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LabVIEW Based Model of Switched Reluctance Motor using PI Controller

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Abstract ***This paper presents new and novel approach towards the development of mathematical model of SRM and controller using Lab VIEW platform Application of PI Controller in Lab VIEW Platform is presented in this paper to reduce settling time and torque ripple, for different combination of K_p and K_i values. All simulation are completely documented with their block diagram and Lab VIEW Subsystem. In Lab VIEW platform, pi controller vi subsystem is developed which helps in reducing torque ripple and settling time..***

Keywords: Lab VIEW, PI.

I. INTRODUCTION

The SRM has been one of the recent entrant to the competitive field of variable speed drive. In the past two decades, Due to continuous research and development in power semiconductor electronics, there has been drastic growth in SRM drive systems suitable for commercial application. A SRM has very good and promising features like simplicity, ruggedness, high torque to inertia ratio and cost effectiveness. The major drawback is torque ripple with causes vibration and acoustic noise. The flux linkage of SRM is a function of both rotor position and the stator current. When stator is excited through converter, rotor tends to occupy minimum reluctance position leading to production of torque which is discontinuous. To overcome this discontinuity of torque, basically two approaches are their one is machine design and another one is control strategy

II. LITERATURE SURVEY

This segment briefly gives overview about the work carried out so far on switched reluctance motor in the field of origin of torque ripple and its minimization techniques using various control strategies , the inspection of few of them are discussed here.

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Different computing and control techniques review has been carried out, .[3] reviews about the techniques used for torque ripple minimization. There are two methods of torque ripple minimization, one is machine design another is control strategy. By machine design methods manufacturing cost is high due to increased in complexity of machine structure, with control strategy cost is less and implementation can be faster. Here control strategy such as current profiling ,TSF, Direct instantaneous torque control, intelligent control are discussed.[1] gives brief overview about causes of torque ripple and a proposed a torque ripple minimization method based on peak valley complementary principle. This principle includes two sets of motor with same rotor and stator to produce two torque ripple waveforms with same amplitude, same frequency and the 180 degree phase difference. Then the resultant of two torque ripple waveform reduces the overall torque ripple, which is verified both theoretically and practically verified in Matlab Simulink environment.[4] gives overview about different methods of minimizing torque ripple such as, conventional PI controller, Fuzzy logic controller and others significantly reduce torque ripple.[5] This paper gives insight about fuzzy logic controller along with PI controller for minimizing torque ripple in SRM.Here FLC uses rotor position and reference current as input and produces compensating current as output using seven membership function.
Lab VIEW is graphical based programming language which helps in machine monitoring and control, research and analysis, control design and parallel processing. In this paper [8] an summary about implementation of SRM model in FPGA target is discussed. Here using FEMM software virtual model of SRM is designed and it is validated by measurements with the variation of voltage in opposition to current methods. The model is Implemented on FPGA device , using the LUTs present .[6]gives overview about introduction of Lab VIEW, control design and simulation module, PID and fuzzy logic tool kit,Labview math script and examples on the same .[11] gives insight about two graphical programming platform such as MATLAB and LabVIEW.Comparsion is done between both the platforms by taking suitable example of PI,PID controller design for DC Motor and results are tabulated with respect to simulation time in both Lab VIEW and MATLAB.[10] describes about FPGA based SRM model ,which provides good accuracy, high efficiency, high torque to inertia ratio, speed performance and good response. Here PI speed controller along with hysteresis controller is implemented in lab VIEW using look up table machine model. Lab VIEW FPGA model is seen on R series board with kintex FPGA chip. Current are sensed and is given to DAQ board, which in turn produces switching signal for converter

III. METHODOLOGY

The analytical model of SRM is based on relevant equations such as toque equation, flux linkage equations, electro mechanical equations and motion equations.
Because of double salience nature and magnetic saturation, flux linked in SRM phase is dependent on rotor position and phase current. The Vi model of SRM in Lab VIEW includes the asymmetric bridge inverter, Vi model, Switch signal .Vi model, Motor Speed and rotor position .Vi, model, SRM linear parameters. Vi model.

