

*A 2-day intensive training class with
Dr. Eric Bogatin, Signal Integrity Evangelist*



EPSt: Essential Principles of Signal Integrity

Build your engineering intuition

Now with hands on labs!

The three critical steps to eliminate signal integrity problems from your product are identify the problem, find the root cause and turn the root cause into a design guideline. But every product is unique and custom. Designing a robust and cost effective product is not about blindly following a general set of design rules, rather it is about following a process that helps you apply your engineering intuition to balance cost and design tradeoffs specific to your product.

Learn this process used by thousands of engineers and build your engineering intuition with this two-day class, designed and offered by Signal Integrity Evangelist **Dr. Eric Bogatin**. In this introductory class the math is stripped away to reveal the underlying truth of how interconnects affect signal integrity. The most essential principles of signal integrity are introduced and reviewed, including principles of:

• Characteristic impedance, return current	• Ground bounce and cross talk
• Reflections	• Bandwidth
• Inductance	• Terminations
• Impedance	• PDN and EMI

Each of these principles is illustrated by examples of measurements or simulations using structures such as IC packages, connectors, printed circuit boards and cables.

Now with hands on labs!

The most common answer to all signal integrity questions is “it depends”. The way we answer it depends questions is by putting in the numbers. While this class introduces many rules of thumb and approximations, sometimes, to get a good answer requires a simulation. This is why numerical simulation tools are critical.

New in 2011 classes, we show you how to use a very easy to use simulation tool, QUCS, and how you can quickly answer common signal integrity problems. This tool runs on any laptop with a Windows OS. We provide you a copy of the tool and all the circuits used in the labs. These are yours to take back.

No previous experience is necessary. Even if you have never done any simulation before, you will find this an incredibly easy tool to use. If you are familiar with SPICE, you will find QUCS to be far easier and more versatile.

To participate in the hands on labs, you must bring your own lap top to the class.



How Do I Register?

Online at www.beTheSignal.com, call 913-393-1305 or email info@beTheSignal.com for questions and group discounts.
Schedule is online at www.beTheSignal.com



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Class Outline

Day One

Signal Integrity Problems and Solutions

- The nine most important principles in signal integrity
- The six families of signal integrity problems and their solutions
- The ten habits of highly successful designers
- Hands-on-lab: introduction to circuit simulation with QUCS

Characteristic Impedance and Return Currents

- The instantaneous impedance all signals see
- Characteristic impedance and transmission lines
- Return currents in transmission lines
- Hands-on-lab: the input impedance of a transmission lines, the voltage launched into a transmission line, designing a microstrip

Differential Pairs and Reflections

- Differential impedance and differential signals
- The origin of reflections
- Measuring and simulating reflections
- Termination strategies
- Hands-on-labs: designing a differential pair, termination strategies, power consumption and terminations

Signal Quality, Routing Topology and Discontinuities

- Star, branch and daisy chain routing
- Maximum data rates and routing topology
- Maximum data rates and terminations
- Reducing stub and series discontinuities
- Hands-on-labs: star, branch and daisy chain circuit topologies, discontinuities

Day Two

Cross Talk in Transmission Lines

- Capacitive and inductive coupling
- Influence of propagation direction on cross talk
- The origin of NEXT and FEXT in coupled lines
- Minimizing NEXT and FEXT by design
- Creating design rules for acceptable cross talk

Ground Bounce

- The physical basis of inductance
- Total inductance and the return path
- Minimizing ground bounce in packages, connectors, vias and planes
- The importance of return vias
- Hands-on-labs: simulating ground bounce and termination strategies

Rise Time, Bandwidth, and High Frequency Effects

- Time domain and frequency domains
- Bandwidth of signals
- Losses in transmission lines
- Minimizing eye collapse by design
- Hands-on-labs: FFT of different rise time signals, attenuation in microstrips from conductor and dielectric loss

PDN and EMC design

- The target impedance and impedance profiles
- Selecting decoupling capacitor values
- Common currents as the source of emissions
- Reducing common currents by design
- Reducing emissions with band aides
- Hands-on-labs: impedance profile of 1, 3 and 10 capacitors