Affordable Power Supply

sdmay21-47

Acknowledgements

- Our project advisor/client is Prof. Gary Tuttle. We would like to take a moment to thank Prof. Tuttle for all the help this year with our project.

Problem and Project Statement

- With Covid-19 limiting lab availability to students, it is difficult for electrical engineering students to work with any hardware because they do not have power supplies to test their circuits. It would be beneficial for students studying electrical engineering to have access to a power supply at home during this pandemic.
- The solution for this problem is to design an affordable power supply that any electrical engineering student can easily build and operate from home. This will allow students to perform any hardware labs for their electrical engineering courses without requiring access to an on-campus lab.

Requirements

- Input: 120 Vrms AC wall power
- Four Functional Outputs:
    - DC 1: 2V to 25V adjustable. 1A max current. Binding post connection.
    - DC 2: -2V to -25V adjustable. 1A max current. Binding post connection.
    - DC 3: 1V to 10V adjustable. 1A max current. Binding post connection.
    - DC 4: 5V fixed. 2A max current. USB type A connection.
- Size of the unit: 7”x 4”x 2”
- Maximum Cost: $100 per unit
- Microcontroller (Optional)
- LCD (Optional)

Intended Users and Uses

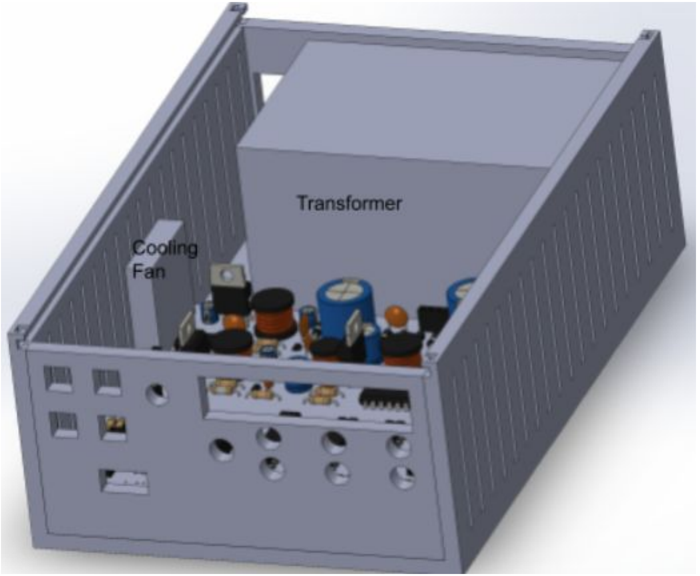
- Students taking circuit based classes that are virtual or would like to test circuits at home
  - EE 201
  - EE 230

Development Standards

- IEEE 1100 - 2005: Recommended Practice for Powering and Grounding Electronic Equipment
  - This standard provides guidance on how to enhance performance and keep safety protocols. It also includes how to protect the devices and resolve any problems with select instruments.
- IEEE 1332 - 2012: Standard Reliability Program for the Development and Production of Electronic Products
  - This standard provides guidance for communication between designer and consumer on best practices for reliability and consistency of electronic products.

Design Overview

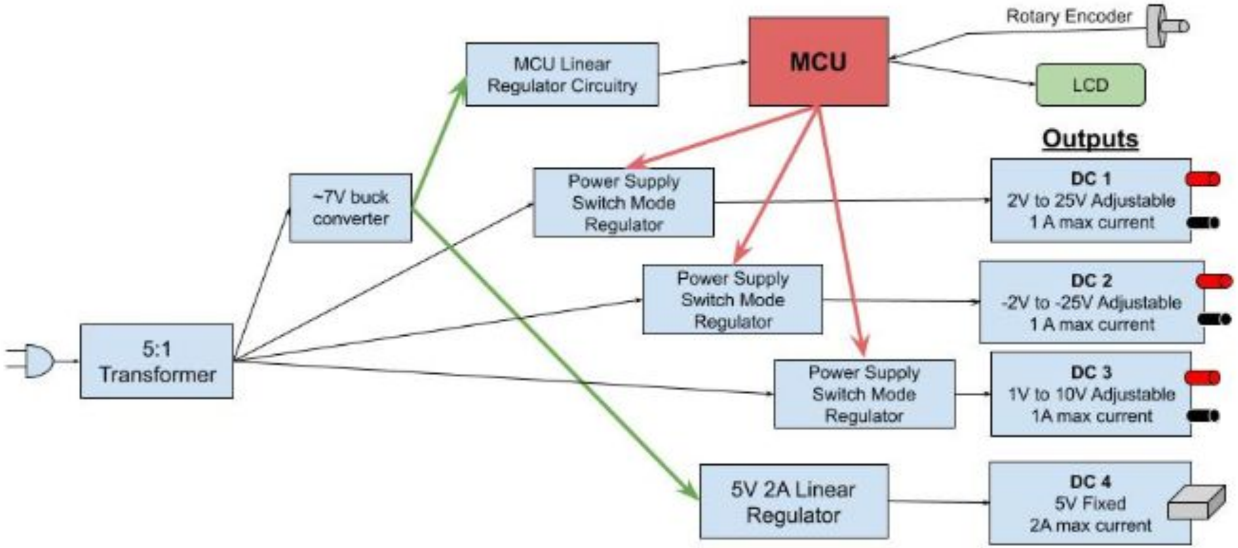
- Multiple voltage regulators
- I/O
  - Rotary Encoder
  - 2x16 LCD display
  - Four buttons
  - Four outputs (3 binding posts + USB-A)
  - Universal ground (Binding post)
- Microcontroller



