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Research Article

Influence of various Pulse generation methods on OWC link using different transmitter powers

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Abstract

Optical wireless communication has undeniably revolutionized the satellite communication systems for use in the coming future. These OWC systems have become popular due to their high data rate performance in different weather conditions. This paper demonstrates a comparative analysis of RZ (Return to zero), NRZ (Non-return to zero) and Gaussian pulse generation methods by varying the levels of input power. The performance of Optical Wireless Communication system link is analysed for long distance transmission. The Inter satellite link has been modelled at a data rate of 10 Gbps for communication range of 200 kilometers.

Keywords: *Optical wireless channel (OWC), RZ (Return to zero) pulse generator, NRZ (Non Return to zero) pulse generator, Gaussian pulse generator, Quality(Q) factor, Height of Eye diagram*

1. Introduction

As the radio frequency spectrum congests, the optical medium provides an attractive alternative, supplying ample and easily-reusable spectral resources. Optical wireless communications (OWC) that use light to carry information through a tetherless channel can offer Gbps connectivity to wireless users (G. D. Fletcher *et al*, 1991).

Indoor and outdoor optical wireless communication systems provide many advantages over other wireless technologies, including significantly higher data rates and a large amount of available licence-free frequency spectrum (N. Kadir, 2011). Despite these major advantages, the widespread deployment of optical wireless systems is hindered by several challenges, such as the demand to maintain strict line-of-sight alignment between transmitter and receiver in some outdoor applications; the need to combat attenuation due to adverse weather conditions such as fog, cloud, and turbulence; and most importantly retaining power levels within the eye safety limits (L. Tan *et al*, 2008; A. Polishuk *et al*, 2004; Robert M. Gagliardi, 2004) .

Thus due to their numerous advantages, OWC systems have been into practice for communication during these days. Besides the above mentioned advantages, the systems suffer from some problems like bandwidth inefficiency, erroneous transmissions, power constraints, and noises in communication systems that need to be overcome for better efficiency (H. Wu *et al*, 2009).

In this paper, simulative analysis on OWC systems has been performed using three different pulse generation methods and the effect of input power on the Quality factor and height of eye diagram of the system has been analyzed at 10 Gbps. The paper is organized as follows: Section II describes the block diagram of the system, Section III elaborates the results and discussion and Section IV concludes the paper.

2. Block diagram of System

The OWC link consists of the optical transmitter, optical wireless channel, EDFA, optical receiver, filter and BER analyser. The block diagram of the system is shown in figure 1.

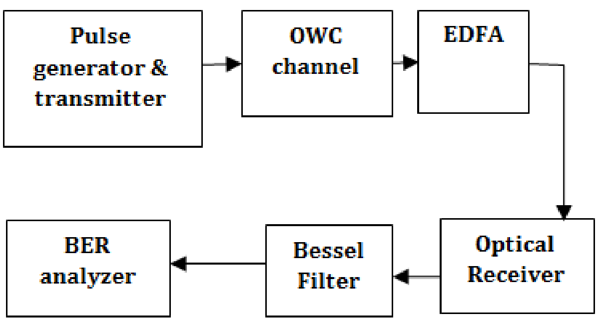

Fig 1: Block diagram of OWC link

The transmitter section consists of a pulse generator, a continuous wave laser and modulator for long distance transmission of information signal. Three pulse

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generators that are RZ pulse generator, NRZ pulse generator and Gaussian pulse generator are considered one by one to find out the most suitable for the link (Navidpour S. M. *et al*, 2007; Y. Kahn J.M., 2001).

Optical wireless refers to transmission of optical data through wireless medium but the transmission takes place through unguided media (V. Sarup *et al*,2014; S, Saini *et al*, 2015). This implementation can be performed using Optisystem software by using the OWC channel between an optical transmitter and optical receiver having an optical antenna with 15 cm aperture at each end. The channel is modelled at a wavelength of 1550 nanometres and two optical channels are modelled each covering a distance of 200 kilometres.

