

Bridgeless Isolated CUK Converter Using BLDC Motor

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Abstract

The CUK topology is used to propose three novel rectifiers with single phase AC-DC Power Factor Correction (PFC) without a bridge. When compared to a standard CUK Power Factor Correction rectifier, the lack of enhanced heat control and reduced conduction losses are achieved by using the current flows; there are only two semiconductor switches and one input diode bridge channel throughout each period of the switching cycles. The proposed topologies are made to operate in the mode of discontinuous conduction, resulting in a deciding element of almost unity as well as low input current Harmonic Distortion in total. Additional benefits in Discontinuous Conduction Mode operating includes zero current is switched on in the power switches, and in the output diode, zero current is turned off, as well as simplified control circuitry. The power switch can be turned on or off.

Keywords: Power Factor Correction, Discontinuous Conduction Mode, Piezoelectric Transformer, Continuous-Conduction-Mode, Current Source, Charge-Pump

1. Introduction

The diode bridge has substantial losses, therefore the Power Factor Correction system has a reduced efficiency. To comply with harmonic rules, many types of electronic equipment now require power sources using active Power Factor Correction methods. Harmonic content is a serious issue with traditional rectifiers. The primary ac current required by modern supply voltage waveform of Non-sinusoidal and phase-shifted power supply, resulting in a low Factor of Strength, making its usage in communications networks a significant source of risk for electricity distribution. As a result, in order to decrease voltage and current distortion and losses in Switched Mode Power Supplies, Power Factor Correction

is a must. A device that converts one voltage to another is known as a buck DC-DC converter.

Its architecture is similar to that of step-up boost converter is a type of Switched Mode Power Supply that, among other things, like the boost converter, An inductor, a capacitor, and two switches (a transistor and a diode) are used. As a result, Power Factor Correction is critical. This sort of the output voltage magnitude of a DC-DC converter is one of the more or less than the magnitude of the input voltage is offered. A non-isolated CUK converter's input and output polarity can only be opposite. Its major energy-storage component is a capacitor rather than an inductor, as in most other types of converters. Due to the reduced number of switches, the bridgeless rectifier decreases switching and conduction losses.

Zhengyu Lu and Bin Su et al. (2010) [1] The use of a totem pole can help bridgeless areas PFC with interleaving totem poles was examined. The recommended converter is made up a pair totem-pole boost bridgeless converter cells that are interleaved and inter-coupled. Under 90 and 264V line input, the conversion efficiency is 95.5 percent and 97.8 percent, respectively, at full load.

Dwari.s, et al. (2013) [2] Traditional Power converters with two stages using Bridge rectifiers are a type of rectifier that uses a bridge wasteful and may or may not be practicable for low-voltage applications such as micro generators, according to the researchers. This research proposes a high-efficiency power converter that converts ac to dc eliminates correction of bridges transforms the insufficient AC input voltage straight in the needed dc output voltage is high. Control techniques for operating the converter are provided based on the study. Design instructions for choosing and controlling the converter component settings are offered. For autonomous functioning of the converter, a self-starting circuit, one that starts on its own is used.

2. Proposed System

The traditional two-stage power converters were proposed. Efficiency, component gain, count harmonics capabilities, as well as the driver circuit are all factors in the proposed converters. Two dc–dc CUK converters are used, one for each half-line period ($T/2$) of the input voltage connected to produce the suggested topologies. It's worth noting that the topology was entered as a novel topology for converters, but was never assessed.

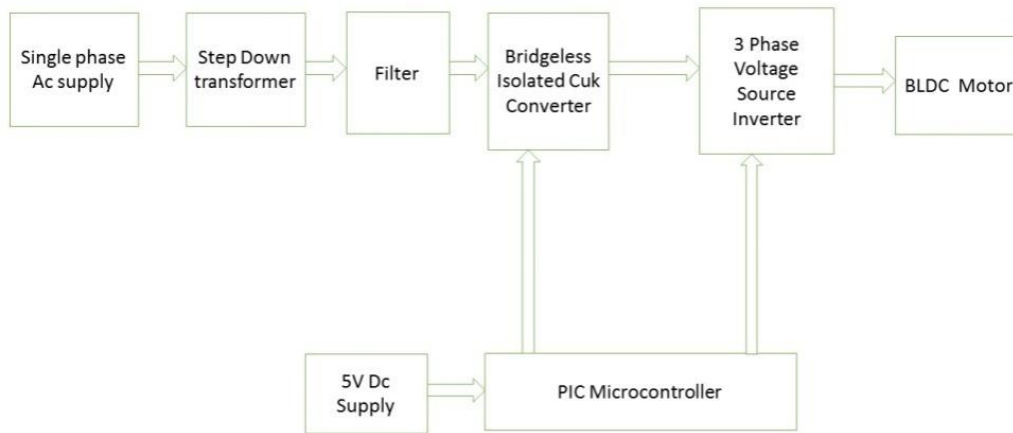


Figure 1. Block Diagram of CUK PFC rectifier

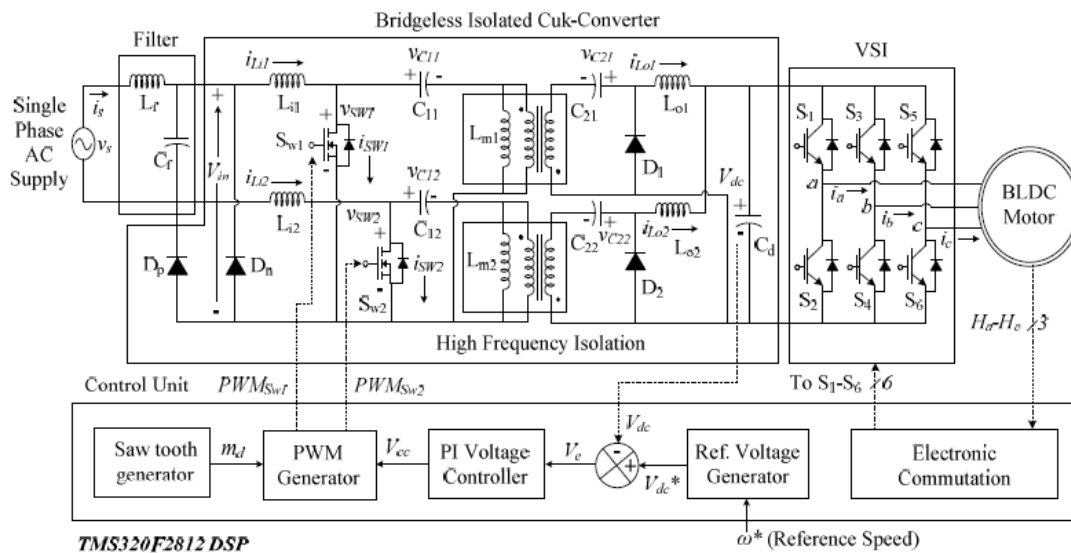


Figure 2. A CUK converter without a bridge supplying the BLDC motor drive

During the functioning of a CUK converter with no bridge, there are several modes of operation, the positive[a-c] and negative [d-f]. The supply voltage half-cycles are proposed.

3. Working

Figure 4 depicts the hardware implementation, which includes a step down transformer and rectifier module for the project's power supply. The DC input comes from the rectifier, which is routed to the isolated CUK converter, which acts as a regulator as well as a voltage level changer for the common Capacitor for DC link. The voltage of the DC connection is delivered in a VSI, which controls a 12 V/2 A BLDC motor. The BLDC motor has a power rating of 24 W.

