ELECENG 3TR4: Communication Systems
Lab 3: DSBDC Modulation

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Simulation

(i). DSB-SC Signal

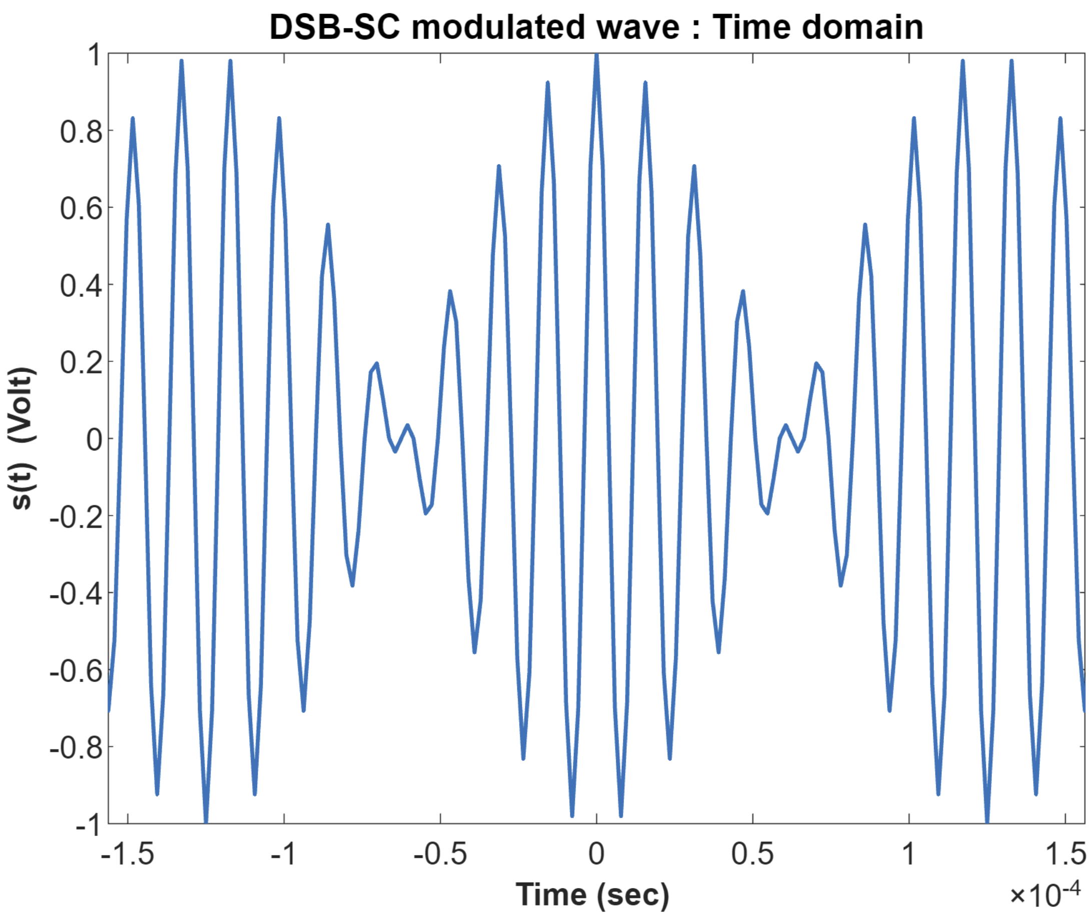

Figure 1. DSB-SC Signal Plot in Time Domain

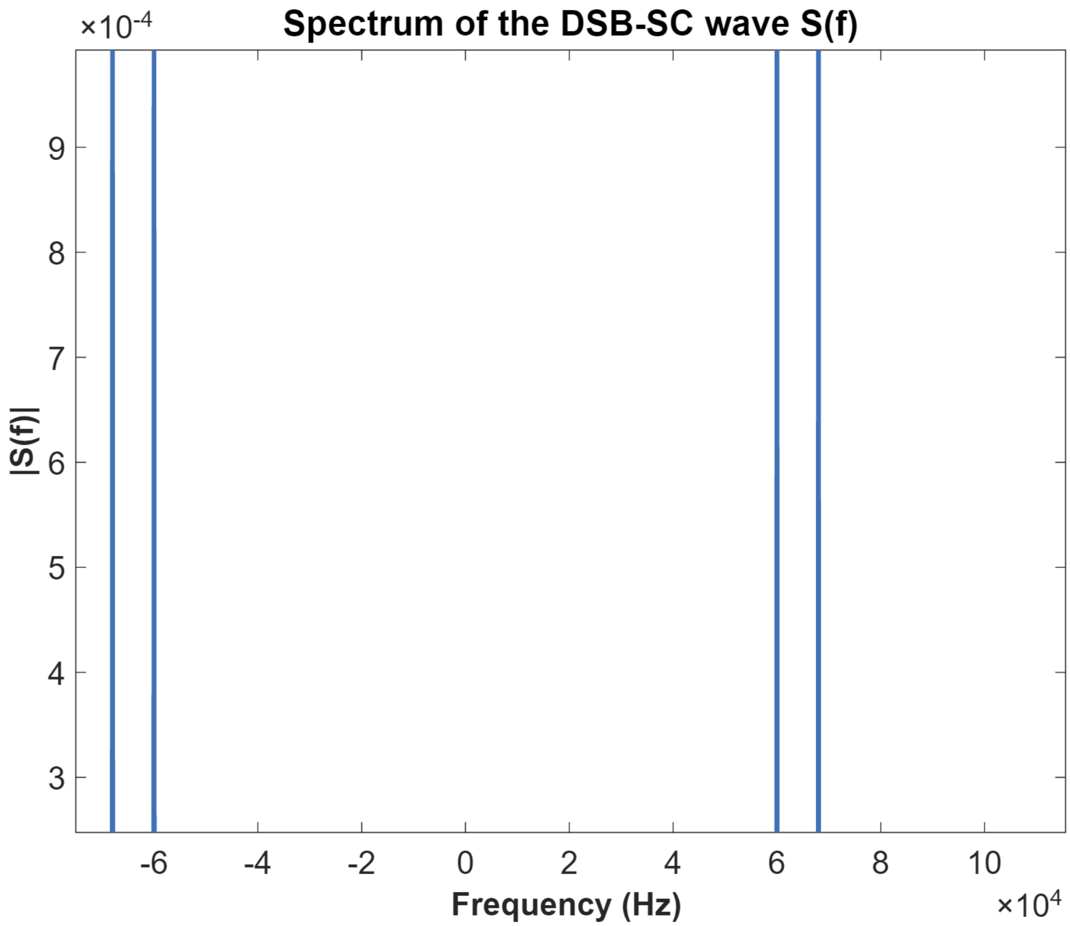

Figure 2. DSB-SC Signal Plot in Frequency Domain

(ii) Carrier Signal

(i). Carrier power is half of the total power in both the sidebands.

