2013

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SANTA CLARA CONVENTION CENTER

Validating EMC Simulation by Measurement in Reverberation Chamber

Session 12-WA1

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CISCO

UBM Tech

Outline

- **Intro**
  - EMC & Challenge
  - Design strategy
- **Tools**
  - Simulation & Measurement Tools
  - Theory & Methodology
- **Cases**
  - Heatsink
  - Chassis Feature
  - Air-Vent
  - I/O Connector
- **Ending**
  - Conclusion
  - Q&A

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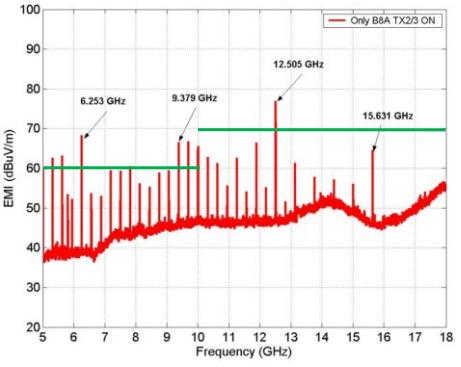
Introduction

What is EMC/EMI?

Part of Electrical Science to prevent the cause of EMI among products



Semi-Anechoic Chamber

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Challenge

1. In EMC Design
   - Little involvement during design phase
   - Relies on experience, rule of thumbs, shielding
     - Works @ low-frequency (up to 1 GHz)
     - More 'Accidental Antennas' at high-frequency (5 GHz +)
   - Not enough EMC research at high frequency
   - EM simulation methodology is not mature yet
   - Impossible to predict the 'Absolute EMI' on system level
2. In EMC Test
   - System level, done towards the end of design cycle
   - 'Band-Aid' fixes (expensive & not leveraged)
   - Component level test difficult to do in Anechoic Chambers

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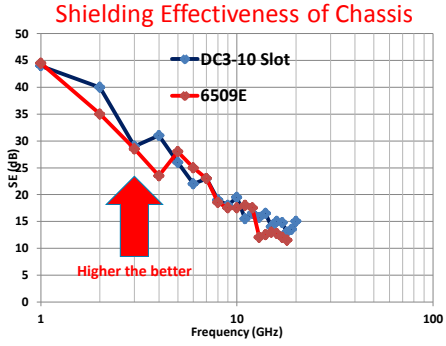
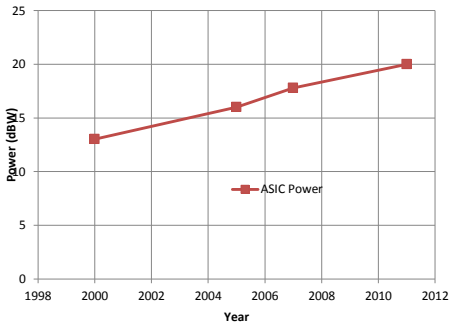
Challenge

Shielding Effectiveness of Chassis



ASIC Power



f (GHz)	SE (dB)
1	45
5	27 (18)
10	17 (28)
15	12 (33)
20	10 (35)

- **SE of chassis decreases while freq. increases**
- **System power requirements are increasing on new products**

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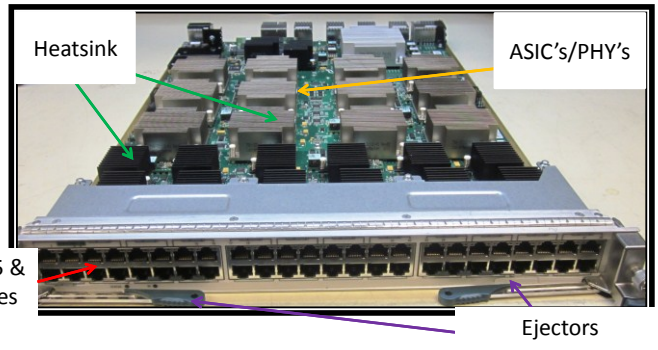
Design Strategy



