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SVPWM BASED CUK-CONVERTER FED SWITCHED RELUCTANCE MOTOR DRIVE FOR POWER FACTOR ENHANCEMENT

[1]DR. R. DEVASARAN, [2]MAILA MEGHANA

[1]Professor, Department of EEE, Holy Mary Institute of Technology & Science, Hyderabad, Ts, India
[2]PG Scholar, Department of EEE (Eps), Holy Mary Institute of Technology & Science, Hyderabad, Ts, India.

ABSTRACT: The primary point of this undertaking is examination of altered double output cuk converter encouraged exchanged reluctance motor drive with power factor redress. The control of a switched reluctance motor (SRM) drive is proposed with a front end control power factor correction (PFC) converter. It utilizes an altered Cuk converter encouraged SRM drive to enhance control quality at AC mains. The converter arrangement comprises of two Cuk converters and every one of them works independently for two half cycles of the supply voltage. The primary goal of this task is power figure amendment altered bridgeless buck support converter sustained SRM drive with SVPWM. The control of an exchanged hesitance engine (SRM) drive is proposed with a front end power factor rectification (PFC) converter. It utilizes an adjusted Cuk converter sustained SRM drive to improve control quality at AC mains. According to the necessity buck support converter is adjusted to get two equivalent DC yield voltages to bolster mid-point converter. The supply current THD because of peaky nature of current in the setup is brought down beneath 5% by utilizing SVPWM.

Index Terms: Power quality; Modified Cuk converter; DCM; Mid-point converter; THD; SRM.

I.INTRODUCTION

These PFC converters are essentially the information current shapers as they lessen the sounds current substance, which are at the recurrence other than the major recurrence. To lessen sounds content from the info supply present, dynamic and in addition latent channels are fused in the circuit, which cut down the supply current THD under worthy points of confinement according to the standard IEC 61000-3-2 [1]. To take care of the demand of vitality productive, minimal effort variable speed drive is a fan sort of load utilized in ventilation, cooling and dryer applications, a PFC converter based adjusted double yield Cuk converter bolstered SRM drive is proposed in this work. The prerequisite of variable speed drive for family unit applications has increased the enthusiasm of producers towards the ease and exceedingly proficient brushless engine drive.

To take care of the present demand, brushed and commutator based machines are no more the decision for industry as a result of related wear, low power thickness and unwavering quality. The brushless engines with lasting magnets, are getting to be well known because of their high productivity, be that as it may, the expense and accessibility of the uncommon earth perpetual magnet material, are the constraints related with these changeless magnet engines. Subsequently, the coming of SRM (Switched Reluctance Motor) has met the necessity of minimal effort variable speed drive engine. Nonetheless, the basic development and nonappearance of rotor windings or any kind of uncommon earth material, have lessened the expense of SRM, adequately. Additionally, SRM likewise experiences a few detriments including high torque swell because of intermittent stage present, acoustic clamor, vibration and so on. Subsequently, numerous on the web and disconnected controls are accounted for in the writing for torque swell minimization in SRM to display SRM as an apparatus engine. Sozer et al. have given the count for substitution edge control based on three control parameters i.e. crest stage current, point when first current pinnacle happens and the edge when inductance starts to increment. Hussain has displayed the cross breed torque minimization controller fused torque minimization method created in the previous couple of decades.

The outline and improvement of variable speed SRM drive for household application and power apparatuses, are exhibited by Ha et al.

In this paper, SRM drive with an enhanced productivity is proposed by diminishing the exchanging gadgets of SRM converter. The paper looks at the proposed split AC converter for SRM drive with a regular converter having all the more exchanging gadgets based on expense and proficiency. In addition, poor power quality with high information current THD, remains undiscussed. Chai et al. have proposed the three stage single switch mode rectifier encouraged SRM drive. The present sounds crossing out plan and voltage control plot, are talked about in it. Test outcomes have exhibited upgraded current and speed dynamic reactions with lessened vibration and speed swells, be that as it may, control factor change has been as yet constrained, which don't consent a standard. Many minimal effort SRM based drives are proposed in the writing however SRM drive with enhanced power quality isn't very much tended to till now.

