Performance Comparison of Different Fiber Standards on 80 Gbps OTDM System

Lovekesh Paul[1], and Himali Sarangal[2]
[1, 2]Department of ECE, GNDU Regional Campus Jalandhar
E-mail: [1]lovekeshpaul1992@gmail.com, [2]himali.sarangal@gmail.com

Abstract. In Optical Time Division Multiplexed transmission system performance is limited by dispersion and kerr effect. In this paper performance of Different Fiber Standards i.e. Standard, Alcatel, ITU 653, ITU 654, ITU 655, is compared on the basis of distance. Pre-dispersion compensation technique is used to reduce the effect of dispersion over long distance transmission of signal. Alcatel Fiber [Dispersion=8 ps/nm/km] observed to be the best suitable Optical Fiber Standard for High Data Rate Transmission for reaching a distance of 700 km with Q factor 6.88. ITU 655 [Dispersion=3.78 ps/nm/km] covered least distance i.e. 300 km, because of small DCF Fiber Length. Results are obtained at C band [wavelength=1550nm].

Keywords: Fiber Standards, Optical Time Division Multiplexed OTDM System, Dispersion Compensation Technique DCT, Alcatel, ITU 653, ITU 654, ITU 655.

1. Introduction

Increased number of users and quantity of traffic over network has increased the demand of Quick Transmissions. This demand is fulfilled by Fiber Optical Communication Systems because of capability of immense bandwidth. This technique has shown a remarkable growth in previous two decades. Because of very easy implementation and better performance OTDM systems have achieved a great demand [1]. Combining the signals of more than one transmitter with defined time delays and combining them on single channel is not a tough task. Only problem with OTDM Systems is dispersion which is directly proportional to the Data Rate of a system. Data Rate directly effect the distance a signal can cover. As data rate is increased, transmission distance decreases [2]. This can be surcharged to some extent by using Laser Diodes rather than LED Diodes [3]. Laser Diodes can produce sharp pulses and more suitable for Single Mode Fibers. Scatteringeffects can be reduced by operating a Laser Diode at 1550 nm wavelength [4]. RZ Pulse generators are observed to be better Pulse generators for long distance transmissions [5]. Dispersion can further be minimized by decreasing the duty cycle of a pulse to an extent [6]. Signal running down a Fiber gets degrade. This effect is called attenuation and is overcome by using optical amplifiers. The quality of signal is improved by increasing gain of an amplifier [7]. But it is very much crucial to know the specified limit of a gain of an optical amplifier [8]. Since observations are made over long distances moreover at high data rates. Various Dispersion Compensation Techniques i.e. pre, post and symmetric DCTs are used to eliminate dispersion to an extent. Dispersion Compensated Fibers are specially designed fibers with negative dispersion [Dispersion= -80ps/nm/km] [9]. They are used to compensate overall dispersion in system. Among all, pre DCT is recorded to be the best suitable [10]. In this paper, comparison is made on the basis of pre DCT. For proper implementation of DCTs over long haul networks loop control helps us effectively in installing fibers of perfect length in repeated manner [11]. Thus DCFs combined with Loop Control mechanism helps us achieve better quality parameters of a signal [12-13].Avalanche Photodiode with gain of 3 dB is used because of its better performance in long distance communications [14]. In this paper, performance of Different Fiber Standards is compared on the basis of transmission distance for 80 Gbps OTDM System. Section II describes the simulation setup of OTDM System, component details and Fiber Standards. In Section III Results are discussed and shown in a form of eye diagrams. Section IV includes the conclusion of this paper.

2. System Design

The work is carried out by simulating different fiber standards in Optisystem 7.0 software. It is software that helps users to simulate different fibers networks and systems. Figure 1 shows the setup of 80 Gbps OTDM System having four 20 Gbps channels combined together to form 80 Gbps channel. Setup is divided into three parts: Transmitter, Channel and Receiver. At transmitter section channels are multiplexed, whereas on receiver side channels are split apart to feed four different users.