- Target the 'Usual Suspects' (components) on PCB
- Design via simulations & reduce EMI profiles (2 different numerical tools)
- Incorporate additional 'Hooks' to reduce EMI
- Validate design in the Reverberation Chamber

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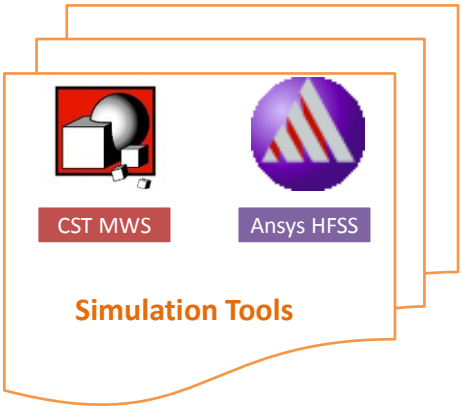
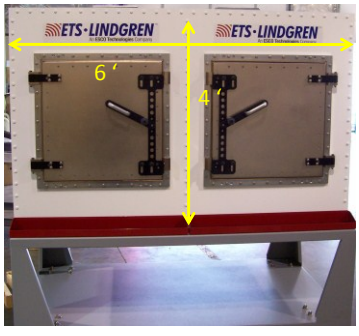
What we are using

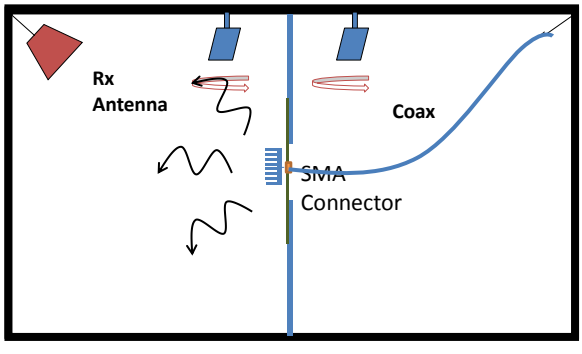


Reverberation Chamber

Dual Reverb-Chamber

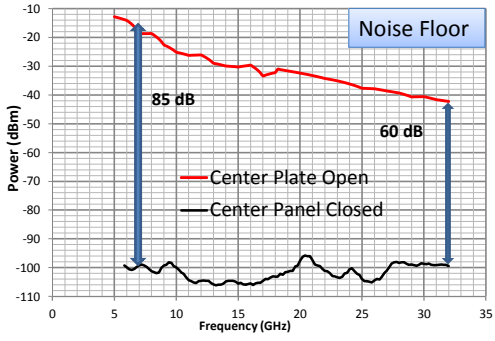


Measurement Illustration



Advantages of RC

1. Isolation of TX and RX Chamber (100 dB).
2. Feasibility to analyze individual components.
3. Easy and cost effective setup than anechoic chamber.
4. Fast and accurate measurements compared to anechoic chamber.
5. Excellent repeatability and predictability.



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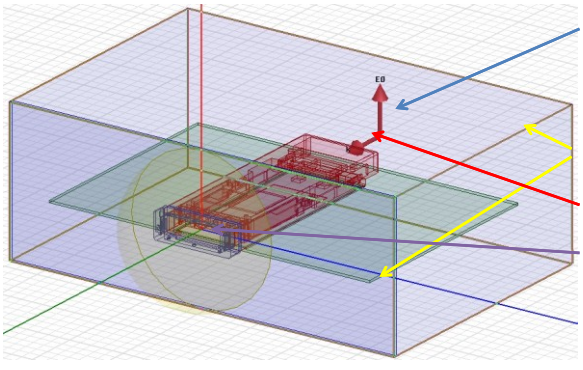
Innovation

