JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

# PERFORMANCE IMPROVEMENT IN OPTICAL FIBER COMMUNICATION SYSTEM USING FIBER BRAGG GRATING

**[1]Anjumanara Begam, [2]Mijanur Rahim, [3]Dr. Md. Asraful Sk**
[1]Research Scholar, [2]Research Scholar, [3]Associate Professor
[1]ECE Department,
[1]Aliah university, Kolkata, India

***Abstract:*** Optical Fiber Communication System is very much useful in our daily life, because it has very advantageous characteristics like- small dimension, low loss and low interference. There are various types of optical fiber in use. In optical Fiber Fiber Bragg Grating (FBG) is playing an important role to compensate the dispersion in optical communication system. FBG has low-cost filter for wavelength selection and it has low insertion loss. It has wide bandwidth and customized reflection spectrum. The performance is evaluated by the simulation of transmission system based on different parameters [P. Gopika and S. A. Thomas,2015]. By using Opti System simulator we have designed the system. Here we have selected the result both for FBG and without FBG. Using FBG we can reduce the bit error rate and enhances the quality factor of the received optical signal.

***Keywords:*** **- Optical Transmission System, Fiber Bragg Grating (FBG), Bit Error Rate, Q-Factor.**

## I. INTRODUCTION

A fiber Bragg grating (FBG) is very much known to us because of it's features which is very much advantageous in Optical Communication System. Distributed Bragg reflector built in a short segment of optical fiber cable that reflects particular wavelengths of light and transmits all others light present in the system. We got this by creating a periodic variation in the refractive index of the fiber core. This is Bragg condition on the wavelength at which reflection occurs is called Bragg wavelength. A fiber Bragg grating can act like as an inline optical filter which can block certain wavelengths and can pass selective wavelengths, It works like wavelength-specific reflector. We can check its performance using BER, Q-Factor etc. In communication system, the BER is the ratio of bits that have errors relative to the total number of bits received by the receiver [Maier, G., Martinelli, M., Pattavina, A. and Salvadori, E., 2000]. A transmission might have a BER of $10^{-6}$, that means, out of 1,000,000bits transmitted, one bit was in error for signal transmission.

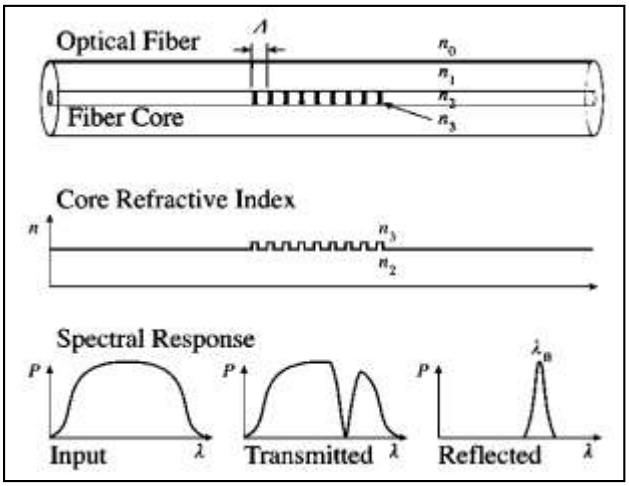


Figure 1. Fiber Bragg Grating (FBG) Structure

In FBG light propagates through the grating with minimum attenuation or signal variation. Only selective wavelengths that satisfy the Bragg condition are considered and strongly back by reflected nature [Toru Mizunami, Member; OSA, Tzvetanka V. Djambova, Tsutomu Niiho, and Sanjay Gupta, 2000]. It has the ability to select accurately preset.

A wavelength called central wavelength of the reflected component, satisfies the Bragg relation which is given bellow.

$$\lambda_{Bragg} = 2n\Lambda \qquad (1)$$

Where,

'n'- is the index of refraction

'Λ'- the period of the index of refraction variation of the FBG.

