Capital University of Science & Technology

WORKSHOP PROJECT REPORT

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DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

DECLARATION

It is declared that this is an original piece of our own work, except where otherwise acknowledged in text and references. This work has not been submitted in any form for another degree or diploma at any university or other institution for tertiary education and shall not be submitted by us in future for obtaining any degree from this or any other University or Institution.

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CERTIFICATE OF APPROVAL

It is certified that the project titled "Making of a 12V variable power supply" carried out by Minal Zahra , Haleema Tahir and Ateeq ur rehman .under the supervision of Sir Yasir Hussain, Capital University of Science& Technology, Islamabad, is fully adequate, in scope and in quality, as a final Semester 1 project for the degree of BS of Computer Engineering.

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ABSTRACT

This project report is about “The making of 12V variable power supply”. The main objective of this project was to be able to understand the basic working principle of power supply and how it transmits power ranging over different values. A 12V variable DC power supply is a type of power supply that allows the output voltage to be adjusted over a range of values. The AC-to-DC converter is used to convert the AC input voltage to a DC output voltage. The voltage regulator circuit is used to control the output voltage by adjusting the amount of current flowing through the load. The adjustment mechanism, such as a potentiometer, allows the user to adjust the output voltage. The display or meter is used to show the output voltage. To ensure safety and reliability, it is important to use high-quality components and follow proper design and assembly techniques.

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Chapter 1:

1.1 Introduction:

A variable DC power supply is an essential component of any power supply unit utilized in any electronic devices. It serves as an interface between the utility and the majority of power electronic devices. A line frequency diode bridge rectifier is often used to convert line frequency ac to dc. A large filter capacitor is utilized at the rectifier output to decrease ripple in the dc output voltage. However, because of the big capacitor, the current drawn by this converter is peaky and immature. This input current has a lot of low order harmonics. Furthermore, as power electronics equipment is widely employed in power conversion, low order harmonics are introduced into the utility. The existence of these harmonics causes a high total harmonic distortion and a low input power factor. Due to issues with low power factor and harmonics, utilities may impose harmonic standards and guidelines that will restrict the amount of current distortion permitted into the utility, and so simple diode rectifiers may not be used. As a result, there is a requirement to accomplish rectification with a power factor near to unity and minimal input current distortion.

1.2 Project idea:

The circuit depicted is for a typical industrial project, and it demonstrates how the batteries take control during an interruption in electrical supply or a variation beyond the normal limits of the voltage line, without interfering with the operation by providing a steady regulated output (5 Volts by U1-7805) and an unregulated supply (12 Volts). The transformer's primary winding (TR1) receives 220V as an input. If the value is at least 12 Volts and the current is 3 amps, the secondary winding can be increased to 15 Volts. The Resistor (R1) functions as a tiny circuit breaker to guard against short circuits or a faulty battery cell. The presence of power causes the LED 1 to illuminate. When there is a power outage, the LED light will turn on, and the batteries will take over.

The circuit was created to provide a more flexible pattern that can be adjusted by using different regulators and batteries to provide regulated and unregulated voltages. A 5V supply may be controlled by using 12 Volt batteries in a positive input 7805 five regulator.

1.3 Purpose of the Project:

The purpose of making a 12V variable DC power supply is to provide a regulated and adjustable DC voltage output that can be used to power electronic devices or circuits that require a specific voltage level. Some common applications for a 12V variable DC power supply include:

Testing and troubleshooting electronic circuits and devices that require a 12V DC power supply.

- Powering electronic devices such as radios, amplifiers, and other consumer electronics that require a 12V DC power supply.
- Powering automotive and industrial equipment that require a 12V DC power supply.
- Powering laboratory equipment and test setups that require a precise and adjustable DC voltage.
- Powering LED lights and other low voltage DC devices.

A variable DC power supply is useful because it allows the output voltage to be adjusted to suit the specific requirements of the device or circuit being powered, which is particularly useful in development and testing phase of electronic project. Additionally, it allows to monitor and read the voltage being supplied to the device or circuit being powered.

1.4 Organization of report:

In our project report we have a total of 5 chapters. The first chapter describes a brief introduction and basic working principle of a 12V variable dc power supply. The second chapter tells about the literature review of our project.

