INVESTIGATION OF VARIOUS PARAMETERS ON THE PERFORMANCE OF HIGH BIT RATE FREE SPACE OPTICS USING DIFFERENT MODULATION FORMAT

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Abstract

The free space optics communication (FSO) system provide a high bandwidth, small size, light weight, low power, and low cost alternative to present microwave system. In this paper, different modulation format RZ, NRZ, and Manchester on the high bit rate free space optical communication system has been investigated. RSoft OptSim software is used to design communication links for these modulations and simulation is done in the block mode.

Keywords: *Free Space Optics, Bit Error Rate, Modulation Formats*

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1. INTRODUCTION

Communication can be broadly defined as the transfer of information from one point to another. When the information is to be conveyed over any distance a communication system is usually required. Within a communication system the information transfer is frequently achieved by superimposing or modulating the information on to an electromagnetic wave which act as a carrier for the information signal. This modulated carrier is then transmitted to the required destination where it is received and the original information signal is obtained by demodulation. Sophisticated techniques have been developed for this process using electromagnetic carrier waves operating at radio frequencies as well as microwave and millimeter wave frequencies. However, 'communication' may also be achieved using an electromagnetic carrier which is selected from the optical range of frequencies [1]. The last two decades free space communication (FSO) has become more and more interesting as an adjunct or alternative to radio frequency communication [2]. Free-space optical communication (FSO) is an optical communication technology that uses light propagating in free space to transmit data for telecommunications or computer networking. "Free space" means air, outer space, vacuum, or something similar. This contrasts with using solids such as optical fiber cable or an optical transmission line. The technology is useful where the physical connections are impractical due to high costs or other considerations.

FSO is an optical technology which requires no spectrum licensing with other uses and provides secure transmission [3]. The FSO technology is capable of providing much higher bandwidth than any other competing wireless solutions [4]. BER of received data increases when path length is increased, also increase when data rate increases. In other case it observed that BER of received data increases when path length is increases, also increase when divergence angle increases and Q factor decreases with increase in distance and divergence angle [5]. The extensive studies in modeling fog and simulating FSO attenuations reveal the complexity behind estimating FSO link availability in a given geographical location. There are many different types of fog that are inhomogeneous along the propagation path. Each type is characterized by water-droplet size and concentration; these parameters are used in Mie scattering theory to compute FSO signal attenuation [6].This focused the impact of transmission power and attenuation in free space optical communication system.

2. SYSTEM MODELLING

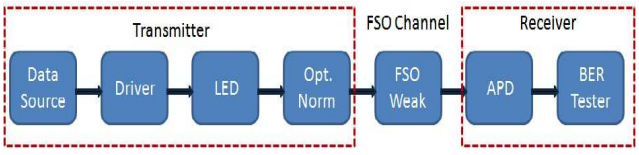


Fig-1: Block Diagram of FSO Communication Link

High data rate FSO design has been modeled and simulated for performance characterization by using OptSim.4.6. Fig.1 shows a design of Free Space Optics link. The transmitter consist of a PRBS generator at bit rate 2Gbps, an RZ,NRZ, Manchester modulation format driver, and a directly modulated LED at 1550 nm. Optical power out of the transmitter is 1.3dBm. The FSO link has a 1Km range with beam divergence angle of 3mrad. The receiver is APD and is followed by a BER tester. The FSO compound component is

shown in Fig.2. It consists of optical attenuator block to model geometrical, additional attenuation and optical noise adder block to add the background radiation to received signal.Fig.3 shows a simulation set-up for the FSO link.

Fig-2: FSO compound component and its internal structure.

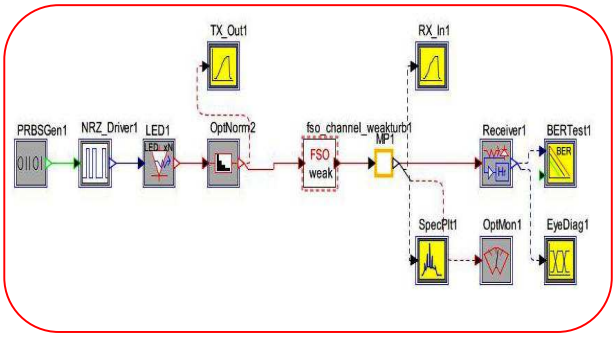


Fig-3: Simulation set-up for FSO link.

