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Comparison of Polarization Shift Keying and Amplitude Shift Keying Modulation Techniques in FSO

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ABSTRACT: In this paper, the objective is to study the performance of Free Space Optical (FSO) communication system using different modulation techniques like Polarization Shift Keying (PolSK) and Amplitude Shift Keying (ASK). Atmosphere is the propagation medium for FSO communication, which is significantly influenced by different weather conditions. For mitigating this, a new modulation technique called polarization shift keying is introduced. For better data transmission, to choose a right modulation technique is the basic key to build a flexible, wide bandwidth, high data rate capacity, outstanding security free space optic network. The performance of ASK and PolSK in FSO system is analysed.

KEYWORDS: ASK, Atmospheric attenuation, Free space optical communication, Optisystem, PolSK

I. INTRODUCTION

Free-space optical communication system is an optical communication technology which uses air as a medium to transmit signal from one place to other in the form of light .Wireless laser communication becomes the development trends in the field of communication in the future. FSO link is mainly characterized by two types of attenuations; they are geometric and atmospheric attenuation [1]. The geometric attenuation can be controlled by changing the parameters like transmitter diameter, divergence angle and link distance etc. but the atmospheric attenuation depend largely on weather conditions like fog and rain. It can be reduced by proper adjustments of parameters like modulation techniques, wavelength and attenuation coefficient in the transmitter, receiver and link sections.

The most common digital modulation techniques [2] are Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK) and Differential Phase Shift Keying (DPSK). Polarization shift keying technology is a new digital modulation technique in free space communication field. PolSK modulation utilized the vector characteristics of carrier light from laser source for binary and multilevel transmission. The polarization state is the most stable parameter for the laser beam propagated in the atmosphere. PolSK can have wide advantages like peak power are limited, because of it has the advantages of constant power in the transmission process of modulated signal and small phase noise affects from the light source. Compared to other modulation schemes the PolSK have another two advantages: (1) it no longer requires the alignment of polarization coordinates of the transmitter and the receiver. (2) Distribution of light intensity will be more uniform after through particle scattering. Therefore, PolSK modulation is manifested to be a good choice for FSO system. In this paper we are comparing the performance of the FSO system using PolSK and ASK modulation techniques.

II. RELATED WORKS

The modulation of the input/source data into the EM wave carrier there are basically no. of technique used to transmit data like: amplitude modulation (AM), frequency modulation (FM), or phase modulation (PM),. For an optical wave, some another modulation technique is also used like intensity modulation (IM), On-Off Keying (OOK). Each of above technique can be theoretically implemented at any frequency and by varying phase, amplitude and frequency we can also achieved high data rate.In modulator part the data signal is modulated with a carrier signal so that it can be transmitted over a channel. There are various methods which are amplitude modulation, phase modulation and

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frequency modulation. During a transmission of signal over a channel, then it experiences fluctuations in amplitude and phase, known as scintillation which may be due to change of refractive index in different weather conditions. It reduces the performance of an FSO communication.

To improve the BER performance of a link due to scintillations, selection of appropriate modulation schemes is an important factor which determines the overall system performance. On-Off shift keying is the simple and widely adopted modulation scheme. In this a transmitted 1 is on and transmitted 0 is off. It has simple receiver design, bandwidth efficiency and cost effectiveness. From the view point of the receiver, RZ (Return to Zero) has been reported to offer better performance over NRZ (No return to Zero) in FSO links.

For error free long distance transmission the Adaptive modulation is very useful. In this technique the channel conditions are estimated at the receiver side and feed this signal to the transmitter using an RF feedback channel, so that the transmitter can be adapted relative to the channel conditions. There is an RF backup channel which is used to provide communication under severe atmospheric conditions if some signal loss is there. The Adaptive modulation is a term used in wireless communication to denote the modulation of the data signal with the carrier and then after transmission used to check the weather conditions so that the modifications can be done before transmission.

III. SYSTEM MODELLING

Differs from the other modulation techniques, PolSK is used the optical wave vector properties, encoding digital information to polarization state of transmit optical signal. It achieves process of laser communication with different polarization states to represent the logic ' 0 ' and logic ' 1 '. PolSK [3] modulate signal suitable for multi-level transmission and can achieve a high bit rate transmission, because of it is not affected by the phase noise of light source and quantum noise limit effect, and it can suppress the nonlinear optical effect. In this paper, we use the left and right circularly polarization states of optical wave representation logic signal ' 0 ' and ' 1 '.

