

Solar Powered Mobile Power Bank Systems

Sambandh Bhusan Dhal^{1,*}, Arun Agarwal¹, Kabita Agarwal²

¹Department of Electronics and Communication Engineering, ITER, Siksha 'O' Anusandhan University, Khandagiri Square, Bhubaneswar-751030, Odisha, India

²Department of Electronics and Telecommunication Engineering, CV Raman College of Engineering, Bhubaneswar-751054, Odisha, India

*Corresponding author: sambandhdhal@gmail.com

Abstract The objective of this research is to design a Solar Powered Portable Power Bank for mobile phone using sunlight as its ultimate power, which can be used effectively during disaster events. It has in-built solar panel which converts the solar energy to electrical energy. The charge is then transferred to a battery for storage of charge for further use, with the battery having a microcontroller indicating the percent of charge present in the battery. The battery is connected to a charging circuit having an USB port as output to the respective Mobile phones.

Keywords: solar energy, portable, disaster recovery, battery

Cite This Article: Sambandh Bhusan Dhal, Arun Agarwal, and Kabita Agarwal, "Solar Powered Mobile Power Bank Systems." *American Journal of Electrical and Electronic Engineering*, vol. 4, no. 5 (2016): 148-151. doi: 10.12691/ajeec-4-5-4.

1. Introduction

The major liability or drawbacks of communication lines comes because of the distortion of electrical lines or lack of generation of electricity as like in remote areas or during disaster or natural calamities. To set back such drawbacks, we need a renewable source of energy which can function round the clock without any disruption. Solar power bank is one of its kind. It works on the power of the sun, converting solar to electrical and helps in charging the cell phones which can be used in communication, and thus, turns to be vital during disasters and power outage.

2. Problem Statement

The major factor that drove us to this project is that it is one the method of charging that utilizes the renewable sources of energy where we can overcome the exhaustible usage of power and charge. It reduces the environmental pollution and is much user friendly. During disasters and power outages, it can be used with ease and with a long and forever durability of device and power. Even in the remote areas having scarcity of electricity, such models can be used. It can be a bit rusty during the rainy and foggy days and needs delicate care.

3. Product Architecture

Component Hierarchy for a Portable Solar Charging Mobile Charger

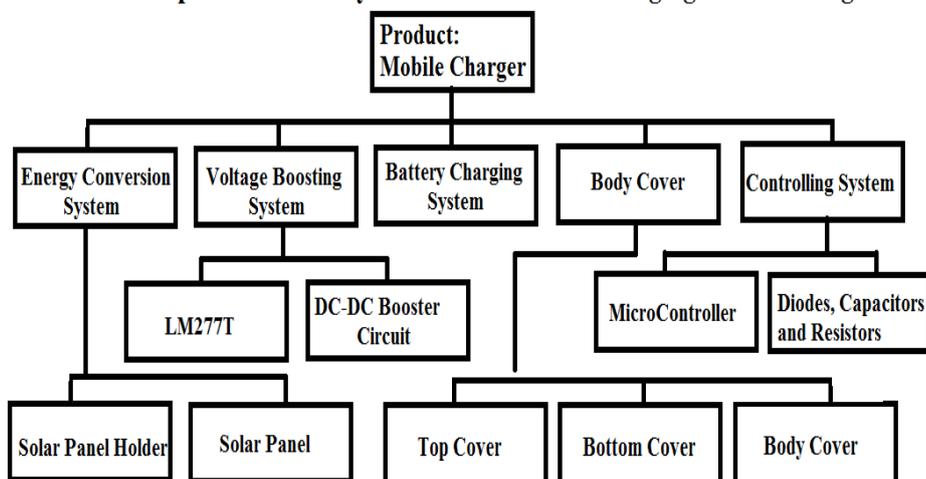


Figure 1. Component Hierarchy of a portable solar charger

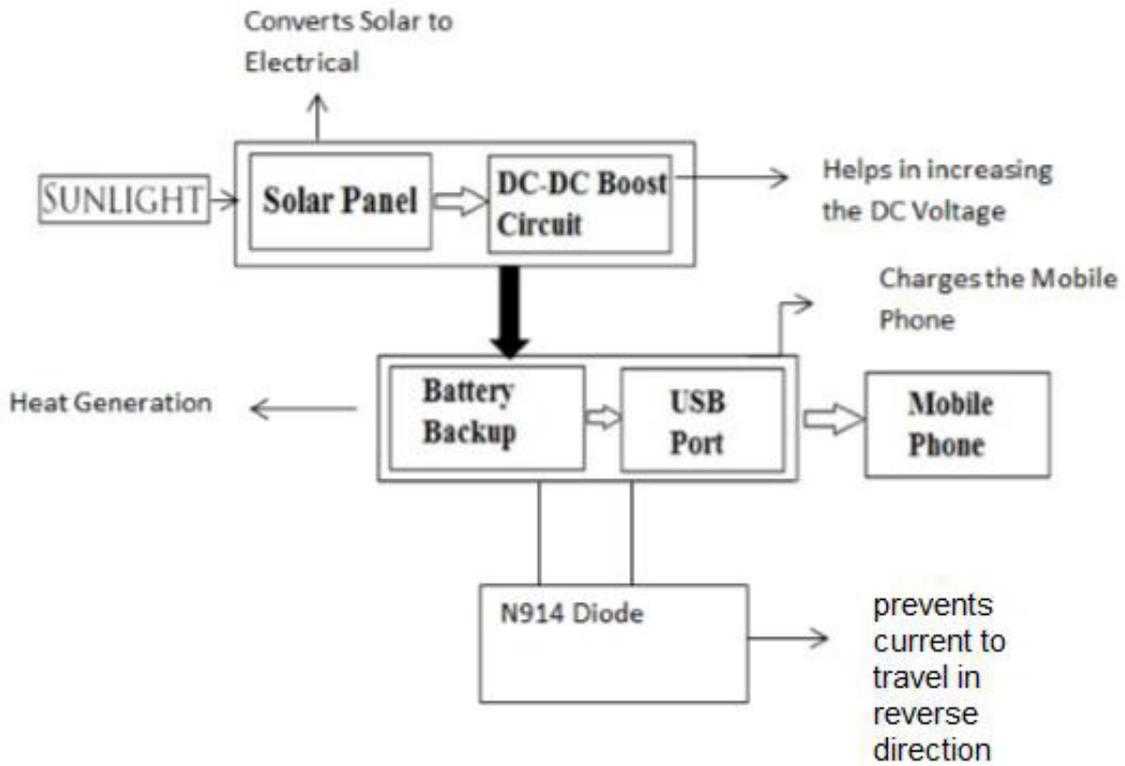


Figure 2. Energy conversion Diagram / Basic clustering Diagram [4]

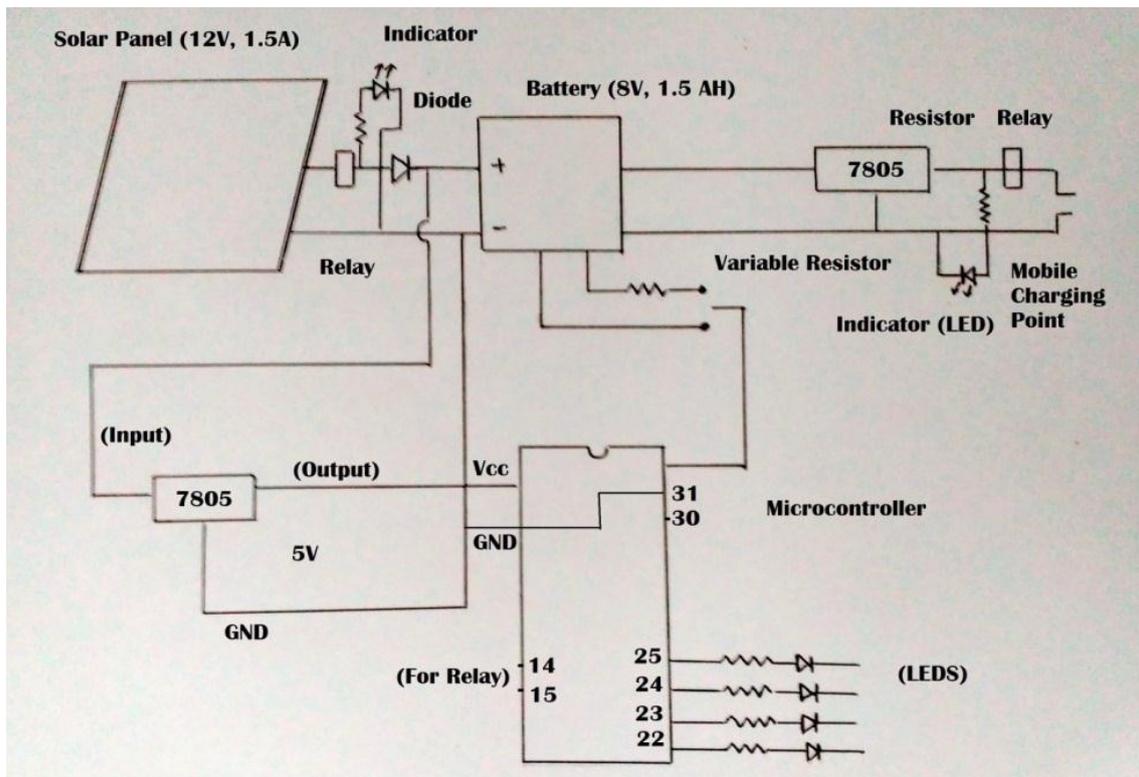


Figure 3. Circuit Diagram [2]

4. Technical Feasibility

There are 2 main things to consider choosing a Solar panel or creating a Solar system. Battery capacity is measured in Amp Hours. The AH figure must be multiplied by the battery voltage to convert this to Watt Hours which is given by the simple calculation below.

$$X \times Y = Z \tag{1}$$

where,
 Y = Battery Voltage
 Z = Power available in watt hours
 X = Battery size in AH.

However, as we know that we will not be able to power the battery once the voltage drops below our equipment's

requirements, that is why, we are never really able to take all the power from a battery. Lead acid batteries will give around 50% of their rated power and Li-ion batteries will give around 80% of their rated power.

Solar panels are the most critical and final part in designing solar panels. The generation of power in a solar panel is measured in Watts (e.g. The power generation of part number STP010 in a solar cell is 10W). Theoretically, the energy that can be supplied to a battery can be calculated by multiplying the power generation rating of the solar panel (measured in Watts) to the number of hours the panel is exposed to sunshine.

A photovoltaic module can be defined as an assembly of 6x10 solar cells connected and packaged together. The solar array of a photovoltaic system which is generally comprised of these photovoltaic cells generate solar electricity and is used in domestic applications. Under standard test conditions, the DC output power of each module ranges between 100 to 365 watts. If the rated output of a solar panel remains the same, the efficiency is determined by the area of the module .i.e. A 16% efficient 230 W solar module will consume half the area as that of a 8% efficient 230W module. Only a few solar panels exceed an efficiency of over 19%. Most installations contain multiple modules as a single solar module generates only a limited amount of power. Some of the typical examples of photovoltaic systems are an array of solar modules, a solar inverter, a battery, a solar tracker and interconnection wiring.

The photovoltaic panels present in solar-charged power banks can trickle-charge the internal battery of the system when placed in direct sunlight. Depending on the capacity of the Power Bank and its current level of charge, it can take quite a while to fill up. For example, the time taken by a smartphone to charge completely is same as the time taken to charge a 1500mAh power bank completely. For larger banks, this charging time can be doubled, tripled or quadrupled. Most Power Banks use LED indicators to show whether these power banks are at capacity and a safety cut-off valve to avoid overheating and overcharging.

5. Engineering Solution

In this paper, the product proposed meets the following requirements.

