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Solar Charge Controller with variable output

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ABSTRACT

A charge controller of a charge regulator limits the rate at which electric current is added to it drawn from electric batteries. It prevents overcharging the battery and protect against over voltage, which can reduce battery performance of lifespan and pose a safety risk. It may also prevent completely drainage ("deep discharging ") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller "or "charge regulator" May refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery powered device, or battery charger. When the electricity is needed during night or periods with little sunlight, the energy is taken back from the grid. In isolated systems, the excess electricity is usually stored in batteries during the day and batteries are used to power the appliances in times when panels do not produce enough energy.

Keywords : Controller, Solar Panel, Battery, Voltage Regulation Unit.

I. INTRODUCTION

Solar energy is a promising system of energy for the near future. An efficient smart design of solar charge controller is an economically workable and technically endurable system. The specifications of a solar charge controller are determined by the type of load and storage device (battery) used in the system. According to IDCOL (Infrastructure Development Company Limited) SHS (Solar Home System) program standards for Solar charge controller, LVD stands for low voltage disconnect. Whenever the battery voltage drops below 11.6 V, it is recommended that the solar charge controller must disconnect the load to prevent deep discharge and ensure depth of discharge (DOD) to maintain at 70%. Why do we need solar charge controller? Most of the people do not know about the importance of solar charge controller hence either they install a local solar charge controller or they directly connect solar panel to the battery. If you connect 12V DC load and 12V battery to a 12 V solar panel, you might think what's the point of solar charge controller? A 12V solar panel can have a maximum voltage of 17.5V or more. If you charge your batteries with high voltage of solar panel, then your battery will start to overcharge. Due to constant overcharging, the internal temperature of the battery will increase. Due to this the water which is present in the battery starts to dry up and after sometime, the batteries are completely damaged. Not just this, the 12V DC load like DC fan, LED bulb or DC TV that are connected to the solar panel, due to high or low voltage, can get damaged easily. Again, we consider the damage due to connecting solar panels directly to the battery. Remember voltage always flows from higher potential to the lower potential. Therefore, in this condition the voltage from the batteries flows in the reverse direction to the solar panel. Due to this the charged battery starts to discharge solar charge controller stops this reverse flow in one direction. This means that the voltage should flow from solar panels to the battery. Solar charge controller protects the battery and DC load from these problems. A solar charge the battery with a constant voltage and constant current. Due to this battery life increases. Along with this, DC load also runs safely.

Solar panel: Solar panels are fast becoming a very appealing Solar Power option, which could end up being magnificently favorable to the environment. The process of coverting sunlight to electrical energy is one that has improved unimpressively over the last few decades, and is now better systematic than ever. The silicon and the conductors in the panel convert the sunlight into direct current (DC) electricity which then flow into the inverter. Surplus electricity that is not used by you can be sustained back to the grid. When the consumers Solar panels fabricate less power than what is required by the consumer at home, they can always buy electricity from utility.

Types of Solar Panels:

The different types of solar panel are as follows:

1. Crystalline Silicon
a) Mono crystalline solar panel
b) Poly crystalline solar panel
2. String Ribbon Solar Cells
3. Thin Film Solar Panel
4. Building Integrated Photo voltaic

Types	Efficiency	Life time (in yrs)
1. Crystalline a) Mono crystalline b) Polycrystalline	 19-22% 14-16%	 30-35 25-30
2. String Ribbon Solar Cells	7-8 %	-
3.Thin Film Solar Panel	10- 12 %	_
4.Building Integrated Photo voltaic	14- 16%	_

Mostly we use the mono crystalline Solar Panel because; it has high efficiency i.e. 19-22% to consume the Energy. The Mono crystalline solar panel is made up of from pure silicon i.e. it is 90-99% of pure. Therefore its life time is also more than others solar panels. The life time of mono crystalline solar panel is 30-35 years. It is also used in winter season because, it has high efficiency. The range of solar panel is depending on the amount of energy we use for purification unit.

Example: For finding the rating of solar panel we use the simple formula,

Suppose the rating of battery is 150AH

Then,

150*2 = 300W

Then, we use the rating of 300W for solar panel.

To charge the battery of 150AH out of 15%

Then,

15÷100*150AH = 22.5A

15% electric current is sufficient to charge the battery. Therefore, the 300W of solar panel is sufficient to charge the battery of 150AH.

