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HIGH GAIN BRIDGELESS CUK CONVERTER WITH POWER FACTOR CORRECTION

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Abstract

A single phase CUK AC-DC power factor correction (PFC) rectifier with high gain output voltage is proposed in the paper. For low output voltage product applications, the rectifier is designed to convert high output voltage to low output voltage. Due to no bridge diodes required and thus decreased input conduction losses, the proposed rectifier efficiency can be improved .The proposed rectifier operates in discontinuous conduction mode and the current loop circuit is hence not needed. Also only single switch is used in the rectifier to simplify the control circuit design.

Keyword: Bridgeless rectifier, CUK converter, low conduction loss, powerfactor correction, Fuzzy logic Controller.

1. INTRODUCTION:

For power supplies with active power factor correction (PFC) techniques are vary essential for many type of electronic equipment to meet harmonic regulations. Most of the PFC rectifiers utilize a boost converter at front end. A conventional PFC technique has lower efficiency because of significant losses in the diode bridge. A conventional PFC CUK rectifier is shown in fig 1. The current flows through two rectifier bridge diodes and the power switch (Q) during the switch ON-time, and through two rectifier bridge diodes and the output diodes (D0) during the switch off time. During each switching cycle, the current flows through three semiconductor devices. As a result, a significant conduction loss, caused by the forward voltage drop across the bridge diode.In a bridgeless PFC circuits, where the number of semiconductors generating losses will be reduced by eliminating the full bridge input diode rectifier.A bridgeless PFC rectifier allows the current to flow through a minimum number of switching devices compared to the conventional CUK rectifier.It also reduces the converter conduction losses and which improves the efficiency and reducing the cost. A bridgeless power factor correction rectifier is introduced to improve the rectifier power density and/or to reduce noise emission via soft-switching techniques or coupled magnetic topologies.The CUK converter has several advantages in power factor correction applications, such as easy implementation of transformer isolation, natural protection against inrush current occurring at start-up or overload current, lower input current ripple, and less electromagnetic interference(EMI) associated with discontinuous conduction mode topology. Thus for applications, which require a low current ripple at the input and output ports of the converter, CUK converter is efficient.

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2. CUK CONVERTER:

The CUK converter is a type of DC/DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It is essentially a boost converter followed by a buck converter with a capacitor to couple the energy.Similar to the buck–boost converter with inverting topology, the output voltage of non-isolated CUK is typically also inverting, and can be lower or higher than the input. It uses a capacitor as its main energy-storage component, unlike most other types of converters which use an inductor.

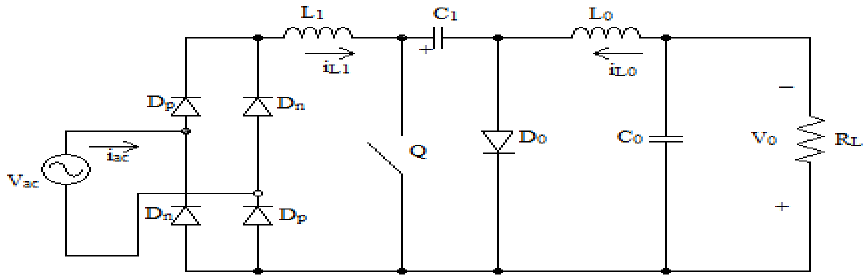
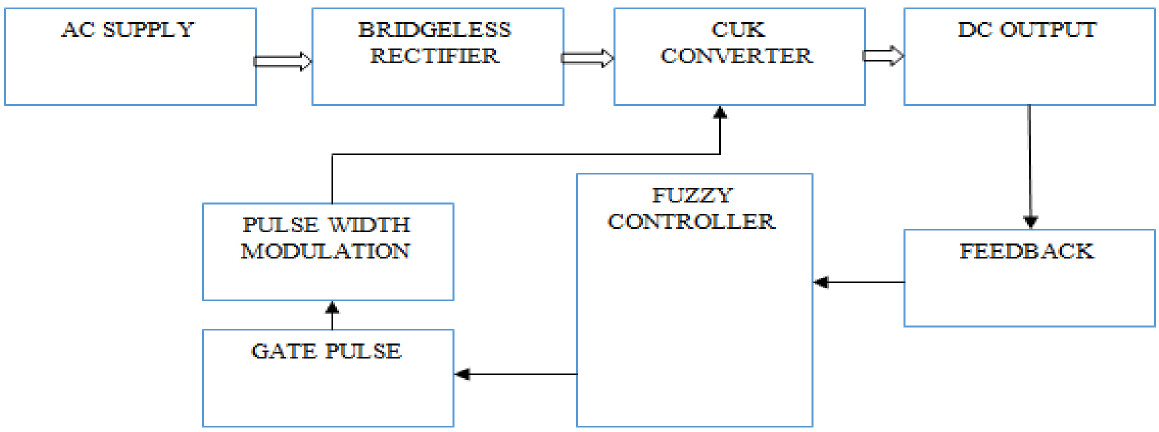


