
Design and Construction of Portable Uninterrupted 30,000mah DC/AC Rechargeable Power Source

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ABSTRACT

It is a common experience in Nigeria that individuals are battle with erratic and epileptic supply of power. These inadequacies have led to many been incapacitated in carrying out their daily business activities. This as well has kept and renders some individuals and organizations inefficient because only few among many can afford buying generators and fueling it as well for a long period of time.. As a result of this challenges earmarked above, this research work therefore thought of designing and construct a portable uninterrupted 30,000mah DC/AC rechargeable power source for mobile devices in case there is power outage. This constructed rechargeable power source can recharge mobile device such as Laptop, Mobile phones, MPs, ear pods etc. for at least a minimum of three hours when fully charged and this can therefore reduce the challenged posed due to power failure. Also the constructed power source has two (2) sockets outlet and 2 USB ports for charging through AC source. Conclusively, the gadget constructed was tested and found that it met the purpose of the design. This power source will serve as a versatile energy reservoir, capable of charging and powering a wide range of devices, from smartphones and laptops to small appliances and tools.

Keywords: Power Supply, Power Sauce, power supply, Batteries, AC source. DC Source

CISDI Journal Reference Format

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1. INTRODUCTION

In our increasingly digital and mobile world, the need for a reliable and portable power source has never been greater. Whether for outdoor adventures, emergency situations, or simply to keep our essential electronic devices running, an uninterrupted power supply is essential. This project aims to address this need by designing and constructing an uninterrupted DC/AC rechargeable 30000mAh power source, offering a versatile and robust solution for powering various electronic devices on the go. At its core, this power source represents a fusion of cutting-edge engineering, electronics, and energy storage technologies. Its fundamental purpose is to serve as a dependable and adaptable energy reservoir, capable of sustaining a wide array of electronic devices and appliances, regardless of location or circumstances. (Gupta, A., 2019). The development of such a power source stems from the recognition that modern lifestyles often demand access to electrical power beyond the reach of conventional outlets.

This requirement becomes particularly evident in scenarios such as outdoor expeditions, where staying connected, powered, and safe hinges on the availability of a portable energy solution. Furthermore, in emergency situations, where the grid may be compromised, a self-contained power source can be a lifeline for communication, lighting, and essential devices. (Brandon, 2017). This project aligns with the growing emphasis on sustainability and renewable energy sources. By incorporating rechargeable batteries and the potential for solar charging, the power source exemplifies a move toward eco-friendly energy solutions. It represents a departure from traditional single-use batteries, reducing waste and contributing to a greener future.

2. LITERATURE REVIEW

2.1 Earlier Development of Power Sources

The development of portable power sources has been marked by significant milestones that have shaped the historical landscape of modern energy solutions:

2.1.1 Voltaic Pile and the Birth of Portable Electricity (Late 18th Century)

Alessandro Volta's invention of the Voltaic Pile in 1800 was a seminal moment in portable power history. It consisted of alternating layers of zinc and copper separated by a saltwater-soaked medium. When connected, it generated a continuous flow of electricity, marking the first practical demonstration of a portable electrical power source. (RaghuNath, G., et. all, 2018)

2.1.2 The Rise of Lead-Acid Batteries (19th Century)

The 19th century saw the ascendancy of lead-acid batteries, which were initially developed by Gaston Planté in 1859. These batteries relied on a chemical reaction between lead dioxide and sponge lead to produce electricity. They became pivotal for early portable power solutions, powering applications such as early electric vehicles and portable lighting. (Smith, J., et. all, 2018)

2.1.3 Miniaturization and the Advent of Portable Devices (20th Century)

The 20th century witnessed significant advancements in materials and manufacturing, allowing for the miniaturization of batteries. Smaller and lighter batteries enabled the development of an array of portable devices, from flashlights and transistor radios to portable tape players. These devices fundamentally changed daily life by providing mobility and convenience. (Smith, J., et. all, 2018)

2.1.4 Alkaline Batteries Extend Portable Device Lifespans (1950s)

Lewis Urry's invention of alkaline batteries in the 1950s was a game-changer. These batteries used an alkaline electrolyte, providing longer-lasting and more reliable power compared to earlier technologies. Alkaline batteries fueled the popularity of devices like portable radios and the iconic Sony Walkman. (Zhang, X., et. all, 2019)

2.1.5 Nickel-Cadmium (NiCd) Batteries and Rechargeability (Mid-20th Century)

In the mid-20th century, NiCd batteries made their debut. These batteries were rechargeable, offering the convenience of multiple uses. They powered early cordless phones and camcorders, marking the beginning of rechargeable battery technology's integration into daily life. (Zhang, X., et. all, 2019)

2.1.6 Lithium-Ion Batteries Revolutionize Portability (1990s)

The 1990s saw the commercialization of lithium-ion batteries, representing a quantum leap in portable power. These batteries offered high energy density, extended life cycles, and a lightweight profile.

