HOLY ANGEL UNIVERSITY
Electronic Circuits Laboratory
S.Y. 2023-204
2nd Semester

TITLE:

Design and Analysis of a 36V Variable DC Power Supply

PREPARED BY:

Alcantara, Jodi Moselle
De Jesus, John Michael
Sanchez, Helaena
Tan, Audrey
To, Miah Angela

PREPARED FOR:

Engr. Cherry Ann Navarro

DATE:

April 15, 2024

HOLY ANGEL UNIVERSITY
Electronic Circuits Laboratory
S.Y. 2023-204
2nd Semester

TABLE OF CONTENTS

INTRODUCTION

The design and analysis of power supply systems are important in different applications, as well as electrical systems, renewable energy systems, and nuclear fusion plants. The goal of this Theoretical Study on Power Systems is to give a full understanding of the design principles, operating mechanisms, and performance optimization strategies that are essential for developing efficient and lasting power supply systems in different areas of use.

In addition, an important component of ensuring the continuous operation of different loads is a power supply system in electric systems. The power supply system shall be responsible for delivering the required voltage and level of output to the load, with a view to ensuring that it is functioning in accordance with the limits laid down. The detection of current and voltage levels in the system by transformers as well as their management via programmed interface controllers are two theoretical approaches to analyze power disruptions in electric systems. Transformers change the power entering the circuit, while a programmed interface controller monitors and controls system operation (Mishra et al., 2021).

Furthermore, to ensure a stable and reliable supply of electricity, renewable energy systems are integrated with diesel power stations based on renewable energy sources such as wind and solar. In order to determine the least cost alternatives for supplying electric power to target sum centers, planning methods and a preliminary study of supply plans are important. Renewable energy's potential is revised in order to increase its reliability and precision, as well as the types of power supply facilities are determined on the basis of current and projected costs for each stage (JICA, 2017).

Besides that, in nuclear fusion plants, the electrical power systems are a critical component of the plant's design. In order to ensure that the power plant is operating in accordance with the defined limits, electrical systems shall have the responsibility of providing the required voltage and current levels of the facility's components. Caldora et al., (2021) describe the preliminary design of electrical power systems for DTT, a nuclear fusion power plant. The design includes the sizing of each device and power line, as well as defining operational parameters, energy flow calculations, or fault analysis. The power flow calculation allows for the definition and size of the needs for power factor compensation systems, while the fault analysis determines both the maximum and the minimum short-circuit levels in each node of the power distribution system (Falvo et al., 2021).

Overall, this theoretical research on power supply systems can help the researchers obtain deep insight into the system design, function mechanisms in the operation process, and the possibility of optimizing the system performance of different applications of the power supply systems. Specifically, it starts with the analysis of the electrical system, then continues with the focus on the feeding system of the renewable energy systems, and finally, it finishes with the analysis of the power supply system of the nuclear fusion plants, which covers deep analysis of the relevant material in the environment, the resonance topology, the load, and the possibility of renewable energy to supply the power.

SCHEMATIC IMPORTANCE AND CONFIGURATION

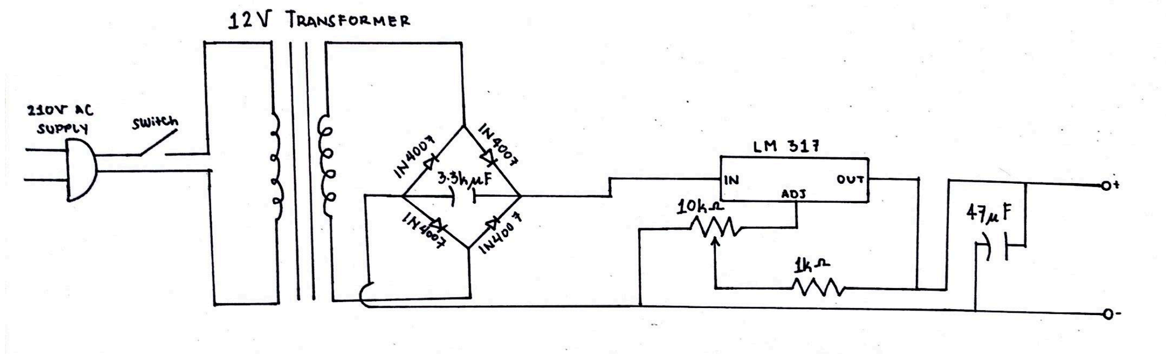


Figure 1: 36V Variable DC Power Supply Circuit Schematic.

