ENERGY HARVESTING SYSTEM
A Solar Powered Cell Phone Battery Charger

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OBJECTIVES

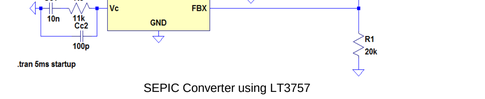
- Explain the methodology of designing of a solar powered cell phone battery charger.
- Show the result of the design simulation and Implementation on a printed circuit board (PCB).

INTRODUCTION

Ambient energy harvesting is the process where different types of energy are absorbed from the surrounding environment and converted into electrical energy. This energy can be used for verity of applications such as (wireless sensors, military systems, battery charging, etc...). There are many types of harvesting sources such as solar cells, thermoelectric generators and piezoelectric.
Nowadays, the cell phone becomes an essential need in our live. However, it needs to be recharged from time to time, depending on the usage. Sometimes, the outlet plug is not available to recharge cell phones. For this reason, the need of an alternative power source is raising. In this project the goal is to provide a solution by designing a solar power cell phone charger.

METHODOLOGY

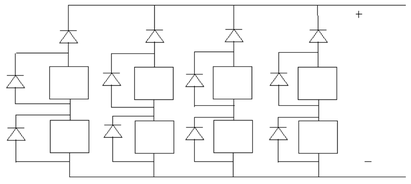
The design starts with determining the most efficient energy harvesting source that gives a reasonable amount of power for the cell phone battery charging. It is found that the solar panels will be the most efficient harvesting source that satisfies the design requirements. Then a appropriate DC/DC converter is designed to maintain a fixed output voltage of 5 V and a maximum current of 1 A for the variable range of DC input voltage supplied by the solar panels. Finally, the system is enhanced by adding a super capacitor, for the purpose of supplying power when the panels does not supply enough power.
The following figure illustrates the block diagram of the system.



A solar powered cell phone battery charger block diagram

- **Harvesting Source**

A parallel and series combination of eight solar panels, of 3.5-6 V, 260mA-320A and 1.5 W each, are used as shown in the figure below:



Connection of solar cells with diodes with bypass and blocking diodes

Bypass diode and blocking diode are used to allow the current to flow when the respective solar panel is blocked and to prevent the current from the battery or from other parallel branch to flow back, respectively.

- **Storage Unit**

1 Farad supercapacitor is used to have a battery charging time of 2.5 h.

- **DC/DC Converter**

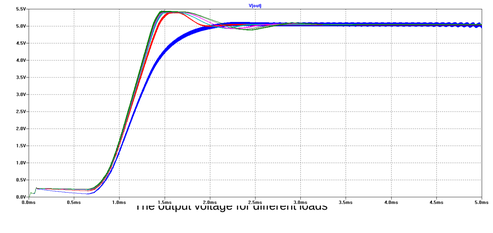
The input voltages of the solar panels varies from (3.5 V - 7 V), depending on the light intensity. Single-ended primary-inductor converter (SEPIC) buck/boost is used to maintain a voltage of 5 V. The final the SEPIC DC/DC converter circuit design using LT 3757 power controller IC is shown in the figure below.

SEPIC Converter using LT3757

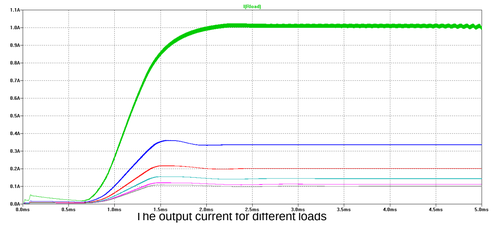
RESULT

- **DC/DC Converter Simulation**

Based on the engendering design the DC/DC converter circuit is simulated using LT Spice. The circuit is simulated at different load values, and the circuit worked as expected. The result of the circuit simulation of an input voltage of 3V (the minimum) and output load of 5, 15,25,35,45 and 50 Ω, which represent the low resistance of the cell phone battery, are illustrated in figures below.



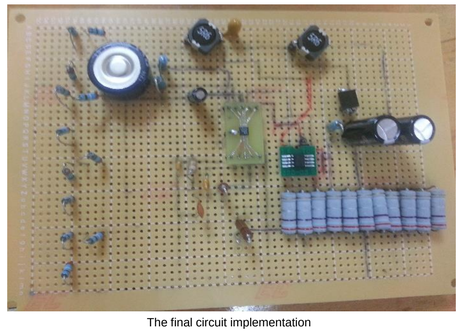
The output voltage for different loads



The output current for different loads

- **The Final Implementation and Test**

The circuit implemented in a blank PCB as shown in figure below. The circuit have been tested at input voltage from 3V to 15V. Unfortunately, the circuit did not work as it supposed .The output voltage for the circuit was between (0.1V to 1V). One possible reason that make the circuit not to work is the usage a parallel combination of 270 mΩ resistors for the sence resistor instate of 24 mΩ is not an optimum choose because it will changed the sence current value. Also, the power controller IC might damaged while soldering, due to the high temperature.



The final circuit implementation

CONCLUSION

An energy harvesting system based on solar panels has been designed and implemented on a blank PCB to charge cell phone battery .The design composed of solar panels followed by a SEPIC DC/ DC converter, which used (LT3757) as power controller, to maintain a constant output voltage despite the variation of the input voltages from the solar panels. The collected power was stored in a supercapacitor for backup power. Unfortunately, the hardware results obtained from the designed system did not match the theoretical and the simulation results. This might be because one or more component was damaged due to the high temperature of the soldering iron.

RECOMMENDATIONS

- Replace the Sence resistor with a single 24 mΩ resistor instate of the parallel combination of the 270 mΩ resistors.
- More efficient solar panels can be used to improve the efficiency of the circuit, but this will raise the cost significantly.
- The system can be improved by using many harvesting sources. However, different DC/DC converter circuit might be needed, which will increase the circuit complexity and cost.