German Jordanian University

Department of Communication Engineering

Digital Communication Systems Lab

CME 313-Lab

Experiment 8

Binary Frequency-shift keying (BPSK)

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Experiment 7

Binary Frequency-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 (BFSK) signal.

Frequency-Shift Keying Modulation

Frequency-shift keying modulation is a form of frequency modulation (FM) where the modulating waveform is a digital waveform. In this system the amplitude of the carrier is constant while its frequency is switched directly from one frequency to another by the modulating signal. Although there could be more than two frequencies involved in an FSK signal, in this experiment the message will be a binary bit stream, and so only two frequencies will be involved.

. The output from such a generator is shown in Fig.1. f_1 is called the mark (binary 1) frequency and f_0 is called the space (binary 0) frequency.

Since FSK is an FM signal we can find its bandwidth (BW) according to Carson's rule:

$$\text{BW} = 2(\Delta f + B)$$

Where B is the BW of the baseband signal and $\Delta f = (f_1 - f_0)/2$. If we take B to be the first null BW for the polar signal, then $B = \text{bit rate}\,(R_b)$. Thus:

$$\text{BW} = 2(\Delta f + R_b)$$

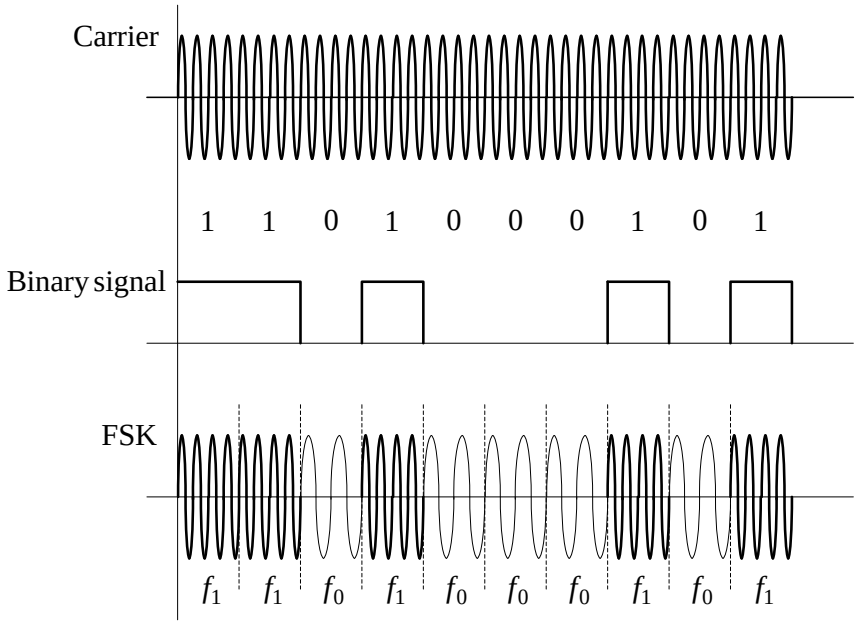

Fig.1 Frequency Shift Keying Signal

BFSK Generation Using CPFSK

The CPFSK can be generated by using a single voltage-controlled oscillator (VCO). The output frequency of the VCO is altered by the modulating signal as shown in Fig.

Fig.2 CPFSK Modulator

This FSK [$\phi_{FSK}(t)$] signal is represented by:

$$\phi_{FSK}(t) = A\cos\left[\omega_c t + k_f \int_{-\infty}^{t} m(\lambda)d\lambda\right]$$

Where $m(t)$ is the binary signal, k_f is a constant and f_c is the free running frequency for VCO. Note $m(t)$ is discontinuous at the switching time but $\phi_{FSK}(t)$ is continuous.

BFSK Demodulation:

Phase Look Loop:

The block diagram of a phase locked loop (PLL) is shown in Figure 1. The principle of operation is simple. Suppose there is a non-modulated carrier at the input. If the VCO was tuned precisely to the frequency of the incoming carrier (ω_0), then the instantaneous output would be a DC voltage of magnitude depending on the phase difference between the output of the VCO and the incoming carrier. Now suppose the incoming carrier started to drift slowly in frequency, then the output voltage will vary according to the frequency variation. If the incoming carrier is frequency modulated by a message, the output of the PLL will follow the message.

