iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 8 **Issue:** III **Month of publication:** March 2020

**DOI:**

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429*
*Volume 8 Issue III Mar 2020- Available at www.ijraset.com*

# Four Quadrant Speed Control of Dc Motor with Microcontroller ATmega 328 (Arduino Uno)

Shreya Jiwane[1], Shivani Nandurkar[2], Swati Chaudhari[3], Asst. Prof. C. S. Hiwarkar[4]
[1, 3, 4]*Department Of Electrical Engineering, KDK College Of Engineering, RTMNU University*

***Abstract:** This paper four-quadrant control of 220V DC motor is presented. The operation of motor is in four quadrants - clockwise, counter clock-wise, forward brake and reverse brake. The speed control is also one of the main aspect and presented in this paper. The main use of DC motor is in Industries, the clockwise, anticlockwise operation is required and it is essential of immediate breaking of DC motor in both directions. The DC motor instant stopping is one of important requirement in Industries and another applications. For that forward breaking and reverse breaking control of DC motor will be carried out by using our four quadrant control system, so that instantaneous brake in both the directions is possible. We are generating PWM pulses using Arduino for speed control application.*

***Keywords:** DC motor, Arduino, L293D IGBT driver IC, DC supply, Speed control, PWM.*

## I. INTRODUCTION

The main disadvantage of DC motor is, it rotates for some time when power is switched off, i.e. it does not stop instantly. Hence, it create problem in the operation of industries. So it is necessary to modify the control circuit of DC motor for better performance. So we are using four- quadrant operation for controlling DC motor. A four quadrant operation is required in industrial as well as so many commercial applications. These applications require both driving and braking, i.e., motoring and generating capability. Some of these applications include electric traction systems, cranes and lifts, cable laying winders, and engine test loading systems. The different quadrant operations drive the motor with normal as well as reversal of both voltage and currents so as to run as well as to break the motor either in forward or reverse directions. So it is necessary to operate the DC motor with better performance four-quadrant operation is used.

## II. BLOCK DIAGRAM

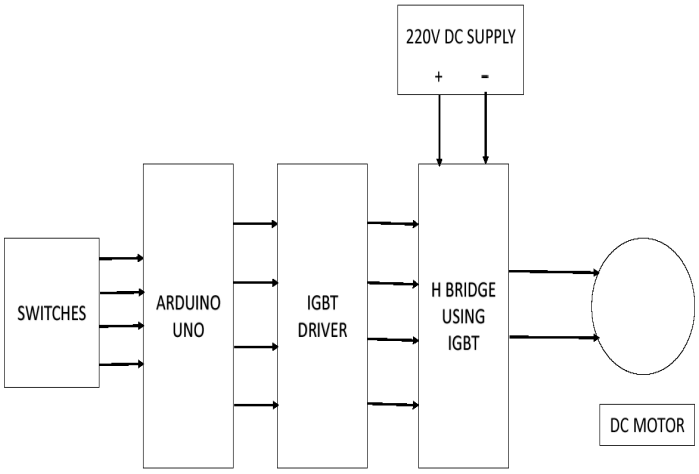



Fig I. Block Diagra

### *A. Block Diagram Description*

We are using 220V, 9Amp, 1500 RPM, DC motor for the four quadrant operation. As per block diagram, we are using four switches for four quadrant operation of motor. The switches are connected to ARDUINO as input. The output of ARDUINO is connected to IGBT Gate driver ICs. The output of Gate driver is connected to H bridge using IGBT, and then DC motor is connected to H bridge.

1) *ARDUINO:* For the speed control of DC motor ARDUINO ATmega 328 is used because ARDUINO microcontroller is AVR and has inbuilt 8 bit PWM output which is used to vary DC motor speed. The programming in ARDUINO is done in C language to operate motor in various modes. Another reason of using ARDUINO ATmega 328 for speed control is that it will reduce the number of component. There are so many components in between ATmega 328 and bridge motor driver. But by using ARDUINO UNO board only ATmega 328 microcontroller is needed.


