

Chopper fed DC drive

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ABSTRACT

This paper deals with speed control of PMDC motor. This paper presents the speed control methodology by varying armature voltage of PMDC motor. The speed of PMDC motor can be control below rated speed by using chopper. The chopper firing circuit gets signal from PIC 18f458 micro controller and then by supplying variable voltage to armature of motor desired speed of motor can be achieved. IGBT is used for switching operation of chopper. For speed control of PMDC, closed loop method is used. The simulation of model is done.

Keyword: Armature voltage control, PMDC motor, PIC 18F458, chopper, PWM technique

1. Introduction

In most of the fields today, Electrical drives are widely used consists of electric motor, power controller and energy transmitting shafts etc. In modern, Power electronic converters are used as power controller. Electric motors mainly classified as, 1. AC motors 2. DC motors

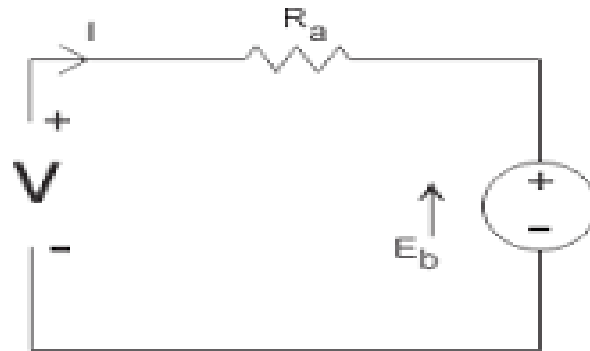
The difference between two is supply/input given to it. But due to various advantages of DC motor over AC motor, DC motors such as low cost, less complex structure, wide range of speed and torque, good speed regulation, braking and reverse, DC motors are widely used. So, its speed controlling according to various application is necessary. Again, DC motors are further classified as

1. Separately excited 2. Self excited 3. Permanent magnet

In Permanent magnet dc motor (PMDC), working principle is same as that of all dc motor i.e. whenever current carrying conductor is placed inside a magnetic field, there will be a mechanical force experienced by conductor. To obtain this magnetic field, obviously magnet is used. When permanent magnet is used to obtain magnetic field, then motor is preferred as PMDC motor. As magnetic field strength of permanent magnet is fixed, it can't be externally controlled i.e. field control of this motor is not possible.

PMDC motor is mainly used where small DC motors are required such as in automobile starters, toys, wipers, washers, hot blowers, air conditioners and also very effective control is not required.

1.1 Introduction to PMDC motor:



. The circuit model or equivalent circuit of a PMDC motor is shown in fig. Since the field flux in a PMDC motor is produced by permanent magnets, the field winding is not shown in the circuit model. The torque is produced by interaction between axial current-carrying rotor conductor and the magnetic flux produced by the permanent magnets. The flux remains constant. So, the speed of a PMDC motor can't be controlled by using flux control method. The speed and torque of PMDC motor can be controlled by armature voltage control, armature rheostat control and chopper control. These motors are therefore, used only where motor speed below base speed are required. They can't be operated above the base speed.

Permanent magnet DC motor have several advantages compared with conventional shunt DC motors in some applications. Since these motors do not require field windings, they do not have field-circuit copper losses. This increases their efficiency. Because no space is required for field winding, these motors are smaller than corresponding wound-pole motors.

PMDC motor are used in many applications ranging from fractions to several horsepower. They are used extensively in automobiles to operate windshield wipers and washers, to raise and lower windows, to drive blowers for heater and air conditioners, in computer drives etc. Millions of such motors are used in toy industries. Other application of PMDC motor are in electric tooth brushes, portable vacuum cleaners, food mixers, portable electric tools such as drills.

