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IMPLEMENTATION OF VOLTAGE DOUBLERS RECTIFIED BOOST-INTEGRATED HALF BRIDGE (VDRBHB) IN CONVERTER FED DC MOTOR

UPPUNOORI. VENKATA REDDY , AMIYA KUMAR, DEEPAK KADU
Department of Electrical Engineering, Abha Gaikwad-Patil College of Engineering, Nagpur, India.

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Abstract: The major objective of this project is to develop an voltage doubler type boost integrated half bridge DC-DC Converter. The modified dc to dc converter (step-down converter), which has low output voltage and current applications are presented in this paper. DC-DC converter boost half bridge converter is used for battery input applications and digital car audio amplifiers and in converter fed dc motor applications. The operation principles of the modified converter and the advantages are analyzed. Thus it finds itself a major role in various applications some of them being battery input application, measured efficiency of the modified converter. The development involves two stages, first stage is to simulate the various circuits using MATLAB and second stage is the hardware implementation of voltage doubler type boost integrated half bridge DC-DC converter with digital audio amplifier applications.

Keywords: Boost converter, dc–dc converter, half bridge (HB) converter, voltage doubler rectifier(VDR), zero current switching (ZCS), zero voltage switching (ZVS).

Corresponding Author: MR. UPPUNOORI. VENKATA REDDY

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INTRODUCTION

In recent years low voltage and high current power supplies are designed to supply power to micro processors. The modified converter can achieve high step -down voltage with appropriate duty ratio .Generally battery charging and digital audio amplifiers ,converter fed dc motors, these are compact in size and more efficient and has a low profile on-board DC-DC converter is required. Among previously modified DC-DC converters, the boost-integrated half bridge converter is suitable for low voltage battery input applications, because the converter has a continuous input current and boosted link voltage. Therefore, to make digital car audio systems more efficient and more compact-sized, a high efficiency and low profile on-board dc–dc converter is required [9]. Among previously proposed dc–dc converters, the boost-integrated half bridge (BHB) converter shown in figure, is suitable for low voltage battery input applications, because the converter has a continuous input current and a boosted link voltage. In addition, the primary MOSFETs are turned-on under zero-voltage-switching (ZVS) condition [10], [11]. However, the main disadvantages of the BHB converter are the high dc magnetizing current of the transformer, high voltage stress and large turn-off voltage oscillation of the secondary rectifier diodes, increased magnetic components count, and considerable freewheeling energy in the transformer. Furthermore, it can be disturbed by the output inductor to supply large instantaneous output current according to abruptly-varying audio signals. In this paper, to overcome these disadvantages of the BHB converter, a new voltage doubler rectified boost-integrated half bridge (VDRBHB) converter is proposed by employing VDR.

The operational principles of the proposed converter are analyzed and the advantages are described.

Boost converter

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 a transistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

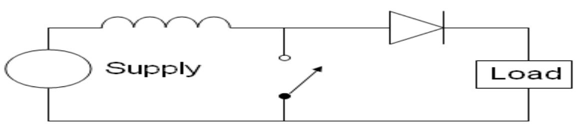


Fig 1: Boost converter Diagram

The basic schematic of a boost converter. The switch is typically a MOSFET, IGBT, or BJT. Switched systems such as SMPS are a challenge to design since its model depends on whether a switch is opened or closed. Applications are Battery powered systems often stack cells in series to achieve higher voltage. However, sufficient stacking of cells is not possible in many high voltage applications due to lack of space. Boost converters can increase the voltage and reduce the number of cells. Two battery-powered applications that use boost converters are hybrid electric vehicles (HEV) and lighting systems. This energy would otherwise be wasted since the low voltage of a nearly depleted battery makes it unusable for a normal load. This energy would otherwise remain untapped because many applications do not allow enough current to flow through a load when voltage decreases.

Continuous mode

Wave forms of current and voltage in a boost converter operating in continuous mode. This is shown below.

