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Development and Analysis of Bidirectional Converter for Electric Vehicle Application

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Abstract- **This paper proposes an integrated electric motion machine and converter topology represents the capability of bidirectional power flow between the electric vehicle to AC supply and load. The inductance winding of the electric motion machine carrying the bidirectional converter operation. This operation of eliminate the additional inductors for charging and transfer the energy to load. The effectiveness of proposed bidirectional converter is better than other traditional model. In Hybrid Renewable Energy System, the efficiency method of Bidirectional Converter will be used in the applications of Electrical Vehicle which are mostly used in Hill side areas. This concept has been analyzed by the MATLAB Simulink software. It has been applied with inductor to share the current and reduce the switching stress in the converter devices. In this type of system size and weight can be minimized.**

Keywords- **Component; bidirectional converter, machine inductance, electric vehicle, buck converter**

I. INTRODUCTION

The bidirectional converter is a major part of field in power electronics and drives. The bidirectional converter are used industrial application and dual operation application. The electric vehicle battery charging and discharging purpose required for bidirectional power flow operation with the low switching operation. It is used for high power application bidirectional converter is simple conversion method. The electric vehicle is an interesting topics for reducing system size and weight and cost. The system size and weight reducing converter is a challenging issues. In case of on-board charger [1] used in electric vehicle in the anywhere. This converter compare with dc-dc converter in addition to higher growth rate. The major concern of this studies reducing switches and size &cost. Various type of converter topology has been developed for electric vehicle for battery charging and discharging purpose. By this method available for bidirectional power flow between the electric vehicle to any other ac or dc load and ac supply to electric vehicle. This bidirectional converter is very flexible and very low cost. However, the power inverter uses the standard four or six switch configuration that has different power convert topology available. This proposed converter topology using relay arrangement using different modes of operation. One of source of power for transportation. Hybrid electric vehicle (HEV) [2] and used full electric vehicle (EV) it is advanced power green transportation. This part of electric vehicle not only for electric train it is also generating few applications. An electric vehicle has huge size using rectifier and using inverter in depending upon the vehicles motor. Then more components require for boost and buck operation (example: inductor and capacitor) this type of components using means vehicle size will be bulk size.an electric vehicle using different operation and at this time doing at one process only

In this paper one approach, the traction motor winding used to the inductors for develop the charging system without the any additional components [3]. This research showed the use of poly-phase machine for the charger. Battery charging system has been used for traction motor winding a used for filter component [4]. On-board charger is this method are available in the proposed system using stator winding are special electric machine type in [5]. This type of charger used for electric scooter. This converter technique reduced the switching stresses and size at this time increasing efficiency. This type of conversion not enough for run the electric vehicle

This proposed converter used ac supply to vehicle battery charging operation without any source inductance. Because it is vehicle motor inductance using to the power transfer element. This type of converter used several modes operation available for vehicle to ac load and ac supply to battery charging. Motor inductance would be enough condition to ac load connected modes operation and high motor inductance required for depends upon the load, blocked rotor condition inductance value will be high that means rotor can be locked that condition. In the vehicle charging condition machine will be stable no electromechanical power flow through the air gab of the machine. This type of machine only electric movement or loading only not allowed for mechanical loading. The converter topology have been developed by electric vehicle in bidirectional operation, this converter used for

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bidirectional power flow capability between the vehicle to any load and ac supply to battery charging this operation without use extra components. This operation using contactor or relay arrangement by the different modes are running to this operation. This type converter used reduce EMI and reduce size and cost [5]. This paper present by machine and power converter are analyzing and modelling by the using MATLAB/Simulink software. This converter advantages for reduce size and cost and bidirectional power flow capability and this converter utilizing the vehicle motor, so this drives operation used for high power application and at this time used for industry application.

II. CIRCUIT DIAGRAM OPERATION

Circuit diagram for bidirectional converter shown in Fig.1.This circuit operate at a two modes. Battery to any ac load example vehicle motor and another modes ac supply to battery charging. This conversion modes the transfer power flow without any extra components.

