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# Comparison of bridgeless CUK converter for power factor correction in led using soft switching technique

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**ABSTRACT**

The electronic equipment uses a rectifier with a capacitor as a filter, and its major problem with the loads are the harmonic currents injected into the power supply and low power factor. CUK converters performs power factor correction with low power range. This paper presents comparative analysis between Bridge and Bridgeless CUK power converters, in the discontinuous conduction mode, using soft switching technique derived by different controllers such as Neural network, PID controller etc., and analyzing it, in order to study their performance in terms of power factor, voltage, current, power

**Keywords:** Neural Networks, PID Controller, CUK Converter

## INTRODUCTION

AC/DC power converters are extensively used in various applications. Power factor is the ratio between the actual power (KW) to the total (apparent) power (KVA) consumed by an item of A.C electrical equipment. Types of power factor correction- passive power factor correction and active power factor correction. Passive power factor correction includes only capacitors and inductors so it is difficult to achieve a higher power factor and lower total harmonic distortion and size is also large. Active power factor correction consists of inductors and capacitor together with uncontrolled rectifier. This is a good solution to achieve higher power factor.

The driver takes the universal input voltage 90V to 250Vrms and delivers it to the LED lamp which operates with dc current. The driver not only performs the unit power factor correction but also regulates the current. PF=cosɵ. The size, the lifetime and cost are also other concerns of the driver. The DCM input circuit can be one of the dc-dc converter topologies. However when they are applied to the rectified line voltage, they may draw different shape of averaged line current.

In this paper CUK converter topologies with bridge and bridgeless rectifiers are investigated. Operating principle of a PFC circuit is to process the input power in certain way that it stores the excessive input energy when the input power is larger than the dc power. In most PFC circuits an input inductor has been connected to bridge rectifier. The input inductor can operate either in continuous conduction mode (CCM) or discontinuous conduction mode (DCM).

The peak of the inductor current is sampling the line voltage automatically. This property of the circuit can be called self-power factor correction because no control loop is required from its input side. This is the main advantage over CCM. Bridgeless CUK converter topology is formed by connecting two dc-dc CUK converters, one for each half-line period(T/2)of the input voltage. By using less number of semiconductor switches, the losses due to current stresses in the switches reduced and the circuit efficiency is improved compared to conventional CUK rectifiers.

**Voltage-Current Characteristics of basic CUK converter:** The CUK converter is essentially Boost converter followed by a Buck converter. CUK converters has two inductors one at its input and another at its output. Input inductor operates in DCM and output inductor operates in CM.

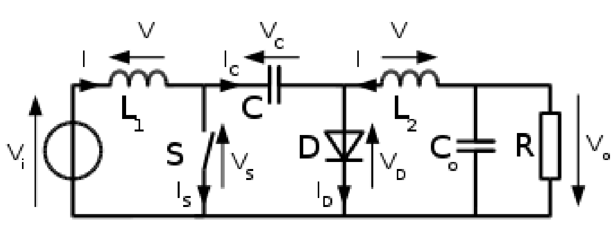

**Fig.1.CUK Converter**

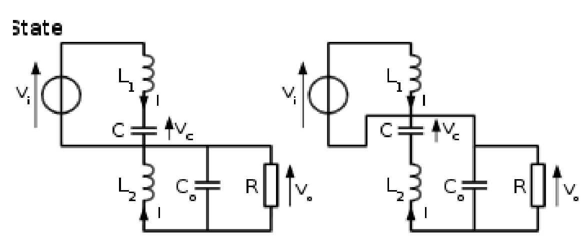

**Fig.2.CUK Converter operation**

Fig 2: The two operating states of a non-isolated CUK converter. In this figure, the diode and the switch are either replaced by a short circuit when they are on or by an open circuit when they are off. It can be seen that when in the OFF state, the capacitor C is being charged by the input source through the inductor $L_1$. When in the ON state, the capacitor C transfers the energy to the output capacitor through the inductance $L_2$.

In order to examine the self pfc capabilities of CUK converter, we first investigate the voltage characteristics of CUK converter which performs the step-up operation. In fig (3) the set input voltage is 20V and the output voltage is boosted to -45V.The output signal of the CUK Converter is continuous and is not pulsating as SEPIC Converter. The input voltage or current can be increased or decreased using step-up and step-down operation of CUK Converter respectively.

The power factor correction stage is based on a CUK Converter because of its intrinsic low current distortion characteristic making it possible to eliminate the Electromagnetic interference filter (EMI).

