Indian Institute of Technology, Kharagpur

Department of Electronics & Electrical Communication Engineering

Subject: Digital Communication Laboratory (EC 39001)
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Experiment 4: BPSK Demodulation

Objective: To implement the demodulation circuit for a BPSK modulated random bit sequence.

Major Components: IC 741 op-amp, Diodes, resistors, breadboard, oscilloscope, function generator, supply voltage, connecting wires.

Theory

For the demodulation, we will follow a procedure which includes differential amplifier followed by envelop detector and comparator.

We know that the BPSK signal can be expressed as –

$$S_1(t) = +\sqrt{P_r}\cos(2\pi f_c t), \qquad 0 \le t \le T_b \quad for\ binary\ 1$$
$$S_0(t) = -\sqrt{P_r}\cos(2\pi f_c t), \qquad 0 \le t \le T_b \quad for\ binary\ 0$$

Where P_r is the power of the received signal.

At the receiver, a noisy version of the BPSK modulated wave is received. However, for this experiment purpose, we assume that at the receiver, BPSK modulated wave is available without any noise added. We further assume that the carrier signal is available at the receiver and its power is same as the signal. We first employ a differential amplifier which can subtract the message signal from the carrier or vice versa.

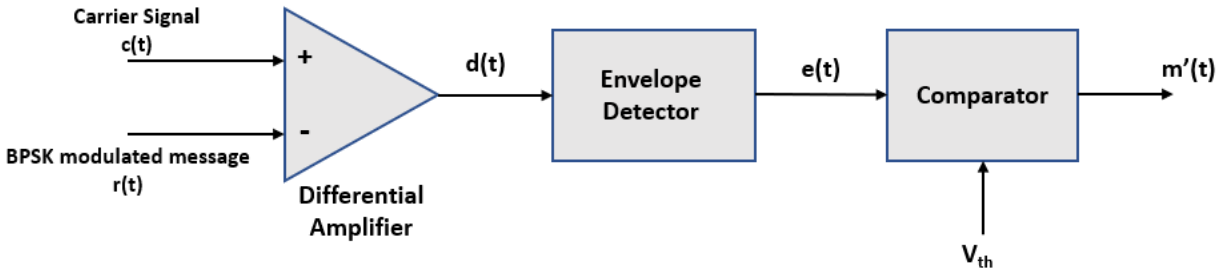
After the Differential Amplifier, the signal will be –

$$D_1(t) = \sqrt{P_r}\cos(2\pi f_c t) - \sqrt{P_r}\cos(2\pi f_c t) = 0, \qquad 0 \le t \le T_b \quad for\ binary\ 1$$
$$D_0(t) = \sqrt{P_r}\cos(2\pi f_c t) - (-\sqrt{P_r}\cos(2\pi f_c t)) = 2 * \sqrt{P_r}\cos(2\pi f_c t), \qquad 0 \le t \le T_b \quad for\ binary\ 0$$

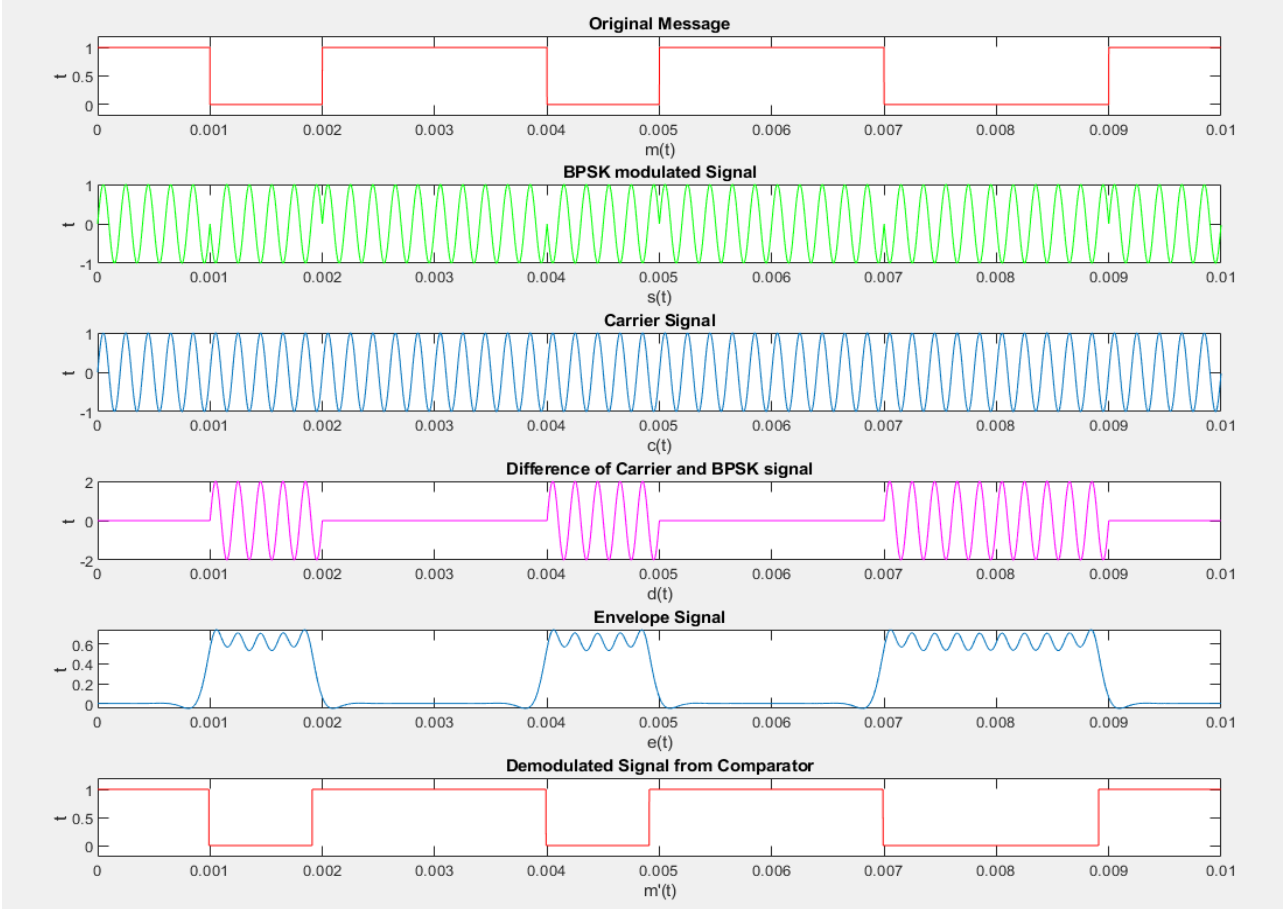
Now if we pass the signal through an Envelop Detector, we can get a low frequency signal which is Zero when the message signal is 1 and some positive voltage when the message signal is 0. Further, the envelop signal is given to a voltage comparator which compares the output of the envelop detector with an appropriate threshold. The output of comparator will be such that the output is High when the envelop is less than the threshold and Low otherwise.

BPSK Demodulator

The block diagram of BPSK demodulator consists of a **differential amplifier** followed by an **envelope detector** and **a comparator**. The diagram is as follows.



The Signals plotted at different stages of the demodulation is given below



Expected Outcome: Taking the signal encoded by the BPSK modulator designed in Experiment-3 as input, implement a BPSK demodulator that gives the original PN sequence as an output. Assume the carrier signal is available at the demodulator side.

References:

1. Proakis, John G., and Masoud Salehi. *Digital communications*.