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Simulation and Performance Analysis of 10Gbps Optical Transmission System Using Fiber Bragg Grating

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Abstract- This paper discussed on a simulation of optical transmission system in optical fiber. To achieve the foremost effective performance of communication system, dispersion should be stipendiary. Fiber Bragg grating is chosen as important components to compensate the dispersion in optical communication system. The simulation of transmission system will be analyzed based on different parameters by using optisystem 0.7 simulator. A 10 Gb/s Non Return To Zero (NRZ) signal is launched on to 10-50 km long standard single mode fiber. By simulating a model of communication system and using the most suitable settings of the system which include input power (10dBm), fiber cable length50Km, the performance of the system will be evaluated. Comparison of eye diagrams and BER show a marked improvement in the link performance due to compensation of dispersion.

Introduction

Fiber optic communication is a method of transmitting information from one place to another by sending light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information. The process of communicating using fiber optics involves the following basic steps: Creating the optical signal using a transmitter, relaying the signal along the fiber, ensuring that the signal does not become too distorted or weak, and receiving the optical signal and converting it into an electrical signal. The use of erbium doped fiber amplifiers (EDFA) in optical communication systems has made chromatic dispersion the most significant limitation for the transmission performance since EDFAs compensate for the transmission losses. The chromatic dispersion in optical fiber is a phenomenon caused by the wavelength dependence of its group refractive index In optical fiber, the wavelength dependence of the fiber group refractive index causes a temporal broadening of the pulses as they are propagating. Fiber Bragg Grating (FBG) is commonly chosen as important components to compensate the dispersion in optical communication system. Because the low cost of filter for wavelength selection and low insertion loss, it has also customized reflection spectrum and wide bandwidth. The simulation of transmission system will be analyzed based on different parameters by using OptiSystem simulator .By simulating a model of optical communication system.

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FIBER BRAGG GRATING (FBG) OPERATION

FBG is a piece of optical fiber with the periodic variation of refractive index along the fiber axis. This phase grating acts like a band rejection filter reflecting wavelengths that satisfy the Bragg condition and transmitting the other wavelengths [2]. The reflected wavelength changes with grating period. Thus, FBG is very simple and low cost filter for wavelength selection that improves the quality and reduces the costs in optical networks. The equation relating the grating periodicity, Bragg wavelength and effective refractive index of the transmission medium is given by:

$$\lambda\ n\gamma\ B = 2 \text{ -------- } (1)$$

In this equation, λB, n and Λ are the Bragg wavelength, refractive index of core and grating period respectively.

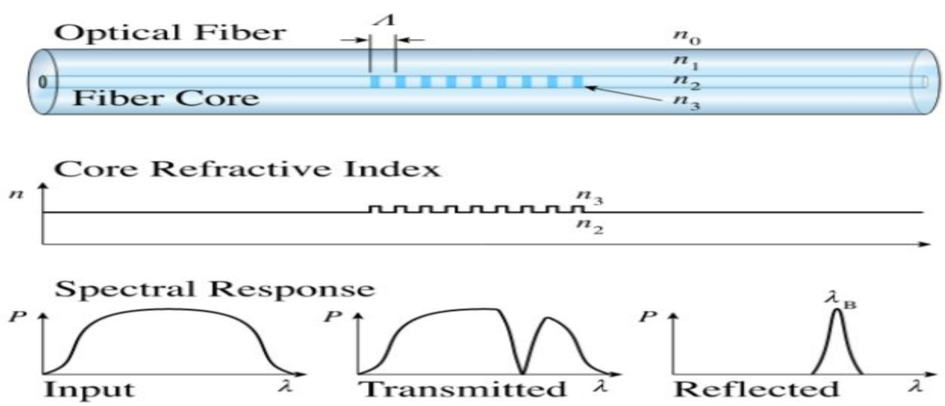

Fig (1) Principle of Uniform FBG

A chirp is variations in the grating period created along the FBG. As shown in Fig.1 when a signal enters into chirp, different wavelengths are reflected from different parts of grating. Thus, a delay related to the wavelength of the signal is produced by grating [3].

DSSIGN CONSIDERATION

The system is operated with the basic optical communication which consists of a transmitter, transmission link and a receiver. The system transmits information using optical carrier wave from transmitter to receiver via optical fiber. The input signal contains electrical data that is represented by 0's and 1's has been generated by a non-return-zero (NRZ) pseudorandom binary sequence. Then the input signal is modulated with semiconductor laser that is represented by Continuous Wave (CW) laser through Mach- Zehnder modulator. CW laser supplies input signal with 1550 nm wavelength and input power of 10dBm which is externally modulated at 10 Gbits/s with a non-return-zero (NRZ) pseudorandom binary sequence in a Mach-Zehnder modulator. The optical fiber used is single mode fiber because single mode fiber can yield higher data rate, less dispersion and also can operate in long haul distance, so it is suitable to be used as transmission link. For the dispersion compensator, the fiber Bragg grating will be used. The length grating that will be used is 2 mm [4]. After dispersion compensation the signal will pass through optical amplifier that represented by Erbium-doped fiber amplifier (EDFA). Optical amplification is required to overcome the fiber loss and also to amplify the signal before receive by Photo detector APD at the receiver part.

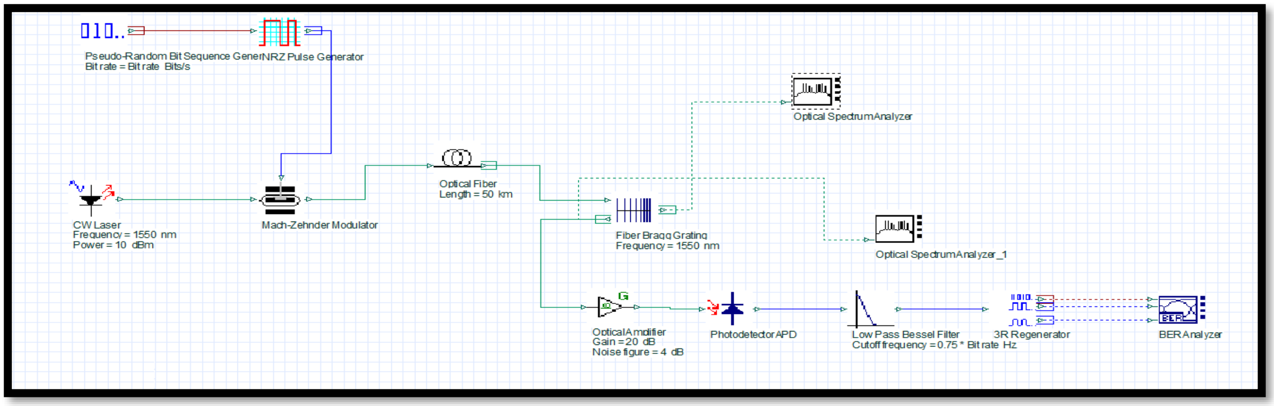

Fig 2: The designed model of simulated system.

TABLE 1: SIMULATION PARAMETERS

Reference Wavelength	1550nm
Fiber length	10 -50 km
EDFA Gain	20dB
FBG length	2mm

RESULTS AND DISCUSSIONS

The simulation and optimization of the design is done by Optisystem simulation software. The eye diagrams and results are tabulated into Table.

TABLE 2: The output readings are tabulated by varying the OFC Length (Km).

OF Length(Km)	Q-Factor	BER
10Km	53.7186	0
20Km	23.4085	1.7436e-121
30Km	14.781	9.45301e-50
40Km	11.3314	4.28721e-30
50Km	11.9418	3.58e-33

