Dispersion Compensation for 40Gbps Light wave System using FBG

[1]Mansee Sharma
M Tech. Scholar
Poornima College of Engineering
mansee.sharma145@gmail.com

[2]Durgesh Kumar
Assistant Professor
Department of Electronics and Communication
Poornima College of Engineering

Abstract-In optical system the data can be transmitted with few losses if the pulse travelling through the fibre does not change its shape. If the data rate is increased up to 40Gbps the pulses start to overlap each other, which at the receiver end becomeindistinguishable. This dispersion can be reduced with the help of special type mechanism likefibreBragg grating.FBG compresses the incident pulse within by index grating hence it will increase the efficiency and reduce the losses during the transmission. The performance of this system is evaluated through the eye diagram and Qfactorby changing various parameters in the proposed system

Keywords-*FibreBragg grating, Q factor, bit error rate*

*****

I. INTRODUCTION

A basic optical system consists of a transmitter which is used to convert electrical signal into a light signal, an optical fibre cable as channel, and a receiver at which the light signal is converted back to electrical signal[1]. Optical waveguide is made up of a dielectric structure which is used to transport energy at a wavelength in the infrared or the visible portions in the electromagnetic spectrum. The waveguides used for optical communication are highly flexible fibres composed of the transparent dielectric material.to transmit high bit rate having low losses single mode fibre is used[2]. If the bit rate is increased to 40Gbps,losses and distortions are introduced in the fibre since it starts to widen and overlaps each other, introducing crosstalk and inter symbolic interference as a result of which at the receiver end it causes errors[3].

One of the methods to compensate dispersion in optical fibre link is by the use of Fibre bragg grating at the receiver side, different wavelengths are reflected by the grating at different distance[4]. Larger distance is travelled by larger wavelengths before reflection and the shorter distance is travelled by the pulses of shorter wavelengths. As a result the expended pulse is compressed by fibre bragggrating [5].

II. FIBRE BRAGG GRATING AS DISPERSION COMPENSATOR

FBG is a type of reflector which transmits all other light waves but reflects a particular wavelength. Within the propagating medium in FBG there is an periodic variation of refractive index[6]. FBG is either used as a wavelength specific reflector or is either used to block certain wavelengths. Due to the periodic changes in the index of the core fibre, the FBG acts as mirror which reflects specific wavelengths.

The fundamental principle behind the operation of FBG is fresnel reflection, where light travelling between media having different refractive indices may reflect or refract at the interface. Over a particular wavelength the refractive index will alternate. Small amount of light is reflected during the refraction[7-8]. These reflected light signals combine to one large reflection at a specific wavelength in which the grating period is approximately half of the input light wavelength. The wavelength at which reflection occurs is called bragg wavelength. This is the wavelength for bragg reflection, it is the phenomenon by which a single large reflection can result from coherent addition of many small reflection from weakly reflecting mirrors spaced a multiple of half of the wavelength apart[8]. The equation relating the grating periodicity and the bragg wavelength depends on the effective refractive index of the transmitting medium, n_{eff}, and is given by

$$\lambda_B = n_{eff}\,\Lambda$$

Where λ_B= Bragg wavelength;

Λ = Grating period;

n_{eff} = Effective refractive index of the transmitting medium.

III. DESCRIPTION OF COMPONENTS AND CONSIDERATION

The system is operated with the basic optical communication system which consists of the transmitter, transmission link and the receiver. The system transmits information using optical carrier wave from transmitter to receiver via optical fibre[9]. The input signal contains electrical data that is represented in 0's and 1's has been generated by non-zero-return (NRZ) pseudo-random binary sequence. The input of the signal is modulated with semiconductor laser that is represents by continuous wave laser through Mach-Zehnder modulator.CW laser supplies input signal with 1554nm wavelength and input power of

20dBmwhich isexternally modulated at 40Gbps with an NRZ sequence.

Optical fibre used is single mode fibre as it yields higher data rate and produces less distortion and can also operate in long haul distances.For the dispersion compensator, theFBG is used. The length grating is 2.2mm for the proposed model.After dispersion compensation the signal will pass through optical amplifier that represented by EDFA, optical amplification is required to overcome the fibre loss and also to amplify the signal before received by photo detector at the receiver.

