Implementation and analysis of 2 Tbps MDRZ DWDM system at ultra narrow channel spacing

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Abstract - **This work is proposed to investigate the modified duo binary modulation scheme in high speed DWDM system. In this work, the system is simulated with 40 channels having a capacity of 50 Gbps multiplexed with the channel spacing of 6.25 GHz to recognize 2 Tbps total transmission distance over the optical span of 900 km by using dispersion compensation technique. The 50 Gbps is encoded by using Mach Zehnder modulator (MRZ) derived by CW laser of power -10 dBm. DWDM system is analyzed by varying the input power from -15dBm to 5 dBm. The effects of variation of channel spacing on transmission distance are observed in terms of Q value, total power received and varying distance keeping BER in acceptable range.**

Keywords - **DWDM, modified duo binary scheme, MRZ, Q-value and BER**

I. INTRODUCTION

Dense wavelength division multiplexing (DWDM) has become a key component of the communication system. DWDM technology is a type of technology that multiplex the optical signal of different frequencies and transmit the optical signal by using the bandwidth provided by SMF's and DCF. This technology is very useful in optical transmission that needs to have small size, low power consumption and low cost. The advantage of DWDM system that it has ability to deal with new technologies such as SONET, ATM, SDH, Ethernet etc. The simulation analysis of DWDM system has been carried out for modified duo binary return to zero (MDRZ) modulation format. The MDRZ system was developed by creating an NRZ duo binary signal using a delay and subtract circuit that drives the first MZM and then concentrating this modulator with a second modulator that is driven by a sinusoidal electrical signal. In previous study it is demonstrated that at high data rate 40 Gbps DWDM system is simulated with 50 GHz over a transmission distance of 1800 km using DRZ and MDRZ modulation formats and moreover the role of laser line-width is also investigate as it plays an important role to minimize the nonlinearity and four wave mixing (**Bansal, Urvashi et al. 2014**). Moreover, 40 Gbps systems provide high spectral efficiency of DWDM transmission systems (**T.Hoshida** *et al* **2002; A.Hodzik** *et al* **2002**). The role of dispersion and nonlinearities produced in the optical fiber should be managed for the transmission systems in which the data rate is higher than 10 Gbps. The post and pre compensation techniques are often employed to compensate the dispersion in optical fibers. It is well known fact that the positive dispersion effect in single mode fiber (SMF) can be overcome by negative dispersion of dispersion compensated fiber (DCF) in the optical transmission link(**M. Forzati** *et al* **2002; K.S.Cheng** *et al* **2002**). Moreover, the effect of various modulation schemes such as carrier-suppressed return-to-zero (CSRZ), duo binary return-to-zero (DRZ) and modified duo binary return-to-zero (MDRZ) modulation formats are also investigated in the presence of Kerr effect. In another work (**Yin, Xin** *et al* **2014**) Similarly the simulative analysis of 40 Gbps long haul DWDM system with ultra high capacity has been used for carrier-suppressed return-to-zero (CSRZ), duo binary return-to-zero (DRZ) and modified duo binary return-to-zero (MDRZ) modulation formats. The Dense wavelength division multiplexing (DWDM) system have been analyzed for the pre, post and symmetrical dispersion compensation schemes in order to find the optimal modulation format for a high bit rate. (**Anu Sheetal, AjayK.Sharma, R.S.Kaler et al. 2008**). Till now the research has shown that duo binary format is suited for 1.6 Tbps data (40 x 40 Gb/s)) over the optical span of 1800 km with channel spacing 50 GHz. Here the work is extended to 2 Tbps data (40 x 50 Gbps) is transported over 900 Km optical fiber by adopting modified duo binary modulation format and DWDM scheme.

