A NOVEL CONTROL OF SOLAR PV FED WITH SRM DRIVE APPLICATIONS OF EHV

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ABSTRACT: -

Electric vehicles are automobiles, which are powered by electrical engine and electrical energy. Due to the limitation of current battery technologies, the driving range is very short. In earlier, in terms of motor drives, high performance permanent-magnet (PM) machines are widely used. In PM machines there is no field winding and the field is provided by the permanent magnet. Most commonly rare earth materials are used. But they are very costlier. To overcome these concerns a photovoltaic panel and a switched reluctance motor can be utilized for power supply and motor drive. In order to reduce the energy adaptation procedure, one advance is to brighten up the motor to embrace some onboard charging tasks. The solar energy exploitation and maximum power point tracking (MPPT) are the unique factors for the PV-fed electric vehicles. In order to achieve low-cost and flexible energy flow modes, a novel low-cost tri-port converter is proposed in this paper in order to coordinate the PV panel, SRM, and battery. To support flexible control of energy flow six operational modes are developed.

KEYWORDS: Electric vehicles, photovoltaic, maximum power point tracking, switched reluctance motors (SRMs), tri-port Converter

I. INTRODUCTION

Electric vehicles are automobiles, which are controlled by electrical motor and electrical energy. An electric vehicle (EV), likewise alluded to as an electric drive vehicle, utilizes at least one electric engines or footing engines for impetus. An electric vehicle might be controlled through an authority framework by power from off-vehicle sources, or might act naturally contained with a battery or generator to change over fuel to power. EVs incorporate street and rail vehicles, surface and submerged vessels, electric air ship and electric rocket. EVs initially appeared in the mid-nineteenth century, when power was among the favored strategies for engine vehicle impetus, giving a level of solace and simplicity of activity that couldn't be accomplished by the fuel autos of the time. The improvement of electric vehicles is an essential and imminent process. Electric vehicles are controlled by an electric engine rather than an inner ignition motor. Electric vehicles are 100% eco-accommodating and they don't discharge any harmful gases like CO2, N2 and so forth which causes Global warming. However, there are a few drawbacks on account of electric vehicles. Because of the impediment of current battery advances, the driving reach is short. This will lessen the wide utilization of electric vehicles. In earlier, in terms of motor drives, high-performance permanent magnet (PM) machines are widely used [4]. In PM machines there is no field winding and the field is provided by the permanent magnet. Most commonly rare earth materials are used. But they are very costlier. So by the utilization of PM machines it will likewise decrease the wide use of electric vehicles. To beat these issues a photovoltaic board what's more, an exchanged hesitance engine can be utilized for control supply and engine drive [3]. By presenting PV board on the highest point of the vehicle, a reasonable vitality source can be accomplished. PV board has low power thickness for footing drives; they can be utilized to charge the batteries. Additionally the SRM require no uncommon earth materials. The switched reluctance motor (SRM) is a type of a stepper motor, an electric motor that runs by reluctance torque [1]. Unlike common DC motor types, power is delivered to windings in the stator (case) rather than the rotor. This greatly simplifies mechanical design as power does not have to be delivered to a moving part, but it complicates the electrical design as some sort of switching system needs to be used to deliver power to the different windings. With modern electronic devices, precisely timed switching is not a problem, and the SRM is a popular design for modern stepper motors. Its main drawback is torque ripple. In order to decrease the energy conversion processes, one approach is to redesign the motor to include some onboard charging functions. The performance of battery modules depends not only on the design of the modules but on how the modules are used and charged as well. In this sense, battery chargers play a critical role in the evolution of this technology [2]. Generally, battery chargers are classified into the following two types:

1) The onboard type and

2) The stand-alone (off board) type.

Because the onboard type of chargers should always be carried by the vehicle, the weight and space, as well as the cost, have to be minimized. Along these lines, it is typically not down to earth to have a powerful level of the installed chargers with galvanic separation. In spite of the fact that confinement is an exceptionally positive alternative in the charger circuits for wellbeing reasons it is normally kept away from because of its cost affect on the framework. Off board chargers are situated at a settled area. They are restricted in their capacity yield by the capacity of the battery to acknowledge the charge. The most extreme power point following (MPPT) and sun based vitality use are the exceptional variables for the PV-bolstered EVs. Keeping in mind the end goal to accomplish minimal effort and adaptable vitality stream modes, an ease tri-port converter can be utilized to arrange the PV board, SRM, and battery.

