MICROCONTROLLER BASED FOUR QUADRANT DC MOTOR

**A MINI PROJECT REPORT**

***Submitted by***

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# BONAFIDE CERTIFICATE

Certified that this mini project “**MICROCONTROLLER BASED FOUR QUADRANT DC MOTOR SPEED CONTROL**” is a bonafide work of **BIJU R (961420105010), BINO KNOX SS (961420105011), CHAISE A (961420105012**)

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INTERNAL EXAMINER EXTERNAL EXAMINER

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and help throughout our project.

# ABSTRACT

The project is designed to develop a four quadrant speed control system for a DC motor. The motor is operated in four quadrants i.e. clockwise; counter clock-wise, forward brake and reverse brake. It also has a feature of speed control. The four quadrant operation of the dc motor is best suited for industries where motors are used and as per requirement as they can rotate in clockwise, counter-clockwise and also apply brakes immediately in both the directions. In case of a specific operation in industrial environment, the motor needs to be stopped immediately. In such scenario, this proposed system is very apt as forward brake and reverse brake are its integral features.

Instantaneous brake in both the directions happens as a result of applying a reverse voltage across the running motor for a brief period and the speed control of the motor can be achieved with the PWM pulses generated by the microcontroller. The microcontroller used in this project is from 8051family. Push buttons are provided for the operation of the motor which are interfaced to the microcontroller that provides an input signal to it and in turn controls the speed of the motor through a motor driver IC. Speed control feature by push button operation is also available in this project. This project can be enhanced by using higher power electronic devices to operate high capacity DC motors.

II

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# ABBREVIATION

|  |  |
| --- | --- |
| DC | Direct Current |
| PWM | Pulse Width Modulation |
| HEV’s | Hybrid Electric Vehicles |
| SEDC | Separately Excited Dc Motor |
| FQDC | Four Quadrant Dc Chopper |
| BLDC | Brushless Direct Current Motor |
| EMF | Electro Motive Force |
| PI  PID | Proportional Integral  Proportional Integral and Derivatives |

**CHAPTER 1 INTRODUCTION**

In recent years, with scientific and technological progress and social development, the electronic technology is developing rapidly, to achieve the portability and low cost and energy efficient, and the noise limit, a DC motor is used widely, so, the study of DC motor speed adjustable is more practical significance. DC machines play a very important role in industries and in our daily life as they offer easily controllable characteristics.

This paper is designed to develop a four- quadrant speed control system for a DC motor using microcontroller. The DC motor is operated in four quadrants i.e., clockwise, anti-clockwise, forward braking and reverses braking. Also, it features speed control. There are four possible modes or quadrants of operation using a DC Motor. When DC motor is operating in the first and third quadrant, the supplied voltage is greater than the back emf which is forward motoring and reverse motoring flow differs.

When the motor operates in the second and fourth quadrant the value of the back emf generated by the motor should be greater than the supplied voltage which are the forward braking and reverse braking modes of operation respectively, here again the direction of current flow is reversed modes respectively, but the direction of current flow is reversed.

Instantaneous brake in both the directions happens as a result of applying a reverse voltage across the running motor for a brief period and the speed control of the motor can be achieved with the PWM pulses generated by the microcontroller.

**Voltage (Speed)**

**Second Quadrant**

**Forward braking**

**First Quadrant**

**Forward accelerating**

**Generating**

**II**

**I**

**Motoring**

**Motoring**

**III**

**IV**

**Generating**

**Third Quadrant**

**Reverse accelerating**

**Fourth Quadrant**

**Reverse braking**

Fig 1.1 Four Quadrant operations

Fig 1 shows the four possible modes or quadrants of operation using a DC Motor. Development of rare earth magnet advances in brush commutator technology and advanced manufacturing techniques of the Permanent Magnet (PM) dc motor with ironized rotor and rotor with very low inertia extends its use in several types of control system. Microcontrollers are used in automatically controlled products and devices.

By reducing the size and cost, microcontrollers make it economical to digitally control even more devices and processes. To obtain variable speed of DC motor, usually armature voltage and field currents are varied. But the range of speed variation is good if armature voltage can be varied. This paper reports a microcontroller-based control system to change the speed and direction of rotation of DC motor. Armature voltage is varied by pulse width modulation (PWM) of DC input voltage by using the microcontroller that sends the signals at the microcontroller’s PWM terminal. By switching the signals at armature terminals of the DC motor by initiating an interrupt signal to the microcontroller.