The most widely used fibre amplifiers in optical communication are the Erbium doped fiber amplifiers for of long distance communications (Shaina *et al* 2015).

EDFAs are usually preferred for the long range communication because they provide in-line amplification of the signal without the requirement of electrical conversion. Moreover, EDFAs provide high power efficiency from pump to the signal power and possess relatively flat gain characteristics which make them suitable for long distance communication. EDFAs are generally operated near 1550 nm window for achieving higher efficiency.

The high sensitivity of the receiver can be achieved by using small, low-capacitance photo detectors or detectors having internal gain mechanisms, such as Avalanche Photo Diodes. APD receivers are capable of providing 5-10 dB improvement over PIN detectors, along with increased cost and a more complex high voltage bias circuit.

The simulations parameters ie Q factor and height of eye diagram, analysed in the paper are viewed at the output of the receiver using BER analyser.

3. Results and discussions

We evaluate the performance of an OWC link with a link length of 200km, operating at a wavelength of 1550 nm using RZ, NRZ and Gaussian pulse generation methods.

3.1 RZ Pulse generation Method

Return-to-zero (RZ) describes a line code used in telecommunications signals in which the signal drops to zero between each pulse. This takes place even if a number of consecutive 0s or 1s occur in the signal (A. Gupta *et al*, 2013; P. Kaur *et al*, 2015).

Figure 2 depicts the eye diagram for an input power of 0.001 W at a distance of 200 kilometres using RZ modulation format. It has been observed that a Quality factor of 17.11, height of Eye diagram is 0.000222 and a bit error rate of 4.24e-66 has been attained for the same which is acceptable for such a long distance transmission.

Figure 3 and 4 explains the eye diagram for an input power of 0.005W and 0.01W respectively. A Quality factor of 40.188 and height of eye as 0.00125 have been attained with a bit error rate of 0 for former case and Q factor 60.80 and height of Eye 0.00257 is achieved in later case which is large as compared to previous two cases. Hence a reduced input power can therefore be advantageous for an efficient communication system but at the cost of reduced system performance characteristics.

