

# 100GBASE-PSM4 Optical Budget Baseline Consensus Proposal

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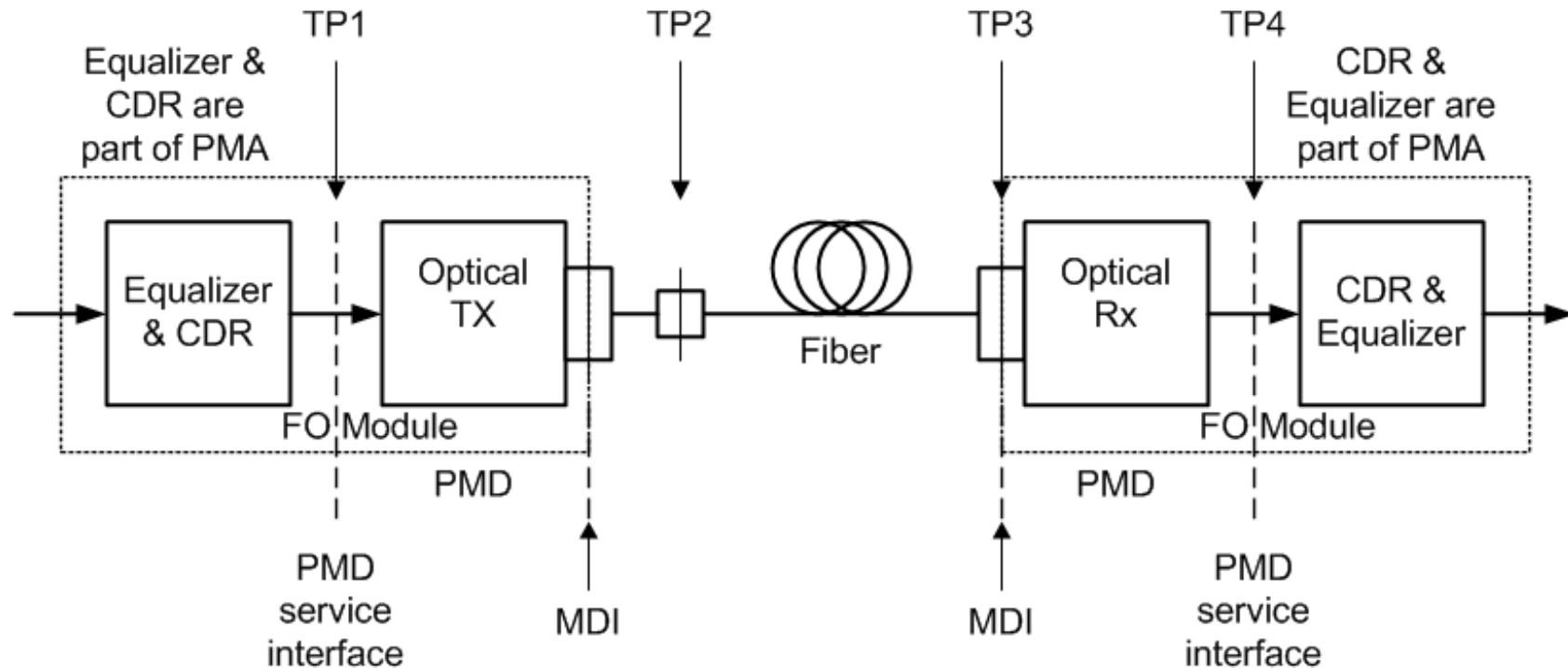
# Introduction

- This presentation provides a consensus proposal for the 100GBASE-PSM4 optical link budget and tx/rx parameter baseline specifications for meeting the 100Gb/s short reach single mode fiber PHY objective.
- Key parameter specifications are proposed, in particular, tradeoff of minimum tx OMA versus center wavelength versus TDP, for enabling multi-supplier (technology) interoperable link solution.