Figure 1.Simulation diagram of dispersion compensation by chirped fibre at for 40 Gbps

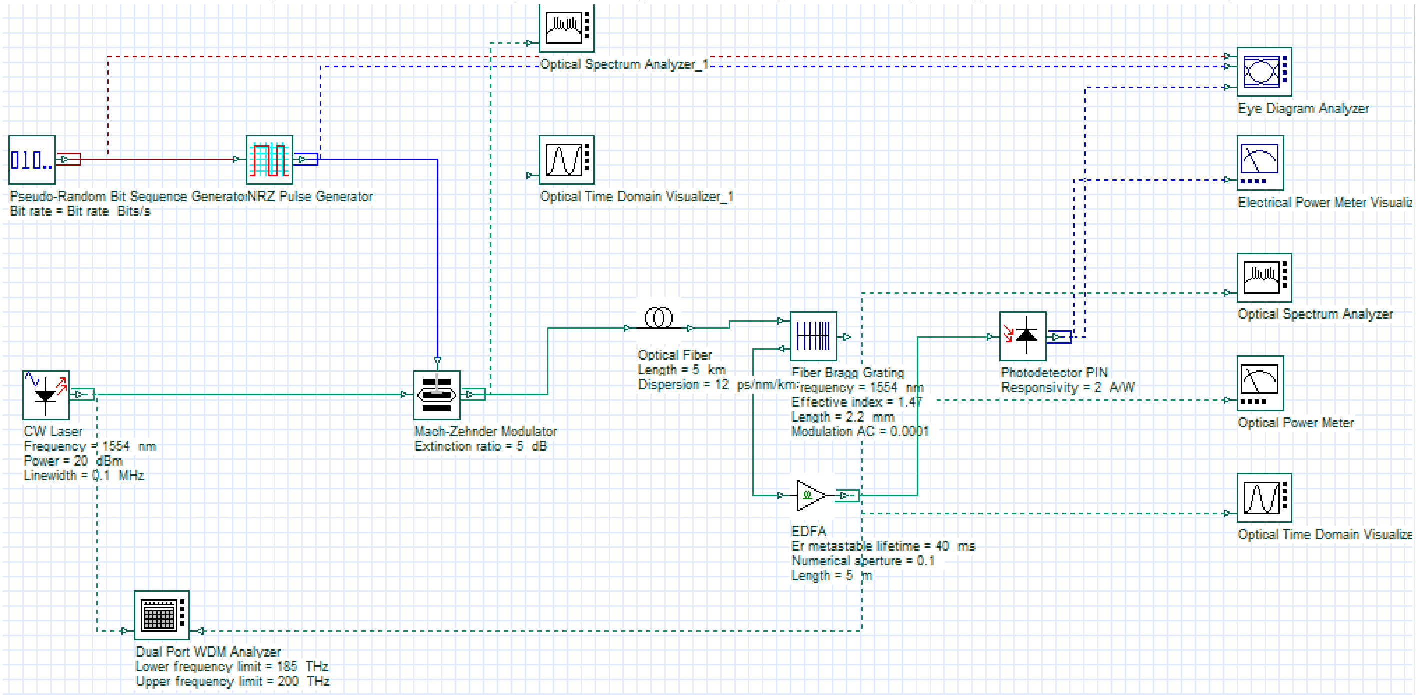
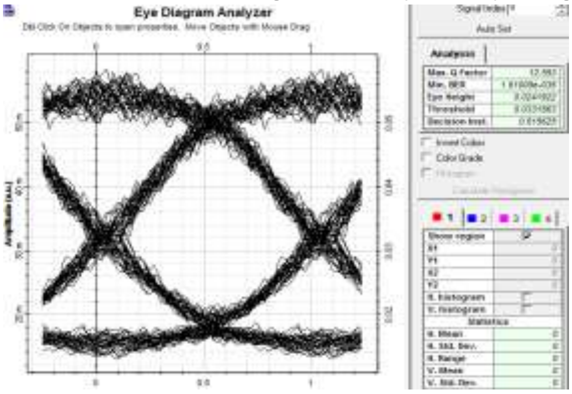