Fig II. ARDUINO UNO

2) *H-BRIDGE*: H-bridge is used to run DC motor in forward or backward direction. It is also used to break the motor where motor terminals are short i.e motor terminal will disconnect from the circuit. H-bridge contain four switching devices which are IGBT. The motor is connected at centre and its look like H structure by activating two particular switches at the same time we can change the direction of the current flow, thus by changing the direction of rotation of motor. The switching elements (s1, s2, s3, s4) are usually IGBT. If s1 and s4 are turned on, the left lead of the armature will be connected to the power supply, while the right lead is connected to ground. Current starts flowing through the armature. Which energizes the motor in (let's say) the forward direction and the motor shaft starts spinning. If s2 and s3 are turned on, the reverse will happen, the motor gets energized in the reverse direction, and the shaft will start running backwards. For controlling the speed of motor the controlled voltage is applied to the armature through switching element.

| S1 | S2 | S3 | S4 | RESULT |
|---|---|---|---|---|
| 0 | 0 | 1 | 1 | Forward Motoring |
| 0 | 1 | 0 | 1 | Forward Breaking |
| 1 | 1 | 0 | 0 | Reverse Motoring |
| 1 | 0 | 1 | 0 | Reverse Breaking |

TABLE NO I.

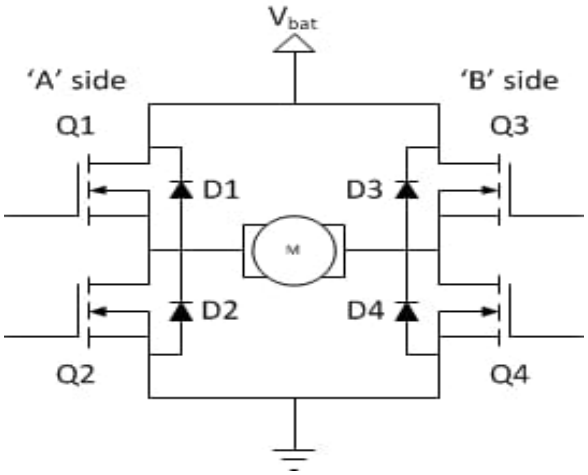



Fig II. H-bridge

*3) IGBT Driver:* The TOSHIBA TLP250 consists of a GaAlAs light emitting diode and a integrated photodetector. This unit is 8−lead DIP package. TLP250 is suitable for gate driving circuit of IGBT or power MOS FET.

Input threshold current: IF=5mA(max.)
Supply current (ICC): 11mA(max.)
Supply voltage (VCC): 10−35V
Output current (IO): ±1.5A (max.)
Switching time (tpLH/tpHL): 1.5μs(max.)
Isolation voltage: 2500Vrms(min.)
UL recognized: UL1577, file No.E67349
Option (D4) type VDE approved: DIN VDE0884/06.92,certificate No.76823 Maximum operating insulation voltage: 630VPK
Highest permissible over voltage: 4000VPK

## III. DC MOTOR CONTROL

A DC motor may operate in one or more modes (or quadrant) in variable speed applications. The major advantage of using DC motor is that the ease of its control. The speed of the DC motor is controlled by applying a variable DC input for below rated speed control. For above rated speeds, the motor is controlled by applying variable current through its field winding. For reversing the direction of rotation, either polarity of the supply voltage (which is applied to armature terminals) or the direction of field current has to be changed. By using DC motors, it is possible to obtain smooth speed control over a wide range in clockwise as well as anti-clockwise directions.

## IV. FOUR QUADARANT OPERATION OF DC MOTOR

Four Quadrant Operation of any drive or DC Motor means that machine operate in four quadrants. They are Forward Breaking, Forward Motoring, Reverse Breaking and Reverse Motoring. A motor operates in two modes – Motoring and Breaking. A motor drive capable of operating in both directions of rotation and of producing both motoring and regeneration is called a Four Quadrant Variable Speed Drive.

In Motoring mode, the machine works as the motor and converts the electrical energy into mechanical energy, supporting its motion. In breaking mode, the machine works as generator and converts mechanical energy into electrical energy and as a result, it opposes the motion. The motor can work in both, forward and Reverse direction, i.e., in Motoring and Breaking operation.

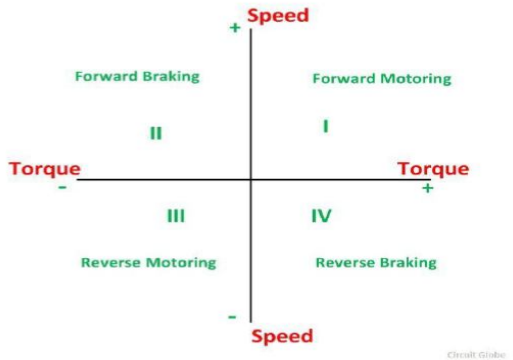



Fig III. FOUR QUADRANT OPERATION OF DC MOTOR

In 1st quadrant power developed is positive and the machine is working as a motor supplying mechanical energy the 1st quadrant operation is called forward motoring. 2nd quadrant operation is known as breaking. In this quadrant the direction of rotation is positive, and the torque is negative, and thus, the machine operate as the generator developing a negative torque, which oppose the motion.

The kinetic energy of rotating parts is available as electrical energy which may be supplied back to the mains. In dynamic breaking dissipated and energy dissipated in the resistance. The 3rd quadrant operation is known as reverse motoring. The motor works, in the reverse direction both speed and torque have negative values while the power is positive.

In the 4th quadrant, the torque is positive, and speed is negative. This quadrant corresponds to breaking in reverse motoring mode.

The four quadrant operation and its relationship to speed, torque and power output are summarized below in the table.

| Function | Quadrant | Speed | Torque | Power output |
|---|---|---|---|---|
| Forward motoring | I | + | + | + |
| Forward breaking | II | + | – | – |
| Reverse motoring | III | – | – | + |
| Reverse breaking | IV | – | + | – |

TABLE NO. II

## V. SOFTWARE IMPLEMTATION

The implementation of this project work requires two softwares. These are:

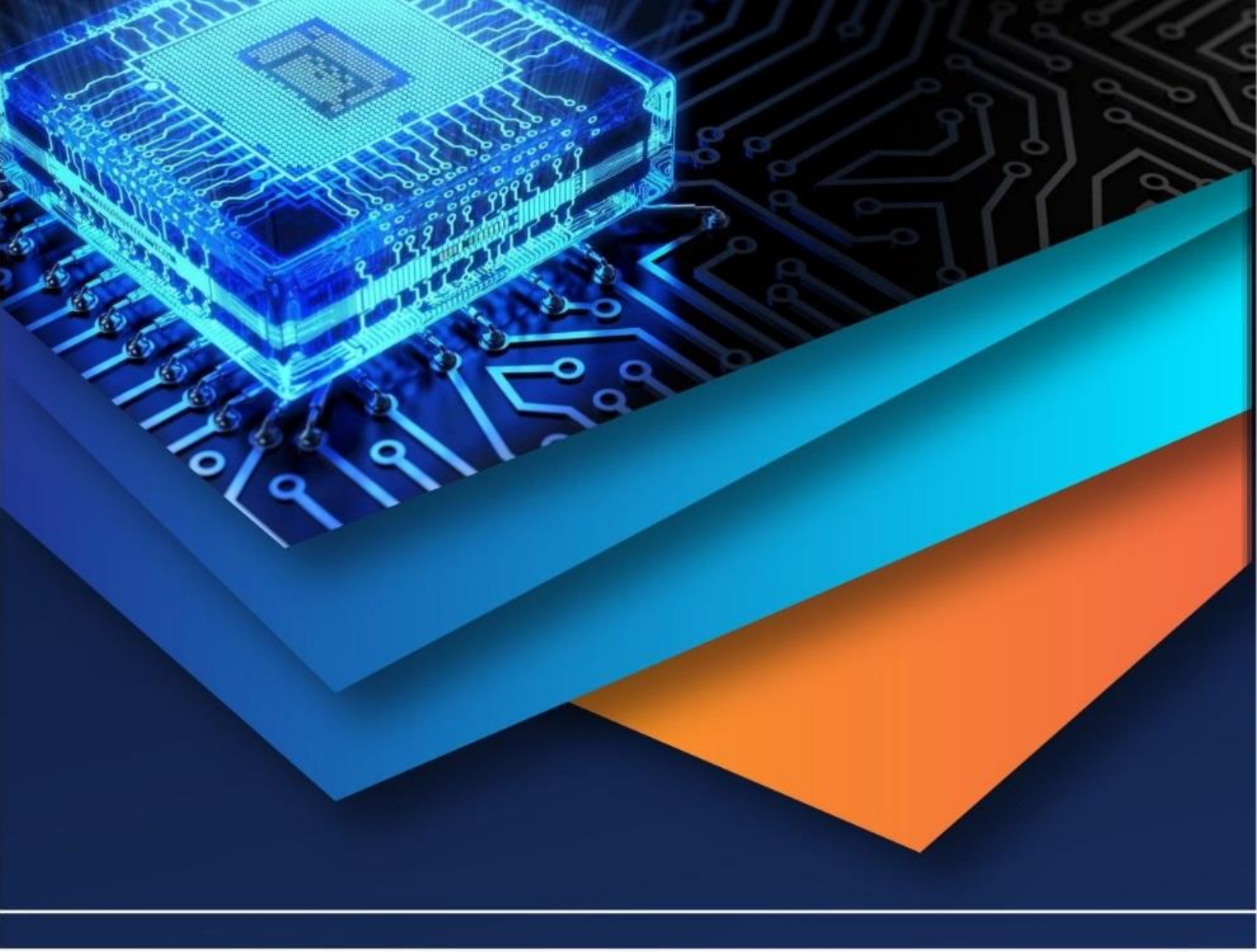
1) *ARDIUNO:* By using ARDIUNO software code will be return in embedded C. It will be compile and uploaded to the ARDIUNO by this ARDIUNO software.
2) *PROTEUS:* It is a software which is used to stimulate the result.

## VI. CONCLUSION

The study of Four Quadrant Speed Control of DC motor using Microcontroller is done. It is high feasible in economic point of view and have advantage of running motor of higher rating. By using Arduino, it overall reduce the component and hence, it will require less space and cost. The system is discover to be more efficient and the consequences with the design hardware. The motor is able to perform in all four quadrant.

## REFERENCE

[1] Vikash Kumar, Prof. Rekha Jha, "Four Quadrant Speed Control Of DC Motor with the help of AT89S52 Microcontroller" Journal for Research (J4R), Volume No. 01, Issue No. 08, (ISSN: 2395-7549), October 2015
[2] Rajeev Valunjkar..,"Four Quadrant DC Motor Drive" IOSR Journal of Engineering, Volume No.08, ISSN(e): 2250-3021, ISSN(p): 2278-8719, PP 47-50' March 2018.
[3] K. Dhivya Darshini.., "Analysis Of Microcntroller Basis Four Quadrant Speed Control System For A DC Motor" International Journal Of Current Engineering And Scientific Research, ISSN : 2393-8374, Volume No. 2, Issue No. 2,2015
[4] https://circuitglobe.com, Four Quadrant Operation of DC Motor, May 2017.
[5] https://www.electronicshub.org, Four Quadrant Operation of DC Motor, Dec 2018.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY