Feasibility of a 3m DAC Link Without FEC

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Supporters

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Observations & Objectives

Observations

- Allowing for no-FEC operation complicates PHY naming and AN issues
- Some server NIC designs will not need the full 6.81 dB host loss budget in the spec
- Switch designs that support 100G and breakout to 25G must work within 6.81 dB host loss
- Recently contributed results with 3m cables are close to passing COM

Questions to address with this study

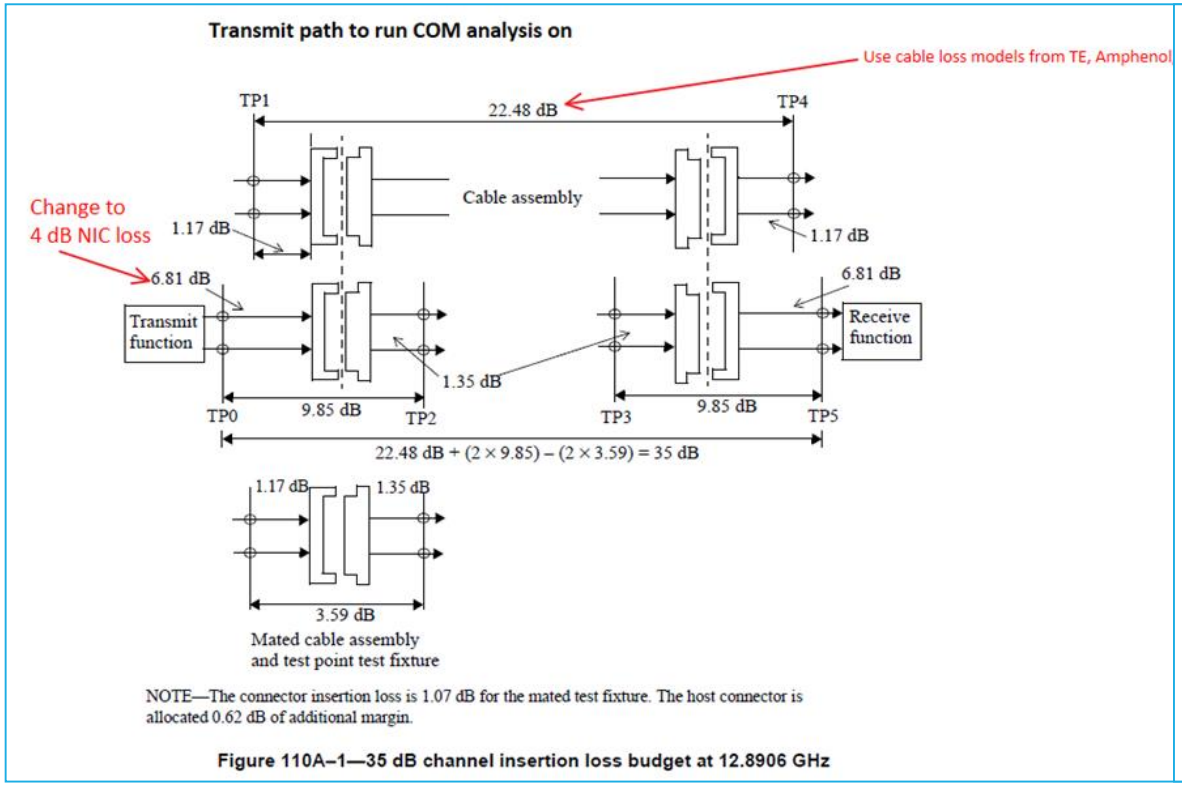
- Is it possible to meet COM with a 3m cable by restricting host loss on only one end of the link?
- If so, what is the resulting server side host loss budget?
- Is it feasible to meet this loss with realistic PCB construction?

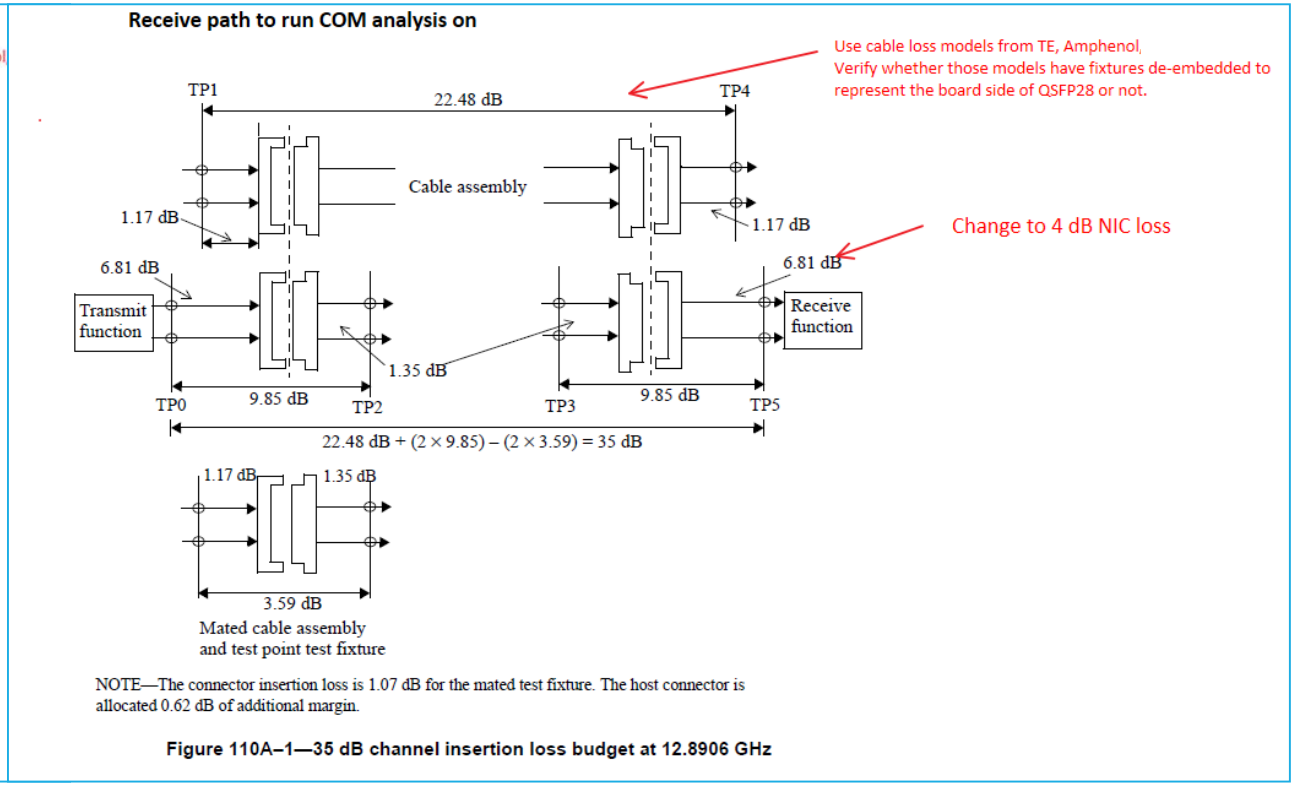
- Note: Intent is not to propose an asymmetric host loss budget in the standard. Additional data offered for possible use in discussions about PHY types.

Methodology

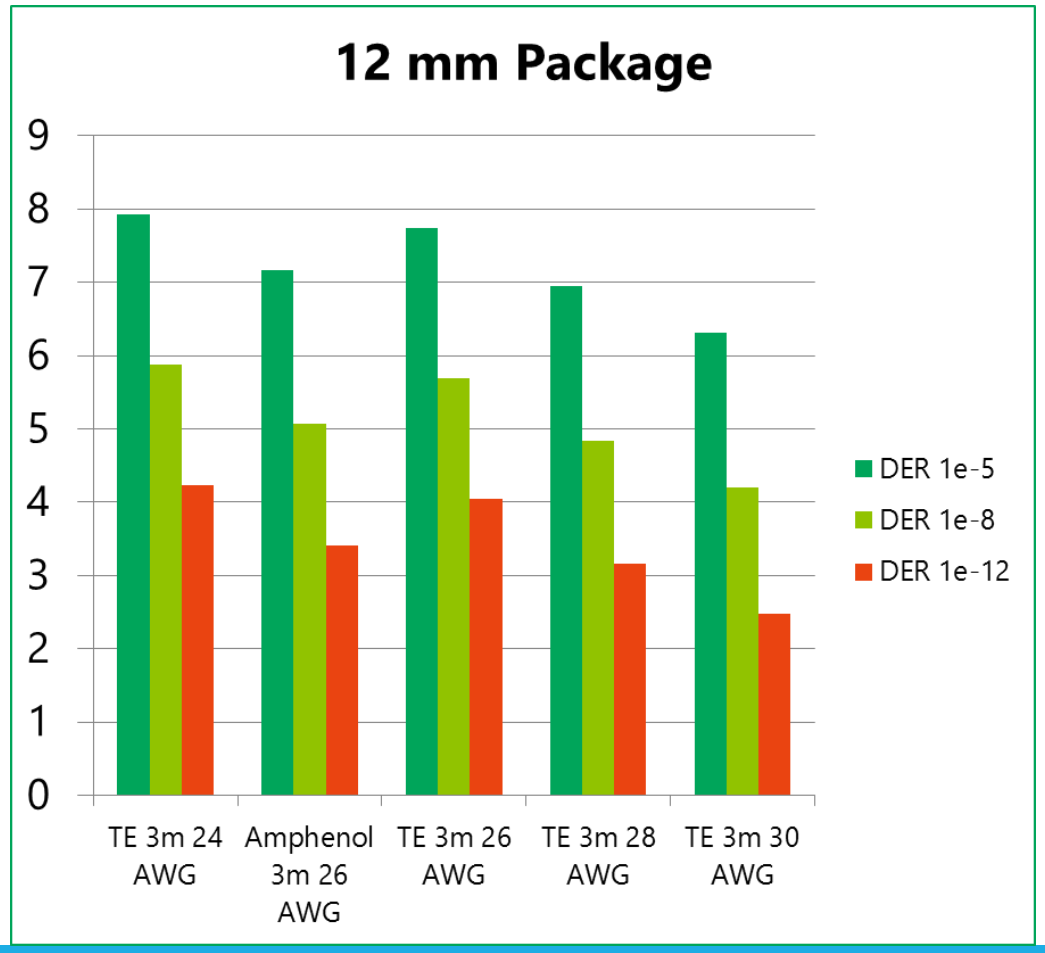
1. Use contributed cable assembly s-parameter data & standard COM tool.
2. Start with a NIC side host loss of 4 dB (3.45 dB for non-de-embedded cable model).
3. Calculate COM using 3m cable models for DER 1e-5, 1e-8 and 1e-12.
4. Verify COM in both directions on breakout cable assemblies
5. Sweep NIC side host losses to find required length to pass COM.
6. Compare simulated board channel to losses in step 2

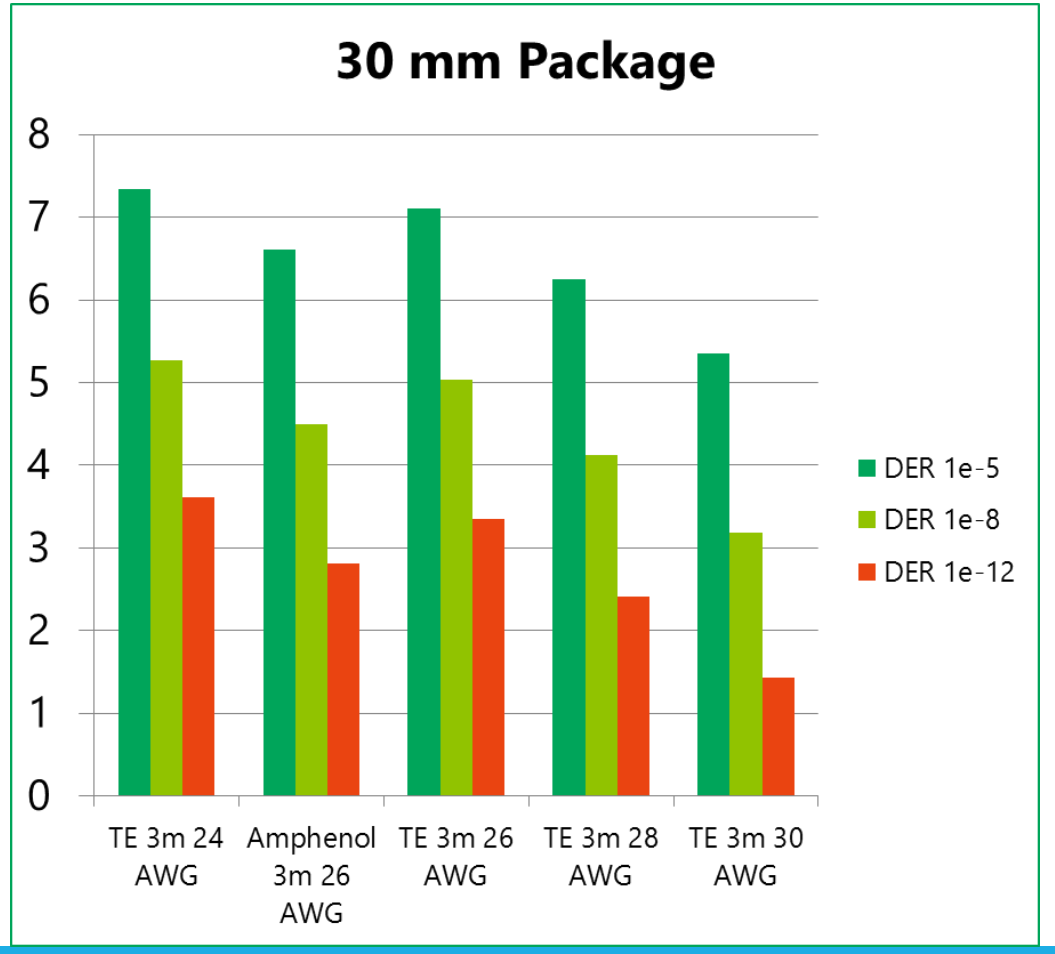
Overall Simulation Topology



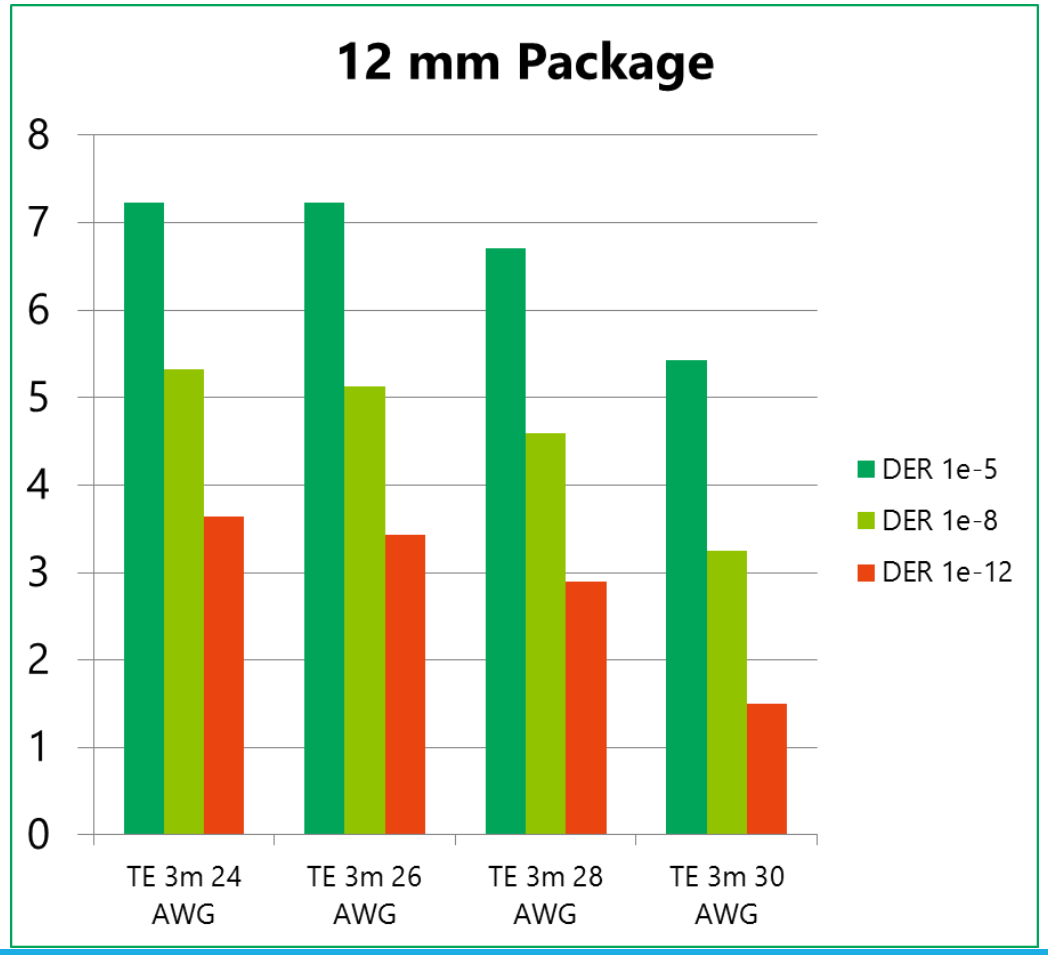


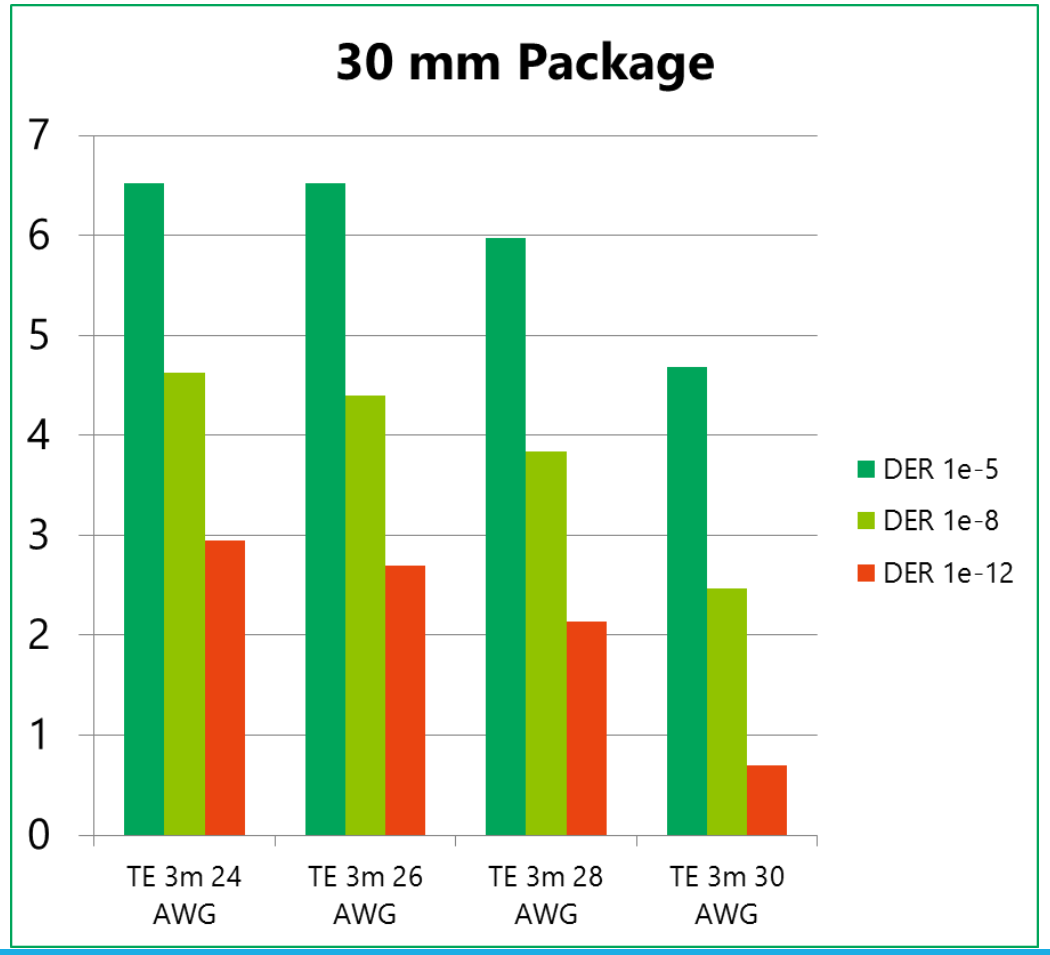
COM for Five Cables - NIC TX to Switch RX





COM for Four Cables – Switch TX to NIC RX





How can we pass COM by adjusting NIC loss?

NIC TX Case

Failing cables:

- Amphenol 26 AWG
- TE 28 & 30 AWG

Cable	Original NIC Loss	Original COM	Improved NIC Loss	Improved COM
Amp. 26 AWG	-3.45 dB	2.816	-1.60 dB	3.012
TE 28 AWG	-3.45 dB	2.415	-1.45 dB	3.007
TE 30 AWG	-3.45 dB	2.481	No passing results	

NIC RX Case

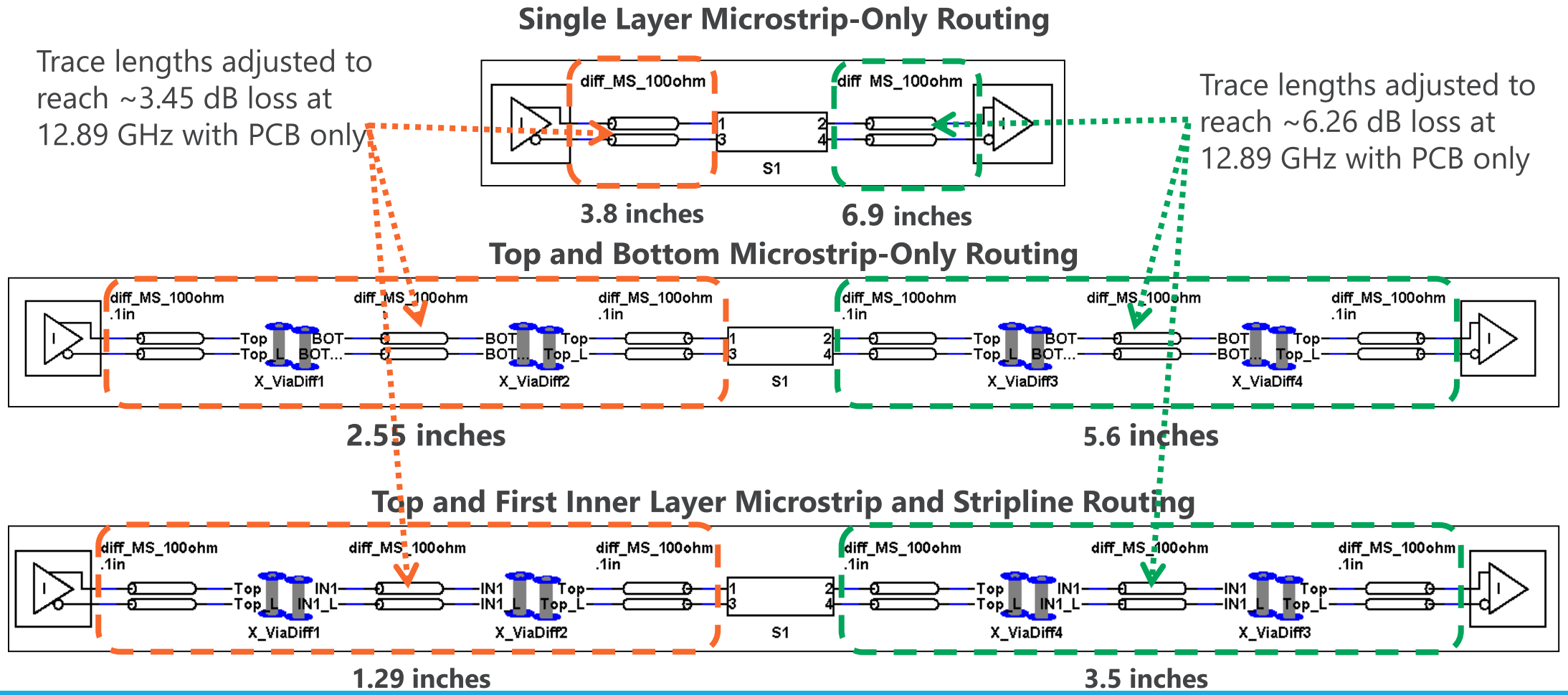
Failing cables

- TE 24, 26, 28 & 30 AWG

Cable	Original NIC Loss	Original COM	Improved NIC Loss	New COM
TE 24 AWG	-3.45 dB	2.945	-3.11 dB	3.033
TE 26 AWG	-3.45 dB	2.692	-1.66 dB	3.022
TE 28 AWG	-3.45 dB	2.895	No passing results	
TE 30 AWG	-3.45 dB	1.495	No passing results	

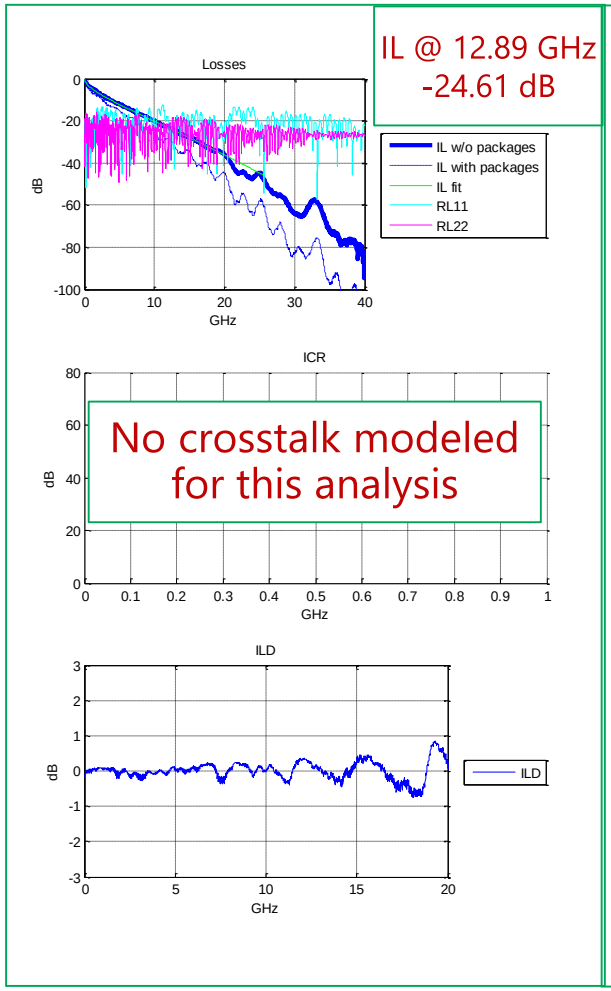
*Only 30 mm package results shown (worst case)

Simulation PCB Topologies

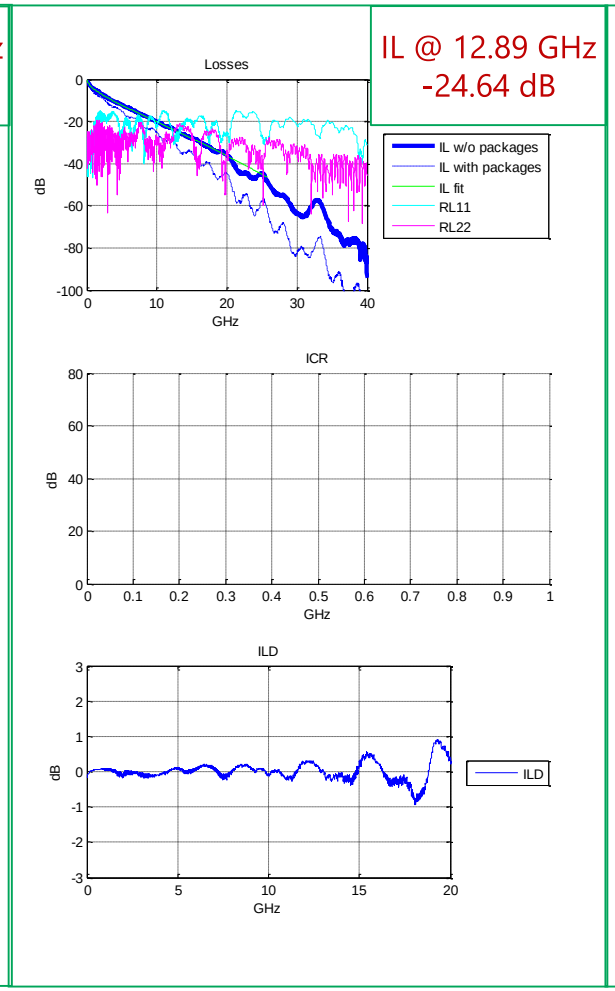


Amphenol 3m Cable with PCB models

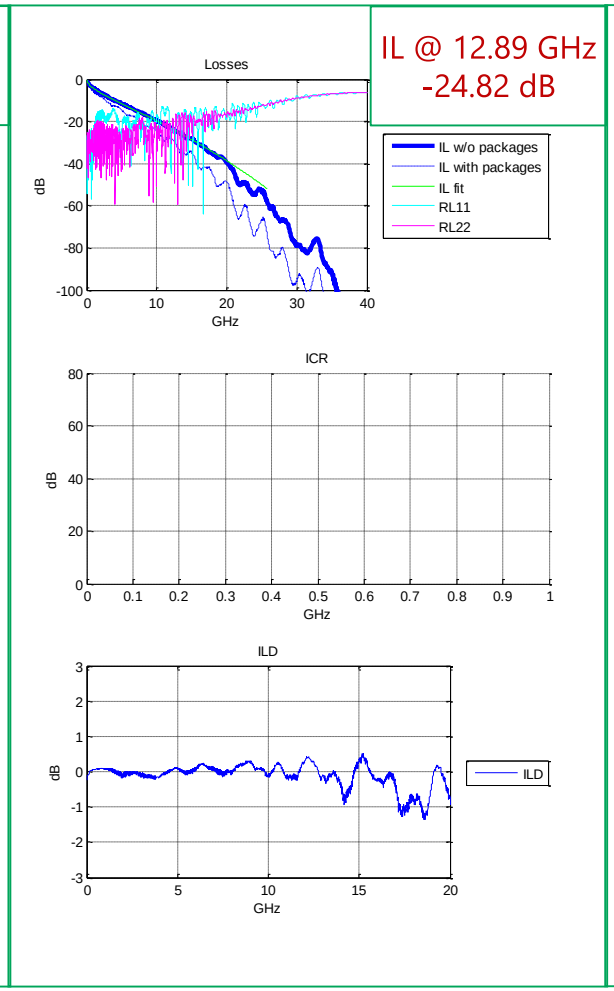
Default COM PCB Loss



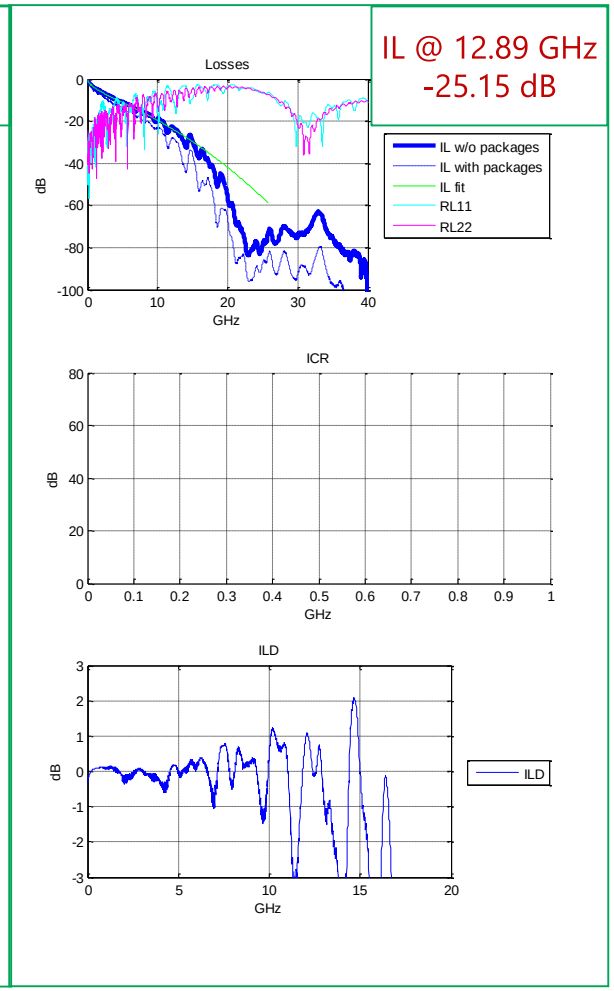
Single Layer Microstrip



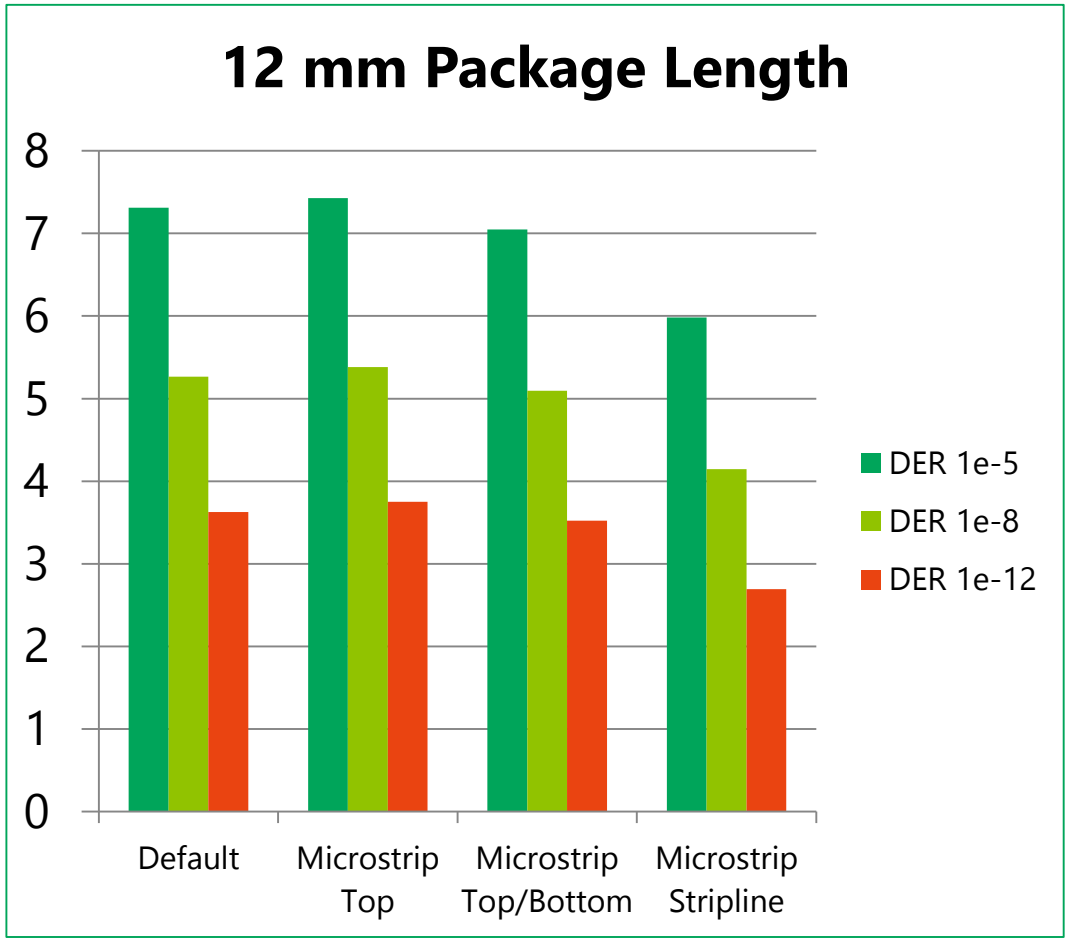
Top/Bottom Microstrip

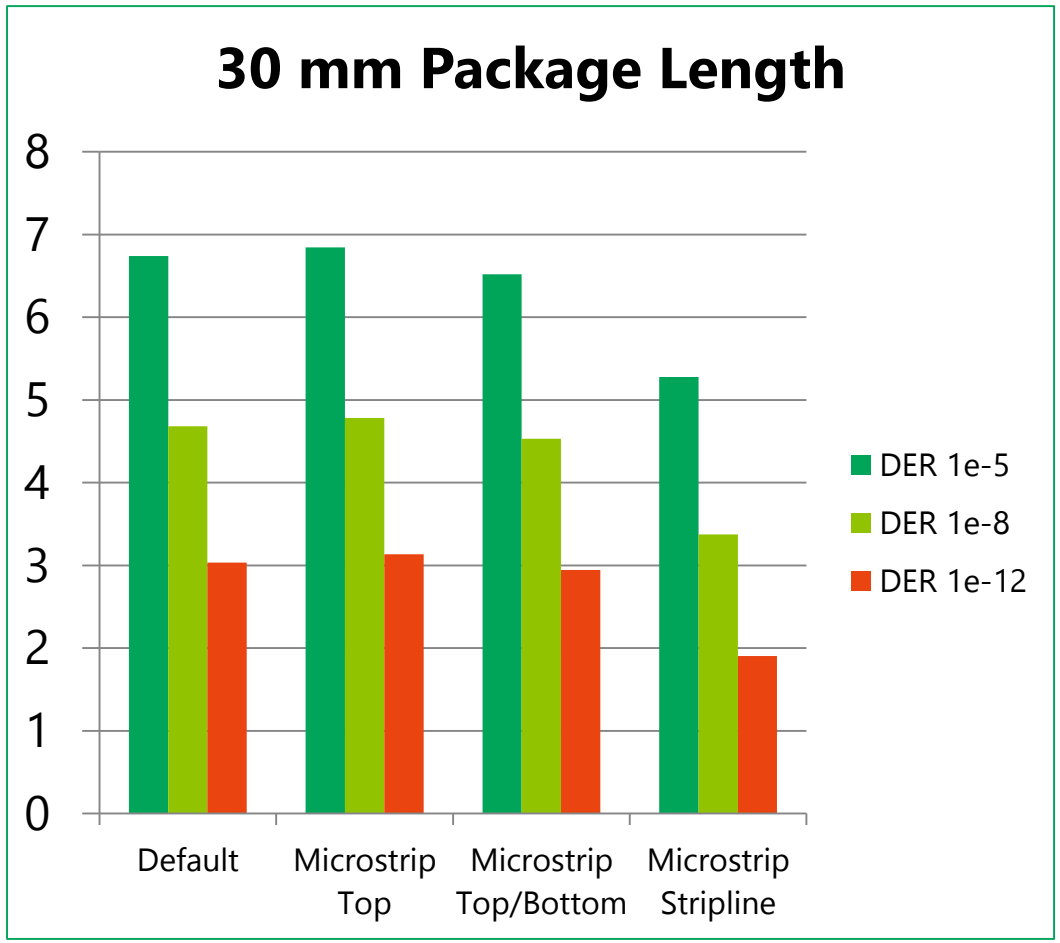


Microstrip and Stripline



COM for Topologies for NIC to Switch, Amphenol Cable





Comments

- Realistic NIC board geometries and careful routing can result in host losses well below the standard.
- Use of resulting NIC host losses can result in passing COM without FEC for some 3m cables.
  - Standard cable loss models still need to be evaluated.
- While primarily of interest in engineered solutions, this scenario reinforces the need to allow for no-FEC options in the PHY and AN definitions.

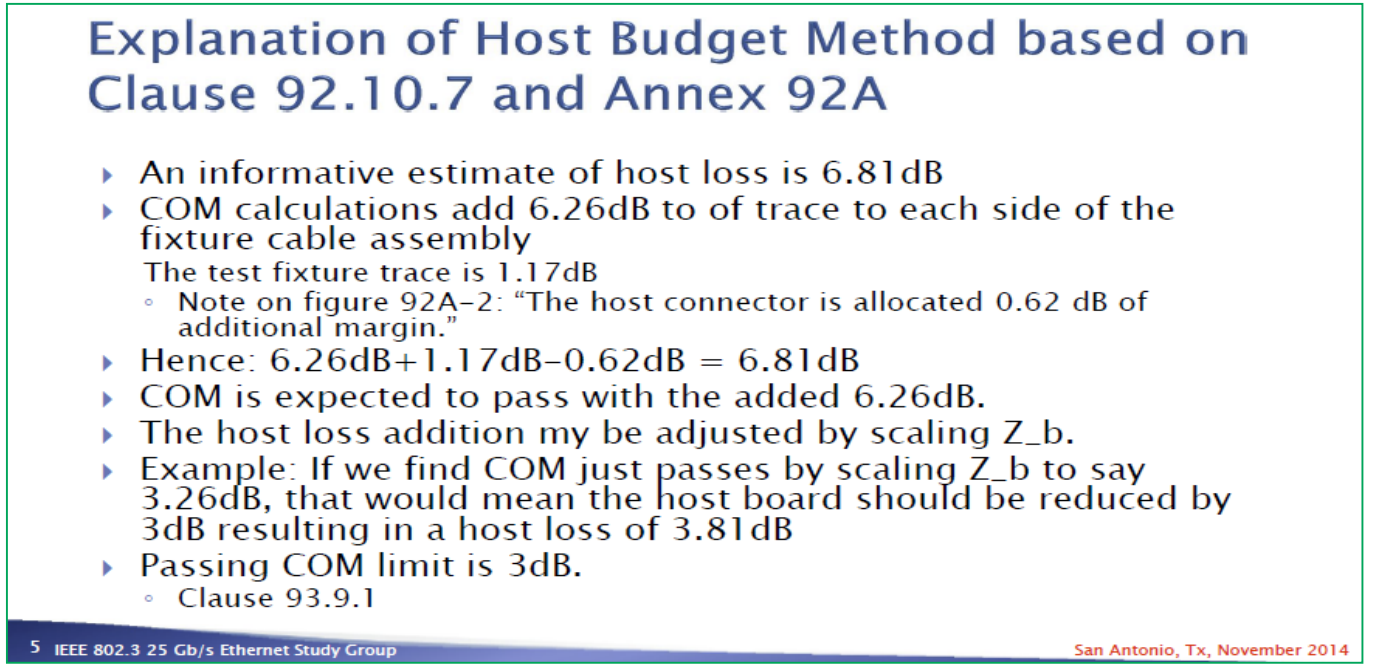
Backup material

Analysis Setup

- 3 m cable analysis for DER 1e-5, 1e-8, 1e-12
- NIC to switch topology
  - 4dB loss on NIC side
    - 3.45 dB for non de-embedded cable assembly models
  - 6.81dB loss on switch side
    - 6.26 dB for non de-embedded cable assembly models

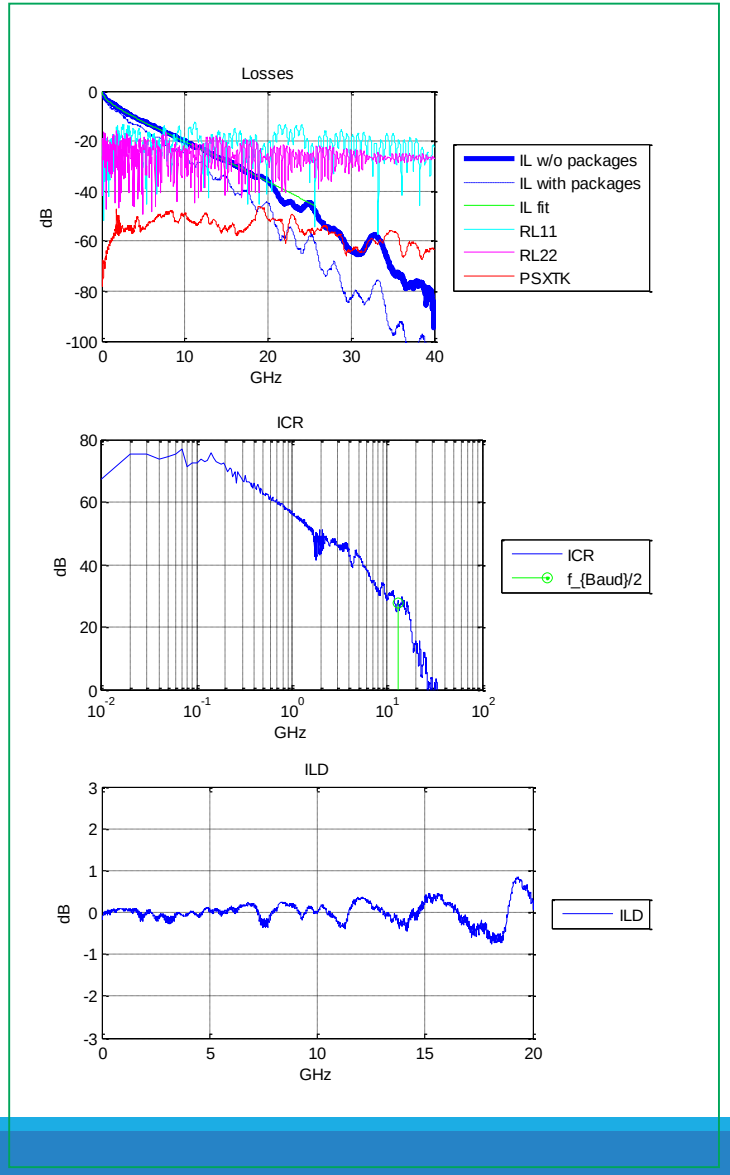
Analysis Setup

- No de-embedding; standard COM adjustment used
  - 6.81 dB – 1.17 dB + 0.62 dB = 6.26 dB
    - ref. Mellitz, Nov. 2014, "Channel Budgeting: dB or not dB"



Amphenol QSFP to 4SFP, 3 m, 26 AWG

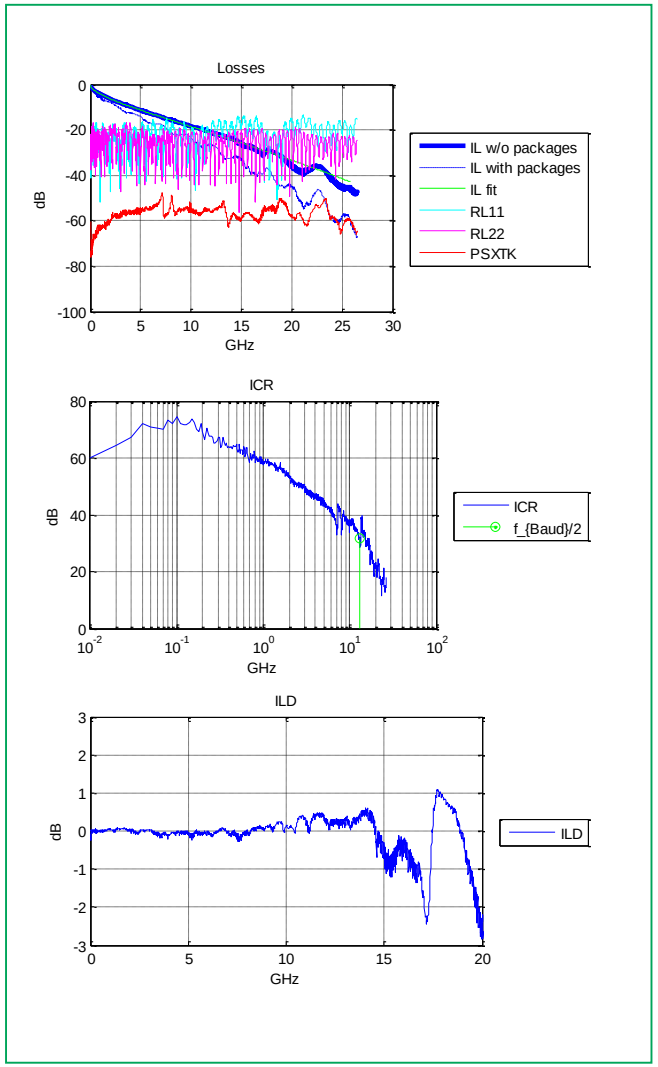
NIC TX to Switch RX



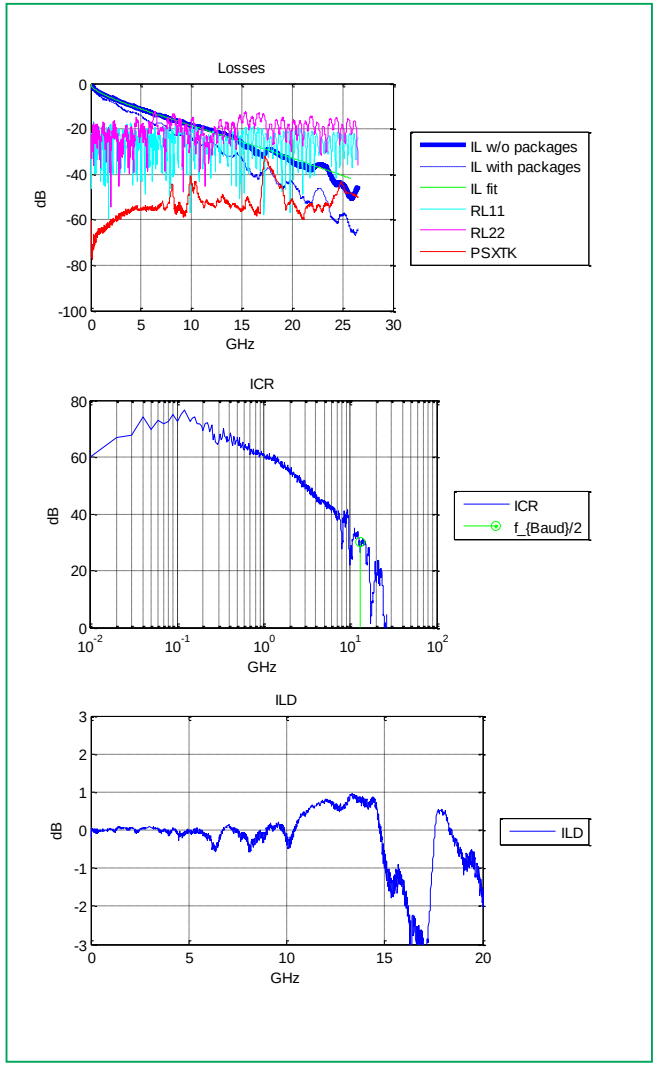
- No model for opposite direction

TE 3m 24 AWG

NIC TX to Switch RX

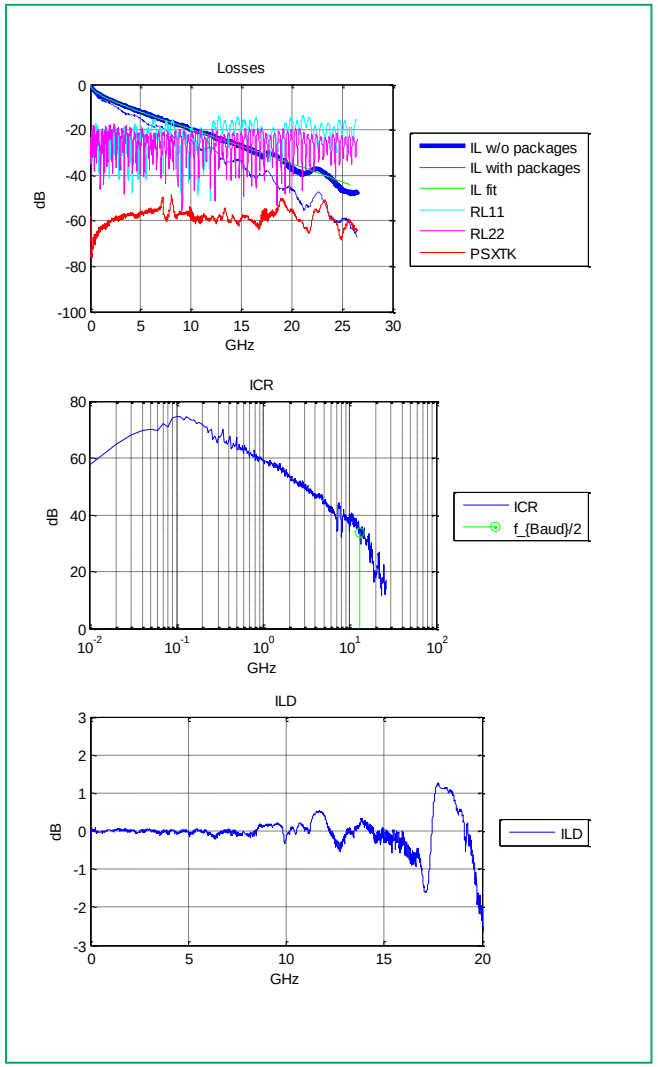


Switch TX to NIC RX

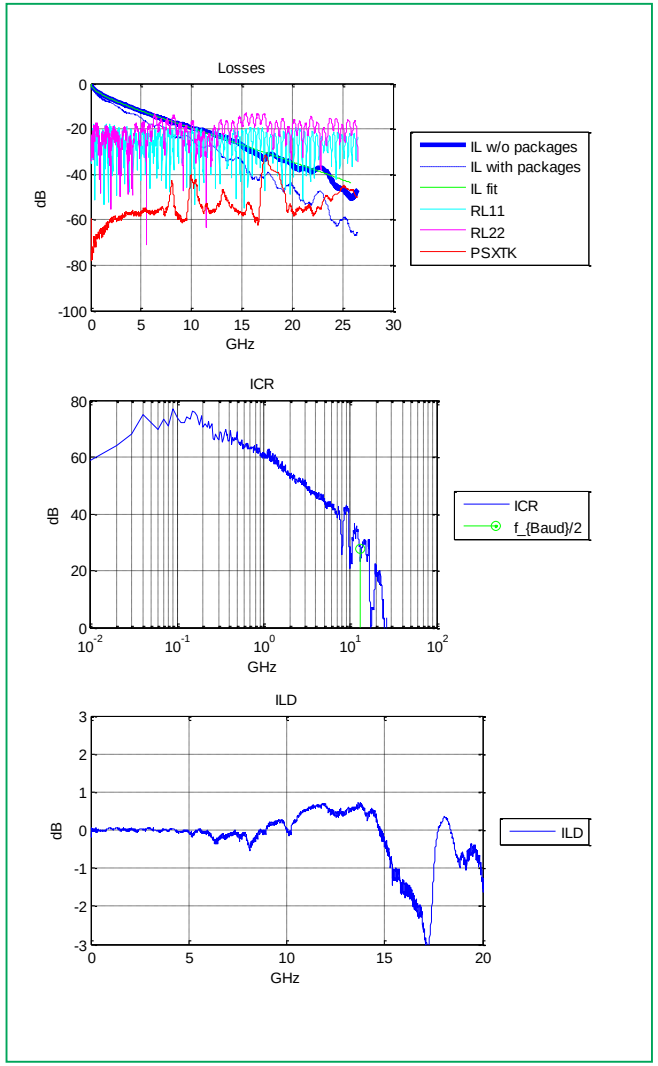


TE 3m 26 AWG

NIC TX to Switch RX

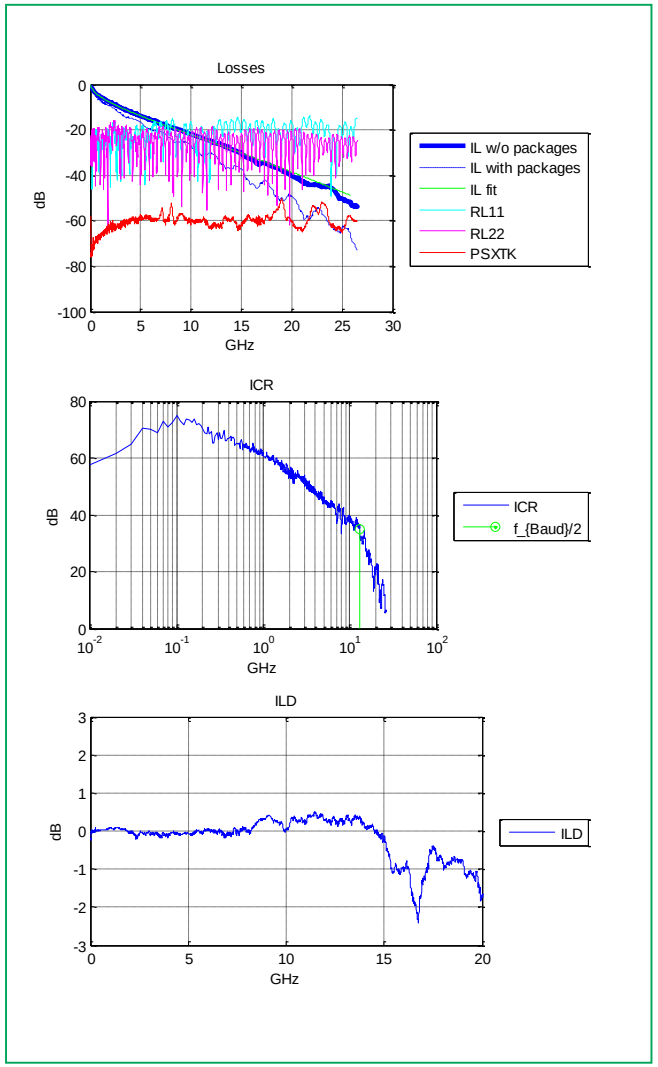


Switch TX to NIC RX

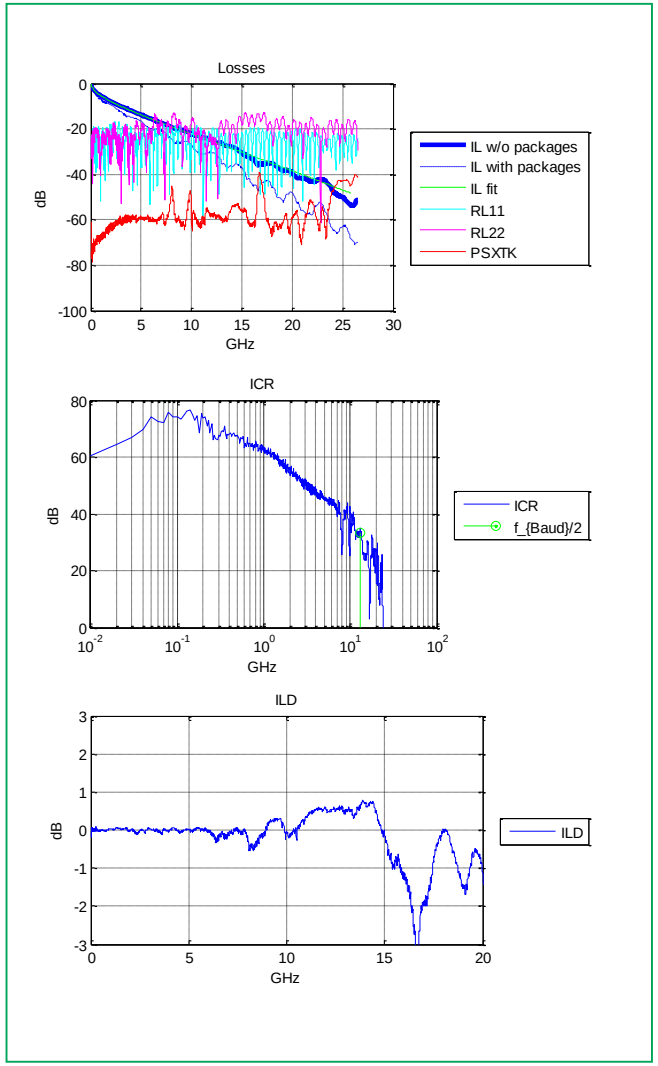


TE 3m 28 AWG

NIC TX to Switch RX

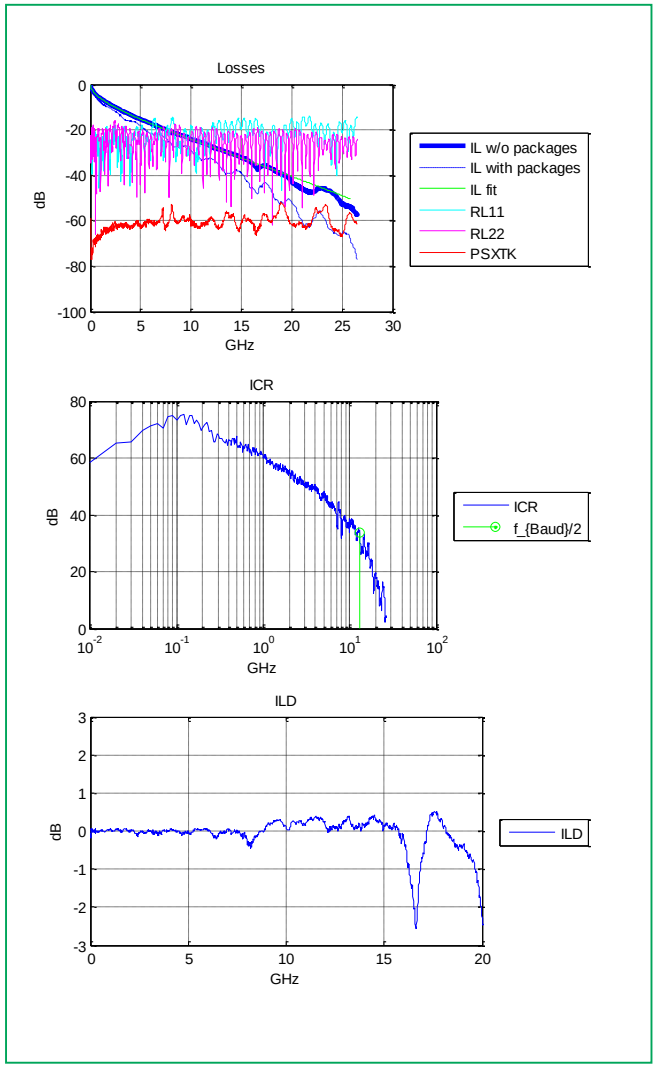


Switch TX to NIC RX

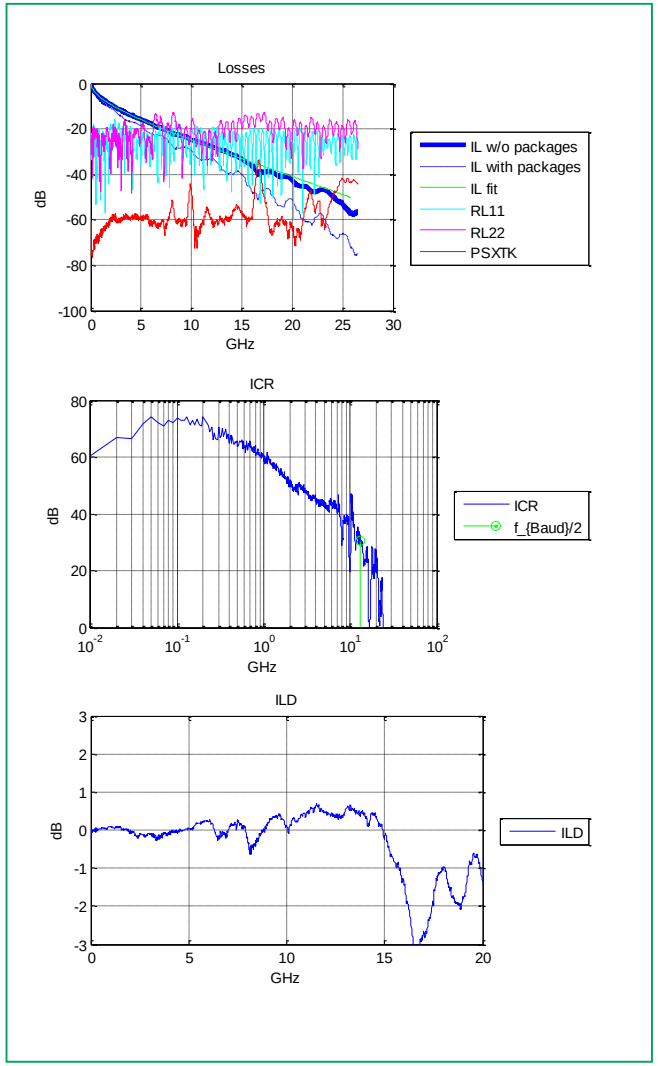


TE 3m 30 AWG

NIC TX to Switch RX



Switch TX to NIC RX



Simulation Setup

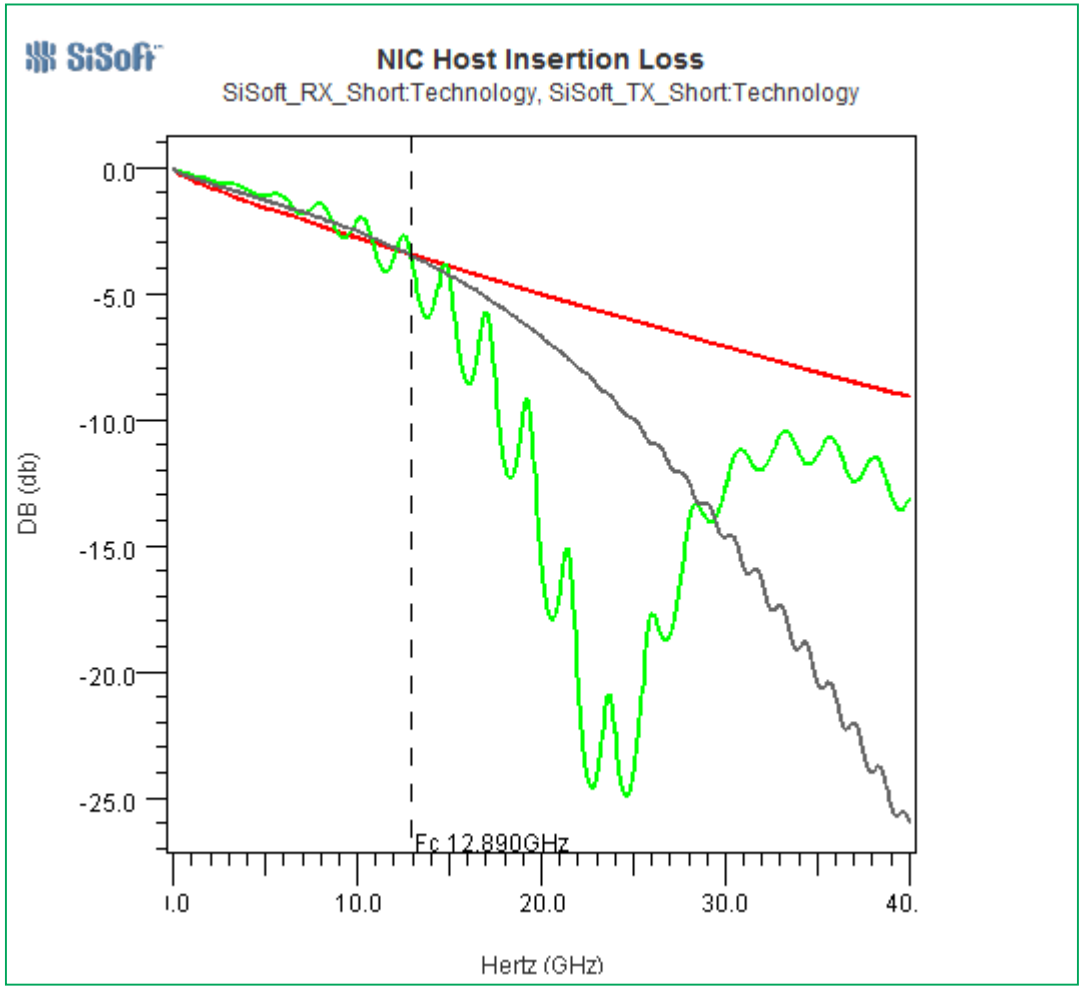
- Three topologies:
  - Single-layer microstrip routing
  - Top and bottom microstrip routing—no via stubs
  - Top and first inner layer microstrip and stripline routing—maximum length via stubs
- S-parameters generated from driver pins to receiver pins
  - Includes variety of cable assembly models
- No crosstalk included

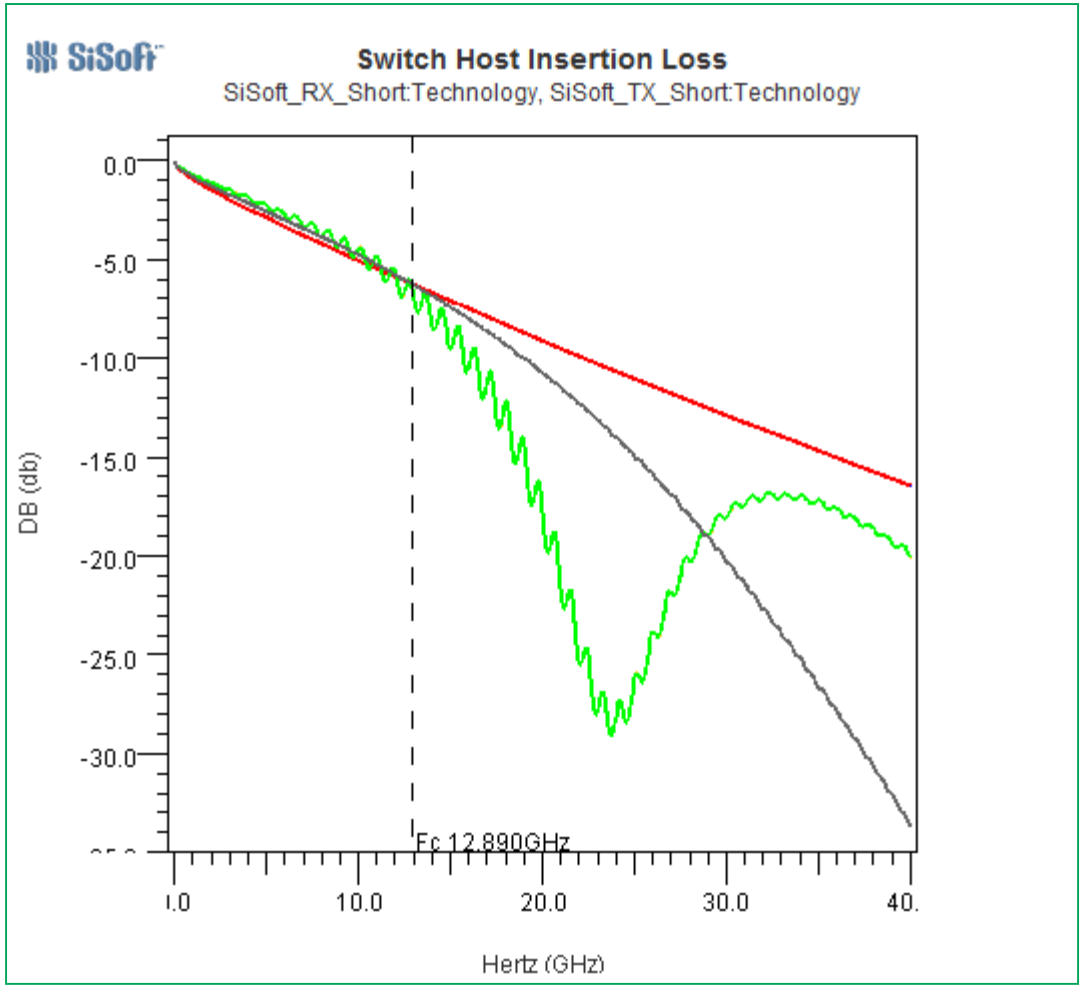
Stackup

Routing layer →
Routing layer →
Routing layer →

Layer	Lyr Type	Finished Cu Wt	Thickness(mils)	Er	Dk
		Soldermask	0.50	3.4	0.0095
1	TOP	0.5 oz+Platting	1.9		
		Prepreg	2.90	3.3	0.0095
2	GND1	0.5 oz	0.65		
		Core	3.00	3.3	0.0095
3	IN1	0.5 oz	0.65		
		Prepreg	5.00	3.4	0.0095
4	GND2	0.5 oz	0.65		
		Core	3.00	3.3	0.0095
5	IN2	0.5 oz	0.65		
		Prepreg	5.00	3.4	0.0095
6	GND3	0.5 oz	0.65		
		Core	3.00	3.3	0.0095
7	VCC1	1 oz	1.30		
		Prepreg	5.00	3.4	0.0095
8	VCC2	1 oz	1.30		
		Core	3.00	3.3	0.0095
9	GND4	0.5 oz	0.65		
		Prepreg	5.00	3.4	0.0095
10	IN3	0.5 oz	0.65		
		Core	3.00	3.3	0.0095
11	GND5	0.5 oz	0.65		
		Prepreg	5.00	3.4	0.0095
12	IN4	0.5 oz	0.65		
		Core	3.00	3.3	0.0095
13	GND6	0.5 oz	0.65		
		Prepreg	2.90	3.3	0.0095
14	BOT	0.5 oz+Platting	1.9		
		Soldermask	0.50	3.4	0.0095
Total Thickness			62.70		

PCB Topology Insertion Loss





Microstrip Only **Microstrip Top/Bottom (No Stubs)** **Microstrip and Stripline (Max Stubs)**

Thank You!