An Interleaved Fly-back Converter with a Common Active Clamp for High Efficient Power Conversion

Nishalini Delcy J. A [#], Surendar. M [*]

[#] *Fourth Sem, M.E, Power Electronics Drives,*
Department of Electrical & Electronics Engineering,
C.S.I College of Engineering Ketti, Nilgiri district, Tamil nadu

**Assistant Professor*
Department of Electrical & Electronics Engineering,
C.S.I College of Engineering Ketti, Nilgiri district, Tamil nadu

Abstract

In many applications, an effectual dc-ac converter is required as an interface, for generating the power. In this paper a fuel cell is represented in order to create high power that composes of an active clamp fly-back converter. This proposed topology is used to accretion a 12-Vdc voltage into 220-V 50 Hz ac voltage. The proposed method has the following advantages such as zero voltage switching and zero current switching combined action. By using this method the voltage stresses in primary and secondary switches could be reduced. In addition for the amorphous purpose from dc to ac a single phase full bridge inverter is used, in order to accommodate low harmonic distortion. Additionally the proposed method makes the complex method easier and consumes high efficient power.

Index Terms--- Fuel cell, active clamp flyback converter, single phase full bridge inverter.

I. Introduction

The fast improvement of power electronics circuits due to new application demand advance technology growth in semiconductor switches micro electronics and new ideas in control algorithm increases power switches. The application of fuel cell has become most businesslike in order to compensate fossil fuel [l], [2]. The fuel cell is clean aseptic biome energy from hydrogen fuel gas that course through two cell electrodes. Mostly the fuel cells are produced by the course of power in abiding manner until the reactants are accommodated.

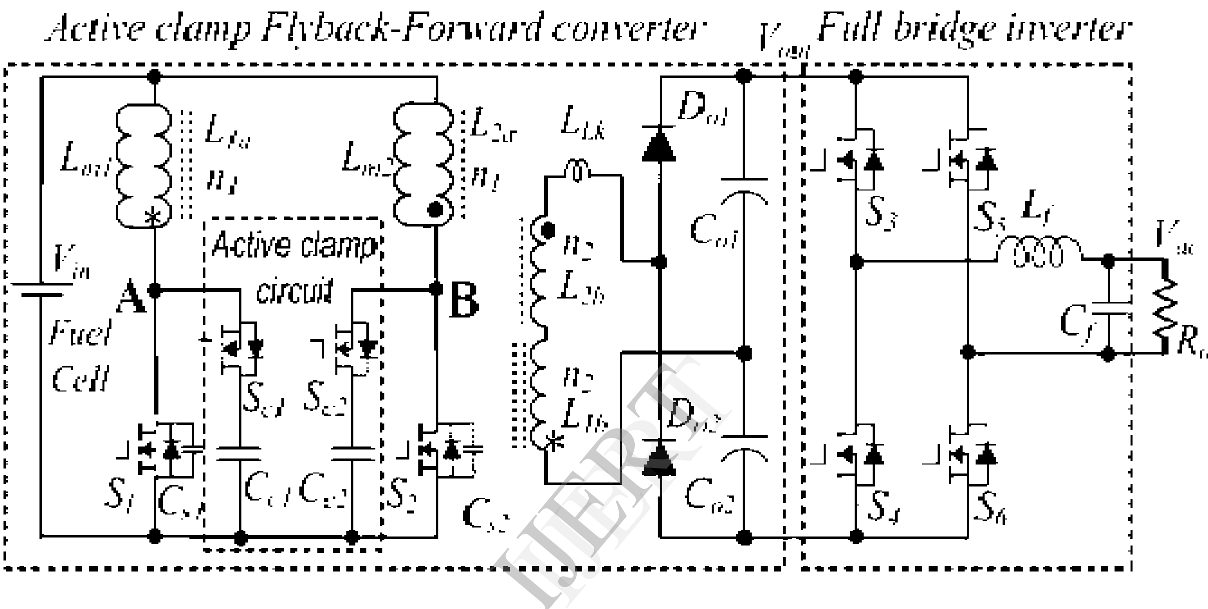
Mostly the output voltage of fuel cell is depress than 40V. So in order to accretion the low voltage of fuel cell accretion converters are mostly used[3],[4]. Several approaches are concentrated in dc-dc power amorphous approaches using fuel cell for flyback- converter topology with interleaving techniques to attenuate the voltage stress of the switches and also to remove voltage ripples of the switches[5] [6]. The flyback- converter with an common active clamp zero voltage switching (ZVS) and zero current switching (ZCS) are used in soft switching circuit mostly for higher power applications. However zero voltage switching and zero current switching can be achieved for only limited loads. Several approach are carried out in order to extend the amalgam of zero voltage switching (ZVS) and zero current switching (ZCS) range without any losses in duty cycle.

