MATLAB Simulation on Speed Control of Four Quadrant DC Drive Using Chopper

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Abstract - This paper deals with the speed of dc motor can be control by using chopper is to designed the four quadrant speed control model. the speed control of dc motor provide designed model for four quadrant in both direction i.e. clockwise direction, counter clockwise direction along with braking of the dc motor .this operation will not superior than ac motor , compare with dc motor because the ac motor changing the rotation of motor is unmanageable and complicated to design as compared with the dc motor. Therefore for the smooth in operation we can used the insulate gate bipolar transistor (IGBT). For speed control of dc motor in both direction the chopper circuit is designed by using IGBT. The pulse width modulation (PWM) is used foe switching operation of IGBT. The PWM designed signal model can be generated by using IC LM324 (quart op-amp). To control the direction and the speed of motor, the four quadrant speed control technique is not a complicated.

Key Words: DC motor. Four Quadrant Chopper, Hybrid Electric Vehicles, I.C. Engines, IGBT.

1. INTRODUCTION

An electric motor is the part of electric drive, its energy transmitting shaft and power controlling. There are two types of electric drive i.e DC drives and AC drives. The application DC motor are use extensively speed drives and position control. The armature voltage control can be controlled by there speed below the base speed. The field – flux control is obtained by the speed above the base speed. As compare to the AC motor a speed control method does the DC motor are simple is construction and therefore its less expensive. Where the wide speed range control is required the DC motor are preferred.

The application of DC drives are requiring adjustable speed control, frequent starting, good speed regulation, braking and reversing. The most important application are paper mile, rolling miles, mine winder, hoists, printing presses, mashing tools, traction, textile mills, excavators and cranes. The servo motor for tracking and positioning are use fractional hours power DC motor. In switch mode power supplies the wide application of DC-DC convertor. In renewable resource the input voltage of converter varies in a wide range especially the source is derived. Therefore, the output voltage expected to have ripple and harmonic free input to these convertor is
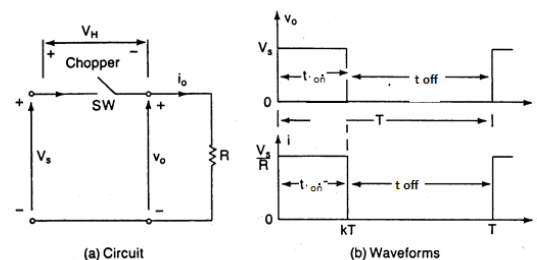
unregulated the energy absorption and injection constitute this are the two process of a switching cycle presented as duty cycle of operation.

1.1 DC Chopper

A chopper is a nothing but simple static switch which is used to convertor fixed dc into variable dc. the thyristor, power BJT, power MOSFET,GTO or IGBT this are the power semiconductor device which is used for a chopper circuit can be forced commutator. In switching element its losses will be low, efficiency will be high which is provide its circuit and either fully ON or fully OFF operation. In this switching element to avoid undesirable or unwanted effect for high switching frequency or may require smoothing frequency.

Fig-1: DC Chopper circuit and waveforms

1.2 Principle of Chopper Operation

The chopper is a convertor which is controlled commutation convertor. the chopper use is to provided with extinguishing auxiliary circuit or completely controlled device in four thyristors. this device called as controlled commutation convertor because of the any device control is much these device both time i.e. entrance time and for blocking their conduction is achieved only at well defined point in time.

In adjustable speed drive and position control application for four quadrant DC motor are mostly used. The speed of base speed of DC motor can be controlled their speeds will be decrease by armature voltage control. The base speed of DC motor can be increase by field flux control. As speed control of AC motor is not a good because of are simper and less costly. For DC motor of speed control method. the use of DC motor where more speed range control will be required. DC chopper also

provided for conversion variable DC output voltage from fixed DC input voltage. the forward motoring, forward breaking ,reverse motoring and reverse breaking this are four quadrant and this quadrant chopper circuit will be operated the application of this type of chopper in reversible motor drive.

1.1 Classification of Chopper

Chopper may be classified as following
1. On basis of input and output voltage level:
   a) Step-down chopper
      - Class A
      - Class B
      - Class C
      - Class D
      - Class E
   b) Step-up chopper
      - Class B
2. On basis of circuit operation:
   - First quadrant
   - Second quadrant
   - Four quadrant
3. On basis of commutation method
   - Voltage commutation
   - Current commutation
   - Load commutation
   - Impulse commutation

2. BASIC OPERATION OF FOUR QUADRANT CHOPPER
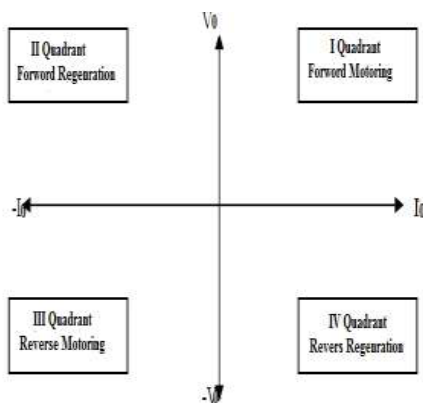
Fig,2.1: Basic operation of four Quadrant chopper.

The dramatically shows the basic operation of four quadrant chopper is shown in fig. 2.1 above. In the basic operation of first quadrant, the path of power can be travel from source to load and hence in the first quadrant voltage and current is positive. In operation of second quadrant, the voltage and current is not positive, the only current is positive and voltage is assumed to be negative and load is act as a inductive load such as a DC motor. In

operation of third quadrant, the direction of both i.e. voltage and current will be change i.e. negative and power is positive. And the last operation of four quadrant , current is positive and voltage will be negative and similarly power will be negative.
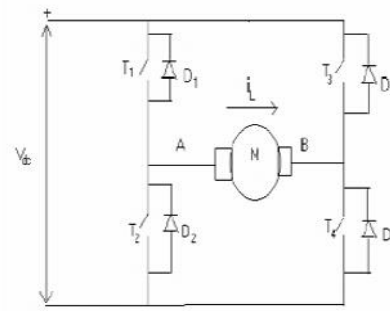
3. CIRCUIT DESCRIPTION

Fig.3.1: Four quadrant chopper circuit

The circuit description of operation of four quadrant chopper is as shown in fig. 3.1

The operation of four quadrant chopper, we can connected four switching device with diode in antiparallel with switching diode, the point A and B is shown is to be connected motor is shown in above circuit.

3.1.1 First Quadrant chopper Operation

The first quadrant chopper is also called as a class A chopper, when the directly supply is given to the four quadrant chopper circuit i.e. fig.3.1. the two diode will be ON position i.e. T1 and T2, the path of current flow is (Vdc+)- T1- load(A-B)- T4-(Vdc-). hence direction of current will be same. So current and voltage is positive, during this operation inductance is charge by positive polarity and hence first quadrant chopper operation can be performed.

3.1.2 Second Quadrant Chopper Operation

The second quadrant chopper is also called as a class B chopper .the second quadrant chopper is a step-up chopper, in this quadrant inductor get fully charge and current can be flowing path through load(B)- D1- (Vdc+)- (Vdc-)- D4- load(A). since direction of current will be change, so voltage is positive and current is negative and second quadrant operation can be performed. the second quadrant chopper is used for regenerative braking of DC motor.

3.1.3 Third Quadrant Chopper Operation

The third quadrant chopper is a combination of class A and class B chopper. This chopper is use step-up as

well as step-down chopper. In above circuit T2 and T3 in ON, the current can be flowing path through (Vdc+)- T3- load(B-A)- T2- (Vdc-), the direction of current and voltage is same i.e. negative. with the same polarity inductor get fully charged. Hence third quadrant chopper can be performed.

3.1.4. Fourth Quadrant Chopper Operation

The four quadrant chopper is also called as a class E chopper, inductor get fully charged in first quadrant operation it will find the path to discharge for that inductor change the polarity and get discharge through path load(B)- D3- (Vdc+)- (Vdc-)- D2- load(A).the direction of voltage and current will be different i.e. voltage is negative and current is positive, fourth quadrant chopper will be performed.
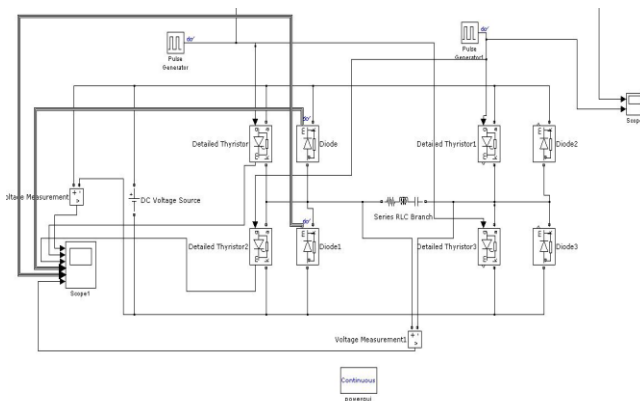
4. **MATLAB SIMULATION MODEL**

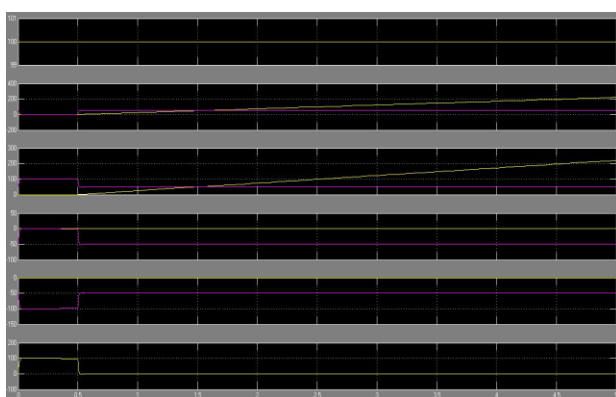Fig.4.1. simulation of four quadrant chopper circuit

Fig.4.2. output waveform of rotor current Ia Vs time

Fig.4.1. shows the simulation diagram of four quadrant chopper and fig.4.2. shows the output waveform of four quadrant chopper circuit.

5. CONCLUSIONS

This paper presents on MATLAB simulation on speed control of four quadrant DC drive using chopper. The MATLAB simulation is used to compare the performance of chopper circuit. To design and implement speed and direction of four quadrant chopper circuit, dc motor can be control.

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