

Speed Control of PMDC Motor Using LM3524 PWM IC

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Abstract:-The goal of this work is to control the speed of PMDC motor using PWM technique. The speed control of PMDC motor is very essential in application where precision and protection is necessary. In this paper implementation of PWM is done with the help of LM3524 for the speed control of PMDC motor fed by a DC chopper. The chopper is driven at a frequency of 20KHZ controlling the PWM duty cycle is equivalent to controlling the motor speed. This chopper circuit used here is 4 quadrants for the rotation of motor in forward and reverse direction.

Keywords:-PMDC motor, speed control, PWM, 4Q chopper.

I. INTRODUCTION

Speed control of PMDC motor could be achieved by using mechanical or electrical techniques. In past, speed controls of DC drives are mostly mechanical and requiring large size hardware to implement. The development has launched these drives back to position of formidable relevance which give rise to A.C drives. Some important applications are rolling mills, paper mills, traction, printing, textiles mills etc.. Fractional horse power D.C drives are widely employed [1]. Due to the ability to supply continuously variable D.C voltage, controlled rectifier and DC chopper made a revolution in modern industrial equipment and variable drives [2]. Adjustable speed drives may be operated over a wide range of, by controlling armature or field excitation.[3]. The invention of power semiconductors saw the advent of the D.C drive system for the most of the early variable speed requirements. Based on the advantage of simple construction and ease of control, this technology continued to be taken up for future improvement. BJT and GTO along with various analog digital chips used in firing or controlling circuits have made DC drives more accessible for control in numbers of applications. Recent development in the area of semiconductors technology have made new power device for variable frequency drives as IGBT. The use of IGBT in chopper circuit to control and rotate the motor in forward and reverse direction. The main objective of this work is to become familiar with design.

II. RELATED WORKS

A reasonable number of works have found in the literature regarding the employment of solid state devices for the control of DC drives. The paper of Alexandra Morar elucidate the use of chopper in half bridge configuration. Due to this the DC motor is rotate in only one direction i.e forward direction [4]. Axelrod B. have shown 4Q bidirectional drive system for DC motor based on PWM dc-dc converter is presented using SPICE software. There converter offers both motoring and regenerative braking mode of operation [5]. Paul A.R and George M. in his paper shows digital pulse width modulation control techniques for trapezoidal brushless D C motor drives. This digital control treats BLDC motor as a digital system and regulation the speed of the motor [6]. Saunders with his colleagues have shown in their paper how PWM techniques is useful for motor drive applications. also they shows IGBT drives have faster output voltage rise time than other power drives[7]. In this paper the PMDC motor with speed control system is presented and direction of motor rotation is presented.

II. METHODOLOGY

A scheme that address on building up such a system as mention above is presented here. As the system is based on speed of PMDC motor, so desired goal is to achieve a system with control speed and direction of rotation at constant load condition. That means motor will run at variable speed at constant load condition. In implementing this work frequency independent PWM output with variable duty cycle from 0% to 100% is generated. Furthermore an direction change logic circuit is fabricated for the changing the direction of motor(forward and reverse). Also there is use of soft start circuit, to protect the motor from inrush current.

A. System Overview

The PMDC motor to be controlled is fed by DC source through a 4 quadrant chopper circuit. The output voltage of chopper is fed to the PMDC motor which rotate in forward and reverse direction according to the conduction of chopper pair. With the help of tachometer we can measure the speed of motor in RMP along with direction of rotation.

B. Circuit Description

The circuit is based on PWM techniques. LM3524 provide desired DC level. By adjusting the register valve the duty cycle can be controlled. When motor run at 20% duty cycle the output voltage develop across chopper is less which in turn makes the speed of motor to be less but for 70% duty cycle the speed of motor get increased. This increase or decreased speed is sensed by tachometer. But if any load occurs , the speed of motor get decreased for the same duty cycle. Also, the direction of PMDC motor can be change with the help of direction change logic circuit. If the motor rotate in forward direction then after switching this switches the motor will rotate in reverse direction. 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 braking takes place.

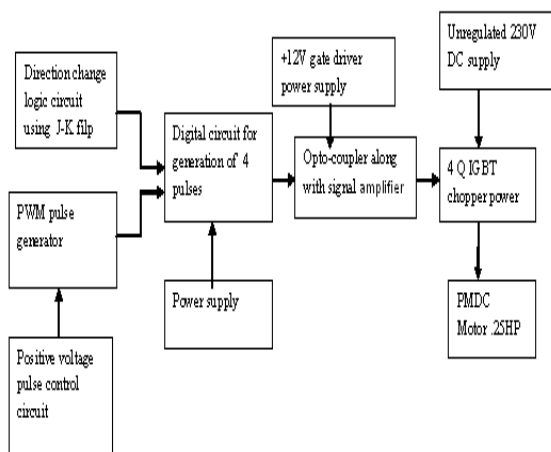


Fig 1 Block Diagram

C. Pulse width modulation

PWM drive technology has become most popular drive technology due to the many advantage:

- High efficiency (97% to 98%).
- Small size.
- Constant high input power factor.
- Open circuit operation.
- Multi-motor applications capability.
- Wide speed range .
- Excellent speed regulations.
- Ride-through capability.
- Operation < 6Hz possible w/o cogging.
- Low sensitive to line transmission.[7]

Here PWM pulse generator is used for generating the desired DC level with the help of 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.

D. Opto-coupler

For driving the IGBT circuits , opto couplers are used . with the advantage of isolation between control circuitry and power circuit. Here MCT2E opto coupler is used. MCT2E consist of a gallium arsenide infrared emitting diode driving a silicon phototransistor in a 6-pin dual in-line package [9].

III. RESULT & DISCUSSION

The result obtained are as expected can be discussed as follows.

A. Chopper circuit output

A pulse of fixed frequency generated by the PWM pulse generator which is fed to the IGBT chopper circuit. The output voltage V_0 (dc) of chopper is given to the PMDC motor. According to the IGBT pair operation the motor will rotate in that direction. A freewheeling diode is used for back emf protection.

**TABLE 1
MOTOR TERMINAL VOLTAGE AT VARIOUS POT POSITION**

POT POSITION	OUTPUT VOLTAAGE FOR FORWARD DIRECTION CONDITION	SPEED OF MOTOR(RPM)
1	07	52.6
2	26	209.40
3	60	245.96
4	85	642.70
5	120	933.20
6	180	1365
7	200	1440
8	217	1695
9	235	1875
10	250	1920
POT POSITION	OUTPUT VOLTAAGE FOR REVERSE DIRECTION CONDITION	SPEED OF MOTOR(RPM)
1	-07	-42.5

2	-26	-196.7
3	-60	-464.3
4	-85	-672.4
5	-120	-931.5
6	-180	-967.9
7	-200	-1161
8	-217	-1730
9	-235	-1842
10	-250	-1956

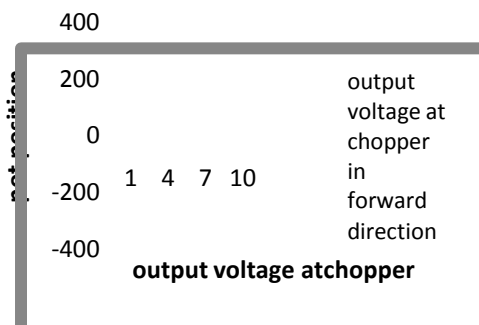


Fig 2 Pot Position vs. Output Voltage

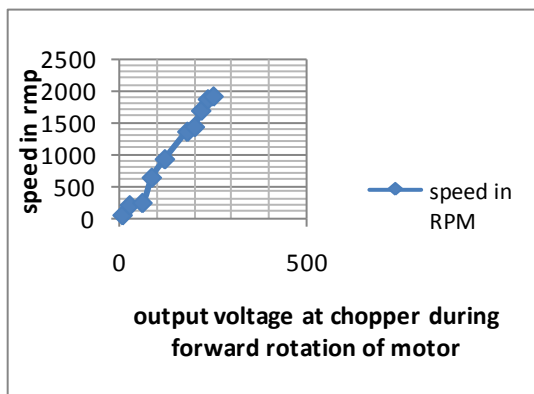


Fig 3 Speed of motor vs. Output voltage

IV. CONCLUSION

The speed control of PMDC motor using PWM technique with chopper has been introduced. Controlling the speed of PMDC motor without feedback is implemented using LM3524 [9]. The system will be made user friendly so that anyone can be operated.

V. ACKNOWLEDGEMENT

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REFERENCES

- [1] Gopal K. Dubey, "fundamentals of Electric Drives", Narosa publishing House New Delhi, 1989
- [2] Muhammad Rasid, "Power Electronics circuits, Devices and Applications" Prentice Hall, 3rd edition.
- [3] Atul Dewangan, Nibbedita, Sashi, Vinod Yadu, "PWM Based Automatic closed loop speed Of DC motor", international journal of engineering trends and technology- volume 3 issue2-2012.
- [4] ALEXANDRU MORAR "DC DRIVE SYSTEM WITH THE INSULATED GATE BIPOLAR TRANSISTORS" by "Petru Maior" University of Tg. - Mures, Faculty of Engineering 1, Nicolae Iorga str.
- [5] Axelrod, B. " Four-quadrant bi-directional drive system based on PWM DC-DC converter" Advanced Motion Control, 2008. AMC '08. 10th IEEE International Workshop , **Page(s):** 377 – 381
- [6] [Paul, A.R.](#), " Brushless DC motor control using digital PWM techniques", Signal Processing, Communication, Computing and Networking Technologies (ICSCCN), 2011 International Conference, **Page(s):** 733 – 738
- [7] Saunders, Skibiniks, EVon, Kempkes, "Riding the Reflected wave- IGBT Drive Technology Demands New Motor and cable considerations" IEEE IAS- Petroleum & Chemical Industry Conference , Philadelphia ,sept.-23-25 ,1996, page -75-84.
- [8] International Rectifier , data catalog(IGBT)
- [9] www.national.com (Regulator IC, LM3524, IC 555, MTC2E)

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