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Monitoring And Suppression Of Chromatic Dispersion In 40Gbps OTDM System

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ABSTRACT: In this paper the effect of dispersion on the transmission distance has been demonstrated. Chromatic Dispersion in signal increases as length of optical fiber increases. This limits the performance of a system. Three dispersion compensation techniques are used to compensate the dispersion in 40Gbps OTDM system: pre-, post- and symmetrical over an Alcatel Dispersion Compensated Fiber (DCF) having dispersion 8ps/nm-km. These three techniques pre, post and symmetrical are compared. With pre- dispersion compensation technique, maximum distance travelled by a signal was 572 km. With Post- dispersion compensation technique, maximum distance travelled by a signal was 616 km. But the best results were observed in symmetrical dispersion compensation technique where maximum distance travelled by signal is 704 km with Q-Factor 7.9. All the results are gained at a wavelength of 1552.52 nm.

Keywords: Chromatic Dispersion; OTDM; DCF; Alcatel SMF; EDFA.

1. INTRODUCTION

OTDM technique has efficiently utilized the channel capacity and therefore achieved higher data rates that can not only fulfill present needs but can also manage the internet traffic of future decade. Chromatic dispersion is an important factor in fiber optic communication systems. It occurs when different colors, or wavelengths, in a light beam reach their destination at slightly different times. The result is a spreading, of the on-off light pulses which convey digital information[1]. Optical Time-division multiplexing (OTDM) is a method of transmitting and receiving independent signals over common transmission line by means of synchronized switches at both ends of the transmission line so that each signal appears on the line only for a fraction of time in an alternating pattern[2]. Large capacity of optical fibers has increased demand of optical systems but the main problem faced is dispersion [3]. Dispersion is a major Factor which limits length of an optical fiber cable for long distance communications[4]. Chromatic Dispersion is a function of length of optical fiber and Dispersion Compensated Fibers can be used to reduce effect of Chromatic Dispersion. It has been observed that dispersion effect get reduced more effectively using DCF's[5]. DCF's are fibers having negative chromatic dispersion. These can be constructed by two methods. One, if core region is narrow and have high refractive index and moreover keeping highly depressed region near core and raised index ring away from core.[6] Two, it is theoretically possible to achieve huge value of negative chromatic dispersion i.e. -185000 ps/nm-km by fiber bending.[7] Fiber bending can open possibilities for new applications such as Photonic Crystal Fibers. Issue of chromatic dispersion is resolved by Dispersion Compensated Fibers. Three ways are used to compensate dispersion thus increasing the range of signal and those are: pre, post and symmetrical compensating techniques.

2. SYSTEM DESIGN

OTDM system is designed by using simulation software named Opti System 11. OTDM System is shown in Fig1. The system consist of a source, four channels, transmission link and four users.

Parameter	Value
Reference Wavelength	1550 nm
Length	40 km
Attenuation	0.25 dB/km
Dispersion	8ps/nm-km
Effective Area	63 um^2

Table 1. *Alcatel Optical Fiber properties*

A CW Laser is used having 1552.52 nm wavelength. Signal is divided into four channels using 1x4 Fork. Signal at each channel is Amplitude Modulated and passed to 4x1 Power Combiner with specific time delay. Initially a fiber length of 3 km is used. Further length is increased and dispersion introduced in it is removed using above mentioned techniques. For achieving data rates of 40 Gbps, four channels are used each having bit rate of 10 Gbps. Optical Fiber used as a transmission link is Alcatel Fiber having Dispersion of 8 ps/nm-km

