Consideration on Tx/Rx OMAouter for DR4, FR4-500 and FR4

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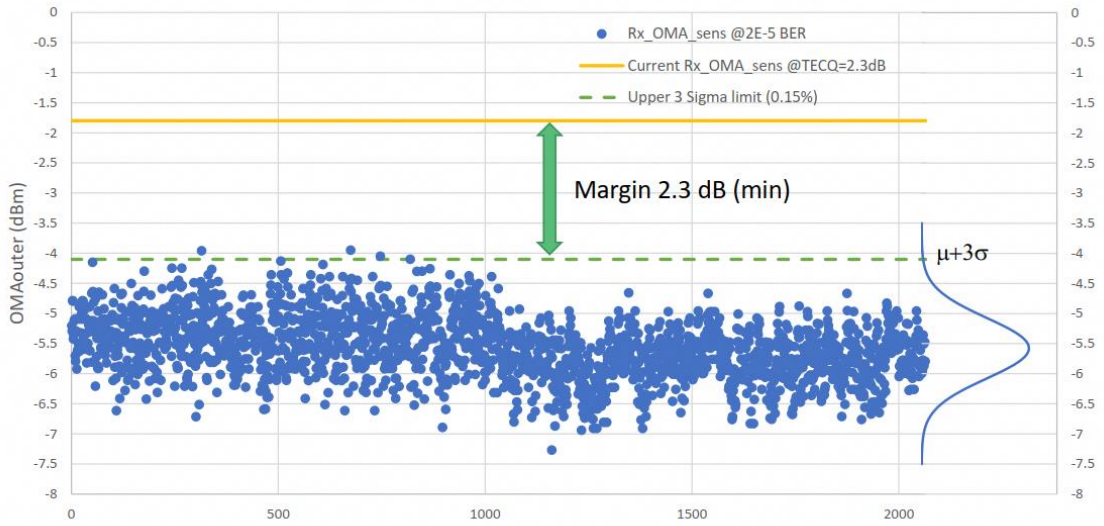
Background

- The 802.3dj PMD baseline for 800GBASE DR4, FR4-500 and FR4 was discussed based on welch_3dj_03b_2309, welch_3dj_04_2309 and welch_3dj_01a_2401 proposal.

- At the January meeting, Tx/Rx OMAouter was once again discussed as a key parameter, which caught our attention. Michael He presented the test data based 1.6T 2×FR4-500 in he_3dj_01b_2601. Rx OMAouter sensitivities were tested @ pre-FEC BER 2E-5. According to experimental data，Michael He proposed to reduce 0.7dB for Rx_sens_OMA_max for FR4-500 and FR4, and reduce Tx OMA_min spec by 0.7dB accordingly to maintain same link loss budget.



Current Specs	DRx	FR4-500	DRx-2	FR4	LR4	Unit
Tx OMAouter, each lane (min) for TECQ ≤ 0.9 dB	-0.1	0.9	0.1	0.8	1.9	dBm
Rx sensitivity (OMAouter), each lane (max) for TECQ ≤ 0.9 dB	-3.4	-3.2	-4.4	-3.7	-5.5	dBm

Proposed Specs	DRx	FR4-500	DRx-2	FR4	LR4	Unit
Tx OMAouter, each lane (min) for TECQ ≤ 0.9 dB	-0.1	0.2	0.1	0.1	1.9	dBm
Rx sensitivity (OMAouter), each lane (max) for TECQ ≤ 0.9 dB	-3.4	-3.9	-4.4	-4.4	-5.5	dBm

- However, Michael He’ s proposal only includes the test data for FR4-500, so the data for DR4 and FR4 was tested to observe whether the Tx/Rx OMAouter needs to be modified in this presentation.

Rx OMAouter Sensitivities Distribution for DR4

- The Rx DUTs are Sipho based 1.6T 2xDR4, the TECQ of the test Tx is in range of 2.5-2.8 dB
- As the analysis of Michael He's proposal indicates, Rx OMAouter sensitivities were tested @pre-FEC BER 2E-5, which should be adequate for receiver error mask.
- The distribution covers more than 700 data samples (32pcs x 8ch x 3-temp). The max Rx OMA sens keeps ~2.1dB margin from 2xDR4 spec @TECQ=2.5dB

