# ECE 440L

# Experiment Y: M-ary PSK Modulation and Demodulation (1 week)

## I. OBJECTIVES

Upon completion of the M-ary PSK experiment, you should be able to:

1. Construct and test the M-ary PSK system described in Figures 1 and 2.
   a. Use proper cut-off frequencies for reconstruction filters.
   b. Adjust system to obtain signal voltages with the appropriate amplitude and phase.
2. Using an 8.3 kHz bit-rate and a ($2048 = 2^{11}$) PN Sequence as an input signal, obtain time domain displays for: QPSK = 4-PSK, 8-PSK, and 16-PSK constellations. Constellations may be displayed on the scope by " i vs. q " from M-Level Encoder.
3. Using an 8.3 kHz bit-rate, a 2048 PN Sequence, and a 100 kHz Carrier, obtain time and frequency domain (PSD) displays for:
   a. The QPSK (= 4-PSK ) Channel.
   b. The output of a demodulating multiplier and its reconstruction filter.
4. Using an 8.3 kHz bit-rate, a 2048 PN Sequence, and a 100 kHz Carrier, compare at least 16 bits of the output PN Sequence with the input. Be observant.

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A. Design experiment(s) to investigate effects of whatever interests you. Keep it focused.[1]
   a. Include: A clear objective -- sometimes, you just want to try something;
      An understandable procedure – include sketch of set-up;
      Results – attach print-outs if appropriate;
      Conclusions – be concise and accurate,
   b. Specify the system gains and selector switch positions. (Get TA help if needed.)
   c. Use proper cut-off frequencies for anti-aliasing and reconstruction filters.
   d. Clearly specify measurements, including where measured in the system.

B. Instead of the 2048 PN Sequence, insert a digitized audio input. Use an 8.3 kHz bit rate for the PCM Encoder and Decoder. Don't forget input and output filters. Organize your experiment to obtain some interesting results.

## II. PRELAB

1. Read your text: 8.1.1 thru 8.1.11
2. Visit a website showing figures similar to those on pages Y-4 and Y-5. Copy and attach the similar material from the website. (Cite the URL.)
3. Skim this lab and try to think of an experiment you might want to do.

[1] For example, a long PN sequence is used as an input test signal. Does the length of the input PN sequence really matter? You must have many other questions – focus on one and answer it.

## III.. INTRODUCTION.

Figures 1 and 2 show the block diagram and connection diagram of the QPSK system to be investigated for this experiment. The system can be used to generate several constellations for M-ary Phase-Shift Key systems as well as generate and demodulate 4-PSK (Quadrature PSK = QPSK) signals. The carrier frequency shown is 100 kHz and the bit-rate is 8.3 kHz.

On the pages following Figure 2, Table 1 and Figures 1, 3 and 7 are from:

**http://www.wj.com/documents/Tech_Notes_Archived/PSK_demod_part1.pdf**

This site is no longer available. These figures give a very quick overview of M-ary PSK.

NOTE: In Figures 1 and 2, below, phased carriers and bit-clock are supplied to the demodulator from the generator.