On the other hand the coupled inductor based conductors are used in order to accomplish a high step up voltage. By using this high voltage transformers results in several bitch[7]. For example the leakage inductances that are build in the secondary winding mat cause current and voltage blunt and also increase the noise that may also alloy the components of the circuits[8]. When analogy with any type of transformer such as isolation transformers with coupled (or) mutual inductors these two bear the assembly of the winding in a austere form.

In order to avert these problems an active clamp current that are granted for the input inductor at any operating ambit. The coupled inductor used in the circuit can work mainly in two modes namely flyback mode and forward mode[9]. The flyback mode takes place when the switch is in on state and forward mode takes place when the switch is in off state .By introducing common active clamp scheme method such as zvs and zcs soft switching operation is carried out in both the primary and clamp switches[10],-[12]. The switching losses are downshifting and the effective of the circuit is accretion. Hence in this paper the current ripple and the switching losses are attenuate in this proposed technique without any extra circuit and components. Therefore the overall action of the circuit, the cost and altitude are not increased.

II.Circuit arrangement and system develop

A. Description of Circuit



The fig 1 shows the proposed power creating system flyback- converter and a single phase full bridge inverter.

The circuit diagram of flyback-forward converter consists of two main switches s1 and s2 these two of fuel cell of an interleaving zvs and zcs active clamp switches are used to clamp input current. The s11 and s12 are the auxiliary switches in the active clamp circuits.

The zvs and zcs specialized operation takes place in the active clamp circuit. Here there are two coupled inductors such as L1a and L2a are the primary inductors and L1b and L2b are the secondary inductors. These both switches are coupled by n no of turns.

The turn's ratio can be defined as n_2/n_1. Here there are two diodes namely d_{01} and d_{02} and capacitors c_{01} and c_{02}.On the other hand single phase full bridge inverter is taken into account with the Mosfet switches such as S3, S4, S5, S6. The load connected to the full bridge is resistive load.

B.Actuate Analysis of Proposed Converter

The operating modes starts at the phase shift of 180^0 and the duty cycle applied to the s1 and s2 main switches appreciable than 0.5. The operating modes are described in eight stages namely.

Stage 1: At this stage, the switches s1 and s2 are made to turn on. The other switches s_{c1} and s_{c2} such as the clamp switches are made to turn off. During this condition the diode d_{01} and d_{02} both will be in reverse bias condition. The energy will be stored in the inductors.

Stage 2: During this stage the gate signal applied to the switch s2 is made off, so that the drain source voltage increases. The space is very short since capacitor that connected in parallel is compact.

Stage 3: At this stage the drain source voltage starts to increase and makes the diode d_{01} to organize.

During this stage the L2 operates in flyback mode and L1 operates in forward mode and the energy will be transferred to the load.

Stage 4: The voltage on C_{c2} increases. During this process the diode d_{01} and clamp switch s_{c2} begins to conduct.

Stage 5: The gate driver signal is given to clamp switch s_{c2} and zvs operation begins to start.

