In support of 3.5 dB Extinction Ratio for 200GBASE-DR4 and 400GBASE-DR4

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Supporters

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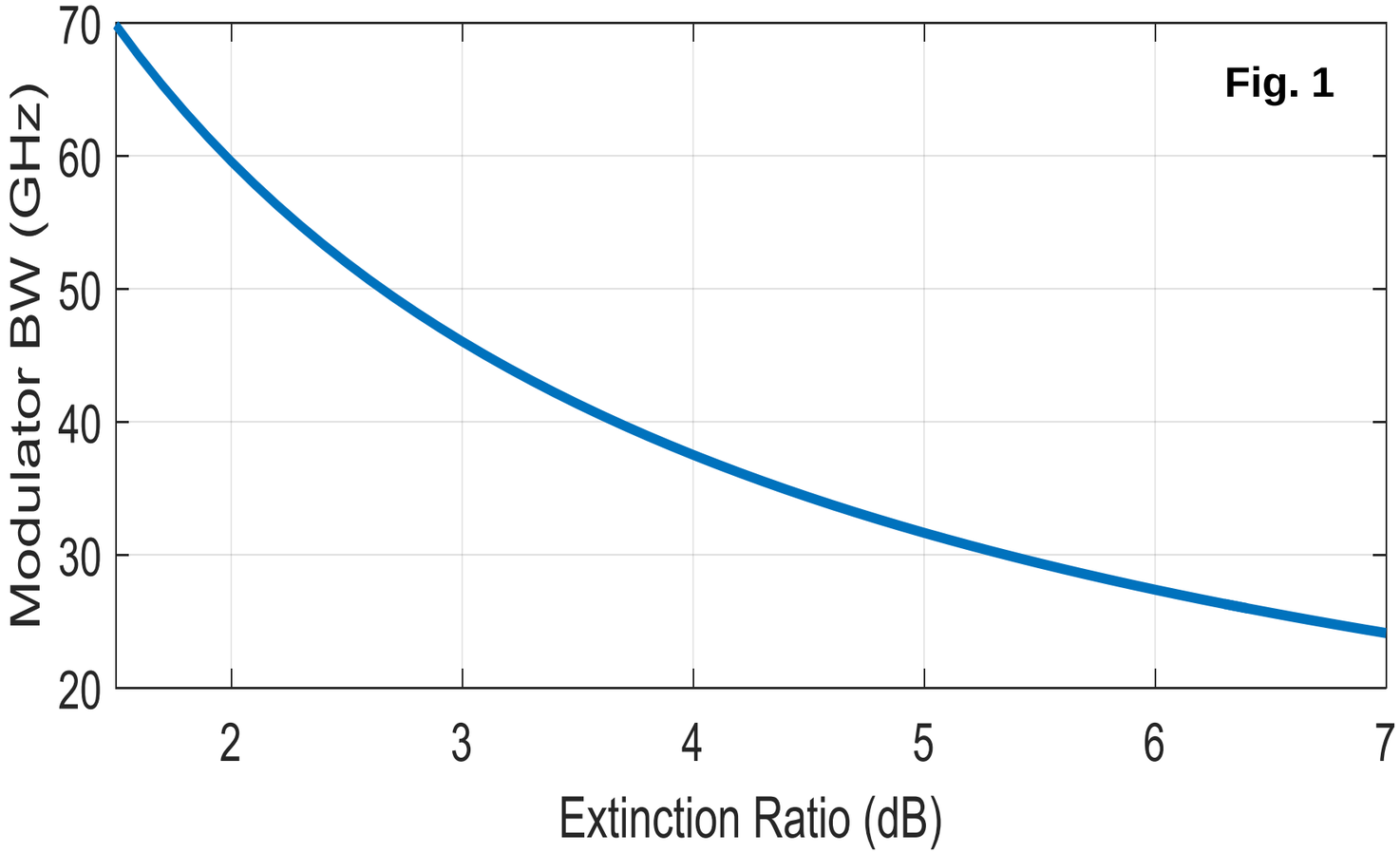
Introduction

