Performance Analysis of 20Gbps 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 simulator. A 20 Gb/s Non Return To Zero (NRZ) signal is launched onto 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 (dbm), fiber cable length, the performance of the system will be evaluated. Comparison of eye diagrams show a marked improvement in the link performance due to compensation of dispersion.**

***Index Terms*-** Optical transmission System, Fiber Bragg Grating, Dispersion compensation, Optisystem Simulator.

I. INTRODUCTION

Fiber optic communication is a method of transmitting information from one place to another by sending light through an optical fiber. The basic optical transmission system consists of three basic elements which are fiber media (transmission channel) , light sources as the input (covert electric signal into optic signal) and light detector as the output (convert optic signal into electric signal). FBG is the key component in optical communication system as, dispersion compensators, filters and flatteners gain. In the transmission section, the gratings are placed in the line with the fiber. It will help to achieve the maximum compression ratio [1].Because of dependence of group Index to wavelength chromatic dispersion takes place in optical fiber it creates an extension of time on pulses [2]. Electromagnetic carrier wave is modulated to carry information. Chromatic dispersion and polar mode dispersion occurs in single mode fiber (SMF). In optical system dispersion can be compensated by also using erbium doped fiber amplifier (EDFA) [3]. The frequency increases along the pulse when the dispersion coefficient parameter of the fiber is negative [4]. Chromatic dispersion is wavelength dependent and is ruling the single mode fiber [5]. Optisystem simulator software is an advanced, innovative, rapidly developing and powerful software simulator tool for the design, testing and optimization of virtually any type of optical link in the physical layer of a broad spectrum of optical networks from ultra-long-haul system to local area networks (LANs) and metropolitan (MANs) [6]. OptiSystem offers optical transmission system design and planning from component to system level and present the analysis and scenarios visually. It can help the users to plan, test and simulate several applications such as WDM/TDM or CATV network, dispersion map design, transmitter, receiver and amplifier design and others . Optisystem is a product that does not depend on other simulation design. It is based on realistic optical fiber modeling as a communication system. There are hundreds of official components in Optisystem component library.

In this paper, the simulation of the optical transmission system in optical fiber has been discussed by analyzing the effect of the components in data receiver by using different parameters setting. The value of Q-factor has been investigated at receiver.

II. FIBER BRAGG GRATING

Fiber Bragg Grating (FBG) is very simple and low cost filter for wavelength selection which has various applications to improve the quality and diminish the costs in optical networks [6]. FBG executes some operations like reflection and filtering with high efficiency and low loses. FBG acts as a dispersion compensator in transmission optical system which is used to compensate chromatic dispersion. Thus, the final expected effect is compression in incident pulse and can be appropriate to compensate chromatic dispersion in a communication link [6]. FBG is single mode which will expose the core to the periodic pattern of intense ultraviolet light. The exposure will increase the refractive index and thus the refractive index is permanently increased. Then the exposure pattern will create a fixed index modulation that called grating. When periodic refraction is changed, a small reflected light will be produced. Then, the small reflected light will be combined into a large reflected light at a certain wavelength. The certain wavelength is when the grating period is approximately half the input light's wavelength which is called Bragg's wavelength. The other light (except the Bragg's light) will be transparent.

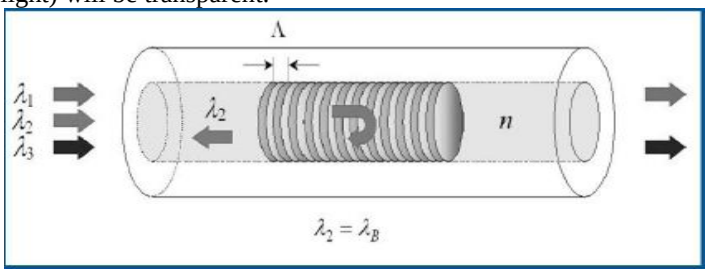

Figure1: Principle of operation of FBG [8]

When a light pulse propagates down an optical fiber, it is dispersed, that is the width of the pulse broadens because the longer wavelength light lags the shorter wavelength light. Consequently, at sufficiently high data rates and fiber lengths,

the pulses in a data stream will begin to overlap. In this way, fiber dispersion limits the maximum data that can be transmitted through a fiber. A dispersed light pulse with the longer wavelengths lagging the shorter wavelengths is incident on a chirped fiber bragg grating [7]. The longer wavelength light is reflected near the front of the grating whereas the shorter wavelengths are delayed relative to the longer wavelengths. The chirped grating can be designed so that all wavelengths in the light pulse exit the reflector at the same time and the dispersion in the optical pulse is equalized.

