Performance Analysis of Long Haul 64 Channel Optical Communication System with DWDM using Fiber Bragg Grating

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Abstract— To meet the nowadays requirement of high speed data transmission, DWDM communication system with data rate of 64 channel is modeled and simulated. Analysis of the simulation results has been done to know the impact of filter. Fiber Brag grating is used as dispersion compensating module. Acceptable values of Q factor and BER are achieved for the length beyond 1200 with NRZ modulation format.

Index Terms— DWDM, Fiber Brag Grating, Optical fiber dispersion, optical filter, Dispersion compensation.

1 INTRODUCTION

The future of the communication network, no doubt, lies on the integrated services given the bandwidth capacity of a single mode fiber. With its primary success, in terms of point to point bandwidth, the DWDM network is reshaping the land scape of the communication networks. The transmission signal used in the optical communication is degraded with increase in distance. With the help of optoelectric repeaters this problem can be eliminated to a great extent. Optical signal in the optoelectric repeater is first converted into electric signal and then regenerated after amplification by transmitter. This regeneration with the help of repeater is more expensive for wavelength division multiplexing systems. [1]. So, instead of repeaters optical amplifiers are used, which directly amplify the optical signal. The amplifiers are used in linear mode as same as repeaters, optical gain blocks and optical preamplifier are used. Optical amplifiers are mainly used for the purpose of amplification of all channels simultaneously in WDM light wave system and that is why they are called optical in-line amplifiers.

2 BASIC OF LONG HAUL OPTICAL COMMUNICATION SYSTEM

Wavelength division multiplexing operates by sending multiple length waves across a single optical fiber. Information is carried by each wavelength is called channel, through either intensity or phase modulation. [7]

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Fibers are standard single mode fibers (SMF) with high group velocity dispersion, enable larger repeater spacing and larger signal to noise ratio (SNR). In this type of fibers it is very important to consider the influence of group velocity, dispersion, non linear effects, PMD and their interplay on transmitted signals. EDFA technology is the Erbium Doped Fiber, which is a conventional silica fiber doped with erbium. Optical filters are used to flatten the gain.

Among the promising advancements towards cost effective long haul transmission is Fiber Bragg Grating (FBG) as the dispersion compensating module. Gain factor is obtained from the optical amplifier and the fiber Bragg grating compensates the fiber dispersion for long distance communication. The feasibility of long haul WDM optical transmission using FBG for the dispersion compensation and the performance is analyzed by comparing the results of the receivers. FBGs could possibly replace DCF as the standard solution for in-line dispersion compensation. The use of FBG is quite successful for achieving acceptable Q-factor and minimum BER as comparison to DCF. [8]. Chirped FBGs have a negligible non linearities, low insertion loss and small size. [2]. For telecommunication applications, FBG components has been already used for purposes such as pump laser stabilizers to improve the performance of pump lasers in optical amplifiers, gain flattening filters to equalize the gain of optical amplifier [3], highly selective filters for channel selection in dense WDM systems [4] and chromatic dispersion compensator for temporal pulse shaping in high bit rate systems [5]. This potentially allows simpler EDFA design by cascading the FBG and transmission without mid stage amplifier, resulting in significant cost reduction [6].

2.2 Design Of proposed long haul system

Optisys 7.0 is used to design and simulate the system. Optisystem simulator is an advanced, innovative, rapidly developing and powerful software simulator tool. It can help the users to plan, test and simulate several applications such as

WDM/TDM or CATV network, dispersion map designing, transmitter, receiver and amplifier design and others. Optisystem is the product that doesn't depend on other simulation design. It depends on the realistic optical fiber mode. The long haul optical communication system simulation design consists of different components, which represents in block diagram.

The simulation design represents the data rate 80 Gbps with 64 channels system using NRZ modulation, channel spacing is 150 GHz and SMF length is 50 km. Optical filters are used to improve the performance.

