An Enhanced EV/HEV with Integrated Inverter/Converter Circuit

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Abstract: In renewable energy sources such as photovoltaic (PV), wind, fuel cell, etc gain importance due to the limitations of conventional energy sources. Renewable energy sources play an important role in rural areas where the power transmission from conventional energy sources is difficult. Other advantages of renewable energy sources are clean, light and does not pollute atmosphere.In order to meet the required load demand, it is better to integrate the renewable energy sources with the load. Hybrid electric vehicles(HEVs) powered by electric machines and an internal combustion engine (ICE) are a promising mean of reducing emissions and fuel consumption without compromising vehicle functionality and driving performances.In the inverter mode, the integrated circuit acts as inverter only. But, in the converter mode, the integrated circuit can act as either a single-phase boost converter or two-phase inter-leaved boost converter. To increase the load torque to meet out the power demand by to boost the converter output voltage. This increase in converter output voltage due to two-phase interleaved boost converter mode operation can be used to increase the torque of the motor drive when the drive load is increased

Keywords: Electric Vehicle (EV), Hybrid Electric Vehicle (HEV), Permanent Magnet Synchronous Motor (PMSM)

I. INTRODUCTION

An electric vehicle is an emission free and environmental friendly vehicle. But, the EV has some problems for the usage because of their inefficient performance and cannot be used for long distances without being recharged [3].So, the vehicle which has both efficient performance and emission free feature are mostly liked by the consumers.So, the HEV are to be introduced, the HEV are powered by the electric machines and an internal combustionengine (ICE) are promising mean of reducing emissions and fuel consumption without making disturbances inits function and performance that are to be charged itself. The beauty of the HEV is that energy can be fed backinto the battery for storage during regenerative braking. The supercapacitors and battery were used as an energy storage unit and made it possible to transfer power bi-directionally between wheels and batteries [2]. As, batteries in HEV's have a more dynamic discharging and charging cycles.

With a full range of analog and embedded processing products, it is at the forefront of helping to bring safer, affordable and more efficient electric transportation solutions to market. TI‟s solutions for this industry range from optimized and dedicated integrated circuits to full system-level solutions to help our customers optimize and accelerate productdevelopment. TI‟s experience in diverse markets such as industrial control, industrial motor drives, digital powersupplies, smart metering and grids, wired and wireless communications, consumer electronics, and energy efficiency enables engineers to meet increasing needs for higher speeds,higher precision, lower power and more robust equipment –all while maintaining the high standards of quality andreliability that the automotive and transportation market demands. The hybrid and electric vehicle system is built of several modules to form the drive train and energy storagesystem. The battery block (typically a Li-ion chemistry in therange of 400 V) is managed and monitored by the batterymanagement system (BMS) and charged via an on-boardAC/DC converter module, with voltages ranging from 110-Vsingle-phase to 380-V three-phase systems. The DC/AC inverter uses the high voltage of the battery to drive the electric motor, but also is used for regenerative breaking,storing energy back into the battery. To connect the high-voltage battery to the conventional 12-V board net requires a DC/DC converter. The connection of a high-voltage battery to the inverter also requires a reversible DC/DC converter in most cases. The complete HEV system has to meet specificsafety requirements (up to ASIL-D) that are specifically relevant for managing the high-voltage battery pack, as well as the drive train used for breaking. Plug-in hybrid electricvehicles (PHEVs)and battery electric vehicles (BEVs) aretwo quickly emerging technologies that use powerful electric motors as the propulsion source. In order to power these electric motors, large battery packs are made up of hundreds of cells, totaling 300-400 V installed in the vehicle. Because batteries have a finite energy capacity, PHEVs and BEVs must be recharged on a periodic basis, typically byconnecting to the power grid. The charging system for

these vehicles consists of an AC/DC rectifier to generate a DC voltage from the AC line, followed by a DC/DC converter to generate the DC voltage required by the battery pack.Additionally, advanced charging systems might also communicate with the power grid using power linecommunication (PLC) modems to adjust charging based onpower grid conditions. The battery pack must also becarefully monitored during operation and charging in order to maximize energy usage and prolong battery life. High-performance analog parts are also available to providecritical system functions and features such as sensorfeedback, isolation, chip power supplies and communicationtransceivers. A converter that increases voltage is called a step-up converter and a converter that decreases voltage is called a step-down converter.