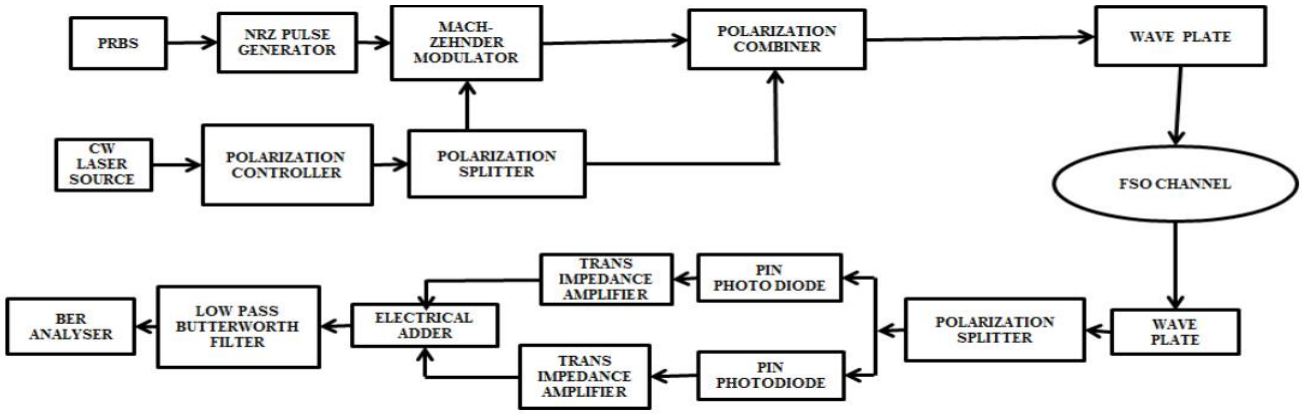

Fig: 1 Block diagram of FSO system using PolSK

The block diagram of FSO system using PolSK is mentioned in Fig.1.Continuous wave laser sends a bunch of continuous laser beam (carrier signal); then beam produces polarization after through polarization modulator and produces a bunch of line polarized light. And then the linear polarized light is divided into two lines of polarized light into X component and Y component by the polarization beam splitter .One of them goes all the way through the Mach-Zehnder modulator (MZM) and the delay to output different polarization for different signals, such as left-handed and right-handed circularly polarized light for 0 signals and 1 signal respectively. The other goes all the way through the MZM modulator and circularly polarized light is produced. According to the theory of polarization optics, after a quarter wave plate, a right-handed circularly polarized light along the first quadrant angle bisector of the coordinate system at the receiving end is converted to linear polarized light. Modulated signal will send into the FSO channel. At the receiver the modulated signal will capture using receiver antenna and the optical signal will detected by the detector using balanced system demodulation technique.

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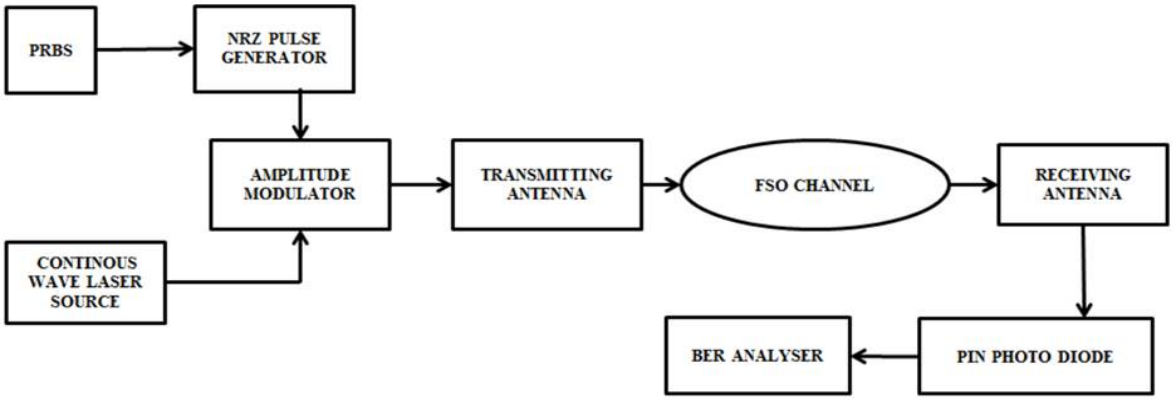

