UBM

Electromagnetic Wave Absorption Technology for Stub Effects Mitigation

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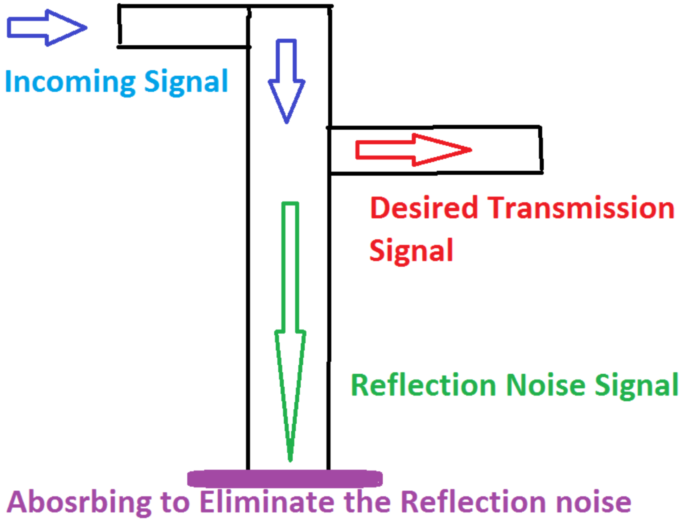
Basic Physical Idea:
Reduce the stub effects by absorbing the reflection noise waves on/around the bottom of the stub

1. The incoming signal is split into two ports: one part goes into the receiver (desired transmission signals), the other part goes into the stub (reflection noise signals).
2. The basic idea is to eliminate the reflection noise signals by using absorbing material attached to the bottom.
3. Most reflection waves around the stub bottom are surface waves or evanescent waves, thus the materials need to be as close to the bottom as possible.
4. Removing the reflection signal can eliminate the ISI, but will has about 50% power loss (or 30% voltage loss) for all frequencies.



What kind of absorbing material can work?

Wave propagation factor for electromagnetic wave:

$$\exp\left(j2\pi\frac{z}{\lambda_0}\frac{1}{\sqrt{\varepsilon_r(1+j\tan\delta)}}\right) = \exp\left(j\cdot imag(2\pi\frac{z}{\lambda_0}\frac{1}{\sqrt{\varepsilon_r(1+j\tan\delta)}})\right)\exp\left(j\cdot real(2\pi\frac{z}{\lambda_0}\frac{1}{\sqrt{\varepsilon_r(1+j\tan\delta)}})\right)$$

propagation factor **attenuation factor** **phase factor**

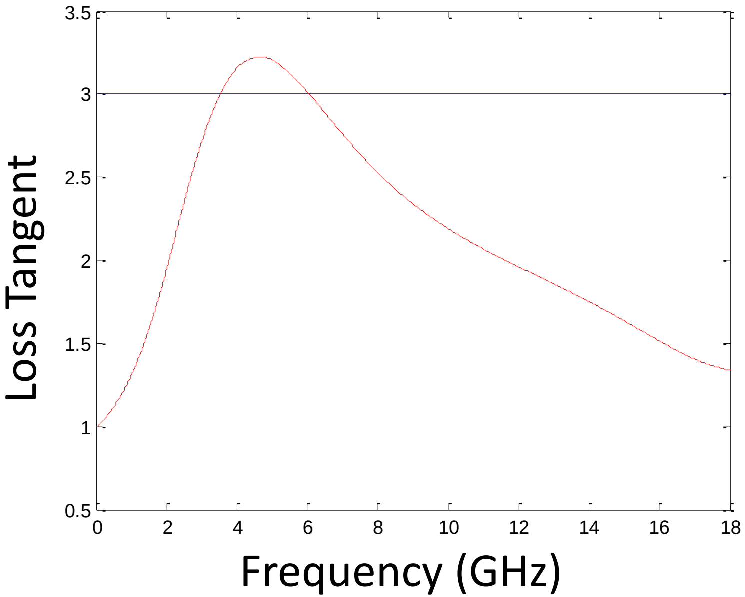
Required condition:

(1)Loss tangent to be large enough, $\tan\delta \gg 0$; and to be constant is a plus.

(2)The dielectric constant $\sqrt{\varepsilon_r}\sim f^{-1}$.

