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# Performance Analysis of PSK on Radio Channels

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## Abstract

**Phase Shift Keying (PSK) is a digital modulation technique in which the phase of the carrier signal is varied in accordance with the incoming message signal to modulate it. It is a modulation scheme of great importance for mobile communications due to its high power efficiency and moderate Bit Error Rates (BER). Therefore it is apt to analyze its performance on different radio channels which portray different aspects of a real time channel, in order to understand the practical implications of real time processes. This paper comprises of a performance analysis of BPSK and 8PSK on the various radio channels. These two modulation schemes will be simulated along with the different radio channels. Each modulation scheme will be run with each channel simulation to determine the effect of the channels on the modulation. A comparative study on the effect of the channels on each types of PSK is presented.**

### Keywords

BER, PSK, Radio channel.

## Introduction

Communication in the layman terms is the transmission of information from one point to another. As engineers we have technical terms for the points i.e. the originating point of the message is the transmitter the point where it is received is the receiver, the message send is the data and the data is being send through a channel.

Now, communication systems can be classified into two depending on the type of channel as wired and wireless communication. In wired communication wires carry the information from one point to another whereas in wireless communication the channel is air. In the latter form of communication, due to the absence of a dedicated single path, physical channel a lot of problems creep in which have to be dealt with while considering the designing of such a system. These problems include signal attenuation, inter symbol interference, and fading.

A channel is the medium through which a message is transferred from one point to another. The channels can be classified on the basis of the fading of signals and the nature of noise. According to this classification there are different communication channels like Additive White Gaussian Noise (AWGN) channel, flat fading and frequency selective fading channels, multipath fading channel, Rayleigh fading channel, and so on. Each of these channels will have a different effect on a similar type of input.

BPSK and 8PSK are simulated and applied to different channels like AWGN channel, and fading channels like Rician channel and Rayleigh channel to understand its behaviour. The bit error rate is plotted against signal to noise ratio to get a picture of the physical parameters of the signal.

The bit error rate (BER) of BPSK in AWGN can be written as $P_b = \frac{1}{2}\, erfc\left(\sqrt{\frac{E_b}{N_O}}\right)$

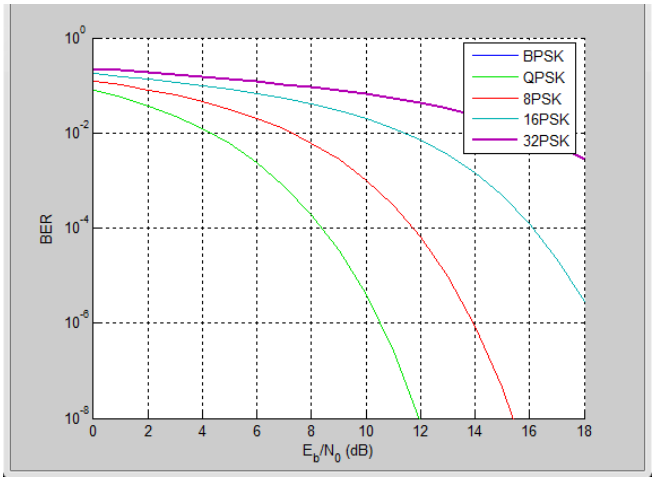
The symbol error rate is the same since there is only one bit per symbol.

This may be approximated for high *M* and high $E_b/N_O$ as $P_s \approx 2Q\left(\sqrt{2\frac{E_s}{N_O}}\sin\frac{\pi}{M}\right)$

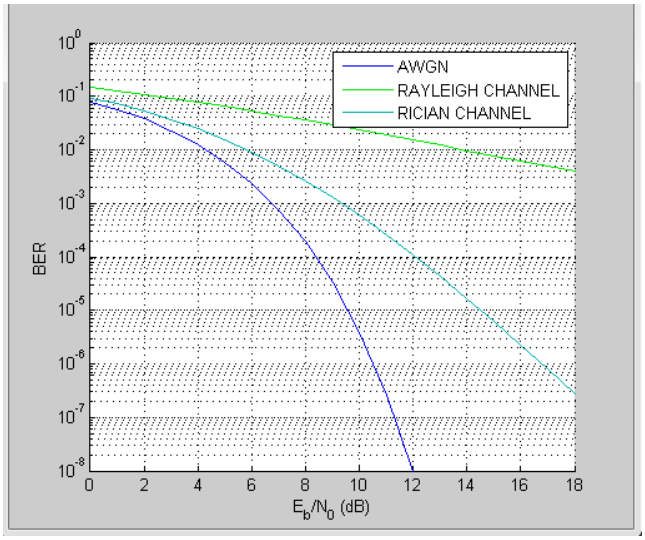
The bit-error probability for $M$-PSK can only be determined exactly once the bit-mapping is known. However, when Gray coding is used, the most probable error from one symbol to the next produces only a single bit-error and $P_b = P_s/M$