If we change temperature and strain the parameters n and Λ, the wavelength of the reflected component will also change. Because it works as function of temperature and/or strain. So it is very important to maintain the temperature and wavelength to get a better result.

In this paper, we have designed an optical transmission system using Opti system-13 simulator and observed the results such as Bit Error Rate (BER) and Quality factor(Q).

## II. DESIGN CONSIDERATION

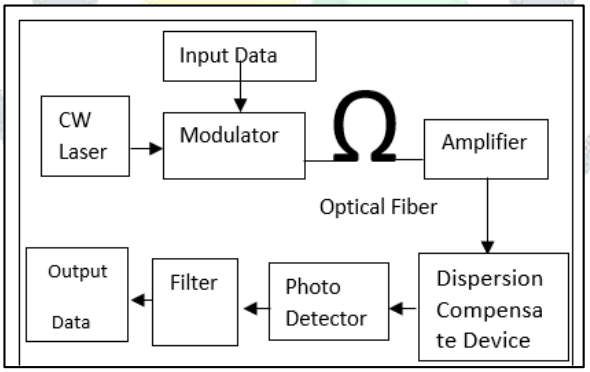


Figure 2. Optical Transmission Structure

Here we have used Continuous Wave (CW) laser and it is externally modulated with a non-return-zero (NRZ) pseudorandom binary sequence in a Mach Zehnder modulator [M. M. Ismail, M. A. Othman, Z. Zakaria, 2012]. Here the extinction ratio is specified. The NRZ pulse generator is used for it. It has an advantage on controlling bandwidth in a certain limit. Because the characteristic of the generator is that the returning signals to zero between bits will not wasting the bandwidth of the data signal. Pseudo-random bit sequence generator is useful to scramble data signal very securely in terms of bit rates. One of the big challenges in Optical fiber communication System is that it has dispersion effect. Fiber Bragg Grating (FBG) is used to compensate chromatic dispersion in Optical Fiber. Erbium doped fiber amplifier (EDFA) is used to compensate the loses in optical transmission system for long distance communication. Photo detector (PIN Photodiode) is used for detection of light (photons) at the receiver. It converts the light directly into electric current. An important characteristic of (FBG) is dispersion compensator. That's why negligible nonlinearity, small size and low insertion loss can improve system output [M. Chakkour, A. Hajaji, and O. Aghzout, 2015]. So, data transmission capacity can be increased by using FBG. Fiber Bragg Grating provides the fiber dispersion for long distance transmission with obtained a gain factor. The simulation is done by Opti System 13 By analyzing the values of system output of quality through the BER (Bit Error Rate) and Quality factor(Q).

BER is the ratio between the number of bits with errors and the number of the total bits transmitted. If the error bit is less the system performs better. The Q factor is dimensionless parameter that indicates the energy losses within a resonant element. Higher the value of Q factor is lower the rate of energy loss. In our design a (CW) laser diode used to generate 1550 nm wavelength optical signals with 5dBm input power, which is externally modulated by NRZ pulses. A single mode optical fiber used as transmission link [An, F., Kim, K. S., Gutierrez, D., Yam, S., Hu, E. S., Shrikhande, K. and Kazovsky, L. G., 2004]. Where we have used 20KM and 50KM length. Here we got higher data rate and less dispersion for a long haul distance communication. with attenuation coefficient at cable section 0.2dB/km.
The system transmits information from transmitter to the receiver using optical carrier wave through optical fiber. We have designed the simulation model with Optisystem 13 software. Where we have taken one power spitter. At one terminal we have connected PIN photodiode and filter.At the other terminal we have connected one FBG between PIN photodiode and filter. Actually we want to compare the data transmission capacity with and without FBG.We will also check the variation of the output by changing some parameters [Nidhiya Shan, Asha A S,2014].If we change the distance we can vary output also. For long distance communication amplifier can improve the signal output. We have evaluated by using FBG and without FBG both.

