Evolution in Electrical and Electronic Engineering Vol. 3 No. 2 (2022) 668-675
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Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Quadrature Phase Shift Keying Modulation and Demodulation Simulation Using MATLAB

Chung Yao Xuan[1], Ariffuddin Joret [1]*

[1]Faculty Of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2022.03.02.079
Received 12 July 2022; Accepted 25 September 2022; Available online 30 October 2022

Abstract: People across the world utilize the 4G wireless communication system. A wireless communication system is one where data is transmitted wirelessly from one point to another without using an electrical conductor as a medium. Quadrature Phase Shift Keying (QPSK) is a technique used for modulation in wireless communication systems. Signal noise is unwanted noise that degrades the performance of wireless communication infrastructure. Many individuals have expressed concern about how signal power would affect QPSK modulation and demodulation. This project simulates QPSK modulation and demodulation. The problem is determining if the noise affects the output data of QPSK modulation and demodulation by modifying the power value of the noise at each time point of the simulation. The graph and data show how noise will affect the output data of QPSK modulation and demodulation. The bit error rate of the data increases with the strength of the noise. The probability of receiving data also increases with the noise power.

Keywords: QPSK Modulation and Demodulation, Noise Power, Bit Error Rate

1. Introduction

In the modern technological era, the world in which we live is changing, revolutionizing, and becoming more difficult. A wireless communication system transfers information wirelessly between two or more sites without using an electrical conductor as a medium [1]. Wireless communication is often accomplished by the transmission of electromagnetic signals by an enabled device inside the air, physical surroundings, or atmosphere [2]. Wireless communication comes in a variety of forms, technologies, and delivery systems, including mobile communication, satellite communication, microwave communication, and others. Quadrature Phase Shift Keying (QPSK) is a technique that is used for modulation in the wireless communication system. QPSK, also known as quadrature phase shift keying, is frequently used in digital satellite modulation [3]. QPSK is a technique for sending digital data across analog channels [4]. It has a lot of advantages such as a high-frequency utilization ratio, easiness of achievement, and strong anti-interference performance. Table 1 shows the list of digital modulation applications.

**Corresponding author: ariff@uthm.edu.my*
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Table 1: Digital Modulation Application

Modulation Type	Bit per Symbol	Application
BPSK	1	Space Telemetry
GMSK	1	GSM
QPSK	2	UMTS, CDMA, DVB-S, DVB-T, WiMAX, WI-FI
8PSK	3	EDGE
16QAM	4	DVB-c, DVB-T, WiMAX, WI-FI
64QAM	6	DVB-T, WiMAX, WI-FI

Signal noise is the undesired noise that deteriorates together with the communication signal. In an industrial setting, signal noise has the potential to wreak havoc on process control systems [5]. Signal noise is come from everywhere neither within the circuit itself nor from the external environments [6]. It will affect the wireless communication system. The signal noise might also be affected by the QPSK modulation and demodulation but how the signal noise affected the modulation and demodulation is the topic that we need to study. In this study, a simulation of QPSK modulation and demodulation is carried out to study the signal noise and its relationship with the bit error rate.

2. Methodology

This section included the study process of simulation for the QPSK modulation and demodulation. It also consists of an explanation for the simulation process. Figure 1 shows the flowchart of the overall process. The software that is used to design the QPSK modulation and demodulation simulation is MATLAB coding. The parameters used in the simulation are all optional and filled in by the user in the prompt window when the simulation run. The parameters are included input data, frequency of the signal, and noise power.

