International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.(02), March 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

DISPERSION COMPENSATION PERFORMANCE IN A LONG HAUL OPTICAL FIBER USING A DCF

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ABSTRACT

Single mode fibre has been used in the long distance communication because of its small core diameter and has low attenuation and higher bandwidth. The two major losses in optical communication is attenuation and dispersion. Attenuation limits the maximum distance. While dispersion limits the information capacity of the fiber. Attenuation can be limited by using amplifiers. Dispersion can be a limited by using a special design. In this paper we investigate three types of compensation methods for 40 Gb/s non-return to zero (NRZ) link using standard dispersion compensated fiber. The simulation is done using the software Optisystem 15.The simulation results are validated by analyzing the Q-factor and bit error rate (BER).

Keyword : ***positive dispersion, negative dispersion, reliability of service,WDM system,PMD, DCF, Q-factor, BER, Eye-diagram***.

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. Next generation communication network will be required to provide increased data rate efficiently along with the flexibility to adapt to various dynamic traffic patterns in a costeffective manner Single mode optical fibers have already been one of the major transmission media for long distance telecommunication, with very low-losses and wide-bandwidth.

An optical fibre communication system operating at high data rate with low losses can satisfy the need of the high data rate with good quality of service to the next generation. But at high data rate inter-symbol interference due to dispersion causes the signal distortion, which needs to be suitably compensated in cost effective manner.An Improved methodology for Dispersion Compensation is discussed in this work, which offers much better performance compared to FBG compensation in long haul Optical Fiber Networks.

1.1 TRANSMISSION CHARACTERISTICS OF FIBER

The transmission characteristics are of utmost importance when the suitability of optical fibers for communication purposes is investigated. The transmission characteristics of most interest are those of attenuation (or loss) and bandwidth. Attenuation is caused by absorption, scattering, and bending losses.As propagation continues attenuation increases.Ultimately, the propagating signal is attenuated until it is at some minimal, detectable, level. That is, the signal is attenuated until it can just be sensed by the receiver in the presence of whatever interference is expected. The output signal at this location can then be regenerated . The signal can be boosted back up to its original energy level using optical amplifiers. The broadening of a pulse as it propagates inside a optical fiber is called as dispersion.This spreading of the signal pulse reduces the system bandwidth or the information-carrying capacity of the fiber. Dispersion limits how fast information is transferred. An error occurs when the receiver is unable to distinguish between input pulses caused by the spreading of each pulse .As a pulse spreads, energy is overlapped.

1.2 DISPERSION COMPENSATING FIBERS (DCF)

The idea of using dispersion compensating fibers for dispersion compensation was proposed in 1980s. As the components of DCF are more stable, not easily affected by temperature, wide bandwidth, DCF has become the most suitable method for dispersion compensation. It is currently used as the standard solution for dispersion compensation in long-haul WDM optical transmission links. The use of DCF is an efficient way to reduce the overall dispersion in WDM network as they have higher negative dispersion coefficient and can be connected to the transmission fiber having the positive dispersion coefficient i.e. the overall dispersion of the link becomes zero.

II. DESIGN METHODOLOGY

Dispersion compensation is done by three different schemes depending upon the position of DCF:

i.Pre-compensation

ii.Post-compensation

iii.Symmetrical-compensation

2.1 PRE COMPENSATION TECHNIQUE

In Pre compensation DCF is placed before SMF .The designing consists of DCF EDFA and SMF. Purpose of EDFA after DCF is that it provides periodic amplification. Dispersion Parameter is expressed in ps/nm/km and is in negative.

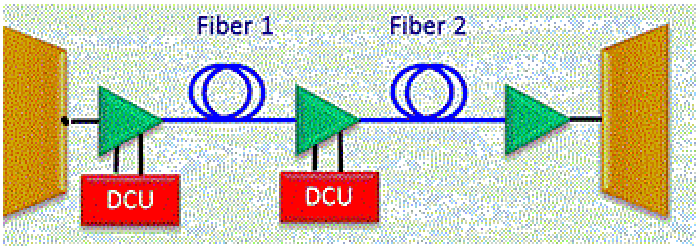

Fig-2.1. Pre-Compensation Technique

2.2 POST COMPENSATION TECHNIQUE

As dispersion causes pulse broadening and pulse distortion. Another compensation is post compensation in which SMF(single mode fiber) is placed before DCF.

