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DESIGN OF SOLAR PHOTOVOLTAIC SYSTEM FOR ELECTRIC TROLLEY

Dr.K.Deepa[1], Samy.K[2], Shasidharan.K[3], Sivaraj.R[4] and Sandhanakrishnan.B[5]

Assistant Professor[1] Student[2,3,4,5]
Department of Electrical and Electronics Engineering,
Peri Institute of Technology, Chennai.

Abstract:

The design of a solar photovoltaic (PV) system for an electric trolley represents a promising step towards sustainable urban transportation. These abstract outlines the key considerations and methodologies employed in the design process. The first step involved a comprehensive analysis of the energy requirements of the electric trolley, considering factors such as route length, passenger capacity, and operational hours. This analysis provided crucial insights into the power demand profile, enabling the sizing of the solar PV system. The solar PV system design incorporated factors such as available roof space on the trolley, solar panel efficiency, and geographical location to maximize energy generation. Advanced simulation tools were utilized to optimize the orientation and tilt angle of the solar panels for enhanced sunlight capture throughout the day. Additionally, energy storage solutions such as batteries were integrated into the system to ensure continuous operation during periods of low sunlight or high demand. The selection of appropriate battery technology involved considerations of energy density, lifespan, and charging efficiency. Furthermore, the design included efficient power management and distribution systems to regulate energy flow between the solar panels, batteries, and propulsion system of the trolley. Smart control algorithms were implemented to dynamically adjust power allocation based on real-time conditions, maximizing overall systemefficiency.

I. Introduction:

The design of a solar photovoltaic (PV) system for an electric trolley represents a promising step towards sustainable urban transportation. These abstract outlines the key considerations and methodologies employed in the design process. The first step involved a comprehensive analysis of the energy requirements of the electric trolley, considering factors such as route length, passenger capacity, and operational hours. This analysis provided crucial insights into the power demand profile, enabling the sizing of the solar PV system. The solar PV system design incorporated factors such as available roof space on the trolley, solar panel efficiency, and geographical location to maximize energy generation. Advanced simulation tools were utilized to optimize the orientation and tilt angle of the solar panels for enhanced sunlight capture throughout the day. Additionally, energy storage solutions such as batteries were integrated into the system to ensure continuous operation during periods of low sunlight or high demand. The selection of appropriate battery technology involved considerations of energy density, lifespan, and charging efficiency. Furthermore, the design included efficient power management and distribution systems to regulate energy flow between the solar panels, batteries, and propulsion system of the trolley. Smart control algorithms were implemented to dynamically adjust power allocation based on real-time conditions, maximizing overall systemefficiency.

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II. Block Diagram :

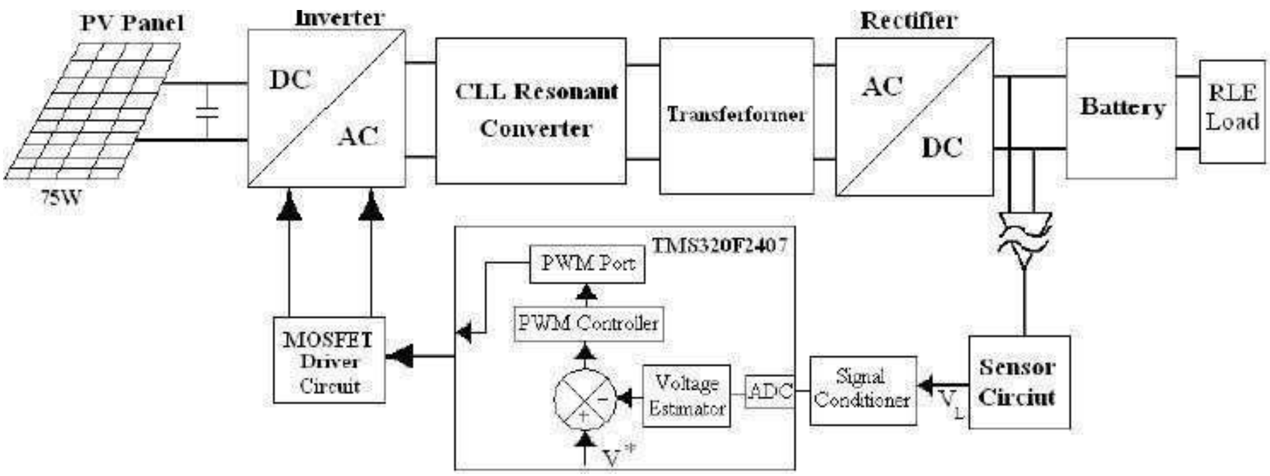

Fig.1.Block diagram of solar panel design

Energy consumption during night and at times when there is less solar radiation. The controller of a solar system has to regulate the battery storage appropriately to prevent disastrous operating conditions such as deep discharge on a regular basis or overcharging. The majority of PV system failures are attributed to storage batteries, which also significantly increase the cost of replacement over time. For changing or fluctuating load situations, the PV system's output voltage is kept constant with the employment of CLL resonant converters with controllers. With the aid of the converters, it is possible to continually lower the charge current while maintaining a specific battery voltage. Fig. 1 displays the block diagram of a photovoltaic panel with a DSP processor for a resonant converter.

III. Exponential block in Simulation:

The SIMULINK model exponential block is shown in Figure 15. By calculating the battery parameters using the mathematical blocks and using Equations, the voltage of the battery is plotted. The modelling is done in such a way that the charging current and discharging current are alternated according to the state of charge of the battery. By this way, both the charging and discharging characteristics are obtained. The characteristics were taken by connecting a resistive load across the battery. As the resistance increases the time taken for discharging completely also increases. For different charging currents, the charging characteristics were observed. It can be found that as the charging current increases, the time taken by the battery to attain full voltage decreases.

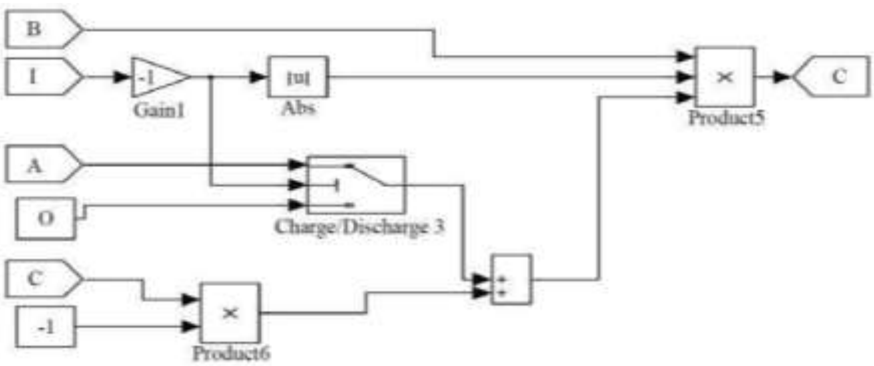

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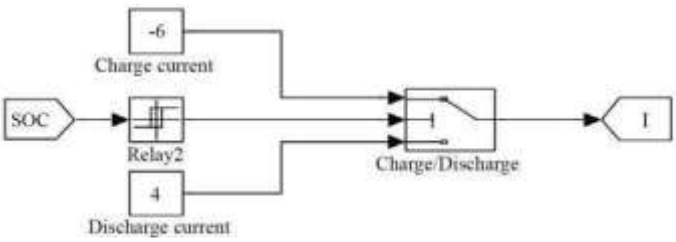
Fig.2. SIMULINK model of exponential block.

Current block:

The charging and discharging of the battery are altered depending upon the state of charge of the battery. When the state of charge reaches a certain maximum level, it begins to discharge up to the minimum value is shown. The value of state of charge



can be fixed depending upon the battery specifications and the manufacturer

Fig.3 SIMULINK model of current block.

