BATTERY MANAGEMENT SYSTEM FOR SOLAR APPLICATION

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A report is submitted in partial fulfillment of the requirement for the degree of Bachelor in Electrical Engineering (Control, Instrumentation and Automation)

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I declare that this report entitle “Battery Management System for Solar Application” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……

Name : ……....

Date :…….....

" I hereby declare that I have read through this report entitle "Battery Management System for Solar Application " and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

Signature : ……

Supervisor's Name : En Norhafiz Bin Salim

Date : ……

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ABSTRACT

Battery Management System for solar application system consists of lead asid battery serving as its energy storage elements. The most commonly used storage technology for solar application is the lead acid battery. This system is constructed for the purpose of gathering data on different charge and discharge current flow through the storage and load. The aim of this project is to analyze a charging process with battery utilization in a way to optimize load variation and making the overall system more reliable. The solar charge controller with Pulse Width Modulation (PWM) technique making the solar panels able to optimize under varying illumination level. The battery charging from different power of solar panel is the key point to found the suitable sources to power up these prototype. The new system configuration with parallel is to create a optimal storage. According to the size of battery characteristic, the battery management is optimized for longer life time and batter performance. Charge and discharge of SLA battery at 50% of battery capacity conducted on the static load resistor through 90 watt laptop adaptor. Voltage and current were recorded during an increment of out power from 10W to 70W. The experimental result analyzed through this project carry out via actual measurement and hardware that has been developed. This prototype of portable dc power supply has been developed and tested under lab experimental . All results were verified through experiment with the load variation that has been done.

ABSTRAK

Sistem Pengurusan Bateri untuk aplikasi sistem solar terdiri daripada bateri asid plumbum berfungsi sebagai elemen storan. Teknologi storan yang biasa digunakan untuk aplikasi solar ini adalah bateri asid plumbum. Sistem ini dibina untuk tujuan pengumpulan data ke atas cas dan nyah cas yang berbeza-beza melalui sistem storan dan beban. Tujuan projek ini adalah untuk menganalisis proses mengecas dengan menggunakan bateri dengan cara untuk mengoptimumkan kepada perubahan beban dan menjadikan keseluruhan sistem ini lebih dipercayai. Pengawal cas solar dengan teknik Pulse Width Modulation (PWM) adalah teknik yang menjadikan panel solar dapat mengoptimumkan di bawah tahap pencahayaan yang berubah - ubah . Bateri cas daripada sumber kuasa yang berubah - ubah dari panel solar adalah kunci kepada penemuan sumber yang bersesuaian untuk sistem prototaip ini berfungsi. Konfigurasi sistem dengan penyambungan selari untuk menghasilkan storan yang optimum. Menurut saiz serta ciri bateri, pengurusan bateri dapat dioptimumkan untuk masa jangka hayat lebih panjang dan serta dengan prestasi lebih baik. Cas dan nyahcas bateri SLA pada 50% kapasiti nya dijalankan pada perintang beban melalui 90 watt adaptor komputer riba. Voltan dan arus telah direkodkan semasa kenaikan kuasa dari 10W sehingga 70W. Hasil experiment di analisa dalam projek ini dijalankan melalui ukuran sebenar serta perkakasan yang telah dibangunkan. Prototaip bekalan kuasa dc mudah alih ini dibangunkan dan diuji dalam makmal eksperimen .Semua keputusan telah disahkan melalui eksperimen dengan perubahan beban yang telah dilakukan.

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CHAPTER 1

INTRODUCTION

1.1 Background

The electrical energy has become of the most important aspect for human, because the equipment and the future of many portable electrical devices such as cellular telephones, notebook computer, personal digital assistant, and etcetera need electricity to get it operated. Continuous use of electronic devices will lead to reduction of the power source. Additional electrical energy are required to continue the without disrupting the work operations. Limitation of power sources are an issue if the laptop or hand phone when there is shortage of battery. So, the portable dc power supply base on Battery Management system (BMS) to be supplied to some of load (laptop or cell phone) at a time is an alternative way. With the availability of solar power as a source of renewable energy, it is easy to handle and easy to recharge solar energy plays an important role in the generate of electric power. Solar photovoltaic modules produce electrical energy in the solar arrays. The nonlinear output power of Photovoltaic (PV) source mainly depends upon the environmental condition such as level of light intensity. For stand-alone solar systems, storage device are required to store energy that are not connected to the grid supply. The selection of the suitable battery type is important to emphasis on deep of discharged to ensure an optimization charge/discharge cycle also to prolong the battery life. The (BMS) with solar charge controller in solar system to improve the efficiency of the array and charge safely to the storage system. The BMS overcome the charge/discharge by implanting system with more reliable and efficiently.