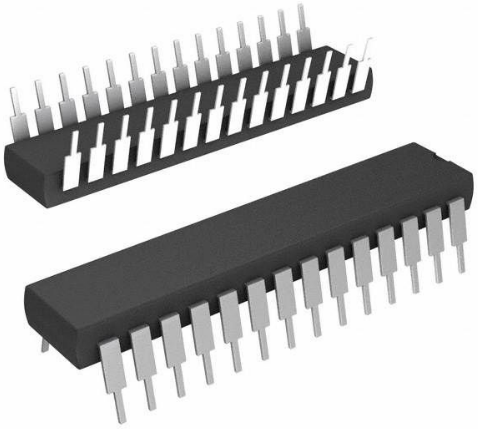
Safety

- Limited output currents
- Limit exposed wiring
- Safety guide in the user manual
- Rubber feet to keep device from sliding
- Fan for cooling

Design Block Diagram

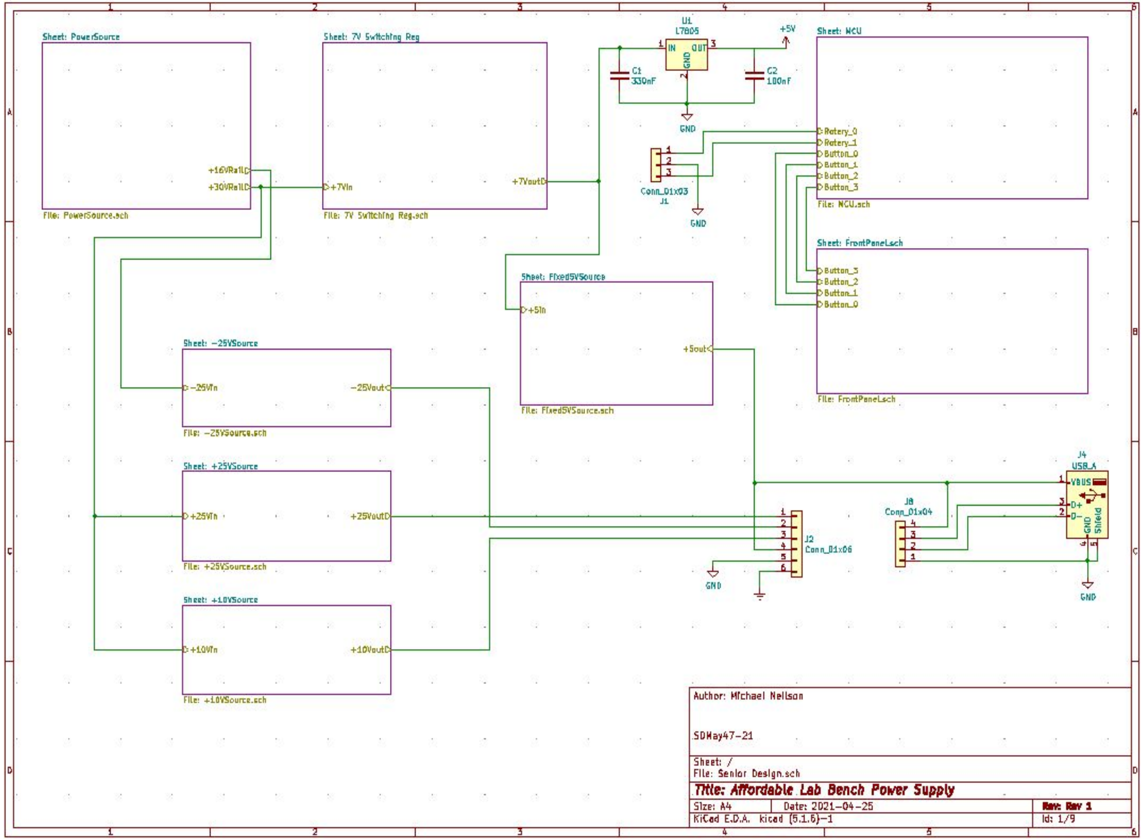


Part Selection

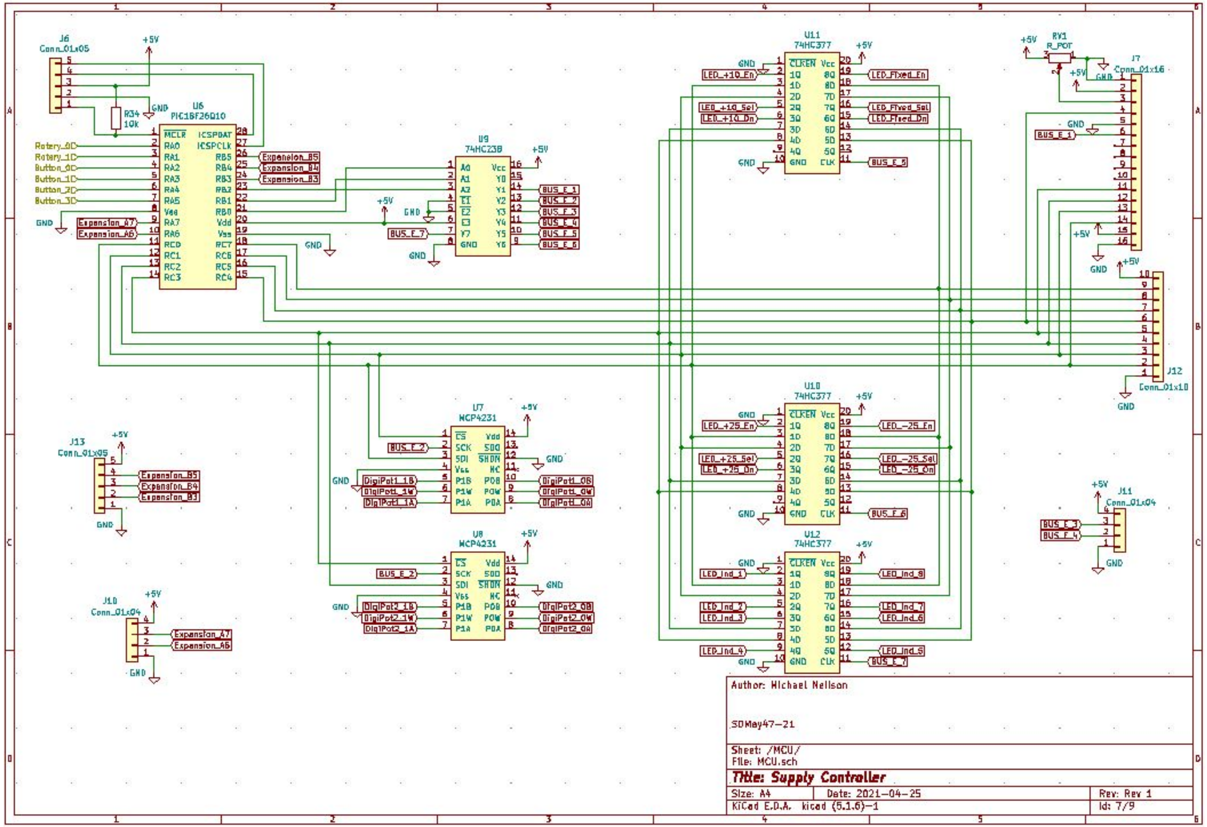


- Microcontroller (PIC18F26Q10)
  - Adequate amount of I/O pins for our needs
  - Internal oscillator
  - Team member had experience with this microcontroller
- 2 to 25 VDC switching regulator (LM2595TADJG)
  - Needed ~30V input with 2-25V at 1A output
  - Many affordable options, through-hole selected
- -2 to -25 VDC switching regulator (LT1931ES5#TRPBF)
  - Difficult to find a part meeting specs
  - Forced to choose surface mount part with 16V max input
- 1 to 10 VDC switching regulator (LMR14010ADDCR)
  - Needed ~30V input with 1-10V at 1A output
  - Difficult to find requirements, forced to choose surface mount part