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ISSN: 2319-8354

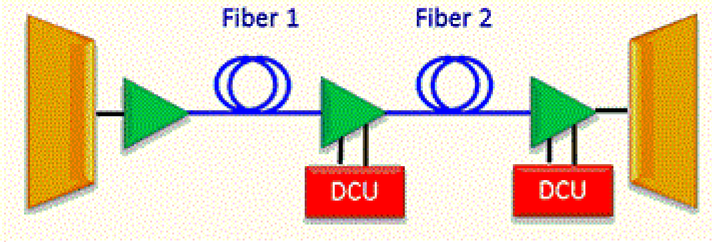

Fig-2.2.Post-Compensation Technique

2.3 SYMMETRIC COMPENSATION TECHNIQUE

In symmetric compensation ,DCF is placed before and after the standard fiber.

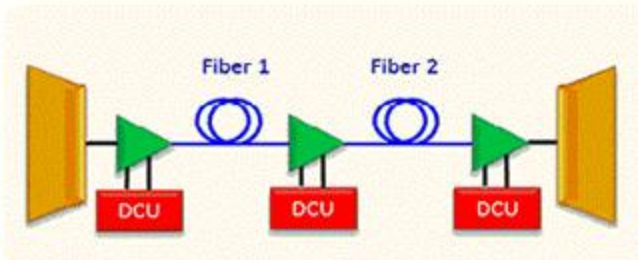

Fig-2.3.Symmetric-Compensation Technique

III. SIMULATION DESIGN AND IMPLEMENTATION

The Simulation model of transmitter and Receiver for optical fiber Communication is implemented using OPTISYSTEM-15 software. A dispersion compensated fiber is used before the SMF. The total length of fiber channel remains same, however it is segmented in the ratioof 1:5 i.e. 10 km DCF and 50 km SMF.

3.1 DESIGN OF PRE-COMPENSATION TECHNIQUE

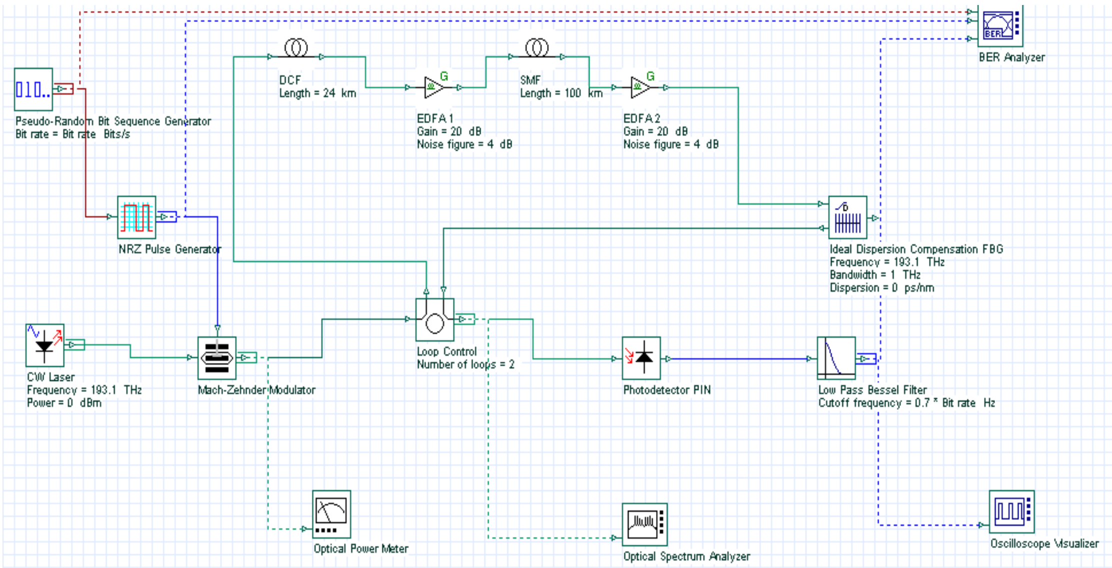

FIG 3.1SIMULATION FOR PRE COMPENSATION

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.(02), March 2018
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ISSN: 2319-8354

