

On The Selection of Optimum Performance Bounds for CO-OFDM Systems Through Standard Fibers

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Abstract

Orthogonal frequency division multiplexing (OFDM) can accomplish high use effectiveness. Various system impairments affect the performance of system. So mechanisms should be adopted to improve the performance of the system. In this paper, a 40 Gbps optical OFDM system is designed. Comparative analysis of the designed system is done using different fiber standards and dispersion compensating mechanisms on the basis of transmission distance and SNR. From the present research, it is clear that pre dispersion compensating mechanisms perform better than post ones. The fiber standards considered in present research are SMF, ALCATEL, ITU G.652, ITU G.654, and ITU G.655. Of all the fibers, ALCATEL (D=8 ps/nm/km) is able to cover maximum distance i.e. 660km with SNR 30.08 dB. For rest of fibers, the performance was remarkable for few hundreds of kilometres and then degraded. ITU G.655 (D=3.78ps/nm/km) gives the best SNR i.e. 32.08 dB upto 418km then degrades due to less DCF fiber length to compensate for dispersion.

Keywords: CO-OFDM, ALCATEL, ITU G.652, ITU G.654, ITU G.655

1. Introduction

Optical OFDM (O-OFDM) transmission has set up to be a solid bearer for rapid information correspondence over the dispersive optical channel and it offers remarkable error free transmission for high information rate. So it could amplify the limit of optical fiber transmission frameworks [1]. While many details of OFDM systems are very complex, the essential idea of OFDM is very straightforward. Information is transmitted in parallel on various distinctive frequencies and therefore its symbol period is any longer than any other serial transmission with the same data rate [2]. Because the symbol period is longer, the equalization is simplified as the ISI affects one symbol period. In most OFDM implementations, the ISI is eliminated by utilizing a type of gatekeeper interim called a cyclic prefix [3].

OFDM is based on Multi carrier transmission which changes a wide-band channel into a gathering of narrowband channels [4]. It has developed to lead correspondence standard in almost each significant standard (Wi-Max, IEEE 802.11a, DVB). OFDM offers two principal points of interest. One is its strength against channel scattering and second is simplicity of phase and channel estimation in a period changing environment. [5].

It is known that with the increase in data rate, the transmission distance decreases due to the increase in dispersion of fiber [6]. Network operators have to keep in mind when installing new transmission lines that which fibers will best meet future traffic requirements and which dispersion compensating mechanism should be followed to achieve maximum transmission distance [7]. For high data rate transmission over the SMF, the dispersion limits the transmission distance. Hence it is of great requirement to investigate different fiber standards and different dispersion compensating mechanisms to have the maximum transmission distance and better performance of the communication system in terms of BER and SNR.

This paper deals with the comparative analysis of 40 Gbps CO-OFDM system with different fiber standards such as ALCATEL, ITU G.652, ITU G.654, ITU G.655, SMF along with the different dispersion compensating mechanisms such as pre and post compensation. This paper is organized as follows. After the introduction section, section II describes the simulative setup and environment used for present research work. After that, section III deals with Simulative results and discussions in form of constellation visualiser along with the performance parameter SNR and the research work is finally concluded in section IV.

2. System Description

A 40 Gbps CO-OFDM system is designed using Optisystem version 13 is shown in Figure 1 consists of three segments *i.e.*, transmitter area, optical fiber connection and recipient segment. The performance of CO-OFDM framework is analysed using different fiber standards and different dispersion compensation techniques.

