Conditions for 100m and >100m reaches on OM3 and OM4 MMF at 10Gb/s/ch

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Goals

• Understand requirements/tradeoffs for a low-cost, robust 100m link on OM3 fiber at 10Gb/s/ch
• Explore feasibility for practical, >100m links on OM3 and OM4 fibers at 10Gb/s/ch
• Addition of the >100m links must not affect the costs for 100m products
• Compared to SMF links, the >100m links should provide significant savings in cost and power dissipation, while enabling higher density and faster time to market
Use 3_1_16a spreadsheet

- Parameters described use 3_1_16a nomenclature
- Always have (straight from 3_1_16a):
  - Wavelength $U_c = 840\text{nm}$
  - RIN (OMA) = -128dB/Hz (3_1_16a uses -130dB/Hz)
  - MPN k (OMA) = 0.3; ModalNoisePen = 0.3dB
  - Baseline wander SD = 0.025 fraction of $\frac{1}{2}$ eye
  - $Rec\_BW = 8,250\text{MHz}; Test \ Rx\ BW = 7500\text{MHz}$
  - Nominal Rx Sensitivity (OMA) = 11.1dBm
  - Power Budget $P = 8.3\text{dB}$
  - Connections $C = 2.0\text{dB}$
- Nominal: (RMS Spectral Width) $U_w = 0.65\text{nm}$ (varies)
- Nominal: $DCD\_DJ = 20\text{ps}; Det. Jitter = 38\text{ps}$ (varies)
  - Maintain 1.9X ratio when they vary
- Variable: (Effective Modal Bandwidth) Eff. BWm
  - Nominal values 2000MHz-km for OM3, 4400MHz-km for OM4
- Variable: (Rise/fall) $Ts(20-80)$
- Arbitrary: Upper limit on $Pisi = 3.0\text{dB}$ (SR uses 3.6dB)
100m OM3 link motivates 35-45ps rise/fall

- RMS = 0.65nm
- Nominal: DCD_DJ = 20ps, Det. Jitter = 38ps
- Want Pisi < 3.0

100m, 2000MHz-km, 0.65nm, Det. Jitter = DCD * 1.9

Better Electrical Interface
Faster VCSELs/drivers
Sample details for 100m, OM3

- Rise/fall = 45ps
- RMS = 0.65nm

### Link Power Budget and Penalties

<table>
<thead>
<tr>
<th>Description</th>
<th>1</th>
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### Transmit Characteristics

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Varying DCD_DJ and Det. Jitter

Example values, not min or max
Jitter and rise/fall tradeoff for 100m, OM3

- Spectral width has negligible effect due to short distance
- Motivates a TWDP to combine the effects of rise/fall, jitter

![Graph showing the relationship between DCD, DJ, and rise/fall times for different spectral widths. The graph includes data points for 0.01nm, 0.25nm, 0.45nm, and 0.65nm spectral widths with DCD*1.9 as the detection jitter term.]
100m on OM2, OM3, OM4, OMX

- Rise/fall = 45ps
- Not very sensitive to modal bandwidth >1500 MHz=km
- Underscores dominance of r/f, jitter to penalties
100m sensitivity to modal bandwidth

- OM3: Res. Launch → 2000MHz-km; OFL → 1500MHz-km
- 1500MHz-km vs 2000MHz-km requires
  ~2ps faster rise/fall OR ~2ps less DCD_DJ

Modal Bandwidth (MHz-km)
≥100m reach on OM3 MMF

- Pisi=3.0 for all points except one (where rise/fall <30ps)
- DCD_DJ = 20ps, Det. Jitter = 38ps

![Graph showing RMS Spectral Width vs. Rise/Fall for different distances and OM3 values.](image)
≥100m reach on OM4 MMF

- Points above black dashed line at Pisi = 3.0
- Points below black dashed line at Margin = 0.0
250m OM4 sensitivity to modal bandwidth

- 3500MHz-km vs 4400MHz-km requires
  ~2ps faster rise/fall time  OR  ~2ps less DCD_DJ
Details for 250m, OM4

- ISI and margin limits are balanced when RMS spectral width = 0.45nm and rise/fall = 40.8ps

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Example values, not min or max

Pisi limited

Margin limited

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Observations

• 35-45ps rise/fall is “sweet spot” for 100m over OM3, and >100m links over OM3 and OM4
• Key parameters for 100m on OM3: rise/fall and jitter
  • Connector loss, max optical power also important
• ≥150m on OM3 links appear feasible for RMS≤0.65nm
• Tradeoffs among rise/fall, jitter, spectral width, and modal bandwidth expand the product space for parallel MMF without compromising the low-cost benefits of the 100m, OM3 objective
• ≥250m on OM4 links appear feasible for RMS≤0.45nm

• Compared to SMF links, the >100m links would provide significant savings in cost and power dissipation, while enabling higher density and faster time to market