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Smart UPS Battery Charging System Utilizing GSM Technology for Accurate Battery Backup Estimation

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Abstract
UPS, which stands for Uninterruptible Power Supply, is a supply system that acts as a bridge between the electric grid and the consumer. It consists of electric hardware components and batteries. The primary purpose of UPS is to provide emergency power supply to critical locations such as hospitals, computer networks, communication systems, and industrial processes.

In the current market, there are various types of UPS available, but some essential features are still missing. To address this, we are working on developing a smart UPS system that includes battery backup estimation based on load changes. This means we utilize a microcontroller and an LCD display to show the remaining life of the batteries or backup batteries. This feature allows workers to easily understand the status of the UPS and take necessary actions within the required time duration.

Additionally, we have integrated a GSM module into our UPS system. This enables the system to send text messages at fixed intervals to the designated mobile device of the personnel responsible for the particular UPS. This feature ensures timely communication and facilitates efficient management of the UPS.

By the end of our paper, we aim to create a reliable and user-friendly UPS system that surpasses the functionalities of other UPS systems available in the market.

Keywords: Uninterruptible Power Supply (UPS), Global System for Mobile Communications (GSM), Monitoring, LCD Display, Battery Back up

1. INTRODUCTION

UPS, an acronym for Uninterruptible Power Supply, functions as a device that connects the electric grid to the consumer. It consists of electrical components and rechargeable batteries. The primary purpose of this device is to provide a consistent and uninterrupted power supply to critical loads. The power required to operate these loads is sourced either from the utility or from the battery during a mains outage.

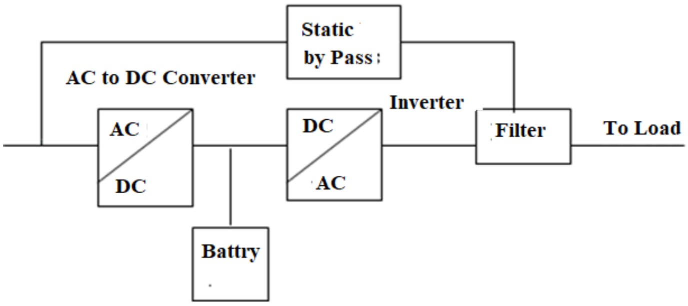

Figure 1 Basic Block Diagram of UPS System

Power from a wall socket can sometimes be unreliable and prone to abnormalities such as blackouts, brownouts, spikes, surges, and noise. These interruptions can range from being a mere inconvenience to causing significant damage to electronic equipment and loss of data in computer systems. To address this issue, Uninterruptible Power Supply (UPS) acts as a buffer by providing clean and reliable power to vulnerable electronics. The fundamental principle behind a UPS is to store energy during normal operation through battery charging and release it through DC to AC conversion during a power failure. While traditional UPS systems were designed using analog components, modern systems can now incorporate a microcontroller with AC sine wave generation, offering numerous advantages [1].

As the global population continues to expand, there is an ever-growing need for electricity, placing a significant strain on power-generation and distribution facilities worldwide. Despite efforts to ensure a reliable power supply, the high demand for electricity increases the likelihood of power outages and other electrical disruptions, such as brownouts. Existing uninterruptible power supply (UPS) systems offer users extended backup power, allowing them to continue using electronic devices like personal computers [2]. However, these UPS systems only provide minimal voltage regulation and filtering for disturbances. Additionally, UPS systems equipped with microcontrollers for monitoring and display purposes are considerably more expensive than standard options available in the market. The incorporation of microcontrollers in UPS systems allows for a wide range of programming and hardware control applications. The objective of this project is to design a UPS that serves as an emergency power supply for critical loads while also featuring a microcontroller-based monitoring system.

Mobility and adaptability have become essential in today's fast-paced society. Individuals can no longer afford to be restricted to a fixed power source location while using their equipment. To address this issue, DC/AC power inverters were invented. Although the position of power inverters in the market is well-established, there are various features that can be enhanced. A comprehensive analysis comparing different power inverters has been compiled. Apart from variations in power wattage, cost per wattage, efficiency, and harmonic content, power inverters can be categorized into three groups: square wave, modified sine wave, and pure sine wave. A cost analysis reveals that while pure sine wave power inverters offer the best power quality performance, they also come with a significant increase in cost per unit power. Another aspect that can be improved is the efficiency of the inverter. The standard sine wave in the market has an average efficiency of 85-90%. Power dissipation resulting from efficiency flaws leads to heat generation and a loss of 10-15% power, ultimately shortening the operational lifespan of inverters. Additionally, the quality of the output power could be enhanced [3]. It is crucial for the output signal to be as clean as possible, as distortion in the signal reduces efficiency and can potentially damage sensitive equipment, particularly in the case of square wave inverters that produce unwanted harmonics.