Load: As we are working on the topic with variable output, it means that the output should be variable. For calculation point of view, we are assuming a room where two light bulbs, one fan and a TV are present. Suppose we want to run following electrical equipment:

- CFL - 15W - 2nos for 8 hrs
- Fan - 40W - 1nos for 10 hrs
- TV - 100W - 1nos for 2 hrs

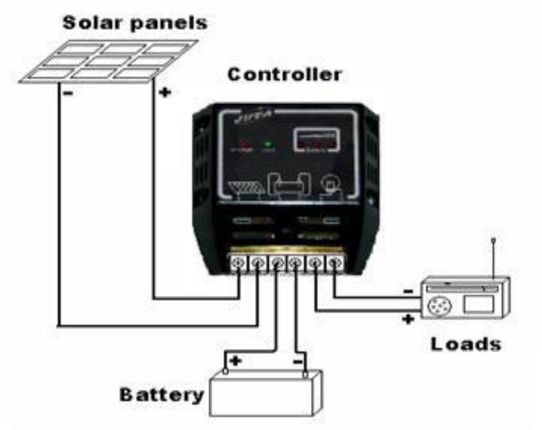
Electrical load will be,
CFL = 2*15*8 = 240Watthour
Fan = 1*40*10 = 400Watthour
TV = 1*100*2 = 200Watthour
Total load = 240+400+200 = 840Watthour

Effective solar energy available for 6hrs in a day solar panel wattage required load,
= 840/60 = 140Watt
Consider, solar panel efficiency as 90%
Solar panel wattage required,
= 140*100/90 = 155.55W
Inverter and wire losses (90% efficiency), = 155.55*100/90 = 172.83W
Here we can use two solar panels of 100W, 12V or one solar panel of 200W, 12V
Maximum load of all equipment = 30+40+100 = 170W
Inverter selection = 200W, 12V or 500W, 12V

Now come to battery,
Total watt-hour storage required = 840Watthour
Battery capacity = 840/12 = 70AH
Battery can discharge up-to 80% level
Hence Battery Capacity = 70*100/80 = 87.5AH

DC to AC loss (inverter and wire loss) 90% = 87.5*100/90 = 97.22AH
Standard battery available above this capacity will be 100AH

Block diagram:



II. PROPOSED SYSTEM

The proposed system is implemented by developing two systems which operate independently of each other.

1) Charge Controller System
2) Analog System
   a) Sensing unit
   b) Signal Conditioning unit
   c) Voltage Regulation unit

1) Charge controller unit

If the battery voltage exceeds the reference limit, the voltage control mode is employed to prevent overcharging of the battery. The operating point of the panel is changed accordingly to obtain a constant output voltage at the battery terminals. The rate at which the battery continues to absorb charge of the current through the battery gradually slows down because the voltage is maintained constant. A voltage band is used to prevent shuttling between the two modes. Charge controllers also monitor battery temperature to prevent overheating. Some charge controller systems also display data; transmit data to remote displays, and data logging to track electric flow over time.

2) Analog System:

All the physical quantities to be sensed are analog in nature. The proposed system requires an accurate sensing and signal conditioning system to realize the physical quantities and to achieve proper control of the entire system. In order to build an independent system, the power supplies for the system components have been derived from panels of the battery thus requiring a voltage regulation unit.

a) Sensing unit

The sensing unit is used to convert the physically available voltage and current variables to appropriate signals which can be processed. The panel and battery voltages are sensed using operational amplifier circuits. The presence of power in utility mains is monitored using power sensing circuit.

b) Signal Conditioning Unit

The current output from the battery has extraneous frequency components due to introduction of power electronic devices, thus requiring a filter circuit to obtain a smooth signal which can be process easily.

c) Voltage Regulation unit

Since the system does not require an external power supply which is an inherent advantage of the system, linear and switching voltage regulators are used.

III. OBSERVATIONS RESULT

- After proper connection of the solar panel and battery leads to their respective terminals on the solar charge controller, the power and undercharging LED's turn ON to indicate battery charging.
- After 12 hours and 20 min of charge the optimum charge LED turns ON indicating full charge and undercharge LED turn OFF indicating that no more current is getting to battery. Generally, the circuit performed satisfactorily.

IV. CONCLUSION

This work has produced a low cost, reliable and functional solar charge controller, using locally sourced and available components. The product worked satisfactorily and can be used in a solar home system to solve problems of power supply in India as well as other countries.

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