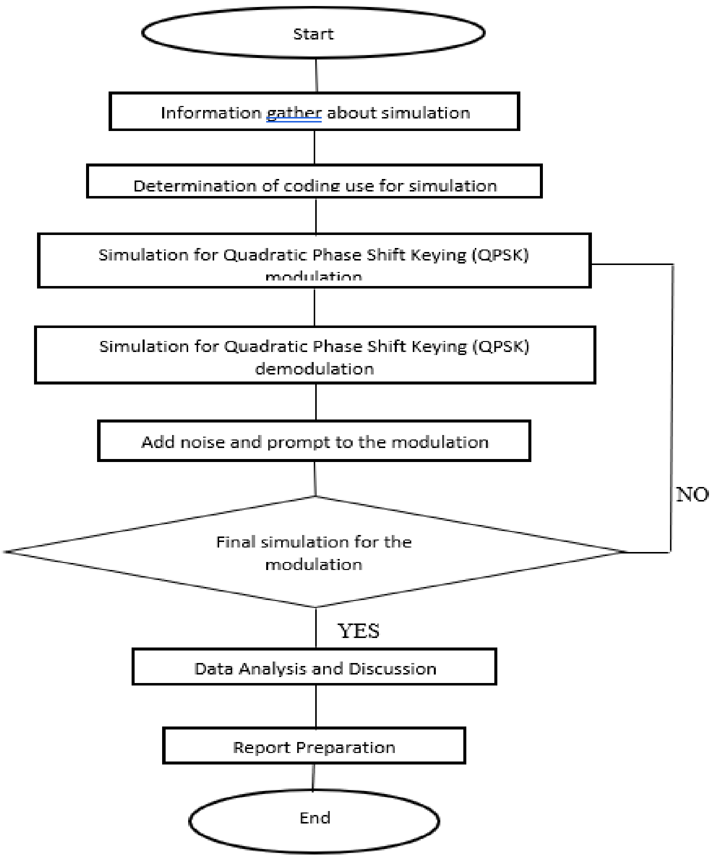

Figure 1: Flowchart of the overall process

The design for the simulation is divided into two parts; QPSK modulation and QPSK demodulation. In the beginning, the user will insert all values such as input data, frequency of the signal, and noise power via the prompt window. The prompt window is shown in Figure 2. Then, QPSK modulation begins with modulating the input data to a specific mode so that it can pass through the medium. The signal will undergo a demodulation process after passing through the medium. This is to get back its original signal so that the receiver can receive the signal message.

After the QPSK modulation and demodulation simulation is complete. Noise is added to the transmission medium. In the simulation, a noise signal with different noise power is used depending on the user's requirement. From there, various type of output data is produced. From the output, we can observe the error occurring in the data and their bit error rate. We will also be able to observe the relationship between the noise power and bit error rate. The simulation will be run using two sets of different input data. Because we can observe the change of error bit rate when run with two different sets of input with the same noise power.

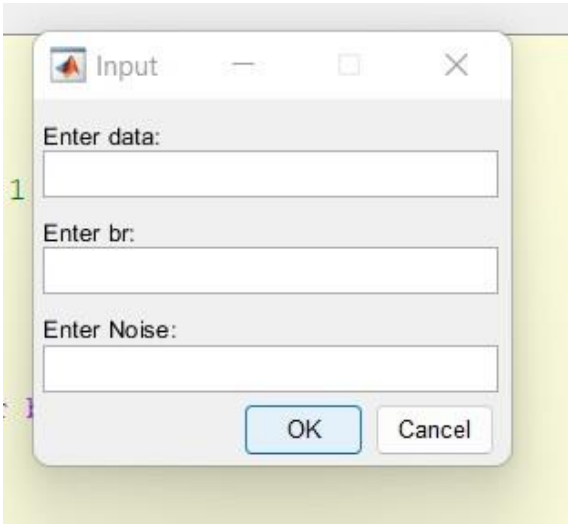

Figure 2: Prompt window for the user to insert input data, frequency, and noise power

3. Results and Discussion

In this section, we will do an analysis and discussion based on the results obtained from the simulation. In the simulation, two set of data is use which is data A [1 0 0 1 0 1 0 0 0 0 1 1 0 0 1 1] and data B [1 0 0 0 0 1 0 0 0 0 0 1 1 1 1 0]. The simulation is repeated 100 times with different values of noise power from 1w to 100w which insert in the prompt window. Figure 3 shows the data, value of br, and also the noise power that appears on the prompt window while Figure 4 shows the results after all the values are inserted into the prompt window.