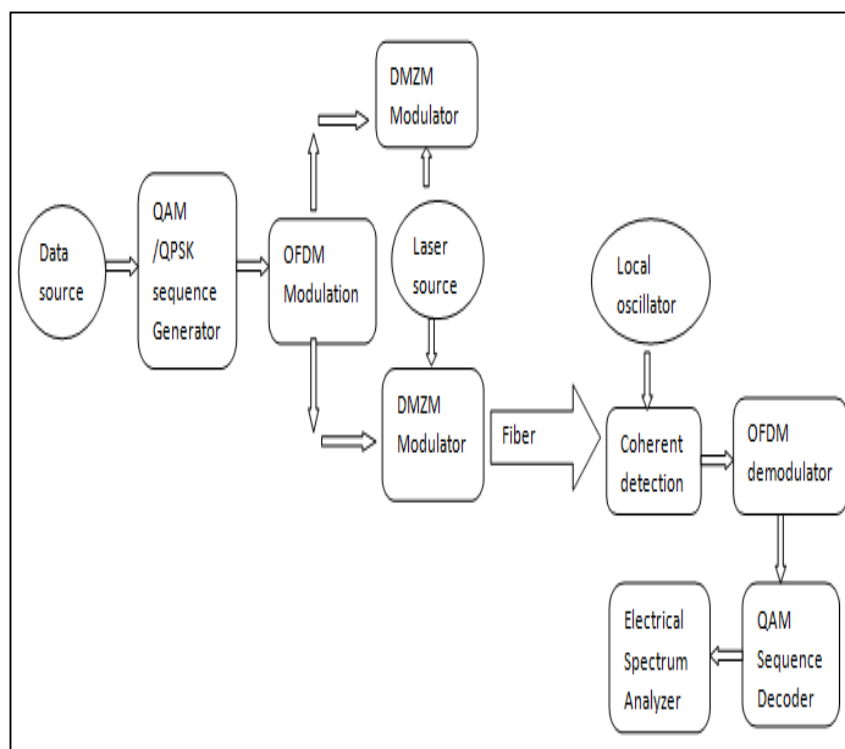


Figure 1. COOFDM System Design

CO-OFDM Transmitter

The information signal generated by QPSK sequence generator is modulated by OFDM modulator. The various parameters of OFDM modulation are described in Table 1. The modulated signal is then applied to the Mach Zehnder modulator and to power combiner. The resultant signal is then dispatched to the fiber link.

Table 1. OFDM Parameters

No of Subcarriers	512
No of FFT points	1024
No of Prefix points	14
Position Array	256

Optical Fiber Link

This link consists of optical fiber, dispersion compensating scheme and loop control. The different fiber standards considered for present research are described in Table 2.

Table 2. Different Fiber Standards

Fiber Standards	Fiber Dispersion(ps/nm/km)
SMF	16
ALCATEL	8
ITU G.652	17.65
ITU G.654	20.13
ITU G.655	3.78

Different Compensating mechanisms used for the analysis are pre and post shown in Figure 2 and 3 respectively.

