ANALOG FINAL PROJECT

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Mohammed El Hofy 8790
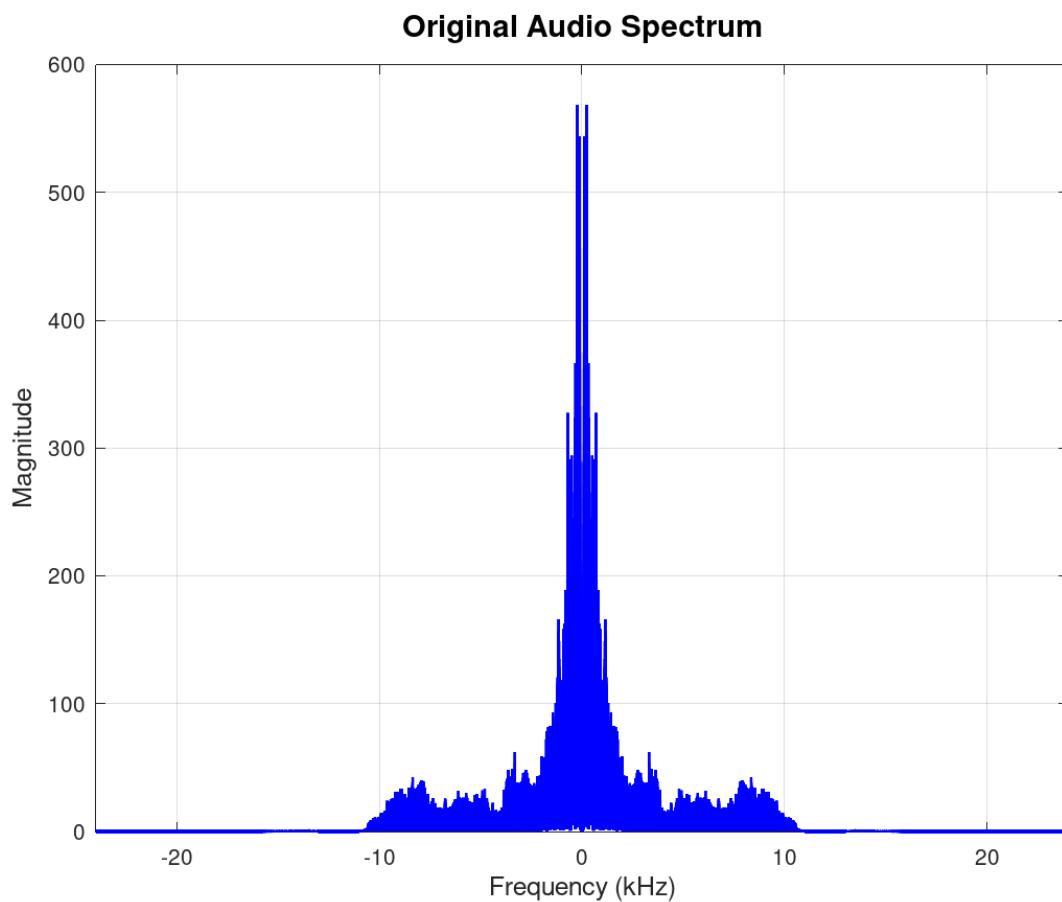
Ahmed Tamer 8842

Mostafa Mohamed El Kassar 8580
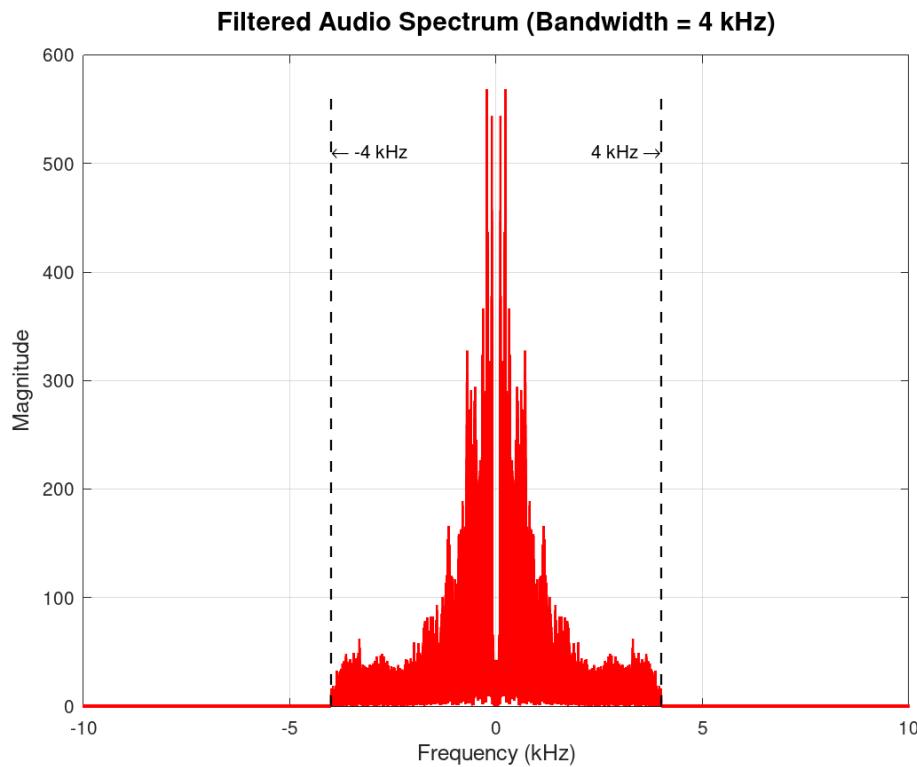
Ahmed Mostafa Kamel 8623

