World-Class EMC/EMI Training Comes to Dresden, Germany

2019
Dresden
October 15 - 17

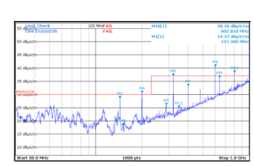
- ***Applying Practical EMI Design & Troubleshooting Techniques***
- ***Advanced Printed Circuit Board Design for EMC + SI***

Taught by Lee Hill, MSEE, SILENT Solutions LLC & GmbH
Member of Adjunct Faculty, Worcester Polytechnic Institute
EMC course instructor, University of Oxford (England)

Each seminar provides 2 full days of interactive and intensive classroom instruction and hardware demonstrations

After attending these classes, you will be able to:

- Systematically analyze and solve noise problems by using the noise model
- Minimize EMI by designing low inductance signal interconnects
- Understand ground loops, how to model them, and how to eliminate them
- Clearly identify and manage the different types of "ground" in schematics and physical circuits
- Identify "accidental antennas" in new designs
- Understand and measure common-mode current in emissions and immunity problems
- Improve the quality of sensor and instrumentation signals in the presence of noise



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Solutions for your noisy world.

Course content is identical to that which is presented annually at the University of Oxford, England. Download course syllabus.

About the 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 University of Missouri-Rolla EMC Laboratory, (now MS&T) emclab.mst.edu. He is a member of the adjunct faculty at Worcester Polytechnic Institute (WPI), and an EMC course instructor for the University of Oxford (England) and the IEEE EMC Society's Global University. He is a past EMC instructor for UC Berkeley, Agilent, and Hewlett Packard.

With over 25 years of EMC design and troubleshooting experience, Lee consults and teaches worldwide, and has presented classes in Poland, China, Singapore, Taiwan, Mexico, Norway, South Korea Canada, France, Germany & United Kingdom. Lee is a past member of the IEEE EMC Society's Board of Directors (2004-2007).

2019
DRESDEN
OCTOBER 15 - 17

Are you frustrated with high frequency noise problems? Tired of failing radiated emissions requirements at EMI test labs? Looking for a logical, systematic way of analyzing and solving electrical noise problems that is based on the latest academic research? Sign up now for North America's premier EMC design & troubleshooting educational event!

This class presents a unique blend of applications, hardware demonstrations, and supporting theory to help design engineers and EMC engineers master key electrical noise reduction techniques. The underlying theory and techniques are equally applicable during design or troubleshooting of regulatory compliance, electrostatic discharge (ESD), RF/wireless, and self-interference problems.

TESTIMONIALS

"Lee effectively penetrates those impenetrable greek equations with simple insights, and de-funking many common EMC myths – converting magic to practice."

"Good teacher, good tech chops, good passion, loved it!"

"Hardware Demos were very, very helpful"

"Everything you didn't learn about EMC in college but wish you had! Never heard such a complex subject spoken about in such a clear way"

"Give him longer. Would have stayed 2 more hours. Wonderful summary to Global University. Very Clear. Clearly in control of his material"

"If your company designs electrical products, you need your engineers to take this course. For all those EMC topics and solutions never covered in school, this course hits them all"

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SILENT provides
EMC Education Worldwide
through **Worcester Polytechnic Institute (WPI), and University of Oxford**

TO REGISTER

ONLINE
http://silentde2019.eventbee.com

Registration Form

EMAIL
courses@silent-solutions.com

PHONE +1 (603) 578-1842

Discounts & Duration

Fee: 995 € per person / per seminar

Note: Each seminar individually is 2 days
Both seminars taken together is 3 days
Day #1 is common to both seminars
Lunch included each day

Discounts: Register for both seminars and receive a 400 € discount

Download Course Syllabus

SILENT Partner Companies

ROHDE&SCHWARZ

LANGER
EMV-Technik

CLASS LOCATION:

LANGER EMV-TECHNIK
ROSENTITZER STR 73
01728 BANNEWITZ, GERMANY

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Applying Practical EMI Design and Troubleshooting Techniques

This two-day course gives engineering professionals the ability to successfully recognize, solve and avoid challenging EMI problems. Demonstrations using working hardware illustrate concepts such as radiated emissions, high frequency antennas, radiated and conducted immunity and crosstalk in connectors, cables and IC packages. Integrating over 30 years of hands-on troubleshooting experience and the latest EMC research, this class is appropriate for experienced circuit and system design engineers, EMC engineers, as well as those who are new to EMI problem solving.

