Quality Factor Compensation of Single Mode Optical Fiber by using Uniform Fiber Bragg Grating

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Abstract

This paper discusses the studies properties of the optical transmission system in optical fiber based on bragg gratings and uniform fiber Bragg gratings used through fiber optic of the two channel and stimulations are performed using Optisystem software . Due to its versatile advantages Fiber Bragg grating are widely used in many optical systems as band filters, dispersion compensators, in-fiber sensors or fiber grating lasers and amplifiers. By simulating a model of communication system and using the most suitable settings of the system which include input power (dBm), fiber cable length (km), there are two different parameters that will be investigated which are Bit Error Rate(BER) and Qulity Factor (Q)at the receiver.

Keywords: Bit Error rate, Eye diagram analyzer, Q factor, FBG

الملخص

ناقش هذا البحث دراسة خصائص لنظام البث البصري في الألياف البصرية بالاعتماد على محزز براغ الغير منتظمة(**FBG**) وكذلك على محزز براغ المنتظمة Uniform FBG والتي تم استخدامهما مع قنوات الألياف البصرية وتم تحليل وظائف النظام البصري باستخدام برنامج Optisystem. ونظرا للمزايا المتنوعة لمحزز براغ لذلك فانة يستخدم على نطاق واسع في العديد من النظم البصرية كمرشحات ، ومعوضات التشتت، وأجهزة للتحسس الليف البصري والليزر شبكة الألياف ومكبرات الصوت.من خلال محاكاة النموذج المقترح لنظام الاتصالات وباستخدام المعلمات الخاصة بالنظام والتي تشمل مدخلات الطاقة (ديسيبل)، وطول الليف البصري ب(كيلومتر)، وجد هنالك نوعان من المعلمات المختلفة التي تم حسابهما وهما معدل نسبة الخطأ (BER)وعامل الجودة عند المستلم.

الكلمات المفتاحية: معدل بت خطأ، العين الرسم محلل، س عامل،FBG

1.Introduction

The communication channel is used to transport the optical signal from transmitter to receiver without distorting. Most light wave communication systems use optical fibers as the communication channel because fibers can transmit light with a small amount of power loss. Fiber loss is, an important design issue, as it determines directly the repeater spacing of a long-haul light wave system. Another important design issue is fiber dispersion, which leads to broadening of pulses inside the optical fiber(Govind P. Agrawal,2002). Optical fiber bragg gratings FBG are important components in fiber communication and fiber sensing fields. For normal fiber gratings, by properly choosing the period, length, index modulation amplitude, chirp and apodization function, one can flexibly design and optimize grating reflection or transmission spectra to satisfy many applications(S. Ugale et. Al,2010).The fiber Bragg grating are used widely in optical telecommunications networks, wire and wireless technology especially industry for dense wavelength division multiplexing technique , and dispersion compensation, (Z. Tan and *at el*,2007),(I . Navruz and N. Fatma Guler,2008),laser stabilization, and Erbium amplifier gain flattening, simultaneous compensation of fiber dispersion , dispersion slope and optical CDMA(Q. Wu, et al,2005), (Z. Tan and *at el*,2007).

This paper reports is study the performance analysis of a minimum of bit error rate and maximum Q. Factor for transmission system. A circuit design which consists of four channel branch, one optical fiber with FBG, optical fiber with uniform FBG , optical fiber CWDM with FBG and end branch is optical fiber CWDM with uniform FBG used for instigating the system. The system transmits the data from 10 -50 km with the input power from 0-10dBm. It is shown that the spectrum begin to be shaped by eye diagram Analyzer, are used for the performance analysis. Optisystem Version 7 software has been used for this simulation.

2.Proposed designed simulation model.

