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Solar Vehicle equipped with super boost converter designed for HVEV

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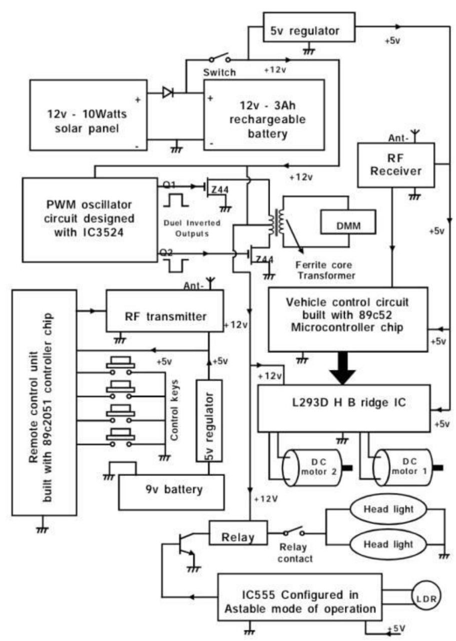
Abstract-As demand for electric vehicles increases worldwide, users expect better performance, longer range fast charging. There is numerous research projects focussed on solving these problems, but the most promising one is increasing battery voltage. Today's EV batteries are 400-volt systems. Higher battery voltage means more energy and higher charging power with increased efficiency. When we charge the battery with high voltage according to the battery rating, means fast charging and less energy consumption. If lower voltage battery is used, higher current rating chargers are essential that lead to more heat and energy loss. If the battery voltage doubled using higher voltage charger with same current, the battery will be charged in less time.

Index Terms—12V – 10Watts solar panel, 12v – 3Ah rechargeable battery, RF transmitter, RF receiver, 89c2051 micro controller chips, L293D H Bridge IC, DC motors, construction of moving mechanism, DC – DC converter oscillator circuit designed with PWM IC3524, power drive stage designed with Z44 power Mos fets, Ferrite core transformer, DMM, etc.

I. INTRODUCTION

A significant factor driving the development of power conversion technology is the need to increase performance while reducing size and improving efficiency. In addition, there is a desire to increase the level of integration of DC-DC converters in order to take advantage of the cost and other benefits of fabrication techniques. The subject of DC-DC converters is gaining popularity because of wide variety of applications; most of the major departments like Railways, Navy, Airfield, etc. are the main customers for quality converters. In this regard, here a high voltage boost converter is designed, which is aimed to charge the high voltage battery of car that is having 110V DC battery.

II. BLOCK DIAGRAM



The block diagram of a solar vehicle equipped with a Super Boost converter designed for High Voltage Electric Vehicles (HVEV) features several crucial components. Solar panels harness sunlight and convert it into electrical energy. This energy is optimized by Maximum Power Point Tracking (MPPT) controllers to ensure maximum efficiency. The Super Boost converter steps up the voltage output from the solar panels to the levels required for HVEV systems. Energy is stored in a battery bank to provide power during periods of low sunlight. An electric motor drives the vehicle using energy from the battery bank. A power distribution system manages electricity flow to various vehicle components, while a controller oversees system operation for optimal performance.

III. COMPONENTS

A. Solar Power Source

The main function of the solar cell is to convert the Sunlight in to electricity directly. The solar cell is the elementary building block of the photovoltaic technology. Solar cells of semiconductor materials, most of the panels more than 90% are made of silicon. A number of solar cells electrically connected to each other and mounted in a single support structure or frame is called a photovoltaic module. Modules are designed to supply electricity at a certain voltage; the most common module is 12V system. The current produced is directly dependant on the intensity of light reaching the module.

B. LDR Sensor

The LDR sensor stands for light dependent resistor it is also called as photo resistor because the resistance of the sensor changes based on the amount of light that the sensor is receiving. It is made up of semiconductor devices like calcium sulphide or cadmium selenide and it is a passive component .LDR sensor works by converting the amount of light that fall on the sensor in to the value of the resistance. The amount of light fall on the LDR sensor is inversely proportional to the value of the resistance of the LDR sensor I.e the resistance of the decreases with the increase of light intensity on the LDR sensor.

C. Buck-Boost Converter

A buck-boost converter is a type of DC-DC converter that can step up (boost) or step down (buck) a voltage, depending on the input and output voltage levels. It's commonly used in power supply circuits to provide a stable output voltage regardless of fluctuations in the input voltage. Buck-boost converters are particularly useful in battery-powered devices where the input voltage can vary as the battery discharges. They're also used in renewable energy systems, automotive electronics, and many other applications where efficient voltage regulation is required.

D. Micro Controller

The 89C51 is a popular microcontroller from the 8051 family, developed by Intel. It's widely used in embedded systems and has been around for quite some time, making it a classic choice for various applications. The 89C51 features a CPU core, RAM, ROM/EPROM, I/O ports, timers/counters, and serial communication ports, making it suitable for a wide range of tasks, from simple control applications to more complex projects. The 89C51 is indeed a bit dated by today's standards, with limited memory and processing power compared to modern microcontrollers. However, its simplicity and availability still make it a viable option for certain applications, especially in educational settings or projects where cost and familiarity are priorities.

