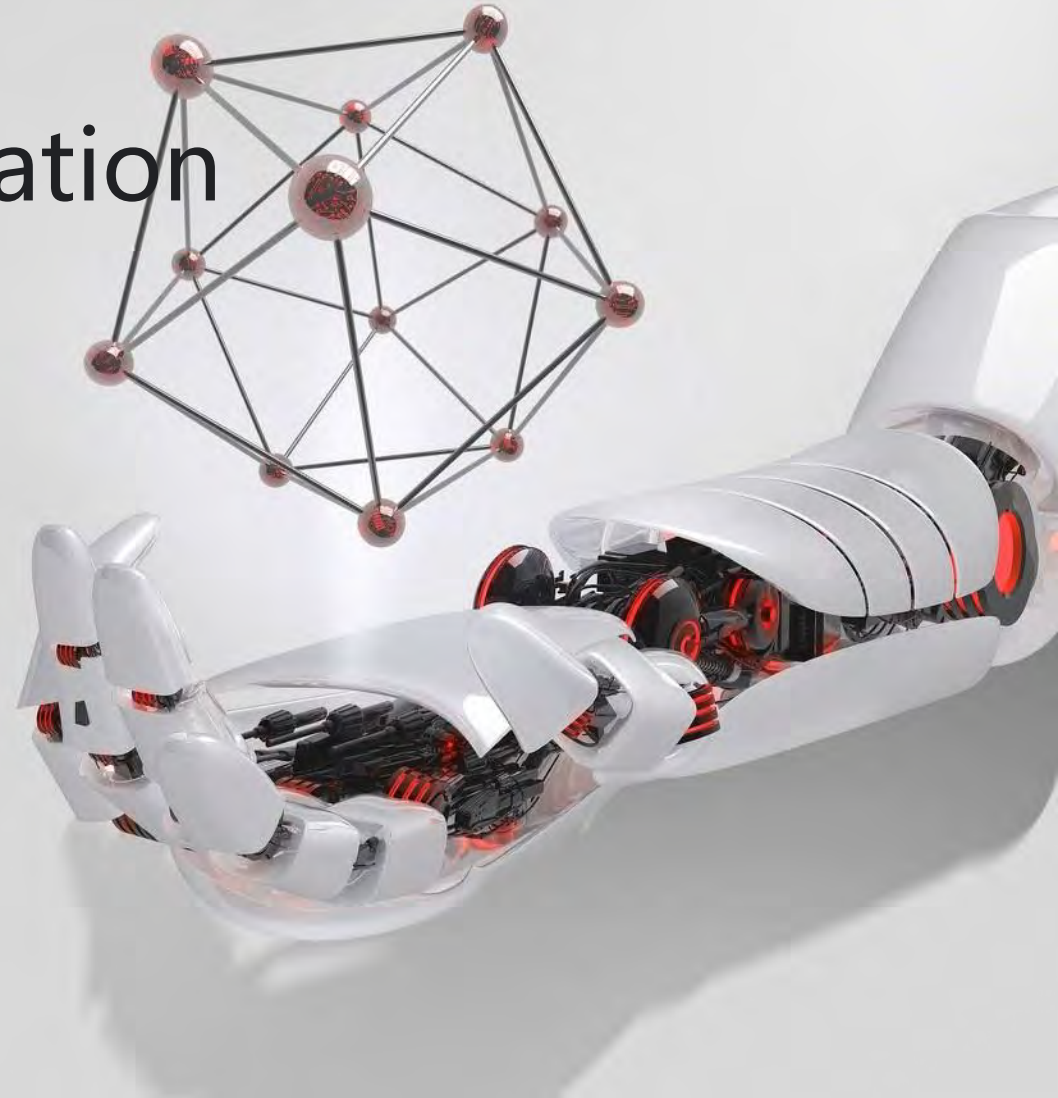


# Proposal to update the specification of 2km optical PMDs

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# Introduction

- The 802.3dj task force has recently released the updated D1.1 specification of 2km optical PMDs.
- Some refinement has been done over the last round of comment resolutions.
- There are still some fundamental TBDs left in the baselines, which largely points to the unsettlement of Ref. Rx

- CD specs
- TECQ/TDECQ max
- CD penalty  $|TDECQ - TECQ|$
- Stressed Rx. Sens.



