ELEC3302/ELEC4402:
COMMUNICATIONS SYSTEMS

Semester 1, 2013

Lab 2 (P2)
ASK and PSK Signal Generation and Demodulation

Environmental Systems Engineering Bldg.
Room 2.03, Project Laboratory

IMPORTANT:

1. Due date: **AC Lab2 Report: 11am**, **Thursday, May 23, 2013.**
Late Penalties: 10% of Lab Report marks will be deducted for each day late in the submission of the lab report and 1% for each hour overdue (to a maximum of 10% per day). Ensure all late submissions are time-stamped by the EECE General Office staff and the lab demonstrator is made aware of your late lab report submission and arrangements made for its collection.

2. All assignments/lab reports shall be submitted with a properly completed and signed assignment cover sheet

3. Total marks for Lab 2: 10% of unit assessment:

a) Lab attendance and completion of all experiments will constitute 3% of the unit assessment. Ensure the lab demonstrator checks your notes for the lab at the end of the lab.

b) The lab report will constitute 7% of the unit assessment.

Pre_Lab Reading

- Please read the lab manual (including the materials regarding the modulation kit that were released along with Lab One manual).

- In the labs, we will use a digital oscilloscope (Agilent Technologies Model: InfiniiVision DSO-X 2002A). You can download the manual of the oscilloscope from the following webpage: http://cp.literature.agilent.com/litweb/pdf/75015-97023.pdf

  From the manual please

  - Find the channel impedance of the FFT function of the oscilloscope
  - Learn how to save reference waveform files to a USB storage device

LAB ATTENDANCE AND COMPLETION (3%)

- For each lab experiment answer as many of the questions posed as possible as notes for the lab. The notes don't need to be neat but they should be legible.
- For the observed waveform and spectrum on the oscilloscope, obtain relevant screenshots and include them in your lab report, ask the lab demonstrator for assistance if necessary. Ensure lab demonstrator checks your notes for the lab at the end of the lab.

LAB REPORT (7%)

The lab report should consist of the following sections:

- **Aims**: State the aims of the this lab in one or two sentences
- **Methodology:** For each experiment briefly describe the experimental setup. Sketch a block diagram of the setup you are using.
- **Results**: For each experiment answer the questions posed. You do not need to show any derivation as in some cases these will be beyond the scope of the unit. BUT do include all final equations and a reference to the literature where their derivation is discussed.
- **Conclusions**: What have you learned from the lab, including issues that you weren't aware of (or was not evident) from the theory and any suggestions for improvements?

Equipment Required:

- Modulation Kit
- Oscilloscope

PRN and Spectrum of Baseband Binary Signals

a) What is the period of the 10 kHz PRN signal? Now what is the period of a 10 kHz periodic rectangular signal? Explain what effect the period of the PRN signal has on its spectrum? Explain what effect the 10kHz periodic rectangular signal has on its spectrum? (Hint: the parameter *m* of the PRN is 15, please refer to http://en.wikipedia.org/wiki/Linear_feedback_shift_register)

b) Setup a -2V to 2V volt 100 kHz PRN binary polar baseband signal. Display and sketch the spectrum of this signal. Now setup a 0 to 4 volt 100kHz PRN binary unipolar baseband signal and display the spectrum. What should be the difference between these two spectrum?

Binary Amplitude Shift Keying (ASK)

a) Generate an ASK signal where the modulating signal is a 10 kHz 1Vp-p unipolar periodic rectangular signal and the carrier is a 100 kHz 2Vp-p sinusoidal signal. Obtain a clear display of this signal on the oscilloscope. Explain the form of the spectrum and correlate the powers in the carrier and the first sideband with that predicted by theory. (Hint: What is the relationship between the ASK passband spectrum and the modulating signal baseband spectrum?)

b) Change the modulating signal to a 10 kHz 1Vp-p unipolar PRN sequence and explain the form of the spectrum.

c) Change the modulating signal to a 1 kHz 2 Vp-p unipolar periodic rectangular signal. Select a loop filter between 10 and 100 Hz for a standard PLL and observe and explain the demodulated signal. Change the modulating signal to a 2kHz 2Vp-p unipolar periodic rectangular signal and explain the change in the shape of the demodulated signal. For both cases take sketches of both the modulating signal and corresponding demodulated signal so that you can compare them.

d) Change the modulating signal to a 1 kHz 1Vp-p unipolar PRN sequence, select proper loop filter and get a stable demodulated signal. Display and sketch an eye diagram for the demodulated signal. (for more information about eye diagram, please refer to http://www.onsemi.com/pub_link/Collateral/AND9075-D.PDF).

   Hints: Using alternating edge trigger, turn on persistence display option, and scale horizon timing properly to display no more than two eyes.

e) Use the oscilloscope to generate a 5 volt noise (offset=0V, amplitude = 5V), and then apply it to the modulated signal in step d). Display and sketch the eye diagram of the demodulated signal.

Binary Phase Shift Keying (BPSK)

a) Generate a binary PSK signal by using a 100kHz 2Vp-p sinusoidal carrier and a 10 kHz 1Vp-p polar periodic rectangular signal. Determine the phase that a logic 1 (0.5V) and a logic 0 (-0.5V) are encoded with using the oscilloscope. Note that the generation of BPSK is similar to the generation of binary ASK, by just changing the signal from the unipolar to polar form.

b) Change the modulating signal to a 10 kHz 1Vp-p polar PRN sequence. Observe the spectrum of this signal. Apart from the carrier impulse, is the spectrum identical with that obtained in part b) of ASK above? Explain.

c) Change the modulating signal to a 1 kHz 2Vp-p polar periodic rectangular signal. Since such a BPSK signal does not have a carrier impulse, a standard PLL cannot be used to demodulate it. However, a COSTAS PLL as shown below can be used. Implement such a PLL (use a loop filter of 25 Hz) and observe the demodulated signal. Explain whether demodulation is successful.