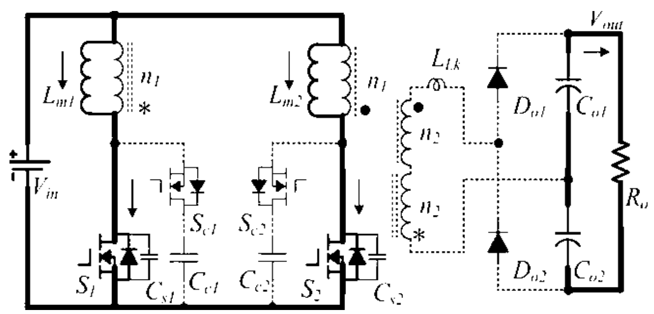
Stage 6: Now the gate signal applied to clamp switch S_{c2}. At this condition the drain source voltage in the S2 such as main switch decreases and the clamp switch S_{c2} increases. It makes the zvs condition to turn off.

Stage7: In this stage the main switch S2 decreases to zero which makes diode d_{02} to conduct. And in every stage, and the stored energy will be stored in load.

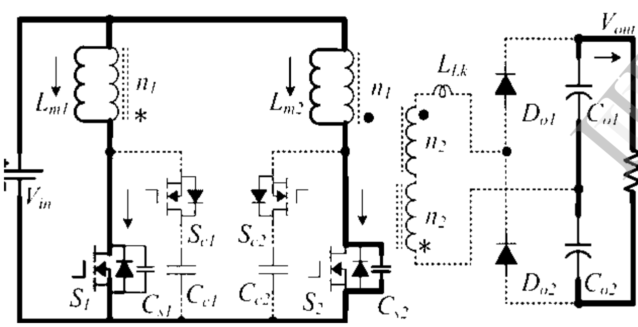
Stage 8: In this stage the zcs operation starts to begin. The antiparallel diode d_{01} will remain in conducting state, the leakage current decreases to zero. The inductors begin to charge at the load.

The zvs and zcs begin to operate in simultaneous manner in order to remove the voltage stress across the switches of the primary side.

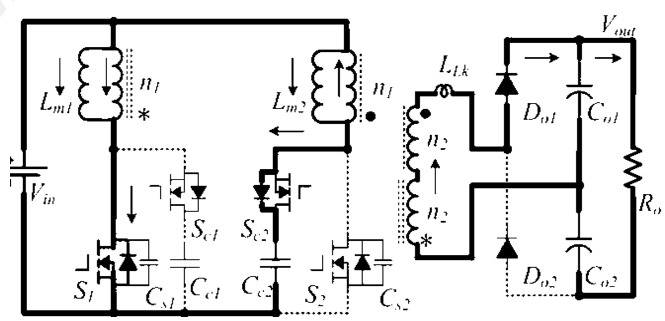
C.Various Topology Operating Stages



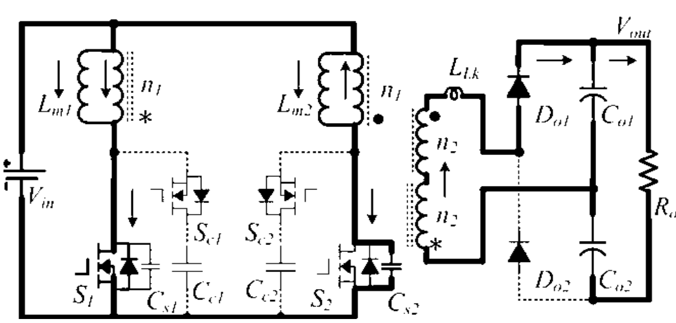
(a)



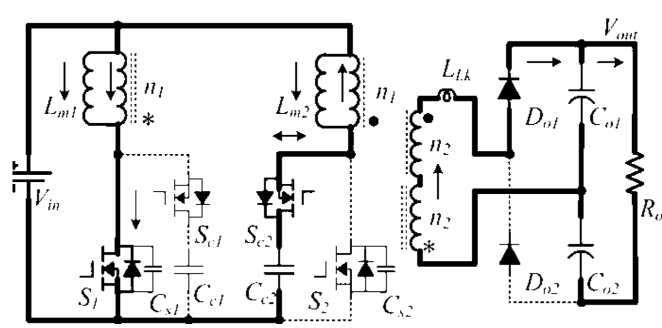
(b)



(d)



(c)



