International Journal on Emerging Technologies **7**(1): 96-100(2016)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Modeling and Simulation of Firing Circuit using Cosine Control System

Abhimanyu Kumar* and Vinay Pathak**
**Research Scholar, Department of Electrical Engineering,*
Bhopal Institute of Technology Bhopal, (Madhya Pradesh), INDIA
***Assistant Professor, Department of Electrical Engineering,*
Bhopal Institute of Technology Bhopal, (Madhya Pradesh), INDIA

(Corresponding author: Abhimanyu Kumar)
(Received 09 May, 2016 Accepted 07 June, 2016)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The study describes the use of cosine control system in modeling and simulation of firing circuit. It is designed of a closed loop model of the dc motor drive for controlling speed. In a closed loop system accuracy and the dynamic responses are better as comparison to other. In this system, acceleration and the deceleration of the motor can be controlled according to the requirement. In order to regulate drives automatically, the controlled variables are measured as compared with a preset reference voltage. The differences between these two signals are fed as an actuating signal to control the elements of the system.

Keywords: firing circuit, Thyristor, DC motors and AC motors, rectifier.

I. INTRODUCTION

An electric motor is an electromechanical device that converts electrical energy to mechanical energy. Electric motors are mainly divided into two types namely, DC motors and AC motors. However, the general working mechanism is the same for all motors. Speed control of an electric motor is very important in many systems and applications such as fans and washing machines. Systems used for motion control are called drives. Hence, drives that use electric motors to control motion are called electric derive [1]. Because they are easy to control, DC motors are widely used in applications where the speed of the motor is to be controlled. DC motors are, in turn, divided into several sub-categories, namely, series motors, long-shunt compound motors, short-shunt compound motors and separately excited DC motors. Two methods of speed control of separately excited DC motors are applicable when the separately excited DC motor is supplied by a constant voltage, namely, armature control method and field control method [2].

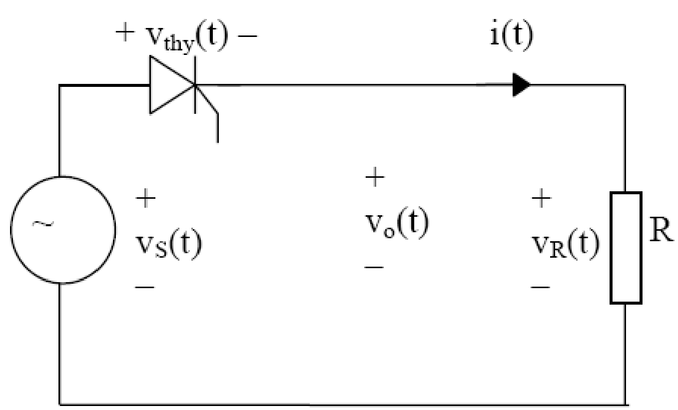

Fig. 1. Half-wave controlled rectifier.

