DESIGN OF SPEED CONTROLLER FOR THE SRM

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Abstract:
This text shows that the modelling techniques and simulation of the SRM. Motor models with control for efficient working. The Initial model is expected on torque and flux generation through definite element analysis and therefore the secondary model is geometry-based model, which are would not to develop the operation logic control for all-quadrant control of an SRM. The results found from these models were would not to develop an impact processes to turn-on and turn-off complete commutation processed. Two controllers, namely the phase current controller for regulating current and thus the proportional-integral speed controller for regulating the speed of the SRM and They are developed to deliver the required output torque of the Switched Reluctance Motor. The controller has developed to base on a feedback for the closed-loop system also**.**

Keywords: SRM, SC, PI, CCR, Modelling, Simulation, EFA etc..

I. INTRODUCTION

The form of the inductance profile of a switched reluctance machine (SRM) along the air-gap between stator and rotor poles depends on the resistance along the gap and pole-widths of stator and rotor as shown in figure 1. The control algorithm is developed supported this inductance profile with reference to rotor position. Motoring are often achieved between unaligned and aligned pole positions due to the positive slope of inductance. Similarly, along the negative slope from aligned to unaligned pole positions, generating torque are often produced by the Motor [1].

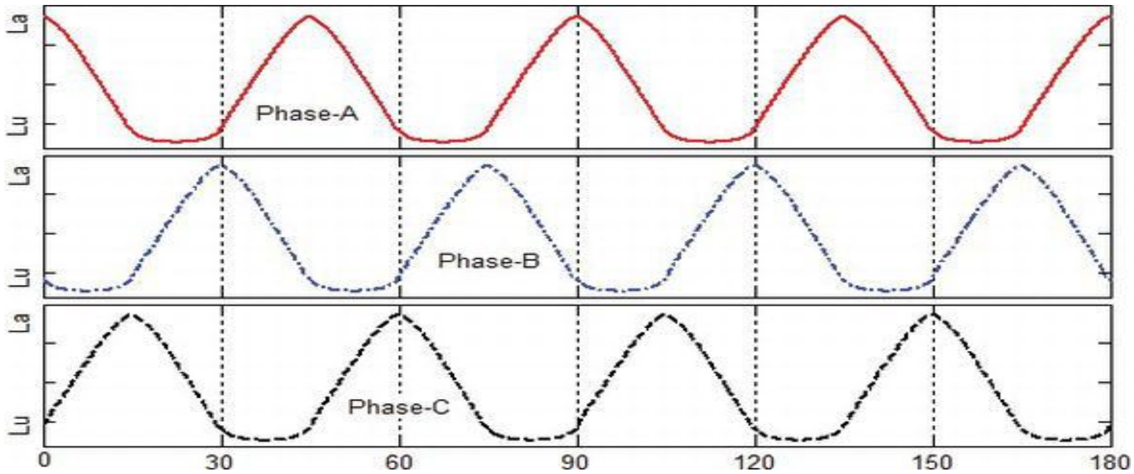

Figure 1.12/8- SRM with respect to rotor position

In the motoring operation mode, the machine produces positive torque between unaligned and therefore the next aligned position within the forward or reverse directions. Within the generation, the inductance is going to be decreasing within the direction of rotation leading to negative torque developed. the present flow within the phase winding is usually unidirectional, because the present profiles for the motor and generator operation modes are precisely the reflection of every other along the aligned position for an equivalent speed and symmetrical turn-on and turn-off angles as shown in figure 2.