Fig: 2 Block diagram of FSO system using ASK

The block diagram of FSO system using ASK contains coder, laser source, modulator, channel and receiver section which is shown in Fig 2 .The coder generates data signal and laser source act as carrier signal. The amplitude modulator changes the amplitude of carrier signal according to the input signal. Through the transmitting antenna the modulated signal will send into the channel. Here atmosphere act as the channel. In receiver section, the receiving antenna captures the signal. The photo detector detects the optical signal and converts that as electrical signal.

IV. SIMULATION LAYOUT

Fig 3 describes the simulation setup of FSO system using ASK which consists of a transmitter, channel and a receiver. Pseudo Random Bit Sequence (PRBS) generates 1.5 GBits/s of binary data. This data is converted into electrical form by using Non-Return (NRZ) pulse generator. Continuous Wave (CW) laser source is act as carrier signal at frequency of 193.1 THz and power of 60 dBm. The output of CW laser and NRZ pulse generator is fed into the amplitude modulator. In an amplitude shift keying technique, the binary symbol 1 is represented by transmitting a fixed amplitude carrier wave and fixed frequency for a bit duration of T seconds. If the signal value is '0' then the carrier signal will not be transmitted otherwise, a signal value of 0 will be transmitted. The modulated signal is send to the FSO channel at length of 5 Km and attenuation 2.5 dB/Km. At the receiver section, PIN photodiode is present. It convert the input optical signal into electrical signal and given to the Bit Error Rate (BER) analyser. It provides the quality of the received signal

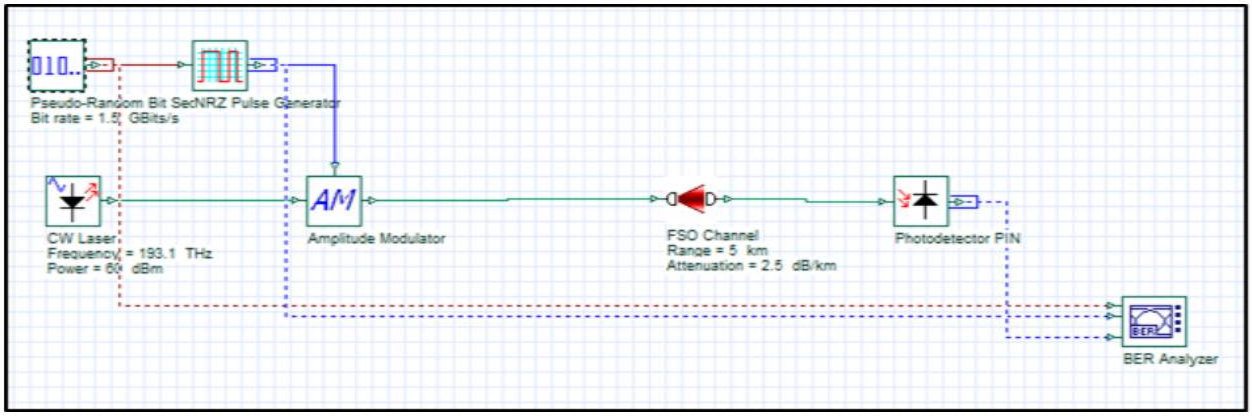

Fig.3. Simulation layout of FSO system using ASK

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The simulation setup of FSO system using PolSK is shown in Fig: 4. CW laser is act as carrier signal with frequency 193.1 THz and power of 60 dBm, PRBS generates 1.5 Gbits/s data. This data is converted into electrical form using NRZ pulse generator.

MZM will modulates the carrier signal under the influence of message signal with data rate of 1.5 GBits/s; then beam produces polarized after through polarization modulator and produces a bunch of +45º line polarized light. And then the linear polarized light is divided into two lines of polarized light by the polarization beam splitter as X component and Y component.

