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BER ANALYSIS OF BPSK, QPSK & QAM BASED OFDM SYSTEM USING SIMULINK

Pratima Manhas[1], Dr M.K Soni[2]

[1]Research Scholar, FET, ECE, [2] ED& Dean, FET, Manav Rachna International University, Fbd (India)

ABSTRACT

Orthogonal frequency Division Multiplexing (OFDM) is a type of multicarrier modulation technique (MCM) in which higher data stream is divided into a number of lower data streams and transmitted over a large number of subcarriers. Various digital modulations techniques can be combined with OFDM for enhancing the performance of OFDM system. This paper focuses the MATLAB simulink model of BPSK, QPSK and QAM based OFDM system which calculates the BER. A comparative study of bit error rate (BER) under normal AWGN channel has been done among various digital modulation techniques of OFDM using MATLAB Simulink model.

Keywords: Bit error rate (BER), Multicarrier modulation (MCM), MATLAB, Simulink.

I. INTRODUCTION

As the customer in today's world not only requires the mobile phone to be connected to other network, they require multimedia services (like data, audio, video) and want everything to be connected to single network. It can be possible only if the lower data rate can be converted into higher data rate. OFDM technique is the solution. In OFDM technique, higher data rate is divided into number of lower data rate and are transmitted simultaneously over a large number of subcarriers. OFDM is a type of multi-carrier modulation (MCM) technique which transmits signals through multiple carriers. These multiple carriers (subcarriers) have different frequencies and all subcarriers are orthogonal to each other [5]. It is used in both wired (ADSL) and wireless communications (wireless LAN).

As there is a demand for higher data rate and it can be possible only by using OFDM systems. As Bandwidth is efficiently used in OFDM system and interference among carriers is also less (as orthogonal subcarrier are used).But OFDM suffers from certain disadvantages such as higher complexity and has high peak to average power ratio (PAPR) and also suffers from inter-carrier interference (ICI) & intersymbol interference(ISI). The paper is organized into different sections. Section II gives the description of OFDM model. A brief introduction to BER is presented in section III. The introduction to various digital modulation techniques (BPSK, QPSK &QAM) and its simulation model are presented in section IV. Section V describes the Simulation analysis & results. Lastly the conclusion is presented in section VI.

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II. OFDM MODEL

OFDM is a type of frequency division multiplexing (FDM) in which a single channel utilizes multiple sub-carriers on adjacent frequencies. As the sub-carriers in an OFDM system are overlapping, so it enhances the spectral efficiency [5]. OFDM system has less interference because of the presence of orthogonal subcarriers. So OFDM system is widely used in wireless communication.

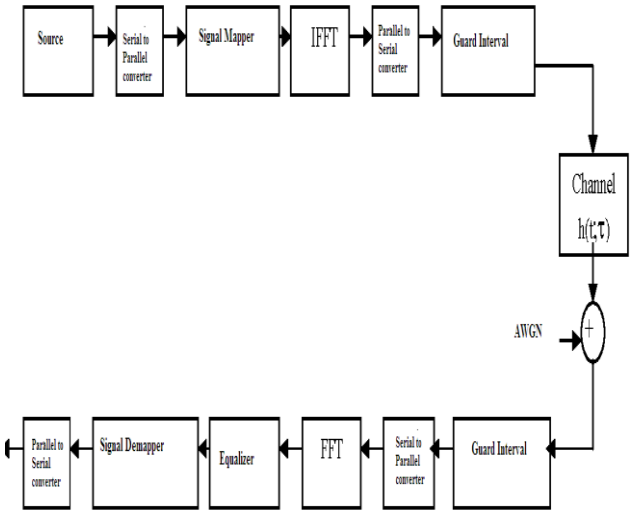

Figure1 Block Diagram of OFDM Model

The block diagram of OFDM model is shown in Figure 1.In this figure 1, the serial data from the source is first converted into parallel form and then the modulation (mapping) technique is done. After mapping technique, the IFFT (Inverse Fast Fourier Transform) operation is performed to convert frequency domain signal into time domain and then the signal is passed to channel and then at the receiver end the FFT (Fast Fourier Transform) operation is performed to convert back the time domain signal into frequency domain and then demodulation is done and the recovered signal is obtained after passing it to parallel to serial converter [2].

