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Performance Analysis Of OFDM Using 4 PSK, 8 PSK And 16 PSK

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Abstract

OFDM stands for Orthogonal Frequency Division Multiplexing. It is a special type of multicarrier modulation scheme. In it a high rate data stream is converted into a number of low rate data streams that are transmitted over parallel, narrowband channels that can be easily equalized and thus it is utilized for high data rate transmission in delay dispersive environments. It reduces the interference effects, distortion effects and multipath delay effects during data transmission and reception. Due to these advantages use of OFDM has become very popular in present day wireless technology. In this paper an OFDM system model has been used for transmission and reception of data in which M-ary Phase Shift Keying (MPSK) modulation technique is used. In M-ary Phase Shift Keying (MPSK) modulation technique the carrier phase takes on one of the M possible values, here we have used M = 4, M = 8 and M =16 i.e. 4 PSK, 8 PSK and 16 PSK modulation techniques. MPSK modulation techniques are utilized for better data transmission. In this paper along with other simulations, BER v/s E_b/N_o curves are simulated to analyze the performance of OFDM using 4 PSK, 8 PSK and 16 PSK modulation techniques. MATLAB® software is used for programming and realizing the OFDM system.

Index Terms – OFDM, BER, OFDM using MPSK, MPSK, 4 PSK, 8 PSK, 16 PSK.

1. Introduction

In wireless communication systems the data or information is transferred between at least two points or more than two points, the important thing in this case is that the points should not have any physical or wired connection between them. The distances between the different points can be short, such as few metres, like for television remote control and it can be even thousands of kilometres as in the case of satellite communications [1]. In OFDM multiple carriers are used for data handling. In it a parallel collection of regularly spaced subcarriers are modulated by data symbols. The frequency separation between various subcarriers is maintained to a minimum value in order to maintain orthogonality of their corresponding time domain waveforms, yet the signal spectra corresponding to the different subcarriers overlap in frequency. Due to the spectrum overlap a waveform is obtained which is capable of using the available bandwidth with very high bandwidth efficiency [2]. Currently OFDM is used for Digital audio broadcasting (DAB), Digital video broadcasting (DVB) and Wireless local area networks (LANs) [3]. In the present modern world various modulation techniques are used. Modern modulation techniques exploit the fact that digital baseband data may be sent by varying both envelop and phase (or frequency) of an RF carrier. Because the envelope and phase offer two degrees of freedom, such modulation techniques map baseband data into four or more possible RF carrier signals. Such modulation techniques are called M-ary modulation, since they can represent more signals than if just the amplitude or phase were varied alone. In M-ary PSK, the carrier phase takes on one of M possible values [4]. In this paper OFDM system model uses M = 4, M = 8 and M =16 for MPSK i.e. 4 PSK, 8 PSK and 16 PSK modulation techniques. E_b/N_o (the energy per bit to noise power spectral density ratio) is an important parameter in digital communication or data transmission. It is a normalized signal to noise ratio (SNR) measure; also known as "SNR per bit" [5].

2. OFDM System

The OFDM system represents the different major blocks which are required for the data transmission and reception using OFDM. We have used the 4 PSK, 8 PSK and 16 PSK modulation techniques in this model and analyzed their performance. This model is realized using MATLAB® software programming.

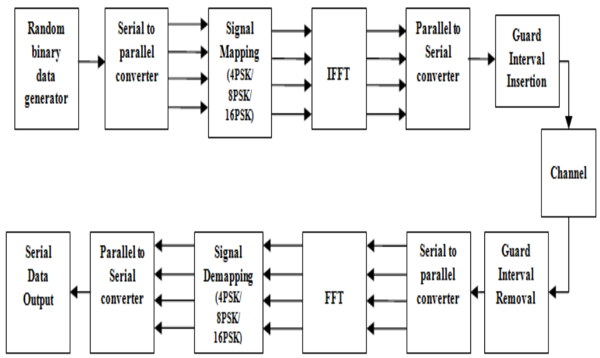

Figure 1: OFDM System for Transmission and Reception of Data.

