Proposal for a PMD for 400GBASE-SR16

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Norfolk, VA

EVERY CONNECTION COUNTS

TE connectivity

Supporters

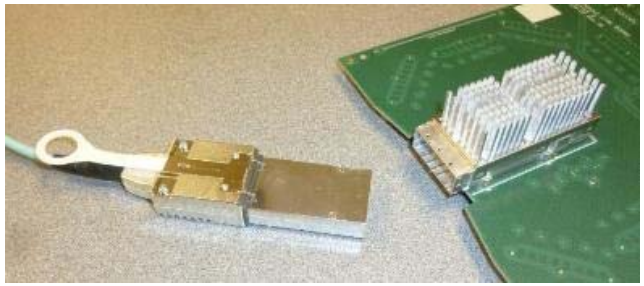
- Ryan Latchman, Macom
- Sharon Lutz, USConec
- Tom Palkert, Molex
- Scott Sommers, Molex
- Pravin Patel, IBM
- Mike Tryson, TE
- Jeffery Maki, Juniper
- David Lewis, JDSU
- Scott Kipp, Brocade

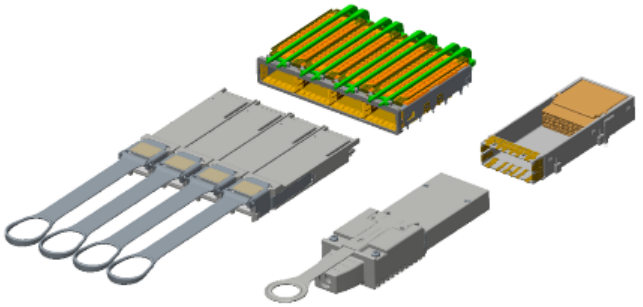
Overview

- Baseline proposal for a retimed PMD to address 802.3bs objective to "provide a physical layer specification which supports a link distance of at least 100m over MMF".
  - Leverage the 100GBASE-SR4 draft significantly to re-use the 25G lane definition for a 400G solution
  - 16 lane parallel, short wavelength based PMD for 400GBASE-SR16
  - 100m reach is enabled by making use of the physical layer specifications from 802.3bm including KR4 FEC defined in 802.3bj Clause 91
  - Use OM4 fiber
  - Allow either MT ferrules in MPO connectors *OR* Prism® MT ferrules in MXC™ connectors

