Fundamentals of Applied EMC Engineering

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 the fundamental or basic aspects of Maxwell's equations (made simple in this course). A brief overview on some concerns related to printed circuit board design and layout along with secondary methods to achieve EMC, such as filtering, shielding and gasketing are presented.

An overview of the international compliance arena is also discussed along with the process one must take toward testing, troubleshooting and certification of a system.

Course Objective

This course covers the following topics, which covers most of the field of EMC engineering. Regardless of how many years one has been working within the field of EMC, a fundamental course may 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. Definition on what the field of EMC covers.
2. What it takes to be EMC compliant.
3. Fundamentals of signal integrity (time domain).
4. Fundamentals of EMC (frequency domain).
5. Fundamentals of PCB design and layout.
6. Grounding systems.
7. Filtering, shielding and gasketing.
8. Approach toward testing, troubleshooting and certification.

Who Should Attend

This course is an introduction to the field of EMC engineering. The target audience is for those responsible for the 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 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
- 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

Fundamentals of Applied EMC Engineering
(Two Day Seminar)

DEFINITION OF EMC TERMS
- Basic Aspects of EMC
- Elements of the EMC Environment
- Regulatory Requirements
- International Immunity Requirements
- Performance Criteria for Immunity Tests

WHAT IT TAKES TO BE EMC COMPLIANT
- Areas of Concerns to Achieve EMC
- System Requirements
- North American and International Limits
- Documentation Requirements

FUNDAMENTALS OF SIGNAL INTEGRITY (TIME DOMAIN)
- Signal Integrity Concerns
- Transmission Lines Concepts
- Relative Permittivity (Dielectric Constant)
- Ringing and Reflections
- Identification of Signal Distortion
- Crosstalk
- Transmission Line Effects
- Termination Methodologies

FUNDAMENTALS OF EMC (FREQUENCY DOMAIN)
- Signal Spectra (Fourier Analysis)
- Maxwell Equations Made Simple
- Electric and Magnetic Field Impedance
- Magnetic and Electric Field Representation
- Closed Loop Circuit
- Loop Area Between Components
- Noise Coupling Mechanism
- Common-Mode and Differential-Mode Currents
- Comparison of Radiation Mechanisms
- Basic EMC Suppression Concept

FUNDAMENTALS OF PCB DESIGN AND LAYOUT
- Fundamental Requirements
- Component Characteristics at RF Frequencies
- Image Planes
- RF Current Density Distribution
- Ground Loop Control
- Functional Partitioning
- Component Selection Related to EMC
- Defining Capacitor Usage
- Using Capacitors in Parallel
- Effects of Capacitors in Parallel
- Power and Ground Plane Capacitance
- Microstrip and Stripline Topology
- Impedance Control
- Capacitive Loading
- Calculating Trace Lengths
- Trace Separation and the 3-W Rule
- Routing Layers and Layer Jumping
- Partitioning
- Isolation (Moating) and Bridging
- Image Plane or Moat Violation
- Digital and Analog Partitioning
- Multi-Point Grounding (I/O Connectors)

GROUNDING SYSTEMS
- What is Ground?
- Grounding Hierarchy
- Different Types of Grounds
- Grounding Misconceptions
- Two Reasons for the Need to Ground
- Floating, Single-Point, Multi-Point, Hybrid
- Cable Shield Grounding

FILTERING, SHIELDING AND GASKETING
- Signal and Power Line Filter Configurations
- Basic Filter Component Characteristics
- Capacitive and Inductive Filtering
- Filtering Guideline
- Shielding Effectiveness
- Transmission Line Theory of Shielding
- Losses Achieved with Shielding Material
- Skin Depth and Absorption Loss
- Reflection Loss - Plane Waves/Thin Shields
- Apertures
- Waveguide Below Cutoff
- Common Gaskets and Mechanical Problems

APPROACH TOWARD TESTING, TROUBLESHOOTING AND CERTIFICATION
- International Requirements and Differences
- Testing Methodology and Approach
- Knowing the Test Environment
- Self-Compatibility
- Validation of Measured Data
- Pitfalls and Problems
- Process for Designing Systems to Achieve EMC
- Formal EMC Qualification Tests Requirements
- Strategy for EMI Debugging/Troubleshooting
- Testing and Troubleshooting Concerns
- Emission, Immunity and In Situ Testing
- Systematic Approach for Testing
- Compliance Measurement Procedure
- Performing Testing-Beyond Standard Procedures
- Systematic Approach to Solving Problems