

Baseline proposals for 200G/L PMD specifications for single wavelength 500m and 2km standards

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Supporters

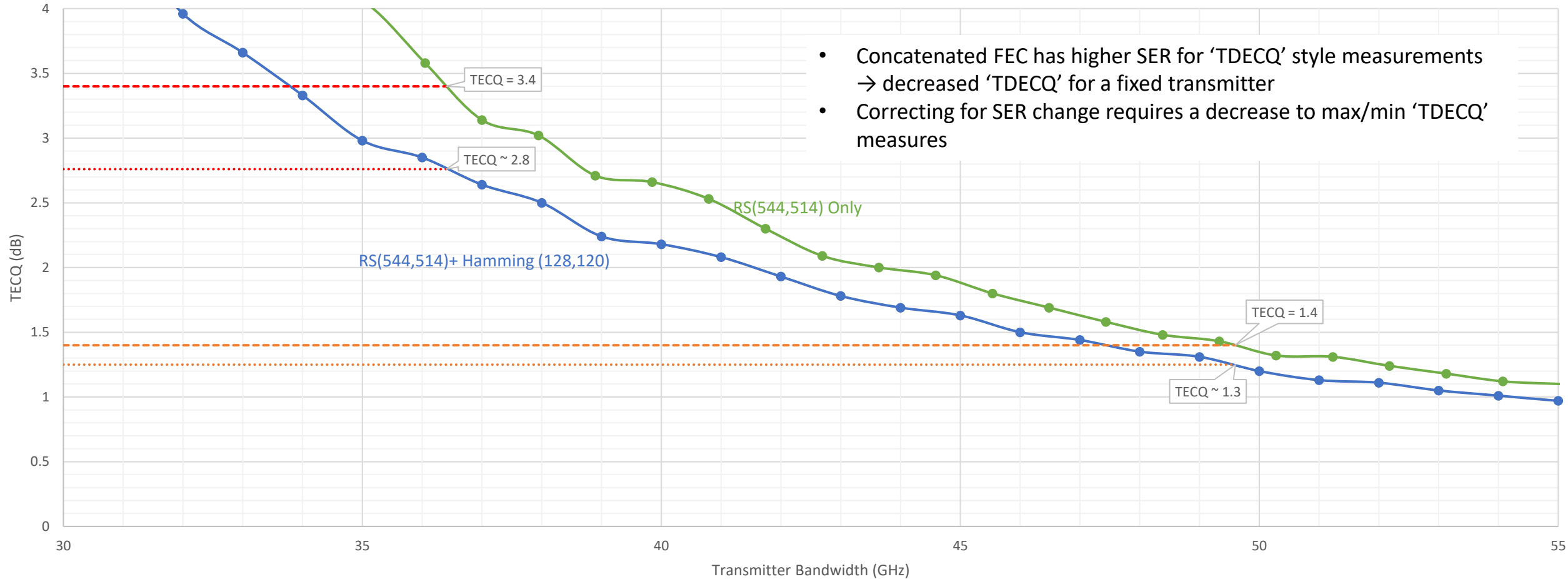
- Frank Chang (Source Photonics)

Overview

- Two PMD types under consideration:
 - Single Wavelength 500m: 200GBASE-DR1, 400GBASE-DR2, 800GBASE-DR4, 1.6TBASE-DR8
 - Single Wavelength 2km: 200GBASE-FR1, 800GBASE-DR4-2, 1.6TBASE-DR8-2
 - Note: No adopted objective for “400GBASE-DR2-2”. Should we have one?
- Two options shown for each
 - Option A: Use RS(544,514) FEC for optical link. Pre-FEC BER = $2.4e-4$
 - Option B: Use RS(544,514) + Hamming inner code for optical link. Pre-FEC BER $\sim 4.85E-3$
- Key differences between the options include
 - Signaling rate
 - TDECQ/TECQ/SECQ (scaled for concatenated proposal to reflect change to SER)
- Key difference from 100G/L standards
 - 1dB positive shift in power budget

Option A vs. B: TDECQ/TECQ/SECQ

TECQ vs BW & SER (FFE5)



