A Nonisolated Multiinput Multioutput Dc–Dc Boost Device for Electrical Vehicle Applications

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Abstract— A replacement nonisolated multiinput multioutput dc–dc boost convertor is planned during this paper. Electrical Vehicles (EVs) develop space with the considerations of gas emission and energy crisis. Electrical Motors, those area unit used for electron volt propulsion should have high potency for optimum utilization of the energy from batteries and/or fuel cells. A combined circuit for motor drives with associate impedance Network beside twin mode management for EV/HEV applications is planned. The pc circuit permits the magnet motor to figure in motor mode or acts as boost inductors of the buck converter, and thereby boosting the output force coupled to constant gear or dc-link voltage of the converter connected to the output of the pc circuit. Bifacial charging supports battery energy injection back to the grid. Though the auto makers have reduced the greenhouse gases like hydro-carbons, CO, carbonic acid gas, etc., from the vehicle, they can't turn out a zero-emission vehicle unless they turn out an electrical vehicle (EV). An electrical vehicle is Associate in Nursing emission (AEVSNE) free, environmental friendly vehicle. The planned convertor has only one inductance. Reckoning on charging and discharging states of the energy storage system (ESS), 2 totally different power operation modes area unit outlined for the convertor. So as to style the convertor system, small-signal model for every operation mode is extracted. The validity of the planned convertor and its management performance area unit verified by simulation and experimental results for various static operation to default conditions.

Key words: Buck converter, Interleaved boost converter, Boost converter and motor drives

I. INTRODUCTION

Multiphase convertor with interleaved management is crucial for the high-energy boost convertor so as to scale back the ripple current and to scale back the scale of passive part. Up to now few literatures associated with the controller style of the high-energy interleaved boost convertor will be found. Electrical transportation is not a fresh development. In spite of plan has been around for over 100 years. However, given growing environmental sensitivities, long supply issues, fuel prices and improved technology, there is a good study motivation to any accelerate this market section. Government rules rather like the 150-g/km (and future planned 115-g/km) greenhouse emission average emission limits for automobile manufacturers in Europe are also different catalysts behind new electrified transportation alternatives. With the adoption of plenty of physics, vehicles become safer, exhibit higher performance, and are plenty of economical. Electrical transportation can be a key half at intervals the renewable energy landscape. Energy for charging is foretold to come back to back from renewable sources like wind, solar-or water powered plants.

This paper following a similar approach utilized in buck convertors and applied it on boost converter, inflammatory disease is designed victimization "Ziegler–Nichols" calibration methodology, wherever the individual effects of P, I, and D is tuned on the closed-loop response to relinquish the desired characteristics Home and public charging stations conjointly can become plenty of current and should make the most of off-season charging (night-time) and inexperienced energy sources like wind. With a full vary of analog and embedded method merchandise, the forefront of serving to bring safer, low-cost and plenty of economical electrical transportation solutions to push. The hybrid and electrical vehicle system is formed of the many modules to make the drive train and energy storage system.

This solution for trade vary from optimized and dedicated integrated circuits to full system-level solutions to help our customers optimize and accelerate development. This experience in numerous markets like engineering, industrial motor drives, digital power provides, sensible metering and grids, wired and wireless communications, shopper physics, and energy efficiency permits engineers to satisfy increasing needs for higher speeds, higher truth, lower power and plenty of hard instrumentality.

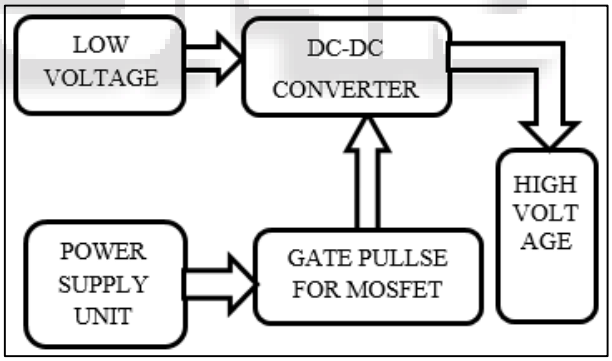

Fig. 1: Block diagram

All whereas maintaining the high standards of quality and responsibility that the automotive and transportation market demands. The battery block (typically a Li-ion chemistry within the vary of 450 V) is managed Associate in Nursing monitored by the battery management system (BMS) and charged via an on-board AC/DC convertor module, with voltages starting from 110-V single-phase to 380-V three-phase systems. The DC/AC electrical converter uses the high voltage of the battery convert to drive the electrical motor, however is also used for regenerative breaking, storing energy into the battery, attach the high-voltage battery to the traditional 12-V board internet needs a DC/DC convertor. The affiliation of a high-voltage battery to the {inverter|electrical convertor} as jointly needs a reversible DC/DC converter in most cases. The entire HEV system has got to meet specific safety necessities (up to ASIL-D) that or specifically relevant for managing the high-

voltage battery pack, yet because the drive train used for breaking. Plug-in hybrid electrical vehicles (PHEVs) and battery electrical vehicles (BEVs) were 2 quickly rising technologies that use powerful electrical motors because the propulsion supply. So as to power these electrical motors, massive battery packs are created from many cells, totaling 300-400 V put in within the vehicle.

The result of batteries have a finite energy capability, PHEVs and BEVs should be recharged on a periodic basis, usually by connecting to the facility grid. The charging system for these vehicles consists of Associate in Nursing AC/DC rectifier to come up with a DC voltage from the AC line, followed by a DC/DC convertor to come up with the DC voltage needed by the battery pack.

