Security Level:

25G EPON PMD tables

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Background

- The major PMD specification of 25G EPON has been agreed in past few meetings, it was agreed to generate D1.0 based on current approved motions

1. **Wavelength and Power Budget:** IEEE_802d3_to_SG15_Q2_0318.pdf
    - Downstream wavelength plan was accepted. Two wavelengths: 1358 +/- 2 nm and 1342 +/- 2 nm. 25G PON will use 1358 +/- 2 nm.
    - 25G PON OLT transmitter launch power: AVPmin = 4.8 dBm and ER min = 8 dB
    - 25G PON ONU receiver sensitivity was accepted: -25.7 dBm at BER= 1e-2 and ER=8 dB
    - Upstream wavelength plan was modified. UW0 1260-1280 nm, UW1 1290-1310 nm, UW2 1320 +/- 2 nm.
    - 25G PON ONU transmitter launch power: (AVP minus TDP) min = 4 dBm, ER min =5 dB
    - 25G PON OLT receiver sensitivity was accepted: -25.0 dBm at BER= 1e-2, ER=5 dB

- This contribution discusses how to populate the current agreed specifications to the final PMD tables in the final draft

Eliminate unnecessary style difference on PMD table between ITU and IEEE

IEEE 802.3av

Table 75–5—PR and PRX type OLT PMD transmit characteristics

Description	10GBASE–PR–D1, 10GBASE–PR–D3, 10/1GBASE–PRX–D1, 10/1GBASE–PRX–D3	10GBASE–PR–D2, 10/1GBASE–PRX–D2	Unit
Signaling speed (range)	10.3125 ± 100 ppm	10.3125 ± 100 ppm	GBd
Wavelength (range)	1575 to 1580	1575 to 1580	nm
Side Mode Suppression Ratio (min)[a]	30	30	dB
Average launch power (max)	5	9	dBm
Average launch power (min)[b]	2	5	dBm
Average launch power of OFF transmitter (max)	–39	–39	dBm
Extinction ratio (min)	6	6	dB
$RIN_{15}OMA$ (max)	–128	–128	dB/Hz
Launch OMA (min)[b]	3.91 (2.46)	6.91 (4.91)	dBm (mW)
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}[c]	{0.25, 0.40, 0.45, 0.25, 0.28, 0.40}	{0.25, 0.40, 0.45, 0.25, 0.28, 0.40}	UI
Optical return loss tolerance (max)	15	15	dB
Transmitter reflectance (max)	–10	–10	dB
Transmitter and dispersion penalty (max)	1.5	1.5	dB
Decision timing offset for transmitter and dispersion penalty	± 0.05	± 0.05	UI

[a]Transmitter is a single longitudinal mode device. Chirp is allowed such that the total optical path penalty does not exceed that found in Table 75B–2.
[b]Minimum average launch power and minimum launch OMA are valid for ER = 9 dB (see Figure 75–4 for details)
[c]As defined in Figure 75–8.

OMA based

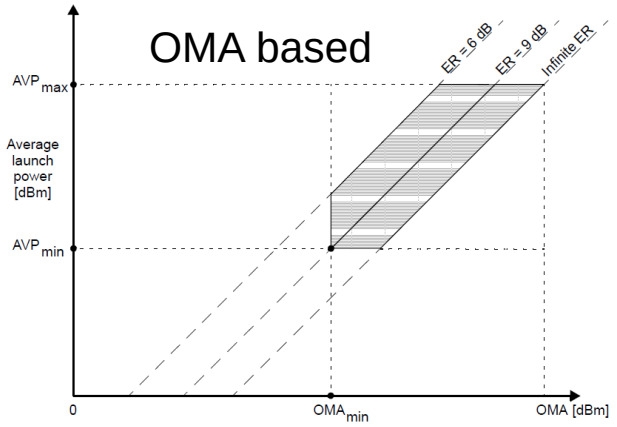


Figure 75–4—Graphical representation of region of PR–D type transmitter compliance

