Case For Using 980 nm (Rather Than 850 nm) VCSELs For Serial 10 Gb/s Links With New Higher-Bandwidth 50MMF

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Objectives

- Compare Serial 10 Gb/s Link Proposals With 1300 nm Lasers Over SMF With 850 nm VCSEL Links Using New 50MMF
- Present Advantages Of Using 980 nm (Rather Than 850 nm) VCSELs With New Higher-Bandwidth 50MMF Links Operating At 12.5 GBd
- Propose Implementing 980 nm Specifications For New 50MMF
  - Current TR42.8 Next Generation Multimode Fiber Proposal Specifies Only At 850 nm & 1300 nm

Key Parameters Of 1300 nm Serial 10 Gb/s SMF Link Proposal

- Line Rate: 12.5 GBd
- Transmitter Average Power Range: 0 To -5 dBm
  - Minimum Wavelength 1295 nm
  - Rise/Fall Time (20-80%): 26 ps
  - Extinction Ratio: 7 dB
- Receiver Average Eye-Center Sensitivity: -14 dBm
- Optical Power Budget (OPB): 9 dB

Key Parameters Of 850 nm 10 Gb/s Serial Link Proposal Leveraging New 50MMF

- Line Rate: 12.5 GBd
- Transmitter Average Power Range: -4 To -9 dBm
  - Minimum Wavelength 830 nm
  - Rise/Fall Time (20-80%): 26 ps
  - Extinction Ratio: 7 dB
- New 50MMF Modal Bandwidth: 2200 MHz*km
- Receiver Average Eye-Center Sensitivity: -17 dBm
- Optical Power Budget: 8 dB

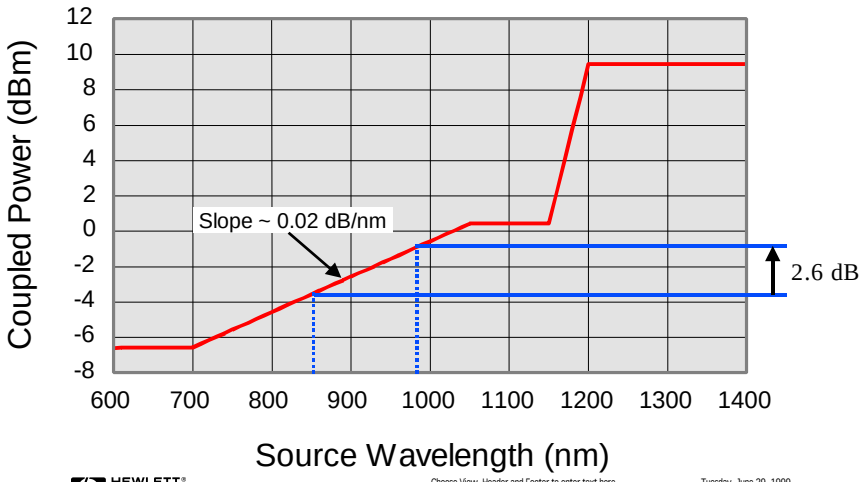
Concerns With 850 nm VCSEL, 12.5 GBd, 300 m, New 50MMF Link Proposal

- The 1300 nm, -14 dBm Receiver Sensitivity Proposals Have Reasonable Production Margins
- Meeting The Class 1 Eye Safety Limit & Supporting An 8 dB OPB Requires A Receiver Having 3 dB Greater Sensitivity
- The 850 nm Preamplifier Requires An Additional 1.8 dB Better Sensitivity Due To Reduced PIN Responsivity vs. 1300 nm
- The Relaxed Source Extinction Ratio (7 dB vs. 9 dB, Used In GbE) Requires An Additional 0.7 dB Receiver Sensitivity

