Study of Binary Phase Shift keying (BPSK) And Binary Frequency Shift Keying (BFSK) Characteristics through AWGN Channel with Same Signal to Noise Ratio (SNR) Using MATLAB and SIMULINK.

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Abstract— This paper presents the characteristics of Binary Phase Shift keying (BPSK), and Binary Frequency Shift Keying (BFSK) through AWGN channel using same Signal to Noise Ratio (SNR) in MATLAB. In Digital Communication several modulation techniques are well flourished in the communications field. Selection of a suitable modulation technique for an application depends on many factors like Bit error rate, data rate, design complexity etc. Among all those modulation schemes the two widely used modulation schemes are BPSK and BFSK.These Modulation schemes are used due to low Bit Error Rate (BER) and simplicity in design when compared to other modulation technique.

The BER of BPSK and BFSK are performed using MATLAB Graphical User Interface (GUI) tool i.e BER tool and it is implemented in Simulink. The modulated signal is produced by modulating a carrier according to a binary code. Such modulated signal is transmitted through an AWGN channel. After that the noisy modulated signal is demodulated by their respective demodulation techniques.

In this paper the values of noise figure are taken as 20 db. 25db and 30 db, where as the standard SNR limit is set by the industry, is 16 db. Taking those values we have plotted the BER curve with respect to SNR and also compared between the two schemes and found which modulation scheme is better and less erroneous.

Index Terms— AWGN, BER, BFSK, BPSK, DEMODULATION, MODULATION, SNR.

1 INTRODUCTION

For many years, corporations and governments have desired to develop a universal digital modulation identification feature in their analog and digital communication systems. As the telecommunication industry continues to grow at an exponential rate, the benefits in terms of both cost and utility of such a device would improve the functionality of networks and communications systems globally. This PAPER investigates the robustness and capabilities of a digital modulation classifier, which uses the statistical features of higher order moments and cumulates.

This paper contains the comparative study of the characteristics of the two most used modulation schemes i.e. Binary Phase Shift Keying (BPSK) and Binary Frequency Shift Keying (BFSK). The transmitter transmits the modulated signal through AWGN channel and received by the receiver. From the receiver end we get the original signal. In AWGN channel we modify the value of SNR parameters. If we increase the noise power in AWGN channel then the nature of the modulated signal get changed .Our work is to compare the both modulated signal in same SNR value and also recommend which modulation scheme is better with respect to SNR.

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2 THEORETICAL BACKGROUND

The basic difference between the analog and digital communication is the modulation technique used with them. The modulation process converts a baseband signal into a band pass modulated signal.

In analog communication an analog signal is taken, while in digital communication a digital signal or binary data is taken but both are modulated using an analog carrier. A device that performs modulation is known as a modulator and a device that performs the demodulation is known as a demodulator.

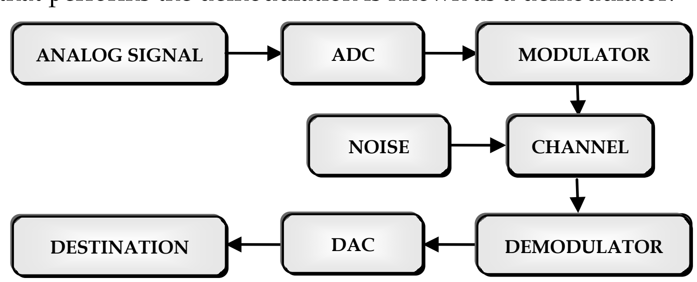

Fig 1. BASIC DIGITAL COMMUNICATION SYSTEM

In the basic digital communication model as shown in Fig1

the first three blocks of the diagram i.e. analog source , Analog to Digital Converter(ADC) and modulator together comprise the transmitter.The source represents the message to be transmitted which includes speech, video, image and text data etc. If the information has been acquired in analog form, it must be converted into digital form to make our communication easier. This analog to digital conversion is done by the ADC block. The modulator converts the digital signal into band pass signal and transmits through the channel.
The last three blocks consisting of detector or demodulator, DAC and destination, form the receiver. The destination data is nothing but the transmitted data.

The digital detector or demodulator reverses the process and extracts the binary baseband information from the received modulated signal which has been subjected to noise, interference and other distortions. The demodulator produces a sequence of binary signal which are same of the transmitted data.

In digital modulation mainly keying techniques, an analog carrier signal is modulated by a binary code. The digital modulator serves as an interface between the transmitter and the channel. The basic types of digital modulation techniques are Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Phase Shift Keying (PSK) respectively.

