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ZVS half bridge dc-dc boost converter for fuel cell

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***Abstract*— It has been found that by using zero voltage switching the output voltage gain was improved. In this research work ZVS dc-dc converter was used. It consists of a ZVS boost converter and ZVS half wave converter stage this circuit was used with fuel to improve the voltage gain. The ZVS and fuel cell system was analysed by using Psim software and hardware. Theoretical and simulation analysis of the proposed converter was verified**

***Index Terms*— Psim, ZVS, Converter, Fuel cell**

I. INTRODUCTION

1. Fuel cell

1.1 Construction and operation

The fuel cell represents one of the successful ways by passing the cycle and converting the chemical energy of fuels directly into electricity. It may be defined as an electrochemical device for the continuous conversion portion of the free energy change in a chemical reaction to electrical energy. It is distinguished from a battery in that it operates with continuous replenishment of the fuel and oxidant at active electrode areas and does not require recharging. The following figure 1 shows the structure of fuel cell.

Overall cell reaction

$$2H2+ O2 \longrightarrow 2H2\ O$$

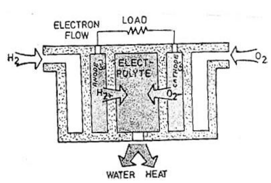

Figure 1 Fuel Cell

The above reactions indicate H2 molecules break up into H Atoms at the anode and they combine with OH ion to form water and free electron at anode.

The formed free electrons travel to the cathode through the external circuit as shown in figure 1. At the cathode, O2 molecules break up into two O2 atoms and these atoms combine with the four electrons arriving by the external circuit and two molecules of water (out of 4 molecules produced at the anode to from 4OH oins. The OH ions migrate towards the anode and are consumed there.

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The electrolyte remains invariant. It is prime requirement that the composition of electrolyte should not change as the cell operates. The major difficulty experienced in the design of fuel cell is to obtain sufficient fuel-electrode-electrolyte reaction sites in a given volume. There are many other types of cells as ion exchange membrane cell, direct and indirect oxidation fuel cells, molten carbonate fuel cells and many others.

1.2 Advantages of Fuel Cell

1. The fuel cell converts its fuel directly to electric power. Pollutant levels range from 1/10 to1/50,000 of those produced by a fossil fuel power plant as there it no combustion
2. No cooling water is needed so it can be located at any desired place.
3. As it does not make noise. It can be readily accepted in residential areas.
4. The fuel cell takes little time to go into operation.
5. It would be an ideal reserve power source within large conventional power plants to handle peak or emergency loads.
6. There is no efficiency penalty for part load operation. Efficiency remains constant from 100% to 25 % of rated load.
7. There is no maximum or minimum size for a fuel cell power plant. Individual fuel cells are joined to form stacks. The stacks are joined to form power modules. The number of modules can be tailored to power plant requirements.
8. The land requirement is considerably less compared with conventional power plants.
9. Possibly the greatest advantage of the fuel cell is its high operating efficiency. Present-day fuel cell efficiency is 38% and it is expected to reach to 60% before the end of this century.
10. Fuel cell power plants may further cut generation costs by eliminating or reducing line losses. Fuel cell power plant in rural areas or highly congested residential areas would eliminate the need for long lines to bring in power from remote generating stations.
11. A wide variety of fuels can be used with the fuel cell. Although presently limited to using substances that produce pure H rich gas, the cell may one day be able to operate on fuels derived from low grade shale oils or highly sulphur coals.
12. The maintenance charges are low as there are no moving parts and outages are also less.
13. Fuel cells have an overload capacity of 50 to 100% for a short duration.
14. The weight and volume of the fuel cell is considerably low compared to other energy sources.
15. In H2-O cell, the reaction product is water which is portable.

II. DC-DC CONVERTER

2.1 Definition

A DC-to-DC converter was an electronic circuit which converts a source of direct current (DC) from one voltage level to another. It was a class of power converter.

DC to DC converters were important in portable electronic devices such as cellular phones and laptop computers, which were supplied with power from batteries primarily. Such electronic devices often contain several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply.

2.2 Types of Converter

2.2.1 Buck Converter

Figure 2 shows the buck converter. The buck converter was a step down converter and produces a lower average output voltage than the dc input voltage.

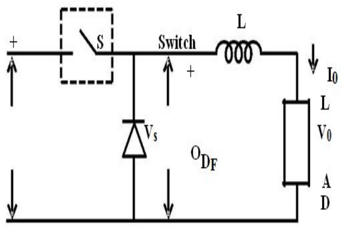

Figure 2 Buck converter

2.2.2 Boost Converter

The output voltage was always greater than the input voltage. The figure 3 shows the Boost Converter.