A. SRM Linear Model

It simulates a Switched reluctance motor using linear model function .It specifies parameters based on linear model function. Its vi model is as shown figure 1

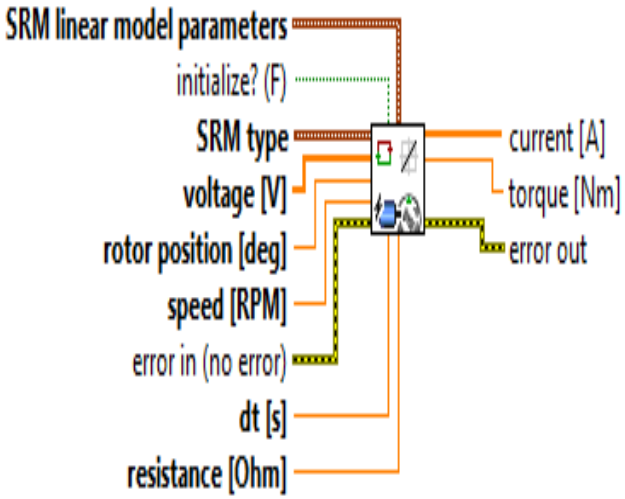

Figure1:SRM Linear model

The inputs are SRM linear model parameters, such as type of SRM, phase voltage , position of rotor in degree ,set speed , resistance of given motor and gives the output which is current and torque.

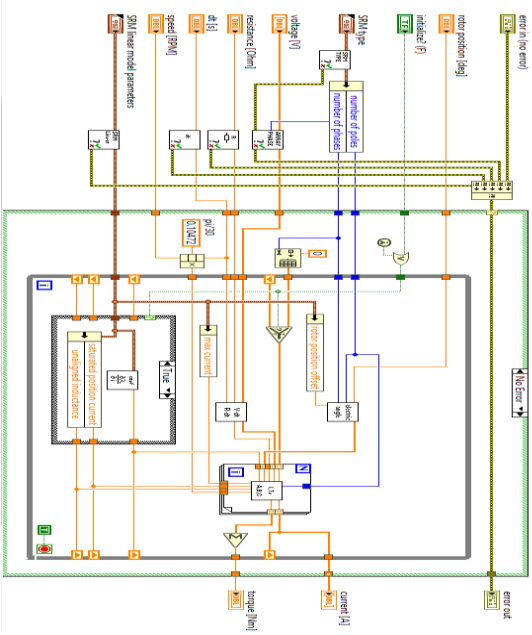

Figure 2: SRM linear Model.vi Block Diagram

B. SRM Asymmetric Bridge Converter.

SRM Asymmetric bridge inverter.vi block diagram is as shown Figure 3. It produces the phase voltage requires for excitation of stator winding for SRM. Based on current command two switch cases are their true or false.

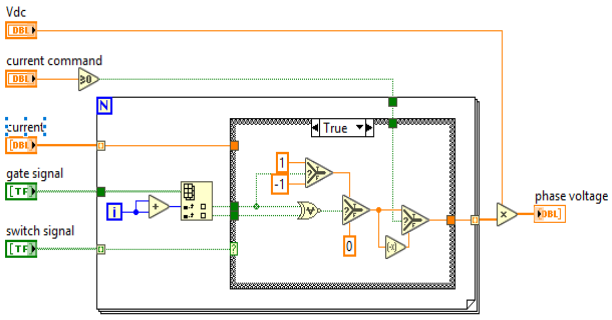

Figure 3: Asymmetric Bridge Converter.

In true case, gate signal passes +1 or -1,,then which will be multiplied with phase voltage.

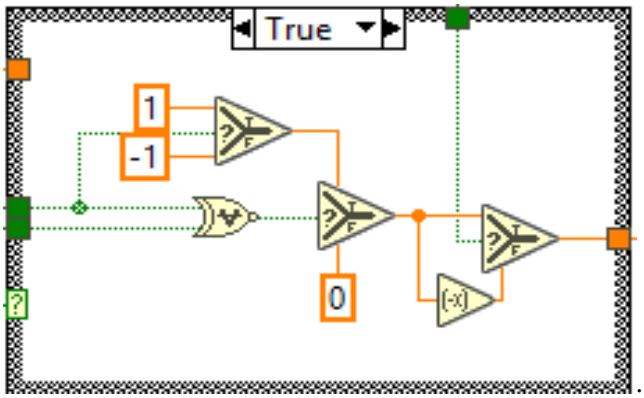

Figure 4: True case.vi

For false case, it is compared with hysteresis band limit which is 0.0001.after comparison if it is within limit, then phase voltage will be multiplied with 0or-1.