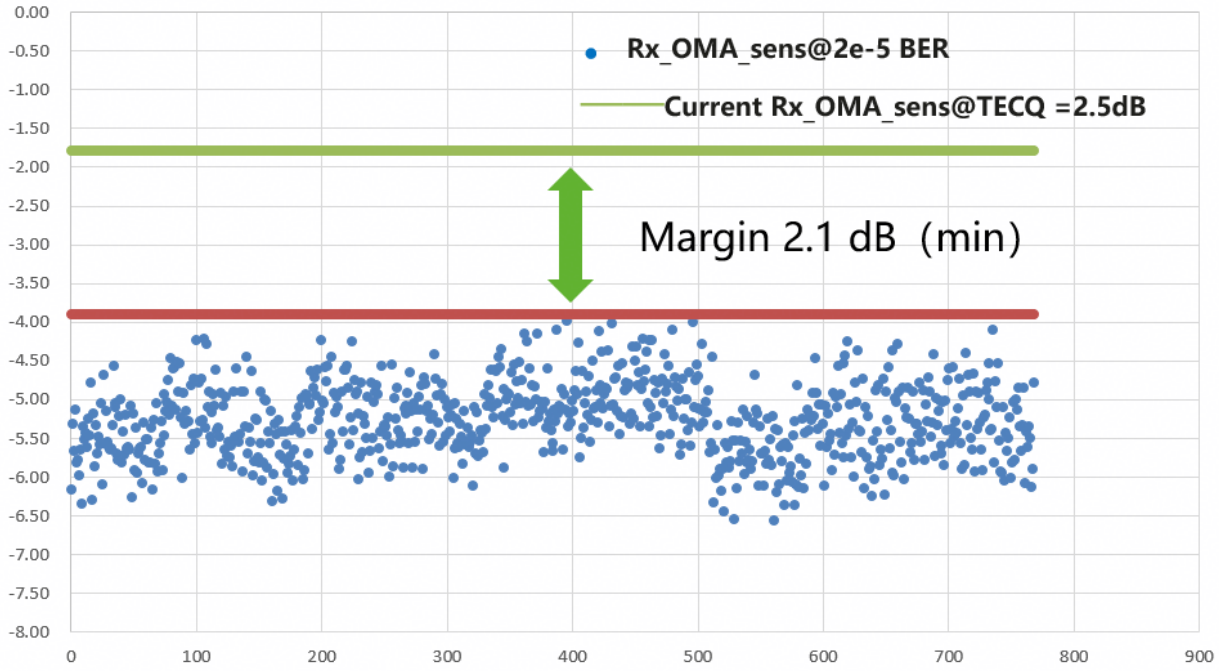
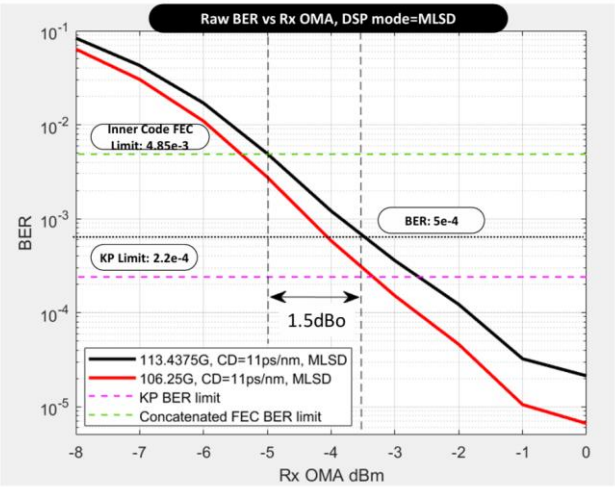


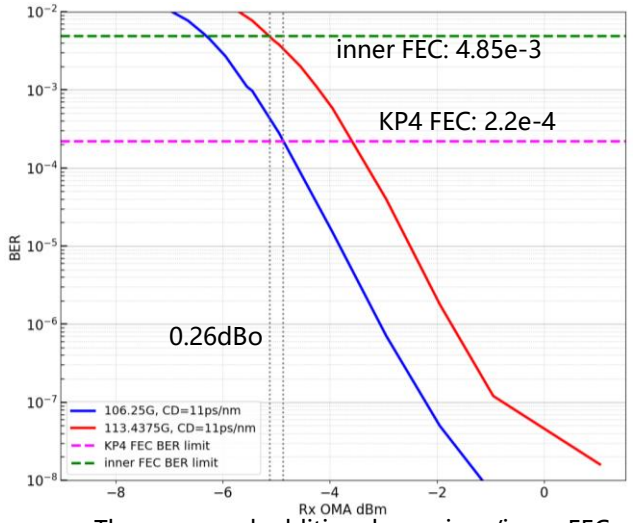
Table 180–8—200GBASE-DR1, 400GBASE-DR2, 800GBASE-DR4, and 1.6TBASE-DR8 receive characteristics

Description	Reference	Value	Unit
Receiver sensitivity (OMA_{outer}), each lane[c] (max) for TECQ < 0.9 dB for 0.9 dB ≤ TECQ ≤ SECQ	180.9.15	 –3.4 –4.3 + TECQ	dBm
Stressed receiver sensitivity (OMA_{outer}), each lane[c] (max)	180.9.16	–0.9	dBm
Conditions of stressed receiver sensitivity test[d]:			
Stressed eye closure for PAM4 (SECQ), lane under test	—	3.4	dB
OMA_{outer} of each aggressor lane[e]	—	4.2	dBm

