PROJECT OF INTRODUCTION TO COMMUNICATION SYSTEMS LECTURE

Project Subject : COMPARISON THE ANALOG MODULATION TECHNIQUES

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DEFINITIONS of AM, DSB-SC, SSB-SC and FM for INTRODUCTION

Amplitude Modulation

AM was the first widespread technique used in commercial radio broadcasting. An AM signal has the mathematical form

$$s(t) = A_c[1 + k_a m(t)] \cos \omega_c t$$

where
• m(t) is the baseband message.
• c(t) = Ac cos(wct) is called the carrier wave.
• The carrier frequency, fc, should be larger than the highest spectral component in m(t).
• The parameter ka is a positive constant called the amplitude sensitivity of the modulator.

Double Side Band Suppressed Carrier Modulation

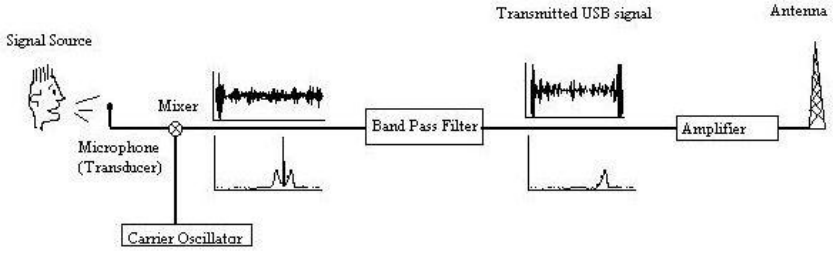
Let m(t) be a bandlimited baseband message signal with cutoff frequency W. The DSBSC-AM signal corresponding to m(t) is

$$s(t) = A_c m(t) \cos \omega_c t$$

This is the same as AM except with the sinusoidal carrier component eliminated.

Single Side Band Suppressed Carrier Modulation

The concept of single side-band (SSB) is very simple: if we don't need two side-bands, we must eliminate one. To make that happen, we merely add a component to your system that removes the extra side-band. That component is called a band pass filter.



Frequency Modulation

In the FM modulation technique, the frequency of the carrier signal is modulated in proportion to the baseband signal. In other words, the frequency of a modulating signal is used to directly vary the frequency of a carrier signal. Bearing in mind that an angle modulated signal;

$$S(t) = A_c \cos(\theta i(t))$$

then for FM signal, θi(t) is given by;

$$\theta i(t) = 2\pi fc\, t + \beta \int (m(t)dt)$$

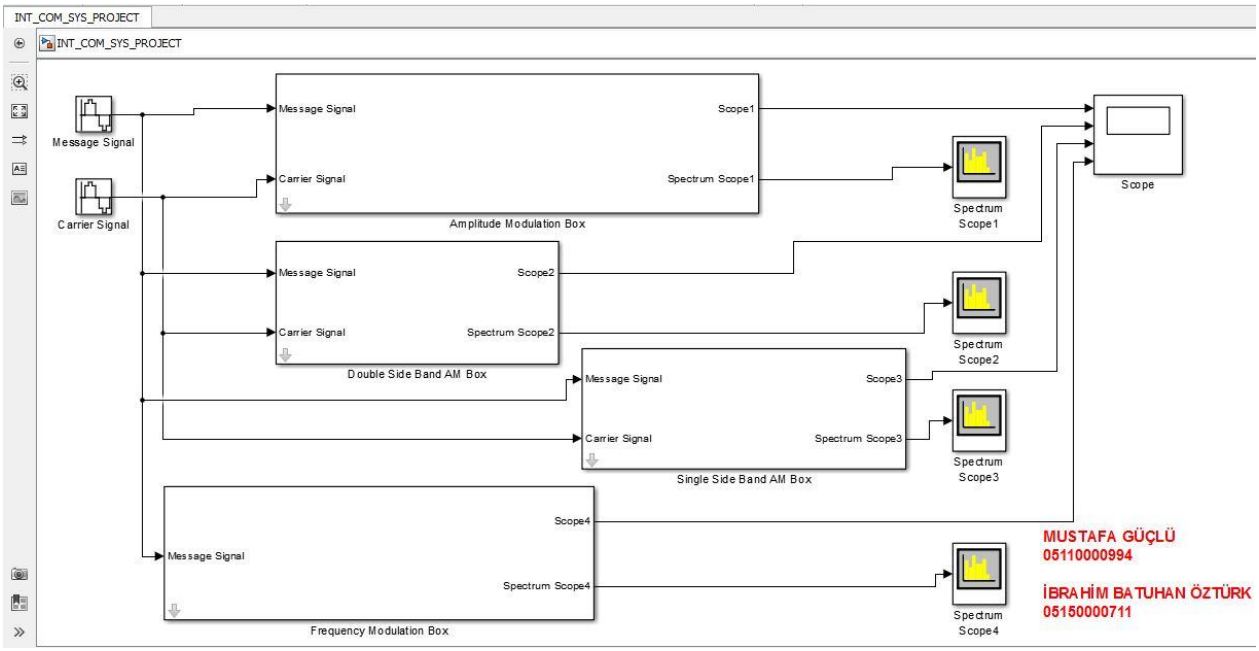
Then a Frequency modulated (FM) signal is given by:

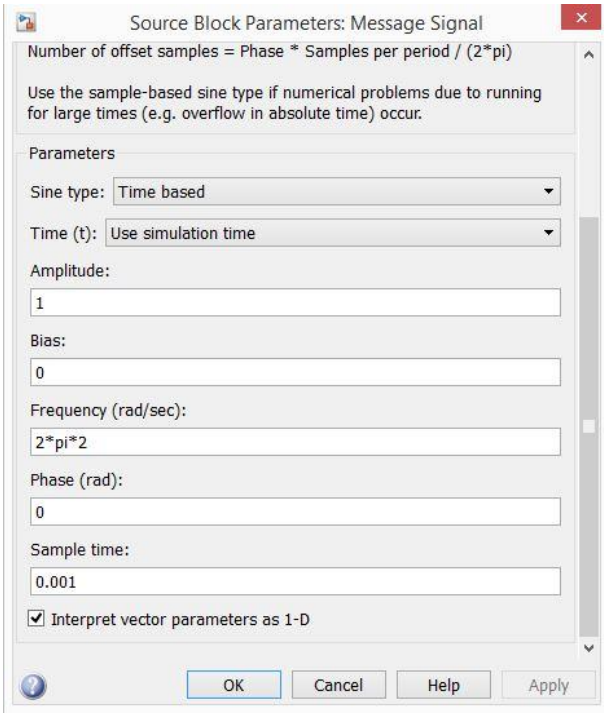
$$S(t) = A_c \cos(2\pi fct + \beta \int m(t)dt)$$

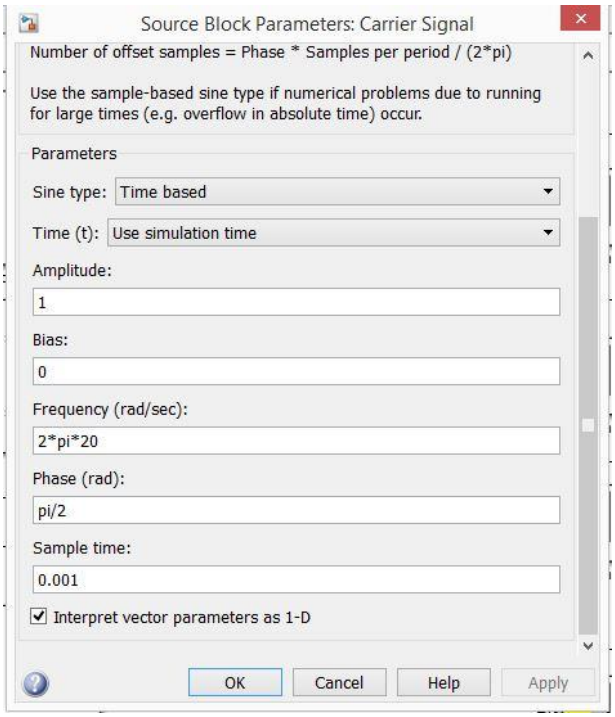
where m(t) is the modulating signal, Ac and fc are the carrier amplitude and frequency respectively, and β is a frequency modulation index. Depending on the value of β, FM can be either narrowband or wideband.

AM, DSB-SC, SSB-SC and in SIMULINK

First of all, we drew block diagrams, created subsystems for every modulation technique, had message signal as a sine wave [sin(2*pi*2)] and carrier signal as a cosine wave [cos(2*pi*20)].

