Recommendation of lower minimum extinction ratio for 10GBASE-PR-U

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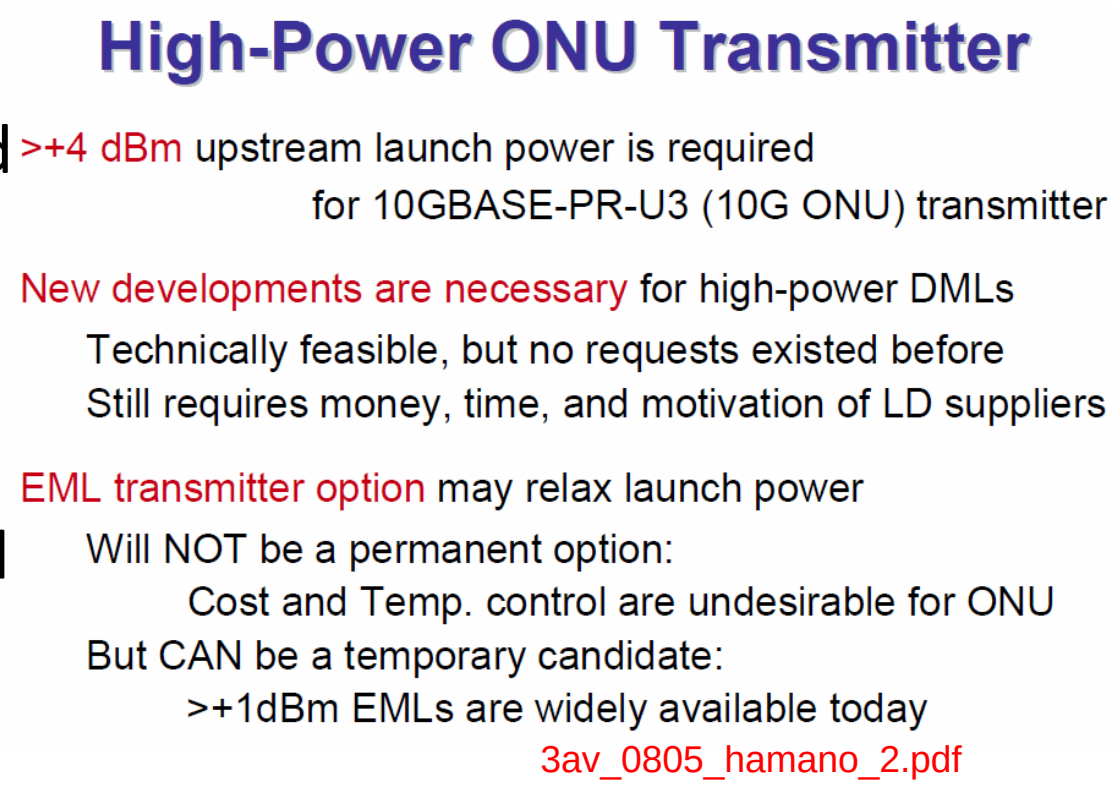
Overview

- Discussion about min. ER on OMA-AVP basis for 10GBASE-PR-U. Current is 6dB. However, 5.3dB is preferable.
  - Consistency with current standards.
  - OLT (10GBASE-PR-D) adopts lower ER.
  - Practical value with high yield and low cost.
  - Min. ER with marginal launch power compensation for APD receiver characteristic.
- It does NOT impact on current power budget table including launch power and sensitivity, also keeps nominal ER (6dB).
  - Nominal ER means ER which can have min. OMA and min. launch power here.

Current ER Option

- Current min. ER is 6dB and there is a reduced launch power option (Comment #1465; 2008-05).
  - This option allows for application of EML ONU transceivers.
  - Baseline adopts high power DML.
  - DFB has degraded frequency response at low power region.
- This is an another way from DML based solution.



Current Standard ER specification

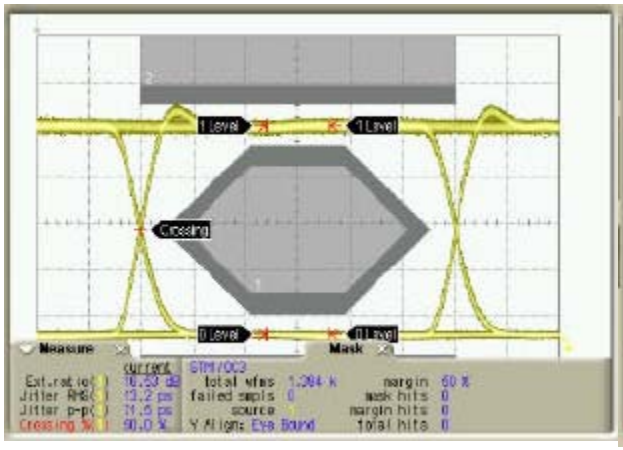
Min. ER=6dB	Min. ER=3.5dB	Min. ER=3dB
1000BASE-BX 10 20 (2004)	10GBASE-LR (2002)	10GBASE-ER (2002)
1000BASE-LX 10 20 (2004)	10GBASE-LX4 (2002)	Mainly for EML
1000BASE-PX 10 20 (2004)	10GBASE-LRM (2006)	

All standards define OMA-average power basis where lower extinction ratio is applicable.
Direct modulation min. ER is 3.5dB for 10G. (6dB for 1.25G.)

