MS. DIPTI K. SHAH, Prof. B. T. DESHMUKH / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue 2,Mar-Apr 2012, pp.220-222

DC TO DC DRIVE CHOPPER FED IGBT POWER CIRCUIT

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Abstract: A D.C drive system, which employs a four quadrant chopper with IGBT, is presented . The chopper circuit employs "full bridge" configuration has advantage such as high operational frequency, smooth and linear control, high efficiency and fast response. IGBT' based power circuit and direction changing logic circuit is used for the D.C drive which does not involve any triggering circuit. Isolation card is also used as a precaution for the IGBT 'S. Pulse width modulation technique is used for controlling the speed of the motor. Soft start circuit is also provided to limit the inrush current to the motor in initial conditions when the motor is provided with the armature supply.

Keywords: Four bridge chopper, Direction change logic circuits, IGBT gate driver circuit, IGBT Power circuit, D.C motor.

I. INTRODUCTION

The appearance of the power transistors with IGBT lead to the necessity of redesigning the power converters structure from the point of view of the gate command and protection circuits. The IGBT advantage are:- very high input impedance which is voltage controlled device , low level of loss in conduction state, low switching loss , high operating frequency(up to 50 KHz), simple protection circuits. They have wide area of applications like, used in Traction Drives for railways, buses & electrically driven vehicles, also in steelworks, hot strip mills, transformer winding machines, in position controls etc.

II. FOUR QUADRANT CHOPPER

Such D.C supplies can be found in many industrial processes, e.g. Transportation systems, chemical and steel plants etc. Expect at very high power levels , the four quadrant chopper has certain advantages such as high operational frequency , smooth and linear control , high efficiency and fast response.

The block diagram of the system is shown in fig 1. The converter is full bridge chopper with four quadrant operation. Because of the four quadrant there is rotation of the D.C motor in the both direction i.e reverse and forward direction , this has been done with the help of direction changing logic circuit.

III. DIRECTION CHANGE LOGIC CIRCUIT

The function of direction change block is to rotate the motor in forward and reverse direction. Basically, it consist of two J-K filpflop, 555 timer, and 4 AND gate. The timer is used in monostable mode.

When the power is turned on the power on reset components connected to reset pin of J-K flip-flops, reset the flip-flops. The 555 connected as Monostable multivibrator gets a trigger pulse on pin 2 on power on and its timing starts. At the end of monoshot timing the level change at the output pin of 555 which is inverted one. This set both the filpflop output to 1. The first flipflop output drives the relay driver circuit, which in turn operates the relay and PWM circuit generates PWM pulse which is desired DC level. At that time second flipflop output goes high so one direction is selected. For other direction, direction change switch is pressed which toggles the JK flipflop output. Now, the first filpflop output becomes zero and relay of soft start circuit is deactivated. The soft start capacitor gets shorted and PWM is not generated. Q output of first flip-flop gives trigger to pin 2 of 555 and Monoshot gets triggered. At the end of monoshot time the set pulse is given to flip-flop and again Q of first flip-flop becomes one and Q output of second flip-flop becomes equal to zero. Thus direction of rotation reverses.

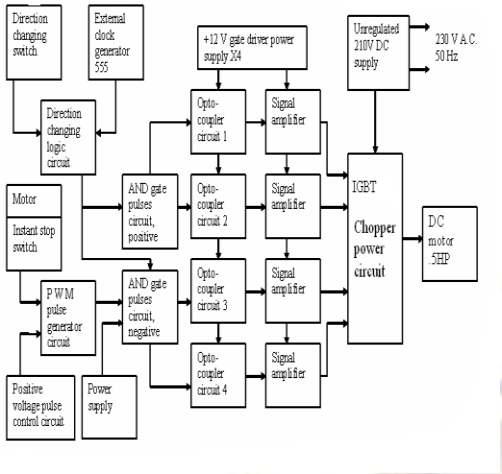

Figure 1 Block diagram

IV. PWM PULSE GENERATOR

PWM pulse generator is used for generating the desired DC level with the help of the positive voltage pulse circuit. This output along with the output of direction change logic circuit is given to the Anding circuit for the generation of four pulses which is used to drive the IGBT gate Driver circuit.

V. IGBT GATE DRIVER CIRCUIT

IGBT is a voltage controlled device and has high input capacitance of 3000 to 7000 pf between its gate and source terminal. The on state voltage across IGBT depends on gate to source voltages Vgs therefore to keep the on state voltage low relatively high positive gate to source voltage must be applied .However the voltage should not exceed breakdown voltage of the gate. Vgs should around 15V.During the off state a negative Vgs should be applied. It is about 2 to 5V.The Vgs must be applied continuously or else IGBT will be turn off. The output current of the driver circuit should be sufficient to charge and discharge the gate to source capacitance as quickly as possible. This will help in reducing Ton and Toff for IGBT. It will also reduce switching losses. The IGBT and control circuit must be electrically isolated. The wiring to the drive circuit to IGBT must be short as possible to avoid oscillations at the gate. The wires must be twisted to eliminate the effect of EMI. The drain current of IGBT must be sensed by sensing circuit. As soon as the drain current exceeds the saturation value the gate drive to the IGBT must be turned off.

The gate driver circuit consist of opto-isolator along with Darlington pair which is used for the driving of the IGBT. The function of opto-isolator is to provide the isolation between the control circuitry and to control the short circuit.

