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MPPT Charge Control for Standalone PV Application

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ABSTRACT:. This paper focuses on the efficient use of battery storage system for overcoming the intermittency conditions in the standalone solar PV applications. A dual-active bridge (DAB) based isolated DC-DC converter has been used for the high energy transfer efficiency, bidirectional power flow, fast dynamic control, and smaller size. But for energy storage applications, the circulating power of the DAB based DC-DC converter at the input and output ends are the major concern. This paper uses a modified phase-shift control algorithm for DAB converter in order to reduce the backpower flow/ circulating power and improve the battery performance over long time. The operation of the standalone solar PV system with the proposed battery converter control has been verified through the PSCAD based simulation results in both the charging and discharging mode.

KEYWORDS: Solar panel, MPPT, DC-DC Converter, Bluetooth module, Voltage Regulator, Arduino Uno

I.INTRODUCTION

One of the most important sources of renewable energy nowadays which have caught theattention of many is the 'Solar Energy' and it is through harnessing this energy that we aremeeting some of our energy demands. It is a known fact nowadays that non-renewable resourcessuch as coal, oil and other such sources are almost on the verge oftermination. On the one hand torenewable energy sources such as the solar energy is plentiful and it has the greatest availabilitycompared to other energy sources. Solar energy is clean and free of emissions, since it does notproduce pollutants or by-products harmful to nature therefore it is nowadays a booming industryof research, where new and more efficient modes of harnessing solar energy is a challenge. Theconversion of solar energy into electrical energy has many application fields.

There are mainly two ways in which the solar to electrical conversion can be done, solarthermal and solar photovoltaic. In terms of Solar thermal, it is the conventional AC electricitygeneration produced by steam turbine; heat extracted from intense solar ray is used to producesteam and apart is stored in thermally insulated tanks for usage during lack of sunshine or night-time. Solar photovoltaic use cells made of silicon or certain types of semiconductor materialswhich convert the light energy absorbed from incident sunshine into DC electricity. To make upfor intermittency and night-time storage of the generated electricity into battery is needed.

II.SYSTEM OVERVIEW

SOLAR PANEL

Solar panels are such type of devices which convert light into electricity. A solar panel is a collection of solar cells. It depends on the amount of light hitting the cells s more the light that hits a cell, the more electricity it produces. Spacecraft's are usually designed with solar panels that can always be pointed at the Sun even while rest of the body of the spacecraft moves around. As we all know the energy from the sun is renewable (not a finite source) and it is completely pollution-free source of electricity.

MPPT CHARGE CONTROLLER

The core function of a charge controller is to maintain the battery at highest possible state of charge so when the PV module charges the battery the charge controller shields the battery from overcharge and detaches the load to prevent deep or full discharging. In other words it simply performs the necessary function of ensuring that the batteries

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cannot be damaged by over- charging by effectively cutting off the current from the PV panels when the battery voltage reaches a certain level.

The efficiency loss in a basic system is due to a miss-match between voltage produced by the PV panels and that required to charge the batteries under certain conditions. Ideally, charge controller directly controls the state of charge of the battery. Without charge control, the current from the module will flow into a battery proportional to the 'IRRADIANCE' (the radiant power received by a surface per unit area), whether the battery needs to be charging or not. If the battery is fully charged, unregulated charging will cause the battery voltage to reach exceedingly high levels, causing electrolyte loss, internal heating and also might lead to grid corrosion. So we can basically say that a charge controller maintains the health and extends the lifetime of the battery. Hence the necessity of having such a type of charge controller has immense advantage while using solar panels. This work done by the controller has a very complex mechanism where the main components are a converter and sensor. There are certain algorithms assigned to the system in order to compare and decide on that right voltage and power which makes the whole system a truly smart and further efficient.

BATTERY

The battery's main responsibility is to store the charge modified from the solar charge controller for later use. Since solar energy is concerned selecting the right type of battery is the most important thing. So in this case the deep cycle type battery is preferred for its efficiency. Basically deep cycle batteries are energy storing units in which chemical reactions occurs that generates voltage hence generates electricity. The reason it is called deep cycled because it works in two cycles.

1) Charging cycle

2) Discharging cycle.

The methodology followed by the deep cycle batteries is very interesting. While a car battery is designed to supply an instant bulk of energy to start up, a deep cycle battery is designed to provide power at a balanced rate slowly powering up the load.

III.OPERATION

The operation of MPPT Charge Control is composed by Arduino Uno, this system consist of MPPT charge controller, relay, battery, and Bluetooth module. The Arduino Uno is a microcontroller and hereweused ATmega328.It is the base with which the modelling starts. MPPT charge controller is a DC-DC converter embedded with MPPT algorithm to maximize the amount of current to the battery from PV module. The charge selector is a voltage sensing relay which can automatically manage charge function between the source and battery.. A rechargeable battery of 12V, 7Ah is used for storing the energy. The serial communication is provided by Bluetooth module HC-05.

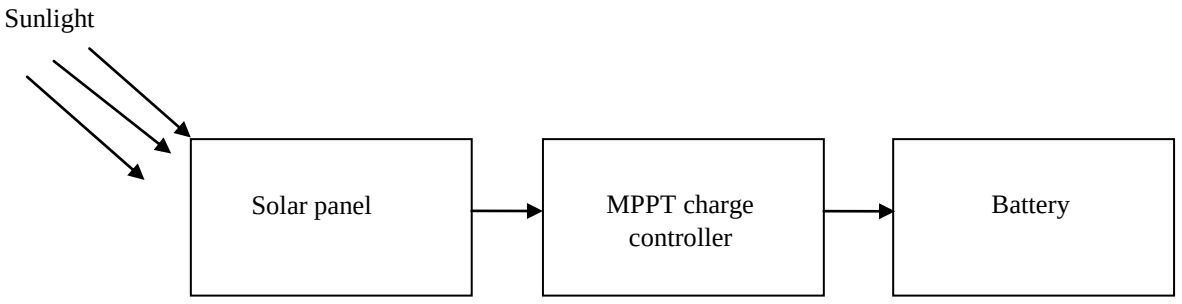

Fig 1**:** An overview of our system with its major components is shown as a block diagram.

a) Solarpanel
b) MPPT Solar ChargeController
c) Battery Each of the major components shown in the block diagram

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In this circuit thebattery voltage is almost remain constant. For this, we have to vary input which is solar voltage to reach or supply sufficient voltage to charge battery. So, for studying the circuit if we start from the beginning, current sensor senses current and voltage divider senses voltage. Before the battery there is current sensor and a voltage divider that calculates the battery condition. When the battery is charging at that time by measuring and using MPPT method voltage will vary by changing duty cycle to give the maximum power.

Fig 2: working model

In this system solar panel is placed with the horizontal axis.The solar panel which is an assembly of photovoltaic cell collect solar radiation and the panel output is fed into MPPT charge controller as its input. Mainly the MPPT charge controller has two functions;

A. If the amount of available solar radiation is higher than that required for charge the battery, then the controller controls the output by lowering it. This function of charge controller is called buck.

B. If the amount of available solar radiation is lower than that required for charge the battery, then the controller controls the output by increasing it. This function of charge controller is called boost.

MPPT charge controller used to produce constant voltage from the solar modules to charge the battery.