2.1 BINARY PHASE SHIFT KEYING [BPSK]

In binary phase shift keying the binary symbols 1 and 0 modulate the pulse of the carrier. The BPSK signal may be generated by applying carrier signal to a balanced modulator. The input of balanced modulator is fed by bipolar NRZ level encoder.

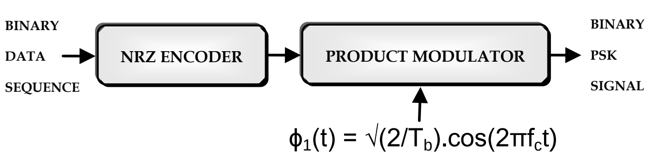

FIG 2. BLOCK DIAGRAM OF BPSK MODULATOR

To detect the original signal a multiplier along with an integrator is needed. The PSK signal is applied to the multiplier and compares the locally generated coherent signal. The multiplier output is compared with threshold of zero volt. If the output of the multiplier is greater than zero then '1' is passed and if the output of multiplier is less than zero then output '0' is passed.

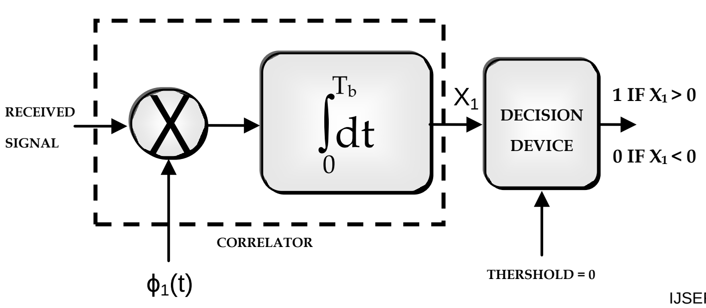

FIG 3. BLOCK DIAGRAM OF BPSK DEMODULATOR

2.1.1 BIT ERROR RATE (BER) OF BPSK

The BER of BPSK is

$$P_e = \tfrac{1}{2}\,\mathrm{erfc}\left(\sqrt{E_b/N_0}\right)$$

As we increase the transmitted signal per energy bit, E_b, for a specified noise spectral density N_0, the message points corresponding to symbols 1 and 0 move further apart, and the average probability of error P_e is correspondingly reduced in accordance with the above equation.

2.1.2 BER ANALYSIS

There are many factors that are involved in selection of perfect modulation scheme. The BER is the most important one, which is directly involved with the SNR. The BER vs. SNR relationship curve describes the performance of modulation scheme. The bit error rate also defines the number of error bits in transmitted signal while a perfect SNR value is set in A

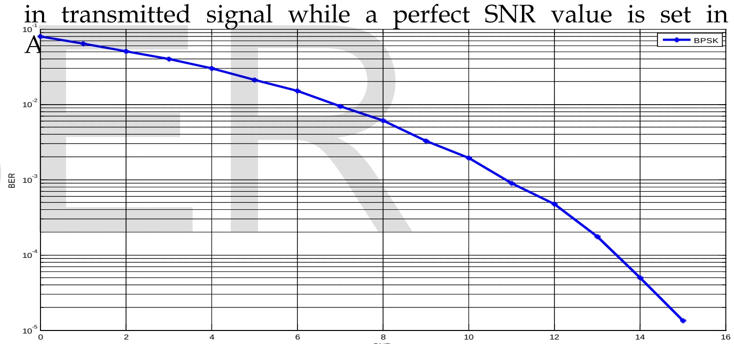

FIG 4. BER vs SNR PLOT OF BPSK IN 16 db

In X axis the SNR is plotted and in Y axis the BER is plotted. Here the SNR value is set as 16 db which is known as ultimate threshold value set by the industry. Measurement of the bit error ratio helps to choose the appropriate forward error correction codes. Since most such codes correct only bit-flips, but not bit-insertions or bit-deletions, the Hamming distance metric is the appropriate way to measure the number of bit errors. Many FEC coders can continuously measure the current BER.
A more general way of measuring the number of bit errors is the Levenshtein distance. The Levenshtein distance measurement is more appropriate for measuring raw channel performance before frame synchronization, and when using error correction codes designed to correct bit-insertions and bit-deletions, such as Marker Codes and Watermark Codes.

2.2 BINARY FREQUENCY SHIFT KEYING [BFSK]

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Frequency shift keying is a frequency modulated scheme in which digital information is transmitted with the instantaneous changes of carrier frequency. BFSK uses two orthogonal frequencies to represent 0 and 1. In this scheme the 1 is called mark frequency and 0 is called space frequency.

