OPTIMIZATION OF DWDM SYSTEM BY DOUBLE FBG AND POLARISATION INTERLEAVING

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Abstract : This paper deals about the optimization of dense wavelength Division Multiplexing (DWDM) optical network by the method of polarization interleaving. Dispersion is the main parameter in any optical network which needs to be compensated in order to provide high level of reliability of service. Fiber Braggs Grating (FBG) is one of the most widely used element to compensate it; however its performance slows down with the increase in distance. In this paper we proposed a method for dispersion compensation which offers much better performance than other existing methods. This method offers almost negligible dispersion and very high value of synchronization by reducing jitter portion in the Eye diagram. This method also offers very high value of Q-factor, SNR and Reduced BER in optical communication networks.

Keywords: **Dense wavelength Division Multiplexing, Polarization Interleaving, Erbium Doped Fiber Amplifier, FBG, PMD, DCF, Q-factor, BER**.

I. INTRODUCTION

DWDM is more advantageous when compared to normal WDM systems as it has made a tremendous progress on transmission capacity (commercial DWDM systems are available with capacities of 32 channels and upwards; providing more than 80 Gigabits/second per fiber), which is defined by optical signal modulation method and bandwidth used for transmission. As the transmission bandwidth is fixed, allowable dispersion values are in inverse proportion to the square of transmission speed, and therefore the faster the transmission bit rate speed, the more important the compensation of accumulated chromatic dispersion over transmission bandwidth .

Another problem in the DWDM system is that the non-linear effects degrade the performance of the system. As the optical signal propagates through the fiber they undergo power fluctuations and crosstalk between the channels in DWDM system. The dominant degradation effect of Cross Phase Modulation causes a nonlinear polarization dependent phase shift between the signals propagating through the same optical fiber. This leads to polarization rotations even in the absence of polarization mode dispersion. Due constant phase shift and polarization rotations produced by XPM additional spectral components are generated in the optical spectra leading to polarization scattering which depolarizes the two Polarization components and causes crosstalk between the X and Y polarization components. A possible counter-measure, which can be used, is alternating the polarization of adjacent channels to re-establish orthogonality in the polarization dimension (polarization interleaving).

In the proposed system the dispersion compensation is done using double FBG with the concept polarization interleaving. The Fiber Bragg Grating is used to reduce the dispersion and to increase the Q-factor. The Dispersion compensation fiber (DCF) and Fiber Bragg Grating (FBG) are used to compensate for linear effects and an Erbium Doped Fiber Amplifier (EDFA) to overcome attenuation losses The proposed system has 8 channels starting from 193.1THz with an adjacent channel spacing of 0.4nm.

II. SIMULATION SETUP

The simulation model of DWDM optical network is implemented on "OPTISYSTEM-13.0" software**.** Fig.1. represents the transmitter block diagram. Eight set of these Transmitter blocks are used to produce eight different channels. Polarization rotator is used to rotate the polarization by -90 degrees at alternate channels**.** Each 10 Gbps signal is multiplexed using multiplexer and travel along the optical link and gets de-multiplexed by a de-multiplexer. The received optical signals are detected by PIN photodiodes. The converted Electrical signals are filtered by an electrical filter. The 3R regenerator is used to reproduce the original signal. In the optical link, the dispersion compensated fiber is used after the SMF. The total length of fiber channel is segmented in the ratio of 1:5 i.e. 10 km DCF and 50 km SMF. Fig**.**2 represents the functional block of the proposed DWDM optical network.

