Matlab Assignment

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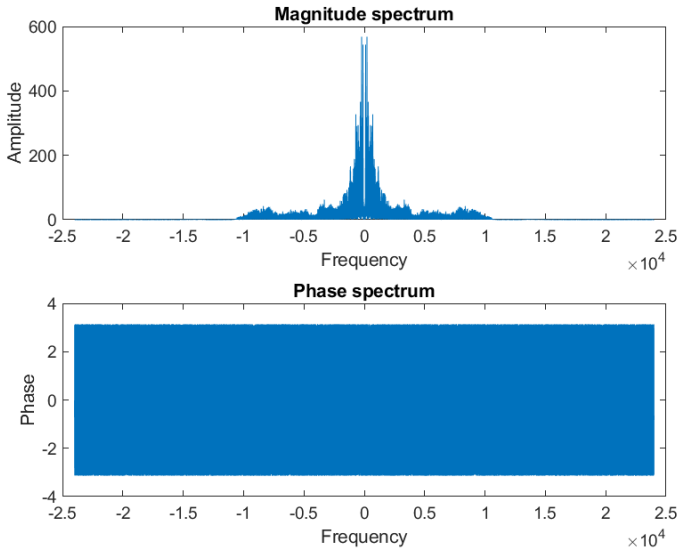
Mazen Mohamed Hassanen - 20011161

Mohamed Ashraf Elsayed Mahmoud - 20011488

October 2023

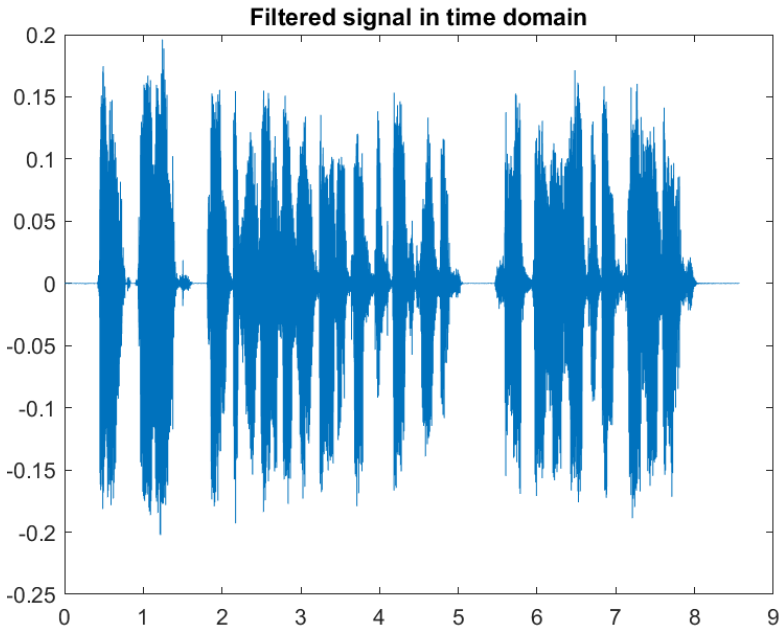
Experiment 1: Double Sided Band Modulation

- **Spectrum of attached audio file**

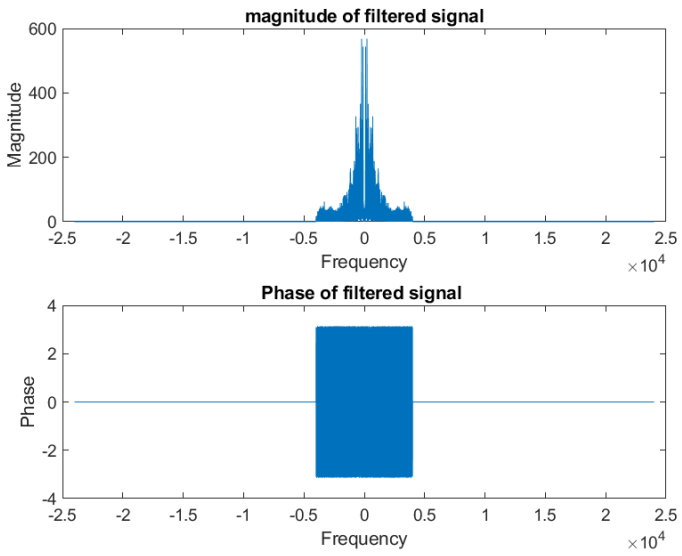


- **Ideal low pass filter** ($BW = 4000Hz$)

