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HUT Communications Laboratory

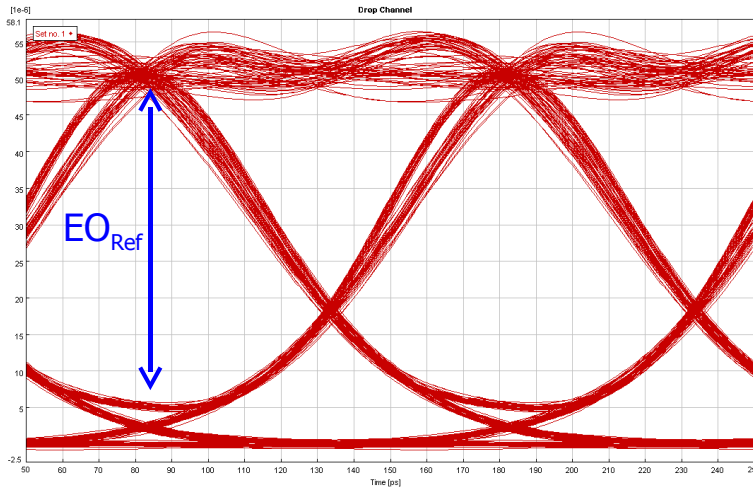


# **S-72.3340 Optical Networks Course (Spring 2007)**

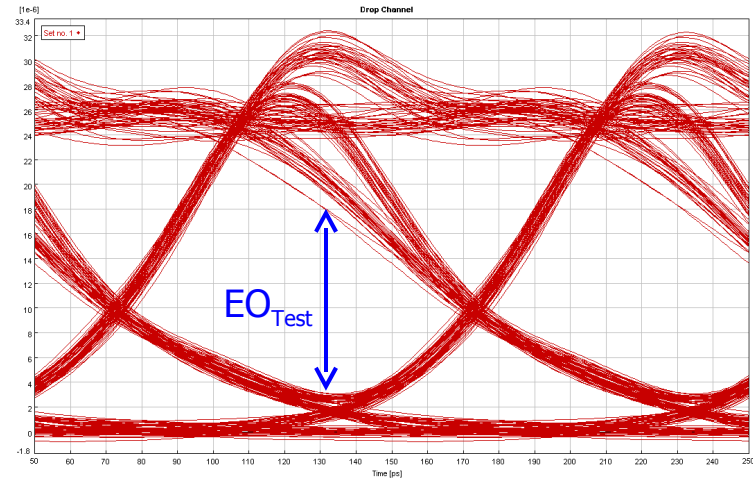
# **Simulation Assignment Solutions**

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# Simulation Problem 1



Offset = 0 GHz



Offset = 10 GHz

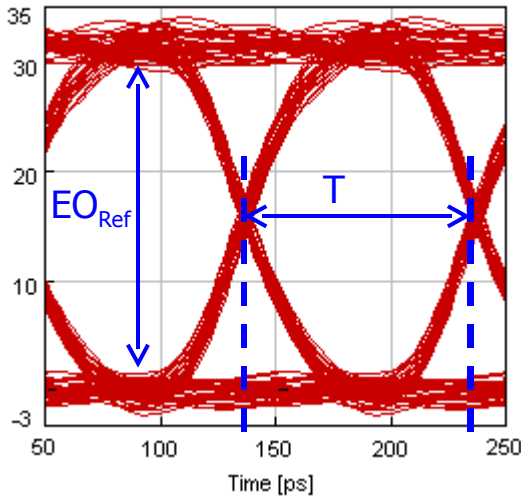
$$EOP = -10\log(EO_{Test}/EO_{Ref}) \text{ dB}$$

When Offset = 0 GHz,  $EO_{Ref} = 4.16e-5$ ;

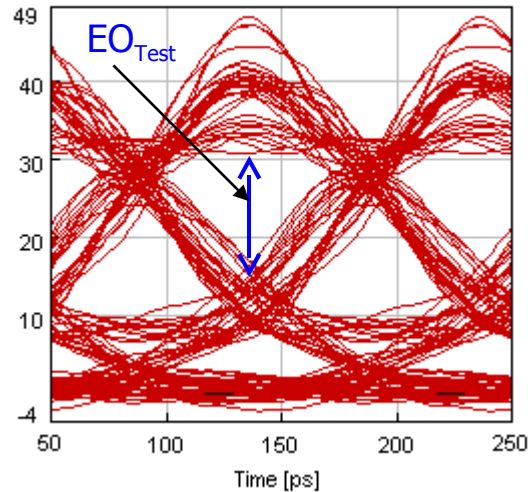
When Offset = 10 GHz,  $EO_{Test} = 1.44e-5 \Rightarrow \mathbf{EOP = 4.6 \text{ dB}}$ ;

# Simulation Problem 2

[1e-6] Back-to-back Reference System

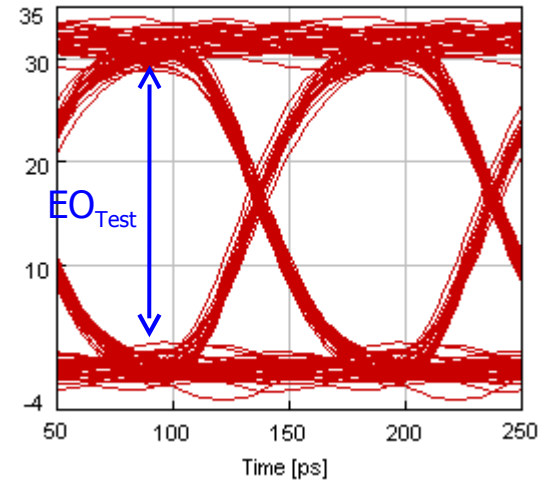


[1e-6] Dispersion Compensation Test System



Without DCF

[1e-6] Dispersion Compensation Test System



With DCF

$$T = 100 \text{ ps} \Rightarrow \mathbf{B} = \mathbf{1/T} \Rightarrow \mathbf{B = 10 \text{ Gb/s}}$$

$$\text{EOP} = -10\log(\text{EO}_{\text{Test}}/\text{EO}_{\text{Ref}}) \text{ dB}$$

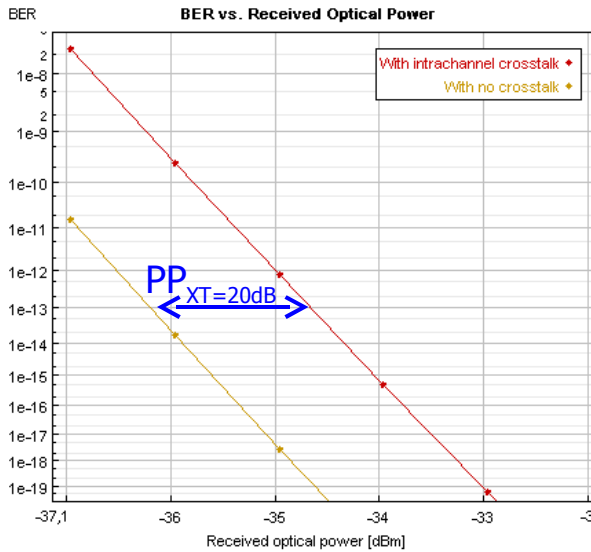
$$\text{Without DCF, } \text{EO}_{\text{Ref}} = 2.75\text{e-}5, \text{EO}_{\text{Test}} = 1.19\text{e-}5 \Rightarrow \mathbf{EOP = 3.6 \text{ dB}};$$

$$\text{With DCF, } \text{EO}_{\text{Ref}} = 2.75\text{e-}5, \text{EO}_{\text{Test}} = 2.7\text{e-}5 \Rightarrow \mathbf{EOP = 0.08 \text{ dB}}; \mathbf{EOP \text{ reduction} \approx 3.52 \text{ dB}}$$

