

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

Presenter: Jim Nadolny



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**

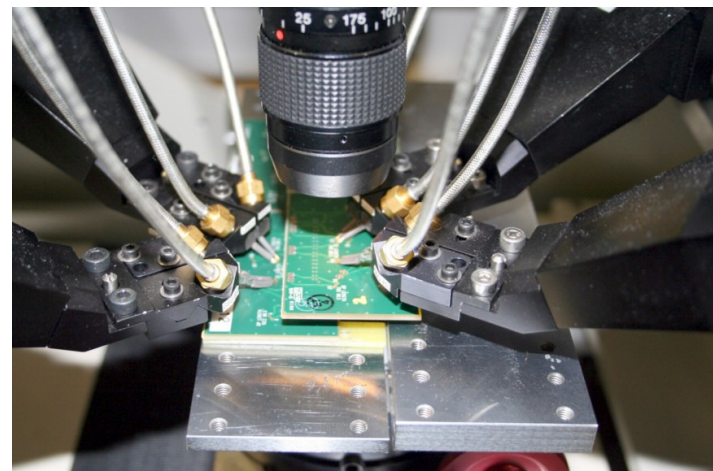
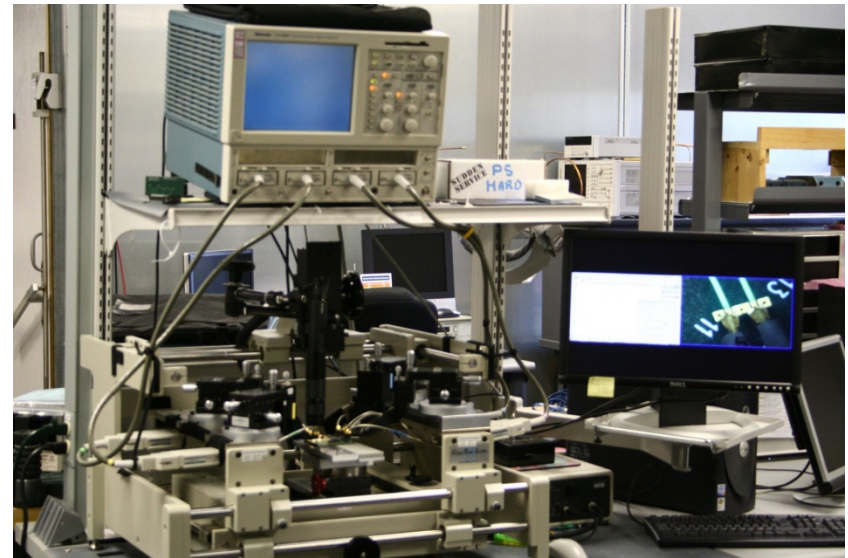
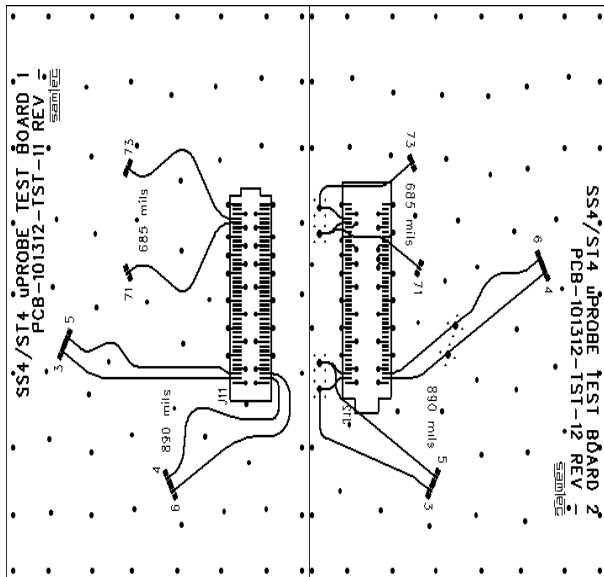
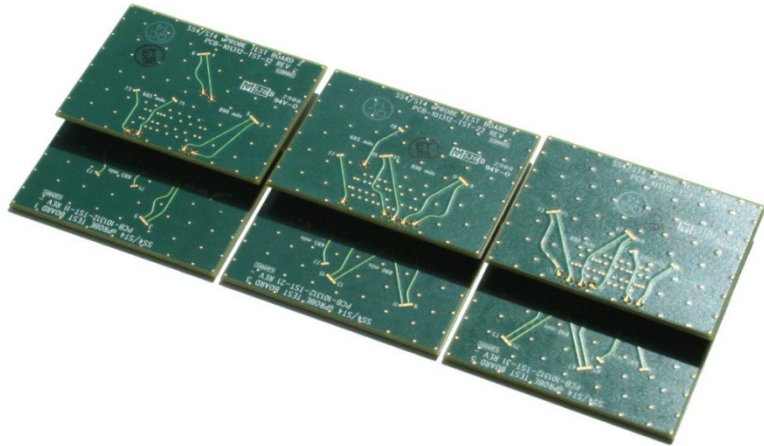
Trend 3 is the focus of this tutorial



