



INSTITUTE OF ENGINEERING CENTRAL CAMPUS, PULCHOWK

COMMUNICATION SYSTEM II

LAB #1

Amplitude Modulation & Demodulation

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1 Title

Amplitude Modulation & Demodulation

2 Objective

- To view amplitude modulation for DSB-TC, DSB-SC, SSB and Amplitude demodulation.

3 Theory

3.1 Amplitude modulation

If amplitude of carrier wave varies in accordance with the amplitude of the signal, then the signal is called amplitude modulation.

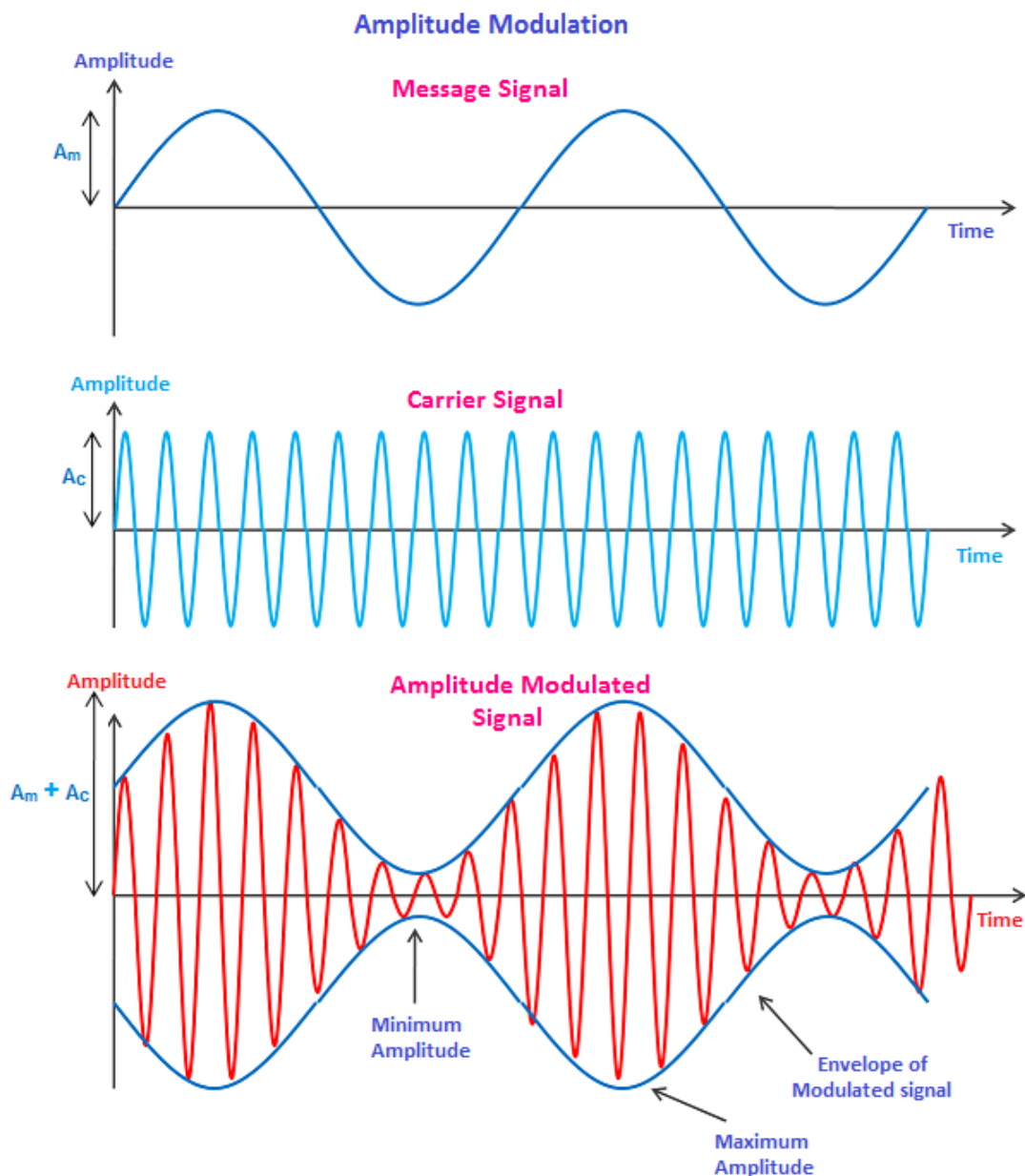


Figure 1: Amplitude modulation

3.1.1 DSB-TC

Double Sideband Transmitted carrier (DSB-TC) is a type of amplitude modulation where modulated signal has full carrier representation. For DSB-TC modulated signal $y(t)$ of a message signal $m(t)$ having carrier signal of frequency f_c :