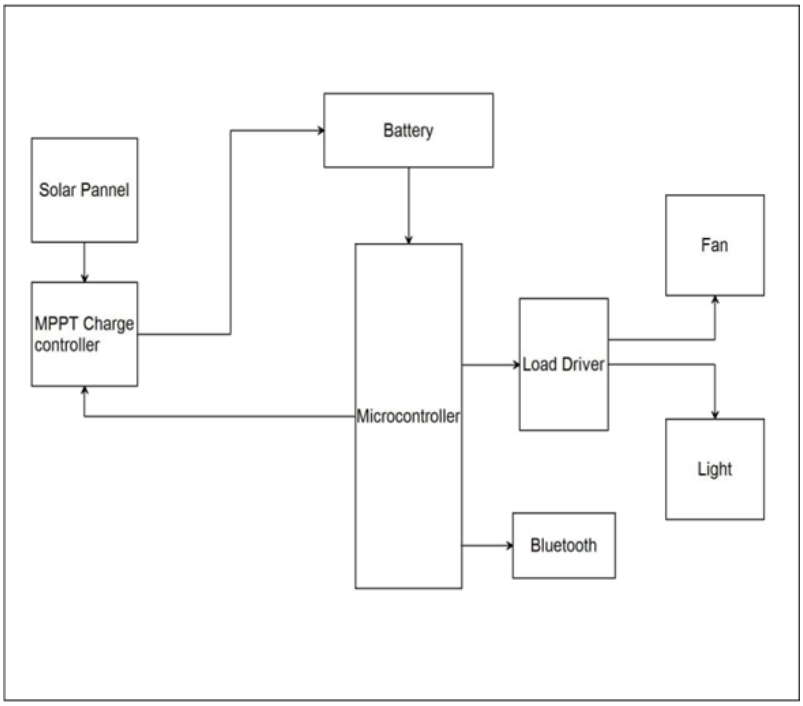

Fig 3: System diagram

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At the time when current is very low the panel voltage will be very high. So Arduino will set the duty cycle to zero so that the MOSFET remain open and highest voltage can be read while the circuit will remain open. When current start to increase then if much voltage supply is not needed then Arduino will start to increase duty cycle slowly which means MOSFET will be short and then voltage will start to decrease. By using this process the MPPT method will try to give maximum power at any time and at any condition. Here the different step of our trial and error process is added. The breadboard implementation, the PCB implementation and the Vero board set up. Ultimately, we made the whole compacted circuit in Vero board that we used for extracting the finaldata.Also a series of four relays are employed in between the sources and battery. Each of the relays has its own function. Their functions are as follows,

- First relay used to buck and boost selection.
- Second relay is used to battery cut off.
- Third relay and Fourth relay are used for the device control of light and fan.

Another striking feature that makes the MPPT charge controller as a smart is the presence of Bluetooth module (HC-05). It enable to connect the MPPT charge controller system to our smartphone.Then we easily monitor the charging and discharging levels of the battery and we can also control the light and fan through smartphone.

IV.RESULT

The prototype model works efficiently at all climatic condition. The design is successfully simulated using proteus software. Fig 4 shows the snap of model simulation.

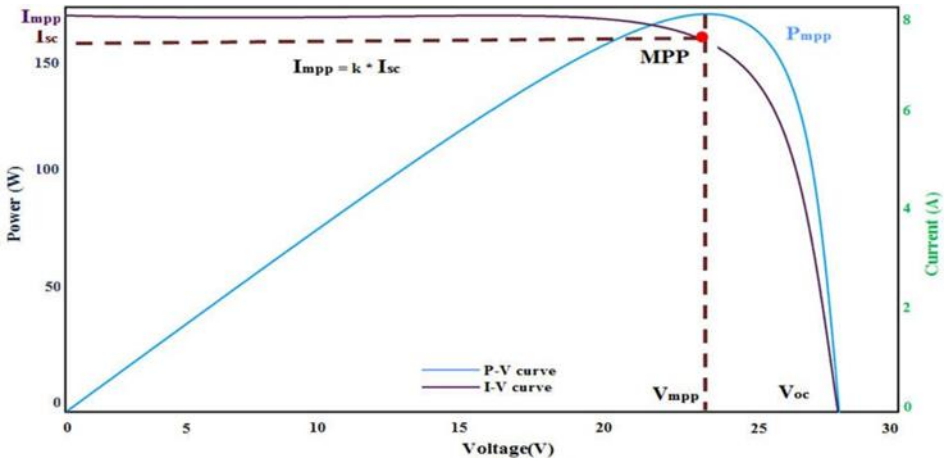

Fig 4:snap of model simulation

V.CONCLUSION

Solar Energy is the ultimate source of ultra clean, sustainable and natural energy. Most importantly it is the most cost efficient energy source we can use in our favor and for securing financial benefits. In this regard developing more efficient charge controller is a progressive step to fulfill the need of power generation using green energy. For that purpose it is our wish to continue further study on making the PV module more efficient. To be specific, the charge controller can be more improved by making the circuit more integrated and coming up with new algorithm to make the maximum power point tracking more efficient. Additionally, more digital logic can be implemented for maximizing the output hence reducing the physical work.

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