Journal of Advanced Research in Embedded System
Volume 7, Issue 1 - 2020, Pg. No. 16-22
Peer Reviewed Journal

Article

Dispersion Compensation in Optical Fiber using Fiber Grating

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DOI: https://doi.org/10.24321/2395.3802.202004

I N F O

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How to cite this article:
Mishra BP, Chauhan L, Nivesh et al. Dispersion Compensation in Optical Fiber using Fiber Grating. *J Adv Res Embed Sys* 2020; 7(1): 16-22.

Date of Submission: 2020-05-03
Date of Acceptance: 2020-05-22

A B S T R A C T

Optical Fiber Communication System is highly in demand because of several advantages namely Extremely High Bandwidth, Longer Distance, Low security Risk, Small Size etc. This system basically consists of Optical Transmitter, appropriate channel and Optical Receiver.

Optical Fiber is generally used for the propagation of optical signals and in this fiber, Dispersion arises which acts as the main hindrance in Optical Fiber Communication.

Dispersion is nothing but the time broadening of pulses because of the inherit property of the Silica Fiber that refractive index of the material depends upon the wavelength used.

In this paper, Compensation of Dispersion is done using the FBG(Fiber Bragg Grating. FBG is a type of filter which passes few wavelengths and reflects rest of them.

Stimulation is done on software named OPTISYSTEM 15. Simulation results are analyzed through Eye Diagram which gave us the values of MIN.BER and Q-Factor.

Keywords: Optical Fiber, Dispersion, FBG, Min BER, Q-factor

Introduction

Fiber optics is a medium for carrying info from one point to another in the form of light. A basic fiber optic system contains of a transmitting device that converts an electrical signal into a light signal, an optical fiber cable that carries the light, and a receiver that accepts the light signal and converts it back into an electrical signal. Fiber Bragg gratings have many applications in fiber optical telecommunication systems such as dispersion compensation, gain flattering for EFDAs, Raman amplifiers add/drop multiplexers and in fiber grating sensors and pulse shaping in fiber lasers. Here it is used as Dispersion Compensator in Optical systems.[1]

But dispersion is a matter of inordinate apprehension

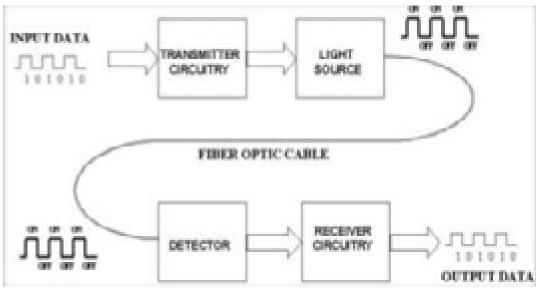

Figure 1. Basic Fiber Optic Communication System

which degrades the complete presentation of fiber optic communication link. As the bit rate is augmented dispersion cause the pulse to widen at the output of the optical fiber. At high data rate, these broaden pulses may intersection with each other causing crosstalk and Inter Symbolic Interference (ISI) which causes errors during reception of the signal at the receiver side of optical link. By the use of Erbium Doped Fiber Amplifier (EDFA) in 1550 nm wavelength window in order to increase the distance of fiber optic link which has been limited by loss caused due to dispersion. But EDFA induces nonlinear effects in the optical fiber which limits the data rate of fiber optical channel and also reduces the maximum repeater distance spacing in fiber optic link.[2]

The combined effect of chromatic dispersion and nonlinear effect are very disastrous for data transmission in a very high data rate optical fiber link which induces overall loss in optical data transmission system. Hence, some dispersion management techniques must be used in order to suppress impairments caused by chromatic dispersion and nonlinear effects so as to achieve high data rates in the optical fiber link. Several techniques have been proposed which can be used to overcome power penalty caused due to nonlinear effects and chromatic dispersion. These include differential delay methods, initial pre-chirp, dispersion compensating devices, mid spam spectral inversion, dispersion supported transmission, optical phase conjugation. Dispersion compensation fiber has a high value of negative dispersion which is used to compensate for positive dispersion caused due single mode fiber.[3]

