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SOLAR CHARGING SUPERCAPACITOR SIMULATOR

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ABSTRACT

The solar power is considered as intermittent energy source, storing its energy is an important issue in order to have continuous energy availability. Rechargeable batteries have been traditionally used to store excess electricity in standalone PV systems. The attempt to replace the batteries with supercapacitor bank to implement an energy storage design using a super-capacitor (SC) bank with a charging control system was proposed in the present study to enhance the charging performance of stand-alone solar PV system. In this study the simulator was implemented for 22.1V, 10Wp, 0.84A solar panel for the 3V output load and the similar behaviors of batteries were observed.

Key words: Supercapacitor charging, Solar Charging, Pulse Width Modulation

1.0 INTRODUCTION

The solar power is considered as intermittent energy source and storing its energy is an important issue in order to have continuous energy availability. Rechargeable batteries have been traditionally used to store excess electricity in standalone PV systems. Energy storage technologies have the potential to offset the intermittency problem of renewable energy sources by storing the generated intermittent energy and then making it accessible upon demand. Currently, the dominating energy storage device remains the battery, particularly the lithium ion battery [3]. Lithium-ion batteries power nearly every portable electronic device. Batteries store energy electrochemically, as a result, batteries have a low power density and lose their ability to retain energy throughout their lifetime due to material damage[2]. In the super capacitor, energy is stored electrostatically on the surface of the material, and does not involve chemical reactions. Given their fundamental mechanism, super capacitors can be charged quickly, leading to a very high power density, and do not lose their storage capabilities over time. Super capacitors can last for millions of charge / discharge cycles without losing energy storage capability [4, 1]. Also the weight is very small, particularly when compared to batteries.

In this research project a single supercapacitor is 2.7V and 100F. To get higher voltages, several supercapacitors are connected in series. Serial connection reduces the total capacitance and increases the internal resistance. Strings of more than three capacitors require voltage balancing to prevent any cell from going into overvoltage. The characteristics including their charging and discharging performance and the drawbacks of the compared with the rechargeable batteries have been focused throughout this research project [4, 3].

2.0 EXPERIMENTAL

This solar charger supercapacitor simulator works in steps.

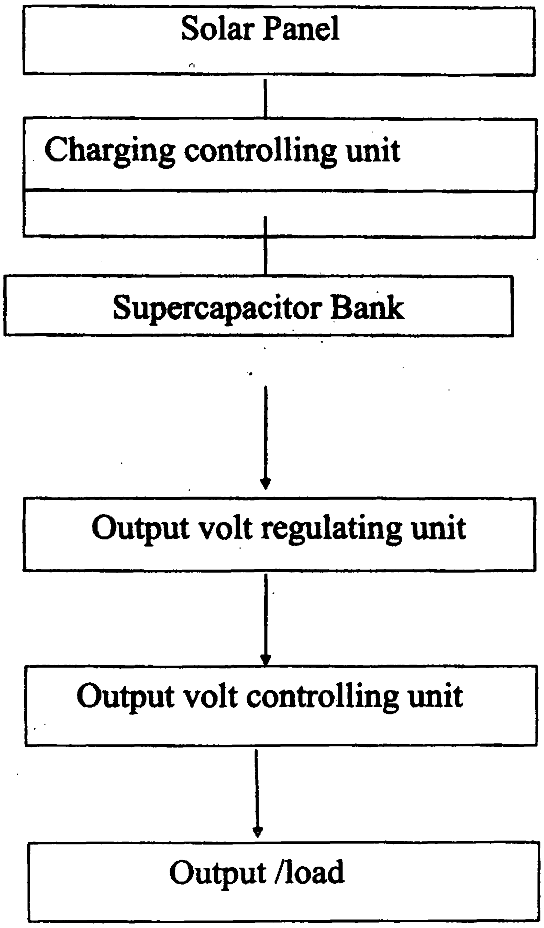

Figure 1: The block diagram of a solar charging supercapacitor simulator

The system mainly consists in basic units of;

2.1 Voltage regulating circuit

A typical solar panel offers output voltage ranging 0 to 24V. This circuit connects directly to the solar panel through a diode. This unit consists of range of 5.5V-30V. It offers 5V to MC34063 step down inverting switching regulator. The diode D3 protects the circuit from the polarity change of the solar panel.

2.2 Charging Control unit

It is designed for regulating photovoltaic solar modules which is connected between solar pane and the battery regulates the voltage and current coming from the solar panels to the battery. I maintains a proper charging voltage on battery. As the input voltage from the solar panel rises, the charge controller regulates the charge to the supercapacitor bank preventing any overcharging.

2.3 Output Controlling unit

This unit covers when the solar power is low the switch SW2 turns the auto on and indicates for any polarity change. MOSFETT transistors are used due to the high efficiency than bipolar and FET transistors.

2.4 Low Voltage Output Cutoff circuit

When the capacitors are discharging this circuit doesn't allow the desired output voltage of the load to be reduced.

2.5 Output Voltage stabilizing circuit

When the capacitors are discharging this circuit keeps the output voltage to be constant.

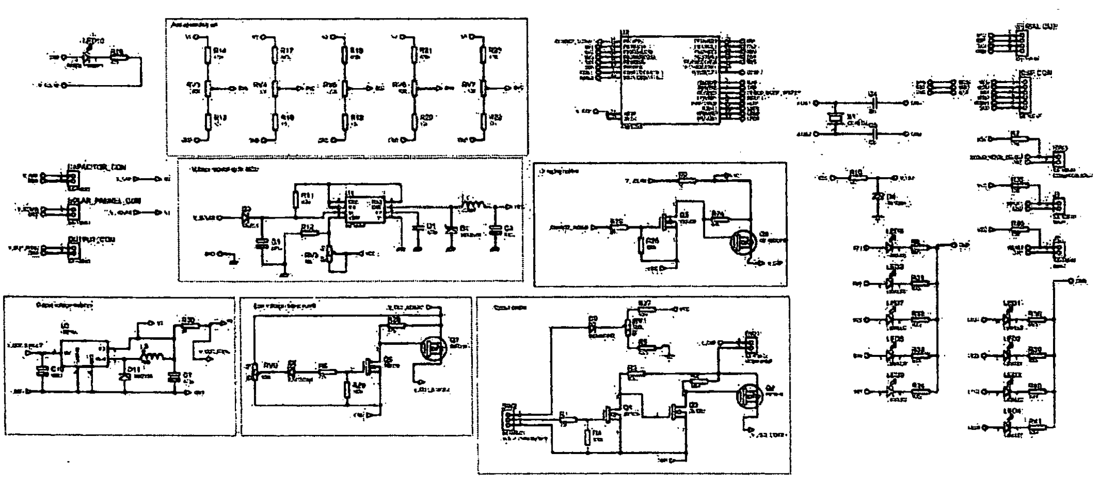

Figure 2: Schematic diagram of the system

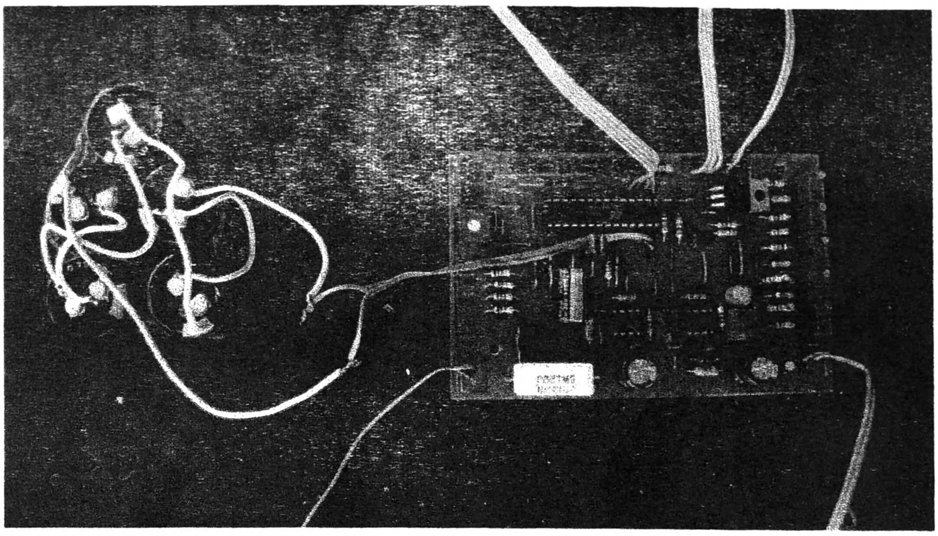

Figure 3: Implemented Circuit of the simulator

3.0 RESULTS AND DISCUSSION

This simulator is tested with the pre described solar panel to observe the charging and discharging patterns of the supercapacitor bank. The capacitance charging and discharging performances are observed

Table 1: The values of current and voltage values obtained from the simulator

Voltage (V)	Current(A)
0.50	0.294
0.75	0.288
1.34	0.247
1.57	0.257
1.98	0.305
2.21	0.324
2.46	0.340
3.11	0.300
3.47	0.411
4.26	0.450
5.16	0.471

4.0 CONCLUSION

The system was developed using MC34063 step down inverting switching regulator for voltage regulating, Atmega 8 for PWM controlling. The maximum input voltage is 20V for this system and the output load is 3V. The system was tested with 22.1V, 10Wp, 0.84A solar panel. The maintenance of the conventional rechargeable battery systems and their hazards for the environment and decaying with the time can be overcome with the supercapacitor bank. The high cost of the supercapacitors is one of a major drawback.

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