To boost, advanced charging systems may additionally communicate with the facility grid mistreatment line communication (PLC) modems to regulate charging supported facility conditions. The battery pack should even be fastidiously monitored throughout operation and charging so as to maximize energy usage and prolong battery life. High- performance analog elements also are accessible to give important system functions and options like device feedback, isolation, chip power provides and communication transceivers. A convertor that will increase voltage is termed a change of magnitude convertor and a convertor that decreases voltage is termed a reduction convertor. In EVs/HEVs change of magnitude and reduction converters ar combined into one unit. Associate in Nursing application of a change of magnitude convertor is changing EV/HEV battery voltage (typically 180-300 volts) to regarding 650 volts to power the traction motor. a plus of employing a convertor to extend voltage from the battery could be a smaller and fewer dear battery could also be used whereas still utilizing an economical high voltage motor. An application of a step down electrical converter would be decreasing the high voltage DC (DC 180-300 volts) from the HEV/EV battery to low voltage. The microcircuit permits the static magnet electric motor to control in motor mode or acts as boost inductors of the boost device, and thereby boosting the output torsion coupled to identical gear or dc- link voltage of the electrical converter connected to the output of the microcircuit.

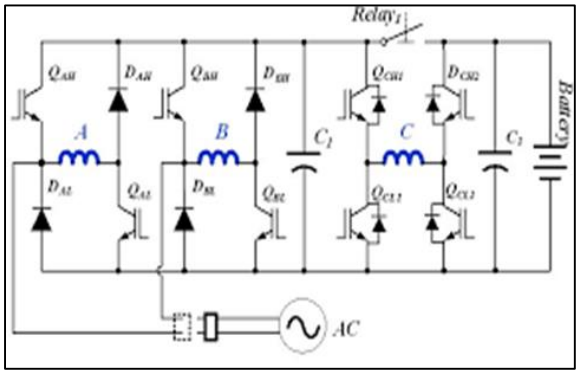

Fig. 2: Equivalent EV/HEV with integrated inverter circuit

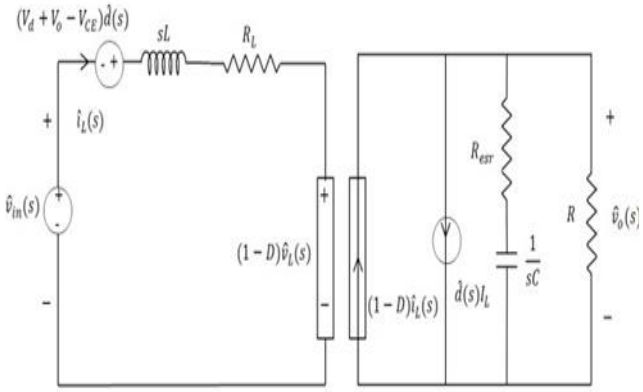

Fig. 3: Small signal equivalent circuit

In motor mode, the microcircuit acts as AN {inverter or electrical device} and it becomes a boost-type boost converter, whereas victimization the motor windings because the boost inductors to spice up the device output voltage. Moreover, a brand new management technique for the projected microcircuit underneath boost device mode is projected to extend the potency. The projected management technique is to use interleaved management to considerably scale back this ripple and thereby reducing the losses and thermal stress underneath heavy-load condition. In distinction, single section management is employed for not invoking further switch and conductivity losses underneath light-load condition. Experimental results derived from digital- controlled 3.5-kW inverter/converter victimization digital signal process show the voltage boost quantitative relation will go up to 600Wto 3.5 kW. The potency is ninety three, 86% underneath full-load condition whereas keeping the motor temperature at the atmosphere level.

II. .BOOST INTERLEAVING DEVICE

Interleaved category multiphase boost converter and control design are introduced A boost device (step-up device) may be a power converter with an output DC voltage bigger than its input DC voltage. Power may also come back from DC sources like batteries, star panels, rectifiers and DC generators. A method that changes one DC voltage to a special DC voltage is named DC to DC conversion. A lift device may be a DC to DC device with AN output voltage bigger than the supply voltage. It's a category of switching-mode power provide (SMPS) containing a minimum of 2 semiconductor switches (a diode and a transistor) and a minimum of one energy storage component. Filters made from capacitors square measure usually further to the output of the device to scale back output voltage ripple. A lift device is typically known as a change of phase magnitude device since it "steps up" the supply voltage.

Since power (P = VI) should be preserved, the output current is below the supply current. A lift device may be brought up as a 'Joule thief'. This energy would preferably be wasted since the battery's low voltage makes it unusable for a standard load. This energy would otherwise stay untapped as a result of in most low-frequency applications, currents won't flow through a load while not a major distinction of potential between the 2 poles of the supply. This term is sometimes used solely with terribly low power battery applications, and is aimed toward the power of a lift device to 'steal' the remaining energy in an exceedingly battery.

A. Operative Principle Of Modeling And Design Boost Converter:

The voltage it produces throughout the discharge section is said to the speed of amendment of current, and to not the first charging voltage, so permitting completely different input and output voltages. The key principle that drives the boost device is that the tendency of AN electrical device to resist changes in current. Once being charged it acts as a load and absorbs energy (somewhat sort of a resistor), once being discharged, it acts as an energy source (somewhat sort of a battery).