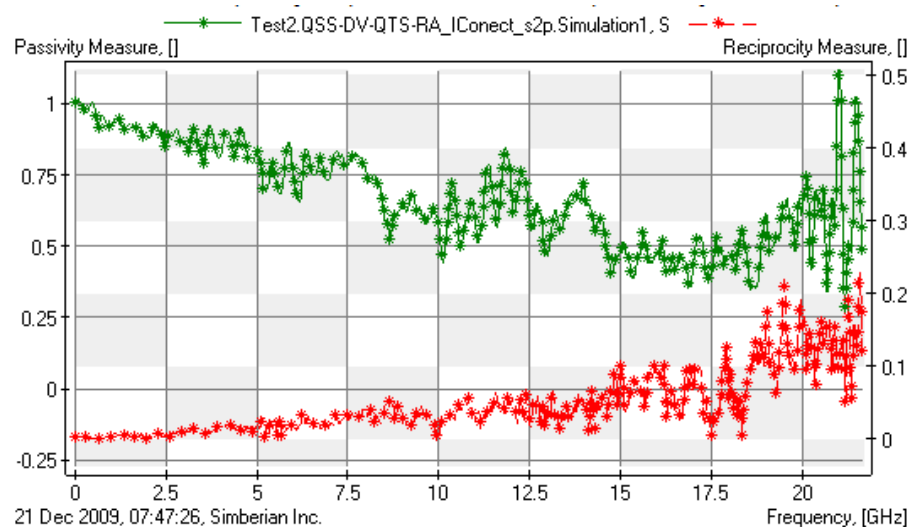
Measurement Motivations (Customer Feedback)

- **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)

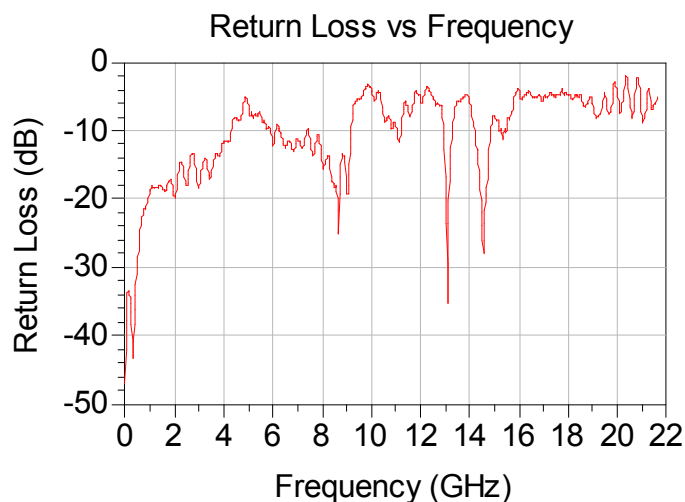
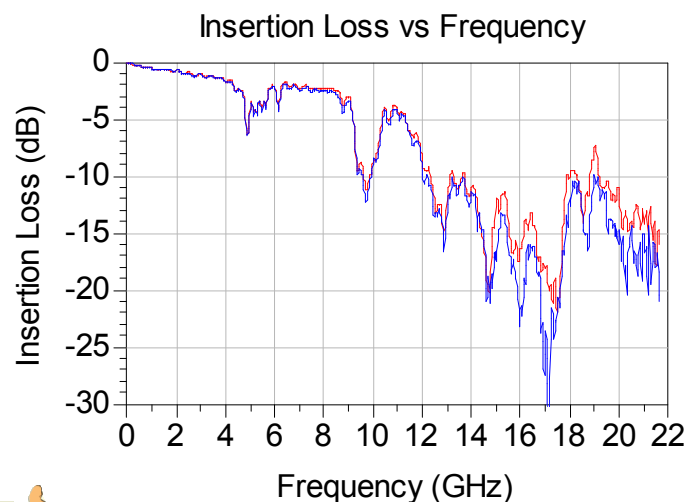


Connector Measurements (Microprobe TDR Measurements)