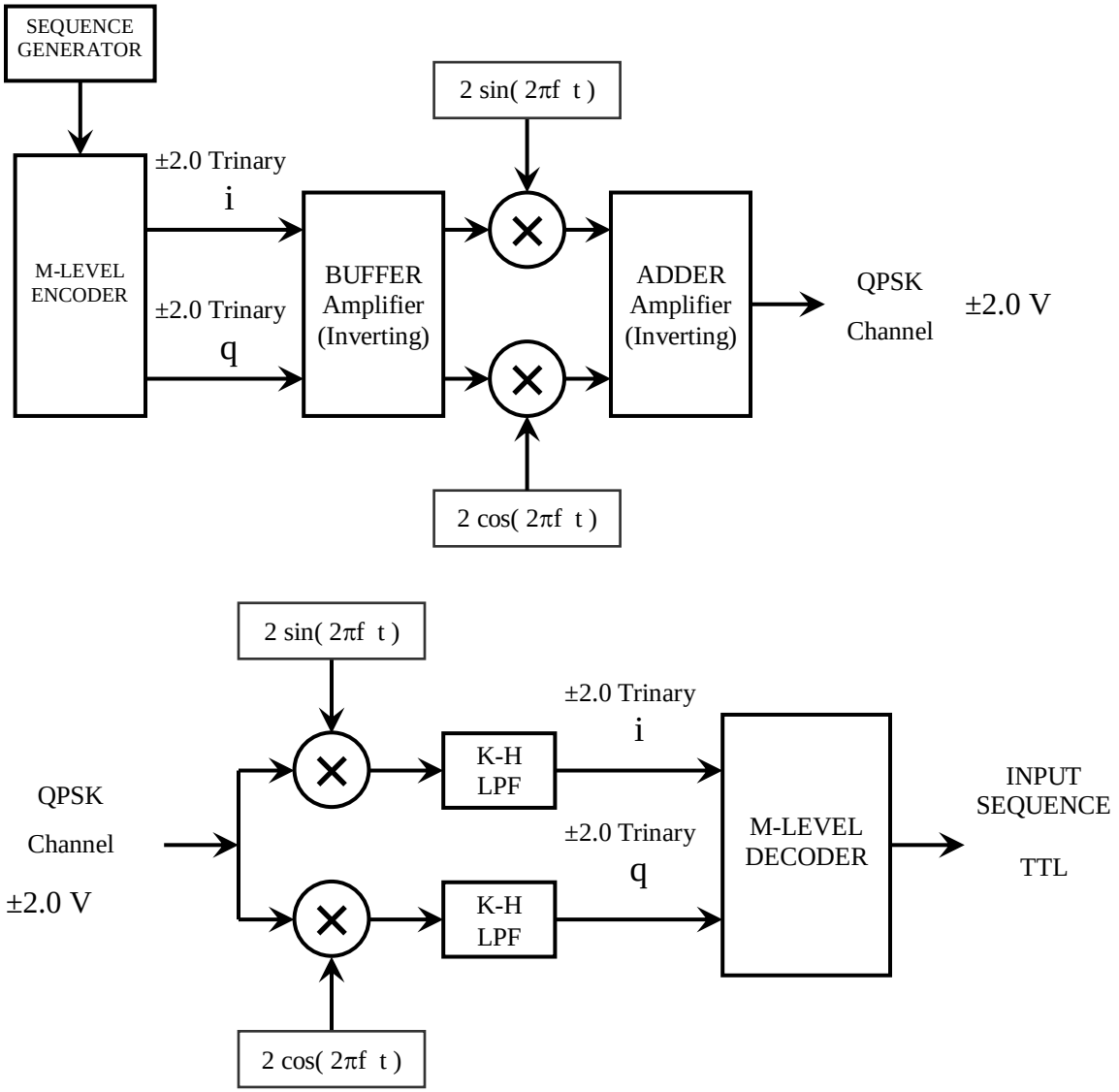


Fig.1. Block Diagram for QPSK System.