  Time Domain

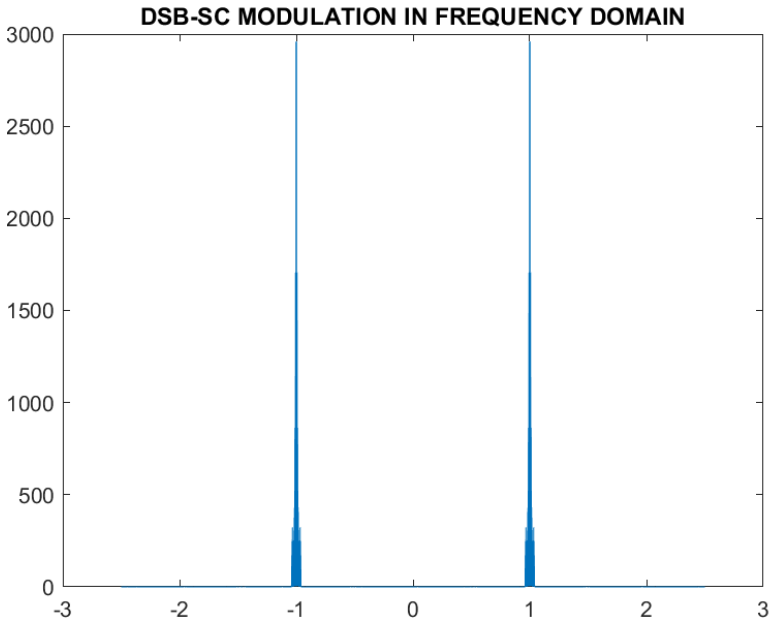


Frequency Domain

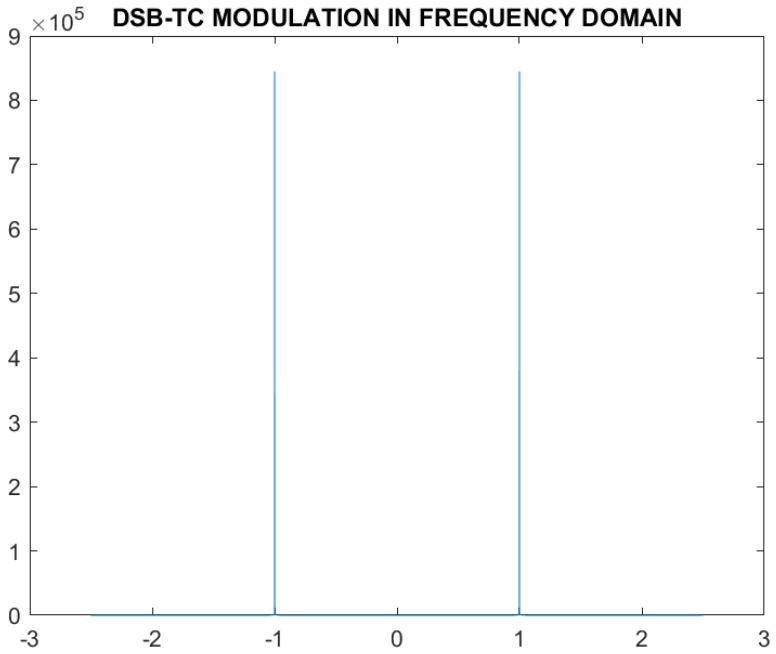


- **Modulation plot in frequency domain** ($fc = 100KHz$)