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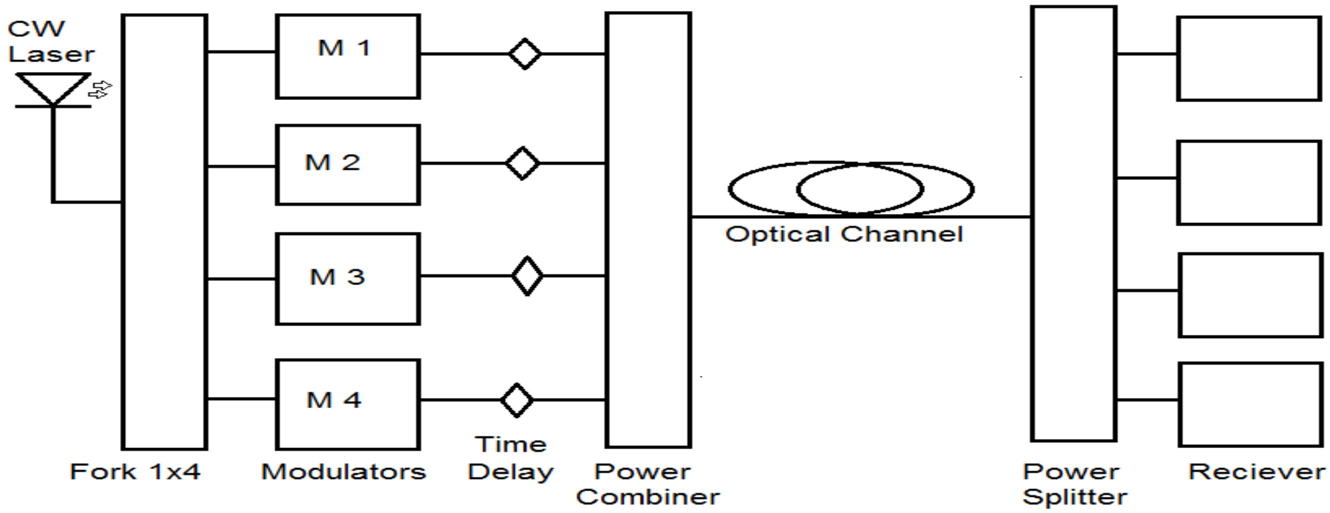

Fig.1 *Simulation set up of 40 Gbps OTDM System*

a) Pre- Compensation Configuration

In this technique, a DCF, an optical fiber and an amplifier is connected in a transmission channel after an EDFA as shown in Fig.2.

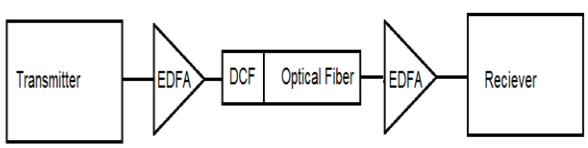

Fig.2 *Pre- Compensation Configuration*

b) Post- Compensation Configuration

In this technique, an optical fiber, a DCF and an amplifier are connected in a transmission channel after an EDFA as shown in Fig.3

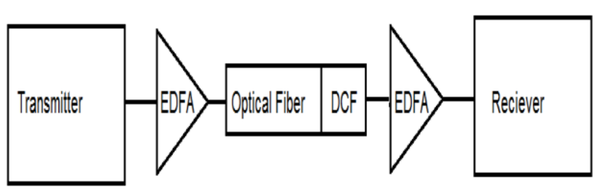

Fig.3 Post: *Compensation Configuration*

c) Symmetrical- Compensation Configuration

It is basically a combination of both pre and post compensation techniques. In this technique, a DCF, an optical fiber one more optical fiber of same length, a DCF and an EDFA are connected respectively. Arrangement is shown in Fig 4.

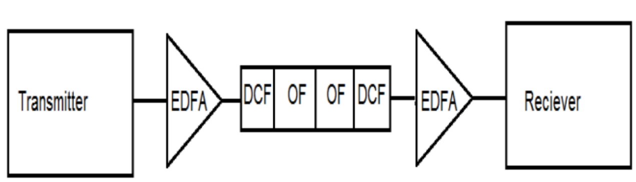

Fig.4 *Symmetrical- Compensation Configuration*

3. RESULTS AND DISCUSSIONS

Observing the results it has been concluded that symmetric compensation technique is supposed to be the best compensation technique. After that comes Post and then Pre compensation technique. Outputs of various techniques are provided in Table 2. Comparison is done on the basis of maximum transmission distance, Q-Factor and BER.