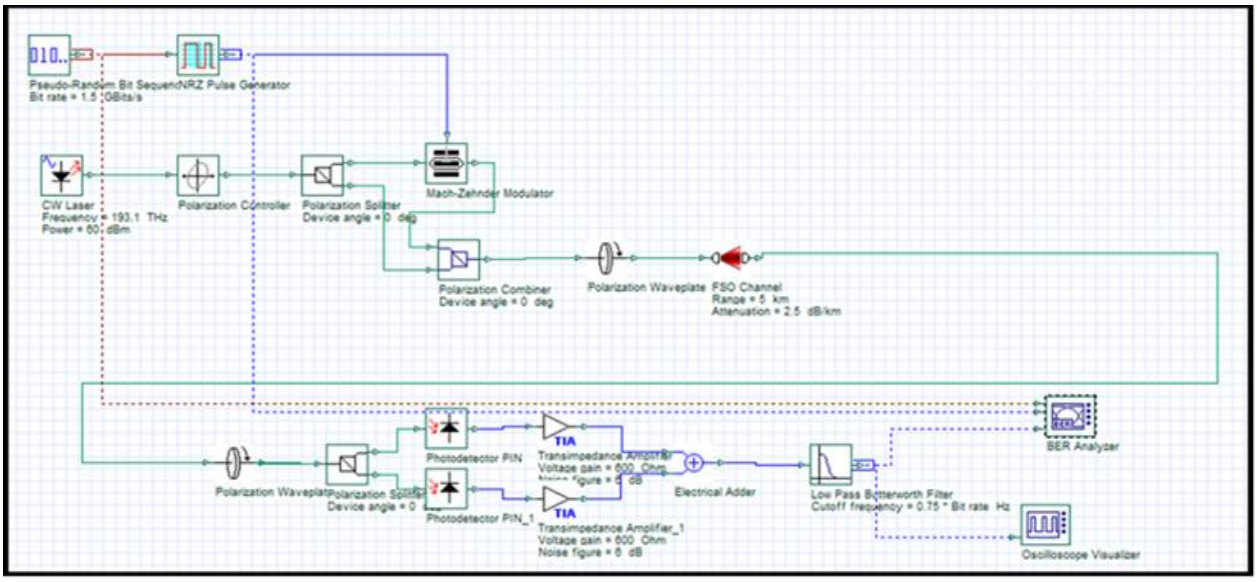

Fig.4. Simulation setup of FSO system using PolSK

One of them goes all the way through the MZM modulation. The delay to output different polarization for different signals, such as left-handed and right-handed circularly polarized light for logic' 0' and logic'1'respectively. The other goes all the way through the MZM modulator and circularly polarized light is produced. Then feds the signals into the receiver section

After a waveguide, a right-handed circularly polarized light along the first quadrant angle bisector of the coordinate system at the receiving end is converted to linear polarized light. The characteristics of the channel is, length 5 Km and attenuation of 2.5 dB/Km. Receiver antennas capture the signal and converted into linearly polarized signal. This lineally polarized signal is split by polarization beam splitter i.e., outputs'1' signal which is reflected back to the detectors D1, $i = i1 - i0 > 0$ known as the signal output by'1' information. In the similar way, linear polarized light is output after polarization beam splitter '0'information and signal $i = i1 - i0 < 0$ output and is completely transmitted to detector D0. Pin photodiode will converted the optical signal into electrical signal. Trans impedance amplifier is used to amplify the input electrical signal and adds thermal noise to the signal output. Low pass Butterworth filter is used to suppress amplified spontaneous emission and background noise. While analysing the BER analyser the quality factor and BER of the signal can be observed.