Whereas our chapter 3 & 4 shows us about the methodology and analysis of our project. And finally chapter 5 which is the conclusion of our project report with all of our findings in it.

Chapter 2:

2.1 Literature Review:

A literature review on 12V variable DC power supplies would involve researching and analyzing existing studies, articles, and other sources of information on the topic. Some key areas of focus in a literature review on 12V variable DC power supplies might include:

2.1.1 Design and construction:

This would involve researching and analyzing the various circuit designs and component choices that are used to construct 12V variable DC power supplies. This could include information on the use of different types of voltage regulators, transformer and rectifier designs, and other circuit elements.

2.1.2 Efficiency and performance:

This would involve researching and analyzing the performance and efficiency of different 12V variable DC power supply designs. This could include information on the output voltage regulation, ripple and noise, and overall power efficiency of different designs.

2.1.3 Applications:

This would involve researching and analyzing the various applications for 12V variable DC power supplies. This could include information on the use of 12V variable DC power supplies in industrial, automotive, and consumer electronic applications, as well as in laboratory and test setups.

2.1.4 Safety and reliability:

This would involve researching and analyzing the safety and reliability of different 12V variable DC power supply designs. This could include information on the use of protection circuit like fuse and over voltage protection, and the impact of different design choices on the overall safety and reliability of the power supply.

2.1.5 Advancement and new trends:

This would involve researching and analyzing the new trends and advancements in 12V variable DC power supply designs and technologies. This could include information on the use of new materials, semiconductors, and other components to improve the performance, efficiency and safety of 12V variable DC power supply.

Overall a literature review would provide an overview of the current state of the art and identify the gaps in knowledge and future direction of research on the topic.

2.2 Related Technologies:

There are several related technologies to 12V variable DC power supplies that are used in conjunction with or as alternatives to traditional power supply designs. Some of these include:

2.2.1 Switching power supplies:

These are power supplies that use switching technology to convert AC or DC input voltage to a regulated DC output voltage. They are generally more efficient than linear power supplies, and are often used in applications where high efficiency and small size are important.

2.2.2 Battery charging and management systems:

These systems are used to charge and manage batteries, and are often used in applications where a reliable and constant DC voltage is required, such as in portable electronic devices and electric vehicles.

2.2.3 Solar power systems:

These systems use photovoltaic cells to convert sunlight into electricity and are often used as a source of power in remote or off-grid applications.

2.2.4 DC-DC converters:

These are devices that convert one DC voltage to another, and are often used to step up or step down voltage levels in a circuit. They are frequently used in portable electronic devices and vehicles.

2.2.5 DC-AC inverters:

These devices convert DC voltage to AC voltage and are widely used in renewable energy systems, uninterruptible power supplies, and other applications where AC power is required.

These technologies often complement or combined with 12V variable DC power supplies to provide a reliable, efficient, and stable power supply, especially in renewable energy system, portable device and automobiles.

2.3 Limitation and Bottlenecks of the related technologies:

2.3.1 Switching power supplies:

It has high efficiency and small size, but may produce radio frequency interference.

2.3.2 Battery charging and management systems:

It ensures a reliable and constant DC voltage, but may have limitations on the types and capacity of batteries they can charge.

2.3.3 Solar power systems:

It is efficient in remote or off-grid applications, but may be affected by weather conditions.

2.3.4 DC-DC converters:

They can step up or step down voltage levels but may have efficiency loss.

2.3.5 DC-AC inverters:

They are widely used in renewable energy systems and uninterruptible power supplies but may have limitations on the power output or efficiency.

2.4 Summary:

In summary, a literature review on 12V variable DC power supplies would involve researching and analyzing existing studies, articles, and other sources of information on the topic in the areas of design and construction, efficiency and performance, applications, safety and reliability, and advancements and new trends. Related technologies such as switching power supplies, battery

charging and management systems, solar power systems, DC-DC converters, and DC-AC inverters are often used in conjunction with or as alternatives to traditional power supply designs. However, these technologies also have their own limitations and bottlenecks such as radio frequency interference, limitations on battery types and capacity, and weather dependency.