3. RESULTS AND DISCUSSION

In our proposed design, performance of different modulation format has been evaluated on free space optical communication. A comparative study has been carried out for free space optical communication at different modulation format of RZ, NRZ and Manchester. Here, the results have been mentioned for FSO system at different modulation format by taking values of the various parameters like: Data rate 1.25Gbps, transmitter wavelength 1550nm, transmitter power 1.3dBm, standard deviation (Sigma) of 1.9dB, divergence angle 3mrad and transmission length 1000m. The receiver is an APD and is followed by a BER tester. Fig.4. shows the power spectrum of FSO system at wavelength 1550nm.

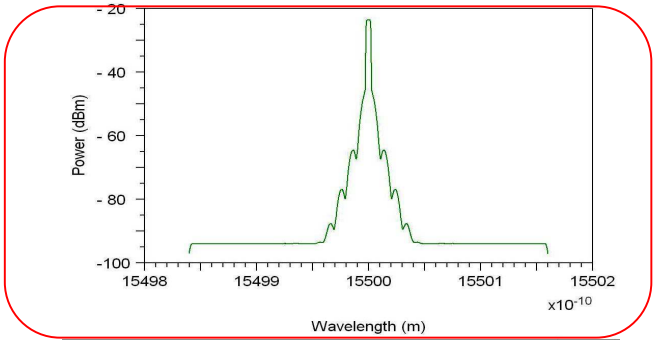
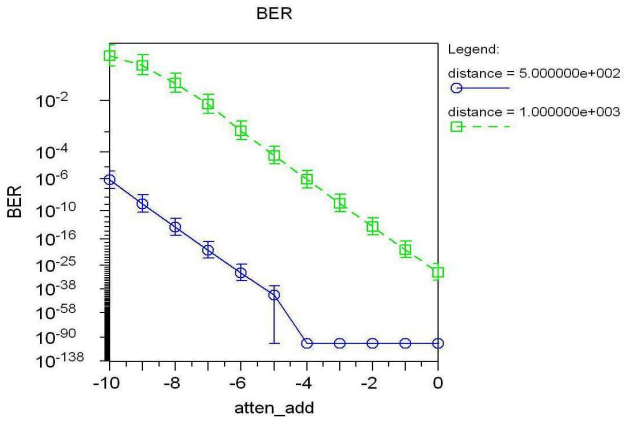
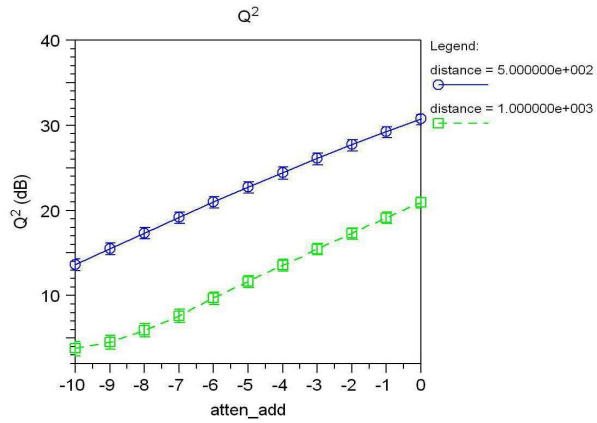


Fig-4: Power Spectrum.