A single phase half controlled rectifier as shown in Fig.1 above is used in our paper. Thyristor is a controlled rectifier in the circuit. It has two main terminals which is anode, cathode and a controlling gate terminal. A thyristor can only forward bias; therefore the current can only flow in the forward direction, which is from anode to cathode [4]. A thyristor will conduct in the forward direction when a gate current is applied to the gate terminal. However, it will block the forward current when a smaller current pulse enters the gate terminal. Therefore, the gate terminal plays an important role to switch on or off the thyristor. With that, a thyristor is different compared to a diode, and works as a controlled rectifier [3]. Furthermore, when we increase the gate pulse, it will reach a "latching" level. At this state, even if we remove the gate pulse, but the thyristor will still remain on. Once established, the anode-cathode current cannot be interrupted by any gate signal. We can only switch off the thyristor with an external switch. In other words, the non-conducting state can only be restored after the current flowing through the thyristor is reduced to zero. For example, to switch off the thyristor, we must switch off the power supply. Moreover, a thyristor acts as a close switch when conducting. It only has a forward voltage drop of 1V or 2V over wide range or current. Despite the low volt drop in the "on" state, heat is dissipated. Therefore an efficient heat sink is required, to cool down and protect the thyristor. Power transistors such as power BJT can control the current flow through by adjusting the base current; therefore it is better than thyristors. However, we use thyristor instead of power transistor because a few reasons. Among the reasons is because the thyristor is lower cost compare to power BJT. On the other hand, the thyristor has the higher power capability compare to BJT. Thyristors allows a very larger current and power to flow through. Furthermore, thyristors have a low triggering power. In other words, a thyristor needs a low gate pulse to switch on. Besides that, a thyristor Basic structure and operation of thyristor Thyristors are usually three-terminal devices that have four layers of alternating p-type and n-type material (i.e. three p–n junctions) comprising its main power handling section. The thyristor circuit symbol is shown in figure 2(a). Generally, the operation of thyristors is as follows; when a positive voltage is applied to the anode (with respect to cathode), the thyristor is in its forward-blocking state. The center junction, J2 (see Figure 2(b)) is reverse biased. In this operating mode the gate current is held to zero (open circuit). In practice, the gate electrode is biased to a small negative voltage (with respect to the cathode) to reverse bias the GK-junction J3 and prevent charge-carriers from being injected into the p-base. In this condition only thermally generated leakage current flows through the device and can often be approximated as zero in value (the actual value of the leakage current is typically many orders of magnitude lower than the conducted current in the on-state). As long as the forward applied voltage does not exceed the value necessary to cause excessive carrier multiplication in the depletion region around J2 (avalanche breakdown), the thyristor remains in an off-state (forward-blocking). If the applied voltage exceeds the maximum forward-blocking voltage of the thyristor, it will switch to its on-state. However, this mode of turn-on cause non-uniformity in the current flow, is generally destructive, and should be avoided. When a positive gate current is injected into the device, J3 becomes forward biased and electrons are injected from the n-emitter into the p-base. Some of these electrons diffuse across the p-base and get collected in the n-base.

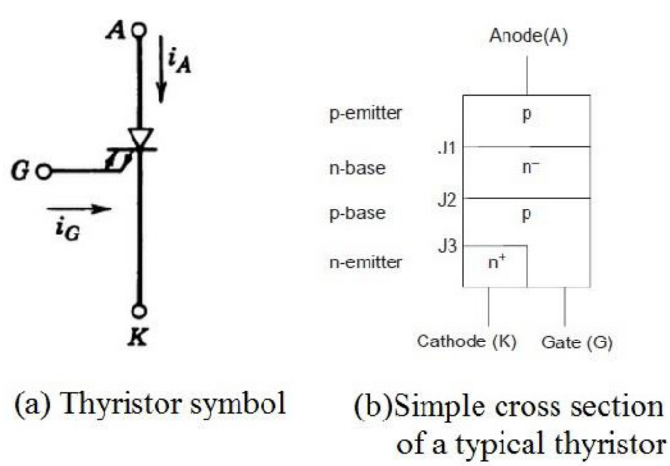

Fig. 2. Circuit symbol and cross section of thyristor.

This collected charge causes a change in the bias condition of J1. The change in bias of J1 causes holes to be injected from the p-emitter into the n-base. These holes diffuse across the n-base and are collected in the pbase. The addition of these collected holes in the p-base acts the same as gate current [7]. The entire process is regenerative and will cause the increase in charge carriers until J2 also becomes forward biased and the thyristor is latched in its on-state (forward-conduction) [5] [6]. The regenerative action will take place as long as the gate current is applied in sufficient amount and for a sufficient length of time. This mode of turn on is considered to be the desired one as it is controlled by the gate signal.

II. FIRING ANGLE CONTROL CIRCUIT

The entire firing angles are with reference to our mains circuit. Mains is 230V. So for control level we have to step down the mains voltage. So, we will use a step down center tap transformer for stepping down the voltage to 10V. We have a control level of +10 or -10. This we give to a zero crossing detector. We can design a positive or negative zero crossing detector with the help of the operational amplifiers. The output of a positive zero crossing detector is shown in figure. This output we give to a ramp generator. The output we will feed to a comparator circuit. Comparator voltage is controlled with the help of a control voltage Ec. The comparator output is given to a monoshot. In this way we can generate the desired gate pulse for the thyristor.

