<u>German Jordanian University</u>

Department of Communication Engineering

Digital Communication Systems Lab

CME 313-Lab

Experiment 7

Binary Frequency-shift keying (BPSK)

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Experiment 6

Binary Phase-shift keying (BPSK)

Objectives:

By the end of this experiment, the student should be able to:

- Generate and demodulate Binary phase shift keying shift keyed (BPSK) signal.

Introduction

In PSK (Phase Shift Keying), the phase of a carrier is changed between two values according to the binary signal level. The information about the bit stream is contained in the phase changes of the transmitted signal. For instance to transmit the signals “0” and ”1”, PSK signals can be chosen as follows:

$S1=A\cos(2\pi t+\Theta 1)$

$S2=A\cos(2\pi t+\Theta 2)$

Here, $\Theta 1$and $\Theta 2$ are constant phase shifts. For Binary PSK (BPSK) the state of $\Theta 1- \Theta 2= 180$ simplifies the modulator design. Moreover, π radian between phases of PSK signals will be most appropriate from error-performance point of view. For example, ($\Theta 1$, $\Theta 2$) phase values can be chosen as $(0, \pi)$ or $(\pi/2, 3\pi/2)$.

The time domain illustration of a BPSK signal waveform is given in Fig.1

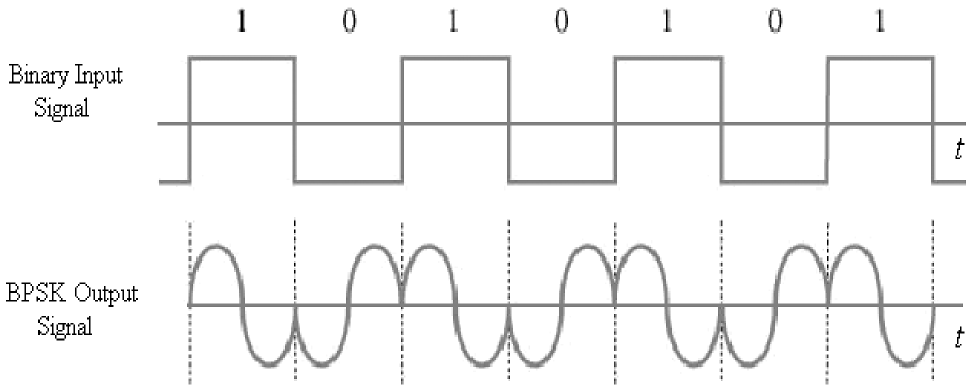

Figure.1 Binary Input Signal and BPSK Output

BPSK Generation

A block diagram of a basic BPSK modulator is shown in Fig.2.

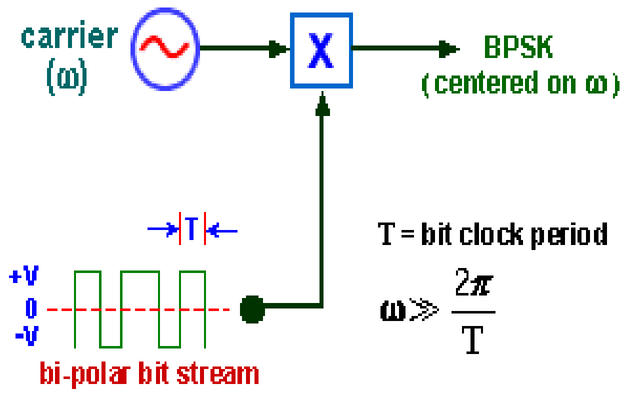

Figure.2 Binary Shift Keying Modulator

As seen from the Fig.2, a sinusoidal waveform is multiplied by the input bit stream. Each time the bit stream changes sign (by crossing zero level), the phase of the PSK signal also changes.

Demodulator of BPSK

Demodulation of a BPSK signal can be considered a two-stage process.

- Translation back to baseband, that is, recovery of the bandlimited message waveform.
- Regeneration from the bandlimited waveform the binary message bit stream.

Translation back to baseband requires a local, synchronized carrier.

Stage 1

Translation back to baseband is achieved with a synchronous demodulator, as shown in Fig.3. This requires a local synchronous carrier. Using phase locked loop, carrier can be extracted from the signal if a low power carrier is transmitted with the signal. Else, Costas loop or squaring may be used to synthesize the carrier reference from the signal. In this experiment, for simplicity, a stolen carrier from transmitter will be used.

Stage 2

The translation process does not reproduce the original binary sequence, but a bandlimited version of it. The original binary sequence can be regenerated with a detector. This requires information regarding the bit clock rate. If the bit rate is a sub-multiple of the carrier frequency then bit clock regeneration is simplified. In this experiment, the DECISION MAKER module is used for the regeneration.

