

Analysis of Dispersion Effect in Single OFDM and WDM System

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Abstract: In this paper we study about the dispersion effect in optical fiber and also effect of the dispersion for 4-QAM CO-OFDM and CO-OFDM WDM system at 10Gbps data rate. Then we investigate the performance for single OFDM and four channel CO-OFDM WDM system with 50 GHz spacing. For this analysis we use opt wave simulation software Optisystem V.14. And then compare effect of dispersion for single OFDM and CO-OFDM system.

Keywords: OFDM, QAM, WDM, Optical Communication

1. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is used in broadband wired and wireless communication systems because it is an effective solution to intersymbol interference (ISI) which is caused by a dispersive channel [1]. OFDM is a special class of multicarrier modulation (MCM) system that has gained consideration in the optical communication, mainly after being projected as the long-haul transmission format in coherent detection [2]. The principle of OFDM is that OFDM divides high data stream into lower data stream. Then whole data low data stream is transmitted at the same time.

Dispersion occur in optical fiber because of broadening of pulse as it travel along the fiber as different wavelength travelled with different speed due to group velocity delay (GVD) [3]. There are three types of dispersion chromatic dispersion (CD), polarization mode dispersion (PMD) and modal dispersion. The effect of chromatic dispersion and polarization mode dispersion (PMD) is less [4]. So for coherent optical OFDM (CO-OFDM) system there is no need to use dispersion compensator for short distance.

In this paper we discussed about the optical OFDM system basics. Then discuss about the effect of dispersion in optical communication at the 10Gbps data rate.

2. SYSTEM DESIGN

Figure 1 shows the coherent optical OFDM system block diagram [5]. There are three parts of this system OFDM transmitter, optical fiber link and OFDM receiver. As shown in figure 1 input signal is given to OFDM transmitter. Input signal is produced by the pseudo random bit sequence generator (PRBS) followed by the NRZ pulse generator. Input signal is delivered through 4- QAM sequence generator and then signal is modulated by OFDM modulator which has OFDM subcarrier 512, FFT points 1024. After that signal pass through optical up convertor in this wave laser and Mach-Zehnder modulator are used to change RF data to optical domain.

Signals from the MZMs are combining and transmitted to optical fiber link [6]. In optical fiber signal feel nonlinearity, dispersion effect and degraded due to fiber deficiencies.

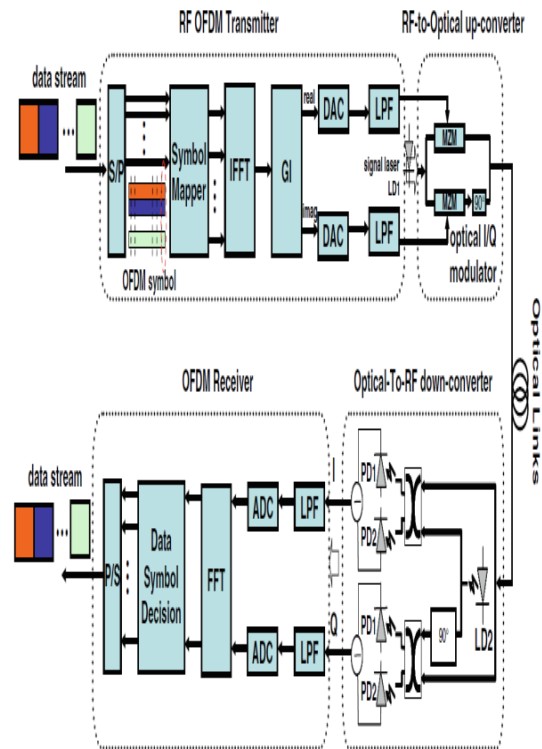


Figure 1: CO-OFDM system block diagram

Now data from the optical fiber link passed through receiver firstly data detect by the coherent detector which has 4 pin photo detectors and local laser with a wavelength center to band. We give the same frequency as the transmitter so synchronized the frequency with the transmitter. And then signal passing through the OFDM demodulator and resulting signal passed through the QAM sequence generator.

3. SYSTEM DESIGN WITH OPTISYSTEM

Figure 2 shows the design of single channel OFDM system design using optisystem. So in this design transmitter has two parts: OFDM transmitter and RF to optical up convertor and receiver also has two parts: optical to RF down convertor and OFDM receiver.

