Free Space Optics Performance Analysis Under 8dBm Impact of Power in Spatial CW Laser and Attenuation 2dB/Km in FSO Channel on Various Atmospheric Effects

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***Abstract*—Free space optics is a technology for optical communication. It is used where the fiber optic cable is impracticalbecause of its high cost in installation or other reason. In FSO the signal/information is transmitted by the transmission of light into free space. Wavelength used for the transmitting of data in FSO system are 850nm, 1310nm, and 1550nm. Out of these wavelengths, 1550nm laser wavelength is preferred mostly as this wavelength provides more wide range, the performance, and safeness. The 1550nm has a high data rate ranging from 20 to 40 Gbps and is less affected by solar and also it has a beam level of power. In this research paper the FSO link is assess on the basis of eye diagram readings in the form of q-factor and BER values. From the simulation we have noticed that link distance is reduced while we increase the range and attenuation of the FSO channel.**

Keywords: BER, Spatial CW Laser, Free Space Optics (FSO),BER Pattern, Q-Factor, Eye Diagram.

I. Introduction

Now is the world of connectivity with high data rates with Recent criteria for high-speed and latency applications have departed Wired and wireless RF interaction, but these are the bandwidth of communication systems is small, so Improving the bandwidth used by wireless technology. FSO has an optical transceiver at both ends to provide the bi-direction capability. FSO is a cost-effective and glamorous solution for high data rate and voice communication. FSO avoids many challenges as the digging of ground, roads, etc practically which is very costly, whereas the FSO system is mounted within a building or top of the building/roofs. As compare to the OFC it has a very low error rate, cost-effective. FSO takes much less time in installation as of OFC. In FSO, the presence of physical connection among the transmitter and receiver is not required [1][2]. And it can be presented to upgrade for long distances up to a few kilometres with high data transferring rate. With the wireless industries growing need for higher rates of transfer and higher speeds Optical cable or cables, the higher the volume of data transmitted, Transfer capabilities are approaching their limits. Minimal expense, permit free, and connections of high speed are provided by FREE-SPACE optical (FSO) systems, which makes FSO a promising solution for a variety of applications [3]. In addition to indoor wireless local area networks and network node interconnections, FSO systems are used as a rapidly deployable network. Communication scheme in circumstances of disaster recovery, the atmospheric vibration occurring due to spontaneous variations in the refractive index of air is adversely affected by the device ability and transmission distance of free-space optical links. A number of approaches have been suggested to minimize the Scintillation effects in FSO systems [4]. By averaging the received waveform over the aperture region, a wide aperture receiver will reduce signal fluctuations if its diameter is larger than the optical scintillation spatial coherence scale. The average factor is limited, however, by the size of the optical beam. The scintillation effects can be reduced by having diversity in space. Other methods, such as finely tuned receive filters and automatic filters gaining controls that are typically used in commercial FSO Scintillation noise cannot be mitigated effectively by systems. In this report, they suggest and experimentally explain a simple approach using CW laser for scintillation suppression of FSO channels. When the gain is saturated by the input turbulent signal, the optical amplifier erbium-doped optical amplifier (EDFA) or semiconductor optical amplifier (SOA) can help in the reduction of variations in amplitude and also amplify the optical signal [5][6]. Atmospheric attenuation or turbulence affects the signal propagating through FSO, leading to complete link loss at the Rx end and degrading the link output [7-19].

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II. Simulation Based FSO Design

