IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 2, Issue 2, Apr-May, 2014
ISSN: 2320 – 8791(Impact Factor: 1.479)
www.ijreat.org

Smart Solar Lantern with improvement in Efficiency

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Abstract

The project is based on LED lantern with auto intensity control using solar power from photovoltaic solar module. Photovoltaic panel is used for charging the battery by converting the sunlight into electricity. A charge controller circuit is used to control the charging and preventing the battery from being overcharged or undercharged.

The electricity generated from the sunlight is stored in a rechargeable Lead Acid battery during the day time. This stored electricity is used after the dusk to light up the LED based solar lantern. The Light intensity of the lantern is controlled by processing the state of charge of the battery.

This project can be implemented in the rural areas where there is lack of electricity. Taking the current energy crises into consideration, this project can be useful for a sustainable future.

Keywords: *Solar Panel, Lead Acid Battery, LED, LED Driver, Microcontroller, Voltage Regulator, DC-DC Buck convertor.*

1. Introduction

Energy is a word that sets even the world's superpowers thinking. The biggest problem that we face today is the energy crisis. Fossil Fuels are diminishing and so some parts of the world are facing immense energy breakdown and environmental unbalance. There are 1.6 billion people in the world without access to electricity. They often rely on kerosene and other fuel-based sources for lighting, but these produce air pollution and are a fire hazard. Kerosene is also expensive, with ongoing fuel costs that range from 5% to 65% of a household's monthly income, depending on the region and income level of the family. Moreover Kerosene causes environmental degradation. This hampers the environmental stability and balance. Energy is used haphazardly in some of the areas due to which wastage of energy is also there. A good amount of electrical energy is used for lighting purposes. Certainly the energy used for lighting can be reduced if effective use of lighting solutions and intensity control is done. Our objective is to develop an efficient, durable and cost effective state of art solar lantern that can take right decisions automatically to use energy in an efficient manner to meet the energy crisis of the world.

This system is designed to solve the following problems associated with traditional lighting solutions:

- Use of kerosene in the traditional lantern which causes pollution
- Power cut in many regions.
- Energy crisis due to lack of Non-renewable energy sources.
- Increase in the pollution in the environment due to use of non-renewable energy.

2. Project Plan

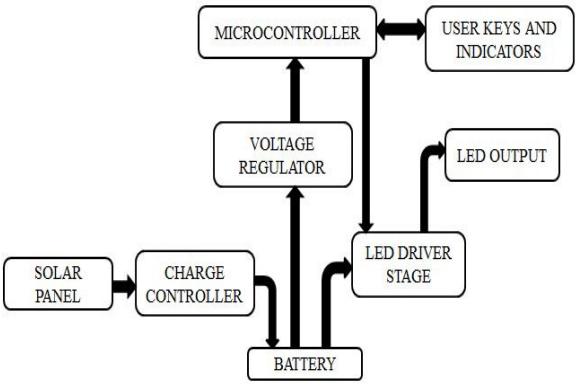

Fig. 1 Block Diagram of Project

Solar Panel: Detachable Solar Panel is used to use the solar energy to produce electrical energy.
Charge Controller: The charge controller is used to control the charging of the battery along with the maximum power point tracking.
Battery: Lead acid battery is used to store the electrical energy during day time and utilize it during night. The battery also powers up the microcontroller and the LED driver circuit.
Linear Regulator: Linear regulator is used to control the voltage to drive the microcontroller.
Microcontroller: It is the core element of the system which controls each and every thing of the system.
User Keys and Indicators: This is a user interface which consists of indicators and on-off switch. The indicators are used to display the low battery & full battery condition.
LED Driver: This stage is used to drive LED strip with optimum efficiency.
LED: Light Emitting Diodes are used for emitting the light.

3. Features

Portable: The solar lantern is handy and can be taken anywhere at any time to access dark areas.
Powered by renewable energy source: The Solar energy is used to charge the battery on which the lantern works. Thus utilization of clean and free energy is done.
Pollution free: Since renewable energy is used, 0% pollution is there from the system. Emission of gases is also not there compared to traditional lantern.
Cost effective: It is a one-time investment. The initial cost may be more but it is cost effective product for longer run. Every common man can effectively invest for it.
Prolonged working hours: This lantern can stay on for more than 25 hours at full intensity.
Auto intensity control: The light emitted from the lantern is controlled smartly by using low power microcontroller. This feature enhances the battery life and also the light is emitted for longer time.