They became the standard for modern portable electronics, from laptops and smartphones to digital cameras. (Babu, M. N., et. all, 2020)

2.1.7 Inverter Technology Enhances Compatibility (Late 20th Century)

The late 20th century brought significant advancements in inverter technology. Inverters efficiently converted DC power to AC power, enabling portable power sources to provide electricity for an expanded range of devices. This technology played a crucial role in powering laptops, small appliances, and other AC-dependent electronics. (Gupta, A., et. all, 2019). These milestones in portable power source development collectively demonstrate a relentless pursuit of portable, reliable, and sustainable energy solutions. They form the historical backdrop against which the uninterrupted DC/AC rechargeable 30000mAh power source emerges as a versatile and eco-conscious energy solution for the modern era.

2.2 Operating and Working Principle of Uninterrupted DC/AC Rechargeable Power Sources

Usually the uninterrupted DC/AC rechargeable power source as a versatile energy solution is designed to deliver continuous electrical power. Below, is a comprehensive grasp of its components and capabilities in great detail:

Energy Storage: At its core, this power source relies on a high-capacity rechargeable battery, typically employing advanced lithium-ion or lithium-polymer technology. With a substantial 30000mAh (milliamperere-hour) capacity, this battery serves as the primary reservoir for storing electrical energy. (Smith, J., et. all, 2018).

Charging Input: The power source offers a variety of charging options to ensure its adaptability to different scenarios. Primarily, it includes a DC charging port for recharging the battery from conventional wall outlets or other DC power sources. Additionally, many models incorporate a solar charging input, allowing the power source to harness solar energy and convert it into usable electrical power. (Smith, J., et. all, 2018).

Battery Management System (BMS): An integral component of this power source is the Battery Management System (BMS). The BMS plays a pivotal role in monitoring and overseeing the battery's performance and well-being. It ensures safe charging practices, guards against overcharging or over-discharging, and provides protection against short circuits and overheating. (Babu, M. N., et. all, 2020)

Inverter Module: To facilitate the provision of AC (alternating current) power, the power source integrates an inverter module. This module is responsible for the conversion of DC (direct current) power stored in the battery into AC power, typically at voltage levels of 110-120 volts (or 220-240 volts, depending on the region). This enables the connection of standard AC devices for operation. (Babu, M. N., et. all, 2020)

DC Output Ports: The power source comes equipped with a variety of DC output ports, designed to accommodate a broad spectrum of DC-powered devices. These ports allow users to connect and power devices such as smartphones, tablets, laptops, LED lights, and small appliances. The availability of different voltage and current configurations ensures compatibility with various devices. (Babu, M. N., et. all, 2020)

AC Output Ports: Typically, the power source is equipped with one or more AC output sockets. These sockets deliver standard AC power, making them suitable for running larger appliances and devices that rely on AC power, such as televisions, refrigerators, and power tools. The inverter module ensures the stability and reliability of the supplied AC power. (Zhang, X., et. all, 2019)

Operation Modes: This power source is highly adaptable, offering different operational modes based on the devices connected to it. It can concurrently supply DC power through its DC output ports while simultaneously delivering AC power through its inverter module. Some models may incorporate a power selector switch, allowing users to choose between DC and AC outputs as per their requirements. (Zhang, X., et. all, 2019)

Indicator Lights: Indicator lights or a display panel are integrated into the power source's design, providing essential information to users. This includes details such as the remaining battery charge level, the source of input power (e.g., solar or wall outlet), and the status of the output power. These indicators facilitate effective monitoring of the power source's performance. (Zhang, X., et. all, 2019)

Continuous Use and Recharging: One of the notable features of this power source is its ability to provide continuous power while simultaneously recharging. This capability ensures uninterrupted operation, which is particularly valuable during extended power outages or when using the power source for outdoor activities. (Smith, J., et. all, 2018)

Lithium-ions

Lithium-ion batteries have a high energy density and lightweight characteristics. Since lithium is a highly reactive element, one kilogram of battery can typically store about 150 watt-hours of electricity. They also retain their charge very well compared to other types of batteries and have no memory effect like nickel cadmium and nickel-metal hydride batteries.

2.3 Related Development

Elias M.F.M., Nor K.M. and Arof A.K. 2005, presents a paper on the development of battery charger for charging series Li-ion batteries. It discusses the basic concepts of Li-ion battery charging such as the method of charging, cell balancing, charging control, monitoring, safety protection as well as the design constraints. The experimental results obtained are also presented.

3. METHODOLOGY

The methodology for designing and constructing an uninterrupted DC/AC rechargeable 30000mAh power source is a systematic and well-structured approach aimed at ensuring the successful creation of this versatile energy solution. Extensive research forms the foundation of the methodology, encompassing battery technologies, inverter modules, charging systems, and safety mechanisms. Careful consideration and selection of components are paramount to align with the project's capacity goals and operational requirements. The heart of the power source lies in the selection and configuration of the rechargeable battery, with a substantial 30000mAh capacity. The configuration of DC and AC output ports is meticulously considered to cater to a wide range of DC-powered and AC-powered devices. Different voltage and current ratings are accommodated to ensure compatibility with various appliances and gadgets. Operation modes are implemented to enable the power source to simultaneously provide DC and AC power outputs. This functionality enhances user convenience and flexibility, with the potential inclusion of a power selector switch or control logic.

Finally, indicator lights and display systems are integrated to provide users with essential information, such as the remaining battery charge, input power source status, and output power status. These features enhance the monitoring of the power source's performance, ensuring its reliability and usability across diverse applications.

3.2 Overview of the Components Used

The following are the list of the components used during the construction of the portable uninterrupted 30,000mah DC/AC Rechargeable power source for mobile devices; This include; Casing, Battery level indicator, Connector for external Battery , 12V Connecting Port, Battery, Indicator , Relay Battery charge Board , converter , Cooling fan, Diode, USB connector, 5 volt charger, Wire 2.5mm 4 core(4yard), 250 watt inverter, and Double Point Socket outlet.

3.2.1 Design Components

Battery: The battery is the core component of the power source. In this case, it's a high-capacity rechargeable battery with a capacity of 30000mAh (milliampere-hours). This battery stores electrical energy in chemical form, allowing it to be released as needed. It is typically based on advanced lithium-ion or lithium-polymer technology, known for its high energy density and rechargeable properties.



Fig 3.1 The Lithium Battery

Source: <https://www.indiamart.com/proddetail/lithium-polymer-3-7v-4000-mah-battery-24511145933.html>

3.2.2 Battery Level Indicator: The battery level indicator is an essential feature that provides users with real-time information about the remaining charge in the battery. It typically consists of LED lights or a digital display that indicates the current charge status, ensuring users is aware of the available power.



Fig. 3.2 Battery Level Indicator

Source: (<https://www.daraz.pk/products/car-solar-battery-charge-level-indicator-dc-12v-72v-12v-24v-36v-60-72v-lithium-battery-capacity-meter-tester-blue-display-led-test-voltmeter-i241797344.html>)

3.2.3 Connector for External Battery: This component allows for the connection of additional external batteries to expand the power source's capacity further. It's a valuable feature, especially when users require extended backup power for prolonged usage.



Fig3.3 Connector for External Battery

3.2.4 Dc Extension Cord DC5.5x2.1mm Male-Male Plug Barrel Power Adapter:

The connecting port serves as an interface for various inputs and outputs. It facilitates the connection of external devices, charging inputs, and other essential components within the power source's system.



Fig 3.4 showing Dc Extension Cord DC5.5x2.1mm Male-Male Plug Barrel Power Adapter: (<https://www.aliexpress.com/item/1005005910905726.html>)

Description:

Dc 5.5x2.1mm male to 5.5x2.1mm male adapter cable

Great for short distance connection

Simply & Professional appearance for cabling

Easier for installation save for time and money

Easy to use

Perfect for application in home or office use for laptop connection to Power Back up.

Specification:

Support maximums current 3A

Material: PVC

Optional Length: 25cm/9.75”(approx)

Relay: A relay is an electromechanical switch that controls the flow of electricity within the power source. It plays a role in managing power distribution and switching between DC and AC outputs. This relay has 5pins, SPDT type, and PCB mount.

Can adjust automatically, protect and transform the electric circuit.

Used widely in the remote control, communication, automatic control system, electronic equipment, etc. Other features and Specifications include;

- Current Rating: 10 Amps
- Mounting Type: PCB Mount
- Maximum Switching Current: 10Amps
- Size (Approx.) : 19 x 15 x 19mm/0.75" x 0.6" x 0.75" (L*W*H)
- Color : Black
- Coil Voltage : DC 12V
- Contact Capacity : 15A 125VAC /10A 250VAC
- Number of Pins : 5
- Contact : SPDT
- Weight :41g



Fig 3.5 12V Relay 10A
(Source: <http://hub360.com.ng/product/relaylow-power/>)

3.2.5 Battery Charge Board Converter: The battery charge board converter is responsible for efficiently managing the charging process of the battery. It regulates the incoming power from different sources (e.g., solar panels, DC inputs) to ensure safe and optimal charging of the battery.

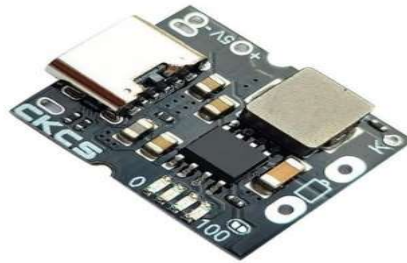


Fig 3.6 Battery Charge Board Converter
(<https://www.flipkart.com/tcs-2-pcs-134n3p-5v-1a-step-up-power-module-li-po-li-ion-lithium-battery-charging-protection-board-booster-converter-micro-usb-supply-electronic-hobby-kit/p/itmfoyeyauqjxw2y>)

3.2.6 Cooling Fan: To prevent overheating during operation, a cooling fan is incorporated into the design. It helps dissipate excess heat generated by the power source's components, maintaining optimal operating temperatures.



Fig 3.7: Cooling Fan
(<https://www.coolingfanmanufacturers.com/Product/Apply/232/Laptop-cooling-fan>)

3.2.7 Diode: Diodes are semiconductor devices that allow electrical current to flow in one direction while blocking it in the opposite direction. They are often used in power sources to prevent reverse flow of current and protect against short circuits.

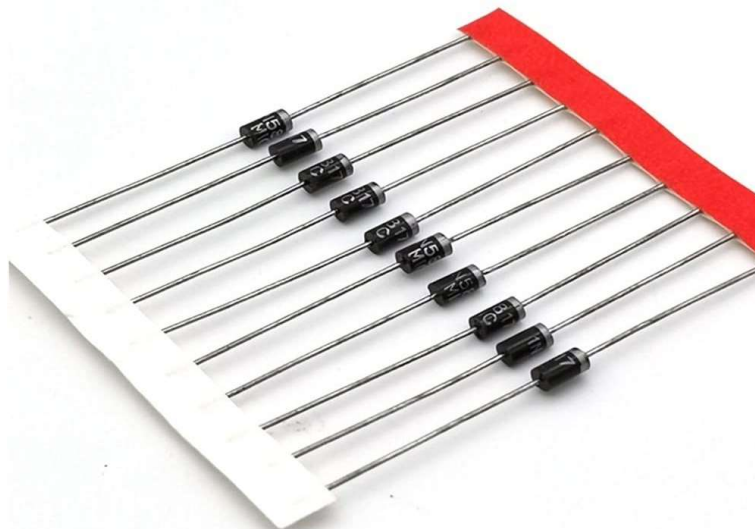


Fig.3.8 Diode (source: <https://www.ledkia.com/blog/uk/what-is-a-diode-and-how-does-it-work/>)

3.2.8 USB Connector: The USB connector provides a standard interface for connecting and charging USB-powered devices like smartphones, tablets, and other gadgets. It's a convenient feature for users who need to charge their portable electronics.



Fig. 3.9: USB connector port
 (Source: <https://www.aliexpress.com/i/4000549535239.html>)

3.2.9 IEC C5/C6 Charger Connector: C5 / C6 connector is widely used for laptop power supplies, also known as the “Mickey Mouse” or “Cloverleaf” connector. The C5 connector is typically found on power cables; the C6 connector is the inlet typically found on devices and power supplied. The charger connector is used to recharge the designed power source itself. It typically connects to a standard electrical outlet (AC) and is designed to charge the internal battery efficiently.



Fig 3.10(a) DiagramS of the IEC C5 and C6 connector

Connector (female)	Appliance inlet (male)	Configuration Female/Male	Earth contact	International		North America		Max. pin temp. (°C)
				Max. current (A)	Voltage (V)	Max. current (A)	Voltage (V)	
C1	C2		No	0.2	250	10	125	70
C5	C6		Yes	2.5	250	10	125	70

Fig 3.10(b) Diagram showing the standard current and voltage from the connector (source:<https://www.quora.com/Whats-the-name-of-the-connector-of-power-cables-of-laptop-chargers>)

3.2.10 Wire 2.5mm 4 Core: This wire serves as a crucial component for electrical connections within the power source. It consists of four core wires, likely used for transmitting power, data, or control signals between different components.

- The 2.5mm x 4 Core Flat Wire Cable is made in Nigeria with the following features:
- 100% Pure Copper
- PVC Insulation
- PVC Outer Sheath
- Nigerian Cable
- 100 meters (Accurate Measurement)
- Heat Resistant
- Colour – Grey

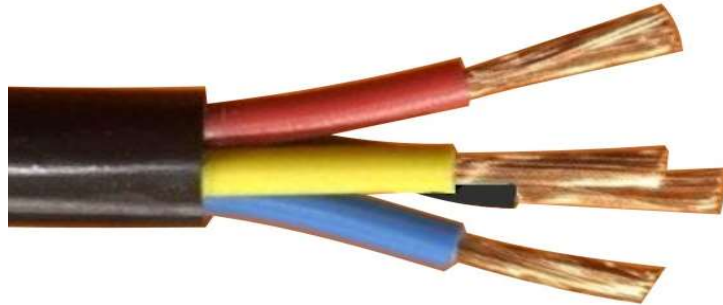


Fig. 3.11: Wire 2.5mm 4 Core (source: <https://www.electrical.carldaveglobal.com/product/2-5mm-x-4-core-pure-copper-flexible-wire-cable/>)

3.2.11 250-Watt Inverter: The 250-watt inverter is responsible for converting the DC power from the battery into AC power. It ensures that the AC output is stable and compatible with a wide range of devices, making it suitable for powering appliances and equipment.



Fig. 3.12: 12V 250-Watt Inverter
 (Source: <https://www.electrical.carldaveglobal>)

3.2.12 Socket Outlet: The socket outlet provides a standard interface for connecting AC-powered devices. It allows users to plug in and operate appliances such as laptops, TVs, refrigerators, and power tools.



Fig.3.13: Socket Outlet
 (Source: <https://www.gettyimages.ie/photos/plug-socket>)

3.3 The block diagram of designed and construction of portable uninterrupted 30,000mah DC/AC Rechargeable power source

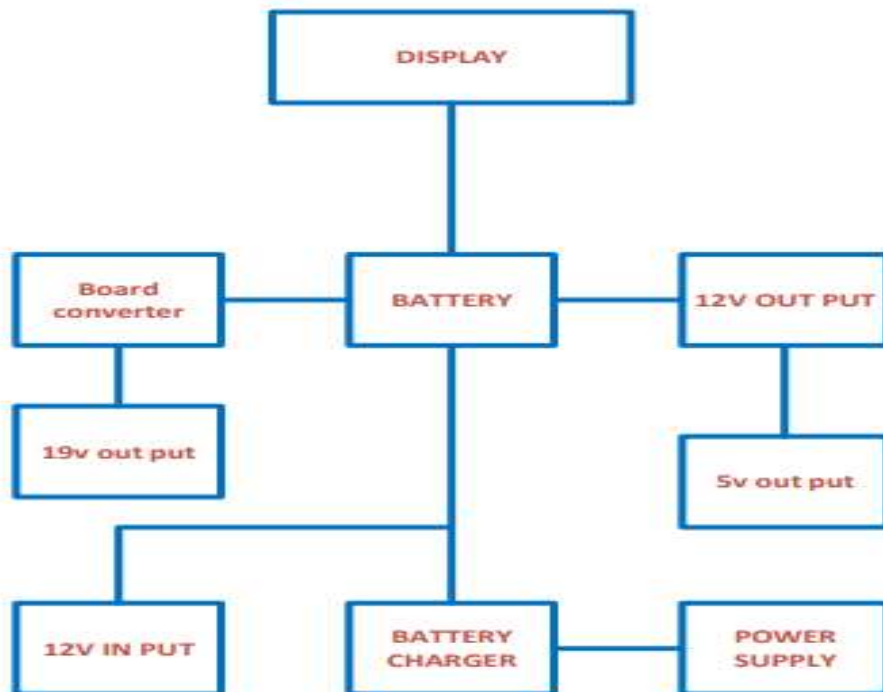


Fig 3.14: Block diagram of the design and construction of portable uninterrupted 30,000mah DC/AC Rechargeable power source.