Fig.1 CUK Converter

3. PROPOSED SYSTEM:



Bridgeless CUK AC/DC power factor correction (PFC) rectifier with positive output voltage is proposed in this paper. For low output voltage product applications, the rectifier is designed to convert high input voltage to low output voltage. Due to no bridge-diodes required and thus decreased input conduction losses, the proposed rectifier efficiency can be improved. The proposed rectifier operates in discontinuous conduction mode (DCM) and the current-loop circuit is hence not needed. Also, only a single switch is used in the rectifier to simplify the control circuit design. A simple translation method to have the positive output voltage in the CUK converter is presented in the rectifier to reduce the component counts and the cost as well.

3.1 PULSE WIDTH MODULATION (PWM):

Pulse Width Modulated (PWM) converters have been widely used in industry. The PWM technique is praised for its high power capability and ease of control. Higher power density, faster transient response and smaller physical size of PWM converters can be achieved by increasing the switching frequency. However, as the switching frequency increases so do the switching losses and electromagnetic interference (EMI) noises. Switching losses and EMI noises of PWM converters are mainly generated during turn-on and turn-off transients

3.2 FUZZY LOGIC CONTROLLER:

The fuzzy logic controller used in this project is to reduce the voltage ripples and to improve the efficiency of the converter. There are set of 49 rules are formed using the membership functions. The controller uses mamdani method which is suitable for variable values. The membership functions are formed by using triangular membership functions.

4. BRIDGELESS CUK POWER FACTOR CORRECTION RECTIFIER:

The bridgeless power factor correction rectifiers are shown in Fig.2. The topology is formed by connecting two DC-DC CUK converters. There are one or two semiconductors in current flowing path. Hence, the current stresses in the active and passive switches are further reduced and the circuit efficiency is improved compared to the conventional CUK rectifier. Here, the output voltage bus is always connected to the input AC line through the slow-recovery diodes D_p and D_n.

The bridgeless rectifiers of Fig.2 consists of two semiconductor switches (Q_1 and Q_2). However, the two semiconductor switches can be driven by the same control circuitry. Compared to conventional CUK converter topology, the structure of topologies utilizes additional inductor, which is often described as a disadvantage in terms of size and cost.However, a better thermal performance can be achieved with the two inductors compared to a single inductor.

It should be mentioned here that the three inductors in the topologies can be coupled on same magnetic core allowing considerable size and cost reduction. Additionally, the “near zero-ripple-current” condition at input or output port of the rectifier can be achieved without compromising performance.

