How IBIS Models Relate to SI, PI, and EMI-EMC

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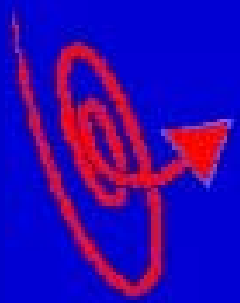
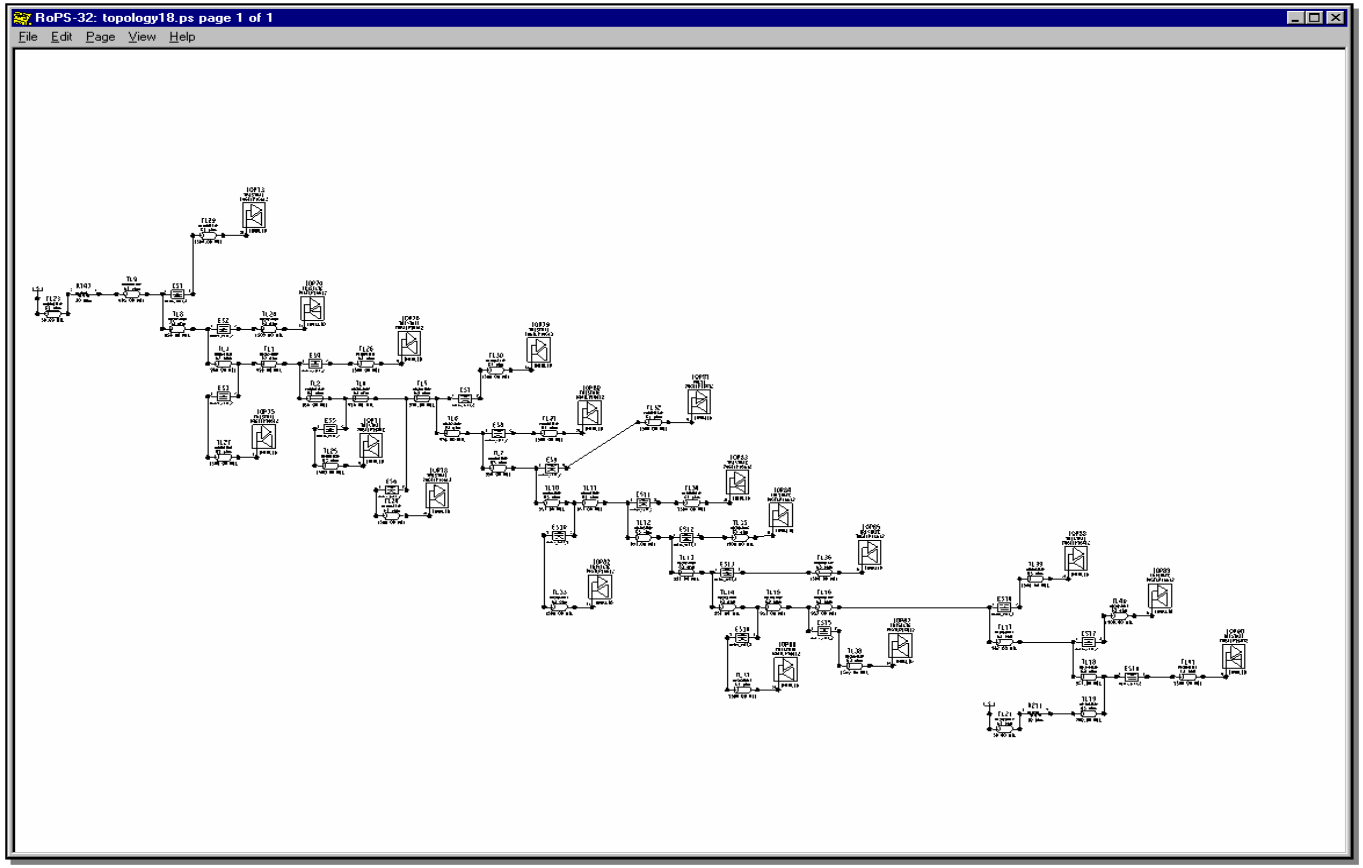
IBIS Summit Meeting
Santa Clara, CA
February 5, 2009



LEVENTHAL DESIGN & COMMUNICATIONS

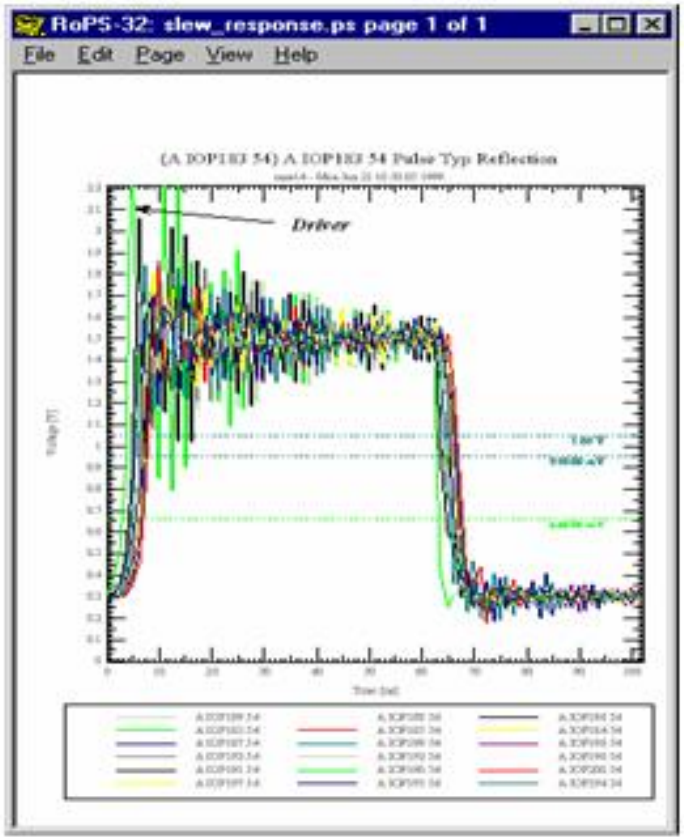
Specializing in Modeling and Simulation Services

