

***Interconnect Measurement
Examples to Demonstrate
High Frequency Challenges***

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Outline (20 minutes - JN)

- **Measurement Motivations (market driven)**
 - Customer expectations
 - Classification of requests and trends
 - Customer feedback
- **Connector Measurements**
 - Method 1 – microprobe TDR measurements
 - Method 2 – Coaxial TRL VNA measurements
 - Method 3 – Microprobe TRL VNA measurements
- **Conclusions**

Measurement Motivations (Customer Expectations)

- **In 2009, Samtec recorded 1,209 requests for SI support. Two general categories...**
 - Will your product work in my application?
 - Do you have a model of product x?
- **Customers expect to be able to get the information and support required to determine SI functionality**



Measurement Motivations (Classification of Requests and Trends)

- **Requests fall into two general categories**
 - Will the product work at my very high data rate?
 - Will this very inexpensive product work at my low data rate?
- **Trend 1 – Fewer SI engineers dealing with passive interconnect, more requests to do channel level analysis**
- **Trend 2 – Low cost products used for low speed applications**
- **Trend 3 – Footprint optimized connectors for high speed applications supported with measurement based models or full wave analysis**

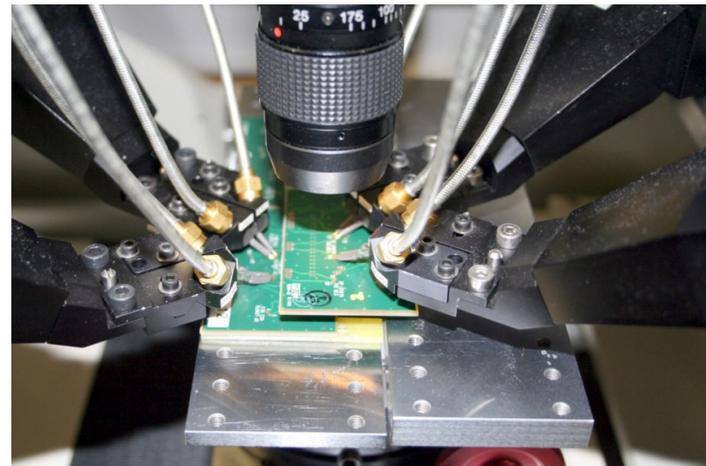
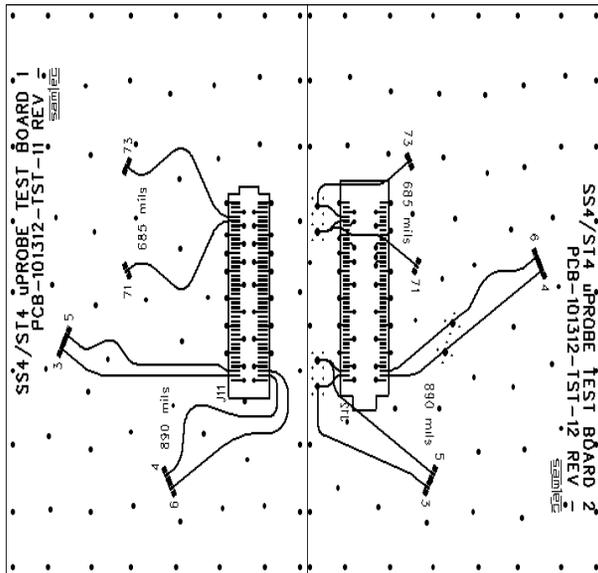
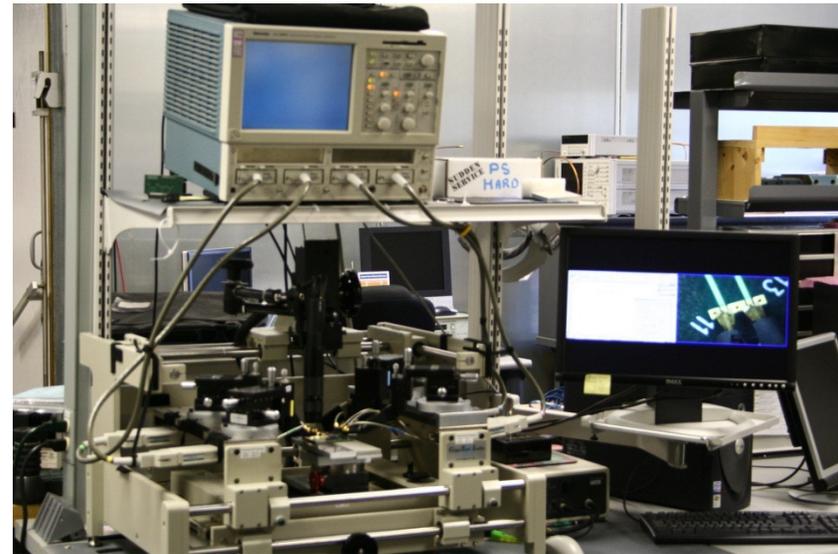
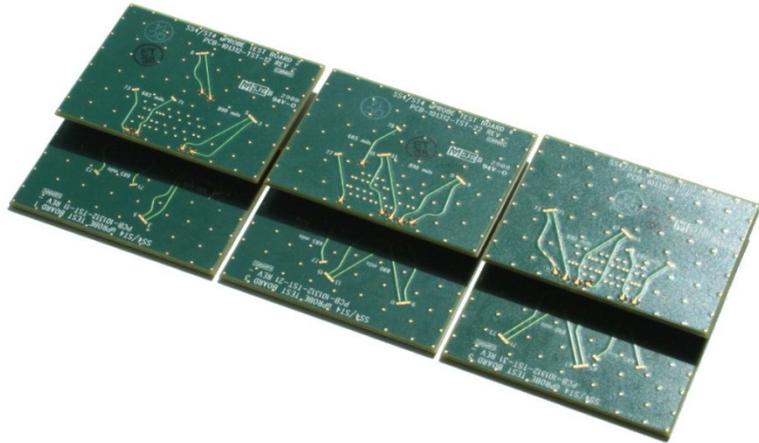
Trend 3 is the focus of this tutorial