ITU G.987.2

Table 9-3 – Optical interface parameters of 9.95328 Gbit/s downstream direction

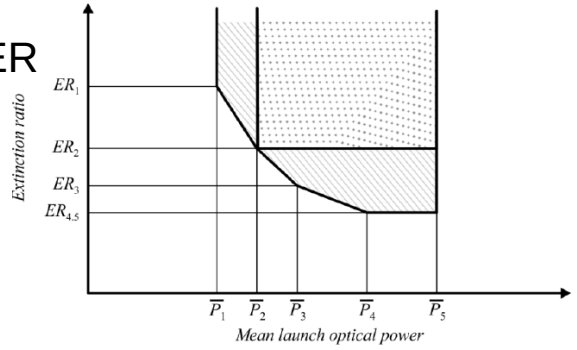
Item	Unit	Value					
OLT transmitter (optical interface O_{td})							
Nominal line rate	Gbit/s	9.95328					
Operating wavelength (Note 1)	nm	1575-1580					
Line code	–	NRZ					
Mask of the transmitter eye diagram	–	See clause 9.2.7.6.1					
Maximum reflectance at S/R, measured at transmitter wavelength	dB	NA					
Minimum ORL of ODN at O_{ta} and O_{td} (Notes 2 and 3)	dB	More than 32					
ODN Class		N1	N2		E1	E2	
			N2a	N2b		E2a	E2b
Mean launched power MIN	dBm	+2.0	+4.0	+10.5	+6	+8	+14.5
Mean launched power MAX	dBm	+6.0	+8.0	+12.5	+10	+12	+16.5
Launched optical power without input to the transmitter	dBm	NA					
Minimum extinction ratio	dB	8.2					
Transmitter tolerance to reflected optical power (Note 7)	dB	More than –15					
Dispersion range	ps/nm	0-400 (DD20) 0-800 (DD40)					
Minimum side mode suppression ratio	dB	30					

ITU G.989.2 amd2

11.1.4.3.2 Extinction ratio and minimum mean launch optical power trade off

This clause is applicable to transmitters subject to the requirement of Table 11-7.

Power and ER based



Minimize the over-estimated margin and allow flexibility for vendors

IEEE 802.3av

10G EPON

Table 75–8—PR type ONU PMD transmit characteristics

Description	10GBASE –PR–U1	10GBASE –PR–U3	Unit
Signaling speed (range)	10.3125 ± 100 ppm	10.3125 ± 100 ppm	GBd
Wavelength (range)	1260 to 1280	1260 to 1280	nm
Side Mode Suppression Ratio (min)[a]	30	30	dB
Average launch power (max)	4	9	dBm
Average launch power (min)[b]	–1	4	dBm
Average launch power of OFF transmitter (max)	–45	–45	dBm
Extinction ratio (min)	6	6	dB
Transmitter and dispersion penalty (max)[d]	3.0	3.0	dB

The TDP is based on the worst worst case, it's serious over-estimated for majority case

ITU G.987.2

Table 9-3 – Optical interface parameters of 9.95328 Gbit/s downstream direction

Item	Unit	Value					
OLT transmitter (optical interface O_{td})							
Nominal line rate	Gbit/s	9.95328					
Operating wavelength (Note 1)	nm	1575-1580					
Line code	–	NRZ					
Mask of the transmitter eye diagram	–	See clause 9.2.7.6.1					
Maximum reflectance at S/R, measured at transmitter wavelength	dB	NA					
Minimum ORL of ODN at O_{ta} and O_{td} (Notes 2 and 3)	dB	More than 32					
ODN Class		N1	N2		E1	E2	
			N2a	N2b		E2a	E2b
Mean launched power MIN	dBm	+2.0	+4.0	+10.5	+6	+8	+14.5
Mean launched power MAX	dBm	+6.0	+8.0	+12.5	+10	+12	+16.5
Launched optical power without input to the transmitter	dBm	NA					
Minimum extinction ratio	dB	8.2					
Transmitter tolerance to reflected optical power (Note 7)	dB	More than –15					
Dispersion range	ps/nm	0-400 (DD20) 0-800 (DD40)					
Minimum side mode suppression ratio	dB	30					

Minimal Tx power and ER are the absolute minimum!

