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Solar PV Tied Electric Vehicle Charging System Using Bidirectional DC-DC Converter Along with BLDC Motor

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Abstract
Renewable energy-based battery charging systems for EV's has been surged in automotive research. Solar EV's with PV are going to examine in this research. We are going to PV's in order to reduce emissions, load levelling, ability to recover energy while braking. To achieve the above things, we have to connect Bi-Directional dc-dc converter along with BLDC motor to PV's battery. The PV vehicle should be able to operate in two distinct modes: Charging ,Discharging In order to meet the energy of PV vehicle battery, we are using Bi-Directional dc- dc converter and to increase engine efficiency BLDC motor is placed.
Keywords: Solar PV Tied Electric Vehicle , BLDC Motor , Bidirectional DC – DC Convertor .

Introduction

Due to energy conservation along with global warming have caused shift towards renewable energy as it has one of its strongest foundations by governments, businesses and people. Now-a-days, EV emerged as an important thing for both public and scholars. Renewable energy include wind, solar, tidal and thermal. A power electronic DC-DC bidirectional converter regulates flow of produced energy and also used for wide range of applications. A broad range of frequencies are operated by switches like MOSFETs and IGBTs. Inductors and capacitors size and cost by depends on operation frequency. This research explains how an electric vehicle is powered entirely by solar energy. Solar PV array is easy to install compared to other renewable energy sources, and also costs cheap. So, PV array based EV battery charging is preferable for many EV owners. Plug-in hybrid electric vehicles (PHEVs), fuel cell vehicles and Uninterruptible Power Supplies (UPS) use bidirectional DC-DC converters as a necessary part of power conversion. Usage of DC-DC converter is difficult when switching from low-voltage to high- voltage source to charge household appliances. There are two types of bidirectional DC-DC converters: isolated as well as non-isolated. Non-isolated has higher efficiency because of its basic design.There has been several topologies published recently that used soft switching approach to improve efficacy of power transfer. Soft switching with the help of hysteresis current controller requires introducing of bidirectional converters with connected inductors .We are also using both MPPT and ANN algorithms to increase the input power and working efficiency of the vehicle Along with BLDC to increase the vehicle's Motor efficiency. Zero-Voltage-Switched (ZVS) and Zero-Current-Switched (ZCS) techniques were developed for bidirectional converters to reduce switching losses as well as in increasing reliability . High power applications benefit from use of multi-phase bidirectional converter. Due to low switching frequency, many converters are linked in parallel or series to reach large voltage or current ratings.

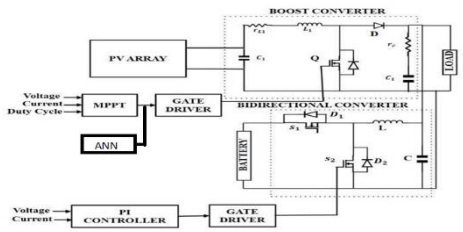

Fig 1: Schematic diagram of solar PV fed EV.

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Converters	Proposed Converter	Converter [19]	Converter [20]	Converter [21]	Converter [22]	Converter [23]
Inductor Count	1	1	1	0	0	2
Capacitor Count	1	3	3	4	3	4
Coupled-Inductor	0	0	0	0	2	0
Common Ground	Yes	Yes	Yes	Yes	Yes	No

TABLE I. COMPARISON WITH VARIOUS PARAMETERS OF CONVERTERS

When converter is operating in continuous conduction mode, state space representation is represented in the above figure. Main purpose of this study is to discuss about functioning of converter in both buck (charging mode) as well as boost (discharging mode) modes. Fig.1 comprises of a PV module that is coupled to boost converter for boosting output voltage and DC-link is created between boost converter and bidirectional converter for transferring of voltage. This setup is made using MATLAB/Simulink to test and validate the working of the developed model in a virtual mode.