The ease exchanged hesitance engine drive bolstered by a solidarity control factor converter, shows up as a promising answer for the accessible drive structure. The mid-point converter which uses single switch and single diode to energize singular stages, is chosen here to construct the proposed drive as a minimal effort framework. Be that as it may, switch voltage rating prerequisite is half a direct result of its split DC connect setup. The main disadvantage related with this so far disagreeable converter topology, is the required voltage symmetry. This energizes the plan of PFC converter, which can deal with power quality issues at AC mains and produces two symmetrical voltages over the two capacitors. In this manner, a double yield Cuk converter nourished SRM drive is proposed here. The determination of altered double yield Cuk converter is made due to following powerful highlights,

- It gives a completely controlled two equivalent yield voltages using single voltage circle.
- It enhances the power quality when the drive works under relentless state and in addition dynamic conditions.
- The chose working mode for proposed converter, has decreased the extent of a yield side inductor subsequently the expense and

required board region, are additionally diminished.

To control SR engine, two control systems are embraced as a steady DC interface voltage based control and a variable DC connect voltage based control. The steady DC interface voltage based control is the customarily embraced control calculation, or, in other words into two working modes based on working rate. In the event that the low speed activity is wanted then the hacking control mode is embraced though a solitary heartbeat mode is chosen at fast task. Amid low speed, the turn on and kill points are kept steady and the required torque is acquired by controlling plentifulness of the current. Be that as it may, amid fast task, the present control isn't conceivable because of practically identical back EMF and DC connect voltage.

In this manner, SR engine at fast is controlled based on turn on and kills edges which can be called as a solitary heartbeat mode control. In this ordinary control strategy, full DC interface voltage is connected over the twisting amid low speed task, which results in high current slope consequently instates the distinctive vibration modes in the stator and produces expanded acoustic commotion. In any case, acoustic commotion winds up noticeable when the stator recurrence of vibration matches with the common recurrence of the stator. The high acoustic clamor and spiral vibrations in SRM, can be decreased utilizing single heartbeat control, or, in other words. In this proposed control calculation, the DC connect voltage is considered as capacity of speed. The PFC converter before mid-point converter bolstered SR engine, gives required power quality change at supply side and in the meantime it is fit for keeping up adequate current to keep up the evaluated torque. Hence low speed activity of SR engine can be effortlessly acquired without utilizing any cleaving control methodology.

2. LITERATURE SURVEY

2.1 Design and Development of Low-Cost and High-Efficiency Variable-Speed Drive System with Switched Reluctance Motor

Low-cost switched-reluctance-motor (SRM) drive systems are actively sought for high-efficiency home appliances and power tools. Minimizing the number of switching devices has been in power converters that is the main method to reduce drive costs. Single-switch-per-phase converters have been cost effective due to the compactness of the converter package resulting in a possible reduction in their cost. However, some of the single-switch-per-phase converters have the drawbacks that include higher losses and low-system efficiency. In order to overcome these shortcomings, the choice narrows down to the split ac converter through the quantitative analysis in terms of device ratings, cost, switching losses, conduction losses, and converter efficiency. Simulations to verify the characteristics of the converter circuit and control feasibility are presented. The motor drive is realized with a novel two-phase flux-reversal-free-stator SRM and a split ac converter. The efficiency with various loads is numerically estimated and experimentally compared from the viewpoint of subsystem and system in details. The acoustic noise with no load and full load is also compared. The focus of this paper is to compare the considered split ac converter to the asymmetric converter through experiments and demonstrate that the split ac converter is the most advantageous with respect to cost, efficiency, and acoustic noise.

2.2 On the Switched-Reluctance Motor Drive with Three-Phase Single-Switch Switch-Mode Rectifier Front-End

This paper presents a switched reluctance motor (SRM) drive powered by a three-phase single-switch (3P1SW) switch-mode rectifier (SMR). The digital controls of both power stages are realized in a common DSP. In the front-end SMR, a robust current harmonic cancellation scheme and a robust voltage control scheme are developed. The undesired line current and output voltage ripples are regarded as disturbances and they are reduced via the proposed robust controls. In voltage control, a feedback controller is augmented with a simple robust error canceller. The robust cancellation weighting factor is automatically tuned according to load level to yield compromised voltage and power quality control performances. The chaotic phenomena can be automatically avoided and better SMR operating performance is obtained simultaneously. With boostable and regulated dc-link voltage, the current and speed dynamic responses of the followed SRM drive are enhanced, and the vibration and speed ripple are also lessened. As to the SRM drive, a random-band hysteresis current-controlled pulse width modulation (CCPWM) scheme (RB-HCCPWM) with harmonic spectrum shaping is developed and applied for its winding excitation control. The winding current harmonic spectrum is more dispersedly distributed to yield reduced stator vibration and speed ripple. Moreover, the commutation advanced shift is applied to yield further performance improvement of SRM drive.

2.3 Minimization of torque ripple in SRM drives.

The torque pulsations in switched reluctance motors (SRMs) are relatively higher compared to sinusoidal machines due to the doubly salient structure of the motor. The magnetization pattern of the individual phases together with the T-i-/spl theta/ characteristics of the motor dictate the amount of torque ripple during operation. Both machine design and electronic control approaches have been used to minimize the torque ripple in SRMs. This paper presents an extensive review of the origin of torque ripple and the approaches adopted over the past decade to minimize the torque ripple. A hybrid torque-ripple-minimizing controller that incorporates the attractive features of some of the techniques developed in the past decade is presented along with simulation and experimental results.

2.4 Optimal turn-off angle control in the face of automatic turn-on angle control for switched-reluctance motors

A new approach to the automatic control of excitation parameters for the switched-reluctance motor (SRM) is presented. The excitation parameters include the turn-on angle, the turn-off angle and the magnitude of the phase current. The objective is to develop an easily implementable control algorithm that automatically maintains the most efficient excitation angles in producing the required current to produce the electromagnetic torque. The control algorithm determining the turn-on and turn-off angles supports the most efficient operation of the motor drive system. The turn-on angle and turn-off angle controllers work

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independently and harmoniously with the speed controller. The turn-on angle controller consists of two pieces: the first piece of the control technique monitors the position of the first peak of the phase current ($thetas_p$) and seeks to align this position with the angle where the inductance begins to increase ($thetas_m$). The second piece of the controller monitors the peak phase current and advances the turn-on angle if the commanded reference current cannot be produced by the controller. The first piece of the controller tends to be active below base speed of the SRM, where phase currents can be built easily by the inverter and $thetas_p$ is relatively independent of $thetas_m$. The second piece of the controller is active above base speed, where the peak of the phase currents tends to naturally occur at $thetas_m$ regardless of the current amplitude. The two pieces of the controller naturally exchange responsibility as a result of a change in command or operating point. The turn-off angle controller works independent of the turn-on angle controller. Through modelling of an experimental SRM and extensive simulation, it is seen that the optimal-efficiency turn-off angles can be characterised as a function of peak phase current and motor speed. Accordingly, the optimal-efficiency turn-off angle is determined from an analytic curve fit. It has been shown that a curve fit using only four optimized points gives very close estimation to the most efficient turn-off angle at any given operating point. The SRM, inverter and control system are modelled in Simulink to demonstrate the operation of the system. The modelling is based on the finite element data that include spatial nonlinearities and magnetic saturation. The control technique is then applied to an experimental SRM system.

3. PRINCIPLE OF PFC TECHNIQUE

The switching control for PFC based converters, can be categorized as a variable frequency control and a constant frequency control. The variable frequency control is generally based on output voltage ripple with constant-on-time (COT) or constant-off-time. Moreover, the converter operates with fixed duty cycle, however, at variable frequency, the converter switch turns on if the condition, Vref>Vdc is true, whereas Vdc is the DC link voltage and Vref is the set reference voltage. The pulse bursting phenomenon is the demerit associated with the COT (Constant on Time) control, i.e., the occurrence of very short off time pulse after COT pulse. Whereas, the constant frequency control is the pulse width modulation (PWM) based control, which are categorized as a voltage based control and a current based control. Figs. 1(a) and (b) represent the conventional Cuk converter in DCM of operation. However, Fig. 1(b) presents the output inductor current behaviour, during switch on period DxT, as the inductor current increases and then it decreases to zero till switch off period DyT, while the remaining period, {1-(Dx +Dy)}T of switching period, is the freewheeling period when the output inductor current freewheels through the circuit diode. To obtain inherent PFC, the duty cycle, Dx is varied from zero to its maximum value for every half cycle of the supply voltage.

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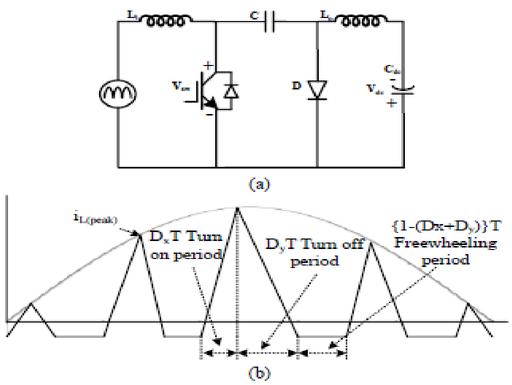

Fig. 1(a) Conventional Cuk converter and (b) Output inductor current during DCM of operation.

