MATLAB Simulation of Four Quadrant Chopper

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Abstract**-- The speed of separately excited DC motor can be controlled from below and up to rated speed using chopper as a converter. The chopper firing circuit receives signal from controller and then chopper gives variable voltage to the armature of the motor for achieving desired speed. Here we simulate the four quadrant chopper using MATLAB/SIMULINK and take the output waveform.**

Index Terms**—Chopper, Thyristor, Diode, DC Supply**

INTRODUCTION

To produce quality goods in any industry the process necessarily required the use of variable speed drives. Variable speed DC & AC drives are being increasingly used in all industries. This drives and processes take power from dc voltage sources, in many cases conversion of the dc source voltage to different level is required. For example, subway car, trolly buses or battery operated vehicles required power from a fixed voltage dc source. However, their speed control requires conversion of fixed voltage dc source to a variable voltage dc source for the armature of the dc motor. For this purpose chopper circuit are used.

THEORY

Figure shows the basic power circuit of type E chopper. It is observed that the four quadrant chopper system can be conside3red as the parallel comination of two type C choppers. In this type chopper configuration, with motor load, the sance of rotation can be reversed without reversing the polarity of excition. In this bfigure CH_1, CH_4, D_2 and D_3 constitute one type C chopper and CH_2, CH_3, D_1 and D_4 frm another type C chopper circuit. Figure shows the class E chopper with R-L load.

If chopper CH_4 is turned on continuously, the antiparaller pair is connected pair of devices CH_4 and d_4 constitute a short circuit. Chopper CH_3 may not be turned on at the same time as cont. on, because that would short circuited sorce E_{dc}. with CH_4 cont. on, and CH_3 always off, operation of chopper CH_1 and CH_2 will make E_0 positive and I_0 reversible, and operation in the first and second quadrant is possible. On the other hand, with CH_2 continuously on and CH_1 always off, operatin of CH_3 and CH_4 will make E_0 negative and I_0 reversible, and operation in the third and fourth quadrant is possible.

Now, the operation of fourth quadrant chopper ia as follows.

When choppers CH_1 and CH_4 are turned on, current flows through the path, E_{dc+}-CH_1-load-CH_4-E_{dc-}. both E_0 band I_0 are positive, we get the first quadrant operation. when both choppers CH_1 and CH_4 are turned off, in load dissipates its energy through the path load –D_3-E_{dc+}-$E_{dc—}$ D_2-load. Now E_0 is negative and I_0 is positive and fourth duadrant operation is possible.

When choppers CH_2 and CH_3 are turned on, current flows through the path, E_{dc+}-CH_3-load-CH_2-E_{dc-}. both E_0 band I_0 are positive, we get the first quadrant operation. when both choppers CH_2 and CH_3 are turned off, in load dissipates its energy through the path load –D_1-E_{dc+}-$E_{dc—}$ D_2-load. Now E_0 is negative and I_0 is positive and fourth duadrant operation is possible.

This four quadrant chopper circuit consists two Bridges, forward bridge and reverse bridge.figure 1 show the simulation model of the four quadrant chopper and figure 2 shows the output waveform of the chopper circuit. Figure 3 shows the timing of the gate pulses for both thyristor pair. We take the pulse generator for applying the pulses to the thyristor.