Electronic Dispersion Compensation (EDC) is another technique which can be used to recompense dispersion by using feed forward equalization or decision feedback equalization or both to compensate dispersion. Another method of dispersion compensation is use of Fiber Bragg Grating in order to compensate dispersion caused due to optical fiber link. In Fiber Bragg Grating different wavelength are reflected inside of grating at different distance. The larger wavelength travels a larger distance before reflection and the shorter wavelength travels a comparatively lesser distance inside the fiber. As a results the pulse which was expanded by dispersion has now been compressed by use of Fiber Bragg Grating.[4]

Optisystem is an ground-breaking optical communication system simulation package that designs tests and optimizes virtually any type of optical link in the physical layer of a broad spectrum of optical networks, from analog video broadcasting systems to intercontinental backbones.[5]

In this paper dispersion compensation in optical fiber is done using FBG method and comparison between without using FBG and with using FBG in optical fiber is done. Simulation is done using OPTISYSTEM and the value of Q-factor, eye height and Bit Error Rate (BER) is determined for these case and their values are compared. Fiber Bragg Grating is discussed in detail in section 2. In section 3 simulation setup for performance analysis is shown. Results and discussion are presented in section 4. In section 5, concluding remarks are given.

Fiber Bragg Grating (FBG)

A fiber Bragg grating (FBG) is a type of dispersed Bragg reflector created in a short segment of optical fiber that reflects specific wavelengths of light and transmits all others. This is attained by creating a periodic variation in the refractive index of the fiber core, which produces a wavelength-specific dielectric mirror. A fiber Bragg grating can therefore be used as an inline optical filter to mass convinced wavelengths, or as a wavelength-specific reflector.[6]

The Fiber Bragg Grating (FBG) is a fiber optic passive component showing basic functional attributes of reflection and filtering. FBG's are relatively simple to manufacture, small in dimension, low cost and exhibit good immunity altering ambient conditions and EM radiation. FBG's have substituted bulk optic mirrors & beam splitters in equipment which increases system stability and movability. A fiber Bragg grating is region of periodic refractive index perturbation inscribed in the core of an optical fiber such that it diffracts the propagating optical signal at specific wavelengths.

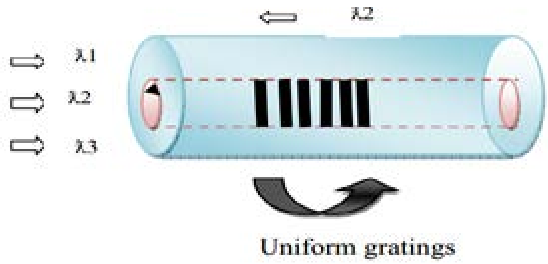

Figure 2.Principle of Fiber Bragg Grating

FBG acts as a dispersion compensator in transmission optical system which is used to compensate chromatic dispersion. Thus, the final expected effect is compression in incident pulse and can be appropriate to compensate chromatic dispersion in a communication link.[7]

FBG is single mode which will expose the core to the periodic pattern of intense ultraviolet light. The exposure will increase the refractive index and thus the refractive index is permanently increased. Then the exposure pattern will create a fixed index modulation that called grating. When periodic refraction is changed, a small reflected light will be produced. Then, the small reflected light will be combined into a large reflected light at a certain wavelength. The certain wavelength is when the grating period is approximately half the input light's wavelength which is called Bragg's wavelength. The other light (except the Bragg's light) will be transparent.[8]

Description of Components

Pseudo Random Bit Sequence (PRBS) is used to scramble data signal in terms of bit rates. NRZ pulse generator has an advantage on controlling bandwidth. This is due to the

ISSN: 2395-3802
DOI: https://doi.org/10.24321/2395.3802.202004

characteristic of the generator that the returning signals to zero between bits. To reduce the device size and the driving voltage, waveguide-based modulators are used for communication applications. The modulator is a Mach-Zehnder modulator, in one arm of which an electro-optic element (Pockels or Kerr cell) is placed to produce a phase shift between the two interferometer arms . Depending on the value of the phase shift, the intensity varies at the output of the interferometer. It has two inputs (optical signal and electrical signal) and one output (optical). Then the input signal is modulated with semiconductor laser that is represented by Continuous Wave (CW) laser Frequency 193.1 THz . Optical Spectrum Analyzer (OSA), to monitoring output signals after each component. Erbium-doped Fibre Amplifiers (EDFAs) have received great attention due to their characteristics of high gains, bandwidths, low noises and high efficiencies. Optical amplification is required to overcome the fiber loss and also to amplify the signal before receive by Photo detector PIN at the receiver part. The optical fiber used is single mode fiber because has higher data rate and long distance transmission. The fiber Bragg grating is used as the dispersion compensator.

