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Simulation of an Improved Non Isolated Fuzzy Based DC-DC Boost Converter for High Voltage Applications

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***Abstract*— This paper presents a ground work for an improved non isolated fuzzy based DC-DC boost converter for high voltage applications based on the use of multiplier cells constituted by diodes and capacitors. Duty cycle can be varied from D=0 to D=1 without affecting the normal operation of the converter, the voltage stress for the diodes is reduced, and the voltage gain can be further increased by adjusting the turns ratio. The fuzzy logic control has been implemented for converter switching control. The entire control concept has been implemented using SIMULINK model. The converter achieves good efficiency, reduced switching losses, and also energy is transferred from the source to the load during most part of the switching period, which is a distinct characteristic of the proposed converter, since in other boost-type converters it only occurs during half of the switching period. The converter can be used to uninterruptible power supplies and is also adequate to operate as a high gain boost stage cascaded with inverters in renewable energy systems. Furthermore, it can be used to systems that demand dc voltage step up such as electrical fork-lift, renewable energy conversion systems, and many other applications.**

***Index Terms*— Fuzzy Logic controller, Boost DC- DC Converter, MATLAB /SIMULINK Software**

I. INTRODUCTION

Nowadays several applications in Power Electronic appliances often demand the low dc voltage to be stepped up. Crucial with these demands, many researchers or designers have been struggling to find the most economic and reliable converter to meet these demands. The idea is to have a DC-DC converter with fuzzy logic controller to ensure desired voltage and thereby running an induction motor effectively for many applications as compared to using PI controller

II. PROPOSED FUZZY LOGIC BASED CIRCUIT

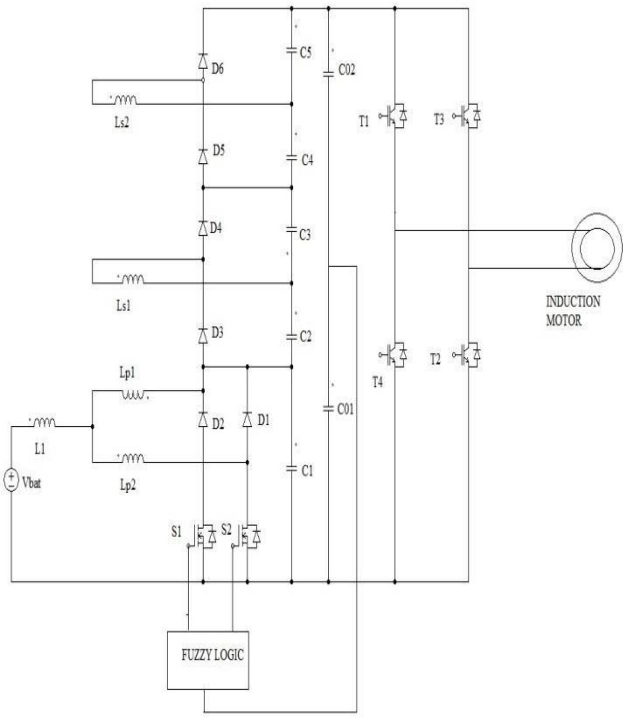

Fig 1: Circuit diagram of proposed fuzzy based DC-DC boost converter

III. PRINCIPLES OF PROPOSED CONVERTER

The proposed converter has high voltage gain,while the input current is continuous with reduced ripple. The input inductor is also designed for twice the switching frequency, implying reduction of weight and size.

The converter is composed of following elements. Input inductor L, Transformer connected to active switches S1 and S2, Diodes D1, D2, D3, D4, D5, D6, polyester capacitors C1, C2, C3, C4, C5, and output electrolyte capacitors C01 and C02. The converter although can be operated in any modes such as discontinuous mode, continuous mode and overlapping mode the working is explained in continuous conduction mode.

A dc input voltage is given, the inductor and the load capacitor is initially charged. In the first stage of operation shown in fig: 2 the two MOSFETS are triggered while all the diodes and capacitors remain in reverse bias condition. There is no energy transfer from the input source to the load, which, on the other hand, is supplied by auxiliary capacitors C1,C2,

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C3, C4, and C5 and output filter capacitors C01 and C02. This stage finishes when *S*1 is turned off.