2.2.1 MODULATION

The BFSK signal is generated in following process.The binary data is fed in the encoder, and the output of the encoder is used as the input of the product modulator where the two sinousoidal carriers are used as the two another inputs of the product modulator.

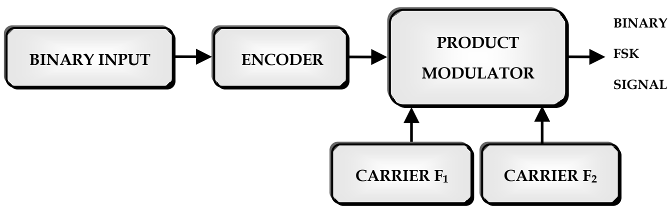

FIG 5. BFSK MODULATOR

2.2.2 DEMODULATION

There are different methods of demodulating FSK. It can be classified into synchronous (coherent) or asynchronous (non-coherent).

- **ASYNCHRONOUS**

The BFSK signal can be demodulated using Envelope detector. The FSK signal has been separated by using two Band pass filters, tuned as Mark and Space frequency.

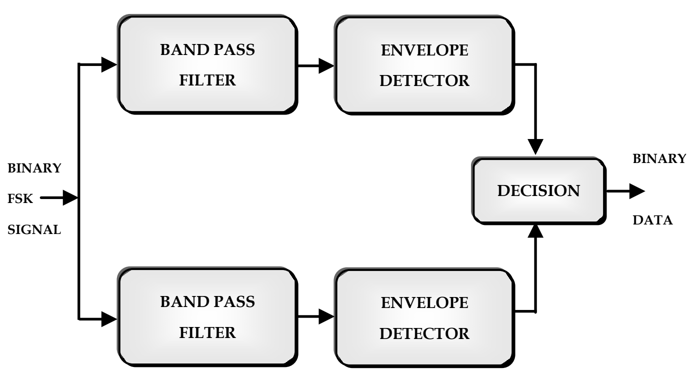

FIG 6. BFSK ASYNCHRONOUS DEMODULATOR

In the decision circuit, where the outputs of two envelope detectors are presented, it selects the output from the two inputs which is most likely one of those two inputs.

- **SYNCHRONOUS**

In the block diagram two local carriers are used to produce two different frequencies for the Product modulators in Synchronous demodulator. Then the signals pass through Band pass Filters. A decision circuit examines the two outputs, and decides which is the most likely. This is, in effect, a two channel receiver.

The bandwidth of each is dependent on the message bit rate. There will be a minimum frequency separation required of the two tones. This demodulator is more complex than the asynchronous demodulators.

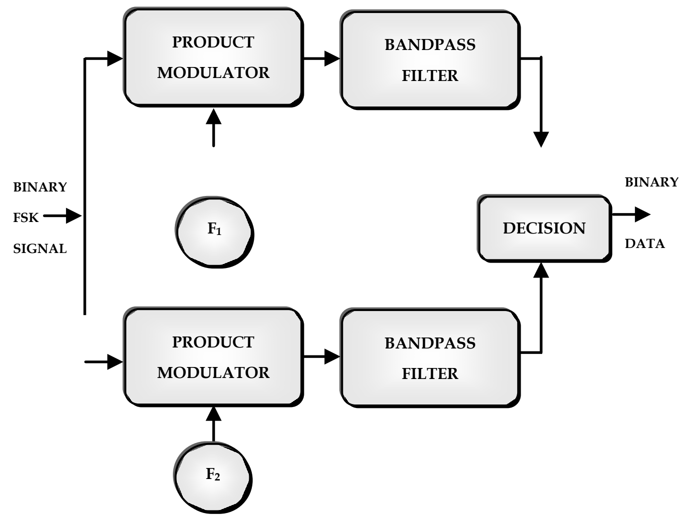

FIG 7. BFSK SYNCHRONOUS DEMODULATOR

2.2.3 BIT ERROR RATE (BER) OF BFSK

Using similar mathematical formula used for BPSK, BER can be found but the distance between the two signals here is reduced by half, so that the error probability of BFSK becomes

$$P_e = ½\mathrm{erfc}\left(\sqrt{E_b/2N_0}\right)$$

For obtaining the same BER of BPSK the BFSK requires 3 db more E_b/N_0. The BPSK is less erroneous than BFSK.

2.2.4 BER ANALYSIS

In the figure below the 16 db BFSK is slightly different from BPSK. Comparing these two diagrams, it is observed that there are few differences between two modulation schemes.

The SNR value is set in AWGN channel, which is directly involved with the BER. In BFSK the two orthogonal frequencies are used, instead of that the noise immunity is slightly less tha

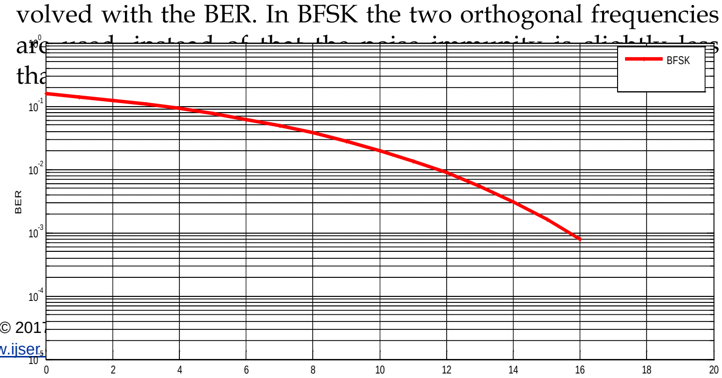

FIG 7. BER vs SNR PLOT OF BFSK IN 16 db

3 COMPARISONS OF BPSK AND BFSK

The figures below show the characteristics of BER vs. SNR curves. The BER is the number of bit errors, which is divided by the total numbers of transmitted bit during transmission. These plots summarize the theoretical BER for Different values of SNR in terms of BPSK and BFSK modulation.

The performances of all modulation techniques are more or less similar but for high SNR values, the BPSK holds better performance than others.

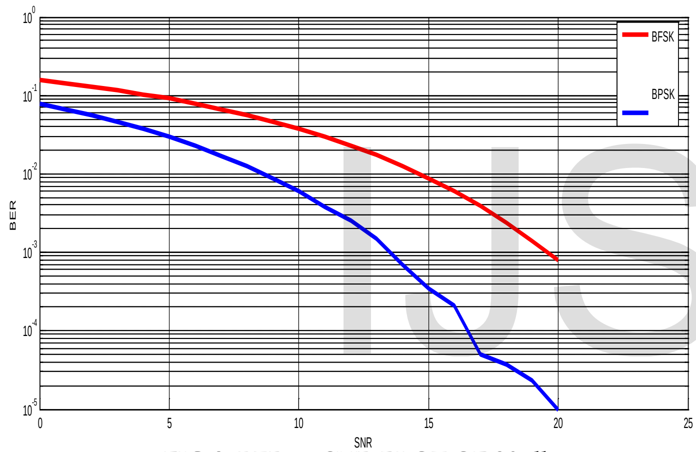

FIG 8. BER vs SNR PLOT OF 20 db

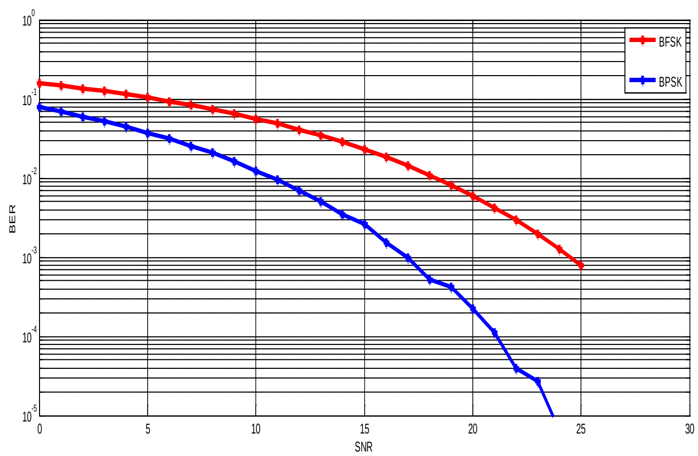

FIG 10. BER vs SNR PLOT OF 25 db

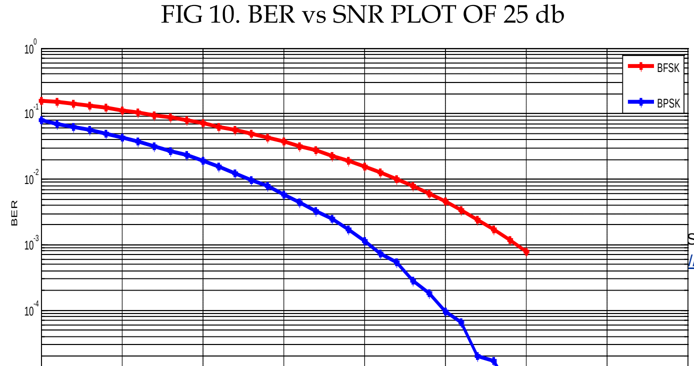

FIG 11. BER vs SNR PLOT OF 30 db

From these plots we observed that in 20 db the BER is almost same, but for 25 db and 30db, the BER of BPSK is slightly less than the BER of BFSK. So, for high SNR value the BPSK holds better noise immunity than BFSK.

