



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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Performance Enhancement of Transceiver System Based Inter Satellite Optical Wireless Channel (IS-OWC) Link Effect of Bit Rate

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ABSTRACT : The optical communications development methods, both long fibres and reliable wireless ones, have given rise to the concept of using an wireless optical link. The possibility of satellite networks as a means of communication between them is suggested by the quick advancements in satellite communication. Higher speed information sharing between satellites is made possible by optical wireless communication (OWC), and a satellite can also serve as a relay between two spacecraft or between a satellite and a ground station. The optical link between satellites uses a high frequency light signal as a carrier, and lasers are frequently utilised as the light source. High data rate is one of the main benefits of OWC over RF link the bit error rate (BER) is acceptable. This research project examines the communication between two satellites in lower earth orbit (LEO). A crucial indicator for evaluating the inter-satellite link's (ISL) performance is the quality factor (Q-factor) or BER. This work demonstrates how the system's performance can be improved by utilising numerous antennas and cutting-edge modulation methods.

KEYWORDS: OWC, BER, LEO, Q-factor, ISL.

I. INTRODUCTION

As more satellites are placed in orbit for a variety of uses, wireless optical communication (WOC) technology is becoming increasingly important in the advancement of telecommunication in space. It is the means of using communication to deliver faster intersatellite communication than radio frequency (RF) lines, enabling longer distances. The two light sources that are most frequently employed in contemporary communications are the LED and LD, or light-emitting and laser diodes. The IS-OWC system's receiving station is made up of comprising a low pass filter and a photodiode. As an optical detector, a photodiode turns incoming illuminated Signal into electrical signals by detecting and detecting them. Additionally, semiconductor junctions that are positively and negatively charged are used to create photo diodes.

For transmission over long distances, a, it is possible to use a light signal with a reduced data rate used. Experimental findings show that long-distance communications with high data rates can work in simplex model be attained by strong gearbox power levels.. Line-of-sight (LOS) technology called OWC transmits information signals only when the two have a direct line of sight, transmitter and the receiver. OWC technique is a subset of optical communication technology since optical signals are used as the information carriers to convey data between two sites, and a subset of wireless communication technology because free air or vacuum is used as the medium for information signal propagation. Utilising Optisystem, The IS-OWC system and connection have been put into place. in this project simulator. A 10 Gb/s simulation of the intersatellite link has been performed for extended distances up to 5000 km. Using the modulation formats RZ and NRZ, a comparison analysis performed. The system has been studied for various transmission distances between 1000 and 5000 kilometres using the CW laser source together with VCSEL.

Performance evaluation of the IS-OWC system has been carried out using the Q-factor and BER. Figure 1 depicts the simplex system model, which is made up of the transmitter station, OWC channel or link, and receiver station. VCSEL laser diodes or CW laser sources are both used as the light source. The flow rate is 10 Gb/s, the input power is 100 W, and the light wave's dBm level is 10 dBm. It is tuned to 193.1 THz for the CW laser. The VCSEL generates a concentrated, narrow, directed beam, in contrast to other laser sources. The bias current for the VCSEL is 5 mA, and its



wavelength is 900 nm. The data rate ranges between 10 and 40 Gb/s. Utilised as an optical modulator, the MZM modulator's main function is to modify the light source's brightness [1-6].

II. LITERATURE SURVEY

A possible approach to fulfil the rising needs for high data transmission rates and channel bandwidth across a long link distance is optical wireless communication (OWC). There are numerous applications for the optical wireless communication technology uses including terrestrial connectivity, inter-aircraft links, and satellite links, among others. The effectiveness of an optical wireless communication link with a range of transmitter and receiver counts is assessed in this study. The system's performance has been evaluated in terms of BER, Q Factor, SNR, and total received signal power. The findings demonstrate that for long-distance networks operating at high data transmission rates, the quality of the received signal is improved by utilising various transceiver technologies.

The effectiveness of numerous OWC transceivers by changing the quantity of Tx/Rx pairs, the system has been simulated and examined. OPTISYSTEM simulation software has been used to carry out the system modelling, design, and simulations. Although the satellites are capable of communicating in full duplex mode using optical information signal carriers, in this project a simplex optical wireless communication link consisting of a single Tx/Rx pair has been considered for the sake of simplicity. There is a 4Tx/4Rx OWC link available [7-10].

III. EXISTING SYSTEM

In this existing work simulates and analyses the performance of an OWC system with numerous transceivers by changing amount of Tx/Rx pairs. OPTISYSTEM simulation software has been used to carry out the system modelling, design, and simulations. For the purpose of simplicity, a simplex method of data transfer has been considered for this project even though the satellites are capable of communicating in full duplex mode using optical information signal carriers. A typical optical wireless communication link consists of a transmitter part, a propagation channel, and a reception section. The optical transmitter part has four further subsections. The pseudo random bit sequence (PRBS) generator creates binary signals from the information signal that has to be sent.

These binary signals are sent to the NRZ pulse generator, which converts them into electrical pulses. The electrical signals are then modulated with an optical carrier signal produced by a continuous wave laser operating at a centre wavelength of 1550 nm using a Mach Zender modulator (MZM). The optical information stream is sent across open space via a transmitting antenna. The vacuum or open space serves as the propagation medium. A reception antenna is used to pick up the optical signal that is being broadcast. Avalanche photodiode (APD) is used to convert optical signal to electrical signal. The received signal's quality is assessed using a BER analyzer after The low pass filter (LPF) has eliminated any high frequency noise [11-14].

