Design And Implementation Of Modified Asymmetric Bridge Converter For Switched Reluctance Motor

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Abstract:- **This project deals with power factor correction circuit with PID controller for switched reluctance motor. because of its simple and robust construction, it is widely used for domestic and industrial applications. These motor are extensively used in aerospace, automative, washers, dryers ,centrifugal pumps and other home appliances. The motor has winding in the stator which is excited from a separate source. The control of these motor drives was obtained using converter circuit that control the excitation of the phase by switching converter switches. The conventional circuit suffers from low power factor and phase current commutation which in-turn affects the performance of the motor drive. A suitable converter circuit was designed that could give an improved power factor and performs phase current commutation faster than asymmetric bridge converter. The simulation of modified asymmetric bridge converter was carried out using MATLAB/SIMULINK the performance of various parameters of switched reluctance motor drive. Power factor correction circuit with PID controller is used to track the line current. The performance of boost converter power factor correction is compared with diode bridge rectifier and it found that the boost converter prove to be a best converter for power factor correction.**

Keywords:

Switched Reluctance motor ,Boost converter, Modified Asymmetric bridge, Current commutation, Power factor correction.

I.INTRODUCTION:

The Switched Reluctance Motor (SRM) is a type of stepper motor, an electric motor that runs by reluctance torque. The motor rotates as a result of the variable reluctance in the air gap between the rotor and the stator. When a stator winding is energized,producing a magnetic field, reluctance torque is produced by the tendency of the rotor to move to its minimum reluctance position.

The Switched Reluctance Motor has inherent mechanical strength due to the absence of rotor winding and permanent magnet. But it suffers from low power factor correction . To improve the power factor correction and to perform the phase current commutation faster, several topologies are analyzed such as buck, boost and buck boost, dc-dc converter .

The proposed converter performs the phase current commutation faster. This paper presents new controller design for Switched Reluctance Motor. The PID controller is used to track the required line current. Using MATLAB software the simulation of the SRM along with the Asymmetric Bridge converter and proposed converter are are performed. The converter simulation results are analyzed and compared, which shows that the new converter performs the phase current commutation faster than the Asymmetric Bridge converter. The selection of control strategy depends on the converter of the drive including power, speed, performance , rating and the possible system costs. A number of attempts were therefore made in recent times to develop a power electronic converter structures for SRM drives, based on the utilization. Due to slow phase current commutation most converts doesnot improve the input power factor. This results in high distortion current harmonic of the utility supply, which should be avoided. So a new proposed converter is designed for faster current commutation.

Power factor:

Power factor is defined as the cosine of the angle between voltage and current in an ac circuit. There is a phase difference Ø between voltage and current in an ac circuit cos Ø is called the power factor of the circuit. If the circuit was inductive, the current lags behind the voltage and power factor is referred to as lagging. For a capacitive circuit, current leads the voltage and the power factor is said to be leading.

Power Factor gives a measure of how effective the real power utilized by the system. It is a measure of distorted line voltage and the line current and the phase shift between them. Lagging and leading of power factor depend on line current. Apparent power is defined as the product of rms value of voltage and current.

Linear Systems:

In a linear system, the load draws pure sinusoidal current and voltage, hence the power factor is unity. But in non-linear system, capacitors are used to improve power factor. Hence the power factor is determined by ratio of real power flowing to load to the apparent power in the circuit.

i.e. PF = cosθ

II. OPERATION OF PROPOSED CONVERTER:

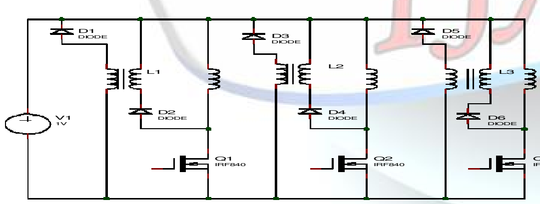


Fig.1 Proposed SRM drive Converter

The proposed system consist of three switches, six diodes and three linear transformer. The proposed converter performs the phase current commutation faster. The simulation of the SRM along with the conventional converter and proposed converter is performed by the MATLAB software. The simulation results are analyzed and compared, which shows that the new converter provide the phase current commutation faster than the Asymmetric Bridge converter due to the reduction of switches .

Modes of operation:

The modes of operation of proposed converter are

1.Magnetization mode
2.De-magnetization mode.
3.Overlap of two phases-mode1
4.Overlap of two phases-mode2

Magnetization mode:

In magnetization mode, the switch T1 turns on to magnetize phase A. The energy is transferred to the phase winding from the source and the current in the phase inductance increases when the switch T1 turns on. The magnetizing inductance of the coupled inductors is not reset yet, then the diode D1 conducts to magnetize the inductance current of the coupled inductors and the input voltage resets the inductor .After that, the magnetizing inductance of the coupled inductors of phase A winding is reset by turning on the diode D1.