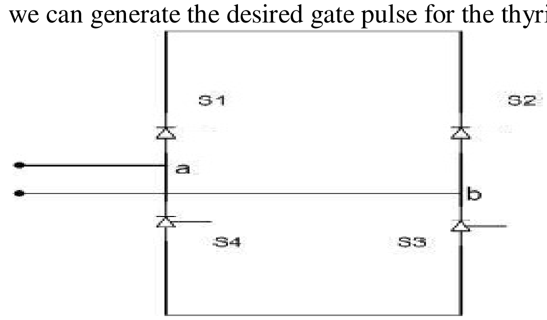

Fig. 3. Firing angle control circuit.

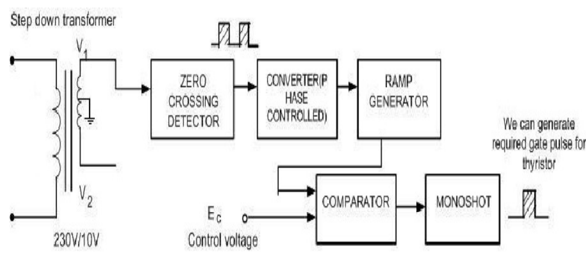

Fig 4. Complete layout Firing circuit.

The entire firing angles are with reference to our mains circuit. Mains is 230V. So for control level we have to step down the mains voltage. So, we will use a step down center tap transformer for stepping down the voltage to 10V. We have a control level of +10 or -10. This we give to a zero crossing detector. We can design a positive or negative zero crossing detector with the help of the operational amplifiers. The output of a positive zero crossing detector is shown in figure. This output we give to a ramp generator. The output we will feed to a comparator circuit. Comparator voltage is controlled with the help of a control voltage Ec. The comparator output is given to a monoshot. In this way we can generate the desired gate pulse for the thyristor.

III. RESULT

Modeling and simulation of firing circuit using cosine control system.

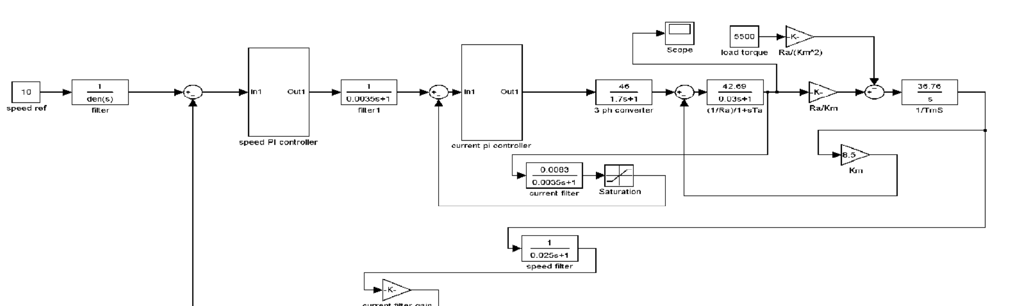

Fig. 5. Modeling and simulation of firing circuit using cosine control system.

It consists of control loops. The inner control loop is the current control loop and the outer control loop is the speed control loop. We are using the PI controllers for both the speed as well as current control.

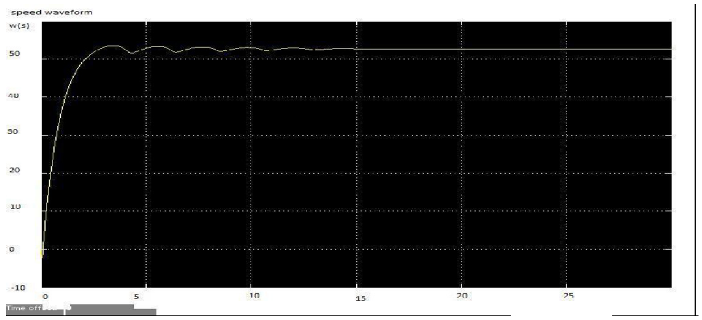

Fig. 6. Motor speed response.

