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Integrated Topology with Less Switches for Dual Mode Electric Vehicle Applications

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ABSTRACT: it is proposed that open loop integrated circuit for motor drives with dual mode control for EV/HEV applications are taken and a reduction technique is proposed for reducing number of switches, when bi-directional batteries are connected to the circuit, which helps in reducing circuit complexity. A closed loop system and the circuit is operated in two modes i.e., Conversion Mode and Inversion Mode. By using controlling technique current ripple content is reduced and losses are minimized resulting in high efficiency and continuous conduction. MATLAB Simulation is used for boosted Output Voltage and Current ripples.
Keywords: Bi-directional batteries, Integrated circuit, Motor drives, Voltage sources, PI Controller.

I. INTRODUCTION

Now-a-days Electric Vehicles usage increased due to high fuel cost and reduced source of lubricants. These Electrical Vehicles aids in pollution free environment. But efficiency of these vehicles is low compared to others. If regulators are placed to vary high speeds, losses become more and it may not give good efficiency. Hence, a Voltage boost is needed for proper working. Therefore an integrated circuit is proposed which serves the purpose[11]. In previous methods, Converters and Inverters are used separately in Electric Vehicles [1]. A normal Boost Converter is used as a converter which boosts up the Voltage. By this Output Voltage is varied based on the Duty Ratio[3]. The other parameter values are fixed for one value. But the circuit cannot withstand for high currents, it may only support up to 2.5 KW power applications. Hence, Interleaved Boost Converter is introduced.[11]. Unlike a normal Boost Converter consisting of one switch and an inductor, an Interleaved Boost Converter has two switches and two inductors. This serves in high Voltage Boost up, lessening of current ripples because of inductors used in circuit, which are acts as filters and support high current applications (above 2.5 KW power applications)[6][7][10]. Based on this interleaved method, a new circuit called Integrated Inverter and Converter is introduced .This circuit itself acts as an inverter and a converter. There are no separate inductors in this circuit and motor windings itself acts as inductors.[1][18].

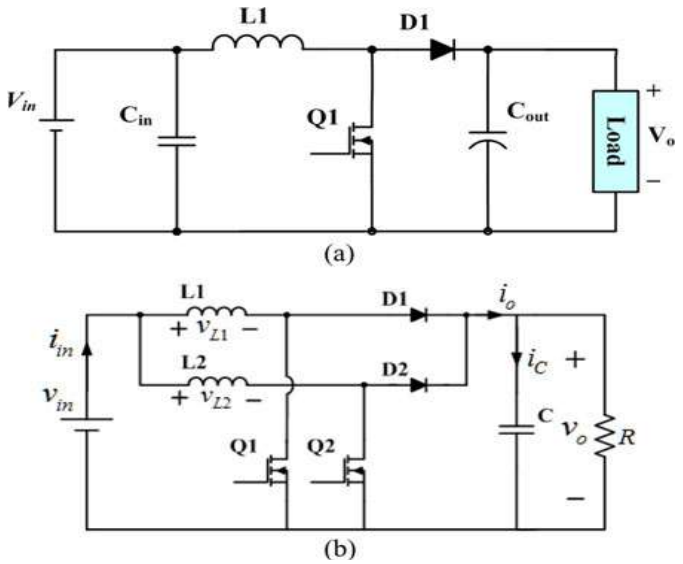


Fig.1(a)normal boost converter,(b)interleaved boost converter

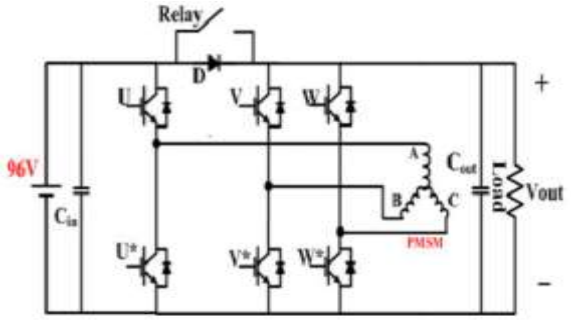


Fig.1(c) integrated inverter/converter circuit

The inverter and converter operation is based on the Relay operation. When Relay is ON the circuit acts as an inverter and when the Relay is OFF the circuit acts as a converter. The circuit operation is explained in four cases. In first case, it acts as a single phase motor. In this only two phase windings are operated.[7]. In second case, three phase windings are operated acting as two phase mode. Compared to single phase mode the voltage is high. In third phase single phase to two phase mode is operated and fourth case two phase to single phase operation take place based on the connected load applications[10][1].

