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SPEED CONTROL OF DC MOTOR BY USING BOOST CONVERTER

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ABSTRACT

This paper presents the design and testing of a boost type DC/DC converter circuit, which can be used for DC motor control applications. The Boost converter is designed using DC chopper and DC chopper cascade configurations. The experimental setup was made by connecting the boost converter circuit with four types of DC motor, i.e. self-excited DC motor shunt, series, compound and separately excited DC motor. The motor was then coupled with a powderbreak as the load. The testing results show accepted performance, where the DC motor speed can be increased due to the increments of the output voltage of the DC/DC converter. The performance test comparison between the DC chopper and DC chopper cascade has presented that both converters have almost the same capability to drive the DC motors. Without load, the DC/DC converter can drive the DC motors to rotate at about 440 rpm at 15V dc supply and 1400 rpm at 55V dc supply. Coupling the motor with load will decrease the motor speed at about 346 until 505 rpm, depending on the load torque value and the DC motor type.

1. INTRODUCTION

The mass usage of the fossil fuels, such as the oil, the coal and the gas, result in serious greenhouse effect and pollute the atmosphere, which has great effect on the world. Meanwhile, there is a big contradiction between the fossil fuels supply and the global energy demand, which leads to a high oil price in the international market recently. The energy shortage and the atmosphere pollution have been the major limitations for the human development. How to find renewable energy is becoming more and more exigent. The PV cell is density of power radiated from the sun at the outer atmosphere is 1.373 kW/m2. Final incident sun light on the earth surface has the peak density of 1 kW/m2 at noon in the tropics. Solar cell can convert the energy of sunlight directly in to electricity [1].
A simplified equivalent circuit of a solar cell consists of a current source in parallel with a diode variable resistor is connected to the solar cell generator as a load. Relationship between the current and voltage may be determined from the diode characteristics equation:

$$I= I_{ph} - I_d = I_{ph} - I_O(e^{qv/kt} -1)..$$

4. DC-DC BOOST CONVERTERS

The DC/DC converters are widely used in regulated switch mode DC power supplies. The input of these converters is an unregulated DC voltage, which is obtained by PV array and herefore it will be fluctuated due to changes in Radiation and temperature. In these converters the average DC output voltage must be controlled to be equated to the desired value although the input voltage is changing. From the energy point of view,

2.LITERATURE REVIEW

The chopper cascade DC/DC converter has been realized in a hardware prototype, and tested its performance with four types of DC motors with and withoud load. At no load condition, the chopper cascade can still drive the DC motors.[1]The study between DC/DC converter chopper type and chopper cascade configuration. The simulation and testing results shows that the chopper cascade has better capability to step up the input voltage into higher[2]The simulation and testing results shows that the chopper cascade has better capability to step up the input voltage into higher voltage level values.[3]This design of open loop and closed loop DC-DC Boost Converter provides smooth control of DC output for open loop and smooth output voltage for close loop DC-DC Boost Converter.[4]Switch mode DC to DC converters are used to match the output of a PV generator to a variable load. DC to DC converters allow the charge current to be reduced continuously in such a way that the resulting battery voltage is maintained at a specified value.[5]

3. OVERVIEW OF A DC-DC CONVERTER

DC-DC converters can be used as switching mode regulators to convert an unregulated dc voltage to a regulated dc output voltage. The regulation is normally achieved by PWM at a fixed frequency and the switching device is generally BJT, MOSFET or IGBT. The minimum oscillator frequency should be about 100 times longer than the transistor switching time to maximize efficiency. This limitation is due to the switching loss in the transistor. The transistor switching loss increases with the switching frequency and thereby, the efficiency decreases. The core loss of the inductors limits the high frequency operation. Control voltage Vc is obtained by comparing the output voltage with its desired value. Then the output voltage can be compared with its desired value to obtain the control voltage Vcr. The PWM control signal for the dc converter is generated by comparing Vcr with a sawtooth voltage Vr.[3]. There are four topologies for the switching regulators: buck converter, boost converter.

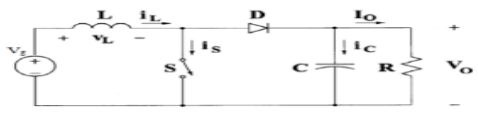


fig1.Equivalentcircuitfordcboostconverter

output voltage regulation in the DC/DC converter is achieved by constantly adjusting the amount of energy absorbed from the source and that injected into the load, the The converter can herefore operate in two different modes depending upon its energy storage capacity and the relative length of the switching period. These two modes are known as discontinues conduction and continuous modes. The DC/DC boost converter only needs four external components: Inductor, Electronic switch, Diode and output capacitor. The converter can therefore operate in the two different modes depending on its energy storage capacity.

