First Libyan international Conference on Engineering Sciences & Applications (FLICESA_LA)
13 – 15 March 2023, Tripoli – Libya

Performance Analysis of Optical Fiber Communication Systems Under Different type of Modulation Formats

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***Abstract*— with the growth in the communication systems, there is a need for large bandwidth to send more data at higher data rate. The frequency chirps of direct modulated laser limit the fiber length to 4.78 km and 9.14 km under NRZ and RZ formats respectively at 10^{-9} BER. The objective of this paper is, to analyze the performance of 55 Gbits/s optical fiber communication systems using externally modulated high-speed continuous wave (CW) lasers with different type of modulation formats. Electrical signals of return to zero (RZ), non-return to zero (NRZ) and Doubinary formats with $10^{-15}-1$ pseudorandom bit sequences are used tomodulate the laser. . The performance of Non-Return-to-Zero (NRZ), return-to-zero (RZ) and Doubinary modulation format at 55 Gbits/s for the optical**

. Keywords— Bit error rate, Q factor, Duobinary,

I. Introduction

The next generation technology is required to be compatible with today's bandwidth needs and to also offer bandwidth ease to support future growth based on network expansion and new application development. Since optical technology has proven to have large bandwidth capacity, it appears to be the proper choice to solve the complexities of access networks [1]. Fiber-optic communication is a method of transmitting information from one place to another by sending light through an optical fiber. Fiber Optic communication systems played a major role in the advent of the information age. Fiber Optic communication technology gives the solution for higher bandwidth. As its advantages over electrical transmission, utilization of optical fiber has largely replaced copper wire communications in the developed world. Optical fiber is the most common type of channel for optical communications. With the explosive growth in demand for capacity in national, regional, and even metropolitan optical networks, the high bit rate fiber state of- the-art communications. Modern optical networks are now primarily based on 2.5 Gbits/s and 10 Gbits/s channels [9]. This frequency chirp is proportional to the differential gain and, therefore, attains large values under intensity modulation in high-speed laser diodes. The frequency chirp was proved to interact with fiber dispersion in such a way to degrade performance of fiber communication systems. Forms of this performance degradation include limitations to the transmission bit rate, transmission distance, and adding to the power penalty of the fiber system [2]. In fiber systems operating at wavelength of 1.55 μm have fiber dispersion as high as ps/nm/km which enhanced the effect of the laser chirp [2]. Among the technical to eliminate such an effect is to replace the direct modulated technique to external modulated technique. It is then necessary to investigate the eliminated effect of the laser chirp on the performance of 55-Gbits/s fiber links using external modulation and dispersion-shifted fibers. This study would help to examine the suitability of these high-speed fiber links for applications in the very reach optical networks and local and/or metro area fiber networks.

II. Modulation Formats

a) NRZ Modulation format

Non return to zero line is a binary code in which one's (1's) are represented as a positive voltage (+v) and zero's (0's) are represented as a negative voltage (-v). NRZ codes use half the baseband bandwidth. The intensity of the carrier light wave is modulated by the applied electric field in which voltage varies with a determined function. The fiber length is varied over an open range. On each fiber length, the laser signal is detected and BER is evaluated by BER Analyzer. Then decided the fiber length 12.09 km at which BER is equal 10^{-9}.

b) RZ Modulation format

It consists Return to Zero (RZ) pulse generator with duty cycle 0.5 (50%), CW laser, +D-NZDSF, Attenuator, Photodetector pin diode and Low pass Bessel filter. External modulation use Mach Zehnder external modulator to modulate the CW Laser and RZ electrical signal. The fiber length is varied over an open range. On each fiber length, the laser signal is detected and BER is evaluated by BER Analyzer. Then decided the fiber length at which BER is equal to10^{-9} .

c) Doubinary Modulation format

In Doubinary format, Phase shifted by π after odd number of zeros. In this DB scheme using less than N/2 Hz of bandwidth to transmit N bits/s. DB gives high dispersion tolerance and narrow band optical filtering, these are the main advantages of using. Conventional DB transmitters apply a differential precoder at the input. BER analyzer is represents the output characteristics of applied Duobinary modulation format with external modulation at the different distances.

