ISSN No. 0976-5697

Volume 8, No. 5, May – June 2017

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

Design And Analysis Of Ultra High Capacity DWDM System With And Without Square Root Module For Different Modulation Formats

Manpreet Kaur
Department of Electronics and Communication
Punjabi University
Patiala, India

Dr. Manjeet Singh Patterh
Department of Electronics and Communication
Punjabi University
Patiala, India

Abstract: In this paper, an ultra high capacity Inter satellite Optical Wireless Communication system (IsOWC) is simulated with and without square root module for different advanced modulation formats. The system is proposed by using 64 channels dense wavelength division multiplexing. For various input powers, the inter satellite link has been designed for external modulation of carrier suppressed return-to-zero(CSRZ), duo binary return-to-zero(DRZ), and modified duo binary return-to-zero(MDRZ) at different bit rate. The system is simulated without square root module at 10, 20 and 40Gbps and only at 40Gbps with square root module. The performance parameters Q-factor, eye diagram, received power are obtained for different bit rates to decide which modulation format is best. Results at 10 and 20Gbps shows that the CSRZ modulation performs better than the other two modulations but at 40Gbps MDRZ modulation performs the best. The results of previous system are only compared at 40Gbps with the new system which includes square root module and comparison shows that MDRZ still have the best performance but the performance of DRZ is very much enhanced as compared to without square root at 40Gbps.

Keywords: IsOWC, CSRZ, DRZ, MDRZ, BER, Q-Factor

I. INTRODUCTION

Wireless communication is used for sending the data from satellite to ground and between the satellites. Optical wireless communication is emerged as a promising technology because of high speed and secure communication. Inter satellite optical wireless communication has become an alternate to present microwave satellite systems due to its high bandwidth, small size, and light weight, low cost and low power.

As the space is considered to be vacuum the data can be sent with minimum attenuation and without much delay by using light as the power source. As the optical link is now used over the RF link have led to the biggest advantage is that the data can be sent at very high speed using tiny payloads to a distance of thousands of kilometers. [1] Combination of optical wireless communication system with dense wavelength division multiplexing results in high bandwidth and high speed as well as higher bit rate transmission over long distance

The inter satellite link between two satellites at distance 1000km with 2.5Gbps data rate has been designed and simulated with square root module to get better results with respective to their previous design[2] .The square root module was introduced to enhance the system and 48% enhancement was shown at distance 5000km with 1.25Gbps[3]. For different minimum input power system was observed with square root module and 67% enhancement was shown[4].A 32 channel OWC system with two modulation formats RZ and NRZ was designed and simulated at 10Gbps[5]. In [6] the system was designed and simulated with 64 channels with 50 GHz spacing for three different modulation formats CSRZ, MDRZ, DRZ at different data rates and the proposed paper is further extension of the above paper with square root module.

The paper is organized as follows. In Section 2, description of different modulation techniques and the model of atmosphere are presented. Proposed system is expressed in Section 3, Simulation description and results are expressed in Section 4 and finally we conclude the paper in Section 5

II. MODULATION TECHNIQUES

Fig.1(a) shows the schematic of the CSRZ modulation, which is defined by reversing the sign of the optical field at each bit transition[7, 8]. The CSRZ modulation which is pseudo-multilevel modulation format has better tolerance to residual chromatic dispersion (CD) and fiber nonlinearity. Here in this modulation, RZ optical signal after Mach-Zehnder modulator (MZM) goes through phase modulator. The 180 phase shift which is in between the adjacent bits in CSRZ modulation is the main difference between the RZ and CSRZ modulation.

Fig. 2(a) shows the schematic of DRZ modulation is a type of modulation that transmits R bits/s using less than R/2 Hz of bandwidth [7, 8]. This modulation format can increase tolerance to the effects of improved narrowband optical filtering and CD. In the format, first NRZ which is duo-binary signal has been created by a duo-binary pre-binary pulse generator. The generator drives the first LiNb MZM and then the second LiNb MZM which is driven by a sine generator with phase 90◦.

