

Optical Specifications of SMF PMD Alternatives Study

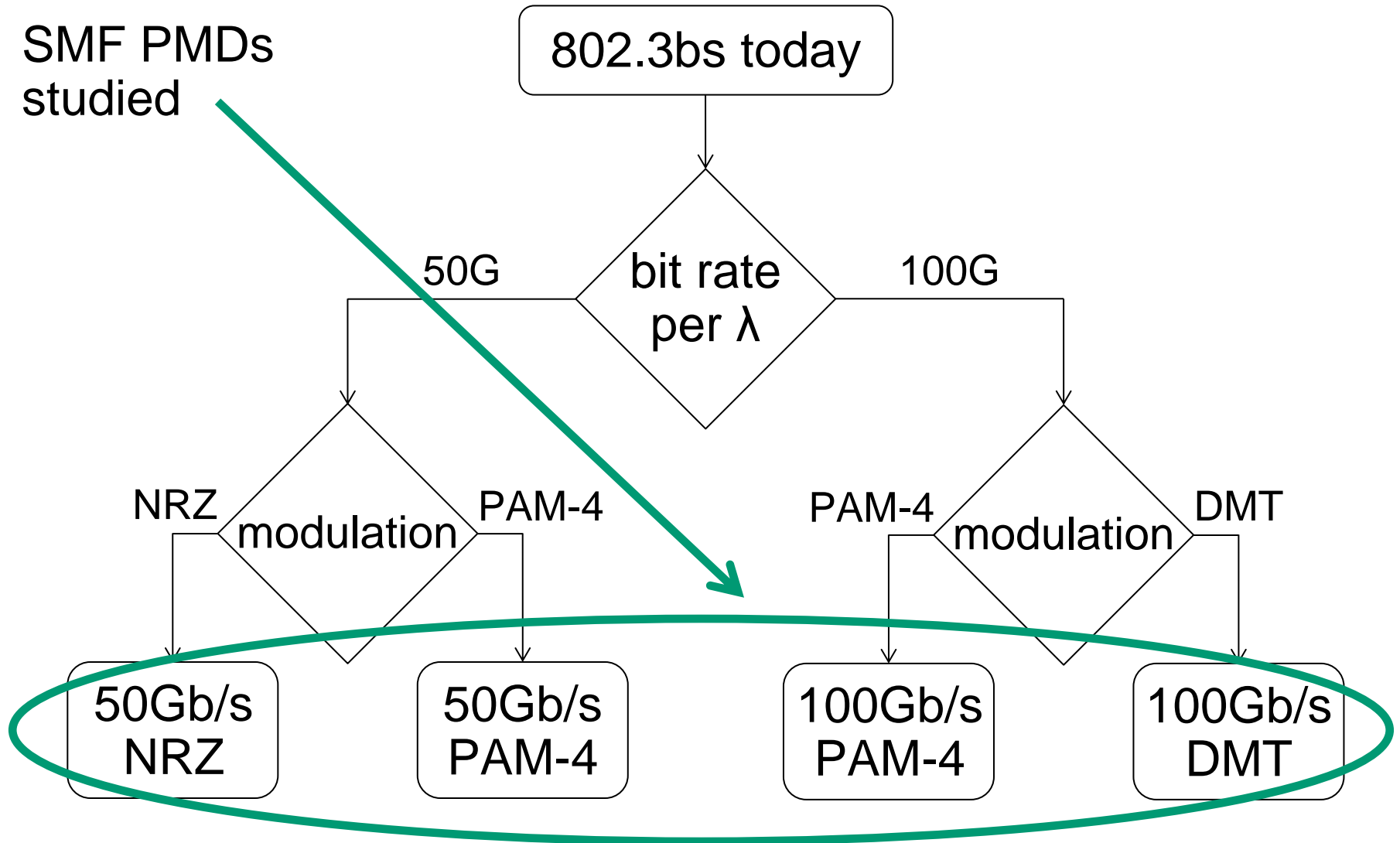
400 Gb/s Ethernet Task Force
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Duplex SMF & PSM4 PMDs Decision Tree