The proposed designed which generates and transmits the power is shown in Figure 1 measured of power 10dBm are generated by the Optical transmitter at frequency 193.1THZ with bite rate 10Gb/s. The modulation type is NRZ. The pulses are launched into the for 1xN which distributed power into four branch . The first channel Single mode optical fiber of length 50 km with attenuation of 0.2 dB/km and dispersion of 16.75ps/nm-km with FBG has effective index1.45 and length is 2mm , second branch Single mode fiber with uniform FBG has bandwidth 125GHz and reflectively 0.99, third and fourth channel used optical fiber CWDM type has differential group delay is 0.2ps/km and dispersion slop 0.075 ps/nm^2/k. All these channels used optical receiver has cutoff frequency 0.75 bit rate Hz and gain is 3. On the end use eye diagram to analysis all parameter will be needed for example minimum of bit error rate and maximum Q factor.

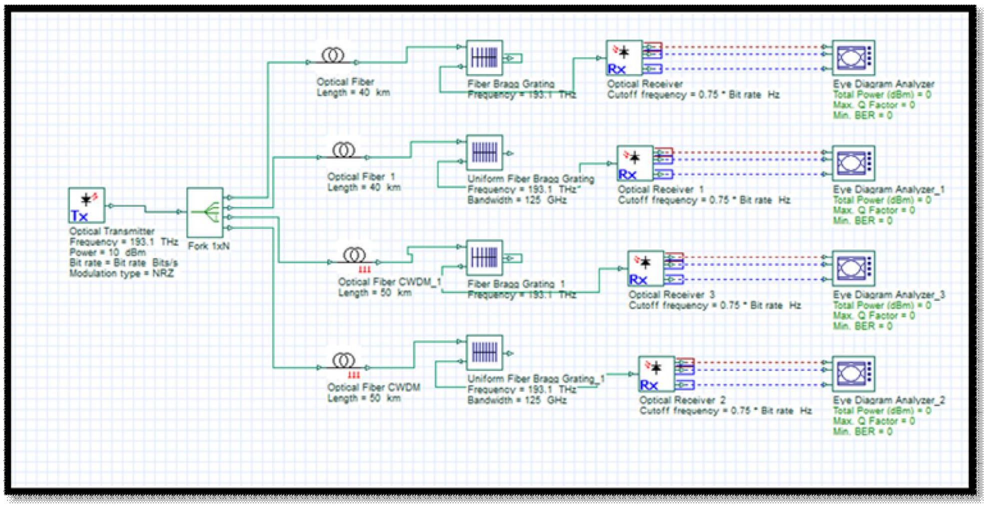
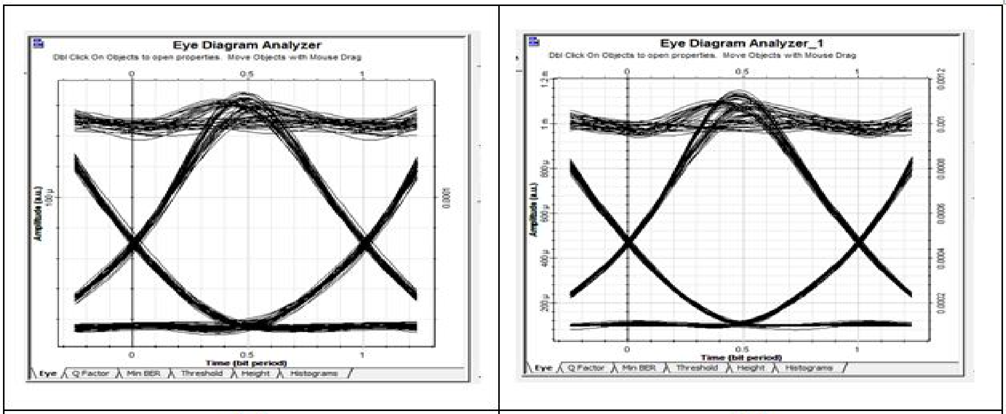