When designing any type of power supply, it is vital to consider the target market and position the product accordingly. Our aim is to design a 300-watt power inverter that offers optimal pure sine wave performance at a minimal cost. In order to meet the design requirements, we must overcome several technical challenges. Our primary constraint is to produce power at a lower cost per unit than what currently exists in the market. Furthermore, our efficiency will exceed 90%, ensuring that even under maximum load, less than 10% of power is wasted.

2. PROBLEM IDENTIFICATION

Nowadays, electricity has become an addiction in daily life for everyone. It has become an integral part of human existence. However, it is not always possible to provide a continuous power supply everywhere due to high demand compared to power generation. Consequently, power cuts have been introduced in certain areas. These power cuts create various problems in people's daily routines for a certain period of time. In critical places like hospitals and banks, power cuts can cause significant issues for individuals. To address these problems, uninterruptible power supplies (UPS) have been invented. There are various types of UPS available in the market for different applications [5].

The current UPS models offer users extended periods of backup power, allowing them to continue using electronic equipment such as air conditioners, computers, and domestic appliances.

2. METHODOLOGY

The necessary hardware specifications for developing our electronic system are as follows:

IC SG 3525

The IC SG 3525 finds wide application in various devices such as DC-DC converters, DC-AC inverters, home UPS systems, solar inverters, power supplies, battery chargers, and many more. By gaining a thorough understanding, you will be able to utilize the SG 3525 in these applications or any other application that requires PWM control [4].

Figure 2 Pin Diagram of SG 3525

IC IRF 540N (MOSFET)

The Rectifier utilizing MOSFETs employs sophisticated manufacturing methods to attain remarkably low on resistance per silicon area. This advantage, coupled with the rapid switching speed and robust device design that MOSFETs are renowned for, offers the designer an exceedingly efficient and dependable component suitable for a diverse range of applications.

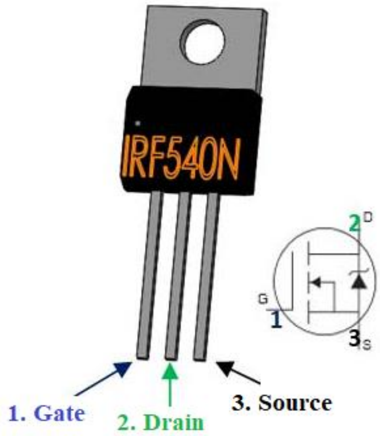

Figure 3 Pin Function of IC 540N

OPTO-COUPLER (TLP 250)

The TLP 250 Opto-coupler comprises of three main components: an input stage, an output stage, and a power supply connection. It functions as an optically isolated driver, where both the input and output are "optically isolated". This isolation is achieved through the use of optical components - the input stage consists of an LED, while the output stage is light sensitive [6].

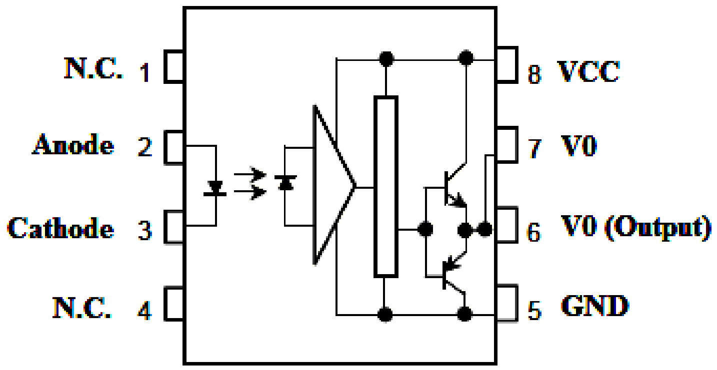

Figure 4 Pin Configuration of TPL 250

Microcontroller (Arduino UNO)

The Arduino Uno is a microcontroller board that utilizes the ATmega328 (datasheet) as its foundation. It is equipped with 14 digital input/output pins, out of which 6 can function as PWM outputs. Additionally, it features 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button.

ACS 712

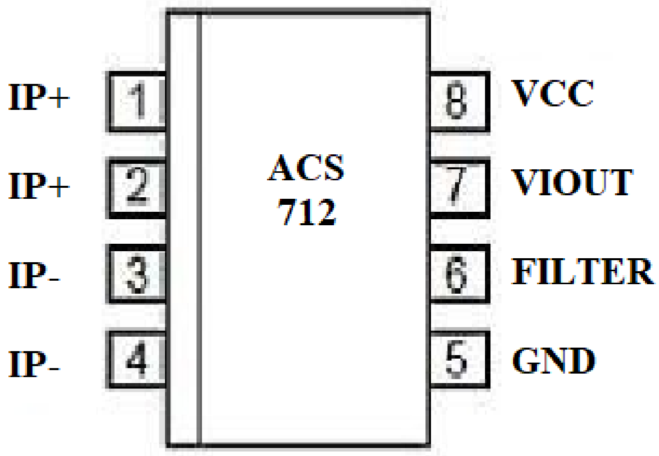

Figure 5 Pin Diagram of ACS 712 IC

The ACS 712 offers cost-effective and accurate options for sensing AC or DC current in various systems such as industrial, commercial, and communications. Its user-friendly package enables convenient integration for customers. Common uses of this device encompass motor control, load detection and management, switched-mode power supplies, and overcurrent fault protection.