- In Jonathan King's presentation (king_3cd_02_0317.pdf), MPI modeling shows that the Extinction Ratio spec for 100GBASE-DR and 400GBASE-DR4 could be reduced to 3.5 dB with an almost negligible increase in MPI penalty (0.03 dB penalty by reducing ER from 4.5 dB to 3.5 dB for 100GBASE-DR)
- Reducing ER to 3.5 dB enables low-cost, low-power DML approach
- In addition to DML lasers, in this presentation, we show that a 3.5 dB ER spec also enables low-cost, low-power Silicon Photonics (SiP) EAM solutions
- We recommend to change ER spec to 3.5 dB for 200GBASE-DR4, 400GBASE-DR4, and 100GBASE-DR in the P802.3cd project
  - Drafts have 4.5 dB for 200GBASE-DR4 and 5 dB for 100GBASE-DR and 400GBASE-DR4
  - In March, comments bs 127,148 and 151, and cd 138, 200, 139 and 211, proposed 3 dB or 3.5 dB ER and were referred for further study and consensus building
  - While comments bs 57 and 58, and cd 129 and 130, to adjust the Tx off and signal detect limits to allow for the related abilities of EAMs in "DC" operation, were accepted

ER	*Extinction ratio*
DML	*Directly modulated laser*
EAM	*Electro-absorption modulator*
MPI	*Multi path interference*

Reduce ER specification for 200G/400G DR4

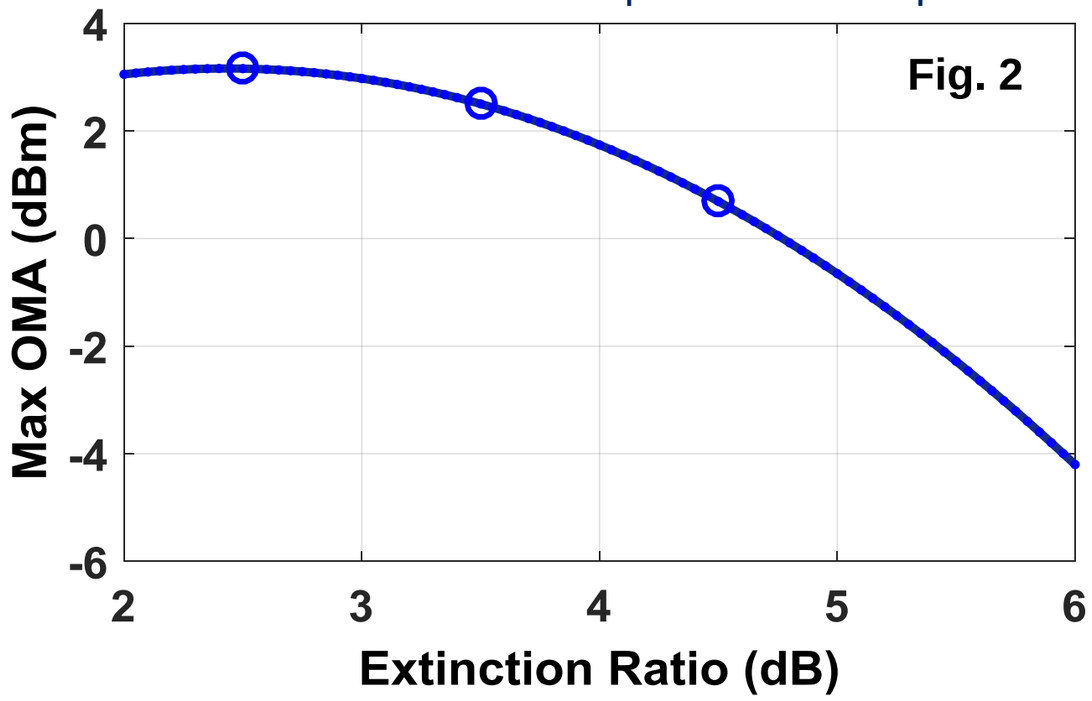
- 50 GBd PAM4 modulation requires a large modulator bandwidth
- Achieving high ER requires a longer device, increasing device capacitance and reducing the RC-limited bandwidth
- Fig.1 shows the modulator bandwidth vs. ER for a SiP EAM
- The modulator bandwidth increases by 10 GHz if ER is reduced from 5 dB to 3.5 dB
- Also reducing ER will lead to lower swing voltage which will reduce the driver power