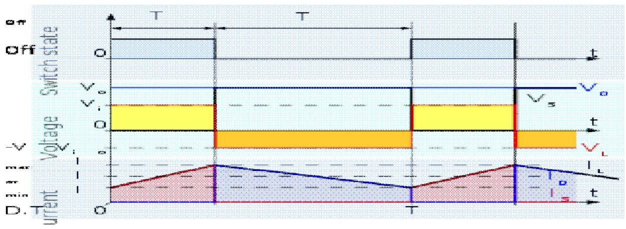


Fig 2: Continuous mode wave form

When a boost converter operates in continuous mode, the current through the inductor (I_L) never falls to zero. Figure 3 shows the typical waveforms of currents and voltages in a converter operating in this mode. The output voltage can be calculated as follows, in the case of an ideal converter.

Discontinuous mode

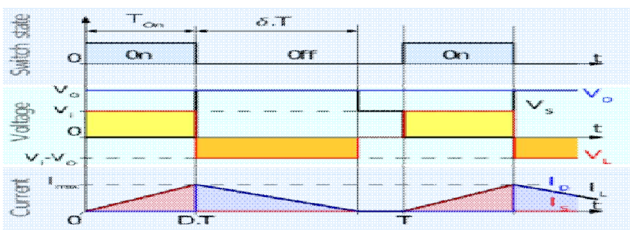


Fig 3: Discontinuous mode wave form

Wave forms of current and voltage in a boost converter operating in discontinuous mode. This is shown below.

In some cases, the amount of energy required by the load is small enough to be transferred in a time smaller than the whole commutation period. In this case, the current through the inductor falls to zero during part of the period.

Voltage doubler

A voltage doubler is an electric circuit with an AC input and a DC output of roughly twice the peak input voltage. They are a variety of voltage multiplier circuit and are often, but not always, a single stage of a general form of such circuits. The term is usually applied to circuits consisting of rectifying diodes and capacitors only. A voltage-doubler rectifier includes an ac full bridge diode rectifier and a dc-to-dc converter having two output boost circuits. One of the output boost circuits is coupled between the rectifier and a dc link, and the other output boost circuit is coupled, with opposite polarity, between the rectifier and the circuit common. Two series-connected filter capacitors are also coupled between the dc link and the circuit common. In a preferred embodiment, the two output boost circuits each comprise either a series, parallel, or combination series/parallel resonant circuit and a rectifier. A switch is coupled between the junction joining one pair of diodes of the rectifier and the junction joining the two filter capacitors. For a relatively high ac line voltage, the switch is open, and the circuit operates in a low boost mode. For a relatively low ac line voltage, the switch is closed, and the circuit operates in a high boost, or voltage-doubling, mode.

Half wave voltage doubler

The Delon circuit uses a bridge topology for voltage doubling. This form of circuit was, at one time, commonly found in television sets where it was used to provide an . voltage supply. Generating voltages in excess of 5kV with a transformer has safety issues in terms of domestic equipment and in any case is not economic. However, black and white television sets required an e.h.t. of 10kV and colour sets even more. Voltage doublers were used to either double the voltage on an e.h.t winding on the mains transformer or were applied to the waveform on the line fly back coils.

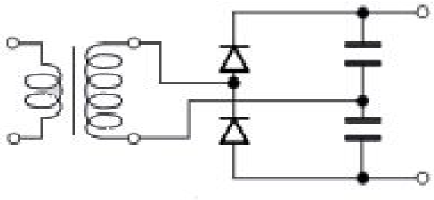


Fig 4.Half wave bridge circuit

Full wave voltage doubler

The circuit consists of two half-wave peak detectors, functioning in exactly the same way as the peak detector cell in the Greinacher circuit above. Each of the two peak detector cells operates on opposite half-cycles of the incoming waveform. Since their outputs are in series, the output is twice the peak input voltage.

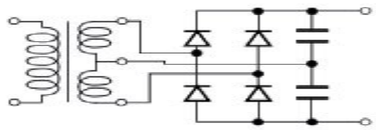


Fig 5.Full wave Voltage Doubler

A full-wave version of this circuit has the advantage of lower peak diode currents, improved ripple and better load regulation but requires a centre-tap to the transformer as well as more components.

