Lab 5 – Frequency Shift Keying

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EEL4515 Fundamental of Digital Communications

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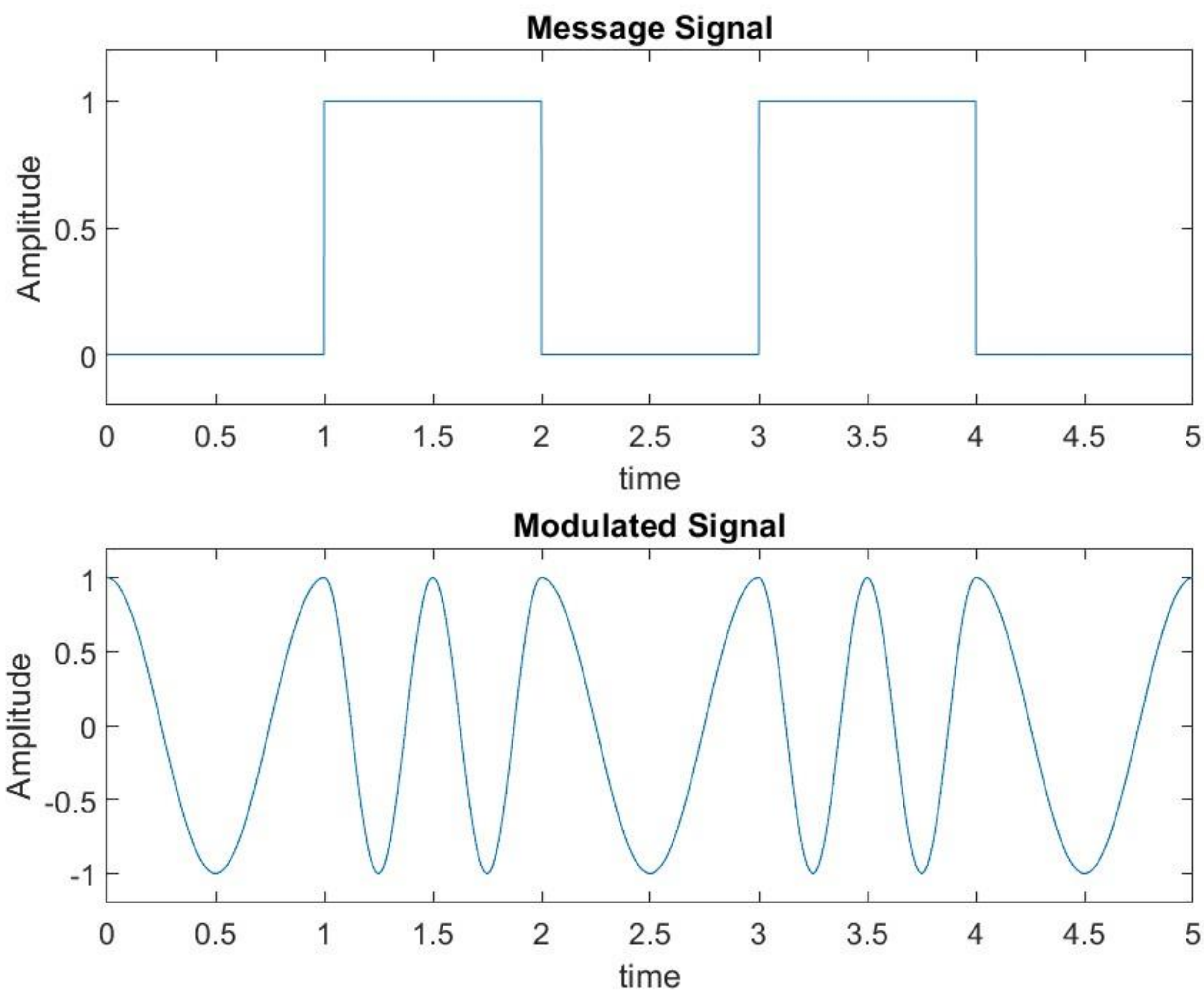
1.0 Experiment Objective
The objective of this lab is to introduce the concepts of Frequency Shift Keying (FSK) modulation technique through simulation. Students apply the concepts of FSK to design a modem, which uses this modulation scheme.

