

# 400G-PSM4: A Proposal for the 500m Objective using 100 Gb/s per Lane Signaling

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# 400G-PSM4

- Proposal: A 4x100 Gb/s parallel SMF interconnect to satisfy the 500m objective.
- Lane Speed: 100 Gb/s per lane using 50 GBaud-PAM4 optical signaling
- Single wavelength solution

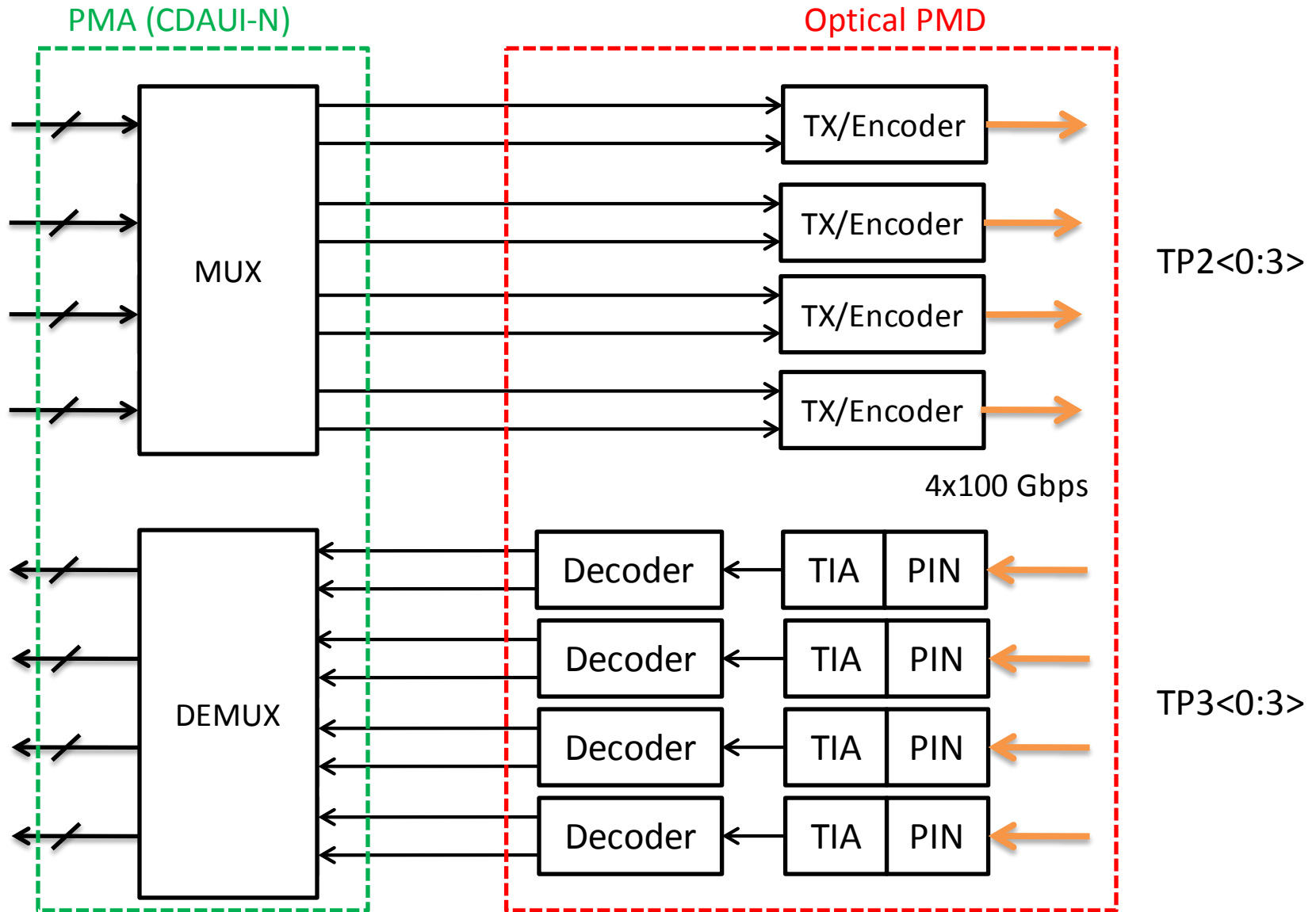
# Updates Since Last Meeting

- Went to a “flat” specification
  - Single value OMA and Sensitivity across 13nm optical window
  - “Contoured” specification moved to Appendix
- Reduced TDP max from 3.5 dB to 2.5 dB
  - OMA max reduced to **4.2**dB (consistent with TDP max reduction)
- BER revised from 2.3e-4 to 2.0e-4
- Relabeled illustrative link budget slide
- Revisions from welch\_3bs\_01\_0715 in **Purple**.

# Motivations for Changes

- Several requests for “Flat” specification:
  - Makes spec easier to understand
  - Simplifies testing