Chapter 3:

3.1 Proposed Design Methodology

The PCB design methodology for a 12V variable DC power supply typically involves several steps:

3.1.1. Schematic Design

The first step is to create a schematic diagram of the circuit, which shows the connections between all the components. This includes selecting the appropriate components, such as the voltage regulator, transistors, diodes, and capacitors, and determining the correct values for resistors and other components.

3.1.2. PCB layout

Once the schematic is completed, the next step is to create the layout for the PCB. This involves placing the components on the board in a way that minimizes the length of the traces and reduces the chance of interference. It's important to consider factors such as component spacing, trace width, and the routing of power and ground lines.

3.1.3. PCB Fabrication

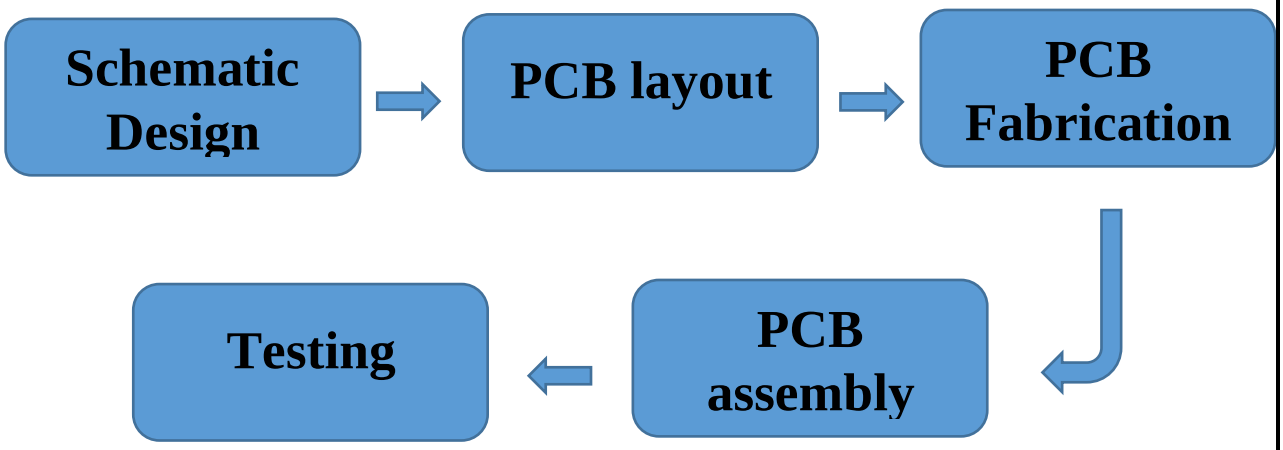
After the layout is complete, the PCB is fabricated. This process involves transferring the layout to a copper-clad board, etching away the unwanted copper, drilling holes for the components, and then applying a protective coating.

3.1.4. PCB assembly

The final step is to assemble the PCB by soldering all the components onto the board. This includes inserting the components into the drilled holes, and then heating them with a soldering iron to melt the solder and make a connection between the component and the PCB.

3.1.5. Testing

After the PCB is assembled, it should be tested to ensure that it functions as expected. This can involve measuring the output voltage and current, and checking for any issues such as short circuits or open connections.



3.2 Analysis Procedure

When analyzing the design of a 12V variable DC power supply, several key factors should be considered:

3.2.1. Efficiency

The efficiency of the power supply is an important factor to consider, as it directly affects the amount of power that is wasted as heat. A high-efficiency design will minimize power loss and reduce the need for cooling.

3.2.2. Output voltage and current

The output voltage and current should be carefully controlled to ensure that the power supply can provide the required voltage and current to the load. This can be achieved through the use of voltage regulators and other control circuits.

3.2.3. Load regulation

The ability of the power supply to maintain a stable output voltage despite changes in the load is known as load regulation. This is an important factor to consider, as a poorly regulated power supply can lead to problems such as overvoltage or undervoltage.

3.2.4. Ripple and noise

Ripple and noise are variations in the output voltage caused by the switching nature of the power supply. These variations can cause problems such as electromagnetic interference (EMI) and can affect the performance of sensitive electronic devices. Minimizing ripple and noise can be achieved through the use of filters and other techniques.