Hardware implementation was done using an 8-bit ATmega16 microcontroller and its software was written in C language using the AVR Butterfly that makes the hex file to be sent to the microcontroller by the Ponyprog software through the ISP port (DB 25). Since its output current is very low, a four-channel monolithic integrated buffer circuit (L293) was used. This IC is capable of handling high voltage and high current and of driving the inductive loads.

Finally, the designed circuit was tested by controlling the DC motor and results are recorded for various speeds. Measured data show very good agreement with the expected output.

# CHAPTER 2 LITERATURE REVIEW

The four quadrant dc motor is used to control the motor speed in any directions. The literaturereview for the above proposed project is stated below in this chapter.

# FOUR QUADRANT CLOSED LOOP SPEED CONTROL OF DC MOTOR

This paper elucidates Low Cost, High performance Chopper based Four Quadrant close loop control of DC Motor. The drive system realized is applicableto Hybrid Electric Vehicles (HEV’s) working in all four quadrants. The drive system has been developed and modeled using Scilab /XCOS. The objective of simulation is to predict the performance of the drive system under realistic operating conditions. Close loop speed control of Chopper fed Separately Excited DC Motor (SEDC) is obtained using TI’s F28069-M launch pad.

High performance motor drives are necessary parts of industrial applications. A motor drive system with high performance has special characteristics such as good dynamic speed command tracking and load regulating response. The methods of control are much simpler and less expensivethan those of alternating current motors. With the intervention of choppers the efficiency of DC machine systems has increased to a great extent and as such the DC choppers have become a key component of the

modern DC applications and as a whole of the entire industry employing DC power. Nowadays choppers have become an essential componentof rapid transit systems. They have also found extensive applications in mine haulers, forklift trucks and marine hoists. The simulated model is applicable to hybrid Electric Vehicles (HEV’s) in open loop working in all the four quadrant.

# FOUR QUADRANT VELOCITY CONTROL SYSTEM BASED MICROCONTROLLER FOR A DC MOTOR

The main purpose of this paper is to create, with the aid of a microcontroller, a four-quadrant speed control of a DC motor. Any industrial organization has the most important part to control the speed of a machine. The main advantage in using a DC motor is that the Speed- Torque relationship can be varied to almost any useful form. To achieve the speed control, an electronic technique called Pulse Width Modulation is used which generates High and Low pulses. Those pulses vary the engine speed. A microcontroller is used for the generation of those pulses. As a microcontroller it is simple to adjust the speed ranges according to the requirement by adjusting the length of the program's duty cycles.

This project is realistic and highly economically feasible, and has the benefit of operating motors with higher ratings. It is good in terms of reliability and durability and also gives a precise and efficient way to monitor speed of a DC motor. The program is found to be efficient and

the results with the designed hardware are promising. The developed control and power circuit functions properly and satisfies the application requirements. The motor is able to operate efficiently in all four quadrants.

# THREE CLOSED LOOP CONTROL OF FOUR QUADRANT CHOPPER FEEDING A SEPARATEY EXCITED DC MOTOR

DC motors are widely used in many position control applications due to its properties such as low cost, high efficiency, easy controllability and successful performance. In this paper, firstly, DC motor to be used is modeled in a simulation environment. Afterwards, four-quadrant chopper circuit that feeds a DC motor is designed by using power electronics components. PI control method that is commonly utilized in motor control applications and automation systems is used for designing of current, speed and position controller. Control of four-quadrant chopper feeding a separately excited DC Motor is carried out by designing these controllers with three closed-loops in a simulation environment.

In this paper, a separately excited DC motor is used for application of position control since it has many advantages mentioned above. Current, speed and position controllers are designed and proposed for four-quadrant chopper fed DC motor driver system in a simulation environment. When the scheme is examined, it can be seen that it has three-closed loops with current, speed and position controller in order to

control more successfully. Current controller is located for current limitation and controllability in the inner closed loop.

# SERIES MOTOR FOUR QUADRANT DC MOTOR

This paper focuses on reverse mode of a proposed Series motor Four Quadrants DC chopper (FQDC). The paper proposes control technique in controlling the acceleration and deceleration of EV with triple cascade PID with ascend descend algorithm for controlling of speed, torque and position. This is to control the electric propulsion motor powered by FQDC for the application of automatic reverse parking of autonomous dc drive electric car. The control technique is simulated using MATLAB/Simulink and the results shown, the technique has successfully met the objective of torque, current, speed and position control for reverse and auto reverse parking and is suitable to be implemented in DC Drive electric car.