Looks like moving towards consensus



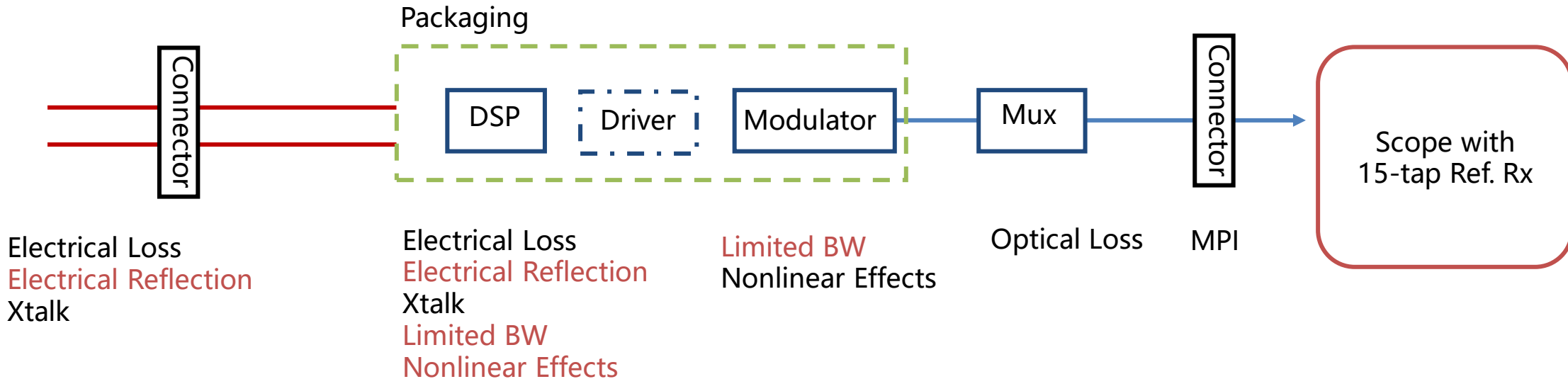
Relies on

1. definition of Ref. Rx, i.e. tap limits of the 15-tap FFE
2. definition of BER threshold used in TECQ

- This presentation provides suggestions to further improve the specification.

# Tap Limits of the 15-tap FFE

Consider a typical Transmitter system ,



- The industry likely will design one set of implementation to work in either FECi or FECo modes, depending on the tested performance of each individual part and its part code
- For the same transmitter system, the impairment needing equalization is set.

113.4375GBd  $\leftrightarrow$  106.25GBd

stronger EQ.

Weaker EQ.

How significant will the difference be?

# A 3-tap FFE analogy: analytical analysis

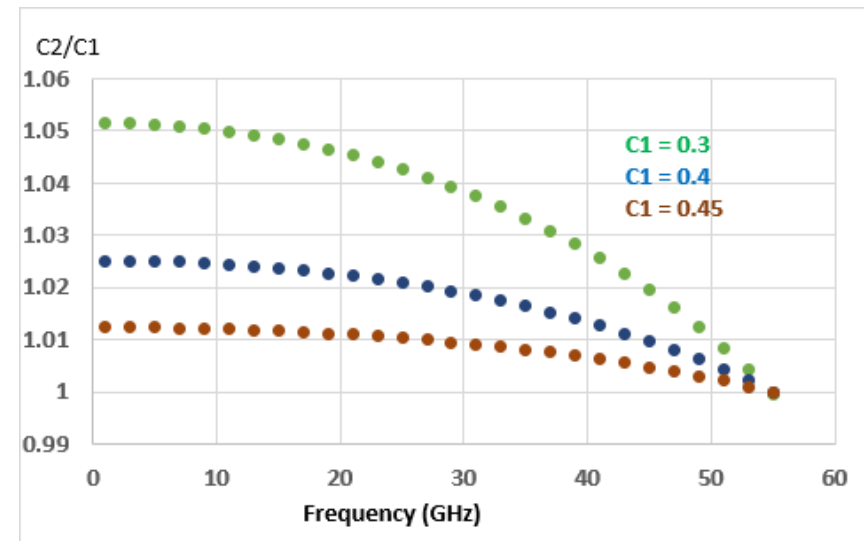
- Assume tap weights  $[-c1, c0, -c1]$  @  $f_1 \Rightarrow 106.25\text{GB}$  and  $[-c2, c0, -c2]$  @  $f_2 \Rightarrow 113.4375\text{GB}$ .
- For the transmitter to get stronger equalization @  $113.4375\text{GB}$ , the amplitude of the equalizer's frequency response should be higher than that for  $106.25\text{GB}$ , the relation between  $c1$  and  $c2$  is as following:

$$\text{To satisfy } H\left(\frac{2\pi f}{f_1}\right) \geq H\left(\frac{2\pi f}{f_2}\right)$$