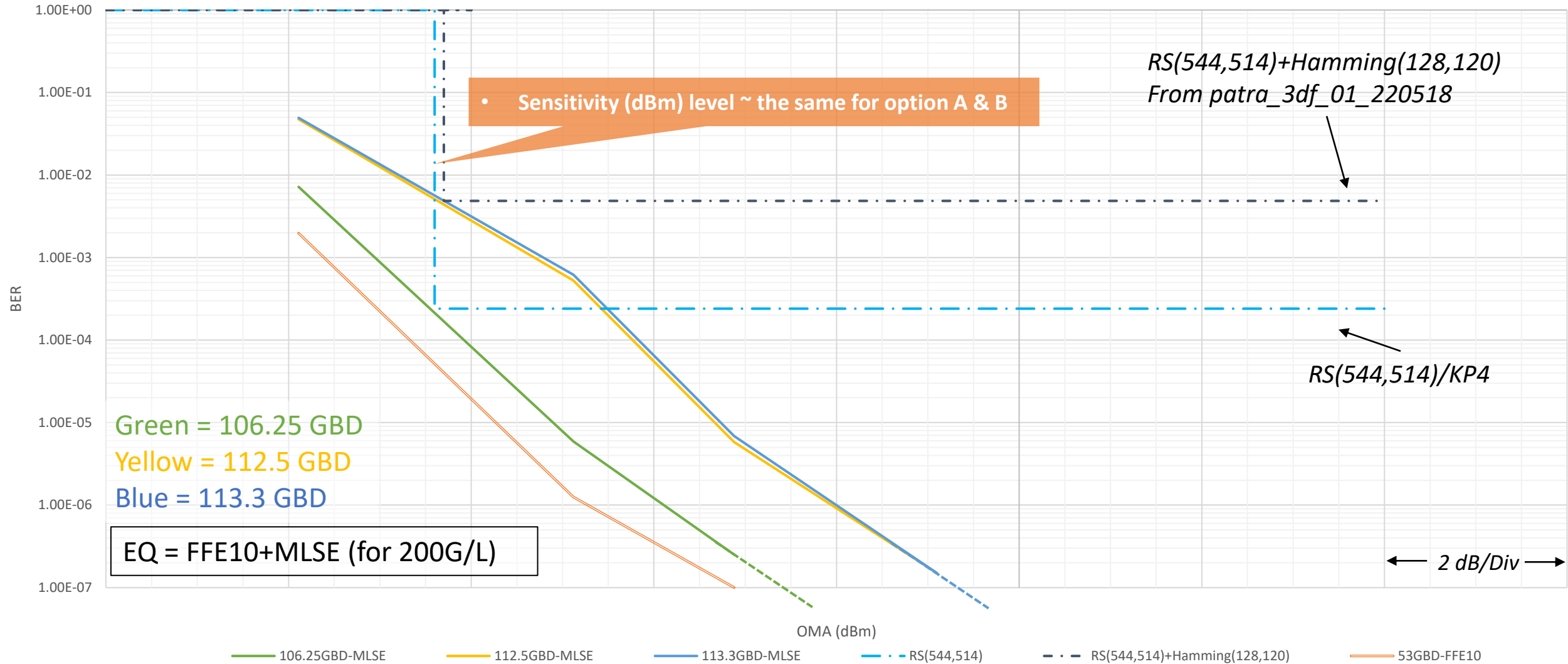
- Concatenated FEC has higher SER for 'TDECQ' style measurements → decreased 'TDECQ' for a fixed transmitter
- Correcting for SER change requires a decrease to max/min 'TDECQ' measures

● 106.25GBD @ Target SER = 4.8e-4
 ● 113.3GBD @ Target SER = 9.7e-3
 - - - Upper Limit for SER = 4.8e-4
 Upper Limit for SER = 9.7e-3
 - - - Lower Limit for SER = 4.8e-4
 Lower Limit for SER = 9.7e-3