Figure 1 : The designed model of simulated system with Optisystem software

3. Simulation results and discussion

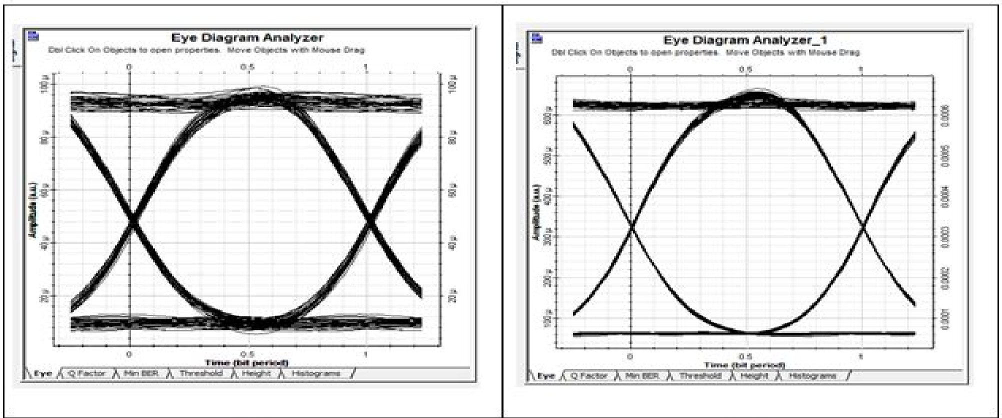
Generally, the eye diagram is an oscilloscope display which gives repetitively sampled digital data signal from the receiver. It is created by talking the time domain signal and overlapping the traces for a certain number of symbols which gives the visual information that can be useful in the evaluation of digital transmission. It gives the BER and Q factor. Eye diagram clearly explicit the BER performance. From Figure 2 to Figure. 11 shows the Maximum Q factor, Minimum BER for optical fiber length from 10km into50 km at different input power starting from 0 dBm to 10 dBm.

From figure 2 into figure 6 shows the reading eye diagram of data1 received from single mode optical fiber with FBG and data2 received from single mode optical fiber with uniform FBG.



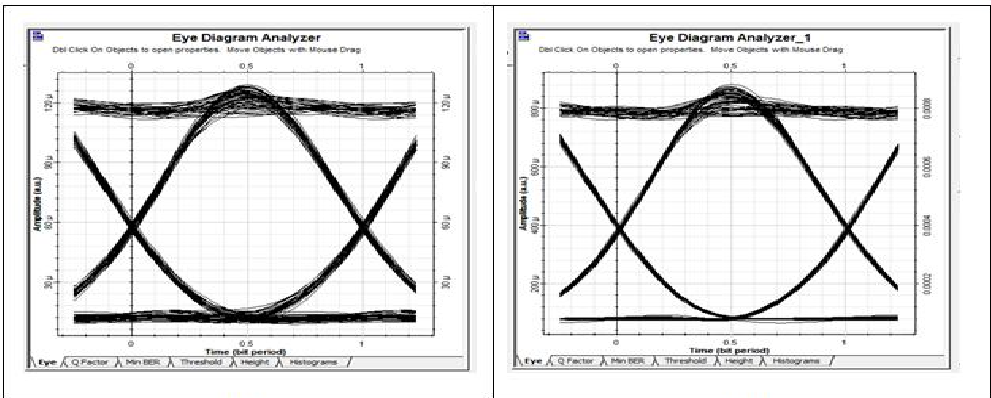
(a)	(b)

Figure2 : Optical fiber of length 10 km at input power of 0 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG.



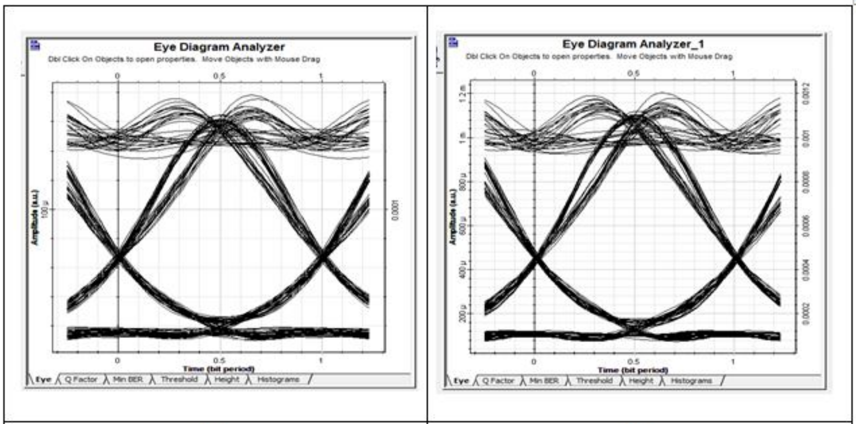
(a)	(b)

Figure3 : Optical fiber of length 20 km at input power of 3 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG



(a)	(b)

Figure4: Optical fiber of length 30 km at input power of 6 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG.