Conventional PV fed EV system

The renewable energy is vital for today's world as in near future the non-renewable sources that we are using are going to be get exhausted. The solar vehicle is a step in saving the non-renewable sources of energy. The basic principle of solar car is to use energy that is stored in the battery during and after charging it from a solar panel. The charged batteries are used to drive the motor which serves here as an engine. Energy is one of the most vital needs for human survival on the earth. We are dependent on one form of energy or the other form for fulfilling our needs.

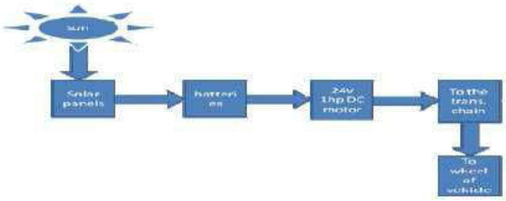


Fig.1 Basic block Diagram Representation of Solar vehicle

The above diagram gives an overview of the working of solar vehicle. Sun is the main source of energy for the vehicle. Energy from Sun is captured by the solar panels and is converted to electrical energy. The electrical energy thus formed is being fed to the batteries that get charged and is used to run 24 V DC high torques DC series motor. The shaft of the motor is connected to the rear wheel of the vehicle through chain sprocket. The batteries are initially fully charged and there after they are charged by panels. This helps in completing the charging-discharging cycle of the batteries, which is very important for proper working of batteries. DC motors were the preferred option in variable-speed operation applications before the development of advanced power electronics. The main disadvantages are low power density compared with alternative technologies, costly maintenance of the coal brushes (about every 3000 h), and low efficiency, although efficiency values over 85% are feasible. DC motors still have a wide market of lower and middle power range commutation vehicles. In earlier, in terms of motor drives, high-performance permanent-magnet (PM) machines are widely used. In PM machines there is no field winding and the field is provided by the permanent magnet. Most commonly rare earth materials are used. But they are very costlier. So by the use of PM machines it will also reduce the wide application of electric vehicles.

II. PROPOSED SYSTEM

The proposed system will helps to achieve low-cost and flexible energy flow modes. For this a low-cost tri-port converter can be used to coordinate the PV panel, SRM, and battery.

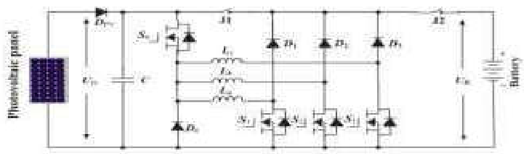


Fig.2 Proposed tri-port topology for PV-powered SRM drive

The proposed tri-port topology consists of three energy terminals, PV, battery, and SRM. The three are linked by a power converter that consists of four switching devices (S0 − S3), four diodes (D0 − D3), and two relays J1 and J2, as shown in Fig. 2.

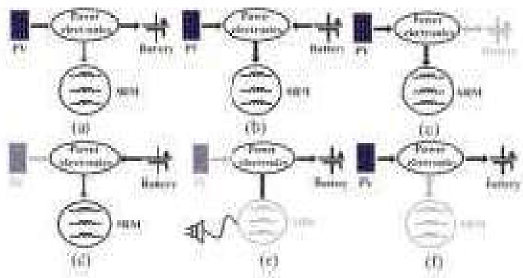


Fig.3 Six operation modes of the proposed tri-port topology. (a) Mode 1. (b) Mode 2. (c) Mode 3. (d) Mode 4. (e) Mode 5.
(f) Mode 6.

In mode 1, PV acts as the energy source to drive the SRM and to charge the battery. In mode 2, the battery and PV are both the energy sources to drive the SRM. In mode 3, PV is the source and the battery is idle. In mode 4, the PV is idle and the battery is the driving source. In mode 5, the battery is charged by a single-phase grid and both the PV and SRM are idle. And in mode 6, the battery is charged by the PV and SRM is idle.

DRIVING MODES

Operating modes 1–4 are the driving modes to provide traction drive to the vehicle.

1) Mode 1: In this mode relay J1 turns off and relay J2 turns on. The PV panel energy feeds the energy to SRM and charges the battery; so in this mode, the battery is charged.

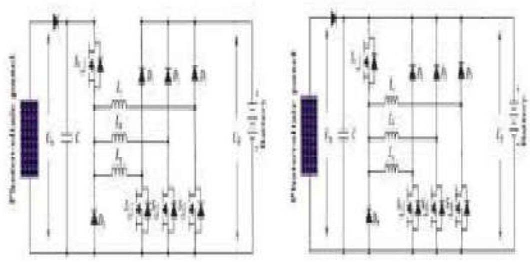


Fig: 4 Mode 1 and 2

2) Mode 2: When the SRM operates in heavy load, both the PV panel and battery supply power to the SRM. Here the relay J1 and J2 are turned on.

3) Mode 3*:* When the battery is out of power, the PV panel is the energy source to drive the vehicle. Here the J1 turns on and J2 turns off.

4) Mode 4*:* When the PV cannot generate electricity due to low solar irradiation, the battery supplies power to the SRM. The corresponding topology is illustrated in Fig.3.6. In this mode, relay J1 and J2 are both conducting.

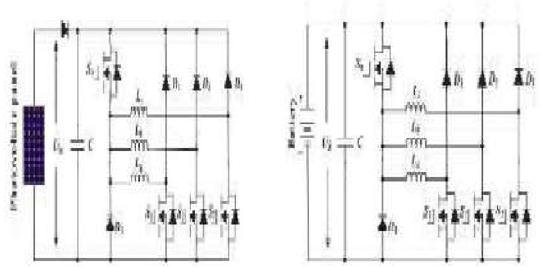


Fig: 5 Modes 3 and 4

5) Mode 5: When PV cannot generate electricity then an external power source is needed to charge the battery. In this ModeJ1 and J2 turn on. Point A is central tapped of phase windings. Here phase windings $La1$ and $La2$ are employed as input filter inductors.

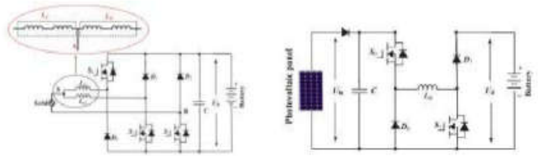


Fig: 6 Modes 5 and 6

6) Mode 6*:* When the EV is parked under the sun, and then the PV can charge the battery. In this mode J1 turns off and J2 turns on.

III. GRID-CHARGING CONTROL STRATEGY

The proposed topology also supports the single-phase grid charging. There are four basic charging states and $S0$ is always turned off in this condition.

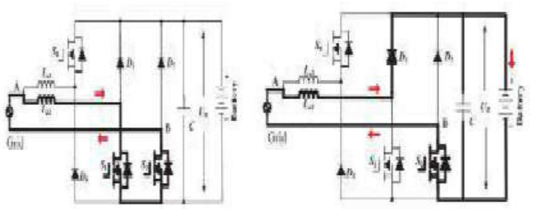


Fig: 7 Grid charging state 1 and 2

In grid charging state 1, the grid voltage charges the phase winding *La*2, the corresponding equation can be expressed as; Ugrid= La2. In grid charging state 2, S1 turns off and S2 conducts, the grid is connected in series with phase winding to charges the battery, the corresponding equation can be expressed as; UB - Ugrid= La2 .

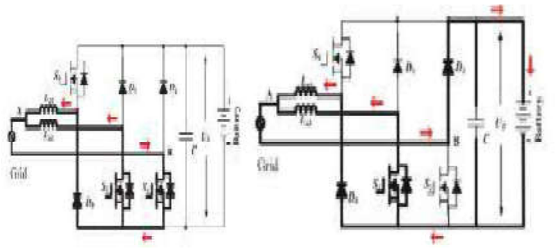


Fig: 8 Grid charging state 3 and 4

In grid charging state 3, S1 and S2 conduct, the grid voltage charges the phase winding *La*1 and *La*2, the corresponding equation can be expressed as; Ugrid= 1 + 2.1 . 2

In grid charging state 4, S1 keeps conducing and S2 turns off, the grid is connected in series with phase winding *La*1 and *La*2 to charges the battery, the corresponding equation can be expressed as; -UB - Ugrid= 1 + 2 .1 . 2

PV-FED CHARGING CONTROL STRATEGY

In this mode, the PV panel charges the battery directly by the driving topology. The phase windings are employed as inductor and the driving topology can be functioned as interleaved buck–boost charging topology.

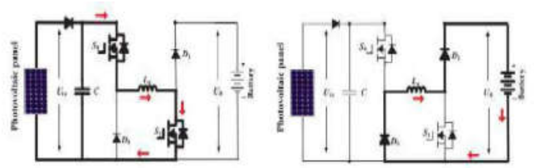
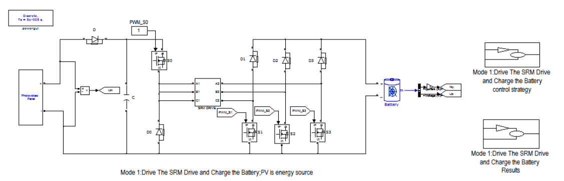


