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EE313-Electronic Circuit Design

Term Project

Electronic Compass

Introduction

In this design I build an analog compass using a Hall-effect sensor, UGN3503. I would like to measure the Earth's magnetic field using this sensor. A red and a green LED indicate the direcitons. Hall-effect sensor works with a supply voltage of 6V, and I feed my opamps with 15V, so that we needed to use voltage regualator to take both 15 and 6V for our circuit. My circuit has to have an auto-zero switch to set the voltages when the Hall-effect sensor is looking to the west or east. When the auto-zero switch is released, it should work as specified for at least three minutes.

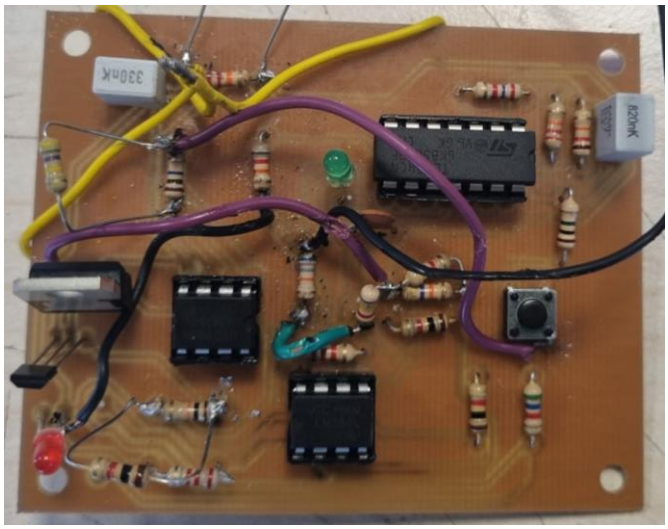
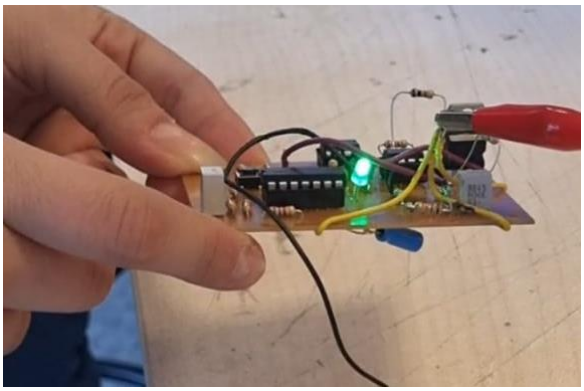
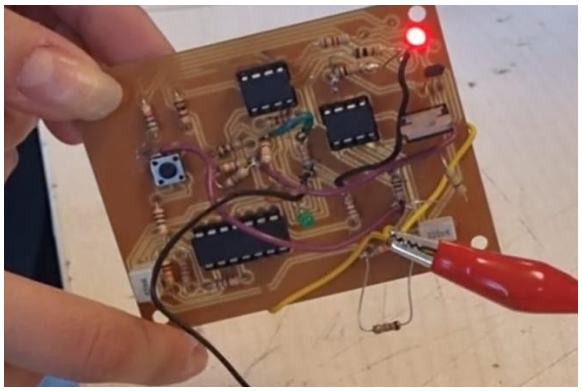


Figure 1: Final Working Compass Circuit

The reason why I put my hall-effect sensor next to my metal voltage regulator, measuring magnetic field (voltage difference) is affected. So that, I bend my hall-effect sensor and made it work vertically instead horizontal movements (South-north observation). So, instead of RED LED showing the North, it turned on when my PCB is perpendicular to the earth and GREEN LED turned on when my PCB is parallel to the earth.





Figures 2 and 3: Red and Green Leds turned on with specific directions.

Specification 1)

Current consumption from +15V supply < 30 mA

Figure 4: Current consumption is 25mA, when applying 15V

Specification 2)

Compass works properly more than 3 minutes after auto-zero.

→ You can check this specification from the video of my working compass at the end of my report, link below!

Specification 3)

Leds turned on within ± 45° of North or South, you can again check this specification from the link. Also, Figures 2 and 3 can be the proof of this specification.

Specification 4)

LEDs should not flicker while turning on or off (should have some hysteresis). Again, you can check this specification from the link.

The Changes I Made After Some Errors in the lab:

1. At first I observed that, my gain amplifier in the input, has a peak output even when I pushed the switch and after waited a while, meaning my differentiator doesn't work as in the simulation of LTspice. The difference between the inverting and non-inverting inputs are so high that, I encounter the maximum output of 13.5V of the opamp. I lower the value of R5, with trial and error. However, my gain was still so high, then I changed R1 and R2 from 10kΩ and 10MΩ to 1kΩ and 470kΩ, repectively. (the gain ratio). Finally reached approxiamtely 6V at Vout1 (Figure 5). At first, I calculated the R1 value from Figure 6, however the value I found

from there didn't work in real life, so I continued with the value I found from trial and error (11kΩ, two 22kΩ's in parallel).