The study on DC drive EV, includes design of new dc motors and Four quadrants chopper to improve the performance and extend the capability such as adding mode of chopper operations. Further Investigation of FQDC hardware and simulation model includes feedback control using direct current control and Optimization using Artificial Intelligence to optimize the all operations to works a complete EV while running in different earth profiles.

This paper further extends on studying and investigating on one of the mode of the proposed chopper operation which is in reverse mode. In this mode, the back emf, armature voltage and torque are negative.

# A FOUR QUADRANT CONTROL STATERGY FOR BDLC MOTOR USING DSPIC

BLDC Motors are permanent magnet Synchronous motors. The stator is having control windings and the rotor is having the permanent magnets. So the construction is like a DC motor turned inside out. When the back EMF goes higher than the supply voltage, it can be functioned like an alternator as the load will feed the supply side. The motor can be controlled in all the four quadrant of a speed torque plane without any energy lose. Control is done by DSPIC.

Four Quadrant operations come when the motor is allowed to rotate in both clockwise and counter- clockwise direction. Whenever there is a change in direction, back EMF goes higher than the supply side voltage, it is called the regeneration mode. The two motoring and two regeneration interval comprises the Four quadrant. This paper intends to save and reuse of regenerated electrical energy. The energy at the regeneration interval is stored in the supply side battery which can be used further instead of wasting as heat at the load.

BLDC motors are so commonly used in all our electrical appliances now days. They can develop high torque with good speed response. In

addition, they can be easily automated for remote control. Due to their construction, they have good thermal characteristics and high energy efficiency. To obtain a variable speed response, brushless motors operate in an electromechanical system that includes an electronic motor controller and a rotor position feedback sensor.

# THE SPEED CONTROL OF FOUR QUADRANT DC MOTOR WITH A PI CONTROL

This research article presents the speed control concept of the four- quadrant DC Motor with a proportional and integrated (PI) Control Topology. The novel method for this research is bootstrap half-bridge control techniques to control the device switch and reduce the circuit's complexity by creating a virtual ground and using the TMS320F28379 microcontroller for controlling the PI tuning with a quick response and less wrong. This research creates a prototype mechanism to test the performance and found that the speed control of the four-quadrant DC Motor with a PI Control Topology can control speed command not less than 95%.

However, when tested by connecting to the motor using the electromagnetic brake is found to be able to control the speed command for not less than 90%. Consequently, it can be concluded that the method and concept of reducing the complexity of the device switch control circuit in the mechanism created can confirm the speed control of the four-

quadrant DC Motor with a PI control topology is better than other types of control circuits. The novel method used for this research is to use control techniques bootstrap half-bridge to control the device switch and simplify the circuit by creating a virtual ground and use the TMS320F28379 microcontroller to control the PI tuning that has a quick response and less and high performance. High-power step-up DC-DC converter design using analog control circuit and DC motor speed regulation using TMS320F240DSP. The principle used is to convert the low voltage input source to high voltage. The conversion has two steps: use of a full bridge to increase the DC voltage

The output of the step-up converter uses a capacitor to hold the charge. This capacitor is used to compensate for the maximum power demand of the load during a sudden change in time to store energy under the braking condition of a DC motor. Principle adjusting the PID control for closed-loop control of the DC chopper motor four quadrants fed DC.

# CHAPTER 3 PROBLEM STATEMENT

* + 1. From the previous case, the dc motor speed control operations can be controlled by using choppers.
    2. In case of a specific operation in industrial environment, the motor needs to be stopped immediately.
    3. In such scenario, this proposed system is very apt as forward brake and reverse brake are its integral features.
    4. To achieve the portability and low cost and energy efficient, and the noise limit, a DC motor. The DC motor speed adjustable and controllable is more practical significance.

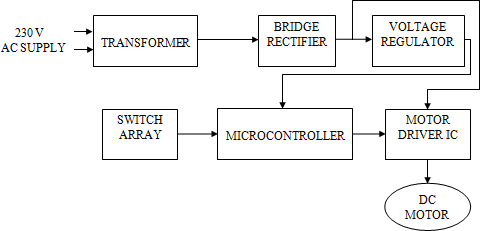
# 3.1 OBJECTIVE

The direction and speed controller of the dc motor using microcontroller. The speed of the motor is directly proportional to armature voltage and inversely proportional to flux. By maintaining the flux constant, the speed can be varied by varying the armature voltage. Armature voltage is varied by PWM of DC input voltageby using the microcontroller that sends the signals at the microcontroller’s PWM terminal.

