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SIGNAL STRENGTH IN OPTICAL FIBER NETWORKS& ITS OPTIMIZATION

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Abstract
The optical fiber network behaves as the backbone of 5th generation communication but there are several limitations like attenuation, dispersion, fragility of fiber, splicing and connecting loss and nonlinearities. So, in order to make successful communication it is important to think how signal is transmitted; what amount of signal is transmitted and how long it is transmitted through the fiber. Finally, it is to be investigated the strength of the signal under the effect of Extinction Ratio for the given Fiber length with XPM treatment by OptiSystem 0.17.

Keywords-Extinction Ratio; Non-Linear Impairment;BER; OTN; XPM; Dispersion

I. Introduction

To improve the power efficiency of the optical fiber communication system, minimize the major drawbacks of the fiber channel like linear and non-linear impairments [1-8] . Actually, in the fiber optic transmission system, signal power can be improved by highly sensitive optical receiver for a noise limited transmission that is power loss can be compensated by amplifier. But the ultimate demand of this information era, higher bandwidth with highest possible data speed is compensated only and only by improving the power efficiency and spectral efficiency of the system[9-10].

Nonlinearity of Fiber: -It is observed that due to higher power or bit rate of transmission, the optical fiber behaves as non-linear medium [11-14] and concerned defects influence the performance of the technology of fiber optic transmission. In order to reduce the effect of them, they are considered as.

(1) **Scattering Based**: -when optic signal propagates at high bit rate then having scattering of signal through fiber that affects the energy of the signal pulse. Like SBS, SRS etc.

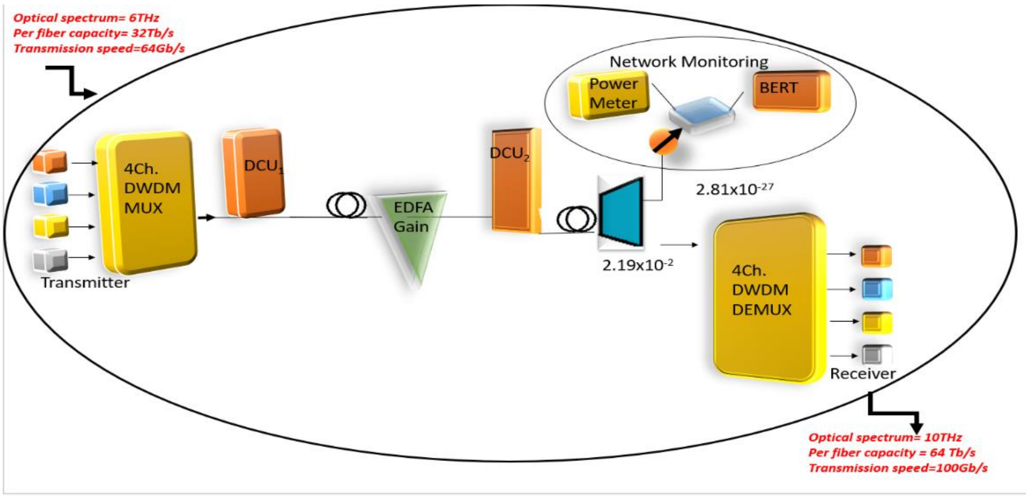
(2) **Refractive Index Based**: -Like SPM, XPM that leads to the deformation of signal pulse due to the change in refractive index of the fiber with the wavelength of the signal. With the use of WDM technique, through the same optical fiber multiple signals can be transmitted, and if during propagation the intensity of one optic signal fluctuates and modulates the phase of any other optic signal, it leads to the cross-phase modulation phenomena (XPM) [1].That is Kerr non-linearity of the index of refraction must be depend upon the susceptibility of the applied electric field inside the fiber channel.

II. Simulation for the suppression of XPM

Treatment of Nonlinearity (XPM) by the adjustment of Power Level in Optical Fiber transmitter with Dense wavelength division multiplex (DWDM) systemto attain the data transmission rate that increases approximately 1.5 times per year.

Now the basic fact of this system i.e. each wavelength has its own virtual fiber as shown in the Figure 1.

Figure 1: Design of 4 channel DWDM Network in NRZ format with higher extinction ratio



Basic Componentsof Simulation Network:
On the basis of OptiSystemprogramming software this four-channel DWDM system with EDFA amplifier and dispersion compensator is created to eliminate the nonlinearity due to XPM by changing the dispersion& Optical Power density in the adjacent channels. In which a post-pair EDFAswith output power is set at 10 dB/m and Optical Fiber of 50km and100 km and its loss is 0.33 dB/km. For the 14 m length, Erbium-doped fiber shows the best output gain.

Table 1: Simulation Parameters

Parameter	Values
Transmitter Frequency	1555 (nm)
Power of each channel	-10 (dBm)
Frequency spacing	100 (GHz)
Modulation Format	NRZ
Fibre Length	50 (km) and 100(km)
Number of loops	5
EDFA gain	10 (dB) and 14m length
Cut off frequency	0.75*Bit rate

III. Simulation Results &Graphical Analysis

There are two simulation conducted for two different values of fiber length corresponding to high and low extinction ratio in the given optical fiber topology (figure 1).

Figure 2: Variation of quality factor with time in NRZ format for 50Km

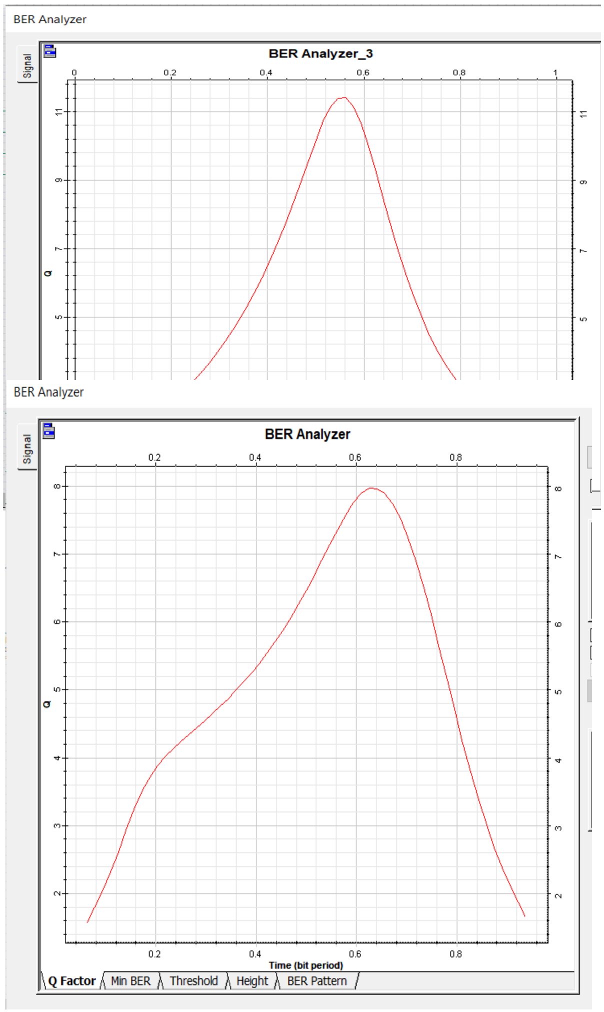


Figure 3: Variation of quality factor with time in NRZ format for 100Km

Eye Diagram Analysis: -

We get the standard graphical relation as shown in the figure 4, by increasing the extinction ratio and asymmetrical distribution of input powers in this DWDM network, bit error rate decreases with higher quality factor which is shown by the maximal eye opening in figure 4.

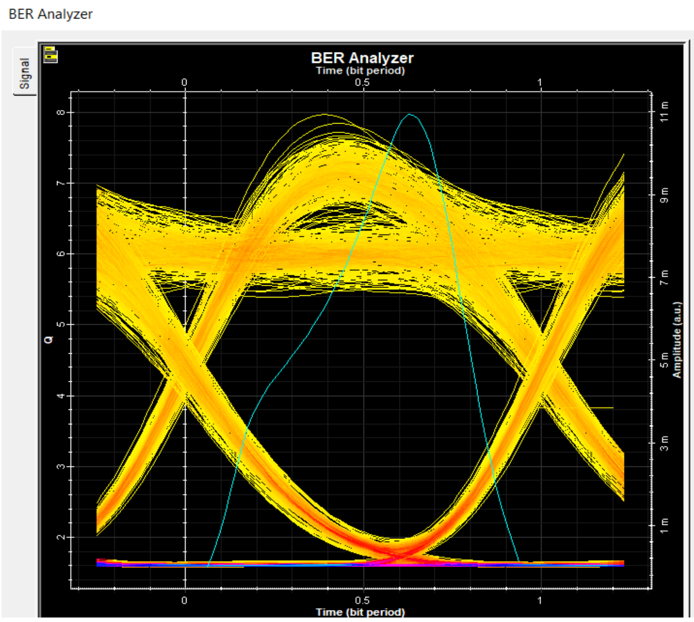


Figure 4: Eye Diagram of eye height 0.00498795 for total length 250 km SMF

Result and Discussion

The simulationbased on the varying transmission power level from 193.025 THz to 193.175 THz with the upgradation of 0.05 THzthen we get theTable-2, which shows the relation between bit error rate and values of Q factor, which indicates the degradation of XPM in the form of improved Q factor obtained in Table 2.

S.No.	Distortion [ps/nm/km]	Quality-factor	Bit Error Rate
1	0	1.99	$2.19 \text{ X } 10^{-2}$
2	1	3.37	$5.39 \text{ X } 10^{-4}$
3	2	6.78	$2.51 \text{ X } 10^{-11}$
4	3	9.51	$1.79 \text{ X}10^{-20}$
5	4	10.91	$2.81 \text{ X}10^{-27}$

Table-2 BER of simulations at 193.075 THz

Now it is crystal clear from the obtained data of the Table 2 that establishing the relation between dispersions and the corresponding quality factors. Further as per the same parameters of table 1 simulation executed for the different fiber length with the same extinction ratio as shown in the table 3,4& 5.

S. No.	Fiber Length(Km)	Q.F at ER = 5 dB	Q.F at ER = 10 dB	Q.F at ER = 20 dB	Q.F at ER = 30 dB
1.	50	38.7	39.9	42.8	44
2.	100	38.4	39	42	43.2
3.	150	34.8	35.7	36.4	36.1
4.	200	25.8	27.9	28.7	27.7
5.	250	17.8	19.6	22	21.6
6.	300	11.9	13.1	15.9	17
7.	350	8	9.6	11.5	12.5

Table-3 Variation of Quality factor with ER and Fiber length

S.No	Total SMF length (km)	Extinction ratio	DCF length(km)	Max.Quality factor	Minimum BER
1.	50	30 dB	10	11.40190	1.86939e-030
2.	100	30 dB	10	7.09624	6.43275e-016

Table-4 Output at particular value of fiber length and High Extinction Ratio

Again, all the parameters are kept constant at the Low Extinction Ratio with the different fiber length.

S.No	Total SMF length (km)	Extinction ratio	DCF length(km)	Max.Quality factor	Minimum BER
1.	50	7 dB	10	7.852	1.98928e-015
2.	100	7dB	10	3.79	3.843e-005

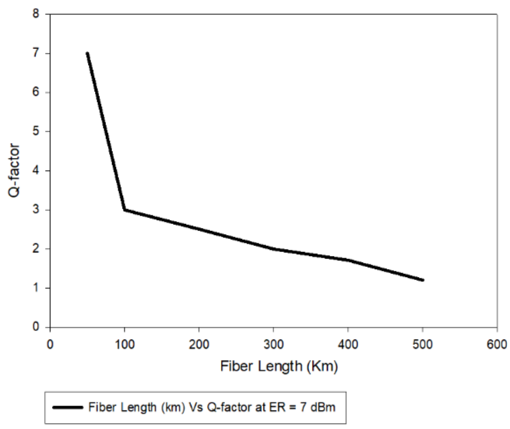
Table-5 Output at particular value of fiber length and Low Extinction Ratio

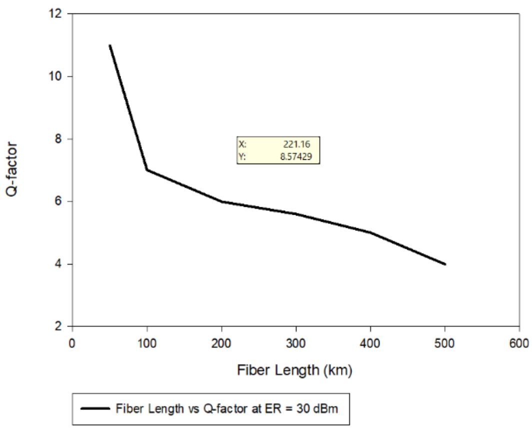
It is said that as per the figure 5 & 6, the extinction ratio specify the performance of transreciver but on the basis of these simulations and Tables 4 and 5, it obsereved that the extinction ratio as the function of fiber length of the given network.

Figure 5

Figure 6

IV. Conclusion





In this research, we have presented the positiveeffect of selection of Extinction Ratio with the suppression of XPM in the Optical Fiber network. Hence Table 4 & 5 indicates that ER behaves as the function of the fiber-length. That is, if the ER is smaller and fiber length of the network is greater, performance must be decreased. Furthermore, this research will have needed to establish the strong relation between them for better performance of fiber networks.

Conflict of Interest: The Authors declare no conflict of interest.

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