No trade-off, no flexibility !

Quick readability

Table 75–5—PR and PRX type OLT PMD transmit characteristics

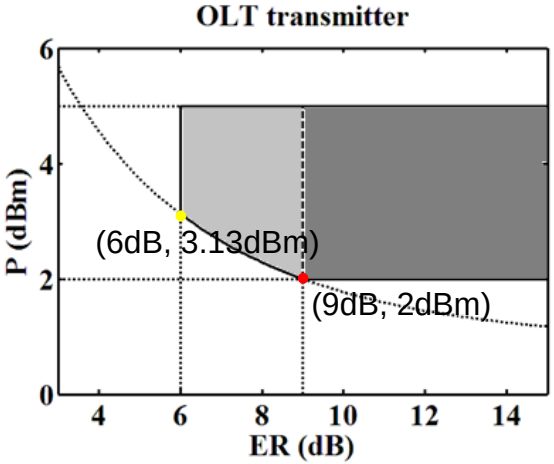
10G EPON OLT spec in 802.3av

Description	10GBASE–PR–D1, 10GBASE–PR–D3, 10/1GBASE–PRX–D1, 10/1GBASE–PRX–D3	10GBASE–PR–D2, 10/1GBASE–PRX–D2	Unit
Signaling speed (range)	10.3125 ± 100 ppm	10.3125 ± 100 ppm	GBd
Wavelength (range)	1575 to 1580	1575 to 1580	nm
Side Mode Suppression Ratio (min)[a]	30	30	dB
Average launch power (max)	5	9	dBm
Average launch power (min)[b]	2	5	dBm
Average launch power of OFF transmitter (max)	–39	–39	dBm
Extinction ratio (min)	6	6	dB
$RIN_{15}OMA$ (max)	–128	–128	dB/Hz
Launch OMA (min)[b]	3.91 (2.46)	6.91 (4.91)	dBm (mW)
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}[c]	{0.25, 0.40, 0.45, 0.25, 0.28, 0.40}	{0.25, 0.40, 0.45, 0.25, 0.28, 0.40}	UI
Optical return loss tolerance (max)	15	15	dB
Transmitter reflectance (max)	–10	–10	dB
Transmitter and dispersion penalty (max)	1.5	1.5	dB
Decision timing offset for transmitter and dispersion penalty	± 0.05	± 0.05	UI

[a]Transmitter is a single longitudinal mode device. Chirp is allowed such that the total optical path penalty does not exceed that found in Table 75B–2.
[b]Minimum average launch power and minimum launch OMA are valid for ER = 9 dB (see Figure 75–4 for details)
[c]As defined in Figure 75–8.

It's easy to mislead readers that " P = 2.0dBm with ER=6.0dB is a compliant PR30 OLT transmitter!

The real Tx area



Suggestion:

- Continue to specify PMD parameters based on launch power and ER as normative spec , rather than in the way of OMA
  - OMA receiver sensitivity is not constant for APD receiver
  - Overload mainly depends on launch power , rather than OMA (overload has very little relationship with ER)
  - Launch power and extinction ratio are more widely be used than OMA
  - It’s good to have a uniform style with ITU PON

- Specify the transmitter based on both“Tx – TDP”and allow trade-off between “launch power” and “extinction ratio”
  - Specify a minimal TDP based on typical case rather than the worst worst case

OLT transmitter specification

Assume:

minimal TDPmax = 1.0dB

Maximal TDPmax = 1.0 + 1.0dB

Motion #7

The 25G EPON PR30 specifications proposed in harstead_3ca_1b_0118
25G ONU receiver sensitivity: -25.7 dBm at BER= 1e-2 and ER=8 dB
25G OLT transmitter: AVPmin = 4.8 dBm and ER min = 8 dB
shall be adopted.