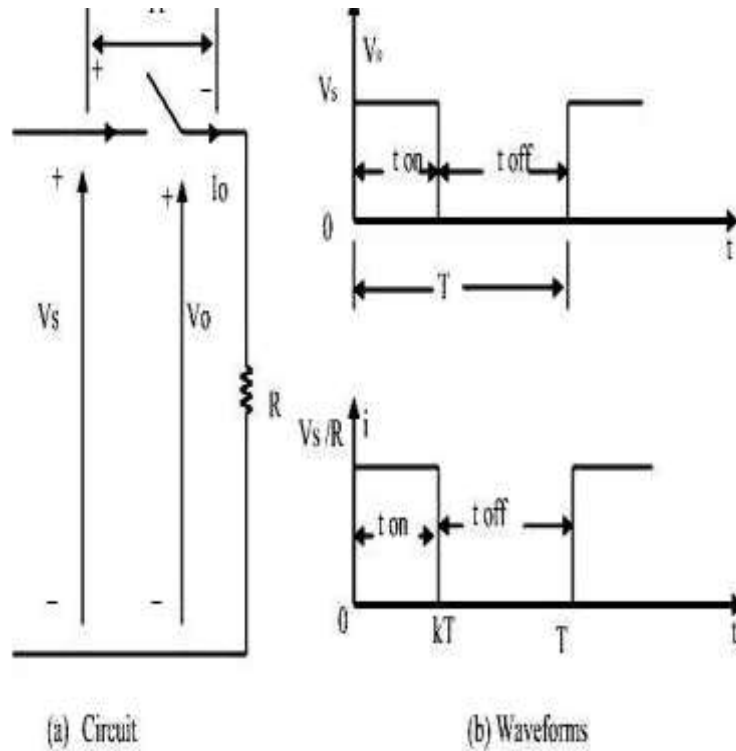
1.2 Introduction to chopper:

A chopper is a static power electronic device which converts fixed dc input voltage to a variable dc output voltage. Choppers are more efficient & are used in marine hoist, in trolley cars, in mine haulers. Chopper systems offer smooth control, high efficiency, faster response & regeneration facility. The power semiconductor device like IGBT is widely used for chopper circuit as a switch.

Principle Of Chopper Operation:

A constant DC supply V_s as input is given to chopper & output voltage obtained across load be V_a .

Figure 1: Chopper circuit diagram and its voltage and current waveform



$$\text{Average voltage} = V_o = \left(\frac{T_{on}}{T_{on} + T_{off}} \right) * V_s = \left(\frac{T_{on}}{T} \right) * V_s = \alpha * V_s$$

$$V_o = f * T_{on} * V_s$$

V_o -average voltage

T_{on} -ON time

T_{off} -OFF time

T -chopping period

V_s -input voltage

α -duty cycle

Average output voltage can be controlled by varying duty cycle. There are various control strategies for varying duty cycle.

In Time ratio control, α is varied by two ways. constant frequency & variable frequency method.

In constant frequency method f remains constant & T_{on} is varied this called as pulse width modulation scheme. In variable frequency method f varies & either T_{on} or T_{off} is kept constant. This method is also called frequency modulation scheme.

In current limit control method two values are set are maximum load current & minimum load current. When load current reaches the value more than maximum value of load current then chopper is switched off & it falls below minimum value the chopper is switched on. Current limit control involves feedback loop & hence it becomes complex therefore PWM technique is widely used.

2. Introduction to PIC 18F458:

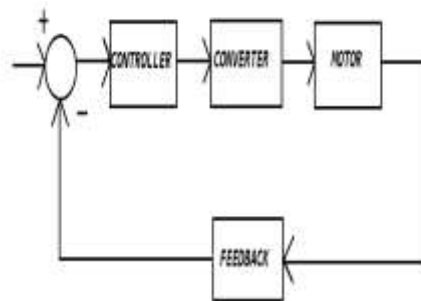
Here, PIC 18F458 micro controller is used to control speed by armature voltage control. So, by using PWM technique, duty cycle is varied according to the requirement of speed.

Features of PIC 18F458

It is a 40 pin micro controller, It supports power on reset, It supports power on timer, It supports CCP module, out of which we are using pwm module, It supports power saving sleep mode.

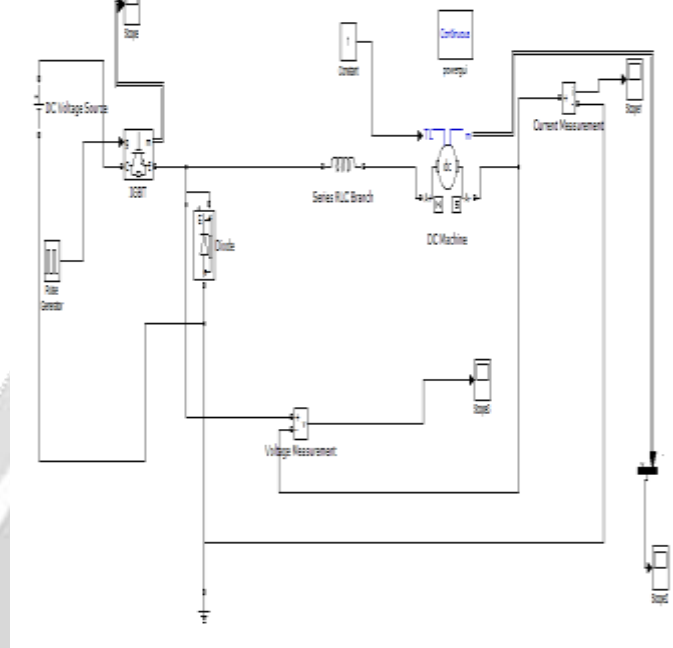
3. Modelling of DC motor for drive system :

