Solar Pv Based Soft Switching Bidirectional Dc/Dc Converter For Hybrid Electric Vehicles

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***Abstract*— A naturally clamped zero-current commutated soft switching bidirectional full-bridge isolated dc/dcconverter is implemented by eliminating the necessity for passive snubbers. Switching losses are reduced significantlyowing to zero-current switching of primary side devices and zero-voltage switching of secondary-side devices. Softswitching and voltage clamping are inherent and load independent. The voltage across primary-side devices isindependent of duty cycle with varying input voltage and output power and clamped at rather low reflected outputvoltage, enabling the use of semiconductor devices of low voltage rating. These merits make the converter promisingfor fuel cell vehicles application, front-end dc/dc power conversion for fuel cell inverters, and energy storage in theDC/DC converter is analysed with zero current Commutation (ZCC) and the natural voltage clamping (NVC) has been analysed and in simulation results has been proposed .**
***Index Terms*—Bidirectional, current-fed converter, fuel cell vehicle (FCV), ZCS(zero current switching), ZVS(zero voltage switching).**

I. INTRODUCTION

In automotive industry most research takes place in the electric vehicles. Two major concepts are electric vehicles(EV) and fuel cell vehicles(FCV). Comparing with EV's, FCV's has clear upper hand as FCV need short charging period andgreater range of driving. In the FCV itself, earlier implementation was using voltage fed converter but it has lotdisadvantages such as high input pulsating current, limited soft-switching range, high circulating current through
switches and relatively low efficiency for high voltage amplifications and high current input applications. Because ofthe draw backs of voltage fed based converter, the later converter based on current source had been implemented usingsnubbers. Usually employed current fed converters were resistor-capacitor-diode(RCD) snubber. But RCD snubberleads to low efficiency owing to clamping energy dissipated in snubber resistor. As a result a novel current fed DC/DCconverter is proposed.

II. PROPOSED TOPOLOGY

A dual half-bridge bidirectional dc/dc converter is proposed as shown in fig.1. However, this topology requires foursplit capacitors that occupy a considerable volume of the converter. It may need an additional control to avoid anyvoltage imbalance across the capacitors. In addition, the topology is not modular and is not easily scalable for higherpower. Peak currents through the primary switches are greater than2.5× the input current and the top and bottomswitches share unequal currents.

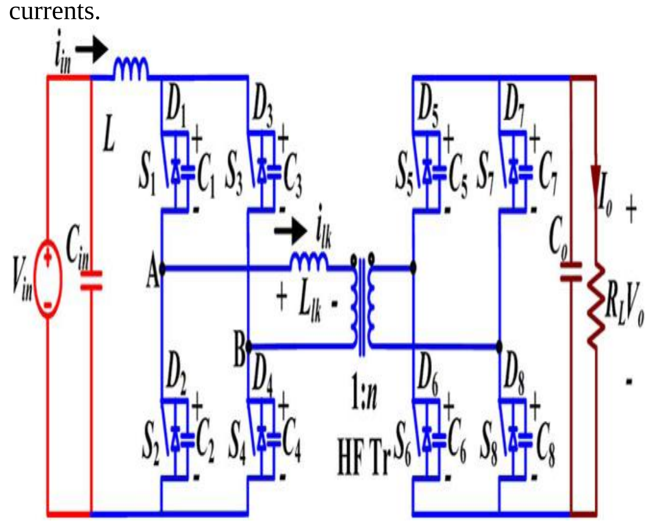

Fig. 1. Proposed ZCS CFDAB dc/dc converter.

Mainly four methods are used here to reduce the switching losses. ZVS, ZCS, ZCC, NVC, ZCS method is used in theprimary switches, when current becomes zero in the switches gate signal is switches to zero, and voltage start to buildup. ZVS is used in the secondary switches, when voltage across the switch becomes zero gate signal is switched to high, so that current start to increase. Before turning off the diagonal switch pairs of primary side switches (S1-S4), theother pair (S2-S3) is turned on. It diverts current from one switch pair to the other, causing the current through the conducting switch pair to rise and the current through conducting switch pair to fall to zero naturally resulting in ZCC.

