# Performance Analysis of Bidirectional power flow between Electrical vehicle and Grid using Converter topology

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**Abstract:** This paper exhibits a coordinated footing machine and converter topology that has bidirectional force stream capacity between an electric vehicle and the dc or air conditioning supply. The footing's inductances engine windings are utilized for bidirectional converter operation to exchange force taking out the requirement for additional inductors for the charging and vehicle-to-matrix converter operations. These operations are not withstanding the vehicle footing mode operation. The electric force train framework size and weight can be minimized with this methodology. The idea has been investigated with limited component coupled reproduction with element examination programming. Trial results are like wise given electric machines. The interleaving strategy has been utilized with the inductors to share the current and lessen the converter exchanging burdens.

**Keywords:** Bidirectional converter, electric vehicle,integrated converter, machine inductance, vehicle-to-grid(V2G)

## I. INTRODUCTION

Due to rising issues concerning environmental problems, like global climate change and urban pollution, additionally as energy issues, automobile manufacturers are being forced to shift their attention toward clean vehicle technologies. Recently, battery electric vehicles (BEVs) will be an alternate to the innercombustion engine vehicles due to advances in battery technologies, power electronics interfaces (PEIs), and control methods.In general, the BEVs are battery-powered by electrical batteries, whichneed to be recharged with electricity from the grid. moreover, the BEVs will offer a perfect answer to scale back the environmental impact of transports and scale back energy dependence as a result of they need low energy consumption and zero loca lemissions [1]–[4]. In alternative words, BEVs are zero-emission vehicles. However, the BEVs still have some challenges, which need to be solved . These challenges are restricted driving range, long charging time, battery period, power electronics performance,and high initial price.

## II. BACKGROUND WORKS

Different types of topologies have been developed for electric vehicles for battery charging and bidirectional power flow between the battery and the power supply. However, the traction inverter uses the standard six-switch configuration that has elements of the various power converter topologies. The proposed converter topology utilizing the traction inverter along with the switches used for reconfiguration is shown inFig. 1(a) and (b) shows the detailed switch or relay arrangements required for different modes of operations. Several different configurations can be obtained by appropriate positioning of the switches,which results in a novel methodology for bidirectional power transfer between a vehicle battery and dc or ac grid. Including the use of the topology as the traction inverter during vehicle operation this power converter can be operated in five different modes: 1) power flowfrom the battery to the dc grid, 2) power flow from the dc grid to the battery, 3) traction mode, 4) power flow from the battery to single-phase ac grid and 5) power flow from a single-phase ac grid to the battery. There configuration switches can be realized with relays or contactors depending on the ratings of the currents.Those relays and contactors are controlled in acoordinated way to accommodate the different modesof use. The contactors with optimum current capacity should be used to minimize the size of the contactor.The size of the contactor has to be accommodated based on the current rating chosen. To minimize the space and size of the contactors, all the switches can be integrated into a single package. The switches will be controlled for the different modes of operation using State 1 and State 2 conditions given in Table I. Fig. 1(b)shows the details of the configuration in the routingbox with the switches which relates to the operations of the switches according to Table I. The terminal numbers are shown in Fig. 1(b) inside the switches which are changed to different positions for the different configurations. When the converter is to connect to a dc grid, Switch 4 will be in State 1 to isolate from the ac grid. When the converter is to connect to an ac grid, Switch 5 will be in State 1 to isolate from the dc grid. Thus, the traction converter can be connected to either a dc or an ac grid. Fig. 2shows the OFF condition where all the switches are in State 1; in this situation, there will be no power transfer.If there is any fault in one or multiple phases in the motor the converter configuration will be switched to State 1 as shown in Fig. 2, and there will be no power transfer between the grid and the battery. The usual protection schemes for a traction inverter will takeover.

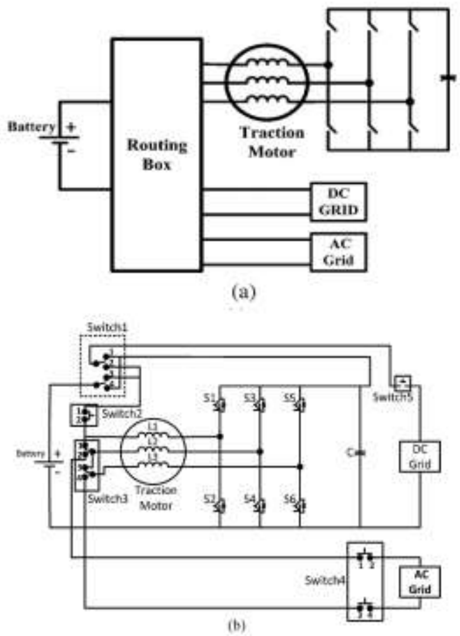


Fig. 1. Converter with switches capable of interfacing with both ac and dc grid (a) combined and (b) details.

