CURRENT CHOPPING CONTROL OF SWITCHED RELUCTANCE MOTOR IN HIGH SPEED APPLICATIONS

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***ABSTRACT*: Switched reluctance motor (SRM) is amongst developing technology in the field of adjustable drives.SRM is used in the application of industrial drive traction, domestic appliances, office and business equipment. The major advantage is the lower cost, simple, fault tolerance capability and high efficiency. The disadvantage that to be rectified is torque ripple and acoustic noise. Torque ripple is defined as the periodic increase or decrease in output torque. Acoustic noise are produced by the harmonics of normal forces will resonate the natural frequency resonant mode of the stator structure. One of the control methods is the current controller method also known as the hysteresis current control method. There are two methods of current control method .They are hard chopping and the soft chopping. In this project both the control methods were collated and the toque ripple as well as acoustic sound was estimated. It is modelled using the MATLAB/SIMULINK software packages.**

Keywords: SRM,hard chopping, soft chopping, torque ripple, acoustic noise.

I.INTRODUCTION:

The switched reluctance motor has vast improvement due to the development of power electronic drives technology. Switched reluctance motor is doubly salient structure.[1]The Turn on and off angles are the two switching angles decides whether SRM develops positive or negative electromagnetic torque. These switching angles are changeable and depend mainly on speed and torque which depends upon the current in phase windings of the SRM. The torque characteristics can be optimized by using the fixed turn on and the turn off angle which is a function of the current and the speed. The difference between the turn on and the turn off angle is called the conduction angle. The differentiation of ON and OFF angle must be maintained at 30degree for optimised power production for SRM. The angle for each leg in the converter gets varied for every 90 degrees. In this project we are using fixed turn on and turn off angle are 45 degree and 75 degree.[3] Different formulas are there to calculate the turn on and off angle for the optimized performance and the reduction of torque ripples. But it is very difficult to calculate the angle so the fixed turn on and off angle are used .since the performance is more efficient compared to this method. [2]There are different types of converter .We use R-dump converter, C-dump converter , asymmetric bridge converts .In this project the asymmetric bridge converter has been used because of its fast rise and the fall time of current produced.[4] Hysteretic mode control was familiar to power electronics from 1967, it has been a control strategy due to its optimized stability, fast dynamic performance, low costs and easy to use architecture. In this project our main objective is to reduce the torque ripple and the acoustic noise with soft chopping control method.The collasion was also made between different types of current controlled method. In this paper they use the four coefficients of speed to calculate the turn on and off angle using the Qin Jiushao's method. The sixth ssdegree polynomials are used in this method for estimated .It is difficult to estimated for sixth degree polynomial.

II.SYSTEM DESCRIPTION

The MATLAB/SIMULINK model for SRM consists of rotor position sensor, and power controller circuit as shown in Fig.1. The power controller circuit used is the classic converter with two switches and two diodes each phase. This is used for giving the proper gating pulses to each phase of SRM according to the signals obtained from rotor position sensor block. In hard chopping controller each leg is considered for each phase. The switches get turn on according to the excitation of the each phase. The modes of operation in this controller is the magnetization and demagnetization mode .The magnetization mode takes place when the phase get excited both the switches in the leg gets turn ON and the demagnetization mode when the switches get de-energized. The difference between the fixed turn ON and turn OFF angle is 30 degree used for maximum power production. The speed is get converted in to radian per second to revolution per second. The converter used in this controller is asymmetric bridge converter because of its immediate rise and fall time of excitation.

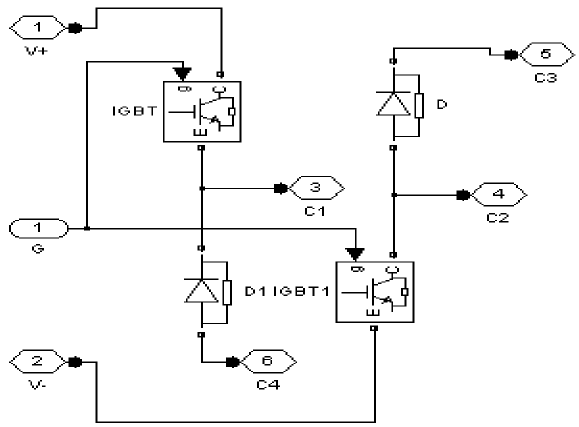

Figure 1 one phase of power converter

2.1.1SENSOR:

Rotor position sensor designed with a discrete time integrator KTs/(z-1) to produce an output vector of phase shifted inductance profiles for each and every phase. Since the phases B , C was lag by 30 degree and 60 degree, the initial condition for integration were given as 0, -30 and -60 so that the discrete time integrator outputs three vectors of angles that are rising in time. If Phase A was at 90 degree, then Phase B was at 60 and Phase C was at 30 deg. As speed rises this phase difference was maintained. w is the speed input . K = 180/л is used to change the speed in RPM into RPS.