$$y(t) = (1 + \mu m(t)) \cos(2\pi f_c t) \quad (1)$$

where, μ is the **modulation index**.

- $\mu < 1$: Under modulation
- $\mu = 1$: Perfect modulation
- $\mu > 1$: Over modulation

3.1.2 DSB-SC

Double Sideband-Suppressed Carrier (DSB-SC) is a type of amplitude modulation where modulated signal has reduced carrier representation in order to save power. For DSB-SC modulated signal $y(t)$ of a message signal $m(t)$ having carrier signal of frequency f_c :

$$y(t) = A_c m(t) \cos(2\pi f_c t) \quad (2)$$

3.1.3 SSB

Single Sideband is a type of amplitude modulation where modulated signal has reduced carrier representation in order to save power and additionally Suppressing one of the side band.. For SSB modulated signal $y(t)$ of a message signal $m(t)$ having carrier signal of frequency f_c :

$$y(t) = m(t) \cos(2\pi f_c t) - \hat{m}(t) \sin(2\pi f_c t) \quad (3)$$

where $\hat{m}(t)$ is the **Hilbert transform** of the message signal.

3.2 Amplitude Demodulation

Amplitude Demodulation is the process of demodulating the received signal to recover the original message.

4 Problems

4.1 DSB-TC(Under,Normal,Over)

```

1  fm=100;
2  fc=1000;
3  fs=10000;
4  t=0:(1/fs):((4/fm)-(1/fs));
5  x=cos(2*pi*fm*t);
6  y_u=modulate(x, fc, fs, 'amdsb-tc', -1/0.5);
7  y_n=modulate(x, fc, fs, 'amdsb-tc', -1/1);
8  y_o=modulate(x, fc, fs, 'amdsb-tc', -1/2);
9  %Plot
10 subplot(2,3,[1 2 3]);
11 plot(t,x);
12 title('Message signal');
13 xlabel('Time (s)');
14 ylabel('Amplitude');
15 subplot(2,3,4)
16 plot(t,y_u);
17 title('Under modulated signal','m<1');

```

```

18 xlabel('Time (s)');
19 ylabel('Amplitude');
20 subplot(2,3,5)
21 plot(t,y_n);
22 title('Normal modulated signal','m=1');
23 xlabel('Time (s)');
24 ylabel('Amplitude');
25 subplot(2,3,6)
26 plot(t,y_o);
27 title('Over modulated signal','m>1');
28 xlabel('Time (s)');
29 ylabel('Amplitude');
30 sgtitle('(PUL074BEX004) AMDSB-TC')