DSB-SC

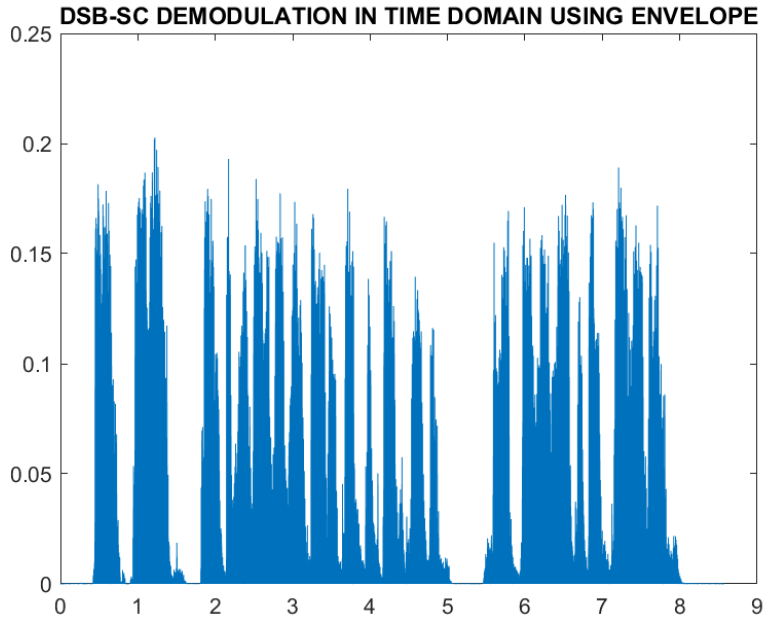


DSB-TC

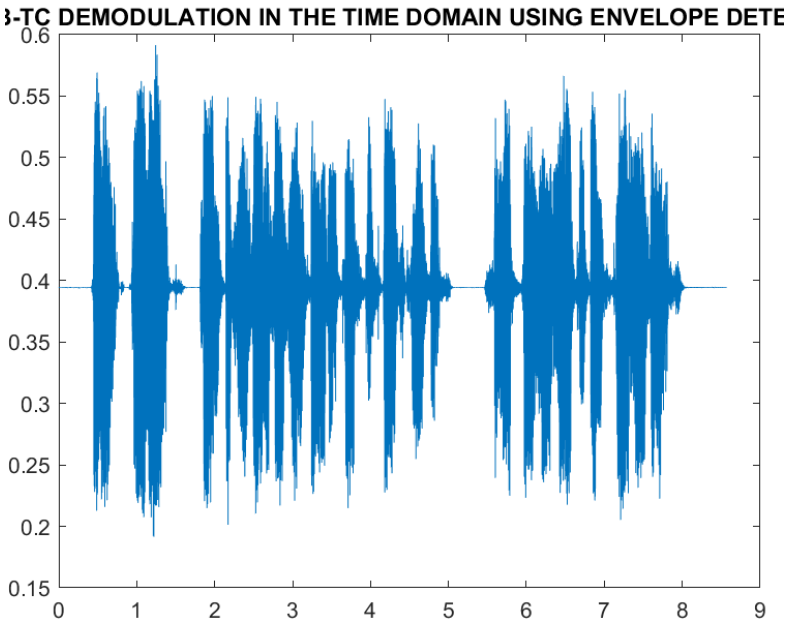


- **Envelop detector in time domain**

DSB-SC



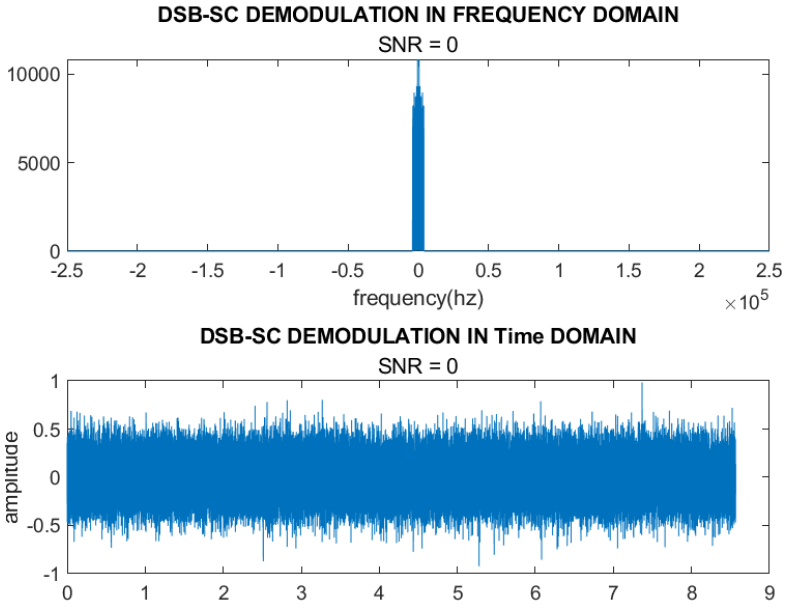
DSB-TC



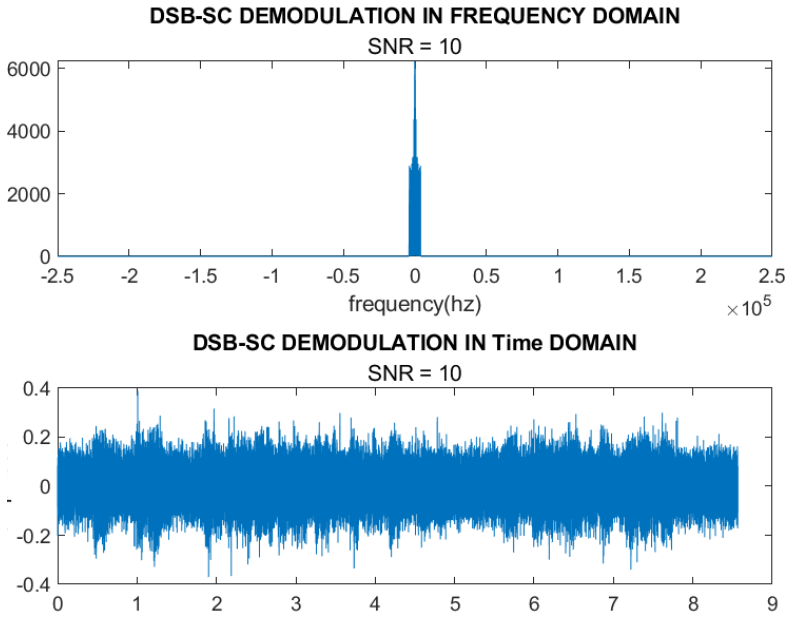
We can recognize that in DSB-SC the signal is distorted while, in DSB-TC is much better. DSB-SC has no DC bias ($A = 0$) then, the modulation index (m) tends to infinity since, $m = \frac{a}{A}$. We can conclude that envelop detection can only be used with DSB-TC.

- **Coherent Detection for DSB-SC**

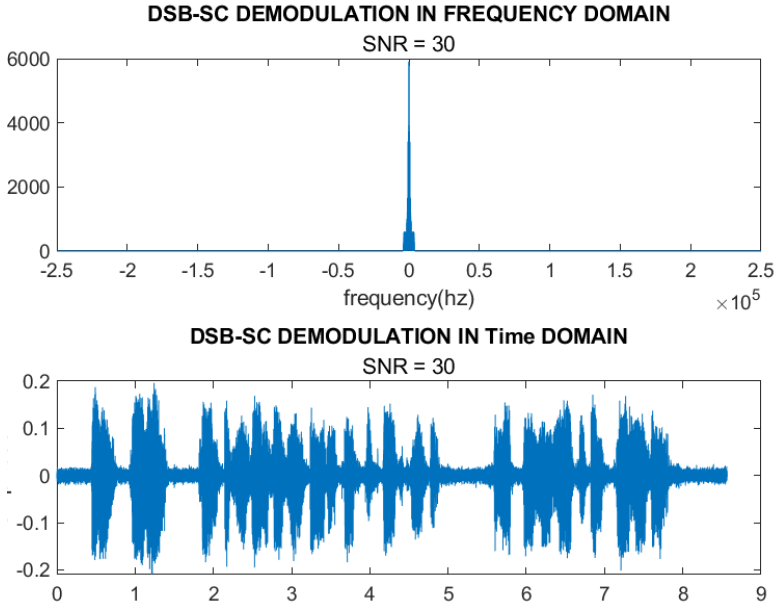
  Signal to noise ratio ($SNR = 0$)



Signal to noise ratio ($SNR = 10$)

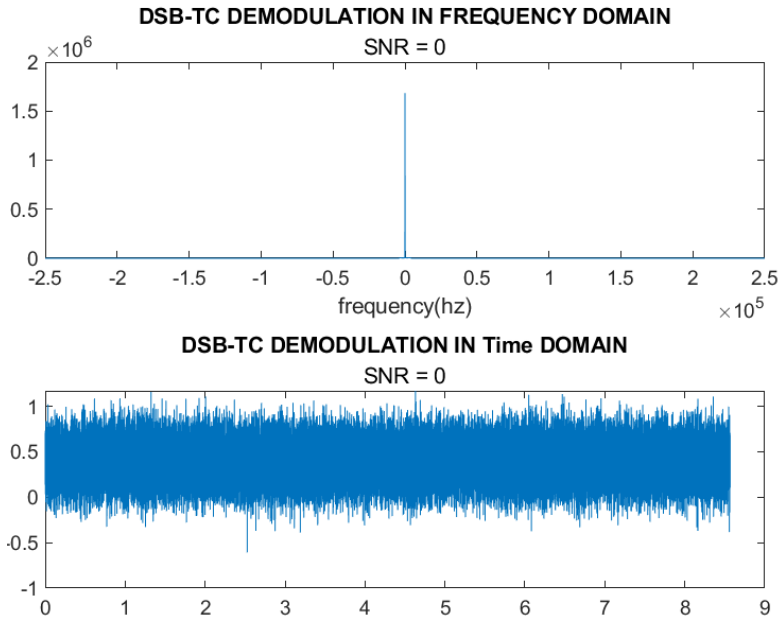


Signal to noise ratio ($SNR = 30$)

