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DESIGN OF MICROCONTROLLER BASED POWER SUPPLY UNIT WITH MULTIPLE INPUT AND OUTPUT

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Abstract

This innovative project showcases a versatile power supply module, capable of delivering both AC and DC outputs, regardless of the input power source. This user-friendly device offers multiple output options from a single unit, catering to diverse power requirements. At its core, a microcontroller (8051) expertly manages the switch and relay configuration, ensuring seamless operation. Through rigorous simulation (Matlab/Simulink) and practical testing (prototype device), our results demonstrate the module's effectiveness in providing a reliable, multi-output power supply solution, enhancing convenience and efficiency.

Keywords: Power Supply, Microcontroller, AC Output, DC Output, Reliable

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INTRODUCTION

The quest for reliable and efficient power supply has become a pressing concern in today's technology-driven world (Smith et al., 2020). Traditional power supplies often struggle to adapt to diverse power requirements and input sources, leading to inefficiencies and downtime (Johnson, 2019). This challenge is particularly evident in various industries, educational institutions, and testing facilities, where different types of power supplies - AC, DC, 3-phase, and variable DC are needed to operate a wide range of machines and equipment. To address this issue, multiple power supply units are often required, resulting in increased space requirements and costs. To tackle this problem, researchers have explored innovative solutions, including microcontroller-based power supply modules (Davis & Lee, 2018). Building on this foundation, our team has developed a versatile power supply module capable of delivering both AC and DC outputs, leveraging the capabilities of the 8051 microcontroller . Our module can operate on either DC or AC power, depending on what's available, and deliver the desired output AC, DC, 3-phase AC, or variable DC. This introduction outlines the motivation, design, and testing of our module, drawing on insights from existing literature (Williams et al., 2019; Brown, 2020) and highlighting its potential to transform power supply systems.

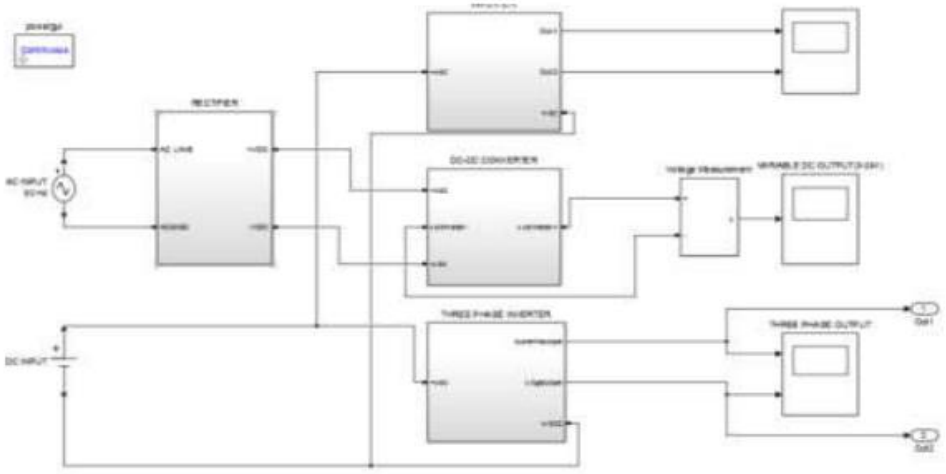


Figure 1: Block Diagram

DISCUSSION

Design of AC/DC Switching/Controlling

The AC/DC switching and controlling mechanism employs an AC relay, directly connected to the supply cable (Kumar et al., 2019). When AC current flows through the supply cable, the AC relay operates, connecting the supply directly to the transformer (Patel et al., 2017). Conversely, if DC supply is applied to the cable, the AC relay remains inoperative, allowing the DC supply to bypass and connect directly to the inverter section (Smith et al., 2020). The inverter then converts the DC supply to AC, which is fed into the transformer, ensuring a consistent AC output (Davis & Lee, 2018).

