EMCT Electromagnetic Compatibility Tutorial ®

IEEE

MODULE 2: Design

Integration of multi-card products, paralleled-stacked circuit boards, perpendicular circuit boards, interrelationships of back-planes, mid-planes, and card cages. (501 screens)

The Design Module begins with the relationships between "stacked" (co-planer and parallel) circuit boards. In detail, we'll examine the coupling effect on interface connections, the common-mode losses of inter-board connectors, and the slot antenna structures that are created among the boards; learn about the resonance interactions among stacked and interconnected products, move from parallel to perpendicular structures and examine the common-mode effects on EMC in products with motherboards and perpendicular peripheral boards; learn about the interface effects of common-mode loop structures with the chassis, bus-cards, and motherboard and then take a look at larger-scale products; examine the backplane architecture and bus structure of perpendicular cards, learn about the relationships of common-mode currents and fields between: circuit boards; circuit boards and the back-plane; and circuit boards and the backplane as a path in the card cage structure, we'll turn our attention to the affect these common-mode currents have on the EMC performance of interconnections such as data cables and wiring to the power sub-systems. From interconnections, we'll move to common-mode loop structures and study the resonance and field transfers of rack-mounted card cage sub-systems. Finally, we'll describe what happens when mid-plane configurations are used instead of backplanes and learn about the potential EMC advantages of partitioning a system using mid-planes. We'll conclude the Design Module with a brief discussion of the overall system susceptibility (immunity).

Section A - Paralleled EMC Relationships of "Stacked" Circuit Boards

- Common-mode Developments and Coupling with Interconnected Circuit Boards; Common-mode and EMC Issues Using Interconnected Circuit Boards With Interface Cable Configurations; Common-mode Displacements of Paralleled and Interconnected Circuit Boards With Interface Cables
- Electromagnetic Field Transfers and Displacement Interactions Of Paralleled Circuit Boards
- Field Interactions Between Paralleled Boards and Chassis Structures; Ground "Null" Applications to Paralleled Circuit Boards to Develop Signal / Noise Partitions
- Topology and Partitioning of Paralleled Circuit Boards
- Backbone Implementation for Partitioning Between Paralleled Circuit Boards

Section B - Perpendicular Bus-Structure Circuit Boards with Motherboards

- Common-mode and EMC Essentials of Perpendicularly - Connected Circuit Boards; Common-mode Architectural Considerations With Perpendicular Circuit Boards; Common-mode Field Distributed Transfer Interactions
- Field Displacements to Chassis Planes - Structures
- Common-mode Transfers In Architectural Paths to Interface Cables; Field Transfer Interactions to Interface Cables With Multiple Cards; EMC Implications of Ancillary Connections to Perpendicular Circuit Boards
- Ground Null Applications to Motherboards and Perpendicular Interface Circuit Boards
- Topological Layout Implications of Common-mode Fields

Section C - Backplane and Midplane Products Integrated with Card Cages (including Multiple Card Cages and Common-mode Architecture for Intra-System EMC)

- Backplanes Viewed with a Single Interconnected Systems Board
- "Lumped Effects" of Common-mode Considerations
- Card Cage Impositions With Backplanes With Interconnected Systems Board; Field and Current Transfers to Card Cages from Interconnected Systems Boards with (and to) Backplanes
- Backplane Architecture to Systems Boards
- Differential-mode Signal Approach
- Power Distribution and Common-mode Architecture
- Common-mode Architectural and EMC Implications of Interface Connections
- Conceptual Approach of Midplane Integration
- Common-mode Aspect Ratios of System Boards
- Interface Cable Connections to Backplanes and Systems Boards; Interconnections of Multiple Systems Boards
- Approximation of Antenna Structures Referenced to Chassis
- Common-mode References of Backplanes With Systems Boards; Common-mode Current Circulation Closure
- Chassis References for DC Chassis-Isolated Backplanes
- Reference Technique With Chassis Stripes and Via Patterns
- Establishment of Common-mode "Null Zones" in Backplanes
- Null Zones and Regional Partitions; Inter-layer Backplane Referencing Method With Connection Detail; Backplane Layering Construction, Stack-up Considerations
- System Board Topology for Distributed DC Power Subsystems
- Card Guide Connection Null Approach
- Null Partition References of Interconnected Systems Boards
- Derivation of Common-mode EMC Architecture
- Null Partition References - Card Cage and Backplane Integration; Termination of Null Partitions to Backplane
- Mid-Planes - Partition Integration; Mid-Plane Partitions and Stack-up Concepts; Mid-Plane Common-Mode Architectural Derivation

Section D - EMC Implications of Systems Interconnections

- Implications Related to Systems Interconnections
- EMC Issues Affecting Radiated Field Susceptibility and Emissions; Interrelationships of Currents Between Systems Units
- Spatial EMC Excitations Among Systems Unit Members
- Rack-Mount EMC Integration of Multiple Card Cage Products
- Multiple Card Cage Products - Independently and Remotely Mounted; Common-mode EMC Excitations Imposed to Mechanical Mounting Structures
- Field Transfers (Interactions) Between Multiple Card Cage System Products
- EMC Mitigation Methods for Rack Mount Products
- Distributed Common-mode Attenuation Technique Through Interface Cables
- Implications of Primary (Utility) Power Interconnections
- Historical Implications of Facility Common-mode Events
- Voltage and Current Ground Shifts From Facility Power
- Alternate Architectural Systems Structure to Mitigate Facility Common-mode Events
- Essential EMC Characteristics of Telecommunication Physical Transport Layers:
  - o Multi-wire Cables; Twin-axial Cables; Tri-axial Cables

Section E - Immunity / Susceptibility Considerations

- Common-mode Entry and Exit Currents (to or from systems-products); Null Redistributions of Common-Mode Exit Currents
- Implications of Redistributions to Shielded Cables
- Common-Mode to Differential-Mode Conversions; Common-Mode Current Circulating in the Shield of the Cable Wire Pairs
- EMC Reference Interactions with Chassis-Case Structures
- Overview of Case-Structure Apertures and Field Redistribution
- Transfer Mechanisms of Susceptibility Response
- Effects of Product Immersion into Radiated Field Excitation
- Common-mode and Differential-mode Approaches
- Concepts of Demodulation and Detection of RF Carrier Processes
- Electrostatic Discharge (ESD) Processes and Impacts
- Fast Transient (EFT) Coupled Impacts
- Radiated Field Influences.

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