E. L293D “H” Bridge IC

The L293D is a popular integrated circuit used as an H-bridge to control the direction and speed of DC motors. It's commonly used in robotics and other projects where motor control is necessary. The H-bridge configuration allows motors to be driven in both directions (forward and reverse) with speed control. It's a versatile and widely used component in electronics projects.The L293D is quite a robust and versatile IC, capable of handling motor currents up to 600mA per channel and peak currents up to 1.2A per channel. Its dual H-bridge design allows it to control two DC motors independently or a single stepper motor. This makes it suitable for a wide range of applications, from small hobby projects to larger robotic platforms.

F. DC Motor

DC motors are widely used, inexpensive, small and poweful for their size. They are most easy to control. One DC motor requires only two signals for its operation. DC motors take direct current voltages as input and convert it into rotation movement. DC motors usually have two wires and can be powered directly from battery or DC power supply. DC motor can also be powered through driver’s circuit that can regulate the speed and direction of the motor. For robot application, DC motor are typically used because of low cost, variable speed, required high starting torque than running torque, and frequent start/stop cycles or closed-loop positioning required. The usual voltage of DC motors used in robotics is 6V and 12V motor. The gear shaft contains inside the power window motor will definitely increase the torque of the motor

G. Battery

A device that converts direct current to alternating current is called a DC-AC inverter. In general, a circuit that converts a specified frequency and voltage by combiningan AC-DC converter and a DC-AC inverter, is called an inverter circuit (inverter). The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.

H. Transmitter Modules

An RF transmitter module is a small Printed Circuit Board Assembly PCB capable of transmitting a radio wave and modulating that wave to carry data. Transmitter modules are usually implemented along a micro controller-which will provide data to the module that can be transmitted. RF transmitters are usually subject to regulatory requirements-which dictate the maximum allowable Transmitter power output harmonics, and band edge requirements.

I. Receiver Modules

An RF receiver module receives the modulated RF signal, and demodulates it. The RF receiver used here can be called as regenerative receiver. Super-regenerative modules are usually low cost and low power designs using a series of amplifiers to extract modulated data from a carrier wave. Super-regenerative modules are generally imprecise as their frequency of operation varies considerably with temperature and power supply voltage.

J. PMW Oscillator

PWM oscillator circuit is constructed with IC 3524, this chip consists of built in oscillator, comparators, error amplifiers and output control circuitry. In most cases as the power system is powered through battery, supply source may not be constant, there by a stable logic supply is essential to power the control circuits, hence this IC generates a stable supply source of 5V through its internal regulator. This voltage remains constant though the input supply from the battery varies from 8V to 24V. As this system is designed to operate through 12V battery source, entire system including main output transformer is designed to operate at this voltage.

K. MOSFET

In a solar vehicle with a Super Boost converter for High Voltage Electric Vehicles (HVEV), MOSFETs are crucial components in the power electronics system. They efficiently regulate voltage and current from solar panels, maximizing energy transfer to the vehicle's battery. This ensures optimal performance and range while minimizing power losses and heat generation. In a nutshell, MOSFETs are key players in the power electronics setup of a solar vehicle with a Super Boost converter for HVEVs. They efficiently manage the flow of electricity from solar panels to the vehicle's battery, ensuring maximum energy transfer for better performance and range. Their fast switching speeds and high efficiency help minimize power losses and heat buildup, contributing to the overall effectiveness of the vehicle's power system.

L. Relay

Relays are electromechanical switches used to control electrical circuits. They consist of a coil and contacts that open or close when the coil is energized. Commonly used in automotive, industrial, and home applications. They switch high currents or control circuits with different voltage levels. Essential for tasks like switching power sources or controlling charging in solar and electric vehicles. Provide reliable control and isolation in electrical systems. Can be used for safety features such as disconnecting batteries in emergencies. Offer versatility in circuit design and implementation. Serve as interface elements between low-power control circuits and high-power loads. Available in various types and configurations to suit different applications.

M. 3 Terminal 1A Positive Voltage Regulator

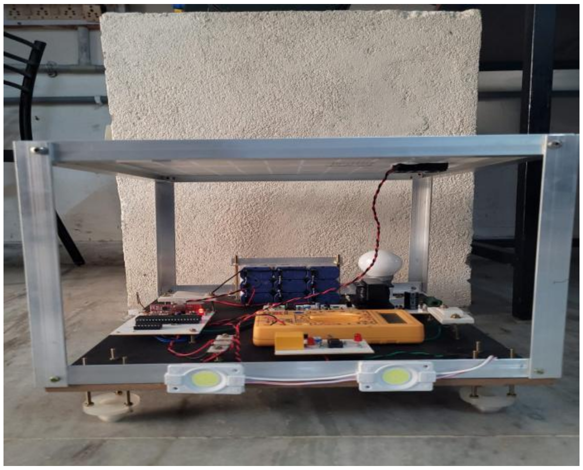
A 3-terminal 1A positive voltage regulator is a type of integrated circuit commonly used in electronic circuits to regulate and stabilize the output voltage. It typically consists of three pins: input voltage (Vin), ground (GND), and regulated output voltage (Vout). The "1A" specification indicates that it can supply a maximum output current of 1 ampere. These regulators are widely used in applications where a stable and constant voltage is required, such as powering micro controllers, sensors, and other integrated circuits in electronic devices. They come in various packages, including TO-220, TO-92, and SOT-223, making them versatile for different circuit layouts and designs.

