Direct Fixture De-embedding (DFD)

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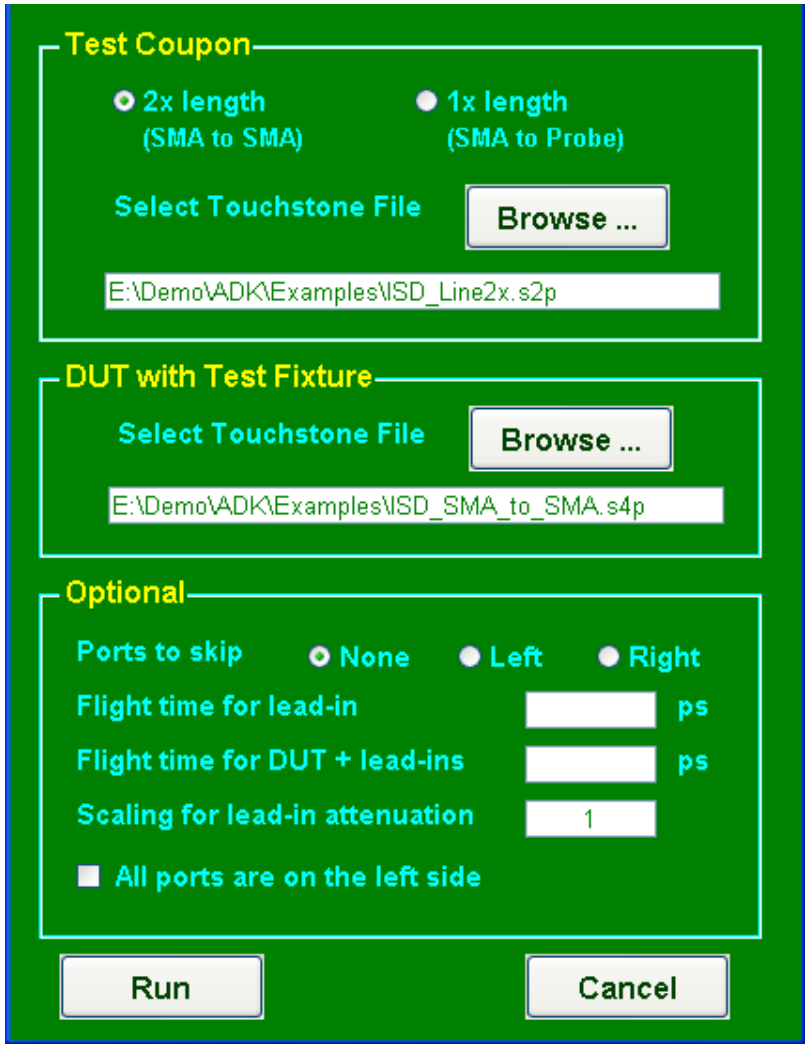
TRL Calibration Replacement

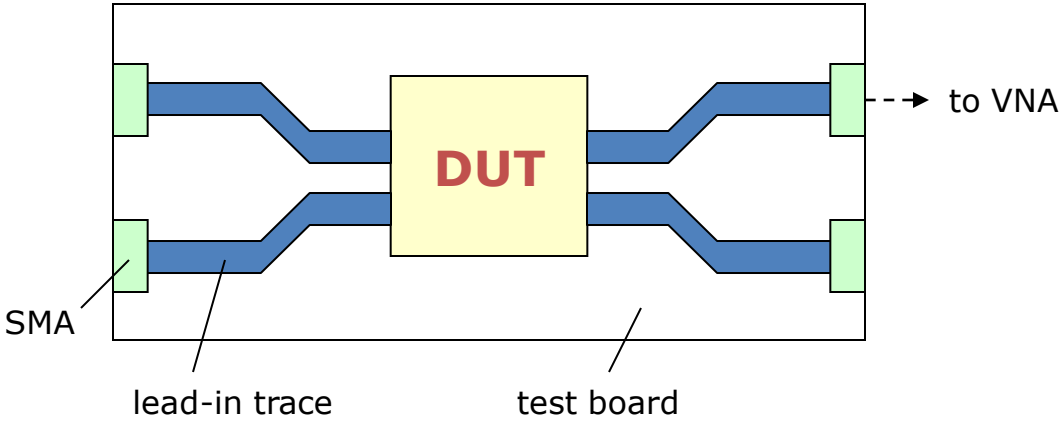


- Patent-pending de-embedding tool to replace TRL calibration
- Save SMAs, board material, and time
- Remove crosstalk from fixture and give causal DUT results