In second stage of operation shown in fig: 3 MOSFET S1 is triggered while the other MOSFET S2 is off. Diodes D2, D3, and D5 are forward biased, whereas diodes D1, D4, and D6 remain reverse biased. Inductor *L*1 and also the input source transfer energy to auxiliary capacitors C1, C2, and *C*4 and to output filter capacitors C01 and C02.

In third stage of operation shown in fig: 4 both the MOSFETS S1 and S2 are triggered. All the diodes D1, D2, D3, D4, D5, D6 are reverse biased. Similarly as explained to the first stage of operation there is no energy transfer from source to load . Moreover, auxiliary capacitors C1, C2, C3, C4, and C5 and output filter capacitors C01 and C02 are responsible for supplying the load. This stage finishes when switch S2 is finally turned off.

Fourth stage shown in fig: 5 can be explained similar to the second stage of operation. Switch S1 is triggered and S2 is in off condition. Diodes D1, D4, and D6 are forward biased, whereas D2, D3, and D5 remain reverse biased. Analogously to the second stage, the energy in L1 and the input source is transferred to auxiliary capacitors C1, C3, and C5 and output filter capacitors C01 and C02.

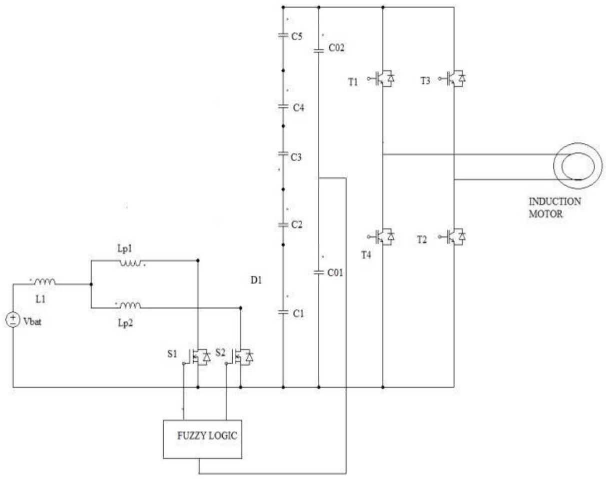

Fig 2: Operating stage

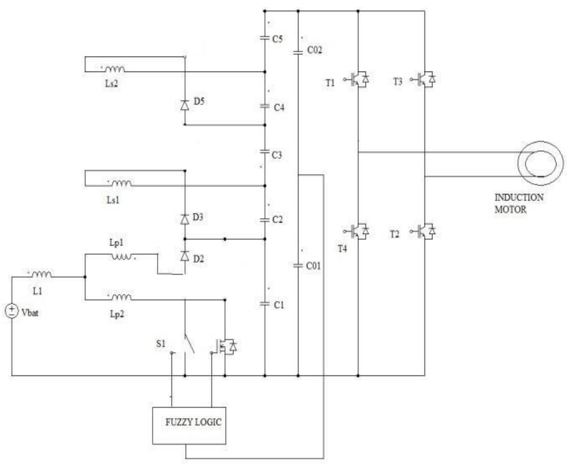

Fig 3: Operating stage 2

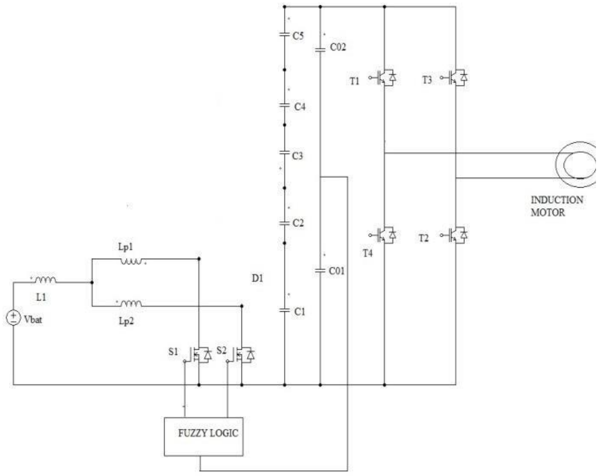

Fig 4: Operating stage 3

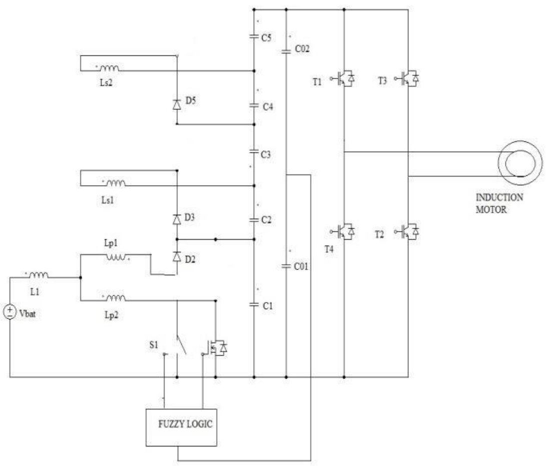

Fig 5: Operating stage 4

The converter can be connected to operate a single phase induction motor as shown in the circuit diagram in Fig: 1. For that a small single phase induction motor is connected to converter via a full bridge inverter circuit. The full bridge inverter shown is of conventional type. So the system can be easily implemented in those areas where there is difficulty for continuous power supply. Also the converter can be operated from solar energy. So the whole circuit applications can be increased.

IV. DESIGN OF FUZZY LOGIC CONTROLLER

