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Implementation of Power Factor for CUK DC-DC Converter

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Abstract: *Before, using variable speed motors meant using conventional ones despite their weak qualities. These limitations were handled by the use of brushless DC motor drives. At present, brushless DC motors are popular in a range of areas such as industrial, home, aerospace, defiance, medical and traction, thanks to their good efficiency, great torque-to-size ratio, compact size, reliable performance, easy-to-control system and little maintenance. Since these motors use an electronic commutator that runs on a three-phase voltage inverter, low-quality power, noticeable torque ripple and changes in speed are all issues. In this research, we focus on the closed-loop operation of a CUK converter two-leg inverter-fed BLDCM drive. A MATLAB/Simulink model was prepared and used to test the control approach for the two leg inverter, CUK converter-fed BLDCM drive with split DC supply. The approach including power factor adjustment ensures the drive system is more efficient all along the speed control range and also leads to reduced torque ripple and improved speed control.*

Keywords: *Torque ripple, Power quality, CUK converter, PFC, Brushless DC motor, EVs.*

I. Introduction

The most widely used electric drives are conventional motors, such as DC and induction motors. Recent advancements in control and power electronics technology have expanded their use in electrical drive systems. The primary benefits of an induction motor are its straightforward design, low maintenance requirements, lack of slide rings, and reasonable dependability. The disadvantages include reduced efficiency and power factor, as well as minor air gap breaking of rotor bars as a result of hot spots. Permanent magnet motors have become a popular choice because of the following advantages of using them in electric machine building: high torque to weight ratio, no excitation losses, improved dynamic performance, ease of construction, and minimal maintenance.

The operation of the motor over a wide various speed range and keeping acceptable efficiency is made feasible by advancements in control and power electronics technology as well as the decline in the cost of power electronics equipment. Energy consumption can be reduced by 4% with a 7% increase in motor efficiency [1]. Only the two-phase windings in a PMBLDC motor carry current, and this current is square or trapezoidal in shape, creating a rotating magnetic field. As a result, there is less loss. Another benefit of brushless motors is that power loss only happens in the stator, which results in optimum heat transfer conditions.

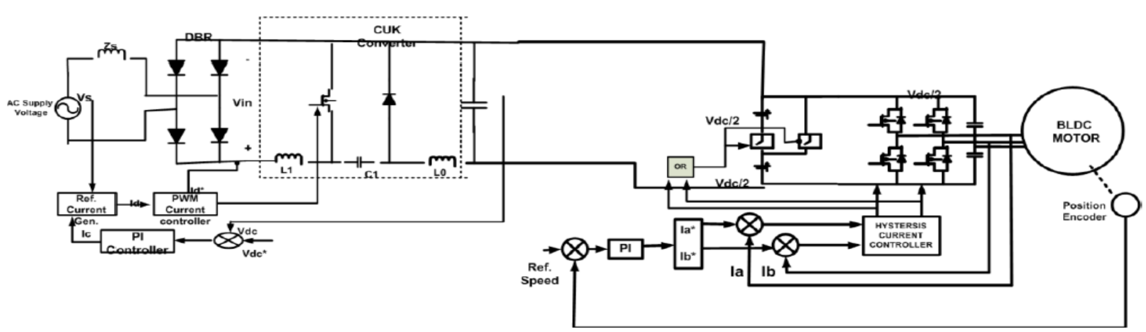

Fig 1: Proposed CUK PFC two leg inverters fed BLDCM with split DC supply

Reasons behind the frequent use of permanent-magnet brushless dc motors in high-performance systems is that they're simple to operate. In these cases, any ripple in the torque must be avoided. The research investigates how using a cuk converter allows a two-leg, inverter-fed BLDC machine to receive power from a split DC source. These results include higher efficiency, less noise, fewer harmonics on the AC side, nearly equal power factor, almost no torque ripple and improved speed control.

II. Two Leg Inverter BLDCM Operation

The below block diagram shows a schematic of the motivated proposed CUK two inverter supplied BLDC without split DC supply for speed control. It runs on two systems: a power factor correction system using a current control loop and a speed loop for the converter in continuous-conduction mode. It uses a concept of current multiplier. The VDC_error signal results from the actual measurement less the first reference DC link voltage. A PI controller receives the signal and generates the action control signal (Ic).