We need:

$$c2 \geq \frac{\left(1 - \cos\left(\frac{2\pi f}{f_1}\right)\right) * c1}{1 - \cos\left(\frac{2\pi f}{f_2}\right) + 2 * c1 * \left(\cos\left(\frac{2\pi f}{f_2}\right) - \cos\left(\frac{2\pi f}{f_1}\right)\right)}$$

$$\text{where } f_2 > f_1, 0 < f \leq \frac{f_1}{2}$$



## Observations

1. The ratio of  $c2/c1$  varies monotonically with frequency, with its maximum value occurs at  $f=0$ :

$$c2_{max} = (c1 * f2/f1) / \left(\frac{f_1}{f_2} - 2 * c1 * \left(\frac{f_1}{f_2} - \frac{f_2}{f_1}\right)\right) \quad \text{for } f = 0$$

2. The ratio of  $c2/c1$  decreases with higher value of  $c1$ . For a tap limit  $>0.4$ , the difference is a minimal value of  $0.01$

# Using one set of tap limit for the 15-tap FFE

The case of 15-tap FFE will be more complicated.

Defining a tap limit to avoid excessive equalization, with margins incorporated

113.4375GBd  $\leftrightarrow$  106.25GBd

stronger EQ.

Weaker EQ.

Dependent on the same implementation  
i.e., same impairment

Tap limit  $\supseteq$  Tap limit

Apply one set of tap limit

Build an envelope  
One single mode in scope

	Symbol	Min	Max	Units
Feedforward equalizer (FFE) length	$N_b$		15	UI
Maximum FFE pre-cursors			3	UI
Maximum FFE post-cursors			13	UI
FFE main tap coefficient limit		0.9	2.5	-
Normalized FFE coefficient limits <sup>†</sup>	$bb(n)$			
$n = -3$		-0.1	0.1	
$n = -2$		-0.1	0.2	
$n = -1$			0.05	
$n = 1$		TBD	0.05	-
$n = 2$		-0.1	0.2	
$n \geq 3$		-0.1	0.1	
FFE Gain <sup>‡</sup>		1	1	-

<sup>†</sup> Measured relative to the main tap

<sup>‡</sup> The sum of FFE Coefficients must equal one

# The other knob on defining the Transmitter Metric

- Change the SER threshold used in TECQ of 2km PMDs to  $9.7e-3$ 
  - Align to the input from Logical Track's work
  - Aligning the BER requirement among **FECi optical PMDs**
    - DRn-2, FR4 and LR4
  - Provide consistency of the standard and avoid future confusion
    - In past generations, all PMDs using KP4 FEC shared the same BER threshold. All PAM4 PMDs used one solitary BER threshold for Rx Sens. and TECQ/TDECQ calculation. The meaning of the BER threshold has been self-explanatory.
    - For 200G/L, two FEC modes are defined, with different coding gain. Therefore it is intuitive that they have separate raw BER thresholds.
    - However, within the PMDs using FECi, the adoption of two different BER threshold has no technical basis.
    - It would cause confusion for readers of the 802.3dj standard. Let's make it precise while writing it
      - E.g. the discussion on MPI and DGD penalty in the last round of comment resolution
      - The relation between OMA and ER in 802.3df
  - **Mitigation to the requirement of Tx performance can be done via setting appropriate TECQ/TDECQ max value**

# Summary and Proposal

- We propose the following change to the current specification of the 2km optical PMDs, including 800GBASE-DR4-2, 1600GBASE-DR4-2, 800GBASE-FR4.
  - Adopt the same tap weight limit of the 15tap reference receiver for both FECi and FECo PMDs
  - Change the SER threshold of 2km PMDs from  $4e-3$  to  $9.7e-3$