There are various physical processes and engineering applications which are analyzed for their operation and performance by simulating them using various software's. Such simulations frequently require using a number (or a set of numbers) that has a random value. MATLAB® software has commands like rand, randint, randn etc. that can be used to assign random numbers to variables [6]. Random binary data generator generates random binary data. Transmitter section consists of serial to parallel converter, signal mapping, IFFT, parallel to serial converter, guard interval insertion. In Serial to Parallel Converter, serial data is available as input which is formatted into the word size required for transmission [7, 8]. In this way the serial to parallel converter converts the serial data stream into parallel data stream. Data modulation is done by the signal mapping before the transmission. The data which is to be transmitted on each different carrier is differentially encoded with the previous symbols and then it is mapped into a phase shift keying format, which can be either 4 PSK, 8 PSK and 16 PSK in this case. Differential encoding requires an initial phase reference so an extra symbol is added at the beginning for this requirement. After that the data on each symbol is mapped to a phase angle based on the modulation method [7, 8]. The frequency domain data is converted into time domain signal by the Inverse Fast Fourier transform (IFFT) and it also maintains the orthogonality among the carriers. Guard period is added to the start of each symbol. Due to the guard period insertion the multipath signals from the previous symbol die away before the information from the current symbol is obtained. Due to the guard interval/period insertion the symbols are converted into a serial time waveform. This is called the baseband signal for the OFDM data transmission process. Signal to noise ratio is set to the signal by adding a known amount of white Gaussian noise to the signal, this is done by using AWGN channel [7, 8]. Receiver section consists of guard interval removal, serial to parallel converter, FFT, signal demapping, parallel to serial converter. The different blocks of the receiver perform the opposite operation as compared to the transmitter blocks. The guard interval/period is removed. The FFT of each symbol is utilized to find the original transmitted signal spectrum. The phase angle of each transmitted carrier is evaluated and converted back to the data word by demodulating the received phase, this is done by signal demapping block. The data words are combined back to the same word size as the original data was transmitted [7, 8].

3. OFDM System performance using 4 PSK, 8 PSK and 16 PSK

The performance of OFDM system using 4 PSK, 8 PSK and 16 PSK can be analyzed by using the simulation results shown in this section.

3.1. Parameters used

The different major parameters used and their values are given in this section.

PARAMETER	VALUE
Symbol Length	1024
Number of OFDM Symbols	100
Modulation	4 PSK, 8 PSK and 16 PSK

Table 1: OFDM system parameters for simulation.

3.2. Simulation Results

The simulation results for OFDM using 4 PSK, 8 PSK and 16 PSK are given in this section.

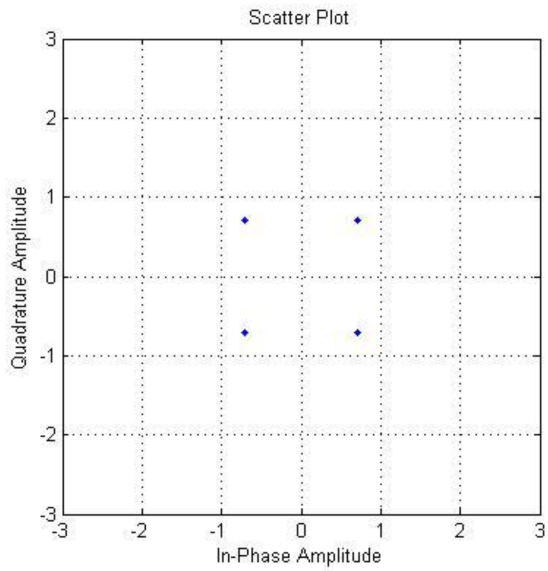

Figure 2: 4 PSK constellation after 4 PSK mapping.