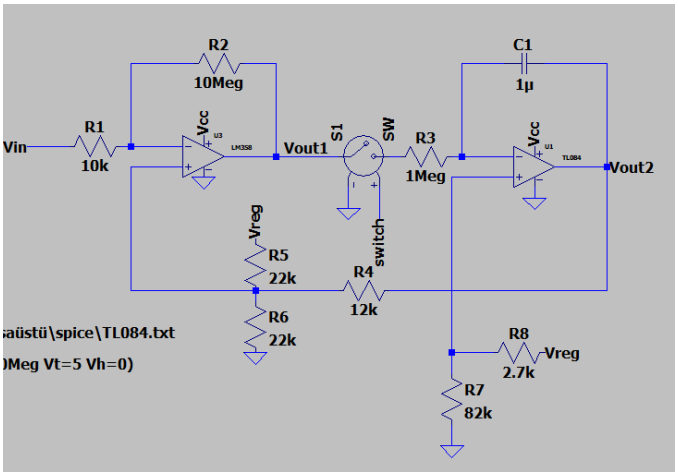


Figure 5: R1, R2, R5 and C1 values are changed

2. I also changed C1 because we shouldn't use electrolitic capacitors and it creates some leakage and affect my circuit, so instead I peaked 820nF. The RC value is still high so didn't affect the auto-zero duration.

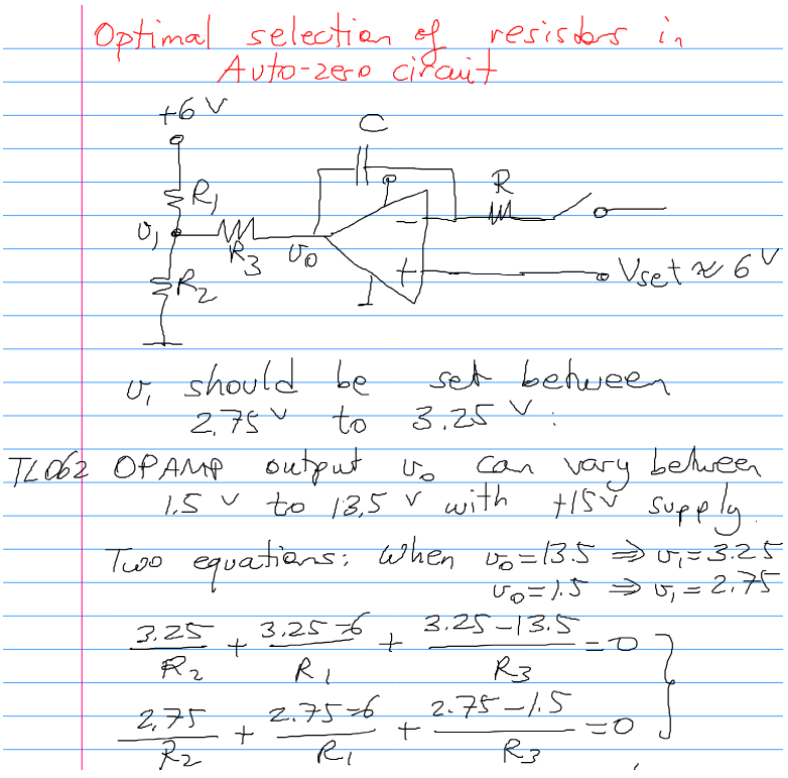


Figure 6: Voltage divider calculation for R1, R2 and R3

3. After I solved the problems with my auto-zero circuit, I continued with the opamps that turn the LEDs on. I had a problem with my red LED, it was ON most of the times, I decreased R17, so that the differences between inverting and non-inverting legs of the opamp decreased and led didn't turned on after this change.

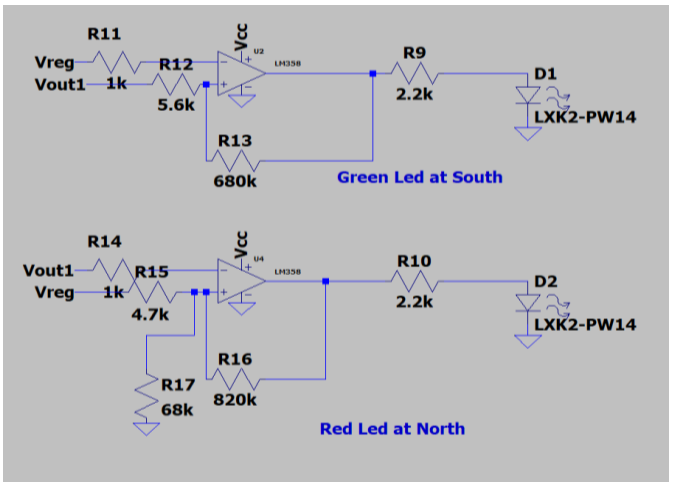


Figure 7: R17 is changed

After the changes and optimizations, my circuit was succesfully working.

Video Link:

https://youtu.be/qj2QgRtTpFQ

References

my own project desing report

https://www.desmos.com/scientific

EE313 Lecture notes , 2024 Spring