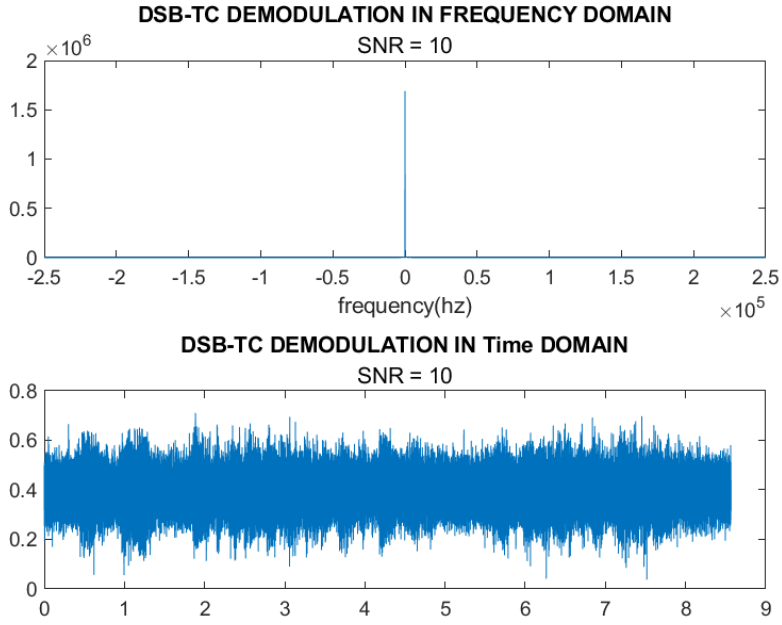


- **Coherent Detection for DSB-TC**

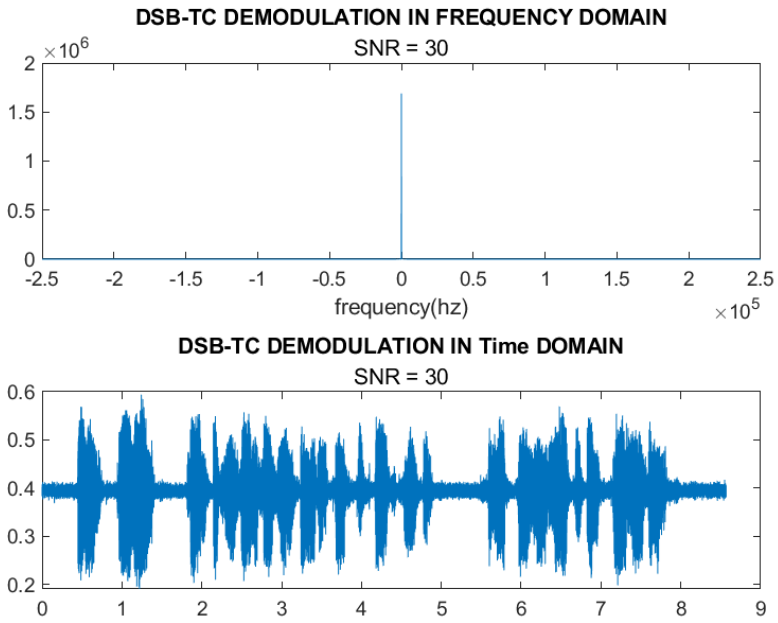
  Signal to noise ratio ($SNR = 0$)



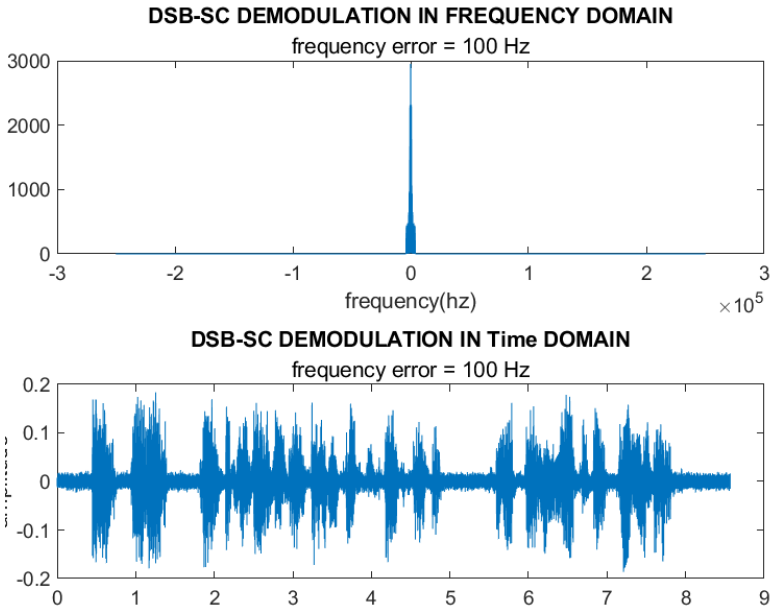
  Signal to noise ratio ($SNR = 10$)



Signal to noise ratio ($SNR = 30$)