Novel Simulation Technique to Duplicate RC Environment



Optimized for

- EM Source
  - Angle of Incidences
  - Wave Polarizations
- Boundary Conditions
- Parameterization
- Received Power
  - TRP
  - SE

No other technique in literature is as comprehensive

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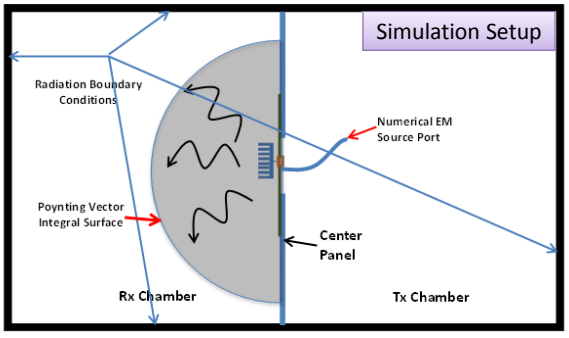
Numerical Algorithm

TRP is the integral of Poynting Vector:

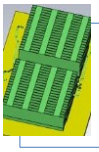
$$P = \frac{1}{2}\int_s real(E \times H)\cdot ds = \int_s real(S)\cdot ds$$

SE is the Ratio of TRP without the DUT (P_1) and the TRP with DUT in the center panel (P_2).