Schematic (High level)

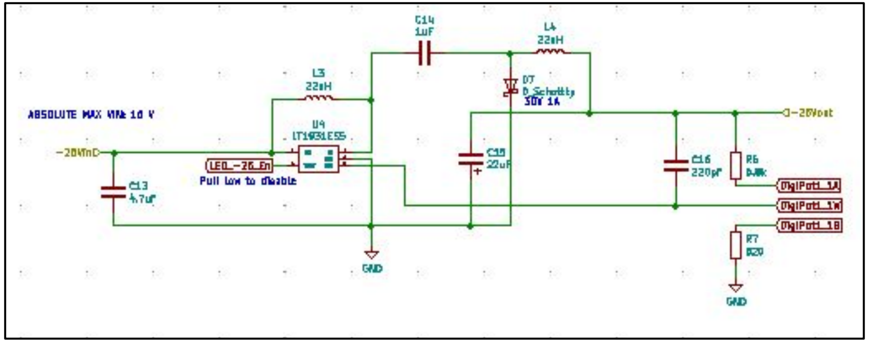


Schematic (MCU)

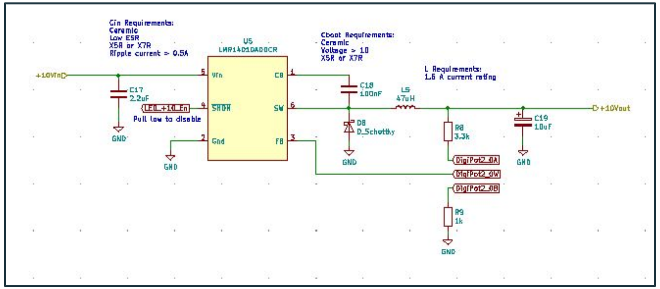


Schematic (Regulators)