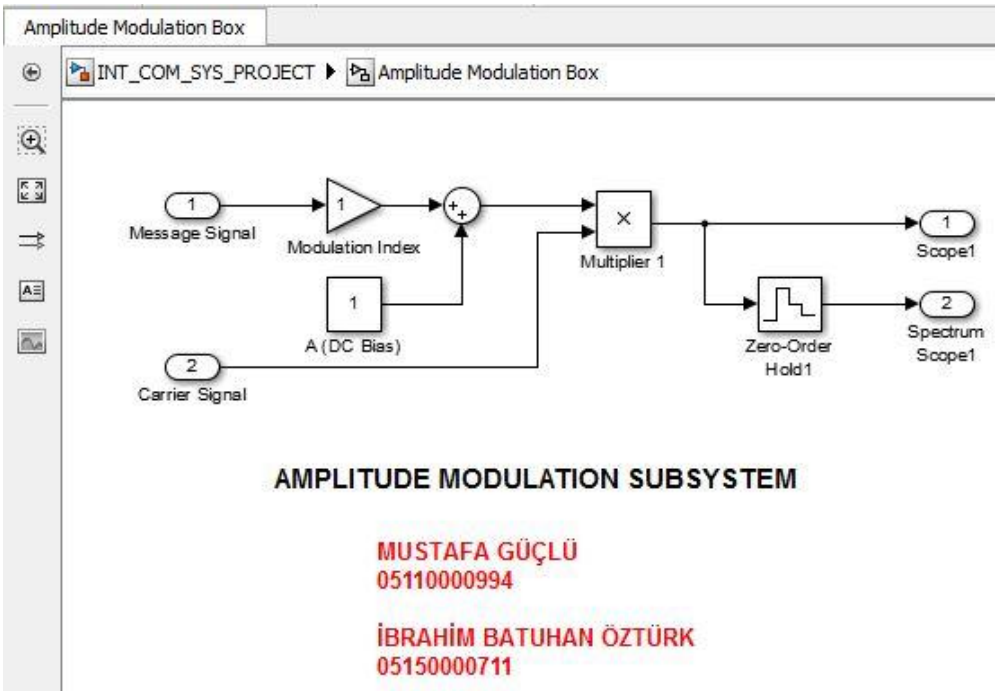






Frequency (rad/sec) : 2*pi*f

- **Subsystem for Amplitude Modulation;**



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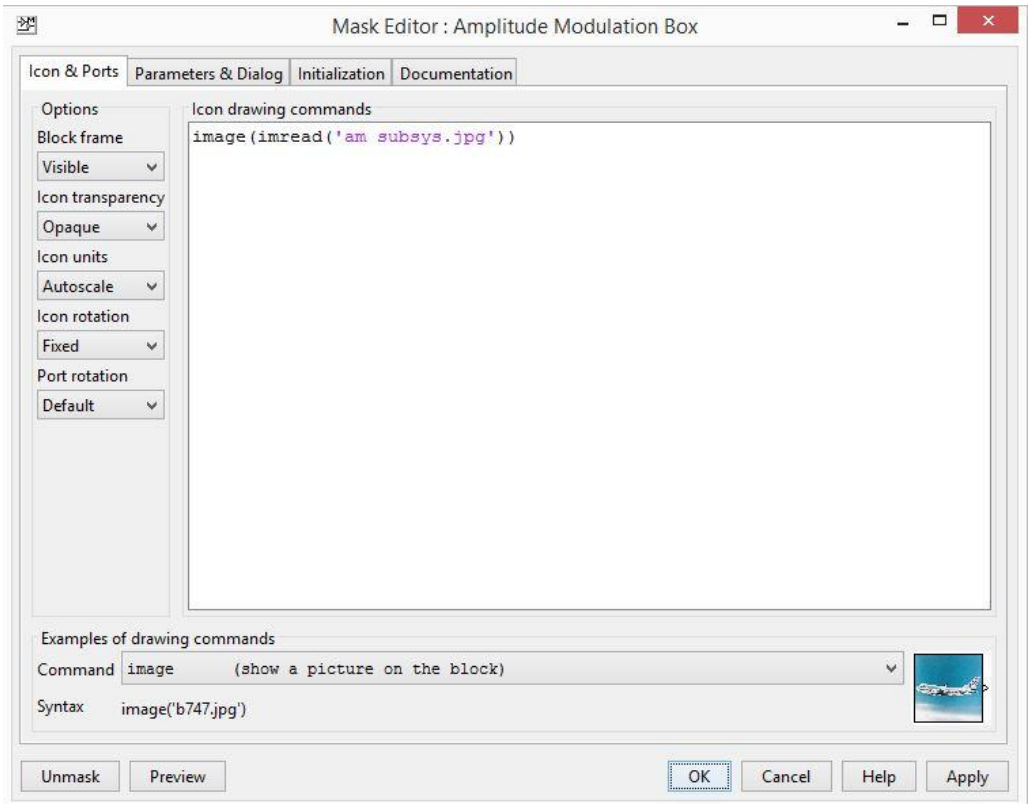

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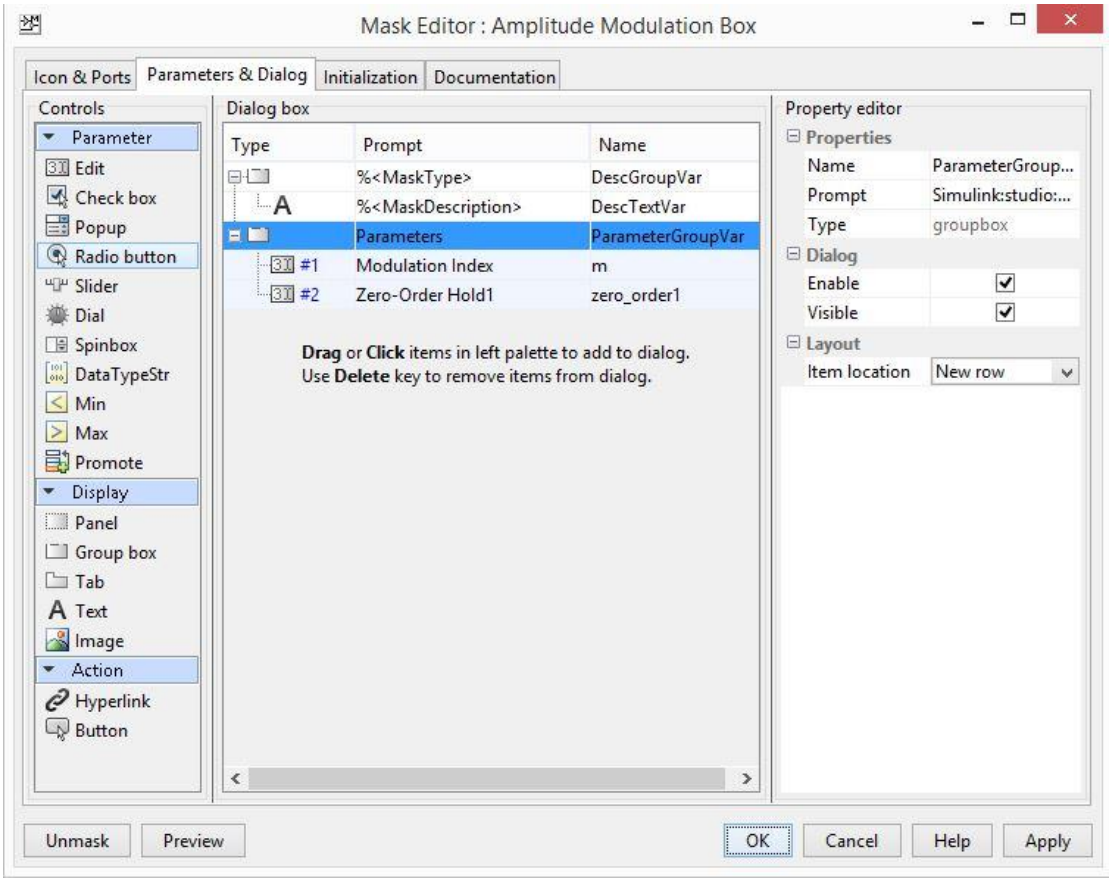
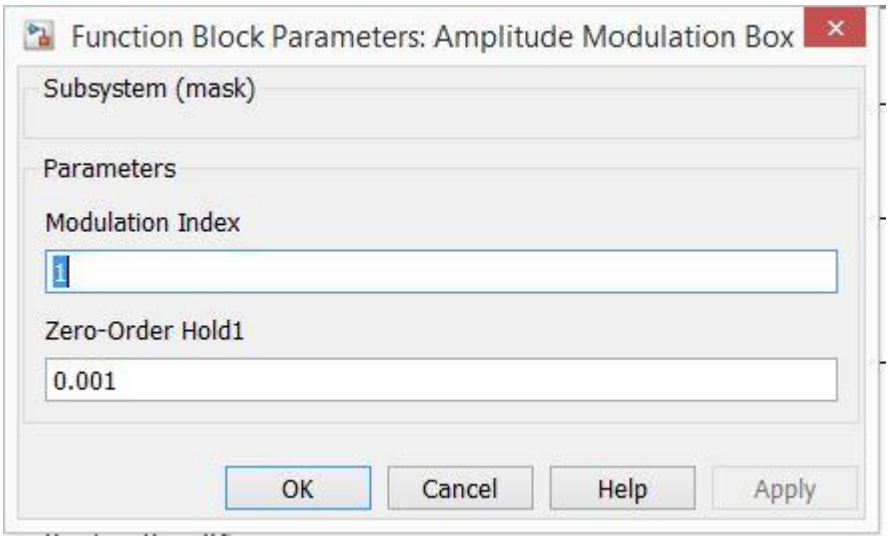
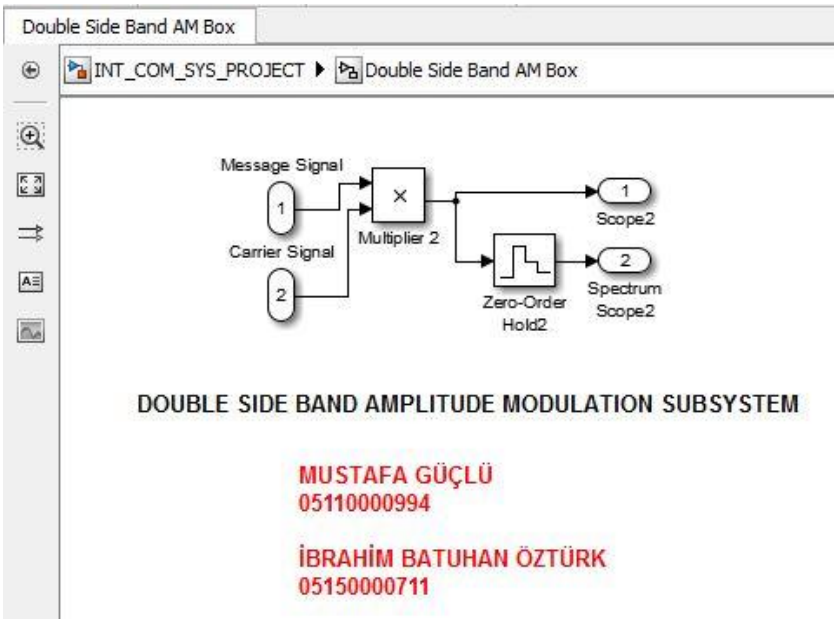