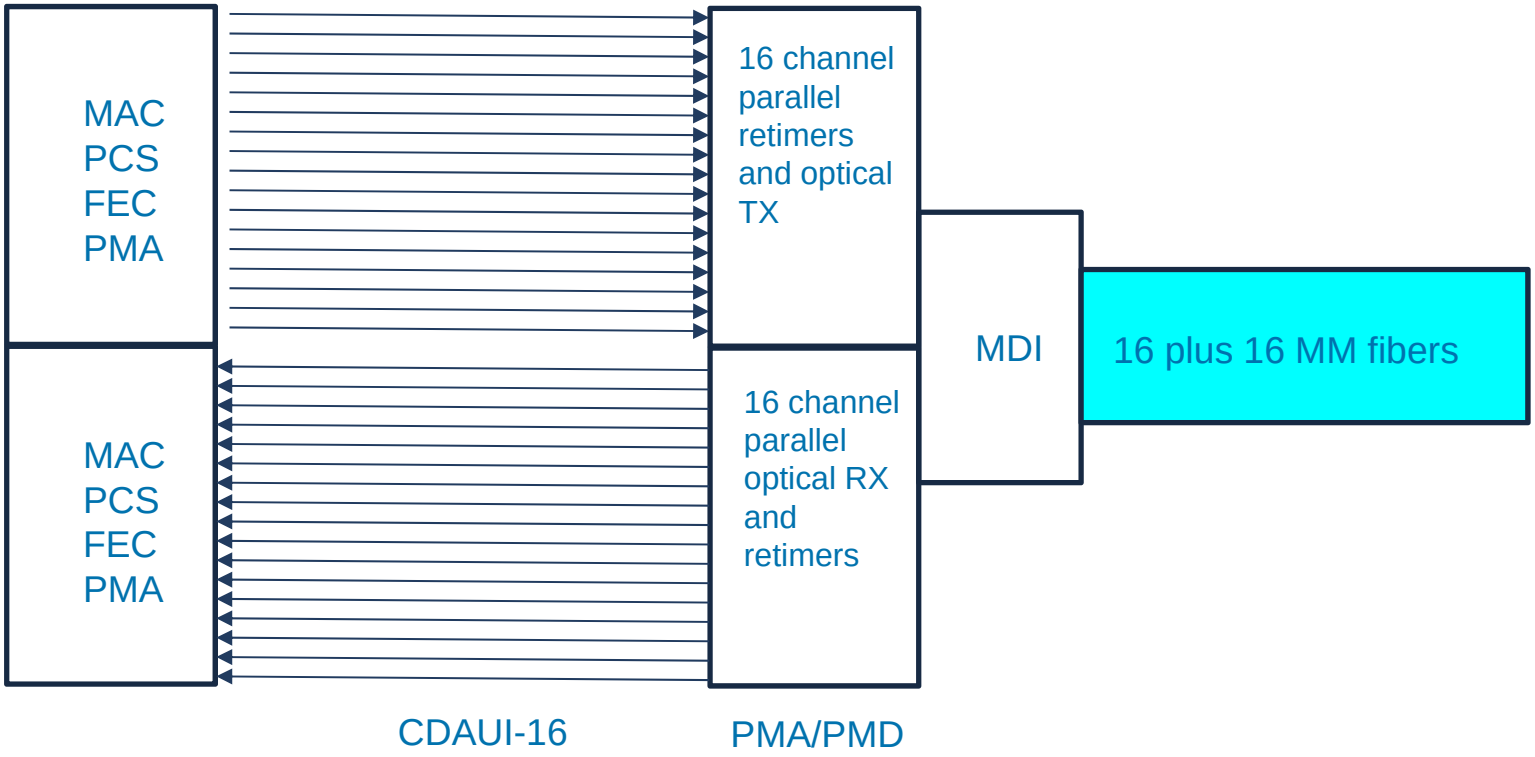
Rationale

- 25G optical lanes are being defined in 802.3bm Clause 95 operating at 25.78125Gb/s based on:
  - OM4 Multimode fiber
  - 850nm VCSEL lasers
  - 4 parallel bit streams in each direction (100Gbs)
- Can be expanded to 16 lane format for 400Gb/s
  - Use of the CDFP form factor will result in significant density increase over 100GBASE-SR4. Other form factors are possible as well.

