Soft-Switching HBC for Multiple E-Source Vehicles

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Abstract

A soft- switching half bridge dc-dc converter (HBC) suitable for electrical vehicles is designed and proposed in this paper. The minimum number of power switching devices are used designed the HBC. The proposed HCB resonant circuit has only two Zero Current power switching (ZCS) devices at primary side and four Zero Voltage power switching (ZVS) devices at secondary side of high frequency transformer, with operating switching frequency of 100kHz and input multiple source are maintained constant, and varied the PWM modulation of power switching devices, due to reduced switching losses, stress, increasing frequency, improved efficiency and performance, The proposed module is designed and simulated results are analyzed using MATLab 2009a.

Index Terms - *HBC, ZCS, ZVS,MATLab.*

I. INTRODUCTION

Your goal is to simulate the usual appearance of papers in the. We are requesting that you follow these guidelines as closely as possible.

The nation was faced lot of economic issues, due to by use of fossil fuel, it has suffered from some factor such as more cost, less efficiency, more contribution of CO_2 and reduced GDP (Gross Domestic Product) was 7.1% in India past year, in the various field of agriculture, industry and transportation system etc. To avoid/curb these above said issues, GDP based upgraded in the field of Transportation System (TS).

The Transportation System (TS) become very important sector to enhance national economy[1-10]. In developing country any increase in the petro-chemical fuels and products prices directly effects on GDP of that nation. The world eco-friendly impacts and native eco-friendly and health impacts are prim issues of the day.

It may preferred the alternative source of hydride energy supply or multiple source based power electronics converter for transportation application other than that of petro-chemical fuels or Internal combustion engine(ICE) become more economically and optimal challenges place in near future, reason that more advantages, such as simple, compact is size, portability, less weight, less volume and good efficiency etc.

EV's , hybrid energy source or multiple input source as input , it consist of parallel combined three sources such as fuel cell stack, DC source and battery , series resistance, input capacitor , boost leakage inductance, two leakage inductances are connected in series with power switches each other , connected in ZCS and transformer leakage inductance at primary side of HFT and four power switches are connected as bridge rectifier in ZVS of secondary of HFT ,it connected through active filter out put leakage inductance and capacitor for load (R/RL-load) as shown in Figure 1.

In the majority of recent transportation vehicles, required the power of proposed converter referred by utilize the hybrid energy source with a bi-direction converter for transportation vehicle applications. The terminal voltage of hybrid source of 24V and switching frequency of 100 kHz maintained constant and regulated by used pulse width modulation power switches in both side to meet required level of output voltage range from 60 to 70V and power of 200W.

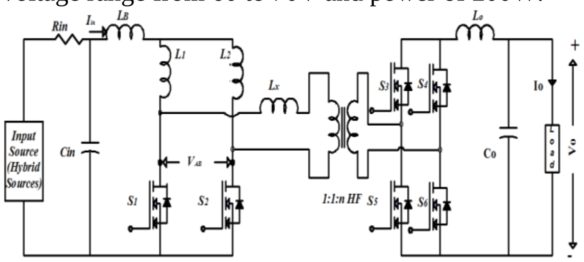


Figure 1. Half-Bridge resonant Converter

II. CONVERTER OPERATION

The converter operation with assumptions explained, use of ZCS in primary and ZVS in secondary of HFT. Primary side of power switching devices are turned off and turned on, output voltage appears across a HFT of Vo/n. The primary side power switches are used as power MOSFET's are S_1, and S_2, turned on the range of pulse width modulation of S_1=25% and S_2=75%, connected ZCS of HFT. Secondary side of HFT, the power MOSFET's are S_3,S_4,S_5,and S_6 , connected as bridge type rectifier and turned on 20% pulse width modulation with use of hybrid or multiple input source of 24V with operating switching frequency of 100kHz.

The assumptions are made as follows for converters,

i) Input leakage inductances (L_1, L_2)are large, assumed kept current constant through them.

ii)The transformer leakage inductance or magnetizing inductance kept assumed to be infinitely.

iii) The components of all are ideal.

iv) Lx is the transformer leakage inductance or series inductance which is includes the transformer leakage.

The basic stable-state operating [1], the pulse width modulation of switches are S_1<25% and S_2>75% in ZCS of primary and S_3 to S_6 are 20% in ZVS of secondary of HFT, pulsating gating signals shifted in the phase angle by 180_0 along with overlap each other. The overlap varies with the pulse width modulation of duty cycle with fixed high frequency is fixed at 100 kHz [1-2], are selected for desired output level.

III. CONVERTER DESIGN

The HBC resonant converter designed steps are explained [1] and on selected of the hybrid/multiple input voltage Vi_n=24V, R_{in}=0.1mΩ, C_1=200μF, L_1=L_2=94μH, L_x=1.7μH , C_o=220μH, R_o=22.62Ω, L_o=100mH, HFT=1150VA rating, output V_o=60-70V, output voltage (nominal=65V), output power P_o=200W, and switching frequency of the power devices f_s=100kHZ.

IV. SIMULATION MODELS

Two modules with resistive load and resistive-inductive load are simulated as explained in this section, simulation based on soft-switching with half bridge resonant is designed in MATLab-2009a, it consisting of hybrid/multiple input source parallel combination of fuel cell, DC voltage, battery of 24V, two power Switches S_1, S_2 are connected to leakage inductances L_1, L_2 in series with power switches in each, transformer leakage inductance Lx, connected in ZCS at primary. Similarly, four power switches (S_3 to S_6) are connected as bridge rectifier in ZVS at secondary side of HFT and also connected through filter circuit to resistive (R_ load) side as shown in Fig.2. Similarly, R-load is replaced by R-L-load (R=21.62Ω, 100mH) as shown in Figure 3.

The simulated results are explained for hybrid multiple input source side parameter of half bridge resonate converter with Resistive load (R=21.62 Ω,) and R-L load(R=21.62 Ω, L=100mH), hybrid input voltage =24V, with operating switching frequency kept constant at 100 kHz are maintained throughout simulation.

Figure 4 input waveforms are closly coincide both R-load and R-L Load shown for is Hybrid input voltage of 24V, input current Iin is observed in scope , linearly increases from 0 to arround reach at peak between 8 and 11A , input power is, defined as the product of input voltage and current , linearly increases from 0 to 280W with respect to time from 0 to before reach time is 0.006seconds, at this duration current and power are going to fluctautes from 0sec to before 0.01sec, after 0.01sec, current going to reach 8 to 9 A and power going to reach 180 to 250 W are shown in the time range of 0.01 to 0.05sec , are shown in Figure 4.

Figure 5 shows current waveforms passing through three primary switches connected in the of series two inductors with switches and transformer leakage inductance are L_1, L_2 and L_x are respectively in undergoes ZCS at the primary side HF.

Current of leakage inductor (L_1), I_1 is start from 5.5A is linearly increases at peak reach 6.2A then again linearly decreases from peak to 4.4A, again repeat same sequence to reach linearly at 6.2A in triangular shape up to with respect to time, repeated previous steps to reach same time up to 0.05s as shown in Figure 5 (a).

I_2 is start from 3A is linearly increases at peak reach 4.8A then linearly decreases from peak to 4.8 A to 3A with respect to time of 0 sec to 0.01sec, same as repeated previous steps to reach same time up to 0.05s as shown in Figure 5(b).

The current through inductance I_x is continuous as illustrated within the analysis. It reflects the 2 primary-side switch currents. I_x is start from -3A is linearly increases at peak reach 7A then again linearly decreases from peak to nearly around -3A again linearly increases 7A with respect to time up to 0.01sec, same as repeated previous steps to reach same time up to 0.05s as shown in Figure 5(c). The results are shows the current waveforms through power switches devices at primary side of HFT transformer in ZCS turn off, turned on, including their respective diodes currents I_{s1}, I_{s2} and secondary side of HFT. Undergo ZVS switches including their respective body diodes. Owing to gate pulses for the primary devices their currents Is1 is starts Zero to increases 11A , naturally decreases through zero to -3A , as repeated same sequence with respect to time range from 0 to 0.05s as shown in Figure 6(a). Switch current of I_{S2} is start from 0A to 11A, and again linearly to -3 A , again linearly increases to 11A through Zero , repeated previous steps same w.r. t. time 0 to 0.05s as shown in Figure 6(b).

Secondary side of HFT ,in ZVS Switch current of I_{S3} is start negative sequence from 0A to -8.5A , and again linearly increases from -8.5A to 0A , as a not pure width Zero , repeated previous steps same w.r. t. time 0 to 0.05s as shown in Figure 6(c). Secondary side of HFT ,in ZVS Switch current of I_{S4} is start negative sequence from -2.5 to 2A , and again naturally fall to zero during short time , linearly decreases from 0 to -5.5A , again negatively increase to -2.5 as a not pure width , repeated previous steps same w.r. t. time 0 to 0.05s as shown in Figure 6(d).

For rectification, body diode physical phenomenon is illustrated. Therefore, devices with quick intrinsic diodes area unit required. Also, the devices are often modulated as synchronous rectifier.

Figure 7 shows the half bridge DC-DC converter topology for R-Load(21.62Ω) for EV's application, observed here, Output voltage, current , power are noting that Vo=65V, Io=3A, Po=200W are linearly smoothly increases w.r.t. time period from 0sec to 0.05sec with disturbances in the system.

Figure 8 shows, the half bridge DC-DC converter topology for R-L-Load (21.62Ω, 100mH) for EV's application, observed here, Output voltage, current, power are noting that Vo=65V, Io=3A, Po is defined as product of output voltage and current, it is reach at peak of 230 W to reach 200-W onwards stable with linearly smoothly increases w.r.t. time period from 0sec to 0.05sec without disturbances in the system. It's resulting in that, good performances and effectiveness, competiveness.

EVs have the powerful to change the climate, upcoming in the future, it has positive good environmental nature, in social, with competiveness, with economic globe impact, that improved the nation or smart city by to significantly reduce the dependence on foreign oil and eliminate harmful. In additionally, FCVs are required for quick charging and refueling (charging and no range and charging limitations) are more complexity, because it is grid independent. However, cost and charging electricity and time, effective efficiently, better performances are more challenges. Also, FCVs for best suitable for electrolyser or Hydrogen production/storage board in only industry purpose. Also, EVs quick charging and interference with smart grid, huge number of EVs are connected in parallel at same time with same locations for mobile network, vehicle networks, also in commercial, local, private, public sector, agriculture, industries etc.

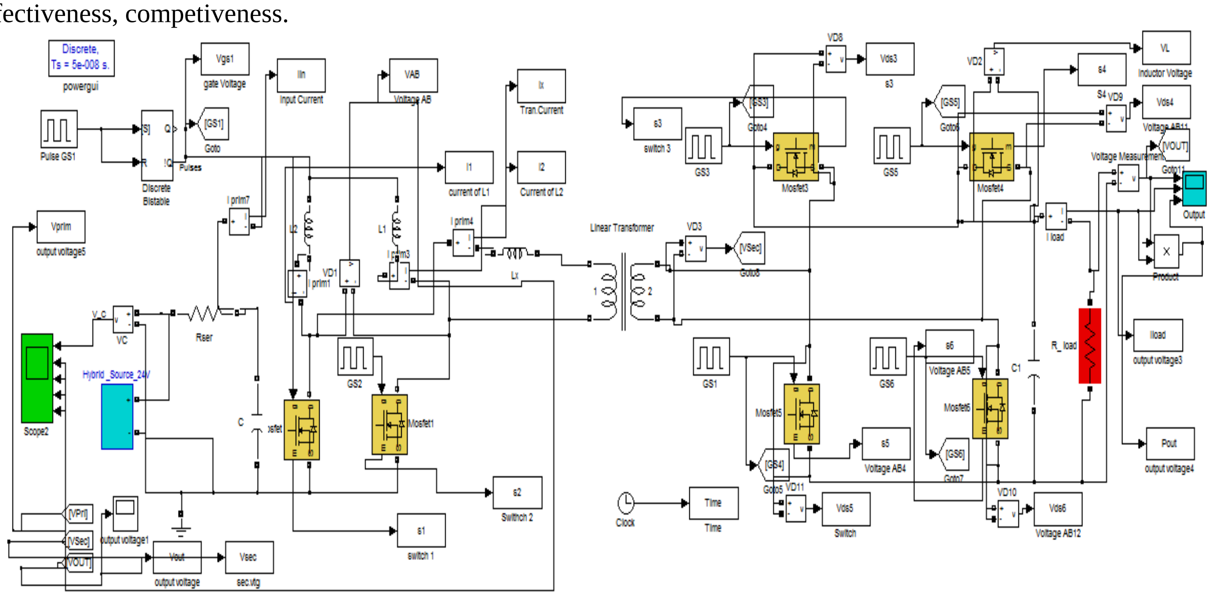


Figure 2. Experimental simulation module of half-bridge resonate converter for R-load

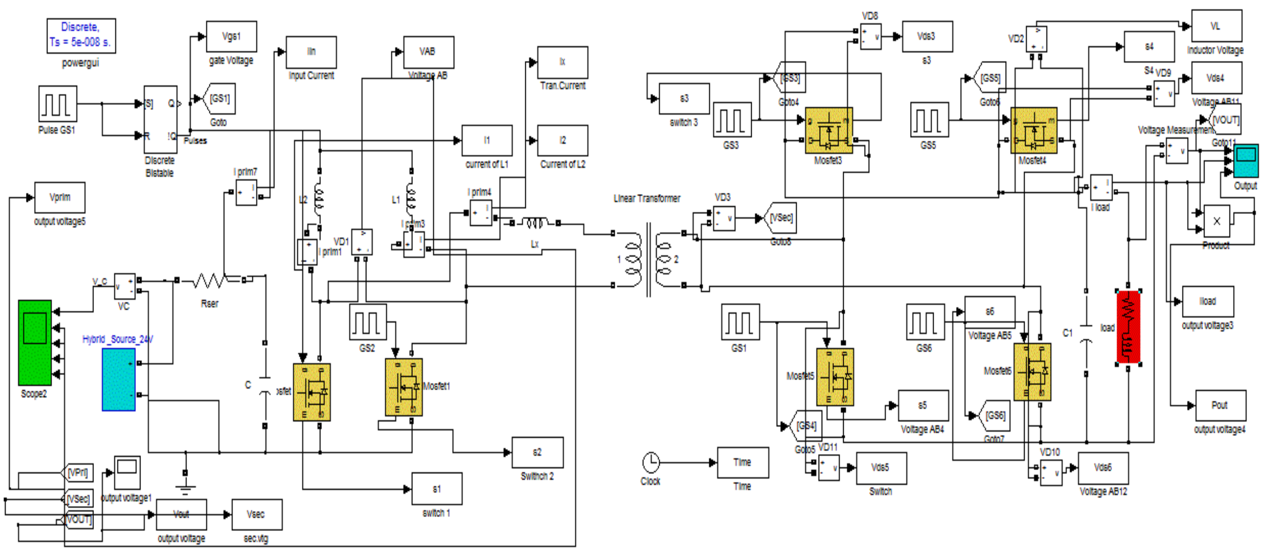
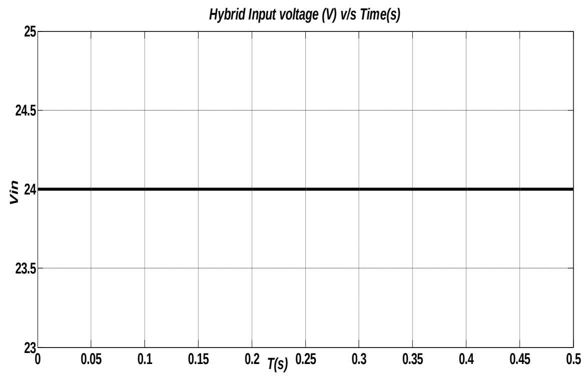


Figure 3. Experimental simulation module of half-bridge resonate converter for RL-load.



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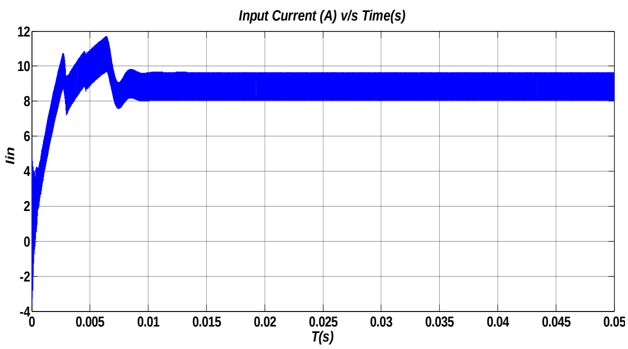

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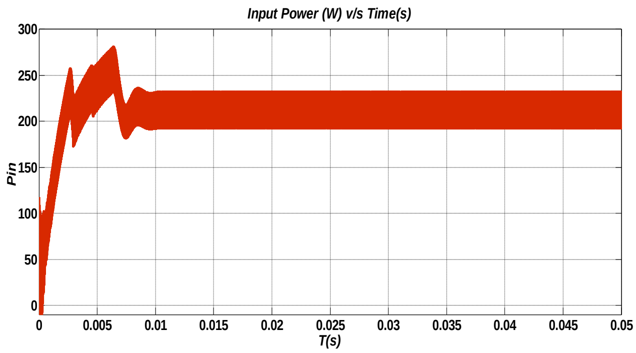

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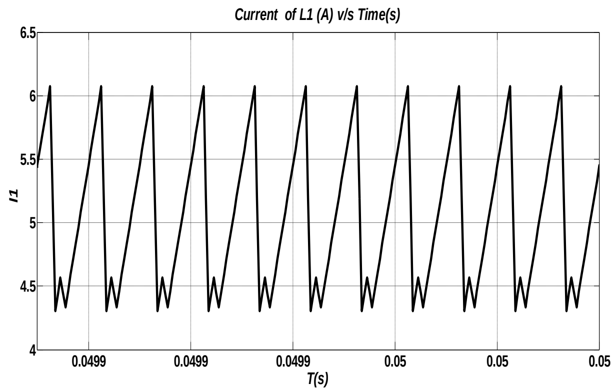
Figure 4. Input waveforms (a) V_{in}=24V, (b) input current (I_{in}),(c) Input Power (P_{in})



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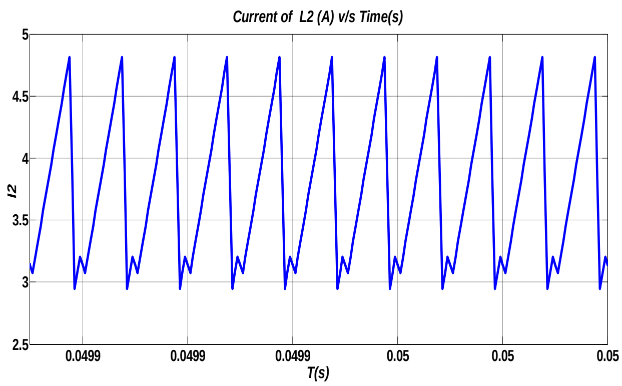

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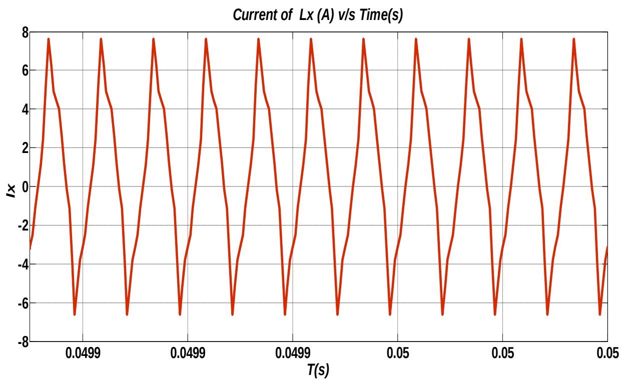

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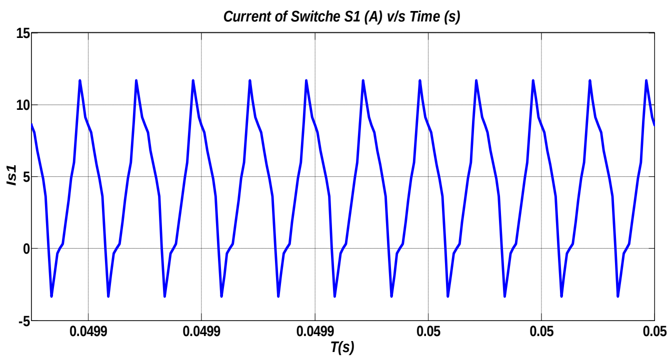
Figure 5. current waveforms through L_1, L_2, and Lx are (a)I_1,(b)I_2,(c)I_x



