Design an Intersatellite System and Comparative Bit Error Rate Analysis for RZ and NRZ Encoding Scheme for Different Power Levels at 40 Gbps Intersatellite Optical Link

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Abstract— In the modern world we require higher data rate and high speed of communication which connect the world. Satellite communication is the system which is used to interconnect the world. Conventional communication system depends on the RF link to connect intersatellite network. But RF has several limitations such as frequency allocation, size of transmitter and receiving antenna and heavy structure hence make it less suitable for intersatellite communication. Hence we move toward the optical technology .Optical link connect the several kilometers link between satellites with high speed advantage. In this paper we are studying the high speed optical link performance with various encoding schemes.

Key words: BER, IsOWC, EDFA, Return to Zero (RZ), Non Return to Zero (NRZ)

I. INTRODUCTION

In the fiber optic communication, there is degradation in transmission signal with the increase in distance. To compensate signal degradation optoelectronic regenerators were used before the advent of optical amplifier. In optoelectronic regenerators, the optical signal is first converted into electric current and then regenerated by using a transmitter. But such regenerators become quite complex and expensive for wavelength division multiplexing systems. This reduces the reliability of networks as regenerator in an active device. Therefore, up gradation of multichannel WDM network will require optical amplifier. To remove loss limitations and to amplify the signal, the optical amplifiers are used which directly amplify the transmitter optical signal without conversion to electric forms as in-line amplifiers. The optical amplifiers are mainly used for WDM (Wavelength division multiplexing) light wave systems as all channels can amplify simultaneously. Optical amplifier increases the transmitter power by placing an amplifier just after the transmitter and just before the receiver.

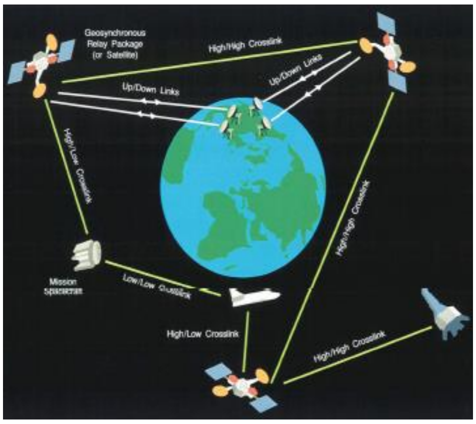

Fig. 1: Basic Intersatellite System

As the need of long haul unrepeated transmission distances and ultra-fast broadband transmission is increasing, the advanced transmission methods have to be investigated. In order to achieve these objectives *i.e.* broadband and repeater less transmission of an optical communication system, it is of utmost importance to optimize the semiconductor optical amplifier and then placement in optical networks. Therefore, it is of utmost important to study, analyze and optimize the optical amplifiers and semiconductor optical amplifier in WDM optical communication network to improve the power budget for increasing the number of supported users.

II. PROPOSED DESIGN

In this paper we design a Intersatellite optical link of 5000 km distance.For dispersion compensation we utilised a fiber bragg grating along with the dispersion compensation fiber at the receiver.In the proposed design we can design the Intersatellite optical linkfor 32 channel with each channel having the operating speed of 40 Gbps hence we get the the total speed in the Terabit range.

