Battery Charge Controller Using Solar and Wind Hybrid Power

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Abstract- *The solar energy is converted to electrical energy by photo-voltaic cells. This energy is stored in batteries during day time for utilizing the same during night time. Similarly wind energy is converted to electrical energy by a generator-turbine arrangement and driven by wind power. This project deals with a controlled charging mechanism which over charge, deep discharge and under voltage of the battery. In this project a solar panel and a wind turbine is used to charge a battery. A set of op-amps are used as comparators to continuously monitor panel voltage, load current etc. Indications are also provided by a green LED for fully charged battery while a set of red LEDs to indicate under charged, overloaded and deep discharge condition. Charge controller also uses MOSFET as power semiconductor switch to ensure cut off the load in low battery or overload condition. A transistor is used to bypass the solar energy to a dummy load while the battery gets fully charged. This protects the battery from getting over charged.*

I. INTRODUCTION

A charge controller is an essential part of nearly all power systems that charge batteries, whether the power source is PV, wind, hydro, fuel, or utility grid. Its purpose is to keep your batteries properly fed and safe for the long term. The basic functions of a controller are quite simple. Charge controllers block reverse current and prevent battery overcharge. Some controllers also prevent battery over discharge, protect from electrical overload, and/or display battery status and the flow of power. This project deals with a controlled charging mechanism which over charge, deep discharge and under voltage of the battery. In this project a solar panel and a wind turbine is used to charge a battery. A set of op-amps are used as comparators to continuously monitor panel voltage, load current etc. Indications are also provided by a green LED for fully charged battery while a set of red LEDs to indicate under charged, overloaded and deep discharge condition. Charge controller also uses MOSFET as power semiconductor switch to ensure cut off the load in low battery or overload condition. A transistor is used to bypass the solar energy and/or wind energy to a dummy load while the battery gets fully charged. This protects the battery from getting over charged. A basic block diagram of the project is shown in Fig. 1.1. It shows a solar photo voltaic source and a wind turbine source connected to a charge controller which uses opamps and MOSFET which is connected to the battery and load. The renewable energy sources are used to charge the battery to get the environmental benefits.

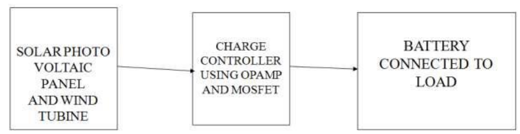

Fig. 1.1 Block Diagram of the Project

To design a circuit capable to do the following:

- To prevent batteries from being overcharged.
- To Block Reverse Current
- To provide Low Voltage Disconnect (LVD)
- To provide Overload Protection.

To meet these objectives a simple yet effective approach using op amps and MOSFET is studied and implemented during this project which also helps to reduce the cost.

II. RESEARCH ELABORATIONS

Off grid solar power applications store the harvested energy in batteries for later use. Controlling the charging of the batteries and harvesting the maximum available power from the solar array is a key requirement for the charging system. For fixed, non-mobile applications, rechargeable lead acid batteries provide a good power-to-weight ratio. They also have high surge current capability and are well suited for driving DC motors for applications such as pumps that usually require high inrush currents. Photovoltaic technology combined with rechargeable lead acid batteries is a good solution for fixed location solar energy systems. With fuel hikes making news, solar energy is the most sought after energy source. Solar chargers are simple, portable and ready to use devices which can be used by anyone especially in remote areas. Going solar can solve more than one problems, right from cutting down on carbon emissions and dependence on fuels, to solving the energy crisis In the past years solar energy has been considered for a much wider range of consumer application, than calculators. The industry is aiming increasingly at more power hunger and daily life devices, like mobile phones, tablets and so on. In this section we will discuss some approach on setting up solar panel system for such devices showing advantages and drawbacks. The major part of portable devices uses Li-ion batteries as power supply, and for most of us to be separated from our gadget is undesirable, even during battery charging process. So, at first, a good solar charger strategy would be use a solar panel to charge an internal battery to further recharge the portable device itself. This avoids heating the portable device, more than necessary, during charge cycles. So the basic components to build up a solar charger system are: the solar cell, a storage battery and a diode to prevent battery discharge to solar cell, as depicted on Figure 2.1