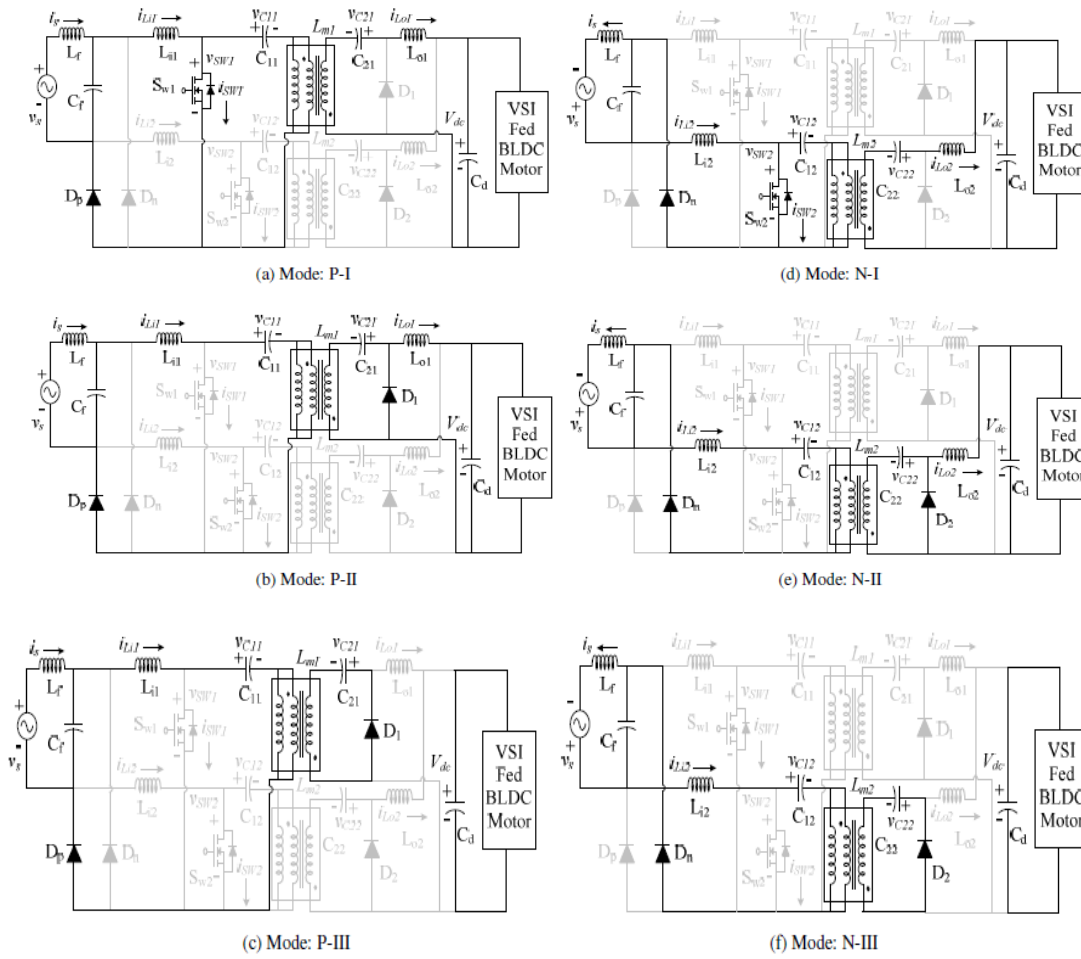


Figure.3. Functioning of a CUK converter

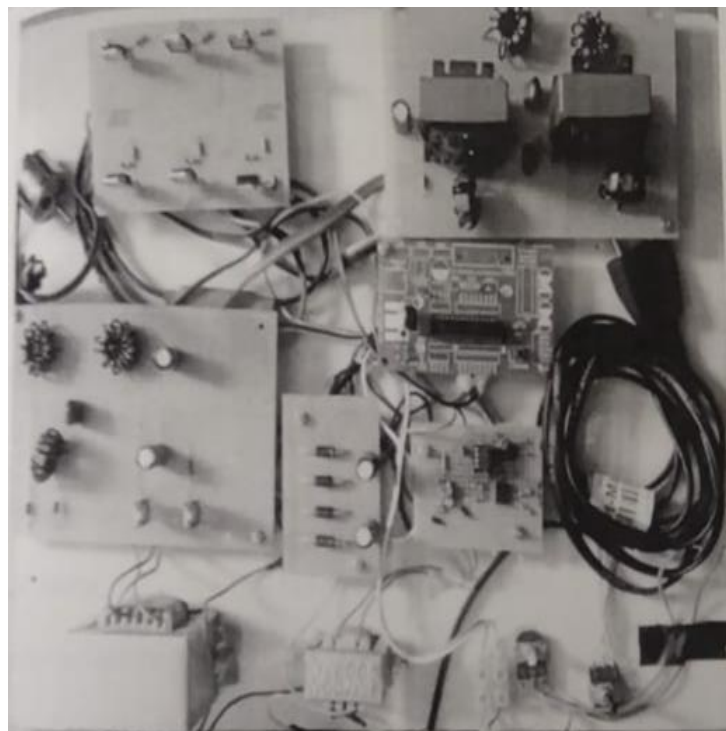


Figure 4. Hardware implementation of the proposed project

Hall sensors sense the rotor position and send the feedback to micro-controller. The gate pulses for VSI are generated by controller based on hall sensor signals to synchronize the rotation of BLDC motor according to the required speed and position.