3.2.5. Safety

Safety is an important consideration when designing a power supply. This includes ensuring that the power supply is designed to meet regulatory standards such as UL and CE, and that it has built-in protection features such as overvoltage and overcurrent protection.

3.2.6. Cost and space

The cost and space of the design should be taken into account. The design should be as compact as possible, and the cost of the components should be minimized without compromising the functionality and safety of the power supply.

By taking these factors into account, it is possible to create a power supply design that is efficient, stable, and safe, while also being cost-effective and compact.

Chapter 4:

4.1 Hardware Tools used

Following are the hardware tools used in our project.

4.1.1 The 1N4007 diode:

It is a type of rectifier diode that is commonly used for power supply applications. It has a maximum reverse voltage of 1000V and a maximum forward current of 1A. It is also known for its high surge current capabilities and general purpose use.

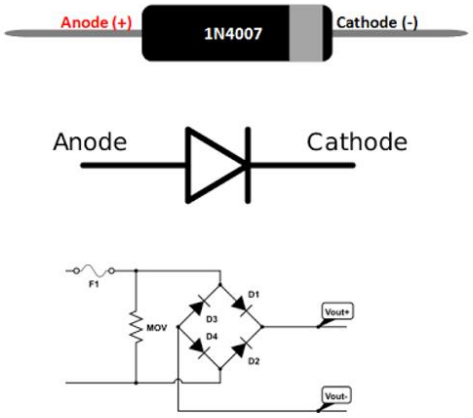


Figure 1 1N4007 Diode

4.1.2 A 12V transformer:

It is an electrical component that changes the voltage level of an electrical power source through electromagnetic induction. It is typically used to lower or increase voltage levels, with an output of 12V, which is commonly used in many devices and

appliances such as power supplies, charging systems and lighting systems.

Figure 2 12V Transformer

4.1.3 capacitor:

It is a device that stores electrical energy in an electric field. It consists of two conductive plates separated by a dielectric material. Capacitors are widely used in electronic circuits for a variety of purposes such as power supply filtering, coupling, and timing. They also play an important role in smoothing out power fluctuations and increasing efficiency in motors, lighting, and HVAC systems.

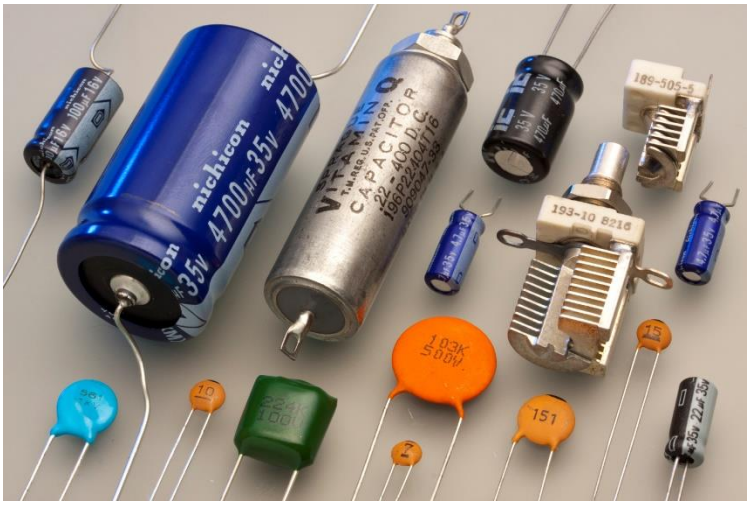


Figure 3 Capacitor

4.1.4 The U1 7805 Regulator:

It is a widely used, adjustable linear **voltage regulator** integrated circuit made by Texas

Instruments. It can output a stable voltage between 1.2V and 37V with a maximum current of 1.5A. This IC is used in a variety of applications requiring a regulated voltage source, such as power supplies, battery-powered devices, and other electronic systems. It also has the ability to regulate both positive and negative voltage levels. Additionally, the U1 7805 includes thermal protection which makes it a dependable option in applications with high power dissipation.

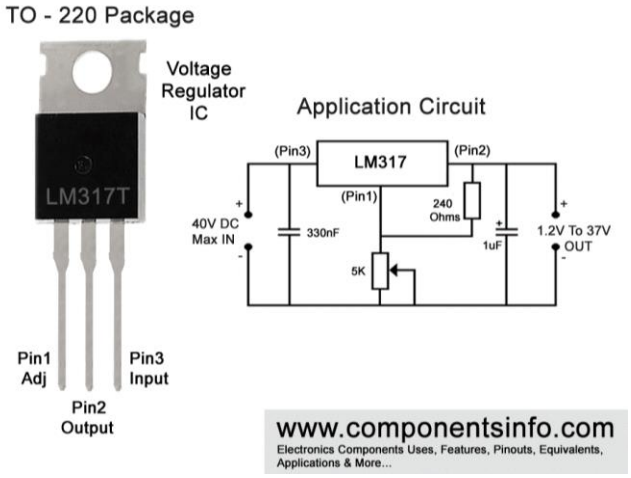


Figure 4 U1 7805 Regulator

4.1.5 Resistor:

It is an electronic component that restricts the flow of electrical current. They are used in circuits to control current, divide voltage, and create a specific voltage drop. Resistors are generally made of carbon, metal, or metal oxide and are identified by their resistance value measured in ohms (Ω). They also have a tolerance level, which is the allowed deviation of the resistance value from its nominal value. Additionally, they have a power rating, which is the maximum amount of power the resistor can handle without getting damaged. They are widely used in

electronic circuits for current limiting, voltage dividing, and impedance matching.

Figure 5 Resistor

4.1.6 A 5kV POT (Potentiometer):

It is a variable resistor that can be used to adjust the voltage level in a circuit. They are often used to adjust the voltage level, gain, or sensitivity in a circuit. This type of POT is rated for a maximum voltage of 5kV, which is a very high voltage level and is typically used in high voltage applications such as power supplies, voltage dividers, and high voltage measurement devices. The 5kV POT may have different resistance, tolerance and power ratings. It is important to note that working with such high voltage level require proper safety measures, handling, and skilled technicians.

Figure 6 Potentiometer

4.1.7 Pin connectors:

It is also known as pin headers or simply headers, are a type of electrical connector that consist of one or more rows of pins that are used to connect two circuit boards or electronic devices together. They are typically made of plastic and metal, and the pins are usually made of copper or other conductive materials. Pin connectors are widely used in a variety of electronic devices, including computers, smartphones, and consumer electronics. They are used for a variety of purposes, including power supply, data transfer, and signal transmission. Some common types of pin connectors include:

1. Single row and double row pin headers
2. IDC connectors
3. JST connectors
4. Molex connectors
5. Dupont connectors

They are available in different sizes, pin configurations and materials, it's important to choose the right type of connector that is compatible with the application and device you are using it for.

Figure 7 Pin Connectors

4.1.7 A yellow LED (Light Emitting Diode):

It is a type of LED that emits yellow light when a current is applied to it. LEDs are semiconductor devices that convert electrical energy into light. Yellow LEDs are typically used in indicator lights, automotive lighting, traffic signals, and other applications where a yellow light is required. Yellow LEDs are less common than red and green LEDs but they are still widely used in many applications because they are highly efficient and have a long lifespan. They are available in different sizes, brightness and package. Some yellow LEDs are also used in combination with other color LEDs to produce white light.

Figure 8 Yellow LED

4.1.8 PCB (Printed Circuit Board) sheet:

It is a thin board made of insulating material, such as fiberglass or plastic, that is used to support and connect electronic components. PCB sheets are used to create electronic circuits by etching conductive pathways, typically made of copper, onto the surface of the board. They come in different sizes, thickness and materials. PCB sheets are used in a wide range of electronic devices, including computers, smartphones, and consumer electronics. They are used to create the base of the circuit and to connect the various components together. PCBs have largely replaced wire-wrapped and point-to-point constructed circuits, due to their small size, low cost, and high reliability. PCB sheets are designed by engineers, then sent to fabrication factories to be manufactured.

