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# IMPLEMENTATION OF SOLAR CELL INTEGRATION BUCK CONVERTER SYSTEM FOR MOBILE PHONES CHARGING

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*Abstract*

***As we know, the sales of mobile phones have increase and are increasing significantly in the market. Partly, the increment of mobile phone usage also is the cause of increasing electricity demand or contribution towards the carbon dioxide gas emission. Even though this is seen as very insignificant matter to be highlighted but if it is ignored continuously it might become a major contributor towards negative environment impact. Therefore, addressing to tackle the minor concern would help to create a healthy environment. Hence, this paper proposes an implementation of mobile phone charging system using solar panel and buck converter. The proposed system is tested and the captured results validate operation of the implemented system.***
***Index Terms – Solar Panel, Buck Converter, Solar Charging, Interactive Device***

## I. INTRODUCTION

Through the years, the solar light is used limitlessly without any impact on the global environment and able to produce energy which is usable as electricity or as power source. Because if this reason, solar cell is developed to convert the falling sun arrays onto the solar cells into a usable electricity. So, to efficiently utilize the sun arrays for a solar based system, an effective system is required to convert the sun arrays into electricity.

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Having briefly discuss the solar light advantages and the requirement to design and develop a solar based system, this project proposes to use 9 Volt solar cell and a buck converter to implement a mobile phone charging system.

As we know, in today's fast moving communication era it is essential to always keep the mobile phone's battery charged. Due to frequent charging requirement to keep the mobile phone's battery charged up, many energy storage gadgets have been developed and it is available to be purchased. Besides that, many of us also use the car charging station which utilizes the electricity energy from the car battery to charge the mobile phone's battery. The car charging station has its limits, car charging station will only supply power for charging when the car engine is switched ON. Some of the developed mobile phones charging gadgets are discussed in the following section.

## II. LITERATURE REVIEW

Tirmare, A. H. and Khandare, V. V. proposed a Solar Energy based Mobile Charger in [1]. The proposed system is developed considering that the requirement of regularly charging the mobile phone is really important. Also, the author mentioned that the applicability of the developed project is focused in public access area and especially at rural areas where electricity access is quite limited. The author proposed a coin based mobile phone charger which is operated using the solar photovoltaic system. The solar photovoltaic system provides the charging voltage and the charging time or duration is depends on the amount of the inserted coins. Similar research work have been done in [2] by Sridevi, S. B. et. al. They used an ATMEL 89C51 40-pins microcontroller integrated with a Liquid Crystal Display (LCD) to perform the solar photovoltaic system based mobile phone charging and monitor the remaining charging time on the LCD. Figure 1 shows the block diagram of the proposed coin operated discussed and described in [2].

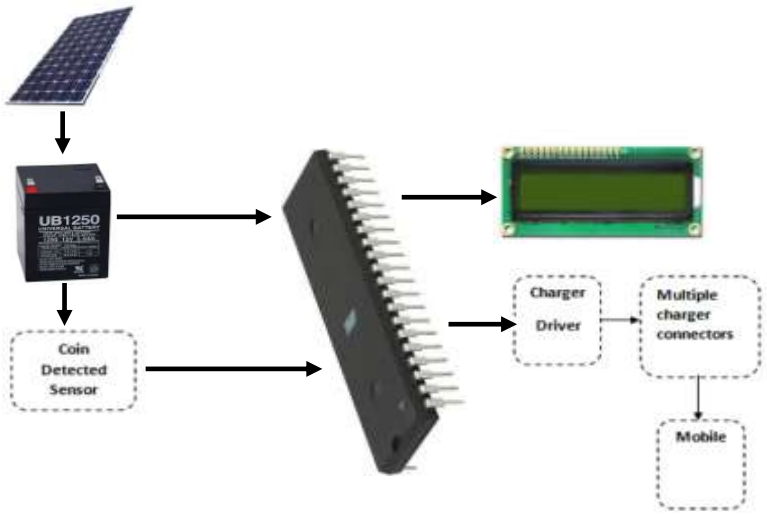


Fig. 1. Solar photovoltaic system coin operated mobile phone charger.

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In [3], Elmahdi, M. A. st. al. has developed a project which is similar to the one in [1] and [2]. In this research the authors have explained the proses of designing and developing the project. The author also presented detail calculation to develop a 10 Volt solar photovoltaic system for mobile phone charging. Figure 2 shows the block diagram of the proposed system in [3].


Fig. 2. 10 Volt Solar photovoltaic system for mobile phone charging.

