



INDIAN INSTITUTE OF TECHNOLOGY DELHI

ELP-101

Design Constant Current DC Power Supply

A report of the mini project submitted in partial fulfilment of the course requirements of
ELP101 – Introduction to Electrical Engineering. (Practical)

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Introduction:

The project aims to design a constant current DC power supply, which involves creating a circuit that can provide a stable output current regardless of load variations. It is a fundamental tool that ensures a durable and predictable flow of electrical current to connected devices. This versatile device is crucial in powering light-emitting diodes (LEDs), charging batteries, and driving numerous electronic components and systems.

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1. Apparatus Required:

- Step-Down Transformer (0-9V AC output)
- Diode 1N4007 – 4
- IC LM317
- Capacitor : 100 μ F, 0.1 μ F
- Resistor: $R_1 = 1K\Omega$, $R_L = 1K\Omega$

1.2.1 Step-Down Transformer

A step-down transformer is an essential component that allows the conversion of high-voltage AC input into a lower voltage suitable for various applications. Specifically, a "0-9 volt" step-down transformer can take input voltage, often at mains voltage levels, and deliver an output voltage ranging from 0 to 9 volts. To understand how it functions, consider the following key points:

- **1. Primary and Secondary Windings:** Step-down transformers have two sets of windings, the primary and secondary. The primary winding connects to the input voltage source, while the secondary winding is linked to the output circuit where the lower voltage is required.
- **2. Turns Ratio:** The ratio of the number of turns in the primary winding to the number of turns in the secondary winding determines the voltage transformation. In step-down transformers, the secondary winding has fewer turns than the primary winding, resulting in a voltage reduction.
- **3. Voltage Conversion:** When alternating current (AC) flows through the primary winding, it generates a magnetic field. This magnetic field induces a voltage in the secondary winding through electromagnetic induction. The output voltage in the secondary winding is directly proportional to the turns ratio. For example, with a 1:10 turns ratio, you can obtain a 10-volt output from a 100-volt input.
- **4. 0-9 Volt Output:** In the case of a 0-9 volt step-down transformer, it offers the flexibility to vary the output voltage within the range of 0 to 9 volts. This feature makes it suitable for a wide range of applications in electronics, powering small devices, or serving as a power supply for experiments and projects.
- These step-down transformers find extensive use in electronic circuits, appliances, and various devices where different voltage levels are required. They provide a safe and efficient means to power devices while mitigating the risk of high-voltage exposure. When using such transformers, it's crucial to consider their power rating, typically measured in VA or watts, to ensure they can handle the load of the connected devices without overheating.

1.2.2 Diode

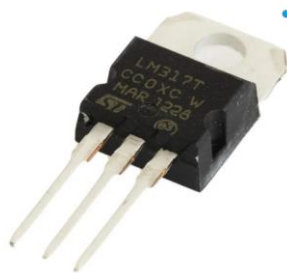
The 1N4007 diode is a widely used silicon rectifier diode belonging to the 1N400x series, often referred to as general-purpose rectifier diodes. These diodes serve a multitude of

applications, primarily for converting alternating current (AC) into direct current (DC). The 1N4007, a prominent member of this series, boasts specific characteristics and ratings:

- **1. Voltage Rating:** The 1N4007 diode has a maximum reverse voltage (peak inverse voltage, PIV) rating of 1000 volts (1 kV). This means it can withstand a reverse voltage of up to 1000V before it starts conducting in the reverse-biased direction.
- **2. Current Rating:** The maximum forward current, typically rated at 1.0 ampere (A), represents the highest continuous current that the diode can handle in the forward-biased direction without overheating.
- **3. Forward Voltage Drop:** While the forward voltage drop of the 1N4007 diode can vary slightly, it usually falls within the range of 0.7 to 1.1 volts when conducting current in the forward direction. This voltage drop is inherent to diodes and plays a vital role in their rectification function.
- **4. Package Type:** The 1N4007 diode comes in various packages, with popular options including the axial-lead glass passivated package and surface-mount packages like DO-41, SMA, and SMB.
- **5. Polarity:** Diodes are polarized components, meaning they have a specific orientation for proper operation. The cathode of the 1N4007 diode is usually marked with a band, line, or another distinguishing feature to indicate its orientation.

1N4007 diodes are versatile and cost-effective components employed in a wide array of electronic projects. They find use in power supply circuits, rectification in power supplies and battery chargers, reverse voltage protection, and various general-purpose diode applications. When selecting a diode, it is crucial to consider the voltage, current, and power requirements specific to your application to ensure the diode can operate effectively.

1.2.3 IC LM317



The LM317 is a highly popular integrated circuit (IC) voltage regulator within the LM3xx series. This IC specializes in linear voltage regulation, providing a stable output voltage from a variable input voltage source. The LM317 is readily available and is manufactured by various semiconductor companies. Here are its key features and characteristics:

- **1. Adjustable Output Voltage:** One of the most significant advantages of the LM317 is its capacity to deliver an adjustable output voltage. By connecting external resistors to the ADJ (adjust) pin, you can set the desired output voltage within a specified range, making it versatile for various applications.
- **2. Output Voltage Range:** The LM317 can be configured to supply output voltages between 1.25 volts and approximately 37 volts, depending on the specific model and input voltage.
- **3. High Voltage Regulation:** The LM317 exhibits exceptional voltage regulation, maintaining a relatively stable output voltage even when input voltage and load conditions fluctuate.
- **4. Current Limiting:** The LM317 is equipped with built-in current limiting to safeguard both itself and the connected circuit from excessive current. The current limit is typically adjustable.
- **5. Thermal Protection:** It incorporates thermal overload protection to prevent the IC from overheating. When the temperature surpasses a safe threshold, the LM317 will reduce its output current to safeguard itself.
- **6. TO-220 and TO-3 Packages:** The LM317 is available in various package types, with the most common options being TO-220 and TO-3, suitable for through-hole mounting on printed circuit boards.
- **7. Versatility:** LM317 voltage regulators find widespread application in power supplies for electronic devices, battery chargers, adjustable voltage sources, and more. They prove particularly useful when a stable and adjustable output voltage is required.

Here's a basic guide on how to use an LM317 voltage regulator:

- 1. Connect the input voltage (Vin) to the IN pin.
- 2. Link the ground (GND) pin to the ground reference.
- 3. Utilize two external resistors (R1 and R2) to set the desired output voltage, following the formula: $V_{out} = 1.25V (1 + R2 / R1)$.
- 4. Connect the load (the device to be powered) between the OUT pin and ground.
- 5. Take care to consider the LM317's power dissipation and current limits and ensure that the input voltage remains within the IC's specified operating range.

1.2.4 Capacitor

A capacitor is an electronic component that stores electrical energy in an electric field by accumulating electric charges on two closely spaced surfaces separated by insulation. It is a passive component with two terminals and serves two primary functions in electronic circuits: filtering (smoothing out rectified DC) and decoupling (stabilizing voltage regulators). Here's how each capacitor functions within the circuit:

- **For filtering:**

A capacitor is used to reduce the ripple or fluctuations in a DC voltage. It smooths out the rectified DC waveform, resulting in a more stable voltage supply for connected components. This is particularly important in power supply circuits to provide a steady source of power.

- **For decoupling:**

Capacitors act as reservoirs of electrical charge and are connected in parallel to a voltage regulator or other integrated circuits. They help stabilize the voltage and reduce noise and voltage spikes. By providing instantaneous current when needed, capacitors ensure that voltage levels remain within the specified range, thus improving the performance and reliability of the circuit.