EXPERIMENT 1
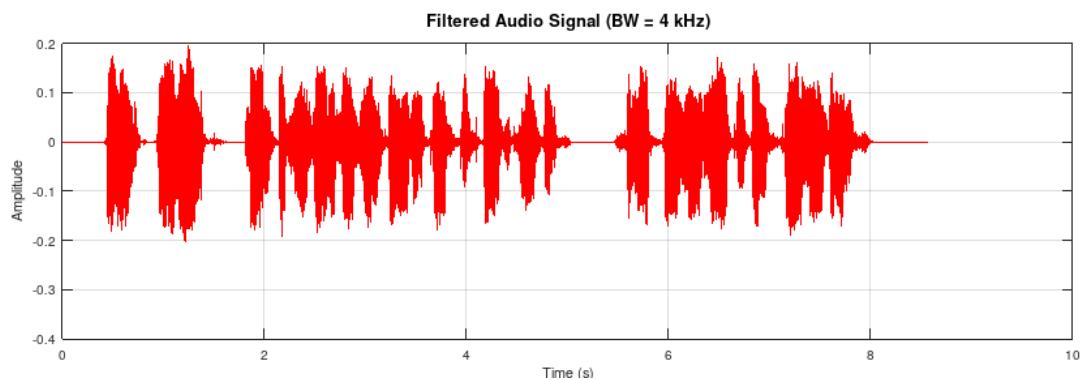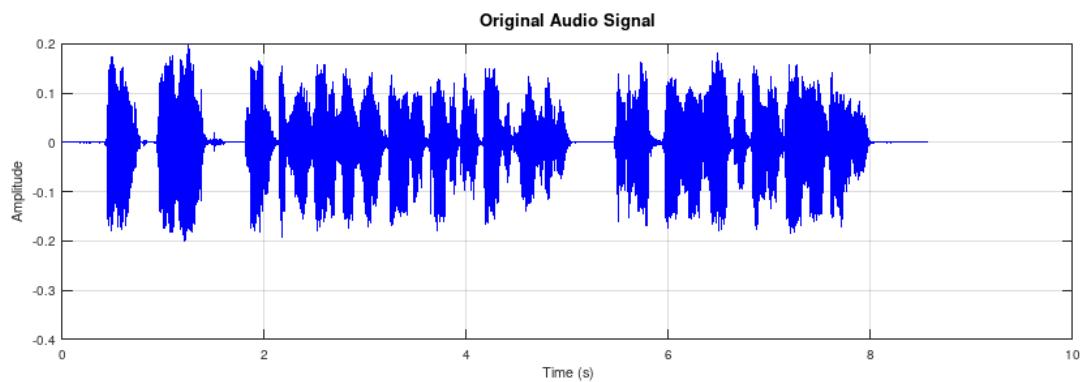
- **Original Spectrum**

Original Audio Spectrum

Filtered Audio Spectrum (Bandwidth = 4 kHz)

- **Time comparison**

Original Audio Signal

Flltered Audio Signal (BW = 4 kHz)
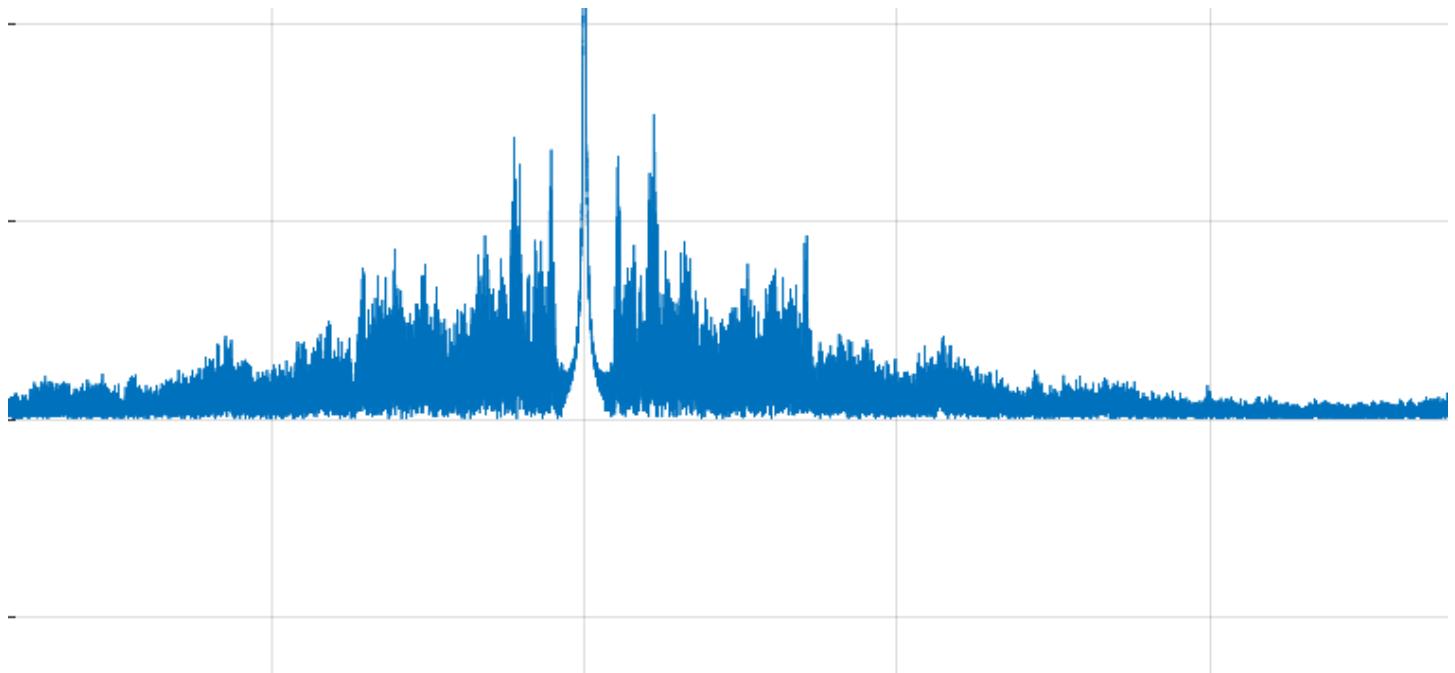
DSB-TC