3.2 DESIGN OF POST-COMPENSATION TECHNIQUE

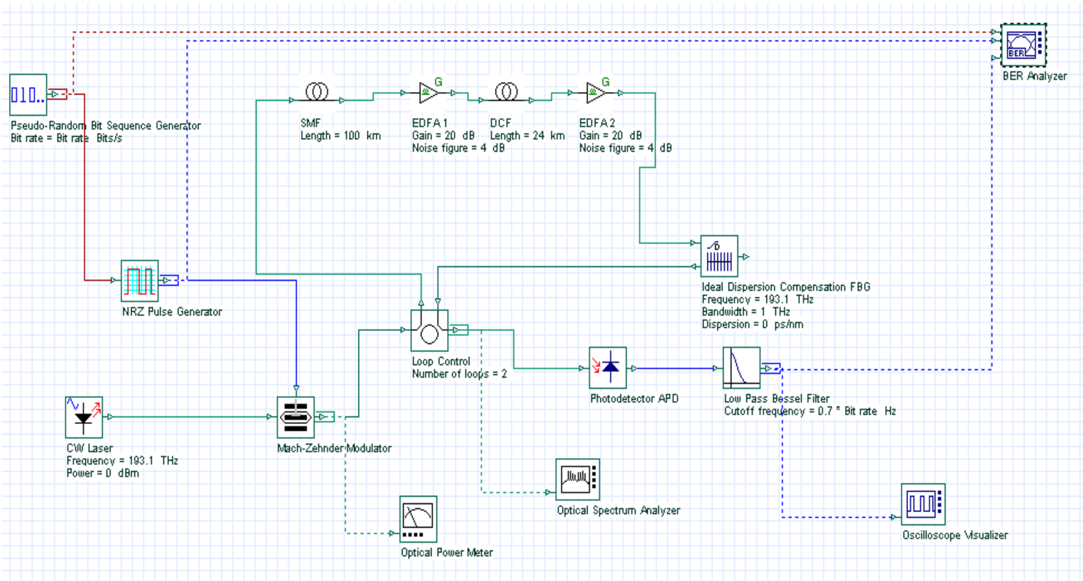

FIG 3.2 SIMULATION FOR POST COMPENSATION

3.3 DESIGN OF SYMMETRIC COMPENSATION TECHNIQUE

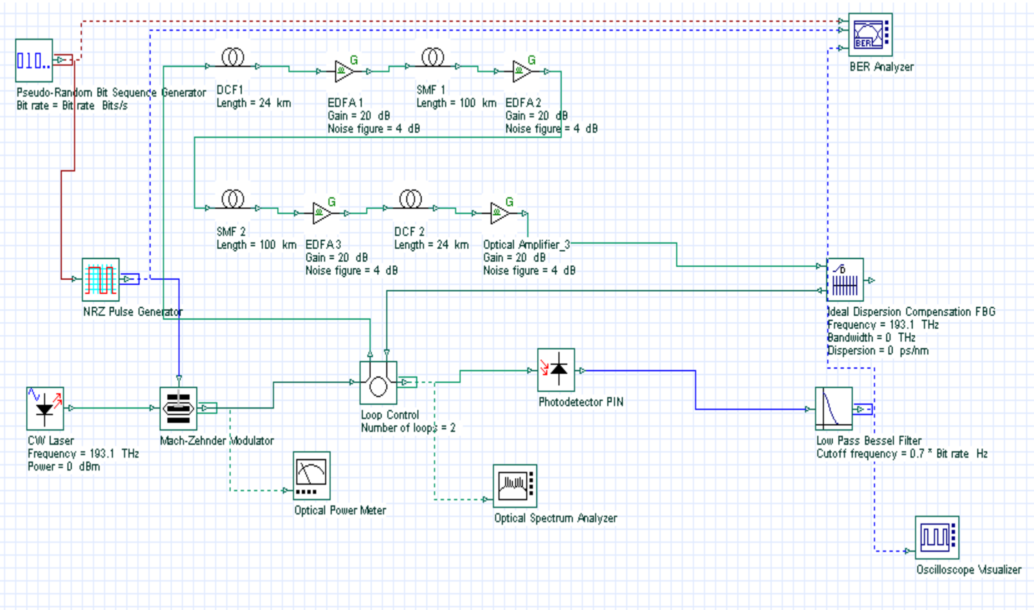

FIG 3.3 SIMULATION FOR SYMMETRIC COMPENSATION

IV. RESULTS AND ANALYSIS

The three dispersion compensation schemes have been analyzed at 40 Gbps for WDM optical network in terms of bit error rate (BER), Q-factor and eye height. The eye diagrams for the pre-, post- and symmetrical-compensation are shown here.