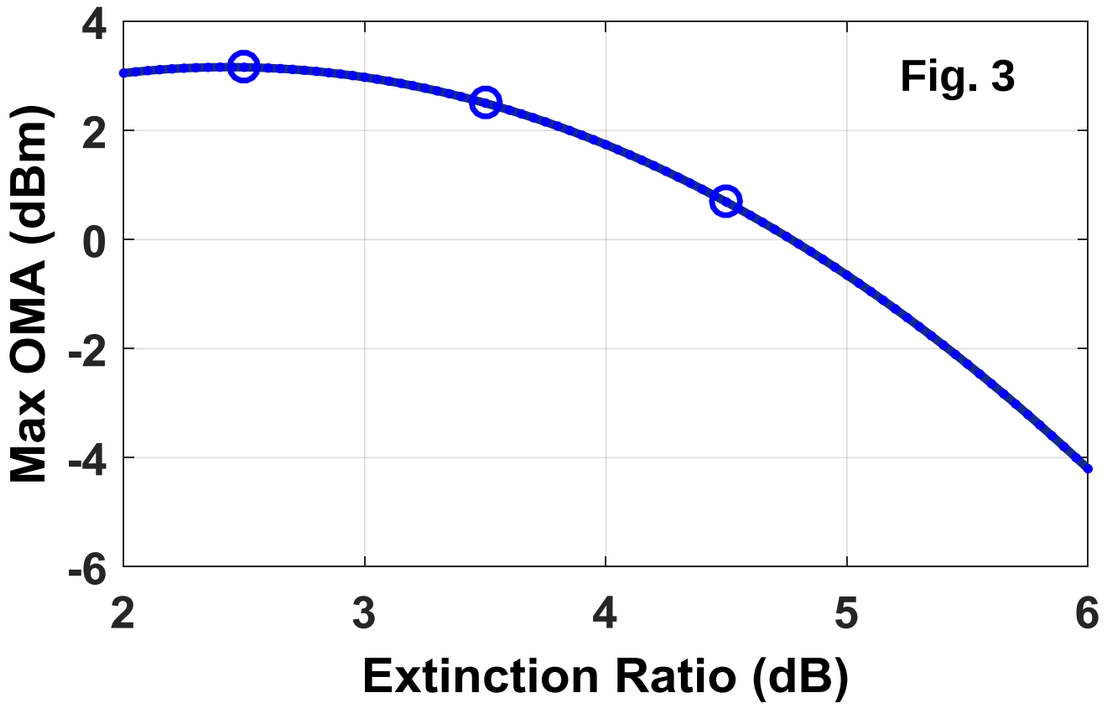


"OMA extinction ratio", not "SONET extinction ratio

Reduce ER specification for 200G/400G DR4

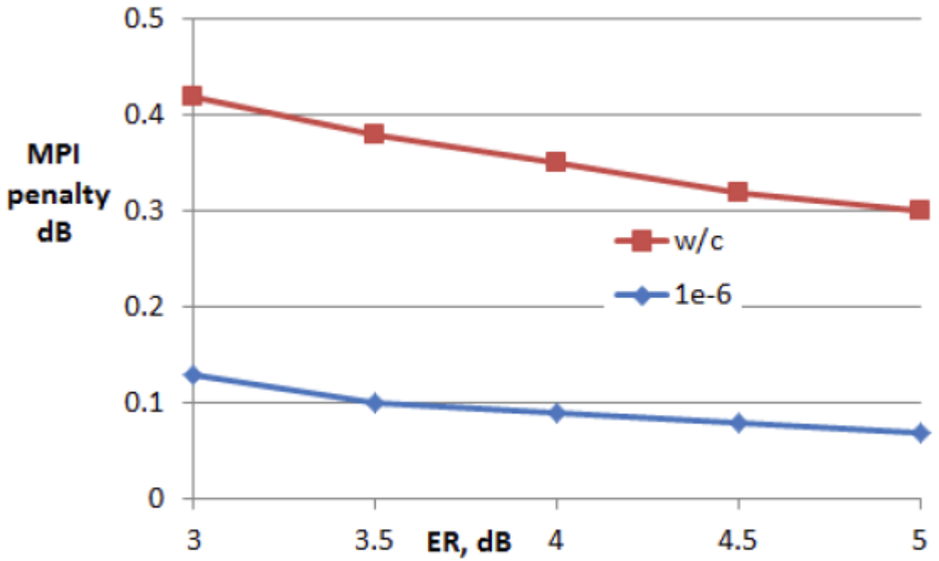
- Reaching a high ER is also possible with a short device. However, this requires operation near the EAM band edge causing the modulator to saturate at low optical power
- Fig. 2 shows a short modulator saturation power at the input of EAM vs. ER for a SiP EAM
- Fig. 3 shows the maximum OMA after SiP EAM vs. ER
- The saturation power increases by 3 dB and maximum OMA after Modulator increases by 3 dB (link insertion loss budget can increase by 3 dB) with reducing the ER from 5 dB to 3.5 dB. The improvement is much greater than the MPI penalty increase
- Better link for lower electrical power consumption





Consequential changes

- Very small changes to allocation for MPI penalty
- If more than rounding errors, could be accounted for by:
- Slight improvement in sensitivity, or
- Slight increase in transmit OMA-TDECQ limits, or
- Slightly adjusting OMA-TDECQ limit according to extinction ratio
  - Or equivalently, taking account of MPI in TDECQ calculation
  - E.g. OMA – TDECQ – fn(ER) > constant



From king_3cd_02_0317.pdf for 200BASE-DR4 and 400GBASE-DR4

MPI for different PHY types

PMD	Discrete reflections	IL (dB)	ER (dB)	MPI penalty (dB)	ER (dB)	MPI penalty (dB)