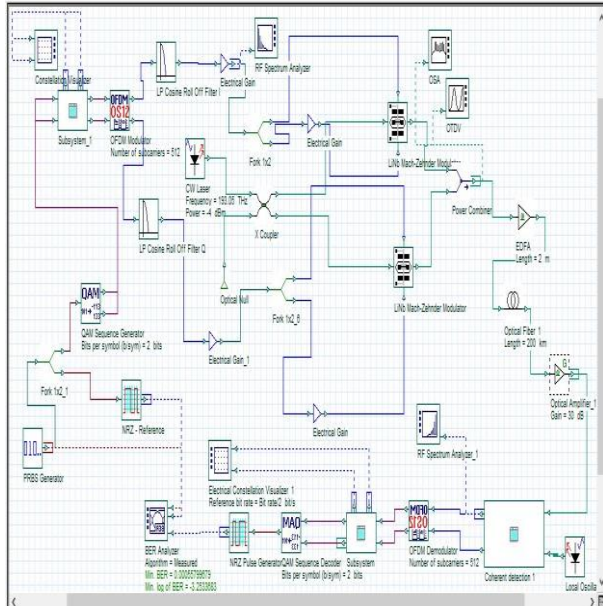


Figure 2: Single channel OFDM system

Figure 3 shows OFDM WDM system which has five parts: OFDM transmitter, RF to optical up convertor, optical link, optical to RF down convertor, OFDM receiver. Optical transmitter converts electrical signal to optical signal. Optical signal launches into optical link. After travelling in optical fiber optical signal received by the receiver.

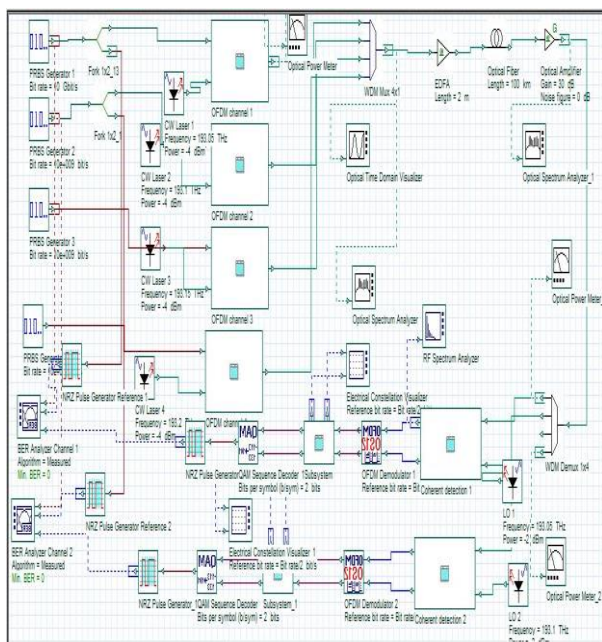


Figure 3: OFDM WDM system

Receiver has two parts firstly signal receive by the coherent detector which converts optical signal to RF signal and then RF signal launches to the OFDM receiver. Figure 4 shows the subsystem which is used in OFDM WDM system. This is also called RF to optical up convertor. Figure 5 shows subsystem 2 of OFDM WDM system also called coherent detector which converts optical to RF.