At the last the schematic diagram of MDRZ modulation formats has been shown in Fig. 3(a)[7, 8]. In this modulation, first NRZ duo-binary signal which is having a delay and subtract circuit is created which then drives the first LiNb MZM and then the other connected to the second LiNb MZM which is driven by a sine wave generator with phase 90 . The MDRZ modulation format has good received attention because it decreases the self-phase modulation in single channel, four-wave mixing and cross-phase modulation and in WDM transmission system.[7]

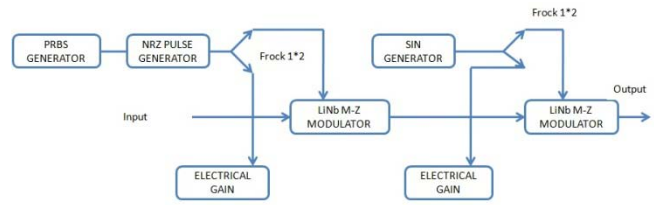

Fig. 1(a) Schematic diagram of CSRZ modulation format

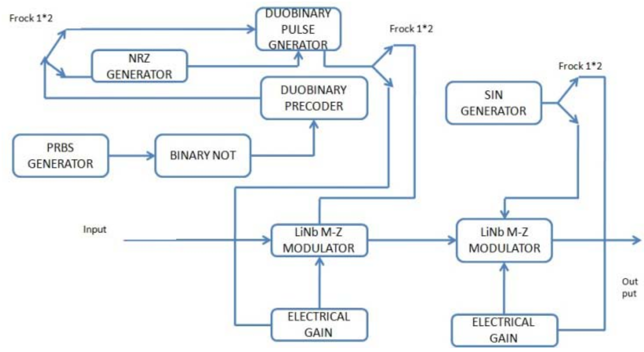

Fig. 2(a) Schematic diagram of DRZ modulation format

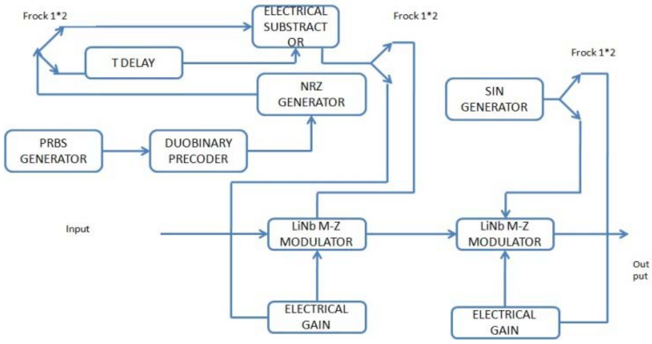

Fig. 3(a) Schematic diagram of CSRZ modulation format

III. PROPOSED SYSTEM

IN Fig.4 the block diagram of the proposed 64-channel DWDM system with OWC channel for distance of 1250 km with square root module has been shown. The system is simulated with different bit-rates with three modulation formats such as CSRZ, DRZ, and MDRZ with and without the Square root module. The proposed system consists of three main blocks transmitter, wireless transmission and receiver. The transmitter contains a 64-WDM transmitter, different modulation formats, and optical multiplexer. The transmission block has OWC channel and two optical amplifiers. One amplifier has pre OWC channel and the other consists of post OWC channel. Also, the optical receiver comprises a PIN photodiode to detect the signal and its wavelength and after that square root module is attached. The Bit error rate (BER) analyzer is used to measure the Q-factor and Minimum BER after the optical receiver.

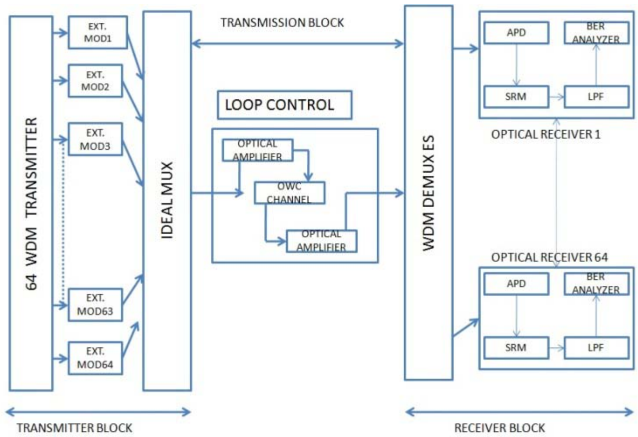

Fig. 4 Block diagram of the proposed system without Square Root Module

IV. SIMULATION

The simulation has been considered in the clear atmosphere weather condition where the visibility is more than 23 km and attenuation is about 0.14 dB/km.
Table 1 denotes the simulation parameters for OWC channel and optical amplifier in the proposed system.