  - Still provides ample wavelength tolerance for uncooled operation
    - Same width as a “CWDM laser”
- TDP value had been a holdover from 100G specification
  - Requests received to reduce for 400G
  - Relaxes receiver design (eye shape and max power)

# 400G-PSM4 Block Diagram



# 400G-PSM4 : Link Parameters

400G-PSM4	
Reach, min (m)	500
Signaling rate, each lane (Range)	53.125 ± 100 ppm GBd
Encoding type	PAM4
Wavelength(s)	1304.5 to 1317.5 nm
Operating BER <sup>F</sup>	2.0e-4
Channel insertion loss, max (dB) <sup>†</sup>	3.0
Allocation for penalties, at max TDP (dB) <sup>‡</sup>	3.0
Power margin, at min TDP (dB) <sup>‡</sup>	9.25
Maximum discrete reflectance (dB)	-35

***F The exact operating BER will be determined by the final FEC and PMA definition***

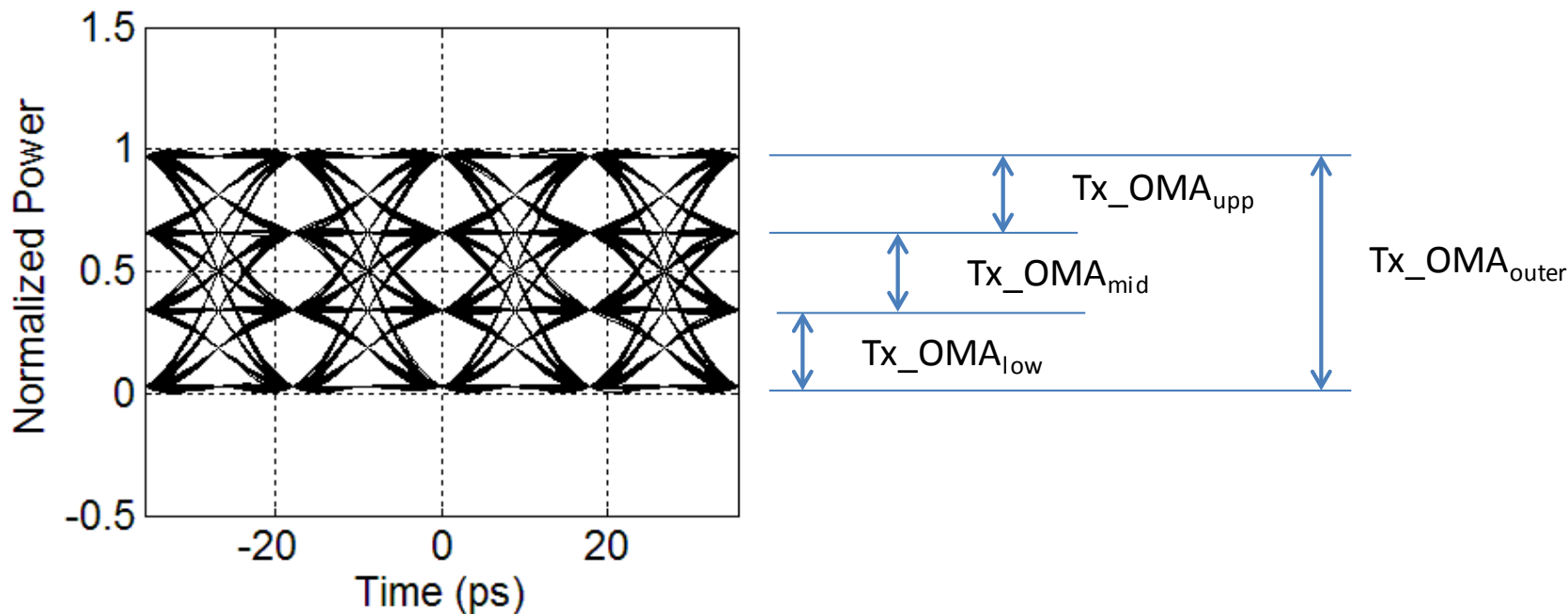
***† From [http://www.ieee802.org/3/bs/public/14\\_05/kolesar\\_3bs\\_01\\_0514.pdf](http://www.ieee802.org/3/bs/public/14_05/kolesar_3bs_01_0514.pdf)***