IV. PROPOSED SYSTEM

Either a VCSEL laser diode or a CW laser source serves as the light source. The light wave's input power is 10 dBm, and its flow rate is 10 Gb/s. The frequency of the CW laser is set at 193.1 THz. The VCSEL provides a concentrated, narrow beam that is directed, in contrast to other laser sources. The VCSEL's bias current is 5 mA, and it. The currently used APD photodiode has a factor of three. It has a responsiveness of 1 and a preset dark current of 10 nA. The frequency of the photodiode operating frequency is 900 nm. The data rate ranges from 10 to 40 Gb/s.

The MZM modulator is used as an optical modulator to modify the light source's intensity based on the pulse generator's output. The OWC channel is the free area between two interacting satellites. It acts as a conduit for the light that is conveyed. There are no pointing mistakes. The satellites are above the earth's atmosphere, thus there is no attenuation loss due to atmospheric causes. The IS-OWC receiver station is composed of an avalanche photodiode (APD) and a low pass filter (LPF). The photodiode collects the optical impulses and converts them into electrical signals placed at 193.1 THz. The aperture of the receiver has a 15 cm diameter. The LPF is positioned to prevent unwanted high frequency signals after the photodiode. Finally, this electrical signal is examined and its quality assessed using BER and electrical carrier analyzers.

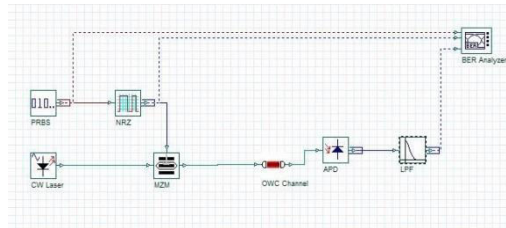


Figure 1. A Single Tx/Rx OWC Link

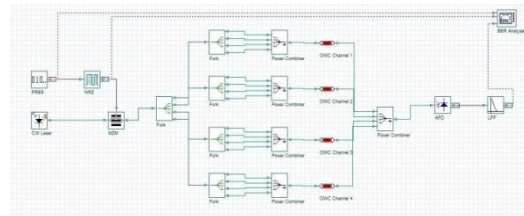


Figure 2. A Multiple Tx/Rx OWC Link

The IS-OWC simplex model is developed and implemented using Optisystem Simulator. The system performance is evaluated and compared while employing the VCSEL laser diode and the CW laser source for both NRZ and RZ modulation formats at 10 Gb/s at various distances up to 5000 km. For both NRZ and RZ approaches, it is a given that the BER grows as the propagation distance between satellites increases. This leads to lower system performance over longer transmission distances.

At different transmission distances, Q-factor records higher values for both modulation schemes when employing the VCSEL laser diode as opposed to the CW laser source. The graphical representation demonstrates Q-factor variations with changes in transmission distance for both CW and a VCSEL laser diode.

Serial No.	Parameters	Value/Type
1.	Rate of transmission	5.5 Gbps
2.	Link length	1300 Km
3.	Functioning Wavelength	1550 nm
4.	Type of Modulation	NRZ
5.	Size of the Antenna Aperture	20 cm
6.	Divergence in Beam	2 mrad
7.	Photo sensor	APD
8.	Distributing Power	6.2 dBm

Table .1 Simulation Parameters

V. EXPERIMENTAL RESULTS

The effectiveness of the IS-OWC relationship is assessed and compared for the VCSEL laser diode and the CW laser source using both NRZ and RZ modulation at 10 Gb/s over varying separations of up to 5000 km between satellites. With an increase in the propagation distance between satellites, the BER rises for both NRZ and RZ schemes meaning that system performance declines as mission distance increases. The Q-factor falls as the increasing the propagation rate and data rate. the separation of satellites. Error rates rise with data rates. Due to the system's higher Q-factor and reduced BER, the VCSEL laser diode improves IS-OWC performance. When utilising VCSEL, the Q-factor gets higher values at various gearbox distances.

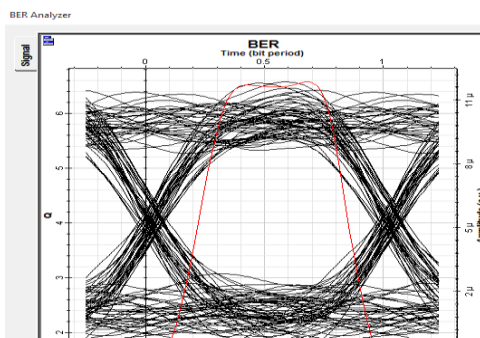


Fig :Eye Diagram of Received Signal with 1Tx/1Rx

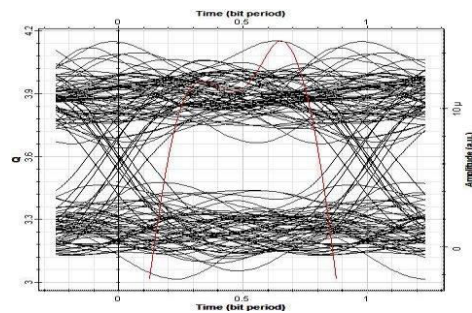


Fig: Eye Diagram of Received Signal with 2Tx/2Rx

VI.CONCLUSION

The suggested method of performance has been examined for various link lengths and data rates while taking into account RZ, NRZ, and CSRZ modulation formats. It has been shown that the impact of ambient noise is greater than the impact of external white light output in terms of degrading the received signal quality. If the NRZ modulation technique is used, the Q-factor falls below the permitted thresholds for increases in background noise beyond -110 dBm. In conditions of background noise and outside white light, NRZ modulation format performs better for a given link distance and data throughput.

Additionally, the impact of an optical filter's bandwidth change and Additionally, LED and other transmitter half-angle variations have been studied. To prevent the crosstalk effect at high data rates, advanced modulation techniques and mode division multiplexing techniques should be researched and tested.

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