

“DESIGN AND SIMULATION OF DOUBLE SIDE BAND SUPPRESSED CARRIER MODEL USING MATLAB SIMULINK TOOL AND EFFECT OF NOISE ON SIMULATION RESULTS USING MATLAB CODING”

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ABSTRACT

For long distance communication efficient and effective transmission plays a vital role for which modulation techniques are required. In conventional AM transmission, the sinusoidal component at the carrier frequency which does not contain information and both the side bands (upper sideband and lower sideband) are present i.e., DSB-AM. Therefore, the presence of carrier results in $2/3^{\text{rd}}$ power loss. In order to

overcome this problem the carrier signal is suppressed, i.e., removed producing double-side band suppressed carrier (DSBSC). In DSBSC real information is preserved and power wastage is prevented. In this paper more emphasis is on the design and simulation of DSBSC modulation and detection using the Simulink tool of MATLAB. This paper also talks about the effect of noise on simulation results.

KEYWORDS: Double side band suppressed carrier, Spectrum analyzer, modulation index, Additive wave gaussian noise (awgn).

INTRODUCTION

Communication refers to sending and receiving and processing of information by electronic means. It is started with wired telegraphy in 18th century developing with telephony, some decades later and radio at the beginning of this century. Radio communication made possible

by invention of triode tubes, thin transistor IC's and semiconductor devices. News of satellite and fiber optics has made communication more wide spread.

Forms of communication:

- Telegraphy
- Telephony
- Broadcasting
- Mobile communication
- Radio communication
- Computer communication
- Radar
- Satellite communication
- Radio telemetry

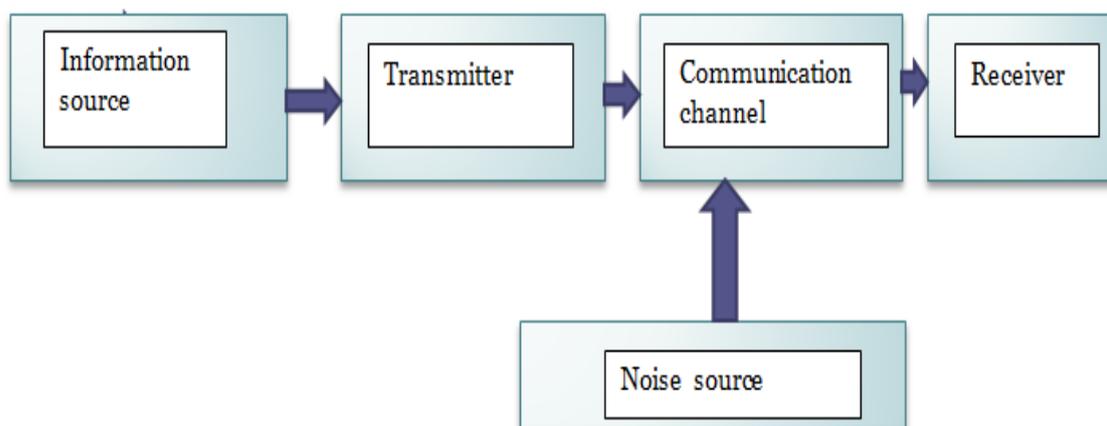


Figure 1: Block diagram of communication system.

What is modulation?

It is defined as the process by which some parameter of a high frequency signal is varied in accordance with the signal to be transmitted.

The parameter here may be frequency, phase, amplitude, etc. OR it can be defined as process of superimposing high frequency carrier signal with the broadcast /modulating signal.

In modulation process baseband signal modifies the carrier signal.

Need of modulation

Modulating signals are incompatible for direct transmission over the medium, and we have to use modulation techniques.

Advantages

- Reduces the height of an antenna.
- Avoids mixing of signals.
- Increase the range of communication.
- Allows multiplexing of signal.
- Improves quality of reception.

Amplitude modulation

When the amplitude of the carrier signal is varied in accordance with the amplitude of modulating signal is called amplitude modulation keeping frequency and phase constant.