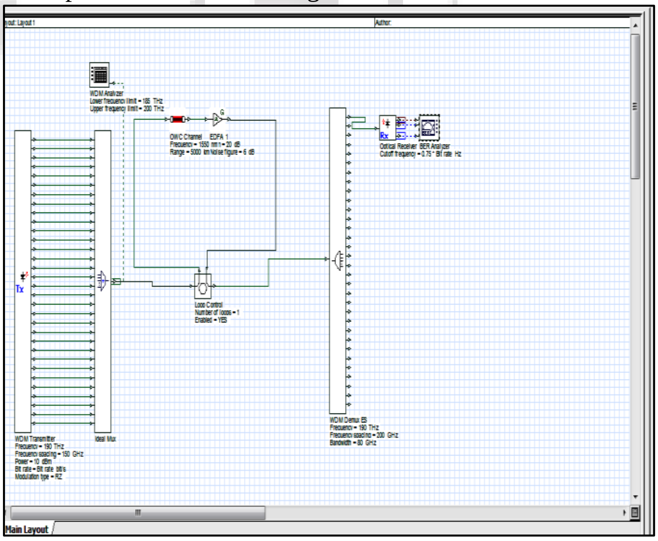

Fig. 2: layout of Intersatellite optical link of 5000 km

The electrical signal is generated by the TT&C system of transmitting satellite which is converted into optical signals with the help of laser. The light generated by the laser is modulated by an optical modulator and transmitted to the space. An optical modulator varies the intensity or amplitude of the input light signal from ILD according to the electrical signal.

III. SIMULATION PARAMETER

Fiber parameter	Intersatellite Optical Link
Distance (in Km's)	5000 km
Dispersion ps/Km/nm)	16 ps/nm/km
Reference wavelength	1550 nm
Loss (Dbm)	0.2 db/km
Sequence length	128 bits
Data rate	40 Gbps
Input power	10,20, 30 dbm
Bit rate	40e+009
Modulation Scheme	RZ, NRZ
DWDM transmitter	32 channel

Table 1: Simulation Parameter

In the proposed system Intersatellite optical link of 40 Gbps over 5000 km is designed and analyzed. The results are generated in the form of eye diagram. Optisystem 13 is used for simulation of project. In the proposed work, comparison is made for two modulation formats for three different level of input power. After analyzed the results for different power levels we decided which encoding scheme perform better in intersatellite optical link. In space there is no atmospheric fluctuation, hence we prefer optical intersatellite network over microwave. The transmitter consist of channel of 150 GHz spacing having line width of 5 MHz. The intersatellite WDM link transmitter receives data from the satellite's system such as Telemetry, Tracking and Communication system.