II. SYSTEM SETUP

The schematic diagram of high speed DWDM based optical transmission system is shown in Fig 1. The introduced model is simulated by using OptiSystem software. In this work, 40 channels with channel spacing of 6.25 GHz are multiplexed and transported over optical link. Each channel is capable of generating 50 Gbps data. The 50 Gbps data is encoded by using modified Duo binary encoder which is further optical modulated by using Mech Zender modulator (MRZ) derived by Continuous wave (CW) laser having power of -10dBm.
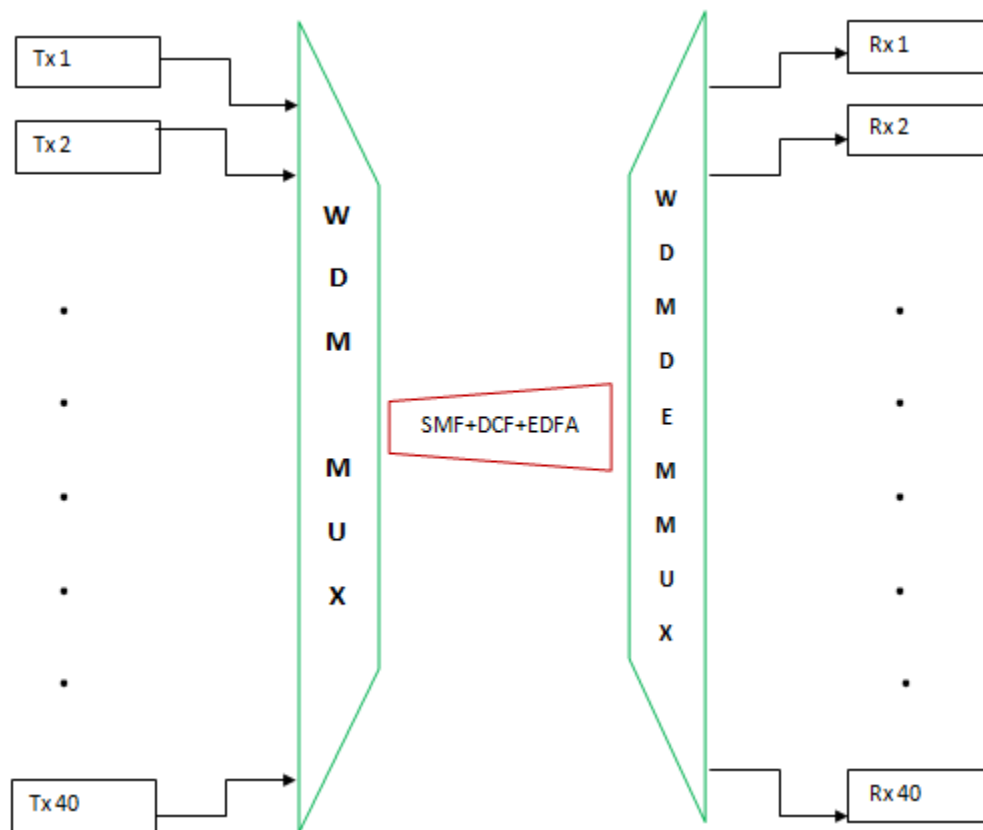
Fig 1: 40 X 50 Gbps Transmission System

