Minnesota State University, Mankato

Electrical and Computer Engineering Department

Lab Assignment 6 –Synchronous Detection of DSB-SC Signals

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Synchronous Detection of DSB-SC Signals

*Abstract*

This lab focuses on the synchronous detection of **Double Sideband Suppressed Carrier (DSB-SC)** signals using Fourier Transform-based spectral analysis. The experiment demonstrates the modulation of a baseband signal, mixing with a carrier, applying a low-pass filter, and performing an inverse Fourier Transform for signal recovery. By analyzing the spectral properties of the signal, we validate the effectiveness of synchronous demodulation in extracting the original baseband signal.

*Materials*

**Equipment Needed                                        Quantity.**

Laptop (Visual Studio Code)                                 1

**Methods (Procedure, Data Collection, and Analysis)**

**Part A: Computing the Fourier Transform of a DSB-SC Signal**

1. **Define the baseband signal**
   * The energy-limited signal is given by:



* + Set **T = 0.01s** and define the time range **t** from **0 to 10T**.

1. **Modulate the signal using DSB-SC**
   * Multiply the baseband signal by a cosine wave at **500 Hz** to generate the DSB-SC signal:

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1. **Compute the Fourier Transform**
   * Apply numerical integration to compute its Fourier Transform:

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1. **Compute and plot:**
   * **Magnitude Spectrum** ∣X(f)∣
   * **Phase Spectrum** ∠X(f)
   * **Energy Spectrum Density** ∣X(f)∣2

**Part B: Fourier Transform of a Time-Shifted Signal x(t−3T)**

1. **Shift the signal by 3T**
   * Modify the baseband signal to:



* + Compute the Fourier Transform of the time-shifted signal:

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1. **Compute and plot:**
   * **Magnitude Spectrum** ∣Xshifted(f)∣
   * **Phase Spectrum** ∠Xshifted(f)
2. **Compare the phase shift with the original spectrum**
   * Verify that only the **phase changes** while the **magnitude spectrum remains the same**.

**Part C: Fourier Transform of a Scaled Signal x(2t)**

1. **Compute the time-scaled signal**
   * Modify the baseband signal to:



* + Compute its Fourier Transform using the time-scaling property:

A number and a number with numbers

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1. **Compute and plot:**
   * **Magnitude Spectrum** ∣Xscaled​(f)∣
   * **Phase Spectrum** ∠Xscaled(f)
2. **Compare spectral compression/stretching with the original spectrum**
   * Observe that **time compression results in spectral stretching** in the frequency domain.

*Results*

A group of diagrams with text

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*Conclusion*

In this lab, we successfully implemented the **synchronous detection of DSB-SC signals** using numerical methods. The **Fourier Transform** allowed us to observe the spectral components of the modulated and mixed signals. We confirmed that:

* **Multiplication by the carrier** shifts the spectrum, allowing for demodulation.
* **Low-pass filtering** effectively removes high-frequency components, isolating the baseband signal.
* **The inverse Fourier Transform** successfully reconstructs the original signal.

Despite numerical artifacts from spectral leakage, the recovered signal closely matched the original baseband waveform. The experiment reinforced key **signal processing** concepts, including time-frequency domain relationships, modulation properties, and filtering techniques.

*Appendices*

A screenshot of a computer program

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A screen shot of a computer program

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A screen shot of a computer code

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*References*

1. <https://rodzah.files.wordpress.com/2011/07/how-to-write-lab-report.pdf>
2. EE343- LAB Assignment 6.pdf