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DC Chopping for High Power Application

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ABSTRACT: Nowadays people using dc power at all places for their work convenient. So requirement of variable dc power is more. It is not easy to get high value of dc power from ac power or from low dc power. Even it is converted ac to dc that produces more losses and also need more cost for conversion. In order to avoid using of two or more number of converters for obtaining variable dc power it is enough to have this single circuit to obtain variable dc power. Zero voltage transition current fed dc to dc converter circuit is used here. To avoid the switching losses soft switching techniques are used. That improves the over all efficiency of the converter. Along with the dc –dc conversion circuit an auxiliary circuit also used for providing soft switching to the main conversion circuit.

KEYWORDS: DC power, dc-dc converter, Switching losses.

I. INTRODUCTION

IGBT is a voltage control device is used to convert one form of electrical power into other form by soft switching techniques. Among the other power semiconducting switches IGBT is the only device having property of transistor and MOSFET.[1] Additional auxiliary circuit is used for proper turn on and turn off of the dc to dc power converter. Low conduction losses are verified in the devices.

Where ever the low input voltage should be converted to high dc output voltage there dc chopping high power application circuit can be used. A step-up dc–dc converter which is the converter producing high dc voltage from low dc voltage are mainly used in industry especially as an interface circuit for batteries, solar cells, and more. Here the IGBT's are used as switches in the inverting block instead of MOSFET's in order to improve the efficiency of the circuit.[3]

The SCR, BJT, MOSFET and IGBT switches can be used. Here IGBT switch is used which is the combination of MOSFET and BJT in order to minimize the losses like switching and conduction losses. So IGBT produces the output with less losses that improves the efficiency of the circuit.

II. RELATED WORK

This dc to dc converter circuit consists of an input inductor named as L_{in} , the main switches S_1 – S_4 ; the switches are IGBT switches, centre tapped transformer T with primary to each secondary turn's ratio of 1: n and its leakage inductance of L_L , rectifying diodes D_1 and D_2 , and capacitor C, which is the converter output voltage filter.

The auxiliary circuit consists of auxiliary switch S_a , two auxiliary diodes D_{a1} and D_{a2} , two coupled inductors L_{a1} and L_{a2} with turn's ratio of 1: m, and the snubber capacitor of the main switches C_a . Current flowing through the switch is defined as drain to source current, and each switch voltage is drain to source voltage.

III. PROPOSED SYSTEM

Interval 1 starts by turning the auxiliary switch ON. By turning S_a ON, C_a voltage is present across L_{a1} and its current increases in a resonance manner until C_a voltage decreases to V_0/n . [5] Now the auxiliary switch turn on is under zero current (ZC) condition due to L_{a1} .

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Interval 2, D_{a1} conducts and a resonance begins between L_L , L_{a1} and C_a . During this resonance, C_a voltage and L_L current are decreasing, and L_{a1} current increases. At the end of interval 2, L_L current has reduced to zero and L_{a1} current has increased to the sum of input current and C_a current. Assuming that I_1 is much smaller than I_{Lin}

At interval 3, C_a completely discharges in a resonance with L_{a1}

At interval 4 L_{a1} current is greater than the input current. During this interval, energy is stored in the input inductor like when all the main switches are conducting.

The 5th interval starts by turning S_a OFF, and since C_a voltage is still zero, S_a turn off is under ZV condition. Because the total ampere turns off L_{a1} and L_{a2} should remain constant, D_{a2} conducts all the current and its current increases to I_4/m . In this interval, S_1-S_4 are all conducting and they are equal, ie, $I_{S1}=I_{S2}=I_{S3}=I_{S4}=(I_{Lin}+I_4/m)/2$

The next interval starts by turning S_1 and S_2 OFF and C_a is charged with current peak of $I_4/m + I_{Lin}$

At the interval 7, a resonance occurs between C_a and L_L , and thus, C_a is charged to its peak value V_1 . The duration of this interval is small, L_{a2} current can be assumed constant during this interval also.

During the 8th interval, the voltage across L_{a2} is essentially constant and equal to V_0/n since L_L value is much smaller than L_{a2} .

