

EMCT Module #2:

“Design & Integration of Multi-Card Products, Back-planes and Card Cages”

In this second of three EMCT modules we examine 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. Finally, we'll learn about the resonance interactions among stacked and interconnected products.

We'll then move from parallel to perpendicular structures and examine the common-mode effects on EMC in products with motherboards and perpendicular peripheral boards. We'll learn about the interface effects of common-mode loop structures with the chassis, bus-cards, and motherboard.

Next, we'll take a look at larger-scale products. We'll examine the backplane architecture and bus structure of perpendicular cards. Then, we'll 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 through eddy currents in the card cage structure.

After we have a good grasp of these relationships, 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 course with a brief discussion of the overall system susceptibility.

MODULE CONTENT:

Introduction to EMC (43 screens)

- Blocked and Lumped Equivalent Models
- Chassis Structures
- Interface Connections
- Conductive Case / Packaging Containment
- Susceptibility Coupling
- ESD Application
- Interface Connections
- Exit Currents
- Antenna Structures

Module 2 Details (492 Screens)

Paralleled Relationships, Stacked Circuit Boards

- Interconnected Circuit Boards
- Interconnected Circuit Boards with Interface cables
- Interconnected and Paralleled Boards with Interface Cables
- Field Transfer Interactions of Paralleled Boards
- Field Transfer Interactions of Case/Chassis Structures
- Ground "Null" Applications to Paralleled Circuit Boards
- Topology and Partitioning of Paralleled Circuit Boards
- Partitioning with Backbone Implementation
- Parallel Integration through Compatible Technologies

Perpendicular Bus Structure, Circuit Boards with Motherboards

- Perpendicularly Interconnected Circuit Boards
- Common-Mode EMC Architectural Considerations
- Common-Mode Field Distributed Transfer Interactions
- Field Displacements to Chassis Planes
- Field Transfer Interactions to Interface Cables
- Parallel Field Displacements to Chassis Planes
- Field Transfer Interactions to Interface Cables - Multiple Cards
- Ancillary Connections to Perpendicular Circuit Boards
- Ground Null Application to Motherboards and Interface Cards
- Topological Common-Mode Field Implications

Backplane / Mid-plane Products Integrated with Card Cages and Multiple Card Cages

- Backplanes with a Single Interconnected Card
- Lumped "Common-Mode" Considerations
- Backplanes with Interconnected Card - Card Cage Imposition
- Backplanes with Interconnected Card - Transfers to Card Cage
- Backplane Signaling Architecture to Systems Boards
- Differential-Mode Signal Approach
- Power Distributions and Common-Mode Architecture
- Mid-plane Integration Approach
- Common-Mode Aspect Ratio of System Boards
- Interface Cable Connections
- Interface Antenna Representation
- Interconnection of Multiple Cards
- Interface Antenna Representation of Multiple Cards
- Equivalent Antenna Structure to Chassis Plane
- Backplanes with Interconnected Card - Backplane References
- Common-Mode Circulation Closure
- Chassis Connection References for DC Chassis Isolated Backplanes
- Reference Connection Stripe/Via Patterns
- Backplane Referenced "Null Zones"
- Distributed Decoupling within Null Zones
- Null Zones and Regional Partitions
- Backplane Interlayer Reference Method
- Backplane Interlayer Reference Method - Connection Detail
- Backplane Layer Construction, Stack-up Notes
- Interconnected Card Edge Reference Application
- Guide Connection Approach
- Distributed DC Power Subsystem Partitioning
- Interconnected Cards - Null Partition References
- Interconnected Card Implementation
- Derivation of Common-Mode Architecture from System Architecture
- Null Partition References - Card Cage and Backplane Integration
- Null Partition Guide Connection Approach
- Null Partition, Termination to Backplane
- Mid-Plane Partition Integration
- Mid-Plane Partition Stack-up
- Mid-Plane Partitions
- Mid-plane Common-Mode Architecture