***‡ Sum of Max TDP (2.5 dB) and MPI penalty (0.5 dB)***

***‡ Power Margin, at min TDP = Modulation Penalty + Channel Loss + MPI + TDP Min + Unallocated Margin***

***All Parameters Subject to Change in Task Force Review***

# Transmitter Specifications



- Max OMA and ER specified based on outer Tx\_OMA<sub>outer</sub>
- Sensitivity and link budget based on inner Tx\_OMA<sub>low/mid/upp</sub>
  - Spec applies to minimum of 3 inner eye transitions



# 400G-PSM4: Transmitter Specifications (TP2)

400G-PSM4	
Signaling rate, each lane (Range)	53.125 ± 100 ppm GBd
Encoding type	PAM4
Wavelength(s)	1304.5 to 1317.5 nm
OMA <sub>outer</sub> , each lane, max (dBm)	4.2
OMA <sub>outer</sub> , each lane, min (dBm)	0 <sup>†</sup>
OMA <sub>low/mid/upp</sub> , each lane, min (dBm)	-4.8 <sup>†</sup>
<b>Launch Power in OMA<sub>low/mid/upp</sub> – TDP, each lane (min) (dBm)</b>	<b>-5.6</b>
Transmitter and dispersion penalty, (TDP) each lane (max) (dBm)	2.5
ER <sub>outer</sub> , each lane, min (dB)	5.0
Average launch power, each lane max (dBm)	4.0
Average launch power, each lane min (dBm)	-2.1 <sup>‡</sup>
Transmitter RIN <sub>ave</sub> , max (dB/Hz)	-142
Transmitter reflectance, max (dB)	-20
Transmitter Eye Mask	TBD