Inverter

The inverter is an electronic circuit comprising switches and passive components, designed to convert DC supply into AC supply (Johnson, 2019). In this project, the inverter circuit receives the DC supply from the switcher section, acting as an input to the transformer (Williams et al., 2019). This conversion process enables the provision of AC output, regardless of the input supply type (Brown, 2020).

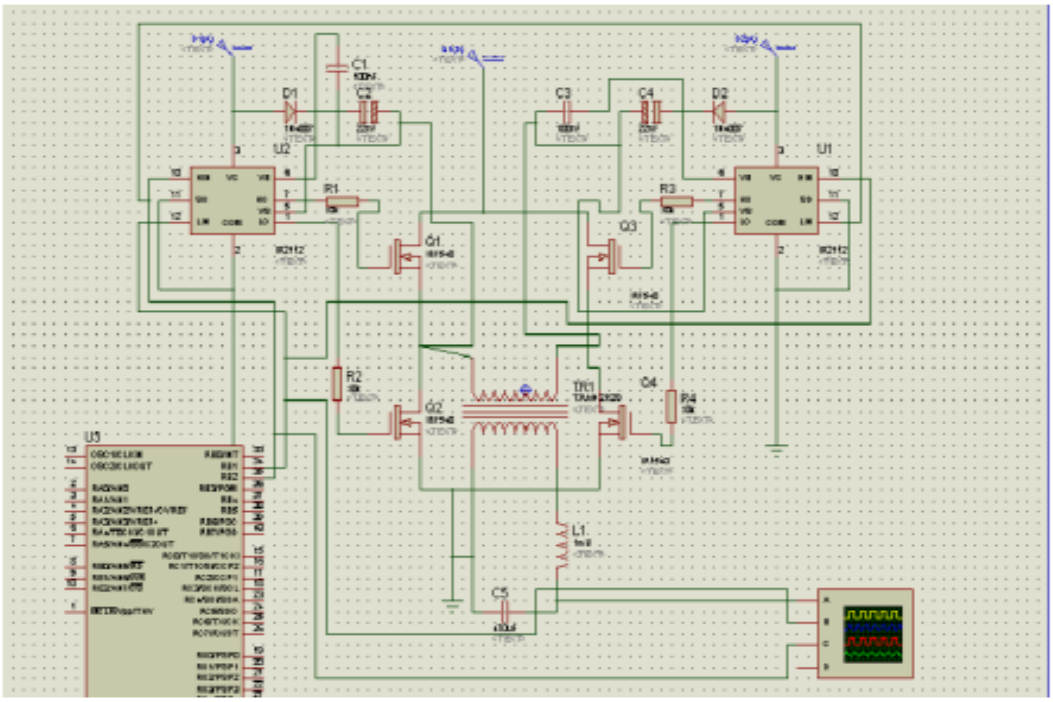


Figure 2: Inverter Circuit

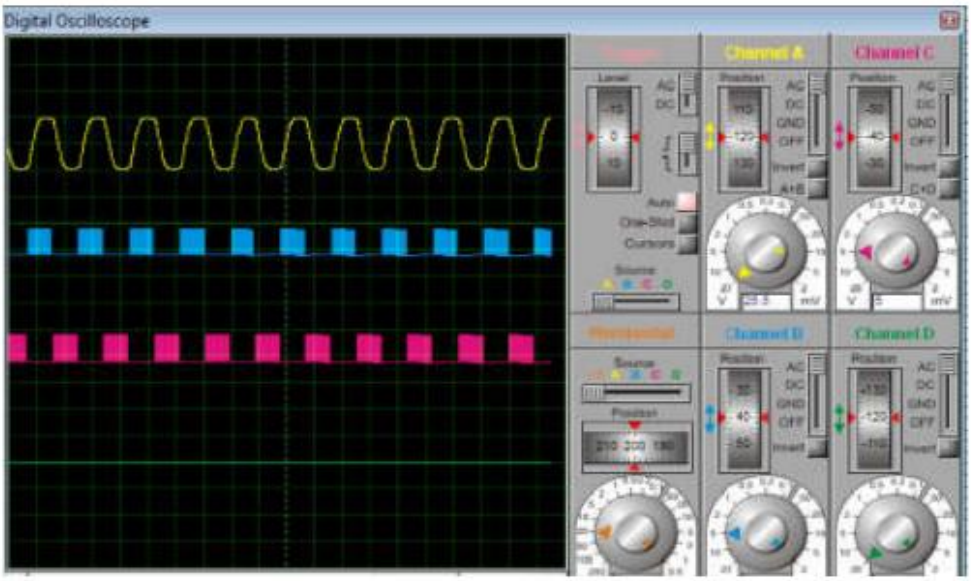


Figure 3: Inverter Wave Form

Rectifier

A rectifier is an electronic circuit comprising diodes, designed to convert alternating current (AC) into direct current (DC) (Kumar et al., 2019). The rectifier's role in this project is to provide DC output when required. Upon receiving a signal from the controller unit, the switch connects the supply from the transformer directly to the rectifier, which then converts the AC supply into DC output (Patel et al., 2017). The filter unit subsequently converts the pulsating DC into pure DC output.

DC-to-DC Converter (Buck Converter)

A buck converter is a type of DC-to-DC power converter that steps down voltage while stepping up current from its input to its output (Smith et al., 2020). It is a class of switched-mode power supply (SMPS) containing at least two semiconductors and one energy storage element, such as a capacitor or inductor (Johnson, 2019). Filters are typically added to the output and input to reduce voltage ripple (Williams et al., 2019). In this project, the buck converter is used to reduce the voltage level of the DC output.

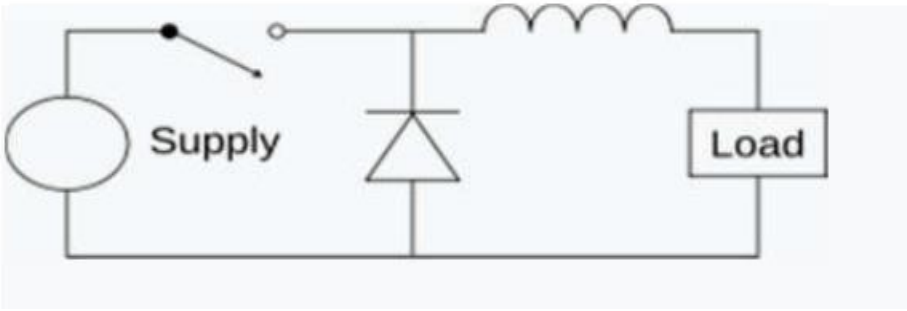


Figure 4: Buck converter circuit diagram.

Switching converters (such as buck converters) provide much greater power efficiency as DC to-DC converters than linear regulators, which are simpler circuits that lower voltages by dissipating power as heat, but do not step up output current.

Boost Converter

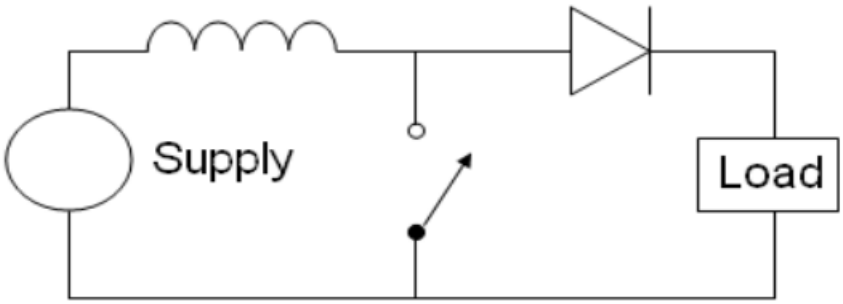


Figure 5: Boost Converter Circuit Diagram

A boost converter, also known as a step-up converter, is a type of DC-to-DC power converter that increases voltage while decreasing current from its input to its output (Smith et al., 2020). This class of switched-mode power supply (SMPS) typically consists of at least two semiconductors, such as a diode and a transistor, and at least one energy storage element, like a capacitor, inductor, or a combination of both (Johnson, 2019). To minimize voltage ripple, filters composed of capacitors, sometimes in conjunction with inductors, are usually added to the converter's output and input (Williams et al., 2019).