**spectrum frequency domain**
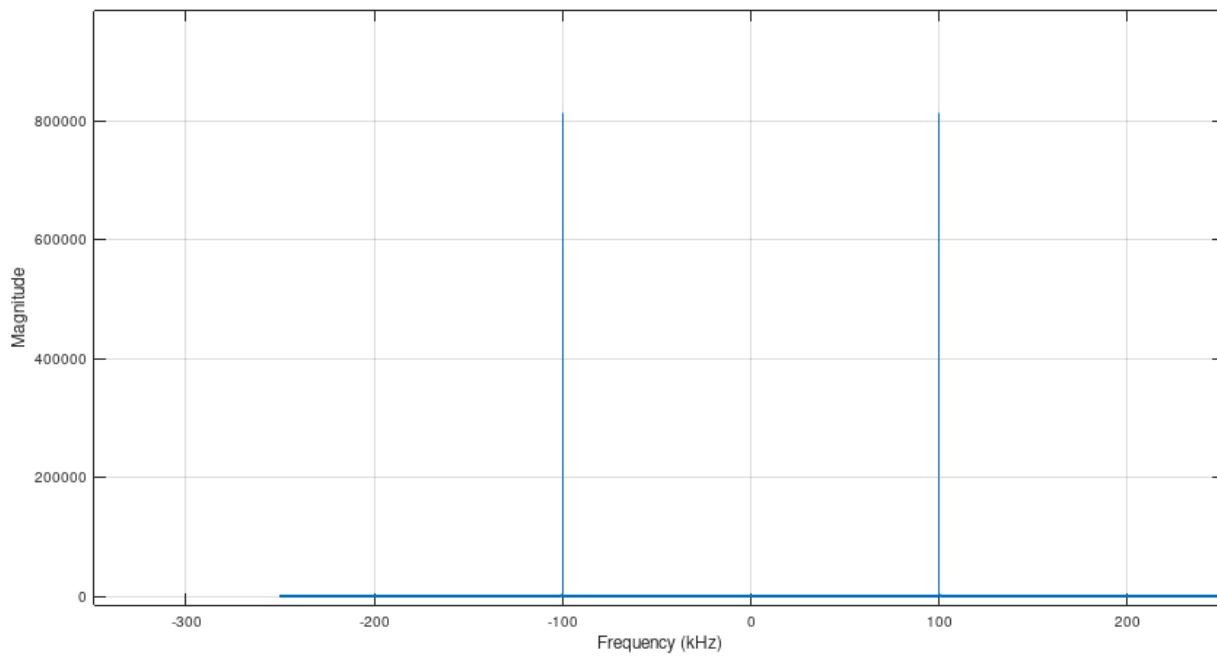
- **DSB-TC spectrum frequency domain**

Zoomed in
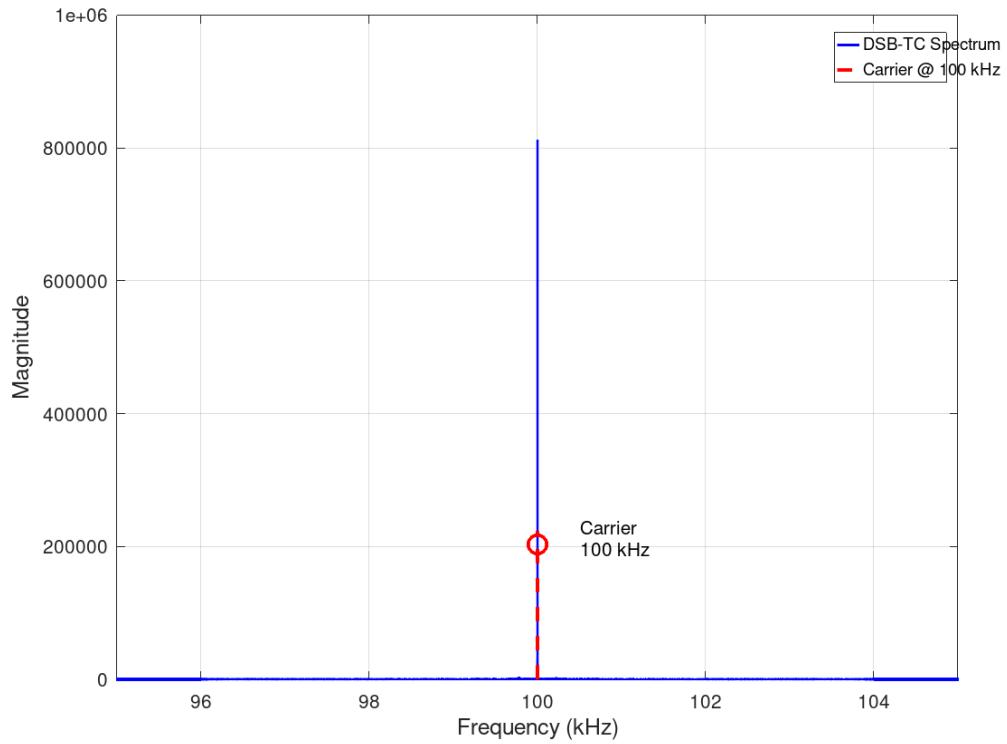
Zoomed out

