LINEAR BENCH POWER SUPPLY — A WORK IN PROGRESS

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Introduction

This linear bench power supply was designed to complement any hobbyist's lab. It features a ±12V DC output for both positive and negative rails, as well as a 6V AC output or a 12V center-tapped (CT) AC output.

The goal of this project for me was to see how far my skills have grown, how much I can push myself to be better at what I do, and to identify what I need to master.

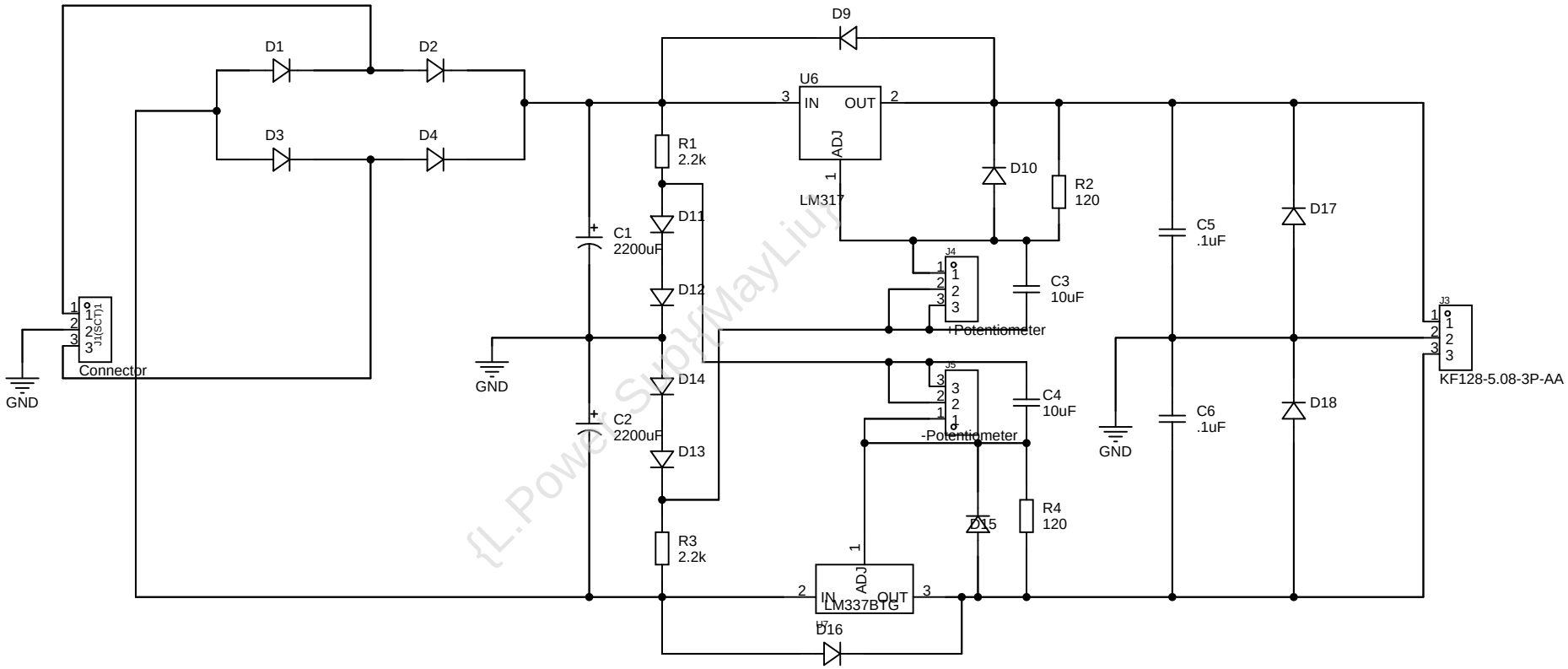
This project is currently a work in progress, and further modifications are expected beyond the interview submission date.

DC Dual Rail Schematic

The schematic was designed using **EASYEDA**, with the intention of ordering the final PCB from their platform.

