Heaven's Light is Our Guide

Rajshahi University of Engineering and Technology

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ECE 3208

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Lab Report 6: Study of Digital Modulation (ASK, FSK, PSK)

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Contents

Study of Digital Modulation (ASK, FSK, PSK)

Theory

Digital modulation transforms digital symbols into waveforms compatible with the transmission medium by varying the carrier signal's amplitude, frequency, or phase according to the digital data. The goal is to efficiently transmit data while maintaining signal integrity and minimizing errors. Common types include Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK) [1].

Amplitude Shift Keying (ASK)

Amplitude Shift Keying (ASK) is a type of digital modulation where the amplitude of the carrier signal is varied in accordance with the binary data. The general form of an ASK signal is:

$$s(t) = \begin{cases} A\cos(2\pi f_c t) & \text{if } m(t) = 1 \\ 0 & \text{if } m(t) = 0 \end{cases}$$

where A is the amplitude, f_c is the carrier frequency, and $m(t)$ is the message signal [2].

Frequency Shift Keying (FSK)

Frequency Shift Keying (FSK) is a type of digital modulation where the frequency of the carrier signal is varied according to the binary data. The general form of an FSK signal is:

$$s(t) = \begin{cases} A\cos(2\pi f_1 t) & \text{if } m(t) = 1 \\ A\cos(2\pi f_2 t) & \text{if } m(t) = 0 \end{cases}$$

where A is the amplitude, f_1 and f_2 are the frequencies for binary 1 and 0 respectively, and $m(t)$ is the message signal [3].

Phase Shift Keying (PSK)

Phase Shift Keying (PSK) is a type of digital modulation where the phase of the carrier signal is varied according to the binary data. The general form of a PSK signal is:

$$s(t) = A\cos(2\pi f_c t + \theta)$$

where A is the amplitude, f_c is the carrier frequency, and θ is the phase shift. For Binary PSK (BPSK), the phase shift θ is:

$$\theta = \begin{cases} 0 & \text{if } m(t) = 1 \\ \pi & \text{if } m(t) = 0 \end{cases}$$

where $m(t)$ is the message signal [4].

Required Apparatus

- ETEK DCS-6000-06 (ASK Modulation & Demodulation Kit)
- ETEK DCS-6000-07 (FSK Modulation & Demodulation Kit)
- ETEK DCS-6000-08 (PSK(BPSK) Modulation & Demodulation Kit)
- Oscilloscope
- Connecting Wires
- Power Supply
- Signal Generator (To make Square Waves to offset to mimic digital signal)

Diagrams

Circuit Diagram of ASK System

Figure 1: Circuit Diagram of ASK System

Circuit Diagram of FSK System

Figure 2: Circuit Diagram of FSK System

Circuit Diagram of PSK System

Figure 3: Circuit Diagram of PSK System

Procedure

1. The ASK Modulation & Demodulation Kit (ETEK DCS-6000-06) was connected to the power supply.
2. The signal generator was connected to the input of the ASK modulator to generate a square wave signal.
3. The modulated ASK signal was observed on the oscilloscope.
4. The output of the ASK modulator was connected to the input of the ASK demodulator.
5. The demodulated signal was observed on the oscilloscope and compared with the original input signal.
6. The above steps were repeated for the FSK Modulation & Demodulation Kit (ETEK DCS-6000-07) and PSK(BPSK) Modulation & Demodulation Kit (ETEK DCS-6000-08).

Observation

- In ASK, the amplitude of the carrier signal changes with the binary data: present for 1, absent for 0.
- In FSK, the frequency of the carrier signal changes with the binary data: f_1 for 1, f_2 for 0.
- In PSK, the phase of the carrier signal changes with the binary data: 0 for 1, π for 0.
- For ASK demodulation, the demodulated signal closely matches the original binary data by detecting the carrier signal's presence or absence, but it wasn't perfect.

Matlab Simulation

Code:

```
% Parameters
fs = 10000;            % Sampling frequency
```

```
t = 0:1/fs:0.1;         % Time vector for 100 ms
f_carrier = 1000;       % Carrier frequency
bit_rate = 10;          % Bit rate
bits = [1 0 1 1 0 1 0 0 1 0]; % Input digital signal

% Generate input digital signal (square wave)
input_signal = repmat(bits, fs/bit_rate, 1);
input_signal = input_signal(:)';

% ASK Modulation
ask_signal = input_signal .* sin(2 * pi * f_carrier * t);

% FSK Modulation
f1 = 500;  % Frequency for bit 0
f2 = 1500; % Frequency for bit 1
fsk_signal = (input_signal == 0) .* sin(2 * pi * f1 * t) +
↪ (input_signal == 1) .* sin(2 * pi * f2 * t);

% PSK Modulation
psk_signal = sin(2 * pi * f_carrier * t + pi * input_signal);

% ASK Demodulation
ask_demodulated = ask_signal .* sin(2 * pi * f_carrier * t);
[b, a] = butter(6, f_carrier/(fs/2));
ask_demodulated = filter(b, a, ask_demodulated);
ask_demodulated = ask_demodulated > 0.5;

% Plotting
figure;

% Plot input digital signal
subplot(5,1,1);
plot(t, input_signal);
title('Input Digital Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot ASK signal
subplot(5,1,2);
plot(t, ask_signal);
title('ASK Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot FSK signal
```

```
subplot(5,1,3);
plot(t, fsk_signal);
title('FSK Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot PSK signal
subplot(5,1,4);
plot(t, psk_signal);
title('PSK Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot ASK demodulated signal
subplot(5,1,5);
plot(t, ask_demodulated);
title('ASK Demodulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');
```