Amplitude Modulation Block Parameters;



- **Subsystem for Double Side Band Suppressed Carrier Amplitude Modulation;**



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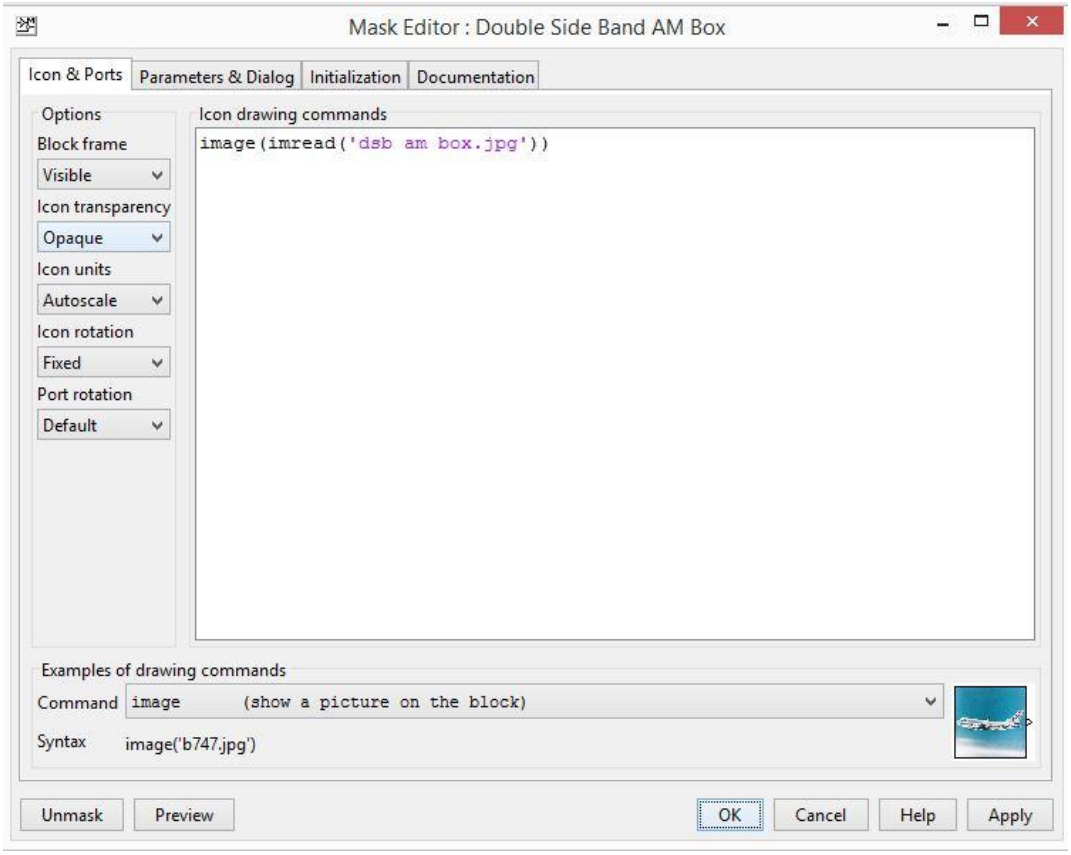