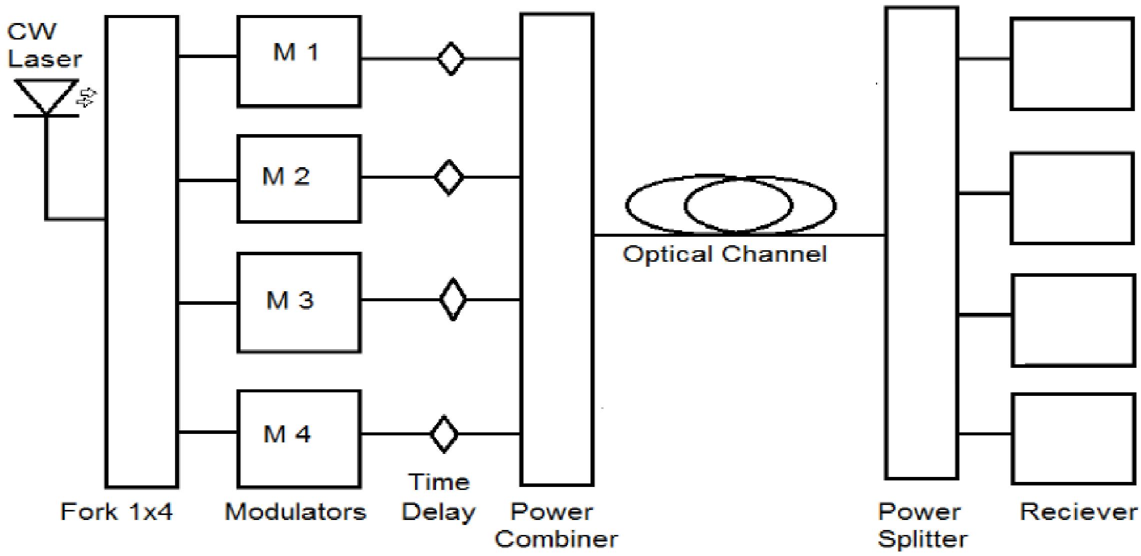

Fig. 1 System design of 80 Gbps OTDM System

CW Laser with linewidth of 10 MHz at 1550 nm wavelength is used as an optical source. This signal is divided into four channels, each generating 20 Gbps Data rate and thus modulating the output of CW Laser. RZ Pulse generators are used instead of NRZ Pulse Generators. RZ Pulse Generators are observed to be having better immunity against dispersion. These four channels are given different time delays and then combined using Power Combiner. A single channel is formed which now carry a data stream of 80 Gbps. This signal stream gets affected by dispersion which is further compensated using optical amplifiers and Pre Dispersion Compensated Technique. At receiver end, the 80 Gbps channel is split to feed four users. To recover signal, Avalanche Photodiode is used instead of PIN diode because of its better performance over long distances. Different Fiber Standards are simulated in this setup one by one and the observation is recorded. Table 1 shows different fiber standards and their dispersion factor.

Table no 1. Different Fiber Standards and their Dispersion effect

Fiber Standard	Fiber Dispersion
Standard SMF	16
Alcatel	8
ITU 653	0.169
ITU 654	20.13
ITU 655	3.78

3. Results and Discussions

Single Mode Fiber with Standard parameters is discussed firstly. Results are measured by taking minimum acceptable Q factor to be 6. Fig. 2 shows the quality of signal observed at maximum distance it can reach. With Standard SMF [Dispersion=16ps/nm/km] distance of 550 km is reached with Q factor 7.09.