1.2 Problem statement

The usage of outlet socket are very important for us to get electric supply for electronic devices. Usually, user must be close with the outlet socket when using the electronic device due to battery weakness. Limitation of power sources is an issue when the electronic device is having a lack of battery supply. With the availability portable dc supply base on Battery Management System (BMS), the user is able to use the electronic devices at anywhere.

BMS is a process to ensure that a battery cell string receives an optimum charge without conducting damage to the battery string. Battery is regular depth of discharged (DOD) because of no ideal dc source from solar energy and this may not to ensure charge/discharge cycle optimally. The poor charge/discharge cycle may results in sulfation, stratification or gassing resulting in the end of battery life. In addition, erratic temperature range during operation interfere optimal storage level. The battery management system is required to overcome these problems by making the system more reliable and efficient. Thus, a proper charging/discharging will prevent the battery becoming repeatedly overcharged or undercharged [3][4].

1.3 Objective

i. To investigate Battery Management and Solar system.
ii. To develop a BMS and Solar network for load variation.
iii. To verify between theoretical and experimental result.
iv. To analyze the entire battery management and solar system.

1.4 Project Scope

In order to achieve this objective, several scopes had been outlined which to implemented of the portable dc power supply base on Battery Management System (BMS). The solar panel will be used to harvest solar energy and the ratings is 30Watt at 18Volt and 75Watt at 17Volt. In this (BMS) , solar charge controller is use in order to optimize the entire system . The Seal Lead Acid Battery (SLA) si selected as a storage elements energy system. The load test will be conducted on laptop and mobile phone as a load. The charge/discharge process and output power of the (BMS) will be analyzed throughout the experimental result that will be taken.

CHAPTER 2

LITERATURE REVIEW AND PROJECT BACKGROUND

2.1 Introduction.

Literature review in terms of definition is a review of the research that has been made about a particular problem that has been identified and needs to be answered. It is done in order to enquire an understanding of the project and to identify what the key issues are. This review should describe, summarize, evaluate and clarify the project. It also goes beyond the search for information and includes the identification and articulation of relationships between the literature and the field of research.

The research can be done through books, journals, web pages, reports and others. From these sources, a literature review has to be organized around and related to the thesis and the result has to be synthesized into a summary so that the areas that are important can be identified. Other than that, questions that need further research are also formulated here. The term 'green system' that has been getting more attention lately making the solar-powered device to be more popular. Thus, come an idea of having a portable solar charger in order to charge up small devices. A solar charger comes with an internal battery where the sun's energy gets stored in the device itself so that devices can be charge even without the presents of lights. The downside of having a charger without battery is that if there is no sun equals no phone or music. Therefore, this paper works out on what is really needed in a solar charger.

2.2 Solar Panel

Solar power is one of the first things that come to people's minds when the topic of renewable energy is discussed. Implementation of solar panels for multipurpose has bring a lot of benefits in many industries such as transportations, agricultural and residential. There are a few advantages of having solar as the renewable source of electricity such as it can provide needed source of electrical to all the household or office consumptions. Other than that, any other additional solar modules that have to be added according to the demand can be done easily as solar modules are only in the form of panels, without moving parts and can be installed in windows, walls or roof tiles form. The electricity is also provided without emitting any greenhouse gases.

There are quite a number of journals that were published regarding to solar and one of it is title "Modeling and Simulation of Maximum Power Point Tracker for Photovoltaic System". It is mentioned in this paper where the utilization of the solar energy can be divided into two ways which are the solar heating and cooling and these energies needed, can be converted into electrical energy through photovoltaic cells. Unfortunately, the disadvantage of the PV system is due to its nonlinear, insolation level and temperature dependent current and voltage. However, in these fast evolving world, the solutions are already found such as the manufacturing process of solar arrays need to be improved, and also by controlling the insulation input to PV array which is shown in this project too [1] .