TABLE 1. Simulation Parameters of the proposed system

Parameters	***Values***
Bit Rate	10, 20, 40Gbps
Sequence Length	128
Samples/bit	64
DWDM channel spacing	50 Ghz
Capacity	64-channel
Range of OWC	250km
Input Power	30Dbm
Number of control loops	5

V. RESULTS

Fig.5(a)–5(c) show the eye diagram of the proposed system at 10 Gbps bit rate in 1250 km distance for different modulation formats CSRZ, DRZ and MDRZ respectively without square root module. The quality factor (Q-Factor) obtained for CSRZ, DRZ and MDRZ modulation at 10Gbps bit rate are 178.23, 177.64 and 152.811 respectively. Also, the Bit Error Rate (BER) was near about zero for all the formats of modulations. Among the three modulations CSRZ performed better a little than the other two.
Fig 6(a)-6(c) show the eye diagram of three modulations CSRZ, DRZ, MDRZ at 20Gbps without square root module respectively. Similarly the Q-Factor obtained were 93.1002, 19.655 and 27.491 and the BER is less than 10^{-50} for the CSRZ, DRZ and MDRZ modulation, respectively where both parameters were acceptable for such long distance. At 20Gbps bit rate CSRZ performance was much better than the other two and while moving from 10 to 20Gbps bit rate Q-Factor was reduced less in CSRZ and more in DRZ and MDRZ.
Finally, the system was simulated at 40Gbps with different modulations without square root module. Here the good performance parameters Q factors were decreased and BER was increased. Fig. 7(a)–7(c) show the eye diagram of three modulations CSRZ, DRZ, and MDRZ at 40Gbps. Q-Factor 5.859, 6.539 and 8.17 and minimum BER 1.84×10^{-9}, 4,7 $\times10^{-11}$ and 1.48×10^{-16} were obtained for CSRZ, DRZ and MDRZ modulation formats respectively and they were

also acceptable for such long distance. At 40Gbps bit rate MDRZ performance was much better than the other two modulations.

The comparison based upon different level of bit rates for CSRZ, DRZ and MDRZ modulation formats is shown in Table 2. It was clear from the diagrams that for 10Gbps the three modulations had a good performance but the CSRZ had Q-factor higher than the DRZ and MDRZ for 10Gbps. And for 20Gbps all the three modulations Q-Factors were reduced and still CSRZ had better results than others. At 40Gbps the MDRZ had the best results although the BER and Q-factor were reduced but were reduced less as compared with DRZ and CSRZ.

Table2. Comparison of modulations at different bit rate

Bit Rate	*Analyzed Parameters*	*CSRZ*	*DRZ*	*MDRZ*
10Gbps	Q-Factor	178.23	177.64	152.811
	BER	0	0	0
20Gbps	Q-Factor	93.1002	19.655	27.491
	BER	0	$2.6*10^{-86}$	$1.097*10^{-166}$
40Gbps	Q-Factor	5.859	6.539	8.17
	BER	$1.84*10^{-9}$	$4.7*10^{-11}$	$1.48*10^{-16}$

The input power varies from 0 to 30dB to study its effects on Q-Factor for different modulation schemes. The maximum Q factor versus the input power for CSRZ, DRZ and MDRZ modulation for 10, 20 and 40 Gbps bit rates, respectively is shown in Fig8(a)-8(c). As the value of the input power was increased, value of the Q-factor enhanced. And the Q-factor for CSRZ modulation was higher relative to the other two types of modulation. All the above results were performed without the square root module.

Now the proposed system was performed at 40Gbps with the help of square root module because at 10 and 20Gbps the results were almost same for three modulation formats. Fig 9(a)-9(c) shows the eye diagram at 40Gbps with square root module. The Q-factor observed was 7.834, 8.75, and 9.062 for CSRZ, DRZ, and MDRZ. Fig.10 shows the comparison of Q-Factor at 40Gbps. The results showed that the MDRZ had the best performance as its Q-factor was increased and BER was reduced less as compared to other modulations and BER was less than 10^{-15} and there was improvement in the DRZ performance as its Q-Factor was enhanced more than the CSRZ Q-factor . Table3 shows the comparison of three modulations at 40Gbps.

Table3: Comparison at 40Gbps for three modulations

Bit Rate	*Analyzed Parameters*	*CSRZ*	*DRZ*	*MDRZ*
40 Gbps	Q-Factor	7.834	8.75	9.062
	BER	$2.289*10^{-15}$	$6.3*10^{-19}$	$6.38*10^{-20}$

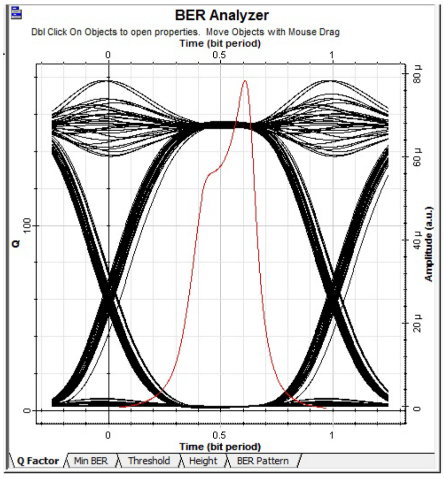

Fig.5 (a) Eye diagram of CSRZ at 10Gbps

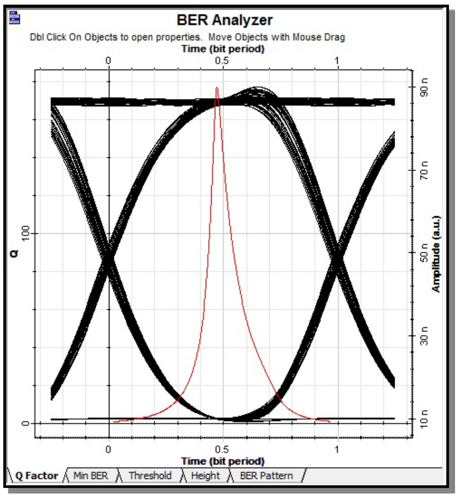

Fig.5 (b) Eye diagram of DRZ at 10Gbps

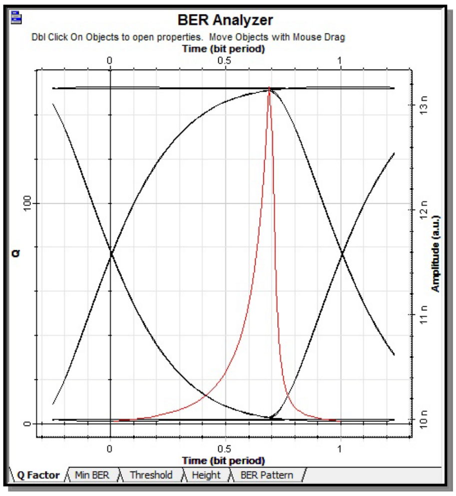