After Attending This Class, You Will Be Able To:

- Systematically analyze and solve noise problems by using the noise model to create and analyze a noise circuit schematic
- Minimize radiated EMI by designing low inductance signal interconnects
- Understand ground loops, how to represent them in an equivalent circuit, and how to eliminate them
- Clearly identify and manage the three different types of "ground" in schematics and physical circuits
- Identify "accidental antennas" in new designs
- Understand and measure common-mode current in emissions and immunity problems
- Improve the quality of sensor and instrumentation signals in the presence of noise

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Applying Practical EMI Design and Troubleshooting Techniques

Day 1

Section 1: Measuring and Inducing Noise

1) Electromagnetic Compatibility
2) Radiated emissions & associated measurements + DEMONSTRATION
3) Radiated immunity + DEMONSTRATION
4) Antenna models
5) Common-mode current
6) Conducted emissions - mode separation, LISNs, troubleshooting
7) Uncertainty in measurements. Underlying problems in predicting results

Section 2: Predicting and Solving Noise Problems

1) Capacitance - in ESD, PC boards, decoupling networks, filter networks, cables+ DEMONSTRATION
2) Inductance - in PC boards, connectors, ICs, signal paths, decoupling networks, filter networks
3) Behavior of current paths at low and high frequencies + DEMONSTRATION
4) How to assign signals to connectors for reduced crosstalk, emissions, and susceptibility

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Applying Practical EMI Design and Troubleshooting Techniques

Day 2

Section 3: The Four Noise Coupling Paths, Functions of "Ground" and "Ground" Loops

1) Common impedance - in PCB power planes, ground planes, cables
2) Capacitive - in PCB power filtering, transformers, heatsinks, connectors +DEMONSTRATION
3) Inductive - in PCB ground planes, connectors, and IC packages
4) Radiative - from small electronic products +DEMONSTRATION
5) Ground - the three distinct functions, ground loop problems, +DEMONSTRATION

Section 4: Optimum Use of EMI Control Components

1) Control components: capacitors, inductors, ferrite beads, common-mode filters +DEMONSTRATION
2) Coping with and improving non-ideal characteristics such as interconnect inductance, DC bias

Section 5: Measuring and Diagnosing Effects of Common and Differential-Mode Sources and Filters

1) Differential-mode current, voltages
2) Common-mode currents, voltages, +DEMONSTRATION
3) Understanding the common-mode current and antenna path for emissions and immunity
4) Antenna currents and relevance to filter networks and troubleshooting
5) Common and differential-mode filtering. Filter network topology and function
6) Inherent difficulties in EMC filter design. Effects of filters on intended and unintended signals
7) Where to use common-mode filters—application circuits
8) Where to use differential-mode filters—application circuits

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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 and conducted 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 advantages and disadvantages 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

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Advanced Printed Circuit Board Design for EMC + SI

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Section 2: Predicting and Solving Noise Problems

1) Capacitance - in ESD, PC boards, decoupling networks, filter networks, cables +DEMONSTRATION
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4) How to assign signals to connectors for reduced crosstalk, emissions, and susceptibility

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Advanced Printed Circuit Board Design for EMC + SI

Day 2

Section 3: PCB Noise Models

1) Review of the noise coupling model
2) Review of the four noise coupling paths
3) Simple conceptual models for emissions and immunity

Section 4: Capacitance, Inductance and Current Paths in PC Board

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

Section 5: Signals on PC Boards

1) Classifying source & victim circuits, which ones are important?
2) What do they look like? Time versus Frequency Domain.
3) Harmonic content versus duty cycle

Section 6: High Frequency PCB Decoupling & Power Distribution

1) Vcc noise
2) Decoupling and filtering
3) Board layer stack-ups
4) Best approaches for power distribution on planes versus traces

Section 7: PCB 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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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.

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

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, and enclosures

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Mechanical Design for EMC

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.