
Proposed 1,2 & 4 GBd 1394b Multimode Fiber Link Specifications & Issues

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Outline

- 1, 2 & 4 GBd MMF Link Design Objectives
- Analysis Of Proposed 1 & 2 GBd Link Specifications
- 4 GBd Extension Analysis & Issues
- Conclusions



1394b Multimode Fiber (MMF) Link Specification Objectives

- Lowest Possible Link Cost By Leveraging & Relaxing Gigabit Ethernet (GbE) Specifications For Shorter Link Lengths
- Focus On 2 GBd Specifications Initially To Create A Single Link Specification Covering 1 & 2 GBd Operation
- Define A Future 4 GBd Link Specification Extension Which Interoperates With The 1 & 2 GBd Specifications
- Achieve A Minimum 50 m Link Length With Both 62MMF & 50MMF



1394b MMF Link Assumptions & Analysis

- The Lowest Cost Source Technology To Achieve Moderate Link Length For The 1-4 GBd Range Utilizes 850 nm Vertical Cavity Surface Emitting Lasers (VCSELs)
- At 850 nm (Based On GbE & TIA FO 2.2 developments) 50/125 um Core/Cladding Diameter MMF (50MMF) Has A 500 MHz*km Worst Case Modal Bandwidth (WCMB) With Laser Launch vs. 62MMF Having WCMB=160 MHz*km
- The Spread Sheet Link Analysis Model Adopted By GbE Provides The Basis For Defining Optical Power Penalties & Link Lengths

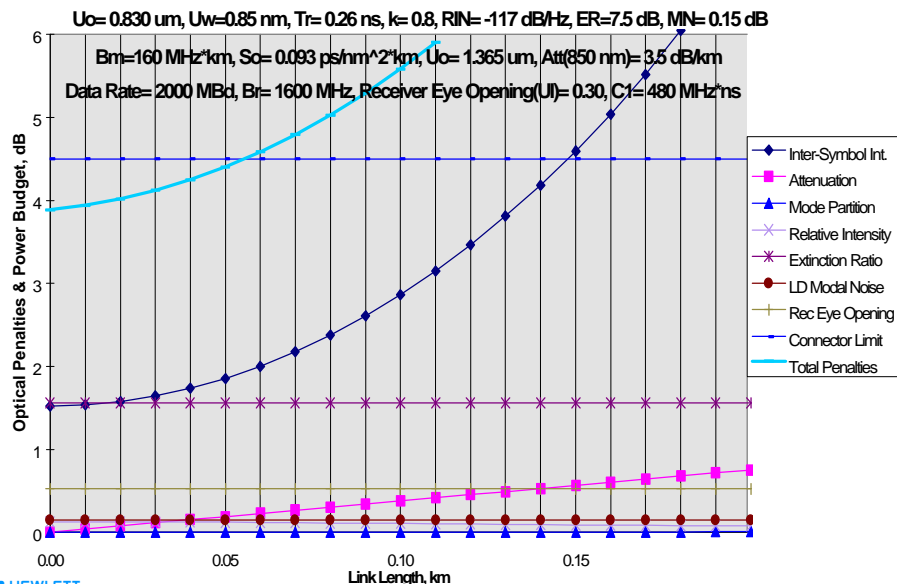


2 GBd MMF Link Specification Process

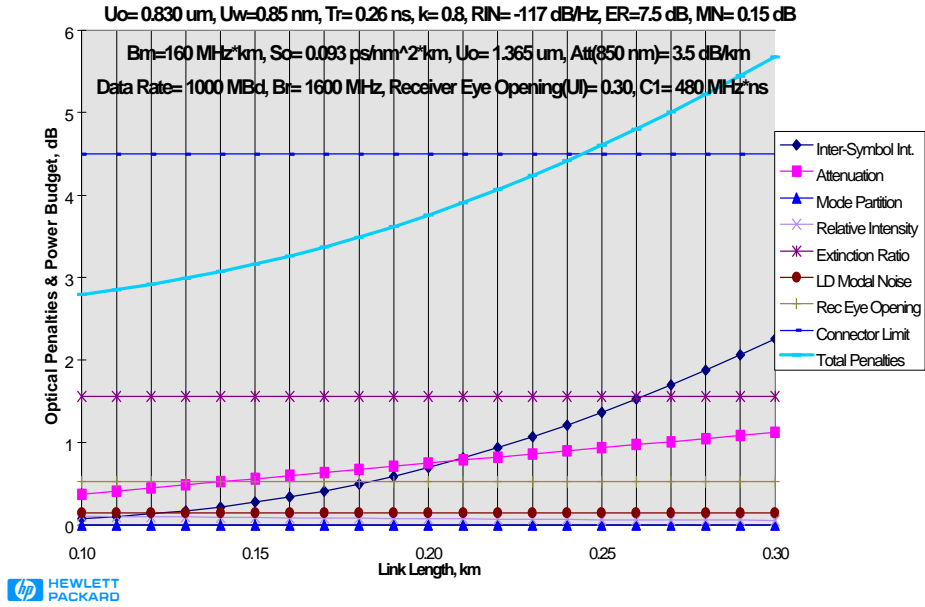
- Leverage GbE MMF Link Specifications In Which The Laser 9 dB Extinction Ratio (ER) Penalty Of 1.1 dB Is Built Into The - 17 dBm Receiver Sensitivity Specification For Operation At 1.25 GBd
- Maintain Laser Output Power Range Of -4 (0 Future?) to - 10 dBm To Ease Future Eye Safety & Laser Driver Implementation
- Reduce Receiver Sensitivity By 2 dB @ 1.6X Larger Bandwidth
- Reduce Budget To 6 dB vs. GbE's 8 dB (7 dB + ER Of 1.1 dB)
- Relax ER From 9 dB To 7.5 dB (Increases Link Penalty=1.56 dB)
- Show ER As An Explicit Link Penalty To Facilitate Trade-Offs



