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ZVS LLC-RESONANT PUSH-PULL DC-DC CONVERTER

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ABSTRACT

The ZVS LLC-Resonant Push-Pull DC-DC Converter is presented in which LLC resonating components are arranged in different fashion. The LLC resonant converter is more popularly used where narrow frequency variation over wide load variation, zero voltage switching even under no load condition and improved efficiency. The new proposed LLC topology is used to reduce switching stress and the MOSFET primary switches operates under zero voltage switching(ZVS) conditions due to commutation of snubbing effect of transformer magnetizing current and drain-source capacitance. The circuit model developed in PSIM are analised and simulated. The circuit simulations and experimental results are presented, the experimental results of DC-DC converter match with the simulated results.

Keywords—LLC converter,push-pull technique,pulse width modulation.

I. INTRODUCTION

In modern technology the smart power supplies are used for different applications. These power supplies have high switching frequency, high efficiency and high power density to meet these trends resonant power supply are more attractive because these converter operates in high switching frequency and high efficiency.

Nowadays the resonant converter topologies, different fashion of L and C components are arranged toreduce switching losses and noise. The resonant technique process the power in a sinusoidal form and the switching devices turn-on and turn-off softly [1]. To increase the switching frequency the system size and weight reduces and increase power density, it is necessary to reduces power losses [2].

Using LLC topology the ZVS technique is applied to the load side. From this technique the voltage across the switches are turned to zero during turn-on and turn-off, this prevents sparking of the switches and reduces switching stress [3]. The transformer of secondary side LLC connected. These LLC elements force the voltage across switch to zero during turn-on and turn-off [4]. The interleaved active clamping DC-DC converter primary side a constant frequency asymmetrical converter and secondary side is a series resonant tank circuit, this will improve the efficiency [5]. Other LLC topologies presented in literature [6]-[10] has advantages such as reduce switching losses, conduction losses, increase the efficiency and reducing the cost and size of the supply. Figure1 represents the block diagram of ZVS LLC push-pull DC-DC converter.

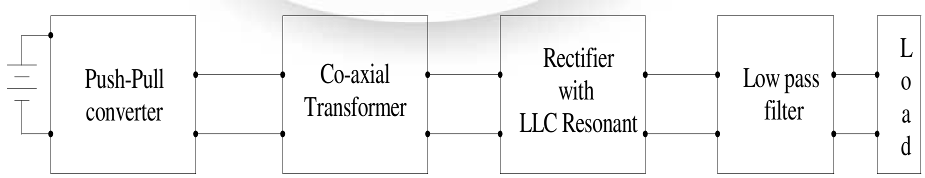

Figure1.Block diagram

II. LLC RESONANT PUSH-PULL TOPOLOGY

In push-pull topology the switch S1 and S2 primary side of the circuit which S1 conducts S2 is off and vice versa, i.e. at a time one switch conducts this reduces the voltage drop. Theswitch S1 and S2 provide 50% duty cycle, and 180^0 phase shift. The equal current flows through both the switches. The square wave from the

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switches is applied to the primary side of transformer. The magnetizing current flows through the body diodes of MOSFET which leads to zero voltage turn on.

The transformer coaxially wound with two turn Centre trapped primary winding and single turn at secondary side. The proposed LLC resonant topology Lm is parallel with secondary side winding of transformer Lr oscillates Cr1, Cr2. The LLC components resonates with twice the switching frequency of S1 and S2, resonating frequency remains constant over different loading. With this reduces stress on MOSFET, size of transformer and resonating elements become small at high switching frequency. [7] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

III. MODES OF OPERATION

The proposed converter has eight operation stages. Referring literature [11]. Stage1 S1 turned on inductor current increases linearly, S2 keeps off. Stage2 inductor current resonates its peak value the rectifier current decreases to zero. Stage3 S1 turned off, on primary side inductor current begins to charge parasitic capacitors of S1 and voltage of the primary side of transformer decline along with S2 of parasitic capacitor discharged to keep voltage balance. Stage4 the voltage and inductor current across S2 decreases to zero. At end of stage4 main switch S2 turn on under ZVS. Similarly stage1 to stage4 repeats again for switch S2.

IV. DESIGN CONSIDERATION

The transformer is designed according to the input and output values using ferrite E-core. LLC resonating tank circuit designed referring literature [12][13][14]. The L and C component is designed with desired switching frequency. Large value of capacitance reduces voltage stress on diodes, introduce high ripple current and large value of inductance reduce ripple current. The optimum value of inductor and capacitor selected for ripple free output current and voltage.

V. SIMULATION RESULTS

LLC resonant push-pull converter consist of DC input source, push-pull topology, full bridge rectifier, purposed LLC resonant converter, high frequency transformer, filter circuit and resistive load as shown in figure2. The DC input is inverter using push-pull topology which is connected to primary side of the transformer. When S1 turns on the upper half winding of Centre tap transformer conducts and S2 turns on the lower winding conducts. The transformer secondary side connected proposed LLC resonant tank circuit. The output of LLC is connected to DC using full bridge rectifier circuit.

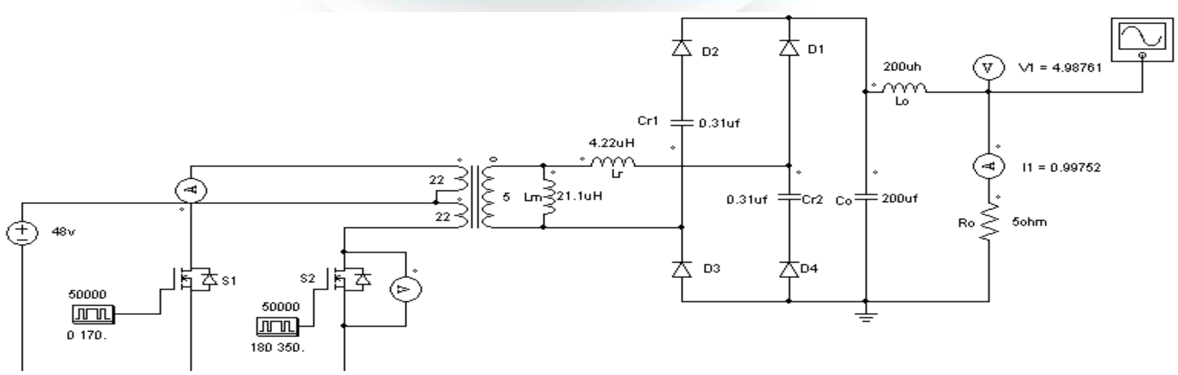

Figure2.Simulated circuit of ZVS LLC push-pull converter

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The proposed converter is simulated using PSIM software. For simulation propose value chosen are Vi=48V,Vo=5V,Io=1A,Fs=50kHz,Lm=21.1uH,Lr=4.22uH,Cr1 and Cr2=0.31uF,Lo=200uH,Co=200uF.

The output voltage is shown in figure3. The output current is shown in fig4.

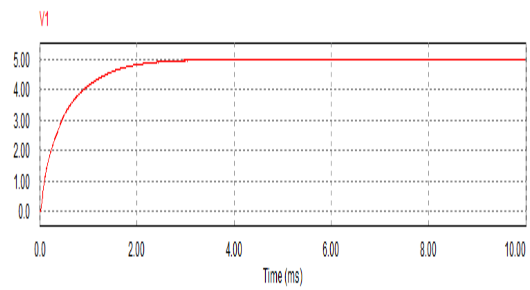

Figure3.Output voltage

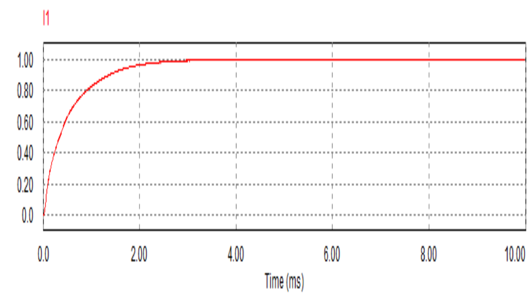

Figure4.Output current

VI. EXPERIMENTAL SETUP AND RESULT

The experimental set up of ZVS LLC push-pull DC-DC converter fed resistive load is shown in figure5. The gating pulses for MOSFET (PFB2N60) switching are generated by PWM generator IC (UC3526). The gate pulse wave form is shown in figure6.

Figure5. Experimental setup

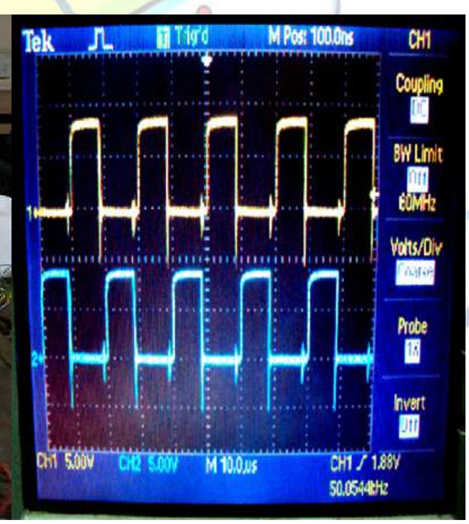

Figure6.Gate pulse waveform of S1and S2

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Figure7. Secondary side of transformer waveform

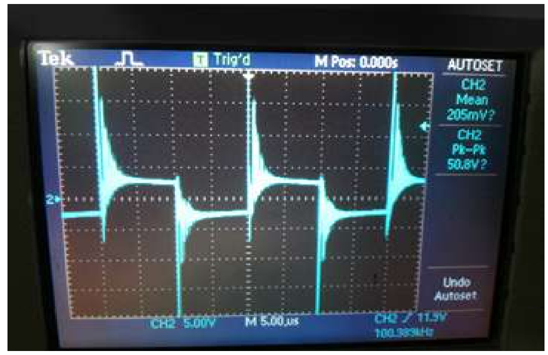

Figure8. VGS and VDS voltage waveform

The secondary side of transformer waveform is shown in figure7. The gate pulse voltage across gate to source and switching voltage drain to source voltage waveform across switch is shown in figure8, by analyzing the waveform we get to know zero voltage switching phenomena taking place. The output voltage and current of converter is shown in figure9 and figure10 respectively.

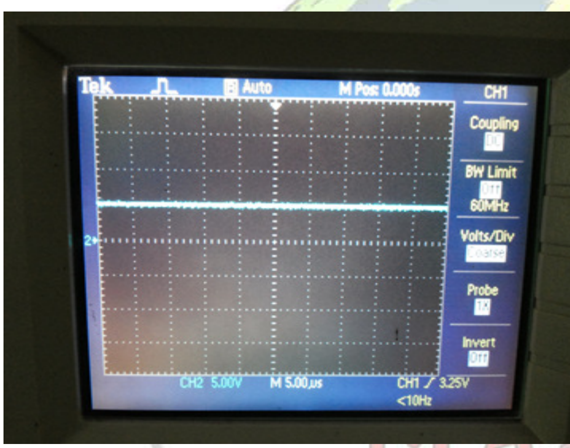

Figure9. Output voltage waveform

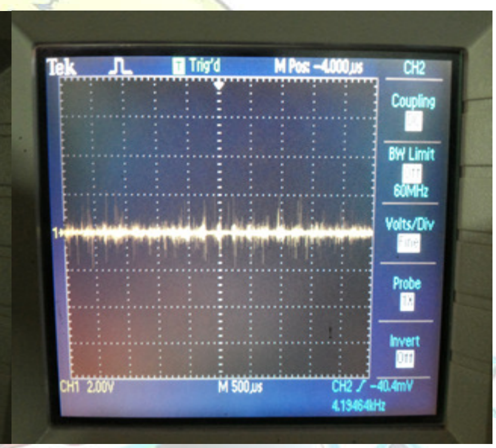

Figure10. Output current waveform

VII. CONCLUSION

The proposed LLC resonant converter is designed and the DC to DC converter system was successfully simulated using PSIM model. Proposed LLC is suited for unregulated DC-DC conversion from a high voltage to low voltage source. The circuit exhibits ZVS for the MOSFET switches. The LLC resonance reduces the transformer size, resonating components and stress across switches. Compared to other topologies proposed LLC topology gives better result. The ZVS LLC push-pull converter experimental results are presented. The designed values of output voltage and current are verified with simulation and experimental results.

REFERENCES

[1] A.F.Witulski and R.W.Erickson, "Design of the series resonant converter for minimum stress,"IEEE Trans.on Aerospace Elec.,vol.AES-22,pp. 356-363,July 1986.
[2] W.S.Choi and S.M.Young, "Improving system reliability using FRFET in LLC resonant converters," IEEE 2008 Power electronics specialist conference, pp.2346-2351
[3] K.H.Liu and F.C.Lee, "Zero voltage switching technique in DC-DC converter," Conf.Rec. IEEE PESC 86,1986,pp.58-70.
[4] "Generalised topology for converter with reactive energy storage," Conf.Rec.IEEE-IAS Annu Meeting,1989,pp.1147-1151.
[5] T.-H. Hsia, H.-Y. Tsai, D.chen, M. Lee, and C.-S.Huang, "Interleaved active-clamping converter with ZVS/ZCS features," IEEE Trans. Power Electron.,vol.26 no.1, pp.29-37, Jan.2011.
[6] B. Yang, F. C. Lee, A. J. Zhang, and G. Huang,"LLC resonant converter for front end DC/DC conversion," APEC 2002, vol.2, pp. 1108-1112.

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Available online at www.ijartet.com

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[7] Christo Ananth, M.A.Fathima, M.Gnana Soundarya, M.L.Jothi Alphonsa Sundari, B.Gayathri, Praghash.K, "Fully Automatic Vehicle for Multipurpose Applications", International Journal Of Advanced Research in Biology, Engineering, Science and Technology (IJARBEST), Volume 1,Special Issue 2 - November 2015, pp.8-12.

[8] R. Beirand, B. Rashidian, M. R. Zolghadri and S. M. H. Alavi" using LLC resonant converter for designing wide range voltage source", IEEE transactions, vol.58, n0.5, pp-1746-1756, May 2011.

[9] Y. Chen, X. Wu, Z. Qianand W. Zhang, "Design and optimization of a wide output voltage range LED driver based on LLC resonant topology," ICPE & ECCE-2011, pp.2831-2837.

[10] F. Musavi, M. Craciun, D. S. Gautam, W. Eberle and W.G. Dunford, "An LLC resonant DC-Dc converter for wide output voltage range battery charging application," IEEE transaction on power electronics, vol no.99, p 1-1, Dec 2013.

[11] Wei Chen, Zhengyu Lu, Xiaofeng Zhang and Shaoshi Ye, "A novel ZVS step-up push-pull type isolated LLC series resonant DC-DC converter for UPS systems and its topology variations," Applied Power Elec. Confer. And Explore 2008.

[12] Shivaraj L, "Modeling and simulation of LLC resonant converter for photo voltaic system," IJETIE, vol1,issue4,April 2015.

[13] Hangseok Chroi, Fairchild semiconductor, "Design consideration for an LLC resonant converter"

[14] M.Santhosh Rani and Subhransu Sekhar Dash "Performance analysis of LLC-LC resonant converter fed PMDC motor," IJC&A,vol.8,no-4-2015,pp. 117-136.