International Journal on Emerging Technologies (Special Issue on *RTIESTM-2016*) **7**(1): 89-93(2016)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Simulative analysis of dispersion Compensation using Different techniques in communication system

Jagjeet Singh*, Kulwinder Singh** and Pankaj Sharma*

**Department of Electronics and Communication Engineering, AIET, Faridkot, (PB), INDIA.*
***Department of Electronics and Communication Engineering, BMSCE, Sri Muktsar Sahib. (PB), INDIA.*

(Corresponding author: Jagjeet Singh)
(Received 04 October, 2015 Accepted 04 November, 2015)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: In this paper analysis is done on dispersion choosing a bit rate of 10 Gb/s. Two WDM channels are launched over two DS fiber spans high quality of 100 km each. Dispersion is completely compensated at each span. The fiber dispersion value is varied from 0-4 ps/nm/km through parametric runs. Dispersion is compensated using different techniques.

Keywords: Dispersion, Wavelength Division Multiplexing (WDM), Dispersion compensating management (DCM), Dispersion compensating fiber, Q value, Jitter.

I. INTRODUCTION

Fiber-optics communication works on the principle of total internal reflection, providing larger transmission distance at huge data rates with lesser impairments in comparison to other forms of communication. Optical fiber communication plays a vital role in the development of high quality & high-speed telecommunication systems. Kaler *et al.* showed that FWM effect can be suppressed by increasing dispersion in the fiber [1]. The FWM signal power decreases with increasing dispersion but the decrease is not same for equal and unequal spacing. The decrease in FWM power is more for unequal spaced channels as compared to equal spaced channels. Manna et al. presented that Four Wave Mixing (FWM) resonances can affect performance of selected channels within the dense wavelength-division-multiplexing band [2]. The FWM resonances may cause Q-factor penalty in excess of 1 dB. They developed an analytical model to predict the spectral location and the intensity of the resonances. Dispersion slope-matched maps and manufacturing variations help to suppress the resonances. Nakajima et al. described about the Four Wave Mixing (FWM) suppression effect of dispersion varying fiber (DVF) whose chromatic dispersion increases (or decreases) along the fiber length [3]. Bang et al. described that CPM and FWM are significant nonlinear optical effects in DWDM systems [4]. CPM leads to spectral broadening which may cause severe pulse distortion, while FWM is a nonlinear interaction that can occur between the several channels of different wavelengths. FWM may result in significant crosstalk among the channels in DWDM systems. Melloni *et al.* showed that in ideal conditions the Four Wave Mixing conversion efficiency can be enhanced by the slowing down factor to the fourth power [5]. They have investigated FWM in Coupled Resonator Optical Waveguides both numerically and experimentally and also in presence of attenuation and chromatic dispersion.

II. SIMULATIVE ANALYSIS

Dispersion is defined as pulse spreading in an optical fiber. As a pulse of light propagates through a fiber, elements such as numerical aperture, core diameter, refractive index profile, wavelength and laser line width cause the pulse to broaden. Dispersion increases along the fiber length. Dispersion compensation can be done using pre compensation, post compensation and symmetrical compensation methods. Fiber used as a dispersion compensating module (DCM) is analyzed. The optimal operating condition of the DCM was obtained by considering dispersion management configurations i.e. pre-compensation, post-compensation and symmetrical compensation. The DCF was tested on a single span and single channel system operating at a speed of 10 Gbit/s with the transmitting wavelength of 1550 nm over 120 km of conventional single mode fiber.

So far, most investigations for SMF transmission are done at high amplifier spacing in the order of 90 km to 120 km focused on conventional NRZ format. The Q-factor and Jitter values are investigated. The results indicate performance for three types of configurations. Fig. 1 shows three compensation schemes i.e. pre-compensation, post-compensation and symmetrical compensation.