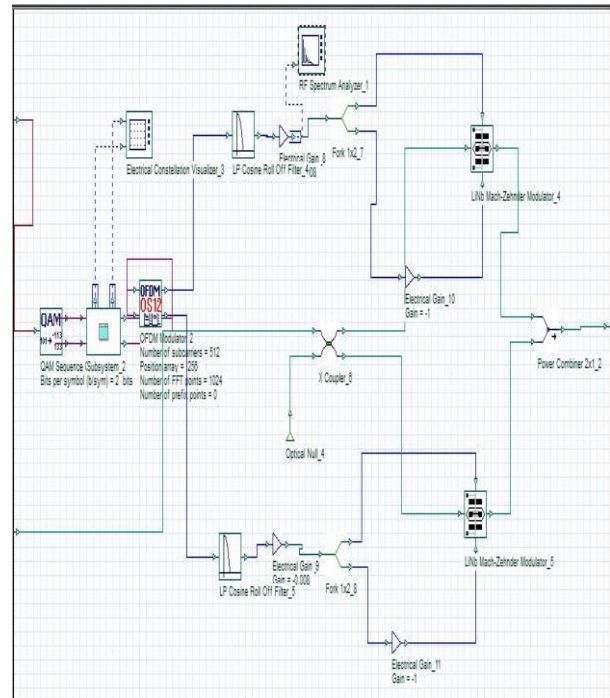


Figure 4: OFDM channel

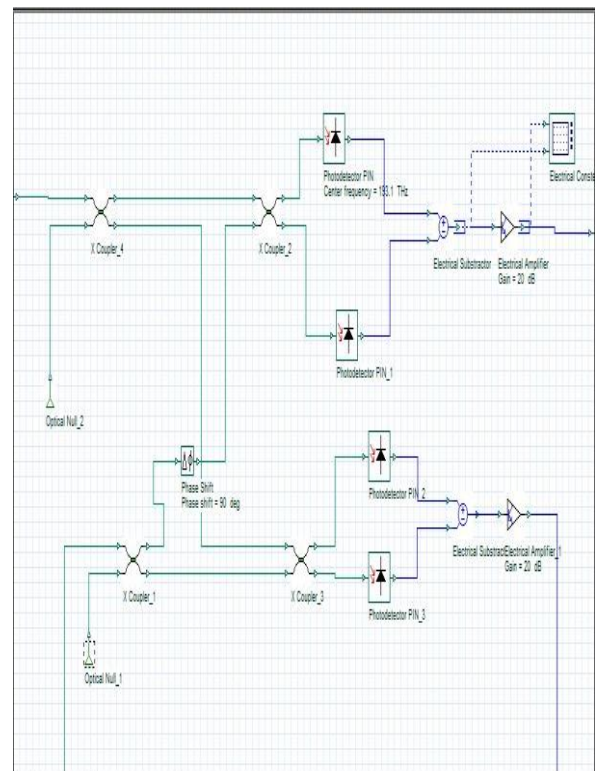


Figure 5: coherent detector

4. RESULT AND DISCUSSION

Input signal is given to the RF to optical up converter. Input signal is generated by the pseudo random sequence generator and input signal is given to the 4-QAM encoder. Figure 6 shows the constellation diagram of transmitter 4 QAM encoder. Resulting signal after OFDM modulator is visualize by RF spectrum analyzer shown in figure 7. Figure 9 shows the optical spectrum after transmitter.

