

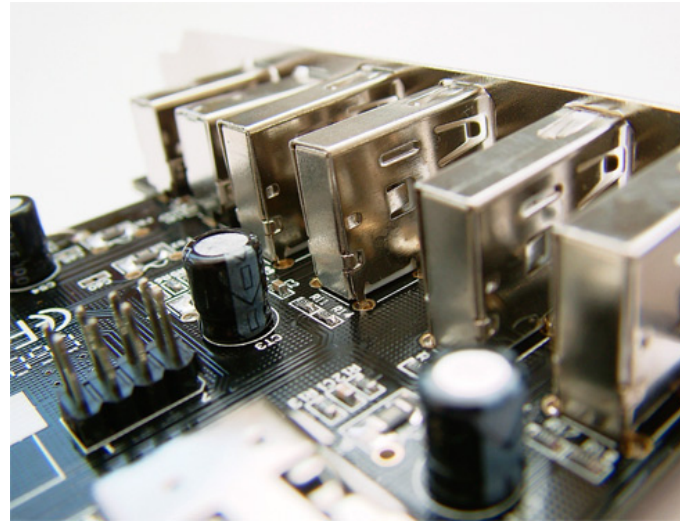
EMC Lab Techniques for Designers

Practical Methods to Find EMC Problems in the Development Lab

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The course covers techniques for finding design issues that may cause EMC compliance problems early in the design cycle, long before an official EMC test. This can be accomplished in the development lab without a lot of fancy EMC equipment. These techniques are easy to use and can find a wide range of potential EMC problems in a design right on the lab workbench.

This seminar describes each technique in depth, how to apply it, and how to interpret results. A list of recommended equipment is presented. The techniques presented sometimes use test equipment in unusual ways. Emphasis is placed on delivering practical knowledge that can be used immediately on the job. Some class time is reserved to discuss problems and interests of those attending. Each class delivery is modified to fit the interests of the attending people.

Objectives and Benefits:

- Learn the simple theory behind easy to use development lab tests that can find EMC problems.
- Learn to find and evaluate potential EMC problems with readily available lab equipment.
- Learn to measure the resonant frequency of physical structures like heat sinks or edge connectors.
- Learn the design errors than can cause EMC problems and how to find them in a design.
- Learn to measure EMI currents in systems and recognize when they are a problem.
- Learn to relate the easily measurable relative phase of EMI currents to fixing EMC problems.
- Learn construction techniques for useful laboratory apparatus that can track down problems.
- Learn how to use test equipment you already have in novel ways to find EMC problems in a design.

Who Should Attend All circuit designers, system designers, design supervisors, even EMC personnel will find the material useful.

Prerequisites A college-level course on circuit analysis is desirable although the seminar will be useful to those with two-year technical degrees

EMC Lab Techniques for Designers

Instructional Mode The course includes a combination of teaching methods including lecture, live experiments, live computer simulations, and still pictures of experiments with results. The combination of methods combined with Mr. Smith's enthusiastic presentation style helps the students learn and enjoy the course.

Course Length Half Day

Major Topics & Lab Outline

Background and Tools

- Magnetic Loops
- Current Probes
- Common Mode Currents and Emissions
- Skin Effect

EMC Troubleshooting – Cable Emissions

- Useful for both design engineers on the lab bench and EMC personnel
- Brief background and theory
- Relating common mode current to FCC/CISPR limits
- Setting up the spectrum analyzer to measure common mode currents and spot problems.
- Experiments and demos later in the day

EMC Troubleshooting – Board Emissions

- Board layout effects on emissions
- Finding problematic structures in a current design

EMC Troubleshooting – IC and Package Emissions

- How to measure noise, crosstalk, and ground bounce inside the package with no direct connection
- How to gauge the impact of noise, crosstalk, and ground bounce in the package on IC operation
- Identifying signal integrity problems including those that occur with very low probability
- Identifying EMC problems
- Measuring internal risetimes in the chip itself

Shielding Effectiveness

- Why industry standard tests often can give incorrect results to PCB and equipment designers
- Measuring magnetic field shielding at high frequencies and why it is important
- Lab data on different materials
- Implications for equipment and device design including small mobile devices like cell phones.

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EMC Experiments

- Pigtail and system cable experiment in the time domain, live demonstration
- Pigtail and system cable data in the frequency domain, sometimes live demonstration
- Effects of board layout, ground plane splits in the time domain, live demonstration
- Effects of board layout, ground plane splits data in the frequency domain, sometimes live demonstration
- Interpreting common mode current phase to find the source of an EMC issue, equipment example
- Emissions data from a PCB, paths that change layers
- Board layer stack-up effects
- Parallel wire experiment showing strong coupling between parallel wires, live demonstration
- IC coupling to nearby conductors, data and video
 - o Inductive coupling
 - o Capacitive coupling

Resonant Frequency of Physical Structures

- How to measure structural resonance
- Needed equipment
- Several examples with data
- Kinds of operational and EMC problems that can be found
- Sometimes as live experiments

Cellphone Induced Problems

- Examples of field problems (devices destroyed by signals in the environment)
- Why you can't just use a cellphone to test for problems.
- A simple test for the development lab

Plus several new video and experiments to demonstrate:

- How an integrated circuit can use nearby cables to cause an emissions failure when the IC alone could not be a problem
- How a power supply or other relatively high powered switching device (like a class D amplifier) can use nearby cable to radiate when the power supply itself would not be problem even with its own cables attached.
- The relationship of vias to board resonances on a 4 layer PCB

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