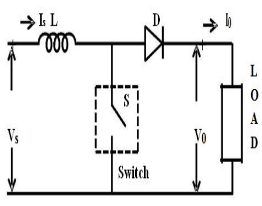

Figure 3 Boost Converter

2.2.3 Buck Boost Converter

The output voltage can be either higher or lower than the input voltage. The following figure 4 shows the Buck Boost Converter.

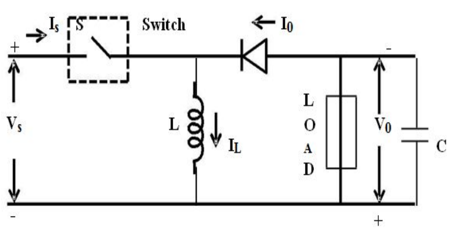

Figure 4 Buck Boost Converters

2.3 Classification based on V and I

Depending on the directions of current and voltage flows, dc converters was classified into five types:

1. First quadrant converter
2. Second quadrant converter
3. First and second quadrant converter
4. Third and fourth quadrant converter
5. Four quadrant converter

III. EXPERIMENTAL RESULT

The following figure 5 shows the Simulation circuit of half bridge dc-dc boost converter. Psim software was to analyse the performance of the ZVS half bridge dc-dc boost converter for fuel cell.

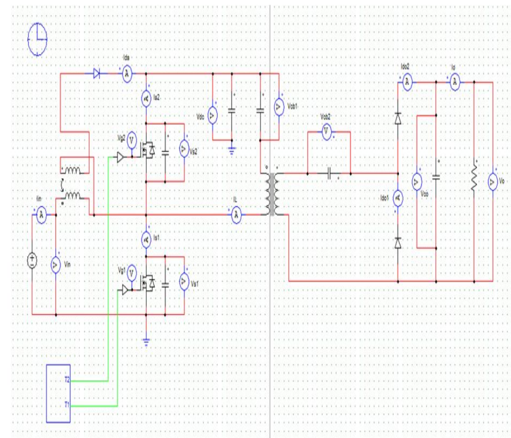

Figure 5 Simulation circuit of half bridge dc-dc boost converter

The following figure 6 shows the wave form measured at Q_1 switch.

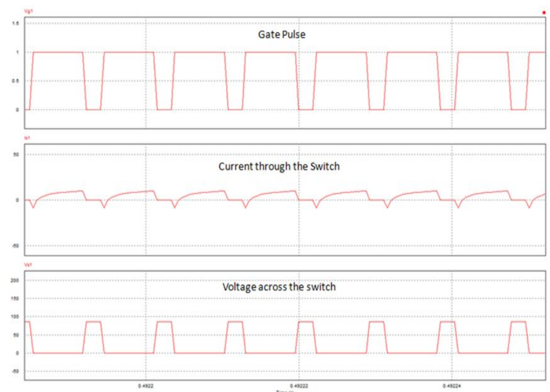

Figure 6 Switch Q_1 waveform

The following figure 7 shows the wave form measured at Q_2 switch.

Figure 7 Switch Q_2 waveform

The following figure 8 shows the output wave forms of the half bridge dc-dc boost converter.

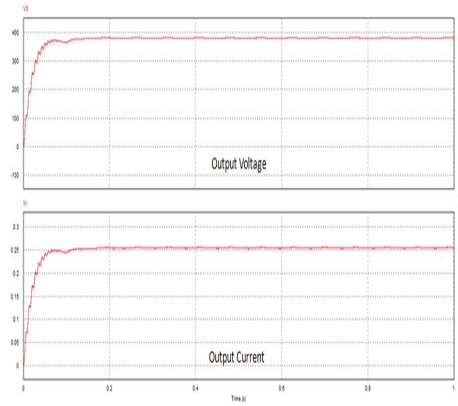

Figure 8 Half bridge dc-dc boost converter output waveform

The following figure 9 shows the hardware circuit of ZVS half bridge DC–DC Converter with fuel cell. In this circuit the improved output voltage gain was measured and verified.

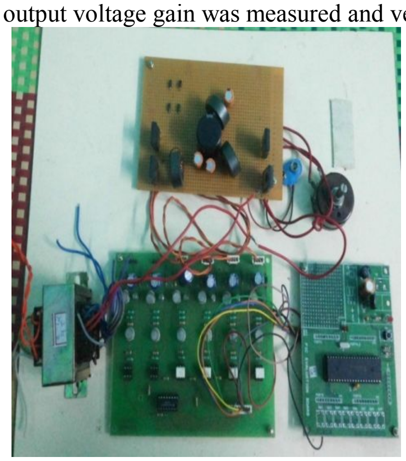

Figure 9 hardware circuit of ZVS half bridge DC–DC Converter

CONCLUSION

The improved voltage gain of the Zero voltage switching dc-dc converter connected with fuel cell was analysed and verified by using Psim software and hardware.

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