TABLE-1: CONTROL DESIGN PARAMETERS

V_{in}	96 V_{DC}
V_o	288 V_{DC}
P_o	3 kW
C	260μF
R_L	170 mΩ
L	2.77 mH
R_{esr}	108 mΩ
V_d	0.462 V
V_{CE}	1.5 V
Voltage drop of D	0.87 V

The above table shows the parameter values of integrated inverter/converter circuit. When bi-directional batteries were connected to this circuit, it became complex resulting in high cost[14][9]. Each battery requires two switches hence using this methods only 9 switches are operated instead of 12 switches reducing circuit complexity. And the inverter operation is also not explained in this circuit. And in vehicle we have 3 modes ,i.e normal mode, low power mode ,high power mode. in normal position vehicle runs normal ,but when it runs at hill areas it require more power. In that situation the charged battery more used and by this easily charged battery complete in vehicle ,so the extra batteries are connected in proposed circuit for better operation[10][1].

II. PROPOSED CIRCUIT AND CONTROL TECHNIQUE

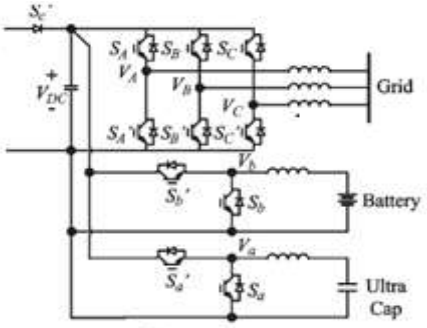


Fig.2.more switches connected integrated circuit

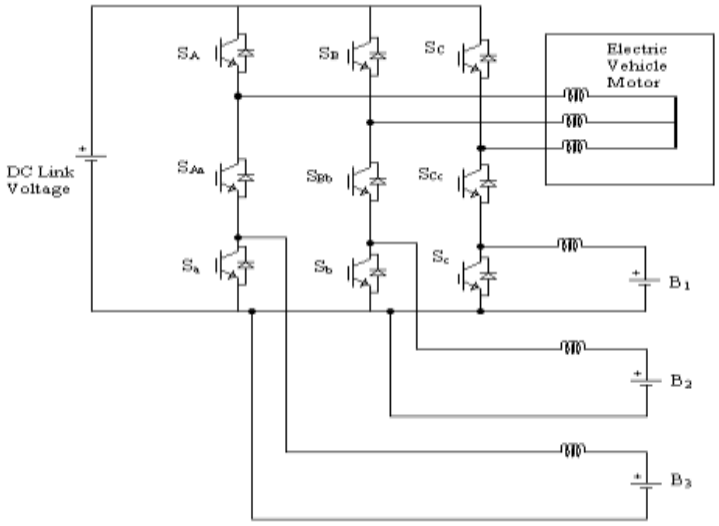


Fig.3. Integrated proposed less switches circuit

TABLE-2: SWITCHING STATES AND OUTPUT VOLTAGES OF FIG.2

S_A	S_A	S_a	S_a	V_A	V_a
ON	OFF	ON	OFF	V_{DC}	V_{DC}
ON	OFF	OFF	ON	V_{DC}	0
OFF	ON	OFF	ON	0	0
OFF	ON	ON	OFF	0	V_{DC}

TABLE-3: SWITCHING STATES AND OUTPUT VOLTAGES OF FIG.3

S_A	S_{Aa}	S_a	V_A	V_a
ON	ON	OFF	V_{DC}	V_{DC}
ON	OFF	ON	V_{DC}	0
OFF	ON	ON	0	0

Fig.2 shows integrated 10 switch circuit, here 10 controllable switches are used. In which 6 switches are for integrated circuit and 4 switches for 2 batteries. When 3 batteries connected it uses 2 more switches extra. Switching states and output voltages for circuits of Fig 2 and Fig.3 are shown in Table 2 and Table3 respectively.