HSDC

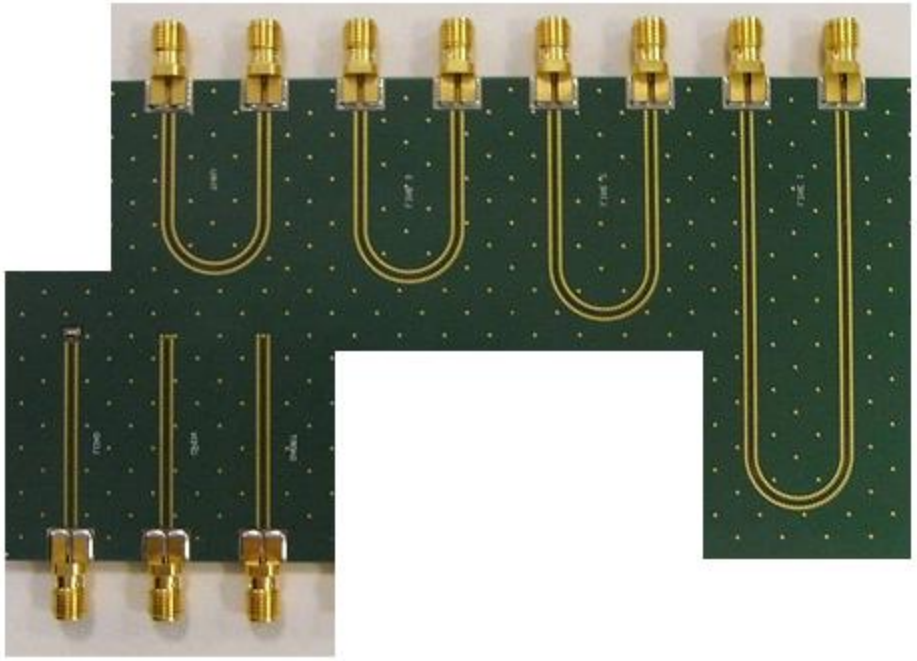
Objective

- The goal is to remove the effect of test fixture (SMA connector + lead-in trace) and extract the S parameters of DUT (device under test).

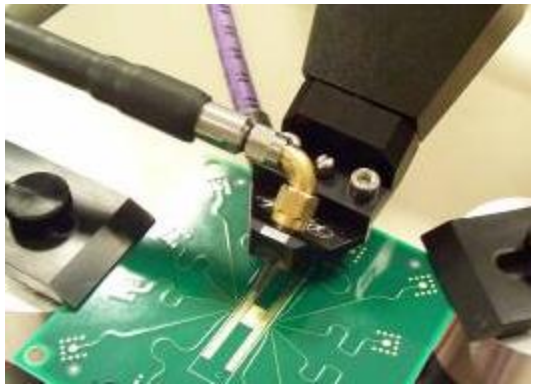


Prior Arts

- The TRL (Thru-Reflect-Line) calibration or direct de-embedding with bare board measurement data has many problems.



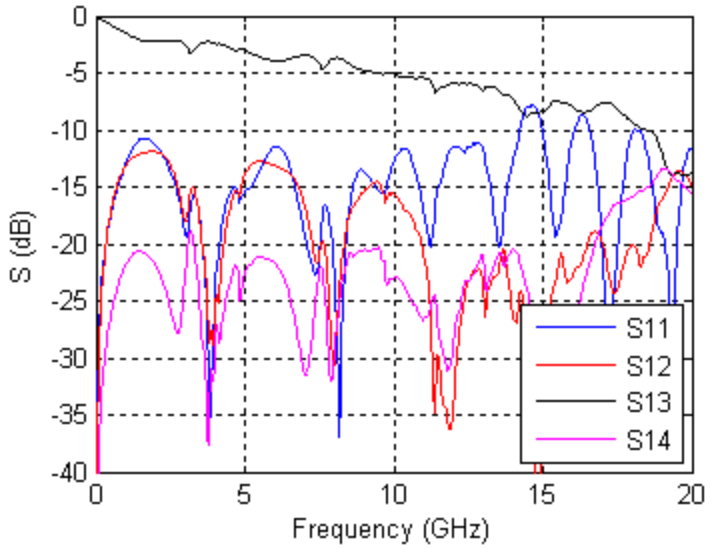
TRL calibration board



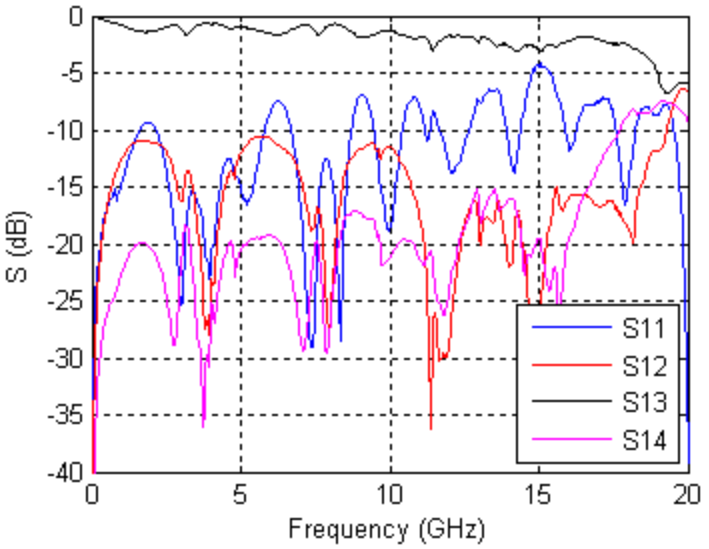
Bare board measurement

TRL Calibration

- Attempt to remove the fixture effect.



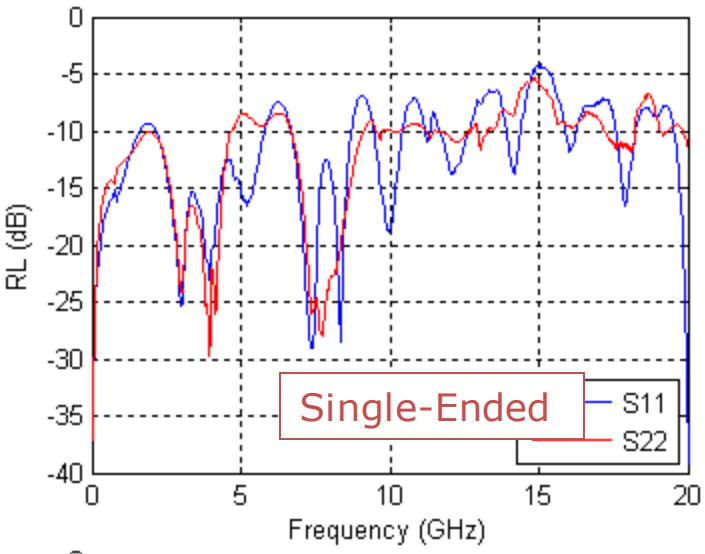
SMA to SMA

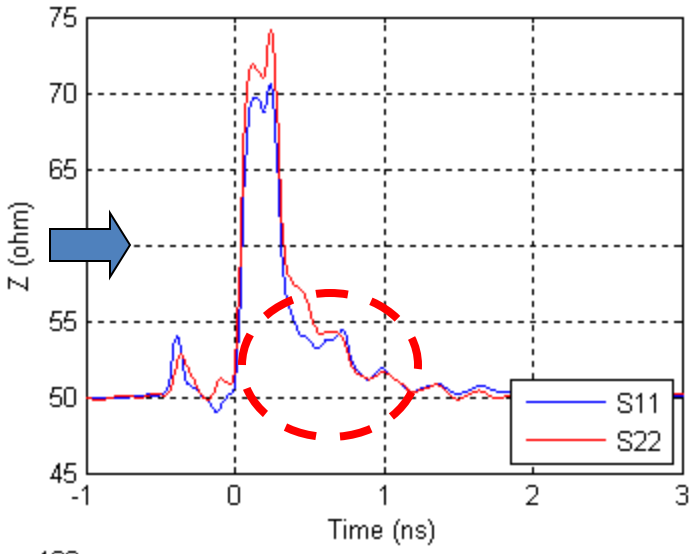


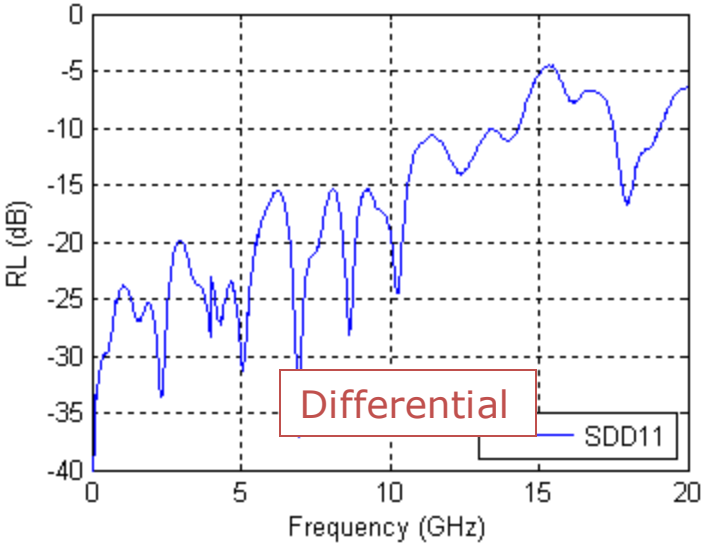
After TRL

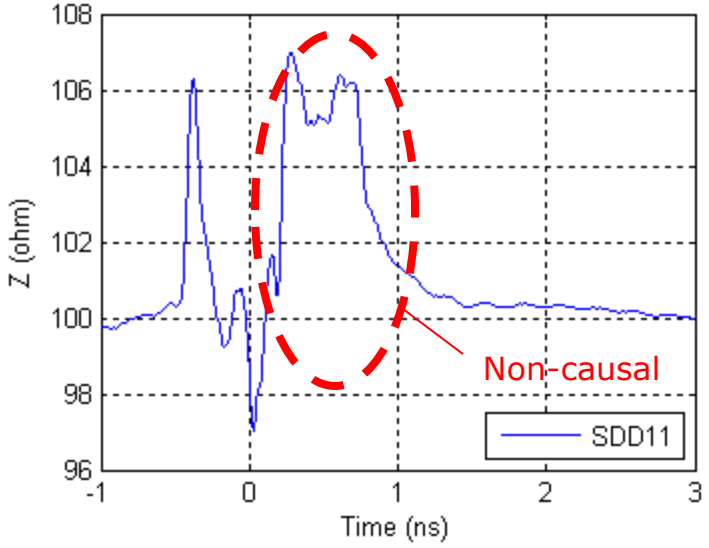
- But, is this correct?

Converting TRL results into time domain shows non-causal response







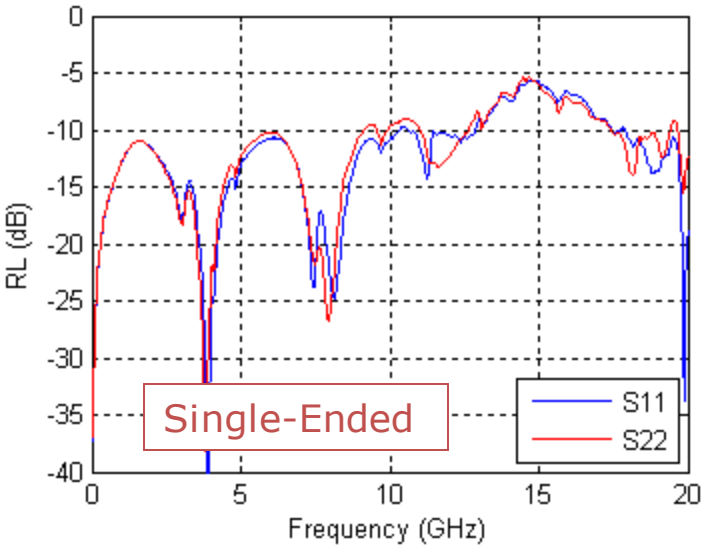


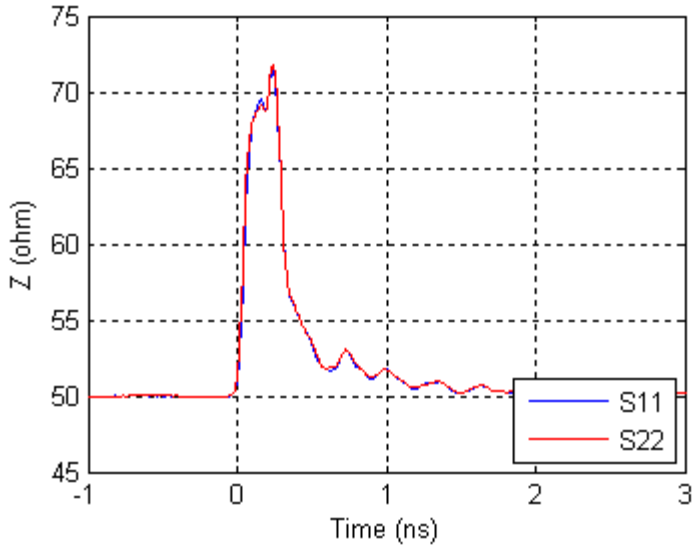
De-embedding Reference

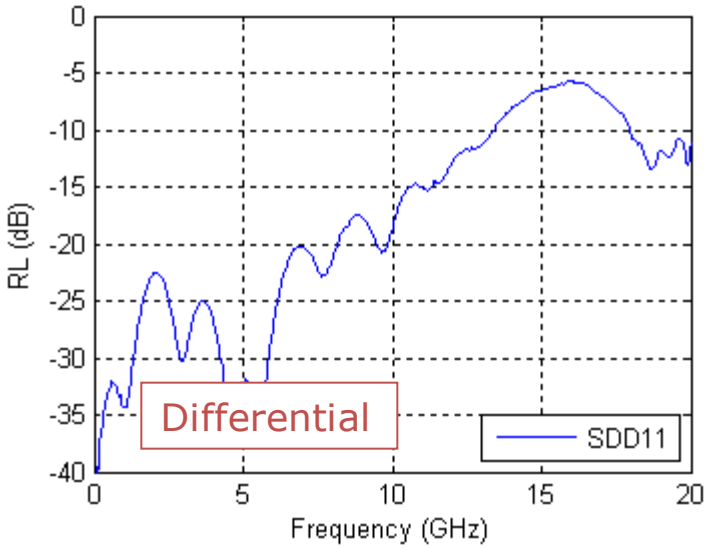
- Only one through test coupon is needed.