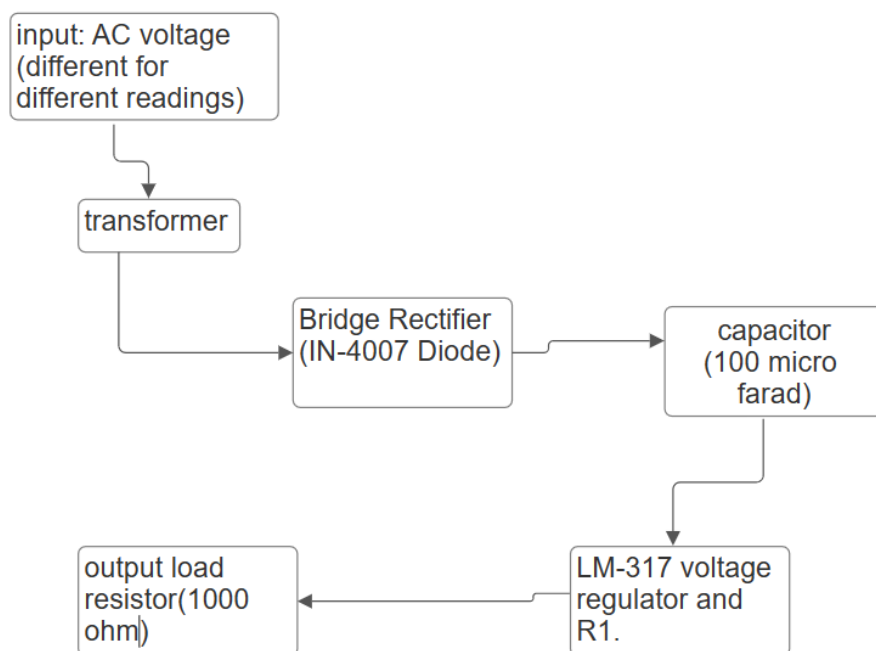
In summary, capacitors are fundamental components in electronic circuits, playing a crucial role in maintaining stable and clean power supplies, which is vital for the proper operation of various electronic devices and systems.

2. Theory:

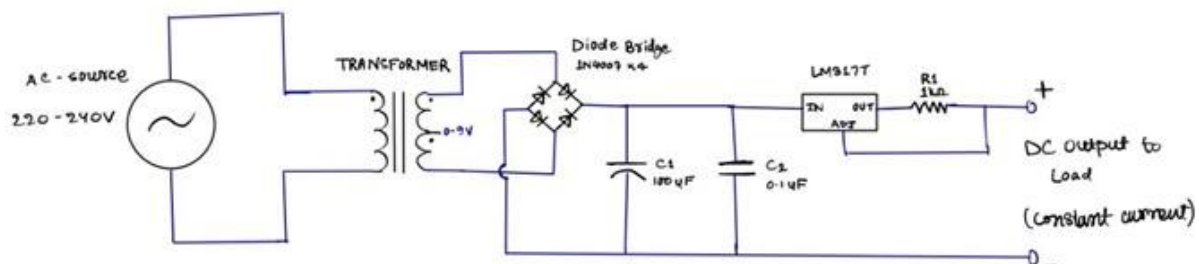
A constant current source in electronics is a device or circuit that produces a constant value of current regardless of variations in source voltage or changes in load resistance. To achieve this in the given circuit, a step-down transformer with a 0-9V AC output is used to reduce the input alternating voltage. Four 1N4007 diodes form a diode bridge, acting as a full-wave rectifier to convert the incoming AC voltage into DC. Capacitors are then employed to filter out fluctuations from the DC current waveform. The heart of the circuit, the LM317T integrated circuit, is a three-terminal voltage regulator designed to maintain a nearly constant output voltage.

3. Setup:

3.1 Block Circuit:



3.2 Circuit Diagram:



4. Bill of Materials:

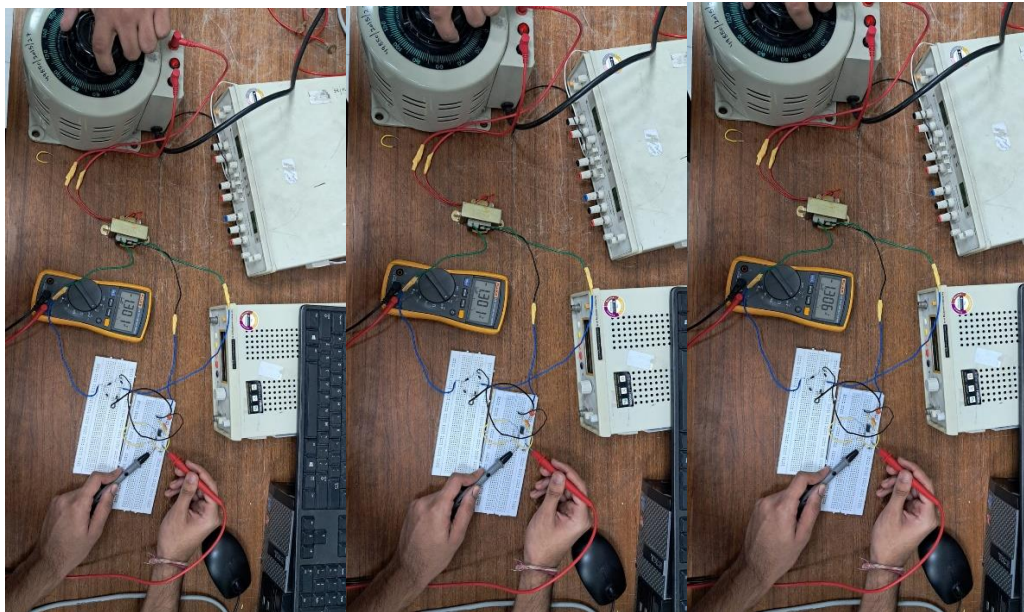
Part name	Quantity	Price per unit(in Rs.)	Total price (in Rs.)
Step down transformer(0-9V AC output)	1	250	250
Resistor(1000Ω)	2	5	10
Diode(IN4007)	4	1	4
Capacitor(100μF)	1	20	20
Capacitor(0.1μF)	1	5	5
IC-LM317	1	100	100