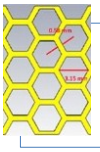
$$SE = 10\log_{10}\frac{P_1}{P_2}(dB)$$



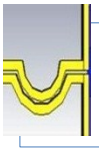
Case Validation



Heatsink
w/ & w/o absorber



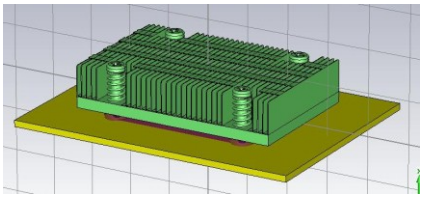
Air-Vent
w/ & w/o absorber

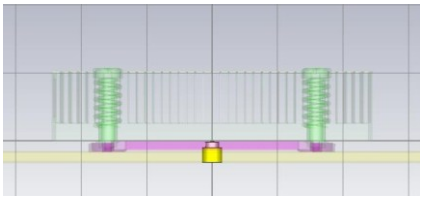


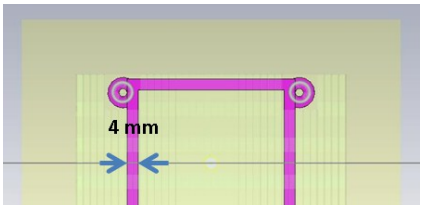
Chassis Feature

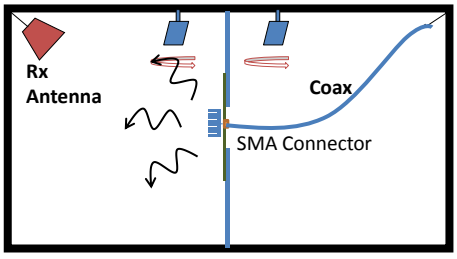
I/O Connector

Validation: Heatsink

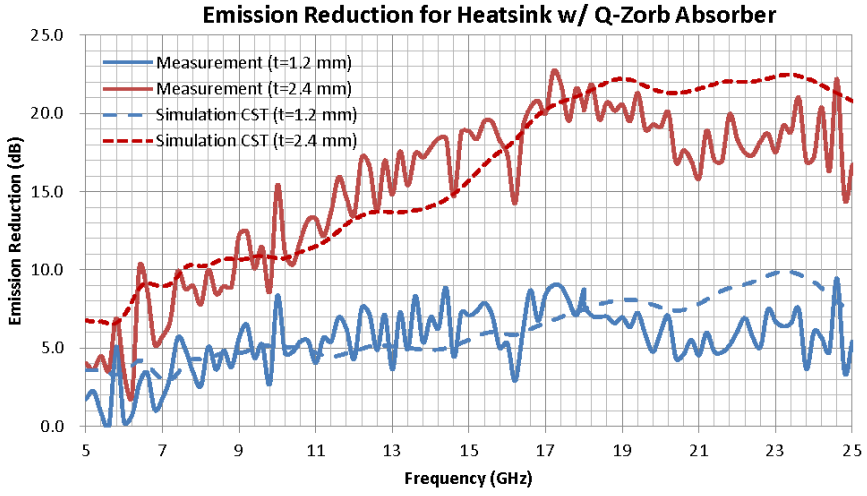




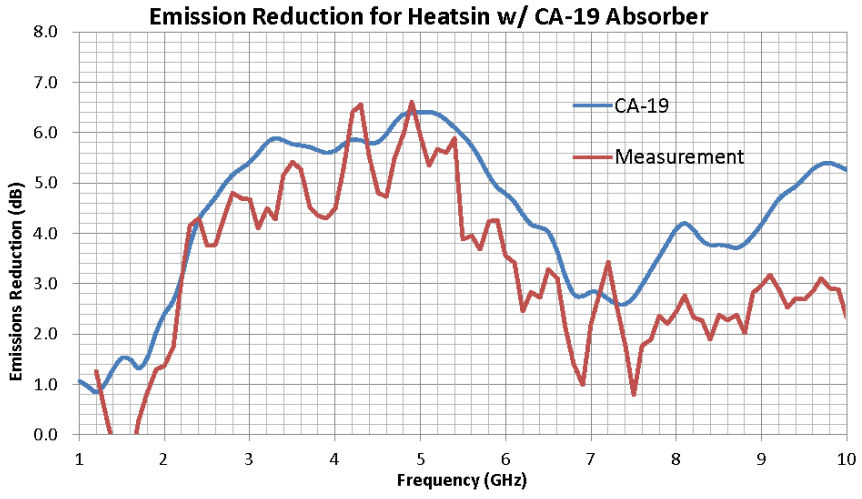




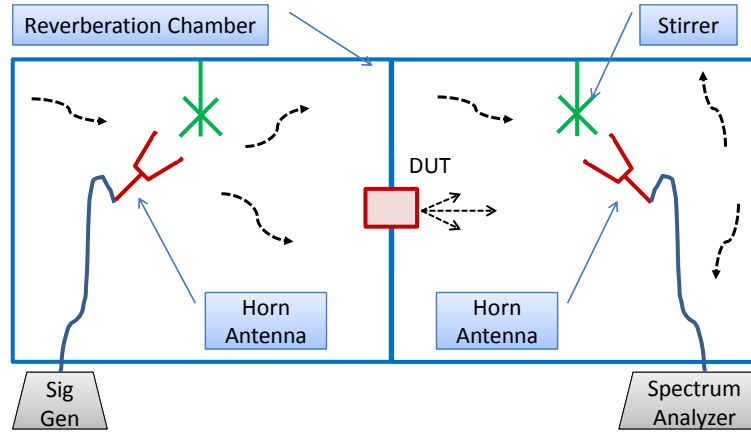
Emission Reduction by Q-Zorb



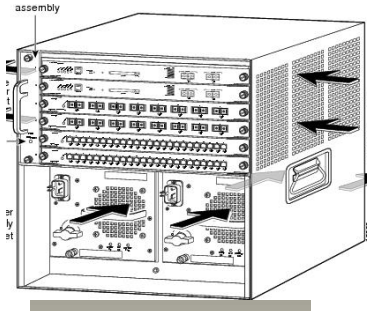
Emission Reduction by CA-19

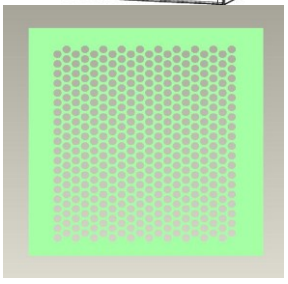