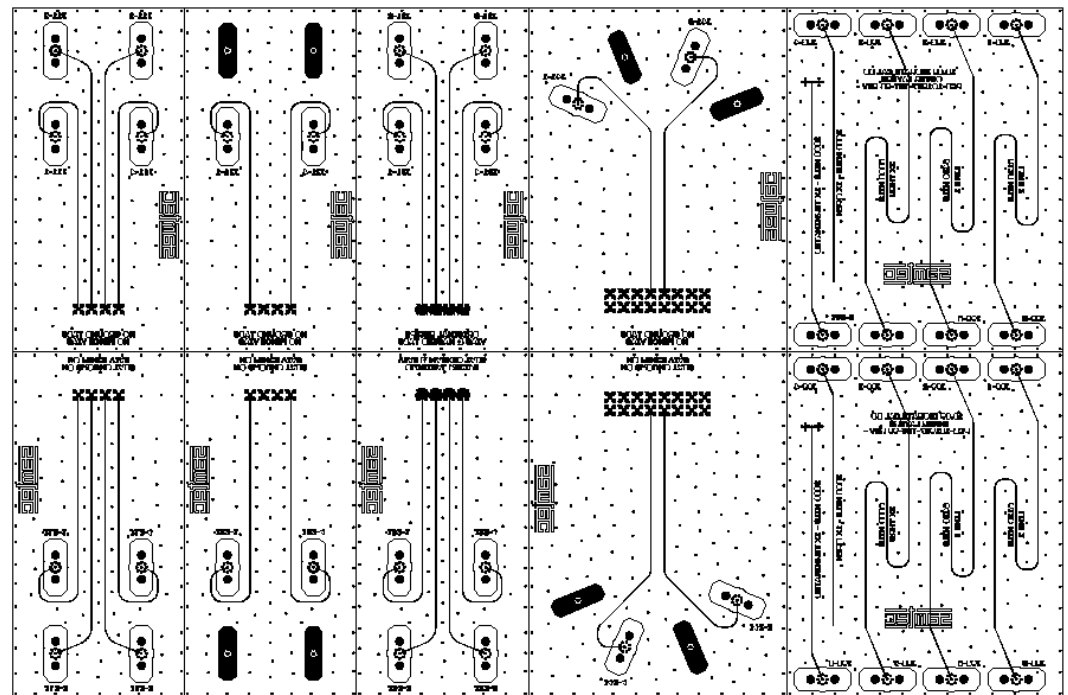
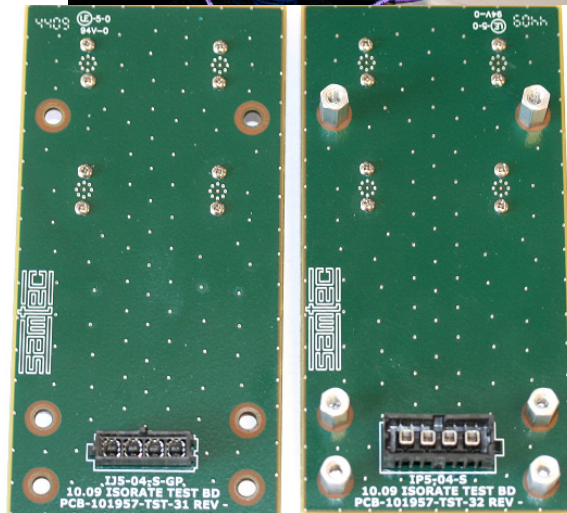
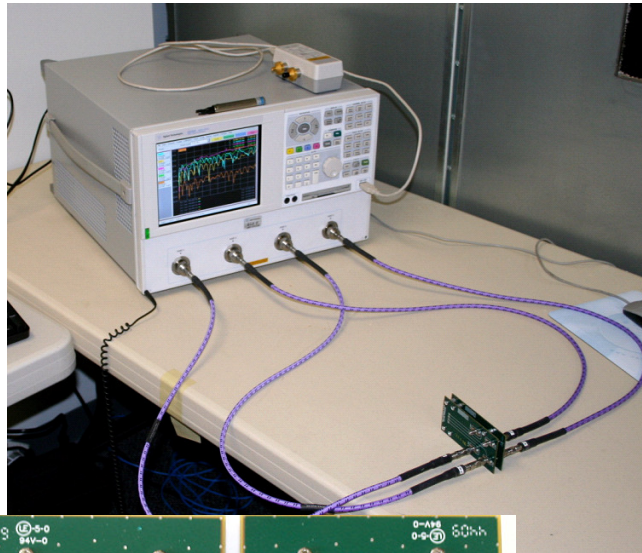


Passivity issues above 20 GHz

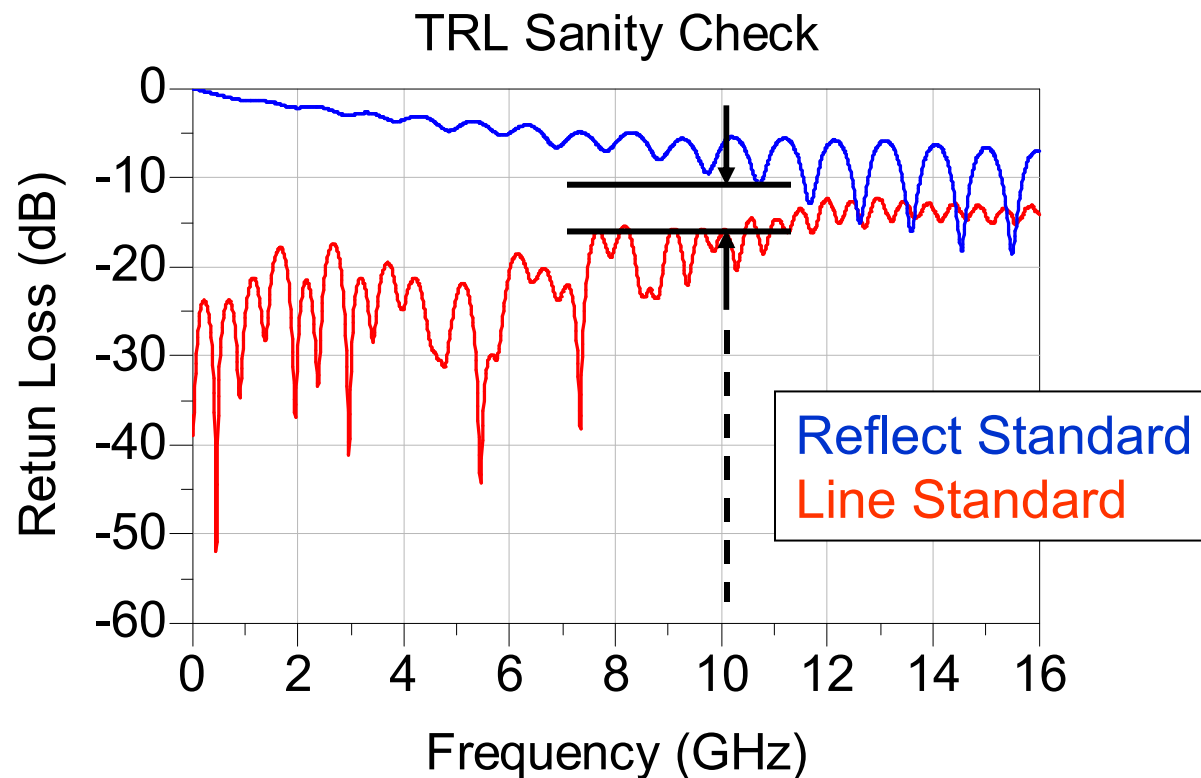
Reciprocity is questionable above 12 GHz



