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Performance Analysis Of Different Dispersion Compensation Schemes In A 2.5 Gbps Optical Fiber Communication Link

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ABSTRACT: In this paper investigation has been done on the performance analysis of different schemes of dispersion compensation using dispersion compensating fiber (DCF) namely post, pre, and symmetric compensation at a particular power level of transmitting laser using different modulation formats such as NRZ modulation format at 2.5 Gbps data rate. The value of eye height, Q- factor, BER was observed in every case using help of eye diagrams. It was observed that symmetric compensation showed best performance with the highest value of Q- factor whereas pre compensation showed worst performance among the three schemes with the lowest value of Q- factor.

Keywords-: Q- factor, BER, eye height, pre, post, symmetrical.

1. INTRODUCTION

Optical Fiber Communication is one of the most important topic of research in today's world communication systems. It reduces the overall net cost of the communication system and also provides a safe way of data transmission at a very high speed [1]. When a information carrying signal is transmitted at the transmission section of optical fiber communication system some losses occur in optical fiber in form of scattering, scintillations, dispersion, absorption etc. As a result of this the actual information in signal is lost [4-7]. In single mode fibers (SMF), the main reason for dispersion is chromatic dispersion and polarization mode dispersion. The reason for chromatic dispersion is the dependence of refractive index and hence the group velocity of silica on the wavelength used for data transmission [5]. Use of Erbium Doped Fiber Amplifier (EDFA) is one of the way dispersion can be compensated in a optical fiber. Dispersion compensating fibers (DCF) and Fiber Bragg grating (FBG) are other techniques which can be used for compensation of dispersion in optical fiber link. In order to compensate dispersion, a very high negative dispersion coefficient in a narrow band frequency is required by the DCF [6]. In FBG the information signal which enters the grating is reflected back at different distances inside of the grating. The signal having larger wavelength travels a longer distance inside the grating before reflection and the signal having smaller wavelength travels shorter distance in grating before reflection. As a result of this the pulse at input of the FBG is compressed at the output and hence dispersion is compensated by the FBG [3]. Electronic Dispersion Compensation is another effective way to compensate dispersion in an optical fiber link. Taking into mind different dispersion techniques available, dispersion compensating fiber has been used in order to compensate dispersion in this case study. The dispersion compensating fiber can either be used in pre, post or symmetrical configuration in order to compensate dispersion. In this paper investigation has been done on all the three configuration of DCF. The length of SMF was taken to be 120 km and dispersion coefficient of fiber was taken to be 16 ps/nm-km whereas length of DCF was taken to be 24 km and dispersion coefficient was taken to be -80 ps/nm-km. No of loops were 2 so total distance travelled was 288 km. The rest of the paper is organized as follows; in section 2, the dispersion compensating fibers are discussed in detail. Simulation setup is described in section 3. In section 4, the results and discussion is discussed and section 5 conclusion of the paper is presented.

2. DISPERSION COMPENSATING FIBERS (DCF)

In 1980's the idea to use dispersion compensating fiber in order to compensate dispersion was introduced.DCF is considered as one of the most appropriate method to compensate dispersion as it has numerous advantages such as wide bandwidth, large stability, less sensitivity to temperature. It is widely used to compensate dispersion in long-haul optical communication system these days [7]. By connecting DCF to a standard SMF in optical communication system the overall dispersion of system can be reduced to zero.
Depending upon the position of DCF in fiber optic link there are three schemes of dispersion compensation:

a) Pre-compensation
b) Post-compensation
c) Symmetrical-compensation

If the DCF is placed before the standard single mode fiber (SSMF) in order to compensate dispersion as shown in Fig. 1, it is pre-compensation technique and if the DCF is placed after the standard single mode fiber (SSMF) as shown in Fig. 2 it is post-compensation. In symmetrical compensation the DCF is placed both before and after the SSMF in order to compensate dispersion as shown in Fig.3.

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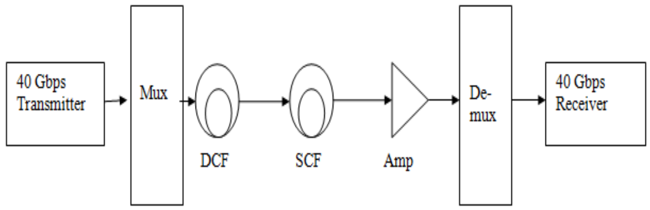


Fig. 1 *Schematic of Pre-compensation [4]*

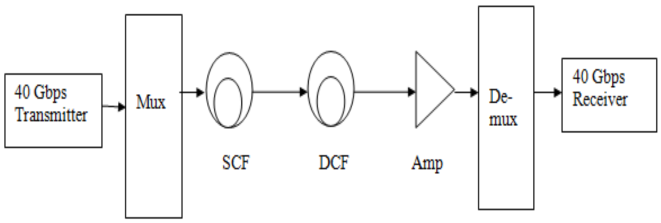


Fig. 2 *Schematic of Post-compensation [4]*

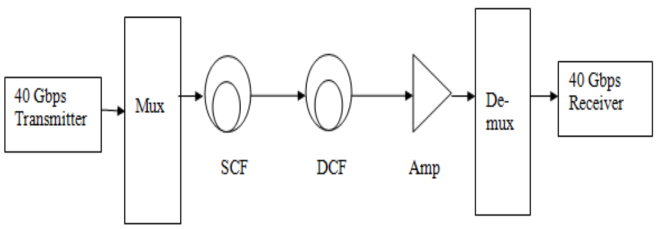


Fig. 3 *Schematic of Symmetrical Compensation [4]*

3. SIMULATION SETUP

The simulation setup designed for dispersion compensation has been designed by using Optisystem 7.0 software Simulations of all the schemes for dispersion compensation (Pre, post, symmetrical) has been done at 2.5 Gbps data rates. Parameters listed in table no.1have been used in our simulations. In the simulation setup, the transmitter section consists of a pseudo random bit generator which generates random stream of 0's and 1's. The output of pseudo random bit generator is fed to NRZ pulse generator which converts binary data into electrical pulses. Next mach-zender modulator is used which modulates the signal from output of NRZ pulse generator with a continuous laser with central frequency at 193.1 THz. The optical link consists of SMF and DCF along with Erbium doped fiber amplifier. The simulation parameter of DCF and SMF used in the simulations are shown in table no. 2. At the receiver side optical signal is converted to electrical signal by APD photodiode output of which is fed to a LPF in order to remove high frequency noise from the received signal.

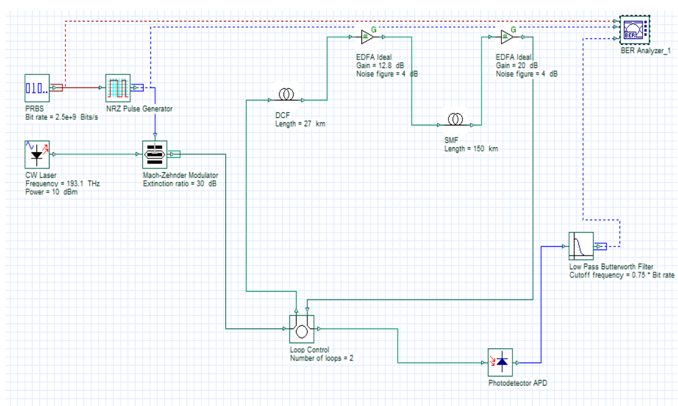
Parameters	Value
Bit rate	2.5 Gbps
Sequence Length	64
Samples per bit	256
Central frequency	193.1 THz
Extinction ratio	30 db
Power	10 dBm

Table No.1: *Simulation Parameters*

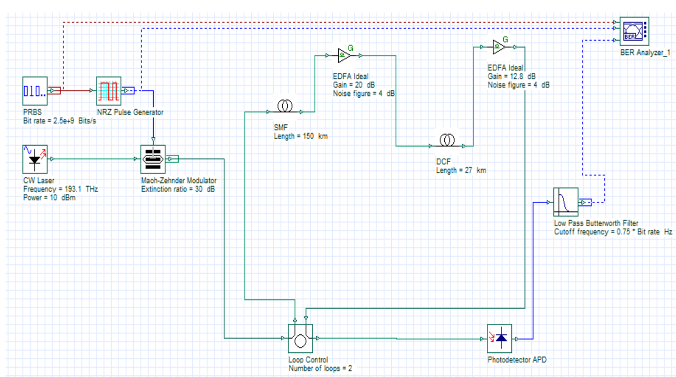
Parameters	SMF	DCF
Length (km)	120	24
Attenuation (db/km)	0.2	0.6
Dispersion (ps/nm/km)	16	-80
Dispersion slop (ps/nm2/km)	0.08	0.3
Differential group delay (ps/km)	0.5	0.5

Table No.2: *Fiber Parameters*

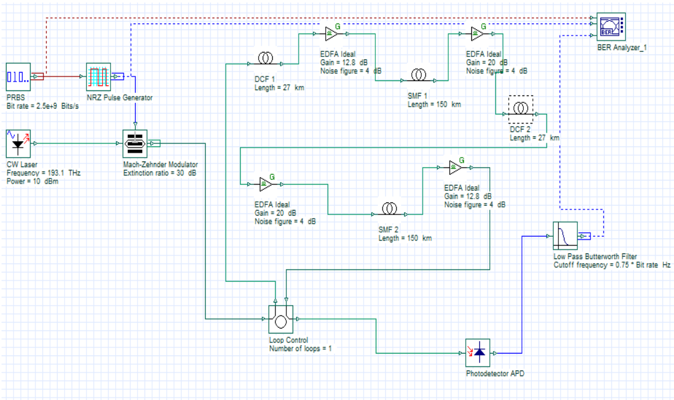
The simulation setup used for pre, post and symmetric compensation are shown in Fig no. 4(a), Fig no. 4(b), Fig no. 4(c) respectively.