Sr No.	Technique	Maximum Tx^n Distance	QFactor	BER
1	Pre	572 km	9.2	1.3e-15
2	Post	616 km	8.08	7.8e-20
3	Symmetric	704 km	7.9	2.9e-16

Table 2. *Comparison of pre-,post- and symmetrical-dispersion compensation technique*

a) Pre- Dispersion Compensation Technique

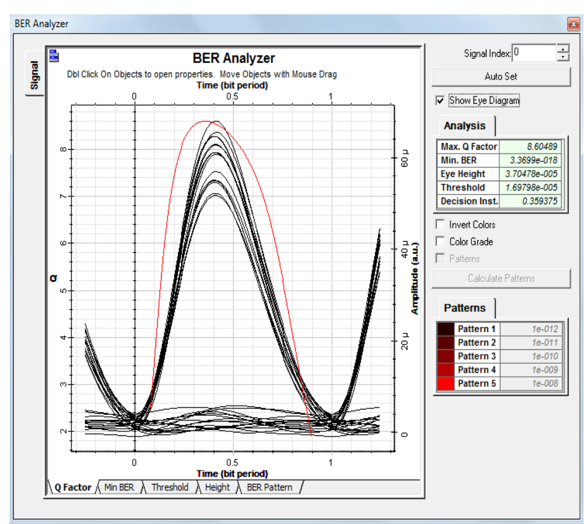

Fig 5 *Eye diagram at channel 1*

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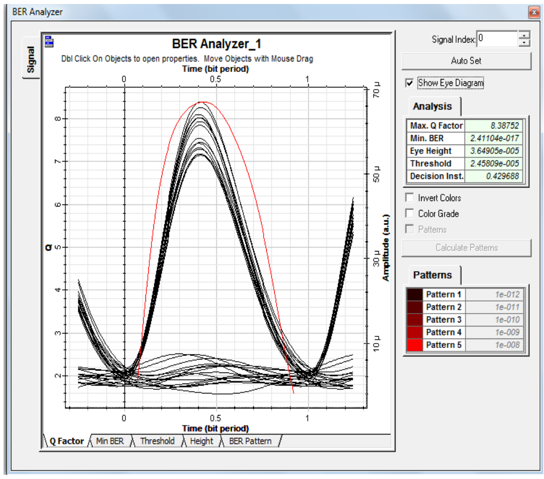

Fig 6 Eye diagram at channel 2

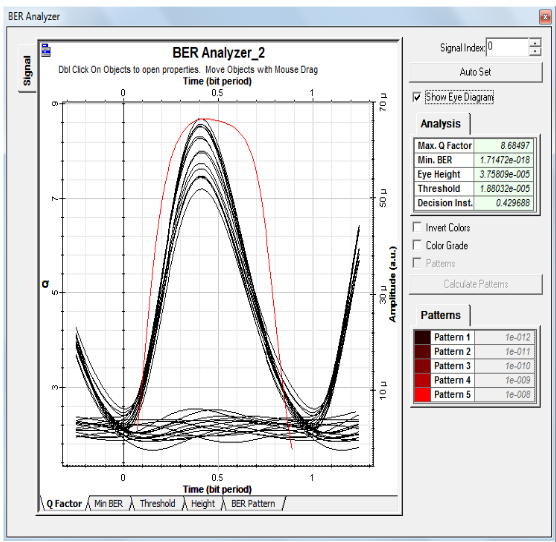

Fig 7 Eye diagram at channel 3

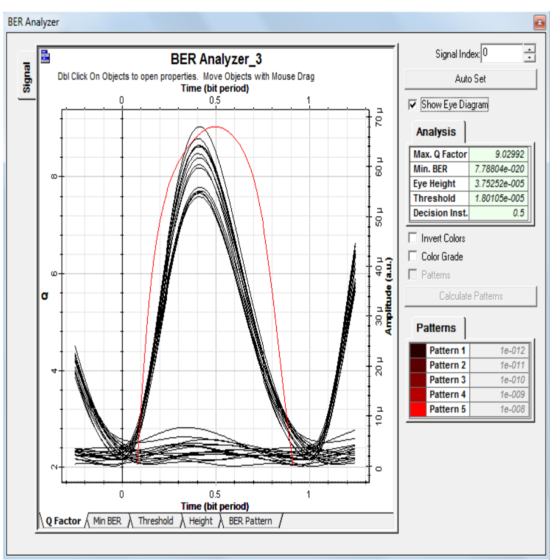

Fig 8 Eye diagram at channel 4

The eye diagram at different channels demonstrates a good performance of Pre compensation technique. The value of Q- Factor is 9 considered to be a good performance result. But at the same time it must be noticed that the signal is carried only up to 572 Km which must not be ignored.