SMF PMDs
studied



Assumptions

- Mux, DeMux loss for 2:1, 4:1 & 8:1 ratios: 1.5, 2.5 & 3.5 dB, respectively
- Channel Insertion Loss & MPI Penalty = 5 dB
= 4 dB base channel loss & up to 1 dB MPI Penalty
- Modulation, BW, TIA design penalties, and FEC optical gain from [cole_01a_0814_smf](#)
- TDP as per [cole_3bs_01a_0714](#) including jitter, and quantization for 100G PAM-4 & DMT
- RX BW penalties for 100G PAM-4 & DMT: 1.1 & 0.0 dB, respectively (DSP RX supports lower BW than Analog RX)
- RX quantization related penalty for 100G PAM-4 & DMT: 0.5 dB for both
- DMT PMD select values from [dedic_3bs_01_0714](#), [lewis_3bs_01_0714](#), and [tanaka_3bs_01_0714](#)
- F_k = DMT-k sub-carrier I & Q channel dB power split factor

400G Duplex SMF PMDs TX Specs

TX Specifications LAN WDM Grid	4x25G NRZ LR4 No FEC MOD / DML		8x50G NRZ KP4 FEC MOD	8x50G PAM4 KP4 FEC MOD / DML		4x100G KP4 FEC PAM4 MOD	4x100G DMT BCH FEC 25G DML
Operating BER	1.0E-12		2.0E-04	2.0E-04		2.0E-04	1.0E-03
ER Full Scale (min) dB	7.0	4.0	4.0	7.0	4.5	7.0	4.5
TX OMA pre-Mux FS (min) @TDP (max) dBm	1.2	2.4	1.0	1.5	2.0	3.0	4.0
Mux Loss dB	2.5		3.5	3.5		2.5	2.5
TX OMA FS (min) @TDP (max) dBm	-1.3	-0.1	-2.5	-2.0	-1.5	0.5	1.5
Modulation Penalty Eye dB	0.0		0.0	5.0		5.0	9 + Fk
TX OMA Eye (min) @TDP (max) dBm	-1.3	-0.1	-2.5	-7.0	-6.5	-4.5	-7.5 - Fk
TDP Eye (max) dB	1.0	2.2	1.5	1.0	1.5	2.5	2.5
TX OMA - TDP Eye each lane (min) dBm	-2.3		-4.0	-8.0		-7.0	-10 - Fk

400G Duplex SMF PMDs RX Specs

RX Specifications LAN WDM Grid	NRZ 4x25G LR4 No FEC MOD / DML	8x50G NRZ KP4 FEC MOD	8x50G PAM4 KP4 FEC MOD / DML	4x100G KP4 FEC PAM4 MOD	4x100G DMT BCH FEC 25G DML
Symbol (or Sample) Rate Gbaud (or GS)	25.8	53.2	26.6	53.2	55.9
Operating BER	1.0E-12	2.0E-04	2.0E-04	2.0E-04	1.0E-03
TX OMA – TDP Eye each lane (min) dBm	-2.3	-4.0	-8.0	-7.0	-10 - Fk
Channel Insertion Loss & MPI penalty dB	6.3	5.0	5.0	5.0	5.0
RX Sens. OMA pre-FEC each lane (max) dBm	-8.6	-9.0	-13.0	-12.0	-15 - Fk
FEC Optical Gain v. 1e-12 BER dB	0.0	3.2	3.2	3.2	3.8
DeMux Loss + Lane BW Penalty dB	2.5	5.1	3.6	3.6	2.5 - Fk
TIA & Quantization Penalties dB	0.0	1.0	0.5	1.5	1.0
RX Sens. OMA post- DeMux v. LR4 dBm	-11.1	-11.9	-13.9	-13.9	-14.7

