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Review Article

Binary Phase Shift Keying Digital Modulation Technique for Noiseless and Noisy Transmission

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Abstract: This paper focuses on the Binary Phase Shift Keying Digital Modulation Technique for Noiseless and Noisy Transmission with the following objectives:(i) to design a BPSK system (ii) to show the modulation and demodulation of a BPSK technique through a noiseless channel and (iii) to show the modulation and demodulation of the same technique through a noisy channel. A model-based design methodology was employed in this work. The entire idea was modelled in Matlab/Simulink environment. The results obtained after analysis and simulation show good system design and specifications. Demodulated bits will be in error if transmission channel is noisy.

Keywords: BPSK, Digital Modulation, Noisy Transmission, Matlab/Simulink

1. Introduction

Wireless digital communication which has evolved sporadically over the past years is just beginning. Digital data transmission via frequency or phase modulation offers better advantages over amplitude modulation that occurs in analogue system [1-5, 11]. The basic digital Frequency shift keying, Phase shift keying, BPSK, QPSK and QAM. However, the two basic limitation in wireless communications are: (i) Noise and (ii) the bandwidth of frequency allocated for the transmitted signals [6, 7, 11].

Therefore, the objectives of this paper includes: (i) to design a BPSK system using Matlab/Simulink. (ii) to show the modulation and demodulation of a BPSK technique through a noiseless channel. (iii) to show the modulation and demodulation of the same technique through a noisy channel.

2. Theoretical Background

Phase shift keying technique is a method of data transmission in which data causes the phase of the carrier to shift by a predefined amount.It is one of the most efficient ways for data modulation. PSK has three common types, namely: Binary Phase Shift keying (BPSK), Quadrature Phase Shift Keying (QPSK) and 8PSK. if number of allowable phase state (M) is greater than four such technique is referred to as M-ary System and the output signal is called a constellation [8, 11].

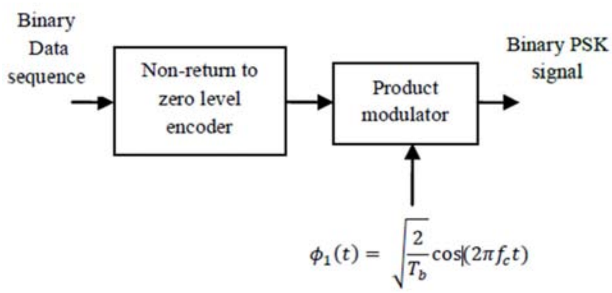

Fig. 1. *BPSK Modulator.*

In BPSK signal the carrier is directly phased modulated, that is, the phase of the carrier is shifted by the incoming binary data. In the generation of BPSK signal the carrier frequency is phase-shifted 180^0. The + and – values are beingfed into 1 of the 2 selector circuit which is driven by the binary data [8, 11].

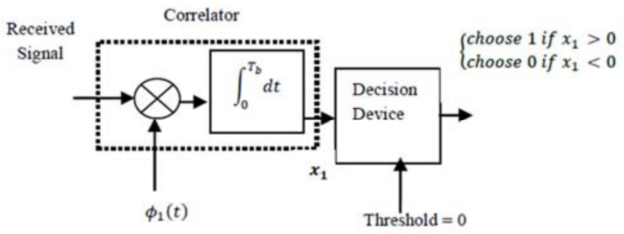

Fig. 2. BPSK Demodulator.

The BPSK receiver detect the phase shift in the received signal. The received signal is fed into the mixer circuit. The other input to the mixer circuit is driven by a reference oscillator synchronized to $Sin(\omega_c t)$. This is known as coherent carrier recovery

Mathematical Expressions

Binary symbols are represented by a pair of signals $s_1(t)$ and $s_2(t)$ in coherent binary PSK system. They are defined by the following expressions.

$$S_1(t) = \sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c t), \text{ for binary } 0 \quad (1)$$

$$S_2(t) = \sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c t + \pi) = -\sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c t) \quad \text{for binary } 1 \quad (2)$$