For switching control signals traditionally, PI, PD and PID controllers are the most popular and widely used in most power electronic closed loop appliances, However recently many researchers successfully adopted Fuzzy Logic Controller (FLC) as one of the intelligent controllers to their appliances. A simple fuzzy logic control is built up by a group of rules based on the human knowledge of system behaviour. The basic scheme of a fuzzy logic controller consists of four principal components such as: a Fuzzification interface, which converts input data into suitable linguistic values; a knowledge base, which consists of a data base with the necessary linguistic definitions and the control rule set; a Decision-Making logic which, simulating a human decision process, infer the fuzzy control action from the knowledge of the control rules and linguistic variable definitions; a Defuzzification interface which yields non fuzzy control action from an inferred fuzzy control action.

Fuzzy sets must be defined for each input and output variable. Seven fuzzy subsets PB (Positive Big), PM (Positive Medium), PS (Positive Small), ZE (Zero), NS (Negative Small), NM (Negative Medium), and NB (Negative Big) have been chosen for input variables error (e) and change of error (de). The Triangular and trapezoidal shapes have been adopted for the membership functions; the value of each input and output variable is normalized in [-1, 1] by using suitable scale factors.

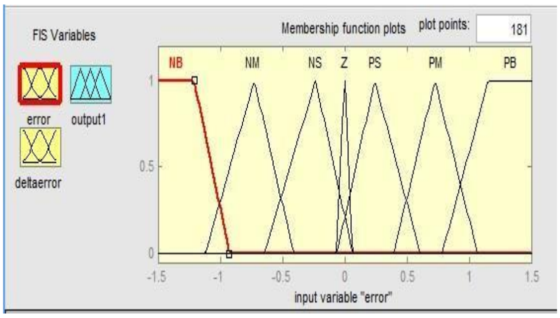

Fig 6: The Membership function plots of error

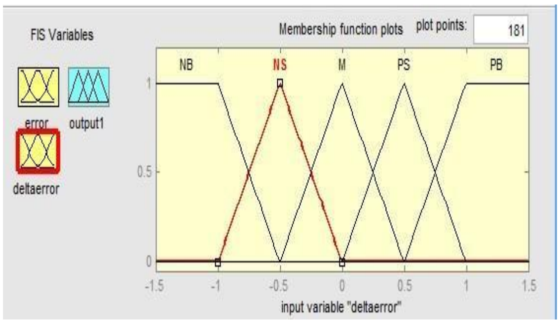

Fig 7: The Membership function plots of change in error

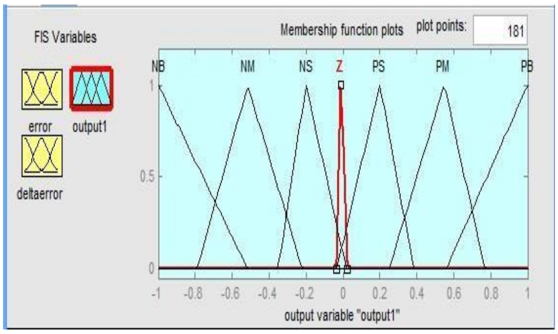

Fig 8: The membership function plot of output

V. SIMULATION RESULT AND DISCUSSIONS

MATLAB/SIMULINK is used for the simulation studies. Fig 9 shows the simulation circuit of An Improved Non isolated fuzzy based DC DC boost converter for high voltage applications