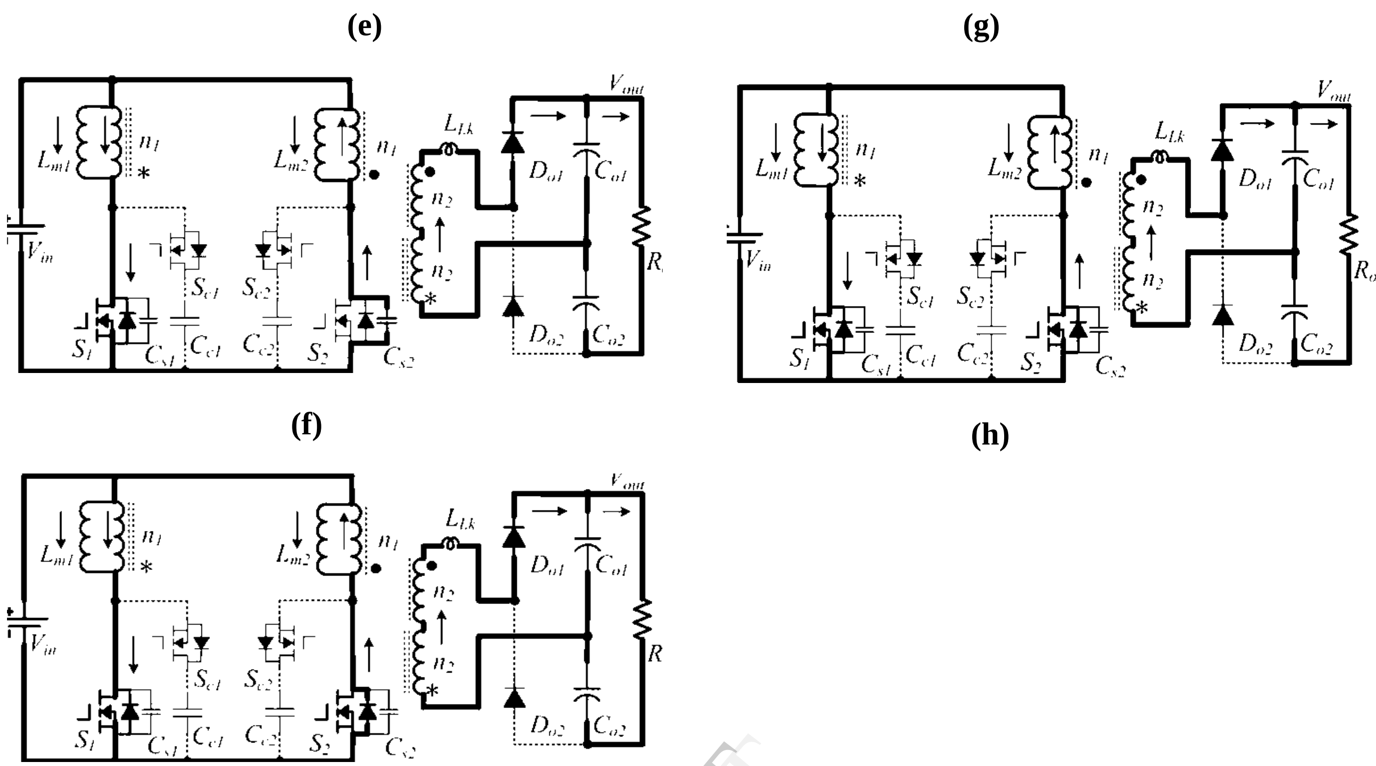


Fig.2.Various topology operating stages

III. Matlab Simulation

Matlab is a high performance language for technical computing. It integrates computation, visualization, and programming in an easy to use environment where problems and solutions are expressed in familiar mathematical notation .The simulation parameters are illustrated in the table 1 that are used for simulation.

Using these values the simulation result are obtained. Depending upon the input value we apply the output value could be obtained in the results.