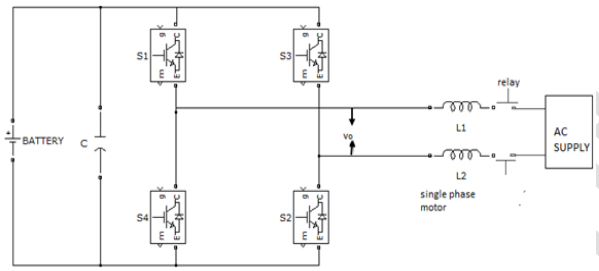

Fig.1. Circiut diagram for bidirectional converter

L1 and L2 are single phase motor inductance and C is the capacitance, S1, S2, S3, S4 are converter switches. To analysis and operation of the bidirectional converter, it is operated a two modes. Conversion and inversion mode this two modes separated at a several application. But here combination of one operation at a bidirectional power flow operation at used electric vehicle application.

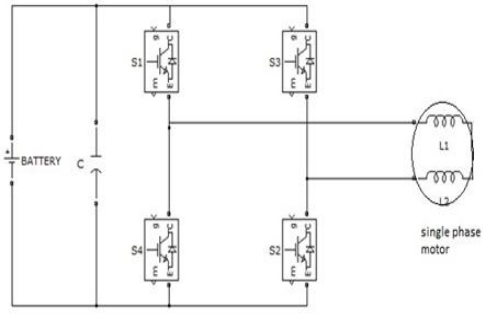

Fig. 2. Circuit diagram for battery vehicle motor

This circuit diagram for vehicle battery to vehicle motor. This inversion mode operated at a four switch it is having two leg circuit so it is connected at a single phase motor shown in Fig. 2.This mode battery backup required for will run the motor operation. This modes having four switches so conducting at two modes. First modes conducting at two switches S1 and S2 are conducting at closed path shown Fig. 2(a), S1 switch are connected at positive side and S2 switch are connected at negative side so circuit will be closed Second mode conducting for two switches S3and S4 are operate at a converter operation, This converter operation will specific application, converter operation is ac voltage to dc voltage. This converter used to battery charging purpose used for electric vehicle

Modes of operation

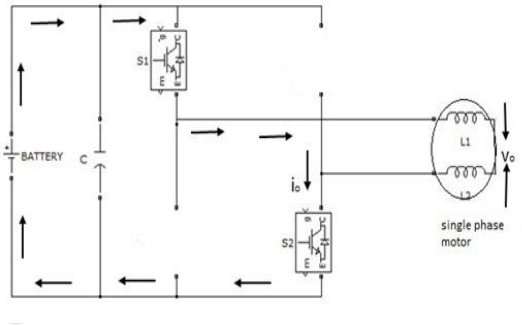

Fig.2 (a).

Conducting mode

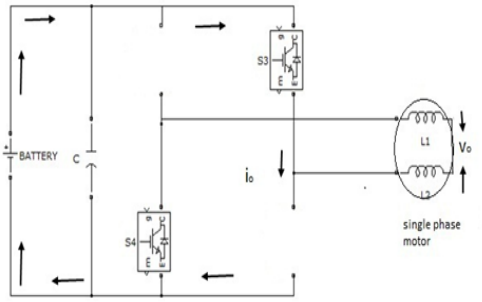

Fig.2 (a)

This modes of operation diagram in inversion process, this inversion process also used for the vehicle running purpose and any ac load using purpose. High efficiency power converter is high power density conversion. This conversion process used for IGBT. Because its capability of transistor operation it is high switching speed. It is advance switching function available, modes of operation will be two IGBT only conducting for first mode. This operation only closed path because current flowing through the closed path,

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that type of flowing current is called output current. This process doing MATLAB Simulink software. This inversion process used for two leg IGBT it is very faster switch speed in the other devices. It is very high efficiency, low switching noise, switching stress is low. to ensure multipurpose use of power converter. To reduce system size, weight &cost. This method to give flexibility the vehicle charging. This operation required for source inductance. High power operation required for high inductance.