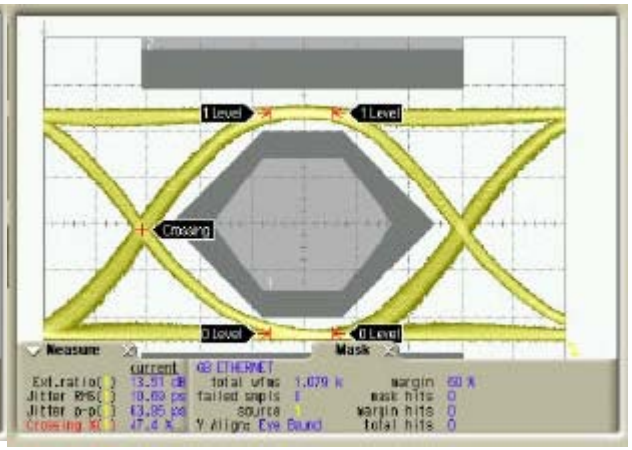
Reason for recommending 5.3dB
For PON ONU launch power range is as narrow as 5dB, there is little tuning space when setting 3.5dB ER.

Bit Rate Trend

- Example of a DML eye and ER at various bit rates.

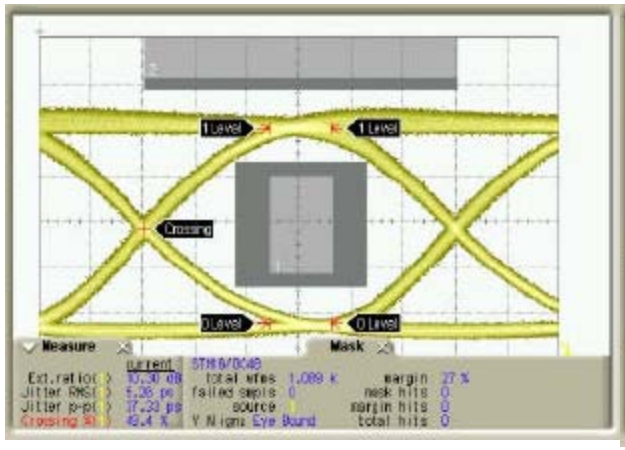


155M (16dB)

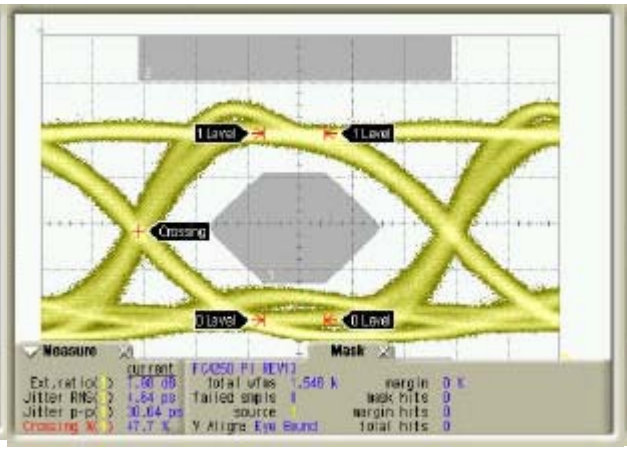


1.25G (13dB)

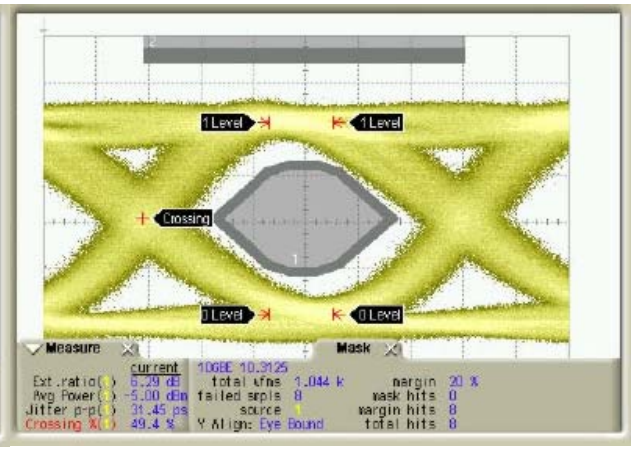
Vendor A



2.5G (10dB)



4.25G (8dB)