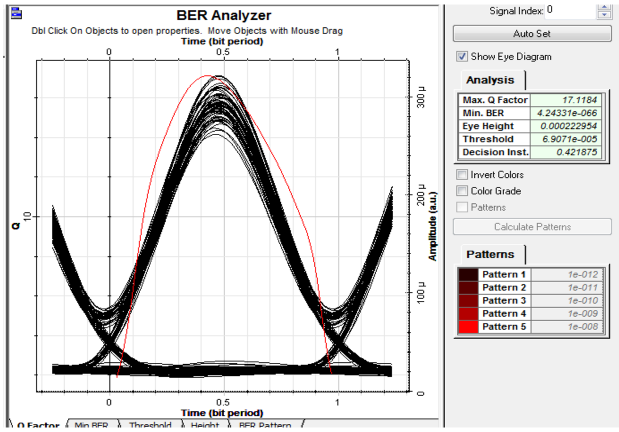

Fig 2: Output of BER analyser at 0.001 W

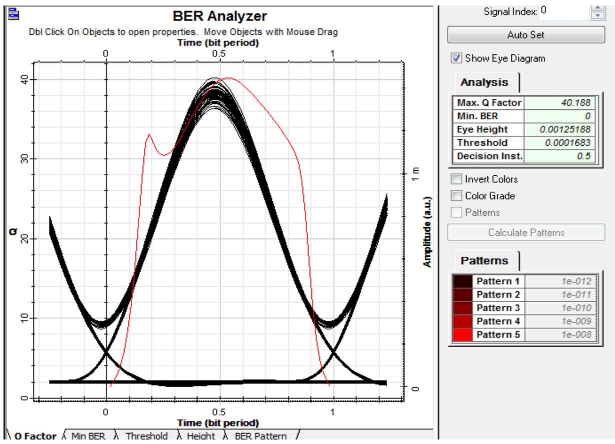

Fig 3: Output of BER analyser at 0.005 W

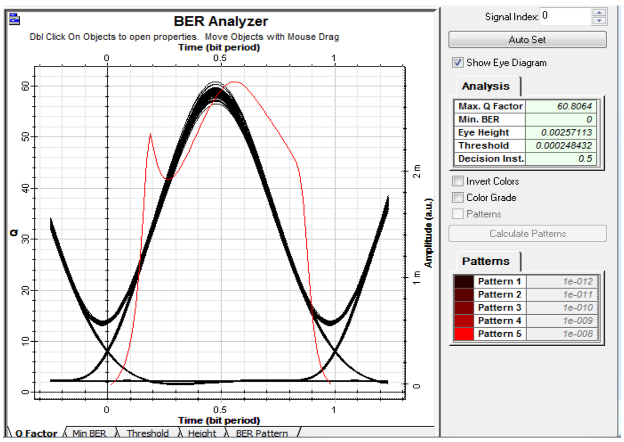

Fig 4: Output of BER analyser at 0.01 W

3.2 NRZ pulse generation method

In telecommunication, a non return to zero (NRZ) line code is a binary code in which ones are represented by one significant condition, usually a positive voltage, while zeros are represented by some other significant condition, usually a negative voltage, with no other neutral or rest condition. The pulses in NRZ have more energy than a return-to-zero (RZ) code, which also has an additional rest state beside the conditions for ones and zeros (A. Gupta, 2012; S. Saini, 2014).

Fig. 5, 6 and 7 shows the eye diagram using NRZ pulse generation method at an input power of 0.001W, 0.005W and 0.01 W. The diagrams show that if we increase the input power to 0.01 W the Quality factor increases to 70.144, height of eye 0.00310 and the bit error rate decreases to 0 which are also acceptable but at the cost of increased input power. The results are better as compared to those obtained for RZ pulse generation method.

