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Modeling and Simulation of Multi Input Bidirectional DC-DC Converter for Hybrid Electric Vehicle Application

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Abstract

Numerical simulation is essential to study the complex heterogeneous absorber/buffer interface in CZTS thin films. In this work, the authors provide a comprehensive report on the numerical simulation of CZTS thin film solar cells with alternate nontoxic buffers in comparison to the toxic CdS buffer modeled through more asserted solar cell capacitance simulator (SCAPS). An analysis is made on the cause for the change in cell performance using different buffers which paves a way to experimentally fabricate completely nontoxic and cost effective high efficiency solar cell.

Keywords: Buffer layer, CZTS solar cells, SCAPS, Simulation, Thin film solar cells.
Reviewed by* **ICETSET'16 *organizing committee*

I. INTRODUCION

Due to increasing diligence on energy crisis and environmental protection, the Hybrid Electric Vehicles (HEV_S) are received lot of attention in recent years. Petroleum is used world-wide at a higher rate due to the wider requirement of transport. It plays a major role in modelling the vehicles with minimum and without consumption of petroleum. And therefore the alternate propulsion technologies have been increasingly engaged by the automobile industries and this hasled to the increased exploitation rate of HEV. One of the main advantages for the HEV drive is to improve the efficiency of the motor drive.The key components of the traction systems in hybrid electric vehicles are the multi input bidirectional DC-DC converters. Multi input bidirectional converters have combine the different sources, such as batteries, ultracapacitor, photovoltaic cells, fuel cells, and other renewable energy sources, with different voltage characteristics.

The designs characteristic of the induction motor are used in HEV (1-6), the overview of HEV are discussed. By applying suitable starting frequency and voltage for the inverter fed induction motor low starting current and high starting torque can be obtained (7). Using high frequency transformer to connect different sources, where each source is connected by full-bridge cells using 12 switches for three sources (8). A current fed half-bridge topologyhas been proposed in [9] to reduce theripple current in the battery using phase shift modulation. The stability analyses of multiple input isolated buck–boost and forward converters along have been presentedin [10]. In these types of converters, power sharing between various sources is difficult tocontrol. In [11], energy flow between number of different sources and the dc link are discussed. In this topology, it is not possible to transfer energy directly between dc sources, and also, a higher number of devices are being used.In this paper a new type of multi input bidirectional DC-DC converter will be proposed in order to integrate various energy sources. The proposed circuit will be analyzed,modelled, designed, controlled, and simulated. Due to the advantages like low cost and compact structure multi input bidirectional DC-DC converter are reported to be designed for HEV application.

II. DC-DC CUK CONVERTER

There are many types of DC-DC converter such as Buck, Boost,Buck-boost, etc. For the proposed circuit Cuk converter is used as a MPPT source. Cuk converter is actually the combination of a boost and a buck converter as shown in Figure 1. It consists of dc input voltage source V_g, input inductor L_1, controllable switch S, energy transfer capacitor C_1, diode D_1, filter capacitor C_2,, inductor L_2 and load resistance R. The advantage of cuk converter is a continuous current at both the input and the output of the converter. When the switch is on, the diode is off and the capacitor C_1 is discharged by the inductor L_2 current. When the switch is in off state, the diode conducts current of the inductors L_1 and L_2, whereas capacitor C_1 is charged by the inductor L_1 current.