Figure 9 PCB Sheet

4.1.9 Banana connector:

It is an electrical connector that is used to connect wires or test leads to a circuit or device. It gets its name from its shape which resemble a banana. These connectors typically made of plastic, have a cylindrical shape with a spring-loaded sleeve that can be screwed or pushed onto the connector to secure the wire in place. They are often color-coded for easy identification. Banana connectors are widely used in many areas of electronics and electrical work such as test equipment, audio and video equipment, laboratory equipment and many other applications such as power supplies, oscilloscopes and function generators. They are usually used in pairs, and are often used with test leads or patch cords to connect test equipment to a circuit under test.

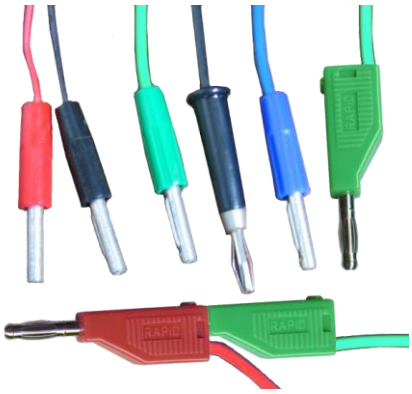


Figure 10 Banana Connectors

4.1.10 An acrylic sheet:

It is a plastic sheet made of a material called polymethyl methacrylate (PMMA). It is known for its transparency, durability, and resistance to weather. They are lightweight and easy to shape, which makes them a popular choice for many applications. Acrylic sheets can be used in signs, displays, protective barriers, glazing, and skylights. They can also be used as a substitute for glass in

windows, doors, and skylights in the construction industry, as well as in automotive industry, medical devices and equipment, and in art and design. These sheets come in various thicknesses, sizes, colors, and finishes, making them versatile and suitable for many different uses.

Figure 11 acrylic Sheet

4.2 Software(s), simulation tool(s) used:

4.2.1 Proteus:

Proteus is a software suite for computer-aided design (CAD) of electronic circuits. It is developed by Labcenter Electronics, a UK-based company. The Proteus software package includes several tools for designing and simulating electronic circuits, including schematic capture, PCB layout, and a 3D visualizer.

4.2.1.1 Schematic Capture:

Proteus schematic capture allows users to design and simulate electronic circuits using a graphical interface. The software includes a library of electronic components that can be easily placed on the schematic and connected using wires. The software also includes a simulation engine that can be used to test the circuit's behavior before it is built.

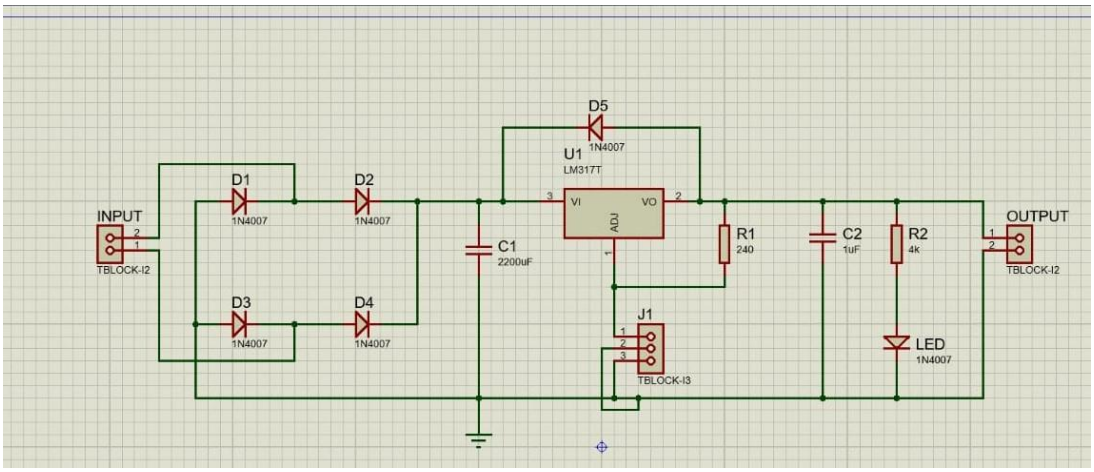


Figure 12: Schematic capture of our project

4.2.1.2 PCB Layout:

Proteus PCB layout is a tool that allows users to design and layout printed circuit boards (PCBs) for their electronic circuits. The software includes a library of footprints for various components, and it can automatically generate a layout based on the schematic. Users can also manually place components and route tracks on the PCB layout.

