ISSN 2250-3153

Performance Analysis Of Dispersed Manage RZ Pulse

Mohammad Arshad*, Mohd. Amir Ansari**

* Department of Electronics & Communication, Integral University Lucknow
** Department of Electronics & Communication, Integral University Lucknow

Abstract- In this paper, the performance of 10 Gbps optical communication system with the dispersion managed RZ pulse has been reported. The return-to-zero (RZ) pulse is efficient for long-distance, high-bit-rate, wavelength division multiplexed (WDM) transmission dispersion-managed systems. In RZ pulse, the power is transmitted only for fraction of bit period. The effect of varying the dispersion parameter of single mode fiber on optical communication system has been noted.

Index Terms- RZ Pulse, NRZ Pulse,Q Value, Jitter,BER.

I. Introduction

The goal of an optical fiber communication system is to transmit the maximum number of bits per second over the maximum possible distance with the fewest errors. There are many modulation schemes that are come into existence for long-haul systems, i.e., the format used to create the optical pulses. The simplest modulation scheme is a non-return-to-zero (NRZ) format, where the pulse is on for the entire bit period.

Alternatively, a return-to-zero (RZ) format can be used where the pulse is on for only a portion of the bit period. Optical return-to-zero (RZ) signals are becoming increasingly important in optical communication systems. They have proven to be superior to the non return- to-zero (NRZ) format both in terms of receiver sensitivity, and in terms of fiber transmission performance. The RZ spectrum has a wider bandwidth than the NRZ spectrum. Receiver sensitivity is defined as the received optical power required in order achieving a certain bit error rate (BER). The electrical power of an RZ pulse with a 0.5 duty cycle will be twice that of an NRZ pulse. The RZ pulse has a 3 dB improvement in receiver sensitivity. The RZ format would be beneficial for systems with few channels but would require NRZ as the number of channels increase. The RZ format has the better receiver sensitivity and nonlinearity tolerance due to which this modulation format is of great interest for research scholars these days. The work is going on achieving high bit rates which is above 40 Gb/s. Due to its relatively broad optical spectrum which results is results in reduced dispersion tolerance and a reduced spectral efficiency. RZ pulse is less susceptible to inter symbol interference and better nonlinear robustness. RZ modulation has become a popular solution for 10 Gb/s systems because it has a higher peak power, a higher signal-to-noise ratio, and lower bit error rate that NRZ encoding .The duty cycle of pulses used also has its effect on the performance of system. So best suitable value for duty cycle must be taken. Dispersion is a big factor which degrades the performance of optical communication networks. Due to this several compensation technique had been developed. Some of the techniques are dispersion shifted fibers and dispersion compensation fibers. In dispersion compensation fibers the negative value of dispersion parameter is given. The amplifiers also have an important role in optical communication systems. With the Erbium doped fiber amplifier, the number of spans of standard single mode fibers has been decreased to great extant.

Mob, Fiirst, Geiger and Flscher el at.[1] theoretically and experimentally analyses advantages of nonlinear RZ over NRZ on 10 GB/s single-span links. Griffin, Walker, and Johnstone el at.[2] demonstrated a four-stage integrated module for 10 Gb/s chirped return-to-zero modulation using GaAs/AIGaAs electro-optic guided-wave technology and its performance is verified by dispersion-managed test bed transmission over 3000 km. Hodzic, Konrad and Petermann el at.[3] had proposed alternative modulation formats in N ×40 Gb/s WDM standard fiber RZ-transmission systems. K. Ennser and K. Petermann el at [4] had investigated theoretically and experimentally the performance of RZ- versus NRZ transmission on standard single-mode fibers. On the basis of computer simulations, the RZ-transmission for the optimum system performance taking into account the dispersion, Kerr nonlinearity, attenuation and ASE noise was investigated. The parameters such as bit rate, distance and power levels are estimated for the lowest system degradation. The work considers different duty ratios including NRZ-pulses. Park, Wiesenfeld and Garret el at.[5] had demonstrated the transmission of a 40-Gb/s signal over multiple (up to six) 120-km spans of conventional single-mode fiber (SMF). They use a very low duty cycle return-to-zero (RZ) format which employs optical pulses much shorter than the bit-period.

