IJournals: International Journal of Software & Hardware Research in Engineering
ISSN-2347-4890
Volume 5 Issue 5 May, 2017

IMPLEMENTATION &ANALYSIS OF SPEED CONTROL OF DC MOTOR USING CHOPPER ON SIMULINK

Author: Shubhanshu Nema[1]; Asst. Prof. Avinash Gupta[2]

Affiliation: UG student, Assistant Prof. Electrical & Electronics Dept., SAIT, (MP) India.

Email- 611shubhanshunema@gmail.com; avinashkumarguptagood@gmail.com

Abstract: **InThis paper the speed control of separately excited DC motor is described. In this paper we have used a chopper for controlling. By using chopper as a controller the speed of DC motor can be controlled. A controller provides a signal to chopper circuit and then by supplying variable voltage to the armature of the motor the speed chopper is achieved which is desired. Two different types of control loops, current controller and speed controller are used in this project. The controller used is Proportional-Integral (PI) type. The delay is removed by using this controller and fast control is achieved. Separately excited DC motor is designed. The current controller and speed controller are designed in order to get accurate and smooth speed control of DC motor. The simulation of model is done and analysed in MATLAB (Simulink) and speed & current curves are achieved.**

Keywords: **chopper, DC motors, open and closed loops MATLAB (Simulink)**

1. INTRODUCTION

Electric motors, power controller and energy transmitting shaft are the basic elements of an electrical drive. Now a day's power electronic converters are widely used as a power controller. Electric drives can be classified in two ways: DC motor drives and AC motor drives. They differ from each other in this way that the power supply in AC drives is AC & in DC drives is DC. DC drives are widely used in applications like adjustable speed control, smooth &frequent starting, good speed regulation, braking and motoring. DC drives are widely used in industries like paper mills, rolling mills, hoists, printing presses, machine tools, traction, textile mills, excavators and cranes. For the purpose of industrial applications, development of high performance motor drives is very necessary. The complexity and cost factor in DC drives is very less in comparison with AC drives. The speed of DC motors can be controlled above or below rated speed. Their speed above rated speed are adjusted by field flux control and speed below rated speed is adjusted by armature

2. field flux control and 3. armature resistance control. Here we have used armature voltage control method & chopper circuit is used for switching for controlling the speed and current of DC motor, speed and current controllers are used. The main work of controller is to detect the errorcompare it with reference value and send signal to control unit and then apply the correction to the system. Therefore, this paper mainly consists of controlling DC motor speed using Chopper as power electronic converter and PI as speed and current controller.

2. INTRODUCTION TO CHOPPERS

A chopper is a static power electronic device which converts fixed dc input voltage to a variable dc output voltage. It can be step up or step down. Controlling of chopper system is very smooth, efficiency of chopper is high, it provides faster response and regeneration facility. The power semiconductor devices which are basically used for a chopper circuit can be force

IJournals

© 2017, IJournals All Rights Reserved

commutated thyristor, BJT, MOSFET, IGBT and GTO. Among above switches IGBT and GTO are widely used. These devices are generally represented by a switch. When the switch is OFF, no current will flow. Current flows through the load when switch is ON.