IV. WORKING

In a solar vehicle equipped with a Super Boost converter designed for High Voltage Electric Vehicles (HVEV), sunlight is captured by solar panels mounted on the vehicle's surface. These panels convert solar energy into electrical energy in the form of direct current (DC). The Super Boost converter, a specialized DC-DC converter, steps up this low-voltage DC input to a higher voltage suitable for charging the vehicle's battery system. This converter efficiently boosts the voltage while maintaining high levels of efficiency. The boosted voltage output is then used to charge the vehicle's high-voltage battery pack, ensuring optimized energy transfer from the solar panels to the battery. This charged battery subsequently provides power for the vehicle's propulsion and other electrical systems, enabling sustainable and eco-friendly transportation.

V. RESULTS AND DISCUSSION

In a solar vehicle equipped with a Super Boost converter designed for High Voltage Electric Vehicles (HVEV), the system efficiently harnesses solar energy through onboard panels. The captured sunlight is converted into direct current (DC) electricity. This DC output is then fed into the Super Boost converter, which elevates the voltage to a level suitable for charging the vehicle's high-voltage battery pack. This conversion process ensures optimal energy transfer efficiency. Subsequently, the charged battery serves as the primary power source for the vehicle's propulsion and other electrical systems, enabling sustainable transportation with minimal reliance on external power sources.



VI. LIMITATIONS

Solar vehicles equipped with Super Boost converters for HVEVs offer promising solutions for sustainable transportation, yet they face notable limitations. While these vehicles harness solar energy efficiently through onboard panels, their range is inherently limited due to factors such as panel surface area and weather conditions. Dependence on sunlight poses challenges, especially in low-light or nighttime scenarios. Additionally, the efficiency of solar panels fluctuates based on environmental variables, impacting overall energy output. Initial costs and complexity associated with integrating solar technology into vehicle design can be significant, requiring specialized expertise and resources. Moreover, balancing weight and aerodynamics while accommodating solar panels may affect performance and handling. Despite continuous solar charging, charging rates may not always meet demand, especially for high-power propulsion or depleted battery packs. Despite these constraints, ongoing technological advancements strive to enhance the feasibility and effectiveness of solar-powered vehicles for specific applications and environments.
panels mounted on street lights, ground-mounted structures. Thesepanels are made up of semiconductor materials like silicon, which generate electricity when exposed to sunlight by exciting electrons in the material. The generated electricity, initially in direct current (DC) form.

VII. APPLICATIONS

Solar vehicles equipped with Super Boost converters designed for HVEVs have several promising applications:

1. Urban Transportation: These vehicles can be used for short-distance urban commuting, reducing reliance on fossil fuels and lowering emissions in densely populated areas.
2. Fleet Operations: Solar-powered vehicles are suitable for fleet operations in industries such as delivery services, where vehicles operate within a limited range and return to base for charging.
3. Public Transport: Solar buses and shuttles can serve as sustainable options for public transportation in cities, providing clean and efficient mobility for commuters.
4. Off-grid Mobility: In remote areas or regions with limited access to conventional power sources, solar vehicles offer off-grid mobility solutions for transportation and logistics.
5. Specialized Vehicles: Solar-powered vehicles can be adapted for specific applications such as agricultural machinery, airport ground support vehicles, or recreational vehicles for outdoor enthusiasts.
6. Research and Development: Solar vehicles serve as platforms for research and development in renewable energy technologies, advancing the understanding and implementation of solar power in transportation.
7. Education and Outreach: Solar vehicles provide educational opportunities for students and the public to learn about solar energy, electric vehicle technology, and environmental sustainability.

These applications demonstrate the versatility and potential impact of solar vehicles equipped with Super Boost converters, contributing to a cleaner and more sustainable future for transportation.

CONCLUSION

In conclusion, solar vehicles equipped with Super Boost converters designed for HVEVs represent a promising advancement in sustainable transportation. While they face limitations such as range constraints and dependence on sunlight, these vehicles offer numerous applications across urban commuting, fleet operations, public transport, off-grid mobility, specialized industries, research, and education. Despite challenges, ongoing technological advancements aim to enhance the feasibility and effectiveness of solar-powered vehicles, contributing to reduced carbon emissions and a cleaner environment. With continued innovation and adoption, solar vehicles have the potential to play a significant role in shaping the future of transportation towards greater sustainability and energy efficiency.

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