A 224 Gbps-PAM4 High-Loss Chip-to-Module Channel with 92 Ohm Impedance and Its Characteristics

Mike Li, Kunia Aihara, Jenny Jiang, Hsinho Wu, Masashi Shimanouchi, Ram Muthukaruppan, Zhiguo Qian, Ilia Radashkevich, Itamar Levin, Ariel Cohen (Intel)
Ali Hammoodi, Sam Kocsis, Michael Rowlands (Amphenol)

January, 2023
Background and Introduction

• Update to Q4’22 presentation “A 224 Gbps-PAM4 High-Loss Chip-to-Module Channel and Its Characteristics” (oif2022.498.00), with
  – Channel PCB impedance be changed to 92 ohm, a proposed change for 224 Gbps channel

• Progress history
  – Update to Q3’22 presentation “224 Gbps Chip-to-Module Link Simulation and Analysis Update 2” (oif2022.355.00), with
    • Updated chip-to-module channel which is based on a real/practical high-density/radix switch device and board design
C2M Channel

To Host IC

- FTR PCB Model
  - 82.8mil
  - 10-inch (85/92Ω)
  - 82.8mil
  - Connector (92Ω)
  - 1-inch (85/92Ω)

To Module

- RX6
- RX8
- TX7

IEEE

Jan 2023
Trace Model

85 Ω

92 Ω
TDR Comparison

C2M From Host PCB (Rev 0.8) End Differential Impedance

- Red line: 92 Ω
- Blue line: 85 Ω

C2M From Module End Differential Impedance

- Red line: 92 Ω
- Blue line: 85 Ω

BGA, Connector, HCB
Return Loss Comparison – 85 Ω Termination

85 Ω showed better return loss than 92 Ω with 85 Ω termination
Return Loss Comparison – 92 Ω Termination

92 Ω showed better return loss than 85 Ω with 92 Ω termination
Insertion Loss Comparison – 85 Ω Termination

92 Ω showed ~ 0.6 dB worse insertion loss than 85 Ω for a 10-inch board with 85 Ω termination
~ 0.5 dB worse for an 8-inch board
Insertion Loss Comparison – 92 Ω Termination

92 Ω showed ~ 0.6 dB worse insertion loss than 85 Ω for a 10-inch board with 92 Ω termination.

~ 0.5 dB worse for an 8-inch board.
Cross Talk Comparison – 85 Ω Termination

Similar Cross talk performance, 92Ω slightly better due to slightly higher IL (with 85 Ω termination)
Cross Talk Comparison – 92 Ω Termination

Similar Cross talk performance, 92Ω slightly better due to slightly higher IL (with 92 Ω termination)
Summary

• Updated a high-loss chip-to-module channel to 92 ohm impedance based on a high-density/radix switch device and board design

• Key characteristics
  – Results are for 10 inch channel, similar trend for 8 inch channel

<table>
<thead>
<tr>
<th>Termination</th>
<th>CH RL (92/85 ohm)</th>
<th>CH IL (92/85 ohm)</th>
<th>CH xtalk (92/85 ohm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>92 ohm</td>
<td>slightly better/worse</td>
<td>0.6 dB worse/better</td>
<td>slightly better/worse</td>
</tr>
<tr>
<td>85 ohm</td>
<td>slightly worse/better</td>
<td>0.6 dB worse/better</td>
<td>slightly better/worse</td>
</tr>
</tbody>
</table>