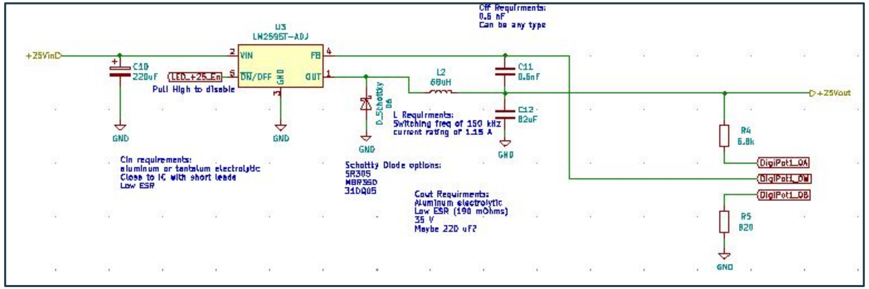
-2V to -25V



1V to 10V



2V to 25V

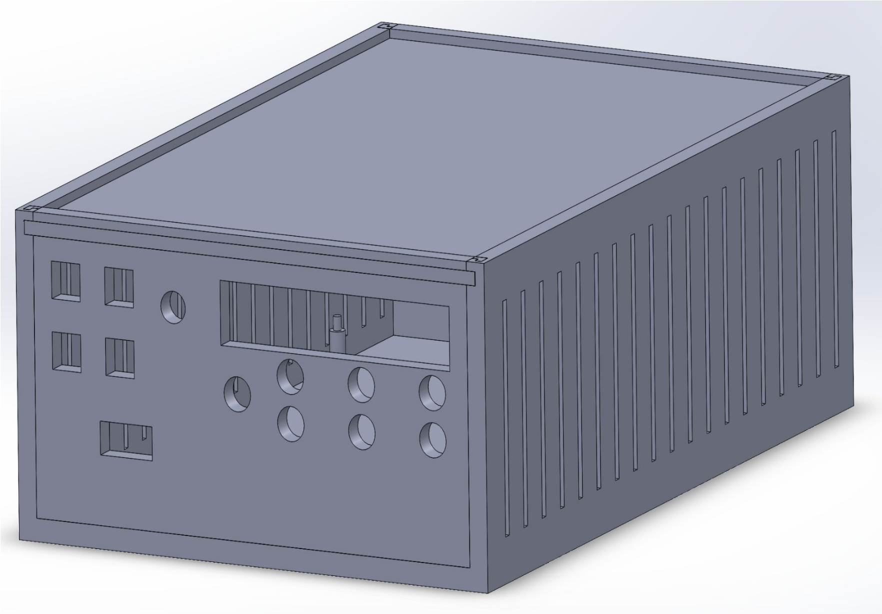


PCB Design

- 4.6 x 4.5in (118 x 115mm)
- Board Stack-up
    - Top- Signal
    - In1- Ground
    - In2- Power
    - Bottom- Signal

Enclosure

- Five parts that slide together to allow easy access to the inside and to build it.
- Chose 3D printing because we could be more specific with the interface, as well as pegs for the PCB to be held by.



Unit Testing

- Tested each individual component separately to verify each component's functionality
- Voltage regulator ICs
    - Built the designed schematic on a breadboard
    - Tested it using a lab supply as input and a multimeter to read the voltage output.
- During the initial run of testing, we used standard analog potentiometers in place of the digital potentiometers in the design.
    - Prefer to use the digital potentiometers during interface testing as well.

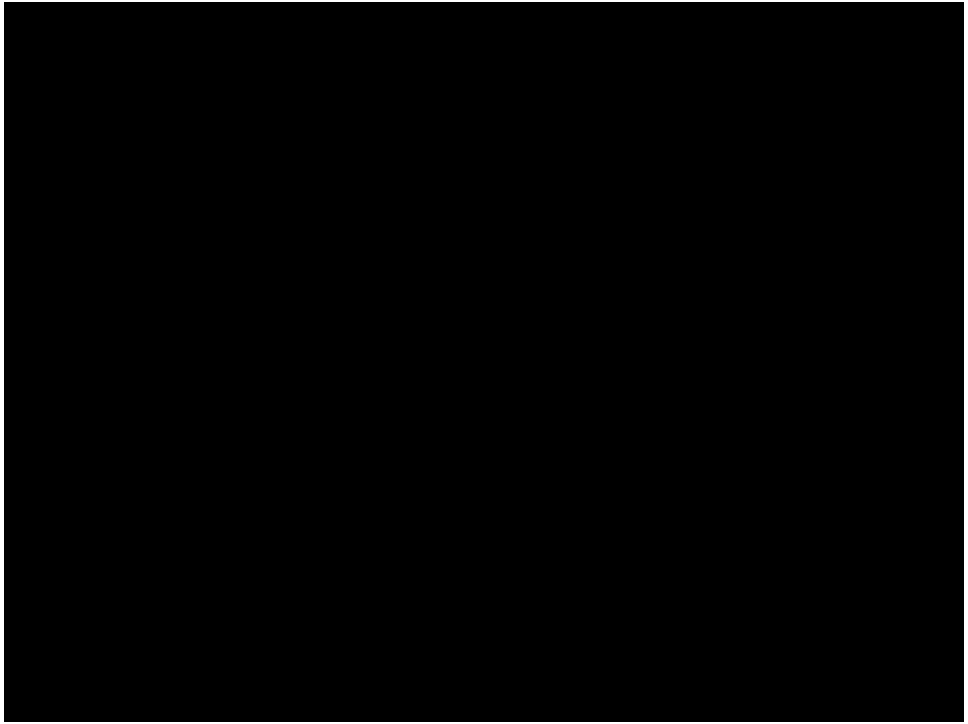
Interface Testing

- LCD, rotary encoder, and push buttons tested with the working voltage regulator circuits
- Confirmed push buttons select voltage output to change
- Confirmed rotary encoder changes voltage level
- Confirmed LCD displays relevant information

Acceptance Testing

- Our acceptance testing for the power supply is done by testing each output voltage and current levels with a multimeter to ensure the voltage ranges are correct.
- Tested the system with the microcontroller and digital potentiometers.
- PCB is needed to complete most the testing, and we encountered an issue with our PCB order and have not received the PCB. The results that we have received thus far have been very good and expect nothing less from the PCB design.