```

Code 1: MATLAB code DSB-TC

(PUL074BEX004) AMDSB-TC

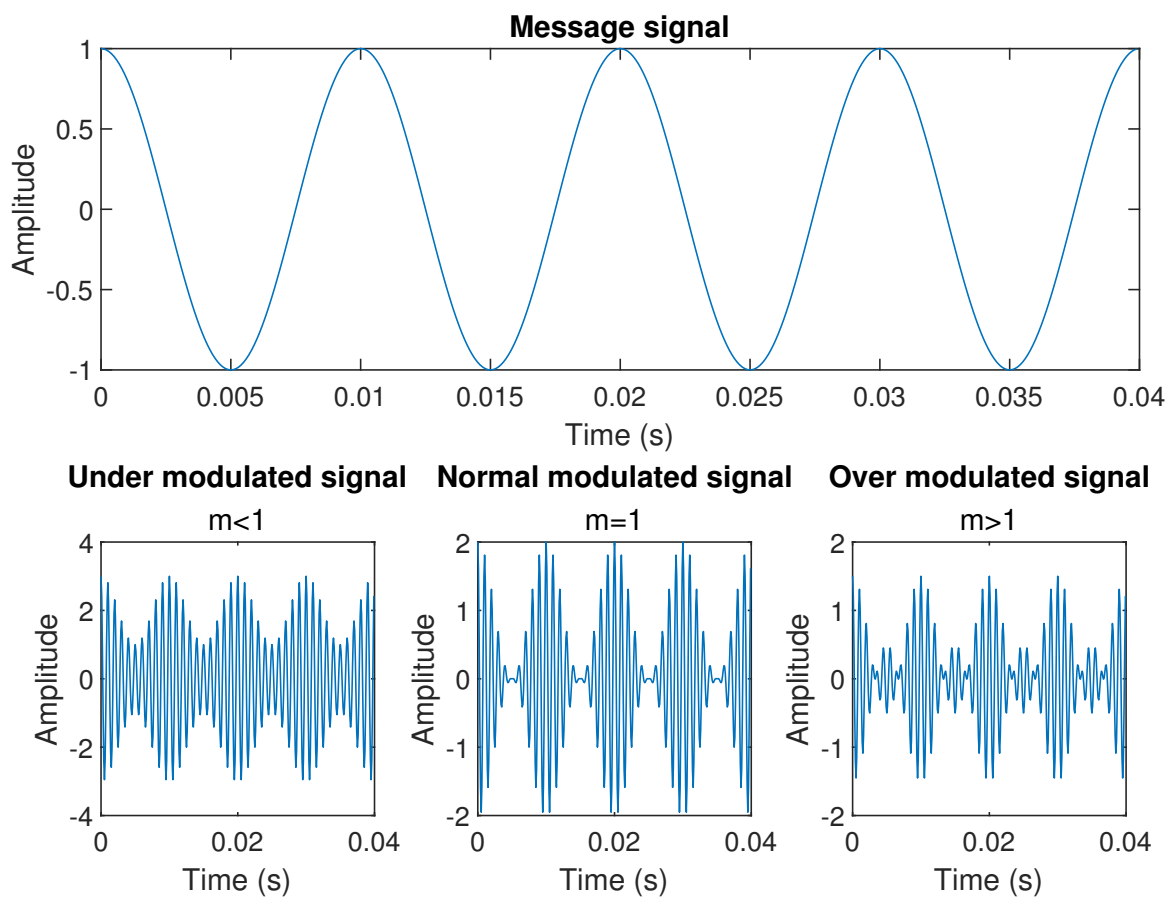


Figure 2: DSB-TC(Under,Normal,Over)

4.2 DSB-SC (Time & Frequency Domain)

```

1 fm=100;
2 fc=1000;
3 fs=10000;
4 t=0:(1/fs):((4/fm)-(1/fs));
5 x=cos(2*pi*fm*t);
6 y=modulate(x, fc, fs, 'amdsb-sc');
7 z=abs(fft(y,1024));
8 f= (-511*fs/1024):(fs/1024):(512*fs/1024);
9 %Plot

```

```

10 subplot(2,2,[1 2]);
11 plot(t,x);
12 title('Message signal');
13 xlabel('Time (s)');
14 ylabel('Amplitude');
15 subplot(2,2,3);
16 plot(t,y);
17 title('Modulated signal','Time Domain');
18 xlabel('Time (s)');
19 ylabel('Amplitude');
20 subplot(2,2,4);
21 plot(f,z);
22 title('Modulated signal','Frequency Domain');
23 xlabel('Frequency (Hz)');
24 ylabel('Spectrum amplitude');
25 sgtitle('(PUL074BEX004) AMDSB-SC')