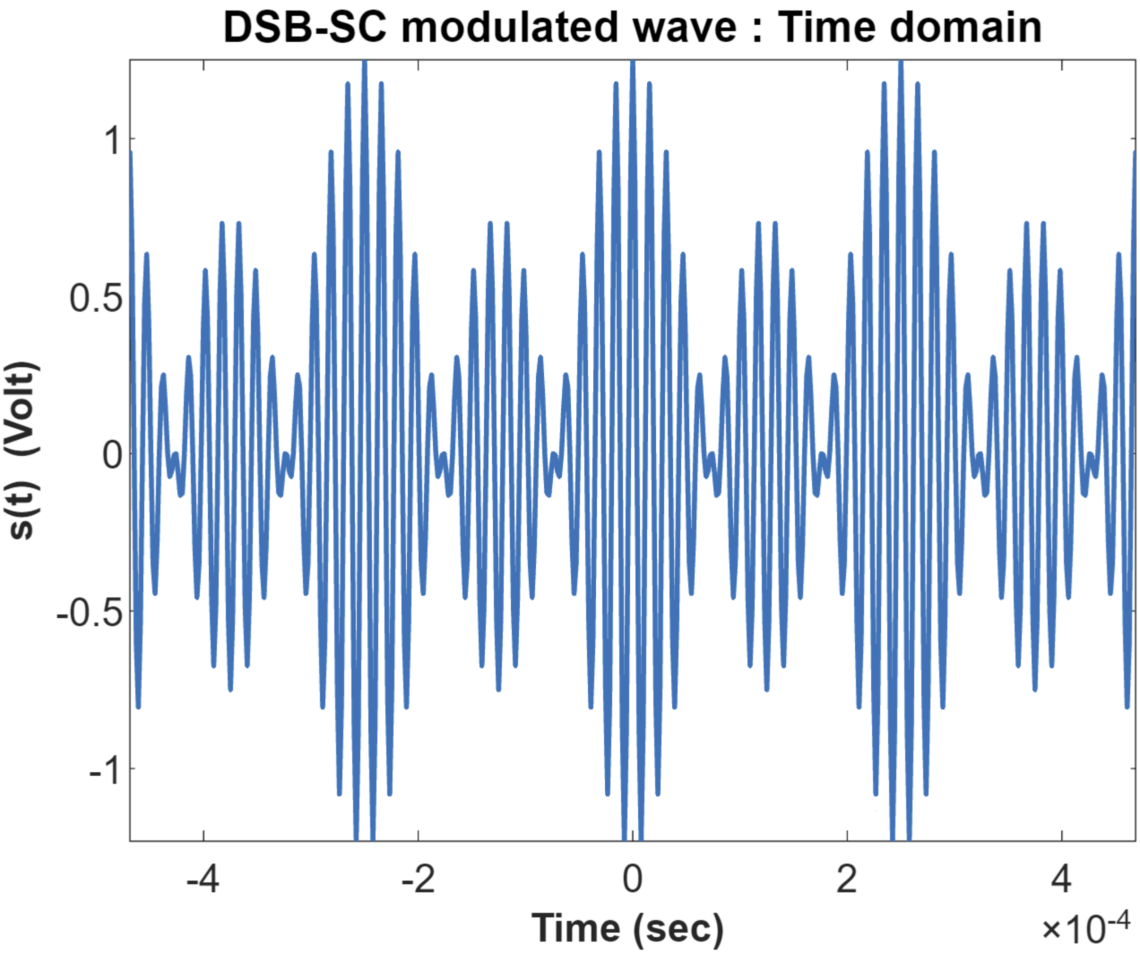

Figure 4. Standard AM Signal with Carrier Power is Half of Sidebands in Time Domain

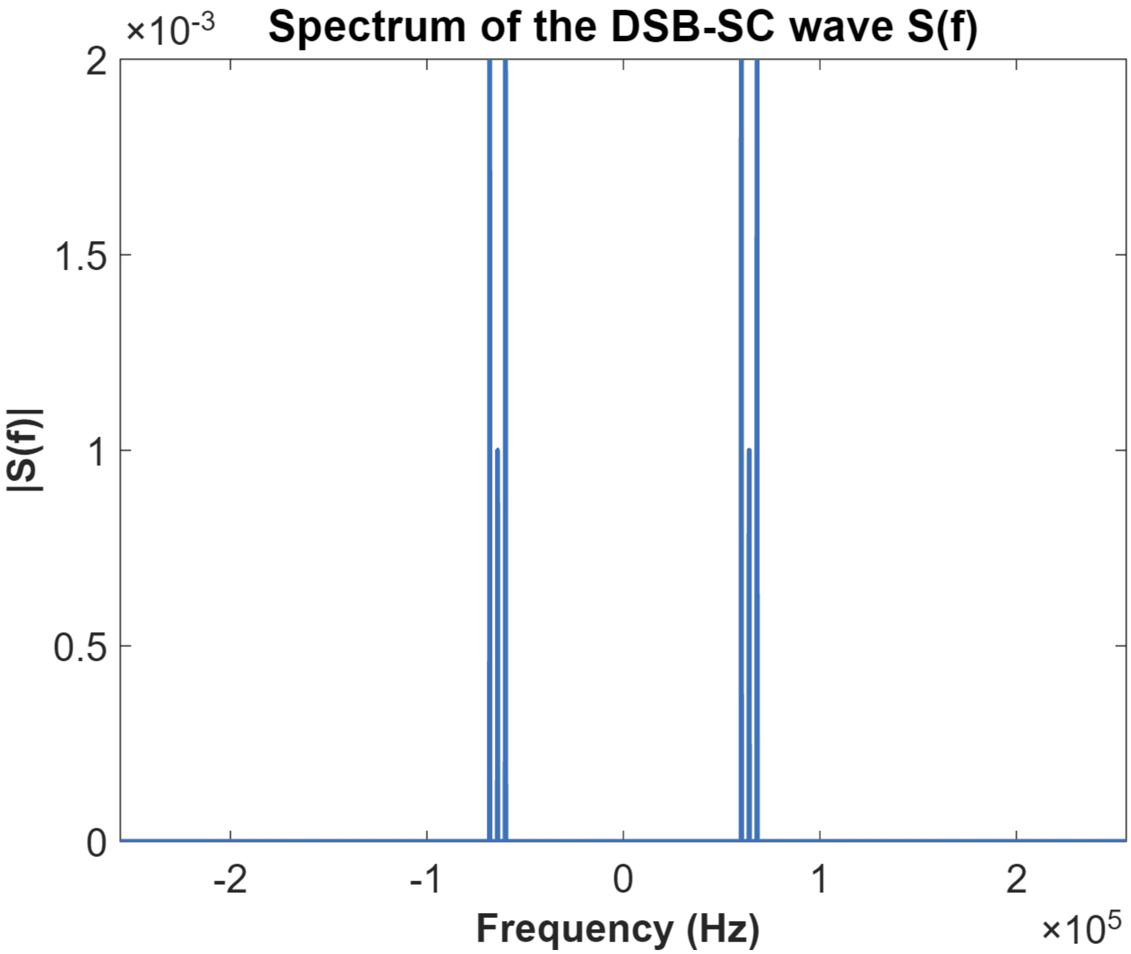

Figure 5. Carrier Power is Half of Sidebands in Frequency Domain

(ii). Carrier power is three times the total power in both the sidebands.