The Darlington connected transistors provide higher output current and lower output resistance. The advantage of using the Darlington pair is that it has very high DC current gain (β) and high collector breakdown voltage**.** The overall β of the Darlington pair is

$$\beta_d = \beta_1 * \beta_2.$$

This reduces the base current required to supply the required amount of collector current.

VI. IGBT POWER CIRCUIT

IGBT power circuit consists of four IGBT. These four IGBT are turned ON and OFF in pairs of IGBT1 & IGBT2, IGBT3 & IGBT4. The IGBT used is IRG4B30FD which have in built snubber circuit with ultra fast soft recovery diode has following specifications : operating frequency 1-5 Khz in hard switching, >20 Khz in resonant mode, Vces =600v, Ic @ 25ºC = 31 A, Vge= ±20V.

As there is in built snuuber there is no need of protection circuit, this is the advantage of this 4th generation IGBT than 3rd generation IGBT with higher efficiency.

VII. D.C. Motor

Electric motors are frequently used as the final control element in positional or speed control system. As there are two types of as D.C & A.C motor. The control of the D.C motor speed by the chopper is required where the supply is d.c. or the a.c. that has already rectified by the d,c. voltage. The most important applications of the chopper are in the speed control of the d.c motor used in the industrial applications or traction drives. Choppers are used for the control of d.c motors because of the numbers of advantages such as high efficiency, flexibility in control, light weight, small sizes, quick response, and regeneration down to very low speeds. Because of the flexible control characteristics, separately excited d.c motors are used. The separately excited motors has separate control of the armature and field currents.

The control of the armature currents is done with the help of IGBT power circuit. Due to the IGBT power circuit the motor is rotated in both the direction. Thus there is forward and reverse regenerative breaking takes place. When there is need to emergency switch off the motor soft start button has to be pressed to perform this function. The specification of the motor is H.P=0.5, current rating 2.5A, Vdc =250V, RPM= 1500, Arm voltage 220-250V is used .

VIII. RESULT

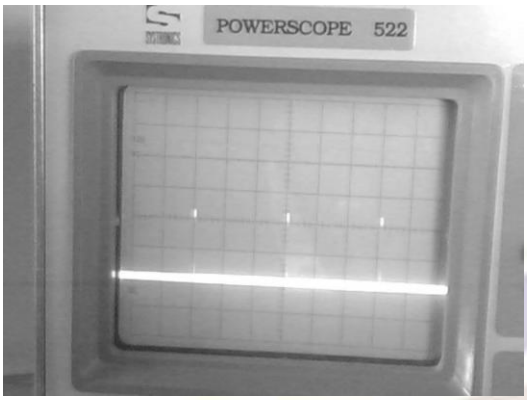

Figure 2 Waveform of PWM circuit at Min. pot position

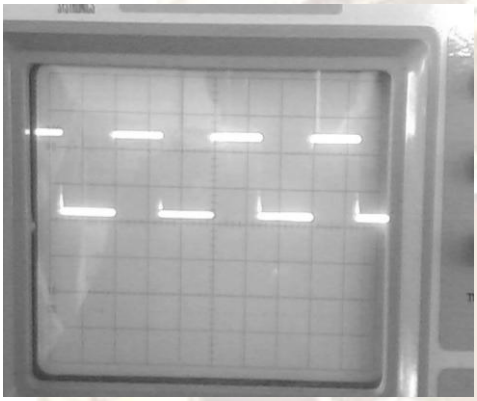

Figure 3 Waveform of PWM circuit at Mid pot position

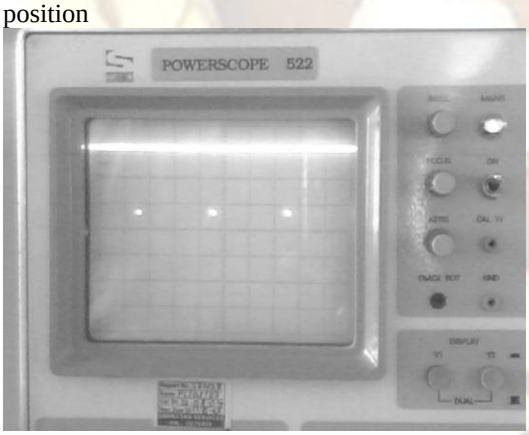

Figure 4 Waveform of PWM ckt. at MAX. pot position

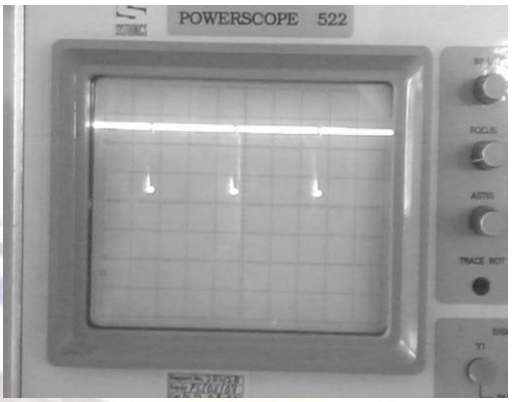

Figure 5 Waveform of Anding ckt. at Max pot position.

IX. CONCLUSION

Thus, Power electronics becomes nowadays most dynamic field of engineering. The application of power electronics are more and more diversified and focus especially on electric power conversion i.e converters. By using modern semiconductors devices having high performance, multiple functions and with new control techniques, the structure becomes simple, size get reduced. They become cheaper & more robust. Furthermore , the conversion quality increase and disturbances against power supply networks and environment decrease.

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