

Power budget analysis of coherent 800G PDM-32QAM for LR application

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Introduction

- In objectives_b400g_210826^[1], the following objective of 800GbE rate was adopted.
 - Define a physical layer specification that supports 800Gb/s operation over a single SMF in each direction with lengths up to at least 10km.
- B400G coherent solution for 10km telecom and campus networks has been proposed to have a competitive advantage over IM-DD solutions^[2].
- Our off-line experiments of coherent solution show promising performance to achieve the goal^[3].
- This contribution focuses on coherent PDM-32QAM solution as an option for 800G LR1.
 - Power budget recommendation for 800G coherent 10km.
 - Power budget analysis of coherent PDM-32QAM solution.

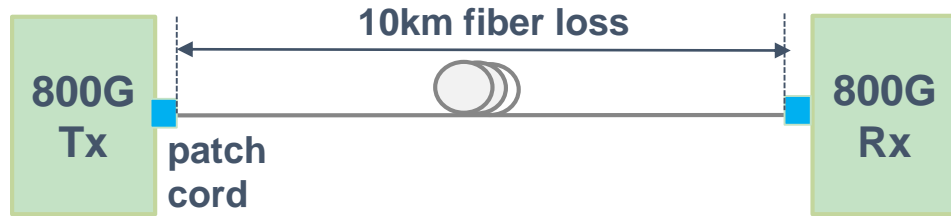
[1] https://www.ieee802.org/3/B400G/proj_doc/objectives_b400g_210826.pdf

[2] https://www.ieee802.org/3/B400G/public/21_07/lam_b400g_01a_210720.pdf

[3] https://www.ieee802.org/3/B400G/public/21_09/zhang_b400g_01a_210909.pdf

Link model and power budget

Link Model(10km unamplified)



Power Budget

- Maximum attenuation coefficient of 0.28dB/km and 0.43dB/km for C band and O band respectively^[4].
- Total connection and splice loss of 2dB(refer to 100GBASE-LR1)^[5].
- Overall link penalty(CD+SOP+PMD+PDL) assumed to be 1dB for C band, and 0.5dB for O band since CD is negligible.
- 5.8dB and 6.8dB power budget is recommended for C band and O band respectively.

[4] Rec. ITU-T G.695 (07/2018) Appendix I: Table I.1 – Assumed attenuation coefficient values

[5] IEEE Std. 802.3cu™-2021 : Clause 140.10.2.1

[6] OIF-400ZR-01.0 : Clause 13.2

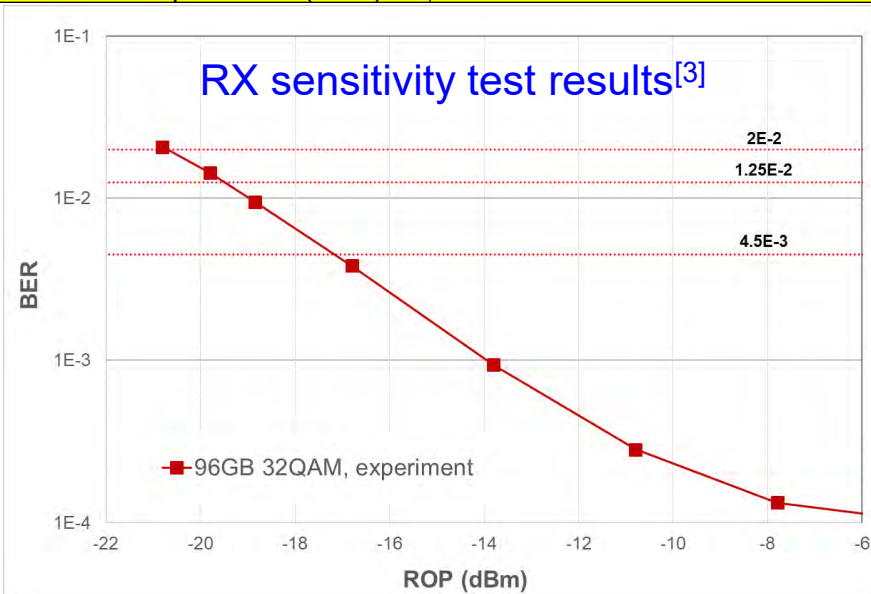
	C band	O band
Maximum Distance(km)	10	10
Maximum Fiber Attenuation(dB/km)	0.28	0.43
Maximum Fiber Loss(dB)	2.8	4.3
Maximum Point Loss (Patch Panels, Connectors, Splices)(dB)	2	2
Maximum Channel Insertion Loss(dB)	4.8	6.3
Allocation for Link Penalties(dB)	1	0.5
Total Power Budget(dB)	5.8	6.8