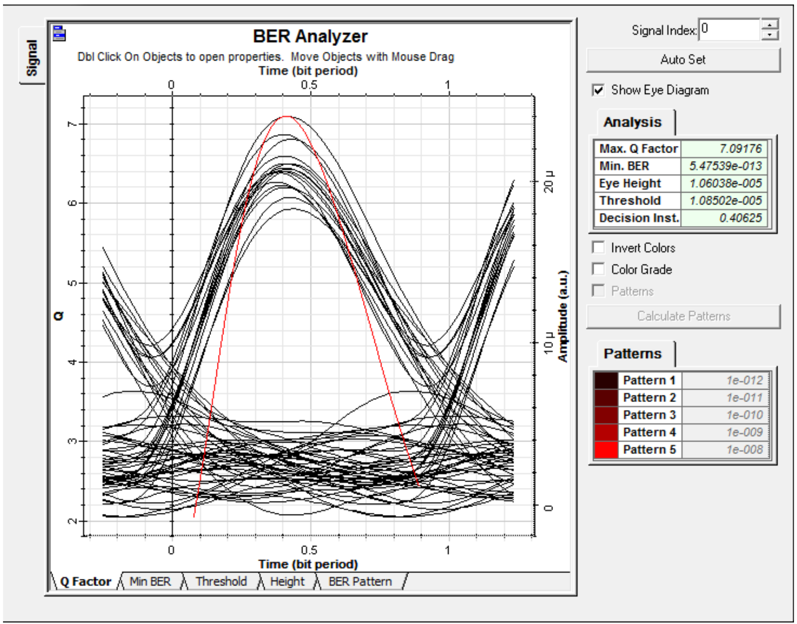

Fig. 2BER Analyzer Results for Standard SMF over distance of 550km

In this section, performance of Alcatel Fiber is shown in the form of eye diagram. Fig. 3 shows that Alcatel Fiber [Dispersion=8ps/nm/km] covers 700 km with Q factor 6.88. Alcatel Fibers, in comparison with other Fiber Standards, are observed to show the best behavior even at high data rates.

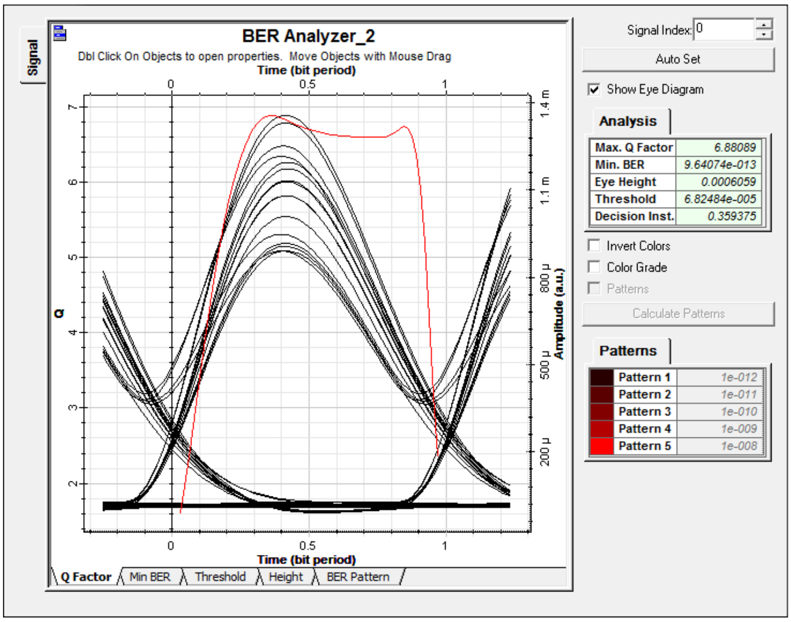

Fig. 3 BER Analyzer Results for Alcatel Fiber over distance of 700km

In this section, performance of ITU 653 Fiber is shown in the form of eye diagram. Fig. 4 shows that ITU 653 [Dispersion=0.169ps/nm/km] covers a distance of 400 km with Q factor 10.54. No doubt the dispersion effect is almost zero in ITU 653 Fibers but still it is unable to reach long distances. This can be due to the fact that the length of DCF used to compensate the dispersion is very less.