b) Post- Dispersion Compensation Technique

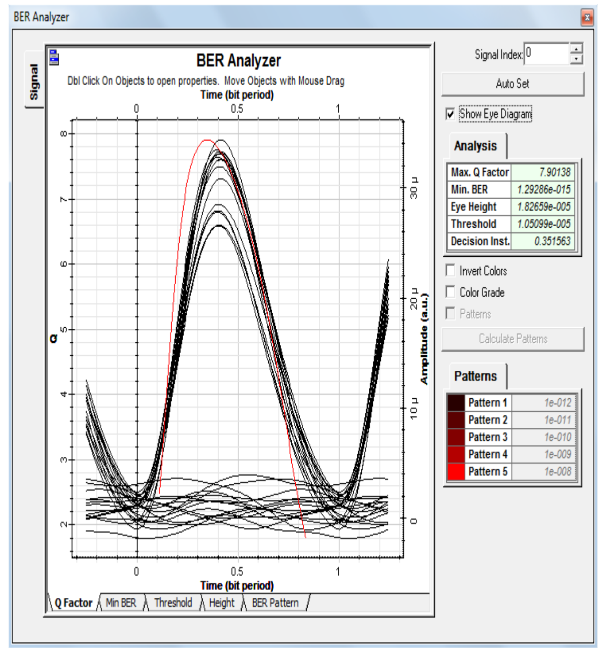

Fig 9 Eye diagram at channel 1

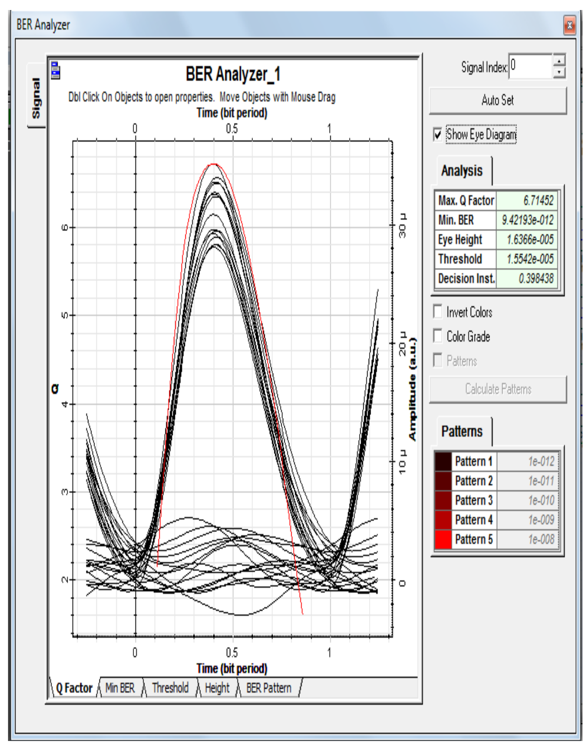

Fig 10 Eye diagram at channel 2

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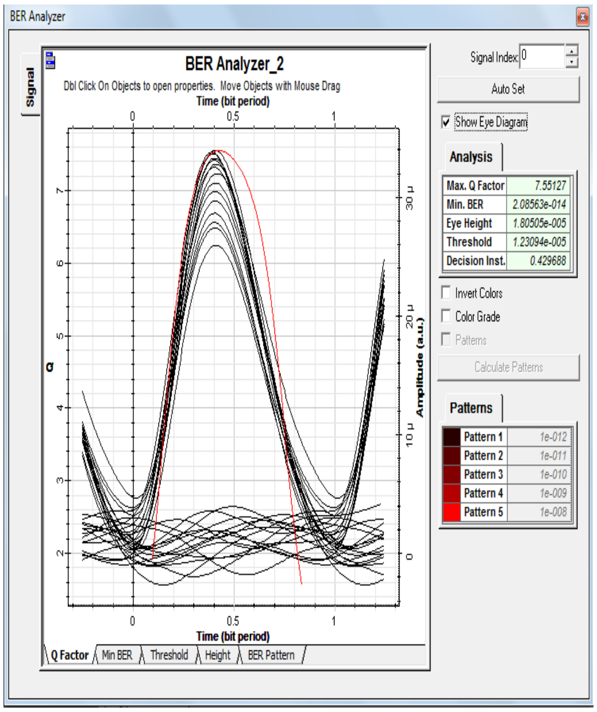

Fig 11 *Eye diagram at channel 3*

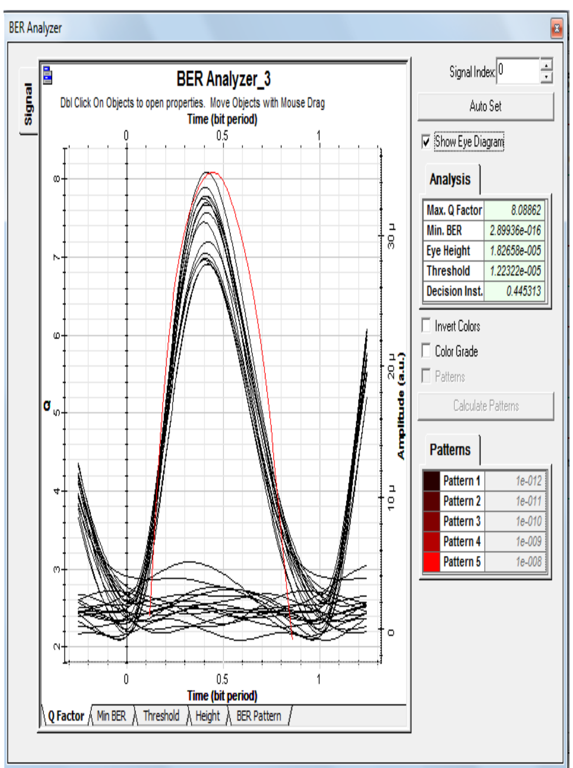

Fig 12 *Eye diagram at channel 1*

In contrast with Pre compensation technique the quality factor is observed to be less i.e. 8.08 but the distance traveled by signal is 44 Km more than that of previous technique. At distance of 572 Km the Q-factor is observed to be 12 which is a very good value.