Connector Measurements (Coaxial TRL VNA Measurements)

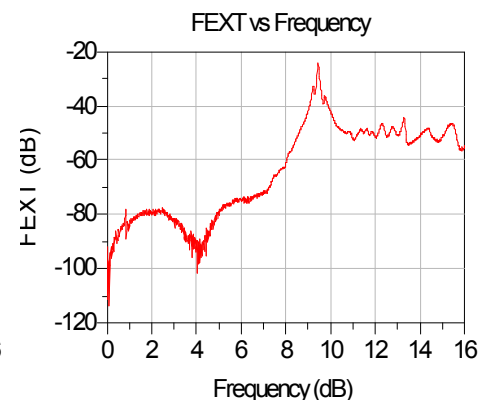
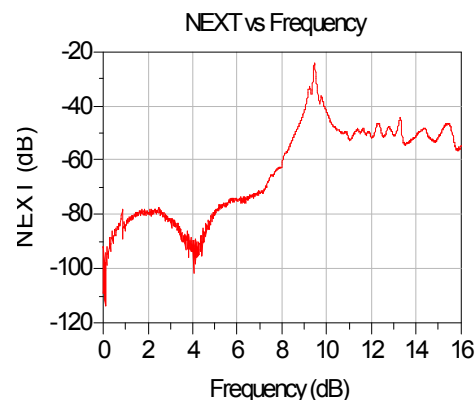
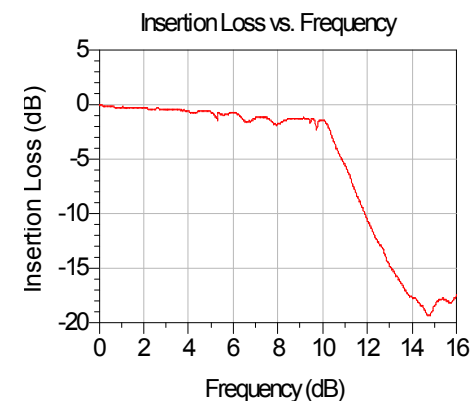
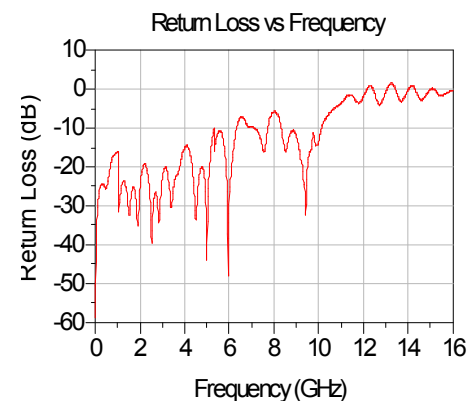
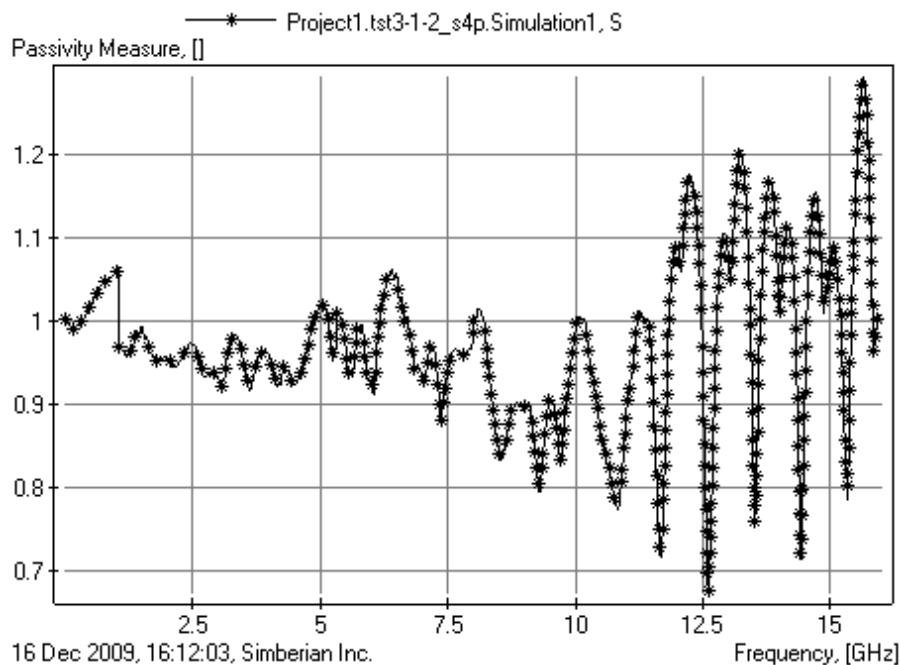