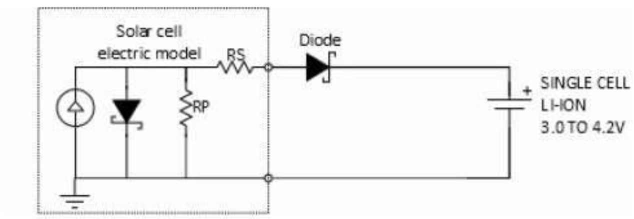

Fig. 2.1 Basic Solar Charging System

Although this is a good starting point, a direct connection between solar cell and battery is not very efficient and there are others drawbacks. For instance: Li-Ion batteries require voltage and current monitoring to avoid overcharge. So plug a battery at an unregulated power supply might not be a good idea, due to the risk of damage it permanently. Besides, at this configuration, cell operation voltage will be defined by the battery voltage summed to voltage drop across the diode, which will vary during charge and won‘t be fixed at the cell‘s maximum power point. This means this system is, in fact, wasting some amount of available light power. A second approach could be done including a battery charger between solar cell and battery, Figure 2.2.Now the battery terminals are connect to a regulated and monitored power supply. This would probably solve overcharge or permanent damage problems for your portable charger. Yet, such kind of system is still wasting bright sun light, once it still does not control the solar cell operation voltage. Besides, the addition of a block into power path will inevitably add losses to overall efficiency. So the battery charger should be designed to be as efficient as possible.

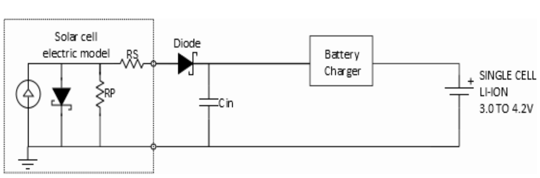

Fig 2.2:Solar Charger System with Battery Charger

So the main task in this project was to design a simple yet efficient charge controller scheme for lead acid type batteries.

SCHEMATIC DIAGRAM EXPLANATION:

CONNECTIONS:

In this Solar Charging Circuit we are using SOLAR PANEL. Here we are using MOSFET whose gate is connected to emitter of the transistor (BC547) drain is connected to +VE terminal & source is connected to GND is parallel to MOSFET a battery of 12V is connected collector of transistor is connected to +ve terminal with resistor R1 of 18K. Whose base is connected to o/p of 1st op-amp (LM324) through resistor R3 of 100K. Pin 11 is connected to GND Pin 4 is connected to VCC for both op-amps‘ known as U1: A & U1B. 2nd Pin of U1:A is connected to Pin 1 of op-amp through two resistors R4 of 330K R5 of 330k. Pin 3 and Pin 5 all shorted and connected to POT of 5K 6th Pin is connected to GND through resistor R10 of 120K. And 7th Pin is o/p Pin with resistor R7 of 2K & LED. VI:C is also an op-amp is whose 10th Pin is connected to POT of 5K whose one of the terminal is also connected to 2nd Pin of U1:A where 9th Pin is connected to GND 4th & 11th Pin are VCC and GND. Where 8th Pin is o/p Pin which is connected to Gate of MOSFET Q2 through Diode IN4148 where 9th Pin is also connected to drain of MOSFET whose gate is also connected to POT of RV1 who will get another o/p of U1:D known as Pin 14. Whose 12th Pin is connected to RV5 22K PRESET 13th Pin is connected to 4diodes in series known as D5, D6, D7,D8 source is connected to GND.

III. WORKING

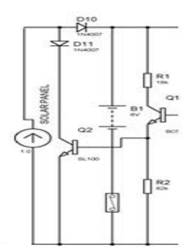

Fig. 4.2 Over-voltage Bypass

Solar panel section:

Battery B1 is charged via D10 and fuse. While battery gets fully charged Q1 conducts from output of comparator. This results Q2 to conduct and divert the solar power through D11 and Q2 and wind power through D12 such that battery is not over charged.