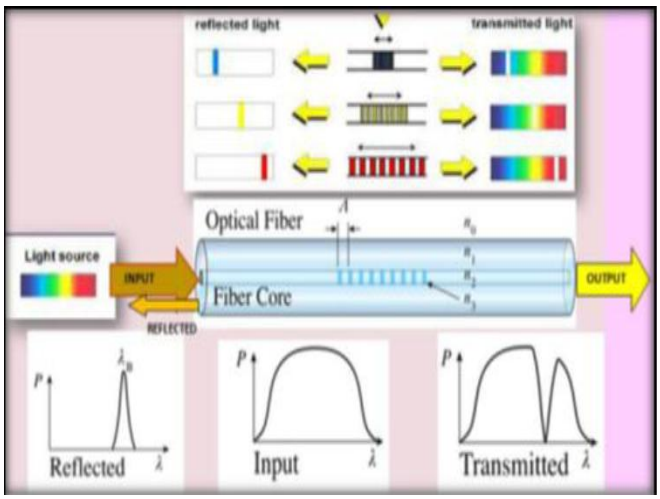

Figure 2: principle of Bragg's light

There are numbers of software available which can mimic the process involved in your research work and can produce the possible result. One of such type of software is Matlab. You can readily find Mfiles related to your research work on internet or in some cases these can require few modifications. Once these Mfiles are uploaded in software, you can get the simulated results of your paper and it easies the process of paper writing.
As by adopting the above practices all major constructs of a research paper can be written and together compiled to form a complete research ready for Peer review.

III. DESCRIPTION OF COMPONENTS

NRZ pulse generator has an advantage on controlling bandwidth. This is due to the characteristic of the generator that the returning signals to zero between bits. Pseudo-random bit sequence generator is used to scramble data signal in terms of bit rates. Mach Zender Modulator (MZ) has two inputs (optical signal and electrical signal) and one output (optical). Then the input signal is modulated with semiconductor laser that is represented by Continuous Wave (CW) laser Frequency 193.1 THz through Mach- Zehnder modulator. Continues laser diode (CW) to generate optical signals supplies input signal with 1550 nm wavelength and input power of 10dBm which is externally modulated at 20 Gbits/s. with a non-return-zero (NRZ) pseudorandom binary sequence in a Mach-Zehnder modulator with 7 dB of extinction ratio. The optical fiber used is single mode fiber because has higher data rate and long distance transmission. The fiber Bragg grating is used as the dispersion compensator. The FBG length 6 mm Photo detector (PIN) Diode Positive Intrinsic Negative to translate the optical signal into an electrical signal.

IV. 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 5dBm which is externally modulated at 20 Gbits/s with a non-return-zero (NRZ) pseudorandom binary sequence in a Mach-Zehnder modulator with 5 dB of extinction ratio. 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 6 mm since the most proper length for proposed model is equal to l = 6 mm by try and error method [1]. 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 PIN at the receiver part.

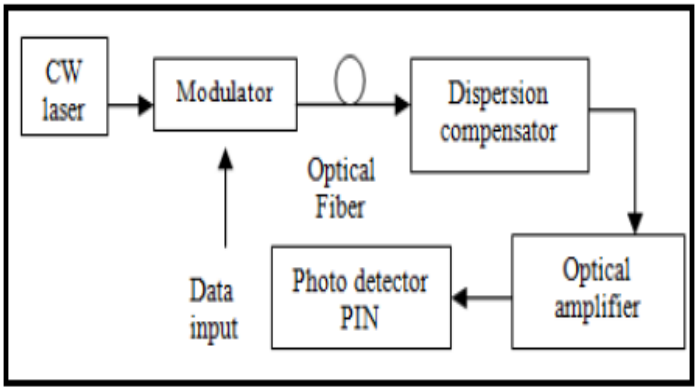

Figure3: The optical transmission system block diagram [8]

