

A Migration Path from 6.25 Gbps Operation to 10 Gbps Operation

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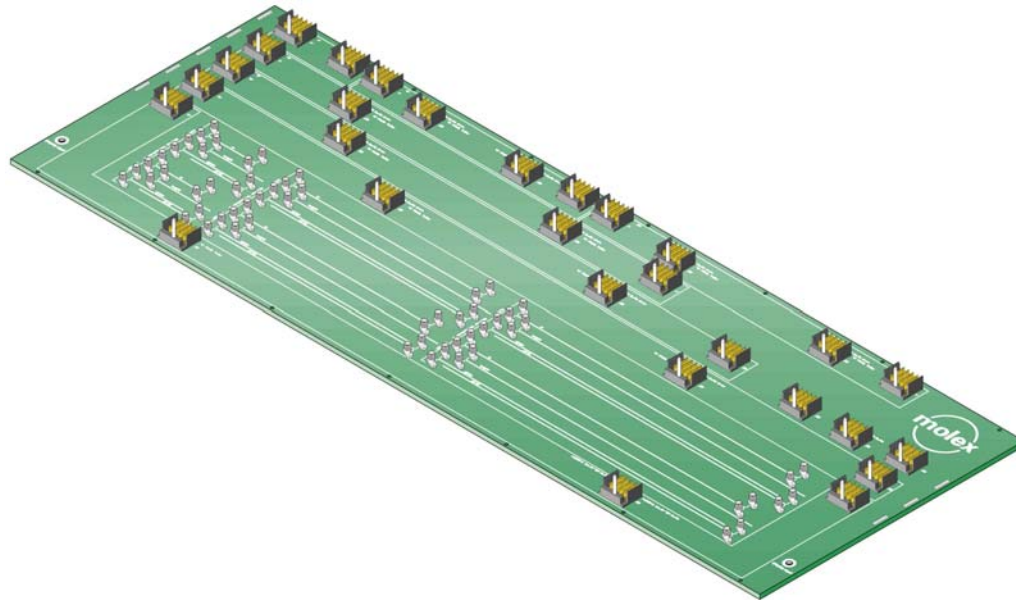
Reference Backplane Objectives

- **Test and demonstration vehicle**
 - Design rules, connectors, and silicon
- **Representative channel lengths**
 - Including 1 m, 1.25 m
 - Channel lengths include daughtercards
 - 2.5 inches of channel on each daughtercard
- **Four lanes**
 - 6.25 Gbps/lane NRZ
 - Limited by available silicon
- **Densities consistent with GbX™ column pitch**
- **Use good practice routing conventions and legacy options that include significant stubs**



Reference Backplane Features

- 38" x 13" backplane with 20 layers
- 7 test lengths including 1.0 m and 1.25 m
- Press-fit GbX connectors
- Channel routing through pin field
- Accommodates active and passive daughtercards



IEEE Backplane Ethernet

Backplane Construction Details

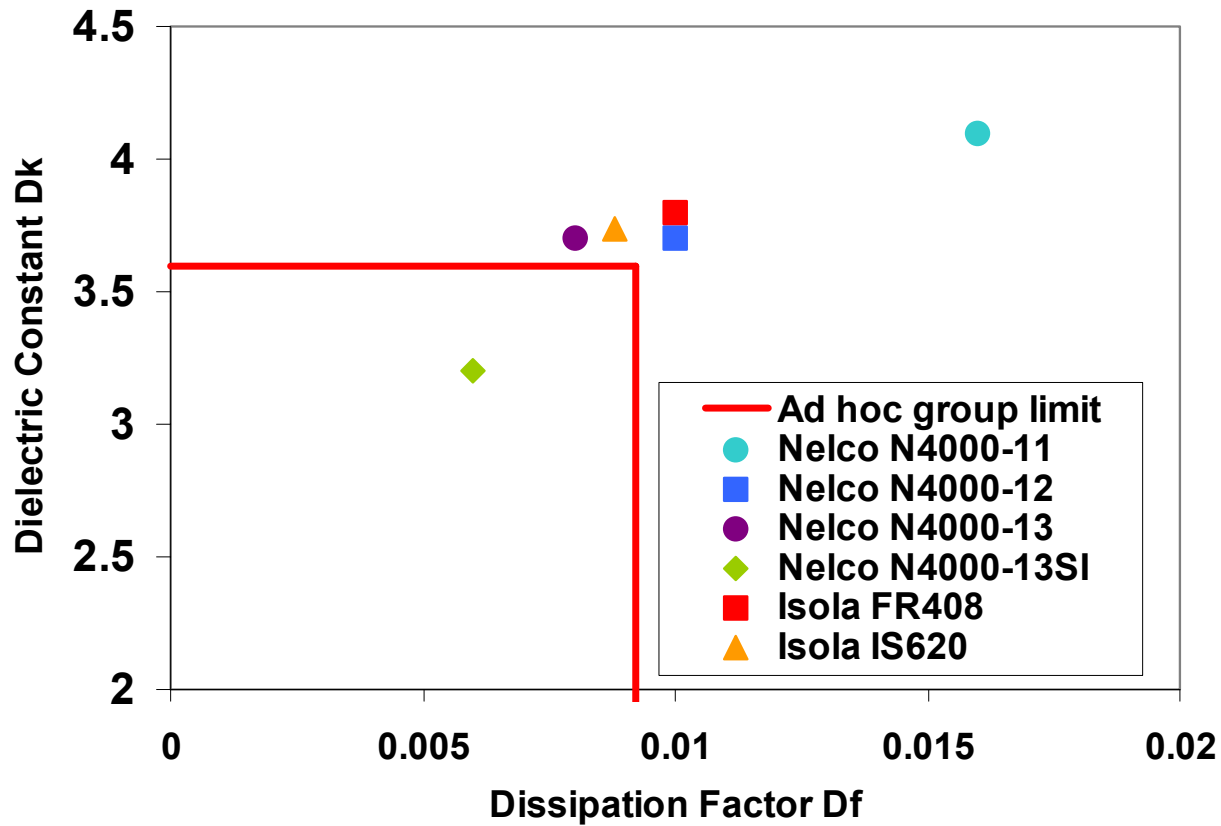
- **Nelco N4000-13 and N4000-13SI**
- **Dk at 2.5 GHz**
- **Bottom half of board mirrored below central core**
- **Total thickness = 225 mils**
 - Can test extended stub performance

Layer	Material Type	Description / Dk	Trace width/space/width
		Soldermask / 3.20	
1	Cu - 1/2oz. N4000-13SI	Prepreg / 3.20	Top Gnd
2	Cu - 1oz. N4000-13SI	Core / 3.25	Gnd
3	Cu - 1/2oz. N4000-13SI	Prepreg / 3.15	Diff. S1 7.75/6.25/7.75
4	Cu - 1oz. N4000-13SI	Core / 3.25	Gnd
5	Cu - 1/2oz. N4000-13SI	Prepreg / 3.15	Diff. S2 7.75/6.25/7.75
6	Cu - 1oz. N4000-13	Core / 3.65	Gnd
7	Cu - 1/2oz. N4000-13	Prepreg / 3.15	Diff. S3
8	Cu - 1oz. N4000-13	Core / 3.81	Gnd
9	Cu - 1/2oz. N4000-13	Prepreg / 3.31	Diff. S4
10	Cu - 1oz. N4000-13	Core / 3.85	Gnd
Center	N4000-13	Core / 3.85	Central Core