II. BACKGROUND WORKS

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage.It is a class of switching-mode power supply (SMPS)containing at least two semiconductor switches (a diode and atransistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination withinductors) are normally added to the output of the converter to reduce output voltage ripple. Power can also come from DC sources such as batteries, solar panels, rectifiers and DC generators. A process that changes one DC voltage to a different DC voltage is called DC to DC conversion. A boost converter is a DC to DC converter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it “steps up” the source voltage. Since power (P = VI) must be conserved, the output current is lower than the source current. A boost converter may also be referred to as a 'Joule thief'. This term is usually used only with very low power battery applications, and is aimed at the ability of a boost converter to 'steal' the remaining energy in a battery. This energy would otherwise be wasted since the battery's low voltage makes it unusable for a normal load. This energy would otherwise remain untapped because in most low-frequency applications,currents will not flow through a load without a significant difference of potential between the two poles of the source(voltage).

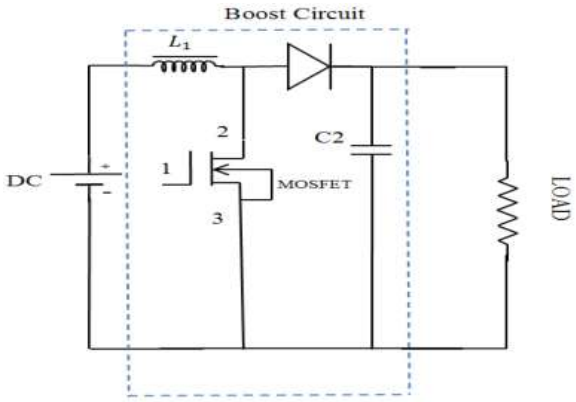


Fig.1. Boost Converter

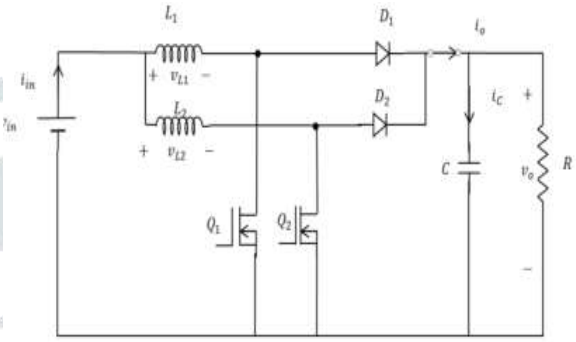


Fig. 2. Interleaved Operation Of Converter

III. SYSTEM CONFIGURATION

Figure 5 shows the integrated circuit for dual mode control. In Figure 5 C in and C out are used to stabilize the voltage when input and voltage voltages are disturbed by source and load respectively. Diode (D) is used to prevent reverse current attainment and voltage impact on the input side.

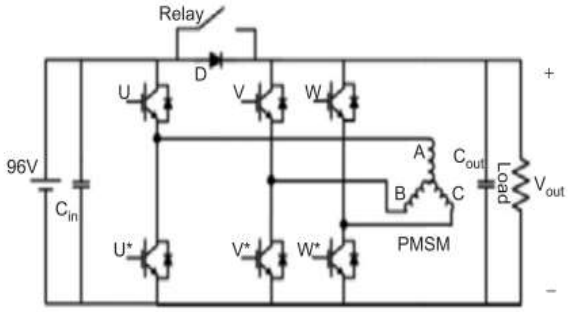


Figure.3 Proposed circuit for dual mode of motoring mode and boost converter

In this paper, Figure 3 shows the proposed integrated circuit act as an inverter or boost converter depending on the operating modes. The conventional boost converter circuits are the most resemblance of the single phase boost converter and also widely used for boost control due to its simplicity. However, for higher power applications the interleaved boost converters are to be preferred. Because all the advantages of interleaving such as higher efficiency and reduced input and output ripple and component stress

thereby reducing the losses and thermal stress are also realized in the boost topology [5]. Interleaved boostconverter model concepts becomes very powerful. Because, it to keep input currents has manageable and to increase the efficiency and meanwhile it's maintaining good power density [6]. In the interleaved controlmethod, the boost- control technique using motor windings as a boost inductor for the proposed integrated circuit.

Motoring (Inverter) Mode: The integrated circuit operate in inverter (motor) mode, the Relay will get turned ON (switch is closed) and six power devices (IGBT-switch) are to be controlled by the PWM control signal [7]. The three phase load is permanent magnet synchronous motor. The three-phase AC voltage is supplied from three phase inverter to PMSM by suitably turn ON and OFF the switches with a delay in 120° mode of operation. PMSM get three phase AC voltage with the mechanical input of torque (T_m).

