Aim ↬ To study the concept and fundamentals of Single Sideband Suppressed Carrier (SSB-SC) Modulation and Demodulation.

Software Required ↬ MATLAB

Theory ↬

Single Sideband Suppressed Carrier (SSB-SC) is an amplitude modulation technique where only one sideband (either upper or lower) is transmitted, and the carrier and the other sideband are suppressed. This method is more power-efficient and bandwidth-efficient than both conventional AM and DSB-SC. By removing the redundant sideband and carrier, SSB-SC reduces bandwidth usage by half while still transmitting all the necessary information.

In SSB-SC modulation, the transmitted signal can be expressed as:

$$s(t) = A_m \cdot m(t) \cdot cos\,(2\pi f_c t)$$

The key difference between DSB-SC and SSB-SC lies in the suppression of one sideband, making it more bandwidth efficient, while still maintaining the full fidelity of the message. The bandwidth of SSB-SC is the same as the message signal, i.e., $B = B_m$, where B_m is the message signal's bandwidth. SSB-SC is widely used in telecommunications and long-distance radio communications due to its efficiency.

Generation of SSB-SC Signal ↴

SSB-SC can be generated using filtering or the phase-shift method. In the filtering method, the modulated DSB-SC signal is passed through a band-pass filter that retains only the desired sideband (either upper or lower). This removes the unnecessary carrier and one sideband, resulting in the efficient SSB-SC signal.

Demodulation of SSB-SC Signal ↴

The demodulation of SSB-SC requires coherent detection similar to DSB-SC. The receiver generates a synchronized carrier to multiply with the received signal. A low-pass filter is applied to recover the original message signal by filtering out the high-frequency components. However, since only one sideband is transmitted, the demodulation is more straightforward than DSB-SC, with fewer components to filter out.

Frequency Spectrum of SSB-SC Signal ↴

In the frequency domain, SSB-SC contains only one sideband:

- Upper Sideband (USB) at $fc + fm$, or

- Lower Sideband (LSB) at $fc - fm$,

where f_m is the highest frequency in the message signal. The carrier and the opposite sideband are fully suppressed.

Method ↴

The code generates an SSB-SC modulated signal by first creating a DSB-SC signal and then applying a filter to remove one of the sidebands. Coherent detection is applied to recover the message signal. The frequency spectrum is calculated using FFT to observe the suppression of the carrier and one sideband.

Code ↬

```
% SSB-SC Modulation
clc;
clear;
close all;

Am = 10;
Fm = 0.05;
Fc = 0.5;
t = 0:0.1:100;

mt = Am * sin(2*pi*Fm*t);
ct = cos(2*pi*Fc*t);
dsbsc = mt .* ct;

N = length(t);
f = linspace(-N/2, N/2-1, N);
DSBSC_f = fftshift(fft(dsbsc));

[b, a] = butter(5, 0.1, 'low');
lsb = filter(b, a, dsbsc);

demodulated = lsb .* ct;
[B,A] = butter(5, 0.1);
recovered = filter(B, A, demodulated);

figure;
subplot(2,2,1);
plot(t, mt);
```

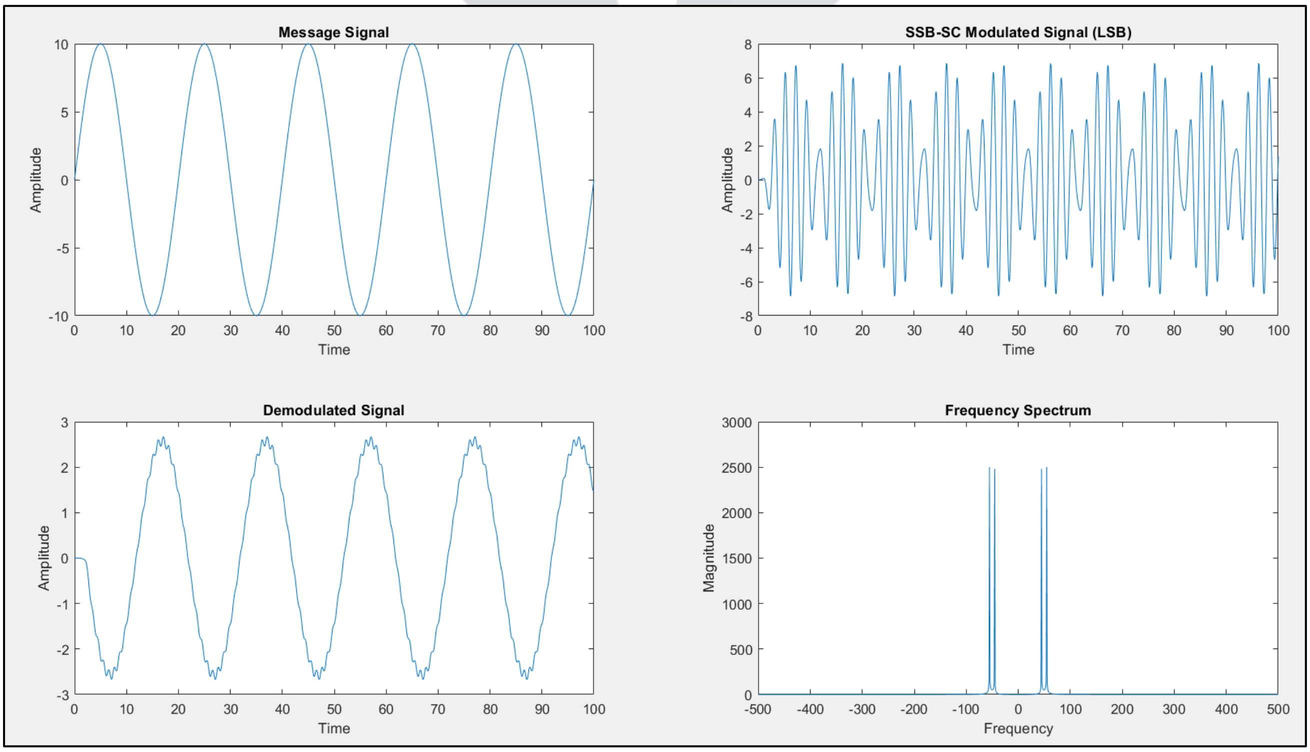
```
xlabel('Time');
ylabel('Amplitude');
title('Message Signal');

subplot(2,2,2);
plot(t, lsb);
xlabel('Time');
ylabel('Amplitude');
title('SSB-SC Modulated Signal (LSB)');

subplot(2,2,3);
plot(t, recovered);
xlabel('Time');
ylabel('Amplitude');
title('Demodulated Signal');

subplot(2,2,4);
plot(f, abs(DSBSC_f));
xlabel('Frequency');
ylabel('Magnitude');
title('Frequency Spectrum');
```

Output ↬



Result ↬

The SSB-SC modulated signal was successfully generated by retaining only the lower sideband. Coherent detection and low-pass filtering accurately recovered the original message signal. The frequency spectrum confirms the suppression of the carrier and one sideband.

Conclusion ↬

SSB-SC modulation improves power and bandwidth efficiency by suppressing the carrier and one sideband. Coherent detection ensures accurate recovery of the message signal with minimal distortion.

Precautions ↬

- Ensure precise synchronization of the carrier for effective demodulation.
- Use appropriate filters to isolate the desired sideband and remove unwanted components.
- Proper sampling rates should be chosen to avoid aliasing