(a) (b)

Figure 5: Optical fiber of length 40 km at input power of 8 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG

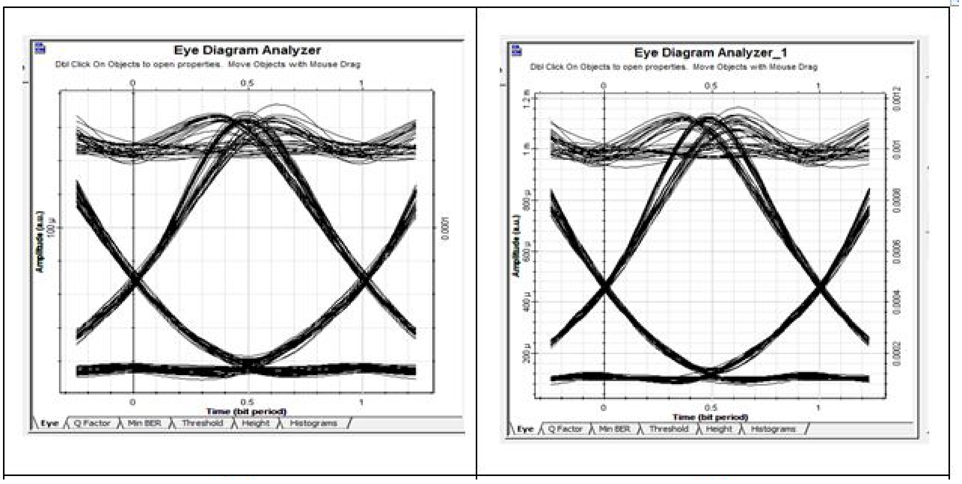


Figure6: Optical fiber of length 50 km at input power of 10 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG.

The output readings are obtained by varying the input power and length of fiber at use the FBG and uniform FBG. The simulation parameters and the result of Maximum Q. factor and Minimum bite error, are listed in Table 1 and Table2 .

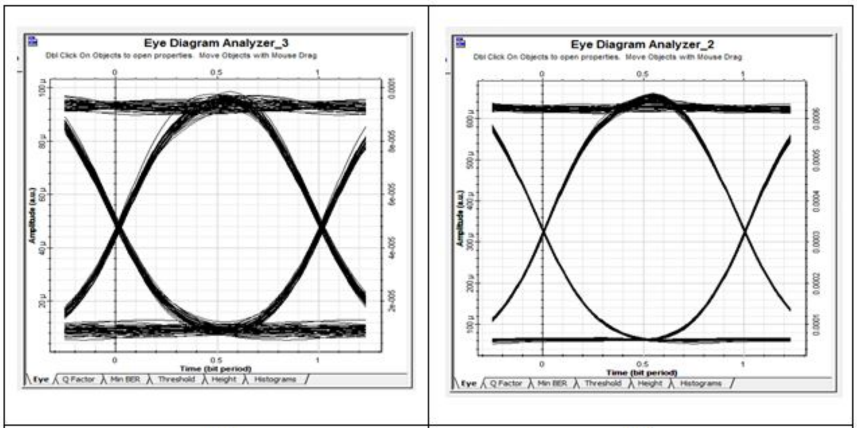
Table 1: Effect of BER and Q Factor with respect to input power and length of the fiber with using FBG.

