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Design and Implementation of BPSK Modulation Using USRP for IoT Healthcare

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Introduction

WBANs for IoT healthcare typically comprise a sensor node, a microcontroller, and a communication module. These sensors can sense real-time events and Transmit sensor data to a base station through wireless transmission[1]. Consequently, a dependable communication system is critical for delivering an appropriate base station without error. One of the primary concerns for receiving a signal at its destination is the modulator's reliability and accuracy [2].

Objectives

1. Investigate the better modulator reliability and accuracy modulation scheme in WBAN.
2. Test different modulation techniques (BPSK, QPSK, and GMSK) to obtain the highest data rate for the WBSN.
3. Choose the best modulation that can be used in the IoT e-health application.

Materials and Methods

We used the USRP B200mini device with the help of MATLAB and GNU Radio software to implement the BPSK modulation scheme. The BPSK modulator takes in a binary input stream and maps it onto a phase shift keying constellation. The modulated signal is then transmitted through the USRP device using an antenna. On the receiver side, the signal is received by another USRP device and demodulated to recover the original binary data. We evaluated the performance of our system in terms of bit error rate (BER) and signal-to-noise ratio (SNR) using a simulated channel with AWGN (Additive White Gaussian Noise) and compared it with the theoretical values.

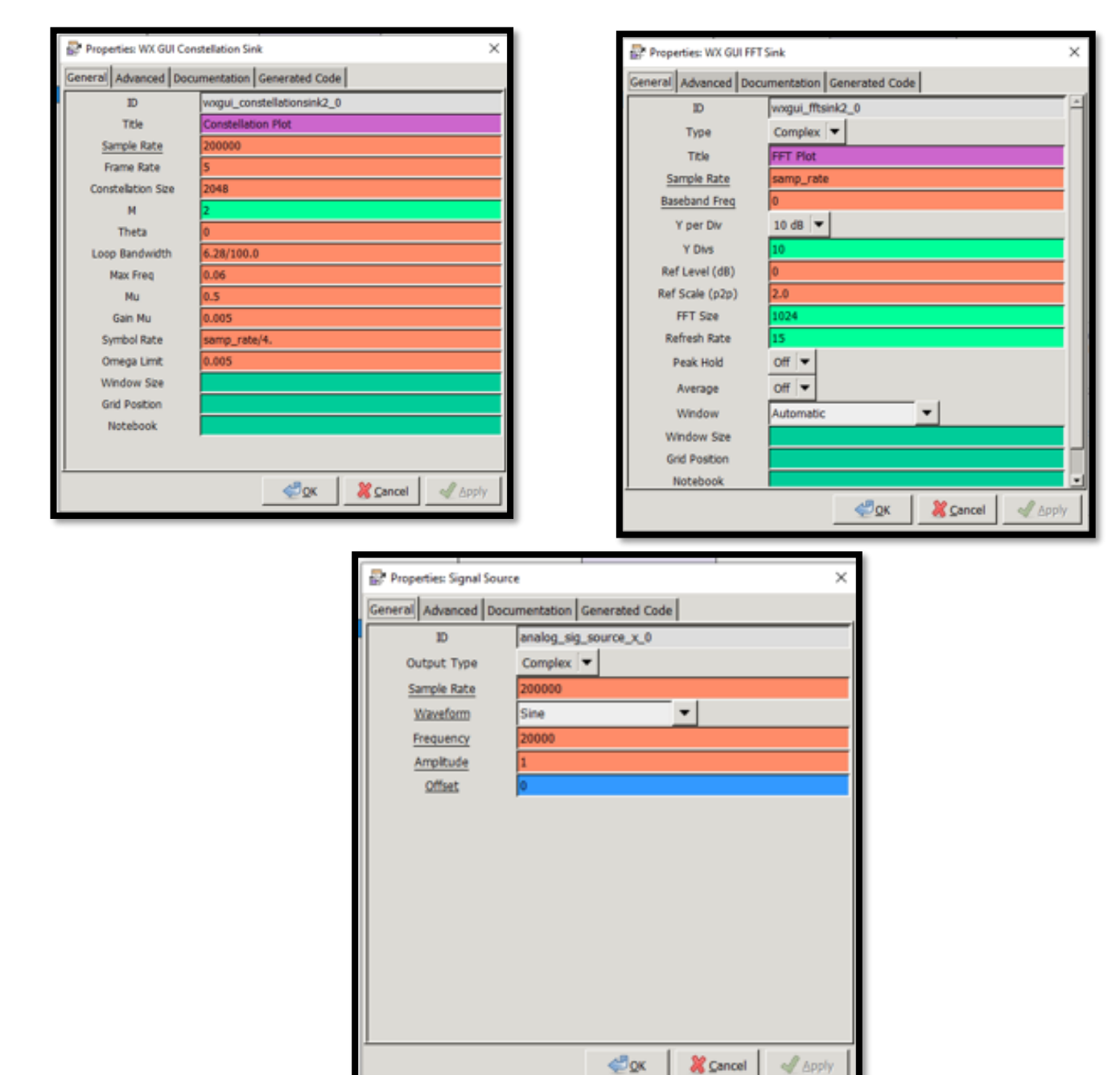
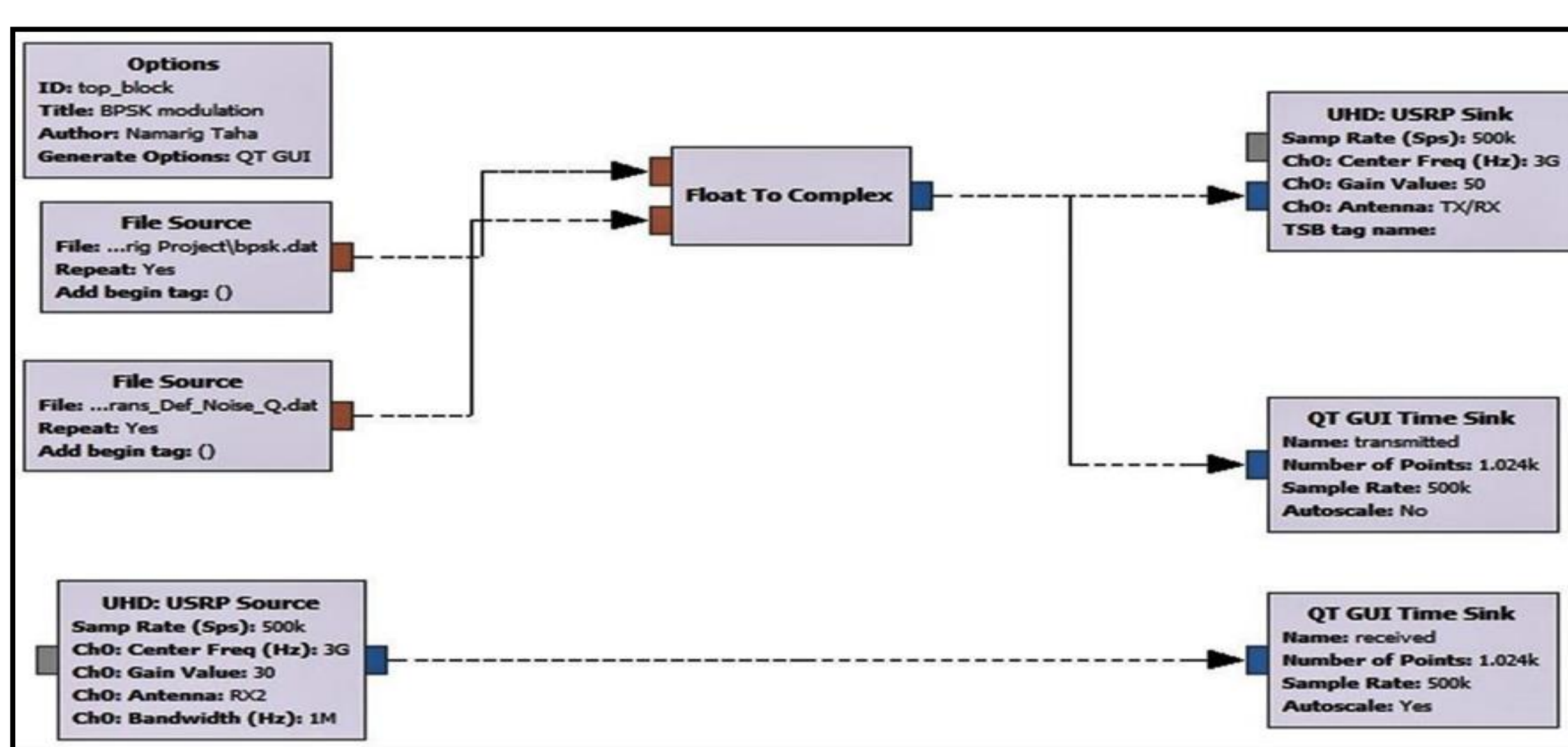
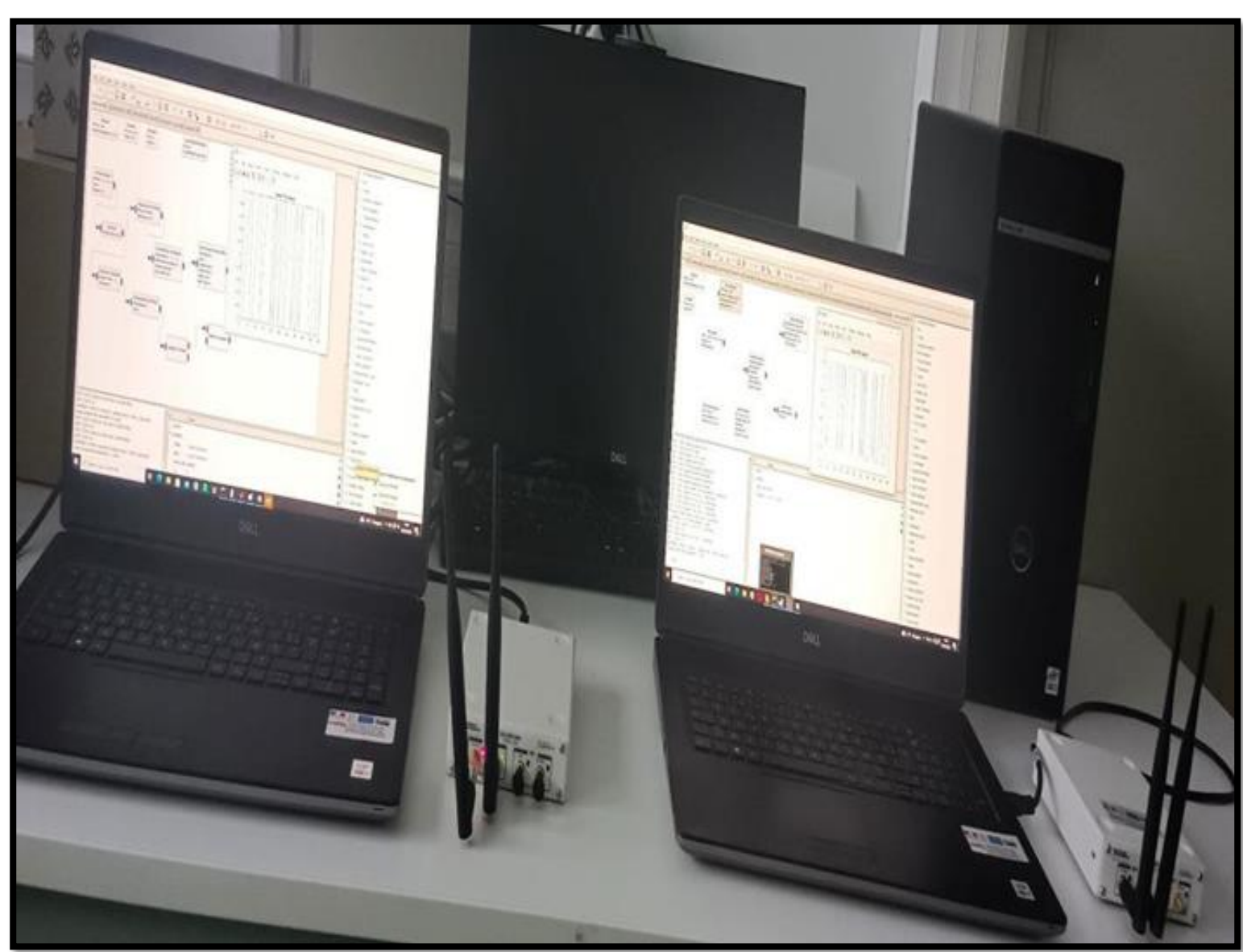


