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Analysis of Pointing Error at 100 Gbps by using Different Encoding Technique in Spatial Diversity based Inter-Satellite Optical Wireless Communication (IS-OWC) System

Priya Sharma
Department of Electronics and Communication Engg.
Government Women Engineering College, Ajmer
Rajasthan, India

Santosh Meena
Asst. Professor,
Department of Electronics and Comm. Engg.
Government Women Engineering College, Ajmer
Rajasthan, India

***Abstract*—- Inter-satellite Optical Wireless Communication (Is-OWC) is an innovative technique used to establish a network between satellites. In these days, optical wireless channel (OWC) based communication system are used in satellites for communication purpose due to no interference occurrence and no need of license requirement. In this paper, we have designed and simulate the Is-OWC system by using 16 OWC (16x16 Tx and Rx antenna) channels at different encoding technique. Due to spatial diversity signal have more than one path to travel from one point to another end by using fork 1: N at high data rate up to 100 Gbps and 10000 Km distance range. In the proposed designing, we analyzed the Is-OWC system with NRZ, AMI, Duobinary encoding technique. The main motive of the system to judge the various types of encoding technique with superior result at large distance coverage with minimum value of BER. Among the three-encoding technique Duobinary signal gives best result at different degrading factors like pointing error up to 3μrad at 20 dBm power level by using OPTISYSTEM 15.0 software. The result expressed in form of Q-factor and BER.**

Keywords—Is-OWC, ISL, AMI, Duobinary encoding technique, Diversity Technique, Q-factor, BER

I. INTRODUCTION

Wireless communication has become important part of modern life, from global cellular telephone system to local and even personal area networks. To cover the entire world for effective communication purpose satellite system is used but as the number of satellites increases day by day, a link required between them either satellites rotate in the same orbit or in the different orbit by using optical wireless channel and called as Inter-Satellite Optical Wireless Communication (OWC). In March 2003, Artemis and SPOT 4 was the first Inter-satellite communication using optical link. Then, successfully link established between KIRARI and Artemis in 2005 [1]. After these many authors has been investigated different theory for performance improvement in Inter Satellite Link (ISL). The technological advances in the field of Inter-satellite communication will be directed with an aim to reduce the size, factor. The optical wireless communication enables the information exchange between two satellites in which one act as a transmitter and another act as a receiver. As we know, mainly satellites rotate in the three different types of orbits which are separate by several thousand of kilometers distance from each other. In this paper system designed are used to communicate the MEO (Medium Earth Orbit) based satellites. Thus, laser is used as optical source for transmitting the information. We required a system which send high data rates of Gbps and at distance of thousands of kilometers apart. There are many advantages of inter satellite optical wireless communication (Is-OWC) system like no licensing requirement, high bandwidth, immunity to RF signal, power efficient and cost effectiveness but many degrading factors reduces the performance of system [2]. But degrading factors limits the performance of Is-OWC system like pointing error, vibration noise, tracking noise which occurs when signal is not properly aligned to receiver or not obtain the proper line of sight. These losses can be mitigated by using diversity technique, accurate tracking with narrow beam of laser, proper line of sight (LOS), and different coding technique [3]. In this paper space diversity technique used to mitigate the different losses with enhancement in the performance of system. Many authors have investigated different degrading factor with their solution for improving the result. In 1990, the study focused on precision pointing and tracking (PAT) control for ISL link. The study also performed modelling and simulation to reduce the various internal degrading factors of communication system [4]. As we know Inter Satellite Link (ISL) is establish for large coverage but as the distance increases strength of the signal is reduced due to misalignment of the signal, tracking problem and so on. Inter-satellite optical wireless communication (Is-OWC) system obtained at 36000 km with data rate of 2.5 Gbps and attenuation of 25 dB/km by using QPSK modulation technique [5]. By using channel diversity technique in the previous paper, the Is-OWC system analyzed for 40 Gbps data rate with 5000 km distance range [6]. But in this paper, we have achieved 100 Gbps data rate with link distance of 10,000 km and at 3 μrad pointing error for the wavelength of 1550 nm by increasing the path of system with fork 1: N and power combiner by using AMI, Duobinary and NRZ encoding technique.

This paper further expressed the section as follows: section II defined the system description, section III provides the

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characterization of encoding technique in spatial diversity based Is-OWC system, section IV consists the simulation result at different types of encoding technique, section V comparison by using diversity technique and in section VI we the conclude the paper.