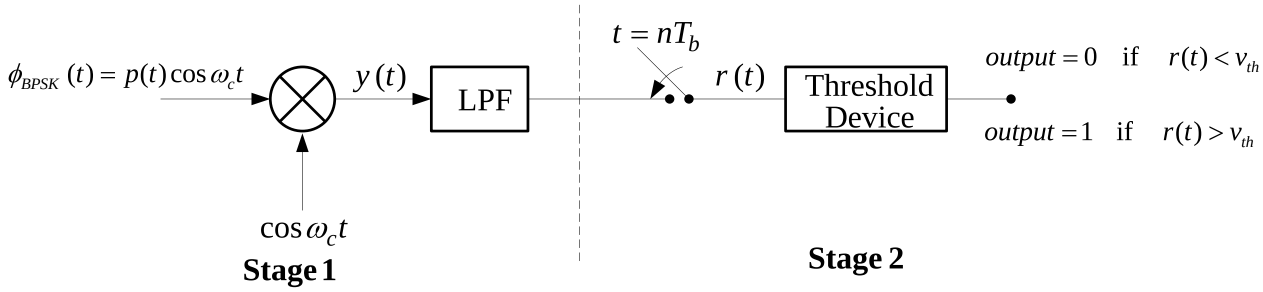

Figure.3 Binary Phase Shift Keying Synchronous Detection

Procedure:

***Part l:* Generation of BPSK :**

1- Construct the TIMS model of the bpSK modulator as shown in below **Fig.4.**

2- Before plugging the SEQUENCE GENERATOR module in locate the on-board switch SW2 and set both toggles UP.

3- Set the frequency of the signal at the output of the AUDIO OSCILLATOR to 8 kHz. Set the MULTIPLIER to DC position.