Simulations Setup

In this paper, simulations have been performed using two scheme without using FBG and with using FBG as dispersion compensation in optical fiber. Various simulations parameters are analyzed and studied.

Results and Discussions

The simulation and optimization of the design is done by Optisystem simulation software. In this proposed system evaluation has been done on the performance of Fiber Bragg Grating in order to compensate dispersion depending upon the Q-factor and the BER.

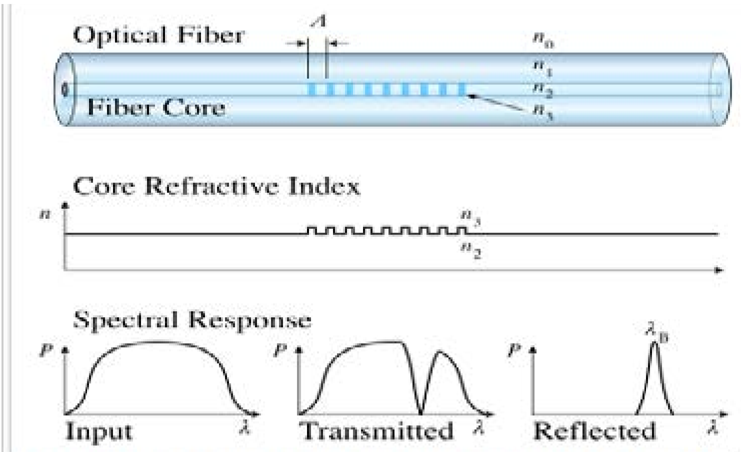

Figure 3.FBG structure

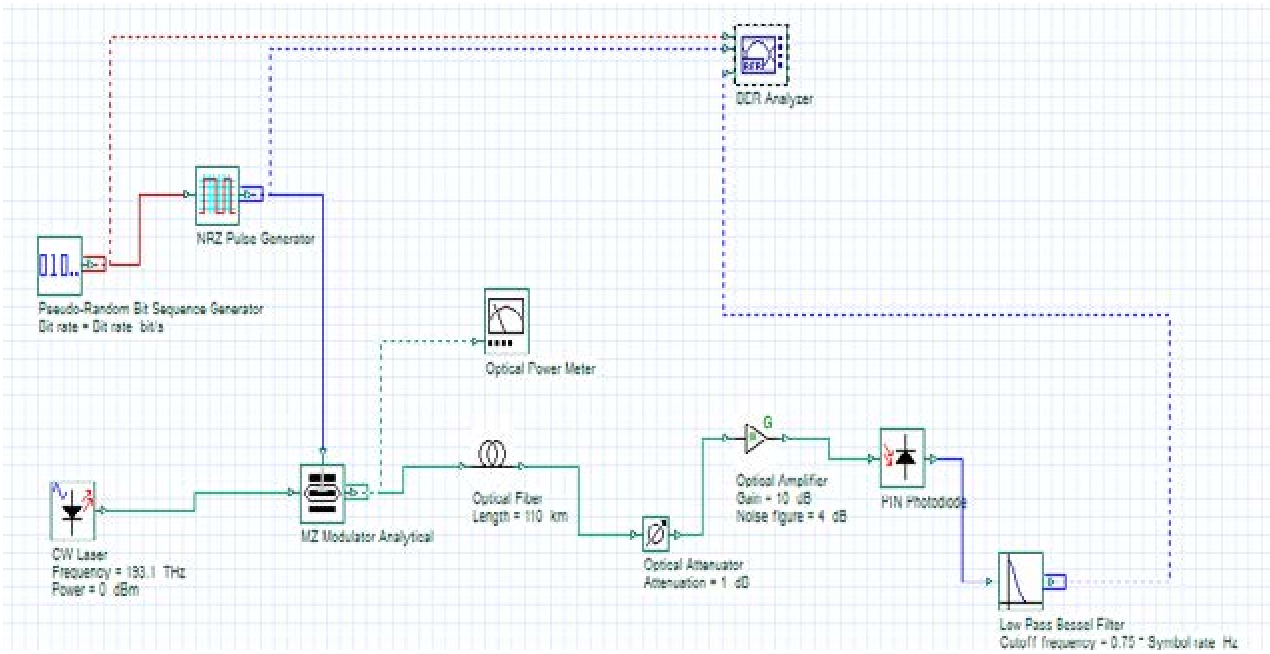

Figure 4.Circuit without FBG

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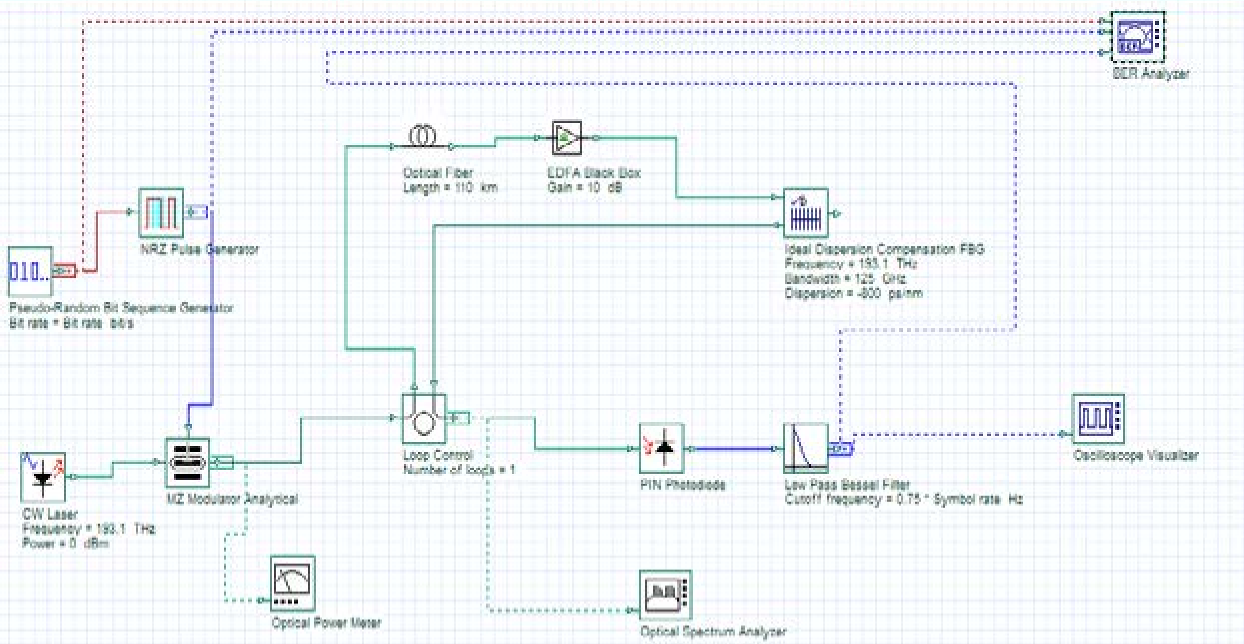

