# Bench Power Supply Project Report

Bench PSU v1.0

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June 8, 2026

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**Abstract**

This document presents the development of **Bench PSU v1.0**, a custom bench power supply project designed for small electronics experiments, DC module testing, motor testing and general low-voltage project work. The project combines a DC input source, a buck converter module, fuse protection, panel-mounted output connectors, active cooling and a custom 3D printed enclosure. The main purpose of this project is to create a cleaner, safer and more practical power source for future electronics work while improving practical skills in wiring, soldering, enclosure design, component placement and project documentation.

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# 1 Project Overview

## 1.1 Project Summary

Bench PSU v1.0 is a compact bench power supply project designed to provide an adjustable DC output for testing small electronic circuits, modules and DC loads. Instead of using loose adapters and temporary jumper wire connections, this project aims to create a more organized and practical power supply unit inside a custom 3D printed enclosure.

The project uses a buck converter module as the main voltage regulation stage. The enclosure is designed and 3D printed specifically for this build. The design includes space for panel components, output connectors, fuse protection, airflow and active cooling.

The approximate amount of filament used for the enclosure is around **150 grams**. This value may change slightly depending on print settings, infill percentage, support material and later design revisions.

## 1.2 Purpose of the Project

The main purpose of this project is to build a practical power supply for small electronics projects and to gain hands-on experience in hardware design. This project is not only about making the circuit work electrically, but also about turning it into a usable physical device.

The project focuses on the following learning goals:

- Understanding how a buck converter can be used as a regulated DC output stage.
- Practicing safe wiring and power distribution inside an enclosure.
- Learning how to use fuse protection in a small power system.
- Designing a 3D printed enclosure for real electronic components.
- Improving soldering, mounting, cable management and documentation skills.
- Creating a project that can be shown as portfolio evidence.

## 1.3 Project Type

| | |
|---|---|
| **Category** | Hardware / Electronics Project |
| **Project Name** | Bench PSU v1.0 |
| **Project Status** | Prototype / In Progress |
| **Main Function** | Adjustable DC bench power supply |
| **Power Source** | It can works with max 32V 8A DC adapter but you should do some adjustments. For this project optimal value is 12V 5A |
| **Output Range** | 12V 5A *depends on input values* |
| **Enclosure Material** | 3D printed plastic, approximately 150g filament used |
| **Design Type** | Mixed system: electronics, wiring, cooling, enclosure and panel layout |

Table 1: General project information

# 2 Main Features

The main features of Bench PSU v1.0 are listed below:

- Adjustable DC output using a buck converter module.
- Fuse protection for safer operation during faults.
- Panel-mounted output connectors for easier use.
- Active cooling to improve thermal behavior inside the enclosure.
- Custom 3D printed enclosure designed for the project.
- Organized internal wiring compared to temporary adapter-based setups.
- Portfolio-ready documentation with photos, files and technical explanation.

## 2.1 Adjustable DC Output

The project uses a buck converter module to step down and regulate the input voltage. This allows the power supply to provide an adjustable output voltage for testing different types of small electronic devices.

The adjustable output is useful for:

- Testing small DC motors.
- Powering Arduino or similar modules.
- Testing LED circuits.
- Powering low-voltage electronics experiments.
- Checking small modules before integrating them into larger projects.

## 2.2 Fuse Protection

A fuse is included in the design to improve safety. If a serious fault or short circuit occurs, the fuse is expected to open the circuit and reduce the risk of damage to the power supply, wiring or connected components.

The fuse is especially important because this project is designed for experimental use, where incorrect wiring or accidental short circuits can happen during testing.

## 2.3 Active Cooling

Active cooling is planned or included to keep the buck converter and internal components cooler during operation. Since the electronics are placed inside a printed enclosure, airflow must be considered carefully.

The cooling system helps with:

- Reducing heat buildup inside the enclosure.
- Improving reliability during longer use.
- Supporting higher load conditions more safely.
- Preventing the enclosure from becoming unnecessarily hot.

## 2.4 Custom 3D Printed Enclosure

The enclosure is designed specifically for this project. It gives the build a cleaner and more finished structure compared to leaving the module and wires exposed.