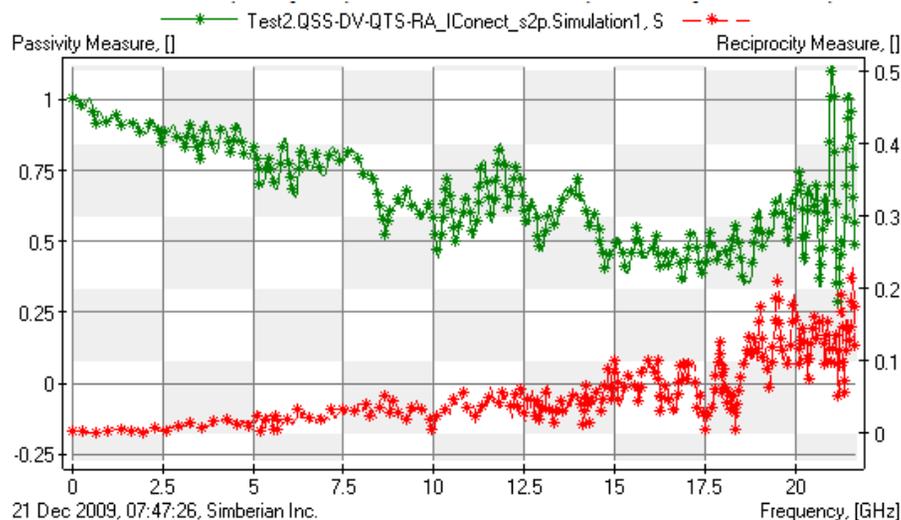
Measurement Motivations (Customer Feedback)

- **Mainstream SI tools perform causality/passivity checks. What do these terms mean and can I use the S-parameter data set you provided even if there are warnings? Should it be corrected?**
- **Need for wider bandwidth models/measurements (20 GHz) to support analysis of 5-10 Gb/s designs**

Connector Measurements (Microprobe TDR Measurements)

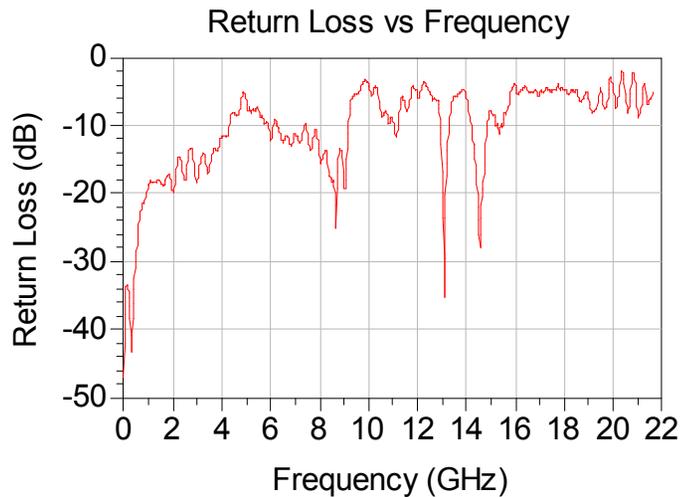
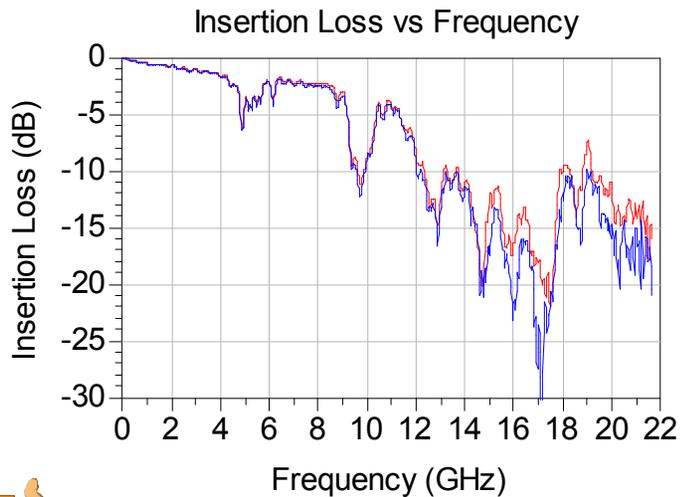