DSB-TC Modulated Signal Spectrum
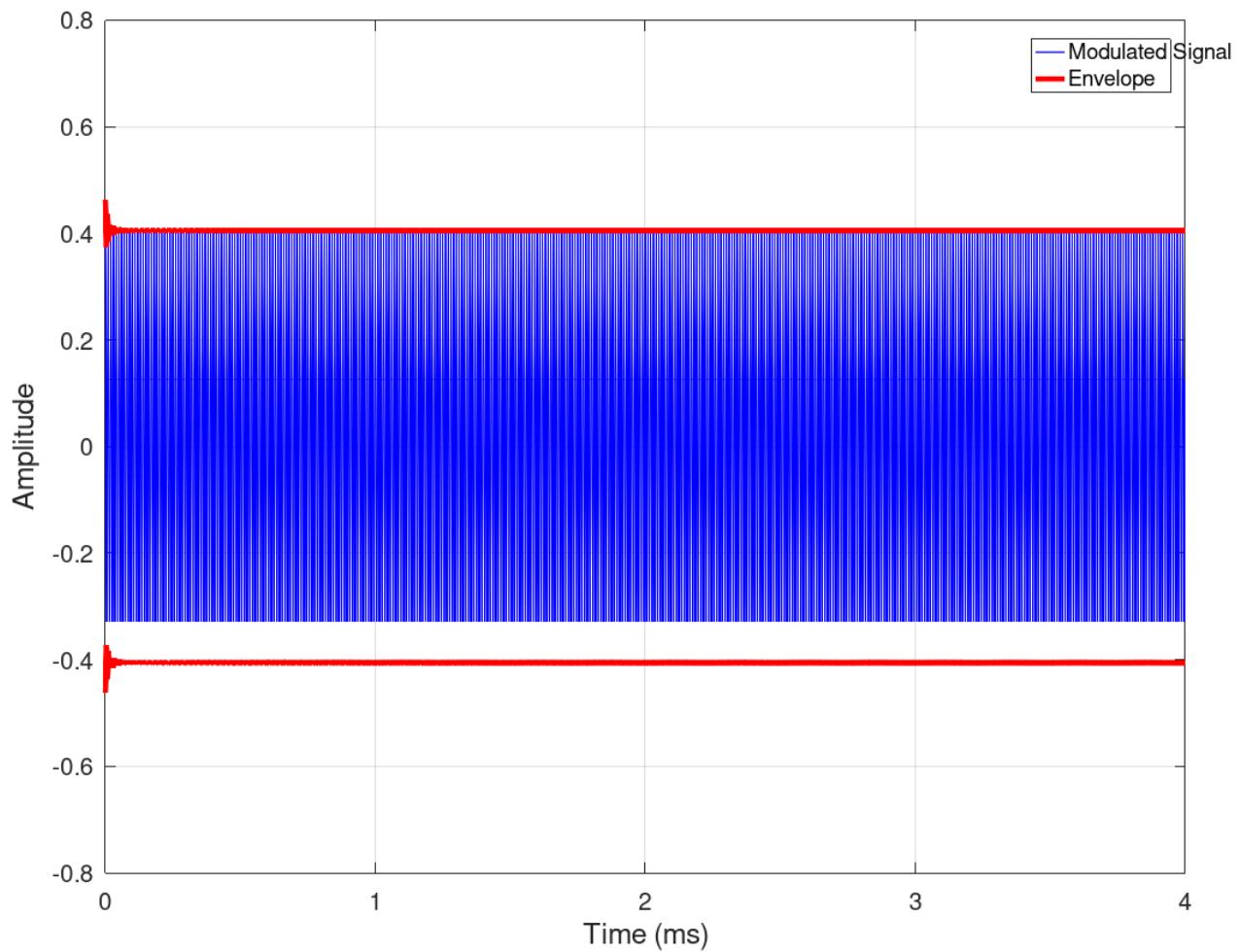
DSB-TC Spectrum (Zoomed Around Carrier)
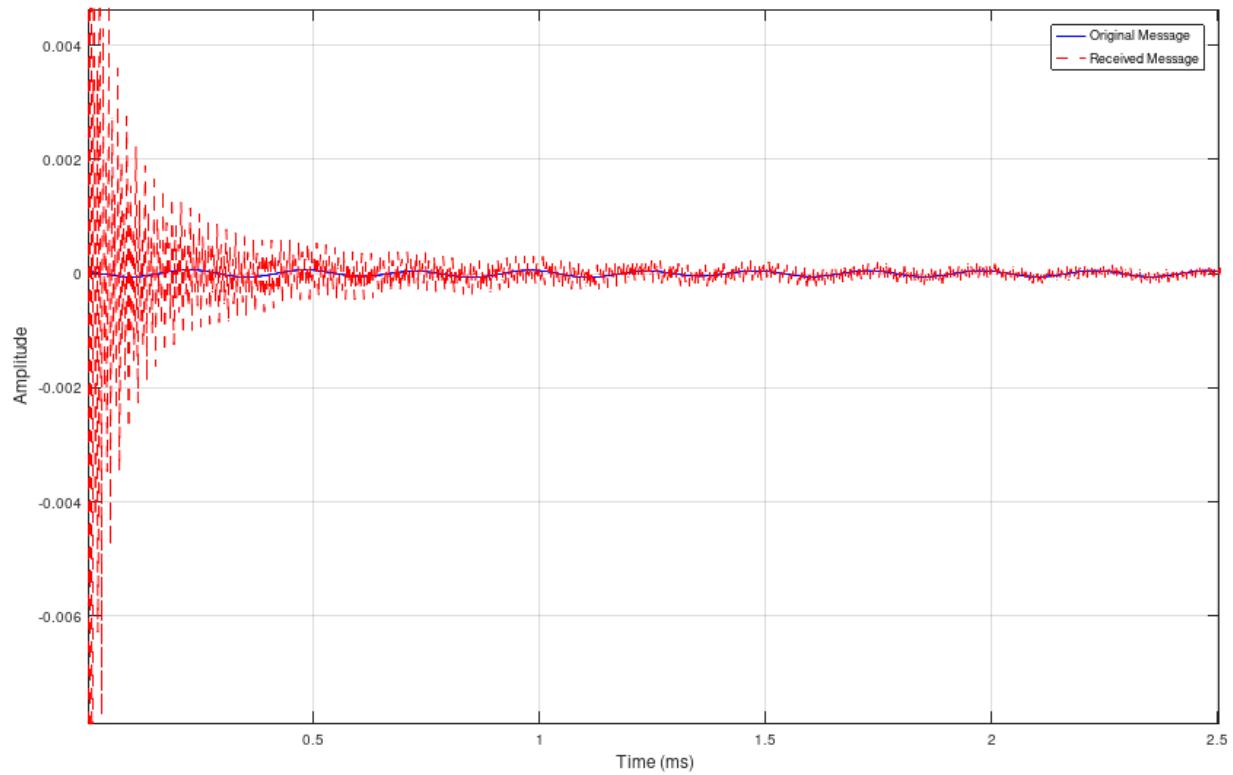
DSB-TC: Modulated Signal with Envelope
