University of Colorado - Boulder

ECEN 5730
Practical PCB Design Manufacture — Fall 2024

Lab 25 Report - Ferrite Filter Performance

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Introduction

This lab explores the use of ferrite filters for noise suppression on power rails, focusing on their filtering capabilities in circuits with sensitive analog devices. Ferrites, a type of inductor with inherent resistance, are particularly effective for reducing high-frequency noise but are unsuitable for high-current applications due to their series resistance and inductance.

What is a Ferrite?

A ferrite is an inductor with moderate inductance and built-in resistance (typically 0.1 to 1 ohm). This resistance makes it inappropriate for general-purpose filtering, such as in SMPS, where high current or low-resistance paths are required. Instead, ferrites are ideal for noise-sensitive analog circuits to suppress high-frequency noise from power rails.

Experimental Setup

The circuit for this experiment included a slammer circuit generating switching noise, connected to a ferrite filter and an LC filter for analysis. The setup aimed to measure noise levels across three configurations:

- A through connection (no filter),
- A series ferrite inductor, and
- An LC filter.

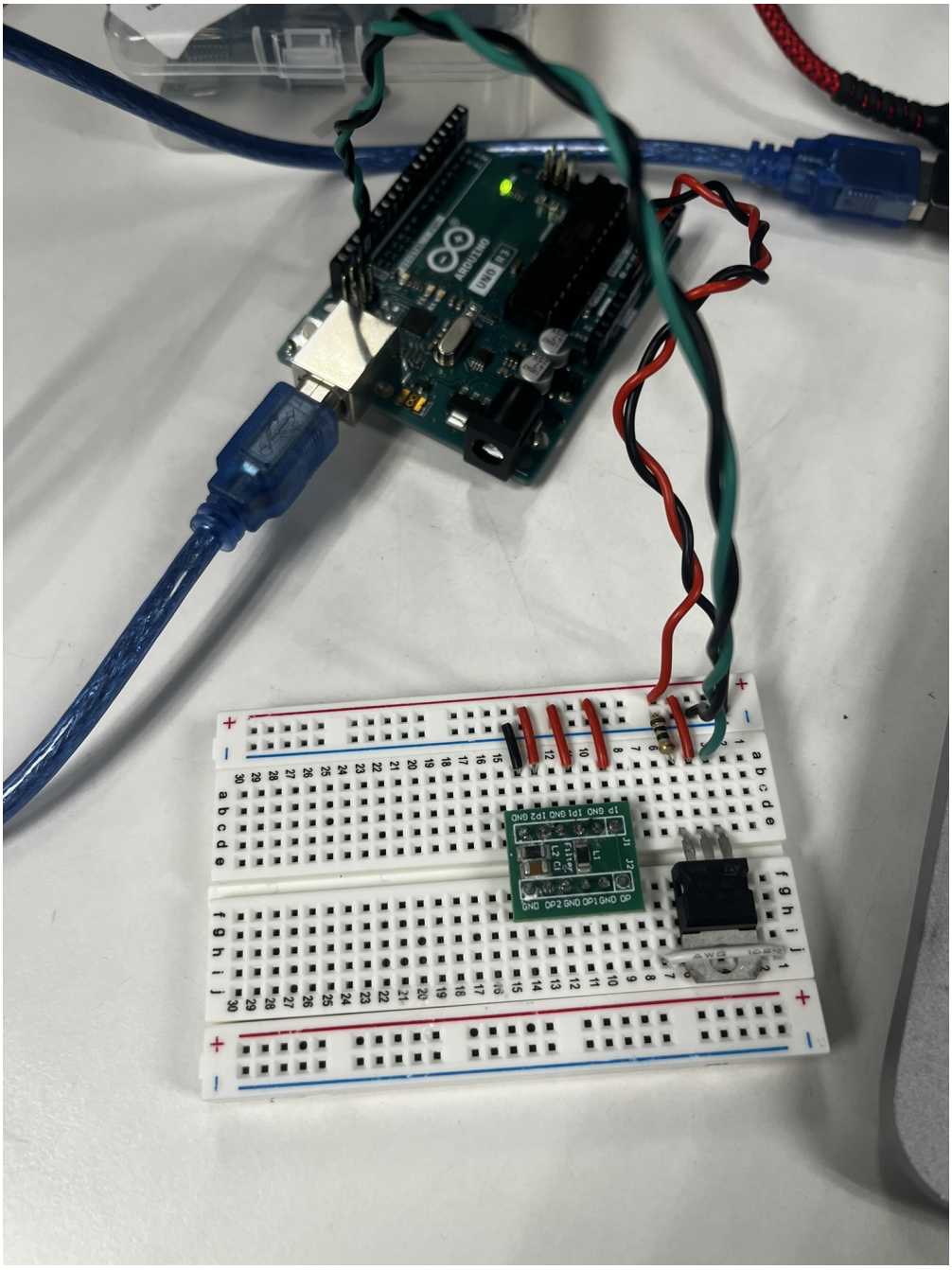

Figure 1: Circuit with slammer circuit and ferrite filter.

Results and Analysis

Noise Measurements

- **Through Connection:** Noise measured at 2.17V.
- **Ferrite Inductor:** Noise measured at 2.53V. The higher noise compared to the through connection highlights the inductive impedance of the ferrite.

- **LC Filter:** Noise reduced to 100mV, demonstrating the superior filtering capability of an LC configuration for high-frequency noise.

Figure 2: Oscilloscope traces of noise reduction: Through (yellow), Series Inductor (green), and LC Filter (blue).

Filtering Discussion

The results underscore the importance of filter orientation. The LC filter's capacitor, placed on the device side, minimizes inductive noise coupling. Conversely, a CL filter would require an additional decoupling capacitor to achieve similar noise reduction, emphasizing the LC configuration's efficiency.

Applications and Limitations

Ferrite filters are effective for analog devices drawing minimal current, where noise suppression is critical (e.g., AVCC pins). However, their use is limited in circuits requiring significant current due to voltage drops and heat dissipation. LC filters should be employed when inductance is necessary for effective high-frequency noise suppression.

Conclusion

This lab highlighted the utility of ferrite filters and LC configurations in noise-sensitive circuits. While ferrites are not suited for high-current applications, their combination with capacitors in an LC filter offers robust noise suppression. Future designs will incorporate LC filters for analog ICs and evaluate pole frequency to ensure optimal filtering.