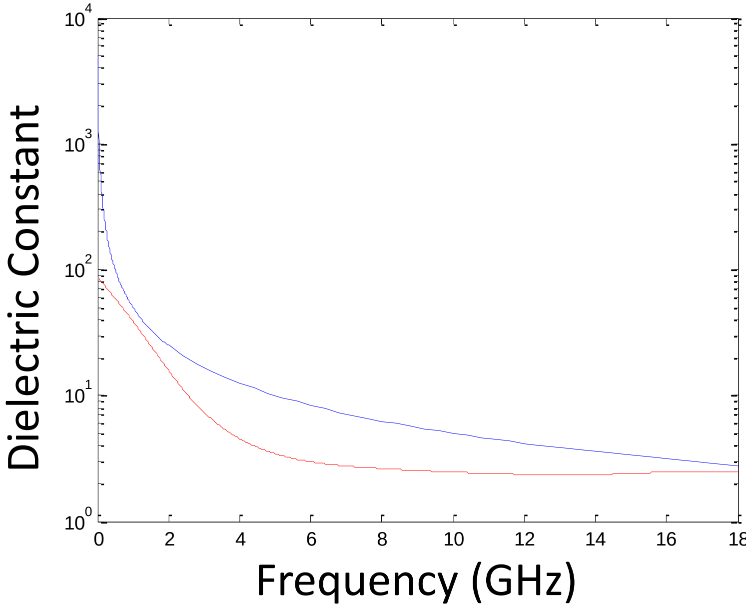
So that the loss, in term of attenuation factor, will keep constant.

Comparisons between ideal absorbing material and one commercial absorbing material



Blue: absorbing material used in the study

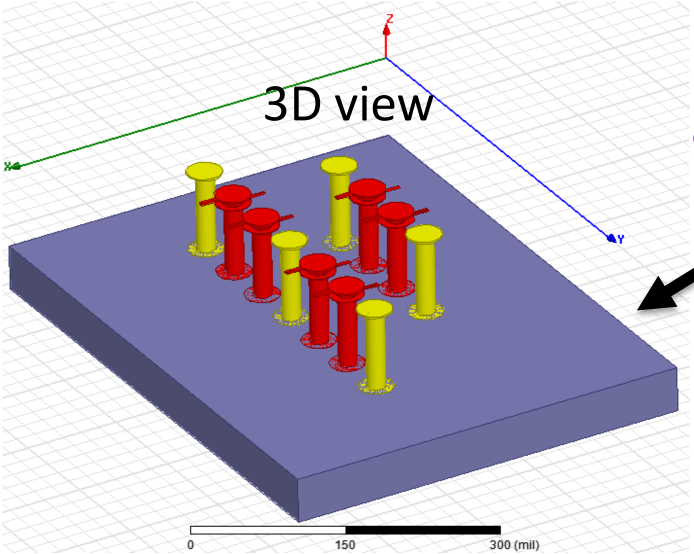
Red: ideal absorbing material



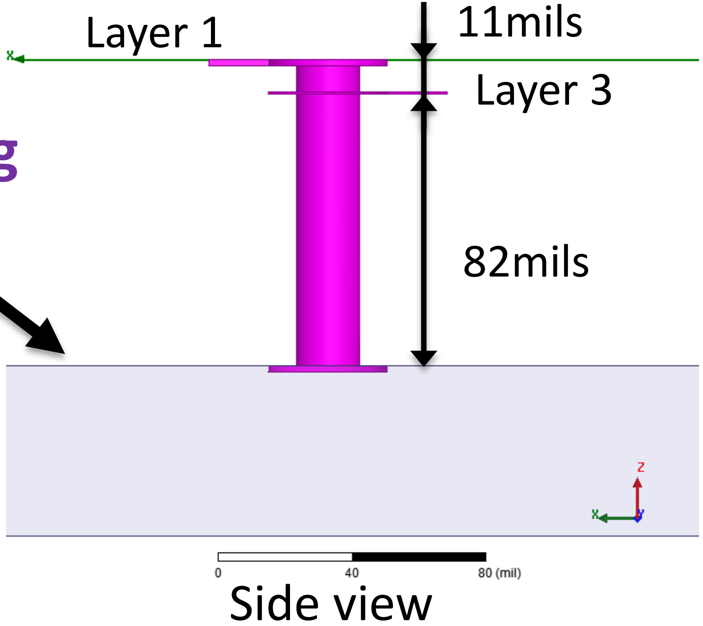
- There are many materials in the industry. We chose one for this study.
- The measurement permittivity data is provided by the material vendor. The data is from 2GHz to 18GHz. Interpolation is used to extend the data range below 2GHz and high than 18GHz.