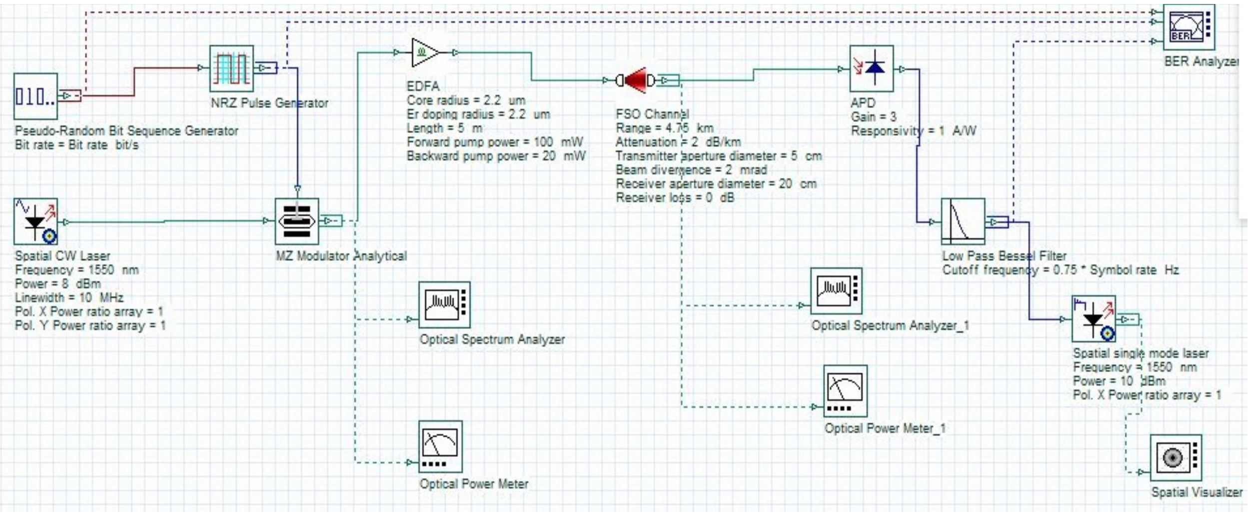

Fig. 1: Simulation Setup FSO Link

In this diagram we used spatial CW laser used at transmitter side, spatial single mode laser is at the receiver. The effect is measured at a wavelength of 1550nm in the above configuration and the power is 8dBm in the Spatial CW laser that generates the invisible laser beamline width is 10MHz. Before that, FSO channel in which they set the core radius as 2.2um, Erbium doping radius as 2.2um, length as 5m, forward pump power as 100mW, and backward power as 20mW, the Erbium-doped fibre amplifier (EDFA) is simulated. But then the FSO under which the Opti-system provides the provision to adjust free space optics parameters FSO channel range is 4.75km, transmitter diameter is 5cm and Receiver is 20cm. where they have set six different link ranges as 4 km, 4.25km, 4.5km, 4.75 km, 5km and 5.25km and other parameters such as attenuation as 2 dB/km, the diameter of transmitter aperture as 5 cm, the divergence of beam as 2mrad, the diameter of receiver aperture as 20cm and loss of receiver as 0dB. The optical power meter and optical spectrum analyzer instruments are attached to the transmitter and receiver to determine the output of the FSO link in order to measure optical power, as shown in Fig. 1. The FSO channel is linked to the APD photodetector whose frequency of gain and cut-off they set as 3 and 1 A/W respectively. Then the low pass filter, whose cut-off frequency is 0.75* Bit rate Hz, before the BER study. The frequency of the spatial single mode receiver is 1550nm with 10dBm capacity.

III. Result and Discussion

The basic design of the FSO system was modelled and simulated for performance characterization using OptiSystem 16.1, a powerful software design tool that allows almost any type of optical connection in the transmission layer of a large range of optical networks to be designed, tested and simulated. The system efficiency in terms of Q-factor was obtained by using different Spatial CW laser wavelength is 1550 nm range in 4km, 4.25km, 4.5km, 4.75km, 5km and 5.25km by varying the data rate and the visibility between the two transceivers in single mode. The simulation results in the form of BER Pattern at BER Analyser are shown in figures 2, 3, 4, 5, 6, and 7.

