SMF PMD Nominal Specifications

400 Gb/s Ethernet Task Force

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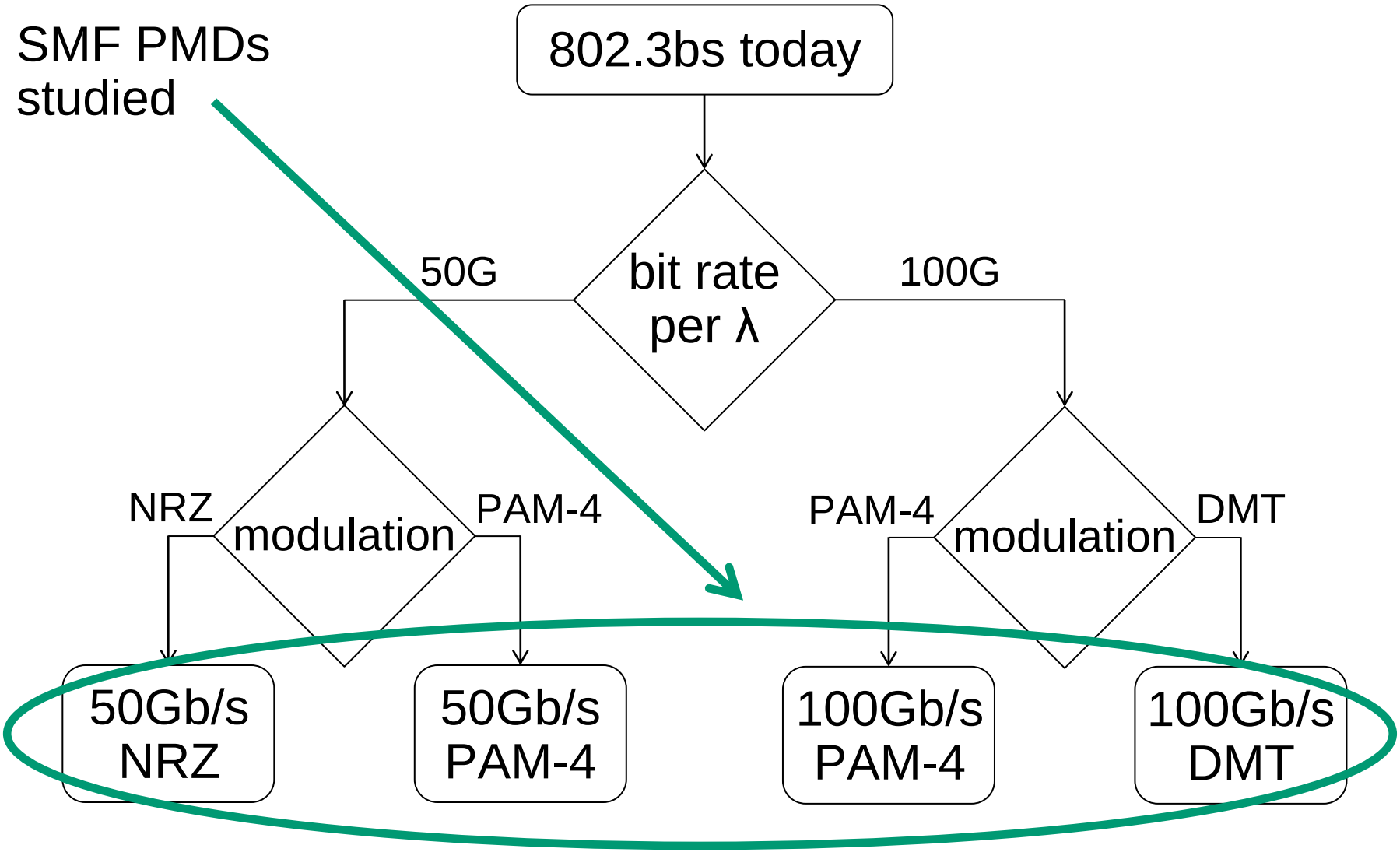
Duplex SMF & PSM4 PMDs Decision Tree



