Physics 4050H: Project 1

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Todo list

Abstract

We successfully automated PHYS-2250H's lab 4 on operational amplifiers through microcontroller operated wave generation and input element switching, however due to time constraints did not automate data collection. Results are similar to those that could be obtained by "manually" completing the lab with most inaccuracy owing to additional resistance in the switching element(s) .

Any other areas?

1 Introduction

The goal of this project was to take a lab from PHYS-2250H (Electronics) and improve upon/automate the content of that lab. We opted to automate lab 4 which involved constructing different configurations of operational amplifiers and verifying that the theoretical equations derived in lecture corresponded to the real-world behaviour of the device. Lab 4 specifically looked at varying the input resistance of an inverting amplifier and looked at a single configuration of differentiating amplifier. Our initial concept for automation was to go the most direct route and use a microcontroller to control a switch which would allow selecting different components as in the case of both the inverting and differentiating amplifiers the only component which is varied between measurements in the element lying between the signal source and inverting input of the amplifier. We additionally sought to eliminate as many components external to those which sit directly on a breadboard and so created a function generator to replace the one used in the original lab.

2 High Level Overview

The automation consists of two key segments, one which generates a fixed frequency and peak-to-peak voltage input and one which controls which element is connected to the inverting input of the amplifier. There is technically a third segment of the device which provides a stable 5 volts supply for the various integrated circuits but due to its simplicity it is left off the following diagrams.

Whole circuit block diagram here

2.1 Wave Generator

The input signal generator uses a single ATMmega328P [2] (through hole, 28-PDIP) microcontroller connected through SPI to an MCP4822[1] digital-to-analog converter.

2.2 Amplifier Control & Measurement

3 Detailed Methods

3.1 Wave Generator

3.2 Amplifier Control

3.3 Measurement

4 Conclusion

4.1 Results

4.2 Areas for Improvement

5 References

References

[1] Microchip Technology. *8/10/12-Bit Dual Voltage Output Digital-to-Analog Converter with Internal VREF and SPI Interface*, 49 2015. Rev. B.

[2] Microchip Technology. *ATmega48A/PA/88A/PA/168A/PA/328/P*, 9 2020. Rev. B.

6 Appendix