The 9th interval begins when L_{a2} current has reached zero and D_{a2} turns off under ZC condition. In this interval, S_3 , S_4 and D_2 are conducting and the converter operates like a regular current-fed full-bridge converter.

A center tapped transformer is used in this project. A transformer is a static electromagnetic device used for the transformation of the alternating current from primary to secondary. The voltage can be controlled by changing the transformation ratio. This can be done by tapping the winding in order to alter the number of turns.[3]

The change in number of turns may be effected when the transformer is out of circuit or when on load. The tapping's are provided on the high voltage winding because of a fine voltage variation is obtain owing to large number of turns. It is difficult to obtain voltage variation within close percentage limits in low voltage winding as there are few turns and voltage per turn is a large percentage of the total voltage.[6]

In transformer the tapping's can be provided at,

- (i) phase ends, and
- (ii) neutral point or in the middle of the windings

When tapping's are made at the neutral point the insulation between various parts are small. This arrangement is economical especially in the case of high voltage transformers.

These center tapped transformer are comes under the category of winding based classifications. In this it comes on sandwich coils. The advantage of this that their leakage can be easily controlled and so any desired value of leakage reactance can be had by the division of windings.

In the transformer side the voltage is conversion is,

$$\frac{\text{secondary winding}}{\text{primary winding}} = \frac{V_2}{V_1} = \frac{N_2}{N_1}$$

Where,

V_1 – primary voltage , V_2 – secondary voltage

N_1 – number of primary windings, N_2 – number of secondary windings

The output voltage or the secondary voltage can be calculated by using the formula,

$$V_2 = \frac{N_2}{N_1} * V_1$$

Here,

$$V_2 = \frac{V_1}{N_1} N_2' N_2''$$

For example, $V_1 = 50$ volts, $N_1 = 4$, $N_2' = 4$, $N_2'' = 4$

Then the output voltage is $V_2 = 50 * 4 * 4 / 4 = 200$ volts

IV. EXPERIMENTAL SETUP

The experiment model was done with MATLAB software. IGBT switches are used to convert DC power into AC power. Gate pulses also given to them. Diode are connected on the output side. A motor is additionlay connected with the output terminal to show the output voltage level through its working. Gate pulse and output speed of the motor are viewd by connecting scope of MATLAB.

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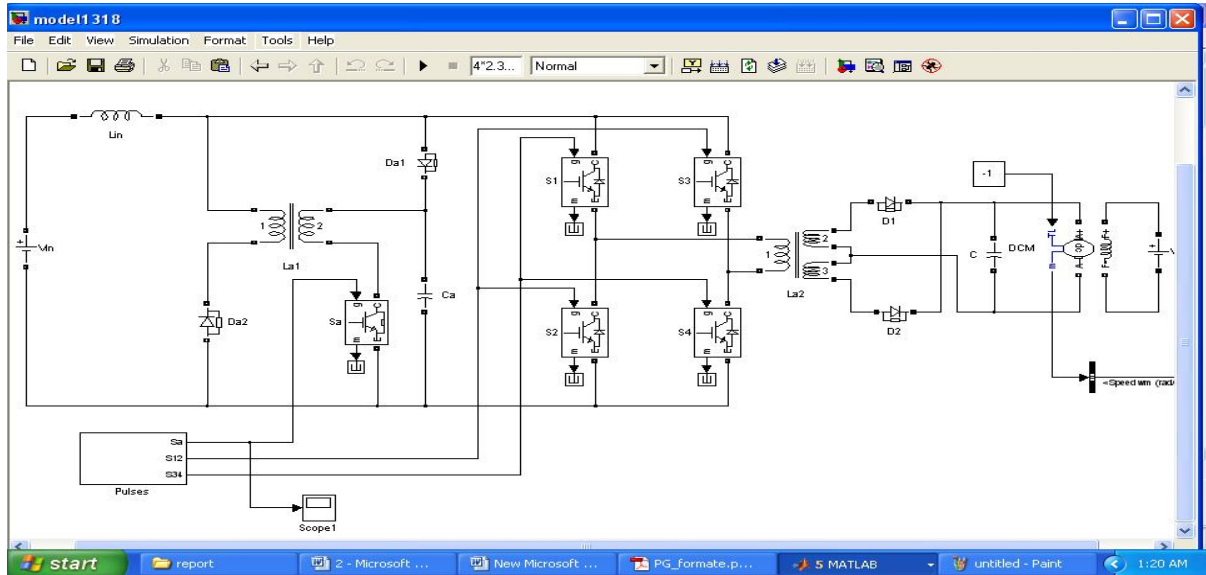