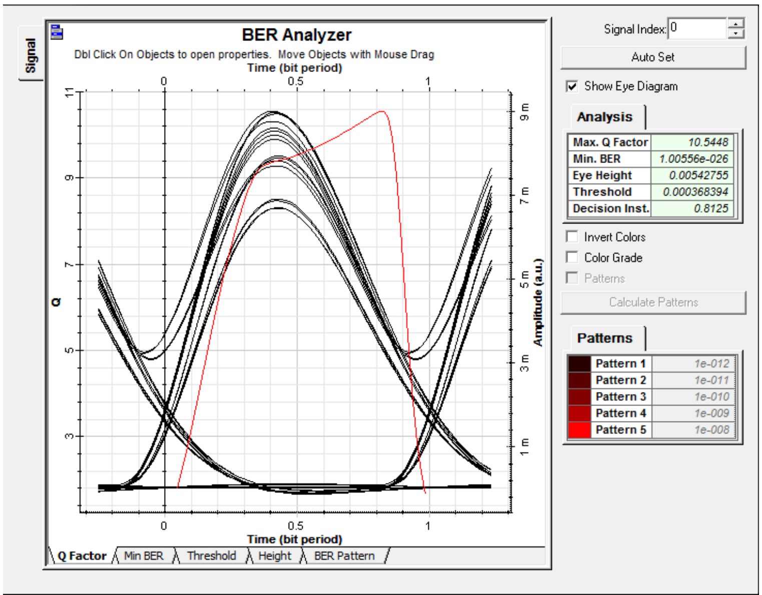

Fig. 4 BER Analyzer Results for ITU 653 over distance of 400 km

In this section, performance of ITU 654 Fiber is shown in the form of eye diagram. Fig. 5 shows that ITU 654 [Dispersion=20.13ps/nm/km] covers a distance of 350 kms with the quality factor of

6.44. Distance covered is quite less as compared to Alcatel Fiber. This may be due to the fact of high Fiber Dispersion.

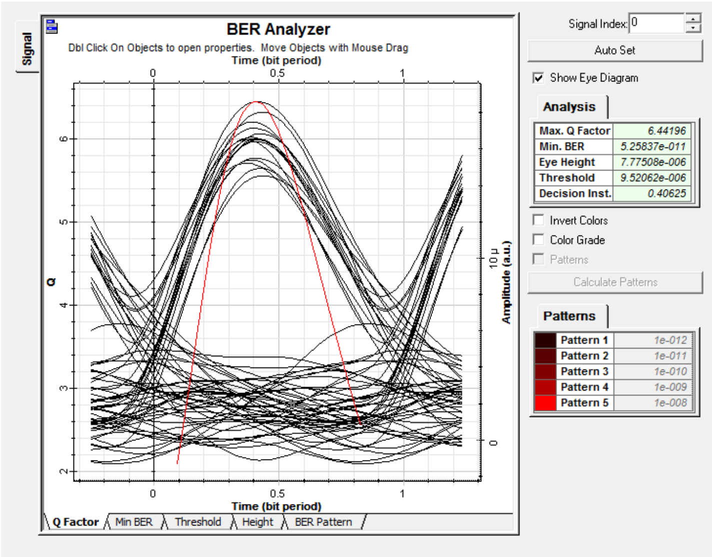

Fig. 5 BER Analyzer Results for ITU 654 over distance of 350 km

In this section, performance of ITU 655 Fiber is shown in the form of eye diagram. Fig. 6 shows that ITU 655 [Dispersion=3.78ps/nm/km] covers a distance of only 300 km with Q factor 8.48. ITU 655 is observed to cover minimum distance among all Fiber Standards. This is due to the fact theDCF installed to compensate dispersion is of considerably low length.