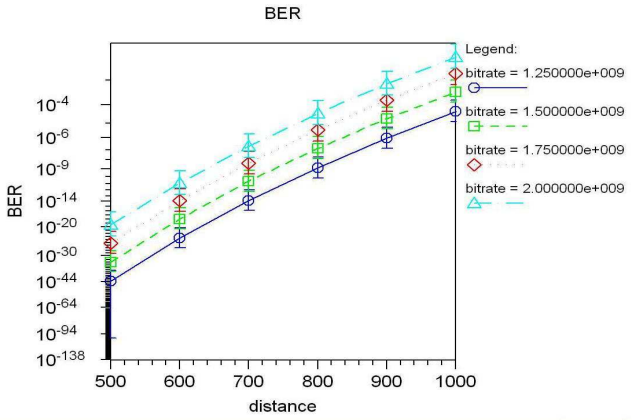


(a)



(b)

Fig-5: (a) BER value and (b) Q^2 value with different distance using RZ modulation format.



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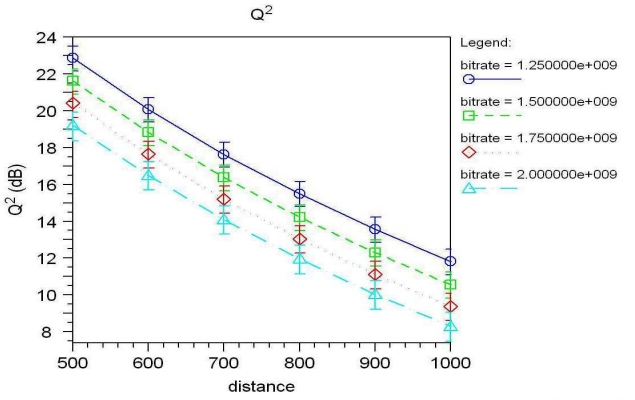
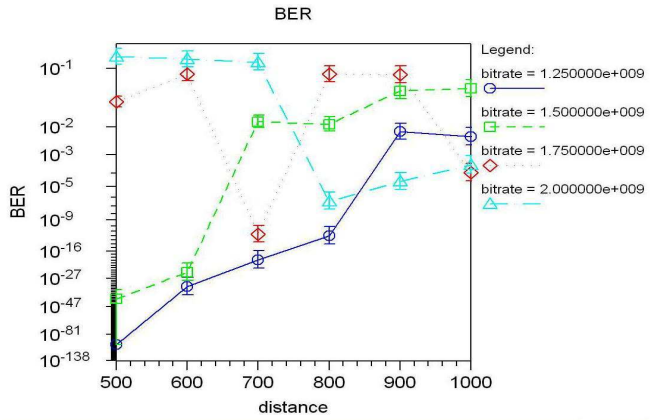
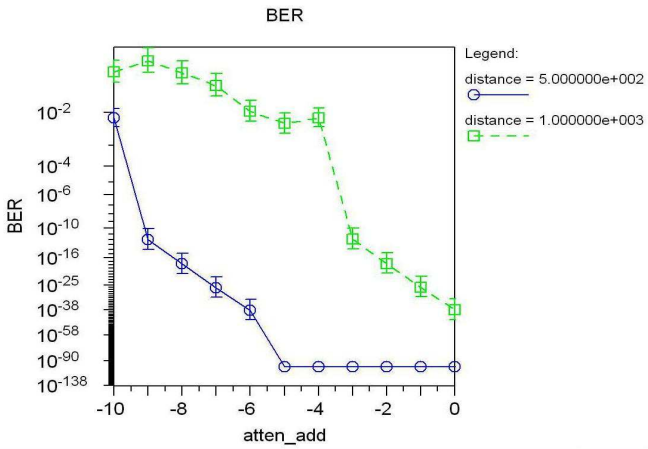


(b)



(a)

Fig-6: (a) BER value and (b) Q^2 value with different bitrates using RZ modulation format.