IV. RESULTS

A. Results for RZ line encoding

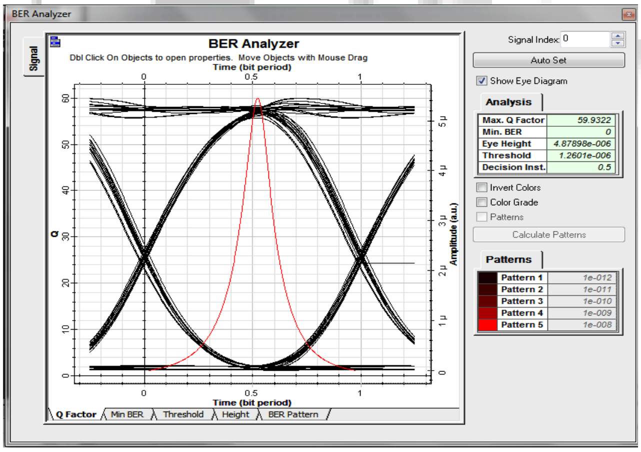

Fig. 3: Eye diagram at 10 dbm input power with NRZ encoding

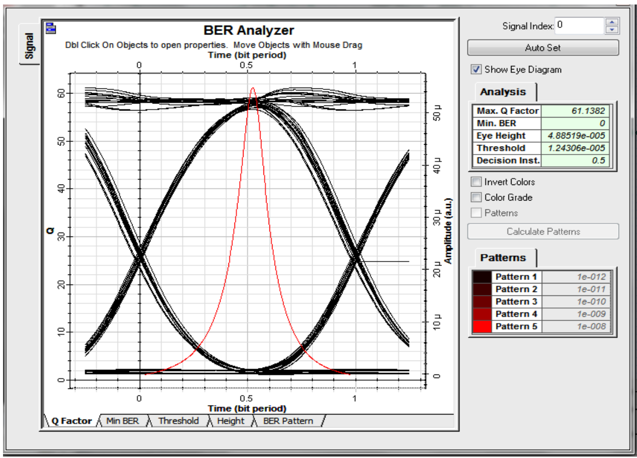

Fig. 4: Eye diagram at 20 dbm input power with NRZ encoding

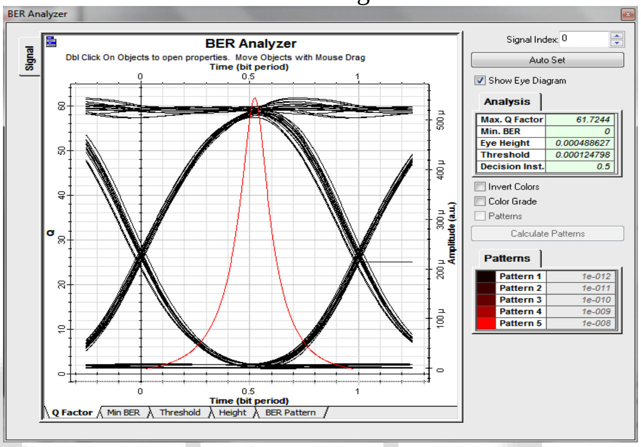

Fig. 5: Eye diagram at 30 dbm input power with NRZ encoding

B. Comparison of BER and Quality factor at different power level with NRZ encoding over intersatellite link

Parameters	5 dbm	10dbm	20 dbm
Max. Q factor	59.932	61.1382	61.7244
Min. BER	0	0	0
Eye height	4.8789e-006	4.8519e-005	0.000488627
Threshold	1.261e-006	1.2436e-005	0.000124798
Decision inst.	0.5`	0.5	0.5

Table 2: Comparison of BER and Quality factor at different power level with NRZ encoding over intersatellite link