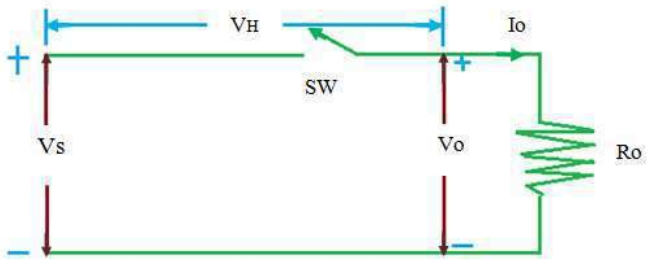

Figure1: Basic Chopper circuit

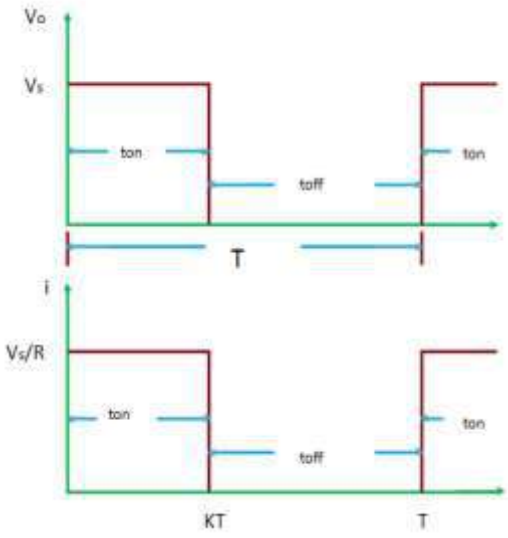

Figure 2: Voltage Waveform

V= Circuits average output voltage
sV= Circuits source voltage

$$V_o = \frac{T_{on}}{(T_{on} + T_{off})} V_{in}$$

$\frac{T_{on}}{(T_{on}+T_{off})}$ = Duty Cycle denoted by α

Hence by varying the value of duty cycle(□□□the average Voltage can be controlled

3. SEPARATELY EXCITED D.C. MOTOR

If the separate supply is provided to DC motor, then the motor is separately excited DC motor. The field windings of the dc motor are used to excite the field flux. Current in armature circuit is supplied to the rotor via brush and commutator segment for the mechanical work. The rotor torque is produced by interaction of field flux and armature current. When a separately excited dc motor is excited by a field current of it and an armature current of Ia flows in the circuit, the motor develops a back EMF and a torque to balance the load torque at a particular speed. The field current if is independent of the armature current Ia. Each winding is supplied separately. Any change in the armature current has no effect on the field current. The *if* is generally much less than the Ia**.**

The armature equation is shown below:

$$V_a = E_g + I_a R_a + L_a \, dI_a/dt$$

The torque equation is given by:

$$T_d = \frac{jdw}{dt} + B_w + T_i$$

Equation for back emf of motor will be:

$$E_g = K\emptyset W$$

Also we know, $T_d = K\emptyset I_a$

$$W = (V - I_a R_a / K\emptyset)$$

Now, from the above equation it is clear that speed of DC motor depends on applied voltage, armature current, armature resistance and field flux. So, there are three ways of controlling speed of DC motor – armature voltage control, armature resistance control and field flux control. Here armature voltage control method is used.

© 2017, IJournals All Rights Reserved

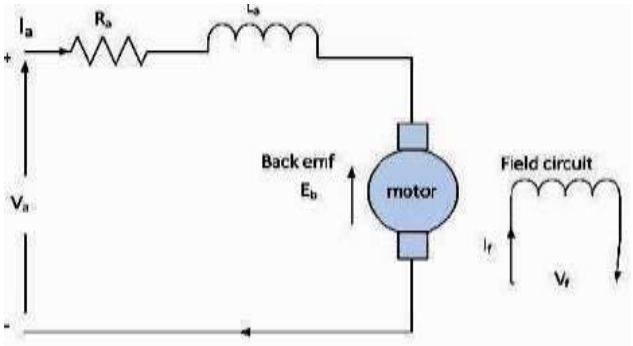

Figure 3: Circuit diagram of separately excited D.C.Motor

4. D.C. MOTOR MODELLING FOR DRIVE SYSTEM

The basic principle behind DC motor speed control is that the output speed of DC motor can be varied by controlling armature voltage for speed below and up to rated speed keeping field voltage constant. The output speed is compared with the reference speed and error signal is fed to speed controller. Controller output will vary whenever there is a difference in the reference speed and the speed feedback.

The output of the speed controller is the control voltage that controls the operation duty cycle of converter. The chopper output gives the required armature voltage to operate motor on the speed which is desired.

The Reference speed is provided through a potential divider because the voltage from potential divider is linearly related to the speed of the DC motor. If the error speed is negative, this means the motor is running slow so that the controller output should be increased and vice-versa The output speed of motor is measured by Tacho-generator and since Tacho voltage will not be perfectly dc and will have some ripple. So, we require a filter with a gain to bring Tacho output back to controller levelThe basic block diagram for DC motor speed control is shown below:

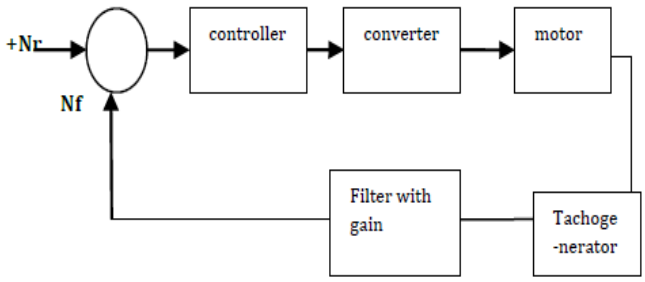

Figure 4: Block Diagram

The controller used in a closed loop model of DC motor provides a very common and easy technique of keeping the speed of motor at point which is desired under any condition such as load changing. A tacho generator is generally used to get a voltage signal attached to the rotor which is proportional to the speed of motor is fed back to the input where signal is subtracted from the set-point speed to produce an error signal. For the desired speed of motor this signal is fed back to the input. If the error speed is positive, this means the motor is running fast so that the controller output should be decreased and vice-versa.

5. MATLAB Simulation, Results & Analysis

5.1 Simulink Model for open loop system

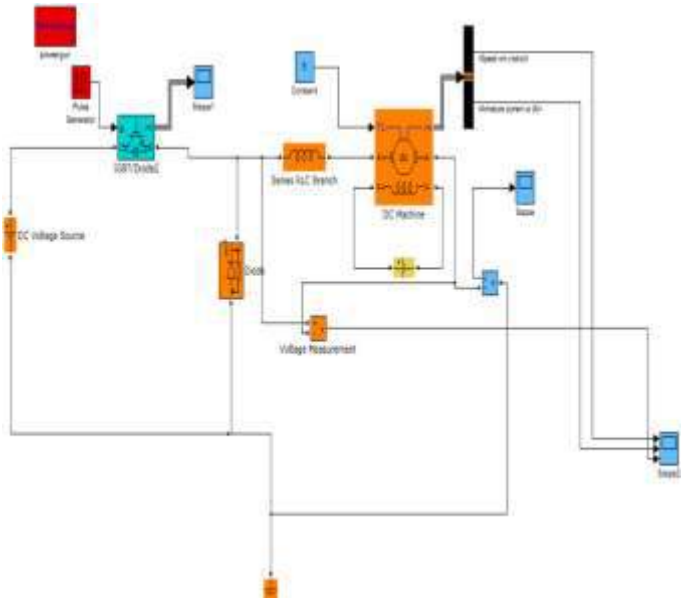

Figure 5: Simulink model of open loop model of chopper with dc machine

IJournals

Model specifications

Rating of the elements used in the above simulation:

Dc voltage source	280 V
Pulse generator:	
Amplitude	10, period – 2e-3,
pulse width (% of period) –	50
Dc motor specification:	
Rating	50 HP, 500 V, 1750 rpm,
Field –	300 V
Torque	5 N-M

After simulation of the above model we are getting a graph of armature voltage, armature current and armature speed with respect to time.

