

Baseline Proposal for 200G per Lane Optical PMDs Supporting 30 m and 50 m MMF – Updated

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Adopted Objectives

Define a physical layer specification that supports 200 Gb/s operation:

- over 1 pair of MMF with lengths up to at least 30 m
- over 1 pair of MMF with lengths up to at least 50 m

Define a physical layer specification that supports 400 Gb/s operation:

- over 2 pairs of MMF with lengths up to at least 30 m
- over 2 pairs of MMF with lengths up to at least 50 m

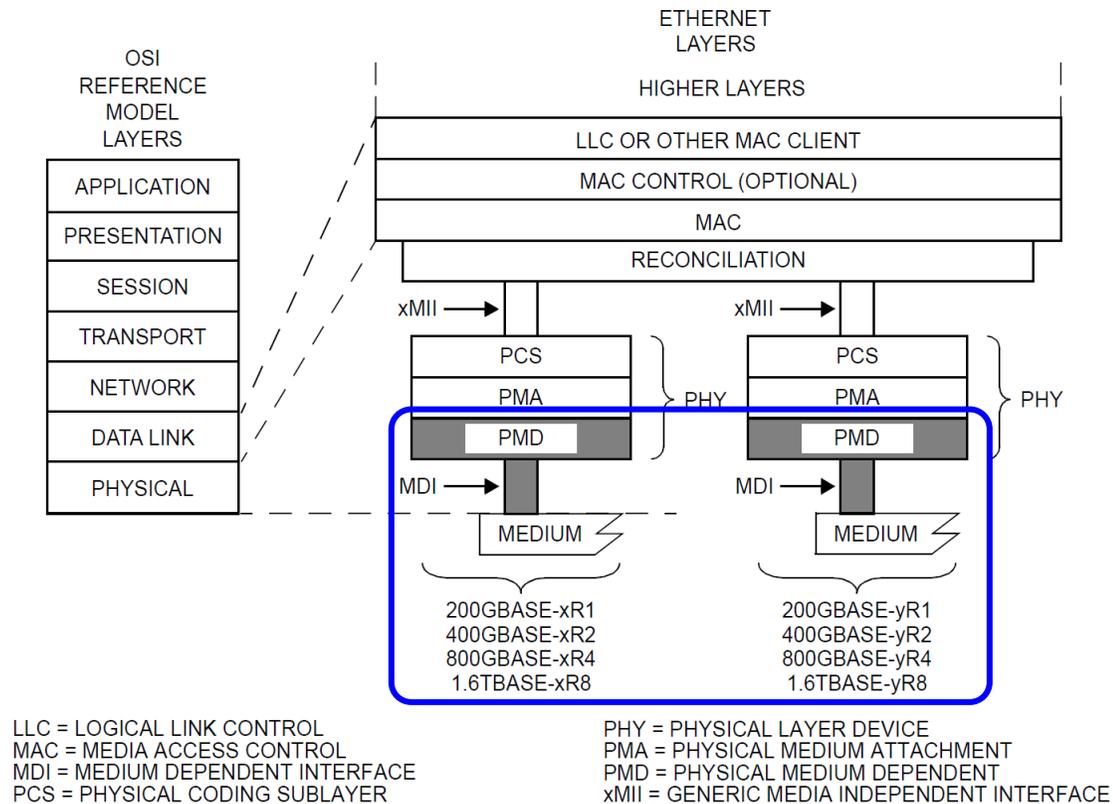
Define a physical layer specification that supports 800 Gb/s operation:

- over 4 pairs of MMF with lengths up to at least 30 m
- over 4 pairs of MMF with lengths up to at least 50 m

Define a physical layer specification that supports 1.6 Tb/s operation:

- over 8 pairs of MMF with lengths up to at least 30 m
- over 8 pairs of MMF with lengths up to at least 50 m

Position in the 802.3 Architecture



Following notation is used because names for PMDs and MMF are not finalized

xR 30 m reach
yR 50 m reach
OMz MMF for 50 m reach

Operating Range

PMD type	Operating range
200GBASE-xR1 400GBASE-xR2 800GBASE-xR4 1.6TBASE-xR8	0.5 m to 15 m for OM3 0.5 m to 30 m for OM4 0.5 m to 30 m for OM5
200GBASE-yR1 400GBASE-yR2 800GBASE-yR4 1.6TBASE-yR8	0.5 m to 50 m for OMz

- PMD reach chosen so that OM4 determines the test methodology for 30 m
- With a compliant input signal, a PMD receiver is expected to meet the block error ratio (BLER) of 1.45×10^{-11} measured at the PMA adjacent to the PMD