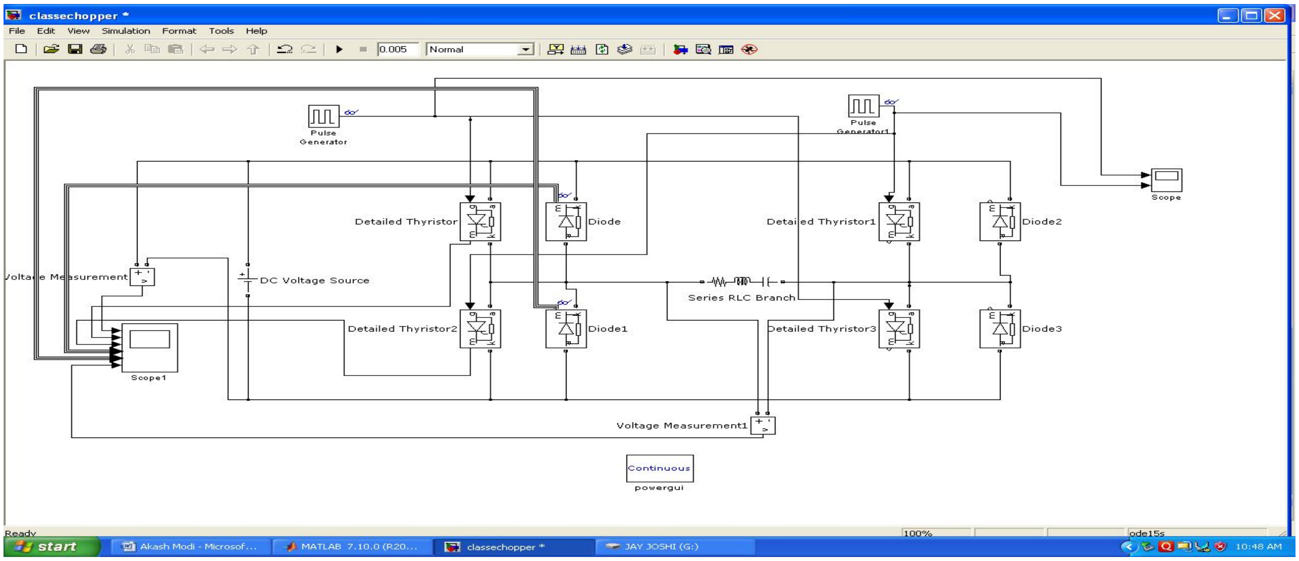

Figure 2 : Simulation Diagram

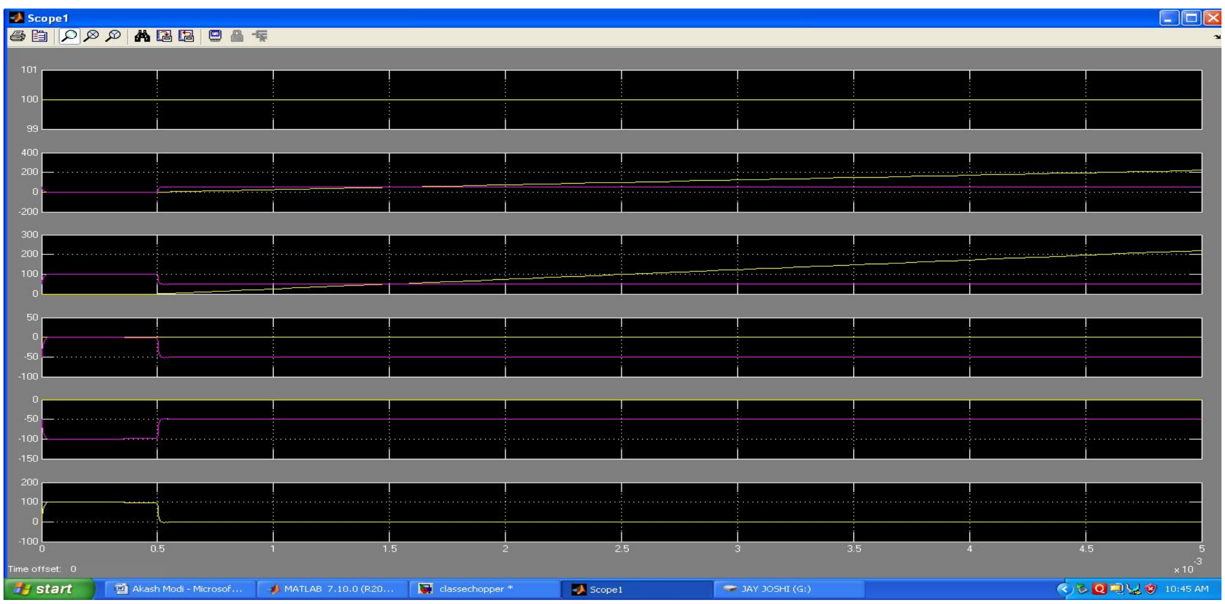

Figure 2 : Output Waveform of

Rotor Current Ia v/s Time

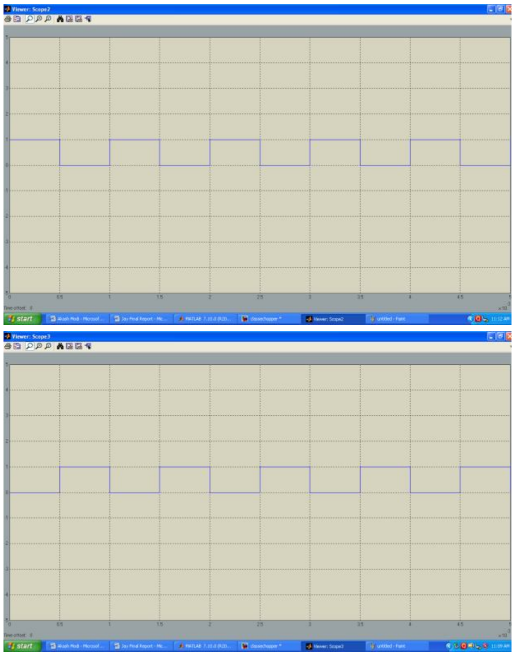

Figure 6: Output of Pulse generator

Table 1: COMPONENT USED IN SIMULATION

SR NO.	COMPONENTS	NOs.
1	DC Voltage Source	1
2	Voltage Measurements	2
3	RLC Branch	1
4	Thyristor	4
5	Diodes	4
6	Pulse Generator	2
7	Powergui	1
8	Scopes	2

CONCLUSION

In this paper an attempt has been made to simulate the operation of Four Quadrant Chopper. For the MATLAB simulation, MATLAB SIMULINK is simultaneously used to compare and analyse the performance of chopper circuit.

