224 Gbps-PAM4 CR Link Simulation and Analysis with a 1 Meter DAC Channel: Design B

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Background and Introduction (I)

• An important use case of 224 Gbps-PAM4 is the cable reach (CR) with a 1 Meter DAC.

• We have created a CR channel to support 1 Meter DAC (oif2023.183.00, li_3dj_09_2305).
Background and Introduction (II)

- We leveraged our established/validated CR/LR simulation/modeling tool-flow-methodology (TFM) (e.g., oif2022.067.00), updated reference package (oif2023.172.00, li_3dj_02_2305), and reference TX, RX to provide link simulation and analysis with this newly created CR/LR channel Design B.
Preliminary 224Gbps PAM4 CR End-to-End COM Analysis

• Proposed CR/LR End-to-End COM configuration
  – DER: $10^{-4}$
  – Reference TX
    • Output amplitude ($A_v/A_{fe}/A_{ne}$): 0.413/0.413/0.608
    • RLM = 0.95, $SNR_{Tx}=33$dB, $A_{DD} = 0.02U_{pk}$, $RJ = 0.01U_{RMS}$
    • 20%-80% Rise/Fall Time ($T_r$): 4ps
    • TX FIR: 4-pre-, 1-post taps
    • TX Die: No change (see oif2022.065.02, mli_3df_01a_220316.pdf)
    • Termination impedance ($R_d$): 46.25 ohms
    • TX Package:
      – $Z_p = 33$mm, $Z_{p2} = 1.8$mm
      – $\gamma_0 \text{ and } a_2 \text{ are updated} \text{ (see oif2023.172.00, li_3dj_02_2305)}$

– Reference Receiver
  • RX Die: Same as TX die
  • Termination impedance ($R_d$): 46.25 ohms
  • RX Package:
    – Same as TX, $Z_p = 31$mm
  • Noise Filter BW ($f_r$) = 0.5 * fb
  • RX EQ
    – CTLE: 2x Scaled from 802.3ck
    – RX FFE: Fixed: 6 pre- + 24 post-taps
    – Floating Taps: 4 groups of 5 consecutive floating taps up to 60 UI
    – RX MLSD: 1 tap, $b_{max} = 0.85$
  • $\eta_0$: $5 \times 10^{-9}$ V²/GHz
### Table 93A

<table>
<thead>
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<th>Parameter</th>
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<th>Units</th>
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</tr>
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<td>GBd</td>
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<tr>
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<td>GHz</td>
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<tr>
<td>$\Delta_f$</td>
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<td>GHz</td>
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### Table 92

<table>
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<th>Parameter</th>
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<tr>
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<tr>
<td>$z_{p</td>
<td>rx}$</td>
<td>TX RX</td>
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<tr>
<td>$z_{p</td>
<td>tx}$</td>
<td>TX RX</td>
<td>110.3</td>
</tr>
</tbody>
</table>

### Notes:
- Changes are marked in yellow.
- COM v4.0 was used in this study.
Preliminary 224Gbps PAM4 CR end-to-end COM Analysis

Case 1

- 2x FEXT + 1 x NEXT
- FFE Taps = (6+M+24) + 4x5
- COM = 3.34 dB
- DER = 1e-4

CH22
Summary

• This 40 dB (bump-to-bump) CR channel (Design A) can be supported with a COM 3.34 dB, at a DER of 1e-4, with the newly developed ref TX, RX, and PKG.

• The newly developed ref TX, RX have the following key characteristics/capabilities:
  – TX FIR: 4-pre-, 1-post taps
  – RX FFE fixed: 6 pre- + 24 post-taps
  – RX FEE floating: 4 groups of 5 consecutive floating taps up to 60 UI
  – RX MLSD: 1 tap, bmax = 0.85