Verification: Simulation

3D Full-wave Simulations using HFSS

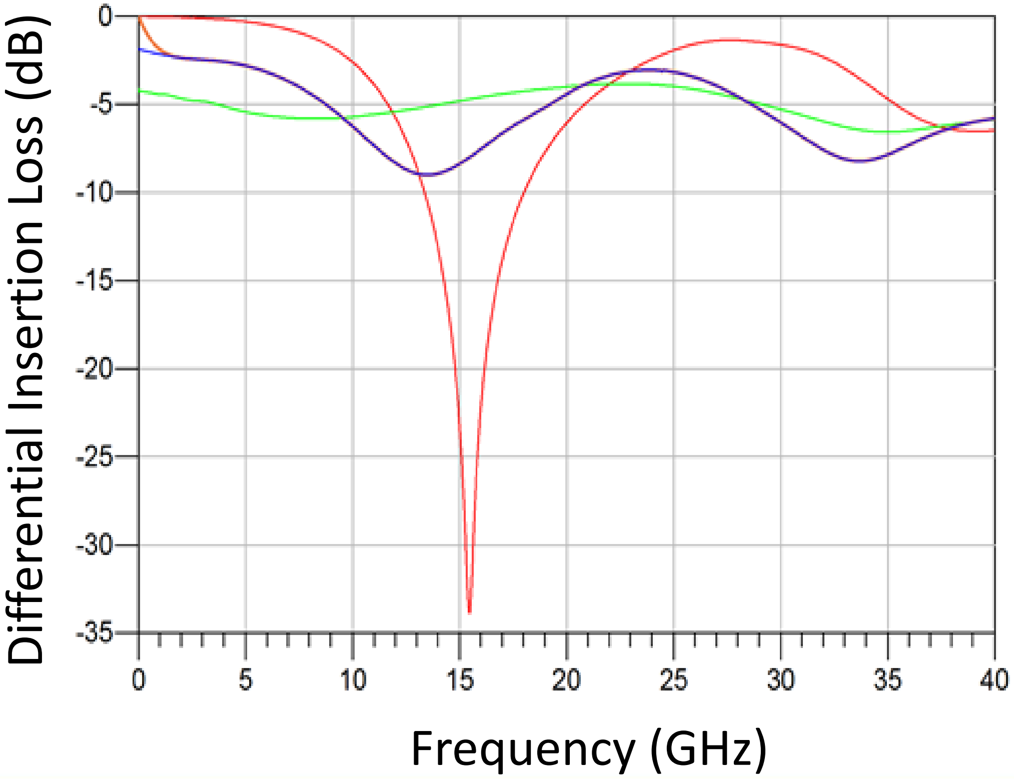


absorbing material



Via stub length = 82mils, through length = 11 mils, 16 Layers, L1 input, L3 output.

Comparison of SDD21 from HFSS simulations



Red: No absorbing material

Green: Ideal absorbing material

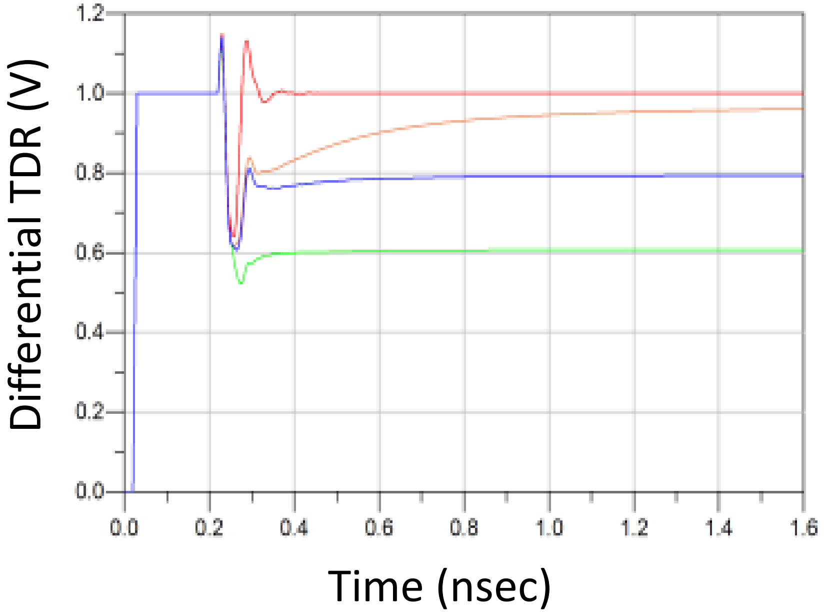
Blue: Absorbing material with S-parameters interpolation below 2GHz