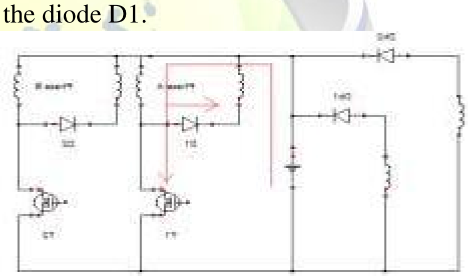


Fig.2(a) Proposed converter, Magnetization mode

De-magnetization mode:

The de-magnetization mode starts when the phase current reaches the reference and T1 is turns off. The voltage across the phase winding is reversed due to the turning on of diode D1. When the diodes D1 and D2 turns on, the negative voltage is appeared across the phase winding in proportion to coupling ratio which accelerates phase current commutation.

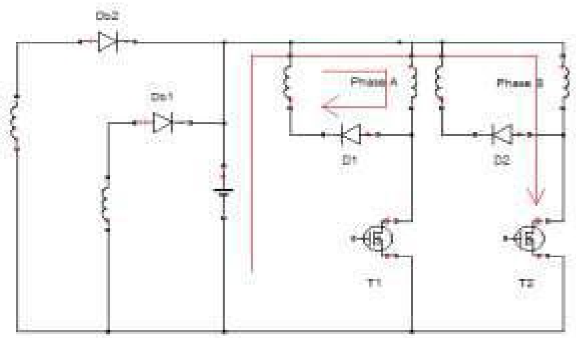
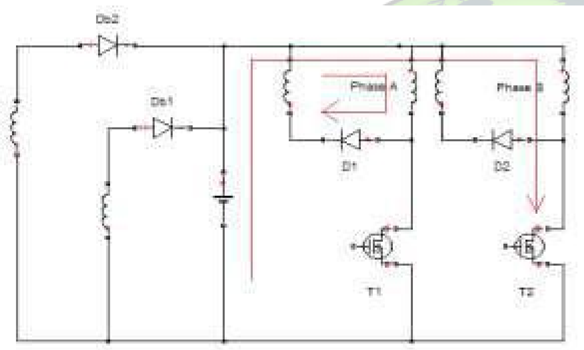


Fig.3(c&d) Overlap of two phases - mode 1 and mode2



III. POWER FACTOR CORRECTION:

The converter used for the switched reluctance drives is for switching the phase currents, this leads to the distorted current waveform. This would result in non -unity power factor, for achieving the unity power factor the power factor correction technique is used in switched reluctance motor.

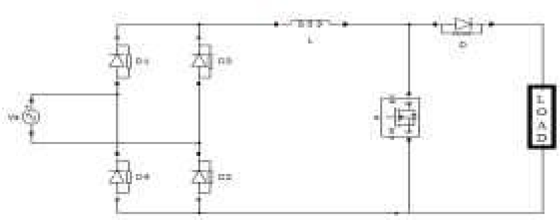


Fig.4 Power factor correction technique using boost converter

power factor correction with boost converter is the advanced power factor correction technique. It consist of the power factor correction, capacitor and ac-dc converter. A PID controller is used for tracking required line current.

The components used in this is the combination of the diode bridge rectifier and a ac-dc converter with filter and energy storage elements can be modified to the other topologies such as buck, buck- boost and cuk converter. From the above topologies boost converter is very simple and it allows low distorted input current with unity power factor.

IV SIMULATION AND RESULTS:

Proposed power correction circuit:

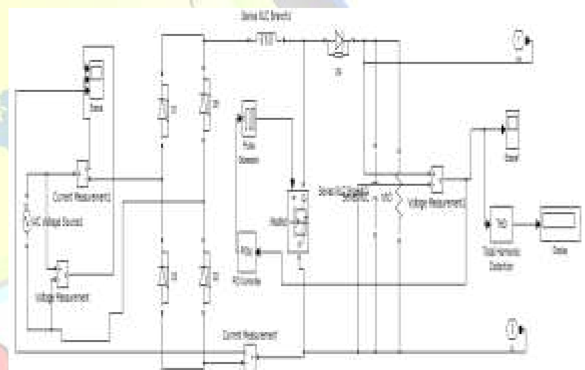
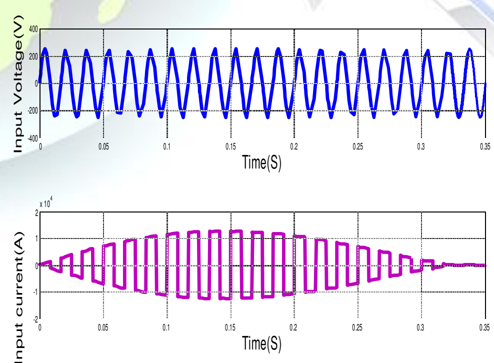


