts, theory and applications are presented in an easy to understand format, *without math*, using practical and real world examples.

Benefits of Attending

- Increased job knowledge
- Enhanced signal integrity and EMC compliance
- Teaches EMC suppression versus containment
- Allows first-time compliance to EMC requirements
- Reduce design time and manufacturing costs
- State-of-the-art design and layout techniques presented

About the Instructor

Mark Montrose is principle consultant of Montrose Compliance Services, Inc., a full service regulatory compliance firm specializing in Electromagnetic Compatibility with 30 years of applied EMC experience. Prior to becoming a consultant, Mark was responsible for regulatory compliance for several high-technology companies in Silicon Valley, California. His work experience includes design, test and certification of both Information Technology (ITE) as well as Industrial, Scientific and Medical products (ISM). He is assessed by a European Competent Body to perform CE compliance approval and in situ testing and certification of industrial products.

Mark is a Senior Member of the IEEE and a past member of the *Board of Directors* of the IEEE as Division VI Director (2009-2010). He is also a long-term past Board member of the IEEE EMC Society plus Champion and First President of the IEEE Product Safety Engineering Society. He was a popular distinguished lecturer for the IEEE EMC Society and is considered an expert in printed circuit board design and system level applications for EMC compliance. He has presented numerous papers based on sophisticated research related to printed circuit boards and the field of EMC at International EMC Symposiums and Colloquiums worldwide. Mark also provides personalized in-house seminars and consulting services to corporate clients worldwide in addition to the University of California, Santa Cruz extension program.

Mark has authored the following best-selling text/reference books published by Wiley/IEEE Press.

- *Printed Circuit Board Design Techniques for EMC Compliance*, 1996-1st ed / 2000-2nd ed.
- *EMC and the Printed Circuit Board - Design, Theory and Layout Made Simple*, 1999.
- *Testing for EMC Compliance – Approaches and Techniques*. 2004.
- Contributing author to the *Electronics Packaging Handbook*, Chapter 6, 2000 (CRC/IEEE Press).

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INTRODUCTION
- Why is this Course Necessary
- Uniqueness of EMC Engineering
- Definition of EMC Terms
- The EMC Environment
- Basic Aspects and Elements of EMC
- Electrical Dimensions
- Logic Families

SIGNAL SPECTRA AND WAVEFORMS
- Signal Spectra - Bandwidth
- Digital vs. Analog Waveforms

BASIC ELECTROMAGNETIC THEORY
- How Circuits Create EMI
- Right Hand Rule
- Maxwell Equations Made Simple
- Electric and Magnetic Field Impedance
- Magnetic and Electric Field Representation
- Closed Loop Circuit
- Common-Mode and Differential-Mode Currents
- Antenna Structures
- What Makes an Efficient Antenna
- Loop Area Between Components

ELECTROSTATIC FIELDS
(a.k.a. ESD or Electrostatic Discharge)
- Description of an ESD Event
- ESD Waveforms
- Tribolectric Series
- Failure Modes

GROUNDING AND 0V-REFERENCING
- Inductance – What is It?
- Path of Least Impedance
- Self Inductance
- Current Return Paths
- Defining Ground
- Grounding Methodologies
- Ground Loop Control
- Breaking Up Ground Loops

COMMON IMPEDANCE COUPLING
- Methods of Coupling
- Common Impedance Coupling

NON-IDEAL BEHAVIOR OF COMPONENTS
- Component Characteristics at RF Frequencies
- Non-Ideal Behavior of Components
- Circuit Analysis
- Passive Component Analysis
- Hidden Digital Component Characteristics

FUNDAMENTALS OF SIGNAL INTEGRITY
- Defining Signal Integrity
- Lossy and Lossless Transmission Lines
- Transmission Line Systems
- Signal Distortion Characteristics
- Lossy Transmission Line Concerns
- Relative Permittivity
- Crosstalk

PRINTED CIRCUIT BOARD BASICS
- Stackup Configurations
- RF Field Distribution
- RF Current Density Distribution
- RF Return Path and Flux Cancellation
- Image Plane with Moat Violations
- Functional Partitioning
- PCB Layout Guidelines

SIMPLE TEST FACILITIES
- Open Area Test Sites (OATS)
- Chambers
- Screen/Shield Rooms
- LISNs/CDNs
- Basic Shielding Theory