System Design for EMC – PCB and System Level

(Two-Day Seminar)

REVIEW-ELECTROMAGNETIC FUNDAMENTALS

- 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

- 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

TRANSMISSION LINE THEORY (SIGNAL INTEGRITY)

- Transmission Line Equivalent Circuit
- Relative Permittivity (Dielectric Constant)
- Propagation Delay Within Various Materials
- Ringing and Reflections
- Typical Transmission Line System
- Identification of Signal Distortion
- Crosstalk
- Terminator Noise and Crosstalk
- Design Techniques to Prevent Crosstalk
- Power and/or Ground Bounce
- Typical Bounce Waveform

EMC SUPPRESSION CONCEPTS-PCBs

- Image Planes
- RF Current Retrun Path and Distance Spacing
- RF Current Density Distribution
- Ground Loop Control
- Three Main Grounding Methods
- Resonance in a Multi-Point Ground
- Aspect Ratio
- Ground Slots and Through-Hole Components
- Partitioning
- Logic Families and Components

CLOCKS, IMPEDANCE CONTROL, TRACE ROUTING

- Calculating Clock Frequency Range
- Microstrip and StriplineTopology
- Impedance Control Equations
- Capacitive Loading
- Calculating Maximum Trace Length for Routing
- Trace Separation and the 3-W Rule
- Trace Routing
- Routing Layers
- Layer Jumping - Use of Vias
- Guard and Shunt Traces

TERMINATIONS (SIGNAL INTEGRITY CONCERNS)

- Fundamental Concepts of Trace Termination
- Transmission Line Effects
- Termination Methodologies
- Correct Method to Implement Termination
- What Happens When One Cannot Terminate

INTERCONNECTS AND I/O

- Partitioning
- Isolation (Moating), Bridging and Violations
- Digital and Analog Partitioning
- Filtering and Grounding
- Common-Mode and Differential-Mode Currents
- Multi-Point Grounding (I/O Connectors)

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 and 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 Lines
- Common Impedance Coupling
- Difference in Loop Area–Square vs. Circle
- Ground Loop Control – System and Adapter Cards
- Avoiding Ground Loops
- Isolation Techniques

GROUNDING IMPLEMENTATION EXAMPLES

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