

# **Fundamentals of Grounding and Shielding** **For System Level Noise Reduction** **(Two Day Seminar)**

## **INTRODUCTION TO EMC**

- Definition of EMC Terms
- The Decibel, Variations and Pitfalls
- Signal Spectra (Fourier Analysis)
- How RF Energy is Created
- Right Hand Rule and Maxwell's Equations
- Electric and Magnetic Fields
- Loop Area Between Circuit and Components
- Component Characteristics at RF Frequencies

## **ELECTRICAL NOISE CONCEPTS**

- Basic Concepts Related to Reducing Electrical Noise
- Digital Components as a Source of EMI
- Basic Aspects of EMC and the Environment
- How Does Current Travel—What Path Does It Take?
- Path of Least Impedance / Typical Wire Configuration
- Concept of Self Inductance
- Common-Mode and Differential-Mode Currents
- Power and/or Ground Bounce

## **BASIC GROUNDING CONCEPTS**

- Grounding Concepts
- Different Types of Grounds Possible in a System
- Multiple Return Path Possibilities
- Grounding Misconception
- Product Safety Requirements
- Dealing With Ground Currents
- Important Grounding Principles

## **GROUNDING METHODOLOGIES**

- Floating/Single/Multiple/Hybrid Ground Systems
- Cable Shield Grounding
- Ground Trees

## **GROUND LOOPS & COMMON IMPEDANCE COUPLING**

- Inductance of Wire
- Minimizing Ground Inductance
- Mutual Inductance/Capacitance Between Transmission Lines
- Common Impedance Coupling
- Difference in Loop Area—Square vs. Circle
- Ground Loop Control – System and Adapter Cards
- Avoiding Ground Loops
- Isolation Techniques

## **PRINTED CIRCUIT BOARD GROUNDING CONCEPTS**

- Grounding and Layout Considerations
- Functional Partitioning
- Identifying a Grounding Plan
- Grounding Analog & Digital Circuits in a PCB
- Variations on Split Plane Configurations
- Routing Traces and Return Currents Using Multiple Planes

- Concerns With Layer Jumping Transmission Lines
- Interplane Capacitance
- Pinout Configurations—Interconnects
- Digital-to-Analog Partitioning (Mixed Signal Grounding)
- RF Current Density Distribution
- Screws as a Radiating Antenna

## **GROUNDING IMPLEMENTATION EXAMPLES**

- Avoiding Common-Impedance Coupling
- Cause of Ground Voltage Potential Between Two References
- Connecting AC Signal Reference to Chassis
- Ground Versus Floating Related to Hazardous Fault Currents
- Grounding Between Different Circuits Using Interconnects
- Ground Concept Summary—Signal Reference and Chassis

## **SHIELDING THEORY**

- Shielding Effectiveness
- Transmission Line Theory of Shielding Effectiveness
- Skin Depth and Absorption Loss
- Multiple Reflections and Loss in Copper and Thin Shields
- Apertures in Shielding Walls
- Waveguide

## **SHIELDING APPLICATIONS AND IMPLEMENTATION**

- Effects of Shield Discontinuity
- Gasketing and Conductive Coatings
- Joint Unevenness
- Common Gasket Material
- Properties - Common Types of RF Gaskets and Fingers
- Characteristics of Common Gasket Materials
- Potential Mechanical Problems When Using Gaskets
- Electrochemical Grouping
- Conductive Gasket Implementation
- Conductive Coatings
- Characteristics of Common Surface Coatings
- Comparison of Metallizing Techniques
- Concerns When Using Coatings
- Shielding Integrity Violations
- Proper and Improper Shield Penetrations
- Common Cable Shielding Configurations
- Cable Shield Termination Concepts
- Implementation a Cable Shield into an Assembly
- Terminating a Cable Shield
- Aspects to Consider When Specifying a Shielded Cable
- Shielded Compartments