III. SIMULATION MODEL

A binary Pseudorandom (PRBS) sequence is the same as a real random sequence in statistical conduct, it is difficult to predict when generated by means of a determinist Algorithm [12]. PRBS can be used in telecommunications, in particular in analog to information conversion [13], but also in authentication, simulation, comparison and flight times. Mach-Zehnder is a typical optical waveguide modulator consisting of a laser source, an optical detector and an MZI modulator structure with a field sensing range. EO conversion Mach-Zehnder modulator, optical connect, O-E conversion Mach-ZehnderLiNb (Lithium noibate). Laser CW is not energized and can cause heating and tissue unwanted damage. The optical attenuator is also known as the optical fiber attenuator used in free space to reduce the level of optical signal strength in the optical fiber. This PIN photodiode transforms the optical signal to an electrical signal that is then amplified to make up the power loss due to the fiber attenuation by means of an electrical amplifier. For reality, optical forces are seldom directly measured. In order to calculate the current, the optical energy is transformed in a relative electrical current via a system such as a PIN photodiode. The ratio between power output and optical energy accidents is referred to as responsivity (described mathematically by symbol R). Ampere units are available per watt (A / W) [14]. For group delay and shaping efficiency, the Bessel filter is used and is very similar to the Gaussian filter. An eye diagram describes the high-rate communication systems and the short or long-haul communication system.

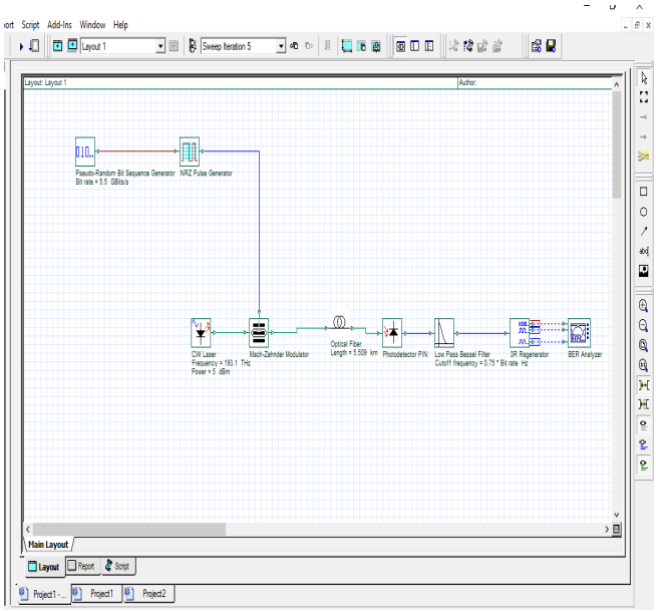

Fig.1 Block diagram of the designed optical fiber communication system.

IV. SIMULATION PARAMETER

The analysis of designed optical link using OPTISYSTEM simulator based upon several qualitative parameters. The parameters used in simulations are shown in the table (1)

Table 1: Parameter values of simulation setup

Parameters	Values(units)
Data Rate	55 GBPS
Wavelength	1550 nm
Detection	PIN
Bessel filter cutoff frequency	0.75*Bit rate (Hz)

V. RESULTS

We characterize and evaluate performance of the proposed 55Gbits/s optical fiber communication system. The performance evaluation parameters include the eye diagram of the detected signal, BER and dispersion-limited fiber length. Figure 2 shows the eye diagram of NRZ at 12.09 km with BER 10^{-9}.