The further development is made by integrating the above circuit by reducing the no. of switches to 9 instead of 12 as shown in Fig.3. In that upper 6 switches $\{S_{A,}\ S_{B,}\ S_{C,}\ S_{Aa},\ S_{Bb,}\ S_{Cc}\}$ are used for inversion and lower 6 switches $\{S_{a,}\ S_{b,}\ S_{c,}\ S_{Aa},\ S_{Bb,}\ S_{Cc}\}$ are for conversion. the switches in the middle are common for both inversion and conversion processes.

OPERATION:A control circuit is designed which creates a reference signal for AC and DC. this reference is made error free using a PI controller. With these reference signals the triggering pulses are generated using PWM technique which helps in switching operation. 3 batteries are connected, each battery voltage is 30V.these will help to supply power to load when more power required for the vehicle .when one battery is not working also the other 2 batteries give the supply to load. From this no interruptions occur in the vehicle.

TABLE-4: PARAMETER VALUES OF CIRCUIT

V_{in}	175V(dc)
Battery voltage	30
Inductor value	5mH
RC	1ohm, 2200µF
RL	13ohm, 1mH

III. EXPERIMENT RESULTS

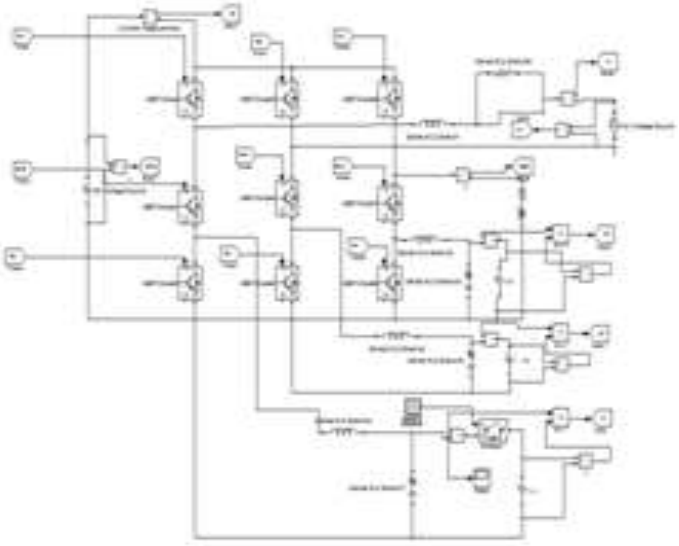


Fig.4.proposed extension circuit

Experiment results of above proposed circuit is given below. In this AC source voltage is 89.5V.

Output values

Source voltage V_S	89.5V
I_S	2A
DC link	175V
Power in battery1(P_1)	100W
P_2	154W
P_3	203W
I_{load}	4A