State of charge block:

The charge of the battery, Q is calculated as

$$Q = \int i dt$$

The above equation gives the result in Ampere-seconds. To get the standard value inAmpere-hour's, the result is divided by

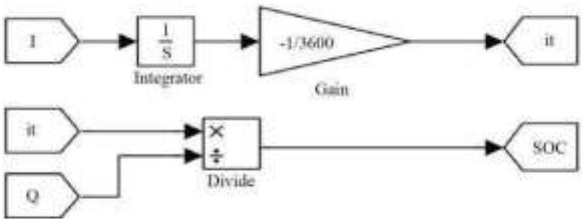


Fig.4 SIMULINK model of state of charge block

3600 and compared with the nominal battery capacity to get the present state of charge is shown.

State of polarization block:

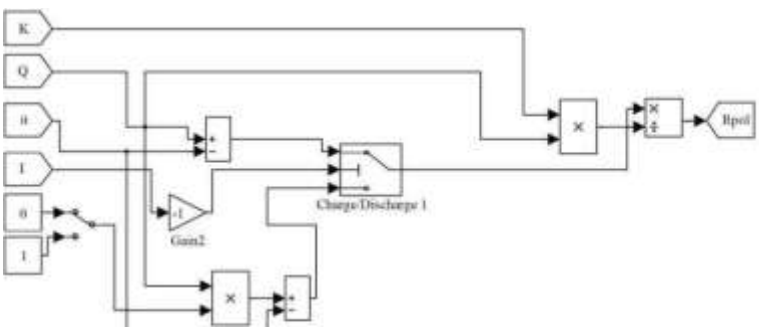


Fig.5 .SIMULINK model of polarization resistor block.

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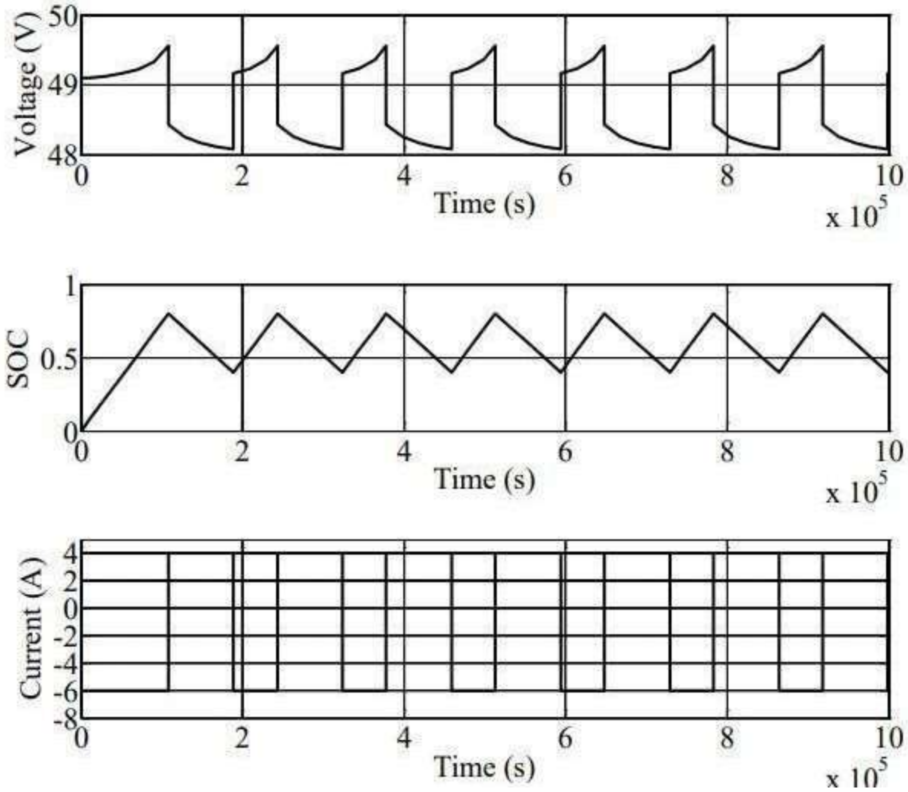

Fig.6. Simulation results of battery characteristics.