4. Working of the Project

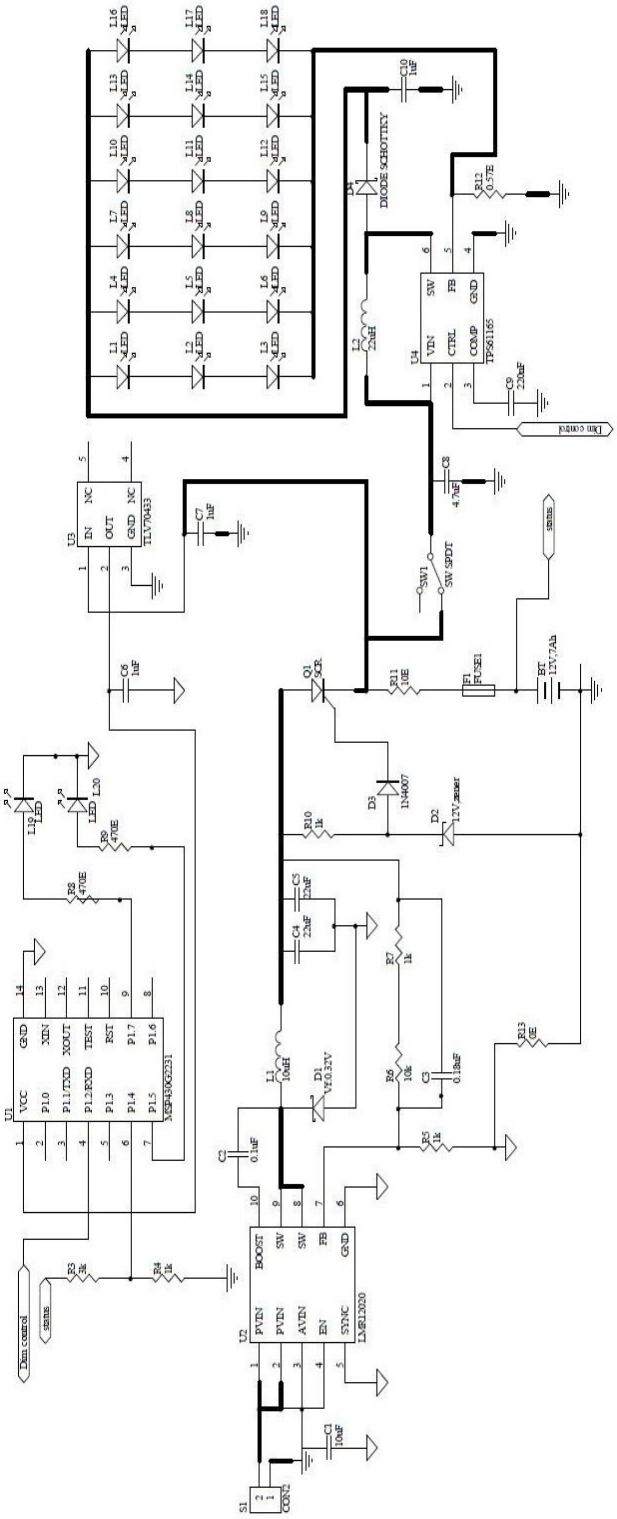

Fig. 2 Schematic of Project

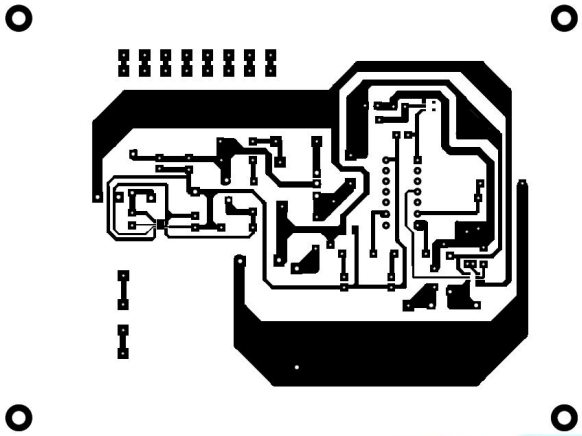

Fig. 3 PCB layout of Project

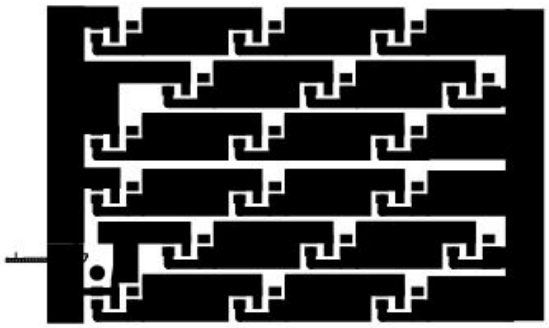

Fig. 4 PCB layout of LED strip used in project

The input from solar panel drives LMR12020 [1], a buck convertor whose output charges the battery with maximum power point tracking [3]. In between LMR12020 [1] and battery, is overvoltage protection circuit which saves the battery from being overcharged. The overcharge protection circuit consists of a SCR which is its core element [2]. Fuse is used for protection which saves all the chips from being damaged. Battery is connected to microcontroller through TLV70433 [1], a voltage regulator which powers up the microcontroller by regulating the input voltage at constant voltage of 3.3V. The signals from the battery are computed by microcontroller and used for the Low battery indication and Full battery indication. Red LED is used for low battery indication and Green LED is used for the Full charged condition. A switch is also used to on/off the output LED strip. Battery is connected to TPS61165 [1], a LED Driver circuit which boosts the voltage and drives the LED. The LEDs consumes less power and hence the power consumption of the battery is also less. The Microcontroller controls the intensity of the LED output using the Pulse Width Modulation Technique which smartly increases/decreases the intensity of the Output LEDs according to the state of charge of the battery. LEDs are arranged in series and parallel combination for optimum output and less power consumption. We have used two different grounds for the project. The signal ground and power ground. The signal ground is common ground for the tracks that are only carrying the signals through the circuit. The power ground is a common ground for the tracks that are carrying high current through the circuit hence preventing the circuit from being damaged.

5. Conclusion

Low power consumption is the best feature of this application. An MSP430 [1] and LED output use the least power and thus power is saved effectively. Maximum power is transferred from the solar panel while charging the battery using the MPPT algorithm which is taken care by LMR12020 [1] buck converter chip. Battery is refrained from being overcharged. Pulse width Modulation is used to control the intensity of the LEDs automatically. The microcontroller checks the state of charge of battery and the controls the light intensity of the output LEDs.

Acknowledgments

We would like to express our gratitude and sincere thanks to Principal, BVM Engineering College for imparting profound knowledge and for encouraging us for the research. We also thank authorities of Baroda Electric Meters Ltd. for helping us with all the resources and instruments needed for the project.

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