Option A: RS(544,514)
Option B: RS(544,514) + Hamming Inner

Option A vs. B: Power Levels

From welch_3df_01a_1022



• Sensitivity (dBm) level ~ the same for option A & B

RS(544,514)+Hamming(128,120)
From patra_3df_01_220518

RS(544,514)/KP4

Green = 106.25 GBD
Yellow = 112.5 GBD
Blue = 113.3 GBD

EQ = FFE10+MLSE (for 200G/L)

← 2 dB/Div →

Option A: RS(544,514)
Option B: RS(544,514) + Hamming Inner

Option A: Changes relative to Clause 140

- Transmitter and Receiver
 - Signaling rate changed to 106.25 GBd \pm 50 ppm
- Transmitter
 - Outer Optical Modulation Amplitude ($\text{OMA}_{\text{outer}}$) (min) increased by 1 dB
 - Average launch power (min) increased by 1 dB
 - Transmitter transition time (max) decreased from 17 ps to 8.5 ps
 - RIN_xOMA (max) decreased by 3 dB
- Receiver
 - Rx sensitivity ($\text{OMA}_{\text{outer}}$) (max) increased by 1 dB
 - Stressed Rx sensitivity ($\text{OMA}_{\text{outer}}$) (max) increased by 1 dB

Option B: Changes relative to Clause 140

- Transmitter and Receiver
 - Signaling rate changed to 112.5 – 113.4375 GBd \pm 50 ppm
- Transmitter
 - Outer Optical Modulation Amplitude ($\text{OMA}_{\text{outer}}$) (min) increased by 1 dB
 - Average launch power (min) increased by 1 dB
 - TECQ (max), TDECQ (max) and $|\text{TDECQ} - \text{TECQ}|$ (max) decreased by 0.6 dB
 - Transmitter transition time (max) decreased from 17 ps to 8 ps
 - RIN_xOMA (max) decreased by 3 dB
- Receiver
 - Rx sensitivity ($\text{OMA}_{\text{outer}}$) (max) increased by 1 dB
 - Stressed Rx sensitivity ($\text{OMA}_{\text{outer}}$) (max) increased by 1 dB

500m Baseline Proposals

200GBASE-DR1, 400GBASE-DR2, 800GBASE-DR4, 1.6TBASE-DR8

Proposed Transmitter Specifications

Description	Option		Unit
	A	B	
Signaling rate, each lane (Range)	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8 106.25 ± 50 ppm	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8 112.5 -113.4375 ± 50 ppm	GBd
Modulation Format	PAM4	PAM4	
Lane wavelengths (range)	1304.5 to 1317.5	1304.5 to 1317.5	nm
Side-mode suppression ratio (SMSR), (min)	30	30	dB
Average launch power, each lane (max)	4	4	dBm
Average launch power, each lane (min)	-1.9	-2	dBm
Outer Optical Modulation Amplitude (OMA _{outer}), each lane(max)	4.2	4.2	dBm
Outer Optical Modulation Amplitude (OMA _{outer}), each lane(min)	0.2		dBm
for TDECQ < 1.4dB	-1.2+TDECQ		dBm
for 1.4 dB ≤ TDECQ ≤ 3.4 dB		0.1	dBm
for TDECQ < 1.3dB		-1.2+TDECQ	dBm
for 1.3 dB ≤ TDECQ ≤ 2.8 dB			dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)	3.4 [†]	2.8 [‡]	dB
TECQ (max)	3.4 [†]	2.8 [‡]	dB
TDECQ - TECQ (max)	2.5	1.9	dB
Average launch power of OFF transmitter, each lane (max)	-15	-15	dBm
Extinction ratio, each lane, (min)	3.5	3.5	dB
Transmitter transition time (max)	8.5	8.0	ps
Transmitter over/under-shoot (max)	22	22	%
RIN _x OMA (max)	-137	-137	dB/Hz
Optical return loss tolerance (max)	21.4 (15.5 for DR1)	21.4 (15.5 for DR1)	dB
Transmitter reflectance (max)	-26	-26	dB

[†] Measured with FFE5 reference equalizer and SER = 4.8e-4

[‡] Measured with FFE5 reference equalizer and SER ~ 9.7e-3

Option A: RS(544,514)

