SILENT SOLUTIONS EMC TRAINING

Unique courses on recognizing, solving, and avoiding the toughest EMI problems, from SILENT Solutions LLC

10 Northern Blvd, Suite 1, Amherst, NH 03031-2328 USA

T: +1 (603) 578-1842 www.silent-solutions.com

Mechanical Design for EMC

This course for mechanical engineers provides clear applications, theory and demonstrations for the successful design of mechanical enclosures for good system emissions and immunity performance. Key topics include grounding at the PCB and enclosure, system ground maps, PCB component placement and control drawings, enclosure and cable shielding, PCB device "cans", resonant slots and enclosures, heat sinks, unintentional antennas, as well as connector, screw, and conductive gasket placement.

Course Instructor

Lee Hill is Founding Partner of SILENT, an independent EMC and RF design firm established in 1992 that specializes in EMC and RF design, troubleshooting, and training. Lee received his MSEE from the Missouri University of Science & Technology EMC Laboratory, emclab.mst.edu. He teaches a graduate course in EMC as a member of adjunct faculty at Worcester Polytechnic Institute (WPI), and is also an EMC course instructor for Texas Instruments, the University of Oxford (England) and the IEEE EMC Society's Global University, which he currently chairs. He is a past EMC instructor for UC Berkeley, Agilent, and Hewlett Packard.

With over 30 years of EMC design and troubleshooting experience, Lee consults and teaches worldwide, and has presented courses in Taiwan, China, Poland, Singapore, Mexico, Norway, Canada, South Korea, France, Germany and United Kingdom. Lee is a past member of the IEEE EMC Society's Board of Directors (2004-2007).

After Attending This Course, You Will Be Able To:

- Effortlessly identify unintentional antennas using pictures of past SILENT projects with EMI problems
- Easily and simply visualize common-mode current in cables and enclosures
- Explain the four noise coupling paths, & identify near-field coupling in real designs
- Understand the function of grounds in electronic product design
- Understand shielding of enclosures and cables, without electromagnetics mathematics
- Design a "good enough" high frequency shield
- Design a "good enough" low frequency shield
- Identify the most common types of grounding and shielding defects
- Apply the concepts of conductivity, transfer impedance, and skin depth to practical designs
- Estimate the resonant frequencies of enclosures, slots, and waveguides
- Specify shielded connectors and cable assemblies to ensure good system EMC

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Mechanical Design for EMC

Day 1

Section 1: Measuring and Inducing Noise

1) The electrical noise model
2) Distinguishing the four noise paths by name, electrical driving function, necessary physical features, and impact of source to victim distance
3) Troubleshooting techniques based on the noise model
4) Far-field versus Near-field coupling + DEMONSTRATION
5) Practical antenna theory for radiated emissions and immunity + DEMONSTRATTION
6) Problems inherent in predicting radiated emissions and radiated immunity test results
7) Conducted emissions—mode separation, LISNs, troubleshooting

Section 2: Predicting and Solving Noise Problems

1) Capacitance—in ESD, PD boards, decoupling networks, filter networks, cables + DEMONSTRATION
2) Electrostatic discharge (ESD). IC and system ESD tests. Problems with test repeatability. Design techniques to improve PCB ESD immunity + DEMONSTRATION
3) Inductance—in PC boards, connectors, ICs, high speed signal paths, decoupling networks,
4) How to use connectors for improved signal quality, reduced emissions, & improved immunity
5) Behavior of current paths at low and high frequencies + DEMONSTRATION

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Mechanical Design for EMC

Day 2

Section 1: Review of Key Concepts and Introduction to Shielding

1. The theoretical, perfectly shielded enclosure
2. The expensive, practical enclosure
3. Review of the four noise paths
4. Understanding & visualizing common-mode current + DEMONSTRATION
5. Accidental antennas and antenna circuits
6. Regulatory and functional emissions and immunity tests
7. The three properties of electromagnetic shields

Section 2: PCB and Mechanical Control Drawings

1. Placement and location of grounds, and connectors
2. Effects of heat sinks
3. “Ground” / reference maps
4. External shielded connector interfaces

Section 3: Shielding

1. Why EMC shielding math in textbooks is wrong
2. Classical shielding and shielding for EMC
3. Problems with the prediction of shielding effectiveness
4. Practical aspects of shielding enclosures
5. Slot and cavity resonances in shielded enclosures + DEMONSTRATION
6. Review: The three properties of electromagnetic shields
7. Reflective and absorptive properties of shields + low frequency shielding
8. Magnetically conductive materials
9. Transfer impedance for base materials, connectors, cables

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Mechanical Design for EMC

Day 2

Section 3: Shielding (continued)

10. Transfer impedance for base materials, connectors, cables and enclosures
11. Effects of apertures
12. Latest research on apertures and cavities
13. Simple tests to verify performance of enclosures and transfer impedance + DEMONSTRATION
14. Overall shielding using enclosures
15. PCB level shields + factors that affect performance
16. Prevention of “accidental antennas”
17. Troubleshooting techniques

Section 4: Shielding of Cables

1. Cable shielding and terminations
2. Applying transfer impedance concepts to cables, connectors, and system interconnect
3. Examples and discussions of common shielded connectors and their defects (ENET, d-sub, video)
4. Shield terminations + DEMONSTRATION
5. What to ground, where, and why
6. Examples of bad cable shielding designs

Section 5: System Design Review Practice

1. During class, review and recommend EMC design changes for a prototype system design.