CIE 337 - Communication Theory and Systems

Frequency Modulation Modules

- Project Report -

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Contents

1 Preface

This Project is done in partial satisfaction of CIE337 course requirements. All the requirements of the project can be achieved by running the *main.m* file[1]. The project is all about the frequency modulation with different method. Part A is done using MATLAB® line code, part B is done using Simulink® self-implemented module, part C is done using Simulink built in module for frequency modulation. Each of these parts are presented in separate section and discussed in details.

[1]All MATLAB® Simulink® files will be attached along with this report

2 Part A: MATLAB FM Line Code

2.1 Information Signal

The first part of part A requires to generate information signal with specific shape and parameters. The function is simply a *sawtooth* function with time shift 0.5 ms. The function is periodic with amplitude of 1 V, having a period $T = 1$ ms, so $f_m = 1$ kHz. A MATLAB code is written to generate the function as shown in Figure 1.

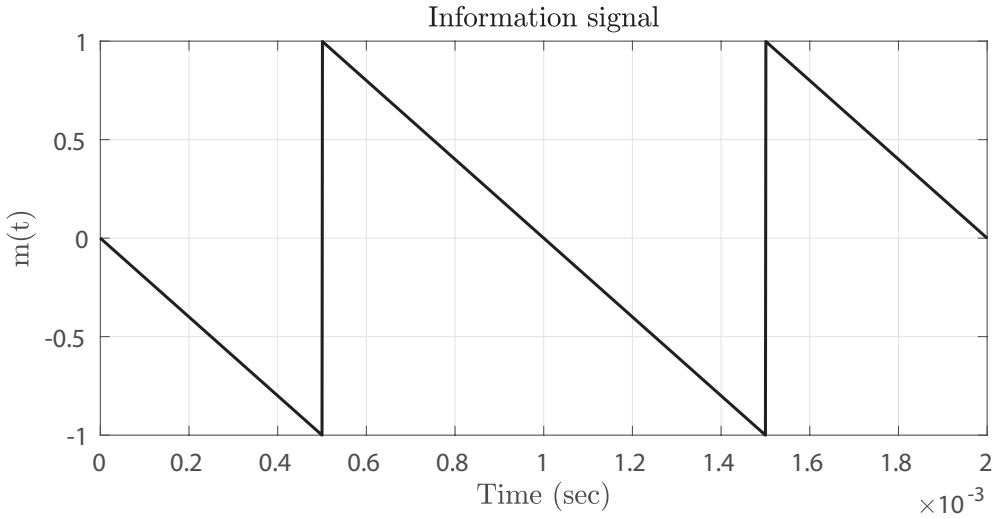

Figure 1: Information Signal $m(t)$

2.2 Phase Deviation Signal

The second part is about generating the phase deviation signal, $\theta(t)$, and plotting the result. The analytical expression for $\theta(t)$ is given by

$$\theta(t) = 2\pi K_f \int_0^t m(\tau) d\tau$$

This integration is preformed using *cumtrapz* function in MATLAB, which computes the integration using trapezoidal numerical method. The output for the phase deviation signal using different values of K_f is provided in figure 2.

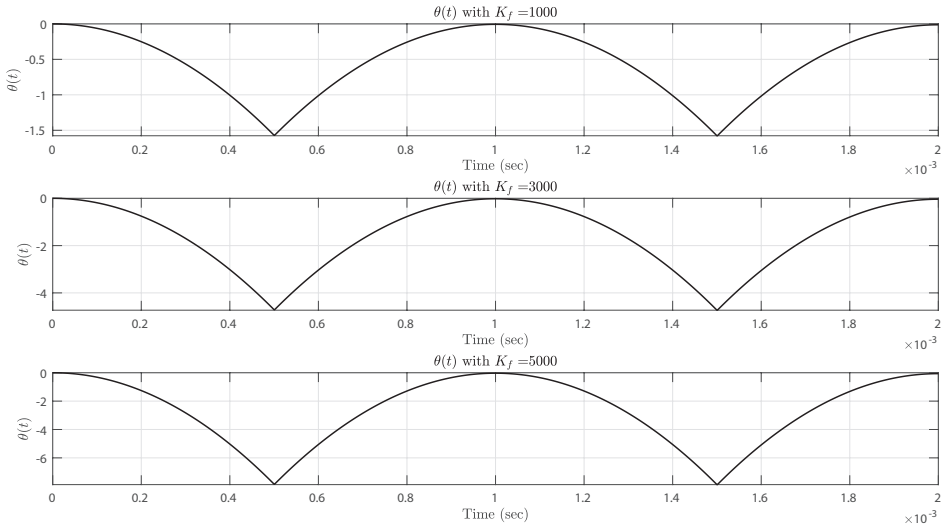

Figure 2: The Phase Deviation Angle with Different K_f

2.3 FM Signals

The third part is about modulated the information signal shown in Figure 1. The modulated signals are shown in Figure 3. The analytical

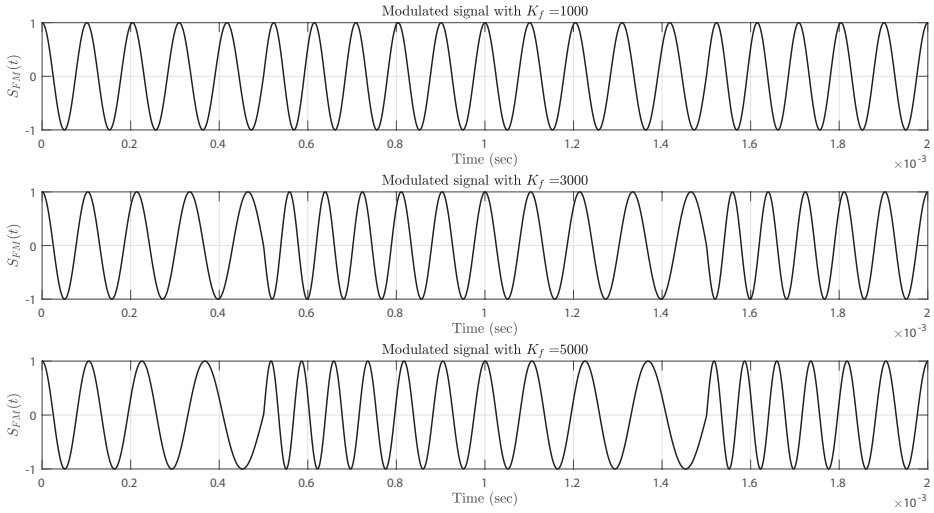

Figure 3: The Modulated Signals with different values of K_f

expression of the frequency modulation can be obtained form

$$S_{FM}(t) = A_c cos\left(\omega_c t + \theta\right) \tag{1}$$

Where θ is the phase deviation signal derived in section 2.2.

2.4 Part A Sum up

All of part A requirement is provided in Figure 4. From Figure 4 from the subplot of all the modulated signal are present together, a conclusion can be made upon the phase deviation signal. Where $\theta = 0$, all of the

modulated signals are on top of each others, that is because the term θ in the cos argument in Equation 1 vanishes. where θ getting bigger they are diverging with respect to each other.

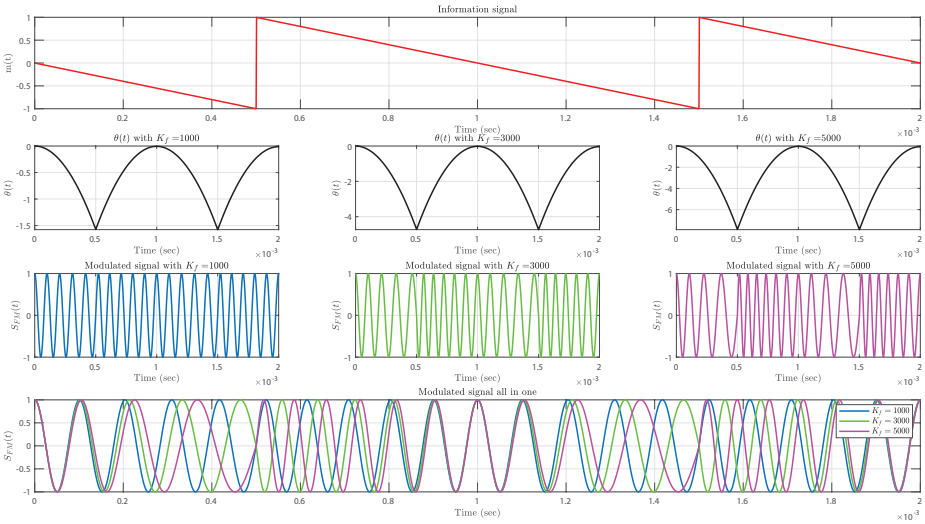

Figure 4: Information Signal, Phase Deviation Signal, Modulated signals separated, and Modulated Signals All in one one Figure.

3 Part B: Simulink Self-Implemented Module

3.1 Model Block Diagram

The block diagram of the FM model done using Simulink is provided in Figure 5.

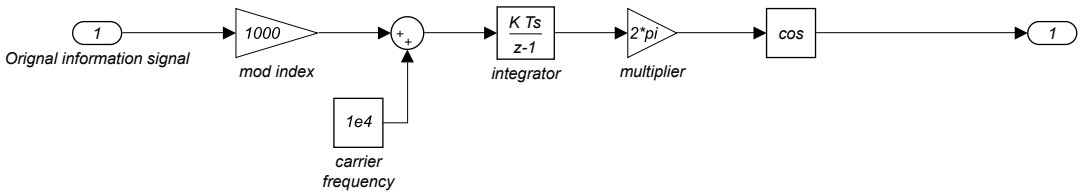

Figure 5: Block Diagram of The FM System

3.1.1 Triangular Message Signal

The block diagram of the FM model for the triangular signal done using Simulink is provided in Figure 6[2]. Each subsystem in the model represents the same modulation technique with different values of K_f.

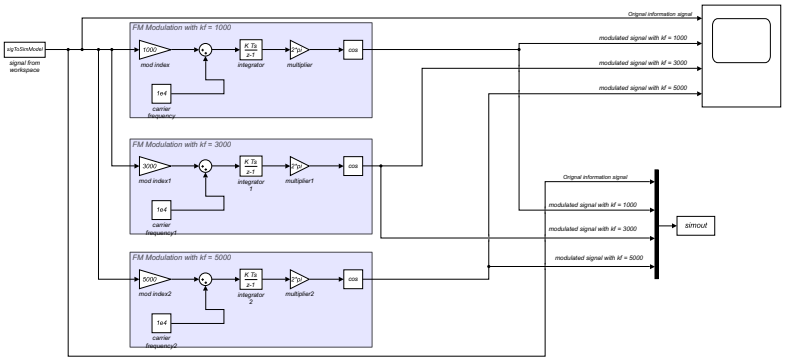

Figure 6: Block Diagram of The FM System used in modulating saw-tooth function

[2]All blocks' parameters will be attached along this report as screenshots

3.1.2 Sinusoidal Message Signal

The block diagram of the FM model for the sine wave function done using Simulink is provided in Figure 7.

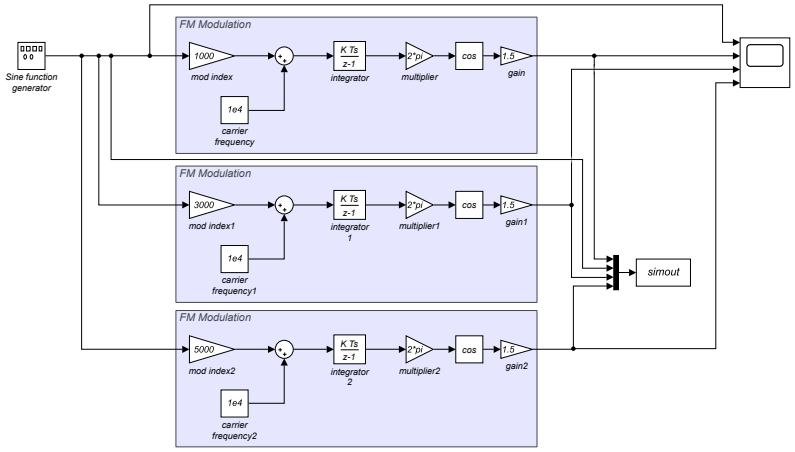

Figure 7: Block Diagram of The FM System used in modulating sine wave function

3.2 Scope Output

3.2.1 Triangular Message Signal

The output of the model represented in Figure 6 is sent back to MATLAB work space through simout block and then the data is being processed. The output can be visualized throughout Figure 8.

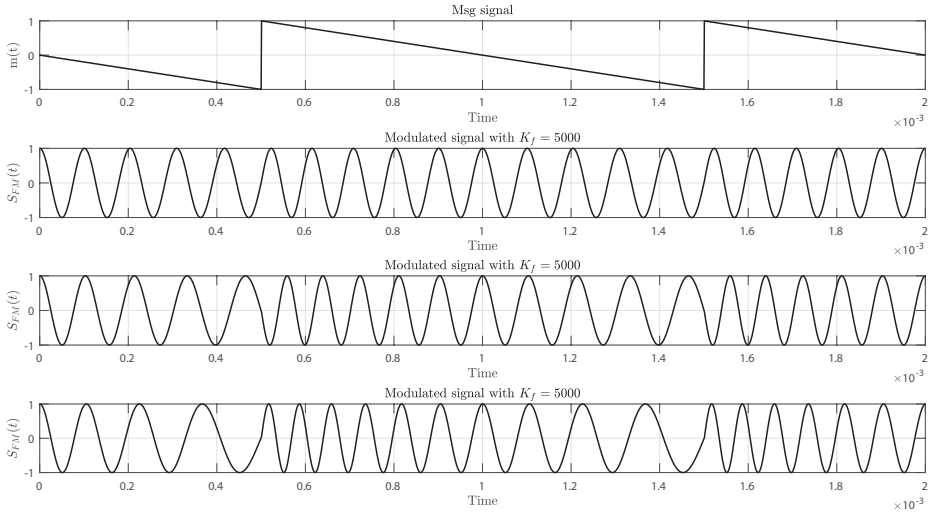

Figure 8: The Scope Output of The Model Represented in Figure 6

3.2.2 Sinusoidal Message Signal

The output of the model represented in Figure 7 is sent back to MATLAB work space through simout block and then the data is being processed. The output can be visualized throughout Figure 9.

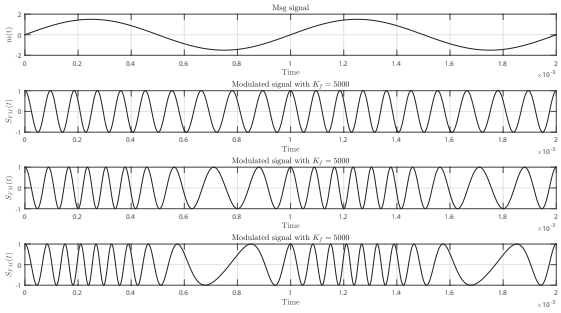

Figure 9: The Scope Output of The Model Represented in Figure 7

4 Part C: Simulink Built In Modules

4.1 Block Diagrams

4.1.1 Triangular Message Signal

The block diagram of the FM model for the triangular signal done using Simulink is provided in Figure 10. Each subsystem in the model represents the same modulation technique with different values of K_f.

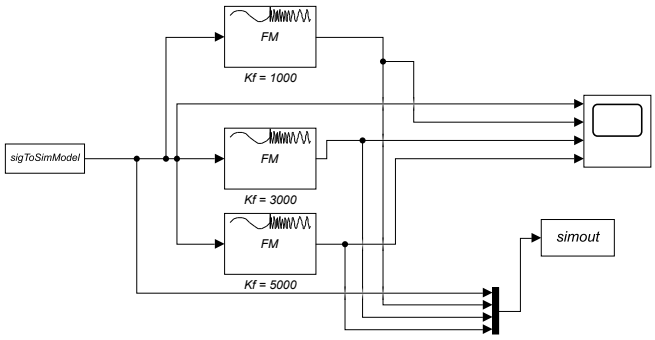

Figure 10: Block Diagram for The Built-in Module for the Triangular Signal

4.1.2 sinusoidal Message Signal

The block diagram of the FM model for the saw-tooth function done using Simulink is provided in Figure 11. Each subsystem in the model represents the same modulation technique with different values of K_f.

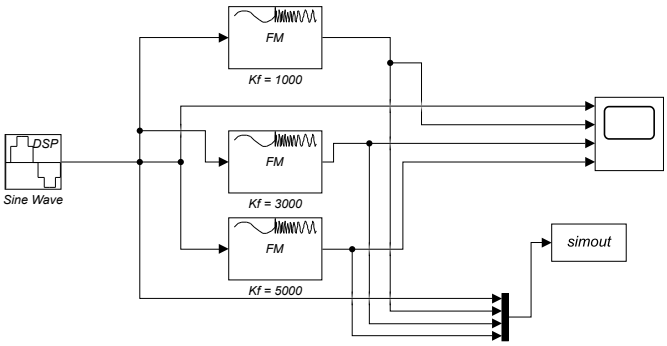

Figure 11: Block Diagram for The Built-in Module for the sinusoidal Signal

4.2 Scope Output

4.2.1 Triangular Message Signal

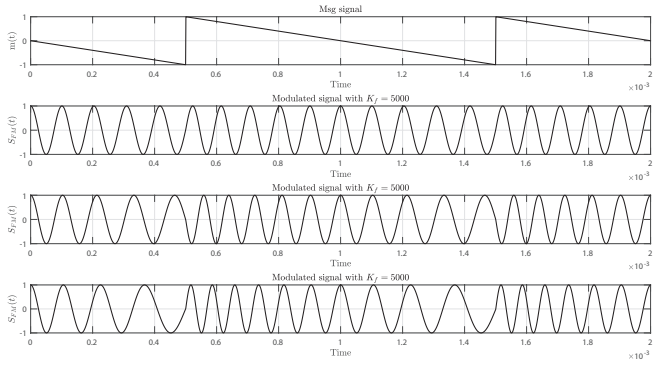

Figure 12: Triangular Message Signal Modulation Using the Built-in Simulink Module

4.2.2 Sinusoidal Message Signal

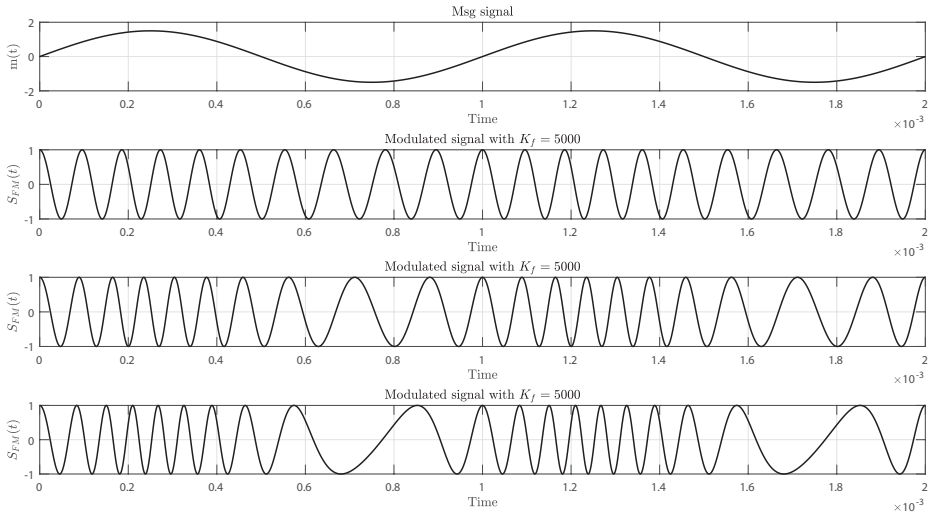

Figure 13: Sinusoidal Message Signal Modulation Using the Built-in Simulink Module