Introduction

- SMF PMD nominal specification numbers from:

  http://www.ieee802.org/3/bs/public/adhoc/smf/14_09_30/cole_01_0914_smf.pdf

- 2km 50G PAM-4 specification range shifted up by ½ dB, with updated numbers highlighted in blue shown in Appendix 1
- Comparison of 100G LR4 and CWDM4 specifications to existing 10G and 40G specifications shown in Appendix 2

400G 2km Duplex SMF PMDs Specs

Specifications	NRZ 4x25G LR4 No FEC MOD / DML	8x50G NRZ KP4 FEC MOD	8x50G PAM4 KP4 FEC MOD / DML	4x100G BCH FEC PAM4 MOD	4x100G DMT BCH FEC 25G DML
Symbol (or Sample) Rate Gbaud (or GS)	25.8	53.2	26.6	55.9	55.9
Operating BER	1.0E-12	2.0E-04	2.0E-04	1.0E-03	1.0E-03
ER Full Scale (min) dB	4.0	4.5	4.5	7.0	4.5
TX OMA (min) @TDP (max) dBm	**-0.1**	**-2.0**	**-0.5**	**1.0**	**2.5**
Modulation Penalty (MP) dB	0.0	0.0	5.0	6.0	9.0
TDP (max) dB	2.2	1.8	1.0	2.0	2.5
TX OMA - MP -TDP each lane (min) dBm	**-2.3**	**-3.8**	**-6.5**	**-7.0**	**-9.0**
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**	**-8.8**	**-11.5**	**-12.0**	**-14.0**

400G (4x100G) PSM4 PMDs Specs

Specifications	4x25G NRZ CWDM4 KR4 MOD / DML	2x50G NRZ KP4 FEC MOD	2x50G PAM4 KP4 FEC MOD / DML	1x100G BCH FEC PAM4 MOD	1x100G DMT BCH FEC 25G DML
Symbol (or Sample) Rate Gbaud (or GS)	25.8	53.2	26.6	55.9	55.9
Operating BER	5.0E-05	2.0E-04	2.0E-04	1.0E-03	1.0E-03
ER Full Scale (min) dB	3.5	4.5	4.5	7.0	4.5
TX OMA (min) @TDP (max) dBm	**-2.0**	**-2.5**	**-1.5**	**0.0**	**2.0**
Modulation Penalty (MP) dB	0.0	0.0	5.0	6.0	9.0
TDP (max) dB	3.0	1.8	1.0	2.0	2.5
TX OMA - MP -TDP each lane (min) dBm	**-5.0**	**-4.3**	**-7.5**	**-8.0**	**-9.5**
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**	**-9.3**	**-12.5**	**-13.0**	**-14.5**

400G 10km Duplex SMF PMDs Specs

Specifications	NRZ 4x25G LR4 No FEC MOD / DML	8x50G NRZ BCH FEC MOD	8x50G PAM4 BCH FEC MOD / DML	4x100G BCH FEC PAM4 MOD	4x100G DMT BCH FEC 25G DML
Symbol (or Sample) Rate Gbaud (or GS)	25.8	55.9	28.0	55.9	55.9
Operating BER	1.0E-12	1.0E-03	1.0E-03	1.0E-03	1.0E-03
ER Full Scale (min) dB	4.0	4.5	4.5	7.0	4.5
TX OMA (min) @TDP (max) dBm	**-0.1**	**-1.0**	**0.0**	**1.0**	**2.5**
Modulation Penalty (MP) dB	0.0	0.0	5.0	6.0	9.0
TDP (max) dB	2.2	2.3	1.5	2.5	3.0
TX OMA - MP -TDP each lane (min) dBm	**-2.3**	**-3.3**	**-6.5**	**-7.5**	**-9.5**
Channel Insertion Loss & MPI penalty dB	6.3	7.0	7.0	7.0	7.0
RX Sens. OMA pre-FEC each lane (max) dBm	**-8.6**	**-10.3**	**-13.5**	**-14.5**	**-16.5**

Discussion

- 802.3bs TF needs to decide how to include Modulation Penalty in Specifications:
- Approach 1: Modulation Penalty (MP) and TDP separate
  - Ex. for 2km, 50G PAM-4: MP = 5.0dB, TDP = 1.0dB
  - The approach in this presentation
- Approach 2: Modulation Penalty included in TDMP
  - Ex. for 2km, 50G PAM-4: no MP, TDMP = 6.0dB
- Other approaches?
- How do we specify a measurement methodology for MP?