The design incorporates a full-bridge rectifier to convert the transformer's 24VAC output to DC. Filter capacitors are used for smoothing the DC output. The **LM317** IC regulates the positive rail, while the **LM337** regulates the negative rail.

General-purpose **1N4001 diodes** are used in the rectifier circuit. Filter capacitor ratings were chosen to be three times the expected voltage output to ensure reliability and safety.



Schematic	Schematic1	Update Date	2024-12-05
		Create Date	2024-11-11
Page	P1	Part Number	JLCPCB-002
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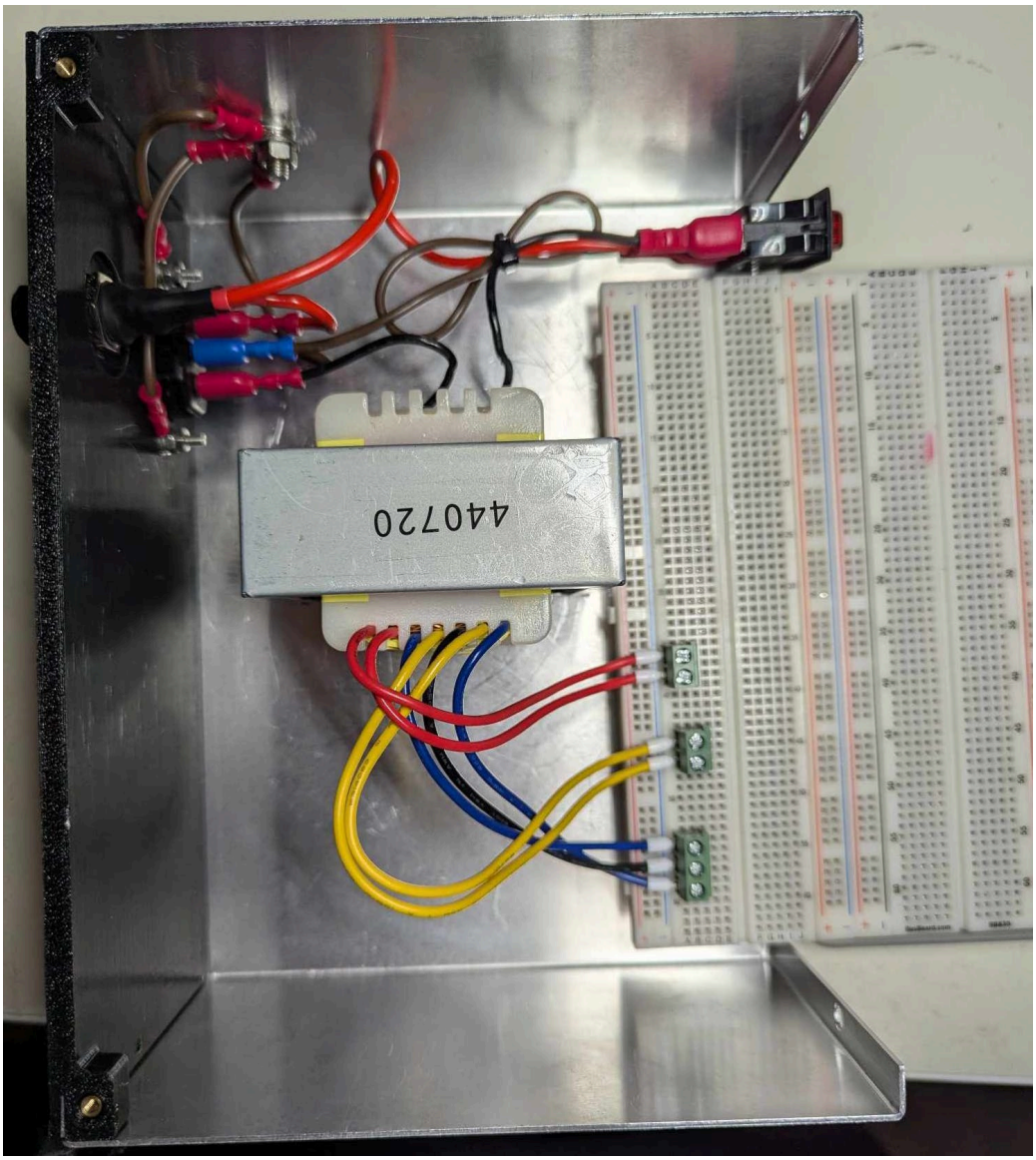
EasyEDA	V0.1	A4	