Moved: Ed Harstead Second: John Johnson

For: 16 Against: 2 Abstain: 12

Technical (≥ 75%) Motion Passed

TDPmax =1.5dB

Table 141-8 — OLT PMD Transmit characteristics

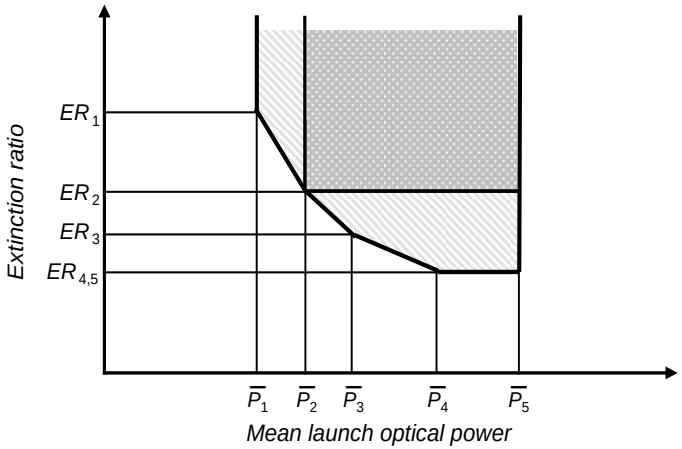
Description	25GBASE-PR30-D	Unit	Comment
Signaling speed (range)	25.78125 ± 100 ppm	GBd	
wavelengths (range)	1356 to 1360	nm	
Side Mode Suppression Ratio (min)	30	dB	From 802.3av
Total average launch power (max)	—	dBm	
Average launch power (max)	7.8	dBm	3dB spread range
Average launch power (min) (note 1, note 3)	4.8 -1.5 + 1.0	dBm	Assume the minimal TDPmax is 1.0dB, can be decided further
Average launch power of OFF transmitter (max)	-39	dBm	From 802.3av
Launch power minus TDP (min) (note 1, note 3)	3.3	dBm	Based on ER=8dB
Transmitter and dispersion penalty (TDP), each lane (max) (note 2)	1.0	dB	
Extinction ratio (min) (note 3)	8	dB	
$RIN_{15}OMA$ (max)	TBD	dB/Hz	
Optical return loss tolerance (max)	TBD	dB	
Transmitter reflectance (max)	TBD	dB	
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	TBD	UI	
Decision timing offset for transmitter and dispersion penalty	TBD	UI	

Note 1: it is based on the maximal TDP = 1.0dB and ER = 8dB.

Note 2: if the actual TDP is worse than 1.0dB, it must be compensated by increasing the transmitter mean launch power minimum specification by X dB for each X dB of extra TDP allowance, where X < 1 dB, while meeting all other Tx specifications.

Note 3: A lower extinction ratio is allowed but must be compensated by a larger transmitter launch power within the limits of the "Average launch power (max)" value. A lower "Average launch power " is allowed but must be compensated by higher extinction ratio. For quantitative treatment of these tradeoffs, see clause xxx

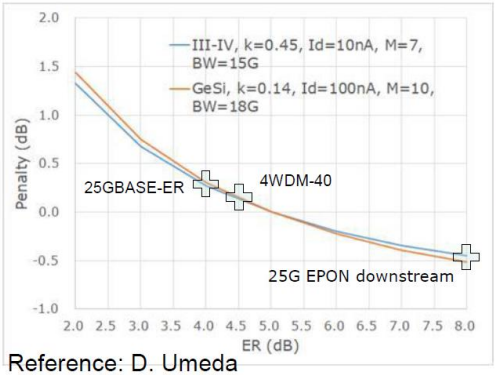
Clause xxx: Extinction ratio and minimum mean launch optical power trade off:



	(ER1,P1)	(ER2,P2)	…	…
Mean launch optical power, dBm	Tbd	4.3	Tbd	Tbd
Extinction ratio, dB	Tbd	8	Tbd	Tbd

The detail trade-off number can be decided based on theory and experiments

- APD sensitivity is OMA dependent.
- Adjust sensitivity for different ER



Reference: D. Umeda

Specification	ER min (dB)	Sensitivity improvement for ER=8 dB (dB)
25G EPON downstream	8	
4WDM-40	4.5	0.7
25GBASE-ER	4	0.8

