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Portable Solar Coat For E-Vehicle

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Abstract

Electric vehicle has got more advantages than normal combustion engine vehicles with no air pollution, no noise, saving energy and reduced carbon dioxide emissions. In general, an electric vehicle runs on rechargeable battery. We charge those batteries from an external power supply, which takes long time to charge completely. Charging stations are not portable and there won't be any charging station in remote areas. In our proposed system we are reducing the time by charging the battery using solar flexible PV modules which help in charging the battery by converting light energy from sun to electrical power. In case of an electric car, flexible solar cells will be stitched with the car cover which helps covering large area of the car providing high energy to charge the battery. The solar cells cannot generate power up to its potential. So, Maximum Power Point Tracker (MPPT) is used to track high power and transfers energy to the battery. With this, in good sunny days, it is possible to charge 40% of battery completely using solar energy. In battery management system in order to increase the life of the battery low-cutoff and high-cutoff circuits are proposed..

Keywords: Flexible solar panel, Maximum Power Point Tracker (MPPT), High-cutoff circuit, Low- cutoff circuit, Electric Vehicle (EV), Battery management system (BMS), BLDC motor.

1. Introduction

In this modern world, greenhouse gases emission is an irresolvable problem. The energy consumption, extraction and supply of fossil fuels are the challenges faced by all countries. Human activities are changing the natural state of greenhousegases. Over the last century the burning of fossil fuels like coal, crude oil, natural gas and petroleum has been increased which in turn increases the

concentration of atmospheric carbon dioxide (CO_2). The root cause of excessive usage of fossil fuels is due to the consumption of gasoline and diesel by combustion engine vehicles. The main downside of exhausting the natural resources is global warming and lack of sustainable development.

As the demand is always increasing, the consumption of gasoline and diesel has increased and are completely depleting the fossil fuels and there may not be any fuel left for the future generation. Increase in usage of fossil fuels in combustion enginevehicles, decreases the air quality by giving out a lot of harmful gases. Carbon dioxide is the major exhaust of vehicles and large emission of carbon dioxide which increases the overall temperature of earth. Heavy load vehicles consume lot of fuels and sometimes give out carbon monoxide which is more harmful than carbon dioxide. In the recent survey by world environmentalist, out of the world's 30 most polluted cities 20 cities are present in India.

To reduce the air pollution and global warming it is needed to reduce the usage of combustion engine vehicles. There will be no fuel left for usage because of the rise in demand for gasoline and diesel. And the main alternative will be Electric vehicle over traditional IC engine vehicle. In 2030, all combustion vehicles might be

replaced by electric vehicles. In recent times, DC solar power based various electric vehicles have been fabricated and tested.

In most of the countries solar power is empowered in all the fields and the energy is utilized in better manner. To the extent that scientists are testing the solar empowered air crafts to reduce the use of fuel.In electric vehicles batteries are used and to charge those batteries mainly supply is taken from thermal power plants, where the generation of electricity is from fossil fuels like coal and petroleum. So, here photovoltaic cells are proposed for charging the batteries in electric vehicles.

The PV modules converts the photons from the solar rays into flow of electrons (electricity). This energy can be stored in lithium-ion batteries. Solar power technology is an alternative source for reducing the usage of combustion vehicles. Solar energy from the sun is stored in a battery and is employed to run a vehicle. These e-vehicles are pollution free in nature.

In today's world the solar panel is directly connected to load (battery). By doing this it is not possible to generate high power, because of inequality in internal resistance of the load and characteristics of solar panel. To equalize this it is needed to use MPPT.

In case of photovoltaic modules, there is one single operating point at any given point in time, where maximum power can be drawn. So it is needed to locate this point and track this point and see the operating point. So, it is needed to use MPPT to maintain the operating point of PV panels at maximum generating point called as MPPT.