TRL Sanity Check



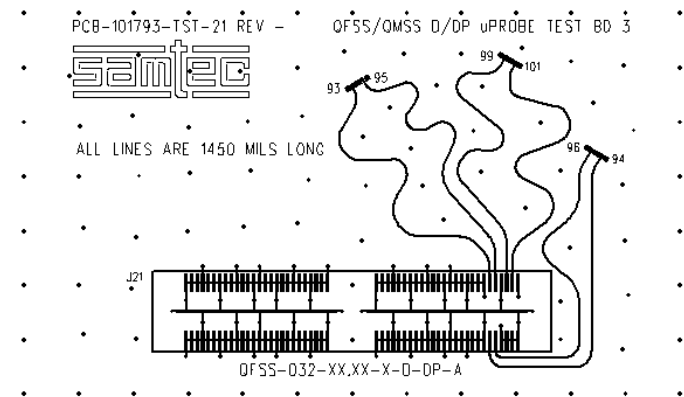
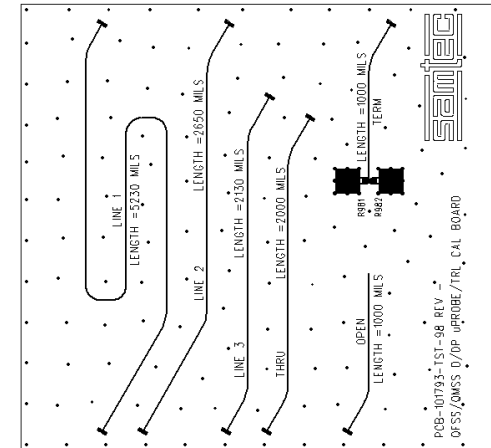
Goal is to have 5-10 dB of separation in return loss between the reflect and line standards. Expect data to be “good” to ~10 GHz

Connector Measurements (Coaxial TRL VNA Measurements)

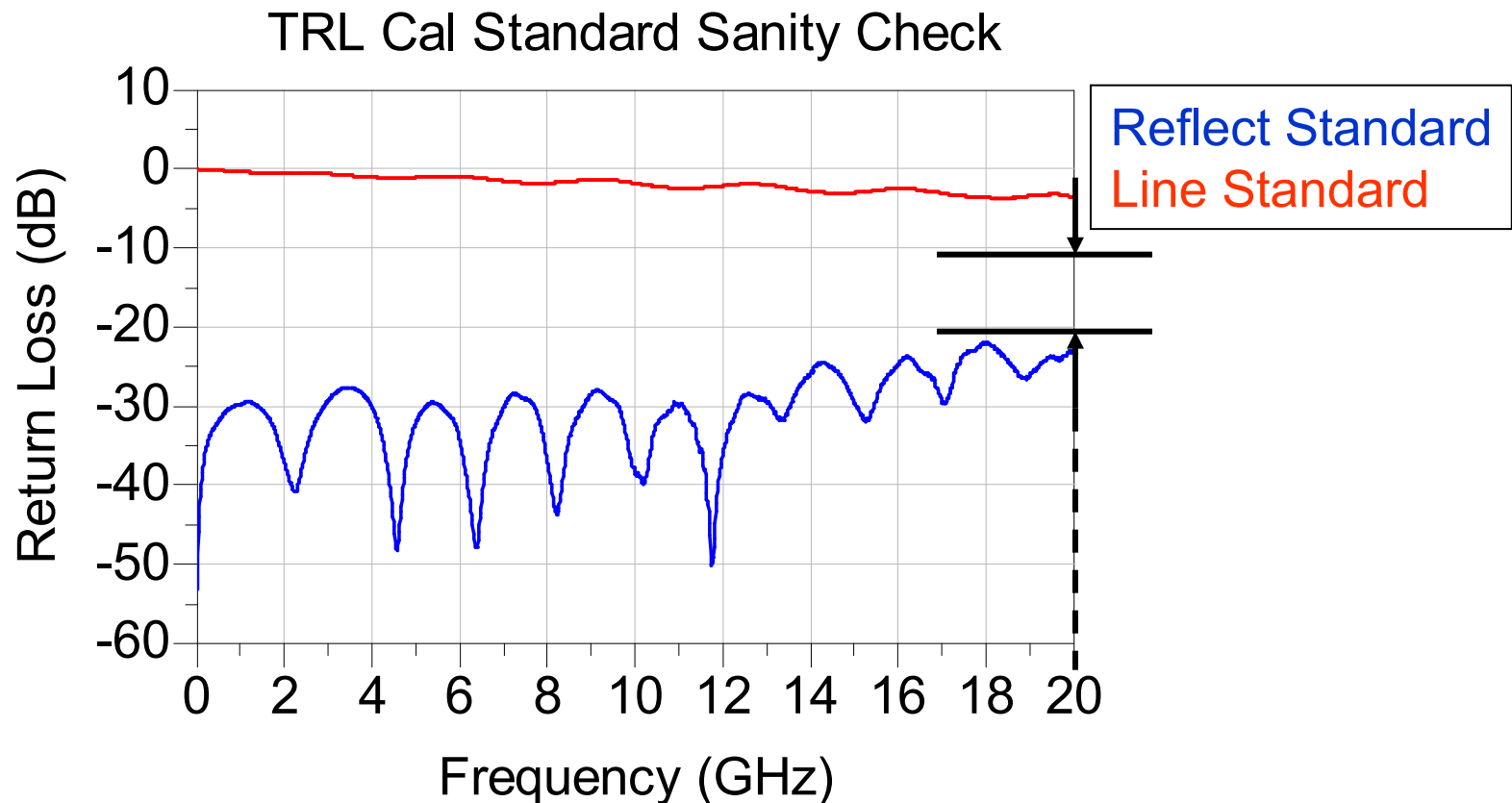


Data is representative but not sufficient for channel simulations

Connector Measurements (Microprobe VNA measurements)