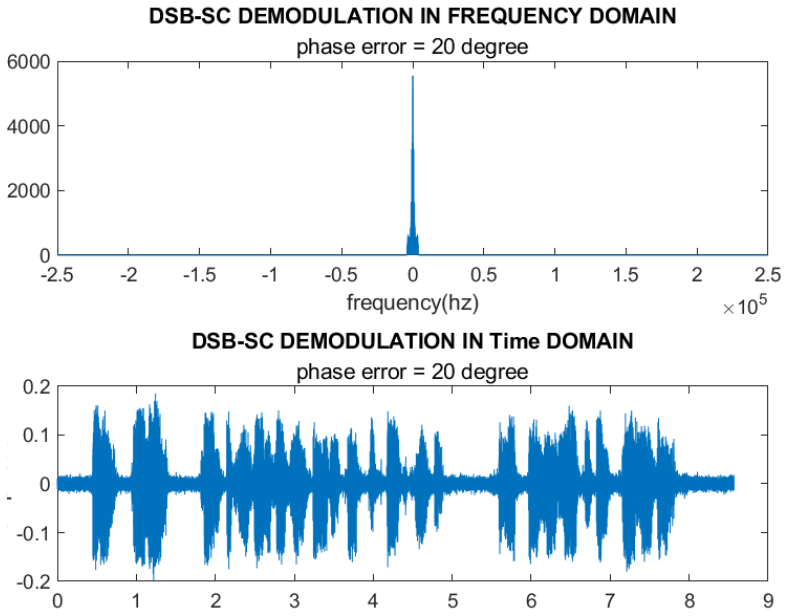


- **Coherent Detection for DSB-SC with frequency error**



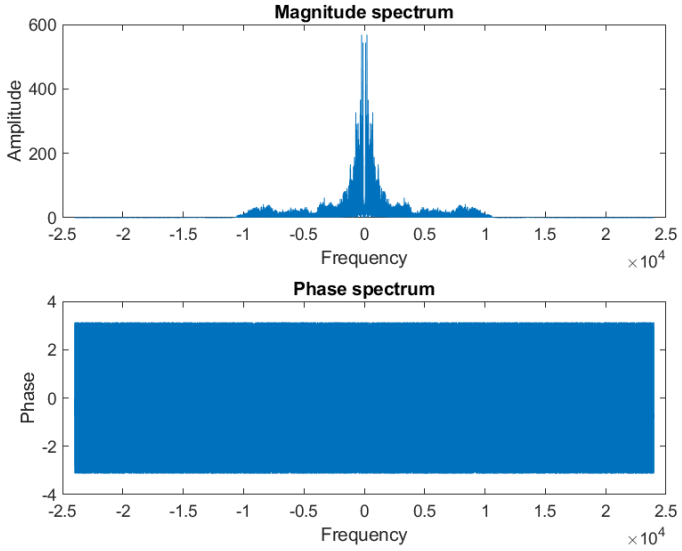
This phenomenon is called beat effect

- **Coherent Detection for DSB-SC with phase error**



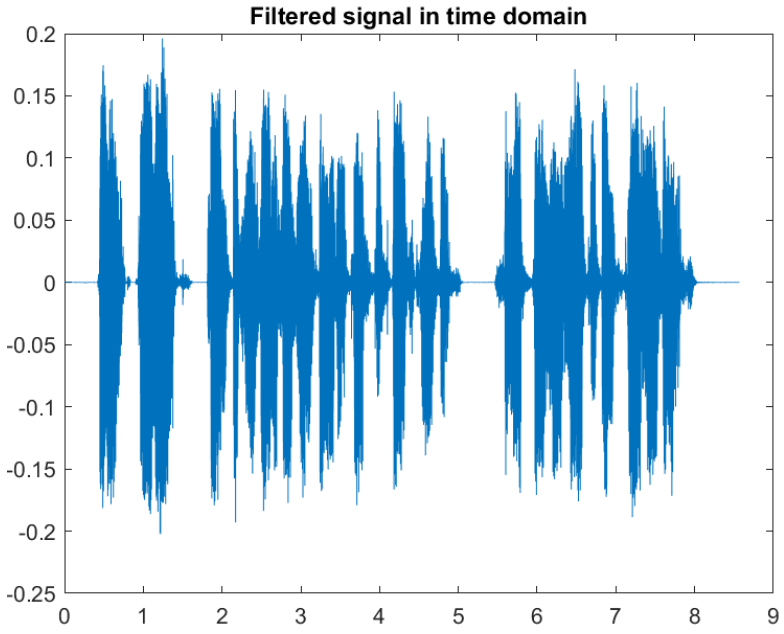
Experiment 2: Single Sided Band Modulation

- **Spectrum of attached audio file**

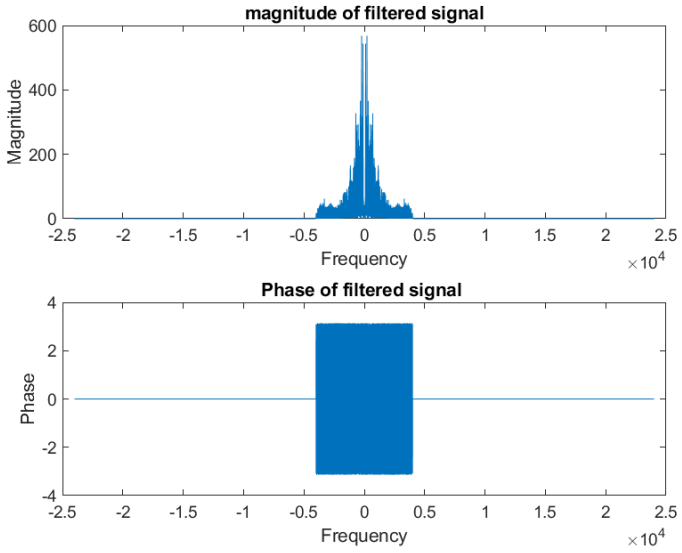


- **Ideal low pass filter** ($BW = 4000Hz$)

