International Journal of Research In Science & Engineering e-ISSN: 2394-8299
Volume: 2 Issue: 3 March-April 2017 p-ISSN: 2394-8280

FOUR QUADRANT CHOPPER – FED DC MOTOR CONTROLLED BY PWM

Prashant Meshram[1], Rachita Kamble[2], Abhishek Bhorkar[3], Abhilash Gobade[4], Monish Ambolikar[5], Monika Borkar[6]

[1]Assistant Professor, Department of Electrical Engineering,Dr. BabasahebAmbedkar College of Engineering and Research, Hingna Road, Nagpur
[2,3,4,5,6]UG Student,Department of Electrical Engineering,Dr. BabasahebAmbedkar College of Engineering and Research, Hingna Road, Nagpur

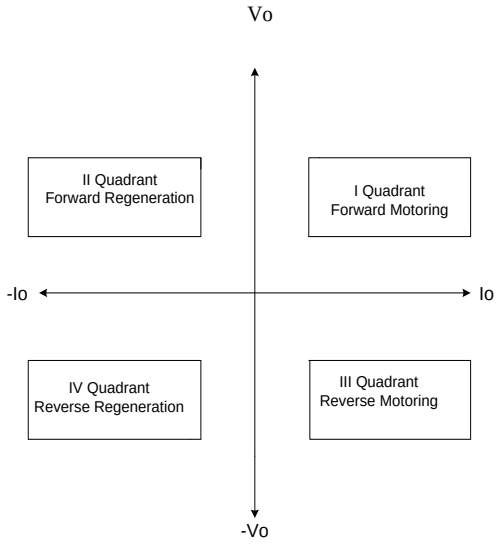
Abstract: In this paper present four quadrant speed control model is designed by using chopper to control the speed of DC motor. The designed model provides four quadrant speed control of DC motor in both directions. The Insulated Gate Bipolar Transistor (IGBT) is used for speed control of DC motor which is very smooth in operation. The switching operation of IGBT is done by can by using Pulse Width Modulation (PWM) technique. The gates of these 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. The above model is simulated in MATLAB. As per the variation in the pulses motor speed will be vary. By Four Quadrant Speed control technique it is very easy to control the direction and speed of the motor.

INTRODUCTION

Four Quadrant DC motor are extremely used inadjustable speed drive and position control application. Their speeds below the base speed can be controlled by armature-voltage control.DC motors provide excellent control of speed for acceleration and deceleration. DC choppers also provide variable dc output voltage from a fixed dc input voltage. Chopper circuit are operate in four quadrant ie. Forward Motoring, Forward Braking, and Reverse Motoring and Reverse braking. This type of chopper is widely used in reversible motor drive. The power supply of a DC motor connects directly to the field of themotor which allows for precise voltage control, and is necessary for speed and torque control applications.DC drives, because of their simplicity, ease of application, reliability and favorable cost have long been a backbone of industrial applications. DC drives are less complex as compared to AC drives system. DC drives are normally less expensive for low horsepower ratings. DC regenerative drives are available for applications requiring continuous regeneration for overhauling loads. AC drives with this capability would be more complex and expensive.

OPERATION OF CHOPPER

Chopper is used for conversion of fixed DC into variable DC. Operation of four quadrant chopper is shown in figure. In the first quadrant operation power can be flow from source to load and hence, current and voltage in the first quadrant are assumed to be positive. Similarly, in second quadrant operation voltage remain positive but change in direction of current ie. Negative this condition happened when load is inductive such as a DC motor in third quadrant operation current and the voltage are both in negative but the power is positive. Similarly in four quadrants operation current is positive and voltage is negative and therefore power is negative which is shown in figure.



Basic operation of four quadrant chopper

FOUR MODE OPERATION OF CHOPPER

Four quadrant operations can be described by the circuit which is show in below figure.1.

First Quadrant:

When the supply is given to the circuit, the T1 andT4 is ON, current flowing through the path, (Vdc+) -T1 – Load (A-B) - T4 – (Vdc-). hence both current and voltage are positive. During this condition the inductance get charge by positive polarity. The first quadrant operation can be achieved.

