Channel Performance Insights

John D’Ambrosia
Tyco Electronics
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Supporters

- Brad Booth, Intel; Joel Goergun, Force10 Networks; Anthony Sanders, Infineon; Kamal Dalmia, Marvel Semiconductors; Jimmy Sheffield, Tyco Electronics; Bill Hoppin, Accelerant Networks; John Stonick, Accelerant Networks; Greg Sheets, Agere Systems, Ted Rado, Analogix; Ali Ghiasi, Broadcom; Bharat Tailor, Gennum; Mike McConnell, KeyEye Communications.

- Thanks to UNH-IOL for all Variable Length Line Card & Alternate Materials Testing

How Far?

- Current Standards and Efforts
  - XAUI – 50 cm (20 Inches)
    - Insufficient reach for backplane applications
  - ATCA - 31 Inches
    - Open system with length restrictions on backplane and line cards
  - OIF – 1m (40 Inches)
- Questions – How far…
  - do we need to go for applications?
  - can we go with signal compensation?
  - can we go given real world tolerances and influences?

Aspects of Channel Potential

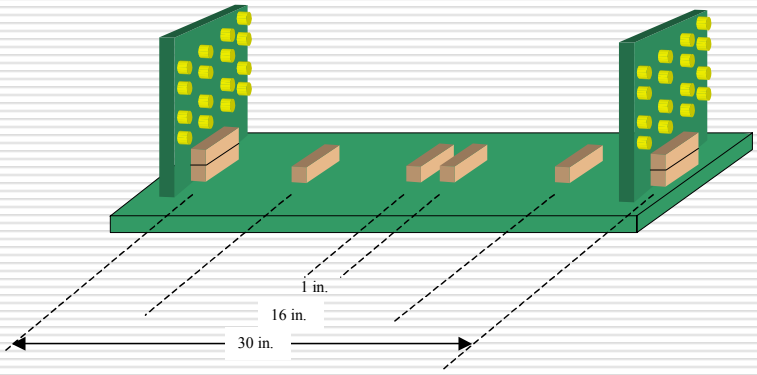
- Channel Loss
  - Length
    - Skin effect
    - Dielectric loss
- Channel Variance
  - Layer connection
  - Manufacturing
  - Environmental
  - Source / Load termination interaction
- Channel Cost
  - Backplane board materials
  - Blade board materials
  - Connectors
  - Stub Removal techniques
  - Manufacturing, processing, assembly
- Frequency content of interest for 10Gb/s
  - Binary (Nyquist @ 5 GHz)
  - PAM-4 (Nyquist @ 2.5 GHz)

Question – Performance is a function of cost, implementation, and power. Where we go impacts our response to the 5 criteria. Where do we want to go?

Backplane System Channels

- Implementation Variances
  - Board Thicknesses
  - PWB materials
  - Trace dimensions of blades and backplanes
    - width
    - length
  - Layer connections
  - Use of stub removal techniques
  - Connectors
  - System densities

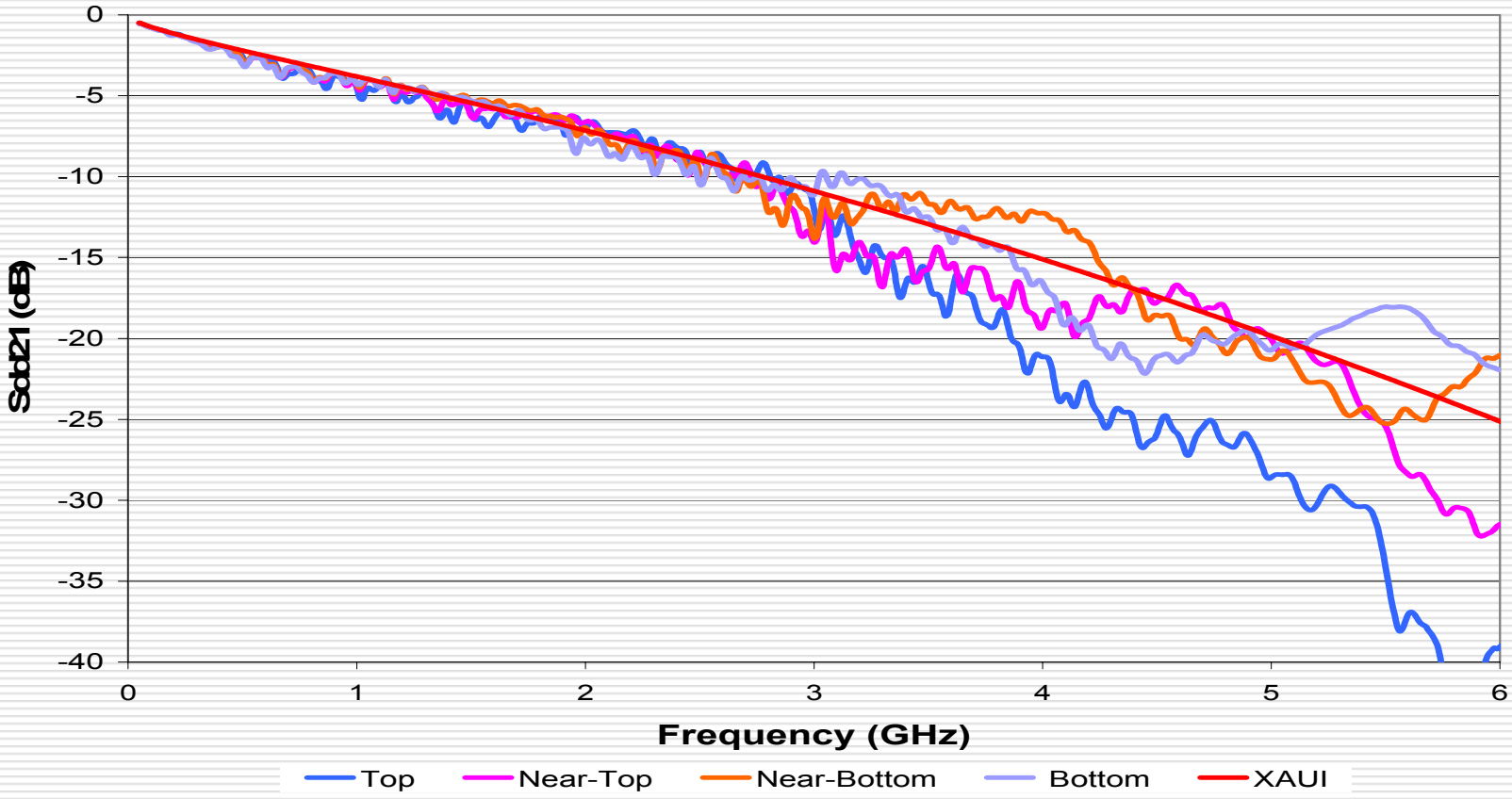
Tyco Electronics - Z-PACK HM-Zd Test Platforms



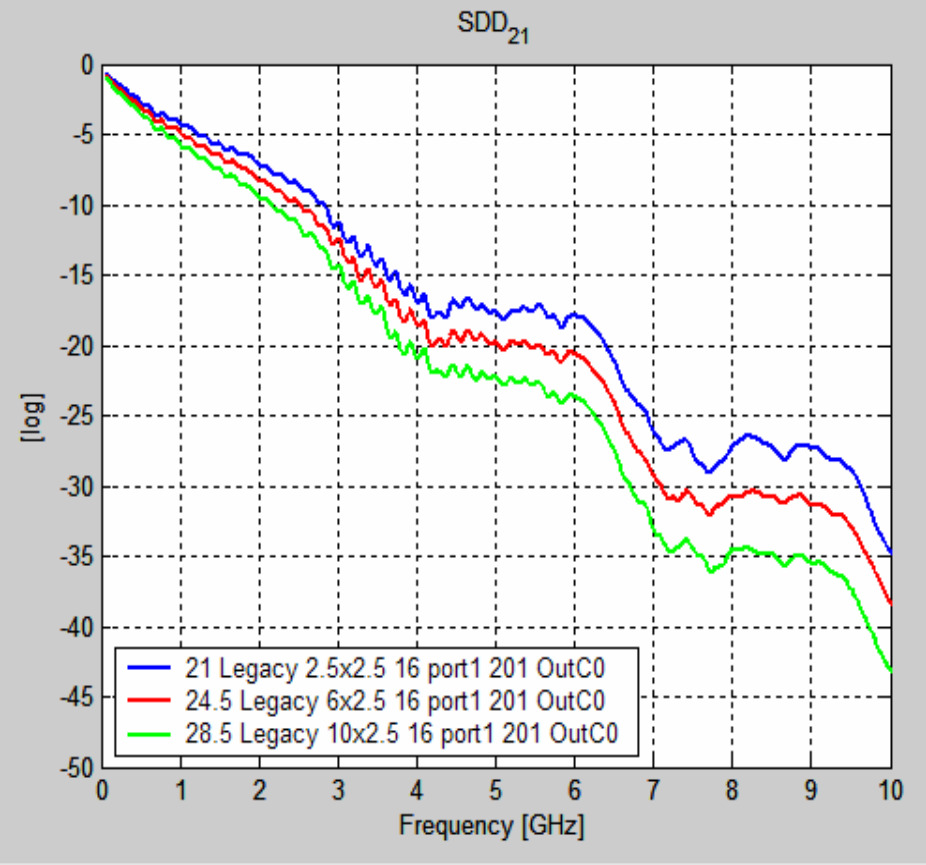
- ***SMA Line Cards – Platforms 1 & 2***
  - Nelco 4000-2
  - 2” trace
  - 6 mil trace width, 100 Ω Differential
  - 0.092” thickness
  - 4 Signal layers throughout board
- ***SMA Line Cards – Platform 3***
  - Nelco 4000-6
  - 2.5”, 6”, and 10” trace
  - 6 mil trace width, 100 Ω Differential
  - 0.092” thickness
  - 4 Signal layers throughout board
  - All boards from same panel