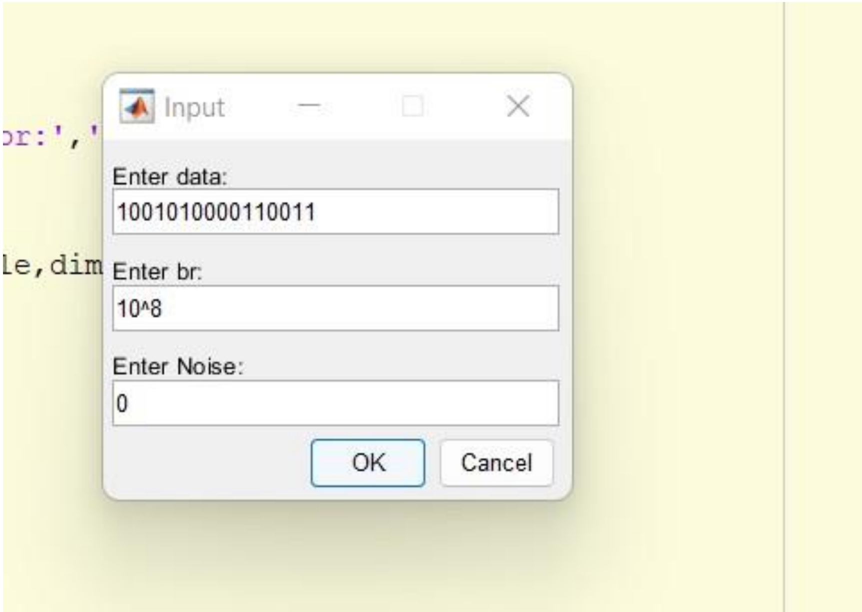

Figure 3: The data, the value of br, and noise power insert through the prompt window