A paper that was published which is entitle "Effect of Dc to Dc Converters on Organic Solar Cell Arrays for Powering Dc Loads", that discuss about solar cells that are divided into two main classes which are organic and inorganic. Inorganic solar cells are made from crystalline silicon and the organic solar cells that differ from inorganic by their carbon-based semiconducting materials such as Buckminsterfulleine. Organic cells have more advantages than inorganic solar whereby they are lighter in their weight, more flexible and also less costly. The only bad side that organic cell has is that the poor power-conversion efficiency [2].

Table 2.1 : Different type of Solar Panel

TYPE OS SOLAR PANEL	EXPLAINATION
 Figure 2.1 a : Monocrystalline cells	Monocrystalline cells are cut from a single crystal of silicon, which means that they are basically a slice from a crystal. In appearance, these cells have a smooth texture and the thickness of the slice will be able to be seen clearly. These cells have to be mounted in a rigid frame are the most efficient and the most expensive to produce.
 Figure 2.2 b : Polycrystalline cells	Polycrystalline cells are a slice cut from a whole block of silicon, which means that these cells consist of a large number of crystals. They have a speckled reflective appearance and the thickness of the slice can be seen. These cells are slightly less efficient and slightly less expensive than Monocrystalline cells but they also need to be mounted in a rigid frame.

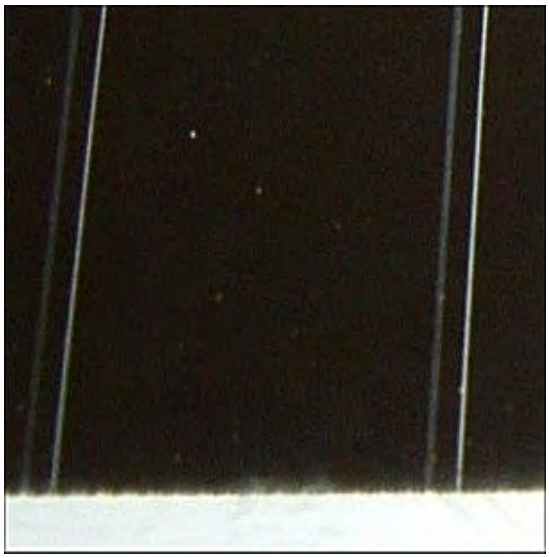

Figure 2.2 c : Amorphous cells

Amorphous cells are manufactured by placing a thin film of amorphous (non crystalline) silicon onto a wide choice of surfaces.
These are the least efficient and least expensive to produce of the three types.

Due to the amorphous nature of the thin layer, it is flexible, and if manufactured on a flexible surface, the whole solar panel can be flexible.

One characteristic of amorphous solar cells is that their power output reduces over time, particularly during the first few months, after which time they are basically stable.

Table 2.2 : Advantages of Crystalline PV Cells

Crystalline PV Cells	**Amorphous PV Cells**
High efficiency level	Cheap and affordable
A single element production Si	It comes in a wide variety
It has a great accuracy in terms of production	Flexible, can adapt different positions
Easy to recycle all environmental impacts	Produced more quickly and efficiently.

Table 2.3 : Disadvantages of Crystalline PV Cells

Crystalline PV Cells	**Amorphous PV Cells**
Very Expensive	Low efficiency level
Hard to produce in different models	Restricted by many constraints
Rigid and hard to adapt visible light beams	A wide array is needed
Large arrays required to achieve sufficient energy	Different elements many undermine the quality

2.3 Solar Charge Controller Operation

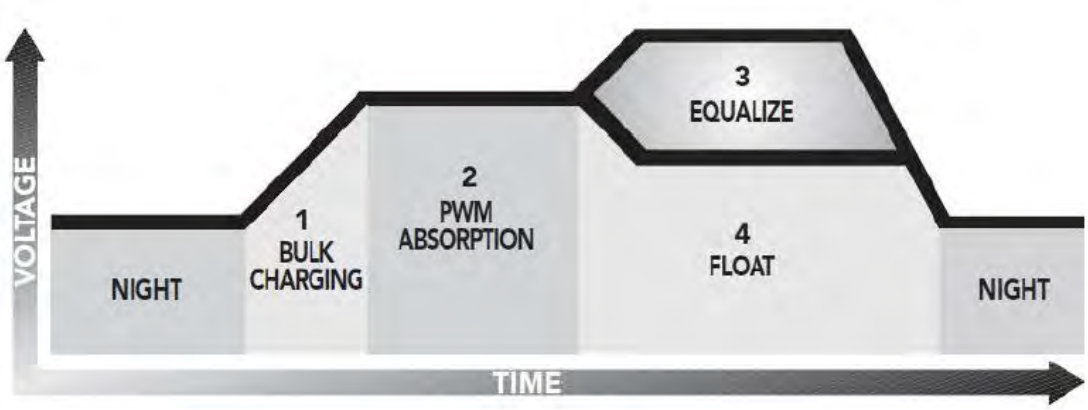

Figure 2.2 : Solar Charge Controller (Battery Charging)

2.3.1 Stage 1 (Bulk Charge)

Current is sent to the batteries of the maximum safe rate they will accept until their voltage rises to about 80 to 90% of their fully charged value. The bulk charging voltage is typically about 14.8V but may be as high as 15.5V for a 12V system, this may vary so that the maximum possible current in maintained. Gel batteries often have lower recommended voltages in the region of 13.8 to 14.1V.

2.3.2 Stage 2 (Boost Charge / absorption charge)

When the battery has recharged to the Boost voltage set point, constant-current regulation is used to prevent heating and excessive battery gassing. The boost stage remains 120minute and then goes to Float Charge. The voltage remains constant, typically about 14.2V for a 12V system(depending on temperature) and the current tapers off as the battery reaches 100% charge.

2.3.3 Stage 3 (Float Charge)

For a 12V battery bank a voltage of about of about 12.8 to 13.2V is maintained across the batteries to keep them in good condition. After the battery is fully charged in Boost voltage stage, the controller reduces the battery voltage to Float voltage set point. When the battery is fully recharged, there will be no more chemical reactions and all the charge current transmits into heat and gas at this time. Then the controller reduces the voltage to the floating stage, charging with a smaller voltage and current. It will reduce the temperature of battery and prevent the gassing, also charging the battery slightly at the same time. The purpose of Float stage is to offset the power consumption caused by self consumption and small loads in the whole system, while maintaining full battery storage capacity. In the Float stage, loads can

continue to draw power from the battery. In the event that the system loads exceed the solar charge current, the controller will no longer be able to maintain the battery at the Float set point. Should the battery voltage remains below boost reconnect charging voltage, the controller will exit Float stage and return to Bulk charge.

2.4 Storage system

In photovoltaic system , the energy is stored in batteries during the day so as to be used at night. Also ,as photovoltaic system's power output varies throughout any day, a battery storage system can provide a relatively constant source of power. Batteries are not hundred percent efficient. Some energy is lost as heat and in chemical reactions. Therefore, additional photovoltaic modules are needed to compensate for the loss. Utility grid -connected photovoltaic system do not require batteries, though they can be used as an emergency backup power source. The following types of batteries are commonly used in PV system : Lead Acid Batteries which are either liquid vented or sealed VRLA - (Valve Regulated Lead Acid) and Alkaline batteries which are also of two types, Nickel Cadmium and Nickel -Iron.

Batteries are electrochemical device and can be classified as a storage in battery management system. Solar batteries wider used in renewable energy system is flooded lead acid battery and low maintenance types such as gel and Absorbed Glass Matte (AGM) lead acid batteries. For both of low maintenance are considerably more expensive and not as currently available [3]. It can be operate at high temperature range compared with flooded lead acid battery. Not only using battery method as a storage device, combining with ultra capacitor can yield the higher density of capacity storage and also improve on charge/discharge cycle. So, at the mean time it can achieve better cycle life of storage system [4]. Otherwise from [5] state that the Li-lon battery is the most higher density capacity storage, and compactable for all situation for Electric Vehicle (EV) system. Various paper discuss of different type of battery. The AGM lead acid battery been identify following suitable characteristic with the propose Battery Management System (BMS). The AGM lead acid battery are found to be attractive for BMS with solar application. This battery is low