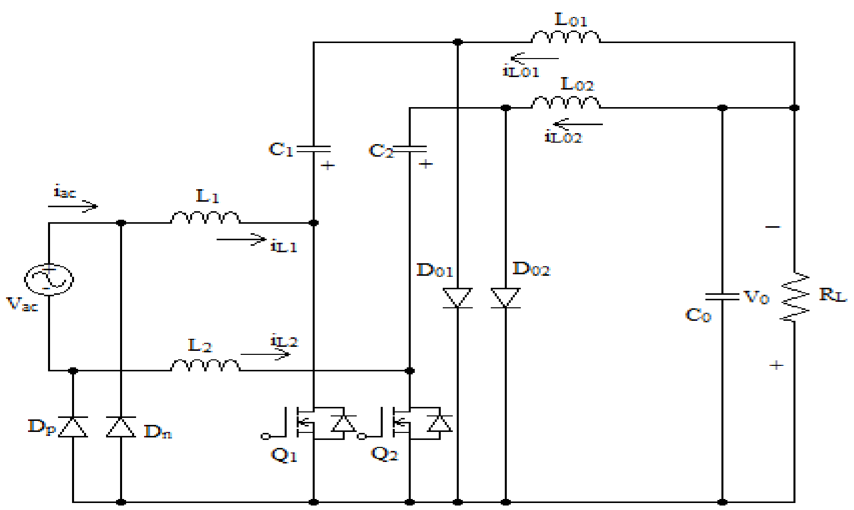


Fig.2 Bridgeless CUK Converter

5. OPERATION PRINCIPLE:

The bridgeless CUK converter will be considered in the paper. The converter is operated at steady state in addition to the following assumptions: pure sinusoidal input voltage, ideal lossless components, and all ripples are negligible during the switching period Ts. Output filter capacitor C0 has a large capacitance such that the voltage across it is constant over the entire line period.

There are one or two semiconductors in the active and passive switches are reduced and the circuit efficiency is improved. During the positive half line cycle as shown in Fig3, the first DC-DC CUK Circuit, L1-Q1-C1-L01-D01, is the active through diode Dp, which connects the input AC source to the output. During the negative half line cycle as shown in Fig.4,the second DC-DC CUK circuit,L2-Q2-C2-L02-D02, is active through diode Dn, which connects the input AC source to the output.

The average voltage across capacitor C1 during the line cycle can be expressed as follows:

$$V_{c1(t)} = \{ Vac(t)+Vo, 0 \leq t \leq T/2$$

$$T/2 \leq t \leq T$$

Due to symmetry of the circuit, it is sufficient to analyse the circuit during the positive half cycle of the input voltage. The operation of the rectifiers of Fig.2 will be explained assuming that the three inductors are operating in DCM. By operating the rectifier in DCM, there are several advantages can be gained. These advantages included natural near-unity power factor, the power switches are turned ON at zero current, and the output diodes are considerably reduced. DCM operation significantly increases the conduction losses due to the increased current stress through circuit components.

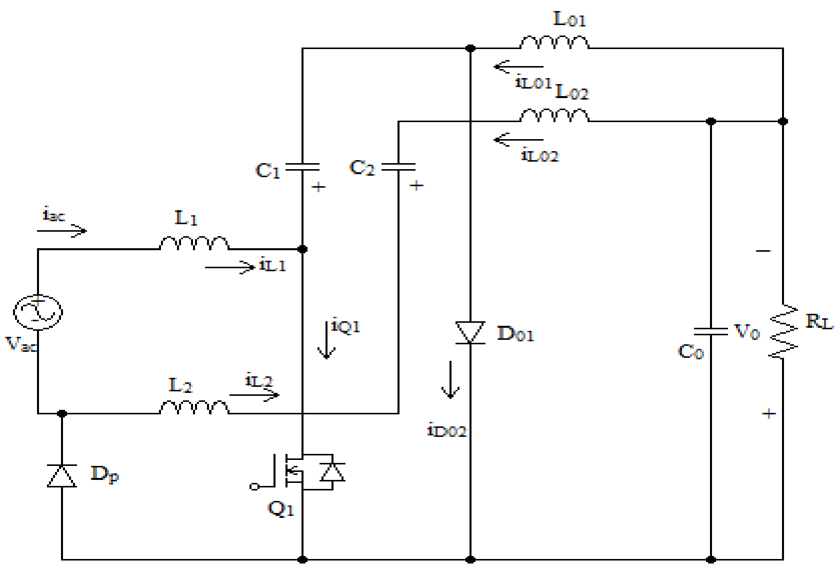


Fig.3 Equivalent circuit of bridgeless rectifier during positive half-line period of the input voltage