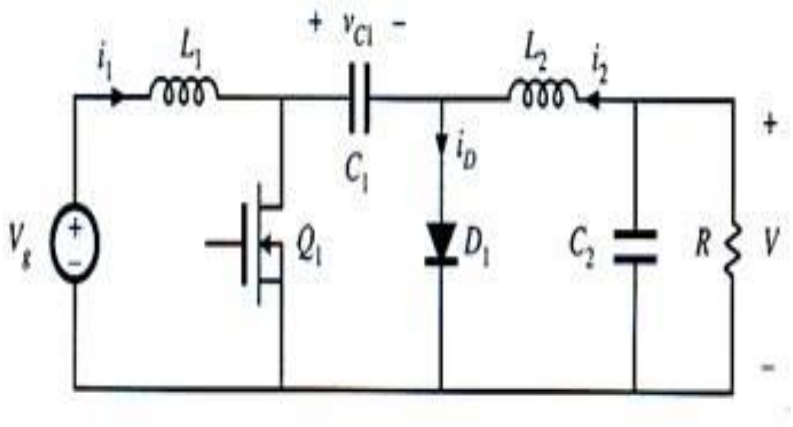

Figure 1. Circuit diagram of DC-DC cuk converter

III. MULTI INPUT BIDIRECTIONAL CONVERTER TOPOLOGY

Multi input bidirectional DC-DC converter is used to interconnect the multiple sources with different voltage levels. It reduces the system size, cost and power losses
due to the less number of components used in the system. The purpose of multi input bidirectional converter is increase or decrease the voltage level of the system with bidirectional power flow capability. Multi input bidirectional DC-DC converter applications areais energystorage systems for hybrid vehicles, renewableenergystorage systems, uninterruptablepowersuppliesand fuelcellstorage systems. The multi input bidirectional converter topology is shown in Figure 2.

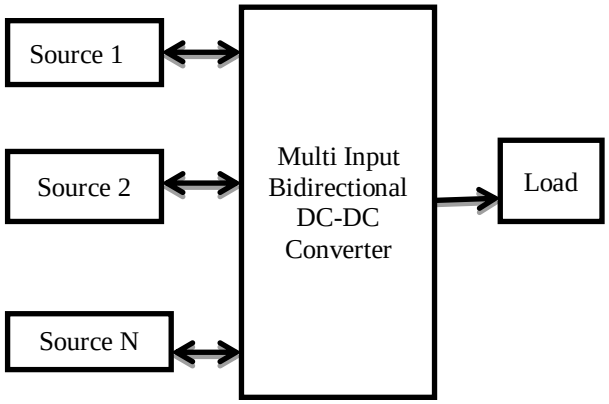

Figure 2. Multi input bidirectional converter system

IV. THE PROPOSED SYSTEM

Solar radiation becomes the most important renewable energy source. Solar panel absorbs the solar radiation to the maximum at constant temperature thereby giving its voltage and current. Maximum Power Point Tracking (MPPT) is a technique that absorbs the maximum power from the solar panel. Maximum power point trackers may implement different algorithms and switch between them based on the operating conditions of the array. There are three different MPPT algorithms such as perturb and observe method, incremental conductance method and
current sweep method. The block diagram of proposed system is shown in Figure 3.The PV panel is connected to the DC-DCconverter isused to step up and step down the output voltage of the solar panel. The required dc-link voltage to the inverter is obtained from the DC-DC converter to run the motor. The maximum power point tracking

technique is used for extracting maximum power from the PV panel and transferring that power to the cuk coverter. In MPPT techniques incremental conductance method is used. The output from the cuk converter is given the dc-link of the three phase inverter. The switching pulses for multi input bidirectional DC-DC coverter is generated by using PWM techniques. In order to match the voltage of the battery with the dc link voltage of the inverter along with the ultracapacitor the multi input bidirectional converter is required. The function of this multi input bidirectional converter is to interfacethese various sources with the dc link of the inverter and to modulate the power flowamong the sources to drive the three phase induction motor.The dc link capacitor is supplies the required voltage to the inverter to drive the three phase induction motor.