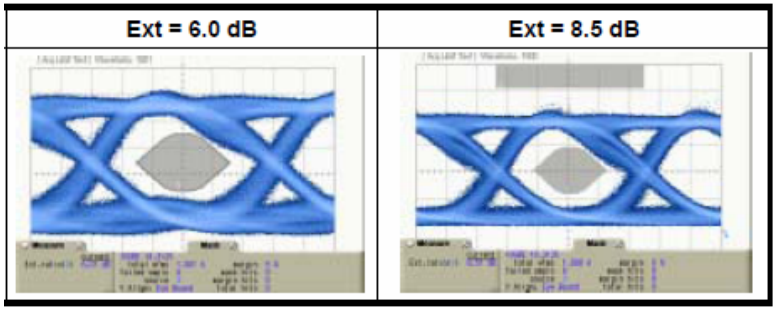


10.3G (6dB)

Feasibility and Productivity

- High power DML for 10GBASE-PR30-U is feasible.
- Operational ER range is limited
  - Better waveform and mask/jitter margin at lower side ER
  - Upper value is limited by 8-9dB due to relaxation oscillation
  - With consideration of temperature, aging, tracking error…
- Wider ER range is good for high yield and low cost.

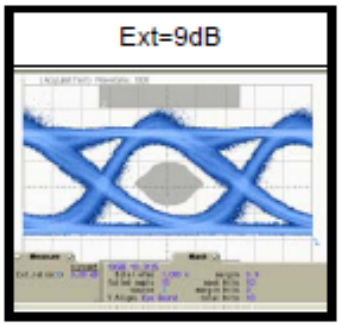
Transmitter setup (worst condition):
Worst waveform: No eye-mask margin ≒ 0 %
Power : +6 dBm (LD drive current is reduced by -40 %)



Vendor B

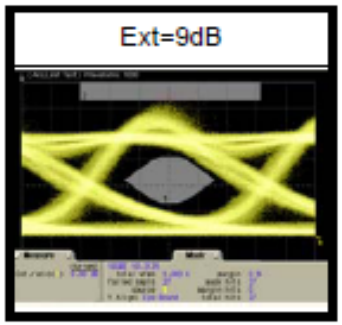
3av_0809_kozaki_1.pdf

Tc=70deg
+4dBm



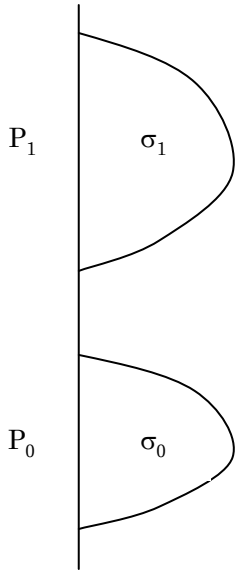
Vendor C

Tc=70deg
+6dBm



Vendor D

Receiver Impact



- APD causes additional receiver penalty
  - Actual device has a value between thermal noise limit and shot noise limit
- Over compensation with considering shot noise limit + α
  - 1dB additional launch power when 5.3dB ER

