Performance of BASK Coherent Detected Signal in an AWGN Channel

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Abstract–Binary Amplitude Shift Keying (BASK) finds application in signal broadcasting and optical fiber communication for laser intensity modulation. It can be detected coherently or non-coherently with the former theoretically offering robust performance. The aim of this paper is to simulate this coherent detected BASK modulated signal using MATLAB and verify its performance using its BER parameter. The simulation is done by integrating MATLAB codes with MATLAB Simulink. Simulation results indicate that the coherently detected BASK signal exhibit the same performance irrespective of the digital input bits. BER was found to decrease with increment in signal to noise ratio indicating a robust performance.
Index Terms - BASK, Coherent Detection, BER, and AWG

I. INTRODUCTION

Communication is the process of transferring information from a source or transmitter to a receiver. To transfer information, the transmitter sends encoded symbols over a communication channel, and the receiver decodes the information to recover the original data [1, 2]. The transmitted signal is first modulated into a format suitable for transmission before being recovered at the receiver via the demodulation process.

In Binary Amplitude Shift Keying (BASK) modulation method, the phase and frequency of the sinusoidal carrier signal are maintained while the amplitude of the signal varies according to the message bits' values ("0" or "1"). In other words, when the message data is 1, the carrier signal is transmitted, and when it is 0, no signal is. The modulated signal in the BASK modulation method is produced by multiplying the bit data by a carrier signal [3, 4].

In reality, communication channels are not free of noise caused by random vibrations of conducting electrons, as well as holes present in the materials used to make the transmitter, channel, and receiver. This noise causes unwanted interference, degrading communication signals and even resulting in signal loss. As a communication designer, it is imperative to purposefully introduce noise into a communication system in order to best prepare for and measure its effect on the system. Additive White Gaussian Noise (AWGN) is a basic and widely accepted noise model that mimics various random processes. The noise is additive, as the name implies, meaning that it is added to a signal. It is white, indicating that the noise has the same power distribution across all frequencies (constant Power Spectral Density) [5]. It is Gaussian because the noise sources are random in nature. Therefore, introduction of AWGN channel in a communication system introduces an average number of errors through the system which help in measuring the system response to noise. Because of the mentioned reasons, the BASK modulated signal is sent through an AWGN channel to the receiver.

The BASK modulated signal can be detected coherently or non-coherently at the receiver. The local carrier wave generated at the receiver is phase locked with the carrier at the transmitter in coherent detection. As a result, both oscillators (carrier waves) are frequency and phase synchronized [6]. The resultant negative effect of this is that the circuitry becomes relatively complex, however, it has the advantage of decreasing the probability of error.

On the other hand, there is no need for the two carriers at the transmitter and receiver to be phased locked in non- coherent (non-synchronous) detection. Thus the system or circuitry becomes simple with an increase in the probability of error.

This paper is concerned with the analysis of the performance of coherent detected BASK modulated signal in an AWGN channel. The simulation is realized by integrating MATLAB codes and Simulink. The performance of the system is evaluated by calculating its bit error rate (BER) [7].

Bit error rate (BER) refers to the ratio of the number of error bits and the total number of bits transmitted. Calculation of the BER value of a transmission enables us to evaluate the performance quality of that system. BER is often calculated in percentage [8]. BER is calculated using equation 1.

$$BER=\frac{\text{Number of Error Bits}}{\text{Total Number of Bits Sent}} \quad (1)$$

Sushmaja and Noorbasha defined BASK using equation 2 [9].

$S(t) = A\, m(t) \cos 2\pi f_c t \;; 0 < t < T$ (2). Where A is a constant, $m(t)$ = 1 or 0, f_c is the carrier frequency and T is the bit duration.

Alternatively, this can be expressed as $S(t) = \begin{cases} A_c \sin 2\pi f_c t & \text{if message data =1} \\ 0 & \text{if message data =0} \end{cases}$

II. METHODOLOGY

The methodology adopted in this research work is described below:

A. Generation of Input Signal

The digital input bits to be transmitted is generated using the randi function. Each individual digit (0 and 1) are mapped using unipolar mapping, it is then converted to NRZ signal as shown in figure 1.