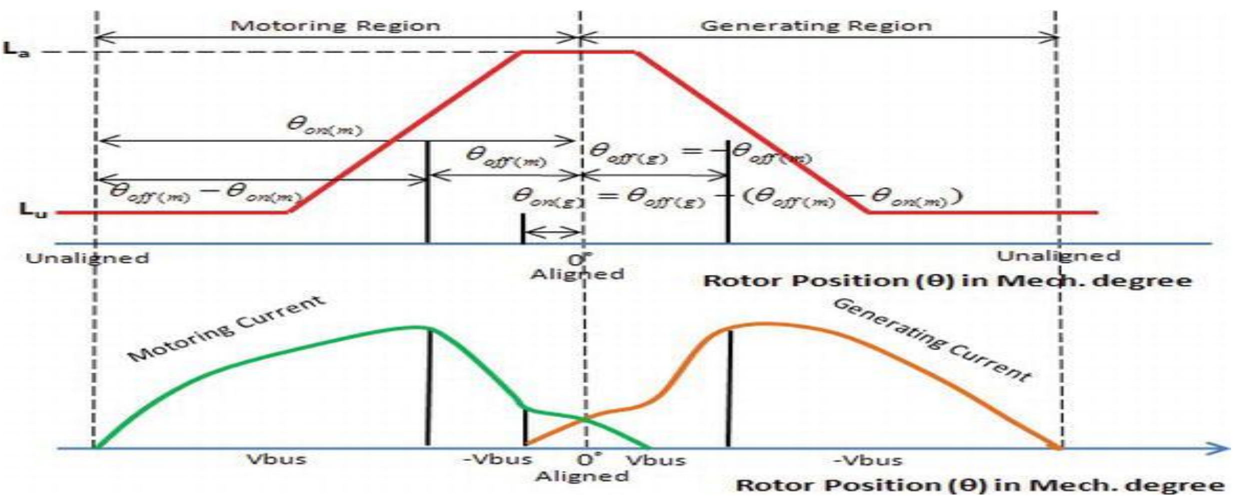

Figure 2. Motor and Generator mode of operation current waveforms.

II. SPEED CONTROLLER:

The performance characteristics from an SRM drive system are often obtained by proper positioning of the phase excitation pulses relative to the rotor position. The turn-on angle "θon," turn-off angle "θoff"(Complete commutation duration) , total conduction period, and therefore the magnitude of the phase current "Iref" determine the typical torque, Torque ripple, and other performance parameters. The complexity of finding the control parameters depends on the chosen control method for a specific application. At low speeds, the present rises almost instantaneously after activate due to the negligible back-emf and therefore the current must be limited by either controlling the typical voltage or by regulating the present level. because the speed increases, the back-emf increases and opposes the supplied DC voltage. Phase advancing is important to determine the phase current at the onset of rotor and stator pole overlap region. Voltage, Pulse Width Modulation is employed to force maximum current into the machine to take care of the specified torque level of the SRM Drive system. The diagram for the overall closed-loop speed and current control of the SRM Drive is shown within the figure 3. In speed control applications, an outer speed loop is added to the faster inner current loop.