2.0 About Laboratory Day and Equipment List

The laboratory session took place on the Thursday section between 9:00am and 11:50am on March 14th, 2024. My lab partner was Isiah. The equipment for the is experiment is listed below,

1. MATLAB
2. Rohde & Schwarz RTM 3034 Oscilloscope
3. Function Generator
4. XR-2206
5. XR-2211

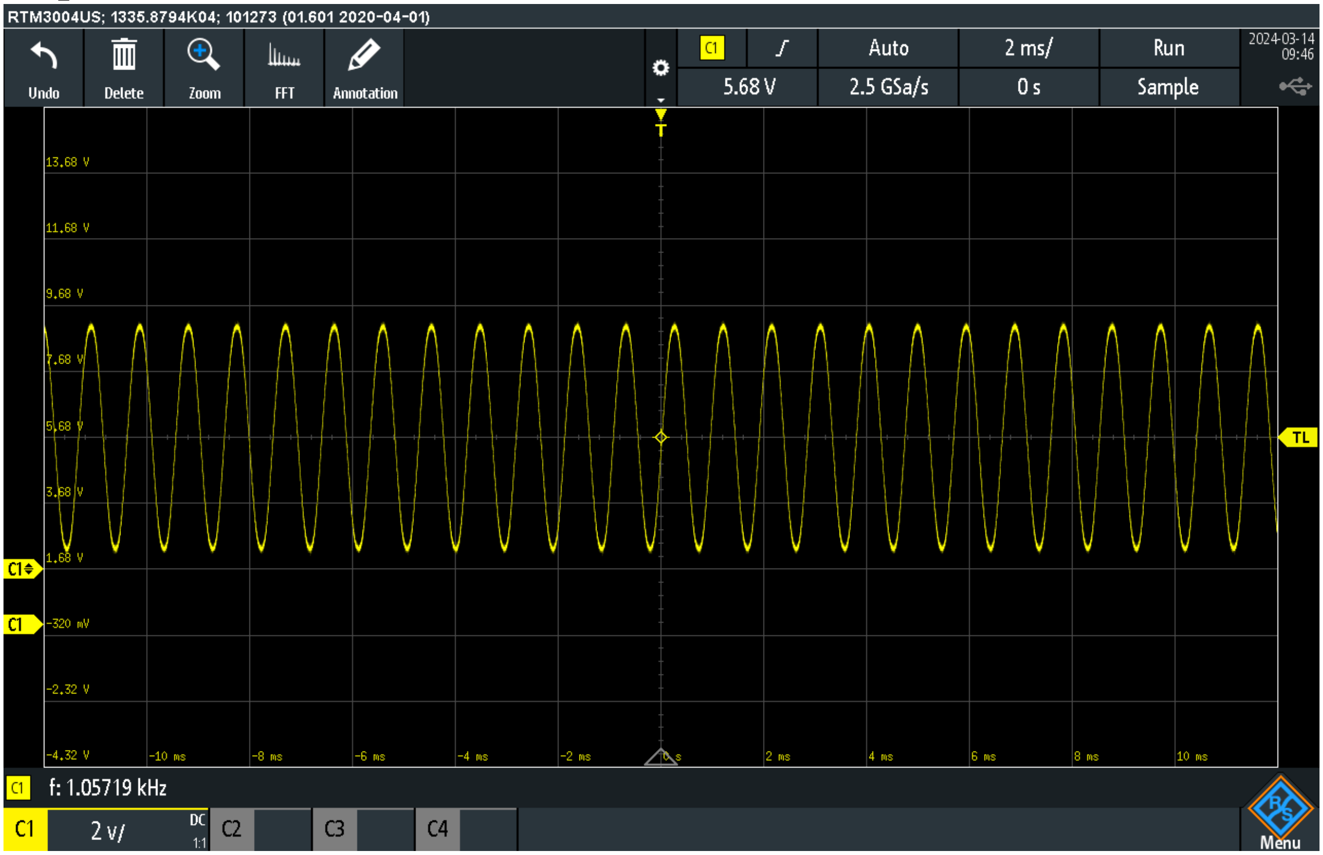
3.0 Simulation



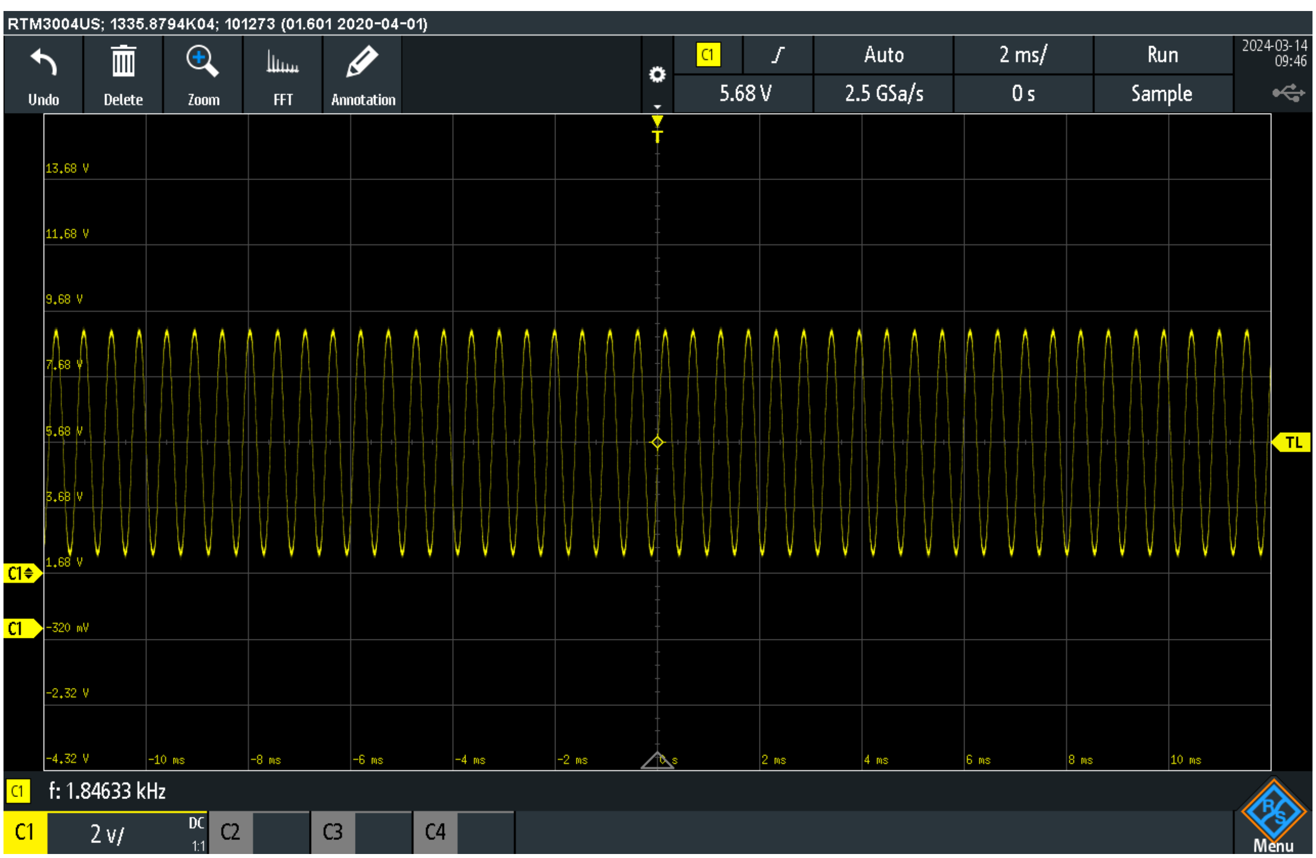
Manchester Encoding Simulation Results

See Section 5.0 for MATLAB code.

