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

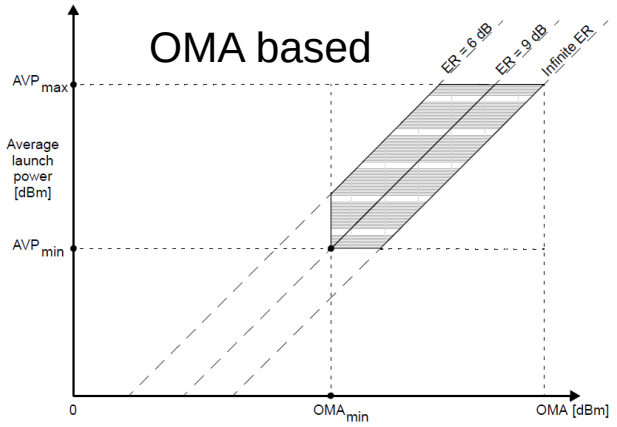



**Figure 75–4—Graphical representation of region of PR–D type transmitter compliance**

## ITU G.987.2

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

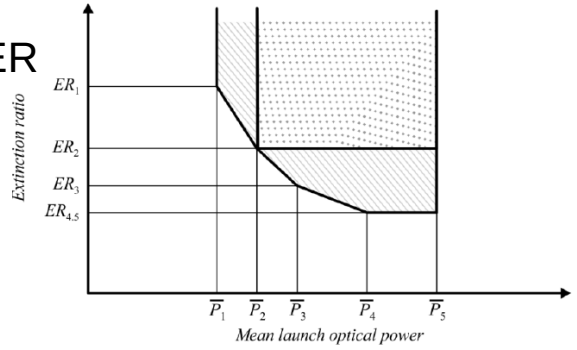
| Item | Unit | Value | | | | | |
|---|---|---|---|---|---|---|---|
| OLT transmitter (optical interface $O_{td}$) | | | | | | | |
| Nominal line rate | Gbit/s | 9.95328 | | | | | |
| Operating wavelength (Note 1) | nm | 1575-1580 | | | | | |
| Line code | – | NRZ | | | | | |
| Mask of the transmitter 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)<br>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)<br>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

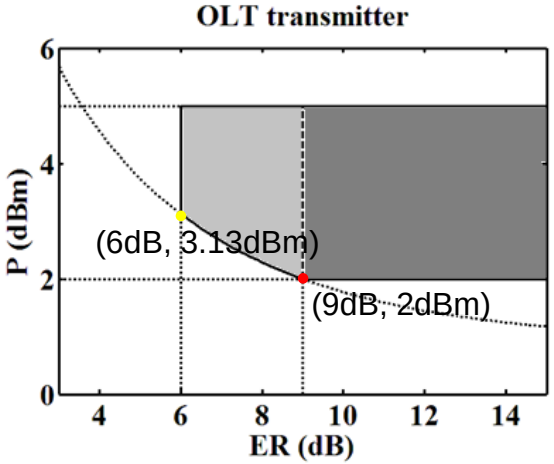
10G EPON OLT spec in 802.3av

| 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**

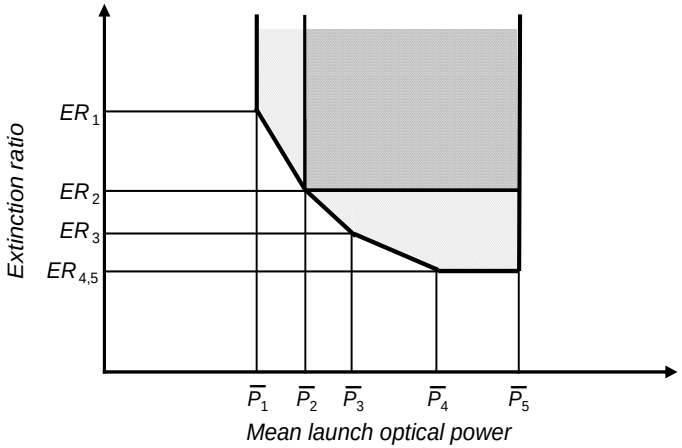
| Description | 25GBASE-PR30-D | Unit | Comment |
|---|---|---|---|
| Signaling speed (range) | 25.78125 ± 100 ppm | GBd | |
| wavelengths (range) | 1356 to 1360 | nm | |
| Side Mode Suppression Ratio (min) | 30 | dB | From 802.3av |
| Total average launch power (max) | — | dBm | |
| Average launch power (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

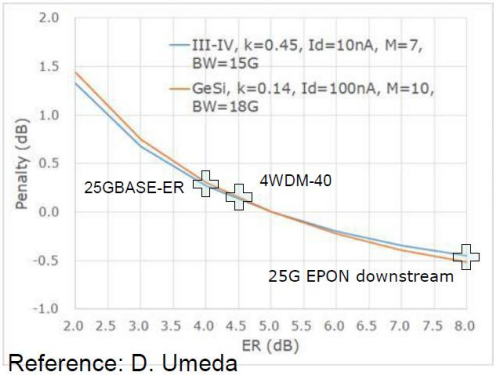
## Clause xxx: Extinction ratio and minimum mean launch optical power trade off:




| | (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**

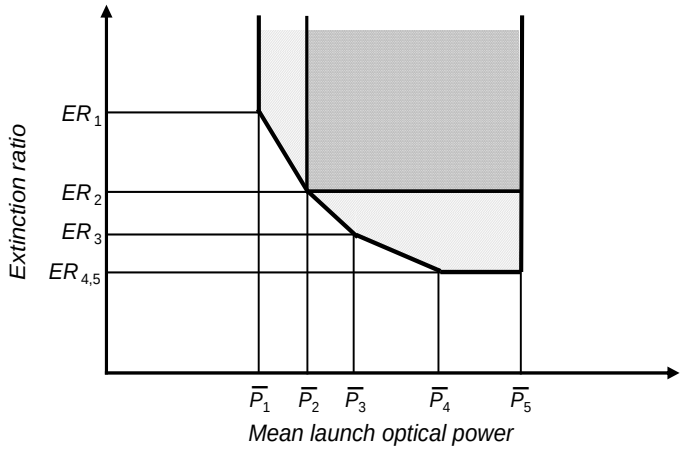
| Description | 25GBASE-PR30-D | Unit | Comment |
|---|---|---|---|
| Signaling speed (range) | 25.78125 ± 100 ppm | GBd | |
| wavelengths (range) | 1260 to 1280<br>1290 to 1310 | nm | |
| Side Mode Suppression Ratio (min) | 30 | dB | From 802.3av |
| Total average launch power (max) | — | dBm | |
| 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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