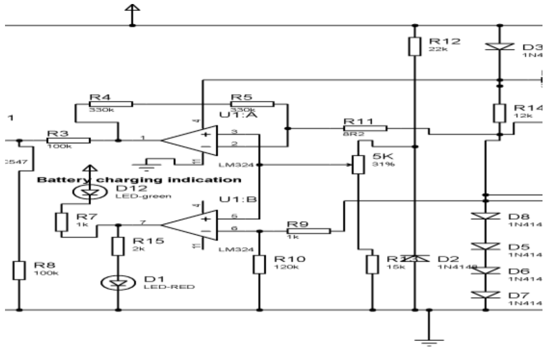

Fig. 4.3 Over-Voltage Indication

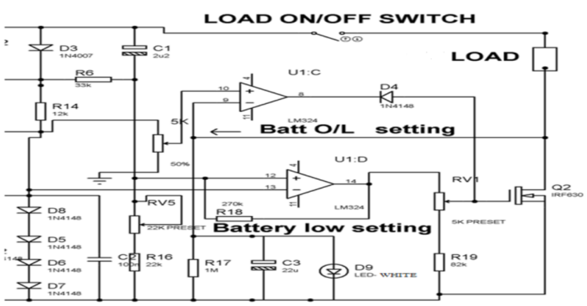

Fig. 4.4 Under-Voltage and Over Load Setting

The project uses one IC lm324 having 4 op-amps used as comparators that is U1:A,B,C,D. U1:A is used for sensing over charging of the battery to be indicated by action of U1:B output fed D1(red)and D12(green) for indicating battery status. Diodes D5 to D8 all connected in series are forward biased through R14 and D3 .This provides a fixed reference voltage of 0.65*4= 2.6v at anode point of D8 which is fed to pin 2 U1:A through R11, pin 13 of of U1:D, pin 6 of U1:B via R9 and pin 10 of U1:C via 5K variable resistor. Solar panel being a current source is used to charge the battery B1 via D10. While the battery is fully charged the voltage at cathode point of D10 goes up. This results in the set point voltage at pin 3 of U1:A to go up above the reference voltage because the potential divider formed out of R12, 5K variable resistor,R13 goes up. This results in pin no 1 of U1:A to go high to switch ‗ON' the transistor Q1 that places drive voltage to the Mosfet IRF640 .such that the current from solar panel is bypassed via D11 and the Mosfet drain and source. Simultaneously pin 7 of U1:B also goes high to drive a led D1 indicating battery is being fully charged. While the load is used by the switch operation Q2 usually provides a path to the (-ve) while the (+ve) is connected to the dc (+ve) via the switch in the event over load the reference voltage at pin 10 results in pin 8 of U1:C going low to remove the drive to the gate through the D4 the Mosfet Q2 that disconnects the load. In the event of over load Q2 voltage across drain and source goes up those results in pin no 9 going above pin no 10 via R22. In the event of battery voltage falling below minimum voltage duly sensed by D3, R6, RV5 and R16 combination at pin 12 results in pin no 14 going zero to remove the drive to Q2 gate via R20 and Rv1. The correct operation of the load in normal condition is indicated by D9 while the mosfet Q2 conducts

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IV. RESULTS OF FINDING

- The results taken during working condition Battery in charging condition : This condition is highlighted by GREEN LED being in ON condition.

- Battery in over-charged condition and hence bypass circuit is triggered :This condition is indicated by RED LED in ON condition.

- Battery in overload / deep-discharge condition : This condition is indicated by WHITE LED in ON condition.

V. CONCLUSIONS

A battery charge control mechanism was studied in this project which makes use of solar and wind power thus developing into a hybrid system. Battery used with this control mechanism thus will have a longer life and reduce the maintenance cost. Moreover hazardous situations caused by overcharging and in some cases deep discharging of batteries will be avoided and thus protection against such occurrences is possible with this project. Solar power and wind power are the future of energy sources but have one drawback that is they cant store energy. Battery as a storage element has tremendous potential in tomorrows market. Additionally they are used as standby or backup units. Hence battery charge controllers are an integral part of the system. An attempt was made through this project to demonstrate low cost battery charge controller system.

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