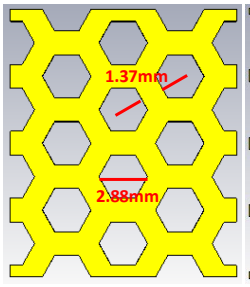
SE Test Method

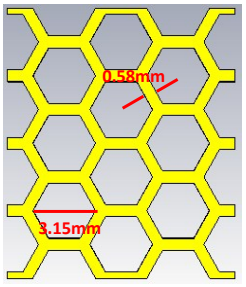


Validation: Vent Holes









	Hex01_1T	Hex02_1T	Hex02_2T
Thickness (mm)	0.85	0.85	1.7
Diameter (mm)	2.88	3.15	3.15
C2C Pitch (mm)	1.37	0.58	0.58
Opening	41.67 %	68.01 %	68.01 %

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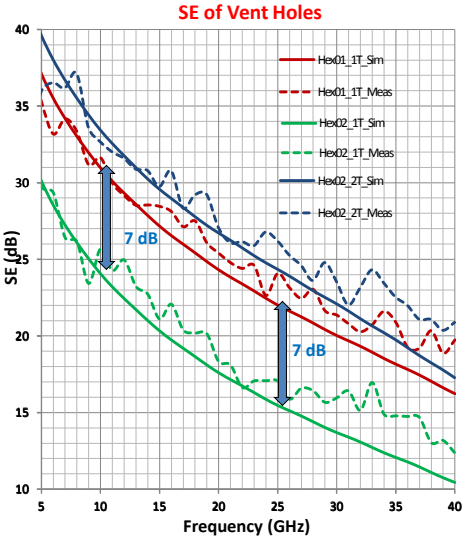
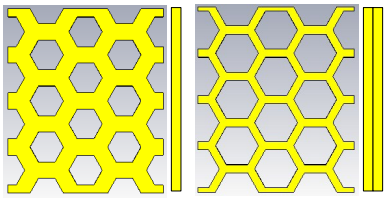
Validation: Vent Holes





41.67 %
t = 0.85mm

68 %
t = 0.85mm

- Allows EMC engineers to evaluate

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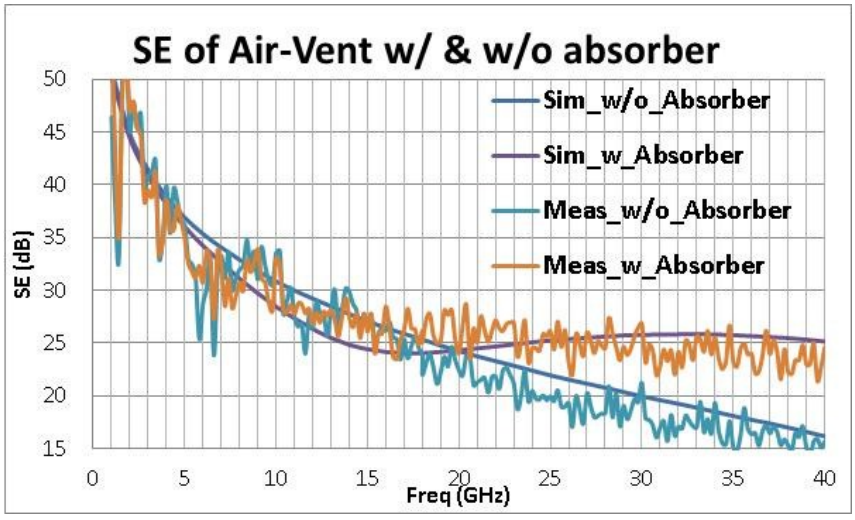
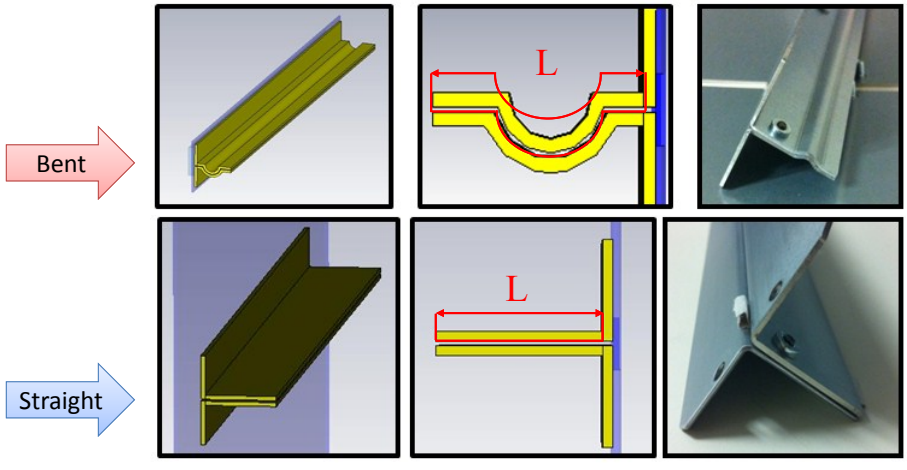
Effect of Absorber