The output of MZM is fed to multiplexer which combines the output of all channels to realize the total transmission of 2Tbps data and transported over optical link. It has been shown from Fig 2 (a) & (b) that after transmission over 25 Km SMF, the optical power is reduced and non linear effects are more significant.
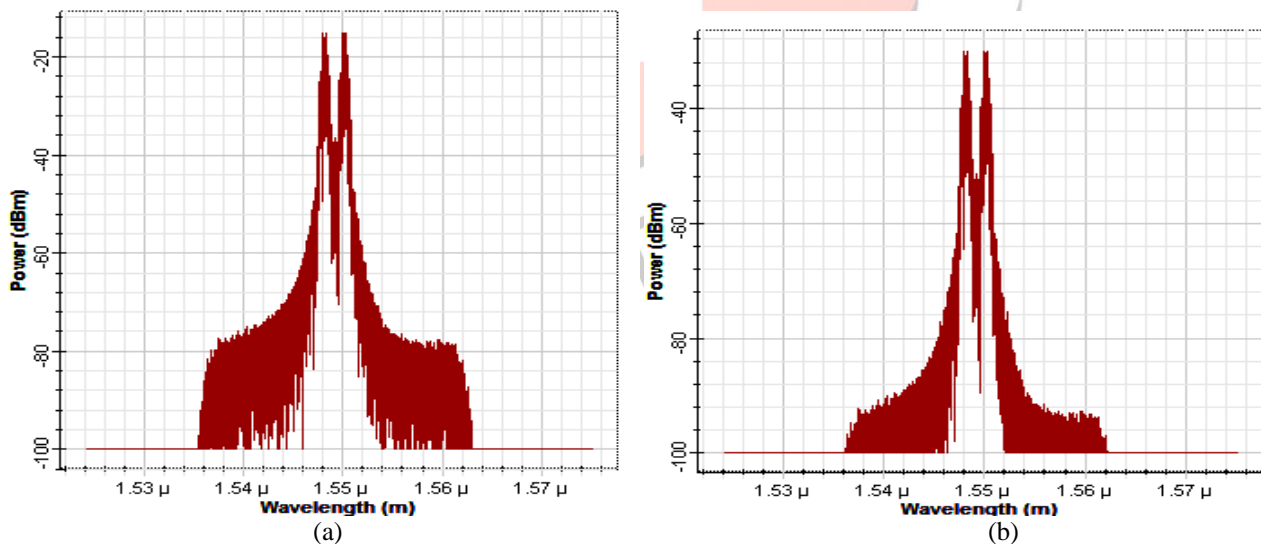

Fig. 2: Optical spectrum (a) After Multiplexer at transmission side (b) After 25 Km of SMF.

It has been shown from Fig 2 (a) & (b) that after transmission over 25 Km SMF, the optical power is reduced and non linear effects are more significant. The optical link is comprised of SMF having length of 25 Km, EDFA with gain of 10 dB, DCF having length of 10 Km and dispersion of -85 ps/nm/km and again EDFA having gain of 5 dB. In the transmission channel, the positive dispersion of 17 ps/nm/km of 50 Km fiber is compensated by using DCF of 10 Km with dispersion of -85 ps/nm/km. The total number of loops for the transmission link is considered to 15 so that 60 km x 15 to realize total length of 900 km. The output of EDFA is fed to the demultiplexer which splits the optical signal into 40 channels. The optical signal is received by optical Gaussian filter having cut off frequency synchronized with the optical wavelength of each channel at the transmission channel. The output of Gaussian filter is fed to PIN photo diode. The eye diagram is used to measure the output signal at PIN Photo diode.

III. RESULTS AND DISCUSSION

In this section, the results from the simulation are presented and discussed. The performance of proposed work is evaluated in terms of total received power and eye diagrams. Figure 3 shows the Q-factor received with respect to varying power for channel 1

and channel 40. The power received for channel 1 is computed as 6.59 dB, 12.17 dB, 8.89 dB, 7.93 dB, 10.40 dB at power of -15 dB to 5 dB as shown in figure 3 (a), which shows that that as the input power of laser increases, the channel length also increases and then get saturated at highest input power.

