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# BER AND SNR ENHANCEMENT ANALYSIS OF BPSK MODULATION TECHNIQUE WITH AWGN CHANNEL

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## ABSTRACT

Now-a-days the requirements the increase in the number of wireless devices and the requirement for higher data rates places an increasing demand on bandwidth. The advance generation of wireless communication systems faces the demand for increased higher mobility data rates, larger carrier frequencies, and more link reliability. Wireless channels are characterized by diversity, fading, multipath, limited bandwidth, and frequency and time variant, time invariant selectivity which make system design a challenges. This necessitates the need for communication systems with increased throughput and capacity. The requirements of wireless communication are to have high voice quality, high data rates, high voice quality multimedia features, lightweight communication devices etc. But the wireless communication channel suffers from much impairment. One of them is fading which is due to the effect of multiple propagation paths, and the rapid movement mobile communication devices. In a typical wireless communication atmosphere, multiple propagation paths often exist from a transmitter to a receiver due to scattering by different objects. Signal copies following different paths can undergo different attenuation, distortions, delays and phase shifts. Thus this is necessary to reduce the difficulty of fading, but not at the cost of additional bandwidth. One efficient solution is proposed for wireless system named diversity, without the requirement of extra bandwidth. This thesis deals with the BPSK modulation and AWGN channel to overcome the effect of fading

diversity is used at the transmitter to get good signal at the receiver diversity. This technique is used to improve the performance of the radio channel.

**KEYWORDS:** Fading, Diversity, Fading channels, Combining techniques, Wireless Communications.

## INTRODUCTION

During the last decades, wireless communications have advanced at an incredible pace. The first example which changes our life-style is the mobile phone and internet. Mobile phones have evolved from the simple phones for voice-calling in 1970s to present smart-phones with computer-like functionality. The second example is wireless local area networks (WLAN), the so-called WiFi. Equipped with a WLAN device, a laptop or desktop computer can connect easily to the Internet without the use of wires. As WLAN devices have been installed in many personal computers, video game consoles, mobile phones, printers, and other peripherals, and virtually all laptop or palm-sized computers and television. The third example is the Global Positioning System (GPS), a space-based global navigation satellite system which provides reliable location and time information in all weather and at all times and anywhere on or near the Earth. With the navigation of GPS, we can drive easily in any cities. GPS has become a useful tool for map-making, land surveying, commerce, scientific uses, tracking and surveillance, and hobbies such as geo-caching and way-marking.

The basic concept of a wireless communication system is almost deceptively easy to understand. An electromagnetic signal is created, modulated, amplified, and broadcast to one or more receivers that can be fixed or mobile. The data in that signal is received and demodulated in order to recover the original information that was sent. A basic system will normally consist of a transmitter, receiver, and a channel (i.e. radio frequency) that utilizes different carrier frequencies for each baseband (information signal) that is transmitted. The basic issues that one must address in the design of wireless systems are common to all of telecommunications, namely the effective use of the available frequency spectrum and power to provide high-quality communications. Some wireless systems often involve mobile services; this implies a constantly changing environment with rapidly changing interference conditions and dynamically variable multi-path reflections. This condition, plus the potential of conflicting demands for the use of radio frequencies in a free-space medium, means difficult challenges for creating high-quality signals.

## DIGITAL COMMUNICATION SYSTEMS

**Figure 1** illustrates a general block diagram for a digital communication system. In this diagram, digital data from a source are encoded and modulated for transmission over a channel. At the other side, the data are extracted by demodulation, decoding, and then sent to a sink. The encoder can be divided into two blocks, namely the source encoder and the channel encoder.

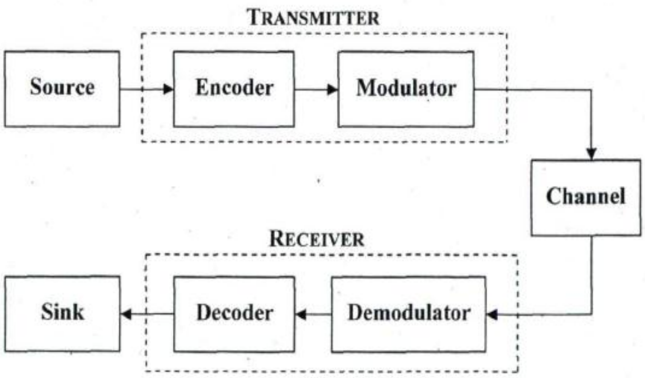


**Figure 1: Block diagram of a digital communication system.**

In some digital communication systems, channel coding and modulation are combined together; this is called coded modulation. In general, there are two main constraints in communication systems, the available spectrum (or bandwidth) and the power required for data transmission. The bandwidth is becoming a rare commodity with the demand of high speed and high quality of service (QoS) for wireless communications. In this paper M-ary phase shift keying (M-PSK) used for improving BER performances.