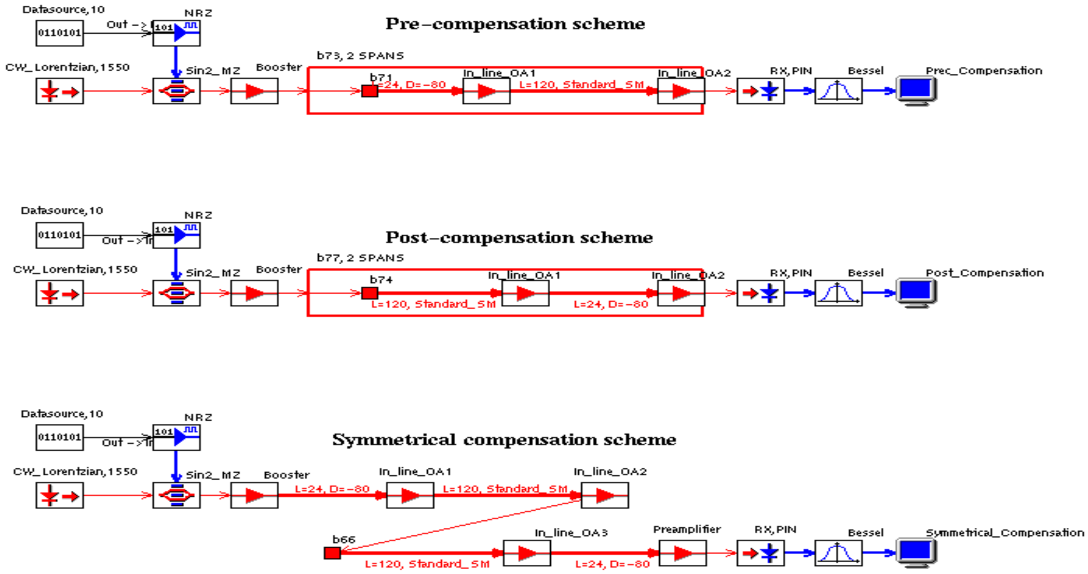

Fig. 1. Dispersion compensation schemes.

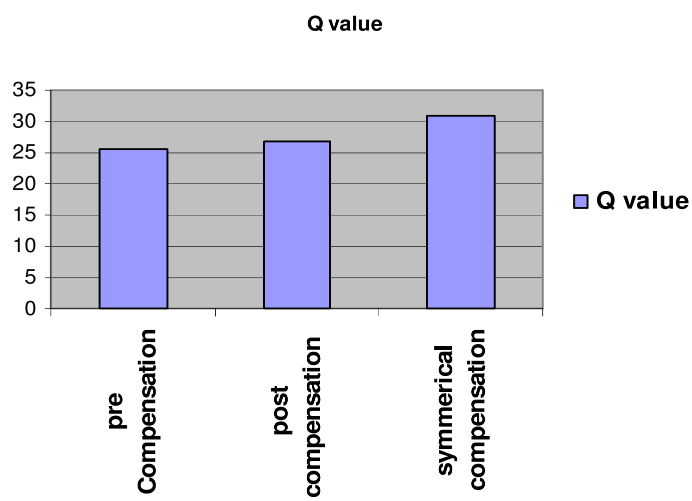

Fig. 2. Q value at different compensation schemes.

Figure 2 shows Q value at different compensation schemes. Symmetrical compensation scheme has 30.85 dB Q value better then other two schemes. Figure 3 shows symmetrical compensation scheme has less jitter value that is 0.02 ns. This value is very less than pre-compensation and post compensation scheme.

Fiber gratings are already key components in optical communication links as these can be used as filters [6], gain flatteners [7] and dispersion compensators [8]. Fiber Bragg gratings (FBG's) are passive, linear and compact. These possess strong dispersion in both reflection and transmission. Different wavelengths in a dispersed pulse are reflected at different positions in the grating, leading to different optical path lengths and thus providing the possibility of compensating for dispersion in long-haul fiber links [8 & 9].

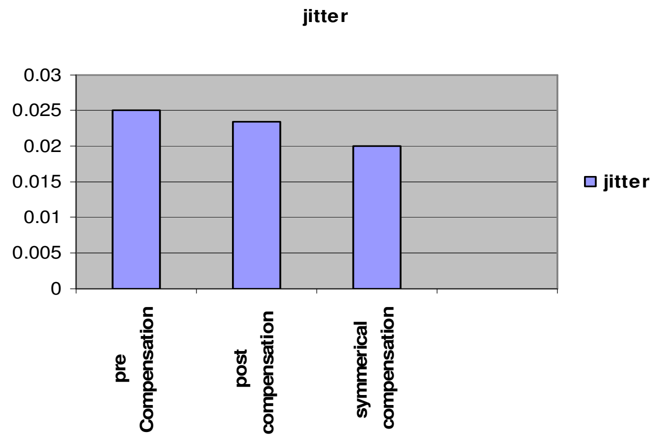

Fig. 3. Jitter at different compensation schemes.