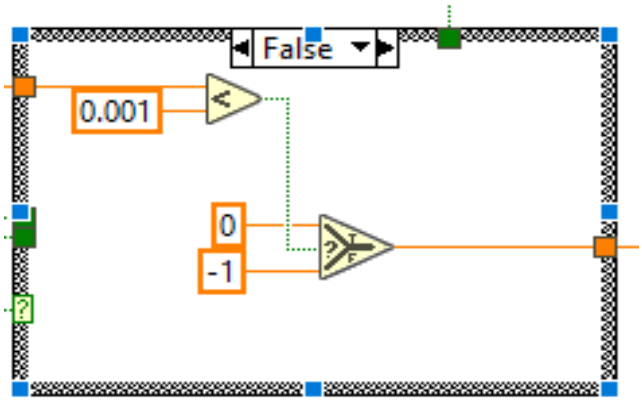

Figure 5:False Case.vi

C. SRM Switch signal .

The switch signal is activated to determine the phase of inverter to be turned on in accordance with position of rotor. Model accepts inputs as SRM type, turn on and turn off angles, speed set point, speed error, rotor position and produce switch signal. Based on rotor position, switch signal activates the next phase. SRM switch signal vi is as shown in fig 6

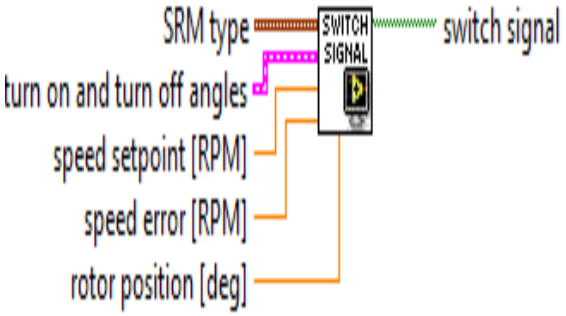

Figure 6: SRM switch signal vi

D. SRM PWM Gate signal.

This block helps to simulate the pulse width modulation signal and gate signal for inverter. Model accepts Amplitude for gate signal is 30V frequency 0f 50000 and time from current simulation time control signal as voltage from PI controller and output will be gate signals for inverter. SRM PWM gate signal.vi is as shown fig 7

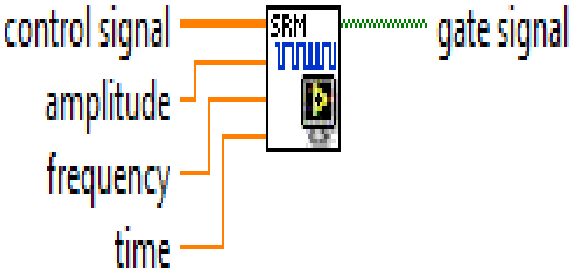

Figure 7: SRM PWM gate signal .vi

E. Motor speed and rotor position

This models helps to evaluate the motor speed and rotor position .It accepts inputs such as speed,rotor,torque and mechanical parameters The speed and rotor position will be given as input to inverter and controller respectively. Motor speed and rotor position ,vi is as shown in fig 8

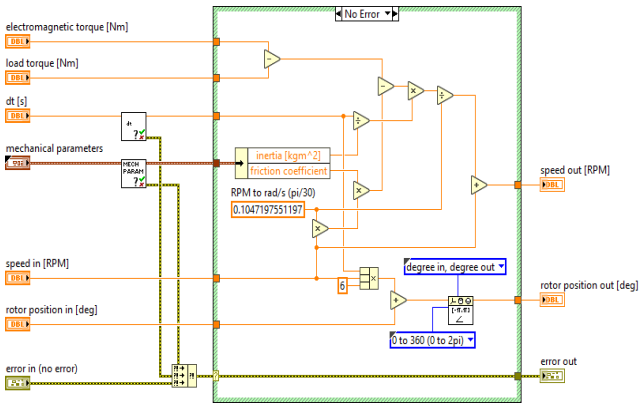

Figure 8:Motor speed and rotor position block diagram

F. SRM PI Controller

The SRM PI controller .vi is as shown Figure 9. It consists of two PI controller block one is speed PI controller and current PI controller. Speed obtained from motor speed and rotor position is compared with reference speed and produces control output as speed which is given as input to speed PI control..

