Heaven's Light is Our Guide

Rajshahi University of Engineering and Technology

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ECE 3208

Course Title

Communication Engineering Sessional

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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 encodes digital data into waveforms by varying the carrier signal's amplitude, frequency, or phase. Common types include ASK, FSK, and PSK [1].

Amplitude Shift Keying (ASK)

Amplitude Shift Keying (ASK) varies the carrier signal's amplitude based on binary data:

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

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

Frequency Shift Keying (FSK)

Frequency Shift Keying (FSK) varies the carrier signal's frequency based on binary data:

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

where f_1 and f_2 are the frequencies for binary 1 and 0 [3].

Phase Shift Keying (PSK)

Phase Shift Keying (PSK) varies the carrier signal's phase based on binary data:

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

where A is the amplitude, f_c the carrier frequency, and $m(t)$ 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

Block Diagram & Waveform of ASK System

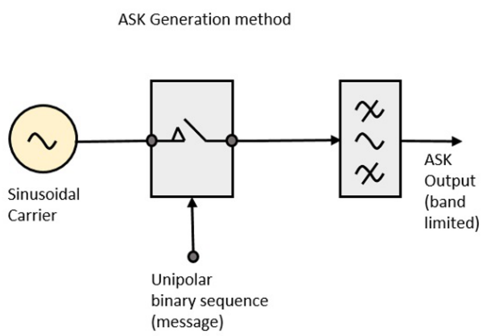

Figure 1: Block Diagram of ASK System

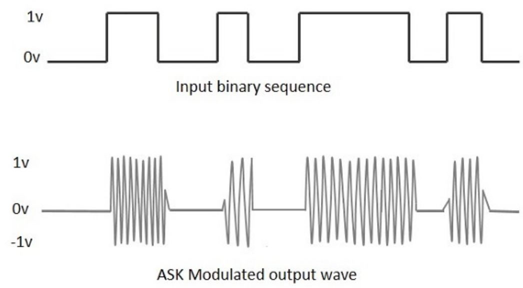

Figure 2: Waveform of ASK System

Block Diagram & Waveform of FSK System

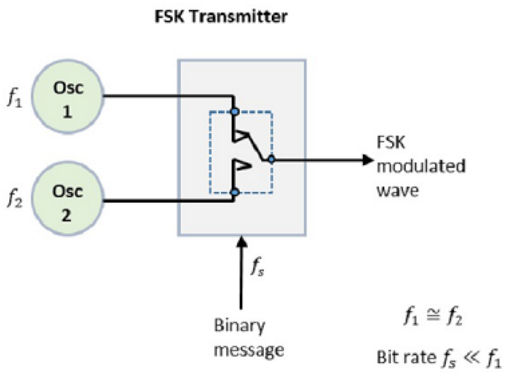

Figure 3: Block Diagram of FSK System

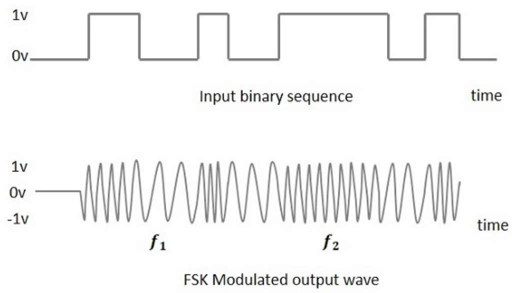

Figure 4: Waveform of FSK System

Block Diagram & Waveform of BPSK System

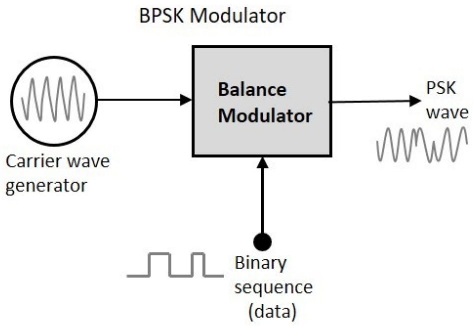

Figure 5: Block Diagram of BPSK System

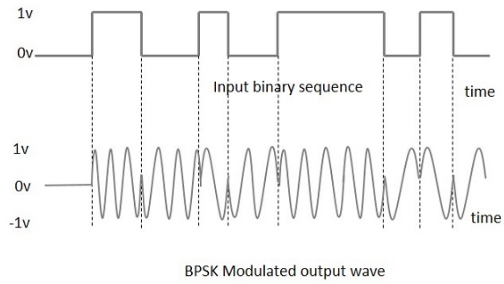

Figure 6: Waveform of BPSK System

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:1;           % Time vector for 1 second
f_carrier = 100;        % Further lowered 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)
samples_per_bit = round(fs / bit_rate); % Ensure samples_per_bit is an integer
t = 0:1/fs:(length(bits) * samples_per_bit - 1) / fs; % Adjust t to match input_signal length
input_signal = repelem(bits, samples_per_bit);