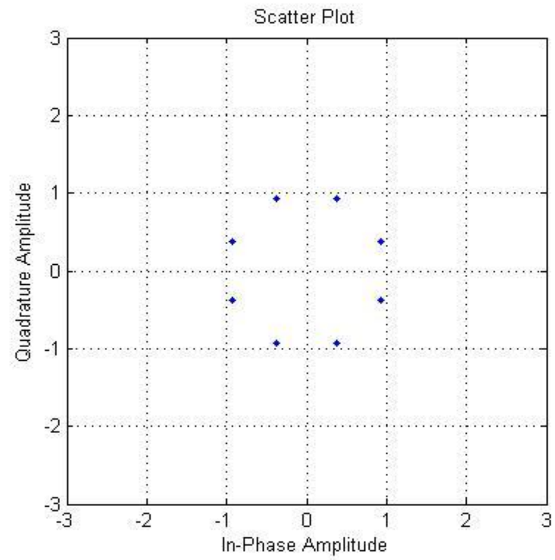

Figure 4: 8 PSK constellation after 8 PSK mapping.

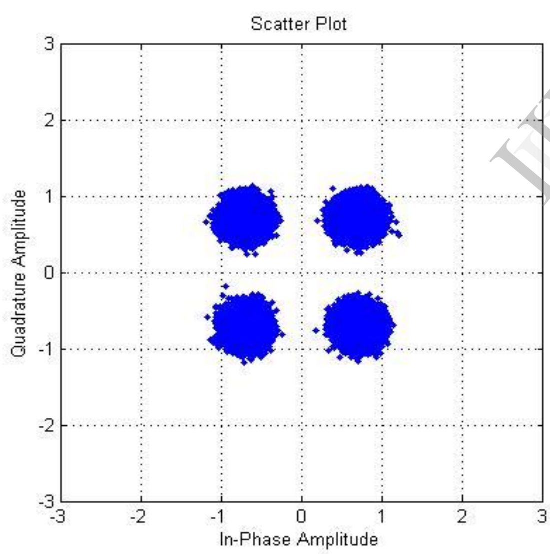

Figure 3: 4 PSK constellation before 4 PSK demapping.

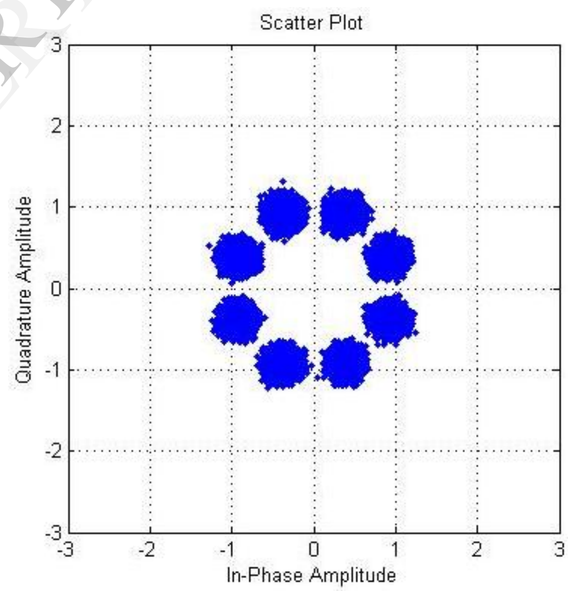

Figure 5: 8 PSK constellation before 8 PSK demapping

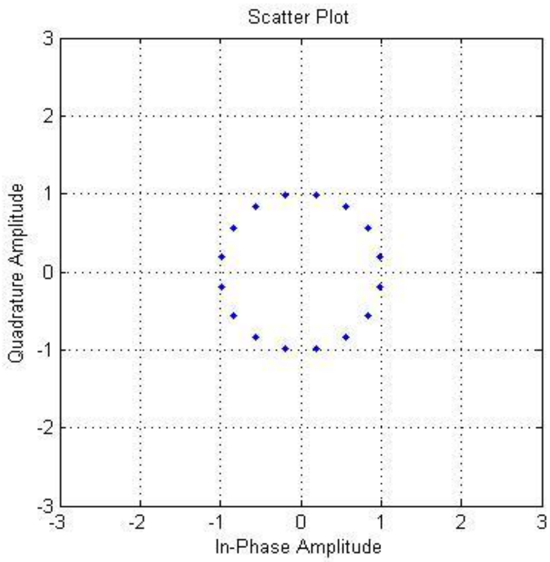

Figure 6: 16 PSK constellation after 16 PSK mapping.