Boost Converter Mode:

In above Figure 4 shows the two-phase interleaved boost converter, the two converter channels are connected in parallel combination. Channel-1 is composed of switch Q1, Inductor L1, Diode D1 and channel-2 are also composed by the same of Q2, L2, and D2. The Filter capacitor C is shared by the two channels commonly at the output. Whereas, the two channels are connected in parallel but operate in an interleaved mode. With theinterleaving design, the gating signals for switch Q1 and Q2 are identical but shifted by 360°/2 = 180°. Here,the 2 is the no of converter connected in parallel [5].

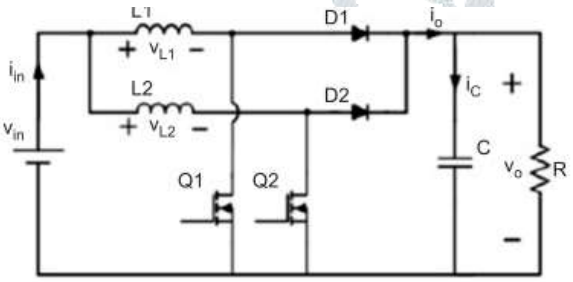


Figure 4 two phase interleaved boost converter

When the proposed integrated circuit is operated in the converter mode, the relay is get turned OFF (switchis open) and single or two-phase interleaved control is applied to control power devices depending upon the load conditions. Two phase interleaved boost converter uses the power switches of V* and W*, the stator windingof A, B and C for boosting the voltage and reduce the current ripple [7].

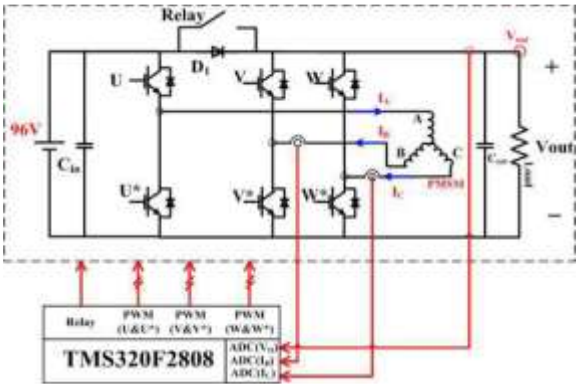
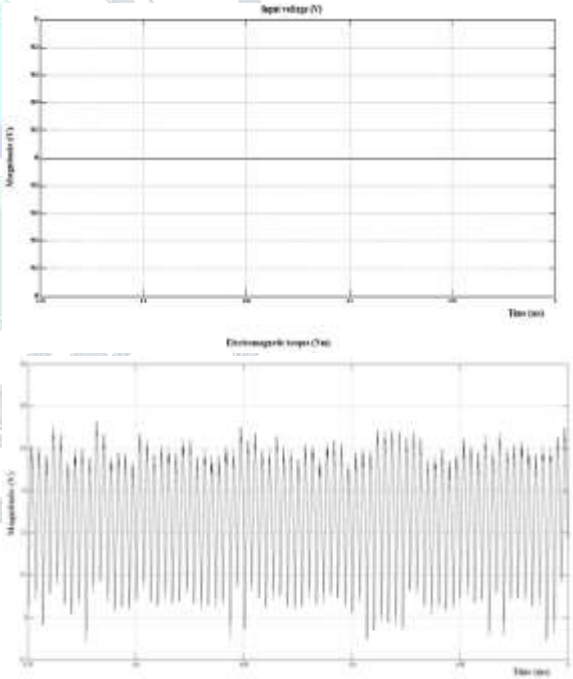


Fig. 5. Block diagram of the integrated circuit and controller.

IV. SIMULATION RESULTS

n the above waveforms, shows the three phase inverter input of DC voltage and output of Electromagnetic torqueof the three phase permanent magnet synchronous motor. Input DC voltage is get from battery alone, becausewhich is based on EV and HEV applications. The three phase AC output voltages are given as the input of threephase motor and by using Demux the motor outputs are to be observed and calculated.



V. CONCLUSION

In this assignment, the integrated circuit is designed for three phase Permanent magnet synchronous motor and its having a competence to operate under the modes of inverter and converter. Using this circuit the three types of operations such as, three-phase inverter, single-phase boostconverter, and two-phase interleaved boost converter is achieved. By this circuit, to boost the converter output voltage and as well as torque of the Motor drive can

beachieved. In the converter mode compared to single-phase boost converter the two-phase interleaved boostconverter provide better output voltage. With the simulation the results will be get related and verified.

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