ONU transmitter specification

Assume:

minimal TDPmax = 1.0dB

Maximal TDPmax = 1.0 + 1.0dB

Motion #7

Adopt the following 25G EPON PR30 upstream specifications:

- 25G OLT receiver sensitivity: -25.0 dBm at BER = 1e-2 and ONU Tx ER = 5 dB,
- 25G ONU transmitter: ERmin = 5 dB, (AVP minus TDP)min = 4.0dBm and upda

Moved: Dekun Liu Second: Ed Harstead

For: 25 Against: 0 Abstain: 0

Technical (≥ 75%) Motion Passed

Table 141-8 — OLT PMD Transmit characteristics

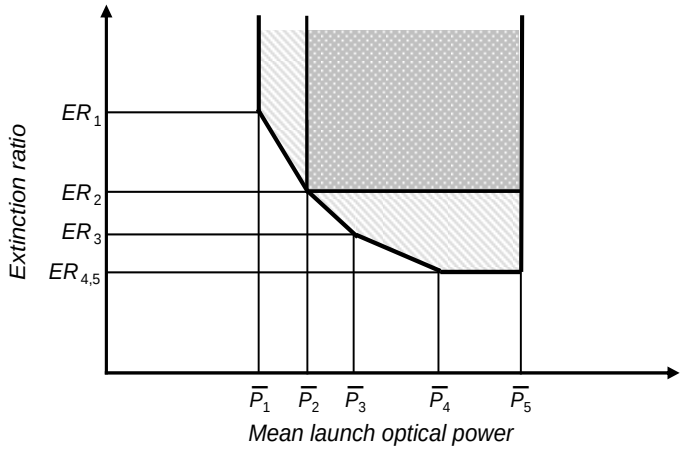
Description	25GBASE-PR30-D	Unit	Comment
Signaling speed (range)	25.78125 ± 100 ppm	GBd	
wavelengths (range)	1260 to 1280 1290 to 1310	nm	
Side Mode Suppression Ratio (min)	30	dB	From 802.3av
Total average launch power (max)	—	dBm	
Average launch power (max)	9	dBm	4dB spread range
Average launch power (min) (note 1, note 3)	4.0 + 1.0	dBm	Assume the minimal TDPmax is 0.5dB, can be decided further
Average launch power of OFF transmitter (max)	-45	dBm	From 802.3av
Launch power minus TDP (min) (note 1, note 3)	4.0	dBm	Based on ER=5dB
Transmitter and dispersion penalty (TDP), each lane (max) (note 2)	1.0	dB	
Extinction ratio (min) (note 3)	5	dB	
$RIN_{15}OMA$ (max)	TBD	dB/Hz	
Optical return loss tolerance (max)	TBD	dB	
Transmitter reflectance (max)	TBD	dB	
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	TBD	UI	
Decision timing offset for transmitter and dispersion penalty	TBD	UI	

Note 1: it is based on the maximal TDP = 1.0dB and ER = 5dB.

Note 2: if the actual TDP is worse than 1.0dB, it must be compensated by increasing the transmitter mean launch power minimum specification by X dB for each X dB of extra TDP allowance, where X < 1 dB, while meeting all other Tx specifications.

Note 3: A lower extinction ratio is allowed but must be compensated by a larger transmitter launch power within the limits of the "Average launch power (max)" value. A lower "Average launch power " is allowed but must be compensated by higher extinction ratio. For quantitative treatment of these tradeoffs, see clause xxx

Clause xxx: **Extinction ratio and minimum mean launch optical power trade off:**



	(ER1,P1)	(ER2,P2)	…	…
Mean launch optical power, dBm	Tbd	5	Tbd	Tbd
Extinction ratio, dB	Tdb	5	Tbd	Tbd

Proposal

- Propose to use the method shown in page 7~10 to define the 25G OLT and ONU transmitter

Thank you

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