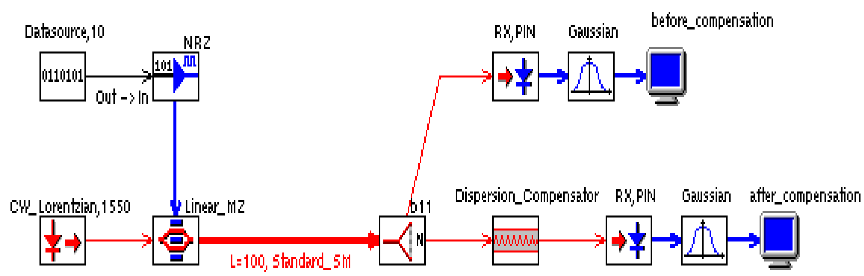

Fig. 4. A Fiber grating component is used to compensate fiber dispersion.

The use of uniform Bragg gratings for transmission dispersion compensation can limit the maximum achievable compression ratio by the small bandwidth of the highly dispersive regions in the transmission spectrum of the grating. Figure 4 shows simulative system using fiber grating component to compensate fiber dispersion. Figure 5 shows simulative system using Phase conjugator component to compensate fiber dispersion.

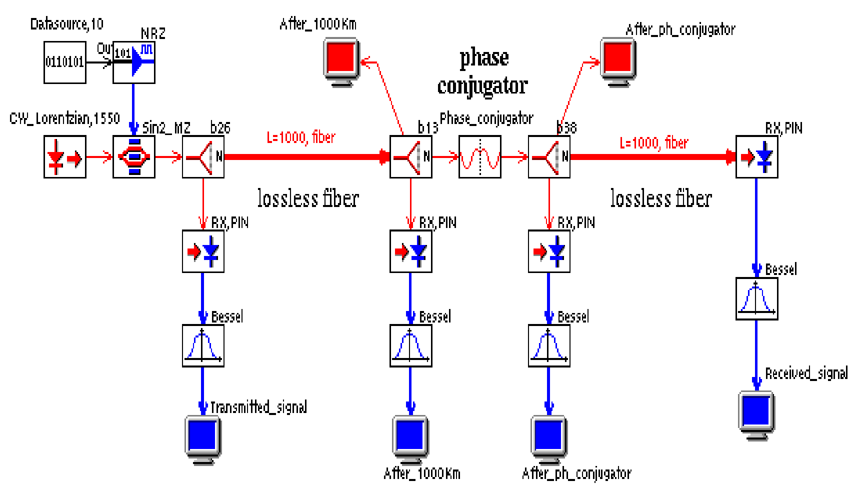

Fig. 5. Phase Conjugator is used to compensate fiber dispersion.

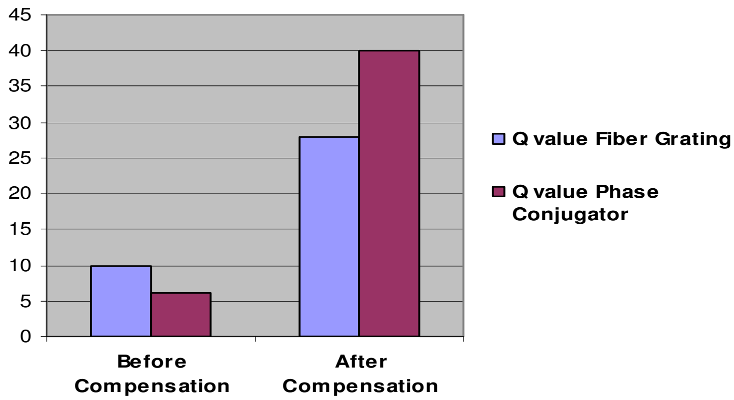

Fig. 6. Q value Fiber grating Vs Phase Conjugator.

Figure 6 shows Q value before compensation and after compensation by using fiber grating component and phase conjugator component. By using phase conjugator as compensating component Q value increases from 6.02 dB to 40 dB.

Figure 7 shows jitter before compensation and after compensation by using fiber grating component and phase conjugator component. By using phase conjugator as compensating component Jitter decreases from 0.026 to 0.018 dB.