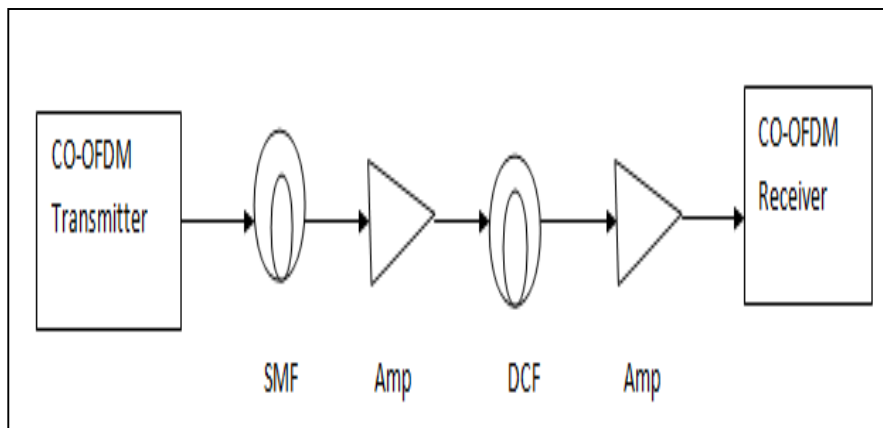


Figure 2. CO-OFDM System with Post- compensation

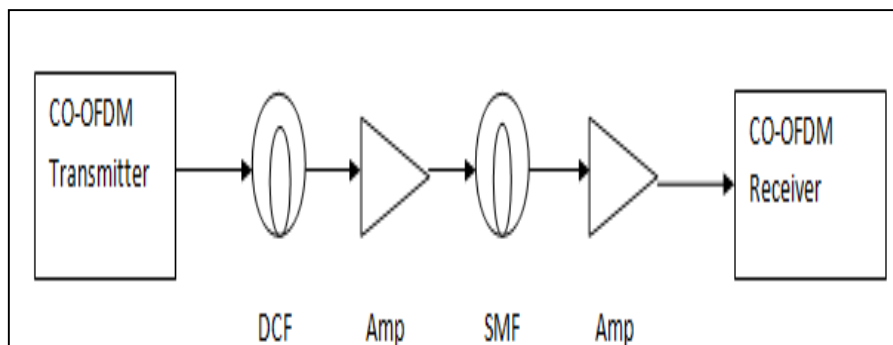


Figure 3. CO-OFDM System with Pre- compensation

CO-OFDM Receiver

The yield signal from the optical fiber is connected to the four PIN Photodetectors to convert the optical signal to electrical signal. The subsequent signal is then connected to the OFDM demodulator and after that to the QAM succession decoder to recover the information signal. The various simulation parameters are described in Table 3.

Table 3. Simulation Parameter

Parameters	Specifications
Data Rate	40 Gbps
Power	-4 dB
Electrical gain	-0.008
Gain of amplifier	5dB

3. Results and Discussions

A 40Gbps COOFDM system is designed. Simulative investigations have been done by having all the fiber standards and dispersion compensating schemes. The optical spectrum analyser at the transmitting and receiving end is shown in Figure 4 and 5 respectively.

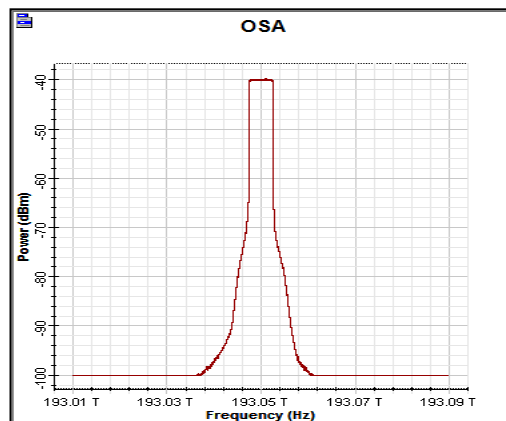


Figure 4. Spectrum at the Transmitting End

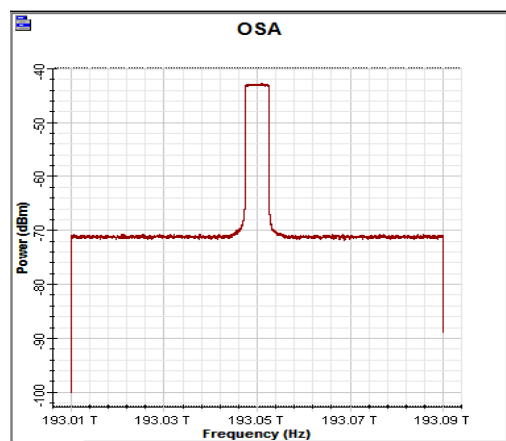


Figure 5. Spectrum at the Receiving End

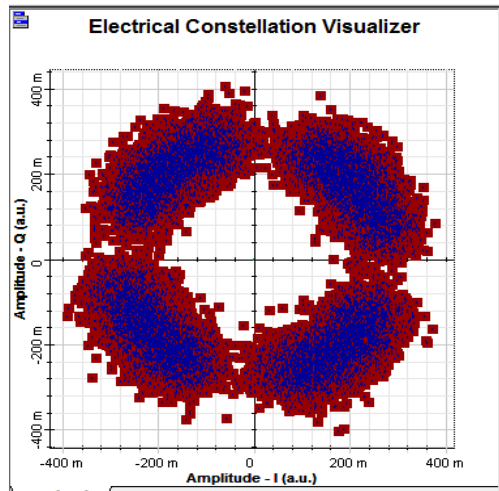


Figure 6(a). Constellation Visualizer at the Receiving End with Post Compensation for SMF