400G Duplex SMF PMDs Comparison Matrix

400G specs. compared to LR4 specs (4x25G NRZ no FEC MOD & DML)	8x50G NRZ KP4 FEC MOD	8x50G PAM-4 KP4 FEC MOD DML	4x100G PAM-4 KP4 FEC MOD	4x100G DMT-K BCH FEC 25G DML	
TX OMA delta (pre-Mux) dB	-0.2	0.3	-0.4	1.8	1.6
RX Sens. delta (post-DeMux) dB	-0.8	-2.8	-2.8	-3.6	

Every RX Sens. delta is preliminary, incomplete and optimistic

400G PSM4 PMDs TX Specs

TX Specifications CWDM Grid	4x25G NRZ CWDM4 KR4 MOD / DML		2x50G NRZ KP4 FEC MOD	2x50G PAM4 KP4 FEC MOD / DML		1x100G KP4 FEC PAM4 MOD	1x100G DMT BCH FEC 25G DML
Operating BER	5.0E-05		2.0E-04	2.0E-04		2.0E-04	1.0E-03
ER Full Scale (min) dB	6.5	3.5	4.0	7.0	4.5	7.0	4.5
TX OMA pre-Mux FS (min) @TDP (max) dBm	-1.5	0.5	-1.5	-0.5	0.0	-0.5	1.5
Mux Loss dB	2.5		1.5	1.5		0.0	0.0
TX OMA FS (min) @TDP (max) dBm	-4.0	-2.0	-3.0	-2.0	-1.5	-0.5	1.5
Modulation Penalty Eye dB	0.0		0.0	5.0		5.0	9 + Fk
TX OMA Eye (min) @TDP (max) dBm	-4.0	-2.0	-3.0	-7.0	-6.5	-5.5	-7.5 - Fk
TDP Eye (max) dB	1.0	3.0	1.5	1.0	1.5	2.5	2.5
TX OMA - TDP Eye each lane (min) dBm	-5.0		-4.5	-8.0		-8.0	-10 - Fk

400G PSM4 PMDs RX Specs

RX Specifications CWDM Grid	4x25G NRZ CWDM4 KR4 MOD / DML	2x50G NRZ KP4 FEC MOD	2x50G PAM4 KP4 FEC MOD / DML	1x100G KP4 FEC PAM4 MOD	1x100G DMT BCH FEC 25G DML
Symbol (or Sample) Rate GBaud (or GS)	25.8	53.2	26.6	53.2	55.9
Operating BER	5.0E-05	2.0E-04	2.0E-04	2.0E-04	1.0E-03
TX OMA - TDP Eye each lane (min) dBm	-5.0	-4.5	-8.0	-8.0	-10 - Fk
Channel Insertion Loss & MPI penalty dB	5.0	5.0	5.0	5.0	5.0
RX Sens. OMA pre-FEC each lane (max) dBm	-10.0	-9.5	-13.0	-13.0	-15 - Fk
FEC Optical Gain dB	2.6	3.2	3.2	3.2	3.8
DeMux Loss + Lane BW Penalty dB	2.5	3.1	1.6	1.1	0 - Fk
TIA & Quantization Penalties dB	0.0	1.0	0.5	1.5	1.0
RX Sens. OMA post- DeMux v. CWDM4 dBm	-9.9	-10.4	-11.9	-12.4	-12.2

400G PSM4 PMDs Comparison Matrix

100G specs. compared to CWDM4 Specs (4x25G NRZ KR4 FEC MOD & DML)	2x50G NRZ KP4 FEC MOD	2x50G PAM-4 KP4 FEC MOD DML	1x100G PAM-4 KP4 FEC MOD	1x100G DMT-K BCH FEC 25G DML
TX OMA delta (pre-Mux) dB	0.0	1.0	-0.5	1.0
RX Sens. delta (post-DeMux) dB	-0.5	-2.0	-2.5	-2.3

Every RX Sens. delta is preliminary, incomplete and optimistic

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Thank you