- Continued -

EMC Implications of System Interconnections

- Implications of System Interconnections
- Issues Affecting Radiated Field Susceptibility and Emissions
- Interrelationships of Currents Between System Units
- Spatial EMC Excitations among System Unit Members
- Multiple Card Cage Products - Rack Mount Integration
- Multiple Card Cage Products - Independently / Remotely Mounted
- Excitations Imposed to Mechanical Mounting Structures
- Field Transfers Between Multiple Card Cage Products
- Lumped Representations of Multiple Card Cage Products
- Rack Mount Integration of Multiple Card Cage Products
- Mitigation Methods for Multiple Card Cage Products
- Distributive Common-Mode Attenuation with Interface Cables
- Interconnections to Primary Power
- Interconnections to Facility Distributions
- Historical Implication of Facility Common-Mode Events
- Voltage and Current Shifts from Facilities Power that Impact Systems
- Alternate Architecture for Facility Common-Mode Events
- Software Coding and Physical (Interface) Transport Layers
- Essential EMC characteristics of Telecommunication Transport Layers (Multiwire, Twin Axial, Triaxial Approaches)

Immunity / Susceptibility Considerations

- Common-Mode Entry and Exit Currents
- Null Redistribution of Common-Mode Exit Currents
- Implications of Shielded Cables
- Common Mode to Differential-Mode Conversions
- Common Mode to Differential-Mode Conversions with Shields
- Common-Mode Current Circulating in the Shield of the Wire Pair
- Reference Interactions with Chassis-Case Structures
- Overview of Case-Structure Apertures
- Transfer Mechanisms of Susceptibility Response
- Immersion into Radiated Excitation Fields
- Bandwidth Limiting (Filtering / Conditioning)
- Common-Mode Approach
- Differential-Mode Approach
- Demodulation and Detection Processes
- Electrostatic Discharge (ESD) Impacts
- Fast Transient Coupled Impacts
- Radiated Field Influences

What is the EMCT?

Brought to you by Elliott Laboratories and the IEEE Standards Information Network, the Electromagnetic Compatibility Tutorial is an EMC education on a CD-ROM. It combines the best qualities of a classroom instructor, a seminar, and a book into one extremely convenient and very powerful teaching medium. The EMCT is easy to carry around. It's more compact than a book or seminar notes—and it's interactive.

Learn from W. Michael King – Reap the benefits of a lifetime of learning and applying EMC in more situations than most EMC engineers would ever hope to encounter. William Michael King is one of the acknowledged pioneers and masters of EMC. He has been in the EMC field for over 40 years and has worked on more than 1000 designs for more than 400 clients worldwide.

Want more? EMCT has successfully completed the IEEE Peer review process so you know it meets the highest professional standards!

Benefits of the EMC Tutorial

EMCT presents over 1,200 images in dazzling color using mixed media. There are 3-D animated graphics, photographs, plots, schematics, and block diagrams. All the images are in vivid color. Some of EMCT's images are even animated, 3-Dimensional graphics depicting radiating fields (books can't show movies). And, remember the old saying "a picture is worth a thousand words?" You'll learn EMC faster because you'll remember the images you've seen—they cement the concepts in your mind.

EMC is a complex subject. In the tutorial, the author masterfully weaves the concepts of EMC into a powerful understanding of complex systems—one simple layer at a time. The teaching method is both conceptual and intuitive. Throughout the tutorial, you're provided with numerous design examples and the design rules. And, what's most important—you're not just blindly learning a bunch of rules. Always, you're learning the concepts, so you'll know when and where to apply the design rules.

Would you like more information? Many topics in the EMCT provide additional screens to clarify and further explain the concepts at hand—the additional information is a path off the main stream of slides.

Another major benefit of the EMCT Self-Study program is that it's self-paced. You learn on your time, when it is convenient for you! Seminars and instructors move at a predetermined pace, not according to your busy schedule. You often miss important concepts because you're too busy taking notes or the topic has been fully explained to your satisfaction. And of course, instructors can run out of time but the EMCT is there for you as long as you need it.

Then there's the ability to administer a self-test to validate your understanding of the subject matter. At any time you choose you can take the EMCT self-test and gauge your progress on the course curriculum. Take it over and over – the questions change every time. And when you're done you'll be directed to the correct screens for each incorrect answer.

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