All Parameters Subject to Change in Task Force Review

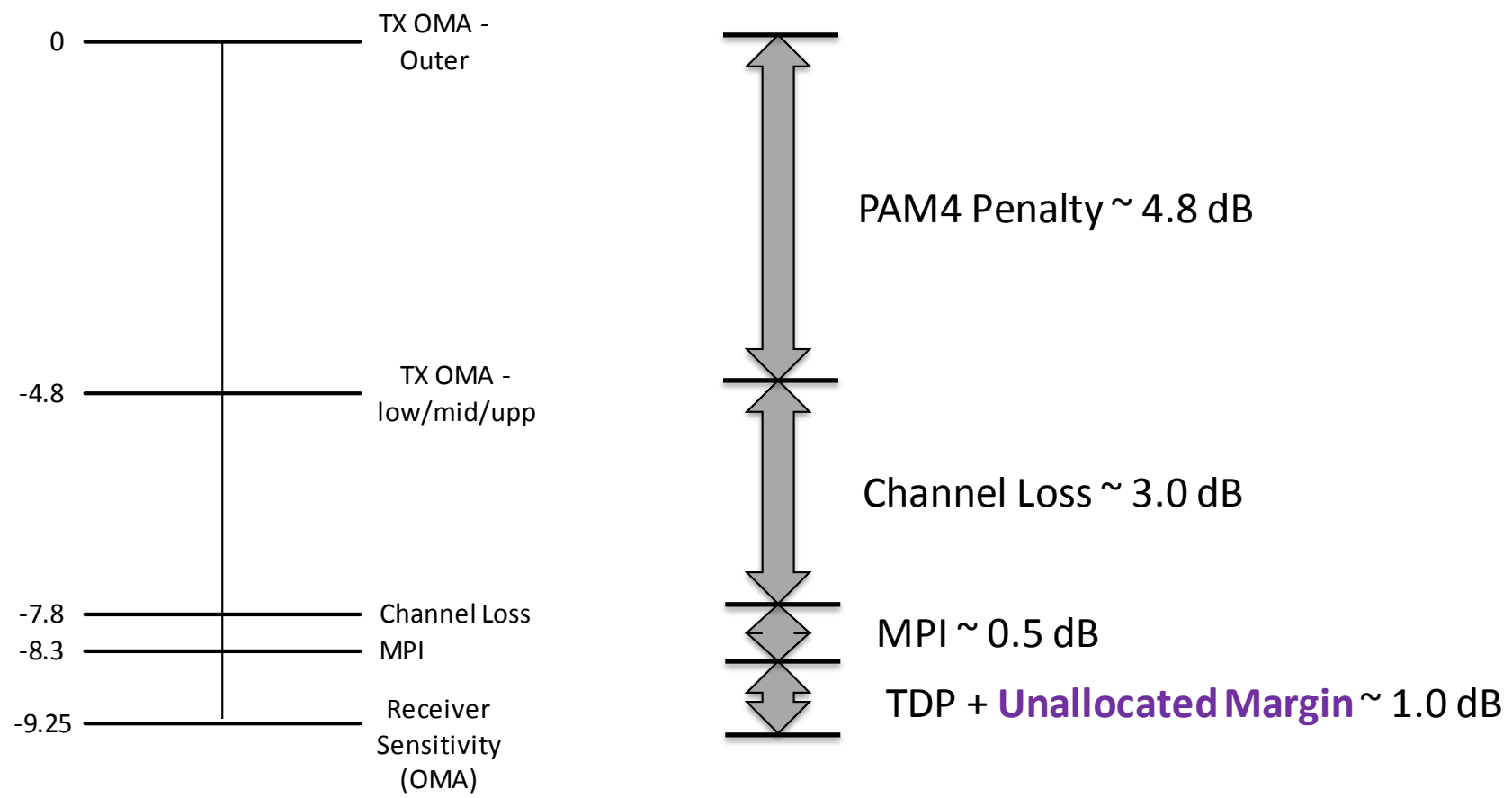
*† Even with TDP < 0.8, OMA values must meet or exceed the stated minimums  
‡ Assuming Min OMA with ER of 10*

# 400G-PSM4: Receiver Specifications (TP3)

400G-PSM4	
Signaling rate, each lane (Range)	53.125 ± 100 ppm GBd
Encoding type	PAM4
Wavelength(s)	1304.5 to 1317.5 nm
Receiver sensitivity (OMA), each lane max (dBm) <sup>†</sup>	-9.25
Average receive power, each lane max (dBm)	4.0
Average receive power, each lane min (dBm)	-5.1
Damage threshold (dBm)	6.5
Receiver reflectance, max (dB)	-26
Stressed receiver sensitivity (OMA), each lane max (dBm)	TBD
Conditions of stressed receiver sensitivity test:	
Vertical eye closure penalty, each lane (dB)	TBD
Stressed eye J2 Jitter, each lane (UI)	TBD
Stressed eye J4 Jitter, each lane (UI)	TBD
Stressed eye mask definition	TBD