% ASK Modulation
carrier_signal = sin(2 * pi * f_carrier * t); % Generate carrier signal
ask_signal = input_signal .* carrier_signal; % Modulate carrier with input signal
```

```

% FSK Modulation
f1 = 50;    % Further lowered frequency for bit 0
f2 = 150;   % Further lowered 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 .* carrier_signal; % Multiply with carrier signal
[b, a] = butter(6, f_carrier/(fs/2));          % Low-pass filter design
ask_demodulated = filter(b, a, ask_demodulated); % Apply low-pass filter
ask_demodulated = ask_demodulated > 0.25;       % Thresholding for binary signal

% Plotting
figure;

% Plot input digital signal
subplot(5,1,1);
plot(t, input_signal, 'LineWidth', 1.5); % Thicker line
title('Input Digital Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot ASK signal
subplot(5,1,2);
plot(t, ask_signal, 'LineWidth', 1.5); % Thicker line
title('ASK Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot FSK signal
subplot(5,1,3);
plot(t, fsk_signal, 'LineWidth', 1.5); % Thicker line
title('FSK Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot PSK signal
```

```
subplot(5,1,4);
plot(t, psk_signal, 'LineWidth', 1.5); % Thicker line
title('PSK Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot ASK demodulated signal
subplot(5,1,5);