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[2] Power Electronics-1 by J S Katre, Tech-max Publication.

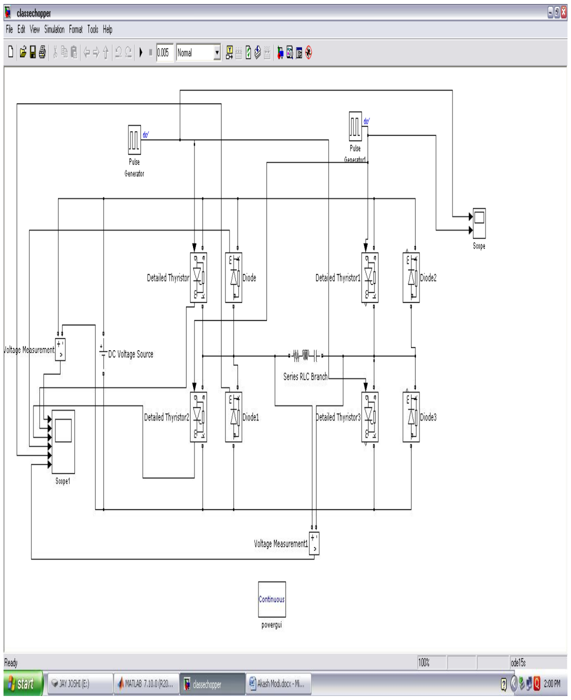

Figure 1: Simulation Diagram

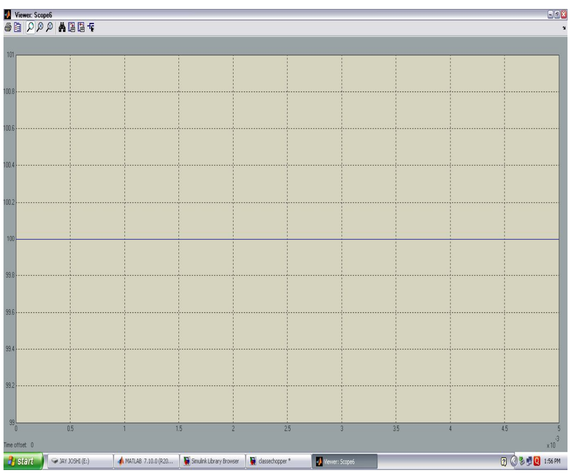

Figure 2: Input DC voltage v/s Time

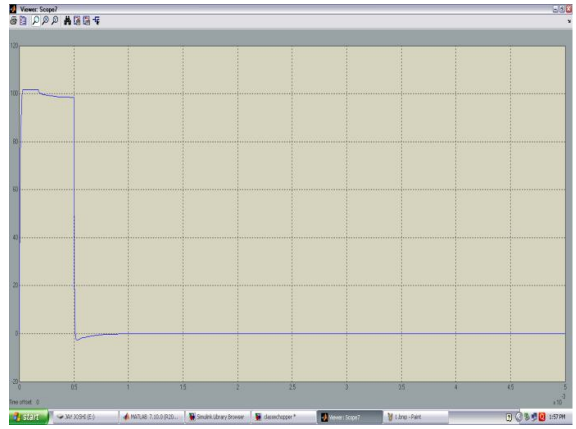

Figure 3 : Output Voltage v/s Time

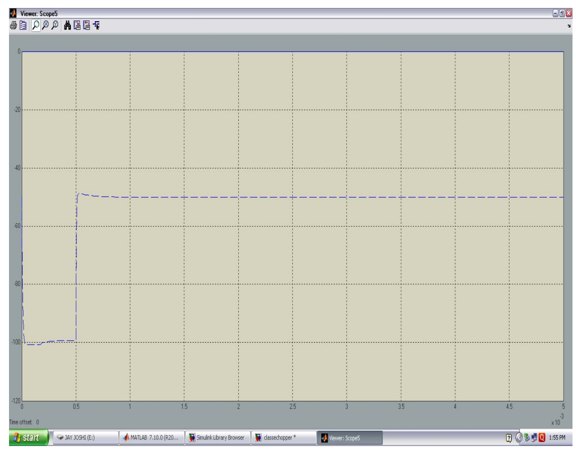

Figure 4: Voltage across Thyristor 1& 4

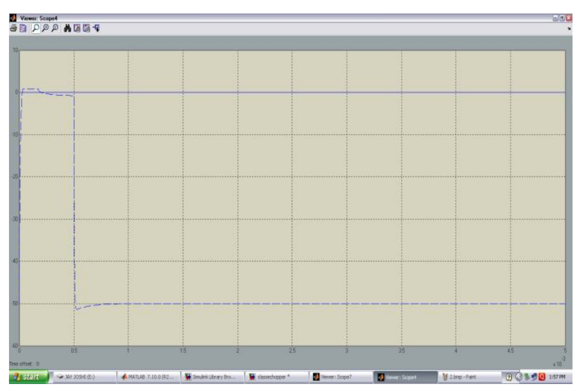

Figure 5: Voltage across Thyristor 2& 3