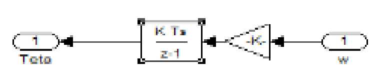

Figure2Block diagram for position sensor

2.1.3PID COMPENSATOR

The inductor maximum and minimum current can be controlled by using the hysteresis current control method. In this current controller it consists of two control loops .They are voltage control and current control .The input to the hysteresis current controller gets compensate using the compensator to generate a control signal it gets multiplied with a reference current to produce a reference current signal. The reference current gets compared with the original current and generate a error given to the hysteresis loop .In this control loop it has been maintained within the limit. Here the compensator used is the proportional Integral Derivative control.

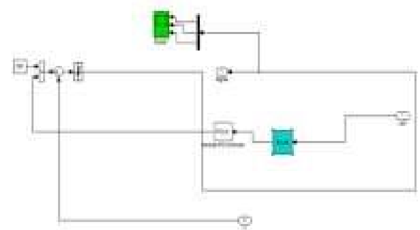

Figure3Block diagram of controller

III.SIMULATION

3.1.1HARD CHOPPING CONTROLLER

In hard chopping controller each leg is considered for each phase. The switches gets turned on according to the energisation of the each phase. The modes of operation in this controller is the magnetization and demagnetization mode .The magnetization mode takes place when the phase get excited both the switches in the leg gets turn ON and the demagnetization mode when the switches get de-energized. The difference between the fixed turn ON and turn OFF angle is 30 degree used for maximum power production. The speed is get converted in to radian per second to revolution per second. The converter used in this controller is asymmetric bridge converter because of its fast rise and fall time of excitation

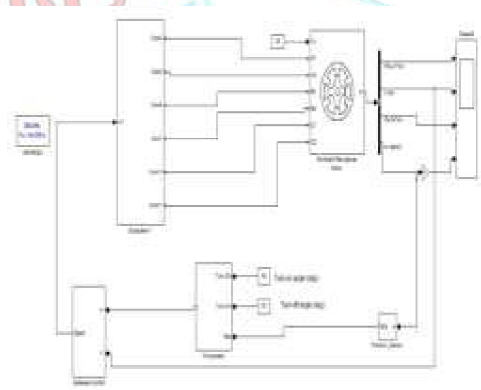

Figure4 Block diagram for hard chopping control of switched reluctance motor.

3.2. SOFT CHOPPING CONTROLLER

In soft chopping control one of the switch always remain ON even after the conduction period gets over. By switching ON one of the switch in each leg always ON it reduces the switching time of each leg so the losses get reduced when compared with the hard chopping controller.

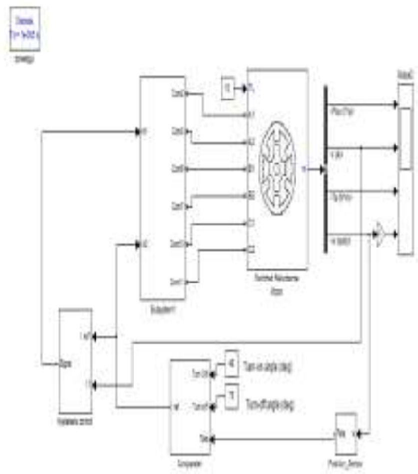

Figure5 Block diagram for soft chopping control of switched reluctance motors.

IV.RESULT AND DISCUSSION

4.1.GRAPH AND TABULAR COLOUMN FOR HARD CHOPPING CONTROLLER

Here we are using a specific type model of switched reluctance motor The output of this model in MATLAB generates a five different signals .They are torque in Nm, speed in rad/sec, flux, current, rotor position. Using the bus selector the five signals can be get separated and can be seen using the scope operator. The graph from the scope obtained is given in figure 5.3.From the graph of electromagnetic torque we can calculate the torque ripple by difference between the maximum and minimum torque divided by the average torque .for various speeds and load torque the torque ripple and the acoustic noise are calculated.

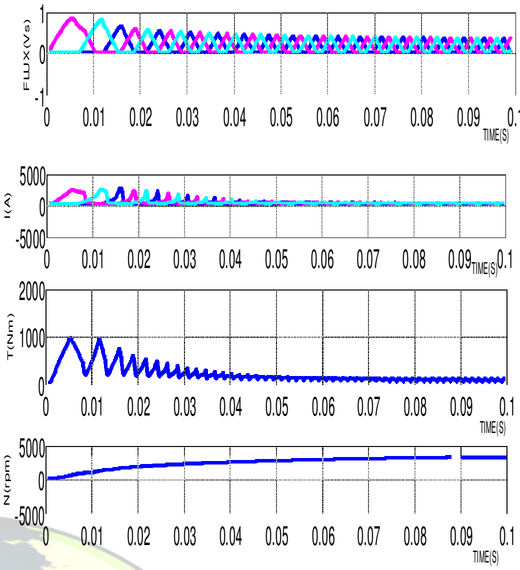

Figure6Graph for proposed hard chopping control

4.1.1 **Tabular column of proposed hard chopping control**

T_L	T_{MAX}	T_{MIN}	T_{AVG}	TORQUE RIPPLE	N(rpm)	THD (%)
10	1014.6	195.56	604.96	1.35	4360	84.26
	1033.65	227.73	630.69	1.28	4500	
	949.04	187.53	568.28	1.34	4000	
20	1015. 3	192.25	603.81	1.36	4100	84
	1018.6	208.12	613.39	1.32	3540	

4.2.GRAPH AND TABULAR COLOUMN FOR SOFT CHOPPING CONTROLLER

The graph for soft chopping controller os switched reluctance is given below in the figure.

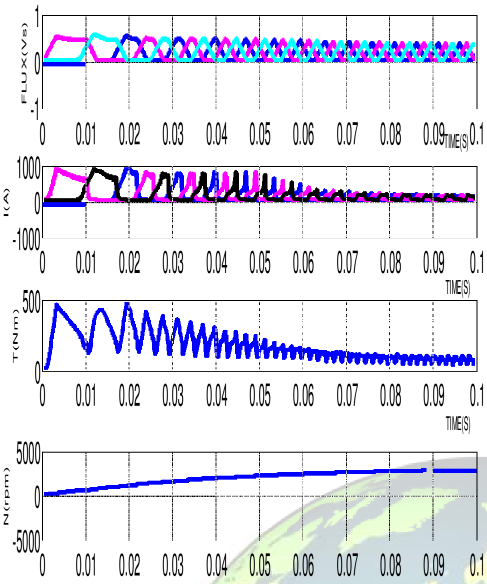

Figure7 Graph for proposed soft chopping controller.

4.2.1 TABULAR COLOUMN FOR PROPOSED SOFT CHOPPING CONTROLLER

Table4.2Table for proposed soft chopping controller.

T_L	T_{MAX}	T_{MIN}	TORQUE RIPPLE	N(rpm)	THD (%)
10	487.9	126.51	1.17	4465	77.14
	492.92	120	1.21	4400	
	480	115.96	1.22	4000	
20	493.48	115	1.24	4175	77.08
	488.82	116.22	1.23	4010	

From the tabular coloumn we can conclude that the soft chopping controller with PID compensator has a falling in torque ripple and acoustic noise collated with the hard chopping control.

V.CONCLUSION

In this project different chopping control for switched reluctance motor using Hysteresis controller has been proposed. When compared with the conventional hysteresis controller using P compensator with the proposed PID compensator has reduced torque ripples and the acoustic noise. As a result this study provides a better controller for switched reluctance motor to reduce the major disadvantage of torque ripples and the acoustic noise. The simulation in MATLAB/SIMULINK has demonstrated both the proposed and conventional method .This controller can be applied for industrial and the aircraft application of the switched reluctance motors. In this method two different chopping methods has been discussed they are the hard chopping and the soft chopping method. From the comparison of the two chopping methods it has been negotiated that the soft chopping controller is better with the reduced torque ripples and the acoustic noise of the switched reluctance motor.

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