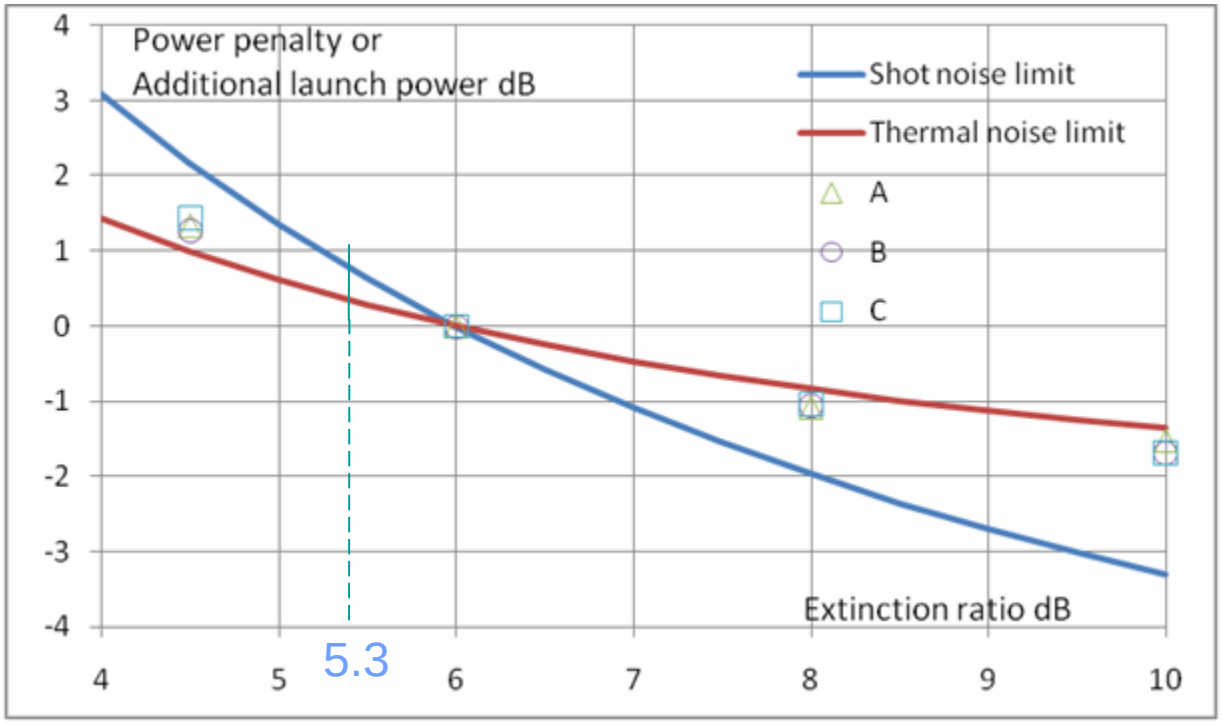
$$\sigma_{1S}^2 = 2qM^2F_ARP_1B$$

$$\sigma_{0S}^2 = 2qM^2F_ARP_0B$$

$$\sigma_{0t}^2 = \sigma_{1t}^2 = \frac{4kTF_nB}{R_L}$$

$$P_{sens} = \frac{1}{2}(P_1 + P_0)$$

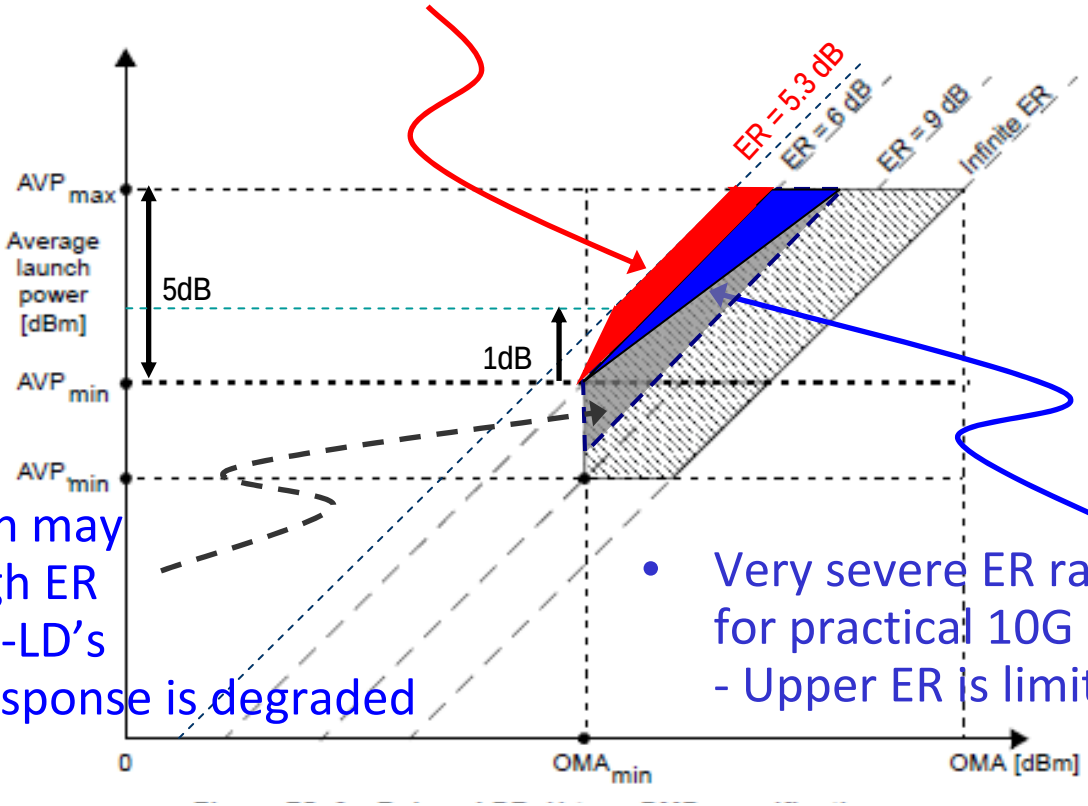
$$Q = \frac{MR(P_1 - P_0)}{\sigma_1 + \sigma_0}$$



Summary

- 5.3dB min. ER is a practical selection with considering high volume/ low cost solution.

- Expanding ER operating range of more than 5.3 dB :
  Allowing lower cost device and design



- Low Pf region may not allow high ER because DFB-LD's frequency response is degraded

- Very severe ER range (e.g. 2.5 dB) for practical 10G DM-DFB use
  - Upper ER is limited by 8 - 9 dB