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Four Quadrant Operation of DC Motor Using H-Bridge Chopper Circuit

Dewang Kore[1], Himanshu Singh[2], Shashidharan Goundar[3], Vinay Gill[4]

[1]Department of Electrical Engineering, Mumbai University, Virar, India
Email: 16405024dewang@viva-technology.org
[2]Department of Electrical Engineering, Mumbai University, Virar, India
Email: 16401033himanshu@viva-technology.org
[3]Department of Electrical Engineering, Mumbai University, Virar, India
Email:16401032shashi@viva-technology.org
[4]Department of Electrical Engineering, Mumbai University, Virar, India
Email: 18401040vinay@viva-technology.org

Abstract*—The speed of dc motor is often control by using chopper is to design the four-quadrant speed control model of dc motor provide designed model for four quadrants in both directions i.e. clockwise direction, the counter-clockwise direction along with side braking of the dc motor. The graceful operational we will use the Metal Oxide Field Effect Transistor (MOSFET) for speed control of dc motor with the assistance of the chopper circuit. The pulse width modulation (PWM) via microcontroller is employed for switching operation of MOSFET.Class E Chopper is employed for the conversion of fixed DC into variable DC. Within the first quadrant operation, current and voltage are to be positive hence power is often the due source to load. In the second quadrant operation voltage remain positive but current remains. Negative during inductive load. In the third quadrant operation, current and therefore the voltage are both negative but the facility is positive. In four-quadrant operation voltage is negative& current is positive*

Keywords— Chopper Circuit, MOSFET, DC motor, microcontroller, Voltage regulator.

I. INTRODUCTION

Four Quadrant DC motor is applicable for speed variation and position control applications. The speed below the reference pre-determined value is often altered by voltage control whereas speeds above the reference pre-determined value are often altered by field-flux control. As compared to AC motor, DC speed control is economical and straightforward in construction. Choppers convert fixed dc input voltage to variable dc output voltage. Class-E or chopper operates in four-quadrant which are as follows Forward Motoring, Forward Braking, and Reverse Motoring and Reverse braking. The mixture of Bipolar transistor (BJT's) and Resistor helps to offer +12v to trigger the Metal Oxide Semiconductor Field Effect Transistor (MOSFET's) via microcontroller. It carries positive attributes of BJT's and MOSFET.

II. LITERATURE REVIEW

The speed of dc motor is often control by using chopper is to design the four-quadrant speed control model of dc motor provide designed model for four quadrants in both directions i.e. clockwise direction, the counter-clockwise direction along with side braking of the dc motor. The graceful operational we will use the Metal Oxide Field Effect Transistor (MOSFET) for speed control of dc motor with the assistance of the chopper circuit. The pulse width modulation (PWM) via Four Quadrant Speed Control of DC Motor Using Chopper Arduino is employed for switching operation of MOSFET.Class E Chopper is employed for the conversion of fixed DC into variable DC. Within the first quadrant, operation power is often a due source to load and hence, current and voltage within the first quadrant are assumed to be positive. In the second quadrant operation voltage remain positive but a change in direction of current i.e. negative this condition happened when the load is inductive like a DC motor in third quadrant operation current and therefore the voltage are both in negative but the facility is positive. In a four-quadrant operation, current is positive and voltage is negative and thus power is negative.

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[I] Samiksha S. Zade et .al:-

In this paper present, the four-quadrant speed control model is meant by using Chopper to regulate the speed of the DC motor. The designed model provides four-quadrant speed control of DC motor in both directions i.e. clockwise direction, the counter-clockwise direction along with side braking of the DC motor. The Chopper is employed for the conversion of fixed DC into variable DC within the first quadrant Operation power can be a due source to load and hence current and voltage within the first quadrant are assumed to be positive. within the second quadrant operation voltage remain positive but a change in direction of Current i.e. The negative this condition happened when the load is inductive like a DC Motor in third quadrant operation current and therefore the voltage are both in negative but the facility is positive. In four-quadrant operation current is positive and voltage is negative and thus power is negative. The switching operation of IGBT is completed by can by using Pulse Width Modulation (PWM) technique. During this designed model PWM signal is often generated by using IC LM324 (Quad op-amp).

[II] Dipesh Bharambe et.al:-

The speed of dc motor is often control by using chopper is to designed the four-quadrant speed control model of dc motor provide designed model for four-quadrant in both direction i.e. clockwise direction, counter clockwise direction alongside braking of the dc motor the graceful operational we will use the insulated gate bipolar transistor (IGBT) For speed control of dc motor with the assistance of chopper circuit. The pulse width modulation (PWM) is employed for the switching Four Quadrant Speed Control of DC Motor Using Chopper operation of IGBT. To regulate the direction and therefore the speed of motor the four-quadrant speed control technique isn't complicated.

[III] Hardik Mehta et.al:-

DC Motors are used extensively in adjustable speed drives and position control Applications This paper proposes an equivalent the d to regulate the speed and direction control of a DC motor by using a four-quadrant DC-DC chopper. The speed below the bottom speed is often controlled by armature voltage control Method IGBT are used for the switching operation of the chopper The gates of this IGBT are given Pulse Width Modulation which provides the four-quadrant operation This Pulse Width Modulation is generated by programming the Digital Signal Processor using the Code Composer Software.

[IV] P.Vinod Kumar et.al:-

The speed of separately excited DC motor is often controlled from 0 to rated Speed using chopper The chopper firing circuit receives a sign from the controller and therefore the chopper responds by providing variable voltage to the armature of the Motor for achieving the specified speed. There are two control loops one for controlling current and another for speed. The controller used is the proportional-integral type which ceases the delay and Provides fast control. The IGBT‘s are triggered by pulse width modulation (PWM) technique Recent HEV’s employ a posh system which involves the vehicle to figure on motor till the speed is appreciable to modify over the control of the Vehicle to the IC engine where the vehicle is driven by the IC engine. The speed Limits depend upon the efficiency of the IC engines within the initial gears i.e. first and second this refers to the above context the four-quadrant operation is meant to work at speeds from 0 to 700 rpm (0 to100 km/hrs).

III. DC MOTOR SPEED CONTROL METHODS

3.1 Flux Control Method

In this method, the magnetic flux from field windings is varied to vary the speed of the motor. The present flowing from field is varied by putting field coil resistor serial which in-turn decreases the present & magnetic flux from field coil .

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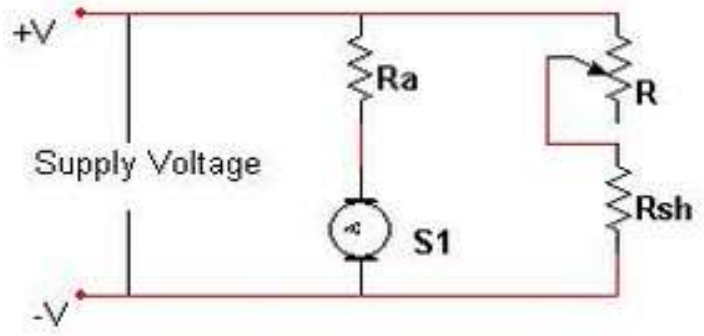

FIGURE 1: Flux Control Method

The resistor which is kept at its minimum position, the rated current flows through the sector winding thanks to a rated supply voltage, and as a result, the speed is kept normal. When the resistance is increased gradually, the present through the sector winding decreases. This successively decreases the flux produced which causes speed of the motor increases beyond its normal value.

3.2 Armature Control Method

DC motor speed is often controlled by controlling the armature resistance to regulate the drop across the armature. The tactic also uses a rheostat serial with the armature.

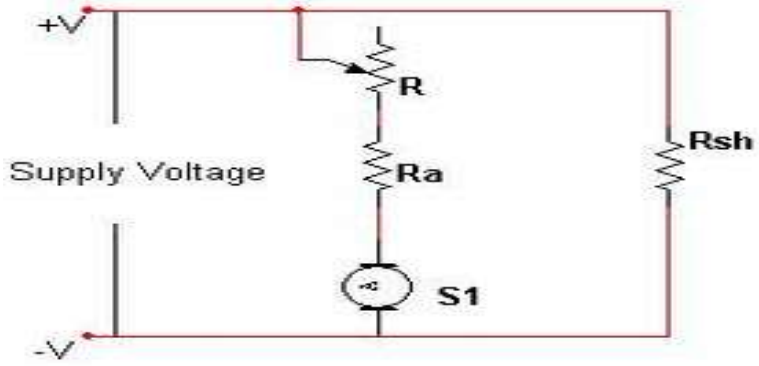

FIGURE 2: Armature Control Method

The rheostat reaches its minimum value, the armature resistance is at normal one, and thus, the armature voltage drops. When the resistance value is gradually increased, the voltage across the armature decreases & in-turn results in a decrease within the speed of the motor. The tactic achieves the speed of the motor below its normal range.

3.3 Voltage Control Method

The mentioned methods cannot provide speed control within the desirable range. However, the flux control method can affect commutation, whereas the armature control method involves huge power loss thanks to its usage of resistor serial with the armature. Thus a special method is usually desirable – the one that controls the availability voltage to regulate the motor speed. In such a way, the sector winding receives a hard and fast voltage, and therefore the armature gets a variable voltage. One such technique of voltage control method involves the utilization of switchgear to supply a variable voltage to the armature. Aside from these two techniques, the foremost widely used technique is the use of pulse width modulation to realize speed control of a DC motor. The PWM involves the application of varying width pulses to the motor driver to regulate the voltage applied to the

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motor. This method proves to be very efficient because the power loss is kept at a minimum, and it doesn't involve the utilization of any complex equipment. The PWM is achieved by varying the pulses applied to the enable pin of the motor driver IC to regulate the applied voltage of the motor. The variation of pulses is completed by the microcontroller, with the input from the pushbuttons.

IV. COMPONENT DESCRIPTION

4.1 Microcontroller

It helps the project to concatenate the H-bridge and provides the PWM formatted signals to Metal Oxide Field Effect Transistor (MOSFET) for respectively switching as needed by user. Converts the input voltages to acceptable levels to drive the gates. Give enough current to charge and discharge the gates fast enough

4.2 H-Bridge Mosfet

Metal Oxide Field Effect Transistor (MOSFET) is generally used as a voltage-controlled device. The FETs are much smaller, so their gate capacitance is basically small. Even a comparatively weak source can quickly charge and discharge them. The smaller FETs even have a way higher Rds(on) value (several ohms) therefore the dynamic shoot-through currents are low enough not be a headache

4.3 Controlling Module

It provides the user a user-friendly customs by giving controls to Arduino as shown in diagram. Such modules are often operated remotely and vicinity also.

V. CIRCUIT DIAGRAM

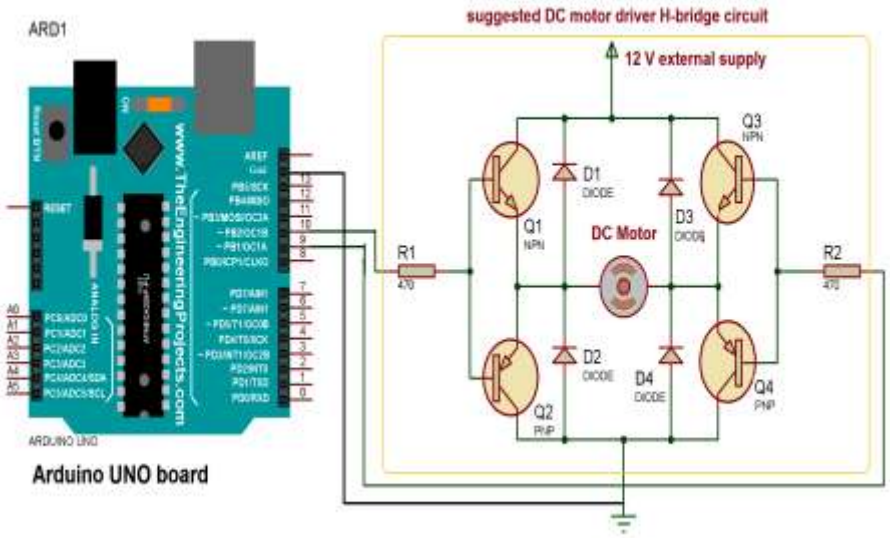

FIGURE 3: Circuit diagram

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VI. OPERATION

7.1 First Quadrant Operation

The first quadrant chopper is additionally called a category A chopper when the direct supply is given to the four-quadrant chopper circuit i.e. fig.3.1. the 2 diodes are going to be ON position i.e. T1 and T2, the trail of current flow is (Vdc+)- T1- load(A-B)- T4-(Vdc-). Hence the direction of the present is going to be an equivalent. So current and voltage are positive, during this operation inductance is charge by positive polarity and hence first quadrant chopper operation are often performed.

7.2 Second Quadrant Operation

The second quadrant chopper is additionally called as a category B chopper .the second quadrant chopper may be a step-up chopper, during this quadrant inductor get fully charge and current are often flowing path through the load(B)- D1- (Vdc+)- (Vdc-)- D4- load(A). Since the direction of the present is going to be changed, therefore the voltage is positive and current is negative and therefore the second quadrant operation is often performed. The second quadrant chopper is employed for regenerative braking of DC motor.

7.3 Third Quadrant Operation

The third quadrant chopper may be a combination of sophistication A and sophistication B chopper. This chopper is used step-up also as a step-down chopper. Within the above circuit, T2 and T3 are ON, the present are often flowing path through (Vdc+)- T3- load(B-A)- T2- (Vdc-), the direction of current and voltage is same i.e. negative. with an equivalent polarity, the inductor gets fully charged. Hence third quadrant chopper is often performed.

7.4 Fourth Quadrant Operation

The four-quadrant chopper is additionally called as a category E chopper, inductor gets fully charged in first quadrant operation it'll find the trail to discharge for that inductor change the polarity and obtain discharge through path load(B)- D3- (Vdc+)- (Vdc-)- D2- load(A). the direction of voltage and current are going to be different i.e. voltage is negative and current is positive, fourth quadrant chopper is going to be performed.

VII. CONCLUSION

In a four-quadrant chopper circuit is the design and implemented during which the speed and direction of the DC motor is control. MOSFET provides smoother control as compared to the SCR hence, the controlling operation of motor is smoother by adjusting the PWM pulses which are further manipulated via microcontroller, the motor speed is going to be controlled fully and motor will complete their operation altogether four-quadrant that's Forward motoring, Forward braking, Reverse motoring, Reverse braking. during this way, the four-quadrant speed control function is often done. this technique gives high reliability. The reconstitute of the whole circuit is straightforward and robust and inquisitive stability makes it independent. Generally, during these operations, the four-quadrant operation of the motor is achieved.

REFERENCES

[1] Imperial Journal of Interdisciplinary Research (IJIR) Vol-3, Issue-5, 2017 ISSN: 2454-1362, http://www.onlinejournal.in

[2] International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 04 Issue: 3 | Mar -2017

[3] C International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 5, May 2015.

[4] Design and Implementation of 4 Quadrant DC Drive Using Chopper publication/281853889, Issue January 2015

[5] IJESRT INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY February 2015] ISSN: 2277-9655 Scientific Journal Impact Factor: 3.449 (ISRA), Impact Factor: 2.114

[6] I Bimbhra, P.S., Power Electronics. New Delhi, Khanna Publishers, 2006.

[7] Bimbhra, P.S., Electrical Machinery. New Delhi, Khanna Publishers, 2006.

[8] Snehlata Sanjay Thakare and Prof. Santosh Kompelli "Design and implementation of dc motor speed control supported pic microcontroller" International Journal of Engineering and computing ISSN: 2319-7242, Volume - 3 Issue -9 September 2014 Page No. 8075-8079.

[9] Valter Quercioli., "Books on PWM technique: Pulse Width Modulated Power supplies".

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[10] Y. S. E. Ali, S. B. M. Noor, S. M. Uashi and M. K Hassan" Microcontroller Performance for DC Motor Speed Control" O-7803-8208,2003 IEEE.

[11] Engineering Sciences & Research Technology, vol. 4 issue 2: February, 2015, ISSN: 2277-9655,pp 401-406.

[12] "DS1103 PPC Controller Board", Germany: dSPACE, July 2008. Janice Gillispie Mazidi. "Books on Microcontroller: 8051 microcontroller and embedded systems"

[13] Maiocchi.G., "Books on DC motors: Driving DC Motors "BL.Theraja. "DC Motors and drives "