Later the body diodes across switching pairs to start conducting and their gating signals are removed leading to ZCS turnoff of the devices. Commutated device capacitance starts charging with NVC.

III. OPERATION AND ANALYSIS OF CONVERTER

Interval 1 (see Fig. 4(a); to < t < t1): In this interval, primary-side H-bridge switches $S2$ and $S3$ and antiparallel body diodes $D6$ and $D7$ of secondary-side H-bridge switches are conducting. The current through inductor Llk is negative and constant. Power is transferred to the load through the HF transformer. Nonconducting secondary devices $S5$ and $S8$ are blocking output voltage Vo, and nonconducting primary devices $S1$ and $S4$ are blocking reflected output voltage Vo/n.

The values of current through various components are $iS2 = iS3 = I$in, $iS1 = iS4 = 0$, $i$lk $= -I$in, and $iD6 = iD7 = I$in$/n$. Voltage across switches $S1$ and $S4$ $VS1 = VS4 = Vo/n$. Voltage across switches $S5$ and $S8$ $VS5 = VS8 = Vo$.

Interval 2 (see Fig. 4(b); t1 < t < t2): At $t = t1$, primary switches $S1$ and $S4$ are turned on. Snubber capacitors $C1$ and $C4$ discharge in a very short period of time.

Interval 3 (see Fig. 4(c); t2 < t < t3): Now, all four primary switches are conducting. Reflected output voltage Vo/n appears across leakage inductance Llk and causes its current to increase linearly. It causes currents through previously conducting devices $S2$ and $S3$ to reduce linearly. It results in conduction of switches $S1$ and $S4$ that started conducting with zero current, which helps reduce associated turn-on loss Since the antiparallel body diodes$D6$ and$D7$ are conducting, switches $S6$ and $S7$ can be gated for ZVS turn-on. At the end of this interval $t = t3$, $D6$ and $D7$ commutate naturally. Primarycurrent reaches zero and ready to change polarity. Currentthrough all primary devices reaches Iin$/2$. Final values are$i$lk $= 0$, $iS1 = iS2 = iS3 = iS4 = Iin/2$, and $iD6 = iD7 = 0$.

Interval 4 (see Fig. 4(d); t3 < t < t4): In this interval, secondaryH-bridge devices $S6$ and $S7$ are turned on with ZVS.Currents through all the switching devices continue increasingor decreasing with the same slope as interval 3. At the end ofthis interval, primary devices $S2$ and $S3$ commutate naturally with ZCC and their respective currents $iS2$ and $iS3$ reach zeroobtaining ZCS. The full current, i.e., input current Iin, is takenover by other devices $S1$ and $S4$, and the transformer currentchanges polarity. Final values are $i$lk $= I$in, $iS1 = iS4 = I$in,$iS2 = iS3 = 0$, and $iS6 = iS7 = I$in$/n$.

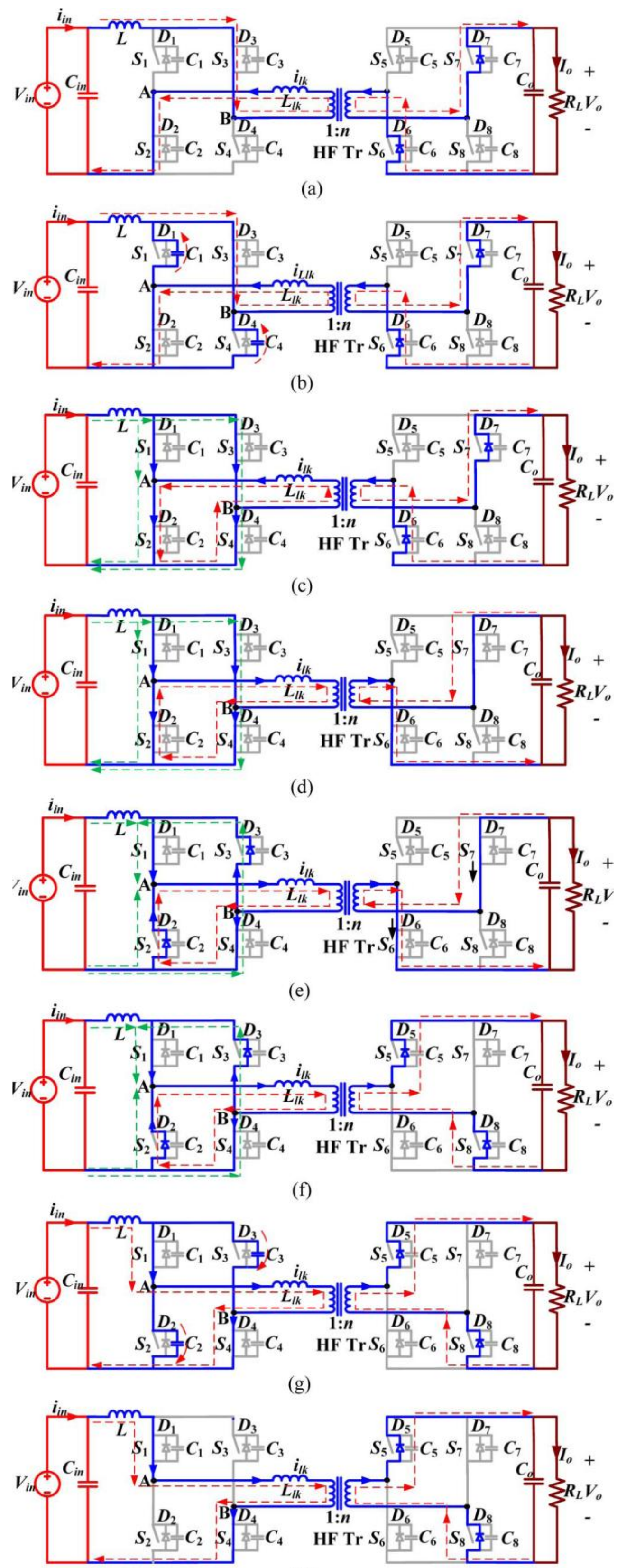

Fig. 2. Equivalent circuits during different intervals of operation .

Interval 5 (see Fig. 4(e); t*4 < *t* < *t*5*): In this interval, theprimary current or leakage inductance current *i*lk further increases with the same slope. Antiparallel body diodes *D*2 and*D*3 start conducting, causing extended zero voltage to appearacross the outgoing or commutated switches *S*2 and *S*3 toensure ZCS turnoff. Now, secondary devices *S*6 and *S*7 areturned off. At the end of this interval, currents through thetransformer and switches *S*1 and *S*4 reach their peak value. Thisinterval should be very short to limit the peak current throughthe transformer and switches, and thus their kilovoltampere ratings.

Interval 6 (see Fig. 4(f); t*5 < *t* < *t*6*): During this interval,secondary switches *S*6 and *S*7 are turned off. Antiparallel bodydiodes of switches *S*5 and *S*8 take over the current immediately.

Therefore, the voltage across the transformerprimary reversespolarity and the current through it starts decreasing. The currents
through switches *S*1 and *S*4 and body diodes *D*2and *D*3also start decreasing.

Interval 7 (see Fig. 4(g); t*6 < *t* < *t*7*): In this interval, snubbercapacitors *C*2 and *C*3 charge to *Vo/n* in a short period oftime. Switches *S*2 and *S*3 are in forward blocking mode now.

Interval 8 (see Fig. 4(h); t*7 < *t* < *t*8*): In this interval, currentsthrough *S*1 and *S*4 and the transformer are constant atinput current *I*in. The current through antiparallel body diodes of the secondary switches *D*5 and *D*8 is *I*in*/n*. The final valuesare *iS*1 = *iS*4 = *i*lk = *I*in, *iS*2 = *iS*3 = 0, and *iD*5 = *iD*8 =*I*in*/n*.Voltage across switches *S*2 and *S*3 *VS*2 = *VS*3 = *Vo/n*.In this half HF cycle, current has transferred from onediagonal switch pair to the other diagonal switch pair, and thetransformer current has reversed its polarity.