Resonant Switch

Prior to the availability of fully controllable power switches, thyristors were the major power devices used in power electronic circuits. Each thyristor requires a commutation circuit, which usually consists of a *LC* resonant circuit, for forcing the current to zero in the turn-off process. This mechanism is in fact a type of zero-current turn-off process. With the recent advancement in semiconductor technology, the voltage and current handling capability, and the switching speed of fully controllable switches have significantly been improved. In many high power applications, controllable switches such as GTOs and IGBTs have replaced thyristors. However, the use of resonant circuit for achieving zero-current-switching (ZCS) and/or zero-voltage-switching (ZVS) has also emerged as a new technology for power converters. The concept of resonant switch that replaces conventional power switch is introduced in this section.

A resonant switch is a sub-circuit comprising a semiconductor switch *S* and resonant elements, L_r and C_r. The switch *S* can be implemented by a unidirectional or bidirectional switch, which determines the operation mode of the resonant switch. Two types of resonant switches, including zero-current (ZC) resonant switch and zero-voltage (ZV) resonant switches, are shown in Fig.3 and Fig.4, respectively.

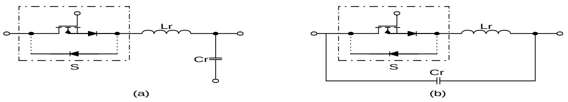


Fig.6 Zero-current (ZC) resonant switch.

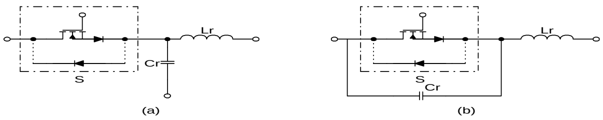


Fig.7 Zero-voltage (ZV) resonant switch.

Zero Current resonant switch

In a ZC resonant switch, an inductor L_r is connected in series with a power switch *S* in order to achieve zero-current-switching (ZCS). If the switch *S* is a unidirectional switch, the switch current is allowed to resonate in the positive half cycle only. The resonant switch is said to operate in *half-wave* mode. If a diode is connected in anti-parallel with the unidirectional switch, the switch current can flow in both directions. In this case, the resonant switch can operate in *full-wave* mode. At turn-on, the switch current will rise slowly from zero. It will then oscillate, because of the resonance between L_r and C_r. Finally, the switch can be commutated at the next zero current duration. The objective of this type of switch is to shape the switch current waveform during conduction time in order to create a zero-current condition for the switch to turn off.

Zero Voltage resonant switch

In a ZV resonant switch, a capacitor C_r is connected in parallel with the switch *S* for achieving zero-voltage-switching (ZVS). If the switch *S* is a unidirectional switch, the voltage across the capacitor C_r can oscillate freely in both positive and negative half-cycle. Thus, the resonant switch can operate in *full-wave* mode. If a diode is connected in anti-parallel with the unidirectional switch, the resonant capacitor voltage is clamped by the diode to zero during the negative half-cycle. The resonant switch will then operate in *half-wave* mode. The objective of a

ZV switch is to use the resonant circuit to shape the switch voltage waveform during the off time in order to create a zero-voltage condition for the switch to turn on.

DC source:

It is the first stage of this project. So it is give the DC supply to Inverter. The DC source may be Battery or fuel cell or rectified from AC source

Inverter:

It is used to convert dc to ac voltage.the phase shift pulsemethosd is used to control the inverter as a result to achieve the ZVS .

High Frequency Transformer:

It is used for step down purpose. It is also used for isolation purpose. The transformer size should be small due to high frequency.

Double boost Rectifier:

It converts AC supply to DC supply. DC supply having some ripples. It is filtered with the help of capacitor filter.

Filter**:**

Rectifier converts AC to DC. This output has ripples. It is filtered with a help of Capacitor filters.