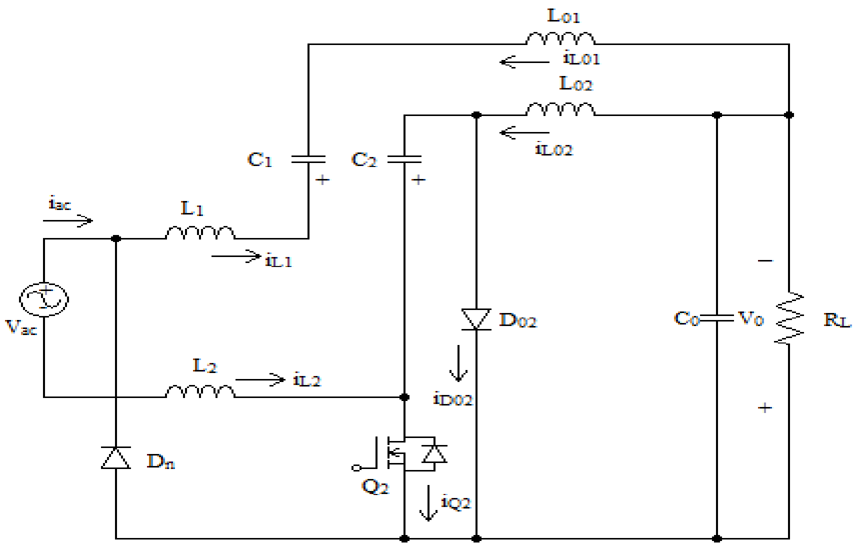


Fig.4 Equivalent circuit of bridgeless rectifier during positive half-line period of the input voltage

6. CONCLUSION

This paper presents Single-phase AC-DC bridgeless rectifier based on CUK topology with and without PI controller. Thecomparison of single-phase ac-dc bridgeless rectifier based on CUK topology with and without PI controller is discussed. From the result it is clear the bridgeless CUK converter with PI controller has constant output voltage. By operating the rectifier in DCM, there are several advantages, which includes natural near-unity power factor. Thus, the losses due to turn-ON switching and the reverse recovery of the output diodes are considerably reduced. The performance of the system was verified in the simulation. In this new single-phase AC-DC bridgeless rectifier based on CUK topology have a better efficiency and power factor. The proposed CUK converter is designed to reduce the input current stress and to bring almostunity power factor in the input side. The design of bridgeless CUK converter is modelled in Mat-lab. The PFC bridgeless CUK converter has ensured near unity power factor in a wide range of the speed and the input ac voltage.

7. REFERENCES

[1] Abbas A. Fardoun, Esam H. Ismail, Ahmad J. Sabzali and Mustafa A.Al-Saffar, “New Efficient Bridgeless CUK Rectifiers for PFC Applications,” inIEEE trans. Power Electron., vol. 27, No. 7, July 2012.

[2] B. Lu, R. Brown, and M. Soldano, “Bridgeless PFC implementation using one cycle control technique,” in Proc. IEEE Appl. Power Electron Conf.,Mar. 2005, pp. 812–817.

[3] A. Sabzali, E. H. Ismail, M. Al-Saffar, and A. Fardoun, “New bridgeless DCM sepic and Cuk PFC rectifiers with low conduction and switchinglosses,” IEEE Trans. Ind. Appl., vol. 47, no. 2, pp. 873–881,Mar./Apr.2011.

[4] E. H. Ismail, “Bridgeless SEPIC rectifier with unity power factor and reduced conduction losses,” IEEE Trans. Ind. Electron., vol. 56, no. 4, pp.1147–1157, Apr. 2009.