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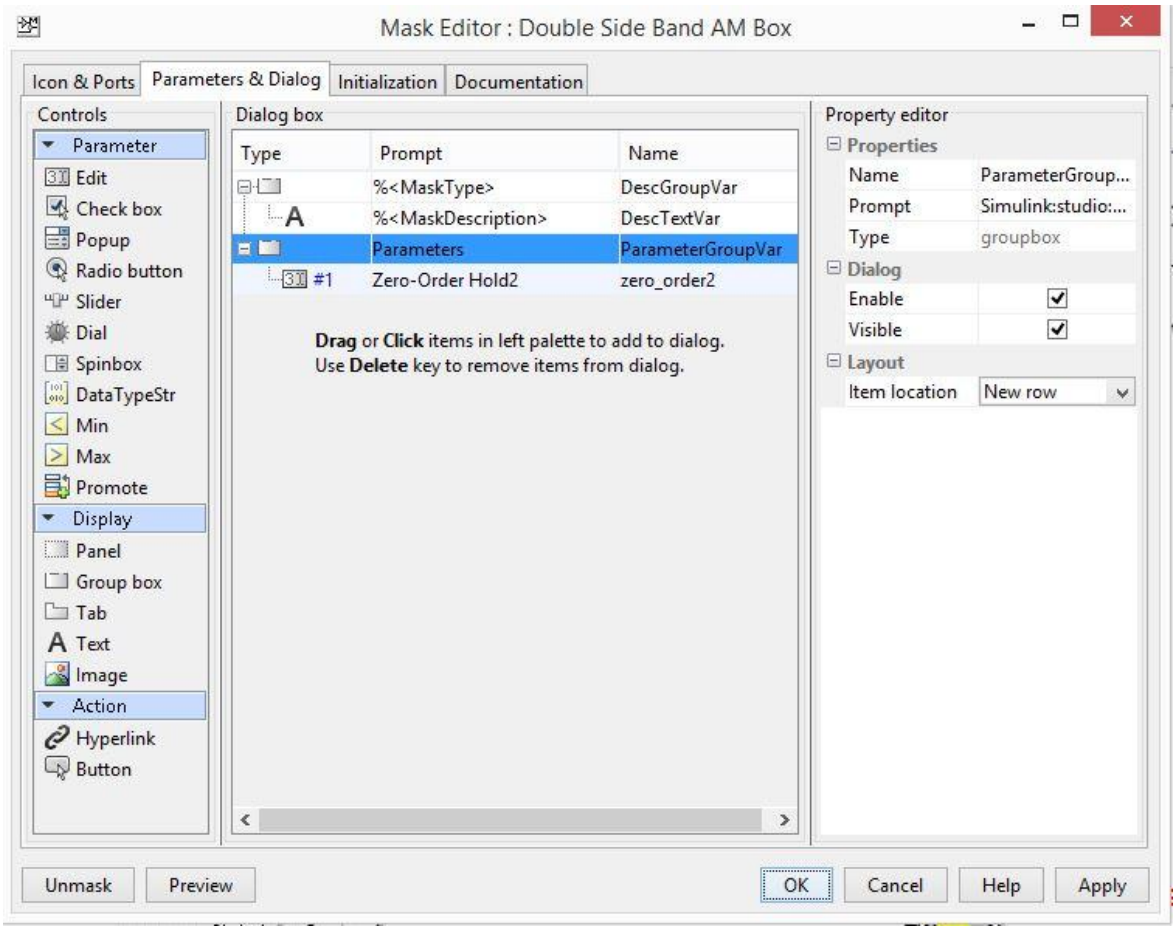
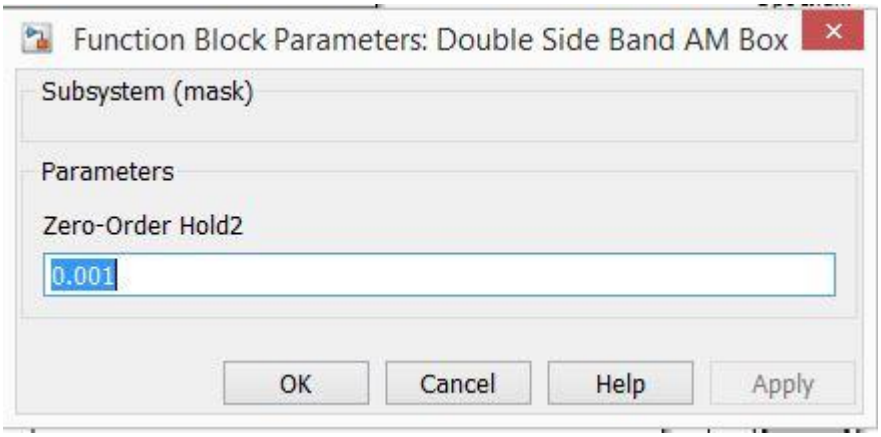
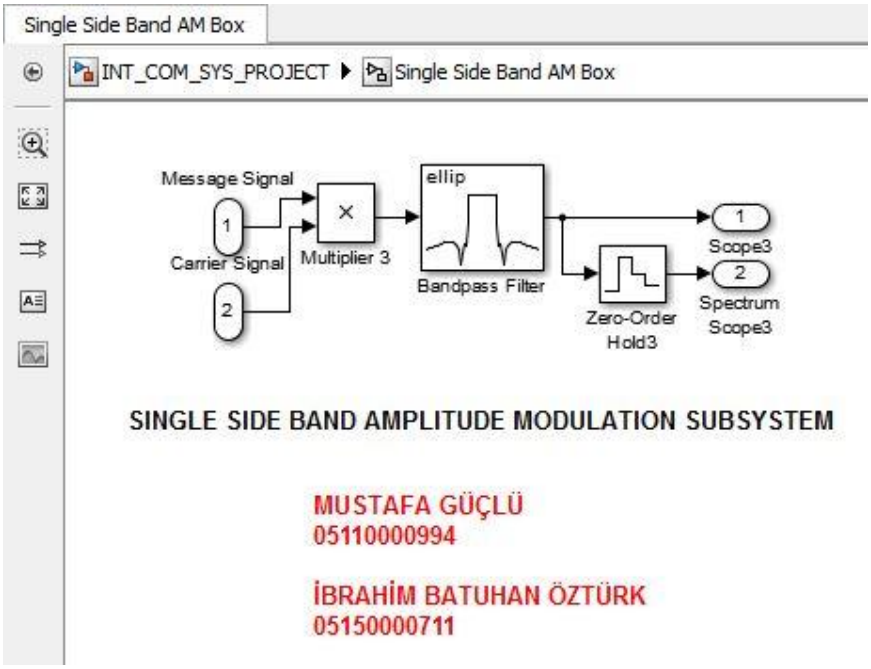


Double Side Band-Suppressed Carrier Amplitude Modulation Block Parameters;



- **<u>Subsystem for Single Side Band Suppressed Carrier Amplitude Modulation;</u>**



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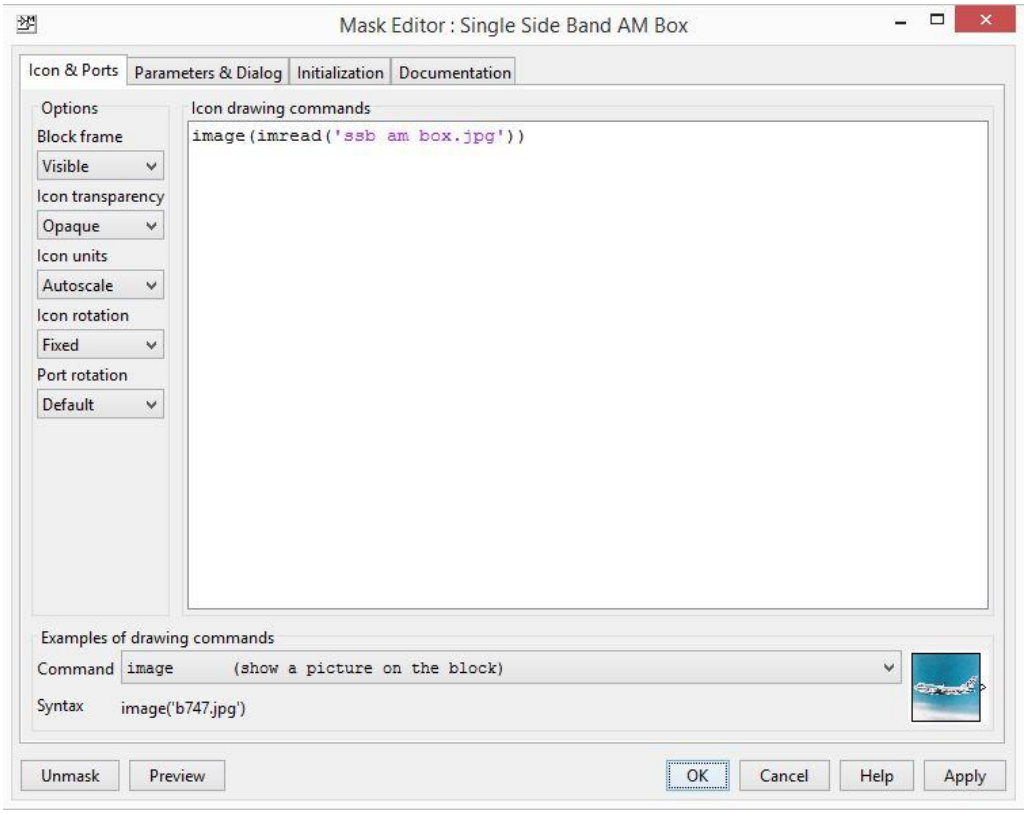