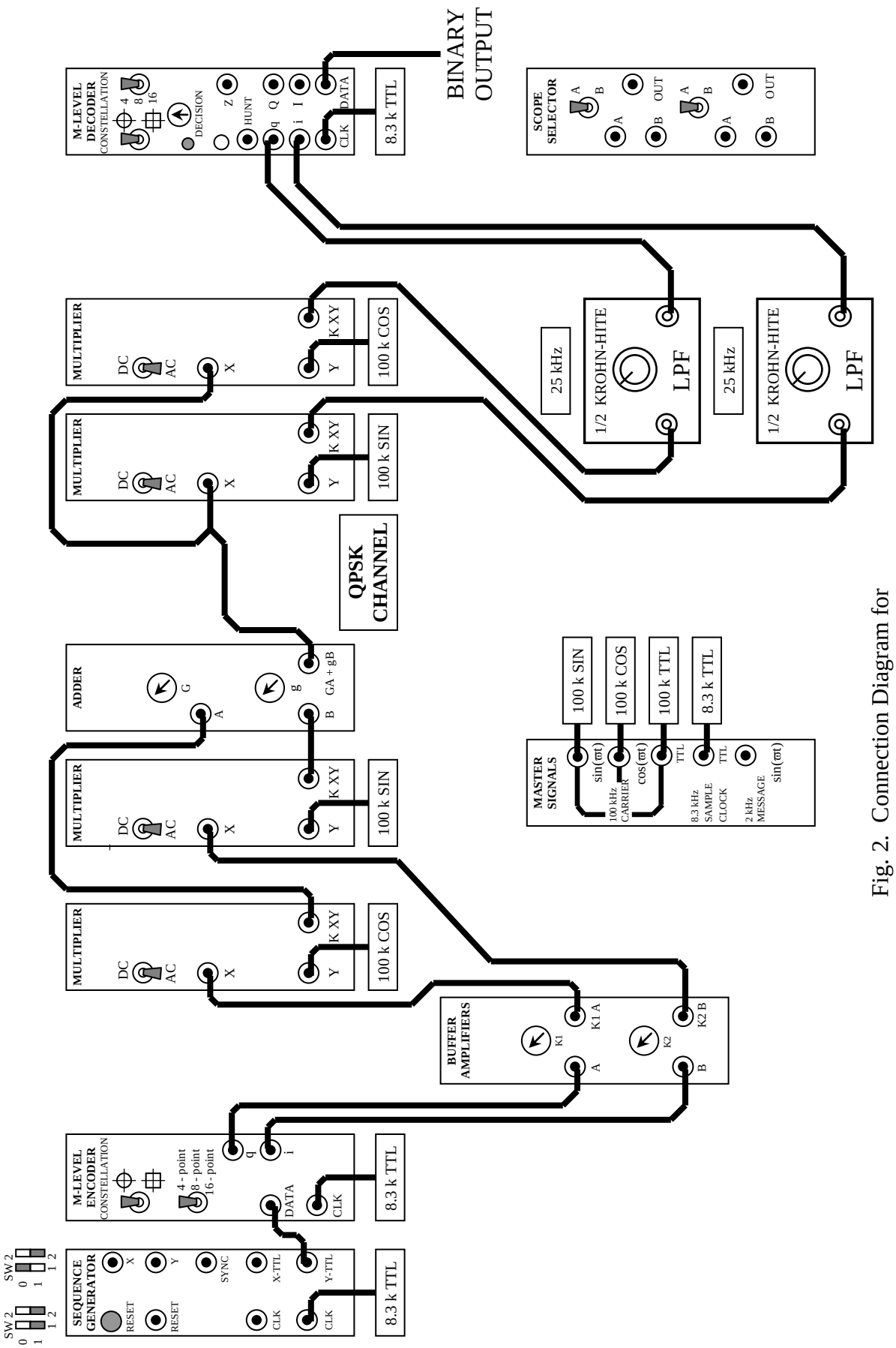


Fig. 2. Connection Diagram for QPSK System

