

100GBASE-PSM4 Optical Budget - Working Consensus View

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Introduction

- One of the objectives adopted at the July, 2012 IEEE 802.3 WG Plenary Meeting for P802.3bm TF is:
Define a 100 Gb/s PHY for operation up to at least 500 m of SMF
- A small group of interested parties has been working to develop a consensus proposal for the 100GBASE-nR4 PMD optical specification based on 4 x 25G parallel single mode (PSM4) optics proposals presented during the 40G & 100G Optical Ethernet Study Group, see e.g.:
[anderson_01_1111_NG100GOPTX](#),
[petrilla_01_1111_NG100GOPTX](#),
[palkert_01_1111_NG100GOPTX](#).
- This contribution provides a status of this working consensus view, with focus on parameters related to the optical link budget. Issues for further study are identified.

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;
 - Optimize for data center structured cabling application, with interconnect reaches up to 2 km and connector loss up to 2.5dB;
 - Use of host FEC for relaxing optical tx, rx parameters; see [petrilla_03a_0912_optx](#)

100GBASE- PSM4 Illustrative link power budget

Parameter	IEEE Std 802.3-2012 100GBASE- LR4 10km	Petrilla 100GBASE- PSM4 2km	Palkert 100GBASE- PSM4 2km	Anderson 100GBASE- PSM4 2km	Consensus 100GBASE- PSM4 2km
Power budget (for max TDP) (dB)	8.5	6.51	5.6	5.6	
Operating distance (km)	10	2	2	2	2
Maximum fiber loss ^a (dB/km)	0.43	0.42	0.43	0.43	0.43
Optical connector loss (dB)	2	2.5	2.5	2.5	2.5
Channel insertion loss (max) (dB)	6.3	3.4	3.4	3.4	3.4
Channel insertion loss (min) (dB)	0	0	0	0	0
Maximum discrete reflectance (dB)	-26	-26	-26	-26	-26
Allocation for penalties (for max TDP) ^b (dB)	2.2	2.28	2.28	2.28	2.28
Allocation for TP4 eye opening (dB)	Not Specified	0.89	0		
Additional insertion loss allowed (dB)	0	0	0	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	Petrilla 100GBASE- PSM4 2km	Palkert 100GBASE- PSM4 2km	Anderson 100GBASE- PSM4 2km	Consensus 100GBASE- PSM4 2km
Signaling rate, each lane (range) (GBd)	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm
Lane wavelengths (range) (nm)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	1260 to 1355	1304.5 to 1317.5	1260 to 1355	
Side-mode suppression ratio (SMSR), (min) (dB)	30	30	30	30	30
Total average launch power (max) (dBm)	10.5				
Average launch power, each lane (max) (dBm)	4.5	1.5	1.5	1.5	1.5
Average launch power, each lane (min) ^a (dBm)	-4.3		-5.5		
Optical Modulation Amplitude (OMA) (max) (dBm)	4.5		4.5		
Optical Modulation Amplitude (OMA) (min) ^b (dBm)	-1.3		-6.5		
Difference in launch power between any two lanes (OMA), (max) (dB)	5		5		

100GBASE- PSM4 Transmit Characteristics Cont.

Parameter	IEEE Std 802.3-2012 100GBASE- LR4 10km	Petrilla 100GBASE- PSM4 2km	Palkert 100GBASE- PSM4 2km	Anderson 100GBASE- PSM4 2km	Consensus 100GBASE- PSM4 2km
Launch power in OMA minus TDP, each lane (min) (dBm)	-2.3				
Transmitter and dispersion penalty (TDP), each lane (max) (dB)	2.2	2.28	2.28	2.28	2.28
Min OMA at max TDP, each lane (dBm)	-0.1	-3.1	-6.5	-4	
Average launch power of OFF transmitter, each lane (max) (dBm)	-30	-30	-30	-30	-30
Extinction ratio (min) (dB)	4	3.5	3.6	3.5	3.5
RIN ₂₀ OMA (max) (dB/Hz)	-130	-128	-128	-128	-128
Optical return loss tolerance (max) (dB)	20	20	20	20	20
Transmitter reflectance (max) ^c (dB)	-12	-12	-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}		{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}	{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}	

100GBASE- PSM4 Transmit Characteristics Notes

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: Transmitter reflectance is defined looking into the transmitter.

100GBASE- PSM4 Receive Characteristics

Parameter	IEEE Std 802.3-2012 100GBASE- LR4 10km	Petrilla 100GBASE- PSM4 2km	Palkert 100GBASE- PSM4 2km	Anderson 100GBASE- PSM4 2km	Consensus 100GBASE- PSM4 2km
Signaling rate, each lane (range) (GBd)	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm	25.78125 +/- 100 ppm
Lane wavelengths (range) (nm)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	1260 to 1355	1304.5 to 1317.5	1260 to 1355	
Damage threshold ^a (dBm)	5.5		5.5		
Average receive power, each lane (max) (dBm)	4.5		4.5		
Average receive power, each lane (min) ^b (dBm)	-10.6				
Receive power, each lane (OMA) (max) (dBm)	4.5		4.5		
Difference in receive power between any two lanes (OMA) (max) (dB)	5.5		5.5		
Receiver reflectance (max) (dB)	-26	-26	-26	-26	-26

100GBASE- PSM4 Receive Characteristics Cont.

Parameter	IEEE Std 802.3-2012 100GBASE -LR4 10km	Petrilla 100GBASE- PSM4 2km	Palkert 100GBASE- PSM4 2km	Anderson 100GBASE- PSM4 2km	Consensus 100GBASE- PSM4 2km
Receiver sensitivity (OMA), each lane (max) ^c (dBm)	-8.6	-9.61 at Q=4.1865	-12.1 at Q = 4.1865	-9.6 at Q=4.1865	
Receiver 3dB electrical upper cutoff frequency, each lane (max) (GHz)	31	Do not spec			
Stressed receiver sensitivity (OMA), each lane (max) ^d (dBm)	-6.8				
Vertical eye closure penalty, each lane ^e (dB)	1.8				
Stressed eye J2 Jitter, each lane ^e (UI)	0.3				
Stressed eye J9 Jitter, each lane ^e (UI)	0.47				

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.

Note d: Measured with conformance test signal at TP3 (see 87.8.11) for BER = 10⁻¹².

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 working view of a 100GBASE-PSM4 optical link budget and PMD specification consensus proposal has been presented.
- Use of FEC has significant advantage for relaxing tx, rx specifications for a 2 km SMF link.
- Additional parameters that require further study include:
 - Optical connector loss
 - Lane wavelength range
 - Allocation for max TDP and TP4 eye opening
 - Launch power in OMA minus TDP
 - Receiver sensitivity in OMA (max)
 - Transmitter eye mask coordinates

End of Presentation

Thanks!