*† Received sensitivity reported in 'NRZ mode' and uncorrected BER, equivalent to sensitivity for any sub-eye low/mid/upp  
All Parameters Subject to Change in Task Force Review*

# 400G-PSM4 Link Budget (at TDP = 0.8 dB)



† Received sensitivity reported in 'NRZ mode' and uncorrected BER, equivalent to sensitivity for any sub-eye low/mid/upp  
All Parameters Subject to Change in Task Force Review

# 400G-PSM4

- Proposal: A 4x100 Gb/s parallel SMF interconnect to satisfy the 500m objective.
- Lane Speed: 100 Gb/s per lane using 50 GBaud-PAM4 optical signaling
- Single wavelength solution

# Appendix

PSM4 with “contoured” TX/RX  
specifications

# 400G-PSM4: Transmitter Specifications (TP2)

400G-PSM4	
Signaling rate, each lane (Range)	$53.125 \pm 100$ ppm GBd
Encoding type	PAM4
Wavelength(s)	1297 to 1323 nm
$OMA_{outer}$ , each lane, max (dBm)	$MAX(3.8+(\lambda-1310)^2/70,4.3)$
$OMA_{outer}$ , each lane, min (dBm)	$MAX(-1.3+(\lambda-1310)^2/70,-0.8)+MAX(TDP,0.8)$
$OMA_{low/mid/uppr}$ , each lane, min (dBm)	$MAX(-6.07+(\lambda-1310)^2/70,-5.57)+MAX(TDP,0.8)$
$ER_{outer}$ , each lane, min (dB)	5.0
Average launch power, each lane max (dBm)	4.0
Average launch power, each lane min (dBm)	$MAX(-3.4+(\lambda-1310)^2/70,-2.9)+0.8$
TDP, each lane, max (dB)	2.5
Transmitter $RIN_{ave}$ , max (dB/Hz)	-142
Transmitter reflectance, max (dB)	-20
Transmitter Eye Mask	TBD