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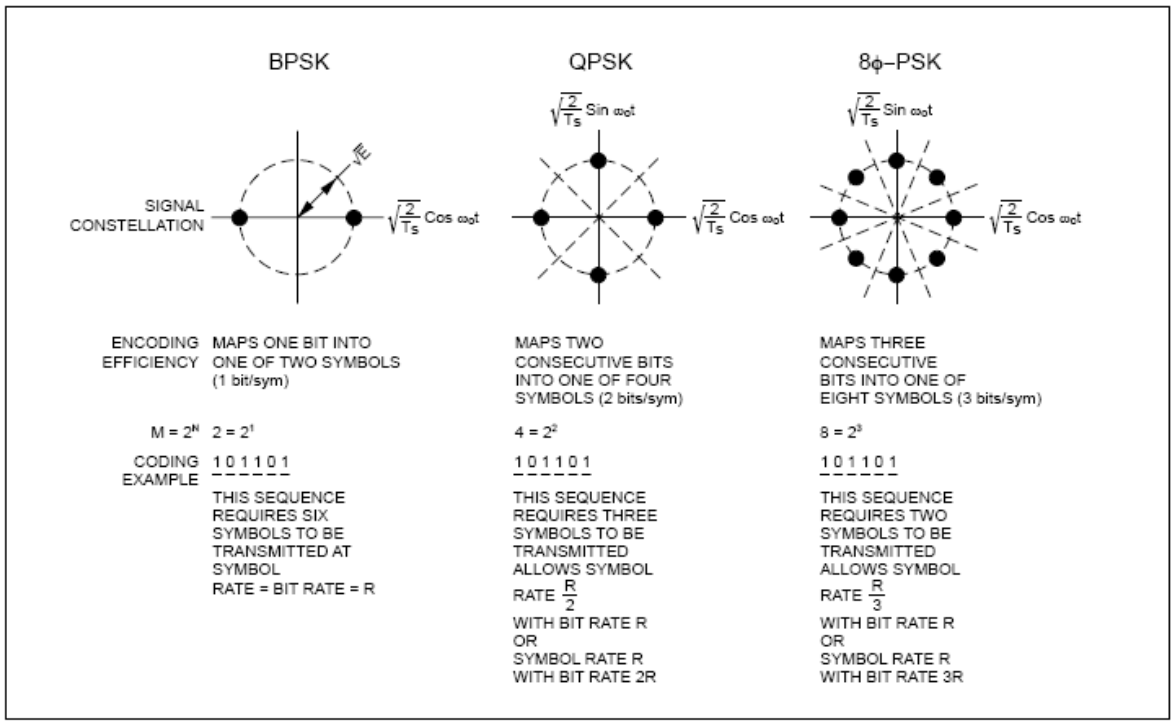