Figure 5.Circuit with FBG

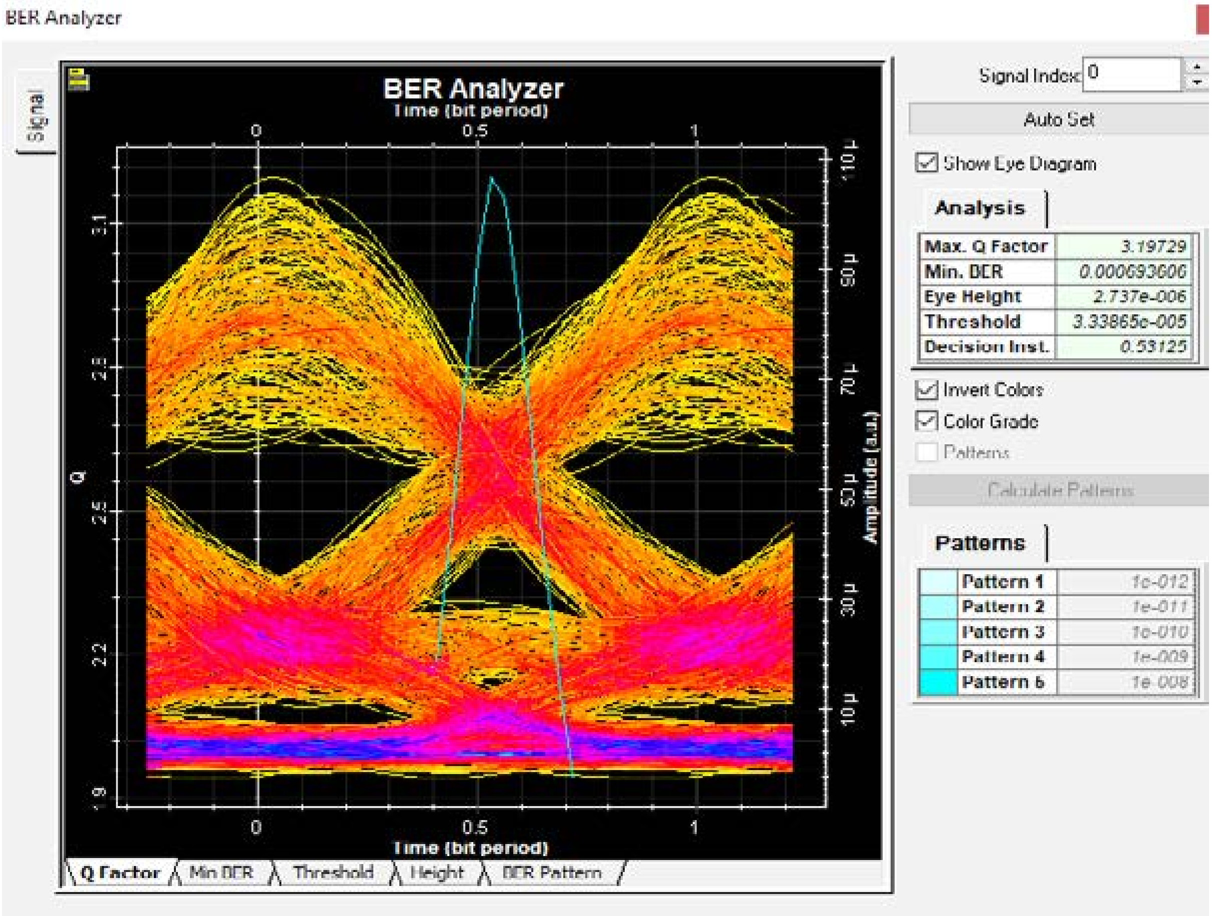

Figure 6.Eye diagram at 10 db gain without using FBG