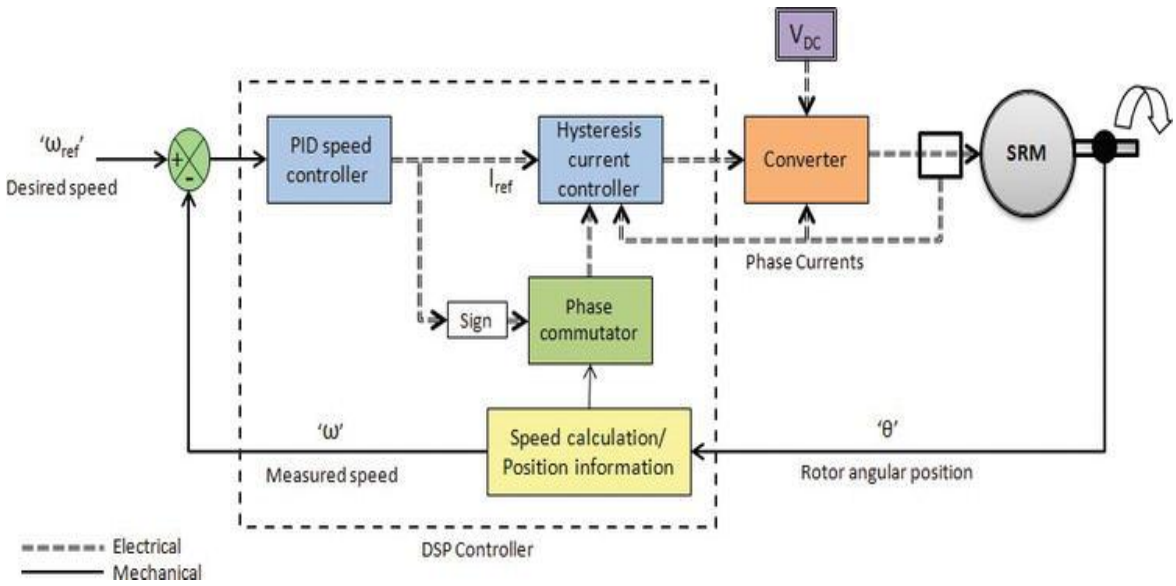

Figure 3. Diagram of the SRM - Closed loop Current & Speed Control

The inner loop creates desired currents within the stator windings necessary to achieve the specified speed specified by the outer loop. The inner current loop is implemented by current regulation, which consists of this controller, the power converter, the SRM stator windings and thus the present sensing devices for feedback control. For current control, an easy hysteresis controller is illustrated here for simplify and Proportional Integral controller for outer speed control.

III. SRM SIMULATION MODEL:

The basic flow chart showing the Switched Reluctance Motor simulation with FEA look-up table-based model is shown in figure 4. The control logic of this simulation is analogous to the geometry-based machine model described below. The table for flux-linkage characteristics consists of varied flux values at different current levels and rotor positions as shown in figure 5.