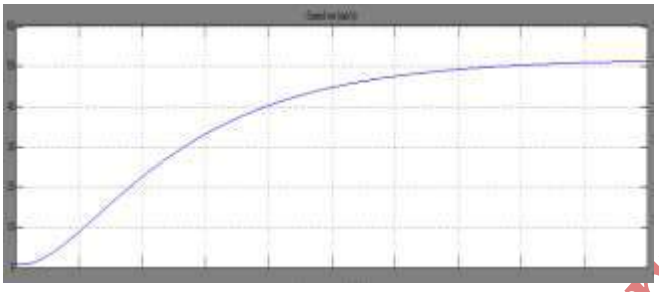

Figure 5.1: Waveform of speed of motor

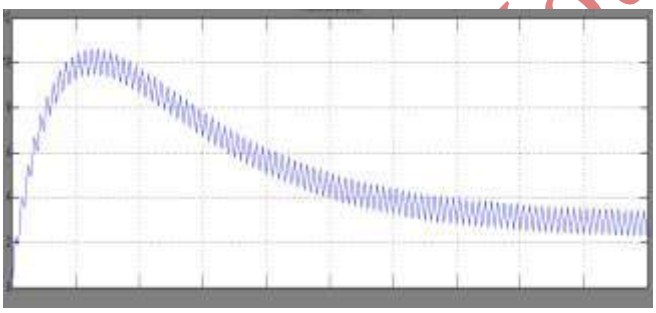

Figure 5.2: Waveform of armature current

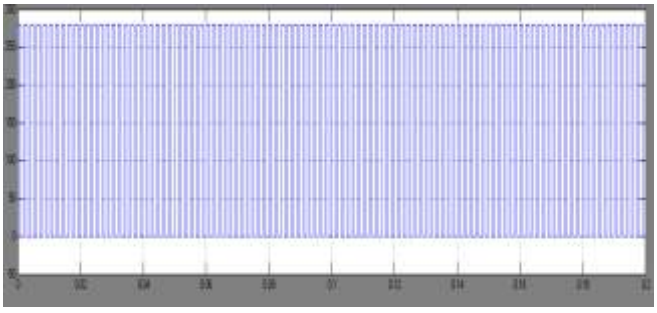

Figure 5.3: Waveform of armature voltage

5.2 Simulink Model for closed loop system

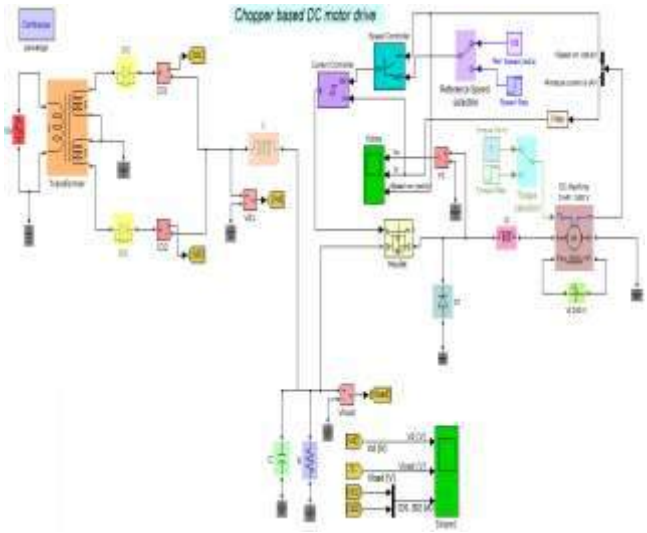

Figure 4: Simulink model of closed loop model of chopper with dc drive

Model specifications

- **Power supply** 400v
  Frequency 50Hz
- **Inductance** 20e-03H
- **Current controller**
  Hysteresis band 2
- **Speed controller**
  Proportional gain Kp 1.67
  Integral gain K 0
  Current limit 30A
- **Ref. Speed selection**
  Constant speed 0.4 Rad/sec
  Step speed
  Step time 0.4
  Initial value 120 Rad/sec
  Final value 160 Rad/sec
  Sample time 0 Sec
- **Torque Selection**
  Constant 5
  Step torque 1.2
  Initial value 5
  Final value 25
  Sample time 0
- **Functional block parameters**
  Of filter
  Numerator coefficient 1
  Denominator coefficient [1e-5 1]
  Absolute tolerance auto
- **Series Inductance** 10e-03 H
- **DC machine**

© 2017, IJournals All Rights Reserved

Preset model field:300V	5HP 240V 1750Rpm,
Mechanical input	Torque TL
Field Type	Wound
Field Voltage	240V

- **MOSFET**

FET resistance	0.1 ohm
Internal diode inductance	0 H
Internal diode resistance	0.01 ohm

Internal diode forward V	0 V
Snubber resistance	1e5
Snubber capacitance	inf

Output waveforms on const. torque & speed

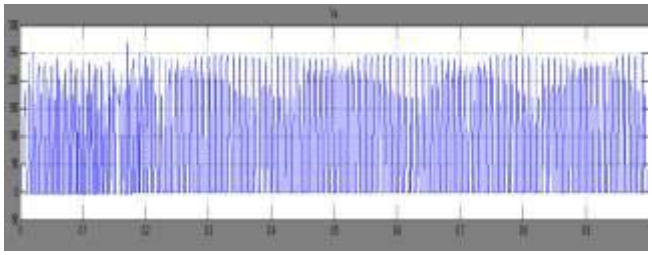

Figure 5.6: Waveform of Armature Voltage (on const. torque & speed)