III. BIT ERROR RATE (BER)

Bit Error rate (BER) is a performance parameter which is used in digital transmission. During the transmission of data over a link, there is a possibility of errors being introduced into the system. Presence of errors in data degrades the performance of the system [3]. So for assessing the performance of digital system, bit error rate (BER) is used to calculate the errors. It is the rate at which errors occur in a transmission system. The bit error rate is given as:

Bit Error Rate (BER) = Number of errors that occurred during transmission /Total number of transmitted bits

BER is inversely proportional to Signal to Noise ratio. High value of signal to noise ratio (SNR) indicates small value of bit error rate (BER) and has no noticeable effect on the overall system.

In OFDM system, the bit-error-rate (BER) is severely affected by the nonlinearity of the high power amplifier .For low SNR value, QPSK gives better BER performance whereas QAM results are better for high SNR value.

The bit error rate (BER) can be defined in terms of the probability of error (POE). The POE is proportional to Eb/No and it is a form of signal to noise ratio. BER can be affected by

- **Lower order modulation:** Lower order modulation schemes can be used, but it results in less data throughput.
- **Reduce bandwidth:** BER can be reduced by reducing the bandwidth. Bandwidth reduction leads to lower levels of noise and therefore the signal to noise ratio will improve. But it results in a reduction of the data throughput.

IV. DIGITAL MODULATION TECHNIQUES

This section deals with the various digital modulation techniques that can be used for OFDM system. They are BPSK, QPSK and QAM.

- BPSK

BPSK stands for Binary Phase shift Key. In this digital modulation two phases are generated for the two bit (1/0) information. For the transmission of '1' bit the phase shift is 0 degree and for '0' bit transmission, the phase shift is 180 degree.

- QPSK

It stands for Quadrature phase shift key .It is a type of Phase shift key in which two bits are send at the same time and two bits represents one symbol and four different phases are generated.

- QAM

It stands for Quadrature amplitude modulation. It is a combination of both Amplitude shift key (ASK) and phase shift key (PSK).

A comparative study of Bit Error Rate (BER) performance of the modulation techniques BPSK, QPSK and QAM using an OFDM transmission system has been done using simulink tool. The work is divided into following steps:

i. Modeling an OFDM system with BPSK, QPSK and QAM digital modulation schemes using MATLAB Simulink.

ii. System Simulation using an Additive White Gaussian noise Channel (AWGN)

iii. Comparative analysis of BER for the simulated models.

V. SIMULINK MODEL

This section describes the simulation models of various digital modulation techniques used for OFDM system.

In this model a random signal generator feeds into the digital modulation techniques (BPSK, QPSK and QAM) used for transmission. Then it is passed through OFDM modulator. An AWGN noise channel is introduced in the transmitted channel. After passing through the channel, then the signal is demodulated using various digital demodulation techniques and then the received signal is used to calculate the error rate for transmission process. MATLAB Simulink tool is used for simulation.

VI. SIMULATION RESULTS & ANALYSIS

The Simulink model for BPSK, QPSK and QAM based OFDM system is shown in the figures 2, 4&6.The BER output of BPSK, QPSK and QAM based OFDM system is shown in figures 3, 5 & 7.