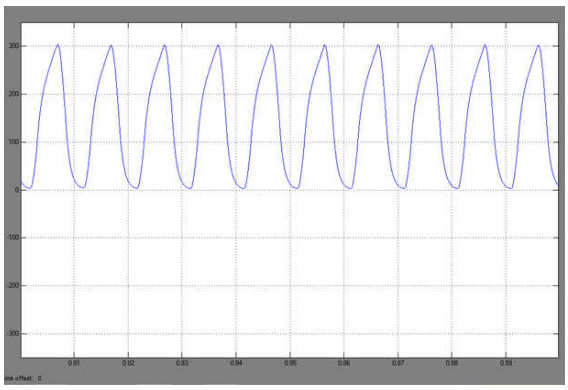
Fig: 9 PV fed charging mode

For one phase, there are two states, as shown in Fig: 9. When *S*0 and *S*1 turn on, the PV panel charges phase inductance; when *S*0 and *S*1 turn off, the phase inductance discharges energy to the battery. According to the state-of charging (SoC), there are three stages to make full use of solar energy and also it will maintain the battery healthy condition. During stage 1, the battery is in extremely in the lack energy condition, the MPPT control strategy is employed to make full use of solar energy. During stage 2, the constant-voltage control is adopted to charge the battery.

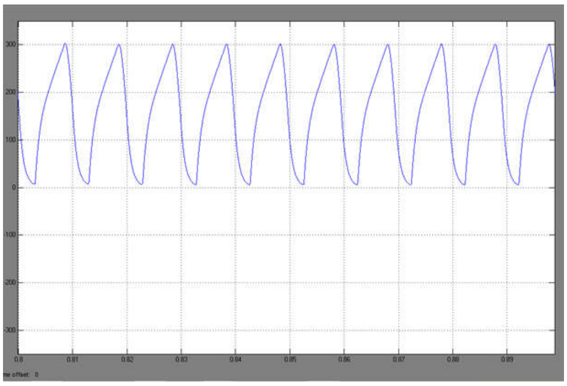
IV. SIMULATION RESULTS



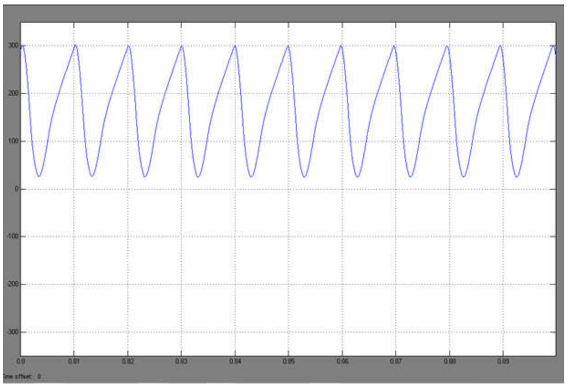
Mode 1: Drive the SRM Drive and Charge the Battery; PV is energy source



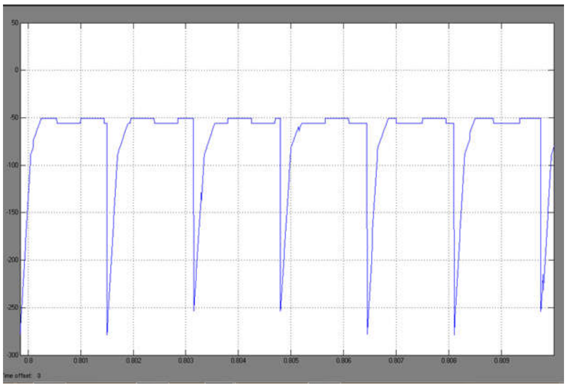
Current at phase a (ia)



Current at phase b (ib)



Ic



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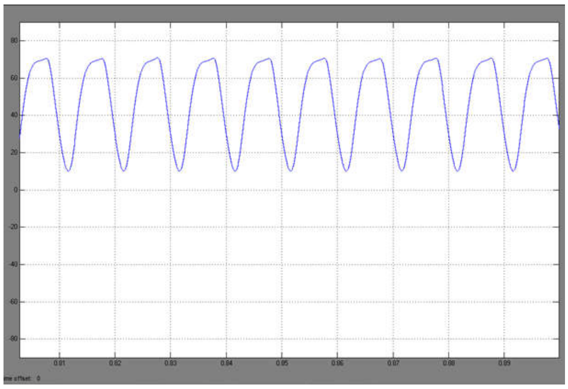
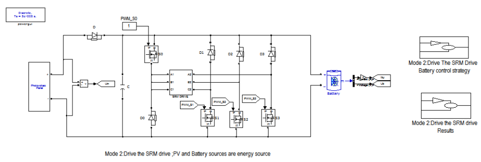
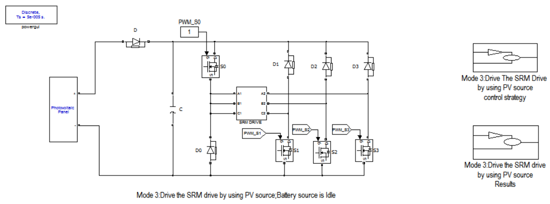