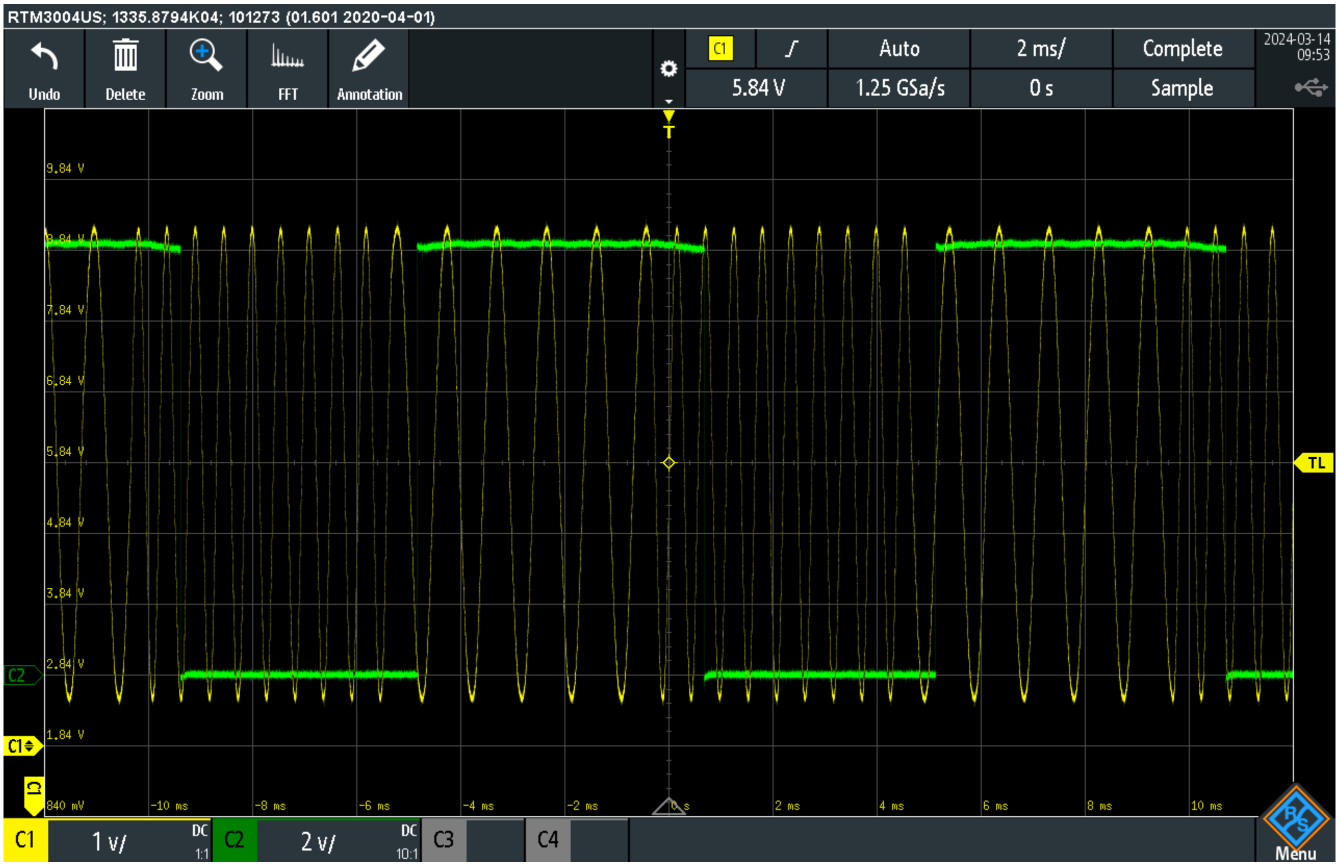
4.0 Implementation



Center Frequency – Zero Bit Frequency



One Bit Frequency



Message Signal vs Modulated FSK Signal

Demodulated Signal

4.5 Questions and Results

FSK modulation works by sending message "symbols", in this case only two symbols were sent, by offsetting the center frequency. The modulator varies the frequencies of the symbols linearly from based on the amplitude of the input message; the modulator IC does this by using a PLL. In this lab we used the XR-2206 to generate the waveforms and for modulation. The XR-2211 was used for demodulation and for PLL tracking. For our lab, we had to change some capicator values because our center frequency was too low. Unfortunately, our group did not record the specific changes.

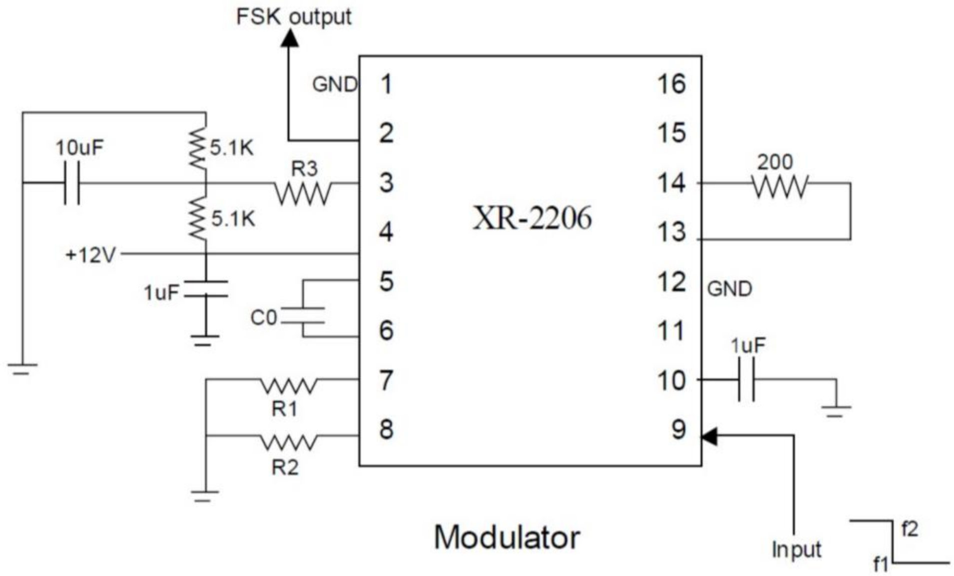
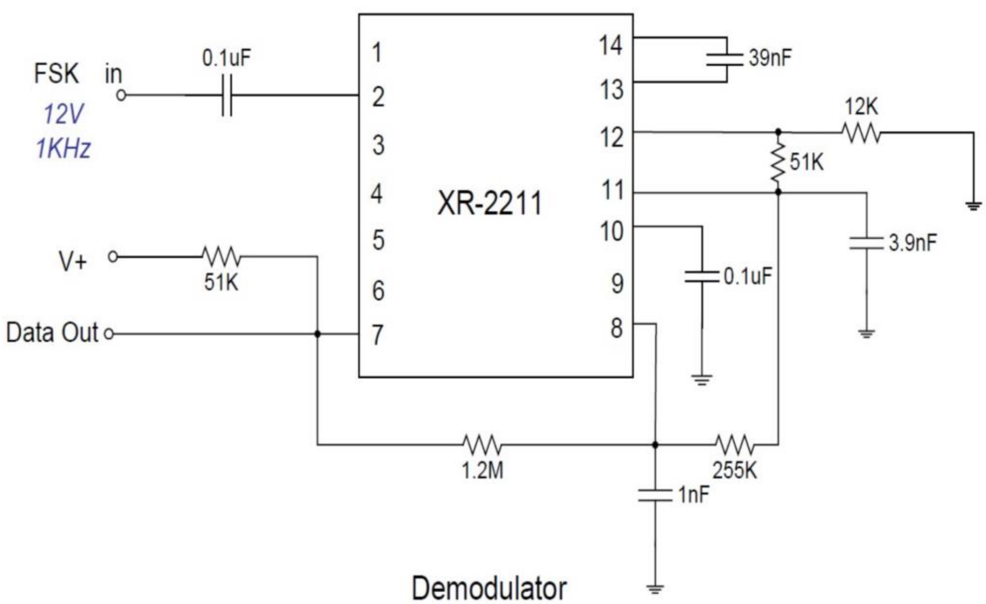


Figure 5.3 (a) FSK modulator



Calculate R0, R4, C1, C2, and CF for a 75 baud FSK demodulator with mark/space frequencies of 1110/1170 Hz.

$$f_0 = \frac{(f_1 + f_2)}{2} = \frac{1110 + 1170}{2} = 1140\ Hz$$

$$f_0 = \frac{1}{R_0 C_1} \; let\; C_1 = 0.027\mu F \rightarrow R_0 = \frac{1}{f_0 C_1} \approx 33\; k\Omega$$

$$R_4 = R_0 \frac{f_0}{f_1 - f_2} \approx 620\; k\Omega$$

$$C_2 = \frac{C_1}{4} = 6.75\; nF \approx 6.8nF$$

$$T_F = \frac{0.3}{75} = 0.004 \rightarrow T_F = R_F C_F \rightarrow let\; R_F = 100\; k\Omega$$

$$C_F = \frac{0.3}{75 R_F} = 40nF$$

5.0 MATLAB Code

Used to generate figure(s)

```
clear all;
close all;
clc;

Tb = 1;
f1 = 1000/Tb;
f2 = 2*f1 + 1/Tb;
phi = pi/4; % delay tranmission
N=5000;
Bits = 5;

u1 = @(t) cos(2*pi*f1*t);
u2 = @(t) cos(2*pi*f2*t);
v1 = @(t) sin(2*pi*f1*t);
v2 = @(t) sin(2*pi*f2*t);

t = linspace(0, Bits, N);

message = linspace(0, 1, N);

last_bit = 1;
for b=1:1:Bits
    len = N / Bits;
    offset = ((b - 1) * len) + 1;
    last_bit = ~last_bit;
    fprintf("%d %d %d\n", b, offset, length(message));
    for i=offset:1:min((len+offset), N)
        message(i) = last_bit;
    end
end

subplot(2,1,1);
plot(t, message);
ylim([-0.2, 1.2]);
title("Message Signal");
xlabel("time");
ylabel("Amplitude");

modulated_signal = linspace(0, 1, N);

for i=1:1:length(message)
```

```
    time = i/1000;
    if message(i)==1
        fprintf("(on) t=%f\n", time);
        modulated_signal(i) = u2(time*2);
    else
        fprintf("(off) t=%f\n", time);
        modulated_signal(i) = u2(time);
    end
end

subplot(2,1,2);
plot(t, modulated_signal);
ylim([-1.2, 1.2]);
title("Modulated Signal");
xlabel("time");
ylabel("Amplitude");
```

6.0 Learned Objectives

- XR-2206 and XR-2211
- FSK Modulation
- MATLAB Simulation

7.0 Conclusion

In conclusion, the lab experiment on Frequency Shift Keying (FSK) modulation provided valuable insights into the fundamental concepts of digital communication. Through simulation using MATLAB and practical implementation using equipment such as the XR-2206 and XR-2211, we gained a deeper understanding of how FSK modulation works, particularly in generating modulated signals and demodulating them. By varying frequencies based on message symbols and utilizing phase-locked loops (PLLs), we observed the transmission and reception of binary data efficiently. Despite encountering challenges with center frequency adjustments during implementation, the exercise enhanced our comprehension of FSK modulation parameters and their impact on signal fidelity. Overall, this lab significantly contributed to our knowledge of digital communication techniques and their practical applications.