

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

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

## Advanced Printed Circuit Board Design for EMC + SI

This two-day class provides a unique blend of theory, applications, and numerous hardware demonstrations to describe effective PCB design strategies to eliminate EMC problems such as radiated emissions & immunity, and ESD, and to improve low and high frequency signal integrity of analog and digital sensors.

The real-time hardware demonstrations use a spectrum analyzer, oscilloscope and signal generators to illustrate inductance, common-impedance coupling, and ground loops in PCBs, cables, and systems. Specific examples of single-point, multi-point, "good", and "bad" grounds will be discussed. We will also apply the course learning by discussing and examining actual SILENT client case histories as well as examples of integrated circuit application notes that give bad EMC design advice.

## After Attending This Class, You Will Be Able To:

- Place decoupling capacitors to obtain best performance for a given layer stackup, based on the latest university research
- Explain the pros and cons of different PCB stackups, and know where to route and not to route high frequency noise sources
- Control trace inductance for signal integrity and low noise design
- Correctly identify the possible noise paths that can disrupt PCB operation and choose appropriate solutions
- Explain the problems that split ground planes cause and how to use them correctly
- Choose & place connectors and assign signals for lowest crosstalk, best signal integrity, and lowest EMI
- How to identify mutual inductance and improve the effectiveness of filter capacitors
- Identify good and bad design practices when viewing actual PCB layout screenshots
- Understand and explain the noise problems shown in the many in-class live demonstrations of functioning PC boards

**SILENT**

Solutions for your noisy world.

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## Advanced Printed Circuit Board Design for EMC + SI

### 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

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## Day 2

### Section 1: PCB Noise Models

1. Review of the noise coupling model
2. Review of the four noise coupling paths
3. Emissions and immunity

### Section 2: Capacitance, Inductance and Current Paths in PC Boards

1. Good and bad capacitance
2. Good and bad inductance
3. Current loops
4. Low versus high frequency current paths
5. Inductance and low versus high frequency current paths + DEMONSTRATION
6. "Ground plane" splits - appropriate and inappropriate uses
7. Connectors, cables, and I/O wires connected to the PCB

### Section 3: Signals on PC Boards

1. Which signals are important?
2. What do they look like? + DEMONSTRATION
3. Transmission lines, characteristic impedance, terminations + SIMULATIONS
4. Harmonic content versus duty cycle + DEMONSTRATION

### Section 4: Power Distribution

1. Functions of PCB "grounds"
2. Vcc noise
3. Decoupling and filtering
4. Board layer stack-ups
5. Funny design ideas, current research, new design applications

### Section 5: Design Techniques and Examples

1. Component placement
2. Signal routing + stackup
3. Examining vendor applications notes that give bad EMC advice for PCB design
4. Examining past SILENT PCB design review findings

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