Use of Microcontroller for Battery Charging and Discharging Control in Hybrid Energy

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Abstract

This paper introduces a battery charging circuit, which utilizes solar and grid power for charging lightweight electric vehicles. The novelty of the proposed approach is the development of hybrid charger with control algorithm that charges the electric vehicle battery using dual input power. This hybrid charging provides electricity to start the electrically powered vehicle and also powers the additional vehicle. The controller can act as fast charger by closed loop operation with battery parameters as input. The speed of the charge level is varied based on the state of charge (SOC) of battery and parameters detected from battery side. Battery state estimation is defined through adopted battery model and their precision affects the accuracy of state estimation. Micro controller acts as a smart charger that controls the parameter of voltage and current level for battery charging. Battery output performance, voltage, and current variation in battery simulator during stage 1 to 2 charging level, current variation during stage 1 to 2 and stage 2 to 3 charging level by simulation and experimental results are also exhibited in the proposed work. Average power usage for conventional charger with proposed one during day and night time was compared. Time taken to reach 100% SOC for conventional charger with proposed system, probability of battery capacity, energy demand of charging station, effects of charging and discharging of battery, and charging capacity and temperature of battery is also further studied. The result analysis part proves that the proposed strategy shown to be superior to its existing methodologies.
Keywords: Microcontroller, Hybrid Energy

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I. INTRODUCTION

The need for energy in modern times continues to increase and electrical energy is the most widely used source of energy until it is used as a basic need, so it is demanded to find various kinds of alternative electrical energy to meet daily needs both on a household and industrial scale [1]. This alternative electrical energy must use new and renewable energy sources that are developed in its utilization because the energy sources produced are environmentally friendly [2], do not contribute to climate change and global warming and the amount is unlimited because the energy obtained comes from sustainable natural processes to minimize energy crisis by reducing the use of non- renewable fossil energy and petroleum so that at any time it can run out [3].

One example of using alternative electrical energy could be making a Hybrid Small Power Plant [4]. However, in its application, this alternative solar and wind power plant requires a storage medium to store electrical energy generated by using a battery according to the load and energy availability from the source used so that electrical energy can be used at a later time [5-7].

Based on the above issues will be made by the control system of charging the battery on Power Hybrid wind and photovoltaic using AT Mega 32 as the brain controlling MOSFET as a series of drivers in the process of charging and in overcoming overcharging by regulating the process of charging when the battery voltage is below par and men - discharge power towards the battery when the battery is fully charged [8]. Then, the controller will also divert and regulate the power use of the battery to the load.

A. History

The hybrid system is defined as a power generation system that combines two or more generators with different energy sources, generally aiming to maximize energy at low prices, pollution-free, good power quality efficiently and optimally, to obtain synergies that provide economic benefits as well as technical [5].

B. Hybrid system

Power plant solar cell is an alternative power plant that uses sunlight as its energy source which is then converted into electrical energy using photovoltaic technology which is made from a semiconducting material called a solar cell [9].

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1) Principle of solar cells

Solar cells can absorb sunlight which contains electromagnetic waves or photon energy. The energy of photons from sunlight produces kinetic energy that is capable of releasing free-moving electrons, in the presence of the transfer of electrons to produce an electric current. The electric current will increase when the intensity of light from the sun increases [5].

2) Efficiency of solar cells

Solar cell efficiency is the ratio of the electrical output of a solar cell to incident energy in the form of sunlight. The energy conversion efficiency (η) of a solar cell is the percentage of solar energy that is exposed to it is not converted into electrical energy. M aka for data analysis of energy conversion efficiency (η) obtained expressed in Eq. (1) below [10].

$$\text{Efficiency } (\eta) = VIPA100\%(\eta) = VIPA100\% \tag{1}$$

D. Wind Turbine Power Plant (WTPP)

WTPP is a power plant that uses wind energy as an energy source that is used to produce electrical energy that utilizes wind kinetic energy using wind turbines or windmills [5]. The wind will later hit the surface of the blade which is a component of the generator itself and rotate the generator rotor, this rotation results in a change in magnetic flux in the stator where the copper winding is located [6, 11].

E. Controller

Controller is used in power generation from fluctuating energy sources as well as constant where it works to regulate the amount of power that will be entered and stored into the battery during the process of charging and regulate the amount of power supplied from the battery to the load. This aims to keep the battery in good condition, in this case, to prevent overcharge during the charging process, as well as overload when the battery is used to supply loads.

F. Motivation

The battery charger was designed to charge in three different modes. This circuit actually uses a constant current which is set by the transformer. The circuit modulates the rate of charging as the battery is getting full with the help of the 555 timer by controlling the speed. The charging mode starts with the burst charge. The burst charge was the first phase of the charging of the batteries. A constant current charging was used to ensure that the voltage of the battery rises to a voltage that is determined by the characteristics of the battery. The battery will charge up to a ninety percent (90%) State-Of-Charge, and the other ten percent (10%) is charged using the Trickle Charge.

II. LITERATURE REVIEW

A. Paper Reviewed

The hybrid controller used here is a microcontroller. This controller has a control over the voltage generated by solar to be fed to the battery.

1) Layyar, Srashti, Tushar Saini, Abhishek Verma, and Ashwani Kumar. 2018

The paper designed in this way that we get the battery of the limitation of solar energy. Charging system of solar battery has an inverter fueled by 12v battery and the inverter create up to 230v AC.

2) B V Rajanna, MalliguntaKiran Kumar, 2019

The various power sources that are available may be invarious forms such as the utility grid, renewable power sources such as solar panel and DC energy storage units such as batteries

B. Objectives of the System

- The application of this device has a wide range from phone batteries, camera batteries, toy batteries etc. The major limitation of the work is that the current output is so small - about 1.5A.
- This is possible with the help of the microcontroller and an adjustable voltage regulator.
- This study discussed ways to improve the management system on battery charging and discharging. Automatic settings for selecting energy sources are also considered

III. PROPOSED SYSTEM

A. Circuit / Block Diagram:

The PWM (series shunt) charge controllers which are based on microcontrollers are designed and manufactured in HIAST. An Atmel microcontroller AT89C2051 with 2kB flash memory was used as shown in Fig.1 Crystal oscillator of 8MHZ clocked the microcontroller. A power MOSFET (IRF640) was used as the solid-state switch for both charge discharge lines. Schottky diodes block the reverse current flow when the panel voltage drops below the battery Voltage. Light emitting diode of two colors was used to display the system status. Over-voltage protection was implemented by connecting surge absorber (VE13 0750) between

the high voltage power points and ground. The ALS75V25A simulator was used instead of PV panel which gives an open-circuit voltage of 21V, a short-circuit current of 10.5A and a maximum power output of 200W. The battery which was used in this test was a lead acid battery (VRLA-AGM) (12V/100Ah).
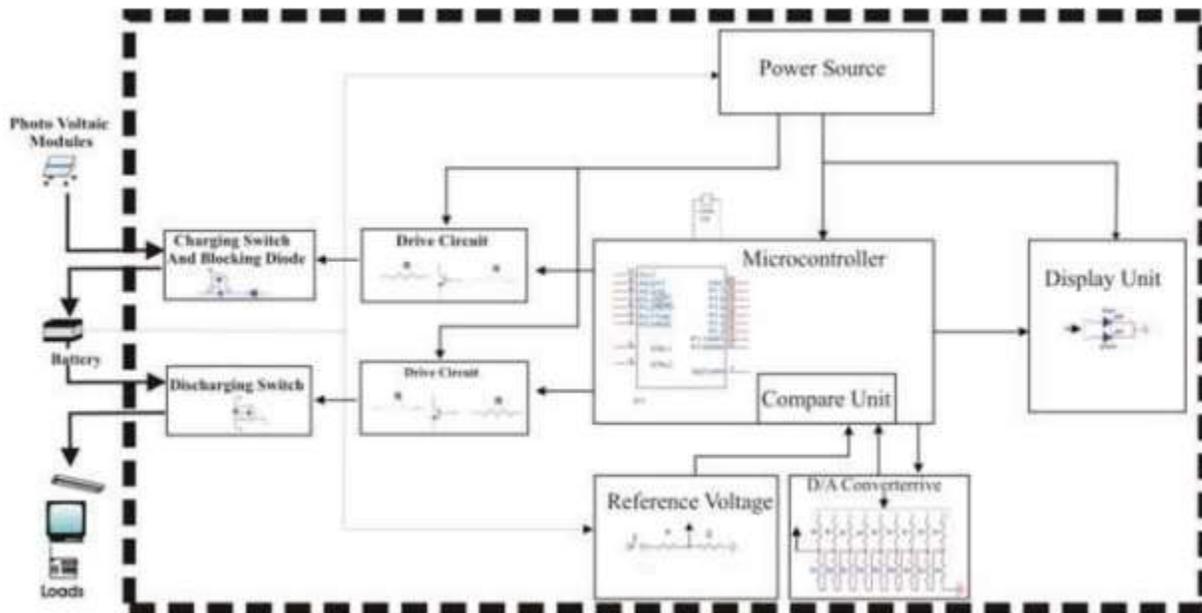

Fig. 1: Block diagram of battery charging and discharging

B. *Flow Chart:*

The charge controller measures the battery voltage levels and reacted to it due to flow chart shown in Fig.2. The battery voltage is cycled between HVD and LVD as shown in table2. With PWM, the charging current is reduced nearly to zero just before the HVD was reached. This minimizes the apparent drop in voltage which enables the microcontroller to monitor the actual battery voltage. During the cycling operation between HVD and LVD the charge controller consumed about 45mA. This is still good within the maximum of 100mA as recommend.
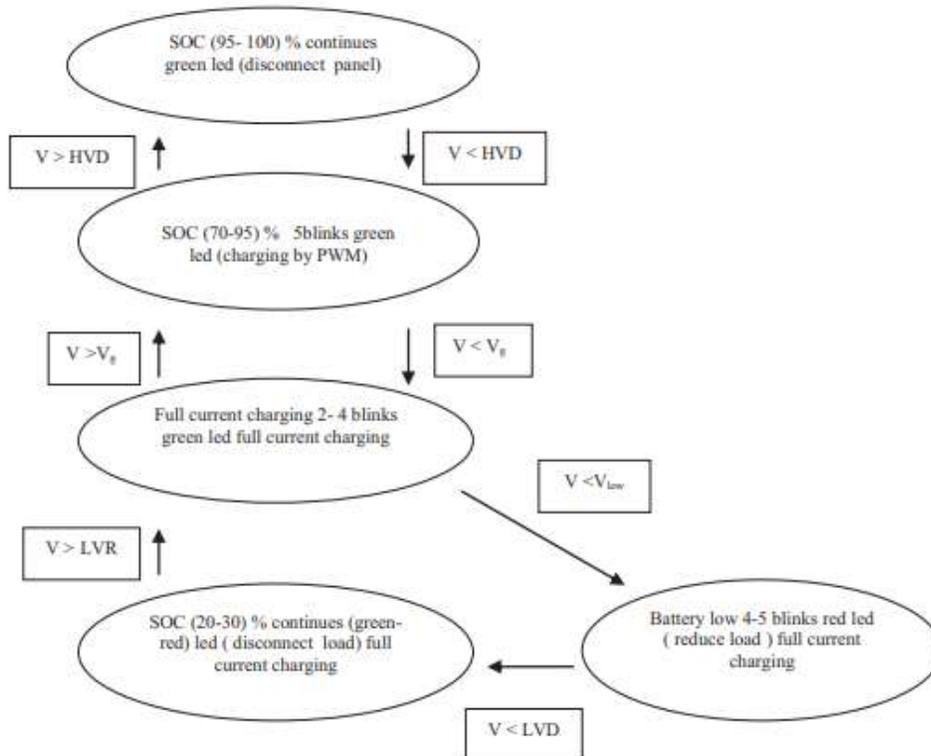

Fig. 2: The flow chart of the battery charge management.

IV. ADVANTAGES:

– Low time required for performing operation.
– The processor chips are very small and flexibility occurs.
– Due to their higher integration, cost and size of the system is reduced.
– The microcontroller is easily to interface additional RAM, ROM and I/O ports.
– Once microcontrollers are programmed then they cannot be reprogrammed.
– At the same time many tasks can be performed so human effect can saved.
– Without any digitals parts it can be act as microcomputer.
– It is easy to use, troubleshooting and systems maintain is simple

V. DISADVANTAGES

– The microcontroller cannot interface high power devices directly.
– It has more complex structure as compared to microprocessor.
– It only performed limited number of executions simultaneously.
– It is generally used in micro equipment.

VI. CONCLUSION

Battery charging and discharging controller by using a microcontroller simplifies the system in many ways: a. Analogue -type feed- back circuitry is avoided as control is incorporated in a software program designed specifically for user requirements. b. Much more sophisticated procedures can be implemented. c. A reduction in power consumption for charging battery is achieved. Using Microcontroller to build charge controller gives flexibility to the designer through: a. Easy way to adjust the set-point values according to battery type. b. Easy way to change the algorithm of charging battery by change some parameters in the program which installed in the Microcontroller.

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