Figure 3: Measured result for proposed 40 x50 DWDM system (a) Q-Factor v/s power (b) Linewidth v/s Q-factor (c) distance v/s Q-factor.
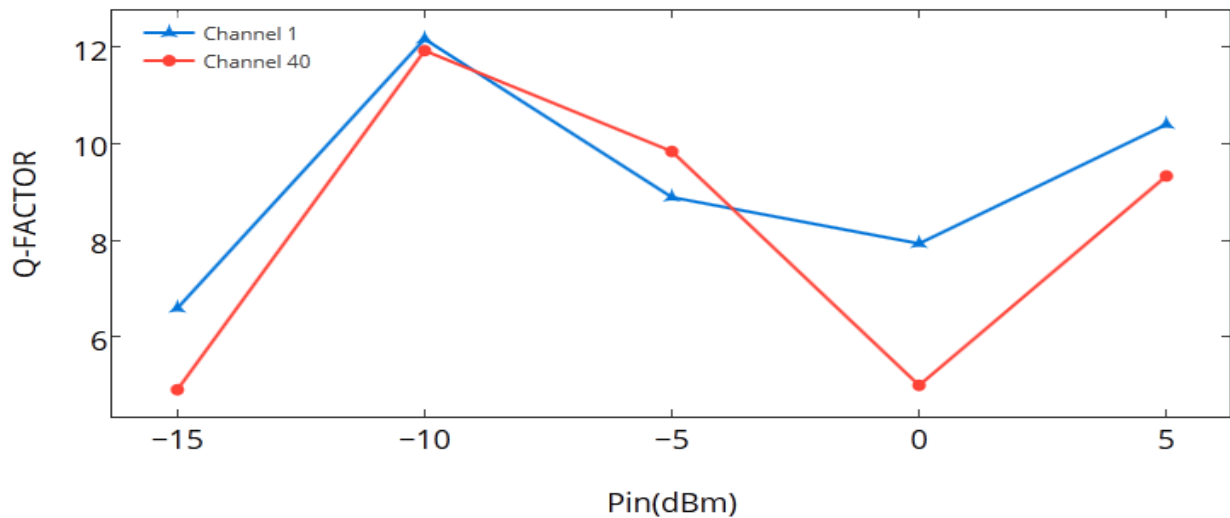
Figure 4: depicts the eye diagrams.

Fig.3 (a) Measured Result for Proposed 40 x 50 DWDM System- Q-Factor v/s power
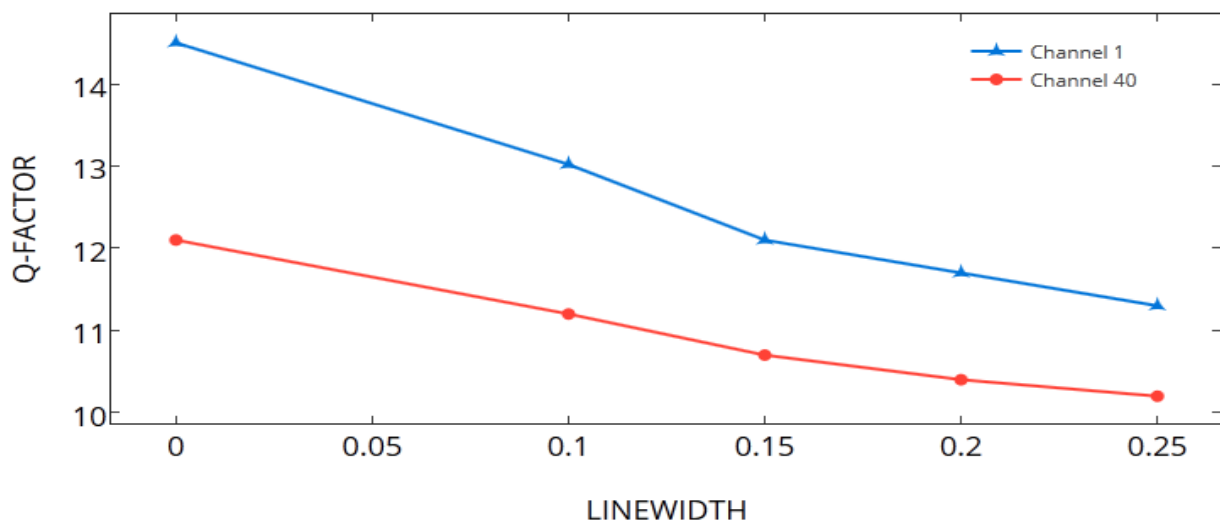