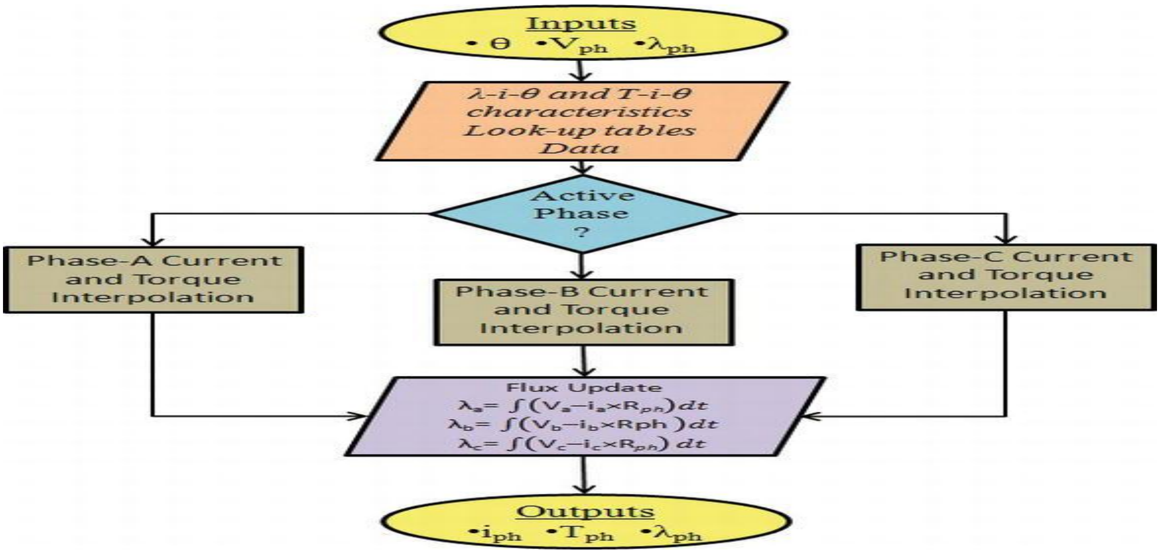

Figure 4. SRM Simulation Flow Chart

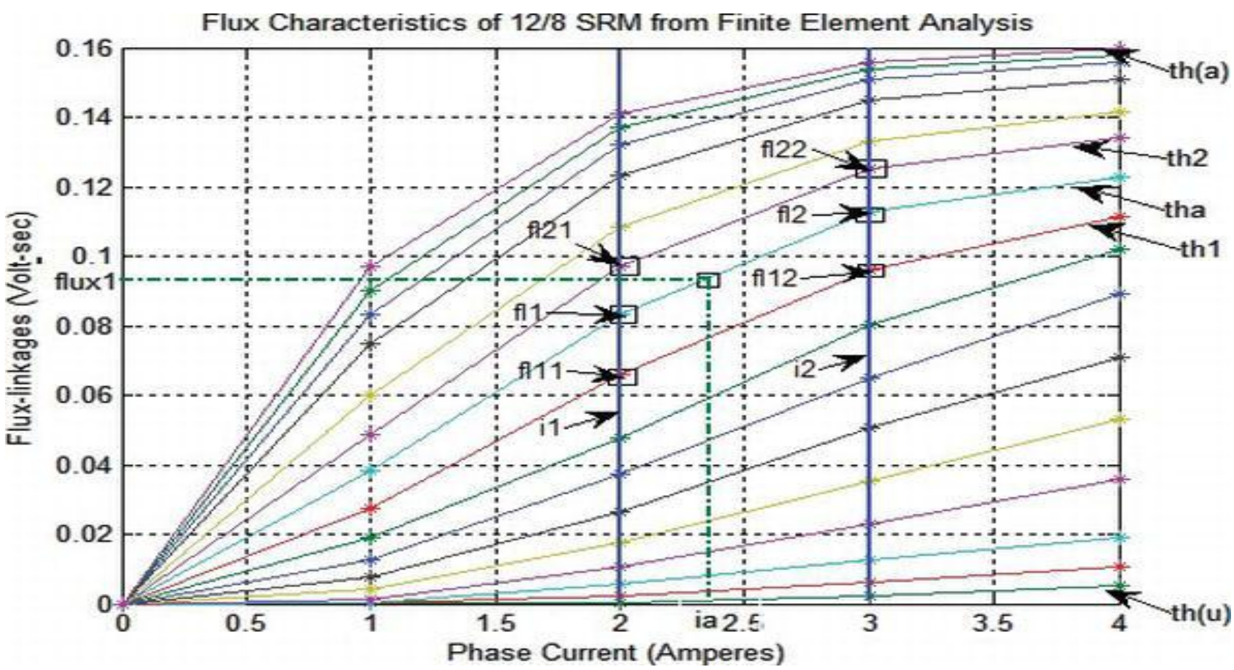

Figure 5.Characteristic of the flux linkage

For torque characteristics consists of phase torque values for various current levels and rotor positions as shown in figure 6. Depends to the mode of operation either motor or generator, the respective rotor positions are considered approximate.