## III. BINARY SHIFT KEYING (BPSK)

In BPSK digital modulation scheme is referred as the simplest form of phase modulation and in this scheme only two phase states are represented by the the carrier phase. A Coherent BPSK system is characterized by having a one dimensional signal space with a constellation diagram consisting of two message points.whereas its BER performance is significantly worse than BPSK since in the signal constellation the signals are packed more closely.

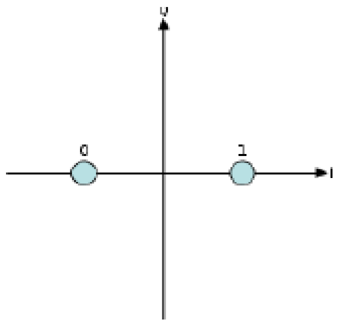


**Fig. 3: Constellation diagram of BPSK.**

The two phases which are separated by 180 degree and can also be referred as 2-PSK. In BPSK, a single carrier is modulated by controlling its polarity according to the binary data signal to be transmitted. The magnitude of the modulated BPSK signal is kept constant, thus increasing the maximum power to be delivered.

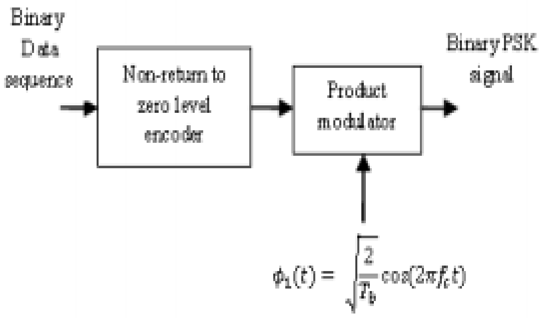


**Fig. 4: BPSK modulator.**

To produce a BPSK signal, the binary sequence in polar form with symbol 1 and 0 are represented by fixed magnitude levels of + (Eb)1/2 and - (Eb)1/2 respectively. The resulting binary wave in polar form and a sinusoidal carrier ϕ1(t), whose frequency is given by fc = (n c/T b) for some fixed integer nc are applied to the product modulator. The carrier and timing pulses used to obtain the binary wave are generally extracted from a common master clock. At the output of modulator the desired PSK waveform can be obtained. The BPSK modulator is basically a two positional switch, controlled by the data stream. The high level in data allows 0 phase and the low level in data permits the 180 phase introduced in the output. The prime advantage of Binary Phase Shift Keying is that it provides a suitable modulation format for downlink data transmission in inductive biomedical telemetry systems, because it achieves high data rates and power efficiencies. BPSK modulation is simple to design and less complex when compared to QPSK, which is almost double the complexity of BPSK design. The BPSK digital modulation technique is generally used in the application of high speed data transfer. It is simple in implementation and gives a 3dB power improvement as compared to BASK modulation technique. The BPSK modulation consists of a phase modulation with two possible states of the intermediate frequency by a serialized numerical signal. The Bit error rate (BER) of BPSK in AWGN channel can be estimated as in.

$$P_b = \frac{1}{2} erfc\left(\sqrt{\frac{E_b}{N_o}}\right)$$

**DIVERSITY TECHNIQUES**

Diversity technique is used to decreased the fading effect and improve system performance in fading channels. In this method, we obtain L copies of desired signal through M different channels instead of transmitting and receiving the desired signal through one channel. The main idea here is that some the signal may undergo fading channel but some other signal may not. While some signal might undergo deep fade, we may still be able to obtain enough energy to make right decision on the transmitted symbol from other signals. There is a number of different diversity which is commonly employed in wireless communication systems. Some of them are following:

1. Multipath/frequency diversity.
2. Spatial/space diversity.
3. Temporal/time diversity.
4. Polarization diversity.
5. Angle diversity.
6. Antenna diversity.