Table 1. Systemparameters for proposed solution

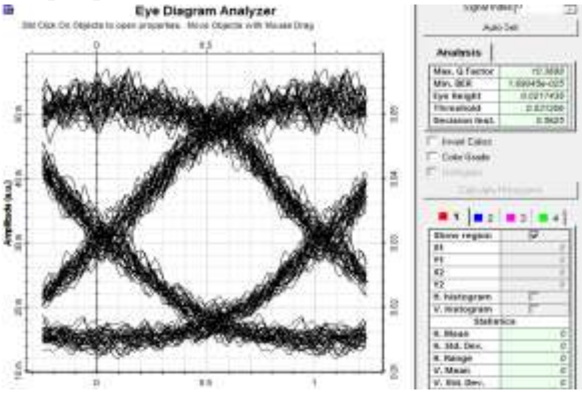
Simulation parameters	Values
CW laser frequency	1554 nm
Reference wavelength	1554 nm
Mach Zehndar modulator(extinction ratio)	5db
FBG length	2.2mm
Bit rate	40Gbps
Fibre length	5km
FBG effective index	1.47
EDFA metastable lifetime	40ms

In optical communication, only optical signal to noise ratio cannot accurately measure the optical performance[10]. Quality factor is one of the important parameters to measure optical performance by which to characterise the BER. Input power is increased upto 20dBm which increases the Qfactor.When the power reaches to 20dBm the Qfactor reaches its maximum value. Increasing the input power more than 20dBm degrades the performance of the system

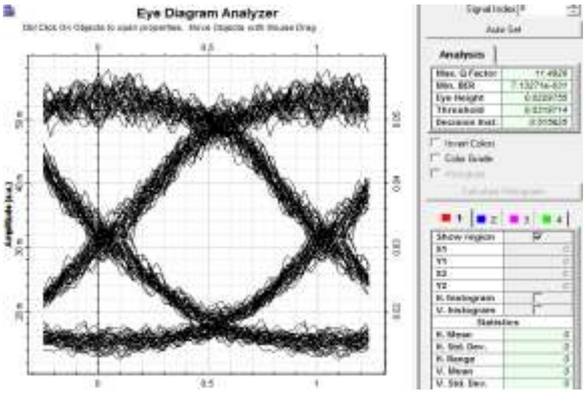
Figure2. Analysis of eye diagram at different input power