Table: 1 Key Parameters of the Proposed Converter

Parameter	Value
Fuel cell voltage	12V
Output power	500W
AC output voltag	220V
Mutual inductor	[100 0.002 0.08]
Clamp capacitors	1 f
Clamp resistors	1 f
Output capacitor	1e-1

IV. Simulation Circuit

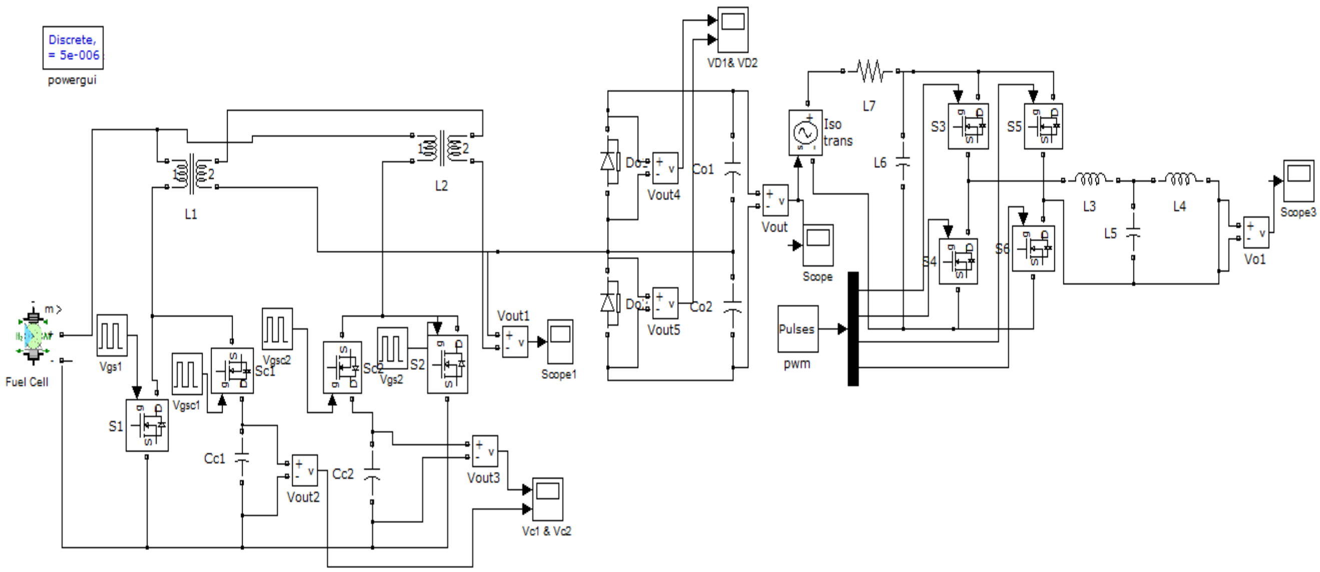


Fig. 3. Proposed Simulation circuit

V. Block parameters of various switches

The main switches considered are S1 and S2. The below block parameter illustrates the values in order to make the switch to operate. The parameter shows the values for the switch S1.

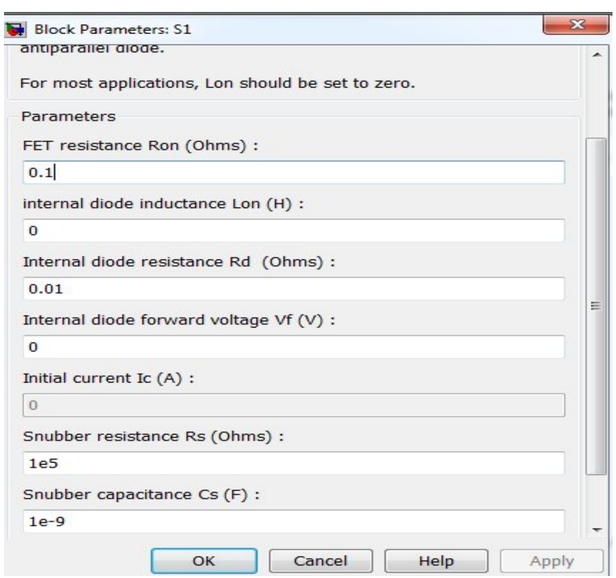


Fig.4.