5. Circuit Explanation:

As evident from the circuit diagram, the fundamental objective is to create a constant current DC power supply. This is achieved through a series of steps:

1. **Step-down Transformer:** The AC input is first connected to a step-down transformer with a 0-9V AC output. The transformer's role is to reduce the voltage and provide a secondary voltage.
2. **Bridge Rectifier:** The output from the transformer is then subjected to a bridge rectifier, composed of four 1N4007 diodes. This bridge rectifier converts the AC voltage into pulsating DC voltage.
3. **Filter Capacitors:** Two capacitors, C1 and C2, are placed in parallel with the DC output of the bridge rectifier. These capacitors serve as filters to smooth out the pulsating DC voltage, thereby reducing ripple and providing a more stable DC supply.
4. **Voltage Regulator (LM317):** The filtered DC voltage is then fed into an LM317 voltage regulator, which is the central element of the circuit. The LM317 is capable of maintaining a nearly constant output voltage and plays a key role in providing a constant current source.
5. **Adjustable Output Voltage:** To set the desired output voltage, resistors R1 and R2 are used in conjunction with the LM317. The output voltage is adjustable and can be calculated using the LM317's voltage divider formula.
6. **Output Capacitor:** A 0.1 μ F capacitor (C1) is connected in parallel with the LM317's output. This capacitor aids in filtering out high-frequency noise from the output.
7. **Load:** The load, representing the device to be powered, is connected to the output of the LM317.
8. **Heat Sink (Optional):** Depending on power dissipation, a heat sink can be added to the LM317 to dissipate excess heat generated during operation.
9. **Testing:** The power supply is tested with the load to ensure it provides the desired voltage and current.

6.Observations:



The output voltage is 1.3V for all values of input voltage.

7. Conclusion:

The experiment has effectively demonstrated the creation of a constant current DC power supply using the LM317 and 1N4007 diodes. However, it is essential to practice careful design and prioritize safety to ensure a reliable and secure power source for electronic projects. DIY enthusiasts, students, and electronics enthusiasts frequently employ LM317-based power supplies for prototyping and experimenting with electronic circuits. The LM317 offers a stable voltage source for various components and devices.

8. Learning from the Project:

This project highlights the versatility and cost-effectiveness of the LM317 and 1N4007 diodes in constructing a custom constant DC power supply. Attention to design details and safety measures are crucial for creating a reliable and safe power source. By employing new components and devices, future results can be improved.

9. Technical Difficulties:

1. The output of the LM317 is limited to a specific range of 1.25 V to approximately 37 V, making it unsuitable for voltages outside this range.
2. It's important to test diodes and the LM317 for proper functioning before use.
3. Careful inspection of wiring to avoid loose connections is essential.

10. Precautions:

To minimize errors and ensure safety, the following precautions were taken:

- Appropriate protective gear was worn.
- Avoidance of exposure to live voltages, using insulated tools.
- Double-checking circuit wiring and connections to prevent short circuits and other electrical hazards.
- Not leaving the switch on for prolonged periods.
- Wearing appropriate footwear and using insulated tools.

11. Acknowledgement:

We would like to express our gratitude to IIT Delhi, the Department of Electrical Engineering, and the staff and instructors of the ELP101 Lab in LHC402 for providing the resources for this project and offering guidance whenever we encountered challenges.