Option B: RS(544,514) + Hamming Inner

IEEE P802.3dj 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s

Ethernet Task Force

Proposed Receiver Specifications

Description	Option	A	B	Unit
		200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	
Signaling rate, each lane (Range)		106.25 ± 50 ppm	112.5 -113.4375 ± 50 ppm	GBd
Modulation Format		PAM4	PAM4	
Lane wavelengths (range)		1304.5 to 1317.5	1304.5 to 1317.5	nm
Damage threshold, each lane		5	5	dBm
Average receive power, each lane (max)		4	4	dBm
Average receive power, each lane (min)		-4.9	-4.9	dBm
Receive power, each lane (OMA _{outer}) (max)		4.2	4.2	dBm
Receiver reflectance (max)		-26	-26	dBm
Receiver sensitivity (OMA _{outer}), each lane (max)				
for TECQ < 1.4dB		-2.9		dBm
for 1.4 dB ≤ TECQ ≤ 3.4 dB		-4.3+TECQ		dBm
for TECQ < 1.3dB			-3	dBm
for 1.3 dB ≤ TECQ ≤ 2.8 dB			-4.3+TECQ	dBm
Stressed receiver sensitivity (OMA _{outer}), each lane (max) [†]		-0.9	-0.9	dBm
Conditions of stressed receiver sensitivity test:				
SECQ		3.4 [†]	2.8 [‡]	dB
OMA _{outer} of each aggressor lane		2.1	1.6	dBm

[†] Measured with FFE5 reference equalizer and SER= 4.8e-4

[‡] Measured with FFE5 reference equalizer and SER ~ 9.7e-3

Option A: RS(544,514)

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Proposed Link Budget

Description	Option	A	B	Unit
		200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	200GBASE-DR1 400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	
Power budget (for max TDECQ)				dB
for extinction ratio \geq 4.5 dB		6.4	5.8	dB
for extinction ratio $<$ 4.5 dB		6.5	5.9	dB
Operating distance		500	500	m
Channel insertion loss		3	3	dB
Maximum discrete reflectance		-35	-35	dB
Allocation for penalties (for max TDECQ)				dB
for extinction ratio \geq 4.5 dB		3.4	2.8	dB
for extinction ratio $<$ 4.5 dB		3.5	2.9	dB
Additional insertion loss allowed		0	0	dB

2km Baseline Proposals

200GBASE-FR1, 400GBASE-DR2-2, 800GBASE-DR4-2, 1.6TBASE-DR8-2

Proposed Transmitter Specifications

Description	Option	A	B	Unit
		200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2	200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2	
Signaling rate, each lane (Range)		106.25 ± 50 ppm	112.5 -113.4375 ± 50 ppm	GBd
Modulation Format		PAM4	PAM4	
Lane wavelengths (range)		1304.5 to 1317.5	1304.5 to 1317.5	nm
Side-mode suppression ratio (SMSR), (min)		30	30	dB
Average launch power, each lane (max)		4	4	dBm
Average launch power, each lane (min)		-2.1	-2.2	dBm
Outer Optical Modulation Amplitude (OMA _{outer}), each lane(max)		4.2	4.2	dBm
Outer Optical Modulation Amplitude (OMA _{outer}), each lane(min)		0.9		dBm
for TDECQ < 1.4dB		-0.5+TDECQ		dBm
for 1.4 dB ≤ TDECQ ≤ 3.4 dB			0.8	dBm
for TDECQ < 1.3dB			-0.5+TDECQ	dBm
for 1.3 dB ≤ TDECQ ≤ 2.8 dB				dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)		3.4 [†]	2.8 [†]	dB
TECQ (max)		3.4 [†]	2.8 [†]	dB
TDECQ - TECQ (max)		2.5	1.9	dB
Average launch power of OFF transmitter, each lane (max)		-15	-15	dBm
Extinction ratio, each lane, (min)		3.5	3.5	dB
Transmitter transition time (max)		8.5	8.5	ps
Transmitter over/under-shoot (max)		22	22	%
RIN _x OMA (max)		-137	-137	dB/Hz
Optical return loss tolerance (max)		21.4 (17.1 for FR1)	21.4 (17.1 for FR1)	dB
Transmitter reflectance (max)		-26	-26	dB