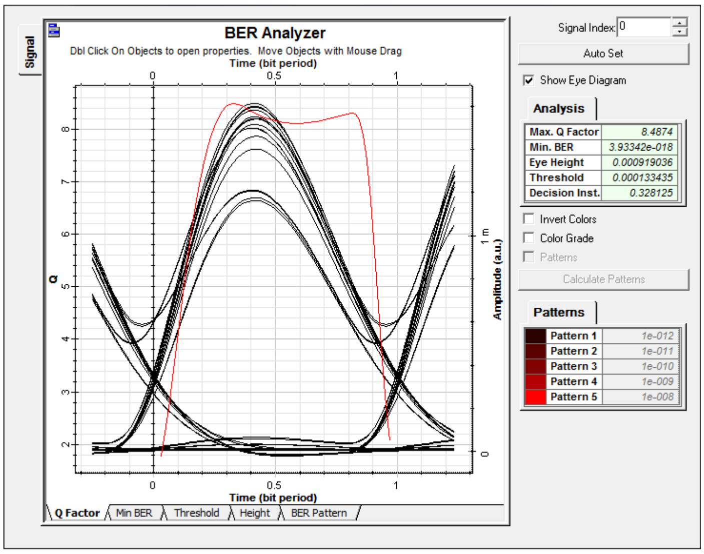

Fig. 6BER Analyzer Results for ITU 655 over distance of 300 km

ISSN: 2229-6913 (Print), ISSN: 2320-0332 (Online) -, Web Presence: http://www.ijoes.vidyapublications.com

Fig. 7 represents the graph of Different Fiber Standards showing distance travelled v/s Q factor. From graph it is observed that all Fiber Standards have shown stable behavior at high data rates. The Quality Factor of Fiber Standards is decreasing as transmission distance is increasing. On other side, Alcatel Fiber is observed to cover the maximum distance of 700 kms. And ITU 655 is observed to cover the least distance i.e. 300 kms. Performance of Different Fiber Standards is represented in graph below.

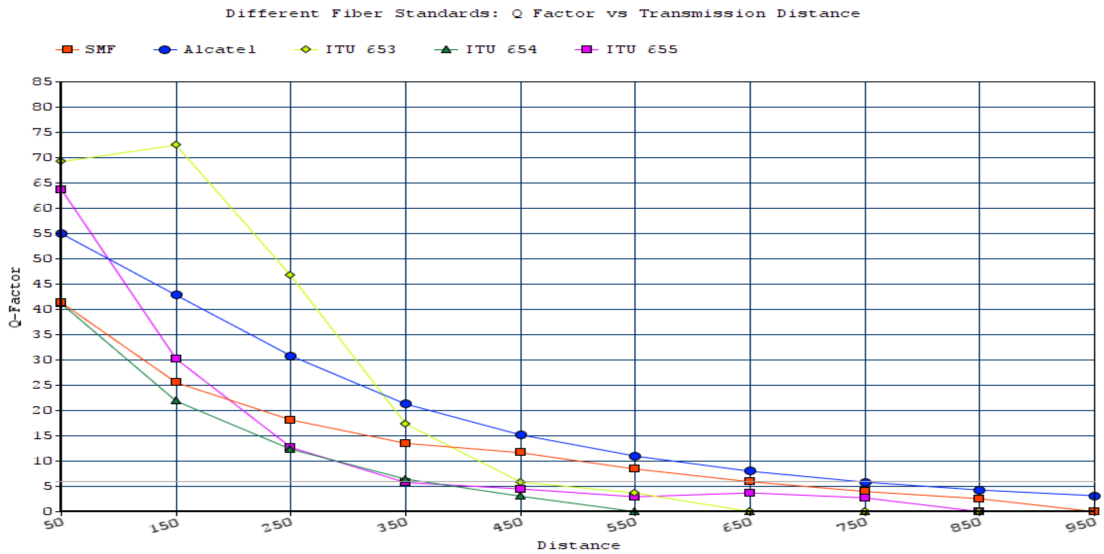

Fig. 7 Graphical Representation of Performance of Different Fiber Standards

4. Conclusion

From simulation, it has been concluded that Alcatel Fiber is able to cover maximum distance. On the other hand, for rest of Fibers, performance was remarkable for first few hundred Kilometers and then degraded gradually for next of the distance. ITU 655 is recorded to cover minimum distance i.e. 300 kilometers with Q factor 8.48. Alcatel Fiber covered largest distance i.e. 700 Kilometer with Q factor 6.88. ITU 653 is fiber with least Dispersion Factor, therefore its performance is best recorded upto 150 kms but then degraded quickly due to the less DCF Fiber length to compensate Dispersion.