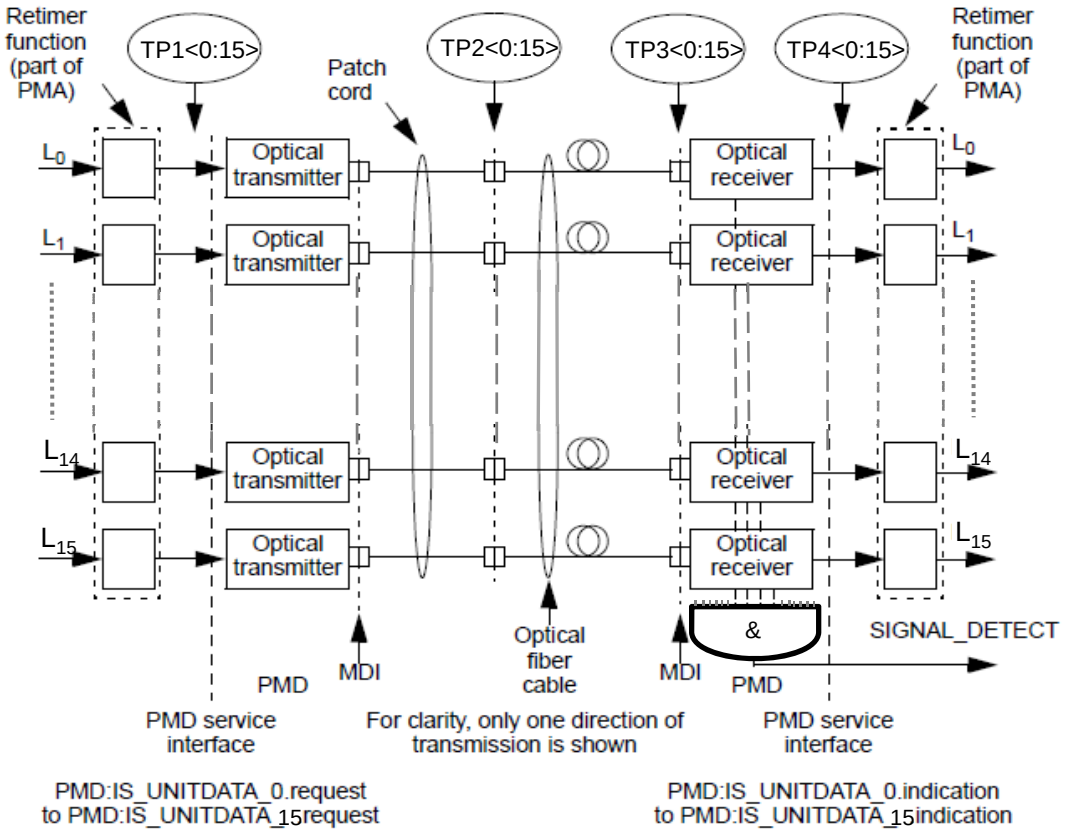




400G Proposal



Block Diagram of 400GBASE-SR16



TX Characteristics

- Propose to use same TX values as Table 95-6 once they are finalized
  - TDP and TxVEC issues still being discussed

Table X-X – 400GBASE-SR16 transmit characteristics

Description	Value	Unit
Signaling rate, each lane (range)	25.78125 ± 100 ppm	GBd
Center wavelength (range)	840 to 860	nm
RMS spectral width[a]	0.6	nm
Average launch power, each lane (max)	2.4	dBm
Average launch power, each lane (min)	–9.1	dBm
Optical Modulation Amplitude (OMA), each lane (max)	3	dBm
Optical Modulation Amplitude (OMA), each lane (min)[b]	–7.1	dBm
Launch power in OMA minus TDP (min)	–8	dBm
Transmitter and dispersion penalty (TDP), each lane (max)	5	dB
Average launch power of OFF transmitter, each lane (max)	–30	dBm
Extinction ratio (min)	2	dB
Optical return loss tolerance (max)	12	dB
Encircled flux[c]	≥ 86% at 19 µm ≤ 30% at 4.5 µm	
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.3, 0.38, 0.45, 0.35, 0.41, 0.5}	

[a]RMS spectral width is the standard deviation of the spectrum.
[b]Even if the TDP < 0.9 dB, the OMA (min) must exceed this value.
[c]If measured into type A1a.2 or type A1a.3 50 µm fiber in accordance with IEC 61280-1-4.

Rx Characteristics

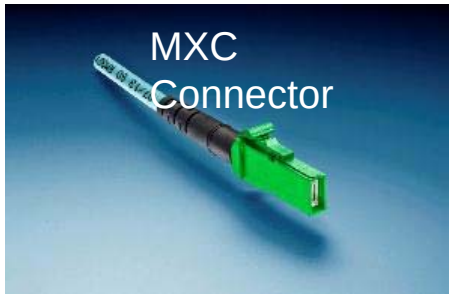
- Propose to use same RX values as Table 95-7 once they are finalized