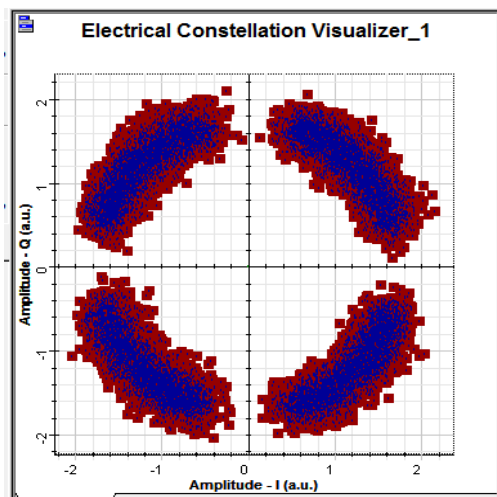


Figure 6(b). Constellation Visualizer at the Receiving End for SMF with Pre Compensation

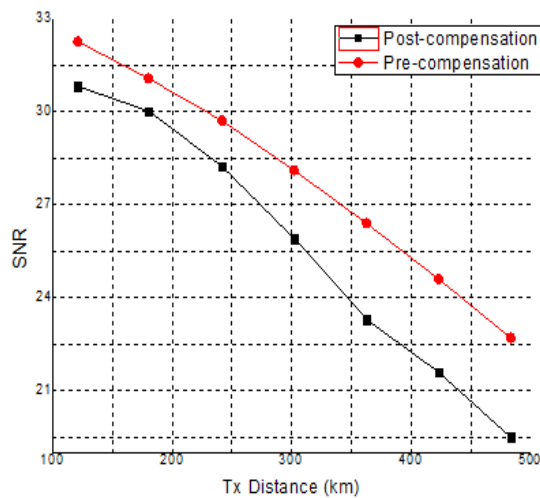


Figure 6(c). SNR v/s Transmission Distance for SMF

The dispersion of SMF is 17.65ps/nm/km. The constellation visualiser at the receiving end with pre and post dispersion compensation mechanism is shown in Figure 6(a) and 6(b). The variation of SNR with the transmission distance considering pre and post compensation is plotted in Figure 6(c). It is clear from the graph that SNR decreases almost linearly with the increase in transmission distance. At 483 km the SNR for post and pre dispersion compensation is 19.5 dB and 22.7 dB. Therefore pre-compensation provides better SNR.

The ALCATEL fiber is having a dispersion of 8 ps/nm/km. The constellation visualiser at the receiving end with pre and post dispersion compensation mechanism is shown in Figure 7(a) and 7(b). The variation of SNR with the transmission distance considering pre and post compensation is plotted in Figure 7(c).

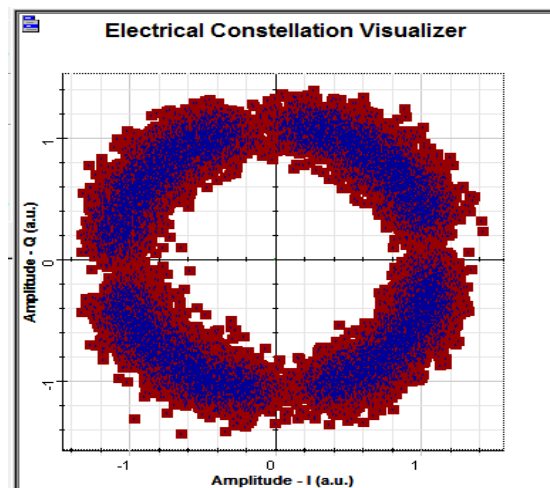


Figure 7(a). Constellation Visualizer at the Receiving End for ALCATEL with Post Compensation

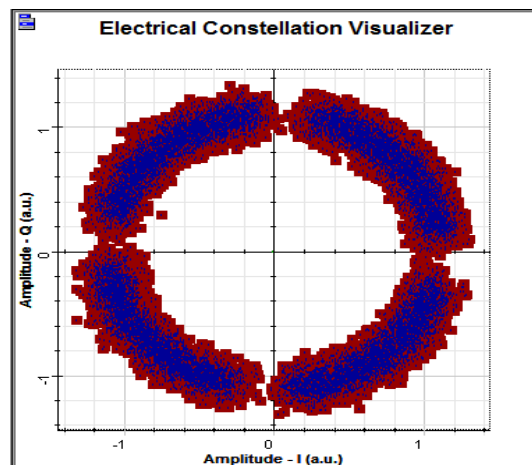


Figure 7(b). Constellation Visualizer at the Receiving End for ALCTEL with Pre Compensation