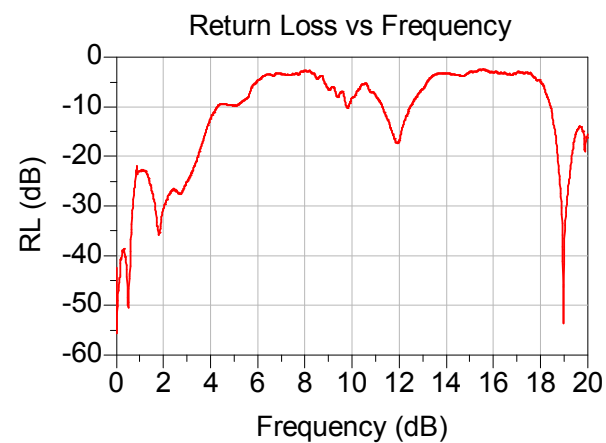
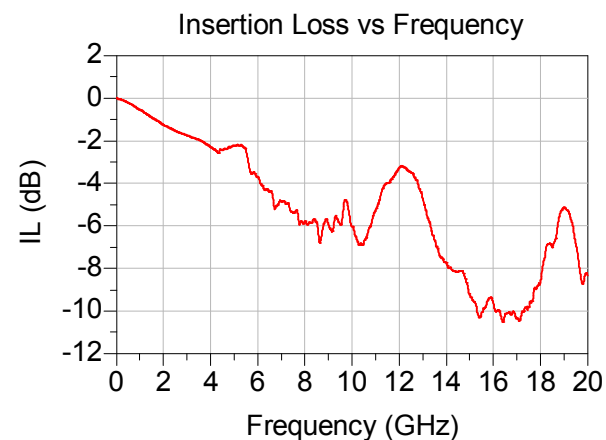
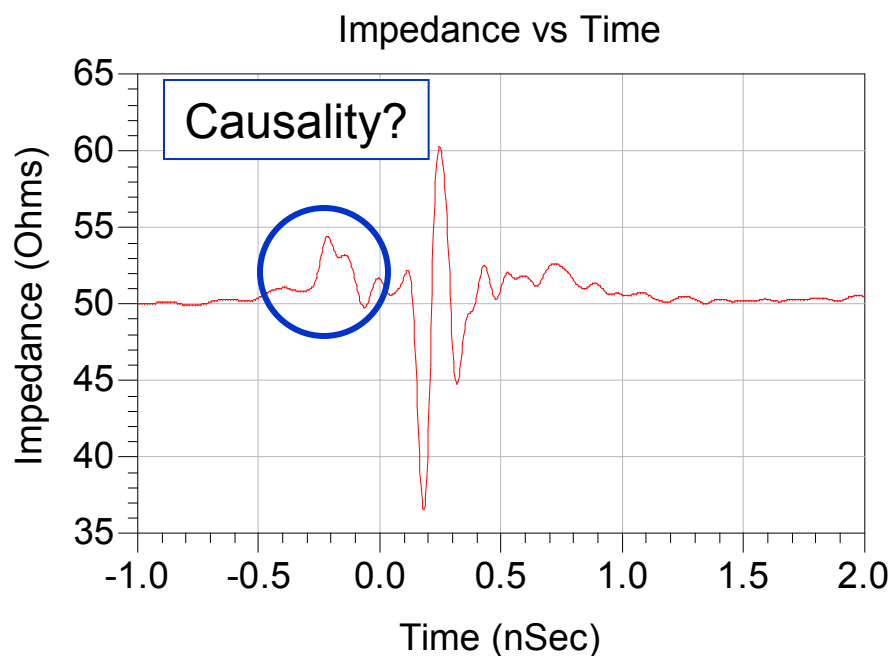