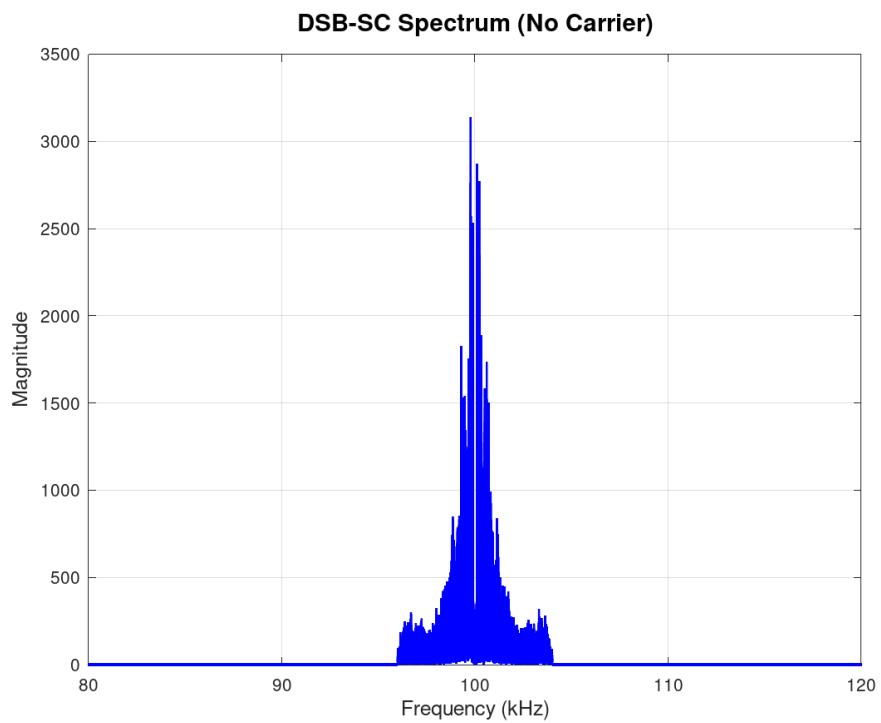
DSB-TC Demodulation: Original vs Received Message
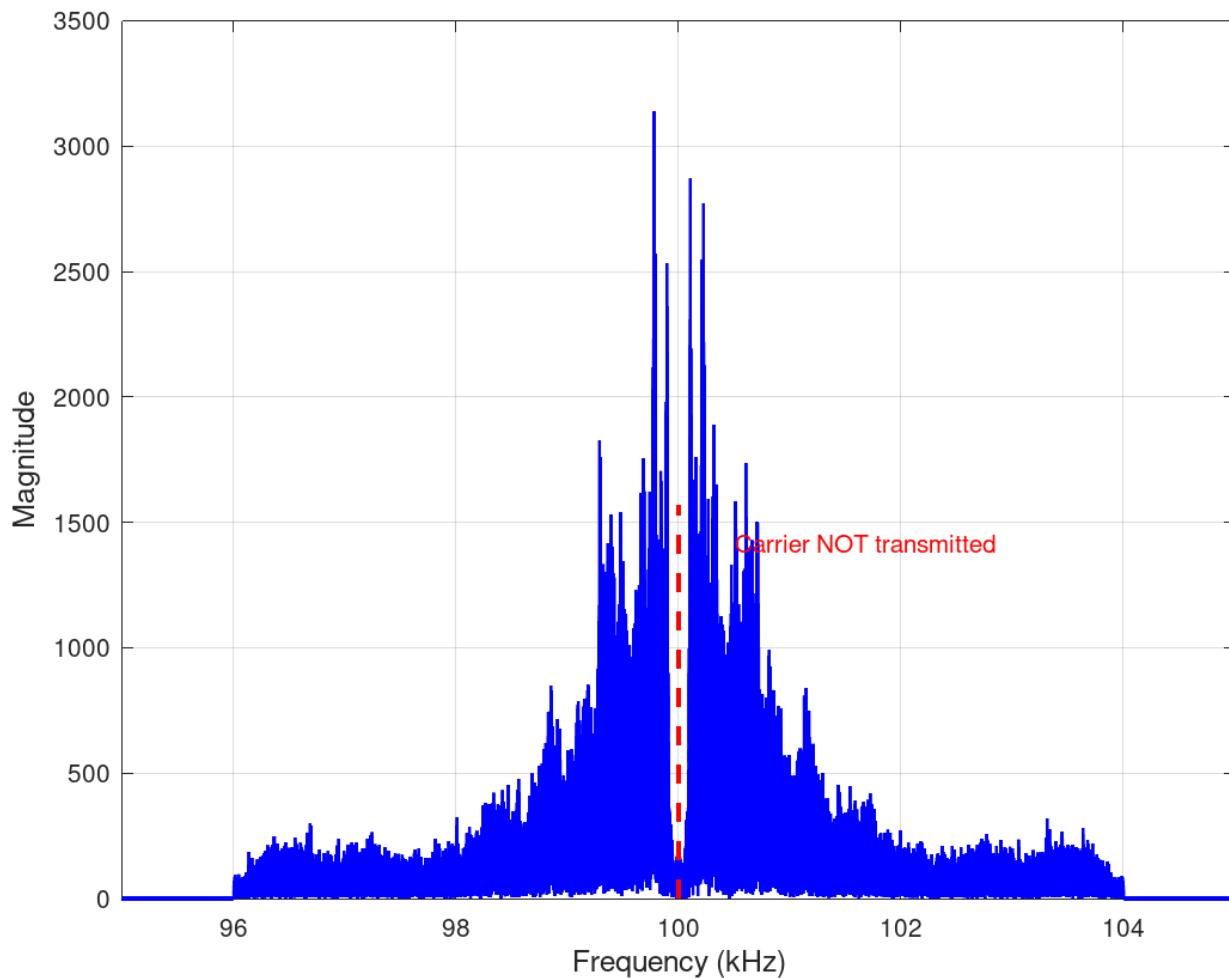
DSB-SC
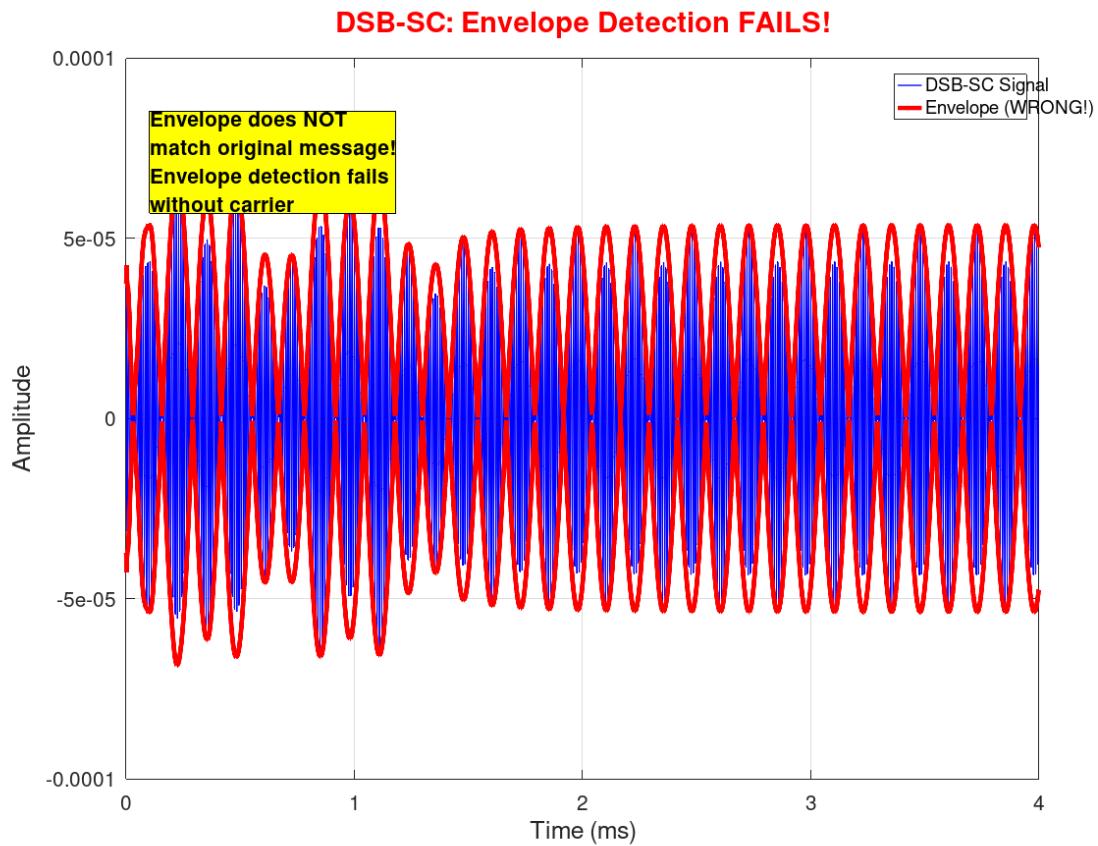
Frequency domain