Input Power (dBm)	Distance of Fiber In km	Max.Q Factor	Min. BER
0	10	29.9545	1.644e-197
3	20	21.8414	4.66e-105
6	30	18.7347	1.14335e-078
8	40	15.4753	2.267e-054
10	50	16.0833	1.62e-058

Table 2: Effect of BER and Q Factor with respect to input power and distance of the fiber with using uniform FBG.

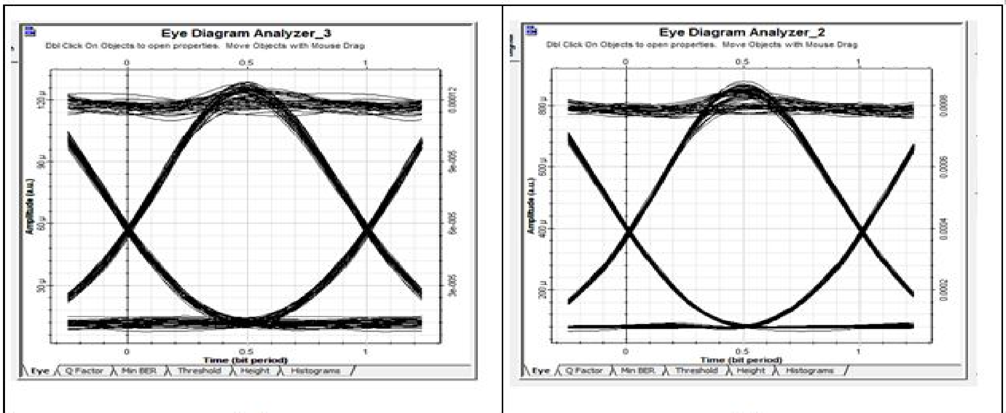
Input Power (dBm)	Distance of Fiber In km	Max.Q Factor	Min. BER
0	10	51.03	0
3	20	25.735	2.33e-146
6	30	17.7995	2.612e-071
8	40	15.786	1.6e-056
10	50	15.167	2.787e-052

from figure 7 into figure 11 shows the reading eye diagram of data1 received from optical fiber CWDM with FBG and data2 received from optical fiber CWDM with uniform FBG.



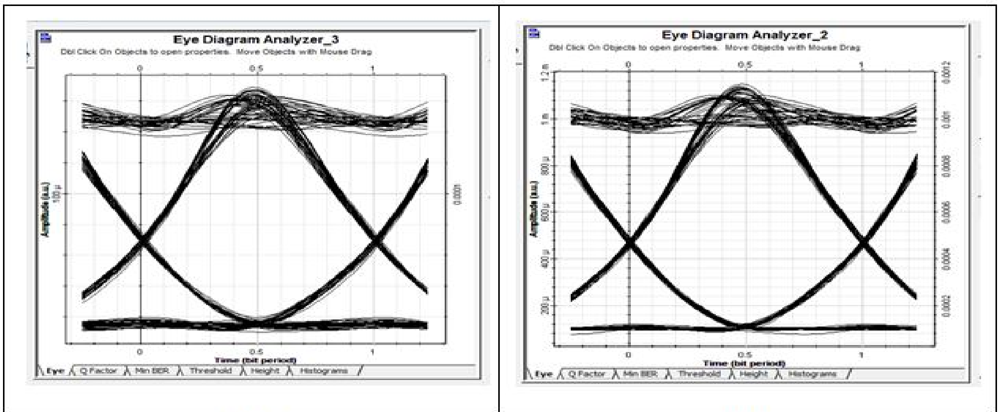
(a) (b)

Figure7: Optical fiber CWDM of length 10 km at input power of 0 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG.