An Example of a Complex Network



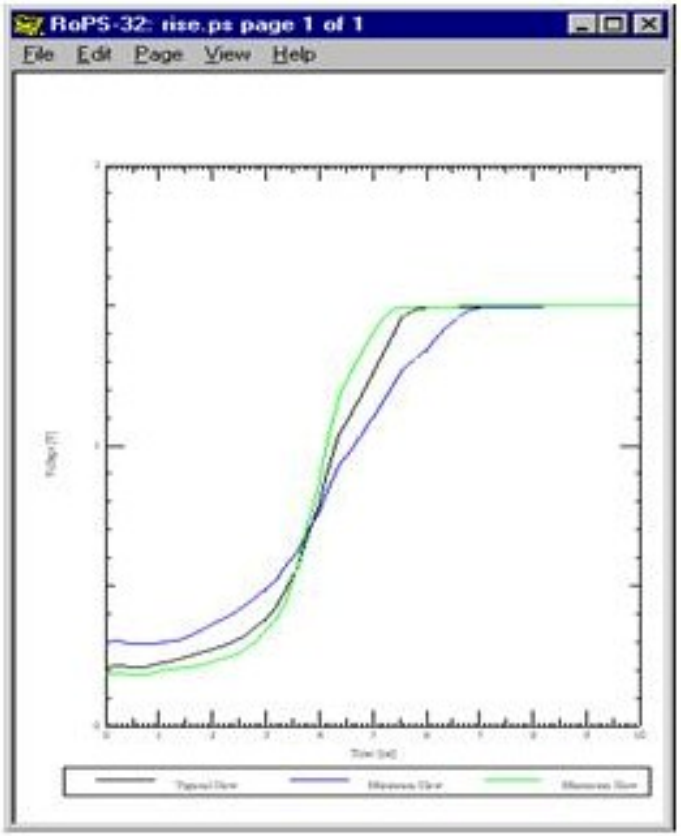
An 18-Slot Bi-Directional Backplane Bus

Simulation Results from too Simple a Model



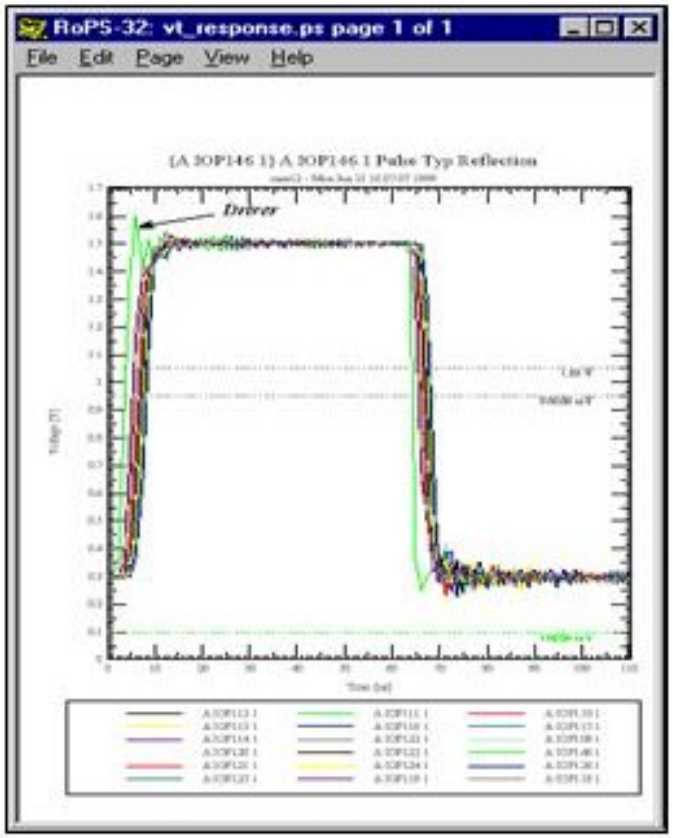
- Complex nets are hard to terminate and have many reflections
- Simple dV/dt modeling and device behavior is inadequate
- V-T curves need to be modeled for correct results in GTL/GTLP busses

IBIS Modeling of V-T Curves
How GTLP Really Behaves



- This slide shows how to correctly model GTL/GTLP
- Soft turn-on/turn-off removes many high-frequency components (think about Fourier transformation) from driving the line
- The results of the change in modeling detail are shown next:

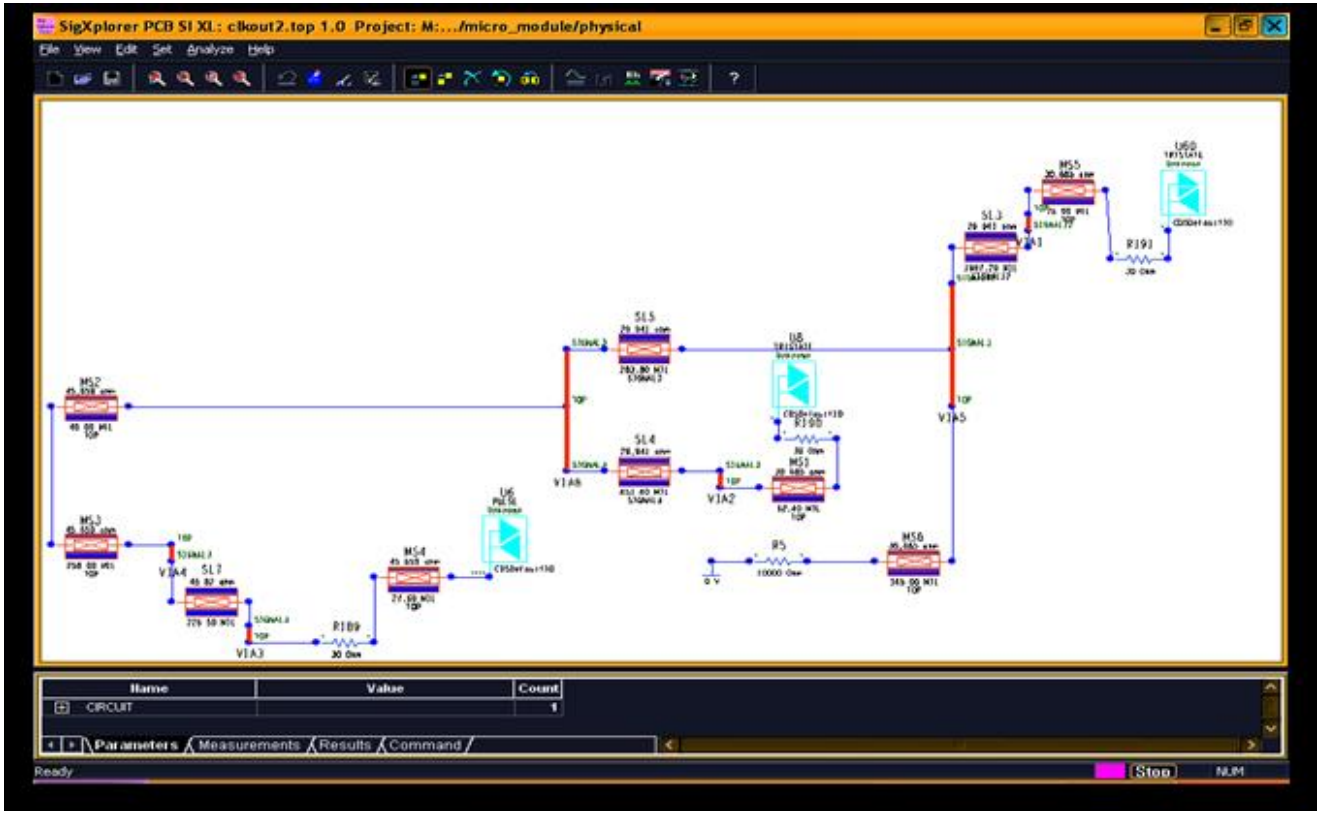
Better Models Give Better Results



"Everything should be as simple as possible *and no simpler*."