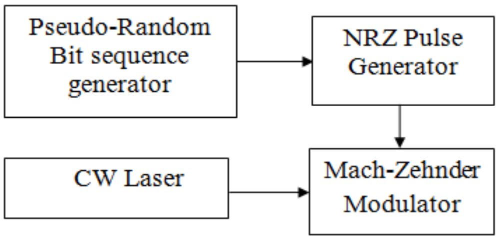

Fig.1. Transmitter block

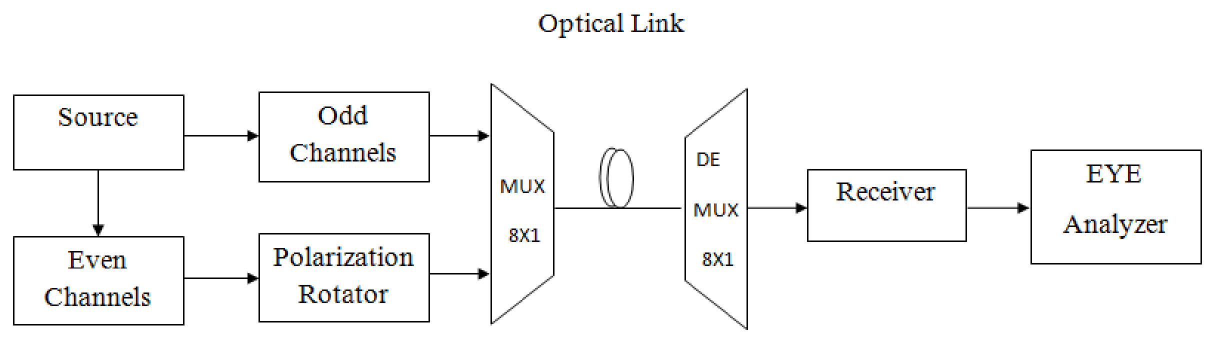

Fig.2. Block Diagram of proposed method

TRANSMITTER

The pseudo-random bit sequence generator provides a bit rate of 10 Gbps. Maximum amplitude of NRZ pulse generator is 1 a.u. and both Rise and fall time are 0.05 bit. A CW laser is the optical source with a frequency of 193.1 THz and sweep power level of 0 dBm. MZM has the excitation ratio of 30 dB and symmetry factor about -1. The Block diagram of the transmitter is shown in Fig.1.

OPTICAL LINK PARAMETERS

Single Mode Fiber:

SMF has the reference wavelength of 1550 nm. The changed values of different parameters are, attenuation=0.2 dB/km, dispersion=16.75 ps/nm/km, dispersion slope=0.0075 ps/nm^2/km, β2=-20 ps^2/km and β3=0 ps^2/km. Differential group delay for PMD of the SMF is 3 ps/km and the PMD coefficient is 0.5 ps/km.

Dispersion Compensating Fiber:

The changed parameters of the DCF for the reference wavelength 1550nm are, attenuation=0.6 dB/km, dispersion=-80 ps/nm/km, dispersion slope=0.21 ps/nm2/km, β2= -20 ps2/km, Differential group delay 3 ps/km, PMD coefficient 0.5ps/sqrt(km), mean scatter section=50 m, scattering section dispersion=100 m, maximum nonlinear phase shift=5 mrad,lower calculation limit=1200 nm, upper calculation limit=1700 nm, effective area=30 um2, n2= 3e-020 m^2/w, Raman self-shift time 1 = 14.2 fs, Raman self-shit time 2 = 3 fs fract. Raman contribution 0.18 and orthogonal Raman factor 0.75.

Fiber Bragg Grating:

Uniform FBG has a frequency of 193.4 THz, Bandwidth of 125 GHz & Reflectivity of 0.99.Noise threshold is about -100 dB, Noise dynamic factor =3 dB, Noise Calculation bandwidth= 1 THz. Sample Rate of FBG is 500 GHz. Digital filter order=64..

Erbium Doped Fiber Amplifier:

The parameters of EDFA gain block are, Gain and Noise figure=20 dB, 3 dB respectively; Saturation power level =10 dBm, the noise Bandwidth =13 THz and noise bins spacing=125 GHz, noise centre frequency of the amplifier =193.4 THz.

These are the different components used which are connected as shown in Fig 3

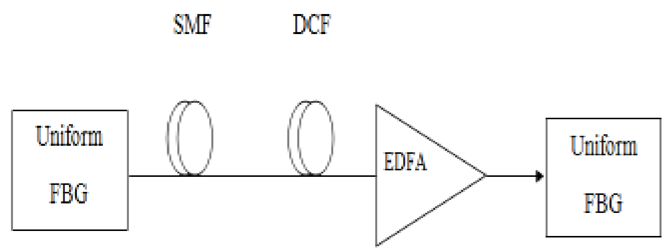

Fig.3 Optical Link Block Diagram

RECEIVER

The PIN photo detectors have the Responsivity of 1 A/W and Dark current of 10 nA. The down sampling rate is 640GHz for the central frequency=193.1 THz. Thermal power density= 2.048e-023 W/Hz, the Random Seed index is 0. A first order low pass chebyshev filter is connected at the every output signal which has a depth of 100 dB and cut-off frequency of “0.999*symbol rate” Hz. The signal is then reproduced using a 3R Regenerator. The result is analysed using an eye diagram analyser. The block diagram of the receiver is shown in Fig 4.

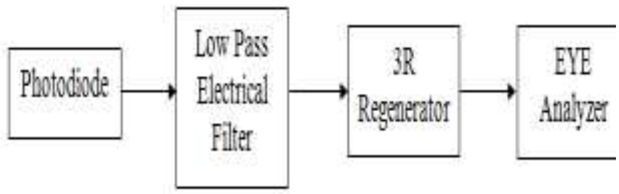

Fig 4 Receiver Block Diagram

III. Q-FACTOR AND BER ANALYSIS

The quality factor is an electrical domain measure of ratio of separation between digital states to the noise associated with the state. Q-factor decides the performance of system parameter such as accumulated optical noise generated by optical amplifiers, polarization dependent losses and polarization mode dispersion occurred in the cannel in the transmission. In the proposed system, maximum achieved Q-factor is shown in Fig 5

BER is the function of system quality factor Q. The bit error rate (BER) is the most significant performance parameter of any digital communications system. It is a measure of the probability that any received bit has an error. A standard bit error rate specified for many systems is $10x10^{-10}$. This means that the receiver has a maximum of one errored bit in every $10x10^{10}$ bits of information transmitted or, putting it another way, the probability that any received bit is in error is $10x10^{-10}$. In the proposed method, achieved BER is about $10x10^{-41}$ which is shown in Fig 5

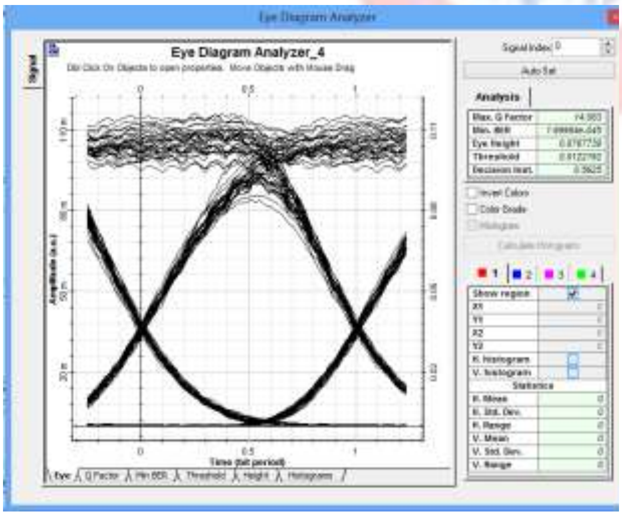

Fig5. BER & Q-factor analysis

IV.CONCLUSION

This work offers improved value of performance parameters such as Q-FACTOR, MIN BER and threshold during the analysis of simulation result it is also observed that BER pattern is much better than other available older methods for dispersion compensation. Eye diagram shows better value of threshold and height which alternatively results in reduced jitter and improved synchronization in Optical Fiber Communication Networks.

V.REFERENCES

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