Operating principles

The proposed converter operates in four modes according to the switching states of the primary MOSFETs and the secondary diodes. The operational modes and the key waveforms are presented. Before, the sum of Ilk and flows through Qm

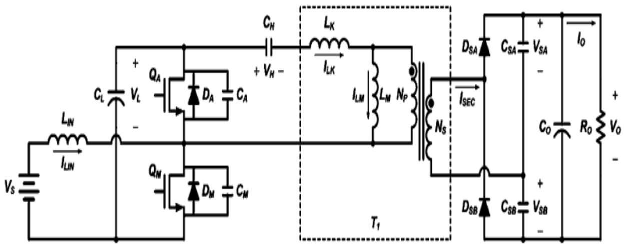


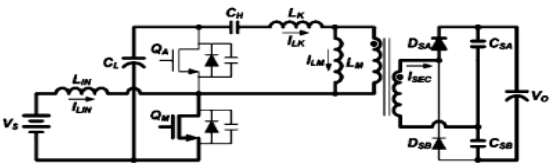
Fig 8:Circuit diagram of the VDRBHB converter

Mode 1 :

When Isec is increased to zero and Dsb is turned-off at , mode 1 begins and Dsa is turned-on, as shown in Fig. (a). The boost inductor current Ilin, and the transformer primary current Ilk, flow through Qm , and linearly increase. The respective slopes of these current are given by

$$\frac{d}{dt}I_{L_{\rm IN}} = \frac{V_S}{L_{\rm IN}},$$
$$\frac{d}{dt}I_{L_K} = \frac{1}{L_K}\left[(V_L - V_H) - \frac{N_P}{N_S}V_{\rm SA}\right].$$

The transformer's secondary current Isec, flows through Dsa and linearly increases, while Csa is charged and Csb is discharged.



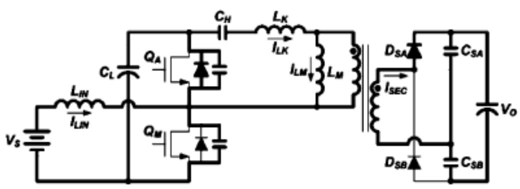
(a)

Mode 2:

When Qm is turned-off at t1, mode 2 begins, as shown in Fig. (b). The sum of Ilin and Ilk initially flow through the parasitic output capacitors Cm and Ca. WhenCa is fully discharged to zero, the sum of Ila and Ilkcommutates to the anti-parallel body diode Da. By firing Qa after the full discharge of Ca, we can achieve ZVS turn-on of Qa. Both ILk and Ilin decrease linearly with the respective current slopes of the following equations:

$$\frac{d}{dt}I_{L_{\rm IN}} = \frac{V_S - V_L}{L_{\rm IN}}$$
$$\frac{d}{dt}I_{L_K} = \frac{1}{L_K}\left[(-V_H) - \frac{N_P}{N_S}V_{\rm SA}\right].$$

Isce flows through Dsa and abruptly decreases, while Csa is charged and Csb is discharged.



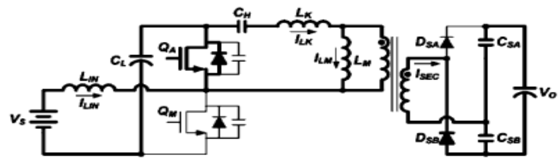
(b)

Mode 3 :

WhenIsec is decreased to zero and Dsa is turned-off at t2, mode 3 begins and Dsb is turned-on, as shown in Fig. (c). Ilk and Iin decreases linearly with the slopes of (3) and (5), respectively. The sum of Ilin and Ilk initially flows through Da, and then it transits to Qa under ZV turn-on condition, since Ilk decreases with steeper slope than Ilin

$$\frac{d}{dt}I_{LK} = \frac{1}{L_K}\left[(-V_H) + \frac{N_P}{N_S}V_{\text{SB}}\right].$$

Isec flows through Dsb and linearly decreases, while Csa is discharged and Csb is charged.