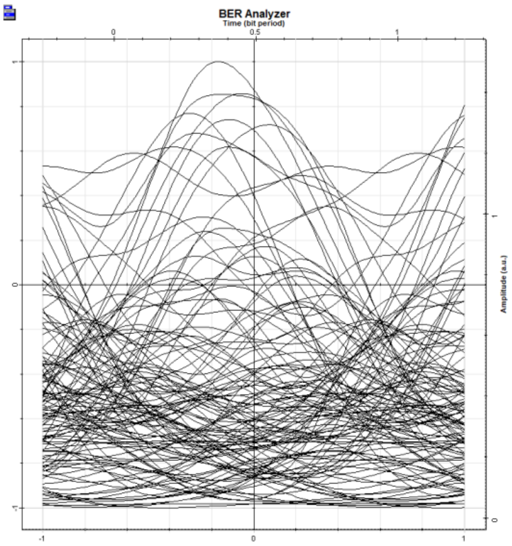

Fig 4.1. Eye diagram of pre compensation

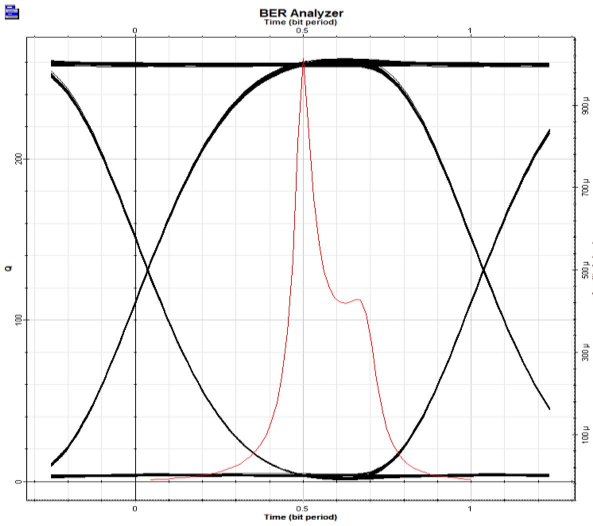

Fig 4.2. Eye diagram of post compensation

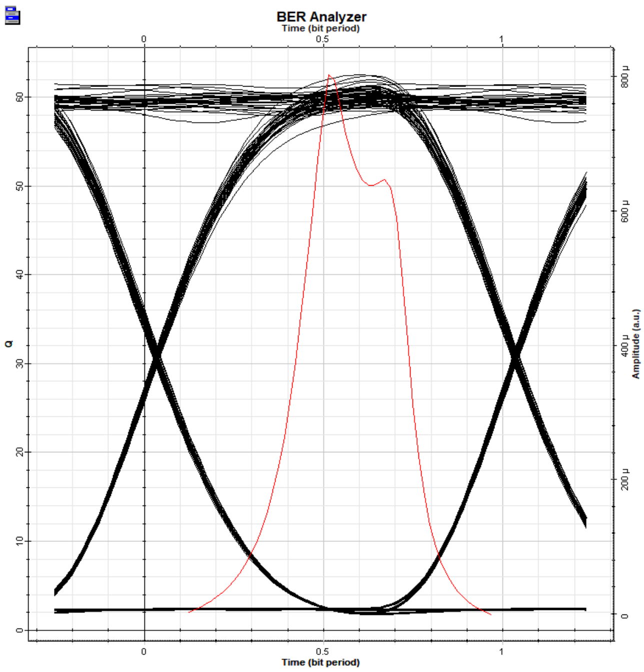

Fig 4.3 Eye diagram of Symmetric compensation technique

V. CONCLUSION

The dispersion compensation fiber is used in 40 Gb/s WDM system as per requirement. EDFA is used as a amplifier in the link can boost the system performance.In this work, improved methodology for dispersion compensation in long haul network is discussed.It is observed that the compensation schemes reduced the dispersion appropriately but among the three compensation schemes post compensation scheme reduced the accumulator fiber chromatic dispersion to the maximum possible extend. This method offers improved value of performance parameters such as Q-FACTOR value compared to FBG compensation technique. This system provides better result.

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