EE 357 – Communication Systems

Lab Experiment

DSB-SC Modulation and Demodulation

Objective: In this experiment, you will design of a DSB-SC modulator and demodulator in Matlab.

The frequency of the message signal (a sinusoidal) will be 15 kHz while the carrier frequency will be 250 kHz. The amplitude of the message signal is 0.5.

Section I - Multiplier Modulator/Demodulator

1 Generate the message signal $m(t)$ in the time interval 0 to 8 sec (use a suitable sampling interval to represent the signal accurately)
2 Multiply the message by a unit (one) amplitude sinusoidal carrier signal.
3 Now implement a multiplier demodulator. Use a Butterworth low pass filter with cutoff $f_{cut} = 2\pi \times 2 \times 15 \times 10^3$ and order 5 in the demodulator.
4 Adjust the amplitude of the oscillator to make the demodulator output equal to the message signal.
5 Plot the spectrum of $m(t)$, the modulator output and the demodulator output (use subplot in Matlab and x-axis should be in kHz)

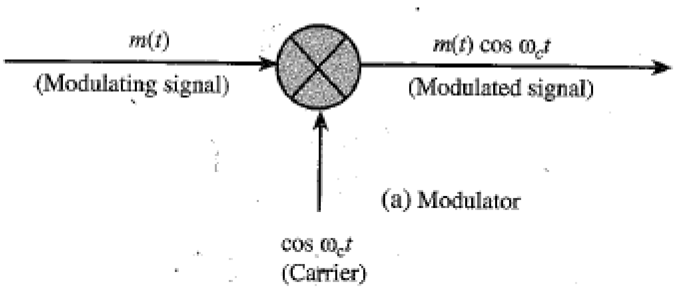

Figure 1(a): DSB-SC Modulation

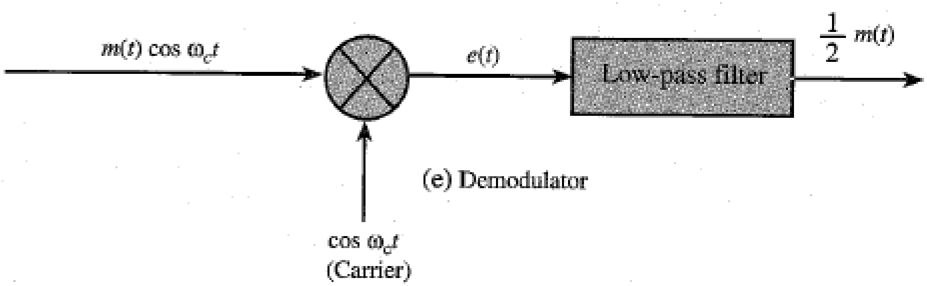

Figure 1(b): DSB-SC Demodulation

Section II - Nonlinear Modulator/Demodulator

1 Implement the nonlinear device based modulator shown in Figure 2. Use the same message signal $m(t)$.
2 In the modulator, use Use a Butterworth order 3 band-pass filter with the parameters $f_c - f_{cut}$ (lower cutoff) and $f_c + f_{cut}$ (higher cutoff) where $f_c = 2\pi \times 250 \times 10^3$ and $f_{cut} = 2\pi \times 2 \times 15 \times 10^3$. The input-output characteristics of the nonlinear device is $y(t) = ax(t) + bx^2(t)$. Set $a = 2$ and $b = 1$ in your experiment.
3 Implement a nonlinear device based demodulator. (The demodulator has a structure very similar to that of the modulator. However, it has a low pass filter at the end. Use the low pass filter developed in Sec. I)
4 Plot the spectrum of $m(t)$, the modulator output and the demodulator output (use subplot in Matlab and x-axis should be in kHz)

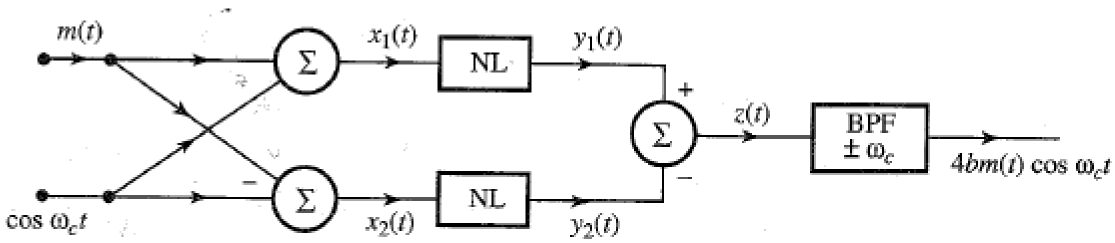

Figure 2: Nonlinear DSB-SC Modulation

Section I – Effect of Phase Offset

1 Use the system in Section I. Consider a sinusoidal message signal $m(t)$ of frequency 3 kHz.
2 Adjust the receiver oscillator phase offsets with respect to the transmit oscillator in the range from 0 to π in steps of $\pi/50$.
3 Observe time domain characteristics of the received signal for each phase offset. Calculate the level of attenuation (with sign) of the received signal and plot the attenuation versus the phase shifts in a figure.

REFERENCE

B. P. Lathi, *Modern Digital and Analog Communication Systems,* 3rd Edition, Oxford University Press, 1998.

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