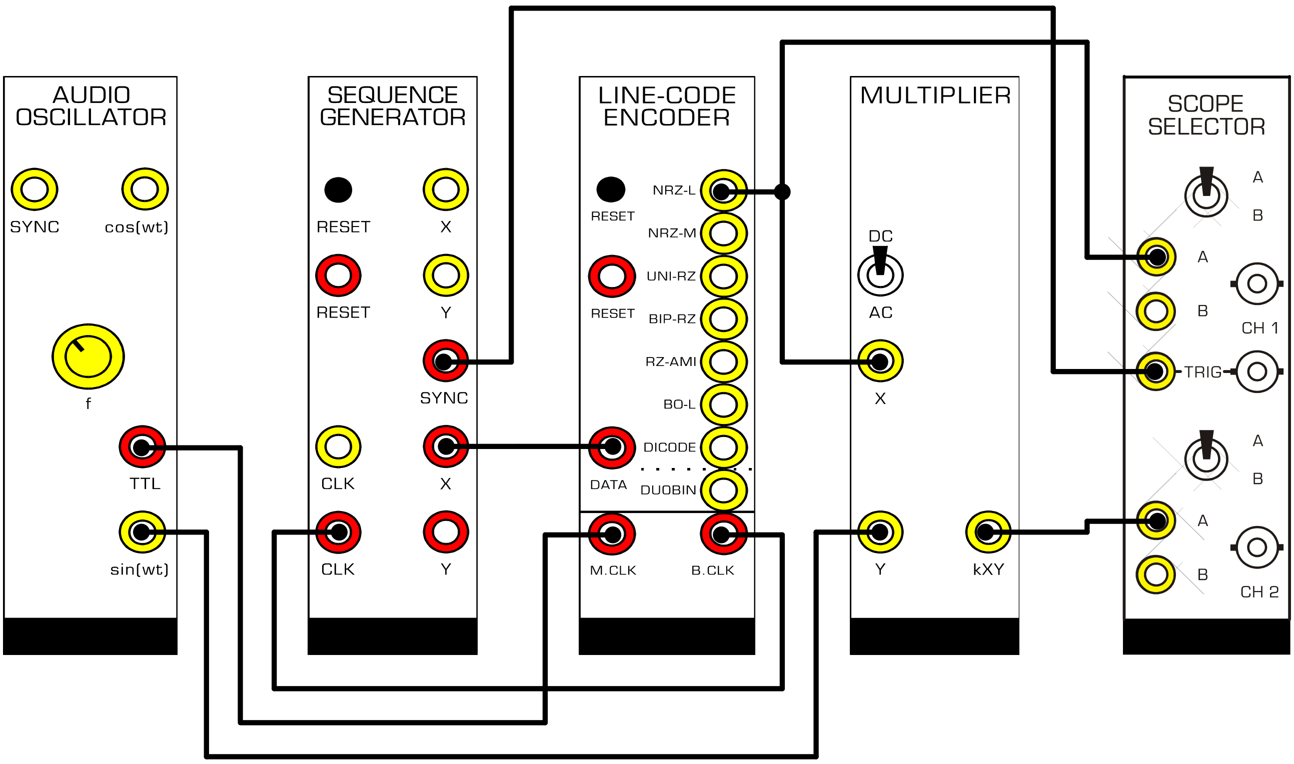

Figure. 4 TIMS Model of BPSK Modulator

- **What do the signals at point X and point Y of the MULTIPLIER represent?**
- **Save and print the signals at X point of SEQUENCE GENERATOR module and that at the output of LINE-CODE ENCODER module.**
- **Save the signals at the inputs of multiplier (X&Y) and its output (KXY).**
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- **What does the signal at the output of the MULTIPLIER represent?**
- **What is the relation between the phase of output of the MULTIPLIER and the phase of the carrier when the signal at X point is in the 0 state?**
- **What is the relation between the phase of output of the MULTIPLIER and the phase of the carrier when the signal at X point is in the 1 state?**
- **Measure the bit period (T_b) and calculate the bit rate (R_b).**

Part ll: Synchronous Detection of BPSK Signal

1- Construct the TIMS model of the BPSK demodulator as shown in below Fig.5.

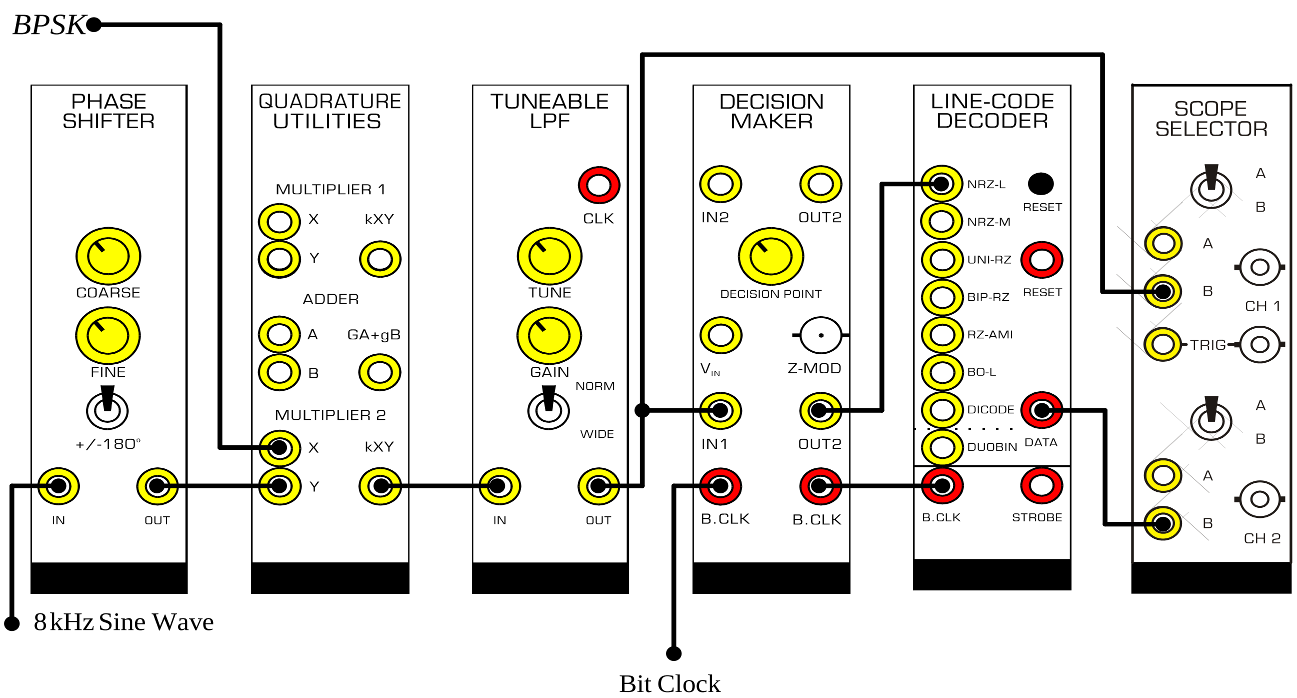

Figure.5 TIMS Model of Synchronous Demodulator of BPSK

2- Before plugging in the DECISION MAKER:

a) Switch the on-board switch SW2 to ‘INT’.

b) Select the NRZ-L line code with the on-board rotary switch SW1.

3- Before plugging in the PHASE SHIFTER, set the on-board switch SW1 to LO range.

4- Adjust TUNE and GAIN controls of the TUNEABLE LPF such that the signal at CH1-B is the best approximation for the envelope of the signal at CH2-A.Use the PHASE SHIFTER control to maximize the output of the LPF.

- **Save the signals at CH1-B and CH2-B.**
- **Write complete comments about the above two signals.**
- **Is the phase of the signal at CH2-B(output of LINE-CODE DECODER) the same as that at CH1-A(input of LINE-CODE ENCODER)?**

5- Toggle the front panel 180° **switch of the receiver PHASE CHANGER.**

- **What happen to the phase between the signals at CH2-B and that at CH1-A? Explain?**