4. Result

Figure 5 depicts the waveform of the output for Capacitor for DC link voltage

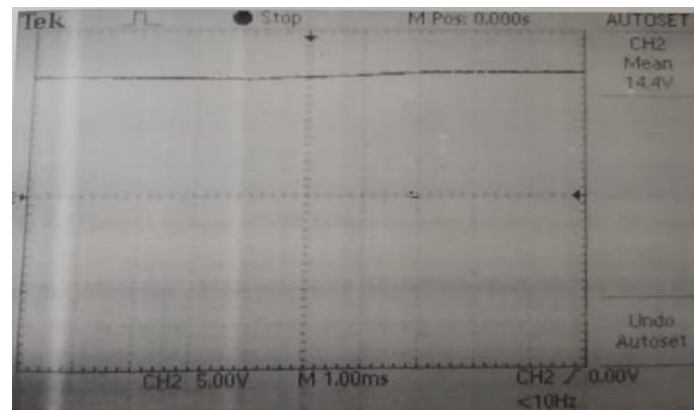


Figure 5. Waveform of the output of Capacitor for DC link voltage

Figure 6 indicates the power supply's output voltage VSI feeding the bridge inverter BLDC motor. Controlling the voltage of the DC link allows the VSI to be switched at fundamental frequency, allowing for electronic BLDC commutation.

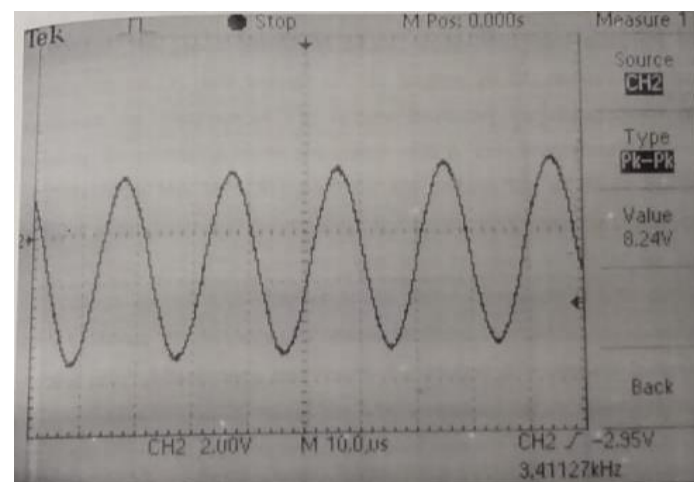


Figure 6. The output voltage of a VSI bridge inverter powers the BLDC motor

Thus A prototype of the proposed project was built for 24 W BLDC motor and its output waveforms are shown to verify the reliability of the project and also to study the

characteristics for building drivers for large sized BLDC motor that has industrial applications.

5. Conclusion

The VSI's DC link voltage supplying BLDC (brushless DC) motor manages to regulate the BLDC motor's rotational speed. This has made it easier for VSI to operate in the mode of low frequency switching, which reduces losses due to switching. This isolated-CUK converter has no bridge created to eliminate the front-end, a diode bridge rectifier and reduce the conversion front-end conduction losses. For DC link voltage control, this PFC converter is run in DICM mode, and the AC mains have intrinsic power factor correction. A DSP is used to implement a prototype of the intended drive. This project presents and discusses based on the CUK architecture, three single-phase AC–DC bridgeless rectifiers. The simulation outcomes are used to validate the authenticity and the results of the suggested topologies. When compared to typical the CUK PFC rectifier, suggested topologies can boost conversion efficiency even further as a result of reduced conduction and switching losses. To put it another way, the suggested circuits may function at a greater switching frequency while maintaining the same efficiency. As a result, the inductor size of the PFC and the EMI filter might be different to be reduced even more. The topologies that are suggested for bridgeless networks have the potential for efficiency gains of PFC CUK rectifier.

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