DSB-SC Spectrum (No Carrier)
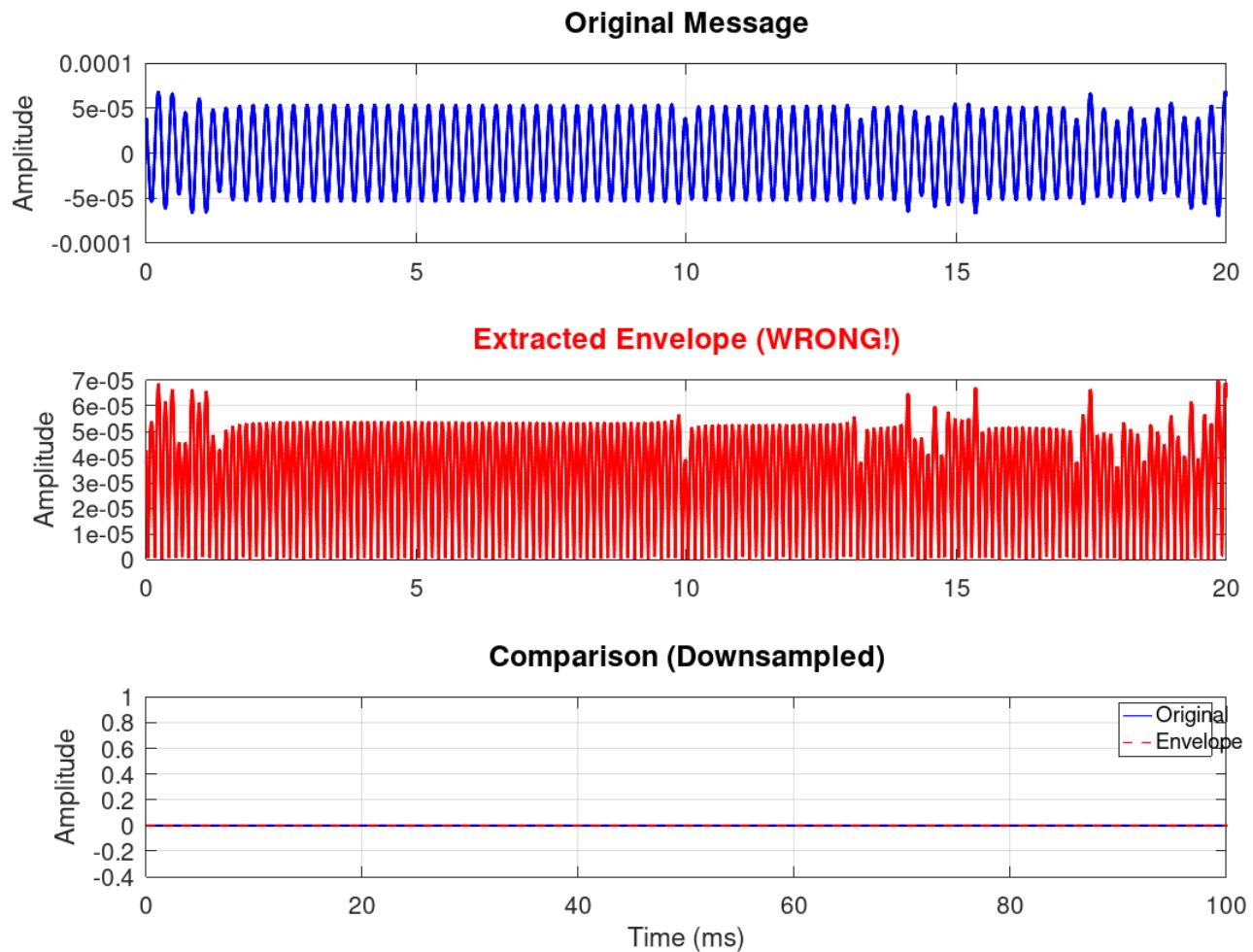
DSB-SC Spectrum (Zoomed - Note Missing Carrier)

