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Research Article

# PERFORMANCE ANALYSIS OF OPTICAL SOLITON TRANSMISSION SYSTEMS BASED ON DISPERSION COMPENSATION SCHEME

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A R T I C L E I N F O

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A B S T R A C T

In this work, performance analysis of soliton transmission systems based on dispersion compensation scheme using soliton parameters with dispersion compensation fiber (DCF) is studied. This work investigates the concepts of optical soliton transmission with and without DCF using soliton parameters. It analyses the system with and without DCF using soliton parameters in terms of Q-factor and BER. From the simulation results, it is found that the Q-factor is improved by 9.414 dB with BER of $1.51\text{x}10^{-9}$ for the soliton system with DCF parameter with the same input parameters. The results show that the pulse broadening is less in the output spectrum of dispersion managed systems both in time and frequency domain. The eye diagrams also show that the noise is minimal for the system with DCF. The results show that the performance of soliton transmission is better with DCF parameters.



## INTRODUCTION

An optical soliton is a special kind of light pulse that can be transmitted over fiber optic channel due to the exact compensation between nonlinearity and linear broadening due to group velocity dispersion. Since the soliton data looks the same at different distances along the transmission, this technique can be used to enahance the data rate, bandwidth, and performance transmission of the communication systems. Optical fiber communication systems make use of optical fiber as a medium for transmitting light from one end to the other for long distance transmission. The pulses launched into the fiber spread out in time as they propagate along the fiber length; resulting in dispersion. As a result, the peak power of the pulse decreases and the width increases. Dispersion thus limits the transmission capacity and reduces the bandwidth [2]. Therefore, dispersion has become a major problem at high bit rates and for long haul optical communication systems. Hence, there is a need to efficiently manage dispersion in optical communication systems. Optical solitons which retains their shape over the propagation distance offer a solution to this problem [4-10,13-15]. Pulse propagation inside an optical fiber is governed by the nonlinear Schrodinger equation and is given by

$$\frac{\partial A}{\partial Z} + i\frac{\beta_2}{2}\frac{\partial^2}{\partial t^2} = -\frac{\alpha}{2}A + i\gamma|A|^2 A \quad \textbf{(1)}$$

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Where $\frac{\partial A}{\partial Z}$ Gives the rate of change of the wave envelope as a function of distance z, $\beta_2$ is the group velocity dispersion (GVD) parameter, α is the attenuation coefficient and γ is the non linear parameter.Dispersion D is related to GVD parameter by the equation given as follow [3].

$$D = -\frac{2\pi c}{\lambda^2}\beta_2 \quad \textbf{(2)}$$

Group velocity dispersion in optical fibers can be compensated easily by using high dispersion fibers.A fiber of length $L_i$ with a dispersion of $D_i$ ps/nm-km can be compensated by using another spool of fiber length $L_j$ whose dispersion parameter $D_j$ such that it satisfies the realtion given by [2].

$$D_i L_i + D_j L_j = 0 \quad \textbf{(1.3)}$$

This paper is organized into sections and subsections. These are abstract, introduction, literature, system design, simulation, result, conclusion and referenece. This organization is done in sequence oder.

## LITERATURE REVIEW

R. Nagesh examined on “A Survey of Dispersion Management Using Optical Solitons in Optical Communication System,” using soliton and without soliton parameters. It analyses the system with and without soliton parameters in terms of Q-factor, pulse broadening and eye diagram. From the simulation results, it is found that the Q-factor is improved by 77.9751$dB$ for the soliton system [10].

N. Badraoui examined “Distortion cancellation for solitons carrying high speed information in WDM systems,”. The soliton pulse can keep its shape during propagation and the main physical effects influence the soliton propagation in fibers [15].

**P. Neheeda** "Analysis of WDM System with Dispersion Compensation Schemes," the performance of a WDM system at 8Gbps employing different dispersion compensation schemes using DCF. It is found that a WDM system using the RZ modulation format and employing a symmetrical compensation scheme provides best performance [2].

**A. Sharma** reviewed the **"**Performance Analysis of 4 × 10Gb / s DWDM Soliton System Using Different Parameters". The system performance analysis is based on the input and output pulse shape with initially the input pulse power is taken as 0 dbm [11].

From the above literatures, it is found that the high data bit rate, bandwidth, performance and quality of optical communication system are the critical and big problems for the large, distant optical systems, communication systems. One of the major factors that limit the performance of a soliton transmission in optical communication system is dispersion that limits data bit rate, quality and performance. The Use of Dispersion Compensating Fiber (DCF) is the most common method for dispersion compensation fiber for analyzing the soliton systems for a high data bite and good quality of the communication system [10-15].

The performance analysis of soliton transmission is better analysed based on dispersion compensation fiber. With the introduction of the DCF in the fiber link, Q factor is improved and BER is minized with same number of loop spans and input paramets compared to the system without DCF in the soliton system.

### *Design and simulation*

In this section two systems are modeled and simulated using soliton parameters with and without DCF. Both the systems consist of three sections, the transmitter section, channel and receiver section.