Fig: 1 Circuit Deign using MATLAB

V. RESULT AND DISCUSSION

The output voltage of the circuit is greater than the supply voltage. This is achieved by dc to dc converter circuit along with transformer circuit. Inversion dc to ac conversion and rectification dc to ac conversion process are done in the single circuit itself with low switching and conduction losses and low cost. Triggering pulses are given to the IGBT switches through PWM techniques. IGBT's are turn on and turn off control switch which is just by giving and removing the pulses the IGBT device can be turned on and turned off. So the circuit doesn't require additional circuit for turn off process like SCR. The ouput voltage obtained from MATLAB is shown.

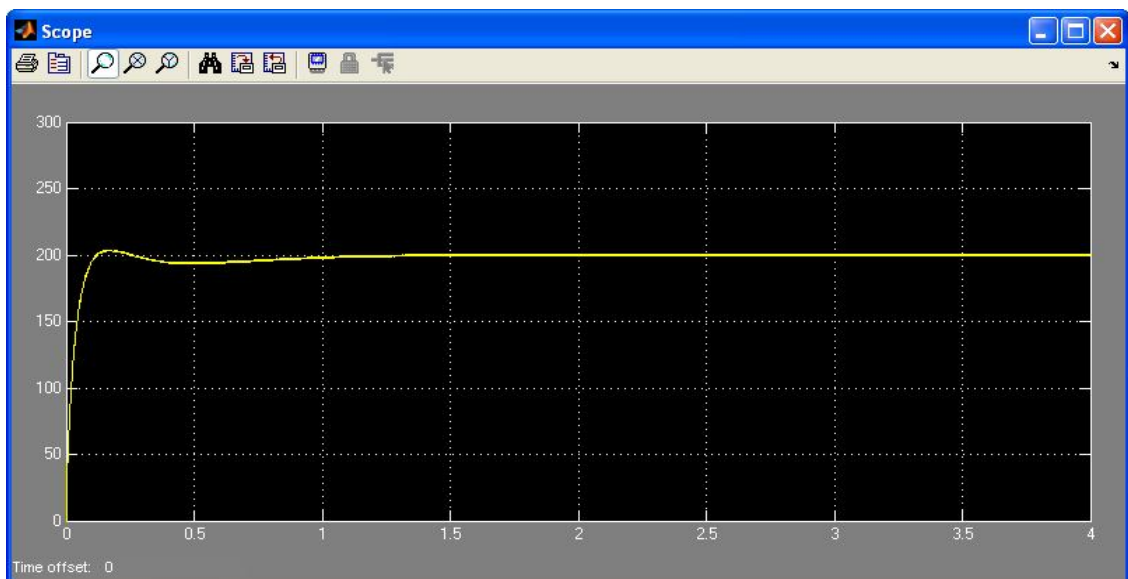


Fig: 2 Output Voltage by Simulation



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VI. CONCLUSION

In this project a small value of DC voltage is converted into a high value of DC voltage by using inverting and rectifying operations. Here the IGBT's are used as switches in the inverting block instead of MOSFET's and SCR's. Among the power semiconductor switches IGBT is chosen here. The IGBT switches converted the high dc power with reduced conduction and switching losses. In this project MATLAB software is used for the simulation process. The related waveforms were shown. The circuit and simulated waveforms were shown by using MATLAB, and a separately excited DC motor is connected along with the circuit. The speed of the DC motor is monitored by the simulation block and controlled the converter technique. The low value of DC voltage is converted into high value of DC voltage by using this circuit and the less supply is utilized to run a dc motor which requires high dc voltage.

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