Fig.5 Power factor currection circuit

Input voltage and current waveform of proposed power factor correction circuit:



Output waveform of proposed PFC circuit:

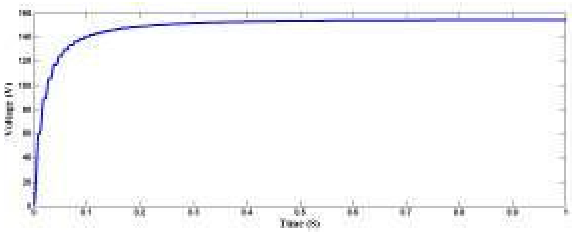


Fig.7 Output Voltage of Proposed Converter Fed SRM Drive with Power Factor Correction

Simulation diagram of proposed circuit:

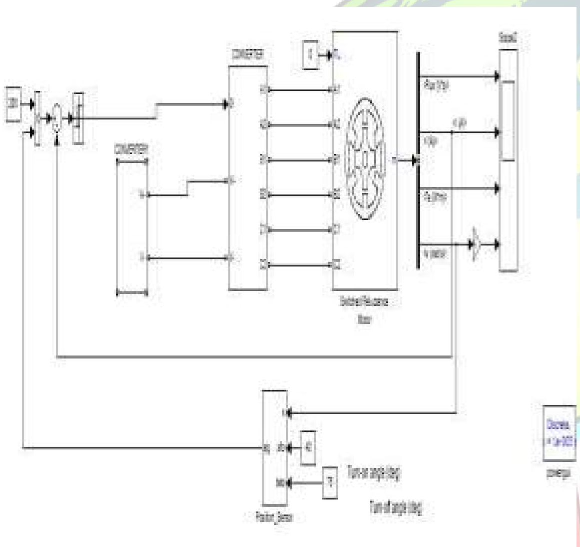


Fig.8 Proposed SRM Drive with Power Factor Correction using MATLAB

Output waveform of proposed system:

The simulation was carried out in MATLAB.The flux,current,torque,speed are measured and compared with conventional circuit.The calculated distributed power factor for proposed system is 0.84 which is greater than the conventional system.

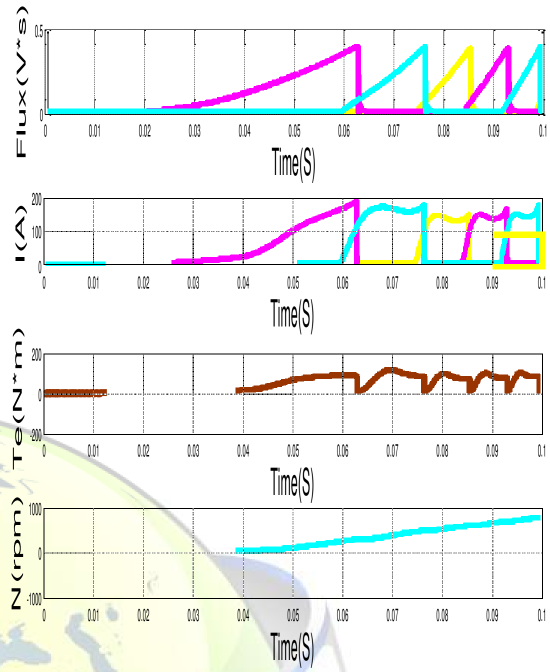


Fig.9 Phase Currents, Electromagnetic Torque, Speed waveforms of Proposed SRM Drive with Power Factor Correction

Boost converter is inserted between the bridge rectifier and the main input capacitors. The boost converter attempts to maintain a constant dc bus voltage on its output while drawing a current that is always in-phase with and from the DC bus.

Calculation:

Load torque=0.
Average torque=58.
Torque ripple=2.
Total harmonic distortion=0.6952.
Power factor=0.82

Power factor=——————

Torque Ripple= ——————————————

THD=Total Harmonic Distortion.

V. CONCLUSION:

The main objective of the project has been to improve the input Power Factor with simultaneous reduction of input current harmonics. Simulations were done for rectifier circuits with employing PFCcircuit. These simulations included circuits with and without inductors and capacitors. The changes in the input current waveform were observed and studied. To achieve a high efficiency, the phase inductance energy is recovered in the proposed system. Calculation of Power Factor was done with the inbuilt MATLAB block for the same. From this analysis the proposed converter suits better for switched reluctance motor by reducing number of switches and power factor correction.

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