400GBASE-DR4 link budget discussion

IEEE P802.3bs, IEEE Interim

September 2016, Fort Worth, Texas

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Re: Comment 112 on 400GBASE-DR4

Cl **124** *SC* **124.7.1** *P* **294** *L* **9** # 112

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Comment Type **T** *Comment Status* **D**

The receiver sensitivity specs for 400GBASE-DR4 are marginal to what is technically feasible for a high volume product, and an additional 0.3 link loss capability is required.

SuggestedRemedy

Move Tx_OMA specs (and dependents) up 0.8 dB, and Rx sensitivity specs (and dependents) up 0.5 dB, to reduce burden on Rx and increase channel insertion loss budget by 0.3 dB. With editorial licence, the details are: In Table 124-6:Increase Tx_OMA-TDECQ from -1.3dBm to -0.5 dBm also Increase OMAouter (max) from 4.2dBm to 5.0dBm. Increase OMAouter (min) from -0.3dBm to 0.5dBm. Increase Average launch power (max) from 4dBm to 4.8dBm. Increase Average launch power (min) from -5.4dBm to -4.6dBm. In Table 124-7:Increase 'Receive sensitivity (OMAinner), each lane (max)' from -9.2dBm to -8.7dBm; also Increase 'Stressed receiver sensitivity (OMAouter), each lane (max)' from -1.9dBm to -1.4dB; Increase 'Receive power, each lane, OMAouter (max)' from 4.2dBm to 5dBm; Increase 'Average receive power, each lane (max)' from 4dBm to 4.8dBm; Increase 'Average receive power, each lane (min)' from -2.4dBm to -1.6dB; Increase 'OMAouter of each aggressor lane' from 4.2dBm to 5.0 dBm. See presentation king_3bs_02_0916.

Comment 112 summary and update

- Original comment proposes to
  - increase the 400GBASE-DR4 loss budget from 3.0 to 3.3 dB
  - move the TX and RX OMA specs up, to increase the manufacturing margin for the receiver, based on expected receiver sensitivity, by 0.5 dB
- Comment was discussed on the SMF ad hoc call (30th August, 2016)
  - There was reasonable agreement on the call and on the 400G reflector that the additional 0.3 dB loss budget should not be a requirement for 400GBASE-DR4
  - More discussion was felt necessary to address the proposal to improve receiver manufacturability margins.

DR4 Receiver sensitivity calculation

- TIA input referred noise (total RMS) of 3 µA (15 pA/rt-Hz, 40 GHz noise bandwidth), Q of 3.5 for KP4 FEC, and 0.9 A/W p/d responsivity, gets to an ideal noise limited inner eye sensitivity of -16 dBm. This might be the sensitivity achievable with a single channel 'gold box' receiver with very good coupling.
- For a high volume/low cost implementation we would add:
  - 1 dB for receiver chain implementation penalty (non-ideal frequency response and electrical reflections)
  - 3.5 dB for a silicon photonics based grating coupler
  - 1 dB for crosstalk penalty (which may be optimistic, since PAM4 is 3x more sensitive to crosstalk effects than NRZ)
  - 3 dB of manufacturing margin (the high yield, low cost, rule of thumb)
- This would give a manufacturable spec for equivalent inner eye sensitivity of -7.5 dBm.
- The current 802.3bs draft 2.0 spec is equivalent to -9.2 dBm inner eye sensitivity, 1.7 dB below what we think is a manufacturable spec, ie in our estimation the current draft has just 1.3 dB of manufacturing margin.

Updated proposed remedy

- Shift Tx OMA specs up by 0.5 dB
  - and consequent specs
- Shift Rx stressed sensitivity up by 0.5 dB
  - and other consequent specs

- Discussion….