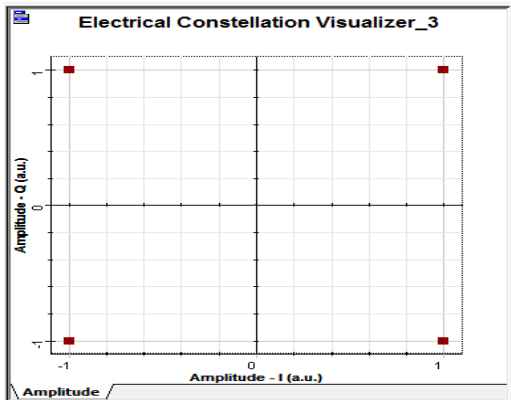


Figure 6: transmitter constellation diagram of 4-QAM encoder

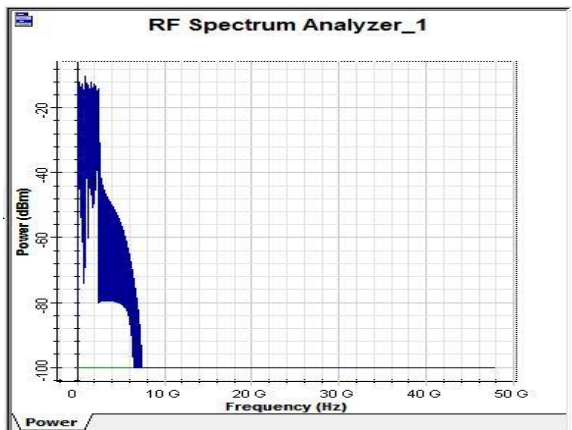


Figure 7: RF spectrum at transmitter

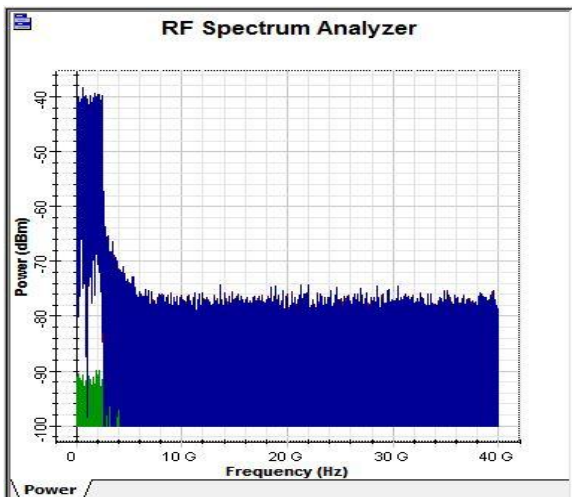


Figure 8: RF spectrum at receiver

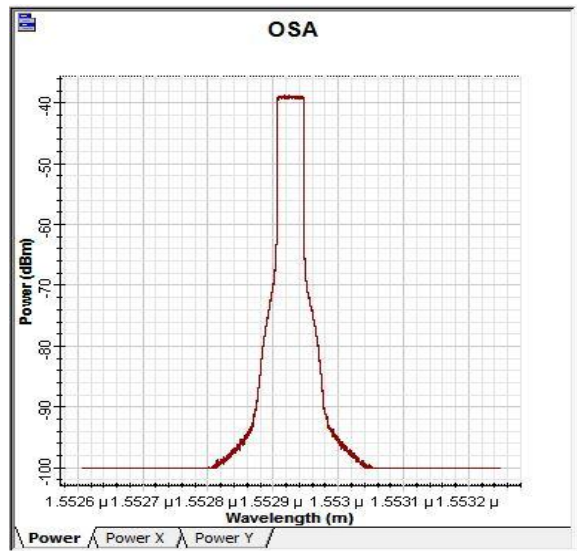


Figure 9: Optical spectrum of single channel OFDM signals

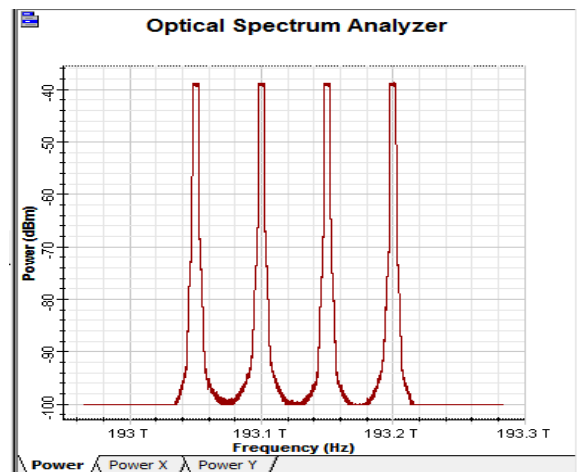


Figure 10: Optical spectrum of 4 channel OFDM WDM signals

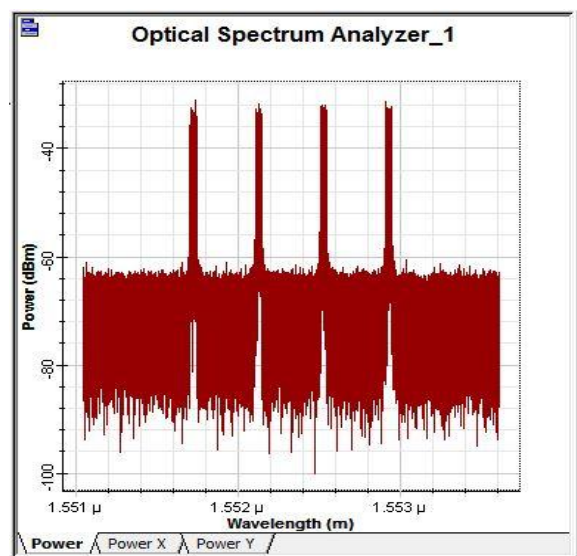
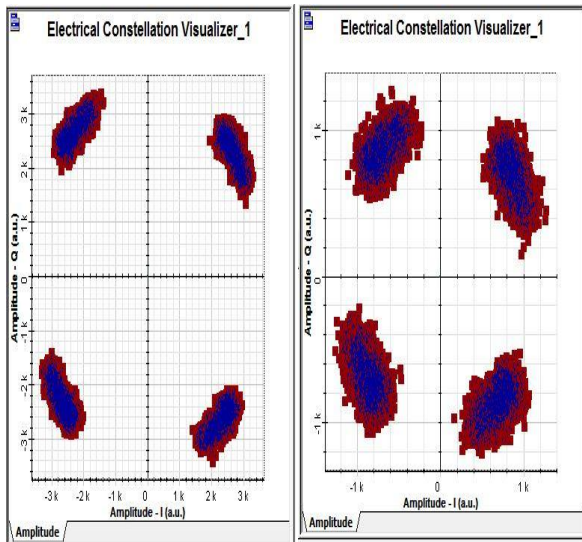
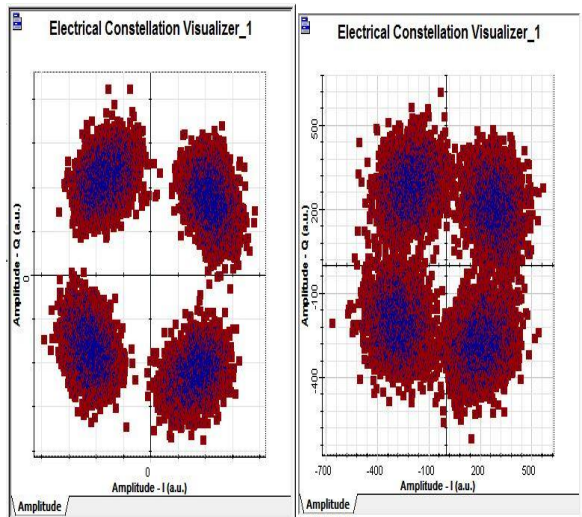


