Analog communication Lab .

General rules

Submission deadline:

This MATLAB assignment should be submitted by 2/1/2021 11:59 PM .

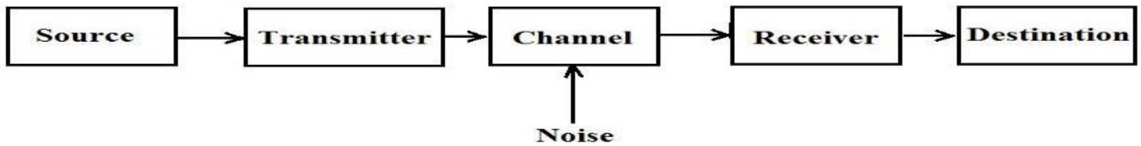
General rules:

(1) Students are to be divided into groups of 4-5 students each.

(2) Any copied codes will be awarded "**zero**" without notification, however doing your best and trying to follow the shown procedure will usually result in above 50% of total mark.

(3) Overall organization of the report/M-files with logical development as well as following the rules described herein is highly appreciated.

1 EXPERIMENT ONE: DOUBLE SIDEBAND MODULATION



1.1 INTRODUCTION

Double Sideband modulation is the easiest and most direct type of analog modulation. In this scheme, the modulated signal is obtained using a direct multiplication of the modulating signal (i.e. the message) by a cosine carrier. This multiplication results in shifting the entire spectrum of the message to a center frequency defined by the carrier frequency. The modulation is said to be double sideband transmitted carrier (DSB-TC) when the carrier is transmitted along the modulation term. If the carrier term is omitted, the modulation is termed double sideband suppressed carrier (DSB-SC). DSB-TC has a significant advantage in the receiver design (i.e. the envelop detector). Also transmitting the carrier independently enables us to extract useful information such as the carrier frequency which can be helpful for carrier synchronization. However, the DSB-TC loses to the other variant (i.e. the SC) in terms of power efficiency.

1.2 AIM

In this experiment, you're required to achieve the following:

1. Get familiar with the concept of DSB modulation, and its parameters.
2. Study the performance of the DSB modulation.
3. Examine different detectors (coherent detector, envelope detector).
4. Study the performance of coherent detection in the presence of frequency or phase mismatch.

1.3 PROCEDURE

1. Use Matlab to read the attached audio file, which has a sampling frequency Fs= 48 KHz. Find the spectrum of this signal (the signal in frequency domain). [*audioread, fft , fftshift , plot*]

2. Using an ideal Filter, remove all frequencies greater than 4 KHz.

3. Obtain the filtered signal in time domain, this is a band limited signal of BW=4 KHz. [*ifftshift ,ifft*]

4. sound the filtered audio signal (make sure that there is only a small error in the filtered signal) [*sound*]

5. Modulate the carrier with the filtered signal you obtained, you are required to generate both types of modulation (DSB-TC and DSB-SC). Choose a carrier frequency of 100 KHz. For the DSB-TC take the DC bias added to message before modulation to be twice the maximum of the message (modulation index =0.5 in this case).

   Note: You will also need to increase the sampling frequency of the filtered audio signal, the sampling frequency must be at least 2 times the carrier frequency, In this simulation use Fs = 5Fc *[resample]*

You have to sketch the modulated signal of both DSB-TC & DSB-SC in frequency domain.

6. For both types of modulations (DSB-SC & DSB-TC), use envelop detector to receive the message (assume no noise). Note: to obtain the envelope you can use the following MATLAB command.

$$envelope = abs(hilbert(modulated\ signal))$$

7. After the reception of both modulation types using envelope detector, sketch the received signal in time domain, and Play the received signal back (Note: to sound signal after demodulation process you have to decrease the sampling frequency again). What observation can you make of this or which type of modulation the envelope detector can be used with?

8. For DSB-TC only add noise to modulated signal with SNR = 0, 10, and 30 db then receive them with envelope detector. Play back the sound file each time after detection and sketch it in time domain. What conclusions do you make of that?

   To add noise to modulated signal you can use the MATLAB function: [*awgn*].

   Hint : the meaning of SNR is that $SNR = \frac{signal\ power}{noise\ power}$

   For DSB-SC, perform steps 9-11.

9. Use coherent detection to receive the modulated signal with SNR=0, 10, 30 dB then sound the received signals and plot them in both time and frequency domain.
10. Repeat the coherent detection with frequency error, F=100.1 KHz instead of 100 KHz and Find the error. Do you have a name for this phenomenon?
11. Repeat the coherent detection with phase error = 20^0 .

1.4 USEFUL MATLAB FUNCTIONS

audioread ,fft, fftshift, ifft, ifftshift , plot, awgn, resample, sound, hilbert, abs, max.

1.5 HINT

You are not allowed to use built in functions for modulation and demodulation like : **ammod, amdemod , modulate , demod.**

EXPERIMENT TWO: FREQUENCY MODULATION

2.1 INTRODUCTION

Frequency modulation (FM) is a modulation type in which the instantaneous frequency of the carrier is changed according to the message amplitude. The motive behind the frequency modulation was to develop a scheme with inherent ability to combat noise. The noise, being usually modeled as additive, has a negative effect on the amplitude by introducing unavoidable random variations which are superimposed on the desired signal. Unlike the amplitude, frequency has a latent immunity against noise. Since it resides "away" from the amplitude, any changes in the amplitude would be completely irrelevant to the frequency. In other words, there is no direct correlation between the variation in amplitude and frequency, thus making FM a better candidate over AM with respect to noise immunity. However, what FM gains in noise immunity lacks in bandwidth efficiency. Since FM usually occupies larger bandwidth, AM is considered more bandwidth wise.

2.2 AIM

In this experiment, we investigate the narrowband frequency modulation .

Students are expected to:

1. Develop an appreciation of FM ability to counteract noise.
2. Be able to simulate the generation and the demodulation of NBFM using MATLAB.
3. To be able to tell the similarities and differences between AM and NBFM.

2.3 PROCEDURE

1. Repeat steps 1 through four in experiment 1.
2. Generate the NBFM signal. Use a carrier frequency of 100kHz and a sampling frequency of $F_s = 5F_c$. Plot the resulting spectrum. What can you make out of the resulting plot?

3.what is the condition we needed to achieve NBFM.

4. Demodulate the NBFM signal using a differentiator and an ED. For the differentiator, you can use the following command: diff. Assume no noise is introduced.

2.4 USEFUL COMMANDS

audioread, fft, fftshift, ifft, ifftshift, awgn ,resample, sound,hilbert, abs, mean, cumsum, diff.

REQUIREMENTS

- Well commented matlab file.
- Report including your obtained results (spectrum plots, waveforms, etc..) ,the code and your personal conclusions