# Optical link budget considerations

- The following aspects are considered in the optical link budget for developing a low cost optical interface, relative to the current 100GBASE-LR4 PMD:
  - 1310nm 4 x 25G parallel SMF optics, based on proposals in [anderson\\_01\\_0112\\_NG100GOPTX](#), [petrilla\\_02a\\_0112\\_NG100GOPTX](#),
  - Fully retimed (CAUI-4) electrical interface for minimizing penalties for tx eye mask, rx VEC;
  - Use of host FEC for relaxing optical tx, rx parameters; see [petrilla\\_03a\\_0912\\_optx](#), [petrilla\\_01\\_1112\\_optx](#)
  - Optimize for data center structured cabling application, with interconnect reaches up to 2 km and connector loss up to 2.0dB; [palkert\\_01\\_1112\\_optx](#)

# Optical link reference architecture



- For cases, as shown above in Figure 1, where retimers are incorporated in the optical module, the PMD service interface is not exposed. TP1 and TP4 remain as points on the PMD service interface and, consequently not exposed.
- The high speed signal inputs and outputs of the optical module are expected to be defined by CAUI-4.

Source: petrilla\_01\_1112\_optx

# 100GBASE- PSM4 Illustrative link power budget

Parameter	IEEE Std 802.3-2012 100GBASE-LR4 10km	P802.3bm 100GBASE-PSM4 2km	Proposed 100GBASE-PSM4 2km
Power budget (for max TDP) (dB)	8.5	(=B+C+E)	6.2
Operating distance (km)	10	(D)	2
Maximum fiber loss <sup>a</sup> (dB/km)	0.43	(F)	0.43
Optical connector loss (dB)	2	(A)	2.0
Channel insertion loss (max) (dB)	6.3	(B = D*F + A)	2.9
Channel insertion loss (min) (dB)	0		0
Maximum discrete reflectance (dB)	-26		-12
Allocation for penalties (for max TDP) <sup>b</sup> (dB)	2.2	(C)	2.9
Allocation for TP4 eye opening (dB)	Not Specified	(E)	0.4
Additional insertion loss allowed (dB)	0		0

Note a: The channel insertion loss is calculated using the specified operating distance and maximum optical fiber attenuation loss of 0.43 dB/km at 1295.0 nm plus allocation for connection and splice loss as specified.

Note b: Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

# 100GBASE- PSM4 Transmit Characteristics

Parameter	IEEE Std 802.3-2012 100GBASE-LR4 10km	P802.3bm 100GBASE-PSM4 2km	Proposed 100GBASE-PSM4 2km
Signaling rate, each lane (range) (GBd)	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm
Lane wavelengths (range) (nm)	1294.53 to 1296.59 nm 1299.02 to 1301.09 nm 1303.54 to 1305.63 nm 1308.09 to 1310.19 nm		1295 to 1325
Side-mode suppression ratio (SMSR)(min) (dB)	30		30
Total average launch power (max) (dBm)	10.5		
Average launch power, each lane (max) (dBm)	4.5	(F ≤ f(G,L))	
Average launch power, each lane (min) <sup>a</sup> (dBm)	-4.3	(=H-3)	
Optical Modulation Amplitude (OMA) (max) (dBm)	4.5	(G)	
Optical Modulation Amplitude (OMA) (min) <sup>b</sup> (dBm)	-1.3	(H=J+TDPmin)	See note c
Difference in launch power between any two lanes (OMA), (max) (dB)	5	(I)	

Note a: Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this value does not ensure compliance.

Note b: Even if the TDP < 0.8 dB, the OMA (min) must exceed this value.

Note c: Trade-offs are available between minimum transmit OMA, center wavelength offset and TDP. See Table 1 and Figure 1.

# 100GBASE- PSM4 Transmit Characteristics Cont.

Parameter	IEEE Std 802.3-2012 100GBASE-LR4 10km	P802.3bm 100GBASE-PSM4 2km	Proposed 100GBASE-PSM4 2km
Launch power in OMA minus TDP, each lane (min) (dBm)	-2.3	(J)	
Transmitter and dispersion penalty (TDP), each lane (max) (dB)	2.2	(K)	2.6
Min OMA at max TDP, each lane (dBm)	-0.1	-0.1	See Note c
Average launch power of OFF transmitter, each lane (max) (dBm)	-30	-30	-30
Extinction ratio (min) (dB)	4	(L)	3.5
RIN <sub>20</sub> OMA (max) (dB/Hz)	-130		-128 (RIN <sub>12</sub> OMA)
Optical return loss tolerance (max) (dB)	20		12
Transmitter reflectance (max) <sup>c</sup> (dB)	-12	-12	-12
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}		

Note c: Trade-offs are available between minimum transmit OMA, center wavelength offset and TDP. See Table 1 and Figure 1.