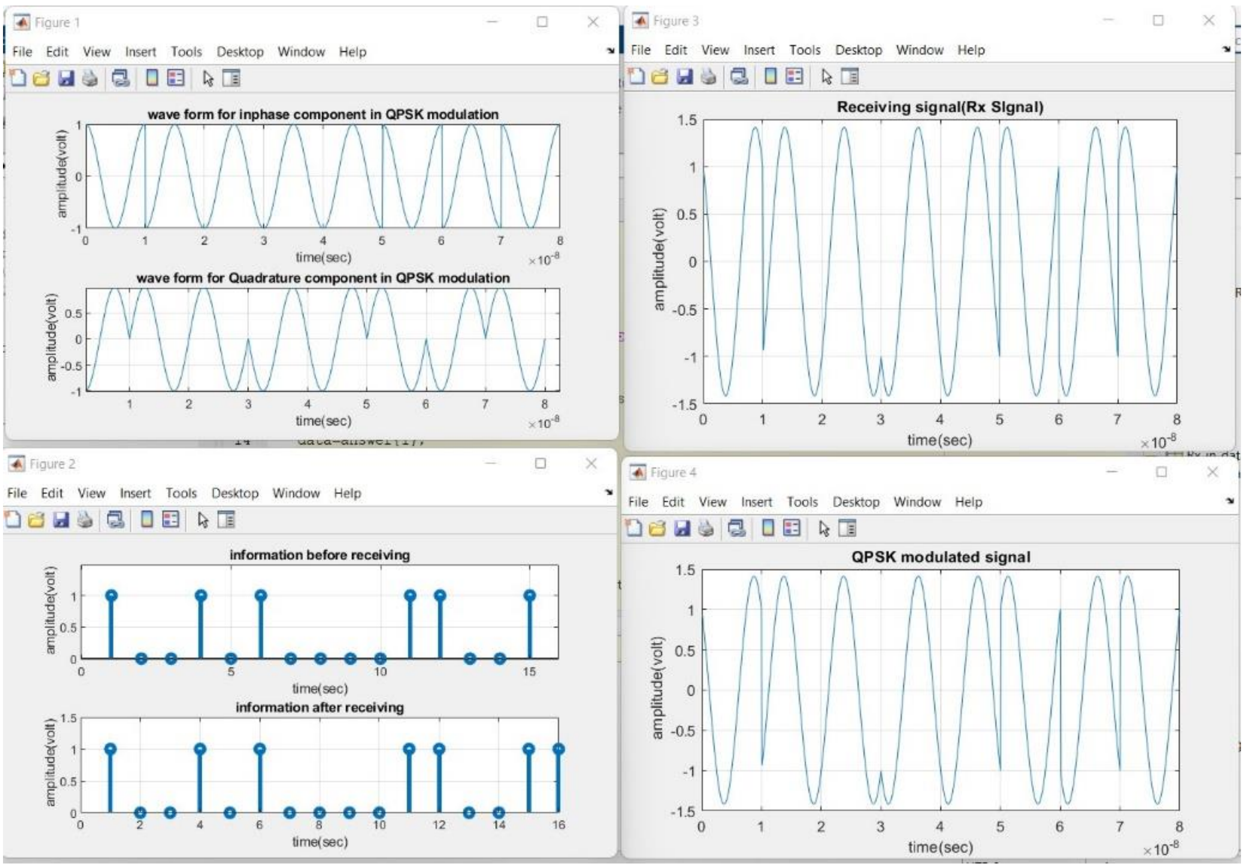

Figure 4: The result show after all the value were inserted through the prompt window

3.1 Noise power: 1W

The stem of the input and output data for noise power 1 is shown in Figure 5. As previously stated, the input data is entered as [1 0 0 1 0 1 0 0 1 0 1 0 1 0 1 1]. The results of the simulation for Quadratic Phase Shift Keying (QPSK) modulation and demodulation are [1 0 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 1]. There is no error occurring in the data as compared to the input data with output data.

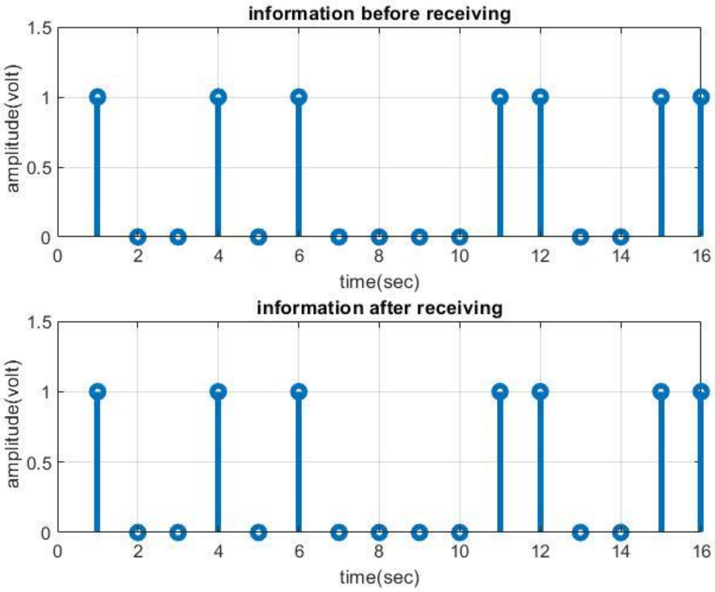

Figure 5: Stem of the input and output data for noise power 1 for data A

The stem of the input and output data for noise power 1 for data B is shown in Figure 6. As illustrated above, the input data is entered as [1 0 0 0 0 1 0 0 0 1 1 1 1 0]. The result of the simulation for Quadratic Phase Shift Keying (QPSK) modulation and demodulation is [1 0 0 0 0 1 0 0 0 1 1 1 1 0]. When comparing the input and output data, there are no errors in the data.