By switching the signals at armature terminals of the DC motor by initiating an interrupt signal to the microcontroller, then the motor will operate in four quadrants.

# CHAPTER 4 PROPOSED METHODOLOGY

The proposed method includes the design of the microcontroller based fourquadrant dc motor speed control. The figure 3.1 represent the block diagram of the four quadrant dc motor. The major blocks in the block diagram are microcontroller, motor driver IC, transformer, voltage regulator, bridge rectifier,DC motor.



**Fig** 4**.**1 block diagram of the system

# MICROCONTROLLER

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industry-standard 80C51

instruction set and pin out.

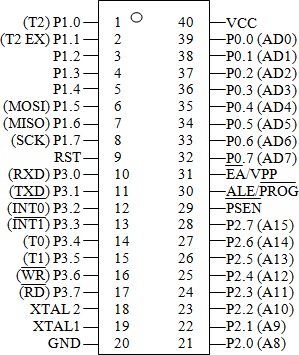


Fig 4.2 AT89s8253 Microcontroller

The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six- vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. This switch array is used to send the control signals to the microcontroller which in turn sends commands to the motor driver IC for controlling the operation of the DC motor.

# MOTOR DRIVER IC

Motor driver ICs act as an interface between microprocessors in robots and the motors in the robot. The most commonly used motor driver IC’s are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two

H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. Most microprocessors operate at low voltages and require a small amount of current to operate while the motors require a relatively higher voltage and current.

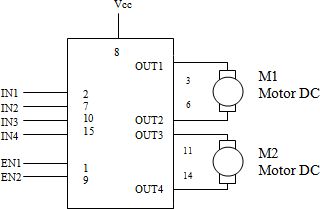


Fig 4**.**3 L293D Motor Driver IC

This is the primary need for the motor driver IC. The L293D IC receives signals from the microprocessor and transmits the relative signal to the motors. It has two voltage pins, one of which is used to draw current for the working of the L293D and the other is used to apply voltage to the motors.

# BRIDGE RECTIFIER

A bridge rectifier is a full-wave rectifier that uses four or more diodes in a bridge circuit and converts alternating current (AC) to a direct current (DC). A filter is also used inside the circuit to improve the bridge rectifier. Many electronic circuits need a rectified DC supply to power the electronic components from the available AC mains supply.

As half of the AC power input remains unused, half-wave rectifiers produce a very inefficient conversion. The current flows across resistor and is the same during negative and positive half cycles. The polarity of the output DC signal may either be completely positive or negative. If the directions of the diodes are reversed, we can obtain a completely negative voltage.

# VOLTAGE REGULATOR

A voltage regulator is designed to automatically ‘regulate’ voltage level. It basically steps down the input voltage to the desired level and keeps that in that same level during the supply. This makes sure that even when a load is applied the voltage doesn’t drop. A voltage regulator is used for two reasons, To regulate or vary the output voltage of the circuit. To keep the output voltage constant at the desired value in-spite of variations in the supply voltage or in the load current.

This reduction in Vbe causes a decrease in the level of conduction which will further increase the collector-emitter resistance of the transistor and thus causing an increase in the transistor collector-emitter voltage and all of this causes the output voltage Vout to reduce. Thus, the output voltage remains constant. The operation is similar when the input supply voltage decreases.

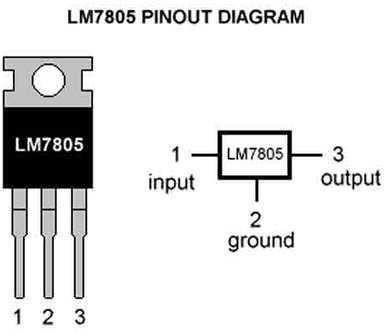


Fig 4.4 Voltage Regulator LM7805

This causes the input current to increase slightly and thus compensates for the decrease in the load resistance Rload. The biggest advantage of this circuit is that the changes in the zener current are reduced by a factor β and thus the zener effect is greatly reduced and a much more stabilized output is obtained.

# TRANSFORMER

A transformer is an electrical device that, by the principles of electromagnetic induction, transfers electrical energy from one electric circuit to another, without changing the frequency. The energy transfer usually takes place with a change of voltage and current.

