DUAL VARIABLE REGULATED POWER SUPPLY

A report submitted to the

Department of Electrical and Information Engineering
Faculty of Engineering
University of Ruhuna
Sri Lanka

On 10th of March 2023

In completing an assignment for the module
EE5207 Electronic Circuit Design

By

Group 5

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ABSTRACT

This report presents the design, implementation, and performance evaluation of a Dual Variable Regulated Power Supply, an essential component of many electronic circuits. The report consists of four chapters, starting with an overview of the power supply's specifications and design requirements in the first chapter. The second chapter details the design calculations and performance analysis, including the voltage and current capabilities and efficiency of the power supply. The third chapter provides practical implementation details, including the selection and integration of key components and construction guidelines. Finally, the fourth chapter presents the results of the performance testing, including measurements of the power supply's voltage and current stability, ripple, and efficiency. Overall, this report provides a comprehensive understanding of the design, implementation, and performance of a Dual Variable Regulated Power Supply, suitable for a wide range of electronic applications.

PREFACE

This report presents the final evaluation of the module EE5207, Electronic Circuit Design, which required the design and implementation of a Dual Variable Regulated Power Supply with continuous variable DC output from 0 to +12V and 0 to -12V. The report includes detailed discussions on the design methodology, component selection, circuit implementation, and testing procedures. The project builds on the basic knowledge obtained from the modules EE2202 Introduction to Electronic Engineering and EE3301 Analog Electronics, and further information was obtained from online resources and books. The report outlines the performance evaluation of the Dual Variable Regulated Power Supply, including measurements of voltage and current stability, ripple, and efficiency. The outcomes of the project demonstrate a comprehensive understanding of the design and operation of a Dual Variable Regulated Power Supply, suitable for a range of electronic applications. The project was completed under the guidance of Dr. Subodha Gunawardena, module coordinator of EE5207, W.G.C.A. Sankalpa lecturer of EE5207 and G.C.W .Thilakarathne lecturer of EE 5207 at the Faculty of Engineering, University of Ruhuna

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LIST OF FIGURES

1. CHAPTER 01 - INTRODUCTION

1.1 INTRODUCTION

A Dual Variable Regulated Power Supply is a versatile and essential electronic circuit that provides two separate, continuously adjustable DC voltage outputs, making it an ideal component in many applications that require a stable and reliable power source. It is commonly used in audio equipment, instrumentation, control systems, and other electronic devices that require precise and adjustable voltage levels.

The output voltage of a Dual Variable Regulated Power Supply can be adjusted over a wide range, typically from 0 to +12V and 0 to -12V, and it is regulated to maintain a constant output voltage even under varying load conditions. The supply is regulated by controlling the amount of current flowing through a voltage regulator, which adjusts the output voltage by varying the resistance or the voltage drop across a series transistor or other regulating device.

To design a Dual Variable Regulated Power Supply, one must have a thorough understanding of electronic components such as voltage regulators, rectifiers, capacitors, and transformers. It is also necessary to consider factors such as output current capability, efficiency, and noise performance, as well as the physical construction and packaging of the circuit.

Dual Variable Regulated Power Supplies are available in different types and configurations, including linear and switching types. Linear types use linear voltage regulators and are simple to design and construct but can be inefficient and generate significant heat. Switching types use pulse-width modulation techniques and are more efficient but more complex to design and require careful consideration of noise and stability issues.

In summary, a Dual Variable Regulated Power Supply is a versatile and essential component in many electronic applications, providing a stable and reliable source of power for a range of electronic devices and systems. Understanding its operation and design principles is essential for anyone working in the field of electronics

1.2. OPERATION OF DUAL VARIABLE REGULATED POWER SUPPLY

A dual variable regulated power supply is an electronic device that provides a stable output voltage and current to power electronic circuits. It is called "dual variable" because it has two independent channels, each with its own voltage and current controls, allowing it to provide two different output voltages and currents simultaneously.

The power supply starts with a transformer that steps down the AC voltage from the wall outlet to a lower AC voltage, which is then converted to DC voltage using a rectifier circuit. The output voltage from the rectifier is typically not smooth, but rather contains ripples and noise, so a filter circuit is used to smooth out the DC voltage and reduce noise.

The voltage regulator circuit is responsible for maintaining a constant output voltage, regardless of changes in the input voltage or load current. This is accomplished using a feedback control loop, where the output voltage is compared to a reference voltage, and the regulator adjusts its output voltage accordingly. The current limiting circuit ensures that the load does not draw more current than the power supply is capable of providing.

1.3 APPLICATION OF DUAL VARIABLE REGULATED POWER SUPPLY

- Testing and troubleshooting electronic circuits: A dual variable regulated power supply is a valuable tool for testing and troubleshooting electronic circuits. By providing a stable and precise source of power, it allows the user to power up and test various electronic components and systems, and diagnose any issues or faults.
- Powering electronic devices: A dual variable regulated power supply is often used to power electronic devices such as microcontrollers, sensors, and other electronic components. The stable and precise output voltage and current ensure that these devices operate correctly and reliably.
- Powering audio amplifiers: Audio amplifiers require a stable and precise source of power to produce high-quality sound. A dual variable regulated power supply is often used to power audio amplifiers, ensuring that the amplifier operates correctly and produces high-quality sound.
- Powering motors and actuators: Motors and actuators often require a stable and precise source of power to operate correctly. A dual variable regulated power supply is often used to power these devices, ensuring that they operate correctly and reliably.
- Charging batteries: A dual variable regulated power supply can be used to charge batteries, ensuring that they are charged correctly and safely. By providing a stable and

precise source of power, the power supply can charge the battery without damaging it.

- Solar panel testing: A dual variable regulated power supply can be used to test solar panels and solar systems. By providing a stable and precise source of power, it allows the user to test the performance of solar panels and systems under different conditions.

1.4 PROBLEM STATEMENT

The purpose of this project is to investigate and comprehend the various properties of dual variable regulated power supplies and their applications, as well as to design a power supply that satisfies the specified voltage and current requirements.

- Input should be 230 V, 50 Hz AC supply.
- 0 to +12 V and 0 to -12 V continuous variable DC output should be obtained.
- Output current should be within 0-3 A range.

1.5 OBJECTIVES

- To understand the principles of operation of a dual variable regulated power supply, including the transformer, rectifier, filter, voltage regulator, and current limiting circuits.
- To design and build a dual variable regulated power supply that meets the specified voltage and current requirements, and is stable and precise in its output.
- To test and evaluate the performance of the dual variable regulated power supply under different conditions, such as varying loads and input voltages.
- To demonstrate the versatility and importance of dual variable regulated power supplies in powering various electronic circuits and devices, such as motors, actuators, sensors, and audio amplifiers.
- To explore the limitations of the dual variable regulated power supply, such as its maximum output voltage and current, and its thermal performance.
- To investigate and compare different types of dual variable regulated power supplies, such as linear and switching power supplies, and evaluate their advantages and disadvantages.
- To document the design, construction, and testing of the dual variable regulated power supply, and present the findings in a clear and concise report

1.6 METHODOLOGY

- Learn about Dual Variable Regulated Power Supplies from analog electronics theory.
- Determine component values based on the provided specification.
- Determining the correct calculations' assumptions
- Developing the Proteus Schematic Design based on calculated parameters
- Check the circuit design with using a breadboard
- Implement the final design on a PCB circuit

As per the project requirements, an input voltage of 230V and frequency of 50Hz is needed. Initially, a center tap transformer with a step-down ratio of at least 230V to 20V was planned to obtain the required input voltage. However, due to cost constraints, the circuit was redesigned to eliminate the transformer and utilize a rectifier bridge.