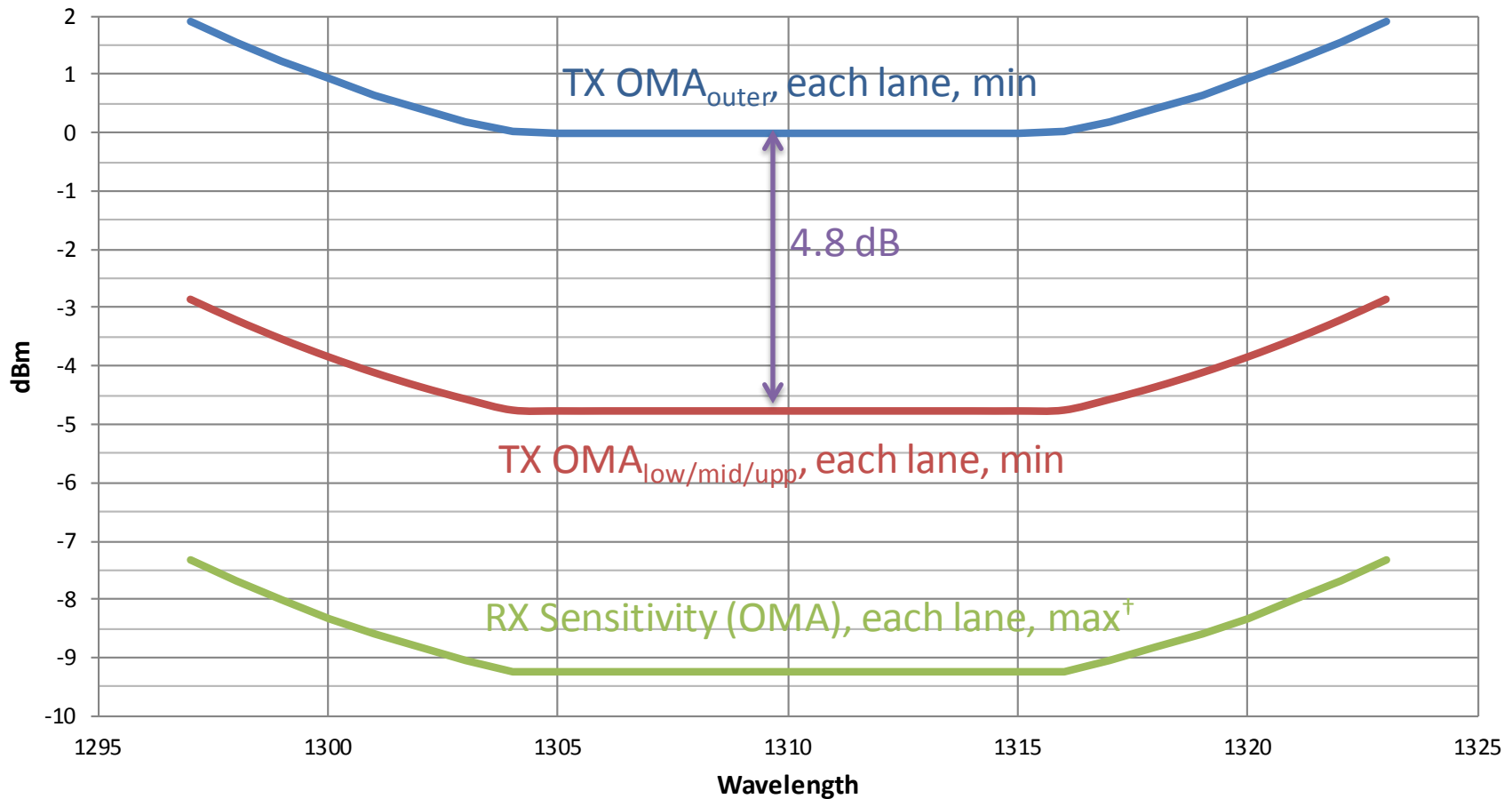
*All Parameters Subject to Change in Task Force Review*

# 400G-PSM4: Receiver Specifications (TP3)

400G-PSM4	
Signaling rate, each lane (Range)	53.125 ± 100 ppm GBd
Encoding type	PAM4
Wavelength(s)	1297 to 1323 nm
Receiver sensitivity (OMA), each lane max (dBm) <sup>†</sup>	MAX(-9.75+(λ-1310) <sup>2</sup> /70,-9.25)
Average receive power, each lane max (dBm)	4.0
Average receive power, each lane min (dBm)	-5.1
Damage threshold (dBm)	6.5
Receiver reflectance, max (dB)	-26
Stressed receiver sensitivity (OMA), each lane max (dBm)	TBD
Conditions of stressed receiver sensitivity test:	
Vertical eye closure penalty, each lane (dB)	TBD
Stressed eye J2 Jitter, each lane (UI)	TBD
Stressed eye J4 Jitter, each lane (UI)	TBD
Stressed eye mask definition	TBD