But this has a major disadvantage, which is the efficiency. The efficiency of normalsolar panel is 15 percent, so it is chosen to use monocrystalline flexible solar panel because of its high efficiency rate. The method is to stitch the flexible PV module in the car cover. In general, for a car, it needs four panels to cover the entire aera of the vehicle to generate morepower to charge the battery. In our system we are using MPPT to maximize the extraction of power under all weather conditions. The efficiency of solar PV module, is totally depending upon the quantity of solar rays hits the panel and the amount of power transferred to the load. These load characteristics keeps the power transfer in highly efficient rate. MPPT is the process to find the maximum tracking point and keeping the load characteristics. To increase the efficiency of the battery we are using two circuits. One circuit is low

cut-off circuit and the other one is high cut-off circuits. These MPPT and battery efficiency increasing circuits are discussed in our proposed system and methodology.

2.Objective

- To cover the major area of the car with PV module and to generate high power.
- Easy to carry and flexible.
- To reduce the overall charging time because of its dual mode system and MPPT.

3. Existing System

In the existing system only the charging station are available to charge electric vehicle. The charging stations are available only in urban areas. So, it is not portable. We need to charge the vehicle only in charging stations. So, the time consumption to charge the vehicle is high. The solar panel is directly connected to the load, so the power extraction is less and the generated excess voltage is wastage. So, to overcome that it is decided to use MPPT.

3.1.Disadvantages

- The charging stations are not portable.
- Cost is high because once the battery is completely drained, again we need to reach out nearby charging stations.
- Charging time is high.

→Power extraction is less

4..Proposed System

4.1.Solar Pv System

A solar PV module is a device that directlytransforms solar energy to electrical energy by the photovoltaic

effect, it defines an electrical characteristic such as current and voltage fluctuates depending on the intensity of light.

In our proposed system, we are stitching the flexible solar PV module in the car cover. The main aim of our system is to cover the complete area of the car, to generate more power from the solar radiation to charge the rechargeable battery.

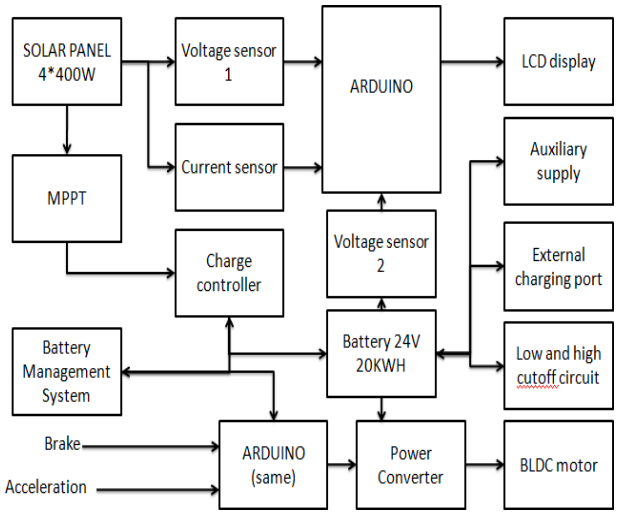


Figure 1. Block Diagram of Proposed System

Our electric vehicle will be having a single socket through which we can charge both from supply and by our solar coat. Normal charging is done mostly at charging stations and it is rare to find charging stations in remote areas, and time taken to completely charge the batteries in electric vehicle is too long.

To overcome these difficulties, we can use the solar coat to reduce the overall charging time in case of time consumption and for the case of remote areas we can charge the 40 percent of total battery in a whole day of sunlight for a medium sized electric vehicle having battery capacity 40 KWAH. As the solar coat is a one time investment, it can charge the vehicle at any time and a solar cell has a power guarantee of 25 years. In case of charging station, we need to pay for the power, every time we charge. And the charging stations are not portable and are difficult to be find in remote areas. In our system we are using dual mode for charging so charging time is less.

4.2.High Cut-Off Circuit And Charge Controller

The power is generated from the flexible solar panel and it is given to MPPT. When the supply from MPPT is directly given to load or a battery, then there will be a drop of voltage and current. Hence, there will not be a constant supply to battery.