Assumptions

- Fiber modal dispersion modeled according to [kolesar_3cm_01_1118](#) for OM3, OM4 and OM5
- Fiber chromatic dispersion modeled according to [abbott_3db_adhoc_01_080620](#)
- Interoperability: Tx for 50 m reach must operate with Rx for 30 m reach and *vice versa*
- Allocation of 1.5 dB for connector loss
- Link budget is drawn with an allocation of ~~4.6~~ *TBD* dB for TDECQ

Transmit Characteristics

Description	200GBASE-xR1 400GBASE-xR2 800GBASE-xR4 1.6TBASE-xR8	200GBASE-yR1 400GBASE-yR2 800GBASE-yR4 1.6TBASE-yR8	Unit	Remarks
Signaling rate, each lane (range)	106.25 ± 50 ppm		GBd	
Modulation format	PAM4			
Center wavelength (range)	844 – 868	852 – 868	nm	
RMS spectral width ^a (max)	0.55	0.45	nm	
Average launch power, each lane (max) <i>(add note)</i>	5		dBm	+1 dB over 802.3db
Average launch power, each lane (min)	-3.4			
Outer optical modulation amplitude (OMA _{outer}), each lane (max)	3.5		dBm	4 dBm?
Outer optical modulation amplitude (OMA _{outer}), each lane (min) for max(TECQ, TDECQ) ≤ 1.8 dB for 1.8 < max(TECQ, TDECQ) ≤ 4.6 TBD dB	-1.4 -3.2 + max(TECQ, TDECQ)		dBm dBm	
Transmitter and dispersion eye closure for PAM4 (TDECQ), each lane	4.6 TBD	4.6 TBD	dB	
Transmitter eye closure for PAM4 (TECQ), each lane	4.6 TBD		dB	
Transmitter overshoot and undershoot, each lane (max)	2.9 TBD		%	@ 3E-3 HR
Transmitter power excursion, each lane (max)	2.3		dBm	

^a RMS spectral width is the standard deviation of the spectrum.

Transmit Characteristics contd.

Description	200GBASE-xR1 400GBASE-xR2 800GBASE-xR4 1.6TBASE-xR8	200GBASE-yR1 400GBASE-yR2 800GBASE-yR4 1.6TBASE-yR8	Unit	Remarks
Extinction ratio, each lane (min)	2		dB	
Transmitter transition time, each lane (max)	⊖ 9		ps	
Average launch power of OFF transmitter, each lane (max)	-15		dBm	same as P802.3dj DR
RIN _x OMA (max)	-135		dB/Hz	-3 dB/Hz over 802.3db
Optical return loss tolerance (max)	TBD		dB	
Encircled flux ^b	≥ 86% at 19 μm ≤ 30% at 4.5 μm			

^b If measured into type A1a.2 or A1a.3, or A1a.4, 50 μm fiber, in accordance with IEC 61280-1-4.

Receive Characteristics

Description	200GBASE-xR1 400GBASE-xR2 800GBASE-xR4 1.6TBASE-xR8	200GBASE-yR1 400GBASE-yR2 800GBASE-yR4 1.6TBASE-yR8	Unit	Remarks
Signaling rate, each lane (range)	106.25 ± 50 ppm		GBd	
Modulation format	PAM4			
Center wavelength (range)	844 – 868		nm	
Damage threshold ^a (min)	6		dBm	+1 dB over 802.3db
Average receive power, each lane (max)	5		dBm	
Average receive power, each lane ^b (min)	-5	-5.1	dBm	
Receive power (OMA _{outer}), each lane (max)	3.5		dBm	
Receiver reflectance (max)	TBD		dB	

^a The receiver shall be able to tolerate, with damage, continuous exposure to an optical input signal having this average power level on one lane. The receiver does not have to operate correctly at this input power.

^b Average receive power, each lane (min) is 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.

Receive Characteristics

Description	200GBASE-xR1 400GBASE-xR2 800GBASE-xR4 1.6TBASE-xR8	200GBASE-yR1 400GBASE-yR2 800GBASE-yR4 1.6TBASE-yR8	Unit	Remarks
Receiver sensitivity (OMA_{outer}) (max) for $TECQ \leq 1.8$ dB for $1.8 < TECQ \leq \del{4.6} TBD$ dB	-3.1 -4.9 + TECQ	-3.3 -5.1 + TECQ	dBm dBm	Value for xR is +1.5 dB over 800GBASE-SR8
Stressed receiver sensitivity (OMA_{outer}) ^c (max)	-0.3		dBm	
Conditions of stressed receiver sensitivity test: ^d				
Stressed eye closure for PAM4 (SECQ), lane under test	4.6 TBD		dB	
OMA_{outer} of each aggressor lane	3.5		dBm	

^c Measured with conformance test signal at TP3 for the BLER specified in 300.2.