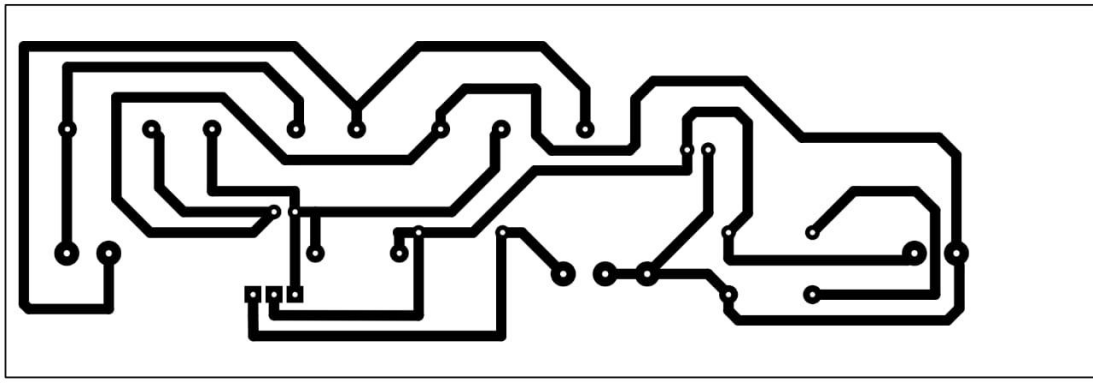


Figure 13: PCB Layout mode

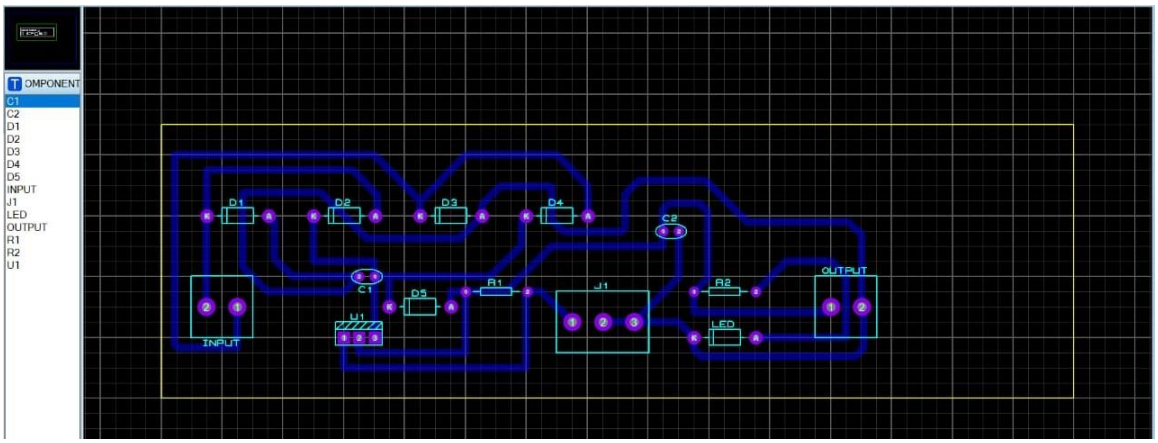


Figure 14: PCB

4.2.1.3 3D Visualizer:

Proteus 3D visualizer is a tool that allows users to view their electronic circuits and PCB layouts in a 3D environment. This tool can be used to check for clearance and collision issues, and it can also be used to create photorealistic renderings of the finished product.

Overall, Proteus is a powerful and versatile tool for designing and simulating electronic circuits. Its schematic capture, PCB layout, and 3D visualizer tools allow users to design and test their circuits before they are built, which can save time and money in the long run.