## III. SIMULATION RESULTS

We can see from the results that the Q factor can be improved by using of FBG for both the cases(50km,20km). EYE height also increases by using FBG.And most important parameter BER (Bit Error Rate) is decreases by using FBG.

Table 1. Values of BER and Q Factor

| optical Fiber | Type | Output Parameters | Value |
|---|---|---|---|
| 50KM | Without FBG | Max. Q Factor | 6.0295 |
| | | Min. BER | $2.1460\times10^{-12}$ |
| | With FBG | Max. Q Factor | 8.3552 |
| | | Min. BER | $1.5429\times10^{-16}$ |
| 20KM | Without FBG | Max. Q Factor | 10.5374 |
| | | Min. BER | $1.2113\times10^{-27}$ |
| | With FBG | Max. Q Factor | 12.0181 |
| | | Min. BER | $1.1359\times10^{-30}$ |

If we use short length optical fiber then we will get better result,which is shown in the above table.1.But using amplifier we can transmit data for long distance communication also[An, F., Kim, K. S., Gutierrez, D., Yam, S., Hu, E. S., Shrikhande, K. and Kazovsky, L. G, 2004]. The following graphs are shown that the selective power can transmit by using FBG.Selective signal can reflect back through the optical fiber. Rest part of the light will be transmitted normally.

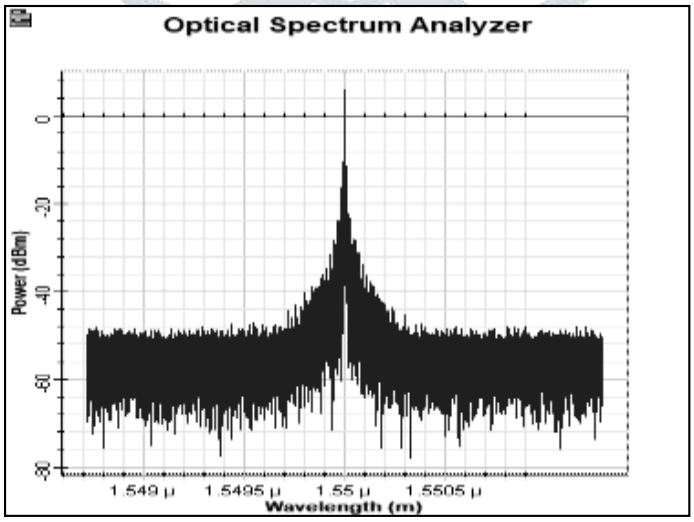


Figure 3. Optical spectrum analyzer output without FBG.

