DEVELOPMENT OF PORTABLE PV GENERATED POWER SUPPLY

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ABSTRACT

Photovoltaic or in short term PV is one of the renewable energy resources that recently has become broader in nowadays technology. The demand or future work is looking for high efficiency, more reliable and economical price PV charge controller which is come in portable size has become very popular in PV system. In general, PV system consists of a PV array, charge controller, rechargeable battery and dc load. PV charge controller is very important in PV system because to control the voltage charging and also to keep the battery from overcharging. In this project, microcontroller (PIC 16F688) are used to monitoring the voltage of the battery. This project used dc-dc buck converter circuit which has been simulated using software of Proteus 7. Liquid Crystal Display (LCD) is used to display the voltage from rechargeable battery. The benefit of this project is an improvement of efficiency voltage change.

ABSTRAK

Photovoltaic atau dalam jangka pendek PV adalah salah satu sumber tenaga boleh diperbaharui yang baru-baru ini telah menjadi lebih luas dalam teknologi masa kini. Permintaan atau kerja masa depan sedang mencari kecekapan tinggi, lebih dipercayai dan PV harga menjimatkan caj pengawal yang datang dalam saiz mudah alih telah menjadi sangat popular dalam sistem PV. Secara amnya, sistem PV terdiri daripada pelbagai PV, pengawal caj, bateri boleh dicas semula dan beban AT. PV pengawal caj adalah sangat penting dalam sistem PV kerana untuk mengawal pengenaan voltan dan juga untuk menjaga bateri dari berlebihan. Dalam projek ini, mikropengawal (PIC 16F688) digunakan untuk memantau voltan bateri. Projek ini menggunakan dc-dc penukar buck litar yang telah perisian simulasi menggunakan Proteus 7. Paparan Kristal Cecair (LCD) digunakan untuk memaparkan voltan dari bateri yang boleh dicas semula. Manfaat daripada projek ini adalah peningkatan perubahan kecekapan voltan.

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LIST OF SYMBOLS

V	-	Voltage
R	-	Resistance
A	-	Ampere
Ah	-	Ampere hours
I	-	Current

LIST OF ABBREVIATIONS

PV	-	Photovoltaic
LCD	-	Liquid Crystal Display
DIP	-	Dual Inline Package
DC	-	Direct Current
AC	-	Alternating Current
PIC	-	Peripheral Interface Controller
LVD	-	Low Voltage Disconnect
LED	-	Light Emitting Diode
IC	-	Integrated circuit
MPPT	-	Maximum Power Point Tracking
RISC	-	Reduced Instruction Set Code
FET	-	Field-effect transistor

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

For many years, fossil fuel has been the primary source of energy. However, there is a limited supply of these fuels on earth and they being used so much more rapidly than they are being created. Eventually, they will run out. In addition, because of safety concerns and waste disposal problem, renewable energy is definitely the solution. Photovoltaic or in short term PV is one of the renewable energy resources that recently has become broader in nowadays technology. The demand or future work is looking for high efficiency, more reliable and economical price PV charge controller which is come in portable size has become very popular in PV system. PV has many benefits especially in environmental, economic and social. In general, a PV system consists of a PV array which converts sunlight to direct-current electricity, a charge controller which regulates battery charging and operation of the load, the inverter for convert dc to ac, energy storage in the form of batteries and loads or appliances.

A charge controller is one of functional and reliable major components in PV systems. A good, solid and reliable PV charge controller is a key component of any PV battery charging system to achieve low cost and the benefit that user can get from it. The main function of a charge controller in a PV system is to regulate the voltage and current from PV solar panels into a rechargeable battery. The minimum function of a PV charge controller is to disconnect the array when the battery is fully charged and keep the battery fully charged without damage. A charge controller is important to prevent battery overcharging, excessive discharging, reverse current flow at night and to protect the life of the batteries in a PV system. A power electronics circuit is used in a PV charge controller to get highest efficiency, availability and reliability. The use of power electronics circuits such as various dc to dc converters topologies like buck converter, boost converter, buck-boost converter and others converter topology as power conditioning circuitry to provide a desired current to charge battery effectively.

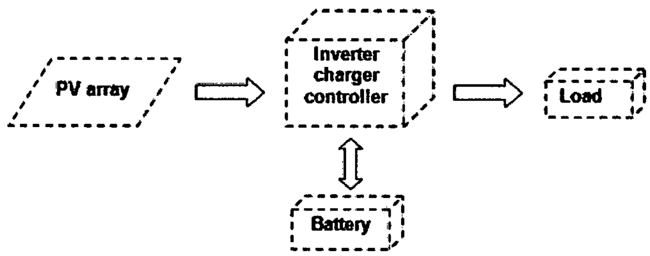

Figure 1.1: Photovoltaic system components

1.2 Objective

i. To develop prototype portable power generator based on photovoltaic technology.
ii. To simulate voltage reading simulation by using Proteus 7 software.
iii. To develop battery voltage reading by using PIC16F688.