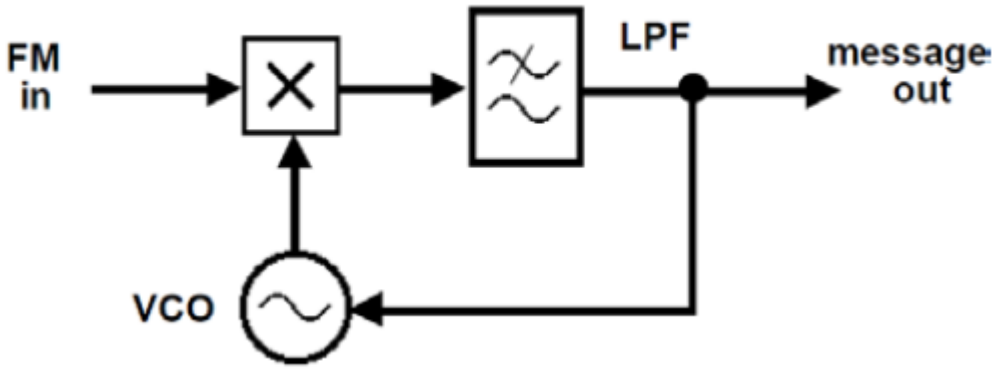

Figure3. Phase Look Loop (PLL)

Procedure:

***Part I* :Generation of CPFSK Signal**

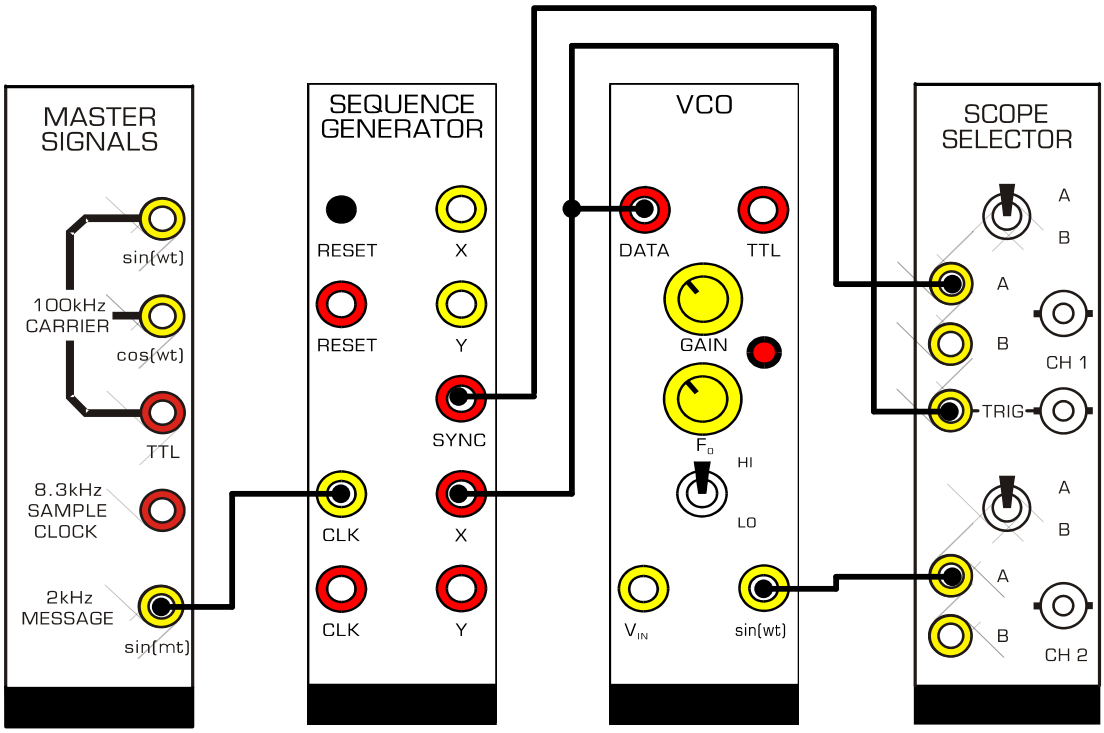

Fig. 4 Generation of CPFSK Signal Connection Diagram

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

2- Before plugging the VCO module, use the on-board switch to select the FSK mode of operation. Turn FSK2 control fully clockwise and Set FSK1 to mid position.

3- Connect the circuit shown in Fig. 4 Set the front panel toggle switch of the VCO to LO position.

- **Using the PICO SCOPE (OSC), save the DATA signal and the signal at the output of VCO.**
- **What does each of the signals represent?**
- **Is there any discontinuities in the FSK signal?**

- **Measure the bit period (T_b) and calculate the bit rate (R_b).**
- **Measure the f_0 and f_1 frequencies.**
- **Calculate the BW of the FSK signal.**

***Part ll* :Demodulation of CPFSK Signal**

1- Before plugging in the DECISION MAKER:

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

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

2. Model the PLL demodulator illustrated in Figure 1.
   - For the filter use RC LPF provided in the Utilities Module.
   - In the Multiplier module set the toggle switch to AC.
   - Before plugging the VCO module, use the on-board switch to select the VCO mode of operation.

3. Patch wire from output of LPF to the input of DECION MAKER DEVICE
   - Save the the signal at the output of LPF and the output of DECION MAKER DEVICE.
   - Comapare between original data and recovered data.