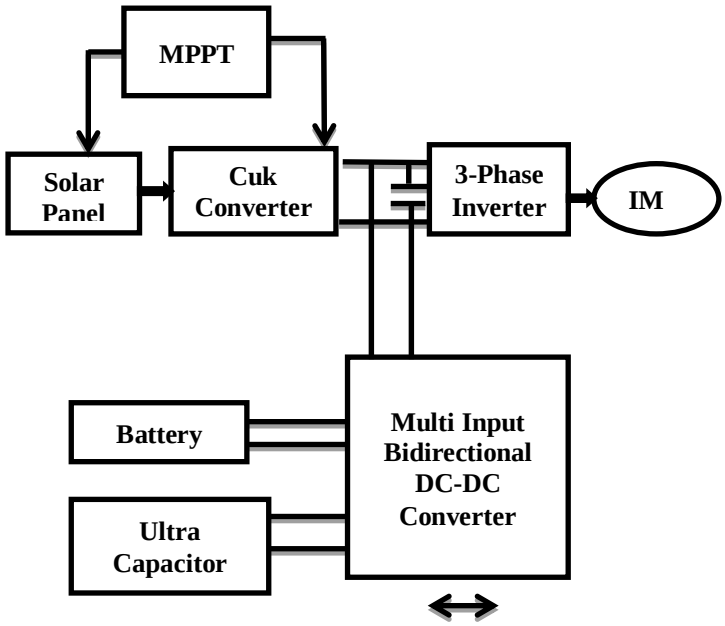

Figure 3. Block diagram of the proposed system

The proposed multi input bidirectional converter can transfers the power between any two sources with different voltage levels. In the proposed multi input bidirectional converter each source is connected with the switching legs through the inductor.The proposed topology consists of three phase inverter and two inductors. The V_{Bt} and V_{UC}represent the sources of battery voltage and ultracapacitor voltage. These sources are interfaced with the dc link of the inverter V_{dc}. The two dc sources battery and ultracapacitor are connected with the two switching legs. Another switching leg is connected with the dc link of the inverter which is fed by the PV cell through a cuk converter. . The design of multi input bidirectional converter is simple then it is easy to implement and control. The proposed circuit topology of multi input bidirectional converter is shown in Figure 4.

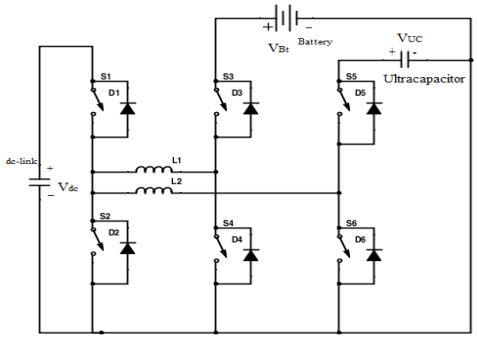

Figure 4. Proposed circuit topology of multi input bidirectional converter

V. MATLAB/SIMULINK MODELS AND SIMULATION RESULTS

A simulation model for multi input bidirectional DC-DC converter fed induction motor is developed using the matlab/simulink software is shown in Figure 5. The final simulation corresponds to the simulink model of the battery, ultra capacitor, multi input bidirectional dc-dc converter and load. The three phase inverter is connected with the cuk converter through the dc- link. The required dc-link voltage to the three phase inverter to the induction motor is fed from the PV panel through the cuk converter.

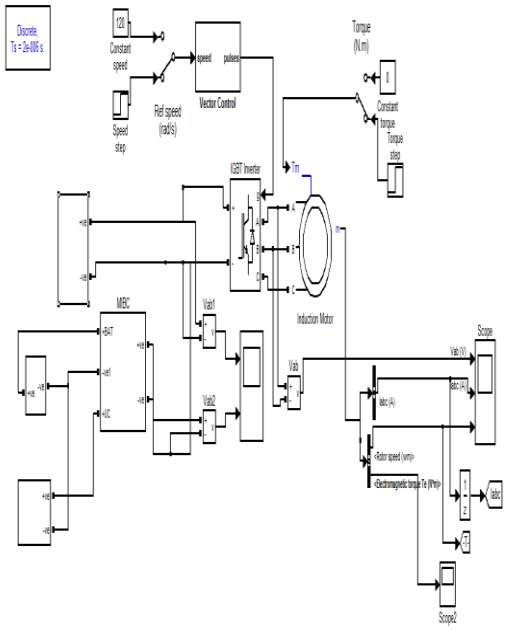

Figure 5. Simulink model of multi input bidirectional converter fed induction motor

The switching pulse for cuk converter is generated with the help of mppt algorithm. The PV panel is connected with the cuk converter to step up the voltage.The simulink model of solar powered cuk converter is shown in Figure 6.