Fig.5 (c) Eye diagram of MDRZ at 10Gbps

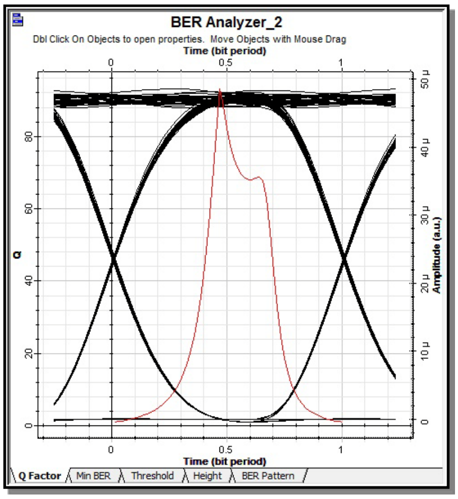

Fig.6 (a) Eye diagram of CSRZ at 20Gbps

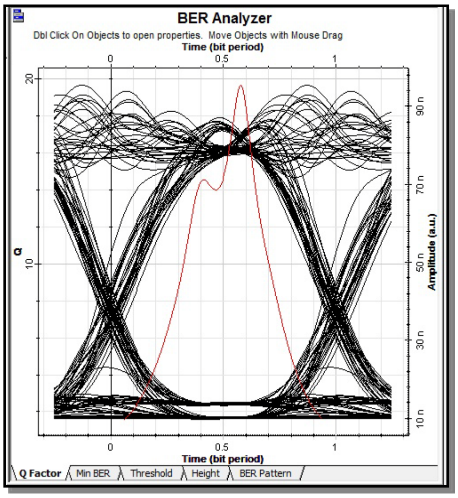

Fig.6 (b) Eye diagram of DRZ at 20Gbps

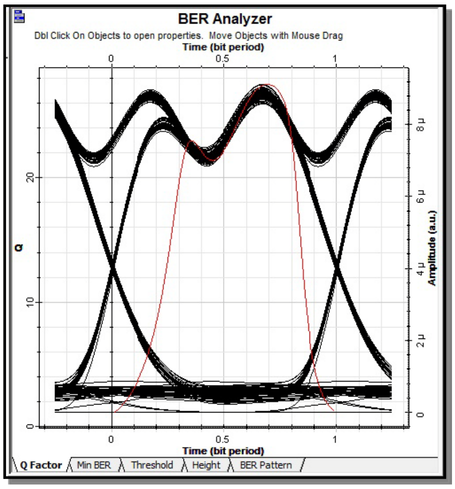

Fig.6 (c) Eye diagram of MDRZ at 20Gbps

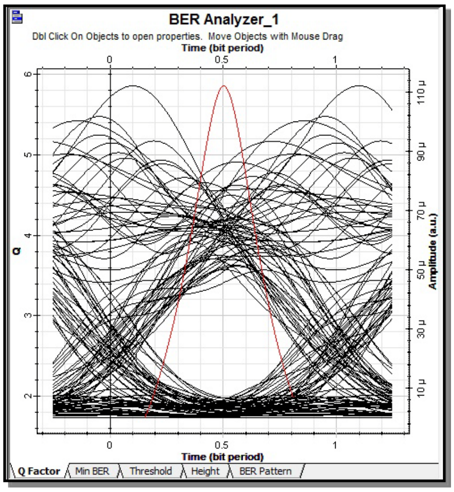

Fig.7 (a) Eye diagram of CSRZ at 40Gbps

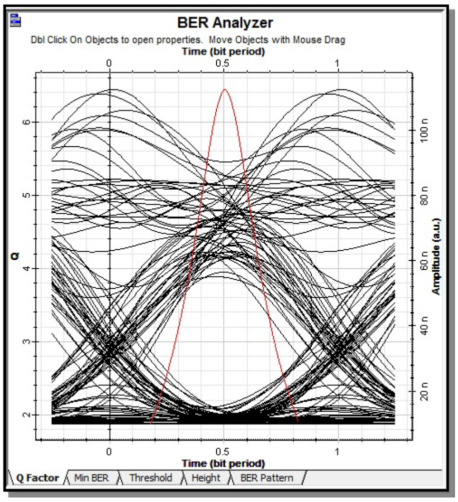

Fig.7 (b) Eye diagram of DRZ at 40Gbps

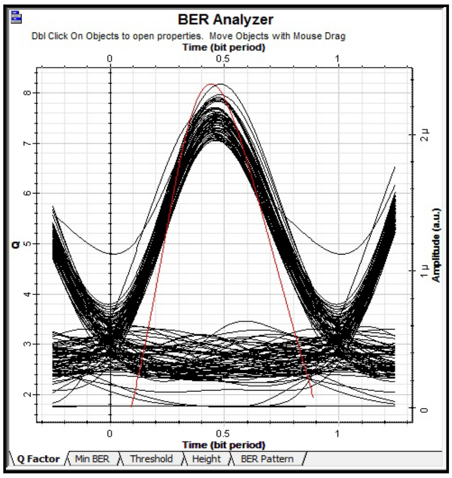

Fig.7 (c) Eye diagram of MDRZ at 40Gbps

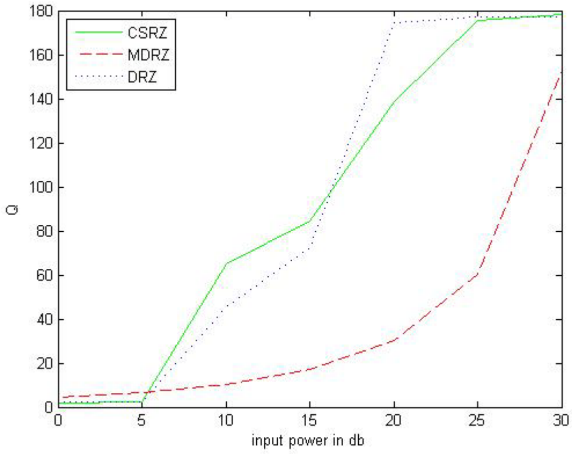

Fig.8 (a) Comparison of Q-Factors of modulations at 10Gbps

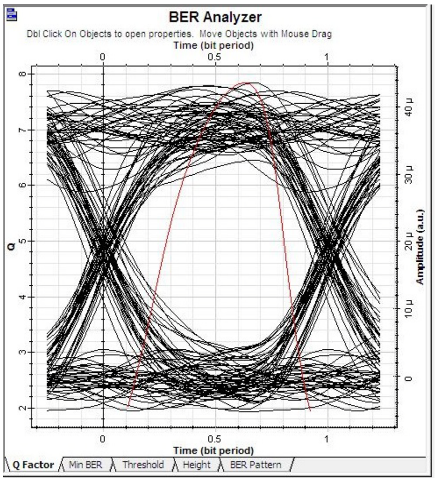

Fig.9 (a) Eye diagram of CSRZ at 40Gbps

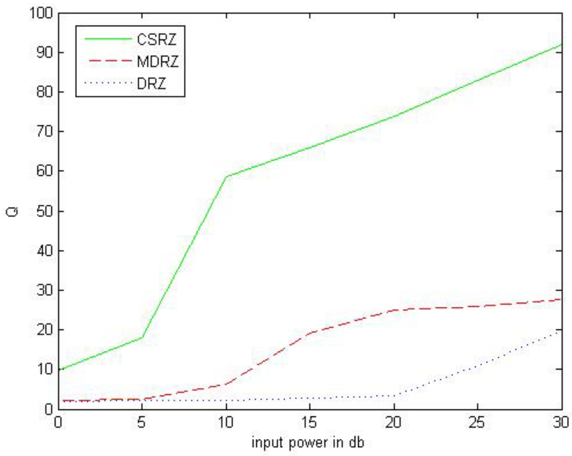

Fig.8 (b) Comparison of Q-factors at 20Gbps

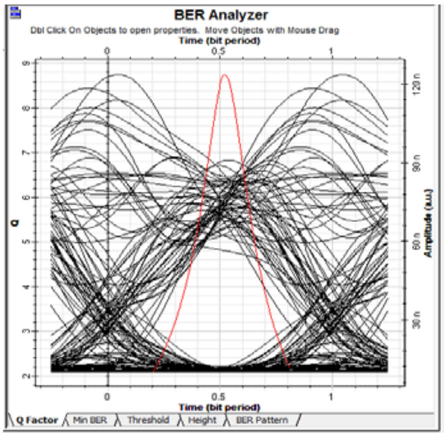

Fig.9 (b) Eye diagram of DRZ at 40Gbps

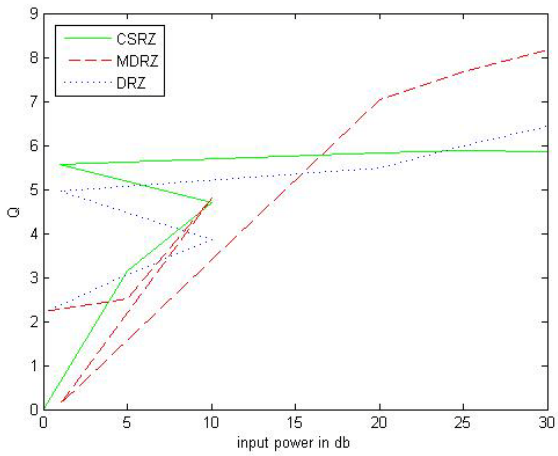

Fig.8 (c) Comparison of Q-Factors at 40Gbps

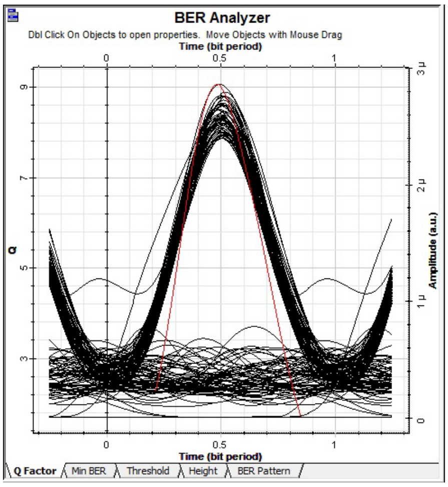

Fig.9 (c) Eye diagram of MDRZ at 40Gbps

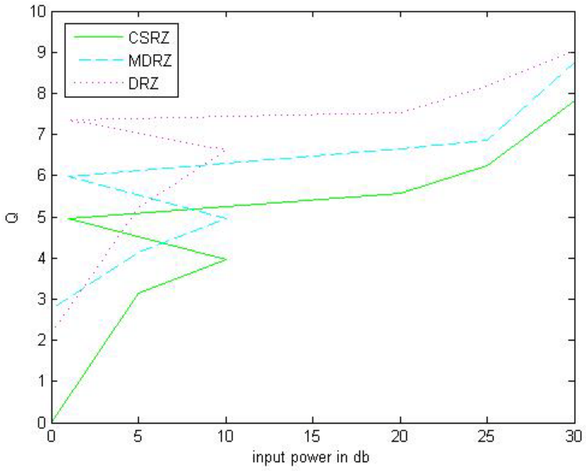