TRL Sanity Check



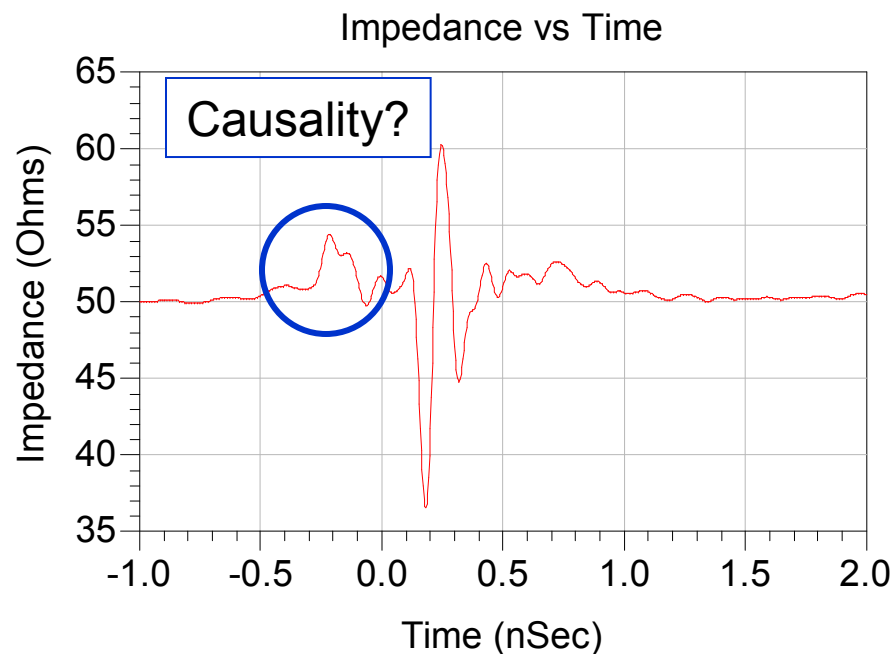
Goal is to have 5-10 dB of separation in return loss between the reflect and line standards. Expect data to be “good” to >20 GHz

Connector Measurements (Microprobe TRL VNA Measurements)

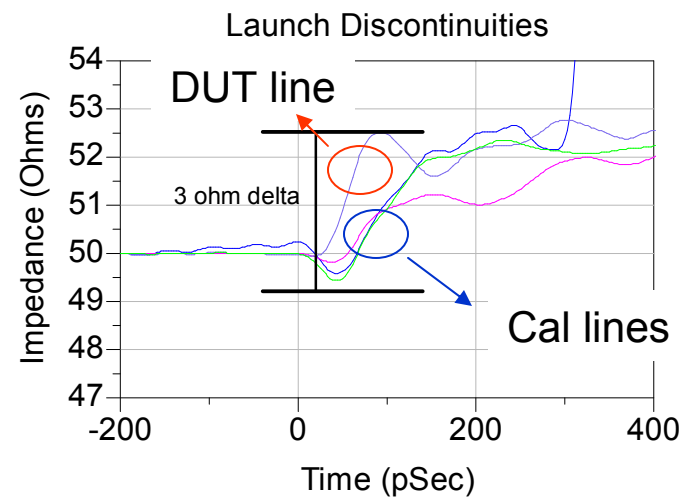
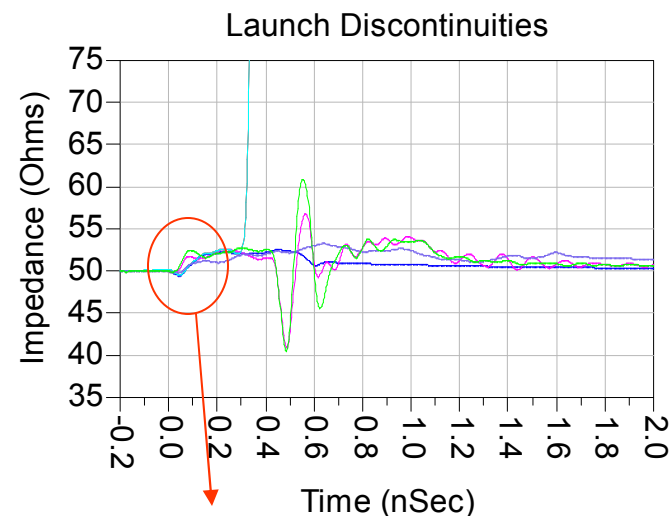