II. SYSTEM DESCRIPTION

When multiple number of Transmitter and Receiver antennas are used for signal transmission from one point to another is termed as Spatial Diversity technique [7]. Fork 1: N are used to provide multiple signal from different paths. As we study in the previous paper, diversity using 16 channels which having 16*16 transmitter and receiver antenna and provide superior result at large distance with transmission of 40 Gbps data using 15 dBm power level [6]. In this paper, we analyzed three different types of encoding technique by transmitting AMI (Alternate Mark Inversion), Duobinary and NRZ signal. Is-OWC system also having different types degrading technique in which pointing error is one of them [8]. Pointing error occur due to misalignment of signal when travel from one satellite to another satellite. Thus, we need such a system which gives excellent result at high bit rate up to 100 Gbps, 10000 km distance range by using 20 dBm transmitting power at 3μrad pointing error.

Spatial based diversity shown in the figure 1 in which transmitting signal travel from more than one path by using fork 1: N and power combiner (4:1). System designing provides the result without the use of any amplifier and signal transmit at low power. Thus, the designing in paper is cost effective and highly efficient. Fig. 1 define the basic block diagram of spatial diversity in which transmitter (Tx.) is one satellite and receiver (Rx.) is another satellite. Transmitter designing of the system is different for different encoding technique.

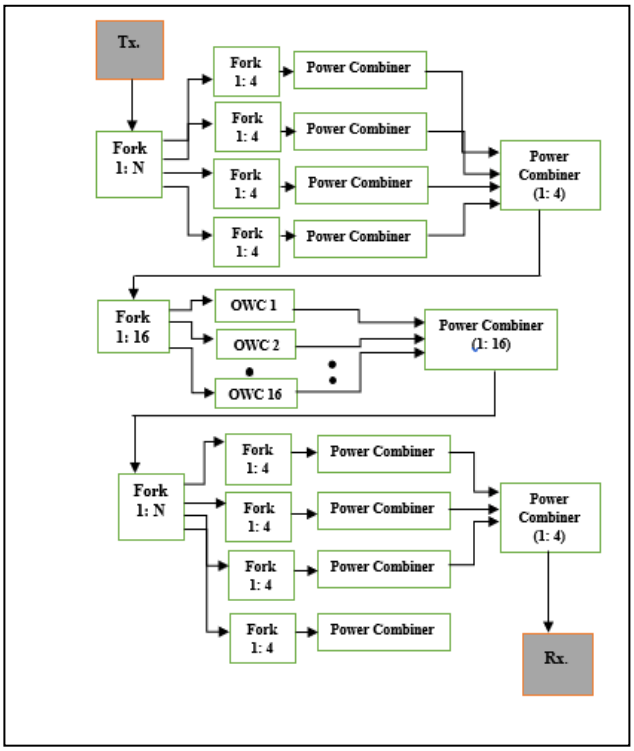

Fig. 1. Basic block diagram of spatial diversity based Is-OWC system

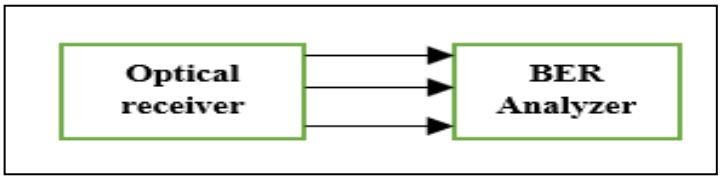

Fig. 2. Block diagram of receiver (Rx.) satellite of Is-OWC system

III. CHARACTERIZATION OF ENCODING TECHNIQUE IN SPATIAL DIVERSITY BASED IS-OWC SYSTEM

In this paper we discuss and analyzed the different types of encoding technique. Basically, we used NRZ electrical signal to modulate with optical signal. But as the advancement in technology different types of encoding technique has come to transmits the signal from transmitter satellite like AMI, Duobinary, Manchester coding and so on. Below we define the AMI, Duobinary signal and NRZ.

A. Alternate Mark Inversion (AMI) signal

There are many advantages to use AMI encoding technique like high SNR and transmission capacity. AMI contains two binary signal 0 and 1 where binary 0 for neural voltage and binary 1 for alternate positive and negative voltage. Fig. 3. Shows the Is-OWC block diagram with AMI transmitter (Tx.) using diversity technique. PRBS (pseudo random bit sequence) is used to transmits 100 Gbps data and LPGF (low pass gaussian filter) is an optical filter to filter out the unwanted signal [10].