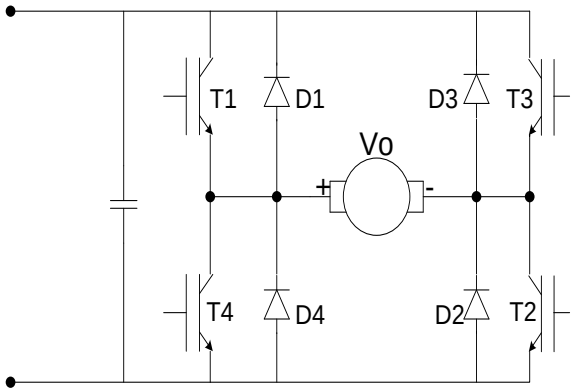


Fig.1.Four quadrant chopper circuit

Second Quadrant:

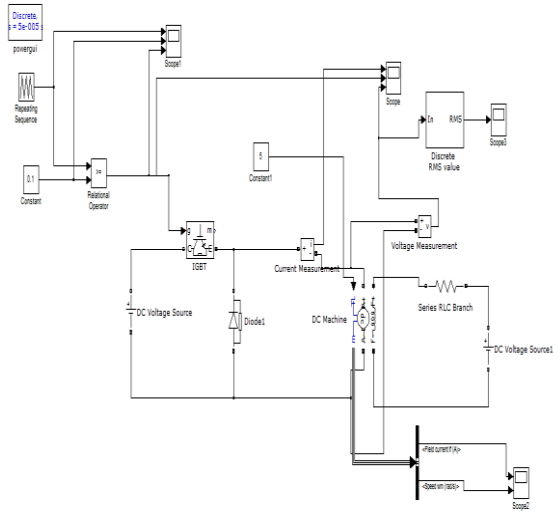
During third quadrant operation inductor get fully charge it find path to get discharge during discharge the energy can dissipated through Load(B) – D1 – (Vdc+) – (Vdc-) – D4 – Load(A) since the voltage is positive and current is negative and second quadrant operation can be achieved.

Third Quadrant:
When T2 and T3 are turned-on current start to flow through path (Vdc+) – T3 – Load (B-A) – T2 – (Vdc-), the current and voltage are negative. The second quadrant operation can be achieved. The inductor gets charge again with the same polarity.

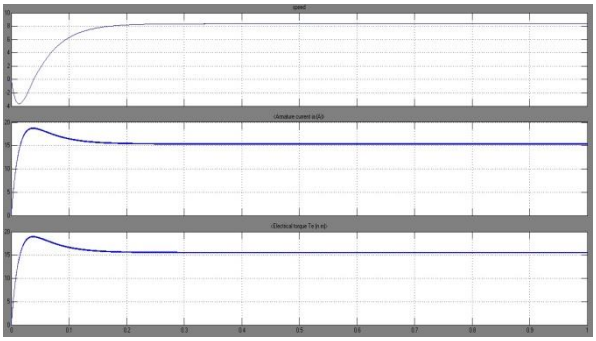
Fourth Quadrant:
During first quadrant operation inductor get fully changed it will find the path to dischargefor that inductor change the polarity and get discharge through path Load(B) - D3 –(Vdc+) – (Vdc -) – D2 – Load(A) in that case voltage negative and current is positive the fourth quadrant operation can be achieved.

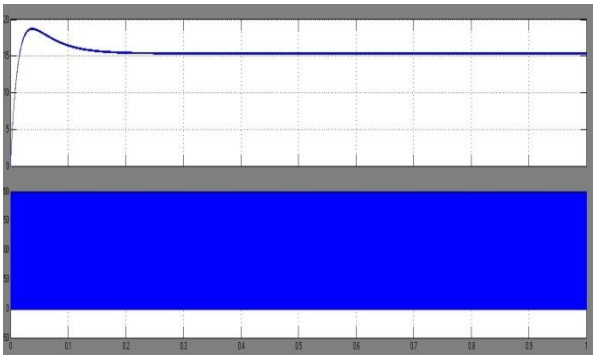
SIMULATION

First Quadrant:

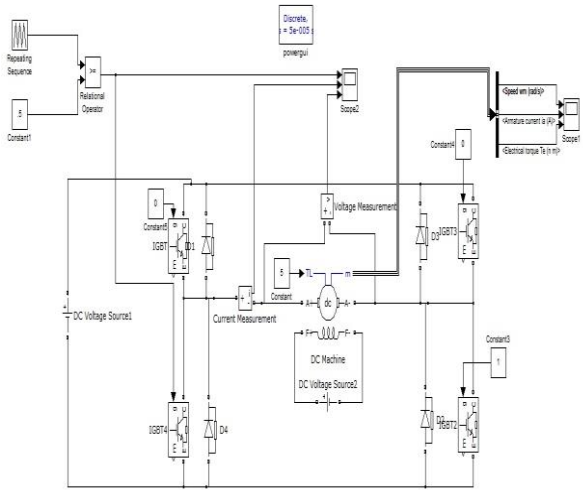


Result: Speed, Current, Torque, Armature Current & Armature voltage

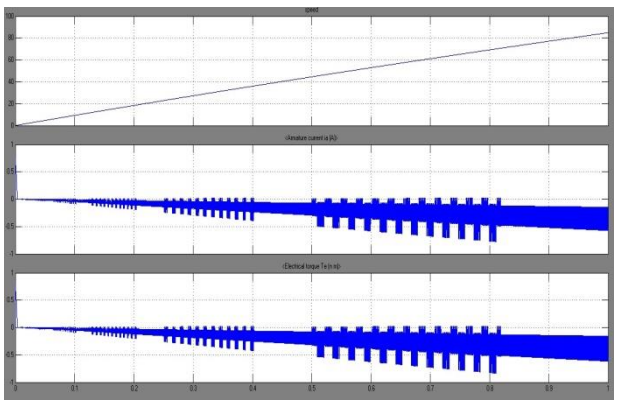


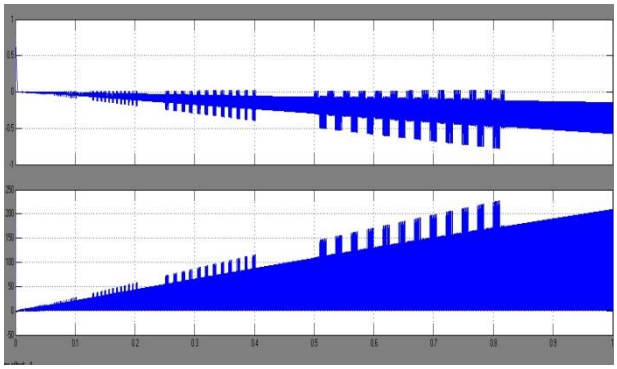


Second Quadrant:

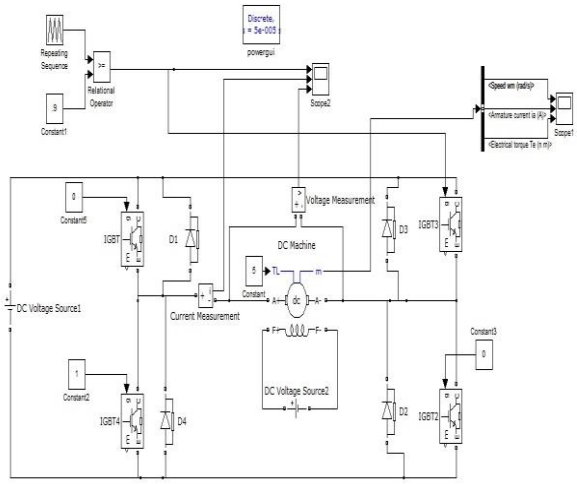


Result: Speed, Current, Torque, Armature current & Armature Current

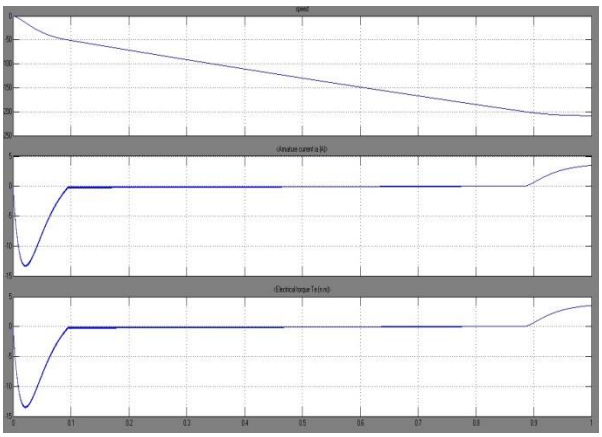




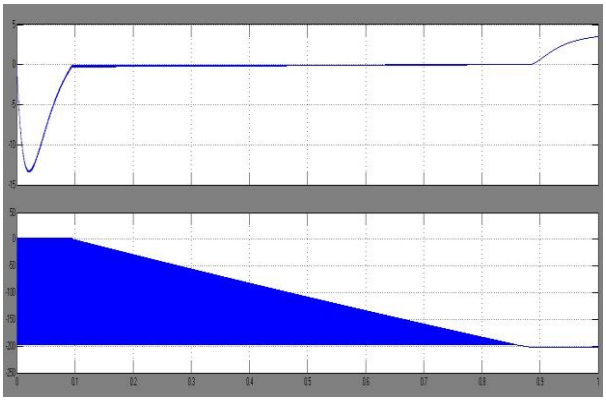
Third Quadrant:



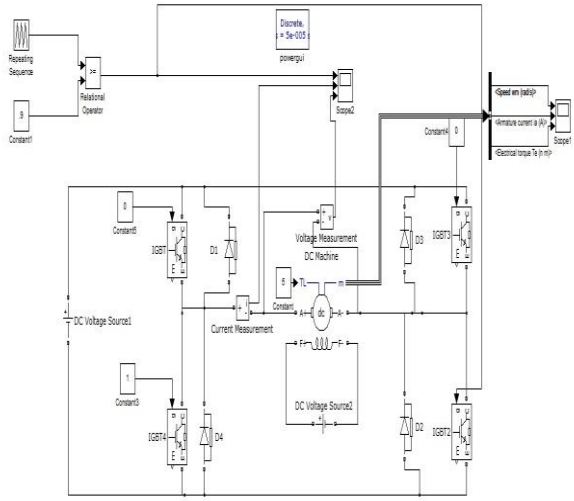
Result: Speed, Current, Torque, Armature Current & Armature voltage



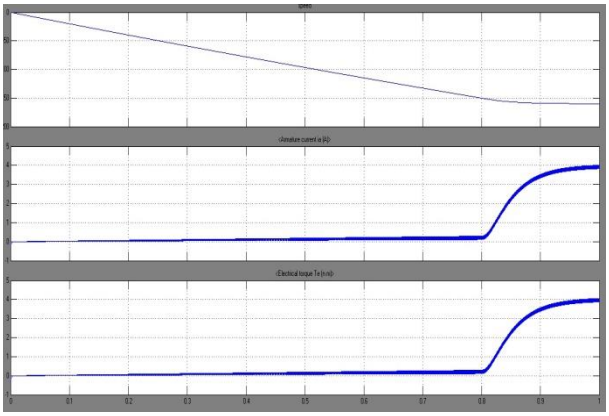
e-ISSN: 2394-8299
p-ISSN: 2394-8280



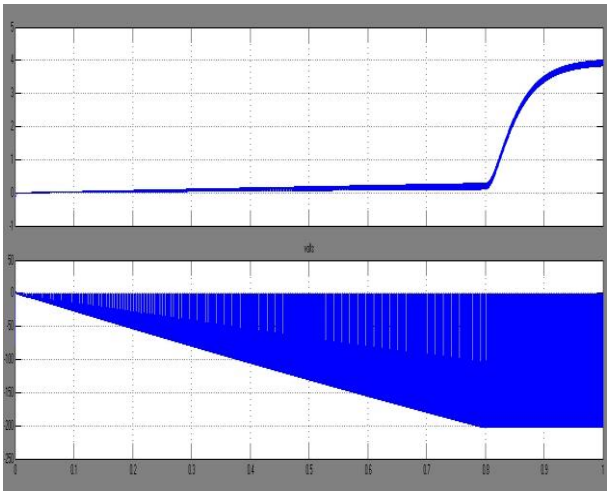
Fourth Quadrant:



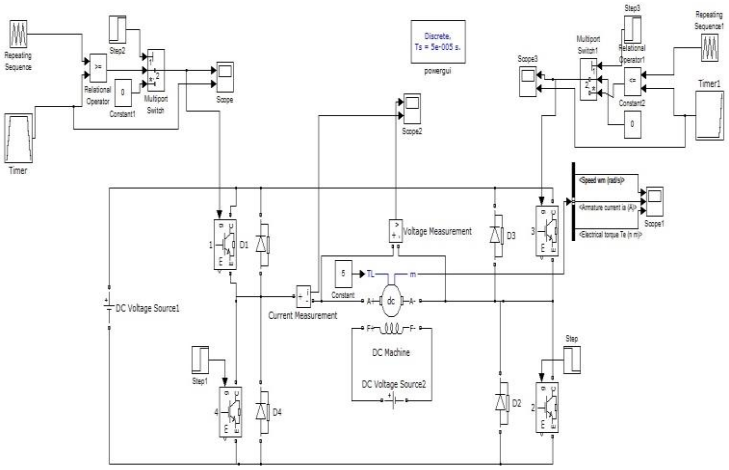
Result: Speed, Current, Torque, Armature current & Armature voltage



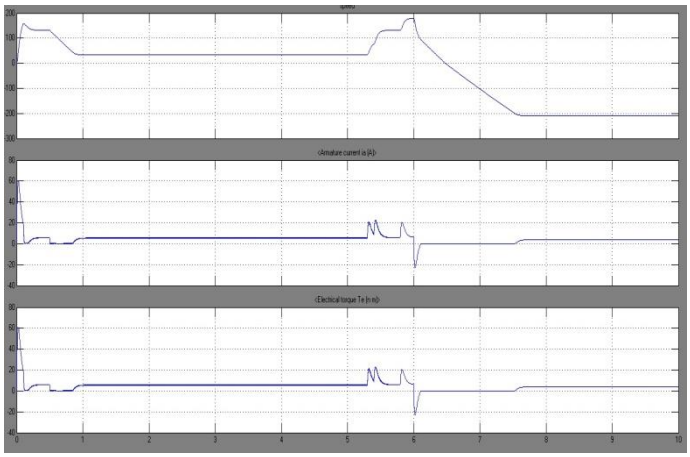
e-ISSN: 2394-8299
p-ISSN: 2394-8280



Forward to Reverse Quadrant Operation:



Result:



REFERENCES

[1] Deodatta Y, Shingare, "Industrial and Power Electronics",Electrotech Publication, 2010, pp.2.36-2.42 and 9.19-9.20.
[2] Prashansa B, Prashant Kumar Strategy for Four Quadrant Operation Of DC Motor Using DSPIC30F4011"International Journal Of Recent Technology&Enginnering (IJRTE) ISSN;2277-3878,vol.3 Issue-3july 2014.pp 73-76.
[3] Pendharkar Sameer, Trivedi Malay, Shenai Krishna "Electrothermal Simulations PunchthroughNonpunch through IGBT's",IEEEtransactions on electron devicesVol. 45, No. 10, October 1998.pp.2222-2231.
[4] Joachima Holtz, Senior member, IEEE "Pulse Width Modulation- A survey ", IEEE Transaction Industrial Elecronics, Vol. 39, No.5, December 1992, pp 410-420.
[5] Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics: Converters, Applications and Design: Wiley, June, 1989.
[6] G.Kironberg, "Industrial DC Motor Drives", *ASEA Journal*, vol. 48, no.5, pp 103-108, 1975.
[7] G-Jones, G.Joos and T.H.Barton, "Four-Quadrant DC Variable Drives," *IEEE Proceedings*, vol. 63, no. 12, pp 1660-1668, 1975.
[8] Rashid M. H., Power Electronics: Circuit, Devices and Applications, 3rd edition, Pearson, New-Jersey, 2004.
[9] Abdelhamid T. H., "Performance of Single-phase DC Drive System Controlled by Uniform PWM Full-Bridge DC-DC Converter," *Electric Machines and Drives, 1999. International Conference IEMD '99*, pp. 670-672, May 1999.
[10] G. Joos and T. M. Barton, "Four-quadrant dc variable-speeddrives-design consideration," in Conf. Rec. 1977 Ind. Appi. Soc. Annu. Meeting, pp. 498-505.
[11]P.T. Finlayson, "Performance comparison of digital AC andDC drives" IEEE-IAS Conf. Record, Annual Meeting, 4-9Oct. 1992, Houston, (USA), pp. 365-369.
[12] Texas Instruments Reference Guide Guide "TMS320LF/LC240xA DSP Controllers Reference Guide System and Peripherals," Literature Number SPRU357C, Revised May 2006.