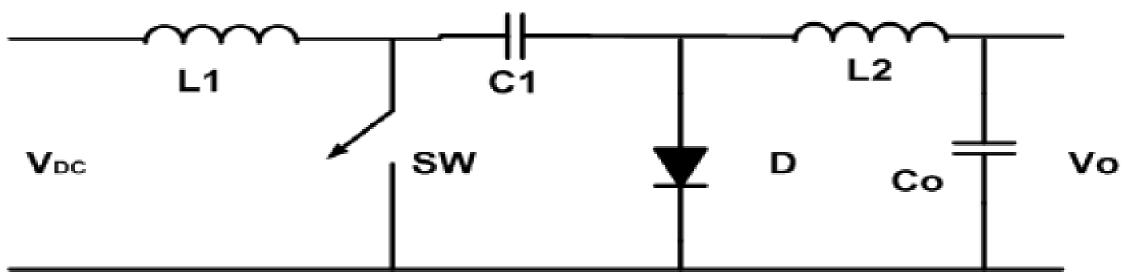

Fig 2: Schematic of CUK converter

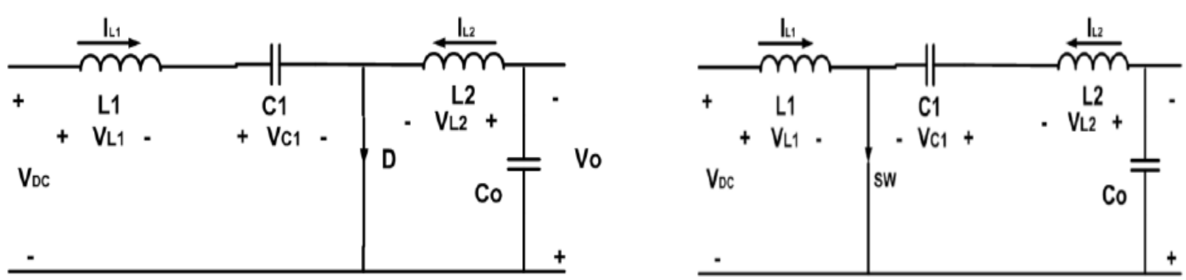

Fig 3: CUK Converter

III. PFC Converter Based on BLDCM

Components of the proposed converter system—the PFC cuk inverter with two-leg BLDC and two input DC—are mathematically described and all the equations are summed to form the total drive system model. The group of PFC converters includes the ripple filter, DBR and cuk converter. A cuk fed BLDCM drive structure is completely represented by a current generator, PWM controller, speed controller, another reference current generator, a PWM current controller and a BLDC motor and voltage controller.

IV. Analysis of CUK Modelling

A Simulink model built using MATLAB was used to analyze how the two leg inverter BLDCM drive performs with a split DC supply. Fig 5 below shows the Simulink block design for a PFC cuk two-leg inverter-fed PMBLDC drive with a split DC supply. In this investigation, we examine the operation of the inverter-fed BLDC drive equipped with two leg PFC cuk by looking at speed, current in the stator, electromagnetic torque, DC link voltage, inductance current and bulk capacitor voltage. The study proves that the BLDCM motor fed by CUK gives the expected results.

A drive's performance with power quality is shaped by its supply voltage, current, power factor and total harmonic distortion. How the drive performs is indicated by data for 210V AC voltage and a 60 Hz supply, both at 100 rpm and a 4 Nm rated torque.