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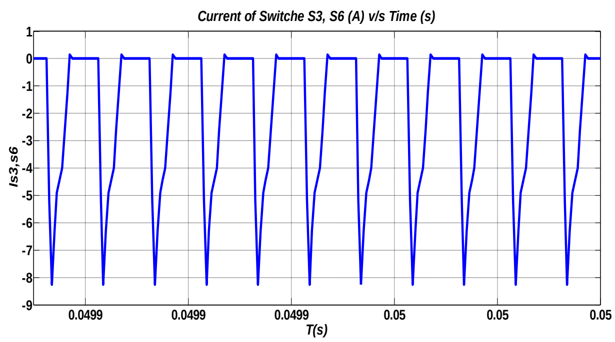

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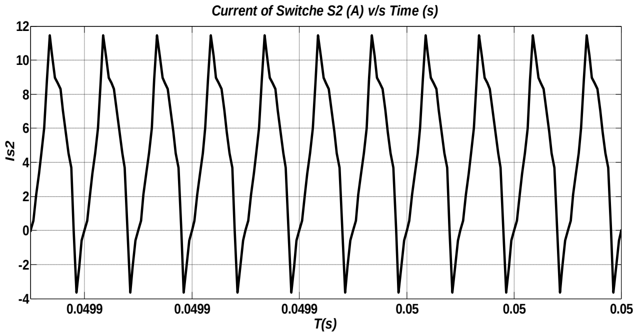

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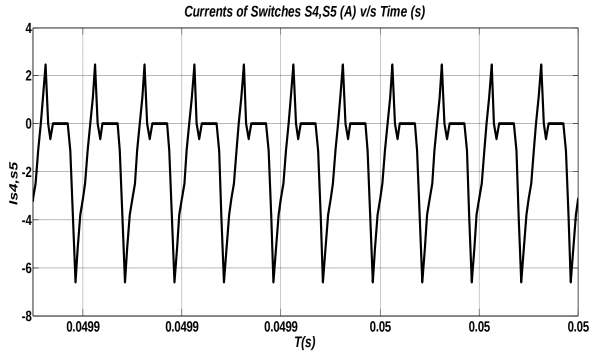
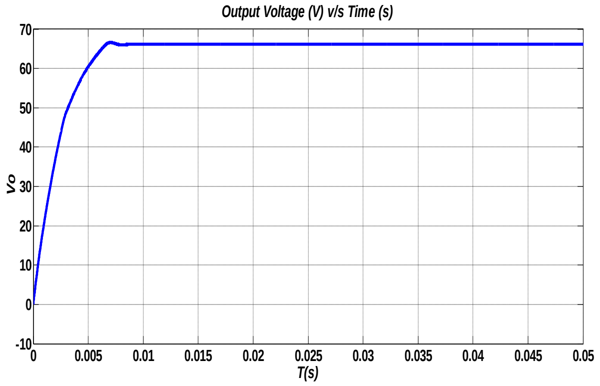


(d)

Figure.6. current waveform through the Switches s_1,s_2,s_3,s_4,s_5,s_6 (a)I_{s1}, (b)I_{s2},(c)$I_{s3,s6}$ (d)$I_{s4,s5}$.



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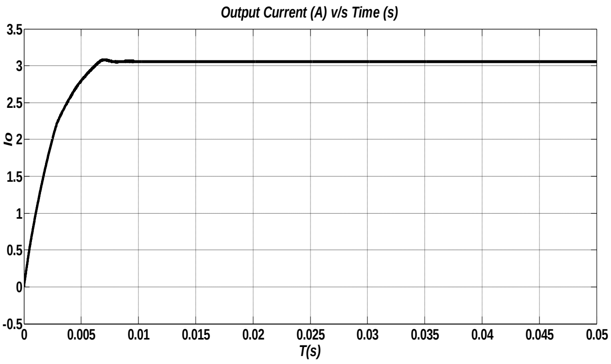

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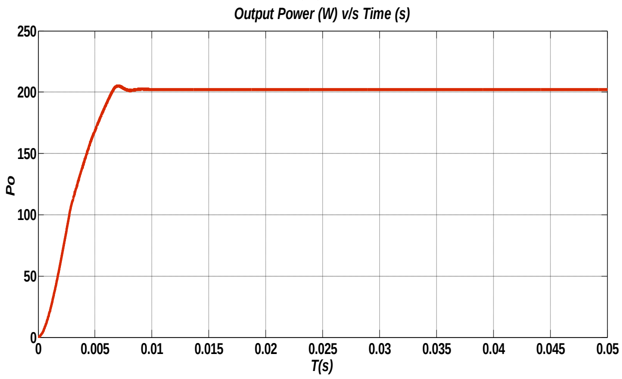

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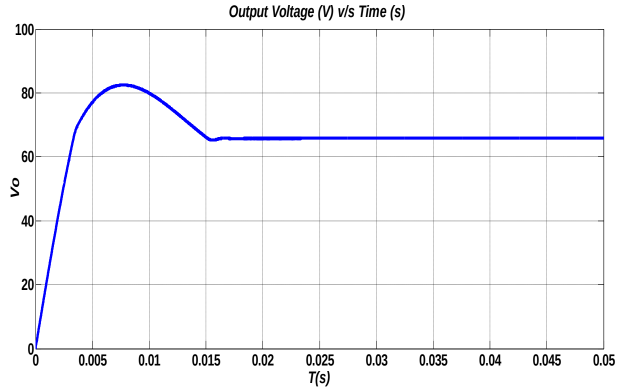
Figure 6. Output waveforms of R-Load (a) V_o,(b)I_o,(c)P_o.



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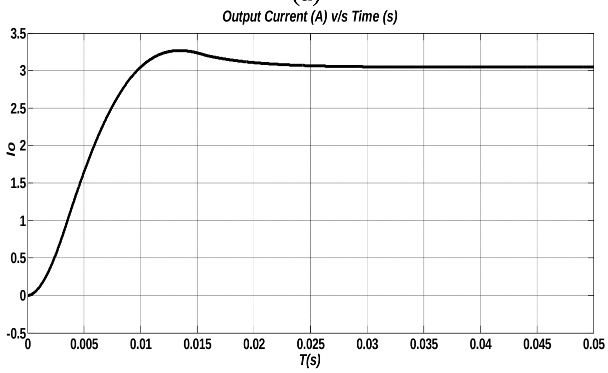

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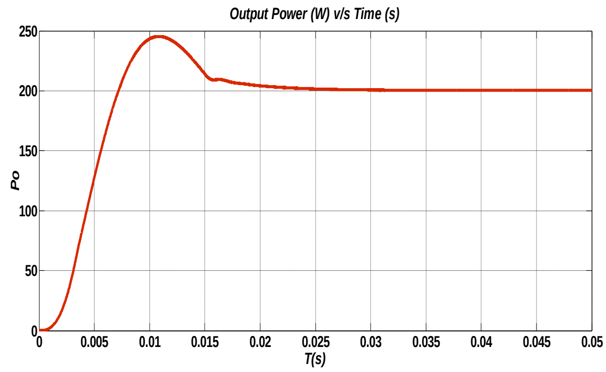

(c)

Figure 7. Output waveforms of RL-Load (a)Vo, (b) Io, (c) Po.

V. CONCLUSION

A soft-switching used to smooth control of half bridge resonate converter for transportation applications. The use of two number of power switches devices are in

ZCS of primary and four number of power switches devices in ZVS secondary of HFT. Switches are controlled by use of PWM varied with help of fixed the operating switching frequency of 100kHz, Hybrid/ multiple input source of 24V. This module was designed, demonstrated, and analyzed simulated results by use the simulink of MATLab 2009a. The proposed method or topology better suitable for high-current with low voltage devices, as such, DC-source grid, fuel cell stack, and battery based application. It is a powerful topology for interfacing to a high voltage dc-bus from low –hybrid/multiple voltage source.

The proposed converter output results such as, voltage, current and power are stable at the time of 0.01sec for R-Load and 0.025sec for RL-load. The rating of converter output parameter are V_o=65V, I_o=3A, and P_o=200W for R-Load/RL-load (R_o=22.62Ω, L_o=100mH) and these gives better with optimal performance of the system.

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