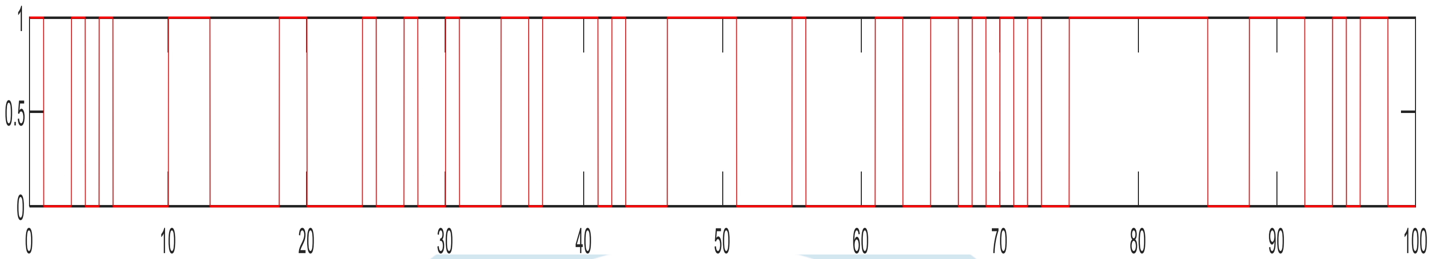


Figure 1: NRZ Signal

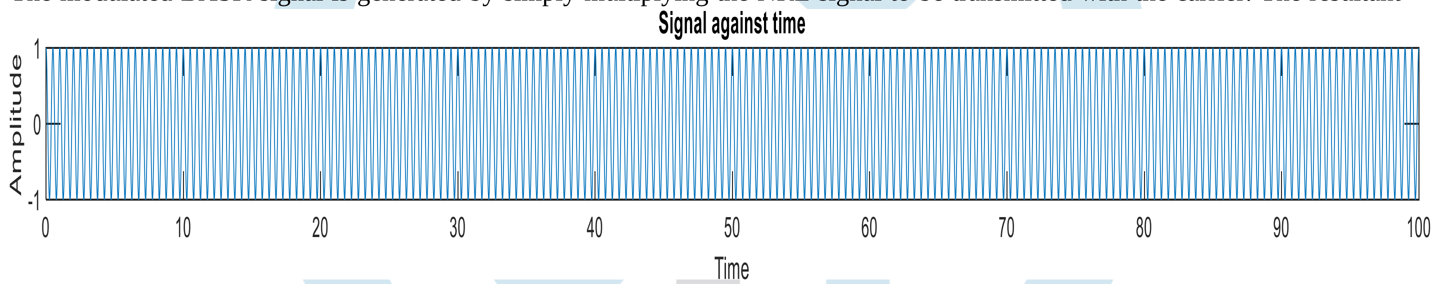
B. Generation of Carrier Wave Form

The carrier waveform whose amplitude is changed in accordance with the information to be transmitted is generated from $C = \cos 4\pi t$. Where t = [0 100] in step of 0.0.1. The generated carrier waveform is shown in figure 2.

Figure 2: Carrier Waveform

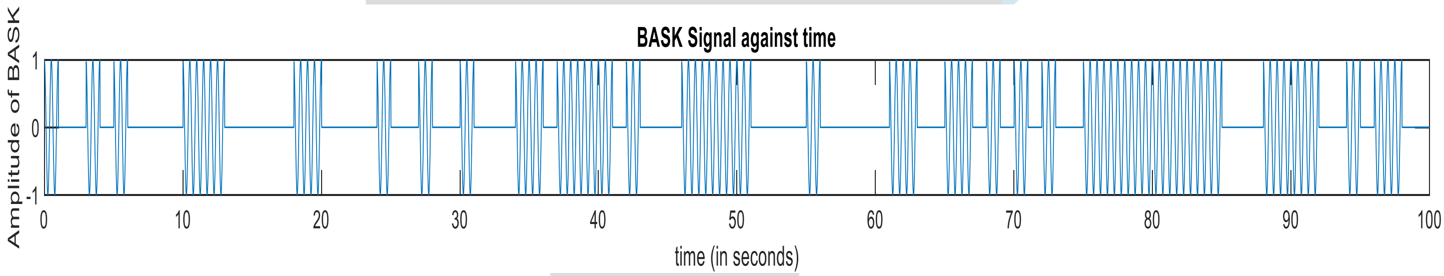
C. Generation of BASK Signal

The modulated BASK signal is generated by simply multiplying the NRZ signal to be transmitted with the carrier. The resultant



BASK signal is shown in figure 3. Close observation of the figure indicates that the carrier wave form is transmitted when the input signal is 1 and no carrier is transmitted when the input signal is 0.