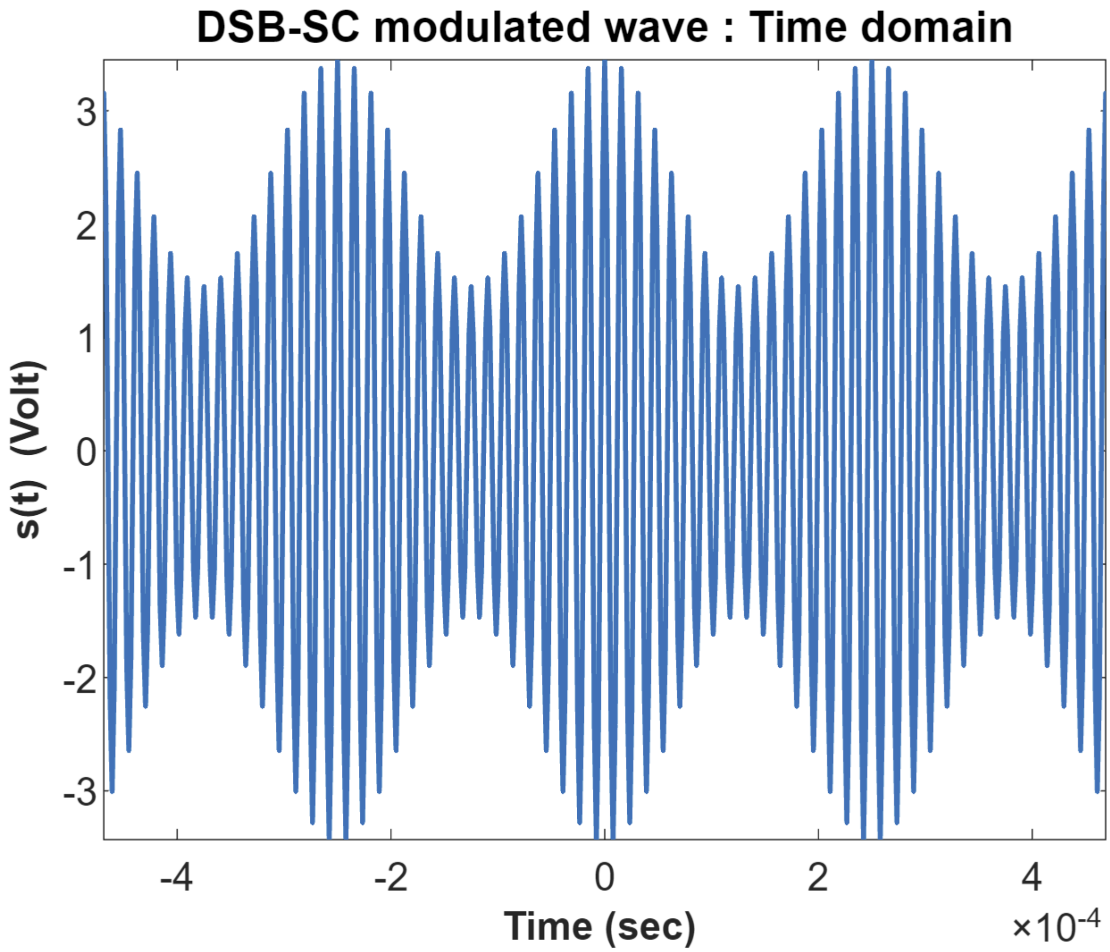

Figure 6. Carrier Power is Three Times Sidebands in Time Domain

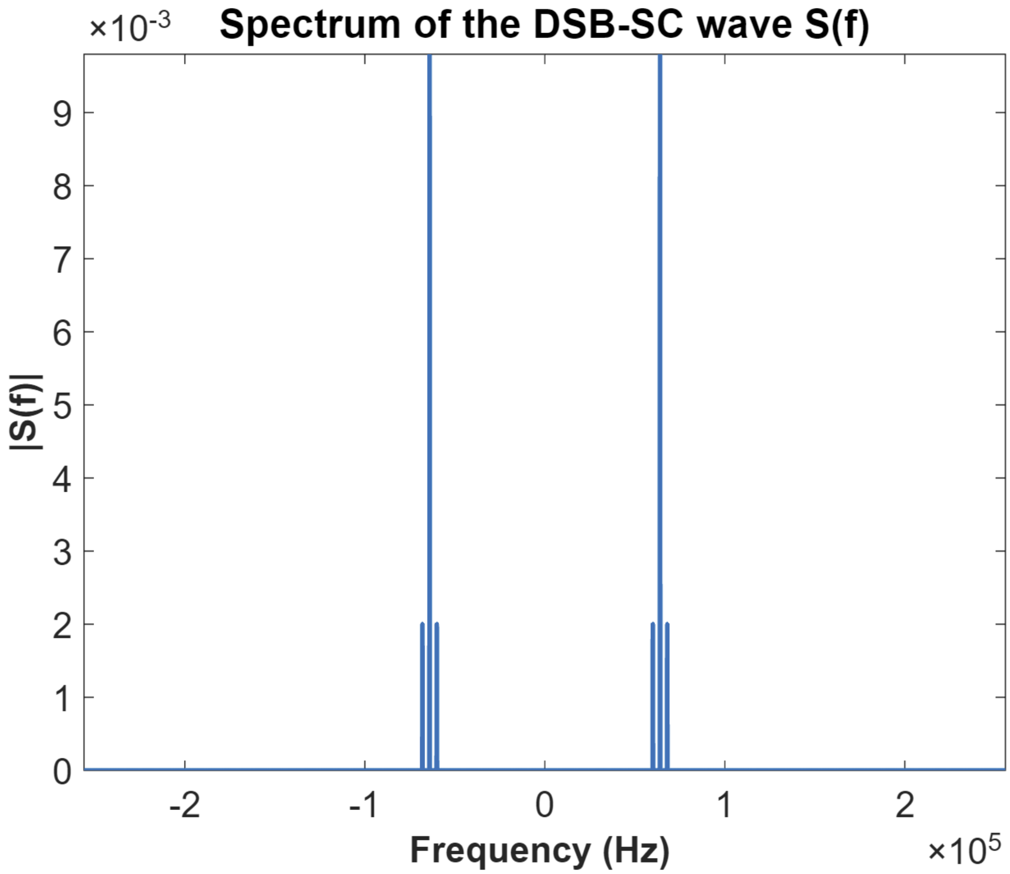

Figure 7. Carrier Power is Three Times Sidebands in Frequency Domain

(iii). Carrier power is more than three times the total power in both the sidebands.