-----Albert Einstein

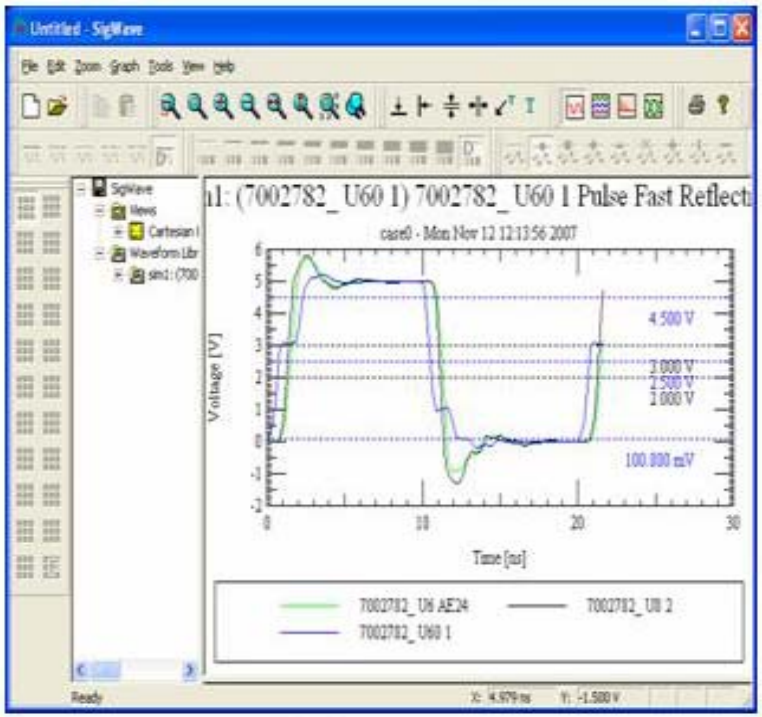
Test Net for SI and EMI



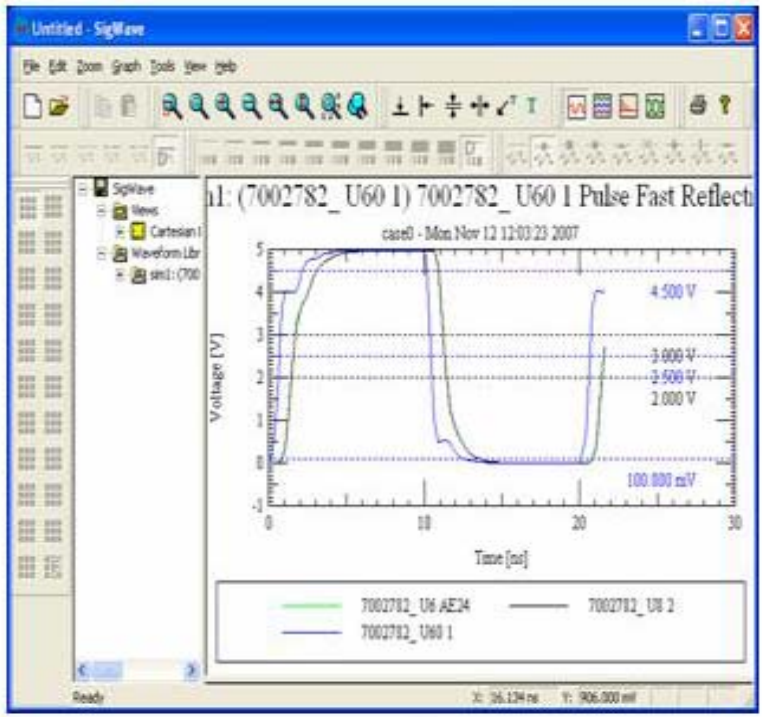
66MHz Clock Topology as Modified

Courtesy of Hamilton-Sundstrand

How SI is Affected by Overshoot



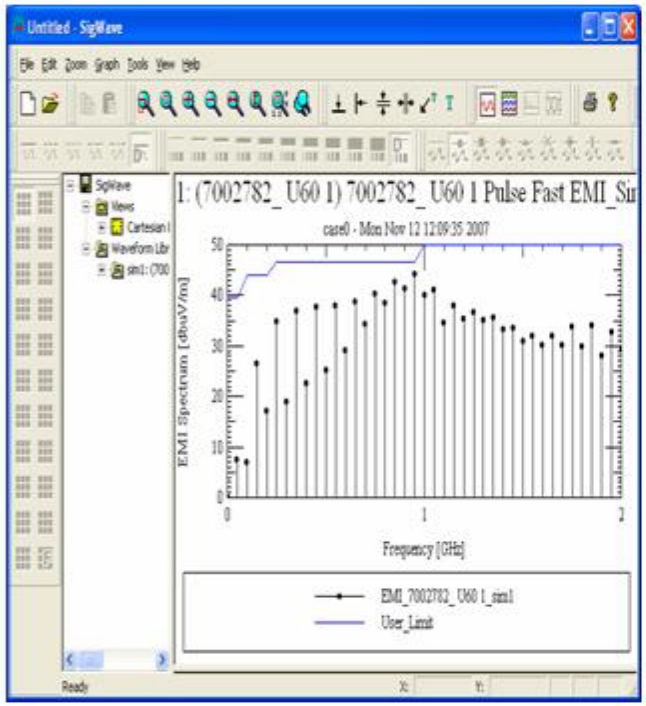
Before Termination



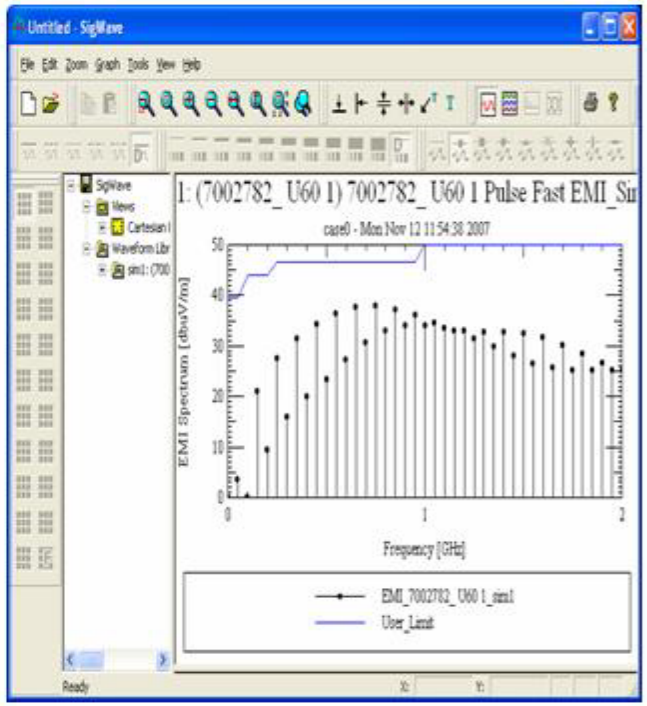
After Termination

Before termination, SI and stress on the receiver is not a high concern – the real payoff will be in EMI control as shown in the next slide.

How EMI is Affected by Overshoot



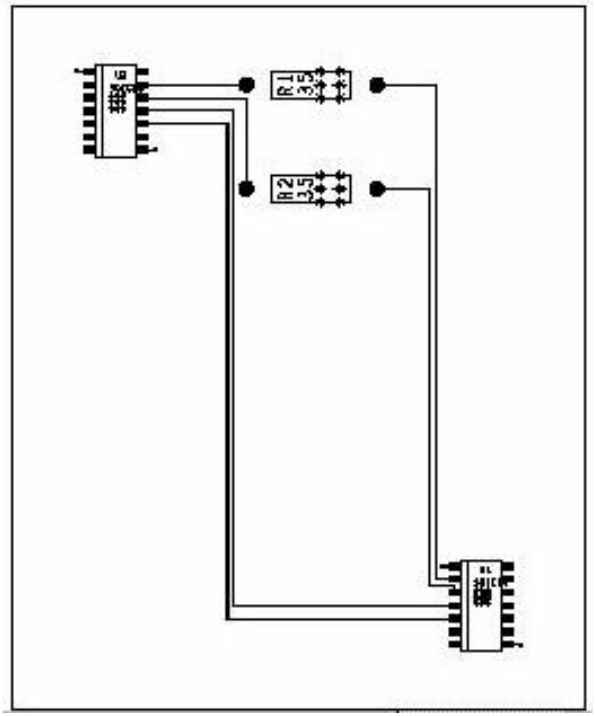
Before Termination



After Termination

The SI Engineer has to manage harmonics out to about the 5th .
The EMI engineer has to manage harmonics out to, perhaps, the 100th.

Example of Virtual Test Board



The board on the left has the following stackup:

- top: 1.2 mil Cu signal Zo = 89Ω
- next: 12 mil FR4 (εr = 4.5)
- next: 1.2 mil Cu shield Vcc
- next: 12 mil FR4
- next: 1.2 mil Cu shield GND
- next: 12 mil FR4
- bottom: 1.2 mil Cu signal Zo = 89Ω
- Etch width is nominally 6 mils

For the shielded version outer shield layers of 1.2 mil Cu spaced by 12 mils of FR4 were added

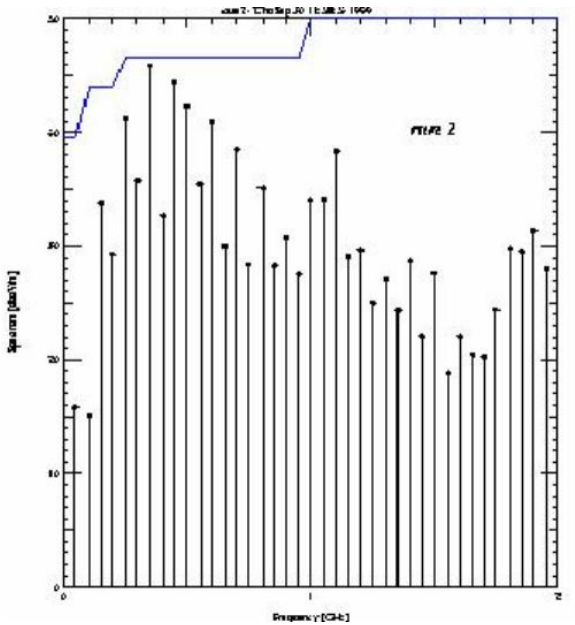
- The nominal 6 mil etch on such an inner layer results in Zo = 59.6 Ω

The board is about 3 inches long.

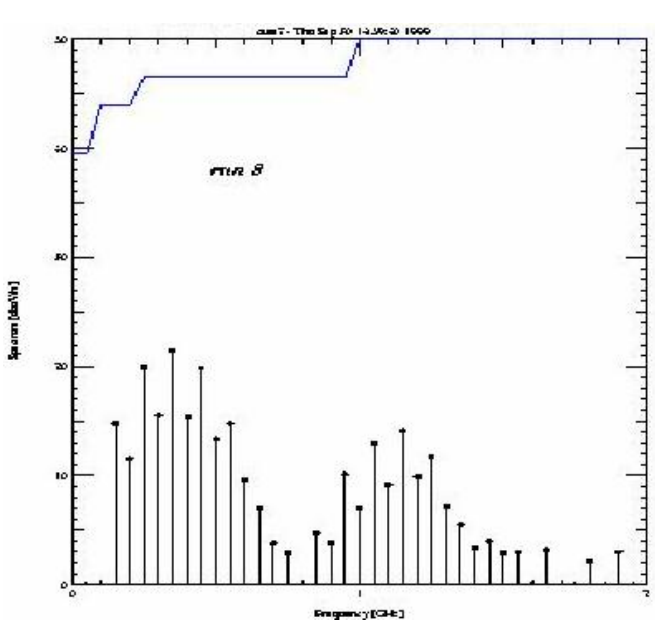
Layout of the Test Board

Stackup of the Test Board

Virtual Test Board
Before and After EMI Treatment



Unshielded, Unterminated,
Non-Constant Impedance Net



Shielded, Terminated,
Constant Impedance Net

Near Field EMI Simulators

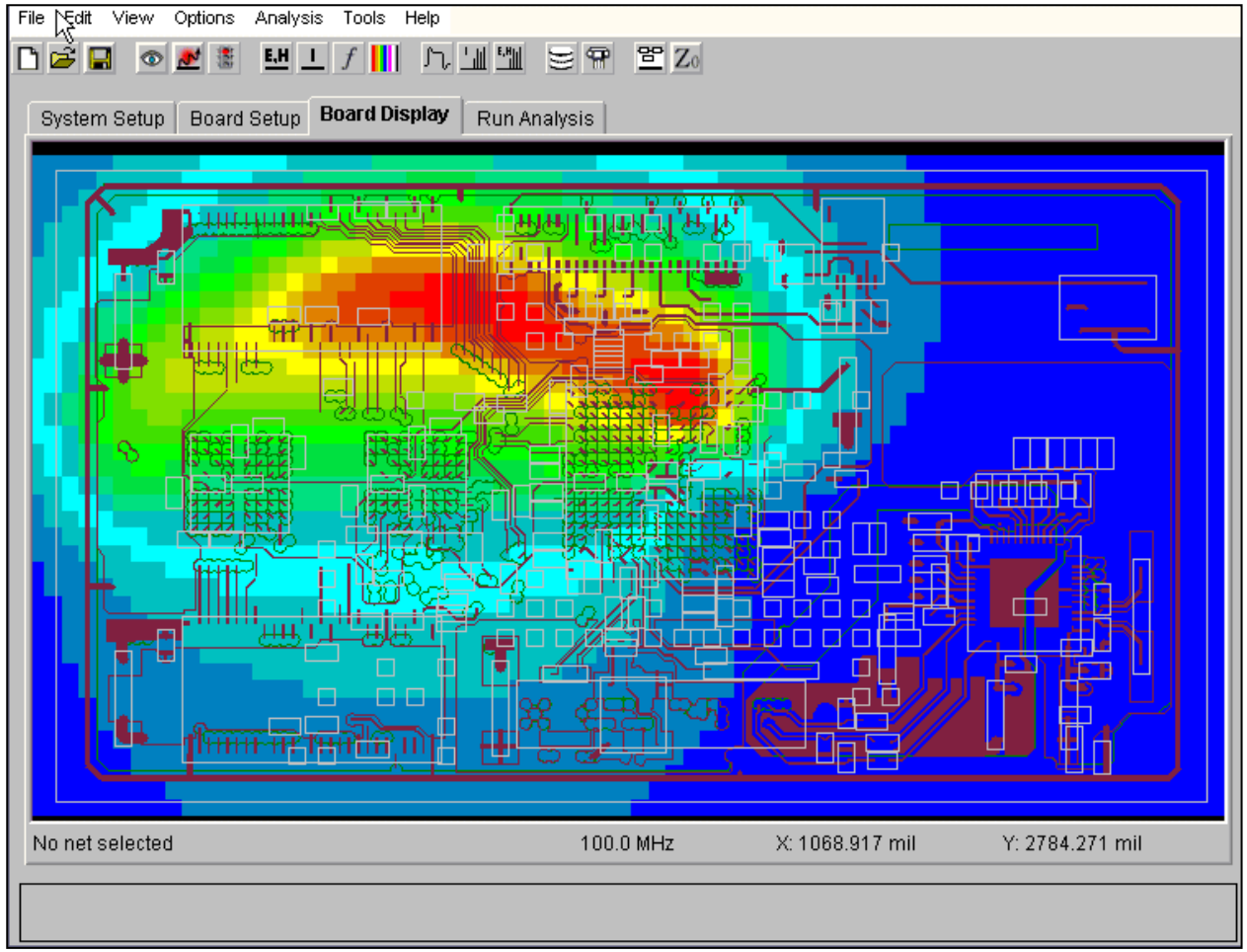
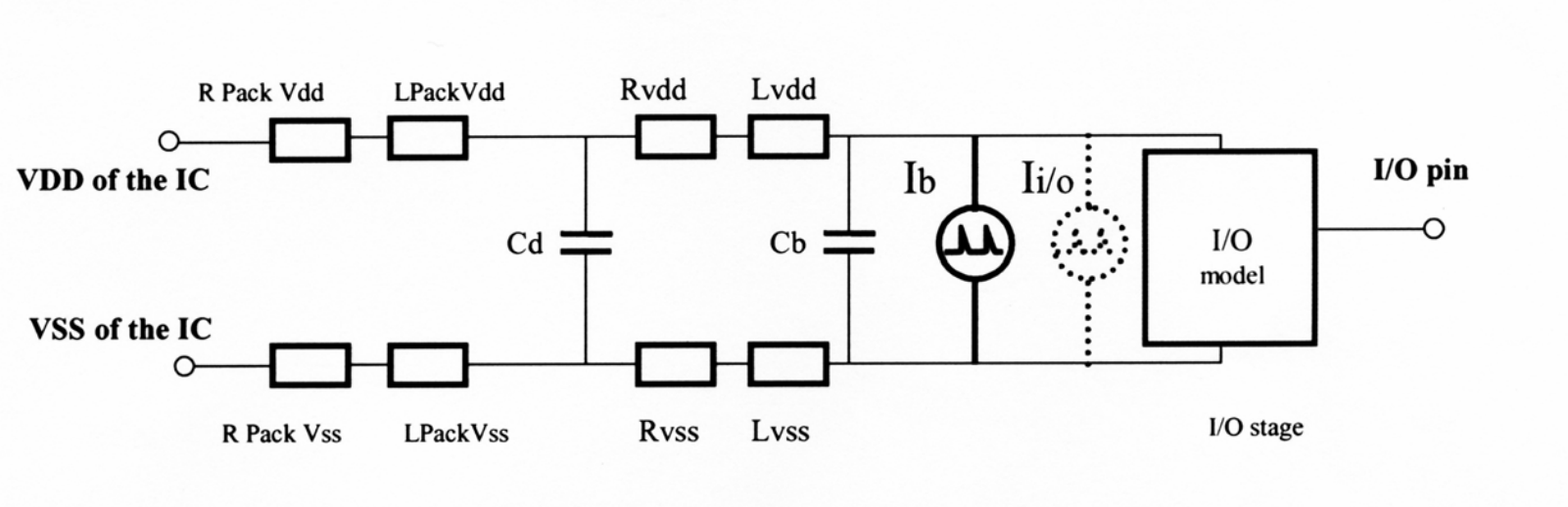