### *Soliton system without DCF Parameters*

A system has been modeled without DCF using soliton parameters and the simulation model is shown below in figure1. The system consists of a transmitter section with user defined sequence generator, optical soliton source, followed by an optical fiber link, amplifier, loop control and a receiver section. In the proposed system, wavelength of the soliton pulse generator source chosen is 1550 nm for a link length of 792 km with six spans. The block diagram of communication system design without DCF parameters is shwon in figure [1] with six spans each with 132 Km length using soliton Parameters.

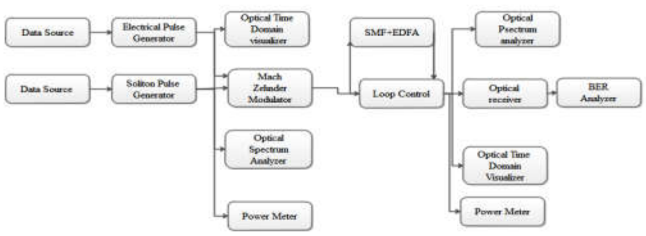



**Figure 1 a)**Block Diagram of Soliton system without dispersion compensation fiber with 6 spans

### *Soliton system with DCF Parameters*

The proposed system consists of user defined bit sequence generator and optical sech pulse generator, followed by an optical fiber and the receiver section. In the proposed system, hyperbolic secant pulse of power 21 dBm generated by the optical sech pulse generator at user defined bit rates. The pulse width is kept at 13.2 ps at a wavelength of 1550 nm.The sech pulses are then launched into the single mode optical fiber of length 132 km for each span with attenuation of 0.2 dB/km and dispersion of 8 ps/nm-km. Table [1] lists the simulation parameters used in the analysis. Figure [2] shows the block diagram of the commuincation system design with DCF parameters with six spans each with 132 Km length SMF and 13.2 Km DCF using soliton parameters.

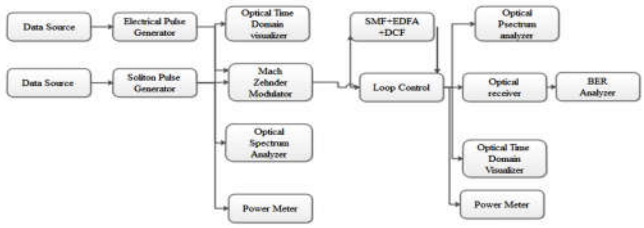


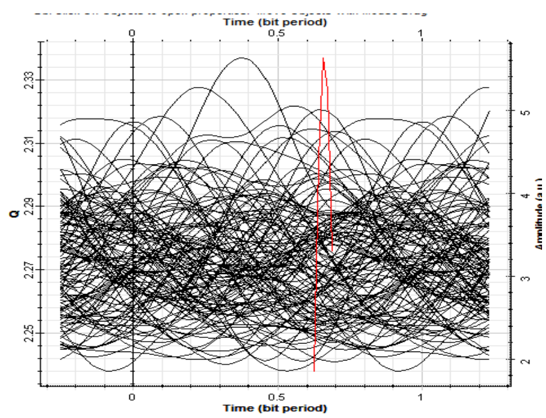

**Figure 2** b)Block Diagram Of Soliton system with dispersion compensation fiber with 6 spans

**Table 1** Simulation parameters of soliton system with EDFA 30 dB.

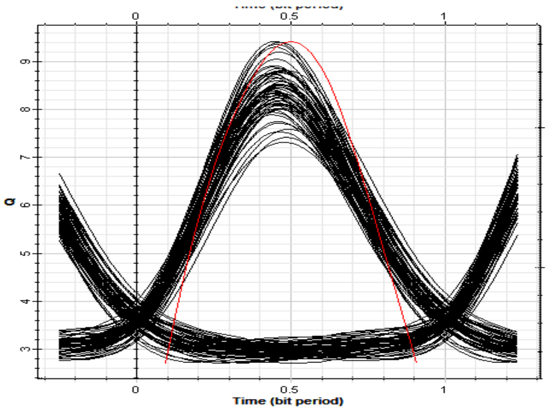
| Parameters & Units | SMF | DCF |
|---|---|---|
| Bit Rate (Gbps) | 15 | - |
| Power (dBm) | 21 | - |
| Pulse Width ($P_s$) | 13.2 | 13.2 |
| Dispersion ($P_s$/nm/Km) | 8 | -80 |
| Wave Length (nm) | 1550 | 1550 |
| Length (Km) | 6*132 | 6*13.2 |
| Attenuation (dB/Km) | 0.2 & | 0.6 |
| $\beta_2(ps^2$/Km) | -20 | -20 |
| Effective Area ($\mu m^2$) | 80 | 22 |

## RESULTS AND DISCUSSION

The performance of the soliton system is modled with and without placing DCF parameters in the transmission link. This can be analysed using the BER and Q-factor measurement metrices obtained at different link lengths of the fiber link. From the simuation results of the two soliton systems it is observed that the Q-facor is maximum with DCF paramerter with value 9.414 dB and the min BER is 1.9849e-021 figure [3a].The soliton system without DCF parameter is obtained as Q-factor of 2.3369 dB and min.BER of 0.0081146 figure [3b]. From the simulation results, it is found that the Q-factor is improved by 7.08 dB for the soliton system with DCF parameter with the same input parameters.