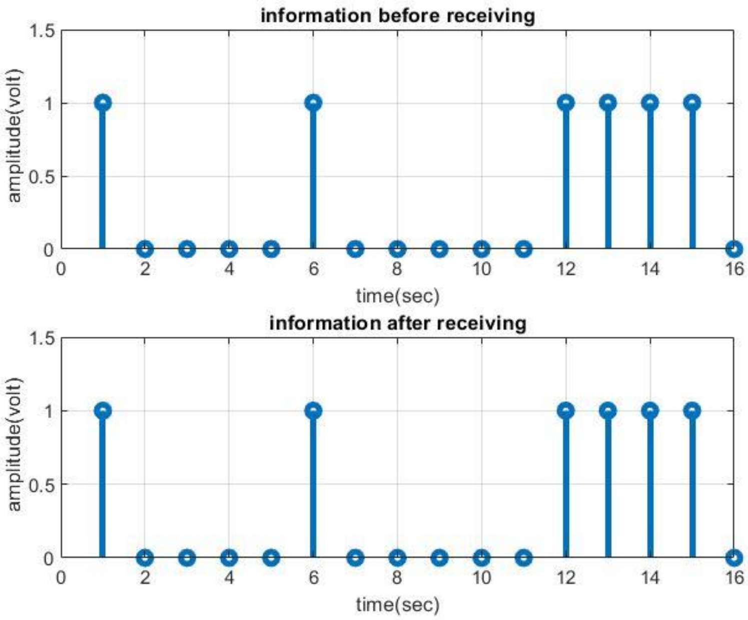

Figure 6: Stem of the input and output data for noise power 1 for data B

From both figures 5 and 6, there is no error occurs although there is a noise power of 1w during the simulation. Because the noise power use is too weak until it is not enough to affect the data to have error. Hence, we can say that errors in data will occur when only the noise power use reaches a certain level of high which can produce interruption.

3.2 Noise power: 100W

The stem of the input and output data with noise power 100 for data A is shown in Figure 7.

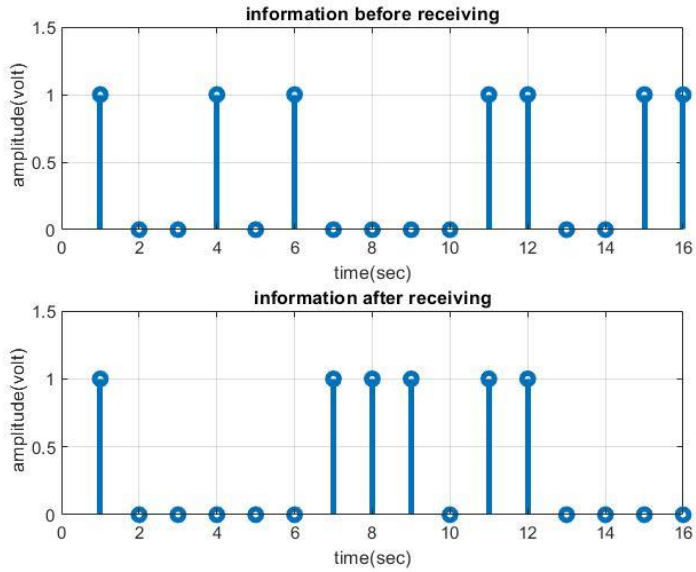

Figure 7: Stem of the input and output data with noise power 100 for data A

The input data is insert as [1 0 0 1 0 1 0 0 0 0 1 1 0 0 1 1] while the output data after the Quadrature Phase Shift Keying (QPSK) modulation simulation is [1 0 0 0 0 0 1 1 1 0 1 1 0 0 0 0]. There are 7 bits of data has errors when comparing both the input data and output data. Hence, the error bit rate for the data when the noise power is 100 is 43.75 %. The stem of the input and output data for data B are shown in Figure 8 with a noise power of 100W.