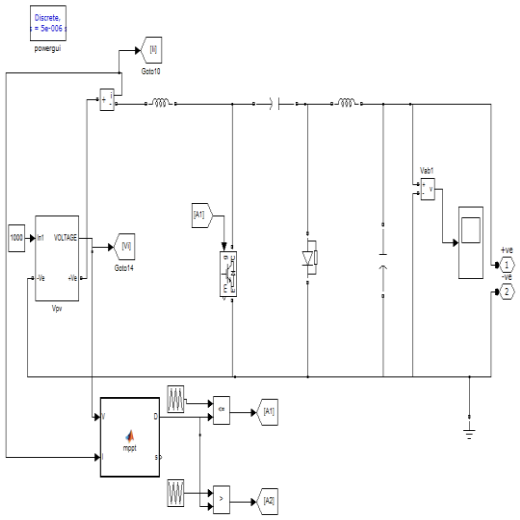

Figure 6. Simulink model of solar powered cuk converter

VI. RESULTS AND DISCUSSIONS

The input source to multi input bidirectional DC-DC converter is battery and ultracapacitor. The output voltage of multi input bidirectional converter is shown in Figure 7. The output voltage obtained from the multi input bidirectional converter is 170 V.

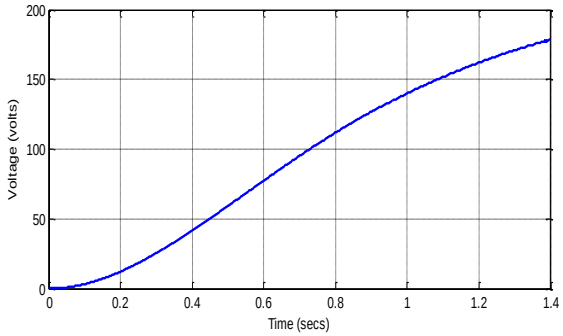

Figure 7.Output voltage of multi input bidirectional converter

Here input source is photo voltaic source. The input voltage of photo voltaic panel is 32 V. The cuk converter can step up voltage of photo voltaic panel. The solar poweredcuk converter output voltage shown in Figure 8. The solar

powered cuk converter output voltage is 150 V.

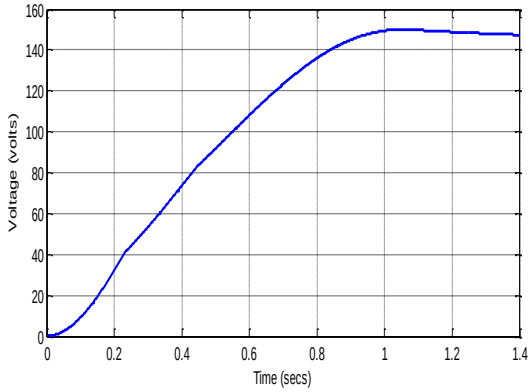

Figure 8. Output voltage of cuk converter

During transient condition, torque and speed varies it will be prevented by using vector control technique.The induction motor torque waveform is shown in Figure 9.

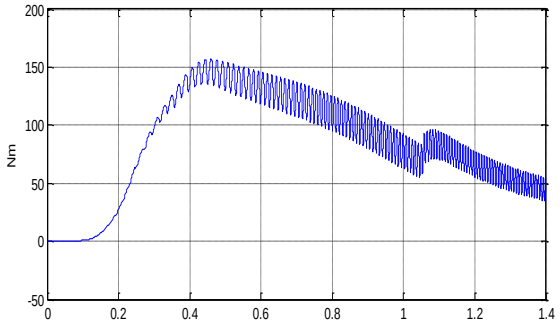

Figure 9.Torque waveform of induction motor

VII. CONCLUSION

The multi input bidirectional DC-DC converter was designed to integrate more than two DC sources with different voltage levels which finds application in HEV.The multi input bidirectional converter can control the power flow between each pair of sources. The required voltage to drive a three phase induction motor is obtained by photo voltaic cells and multi input bidirectional DC-DC converter. MPPT control technique is used to extract the maximum power from solar irradiation. Instead of using individual converter in hybrid system using multi input bidirectional DC-DC converter is reduces the system size and cost. Therefore proposed converter provides the better efficiency but harmonics presents in voltage source. The performance of the system has been verified by simulation using MATLAB/SIMULINK environment.

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