for C band application	OIF 400ZR ^[6]	800LR
Baudrate(GB)	60	96?
Modulation Format	16QAM	32QAM
CD Tolerance(ps/nm)	1200	200
PMD Tolerance(ps)	7	5
Peak PDL Tolerance(dB)	1.5	1.5
SOP Change Tolerance(krad/s)	50	50
Overall Link Penalty(dB)	0.5(measured)	1(estimated)

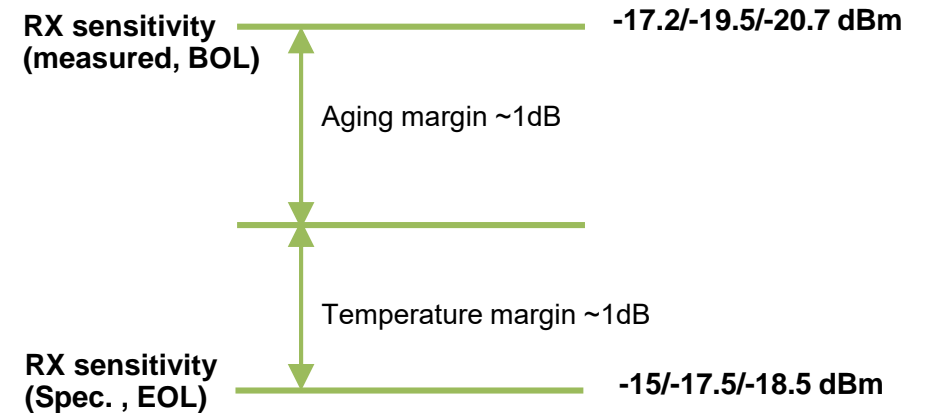
TOP and RX sensitivity of PDM-32QAM

- Transmitter output power (TOP)
 - TOP spec. of -9dBm is proposed over temperature and lifetime for a fixed wavelength of C band based on test results.
 - -9dBm is also achievable for O band with proper optimization of the design of optics.

EOL spec. over temperature	Fixed Wavelength @C band or O band(estimated)
Laser Output Power(dBm)	16.5
Transmitter Total Loss(dB)	25.5
Transmitter Output Power(dBm)	-9