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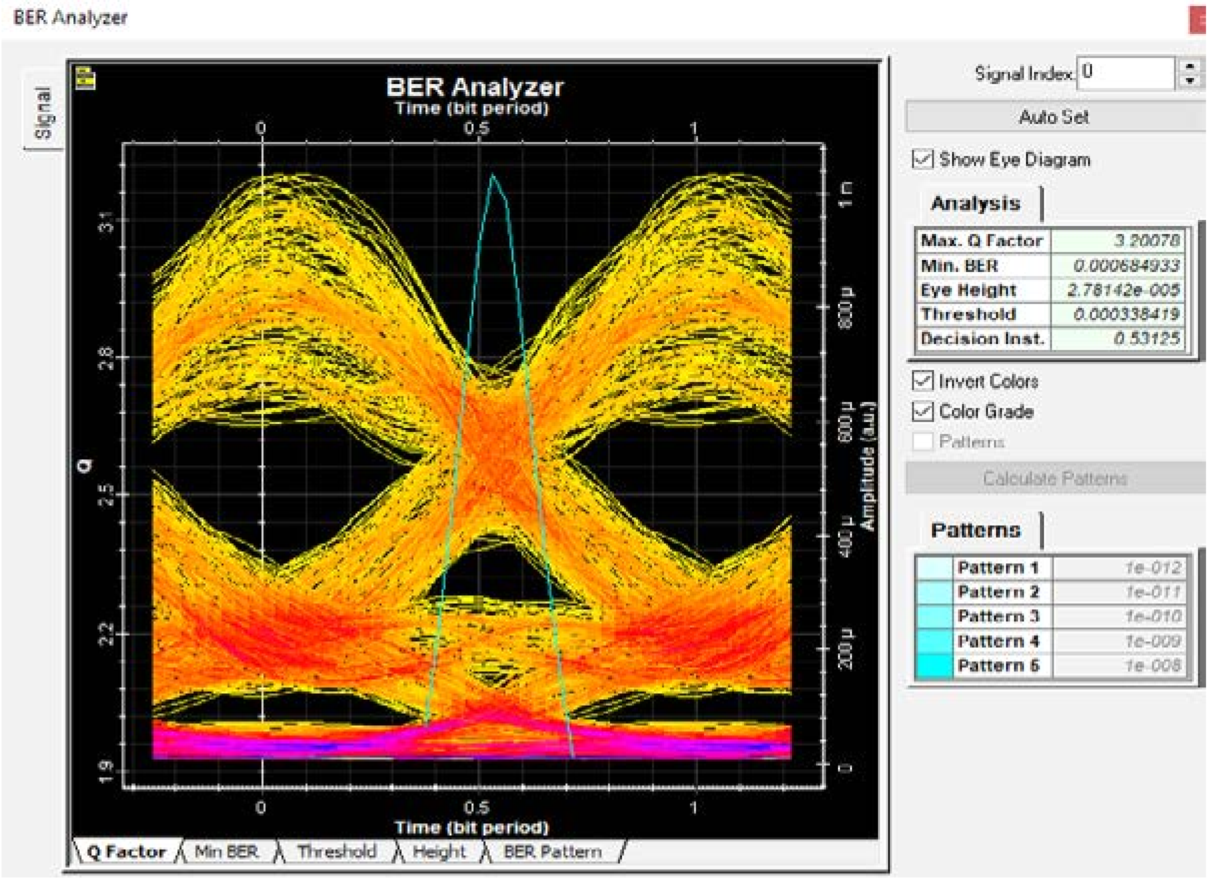