IV. Simulation Results

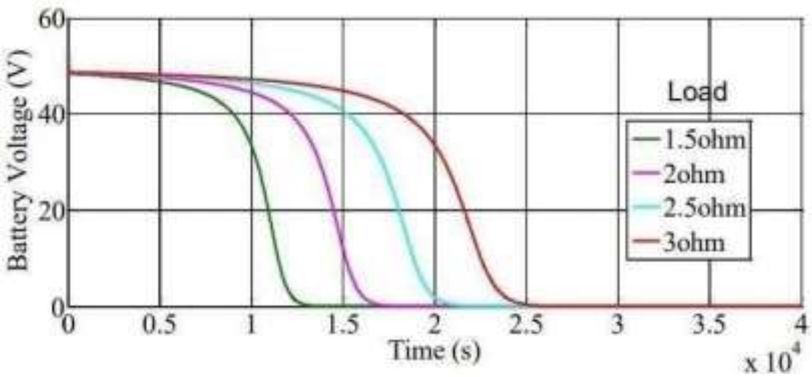

Fig.7. Simulation results for battery voltage for various R load.

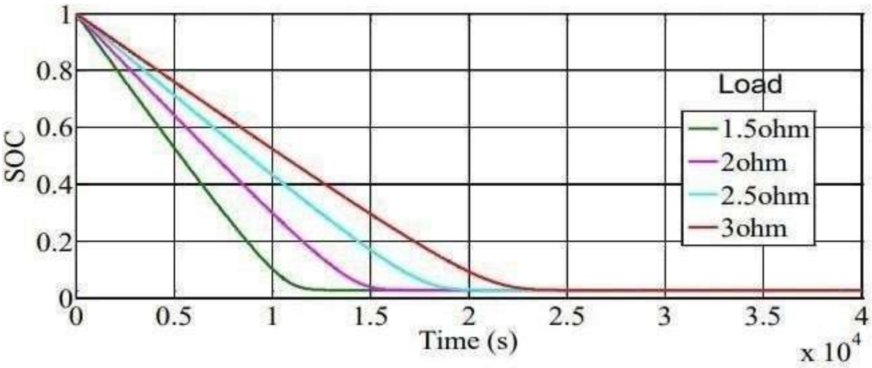

Fig.8. Simulation results of SOC for various R load

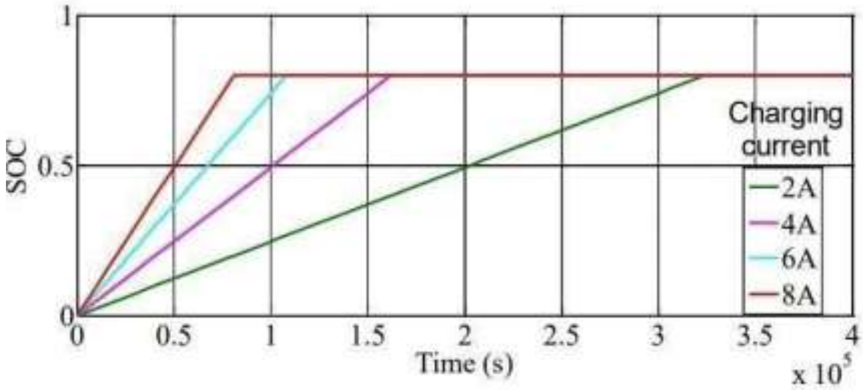

Fig.9. Simulation results of SOC for various charging current.

V.

VI. Experimental setup for PV interface boost converter:

Fig.10. Experimental setup for PV interface boost converter

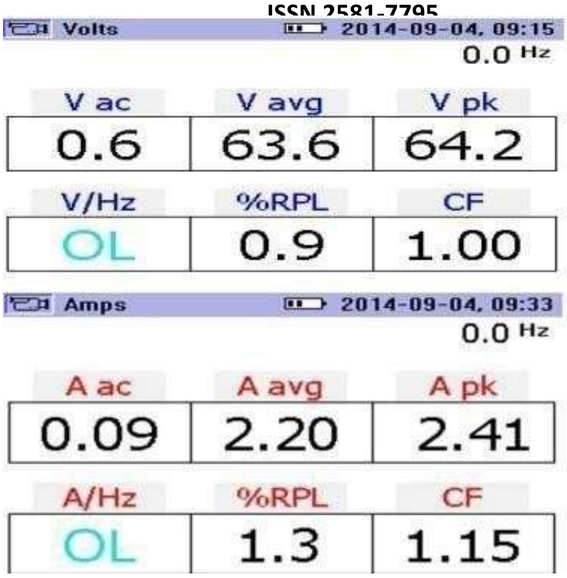

Fig.11. Output voltage and input current ripple of boost converter for 50% duty cycle