Fig.10 Comparison of Q-Factor at 40Gbps

VI. CONCLUSION

An ultra-high capacity IsOWC with and without Square root module was presented. Taking the atmospheric condition in consideration ,the proposed system was designed and simulated at different bit rates, 10, 20 and 40Gbps by CSRZ, DRZ and MDRZ modulation formats. The proposed system had better quality factor Q and BER at 10 and 20Gbps for all the three modulations. But at 40Gbps the scenario was different as Q-factor was much reduced and BER was increased and at the bit rate MDRZ performed better than the other two modulations. Considering the square root module, at 40Gbps the MDRZ still performed the best and the performance of DRZ was enhanced very much as compared to the upper part without the square root module.

VII. REFERENCES

[1] Sun, Z, "Satellite Networking - Principles and Protocols". UK: John Wiley & Sons. 2005

[2] Sharma V, Kumar N." Improved analysis of 2.5 Gbps inter- satellite link (ISL) in inter-satellite optical-wireless communication (IsOWC) system." Opt. Communications 286 (2013) 99–102

[3] Kumar.N, "Enhanced performance analysis of inter-satellite optical-wireless communication (IsOWC) system." Opt. Communications 125(2014)1945-1949

[4] S. Sarath Ganga, "Design of a Standardized Inter Satellite Optical Wireless Communication (IsOWC) System with Minimum Input Power." Procedia Technology 25(2016) 567-573

[5] P. Kaur, A. Gupta, M. Chaudhary, "Comparative analysis of Inter satellite Optical Wireless Channel for NRZ and RZ modulation formats for different levels of input power." Procedia Comput. Sci. 58 (2015) 572–577.

[6] A.Alipur et al, "Ultra high capacity inter-satellite optical wireless communication system using different optimized modulation formats." Opt. Communications 127(2016)8135-8143

[7] B. Patnaik, P.K. Sahu, " Ultra high capacity 1.28 Tbps DWDM system design and simulation using optimized modulation format." Optik—Int. J. Light Electron Opt. 124 (2013) 1567–1573

[8] D. Dahan, G. Eisenstein, " Numerical comparison between distributed and discrete amplification in a point-to-point 40-Gb/s40-WDM-based transmission system with three different modulation formats." J. Light Wave Technol. 20 (3) (2002)