1.3 Scope of Project

i. The scope of project is to developed portable generator by using photovoltaic (PV).

ii. To make the portable PV generator that can use at least for two hours by used 12V 7.2AH battery with load of 18W lamp.

iii. To develop voltmeter using PIC 16F688 for monitoring voltage storage.

1.4 Problem Statement

Most of portable generators nowadays just use gas or fuel as a source of energy to generated power. By using that kind of source will cause harm to environment. For example, by using gas it will produce carbon dioxide (CO_2) but if using renewable energy it will not produce that kind of waste. Besides that, the price of gas or fuel is very expensive and also the maintenance cost also high. So to overcome this problem, PV generator was develop by using renewable energy.

1.5 Thesis Overview

The project is about to development portable generator by using solar as a source of energy. The portable generator must in simple design and easy to use in everywhere. It using photovoltaic (PV) array to convert solar energy to electricity. The battery storage used to storage energy that can use at least for two and half hours.

1.6 Thesis Outlines

Basically this thesis is about to development of portable PV generator power supply. These theses contain five of chapter which is introduction, literature review, methodology, result and discussion and conclusion and recommendation.

For the introduction part, it contains the background of the PV technology, the objectives of project, the scope of project, the problem statement and the thesis overview. In chapter of literature review, it consist the review of the journal that relates to the project like about the photovoltaic, the battery and so on.

Next is the methodology part. In this part is about hardware development design such as equipment procedures and method design for charge controller and inverter. The relevant information is gathered from the literature review.

In chapter result and discussion, it consist the hardware and software result and the discussion about every part of project hardware and software. Lastly is the chapter conclusion and recommendation of the project development.

CHAPTER 2

LITERATURE REVIEWS

2.1 Photovoltaic System

A standalone system does not have a connection to the electricity "mains" (aka "grid"). Standalone systems vary widely in size and application from wristwatches or calculators to remote buildings or spacecraft. If the load is to be supplied independently of solar insolation, the generated power is stored and buffered with a battery. In non-portable applications where weight is not an issue, such as in buildings, lead acid batteries are most commonly used for their low cost. A charge controller may be incorporated in the system to avoid battery damage by excessive charging or discharging and to optimizing the production of the cells or modules by maximum power point tracking (MPPT) [4]. However, in simple PV systems where the PV module voltage is matched to the battery voltage, the use of MPPT electronics is generally considered unnecessary, since the battery voltage is stable enough to provide near-maximum power collection from the PV module. In small devices (e.g. calculators, parking meters) only direct current (DC) is consumed. In larger systems (e.g. buildings, remote water pumps) AC is usually required. To convert the DC from the modules or batteries into AC, an inverter is used.

The proposed system consist of Photovoltaic array, charge controller, battery, inverter, load the single line diagram is shown in Figure 2.1, the description of each block as follows:

2.1.1 Photovoltaic Array

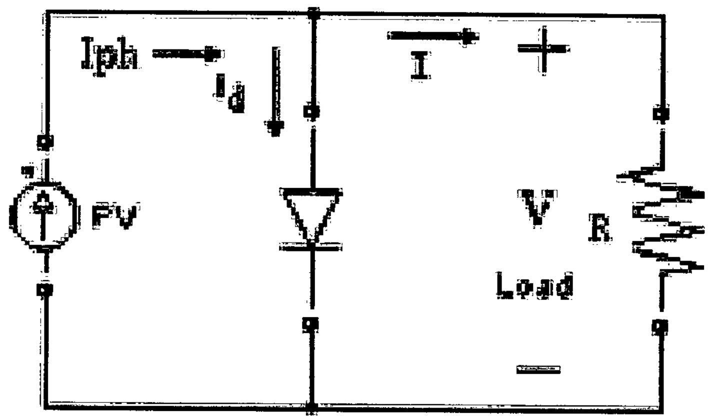

Figure 2.1: Equivalent circuit of PV cell

Photovoltaic (PV) is the field of technology and research related to the application of solar cells for energy by converting sun energy (sunlight or sun ultra violet radiation) directly into electricity. Due to the growing demand for clean sources of energy, the manufacture of solar cells and PV arrays has expanded dramatically in recent years.

Semiconductor material, typically silicon, is used in thin wafers or ribbons in most commercially available cells. One side of the semiconductor material has a positive charge and the other side is negatively charged. Sunlight hitting the positive side will activate the negative side electrons and produce an electrical current. There are two types of cells which is crystalline silicon and amorphous silicon. Crystalline cells have been in service the longest and exhibit outstanding longevity. Cells developed almost 40 years ago are still operating and most manufacturers offer 10-year or longer warranties on crystalline cells.

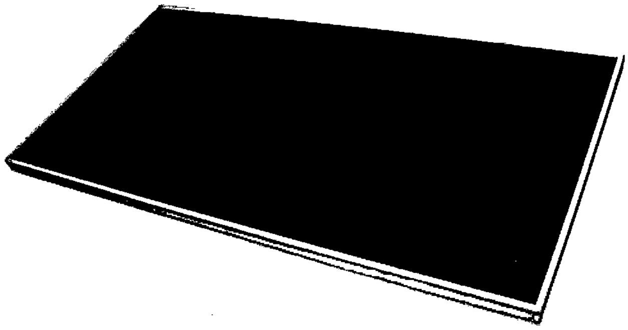

Figure 2.2: Amorphous silicon

There are two sub-categories of crystalline cells – single crystal and polycrystalline. They both perform similarly. The efficiency of crystalline cells is around 13%. Amorphous silicon is a recent technology for solar cells. It is cheaper to produce and offers greater flexibility, but their efficiency is half of the crystalline cells and they will degrade with use. These types of cells will produce power in low light situations. This technology is expected to improve application possibilities far exceeding crystalline technology. Currently, the best choice for solar cells will be the crystalline variety.

Figure 2.3: Crystalline silicon

The diode equation usually describes the operation of the solar PV cell. Sun light exposure of a solar PV cell results in the creation of an electric current as excited "electrons and the remaining holes are swept in different directions by the built in electric field of the depletion region". [1]. Figure 2.1 shows a simple equivalent circuit for a PV cell. The circuit consists of an ideal current source (representing the current generated due to photon interaction) and an ideal diode which is given by

$$I = I_{ph} - I_d$$

Where I_{ph}=Short-circuit current due to sunlight, Id=Current shunted through the diode, R= Load resistance, I=Current through the load, V= Voltage across the load.

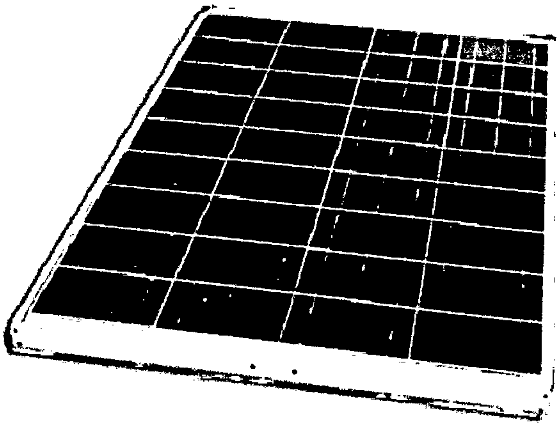

Figure 2.4: Solar Panel

2.1.2 Charge Controller

The charge controller regulates the flow of electricity from PV modules to the battery and the load [2]. The controller keeps the battery fully charged without overcharging it. When the load is drawing power, the controllers allow charge to flow the modules into the battery, the load, or both. When the controller sense the battery fully charged, it stops the flow of charge from the modules. Many controllers will also when loads have taken too much electricity from batteries and will stop the flow until sufficient charge is restored to the batteries. This last future can greatly extend the battery's lifetime. However, controllers in stand-alone photovoltaic system are more complex device that depends on battery state-of-charge, which is turn, depends on many factors and is difficult to measure. The controller should ensure that no current flows from the battery to the array at night or not use.

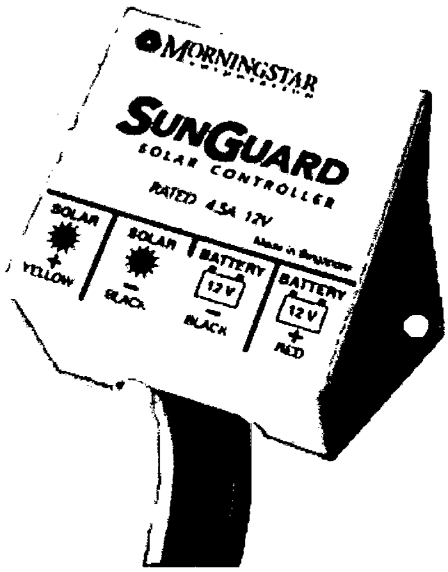

Figure 2.5: Charge Controller

When the storage batteries of a PV solar panel array installation becomes fully charged, the array will continue to produce additional power as long as the sun is present, unless some control circuitry is used to shut down the power generation process. If power continues to be applied to the storage batteries, it will overcharge them creating a potentially dangerous situation. Overcharged batteries can overheat and possibly explode. The additional power being generated is also being wasted.