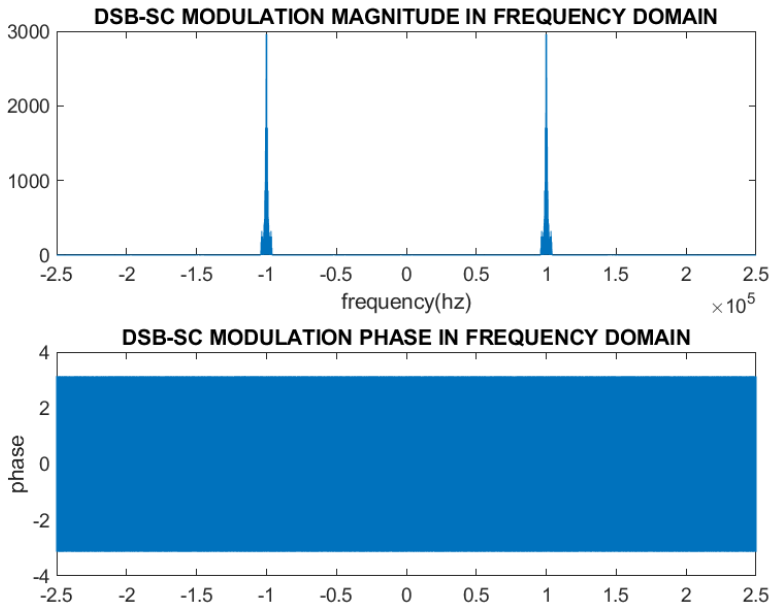
  Time Domain



Frequency Domain

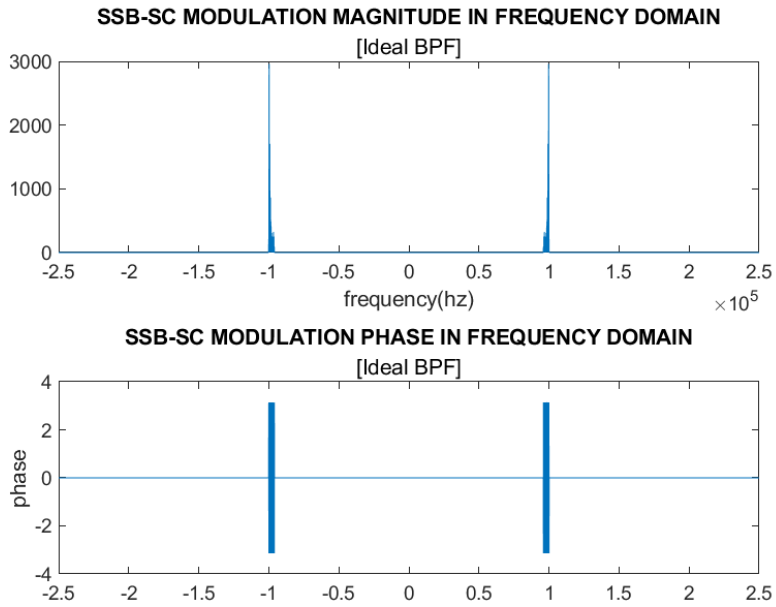


- **DSB-SC modulated in frequency domain**

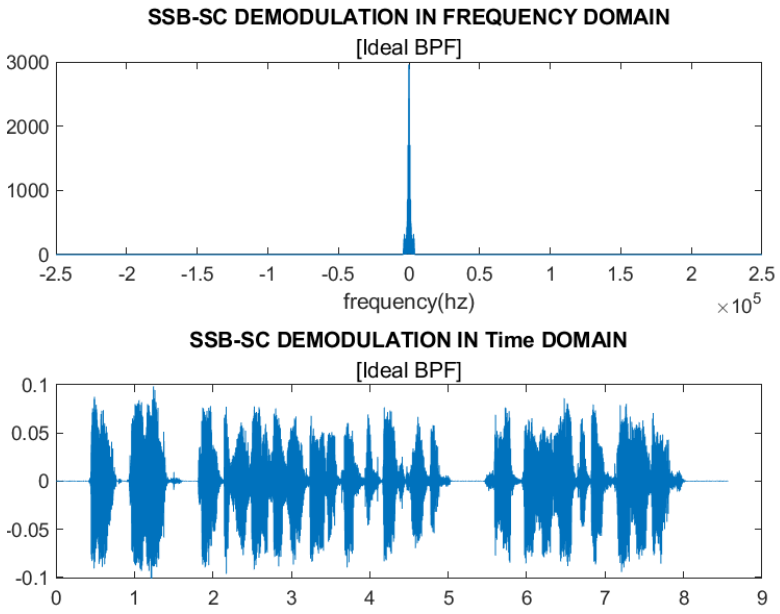


- **Demodulation with ideal LPF**

SSB LSB obtained from DSB-SC

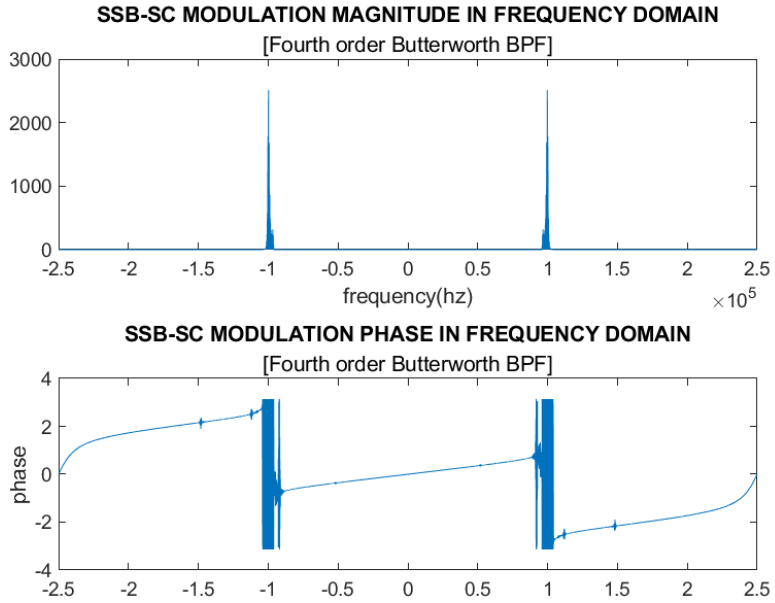


Coherent detection demodulation for SSB-SC

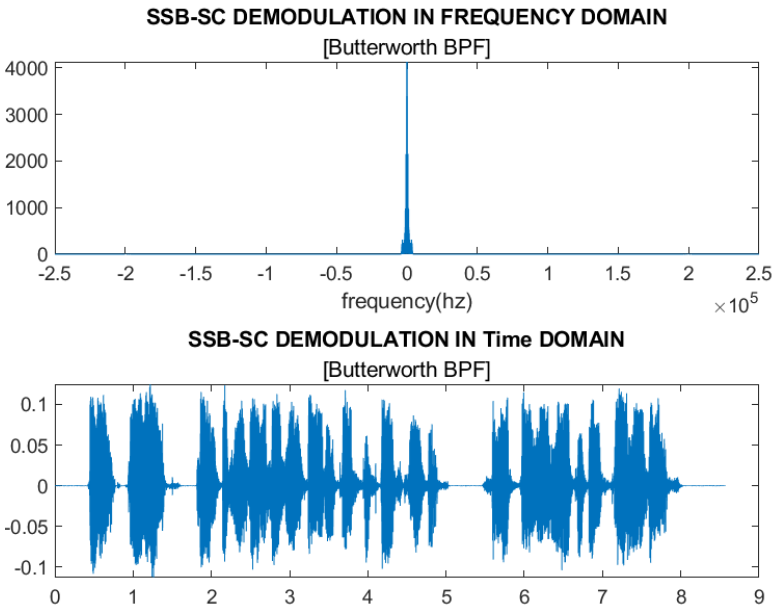


- **Demodulation with $4th$ order butterworth filter**