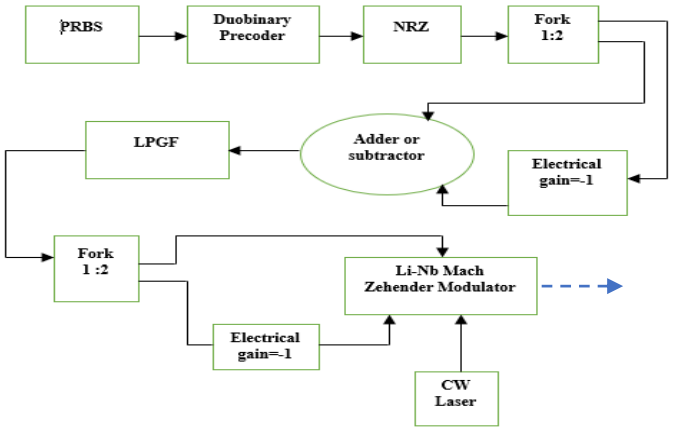

Fig.3. Block diagram of AMI transmitter (Tx.)

B. Duobinary signal

Duobinary signal is also called as 3 level output signal (-1, 0, +1 volt) and used to double the transmission speed. This type of signal increases the spectral efficiency, robust against chromatic dispersion provide the secure environment at higher data rates by adding 1-bit delayed data to present data, and increase its level [11]. It having narrower bandwidth compared to binary NRZ modulated signal. Fig.4 shows the block diagram of duobinary signal based transmitter.

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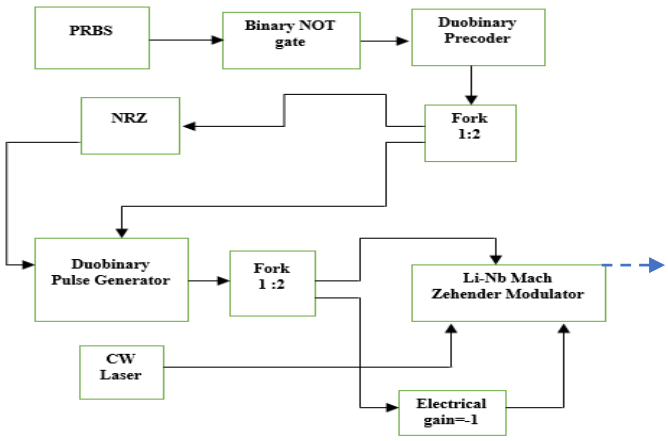

Fig.4. Block diagram of Duobinary signal transmitter (Tx.)

C. NRZ signal

A non-return to zero-line code is a type of binary code in which ones are represented by positive voltage and zeroes are represented by negative voltage [9]. In fig.5 we define the NRZ based encoding technique.

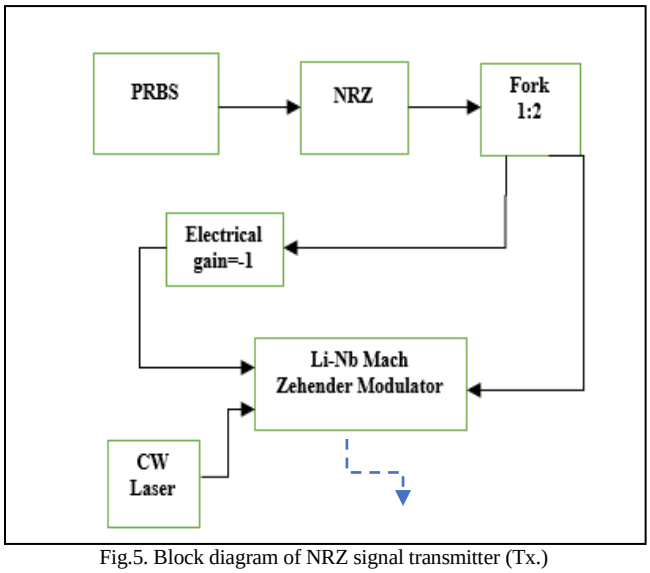

Fig.5. Block diagram of NRZ signal transmitter (Tx.)

IV. SIMULATION RESULT

In this paper, we defined the three types of encoding technique and simulate the result by transmitting 100 Gbps for 10000Km distance at 20dBm power level. Pointing error is the degrading parameter and we analyze it for different transmitting signal format. In which Duobinary signal gives the excellent result compare to NRZ and AMI signal. In figure 6(a), 6(b) and 6(c) shows the Q factor value by using 16 OWC (16*16 Tx. &Rx.) channel.