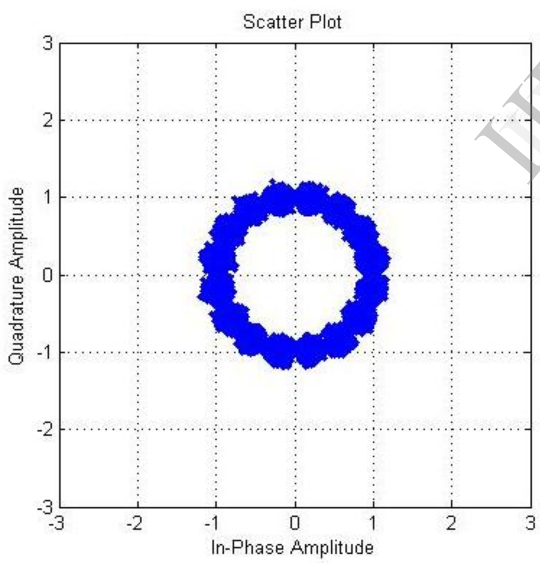

Figure 7: 16 PSK constellation before 16 PSK demapping.

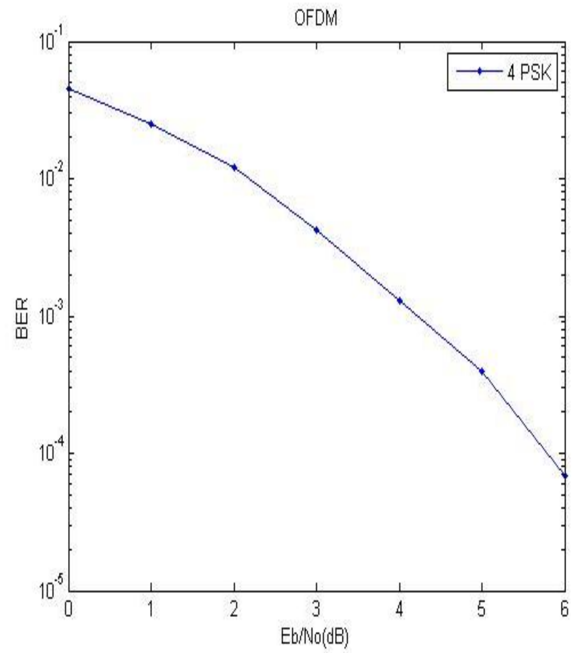

Figure 8: BER v/s E_b/N_o curve of OFDM using 4 PSK.

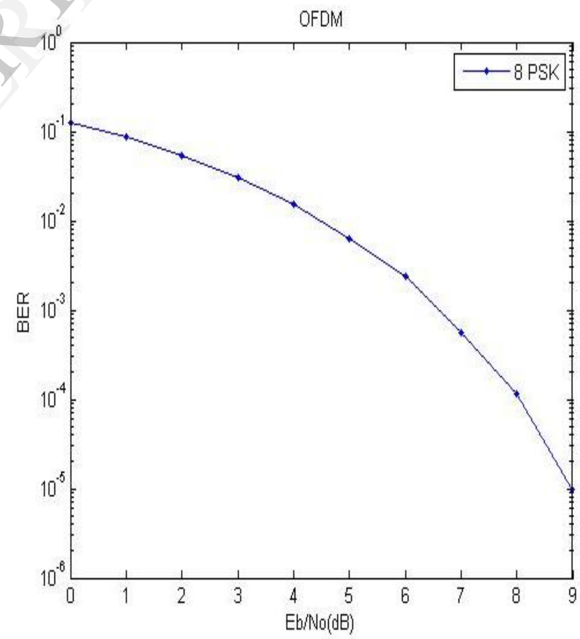

Figure 9: BER v/s E_b/N_o curve of OFDM using 8 PSK.

