Design of Solar Charging Case for Mobile Phones

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Abstract. Every day in this modern era, a new technology is introduced in a mobile phone, and one major concern that every mobile phone user has is its battery backup. Whatever the advancements in mobile phones, the chargers we use have remained consistent since the beginning. Our project's goal is to create an integrated solar mobile charger that can be seamlessly incorporated into the protective case of the mobile phone. The proposed design traps solar energy and stores it in a rechargeable battery. This system has the ability to serve dual role, both as a protective case and act as power backup for the mobile phone.

1. Introduction
Mobile phones have evolved dramatically over the years, from simple to smart, starting from the year 1973. These mobile phones have become the primary data and correspondence centres for humans. One could argue that a cell phone is fundamental to modern life. However, the chargers used for these phones have not seen significant advancement since their inception. As mobile phones have become an integral part of people's lives, they really don't have the time to put their phones on charge and wait near a power outlet for an hour or more. The best alternative solution to this issue is to use renewable energy as a power source [1]. And the ideal renewable energy source that is compatible for this project is unquestionably solar energy. It is a highly efficient energy source that has had a significant impact on society and industry. It is possible to charge any device without using electricity with the proposed model. People who always use mobile phones for their work and people in remote areas find it hard to charge their devices due to a lack of electricity and most importantly lack of time [2]. The goal of this project is to design and implement a portable solar phone charger using PV cell and Li-ion battery.

The following objectives were created in order to achieve this goal:

- Study of various photovoltaic cells and batteries performance characteristics.
- Select ideal components for the model based on requirements.
- Designing of the circuit and prototype model.
- Construction and Testing of the prototype.

2. Methodology and Modelling
First, the photovoltaic cells absorb energy from the sun. The DC output of the solar panels is then passed to the USB charging circuit (TP4056 IC) which is generally used for charging the mobile phones in the traditional phone chargers. The output from the IC directly goes to the 5000
mAh Li–ion battery. The energy obtained from the photovoltaic cells are constantly collected and stored in the battery.

The charge stored in the battery is then sent to a DC – DC boost circuit (XL6009 IC). This circuit steps up the battery output from 3V to 5V and sends to the USB step up converter. The step-up converter provides constant 5V output in order to provide consistent charging mechanism for the mobile phone. The figure 1 depicts the simplified block diagram of the prototype.

![Block diagram of the project](image)

**Figure 1.** Block diagram of the project

The designed circuit is then arranged behind the back of the Silicon protection case of the mobile phone. The solar panels are placed above the charging and battery circuit so that whenever we turn the phone upside down, the panel captures the sunlight and stores in the battery. And whenever we want the phone to get charged, we just have to tap on a switch and the phone starts charging.

The major components used in this project are listed below:

2.1. **Photovoltaic Cell / Solar Panel**

The solar panel used in this project is a 3v 150mA mini–Solar Panel that has Polycrystalline solar cells which are encased and protected by a durable outer poly frame. This mini–Solar Panel is light weighted, very strong and weather resistant. These Small panels are simple to install or add to the existing product and their construction requires no frame or special modifications.

- Max output power (without load): 0.45W
- Max working voltage (without load): 3.3V
- Max charging current (without load): 150mA
- Min output power (without load): 0.45W
- Min working voltage (without load): 3V
2.2. **USB Charging Circuit**

The TP4056 is a complete constant-current/constant-voltage linear charger for single cell lithium-ion batteries. Its SOP package and low external component count make the TP4056 ideally suited for portable applications.

2.3. **Lithium Polymer Battery**

The Battery used in this circuit is a 3.7V 5000mAH (Lithium Polymer) Lipo Rechargeable Battery also known as Lipo or Lipoly batteries. These are thin, light and powerful. This battery has a capacity of 5000mAH. These Batteries are widely used in GPS, DVD, iPod, Tablet PC, MP4 Player, Power Bank, Mobile Backup Power Supply, Bluetooth Speaker, IOT and other Industrial applications.
2.4. DC – DC Boost Converter
XL6009 module is a non-isolated step-up boost voltage converter featuring adjustable output voltage, high efficiency. It converts input voltage of 5-32V DC to an output voltage of 4-38V DC.

Figure 4. Lithium Polymer Battery

Figure 5. XL6009 DC-DC Boost Converter

3. Related Works
Users can carry mobile phone chargers with them wherever they go, but electricity may not always be available. This solution can be used to defeat this problem in many places that do not have electricity, such as rural areas and some hill stations. In this article, the author provides a solution for charging multiple devices in a public place. During the night, the stored energy is used for both lighting and charging.[3]

The author created the solar backpack to address the issue of people becoming frustrated when they are unable to contact friends due to a dead phone [4]. This backpack stores energy from solar cells on the outside that can be used to charge electronic equipment such as cellular phones and iPods. The panel is joined to the charging cycle, which contains a Voltage regulators, by means of four blocks of three solar cells in parallel which make up a panel. He also evaluated the use of two ultra-capacitors, which also save energy, to store charges and a backup battery. The result was a portable solar recharge pack. The strength of this system is the use of ultra-
capacitors and backups that deliver sufficient load current. However, this system presents a challenge. Instead of a potentiometer, a special 550Ω resistor was used in the voltage controller circuit so a user can vary the voltage and charge different devices. Cell phones with a voltage need less than 5V can be charged with this backpack unit [5].

The green power charger is designed to meet the insatiable demand for power for irresistible gadgets using renewable energy resources. This design is a portable green power charger that uses solar energy to mitigate the sustainable energy challenge. They use the concept of capture, store, and charge here, with the capture coming from a green resource [6].

In this study, the input is provided by a photovoltaic cell, and the amount of voltage required is controlled by a charge controller. The received voltage is passed through an IC circuit and wirelessly transmitted to the respective device to charge it.

4. Result And Conclusion

![IV Characteristics of the solar cell used](image1)

**Figure 6.** IV Characteristics of the solar cell used

The IV characteristics of the solar cell purchased was measured using a solar simulator with an irradiance of 1000w/m² at room temperature [7]. The IV characteristics of the solar cell is depicted in Figure 6. The data matches well with the specification of the solar cell purchased.

![Charging of a 5000mAh battery using the solar powered charging case](image2)

**Figure 7.** Charging of a 5000mAh battery using the solar powered charging case
The portable mobile Solar Charger was designed and fabricated to be compact in size and cost efficient, reliable, portable, light weight and economically viable for charging cell phones [8]. The charging of the mobile phones was tested by installing the solar based charger unit in the protective case. The charging of the mobile phone was recorded for every one hour in terms of the percentage. Since we have used two solar cells with an short circuit current of 150 mA, the complete charging of the 5000mAh battery could be completed only after 20 hours of charging.

5. Future Scope
There are still many improvements to be made to this portable solar charging case now that it has been designed.

- The first significant area for improvement to this project is the use of photovoltaic cells that can be charged not only by sunlight but also by incandescent or LED lights.
- Another major upgrade that can be done to this project is to introduce wireless charging mechanism so that the phone automatically gets charged when the phone is placed in the case which in turn reduces the wires and from the model.
- This circuit can further be modified and can be used for other electronic devices like Bluetooth headsets, speakers.

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