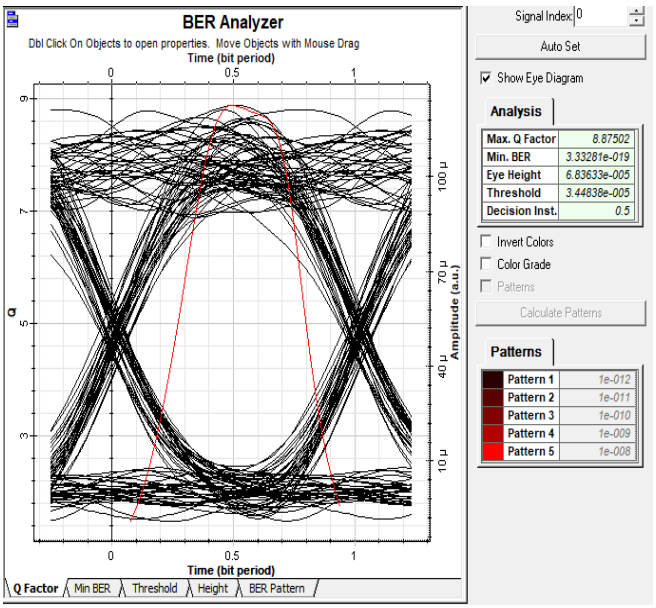

Fig.6 (a) Diversity based Is-OWC system by using AMI encoding technique (16*16 Tx. & Rx.)

AMI encoding technique having Q- factor value 8.87 value for 10,000 Km distance at 3μrad in fig.6(a), while 9.96 Q factor by using Duobinary encoding technique and Q- factor 5.44 of NRZ encoding technique gives least value among these three techniques.

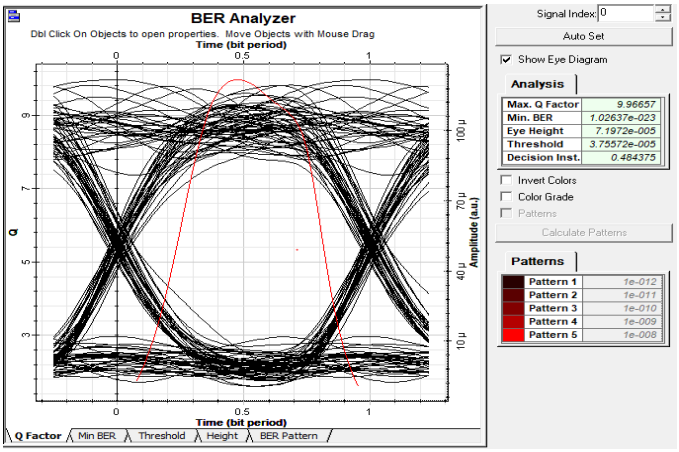

Fig.6 (b) Diversity based Is-OWC system by using Duobinary encoding technique (16*16 Tx. & Rx.)

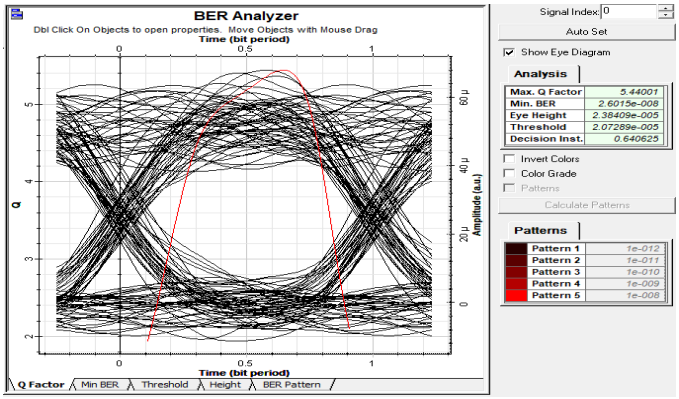

Fig 6(c) Diversity based Is-OWC system by using NRZ encoding technique (16*16 Tx. & Rx.)

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We analyze that Duobinary encoding technique gives best result at large distance and pointing error value.

