

Performance Analysis of a 40Gbps WDM System for 8 Channels using FBG

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Abstract— In this paper, dispersion compensation methods for 40 Gbps non-return to zero (NRZ) and return to zero link using standard fibers (SMF) and fiber bragg grating (FBG) are analyzed through computer simulation to optimize high data rate optical transmission. Graphical analysis is done to evaluate the performance in terms of various characteristics like BER (bit error rate), Q-factor, etc. This paper compares all the three results for Q-factor and BER and it will be shown that when the fiber length is increased then Q- factor decreases and the BER is increases.

Key words: SMF (Single Mode Fibre), FBG (Fiber Bragg Grating), BER (Bit Error Rate), Q-Factor

I. INTRODUCTION

In optical fiber different colors of light travels at different speed. Even though they start from the same point, but they reach the destination at different time. This time delay is called chromatic dispersion. When multiple light pulses travel inside the fiber the light pulses get wider and overlap with each other at the output end of the fiber. Hence it becomes difficult to detect the signals individually at the output. This dispersion also causes Bit error rate. Chromatic Dispersion is sum of two different types of dispersion. These are Material dispersion and Waveguide dispersion. The refractive index of silica is frequency dependent. Different frequency components of light i.e. different wavelengths of light travel at different speed in silica fiber. Material dispersion depends upon the refractive index of the material, and it cannot change. The second type of dispersion is called waveguide dispersion. The light pulse travels partly in core and partly in cladding. Light cladding. The overall speed and the power which is distributed in the fiber vary. Hence it causes dispersion. The detection of pulses becomes even more difficult for fiber systems with high data rate for example 40Gbps systems and above. Therefore it is essential to compensate the dispersion of the signal before its detection for error free transmission.

It is most promising method to use fiber bragg grating (FBG) efficiently to upgrade installed link made of standard single mode fiber (SMF). These type of passive and devices are commercially available, easy to install and cascable in networks, indicating that at present the FBG technique can effectively compete with any other dispersion management approach. Whenever SMF is used in any research for high bit rate transmission with low loss but dispersion is an important impairment that degrades overall system performance. (1) The application of optical fiber are very important to the transmission quality of optical fiber transmission system. Therefore, it is very necessary to investigate the transmission characteristics of optical fiber And the main goal of communication systems is to increase

the transmission distance. Loss and dispersion are the major factors that affect fiber optical communication (2).

To compensate the dispersion of the signal three methods are used: pre, post and symmetrical compensation. In this paper, investigated the behavior fiber at different distances 40gbps non-return to zero (NRZ) and return to zero link using standard fibers (SMF) and fiber bragg grating (FBG) for multiple channels and also evaluate the performance in terms of various characteristics like BER (bit error rate), Q-factor, etc.

II. SIMULATION SETUP

Figure 1 shows the Simulation model of WDM system using FBG dispersion compensation technique at 40gbps data rate.

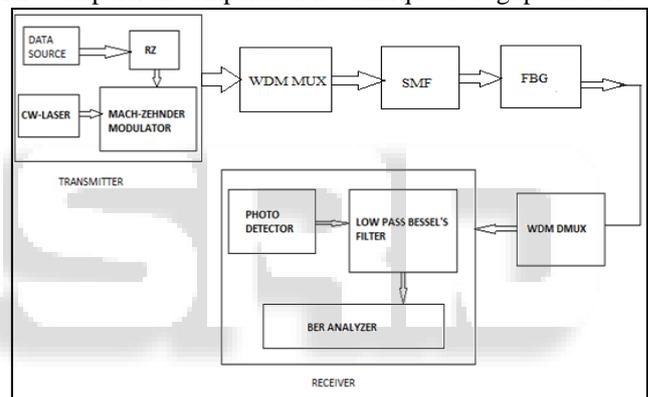


Fig. 1: Block Diagram for the simulation model

The transmitter section consists of data source, Laser source and Mach-Zehnder modulator. The data source is then converted to Non-Return to Zero (NRZ) format. The Data source laser signal are fed to the Mach-Zehnder modulator, where the inputs generated from data source are modulated with the laser signal are transmitted. The output from the modulator is now an optical signal with certain wavelength. When multiple optical signals are transmitted in a fibre they are multiplexed with wavelength division multiplexer. The multiplexed signal is then passed through the SMF fibre, then signal passed FBG that can be compensated the dispersion losses over the fiber.

In the detector section the de-multiplexer is used to get the different optical signals with different wavelengths which were multiplexed at the transmitter side. The Receiver side consists of photo-detector, low-pass filter and the BER analyzer. The photo-detector detects the optical signal and then the signal is passed through a low pass filter. The BER analyzer is used to check the Bit Error rate and the Q-factor of each signal.

Model Parameter	Value
Data bit rate	40Gb/s
Length of SMF	100,115,125 km
Frequency	193.1THZ

Frequency spacing	100 GHz
Power	10dbm
Dispersion	16 ps/nm/km
Dispersion slope	0.08 ps/nm/km

Table 1: Simulation Parameter

III. RESULTS AND DISCUSSION

This paper analyzes the performance of a 40Gbps WDM system for 8 channels at various transmission distances using optisystem 7.0 software.

We know that, when a longer fiber is used for long distance transmission large dispersion and attenuation are occur that is decreases the performance of the system. so in this paper dispersion can compensated by using FBG (Fiber Bragg grating). The different transmission distance considered here are 100km, 115km, 125km and the different modulation schemes are return-to-zero (RZ) and non-return to zero (NRZ) used in WDM system. But for long distance transmission non-return to zero (NRZ) modulation schemes gives better results. So that in paper NRZ modulation scheme using in WDM system.