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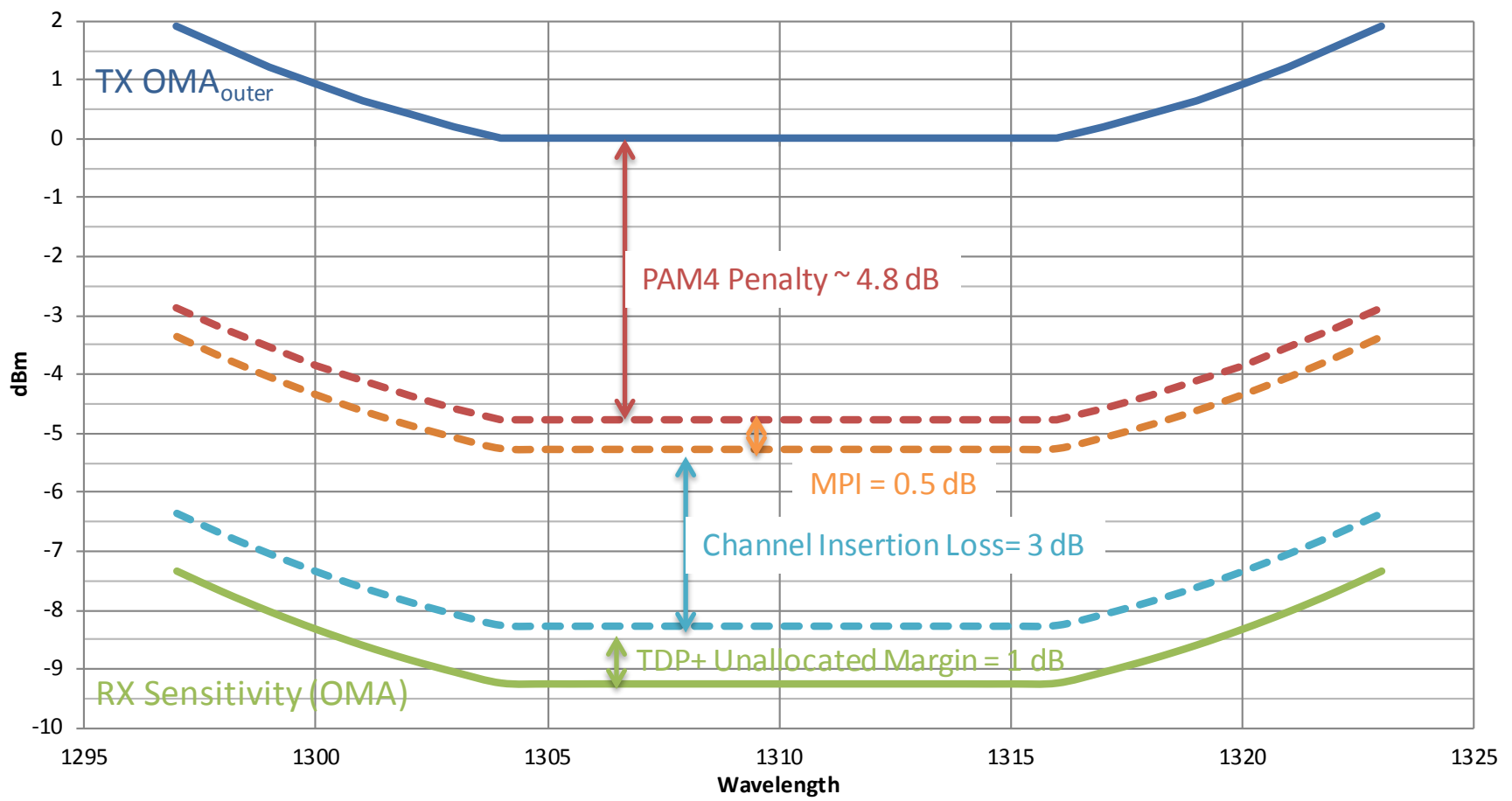
# 400G-PSM4 Specifications



† Received sensitivity reported in 'NRZ mode' and uncorrected BER, equivalent to sensitivity for any sub-eye low/mid/upp  
All Parameters Subject to Change in Task Force Review



# 400G-PSM4 Link Budget (at TDP = 0.8 dB)



† Received sensitivity reported in 'NRZ mode' and uncorrected BER, equivalent to sensitivity for any sub-eye low/mid/upp  
 All Parameters Subject to Change in Task Force Review