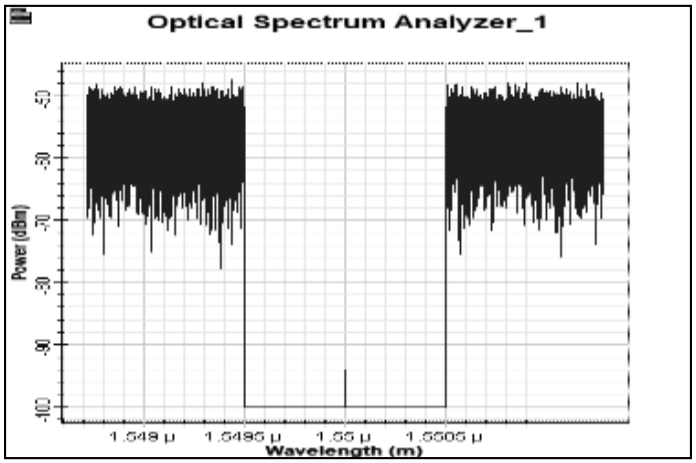


Figure 4. Optical spectrum analyzer output of Transmitted power with FBG

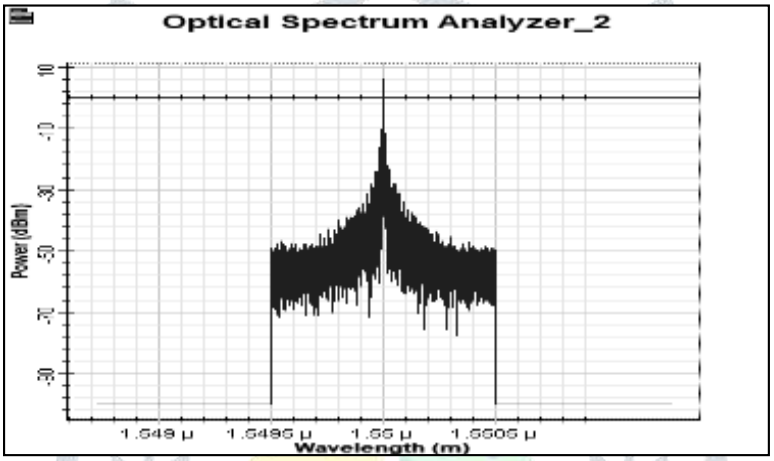


Figure 5. Optical spectrum analyzer output of Reflected power with FBG.

## IV. CONCLUSION

The system will transmit information using optical carrier wave from transmitter to receiver via optical fiber. Based on the research, the transmission system block diagram (Figure 3) has been designed which consists of laser light as the source, modulator, single mode optical fiber as the channel, fiber Bragg grating (FBG) as the dispersion compensator, optical amplifier and the photo detector as the light detector.We have checked the changes of different output parameters with the changes of length and attenuation constant of optical fiber cable. We noticed that the output parameters can be better by using FBG.

## V. ACKNOLEDGEMENT

I am thankful for the help and support of Dr. Asraful Sekh, Associate Professor of ECE Department. All the faculty members and staffs are also supporting in Aliah University,Kolkata.

## REFERENCES

[1] Govind P. Agrawal, " Fiber-Optic Communications Systems ", Third Edition, (2002).
[2] Toru Mizunami, Member; OSA, Tzvetanka V. Djambova, Tsutomu Niiho, and Sanjay Gupta.“Bragg Gratings in Multimode and FewMode Optical Fibers”.Journal of Lightwave Technology, Vol. 18, No. 2, February 2000.
[3] P KRaghav,Renu Chaudhary,”Compensation of Dispersion in 10Gbps WDM system by using Fiber Bragg Grating,”IJCEM International Journal of Computational Engineering and Management, Vol. 15,Issue 5,September 2012.
[4] 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.
[5] Maier, G., Martinelli, M., Pattavina, A. and Salvadori, E. (2000). Design and cost performance of the multistage WDM-PON access networks. J. Light. Technol.. 18 (2): 125–143.

[6] An, F., Kim, K. S., Gutierrez, D., Yam, S., Hu, E. S., Shrikhande, K. and Kazovsky, L. G. (2004) .SUCCESS : A Next-Generation Hybrid WDM / TDM Optical Access Network Architecture. J. Light. Technol.. 22 (11): 2557–2569.
[7] M. M. Ismail, M. A. Othman, Z. Zakaria et al., "EDFA-WDM optical network design system," in Proceedings of the Malaysian Technical Universities Conference on Engineering and Technology, MUCET 2012, pp. 294–302, Malaysia, November 2012.
[8] M. Chakkour, A. Hajaji, and O. Aghzout, "Design and Study of EDFA-WDM Optical Transmission System using FBG at 10 Gbits/s Chromatic Despersion Compensation Effects," in Mediterranean Conference on Information & Communication technologies, May 2015.
[9] P. Gopika and S. A. Thomas, "Performance analysis of dispersion compensation using FBG and DCF in WDM Systems," International Journal of Advanced Research in Computer and Communication Engineering, vol. 4, no. 10, October 2015. [12] A. Bindal and S. Singh, "Dispersion analysis of fiber Raman amplifier for WDM system," Elsevier in Optics & LaserTechnology, vol. 58, pp. 20–25