Image Courtesy of Johnson Controls Automotive, Inc. Used with permission

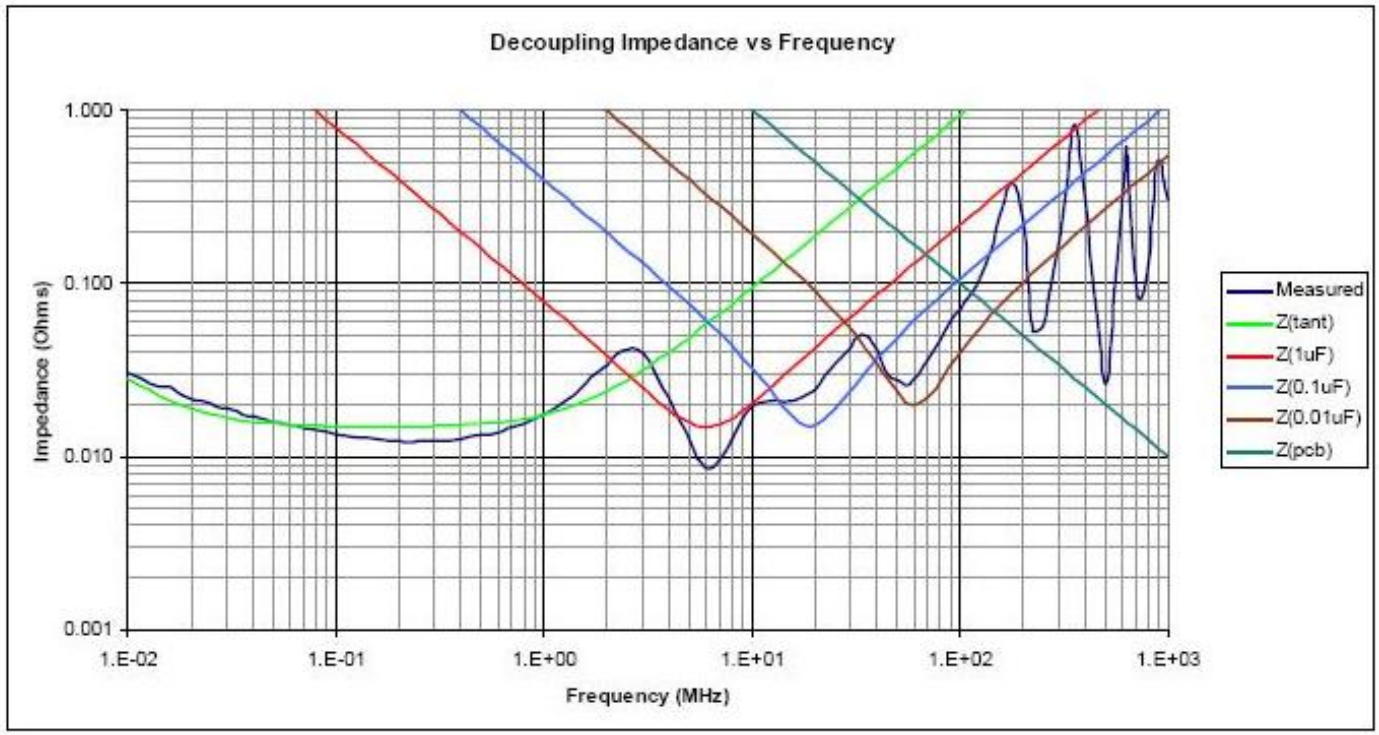
PI and the IEC 62014-3 Proposal



Slide courtesy of Etienne Sicard, INSA-Toulouse

What is happening with IEC 62014-3?

Bypassing the Power Supply for PI

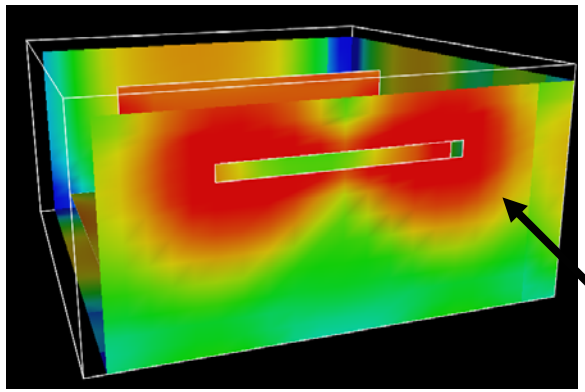


Slide courtesy of Lee Ritchey, Speeding Edge

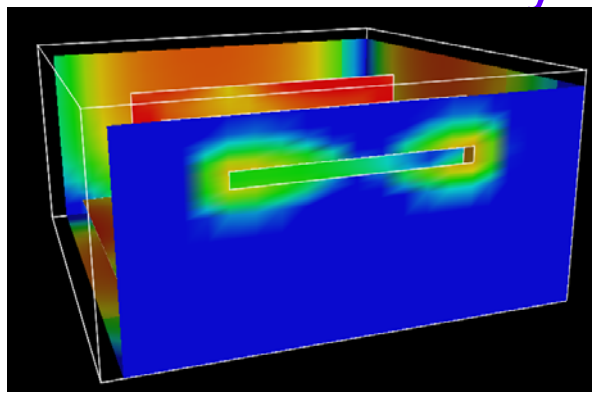
Reminder to myself: Let's have a discussion of some of the latest PCB techniques for controlling power plane bounce, crosstalk, and emissions