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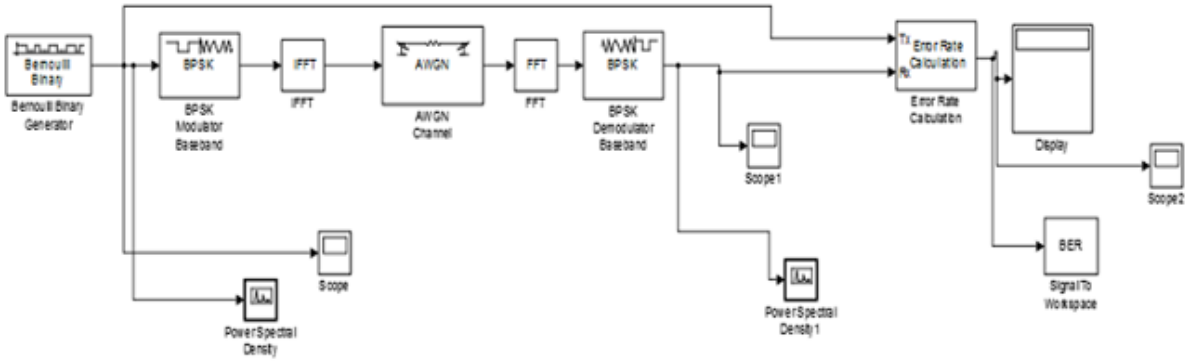

