Baseline Proposal for 400GPL Single Wavelength Objectives

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Overview

- Follow on to welch_400GPL_01a_2609
  - Evolution from 200GPL single wavelength specifications with 1.5dB increase in transmitter OMA and receiver sensitivity
  - Reuse FECo (RS544 only)
- Revises TBD entries from previous contribution
- Addresses questions from previous contribution

From 400GPL_Objectives_260917.pdf

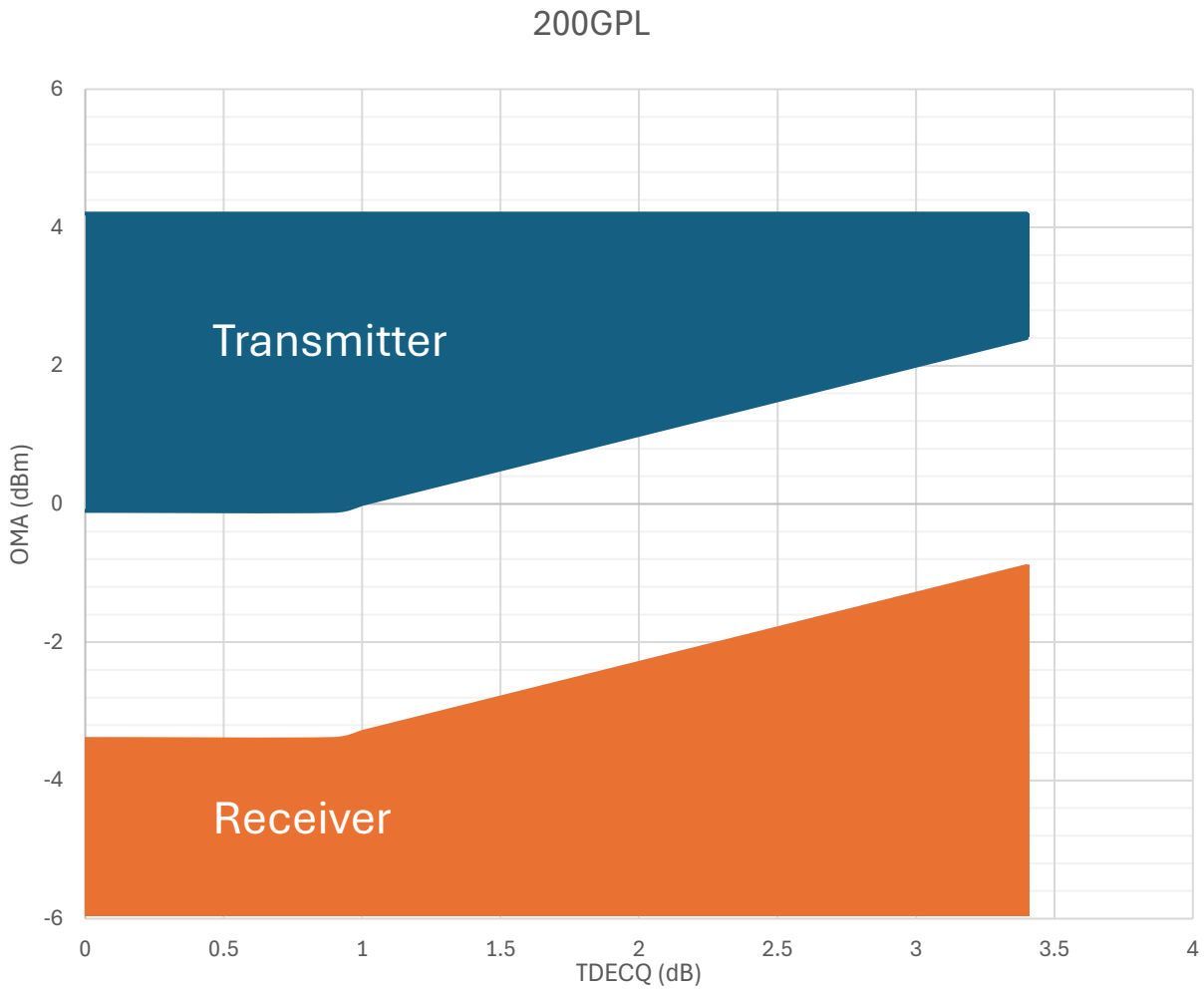
Applicable Objectives