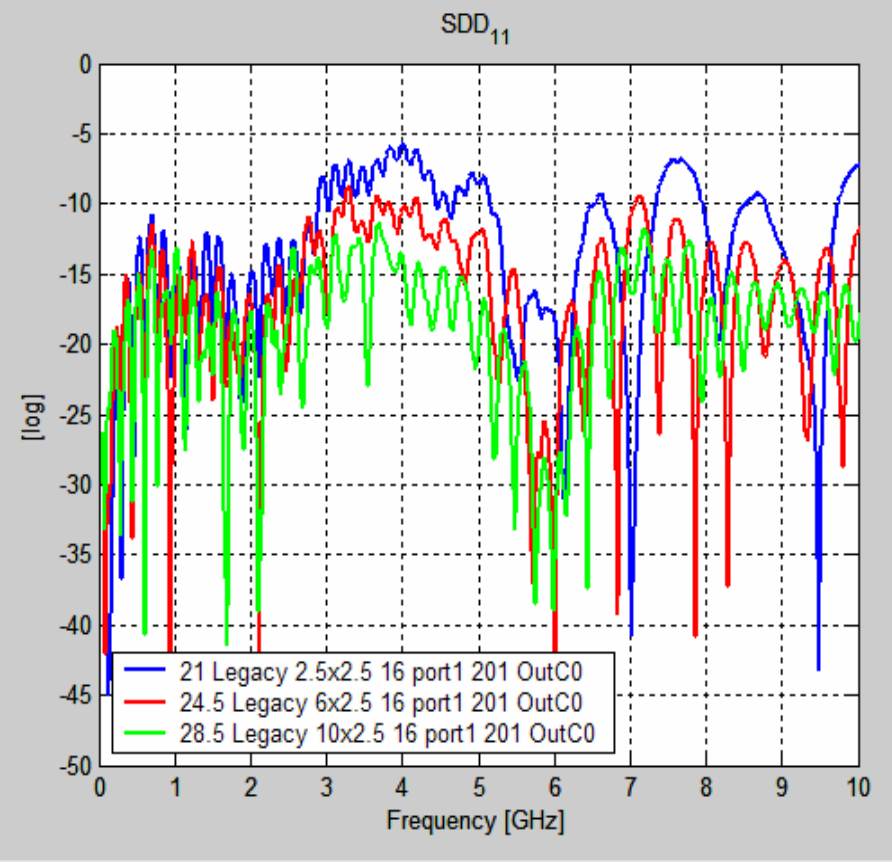
- ***Platform #1 – XAUI HM-Zd Interoperability Backplane***
  - Nelco 4000-2
  - 1”, 16”, and 30” traces
  - 10 mil trace width
  - 0.200” thickness, 100 Ω Differential
  - 4 Signal layers throughout board
- ***Platform #2 – HM-Zd QuadRoute Backplane***
  - Nelco 4000-13 unless otherwise noted
  - 2”, 16”, and 30” traces
  - 4.75 mil trace width
  - 0.125” thickness, 100 Ω Differential
  - 8 Signal layers throughout board
    - Same routing capacity as 16 signal layers
- ***Platform #3 – HM-Zd Legacy Backplane***
  - Nelco 4000-6
  - 1”, 16”, and 30” traces
  - 5.5 mil trace width
  - 0.200” thickness, 100 Ω Differential
  - 6 Signal layers throughout board