Figure 7.Eye diagram at 20 db gain without using FBG

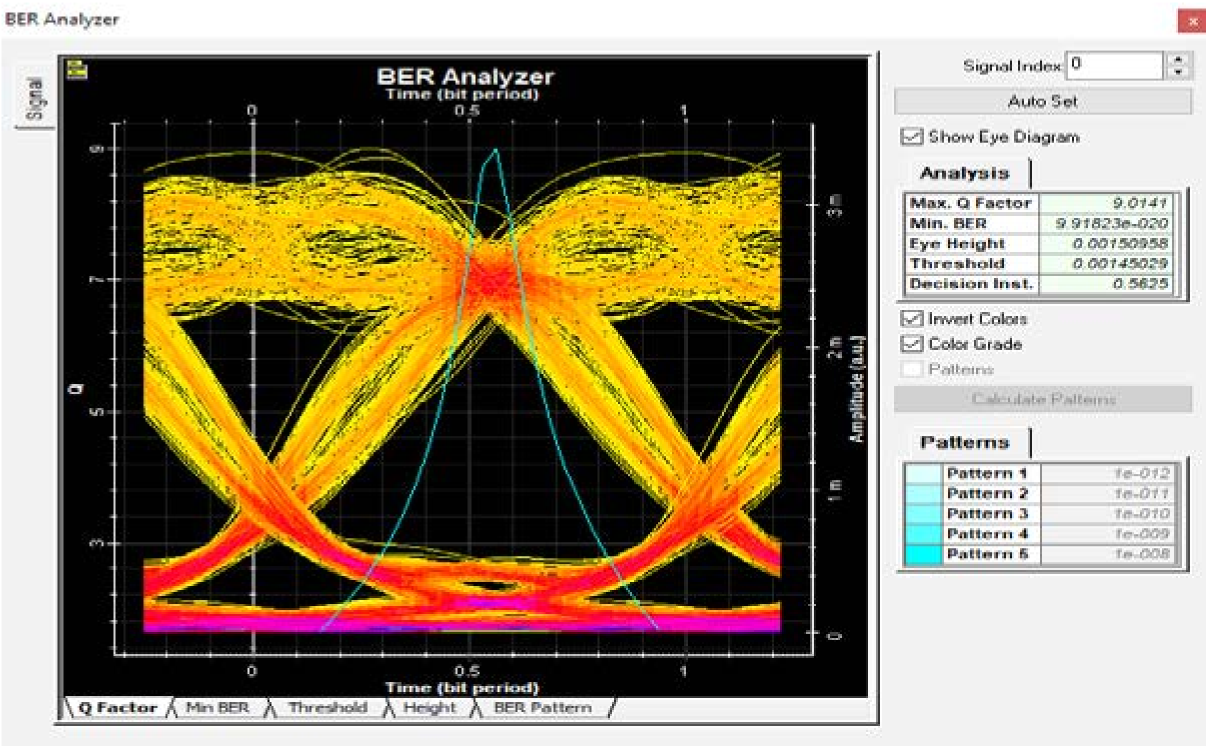

Figure 8.Eye diagram at 10 db gain with using FBG

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DOI: https://doi.org/10.24321/2395.3802.202004