The 36V variable DC power supply is shown in this schematic. A variable DC power supply is a type of electronic device that converts an unregulated AC mains voltage, like 120V or 240V, into stable direct current DC voltages that can be adjusted to the desired value. They've been extensively applied in electronics, where they serve as a constant voltage source for electrical circuits (Boydstad et al., 2020).

This schematic shows a simple circuit to adjust the power supply. It uses a voltage regulator to set a fixed DC voltage, a bridge rectifier to convert an AC voltage to DC voltage, a transformer to reduce an AC voltage, and capacitors to reduce any residual AC voltage ripple in the output voltage (Texas Instrument, n.d.).

HOLY ANGEL UNIVERSITY

Electronic Circuits Laboratory

S.Y. 2023-204

2nd Semester

The following is an outline of the circuit's design, based on a diagram and guidelines for adjusting power supply equipment:

- **Transformer (12V):** The transformer steps down the high-voltage AC mains supply (230V AC in the schematic) to a lower-voltage AC voltage (around 12V AC based on the label near the transformer). With this reduced AC voltage, the circuit is much easier to operate.

- **Bridge rectifier 4 x 1N4007 diodes:** The converter's AC voltage is converted to an unregulated DC voltage by four 1N4007 diodes, which are the bridge regulators. If the AC voltage is constantly changing polarity from positive to negative and vice versa, the bridge rectifier only allows an electric current to pass through a single circuit in either direction.

- **Capacitor (3300 µF):** Often referred to as a smoothing capacitor, this capacitor removes the pulsing feature of the bridge rectifier's DC voltage. The output voltage would not be stable, but it's still going to vary wildly and look like a wave pattern if this capacitor wasn't in place. This capacitor stabilizes the DC voltage input.

- **LM317 voltage regulator:** Applications shall be made for the purpose of determining a level at which an LM317 voltage regulator regulates DC voltages in capacitors, resistors, and potentiometers. The output voltage of the LM317 may be changed since it is an adapted, configurable regulator.

- **Capacitor (47 μF):** This capacitor, also referred to as a bypass capacitor, is intended for further removal of any high-frequency noise or remaining AC ripple that may exist in the voltage regulator output. In order to ensure a pure and constant output voltage, the capacitor also ensures that any such noise is attenuated to the ground.

- **Resistors (1kΩ and 10kΩ potentiometers):** These resistors are used in conjunction with the LM317 voltage regulator to modify output voltages. A 10kΩ potentiometer may be used to adjust the output voltage, while a resistance base of 1kΩ resistors is set. The resistance value can also be changed by turning the potentiometer's knob. The formula described above shall apply to this change in output voltage.

- **Switch:** The switch controls the electrical supply on and off.

All in all, this illustrates a simple circuit for an adjustable power supply. For the design, comprehension, and construction of electronic circuits, schematics are vital resources. The circuit's parts, connections, and operations are all clearly shown in order to produce the required power output..

STEPS AND PROCEDURES

QUANTITY	VALUES	COMPONENTS
1	12V	Transformer
4	1N4007	Diodes
2	3300 micro F 47 micro F	Capacitor
1	LM317	Voltage Regulator
1	-	Switch
1	-	Power Plug
1	-	Veroboard
1	10 kΩ	Potentiometer
1	1 kΩ	Resistor

STEP BY STEP PROCESS

1. **Prepare the Veroboard:**
    - Based on the schematic and scale of the veroboard, plan circuit design.

- Based on design, precut the solid core wires to appropriate lengths.

2. Assemble the Bridge Rectifier:

- Connect four 1N4007 diodes to a square pattern on the veroboard after configuration of the bridge rectifier in the diagram. The cathode (striped end) of one diode should connect to the anode (non-striped end) of the next diode in a continuous loop.

3. **Connect the Transformer:**

- Solder to designated points on the veroboard according to the diagram, the two wires from the secondary winding of the transformer, typically lower voltage AC outputs.

4. Connect the output of the bridge rectifier:

- According to the diagram, connect a positive DC output of the bridge rectifier to an area on this board.
- The ground GND of the veroboard is connected to the other output of the bridge rectifier, which is a negative DC.