```

Code 2: MATLAB code DSB-SC

(PUL074BEX004) AMDSB-SC

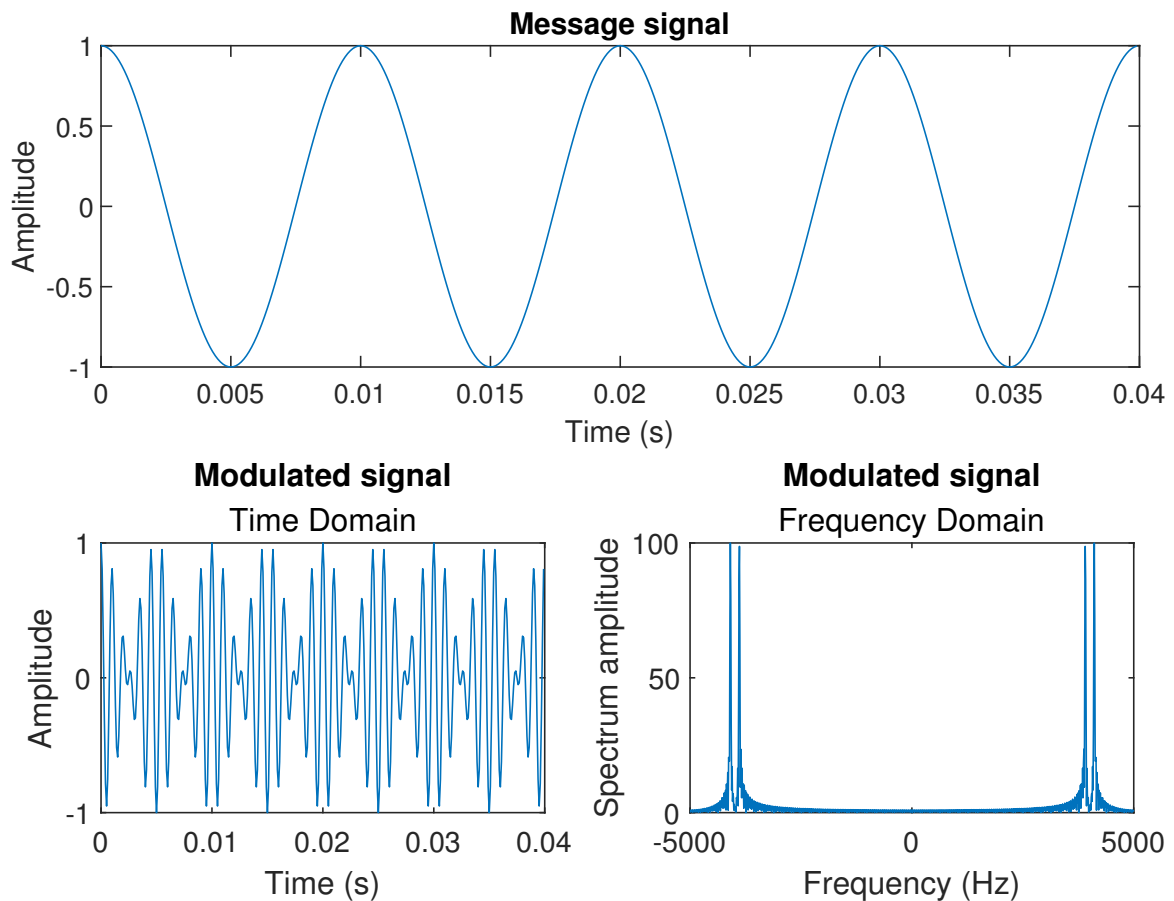


Figure 3: DSB-SC (Time & Frequency Domain)

4.3 SSB (Time & Frequency Domain)

```

1  fm=100;
2  fc=1000;
3  fs=10000;
4  t=0:(1/fs):((4/fm)-(1/fs));
5  x=cos(2*pi*fm*t);
6  y=modulate(x, fc, fs, 'amssb');
7  z=abs(fft(y,1024));
8  f= (-511*fs/1024):(fs/1024):(512*fs/1024);
9  %Plot
10 subplot(2,2,[1 2]);
11 plot(t,x);
12 title('Message signal');
13 xlabel('Time (s)');
14 ylabel('Amplitude');
15 subplot(2,2,3);
16 plot(t,y);
17 title('Modulated signal','Time Domain');
18 xlabel('Time (s)');
19 ylabel('Amplitude');
20 subplot(2,2,4);
21 plot(f,z);
22 title('Modulated signal','Frequency Domain');
23 xlabel('Frequency (Hz)');
24 ylabel('Spectrum amplitude');
25 sgtitle('(PUL074BEX004) AMSSB')