Where 0 ≤ t ≤ Tb, and Eb is the signal transmitted energy per bit, where fc is the frequency of the carrier wave. Antipodal signals space can be represented by the single basis function.

$$\varphi_1(t) = \sqrt{\frac{2}{T_b}}\cos(2\pi f_c t), \text{ where } 0 \le t < Tb \quad (3)$$

Where 1 is represented by $\sqrt{E_b}\varphi_1(t)$ and 0 is represented by - $\sqrt{E_b}\varphi_1(t)$

A coherent binary PSK system is therefore characterized by having a signal space that is one dimensional (i.e., N =1), with a signal constellation consisting of two message points (i.e., M = 2). The co-ordinates of the message points are

$$S_{11} = \int_0^{T_b} S_1(t)\varphi_1(t)dt = \sqrt{E_b}$$

and

$$S_{21} = \int_0^{T_b} S_2(t)\varphi_1(t)dt = -\sqrt{E_b}$$

3. Computer-Based Design Methodology

Simulink opens with the Library Browser. The Library Browser is used to build simulation models; and it contains the following Block Sets: Continuous Elements, Discontinuous Elements, Maths Operation Elements, Signal Routing, Source Models, Sink Models, Additional Linear Elements etc.[9-10].Some of the block sets are shown in Fig.3 and Fig.4

3.1. Designed –Model BPSK Technique for Noiseless Transmission

The design-steps for the Simulink model in Fig 5. are as follow:

a The simulation start time is set to 0.0 and the stop time is set to 999999.
b Select all the blocks from Simulink block library browser.
c The message signal is generated using a uniform random number generator which acts as the binary data source.
d The uniform random number generator and is found in Simulink/Sources and the parameters are set to: Min (-1), Max (1), seed (0), sample time (1)
e The direct lookup table (n-D) is found in the Simulink/lookup table library. block parameters settings: The number of table dimensions is changed to 1, table data: [-1 0 1: -1 1 1].sample time as 1.

Modulation settings:

The first carrier signal of the BPSK is generated using an fcn block with the parameters set to cos(4*pi*u). The input time variable u, a product block, a scope (scope 3) to view the resulting signal were also connected

Demodulation Settings:

The second carrier signal of the BPSK is generated using another fcn block which is set to 2*cos(4*pi*u). The input time variable u, a product block, a scope (scope 3) to view the resulting signal were also connected.

3.2. Designed –Model BPSK Technique for Noisy Transmission

The BPSK with additive white Gaussian noise channel (AWGN) and matching filter Simulink model is shown in Fig.6.

The additional blocks include: An additive white Gaussian noise channel (AWGN) and integrator block is found in the Simulink/Continuous library. The reset signal for the integrator is generated by the pulse generator. The pulse generator parameters are set to: Amplitude (1), period (1), pulse width (50), phase delay (0).