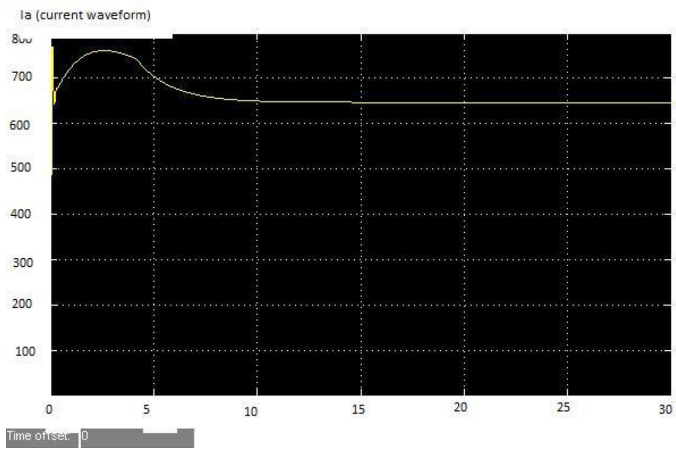

Fig. 7. Aramature current response.

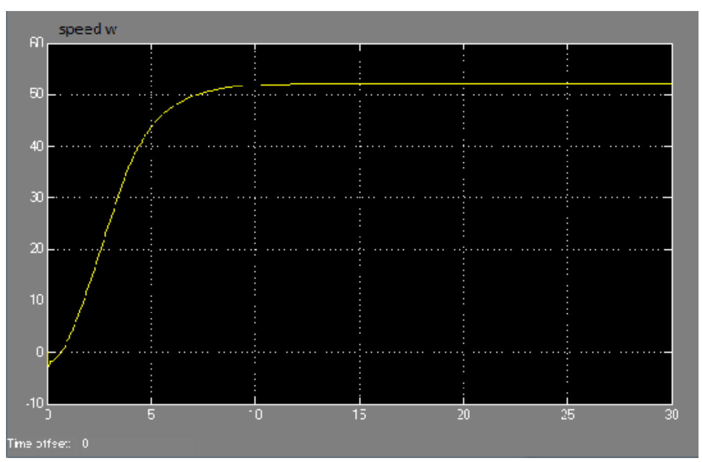

Fig. 8. Motor speed response.

IV. CONCLUSIONS

Diodes are widely used in power electronics circuits for the conversion of electric power and power processing. Ac-dc converters, usually called rectifiers, utilize diodes and provide a fixed output dc voltage. The diodes considered in the application circuits to follow would be considered to be ideal, i.e. having negligible reverse recovery time and forward voltage drop.

The dynamic performance of a control system is good if the controlled variable rapidly reaches the reference limit. For any frequency variation (between the bandwidth) of the input variable, the output should track the input variable instantaneously. For any frequency of input, output follows input as closely as possible. The output speed is compared with the reference speed. The error signal is fed into the speed controller. This controller output will vary whenever there is a mismatch in the reference speed and the speed feedback. Here we are controlling the dc motor. We are controlling the speed by controlling the armature voltage. The output of the controller is he average standard deviations are for each force level and hand condition. In agreement with previous results, the standard deviation in both conditions was a convincingly linear function of the instructed force level. As predicted, the force errors in the two-hands condition were smaller, and the ratio.

REFERENCES

[1] H. Song: *Flexible AC Transmission Systems IEEE, 2010.*

[2] L. Gyugyi, C.D. Schauder and K.K. Sen: *Static Synchronous Series Compensator: A Solid-State Approach to the Series Compensation of transmission Lines*. In: IEEE Trans. Power *Delivery,* vol.**12** No.1, pp.406-417, USA, 2011.

[3] L. Sunil Kumar and A. Ghosh: *Modeling and Control Design of a Static Synchronous Series Compensator.* In *:*IEEE Trans. *Power Delivery,* vol. **14** No. 4, pp. 1448-453, USA, 2009.

[4] Zuniga Haro p, Ramirez J M.L: *Multipulse VSC based SSSC*. In: IEEE Power and society general meeting, conversion and *delivery of electrical energy in the 21st century, pp. 1-8, July 2008.*

[5] Byung-Moon Han, Hee-Joong Kim, Seung-Taek Baek *Performance analysis of SSSC based on three-level multibridge.*

PWM inverter. In*:* Electric *Power Systems Research* vol. **61** pp 195–2002.

[6] B. Han, S. Baek, H. Kim *Static synchronous series compensator based on cascaded H-bridge inverter.* In:Electric *Power Systems Research* vol. **65** pp159_ 168. 2003.

[7] Haiwen Liu, Leon M. Tolbert, Burak Ozpineci, *Zhong, Converters. Applications, and Design, IEEE,2009.*