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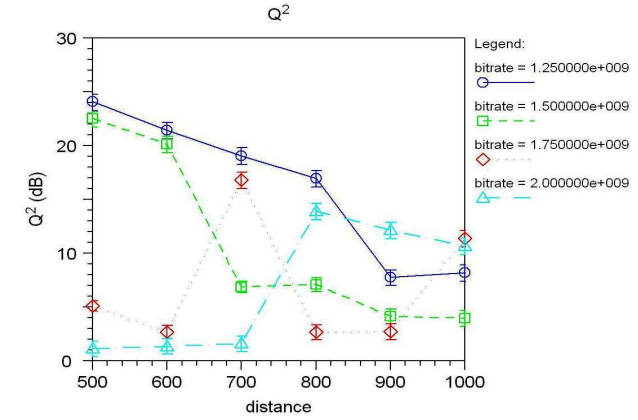
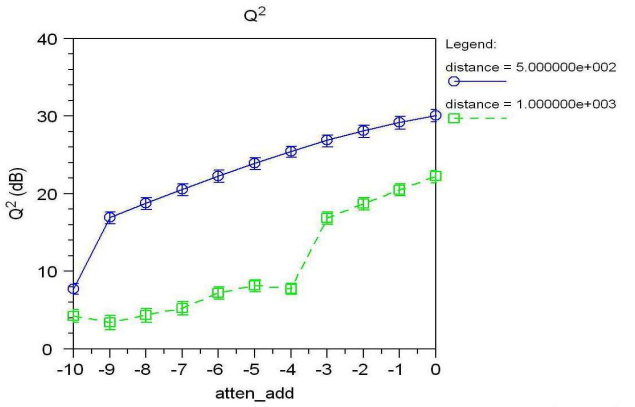
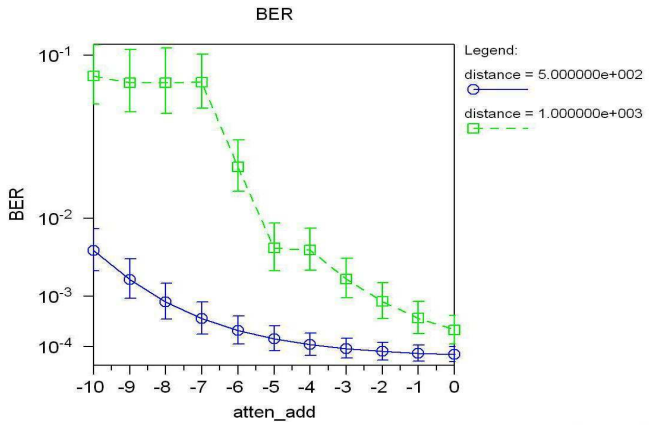


(b)

Fig-8: (a) BER value and (b) Q^2 value with different bitrates using NRZ modulation format.

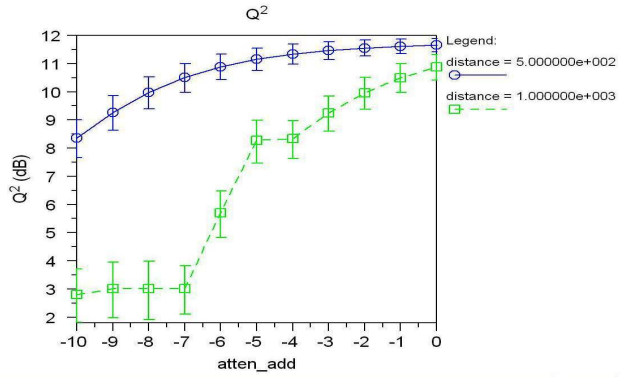


(b)



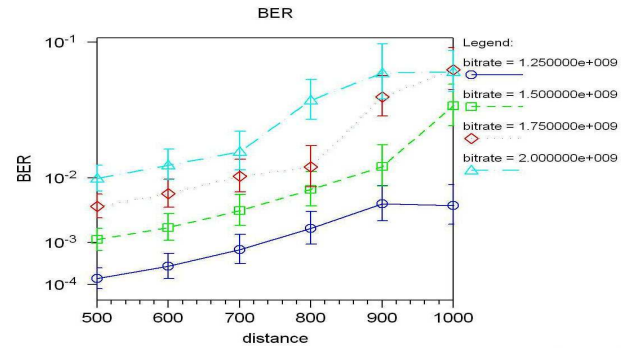
(a)

Fig-7: (a) BER value and (b) Q^2 value with different distance using NRZ modulation format.