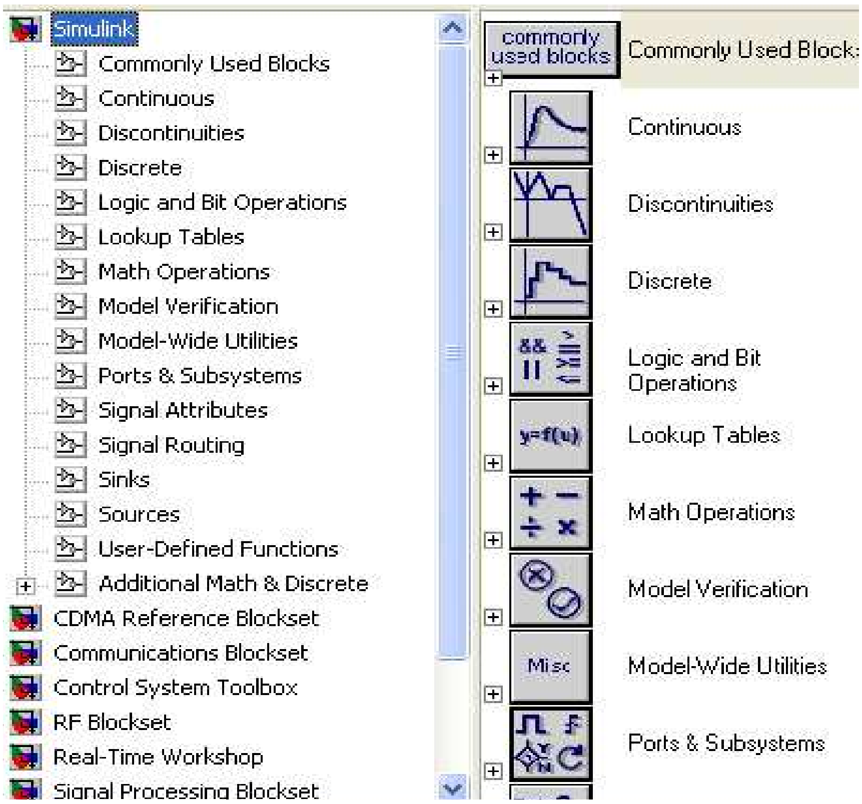

Fig. 3. *Library Browser.*

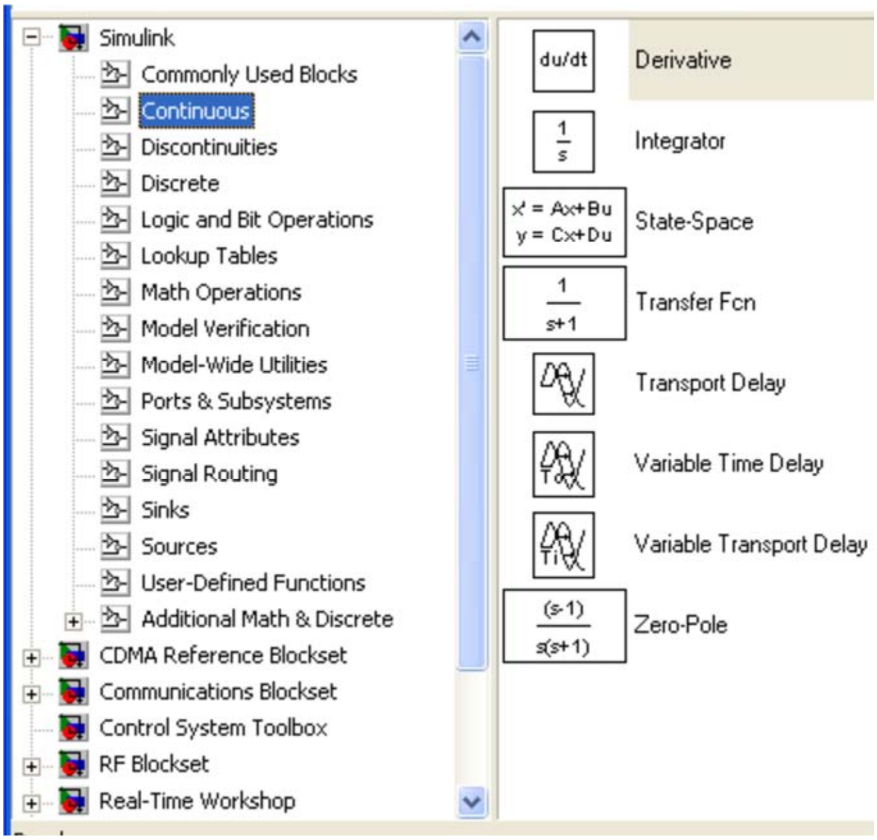

Fig. 4. *Continuous Elements.*

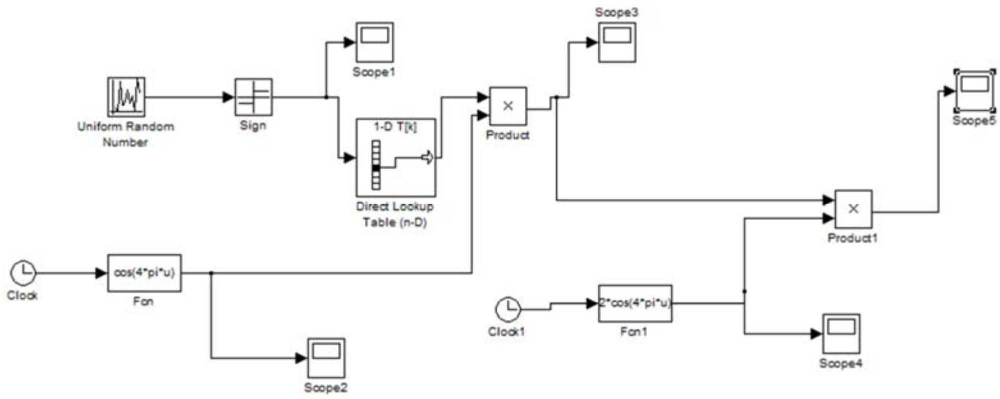

Fig. 5. BPSK technique for noiseless transmission Simulink model.

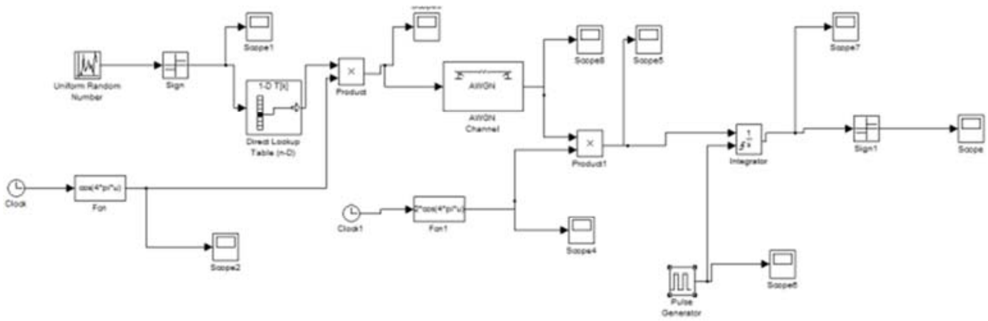

Fig. 6. BPSK with additive white Gaussian noise channel (AWGN) and matching filter Simulink model.

4. Results and Discussions

Simulation for Binary Phase Shift Keying with a noisy and a noiseless channel were performed on the Simulink and the following parameters obtained.

4.1. For a Noiseless Transmission of the BPSK Signal

a At sample time = 0 for carrier 1 (cos(4*pi*u)) and carrier 2 (2*cos(4*pi*u))

- The first carrier signal used during modulation was a sinusoidal wave.
- The second carrier used during demodulation is a sinusoidal wave and its amplitude is from -2 to 2
- The modulated signal is a sinusoidal wave with an amplitude from -1 to 1 and a duration of 10. It is shown in scope 3.
- The demodulated signal is a sinusoidal wave with and amplitude from -2 to 0.2.

Because the resulting signal after modulation is a sinusoidal wave this means no sampling took place as the sample time of the carriers are 0.

b At sample time=1 for carrier 1 (cos(4*pi*u)) and carrier 2 (2*cos(4*pi*u))

- The both carrier signals are square waves because sampling occurred.
- The modulated and demodulated resulting signals are square waves. The duration and the position of the signals remains the same but the amplitude changes.

c As the sample time of both carriers increases the modulation and demodulation signal remains a square wave there is little or no difference when the sample time changes for both the carrier signals.

This means that as sampling time increases for the carrier waves, BPSK modulation and demodulation signal remains the same.This means that between the transmitter and the receiver, no noise or channel fading occurred within the channel. See results in Fig. 7 to Fig. 12.

*4.1.1. Increasing the Carrier Signal1 (cos(4*pi*u))*

The first carrier signal is increased to see what the variation would result in. table 1 shows the amplitude of the modulation signal and the demodulation signal as the carrier signal is varied.

