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An Integrated Circuit That Enables Synchronous Motor to Operate In Dual Mode in Order To Boost the output Torque

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Abstract:

Renewable energy is converted into dc and buffered with energy storage elements, and then it is inverted to ac and fed into the utility grid. To use renewable energy more efficiently, dc electricity should be directly supplied to these loads. Such a supply scheme is far different from that of the conventional ac distribution and supply system. A combined circuit for motor drives with an Impedance Network along with dual mode control for EV/HEV applications is proposed. The integrated circuit allows the permanent magnet synchronous motor to operate in motor mode or acts as boost inductors of the boost converter, and thereby boosting the output torque coupled to the same transmission system or dc-link voltage of the inverter connected to the output of the integrated circuit. In motor mode, the proposed integrated circuit acts as an inverter and it becomes a boost-type boost converter, while using the motor windings as the boost inductors to boost the converter output voltage.

Keywords:
Energy management system, Boost converter, inverter, motor drives, MATLAB/SIMULINK.

Introduction:

A DC–DC converter with a high step-up voltage gain is used for many applications, such as high-intensity discharge lamp ballasts for automobile headlamps, fuel cell energy conversion systems, solar-cell energy conversion systems and battery backup systems for uninterruptible power supplies. Theoretically, a dc–dc boost converter can achieve a high step-up voltage gain with an extremely high duty ratio. However, in practice, the step-up voltage gain is limited due to the effect of power switches, rectifier diodes and the equivalent series resistance (ESR) of inductors and capacitors.

In general, a conventional boost converter can be adopted to provide a high step-up voltage gain with a large duty ratio. However, the conversion efficiency and the step-up voltage gain are limited due to the constraints of the losses of power switches and diodes, the equivalent series resistance of inductors and capacitors and the reverse recovery problem of diodes.

BOOST CONVERTER:

A boost converter (step-up converter) is a DC-to-DC power converter with an output voltage greater than its input voltage. It is a class of switched- mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element, a capacitor, inductor, or the two in combination.

Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

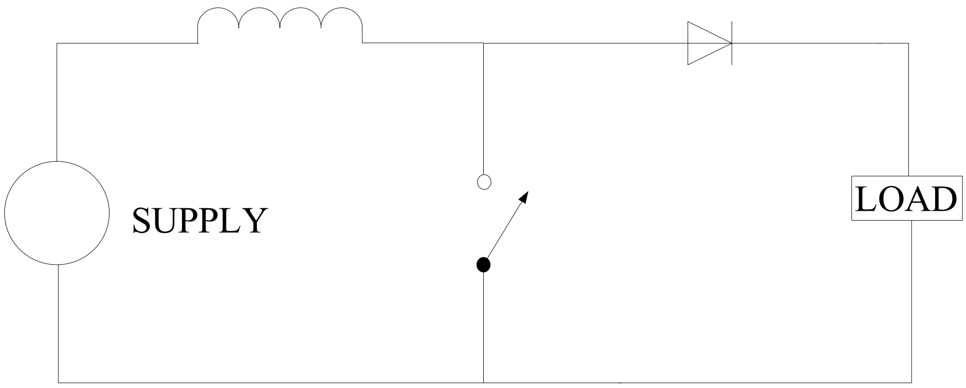

Fig: the basic schematic of a boost converter

HYBRID ELECTRIC VEHICLE

Hybrid Electric Vehicle (HEV) is an emerging technology in the modern world because of the fact that it mitigates environmental pollutions and at the same time increases fuel efficiency of the vehicles. Multilevel inverter controls electric drive of HEV of high power and enhances its performance which is the reflection of the fact that it can generate sinusoidal voltages with only fundamental switching frequency and have almost no electromagnetic interference. This paper describes precisely various topology of HEVs and presents transformer less multilevel converter for high voltage and high current HEV. The cascaded inverter is IGBT based and it is fired in a sequence. It is natural fit for HEV as it uses separate level of dc sources which are in form of batteries or fuel cells. Compared to conventional vehicles, hybrid electric vehicles (HEVs) are more fuel efficient due to the optimization of the engine operation and recovery of kinetic energy during braking. With the plug-in option (PHEV), the vehicle can be operated on electric-onlymodes for a driving range of up to 30–60 km. The PHEVs are charged overnight from the electric power grid where energy can be generated from renewable sources such as wind and solar energy and from nuclear energy. Fuel cell vehicles (FCV) use hydrogen as fuel to produce electricity, therefore they are basically emission free. When connected to electric power grid (V2G), the FCV can provide electricity for emergency power backup during a power outage. Due to hydrogen production, storage, and the technical limitations of fuel cells at the present time, FCVs are not available to the general public yet.HEVs are likely to dominate the advanced propulsion in coming years.