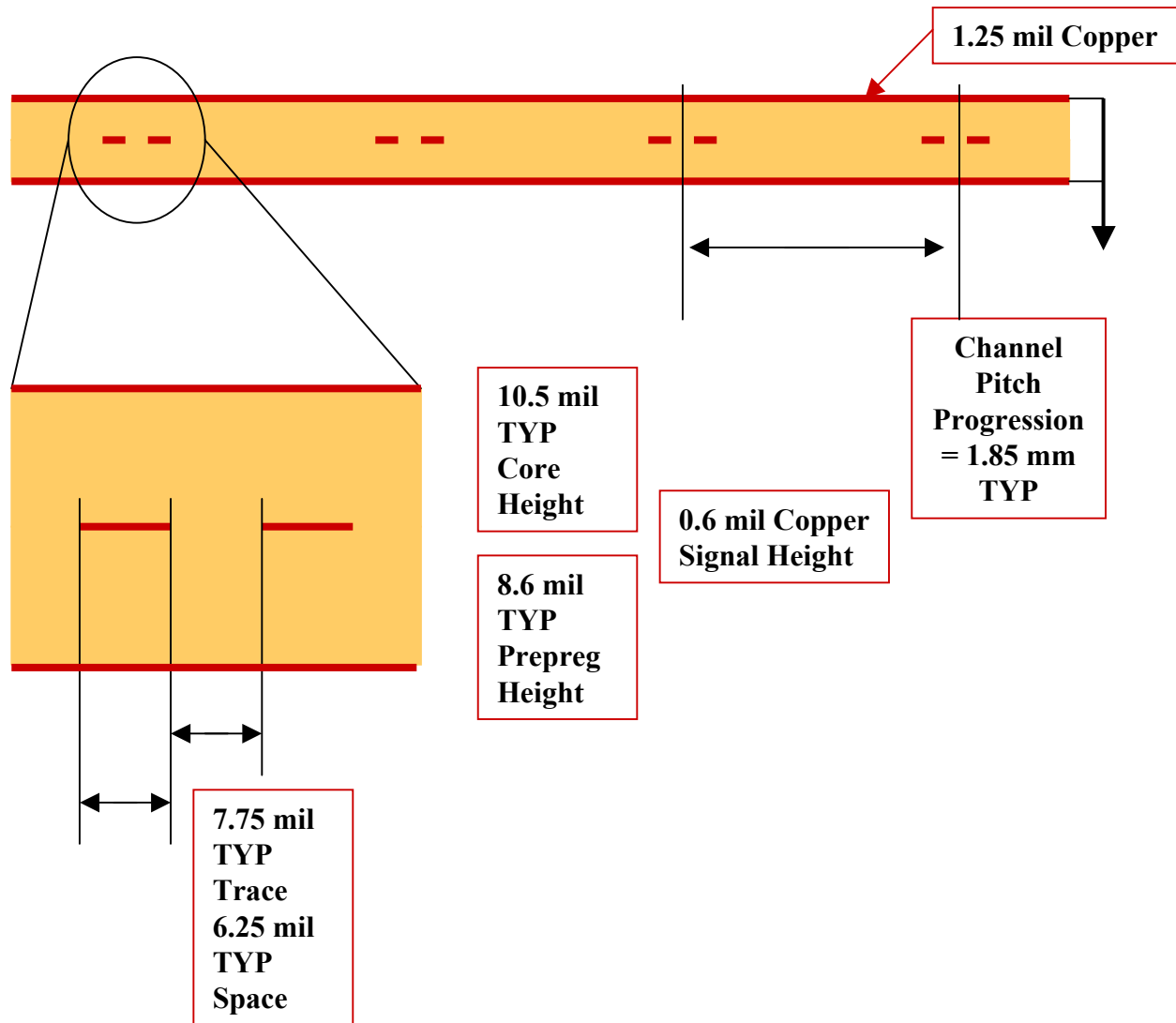


Material Map

- Results from Nelco N4000-13SI
 - improved FR-4



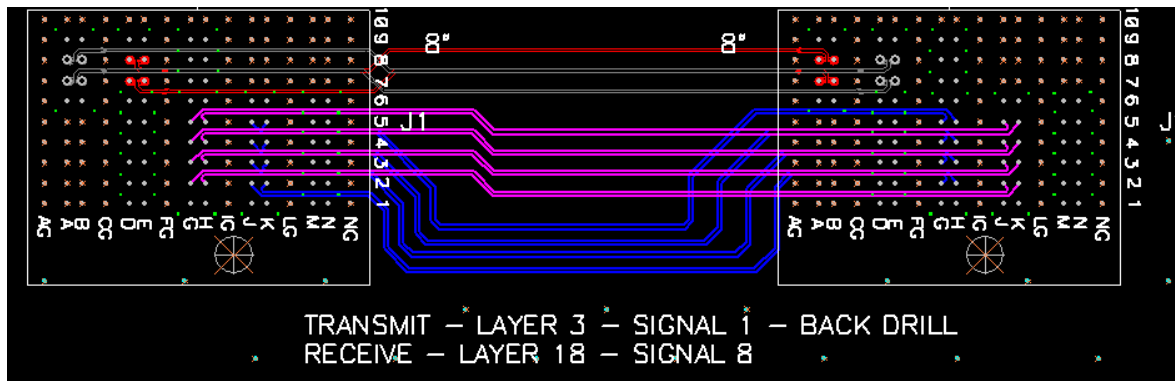
Channel Structure Details



Board Layout

- Channels blocked in groups of 4 TX pairs and 4 RX pairs per connector

Outbound: TX → RX
 Inbound: RX ← TX



- Different stub lengths allow channel performance comparison

Length (m)	Direction	Layer	Stub Length (um)
1.0	outbound	3	191
1.0	inbound	18	34
1.25	outbound	5	15
1.25	inbound	16	16