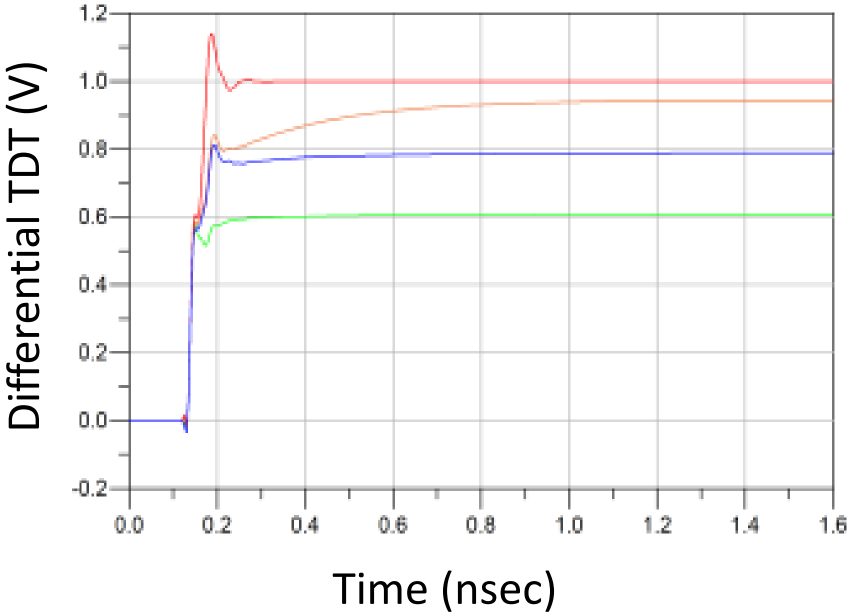
Orange: Absorbing material with permittivity interpolation below 2GHz

Step Responses from ADS simulations

Red: No absorbing material **Blue:** Absorbing material with S-parameters interpolation below 2GHz

Green: Ideal absorbing material **Orange:** Absorbing material with Permittivity interpolation below 2GHz



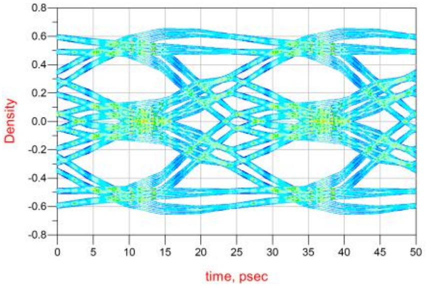


HFSS output S-parameters are used as input data

Eye diagrams from ADS simulations

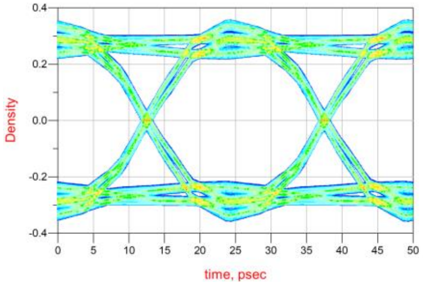
Data rate=40Gbps;   HFSS S-parameters are used as input data.