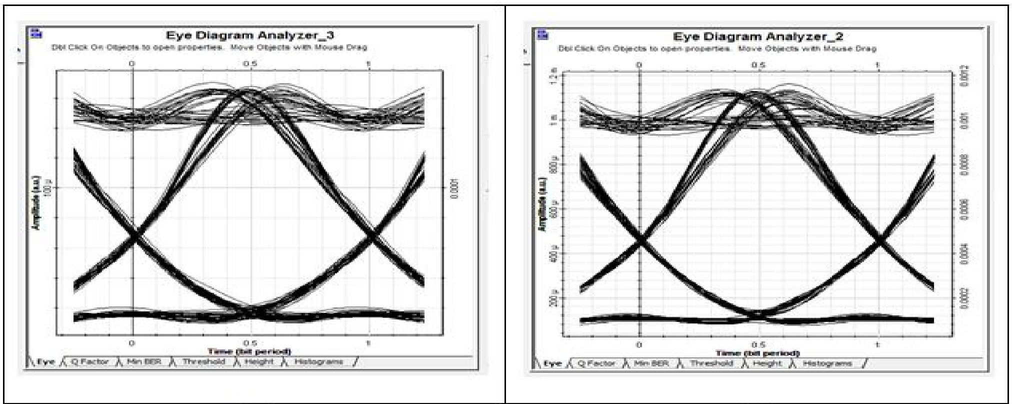
(a) (b)

Figure8 : Optical fiber CWDM of length 20 km at input power of 3 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG.



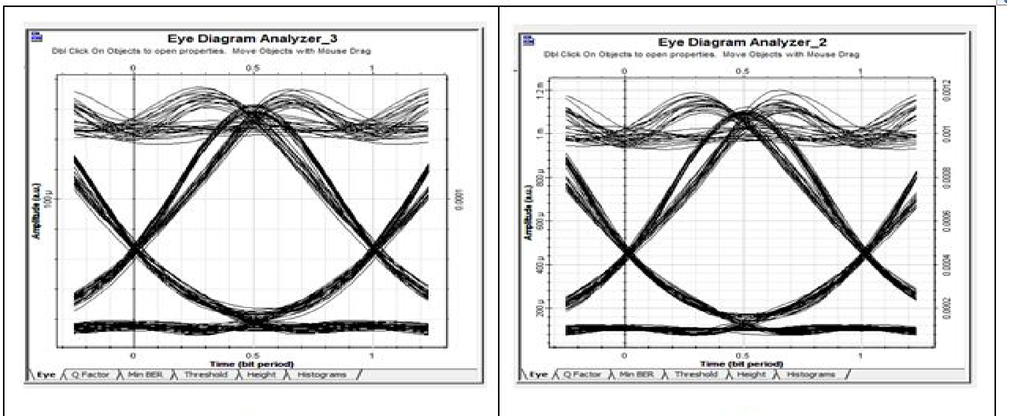
(a) (b)

Figure9: Optical fiber CWDM of length 30 km at input power of 6 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG.



(a)	(b)

Figure10 : Optical fiber CWDM of length 40 km at input power of 8 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG .



(a)	(b)

Figure11 : Optical fiber CWDM of length 50 km at input power of 10 dBm(a) Eye diagram with using FBG (b) Eye diagram with using Uniform FBG

The effect of BER and Q Factor with respect to input power and distance of the optical fiber CWDM type for use the FBG and uniform FBG. The simulation parameters are obtained listed in Table 3 and Table 4 .

Table 3

Effect of BER and Q Factor with respect to input power and distance of the fiber CWDM type with using FBG.

Input Power (dBm)	Distance of Fiber In km	Max.Q Factor	Min. BER
0	10	29.208	7.5e-188
3	20	22.88	3.42e-116
6	30	17.25	4.84e-067
8	40	15.9507	1.251e-057
10	50	16.247	1.16e-059

Table 4

Effect of BER and Q Factor with respect to input power and distance of the fiber CWDM type with using uniform FBG.

Input Power (dBm)	Distance of Fiber In km	Max.Q Factor	Min. BER
0	10	48.04	0
3	20	25.713	4.025e-146
6	30	17.832	1.54e-71
8	40	15.778	1.81e-056
10	50	15.264	6.36e-53

It is observed in figure 12 that Maximum Q Factor calculated with change the length of optical fiber which indicated from Table 1 into Table 4.