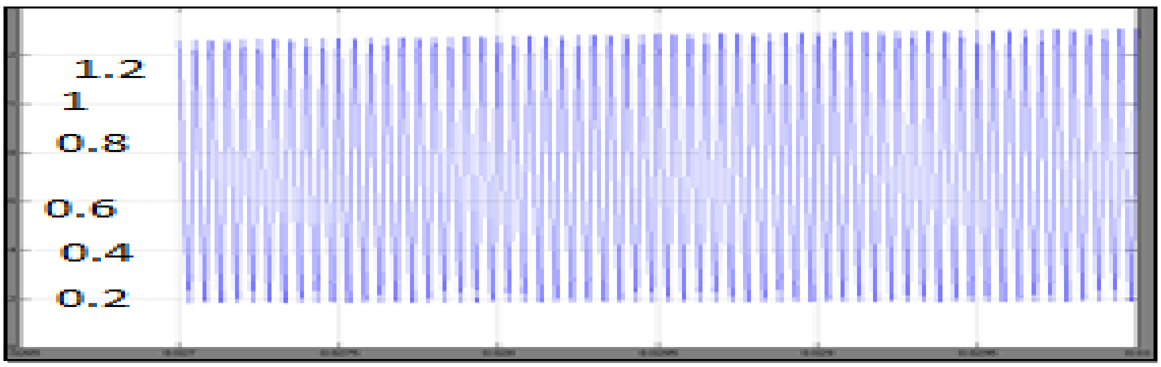


**Fig.3.Current Vs Time period**

In an effort to maximize the power supply efficiency, considerable research efforts have been directed towards the development of efficient. A Bridgeless PFC circuit allows the current to flow through a minimum number of switching devices compared to the conventional PFC circuit. Accordingly, the converter conduction losses can be significantly reduced and high efficiency can be obtained as well as cost savings.

**Bridgeless CUK Converter**

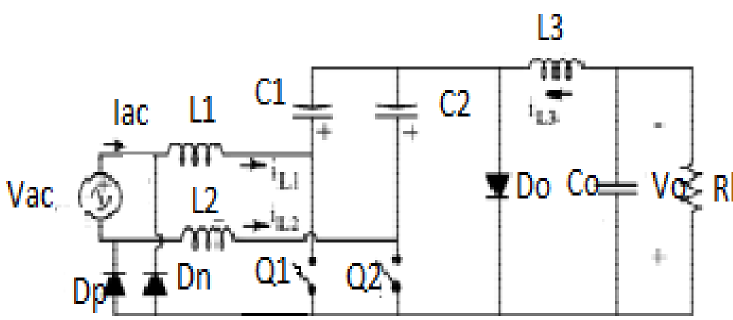


**Fig.4.Bridgeless CUK Converter**

Bridgeless CUK converter topology is formed by connecting two DC–DC CUK converters, one for each half-line period (T/2) of the input voltage. By using lesser number of semiconductor switches, the losses due to current stresses in these switches reduced and the circuit efficiency is improved compare to the conventional CUK Rectifiers. Due to the symmetry of the circuit, it is sufficient to analyze the circuit during the positive half cycle of the input Voltage. Moreover, the operation of the Circuit in will be described assuming that the three inductors are operating in DCM. Thus, the losses due to the turn-ON switching and the reverse recovery of the output diodes are considerably reduced. Conversely, DCM

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operation significantly increases the conduction losses due to the increased current stress through circuit components, which limits its use to low-power applications.

**A Bridgeless Rectifier with PI controller of CUK Converter:**

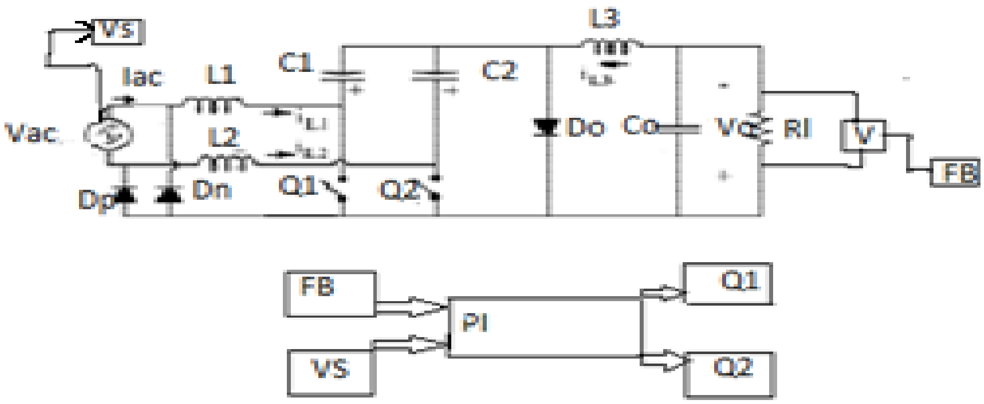


**Fig.5.Bridgeless rectifier with PI controller**

A PI controller is an algorithm that can be implemented without resorting to any heavy control theory. The aim of such an algorithm is to determine the plant input that will make the measured output reach the reference. The simulation output and the hardware output is not said to be equal.