In the figure (3) shows a step up or PWM boost converter. It consists of a dc input voltage source Vg; boost inductor L, controlled switch S, diode D, filter capacitor C, and the load resistance R. When the switch S is in the on state, the current in the boost inductor increases linearly and the diode D is off at that time. When the switch S is turned off, the energy stored in the inductor is released through the diode to the output RC circuit [4].

a) MODE 1 (0< t < ton) ON STATE:

In the ON state, the circuit diagram is as shown below in Figure 4, Mode 1 begins when IGBT's is switched on at t=0 and terminates at t=ton. The inductor current IL(t) greater than zero and ramp up linearly.

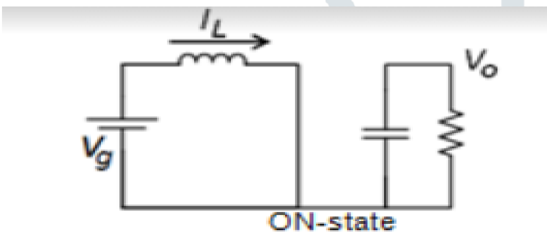


Fig.2 Equivalent circuit of ON STATE Boost Converter.

b) MODE 2 (ton < t < T) OFF STATE:

In the OFF state, the circuit becomes as shown in the Figure.

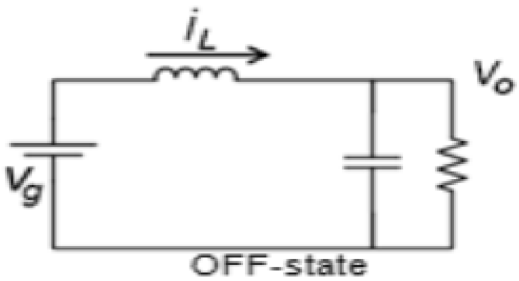
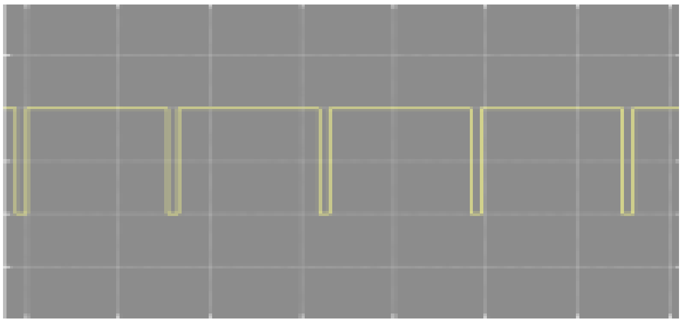


fig.3 Equivalent circuit of OFF STATE Boost onverter

6.SIMULATION OF Open Loop DC –DC BOOST CONVERTER

Using the MATLAB simulation program we get the result of Dc-Dc boost converter for 24V-400V DC Voltage. So design section value of inductor L=2.60Mh,Capacitor value C= 468uF and Resistor value R=300 ohm .show the waveform across the load voltage and inductance across the flow of current and gate pulse.



Mode 2 begins when IGBT's is switched off at t=ton and terminates at t=Ts. The equivalent circuit for the mode 2 is shown in Fig. 5. The inductor current decrease until the IGBT's is turned on again during the next cycle. The voltage across the inductor in this period is Vi-Vo. Since in the steady state time integral of inductor voltage over one time period must be zero. When the switch is off, the sum total of inductor voltage and input voltage appear as the load voltage. Show the waveform on output voltage across the inductor and flow of the inductor current.

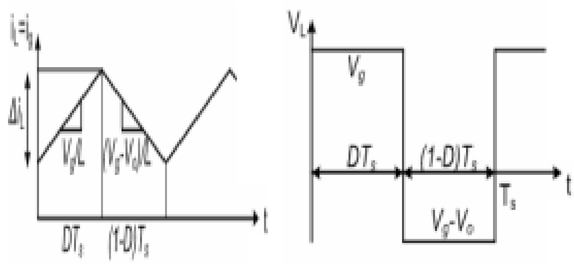


Fig 4.1 Inductor current **Fig4.2** Inductor voltage

The minimum value of the filter capacitance that results in the voltage ripple Vr[8] is given by,

5. DESIGN OF THE BOOST CONVERTER

Current ripple factor (CRF): the DC/DC converter is achieved by constantly adjusting the amount of energy absorbed from the source and that injected into the load, the converter can here fore operate in two different modes depend upon its energy storage capacity and the relative length of the switching period. These two modes are known as discontinues conduction and continuous modes. The DC/DC boost converter only needs four external components: Inductor, Electronic switch, Diode and output capacitor. The converter can therefore operate in the two different modes depending on its energy storage capacity and the relative length of the switching period. The DC/DC converter has two modes, a Continuous Conduction Mode for high power conversions.