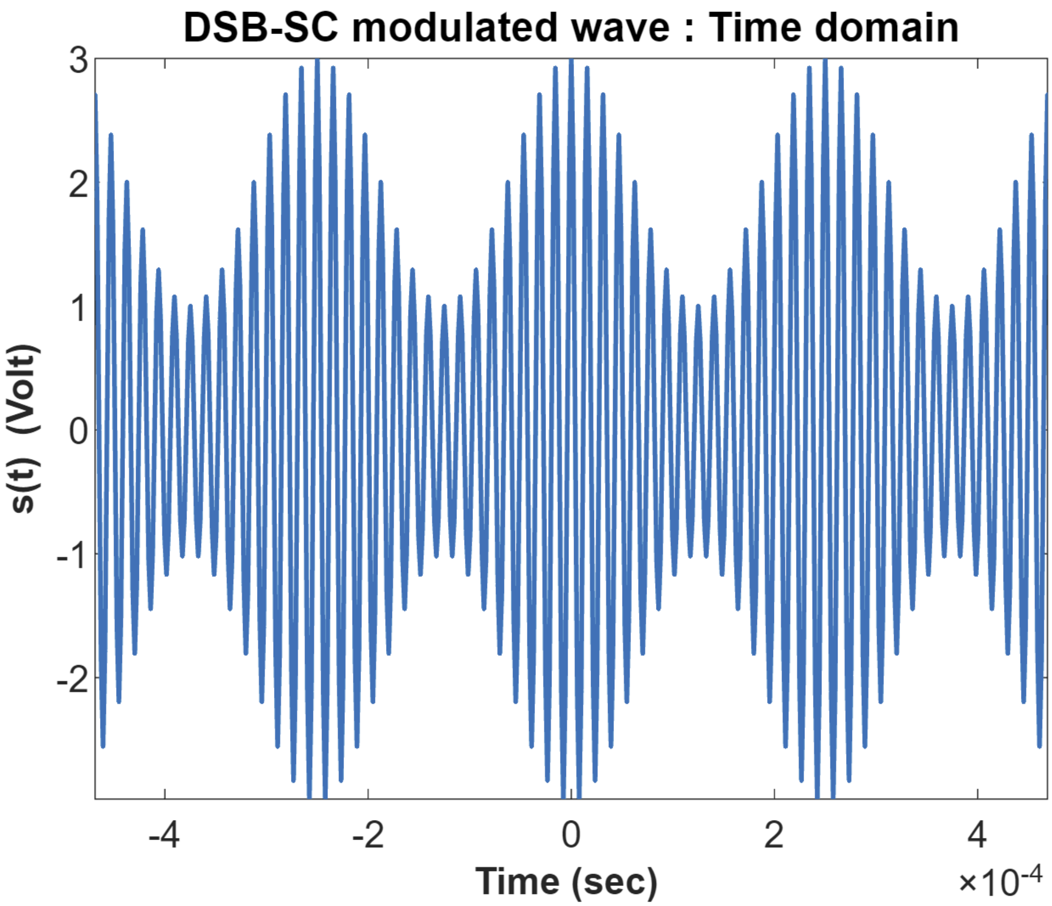

Figure 8. Carrier Power is More Than Three Times Sidebands in Time Domain

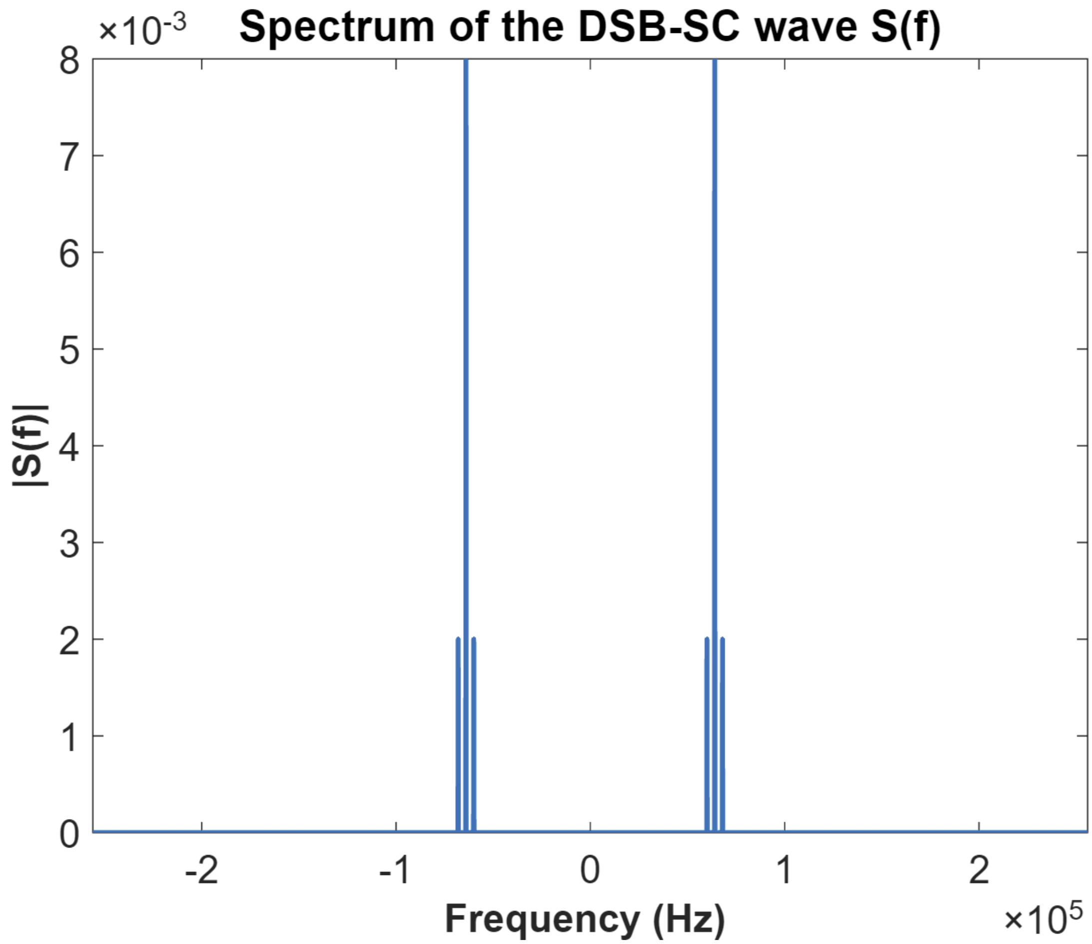

Figure 9. Carrier Power is More Than Three Times Sidebands in Frequency Domain

(iii) Load Osccillator

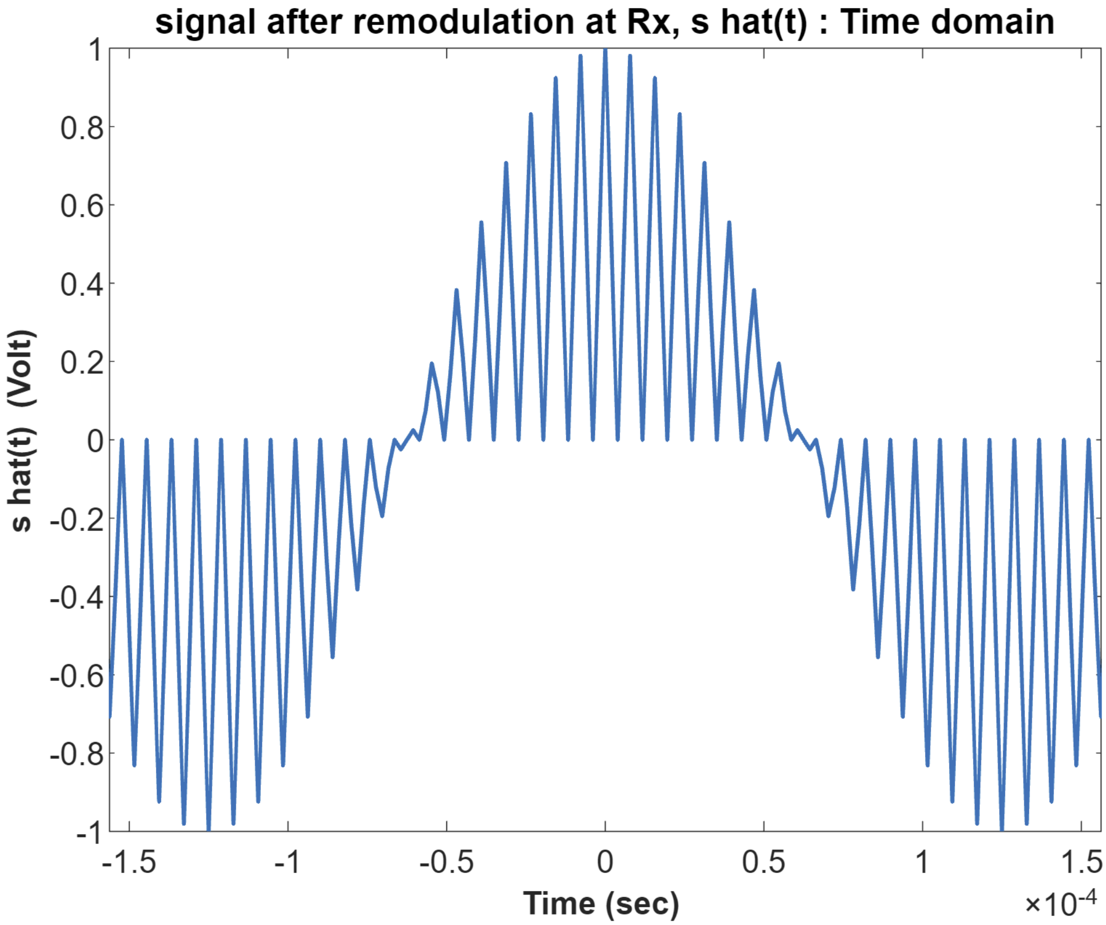

Figure 10. Remodulation Signal in Time Domain

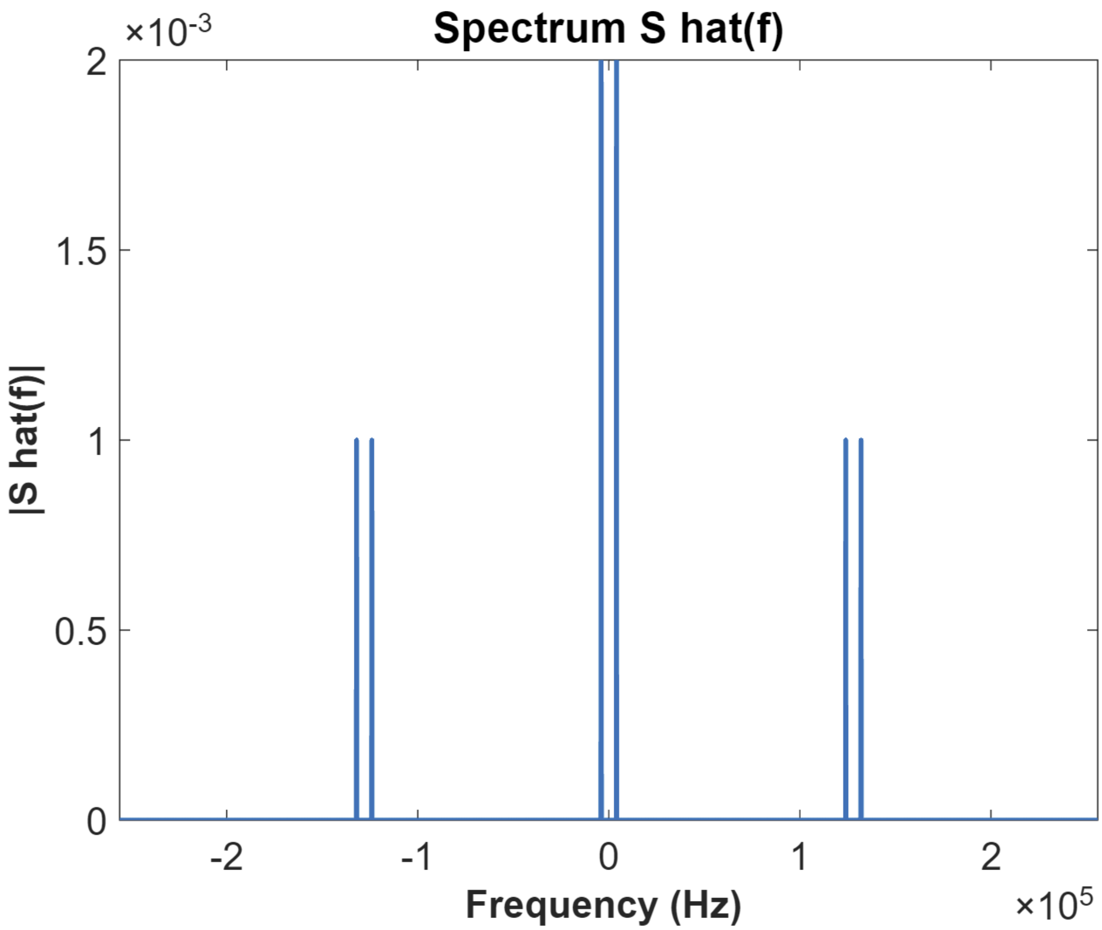

Figure 11. Remodulation Signal in Frequency Domain

(iv). Ideal Low pass filter