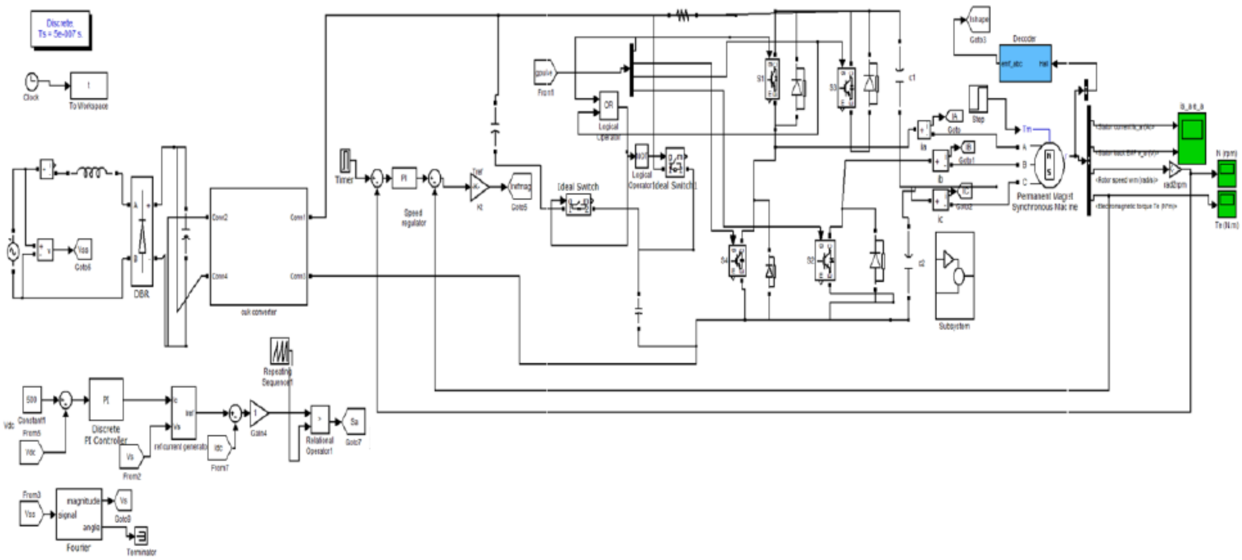

Fig 4: The Simulink model of PFC cuk

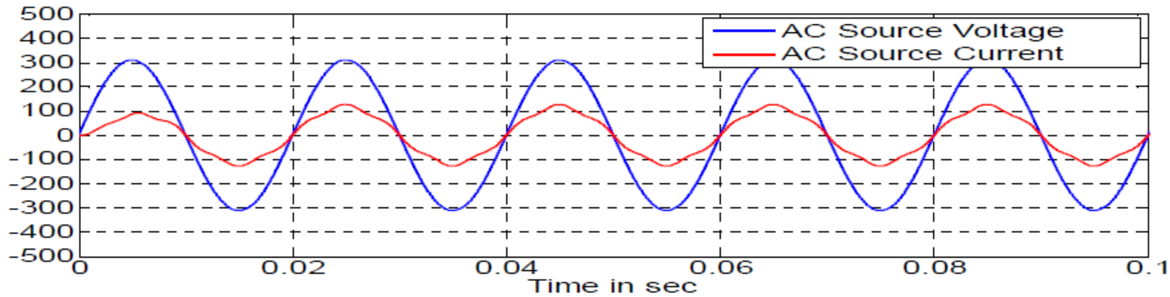

Fig 5: Simulation model for AC source voltage

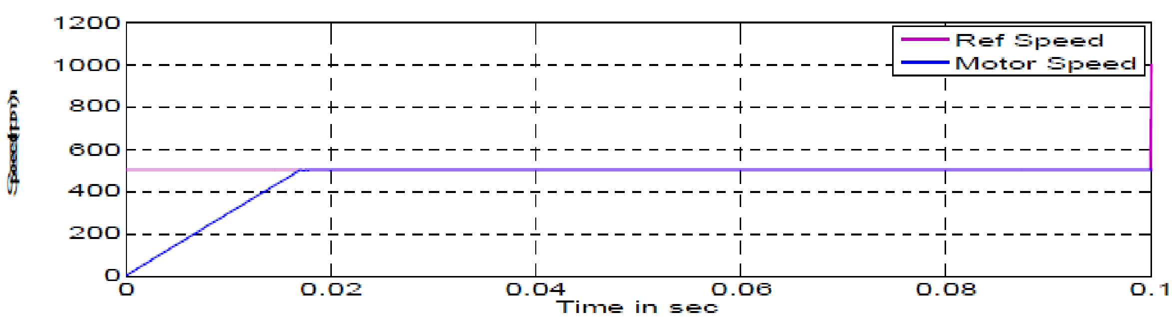

Fig 6: Starting speed response

V. Conclusion

Because BLDCM perform very efficiently, are not too heavy for their strong torque, are simple to control and do not break easily, people tend to opt for them instead of traditional motors. This work investigates and establishes a two-leg inverter PMBLDCM drive connected to a split DC supply, containing a PFC cuk. When the dc link voltage is kept steady, the motion of the motor becomes smoother. It works well with a stable voltage and does not vary much in torque or control of speed. Usually, the proportion separating the figures is no more than 7 percent. However, it continues to follow all global sports standards.

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