THEORY**What is DSBSC?**

DSB-SC is a double sideband suppressed carrier modulation. When amplitude modulation is carried out; the modulating signal spectrum is shifted to the carrier frequency band. DSB-SC is named because the modulating signal extends symmetrically on both sides of the carrier wave. DSB-SC is a transmission in which frequencies produced by amplitude modulation (AM) are symmetrically spaced above and below the carrier frequency and the carrier level is reduced to the lowest practical level, ideally being completely suppressed. In the DSB-SC modulation, unlike in AM, the wave carrier is not transmitted; this much of power is distributed between the sidebands, which imply an increase of the cover in DSB-SC, compared to AM, for the same power used.

The real information is conveyed using two side-bands. To make AM system more efficient, we will simply suppress the carrier which does not contain any information.

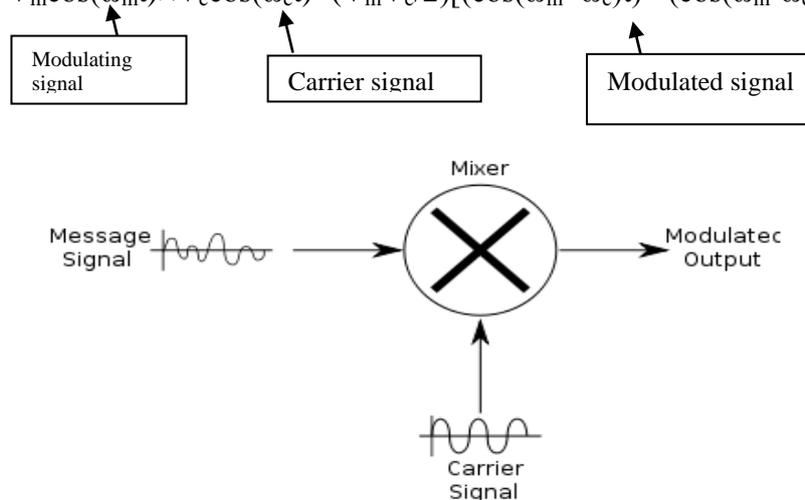
When the carrier signal is removed then the remaining signal contain only two side bands such signal called double sideband suppressed carrier (DSB-SC) signal.

Modulation

The simplest modulation method to implement is DSB, in which the translated spectrum of the message signal is transmitted without further modification. From the real signal frequency translation property of the Fourier transform, the spectrum of the message signal $x(t)$ is translated to the frequency f_c by multiplying $x(t)$ with a carrier waveform $A_c \cos(2\pi f_c t)$. The modulated waveform $x_c(t)$ is $x_c(t) = A_c x(t) \cos(2\pi f_c t)$ whose spectrum is:

$$X_c(f) = (A_c/2) * [X(f+f_c) + X(f-f_c)]$$

$$V_m \cos(\omega_m t) \times V_c \cos(\omega_c t) = (V_m V_c / 2) [(\cos(\omega_m + \omega_c)t) + (\cos(\omega_m - \omega_c)t)]$$



[1]

Demodulation

Coherent (Synchronous) Demodulator (Detector): The receiver knows exactly the phase and frequency of the received signal. Demodulation is done by multiplying the DSB-SC signal with the carrier signal just like the modulation process. This resultant signal is then passed through a low pass filter to produce a scaled version of the original message signal. DSB-SC can be demodulated by a simple envelope detector, like AM, if the modulation index is less than unity. Full depth modulation requires carrier re-insertion.

$$(V_m V_c / 2) [(\cos(\omega_m + \omega_c)t) + (\cos(\omega_m - \omega_c)t)] \times V_c' \cos(\omega_c t) = \\ (V_c V_c' V_m) \cos(\omega_m t) + 1/2 V_c V_c' V_m [\cos((\omega_m + 2\omega_c)t) + \cos((\omega_m - 2\omega_c)t)]$$

The equation above shows that by multiplying the modulated signal by the carrier signal, the result is a scaled version of the original message signal plus a second term. Since, this second term is much higher in frequency than the original message. Once this signal passes through a low pass filter, the higher frequency component is removed, leaving just the original message.