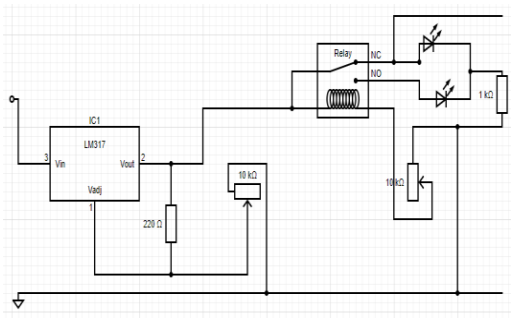


Figure 2. High cutoff and charge controller

In order to charge a battery completely it is needed to give constant value of current and voltage. So, we need a charge controller to give constant value of current and voltage to battery so as to charge it uniformly. In our proposed model we will be using lm317 regulator and a potentiometer to regulate and control the voltage accordingly depending upon the battery. Li-ion battery is used and there will be many cells in it. And each and every cell will be having a different charging voltage. So, it is needed to give constant amount of voltage and current to each and every cell. Battery management system is being used, interfaced with Arduino to set a

particular charging voltage to each and every cell in the battery unit. Once the battery is full, it is important to cutoff the supply to battery to reduce overheating and damage to the battery. To overcome this problem, there is need for overcharge protection for the battery unit, which is very important to increase the life and efficiency of the battery. So, to detect and cut-off the supply to the battery once it is full, we use a protection circuit.

4.3.Low Cut-Off Circuit

The low cut-off circuit is used to cut off the supply from the battery to load when the battery is deeply drained. By including this circuit, it is possible to increase the efficiency of the battery. This method will be connecting this low cut-off circuit between the battery unit and load. When there is load connected, the charge will be drained from the battery. And it is important to know the level of battery to know the low cutoff point.

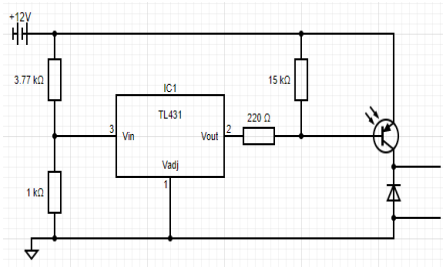
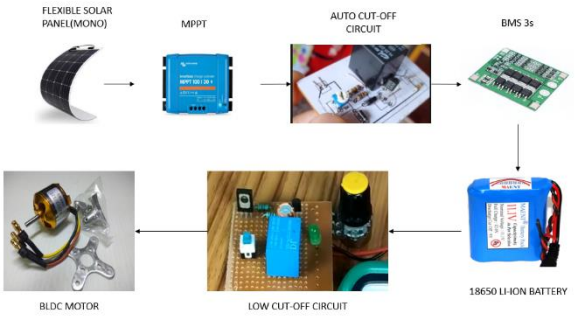


Figure 3. Low cutoff circuit

There is a particular charge below which, when we drain the charge, the battery gets damaged and the life time of the battery gets reduced, that point is known as low cut off point. It is important to cut down the supply to load when this point is reached for the battery unit. To achieve this, a voltage regulator and transistor is used to know the low cutoff point of each and every cell in the battery unit and set the cutoff limit.

5. Methodology



In the system, flexible monocrystalline solar module is used to generate power. But when solar panel is directly connected to the load (Battery), much of the power that the solar panel has potential to generate it may not be generated. Because of the unequal of inner resistance of load and load characteristics of solar panel. To overcome this, we are using MPPT. MPPT is used to isolate the solar panel and the battery. To extract more power, it is needed to equalize the inner resistance of load and characteristics of solar panel. MPPT can able to handle high voltage and are more efficient than PWM. It is used to charge the battery faster. For example, if we need to charge the 12volt battery but, our PV module generate 14volt. Only the 12 volt is consumed. Remaining 2 volt is wastage. So, to avoid

that wastage MPPT is used. It converts the excess voltage into current. It is also helping us to reduce voltage drop. MPPT is then connected to auto cut-off circuit and charge controller. The auto cut-off is used to limit the voltage to the charging voltage of the battery. We connect the battery management system to auto cut-off circuit. As, we are using combination of 18650 li-ion battery, each and every cell in the battery will be having different charging voltage and each and every cell in the battery will be having different charge level. So, to charge all the cells uniformly with its particular charging voltage, we use BMS. And then BMS is connected to battery.