```

Code 3: MATLAB code SSB

(PUL074BEX004) AMSSB

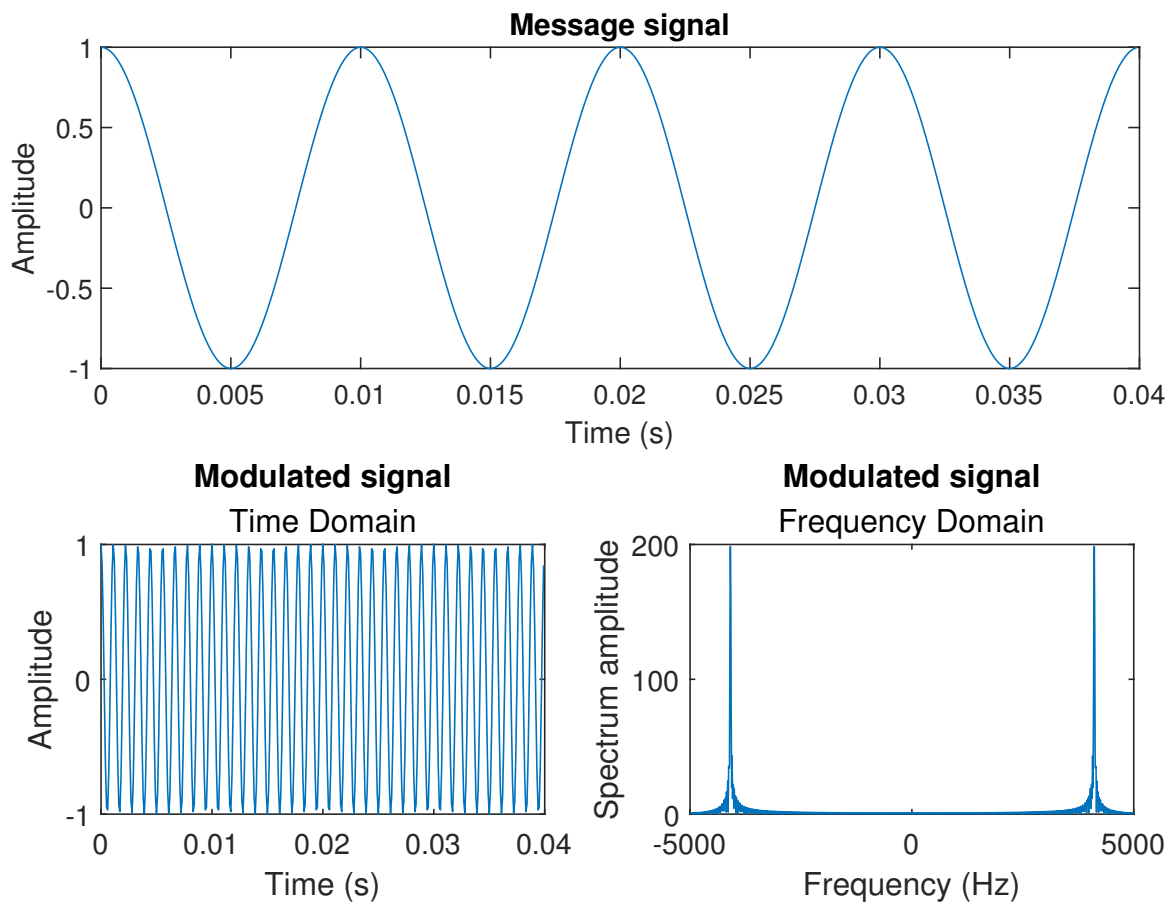


Figure 4: SSB (Time & Frequency Domain)

4.4 Demodulation

```

1  fm =100;
2  fc =1000;
3  fs =10000;
4  t=0:(1/ fs ) :((4/ fm ) -(1/ fs ) ) ;
5  x =cos (2* pi* fm * t ) ;
6  y = modulate (x , fc , fs , 'amdsb -sc ' ) ;
7  z = demod (y , fc , fs , 'amdsb -sc ' ) ;
8  % Plot
9  subplot (3 ,1 ,1)
10 plot (t , x ) ;
11 title ('Message signal ' ) ;
12 xlabel ('Time (s)') ;
13 ylabel ('Amplitude ' ) ;
14 subplot (3 ,1 ,2)
15 plot (t , y ) ;
16 title ('Modulated signal ' ) ;
17 xlabel ('Time (s)') ;
18 ylabel ('Amplitude ' ) ;
19 subplot (3 ,1 ,3)
20 plot (t , z ) ;
21 title (' Demodulated signal ' ) ;
22 xlabel ('Time (s)') ;
23 ylabel ('Amplitude ' ) ;
24 sgtitle ('( PUL074BEX004 ) Demodulation ')