Basic block diagram

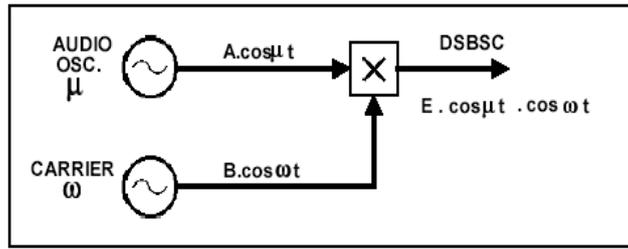


Figure2: Block diagram to generate $E \cdot \cos \mu t \cdot \cos \omega t$ ^[1]

Waveforms

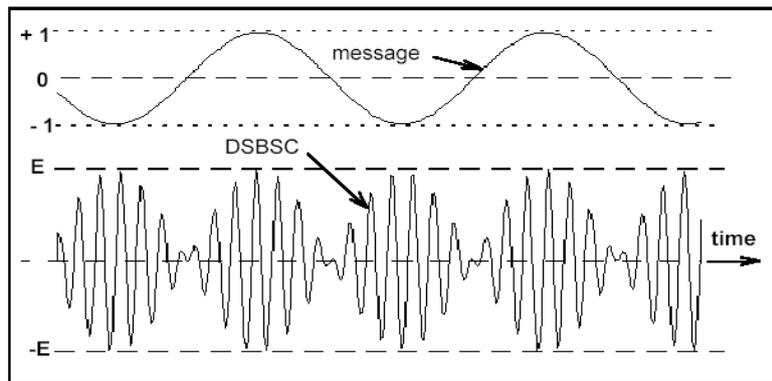


Figure 3: a DSB-SC has seen in the time domain.^[1]

Explanation

Consider two sinusoids or cosinusoids $\cos(\mu t)$ and $\cos(\omega t)$. A double sideband suppressed carrier signal, or DSBSC, is defined as their product namely,

$$DSBSC = E \cdot \cos(\mu t) \cdot \cos(\omega t) \dots \dots \dots (1)$$

Generally

$$\mu \ll \omega \dots \dots \dots (2)$$

Equation 1 can be expanded to give.

$$\cos \omega t \cdot \cos \mu t = (E/2) \cos(\omega - \mu)t + (E/2) \cos(\omega + \mu)t \dots \dots \dots (3)$$

Equation 3 shows that the product is represented by two new signals, one with a frequency that is the sum frequency $(\omega + \mu)$ and the other with a frequency that is the difference $(\omega - \mu)$ - see Figure 1.

Remembering the inequality of equation (2) the two new components are located close to the frequency ω rad/s, one just below, and the other just above it. These are referred to as the lower and upper sidebands respectively.

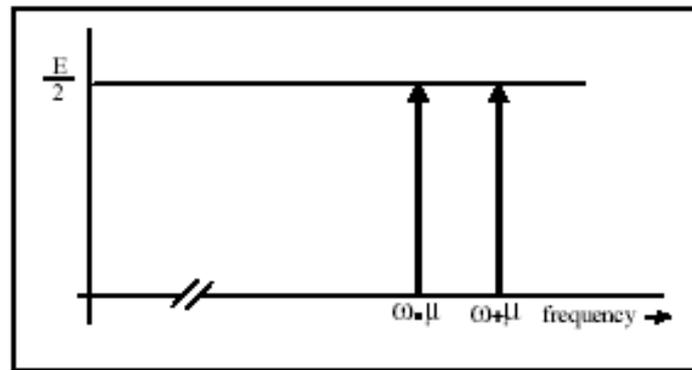


Figure 4: Spectral components.^[1]

These two components were derived from a carrier term with a frequency of ω rad/s, and a message with a frequency of μ rad/s. Due to the absence of the carrier component in the product signal, this product signal is described as a Double Sideband Suppressed Carrier (DSBSC) signal. The term carrier comes from the context of double sideband amplitude modulation (commonly abbreviated to just AM). AM is introduced in a later experiment (although, historically, AM preceded DSBSC). The time domain appearance of a DSBSC (equation. 1) is generally as shown in Figure 2. Although the message and the carrier are periodic waveforms (sinusoids), the DSBSC itself need not necessarily be periodic.