The comparison of additional margin w/inner FEC based on simulation and test for FR4



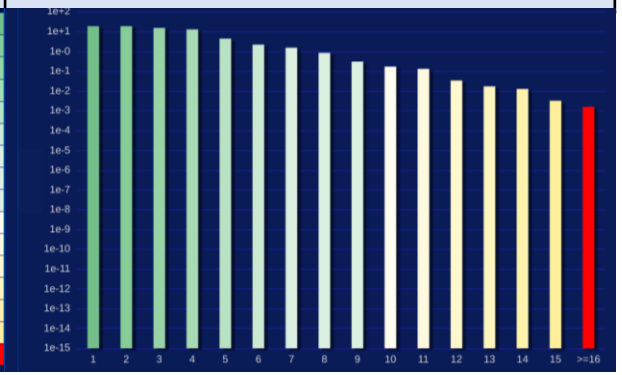
The simulated additional margin w/inner FEC in [parthasarathy_3dj_01_23013]



The measured additional margin w/inner FEC

Number of symbol error in codeword	Number of codewords	percentage
1	3241449	3.13616e+1
2	2789193	2.69859e+1
3	1841032	1.78123e+1
4	1111110	1.07502e+1
5	632427	6.11884e+0
6	348224	3.36913e+0
7	184920	1.78913e+0
8	94833	9.17525e-1
9	48098	4.65356e-1
10	23404	2.26438e-1
11	11438	1.10665e-1
12	5446	5.26910e-2
13	2409	2.33075e-2
14	1069	1.03428e-2
15	483	4.67311e-3
>=16	202	1.95438e-3

Probability distribution

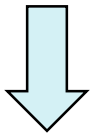


The probability distribution of symbol error in codeword

- The BER vs Rx OMA data was tested based on the channel with the maximum dispersion of FR4, and it shows that the additional margin with inner FEC is only 0.26dBo.
- The test data for FR4 shows that the additional margin with inner FEC is not as ideal as the simulation predicted. As there is currently no conclusive evidence to suggest that the Tx/Rx OMAouter for FR4 should also be reduced, the presentation suggests that the Tx/Rx OMAouter for FR4 keep unchanged to avoid the risk of bit errors.

Proposed updates for 802.3dj optical PMD Tx/Rx OMAouter Specs

Current Specs	DRx	FR4-500	DRx-2	FR4	Unit
Outer optical modulation amplitude (OMAouter), each lane (min) for max(TECQ, TDECQ) < 0.9 dB for 0.9 dB ≤ max(TECQ, TDECQ) ≤ 3.4 dB	-0.1 –1 + max(TECQ, TDECQ)	0.9 max(TECQ, TDECQ)	–0.1 –1 + max(TECQ, TDECQ)	0.8 –0.1 + max(TECQ, TDECQ)	dBm
Receiver sensitivity (OMAouter), each lane (max) for TECQ < 0.9 dB for 0.9 dB ≤ TECQ ≤ SECQ	–3.4 –4.3 + TECQ	–3.2 –4.1 + TECQ	–4.4 –5.3 + TECQ	–3.7 –4.6 + TECQ	dBm



Current Specs	DRx	FR4-500	DRx-2	FR4	Unit
Outer optical modulation amplitude (OMAouter), each lane (min) for max(TECQ, TDECQ) < 0.9 dB for 0.9 dB < max(TECQ, TDECQ) < 3.4 dB	**-0.6** **–1.5 + max(TECQ, TDECQ)**	**0.2** **-0.7+max(TECQ, TDECQ)**	–0.1 –1 + max(TECQ, TDECQ)	0.8 –0.1 + max(TECQ, TDECQ)	dBm
Receiver sensitivity (OMAouter), each lane (max) for TECQ < 0.9 dB for 0.9 dB < TECQ < SECQ	**–3.9** **–4.8 + TECQ**	**–3.9** **–4.8 + TECQ**	–4.4 –5.3 + TECQ	–3.7 –4.6 + TECQ	dBm

From he_3dj_01b_2601

- For DR4, Rx_sens_OMA_max and Tx OMA_min can be reduced 0.5dB based on the test data in this presentation.

Summary

- This presentation has displayed a substantial amount of test data showing Rx Sensitivity with good margin vs. baseline Rx_Sens specification for DR4.
- As stated in Michael He’ s proposal, shifting Rx_sens_OMA_max and Tx OMA_min to lower level will lead to savings in bothe power consumption and cost.
- Suggesting to reduce 0.5dB of Rx_sens_OMA_max and Tx OMA_min for DR4 due to good margin and cost-effectiveness.
- However, the test data in this presentation indicates that the Tx/Rx OMAouter for FR4 should keep unchanged to avoid the risk of bit errors. More evidence is needed if wanting to change it.

Thanks