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# Development of Portable Photovoltaic (PV) Kit for Low Load Application in Northern Region Malaysia

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Nurul Asmidar Roslli[1,*], Nur Irwany Ahmad[1], Nazrul Azril Nazlan[2], Diyya Hidayah Abd Rahman[1], Amir Amri Rahim[1], Ahmad Bazli Lokman[1], Siti Nur Shazwanie Mohamad Jasin[1]

[1] Department of Electrical Engineering, Faculty of Electrical Engineering Universiti Malaysia Perlis, 02100 Padang Besar, Perlis, Malaysia
[2] Plexus Manufacturing Sdn Bhd, Plot 139 Bayan Lepas Free Industrial Zone, Phase 2, 11900 Bayan Lepas, Penang, Malaysia

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**ABSTRACT**

Solar energy is the largest renewable energy source that can be use to generate electricity in direct way and the development of the portable photovoltaic (PV) kit are easy to carry and reliable to any emergency cases. Solar energy is also considered as the most efficient and high power among sources such as wind and hydro. Photovoltaic (PV) also usually installed on the roof of houses or buildings but fixed on place and cannot be brought anywhere due to the static installation. Thus, photovoltaic (PV) kit is design to simplify the using of power anywhere and anytime or even during blackout that could occur without any backup energy. The main purpose of this project is to design a portable photovoltaic (PV) kit for low load applications. The output voltage depends on the input voltage directly obtained by the solar panel and the time required of the battery to get fully charged. Therefore, this project used two photovoltaics solar cells which connected in parallel with charging requirement for the rechargeable lead acid battery for the usage of low load applications. Due to the weight and size of the kit, some approachable method are applied such as adding wheel to the kit which could reduce the weight, and portable to be carried anywhere. The usage of PVC as the material used in this project is lightweight but still can withstand the weight of the battery and load. This project was tested at two different areas in northern region Malaysia which were in Penang and Perlis. The battery performance was analysed based on the output power that have been produced from the solar panel.

***Keywords:***
Photovoltaic, Direct Current (DC), Northern region, Malaysia



## 1. Project Background

When the sunlight hits the photovoltaic cells, some parts of the electrons is being absorbed into the semiconductor and this happens to loosen the electrons that allows them to move freely [1-2]. The photovoltaic systems are highly reliable and often chosen because of the lowest life-cycle cost and it is a favourable economic choice [3]. The applications of the PV is either the stand-alone applications or the grid-connected systems where the stand-alone system is independent of the

* *Corresponding author.*
*E-mail address: azani.mustafa@gmail.com (Nurul Asmidar Roslli)*

electricity-grid and with the energy produced usually stored in batteries [4]. The output of a single cell are depend on the design created and from the semiconductor material chosen and in order to provide an appropriate quantity of electrical power, a number of cells must be electrically connected [3].

The compositions of photon is the light which are simply a small bundles of energy or the electromagnetic radiation where these photon can be absorbed by the photovoltaic cell [5-6]. Suitable wavelength of light hits the cells producing energy from the photon is being transferred to an atom of the semiconducting materials in the p-n junction [7]. When the silicon exposed to the sunlight, electrical charges are generated and this conducted away by the metal contacts as the direct current (DC) [1].

## 2. Project Construction

### *2.1 Project Design*

The design aspect from this project is a vital requirement to construct a charging circuit. However, the PV module selection, circuit and all the other components have been considered according to the parameters needed. The development of portable photovoltaic (PV) kit consists of charging circuit, voltage indicator circuit and the 5 V voltage regulator circuit as in Figure 1. Other than using the charging circuit, the solar charger controller is a switching device that connect and disconnect of the battery to stop the correct amount of voltage [8]. The DC battery then will supply the power to the load. The system flow from the charging circuit unit to other circuits to supply voltage to the Arduino Board as shown in Figure 2.

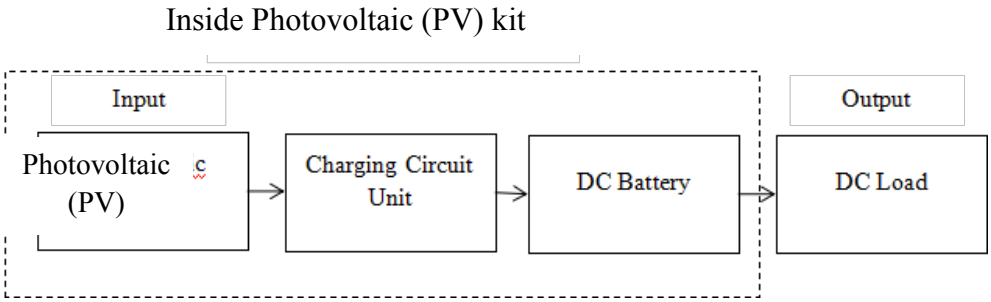


**Fig. 1.** Block diagram of project

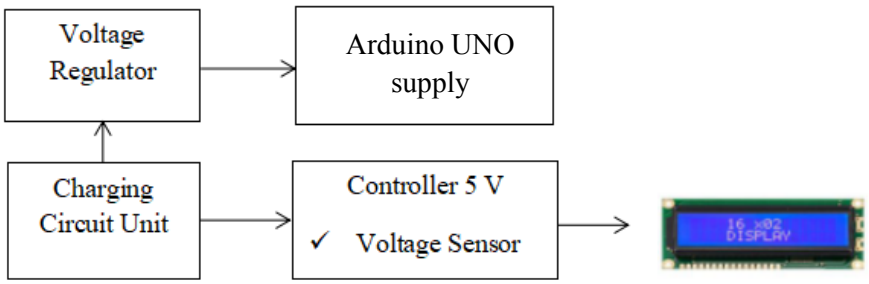


**Fig. 2.** System flow

### *2.2 Portable Photovoltaic Kit for Low Load Application*

Different views of the project design from AutoCAD software and final product as shown in Figure 3. The design of the prototype are presented in 3D view and with specific dimension of portable photovoltaic kit for low load application as in Figure 3. The portable photovoltaic kit design that consists of two PV panel connected in parallel to each other as shown in Figure 4. The PV panel attached to each side of the kit and have a mechanism that can be lift until 90 degree. However, the elevation enable the PV panel to be in any angle to achieve the best performance of PV panel. This portable PV kit are made of PVC which the material used are lightweight and have the capability to withstand the weight of battery and load.

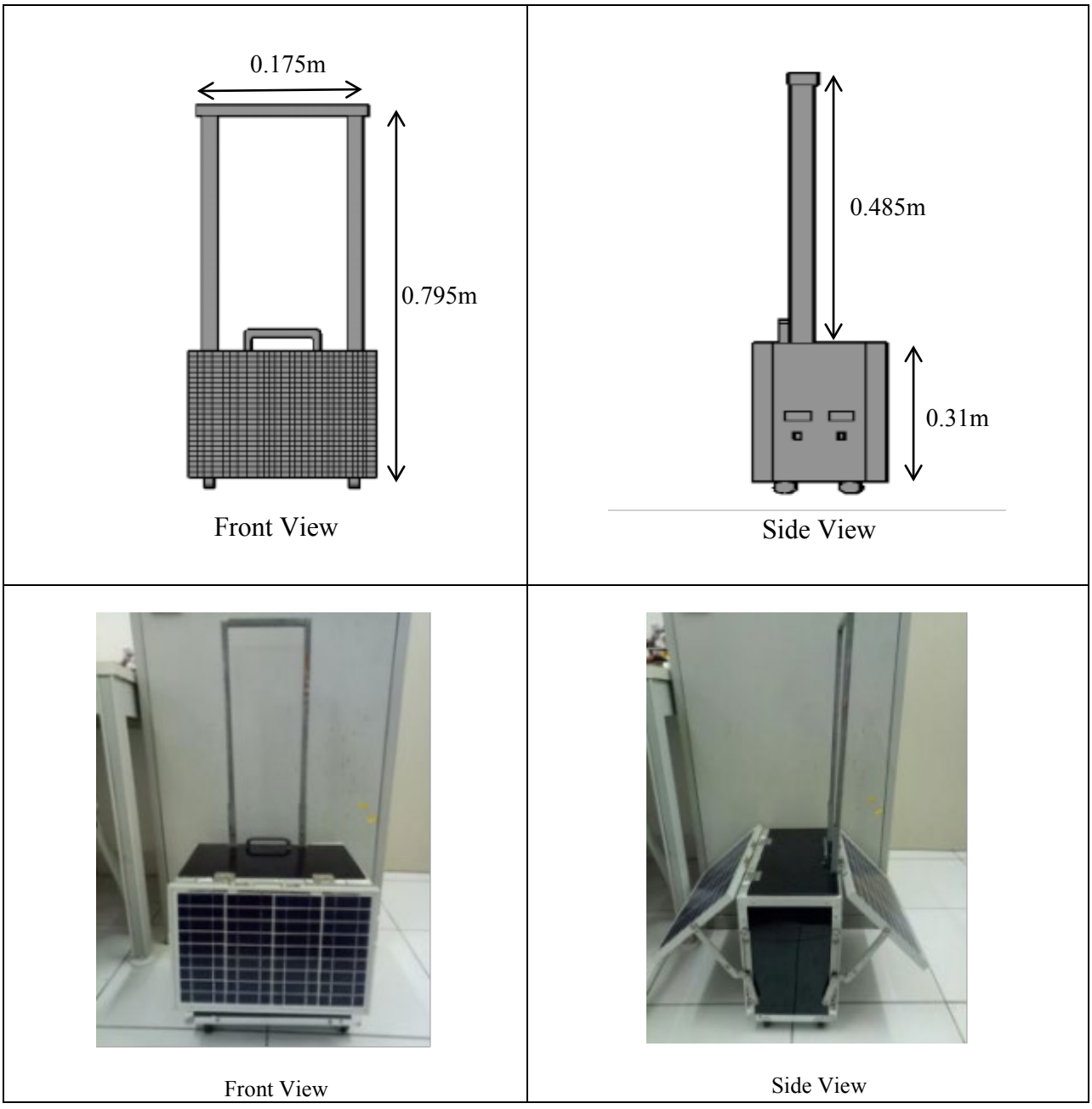


**Fig. 3.** View of the product from AutoCAD softwar

## 3. Results and Discussion

### *3.1 Battery Performance*

The time needed for the battery with capacity of 7.2 Ah to charge were calculated. The charging current of the battery is given 2.1 A to reach 100% charging. The calculation shown as below.

$$\text{Battery capacity} = \text{current} \times \text{time} \quad (1)$$

**Table 1**
Time needed based on current received from solar panel

| Current/hours | Battery | 1 solar panel | 2 solar panel |
|---|---|---|---|
| Max Current (A) | 2.1A | 0.84A | 1.68A |
| Hours (h) | 3.43h | 8.6h | 4.3h |

Table 1 shows the time needed based on the current received from the solar panel. By using two solar panel, the current received are two times of single solar panel. Thus, the time needed are shorten for the battery to fully charge if the battery received enough maximum current. However, the battery also needed battery protection to avoid excessive voltage and overheat when discharging or charging [9-11]. Moreover, the calculation shows below are the theoretical calculation when using one or two solar panel and the time needed depending on the current obtained [12].

### *3.2 PV Performance Result*

The performance of the solar panel is tested under two different location which is in Penang and Perlis to obtain results. The weather and temperature of particular location does not same and could be varying from time to time [13]. The data recorded are within three days both places are shown in Table 2 and Table 3. Due to the condition where the standard temperature for solar energy to be optimum is at 25°C, higher than the temperature level will causes a phenomenon of hotspot to occur toward the solar panel [14].

**Table 2**
Data recorded in Penang

| Experimental assessment | Time (h) | Voltage (V) | Current (A) | Power (W) |
|---|---|---|---|---|
| 1 | 10.00 a.m. | 11.58 | 0.1 | 1.16 |
| | 11.00 a.m. | 12.32 | 0.1 | 1.23 |
| | 12.00 p.m. | 12.59 | 0.4 | 5.04 |
| | 1.00 p.m. | 13.01 | 0.6 | 7.81 |
| | 2.00 p.m. | 12.52 | 0.2 | 2.50 |
| 2 | 10.00 a.m. | 12.01 | 0.2 | 2.40 |
| | 11.00 a.m. | 12.15 | 0.5 | 6.08 |
| | 12.00 p.m. | 13.00 | 0.7 | 9.10 |
| | 1.00 p.m. | 13.04 | 0.9 | 11.74 |
| | 2.00 p.m. | 13.04 | 0.7 | 9.13 |
| 3 | 10.00 a.m. | 12.20 | 0.1 | 1.22 |
| | 11.00 a.m. | 12.92 | 0.3 | 3.88 |
| | 12.00 p.m. | 12.98 | 0.4 | 5.19 |
| | 1.00 p.m. | 13.20 | 0.6 | 7.92 |
| | 2.00 p.m. | 13.20 | 0.7 | 9.24 |

**Table 3**
Data recorded in Perlis

| Experimental assessment | Time (h) | Voltage (V) | Current (A) | Power (W) |
|---|---|---|---|---|
| 1 | 10.00 a.m. | 12.92 | 0.4 | 5.17 |
| | 11.00 a.m. | 12.41 | 0.3 | 3.72 |
| | 12.00 p.m. | 12.38 | 0.3 | 3.71 |
| | 1.00 p.m. | 12.38 | 0.1 | 1.24 |
| | 2.00 p.m. | 12.38 | 0.1 | 1.24 |
| 2 | 10.00 a.m. | 12.47 | 0.2 | 2.49 |
| | 11.00 a.m. | 12.49 | 0.2 | 2.50 |
| | 12.00 p.m. | 12.67 | 0.4 | 5.07 |
| | 1.00 p.m. | 12.58 | 0.3 | 3.77 |
| | 2.00 p.m. | 12.59 | 0.3 | 3.78 |
| 3 | 10.00 a.m. | 12.83 | 0.4 | 5.13 |
| | 11.00 a.m. | 12.90 | 0.4 | 5.16 |
| | 12.00 p.m. | 13.2 | 0.8 | 10.42 |
| | 1.00 p.m. | 13.02 | 0.9 | 11.70 |
| | 2.00 p.m. | 13.04 | 0.9 | 11.74 |