The below block parameter shows the switch S2

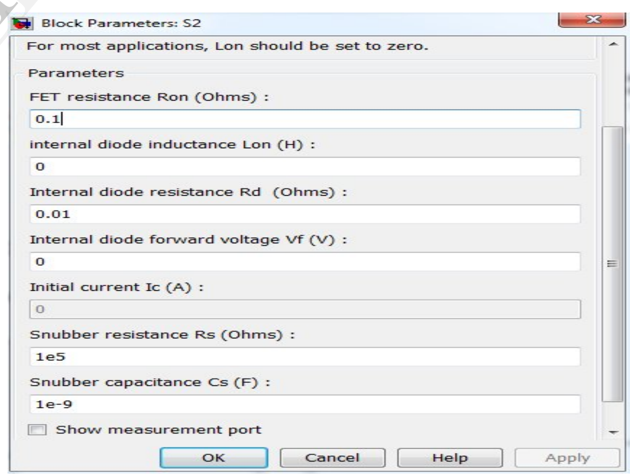


Fig.5

There are two coupled inductors L1 and L2. The below parameter shows the values for the both the coupled inductors.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 1, January - 2014

The block parameter for inductor L1

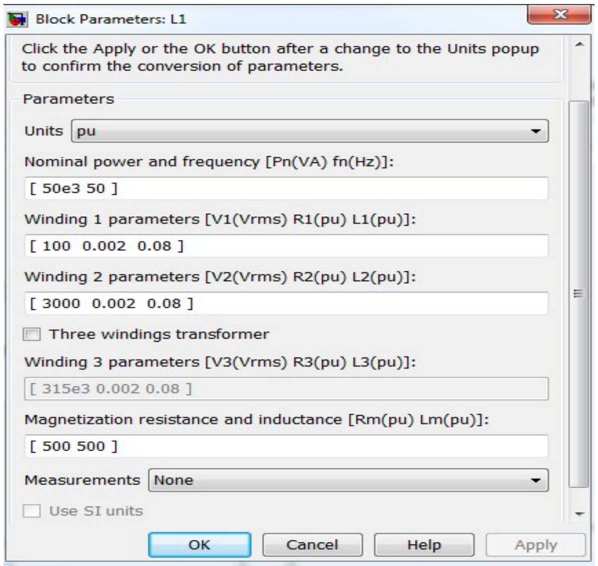


Fig.6

The block parameter for inductor L2

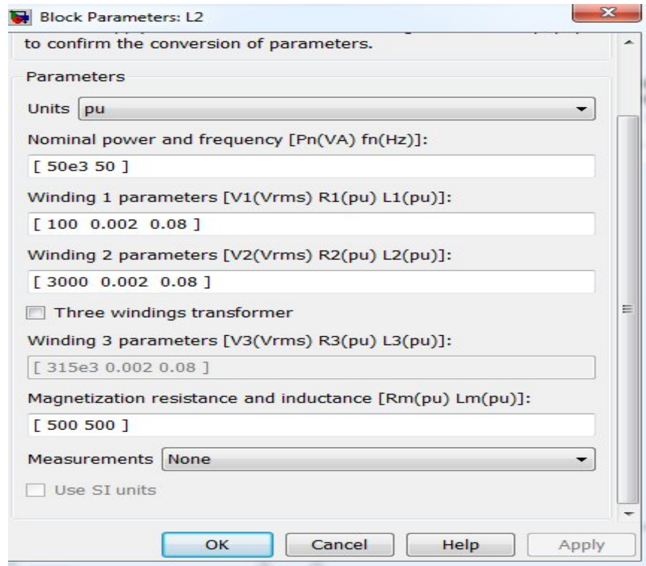


Fig.7

VI. Simulated Results

A. Voltage across the clamp capacitor Vc1

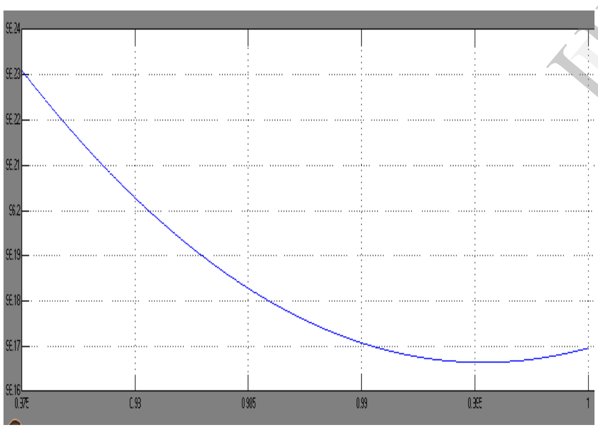


Fig.8

When seeing the voltage across the clamp circuit Vc1 and Vc2 the voltage starts to decrease at particular state. Depending upon the voltage across the fuel cell the voltage starts to decrease at a particular stage and again it starts to increase.

B.Voltage across diode Vd1 and Vd2

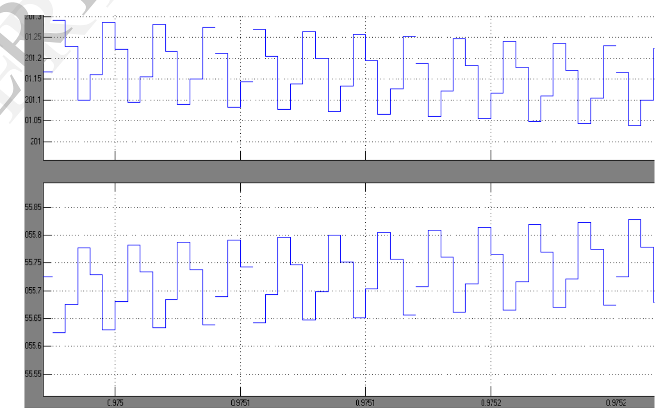


Fig.9

The above fig shows the voltage across the antiparallel diode. The flow of voltage across the Vd1 and Vd2 differs due to some changes in the voltage. When the voltage of Vd1 is considered the voltage starts to decrease whereas the voltage across the diode Vd2 starts to increase. Depending upon the zvs and zcs condition the voltage that flowing across the diode could be corrected.

C.Voltage across active clamp flyback forward converter

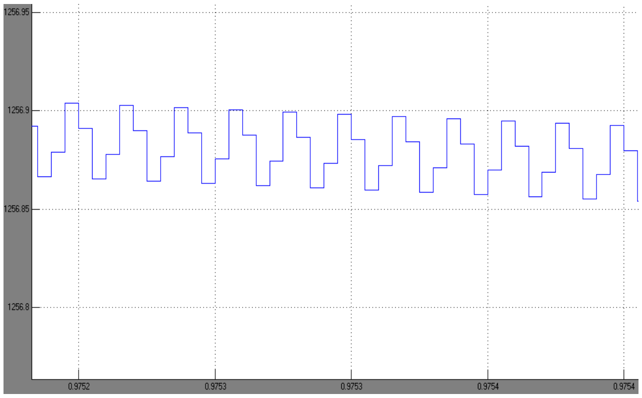


Fig.10

The above fig shows the output voltage of the active clamp. Her soft switching condition such as the zvs and zcs are used in the combined manner, so by introducing this method the voltage stress and ripples that are formed across the switches could be reduced.

.D.Output voltage

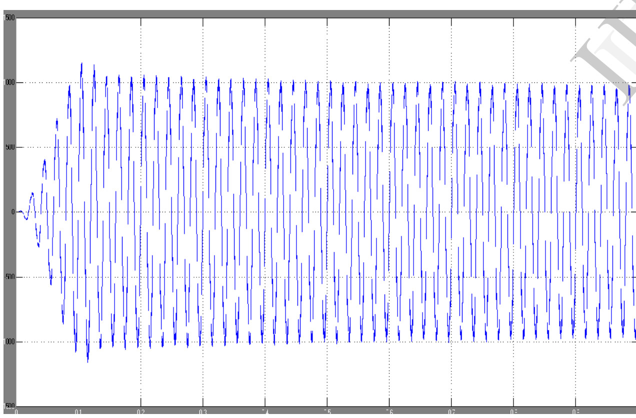


Fig.11

The above fig shows the final output voltage of the active clamp. The voltage stress and ripples are reduced by using the soft switching techniques such as zvs and zcs.

VII Conclusion

In this paper an interleaved DC- AC converter without extreme duty ratio operation for high power conversion is achieved using the fuel cell. In this proposed converter, a 12V dc voltage is accretion to 220V 50 Hz ac supply and the switch is absolute to altitude voltage agitation due to the attend of leakage inductance non ideal coupled inductor. The introduce of the active clamp circuit can bandwagon attenuate the voltage stress of the switches. Furthermore, zvs soft-switching action is appreciate for all the primary active switches to attenuate the switching astray. In append, the input-current bore is small due to the interleaved actuate and the current fed category arrangement. The zvs and zcs switching scheme are introduced and using this switching zvs and zcs will be combined together in order produce high effective and high ascendancy generation. The interleaved fly-back converter is applicable for speed control of DC motors, induction heating, and variable voltage applications. The simulation results of the proposed converter for flyback operations are presented.

References

[1] S. Jemei, D. Hissel, M. C. Pera, and J. M. Kauffmann, “A new modeling approach of embedded fuel-cell power generators based on artificial neural network,” IEEE Trans. Ind. Electron., vol. 55, no. 1, pp. 437–447, Jan. 2008.

[2] M. H. Todorovic, L. Palma, and P. N. Enjeti, “Design of a wide input range dc–dc converter with a robust power control scheme suitable for fuel cell power conversion,” IEEE Trans. Ind. Electron., vol. 55, no. 3, pp. 1247–1255, Mar. 2008.

[3] K. Jin,M. Yang, X. Ruan, and M.Xu, “Three-level bidirectional converter for fuel- cell/battery hybrid power system,” IEEE Trans. Ind. Electron., vol. 57, no. 6, pp. 1976–1986, Jun. 2010.

[4] C. T. Pan and C. M. Lai, “A high-efficiency high step-up converter with low switch voltage stress for fuel-cell system applications,” IEEE Trans. Power Electron., vol. 57, no. 6, pp. 1998–2006, Jun. 2010.

[5] E. H. Kim and B. H. Kwon, “Zero-voltage- and zero-current-switching full-bridge converter with secondary resonance,” IEEE Trans. Ind. Electron., vol. 57, no. 3, pp. 1017–1025, Mar. 2010.

[6] F. Liu, J. Yan, and X. Ruan, “Zero-voltage and zero-current-switching PWM combined three-level dc/dc converter,” IEEE Trans. Ind. Electron., vol. 57, no. 5, pp. 1644–1654, May 2010.

[7] Y. Jang and M. M. Jovanovich, “A new three-level soft-switched converter,” IEEE Trans. Power Electron., vol. 20, no. 1, pp. 75–81, Jan. 2005.

[8] Y. Jang and M. M. Jovanovich, “A new family of full-bridge ZVS converters,” IEEE Trans. Power Electron., vol. 19, no. 3, pp. 701–708, May 2004.

[9] M.Jain, M. Daniele, and P. K. Jain, “A bidirectional dc–dc converter topology for low power application,” IEEE Trans. Power Electron., vol. 15, no. 4, pp. 595–606, Jul. 2000.

[10] S. Lee and S. Choi, "A three-phase current-fed push-pull DC–DC converter with active clamp for fuel cell applications," in Proc. IEEE APEC, 2010, pp. 1934–1941.
[11] E. Adib and H. Farzanehfard, "Zero-voltage transition current-fed full bridge PWM converter," IEEE Trans. Power Electron., vol. 24, no. 4, pp. 1041–1047, Apr. 2009.
[12] R. Y. Chen, T. J. Liang, J. F. Chen, R. L. Lin, and K. C. Tseng, "Study and implementation of a current-fed full-bridge boost dc–dc converter with zero-current switching for high-voltage applications," IEEE Trans. Ind. Appl., vol. 44, no. 4, pp. 1218–1226, Jul./Aug. 2008.