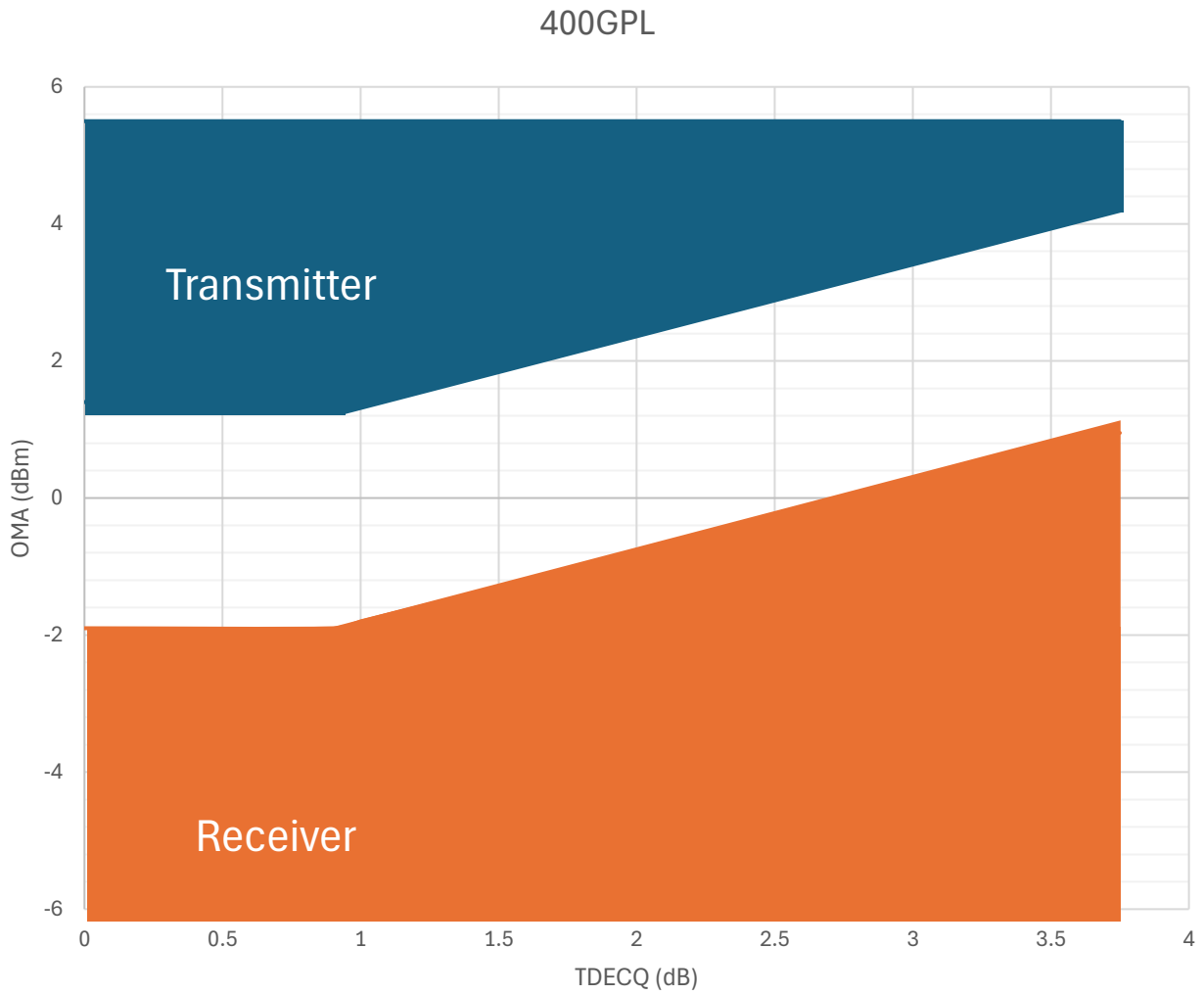
- **400 Gb/s Related** (400GBase-DR1)
  - Define a physical layer specification that supports 400 Gb/s operation over 1 pair of SMF with lengths up to at least 500 m
- **800 Gb/s Related** (800GBase-DR2)
  - Define a physical layer specification that supports 800 Gb/s operation over 2 pairs of SMF with lengths up to at least 500 m
- **1.6 Tb/s Related** (1.6TBase-DR4)
  - Define a physical layer specification that supports 1.6 Tb/s operation over 4 pairs of SMF with lengths up to at least 500 m

Comparison of Key Specifications

Description	**200GBase-DR1** **400GBase-DR2** **800GBase-DR4**	**400GBase-DR1** **800GBase-DR2** **1.6TBase-DR4**	**Unit**
Signaling rate, each lane (range)	106.25 ± 50 ppm	212.5 ± 50 ppm	GBd
Average launch power, each lane (max)	4	5.5	dBm
Average launch power, each lane (min)	-3.1	-1.6	dBm
Outer Optical Modulation Amplitude (OMAouter), each lane (max)	4.2	5.7	dBm
Outer Optical Modulation Amplitude (OMAouter), each lane(min) for MAX(TECQ,TDECQ) < 0.9 dB for 0.9 dB ≤ MAX(TECQ,TDECQ) ≤ 3.4 dB	 -0.1 -1 + max(TECQ,TDECQ)	 1.4 0.5 + MAX(TECQ, TDECQ)	 dBm dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)	3.4	3.75	dB
Extinction ratio, each lane, (min)	3.5	3	dB
Average receive power, each lane (max)	4	5.5	dBm
Average receive power, each lane (min)	-6.1	-4.6	dBm
Receiver sensitivity (OMAouter), each lane (max) for TECQ < 0.9 dB for 0.9 dB ≤ TECQ ≤ SECQ	 -3.4 -4.3 + TECQ	 -1.9 -2.8 + TECQ	 dBm dBm
Channel Insertion Loss	3	3	dB

Comparison of Key Specifications - Illustrated





Detailed Optical Transmitter Specifications

Description	**400GBase-DR1** **800GBase-DR2** **1.6TBase-DR4**	**Unit**
Signaling rate, each lane (range)	212.5 ± 50 ppm	GBd
Modulation Format	PAM4	
Lane wavelengths (range)	1304.5 to 1317.5	nm
Side-mode suppression ratio (SMSR), (min)	30	dB
Average launch power, each lane (max)	5.5	dBm
Average launch power, each lane (min)	-1.6	dBm
Outer Optical Modulation Amplitude (OMAouter), each lane (max)	5.7	dBm
Outer Optical Modulation Amplitude (OMAouter), each lane(min) for MAX(TECQ,TDECQ) < 0.9 dB for 0.9 dB ≤ MAX(TECQ,TDECQ) ≤ 3.75 dB	 1.4 0.5 + MAX(TECQ, TDECQ)	 dBm dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)	3.75	dB
TECQ (max)	3.75	dB
|TDECQ – TECQ|, each lane (max)	2.5	dB
Average launch power of OFF transmitter, each lane (max)	-15	dBm
Transmitter functional symbol error histogram, each lane (max)	TBD	
Extinction ratio, each lane, (min)	3	dB
Transmitter transition time (max)	6	ps
Transmitter over/under-shoot (max)	27	%
RINxOMA (max)	-142	dB/Hz
Optical return loss tolerance (max)	21.4 (15.5 for 400GBase-DR1)	dB
Transmitter reflectance (max)	-26	dB

Detailed Optical Receiver Specifications

Description	**400GBase-DR1** **800GBase-DR2** **1.6TBase-DR4**	**Unit**
Signaling rate, each lane (range)	212.5 ± 50 ppm	GBd
Modulation Format	PAM4	
Lane wavelengths (range)	1304.5 to 1317.5	nm
Damage threshold, each lane	6.5	dBm
Average receive power, each lane (max)	5.5	dBm
Average receive power, each lane (min)	-4.6	dBm
Receive power, each lane (OMAouter) (max)	5.7	dBm
Receiver reflectance (max)	-26	dB
Receiver sensitivity (OMAouter), each lane (max) for TECQ < 0.9 dB for 0.9 dB ≤ TECQ ≤ SECQ	 -1.9 -2.8 + TECQ	 dBm dBm
Stressed receiver sensitivity (OMAouter), each lane (max)	0.95	dBm
Conditions of stressed receiver sensitivity test: SECQ OMAouter of each aggressor lane	 3.75 5.7	 dB dBm