Testing Preparation

Due to the nature of this project, it was crucial to take proper safety precautions. Wires were crimped to sheathed ring connectors, all exposed metal parts were grounded, and a 1A fuse was installed on the back panel.

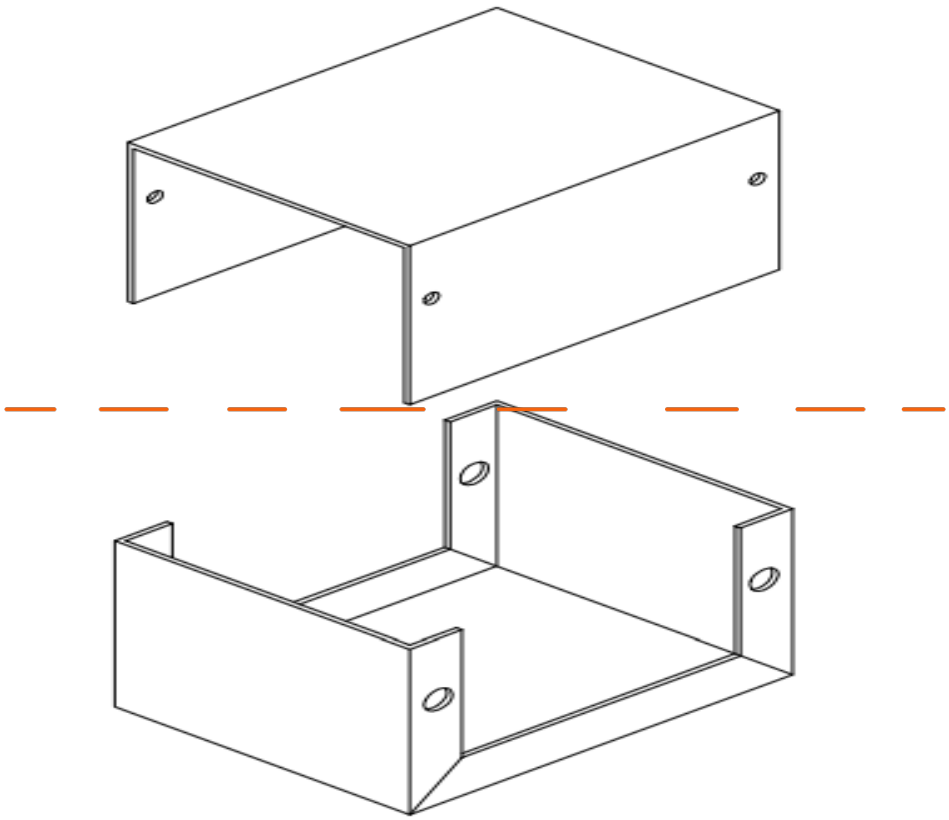
With that in place, I had mains isolated from my test area, and the fuse for protection.