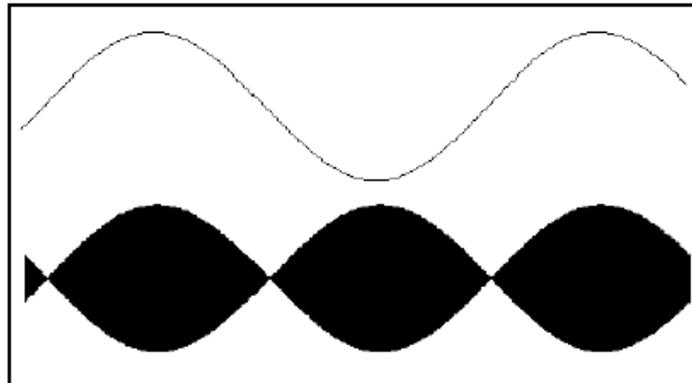
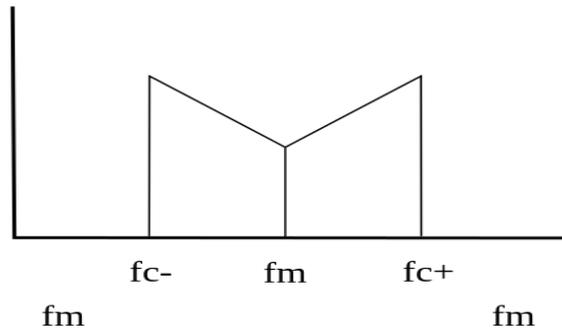


Figure 5: Typical display of a DSBSC with the message from which it was delivered as seen on an oscilloscope.^[1]

Spectrum analysis

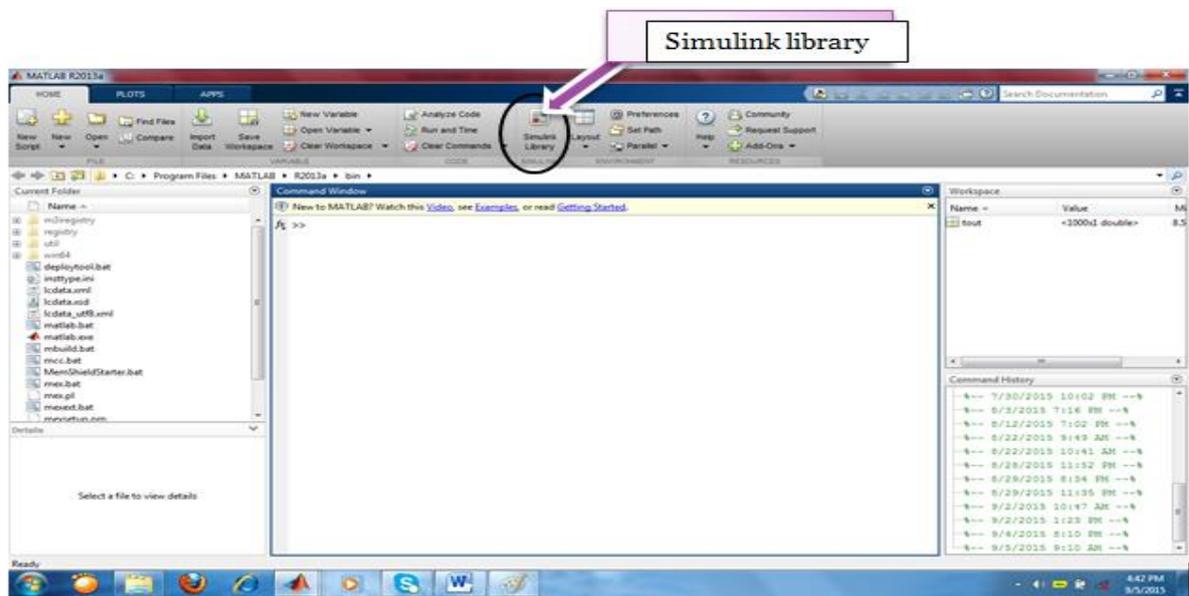
DSB-SC is basically an amplitude modulation wave without the carrier, therefore reducing power waste giving it a 50% efficiency. this an increase compare to normal AM channel (DBS) maximum efficiency of 33.333% since 2/3 of the power is in the carrier which carries no intelligence, and each sideband carries the same information.