Transformers are electrical devices that are passive in nature, and transfer electrical energy via the process of electromagnetic induction, from one circuit to another. They are capable of increasing voltage (step- up) and decreasing voltage (step-down) levels to allow for better transfer and distribution of electrical energy.

Transformer as a static device uses the electromagnetic induction principle of Faradays’ Law of Electromagnetic induction. Instead in transformer the flux is not fixed or constant but varying to get the relative effect. An alternating voltage is connected to the primary coil. These create flux in the coil. As the voltage is alternating or time varying so is the produced flux. These time-varying flux produces induced voltage in the secondary winding when it cuts through the secondary coil or winding.



Fig 4.5 Electrical Transformer

Transformer transfers energy from primary to secondary through electromagnetic induction. These primary and secondary windings are coupled by mutual magnetic flux.

# DC MOTOR

A DC motor is an electrical machine that converts electrical energy into mechanical energy. In a DC motor, the input electrical energy is the direct current which is transformed into the mechanical rotation. any electric motor that is operated using direct current or DC is called a DC

motor. any electric motor that is operated using direct current or DC is called a DC motor.



Fig 4.6 Dc Motor

A magnetic field arises in the air gap when the field coil of the DC motor is energised. The created magnetic field is in the direction of the radii of the armature. The conductors located on the other pole are subjected to a force of the same intensity but in the opposite direction. These two opposing forces create a [torque](https://byjus.com/physics/torque/) that causes the motor armature to rotate.

A DC Motor is an electrical device that converts electrical energy into mechanical energy. Going by the dc motor full form, the device uses Direct Current (DC) for its operation. In the DC motor above, the supply voltage E and current I is given to the electrical port or the input port and we derive the mechanical output i.e. torque T and speed ω from the mechanical port or output port.

# CHAPTER 5 COMPONENTS USED

|  |  |  |
| --- | --- | --- |
| **SL NO** | **COMPONENTS** | **QUANTITY** |
| 1 | Microcontroller AT89s8253 | 1 |
| 2 | Motor Driver IC L293D | 1 |
| 3 | Bridge Rectifier | 1 |
| 4 | Voltage regulator LM7805 | 1 |
| 5 | Transformer | 1 |
| 6 | Dc Motor | 1 |

**5.1 SOFTWARE USED**

PROTEUS PCB **-** The proteus PCB software - contains a schematic capture, microcontroller simulation, PCB design and 3D verification. The microcontroller simulation in proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it.

# CHAPTER 6 HARDWARE IMPLEMENTATION

**6.1 MICROCONTROLLER AT89s8253**

The microcontroller AT89s8253 can be used to control the voltage signals to send the motor driver IC and it can be operating the motor.

Connect the microcontroller to the motor.

|  |  |
| --- | --- |
| Features | Microcontroller |
| EEPROM | 2K bytes |
| I/O Lines | 32 |
| Data pointer | 2 |
| Serial port | Full duplex |
| Timers/counters | 3 |

# features of Microcontroller

The on-chip Flash allows the program memory to be reprogrammed in- system or by a conventional nonvolatile memory programmer. The microcontroller block is interfaced with DC motor using motor driver IC, the power supply block provides power supply to the project kit, and switch array.

# MOTOR DRIVER IC

|  |  |
| --- | --- |
| Motor Driver IC Characteristics | Specification |
| Supply voltage range | 4.5V to 36V |
| Output current | 600mA per channel |

|  |  |
| --- | --- |
| Peak output current | 1.2A per channel |

* 1. **motor driver IC characteristics**

A motor drivers IC is an integrated circuit chip which is usually used to control motors. The most commonly used motor driver ICs are from the L293 series such as L293D.Thus current cannot be supplied to the motors from the microprocessor. This is the primary need for the motor driver IC. The L293D IC receives signals from the microprocessor and transmits the relative signal to the motors.