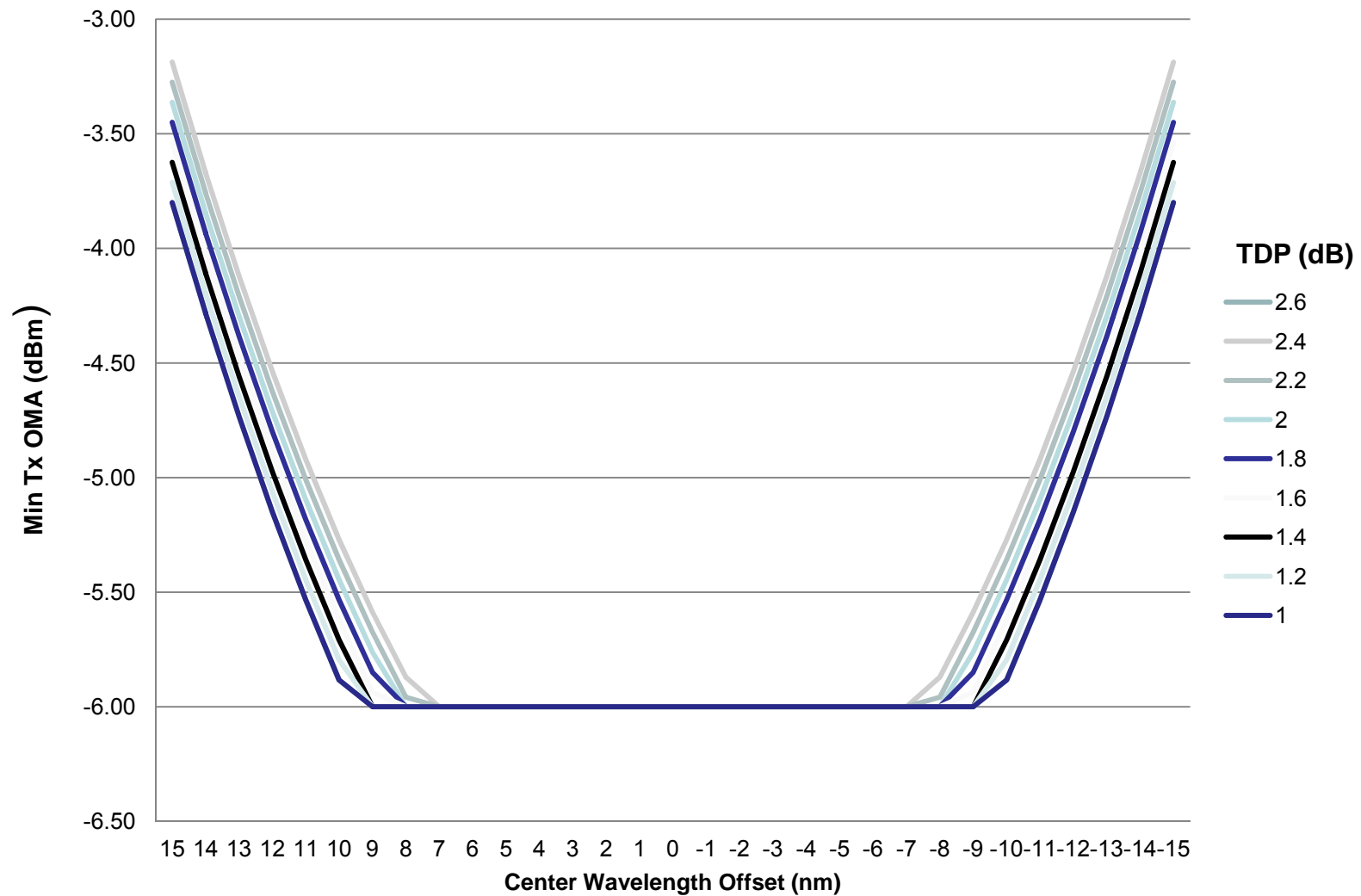
Note d: Transmitter reflectance is defined looking into the transmitter.