However, it was observed that the signal generator used to generate a sinusoidal input signal was not capable of providing a 20V output. Despite this, the circuit was further modified without the use of a transformer and rectifier bridge to address this limitation.

2. CHAPTER 02 - CALCULATIONS

Adjustable Positive Voltage Regulator

$$V_{out} = 1.25\left(1 + \frac{R_2}{R_1}\right)$$

Here $V_{out} = \ 12\ V$

$$\frac{R_2}{R_1} = 8.6$$

We selected $R_2 = 10\ k\Omega$ and $R_2 = 1\ k\Omega$

Adjustable Negative Voltage Regulator

$$-V_{out} = -1.25\left(1 + \frac{R_2}{R_1}\right)$$

Here $V_{out} = \ 12\ V$

$$\frac{R_2}{R_1} = 8.6$$

We selected $R_2 = 10\ k\Omega$ and $R_2 = 1\ k\Omega$

The capacitors were selected by using the datasheet of the LM317 and LM337

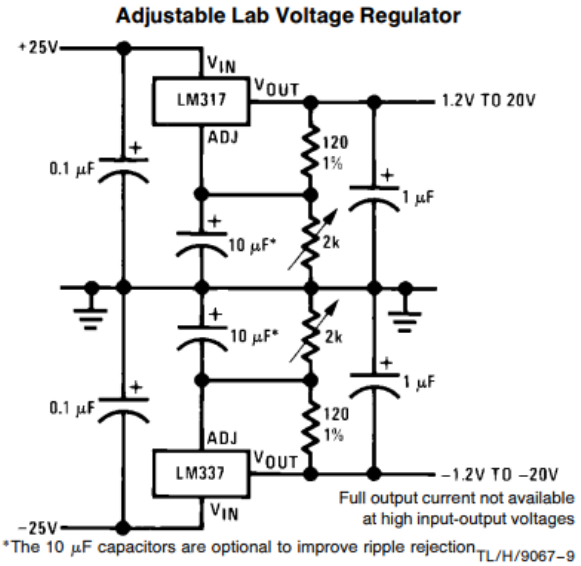

Figure 1 : Dual Variable Regulated Power Supply

3. CHAPTER 03 – IMPLEMENTATION

3.1 COMPONENTS LIST

RESISTORS

- 1 kΩ × 2
- 10 kΩ × 2 3296 Trimmer Potentiometers

CAPACITORS

- 0.1μF × 4
- 10 μF × 2
- 100 μF × 2

VOLTAGE REGULATORS

- LM317T
- LM337T

TBLOCK-13 x 2

3.2 PROTEUS SCHEMATIC CAPTURE

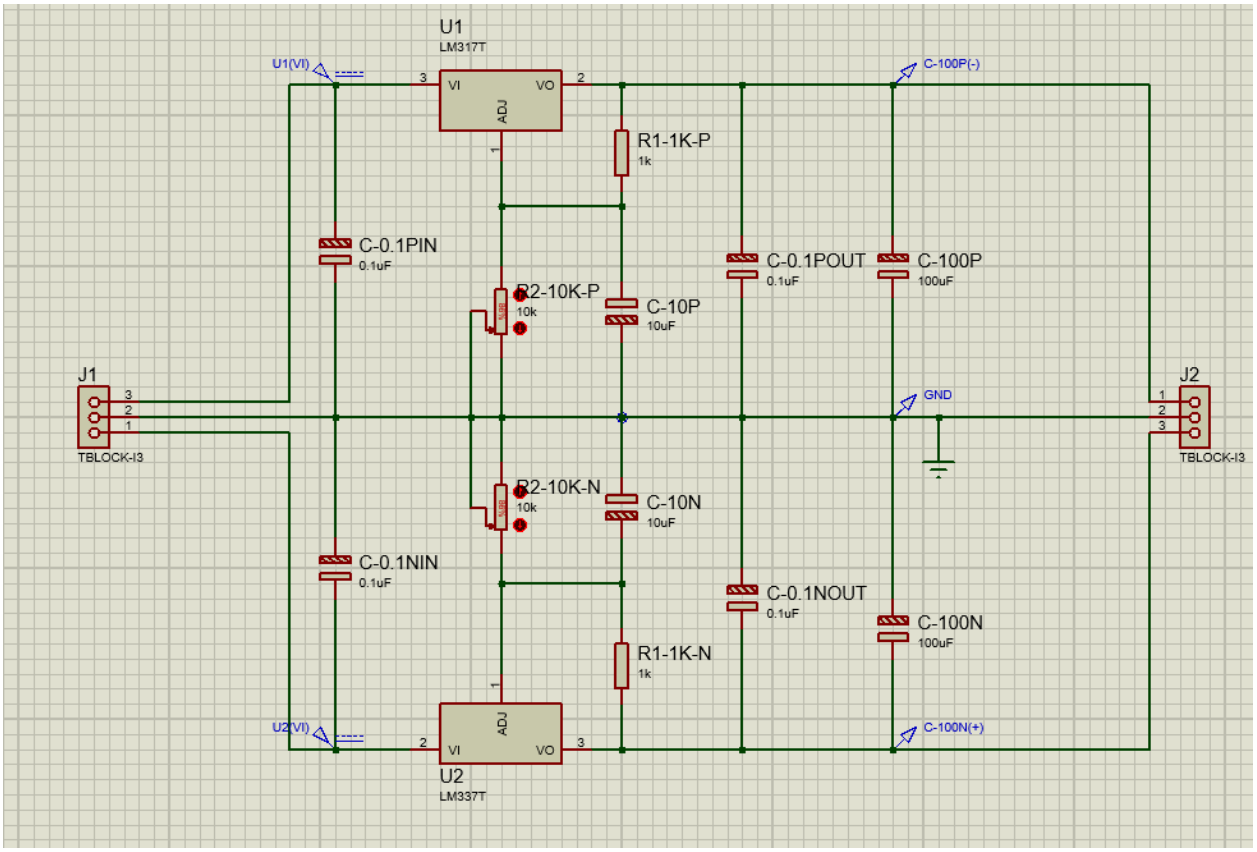

Figure 2 : Proteus Schematic Capture

3.3 PCB LAYOUT

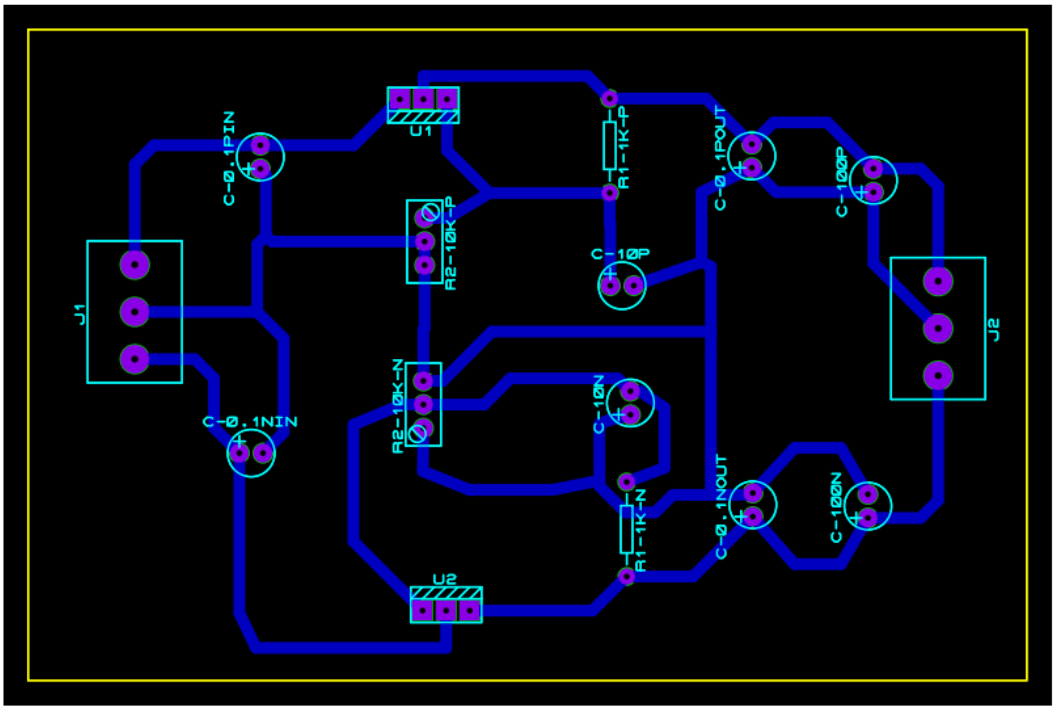

Figure 3 : PCB Layout

3.4 3D VISUALIZATION (TOP VIEW)

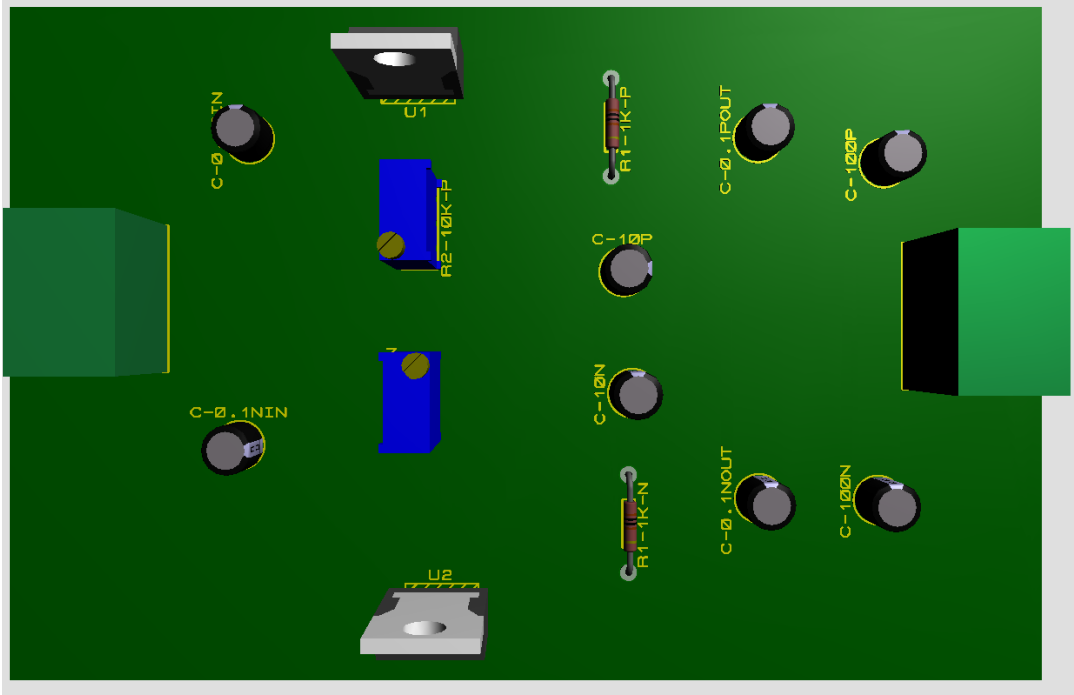

Figure 4 : 3D Visualization (Top View)

3.5 3D VISUALIZATION (BOTTOM VIEW)

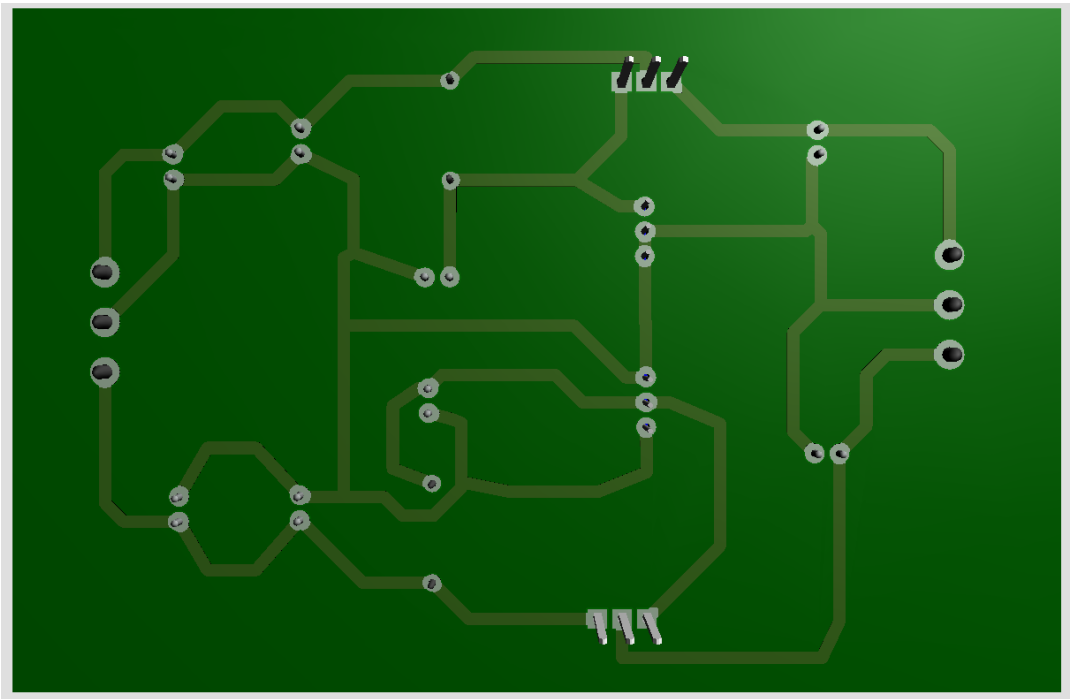

Figure 5 : 3D Visualization (Bottom View)