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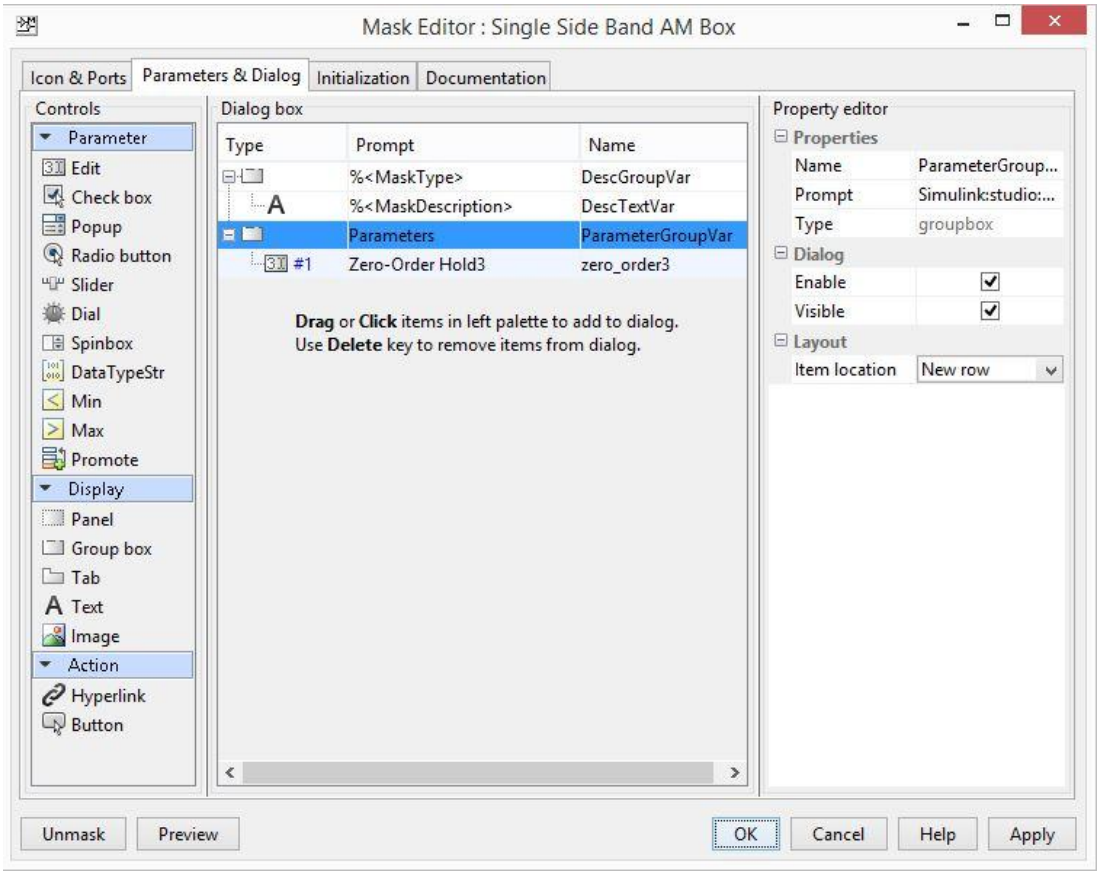
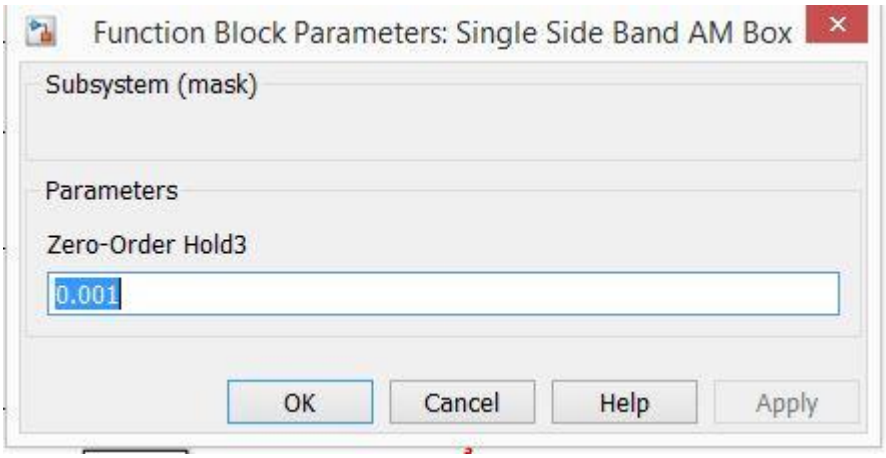
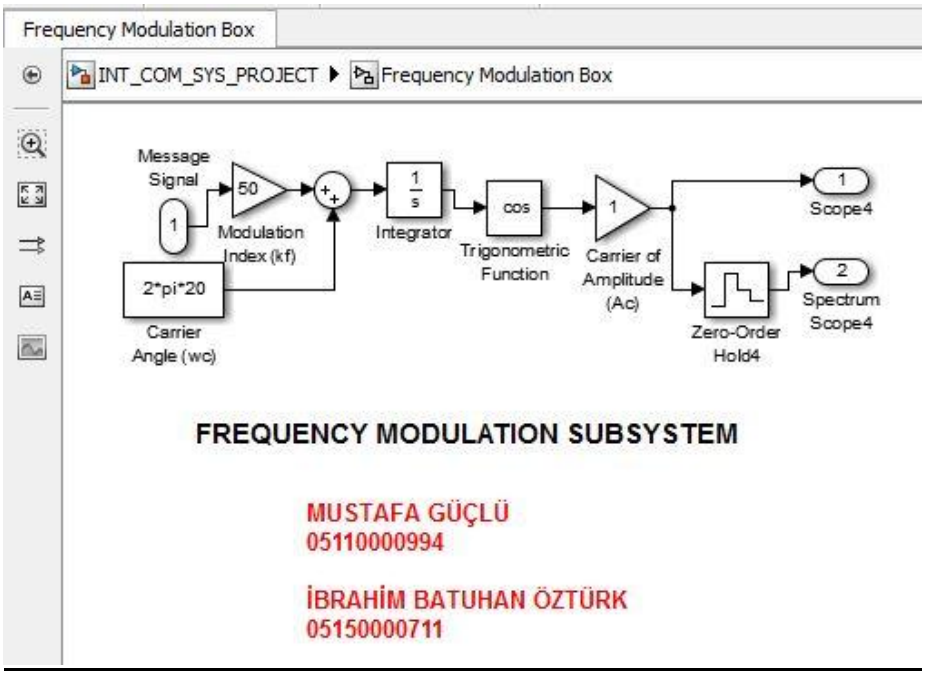


Single Side Band-Suppressed Carrier Amplitude Modulation Block Parameters;



- **Subsystem for Frequency Modulation;**



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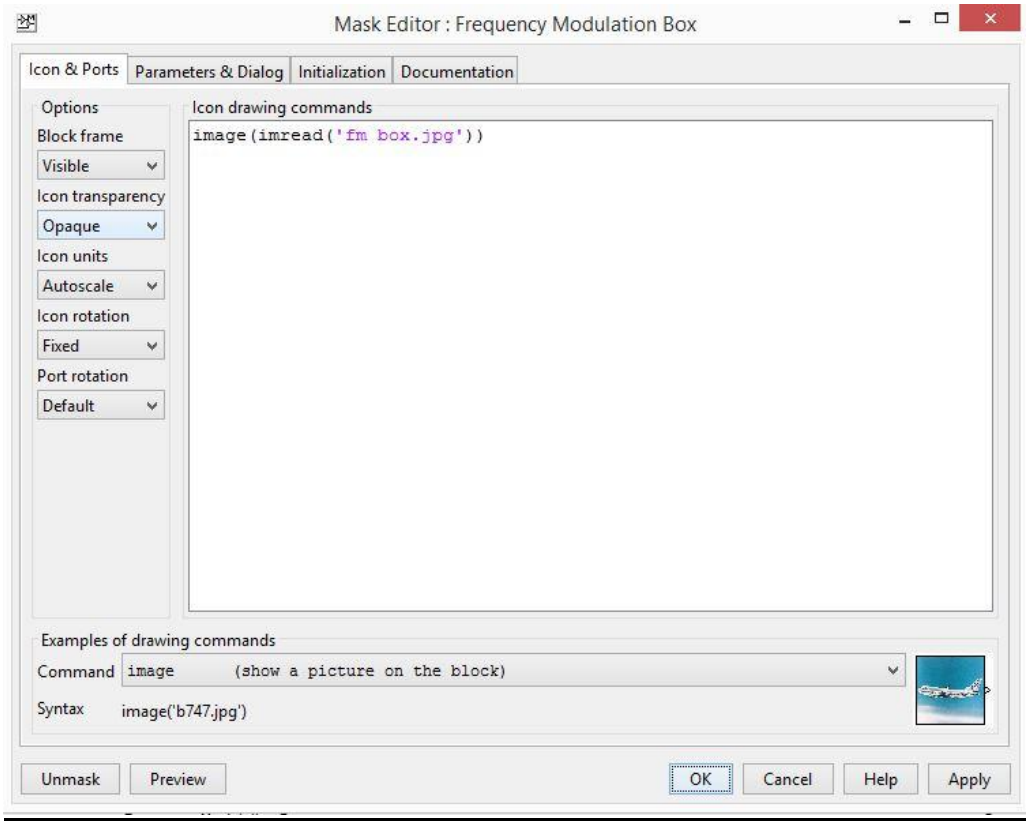