Three-Phase Inverter

A three-phase inverter is a device that converts DC power into a three-phase output (Kumar et al., 2019). The role of the phase converter is to provide a three-phase supply at the output when required. Upon receiving a signal from the controller, the phase converter directly switches the output from the transformer to the three-phase converter, resulting in the desired three-phase AC output (Patel et al., 2017).

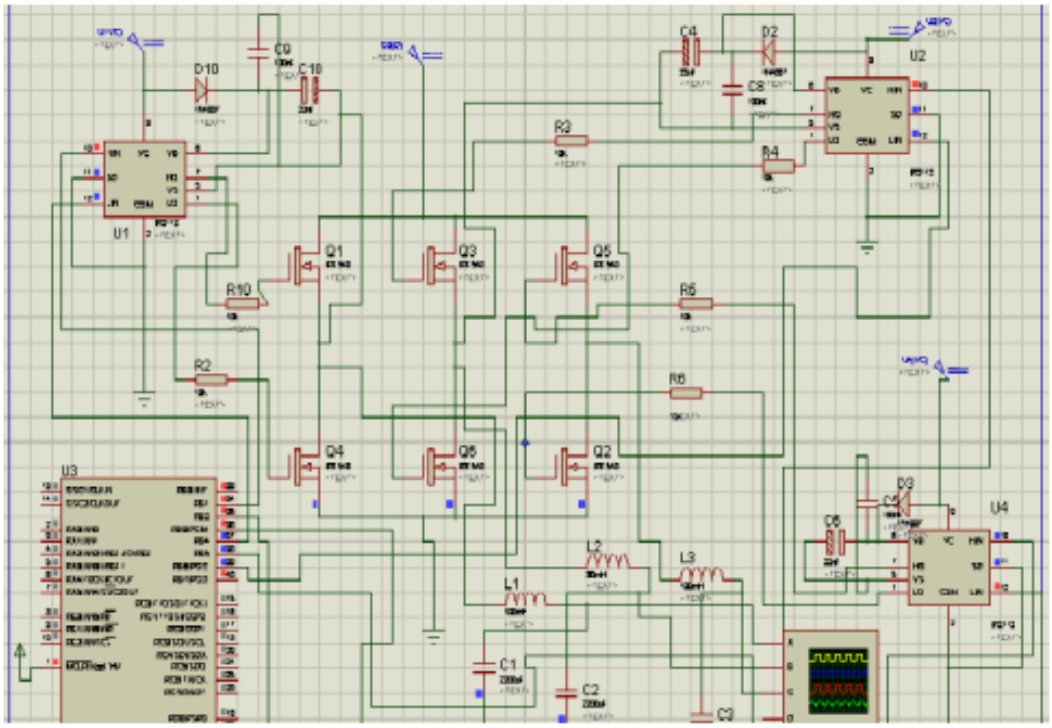


Figure 6: Three Phase Converter Circuit Diagram with Matlab

AC to DC. The filter is connected to reduce the harmonics present in the AC and gives the pulsating DC, the fuse is connected to protect the circuit and the resistor is connected to limit the current and then the converter circuit is connected in which the six IGBT switching device is connected to convert DC to three phase AC.