^d These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

Test Methodology

TECQ/TDECQ Calculation

Description	Value	Unit
Histogram spacing	0.08	UI
Histogram width	0.04	UI

Add an editors' note stating that the values will be reviewed. An alternative proposal is histogram spacing of 0.10 UI and histogram width of 0.02 UI.

Reference Receiver and Equalizer

PMD	Value	Unit
Reference receiver 3 dB bandwidth	53.125	GHz
Reference equalizer	15-tap FFE + 1-tap DFE	—

Fiber Emulation Filter

PMD	3 dB bandwidth f_A (GHz)
200GBASE-xR1 400GBASE-xR2 800GBASE-xR4 1.6TBASE-xR8	60.7
200GBASE-yR1 400GBASE-yR2 800GBASE-yR4 1.6TBASE-yR8	48.2

Reference Equalizer Tap Coefficient Limits

Description	Symbol	Value		Remarks
		Minimum	Maximum	
Feedforward equalizer length	N_w	15		Same as P802.3dj DR
Number of equalizer precursor taps	—	0	3	
Main tap coefficient limit	$w(0)$	0.8	2.5	
Normalized equalizer tap coefficients:	$w(i)/w(0)$			
i=-3		-0.15	0.1	
i=-2		-0.1	0.25	
i=-1		-0.5	0.1	
i=1		-0.6	0.2	
i=2		-0.2	0.3	
i=3		-0.15	0.15	
i=4		-0.15	0.15	
i=5		-0.15	0.15	
i=6		-0.15	0.15	
i≥7		-0.1	0.1	
Pre-post equalizer coefficient difference limit: $ w(1)/w(0) - b(1) - w(-1)/w(0) $	—	—	0.25	Add an editors' note that the value will be reviewed.
Equalizer DC gain	—	1		
Decision feedback equalizer (DFE) length	N_b	1		
DFE coefficient limit	$b(1)$	0	0.4	

Illustrative Link Power Budget

Parameter	200GBASE-xR1 400GBASE-xR2 800GBASE-xR4 1.6TBASE-xR8			200GBASE-yR1 400GBASE-yR2 800GBASE-yR4 1.6TBASE-yR8	Unit
	OM3	OM4	OM5	OMz	
Effective modal bandwidth at 850 nm	2000	4700		—	MHz·km
Effective modal bandwidth at 860 nm	—	—	—	5200	MHz·km
Power budget (for max TDECQ)	6.3 TBD			6.5 TBD	dB
Operating distance	0.5 to 15	0.5 to 30		0.5 to 50	m
Channel insertion loss	1.6	1.6		1.7	dB
Allocation for penalties (for max TDECQ)	4.7 TBD			4.8 TBD	dB
Additional insertion loss allowed	0	0		0	dB

↓
add OM3, OM4 and OM5 during CR

Test Methodology (2)

1. Transmitter functional symbol error histogram and functional receiver
2. Codeword error ratio TDECQ ($TDECQ_{CER}$)

These tests will be defined following further discussion in P802.3dj.

Key Parameters

- **TDECQ** TDECQ is calculated according to P802.3dj D3.0 subclause 180.9.6 with the following exceptions:
 - Histogram spacing is 0.08 UI [with as editors' note that the value will be reviewed \(see slide 11\)](#)
 - P_{th1} , P_{th2} , P_{th3} are varied from their nominal values by up to $\pm 2\%$ of OMA_{outer} in order to optimize TDECQ (same as 802.3db)
- **Equalizer tap coefficients** Limits on reference equalizer tap coefficients follow P802.3dj D3.0 Clause 180 with the following exception:
 - Max value of DFE tap coefficient, $b(1)$, is 0.4 [with an editors' note that the value will be reviewed \(see slide 12\)](#)
- **Overshoot and undershoot** Transmitter overshoot and undershoot has a limit of ~~29~~ **TBD**% at 3E-3 hit ratio (HR)
 - Same value as 100G per lane multimode link (802.3db)
 - Equivalent to the P802.3dj Clause 180 value of max 22% at 1E-2 HR
- **Average power** Average power per lane (max) is 5 dBm, an increase of 1 dB from 100G per lane multimode (802.3db)
 - Eye safety must be verified for this value

Items Not Covered

1. Link training

Link training will allow independent laser drive setting (Tx FIR) for short and long links
Annex 178B describes the process and scope of link training

[ghiasi_200gmmf_01_1125](#) described the approach for implementation of link training in P802.3ds

Cycling through a series of presets to determine the optimum laser drive setting is a good approach for 200G multimode

⇒ A presentation containing a comprehensive description of the process along with proposed amendments to Annex 178B will help add link training.

2. 1060 nm link

Specifications are expected to be similar to the 850 nm link with differences in some parameters including RMS spectral width, receiver sensitivity, and MMF parameters.

Summary

Proposed a baseline for 200G per lane optical PMDs over multimode fiber covering the adopted reach objectives