Table X-Y – 400GBASE-SR16 receive characteristics

Description	Value	Unit
Signaling rate, each lane (range)	25.78125 ± 100 ppm	GBd
Center wavelength (range)	840 to 860	nm
Damage threshold[a] (min)	3.4	dBm
Average receive power, each lane	2.4	dBm
Average receive power, each lane[b] (min)	–11	dBm
Receive power, each lane (OMA) (max)	3	dBm
Receiver reflectance (max)	–12	dB
Stressed receiver sensitivity (OMA), each lane[c] (max)	–5.6	dBm
Conditions of stressed receiver sensitivity test:		
Vertical eye closure penalty (VECP),[d] lane under test	4.2	dB
Stressed eye J2 Jitter,[d] lane under test	0.41	UI
Stressed eye J4 Jitter,[d] lane under test	0.55	UI
OMA of each aggressor lane	3	dBm
Stressed receiver eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.28, 0.5, 0.5, 0.33, 0.33, 0.4}	

[a]The receiver shall be able to tolerate, without 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 informative and 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.
[c]Measured with conformance test signal at TP3 (see 95.8.8) for the BER specified in 95.1.1.
[d]Vertical eye closure penalty and stressed eye jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

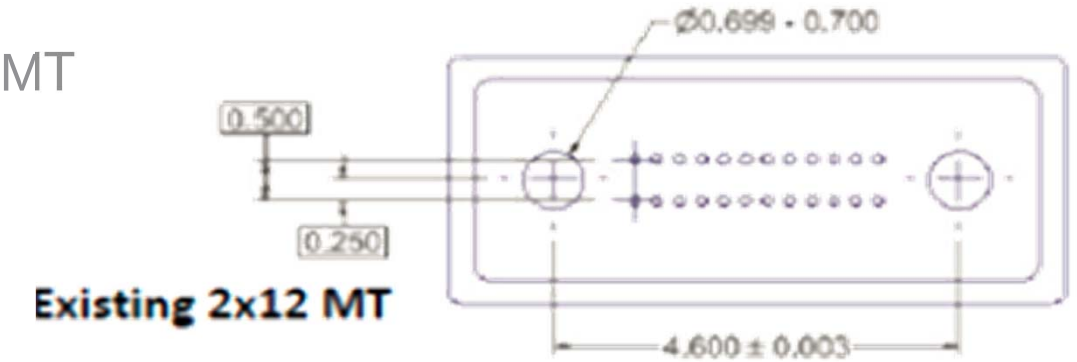
Fiber Optic Cabling



- OM4 cabling should be used for the 100m reach objective
- Interconnects can use two ferrule options:
  - The 2x16 fiber Physical Contact MT ferrule that is currently being defined in IEC
  - The 2x16 fiber Expanded Beam Prism® MT ferrule
- Propose to allow both options as follows:
  - 2x16 physical contact MT Ferrule will be housed in the standard MPO connector body
    - IEC and TIA are in process of documenting this ferrule
  - 2x16 Prism® MT will be housed in the MXC™ connector body
    - Link to Open Compute MXC™ information:
      http://www.opencompute.org/assets/Uploads/Open_Compute_Project_Open_Rack_Optical_Interconnect_Design_Guide_v0.5.pdf

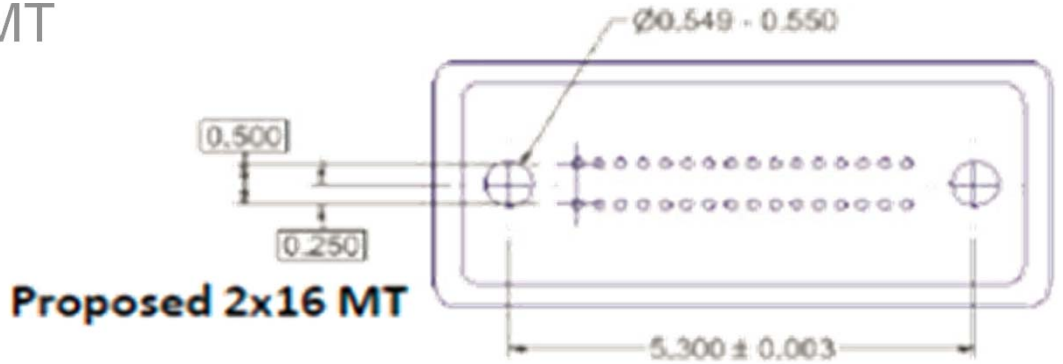
MultiFiber Physical Contact MT Ferrule Comparison

