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# A PWM SOLAR CHARGE CONTROLLER FOR BATTERY CONSERVATION THROUGH LOAD REGULATION

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## ABSTRACT

In a garden solar lamp system, the major concern over maintenance is the battery backup storage supplied with the system becoming unusable in a shorter period of time, even before the expiry of the guarantee period of a battery. The main reason behind this is the irregular charge and discharge cycles of the batteries. The existing charge controllers only focus on the voltage present on the battery. But according to this study, the life time of a lead acid battery is expected to go higher through proper charge controlling with Pulse Width Modulation and temperature compensation; and discharge control with load control. The designed system has a separate Liquid Crystal Display (LCD) to display the solar panel voltage, battery voltage, battery temperature, load power and energy for monitoring.

**Keywords**: solar charge controller, solar PV system, temperature compensation, load control

## 1. INTRODUCTION

Solar energy has been identified as a very popular renewable energy source during the past few decades, since its energy is free and clean. For centuries, people have tried and used many ways to generate electricity. Those methods were expensive and required maintenance. Solar panels convert solar energy to electricity; but they can't store the generated energy to be used when the sun light is not available. Batteries are used to store energy to be used at a later time. The life time of the batteries used in them is very important. In order to reduce the maintenance cost, it is important to extend the battery life as much as possible. This can be done by optimizing the charging and discharging of the battery. Charging is controlled by the charge controller. When charging a battery, there are many factors to be concerned about, such as capacity of the battery, temperature of the battery and charging current cycle. When discharging, the maximum current that can be drawn from the battery should be a concern. This study suggests a charge controller with load controlling facility which also takes into account the important parameters in battery charging such as temperature compensation and battery voltage.

### 1.1 Garden Solar Lamp System

Garden solar lamps are quite suitable to light up places situated in areas where wiring is very difficult. In a garden solar lamp system, there are 4 major parts [1]. They are solar panel, charge controller, battery and the load (usually LED lamps of 5W or 10W). Lamps are automatically lit when the dark comes and turns off in the morning without human intervention.

## 2. EXPERIMENTAL

The charge controller designed in the present work is a microcontroller based system (AtMega 328). The microcontroller in the Arduino Nano 3.0 [2] board controls the charging process, the load control process and the LCD display. Voltage values of the solar panel and the battery, battery temperature value and the load current value are the inputs to the system

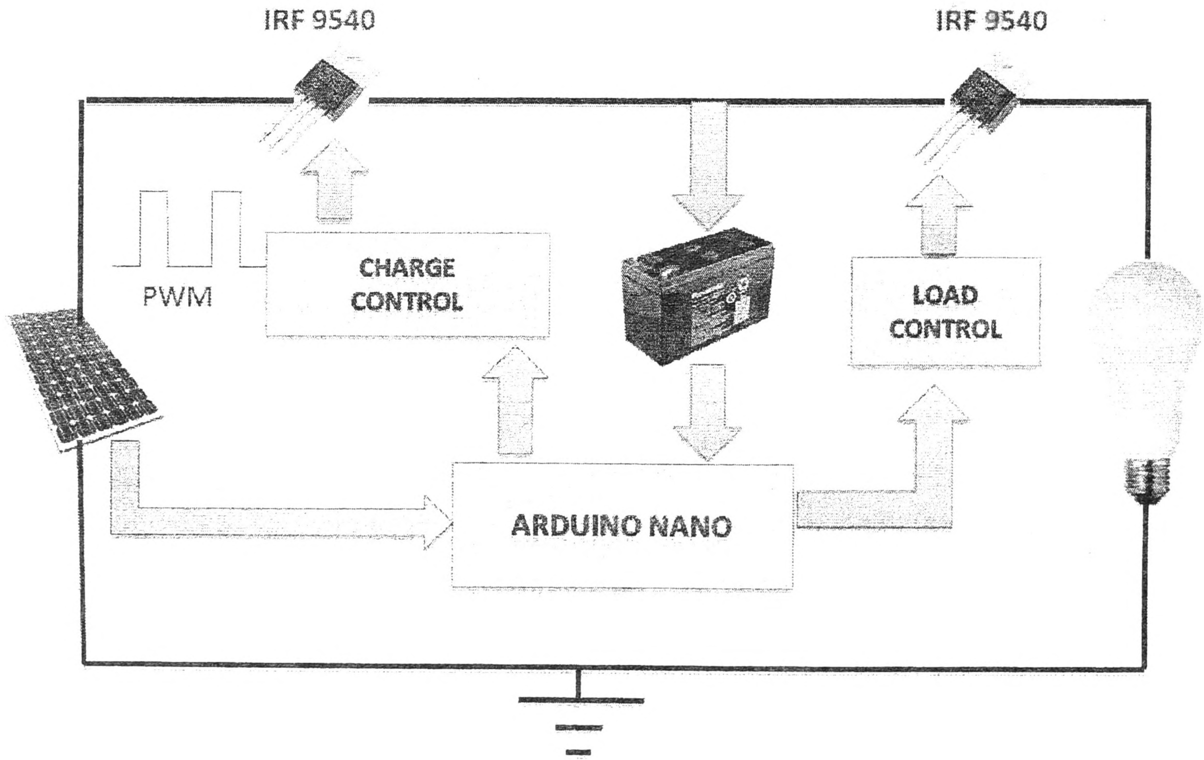


Figure 2.1: Block Diagram of the Charge Controller

2.1 Operation of the Circuit

The microcontroller takes the voltage values of the solar panel and the battery. The solar panel itself was used as the light sensor. If the voltage of the solar panel is less than 5V (during the dark) and the battery voltage is greater than 10.5V, the load is turned on. If the solar panel voltage is greater than 5V or battery voltage is less than 10.5V, the load is cut off. The resistance effects on the charging current decreases with the temperature. Therefore, the room temperature was measured and the width of the charging pulse (time duration of the pulse) was changed accordingly.

Existing voltage of the battery at a time concerned was measured, and there also the charging pulse width was changed. During the night, if the battery voltage is reduced below 12V, then the Q4 MOSFET in Figure 2-2 is activated and Q6 MOSFET is turned off. Then a low current is drawn from battery and it can keep the load on for a longer time.

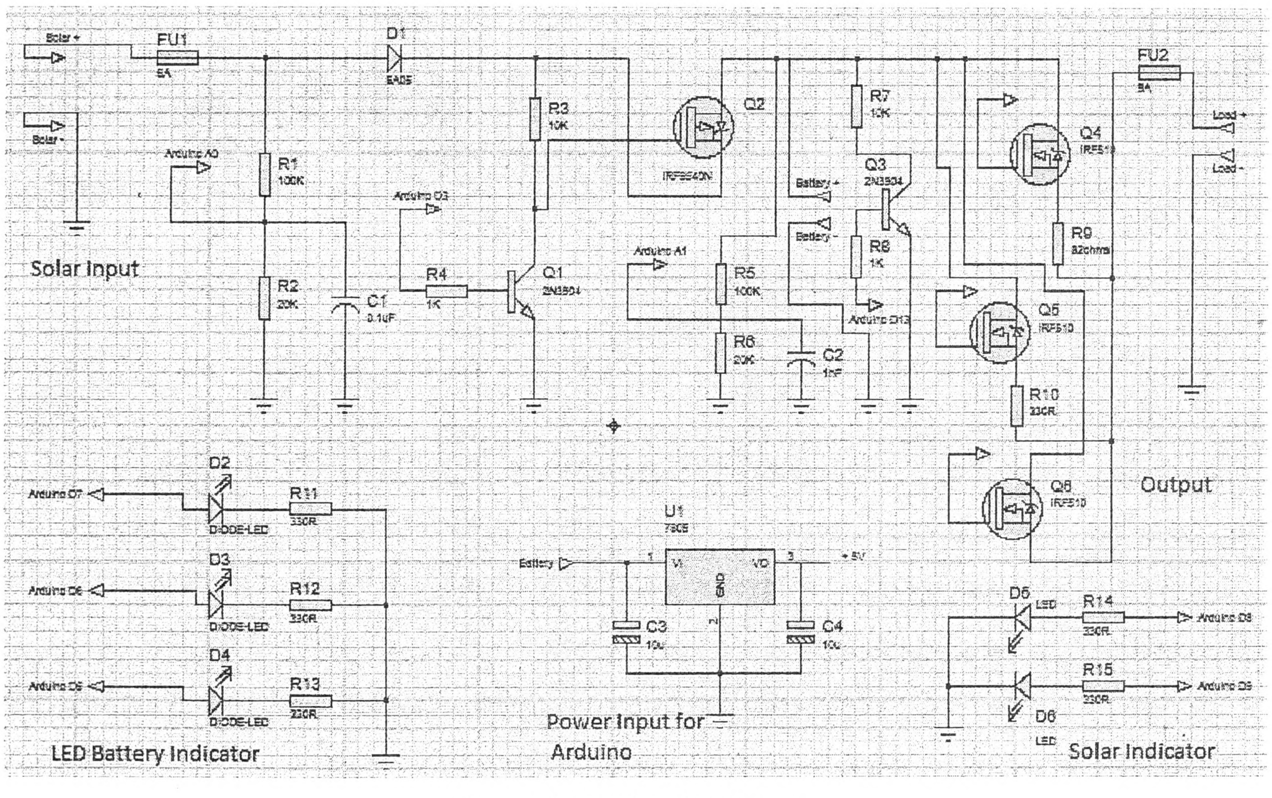


Figure 2.2: Circuit Diagram

## 3. RESULTS AND DISCUSSION

The charge controller system gave a smooth charge cycle without sudden declines in the battery voltage. The fuse attached to the load side, protected the battery from outputting a large current and short circuiting at the load side.

3.1 Temperature Compensation

Lead acid batteries store energy and generate current through a series of chemical reactions. The chemical reactions in a lead acid battery are affected by the temperature. As the temperature increases, the gas generation inside the battery increases; which means resistance for charging decreases and when the temperature decreases the reverse happens. (3)

Depending on how much the battery temperature varies, it is important to adjust the width of the charging pulse for temperature changes. Therefore it is important to adjust charging to account for the temperature effects. The temperature sensor will measure the battery temperature, and the Solar Charge Controller uses this input to adjust the charge set point as required.

3.2 Charging Pulse

Battery is charged by supplying a series of pulses, whose width is changed according to the existing voltage of the battery.

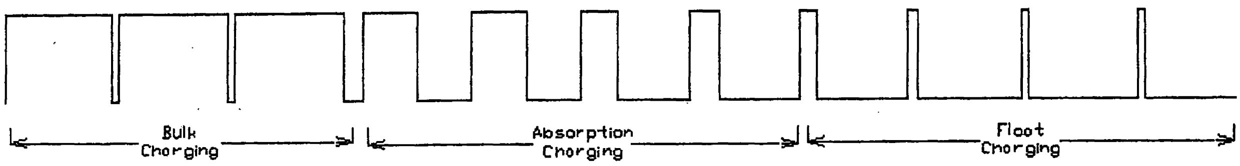


Figure 3.1: Charging Pulses applied

3.3 Load Control

Preserving the power of the battery is very important in fulfilling the required purpose of a garden solar lamp system. There may be rainy days or shadowy days on which the sun light won't be fallen enough on the solar panels so that the battery get fully charged. But the lamps should be lit up for a whole night.

In order to achieve this, few parallel outputs are connected to the load through logic level MOSFETs whose gates are connected to the output pins of the Arduino and switched on only one MOSFET at one time. Each path has different resistance values to regulate the current from the battery according to the battery's voltage. (4)

## 4. CONCLUSION

This study and the implementation presented in this paper was an attempt to solve one of the problems in solar garden lamps; battery becoming unusable in a short period of time. The concepts of microcontrollers and electricity were used in this study to achieve the project goals. The developed solar charge controller will be useful to illuminate large states and isolated places through solar power, because it helps prolong the lifetime of the battery.

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