# Optical Modulation Amplitude (OMA) for single-mode serial PMDs

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# Previous presentations on OMA

- Donhowe et al.

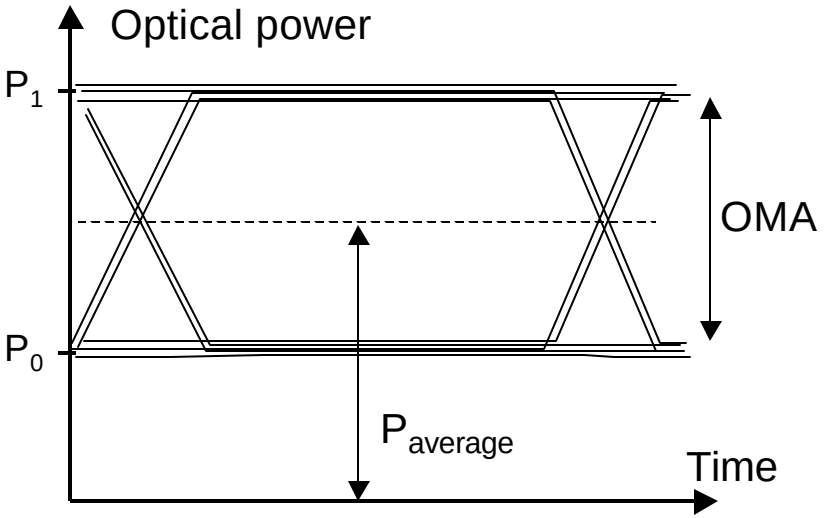
  http://www.ieee802.org/3/10G_study/public/sept99/donhowe_1_0999.pdf

- Frojdh

  http://www.ieee802.org/3/ae/public/may00/frojdh_1_0500.pdf

  http://www.ieee802.org/3/ae/public/jul00/frojdh_1_0700.pdf

# What is OMA ?




$OMA = P_1 - P_0$

$P_{average} = (P_1 + P_0)/2$

$ER = P_1/P_0$

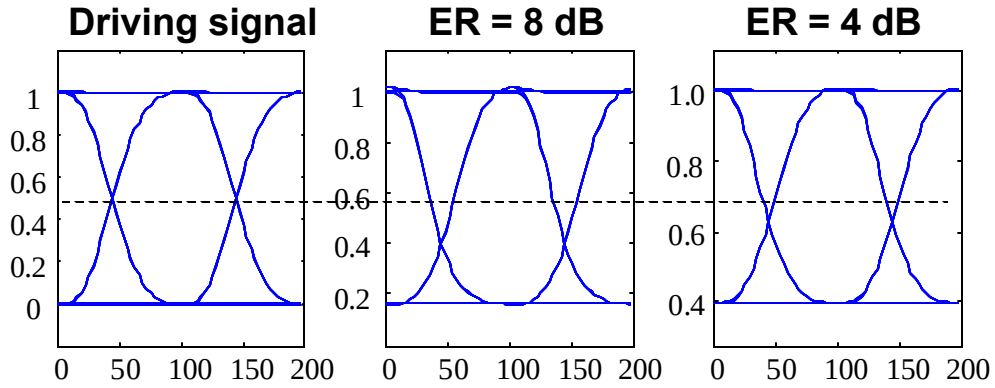
- Used by FC
- At high ER: $OMA/2 = P_{average}$
- Measurements are somewhat different
  - Changes in 52.6
- You could measure
  - $P_{average}$ & ER
  - and calculate OMA

# Why use OMA ?

- At the receiver OMA matters not $P_{average}$
  - With average power, we have to consider extinction ratio penalty (2.2 dB @ ER=6dB)
- With OMA, it is possible to use low or high extinction ratio, provided that
  - eye safety is OK at the transmitter
  - we do not overload the receiver
- At this point we do not touch the numbers
  - but we think OMA sets the stage for improvements

# Reasons for low ER, external modulator

- Electrical driving easier
- Easier to get symmetric eye with an electro-absorbtion modulator




- Short modulator → lower modulator loss.