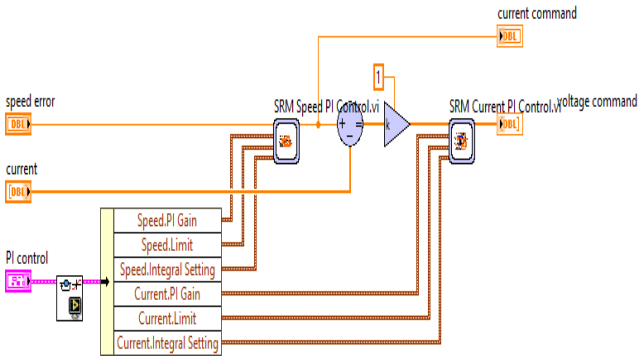

Figure 9:SRM PI controller.vi block diagram

The output of speed PI control is current compared with output current of SRM produces control output acts as input to asymmetric bridge converter for controlling switches

IV. RESULTS AND DISCUSSION

The SRM linear model block diagram and front panel diagram is showcased .Typical waveforms for 800 rpm and 0.6N-M is as shown below.

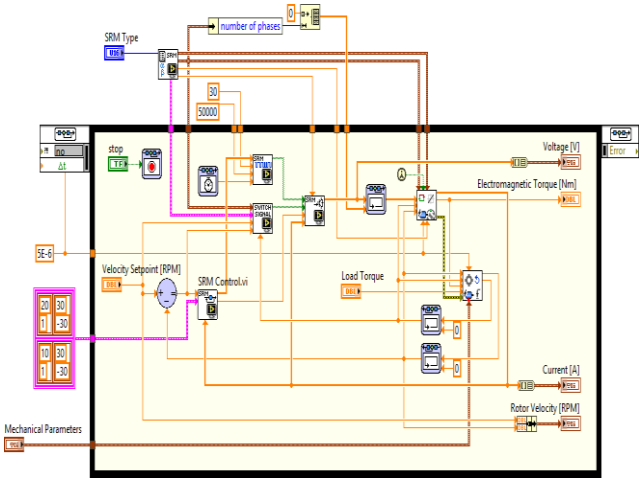

Figure 10: Linear model of SRM with PI controller, block diagram

Figure 11:Friont panel diagram of SRM model using PI controller

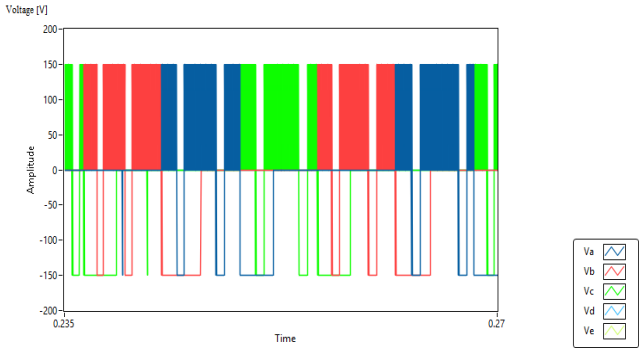

Figure 12: 3 phase SRM with speed of 800rpm,load torque 0.6 N-m

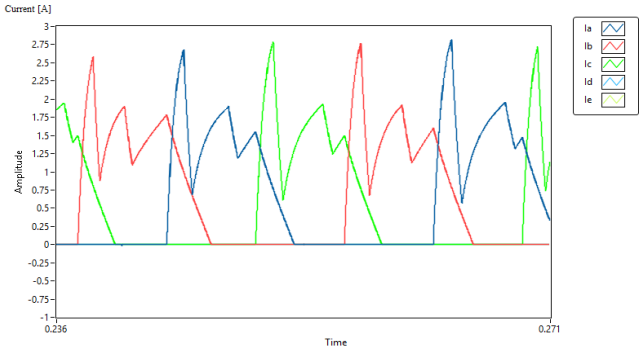

Figure 13: waveform of current(A) v/s time(sec)