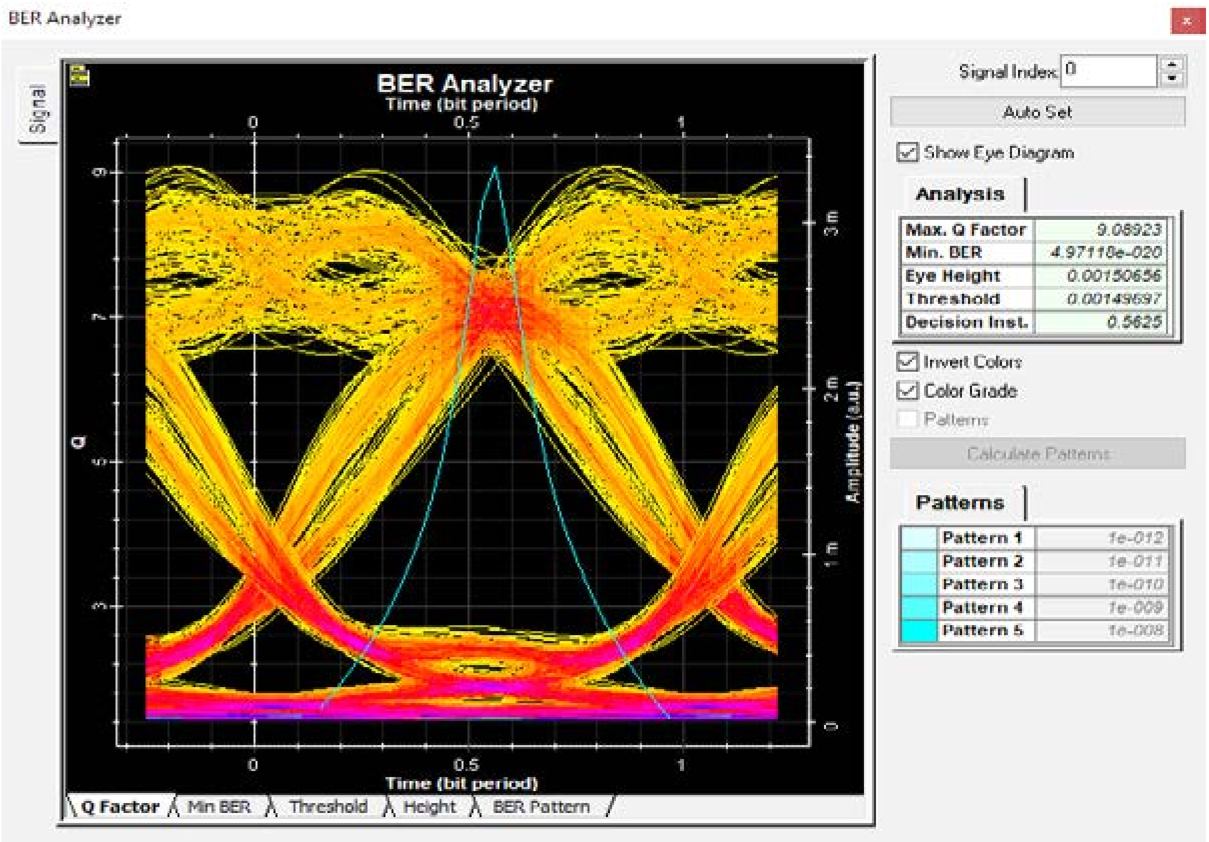

Figure 9.Eye diagram at 20 db gain with using FBG

Table 1.Comparison of values of Q-factor, Eye Height, and BER at different gain without using FBG

Gain	Max. Q-factor	Min. BER	Eye Height
10 db	3.19729	0.000693606	2.737e-006
20 db	3.20078	0.000684933	2.78142e-005

Table 2.Comparison of values of Q-factor, Eye Height, and BER at different gain with using FBG

Gain	Max. Q-factor	Min. BER	Eye Height
10 db	9.0141	9.91823e-020	0.00150958
20 db	9.08923	4.97118e-020	0.00150656

The eye diagram figures for different schemes are shown in fig6 to fig 9.

The comparison for values of BER, eye height, and Q- factor for different formats without using FBG and with using FBG at different gain(10db and 20db) are presented in table no. 1 and table no. 2 respectively.

Conclusion

In this paper, Dispersion-the main hindrance in optical fiber communication is being compensated using FBG. The results are compared and tabulated on three factors i.e. minimum BER, maximum Q-factor and Eye Height. Finally, the study of the system made us to conclude that the Quality of the system is improved by using FBG as a dispersion compensator. The distance of efficient Optical communication is increased from 50km to 110km using FBG

Acknowledgments

The authors would like to express their thanks to the Department of Electronics & Communication Engineering, JSS Academy of technical education, Noida for their support and encouragement in developing the system and for carrying out this research work in the research and development lab.

References

1. Jaiswal AK, Agrawal N, Nitin N. Design Performance of high speed optical fiber WDM system with optimally places DCF for Dispersion compensation. *International Journal of Computer Application* 2015; 122(20).
2. Tosson M, El-Deeb WS, Abdelnaiem AE. Dispersion Compensation Techniques for DWDM Optical Networks. *International Journal of Advanced Research in Computer and Communication Engineering* 2015; 4(8).
3. Gopika P, Thomas SA. Performance Analysis of Dispersion Compensation using FBG and DCF in WDM Systems. *International Journal of Advanced Research in Computer and Communication Engineering* 2015; 4(10).
4. Singh M. Different Dispersion Compensation Techniques in Fiber Optic Communication System. *International Journal of Advanced Research in Electronics and Communication Engineering* (IJARECE) 2015; 4(8).
5. DeCusatis CM, SherDeCusatis CJ. FIBER OPTIC ESSENTIALS, 2nd edition, Academic Press 2006, ISBN 13: 978-0-12-208431-7.
6. Singh S. Tyagi VB. Performance Analysis of WDM Link Using Different DCF Techniques. *International Journal of Advanced Research in Computer Science and Software Engineering* 2012; 2(8).
7. Kashyap K, Singh H, Singh P et al. Compensation of Dispersion in Optical Fiber Using Fiber Bragg Grating (FBG). *International Journal of Advanced Research In Science and Engineering* 2013; 2(4).
8. Bo-ning HU, Jing W, Wei W et al. Analysis of Dispersion Compensation with DCF based on Optisystem,"2nd International Conference on Industrial and Information Systems,2010.
9. Singh G, Saxena J, Kaur G. Dispersion compensation using FBG and DCF in 120 Gbps WDM systems. *International Journal of Engineering Science and Innovative Technology* (IJESIT) 2014; 3(6).

ISSN: 2395-3802
DOI: https://doi.org/10.24321/2395.3802.202004