Table 1: 100GBASE- PSM4 minimum transmit OMA as a function of center wavelength offset and TDP

Center Wavelength (nm)	Transmitter and Dispersion Penalty (TDP) (dB)																
	2.6	2.5	2.4	2.3	2.2	2.1	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1
1325	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10
1324	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58
1323	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03
1322	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45
1321	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83
1320	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18
1319	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50
1318	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78
1317 to 1303	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00	-6.00
1302	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78	-5.78
1301	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50	-5.50
1300	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18	-5.18
1299	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83	-4.83
1298	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45	-4.45
1297	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03
1296	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58	-3.58
1295	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10	-3.10

Figure 1: 100GBASE- PSM4 minimum transmit OMA as a function of 1310nm center wavelength offset and TDP



# 100GBASE- PSM4 Receive Characteristics

Parameter	IEEE Std 802.3-2012 100GBASE-LR4 10km	P802.3bm 100GBASE-PSM4 2km	Proposed 100GBASE-PSM4 2km
Signaling rate, each lane (range) (GBd)	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm
Lane wavelengths (range) (nm)	1294.53 to 1296.59 nm 1299.02 to 1301.09 nm 1303.54 to 1305.63 nm 1308.09 to 1310.19 nm		1295 to 1325
Damage threshold <sup>a</sup> (dBm)	5.5	(>F-N+1)	
Average receive power, each lane (max) (dBm)	4.5	(=F-N)	
Average receive power, each lane (min) <sup>b</sup> (dBm)	-10.6	(=H-3-B)	
Receive power, each lane (OMA) (max) (dBm)	4.5	(=G-N)	
Difference in receive power between any two lanes (OMA) (max) (dB)	5.5	(=I + Δ)	
Receiver reflectance (max) (dB)	-26		-12
Receiver sensitivity at target BER (OMA), each lane (max) <sup>c</sup> (dBm)	-8.6	(=J-B)	-9.3 at Q=4.02661 (2.84E-5)

Note a: The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level.

Note b: Average receive power, each lane (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

Note c: Receiver sensitivity (OMA), each lane (max) is informative.

# 100GBASE- PSM4 Receive Characteristics Cont.

Parameter	IEEE Std 802.3-2012 100GBASE-LR4 10km	P802.3bm 100GBASE-PSM4 2km	Proposed 100GBASE-PSM4 2km
Receiver 3dB electrical upper cutoff frequency, each lane (max) (GHz)	31		Do not spec
Stressed receiver sensitivity (OMA), each lane (max) <sup>d</sup> (dBm)	-6.8	(=J-B+M)	-7.1 at Q=4.02661 (2.84E-5)
Conditions of stressed receiver sensitivity test:			
Vertical eye closure penalty, each lane <sup>e</sup> (dB)	1.8	(M)	1.8
Stressed eye J2 Jitter, each lane <sup>e</sup> (UI)	0.3		0.32
Stressed eye J9 Jitter, each lane <sup>e</sup> (UI)	0.47		0.61

Note d: Measured with conformance test signal at TP3 (see 87.8.11) for BER = 2.84E-5.

Note e: Vertical eye closure penalty, stressed eye J2 Jitter and stressed eye J9 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

# Summary

- A consensus proposal for the 100GBASE-PSM4 optical link budget and key tx/rx parameter baseline specification has been presented.
- Use of FEC is employed for relaxing tx, rx specifications for a 2 km SMF link.
- Transmitter OMA is specified as tradeoff relationship of OMA min versus center wavelength offset versus TDP max for enabling multi-supplier (technology) interoperable link solution.
- Less critical parameters are TBD (or may be eliminated) following further study.

End of Presentation

Thanks!