As we know, there is point called low cut-off point for any battery below which, we discharge, the battery gets damaged. From protecting the battery from damage, we use low cut-off circuit, which cuts down the supply at the given low voltage point of the battery by preventing the battery getting damaged. And then it is connected to Electronic Speed Controller (ESC) of BLDC motor, which helps in driving the motor. Connecting ESC to Arduino helps in regulating and maintaining the speed of the motor.

The foremost intent of this paper is to cover the major part of the car area to generate high power to charge the battery. The low cutoff and high cutoff circuits used in the battery management system will help to increase the efficiency of the battery.

6.Components Solar Panel

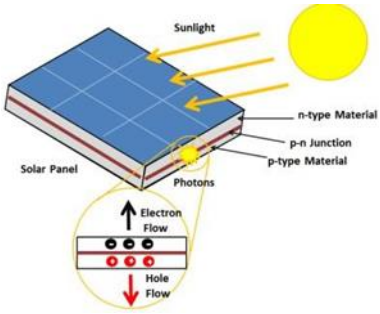


Figure 4. Solar cell

The solar panel is an electronic device. A solar panel (PV) module is an assembly of photovoltaic cells.

These devices are used to absorb solar radiation and converted them into electricity. This happens becauseof the photovoltaic effect. Mostly solar panel is made up of crystalline solar cells. Of this monocrystalline solar panels are highly efficient. It can reach an efficiency higher than 20 percent, while other typesof panels usually have efficiencies between 15 to 17. This solar panel does not form air pollution it liberates only in the form of heat. So, it is eco- friendly. In our system, we are using a flexible solar panel.

6.1..Flexible Solar Pv Module

Figure 5. Flexible solar module

This solar panel is flexible with lightweight and versatile. It is portable and because of its lightweight, we can easily carry it. The flexible solar panel is stitched in the car cover to cover the entire area of the car. This solar panel capable of producing voltages that exceeds 50V. This flexible panel is tested by depositing the photovoltaic materials on a polyethylene terephthalate (PET) material. This sheet can be folded several times, because of folding there is no deterioration in their performance and efficiency. The efficiency of a flexible solar panel is about 17 percent.

6.2.Maximum Power Point Tracking System (Mppt)

MPPT is a dc-dc converter. This technique is used to maximize the power extraction from sunlight under all climatic conditions. It is used to isolate the solar panel and the battery. The solar panel output is also depending upon internal resistance of load. When the

Figure 6. MPPT

solar panel generate peak power, the internal resistance at this point is called as characteristics of the panel. The main purpose of using MPPT is to equalize the internal resistance of load and the characteristics of solar panel. MPPT is to increase the efficiency of power transfer from the solar cells. It also depends upon the amount of sun rays that hit the PV panel, and the electrical characteristics of the load. As these conditions may vary, the load characteristics which give the maximum power transfer efficiency change. It is the process of finding this point and keeping the load characteristics there. MPPT reduces the complexity of the system while the output has high efficiency. The process of trying to maintain the operating point of PV panels at maximum power point called as MPPT.

6.3.Battery

In this system, 18650 lithium-ion battery is used. This battery is used in electric vehicle (EV) battery because of its rechargeable property. During discharge, the lithium ions in the battery move from cathode to the anode through the electrolyte process. During charging the reversal changes take place. In a lithium-ion battery, graphite is used as the cathode of the battery and a positive electrode intercalated lithium compound is used. These batteries have huge energy density and less discharge. The lithium-ion battery is weighed less. So, by using this battery we can decrease the overall vehicle weight. These batteries are designed to give power for sustained periods. The lithium-ion battery is much safer than a lead-acid battery. During any unpredictable accident, the lithium-ion battery does not explode because it does not contain much energy when discharge. When compared to its weight their

energy density is high. It shows that lithium-ion battery has a high power to weight ratio. Other batteries are heavier but have low energy density. So, the lithium-ion battery is much better than any other battery.