The approximate filament usage is **150 grams**. This makes the enclosure relatively lightweight while still providing enough structure for mounting components.

The enclosure design considers:

- Component placement.
- Panel layout.
- Cooling airflow.
- Mounting holes.
- Cable routing.
- Ease of access during assembly.

# 3 Components and Materials

The following table lists the main components used or planned in the project. Some values should be updated after final assembly.

| Component | Quantity | Purpose |
|---|---|---|
| DC Power Adapter | 1 | Provides input power to the system. 12V 5A |
| Buck Converter Module | 1 | Regulates the input voltage and provides adjustable DC output. |
| Fuse / Fuse Holder | 1 | Provides protection during fault or short circuit conditions. |
| Panel Output Connectors | 2 | Used for connecting external circuits or devices. |
| Cooling Fan | 1 | Provides airflow inside the enclosure. 3.7V drone motor. |
| Switch | 1 | Used for turning the system on or controlling part of the circuit. |
| Panel Display / Meter | 1 | Displays voltage/current if included in the final design. |
| 3D Printed Enclosure | 1 | Holds all main parts inside a custom physical structure. |
| Filament | Approx. 150g | Used for printing the enclosure. |
| Wires and Heat Shrink Tubing | As needed | Used for internal connections and insulation. |
| Screws / Mounting Hardware | As needed | Used to secure components and enclosure parts. |
| batteries / AA Holders | 2 each | Used to power feed cooling system. |

Table 2: Main components and materials

### 3.1 Material Usage

The enclosure used approximately **150 grams of plastic filament**. This value is useful for documenting the physical cost and material requirement of the project.

The final material consumption depends on:

- Wall thickness.
- Infill percentage.
- Support material.
- Number of failed or revised prints.
- Final enclosure dimensions.

## 4 Design Approach

### 4.1 Electrical Design

The electrical design is based on a DC input source connected to a buck converter module. The buck converter is responsible for regulating the output voltage. The output is routed to panel connectors so that external circuits can be connected more easily.

A simplified expected power path is:

1. DC input source provides power.
2. Input power passes through protection elements.
3. Buck converter regulates voltage.
4. Output is sent to panel connectors.
5. Cooling system helps control temperature inside the enclosure.

## 4.2 Mechanical Design

The mechanical structure is based on a custom 3D printed enclosure. The enclosure is designed to hold the buck converter, connectors, fuse holder, fan and other panel components in a cleaner arrangement.

The mechanical design focuses on:

- Keeping the front panel usable.
- Preventing loose wires and exposed components.
- Leaving enough space for airflow.
- Making the device easier to move and store.
- Improving the visual quality of the project.

## 4.3 Design Constraints

The project has several practical design constraints:

- The enclosure must fit all internal components.
- The buck converter needs enough airflow.
- Wiring must be thick enough for the expected current.
- The fuse rating must match the expected use case.
- Plastic enclosure material should not be exposed to excessive heat.
- Panel holes must match the actual dimensions of connectors and switches.
- The design should be printable without unnecessary material waste.

# 5 Circuit and Wiring

## 5.1 Circuit Diagram

| coming soon |
|---|

Figure 1: Circuit or wiring diagram of Bench PSU v1.0

## 5.2 Circuit Explanation

The input voltage enters the system through the main power input connector. From there, the power is routed toward the regulation and protection stages. The buck converter module adjusts the voltage to the desired output level. The regulated output is then connected to panel-mounted output terminals.

The fuse is included to provide protection in case of serious faults. If the current exceeds the fuse rating for long enough, the fuse should open the circuit and disconnect the output.

# 6 Calculations

## 6.1 Estimated Output Power

The expected output power depends on the buck converter settings and load.

$$P_{out} = V_{out} \times I_{out}$$

Example:

$$P_{out} = 12V \times 5A = 60W$$

## 6.2 Plastic Material Usage

The enclosure used approximately:

$$m = 150g$$

This is useful for estimating the material cost of the enclosure.