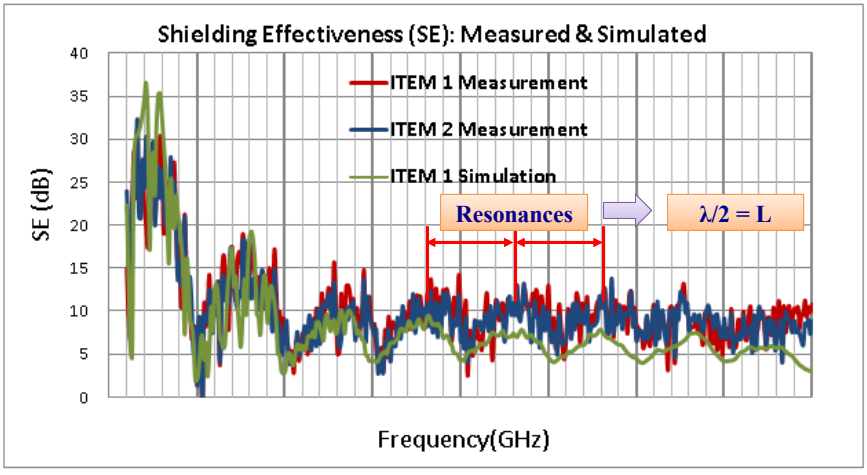


Chassis Feature



$L_{Bent} = L_{Straight}$

SE Comparison



The two features have No Difference.

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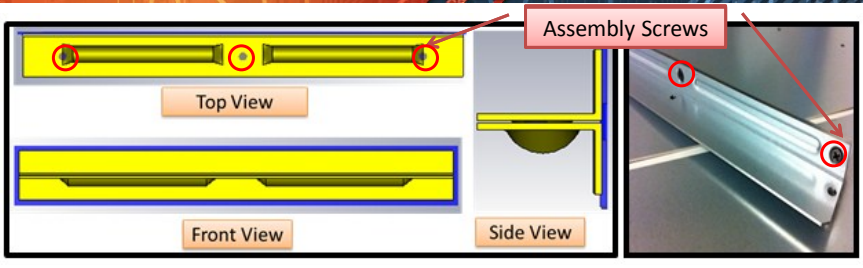
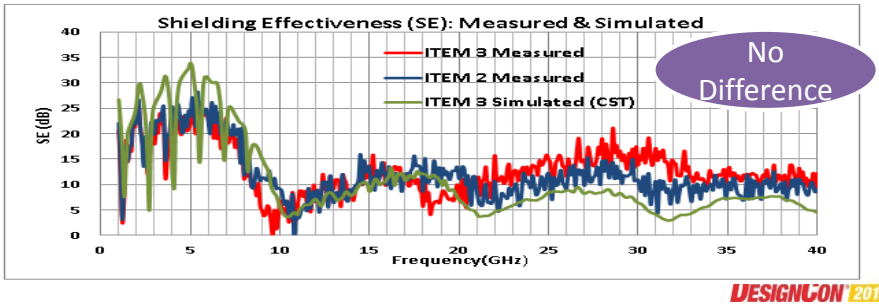
Intermittent Bend Feature





