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TO ANALYSE THE PARAMETER OF COARSE WAVELENGTH DIVISION MULTIPLEXING BY USING EDFA

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ABSTRACT

It is difficult in optical communication systems to predict the final signal at the receiver side because of using various components. In this current work, Opti-system 7th version software is used to analyze the four channels of coarse wavelength division multiplexing (CWDM) with channel bandwidth 40Gb/s, 10Gb/s for each channel, from the transmitter to the receiver based on extinction ratio, pump power and the distance of the optical fiber until 100km and simulation helps to analyze the performance before any actual hardware is done. An Erbium-Doped Fiber Amplifier (EDFA) is used for amplification purpose for long distances. The result have to be found that the maximum Q factor and eye height decreased and minimum BER increased as the fiber length increase after simulation. When the extinction ratio increased, the eye height increased. Pump power effect the gain of the system. If the pump power increases then the gain also increase but no effect on maximum Q factor and minimum BER.

KEYWORDS:

Bit Error Rate (BER), Coarse Wavelength Division Multiplexing (CWDM), Erbium-Doped Fiber Amplifier (EDFA).

1. INTRODUCTION

Transmission of information from one place to another through one medium is called communication. Mankind has been using many mediums for the data transmission. One of these mediums for data transmission was coaxial-cable system. The first coaxial-cable system, deployed in 1940, was a 3MHz system which could transmit 300 voice channels. The optical fiber is a waveguide used for transmission of light. It consists of a dielectric fiber core, usually from glass, surrounded by a layer of glass or plastic cladding characterized by the refraction index lower than that of the core. Optical fiber communication is a new technology in recent years, its rapid development and the broad range of application. It becomes the new technological revolution in the world. Main transmission of various information tools, it is of great importance in the future. Now a day's optical communication systems are becoming more important. Optical communication system often include multiple signal channels, different topology structure, nonlinear devices and non-Gaussian noise sources, which make their design and analysis quite complex. Now a day, the need of bandwidth is increasing day by day. To fulfill this need, companies have to investigate on increasing their channels' capacity with the lowest cost. Cost is reduced by using wavelength division multiplexing (WDM). A number of wavelengths can be transmitted through a single fiber by using WDM. Coarse wavelength division multiplexing (CWDM) and dense wavelength division multiplexing (DWDM) are two type of wavelength division multiplexing. CWDM is mostly used in access, metro, and cable TV network. CWDM can transmit wavelengths ranging between 1270 nm to 1610 nm and wavelengths are separated by 20 nm .CWDM systems are less expensive as compare to DWDM system.

Opti-system will allow the design and analysis of these systems become quickly and efficiently. The optisystem enables users to plan, test and simulate the following:

- WDM/TDM or CATV network design.
- SONET/SDH ring design.
- Transmitter, channel, amplifier and receiver design.
- Dispersion map design.
- Estimation of BER and system penalties with different receiver models.
- Amplified system BER and link budget calculations.

The analyses of CWDM systems are done by using the optisystem version 7.0 and a schematic design of four channels CWDM is presented in Figure 1.1.

2. PROBLEM FORMULATION AND METHODOLOGY

In optical communication systems to predict the final signal at the receiver side is very difficult because of using various components and many other effects. So simulation helps to analyses the performance of the systems before any actual hardware is done. Optisystem has the ability to change the design and the parameter to get better results.

In this paper, optisystem 7th version software is used in order to analyze four channel of coarse wavelength division multiplexing (CWDM) from the transmitter to the receiver based on extinction ratio, pump power and length of the optical fiber. When the fiber length reaches 40km, EDFA is used for the purpose of amplification. The design consists of 4 transmitters and 4 receivers. At the transmitter side, pseudo-random bit sequence (PRBS) is generated by return to zero (RZ) pulse generator. Then the modulation of electrical signal from RZ with continuous wave (CW) laser is done by mach-Zehnder. Optical fiber with different distances is used to provide the connection between transmitter and receiver. Upto 40km distance EDFA is not used.

EDFA can amplify a wide wavelength range (1500nm-1600nm) simultaneously, hence is very useful in wavelength division multiplexing for amplification. EDFA basic says when an optical signal such as 1550nmwavelength signal enters the EDFA from input; the signal is combined with a 980nm or1480nm pump laser. The input signal and pump laser signal pass through fiber doped with erbium ions. Here the 1550nm signal is amplified through interaction with doped erbium ions used.

At the receiver side optical signals are converted into electrical signals with the help of Avalanche photo detectors (APDs). Photodiode convert the light into electrical signal. The more sensitive APDs longer are length of fiber optics link. Then Trans-impedance amplifiers (TIAs) amplify the electrical signals. A transimpedance amplifier is a current to voltage converter; most often implemented using an operational amplifier. A second order low pass Gaussian filter are used which filters the amplified signals. A Gaussian filter is a filter whose impulse response is a Gaussian function. It has the properties of having no overshoot to a step function input. Then the signals are applied to BER analyzer. BER analyzer is used to analyze the bit error rate. BER analyzer can estimate the bit error rate using and derive different metrics from the eye diagram, such as Q factor, eye opening, eye closure, extinction ratio, eye height, jitter, threshold etc.

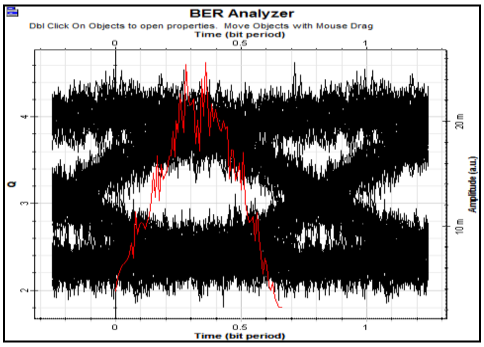
3. RESULT AND DISCUSSION

3.1 Eye Diagram

Eye diagram is also known as eye pattern in Telecommunication. Totally opened eye pattern represents the lowest level of distortion and closing of eye represents the highest level of distortion. Eye diagram are a very successful way of quickly assessing the quality of a digital signal. Because of the shape of the pattern that looks as if it is an eye, it is called an eye diagram.

3.1.1 Eye Diagram of 40 km without EDTA

Fibre length is 40 km and 8 db Extinction ratio



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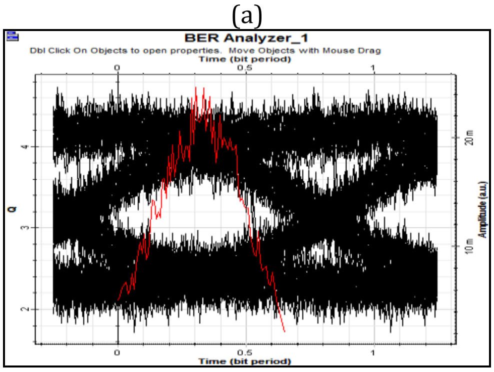

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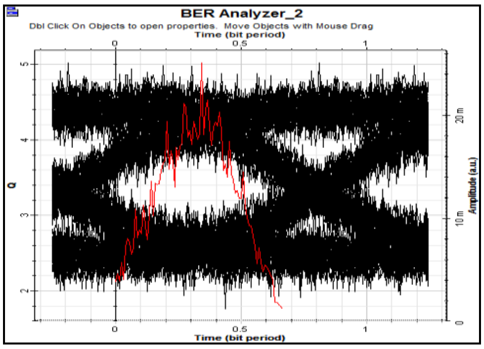

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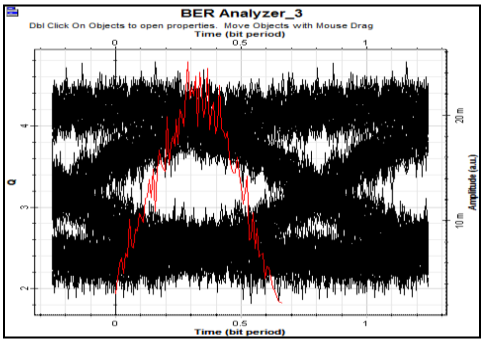


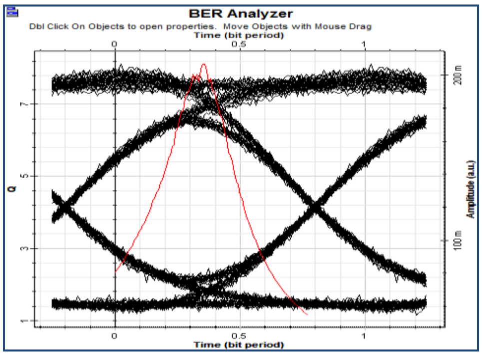
(d)

Fig 3.1: Eye diagram of 40km 8dB. a) Eye diagram of channel 1. b) Eye diagram of channel 2. c) Eye diagram of channel 3. d) Eye diagram of channel 4.

Eye Diagram for 4 channel system at 40 km without EDTA is shown in figure 3.1. This figure shows large amount of distortion present at the output.

3.1.2 Eye Diagram of 40km Using EDFA

Eye diagrams are presented when 40km fiber length, 8dB extinction ratio, and EDFA are used. It is concluded that there are more distortion and noise in the signal when we are not using EDFA. So we cannot transmit that signal at long distance. Signal will die out before reach at destination. EDFA is used for long distance communication.



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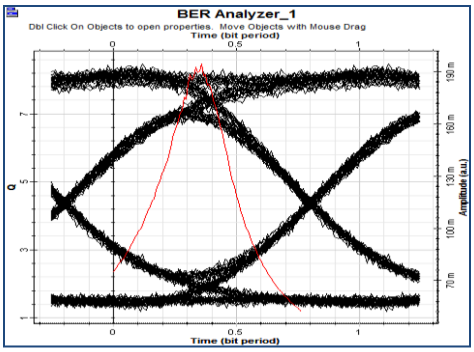

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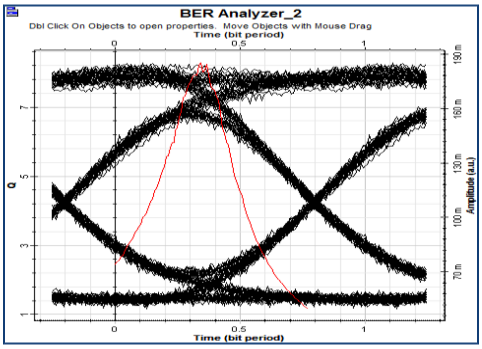

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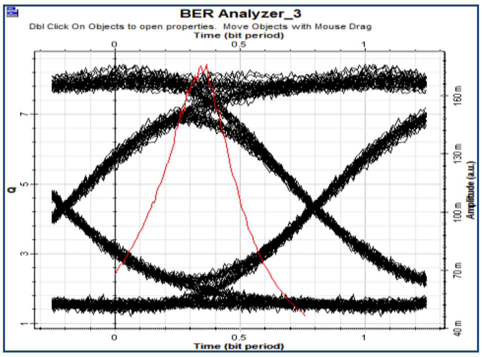


(d)

Fig 3.2: Eye diagram of channel 1, 2, 3 & 4are shown in a, b, c and d respectively.

Eye diagram for 4 channel system at 40 Km using EDFA is shown in figure 3.2.This figure shows that distortion is reduced at the output by using EDFA. So distortion is reduced by using EDFA.

3.2 Effect of varying fiber length with using EDFA

As the fiber length increased the bit error rate are increased and distort the information. Q-factor decreased with increased the fiber length as shown in figure 3.3.

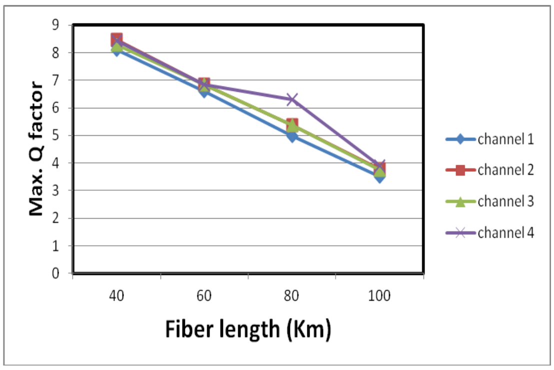


Fig. 3.3: Maximum Q factor vs. fiber length.

Minimum bit error is almost constant upto 80km but it is suddenly increased when length reaches at 100km shown in fig.3.4.

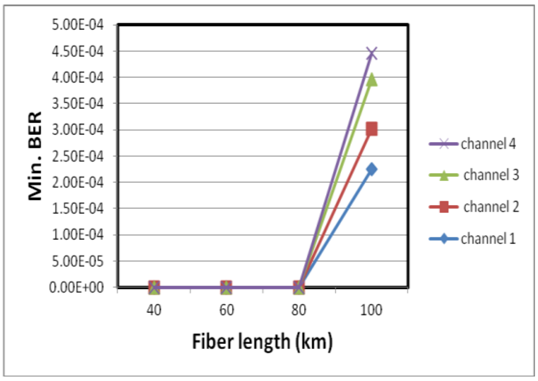


Fig 3.4: Minimum BER vs. fiber length

Eye height decreased with increased fiber length. It means distortion increased when fiber length increased as shown in figure 3.5.

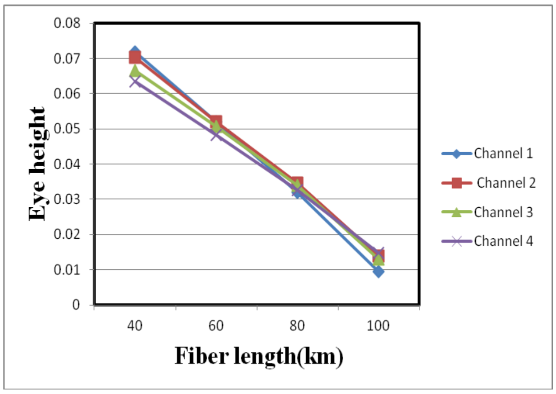


Fig 3.5: Eye height vs. fiber length

3.3 Effect of varying Extinction ratio on Maximum Q factor:

Extinction ratio is the proportion of the average energy in an addressed logic '1' to the average energy in an addressed logic '0'.

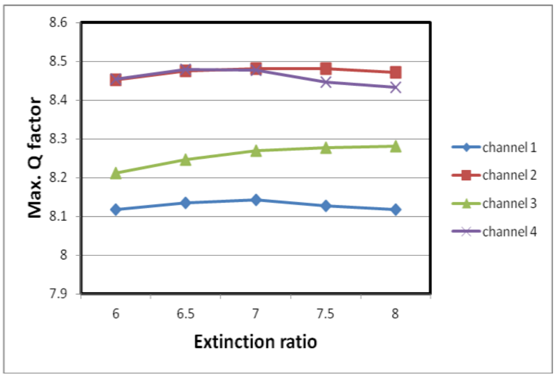


Fig 3.6: Maximum Q factor vs. Extinction ratio

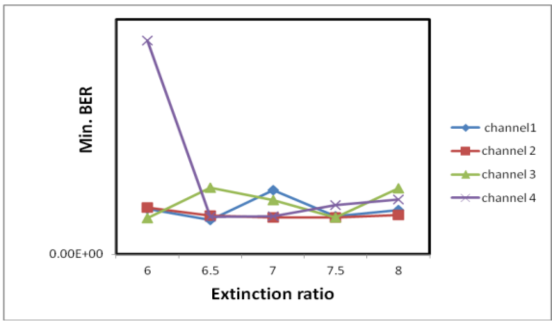


Fig 3.7: Minimum BER vs. Extinction ratio

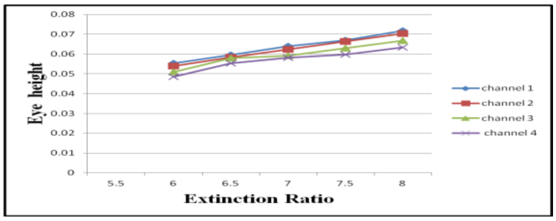
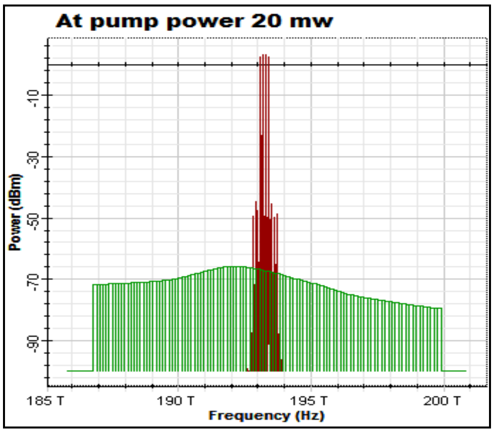


Fig 3.8: Eye height vs. Extinction ratio

From the simulation obtained, the extinction ratio has no specific pattern on maximum Q factor and minimum BER shown in fig.3.6 and fig.3.7.But eye height increased as the value of extinction ratio increased shown in fig.3.8.So extinction ratio mostly effects the eye height.

3.5 Effect of varying pump power on gain and noise figure

EDFA in a WDM system are often required to have equalized gain spectra in order to achieve uniform output powers and similar signal-noise ratios (SNR). There are several methods in designing a flat spectral gain EDFA such as by controlling the doped fiber length and the pump power. The fiber length is bound between 1 and 20m and pump power is bound between 0 to 50mW.



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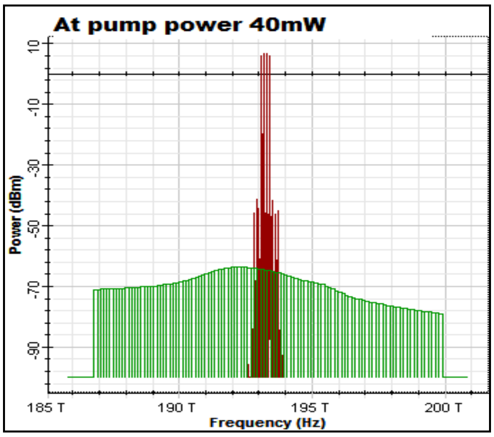

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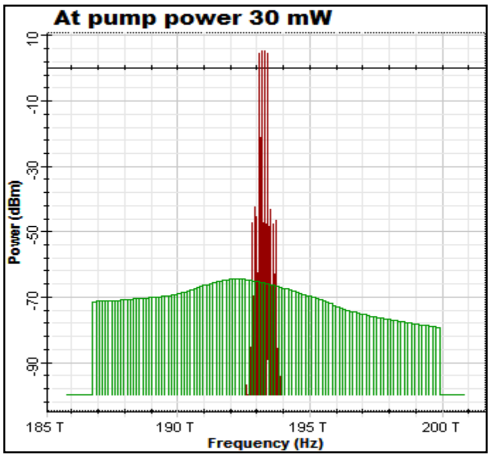

(c)

Fig 3.9: output power (red) and noise spectrum (green)

Gain of the EDFA amplifier increase when the pump power is increased that is shown in figure 3.9. The output power is measured by varying pump power and fiber length at a constant input power .The optical gain and noise figure (NF) were measured for different pump powers.

4. CONCLUSION

In the current research, simulation for 4 channels CWDM has been done. The advantages of CWDM are its large bandwidth with low cost as compare to DWDM. An EDFA has been used for amplification purpose for long distances communication. As we observed from the results that maximum Q factor and eye height decreased and minimum BER increased as the fiber length increased .But extinction ratio does not have a specific pattern on maximum Q factor and minimum BER.As the value of extinction ratio increased, eye height also increased. Pump power effect the gain of the system. If the pump power increases then the gain also increase. As the pump power increase then there is no effect of pump power on maximum Q factor and minimum BER.

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APPENDIX

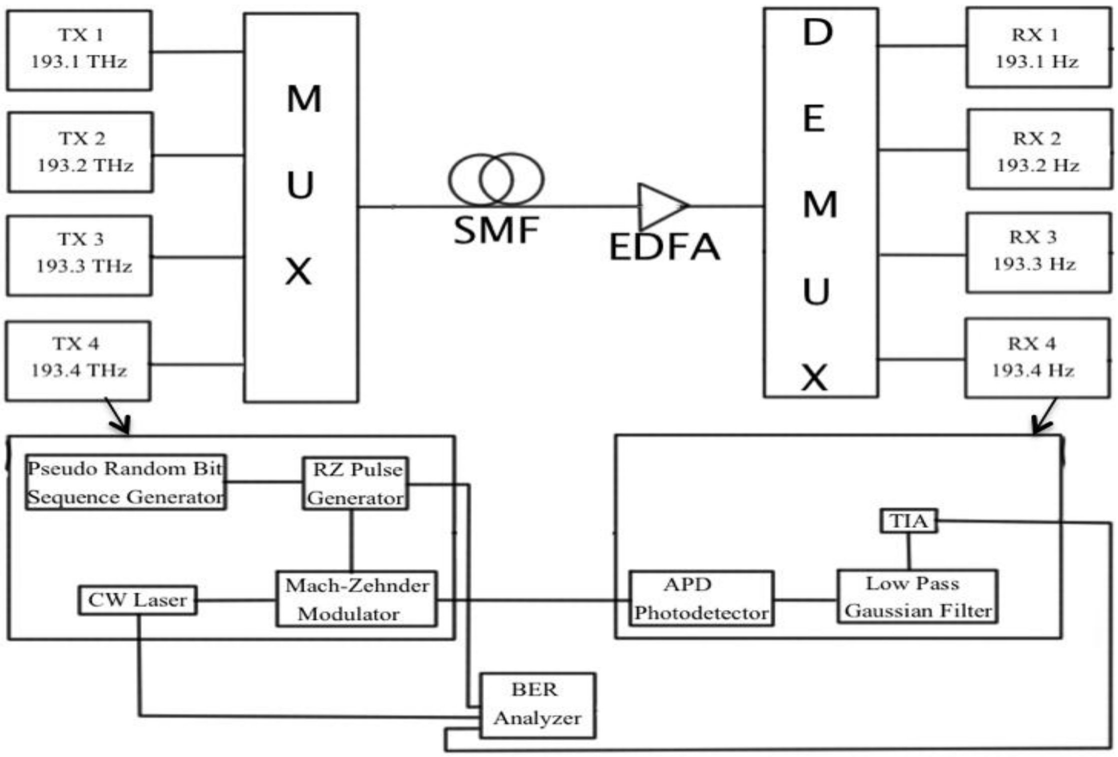

Fig 1.1: A schematic design of four channels CWDM