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Causality Issue

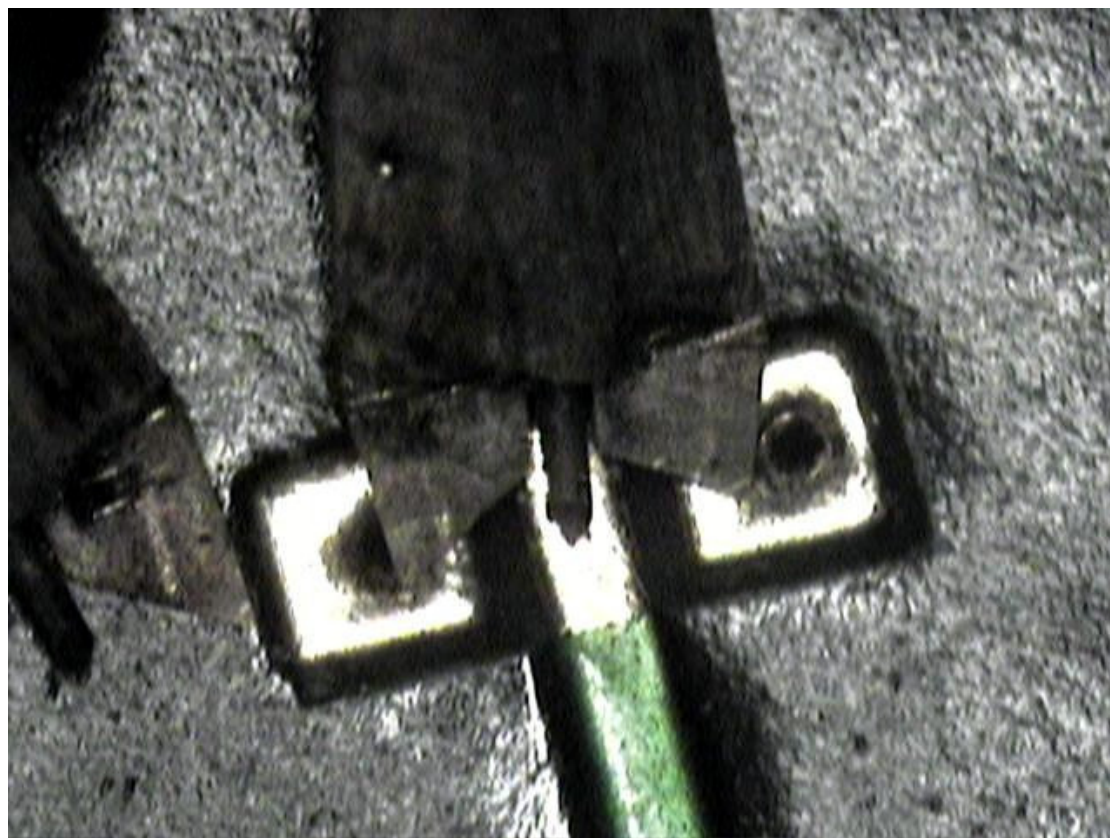


TRL cal lines have different impedance profile than connector test lines resulting in non-causal reflection term



SOLT measure of cal lines and DUT

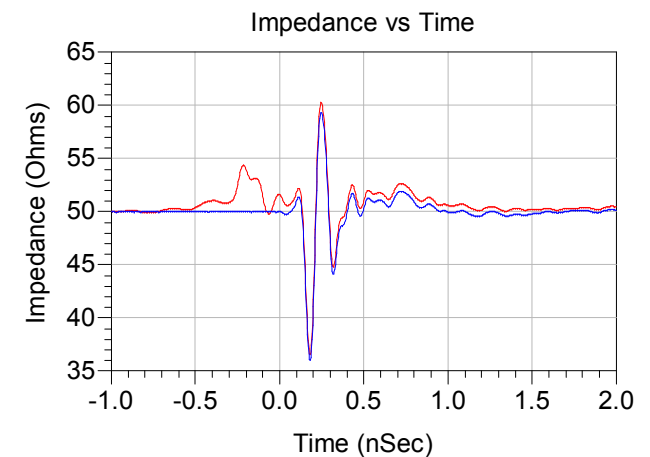
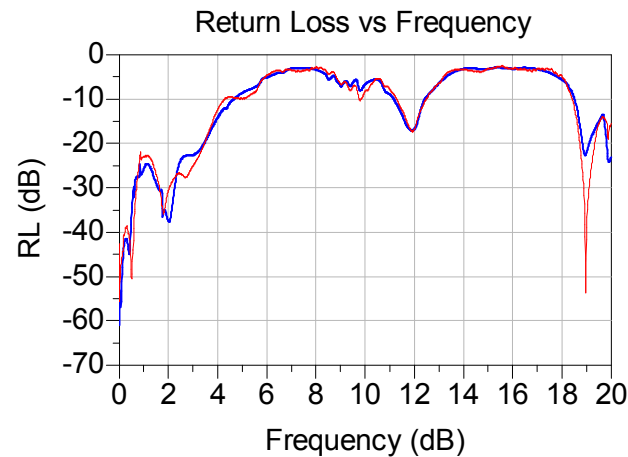
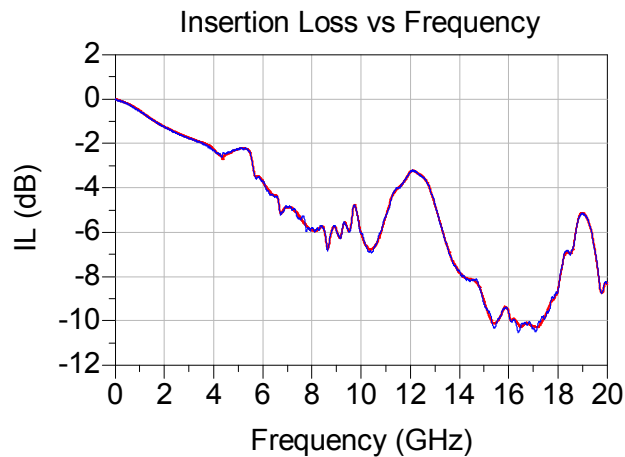
Causality Issue



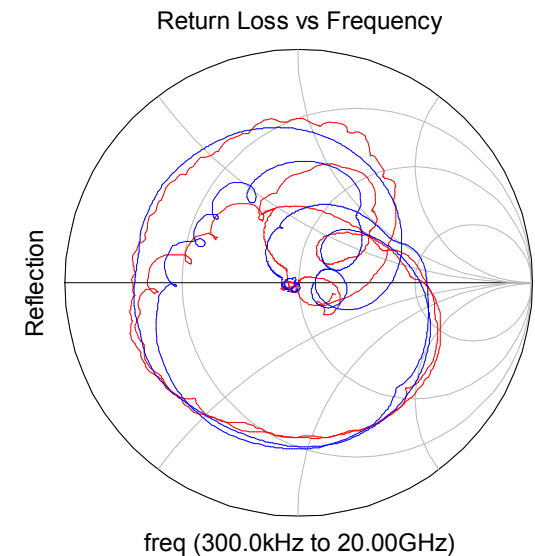
Where you make attachment to the microprobe target matters!

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