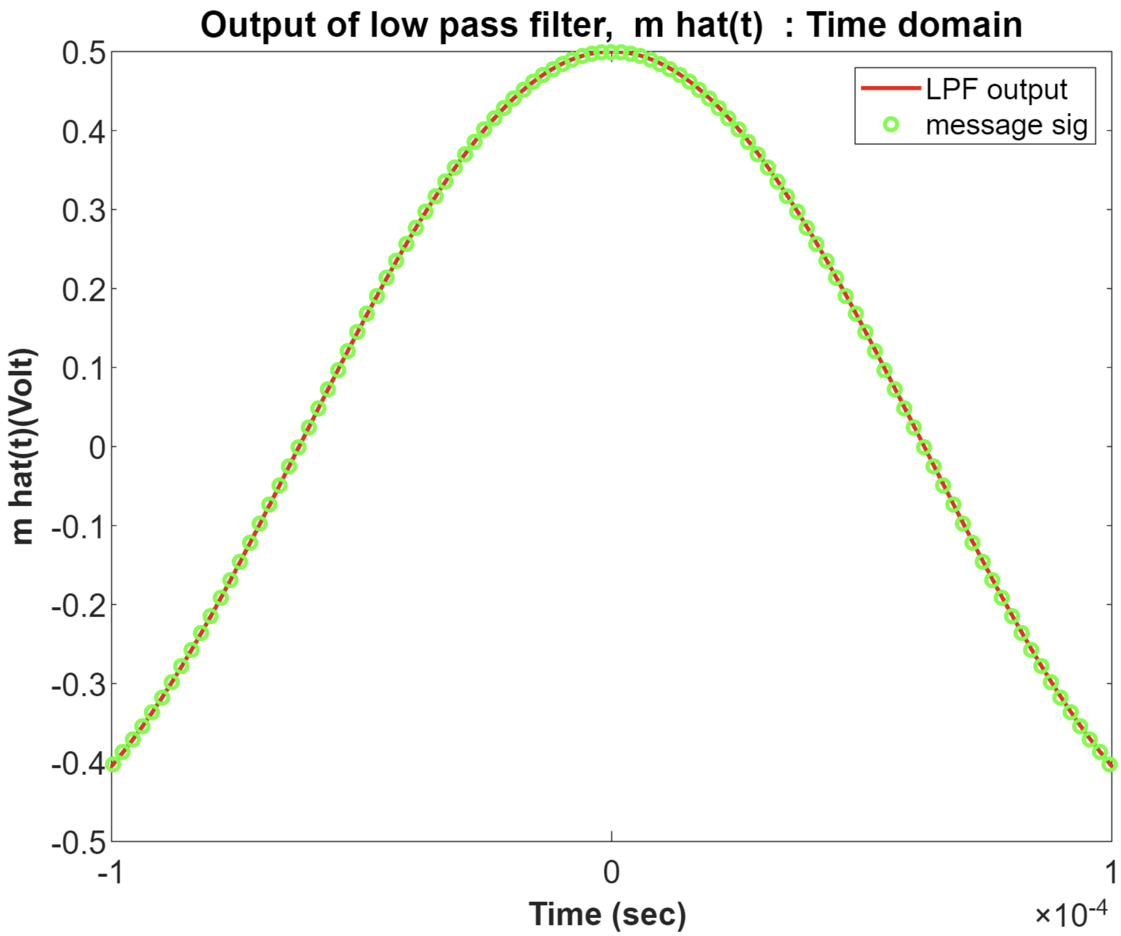

Figure 12. Remodulation Signal in Time Domain

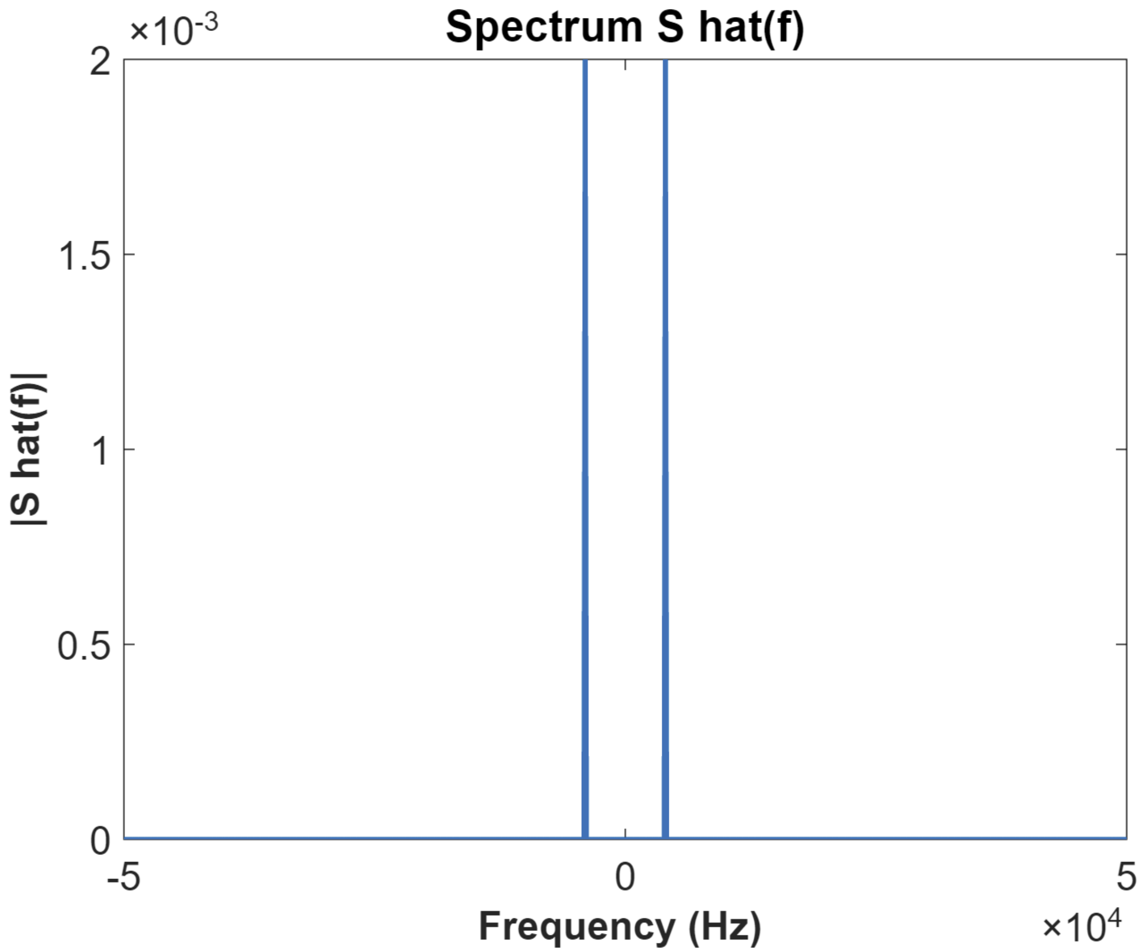

Figure 13. Remodulation Signal in Frequency Domain

Experiment:

Transmit Section

a. **Comparison:**
The observed and simulated Double Sideband-Suppressed Carrier (DSB-SC) waveforms exhibit the same general shape in both the time and frequency domains, indicating that the simulation accurately models the essential characteristics of the DSB-SC modulation process. One notable discrepancy is in the representation of negative values within the waveforms. In a simulated environment, the DSB-SC waveform can accurately depict both positive and negative amplitude values, reflecting the true nature of the modulated signal. In contrast, physical measurement devices such as oscilloscopes might have limitations in directly displaying negative amplitude values, particularly when set to certain modes or configurations.