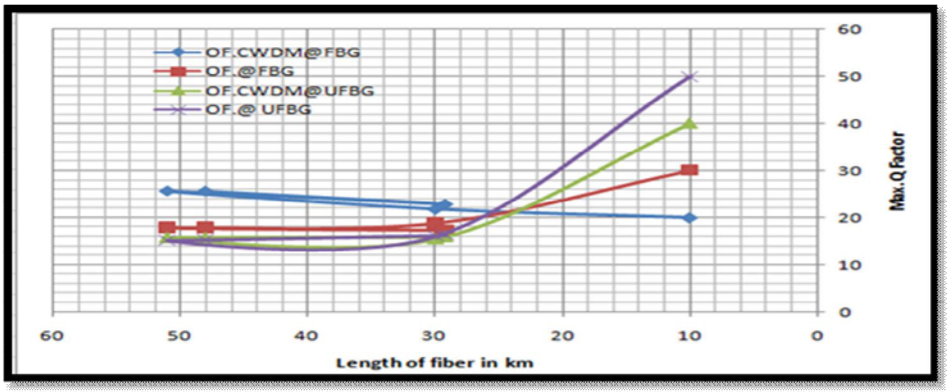


Figure12: Max Q Factor figure versus Length of fiber in km

Figure 13 it is observed that Minimum BER calculated with change the length of optical fiber which indicated from Table 1 into Table 2.

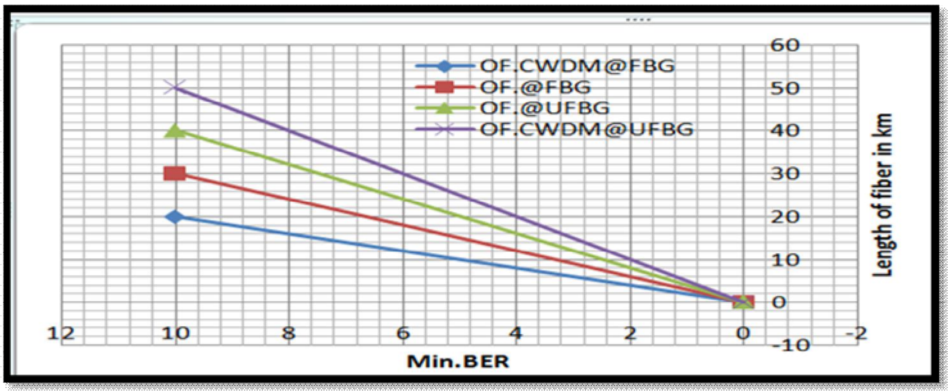


Figure13: Min BER figure versus Length of fiber in km

In this work, implementation and performance analysis of a minimum bit error rate and maximum Q. Factor for transmission system. From this design, the optical fiber transmission system can be combined with Fiber Bragg Grating (FBG) and uniform FBG acts as to improvement Max. Q. Factor and BER. As seen from above results which abstract from Tables 1 into Tables 4 ,when compare the result for use single mode fiber show that the Max. Q. Factor with FBG is 29.9545 and BER of 1.644e-197 but with uniform FBG is 51.03 and BER is 0. In the other hand for using optical fiber CWDM the Max. Q. Factor with FBG is 29.208 and BER of 7.5e-188 but with uniform FBG is 48.04.at 10km fiber length and input power 0dBm.Figure12, shows that with increasing fiber length, the maximum quality factor decreases while in the figure 13, minimum bite error rate increase linearly as increasing length of optical fiber. The BER increases with the increase in distance, while Q-factor decreases. The FBG used in simulation model have uniform grating pattern to compensate the quality factor. It is concluded that Q-factor decreases with the increase in distance.

4. **CONCLUSION**

In this paper, the design and implementation of transmission system for various input power with various length of fiber has been studied. These results are valuable for improving system performance by using uniform FBG , for channels of the fiber optic system. As seen from above results, In optical fiber with uniform FBG channel, improvement the quality factor and bite error rate compare with use FBG .In optical fiber CWDM with uniform FBG channel, improving system performance by increasing quality factor and reduce bite error rate compare with use FBG .It is observed that the using single mode fiber with uniform FBG, give a best quality factor and a low BER. compare with optical fiber CWDM combined with uniform FBG .

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