A1: 400G 2km Duplex SMF PMDs TX Specs

TX Specifications	4x25G NRZ LR4 No FEC MOD / DML		8x50G NRZ KP4 FEC MOD	8x50G PAM4 KP4 FEC MOD / DML		4x100G BCH FEC PAM4 MOD	4x100G DMT BCH FEC 25G DML
Operating BER	1.0E-12		2.0E-04	2.0E-04		1.0E-03	1.0E-03
ER Full Scale (min) dB	7.0	4.0	4.5	7.0	4.5	7.0	4.5
TX OMA pre-Mux (min) @TDP (max) dBm	**0.7**	**1.9**	**1.0**	**2.2**	**2.5**	**3.0**	**4.5**
Mux Loss dB	2.0		3.0	3.0		2.0	2.0
TX OMA (min) @TDP (max) dBm	-1.3	-0.1	-2.0	-0.8	-0.5	1.0	2.5
Modulation Penalty dB	0.0		0.0	5.0		6.0	9 + Fk
TX OMA Eye (min) @TDP (max) dBm	-1.3	-0.1	-2.0	-5.8	-5.5	-5.0	-6.5 - Fk
TDP (max) dB	1.0	2.2	1.8	0.7	1.0	2.0	2.5
TX OMA Eye - TDP each lane (min) dBm	**-2.3**		**-3.8**	**-6.5**		**-7.0**	**-9 - Fk**

A1: 400G 2km Duplex SMF PMDs RX Specs

RX Specifications	NRZ 4x25G LR4 No FEC MOD / DML	8x50G NRZ KP4 FEC MOD	8x50G PAM4 KP4 FEC MOD / DML	4x100G BCH FEC PAM4 MOD	4x100G DMT BCH FEC 25G DML
Symbol (or Sample) Rate Gbaud (or GS)	25.8	53.2	26.6	55.9	55.9
Operating BER	1.0E-12	2.0E-04	2.0E-04	1.0E-03	1.0E-03
TX OMA Eye - TDP each lane (min) dBm	-2.3	-3.8	-6.5	-7.0	-9 - 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**	**-8.8**	**-11.5**	**-12.0**	**-14 - Fk**
FEC Optical Gain v. 1e-12 BER dB	0.0	3.2	3.2	3.8	3.8
DeMux Loss + Lane BW Penalty dB	2.0	4.6	3.1	3.2	2 - Fk
TIA, Xtalk, Quantization Penalties dB	0.2	1.8	1.3	1.8	1.3
RX Sens. OMA post-DeMux v. LR4 dBm	**-10.8**	**-12.0**	**-12.7**	**-13.2**	**-13.5**

A1: 400G 2km Duplex SMF PMDs Comparison

400G 2km - LR4 specs 4x25G NRZ No FEC MOD & DML	8x50G NRZ KP4 FEC MOD	8x50G PAM-4 KP4 FEC MOD	DML	4x100G PAM-4 BCH FEC MOD	4x100G DMT-K BCH FEC 25G DML
TX OMA delta (pre-Mux) dB	0.3	1.5	0.6	2.3	2.6
RX Sens. delta (post-DeMux) dB	-1.2	-1.9		-2.4	-2.7
Total delta dB	1.5	3.4	2.5	4.7	5.3

A2: 100G LR4 & CWDM4 Comparisons

Specs	100G LR4 Gen1 (EML) - 40G FR EML TX & 10G LR RX	100G LR4 Gen2 (DML) - 10G LR DML TX & 10G LR RX	100G CWDM4 - 10G LR DML TX & 10G LR RX
TX OMA delta (pre-Mux) dB	-1.0	4.9	3.0
RX Sens. delta (post-DeMux) dB	-1.2	-1.2	0.0
Total delta dB	0.2	6.1	3.0

Optical Specifications of SMF PMDs Study

Thank you