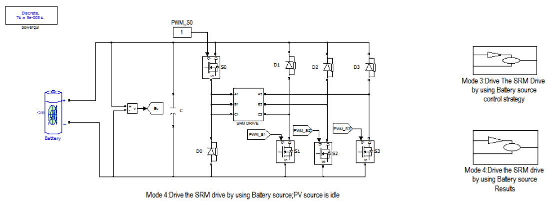
Torque



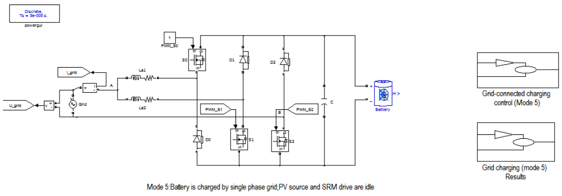
Mode 2: Drive the SRM drive ; PV and Battery sources are energy source



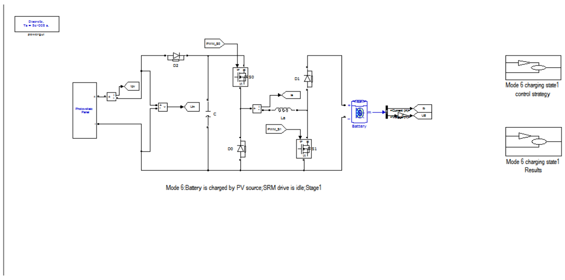
Mode 3: Drive the SRM drive by using PV source; Battery source is Idle



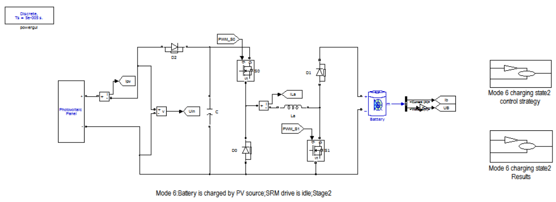
Mode 4:Drive the SRM drive by using Battery source; PV source is idle



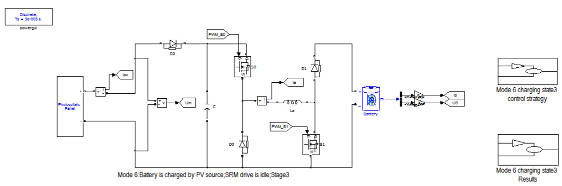
Mode 5: Battery is charged by single phase grid; PV source and SRM drive are idle



Mode 6: Battery is charged by PV source; SRM drive is idle;Stage1



Mode 6: Battery is charged by PV source; SRM drive is idle; Stage2



Mode 6: Battery is charged by PV source; SRM drive is idle; Stage3

V. CONCLUSION

In order to increase the range of EVs and decrease the system cost, a combination of the PV panel and SRM is proposed as the EV driving system. DC motors were the preferred option in variable-speed operation applications before the development of advanced power electronics. The main disadvantages are low power density compared with alternative technologies, costly maintenance of the coal brushes (about every 3000 h), and low efficiency, although efficiency values over 85% are feasible. The low utilization factor of private vehicles makes the coal brushes essentially maintenance free. DC motors still have a wide market of lower and middle power range commutation vehicles. In earlier, in terms of motor drives, high-performance permanent-magnet (PM) machines are widely used. In PM machines there is no field winding and the field is provided by the permanent magnet. Most commonly rare earth materials are used. But they are very costlier. So by the use of PM machines it will also reduce the wide application of electric vehicles. To overcome these issues a photovoltaic panel and a switched reluctance motor can be used for power supply and motor drive. A tri-port converter is used to coordinate the PV panel, battery, and SRM. Six working modes are developed to achieve flexible energy flow for driving control, driving/charging hybrid control, and charging control. A PV-fed battery charging control scheme is developed to improve the solar energy utilization. Since PV-fed EVs are a greener and more sustainable technology than conventional ICE vehicles, this work will provide a feasible solution to reduce the total costs and CO2 emissions of electric vehicles.

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MADURI GOPIKA PURSING M.TECH IN SANA ENGINEERING COLLEGE WITH STREAM OF POWER ELECTRONICS

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