1 m Channel Results #1

■ Outbound

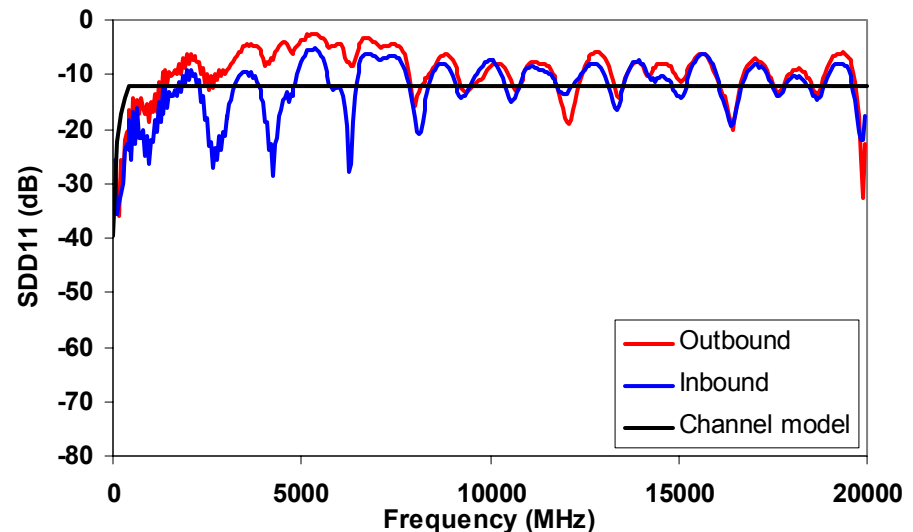
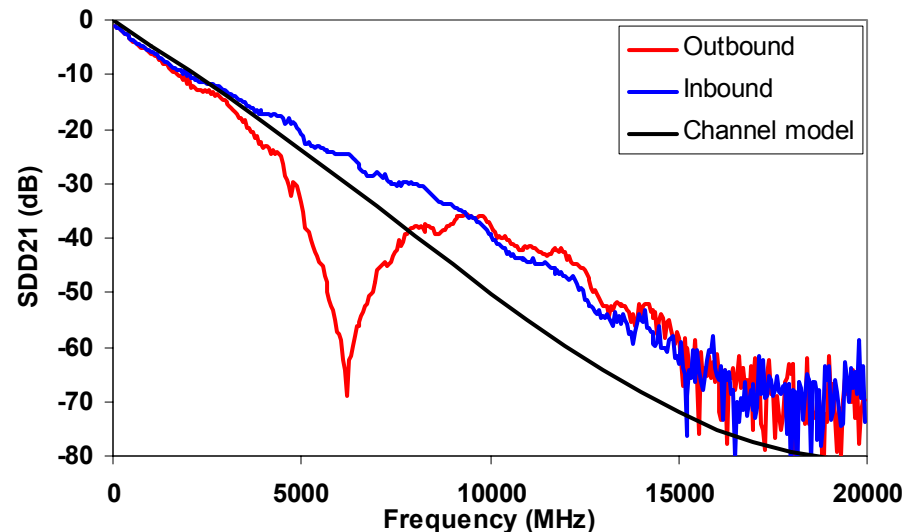
- Red trace
- Routed on top of PCB
- Vias have significant stub

■ Inbound

- Blue trace
- Routed on bottom of PCB

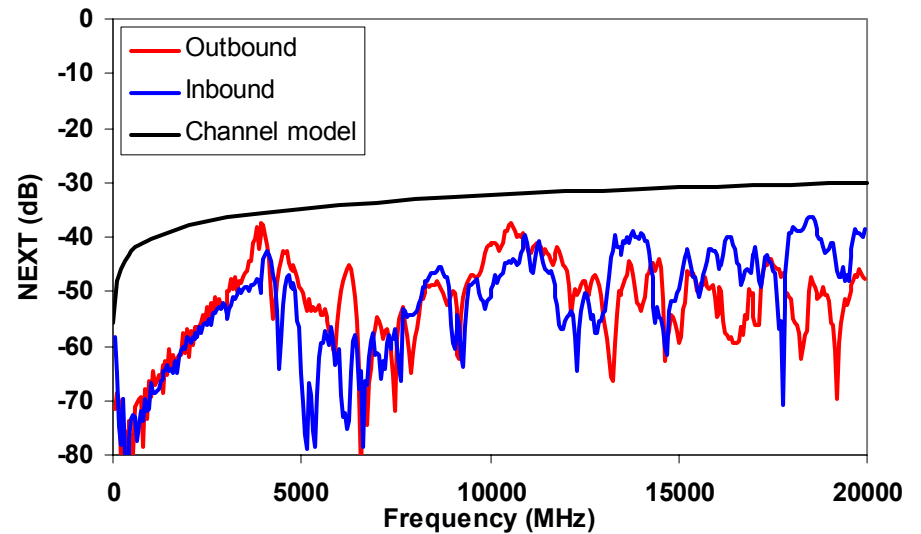
■ Ad-hoc model

- Black trace

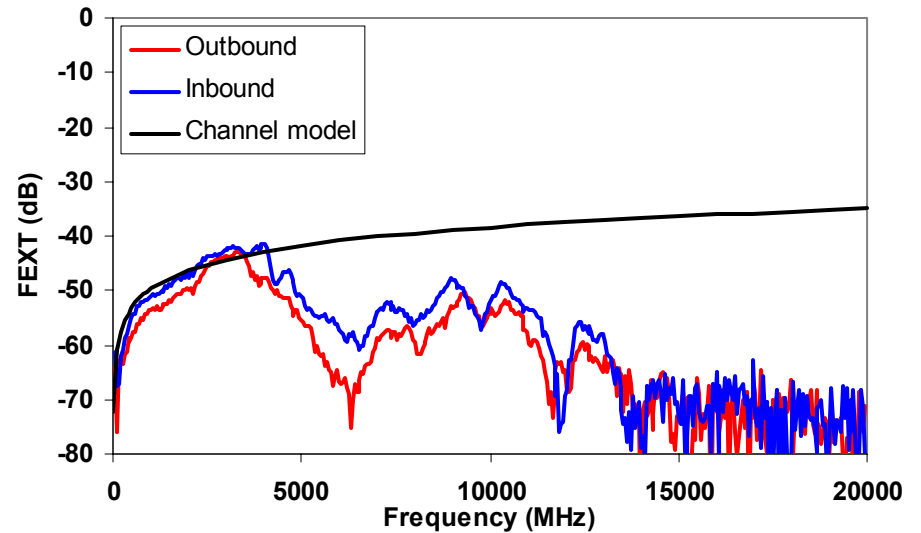


1 m Channel Results #2

■ NEXT



■ FEXT



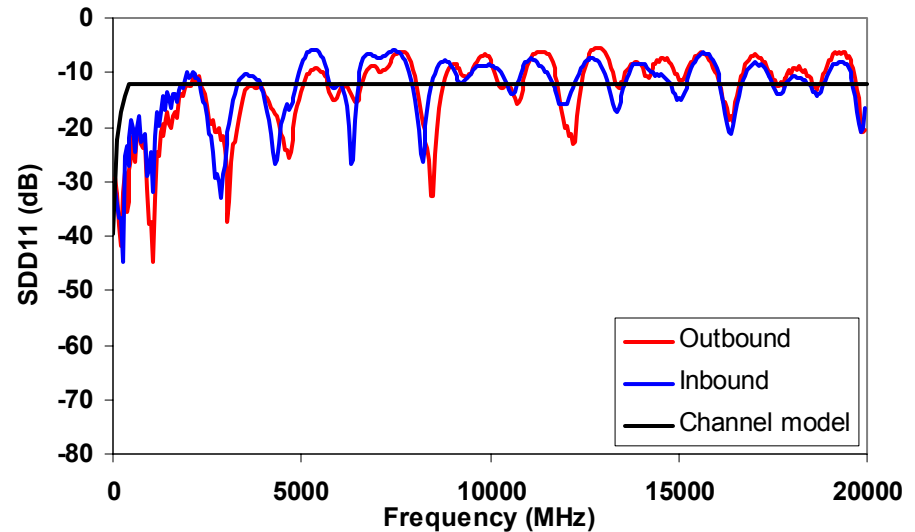
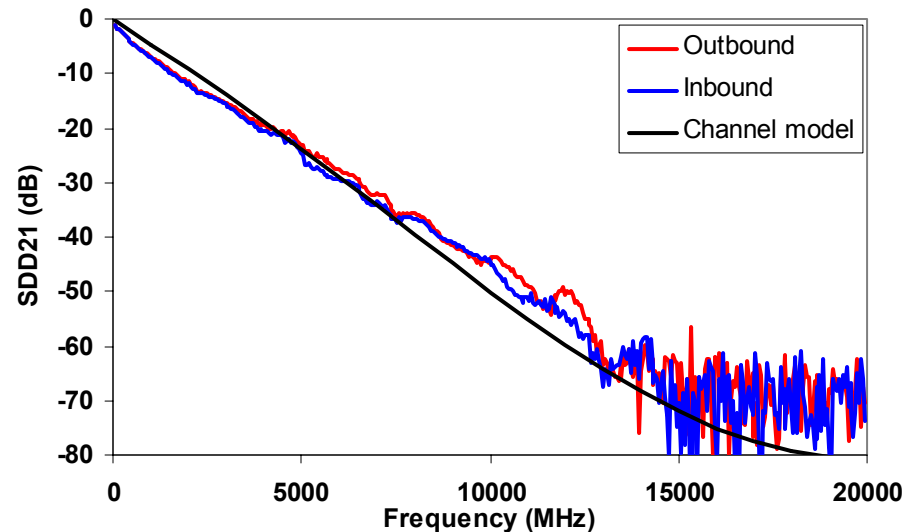
1.25 m Channel Results #1

■ Outbound

- Red trace
- Routed on top of PCB
- Vias are backdrilled

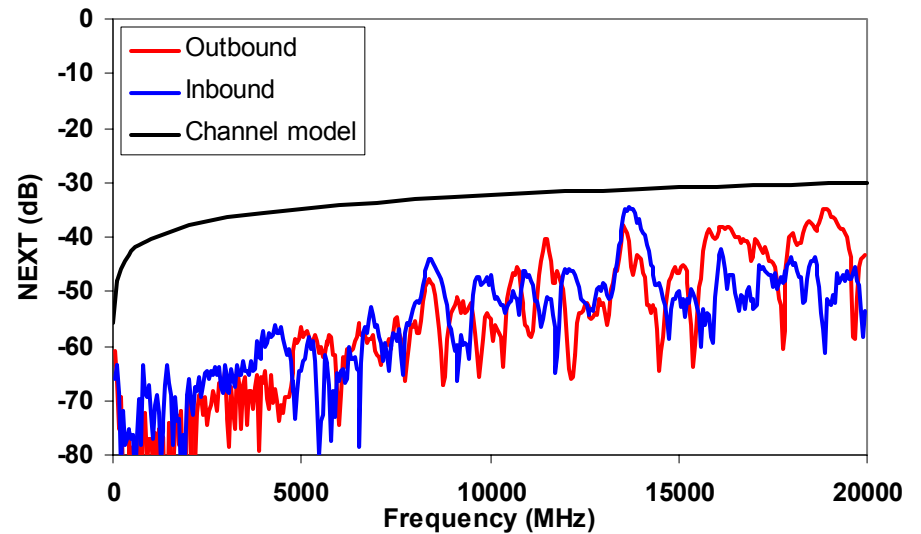
■ Inbound

- Blue trace
- Routed on bottom of PCB
- Vias are backdrilled

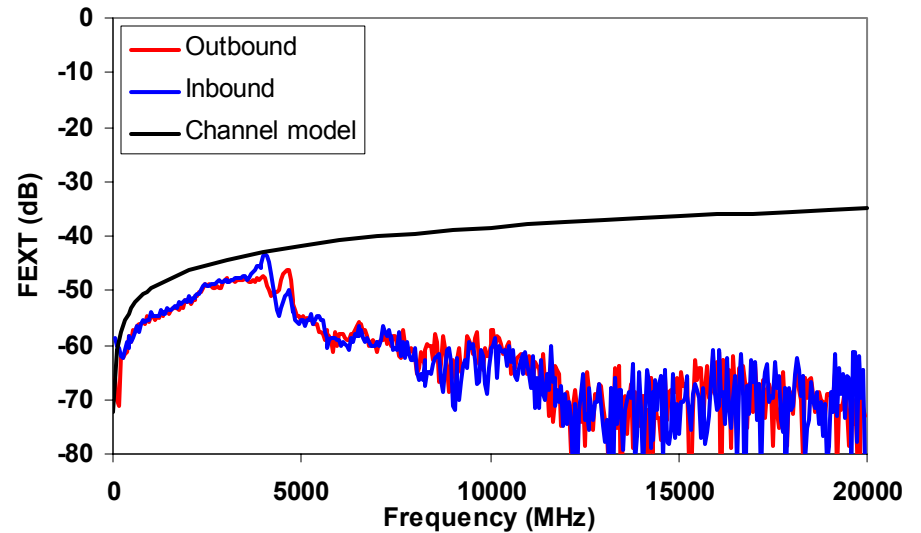


1.25 m Channel Results #2

■ NEXT



■ FEXT



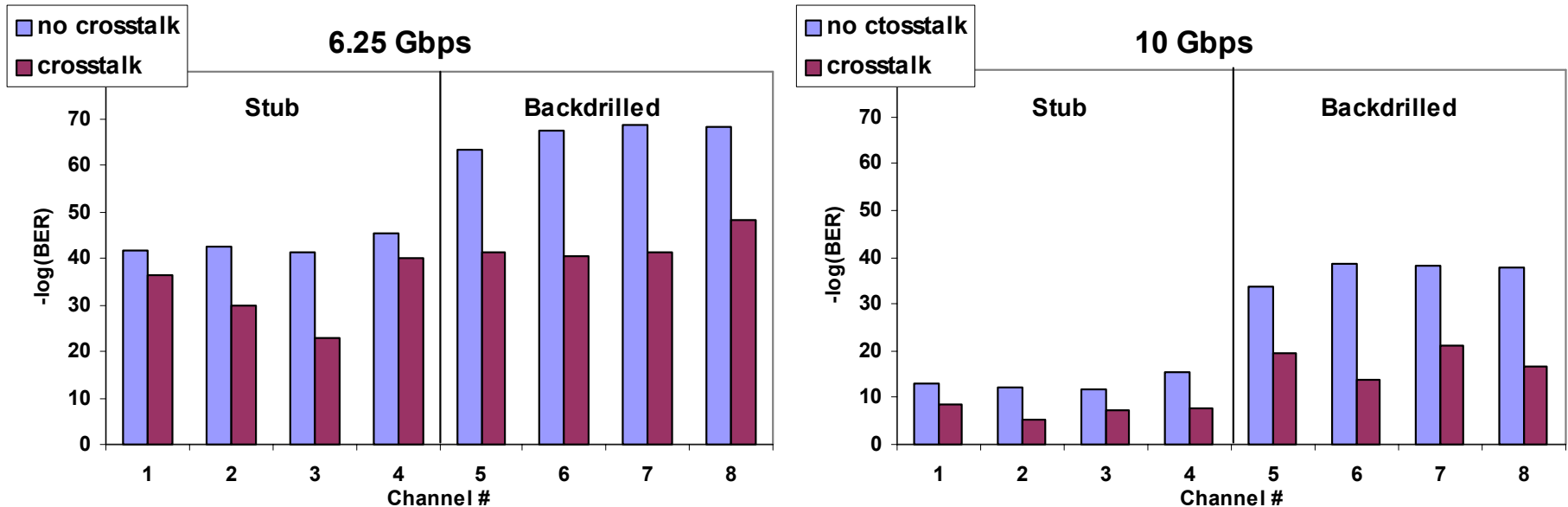
System Testing

- **Direct BER measurements**
- **1 m channel**
 - 65 hours
 - 4 inbound lanes and 4 outbound lanes
 - 6.25 Gbps PRBS-31 traffic
 - 0 errors recorded
 - BER < 10^{-15} at 99% confidence limits
- **1.25 m channel**
 - 280 hours
 - 4 inbound lanes and 4 outbound lanes
 - 6.25 Gbps PRBS-31 traffic
 - 0 errors recorded
 - BER < 10^{-15} at 99% confidence limits



PMC-Sierra Statistical BER Analysis

- Measure S parameters
 - Use to predict BER at 6.25 Gbps and 10 Gbps
- Predict BER $<10^{-15}$ at 10 Gbps on 1 m channel
 - Have to backdrill vias



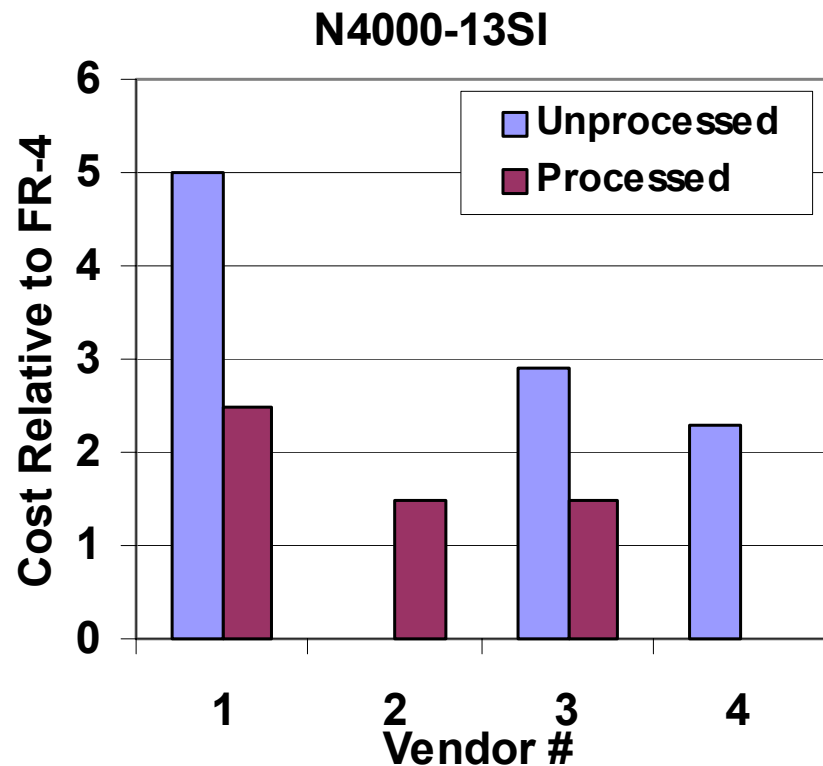
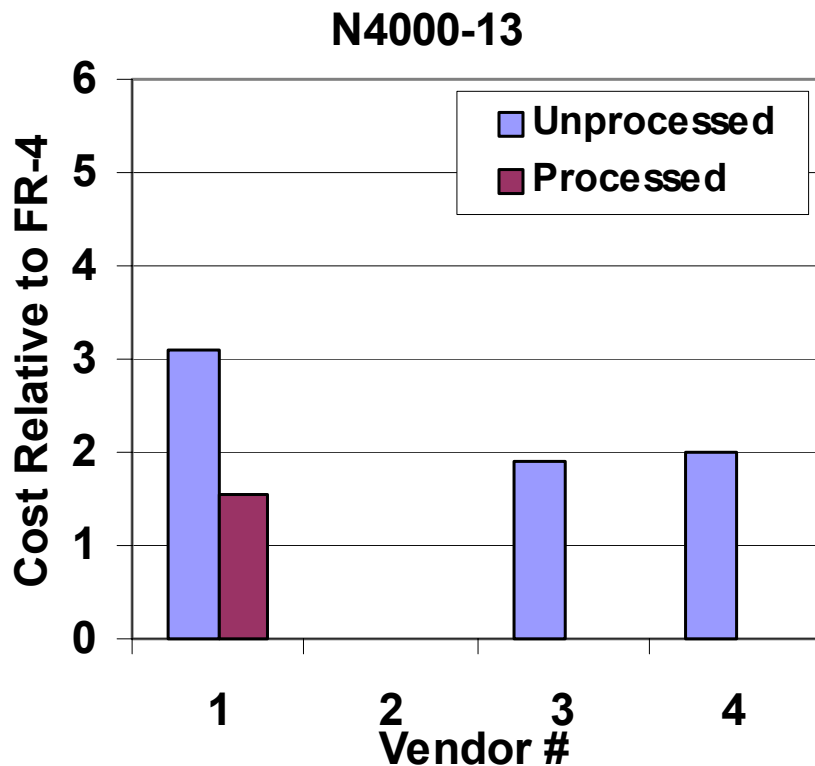
- Acknowledgements:
 - Graeme Boyd - PMC Sierra
 - Arash Haidari-Khabbaz - PMC Sierra



Relative Cost Data

■ N4000-13SI

- Unprocessed cost ~3.4 x unprocessed FR-4
- Processed cost ~1.8 x processed FR-4



Summary

- **Demonstration backplane**
 - Nelco N4000-13SI
 - GbX connectors
 - Four lanes in each direction
 - 6.25 Gbps per lane
 - 1 m & 1.25 m channels with two daughtercards
 - Demonstrated BER $\ll 10^{-15}$
 - Cost $\sim 1.8 \times$ “plain vanilla” FR-4
- **Extrapolation to 10 Gbps**
 - Measured S parameters
 - PMC statistical BER analysis suggests BER $< 10^{-15}$ @ 10 Gbps over 1 m with backdrilling