4. MODIFIED DUAL OUTPUT CUK CONVERTER FED SRM DRIVE

The proposed PFC converter fed SRM drive is shown in Fig. 2. The need for a dual output, arises as a special split capacitor converter configuration is used, such that each phase is connected through a single switch and one diode to drive a SRM. The converter circuit comprises of two Cuk converters with one common switch and featured with two output voltages equal in magnitude. This converter topology is derived from PFC based three phase rectifier topology first proposed. The proposed converter consists of single input inductor operating in CCM to reduce input current ripple. The other circuit components include intermediate capacitors, output side inductors and output capacitors. This configuration has added advantage of self-balanced output voltages without any required complex control for voltage balancing. The balanced output voltages have reduced the sensor cost, as while sensing output voltage across one output capacitor gives total DC link voltage. The sensed DC link voltage is compared with reference DC voltage to generate switching pulses for the converter.

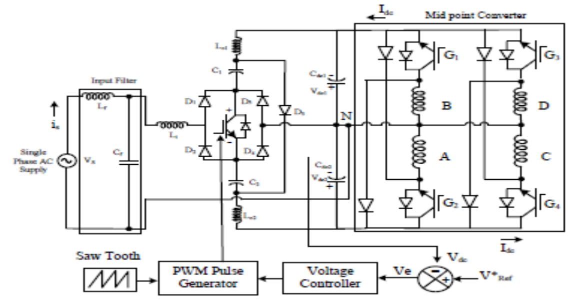

FIG. 2. Proposed modified Cuk converter fed SRM drive

5. OPERATION OF MODIFIED CUK CONVERTER

The converter operation is divided into two half cycles i.e. negative half and positive half of the input voltage waveforms. Two intermediate capacitors, C1 and C2 and output inductors Lo1 and Lo2 are introduced in the circuit. The input side inductor Li operates in continuous current mode (CCM) and output inductors Lo1 and Lo2 are allowed to enter discontinuous conduction mode (DCM) during each cycle of operation, which is shown in Fig. 3.

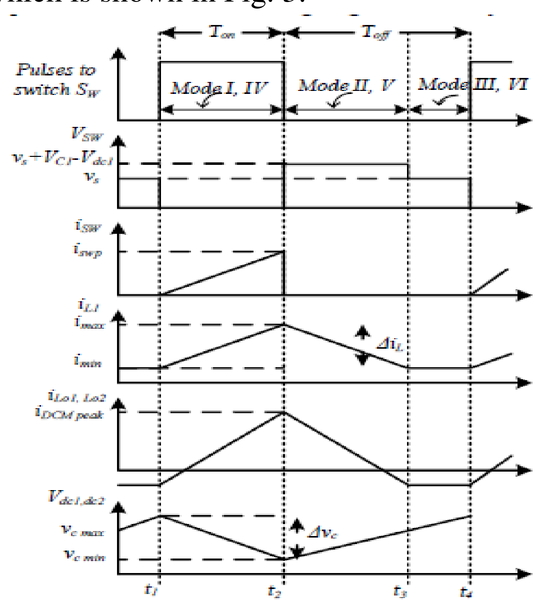

Fig. 3. Theoretical waveforms during different operating modes.

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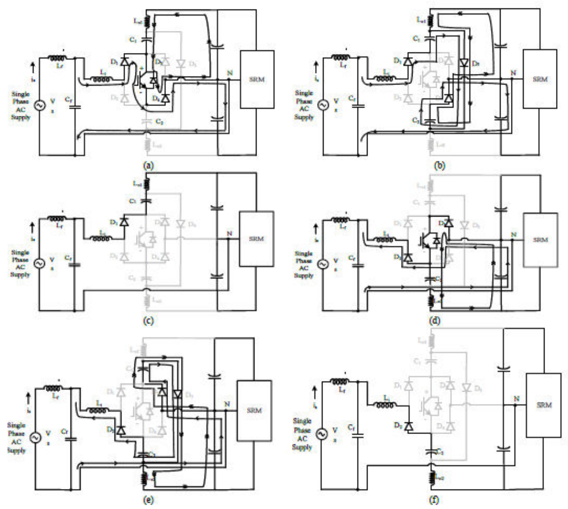

Fig. 4. Converter operating modes during positive half : (a) Mode I (t2-t1), (b) Mode II (t3-t2), (c) Mode III (t4-t3) and during negative half (d) Mode I (t2-t1), (e) Mode II (t3-t2), (f) Mode III (t4-t3).