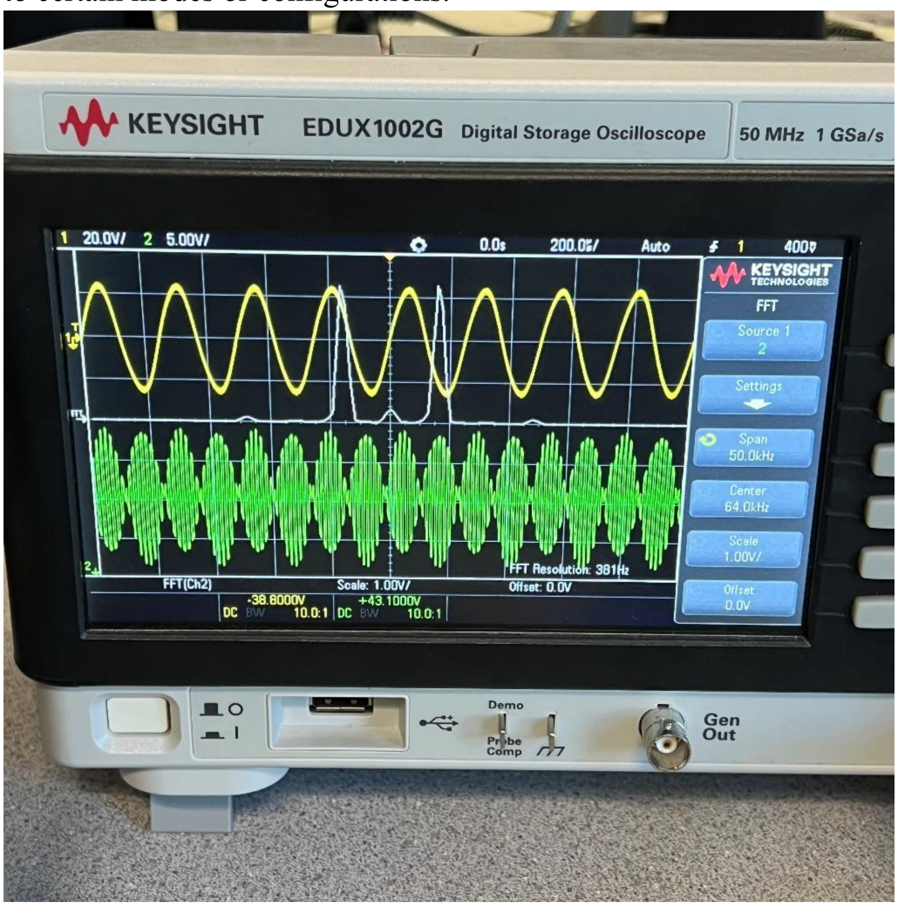

Figure 14. The Observed DSBSC Waveform in time and frequency domains

b. **Linearity:**
   i. Adjusting PT2 directly affects the amplitude of the DSB-SC signal. An increase in the carrier level leads to a proportional increase in the overall amplitude of the modulated signal. This adjustment does not alter the basic

waveform or temporal characteristics of the signal; the modulation pattern remains consistent, reflecting the original message signal's information.

ii. In the frequency domain, adjusting PT2 impacts the amplitude of the DSB-SC signal's sidebands but does not change their frequency distribution. The sidebands are located symmetrically around the carrier frequency, and their amplitude increases with the carrier level, but the bandwidth remains constant, reflecting the frequency content of the message signal.

iii. It is crucial to note that excessive adjustments to the potentiometer PT2 can cause non-linear responses within the modulation circuit, potentially leading to signal distortion.

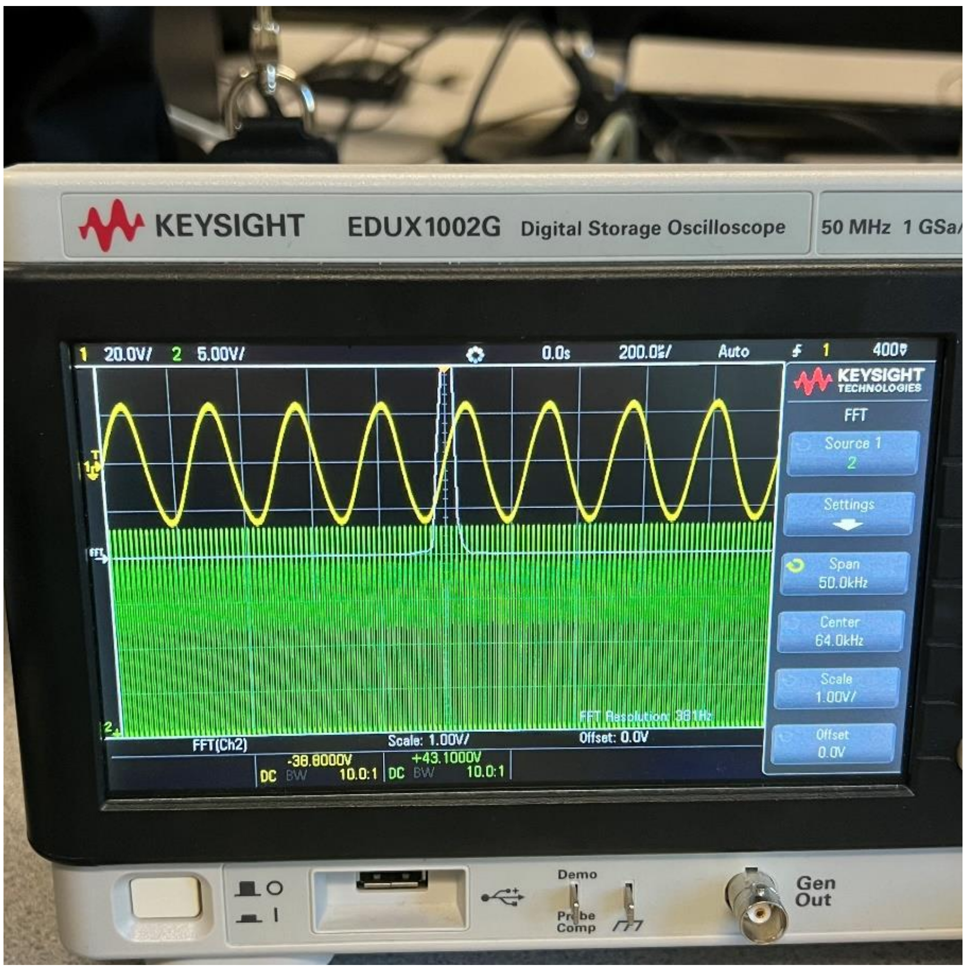

Figure 15. Signal Distortion by varying TP5

c. **4khz message signal:**

The 4 kHz message signal on the board is created by first buffering and level shifting a 64 kHz sine wave input to match digital logic levels. This signal is then shaped into a square wave by a Schmitt trigger, which ensures signal stability and noise immunity. The square wave is subsequently reduced to 4 kHz through a divide-by-16 counter, producing the desired message frequency. Finally, an op-amp buffer is used to maintain the signal integrity and drive capability of the 4 kHz output, available at test point TP1.

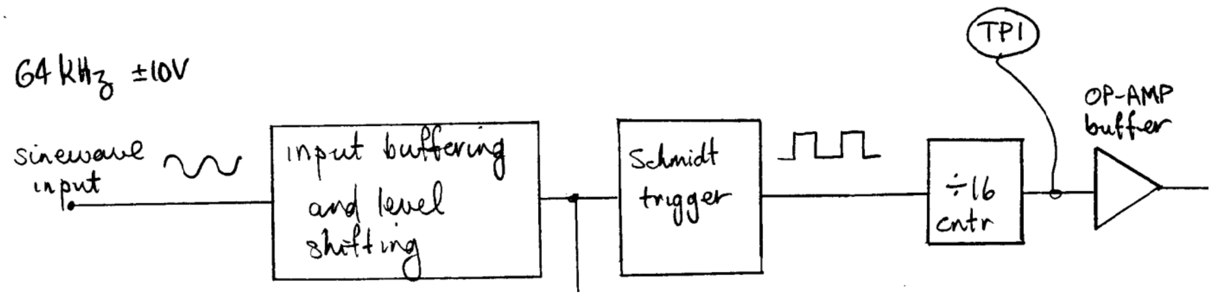

Figure 16. Partial Lab3 Figures

Receive section

(i). In the time domain, the general shape or envelope of the signal at TP4 mirrors that of the simulated signal, indicating that the essential characteristics of the modulation are being captured accurately. However, unlike the simulation which can display both positive and negative values, the physical oscilloscope used to observe TP4 might only show the waveform above a certain baseline due to its display or measurement capabilities, essentially clipping the negative parts of the signal. In the frequency domain, while the main spectral components should theoretically match the simulation, there may be observable leakage of the input signal or other unintended frequencies at TP4.