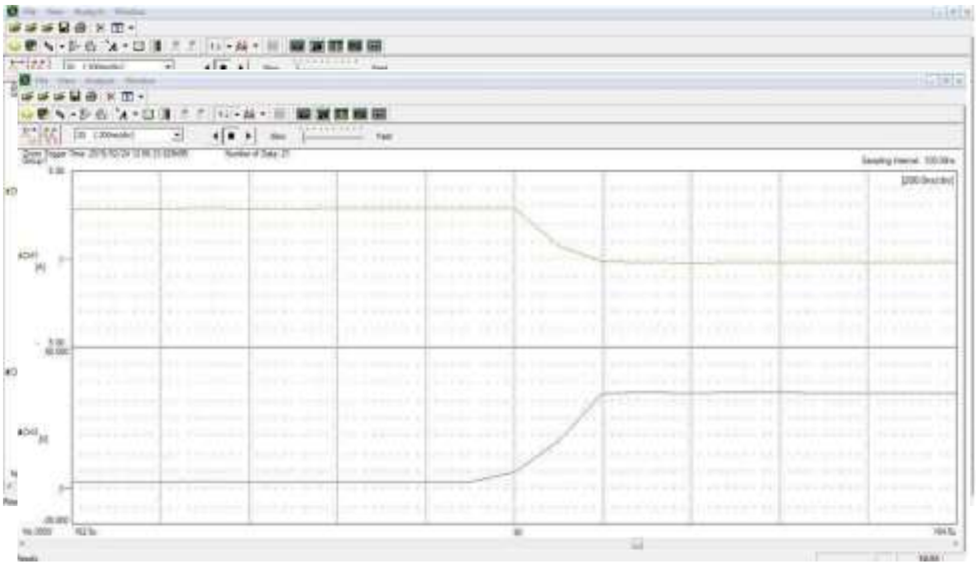

Fig.12. Experimental results for charging characteristics.

Fig.13.Experimental results for discharging characteristics.

Fig.14 Solar powered electric vehicle

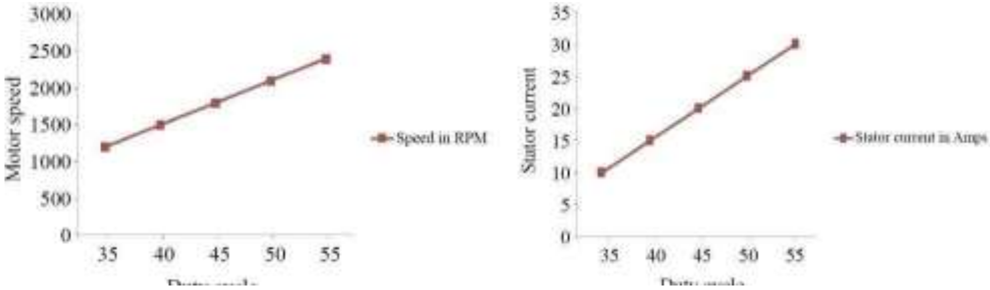

Fig.15. Experimental values of motor speed and stator current vs. battery voltage

VII. CONCLUSION

The importance of utilization of solar power in electric vehicle application is discussed in this paper. The proposed electric vehicle will be fuel efficient, reduce the pollution and provide noiseless operation. The drive range of the proposed electric vehicle powered by solar is improved compared with the conventional one. Selection of BLDC drive for the vehicle provides high efficiency, high operating life, torque/speed characteristics, high output power to size ratio and noiseless operation. The design of DC-DC boost converter is investigated, and the input and output voltage ripple are reduced which is verified experimentally. Therefore, solar powered electric vehicle will reduce the pollution and improve the economy of the country.

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