Effect of Fiber Bragg Gratings in 10-Gb/S Transmission by Employing Modulation Technique

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Abstract— The trend toward higher bit rates in light wave communication has interest in dispersion-shifted fiber to minimize dispersion penalties. At the same time optical amplifiers have increased interest in wavelength multiplexing. In this paper, we have designed an external modulation system model using fiber bragg grating. The model is analyzed by considering different input power of CW laser & at different types of fiber bragg grating. The performance is analyzed using external modulation schemes like CSRZ under FWM nonlinearity effect with the help of eye diagram. All the simulations are done in OPTISYSTEM 7.0 simulation software at 10 Gbits/sec.

Key words: Optical Fiber Dispersion, Fiber Bragg Grating, Linb Modulator, CSRZ, Eye Diagram, Q-Factor

I. INTRODUCTION

Optical fibre communication provides a very large bandwidth (50 THz) and it becomes the most modern means of communication. Fiber-optic communication systems have revolutionized the telecommunications industry and played a major role in the advent of the information age.[1]. Optical communication is a system transmitting information in form of light through an optical fiber. The light acts as an electromagnetic carrier wave that is modulated to carry information. The basic optical communication system consists of three elements which are light source that convert electrical signal into optical signal, optical fiber which acts as a transmission medium and photo detector or light detector that converts the optical signal into electrical signal at the receiver side. The goal of every communication system is to increase the transmission distance and speed [2].In every communication system different obstacle produce the change in signal transmission. Similarly when any signal is transmitted over optical fiber non-linearity effects are producing like four wave mixing, dispersion or scattering. Among them the dispersion affects the system most and it is difficult to overcome as compared to other losses. Thus it is important to incorporate an effective dispersion compensation technique in optical communication systems that lead to performance enhancement of the transmission system [3].

Dispersion is defined as the pulse spreading in an optical fiber. When different wavelengths of light pulses are launched into the optical fiber, these pulses travelled with different speeds due to the variation of refractive index with wavelengths. The light pulses tend to spread out in time domain after travelling some distance in fiber and this is continued throughout the fiber length. This phenomenon is known as dispersion. In order to improve the system performance affected by dispersion, several dispersion compensation techniques are proposed and analyzed. Among the various techniques proposed in literature, the most suitable techniques are: Dispersion compensating fibers (FBG), Fiber bragg gratings (FBG), Electronic dispersion compensation (EDC).The selection of modulation technique is a vital role in the system design process[4]. In this paper, the system is designed by using modulation like CSRZ. At high bit rates, the modulation format, type of dispersion compensation scheme, and channel power become important issues for optimum system design.

The paper is organized as follows. In Section 2, system description is presented, Section 3 described the proposed system, Section 4 describes Simulation and results and finally we conclude the paper in Section 5.

II. PROPOSED SYSTEM DESCRIPTION

Light source is the most important component in optical signal since communication is done by transmitting light. In any optical communication system transmitter, Receiver and channel blocks are required. To generate light signal as input source different optical sources can be used. CW laser is used in optical communication [5].The input power of CW laser is considered as 20dbm, 30 dbm & 40 dbm respectively. Transmitter consists of a pseudo random bit sequence (PRBS) generator followed by optical transmitter. So, we have included PRBS, NRZ, CW laser, Modulator (LiNb-Mech Zehnder) in transmitter section; Fiber bragg grating, optical receiver & eye diagram analyzer in receiver side.

Modulators are basically used for manipulate the intensity of beam i.e., to modulate the current driving the light source, e.g. a laser diode. This sort of modulation is called direct modulation, as opposed to the external modulation performed by a light modulator. For this reason light modulators with laser diodes where narrow line width is required, direct modulation is avoided due to a high bandwidth "chirping" effect when applying and removing the current to the laser. MZ (Mech-Zehnder) Modulators achieve better performance as compared to LiNb (Lithium-Niobate) Modulator as MZ achieves Zero-chirping condition as compared to LiNb MZ modulator [6].

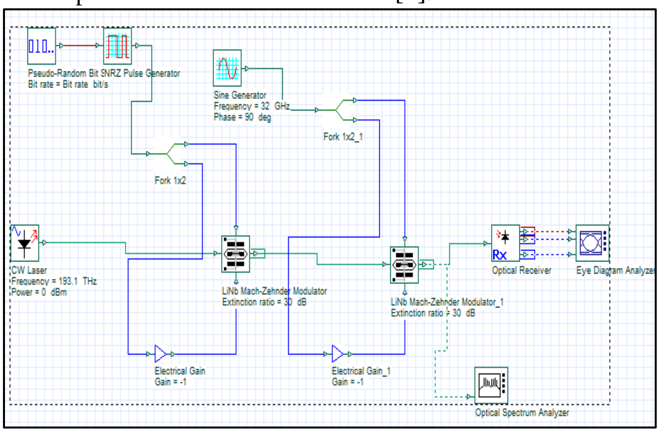


Fig. 1: schematic model of CSRZ modulation without FBG

Fig.1 shows the schematic of CSRZ modulation formats without fiber bragg garting in which is one of the advanced modulation formats in optical communication systems. It is characterized by reversing the sign of the optical field at each bit transition. The CSRZ modulation pseudo-multilevel modulation format has better tolerance to fiber nonlinearity and residual chromatic dispersion (CD). In this modulation, RZ optical signal after Mach-Zehnder modulator (MZM) goes through phase modulator [7] .Fig. 2 shows the optical spectrum at 193.1 THz.