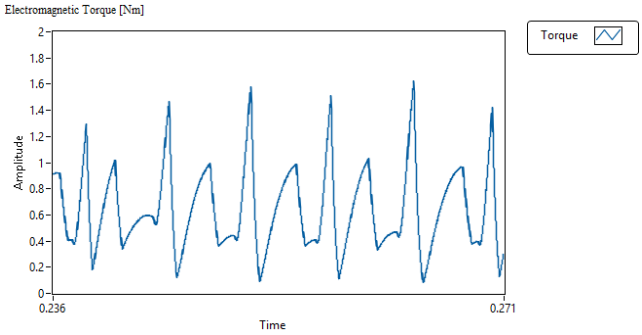

Figure 14: waveform of TorqueNm) v/s time(sec

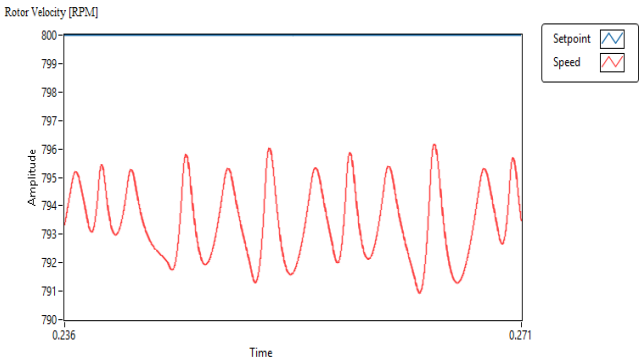

Figure 15: waveform of velocity (RPM) v/s time (sec)

V. CONCLUSIONS

In this paper,vi model of SRM is developed in LabVIEW platform. Here new approach is made for minimize torque ripple and settling time by designing PI controller using control and simulation tool box. As a future work ,gating signals for SRM can be derived as a part of hardware implementation.

REFERENCES

1. Maheshbabu Valeti,D.sussitra" Methods of torque ripple minimization techniques on switched relectance motor" IJRTE Journal of Recent technology and Engineering , volume 8 ,Issue 2S4, 204-208,2019.
2. Mohamed Yaich1, Moez Ghariani2, "A Novel Technique for Tuning PI-controller in Switched Reluctance Motor Drive for Transportation Systems'', International Journal of Electrical and Computer Engineering (IJECE) Vol.8, No.6, 4272-4281, December 2018.
3. Ganesh Velmurgan,serhiy Bozhko,Tao Yang"A Review of Torque ripple minimization techniques in switched reluctance Machine" 978-1-5386-4192-7,IEEE,2018.
4. Ningli wang,Hao Feng," Research on torque ripple and its minimization method of switched reluctance motor"international conference on information,cybernetics and computational social systems,IEEE,2018
5. P.Pranay Kumar," Torque ripple minimization of a switched reluctance Motor using Fuzzy logic control current compensation technique"Inertnational Journal of pure and applied Mathematics",volume 120,No .6,2018
6. Control and Simulation in LabVIEW by V Hans-Petter Halvorsen.2017.
7. Megha Chaple, Sanjay B. Bodkhe," Torque Ripple Minimization of the of 6/4 Switched Reluctance Motor with Speed Controller" ,IEEE conferenece on Energy, Communication, Data Analytics and Soft Computing,1594-1598,2017
8. Humor Nagy,Mircea Ruba ,Horia Hedesiu,claudia Martis"Rapid control Prototyping of a speed control strategy for aswitched reluctance Machine" International conference and exposition on electrical and power engineering,664-668,2016.
9. Vikramarajan Jambulingam, "Fuzzy Logic Controller Design for Switched Reluctance Motor", International Journal of Science and Research (IJSR) 2319-7064, Volume 5, Issue 4, April 2016
10. Sebastian Kula, Sorin Cosman, "Switched Reluctance Motor Model Implemented on PXI FPGA Target" International symposium on Fundamentals of Electrical Engineering. National Instruments, 2016.
11. Civan Artun Cansalar, Ertan Maviş, Coşku Kasnakoğlu "Simulation Time Analysis of MATLAB/Simulink and LabVIEW for Control Applications" IEEE International Conference on Industrial Technology (ICIT), PP 470-473,2015.
12. Sunita.Ch1, M.V.Srikanth,"Modeling And Analysis Of 6/4 Switched Reluctance Motor With Torque Ripple Reduction ", IOSR Journal of Electrical and Electronics Engineering, volume3,number 4, 37-42,2014.

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