Connector Measurements (Microprobe TDR Measurements)

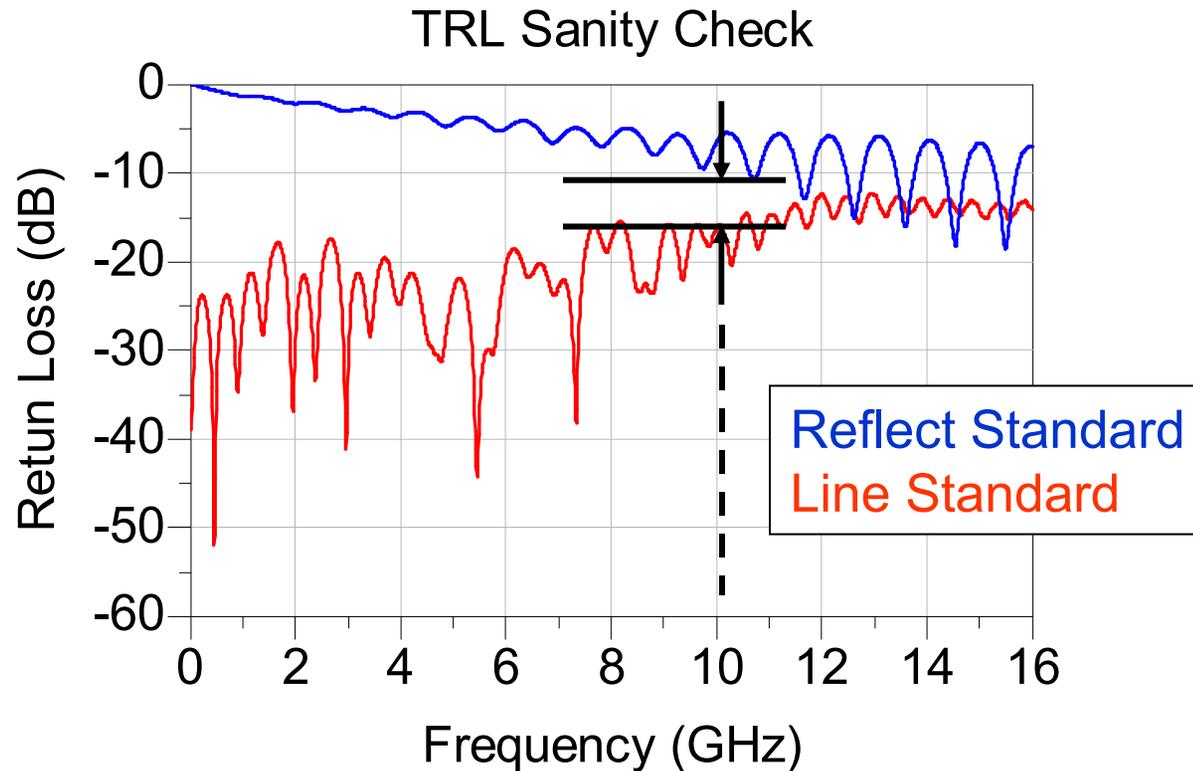


Passivity issues above 20 GHz

Reciprocity is questionable above 12 GHz

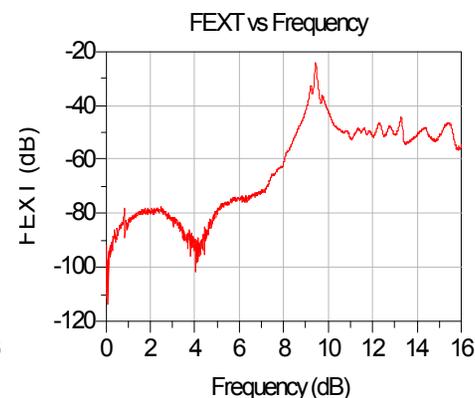
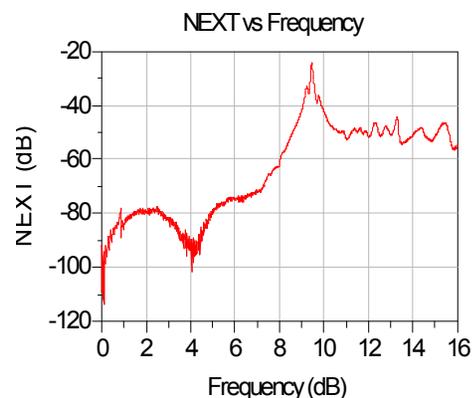
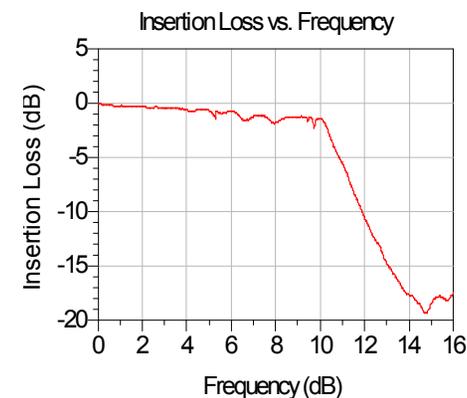
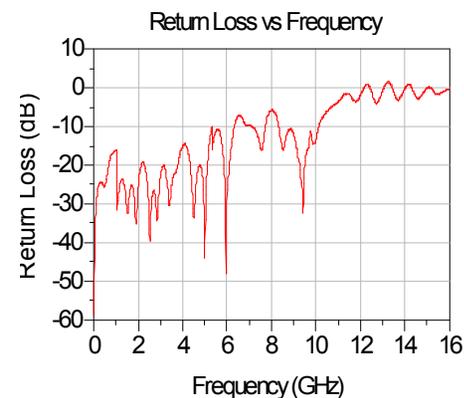
