An Innovative Way Of Implementing Efficient Mobile Charger Powered By Solar Energy

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Abstract. As non renewable energy sources are getting exhausted from earth, renewable energy sources need to be incorporated for daily needs. Mobile phones have become a vital part in life and its importance has increased so much that it needs to be kept charged. This paper proposes a system which is powered by solar energy to charge the mobile phones. The proposed system is designed to trap the solar energy and store it in a rechargeable battery. A mechanism to limit the over current flow in the circuit and to prevent the draining of battery and low voltage operation is incorporated in the system. Many low-voltage devices including mobile phones can be charged using this system and the charge in the battery is displayed with the help of LCD and a micro-controller

Keywords: Renewable energy, solar energy, mobile phones, battery, low voltage devices

1. Introduction
Gadgets are small machines that make human work easy. They are simplified applications to perform some task and have become a part of life. Television, refrigerator, mixer grinder, dish washer, music system are some of the examples of gadgets. Gadgets have improved the efficiency of human and made this world a better place to live. Dependency on gadgets has gone to such a level that one can’t think of completing a task without the intervention of gadgets. They help to save the space and make things compact. Gadgets have made life simple, luxurious and comfortable. Among gadgets, the most important one is communication gadgets, like mobile phones, tablets, laptops etc, as they control interaction with the world.

Mobile phone, communication gadget, is a device that human carries everyday with them. This gadget helps to stay connected and it provides a fast and easy way for communication. Mobile phone has many sophisticated features in it. It allows the user to take pictures, personal data, emergency services, business and education services, travel and tourism, health and financial data etc. It ensures safety and provides continuous and uninterrupted communication irrespective of movements and distance. Hence it has become an integral part of modern human life. This helps to understand the importance of charging the mobile phones and keeping it ready. Charging these mobile phones especially outside home is a challenge. It needs an AC or DC source to charge the mobile phones batteries. It is difficult to find these sources to charge mobile phones while travelling or outside home. As renewable energy sources are abundant in nature and it is a high time to think about an alternate source of energy that depends on fossil fuels, this paper proposes a system to charge mobile phones which is powered by solar energy.
1.1. Review on solar power systems
In an on-grid system solar power systems will be connected to the utility grid. These systems will generate the electricity which is required to power the home appliances. As the house is connected to the grid, grid power can be utilized if the generated solar power is less. When the solar systems are producing more energy than what is needed for the home appliances, the excess energy can be send back to the grid and can earn the credits for the power which is selling to the grid company [1]. This excess energy can also be stored in a battery for future usage.

Figure.1 shows the layout of an off grid solar system. Electricity produced by an off grid system need a battery storage device for a continuous supply of energy. It is uncertain to generate the required energy by an off grid solar system during a cloudy day. Also there will not be any provision to get some excess energy unless an extra storage device is available.

Fig.1 Layout of an off grid system

2. Methodology
The following components are used in the proposed system

2.1. Solar Panel
Solar panel absorbs the energy from sun to generate electricity [1]. PV (photo voltaic) modules constitute an array of a photovoltaic system to produce electric energy. DC output from each PV modules is considered as its rating and usually it ranges from 100 to 350 W. A solar panel of rating 100W, 12 V polycrystalline module is used for the proposed system.

2.2. Battery
Batteries are needed to store the excess solar energy to provide continuous supply of electric energy. Rechargeable solar batteries are used in off-grid PV systems in which some are wet cells and some are gel cells. Lead acid battery is most commonly used in power stations and substations because of its lower cost and higher cell voltage.

2.3. Charge flow Controller
Charge flow controllers are mainly used in the system to limit the over current flow in the circuit. This is used in the proposed system to limit the overcharging of battery. Figure.2 shows the connection diagram of charge controller circuit.
2.4. Relay
Relays are switches that operate by electromechanical or electronic operation to open or close the contact. A relay operating in one circuit can control another electric circuit by opening and closing its contact. As shown in the diagram, when the relay is not energized it provides a normally open (NO) contact and when it gets energized it provides a normally closed (NC) contact. In the proposed project, a relay of rating 13V, 5A is used to prevent the draining of battery and low voltage operation. Figure 3 shows the basic connection diagram of a relay.

2.5. Buck boost converter
Buck boost converter can also be called as DC to DC converter. The output voltage of this dc to dc converter can be made lesser or greater than the input voltage by controlling its duty cycle [2,4&5].

In the step up operation mode of the buck boost converter $V_{in} < V_{out}$ and $I_{in} > I_{out}$ and in a step down operation mode $V_{in} > V_{out}$ and $I_{in} < I_{out}$.

2.6. Voltage divider circuit
Voltage divider circuit helps to step down the DC voltage further, after a Buck-Boost circuit. It helps to taper down the voltage so that it becomes compatible to be read by a microcontroller via an ADC. The output is nothing but a varying DC. The components are so arranged that there is enough protection for the microcontroller. Figure 4 shows the connection of the voltage divider circuit.

2.7. LCD and microcontroller

A Liquid crystal display (LCD) can be used to present the information with the help of an array of tiny segments. LCD doesn’t emit light directly instead it uses light modulating technologies to present the information. JHD162A (LCD) with microcontroller configuration is used in the proposed project.

The following flowchart in figure 5 explains the working of the proposed system for charging the mobile devices using solar power [3&4].

![Flow chart of solar mobile charger](image)

The parameters and rating of the solar module is given below in table 1.

| Parameters                          | Ratings       |
|-------------------------------------|---------------|
| Rated Power (Vmp)                   | 100W          |
| Short Circuit Current (Isc)         | 5.92A         |
| Open Circuit Voltage (Voc)          | 22V           |
| Voltage at Max Power (Vtn)          | 18.3V         |
| Current at Max Power (Im)           | 5.5A          |
| Range of Operation Temperature      | -10 to 80°C   |
| Efficiency                          | 18.09%        |
| Resistance in shunt                 | 47.11Ω        |
| Resistance in series                | 0.29Ω         |
Details of the components [2 & 3] used are given below

- Solar panel - 12V/100W
- Lead Acid Battery - 12V/12Ah
- Charge flow controller
- Buck - boost converter - Input :10-30V, Output:12V
- Voltage divider circuit
- Relay - 5V/10A DC
- LCD - JHD162A with KS0066(Microcontroller)
- Mobile charging slot - 5V/1A

3. Designing of PV system

3.1. Power Requirement of load

The power rating of a mobile phone battery is taken as load. Voltage: 3.7 V DC, Capacity: 1000mAh.

Power of the load can be calculated as, \( P = 3.7 \times 1000 \text{mA} = 3.7 \text{watt} \). Two mobile chargers are used in the proposed system. So the power requirement is, \( P = 3.7 \times 2 = 7.4 \text{watts} \)

3.2. Battery Bank

A lead acid battery of 12 V, 12000 mAh is used in the proposed system. The power rating of the battery bank will be \( P = 12 \times 12000 \text{mAh} = 144 \text{Wh} \).

3.3. Power calculation for solar panel

Considering the power requirement of battery bank, number of solar panels can be obtained as

1. Required Power output - 144Wh
2. Considering the 30% of power loss in PV, 30% x 144Wh = 43.2Wh
3. Average solar energy in hours / day -6 hours
4. Required power for PV panel (144 Wh+43.2Wh)/6 h=31.2 W
5. Proposed system module > 31.2 watt

3.4. Configuration of LCD with Microcontroller

LCD has been configured with microcontroller using C program and it has been connected with ports as per the datasheet in table 2:

| Pin NO. | Symbol | Level | Description |
|---------|--------|-------|-------------|
| 1       | VSS    | 0V    | Ground      |
| 2       | VDD    | 5.0V  | Supply voltage for logic |
| 3       | V0     | ---   | Input voltage for LCD |
| 4       | RS     | H/L   | H : Data signal, L : Instruction signal |
| 5       | RW     | H/L   | H : Read mode, L : Write mode |
| 6       | E      | H/L   | Chip enable signal |
| 7       | DB0    | H/L   | Data bit 0 |
| 8       | DB1    | H/L   | Data bit 1 |
| 9       | DB2    | H/L   | Data bit 2 |
| 10      | DB3    | H/L   | Data bit 3 |
| 11      | DB4    | H/L   | Data bit 4 |
| 12      | DB5    | H/L   | Data bit 5 |
| 13      | DB6    | H/L   | Data bit 6 |
| 14      | DB7    | H/L   | Data bit 7 |
| 15      | LED A (+) | 4.7V | Back light anode |
| 16      | LED K (-) | 0V  | Back light cathode |
4. Results & Discussions

I-V characteristics of a solar panel have been tabulated (Figure.6) from which the following maximum current and maximum voltage can be determined from table.3

**Table3**: I-V characteristics of solar panel

| Voltage(V) | Current(A) | Power(W) |
|------------|------------|----------|
| 0.9        | 8.4        | 7.56     |
| 1.8        | 8.4        | 15.12    |
| 2.9        | 8.4        | 24.36    |
| 5.4        | 8.4        | 45.36    |
| 8.1        | 8.2        | 66.4     |
| 10         | 8.1        | 81       |
| 13.2       | 8.0        | 105.6    |
| 15.4       | 7.9        | 121.66   |
| 17.2       | 7.8        | 134.16   |
| 18.9       | 6.9        | 130.41   |
| 20.7       | 5.4        | 111.78   |
| 21.3       | 3.9        | 83.07    |
| 22         | 2          | 44       |

Fig.6: Connection for finding I-V characteristics of a solar panel

The time required to charge the battery using the solar panel is given in the table 4. The hardware implementation of the mobile charger powered by solar energy is shown in figure.7

**Table4**: Time required for battery charging

| Measurement time | Time required for battery charging |
|------------------|------------------------------------|
| 8am              | 2hrs                               |
| 12am             | 1hr15 minutes                      |
| 2pm              | 35 minutes                         |
| 5pm              | 1 hr 35 minutes                    |
5. Conclusion & Future scope
Solar energy is abundant in nature and it will never get exhausted. This energy need to be trapped for our daily needs. In the proposed system a solar powered mobile charger is used to charge the mobile phones. The biggest challenge with the solar energy is the variation in the intensity of solar irradiance and that results in the unregulated voltage output. Voltage regulator is used to overcome this challenge. The trapped solar energy is stored in the battery and is fed to various loads. LCD with a micro-controller is used to display the charging level of the battery.

Weight and size of the lead acid battery used in the proposed system makes it non portable. If this device is designed with an optimal weight and pocket size it can be made portable. Also the solar panel is non portable and bulky. Different technology can be used to fabricate the solar panel to reduce the size of the device.

![Fig.7 Hardware implementation of solar mobile charger](image)

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