400GBASE-DR2-2 is not an active 802.3dj objective

† Measured with FFE5 reference equalizer and SER= 4.8e-4

‡ Measured with FFE5 reference equalizer and SER ~ 9.7e-3

Option A: RS(544,514)

Option B: RS(544,514) + Hamming Inner

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Proposed Receiver Specifications

Description	Option		Unit
	A	B	
	200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2	200GBASE-FR1 400GBASE-DR2-2 800GBASE-DR4-2 1.6TBASE-DR8-2	
Signaling rate, each lane (Range)	106.25 ± 50 ppm	112.5 -113.4375 ± 50 ppm	GBd
Modulation Format	PAM4	PAM4	
Lane wavelengths (range)	1304.5 to 1317.5	1304.5 to 1317.5	nm
Damage threshold, each lane	5	5	dBm
Average receive power, each lane (max)	4	4	dBm
Average receive power, each lane (min)	-6.1	-6.1	dBm
Receive power, each lane (OMA _{outer}) (max)	4.2	4.2	dBm
Receiver reflectance (max)	-26	-26	dBm
Receiver sensitivity (OMA _{outer}), each lane (max)			
for TECQ < 1.4dB	-3.5		dBm
for 1.4 dB ≤ TECQ ≤ 3.4 dB	-4.9+TECQ		dBm
for TECQ < 1.3dB		-3.6	dBm
for 1.3 dB ≤ TECQ ≤ 2.8 dB		-4.9+TECQ	dBm
Stressed receiver sensitivity (OMA _{outer}), each lane (max) [†]	-1.5	-1.5	dBm
Conditions of stressed receiver sensitivity test:			
SECQ [‡]	3.4 [†]	2.8 [‡]	dB
OMA _{outer} of each aggressor lane	2.1	1.6	dBm

400GBASE-DR2-2 is not an active 802.3dj objective

[†] Measured with FFE5 reference equalizer and SER= 4.8e-4

[‡] Measured with FFE5 reference equalizer and SER ~ 9.7e-3

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IEEE P802.3dj 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s

Ethernet Task Force

Proposed Link Budget

Description	Option		Unit
	A	B	
	200GBASE-FR1 <i>400GBASE-DR2-2</i> 800GBASE-DR4-2 1.6TBASE-DR8-2	200GBASE-FR1 <i>400GBASE-DR2-2</i> 800GBASE-DR4-2 1.6TBASE-DR8-2	
Power budget (for max TDECQ)			dB
for extinction ratio \geq 4.5 dB	7.7	7.1	dB
for extinction ratio $<$ 4.5 dB	7.8	7.2	dB
Operating distance	2000	2000	m
Channel insertion loss	4	4	dB
Maximum discrete reflectance	-35	-35	dB
Allocation for penalties (for max TDECQ)			dB
for extinction ratio \geq 4.5 dB	3.7	3.1	dB
for extinction ratio $<$ 4.5 dB	3.8	3.2	dB
Additional insertion loss allowed	0	0	dB

400GBASE-DR2-2 is not an active 802.3dj objective

Summary

- Baseline proposals are presented for 500m and 2km 200G/L single wavelength reach objectives, for two different FEC directions [RS(544,514) only vs. RS(544,514) + concatenated code]
 - Options differ from each other in rate and BER/SER specifications (and affiliated specifications).
- Proposals shift the power budget up by approximately 1dB compared to comparable 100G/L objective
 - Should enable multi-rate module designs that enable backward compatibility between 200G/L and 100G/L solutions.

Next Steps

- Add Objective for 400GBASE-DR2-2?
- Refine Option B based on latest inner code contributions
- Bring additional/separate contribution(s) on 800GBASE-FR4

Questions

Potential Motion: 400GBASE-DR2-2

- Define a physical layer specification that supports 400 Gb/s operation over 2 pairs of SMF with lengths up to at least 2km
- Mover:
- Seconder:
- Y: N: A: