Electrical Communications Systems Lab 3: Frequency Modulation and Demodulation

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Abstract

In this lab, various methods of FM radio are looked at and compared. This is done through a software simulation using the Simulink toolbox in the program MATLAB. Signals were modulated, noised, and demodulated in order to determine the noise resistance of each method.

I. Introduction

Frequency modulation is one of the most common types of radio modulation. FM encodes signals by changing the frequency of the carrier wave form. Using Simulink and MATLAB, these signals can be simulated to compare the performances between each method with how well each type deals with noise injection.

II. Results

To initialize the following designs a test FM signal and carrier frequency were used. The following chosen sine waves are: These two waves were used to initialize and create the

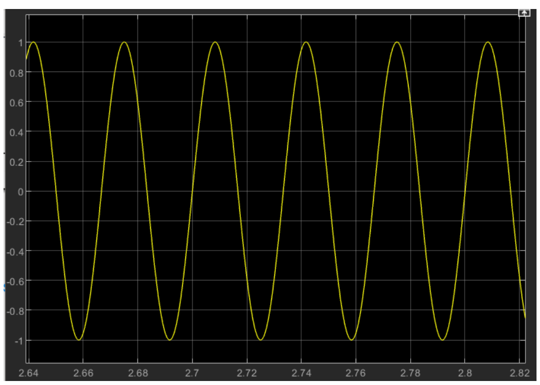

Fig. 1. Default Sine Wave of sin(2*pi*30*t)

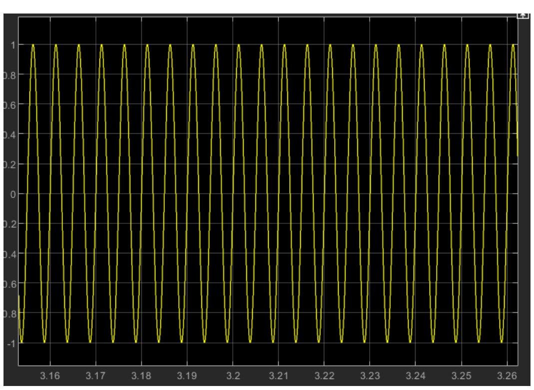

Fig. 2. Carrier Wave of sin(2*pi*200*t)

base form of all simulink designs.

A. FM Signal

The following set up, in Figure 3, was created to modulate and demodulate an incoming FM signal according to a given carrier. The modulation for the above simulink design in

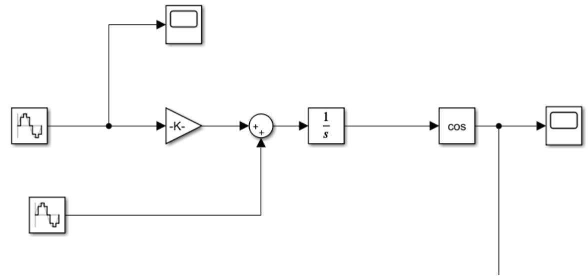

Fig. 3. MATLAB Simulink FM Signal Design

Figure 3 is using the following FM signal modulation method.

$$s(t) = [A_c + A_m * cos(2\pi f_m t)]cos(2\pi f_c t) \tag{1}$$

Using the above method the modulation uses a value of 1 for Ac and Am and the appropriate signals as shown in Figures 1 and 2. The resulting modulated signal looks as such,

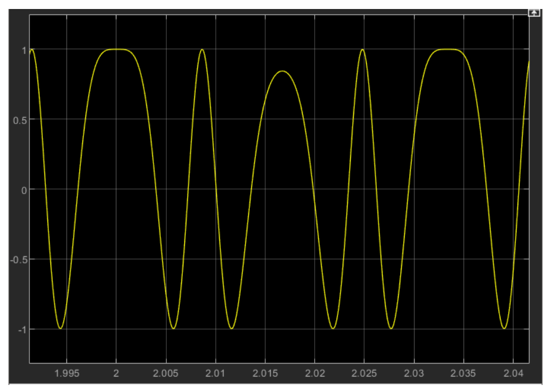

Fig. 4. Modulated FM signal

To demodulate the signal a square law detector was used. In which the modulated signal is squared, multiplied by a scalar gain of 2, and then passed through an ideal low pass filter, had the absolute square root taken, and had 1 subtracted from all values in order to output the original signal. The following configuration to implement a low pass filter, with f being the frequency of the input sign wave:

$$\frac{Output}{Input} = \frac{1}{\tau + 1}; \tau = \frac{1}{2 * \pi * f} \tag{2}$$

The final output for the demodulated signal is shown below in Figure **??**; it is not as exact as the original signal but the intent of the signal remains and as such can be understood.

III. Summary and Conclusion

The lab, overall, shows the capability for Simulink to rapidly do the work of entire lines of MATLAB code with a mere connection of two blocks. Simulink was used to modulate, demodulate and view the spectral results of a FM signal. Overall, it was shown that the signal will leave the system with some modifications from an overall signal standpoint. The added noise, even before adding noise, is not much of an issue for the sound output. With noise, especially heavy noise, the input signal can be rapidly disturbed beyond the recreation abilities of the demodulator due to the noise affecting both the carrier and the signal. The carrier does protect the signal from a lot of the noise.

References

[1] Waveform Synthesis and Spectral Analysis.

IV. Appendices