II. Simulation Setup For Optical Communication System To Examine Performance Of Dispersed Manage RZ Pulse

The particular system setup of optical communication system for dispersed manage RZ pulse is shown in figure (1). The component used in figure (1) are chosen from the Optsim component library palette and placed as per requirement in the design area of the Optsim editor.

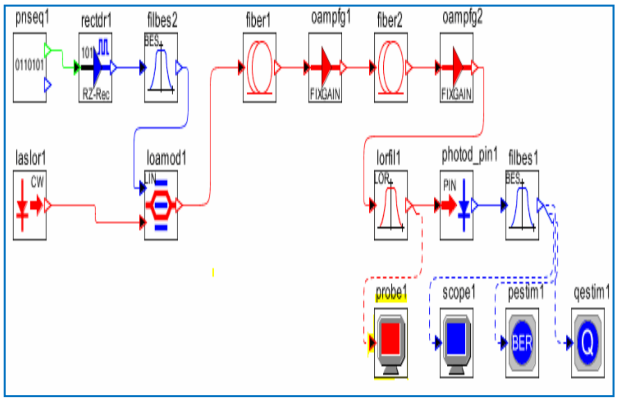

Figure 1

As shown in figure (1), the transmitter section consists of data source (pnseq1), modulator driver (rectdr1), electrical filter (filbes2), laser source (laslor1) and modulator (loamod1). Data source produces a pseudo-random sequence of bits at a rate of 10 Gbit/s. The output of data source is given to modulator driver which produces a RZ format pulse with duty cycle of 0.5.From this the signal goes to the electrical Bessel filter having low pass type characteristics and -3dB bandwidth equal to 10 GHz. The output of laser source which is CW Lorentizan type and electrical filter is given to the modulator. The modulator is of amplitude modulator type which has $\sin^2$ shaped input-output characteristics. The transmission medium used is a combination of standard single mode fiber (fiber1), dispersion compensation fiber (DCP), in line amplifier and pre-amplifier. In line amplifier (ampfg1) and pre-amplifier (oampfg2) is EDFA fixed gain amplifiers. The standard single mode fiber used is of 120 km length and the length of dispersion compensation fiber is 20 km. The output of pin photodiode is passed through a band pass Bessel filter (filbes1) with center frequency at 20 GHz. It is simulated to have 3 poles with -3 dB bandwidth of 10 GHz. The output from the filter is given to the measurement devices which are electrical scope (scope1), Q estimator (qesbm1), BER estimator (pesbm1) and optical probe (probe1) to get the results.

III. RESULTS

Figure (2), shows the bit error rate (BER) for various values of dispersion parameters against the fiber length of standard single mode fiber. Upto a certain length of fiber the effect of dispersion parameter on BER is negligible but as the length of fiber increases, the effect can be noted. It can be seen that with dispersion value of 14, minimum BER is achieved. Hence with increase in dispersion parameter, the value of BER is decreased.

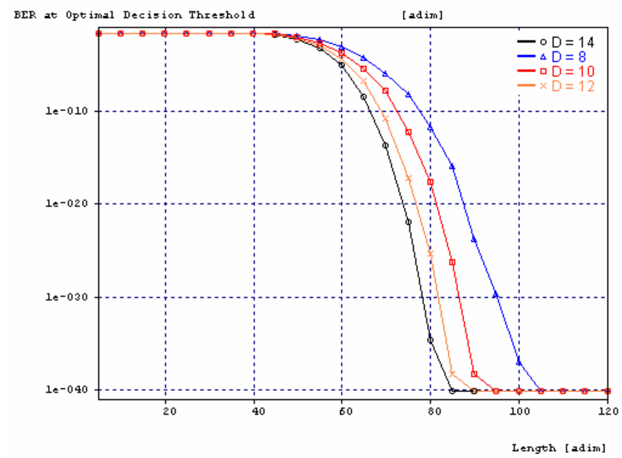

Figure 2: BER value versus single mode fiber length for variable dispersion parameter = 8, 10, 12, and 14 of RZ pulse