References

[1] A. Gangwar, and B. Sharma, "Optical Fiber: The New Era of High Speed Communication (Technology, Advantages and Future Aspects)," *Int. Journal of Engg. Research and Develop.*, vol. 4, pp. 19-23, October 2012.

[2] A. Gupta, Jyotsana, and H. Sarangal, "Performance Analysis of OTDM System at Different Data Rate," *Int. Journal of Engg. and Computer Science*, vol. 4, pp. 12273-12272, June 2015.

[3] F. Idachaba, D. U. Ike, and O. Hope, "Future Trends in Fiber Optics Communication," *Proc. Of the world Congress on Engg.*, vol. 1, pp. 1-5, July 2014.

[4] R. Gupta, S. Sharma, and M.K. Sharma, "Modification in Parameter of Intersatellite Communication using Multiple Transmitter and Receiver," *Int. Journal of Engg. trends and tehnol.*, vol. 12, pp. 495-498, Jun 2014.

[5] V. Kumar, A.K. Jaiswal, and R. Saxena, "Design and Performance Analysis of Optical Transmission System," *Int. Org. of Scientific Research Journal of Engg.*, vol. 4, pp.22-26, May 2014.

[6] L. Paul, Jyotsana, J. Malhotra, "Monitoring And Suppression Of Chromatic Dispersion In 40Gbps OTDM System," *Int. Journal of Technol. Enhance. andEmerg. Engg. Research.*, vol. 3, pp. 26-30, June 2015.

[7] B. Barua, "Evaluate the Performance of Optical Time Division Demultiplexing with the Gain Saturation effect of Semiconductor Optical Amplifier," *Int. Journal of Engg. and Technol.*, vol. 3, pp. 473-479, October 2011.

[8] S.M. Sajjan, V. Seshasai, and G. Sadashivappa, "DWDM Link Design and Power Budget Calculation," *Int Journal of Advanced Research in Electrical, Electronics and Instrumentation Engg.*, vol. 4, pp. 2538-2548 , April 2015.

[9] Jyotsana, R. Kaur, and R. Singh, "Performance Comparison of pre-, post- and symmetric dispersion compensation techniques using DCF on 40 Gbps OTDM System for Different Fiber Standards," *Int. Journal of Light and Electron Optics,*vol. 125, pp. 2134-2136, May 2014.

[10] N. K. Kahlon, and G. Kaur, "Various Dispersion Compensation Techniques for Optical System," *Open Journal of Comm. and Software*, vol 1, pp. 64-73, May 2014.

[11] C. P. Vind, and N. Srivastava, "An Improved Methodology for Dispersion Compensation and Design of Dense WDM System in Optical Fiber Communication Networks," *Int. Journal of Emerg. Technol. and Advanc. Engg.*, vol. 4, pp. 370-375, January 2014.

[12] M. Kaur, H. Sarangal, and P. Bagga, "Dispersion Compensation with Dispersion Compensating Fibers (DCF)," *Int. Journal of Advanc. Research in Computer and Communication Engg.* vol. 4, pp. 354-356, Feb 2015.

[13]] E. I. Essa, "Software Simulation the Hybrid Dispersion Compensation Scheme Based on the 16x40Gbps DWDM using RZ Modulation Format,"*College of Computer Science and Mathematics*, vol. 9, pp. 202-208, July 2010.

[14] O. Kharra, and D. Forsyth, "Performance comparisons between PIN and APD photodetectors for use in optical communication systems," *Optik*, vol. 124, pp. 1493-1498, November 2011.