- is compact and lightweight to conserve resources;
- achieves the top levels of energy conservation performance;
- manages hazardous chemical substances ;
- is easily recycled at the end of life;
- Parts reuse/recyclability, disassembly/dismantling
- Sustainably uses the renewable resources
- Minimises the use of number of interconnecting wires or cables

6. Physical Prototype

The proposed system is solar based and solar panel plays a vital role in the experiment. Here, we have two solar panels each of 6v, for receiving the sunlight, which is connected to the battery of the system where the charge

from the sun is stored for future use. The battery is also of 12v with three 4v battery connected in series. Then, the battery is connected to the mobile charging circuit which is further connected to a USB Port from where a mobile can be connected for charging. There are two relay circuits, one attached between the solar panel and the battery and other one attached between the battery and the mobile phone which is controlled by the microcontroller. The microcontroller is the brain of the whole circuit as it checks and allows the required amount of flow of charge from one end to another. If at any point, we might get low or high voltages, then the microcontroller signals the relays and the relays cut the connection by switching off to protect the appropriate elements like the transistor, resistor etc. There are also LEDs attached at the solar panel side, at the charging point for detection of flow of charge. There are also 4 LEDs to show the percentage of charge present in the battery.

When the solar panels are open, then sunlight direct falls on the photovoltaic cell of the panel and it converts the solar energy to electrical energy. The panel gives a voltage of 12v and the charge flows through the relay to the battery if the voltage is appropriate and is equal to the value set by the microcontroller to the battery. There is also a LED which displays the transfer of charge from the panel to the battery. When the battery is charged perfectly up to its full capacity, which is shown by the 4 LEDs connected to the battery through the microcontroller, the microcontroller shows the percentage of charge present in the battery and then we can connect a mobile phone at the end of the circuit. Here, we also attach a relay circuit which checks the flow of voltage. If we get low or high voltage, the relay switches off and the circuit becomes open. With the appropriate charge, we can charge the mobile phone at the end of the circuit where we can get an USB port and the phone will be charged by connecting to the port.

After conducting the experiments, we concluded that in order to operate with high efficiency, we need to go through these selections:

- We need bright and sunny weather for a better charging.
- The panel wings should be placed under direct sunlight for better efficiency.
- We need two solar panels each of 6v to power the battery.
- Simultaneously connecting the phone for charging and the battery being charged from the solar panels might take a longer time for the battery to charge.
- The microcontroller requires a 12v so; we need a battery minimum of 12v for better operation.



Figure 4. Solar Powered Power Bank

7. Suggested Improvements

We have chosen two solar panels instead of one to make it more portable and handy. A relay circuit has been added to improve the safety of the circuit, battery and the mobile phone. If the phone is undercharged or overcharged, the relay will cut the supply saving the battery and mobile from getting damaged. We have improvised the battery with an indicator integrated with a microcontroller which gives indication about the battery percentage.

References

- [1] Chih-Hao Hou, Chun-Ti Yen, Tsung-Hsi Wu, Chin-Sien Moo, "A Battery Power Bank of Serial Battery Power Modules with Buck-Boost Converters", The 2014 International Power Electronics Conference, pp. 211-216, 2014.
- [2] Ke Liu, John Makaran, "Design of a solar powered battery charger", Electrical Power & Energy Conference (EPEC), 2009 IEEE, 2009, pp. 1-5.
- [3] Sangyoung Park, Bumkyu Koh, Yanzhi Wang; Jaemin Kim, Younghyun Kim, Massoud Pedram, Naehyuck Chang, "Maximum power transfer tracking in a solar USB charger for smartphones", Low Power Electronics and Design (ISLPED), 2013 IEEE International Symposium, pp. 88-93.
- [4] Kevin Otto & Kristin Wood, Product Design –Techniques in Reverse Engineering and New Product Development, 4th ed. Noida (U.P): Pearson Education, 2014, pp. 51-409.
- [5] K.Jaiganesh, K.Duraiswamy, "Dump Power Control Techniques for standalone Hybrid Wind / Solar Power Generation Control", 2012 - International Conference on Emerging Trends in Science, Engineering and Technology, pp. 422-428.
- [6] AtmelAVR. Wikipedia. Retrieved 12 February, 2016, from https://en.wikipedia.org/wiki/Atmel_AVR.
- [7] Solar panel. Wikipedia. Retrieved 14 February, 2016, from https://en.wikipedia.org/wiki/Solar_panel.