HM-Zd XAUI Backplane – Layer Variation @ 20 Inches

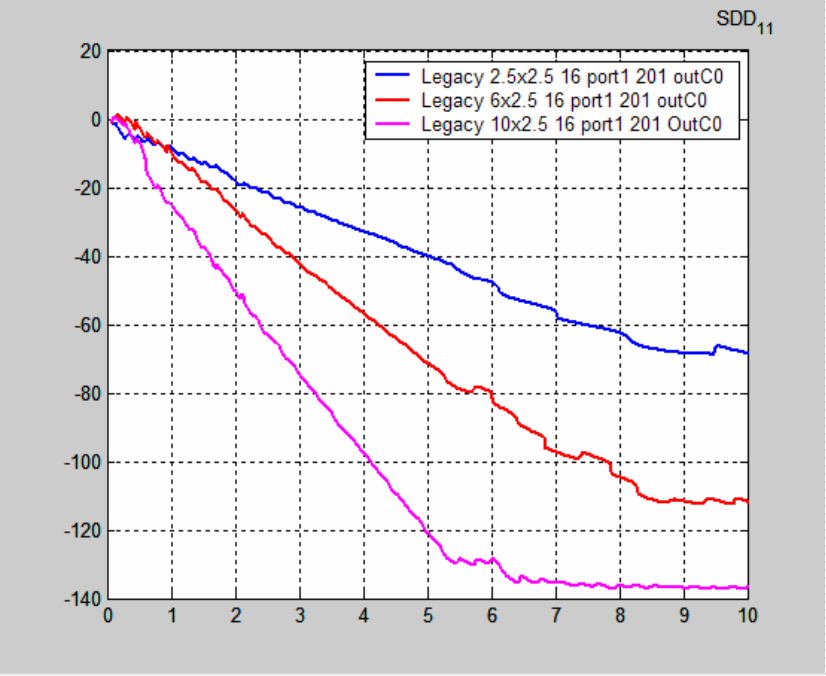


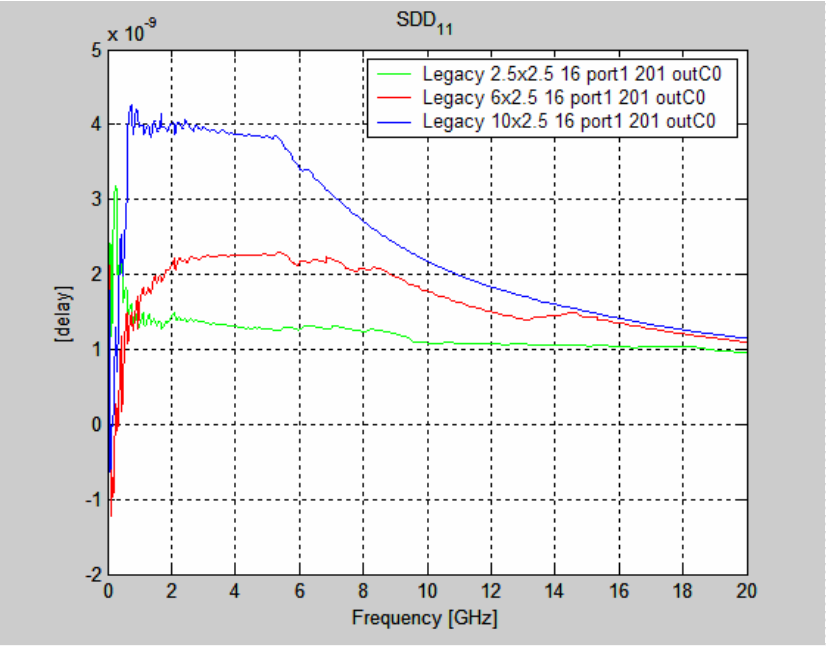
HM-Zd Legacy Backplane – Line Card Length Variation



