Performance Enhancement of Optical Fiber Link using Optical Soliton Compensation Technique

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Abstract— In optical fiber communication when signal pulse is transmitted that time dispersion is occurring. So to remove that dispersion in optical fiber communications there are different types of dispersion compensation techniques available. One of them is optical soliton compensation technique. Optical soliton refers to any optical field that does not change during propagation because of dedicated balance between nonlinear and linear effects in the medium with its correlative self-phase modulation (SPM). This paper demonstrates the design and analysis of soliton emanation from 9,000 km to 27,000 km using erbium doped fiber amplifiers (EDFA) and dispersion compensating fibers (DCF).

Key words: Optical sech pulse, EDFA, DCF, Q-factor, Eye-diagram

I. INTRODUCTION

In Long haul communication, optical Solitons are now major anxiety because of its elemental property of maintaining its pulse shape and velocity throughout the total length of the transmission line. The absorbing feature is complementing the dispersive effect with the self-phase modulation periodically [1].

Soliton transmission using periodic dispersion compensation has recently become an attractive method to reduce amplitude and timing errors by means of soliton power enhancement in low path-averaged dispersion transmission lines. [2] Solitons have a finite, localized energy and propagate unchanged. They form from the competition between linear dispersion and the nonlinear index of refraction. Surprisingly, when the sign of the linear dispersion periodically varies, as in long distance fiber communications, a new breed of soliton forms. The change in the sign of the dispersion causes these so-called dispersion managed (DM) solitons to temporally broaden and recompress or ‘‘breathe’’ as they propagate. [3] Dispersion management strategy, involves altering the local dispersion between a large positive and a large negative GVD such that the average GVD is small. DM strategy gives rise to several very striking improvements over conventional soliton transmission systems [4].

This paper illustrates the design, enhancement and performance analysis of a lossless and dispersion managed soliton transmission system.

A rotating loop which dwells of three regular fiber spans, one dispersion compensating fiber (DCF) span, Bessel optical filter and EDFA is used for fomenting the system. The system transmits the data up to 27,000 km with the data rate of 10 Gbps. It is shown that the pulse spectrum is enriching due to the high-order soliton effect & third order dispersion near the zero dispersion wavelength, the spectrum begin to be shaped by Bessel optical filter installed at the end of the loop which expels the undesirable spectral peak that gets created on the left hand side of the spectrum. Eye diagram Analyzer, Optical Time Domain Visualizer and Optical spectrum Analyzer are used for the performance analysis. Optisystem Version 13 software has been used for this simulation.

The rest of the paper is structured as follows: In Section 2, the circuit diagram of soliton systems is presented. In Section 3, the simulation results are discussed. Section 4 concludes the paper.

II. SYSTEM DIAGRAM

The circuit diagram which transmits the soliton pulses is shown in figure 1. The pulse of the power 14mW is generated by the optical sech pulse generator at user defined bit sequence generator in wavelength 1550nm. The pulse width is 0.7 bit and the sech pulse is circulating loop with three spans of single mode optical fiber and one dispersion compensation optical fiber. After the every optical fiber there is erbium doped fiber amplifiers used to amplify the noise. The single mode optical fibers have length 60 km with attenuation of 0.2 dB/km and dispersion of 0.2ps/nm-km. Although the dispersion compensation optical fiber has used a length 0.16 km with negative dispersion of -72 ps/nm-km and dispersion slope is 0.7 ps/nm^2-km.The EDFA is amplify the attenuated sech pulses with gain 12 dB. Optical Bessel Filter is used with the bandwidth 2.7 nm. Three fiber spans of 60 km and loop value of 150 is transmitted the soliton sech pulses over 27,000 km.

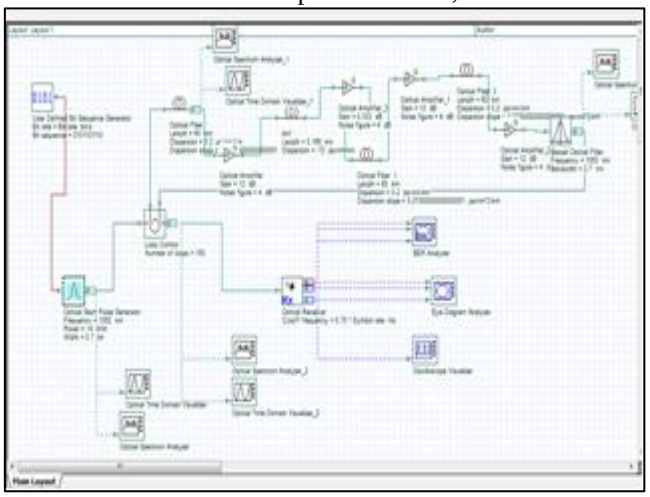

Fig. 1: Simulation setup of optical soliton link for 27,000 km

Parameters	Value
Bit rate	10 Gbps
Data source	Optical Sech Pulse Generator
Pulse width	0.7 bit
Loop	150
Single mode fiber (SMF)	60km

Attenuation	0.2 dB/km
Dispersion compensation Fiber(DCF)	0.16 km
Dispersion	-72 ps/nm-km
Gain	12 dB
Optical Filter	Bessel Optical Filter

Table 1: Parameters of optical soliton link

III. Simulation Results and Discussion

In simulation, the eye diagram and BER rate shown. The BER at which transmitted 1 and 0 bits are received in error is calculated via comparison of transmitted sequence to the received sequence. The figure 2 to figure 4 shows the minimum BRE, maximum Q-factor, threshold and eye height.