An open circuit regulator monitors the balance of voltage in the charging system and creates an open circuit condition to separate the PV array from the charging system. When the battery voltage falls off to a predetermined level, the regulator closes the circuit so the PV array can start charging the storage batteries again. The drawback to this type of regulator is that the PV array will continue to provide energy as long as light is present-the energy generated while the regulator is in the open circuit condition is simply wasted.

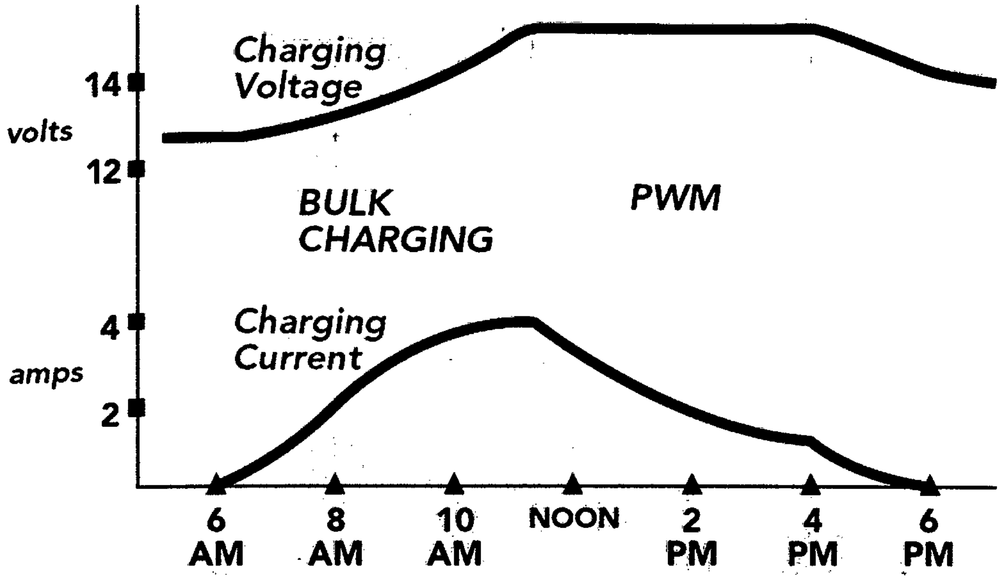

Figure 2.6: Advanced PWM Battery Charging

2.1.3 Battery

Car batteries are not suitable for PV applications as they cannot handle the deep discharges that can occur with PV systems. "RV" or "marine" batteries can handle a deeper discharge than car or starter batteries and can be used in a beginning system. They will last 2 to 3 years. Gell cell sealed batteries can be used in limited conditions, but also will not handle deep discharges. Because they are sealed, they are suited to marine applications.

Deep cycle batteries are available for golf carts, and include Industrial Chloride batteries. These batteries are the best choice for PV systems as they can be discharged 80%. The golf cart batteries will last 3-5 years. There are some larger capacity deep cycle batteries that will last 7-10 years. Industrial Chloride batteries will last 15-20 years.

Non lead-based batteries such as nickel-cadmium batteries are costly but can last a very long time if they are not discharged excessively. A new type of nickel-cadmium battery, fiber-nickel-cadmium, has outstanding longevity at a 25%

discharge rate. Nickel-cadmium (NiCad) batteries have different operating and maintenance characteristics than lead-acid batteries that must be considered. For example, it is difficult to measure the depth of discharge that is occurring with a NiCad battery since its output is constant right up to the last moments before being completely discharged. Check with the suppliers in the Resources section about the operation and maintenance characteristics of the NiCad batteries they offer.

For large systems, the best battery choices will be the "true" deep cycle types. Caution in using batteries must be observed along with recognition of their characteristics in response to temperature changes (lead-acid batteries operate less efficiently in cold temperatures) and ventilation requirements.

Batteries are device that produce DC electricity through a chemical reaction process. The chemicals in the battery react with its terminals when external path for current flow is provided. The process causes free electrons to gather at the negative terminal of the battery while a depletion of electron occurs at the positive terminal. This provides the push and pull to create current flow through an external circuit. When an external pathway is provided the electrons flow from the negative terminal through the external circuit and back into the positive terminal of the battery. It is very low resistance load is placed across the terminals, a large flow of electron current will occur. Larger resistive loads draw lower levels of current flow from the battery, as described by the basic Ohm's Law formula for current, voltage and resistance.

Batteries are often used in PV systems for storing energy produced by the PV array during day time and supplying it to electrical loads as need during night time or cloudy weather. Moreover, batteries are also needed in the tracker system to keep the operation at MPP in order to provide electrical loads with stable voltage. Nearly most of the batteries used in PV systems are deep cycle lead acid. These batteries have thicker lead plates that make them tolerate deep discharges. The thicker the lead plates, the longer the life span. The heavier the battery for the given group size, the thicker the plates and the better the battery will tolerate deep discharges.