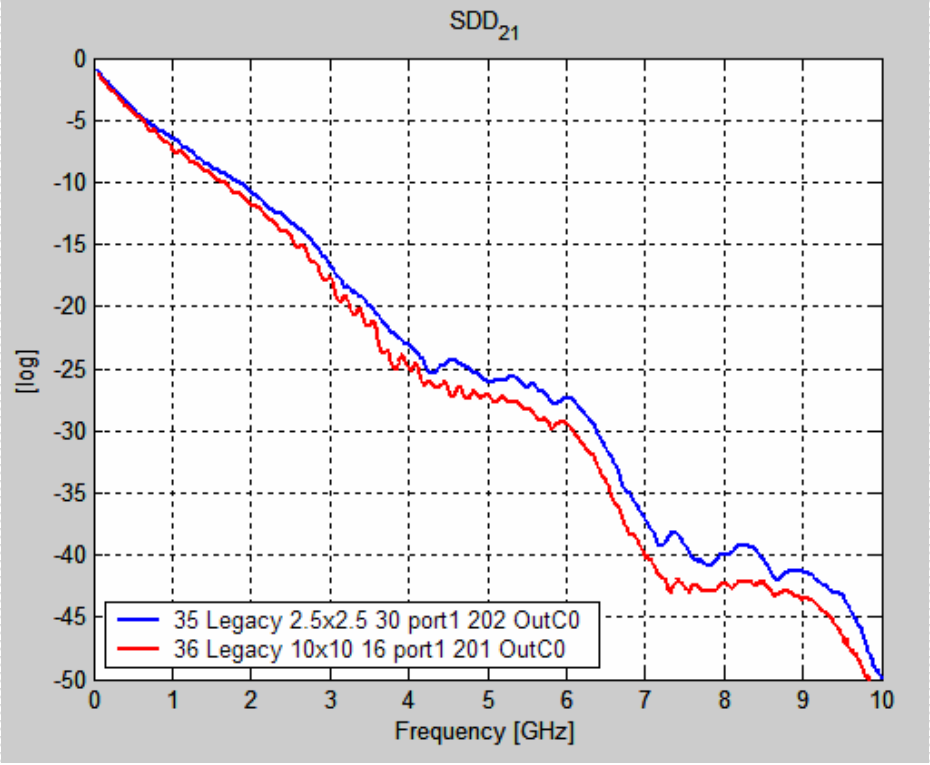


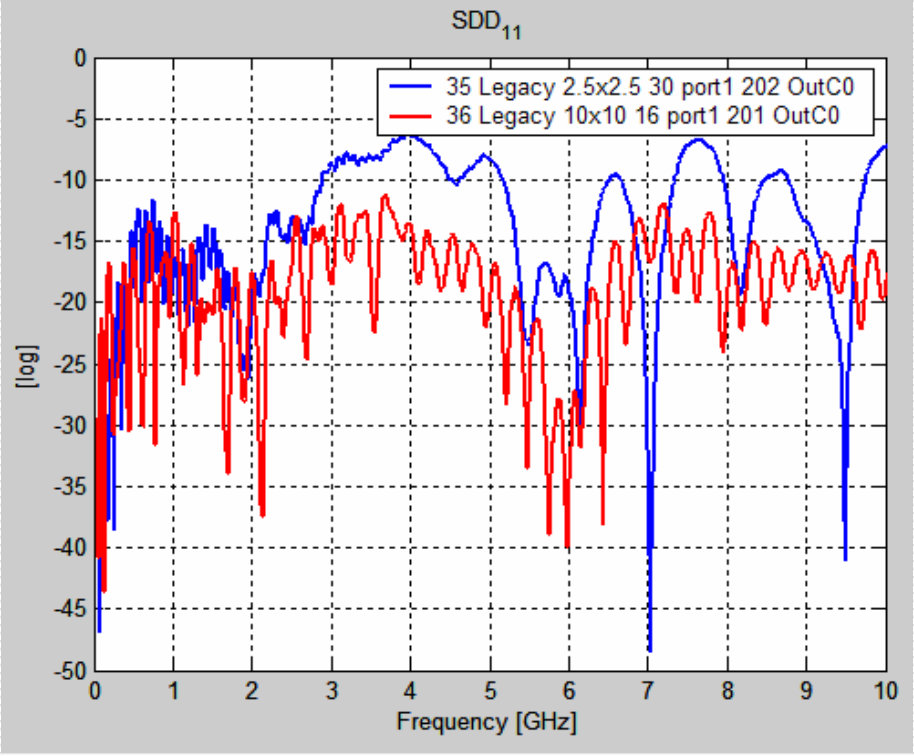
HM-Zd Legacy Backplane – Line Card Length Variation





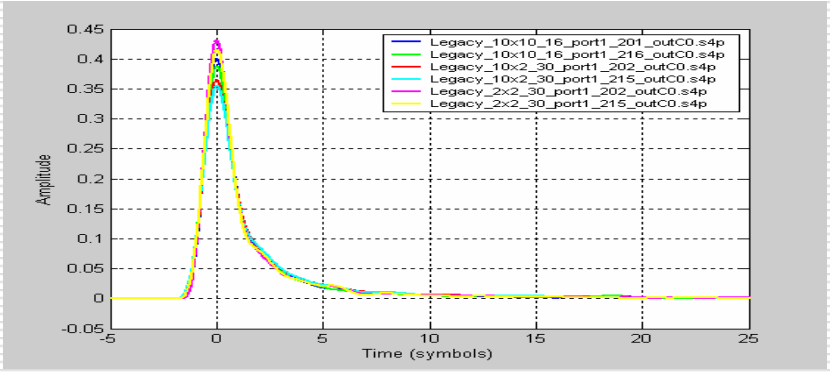
HM-Zd Legacy Backplane – 36” Length Configuration Variation