Comparison Of 980 nm vs. 850 nm VCSELs For 12.5 GBd MMF Links

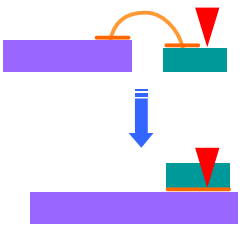
- Eye Safety Limit Relaxation
- VCSEL Transparent vs. Absorbing Substrate Benefits
- DC Light-Current-Voltage (LIV) Performance Advantages

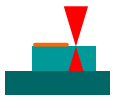
Class 1 Eye Safety Limits (IEC 825-1)



Advantages Of 980 nm VCSEL Transparent Substrate Operation

- Flip-Chip Bonding (Substrate Emission)
  - No Bond Wires
    - Lower Series Inductance
    - Lower EMI
  - Better Thermal Conductivity
    - Less VCSEL Temperature Rise
    - More Output Power
    - Higher Self-Resonant Frequency
- Monitor Photodiode (Access To Both Ports)





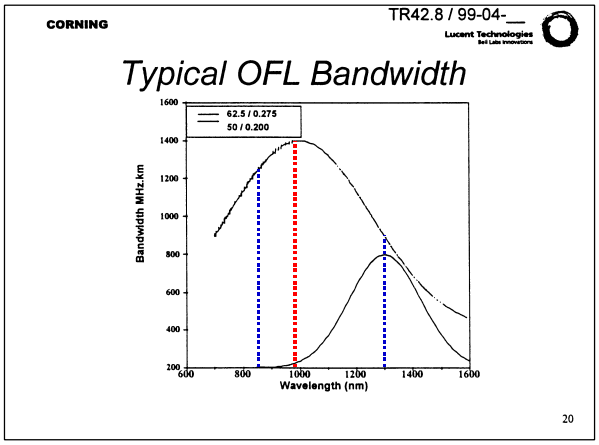
980 nm vs. 850 nm Link Benefits

- DC LIV Advantages With 980 nm VCSELs
  - Threshold Current Is Reduced By A Factor Of ~2
  - Threshold Voltage Is Reduced By ~0.2 V
  - Power Output Is Increased (Flip-Chip Bonding)
  - External Quantum Efficiency Is Not Affected
- InGaAs Detector Advantages From 980 nm Operation
  - 980 nm PIN Responsivity Is 0.6 dB Better
  - Transparency Allows Preamplifier Flip-Chip Bonding
  - PIN Is Compatible With 1300 nm Link Operation

Key Parameters Of A 12.5 GBd, 980 nm, Serial 300 m Link Proposal Using New 50MMF

- Line Rate: 12.5 GBd
- Transmitter Average Power Range: -1.5 To -6.5 dBm
  - Minimum Wavelength 970 nm
  - Rise/Fall Time (20-80%): 26 ps
  - Extinction Ratio (ER): 7 dB
- New 50MMF Modal Bandwidth: 1900 MHz*km
- Receiver Average Eye-Center Sensitivity: -14.5 dBm
- Optical Power Budget (OPB): 8 dB
  - At 2200 MHz*km, Link Margin Would Be + 0.8 dB

New 50MMF Modal Bandwidth Profile



Ref: Next Generation Multimode Fiber Objectives
P. Kolesar & S. Swanson, TIA TR42.8, 3/24/99

Case For Using 980 nm vs. 850 nm For 300 m, 12.5 GBd, New 50MMF Links

- The Current 850 nm VCSEL, 12.5 GBd, 300 m Link Proposal Using New 50MMF Puts Unrealistic Requirement On Receiver Sensitivity To Meet Transmitter Class 1 Eye Safety
- All Source, Fiber & Detector Performance Is Better At 980 nm
- Operation At 980 nm Improves Link Specification Margin By 3.2 dB (2.6 dB Eye Safety & 0.6 dB Detector Responsivity) & Supports Class 1 Eye Safety & Specification Margins
- Introducing A New "Green Field" 50MMF Allows The Opportunity To Support 980 nm Performance Specifications
- Might Reference Specifications At 850 nm & 1300 nm