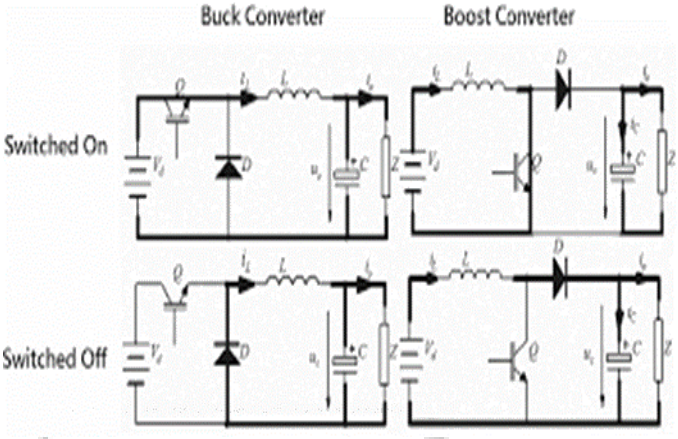

Fig. 4: Boost Converter

- In the On-state, the switch S is closed, leading to a rise within the inductance current;
- In the Off-state, the switch is open and therefore the solely path offered to inductance current is a way of flyback diode D, the condenser C and therefore the load R. These leads to transferring the energy accumulated throughout the On-state into the condenser.

The input current is that the same because the inductance current. It's not synchronous as within the buck convertor and therefore the needs on the input filter square measure relaxed.

B. Convertor Interleaving:

- This will be thought of as a technique of paralleling converters.
- However, it's further advantages to supply additionally to those obtained from standard approaches of paralleling converters.
- Widely utilized in laptop computer trade to power central process units.

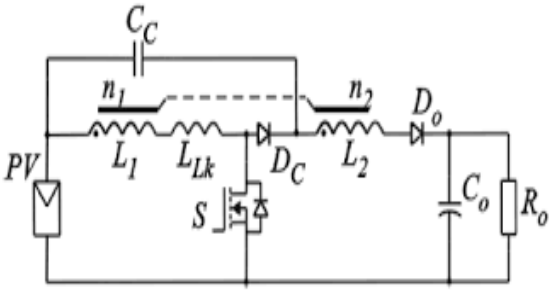

Fig. 5: Four cell Interleaved boost converter

C. Isolated Gate-Control Signals For The Switches:

The individual management signal for the switches has to be provided across the gate (base) and supply (or emitter) terminals of the actual switch. The gate management signals square measure low voltage signals stated the supply (emitter) terminal of the switch. For n-channel IGBT and MOSFET switches, once gate to supply voltage is over threshold voltage for stimulant, the switch activates and once it's but threshold voltage the switch turns off. As already mentioned the switches in bridge configurations of inverters have to be compelled to be given isolated gate (or base) drive signals. The edge voltage is mostly of the order of +5 volts except for faster switch the stimulant gate voltage magnitude is unbroken around +15 volts whereas turn-off gate voltage is zero or very little negative (around –5 volts). It's to be remembered that the 2 switches of associate inverter-leg square measure controlled in a very complementary manner. The corresponding lower switch remains "off" and vice-versa, once a switch is "on" its electrode and collector terminals square measure just about shorted. Although with higher switch "on", the electrode of the higher switch is at positive dc bus potential. Equally with lower switch state "on", the electrode of higher switch of that leg is just about at the negative dc bus potential. Emitters of all the lower switches square measure solidly connected to the negative line of the dc bus. Since gate management signals square measure applied with relevance the electrode terminals of the switches, the gate voltages of all the higher switches should be floating with relevance the dc transit line potentials. This implies of isolation between the gate management signals of higher switches and between higher and lower switches. The emitters of lower switches of all the legs square measure at an equivalent potential are since all of them square measure solidly connected to the negative dc bus and therefore the gate management signals of lower switches needn't be isolated among themselves. As ought to be clear from the higher than discussion, the isolation provided between higher and lower switches should stand up to a peak voltage stress adequate to dc bus voltage. Gate-signal isolation for electrical converter switches is mostly achieved by suggests that of optical-isolator circuits. The circuit makes use of a commercially offered opto-coupler IC. Input stage of the IC could be a lightweight emitting diode (LED) that emits lightweight once forward biased. Although the sunshine output of the semiconductor diode falls on reverse biased junction of associate optical diode. The semiconductor diode and therefore the photo-diode square measure fitly positioned within the opto-coupler chip to make sure that the sunshine emitted by the semiconductor diode falls on the photodiode junction. The gate management pulses for the switch square measure applied to the input semiconductor diode through a current limiting electrical device of applicable magnitude. These gate pulses, generated by the gate logic circuit, square measure primarily within the digital type. A high level of the gate signal is also taken as "on" pre technique command and an occasional level at the ground level is also taken as "off" command. Even though this assumption, the cathode of the semiconductor diode is connected to the bottom purpose of the gate-logic card and anode is fed with the logic card output. The circuit it determine on the output (photo- diode) facet is connected to a floating dc power provide.