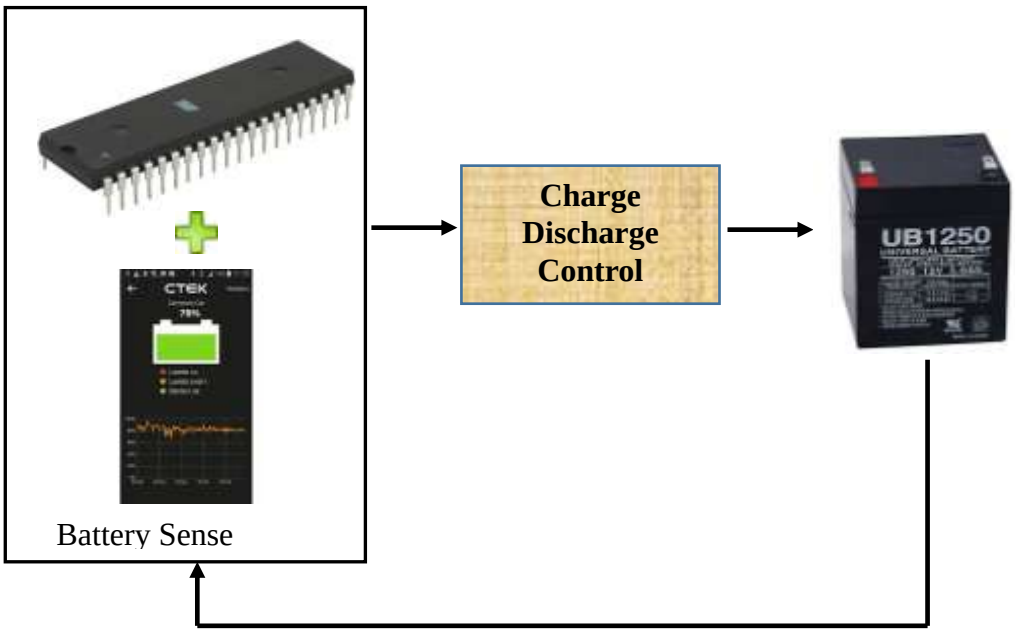


Fig. 3. Overvoltage protection with cut-off system.

Karemore and Welekar proposed an auto power cut-off multi mobile charger integrated with solar panel system in [4]. The project presented in this research also emphasis on the inaccessible and rural areas applications. It is to help the community to keep their mobile phone charged for any emergency cases. This project is consists of a sensing unit, microcontroller, buck converter and battery. Buck converter is integrated to control the charging voltage from the battery to the mobile phone. In another similar work in [5][6], the proposed project integrates the microcontroller to switch ON the buck converter for mobile phone charging process. It also integrated the overvoltage protection with auto cut-off system to protect the battery from being over charged. The diagram of overvoltage protection with auto cut-off system is presented in Fig. 3.

A number of research papers related to the proposed research are studied and their summary is presented in the literature review section. Through the literature review studies, it has been found that the solar photovoltaic/panels can be innovatively integrated with the remaining electronic components which can be used as an active system. Therefore, after reviewing some of these papers, this research paper proposes to implement a solar panel integrated with buck converter for mobile phone charging.

This research project is aimed to design and develop a complete working prototype of mobile phone charging system which is built using a car mobile phone holder. The remaining of this paper is arranged as following: 1) system design and development description, 2) Results and Analysis, 3) Discussions and finally is the conclusions.

## III. SYSTEM DESIGN AND DEVELOPMENT DESCRIPTION

Figure 4 shows the block diagram of the proposed solar panel integrated with buck converter for mobile phone charging.

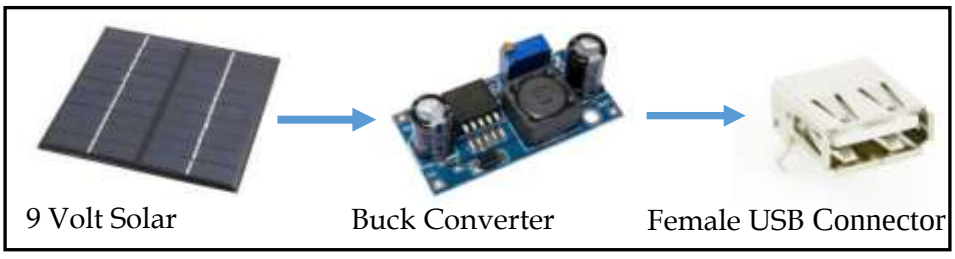


Fig. 4. Implemented solar panel integrated with buck converter block diagram.

As it is presented in Fig. 4, the 9 Volt solar panel, buck converter and a female USB connector are integrated to complete as a system. 9 Volt solar panel with 1 Ampere current is used to produce sufficient amount of energy to the buck converter. The 9 Volt from the solar panel is step down to 5 Volt 1 Ampere and the 5 Volt 1 Ampere output is connected to the female USB connector.

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## IV. BUCK CONVERTER OPERATION

Figure 5 show the schematic diagram of buck converter. A buck converter is just a fundamental circuit consists of an inductor, diode and a capacitor. The presented buck converter in Figure 4 is a switch controlled and the operation of the presented buck converter is explained in the following section.

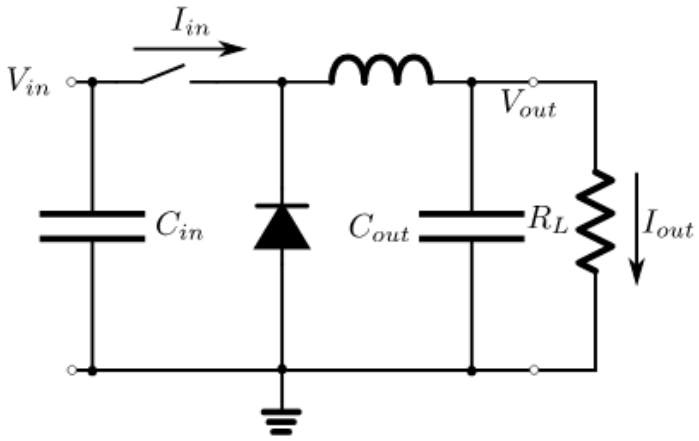


Fig. 5. Buck converter schematic diagram.

The switch turning ON and OFF is periodically controlled. Where, the $t_{on}$ is the time the buck converter is ON and the $t_{off}$ is the time the buck converter is OFF. Therefore, the total time $T$ is equal to $t_{on} + t_{off}$.

When the switch is closed (ON), the output voltage at the inductor is equivalent to $V_{in} - V_{out}$.During this period, the current at the inductor rises to the rate of $\frac{V_{in} - V_{out}}{L}$. When the current at the inductor rises, the diode, $D$ is reverse biased and is in not conducting position.

When the switch is open (OFF), the inductor current keeps flowing at the same rate. As a result, the current from the inductor continues to flow into the load. At this moment the diode, $D$ connects back to the return path with diode current $I_{diode}$ equal to $I_{out}$ flowing through the diode. Also, the polarity of the voltage across the conducting inductor is reserved and the current starts to decrease through the inductor which is equal to $-\frac{V_{out}}{L}$.

To demonstrate the real-time operation of the proposed system, next section presents the results, analysis and discussion of the system's operation. The results, analysis and discussions presented shows the actual hardware setup for system's operation analysis.

## V. RESULTS, ANALYSIS AND DISCUSSION

### a) Solar Panel Operation (Voltage and Current measurement)

Figure 6 presents the operating solar panel measured voltage. The multimeter is used to measure the 8.94 Volt operating solar panel and this voltage is given as an input to the buck converter to step down the voltage to 5 Volt for mobile phone charging.

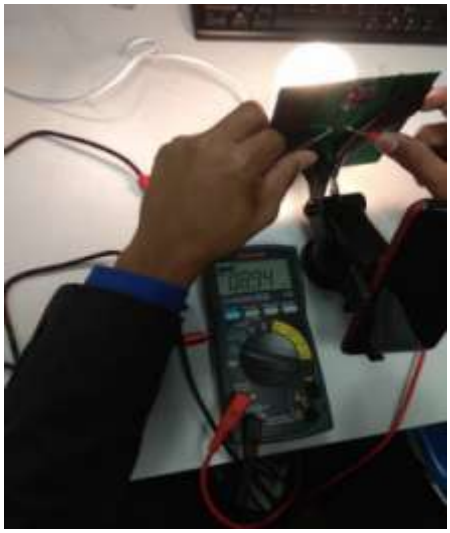

Fig. 6. Operating Solar Panel measured voltage.

Fig. 7. Operating Solar Panel measured current.

Figure 7 presents the operating solar panel measured current. The multimeter is used to measure the 12mA (mili Ampere) which is the output current from the solar panel. The measured current is significantly low due to low solar irradiance showering onto the solar panel.

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**b) Buck Converter (Voltage and Current measurement)**

Fig. 8. Operating Buck Converter measured voltage.

Figures 8 and 9 presents the operating Buck Converter measured voltage and current. The multimeter is used to measure the 4.18 Volt and 2.19mA (mili Ampere) which is the output voltage and current from the Buck Converter. The measured voltage current is considered low to start charging the mobile phone but eventually it still charge the mobile phone.

Fig.9. Operating Buck Converter measured current.

**c) Complete system operation**


(a) (b)

Fig. 10. Complete system testing and demonstration.

Figure 10 presents the complete system testing and demonstration. Figure 10 (a) shows the mobile phone is not connected to charging circuitry. Figure 10(b) shows the mobile phone is connected to the charging circuitry and the power source from the solar panel is sufficient to start charging the mobile phone.

## VI. CONCLUSIONS

This work presents a solar panel charging integrated with Buck Converter for mobile phones. The presented result and analysis validate the system's operation and functionality. Also, the presented system can be used as a replacement charging system in the car, which conventionally USB car charger is used for charging the mobile phones. This utilizes the car battery power and also when the car engine is not switched ON the charger will not perform the mobile phone charging. Whereas, our proposed system is able to perform the mobile phone charging even though the car engine is not switched ON.

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