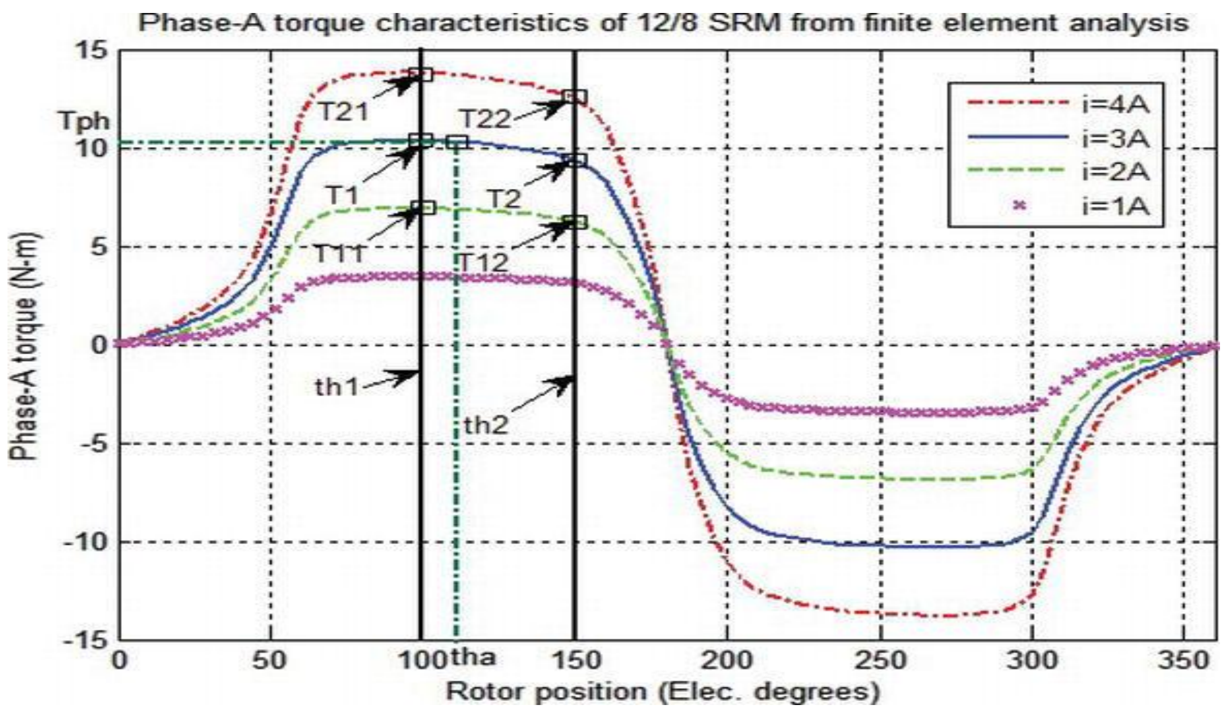

Figure 6 Characteristic of the Torque in the SRM

IV. MODELING OF SRM IN MAT-LAB:

The SRM is usually operated within the magnetically saturated mode to maximize the energy transferred. Knowledge of the magnetic flux linked by a phase is important to develop a classy Switched Reluctance Motor controller. The magnetic non-linearity of the SRM must be taken under consideration by accurate modeling of the motor characteristics [5]. The high degree of non-linearity makes it [8] impossible to model the flux-linkage or phase L (inductance) by a Switched Reluctance Motor through phase accurately. The phase inductance and flux-linkage vary with rotor position thanks to stator and rotor saliencies. The analytical model developed by A. Radun springs from the machine geometry and material magnetic property. The model uses an analytical solution for the flux linked and static torque produced by the SRM. The separate analytical models for the flux linked by a phase when its stator and rotor poles do overlap one another [6] and don't overlap of every other [6] are combined to supply an entire model of a given SRM .When the poles overlap, saturation must be included, especially within the pole tips, whereas linear representations are often used for the unsaturated regions. The flux linked by the SRM is decided from the sum of the most flux and therefore the fringing flux that's linked to the Machine. Analytical model might be wont to calculate motor parameters .The above model described is use within the Mat-lab simulation [7]. The diagram of the simulation is shown in figure 7. The modules of the simulation are the Motor model, the speed and current control by this model, the facility converter, and therefore the load model.