Comparison of Illustrative Power Budget

Description	**200GBase-DR1** **400GBase-DR2** **800GBase-DR4** **1.6TBase-DR8**	**400GBase-DR1** **800GBase-DR2** **1.6TBase-DR4**	**Unit**
Power budget (for max TDECQ)	6.7	7.05	dB
Operating distance	500	500	m
TECQ/TDECQ (max)	3.4	3.75	
Channel insertion loss	3	3	dB
Maximum discrete reflectance	-35	-35	dB
Allocation for penalties (for max TDECQ) - includes 0.3 dB MPI/DGD allocation	3.7	4.05	dB
Additional insertion loss allowed	0	0	dB

TDECQ Reference Equalizer

Parameter	Symbol	Value	
		Minimum	Maximum
Number of feed-forward taps	N_w	22	
Number of pre-cursor fee-forward taps	_	0	5
Main tap coefficient limit	w(0)	0.8	2.5
Normalized feed-forward tap coefficient limits: *i* ≤ -3 *i* = -2 *i* = -1 *i* = 1 *i* = 2 *i* = 3 *i* = 4 *i* = 5 *i* = 6 *i* ≥ 7	w(i)/w(0)	 -0.15 -0.1 -0.5 -0.6 -0.2 -0.15 -0.15 -0.15 -0.15 -0.1	 0.1 0.25 0.1 0.2 0.3 0.15 0.15 0.15 0.15 0.1
Pre-post-cursor tap coefficient difference limit: |w(1)/w(0)-b(1)-w(-1)/w(0)|		-	0.25
Feed-forward tap DC gain		1	
Number of feedback taps		1	
Feedback tap coefficient limit		0	0.7

Responses

To September 400GPL Pre-Baseline Presentation Questions

Response: Receiver Performance (Preliminary)

