Part B

Error Performance of BPSK

Aim :

1.To generate a string of message bits.

2. To encode using BPSK with energy per bit E_b and represent it using points in a signal-space.

3. To simulate transmission of the BPSK modulated signal via an AWGN channel with variance $N_0/2$.

4. To detect using an ML decoder and plot the probability of error as a function of SNR per bit E_b/N_0.

Brief theory:

Phase Shift Keying is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time. PSK is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications. Binary Phase Shift Keying BPSK is also called as 2-phase PSK or Phase Reversal Keying. In this technique, the sine wave carrier takes two phase reversals such as 0° and 180°. BPSK is basically a Double Side Band Suppressed Carrier DSBSC modulation scheme, for message being the digital information. Figure 1 shows the block diagram of BPSK modulator. Figure 2 Shows the BPSK in time domain and frequency domain. Figure 3 shows the block diagram of BPSK receiver.

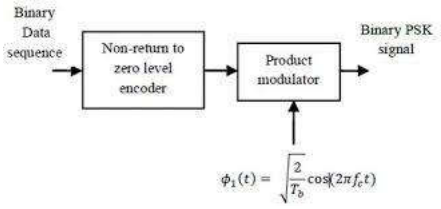


Figure 1.BPSK modulator

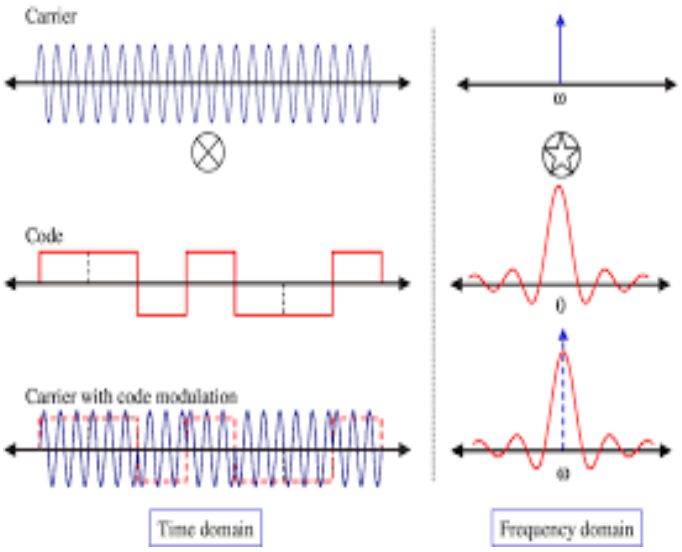


Figure 2 BPSK signal in time and frequency domain.

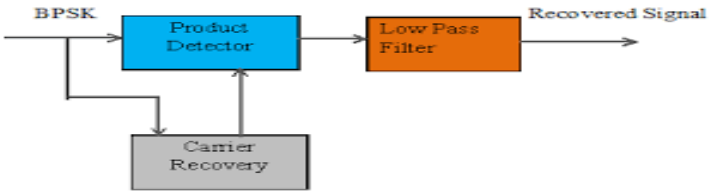


Figure 3. BPSK detector

Bit error rate (BER) of a communication system is defined as the ratio of number of error bits and total number of bits transmitted during a specific period. It is the likelihood that a single error bit will occur within received bits, independent of rate of transmission. For any given modulation, the BER is normally expressed in terms of signal to noise ratio (SNR). The bit error probability is given by

$$P_b = \frac{1}{2} erfc\left(\sqrt{\frac{E_b}{N_0}}\right)$$

The simulation is done as follows:

A randomly generated bit stream is generated and converted to BPSK waveforms. BPSK waveforms are transmitted through an AWGN channel with a fixed SNR . The received symbols are converted again to bits. The received bits are compared with transmitted bits and error is calculated.

As the energy increases, the error reduces , so bit error probability also decreases. The signal to ratio is then varied and the process is repeated. Monte Carlo simulation is used to calculate Bit error probability.

Monte Carlo simulation describes a simulation in which a parameter of a system, such as the bit error rate (BER), is estimated using Monte Carlo techniques. Monte Carlo estimation is the process of estimating the value of a parameter by performing an underlying stochastic, or random, experiment.

Algorithm:

Step 1 Define message frequency, carrier frequency and amplitude.

Step 2 Define sampling frequency (about 30 time's carrier frequency).

Step 3 Define the time period for which the waveform has to be plotted.

Step 4 Generate a random binary data stream (0's and 1's) to modulate.