Speed control of DC motor can be achieved by controlling armature voltage keeping field voltage constant. The output speed is compared with reference speed & error signal given to controller. The difference between reference speed & feedback speed is controlled by controller. The output voltage of controller controls duty cycle of converter. The converter output gives required voltage V to bring motor speed back to the dc motor. The reference speed is provided through keypad. The output speed of motor is measured by using sensor



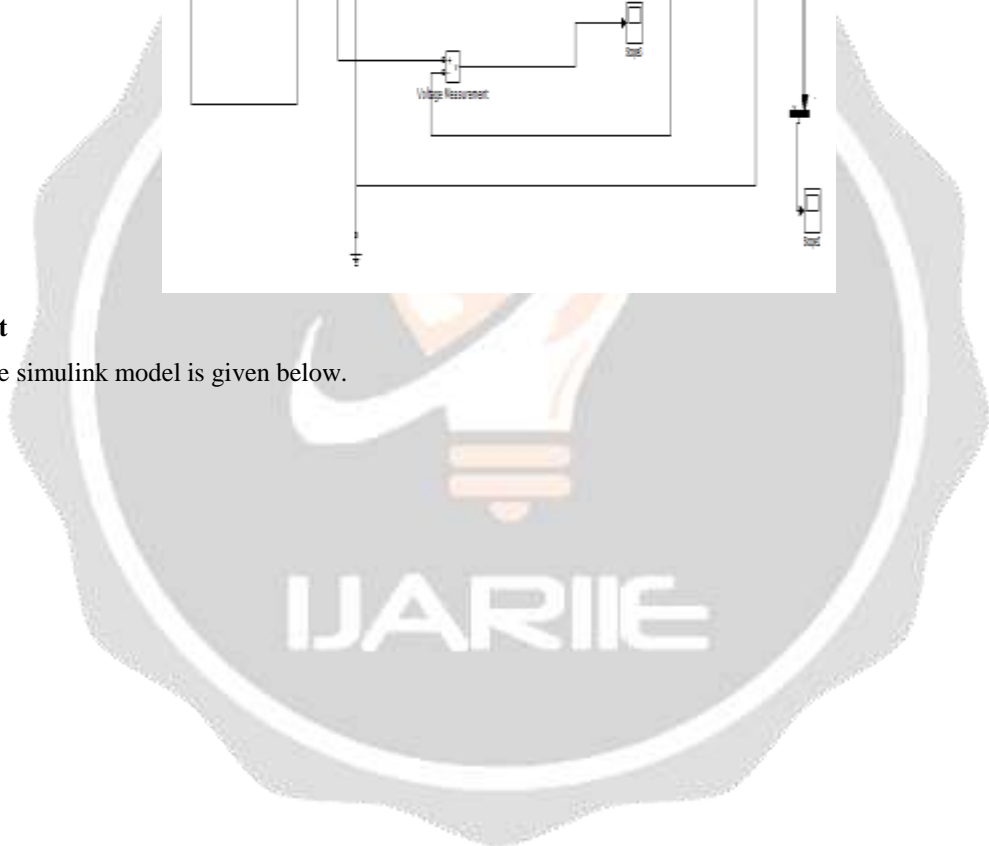
The above diagram presents the closed loop system in this system. The controller used as PIC 18f458 microcontroller for the generating PWM Signal through CCP/ECCP mode. And also varying duty cycle which is proportional to the speed of the motor. And chopper is used as converter. It gives fixed dc to variable dc & speed control is achieved.

4 Simulation:



4.1Result

Result of the simulink model is given below.





5. CONCLUSIONS

The speed of PMDC motor has been successfully controlled by using chopper as converter and PIC as controller. Initially study of various components such as PMDC motor, chopper, PIC18f458 etc. is done. Then, simulation is done by using MATLAB software, results are studied and analyzed.

6. REFERENCES

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