Fig. 1: Schematic Diagram for complete BPSK implementation

Results and Discussion

The performance of BPSK modulation is shown in Figure (8), with the BER decreasing rapidly as the SNR increase until it reaches a minimum value, which is affected by the modulation scheme, channel characteristics, and receiver design. Our implementation has effectively attained a minimum bit error rate (BER) and higher signal-to-noise ratio (SNR) values, indicating the reliability and efficiency of the communication system. Moreover, implementation demonstrates robustness against radio-frequency interference, ensuring improved quality in transmitting medical information.

- BPSK signal using raised cosine filtering

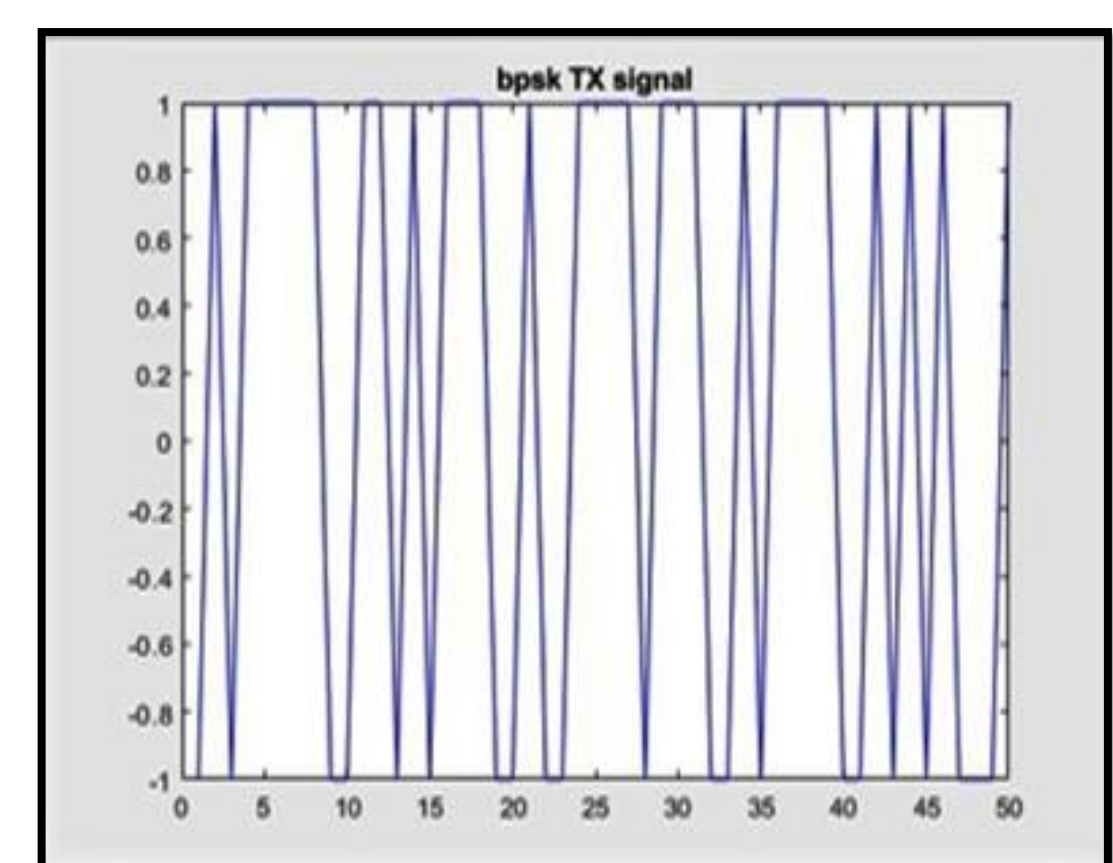


Fig. 2: BPSK transmit Signal

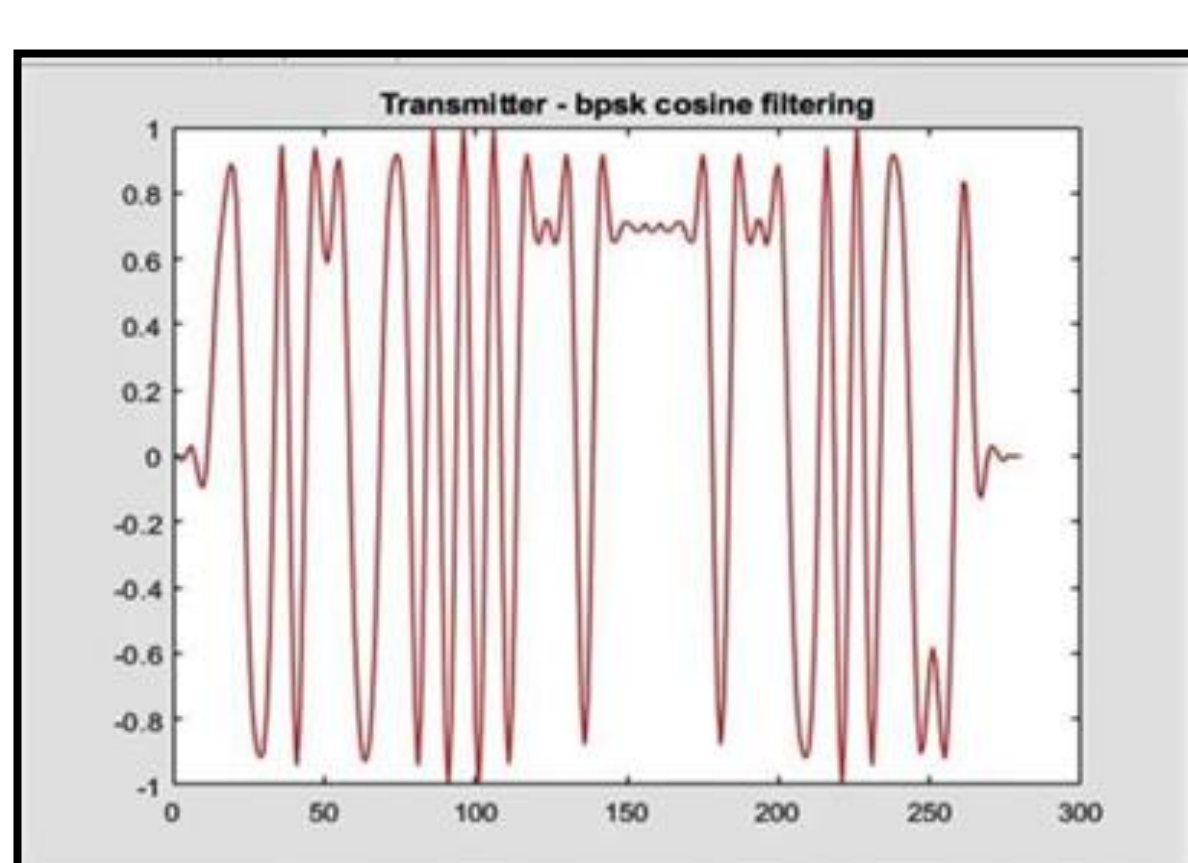