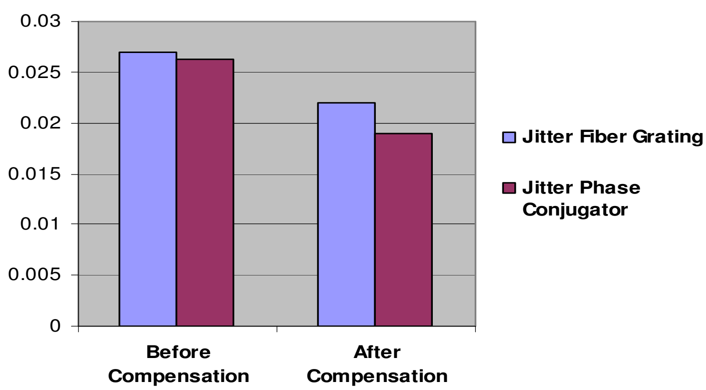

Fig. 7. Jitter Fiber grating Vs Phase Conjugator.

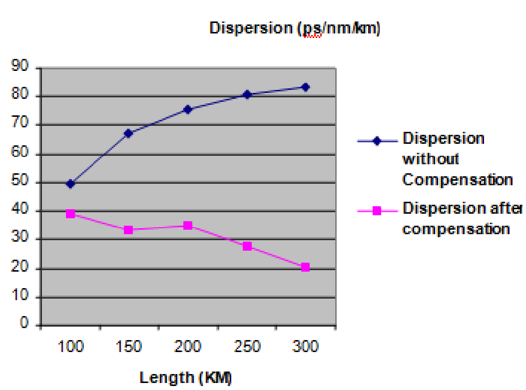

Fig. 8. Dispersion compensation at different length Intervals.

From figure 8 it is observed that at 200 km length fiber dispersion is 75.5 ps/nm/km. This high amount of dispersion can cause a serious problem in the system but by using compensating component dispersion is decreased up to 33 ps/nm/km.

III. CONCLUSION

In this paper, we analyzed different dispersion compensation techniques, and concluded that symmetrical compensation technique is better amongst other two techniques. When we used phase conjugator as dispersion compensation component then high Q value and low jitter values are obtained. Also, it is observed that at 200 km length fiber dispersion is 75.5 ps/nm/km but by using compensating component dispersion is decreased up to 33 ps/nm/km.

REFERENCES

[1]. Dr. R S Kaler, A K Sharma and Prof.(Dr) T S Kamal, "Simulation Results for Four Wave Mixing in an Optical Fiber near Zero-dispersion Wavelength", *IE(I) Journal – ET*, Vol. **85**, pp. 31-36, July 2004.

[2]. Massimo Manna and Ekaterina A. Golovchenko, "FWM Resonances in Dispersion Slope-Matched and Nonzero-Dispersion Fiber Maps", *IEEE Photonics Technology Letters,* Vol. **14**, No. 7, pp. 929 – 931, July 2002.

[3]. K. Nakajima, M. Ohashi, and Y. Miyajima, "Four Wave Mixing Suppression Effect of Dispersion Varying Fiber", *IEEE Photonics Technology Letters*, Vol. **10**, No. 4, pp. 537-539, April 1998.

[4]. S. W. Bang and D. G. Daut, "Analysis of CPM and FWM Phenomena for Various Signaling Formats in 16 Channel DWDM", *The First IEEE and IFIP International Conference in Central Asia*, September 2005.

[5]. Andrea Melloni, M. Torregiani, et al., "Four Wave Mixing and Wavelength Conversion in Slow Light Regime", *IEEE/LEOS Winter Topical Meeting Series*, pp. 148 – 149, February 2009.

[6]. G. Meltz, W. Morey and W. H. Glenn," Formation of Bragg gratings in optical fibre by transverse holographic method", *Optical letters*, Vol. **14**, pp. 823-825, August 1989.

[7]. M. Vengsarkar, J. R. Pedrazzani, J. B. Judkins and P. J. Lemaire, "Long period fibre grating based gain equalizer", *Optical letters*, Vol. **21**, pp. 336-338, March 1996.

[8]. P. A. Krug, T. D. Stephens, G. Dhosi, G. Yoffe, F. Ouellette, and P. C. Hill, "Fibre Bragg gratings for compensation in transmission", *Electron Letters*, Vol. **31**, pp. 1091-1093, August 1995.

[9]. W. H. Loh, R. I. Laming, N. Robinson, A. Cavaciuiti, F. Vaninetti, C. J. Anderson, M. N. Zervas and M. J. Cole, "The effect the group delay ripple of chirped fibre grating on composite second order in optical fibre", *IEEE Photonics Technology Letters*, Vol. **8**, pp. 944-947, November 1996.