EW=3.2ps
EH=47mV



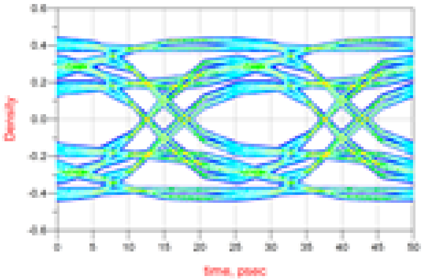
No absorbing material

EW=23.4ps
EH=462mV



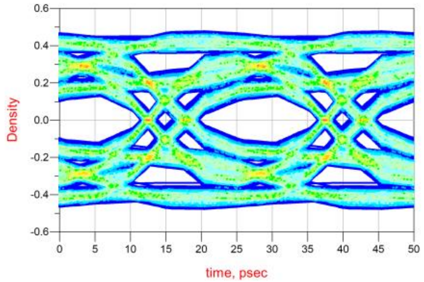
Ideal absorbing material

EW=18.1ps
EH=308mV



Absorbing material with S-parameters interpolation below 2GHz

EW=17.1ps
EH=246mV



Absorbing material with permittivity interpolation below 2GHz

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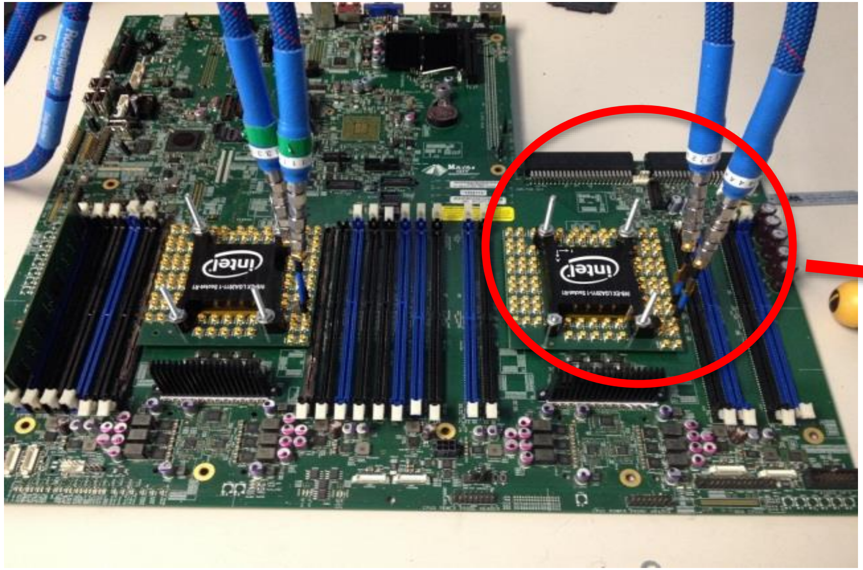
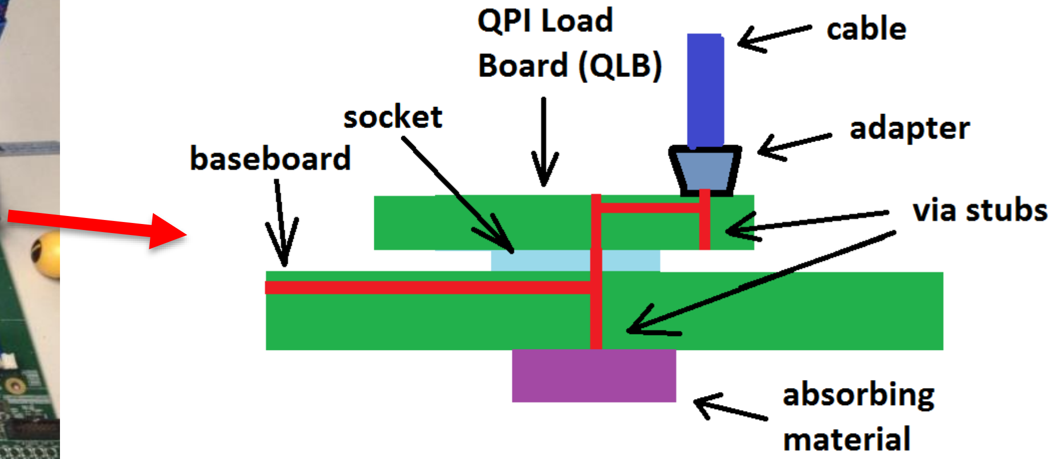
Verification: Measurement

