100G PMD Cost Comparison

from a Free Space Optical Platform

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Outline

- We compare the cost of different 100G PMDs from a **free space optics perspective.**
- We analyze the current 40G cost, project the 100G cost, and estimate the total link cost (module + fiber link).
- We conclude that CWDM is the most cost effective 100G PMD for the >500M objective.

40G PMD Cost Structure

- We are a producer of the three PMDs and have solid cost data.
- Projected BOM cost at end of 2013
- SR4 cost as the baseline = 1.00
- SR4 w/850nm VCSELs, LR4 w/1310nm uncooled CWDM DFBs, PSM4 w/ 1310nm FPs

40G QSFP+	SR4 MMF	CWDM LR4	PSM4 >500M
Laser/LD driver	1.00	4.00	2.00
PIN/TIA	1.00	1.54	1.54
Optical Components	1.00	16.00	12.00
TOSA/ROSA Yield Loss	1.00	5.00	4.00
ICs (MCU etc.)	1.00	2.00	2.00
PCBA/Housing	1.00	1.50	1.50
Total	**1.00**	**5.08**	**3.69**

Cost Increase from 40G to 100G

- Assumed straight line increase on lasers/detectors and LD/TIAs.
  (current market cost >4X, at maturity 2.5X is reasonable)
- Optical components largely stay the same for 40 and 100G.
- Yield assumption calculated based on the % component cost increase
- Quad CDRs assumed in all parts. (CDRs not needed in 40G QSFP+)

Component	% Increase 40G to 100G
Lasers	250%
Detectors	250%
TIAs	250%
Optical components	110%
Yield Loss	158%
Laser Drivers	250%
ICs	NA
PCBA/Housing	150%

CDRs needed for 100G, not 40G

100G PMD Cost Structure

- Estimated 100G cost based on the Cost Increase formula
- SR4 cost as the baseline = 1.00
- SR4 w/850nm VCSELs, CWDM w/1310nm uncooled DMLs, PSM w/ 1310nm FPs/VCSELs

100G QSFP28	SR4 MMF	CWDM >500M	PSM >500M
Laser/LD driver	1.00	4.00	2.00
PIN/TIA	1.00	1.54	1.54
Optical Components	1.00	16.00	12.00
TOSA/ROSA Yield Loss	1.00	5.00	4.00
ICs (CDR, MCU, etc)	1.00	1.25	1.25
PCBA/Housing	1.00	1.50	1.50
Total	**1.00**	**3.10**	**2.30**

PMD Cost Only. Need to add Fiber Link cost.

100G Total Link Cost

Channel Type	Link Cost Ratio		
Reach	100m	500m	2km
DL 2f SMF	1.5	2.5	6
DL 8f MMF	6	NA	NA
DL 8f SMF	6	10	24

(Cole_01a_0512 Cabled Fiber Link Relative Cost)

(2 PMDs + Fiber Link Cost, SR4 = 1.0)

100G QSFP28	100M	500M	2000M
SR4 MMF	1.0	NA	NA
CWDM	1.4	1.5	1.8
PSM 4	1.5	1.9	3.3

Power Consumption Estimate

	100G CWDM	100G LWDM	Comments
Lane Count	4	4	
Signal Rate/Lane	25.78GBd	25.78GBd	
CDR	200mW/Lane	200mW/Lane	Sample in Q3 2013
TEC	Not Req'd	350mW/Lane	
Driver	400mW/Lane	400mW/Lane	Sample in Q4 2013
TIA	145mW/Lane	145mW/Lane	
DM-DML	75mW/Lane	51mW/Lane	
XCVR Total	**~3500 mW**	**~ 5000 mW**	
Form Factor	QSFP28		<3.5W
	CFP4	CFP4	<6.0W

- **Tight wavelength for LWDM needs an efficient temp control, adding higher cost for TEC, packaging, additional ICs and components.**
- **By eliminating TEC, CWDM LR4 can be implemented in a QSFP28 form factor yielding additional density and power benefit.**

CWDM is the most cost effective solution for 100G

- 100G CWDM is the most cost effective SMF PMD for data center links.
- Even for 100M links, CWDM is a very attractive alternative to SR4 MMF when inventory and deployment cost are considered.
- Most structured cable plants for the newly built DCs are based on SMF fiber infrastructure.
- Very large data centers and ISPs request ~2km links. (palkert_01a_0313)
- For field terminations and cable management, SMF is substantially better than parallel fibers.