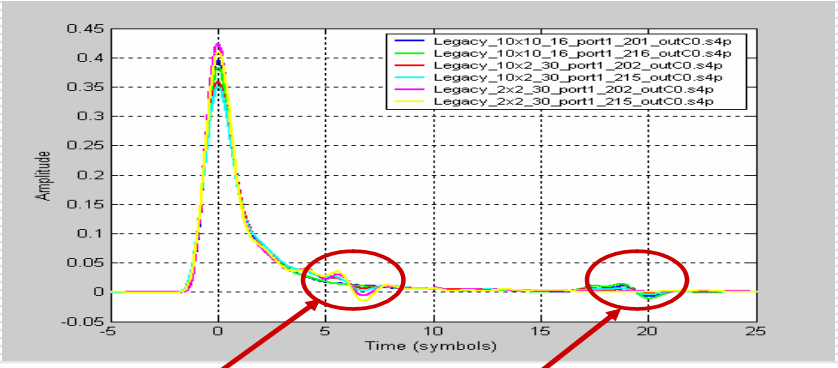


HM-Zd Legacy Backplane – Impact of Device Terminations

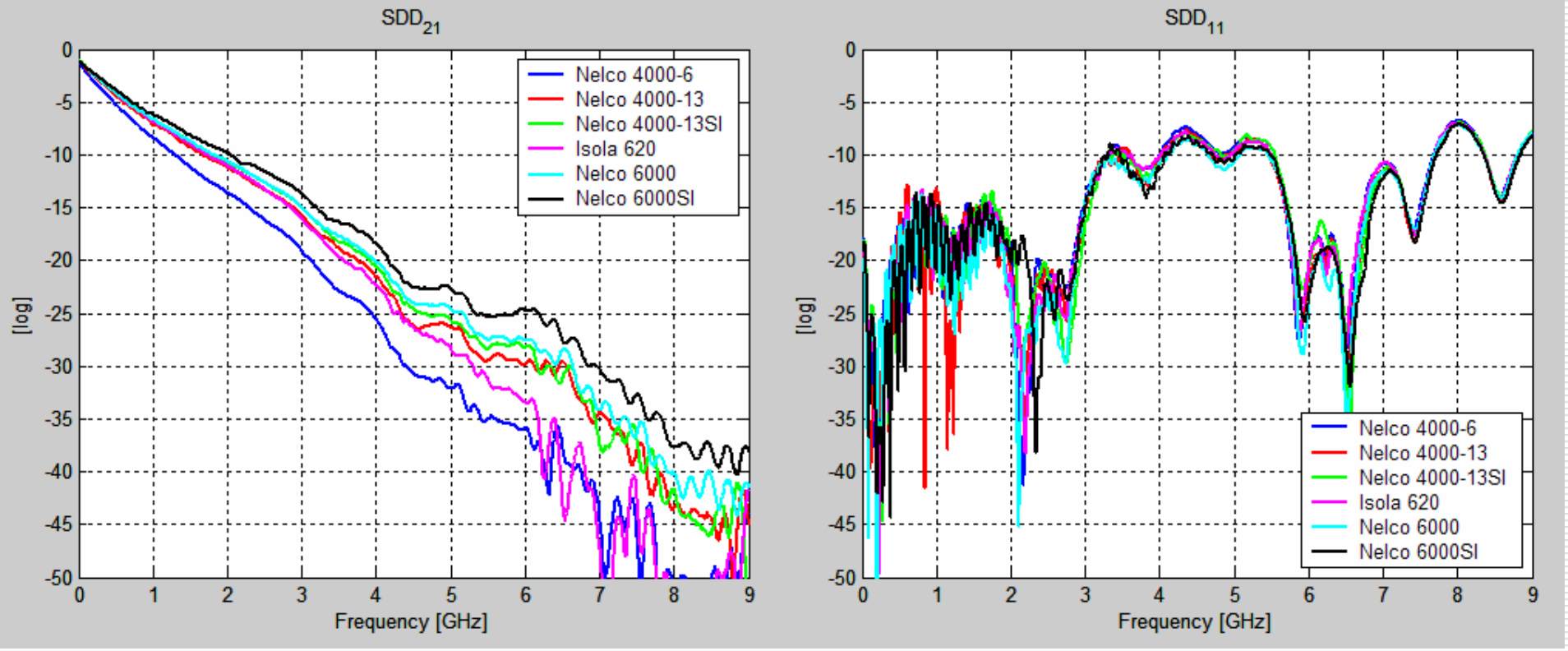
Perfect



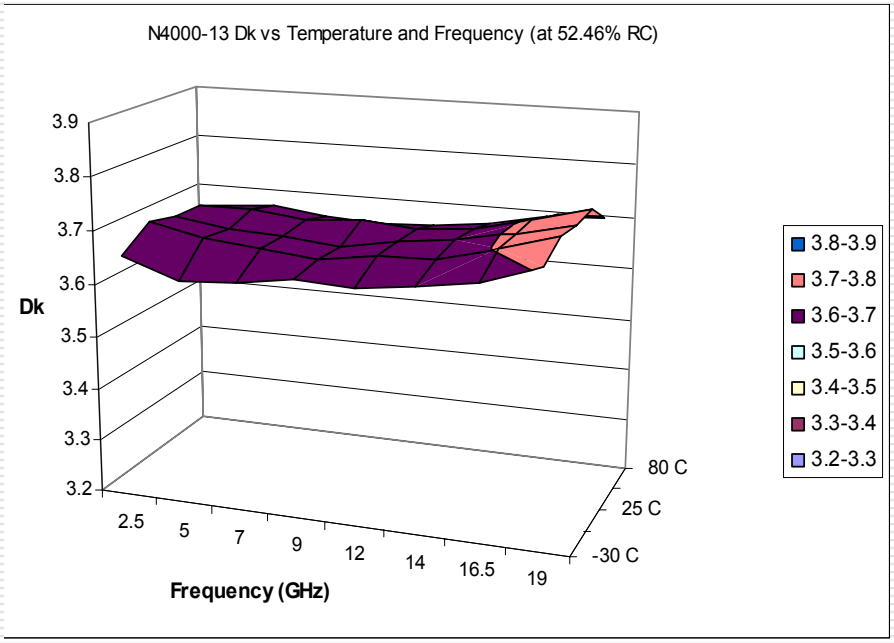
Example of Imperfect Terminations



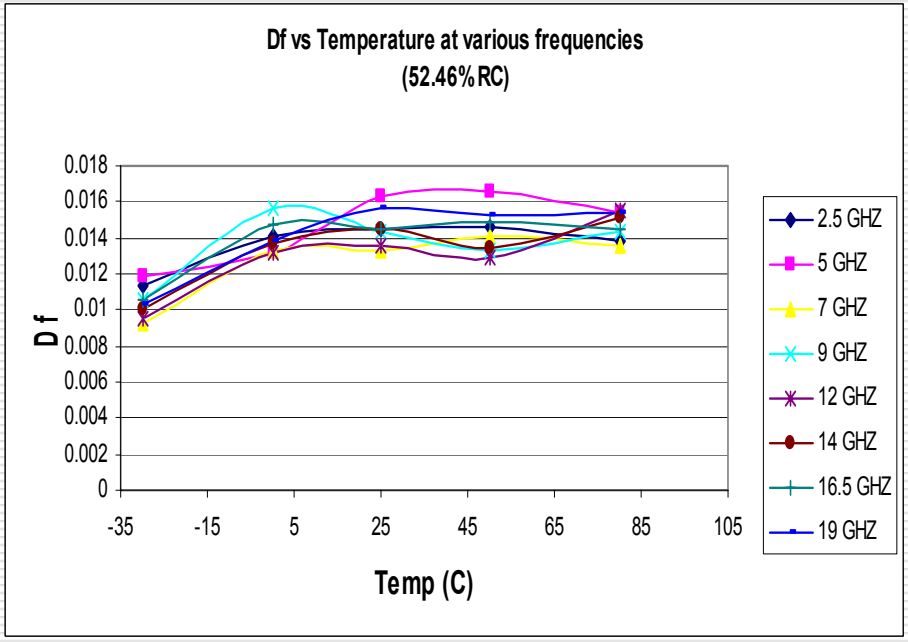
HM-Zd QuadRoute Backplane – Materials Comparison @ 34 Inches



Material Variance



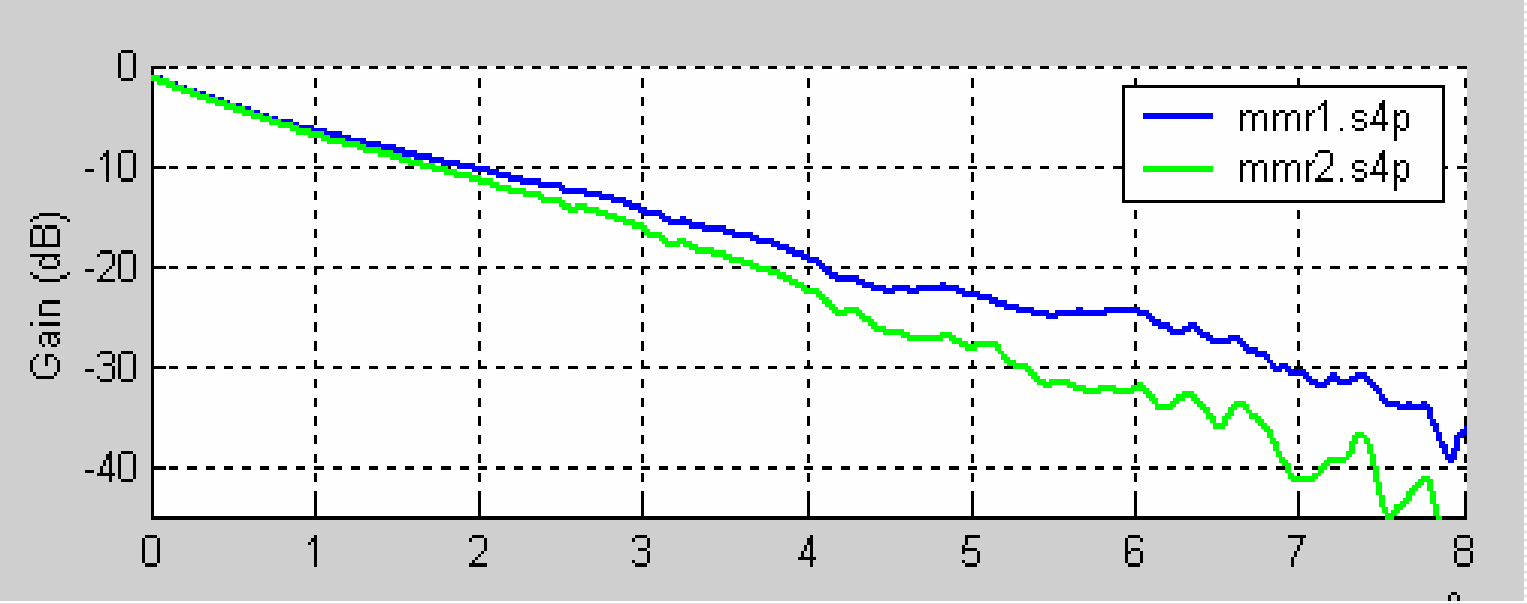
Impact of Temperature and Frequency on d_k for Nelco 4000-13