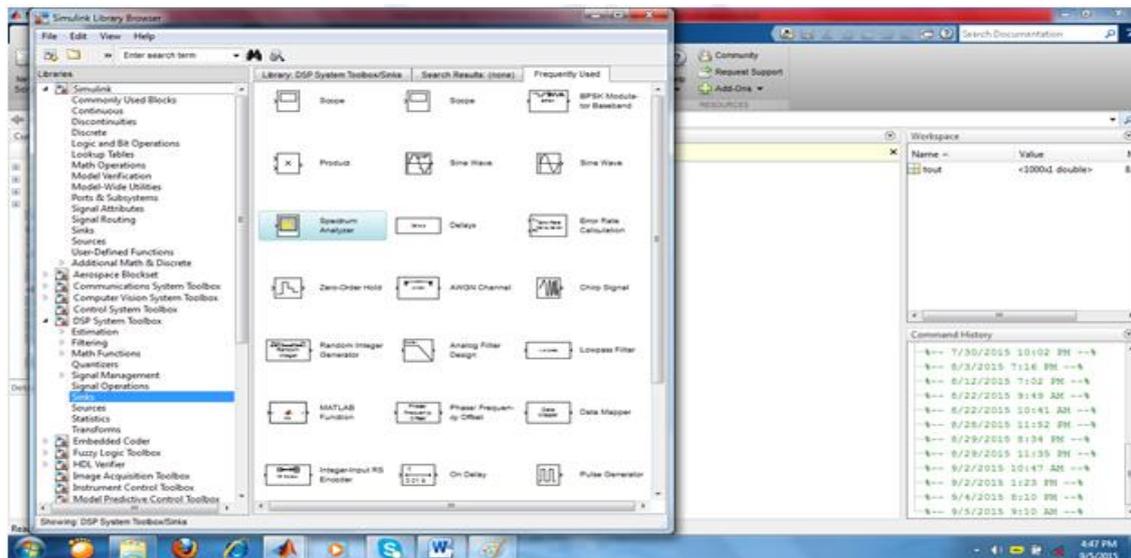
Simulink model of DSB-SC

There are few steps that are to be followed

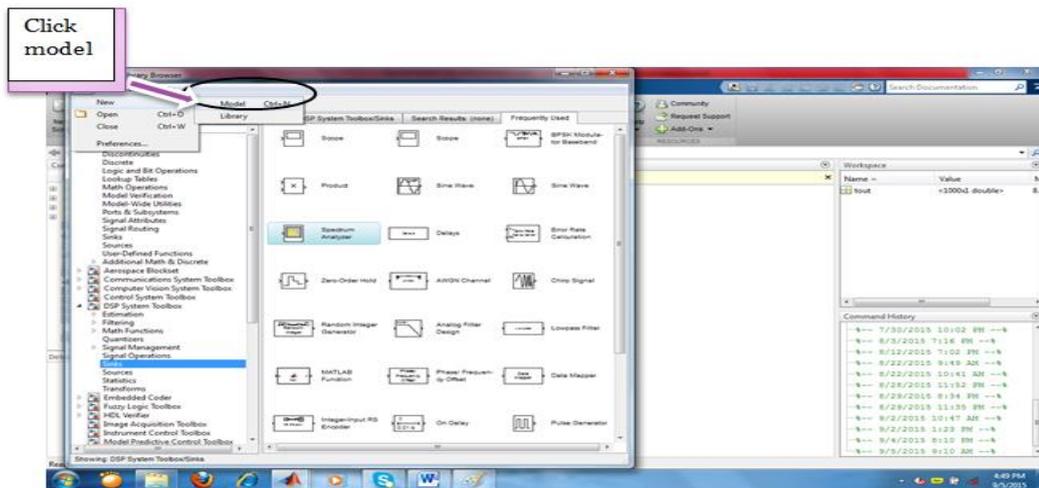
Step 1: Open the matlab window.