### *3.3 Effect of Current to the Battery Performance*

The result obtained have maximum current of 0.9 A and a new calculation of time taken for battery to charge to compare between the maximum current, minimum current and average current were calculated and shown in Table 4. The current produced will affect the battery performance from the calculation of time taken to fully charge [15-16].

**Table 4**
Time needed for battery to charged

| Current/hours | Battery | Hours |
|---|---|---|
| Max Current (A) | 0.9 A | 8 hours |
| Min Current (A) | 0.1 A | 72 hours |
| Average Current (A) | 0.5 A | 14.4 hours |

## 4. Conclusion

This portable photovoltaic kit for low load application can be used at any places because of the small size and lightweight materials used. The voltage indicator can monitor the voltage entry from the PV panel. Meanwhile, the battery indicator can monitor the battery level which gives more safety and better battery protection as the charging circuit have no cut-off supply facilities. The product encourage the usage of solar energy and make it easy to use at any open areas. Moreover, the charging circuit does not require any grid connected power supply to power up. This project have large potential commercialization and more advantages than the existed product.

## References

[1] El-Ghonemy, A. M. K. "Photovoltaic Solar Energy." *Int. J. Sci. Eng. Res.* 3, no. 11 (2012): 1-43.
[2] Potochik, Andris Piebaigs and Janez. "Photovoltaic Solar Energy." Development and current research (2009): 5-7.
[3] Pearsall, Nicola M., and Robert Hill. "Photovoltaic modules, systems and applications." In *Clean Electricity from Photovoltaics*, pp. 671-712. 2001.
[4] "Inside High-Rise Facilities: Building-Integrated Photovoltaics." (April 14 2017).
[5] Davis, S. "Solar System Efficiency: Maximum Power Point Tracking is Key (2015)." *Power electronics. Saatavissa: http://powerelectronics. com/solar/solarsystem-efficiency-maximum-power-point-tracking-key [viitattu 16.2. 2017]*(2017).

[6] Mr.Suraj.S.Utture, Prof S.P.Nangare and. "3P(Printed Paper Photovoltaic) Technology." IOSR Journal of Mechanical and Civil Engineering (4-7).
[7] Sharma, Shruti, Kamlesh Kumar Jain, and Ashutosh Sharma. "Solar cells: in research and applications—a review." *Materials Sciences and Applications* 6, no. 12 (2015): 1145.
[8] Gohil, UG Pragnesh B., UG Digvijay P. Jadav, UG Chirag N. Katakiya, and Jaydipsinh B. Zala. "SOLAR BATTERY CHARGER." (2017).
[9] Ziadi, Youssef, and Hassan Qjidaa. "A High Efficiency Li-Ion Battery LDO-Based Charger for Portable Application." *Active and Passive Electronic Components* 2015 (2015).
[10] Yu, Byunggyu. "Design and experimental results of battery charging system for microgrid system." *International Journal of Photoenergy* 2016 (2016).
[11] Huang, Tzu-Chi, Ruei-Hong Peng, Tsu-Wei Tsai, Ke-Horng Chen, and Chin-Long Wey. "Fast charging and high efficiency switching-based charger with continuous built-in resistance detection and automatic energy deliver control for portable electronics." *IEEE Journal of Solid-State Circuits* 49, no. 7 (2014): 1580-1594.
[12] Masters, Gilbert M. *Renewable and efficient electric power systems*. John Wiley & Sons, 2013.
[13] Woofenden, Justine Sanchez&Ian. "Pv Systems Simplified." (August&September 2011): 9.
[14] Celani, J. "Solar battery charger maintains high efficiency in low light." *LT J. Analog Innov* (2013): 24-27.
[15] Sulaiman Shaari, Ahmad Maliki Omar, Shahril Irwan Sulaiman. Fundamentals of Solar Photovoltaic Technology.
[16] Lu, Shuh-Tai, Ren-Her Chen, Wun-Tong Sie, and Kuen-Chi Liu. "Double Protection Charger for Li-Ion Battery." *World Electric Vehicle Journal* 4, no. 2 (2010): 379-385.