**CONCEPTS OF DIVERSITY COMBINING TECHNIQUES**

It is important to combine the uncorrelated faded signals which were obtained from the diversity branches to get proper diversity benefit. The combing system should be in such a manner that improves the performance of the communication system. Diversity combing also increases the signal-to-noise ratio (SNR) or the power of received signal. Mainly, the combining should be applied in reception; however it is also possible to apply in transmission. There are many diversity combining methods available but only three of them are prevalent.

1. Maximal ratio combining (MRC)
2. Equal gain combining (EGC)

3. Selection combining (SC)

The combining processes which use to combine multiple diversity branches in the reception, has two classes such as post-detection combing and pre-detection combining. The signals from diversity branches are combined coherently before detection in pre-detection combining. However, signals are detected individually before combining in post-detection. The performance of communication system is the same for both combining techniques for coherent detection. However, the performance of communication system is better by using pre-detection combining for non-coherent detection. It does mean that there is no effect in performance by the type of combining procedure for the coherent modulation case. The post-detection combining is not complex in non-coherent detection, results very common in use. There is a difference in system performance when used pre-detection combining and post-detection combining for non-coherent detection such as frequency modulation (FM) discriminator or differential detection schemes. Moreover, the terms pre-detection and post-detection are also indicates the time of combining means when the combining is performed, before or after the hard decision.

**Performance Measure of Communication System**

Some key measures of performance related to practical communication system design are as follows:

1. **Signal to noise Ratio (SNR**)*:* It is a vital performance measure of a communication system. This performance measure is usually measured at the output of the receiver and indicates the overall quality of the system. For wireless communication system due to the presence of fading, the instantaneous SNR is a random variable.
2. **Outage Probability:** It is another important measure of performance to calculate the quality of service provided by wireless systems over fading channels and is defined as the probability that SINR falls below a certain threshold.
3. **Average Bit Error Probability (BEP):** It is one of the most informative indicators about the performance of the system. This measure can be obtained by averaging the conditional (on the fading) BEP over fading statistics.
4. **Bit Error Rate (BER):** In digital modulation techniques, due to some noise, interference, and distortion the received bits are altered .So bit error rate is defined as the no of error bits divided by total no of transmitted.

$$\text{Bit Error Rate (BER)} = \frac{\text{No of bits in error}}{\text{Total no of transferred bits}}$$

The performance of modulation is calculated measuring BER with assumption that system is operating with Additive white Gaussian noise. Modulation schemes which are capable of delivering more bits per symbol are more immune to errors caused by noise and interference in the channel. Moreover, errors can be easily produced as the number of users is increased and the mobile terminal is subjected to mobility. Thus, it has driven many researches into the application of higher order modulations.

**STEPS INVOLVED IN THE PROPOSED ALGORITHM**

Steps involved in the proposed system are:

1. At the transmitter Bernoulli binary generator is used to generate binary bits these binary bits are given as input to BPSK modulator. After which the signals are transmitted using antennas (In this work transmitter space diversity is used). These signals are transmitted over Rayleigh Flat fading channel.
2. At the receiver the signals from different transmitting antennas are received and these signals are combined using MRC diversity combining method.
3. The combined output is then given to BPSK demodulator.
4. BER is calculated for the received bits.

From the simulation diagram (figure 2) it is can be seen that on the transmitter side there is a Bernoulli binary generator, which generated binary bits. These binary bits are given to M ary phase shift keying modulator. After modulation these bits are transmitted through L antenna channels (Transmitter space diversity is used). At the receiver outputs from L antennas are combined using Maximal Ratio Combining (MRC), after that MRC output is given to BPSK demodulator. Bit Error Rate (BER) is computed for the proposed system.