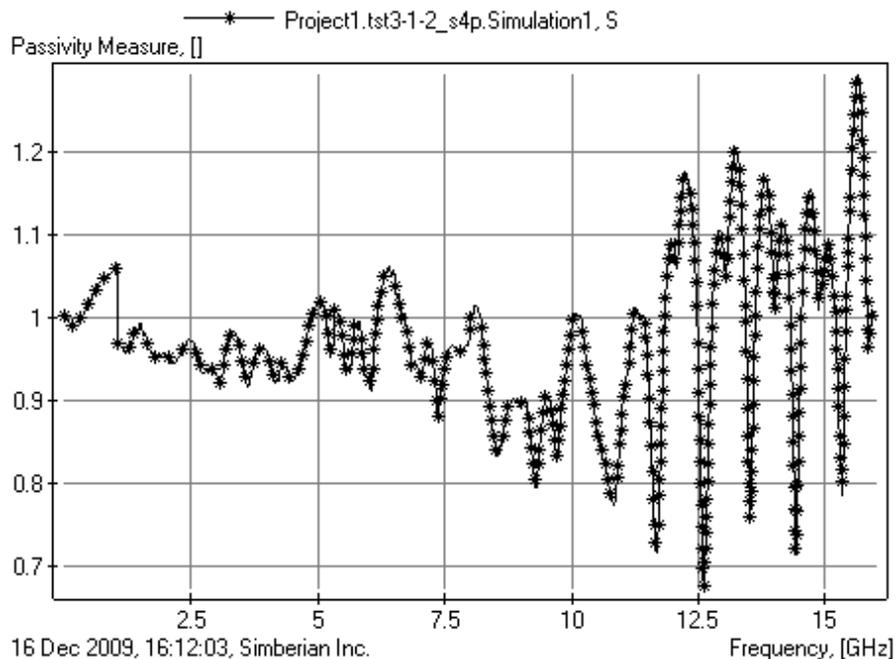


TRL Sanity Check



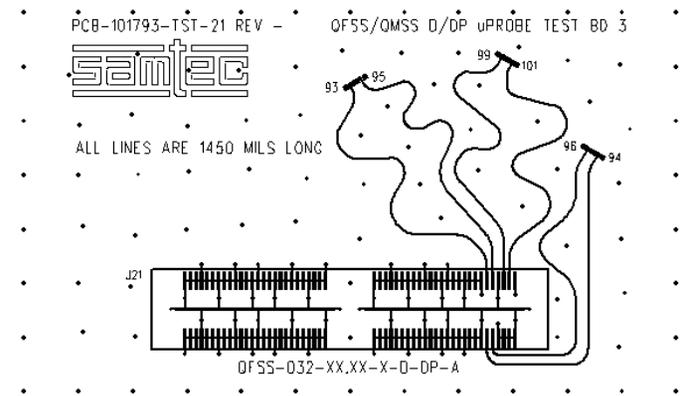
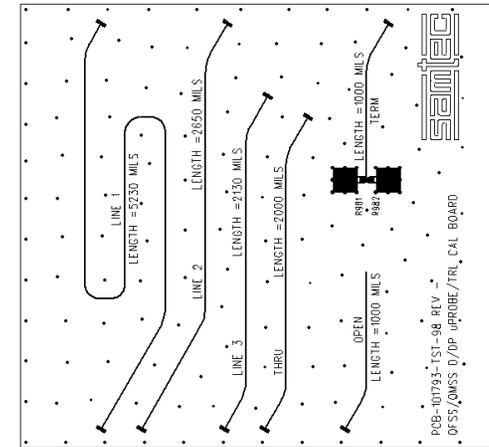
Goal is to have 5-10 dB of separation in return loss between the reflect and line standards. Expect data to be “good” to ~10 GHz

Connector Measurements (Coaxial TRL VNA Measurements)

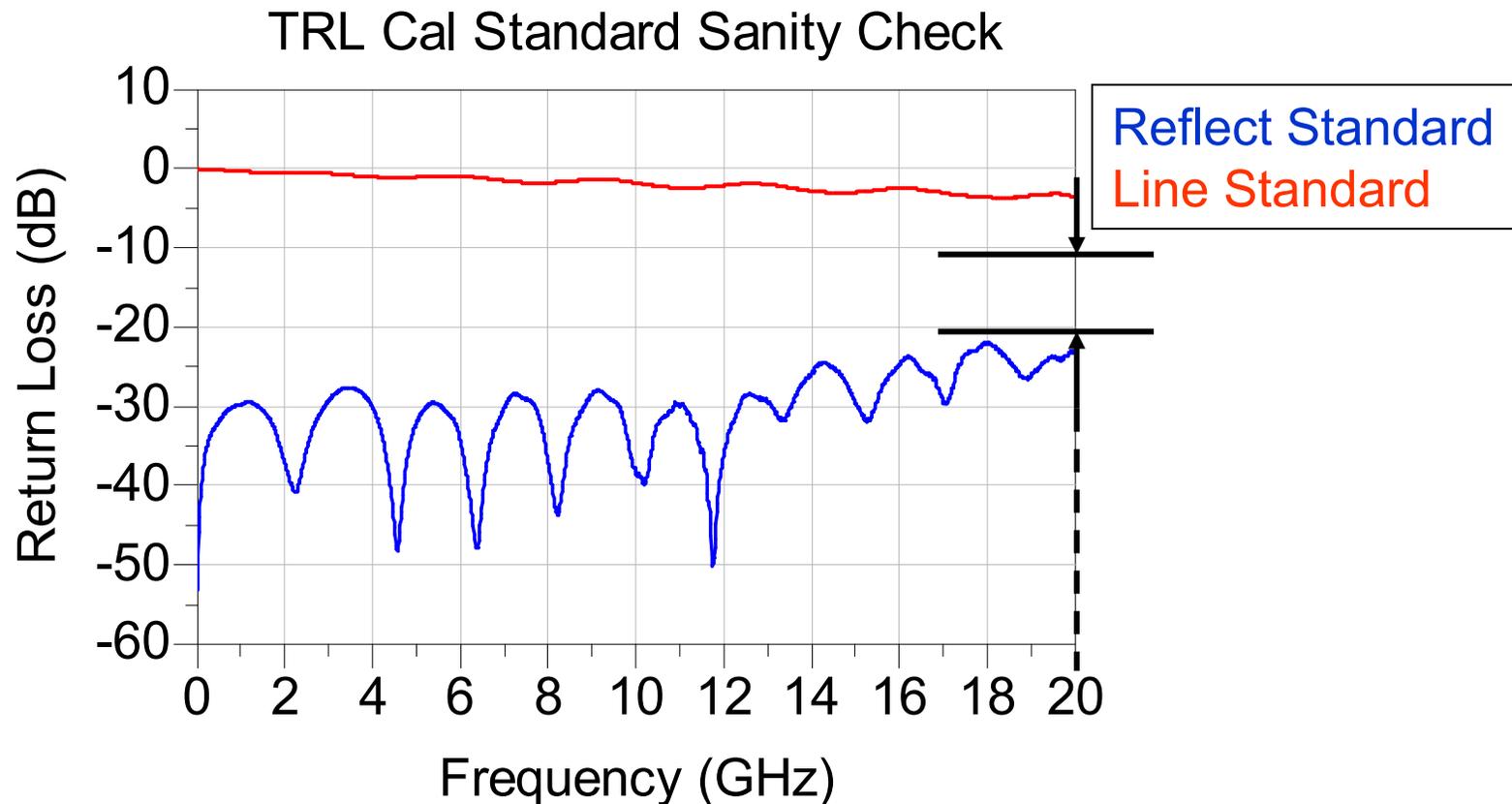


Data is representative but not sufficient for channel simulations

Connector Measurements (Microprobe VNA measurements)

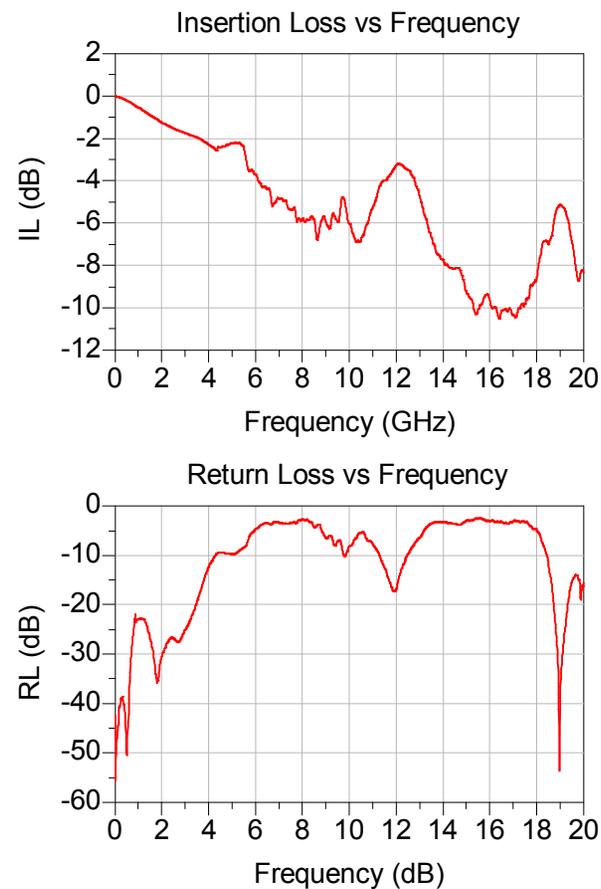
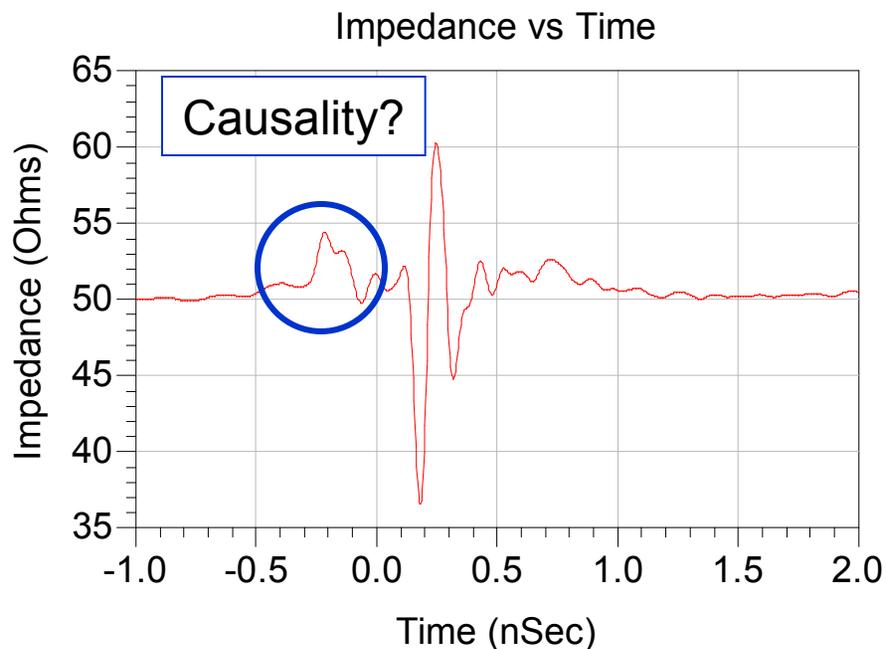


TRL Sanity Check



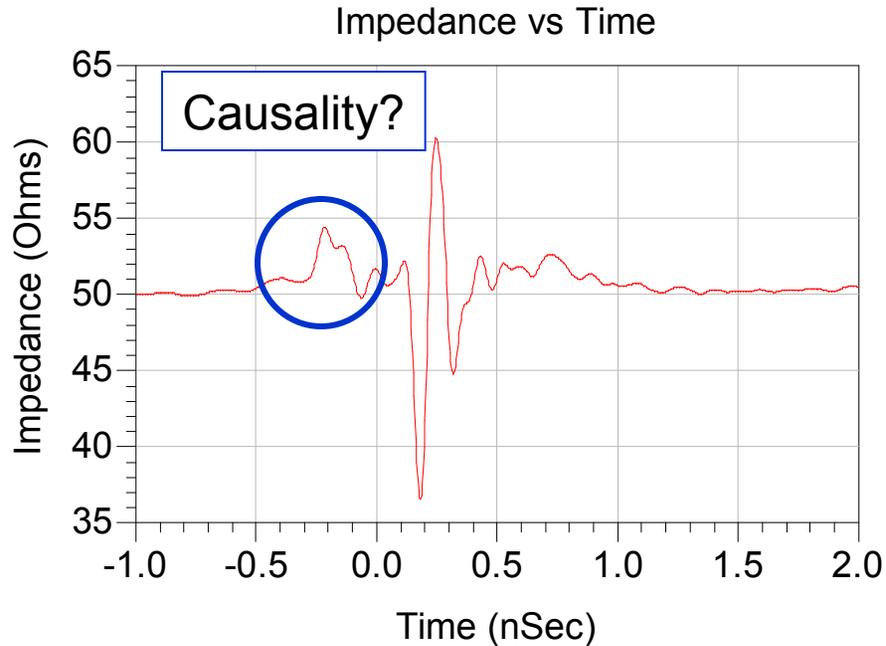
Goal is to have 5-10 dB of separation in return loss between the reflect and line standards. Expect data to be “good” to >20 GHz

Connector Measurements (Microprobe TRL VNA Measurements)

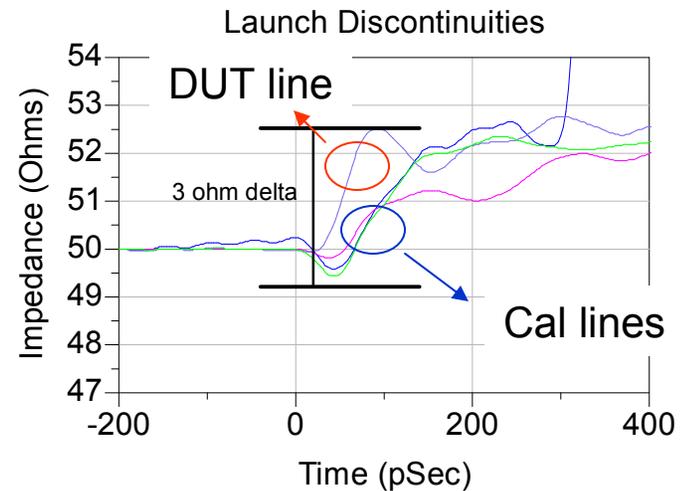
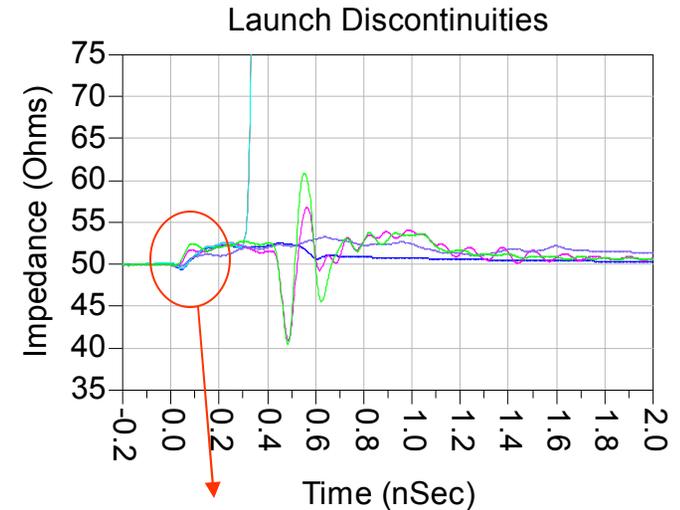


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Causality Issue

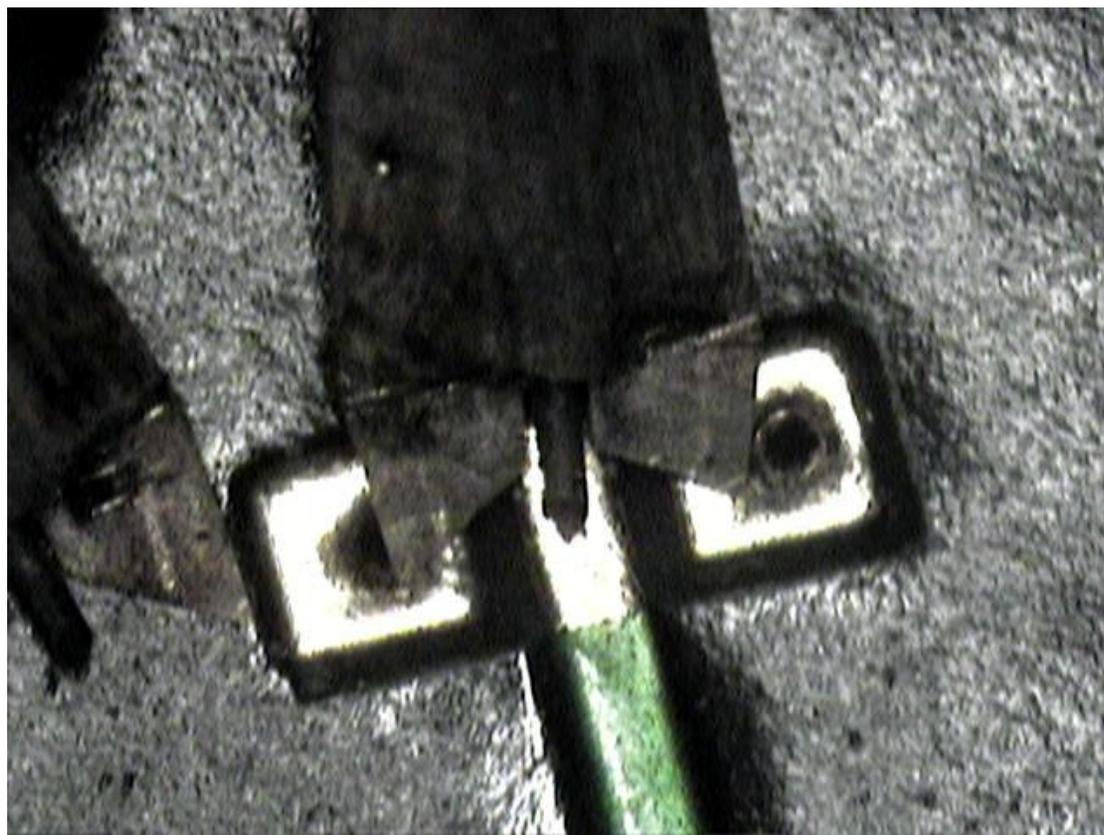


TRL cal lines have different impedance profile than connector test lines resulting in non-causal reflection term