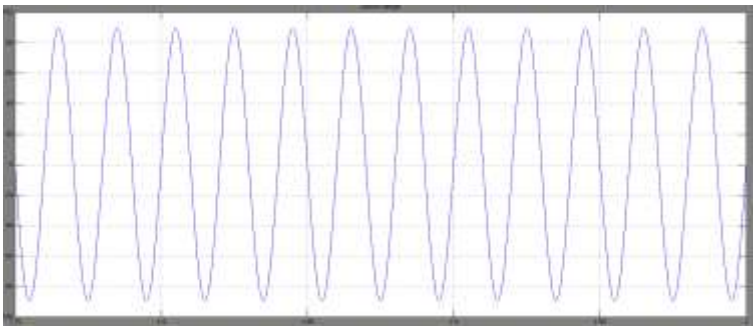


Fig.5.source voltage

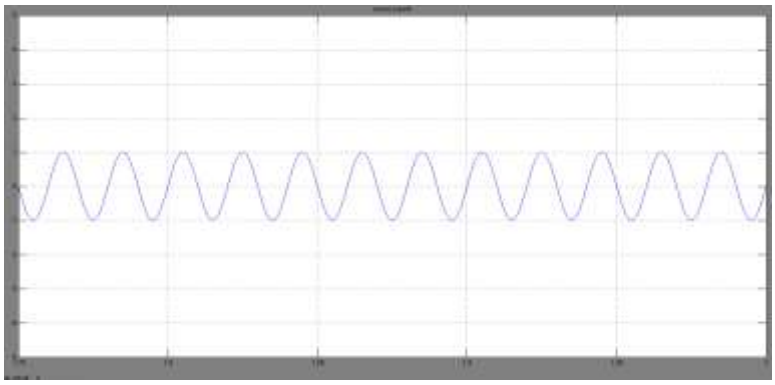


Fig.6.source current

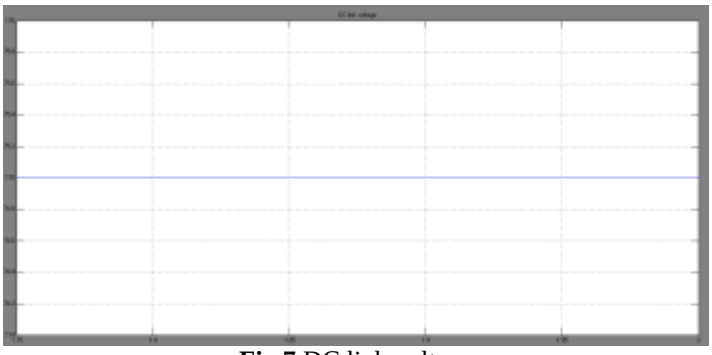


Fig.7.DC link voltage

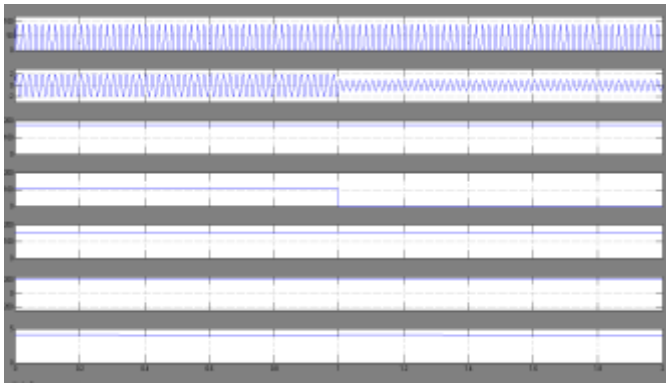


Fig.8. Simulation results of extension circuit

In the above results it shows source voltage, source current, DC link voltage, powers flowing in 3 bidirectional batteries, load current. The below fig shows the control circuit of the circuit, in this reference voltage for AC, DC are generated.

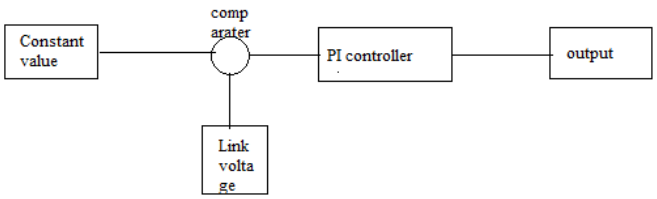


Fig.9.control circuit

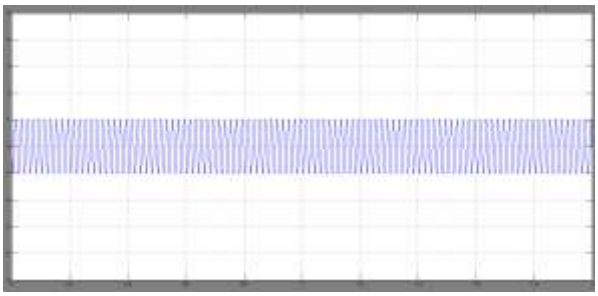
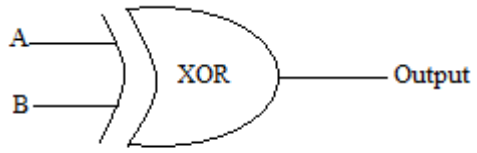


Fig.10.simulation result of AC reference

Fig.11.simulation results

The gating pulses for the middle switches in the circuit are generated based on the XOR gate, XOR gate decides that which switch should ON. There are three set of switches in the circuit. The first and second set of switches are for inversion operation, and second and third switch sets are for conversion(rectifier) operation. the second set of switches are common for both conversion and inversion. The problem is If all 3 sets ON, it leads to shoot through or short circuit. So to avoid this we are using XOR gate, when either set 1 or set 3 operating thus XOR gate allows generation of pulses using PWM technique .If set 1,set 3 both are operating, the XOR gate output is "0"



A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	0

Fig.12.XOR gate diagram and truth table

IV.CONCLUSION AND FUTURESCOPE

From the above it is concluded that when charged power is completed in the vehicle, the alternate multiple batteries are supply the power to vehicle. when 3 bidirectional batteries are connected to the vehicle, these will supplies the power to the vehicle with out interruption. If any battery is not responding also the other batteries will supplies power to load. the switches used in this circuit are also less used. By this circuit complexity decreases and cost and losses also decreased. and conversion and inversion operation performed in only one circuit. And also it gives good efficiency with these changes.As the implementation needs more research and development, a brief and depth study may help in improving performance and efficiency. And also in future vehicle to grid operation is possible, by this saving of power is possible.

REFERENCES

[1]. Yen-shin lai, senior member, ieee, wei-ting lee, yong-kai lin, member, ieee, and jian-feng tsai, "Integrated Inverter/Converter Circuit And Control Technique Of Motor Drives With Dual-Mode Control For Ev/Hev Applications", ieee transactions on power electronics, vol. 29, no. 3, march 2013.

[2]. X. D. Xue, member, ieee, k. W. E. Cheng, senior member, ieee, j. K. Lin, z. Zhang,k. F. Luk, t. W. Ng, and n. C. Cheung, senior member, ieee. "Optimal Control Method Of Motoring Operation For Srm Drives In Electric Vehicles" ieee transactions on vehicular technology, vol. 59, no. 3, march 2010.

[3]. Dipl. El. -ing. Andrea vezzini, pro$ dr: konrad reichert department of electrical machines, swiss federal institute of technology, switzerland physikstrasse 3, ch-8092 zurich, "Power Electronics Layout In A Hybrid Electric Or Electric Vehicle Drive System", 1996 ieee.

[4]. Ali emadi, senior member, ieee, young joo lee, student member, ieee, and kaushik rajashekara, fellow, ieee, "Power Electronics And Motor Drives In Electric,Hybrid Electric, And Plug-In Hybrid Electric Vehicles", ieee transactions on industrial electronics, vol. 55, no. 6, june 2008.

[5]. K. T. Chau, senior member, ieee, c. C. Chan, fellow, ieee, and chunhua liu, student member, ieee, "Overview Of Permanent-Magnet Brushless Drives For Electric And Hybrid Electric Vehicles", ieee transactions on industrial electronics, vol. 55, no. 6, june 2008.

[6]. Shuai lu, student member, ieee, keith a. Corzine, senior member, ieee, and mehdi ferdowsi, member, ieee, "A New Battery/Ultracapacitor Energy Storage System Design And Its Motor Drive Integration For Hybrid Electric Vehicles", ieee transactions on vehicular technology, vol. 56, no. 4, july 2007.

[7]. Omar hegazy, member, ieee, joeri van mierlo, member, ieee, and philippe lataire, "Analysis, Modeling, And Implementation Of A Multidevice Interleaved Dc/Dc Converter For Fuel Cell Hybrid Electric Vehicles", ieee transactions on power electronics, vol. 27, no. 11, november 2012.

[8]. Wei qian, honnyong cha, member, ieee, fang zheng peng, fellow, ieee,and leon m. Tolbert, senior member, ieee, "55-Kw Variable 3x Dc-Dc Converter For Plug-In Hybrid Electric Vehicles", Ieee Transactions On Power Electronics", vol. 27, no. 4, april 2012.

[9]. Murat yilmaz, member, ieee, and philip t. Krein, fellow, ieee, "Review Of Battery Charger Topologies, Charging Power Levels, And Infrastructure For Plug-In Electric And Hybrid Vehicles", ieee transactions on power electronics, vol. 28, no. 5, may 2013