6.4.Battery Management System

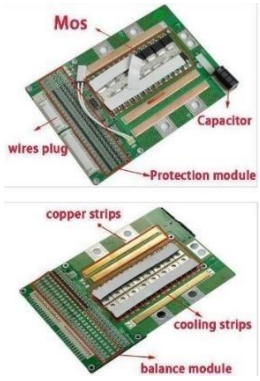


Figure 7. Battery Management System

Battery Management System is an embedded system that has a list of components in circuit boards. BMS helps to manage the batteries and it will collect the data from the battery unit to eliminate risk. The BMS's primary function is safety. Electric vehicles run on lithium-ion batteries which are high voltage battery packs. So, the BMS continuously monitors parameters like temperature, voltage, and current in and out of the battery. The BMS is monitoring parameters to ensure that battery is operating in a safer condition. BMS responsible for the thermal management system. If required the BMS can adjust cooling for safety measures. If overheating is detected in the battery the BMS will limit the vehicle's output power. Overcharging can also lead to damage. The BMS continuously monitors voltage and individual battery cells. In case the overcharging is detected the BMS controls the input limit. BMS is responsible for optimizing the performance of the battery. State of charge is maintained. The overcharging and deep discharging affect the capacity of the battery. During charging the BMS will determines the current which requires a safe move and it gives the signal to the charger. During the discharging of the charges, BMS will make contact with the motor controller to avoid

cell voltages reaching too low. The state of health of the battery is monitored by BMS which compares the current condition of the battery to its original condition. BMS is a must for the electric vehicle to monitor and control

6.5.Arduino Uno

Figure 8. Arduino

The Arduino UNO is an electronic microcontroller. This device is mainly equipped with analog and digital, input and output pins. The Arduino uno has 14 digital input-output pins. It has 6 analog input-output pins. It is programmable with Arduino Integrated Development Environment using a laptop /monitor connected with type B USB cable. The Arduino has been powered through an external source. In our system, the Arduino is interfaced with BMS to control the speed of the motor. The acceleration and break are controlled by Arduino.

6.6.Bldc Motor

In recent days the car manufacturers using BLDC motor because it is an electronically commuted DC motor that does not have brushes. The BLDC motor has a permanent magnet rotor surrounded by a stator. Most of them prefer BLDC because the peak point efficiency is high and rotor cooling is simpler. This motor can operate in unity power factor. This motor is brushless so they are high power to weight ratio. They required less maintenance. It has more efficient about 80-90 percent. It is more durable, smaller, and lighter. It is simpler to speed control and reverse.

6.7.Electronic Speed Controller (Esc)

Figure 9. Electronic Speed Controller

The Electronic Speed Controller (ESC) is an electronic circuit used to control and regulate the speed of a BLDC motor. It also prevents the motor from reversing and dynamic braking. It will control the motion of BLDC motor or the speed of the motor by triggering the appropriate MOSFETs to create the rotating emf. So, that the motor rotates at particular speed. The higher the frequency higher the speed of the motor. To activate the ESC, we need to find the position of rotor. We have two methods to find the rotor position. First used to find the rotor position is using hall-effect. The next one is done by sensing back electromotive force. The ESC takes the signal from the controller and power from the battery and it makes the brushless motor spin. So, to control the speed of the motor ESC is required.

6.8.Low Cut-Off Circuit

When the supply from the battery is deeply drained it affects the efficiency of the battery. Due to the deep drain of the battery, the non-linear supply is given to the load. So, the load will lead to interior damage. So, to avoid that we are using a low cut-off circuit.

6.9.Resistor

In most electric vehicles, regenerative braking happens in which energy will be lost through braking. So, resistors will be useful in the event of an electrical fault. It is used to drop the pressure in the battery. In our system, we are using a 1k resistor.

6.10zener Diode

The Zener diode is used to generate a fixed voltage output depending on its value. It is a bi-directional

device. So, it works in the reverse breakdown region. It is used to drop out voltages. To limit the current,

Zener diode must be connected with the resistor. It helps to prevent the device from damage. In our system, we are using a 6.2V Zener diode.

6.11.Relay

Relay is an electro-mechanical switch. It is used to cut-off the power which passes in the circuit either manually or automatically by the given condition. The load remains ON when the output is low. When the excess current flows in the coil of the relay the magnetic field is induced which attracts the lever and changes the switch contacts. Relays are used when the necessary control needs in the system.