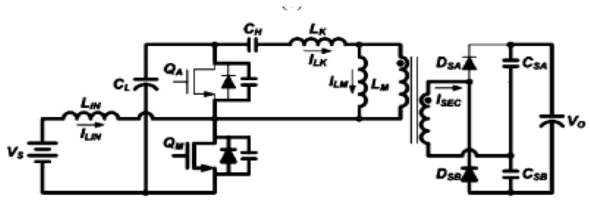


(c)

Mode 4 :

When Qa is turned-off at t3, mode 4 begins, as shown in Fig. (d). The sum of Ilk and Ilin flows through the parasitic capacitors, discharging Cm and charging Ca . When Cm is fully discharged to zero, the sum of Iin and Ilk commutates to Dm . Provided that the gating signal of Qm,Vgs(Qm) becomes actively high when Cm is fully discharged to zero, ZVS turn-on of Qm can be obtained and the sum Ilin of and Ilk flows through Qm . Similarly to mode 1, Ilin increases linearly with the slope of the (1), and Ilk increases abruptly increases with the slope of the (6)

$$\frac{d}{dt}I_{LK} = \frac{1}{L_K}\left[(V_L - V_H) + \frac{N_P}{N_S}V_{\text{SB}}\right].$$



(d)

Isec flows through Dsb and abruptly decreases, while Csa is discharged and Csb is charged.

SIMULATION RESULTS AND DISCUSSION

VDRBHB converter

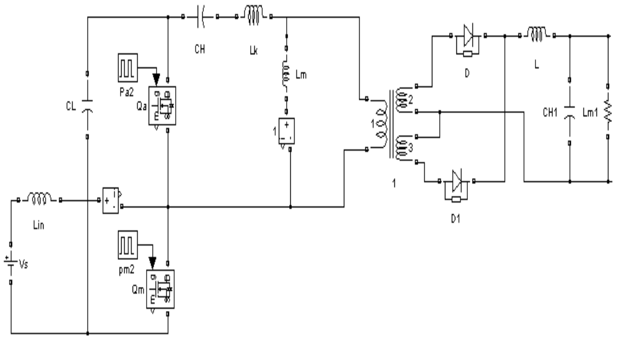


Fig 9. Conventional BHB Converter Circuit Diagram

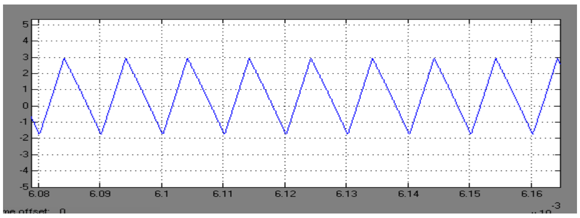


Fig 10: Current Through Lin

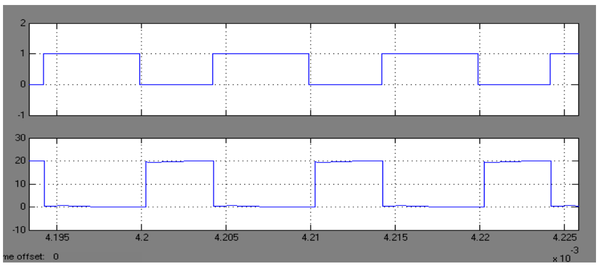


Fig 11: Driving Pulse And Voltage Across Switch Qa

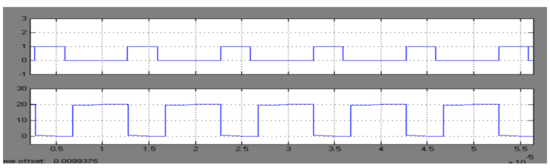


Fig 12: DRIVING PULSE AND VOLTAGE ACROSS SWITCH Qm

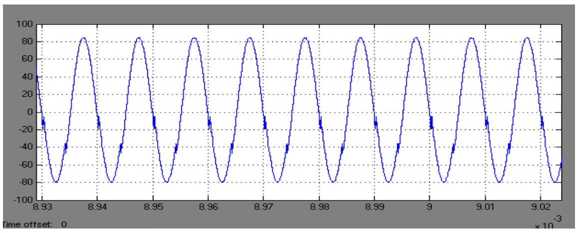


Fig 13: Transformer Output Voltage

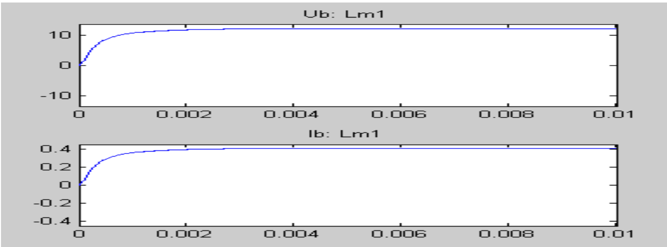


Fig 14: Output Voltage And Current

Proposed converter

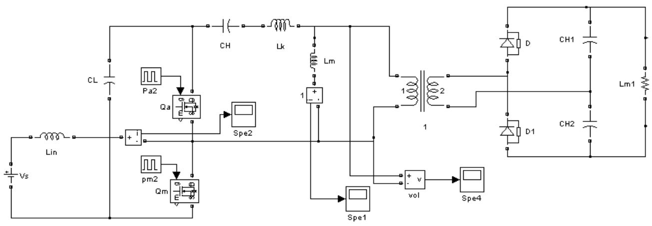


Fig 15: Proposed Converter Circuit Diagram

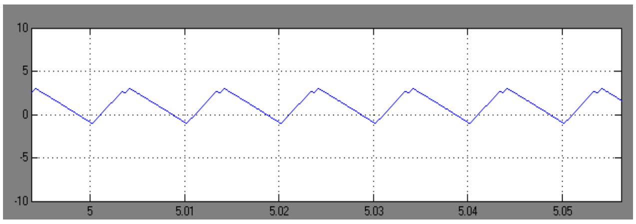


Fig 16: Current Through Lin

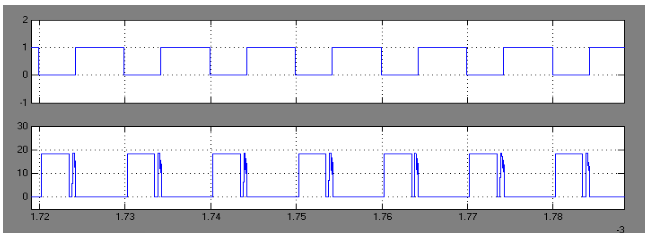


Fig 17: Driving Pulse And Voltage Across Switch Qa

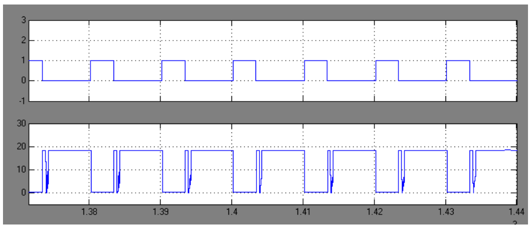


Fig 18: Driving Pulse And Voltage Across Switch Qm

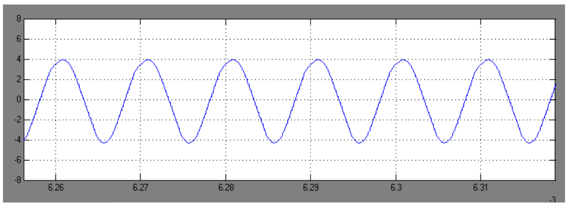


Fig 19: CURRENT THROUGH Lm

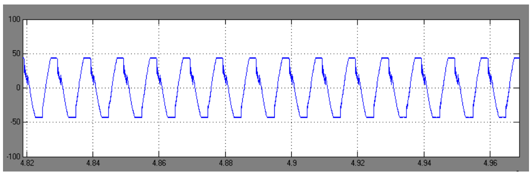


Fig 20: Transformer Output Voltage

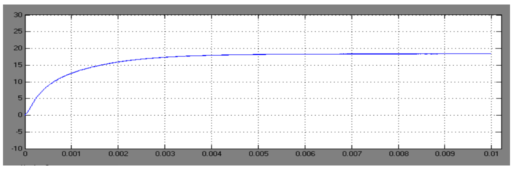


Fig 21: Output Voltage And Current

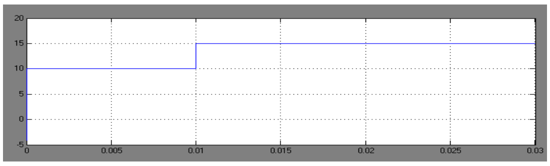


Fig 22: Input Voltage With Disturbance

VDRBHB FOR MOTOR LOAD

