1 Preliminaries

In this week, we continue amplitude modulation with single sideband amplitude modulation (SSB-AM) method. In laboratory works, we will construct the message and carrier signals as we did in the previous labworks. In order to construct a signal in Matlab, it is essential to generate a time vector by using various parameters such as the sampling period (T_s) which is given by $T_s = 1/f_s$ where f_s is the sampling frequency, message frequency (f_m) and the signal duration (d). Then, the message and carrier signals can be generated by using this time vector.

In SSB-AM, only the upper or lower sideband is transmitted. Firstly, we generate a DSB-SC modulated signal by using a product modulator. Then, we filter the modulated signal with a filter that is designed to pass one of the sidebands and suppress the other. The designed filter should have a passband that includes the desired sideband, a stopband that includes the unwanted sideband and a transition band that is twice the the lowest frequency component of the message signal. A coherent detector can be employed to demodulate a SSB modulated signal. The overall block diagram of SSB modulation and demodulation is given in figure 1.

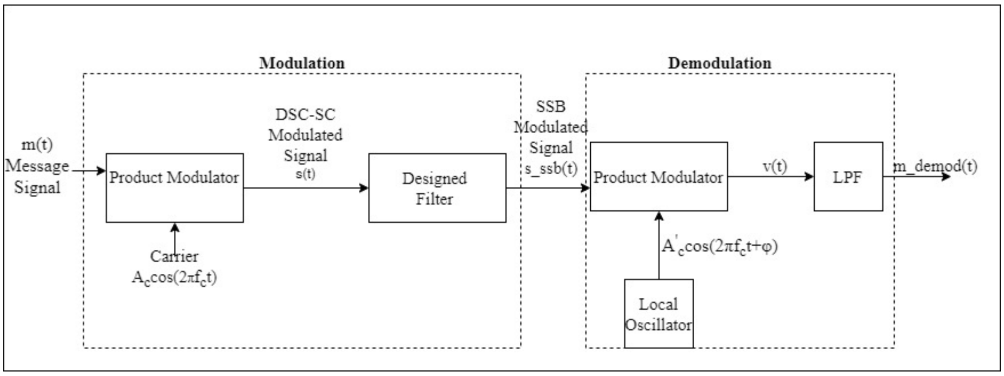

Figure 1: SSB Modulation and Demodulation System Design

2 Labwork

Read the preliminaries given above carefully before doing the experiment given below.

2.1 SSB Modulation

a. Construct a message signal $m(t) = 3\cos(2\pi f_m t)$ with $f_m = 450Hz$ and a carrier signal $c(t) = \cos(2\pi f_c t)$ with $f_c = 5kHz$. The sampling frequency $F_s = 20kHz$ and the duration is $30ms$.

b. Obtain the DSB-SC modulated signal $s(t)$ by applying the operations given in the modulation part of figure 1.

c. Design two Butterworth filters. Order of the first filter should be $n_1 < 5$ and order of the second filter should be $n_2 > 20$. For both of them, decide filter type (HPF or LPF), cutoff frequency and filter order to obtain a upper sideband (USB) modulated signal.

d. Plot the magnitude response of the filters that you designed above on the same Figure with *hold on* command.

e. Obtain the upper sideband modulated signals $s_{usb1}(t)$ and $s_{usb2}(t)$ by appying the filters designed in (c).

f. Plot the frequency responses of $s(t), s_{usb1}(t)$ and $s_{usb2}(t)$ by using *subplot()* function. You should choose a suitable fft length. Compare and comment on the frequency content and magnitudes of the signals.

2.2 SSB Demodulation

a. Comment on the modulated signals $s_{usb1}(t)$ and $s_{usb2}(t)$ and choose the one to have SSB modulated signal. The overall SSB system is presented in figure 1. Follow the block diagram to obtain the demodulated signal $v(t)$ (before filtering).

b. Construct an ideal low pass filter (LPF) to obtain the message signal. Decide filter order and cutoff frequency for LPF in order to obtain message signal correctly. Comment on your filter design.

c. Obtain the demodulated signal $m_{demod}(t)$ after filtering.

d. Plot the frequency response of $m(t)$, $v(t)$ and $m_{demod}(t)$ by using *subplot()* function. Compare and comment on the frequency content and magnitude of the signals.

e. Plot the message signal, $m(t)$, and **the demodulated signal after filtering**, $m_{demod}(t)$, in time domain in the same figure by using *hold on* command. Compare and comment on the signals.