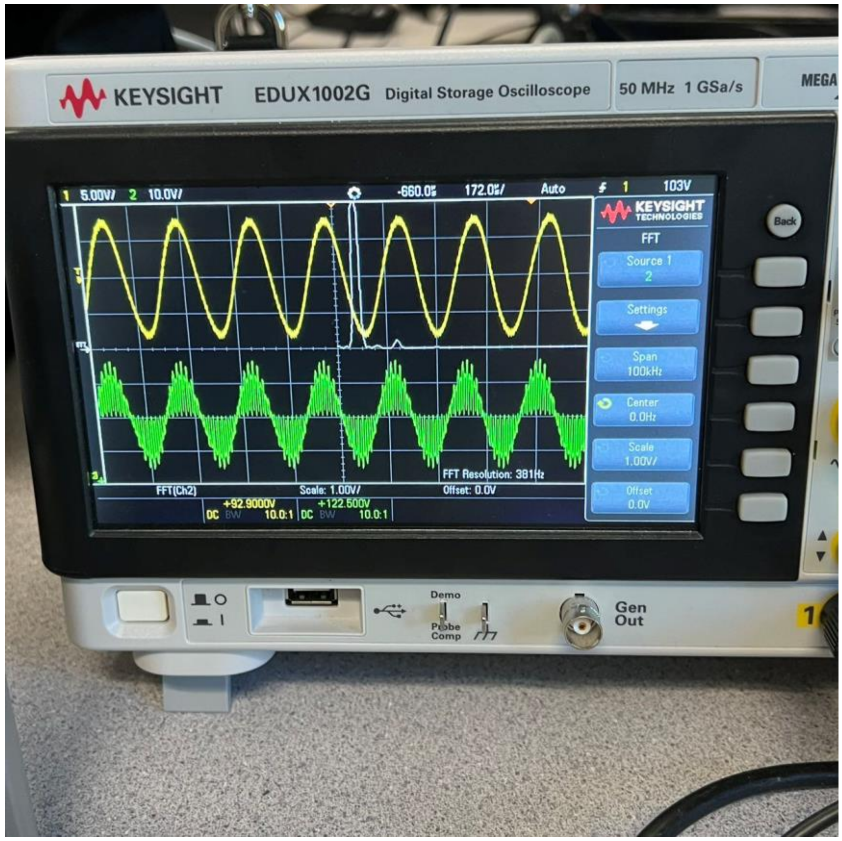

Figure 17. The Signals at TP4 and TP5 in both time and frequency domains

ii). In comparing the demodulated output at TP5 with Matlab simulation outputs, it is observed that the signal retains the fundamental shape of the original message $m(t)$, indicating a generally successful demodulation process. However, discrepancies such as amplitude variance or residual carrier effects may be present due to practical non-idealities. To enhance the fidelity of the demodulated signal to the original message, it is recommended to implement precise filtering, maintain component linearity, utilize automatic gain control, and apply signal conditioning techniques. Additionally, strategies for noise reduction and regular calibration of equipment should be adopted.

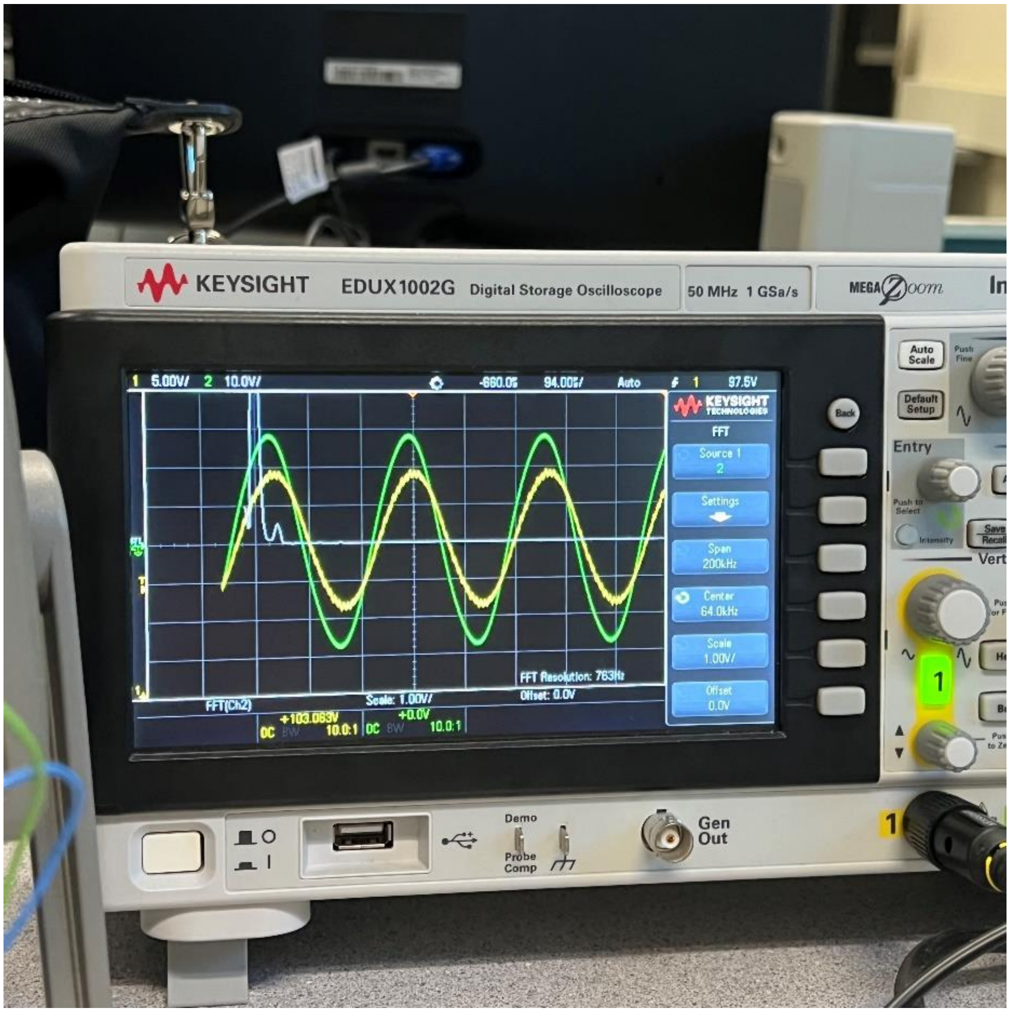

Figure 18. The Demodulated Output at TP5

iii). During the examination of PT1's influence on signal amplitude, it was observed that a clockwise rotation incrementally increases amplitude until a distortion threshold is reached, where non-linear effects begin to compromise signal integrity. Counter-clockwise adjustment, in contrast, reduces amplitude, potentially to levels where the signal is obscured by noise.