# BRIDGE RECTIFIER

|  |  |
| --- | --- |
| Attribute | Value |
| Peak forward volage | 1.05V |
| Peak reverse current | 500microA |
| Length | 30.3mm |

* 1. **Specification of Bridge Rectifier**

A bridge rectifier is a full-wave rectifier that uses four or more diodes in a bridge circuit and converts alternating current (AC) to a direct current (DC). A filter is also used inside the circuit to improve the bridge rectifier. Many electronic circuits need a rectified DC supply to power the electronic components from the available AC mains supply. A rectifier converts an oscillating two-directional alternating current (AC) into a single-directional direct current (DC). The current flows across resistor and is the same during negative and positive half cycles

# VOLTAGE REGULATOR

A voltage regulator is designed to automatically ‘regulate’ voltage level. It basically steps down the input voltage to the desired level and keeps that in that same level during the supply.

|  |  |
| --- | --- |
| Attribute | Value |
| Minimum Input voltage | 7V |
| Maximum Input voltage | 35V |
| Current rating | 1A |
| Minimum Output voltage | 4.8V |
| Maximum Output voltage | 5.2V |

# Specifications of Voltage Regulator

A voltage regulator is used for two reasons, To regulate or vary the output voltage of the circuit. To keep the output voltage constant at the desired value in-spite of variations in the supply voltage. When the input supply voltage increases zener voltage Vzener is constant. The collector- emitter resistance of the transistor increase and also increase in the transistor collector-emitter voltage and all of this causes the output voltage Vout to reduce. Thus, the output voltage remains constant.

# TRANSFORMER

|  |  |
| --- | --- |
| Attribute | Value |
| Input voltage | 230V |

|  |  |
| --- | --- |
| No. of. phases | 1 |
| Type | Oil immersed |
| frequency | 50Hz |

* 1. **Specifications of Electrical transformer**

Transformer is used to step up or step down the voltage level. A transformer is an electrical device that, by the principles of electromagnetic induction, transfers electrical energy from one electric circuit to another, without changing the frequency. Transformers are electrical devices that are passive in nature, and transfer electrical energy via the process of electromagnetic induction, from one circuit to another.

They are capable of increasing voltage (step-up) and decreasing voltage (step-down) levels to allow for better transfer and distribution of electrical energy. Transformer transfers energy from primary to secondary through electromagnetic induction. These primary and secondary windings are coupled by mutual magnetic flux.

# DC MOTOR

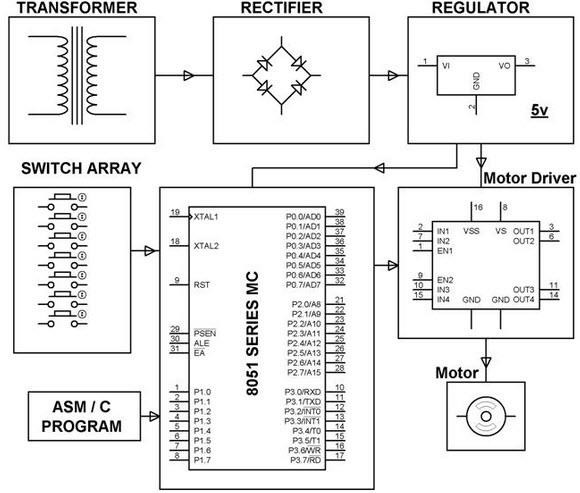
|  |  |
| --- | --- |
| Attribute | Value |
| Operating voltage | 12V |
| Speed | 300rpm |
| Load current | 0.3A |
| No load current | 0.06A |

* 1. **Specifications of DC motor**

A DC motor is an electrical machine that converts electrical energy into mechanical energy. In a DC motor, the input electrical energy is the direct current which is transformed into the mechanical rotation. Any electric motor that is operated using direct current or DC is called a DC motor. A DC motor in simple words is a device that converts direct current (electrical energy) into mechanical energy.

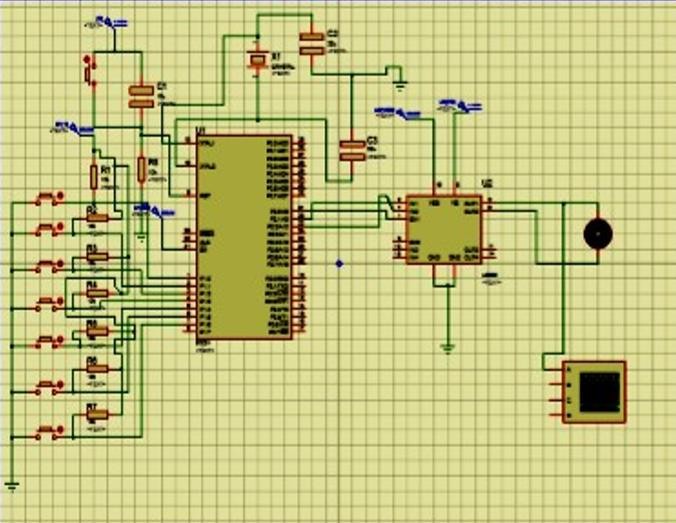
A rotary component called an armature coil rests inside the motor’s casing surrounded by strong permanent magnets. When a current is applied to the armature through a rotary electric switch called a commutator, the magnetic field created by the armature interacts with the magnetic field of the stationary magnet to apply a torque on the armature, causing it to rotate.