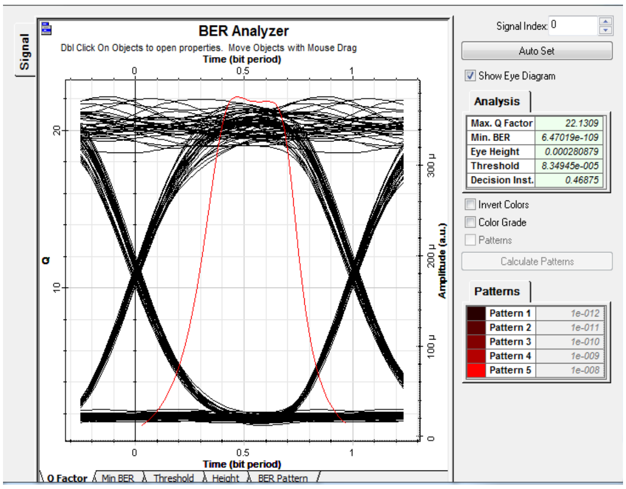

Fig 5: Output of BER analyser at 0.001 W

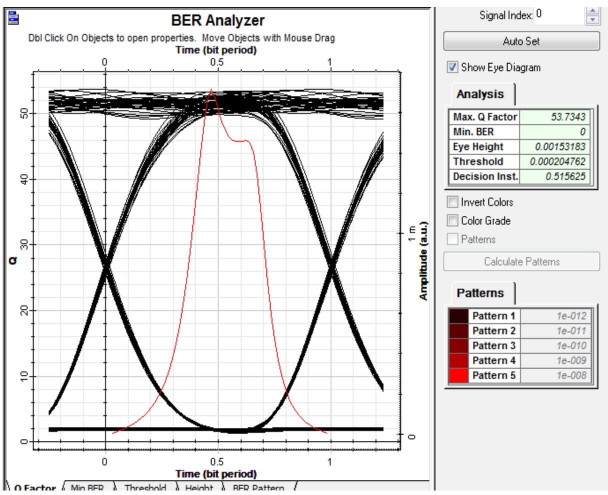

Fig 6: Output of BER analyser at 0.005 W

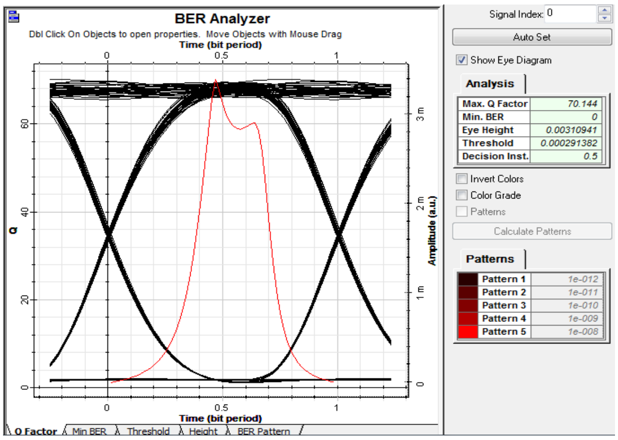

Fig 7: Output of BER analyser at 0.01 W

3.3 Gaussian Pulse generation method

A Gaussian pulse is shaped as a Gaussian function and is produced by a Gaussian filter. It has the properties of maximum steepness of transition with no overshoot and minimum group delay.

In Fig. 8, 9 and 10 the eye diagram has been analyzed for an input power of 0.001 W, 0.005W and 0.01 W at a distance of 200 kilometres by using the gaussian modulation format. The eye diagram reveals that if we increase the input power to 0.01 for the same system configuration, the results are better than RZ format but not as good as NRZ modulation format.