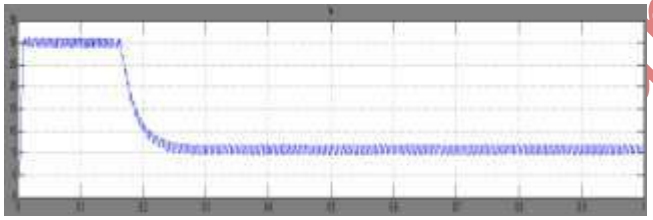

Figure 5.7: Waveform of Armature current (on const. torque & speed)

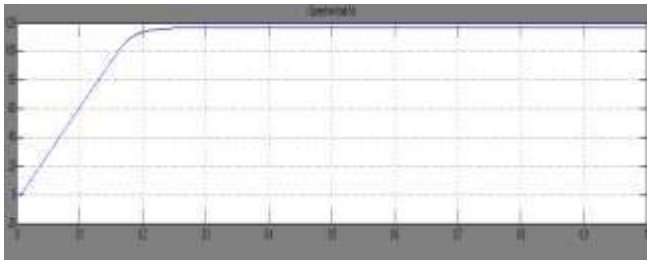

Figure 5.8: Waveform of speed of motor (on const. torque & speed)

Output waveforms on step torque & step speed

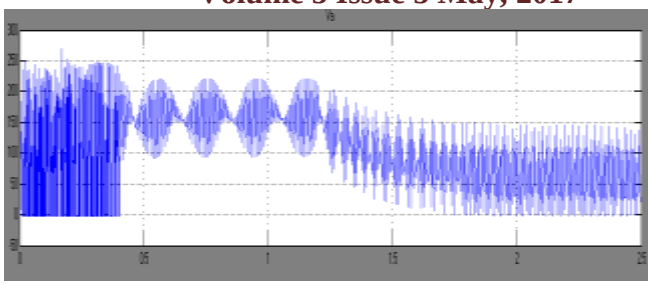

Figure 5.9: Waveform of armature Voltage (on step torque & step speed)

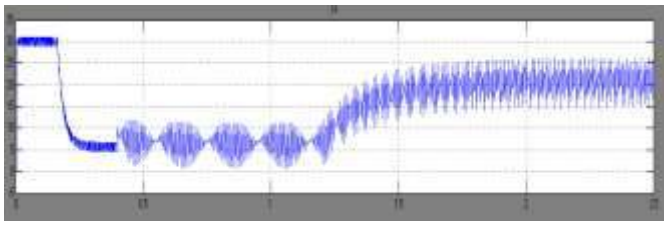

Figure 5.10: Waveform of armature current (on step torque & step speed)

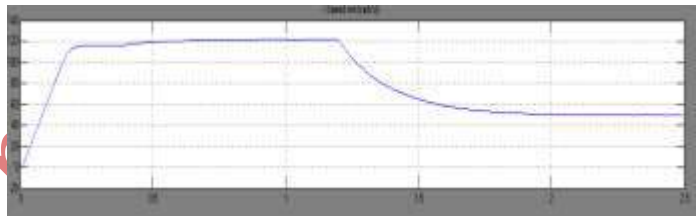

Figure 5.11: Waveform of speed of motor (on step torque & step speed)

6. Conclusion

This paper presents the literature review on MATLAB simulation of speed control of DC motor using Chopper. The speed of a dc motor has been successfully controlled by using Chopper as a converter and Proportional-Integral Type Speed and Current controller. The speed below rated speed is controlled by using armature voltage control method. The closed loop control system is used for speed control. The PI controller and current controller are studied as well. Similarly,Since, the simulation of speed control of DC motor has been done. We can also implement it in hardware to observe actual feasibility. Here speed control of DC motor is done for rated and below rated speed

© 2017, IJournals All Rights Reserved

7. References

1. MATLAB SIMULINK version, Simpower system, single quadrant drive.

2. www.electrical4u.com

3. SIMULINK Model-based and system based design using Simulink, Maths works, Inc Natick

4. Bimbhra, P.S., Power Electronics. New Delhi Khanna Publishers.

5. Rashid, M.H., Power Electronics, Prentice Hall of India, New Delhi

IJournals