5. **Capacitor (3300 µF):**
   - The veroboard position where the positive output of the bridge rectifier is connected is also the point where the positive leg of the 3300 µF capacitor is attached.
   - The veroboard's ground (GND) is connected to the capacitor's negative leg.

6. **Voltage Regulator (LM317):**
   - Three pins on the LM317 voltage regulator are labeled as adjust (ADJ), output (OUT), and input (IN). Below is a description of the LM317 pin from its datasheet. These pins will be labeled on the component itself as well.
   - Connect the LM317's input (IN) pin to the positive connection point, which is where the bridge rectifier output and 3300 µF capacitor are connected.
   - As shown in the schematic, solder the LM317's output (OUT) pin to a specified output location on the veroboard. It's the variable output voltage on the power supply.
   - Connect the adjust (ADJ) pin of the LM317 to a designated point on the veroboard according to the schematic.

7. **Resistors:**
   - Solder the 1kΩ resistor between the adjust (ADJ) pin of the LM317 and the positive connection point where the 3300 µF capacitor and bridge rectifier output are connected.
   - The 10kΩ potentiometer's leg should be soldered to the same positive connection point. On the veroboard, solder a potentiometer's other leg to the ground (GND).

8. **Capacitor (47 µF):**
   - Solder one of the 47 µF capacitor's legs to the LM317's output (OUT) pin.
   - On the veroboard, solder the capacitor's opposite leg to the ground (GND).

9. **Switch:**
   - The schematic uses DPDT switching. It can use the SPST switch if it only needs to shut down and off the power supply.
   - Attach one side of the switch, usually a live wire, to an outlet as shown in the diagram.

- Solder the other side of the switch to the positive input point on the veroboard where the bridge rectifier output and 3300 μF capacitor are connected.
- Solder the remaining terminal of the switch, common to the positive input pin of the transformer, typically the higher voltage AC input.

10. Power Plug:

- Connect the neutral wire from the power plug to the ground (GND) on the veroboard. Double check that the proper connections are made according to the schematic before proceeding.

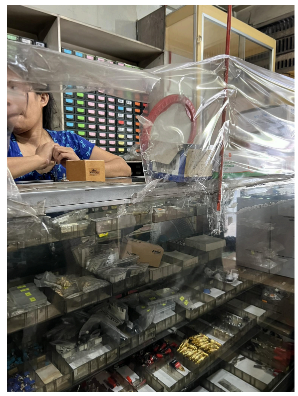
11. Final Touches:

- Double check for loose wires or shorts when all components are soldered and connected. Make sure all connections are secure, and follow the diagram.
- Attach the knob of the potentiometer to the shaft for easy adjustment of the output voltage.

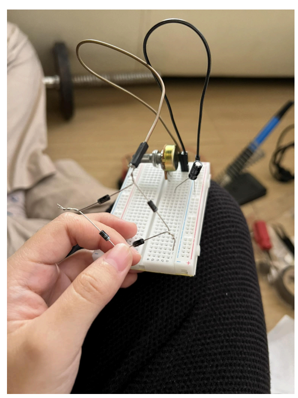
HOLY ANGEL UNIVERSITY
Electronic Circuits Laboratory
S.Y. 2023-204
2nd Semester

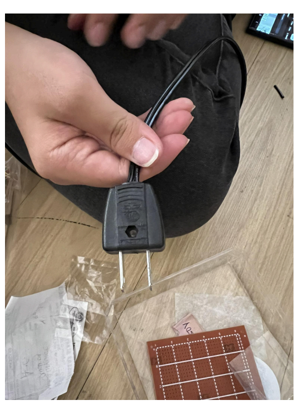
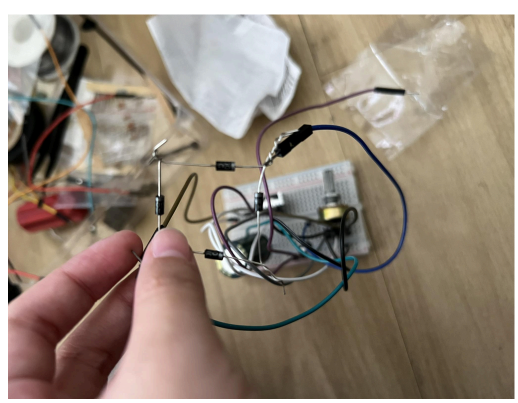
DOCUMENTATION