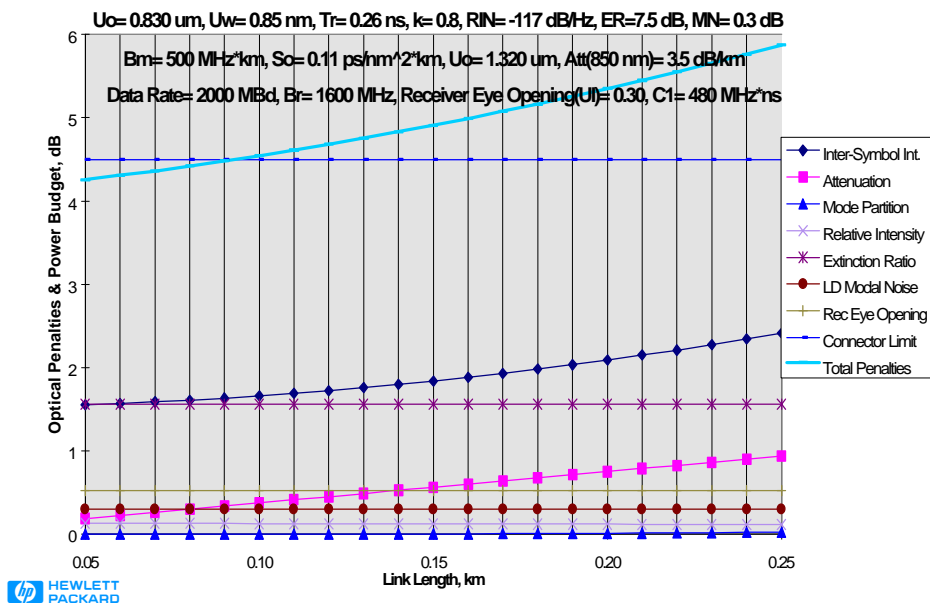
2 GBd 1394b 62MMF Link With 850 nm VCSEL Leveraged From GbE