Figure (3), shows Q-factor for various values of dispersion parameters against the fiber length of standard single mode fiber. It is seen that the Q-factor remains same for certain value of length. As the length of the fiber increases, the effect of dispersion parameter on Q-factor can be noted. The value of Q-factor at 120 km length for dispersion value 8, 10, 12, 14 is 24dB, 26dB, 27.1dB, 28.3dB respectively. Hence, the Q-factor of the system improves as the fiber length increases with increase in the value of the dispersion parameter for the dispersed manage RZ pulse system.

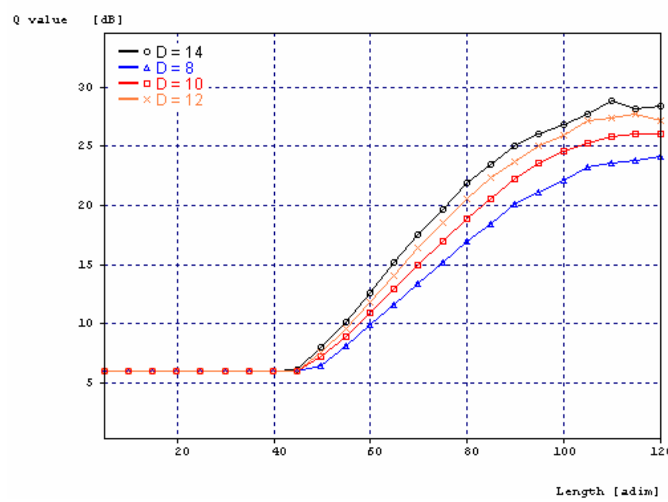

Figure 3: Q value versus single mode fiber length for variable dispersion parameter = 8, 10, 12, and 14 of RZ pulse.

Figure (4) shows average eye opening for various values of dispersion parameters against the fiber length of standard single mode fiber .For the value of fiber length upto 40 km, the average eye opening for low dispersion parameters is more than the higher value of dispersion parameter. After that the average eye opening value is better for high values of dispersion parameter. The average eye opening value is almost same for dispersion value of 12 and 14 at fiber length of 120 km. Hence at low value of fiber length, the average eye opening is more for small values of dispersion parameters and vice-versa. Hence with increase in the valve of dispersion parameter, the performance of the system becomes better as there is increase in the value of average eye opening.

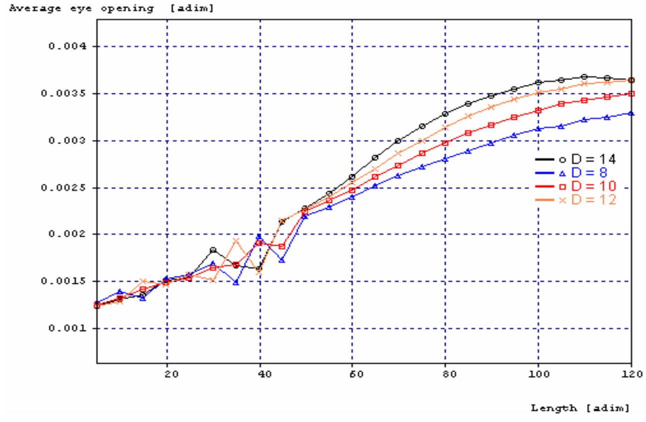

Figure 4: Average Eye opening value versus single mode fiber length for variable dispersion parameter = 8, 10, 12, and 14 of RZ pulse.