GSM 800a Module

The SIM800A modem is equipped with a SIM800A GSM chip and an RS232 interface, allowing for convenient connectivity with a computer or laptop through a USB to serial connector, or with a microcontroller through an RS232 to TTL converter.

3. HARDWARE BLOCK DIAGRAM

This paper present apparatus serves the purpose of constantly overseeing the voltage. The Arduino analog input has a constraint of only accepting a 5VDC input. Essentially, it operates as a voltage divider with a ratio of 5:1, achieved by utilizing a 30K and a 7.5K Ohm resistor. It is crucial to bear in mind that the voltages being monitored must not exceed 25Volts. The inputs consist of GND and VCC, while the outputs are denoted as S, +, and -.

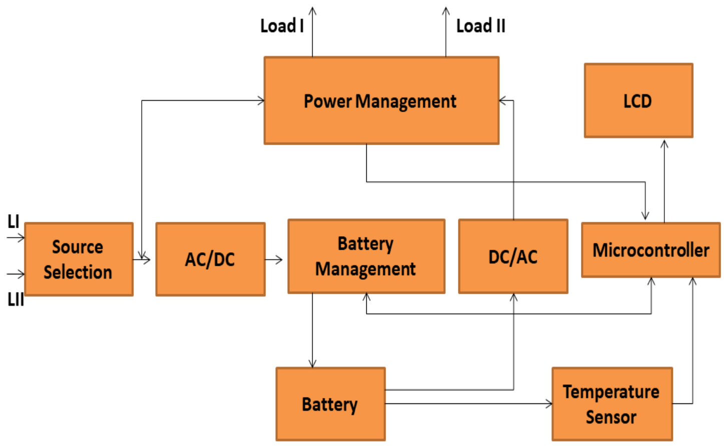

Figure 6 Block Diagram of Hardware

3.1 Inverter Design Implementation

The main challenge in designing an inverter lies in selecting the appropriate rating for its components. Therefore, when designing a 1kVA inverter, we conduct thorough research on various websites and reference books to finalize the components. The inverter comprises of 4 n-channel MOSFETs, an IC SG 3525, a TLP 250 opto-coupler transformer, resistors, capacitors, and LC filters. The IC SG 3525 serves as a PWM IC, generating a square wave output. This output is then fed into the TLP 250 opto-coupler, which increases the voltage from 12V to 20V for the MOSFETs and smoothens the waveforms, thereby reducing distortion. At any given time, two MOSFETs are triggered, followed by another two after a certain dead time. The output of the MOSFETs reaches up to 25V, which is why the transformer is connected to step up the voltage from 12V to 250V AC.

The primary objective of an inverter is to produce a clean sine wave. To achieve this, LC filters are connected to the output of the MOSFETs, which effectively purify the waveforms. As a result, an AC sine wave is generated. In terms of hardware design, a 12V, 50Ah battery is used as the input for the inverter. This represents the initial phase of the hardware design process.

3.2 Battery Monitoring System Design Implementation

The microcontroller and GSM module are included in the second part of the project design. A battery is now connected to the ACS712 and the load. The ACS712 is connected to the microcontroller, and the controller is connected to the LCD display.

The main function of the ACS712 is to calculate the current rating whenever the load changes, and then send this information to the microcontroller. Based on the load rating, the microcontroller calculates the battery life backup and continuously displays the estimated time of battery usage. The GSM module is also connected to the microcontroller, so that at a fixed time, the information about the battery backup is sent to the designated contact numbers.

All the parts are interconnected, allowing the information to be forwarded. This enables everyone to easily monitor the running time of the battery backup system and take immediate action if necessary.

4. CONCLUSION

Based on the previous discussion or project design, it can be inferred that by utilizing an advanced UPS battery monitoring system, we can effortlessly obtain information regarding the backup battery life in accordance with load fluctuations. Additionally, this system provides the convenience of receiving text message notifications. The implementation of such an advanced UPS system proves highly advantageous for various industries, as it not only saves time in battery calculations based on load changes but also offers cost-effectiveness.

REFERENCES

1. Tanvir Singh Mundra "Microcontroller based power supply". Journal of Computer Science. FindArticles.com. 09 Aug, 2011.
2. Farrukh, K. and T.G. Habetler, 1998.A novel online UPS with universal filtering capabilities. IEEE Trans. on Power Electronics, 13: 3.

3. Matthew, S.R., J.D. Parham and M.H. Rashid, An Overview of Uninterruptible Power Supplies. IEEE Proc., pp: 159-164.
4. S.A.Z. Murad "Monitoring system for uninterruptible power supply". American Journal of Applied Sciences. FindArticles.com. 09 Aug, 2011.
5. Uninterruptable Power Supply Manuals
6. www.hitachi-hirel.com