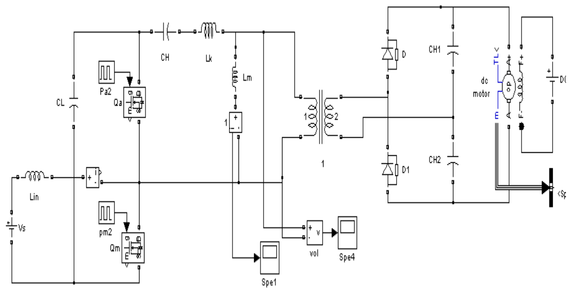


Fig 23: Circuit Diagram

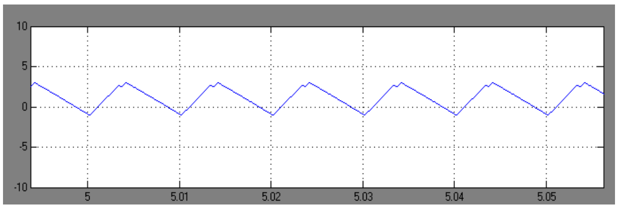


Fig 24: Current Through Lin

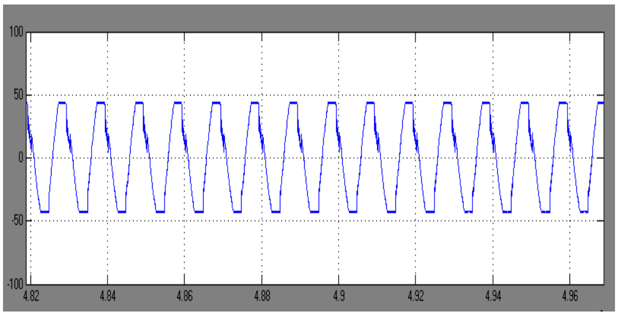


Fig 25: Transformer Output Voltage

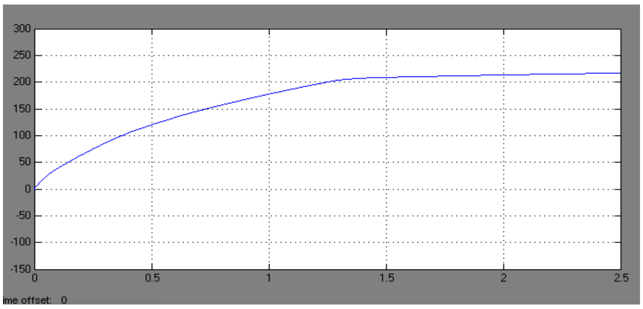


Fig 26: Armature Speed

CONCLUSION

In this paper, a new VDRBHB converter for converter fed dc motor or battery charging applications and digital car audio amplifiers proposed. The proposed converter shows no dc magnetizing current for the transformer, low voltage stresses of the overall active components, ZCS turn-off of the secondary diodes, and no output inductor. Furthermore, the proposed converter has a wide ZVS range for the primary MOSFETs and a continuous input current. The operational principles of the proposed converter are analyzed and the advantages are described. The measured efficiency of the proposed converter is 88.3% at the nominal input voltage and it is higher than that of the BHB converter at the overall input voltage range The proposed converter demonstrates suitability for high efficiency and low profile on-board dc–dc converters for digital car audio amplifiers and other low input voltage applications

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