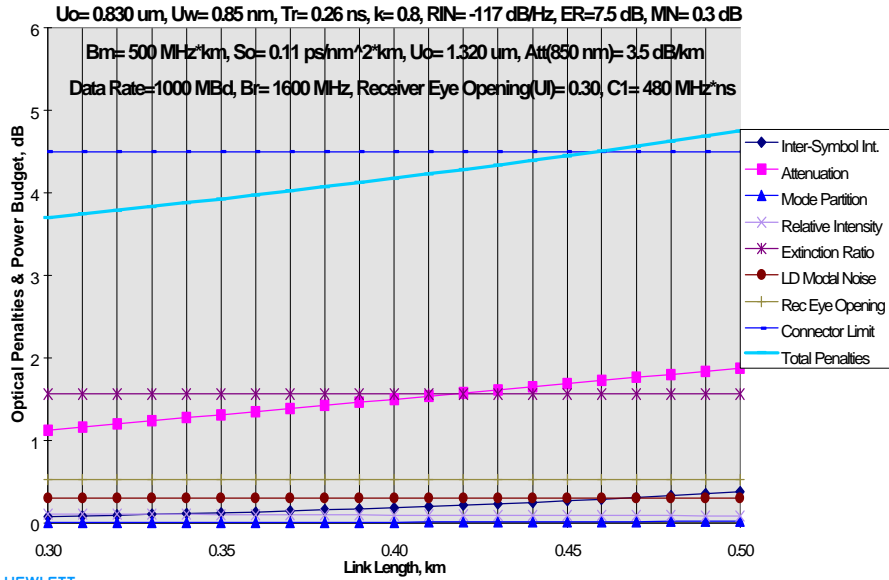
1394b 62MMF Link Operated At 1 GBd



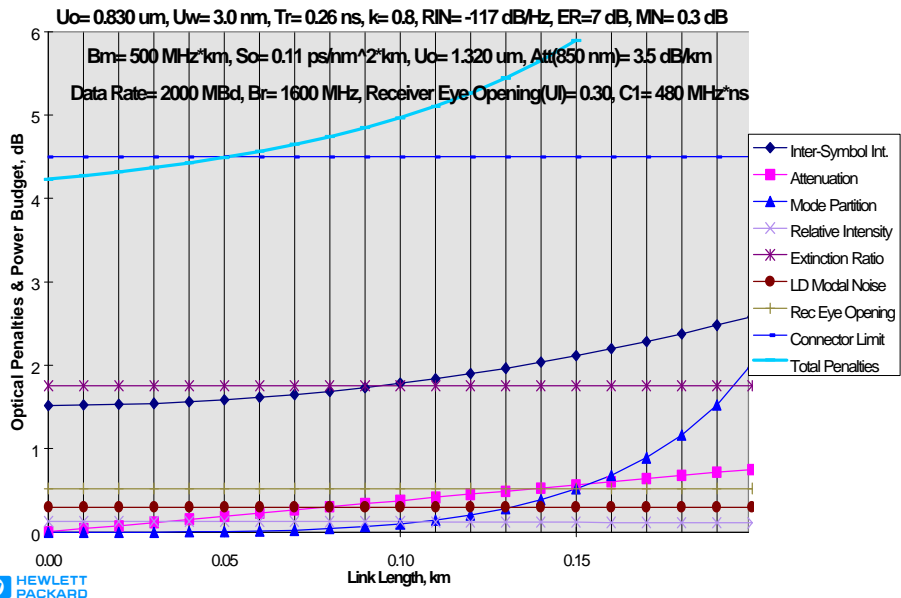
2 GBd 1394b 50MMF Link With 850 nm VCSEL Leveraged From GbE



1394b 50MMF Link Operated At 1 GBd



For 50MMF Only, 50 m @ 2 GBd With Relaxed Specs ($U_w = 3.0 \text{ nm}$, $ER = 7 \text{ dB}$)



1 & 2 GBd MMF Link Length Summary

- Power Budget Assumptions
 - ▶ Transmitter Range: -4 (0 Future?) To -10 dBm
 - ▶ Receiver Range: 0 To -16 dBm (Center-Of-Eye)
- 62MMF Limitation Of 50 m @ 2 GBd (ER=7.5 dB, Uw=0.85 nm)
 - ▶ 62MMF : 50 m @ 2 GBd, 245 m @ 1 GBd
 - ▶ 50MMF: 90 m @ 2 GBd, 460 m @ 1 GBd
- For 50MMF Only: Limitation 50 m @ 2 GBd With Relaxed Specs
 - ▶ ER=7 dB, Uw=3.0 nm