# CIRCUIT DIAGRAM



* 1. **Circuit diagram of the system**

# SOFTWARE IMPLEMENTATION



* 1. **System tested in software**

The overall block of the system is implemented in the proteous software and the response and the operation of the motor. The response of the motor connected can be seen visually according to the program fed into the microcontroller and the operations are carried accordingly. It is the easiest way to check whether the hardware will get the desired output.

# WORKING

In the above circuit diagram, 230V AC supply is connected to the transformer. A 230V AC supply is converted in 12V AC input supply then with the help of 4 diode bridge rectifier is form which convert AC supply into pulsating DC supply. which is unregulated is regulated to constant 5V DC. This 5V supply is connected to 40 pins of the microcontroller and ground is connected to 20 pins of the microcontroller. Pin no 1 to 7 of port 1 are connected to switches and pin no 21, 22, 23 of the microcontrollers are connected to input 1,2, enable pins of motor driver L293D and pin 3 and 6 are connected to motor terminals.

The start switch is pressed the motor starts rotating in full speed being driven by a motor driver IC L293D that receives control signal continuously from the microcontroller. When clockwise switch is pressed the motor rotates in forward direction as per the logic provided by the program from the microcontroller to the motor driver IC. While forward brake is pressed a reverse voltage is applied to the motor by the motor driver IC by sensing reverse logic sent by the microcontroller for a short time period. PWM switch is used to rotate the motor at varying speed by delivering from the microcontroller a varying duty cycle to the enable pin of the motor driver IC. Stop button is used to switch OFF the motor by driving the enable pin to ground.

# CHAPTER 7 RESULTS AND DISCUSSION

The installation of the microcontroller based four quadrant dc motor speed control can be varying the motor speed and direction. Energy efficiency and Security Enhancement.

The switch is pressed the microcontroller activates to send the signals to the motor driver to rotate the motor in clockwise or counter clockwise direction.

|  |  |
| --- | --- |
| Pressed Switch | Motor Rotation |
| Forward motoring | Clockwise |
| Reverse braking | Counter clockwise |

# 7.1 Output of the motor operation

The stop switch is pressed microcontroller can stop sending the signals to the motor driver IC, then the motor didn’t receive the signals. Then motor will turn off. The four quadrant dc motor speed control is used to operate the motor direction and the speed.

# CHAPTER 8 CONCLUSION

The hardware for four quadrant DC motor speed control using microcontroller is designed. The prototype hardware model for the four quadrant DC motor speed control using microcontroller is designed. A simulated model has been developed by Proteus software and then result has been verified using a prototype hardware model. By variation in duty cycle, applied voltage varies therefore the speed of DC motor can be controlled. The waveform of input pulse given to DC motor has been taken for different values of duty cycle and it has been observed that speed of DC motor is directly proportional to duty cycle, i.e., as the one-time duty cycle increases the speed of DC motor also increases.

In the experimental result, it has been observed that some harmonics are occurring. It is due to different nonlinear electronic components such as diodes, transistors etc., present in the prototype developed model. This project is practical and highly feasible in an economic point of view and it has an advantage of running motors of higher ratings. It is good in terms of reliability and durability and also it gives an accurate and efficient way of speed control of a DC motor. The motor is able to operate in all the four quadrants successfully. Regenerative braking is also achieved. Simulation and experimental results tally with each other and justify effectively the developed system.

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# APPENDIX 1

**PROGRAM:**

#include<reg51.h> sbit sw=p2^7;

sbit ENABLE=p2^0; sbit MTR\_0=p1^1; sbit MTR\_1=p1^2;

void main()

{

sw=1; ENABLE=0; MTR\_0=0; MTR\_1=0;

while(1)

{

ENABLE=1;

if(sw==1)

{

MTR\_0=1;

MTR\_1=0;// clockwise direction

}

else

{

MTR\_0=0;

MTR\_1=1;// anti-clockwis direction

}

}

}