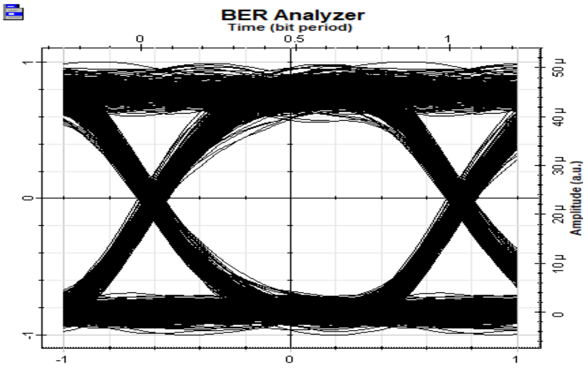

Fig. 2: Range 4km BER Pattern

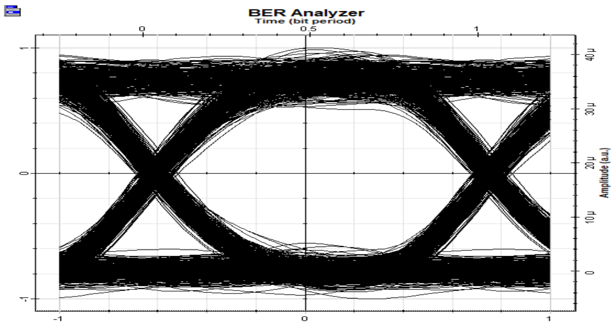

Fig. 3: Range 4.25km BER Pattern

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Several parameters, including geometrical loss, link margin, obtained power and BER, can determine the output of the FSO link. This work focuses on two parameters to evaluate the output of the FSO connection, which is the BER and power obtained, Power 8dBm. BER pattern is shown in Fig. 2 to Fig.7.

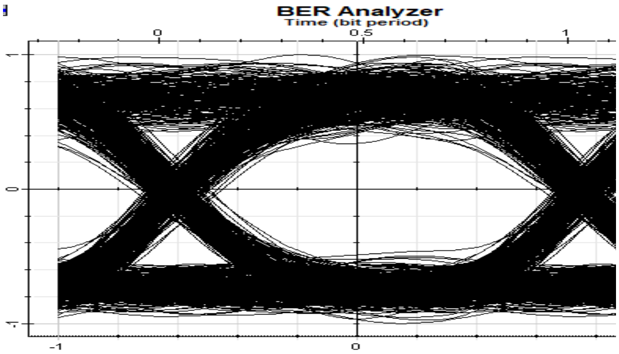

Fig. 4: Range 4.5 km BER Pattern

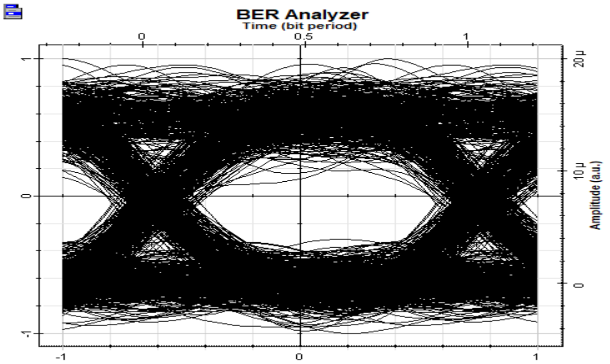

Fig. 6: Range 5 km BER Pattern

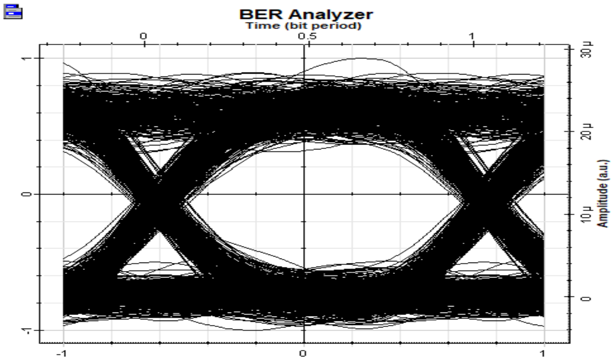

Fig. 5: Range 4.75 km BER Pattern

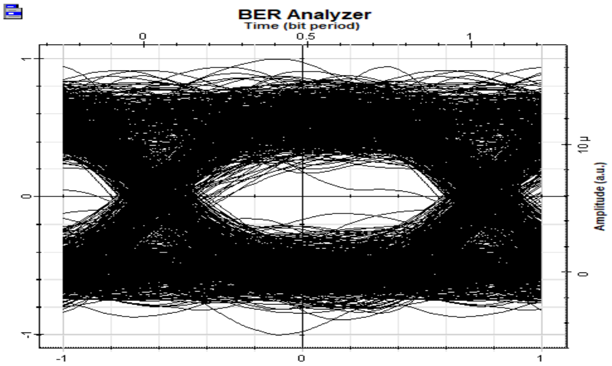

Fig. 7: Range 5.25 km BER Pattern

TABLE 1. SHOWS SIMULATION RESULTS AT BER ANALYSER.