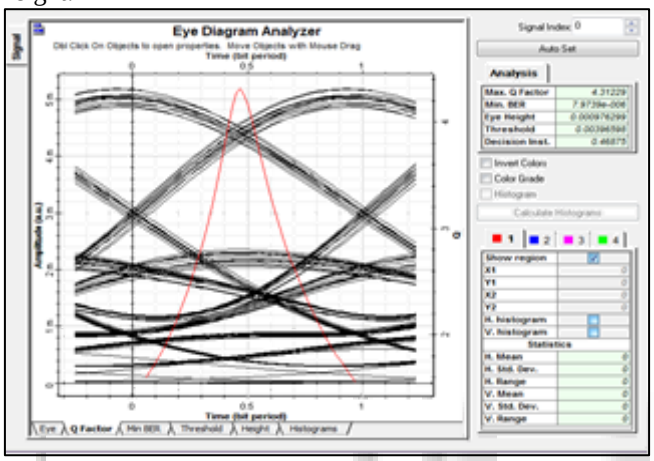

Fig. 2: Eye Pattern for 9000 km

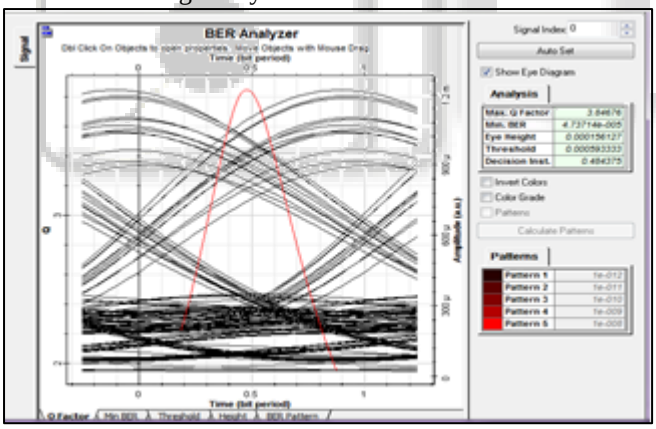

Fig. 3: Eye Pattern for 18,000 km

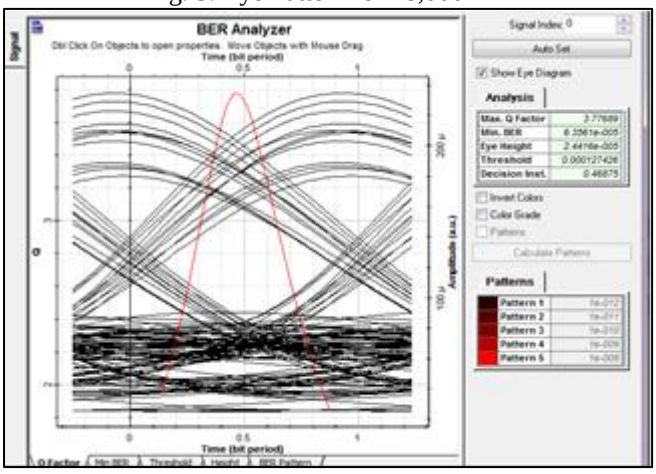

Fig. 4: Eye Pattern for 27,000 km

Sr no	Distance	BER	Q-factor
1	9000 km	7.97E-06	4.31229
2	18000 km	4.74E-05	3.84676
3	27000 km	6.36E-05	3.77689

Table 2: Results of different distance and

Table 2 shows the results of distance of 9000, 18000 and 27000 km and their BER and Q-factor.

IV. Conclusion

In this paper, solitons have shown extraordinary opportunity in long haul high speed optical fiber communication systems because of cancellation of linear and non-linear effect in an optical fiber. In simulation system at 27,000 km of soliton optical system link and achieved the minimum BER of 6.36e-05.

References

[1] Anjan Biswas, "Asymtotic Analysis for Dispersion Managed Optical Solitons", International Mathematical Forum, 1, 2006, no. 3, 103-137
[2] T. Yu, E. A. Golovchenko, A. N. Pilipetskii,C. R. Menyuk , "Soliton Interactions In Dispersion-Managed Fibers",IEEE vol 1,1997,page no 347-348.
[3] C.Lin, H.Kogelink, and L.G. Cohen, "Optical pulse equalization of low-dispersion transmission in single-mode fibers in the 1.3-1.7 µm spectral region", Opt.Lett. 5 (11),476-478(1980)
[4] [online]Available:http//photonicssociety.org/newsletters/feb99/solit.htm
[5] Kadam Bhambri and Neena Gupta, "Dispersion managed solitons transmission in 54,000 km optical link", International Conference on Radar, Communication and Computing (ICRCC), 21 - 22 December, 2012. pp.312-314.
[6] J. Adaikala Susai and S. Robinson, "Analysis The Transmission Performance of The Optical Soliton System" International Journal of Emerging Technology and Advanced Engineering(ISSN 2250-2459, ISO 9001:2008 Certified Journal), Volume 3, Issue 2, February 2013, pp.137-140.
[7] G. Keiser, Optical Fiber Communications, McGraw Hill, 3rdEdition, 2000
[8] G. A. Agrawal. ―Fiber Optic Communication Systems‖, 2nd edition, John Wiley & Sons, New York, 1997.