			Today's drafts		Proposed	
200GBASE-DR4	e.g. 4 at -45 dB	3	4.5	0.1	3.5	0.1 to 0.12 TBC
(50GBASE-FR), 200GBASE-FR4, 400GBASE-FR8	e.g. 4 at -35 dB	4	4.5	0.3	3.5	0.4 to 0.42 TBC
(50GBASE-LR), 200GBASE-LR4, 400GBASE-LR8	e.g. 4 at -33 dB	6.3	4.5	0.5	3.5	~0.55 to ~0.6 TBC
(100GBASE-DR)	e.g. 4 at -35 dB	e.g. 2.8	5	e.g. 0.3	3.5	Up to 0.5
400GBASE-DR4	e.g. 4 at -45 dB	3	5	0.1	3.5	0.13

Two MPI calculations gave slightly different results

IL: Channel insertion loss

Summary

- Jonathan King's MPI modeling already shows ER can be reduced to 3.5 dB with an almost negligible increase (0.03 dB for the 100GBASE-DR case) in MPI penalty.
- This will enable solutions based on a low-cost, low-power DML approach
- Here we have demonstrated additional benefits of reducing ER spec to 3.5dB for solutions deploying Silicon Photonics EAM modulators:
  - Bandwidth of SIP EAM can increase by 10 GHz
  - Decrease modulator driver power significantly by reducing the voltage swing required
  - Increase Tx OMA and hence improve link margin by as much as 3 dB which is much greater than the MPI penalty increase
- Reducing ER to 3.5 dB enables low-cost, low-power SiP EAM based solutions
- We recommend to change ER spec to 3.5 dB for 200GBASE-DR4, 400GBASE-DR4, and 100GBASE-DR in the P802.3cd project