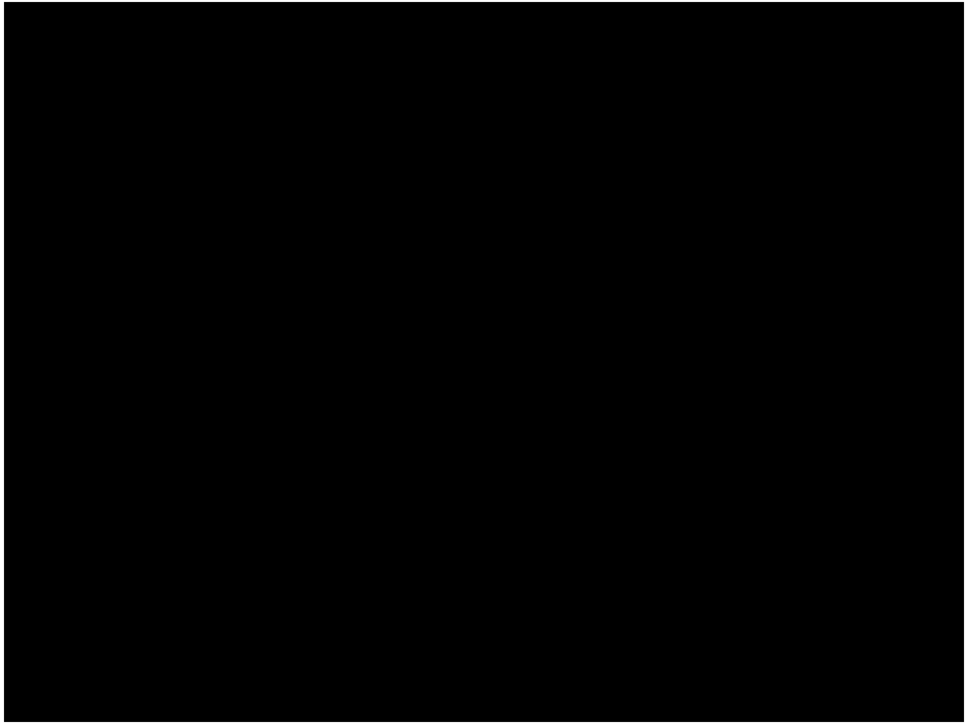
Demonstration (1 to 10 VDC Output)



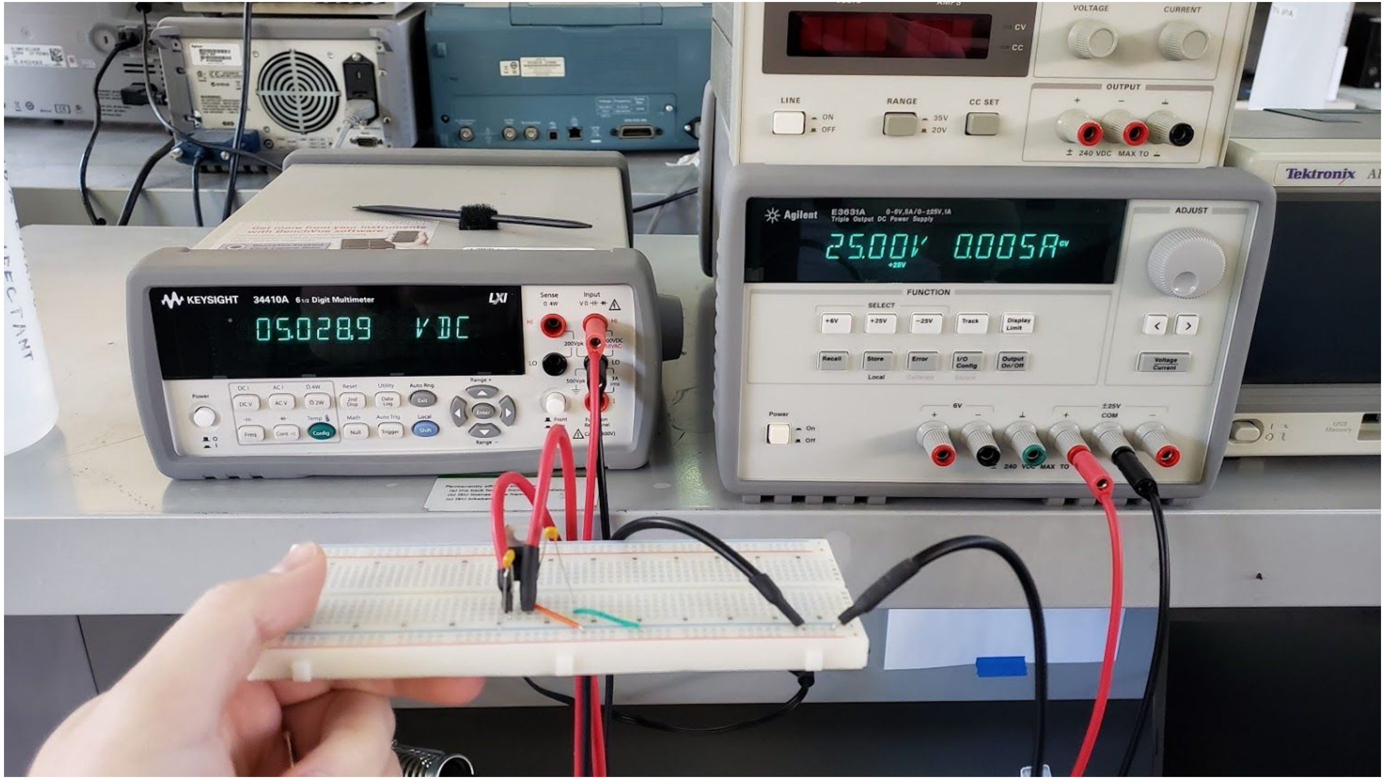
Demonstration (-2 to -25 VDC Output)