Figure2 Simulink Model for OFDM System Using BPSK Modulation

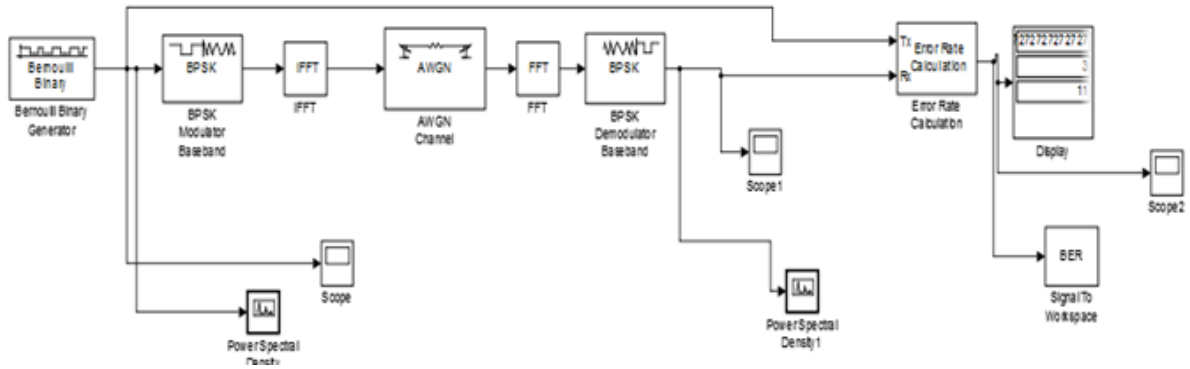

Figure3 BER Output of OFDM System Using BPSK Modulation

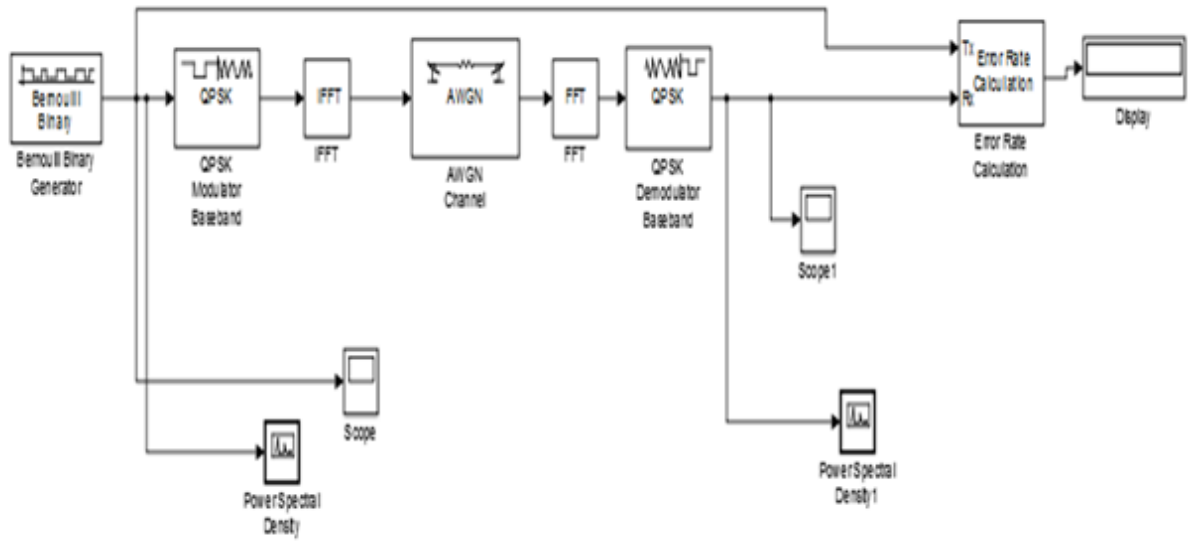

Figure 4 Simulink Model for OFDM System Using QPSK Modulation

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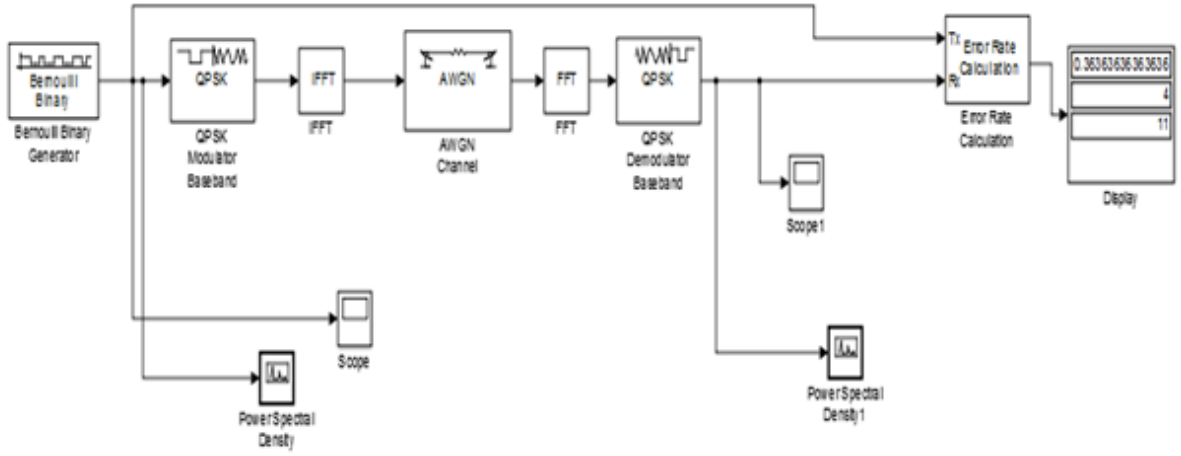