**Table 1.** Three common versions of phase-shift keying (BPSK, QPSK and 8ϕ-PSK).

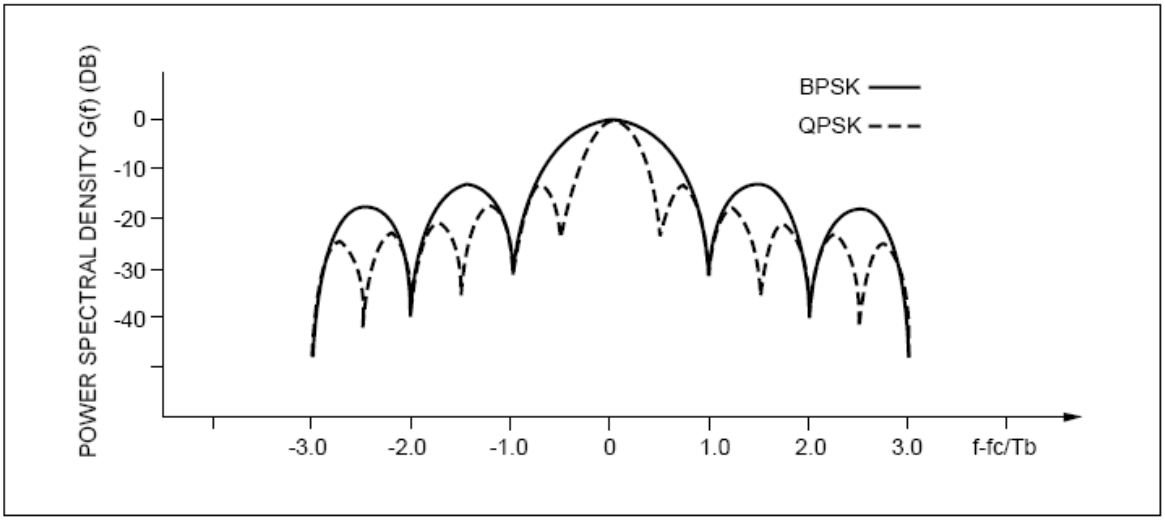


**Figure 1.** BPSK and QPSK spectra.

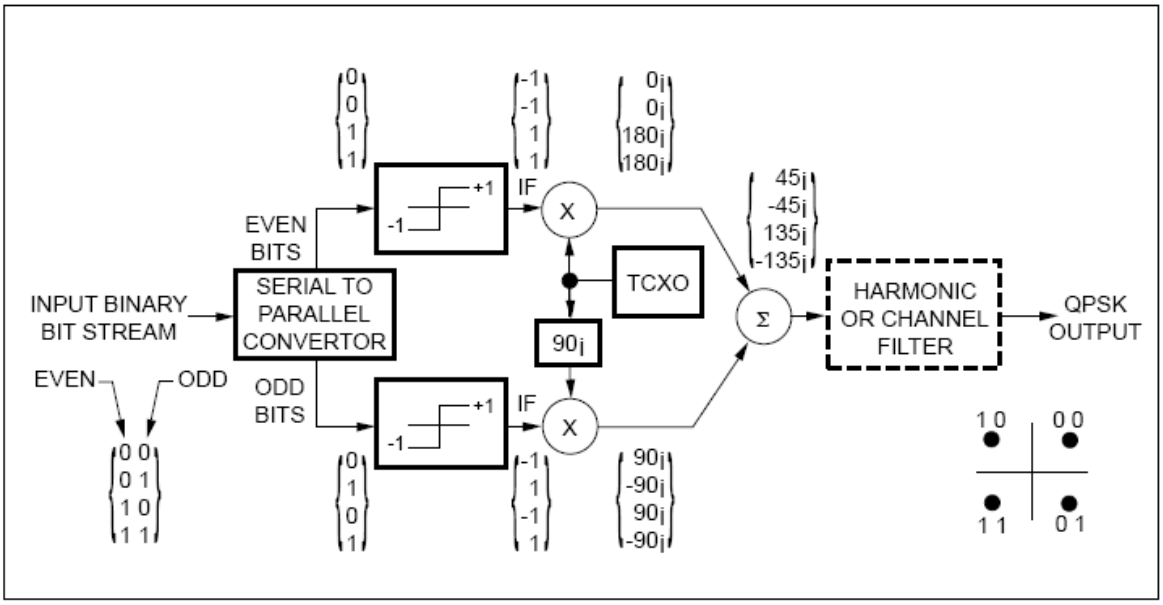


**Figure 3.** QPSK modulator.

NOTE:

The circuit of Figure 7 demodulates without a carrier from the modulating circuit.

The next trick would be to "steal" the bit clock from the data signal.

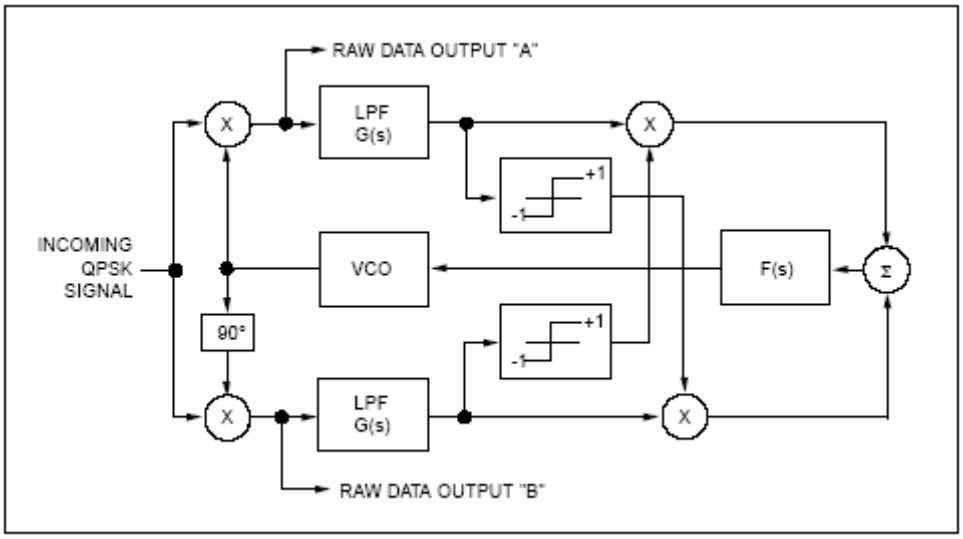


**Figure 7.** Modified (hard-limited) QPSK Costas loop.

IV. EXPERIMENT.

Perform experiments required to meet the stated objectives.
Record your procedures and results.