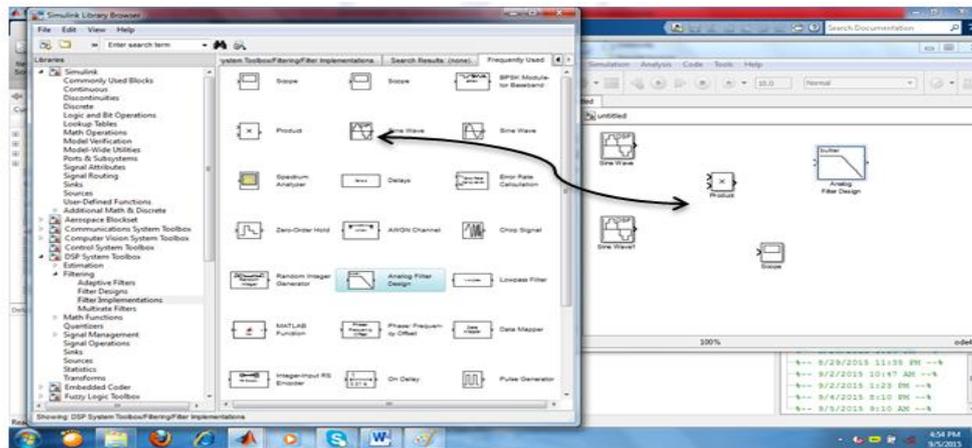
Step 2: Open Simulink library.



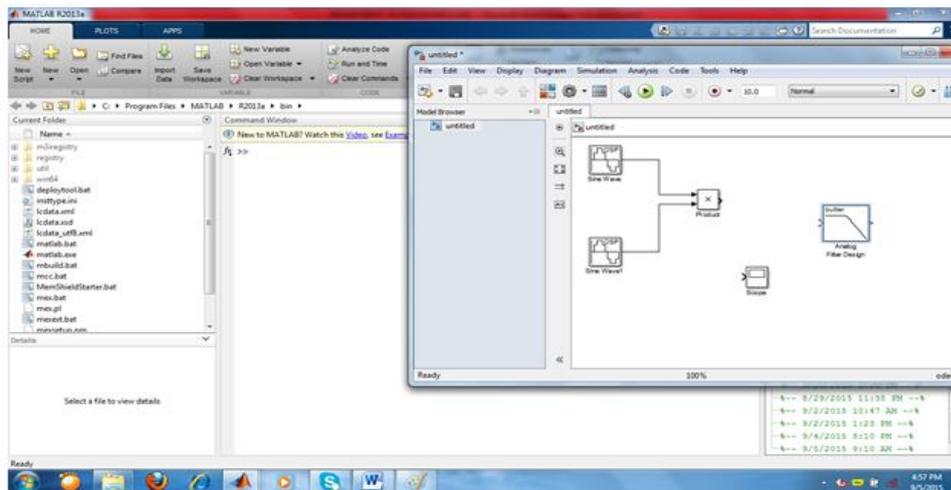
Step 3: Open new model.



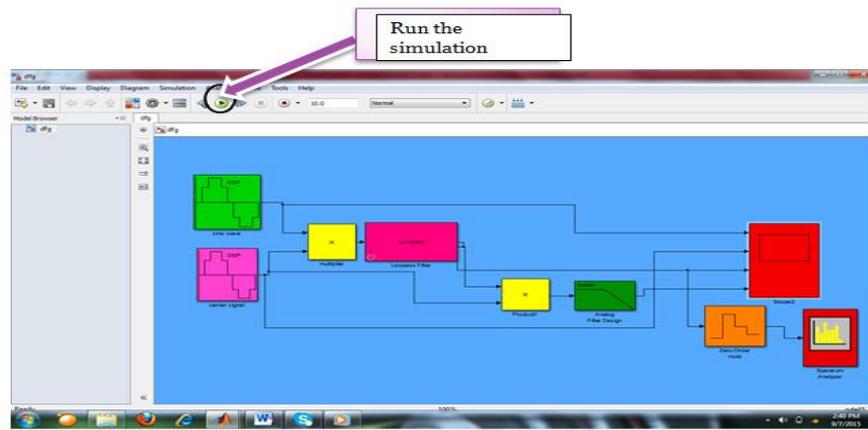
Step 4: Place the blocks.



