Q1

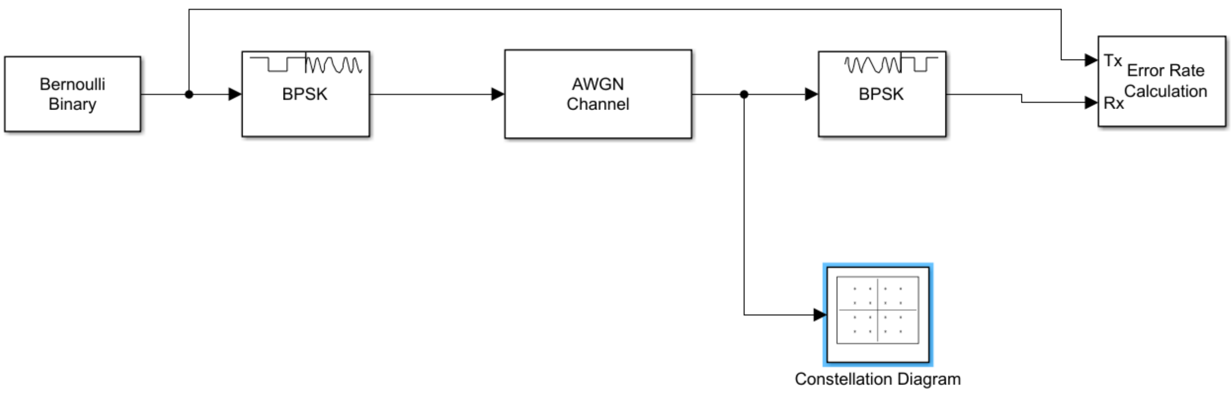

Figure 1 – BPSK Simulink Model

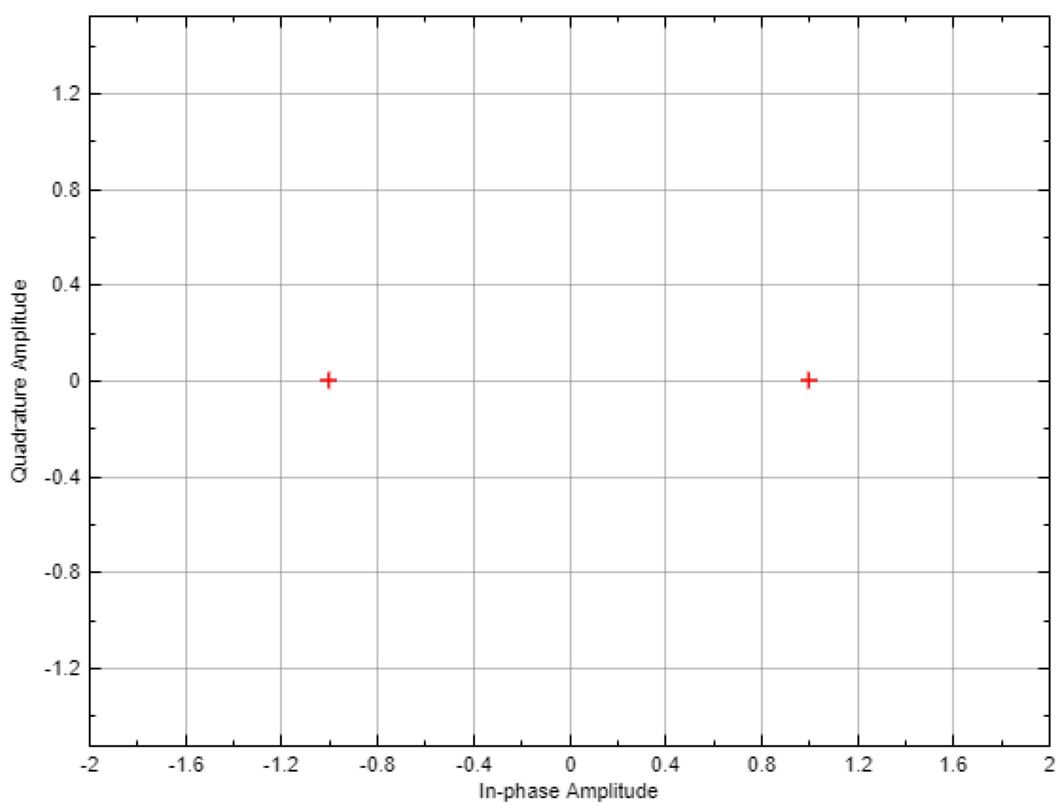

Figure 2 – Location Of BPSK

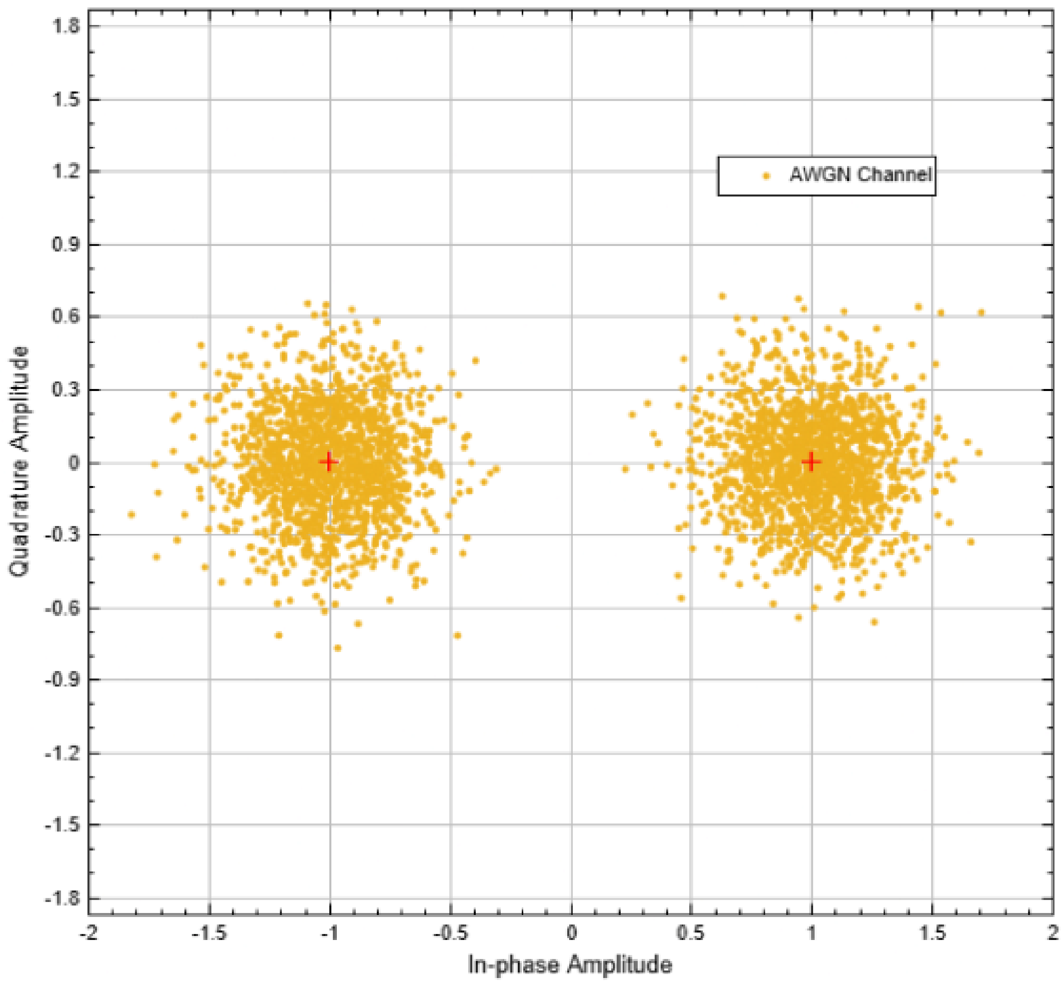

Figure 3 – Received BPSK Samples

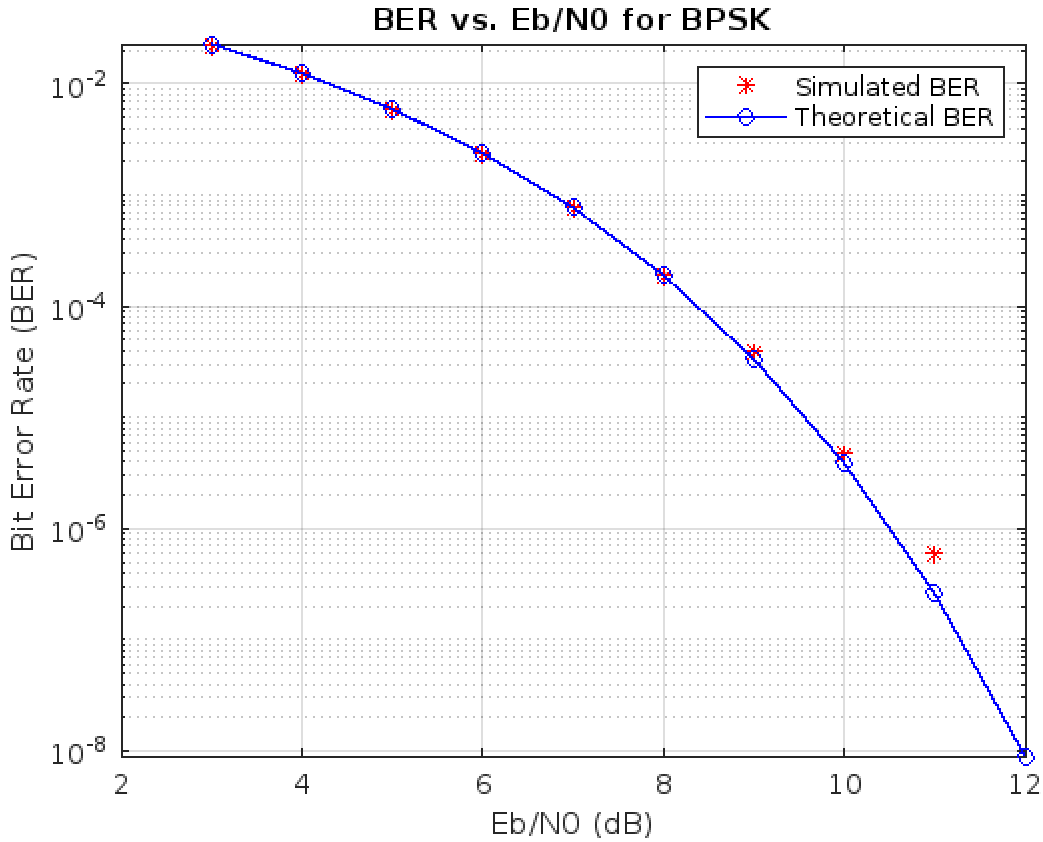

Figure 4 – BER vs. Eb/N0 for BPSK

```
Simulated BER: 3.599280e-06
Theoretical BER: 3.872108e-06
```

$$P_b = Q\left(\frac{A}{\sigma_0}\right) = Q\left(\sqrt{\frac{2 * E_b}{N_0}}\right)$$

$$For\ BPAM: \frac{E_b}{N_0} = 10\ dB$$

$$P_b = Q\left(\sqrt{2 * 10}\right) = Q\left(\sqrt{20}\right) = Q(4.47) = 0.3911E - 05$$

$$10 * \log_{10} \frac{E_b}{N_0} = 10 \rightarrow \frac{E_b}{N_0} = 10$$

When comparing the simulated Bit Error Rate (BER) with the theoretical BER for Binary Phase Shift Keying (BPSK), it's important to note that the simulation results are based on a finite number of samples. This can lead to small discrepancies between the simulated and theoretical values.

Because the simulation can only generate a limited number of samples, the estimated BER might not perfectly match the theoretical value. These small differences are typically due to statistical variations and noise in the simulation process. As the number of samples increases, the simulated BER approaches the theoretical value more closely, but it can never be exactly the same because of the inherent randomness and the finite nature of the simulation.