# Reason for low extinction ratio, directly modulated laser

- You want to stay well away from the threshold
  - Laser is slowest near the threshold
  - Low ER improves high-speed performance
- Simpler driving electronics
- Lower dispersion penalty, important for 1550 nm

# Introduction of OMA: 10GBASE-LR/LW

- Specification @ ER=6 dB → 2.2 dB penalty
  - Change from average power to OMA/2:
    Decrease powers by 2.2 dB.
- Table 60:

  Launch power (max): +1 dBm → -1.2 dBm

  Launch power (min): -4 dBm → -6.2 dBm
- Table 61:

  Receive power (max): -1 dBm → -3.2 dBm

  Receive sensitivity: -14 dBm → -16.2 dBm

  Stressed sensitivity: -11.45 dBm → -13.65 dBm
- Add eye safety (Tx) and overload (Rx) specs

# Introduction of OMA: 10GBASE-ER/EW

- Specification @ ER=8 dB → 1.4 dB penalty
  - Change from average power to OMA/2:
    Decrease powers by 1.4 dB.
- Table 60:

  Launch power (max): +2 dBm → 0.6 dBm

  Launch power (min): -2 dBm → -3.4 dBm
- Table 61:

  Receive power (max): -8 dBm → -9.4 dBm

  Receive sensitivity: -20 dBm → -21.4 dBm

  Stressed sensitivity: -15.41 dBm → -16.81 dBm
- Add eye safety (Tx) and overload (Rx) specs

# Table 52-8: Transmit characteristics

| (Proposed changes indicated in blue italics) | | | |
|---|---|---|---|
| **Description** | **10GBASE-LR/LW** | **10GBASE-ER/EW** | **Unit** |
| Transmitter type | Directly modulated single longitudinal mode laser. | Externally modulated laser | |
| Signaling speed (range) | | | GHz |
| 10GBASE-LX/EX | 10.3125± 100 ppm | | |
| 10GBASE-LW/EW | 9.95328 ± 100 ppm | | |
| Wavelength(range) | 1290 to 1330 | 1530 to 1565 | nm |
| $T_{Rise}/T_{Fall}$ | 40.0 | 30 | ps |
| RMS spectral width | 0.4 | 0.034 | nm |
| *Average launch power for eye safety (max)* | 1 *(TDB)* | 2 *(TBD)* | dBm |
| *Modulated launch power OMA/2 (max)* | *-1.2* | *0.6* | dBm |
| *Modulated launch power OMA/2 (min)* | *-6.2* | *-3.4* | dBm |
| Average launch power of off transmitter (max) | -30 | | dBm |
| Extinction ratio (min) | 6 | 8 | dB |
| RIN (max) | -130 | -140 | |

# Table 58-9: Receive characteristics

| (Proposed changes indicated in blue italics) | | | |
|---|---|---|---|
| **Description** | **10GBASE-LR/LW** | **10GBASE-ER/EW** | **Unit** |
| Signaling speed (range) | | | GHz |
| 10GBASE-LX/EX | 10.3125±100 ppm | | |
| 10GBASE-LW/EW | 9.95328±100 ppm | | |
| Wavelength(range) | 1290 to 1330 | 1530 to 1565 | nm |
| Average receive power (max) | -1 *(TBD)* | -8 *(TBD)* | dBm |
| *Modulated receive power OMA/2 (max) ** | *-3.2* | *-9.4* | dBm |
| *Receive sensitivity modulated power OMA/2 ** | *-16.2* | *-21.4* | dBm |
| Return loss (min) | 12 | 12 | dB |
| *Stressed receive sensitivity modulated power OMA/2 ** | *-13.65* | *-16.81* | dBm |
| Vertical eye closure penalty | 1.71 | 2.72 | dB |
| Received electrical 3 dB upper cutoff frequency (max) | *TBD* | *TBD* | GHz |

* The extinction ratio in not very important when OMA is specified, but we could choose to specify this measurement at a specific ER.

# Table 58-10: Worst case link power budget and penalties

No changes

# Future issues for the serial PMDs (1)

- Extinction ratio (1310 & 1550):
  - With the introduction of OMA the ER can be lowered. (Example: 4 dB*)
  - Makes transmitter design easier.
- If OMA is adopted, we need to add and/or change some measurements in 52.6
- Receiver (1550):
  - A sensitivity of -21.4 dBm may force us into an expensive APD solution. (Better: -18 dBm*)

*** This number is meant to indicate directions of a future change**

# Future issues for the serial PMDs (2)

- Transmitter (1550):
  - Needs to be changed if the receiver spec is changed
- Make it possible to use externally or directly modulated laser for both 1300 & 1500
  - Technology makes progress and the standard should not lock itself into a specific implementation
- Current RIN specs can be too hard