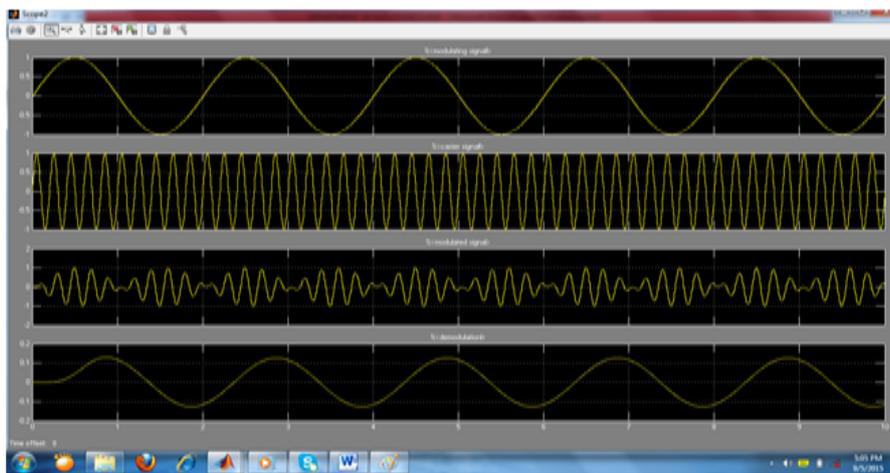
Step 5: Connect the blocks in proper order.



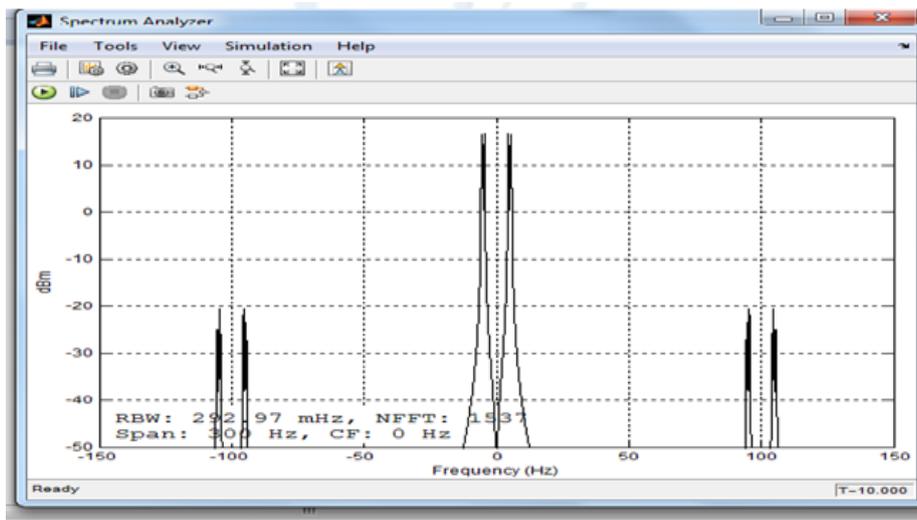
Step 6: Required Simulink model.



Step 7: Output



Step 8: Spectrum analysis



MATLAB Coding and effect of noise on

DSB-SC signal.

```
clc;
clear all;
t = 0:0.001:1;
Message_Signal_Amplitude = input('Enter the Amplitude of Message Signal = ');
Carrier_Signal_Amplitude = input('Enter the Amplitude of Carrier Signal = ');
Message_Signal_Frequency = input('Enter the Message Frequency = ');
Carrier_Signal_Frequency = input('Enter the Carrier Frequency = ');
m = Message_Signal_Amplitude/Carrier_Signal_Amplitude;
% Representation of the Message Signal
sm = Message_Signal_Amplitude.*sin(2*pi*Message_Signal_Frequency*t);
subplot(7,1,1);
plot(t,sm,'b');
xlabel('Time');
ylabel('Amplitude');
title('Message Signal');
legend('Message Signal');
grid on;
% Representation of the Carrier Signal
sc = Carrier_Signal_Amplitude.*sin(2*pi*Carrier_Signal_Frequency*t);
subplot(7,1,2);
plot(t,sc,'black');
xlabel('Time');
ylabel('Amplitude');
title('Carrier Signal');
legend('Carrier Signal');
grid on;
% Representation of the AM Signal
Amplitude_Modulated_Signal =
(Message_Signal_Amplitude+m*Message_Signal_Amplitude.*sin(2*pi*Message_Signal_Fr
equency*t)).*sin(2*pi*Carrier_Signal_Frequency*t);
subplot(7,1,3);
plot(t,Amplitude_Modulated_Signal,'red');
```

```
xlabel('Time');
ylabel('Amplitude');
title('Amplitude Modulated Wave');
legend('AM Signal');
grid on;
%%%NOISE
% Representation of the Message Signal
sm = Message_Signal_Amplitude.*sin(2*pi*Message_Signal_Frequency*t);
y=awgn(sm,1);
subplot(7,1,4);
plot(t,y,'b');
xlabel('Time');
ylabel('Amplitude');
title('Message Signal');
legend('Message Signal');
grid on;
% Representation of the Carrier Signal
sc = Carrier_Signal_Amplitude.*sin(2*pi*Carrier_Signal_Frequency*t);
subplot(7,1,5);
plot(t,sc,'green');
xlabel('Time');
ylabel('Amplitude');
title('Carrier Signal');
legend('Carrier Signal');
grid on;
% Representation of the AM Signal
Amplitude_Modulated_Signal =
(Message_Signal_Amplitude+m.*y).*sin(2*pi*Carrier_Signal_Amplitude);
y=awgn(Amplitude_Modulated_Signal,1);
subplot(7,1,6);
plot(t,y,'red');
xlabel('Time');
ylabel('Amplitude');
title('Amplitude Modulated Wave');
```