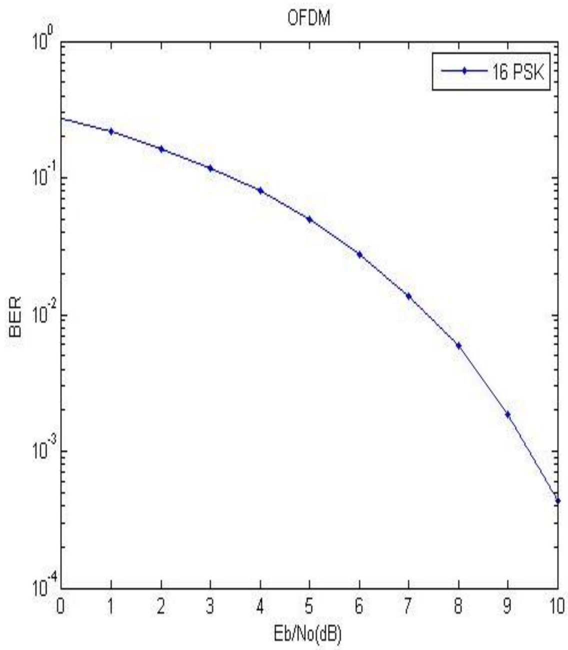

Figure 10: BER v/s E_b/N_o curve of OFDM using 16 PSK.

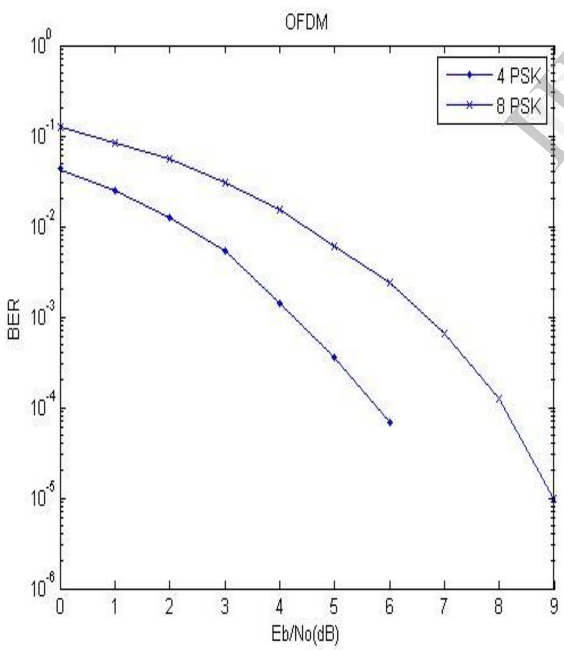

Figure 11: BER v/s E_b/N_o comparison curves of OFDM using 4 PSK and 8 PSK.

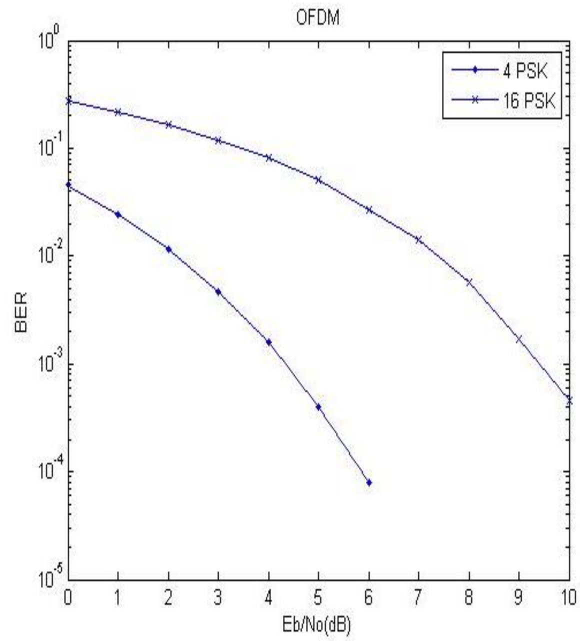

Figure 12: BER v/s E_b/N_o comparison curves of OFDM using 4 PSK and 16 PSK.