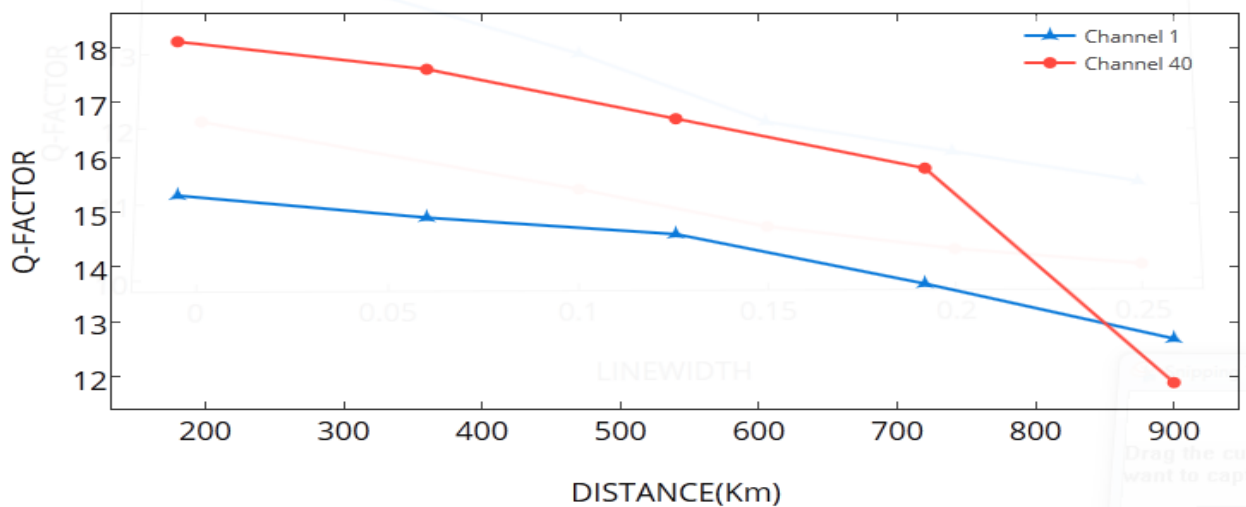Figure 3(b): Q -factor v/s linewidth for channel 1 and channel 40

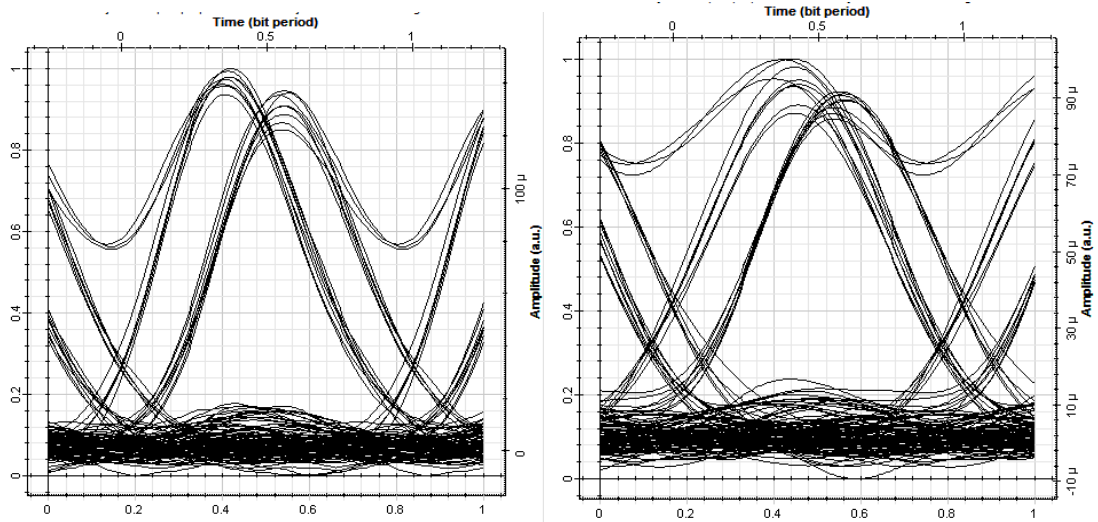Figure 3(c): Distance v/s Q-factor for channel 1 and 40

