10 Gbps Data Transmission in FR408 and Nelco 4000-13SI GbX® Reference Backplane

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Introduction

- Isola FR408 reference backplane
  - Test and demonstration vehicle
  - Set of channels ranging from 8” to 1.25 m
  - GbX connectors

- Extension of Nelco 4000-13SI work
  - Performance comparison
  - Lower relative cost
Backplane

- Overall length: 97 cm; overall width 33 cm
- Thickness: 5.7 mm
- 1.85 mm channel pitch progression maintained over length of channel
Backplane Construction

PCB Stack – Channel Construction Group 2A

Critical Depth: 1.9 mm

L1 – 1 oz. Cu Ground
L2 – 1 oz. Cu Ground
L3 – 0.5 oz. Signal
L4 – 1 oz. Cu Ground
L5 – 0.5 oz. Signal
L6 – 1 oz. Cu Ground
L7 – 0.5 oz. Signal
L8 – 1 oz. Cu Ground
L9 – 0.5 oz. Signal
L10 – 1 oz. Return Reference
L11 – 1 oz. Return Reference
L12 – 0.5 oz. Signal
L13 – 1 oz. Cu Ground
L14 – 0.5 oz. Signal
L15 – 1 oz. Cu Ground
L16 – 0.5 oz. Signal
L17 – 1 oz. Cu Ground
L18 – 0.5 oz. Signal
L19 – 1 oz. Cu Ground
L20 – 1 oz. Cu Ground

Approx. PCB Thickness: 0.021”

Isola FR 408 core
Core Sizes Listed

L3 Signal Pair
7.2 6.8 7.2

L5 Signal Pair

L7 Signal Pair
5.6 4.4 5.6

L9 Triad Signal Pair
4.7 4.3 4.7
Triad Return References – 20 mils wide

L12 Triad Signal Pair
4.7 4.3 4.7

L14 Signal Pair
5.6 4.4 5.6

L16 Signal Pair
7.2 6.8 7.2

Note: Channel constructions appear on 1.85 mm channel-to-channel pitch. This is consistent with 6x6 routing.

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Backplane Construction

- Core Dk = 3.57
- Core Dissipation Factor = 0.013
- Prepreg Dk = 3.43
- Prepreg Dissipation Factor = 0.013
- Channel Lengths = 44.21”, 34.37”, 25.00”, 20.00”, 15.00”, 10.00”, 3.00”

8 mil TYP Prepreg

10.2 mil TYP Core

7.2 mil TYP trace
6.8 mil space

1.25 mil Copper

0.6 mil Copper

Channel Pitch Progression = 1.85 mm TYP
Channel Routing Example

- Shows 8 inch channel
- 1 m channel is similar
- Channel nomenclature from connector pin locations
Channel Nomenclature

- Aids interpretation of posted data
- Description posted to Channel Model Library
- All FR408 channels discussed here are backdrilled or bottom-routed
- Nelco channels include worst-case via stub
NEXT and FEXT Measurements

Inbound FEXT Example

Layer 3 (top) backdrilled

Layer 18 (bottom)

Outbound

TX
J2K2
J3K3
J4K4
J5K5

RX
G2H2
G3H3
G4H4
G5H5

Inbound

RX
G2H2
G3H3
G4H4
G5H5

TX
J2K2
J3K3
J4K4
J5K5

Inbound Thru Channel → sj2k2g2h2

• Associated FEXT Channels → Located in Inbound FEXT Channel Folder
  • sj2k2g3h3
  • sj2k2g4h4
  • sj2k2g5h5

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**NEXT and FEXT Measurements**

**Inbound NEXT Example**

Layer 3 (top) backdrilled

Layer 18 (bottom) backdrilled

- **Outbound**: TX J2K2, J3K3, J4K4, J5K5 → RX G2H2, G3H3, G4H4, G5H5

- **Inbound**: RX G2H2, G3H3, G4H4, G5H5 → TX J2K2, J3K3, J4K4, J5K5

- **Inbound Thru Channel**: sj2k2g2h2

- **Associated NEXT Channels**: Located in Inbound NEXT Channel Folder
  - sj2k2g2h2
  - sj2k2g3h3
  - sj2k2g4h4
  - sj2k2g5h5
Measurement Results

- Test configuration
  - Xilinx silicon
Compare to Nelco 4000-13SI Backplane

- SDD21 and SDD11 (dB)
- Frequency (MHz)
- SDD21 FR408
- SDD21 Nelco
- SDD11 FR408
- SDD11 Nelco
## BER Data @ 10 Gbps

<table>
<thead>
<tr>
<th>Backplane Material</th>
<th>Channel length</th>
<th>Far end crosstalk?</th>
<th>Max pattern length</th>
<th>BER</th>
</tr>
</thead>
<tbody>
<tr>
<td>N4000-13SI</td>
<td>1m</td>
<td>No</td>
<td>$2^{11-1}$</td>
<td>$&lt;4\times10^{-13}$</td>
</tr>
<tr>
<td>FR408</td>
<td>1m</td>
<td>No</td>
<td>$2^{11-1}$</td>
<td>$&lt;2\times10^{-13}$</td>
</tr>
<tr>
<td>FR408</td>
<td>1m</td>
<td>Yes</td>
<td>$2^{7-1}$</td>
<td>$&lt;1.45\times10^{-15}$</td>
</tr>
</tbody>
</table>

Measurements made by Xilinx

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Eye Diagrams

- FR408 backplane eyes with pre-emphasis, before receiver equalization

No crosstalk

With crosstalk

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Interoperability data

- Backplane included in OIF interoperability tests
- Tested with silicon from four providers
- Interoperability successfully demonstrated at 10 Gbps on the 1 m channel
Summary

- Isola FR408 backplane
  - GbX connectors
- 1m, 1.25m channels
- S-parameter measurements up to 15 GHz
  - Posted to IEEE and OIF
- Demonstrated data transmission at 10 Gbps
  - Measured BER \( \sim 1 \times 10^{-15} \)
- Compared with Nelco 4000-13SI backplane
  - Slight return loss decrease
  - Slight insertion loss increase
  - Comparable performance at lower cost

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Thank You