Hybrid technologies can be used for almost all kinds of fuels and engines. Therefore, it is not a transition technology. In HEVs and FCVs, there are more electrical components used, such as electric machines, power electronic converters, batteries, ultra capacitors, sensors, and microcontrollers. In addition to these electrification components or subsystems, conventional internal combustion engines (ICE), and mechanical and hydraulic systems may still be present. The challenge presented by these advanced propulsion systems include advanced powertrain components design, such as power electronic converters, electric machines and energy storage; power management; modeling and simulation of the powertrain system; hybrid control theory and optimization of vehicle control

PROPOSED CONCEPT:

In Parallel hybrid electric vehicle (HEV) and electric vehicle (EV) system as shown in Fig. 3.1, the converter is used for boosting the battery voltage to rated dc bus for an inverter to drive motor. In the multimotor drive system the system will use two or more motors to boost torque, especially under low speed and high-torque region as shown in Fig. below. For such applications, two or more inverters/converters are required. Next Fig shows the application of the proposed integrated circuit for motor drives with dual-mode control for EV/HEV applications.

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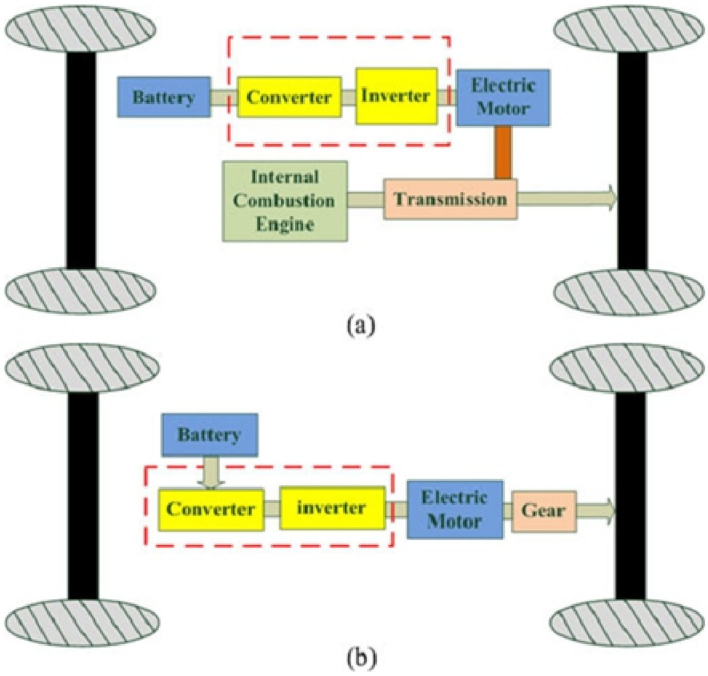
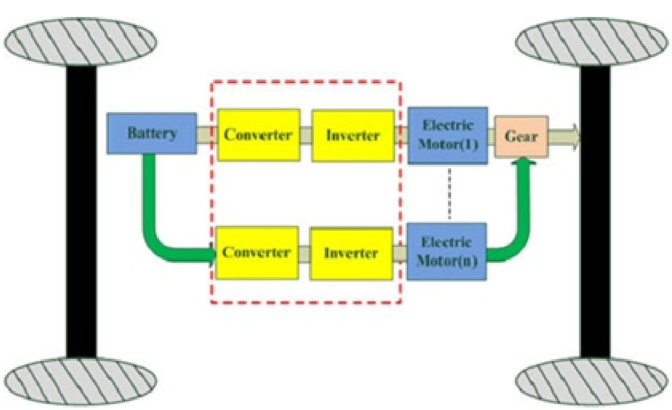
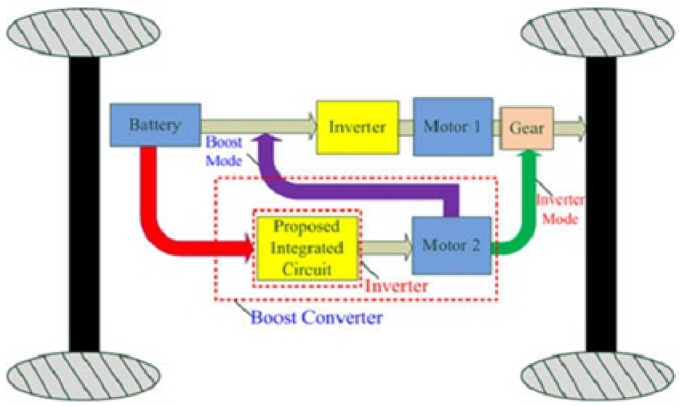


HEV and EV system. (a) Parallel HEV drive train. (b) EV drive train

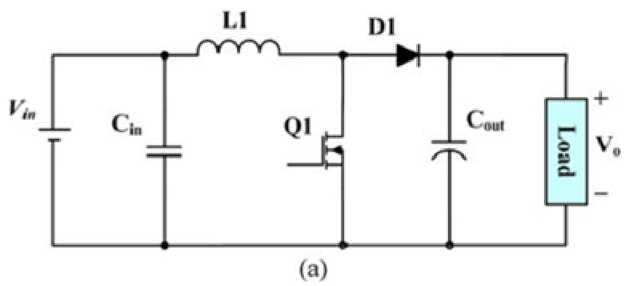


Conventional multimotor drive system of EV/HEV.



Proposed integrated inverter/converter for the multimotor drive system of EV/HEV.

(PMSM) to operate in motor mode or acts as boost inductors of the boost converter, and thereby, boosting the output torque coupled to the same transmission system or dc-link voltage of an inverter connected to the output of the integrated circuit. In motor mode, the proposed integrated circuit acts as an inverter and it becomes a boost-type boost converter, while using the motor windings as the boost inductors to boost the converter output voltage.Therefore, the proposed integrated circuit can significantly reduce the volume and weight of the system. As shown in Fig, the proposed integrated circuit allows the permanent magnet synchronous motor.



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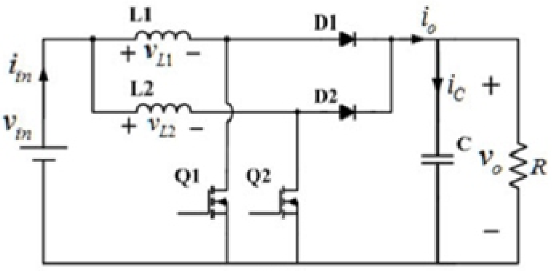


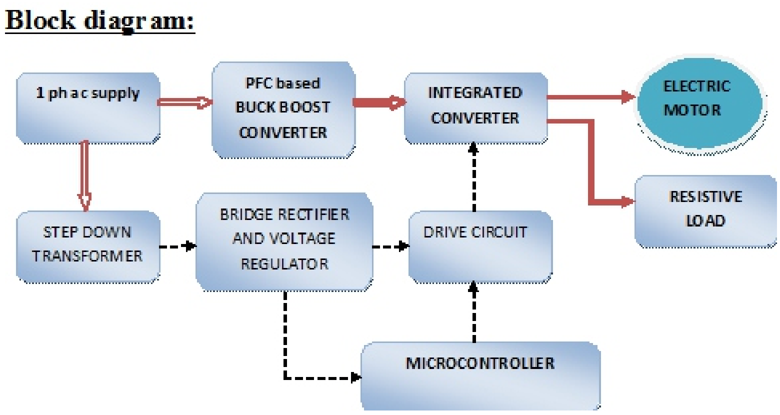
(b)

Boost converter with and without interleaved control. (a) Single-phase boost converter. (b) Interleaved boost converter.

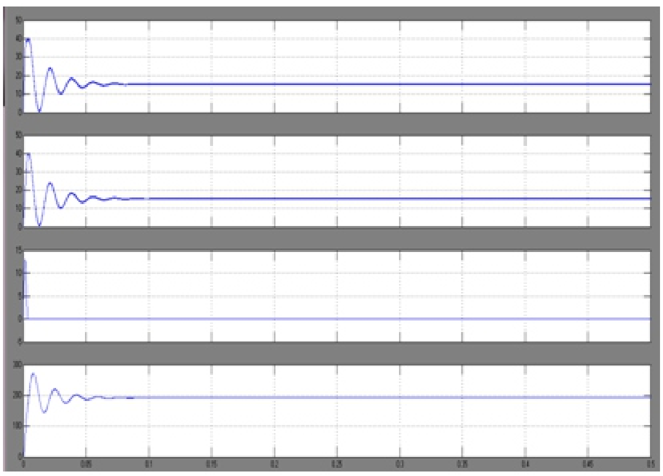
The integrated circuit presented in this project can act as an inverter and a boost converter depending on the operation mode. For the integrated circuit, it not only can reduce the volume and weight but also boost torque and dc-link voltage for motor/converter modes, respectively.

Moreover, a new control technique for the proposed integrated circuit under boost converter mode is proposed to increase the efficiency. For conventional circuit, shown in (a) and (b), a single phase boost converter has been widely used for boost control due to its simplicity. However, for higher power applications, an interleaved boost converter can reduce the current ripple and components stress and thereby reducing the losses and thermal stress. Based upon the interleaved control idea, a boost-control technique using motor windings as boost inductors for the proposed integrated circuit will be proposed. Under light load, the integrated circuit acts as a single-phase boost converter for not invoking additional switching and conduction losses, and functions as the two-phase interleaved boost converter under heavy load to significantly reduce the current ripple and thereby reducing the losses and thermal stress.

Block diagram:



RESULTS:



measured current with and without interleaved control, Single-phase interleaved boost converter.

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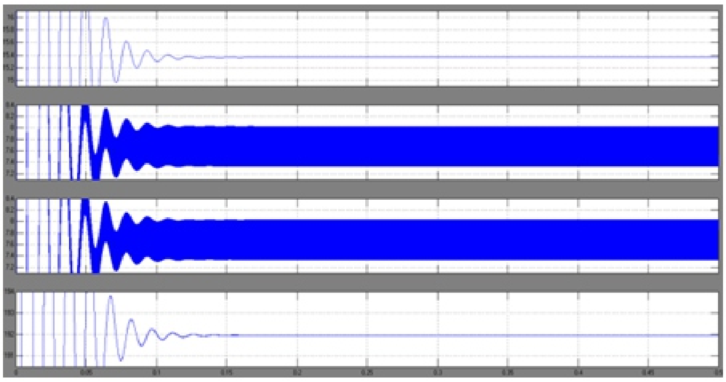
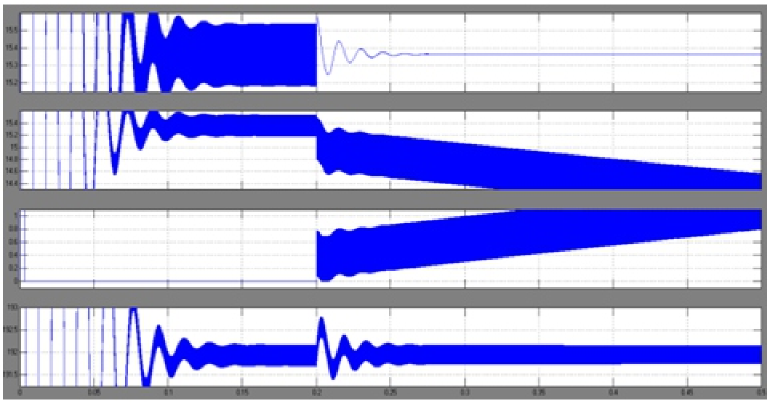
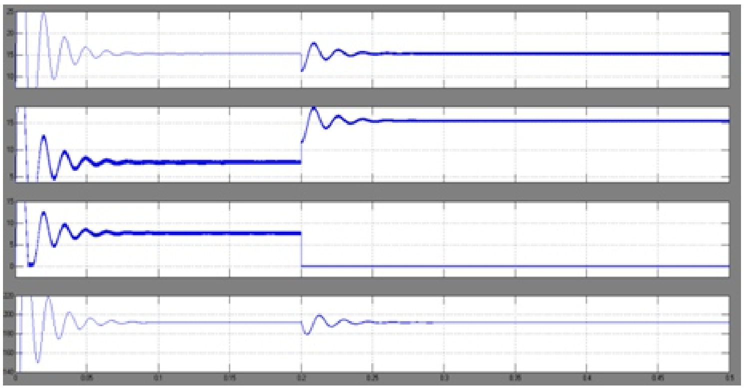


Measured current with and without interleaved control, Two-phase interleaved boost converter.



Simulated waveforms for the transition between single-phase control and two-phase interleaved control from two-phase interleaved to single-phase modes.



Simulated waveforms for the transition between single-phase control and two-phase interleaved control single-phase to two-phase interleaved modes.

CONCLUSION:

The contributions of this project include:

1)proposal of a new integrated inverter/converter circuit ofmotor drives with dual-mode control for EV/HEV applications to significantly reduce the volume and weight;

2)proposal of a new control method for the integrated inverter/converter circuit operating in boost converter modeto increase the efficiency;

3)verification of the proposed integrated inverter/convertercircuit;

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