This mode of operation must use for buck converter because of battery voltage will be low voltage.Whichconversion used luo converter. This converter operation will specific application, converter operation is ac voltage to dc voltage. This converter used to battery charging purpose used for electric vehicle.

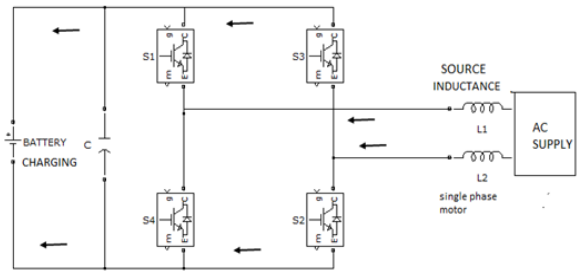

Fig. 3. Circuit diagram for ac supply to battery charging

This rectifier circuit used to ac supply to battery charging, this circuit modes used moreover any battery charging application used this circuit. The effect of source induce in the rectifier circuit because diode current transfer to the one diode to another diode instantaneously, the output dc voltage Vd is rectifier falls from with load current Id. In additional voltage drop in the diode conducting stage across this stage diode current will be increase.

In the buck converter DC-DC converter. This type of conversion is high voltage to low voltage. This type normal buck converter contains high voltage ripples. This type ripples in change the low current and change the output. So we can use luo buck converter [10], which is reduced the harmonics. This converter low cost, which reliable and efficient.

SYSTEM ANALYSIS

In this converter design calculation is full bridge inverter, a single phase full bridge inverter is connected RL load. For a dc source voltage of Vs and output frequency f=$1/T$.

For first half cycle 0<t<$T/2$, voltage equation for RL load is

$$V_S = RI_{0\backslash} + L \text{ dio } /dt \quad (1)$$

Its Laplace transform, with zero initial conditions, is

$$RI(s) + Ls.\ I(s) \quad (2)$$

Its time solution is,

$$Io\ (t) = (1\text{-e t}) \quad (3)$$

For second half cycle, the time limit is from to T, the voltage equation RL load in second half cycle

$$-Vs=Rio+L \quad (4)$$

Its time solution is

$$Io\ (t) = -\frac{Vs}{R} + \frac{Vs}{R}(2\text{- e-}\frac{RT}{2l})\ e^{\frac{-R}{L}t} \quad (5)$$

Under steady state, t=0, io (0) =-Io under this condition Laplace transform of equation (1) is

$$=I(s)\ [R+Ls) + LIo \quad (6)$$

Its time solution is

$$Io\ (t) = (1\text{-e t})\text{-Io e t} \quad (7)$$

Vs is source voltage, Io is an output current its value operate at the depend upon time value. Design of converter and calculation

SIMULATION RESULTS

In this converter used for different application, it is used for different type machines and different rating used for automotive application.in the electric vehicle application, electric vehicle different type of electric loads available different type of electric loads are tested for simulation models would provide realistic predictions. Simulation of bidirectional converter in using MATLAB SIMULINK software in Fig. a

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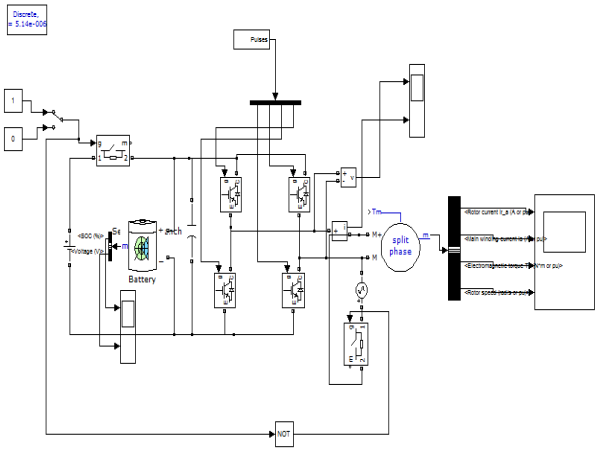


Fig.a. simulation diagram for bidirectional converter

PWM MODELS

The duty cycle 'a' is generated by comparing of reference signal Vr and saw tooth carrier signal Vcr. This is shown Fig.b. Modulation index is ratio of reference by carrier signal the duty cycle varied by 0 to 1, to obtain square pulses by the comparator.

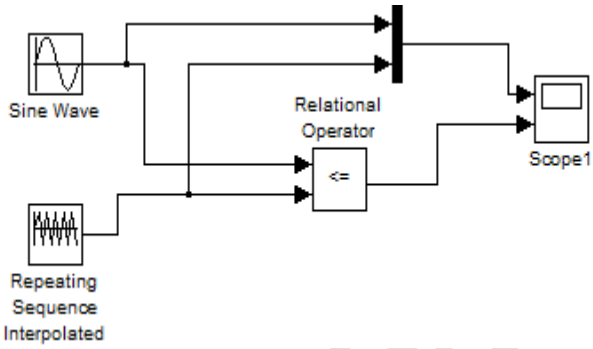
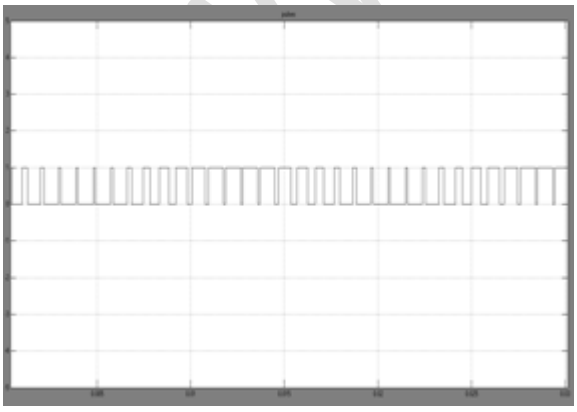


Fig.b.



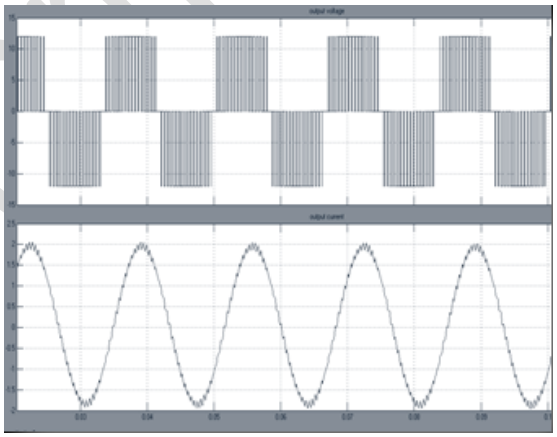
(c)

TABLE 1

DESIGN PARAMETER AND SIMULATION RESULTS

Input voltage range	12v-24v dc
Maximum output voltage	250v
Phase inductance	0.5mH
Switching frequency	50KHz
Load resistance	5Ω
Load current	12A

Inverter output



(d)

Motor output

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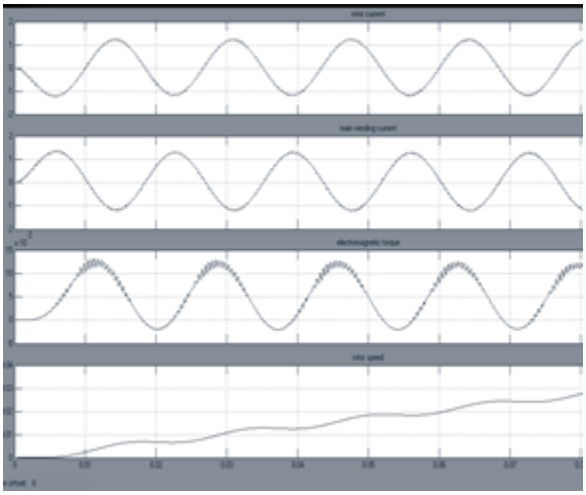
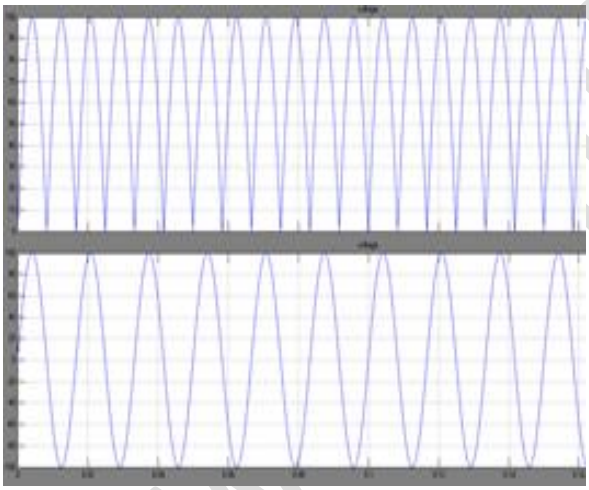


(e)

Converter output



(f)

CONCLUSION

The converter- machine topology is proposed in this paper. This paper provides a new concept in the drive industry for electric vehicle applications, here the machine inductors are used as a source inductors of the converter whereas this may act as a motor load. Therefore there is no requirement of extra impedance devices. In such a way we can reduce the size of the drive model as well as cost of the model is going to be reduced due to the effect of fewer devices account. It having the great feature of the bidirectional power flow operation owing to the relay arrangement. This topology analyzed by the matrix laboratory software (MATLAB). This will act as a battery backup inverter, this power flow operation could be from the battery to the AC load and from AC supply to the battery via bidirectional converter.

APPENDIX

The components values are inductor L- 0.5mH, switching frequency 50 KHz, and load resistance 5Ω, and maximum load current 12A

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REFERENCES

[1]S. Lacroix, E. Laboure, and M.Hilairet, "an integrated fast battery charger for electric vehicle", in proceeding IEEE Veh Power and Propulsion conference. Oct 2010, pp. 1-6.

[2] M. Milanovic, A. Roskaric, and M.Auda, "Battery charger based on double buck and boost converter", in proceeding. IEEE Int Symp, Ind Electron., July 1999, vol.2, pp. 747-752.

[3] A. G. Coccori, "combined motor drive and battery recharge system", U.S. Patent 5 341 075, 23 Aug. 1994.

[4] S. K Sul and S.J Lee," an integral battery charger for four wheel drive electric vehicle", IEEE Transaction industrial application. Volume 31, no 5, pp 1096-1099, sep/oct 1995

[5] D. Thimmesch, "An SCR inverter with an integral battery charger for electric vehicle," IEEE Trans. Ind. ppl., vol. IA-21, no.4, pp. 1023-1029, jul./Aug. 1985.

[6] L. Solero, "Nonconventional on-board charger for lectric vehicle propulsion Batters," IEEE Trans. Veh. Tehnol, vol. 50, no. 1, pp. 144-149, Jan. 2001.

[7] S.Heghbin, S.Lundmark, M. Alak"ula, and O. Carlson, "An Isolated high power integrated in charger in electrified vehicle applications," IEEE trans.veh. Tehnol. vol. 60, no. 9, pp.4115-4126, Nov.2011.

[8]R.T Naayagi, A.J.Forsyth, "bidirectional DC-DC converter for aircraft electric energy storage systems.

[9] N.M.L. Tan, T. Abe, and H.Akgai, "A 6-KW,2-kwh lithium-ion battery energy storage system using a bidirectional isolated dc-dc converter," .

[10] A.Manikandan, N.Vadivel"Design and implementation luo converter for electric vehicle application

[11] Y. Lee, A. Khaligh, and A. Emadi, "Advanced integrated bidirectional AC/DC and DC/DC Converter for plug-in hybrid Electric vehicles," IEEE Transactions

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on vehicular technology, vol. 58, oct.2009, pp. 3970-3980.