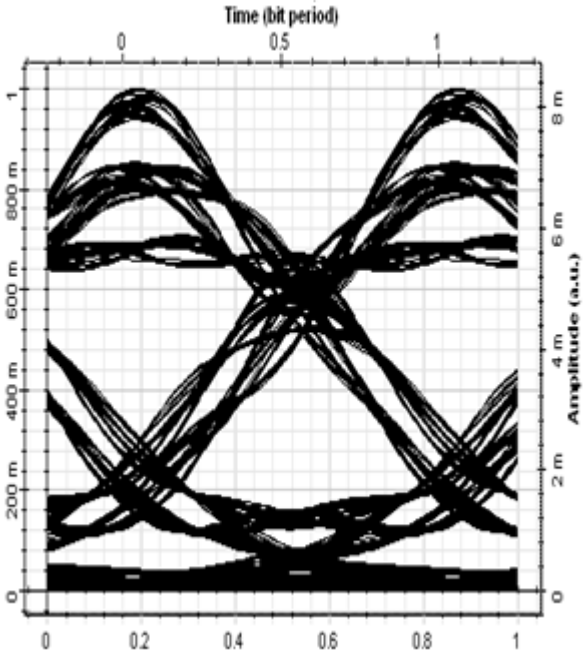

Fig 2. the simulated eye diagrams under NRZ

Figure.3 shows the eye diagram of RZ at 13.23 km with BER 10^{-9}

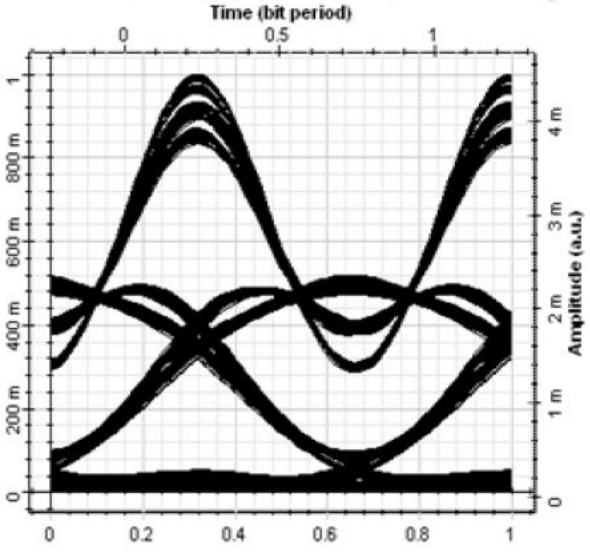

Fig 3. the simulated eye diagrams under RZ

Figure 4 shows the eye diagram Duobinary-modulated signal at 20.20km with BER 10^{-9}.

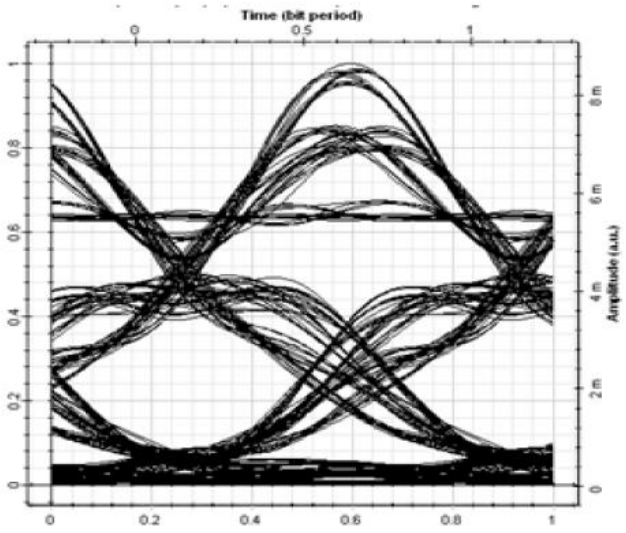

Fig 4. the simulated eye diagrams under Duobinary

VI. CONCLUSION

We simulated the optical fiber communication systems under 55Gbits/s modulation and quantified its performance. The system performance is evaluated in terms of eye diagram, BER, receiver sensitivity, and limitations on the fiber length. Inside optical fiber communication system, Duobinary modulation provides better results as compared to NRZ and RZ modulation format. Distance is the crucial factor for measuring the system performance at BER=10^{-9}.The fiber lengths are increase to 12.09 km for NRZ, 13.23 km for RZ and 20.2 km for Duobinary with limits BER= 10^{-9}.when the direct modulation is replaced by external modulation technique. Hence from these results it has been concluded that in terms of length for Duobinary modulation format is more as compare to RZ and NRZ modulation formats, it can be used for long distance transmission. So, this work is further extended with the use of advanced modulation formats. We can also vary the data rate and length of fiber with applying dispersion compensation techniques.

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