6. CONTROL ALGORITHM

The control of proposed drive consists of control of PFC converter and SRM. The control is designed to operate the converter at high switching frequency to obtain inherent PFC and output voltage control. The switching frequency, fs is selected as 20 kHz to reduce the overall size of the system. To obtain PFC, two approaches are conventionally used i.e. voltage follower approach and current follower approach. Considering the cost and size constraints, the voltage follower approach is adopted here. As the sensor requirement is reduced in this approach, the size of inductor is also reduced while selecting this approach as the current through the inductor, is allowed to enter discontinuous conduction mode.

7. SIMULATION RESULTS

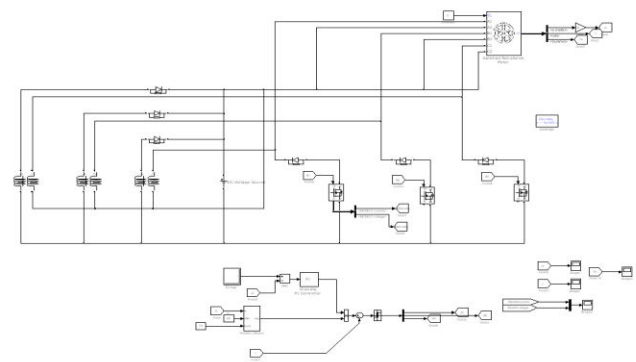

Fig5. Simulink diagram of proposed converter

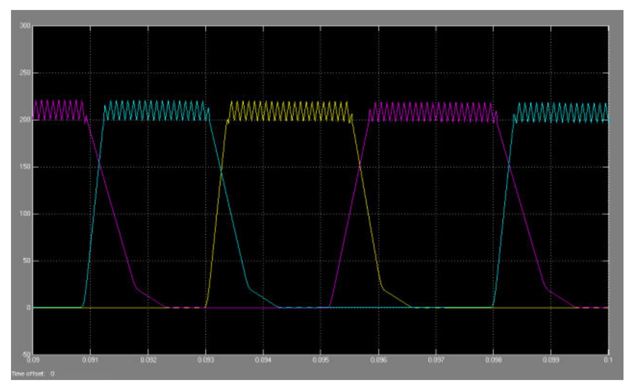

Fig6. Simulation results of Phase current of SRM drive at1500 rpm.

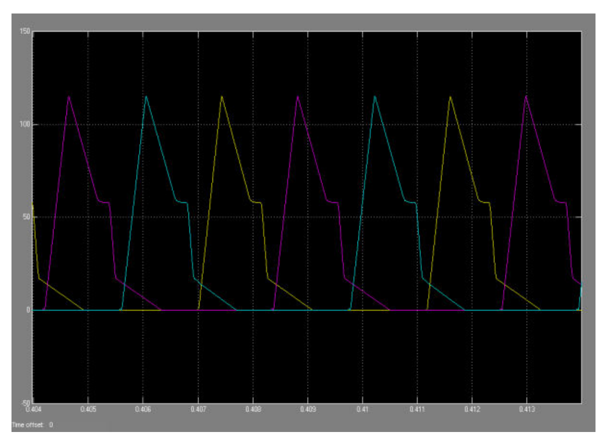

Fig7. Simulation results PF Phase current waveforms of SRM drive at 4000 rpm.

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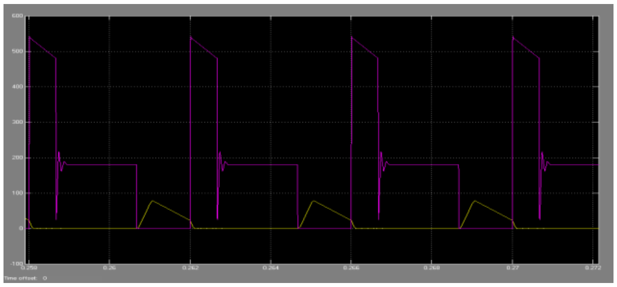

Fig8. Simulation results of Voltage and current of one switch

CONCLUSIONS

Test outcomes have approved execution of proposed SRM drive. This Cuk converter with two indistinguishable yield voltages, has been outlined with intermittent yield inductor current. The chose inductor, has diminished the size and cost of the attractive parts. The converter yield voltage is very much managed by single voltage sensor with inborn wave-molding of info current. The extensive variety of speed control has additionally been gotten while utilizing just a single voltage sensor at converter yield. Drive execution under unfaltering and elements state, is discovered tasteful. The info current THD of decreased esteem. Going for practical option in contrast to traditional electric drives, a SRM drive is ended up being a decent determination for home machines.

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