If the filament spool is 1000g, then the percentage of spool used is:

$$\frac{150}{1000} \times 100 = 15\%$$

Therefore, the enclosure used approximately **15% of a 1kg filament spool**.

# 7 Build Process

## 7.1 Step 1: Planning

The first step was planning the general layout of the power supply. The required functions were determined: adjustable output, protection, cooling, output connectors and enclosure design.

## 7.2 Step 2: Component Selection

The main components were selected according to the target use case. A buck converter module was chosen for voltage regulation because it is compact and practical for small bench power applications.

## 7.3 Step 3: Enclosure Design

The enclosure was designed to fit the electronic components and panel elements. The main challenge was leaving enough space for connectors, wiring, airflow and mounting.

The enclosure was then 3D printed. The approximate plastic usage was around **150 grams**.

## 7.4 Step 4: Assembly

The components were placed inside the enclosure. Panel components such as output connectors, fuse holder, switch and display elements were planned or mounted depending on the current stage of the project.

TODO: Add final assembly photos and notes.

## 7.5 Step 5: Testing

The final step is testing the power supply with real loads, checking output voltage stability, heat behavior, wiring safety and fuse behavior.

TODO: Add final test results.

# 8 Testing

## 8.1 Test Setup

The following test methods should be used to verify the project:

- Continuity test using a multimeter.
- Output voltage measurement.
- Output current test under load.
- Fan operation test.
- Temperature observation during use.
- Fuse behavior check under safe test conditions.

## 8.2 Test Results

| Test | Expected Result | Measured Result | Status |
|---|---|---|---|
| Input Voltage | TODO | TODO | TODO |
| Output Voltage Range | TODO | TODO | TODO |
| Output Current Test | TODO | TODO | TODO |
| Continuity Test | Correct wiring | TODO | TODO |
| Fan Test | Fan operates normally | TODO | TODO |
| Temperature Test | Safe operating range | TODO | TODO |
| Fuse Protection | Opens circuit during fault | TODO | TODO |

Table 3: Hardware test results

## 8.3 Problems and Fixes

Write the problems encountered during the project and how they were fixed.

Possible examples:

- Problem: Panel holes did not fit perfectly.
- Fix: Adjusted the enclosure design and used heat to help parts fit.
- Problem: Wiring space was too tight.
- Fix: Improved internal layout and cable routing.
- Problem: Cooling airflow was not enough.
- Fix: Added or repositioned fan openings.

# 9 Visual Documentation

Add photos of the project.

Add front view photo here

Figure 2: Front view of Bench PSU v1.0

Add internal layout photo here

Figure 3: Internal layout and wiring

Add testing photo here

Figure 4: Testing process

# 10 Limitations

The current version has several limitations:

- The project is still a prototype and may require further testing.
- The enclosure may need tolerance improvements after final fitting.
- Thermal performance must be tested under longer load conditions.
- The real output current limit should be verified with measurements.
- Fuse rating and wiring thickness should be confirmed according to the final current target.
- Internal cable management can be improved in later revisions.
- The final documentation needs real photos, diagrams and measurement results.

# 11 Future Improvements

Possible improvements for future versions:

- Add clearer labels for voltage, current, input and output sections.
- Improve cable routing inside the enclosure.
- Add more airflow holes or a better fan placement if needed.
- Add final wiring diagram and measurement photos.
- Add proper load test data.
- Improve the enclosure based on assembly experience.
- Create a cleaner front panel layout.
- Add versioned documentation for future revisions.

# 12 Conclusion

Bench PSU v1.0 is a practical electronics project that combines power regulation, protection, cooling and enclosure design. The project helped improve hands-on understanding of electronics, wiring, soldering, 3D printing and technical documentation.

The project is valuable not only as a usable bench tool, but also as portfolio evidence because it demonstrates the process of turning loose electronic components into a more complete physical device. Future work will focus on measurement results, final wiring documentation, better cable management and improved visual documentation.

## 13 Links

- Portfolio Page: https://canturkege.github.io/Website/bench-power-supply.html
- GitHub Profile: https://github.com/CanturkEge
- LinkedIn Profile: https://www.linkedin.com/in/ege-cant%C3%BCrk-461910365/