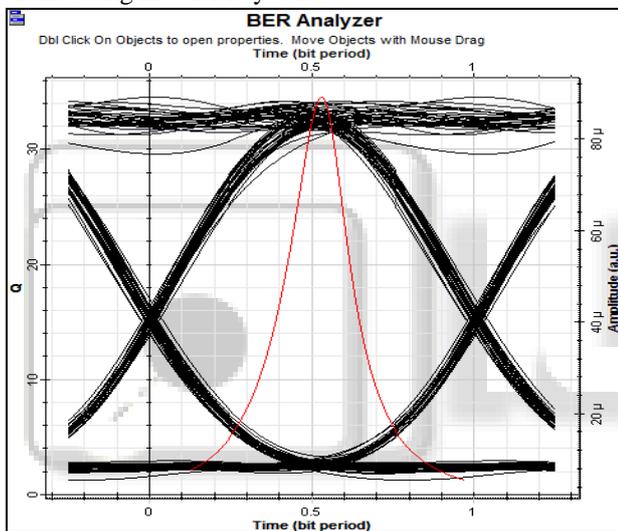


Fig. 1: Eye diagram of Max. Q-Factor & Min BER at 40Gbps over 100km.

The WDM system can be analyzed in two factors are Q-factor and BER that can be represented by Eye diagram.

Figure 1 we can see that the eye opening is maximum which can be representing the less amplitude distortion into receiving signals.

So it can be reduces BER but increases Q-factor in given system. The highest point of Eye diagram is called best sampling time. The best time to sample the received waveform is when the height of the Eye opening is largest. This height is reduced as a result of amplitude distortion in the data signal.

The Max Q-factor (34.524) and Min BER (1.59×10^{-261}) with respect to different time interval at 40 Gbps data rate over 100km.

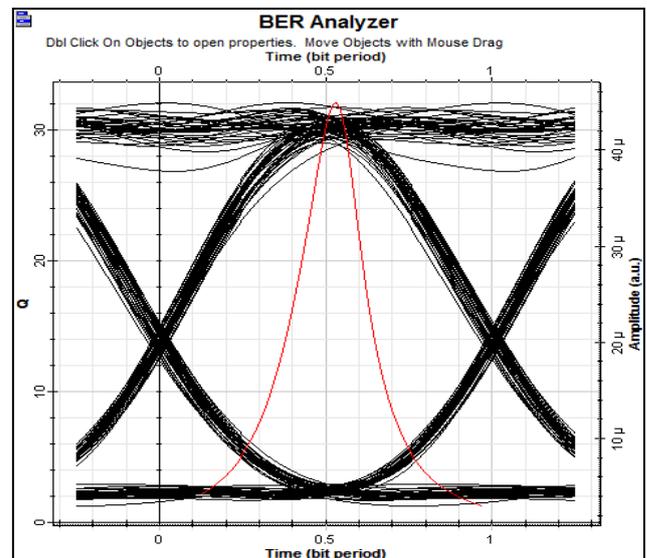


Fig. 2: Eye diagram of Max. Q-Factor & Min BER at 40Gbps over 115km.

Figure 2 represented the Max Q-factor (32.0866) and Min BER (3.14×10^{-226}) with respect to different time interval at 40Gbps data rate over 115km.

Figure 3 The Max Q-factor (25.58) and Min BER (1.147×10^{-144}) with respect to different time interval at 40Gbps data rate over 125km.

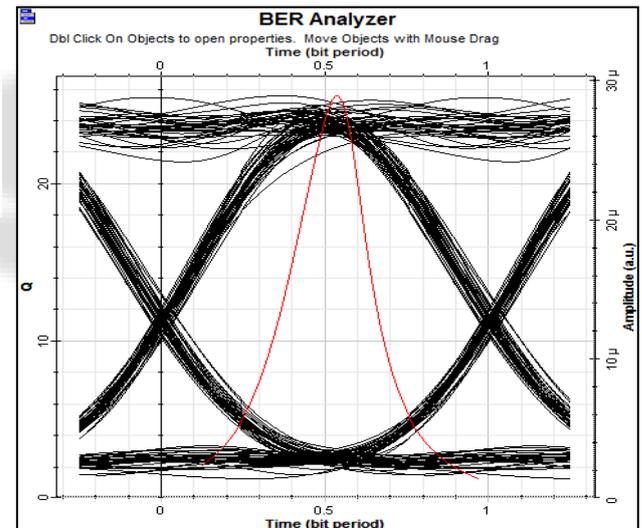


Fig. 3: Eye diagram of Max. Q-Factor & Min BER at 40Gbps over 125km.

IV. RESULTS

Fiber length (km)	Q-factor	BER
100	34.524	1.59×10^{-261}
115	32.0866	3.14×10^{-226}
125	25.58	1.147×10^{-144}

Table 1: Max. Q-Factor & Min BER at 40Gbps over different fiber length.

Table 1 represented Max Q-factor and min BER at different fiber length. The corresponding Q- factor is also found to be decreasing when the fiber length is increased.

V. CONCLUSIONS

The work has emphasized on the dispersion compensation techniques in a WDM network at 40GB/s. A simulation model is presented for the dispersion compensation in

optical fibers for a multiple channel into fiber and dispersion can be compensated by FBG at different length of fiber (100,115,125km). The simulation result analyzed into two important factors (BER, Q-Factor) and represented by eye pattern. The eye height is maximum which represented less distortion and also found maximum Q-factor and minimum BER at 40gbps data rate. But when the fiber length is increased then Q- factor decreases.

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