Q2

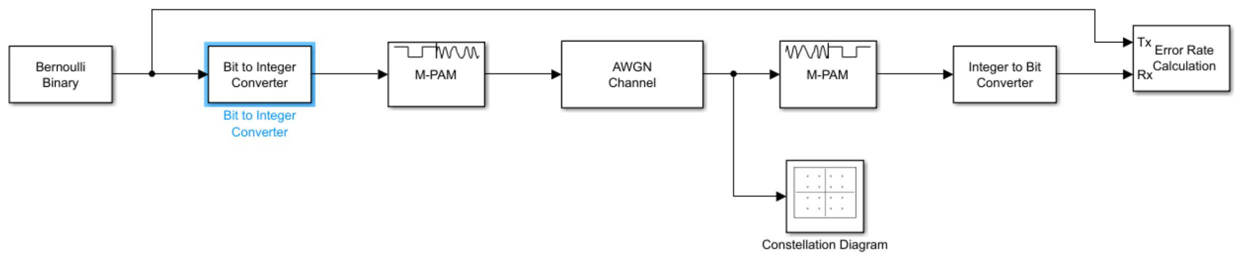

Figure 5 – MPAM Simulink Model

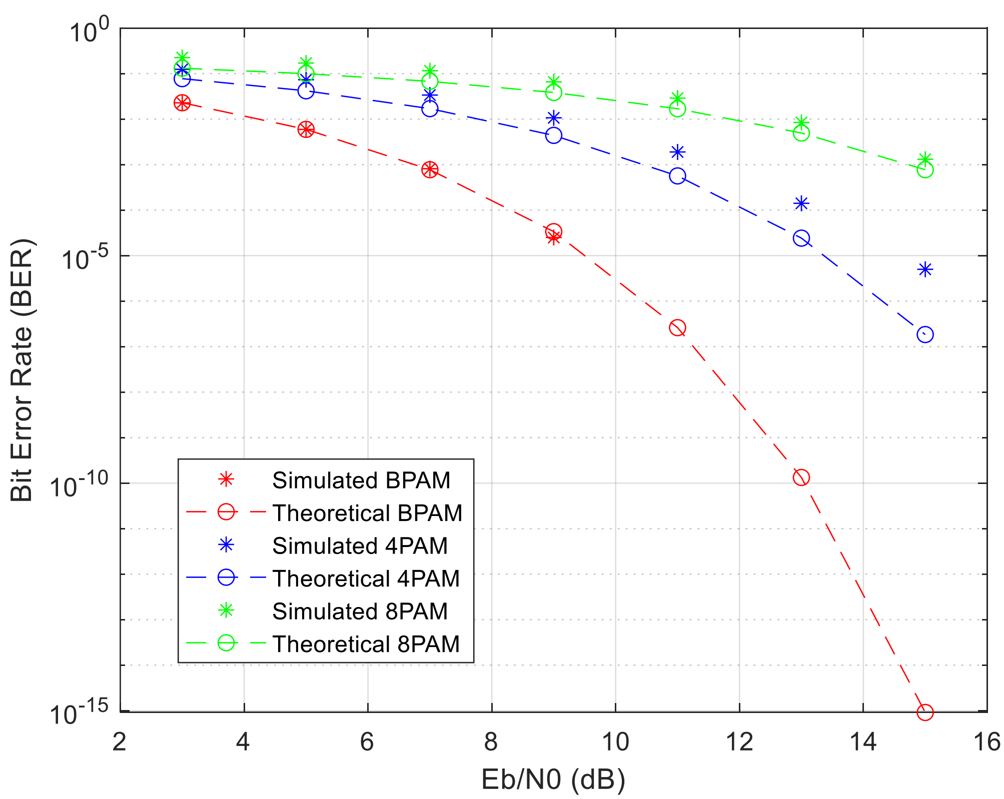

Figure 6 – BER vs. Eb/N0 for MPAM

$$P_s = \frac{2(M-1)}{M} * Q\left(\sqrt{\frac{6 * \log_2 M}{M^2 - 1} * \left(\frac{E_b}{N_0}\right)}\right), P_b = \frac{P_s}{\log_2 M}$$

As M increases, the distance between constellation points decreases, making the modulation scheme more susceptible to noise, hence higher BER.

The theoretical and simulated BER curves should match closely, validating the model's accuracy.

For higher values of Eb/N0, the BER decreases, indicating better performance with increased signal energy.