The table 1 shows that the modulation and the demodulation amplitude increases as the carrier signal1 increases. The modulation amplitude increases by multiples of 1 while the demodulation amplitude increases by multiples of 2.

*4.1.2. Increasing Carrier Signal2(2*cos(4*pi*u))*

The second carrier signal is increased to see the resulting amplitude of the modulation signal and the demodulation signal. This is seen in table 2.

The amplitude of the resulting modulating signal does not change and remains unaffected by thechange in the carrier signal2. But the amplitude of the resulting demodulating signal changes as the carrier signal2 changes.

4.1.3.Varying the Seed of the Uniform Random Number Generator

If the seed of the uniform random number generator is changed. It can be seen that the signal waveforms for the modulated and demodulated signal does not change very much except in the position.

The variations in the seed value of the uniform random number generator results in different resulting signals for the modulated signal and the demodulated signal. The pulse and the duration of the signal remains constant but the amplitude changes as the seed value varies.

4.2. For a Noisy Transmission of the BPSK Signal

An AWGN channel was added between the modulator and the demodulator. This AWGN is used to represent thermal noise generated by electrical instruments.

Table 1. *Increasing the carrier signal1 (cos(4*pi*u)).*

Carrier signal1(cos(4*pi*u))	Modulation amplitude	Demodulation amplitude
cos (4*pi*u)	1	2
2*cos (4*pi*u)	2	4
3*cos (4*pi*u)	3	6
4*cos (4*pi*u)	4	8
5*cos (4*pi*u)	5	10
6*cos (4*pi*u)	6	12
7*cos (4*pi*u)	7	14
8*cos (4*pi*u)	8	16
9*cos (4*pi*u)	9	18
10*cos (4*pi*u)	10	20

Table 2. *Increasing carrier signal2(2*cos(4*pi*u)).*

Carrier signal2(2*cos(4*pi*u))	Modulation amplitude	Demodulation amplitude
cos (4*pi*u)	1	1
2*cos (4*pi*u)	1	2
3*cos (4*pi*u)	1	3
4*cos (4*pi*u)	1	4
5*cos (4*pi*u)	1	5
6*cos (4*pi*u)	1	6
7*cos (4*pi*u)	1	7
8*cos (4*pi*u)	1	8
9*cos (4*pi*u)	1	9
10*cos (4*pi*u)	1	10