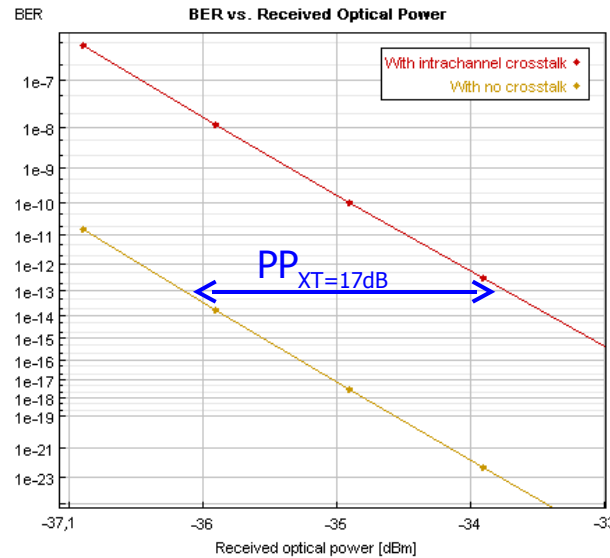
$$L_{\text{SMF}} = 110 \text{ km}, D_{\text{SMF}} = 17 \text{ ps/nm-km}, D_{\text{DCF}} = -100 \text{ ps/nm-km}$$

$$L_{\text{DCF}} = \frac{L_{\text{SMF}} \cdot D_{\text{SMF}}}{|D_{\text{DCF}}|} \Rightarrow \mathbf{L_{\text{DCF}} = 18.7 \text{ km}}$$

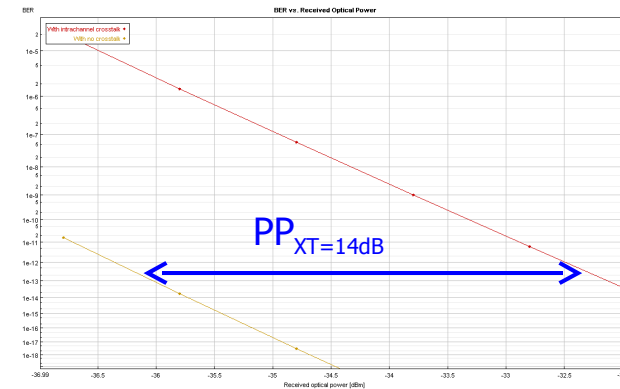
# Simulation Problem 3



Xtalk\_dB=20 dB



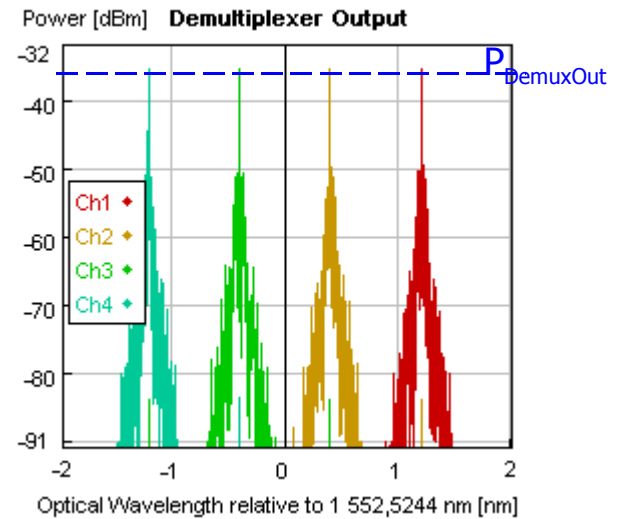
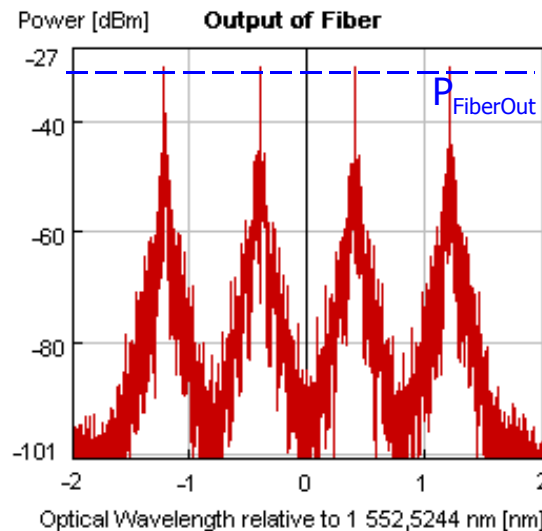
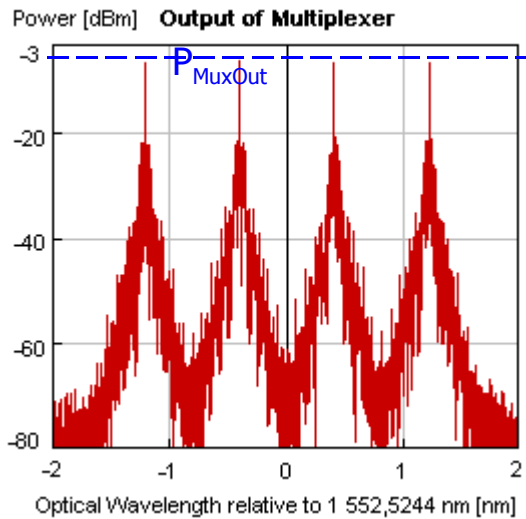
Xtalk\_dB=17 dB



Xtalk\_dB=14 dB

- Xtalk\_dB=20 dB  $\Rightarrow$   $PP_{XT=20dB} = 1.5$  dB
- Xtalk\_dB=17 dB  $\Rightarrow$   $PP_{XT=17dB} = 2.4$  dB
- Xtalk\_dB=14 dB  $\Rightarrow$   $PP_{XT=14dB} = 3.85$  dB

# Simulation Problem 4



$P_{Trans} = 0 \text{ dBm}$ ,  $P_{MuxOut} = -6.2 \text{ dBm}$ ,  $P_{FiberOut} = -30.28 \text{ dBm}$ ,  $P_{DemuxOut} = -35.2 \text{ dBm}$ ,  $P_{Rec} = -27.0 \text{ dBm}$

• Mux Loss =  $P_{Trans} - P_{MuxOut} \Rightarrow$  **Mux Loss = 6.2 dB**

• Fiber Loss =  $P_{MuxOut} - P_{FiberOut} \Rightarrow$  **Fiber Loss = 24.08 dB**

• Fiber Length = Fiber Loss/Attenuation Coefficient  $\Rightarrow$  **Fiber Length=96.32 km**

• Required channel gain  $\geq P_{Rec} - P_{DemuxOut} \Rightarrow$  **Required gain  $\geq 8.2 \text{ dB}$**

• See the next page for clarification on the difference between dB and dBm

# Note: Difference between dB and dBm

- ❑ **dBm** used to indicate absolute power values
  - Unit used for power level measures such as optical transmitted power, received power etc.
  - Optical signal power levels usually in terms of milliwatt (mW) or less
  - Example:  $P_{\text{dBm}} = 10\log_{10}(P_{\text{mW}})$  dBm e.g. 1 mW = 0 dBm, 10 mW = 10 dBm
  
- ❑ **dB** indicates relative values of power
  - Unit used for gain or loss measures such as attenuation, insertion loss, power penalty, isolation, amplification etc.
  - For instance, a signal attenuated by a factor of 1000 would undergo a 30 dB loss, a signal amplified by factor of 1000 would have a 30 dB gain.
  - Consider  $A = P_{\text{mW1}}/P_{\text{mW2}}$ 
    - Then  $A_{\text{dB}} = 10\log_{10}(A)$  dB =  $P_{\text{dBm1}} - P_{\text{dBm2}}$
    - Example: if  $P_{\text{mW1}} = 0.001$  mW (or -30dBm) and  $P_{\text{mW2}} = 1$  mW (or 0 dBm), then  $A = 0.001 \Rightarrow A_{\text{dB}} = -30$  dB