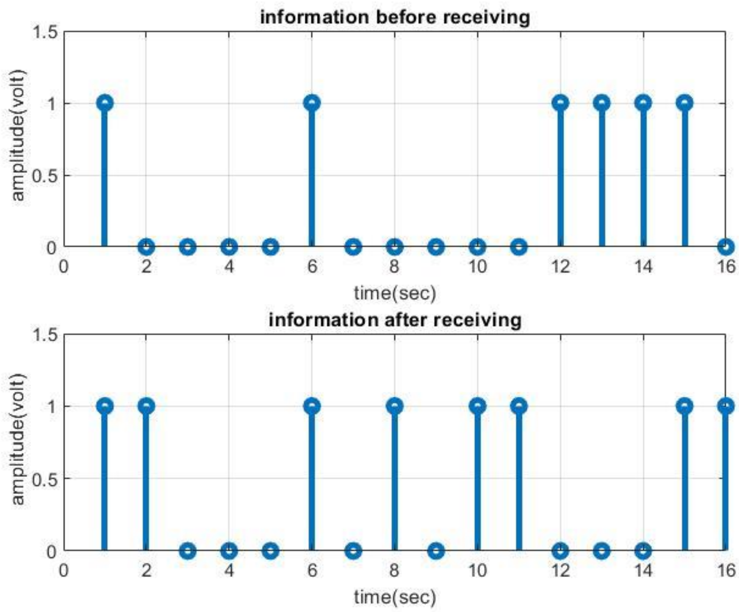

Figure 8: Stem of the input and output data with noise power 100 for data B

As previously illustrated, the input data is entered as [1 0 0 0 0 1 0 0 0 0 0 1 1 1 1 0] while the output data after QPSK modulation and demodulation simulation is [1 1 0 0 1 0 1 0 1 0 1 1 0 0 1 1].

The data has an error in 8 bits. Hence, the data has an error bit rate of 50.00% when the noise power is 100.

From Figure 7 and Figure 8, we have observed that there are a lot of errors occurring in the output data and the error bit rate is also very high. As the noise power insert is high, so the probability of data getting an error will also be high. The data will 100% get an error when the noise power insert is as high as 100w and there is no possibility that there is no error occurred.

3.2 Error Bit Rate vs Noise Power

Figure 9 displays the graph of the error bit rate against noise power for data A, whereas Figure 10 displays the graph of the error bit rate against noise power for data B.