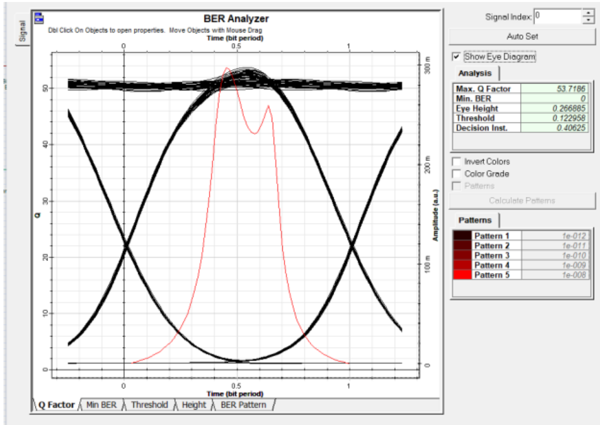

Figure3: Eye diagram analyzed at 10 Km

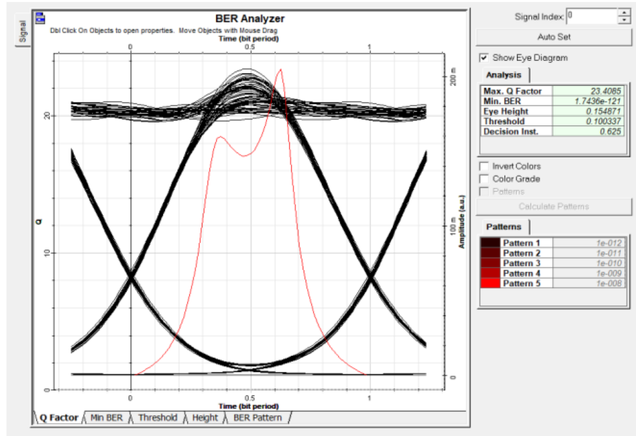

Figure4: Eye diagram analyzed at 20 Km.

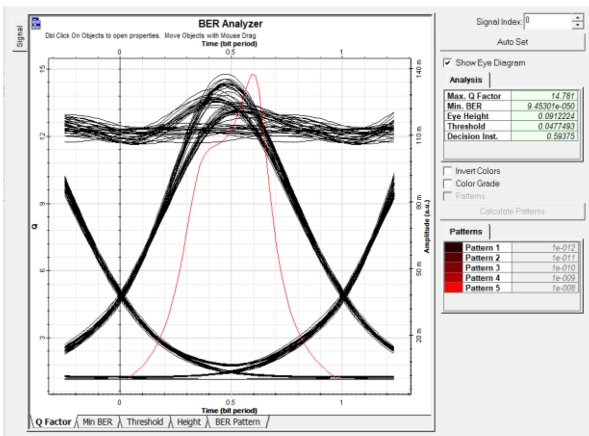

Figure5: Eye diagram analyzed at 30 Km.

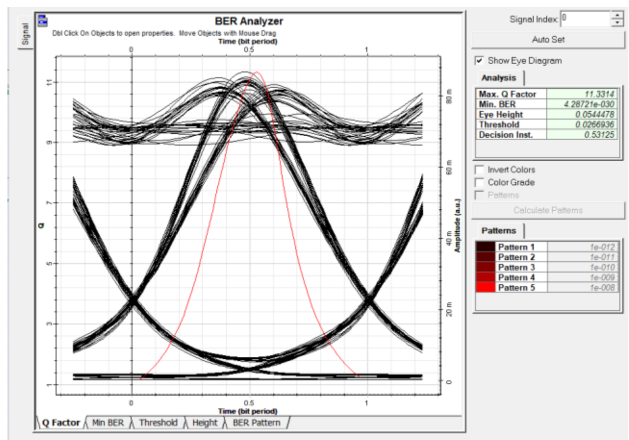

Figure6: Eye diagram analyzed at 40 Km.

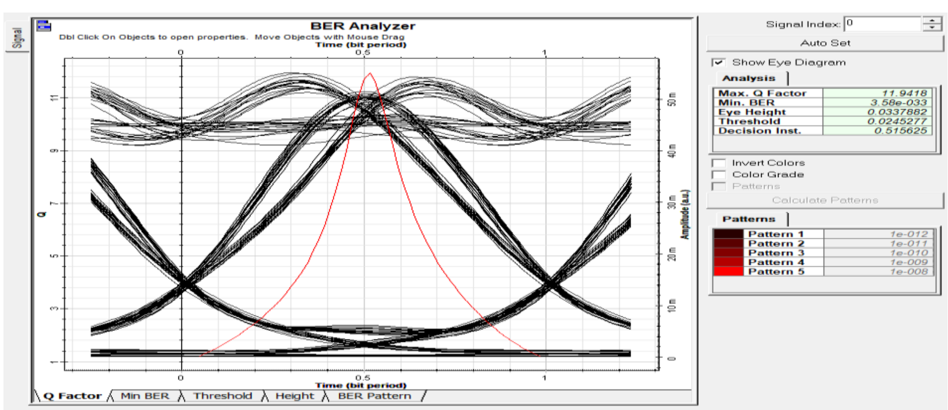

Figure7: Eye diagram analyzed at 50 Km

CONCLUSION

The system will transmit information using optical carrier wave from transmitter to receiver via optical fiber. Based on the research, the transmission system has been designed which consists of laser light as a source, modulator, single mode optical fiber as the channel, fiber bragg grating as the dispersion compensator, Erbium Doped Fiber Amplifier (EDFA) and the photo detector as a light detector. From the simulation result, it can conclude that the optical fiber length is inversely proportional to the Q-Factor and BER. The Q-Factor and BER are the measure of the system performance.

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