1. Purchasing of materials.

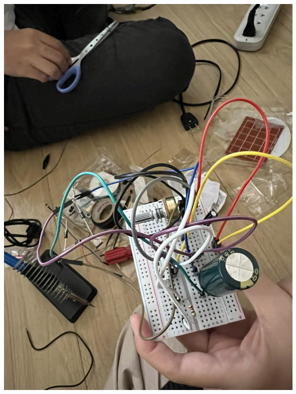


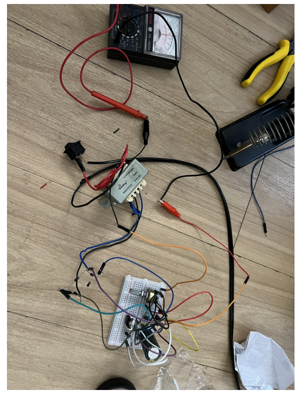
2. Component placement and interconnection of veroboard.

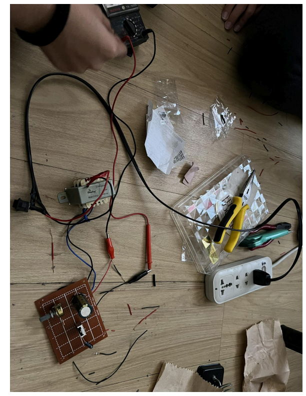



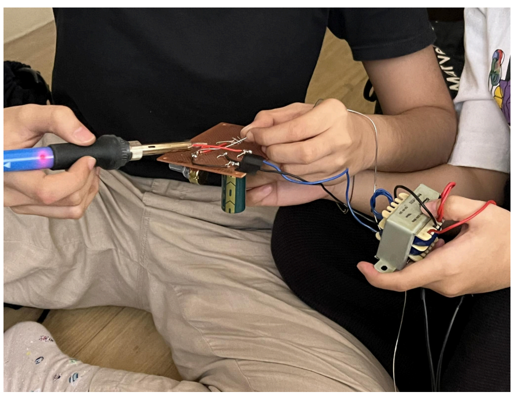



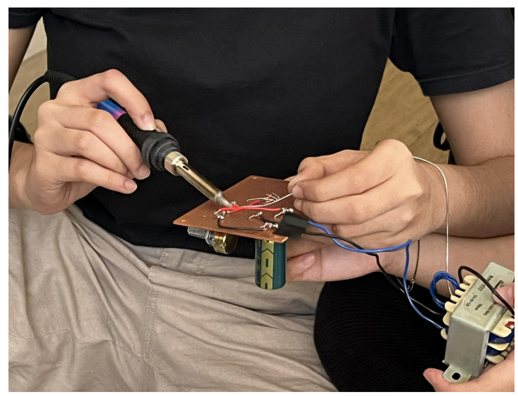
HOLY ANGEL UNIVERSITY
Electronic Circuits Laboratory
S.Y. 2023-204
2nd Semester











REFERENCES

Mishra, A., & Choudhary, A. (2021). THEORETICAL APPROACH TO STUDY THE POWER OUTAGES IN ELECTRICAL SYSTEM. International Journal of Creative Research Thoughts, 9(4), 984-986. https://ijcrt.org/papers/IJCRT2104137.pdf

Power Supply Design: Topologies and Theory. (2022). Retrieved from https://resources.pcb.cadence.com/blog/2022-power-supply-design-topologies-and-theory

Caldora, M., Falvo, M. C., Lampasi, A., & Marelli, G. (2021). Preliminary Design of the Electrical Power Systems for DTT Nuclear Fusion Plant. Applied Sciences, 11(12), 5446. https://www.mdpi.com/2076-3417/11/12/5446

"Preliminary Study on Power Supply Master Plan" (2023), Japan International Cooperation Agency (JICA). https://openjicareport.jica.go.jp/pdf/11597176_06.pdf

Texas Instruments. (n.d.). LM317 Adjustable voltage regulator. https://www.ti.com/product/LM317

Boylestad, R. L., & Nashelsky, L. (2020). Introduction to Electronic Devices and Circuit Theory. https://ia801603.us.archive.org/0/items/ElectronicDevicesAndCircuitTheory/Electronic%20Devices%20and%20Circuit%20Theory.pdf