V. SIMULATION OF TRANSMISSION SYSTEM

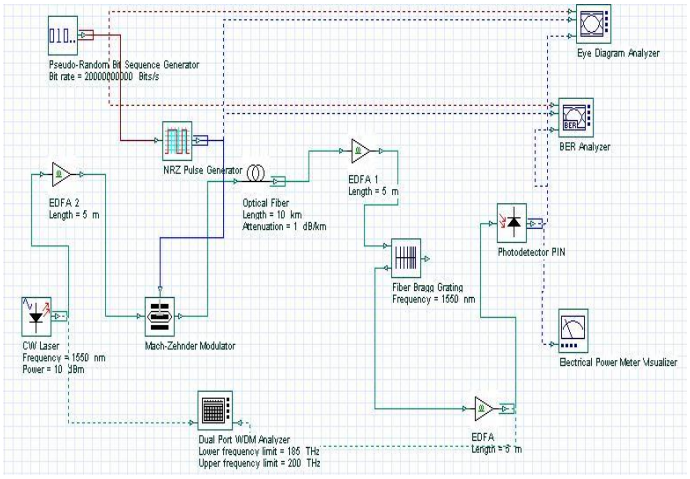

Figure 4: The designed model of simulated system .

TABLE 1: SIMULATION PARAMETERS

C/W Input Power	5dbm
C/W laser Frequency	193.1THZ
Reference Wavelength	1550 nm
Mach-Zender modulator with of extinction ratio	7db
Fiber length	50 km
Attenuation at cable section	0.2db/km
EDFA length	5m
FBG length	6mm

VI. 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).

OFC Length	Q-Factor
10	23.8289
20	19.819
30	12.7887
40	8.66328
50	7.21557

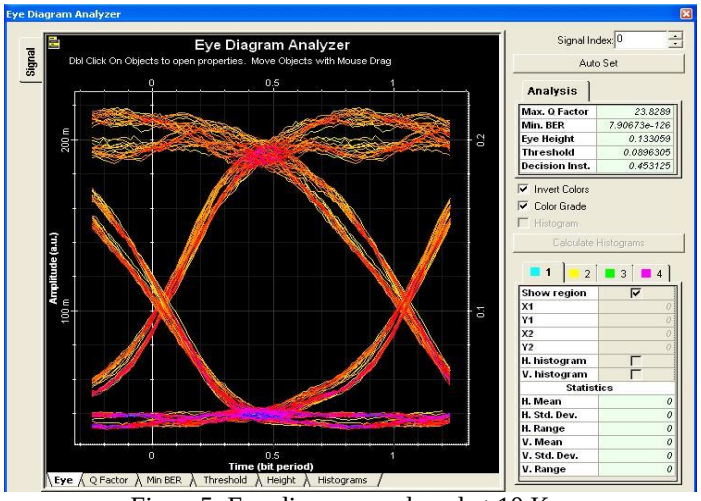

Figure5: Eye diagram analyzed at 10 Km

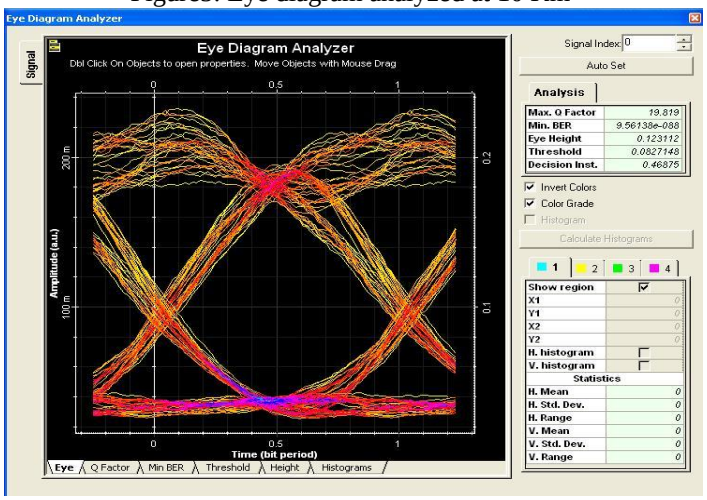

Figure6: Eye diagram analyzed at 20 Km.

