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Course: ECE 5210

Subject: Lab 2, Moving Average

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1 Introduction

In this lab, we explore the implementation and analysis of a moving average filter on STM32F769I development boards, a fundamental tool in digital signal processing for noise reduction and data smoothing. Through theoretical insights and practical experimentation, we aim to understand the behavior of the filter and its performance in real-time signal processing applications.

Beginning with an overview of the moving average filter's theoretical foundations, including its mathematical formulation and properties, we proceed to implement the filter using Cube IDE. By utilizing provided starter code for basic audio pass-through functionality, we ensure the proper setup of the hardware. Experimental testing involves assessing the filter's ability to attenuate high-frequency noise while preserving essential signal characteristics, with comparisons made to theoretical expectations derived from the Discrete-Time Fourier Transform (DTFT). This lab bridges theoretical concepts with hands-on experience, providing insights into digital filtering techniques and their practical applications in microcontroller-based systems.

2 Theory

This lab required the calculation of impulse response. Fortunately the book provided an equation that we could plug values into which yields

$$h[n] = \frac{1}{7} \cdot \frac{\sin\left(\frac{\omega(7)}{2}\right)}{\sin\left(\frac{\omega}{2}\right)} \cdot e^{-3j\omega} \tag{1}$$

Another potential calculation was for phase correction however, my board did not require this calculation.

3 Results

The biggest time save for this lab was that my board did not add a phase offset and therefore did not require any phase correction. This can be seen in Fig.1 by it's completely linear slope. Fig.2 shows a filtered square wave compared to the pass through channel. Using the built in frequency sweep I generated Fig.3 which contains two plots one for the magnitude and one for the phase. On each subplot the analytical and measured values are plotted and line up nearly perfectly.

4 Discussion and Conclusions

As mentioned in the results section our plots from the implemented code matches the goal for this lab. The coding for this lab was pretty easy to write and I probably should have finished this lab much sooner. Nonetheless the plots produced in this lab are all as expected. I've really enjoyed the labs for this class they have a good amount of theoretical but still contain a good portion of actual data gathering. They also require much less time than the labs from signals. It is really interesting learning how to use the board and the new IDE.

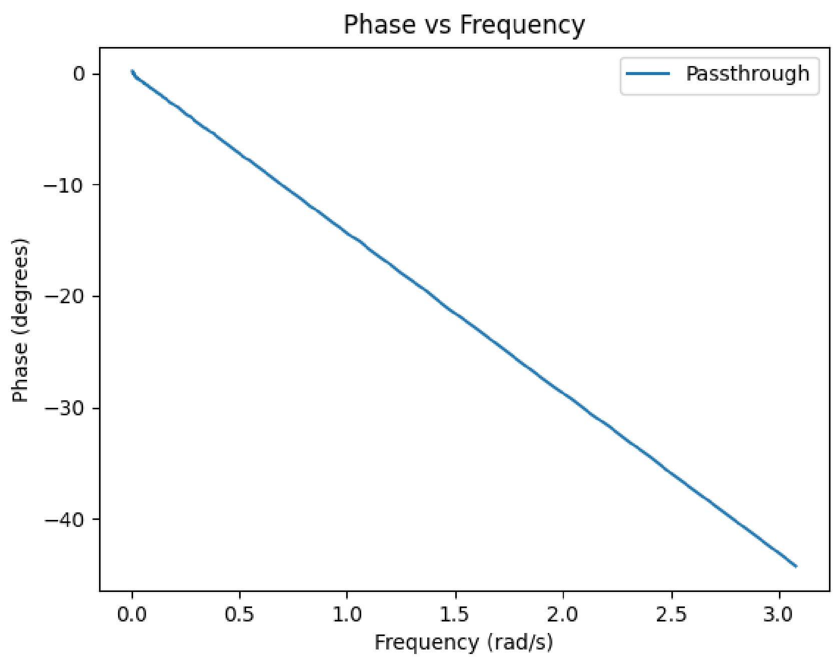

Figure 1: Frequency sweep used to determine phase correction if necessary.