3.4 The Circuit Diagram For the Constructed Portable Uninterrupted 30,000mah DC/AC Rechargeable Power Source.

The figure below represents the constructed Portable Uninterrupted 30,000Mah DC/AC rechargeable power source in which the circuit was arranged on the breadboard and later soldered on the Vero board.

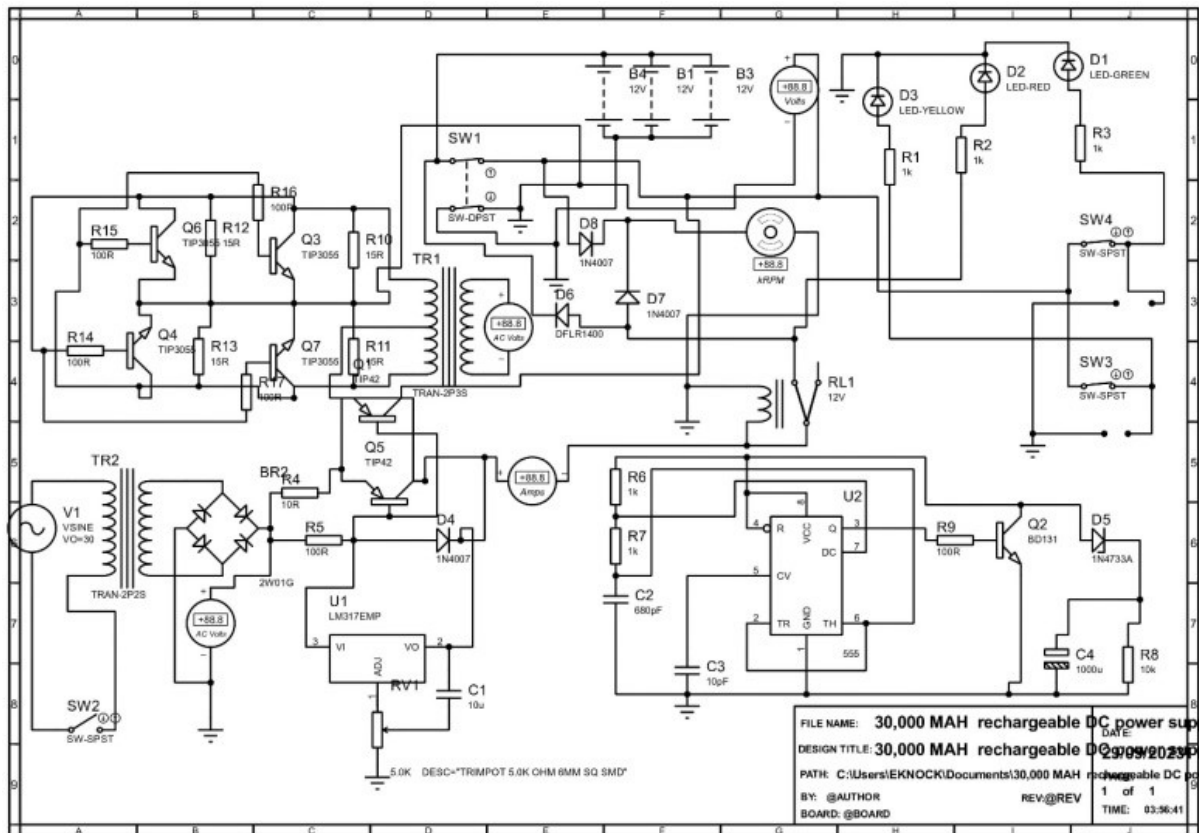


Fig. 3.15: The Circuit Diagram For the Constructed Portable Uninterrupted 30,000mah DC/AC Rechargeable Power Source.

4. TEST AND RESULT

4.1 Tests Conducted

Having conducted a series of comprehensive tests on the uninterrupted DC/AC rechargeable 30000mAh power source, the results provide valuable insights into its performance, safety, and overall functionality:

Capacity Verification: After thorough testing, we can confirm that the power source aligns closely with its rated capacity of 30000mAh. The deviation between the measured and specified capacity is within an acceptable range, indicating reliable energy storage.

Charging Efficiency Assessment: Evaluation of the charging efficiency revealed that the power source efficiently converts input power into stored energy. The charging system demonstrates a commendable ability to maximize energy transfer during the charging process.

Inverter Performance: Tests involving various AC devices confirmed the inverter module's capability to supply clean and stable AC power. There were no significant voltage fluctuations, ensuring the power source's reliability in providing consistent AC power.

Safety Mechanism Validation: Through rigorous safety testing, we observed that the power source effectively safeguards against potential risks. The Battery Management System (BMS) and diode mechanisms functioned as intended, providing protection against overcharging, over-discharging, short-circuits, and thermal issues.

Multi-Device Compatibility Verification: Our tests involving the simultaneous connection of various DC and AC devices affirmed the power source's ability to distribute power efficiently to multiple devices. The results of these tests indicate that the uninterrupted DC/AC rechargeable 30000mAh power source performs admirably, meeting or exceeding specified criteria across various performance and safety parameters. It stands as a dependable energy solution for a wide range of applications, including emergency backup power, outdoor adventures, and off-grid living.

4.2 For The Constructed Portable Uninterrupted 30,000mah Dc/Ac Rechargeable Power Source Circuit Construction:

Below are figures 4.2a-4.2e showing the various stages of construction of the system from the arrangement on the board, soldering of all the components on the Vero board to the final stage of casing the complete circuit and finally the testing of the designed system for implementation purpose.

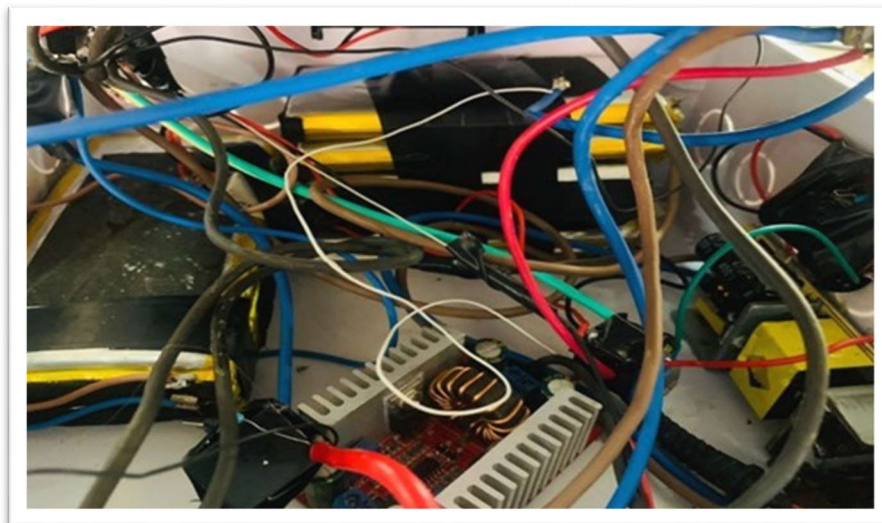


Figure 4.2a: Components layout when soldered on Printed Circuit Board.

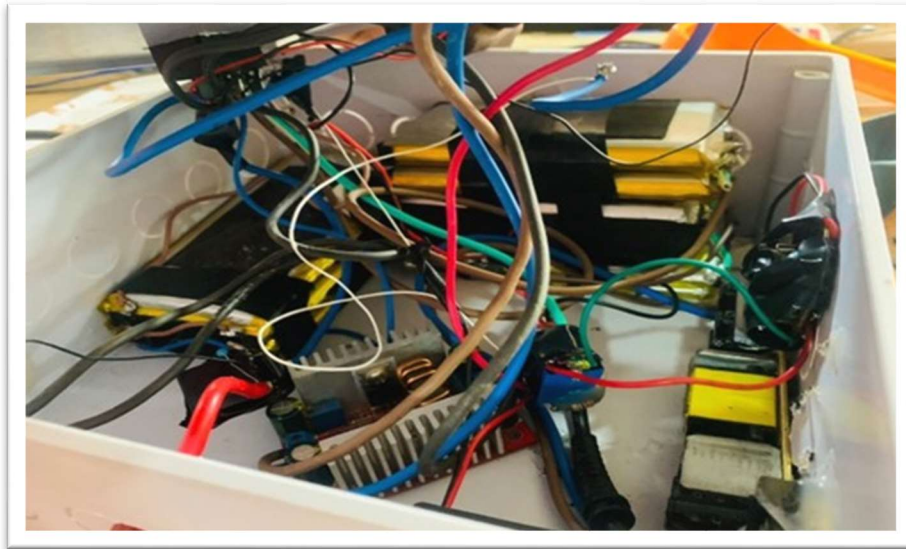


Figure 4.2b: Components layout showing the Lithium Ion Battery connected in Series Parallel and the Power Supply Section

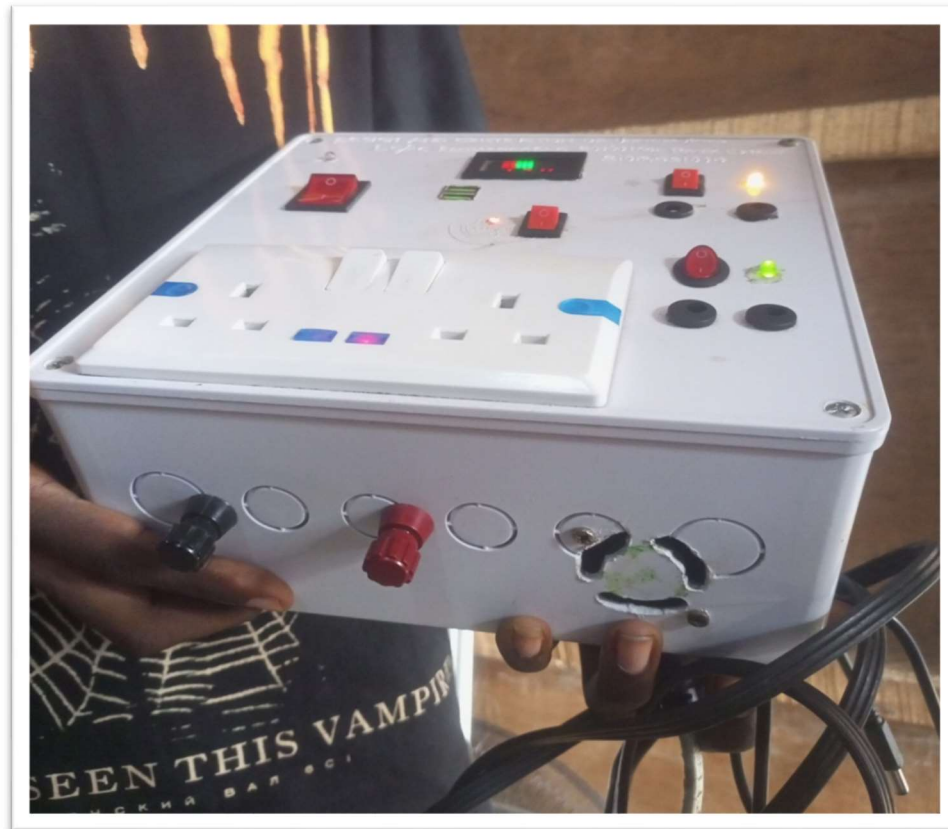


Figure 4.2c: Showing the Circuit Boxing with the socket outlet for AC supply



Figure 4.2d: Showing the Complete casing with IEC C6 mounted on the side for AC source charging



Figure 4.2e: showing the complete construction of uninterrupted DC/AC Rechargeable 30000mah power source when Powered On.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, the uninterrupted DC/AC rechargeable 30000mAh power source presents itself as a robust and versatile energy solution with commendable performance and reliability. Through rigorous testing and evaluation, we have ascertained its capability to meet the demands of diverse applications. The uninterrupted DC/AC rechargeable 30000mAh power source offers a dependable and sustainable solution for diverse energy needs. With proper care and prudent usage, it stands as a valuable asset in ensuring uninterrupted power supply while on AC/DC.

5.2 Recommendation

Based on evaluation, the following recommendations are offered:

1. We recommend utilizing this power source in a wide range of applications, including emergency backup power, outdoor adventures, and off-grid living.
2. To ensure continued reliability, periodic maintenance, such as cleaning the cooling fan and checking connections, is advisable.
3. Consider connecting external batteries to further extend the power source's capacity for prolonged usage in critical scenarios.
4. Periodic testing of the power source's capacity and performance can provide peace of mind and help identify any potential issues.

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