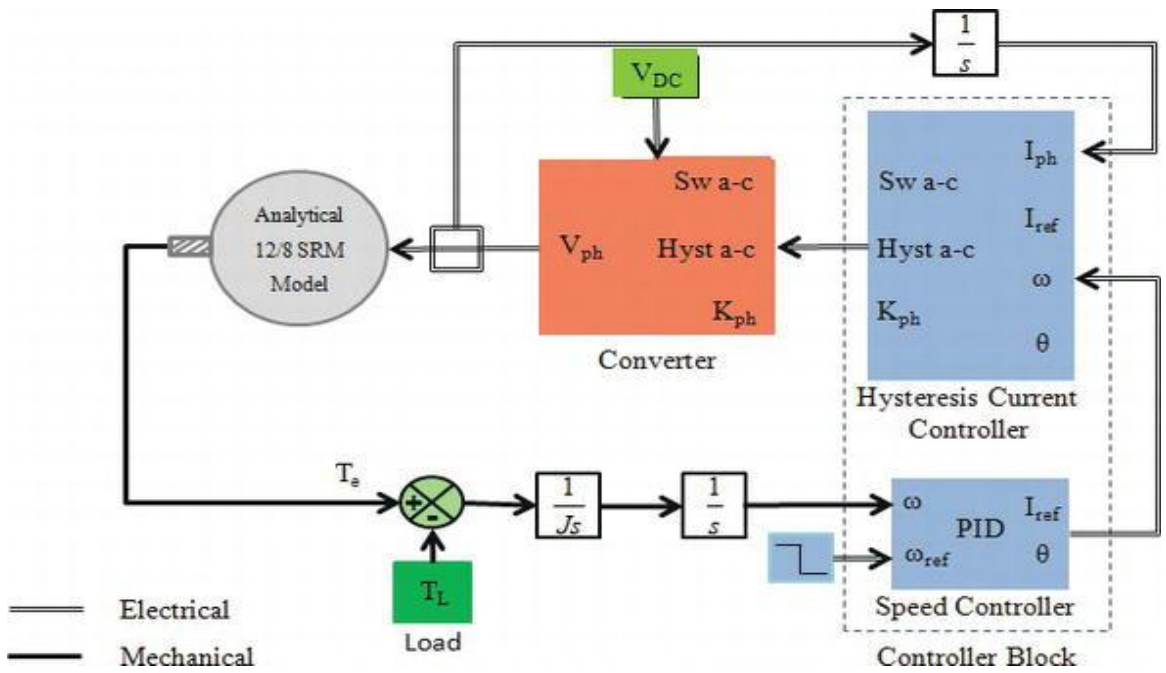

Figure 7. Simulation Model of the SRM

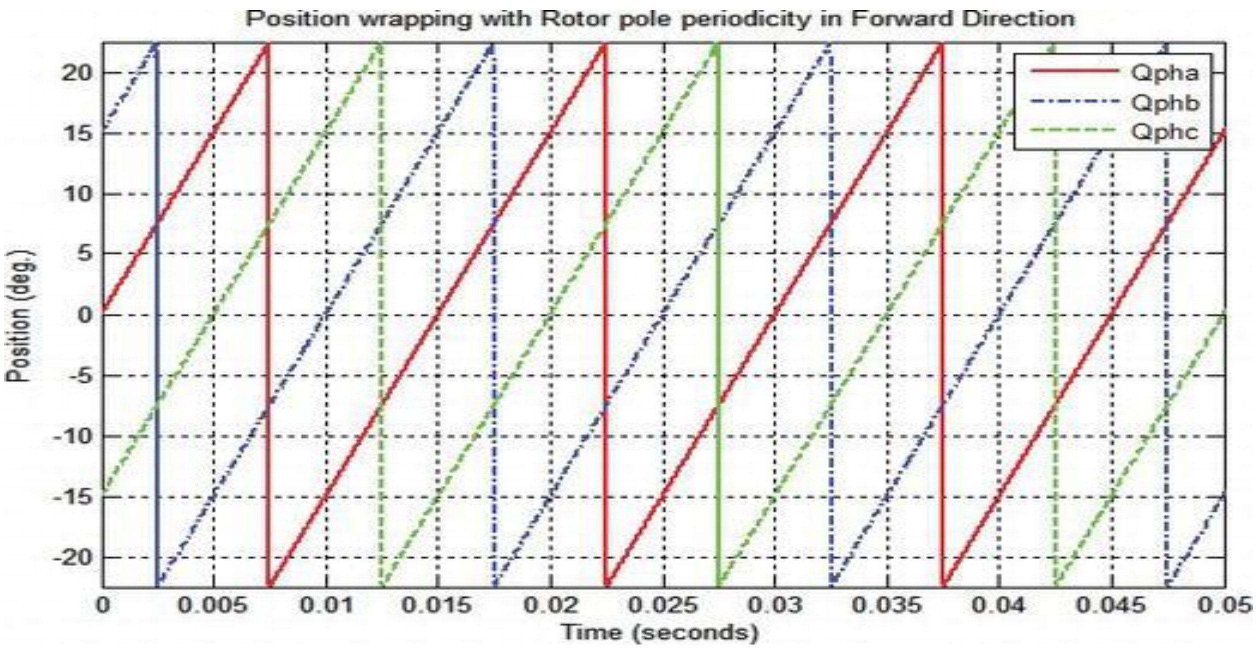

Figure 8. Position wrapping with rotor pole

The inputs to the machine model are the phase voltages and therefore the earlier step phase currents and position information.

The equations to calculate the phase torque, phase inductance, back-emf and phase currents are derived from the machine model. The essential inputs used for this simulation are the geometric parameters and operating conditions of the machine

V. RESULT (MOTORING MODE) OF THE SRM:

Turn-on and turn-off angles are tuned for correct current and speed control supported the inductance profile of the machine [8]. the numerous operations introduces in modeling of the closed-loop control to the SRM for motoring mode of operation, phase switching and PI speed control

1. Active phase determination: The active phase to be turned on for power processing is predicated on the rotor position. Phase A aligned position is employed because the reference (initialized to 0°); therefore, phase C are becoming to be starting phase for motoring operation if getting into forward direction of motion or phase B if getting into reverse direction. When the phase is functioning in its increasing inductance region and within the conduction period, it's said to maneuver . The turn-on and turn-off angles may change, and thus the quantity of phase operation can also vary counting on the torque demand and operating speed.