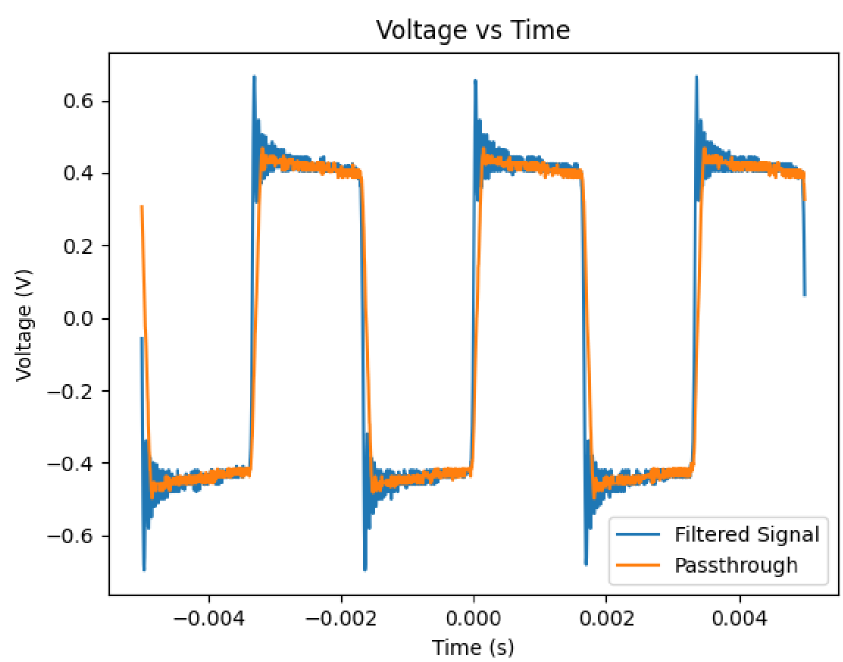

Figure 2: Processed square wave plotted with the input square wave using the moving average filter.

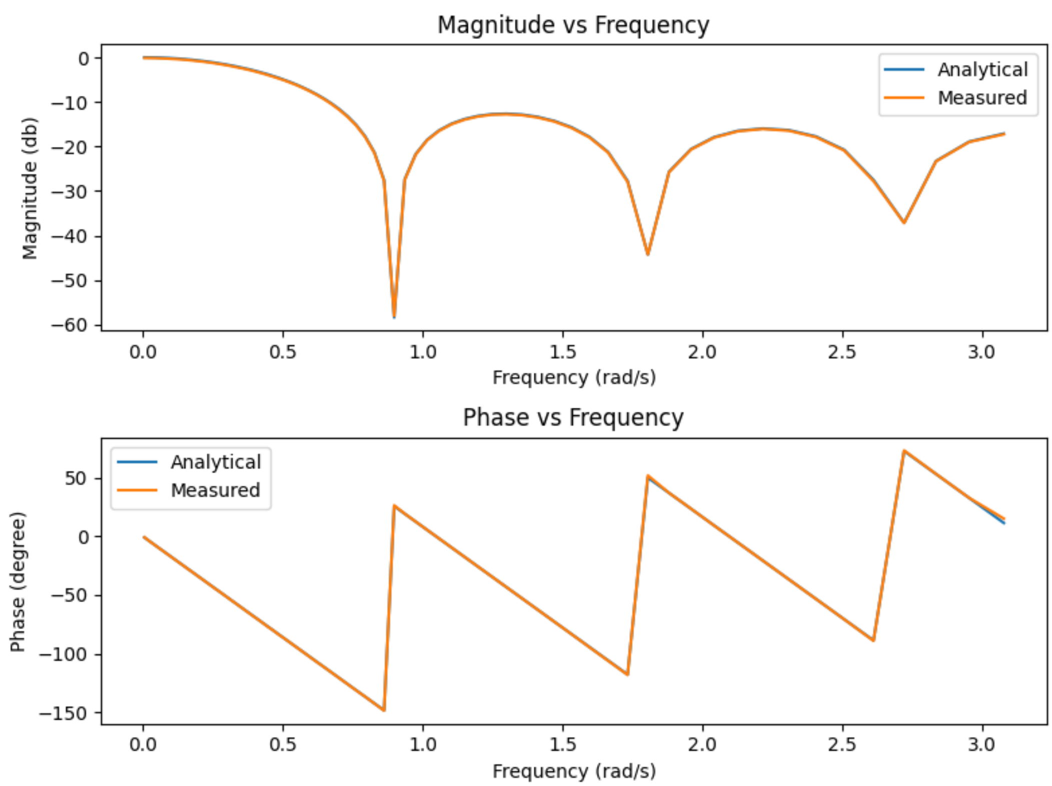

Figure 3: Magnitude and phase plots for the moving average filter using a frequency sweep.