plot(t, ask_demodulated, 'LineWidth', 1.5); % Thicker line
title('ASK Demodulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');
```

Output

Experimental Output

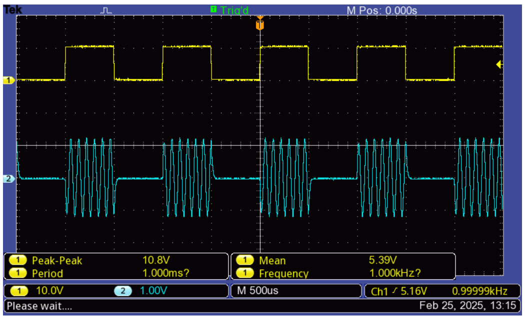

Figure 7: ASK Modulation; Message (Yellow), Modulated Signal (Blue)

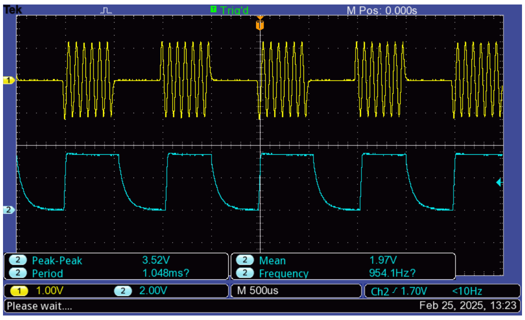

Figure 8: ASK Demodulation; Modulated Signal (Yellow), Demodulated Signal (Blue)

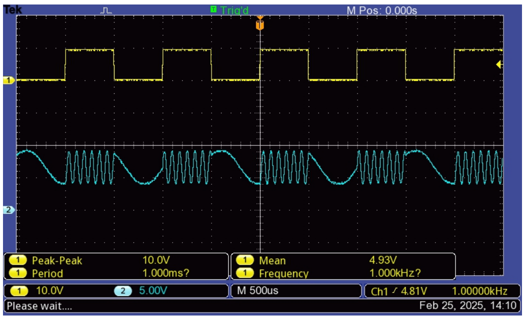

Figure 9: FSK Modulation 1; Message (Yellow), Modulated Signal (Blue)

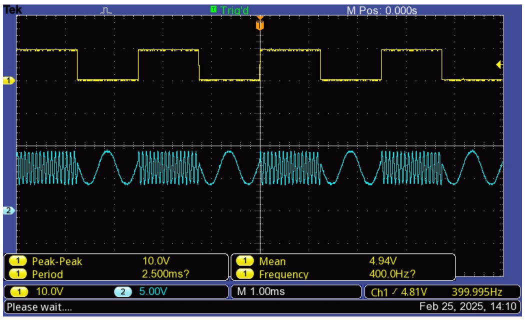

Figure 10: FSK Modulation 2; Message (Yellow), Modulated Signal (Blue)

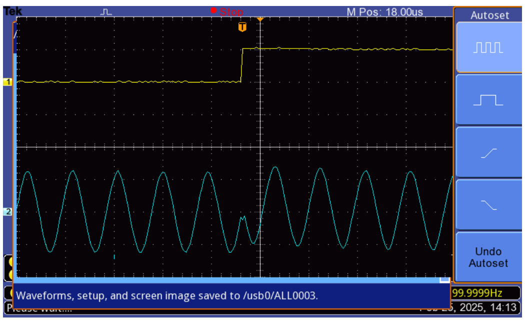

Figure 11: PSK Modulation 1; Message (Yellow), Modulated Signal (Blue)

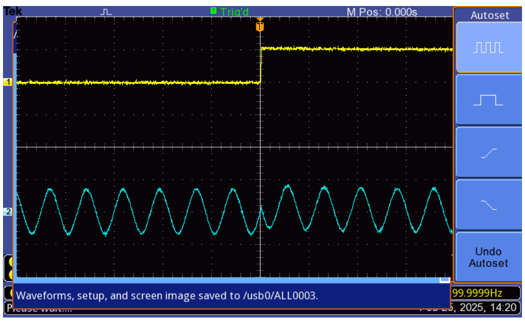

Figure 12: PSK Modulation 2; Message (Yellow), Modulated Signal (Blue)

Matlab Simulation Output

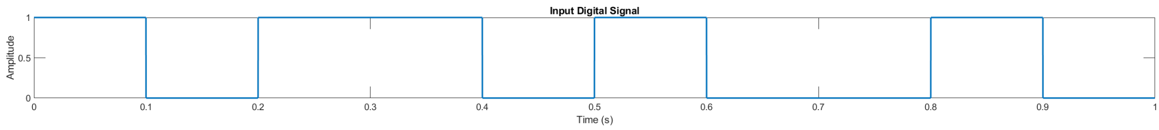

Figure 13: Digital Message Signal

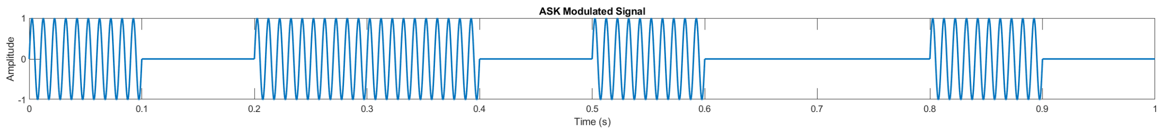

Figure 14: ASK Modulated Signal

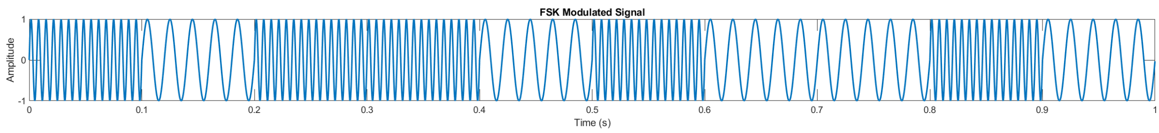

Figure 15: FSK Modulated Signal

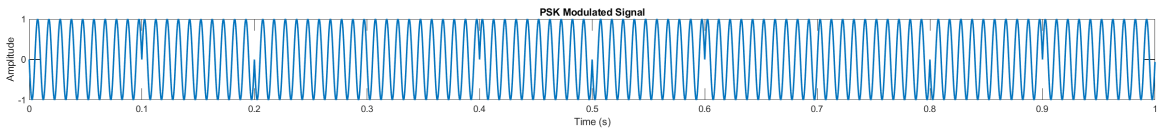

Figure 16: PSK Modulated Signal

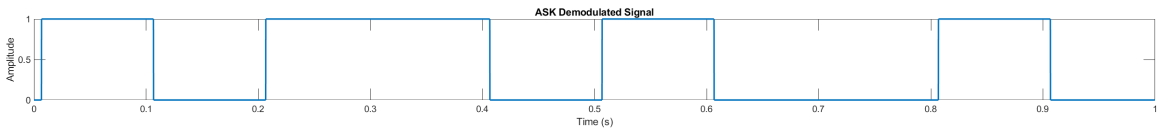

Figure 17: ASK Demodulated Signal

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.