1-800-633-1440
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training@mindshare.com

Advanced High-Speed Design

Let MindShare Bring "High-Speed Design" to Life for You

With edge rates ever decreasing and clock rates becoming faster, it is vital that engineers understand the underlying issues of the transmission line to insure signal integrity. Also, bypassing these higher frequency edge rates and the ever-increasing power of today's FPGAs and micros require a better grasp of signal power switching. PCBs are becoming more complex with finer traces and spaces and more layers with more blind and buried vias. This requires more attention to controlling crosstalk, EMI, impedance control.

You Will Learn:

- How to cost effectively design and layout a high-speed PCB without sacrificing signal integrity
- How to comply with Signal Integrity (SI) & EMI standards
- Cookbook design rules that ensure your PCB will function properly in the prototype stage

Course Length: 3 Days

Who Should Attend?

- Digital logic engineers and system architects
- EMC specialists
- Technicians
- PCB layout professionals
- IC designers
- Applications Engineers

Course Contents:

- Advanced High Speed Concepts
    - Impedance of structures to both clock rate harmonics and edge rate harmonics
    - Resonance on Transmission Lines: Serial and Parallel resonance. Quarter wave length differences of high and low end impedance termination.
    - Near field and far field definitions and their effects on the magnetic and electric field strengths
    - The quality factor for lumped circuitry: Why they can ring, crosstalk and cause EMI radiation
- Transmission Lines (TL)
    - The TL Cell-Defining, Rdc, Rac, Skin Effect, Proximity, and the Dielectric Loss
    - Current Travel on TLs: Converting the B field to eddy currents and how it creates the skin effect and proximity effect
    - Characteristics of PCB Material: What material is used for high frequency: DF, Cost, DFM, DFA
- Performance Regions
    - The basic RLGC cell and its effect on rising and falling edges
    - The Lumped Element region-parameters and model
    - Practical applications of the lumped model
    - The RC Region of the lumped model. Input/characteristic/Output impedance. Propagation velocity, Elmore's delay and lumped model algorithm
    - The Constant Loss Region: Boundary Conditions, propagation coefficient, resonance, termination considerations

  - The Skin Effect Region: Boundary Conditions, characteristic impedance, propagation delay parameters, termination options, speed and distance
  - Dielectric Region: Boundary Conditions, characteristic impedance, dielectric loss/tangent loss, propagation delay, resonance, termination
- The Printed Circuit Board (PCB)
  - Modeling PCB Traces
  - Skin Effect and Dielectric Loss for PCB Traces: microstrip and stripline
  - Dielectric Properties, relative costs and core/prepreg issues for high speed stackups
  - Effects of temperature, frequency and mfg tolerance on characteristic impedance
  - Solder Mask and Conformal Coating: effects on Z0, propagation delay and impedance equations
  - Matching Capacitive and inductive loads using trace width modification
  - Far end and Near end Crosstalk: Inductive and capacitive for microstrips and striplines
  - Matching traces to connectors: Minimizing reflections, crosstalk and EMI
  - Vias: C and L of vias (through hole, blind, buried), via discontinuities and eliminating reflections of vias
- Advanced Topics in Bypassing
  - Shoot through current and die capacitance
  - Eliminating mode conversion
  - Why the 0201, the long electrode and the Y cap may be essential to control switching impedance and EMI radiation
  - Breakout and bypassing the 4, 5, 6 perimeter ring and fully populated BGA
  - Do copperfills (pours) really help in bypassing?
  - What is the present status of innerplane C materials (FR4, ceramic filled, and polymide) and how thin can they practically be made?
  - How much C is needed and layout considerations for today's FPGAs and micros?
  - Return current and intelligent via placement
- Differential Signaling
  - Attributes/drawbacks of loosely/tightly coupled differential pairs
  - Definition and examples of differential and common mode V and I
  - Differential impedance: Odd and even modes
  - Advantages and disadvantages of Edge (side by side), Broadside (dual), asymmetric, and microstrip differentials
  - Reflections and crosstalk in differentials. Metastability, Clk skew, driver skew, bit pattern sensitivity, ISI, skin effect and dielectric constant. Jitter, BER, and the eye diagram
  - Matching electrical lengths
- High Speed Clocking
  - Clock skew and jitter
  - PLLs, DDLs, serpentine traces and programmable delays
  - Source and end termination considerations for star, daisy chain and driving multiple loads
  - Clock driving high speed buses: RAMbus and address drivers, minimizing the C load.
  - Random and deterministic jitter. Power Supply noise and Clk jitter
- High Speed Data Transmission
  - Pre-emphasis and equalization Techniques
  - The effects of ISI, Skin and dielectric losses
  - The effect of various base materials of long haul transmission. The effects of eye closure on BER
  - A real world example of compensation techniques

Recommended Prerequisites:

An understanding of the course material contained in the high-speed digital design and PCB layout course. The high-speed digital design and PCB layout course is not a prerequisite but familiarity with the material would be helpful in understanding the advanced concepts in this class.

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Course Material:

This course includes the text, "*High-Speed Signal Propagation: Advanced Black Magic*," by Howard Johnson, Ph.D. and Martin Graham, Ph.D. plus a 284-page book of class notes.

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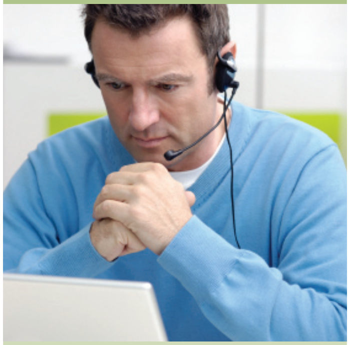

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