c) Symmetrical- Dispersion Compensation Technique

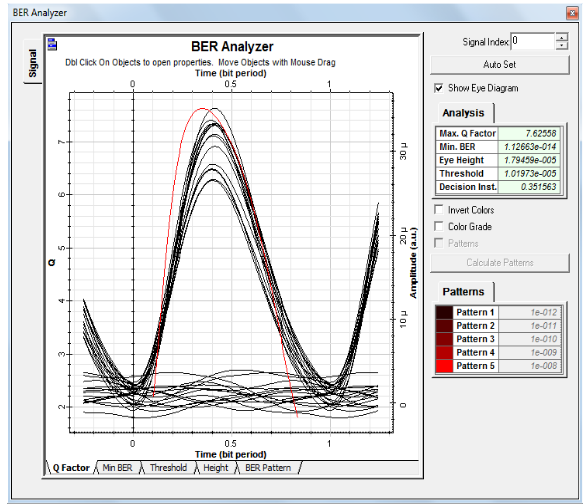

Fig 13 *Eye diagram at channel 1*

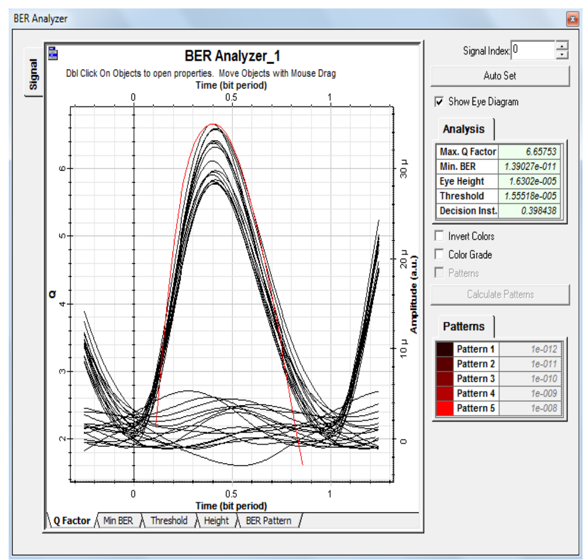

Fig 14 Eye diagram at channel 2

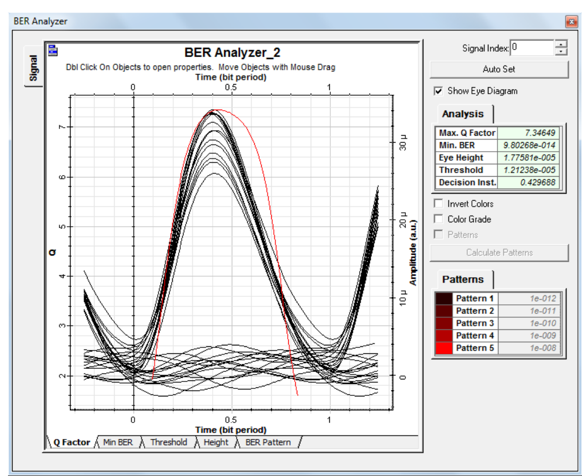

Fig 15 *Eye diagram at channel 3*

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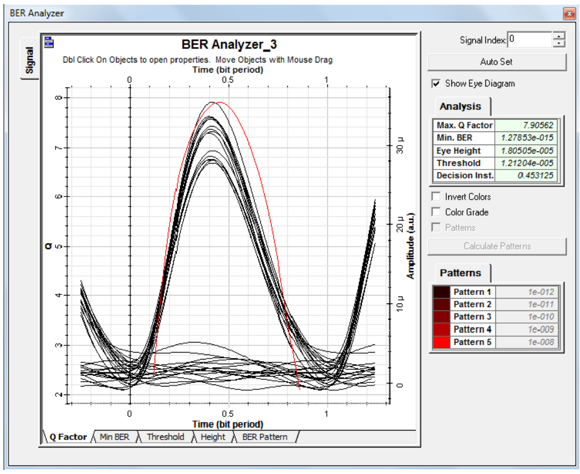

Fig 16 *Eye diagram at channel 4*

Symmetrical- dispersion compensation technique is observed to be the combination of both Pre and Post combination techniques therefore the output is observed to be the best in this technique. More over the signal has travelled a distance of 704 km. This is so because the dispersion is compensated two times in one loop.

4. CONCLUSION

It is concluded from simulation results that for Alcatel Optical Fiber, Symmetrical- dispersion compensation technique is best suited technique as compared to pre and post compensation technique. Symmetric compensation technique has travelled a distance of 704 Kilometers with Q-Factor of 7.9 which is observed to be a good value.

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