Fig.5.1 Waveform for speed control

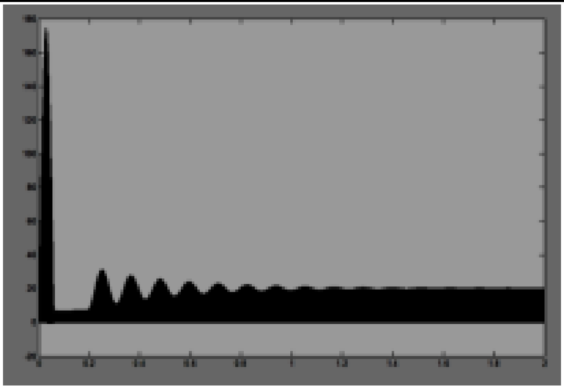


Fig.5.2 Wave form speed control

Various duty cycle and output voltage across load

Varying Duty Cycle	Output Voltage	
40	45.84	600
60	78.15	900
70	129.9	1050
93	393.8	1395

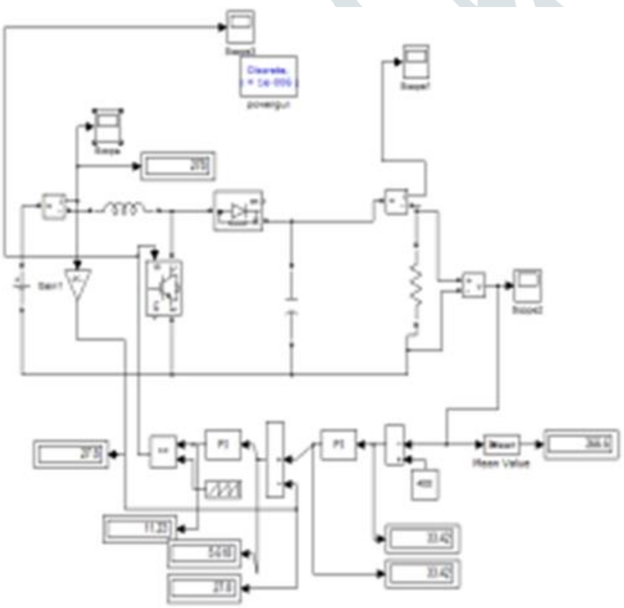


Fig.7 Boost converter close loop circuit.

7.SIMULATION ON A CLOSE LOOP DC-DC BOOST CONVERTER

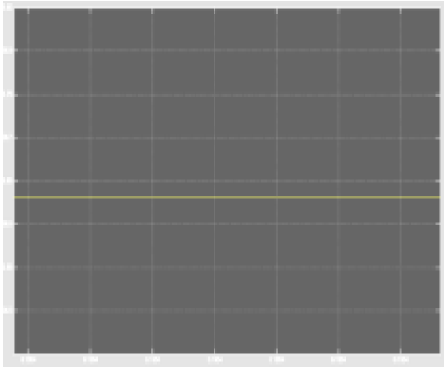


Fig.6.1.waveform for DC boost converter

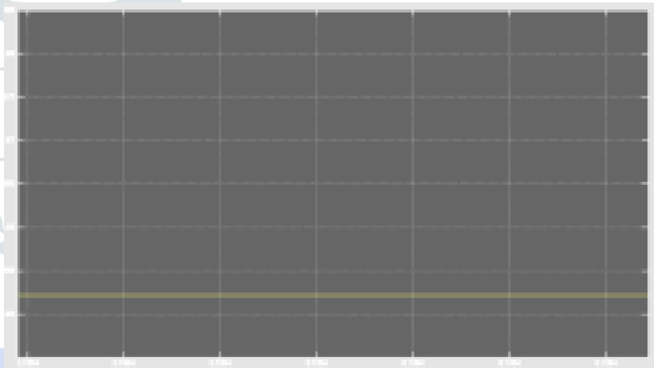


Fig6.2 wave form for boost converter

CONCLUSION

This design of open loop and closed loop DC-DC Boost Converter provides smooth control of DC output for open loop and smooth output voltage for close loop DC-DC Boost Converter.

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