Carrier NOT transmitted

DSB-SC Envelope

DSB-SC: Envelope Detection FAILS!

Original Message

Extracted Envelope (WRONG!)

Comparison (Downsampled)
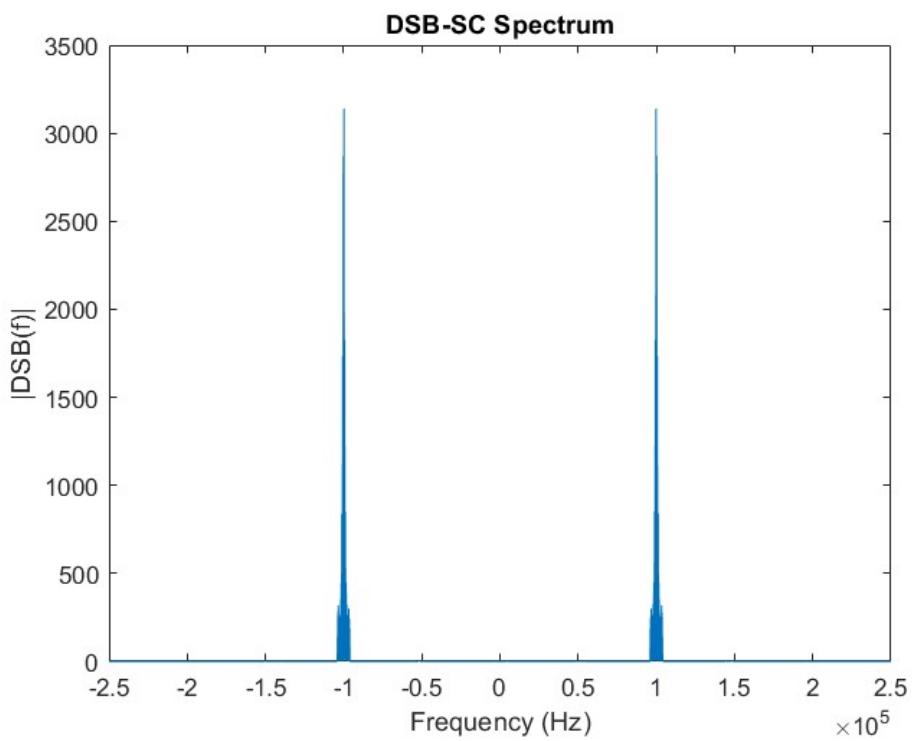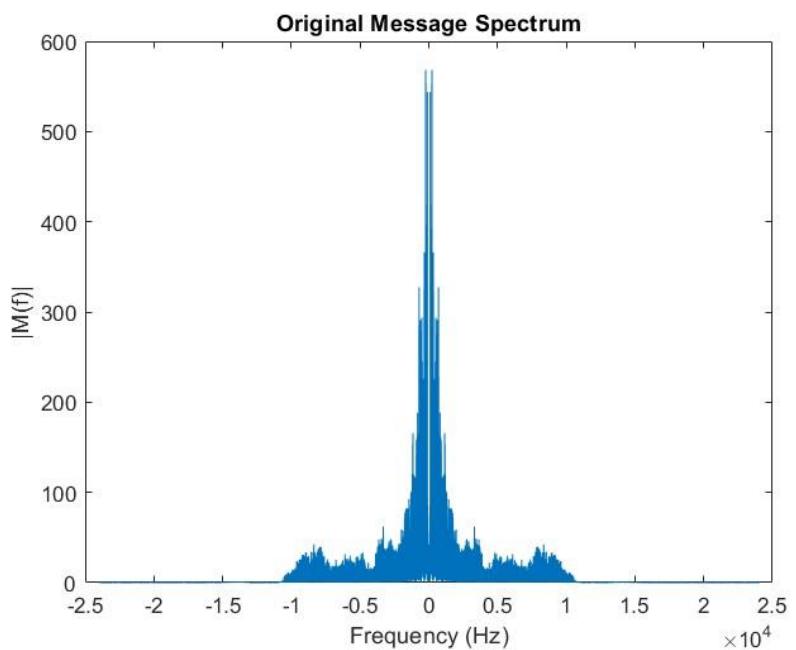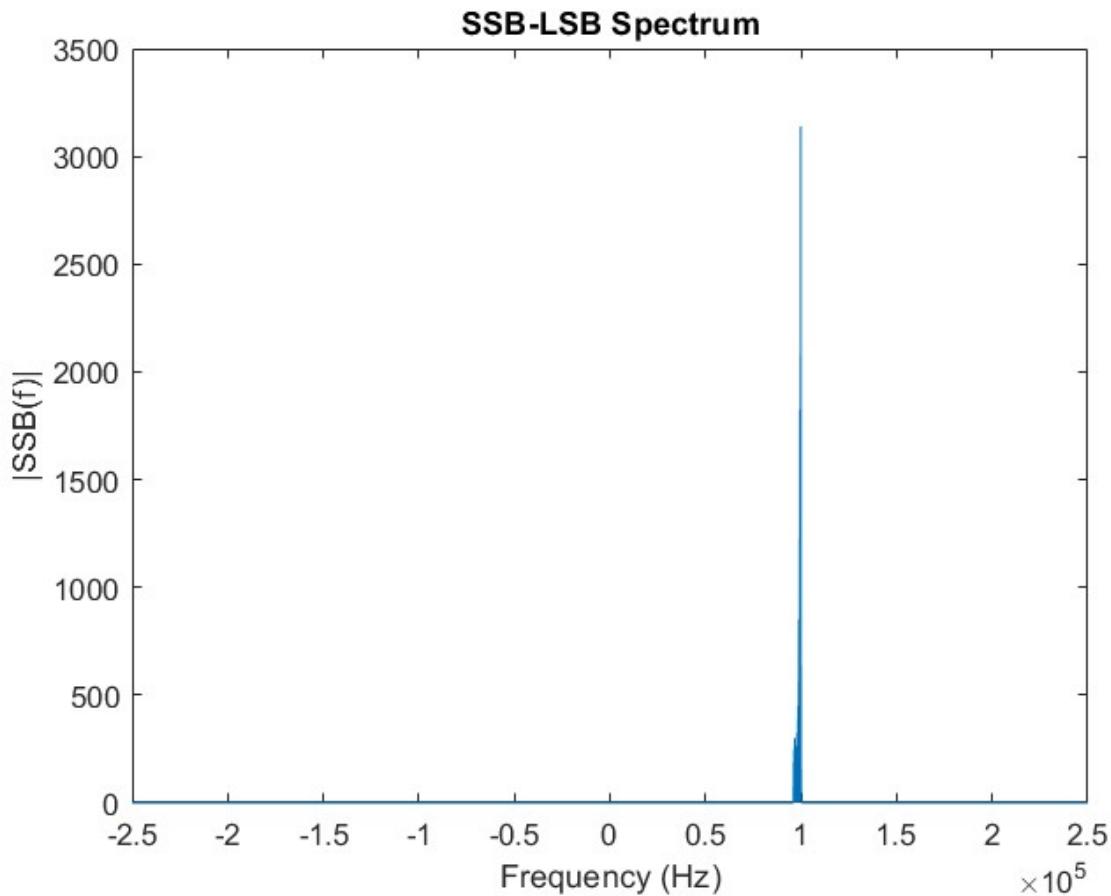
- For DSB TC: The demodulated signal is slightly attenuated or/and distorted