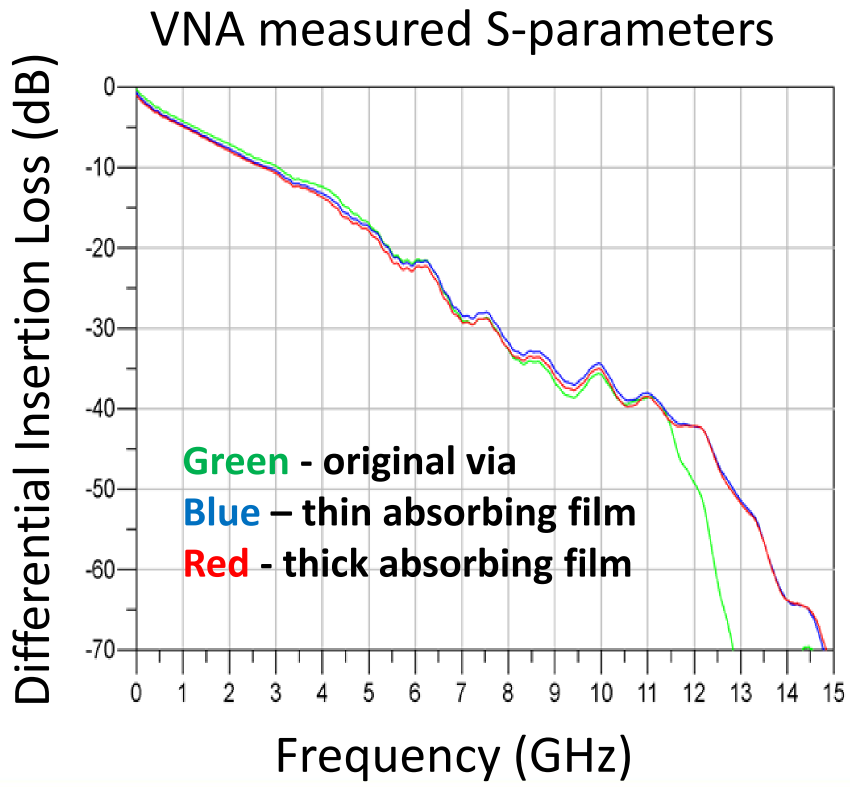
VNA Measurement Setup

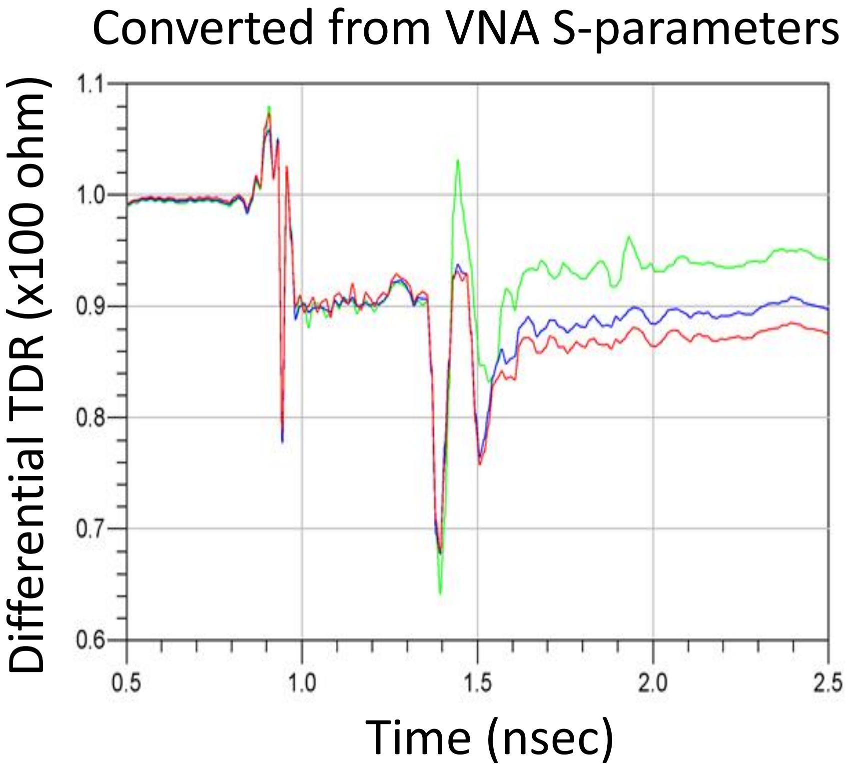
4-ports VNA measurement using a server Platform Intel® QuickPath Interconnect (QPI) channel with QPI Load Board (QLB).





Measurement Results: S-parameters and TDR Impedance





Simulation Results: eye width and height comparison

EW and EH comparisons for QPI lane 10, simulated with measured s-parameter

Data Rate	Absorbing (thin film)	Original stub
11 Gbps	EW=0.665UI, EH=88mV	EW=0.640UI, EH=86mV
13 Gbps	EW=0.625UI, EH=39mV	EW=0.571UI, EH=37mV
15 Gbps	EW=0.279UI, EH=10mV	EW=0.115UI, EH=1mV

Improve EW by 0.17UI and EH by 9mV

Summary

- A new wave absorbing via technology is proposed to be useful for stub effect mitigation.
- Both ideal absorbing material and real commercial absorbing materials are used in the study.
- Simulations and measurements are performed to prove the effectiveness of the proposed technology.
- Results show the proposed technology is useful for via stub mitigation.

Thank you!

QUESTIONS?