

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

T: +1 (603) 578-1842 [www.silent-solutions.com](http://www.silent-solutions.com)

## Mechanical Design for EMC

This two-day 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.

### After Attending This Class, 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 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 assembly to ensure good system EMC

**SILENT**

Solutions for your noisy world.

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

T: +1 (603) 578-1842 [www.silent-solutions.com](http://www.silent-solutions.com)

## Mechanical Design for EMC

### Day 1: Attend Day 1 of Electronic Product Design & Retrofit

#### Section 1: Measuring and Inducing Noise

1. Electromagnetic Compatibility
2. Radiated emissions & associated measurements + DEMONSTRATION
3. Uncertainty in measurements. Underlying problems in predicting results
4. Conducted emissions—electrical schematic and the purpose of LISNs
5. Function and purpose of immunity tests with simplified schematics

#### Section 2: Predicting and Solving Noise Problems

1. Capacitance—in ESD, PD boards, decoupling networks, filter networks, cables + DEMONSTRATION
2. Inductance—in PC boards, connectors, ICs, high speed signal paths, decoupling networks, filter networks
3. Behavior of current paths at low and high frequencies + DEMONSTRATION
4. Develop a customized source/victim/coupling-factor list of your company's designs
5. Improving your skills – additional topics

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

T: +1 (603) 578-1842 [www.silent-solutions.com](http://www.silent-solutions.com)

## Mechanical Design for EMC

### Day 2

#### Section 3: 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 4: 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 5: 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 and enclosures
10. Test your knowledge by reviewing a proposed design

**SILENT**

Solutions for your noisy world.

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

T: +1 (603) 578-1842 [www.silent-solutions.com](http://www.silent-solutions.com)

## Mechanical Design for EMC

### Day 2 (cont'd)

#### Section 6: Shielding (continued)

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

#### Section 7: 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