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Comparative Performance Analysis of M-ARY PSK Based Modulation Technique under AWGN Channel using Simulink

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Abstract: The main objective of the Digital Communication System is to receive data at receiver side as similar as the data sent from the transmitter. To view the system's performance it is important to analyze the system in term of probability of error or bit error rate. In this paper mathematical and simulink curve of BER performances is compared for Gaussian channel for M-ARY PSK. The main objective of this paper is to analysis how much improvements of BER is occurred using M-ARY PSK for Gaussian channel . In order to choose the most suitable modulation for getting better performance several criteria such as power efficiency, bandwidth efficiency, and bit error rate are used for analysis. This paper focuses on error performance of different order of phase modulation schemes in gaussian channel and compare mathematical analysis with simulink analysis.

Keywords: Additive white Gaussian noise, Bit error rate, Gaussian channel, Phase shift keying, Signal to Noise ratio.

I. INTRODUCTION

With the growth of digital communication industry the applications of modulation techniques also grow. In Modern wireless Communication system, digital modulation techniques are use because over the analog modulation techniques digital modulation techniques have many advantages. The amplitude shift keying (ASK), frequency shift keying (FSK), Phase shift keying (PSK) and Quadrature amplitude modulation (QAM) all are forms of digital modulation techniques. The choice of modulation technique depends upon the requirement according to applications. As compare to other modulation techniques Phase Shift Keying (PSK) has better error performance and band width efficiency among other modulation techniques . In PSK the phase of the analog carrier is varied according to the baseband digital signal to represent two or more different signal elements. In PSK the peak amplitude and fundamental frequency of the carrier are fixed. Digital modulation technique has different performance characteristics i.e. Bandwidth efficiency, cost, Power efficiency, Error rate etc. The aim of our analysis is to comparing mathematical and simulink performance of various M-Ary PSK modulation techniques in terms of their bit error rate. In this paper goal of our analysis is to compare the performance of various M-Ary PSK modulation techniques in gaussian channel in terms of their bit error rate.

II. BIT ERROR RATE

In Digital communication system the number of bit errors is define as the number of received bits of a data stream over a communication channel that has been altered due to noise, interference, bit synchronization errors or distortion. Mathematically bit error rate or bit error ratio (BER) is the number of bits in error divided by the total number of transferred bits during a time interval from transmitter. BER is a unit less but performance measure expressed in term of percentage.

III. DIGITAL MODULATION TECHNIQUE

Modulation is defined as the process in which a carrier wave is able to carry the message or base signal (In case of digital signal series of ones and zeroes). There are three major classes of digital modulation techniques used for transmission of digitally represented data (i) Amplitude Shift Keying (ASK), (ii) Frequency Shift Keying (FSK), (iii) Phase Shift Keying (PSK). All three classes convey data by changing some parameter of a carrier signal, the carrier wave in response to a data signal. For ASK, FSK and PSK, the amplitude, frequency and phase are changed respectively. In the case of frequency and phase modulation, amplitude envelope has constant, so in case of FSK and PSK the effect of non-linearity and noise interference is minimum. However, these effects are more striking in case of ASK. Also, In case of ASK the quality of amplitude modulated analog carriers to transport digital information is a relatively low, cost type of digital modulation low and it is very less used except for very low speed telemetry circuits. Even though the generation of BFSK is easier but its BW is almost double as compare of BW of BPSK. Also, FSK has a poorer error performance than PSK and consequently is very less used for high performance digital wireless systems.

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Its use is restricted to low performance, low cost, asynchronous data modems that are used for data communications over analog voice band telephone lines. Therefore, M-ary PSK is the most commonly used digital modulation technique.

IV. M- ARY PSK MODULATION TECHNIQUES OVER AWGN CHANNEL

The term noise define as the unwanted electrical signals that are always present in communication systems. In communication systems, the most common type of noise added over the channel is the Additive White Gaussian Noise (AWGN).

The received signal is equal to the transmitted signal plus the noise so it is called additive noise. It is called white because it has a constant power spectral density. It is Gaussian because its probability density function is similar modeled to behave like a Gaussian distribution. It is noise because it distorts the received signal. The values of the noise 'n' follow the Gaussian probability distribution function p(z)

$$p(z) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{z-a}{\sigma}\right)^2\right]$$

Because the bandwidth of the signal is very less as compare to the bandwidth of the AWGN channel. The higher the variance of the noise the deviation of the received symbols are more with respect to the constellation set and the probability to demodulate a wrong symbol is higher and create errors.

V. SIMULATION ANALYSIS AND RESULT

The results of Simulink analysis of BER performance of M-ary Phase Shift Keying for M=2, 4 and 8 is obtained using communication toolbox in SIMULINK which are shown in Fig. (1), (2) and (3).

The comparative performance analysis of theoretical and simulated curves for BER vs Eb/ No (signal to noise ratio) for BPSK, QPSK and 8-PSK over AWGN channel are given in Fig. (4), (5) and (6).