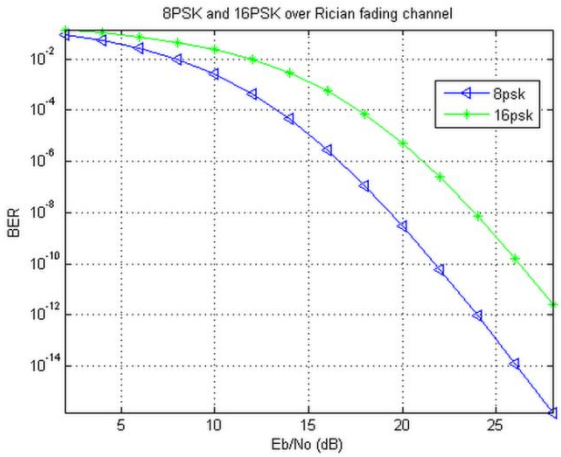
## Results & Discussion

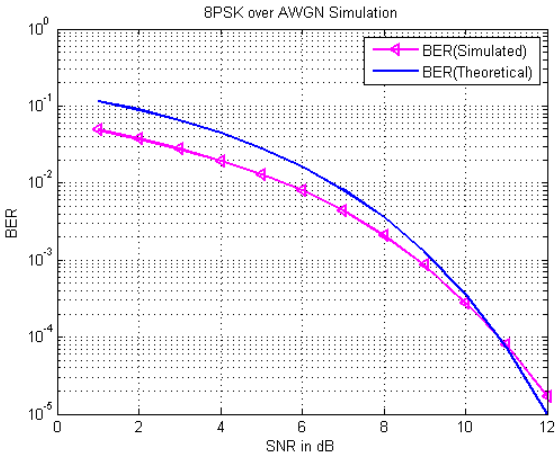
From the results obtained, it can be concluded that as the level of encoding rises in PSK, higher BER is induced in the channel. That is as we move from BPSK to higher order PSKs the BER value is increased as shown in the graph below. This is because in higher order PSKs one symbol itself carries several bits encoded in it. So if one symbol is received in error, several bits can be in error depending on the level of encoding. It is also seen that BPSK and QPSK gives identical performance in terms of BER which makes QPSK the better choice for practical systems as for the same BER performance, it performs encoding also which can be used to reduce the bandwidth required or to double the data rate for a given bandwidth. This observation justifies the use of QPSK in OFDM systems. The graph showing this comparison is included below.

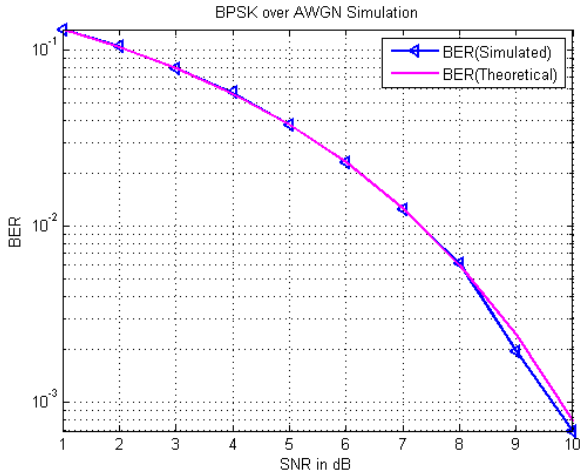



Also AWGN channel induces maximum amount of distortion in a signal while Rayleigh channel induces maximum error due to multipath fading. If a modulation scheme is devised which gives good performance with AWGN and Rayleigh channels, it can perform well in almost all real life situations. Rician and Rayleigh fading channels induce more error in the signal compared to AWGN channel. They differ from each other in terms of line of sight. Since Rician channel involves line of sight communication, it gives a much better performance than Rayleigh channel as seen from the graphs. The performance of Rician channel depends on its diversity order. As diversity order increases, the error rate also increases.


AWGN
RAYLEIGH CHANNEL
RICIAN CHANNEL
BER
$E_b/N_0$ (dB)


8PSK and 16PSK over Rician fading channel
8psk
16psk
BER
Eb/No (dB)


8PSK over AWGN Simulation
BER(Simulated)
BER(Theoretical)
BER
SNR in dB




## Conclusion

The above mentioned modulation schemes are applied in a wide variety of digital communication techniques. The analysis performed is crucial while deciding the modulation that would be used for a particular type of channel. It is also valid in choosing modulation while designing digital systems.

## References

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