3D Full-Wave EMI Simulators

Baseline

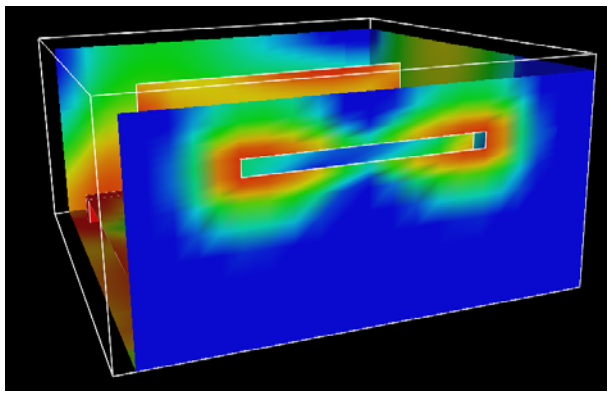


Ground Pins Only

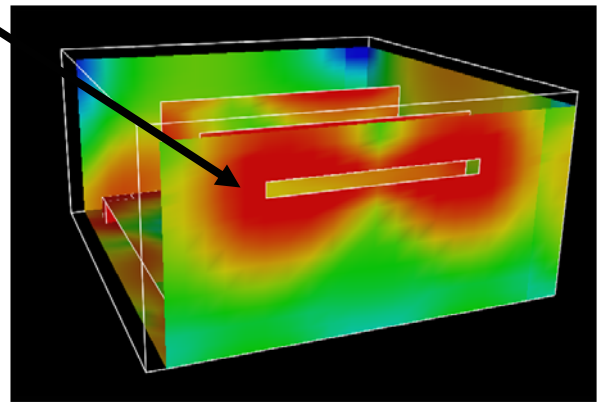


Strong Coupling to Slot-WHY?

Standoffs Only



Pins and Standoffs



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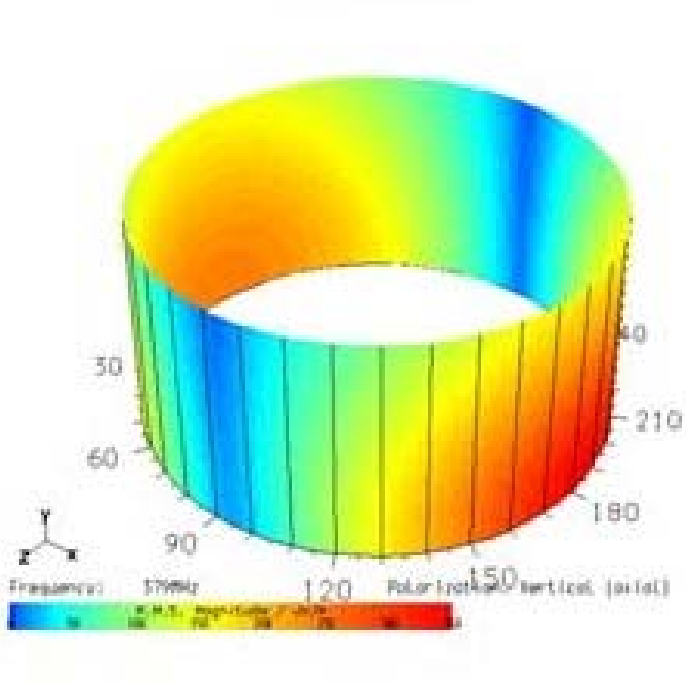
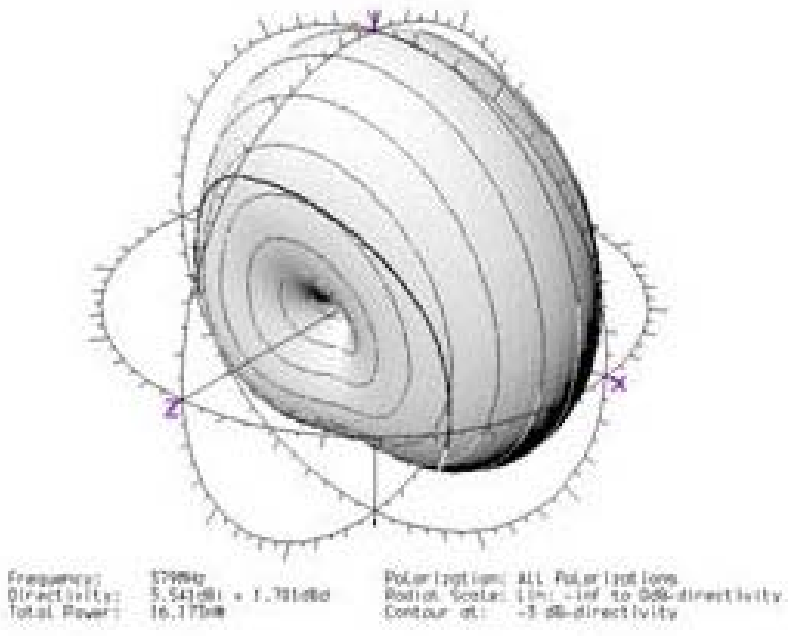
Far-Field EMI Simulators