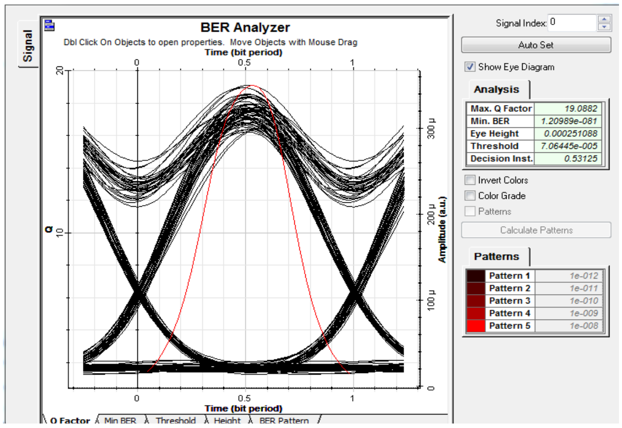

Fig 8: Output of BER analyser at 0.001 W

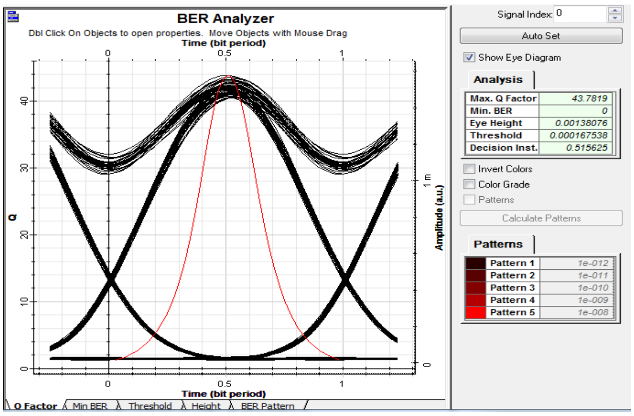

Fig 9: Output of BER analyser at 0.005 W

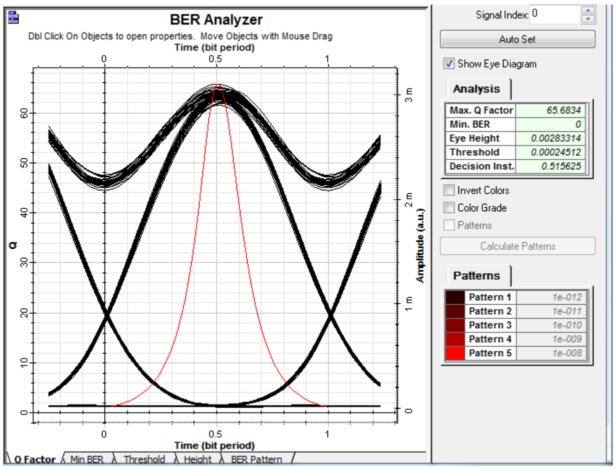

Fig 10: Output of BER analyser at 0.01 W

Hence it is preferable to use NRZ pulse generation method for optimum working of the system as it makes a trade off between the input power as well as the system's Quality factor and Bit error rate.

Conclusions

The Q factor and height of eye diagram of an OWC link with different pulse generations techniques at various transmitter powers are evaluated. A brief comparative analysis has been provided in the paper. It is seen that the value of both the Q factor and height of eye diagram improve as the power of transmitter is increased. Moreover, the NRZ pulse generation method is more significant in generation of pulse for transmission. We observe that the value of both simulation parameters is maximum in case of NRZ technique over other two techniques.

References

G. D. Fletcher, T. R. Hicks and B. Laurent (1991), The SILEX optical interorbit link, *Electronics & Communication Engineering Journal*

N. Kadir, A. 1. Aziz, S. J. Chowdhury, S.Shamma and M. Tarique (2011), Performance Improvement of the Tracking System of a Satellite Laser Communication, *International Journal of Computer Applications (0975 - 8887)*, 26(6)

L. Tan,Y. Yang,J. Ma, J. Yu (2008), Pointing and tracking errors due to localized deformation in inter-satellite laser communication links, *Optics Express* 13372,16(17)

A. Polishuk and S. Arnon (2004), Optimization of a laser satellite communication system with an optical preamplifier, *Journal of Opt. Soc. Am. A 1307* ,21(7

Robert M. Gagliardi (2004), Satellite communication, I edition, CBS publishers and distributors ,New Delhi

H. Wu, H. Yani, X. Li (2009), Performance analysis of bit error rate for free space optical communication with tip-tilt compensation based on gamma-gamma distribution, *Optical Application*, 39(3)

Navidpour S. M., Uysal M., Kavehrad M.(2007), BER performance of free-space optical transmission with spatial diversity, *IEEE Transactions on Wireless Communication, 6(8)*, pp. 2813-2819

Y. Kahn J.M.(2001), Average power reduction techniques for multiple- subcarrier intensity--modulated optical signals, *IEEE Transactions on Communications* , 49(12), pp. 2164-2171.

V. Sarup, A. Gupta(2014), Performance analysis of an ultra high capacity 1 Tbps DWDM-RoF system for very narrow channel spacing, *Eleventh International conference on Wireless and Optical Communication Networks*, pp.

S. Saini, A. Gupta(2015), Modeling and Performance Analysis of DWDM Based 100 Gbps Low Power Inter-satellite Optical Wireless Communication (LP-IsOWC) System, *SOP transactions on signal processing*, 2(1

Shaina, A. Gupta (2015), Performance analysis of Free Space Optics link under effects of rain intensity variation, *International Conference on Next Generation Computing Technologies,IE*

A Gupta, RS Kaler, H Singh (2013), An inimitable scheduling technique for optical burst switched networks, *Optik-International Journal for Light and Electron Optics*, 124(8), pp.-689-69

P. Kaur, A Gupta (2015), Simulative analysis of DWDM systems using loop control in inter satellite optical wireless communication channel for 10,000 kilometers long distance transmission, *Third international conference on emerging research in computing, information, communication and applicat*

A Gupta, H Singh, J Kumar (2012), A novel approach to reduce packet loss in obs networks International Journal of Computer Applications.

S. Saini, A. Gupta (2014), Investigation to find optimal modulation format for low power inter-satellite optical wireless communication (LP-IsOWC), *Eleventh International conference on Wireless and Optical Communication Networks*, pp. 1-4