A Unity Power Factor Bridgeless Isolated Cuk Converter-Fed Brushless DC Motor Drive

Abstract

Introduction:
A BLDC motor consists of three-phase concentrated windings on the stator and permanent magnets on the rotor. A three-phase voltage-source inverter (VSI) is used for achieving an electronic commutation of the BLDC motor based on the rotor position as sensed by Hall-effect position sensors. A VSI-fed BLDC motor drive is generally supplied by a combination of a diode bridge rectifier (DBR) with a high value of smoothening dc link capacitor. This combination of DBR and dc link capacitor draws current only for a small duration when the instantaneous value of supply voltage is higher than the dc link voltage. Therefore, a peaky current is drawn from the ac mains, which has very high value of harmonic contents. The total harmonic distortion (THD) of such current is of the order of 60%–80% which leads to a very poor power factor (PF) of the order of 0.6–0.7 at ac mains.
Existing system:
The boost converter charges a bulk energy storage capacitor to a voltage higher than the peak line voltage. Finally a voltage-fed, step-down inverter is used to drive the brushless DC motor. These capacitors are typically electrolytic and are physically large, expensive and failure prone, limiting the lifetime of the drive. Under certain conditions efficiency may be improved by the elimination of the boost stage.

Proposed system:
A single-phase supply followed by an LC filter is used to feed a bridgeless isolated Cuk converter. This maintains the required dc link voltage of the VSI and provides PFC at ac mains. The proposed PFC converter is designed to operate in DICM to act as an inherent power factor corrector. The dc link voltage of the VSI is controlled for adjusting the speed of the BLDC motor. The VSI feeding the BLDC motor is operated in a low frequency switching to achieve an electronic commutation of the BLDC motor for reduced switching losses. The proposed configuration uses a single voltage sensor to control the dc link voltage for the speed control of the BLDC motor.
Advantages:

- Reduced the switching losses.
- Reducing the conduction losses in the front-end converter.

Applications:

- Household appliances.
- Industrial tools.
- Medical equipment.
- Precise motion control.
- Automation and transportation.

Tools and software used:

- MPLAB – microcontroller programming.
- ORCAD – circuit layout.
- MATLAB/Simulink – Simulation.