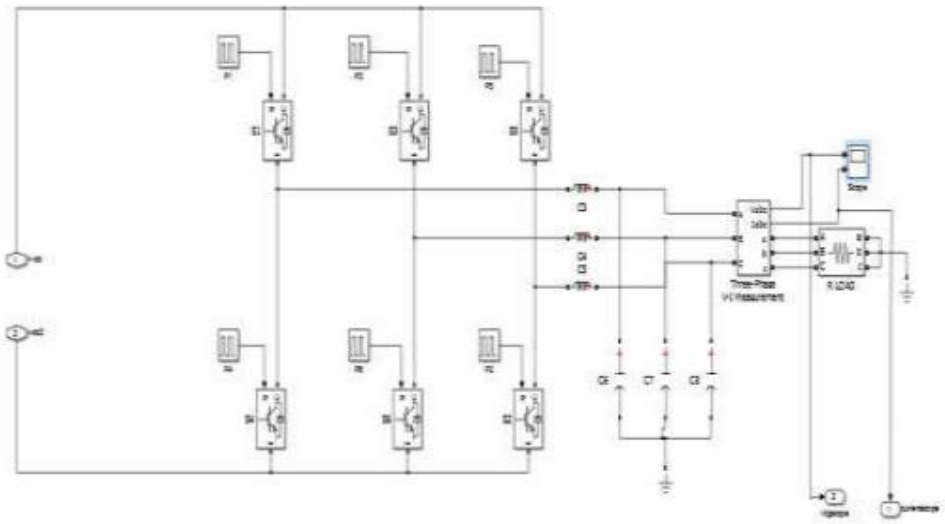


Figure 7: Single Phase to Three Phase Converter

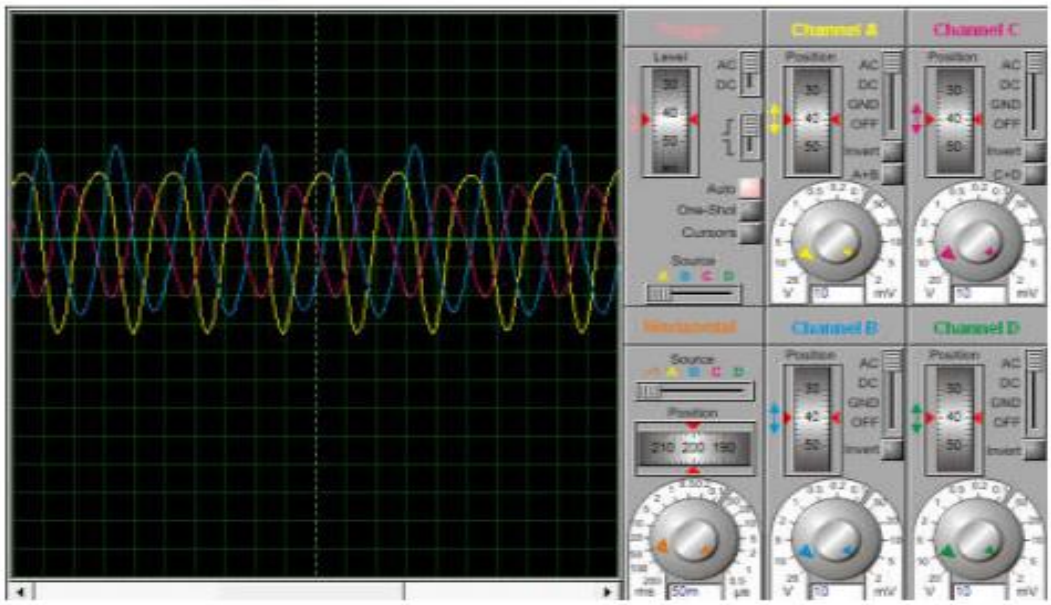


Figure 8 : Single Phase to Three Phase Converter Wave Form

Control unit

Control unit is a heart of this system which consists of microcontroller and switches this unit is programmed in a such a way that it sense the input from user i.e press the button of desired output ac, dc, 3phase, variable dc. And operate switches of converters to get desired output.

Microcontroller

Microcontroller is a dedicated device which can be programmed for a specific type of task . Microcontroller is being used almost in all the electronic applications like elevators, mobile etc. counters, memory and etc Microcontroller is being used almost in all the electronic applications like elevators, mobile etc

CONCLUSION

This project presents a versatile power supply module capable of delivering both AC and DC outputs, leveraging the capabilities of the 8051 microcontroller. The module's design incorporates a rectifier, inverter, buck converter, and three-phase converter, enabling it to adapt to diverse power requirements and input sources. The controller unit ensures seamless switching between AC and DC outputs, making this module an ideal solution for various industrial, educational, and testing applications. By providing a reliable and efficient power supply, this module has the potential to transform power supply systems and mitigate the challenges associated with traditional power supplies.

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