Figure 5 BER Output of OFDM System Using QPSK Modulation

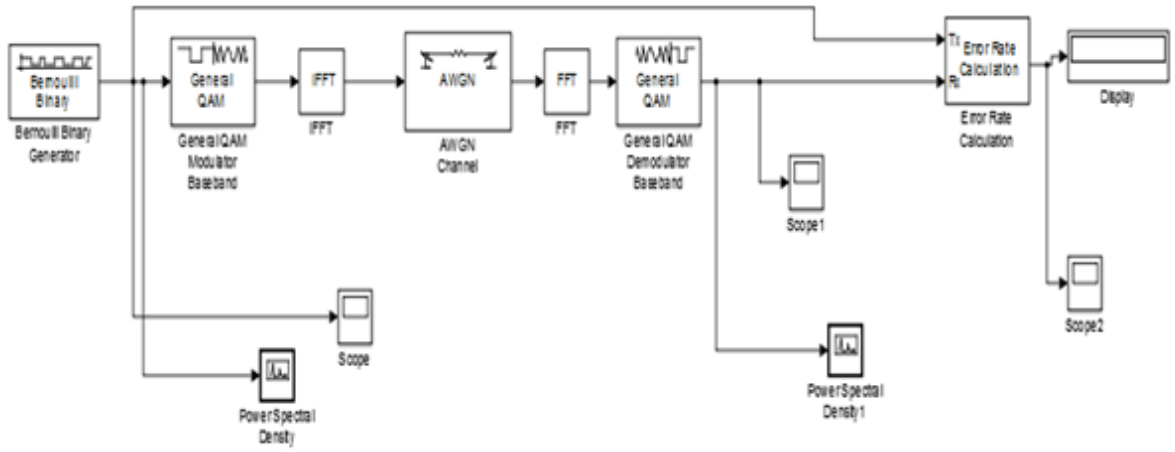

Figure 6 Simulink Model for OFDM System Using QAM Modulation

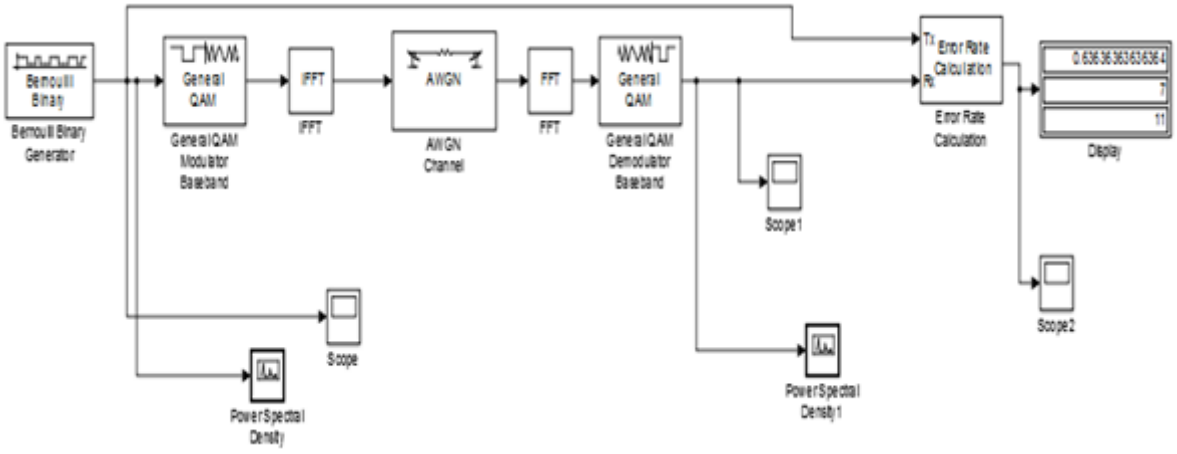

Figure 7 BER Output of OFDM System Using QAM Modulation

Table1 summarize the performance of OFDM system using various digital modulation techniques (BPSK, QPSK and QAM) on the basis of BER calculation.

Table 1 BER Calculation of Various Digital Modulation Techniques

S.NO	Digital Modulation	BER value
1	BPSK based OFDM system	0.2727
2	QPSK based OFDM system	0.3636
3	QAM based OFDM system	0.6363

It is concluded from the table1 that BER value is less in case of BPSK modulation and higher in case of QAM system. As BER is inversely proportional to SNR (signal to noise ratio) so if BER is less, than the SNR is high and SNR is used to measure the quality of transmission channel. The high SNR ratio will easily isolate & eliminate the source of noise. So minimum value of BER is required to enhance the performance of OFDM system.

VII. CONCLUSION

In this paper different digital modulation technique (BPSK, QPSK&QAM) has been applied on OFDM system using AWGN channel. A simulation study is performed using MATLAB Simulink tool to study the BER performance parameter on AWGN channel. It has been found that BPSK based OFDM system has least BER value as compared to other digital modulation techniques. Hence the performance of BPSK based OFDM system is better than others. BER enhancement can be improved further in OFDM by using channel coding(such as cyclic or linear block codes).

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