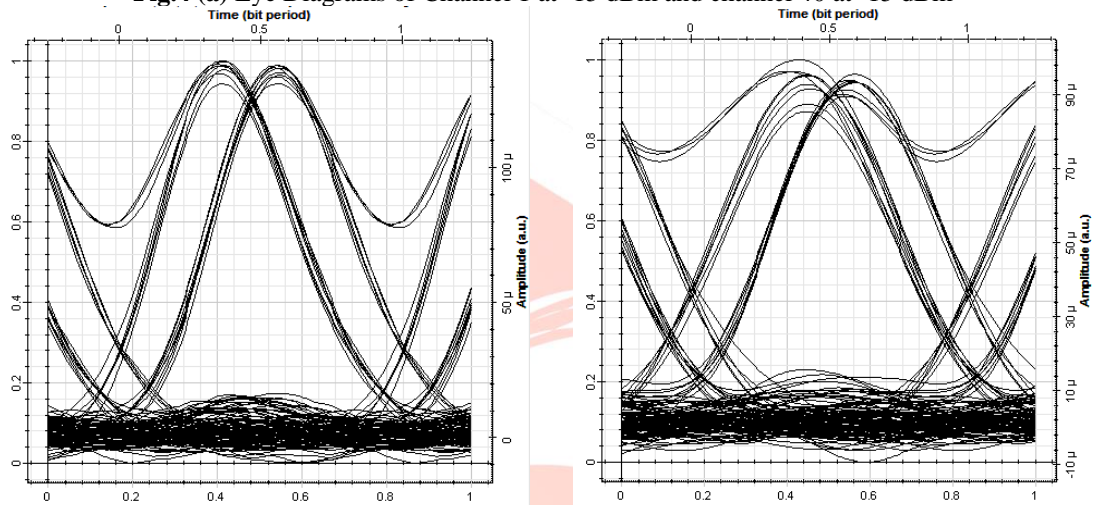**Fig.4 (a)** Eye Diagrams of Channel 1 at -15 dBm and channel 40 at -15 dBm

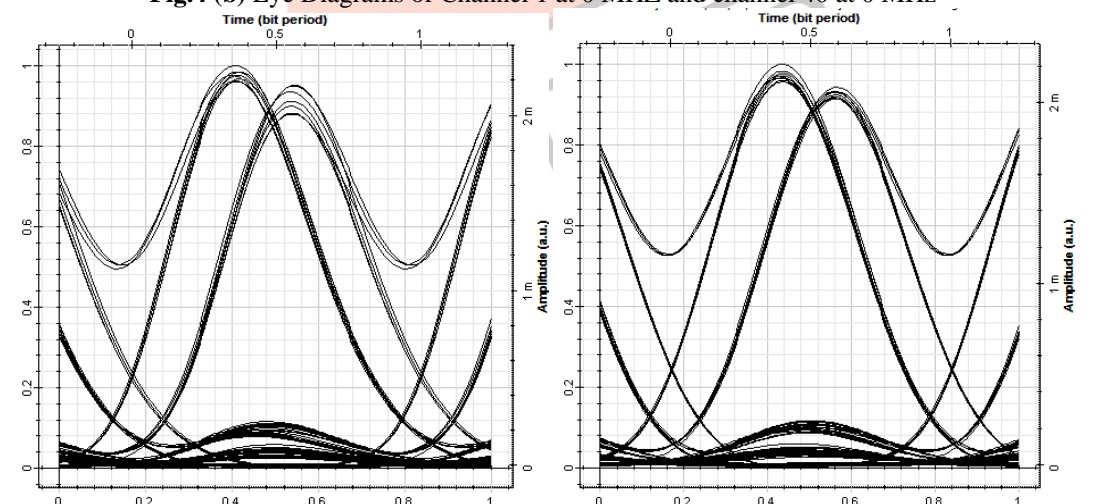**Fig.4 (b)** Eye Diagrams of Channel 1 at 0 MHZ and channel 40 at 0 MHz