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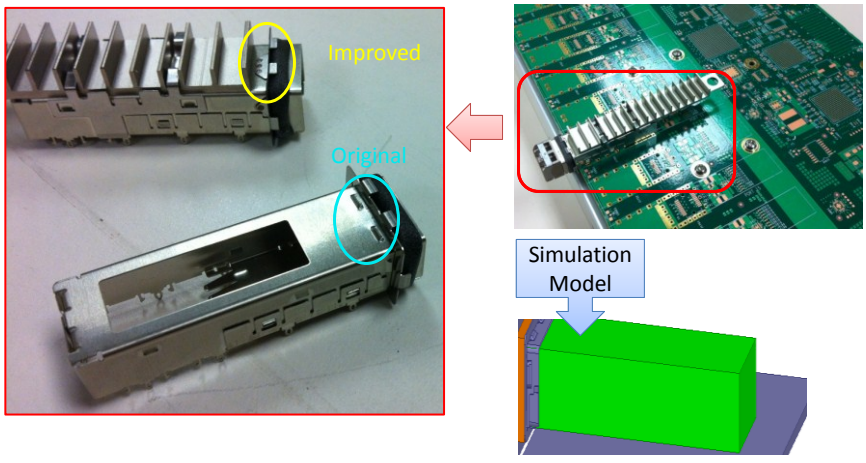
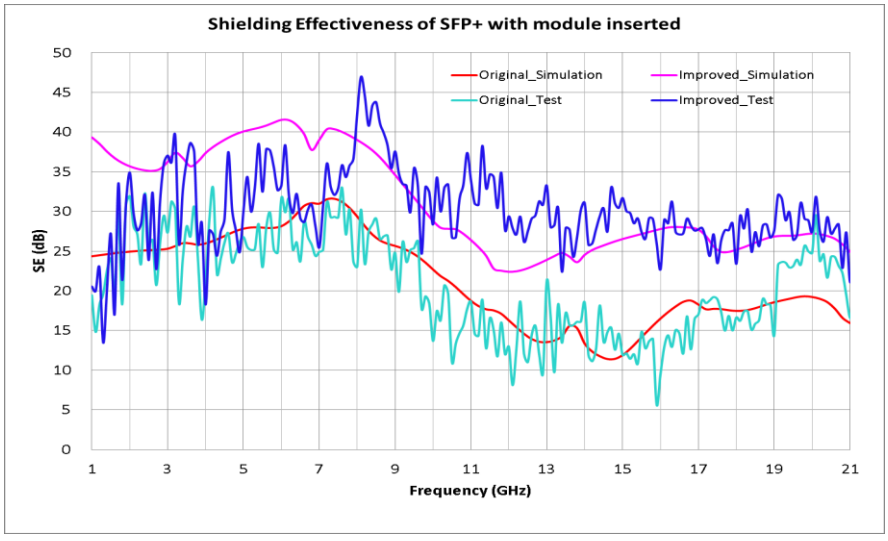
I/O Connector



SE Comparison



Conclusion

- Novel simulation method to predict the TRP and SE tested by RC.
- Validated by 4 different applications: Heatsink with and without absorber, Air-vents, Chassis features and I/O connectors.
- Results obtained by HFSS and CST agree well with test data in whole frequency range (1 - 40GHz).
- This simulation technique as well as the use of reverberation chamber is becoming an integral part of EMC design at Cisco.

Acknowledgment

Thank you !

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Jianquan Lou and *Li Wan.*

Q & A

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