C. Results for RZ line encoding

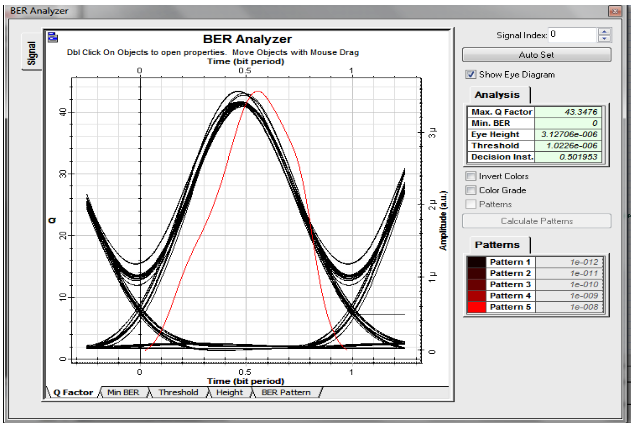

Fig. 6: Eye diagram at 10 dbm input power with RZ encoding

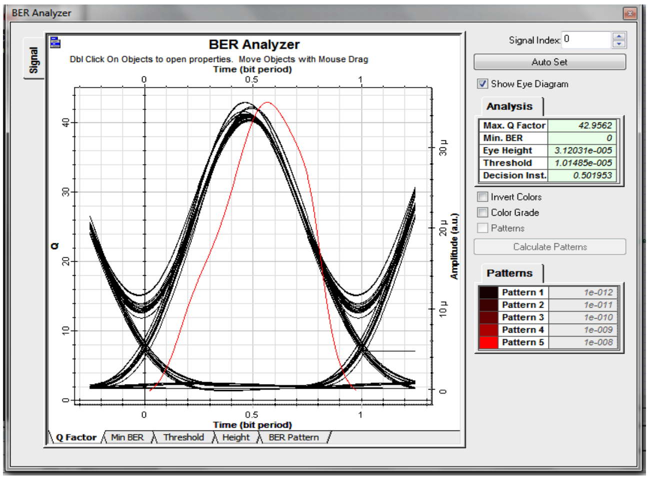

Fig. 7: Eye diagram at 20 dbm input power with RZ encoding

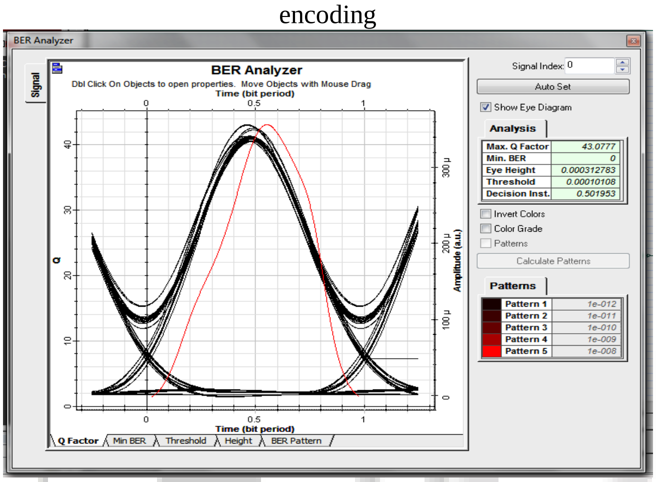

Fig. 8: Eye diagram at 30 dbm input power with RZ encoding

D. Comparison of BER and Quality factor at different power level with RZ encoding over intersatellite link

Parameters	5 dbm	10dbm	20 dbm
Max. Q factor	43.3476	42.9562	43.077
Min. BER	0	0	0
Eye height	3.12706e-006	3.1203e-005	0.00312783
Threshold	1.0226e-006	1.01485e-005	0.00010108
Decision inst.	0.5	0.5	0.5

Table 3: Comparison of BER analysis at different power levels with RZ line coding over intersatellite link

E. Comparison of BER analysis at different power levels with RZ and NRZ line coding over intersatellite link

Below table shows the comparison between RZ and NRZ line encoding scheme for three different input power levels. It is clearly depicted from the table that the performance of NRZ is better than the RZ format for all three input power level.

The system is designed for 32 channels operated at 40 Gbps speed using different modulation format by varying input power level. After analyzed the proposed model it is concluded that the NRZ scheme perform better than RZ scheme. The NRZ scheme achieves high quality factor and minimum bit error rate with respect to NRZ line encoding. It is also concluded that the system perform better at high power level of 30 db with respect to lower power levels.

Parameters	With NRZ line encoding			With RZ line encoding		
	10dbm	20dbm	30 dbm	10dbm	20dbm	30 dbm
Max. Q factor	59.932	61.1382	61.7244	43.3476	42.9562	43.077
Min. BER	0	0	0	0	0	0
Eye height	4.8789e-006	4.8519e-005	0.000488627	3.12706e-006	3.1203e-005	0.00312783

Table 4: Comparison of BER analysis at different power levels with RZ and NRZ line coding over intersatellite link

V. Conclusion

In the proposed model Intersatellite optical link of 40 Gbps over 5000 km is designed and analyzed. The comparative analysis is done between RZ and NRZ line encoding scheme for three different input power levels. It is clearly depicted from the table that the performance of NRZ is better than the RZ format for all three input power level. The system is designed for 32 channels operated at 40 Gbps speed using different modulation format by varying input power level. After analyzed the proposed model it is concluded that the NRZ scheme perform better than RZ scheme. The NRZ scheme achieves high quality factor and minimum bit error rate with respect to NRZ line encoding. It is also concluded that the system perform better at high power level of 30 db with respect to lower power levels. When the proposed model is compared with existing results, it is concluded that by increasing the power gain of EDFA black box the system perform better. The existing system work on 10 Gbps speeds whereas the proposed system work on the 40 Gbps speeds. . It is clearly depicted from the table 5.4 that the performance of proposed system for NRZ and RZ format is better than the existing system for all three input power level and achieves high quality factor and minimum bit error rate.

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