ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 4, Issue 9, September 2015**

# Solar Charger Based On Super Capacitor Incorporation for Smart Phones

T.Harish[1], CH.S.S.V.Ramana[2], M.Ramu[3]

UG Student, Dept. of EEE, GITAM University, Visakhapatnam, Andhra Pradesh, India[1]

UG Student, Dept. of EEE, GITAM University, Visakhapatnam, Andhra Pradesh, India[2]

Assistant Professor, Dept. of EEE, GITAM University, Visakhapatnam, Andhra Pradesh, India[3]

**ABSTRACT**: Most of the places in the world which lie on the equator receive 5000 trillion kwhr / year, which is greater than any countries energy consumption. Most popularly solar energy is produced based on the principle of photovoltaic effect. This paper helps to provide new results for mobile charging using solar energy. Now a day smart mobiles do not have much battery backup, so they need to charge their mobile frequently. Use of solar charger attached to their mobile panel helps to charge their mobile frequently without any need of charging point. In this paper we focused on ambient light sensor and accelerometer to find the suitable location orientation of solar charger. We conducted different experiments using sensors, super capacitors etc. We decreased the time required for charging. In this paper experimental results are included and compared with literature.

**KEYWORDS:** Ambient light sensor, Accelerometer, Super capacitors.

## I.INTRODUCTION

In today world smart phone has become the most common thing that everyone has. Many things in the world are being done by using these smart phones (online transfer, shopping etc.).Rapid change in the hardware and software of the phone leads to increase of required energy for sustainable usage. So in future the battery of the phone is going to be the bottle neck of the phone. But the main problems associated with smart phones are that they do not have long battery life. Portable Solar chargers are used to overcome the problems of batteries as they have high charge density compared to other power generation resources [1].It is very useful as it charges our mobile phones when ever required such as library, office, home etc. without any USB or electrical socket [3]. The amount of power that is delivered by the solar charger also depends on various factors like ambient temperature, solar irradiance etc., as it has to work both in indoor and outdoor conditions [4].Sensors in smart phone helps to find out the maximum potential points in the surroundings so that maximum amount of energy is used that is available in the surroundings [4].Generally the output of the solar charger should not be less than charging power. USB charging current which is used to charge the phone do not have the capability to change with respective the irradiance intensity of solar panel, so solar panel cannot provide 100% duty power to the smart phone [5]. So use of super capacitors in USB compatible solar charger increases the efficiency that is by decreasing the charging time.

## II. BACKGROUND

### METHODS TO OBTAIN MAXIMUM POWER POINT

**A. Characteristics OF Photo Voltaic Cell :**

Now-a-days Photo Voltaic cells are getting familiarized as they are used in energy harvesting techniques. These are mostly used because they have high charge density and due to its nonlinear characteristics we can obtain the desired power from a solar panel.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 4, Issue 9, September 2015**

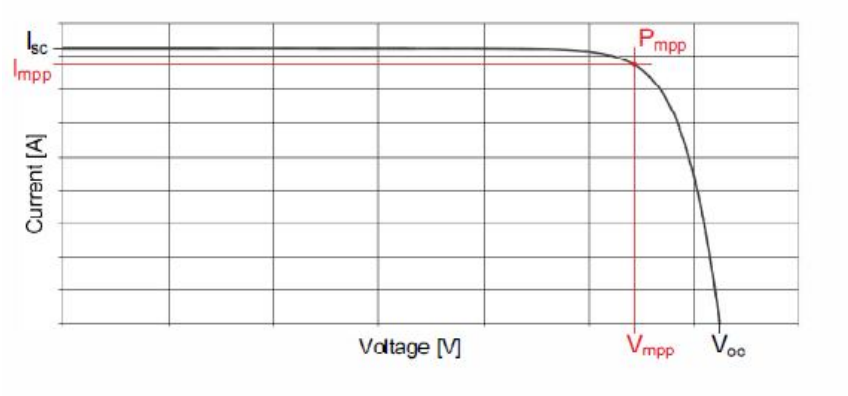


Fig.1 Characteristics of PV Cells [2]

As we can see the I-V characteristics of a photo voltaic cell, these describe that the photovoltaic cell gives the maximum output at MPP(maximum power point). The maximum power point depends upon many conditions like temperature, radiation etc.

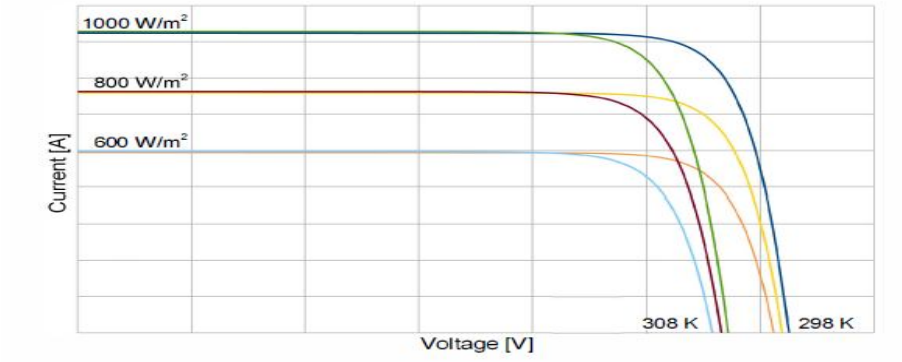


Fig.2 Characteristics of PV cell under different irradiance [2]

Here we can see that as the maximum power point changes with respective the radiation and temperature. The Voltage obtained in different radiations must be made equal to that of the voltage of mpp otherwise the power produced in cell will not be optimal. These can be achieved by dc-dc converter, super capacitor etc.

**B.USING DC-DC REGULATOR**

DC-DC regulators are used to define the maximum power point. In this we maximum power point is determined by changing the duty cycle of the dc-dc converter. Firstly the current and voltage across the solar panel and across battery are measured. As the voltage across the battery does not change rapidly that is, it is in the process of charging, it is taken as an advantage to determine the MPP by algorithm. Power in solar panel is given by the equation $V_{solar}I_{solar}=\underline{V_{batt}I_{batt}} / E_{dc/dc}$

**Algorithm is as follows**:

Step 1: First the current in the battery is noted ($I_{batt}$ ), the current position and the regulation is increased by changing the duty cycle of the converter. Now the battery current is measured ($I_{batt+e}$). If this process is done in very quick manner then the voltage of the battery will be same in both the conditions and the power of solar panel depends only on the battery current.

Step 2: If the new current is greater than that of the battery current then, the system is moved towards the maximum power point.

Step 3: If $I_{batt+e} < I_{batt}$ then we have crossed the maximum power point and then the regulation has to be decreased to reach the maximum power point.

Step 4: If $I_{batt+e} = I_{mpp}$ , it indicates that we are exactly at the maximum power point.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 4, Issue 9, September 2015**

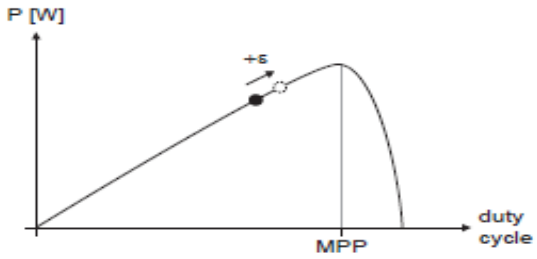


**Fig.3** Characteristics of PV cell with DC-DC Converter [6]

**C.USING SUPER CAPACITORS**

Super capacitors may also be used to obtain the maximum power point, but change in terminal voltage of super conductor results in decrease of efficiency.

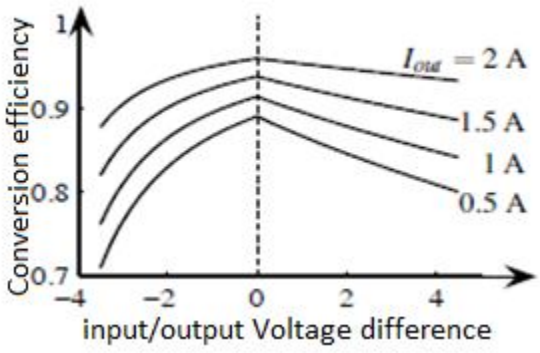


Fig.4 Characteristics of solar charger using super capacitor [5]

From the above fig we can see that as the terminal voltage is too high or low of the super capacitor it results in high conversion loss. Therefore there is a need of super capacitor which decreases the conversion losses and maximizes the charging power to the battery. In dc-dc converter the system operates in low efficiency region due to stop and go process as shown in fig.5, though some part of system operates in high efficiency region, the overall charging of the phone is inefficient due to more number of stop and go cycles as shown in fig. By using this, the efficiency of the solar charger is improved to 34.5%.

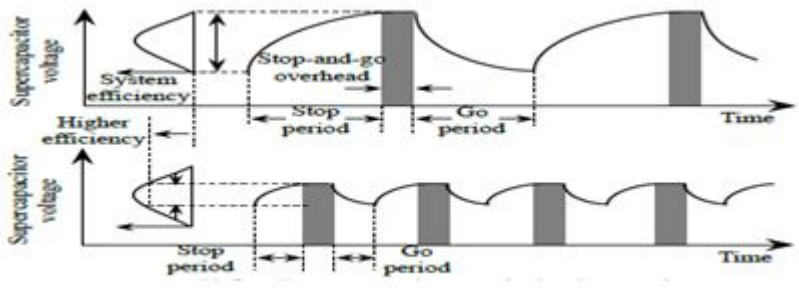


Fig.5 Stop and Go process with large and small capacitors [5]

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 4, Issue 9, September 2015**

**D.USING SENSORS ON PHONE**

As the power of the solar panel also depends on the radiation of the sunlight, we can use sensors that are present in the mobile phones to detect the maximum illuminance point in the surroundings. In this the sensors like ambient light sensor is used to detect the maximum illuminance point and the sensor like accelerometer is used to tilt the phone towards the maximum illuminance point. By this the solar panel can obtain the maximum power point.

## III. METHODOLOGY and RESULTS

In this paper we tried reduce the charging time of the smart phone using solar charger. We conducted many experiments based on previous papers. In this we took a LG smart phone and noted the charging time through USB charger. Then we noted the charging time of the phone when it is charged through solar charger. In this charger we used a solar panel of 5watts capacity and in the circuit we used a voltage regulator of 7805 which is used to send the voltage of 5 volts to charge the phone. Firstly we noted the time of charging through this basic circuit, we measured the charging time during a temperature of $31^0$ from 8am-12noon and the time taken for charging is 3.5 hours. Then we have repeated the experiment from 12noon-4pm and then the charging time is noted to be 3.256 hours. Again we have conducted the experiment from 10am-2pm and in this case the charging time noted to be 3.756hours. Then we have conducted the experiment by replacing the normal capacitor with the super capacitor then we have noted the time taken for charging of the phone during a temperature of $30^0$ from 8am-12noon and the charging time is noted to be 2.3hours.Now we have repeated the experiment from 12noon-4pm and the charging time is noted as 2.14hours.Again we have conducted the experiment from 10am-2pm and this case the charging period is noted as 2.47 hours.

| Charging of Smart Phone through Solar Charger in different sessions. | Sessions-1 (8am-12noon) | Session-2 (12noon-4pm) | Session-3 (10am-2pm) |
|---|---|---|---|
| Time taken | 3.5hrs | 3.256hrs | 3.756hrs |

**Table-1** Charging Time for different sessions of a day (without super capacitor)

| Charging of Smart Phone through Solar Charger in different sessions incorporating super capacitor | Sessions-1 (8am-12noon) | Session-2 (12noon-4pm) | Session-3 (10am-2pm) |
|---|---|---|---|
| Time taken | 2.3 hrs | 2.14 hrs | 2.47 hrs |

**Table-2** Charging Time for different sessions of a day with super capacitor

## IV.CONCLUSION

In this paper we presented a new kind of renewable energy charger which is portable and efficient when compared ordinary solar charger. This modified solar charger reduces the time taken for charging when compared with ordinary solar charger. Since by adding super capacitor to the ordinary charger, the charging time is further reduced. The charging time is different during various sessions of a day, the least time to charge the battery completely is during session-2, and the more time consumed to charge the battery is during session-3 with and without super.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 4, Issue 9, September 2015**

## V.FUTURE WORK

This project could be further modified by reducing the size of the solar panel, such that it is compatible with the size of the phone. Also its efficiency could be improved by adding additional batteries based on requirement so that the phone could be powered in the absence of sunlight. Hybrid charger that is combination of grid power and solar power could also be implemented with the help of decision making algorithms as to when to use solar power and when to use grid power.

## REFERENCES

[1] C. Schuss, J. Huikari, T. Leikanger, B. Eichberger and T. Rahkonen, "Evaluating Ambient Conditions for Solar Chargers with the Help of Sensors on Smartphones", Instrumentation and Measurement Technology Conference (I2MTC), 2015 IEEE International, pp. 103-108, 2015.
[2] C. Schuss, B. Eichbergert and T. Rahkonen,"Design Specifications and Guidelines for Efficient Solar Chargers of Mobile Phones", Multi-Conference on Systems, Signals & Devices (SSD), 2014 11th International, pp. 1-5, 2014.
[3] M. Fareq, M. Fitra, M. Irwanto, Syafruddin. HS, N. Gomesh, Farrah. S, M. Rozailan,"Solar Wireless Power Transfer Using Inductive Coupling for Mobile Phone Charger", Power Engineering and Optimization Conference (PEOCO), 2014 IEEE 8th International, pp. 473-476, 2014.
[4] C. Schuss, T. Leikanger, B. Eichberger, T. Rahkonen, "Efficient Use of Solar Chargers with the Help of Ambient Light Sensors on Smartphones", Open Innovations Association (FRUCT16), 2014 16th Conference of FRUCT ASSOCIATION, pp. 79-85, 2014.
[5] S. Park, B. Koh, Y. Wang, J. Kim, Y. Kim,M. Pedram and N. Chang, "Maximum Power Transfer Tracking in a Solar USB Charger for Smartphones", Low Power Electronics and Design (ISLPED), 2013 IEEE International conference, pp. 88-93, 2013.
[6] M. Pastre, F. Krummenacher, O. Kazanc, N. Khosro Pour, C. Pace, S. Rigert, and M. Kayal, "A Solar Battery Charger with Maximum Power Point Tracking", Electronics, Circuits and Systems (ICECS), 2011 18th IEEE International Conference , pp. 394-397, 2011.