When seed = 1

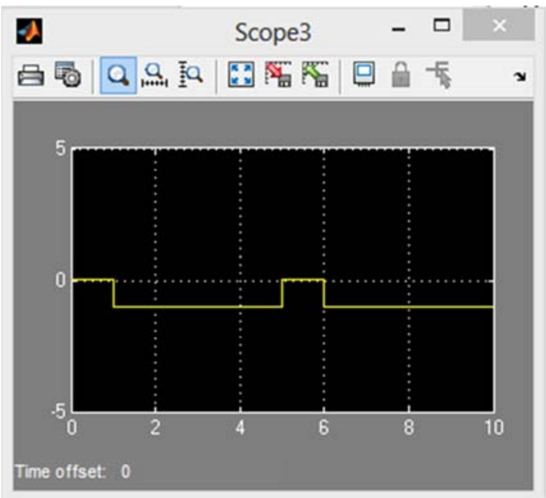

Fig. 7. *Modulation Signal, when seed=1.*

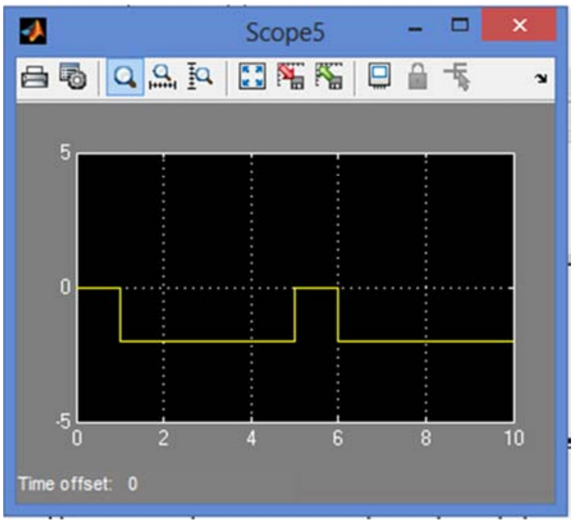

Fig. 8. *Demodulation Signal when seed=1.*

When seed = 2

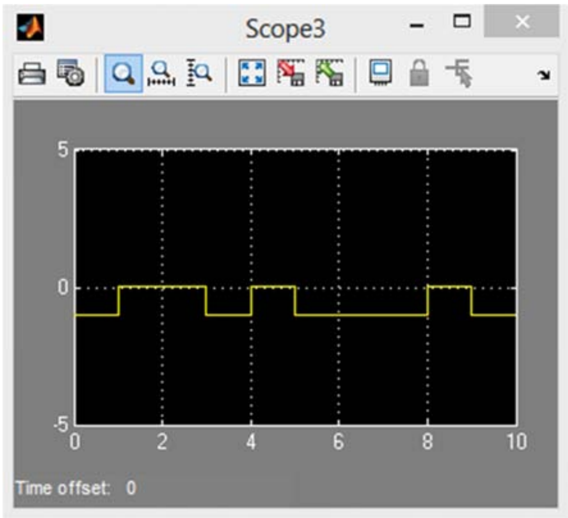

Fig. 9. *Modulation Signal, when seed=2.*

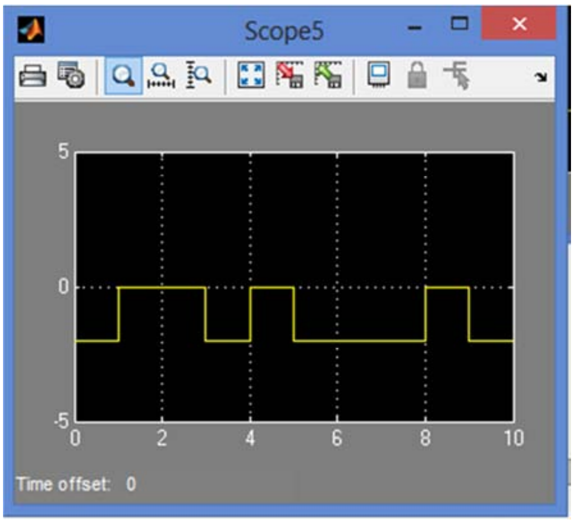

Fig. 10. *Demodulation Signal when seed=2.*

When seed = 3

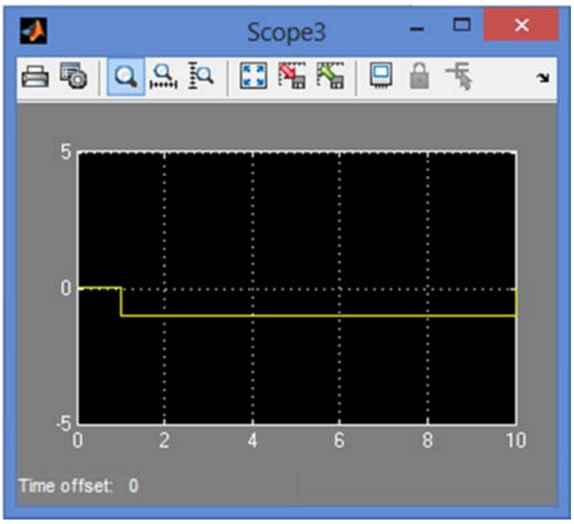

Fig. 11. *Modulation Signal, when seed=3.*

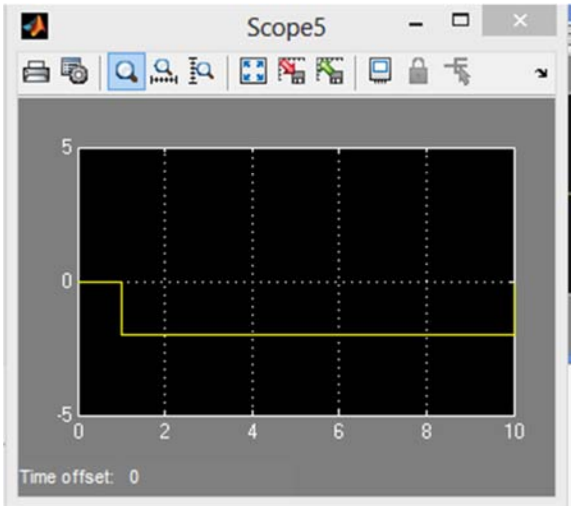

Fig. 12. *Demodulation Signal when seed=3.*

The resulting signal from various transmission points are shown in Fig.13-16.