SSB LSB obtained from DSB-SC

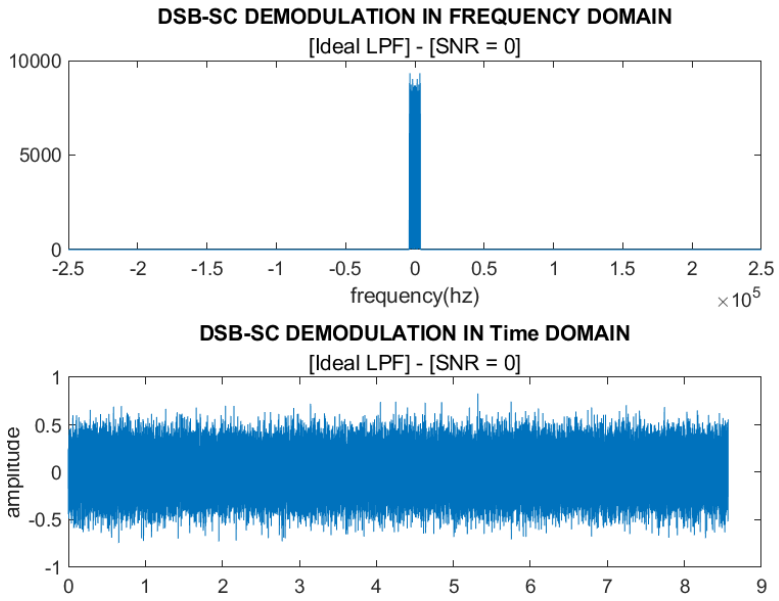


Coherent detection demodulation for SSB-SC

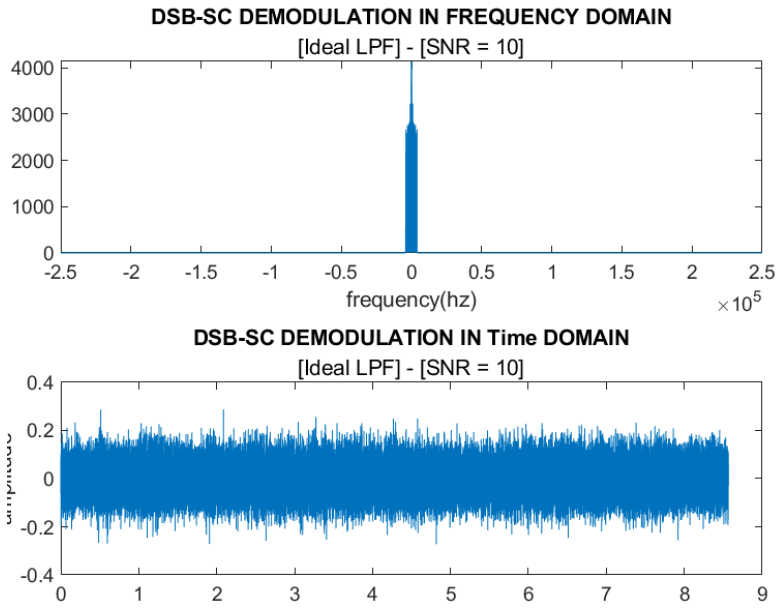


- **Recieved signal with added noise (ideal LPF)**

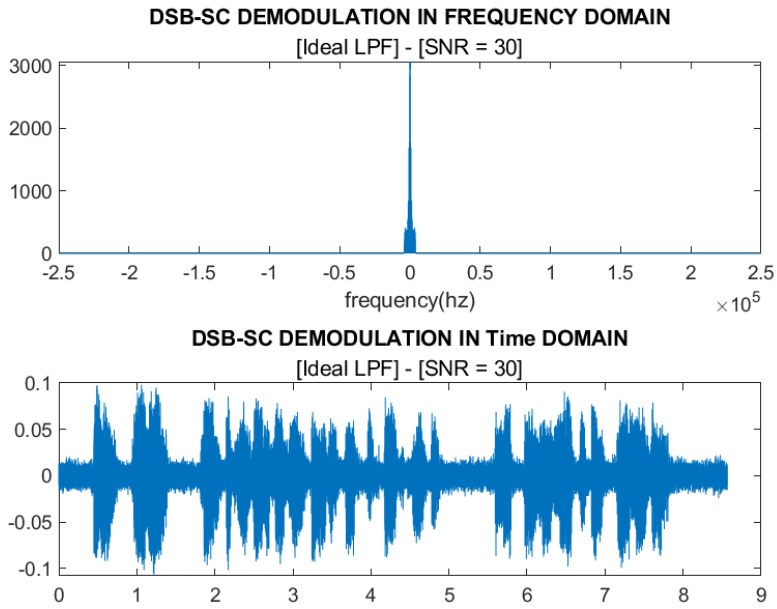
  Signal to noise ratio ($SNR = 0$)



  Signal to noise ratio ($SNR = 10$)

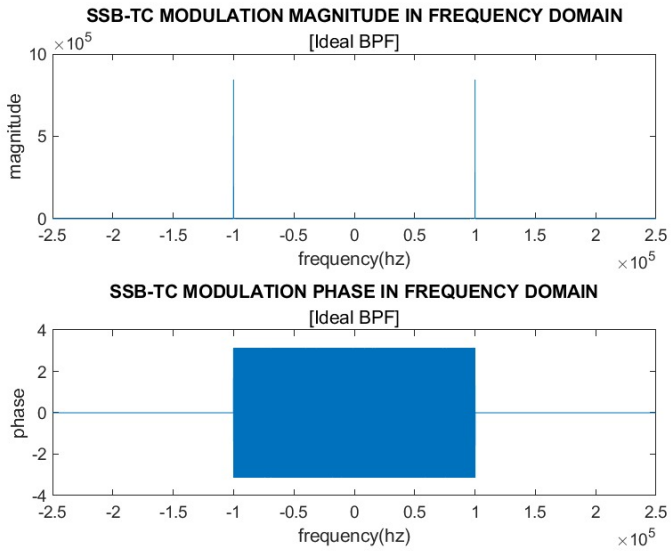


Signal to noise ratio ($SNR = 30$)