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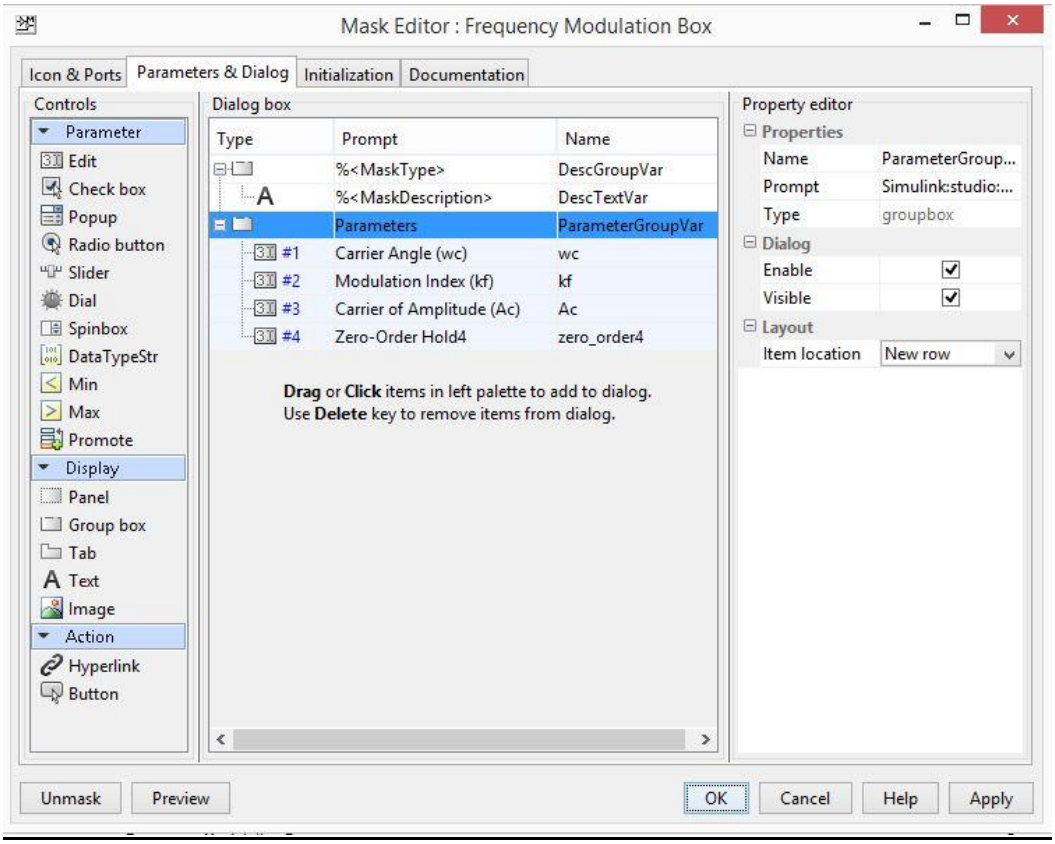
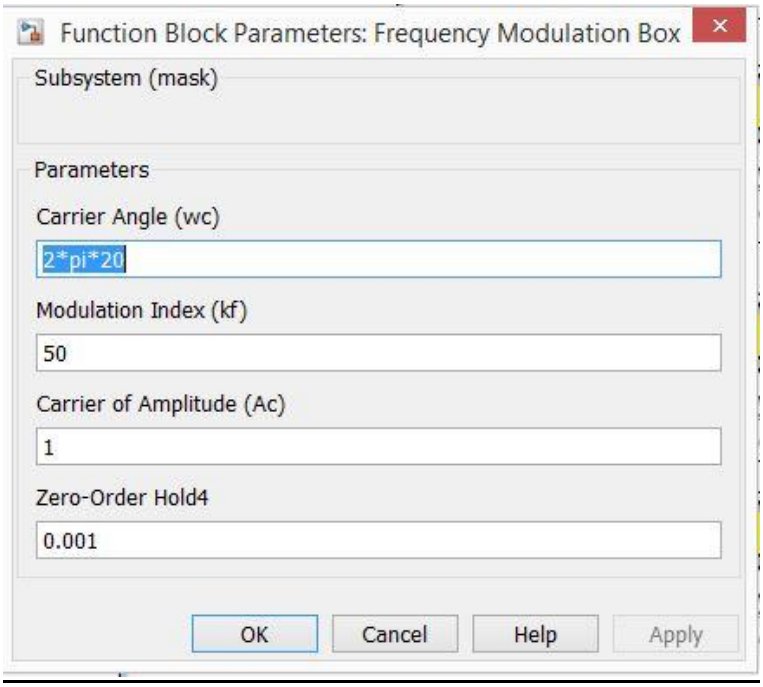
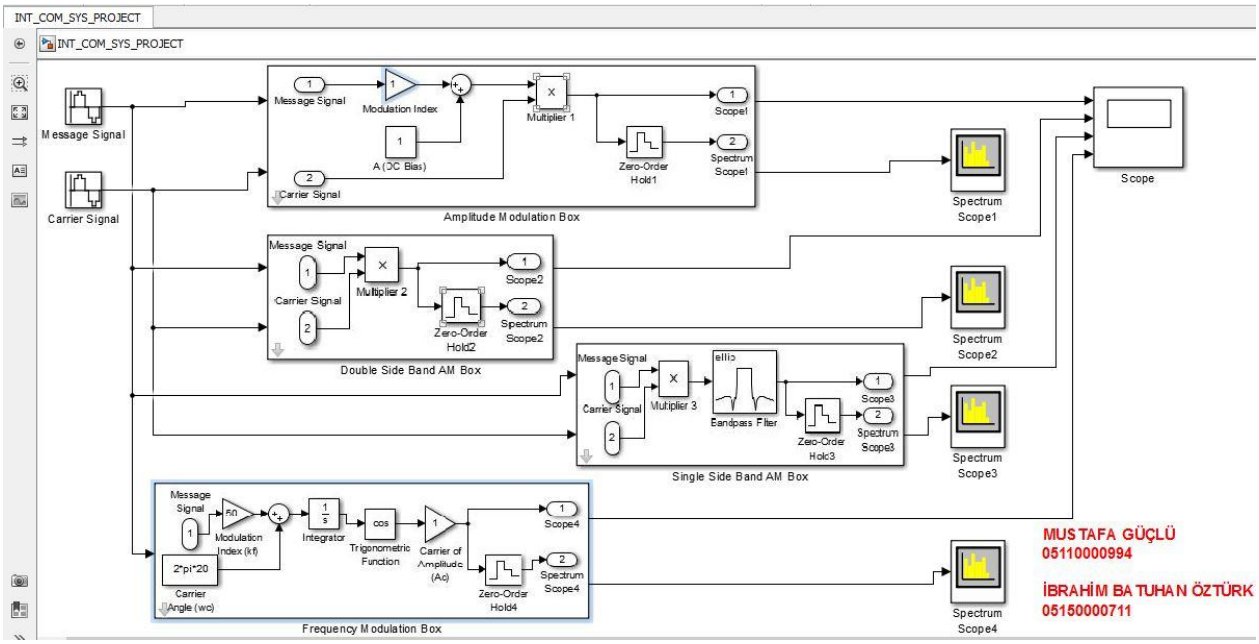


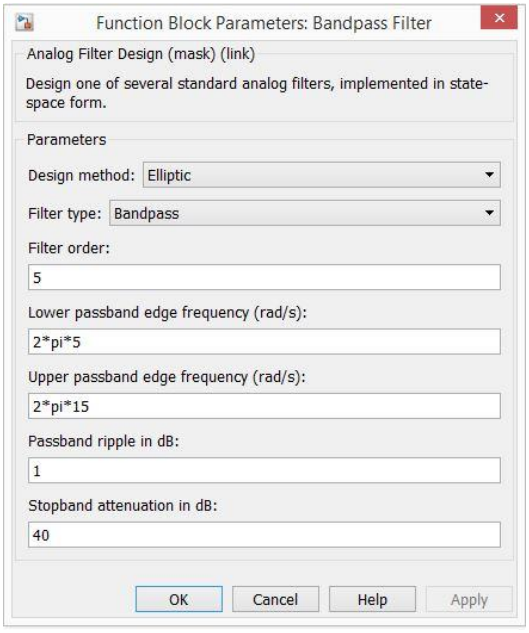
Frequency Modulation Block Parameters;



We achieved screen-shots for every subsystem and added all screen-shots in subsystem blocks via ex."image(imread('dsb am box.jpg'))" from Mask Editor > Icon & Ports.