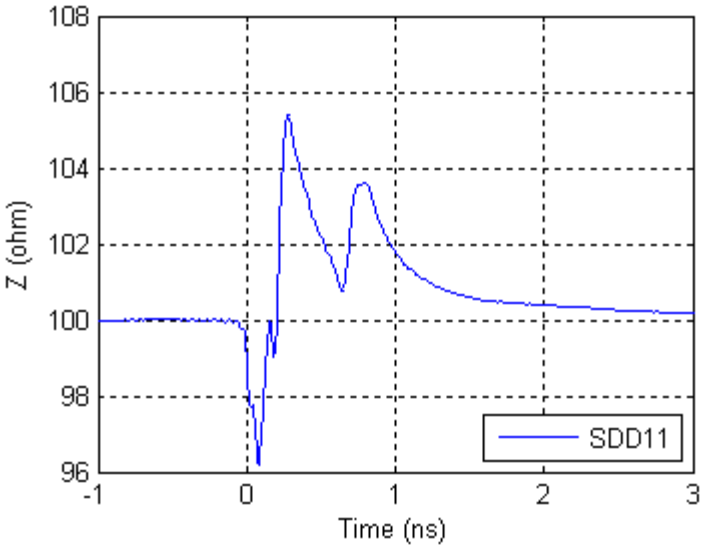
test coupon

DUT model extracted by Direct is causal

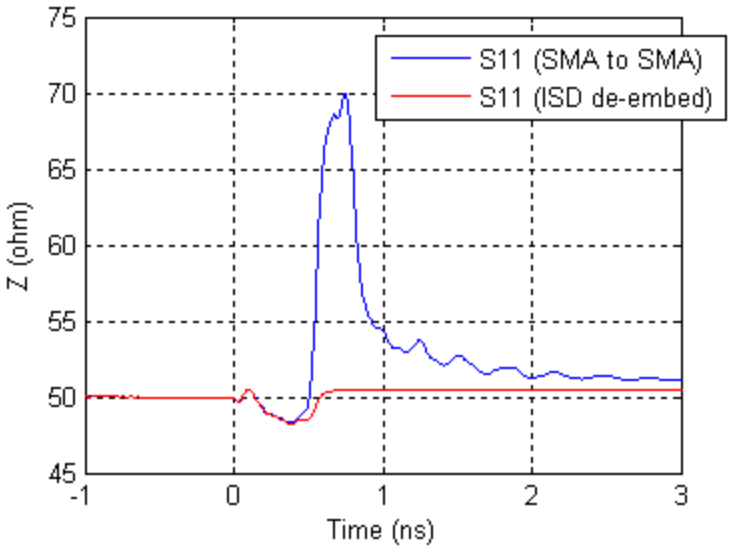




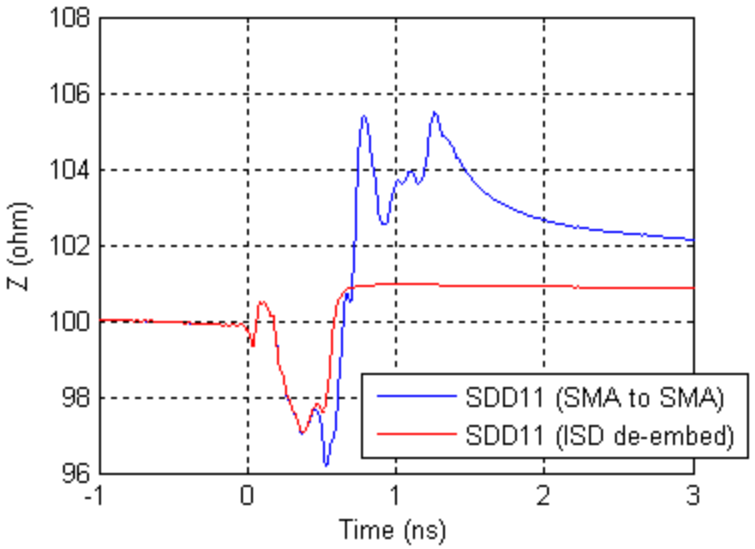




de-embeds exactly the same lead-in impedance



Single-ended



Differential

More Accurate and Simpler

TRL Calibration	Bare Board De-Embedding	DFD De-Embedding
Inaccurate	**Inaccurate**	**Accurate**
Unable to remove coupling	Difficult to de-embed probe pads and remove coupling between probe pads	Able to remove coupling among lead-in traces
	SMA and trace's electrical behaviors change after DUT is mounted and reflowed	
Lead-in traces near DUT see different environment in TRL calibration board vs. test fixture with DUT mounted	Lead-in traces near DUT see different environment in bare board vs. final test board with DUT mounted	Lead-in traces near DUT are de-embedded exactly with effect of DUT accounted for
Non-causal	Non-causal	Causal
Difficult	**Time-consuming**	**Simple**
Many test coupons	Need to use microwave probes	Only one through trace for test coupon
	Cannot mount DUT until bare board measurement is done	1X test trace can also be used for BGA package extraction, etc.
Expensive	**Expensive**	**Inexpensive**
High quality calibration and test boards and SMAs	May need to use expensive re-usable SMAs to minimize reflow problems	FR4 boards and inexpensive SMAs can be used
Tight etching tolerance		Loose etching tolerance