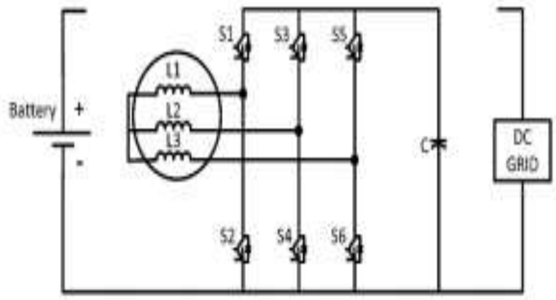


Fig. 2. Circuit with all switches in State 1

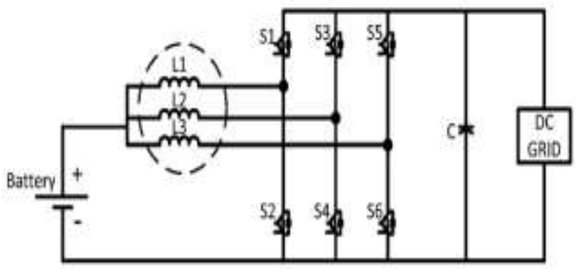


Fig. 3. Circuit with Switch 2 and Switch5 in State 2 forV2G boost or G2V buck operation with vehicle sideinductors interleaved

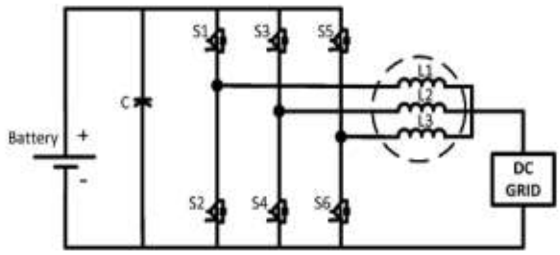


Fig. 4. Circuit with Switch 3 and Switch 4 are in State 1for V2G buck or G2V boost operation with dc grid sideinductors interleaved

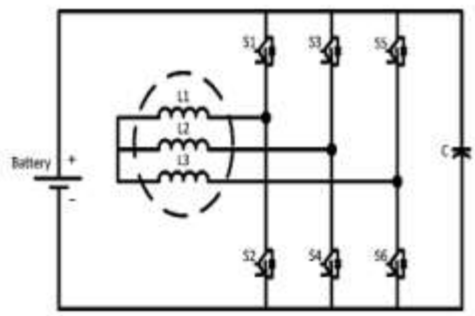


Fig. 5. Circuit with Switch 1 is in State 2 for tractionmode operation.

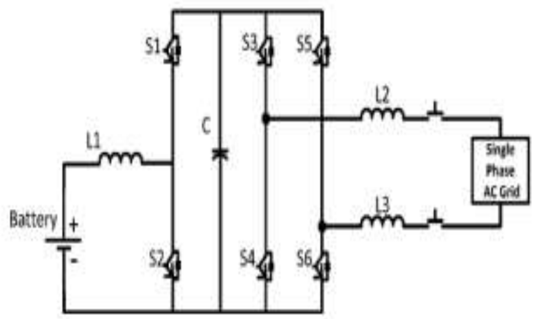


Fig. 6. Circuit configuration for bidirectional interfacewith a single-phase ac grid

## III. SYSTEM CONFIGURATION

An induction machine is also a common type of electric machine type used in traction applications. A 10 HP,three-phase induction machine where the neutral pointis available has been chosen as a traction machine for experimental verification. Dynamic simulation using MATLAB/Simulink has been done with the inductances of the machine windings. The power transfer characteristics and the interleaving technique for distributing the input currents into the three-phase windings can be analyzed with this simulation. 1)Mode 1 and Mode 2 Simulation: Mode 1 is for powerflow from the battery to the dc grid and Mode 2 is fo rpower flow from the dc grid to battery. In the simulation, three inductors with the same values of the winding inductance of the induction machine have been used to build the converter as the topology of Fig. 3 for V2G boost mode of operation. The simulation block diagram is shown in Fig. 7(a). The simulation for V2G buck mode of operation using the configuration of Fig.4 has been also done; the simulation block diagram for this mode is shown in Fig. 7(b). The simulation parameters for boost operation are: input voltage is 200 V, output reference voltage is 260 V, maximum input current limit is 30 A, induction machine phase inductance is 5mH, output capacitor is 3300 µF, load resistance is 20Ω, and PWM switching frequency is 20 kHz. From the simulation result shown in Fig. 8(a), it is observed thatthe output voltage is following the reference voltage of 260 V in the boost mode of Fig. 3. The simulation parameters for buck operation are: input voltage is 400V, output reference voltage is 200 V, maximum input current limit is 30 A, induction machine phase inductance is 5 mH, load resistance is 10 Ω, and PWM switching frequency is 20 kHz. From the simulation result shown in Fig. 8(b), it is observed that the outputvoltage is following the reference voltage of 200 V in the buck mode of Fig. 4. In the case of boost operation,the output power level is 4 kW. The interleaving technique has been applied in the battery side of the system as shown in Fig. 3 and Fig. 7(a).

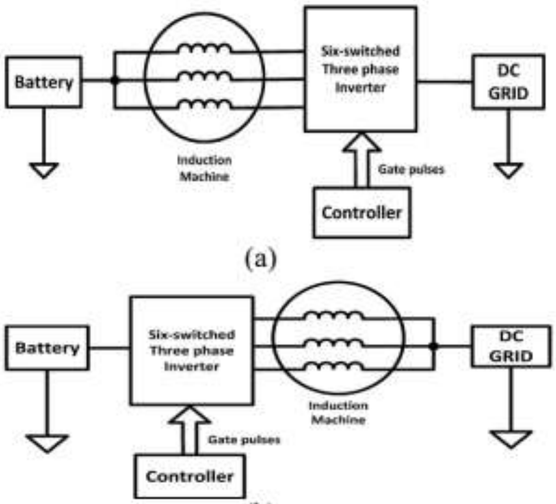


Fig 7 Integrated converter and induction machine operation with dc grid; (a) V2G boost mode ofoperation and (b) V2G buck mode of operation

## IV. SIMULATION RESULTS

*In automotive applications, different kinds and ratings of electric machines are used. The applicability of the concept on different electric machines used in automotive applications is tested with simulation models that would provide the most realistic predictions.*

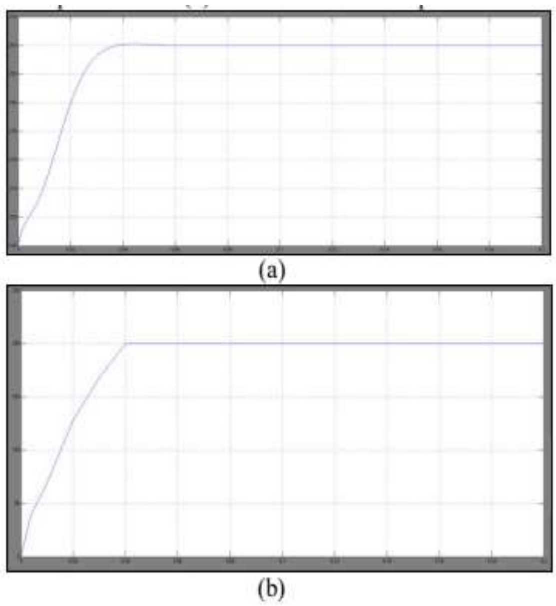


*Fig 8 Output voltage in Mode 1 and Mode 2 of the integrated motor/converter: (a) for boost operation, and(b) for buck operation*

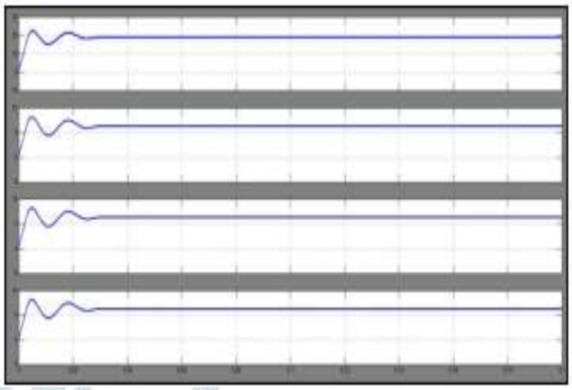

*Fig. 9. Input current in boost mode of operation and shared input currents in the three-phase windings on themachine.*

The results inFig. 9 show that the input current can be equally shared through the windings of the three-phase induction machine.

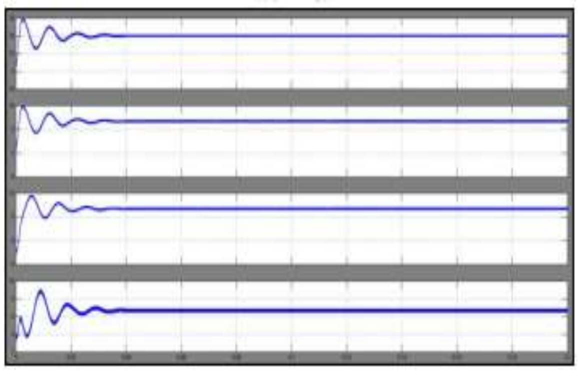

*Fig. 10. Output current in buck mode of operation andshared output currents in the three-phase windings onthe machine.*

*The results in Fig. 10show that the output current can be equally shared through the windings of the three-phase inductionmachine. 2) Mode 4 and Mode 5 Simulation: Mode 4 and Mode 5 allow power flow from the battery to a single phase ac grid and from a single phase ac grid tobattery, respectively. In the simulation, three inductorsof the same values as that of the induction machinehave been used in the topology of Fig. 6.*

## V. CONCLUSION

A coordinated machine-converter topology and re configuration technique have been proposed in this paper, where footing machine windings can be utilized as the converter's inductors to exchange force between a vehicle battery and either a dc or an airconditioner lattice. The converter reconfiguration ideais helpful in minimizing the size and parts in the force train of an electric vehicle. The machine-converter coupled reproduction results demonstrated that the coordinated converter can be utilized for the force exchange with flexibility without essentially additional force components.

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