Fig. 3: BPSK cosine filtering

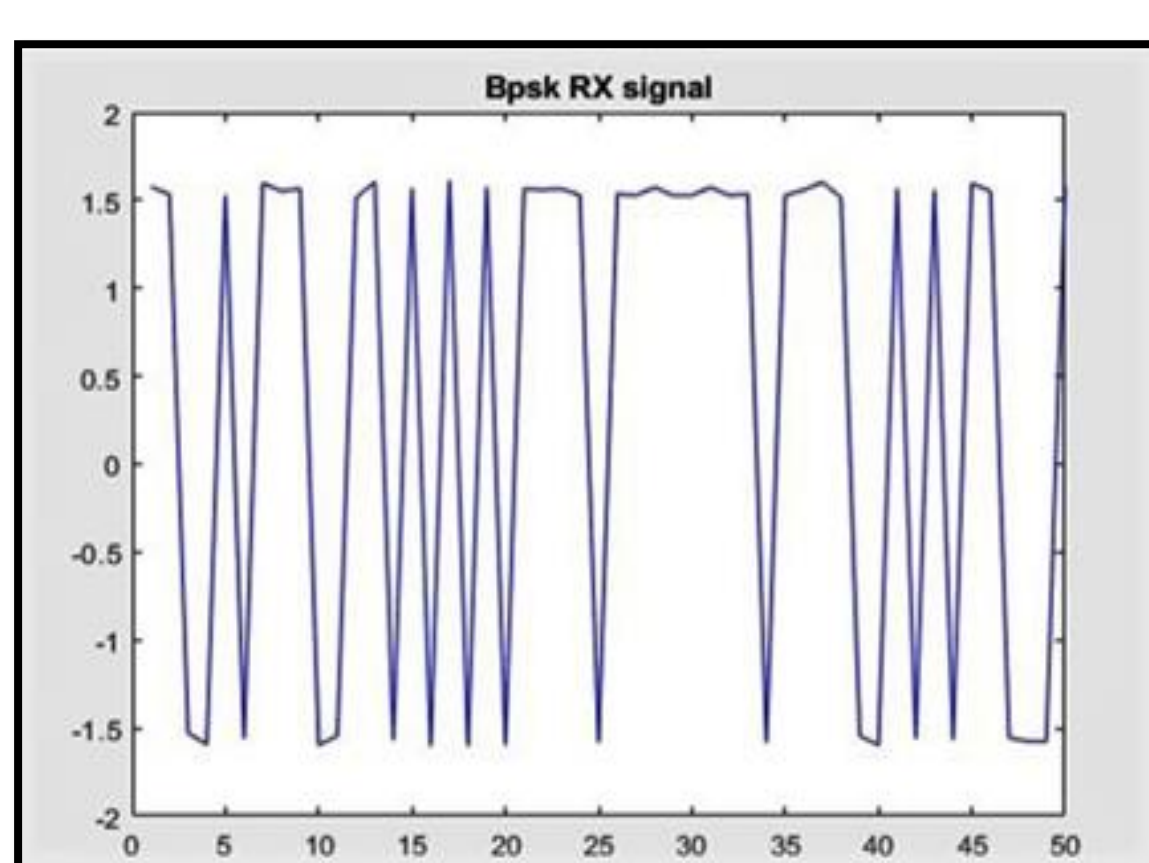


Fig. 4: BPSK received signal

- BPSK Implementation in real-time

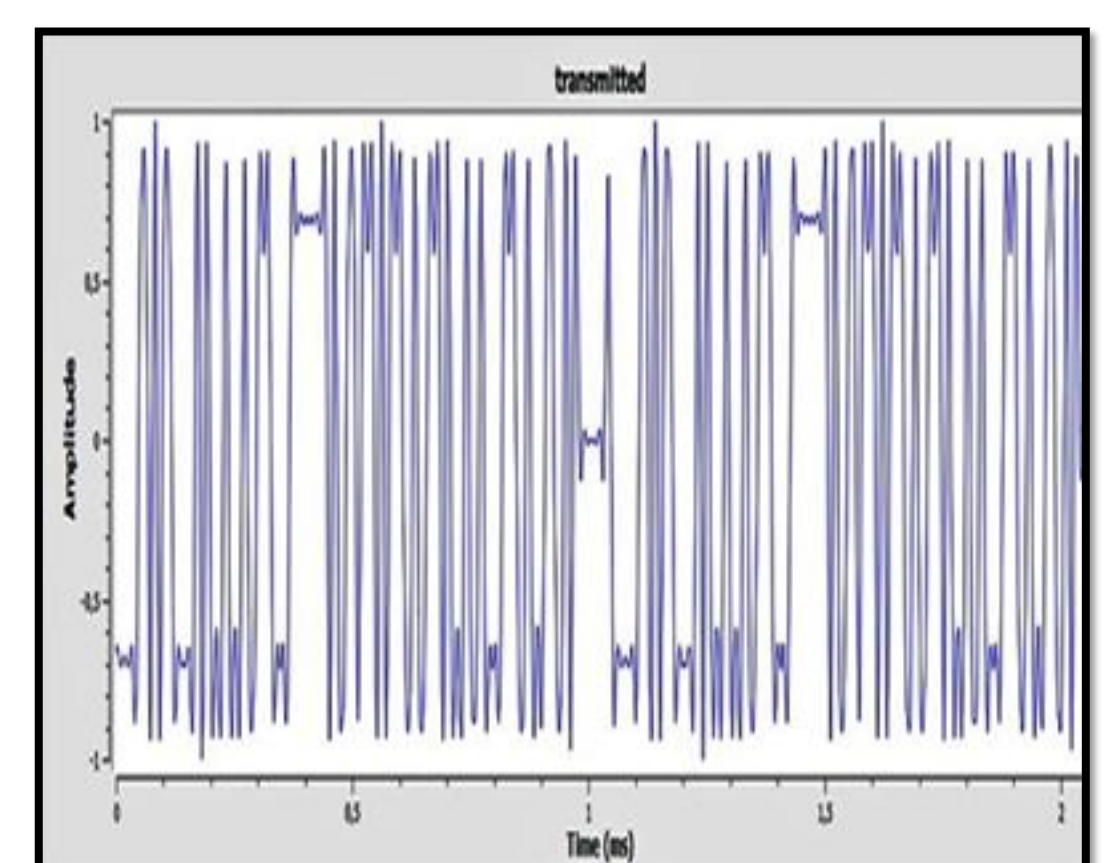


Fig. 5: Transmit signal

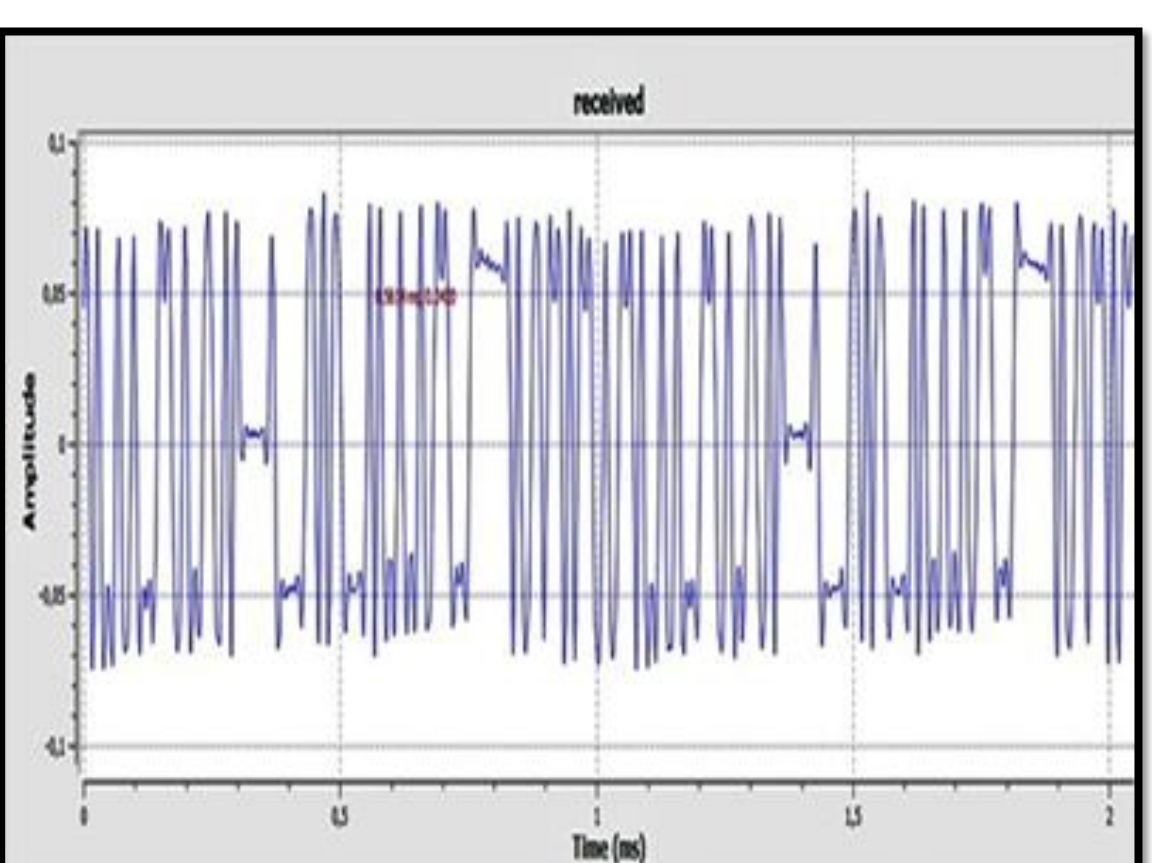


Fig. 6: Received signal

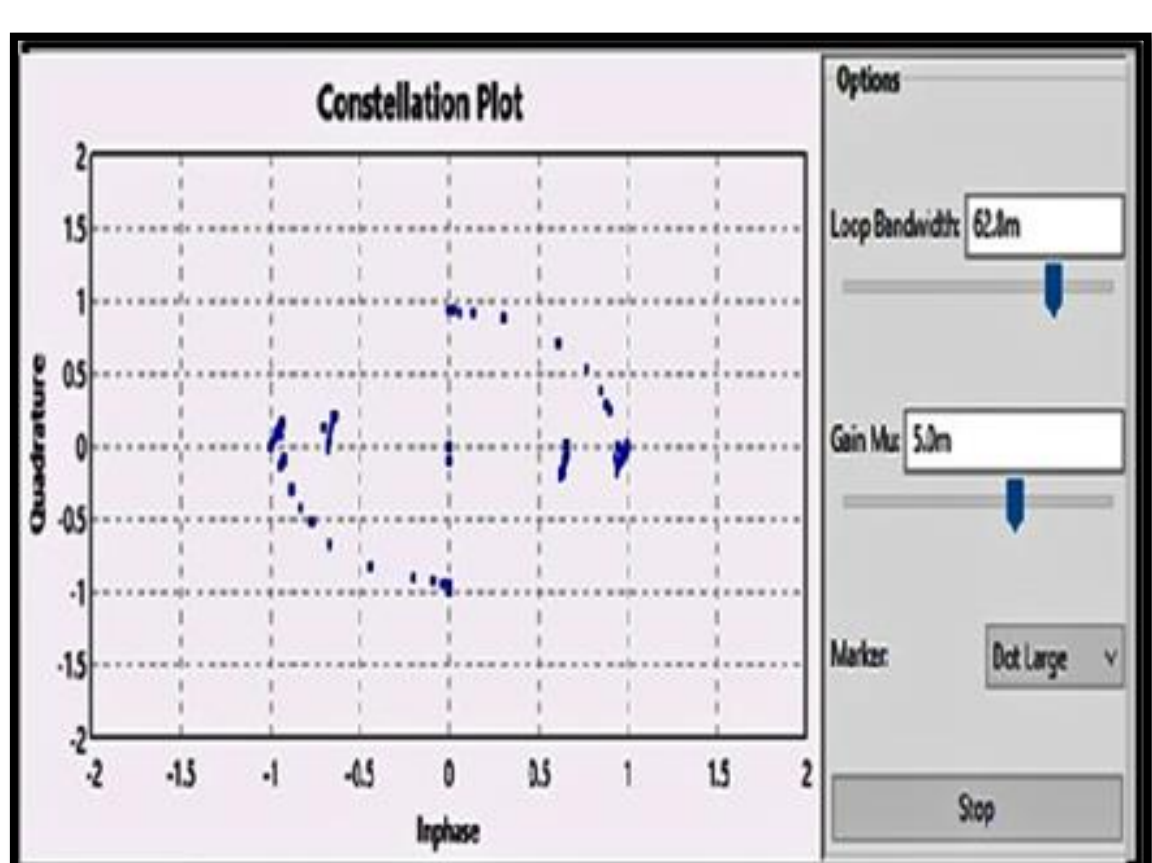


Fig. 7: Constellation plot

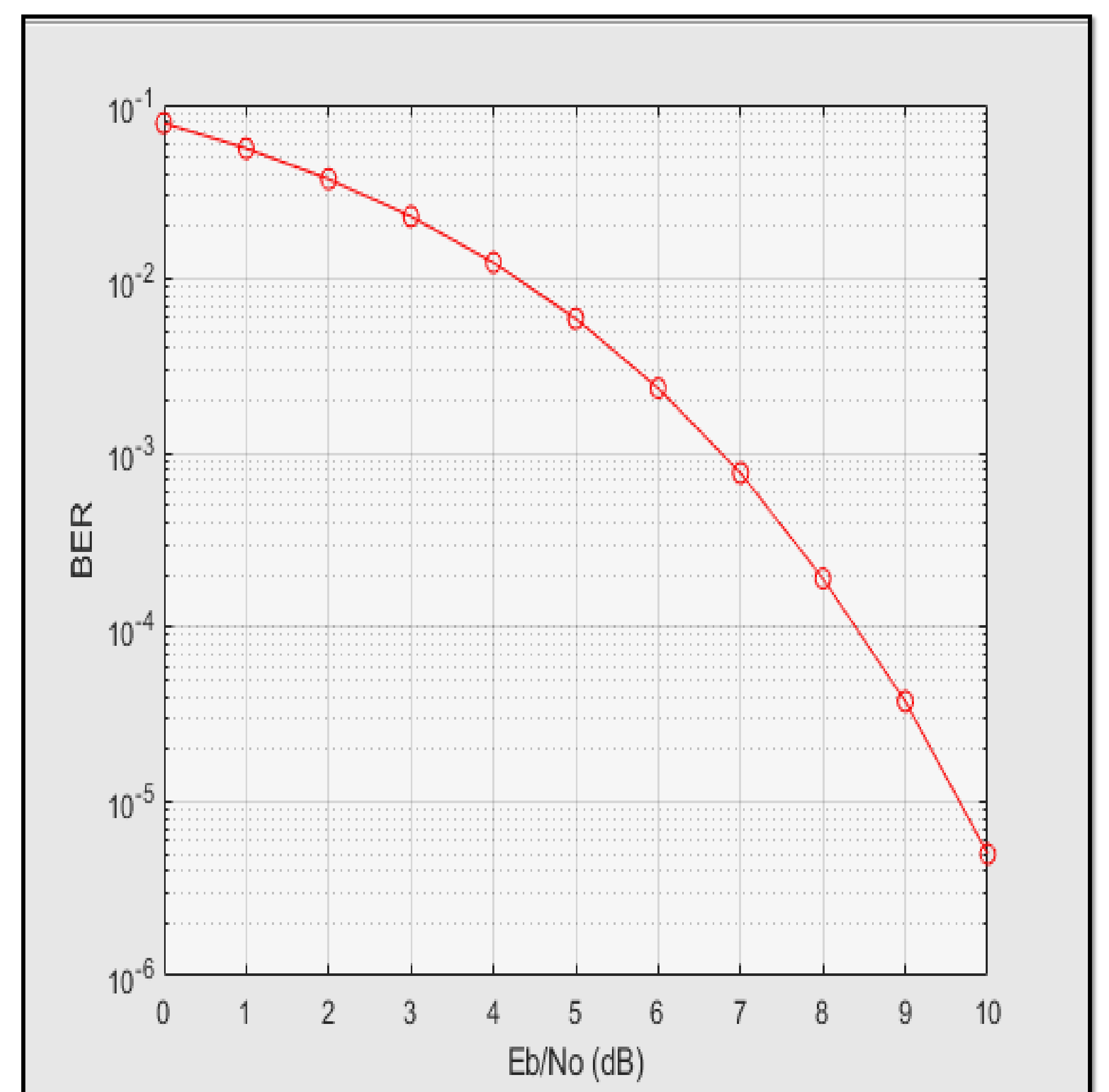


Fig. 8: BER vs SNR

Conclusion

BPSK modulation with USRP offers a dependable and efficient approach for transmitting data over short distances while consuming minimal power. This system was tested in a laboratory environment and successfully transmitted and received medical data with a low bit error rate. We also demonstrated the ability to adapt to changing environments and interference by adjusting the receiver's gain and frequency. From Figure 6, 7, because we used an attenuator, ideal channel, and raised cosine filtering (to avoid spectral spreading), we can observe that the symbol error rate =0 and PDR =100%, which is very important in IoT eHealth applications.

Acknowledgment

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References

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