2. Phase commutation: soon realize precise control of phase current at various machine operating speeds, each active phase possesses to be operated between the optimum turn-on and turn-off angle positions. When the phase operation starts, the winding is happy until this command is reached then demagnetized when the phase operation is turned off.

3. Current chopping: Once the phase is pleased with both switches turned on +Vdc is applied, the phase current will increase because the phase voltage dominates over the back-emf

(E_b) leading to positive di/dt as described by Eq. (1)

$$\frac{di}{dt} = (Vp - Eb - i * Rp)/Lin.(\theta) \quad \text{----------------} (1)$$

When this reaches the upper band , one among the switches is turned off, whereas the opposite switch is kept on for the phase current to the switches are turned on to extend the phase current. Both the switches are turned off when the phase possesses to commute upon approaching the turn-off angle so as that the phase current decays to zero quickly as shown in figure 10 .

The switches are turned on to extend the phase current. Both the switches are turned off when the phase possesses to commute upon approaching the turn-off angle so as that the phase current decays to zero quickly as shown in figure 9. During motoring operation, the phase voltage applied across the phase winding by switching of transistors is shown in figure 9. This procedure is repeated for next in-coming phases. The machine rotor speed “ωm” and position “θ” is computed with the known moment of inertia “J” the entire electromagnetic torque “Te” developed by the machine, and thus the opposing load torque “TL” using the equation (2)