3.6 IMPLEMENTED CIRCUIT

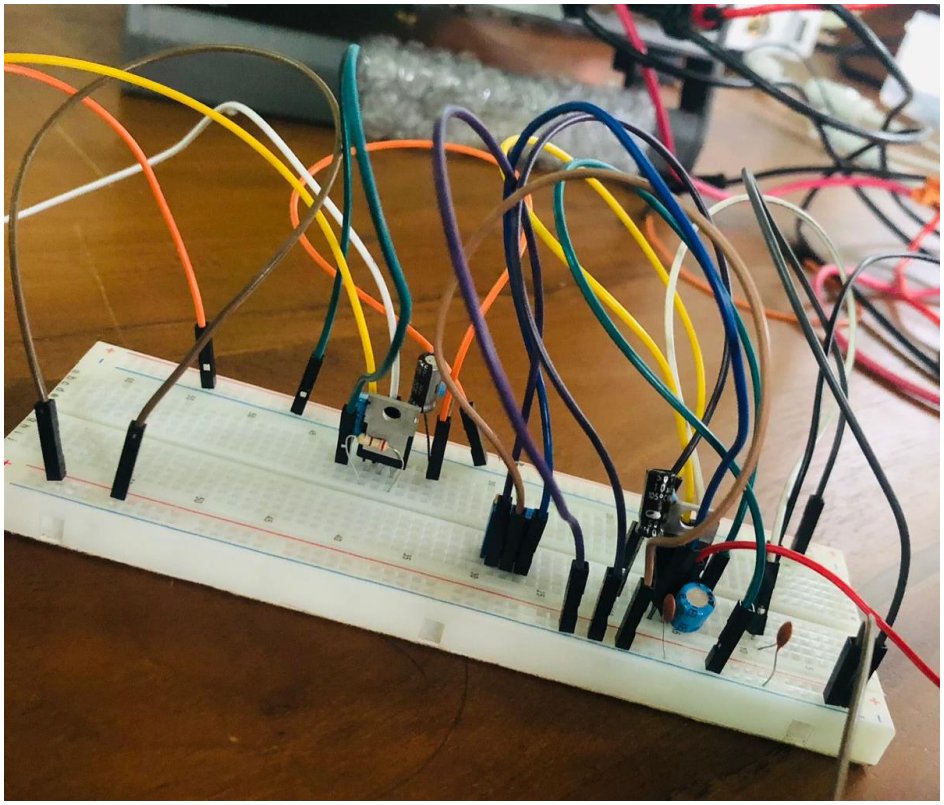

Figure 6 : Practical Implemented Circuit using Bread Board

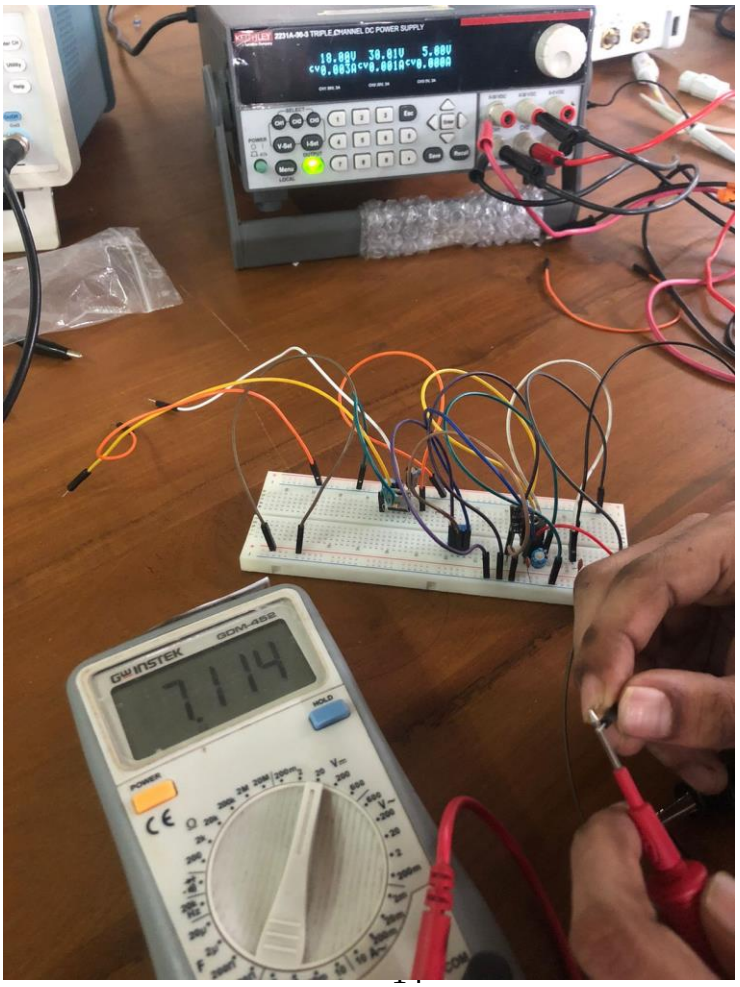

Figure 7 : Testing the practically implemented circuit using breadboard

Figure 8 : Making PCB layout on the Copper plate

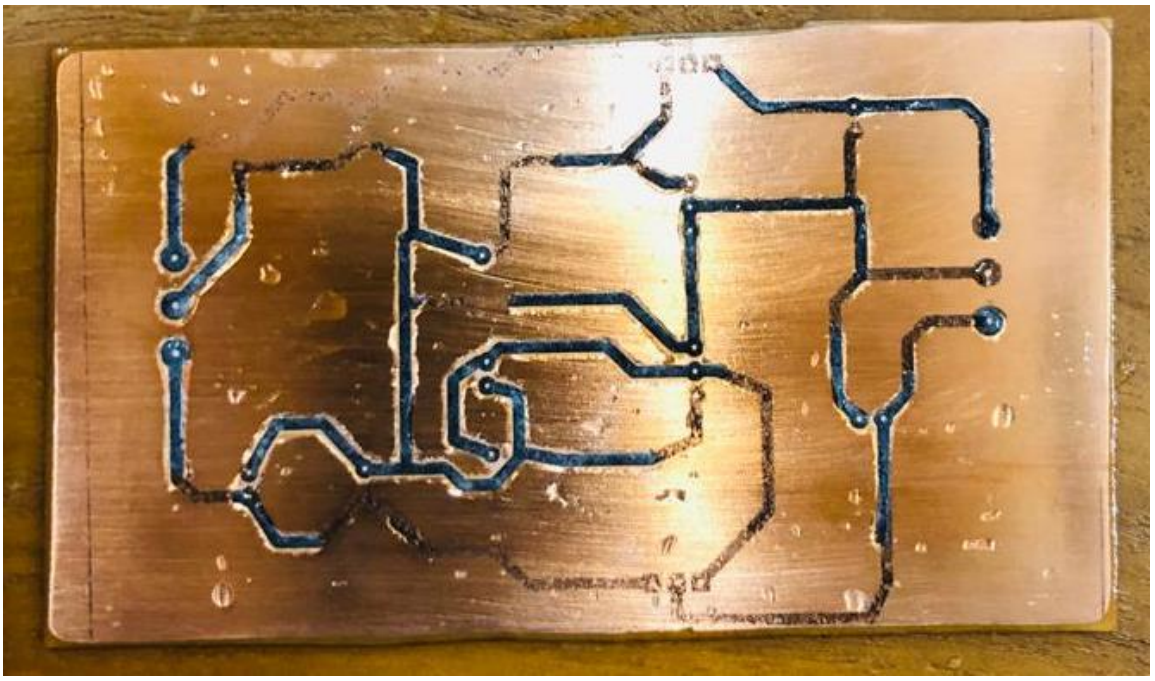

Figure 9 : After removing the Paper on the Copper plate

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Figure 10 : Removing copper from the PCB substrate, leaving behind the desired Copper traces and paths

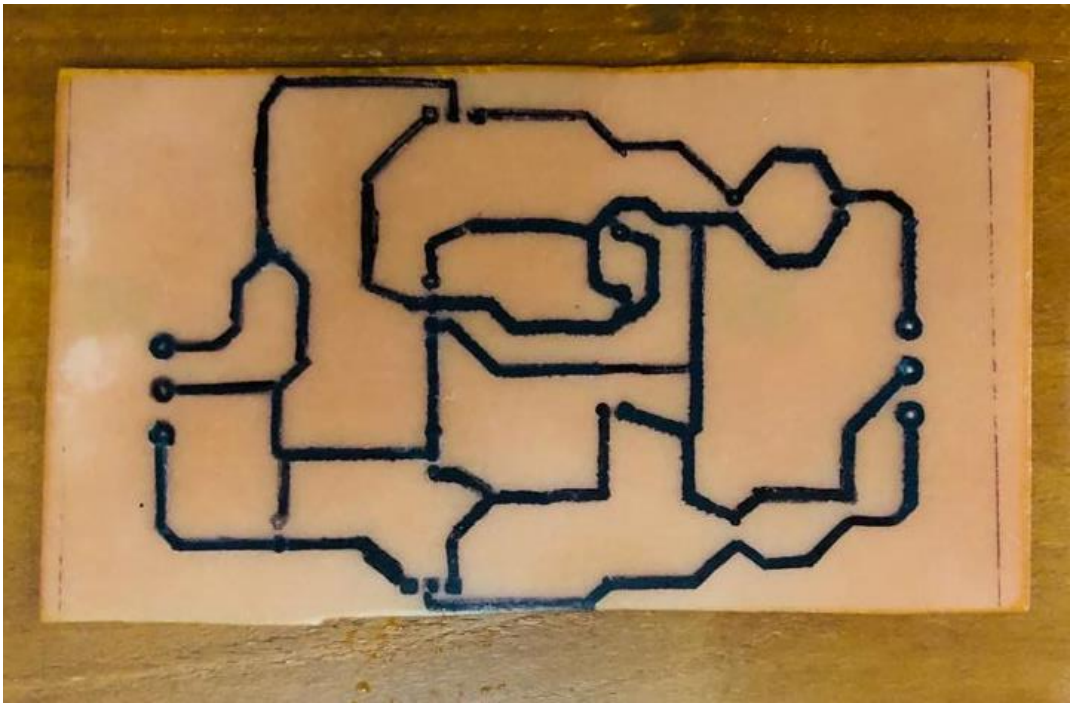

Figure 11 : After removing the Unwanted Copper from PCB substrate

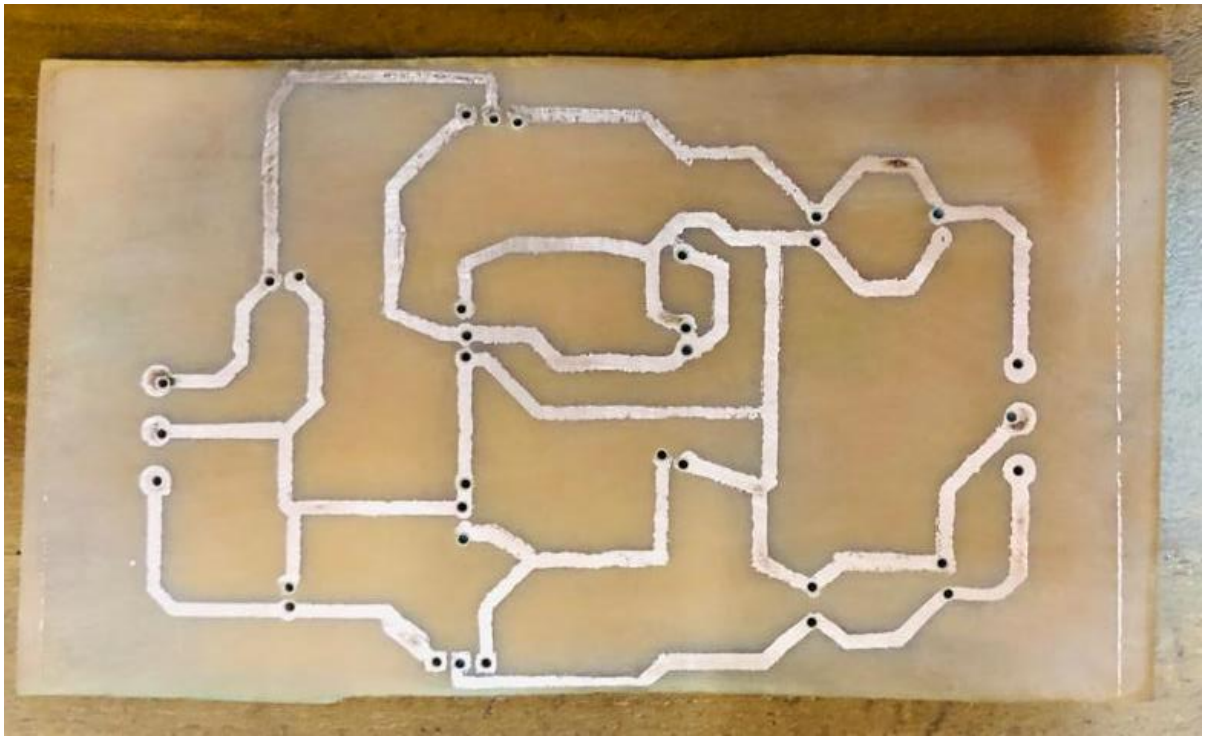

Figure 12 : After Drilling the PCB and Getting the traces in PCB

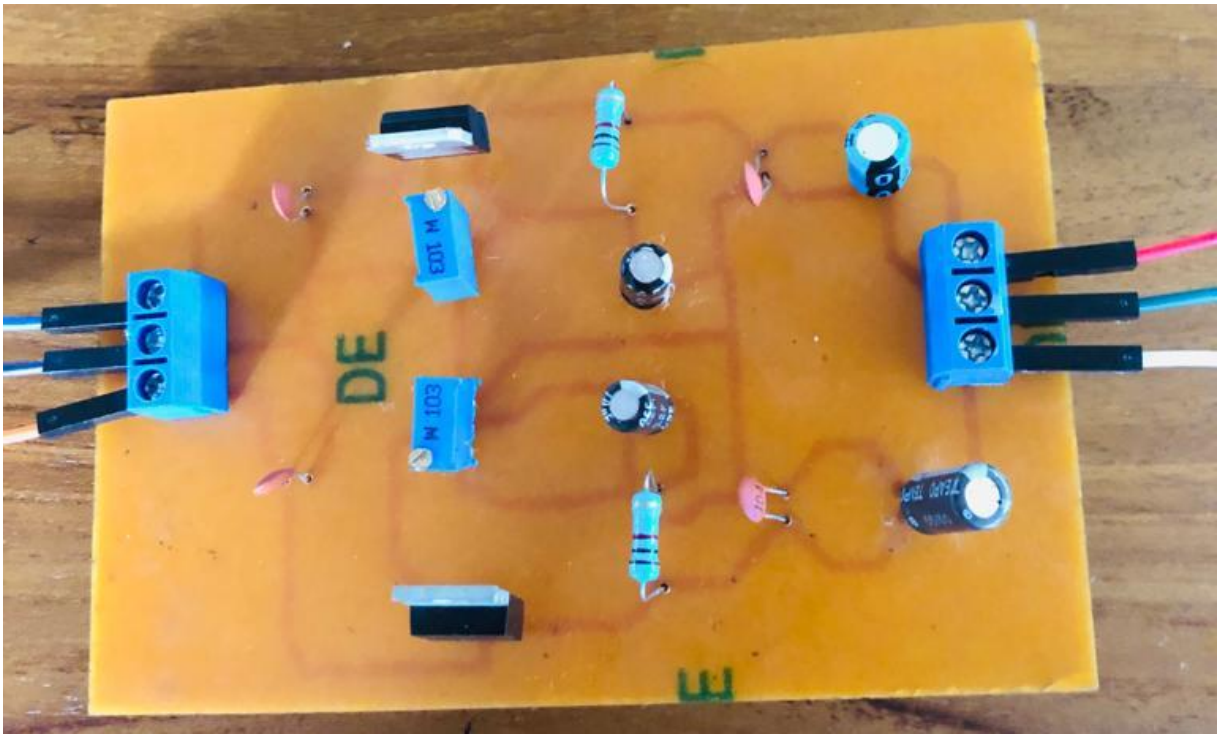

Figure 13 : Top View of the practically implemented Circuit

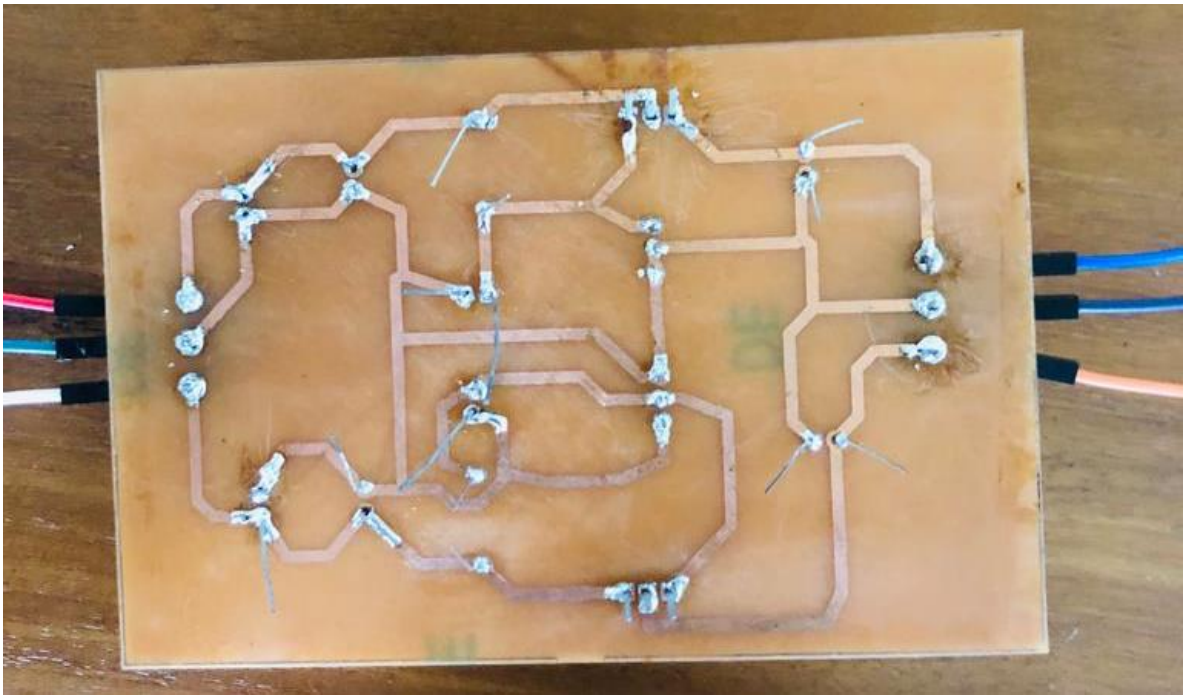

Figure 14 : Bottom View of the practically implemented Circuit

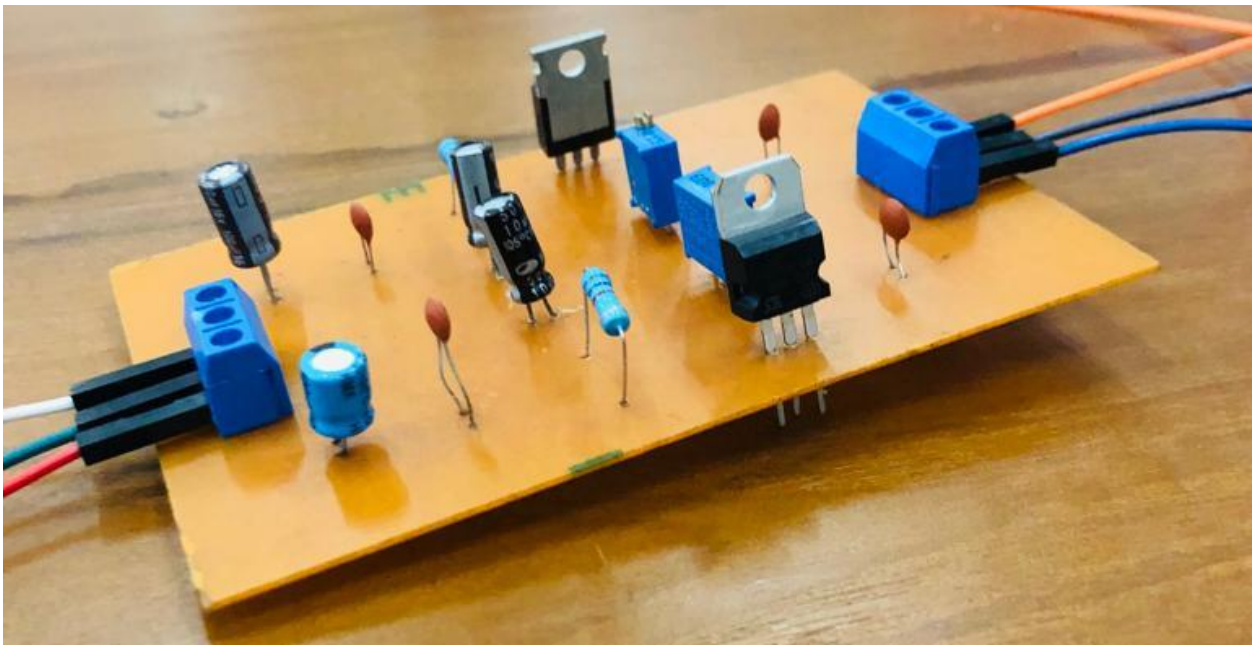

Figure 15 : Front View of the practically implemented Circuit

4. CHAPTER 04 - RESULTS AND DISCUSSION

4.1 VIRTUAL SIMULATION RESULTS USING PROTEUS SOFTWARE

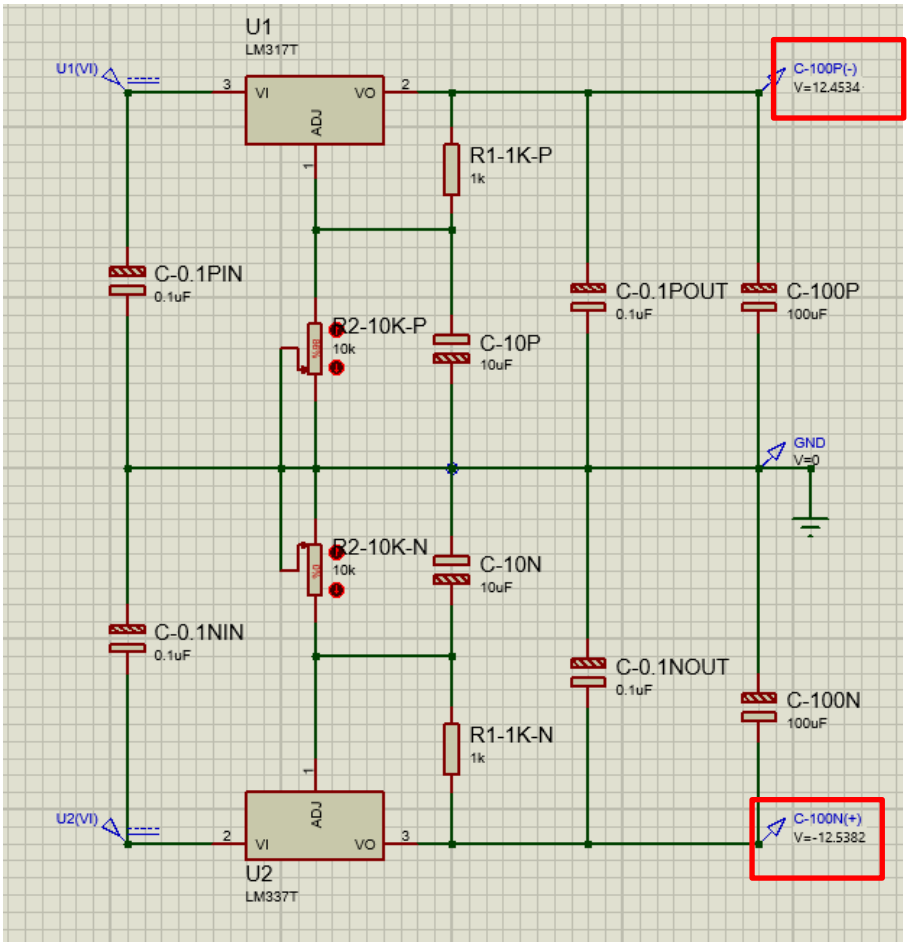

FIGURE 7: SCHEMATIC DIAGRAM OF CIRCUIT WITH OCSILLOSCOPE

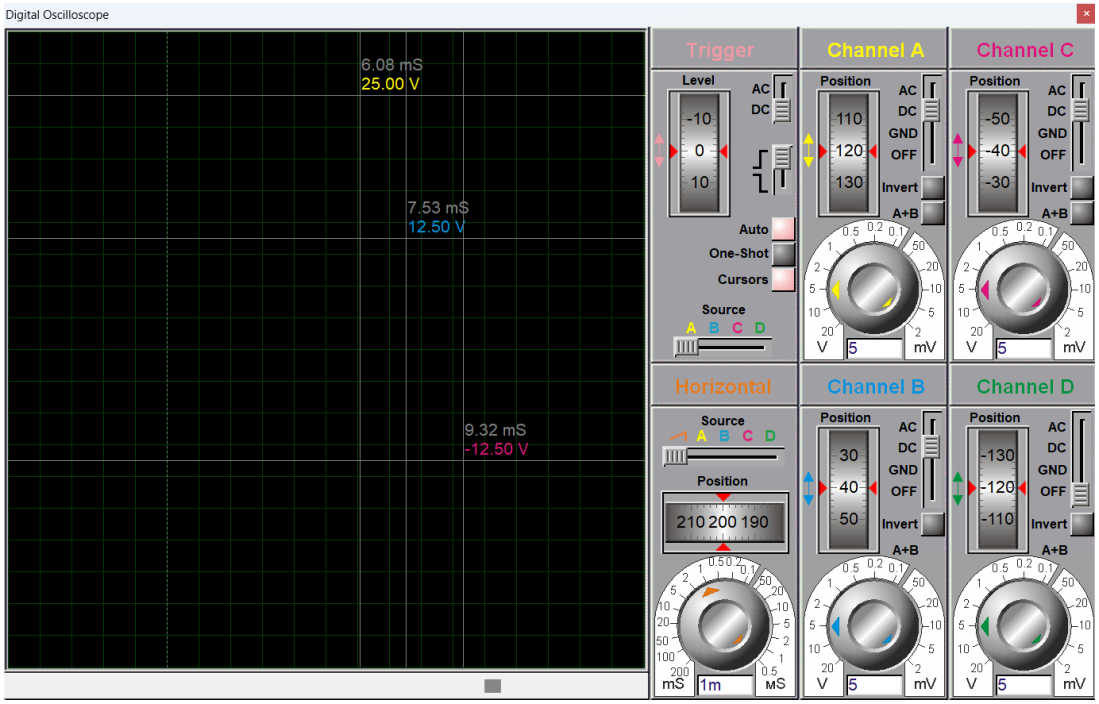

FIGURE 16: SIMULATION RESULTS OF PROTEUS

Supplied voltage = 25.0 V

Output Voltage of Positive voltage regulator = 12.5 V

Output Voltage of Negative voltage regulator= -12.5 V

4.3 PRACTICAL SIMULATION RESULTS

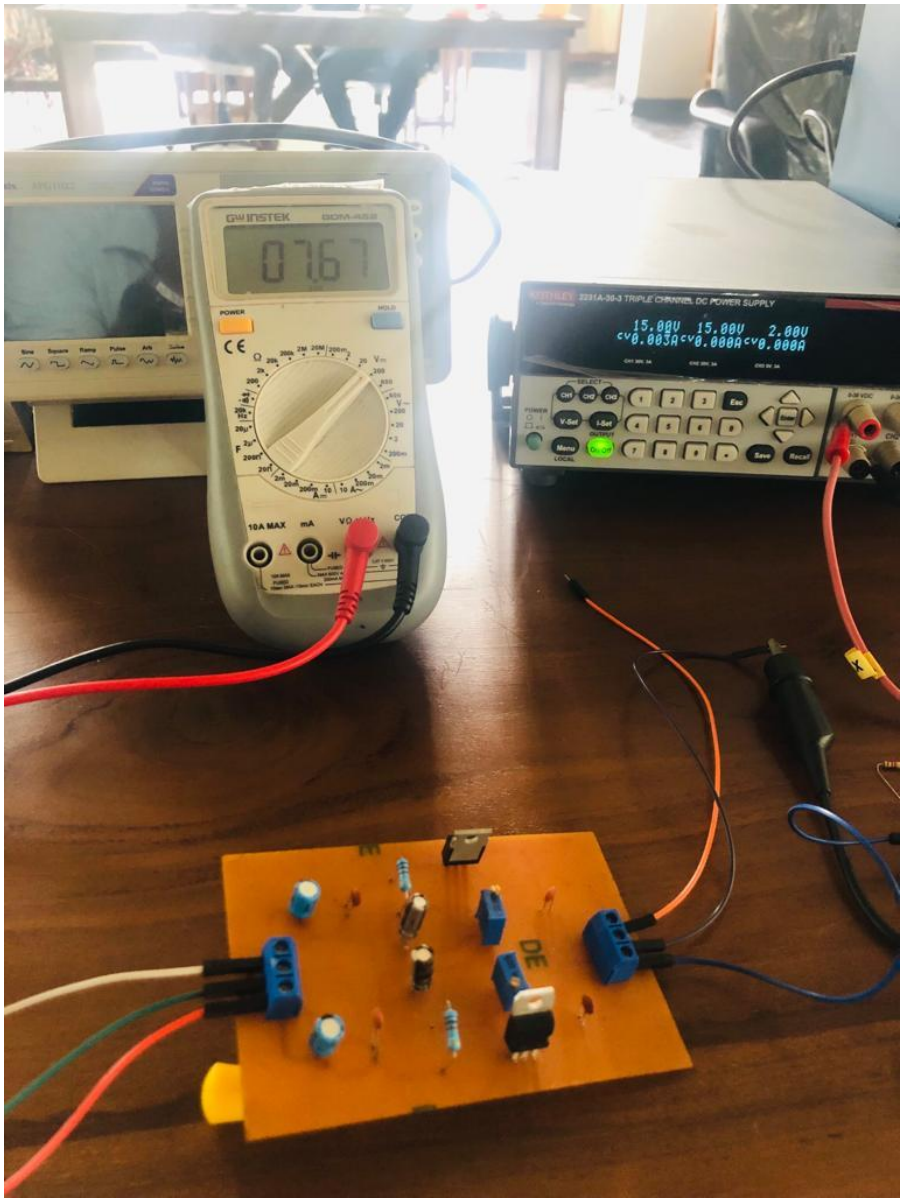

Figure 17 : Practical Simulation Results (7.67 V output voltage at 15 V input voltage)

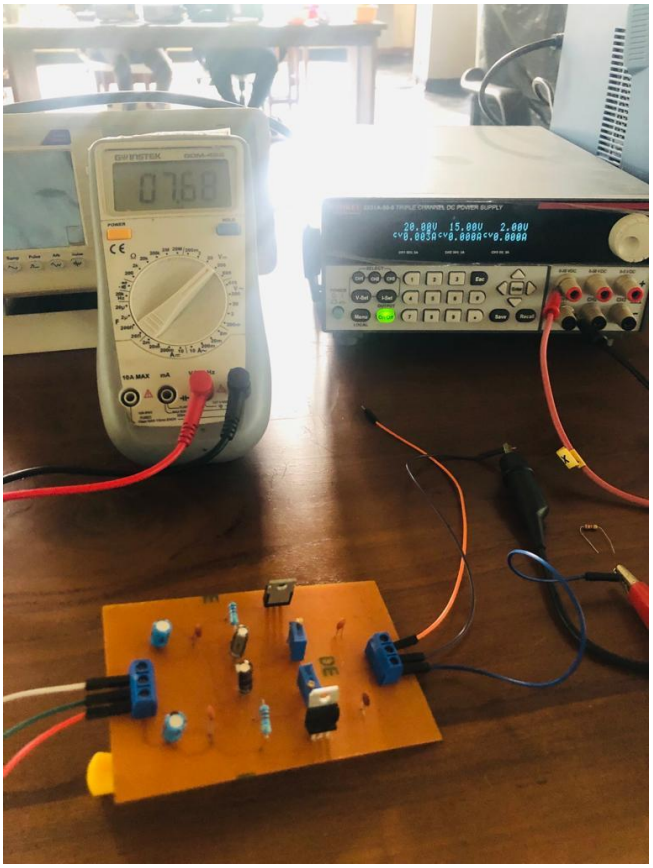

Figure 18 : Practical Simulation Results (7.68 V output voltage at 20 V input voltage)

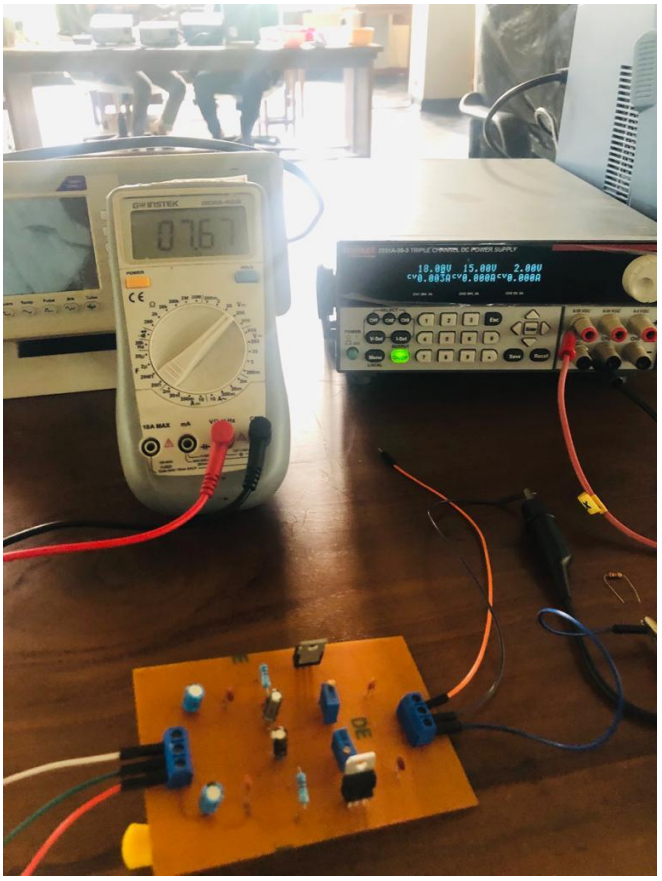

Figure 19 : Practical Simulation Results (7.67 V output voltage at18 V input voltage)

DISCUSSION

A dual variable power supply is an electronic device that provides two independent output voltage levels that can be adjusted separately. It is a versatile power supply that is commonly used in various applications, including electronics testing, prototyping, and repair

One practical problem that can cause the voltage to be changed in a dual variable power supply is component compatibility. Different electronic components have different voltage requirements, and it is essential to ensure that the voltage output of the power supply is compatible with the needs of the component. If the voltage is not adjusted to match the requirements of the component, it may not function properly or even be damaged.

Another practical problem that can cause the voltage to be changed in a dual variable power supply is voltage regulation. Voltage regulation refers to the ability of the power supply to maintain a consistent output voltage level, even as the input voltage or load changes. If the voltage regulation is poor, the voltage output of the power supply may fluctuate or drop, which can affect the performance of the components being powered. In this case, the voltage may need to be adjusted to compensate for the fluctuation or drop in voltage.

A third practical problem that can cause the voltage to be changed in a dual variable power supply is voltage drop. Voltage drop refers to the reduction in voltage that occurs as a result of current flowing through a component or wire with resistance. If the voltage drop is significant, it can cause the voltage output of the power supply to drop below the desired level, which can affect the performance of the components being powered. In this case, the voltage may need to be increased to compensate for the voltage drop.

The following reasons also affected to the change of the regulated voltage in dual variable power-supply.

1. Poor component quality: The quality of the components used in the power supply can affect its performance. Poor quality components may have higher tolerances or variations in their specifications, which can cause the voltage output of the power supply to be unstable or fluctuate.
2. Incorrect component values: Using components with incorrect values or tolerances can cause the voltage output of the power supply to be incorrect or unstable. For example, using

resistors with values that are too high or too low can affect the output voltage.

3. Poor circuit layout: The layout of the circuit board and the placement of the components can affect the performance of the power supply. Poor layout or improper grounding can cause noise or interference that can affect the voltage output.
4. Temperature: The LM317 and LM337 voltage regulators are sensitive to temperature changes. The voltage output of the power supply may change if the temperature of the voltage regulators changes significantly.
5. Aging of components: Over time, the components in the power supply may age and degrade, which can affect their performance and cause the voltage output of the power supply to change.

To mitigate these issues, it is important to use high-quality components, ensure that the component values and tolerances are correct, and pay attention to the circuit layout and grounding. Additionally, using heat sinks or fans to cool the voltage regulators can help maintain a stable voltage output. It is also important to periodically check the power supply and replace any aging components to ensure its continued performance.

REFERENCES

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[2] EE4105 – Electronics Project lecture notes.

[3] Jayasundare, Dr. N.D., 2015. Introduction to Electronic Engineering. 1st ed. Colombo.

[4] EE3301 – Analog Electronics lecture notes.