In the simulation diagram for the proposed boost converter based on 3SSC (Three State Switching Cell) and in simulation switches S1and S2 are taken as MOSFET's and it produce the output voltage as 230V. In these the input voltage is given as 48V. The simulation parameters used are given in the table below

Vin	48V
L	30 µH
C1	470 µF
C2	470 µF
C3	470 µF
C4	470 µF
CO1	10000 µF

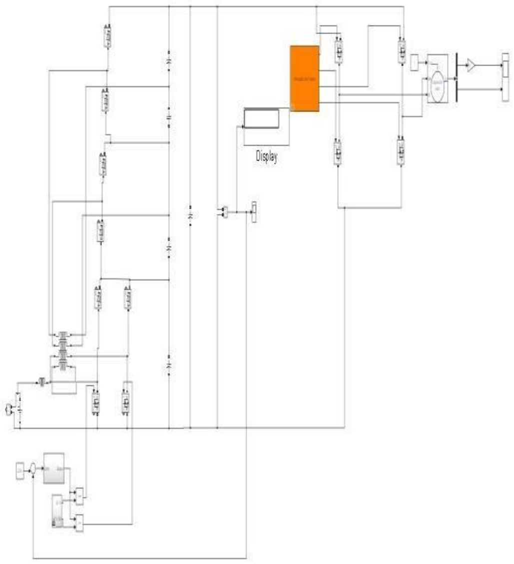

Fig: 9: Simulation diagram

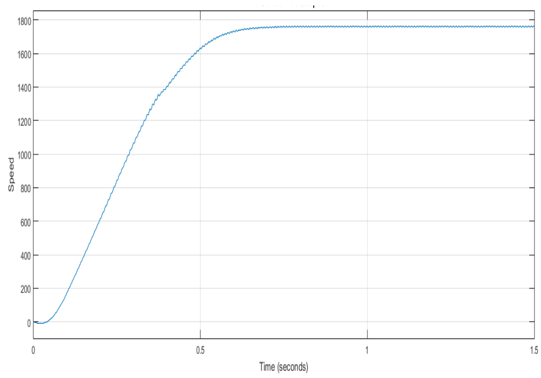

Fig 11: Speed waveform of induction motor

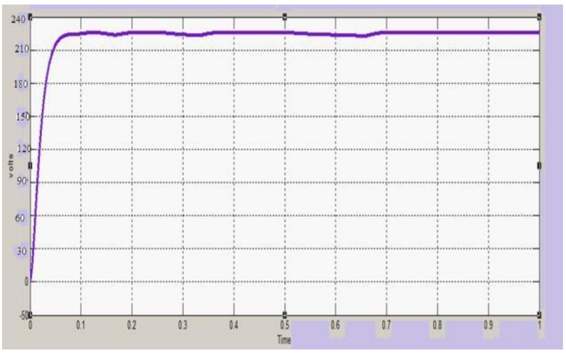

Fig 10: Output DC voltage of converter

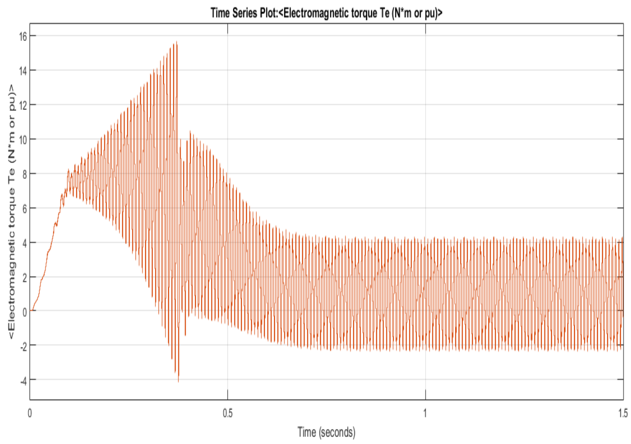

Fig 12: Toque waveform of induction motor

CONCLUSION

DC-DC Boost converter with high voltage gain based on the three-state switching cell is presented. The proposal aims at a converter which has high voltage gain, while the input current is continuous with reduced ripple. Powering a single phase induction motor from a small dc supply with high efficiency. The converter achieves good efficiency, reduced switching losses, and also energy is transferred from the source to the load during most part of the switching period, which is a distinct characteristic of the proposed converter.

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