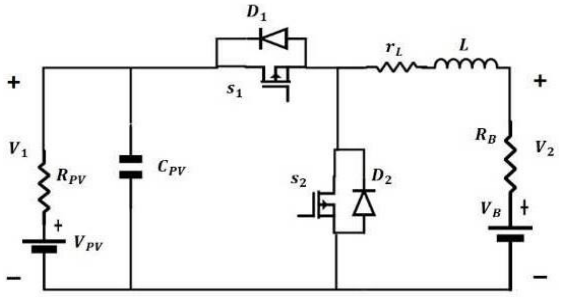

Fig. 2. Bidirectional DC-DC converter

1. CIRCUIT DESCRIPTION:

Fig. 2 explains continuous conduction of DC-DC converter. Anti-parallel diode D1 serves in boost mode modulating switch S2 to operate boost converter. Anti-parallel diode D2 serves in buck mode when power flow is reversed transforming topology in buck converter by switch S1. The inductor current in two modes is conducting in opposing directions. Fig. 3 depicts gate drivers for switches S1 and S2

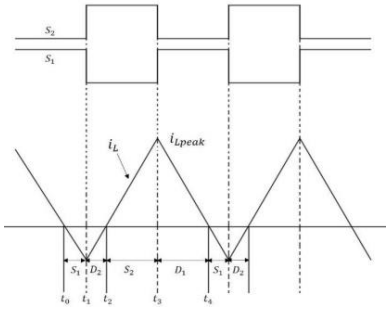

Fig. 3. Gate drivers for switches and diodes.

A. Comparison with Previous Converters

Table I shows the comparison result of proposed converter with available bidirectional DC-DC

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converters.The parameters like switch count, inductor count, capacitor count, coupled inductor and common ground are the basic components that has dynamic role into designing converter circuit. Less number of components less will be the complexity of circuit. By table it could be observed that suggested converter requires very less number of switch count as compared with the converter requires equal number of switch count. The converter requires highest number of switch count. Another parameter is inductor count.

2. CONTROL TECHNIQUE:

In this study, two types of control were used. In solar PV,most often utilized algorithms is Maximum Power Point Tracking (MPPT) method. Even though certain modules maybe affected by shadowing, MPPT algorithm plays an important role in extracting optimum power from solar PV panel throughout all times. Although certain modules have been obscured, remainder of battery pack will be energized to guarantee that EV functions properly. MPPT adjusts the value of solar PV power in line with the load or battery charger need. Another control method is for converter circuit.Bidirectional DC-DC converters may operate in both buck - boost converter modes, hence control circuit has beenbuilt as illustrated in Fig. 4.

PI controller and PWM generatorcomprise responses closed loop control circuit block diagram, which detects and controls error signal in relation toreference signal. Inner current loop as well as outer voltageloop are part of control circuit. In the outer voltage loop, we calculate V_b (battery's voltage) as well as contrast it to V_{ref}. PI controller receives difference among two values. Using PI controller, steady state error among battery current being measured as well as reference battery current being monitored may be reduced or eliminated.

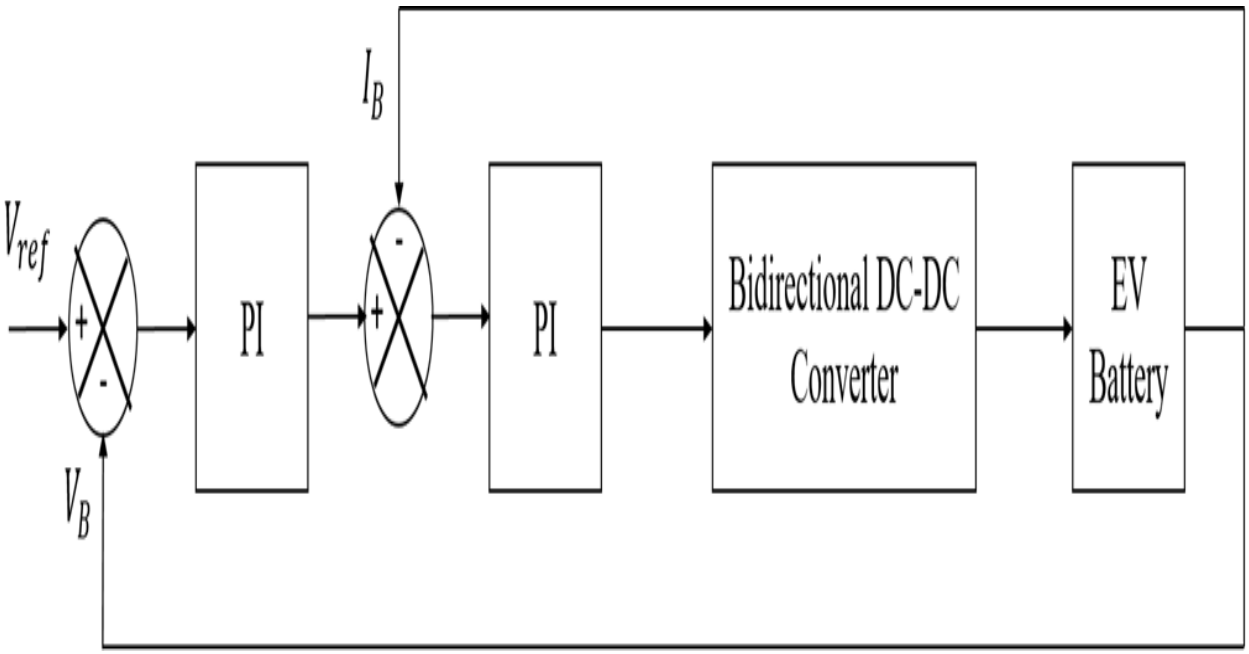

Fig.4.Closed loop control circuit for bidirectional DC-DC Converter

3.SIMULATION RESULTS:

In this section, the performance of the proposed modelof Bidirectional DC-DC converter is analyzed utilizing theMATLAB Simulink platform. Figures below showing various parameters including the PV module voltage, current and corresponding power, DC link voltage, EV battery voltage, battery's State of Charge (SoC) at different level of irradiations on the PV side. It's not regarded inductor parasitic resistance or MOSFET turn-on resistance. To determine if suggested topology works, following converter parameter values are taken into account throughout testing process

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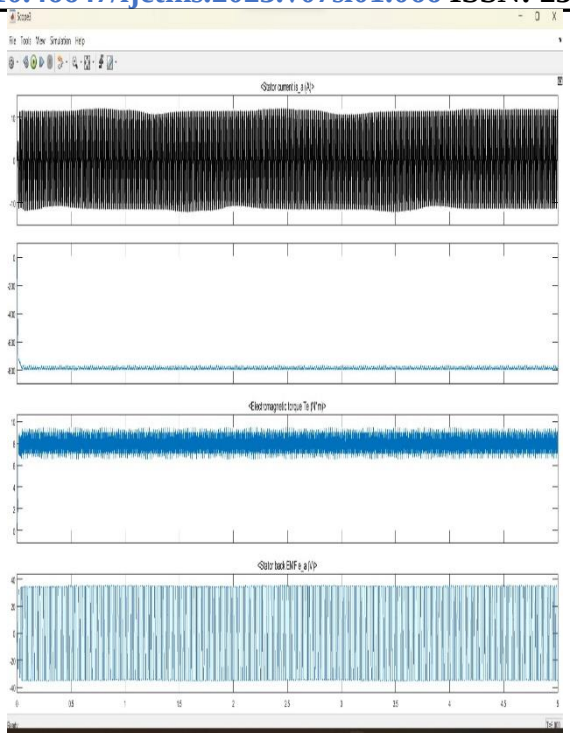

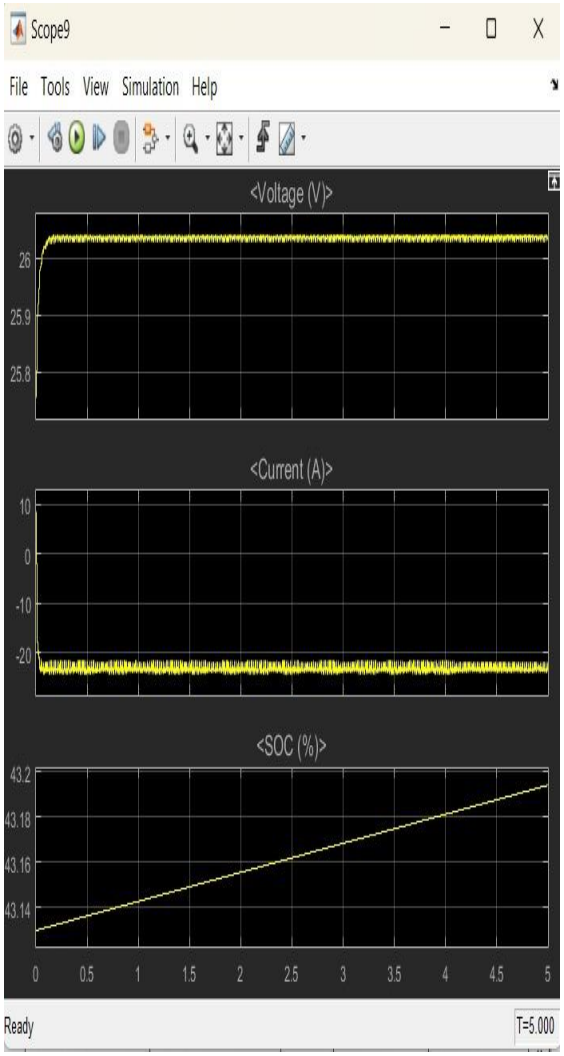

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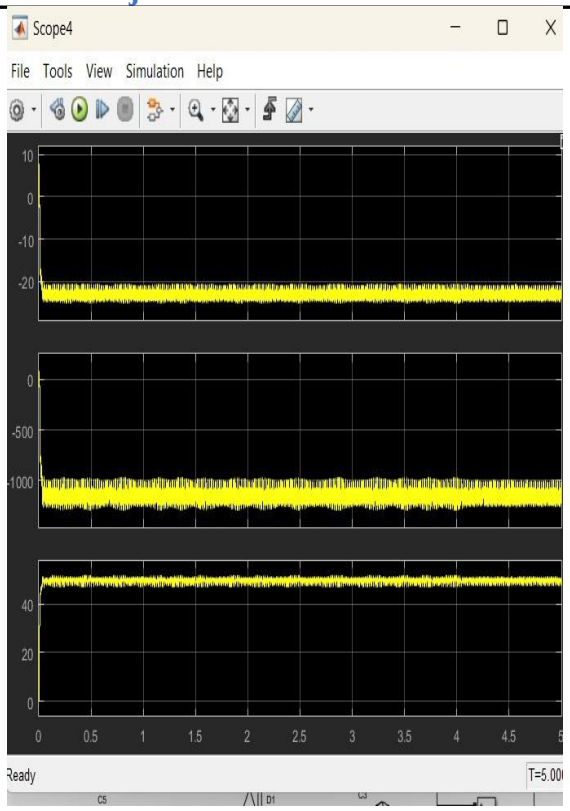

3. CONCLUSION:

Hybrid Solar cars will become popular in future due to the usage of renewable (solar) energy for charging.This paper proposes the integrated circuit of EV with a battery connected to solar for making the charging cost cheaper along with a Brush Less DC (BLDC) motor to increase the efficiency. The vehicle will not be able to face any interruptions at the time of operation.Maximum amount of power is derived by MPPT (perturb and observe) algorithm.The whole circuit of EV can be able to operate in two ways i.e. charging and discharging due to which the battery also gets charged when brakes are applied by using bidirectional DC-DC converter.This will be a very useful invention to the mankind to reduce global warming and also to reduce the usage of fossil fuels.

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