Performance of OM3 and OM4 Fibers with Relaxed Transceivers

Yi Sun, Robert Lingle, Jr., Alan McCurdy, George Oulundsen
OFS

Kenneth Jackson, John Dallesasse, Emcore
Objectives for this Work

Follow-up work from sun_01_1107

- In previous work, sub-optimum driving of the TOSA gave higher B2B sensitivities between –11.5 and –12.5 dBm (OMA).
  - Rx sensitivities here range from –13 to –13.5 dBm (OMA).
  - Penalty is reduced from 2.5 dB (previously) to 1.7 dB (now) for the same 300m, corner-case not-quite-OM4 fiber with a 0.56 nm RMS spectral width TOSA.
- Effect of spectral width remains under study
- Electrical filter (“rise time converter”) employed to explore slow rise/fall times

Continue to study the tradeoffs between Tx and fiber properties and reach:
- IEEE P802.3ba needs an option for supporting longer reach, approaching 300m, on MMF
- OM4 MMF is commercially available with 4700 MHz-km minimum modal bandwidths
- How can this bandwidth be used?
Approach for Study

Select TOSAs with RMS spectral widths of ~0.42 and ~0.56 nm

Use a 7.5G B-T filter in front of the TOSA to increase the rise/fall time of the laser from ~38 ps to ~48 ps

OM3 and “almost OM4” Fibers

• 100m and 200m length for OM3 fibers with EMB ~ 2600 MHz-km
  – Not a corner-case OM3 fiber, but we had the right lengths on hand
• 100m, 200m, 300m length almost-OM4 fibers, EMB ~ 4300-4400 MHz-km
  – Represent the lower bounds for OM4 performance
  – Are labeled “OM4” in the figures, but do not meet OFS’ OM4 specifications

Compare transmission penalties between experiment and spreadsheet model

• Show trends in penalty as fiber or spectral width changes
• These experiments do not combine all of the simultaneous relaxations that have been proposed, so the measured absolute penalties may be lower bounds.
RTC: Rise/Fall time conversion with a 7.5G 4th order BT filter
Optical Eyes at TP3
(TOSA A: RMS spectral width ~0.56nm)
TOSA A with Spectral Width ~0.56nm

Black = measured penalty; Red = spreadsheet penalty
Optical Eyes at TP3
(TOSA B: RMS spectral width ~0.42nm)
TOSA B with Spectral Width ~0.42nm

Black = measured penalty; Red = spreadsheet penalty
The spreadsheet model predicts twice the increase in penalty in going from 0.56 to 0.65nm RMS spectral width at 840nm as in going from 0.42nm to 0.56nm RMS at 854nm.

Modeling of a non-retimed PMD at 0.56nm RMS using DCD=20ps and DJ=38ps indicates increase of 0.6 dB at 200m and an “off-the-chart” increase for 300m.
Summary

High bandwidth OM4 MMF offers an added degree of freedom for preserving long reach while permitting transmitter cost reduction

Transmitter RMS spectral width relaxation

- For links >200m, penalty increases rapidly with spectral width \( \geq \sim 0.55\)nm
- Caution should be exercised when relaxing spectral width
- If spectral width is relaxed to 0.65 nm, it may be desirable to also define a class of Tx with narrow spectral width \( \leq 0.45\) nm

An un-retimed PMD follows current trends for SR in SFP+

- Spreadsheet predictions with \( DJ=1.9\times DCD\), \( DCD=20\) ps (jewell_01_0308) indicate that reach of 100m vs. 250m might be obtained by varying a few transceiver specs:
  
<table>
<thead>
<tr>
<th></th>
<th>Pisi</th>
<th>V.E.C.P.</th>
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</thead>
<tbody>
<tr>
<td>100m OM3, 0.65nm RMS, 45ps R/F time, 2dB connector loss:</td>
<td>&lt; 3.0 dB</td>
<td>3.7 dB</td>
</tr>
<tr>
<td>250m OM4, 0.45nm RMS, 41ps R/F time, 2dB connector loss:</td>
<td>&lt; 3.0 dB</td>
<td>3.75 dB</td>
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Experimental study of real parts with relaxed specs with corner case fibers is a necessity
## Detailed Summary of Fiber, TOSA and Tx Properties

<table>
<thead>
<tr>
<th></th>
<th>fiber data</th>
<th>TOSA A</th>
<th>TOSA B</th>
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<tbody>
<tr>
<td></td>
<td>length (m)</td>
<td>EMBc (MHz.km)</td>
<td>MW18 (ps/m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>no RTC</td>
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<tr>
<td>100</td>
<td>4303</td>
<td>0.122</td>
<td>0.262</td>
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<tr>
<td>200</td>
<td>4303</td>
<td>0.122</td>
<td>0.262</td>
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<td>0.127</td>
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<tr>
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<td>2665</td>
<td>0.297</td>
<td>0.301</td>
</tr>
<tr>
<td>200</td>
<td>2610</td>
<td>0.307</td>
<td>0.307</td>
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</tbody>
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Notes:  
1) Penalties have ± 0.25 dB error bars  
2) OM4 fiber limits are MW18, MW23 < 0.14 (“flat mask”), sliding window < 0.11 ps/m  
3) OM3 limits are MW18, MW23 < 0.33 (“flat mask”), sliding window < 0.25 ps/m
# Measured vs. Spreadsheet Penalties

<table>
<thead>
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<td>length (m)</td>
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Parameters used in spreadsheet calculations:
Penalties are the difference in LP_pen at stated reach vs. 2 m. Ts(20-80): 35 ps w/o RTC, 45 ps with RTC; DJ=DCD = 6 ps; RIN(OMA) = -130 dB/Hz; actual values for RMS spectral widths and center wavelengths; other parameters are like those in 10GEPBud3_1_16a.xls