Distance	Q-FACTOR	BER	Eye Height	Threshold	Decision Inst.
4km	14.4565	1.19×10-15	3.60×10-5	1.92×10-5	0.65625
4.25km	11.9996	2.42×10-11	2.67×10-5	1.5×10-5	0.6875
04.5km	9.74506	2.04×10-8	1.9×10-5	1.2×10-5	0.625
4.75km	7.91678	1.19×10-15	1.41×10-5	9.75×10-6	0.53125
5km	6.57303	2.42×10-11	9.99×10-6	8.33×10-6	0.6875
5.25km	5.48527	2.04×10-8	6.805×10-6	6.805×10-6	0.53125

TABLE 2. MEASUREMENT OF THE OPTICAL POWER METER PORTION OF THE TRANSMITTER AND RECEIVER

Transmitter Section Optical Power Meter		Receiver Section Optical Power Meter on Different FSO Range					
		4km	4.25km	4.5km	4.75km	5km	5.25km
Noise Power	0.000 w -100.0dbm	3.925E-9w -54.061dbm	3.093E-9w -55.095dbm	2.460E-9w -56.090dbm	1.972E-9w -57.051dbm	1.772E-9w -57.851dbm	1.287E-9w -58.905dbm
Parameterized Signal Power	0.000 w -100.0dbm	0.000 w -100.0dbm	0.000 w -100.0dbm	0.000 w -100.0dbm	0.000 w -100.0dbm	0.000 w -100.0dbm	0.000 w -100.0dbm

Table 2 (Contd.)...

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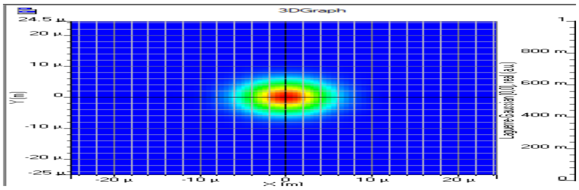
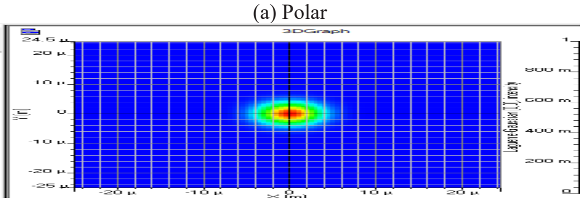
Sampled Signal Power	2.975E-3w 4.737 dBm	7.053 E-6 w -21.515dBm	5.573 E-6 w -22.539 dBm	4.434 E-6 w -23.532 dBm	3.548 E-6 w -24.500 dBm	3.148 E-6 w -24.900 dBm	2.309 E-6 w -26.365 dBm
Signal Power	2.975E-3w 4.737 dBm	7.053 E-6 w -21.515dBm	5.573 E-6 w -22.539 dBm	4.434 E-6 w -23.532 dBm	3.548 E-6 w -24.500 dBm	3.148 E-6 w -24.900 dBm	2.309 E-6 w -26.365 dBm
Total Power	2.975E-3w 4.737 dBm	7.057 E-6 w -21.513dBm	5.576 E-6 w -22.537 dBm	4.436 E-6 w -23.530 dBm	3.550 E-6 w -24.498 dBm	3.150 E-6 w -24.898 dBm	2.311 E-6 w -26.363 dBm

The3D graph shows the polar and rectangular at sum in the spatial visualizer by using the spatial signal laser beam with the frequency of 1550nm, power =10dBm and pol. X power ratio array =1



(a) Polar



(b) Rectangular

Fig.8: Single-mode Laser Polar and Rectangular 3D Graph

IV. Conclusion

The main objective of this research is to analyze the Free space optics performance under 8 dBm impact of power in spatial continuous wave laser and FSO channel attenuation of 2dB/km and in our study the range for the transmission of signal is taken from 4km to 5.25km with the gap of 0.25km such as 4km, 4.25km, 4.5km, 4.75km, 5km, and 5.25km. With the wavelength of 1550nm the performance is taken on basis of Q-Factor and BER at the BER analyser.At the range of 5.25km the Q-Factor is 5.48527. In this research for FSO we prefer Mach-Zender modulator with an NRZ Modulation technique.

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