Figure 3: BASK Waveform



D. Addition of AWGN

In order to measure the system response to noise, AWGN is added to the modulated BASK signal and the resultant output waveform is shown in figure 4.

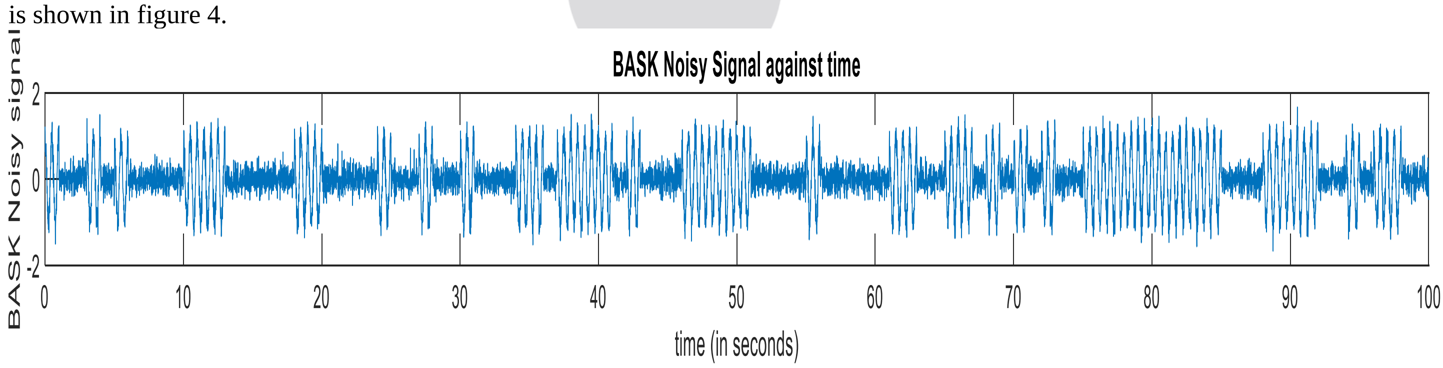
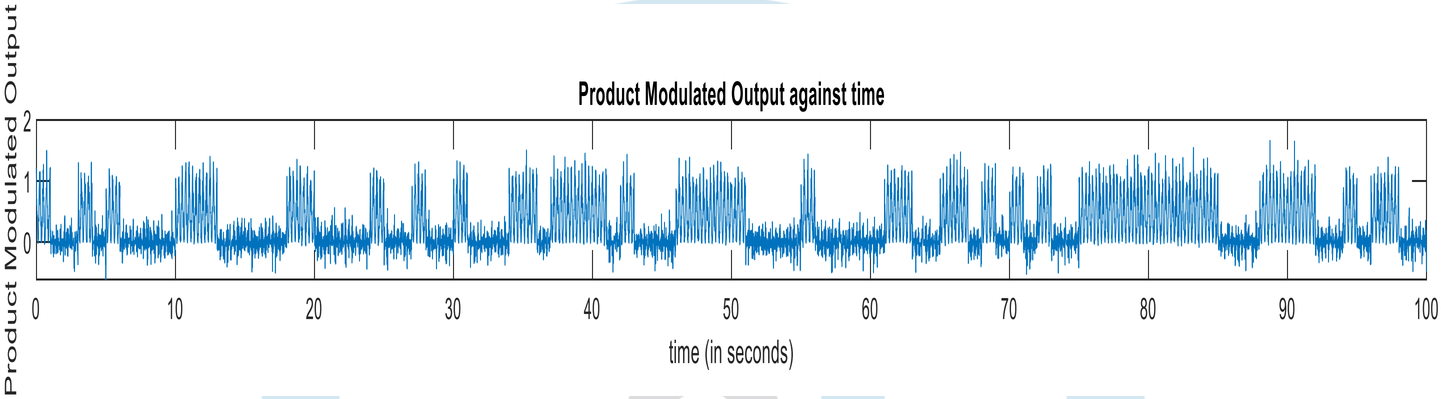


Figure 4: Noise Added to BASK Waveform

E. Coherent Detection

To coherently detect the transmitted noisy BASK signal, a product modulated output (y_1) is formed by multiplying the noisy BASK transmitted signal with a synchronized copy of the carrier at the receiver. The product modulated output with the noise removed is a replica of the transmitted input signal. To remove the noise, the product modulated output is passed through an integrator which function as a low pass filter. The modulated output waveform is shown in figure 5. The output of the integrator implemented using trapezoidal function are the transmitted bits from which the bit error rate (BER) are computed to determine the performance of the Coherent BASK signal in AWGN channel.