U1 Star com Box



3m cylinder scan

U1 Star com Box



Far-Field radiation

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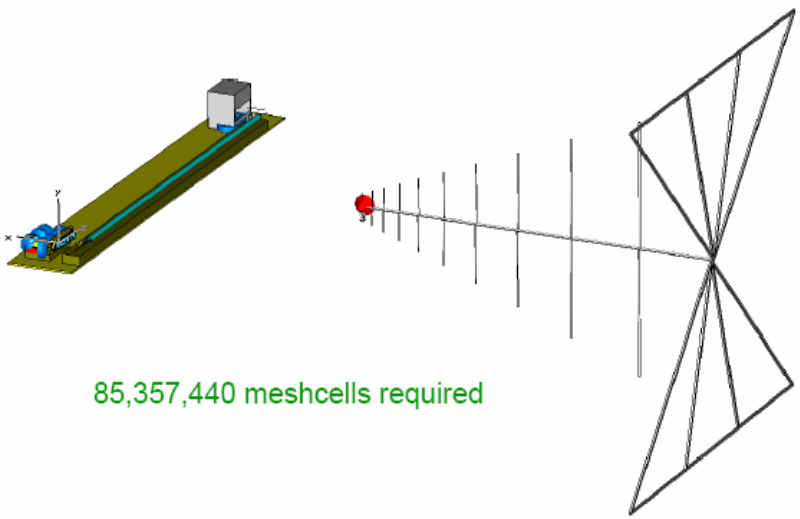
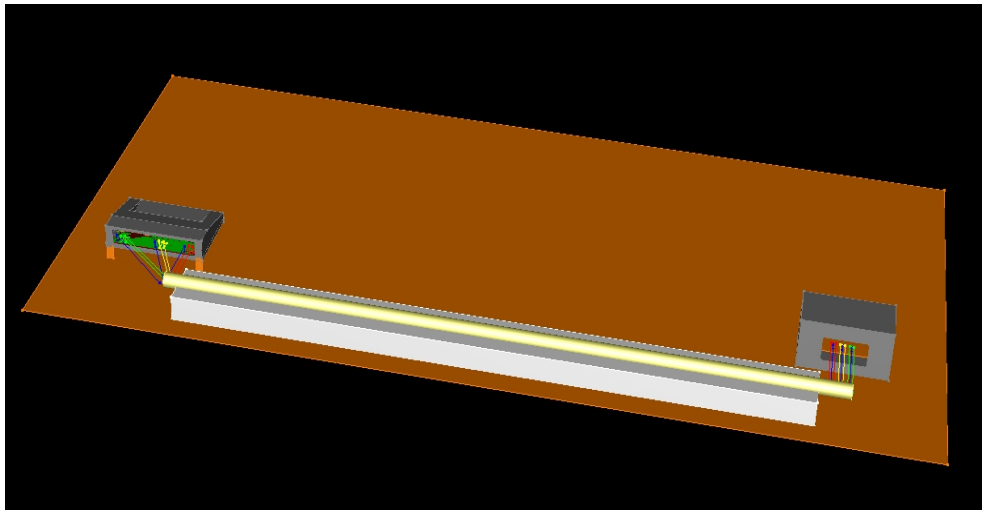
The Virtual Test Bench





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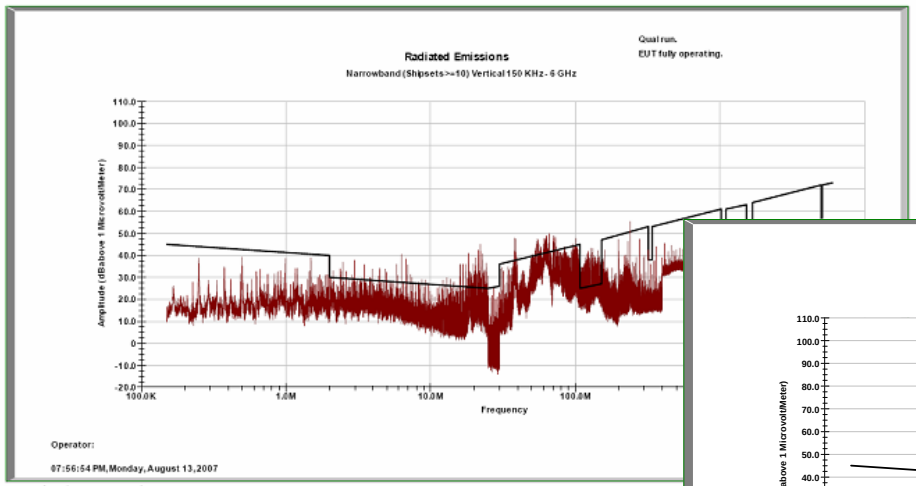
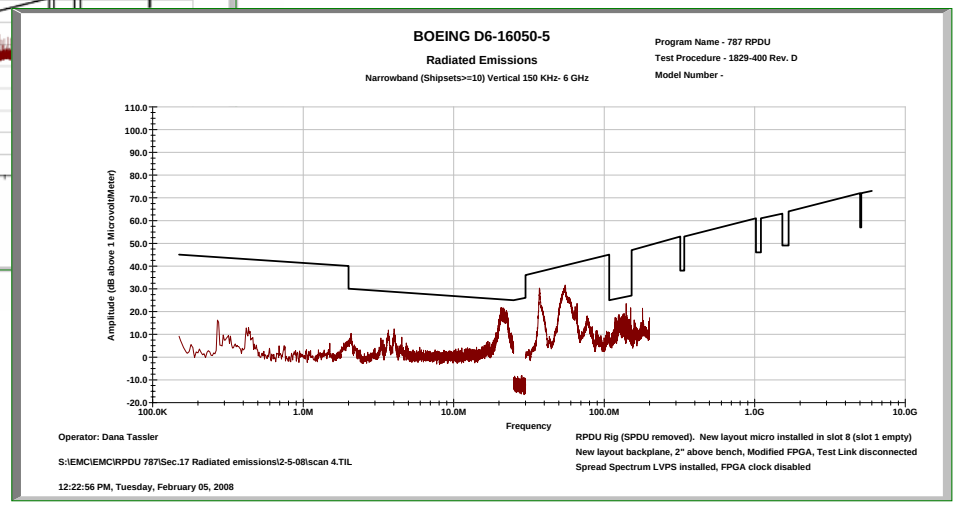
Modelers Need to Use the Language of the Frequency Domain in Talking to EMI Engineers

Plots of a typical regulatory EMI problem and its solution



Vertical NB 150k to 6G

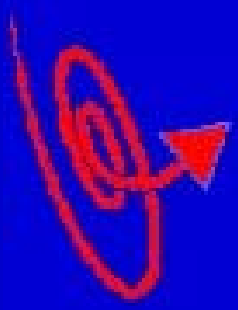
Before



After

Summary

- EMI
  - Is driven by the strength and speed of the output driver
  - Is driven by the discontinuities of the transmission net
  - Extends to much higher harmonics than SI issues
- EMI can be controlled by sophisticated techniques for resolving the problems created by high-speed drivers
- EMI issues at the PCB, enclosure, and system level can be studied with sophisticated CEM tools. CEM facilitates the study of EMI design tradeoffs related to models and net design.
- Modelers use time domain concepts. EMI Engineers use frequency domain concepts. They need to communicate in each other's language.



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