4 SIMULINK MODEL

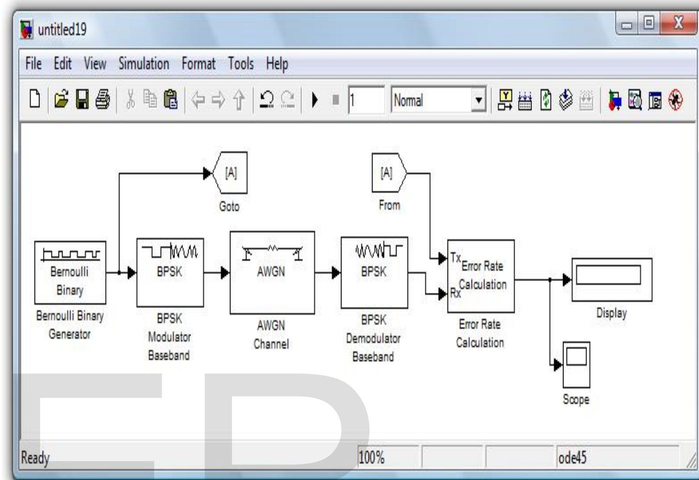

FIG 12. BPSK BLOCK DIAGRAM USING AWGN CHANNEL

This is the block diagram of BFSK in AWGN channel using MATLAB SIMULINK. Here Bernouli binary generator acts as a binary source. Then the signal is modulated in BPSK scheme, and then it passes through an AWGN channel, where the SNR value is set. After passing through the channel the signal is fed in BPSK demodulator. After demodulator the error rate calculation block is connected, where the errors are eliminated. Then we can get back the original signal.

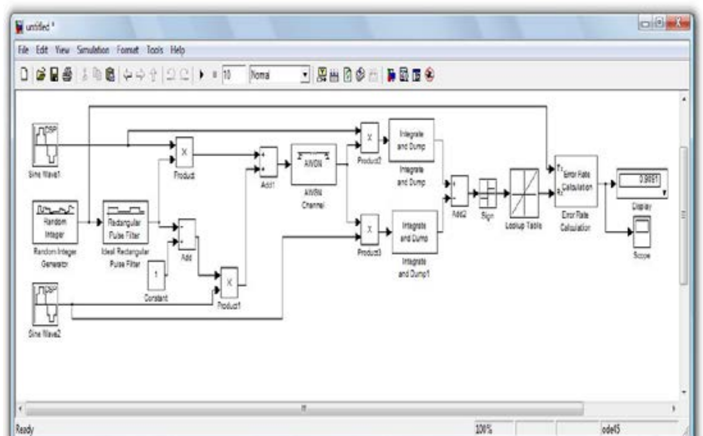

FIG 13. BFSK BLOCK DIAGRAM USING AWGN CHANNEL

In this figure the two orthogonal sine waves are taken which are discrete in nature. After that a random integer is taken which is connected to an ideal rectangular pulse filter, then using the the BFSK modulation scheme the modulated signal is transmitted through AWGN channel. After passing through the AWGN channel the noisy signal is demodulated by using integrate and dump filter. Then it passes through error rate calculation block where the errors are rectified. In this block the signal is compared with a random integer. If the upcoming signal is greater than the integer value then the 1 is passed, else 0 is passed.

5 RESULTS

Here the SNR vs BER plottring has been performed using MATLAB and the model is created in MATLAB SIMULINK. In the code, the BER value has been compared by using a particular SNR value. In the SIMULINK the design contains modulator, AWGN channel, error rate calculation block, few operator blocks and scope. Hence the operation has explained.

6 CONCLUSION

The aim of the paper is to compare the two modulation schemes BPSK and BFSK. Using BER we can compare the characterictics of both the modulation schemes. At first we have used MATLAB code for BER, and then we have used SIMULINK to generate blockwise result. After observing both the characteristics we can draw conclusion that BPSK is better than BFSK through AWGN channel with respect to a specific SNR.

7 ACKNOWLEDGEMENT

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