Simulink Block for Every Modulation Techniques

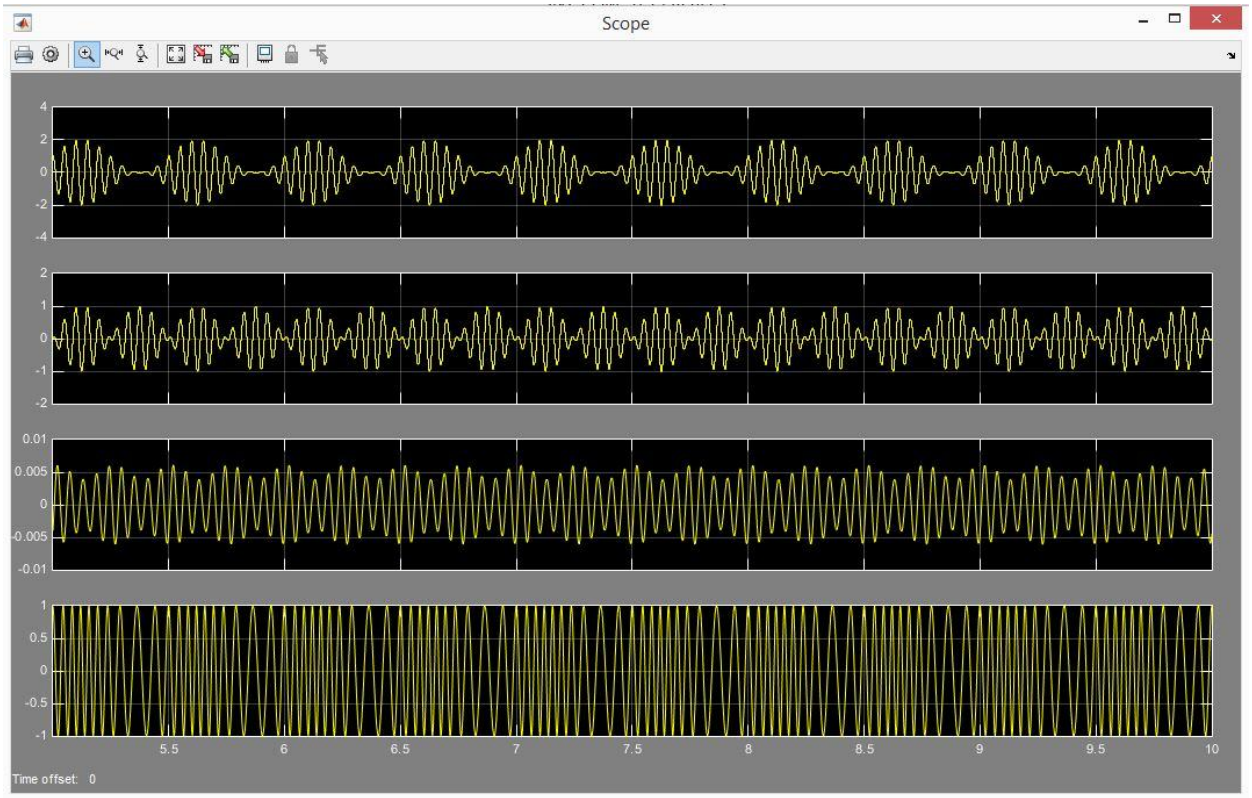




We used 5th order Elliptic Bandpass Filter for getting SSB-SC, and selected 1db for passband ripple and 40 db for minimum stopband attenuation.