- 2x12 MT



Existing 2x12 MT

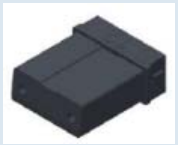
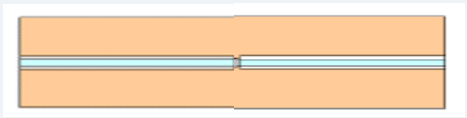
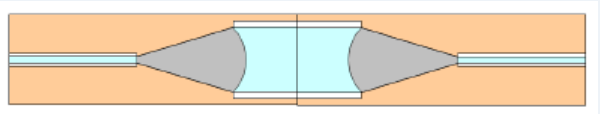
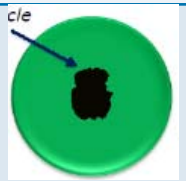
- 2x16 MT



Proposed 2x16 MT

MT and Prism ® MT Ferrules

Physical contact ferrules compared to lensed ferrules

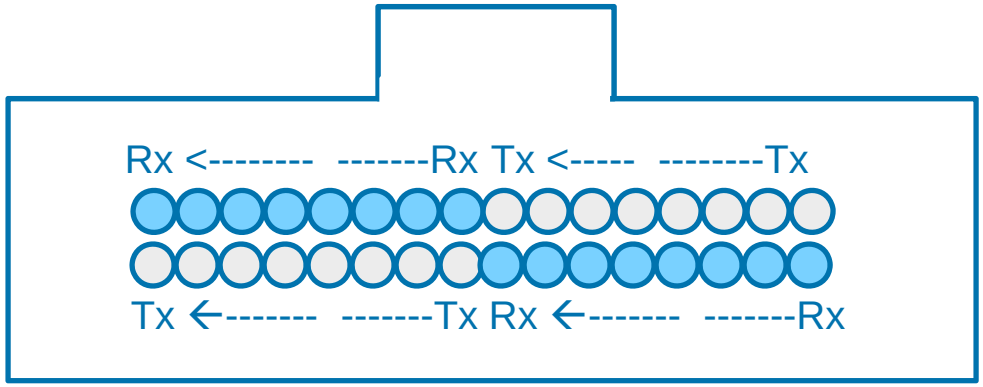
	MT Ferrule	Prism MT Ferrule
Ferrule		
Alignment		
Dust		
Higher Density		

Proposed Optical Lane Assignment for SR16

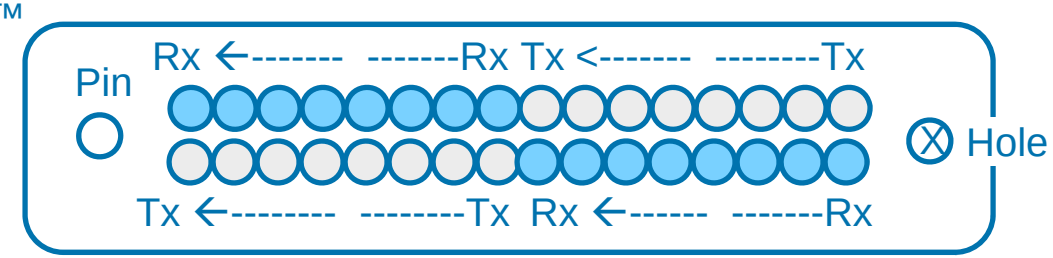
(Looking into the module)

Consistent with CDFP MSA

- MPO



- MXC™



Benefits of this Proposal

- Provides a near term solution for 400Gb/s 100m objective
- Using CDFP as a possible form factor delivers a density increase over 3 times 4x100GBASE-SR4 discrete modules
  - www.cdfp-msa.org
- Other form factors are possible
- Reuse of Clause 95 parameters allows compatibility between 100G and 400G
- 400Gb/s links could be single module to 4 discrete modules
- Also supports breakout cabling capability