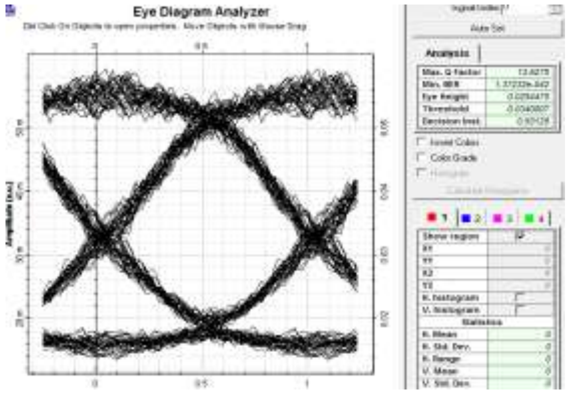
(a)2dBm



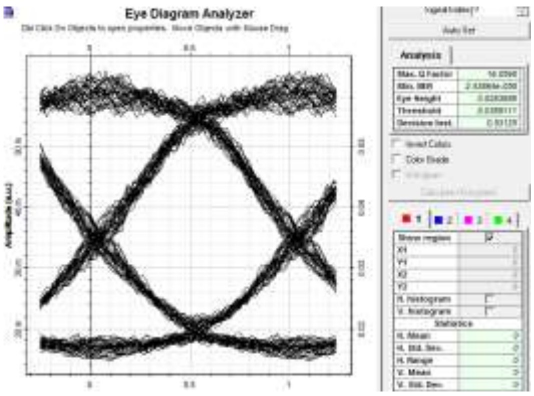
(b)4dBm



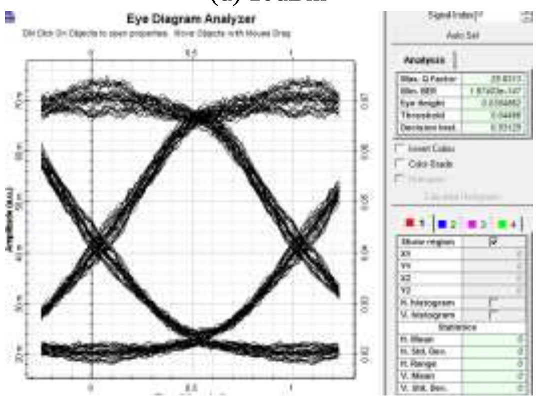
(c) 8dBm



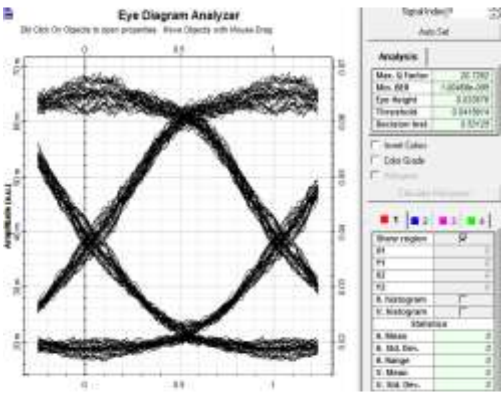
(d) 10dBm



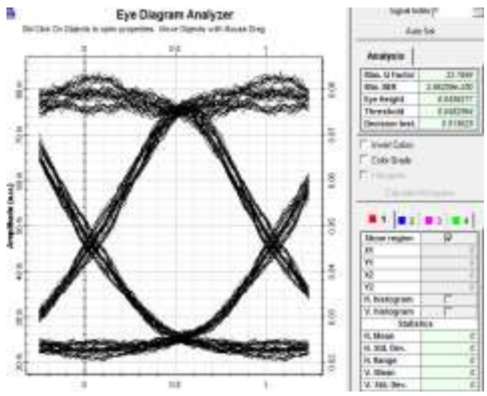
(e) 12dBm



(f) 14dBm



(g) 18dBm



(h) 20dBm

Table 2. Output readings tabulated by varying input power

Input power(dBm)	Qfactor	BER
2	10.3698	1.69045e-025
4	11.4928	7.13271e-031
8	13.6275	1.37232e-042
10	14.764	1.24883e-049
12	16.0598	2.43864e-054
14	17.84	1.72777e-071
18	25.8313	1.97403e-147
20	33.7684	2.86259e-250

IV. CONCLUSION

We have analysed the dispersion compensation using Fibre Bragg Grating at different fibre lengths, the simulated transmission system have been analysed on the basis of different parameters. By simulating a model of communication system and using the most suitable settings of the system which includes input power (dBm), fibre cable length (km), FBG Length (mm) and attenuation coefficient (dB/km) at cable section. All the results are analysed using OPTISYSTEM.

REFERENCES

[1] Dabhades, and bhosale(2012).Fiberbragg grating and optical phase conjugatorasdispersion compensator, international journal of advanced electrical and electronics engineering, vol 1(1)
[2] S. O. Mohammadi, saeedmozzaffari and m. Mahdi shahidi, (2011). Simulation of a transmission system to compensate dispersion in an opticalfiber by chirp gratings. International journal of the physical sciences, vol. 6(32), 2 december
[3] optisystem getting started (2003), optical communication system design software, version 3.0 for windows® 2000/xp, optiwave corporation.
[4] G.p. agarwal, fiber-optic communication systems, john wiley& sons, new york, 1997.
[5] p.c. becker, n.a. olsson and j.r. simpson, erbium-doped fiber amplifiers: fundamentals and technology, academic press, new york, 1999
[6] a.c. cokrak and a. Altuncu (2004), gain and noise figure performance of erbium doped fiber amplifiers, journal of electrical & electronics engineering, vol. 4, pp. 1111-1122.
[7] M.K. Gupta, JyotiAgarwal, AnilaDhingra, G. Singh, "Performance analysis and optimization of 40 Gbps Transmission System over 4000 km with FBG", communicated in 2014 International Conference on Recent Cognizance in Wireless Communication & Image processing, January 2015.
[8] Mukesh Kumar Gupta and Ghanshyam Singh "2×40 Gbps WDM-PON Long Haul system using FBG andDicode" IEEE International Conference, WRAP-2015, IISC Bangalore, India, 16-17 Dec. 2015.
[9] Nidhiya Shan, Asha A S, "Simulation and Analysis of Optical WDM System Using FBG as Dispersion Compensator, "International Journal of Engineering Research and General Science, Volume 3,Issue 2,March-April 2015.
[10] Bo Xiang (2010). Applications of fiber grating (FG) in modern optical communications and beyond. International Journal of Advances in Optical Communication and GratingWorks 1(1).