ECE F311 COMMUNICATION SYSTEMS

Experiment 11

Name: ANANTHA SAI SATWIK VYSYARAJU

ID NO: 2019A3PS1323H

Section: P1

Title: Binary Phase Shift Keying (BPSK)

Aim: This experiment is intended to make the student perform experiments on BPSK and its demodulations using MATLAB.

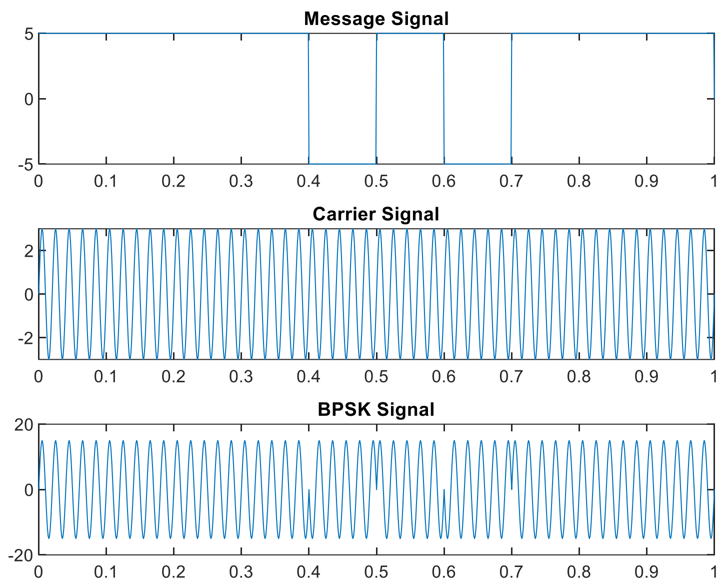
A – Generation of Binary Phase Shift Keying (BPSK) signal

Similar to ASK and FSK studied in Experiment 10, BPSK is also a continuous-wave digital modulation scheme. Here, the digital data represented in its NRZ-L form modulates the phase of a continuous-time high frequency carrier signal. Since binary digits occupy one of two level (logic '0' and logic '1'), the phase of the carrier needs to be switched between two values φ_0 and φ_1. Therefore, the modulated signal would be $A_c\cos(2\pi f_c t + \varphi_0)$ for one bit period, when the data is a logic '0' and $A_c\cos(2\pi f_c t + \varphi_1)$ for one bit period, when the data is a logic '1'. Note that the amplitude and frequency of the two carrier signals remain the same. At the receiver end, to minimize the chances of ambiguity in detection, we maximize the separation between φ_0 and φ_1. Since the carrier signals are periodic with 2π, we enforce $\varphi_0 - \varphi_1 = \pi$ (maximum possible separation). For ease of generating the BPSK signal, we choose $\varphi_0 = 0$, which leads the carrier signals for logic '0' and logic '1' to be $A_c\cos(2\pi f_c t)$ and $-A_c\cos(2\pi f_c t)$, respectively. Note that this can be easily implemented by multiplying the digital data in its NRZ-L form with a carrier signal $A_c\cos(2\pi f_c t)$ and dividing by the amplitude of the NRZ-L waveform.

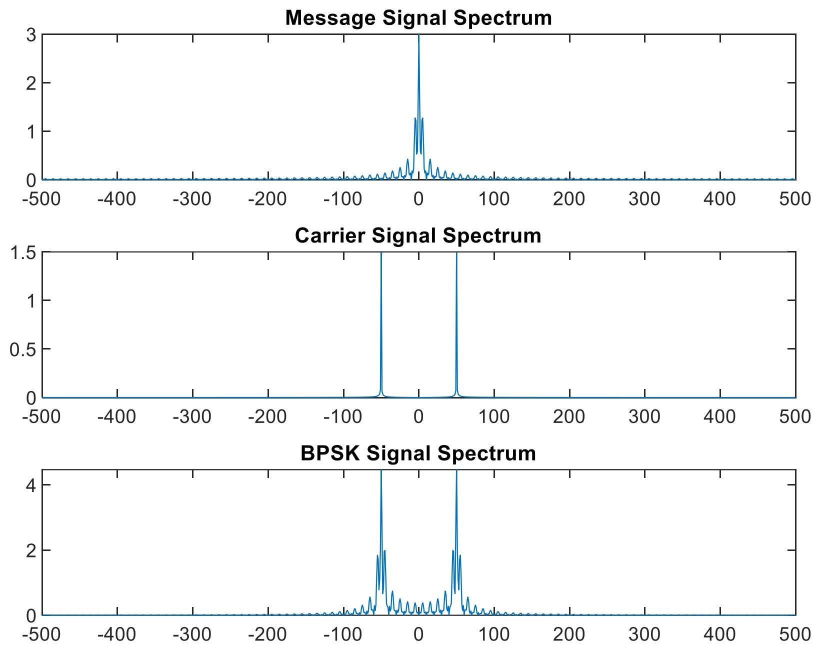
First, we will generate the BPSK signal.