SOLT measure of cal lines and DUT

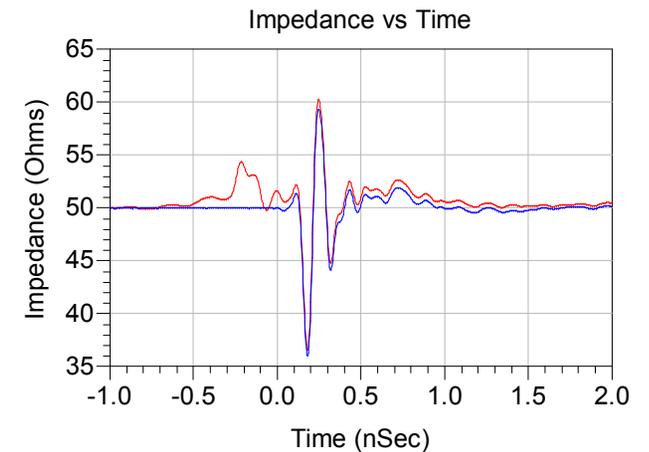
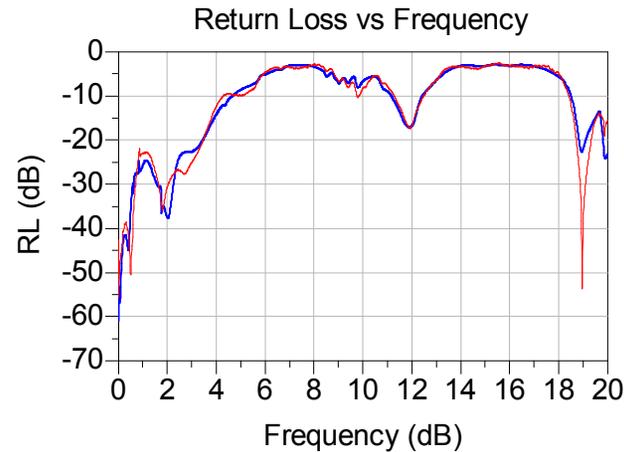
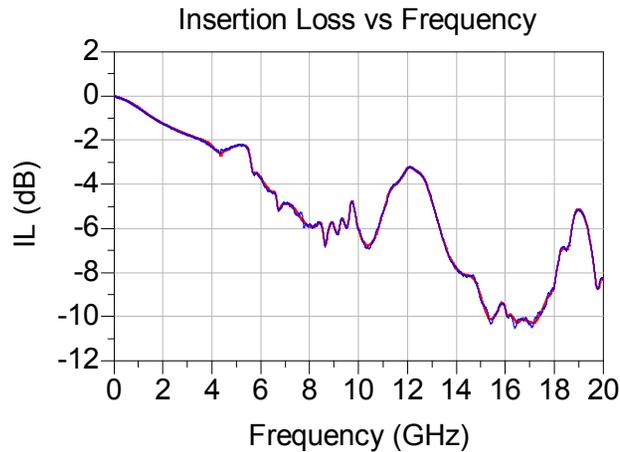
Causality Issue



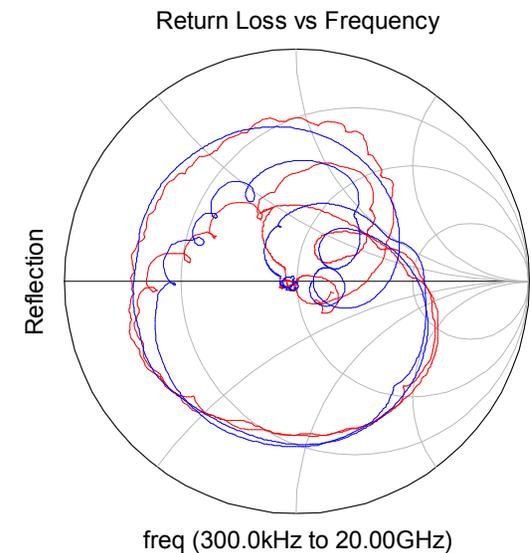
Where you make attachment to the microprobe target matters!

Correction

Raw data
"Corrected" (vector curve fit)



- Minor "measurement noise" can be corrected with model extraction methods
- Objective is to start with the cleanest possible data and apply minimal correction



Conclusions

- **There are two categories of measurements**
 - Characterization
 - What is the IL, RL and NEXT of a product?
 - Multiple techniques give good results
 - Model extraction
 - Much greater demand on measured data quality
 - Would be a lot easier without de-embedding
 - Quality of TRL calibration standards is critical