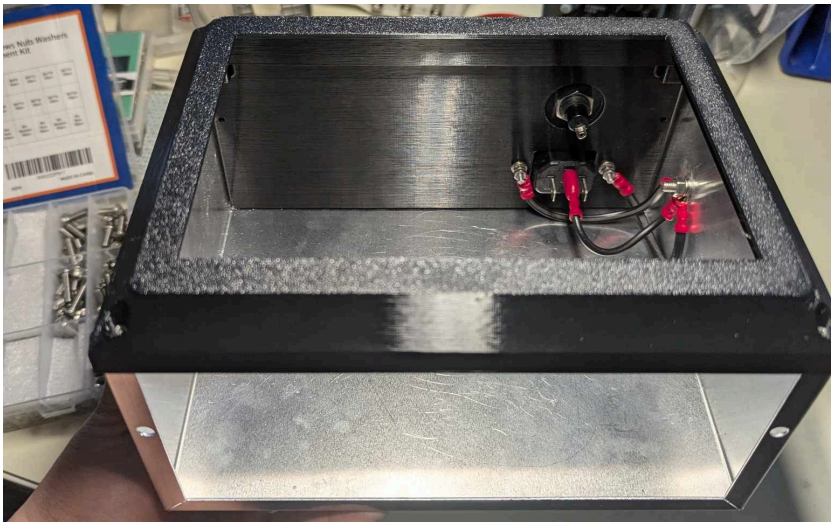


Enclosure Design

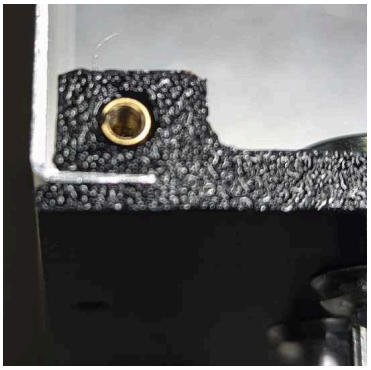
The enclosure was designed in SolidWorks with the limitations of the FDM 3D printer in mind. 45-degree angles were necessary to avoid drooping of bridges, and a tolerance of +/-0.3mm was applied to account for measurement discrepancies.

The enclosure utilizes half of a 6x8 inch aluminum enclosure found on digikey. The intention was to split the cost of the project by only utilizing one half of the enclosure and saving the other half for future projects.