**a**




**b**

**Figure 3** Q-factor of soliton system a) without DCF parameters and b)with DCF parameters using the BER analyzer

The results show that the pulse broadening is less in the output spectrum of dispersion managed system with the DCF parameters figure [4]. The eye diagrams also show that the noise is minimal for the system soliton with DCF. The results in figures [3] show that the performance of dispersion managed system with DCF is improved four times that of the system without DCF parameter. The BER analyzer of the system Q factor without and with DCF parameters at 132 Km with six spans of length is shwon in figure [3].

DCF parameters.The Q-facor is maximum with DCF paramerter with value 9.414 dB and the Min BER is $1.51x10^{-9}$ The soliton system without DCF parameter is obtained as Q-factor of 2.3369 dB and Min.BER of 0.0081146. The quality best recovered with introduction of the DCF parameters.The Q-factor is better analysed using the DCF with the same parameters of the soliton system. The eye diagrams also show that the noise is minimal for the system with DCF parameters. The results show that the performance of dispersion managed system with soliton is good

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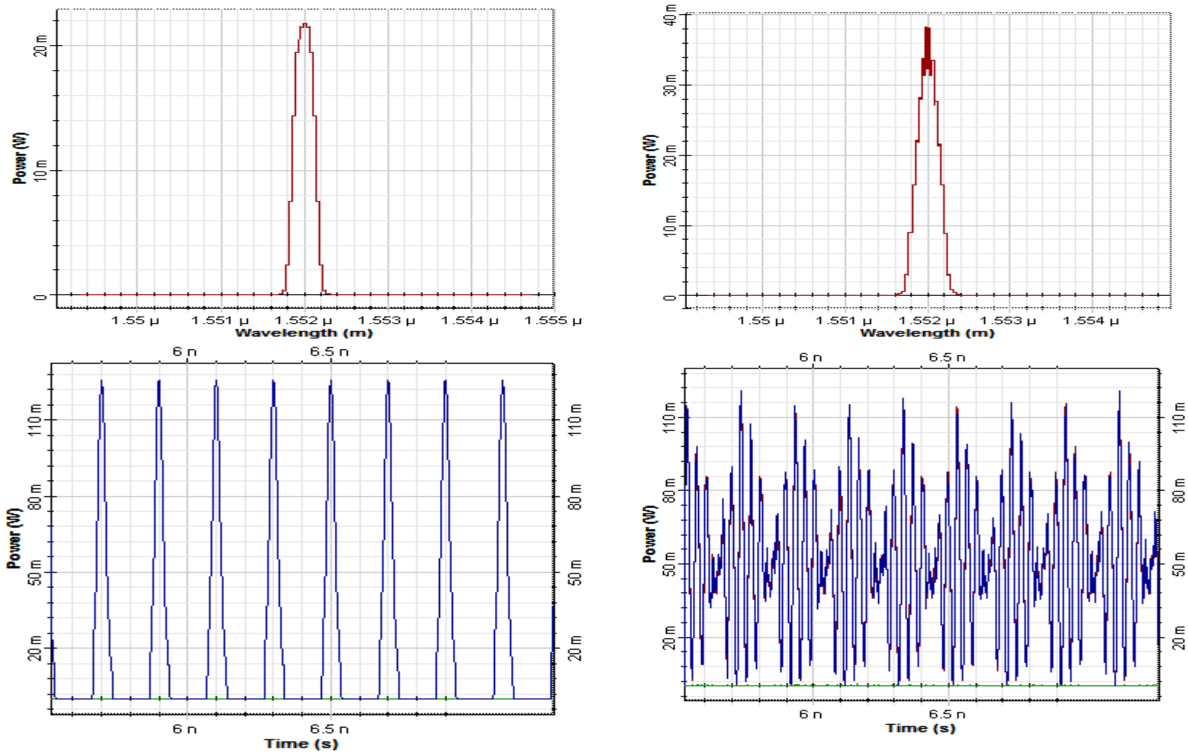


**a)** **b)**

**Figure 4** Output time domain and frequency domain soliton signals a)without DCF b) with DCF parameters From above it is observed that the transmission performance of soliton is best optimized by using the DCF parameters. The soliton system with DCF parameters is best signal quality recoved.

## CONCLUSION

In this work, the performance of solitons transmission system is studied based on dispersion compensation scheme and it also compares the system with and without DCF using soliton parameters. The performance of the system is evaluated using the parameters, BER and Q factor, with dsipersion compensation techniques using DCF at various link lengths. The performance of the soliton system is obtained by using


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