```

Code 4: MATLAB code Demodulation

(PUL074BEX004) Demodulation

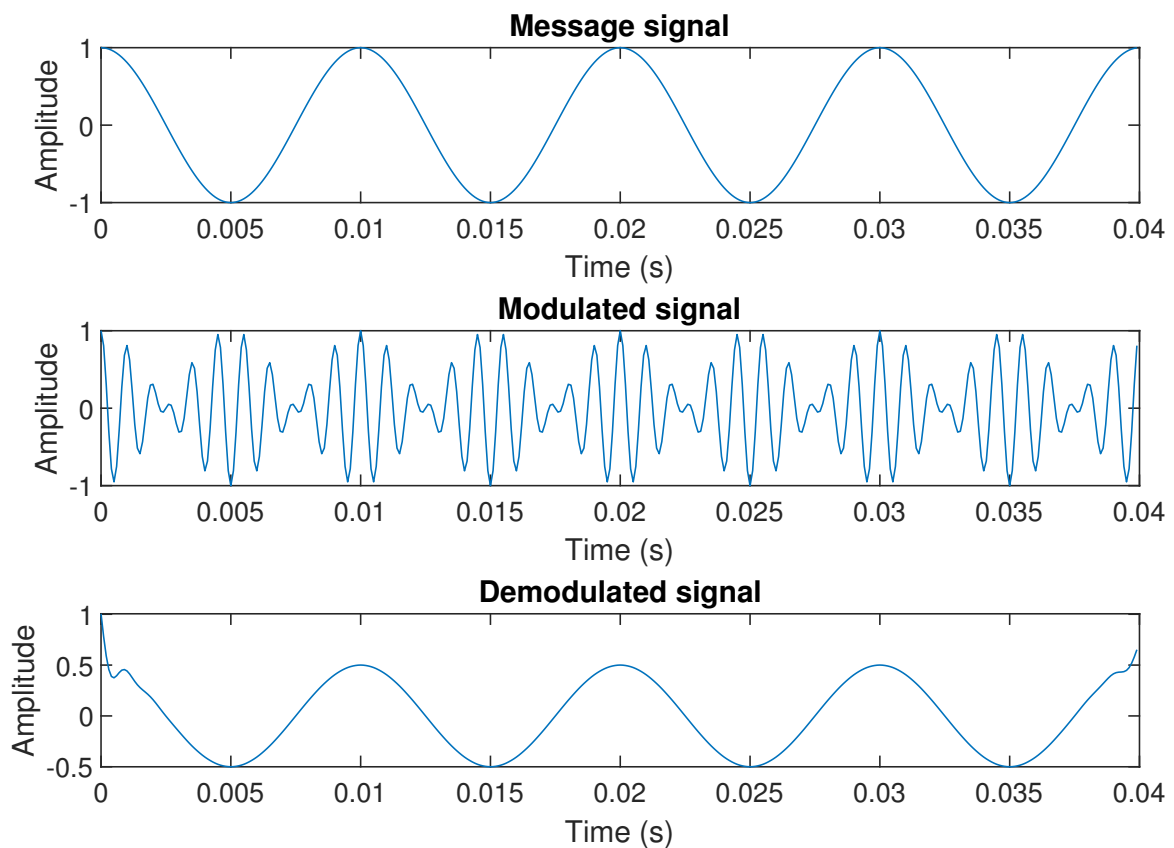


Figure 5: Demodulation Observation of DSB-SC

5 Discussion and Conclusion

In this lab we observed amplitude modulation of DSB-TC, DSB-SC, SSB and Demodulation of DSB-SC signal. We used MATLAB and its modules to implement the above mentioned process and generating plots.