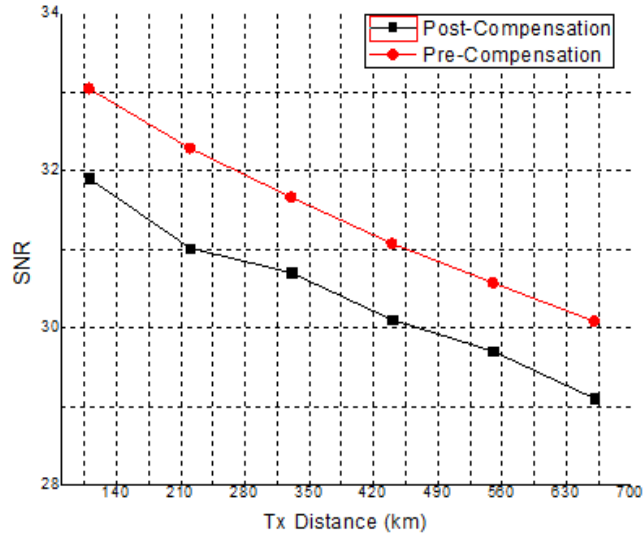


Figure 7 (c). SNR v/s Transmission Distance for ALCATEL

It is clear from the graph that SNR decreases with the increase in transmission distance. At 660 km the SNR for pre and post compensation mechanisms is 30.08 dB and 26.59 dB. Therefore for the ALCATEL fiber, the pre compensation is better.

For this fiber, the dispersion is 17.65 ps/nm/km. The electrical constellation visualiser at receiving end with post and pre compensation is shown in Figure 8(a) and Figure 8(b).

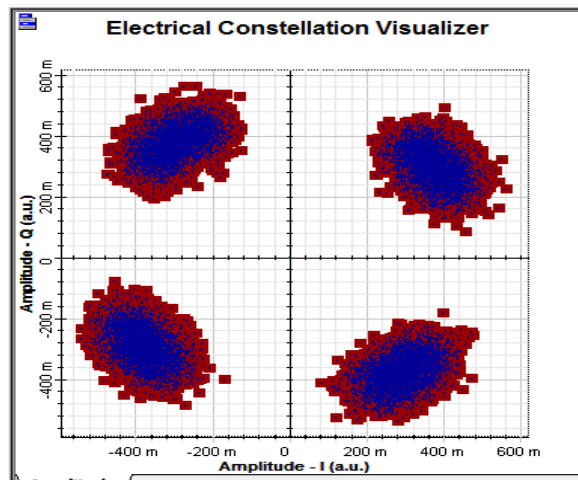


Figure 8 (a). Constellation Visualizer at the Receiving End for ITU G.652 with Post Compensation

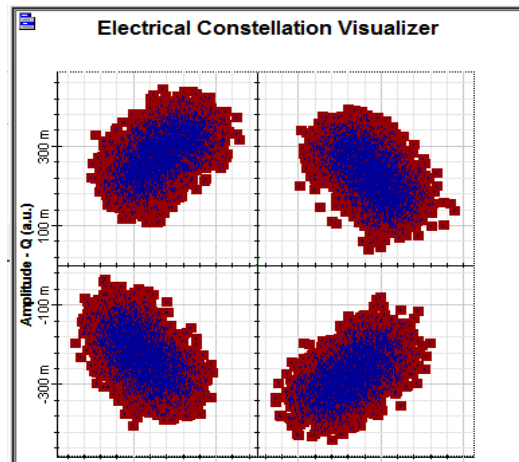


Figure 8(b). Spectrum at the Receiving End for ITU G.652 with Pre Compensation

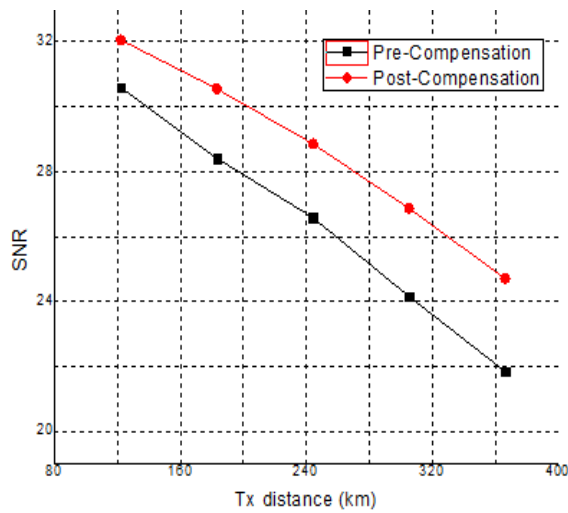


Figure 8(c). SNR v/s Transmission Distance for ITU G.652

At 366 km, the SNR for pre and post compensation is 24.7 dB and 21.84 dB. Therefore, for ITU G. 654 pre compensation is better.