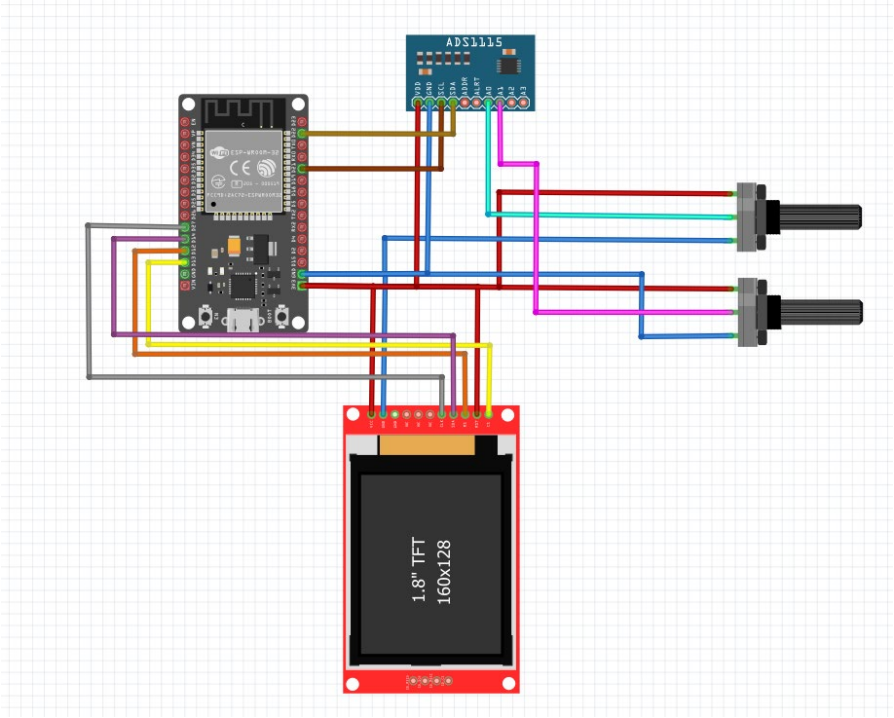
M3 threaded inserts installed

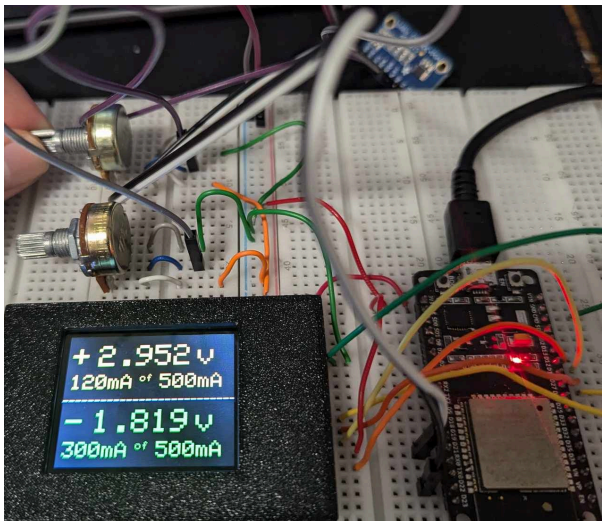


Files for the enclosure design may be accessed through my thingiverse!

Display

The goal was to have a display for the DC rails that could accurately measure the voltage down to 3 decimal places. The ESP32 S2 was selected because of its availability and its fast response in updating the display compared to the Arduino modules on hand.





Coding

An external analog to digital conversion is done via an ADS1115 module.

The ADS1115 is a 16-bit ADC with 0.1875mV/step

Conversion formula is ADC_{Raw}*0.1875mV

Divided by 1000 to convert mV to V.

```
void loop() {
  // Read ADS1115 values
  pos_voltage = ads.readADC_SingleEnded(0) * 0.1875 / 1000; // Convert to volts
  neg_voltage = ads.readADC_SingleEnded(1) * 0.1875 / 1000;
  Serial.println(ads.readADC_SingleEnded(0));
  Serial.println(ads.readADC_SingleEnded(1));
  // Update Display
  updateVoltageDisplay(pos_voltage, 30, 10, ST77XX_YELLOW, true); // Update positive voltage
  updateVoltageDisplay(neg_voltage, 30, 75, ST77XX_GREEN, false); // Update negative voltage

  delay(100); // Optional: Adjust refresh rate
}
```

With it being able to accurate display voltages in real time without visible flickering. Conditions were also placed stabilize the display, so the 3rd decimal doesn't update from 0.001v voltage fluctuations.

```
void updateVoltageDisplay(float voltage, int x, int y, uint16_t color, bool isPositive) {
  static float previous_pos_voltage = 0.0; // Track previous positive voltage
  static float previous_neg_voltage = 0.0; // Track previous negative voltage

  // Ignore negative voltages for positive displays
  voltage = abs(voltage); // Convert all voltages to positive

  float& previous_voltage = isPositive ? previous_pos_voltage : previous_neg_voltage;

  if (voltage < 0 || voltage == 0){
    voltage = 0.000;// Set to 0 if needed to avoid displaying a blank
    tft.setTextColor(ST77XX_BLACK, ST77XX_BLACK);
    tft.setCursor(x, y);
    tft.setTextSize(3);
    tft.print("      "); // Add enough spaces to clear old text

    // Print updated value
    tft.setTextColor(color, ST77XX_BLACK);
    tft.setCursor(x, y);
    tft.print(voltage, 3); // Limit to 3 decimal places
  }

  // Deadband filter to avoid frequent updates for small changes
  if (abs(voltage - previous_voltage) > 0.001) {
    previous_voltage = voltage;


    // Clear previous value by overprinting
    tft.setTextColor(ST77XX_BLACK, ST77XX_BLACK);
    tft.setCursor(x, y);
    tft.setTextSize(3);
    tft.print("      "); // Add enough spaces to clear old text

    // Print updated value
    tft.setTextColor(color, ST77XX_BLACK);
    tft.setCursor(x, y);
    tft.print(voltage, 3); // Limit to 3 decimal places
  }
}
```

Upcoming tasks for the Project:

1) Design a circuit that allows the ADS1115 to read negative voltages
2) Implement current limiting to the schematic
3) Decide between through hole or SMD PCB design
4) Purchase a differential probe