TIA

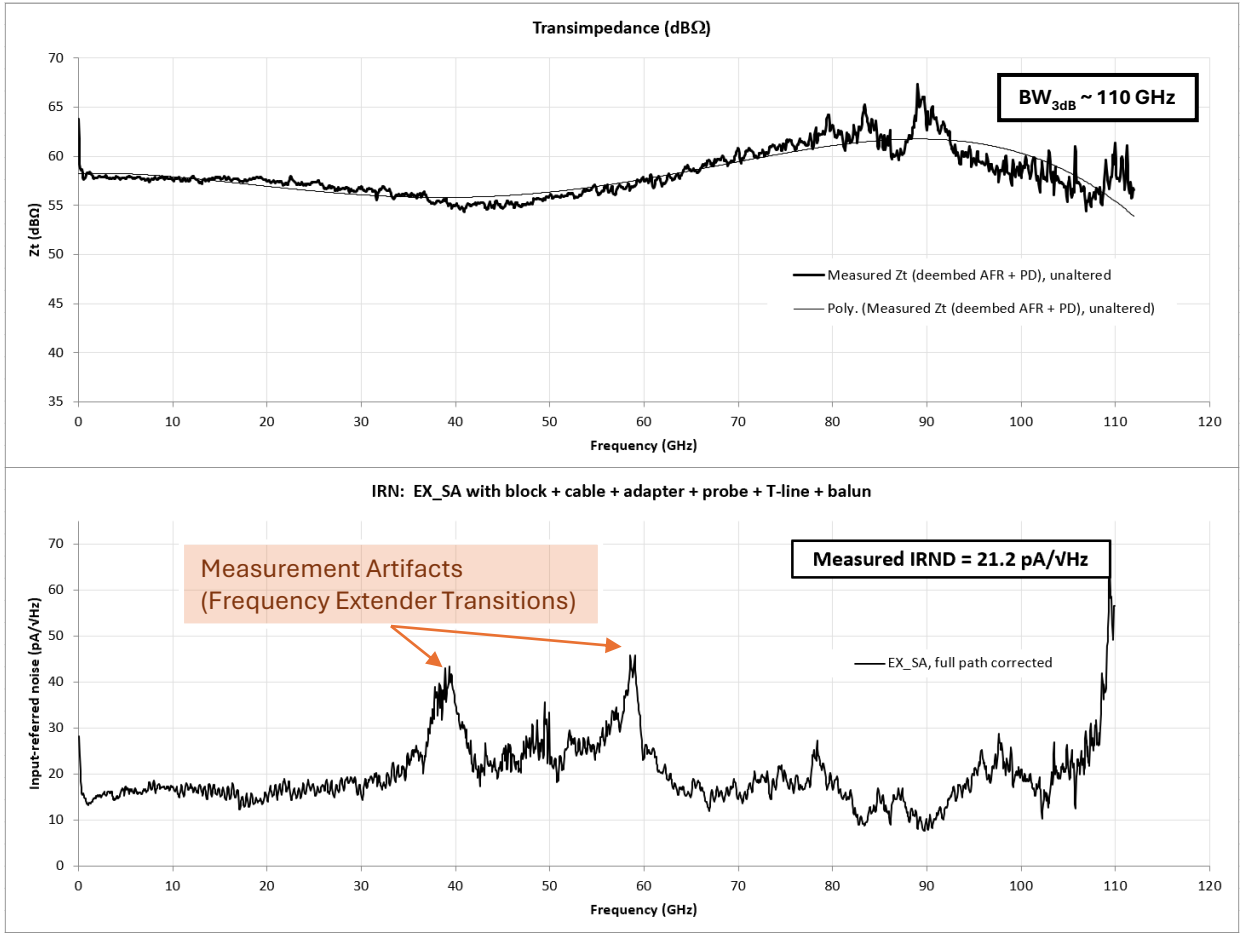
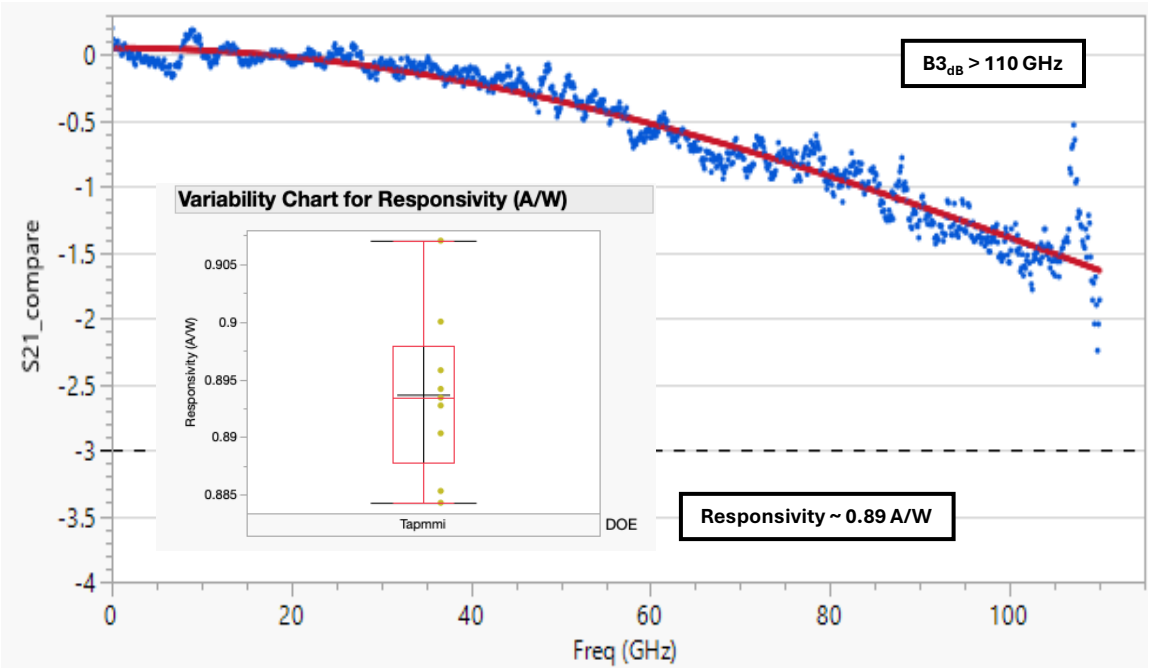