- PCB was not going to arrive in time for testing
- Decided to demo individual outputs in its absence
- Negative output worked during initial unit testing, but did not work when we recorded demos this week
    - Did not have enough lab time to thoroughly troubleshoot the issue as plan was just to record demos
- Confident that output would work on PCB

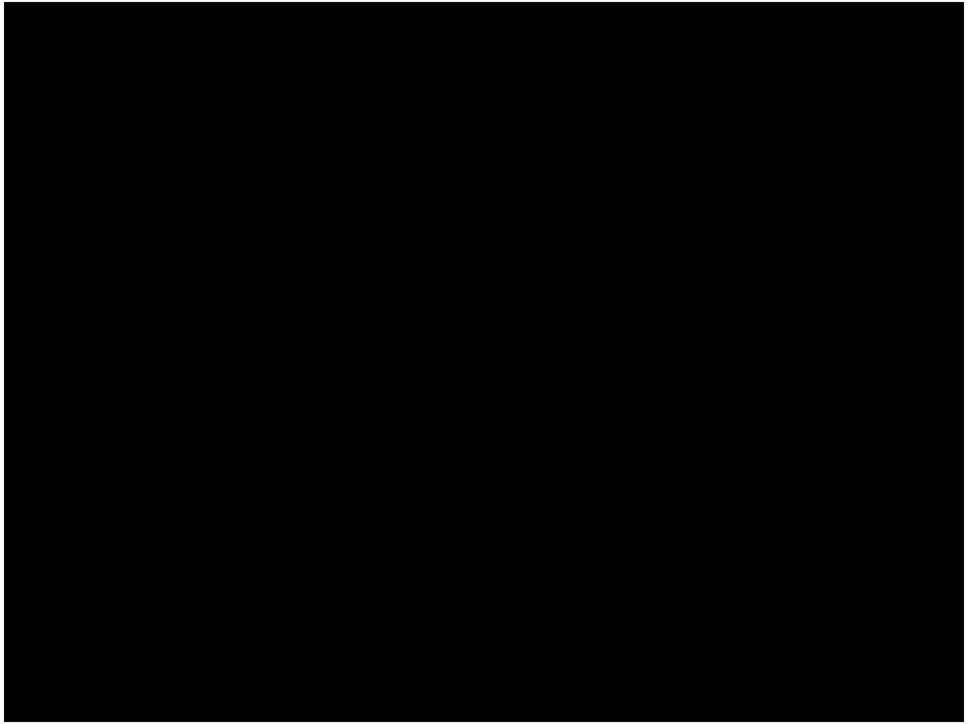
Demonstration (2 to 25 VDC Output)



Demonstration (5VDC Fixed Output)



Demonstration (Rotary Encoder)



Conclusion

- Final approximate price per unit including PCB and casing: $95
- Below price requirement of $100
- Significantly cheaper than market quad-output power supplies

Group Members and Roles

- Ben Almquist- Test Engineer
- Mary Le- Test Engineer
- Michael Neilson- Technical Expert
- Adam Simodynes- Team Leader
- Krishan Sritharan- Report Manager
- Chance Webster- Meeting Facilitator