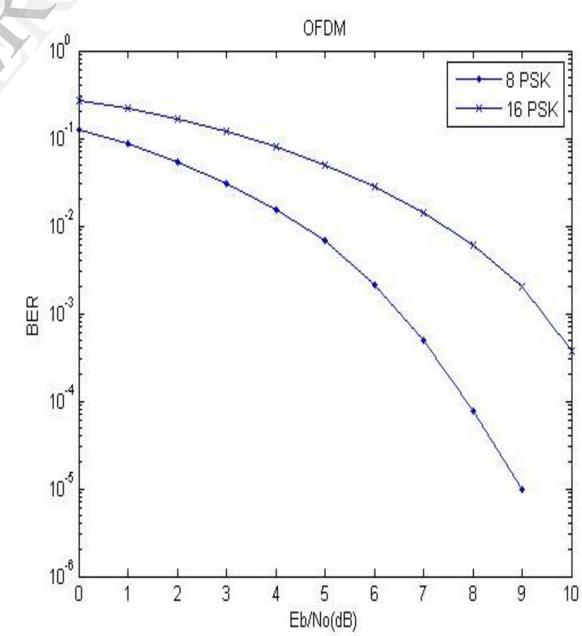

Figure 13: BER v/s E_b/N_o comparison curves of OFDM using 8 PSK and 16 PSK.

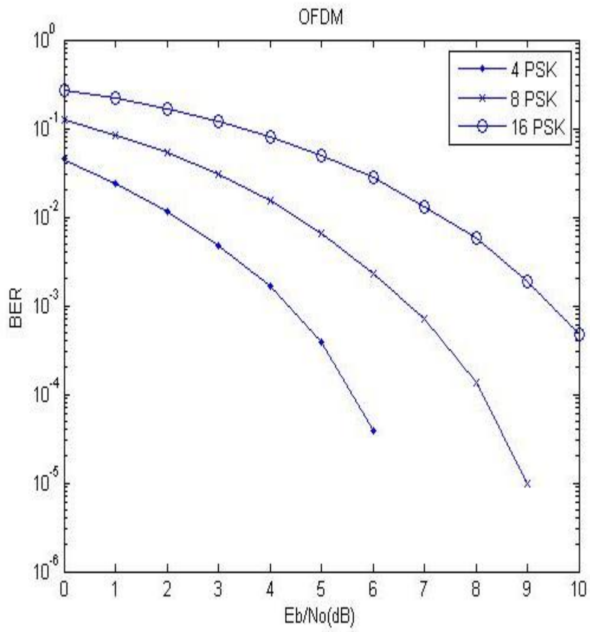

Figure 14: BER v/s E_b/N_o comparison curves of OFDM using 4 PSK, 8 PSK and 16 PSK.

4. Conclusion

From the simulations obtained in the figures 2, 3, 4, 5, 6 and 7 we analyzed that the noise randomly mixes with the transmitted signal somewhere in the transmission path which has affected the constellations of 4 PSK, 8 PSK and 16 PSK in figures 3, 5 and 7 but the received signal phase and amplitude did not change very much with respect to the transmitted signal. From the simulations obtained in the figures 8, 9, 10, 11, 12, 13 and 14, when we consider the BER, the performance of 8 PSK is better than 16 PSK because the BER values with respect to the E_b/N_o (in dB) in case of 8 PSK are lower than the values obtained in the case of 16 PSK. The performance of 4 PSK is better than both 8 PSK and 16 PSK because the BER values with respect to the E_b/N_o (in dB) in case of 4 PSK are lower than the values obtained in the case of 8 PSK and 16 PSK. The spectral width of 8 PSK is more than that of 4 PSK so it can carry more traffic as compared to 4 PSK but at the expense of BER; and the spectral width of 16 PSK is more than both 8 PSK and 4 PSK therefore 16 PSK can carry more traffic as compared to 8 PSK and 4 PSK but at the expense of BER. So finally it can be concluded that 4 PSK has better BER performance than that of 8 PSK and 16 PSK but at the expense of spectral width.

5. References

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