V. RESULT AND DISCUSSION

The aim of this section is to evaluate the performance of the optical communication system using different modulation techniques like ASK and PolSK with the help of visualization tool such as BER analyzer, and is analyzed using the parameter Q-Factor under the condition given in the table: 1 Figure: 5. shows the obtained eye diagram when analyzing the FSO system using modulation techniques like ASK and PolSK

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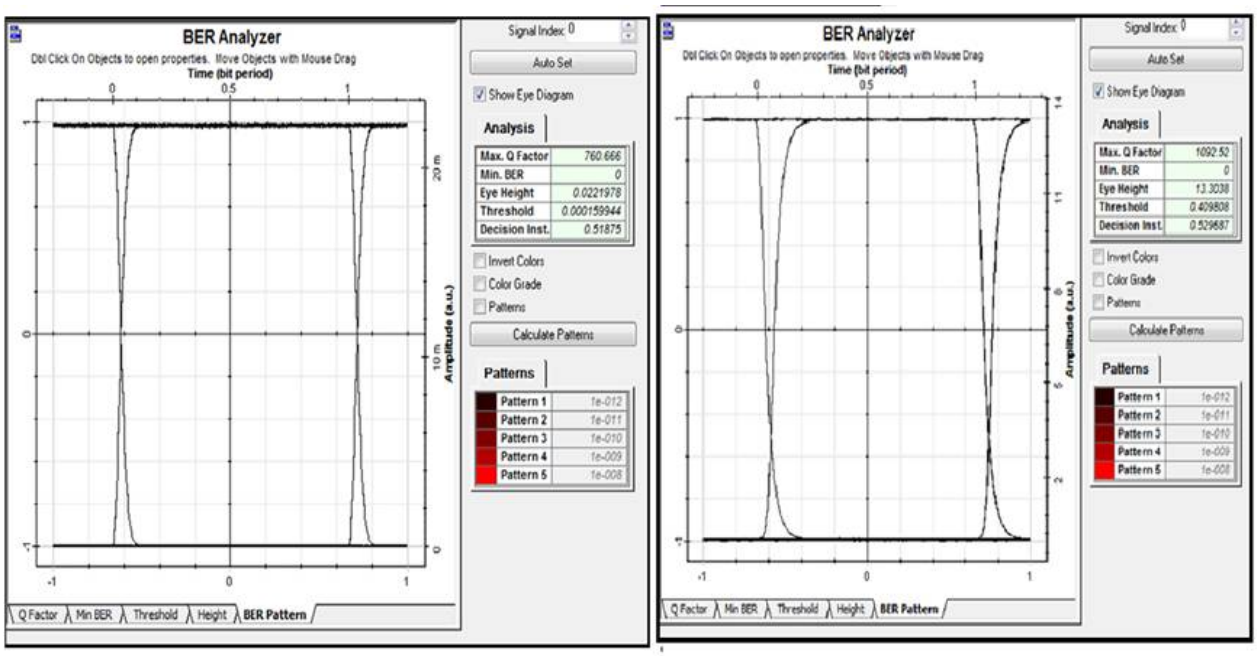
Table: 1.Parameters of simulation system

Devices	Parameters	Setting value
CW Laser	Frequency Power	193.1 THz 60dBm
PRBS	Data Rate	1.5 GBits/s
FSO Channel	Length Attenuation	5 Km 2.5dB/Km
PIN Photodiode	Responsively	1 A/W

The Q factor for ASK and PolSK are 760.66 and 1092.52 respectively. The eye opening is better indicating that the received signal is less distorted. When PolSK modulation is compared with ASK, the PolSK have high eye opening and the Q factor is high. For increasing the quality of the received signal and minimizing the losses new modulation techniques are introduced called PolSK. The eye diagram shows that the PolSK modulations technique have high quality received signal Then comparing these two modulation techniques PolSK technique is suitable for FSO system. When the channel length increases the quality of the signal will decreases because of the atmospheric disturbances [4][5].



(a) (b)

Fig.5 .Eye diagram of (a) ASK and (b) PolSK modulations in FSO system

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VI. CONCLUSION

Polarization shift keying modulation technique has many advantages such as excellent BER performance and freedom from the alignment of polarization coordinates of the transmitter and the receiver, etc. It turns out to be a good choice to FSO system. FSO system using ASK and PolSK modulation techniques is studied by simulation using optisystem software; it is found that the communication performance of the system is excellent for PolSK modulation in most weather disturbance. To improve the communication efficiency and communication rate of free space laser communication. Polarization Shift Keying (PolSK) modulation technique is used to adapt to the demands of the rapid development of the current space laser communication

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BIOGRAPHY

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