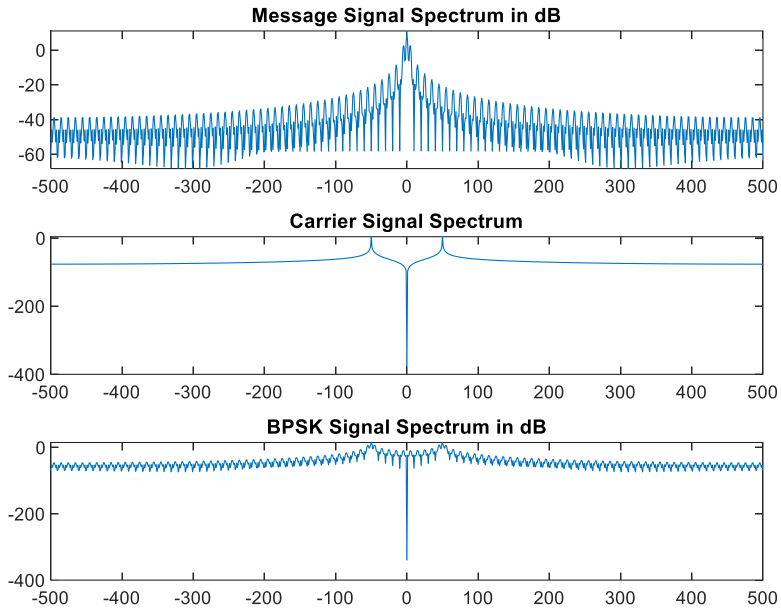
a) Generate 10 bits of data randomly. To do this, you may use the ***randi*** MATLAB command. Use a bit rate (R_b) of 10 bits per second.
b) Similar to Experiment 8, represent these data bits using NRZ-L format with 5 V and -5 V as the levels.
c) Generate a sinusoidal carrier signal of 3 V peak-to-peak value such that exactly 5 cycles of the carrier fit into one bit period (T_b).

d) The BPSK signal is obtained by multiplying the NRZ-L signal with the carrier signal and appropriately multiplying the product to obtain an amplitude of 3 V peak-to-peak. Plot the data, the carrier and the BPSK signals one below the other in a single figure.



e) Obtain and plot the spectra of the data, the carrier and the BPSK modulated signals one below the other, both in ratio form and in the decibel scale.



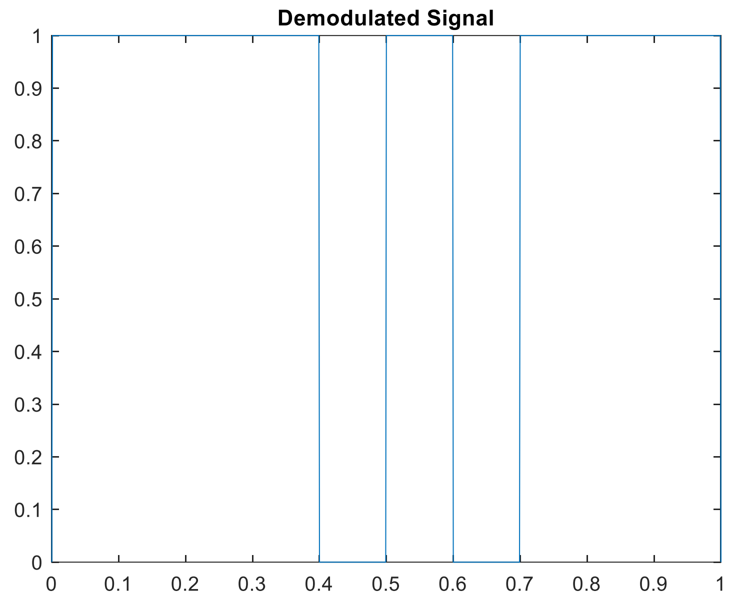


f) Vary the bit rate and the carrier frequency, one at a time, while ensuring that an integral number of complete cycles of the carrier fit into one bit period and observe the spectrum of the modulated signal. What do you observe?

The peaks in the frequency spectrum become less noticeable as the bitrate is increased while the number of cycles remains constant. The gaps in the frequency spectrum of the modulated signal shrink as the number of cycles in one-bit period increases.

B – Demodulation of an BPSK signal

The BPSK signal can be demodulated using coherent detection. The modulated signal is multiplied with the carrier signal. If the sum of products over one bit period is a nonnegative number, it is detected as a '1,' and if not, it is decoded as a '0'.



C – Conclusions

We plotted the random bits generated as well as the carrier signals in this experiment. We used Binary Phase Shift Keying(BPSK) modulation techniques to modulate the generated bits. When the bitrate and carrier frequency change independently, we've seen variations in the frequency spectrum. Finally, we used the coherence detection approach to demodulate the above modulated signals and plot the demodulated signals.