$$\frac{Jd\omega m}{dt} = T_e - T_L \quad \text{--------------} (2)$$

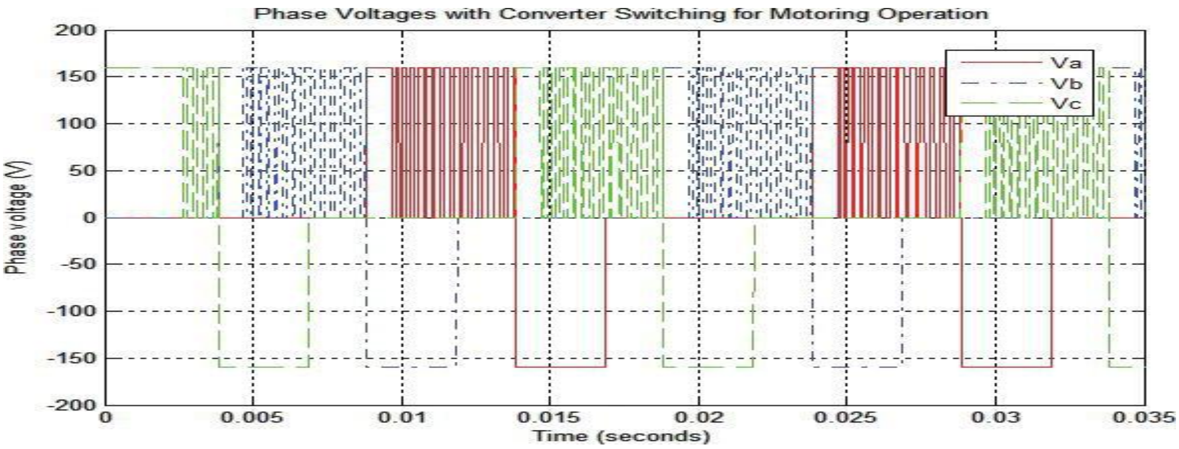

Figure 9. Voltage switching for Motor mode Operation of SRM

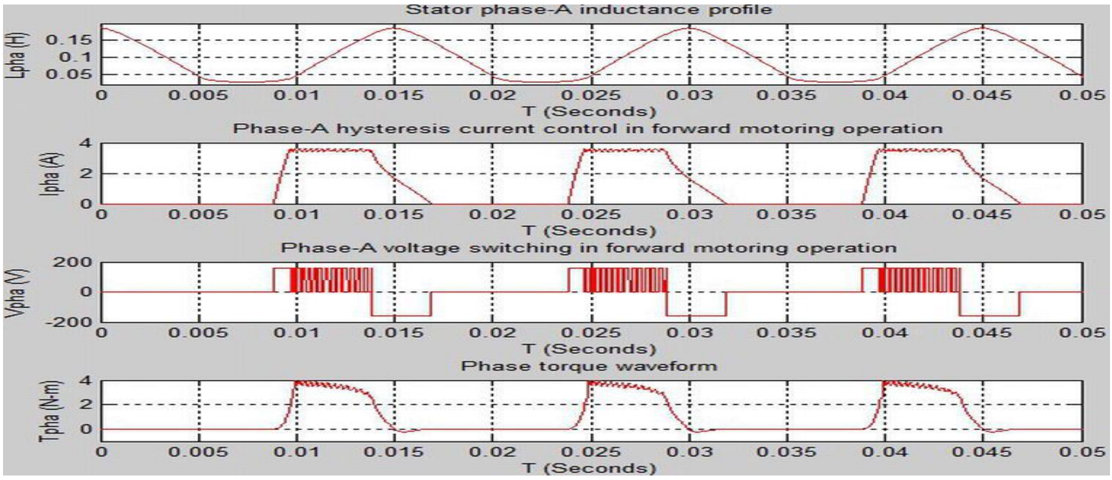

Figure 10. Phase A- motoring operation of SRM.

VI. CONCLUSION:

A Switched Reluctance Machine is type special DC machine with non-linear characteristics. This paper provides modeling approach of two different techniques, one supported the analytical equation and other supported finite element analysis. The techniques provide guidance on the because of obtain the optimized commutation angles from the modeling and by utilizing them within the software simulation. The closed-loop control of the SRM in motoring operation is demonstrated. With the optimized commutation angles, precise control of speed, torque, and current in various operational modes in four-quadrants like forward motoring, reverses motoring. In future, we'll run this motor in forward generation and reverse generation also.

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