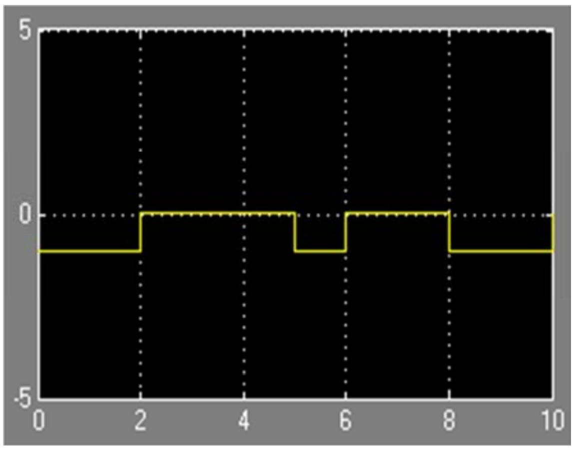

Fig. 13. *Shows the resulting modulated signal.*

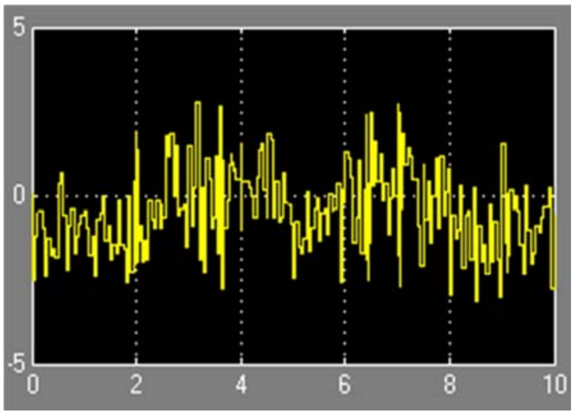

Fig. 14. *Shows the noise signal that is introduced to the channel.*

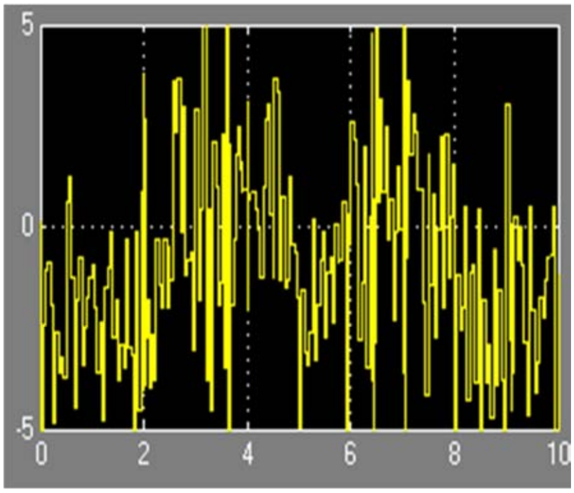

Fig. 15. *Shows the resulting demodulated signal after noise has been added.*

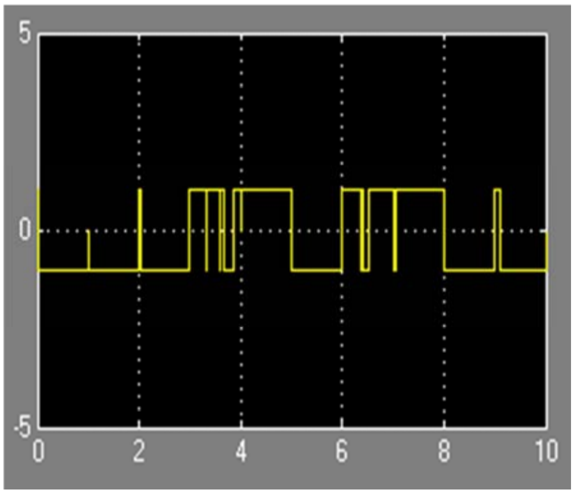

Fig. 16. *Shows the signal at the receiver after filtering of the noise from the demodulated signal.*

- From Fig.13, the modulated signal has an amplitude of –1 to 0 (which is 1).
- From Fig.14, the signal from the AWGN can be seen, its amplitude varies.
- From Fig.15, which shows the resulting demodulated signal after the noise has been added to it, it can be seen that the amplitude of the both signal increases as the

incoming signal is greatly affected by the noise in the channel.

- Fig.16 shows the signal after filtering has occurred. After filtering occurred, the received signal is still not an exact replica of the transmitted signal.

5. Conclusion

In this paper, the model-based design and analysis ofBinary Phase Shift Keying Digital Modulation Technique for Noiseless and Noisy Transmission have been achieved. This includes the design of a BPSK system using Matlab/ Simulink, the demonstration of modulation and demodulation of a BPSK technique through a noiseless and noisy channel. It was observed that if the channel is noisy then some of the demodulated bits will be in error. However, this error which occurs due to channel noise is a practical example of what occurs in real life communication channels. The electrical instruments used the design generate thermal noise, this means no communication channel is ever a 100% noise free, so filters and better modulation techniques are used in other to achieve a channel with less error. And even with this, at best a channel can only be 99.9% free of errors. For further research, other PSK modulation techniques such as QPSK, 8-PSK, 16=PSK and so on can be designed.