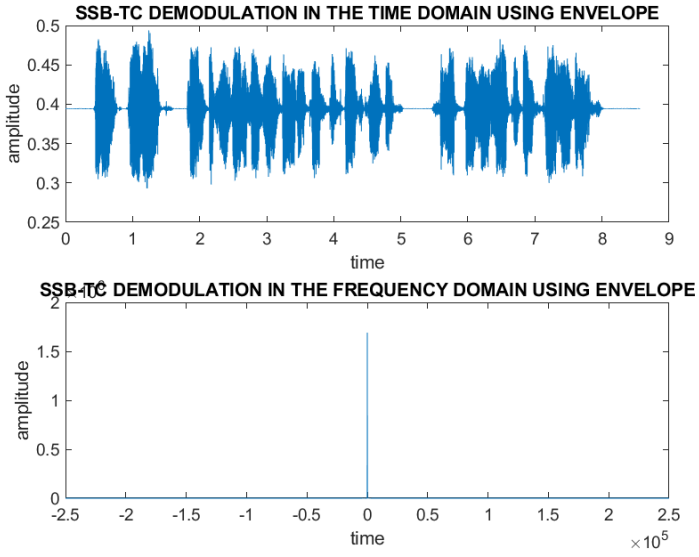


- **Generated SSB-TC**

  Frequency Domain

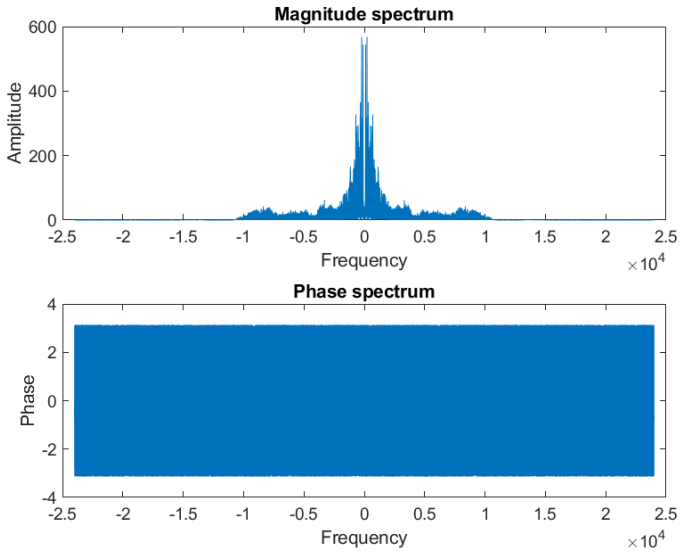


- **Envelop detected SSB-TC**



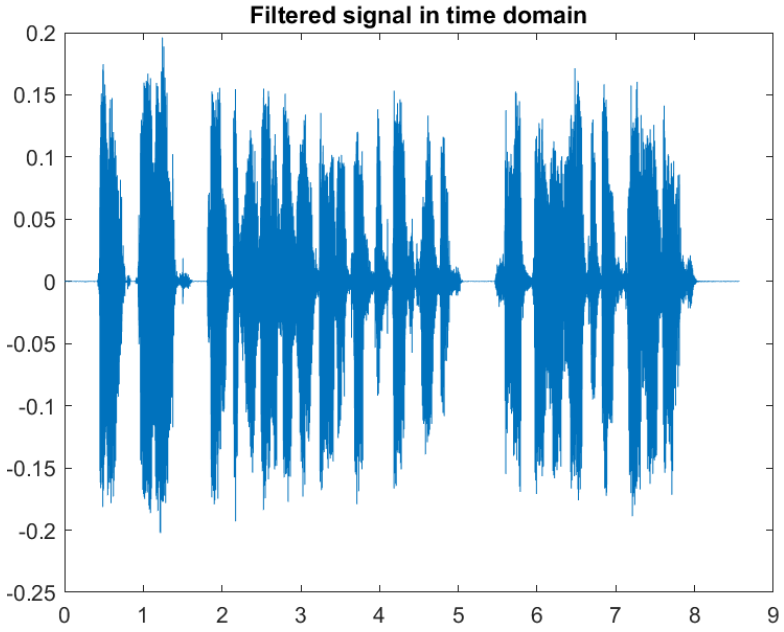
Experiment 3: Single Sided Band Modulation

- **Spectrum of attached audio file**

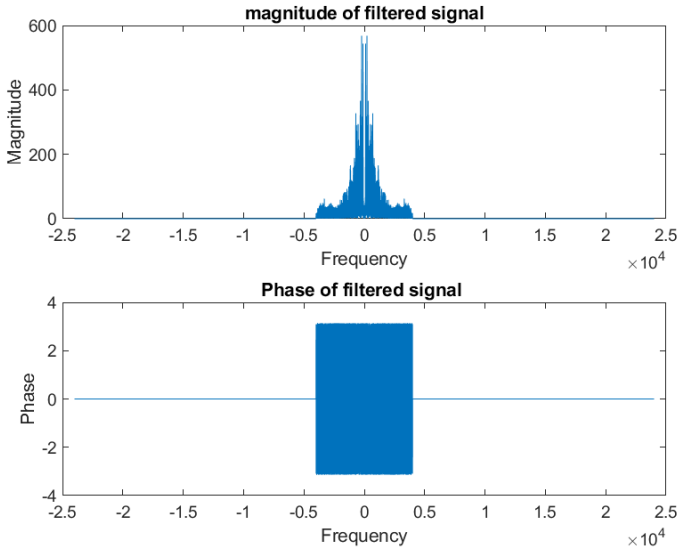


- **Ideal low pass filter** ($BW = 4000Hz$)

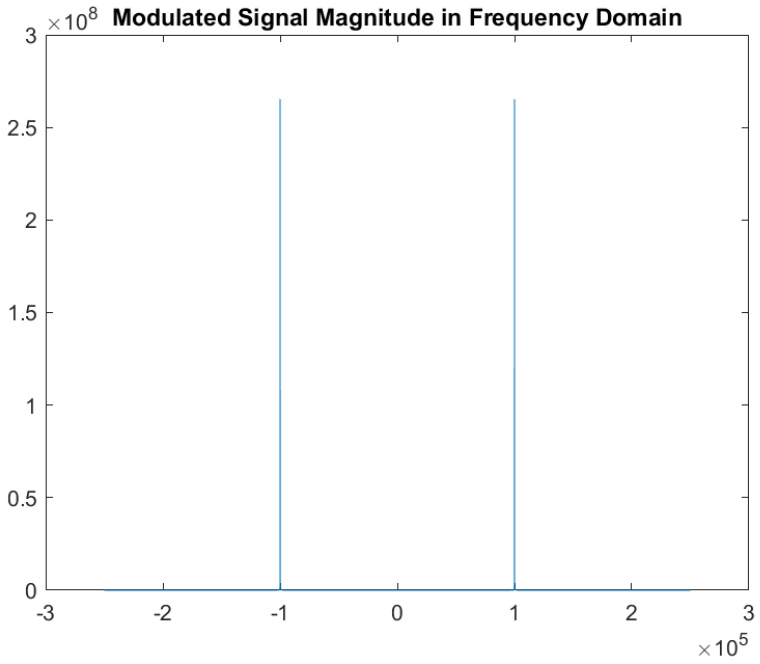
  Time Domain



Frequency Domain



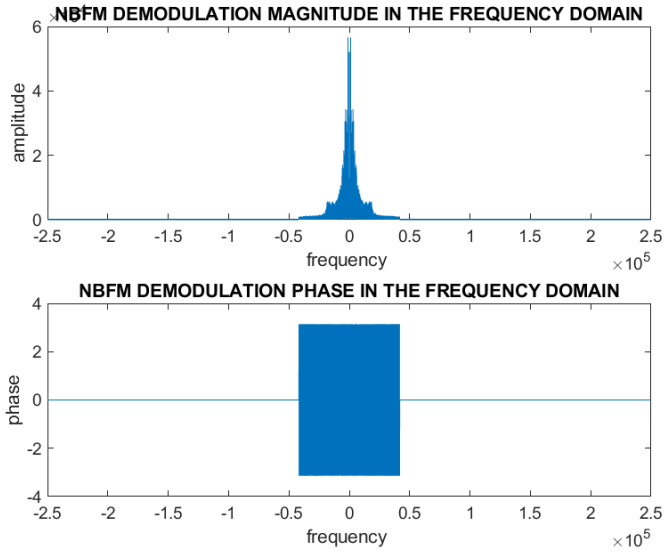
- **Generated NBFM signal in frequency domain**



We can recognize that the spectrum is same as DSB-TC. One of its drawbacks that it needs double the bandwidth.

The condition to achieve narrow band frequency modulation is having small frequency deviation, $Q(t) <= \frac{\pi}{6}$

- **Demodulation of NBFM signal**



We have assumed that $kf = 1$ and $A = 10$.