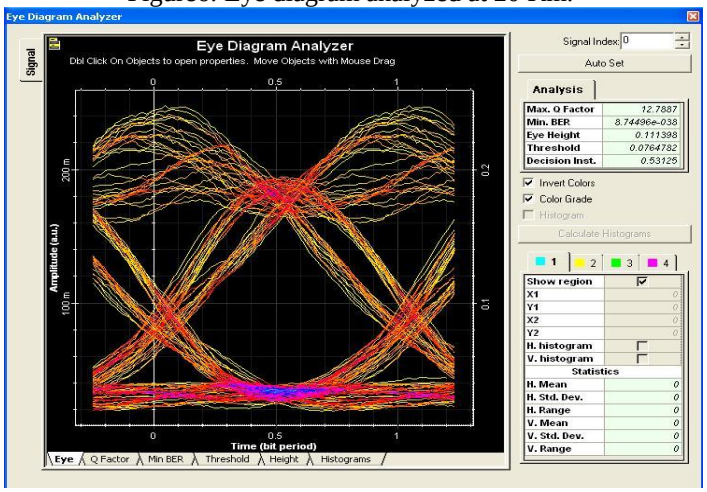

Figure7: Eye diagram analyzed at 30 Km.

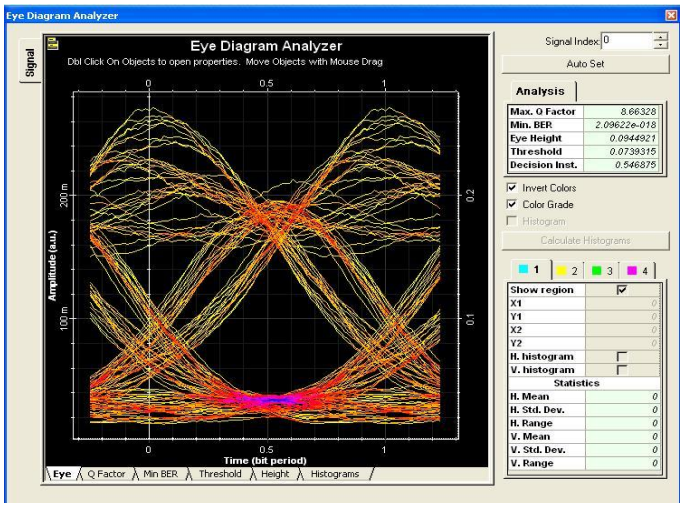

Figure8: Eye diagram analyzed at 40 Km.

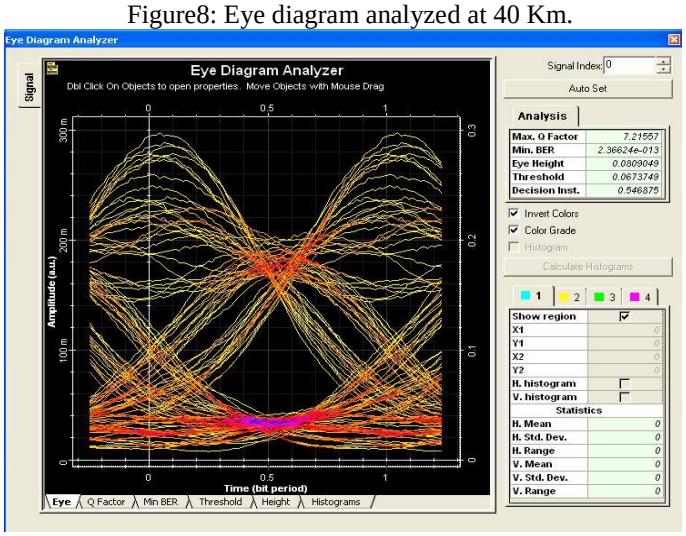

Figure9: Eye diagram analyzed at 50 Km

CONCLUSION

From design and simulation of optical transmission system, the journals related about optical transmission system have been discovered and studied in order to propose the design idea for a simulation of optical transmission system. 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 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. The Q-Factor is the measure of the system. performance.

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