2.3 Block diagram

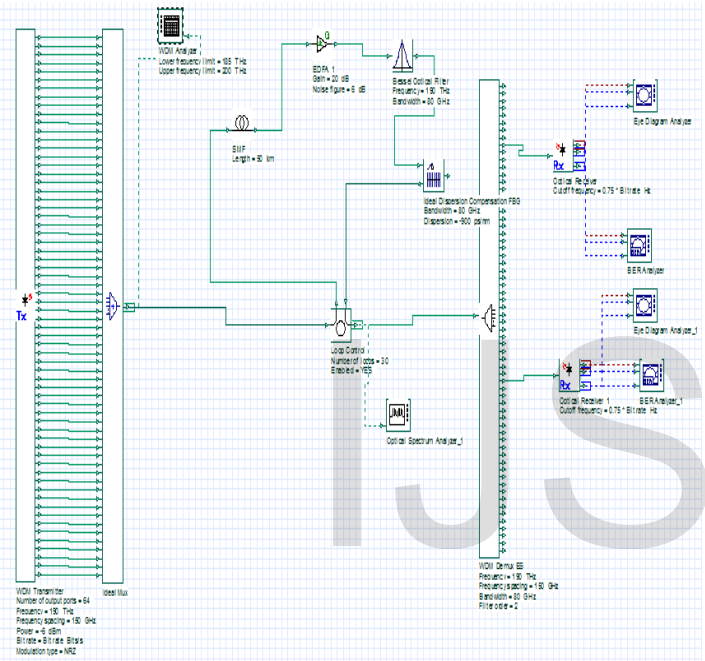


Fig 1 Block diagram

3 SIMULATION ANALYSIS

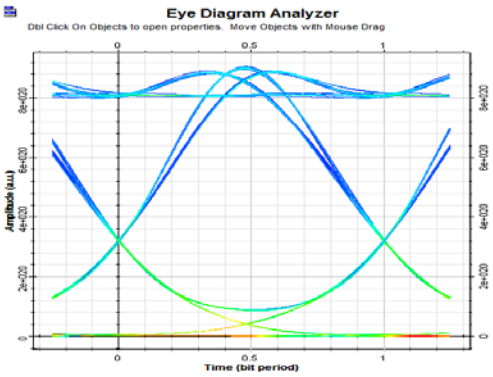
In this system design analysis using different filters at the distance of 1250 km and 1500 km has been done. It is observed that quality factor and BER has been improved to the great value using the filters. Gaussian, Butterworth and Bessel filter are used one by one to improve the quality factor and BER at the distance of 1250 km and 1500 km. Among Gaussian, Butterworth and Bessel filter, Gaussian gives the best performance at 1250 km where as Bessel filter gives highest performance for 1500km. Numerical value comparison has been shown in tables.

3.1 Effect of filters on quality factor and BER

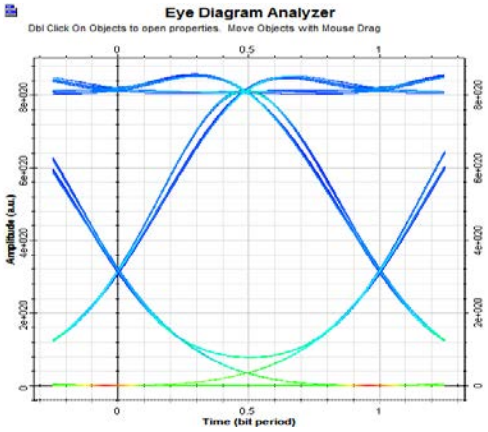
Distance	BER			
	Without Filter	Gaussian filter	Butterworth filter	Bessel Filter
1250	1.85e-054	4.4e-217	9.323e-146	8.77e-185
1500	5.5e-039	4.9e-148	8.9233e-072	1.4e-154

Distance	Quality Factor			
	Without Filter	Gaussian filter	Butter worth filter	Bessel Filter
1250	15.49	31.41	25.6775	28.959
1500	13.008	25.86	18.1289	26.4425

3.2 Eye diagrams



(a)



(b)

Fig 2 eye diagram for 1500 km (a) without any filter (b) using Bessel filter

4 Conclusion

64 channel long haul optical communication system having data rate of 80 Gbps simulated using NRZ modulation technique, FBG dispersion compsation technique. It is observed that among Gaussian, Butterworth and Bessel filter, Gaussian gives the best performance at 1250 km where as Bessel filter gives highest performance for 1500km. Using FBG as dispersion compositor is cost effective as comparison to the DCF.

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References

[1] A. Guirmarles, J.M. Chavez Boggio, J.D. Marconi, F.A. Callegari and H.L. Fragnito," High Performance Hybrid EDFA-FOPA Pre amplifier for 40 Gbps Transmission", IEEE Conference on Laser and Electro- Optics, Pages 898-991, 2005.

[2] Ouellette.F," Dispersion cancellation using chirped brgg grating filter in optical waveguides", Optics letters, 12 , no 10, pp.847-849,1987.

[3] Meltz G, Morey, W.W. and Glenn W.H ,"formation of Bragg gratings in optical fibers by a transverse hoographic method", Optics Letters, 14, no 16, pp. 823-825, 1989.

[4] Hill.K.O, Fujii.Y., Johnson .D.C. and Kawasaki B.S, "photosensitivity in optical fiber waveguides: Applications to reflection filter fabrication", applied Physics letters, 32, no 10, pp. 647-649, May 1979.

[5] Kersey A.D, Davis M.A, Patrick H.J, Labnanc M, Koo K.P, Askin C.G, Putnam M.A and Friebele E.J, "Fiber garting sensors", Journal of Lightwave Technology, 15, n08, pp. 1442-1463, August 1997.

[6] Optical Receivers Theory And Opreations , electrical and computer Engineering Ryerson University.

[7] Govid P. Aggarwal," Fiber Optics Communication System", John Wiley & sons, Inc. Publications, 2003.

[8] Muhammad Imran, Department of Electrical Engineering,UET Taxila, Pakistan,"Design and Simulation of Dispersion Compensated DWDM System Based on Amplifier ", International Journal of Computer Applicatiions, 69, No 10, May 2013.