Output

Experimental Output

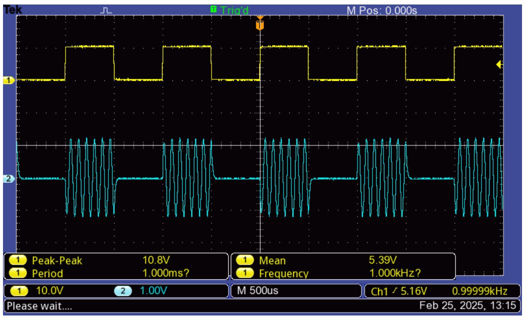

Figure 4: ASK Modulation; Message (Yellow), Modulated Signal (Blue)

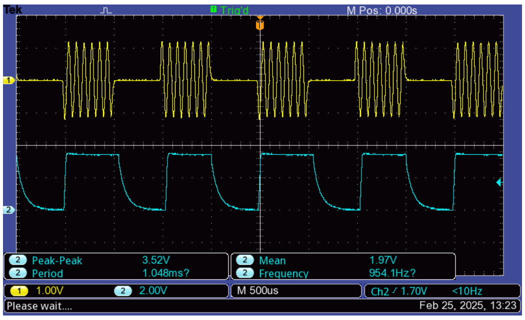

Figure 5: ASK Demodulation; Modulated Signal (Yellow), Demodulated Signal (Blue)

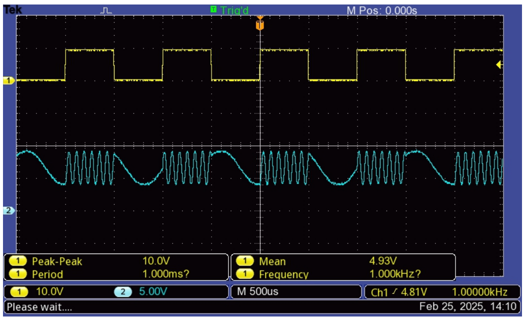

Figure 6: FSK Modulation 1; Message (Yellow), Modulated Signal (Blue)

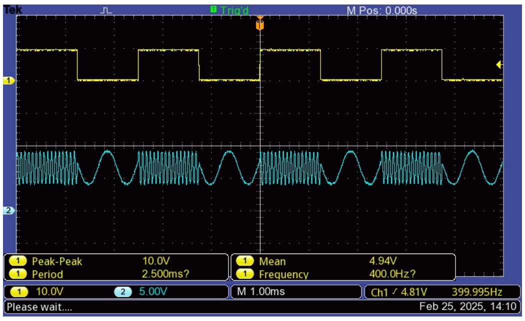

Figure 7: FSK Modulation 2; Message (Yellow), Modulated Signal (Blue)

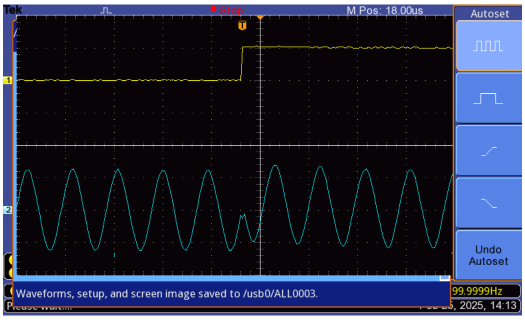

Figure 8: PSK Modulation 1; Message (Yellow), Modulated Signal (Blue)

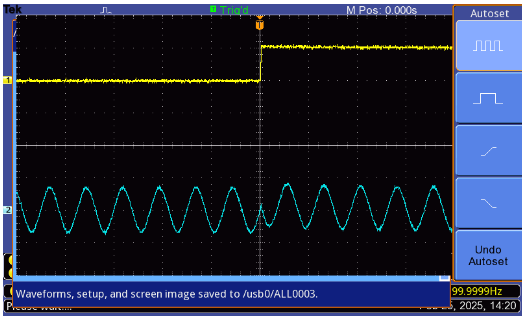

Figure 9: PSK Modulation 2; Message (Yellow), Modulated Signal (Blue)

Matlab Simulation Output

Discussion and Conclusion

The experiment aimed to study digital modulation techniques: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK). Using specific modulation and demodulation kits, we observed the modulated and demodulated signals on an oscilloscope and compared them with the original input signals.

In ASK, the carrier signal's amplitude changed with the binary data, present for 1 and absent for 0. In FSK, the frequency changed, with f_1 for 1 and f_2 for 0. In PSK, the phase changed, with 0 for 1 and π for 0. For ASK demodulation, the demodulated signal matched the original binary data by detecting the carrier signal's presence or absence. However, a slight curve in the demodulated message signal indicated it was not a perfect digital signal.

In conclusion, the experiment demonstrated the principles of ASK, FSK, and PSK modulation and demodulation. The oscilloscope observations confirmed the theoretical expectations. The slight imperfection in the ASK demodulated signal suggests minor distortions in real-world implementations, which should be considered in practical applications. Overall, the experiment provided valuable insights into digital modulation techniques and their practical implications.

References

[1] J. G. Proakis and M. Salehi, *Digital Communications.* McGraw-Hill, 2007.

[2] B. Sklar, *Digital Communications: Fundamentals and Applications.* Prentice Hall, 2001.

[3] S. Haykin, *Communication Systems.* Wiley, 2001.

[4] B. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems.* Oxford University Press, 2009.