(a)



(b)

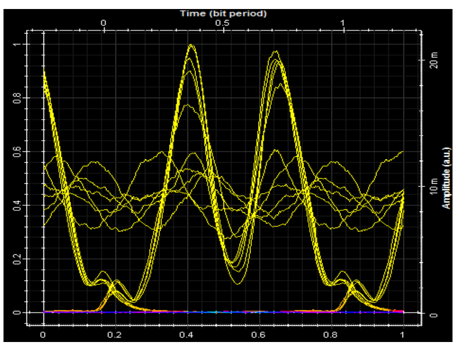


(c)

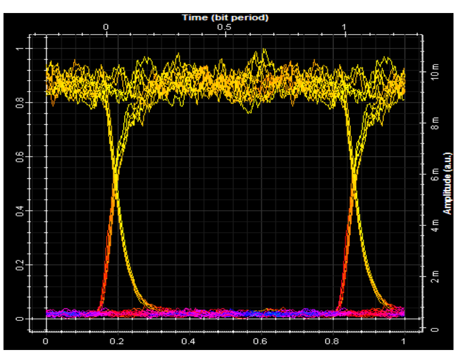
Fig no.4 *Simulation setup for (a) pre-compensation (b) post-compensation and (c) symmetrical-compensation*

4. RESULTS AND DISCUSSIONS

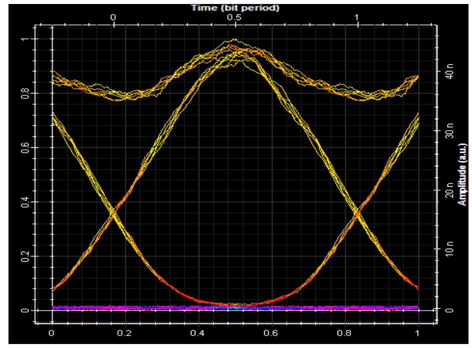
All the different dispersion compensation techniques have been analyzed at 2.5 Gbps data rate in terms of bit error rate (BER), eye height and Q- factor. Fig no. 5 shows eye diagram for pre, post and symmetric compensation respectively. The values of BER, eye height and Q- factor for pre, post and symmetric compensation at 193.1THz of power are compared in table no. 3.



(a)



(b)



(c)

Fig no. 5 *Eye diagrams of (a) pre-compensation (b) post-compensation and (c) symmetrical-compensation*

At 193.1 THz

	Pre Compensation	Post Compensation	Symmetric Compensation
Q-factor (db)	19.5328	41.4734	48.1097
Eye height	0.00673181	0.00847089	0.00941863
BER	3.3325e-005	0	0

Table no. 3 *BER, eye height and Q- factor for pre, post and symmetric compensation at 193.1THz*

5. CONCLUSION

This informative article analyzes the performance of different schemes of dispersion compensation in an optical fiber link. From the above presented results it is concluded that the performance of symmetrical compensation is best among the different schemes of compensation as it provides the largest Q- factor of 48.1097 and least BER to optical fiber link of length 288 Km at 2.5 Gbps data rate.

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REFERENCES

[1] R.S. Kaler, “Simulation of 16 x 10 Db/s WDM system based on optical amplifiers at different transmission distance and dispersion,” Optik 123, 1654-1658, 2012.

[2] M.I. Hayee, A.E. Willner, Senior Member, “Pre and post-compensation of dispersion and linearities in 10-Gb/s WDM, IEEE Photon. Technology, Lett. 9 (9), 1999.

ISSN 2347-4289

[3] R.J. Nuyts, Y.K. Park, P. Gallion, Dispersion equalization of a 10 Gb/s repeatered transmission system using dispersion compensating fibers, J. Lightwave Tech nol. 15 (1), 31–42, 1997.

[4] Gurinder Singh, Ameeta Seehra and Sukhbir Singh, “Investigations on order and width of RZ super Gaussian pulse in different WDM systems at 40 Gb/s using dispersion compensating fibers,” Optik 125, 4270-4273, 2014.

[5] R.S. Kaler, A.K. Sharma, T.S. Kamal, “Comparison of pre-, post- and symmetrical- dispersion compensation schemes for 10 Gb/s NRZ links using standard and dispersion compensated fibers,” Optics. Communication, 209, 107–123, 2002.

[6] Bo-Ning HU, Wang Jing, Wang Wei, Rui-Mei Zhao, “Analysis on Dispersion Compensation with DCF based on Optisystem,” IEEE 2nd International Conference on Industrial and Information Systems, 40-43, 2010.

[7] Manpreet Kaur, Himali Sarangal, “Analysis on Dispersion Compensation with Dispersion Compensation Fiber (DCF),” SSRG International Journal of Electronics and Communication Engineering (SSRG-IJECE), ISSN: 2348 – 8549 – vol. 2 issue 2, 56-59, Feb 2015.