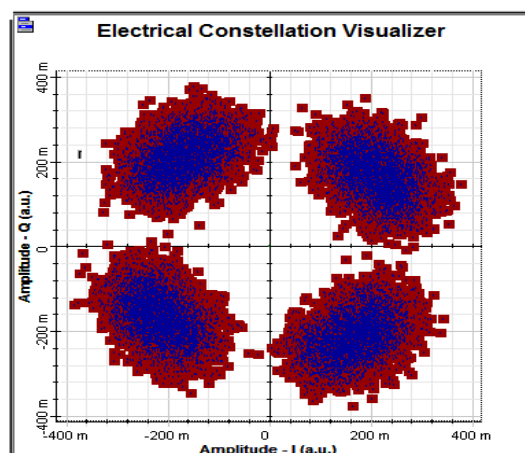


Figure 9 (a). Constellation Visualizer at the Receiving End for ITU G.654 with Post Compensation

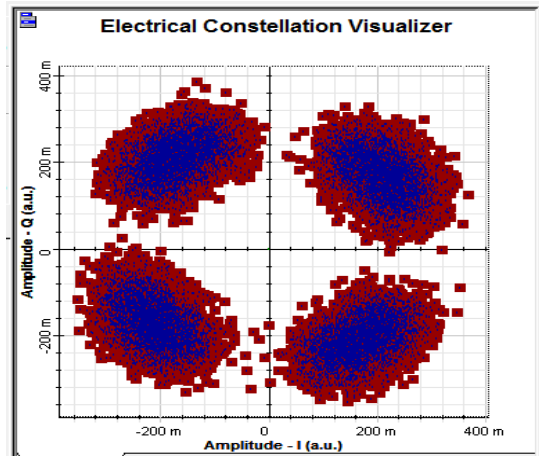


Figure 9 (b). Constellation Visualizer at the Receiving End for ITU G.654 with Post Compensation

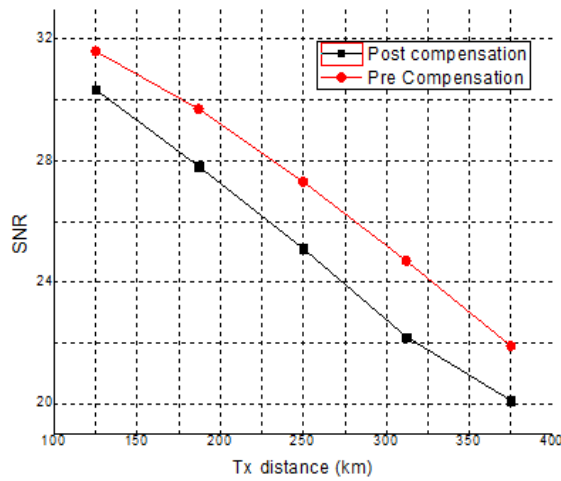


Figure 9(c). SNR v/s Transmission Distance for ITU G.654

For ITU G.654 fiber, the dispersion is 20.13 ps/nm/km. Constellation visualiser shown in Figure 9(a) and 9(b). It is clear from 9(c), at 375 km the SNR for post and pre compensation is 19.93 dB and 21.7 dB.

