

### **SNS COLLEGE OF TECHNOLOGY**



Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

### DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

#### MICROWAVE ENGINEERING

IV YEAR/ VII SEMESTER

UNIT 5 – OPTICAL NETWORKS

TOPIC -POWER BUDGET ANALYSIS



#### RISE TIME BUDGET



Rise time gives important information for initial system design. Rise-time budget analysis determines the dispersion limitation of an optical fiber link.

□ Total rise time of a fiber link is the root-sum-square of rise time of each contributor to the pulse rise time degradation.

$$t_{sys} = \sqrt{t_{r1}^2 + t_{r2}^2 + t_{r3}^2 + \cdots}$$

$$t_{\text{sys}} = \left(\sum_{i=1}^{N} t_{ri}^{2}\right)^{1/2}$$





Four basic elements that contributes to the rise-time are,

- •Transmitter rise-time (ttx)
- •Group Velocity Dispersion (GVD) rise time (tGVD)
- •Modal dispersion rise time of fiber (tmod)
- •Receiver rise time (trx)





$$t_{sys} = [t_{tx}^2 + t_{mod}^2 + t_{GVD}^2 + t_{rx}^2]^{1/2}$$

Rise time due to modal dispersion is given as

$$t_{mod} = \frac{440}{B_M} = \frac{440 Lq}{B_0}$$

where,

BM is bandwidth (MHz)

L is length of fiber (km)

q is a parameter ranging between 0.5 and 1.

B0 is bandwidth of 1 km length fiber,





## •Rise time due to group velocity dispersion is

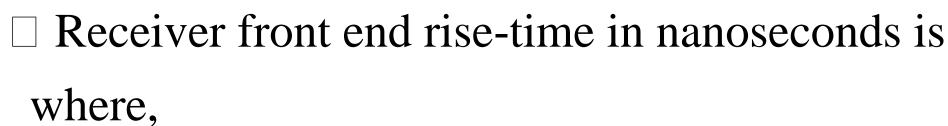
$$t_{GVD} = D^2 \sigma_{\lambda}^2 L^2$$

where,

D is dispersion [ns/(nm.km)]

 $\Sigma\lambda$  is half-power spectral width of source

L is length of fiber



Brx is 3 dB - bW of receiver (MHz).

☐ Equation can be written as

$$t_{rx} = \frac{350}{B_{rx}}$$





$$t_{sys} = [t_{tx}^2 + t_{mod}^2 + t_{GVD}^2 + t_{rx}^2]^{1/2}$$

$$t_{sys} = \left[t_{tx}^2 + \left(\frac{440 \ Lq}{B_0}\right)^2 + D^2 \sigma_{\lambda}^2 L^2 + \left(\frac{350}{B_{rx}}\right)\right]^{1/2}$$

The system bandwidth is given by

$$BW = \frac{0.35}{t_{gyg}}$$





Example1 .For a multimode fiber following parameters are recorded.

- i) LED with drive circuit has rise time of 15 ns.
- ii) LED spectral width = 40 nm
- iii) Material dispersion related rise time degradation = 21 ns over 6 km link.
- iv) Receiver bandwidth = 235 MHz
- v) Modal dispersion rise time = 3.9 nsec

Calculate system rise time.





Solution:  $t_{tx} = 15 \text{ nsec}$ 

 $tT_{mat} = 21$  nsec

 $t_{mod} = 3.9 \text{ nsec}$ 

Now

$$t_{_{PX}}=\frac{350}{B_{_{PX}}}$$

$$t_{YX} = \frac{350}{25}$$

Since

$$t_{sys} = \left(\sum_{i=1}^{N} t_{ri}^{2}\right)^{1/2}$$

$$t_{sys} = \left[15^{2} + 21^{2} + 3.9^{2} + 14^{2}\right]^{1/2}$$

=29.61nsec





# **THANK YOU**