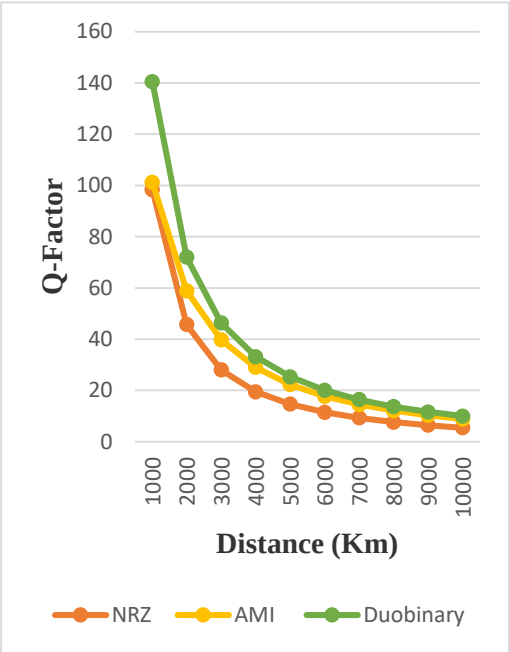

Fig.7 Graphical representation of Is-OWC system by using channel diversity technique

V COMPARISON BY USING DIVERSITY TECHNIQUE

In this section we compare the Is-OWC system by using different techniques like channel diversity, different encoding technique (AMI, NRZ, Duobinary signal). In the below table1 comparison between proposed model and previous system designing using 16 channels. When we use the previous system designing at 100 Gbps, 10000 km distance, 3 μrad pointing error system work up to 3000 Km and by using proposed system designing enhancement in result occur. Among the proposed system Duobinary system gives superior result.

Distance (Km)	**Proposed System (Q-factor)**			**Previous system (Q- factor) By using 16-OWC [6]**
	AMI	***Duobinary***	***NRZ***	
1000	101..27	140.56	98.39	11.54
2000	58.84	71.99	45.69	4.40
3000	39.7	46.31	28.02	2.16
4000	29.02	33.17	19.44	0
5000	22.27	25.29	14.67	0
6000	17.72	20.08	11.50	0
7000	14.48	16.40	9.26	0
8000	12.09	13.68	7.63	0
9000	10.28	11.60	6.39	0
10000	8.87	9.96	5.44	0

Table 1: Comparison between different designing system

VI CONCLUSION

In today's world we require a fast, cost effective and efficient technique. So, we required a system which gives best result at large distance and high bit rate. In this paper, we designed a system which fulfill the requirement of Is-OWC communication system for 16 OWC channels, 10000 Km distance range, power 20 dBm and 100 Gbps data rate by using Duobinary encoding technique whose highest Q-factor value is 9.96 while if we used same parameters with previous designing highest BER value at 4000 km means work at 3000 km only.

REFERENCES

[1] Gurwinder kaur, Amandeep kaur brar "A Review: Limitations /Challenges to Earth Orbit Satellite Communication Systems" International Journal of Engineering Development and Research 2017

[2] M. A. Krainak, "Inter-satellite communications optoelectronics research at the Goddard Space Flight Center", Aerospace and Electo-system Magazine, IEEE, vol. 7, pp.44–47,1992

[3] Vishal Sharma, and Amandeep Kaur, "Challenging Issues in Inter-Satellite Optical Wireless Systems (Is-OWC) and its Mitigation Techniques".

[4] Victor Trent, Michael Greene, and Stephen Hung "Precision Pointing Error Analysis in a Satellite Optical Communication Optical System" 1990 IEEE.

[5] A Penchala Bindushree, Nataraju A. B., Vijesh T V, Laxmiprasad A S, "Design and Simulation of QPSK Modulator for Optic Inter Satellite Communication".

[6] Priya Sharma, Santosh Meena, "Performance Analysis of Inter-Satellite Optical Wireless Communication (Is-OWC) System by using Channel Diversity Technique" ICIRCA 2018.

[7] Pradhan S, Sahu PK, Giri RK, Patnaik B (2015) Inter-satellite optical wireless communication system design using diversity techniques

[8] Hemani Kaushal and Georges Kaddoum (2016) Optical Communication in Space: Challenges and Mitigation Techniques

[9] B. Patnaik and P.K. Sahu, "Inter-satellite optical wireless communication system design and simulation" doi: 10.1049/iet-com.2012.0044

[10] Kamal Kishore Upadhyay, Saumya Srivastava, N. K Shukla and Sushank Chaudhary, "High-Speed 120 Gbps AMI-WDM-PDM Free Space Optical Transmission System" doi.org/10.1515/joc-2017-0086

[11] Mini Rani, "Analysis of Is-OW channel for improved transmission data rate",October 2017 (IJRASET) ISSN:2321-9653