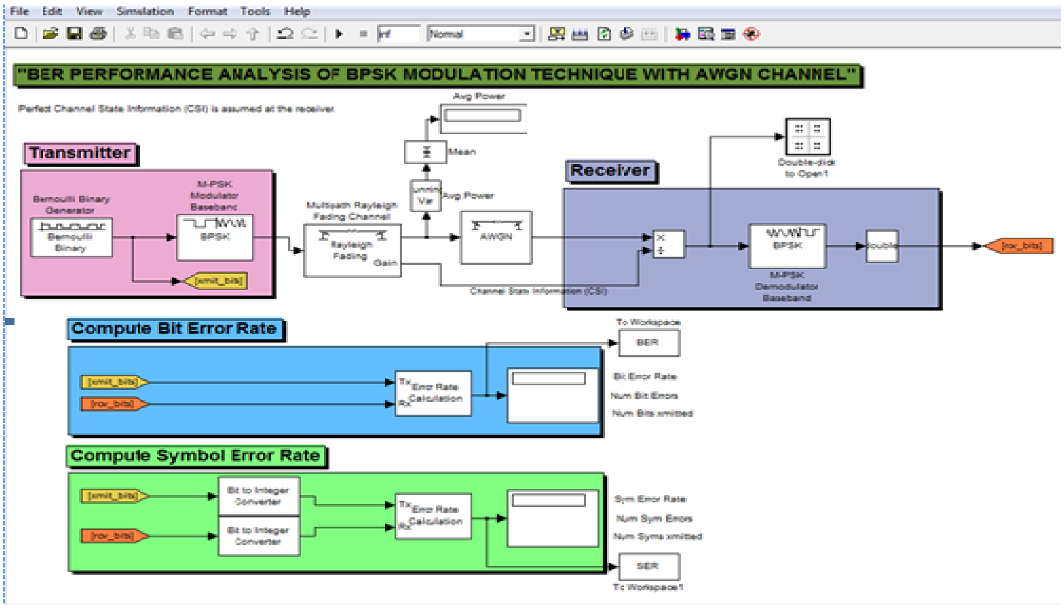


**Figure 2: Simulation flow diagram.**

## SIMULATION RESULTS

The proposed system simulation outputs are as under.

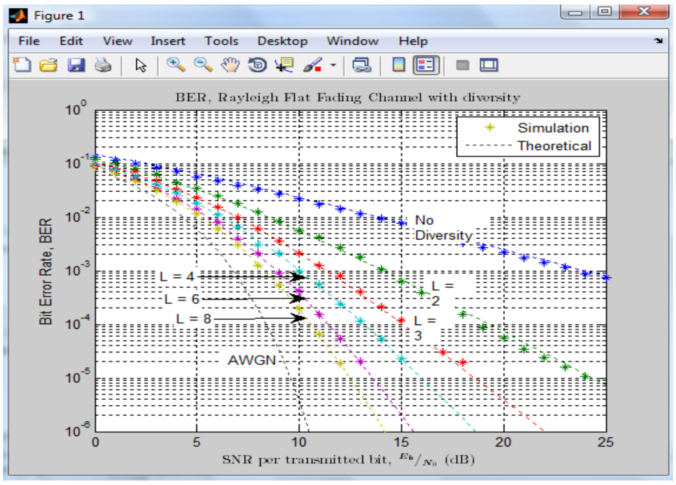


**Figure 3: BER, Rayleigh Flat Fading Channel with Diversity.**

**Table 1: BER obtained for system with no diversity and for the proposed system.**

| SNR per transmitted bit (db) | BER of system no diversity(BPSK) | BER of system with diversity (BPSK) | BPSK (Old method) |
|---|---|---|---|
| 10 | 0.2020800 | 0.1925 | 0.4545 |
| 6 | 0.4457391 | 0.26200 | 0.4545 |

From the table above it can be seen that bit error rate decreases with the increase in the order of diversity. The systems are analysed for the SNR values of 2dB, 4dB, 6dB, 8dB and 10dB.

## CONCLUSION

The objective of this dissertation work is to develop an efficient wireless system based on BPSK by making use of diversity. The proposed system is analysed on Rayleigh flat fading channel using BPSK. Space transmitter diversity is used to reduce the bit error rate. From the results it can be concluded that the proposed system has a better performance (reduced BER) over Rayleigh flat fading channel at SNR of 2dB, 4dB, 6dB, 8dB and 10dB. Diversity of order 2, 3, 4, 6 and 8 are analysed, it can be observed that with the increase in the order of diversity the BER goes on decreasing, but due to some limitations the diversity order can be increased up to a limit and it also depends on the application for which the system is being used.

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