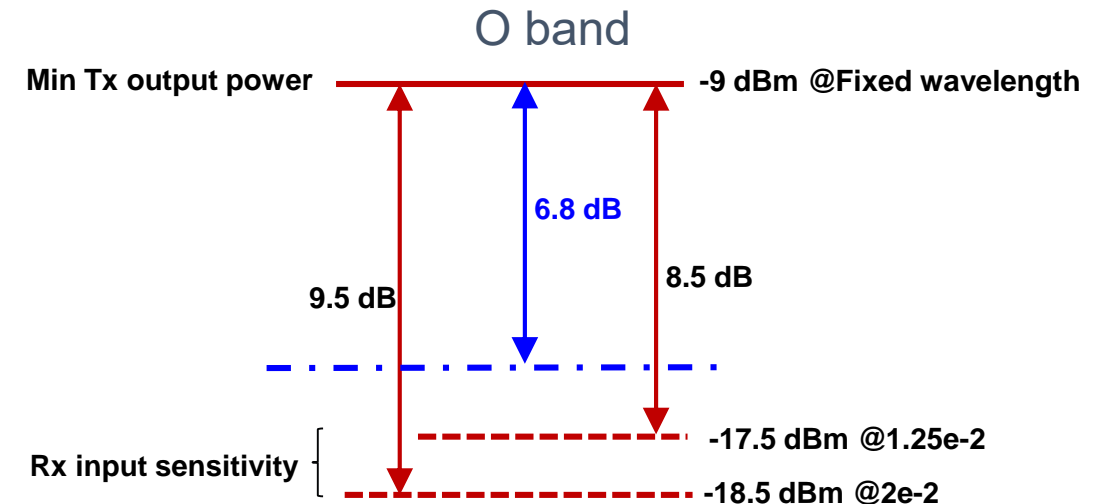
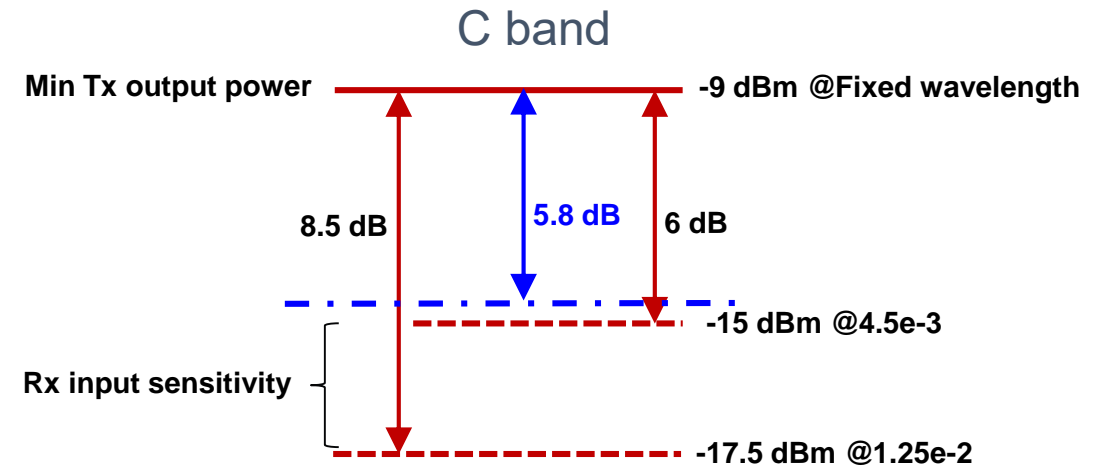


- RX sensitivity
 - Performance of -17.2dBm@4.5e-3, -19.5dBm@1.25e-2 and -20.7dBm@2e-2 with a BER floor of ~1e-4 is obtained for C band based on our offline platform^[3].
 - The same performance for O band because of the broad absorption spectrum of PD responsivity.
 - ~2dB margin, including 1dB over lifetime and 1dB over temperature, need to be considered in the spec.



Power margin of coherent PDM-32QAM

- C band
 - Given 5.8dB power budget for 10km, there is still 0.2dB power margin for coherent PDM-32QAM with pre-FEC BER of $4.5e-3$.
- O band
 - Given 6.8dB power budget for 10km, pre-FEC BER of $1.25e-2$ has 1.7dB power margin for coherent PDM-32QAM.
 - Pre-FEC BER of $4.5e-3$ might be a potential option if further optimizations made for OE components and DSP.



Summary

- Power budget of 5.8dB and 6.8dB are proposed for 800G LR1 coherent solution for C band and O band respectively.
- There is little difference of the transmitter output power and receiver sensitivity between O-band and C-band if the OE components are optimized.
- coherent PDM-32QAM @C band with pre-FEC BER lower than $4.5e-3$ is a promising solution for 800G LR1.
- Coherent PDM-32QAM @O band with pre-FEC BER lower than $1.25e-2$ is also an option.