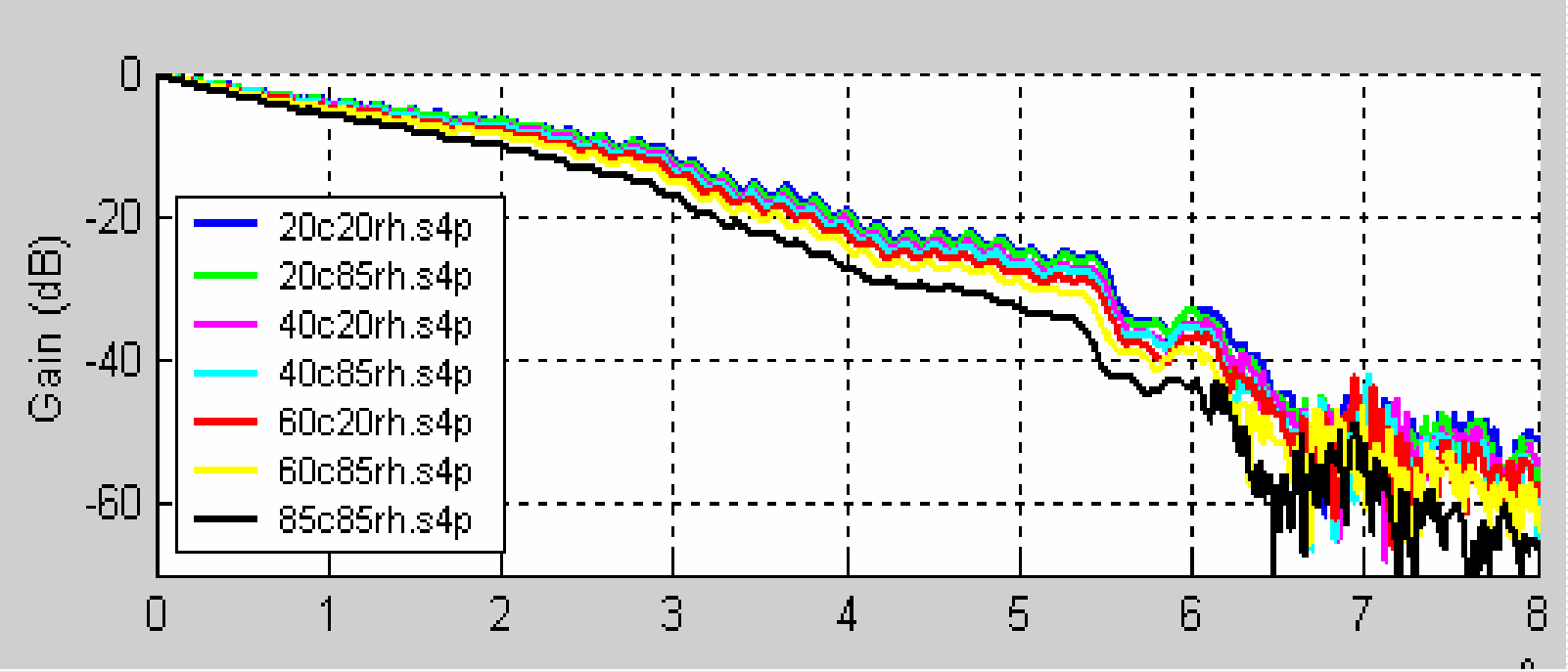
Impact of Temperature and Frequency on d_f for Nelco 4000-13

Data provided by Park Nelco

QuadRoute Backplane – Manufacturing Variance @ 34 Inches



HM-Zd XAUI Backplane – Environmental Variance @ 20 Inches



Data Source – Courtesy of Agere Systems, "The Impact of Environmental Conditions on Channel Performance," John D'Ambrosia, Greg Sheets, DesignCon 2004.

Observations

- Layer connection @ 21 inches
  - HM-Zd XAUI / Legacy Backplanes with no stub reduction
    - @ 2.5 GHz – 8 to 12 dB, 4 dB deviation
    - @ 5 GHz - 17 to 27 dB, 10 dB deviation
- Layer connection @ 28 to 32 inches
  - HM-Zd XAUI / Legacy Backplanes with no stub reduction
    - @ 2.5 GHz – 12 to 17 dB, 5 dB deviation
    - @ 5 GHz - 22 to 35 dB, 13 dB deviation
- Layer connection @ 38 to 40 inches
  - HM-Zd Legacy Backplane with no stub reduction
    - @ 2.5 GHz – 15 to 20 dB, 5dB deviation
    - @ 5 GHz - 27 to 42 dB, 15 dB deviation
  - HM-Zd QuadRoute Backplane with high performance material with stub reduction
    - @ 2.5 GHz – 13 to 17 dB, 4 dB deviation
    - @ 5 GHz - 24 to 32 dB, 8 dB deviation

Observations

- Manufacturing @ 34 inches
  - @ 2.5 GHz – 3 dB deviation
  - @ 5 GHz - 6 dB deviation
- Environmental @ 20 inches
  - @ 2.5 GHz – 5dB deviation
  - @ 5 GHz - 7 dB deviation

Observations

- System needs to be considered not just backplane
  - SDD11 / 22
    - Shorter card length increases initial reflection amplitude
    - Longer card length resulted in reflections later
    - Combines with device termination variation
  - Overall system loss is function of distribution of losses on backplane and line cards

Conclusions

- Channel loss function of cost and implementation
  - Length
  - PWB Materials
  - Board(s) thickness and stub removal techniques
  - Skin effect loss
- Channel loss impacted by real world
  - Interaction with device terminations
  - Manufacturing variance
  - Environmental variance
- Further improvement over numbers reported with Legacy Backplane anticipated (estimate 3 to 5 dB) with shift to higher performance FR-4

Recommendations to the Study Group

- Channel performance is a function of the compromises made between cost, implementation, and power. This should be taken into consideration in the development of a channel objective.
- The Study Group should take real world limitations into consideration when developing channel objectives.