legend('AM Signal');

grid on;

Output

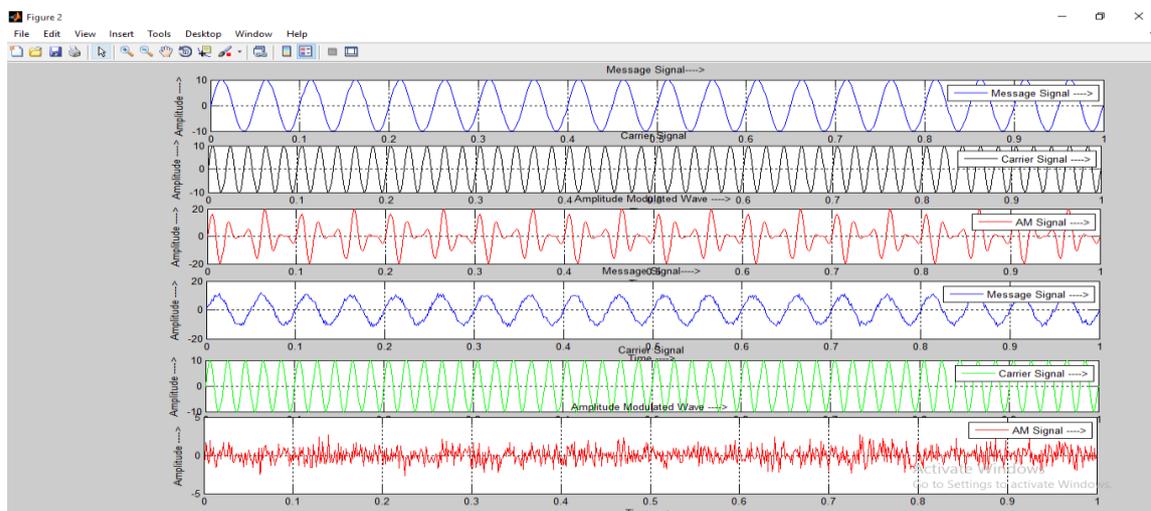
Enter the Amplitude of Message Signal = 15

Enter the Amplitude of Carrier Signal = 20

Enter the Message Frequency = 30

Enter the Carrier Frequency = 50

Waveforms



CONCLUSION

After doing this model it is clear that due to suppression of carrier signal, power is not wasting. The System becomes more efficient. Efficiency becomes 100%.

But there are some disadvantages

Both the side-bands contain the same information. Hence passing of two sidebands leads to power wastage. Hence, after improving this system single side-band suppression carrier has been obtained.

Future scope

The model works in theory, but not in practice due to the fact that second sine wave in the model used as a mixer cannot have the same specifications as the carrier in real application.

The original carrier and the second sine wave will run relative to one another in real-time. It is only a phase locked loop that can keep track of the instantaneous differences between

frequency and phase of two signals. Further work on this model is the designed model of the SSB-SC and VSB.

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