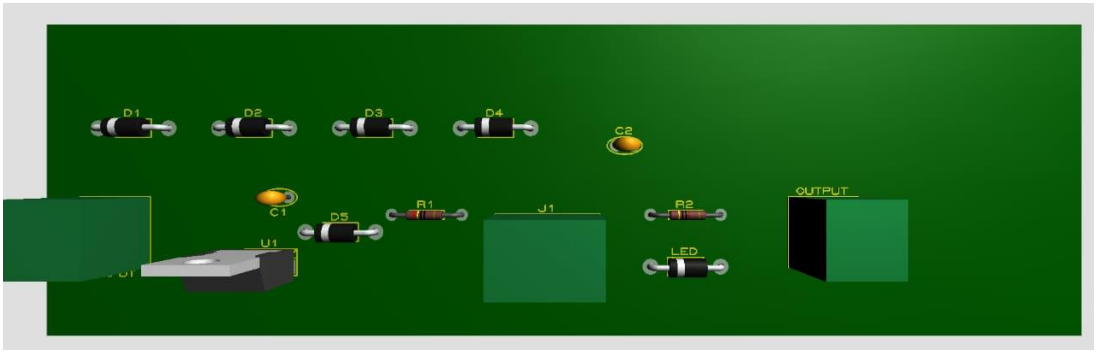


Figure 15: 3D Visualizer

Chapter 5:

5.1 Project results and evaluation:

A 12V variable DC power supply is a device that can output a DC voltage that can be adjusted to a desired level within a certain range, typically between 0 and 12 volts. The project result and evaluation of such a power supply would depend on the specific design and implementation. However, some key factors that should be considered in evaluating a 12V variable DC power supply include the following:

5.1.1 Output voltage range:

The power supply should be able to output a voltage that can be adjusted within the desired range, typically between 0 and 12 volts.

5.1.2 Output voltage stability:

The output voltage should remain stable and not fluctuate significantly under varying load conditions.

5.1.3 Output current capability:

The power supply should be able to supply enough current to meet the needs of the load.

5.1.4 Efficiency:

The power supply should be as efficient as possible, converting as much input power as possible into useful output power.

5.1.5 Safety:

The power supply should be designed with safety in mind, to prevent dangerous conditions such as overloading, overheating, and short-circuiting.

5.1.6 Cost:

The cost of the power supply should be reasonable and competitive.

Overall, a 12V variable DC power supply that meets these criteria would be considered a successful project.

5.2 Limitation of the Working Prototype:

A 12V variable DC power supply, like any other electronic device, may have some limitations depending on its design and implementation. Some of the potential limitations of a 12V variable DC power supply include:

5.2.1 Output voltage range:

The output voltage range may be limited to a specific range, typically between 0 and 12 volts, which may not be suitable for all applications.

5.2.3 Output current capability:

The output current capability may be limited, which means it may not be able to supply enough current to power certain high-current loads.

5.2.4 Efficiency:

Efficiency may be lower at lower output voltages and higher output currents, which can result in wasted energy and heat.

5.2.5 Line and load regulation:

The output voltage may vary depending on the input voltage and the load connected to the power supply.

5.2.6 Ripple and noise:

The output voltage may have some unwanted ripple and noise, which can affect the performance of sensitive loads.

5.2.7 Safety:

The power supply may not have adequate protection against overloading, overheating, and short-circuiting, which can be dangerous.

5.2.8 Cost:

The cost of the power supply may be higher than other power supply options, making it less cost-effective.

5.2.9 Size and weight:

The size and weight of the power supply may be larger than other power supply options, making it less portable.

It's important to keep in mind that these limitations may vary depending on the specific design and implementation of the power supply. Therefore it's important to evaluate the power supply according to the specific needs and requirements of the application.

Chapter 6:

6.1 Conclusion:

In conclusion, a 12V variable DC power supply is a useful device that can output a DC voltage that can be adjusted to a desired level within a certain range, typically between 0 and 12 volts. The project report of such a power supply should detail the design, implementation, and evaluation of the power supply. The project aims to design and build a 12V variable DC power supply, which is a device that can convert a fixed AC voltage to a variable DC voltage.

The design process will involve the use of a transformer to step down the incoming AC voltage, a rectifier to convert the AC voltage to DC voltage, and a voltage regulator to control the output voltage. The output voltage can be adjusted using a potentiometer or a digital control circuit. The final product will be tested to ensure it meets the specifications and is able to provide a stable output voltage. This power supply can be used for a wide range of applications such as testing electronic circuits and powering small devices like motors, lights and other electronic devices.