Universiti Malaysia PAHANG
Engineering • Technology • Creativity

Faculty of Electrical & Electronics Engineering
BEE3413 Principles of Communication Systems

LAB 2

Mapping CO, PO:
CO 04: Use and apply modern computational techniques and tools to measure the parameters for analog and digital communication system.
PO 05: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.

Learning Outcomes:

By the end of the experiment, students should be able to:

- Investigate the process of digital modulation
- Understand the theory and apply the concept of binary FSK and PSK modulation

Equipment needed:

- Waveform generator 33521A
- Digital oscilloscope DSO-X3024A

Project Task:

In digital communications, the modulation process corresponds to switching or keying the amplitude, frequency, or phase of a sinusoidal carrier wave according to incoming digital data. Three basic digital modulation techniques are amplitude-shift keying (ASK), frequency-shift keying (FSK) and phase-shift keying (PSK). You are required to investigate the properties of FSK and PSK using the equipment given above. Report your analysis and discussion based on the result obtained during experiment.

Instructions:

Setup your waveform generator and digital storage oscilloscope with an appropriate cable and value. Save all the displayed waveform in oscilloscope (use your own USB flash drive). Prepare a short report in IEEE format of your findings. No plagiarism is allowed.

PART A: FSK

Frequency-Shift Keying (FSK) is a form of digital modulation that represents digital data solely through discrete variations in the frequency of a carrier signal. Equation (1) gives the equation for FSK signal

$$v_{FSK}(t) = V_c \cos\left\{2\pi\left[f_c + v_m(t)\Delta f\right]t\right\} \qquad (1)$$

Where: $v_m(t)$ = digital information (modulating) signal (+1 or -1 volt)

V_c = carrier amplitude (volt)

f_c = analog carrier frequency (hertz)

Δf = frequency shift: change in the carrier frequency (Hz)

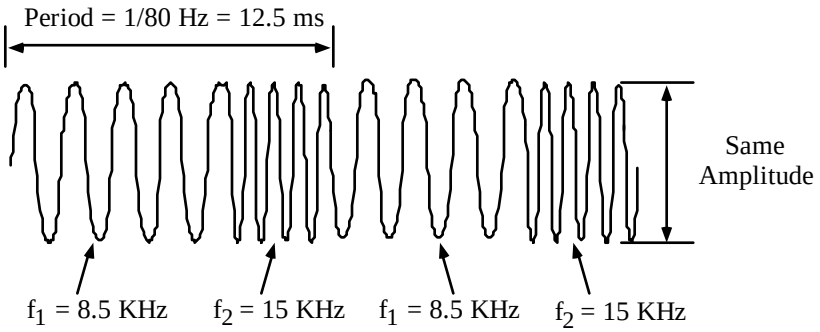
1. You are required to generate an FSK signal based on *equation (1)*.
2. Set the Agilent 33120A to give an FSK signal with Vppk = 500 mV.

   $f_1 = f_0$ (8.5 KHz) [First Frequency]

   f_2 = 15 KHz [Hop Frequency]

   FSK Rate = 80 Hz [FSK Rate]

3. The FSK signal should look like:



4. To Set an FSK Waveform:
   (i) First set f_1 normally to 8.5 KHz and Vppk = 500 mV.
   (ii) Enter into FSK mode.

5. To Set the ñHopò Frequency: Set f_2 to 15 KHz.

6. To Set the FSK Rate: Enter 80 Hz as the FSK rate.

7. Observe the waveform with a long enough time base to see the FSK signal. You should see clearly the FSK signal.

8. While f_1 is fixed at 8.5 kHz, vary the hop frequency from 15 kHz to maximum 40 kHz (use step size of 5 kHz). What happen to the FSK signal? Observe, record, and discuss your results. Find out the frequency deviation for each observation.

PART B: PSK

Phase-shift keying (PSK) is a digital modulation scheme that conveys data by changing, or modulating, the phase of a reference signal (the carrier wave). PSK uses a finite number of phases; each assigned a unique pattern of binary bits. Usually, each phase encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular phase. Equation (2) below shows basic mathematical representation for binary PSK. The equation shows that 180° phase shift is used to differentiate binary input ó0ô from binary input ó1ô.

$$s(t) = \begin{cases} A\cos(2\pi f_c t) & \text{binary 1} \\ A\cos(2\pi f_c t + \pi) & \text{binary 0} \end{cases} \quad \text{é é é é .. (2)}$$

1. You are required to generate BPSK signal based on *equation (2)*. Then investigate other types of PSK : quadrature PSK and 8-PSK using the equipment above.
2. Set the following:

   f_1 = 50 kHz, PSK rate = 10 kHz,

   Vc = 50mVpp, phase shift = 180°.

   Observe, record and discuss your results.
3. Vary the phase shift to 90°. Observe, record and discuss your results.
4. Vary the phase shift to 45° Observe, record and discuss your results.
5. Based on equation 2, state the equation for both QPSK and 8PSK.

Appendix – how to operate equipments

1) Waveform Generator 33500B SERIES

a) Press Channel 1.
b) Press waveform>sine.
c) Press parameter>Channel 1 Parameters> Press Frequency= 50kHz, Press Amplitude 2mV
d) Press Modulate> CH1 Modulate>Press Type FSK>Press é .
e) Press Channel 1> output ON.

2) Oscilloscope DSO-X 3024A

a) Press Auto Scale> Press Default setup.
b) Rotate the knob just above channel 1.
c) For modulate the AM signal>Press> turn on> single.
d) For modified antenna frequency. Push Tune Horizontal.
e) Press trigger>back. For tuning purposes.
f) For save result. Press Save/Recall.