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EXTINCTION RATIO VARIATION IN THELONG HAUL FIBER NETWORKS

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Abstract
In order to improve the strength of Signal in the fiber network, not only higher quality factor and minimum bit error rate are required but also the role of ER cannot be neglected. Since, only the treatment of linear and nonlinear impairmentsare not sufficient, there must be a need of degradation of signal leakage through the optical fiber networks related to the extinction ratio. Also, theextinction ratio is the significant parameter to measure the optical signal quality of the transmitter and receiver.Therefore,this research is to investigate that how much the effect of ER on the performance of fiber optic networks based on OptiSystem 17.0 designed with EDFA and DWDM technology.

Keywords: Extinction ratio, Optical modulation amplitude, modulation index, Power penalty

Introduction

The performance of optic fiber network degrades mainly due to the dispersion and the leakage of signal through the optical fiber. In this situation the extinction ratio is an important measure of the quality of an optical signal transmitted by the transmitter. Because the ER is used to evaluate the maximal biasing conditions of the given optical transmitter that describes how much transmitter power is converted to the modulated power in the high-speed optic signal transmission. When the values of 0-level and 1-level are precisely recorded from the eye diagram then the equation of extinction ratio is written as

$$ER = 10 \log10(E_1/ E_0)$$

Where $E_1$is the energy of the signal corresponding bit 1 and$E_0$is the energy of the signal corresponding to the bit 0[1,2].As per the optical standards like ITU-T G.691 and G.959.1 it is necessary to use the fourth order Bessel Thomson filter in order to obtain the equivalent value of energy by the closed approximation of the integration of signal.ER is also used to calculate the optical modulation amplitude(OMA),sometimes it can be specified in place of receiver sensitivity and written as.

$$OMA = P_1 – P_2$$

Where P_1 indicates that the power corresponding to high level signal and P_2 indicates the same corresponding to lower value of signal. Since the extinction ratio and OMA both are equivalently explain the attenuation of the fiber network system. Whereas the optical modulation amplitude directly indicated by the bit error rate of network but the extinction ratio and OMA both are related to the performance of the optical transmitter. Again, the quality and strength of optical signal transmitted by the transmitter is calculated on the basis of modulation index [3,4]. Actually, the fluctuation in amplitude of the carrier (wave)with respect to its average value, must be minimal for the lower value of modulation index then signal strength becomes feeble. As and when the value of extinction ratio is minimum then it requires the increment in transmission power in order to maintain constant or same bit error rate at the receiver end. Thus, the increase in transmitted power to make stable the value of ER is appeared as power penalty of the fiber network.

Now on the basis of general aspects of extinction ratio and decreasing numbers of amplifiers and regenerators in the long-haul fiber network the role of extinction ratio is important because in the long-haul transmission, the value of bit error rate increases and the noise level becomes dominant over signal level at receiver[5-10]. Finallyit is said that the extinction ratio of the transmitter end gives impact on the length of fiber in optical fiber network because the modulation power is related with extinction ratio.

Simulation

In order to evaluate the quality factor and bit errorrate under the effect of the extinction ratio for the given optical network based on DWDM technology with EDFA,dispersion compensation fiber (DCF) at the different lengths of the single mode fiber[5,6].

On the basis of Opti System software 0.17, this four-channel DWDM system withdispersion compensator and EDFA amplifier of fiber length 14mis designed to eliminate the nonlinearity due to XPM. By the selection of asymmetrical distribution of input power in different channel, increasing wavelength spacing in the adjacent channels and finally selecting signal of fixed negative dispersion fiber, in this network. In which a post-pair EDFAs with output power is set at 10 dB/m and Optical Fiber of 50km and100 km and its loss is 0.33dB/km, Erbium-doped fiber shows the best output gain. As per the ITU G.709 protocol, DWDM system facilitates the controlled, protected, repaired data in the various forms.

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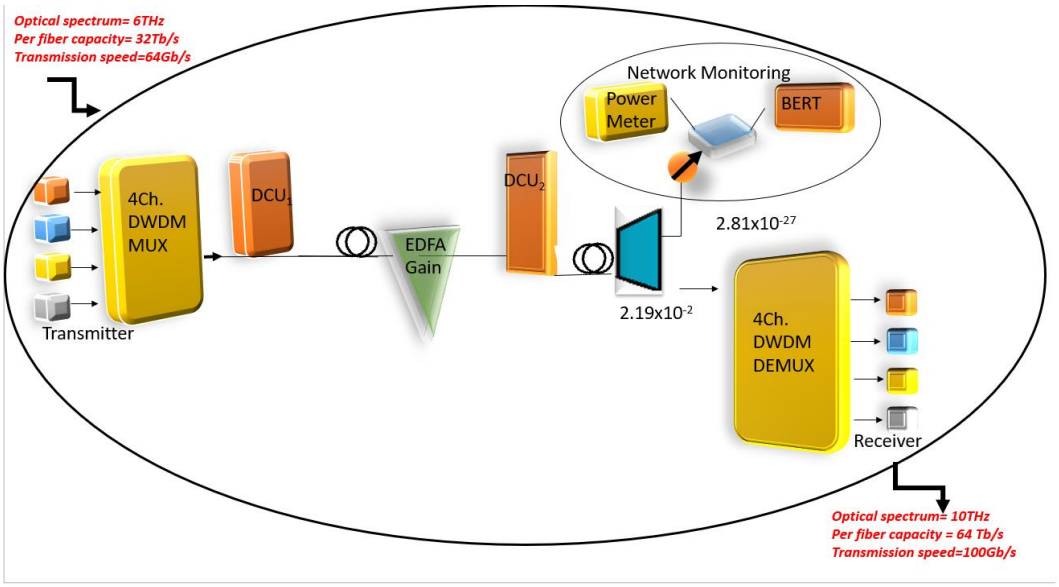
Figure 1: Design of 4 channel



DWDM Network in NRZ format with higher extinction ratio.

In this simulation work Opti system 17.0 is used to analyze the performance and optimized it by the use of DCF with appropriate selection of parameters of EDFA as shown in the Table 1. Finally,the impact of ER of transmitter observed on the performance of optical fiber network by the variation of fiber length.

Description of Simulation Network: -

Table 1: Simulation Parameters

ırameter	ılues
ransmitter Frequency	55 (nm)
ower of each channel	0 (dBm)
equency spacing	0 (GHz)
odulation Format	RZ
bre Length	(km) and 100(km)
ımber of loops	
DFA gain	(dB) and 14m length
ıt off frequency	75*Bit rate

Graphical Analysis:

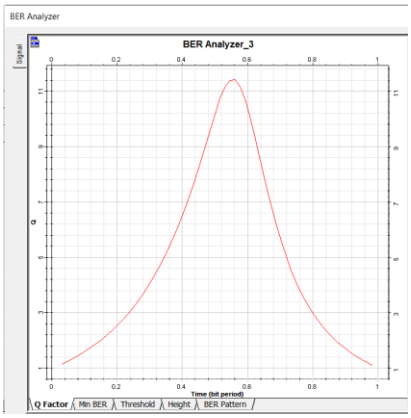


Figure 2: Variation of quality factor with time in NRZ format for 50Km

Table-2 Quality Factor and BER at High Extinction Ratio

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No	MF Length(Km)	gnal power(dBm)	aximum Quality factor	inimum BER
	)	0	.04190	86939e-030
	)0	0	09624	43275e-016

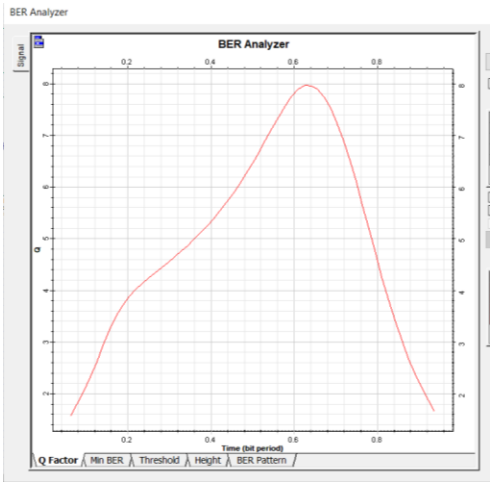


Figure 3: Variation of quality factor with time in NRZ format for 100Km

Eye Diagram Analysis: -

The standard graphical relationas shown in the figure 2, 3 and 4, it is observed that by increasing the extinction ratio and asymmetrical distribution of in input powers of the transmitting channelof this DWDM network. Again, bit error rate decreases with higher quality factor for smaller fiber of length 50Km, which is shown by the maximal eye opening in figure 4. Whereas the distortion in the upper part of the eye pattern proves that high extinction ratio gives negative effect directly on the quality of the optical signal and indirectly on the performance of optical components of the Networks.

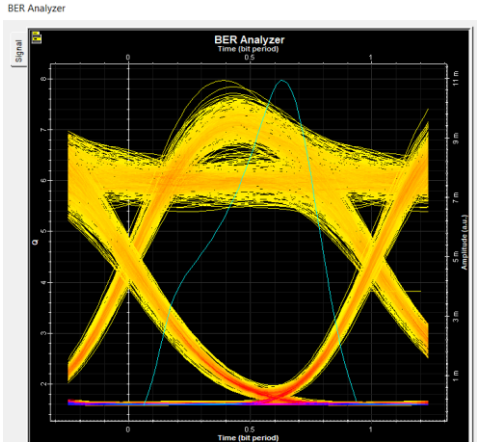


Figure 4: Eye Diagram of eye height 0.00498795 for high ER

Result and Discussion

As per the given parameters of Table -1, the performance of optical fiber network is calculated in terms of BER and Quality factor whereas ER kept at higher value.

Table-3 Output at particular value of fiber length and High Extinction Ratio

No	otal SMF length (km)	xtinction tio	CF length(km)	ax.Quality ctor	inimum BER
	)	) dB	)	.40190	86939e-030
	)0	) dB	)	09624	43275e-016

Furthermore in order to improve the quality factor of the signal, emphasized on the asymmetrical distribution of input powers of producing fixed dispersion values in the fiber,the power spectrum shows better result.
On the basis of obtained data of Table-1, it is crystal clear that the higher value of ER is required for the greater length of the fiber then the performance ofoptical fiber network improved.
Again in this simulation, all the parameters are kept constant and the performance calculated in terms of BER and quality factor with Low Extinction Ratio, which shown in the Table-4.

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

No	otal SMF length (km)	xtinction tio	CF length(km)	ax.Quality factor	inimum BER
	)	dB	)	852	98928e-015
	)0	lB	)	79	843e-005

Now on the basis of graphical analysis of figure 2, 3 & 4 and the tabular data of Table-1, 2 &
4, it can be obtained that there must be the relation between Extinction Ratio and quality factor of the Network.

Figure 5

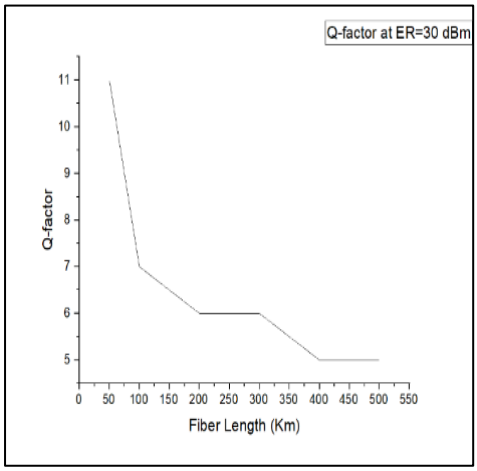
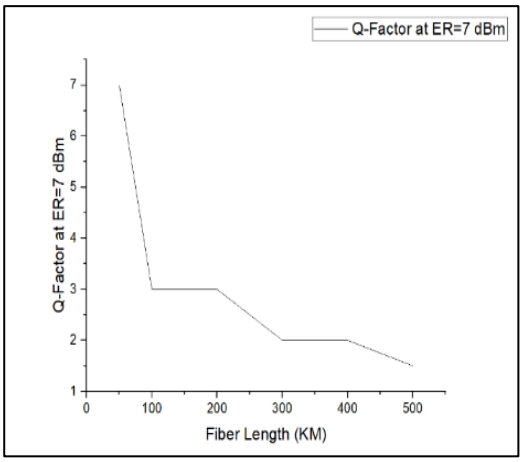


Figure 6



Also, it is crystal clear information from the figure 5 & 6 that the highest possible quality factor attended at higher power of Extinction Ratioand vice-versa [.At last, but not least, the small change in Extinction Ratio shows larger difference in the value of power required to make stable and lower bit error rate.

As the extinction ratio improves in the optical fiber network,the bit error rate becomes lower because at lower extinction ratio the power level of transmitter is also lower and having over lapping of signals in eye diagram that is became difficulty to detect the signals corresponding to 0 bit and 1bit.

Conclusion

In this research, the performance of a given fiber network evaluated and the result can be concluded as the dominancy of nonlinearities in terms of BER with the significance of Extinction Ratio which indicates that ER in the Optical Fiber network behaves as the function of the fiber-length.

At thesame value of ER, the fiber length of value 50Kmprovides better performance in the optic communication system as per the figure 2 whereas the fiber of length 100Km, at the same parameter, the performance of the network system degrades as shown in the figure 3.

Finally, the role of extinction ratio is as the key indicator in fiber network because the performance of the optical fiber network depends upon extinction ratio. Due to the power, noise and temperature related drifts in channel, theaccurate calculation of extinction ratio is difficult in practice. So, the ER and its exact formulationwith the fiber length is thefurthertopic of researchby extracting the information from the potential sources of error.

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