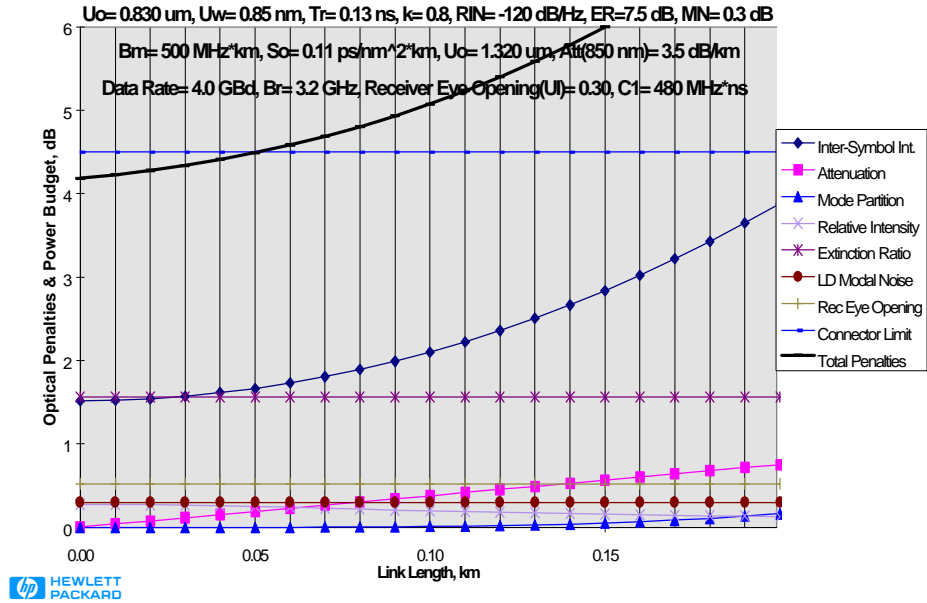


4 GBd Specifications Targeted To Be Compatible With 1 & 2 GBd Links

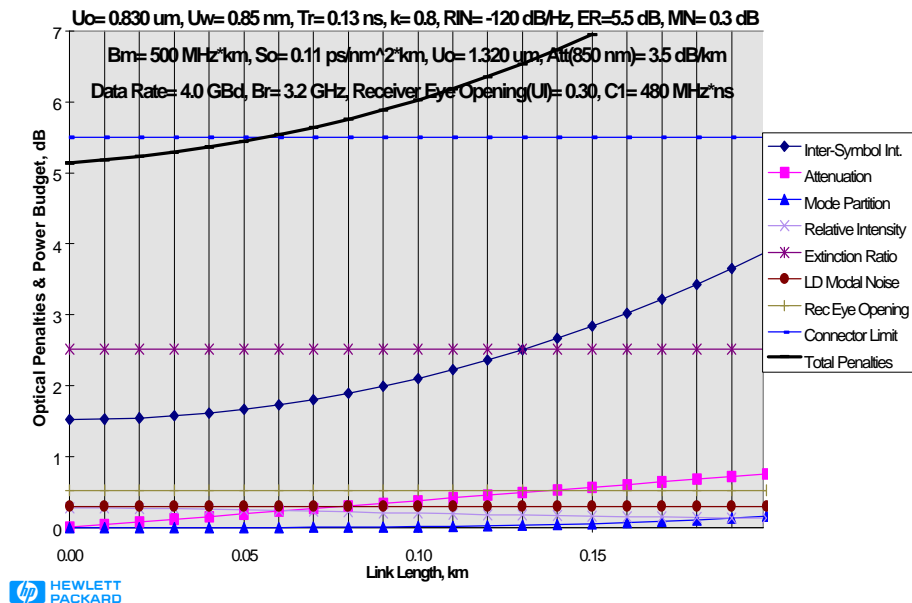
- Reduce Laser Response Times ($T_{r,f}$) By 50% But Maintain Transmitter Output Range: -4 (0 Future?) To -10 dBm
- Relax ER To Support Reduced $T_{r,f}$; Must Increase Power Budget To Compensate
- In RIN Penalty Calculation, Remove Laser Response Time Filtering (Utilize Fiber + Receiver Bandwidth Filtering Only)
- Must Improve RIN Specification From -117 dB/Hz To -120 dB/Hz To Achieve 50 m Link With 50MMF (Due To Reduced RIN Filtering)



4 GBd 1394b 50MMF Link With Power Budget=6 dB, ER=7.5 dB, Tr,f=0.13 ns



4 GBd 1394b 50MMF Link With Power Budget=7 dB, ER=5.5 dB, Tr,f=0.13 ns



4 GBd 50 m Link Specification Issues (Relative To 1 & 2 GBd Proposal)

- A 50 m Link Length Is Achievable Only With 50MMF
- With The Same Technology, Increasing Receiver Bandwidth By 2X Reduces Receiver Sensitivity By 4 dB
- If ER=7.5 dB, A 6 dB Power Budget Requires A 4 dB Improvement In Receiver Sensitivity Relative To 2 GBd; Requires A GaAs Detector & Preamplifier
- If ER Must Be Relaxed To 5.5 dB, The Power Budget Must Be Increased To 7 dB; Requiring A 5 dB Improvement In Receiver Sensitivity Which May Not Be Achievable With A Single 3.3 V Supply



Conclusions

- 1 & 2 GBd 1394b MMF Link Specifications
 - ▶ Based On GbE, 50 m Link Length Specifications Are Readily Achievable With Either 50MMF Or 62MMF
 - ▶ Some Open Issues: MMF Fiber Type(s), Optical Connector, Electrical I/O Interface Definition & Transceiver Footprint
- Some Open Issues For Compatible 4 GBd Link Specification:
 - ▶ How Much Must The Laser ER Be Relaxed?
 - ▶ Can The Necessary Receiver Sensitivity & Dynamic Range Be Achieved In A Cost Effective Manner?
 - ▶ Can A Single 3.3 V Power Supply Be Utilized?