Figure 11: Optical spectrum after optical fiber transmission

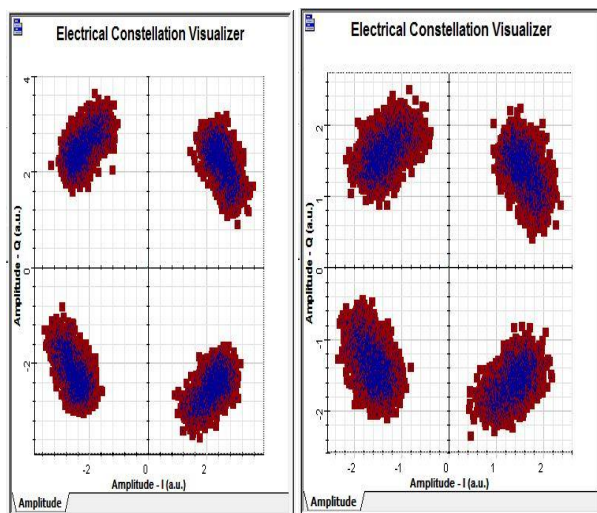


(1) (2)

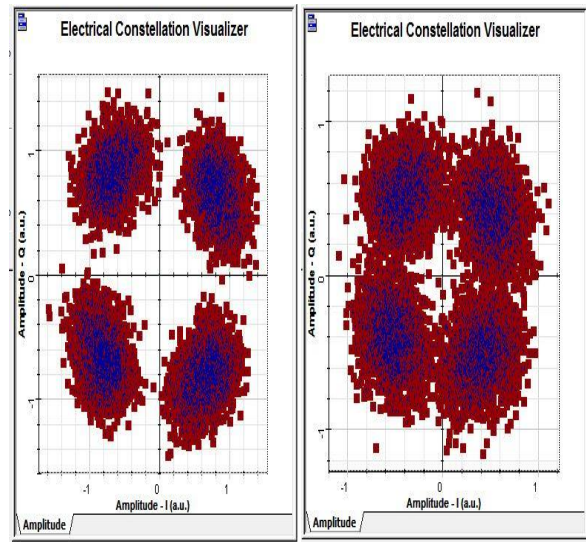


(3) (4)

Figure 12: Four QAM output constellation of single channel CO-OFDM system after different transmission length 1) 120km 2) 170km 3) 200km 4) 220km



(1) (2)



(3) (4)

Figure 13: Four QAM output constellation of four channel CO-OFDM WDM system after different transmission length 1) 120km 2) 170km 3) 200km 4) 220km

To evaluate the dispersion effect of optical fiber we analyzed the signal constellation diagram at the receiver side with different fiber length. Figure 12 shows the constellation diagram of single channel OFDM system at receiver side and figure 13 shows the constellation diagram of OFDM WDM system at receiver side. Both diagram shows as the length increase distance between two symbols decrease. It is clearly shows that compare to single channel OFDM system OFDM WDM system symbols distance is less. So single channel OFDM system is better than OFDM WDM system.

5. CONCLUSION

In this paper, we analyzed the effect of the dispersion in optical fiber. Investigation is done on dispersion of single channel and OFDM WDM 4 QAM at 10Gbps data rate. After comparing dispersion of single channel and OFDM WDM we analyzed single channel is better than OFDM WDM system without dispersion compensation.

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