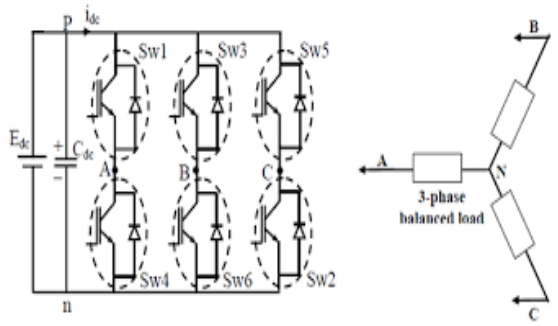

Fig. 6: Three-Phase VSI topology

An electrical device asynchronous with the diode indicates the magnitude of the reverse escape current of the diode. Once an input signal to semiconductor diode is high, LED positive bus 11 by turning on switches Al and A2. Turning switches A3 and A4 on connect the phase A output integrated a negative bus, and turning switches A2 and A3 on connects the phase A output deliver to the neutral bus. The other two phases operate in the same manner, but with phase shifted results with respect to phase A. The resulting waveforms for the switches in leg A, where N covers one cycle of the desired output waveform. The control strategy for the NPCI is similar to a conventional converter in that a control voltage signal, a repetitive triangle wave signal, and a comparator function are used to produce the gate signals. The control voltage signal for each phase of the NPCI is the same signal used in the conventional converter, and likewise for the triangle wave.

III. METHODOLOGY

A. Existing Integrated Circuit:

The electrical device connected in nonparallel with the photo-diode currently has higher chip thanks to the exaggerated outflow current. A sign comparator circuit senses this condition and outputs a high level signal, that is amplified before being output.

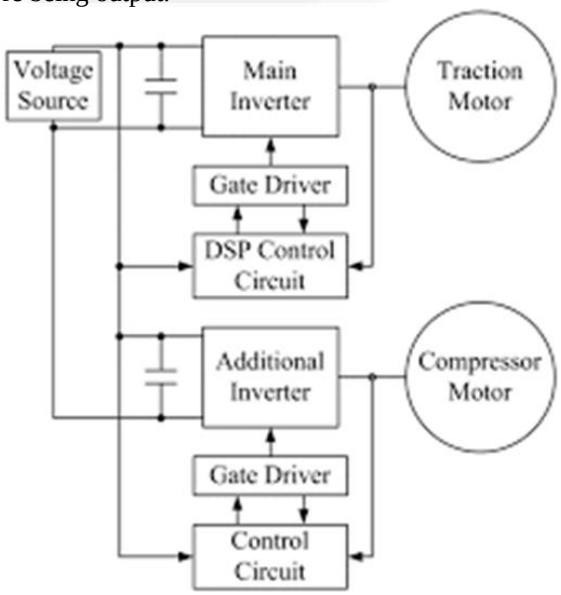

Fig. 7: Conventional Multi-motor Drive System

Therefore associate isolated and amplified gate signal is obtained and will directly be connected to the gate terminal of the switch conducts and therefore the emitted light-weight falls on the reverse biased tangency. Irradiation of sunshine causes generation of serious range of electron-hole pairs within the depletion region of the reverse biased diode. As a result magnitude of reverse outflow current of the diode will increase appreciably.

B. Neutral Purpose Clamped Electrical Converter:

These six clamping diodes connected to the neutral bus management the voltage distribution among the four IGBTs in every section leg. a traditional electrical converter needs the switches to sustain the complete dip between the positive and negative DC buses. NPCI topology that enables for line-to-line waveforms with 5 voltage levels and line-to-neutral waveforms with 3 voltages Neutral purpose Clamped electrical converter topology levels.

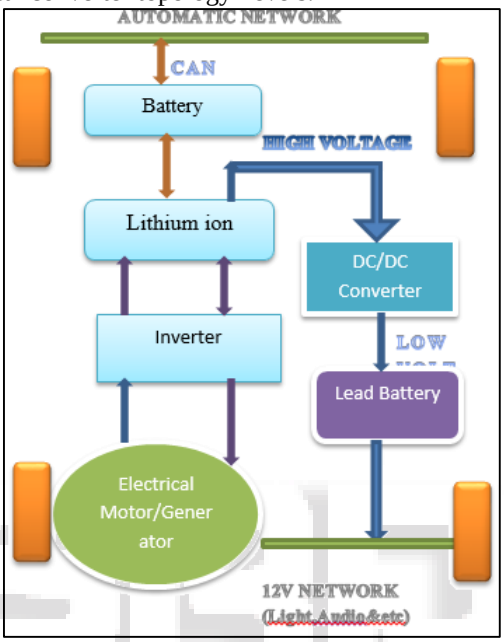

Fig. 8: Integrated Inverter/Converter multimotor drive system.

The section outputs square measure the middle purpose of a series association of 4 IGBTs, and therefore the DC bus input is connected to the highest and bottom row of devices, Al, Bl, CI, and A4, B4, C4, severally. The middle purpose of the DC bus is shown by a ground image ten and is connected between a combine of series connected diodes in every section. However, the chip stress across every switch of the NPCI is one half the voltage between both positive and negative bus since the switches on either facet of the neutral bus square measure a hybrid nonparallel, associated an actual neutral purpose exists. The documented between the several IGBT gate and every IGBT has a private gate signal that has to be electrode terminal. The diode shown between the collector and electrode of every IGBT is an interior "body diode" it parent inherent to the IGBT device structure. The DC bus incorporates a positive, negative, and neutral association with massive low frequency filter capacitors and smaller high frequency filter capacitors. The bus structure is mentioned in additional detail within the physical system section. Operation This specific NPCI topology uses 3-level change rather than 2- level change utilized in typical 3-phase inverters. The 3 levels correspond to the positive, negative, and neutral buses.

In Parallel hybrid electrical vehicle (HEV) and electrical vehicle (EV) system, the convertor is employed for reinforcing the battery voltage to rated dc bus for associate electrical converter to drive motor. Within the multimotor

drive system the system can use 2 or a lot of motors to spice up torsion as in Fig. 4, particularly underneath low speed and high-torque region for such applications; 2 or a lot of inverters/converters square measure needed. Fig. five shows the applying of the microcircuit for motor drives with dual-mode management for EV/HEV applications. As shown in Fig. 5, the microcircuit permits the static magnet electric motor (PMSM) to work in motor mode or acts as boost inductors of the boost convertor, and thereby, boosting the output torsion coupled to an equivalent gear mechanism or dc-link voltage of associate electrical converter connected to the output of the microcircuit. In motor mode, the microcircuit acts as associate {inverter|electrical convertor} and it becomes a boost-type boost converter, whereas exploitation the motor windings because the boost inductors to spice up the convertor output voltage. Therefore, the microcircuit will considerably cut back the amount and weight of the system.

C. Integrated Circuit For Dual Mode Of Motor Drives:

This paper will act as associate and a lift converter counting on the operation mode. For the microcircuit, it not solely will cut back the amount and weight.

However combine boost torsion and dc-link voltage for motor/converter modes, severally. Moreover, a replacement management technique for the microcircuit underneath boost convertor mode is planned to extend the potency. For typical circuit one section boost convertor has been wide used for boost management thanks to its simplicity.

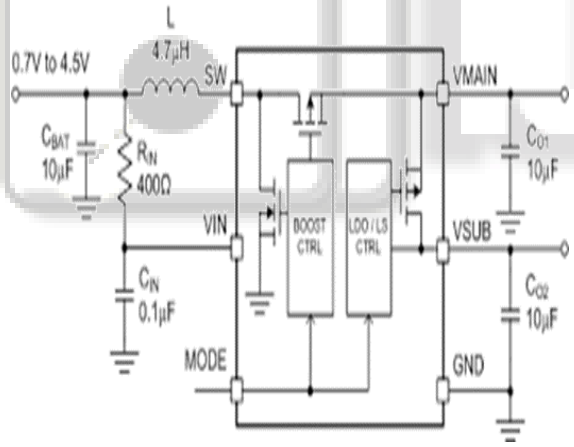

Fig. 10: Integrated circuit for dual mode of motor drives and boost converter

However, for higher power applications, associate interleaved boost convertor will cut back the present ripple and reality stress then thereby reducing the losses and thermal stress.

Based mostly upon the interleaved management plan, a boost-control technique exploitation motor windings as boost inductors for the microcircuit are planned. underneath light-weight load, the microcircuit acts as a single-phase boost convertor for not invoking further change and conductivity losses, and functions because the two-section interleaved boost convertor underneath serious load to considerably cut back the present ripple and thereby reducing the losses and thermal stress. Therefore, the management technique for the microcircuit underneath boost convertor mode will increase the potency.

Fig. half-dozen shows the microcircuit for dual-mode management. Diode (D) is employed for preventing output voltage impact on the input facet. once the microcircuit is operated in electrical converter (motor) mode, relay are turned ON and 6 power devices (IGBTs in Fig. 6) square measure management by pulse dimension modulation (PWM) control signals. Once the microcircuit is operated within the convertor mode, relay is turned OFF. And a single-phase or interleaved to management technique are applied to regulate of the facility devices relying upon the load conditions.

D. Proposed Integrated Circuit:

A new microcircuit for motor drives with twin mode management for EV/HEV applications with the static magnet electric motor is planned. The static magnet synchronous motors (PMSM) operate in motor mode or acts as boost inductors of the boost device. The microcircuit could be a combination of power IGBT will act as associate and a lift converter betting on the operation mode. underneath lightweight load, the microcircuit acts as a single- part boost device for not invoking further change and physical phenomenon losses, and functions because the two-phase interleaved boost device underneath significant load to considerably cut back the present ripple and thereby reducing the losses and thermal stress.. Employment of electrical phenomenon network reduces the shoot-through result made by the 2 IGBT once turned ON at same time. The potency for interleaved management is enhanced as a load goes additional as compared thereto for single-phase management.

Block Diagram:

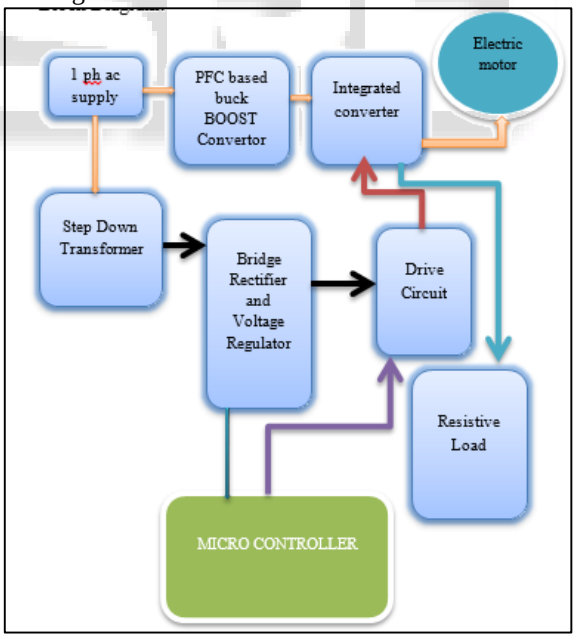

Fig. 10: Proposed Integrated Inverter/Converter for the multi-motor drive system of EV/HE

Therefore, the boost device is management by the planned hybrid control methodology, as load is quite the change purpose of power quantitative relation for the given voltage quantitative relation shown in Fig. 12(b), the device is controlled by interleaved mode to considerably cut back the present ripple and thereby reducing the losses. In distinction, as load is a smaller amount than the change purpose of power quantitative relation for the given voltage the device is managed by the one part management methodology while not

invoking further physical phenomenon and change losses as compared thereto for two-phase interleaved control. The transition purpose is decided by the load condition and enforced within the interrupt subroutine (ISR) for the flow chart of the planned management for the planned microcircuit underneath boost device mode. It is quite common that associate IGBT used for motor drive, UPS and some other industrial applications, be elect for ten micro-second short circuit withstand time (SCWT) if regular of protective drivers.

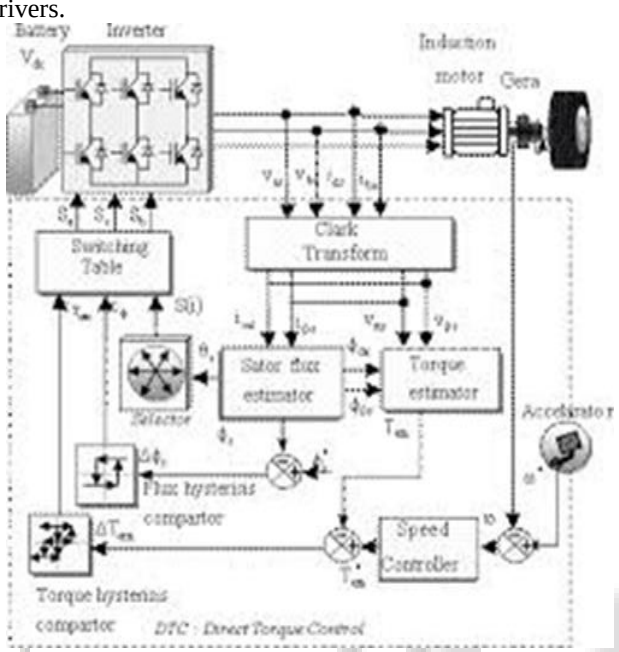

Fig. 11: Circuit diagram of proposed system

However this driver generates high turn-off stress to the IGBT during inverter short or the output becomes faulty. These abnormal conditions once the IGBT is turned-off dead, failures it will occur if the IGBT isn't elect properly. If the sensible fault protection is not used, high turn-off loss are going to be generated and even short current will ramp-up to a dangerous level destroying the IGBT. There are so many ways in which to turn-off the IGBT once fault condition is detected. Gate is discharged through high gate resistance. This discharge of de illuminated path is activated solely throughout the higher than same abnormal conditions. This is not the simplest resolution. Gate voltage is dead reduced to zero.

Gate de-bias happens and therefore the shoot through result made by IGBT within the microcircuit Fig.10 is reduced victimization electrical phenomenon network. The use of capacitors at each input and output finish stabilizes the voltage by distributing the supply and cargo voltage.

IV. CONTROL DESIGN OF BOOST DEVICE FOR IN PLANNED SYSTEM

A. Implementation Of Boost Converter:

This section can introduce the model of boost device and derive the transfer operate of the voltage controller. It considers non ideal condition of components: electrical device winding resistance RL, collector-emitter saturation voltage VCE, diode forward fall Venus's curse, and equivalent series resistance of condenser Rescue. Analysis of the boost device by victimization the state-space averaging methodology, small-signal ac equivalent circuit will be derived, as shown in Fig.11 the transfer concessional operate of the voltage controller will be derived.

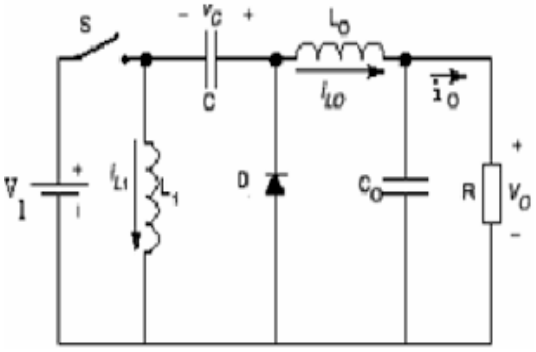

Fig. 12: Equivalent circuit of boost converter

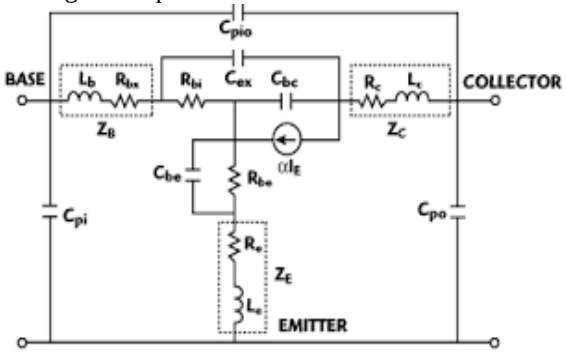

Fig. 13: small signal equivalent circuit

B. Simlation Circuit Of Planned System:

$$G(s=)$$

$$S^3.\ L\cdot C(R+R_{esr})+s[L+C\cdot RL(R+R_{esr})+(1-D)^2.\ C\cdot R\cdot R_{esr}\ ]+[(1-D)^2\cdot R+RL]$$

$$-s^3.\ C\cdot R\cdot R_{esr}\cdot L\cdot I_L+s\{C\cdot R\cdot R_{esr}\ [(V_d+V_O-V_{CE})(1-D)\ -RLI_L]-R\cdot L\cdot I_L\}+R\cdot[(V_d+V_O\ -V_{CE})(1-D)\ -R_L\ I_L]$$

Substitute controller design parameters of Table 1 in equation

$$G(s=)$$

$$\frac{-6.737*10^{-5}s^2+0.06827s+2498}{3.004\times10^{-5}s^2+0.00409s+3.242}$$

DESIGN PARAMETERS	
Source Inductance	0.15mH
Source Resistance	0.1Ω
Source Voltage(Vs)	415V
Load Inductance	10mH
Load Resistance	50Ω
Filter Inductance	10mH
Filter Resistance	0.0001
Reference DC link Voltage	1200µF
Reference DC Voltage	880V

Table 1: Design Parameters

In this paper, the switch frequency is 21 rate and voltage loop information measure are going to be but two rate. The section margin should be over forty five. to reinforce the noise immunity. The information measure is seven.73Hzand the section margin is 93.8 .The planned computer circuit that acts as inverter/boost device and DSP electrical device to convey PWM management signals of

inverter/converter based mostly upon the feedback signals and reference.

V. SIMULATION AND RESULTS

A. Simulation Circuit Of Existing System:

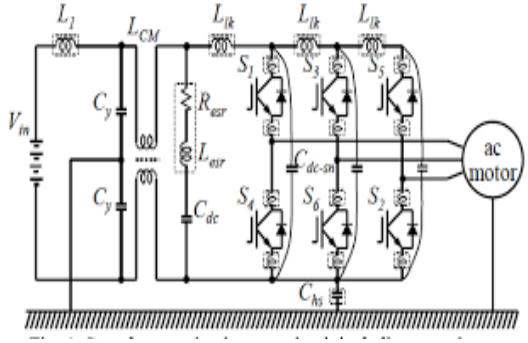

Fig. 14:

B. Output Voltage And Current:

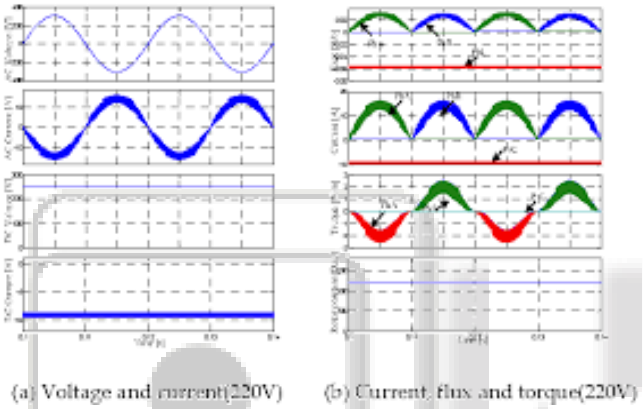

Fig. 15:

C. Simlation Circuit Of Proposed System:

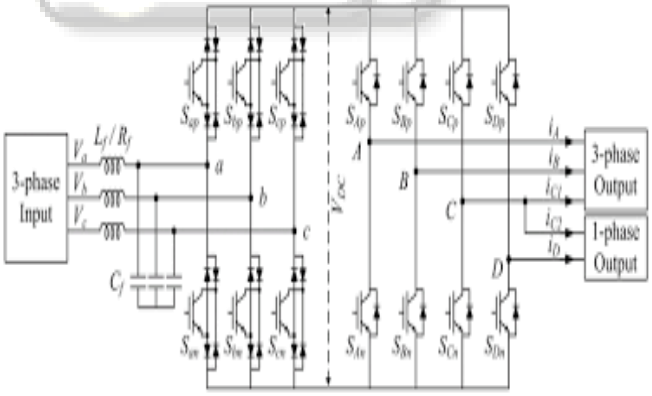

Fig. 16:

D. Simulation Waveform Analysis:

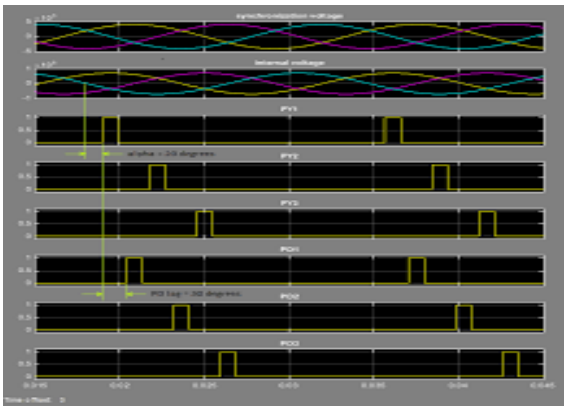

Fig. 17: Output Voltage Ripples

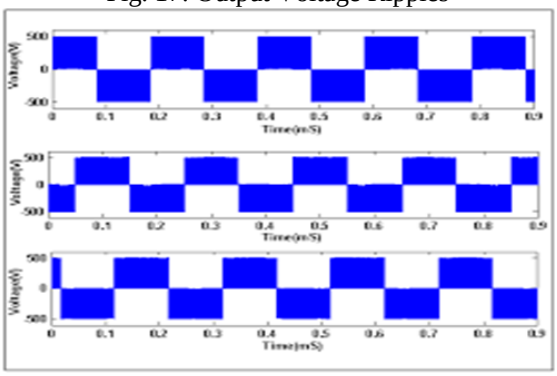

Fig. 18: Pulse signal for IGBT a,b,c,d,e,f

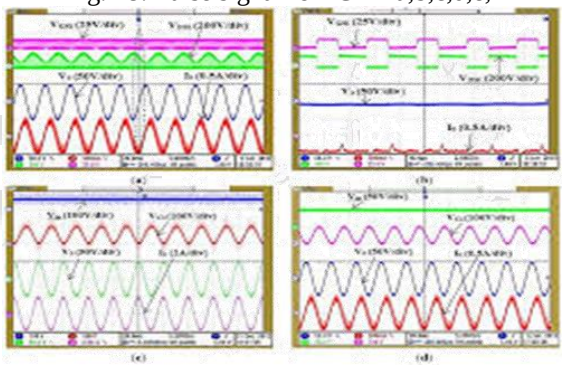

Fig. 19: Output voltage and current of proposed system

VI. CONCLUSION

This system may be a part of the twin voltage design that may be employed in future coach installation. Supported the simulation results, it sequence performance of the dc-to-dc boost device system provides variety of options that don't exist in today's electrical systems. The Proposal of a brand new technic to integrated new inverter/converter circuit of motor drives with dual-mode management for EV/HEV applications to significantly prune the degree and weight. during this paper, analysis, style and simulation of 14V/42V interleaved three-phase dc/dc boost device system with 1.2kW output power is conferred Proposal of a greenhorn management technique operational in boost device mode to increase the potency and Verification of the planned management methodology. Experimental results show that the voltage boost magnitude relation will go up to three. Even though full-load condition, the most potency is over 97% and potency will be maintained at over 94.7% for voltage ratios varies from 2 to 3. These results totally ensure the claimed

deserves of the planned computer circuit and management methodology.

REFERENCES

[1] W. Qian, H. Cha, F. Z. Peng, and L. M. Tolbert, "55-kW Variable 3X DCDC Converter for plug-in hybrid electric vehicles," IEEE Trans. Power Electron., vol. 27, no. 4, pp. 1668–1678, Apr. 2012.
[2] M. Yilmaz and P. T. Krein, "Review of battery charger topologies, charging power levels, and infrastructure for plug-in electric and hybrid vehicles," IEEE Trans. Power Electron., vol. 28, no. 5, pp. 2151–2169, May 2013.
[3] M. Habib Ullah, T. S. Gunawan, M. R. Sharif, and R. Muhida, "Design of environmental friendly hybrid electric vehicle," in Proc. IEEE Conf. Comput. Commun. Eng., Jul. 2012, pp. 544–548.
[4] O. Hegazy, J. Van Mierlo, and P. Lataire, "Analysis, modeling, and implementation of a multidevice interleaved DC/DC converter for fuel cell hybrid electric vehicles," IEEE Trans. Power Electron., vol. 27, no. 11, pp. 4445–4458, Nov.2012.
[5] G. Maggetto and J. Van Mierlo, "Electric and electric hybrid vehicle technology: A survey," in Proc. IEE Semin. Electric, Hybrid Fuel Cell Vehicles, Apr. 2000, pp. 1–1-111.
[6] J. Zhang, X. H.Wen, and L. Zeng, "Optimal system efficiency operation of dual PMSM motor drive for fuel cell vehicles propulsion," in Proc. IEEE Int. Power Electron. Motion Control Conf., May. 2009, pp. 1889–1892.
[7] A. Shrud, H. Kharaz, A. S. Ashur, A. Faris and M. Benamar, "A study of Modeling and Simulation for Interleaved Buck Converter", 1st Power Electronic & Drive Systems & Technologies Conference, Page(s): 28 – 35, 2010.
[8] Marian K. Kazimierczuk," Pulse-width Modulated DC–DC Power Converters" A John Wiley and Sons, Ltd, Publication 2008.
[9] Idris Gadoura, Kai Zenger, Teuvo Suntio, Petri Vallittu, "New Methodology for Design, Analysis, and Validation of DC DC Converters Based on Advanced Controllers" Telecommunication Energy Conference, 1999. INTELEC '99.
[10] Xingyi Xu, Lizhi Zhu, "A DSP Based Controller for High- Power Interleaved Boost Converters" APEC'03, vol. 1, pp.327-333, 9-13 February 2003.
[11] On semiconductor," WITCHMODE™ Power Supplies Reference Manual and Design Guide" 2007.
[12] V. Ramanarayanan, "Course Material on Switched Mode Power Conversion" Department of Electrical Engineering Indian Institute of Science Bangalore Second Edition 2006.
[13] Jianping Xu, "An analytical technique for the analysis of switching DC-DC converters" Circuits and Systems, 1991., IEEE International Sympoisum on vol.2 PP.1212 – 1215.
[14] S,Karthik Kumaran , KR Santha ," DSP Control of DC/DC Boost Converter for Fuel Cell based Hybrid Electric Vehicle", IEEE- International Conference On Advances In E.ngineering, Science And Management (ICAESM -2012).
[15] Yabin Zhang, Paol Bagnoli, Emilio Franchi."Theoretical Design of Compact Multi-phase Interleaved Buck DC-DC Converter for Automotive Power Applications" International Symposium on Power Electronics, Electrical Drives, Automation and Motion (SPEEDAM), 2012, Page(s): 1324 – 1329.
[16] Wennan Guo, Praveen K. Jain, "Analysis and Modeling of Voltage Mode Controlled Phase Current Balancing Technique for Multiphase Voltage Regulator to Power High Frequency Dynamic Load" Applied Power Electronics Conference and Exposition, 2009. APEC 2009. Twenty- Fourth Annual IEEE Pages: 1190 – 1196.
[17] Timothy C. Neugebauer and David J. Perreault "Computer aided optimization of DC/DC converters for automotive applications," IEEE Transactions on Power Electronics.VOl.18., NO.3, May, (2003).