Figure 5: Product Modulated Output Waveform



III. RESULT AND DISCUSSION

The results of BER test on the coherent BASK detected signal in the AWGN channel for different values of input bits are displayed in figure 6 to 8.

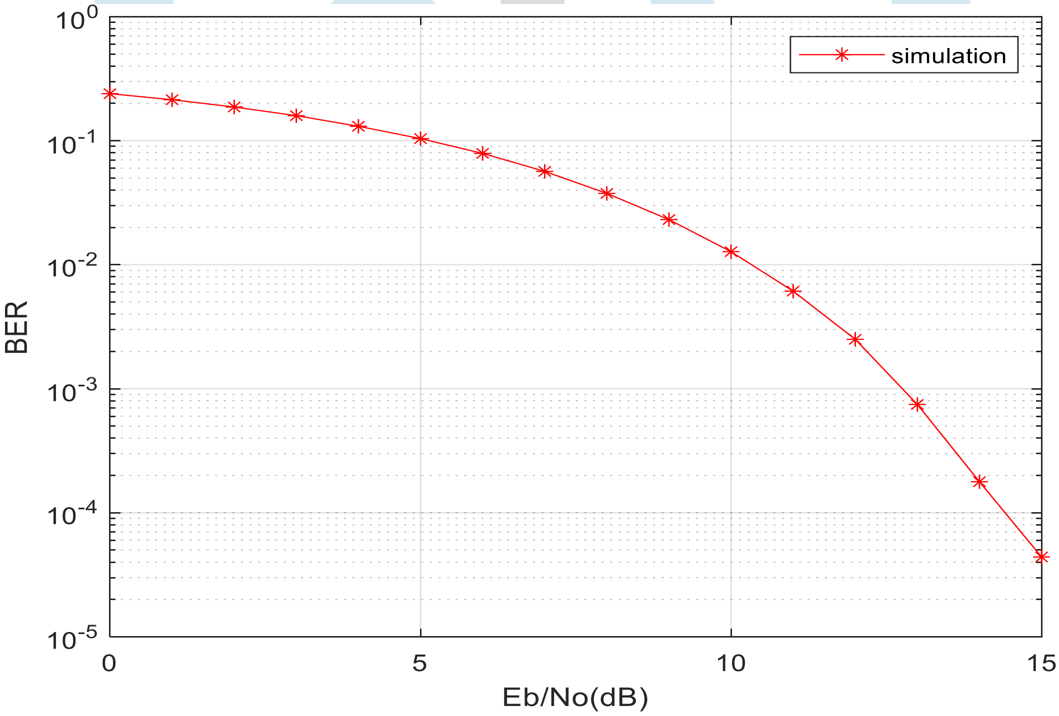


Figure 6: BER vs Eb/No(dB) with N =1000000

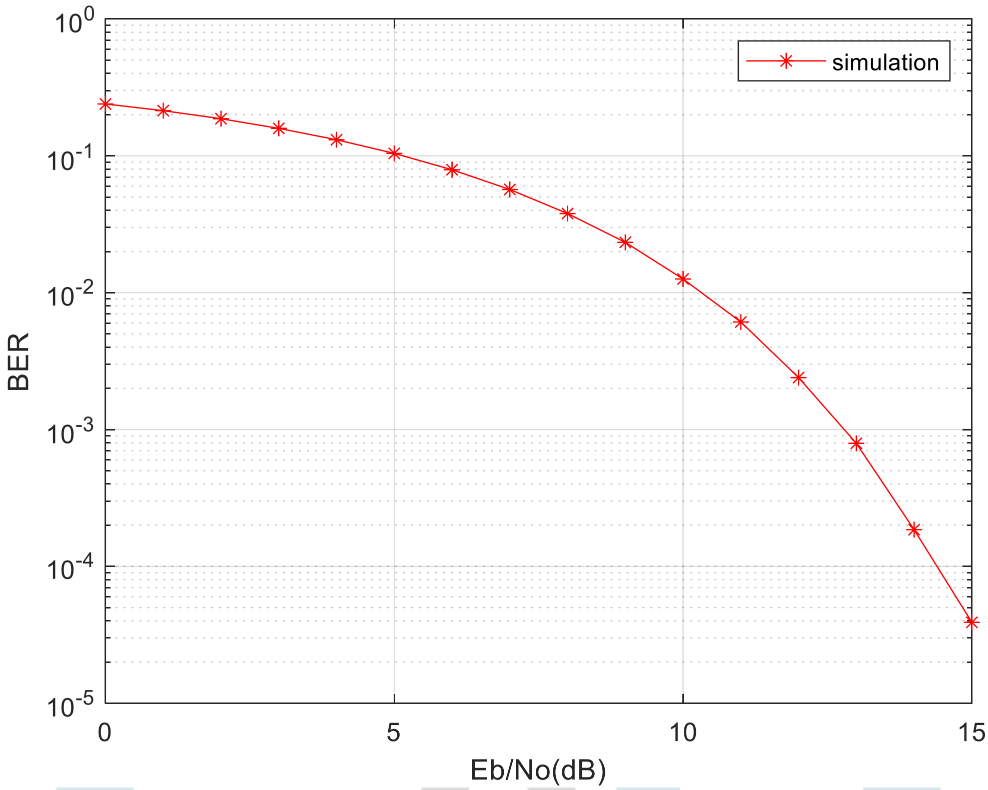


Figure 7: BER vs Eb/No(dB) with N =2000000

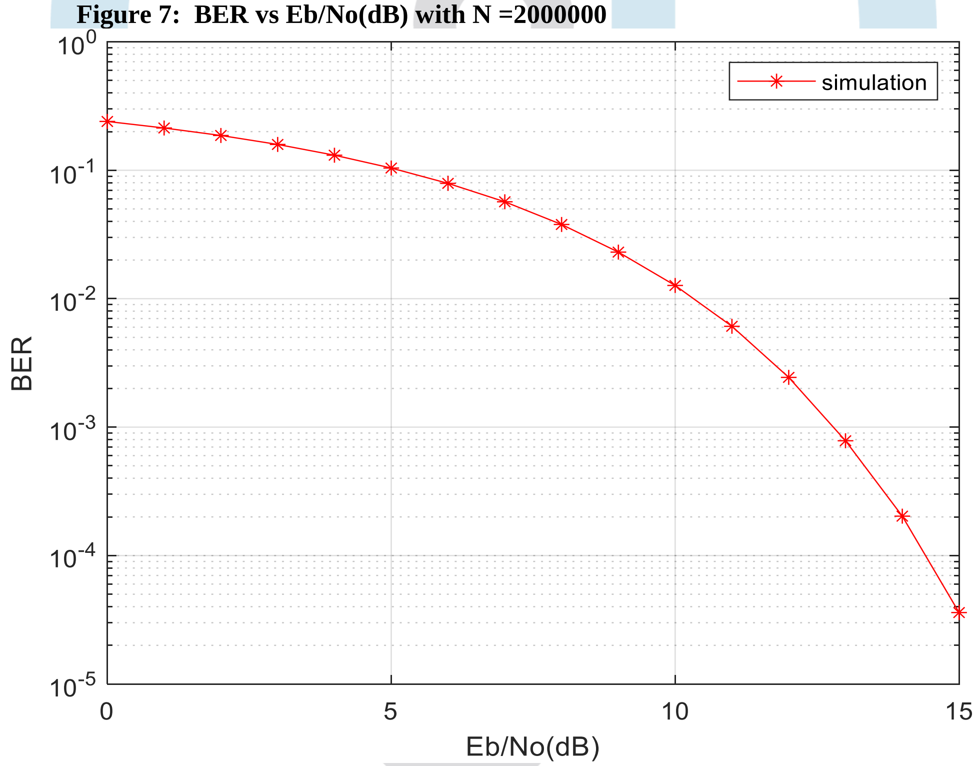


Figure 8: BER vs Eb/No(dB) with N =4000000

From figure 6, 7 and 8, it is evident that same result is obtained for the coherent detected BASK signal irrespective of the number of input digital bits. Similarly, as the signal to noise ratio increases the BER reduces showing the robustness of this detection scheme.

IV. CONCLUSION

Research results clearly indicate that it is efficient in terms of BER performance to coherently detect a BASK modulated transmitted signal.

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