IV.SIMULATION RESULTS

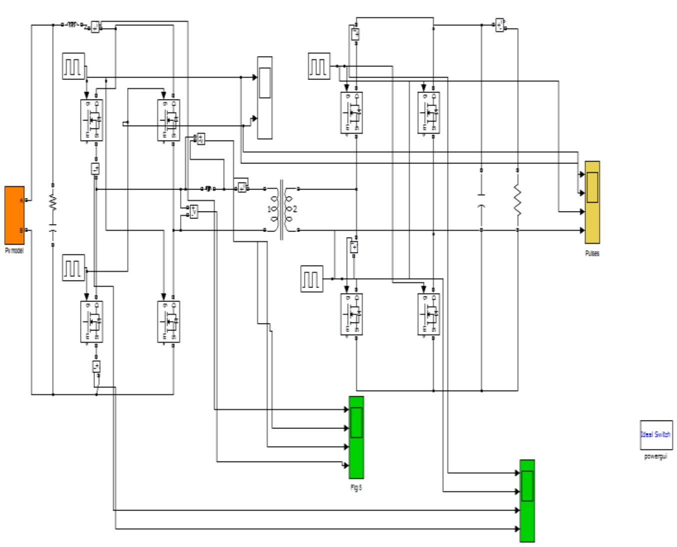

Fig 3. Simulation circuit pv based bidirectional converter

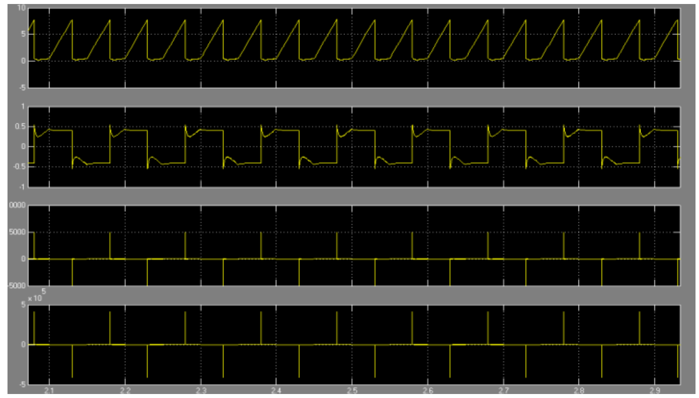

Fig 4. Current waveforms through input inductorI(L) and leakage inductanceI(Llk), voltage waveform across leakage inductance V(Llk),and voltage waveformVAB.

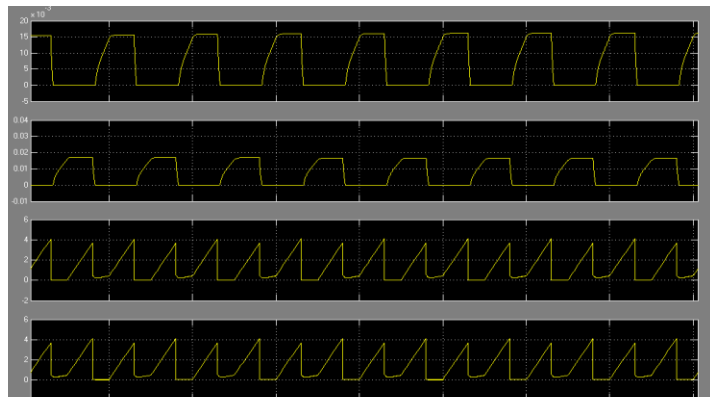

Fig 5. Current waveforms through primary switchesI(S1)andI(S2)and secondary switchesI(S5)andI(S6).

V.CONCLUSION

A new dc/dc to converter is proposed in which use ZCStechnique in the primary andZVStechnique in the secondarywhich ensure minimum switching loss. In the converter also use the possibility of ZCC and NVC. It therefore eliminatesthe need of an active-clamp or passive snubber.Usage oflow-voltage devices results in low conduction lossesin primary devices, which is significant due to higher currents on the primary side. The proposed modulation method issimple and easy to implement. This dc/dc and dc/ac converter find applications in the modern electric vehicles asinterface between battery and three phase motor. These merits make the converter promising for interfacing alowvoltage dc bus with a high-voltage dc bus for higher current applications such as FCVs. Can be employed in frontenddc/dc power conversion for renewable (fuel cells/photovoltaic) inverters, uninterruptible power system, microgrid and energy storage.

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