Fig.4 (c) Eye Diagrams of Channel 1 at 180 km and channel 40 at 180 km

IV. CONCLUSION

In this work, Modified Duo binary scheme is proposed as modulation scheme for transmission of 40 channels with 50 Gbps data rate. The performance of proposed 40 X 50 high speed system is evaluated in terms of varying power, linewidth and varying distance. At lower power -15dB Q-factor received is 6.59 and at maximum power Q-factor received is 10.40. So as we vary a power in ascending order Q-factor increases. Similarly, results from above experiment represent that at 180 km Q-factor is 15.3 and at maximum distance 900 km Q-factor is 12.7 with acceptable BER. Further work is investigated by varying laser linewidth from 0MHz to 0.25 MHz and best results comes at 0.25 MHz

V. REFERENCES

[1] Bansal, Urvashi and kaur, kamaldeep, Dec 2014, 1.6 Tbps High Speed Long Reach Dense wavelength division multiplexing System by incorporating Modified duo binary Scheme, International Journal of Current Engineering and Technology, Vol. 4, Issue 6, pp. 4047-4051.

[2] O.Vassilieva, T.Hoshida S.Choudhary (2002),R Pecqueur, K.Yamada ,H. Kuwahara, Optimal 40 Gb/s modulation formats for spectrally efficient long-haul Reach Dense wavelength division multiplexing System (DWDM) systems, IEEEJ.LightwaveTechnol.20(12),pp 989.

[3] M. Forzati, J. Martensson, A. Bernutson, A. Djupsjobaska, P. Johannisson(2002), Reduction of intra channel FWM using the alternate-phase RZ modulation format,IEEE Photonics Technol.Lett.1 4(9,14),pp 1285.

[4] Yin, Xin(2014),Performance evaluation of single carrier 40-Gbit/s downstream for long-reach passive optical networks. Optical Network Design and Modeling, International Conference on. IEEE.

[5] Ajay K. Sharma, Anu Sheetal, and R.S. Kaler, "Simulation of high capacity 40 Gb/s long haul Dense wavelength division multiplexing (DWDM) system using different modulation formats and dispersion compensation schemes (DCF) in the presence of Kerr's effect", science direct, Nov 2008.

[6] Bijayananda Patnaik(2013), P.K. Sahu, Ultra high capacity 1.28Tbps Dense wavelength division multiplexing system design and simulation using optimized modulation format, Optik - International Journal for Light and Electron Optics, Vol. 124, Iss. 13, pp 1567-1573.

[7] G.Bosco, R.Gaudino A.Carena, V. Curri, P. Poggiolini(2002), On the use of NRZ, RZ, and CSRZ Modulation at 40 Gb/s with narrow Dense wavelength division multiplexing System (DWDM) channel spacing, J. Lightwave Technol. 20 (9),pp 1694.

[8] A.Hodzik, B.Konrad, K.Petemann (2002), Alternative modulation formats in N X40 Gb/s WDM standard fiber RZ-transmission systems, IEEEJ. LightwaveTechnol.20, pp 598.

[9] Shi Yuhu, "Research on the dispersion problem in High Speed Optical Communication Systems", IEEE 2011

[10] J. Conradi, K.S. Cheng, Reduction of pulse-to-pulse interaction using alternative RZ Formats in 40-Gb/s systems, IEEE Photonics Technol. Lett. 14 (1) (2002) 98.

[11] R.S. Kaler, S. Singh, Simulation of DWDM signals using optimum span scheme with cascaded optimized semiconductor optical amplifiers, Optik—Int. J. Light Electron. Opt. 118 (2007) 74–82.

[12] J. Conradi, K.S. Cheng, Reduction of pulse-to-pulse interaction using alternative RZ Formats in 40-Gb/s systems, IEEE Photonics Technol. Lett. 14 (1) (2002) 98.