- While for DSB – SC: the demodulated signal is distorted and unintelligible

EXPERIMENT 2

Original Message Spectrum

DSB-SC Spectrum

SSB-LSB Spectrum
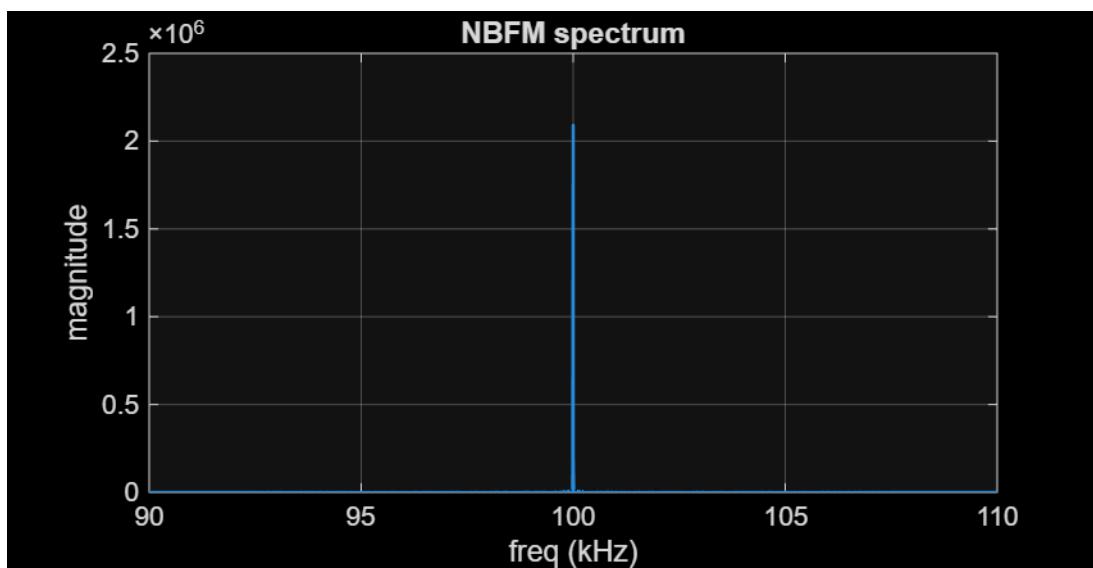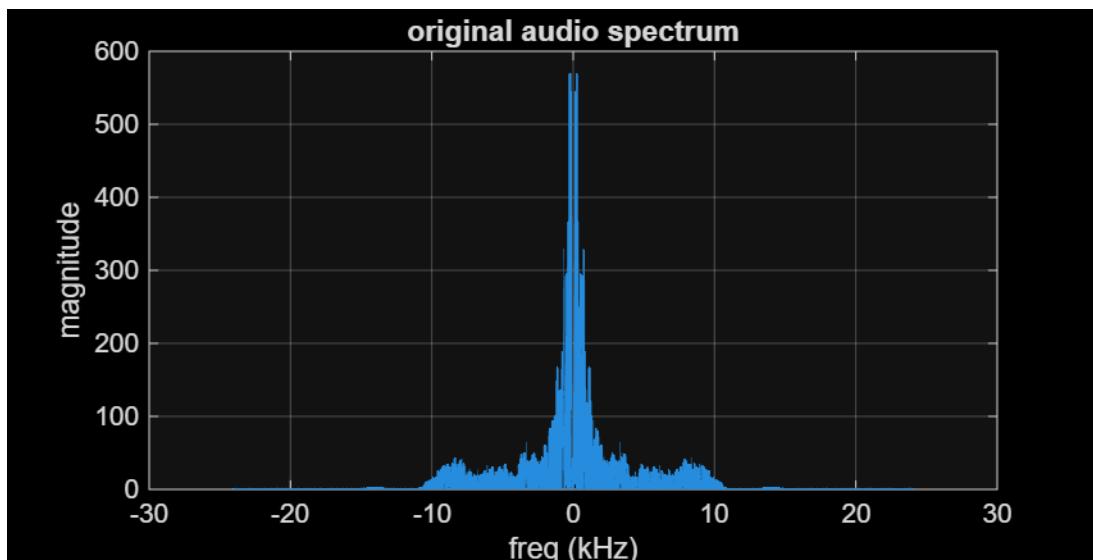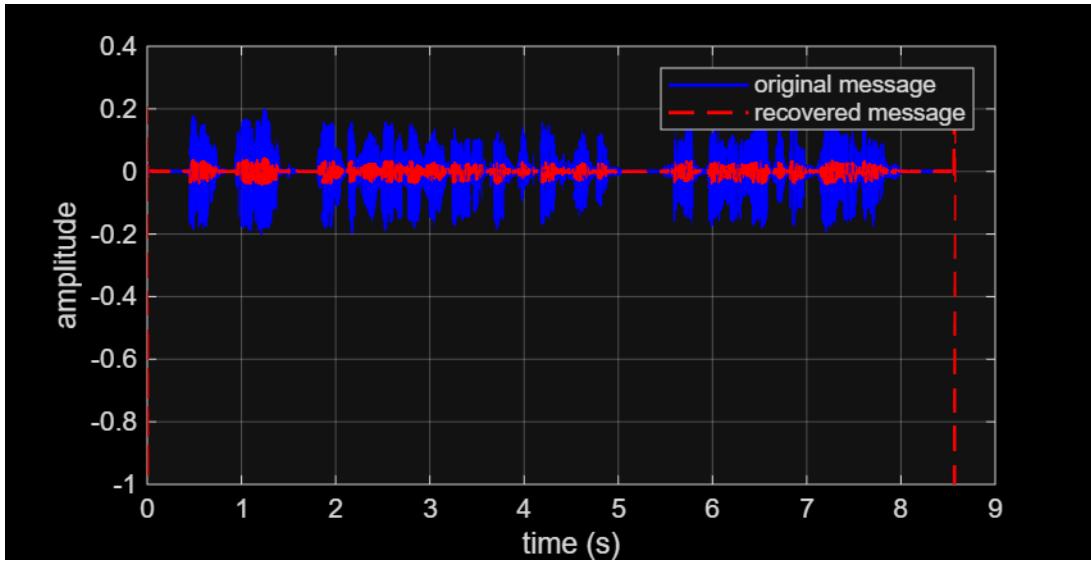
Disadvantages of SSB:

- Generating SSB requires sharp filtering (to remove exactly one sideband without hurting the other) or complex phase-shifting networks.

- SSB-SC requires precise Coherent Detection (synchronization of frequency and phase). A slight frequency error results in the "Donald Duck" effect (pitch shift), unlike DSB where it might just result in fading.

- Practical SSB filters struggle to separate sidebands if the message has significant low-frequency content near DC, as the gap between the LSB and USB vanishes at f_C.

EXPERIMENT 3

Observation:

- The envelope of the recovered signal matches the timing and shape of the original message.

- The recovered signal has a significantly lower amplitude than the original signal. Since this is Narrowband FM, the modulation index β and frequency deviation are intentionally kept small, so the resulting amplitude variations after differentiation are also very small. To match the original signal, the recovered message would need to be amplified.

Similarities and Differences AM vs. NBFM:

- Similarities:

  - They both occupy the same bandwidth (2×BW).

  - Both signals consist of a discrete carrier component and two sidebands (Lower Sideband and Upper Sideband) located at fc±fm.

- Differences:

  - AM has variable amplitude while NBFM has variable frequency.

  - In AM, total power fluctuates with the message. In FM, the total transmitted power is constant regardless of modulation