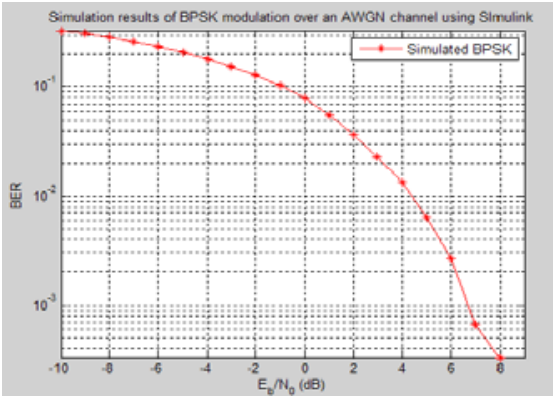

Fig (1) BER performance of BPSK over AWGN Channel using Simulink

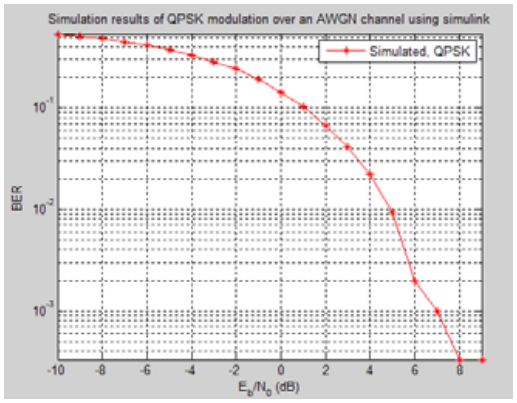

Fig (2) BER performance of QPSK over AWGN Channel using Simulink

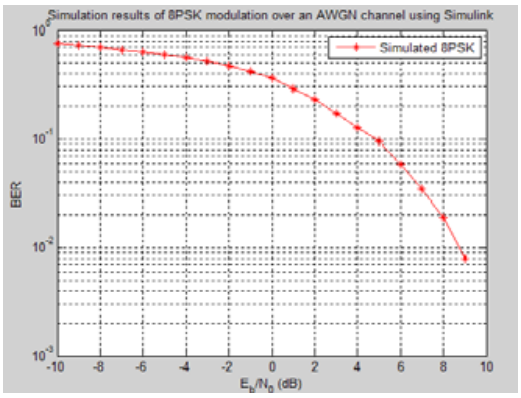

Fig (3) BER performance of 8PSK over AWGN Channel using Simulink

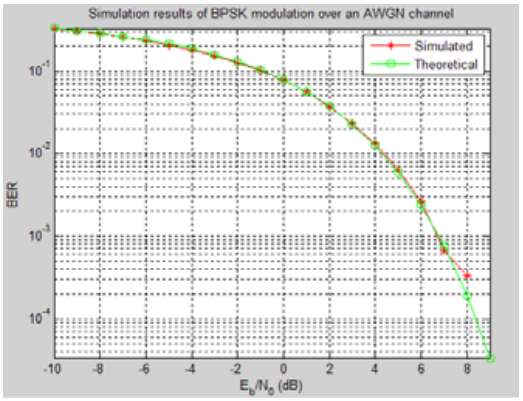

Fig (4) Comparative performance analysis of BPSK over AWGN Channel using Simulink

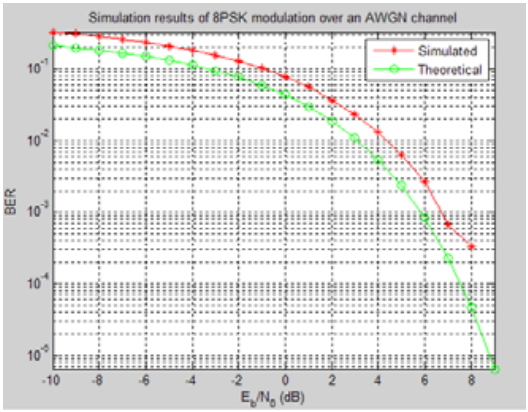

Fig (5) Comparative performance analysis of 8PSK over AWGN Channel using Simulink

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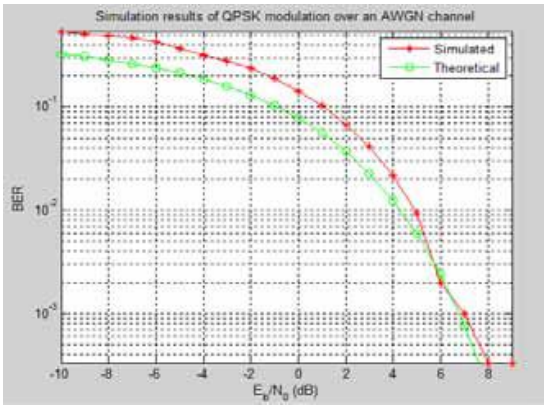

Fig (6) Comparative performance analysis of QPSK over AWGN Channel using Simulink

VII. CONCLUSION

The mathematical analysis of M-ARY PSK show that BER decrease with increasing signal to noise ratio and we can also see simulation analysis using Simulink tool shows that the BER for all the M-ary PSK based digital modulation schemes decrease monotonically with increasing values of signal to noise ratio. A QPSK system transmits information at twice the bit rate of a BPSK system for the same BW channel. Due to this advantage in practical QPSK is mostly used. Similarly 8-PSK system transmits information at thrice the bit rate of a BPSK system. It is observed from the simulation curves and the mathematical analysis of the signals that as the number of signals or number of M increases, the error probability also increases over AWGN channel. It is seen that higher order modulations contain higher bit error rates, in exchange however it a deliver high raw data rate.

VIII. SCOPE OF FUTURE WORK

In this paper we analysis the performance of BPSK , QPSK and 8-PSK in presence of AWGN Channel. We compare Mathematical Bit Error Rate with the Bit Error Rate get from Simulation. In future work we can analysis the performance of higher PSK like 16-PSK, 32-PSK. And also we can analysis the performance of M-ARY PSK for the Rayleigh channel , Rician Channel or etc.

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