References

[1] Y. Rosmansyah, P. Sweeney, R. Tafazolli, "Air-Interface Techniques for Achieving High Data Rates for UMTS.

[2] A.S. Madhukumar, Francois Chin, "An Efficient Method for High-Rate Data Transmission Using Residue Number System Based Ds-Cdma", IEEE.

[3] Min-Yan Song, Yang Xiao, Joachim Habermann, "High Data Rate Wireless System", IEEE, Pp. 1344-1350.

[4] Haifeng Wang, Zhenhong Li, "Novel Soft-Bit Demodulator with Multi-Dimensional Projection for High-Order Modulation", IEEE, Pp. 2051-2054, 2002.

[5] Troels Emil Kolding, Klaus Ingemann Pedersen, JeroenWigard, Frank Frederiksen, PrebenElgaard. Mogensen, "High Speed Downlink Packet Access (Hsdpa): W-Cdma Evolution", IEEE Vehicular Technology Society News, February, 2003.

[6] Simon Haykin," Digital Communication" Edition, 2006.

[7] Aun Ali TahirFeng Zhao "Performance Analysis on Modulation Techniques of W- Cdma in Multipath Fading Channel" Electrical Engineering Blekinge Institute of Technology January 2009.

[8] G. Tharakanatha, SK. Mahaboobkamal basha, Vijay Bhaskar chanda, I. Hemalatha (2013):Implementation and Bit Error Rate analysis of BPSK Modulation and Demodulation Technique using MATLAB, International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 9- Sep 2013.pp:4010-4014.

[9] Weizheng. W (1997): Simulink Communication Toolbox, Mathworks, Inc. http:www.mathwork.com

[10] *Omijeh.B.O (2016): Applied Engineering Mathematics withMatlab/Simulink,* M & J Grand Orbit Communications Ltd, Port Harcourt, 2016; PP:201-203.

[11] Jeffery.S.B and Gary.M.M (2008):Modern Electronic Communication, Prentice-Hall of India Private Ltd, New-Delhi-110001; PP:466-470.