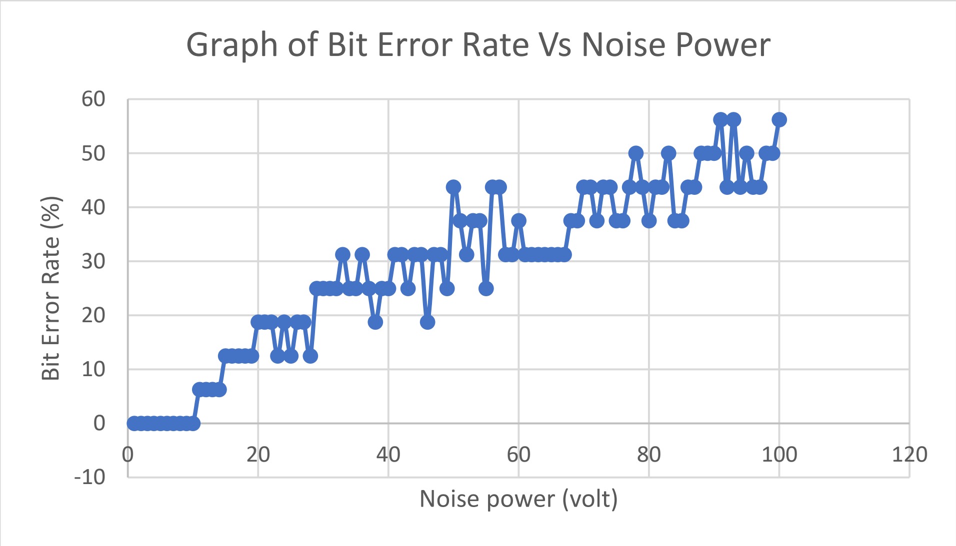

Figure 9: Graph of error bit rate vs noise power for data A

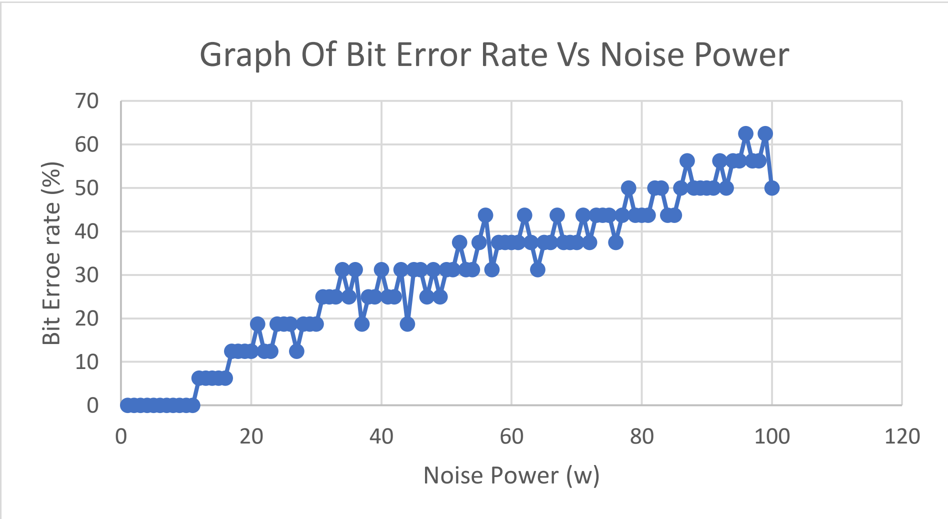

Figure 10: Graph of error bit rate vs noise power for data B

The erroneous bit rate from the simulation was used to inform both graphs. The bit error rate for the data is zero when the noise power is between 0 and 10 volts, as shown by the two graphs above. From the two graphs, we are aware that if the noise power is below 10 V, the data would not be affected by the noise. In addition, we have seen that when the noise power is 100, the error bit for data might reach above 50%. The graph above shows that the erroneous bit rate of data increases as noise power increases. As noise power grows, so does the bit error rate of data. Since the shape of the two graphs is almost the same while two different sets of data are inserted, we may draw the tentative conclusion that the bit error rate of data is affected by noise power.

4.0 Conclusion

Based on the result obtained above, we can deduce that the design for QPSK modulation and demodulation simulation is successful. We have concluded that the bit error rate of data relies on the value of noise based on the graph of noise power and error bit rate for the data shown above. When the noise power grows, the data error bit rate also rises. As a result, we now understand and can monitor how noise and data error bit rate interact. In addition, we have concluded that when noise power grows, the likelihood that data may contain errors rises. We know that when the amount of noise rises, inaccuracy will likely arise because of all the outcomes that were collected. Based on the study in the journal or report, everything that was inferred above is what we anticipated. Besides that, our effort to create a prompt window for the simulation system was successful. Utilizing different types of data, frequencies, or noise power, several types of simulation may be carried out using the prompt window. A quick analysis and debate are possible when using the prompt window system.

Acknowledgment

The authors would also like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] "The wireless revolution," The Economist. January 21, 1999. Retrieved 12 September 2019

[2] B.I.Bakare1 and J.D.Enoch, "Investigating Some Simulation Techniques for Wireless Communication System," IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), Vol.14, PP 56-65, June 2019

[3] Xiaoling Hu, "Modulation and Demodulation of QPSK Communication System Based on MATLAB," International Conference on Logistics Engineering, Management and Computer Science, LEMCS 2015

[4] Tayab Memon & Bhawani Shankar Chowdhry, Dr. BS Chowdhry, Ayaz A shaikh, "Quadrature Phase Shift Keying Modulator & Demodulator for Wireless Modem, "41st International Spring Seminar on Electronics Technology (ISSE), May 2018, DOI: 10.1109/ISSE.2018.8443613

[5] Simon Paonessa, "Reducing Signal Noise In Practice," Precision Digital, 2022. [Online]. Available: https://www.predig.com/whitepaper/reducing-signal-noise-practice

[6] Janet Heath, "Electrical noise can come from anywhere," Analog IC Tips: An EE World Online Resource, Jan 2021. [Online]. Available: https://www.analogictips.com/electrical-noise-can-