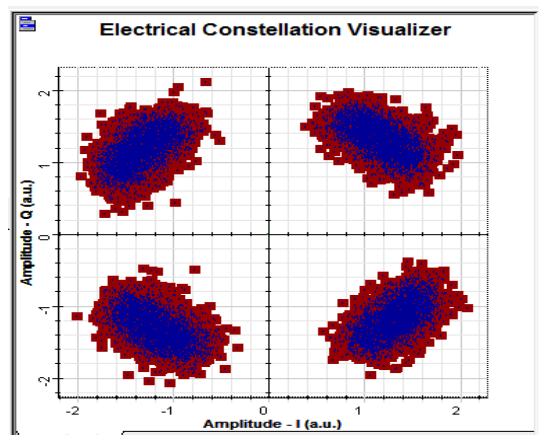


Figure 10(a). Constellation Visualizer at the Receiving End for ITU G.655 with Post Compensation

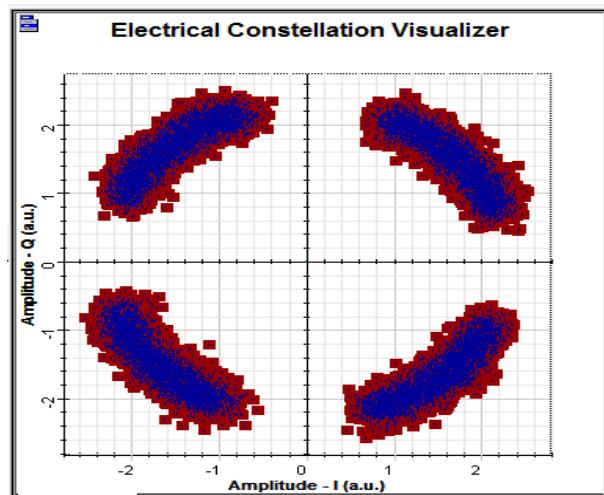


Figure 10 (b). Constellation Visualizer at the Receiving End for ITU G.655 with Post Compensation

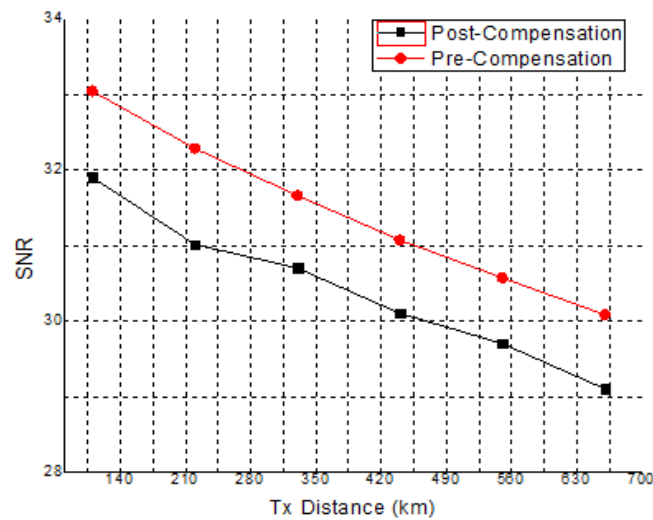


Figure 10(c). SNR v/s Transmission Distance for ITU G.655

For ITU G.655, the fiber dispersion is 3.78ps/nm/km. The electrical constellation for pre compensation is better than post compensation as depicted in Figure 10 (a) and (b).

From Figure 10(c), SNR degrades with the increase in transmission distance. At 418 km, SNR for post and pre compensation is 30.27 dB and 32.27 dB which shows is compensation is 2 dB better than post.

Table 4. Comparison of Different Fibres

Fiber Stand-ard	SNR (dB)		Transmission Dist-ance (km)
	Post-Compensation	Pre-Compensation	
SMF	19.5	22.7	483
ALCATEL	26.59	30.08	660
ITU G.652	21.84	26.87	366
ITU G.654	19.93	21.7	375
ITU G.655	30.07	32.26	418

4. Conclusion

A 40 Gbps CO-OFDM system is designed. Performance analysis of the system is done using different fiber standards along with different compensation techniques as shown in Table 3. It is concluded from the table that pre-compensation technique gives better performance than the post compensation technique. The ALCA TEL ($D=8$ ps/nm/km) fiber has the maximum transmission distance i.e. 660km than other fibers. The performance of rest of fibers is better at small distances and then degrades. ITU G.654($D=20.13$ ps/nm/km) covers minimum distance i.e. 366km. ITU G.655 ($D=3.78$ ps/nm/km) gives best performance in terms of SNR i.e. 32.26 dB but then degrades because of less DCF length to compensate dispersion.

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