Photo-Diode

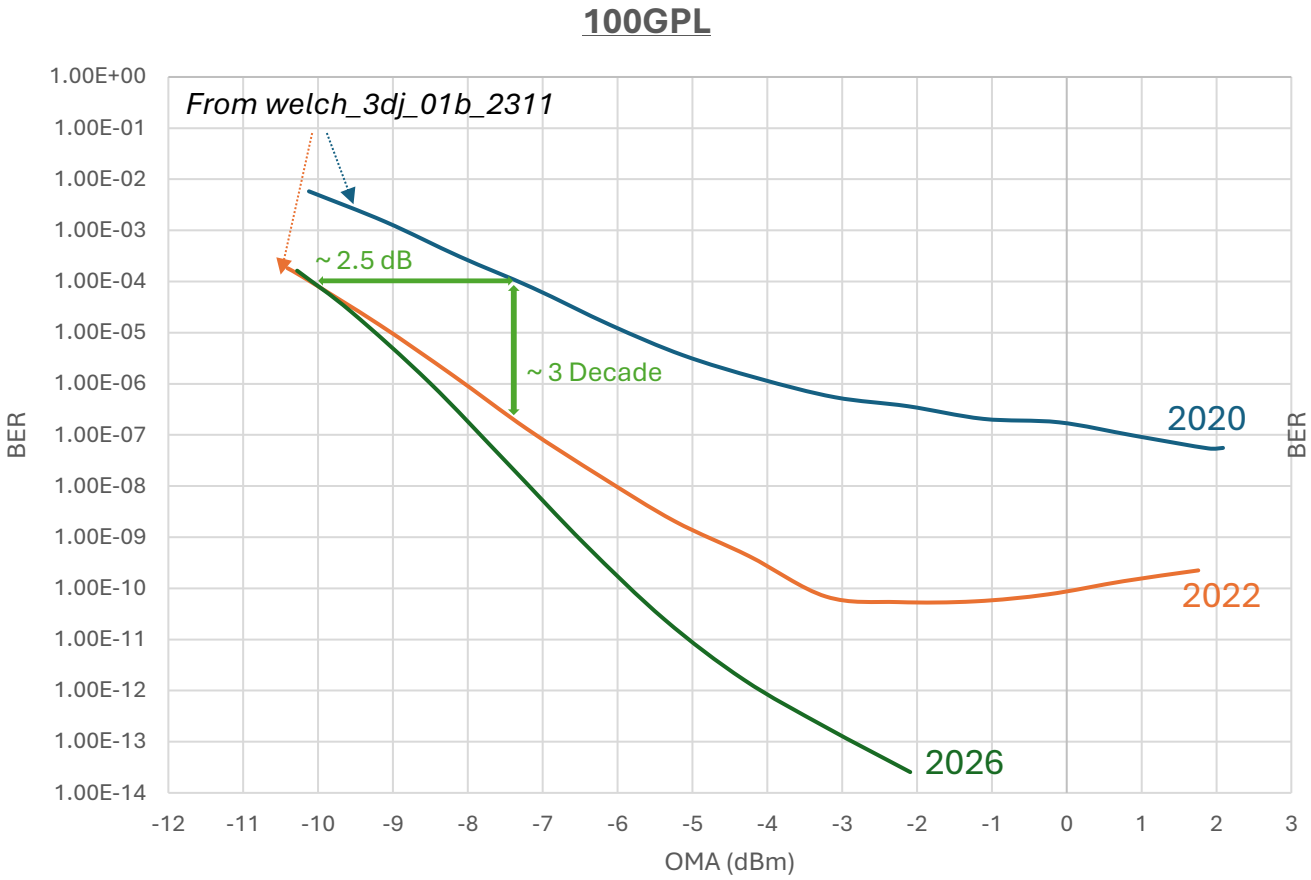


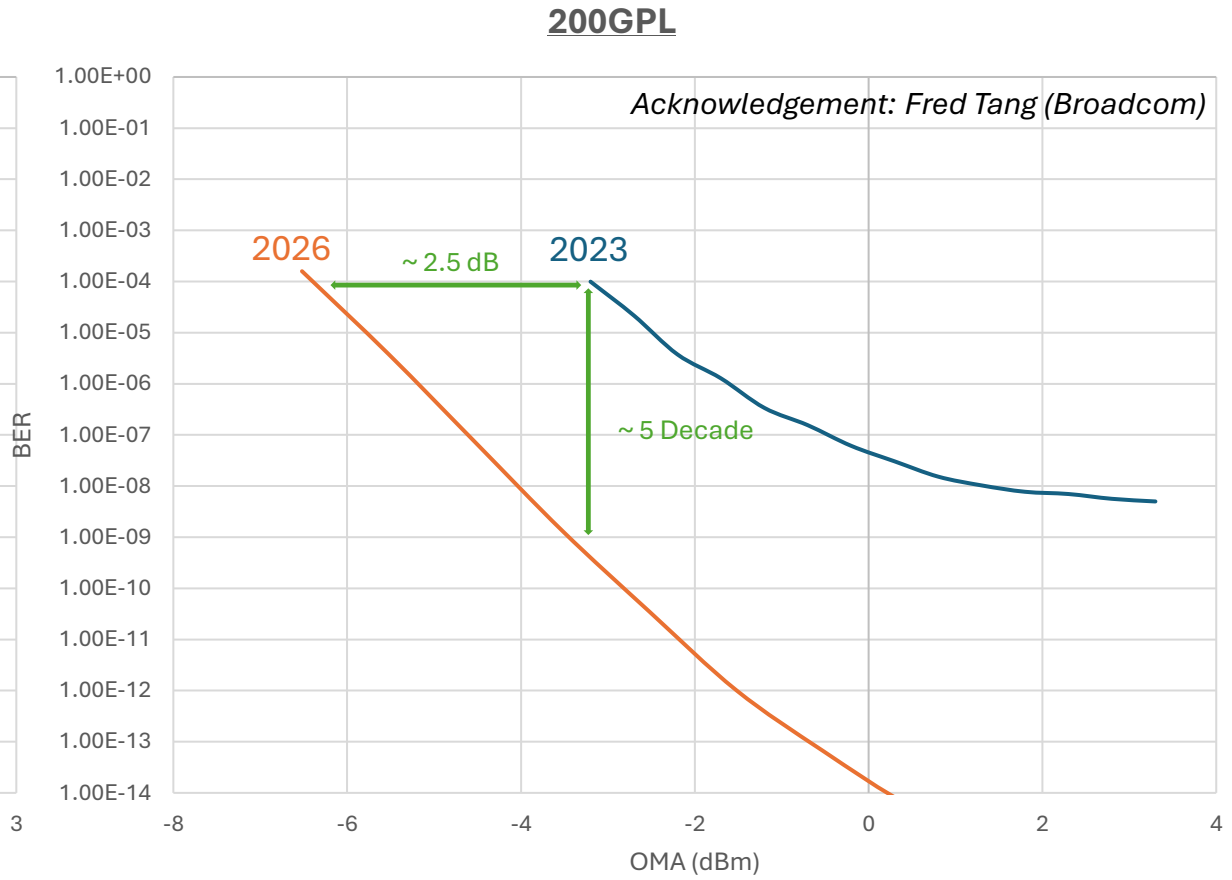
- **TIA+PD Limited Sensitivity ~ -10 dBm**
- ***Other factors (TX & SERDES) will impact value.***

Response: DFE Tap Weight

- See “Lower BW TX in 400G/Lane” (Balan_3dv_01_2611)

Other : Improvements in Time





Each rate generation has seen considerable margin expansion during production ramp

Summary

- A baseline for to satisfy the 802.3dv objectives for physical layer signaling over 500m of SMF has been proposed.

- Proposal builds on 200GPL 802.3 standards for 500m signaling

- Responses/references to technical questions that were raised during September study group meeting have been included.

End