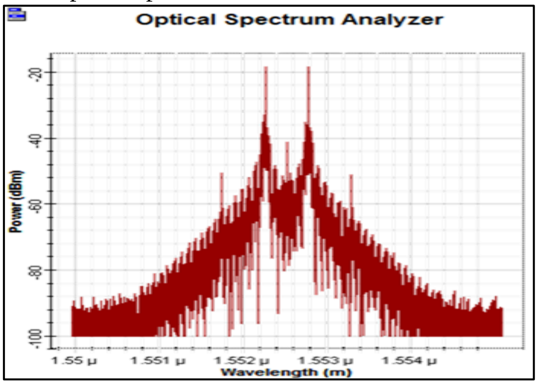


Fig. 2: Optical Spectrum of CSRZ modulation

Fig-3 shown the schematic of CSRZ modulation formats by using fiber bragg garting The simulation is taken by putting the FBG in the path of modulator & FBG is so chosen which has step size of 2 mm.

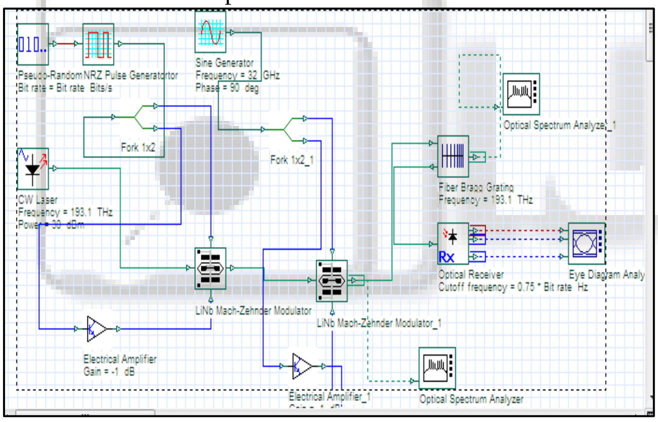
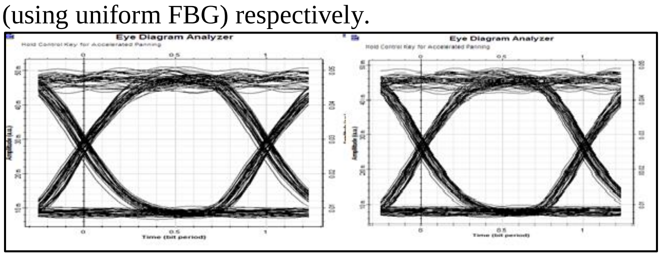


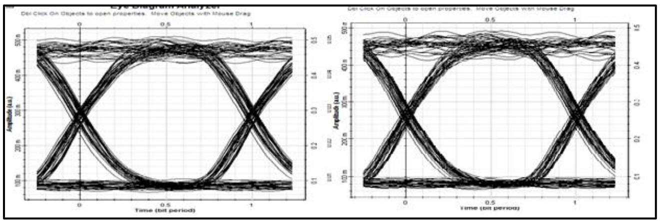
Fig-3 schematic model of CSRZ modulation using FBG

III. SIMULATION AND RESULTS

The simulation and optimization of the system model is performed by Optisystem 7 simulation software. The eye diagrams at receiver are displayed by using different values of input power (dBm) and various types of fiber bragg gratings. Fig. 4(a) & fig 4(b) represent the eye diagram of the proposed model at 10 Gbps bit rate by using CSRZ without FBG & with uniform FBG. The maximum quality factor are 18.864 Gbps (without using FBG) & 19.349 (using uniform FBG) respectively.



(a)Without FBG (b) with uniform FBG
Fig. 4: (a),(b) Eye diagram for CSRZ at 30dBm in 10 gbps



Without FBG (b) with uniform FBG
Fig. 5: (a), (b) Eye diagram for CSRZ at 40dBm in 10 gbps

The comparison of simulated result is shown in table-1. From that table we can verify that Q-factor changes its value with change in grating and input power.

Input Power	Without FBG Q-Factor	With FBG Q-Factor	With Uniform FBG Q- Factor
20dBm	18.82	18.1429	19.27
30dBm	18.852	18.03	19.3398
40dBm	18.8604	18.3248	19.349

Table 1: Comparison between quality factor at different input power & at 10gbps

IV. CONCLUSION

In this paper, we have simulated CSRZ modulation technique using various fiber bragg grating and optimized the system performance for the symmetrical dispersion compensation by varying signal input power & by changing types of bragg grating. It is verified that uniform grating provides high quality factor as compared to simple fiber bragg grating at low bit rate. The comparative analyses show that at 10 Gbps, the proposed system has maximum quality factor and minimum BER for CSRZ modulation. This proposed model can be extended by changing different modulation techniques like DRZ, QPSK & MSK.

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