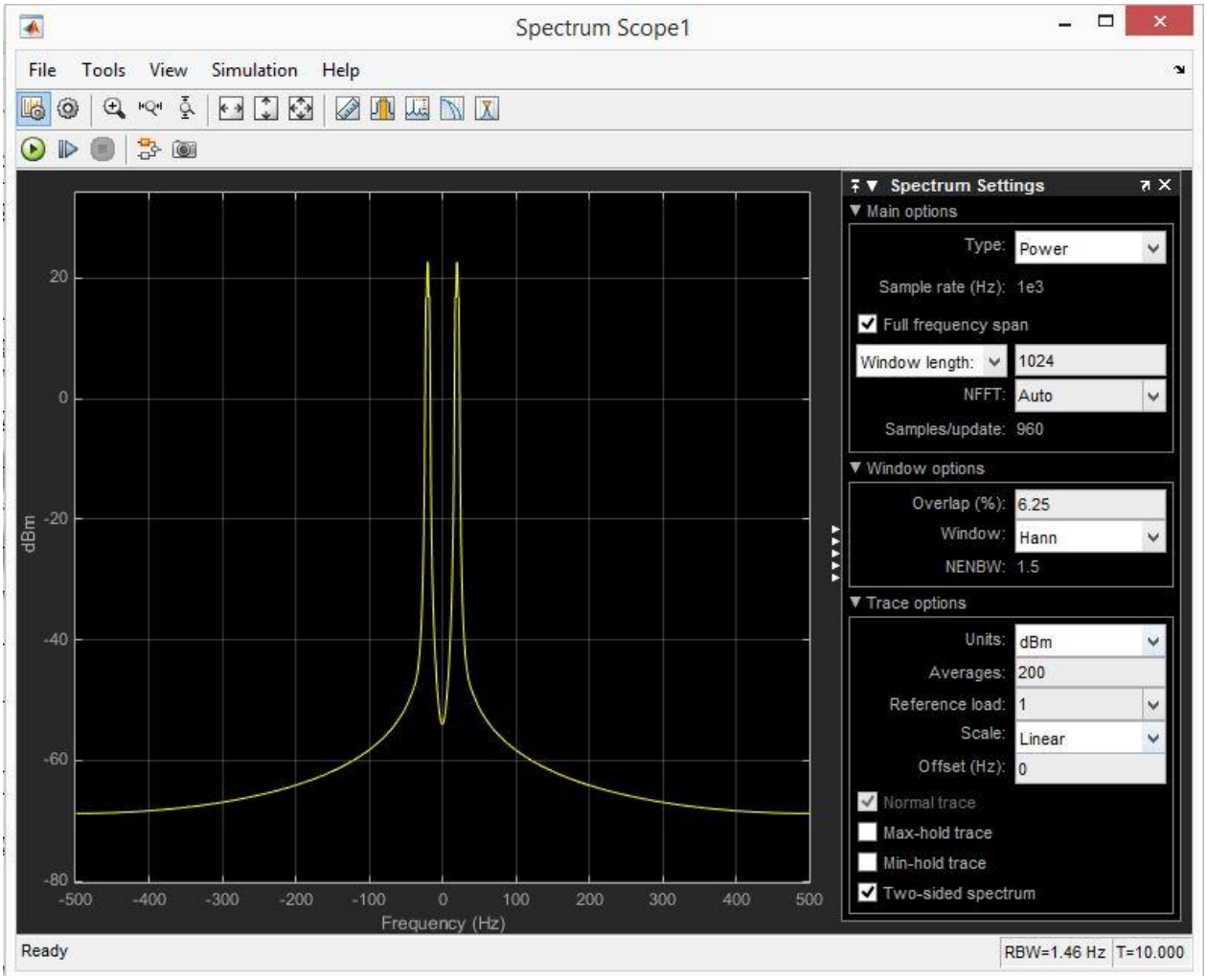
Simulation Results on the Scope

1. Amplitude Modulation
2. DSB-SC Modulation
3. SSB-SC Modulation
4. Frequency Modulation

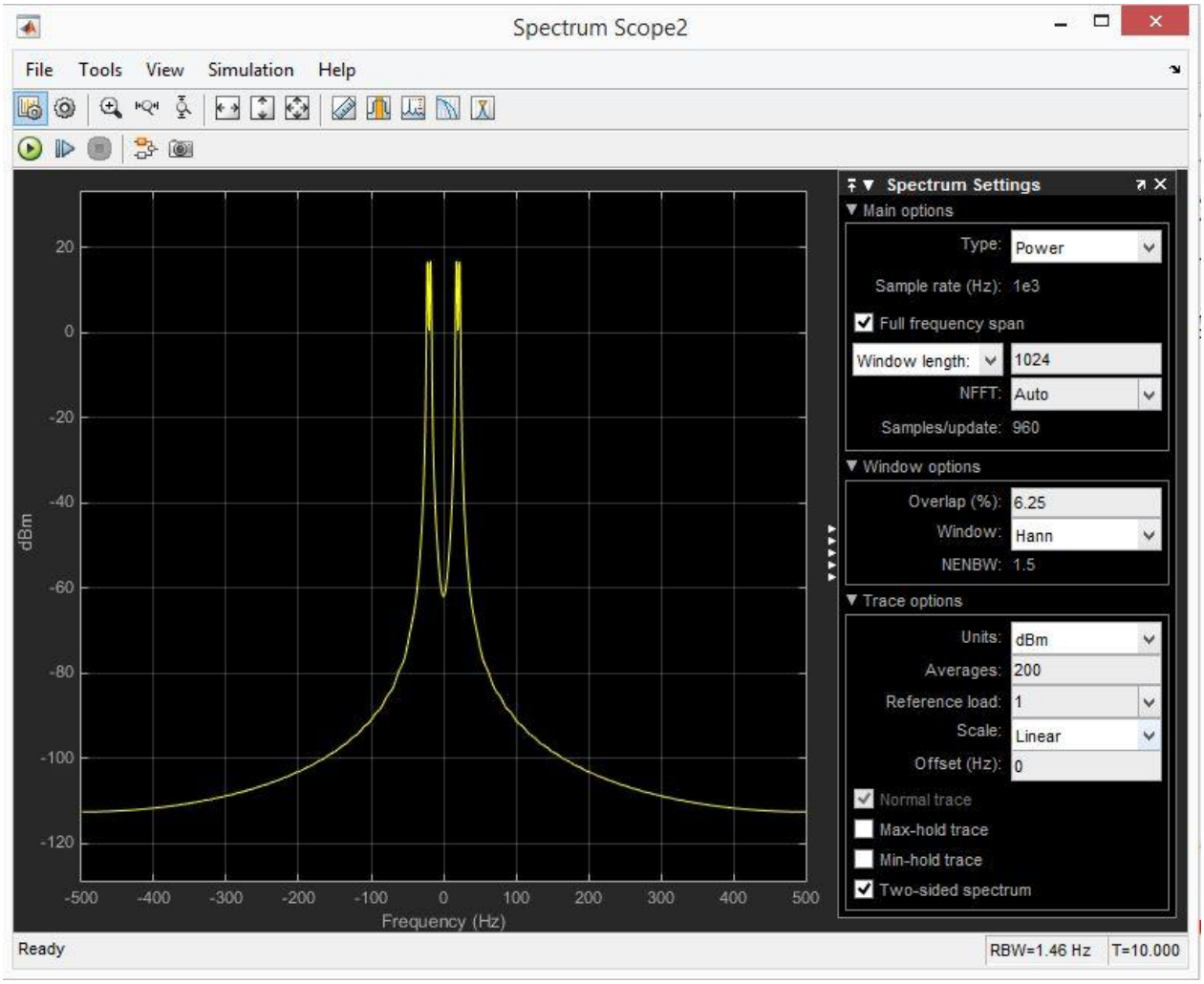


Simulation Results on the Spectrum Scope

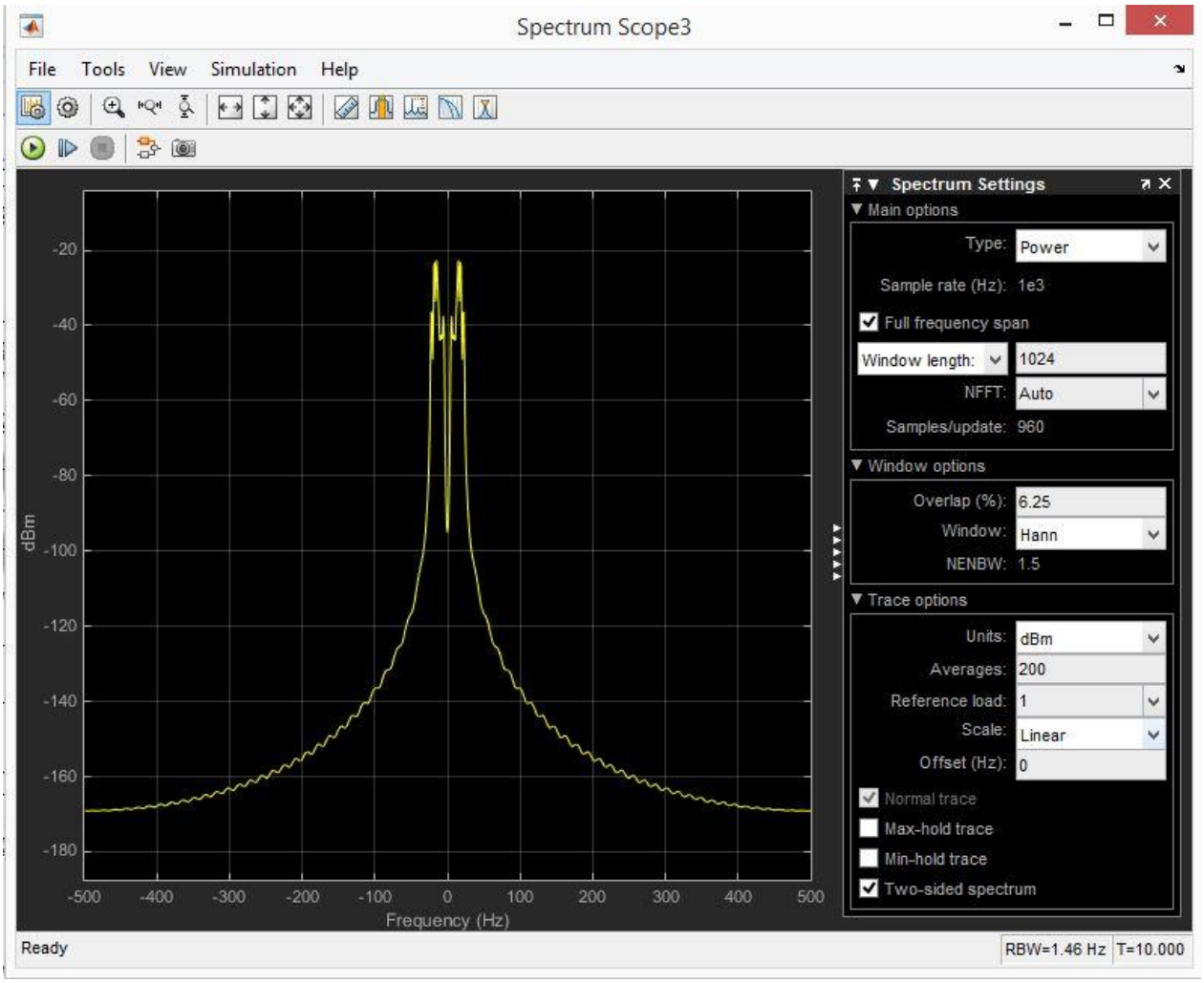
1. Spectrum Analysis for Amplitude Modulation



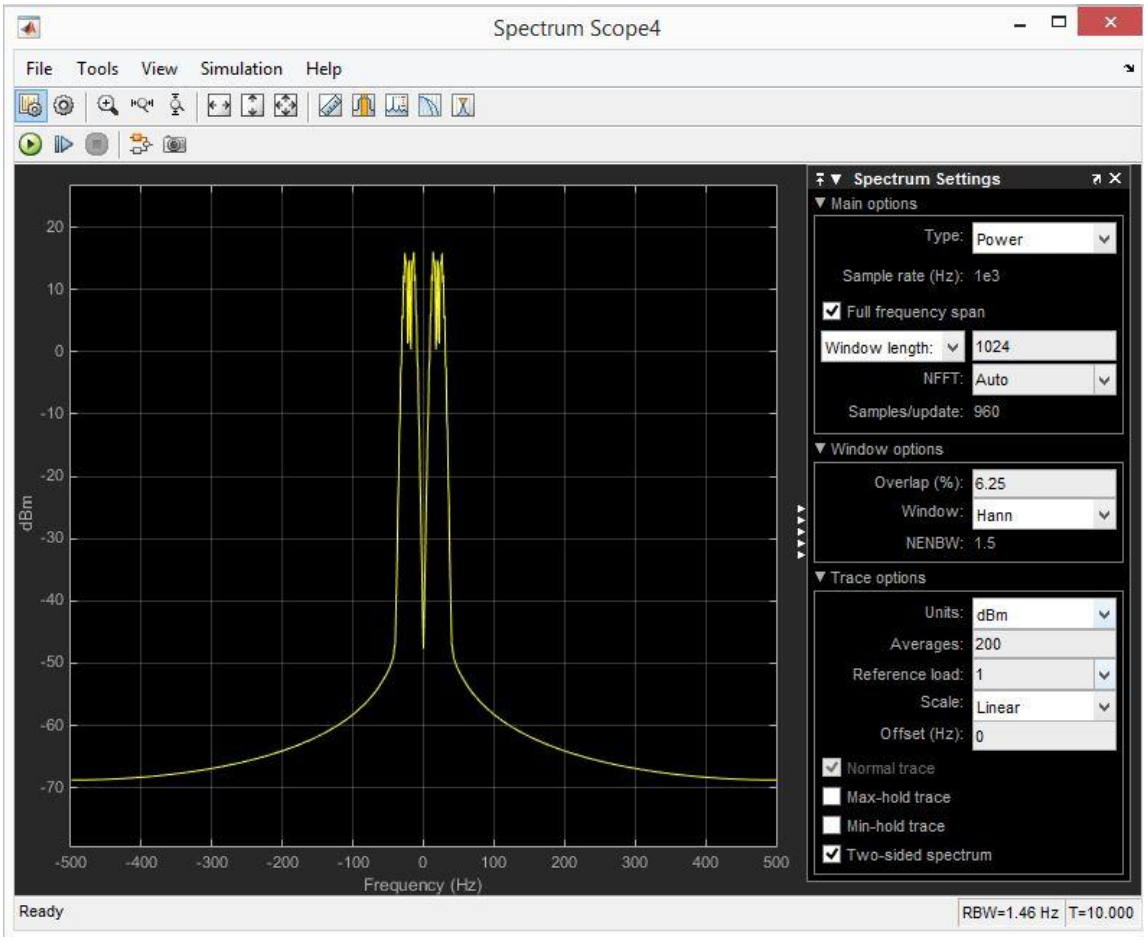
2. Spectrum Analysis for DSB-SC Modulation



3. Spectrum Analysis for SSB-SC Modulation



4. Spectrum Analysis for Frequency Modulation



CONCLUSION

In amplitude modulation, the amplitude of the carrier wave is modified in order to transmit information. In DSB-SC modulation, output signal is equal to product of message and carrier signals. In SSB-SC modulation, we get LSB or USB according to filter type (Low Pass Filter or High Pass Filter) after product of message and carrier signals. In frequency modulation, the instantaneous frequency of the carrier wave is modified in order to transmit information.