6.12.High Cut Off Circuit

Figure 10. High cut-off circuit

When the power supply received at the load end has voltage fluctuations or overcharging occurs in the circuit, it leads to the reduction in the lifespan of batteries. So, to avoid that high cut-off circuits are used to increase the life span of the battery.

6.13 Lm317 Voltage Regulator

The LM317 voltage regulator is a three-terminal device. It is a current limiter. It is also a thermal overload protector. When the excess charging takes place in a rechargeable battery this voltage regulator will limit the current. The main purpose of this voltage regulator is to keep the voltage close to the desired value.

6.14.Potentiometer

The potentiometer is a measuring instrument. It is basically a voltage divider which is used to measure electric potential (voltage) and current. Sometimes it also helps us to limit the current and voltage. The

voltage and current values are determined and by using this value when the voltage and current exceed beyond the limit the relay used in this circuit will disconnect the supply.

6.15.Resistor

When a resistor is connected with the potentiometer, we can able to resist the current and voltage level and prevent the circuit from damage. In our system, we are using 1k, 220-ohm resistor.

6.16relay

Relay is electrical switches that will cuts the supply from the battery by following the condition from the values received from the potentiometer.

7. Result

For an electric car having a battery capacity of 24V- 20KWH. In Existing model, the solar panel is fixed on car top and the area covered by solar panel on the car is very less and can only fetch the power to charge the $1/9^{th}$ part of the battery in a day,

- Total battery capacity of EV (medium size)-20KWH- 24V.
- Total amps- 800A(approximately).
- Wattage of normal solar panel - 400W-24V- 9A (per hour).
- We can maximum connect 1-2 panels- 13Aper hour.
- 6 hours a day of sunlight- total amps 80A.
- 1/10th of the total battery can be charged ina day.

But in our proposed system, we completely stitch the flexible solar panel on the car cover. So, when the caris covered, the total area of the car is covered by solarpanel, which will help in generating more power through

which we can charge up to 1/4th of the batteryin a day,

- Total battery capacity of EV (medium size)-20KWH- 24V.
- Total amps- 800A(approximately).
- Wattage of flexible solar panel - 400W-24V- 10A (per hour).
- We use 4 panels- 40A per hour.
- 6 hours a day of sunlight- total amps 240A.
- 1/4th of the total battery can be charged in aday.

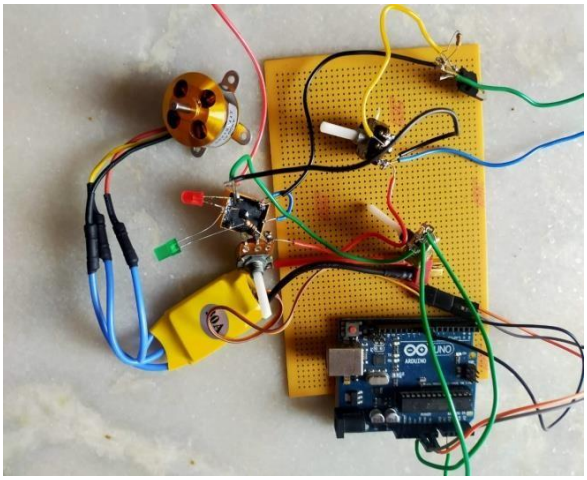


Figure 11. Prototype model

Figure 12. Experimental setup

By using our solar coat, we can able to generate high power. MPPT used to track the maximum power and transfer the power to the battery. In battery management system the low cut-off and high cut-off circuits increase the efficiency of the battery. Our system is successfully implemented in an effective manner. The size of the single 400W panel is 2m length*1m breadth, we can stitch two panels from front engine to back silencer and remaining two on both the sides.

8. Conclusion

In conclusion, this project has proposed a modern way to charge the battery of electric vehicle using Portable solar coat. It can be carried to any remote areas where there is no charging station and charge the vehicle. It is easily foldable and can be carried easily.Our system can charge 25 percent of the battery in a day (6 hours of light) whereas existing model has the capacity to charge only 10 percent. It is clear that our coat will be a better choice to reduce the total time of charging..

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