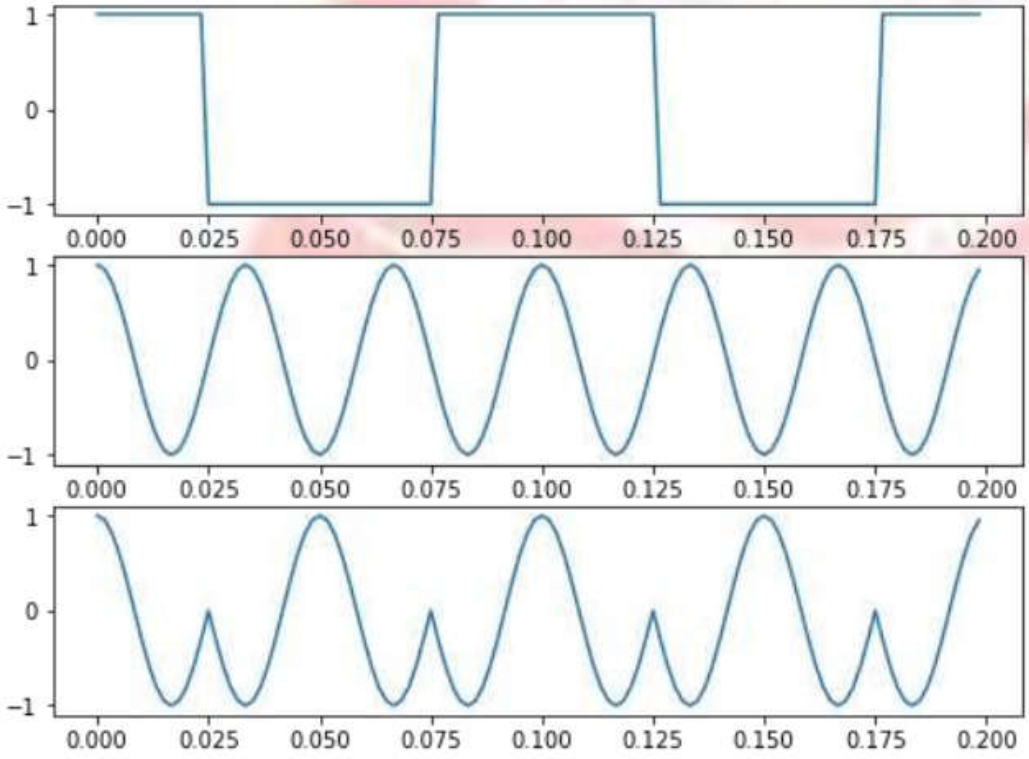
Step 5 If the binary bit is 0 then multiply the carrier signal by -1 otherwise use the same carrier.

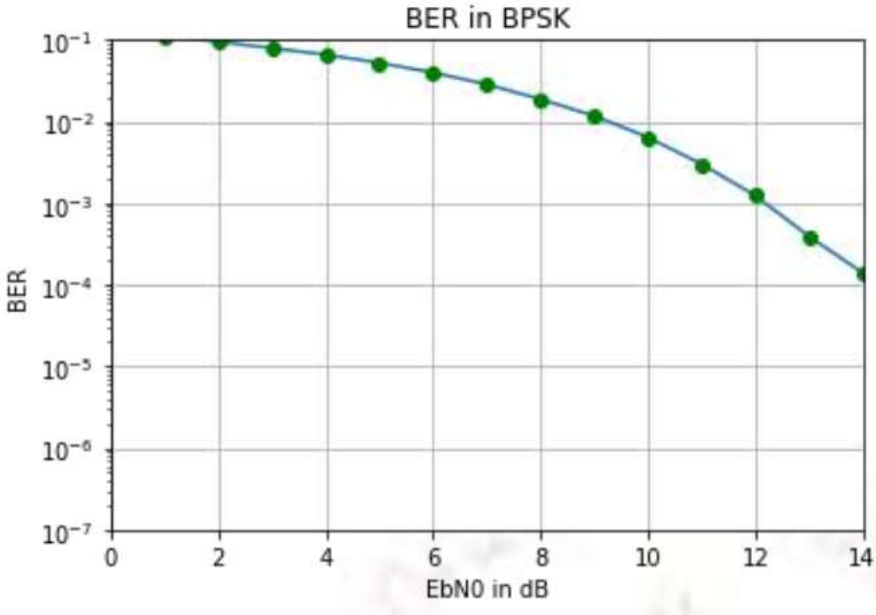
Step 6 Plot the waveform.

Monte Carlo simulation

1. Mention the no. of samples taken
2. Specify the range of Eb/No
3. Simulate BPSK modulator , AWGN channel, and detector.
4. Find errors.
5. Find BER for each value of Eb/No and store it as an array.
6. Plot the graph BER vs Eb/No.

Expected graphs and waveforms


1
0
−1
0.000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200


BER in BPSK
BER
EbN0 in dB
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
2
4
6
8
10
12
14

Program :

(input your programs)

Result :

BPSK signal is encoded with energy per bit E_b. BPSK modulated signal is transmitted via an AWGN channel with variance $N_0/2$. BPSK signal is detected using an ML decoder and the probability of error as a function of SNR per bit E_b/N_0 is plotted.