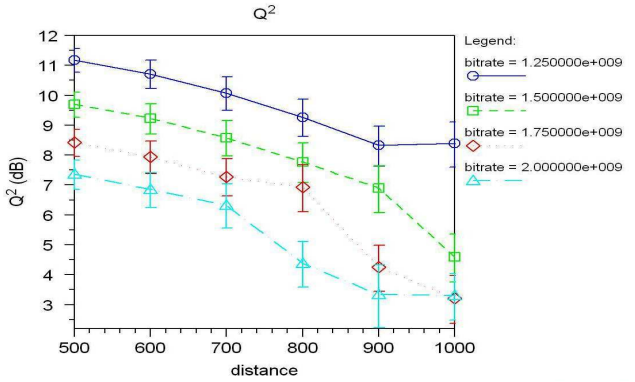


(b)

Fig-9: (a) BER value and (b) Q^2 value with different distance using Manchester modulation format.



(a)



(b)

Fig-10: (a) BER value and (b) Q^2 value with different bitrates using Manchester modulation format.

Fig.5 (a) and (b) indicates the graph between BER value and Q^2 versus the attenuation addition (atten_add) at different distance using RZ modulation format. From results it has been observed that there is significant increase in the value of BER. Further, it has been observed that there is significant decrease in the value of Q factor.

Fig.6 (a) and (b) indicates the graph between BER value and Q^2 the transmission distance at different bitrates using RZ modulation format. From results it has been observed that there is significant increase in the value of BER. Further, it has been observed that there is significant decrease in the value of Q factor.

Fig.7 (a) and (b) indicates the graph between BER value and Q^2 versus the attenuation addition (atten_add) at different distance using NRZ modulation format. From results it has been observed that there is significant increase in the value of BER. Further, it has been observed that there is significant decrease in the value of Q factor.

Fig.8 (a) and (b) indicates the graph between BER value and Q^2 the transmission distance at different bitrates using NRZ modulation format. From results it has been observed that there is significant increase in the value of BER. Further, it has been observed that there is significant decrease in the value of Q factor.

Fig.9 (a) and (b) indicates the graph between BER value and Q^2 versus the attenuation addition (atten_add) at different distance using Manchester modulation format. From results it has been observed that there is significant increase in the value of BER. Further, it has been observed that there is significant decrease in the value of Q factor.

Fig.10 (a) and (b) indicates the graph between BER value and Q^2 the transmission distance at different bitrates using Manchester modulation format. From results it has been observed that there is significant increase in the value of BER. Further, it has been observed that there is significant decrease in the value of Q factor.

4. CONCLUSIONS

In this work, we have designed a FSO system to establish a FSO link of 1km length between transmitter and receiver at data rate of 2 Gbps. It is concluded from our simulated FSO system using RSoft OptSim simulator to establish different modulation format RZ, NRZ, and Manchester on the high bit rate free space optical communication system has been investigated. Simulation results show that RZ modulation format is best.

REFERENCES

[1]. John M.Senior, “Optical fiber communication”, 2ndedn, Prentice-Hall of India private ltd., Newdelhi (2005) .
[2]. HennesHENNIGER, OtakarWILFERT,“An introduction to free space optical communication”radio engeneering (June 2010) vol.19, page203-212.

[3]. Visual Sharma ,GurimandeepKaur,"Degradation Measures in Free Space Optical Communication (FSO) and its Mitigation Techniques" International journal of computer applications Vol.55, issue.1 (2012).
[4].Wakamorikazuhiko(HamamatsuhotonikusuKaihatsuhombu) "The Free-Space Optical Communication Systems" Japanese Journal of Optics, VOL.33; NO.10; PAGE.588-594(2004).
[5]. Jitendrasingh, vinodkapoor"IJCA Special Issue on Communication and Networks" Number 1(2011).
[6]. MahaAchour"Free-space optics wavelength selection: 10 µm versus shorter wavelengths" Journal of Optical Networking, Vol. 2, Issue 6, pp. 127-143 (2003).

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