Figure (5) shows timing jitter values for various values of dispersion parameters against the fiber length of standard single mode fiber. For the value of fiber length upto 60 km, there is a fluctuation in the values of timing jitter for all the values of dispersion parameter. After that the timing jitter value decreases with increase in the value dispersion parameter. The dispersion parameter with value of 14 has less timing jitter value. The values of timing jitter at 120 km length of single mode fiber for dispersion value of 8, 10, 12 and 14 is 22ps, 8ps, 4ps, 3.6ps respectively. It can be seen that for the values of 12 and 14 the jitter value is almost same. Hence, there is an improvement in the system performance with increase in the dispersion parameter.

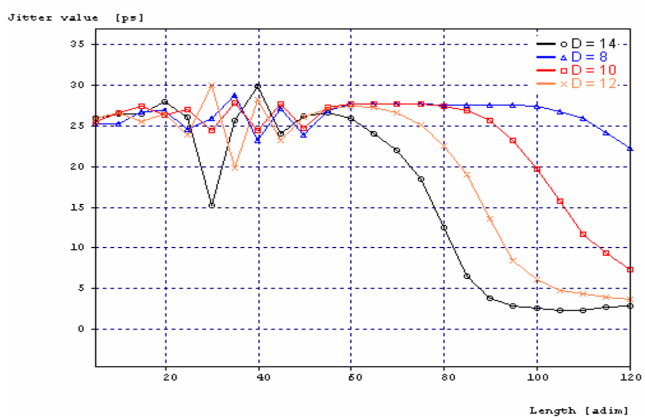

Figure 5: Jitter value versus single mode fiber length for variable dispersion parameter = 8, 10, 12, and 14 of RZ pulse.

IV. CONCLUSION

The performance of 10 Gbps optical communication with the dispersion managed RZ pulse has been reported. The effect of varying the dispersion parameter of single mode fiber on optical communication system has been noted. It is observed that with increase in the value of dispersion parameter, there is an increase in the average eye opening and Q-factor value. The best result is achieved at the dispersion value of 14. It is reported that timing jitters decreased with increase in the vales of dispersion parameter. Also a good desirable bit error rate value is achieved as the value of dispersion parameter is increased in the dispersed manage system.

REFERENCES

[1] G. Mohs, C. Fiirst, H. Geiger, and G. Fischer, " Advantages of nonlinear RZ and NRZ on 10 Gb/s single-span links," Optical Fiber Communication Conference (OFC), 4(FC2):35–37, March 2000

[2] R. A. Griffin, R. G. Walker, R. I. Johnstone, R. Harris, N. M. B. Perney, N. D. Whibread, T. Widdowson, and P. Harper, " Integrated 10 Gb/s chirped return-to-zero transmitter using GaAs/AlGaAs modulators," Optical Fiber Communication Conference (OFC), March 2001.

[3] Hodzic, B. Konrad, and K. Petermann,"Alternative modulation formats in Nx40 Gb/s WDM standard fiber RZ-transmission systems," Journal of Lightwave Technology, 20(4):598–607, April 2002.

[4] K. Ennser and K. Petermann, "Performance of RZ- versus NRZ transmission on standard single-mode fibers," IEEE Photon. Technol.Lett., vol. 8, pp. 443–445, Mar. 1996.

[5] S. G. Park, A. H. Gnauck, J. M. Wiesenfeld, and L. D. Garrett, " 40-Gb/s transmission over multiple 120- km spans of conventional single-mode fiber using highly dispersed pulses," IEEE Photonics Technology Letters, 12(8):1085–1087, August 2000.

[6] M.I.Hayee and A.E.Willner, "NRZ versus RZ in 10-40-Gb/s dispersion-managed WDM transmission systems,"IEEE Photonics Technology Letters, 2003.

AUTHORS

First Author – Mohammad Arshad, M.Tech from J.K Institute of Applied Physics,Allahabad University ,currently Assistant Professor at Integral University Lucknow.
marshad.au@gmail.com.

Second Author- Mohd Amir Ansari, M.Tech. form Jamia Milia Islamia. currently Assistant Professor at Integral University Lucknow.
aamir.elex@gmail.com

Correspondence Author – Mohammad Arshad, marshad.au@gmail.com.
Mohd. Amir Ansari, aamir.elex@gmail.com