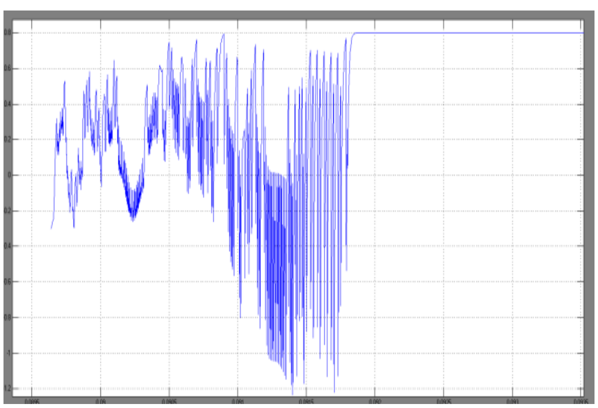

**Fig.6.Voltage Vs Time period**

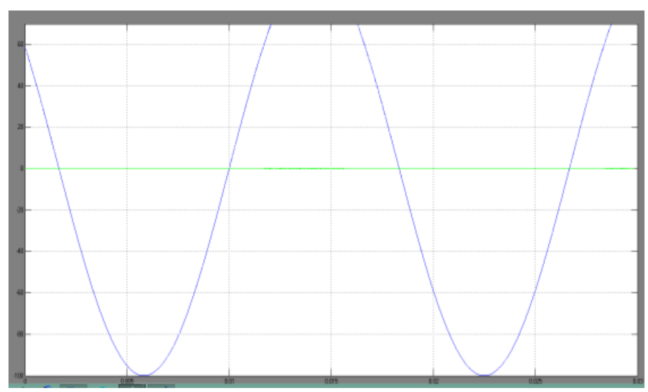

**Fig.7.VoltageVs Current**

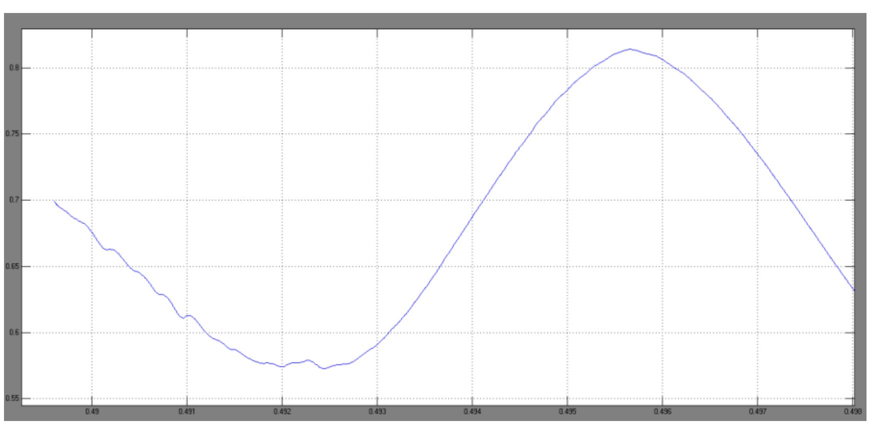

**Fig.8.Power factor waveform**

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**A Bridgeless Rectifier with Neural Network of CUK Converter:**

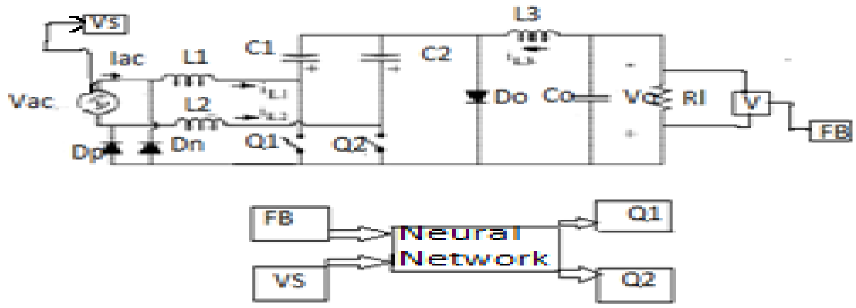


**Fig.9.A Bridgeless Rectifier with Neural Network of CUK Converter**

Neural network is an abstract simulation of the biological nervous system and working is similar to that of brain. The main objective of the neural network is to develop a computational device for modeling brain to perform computational tasks at a faster rate than the traditional system. The simulation output and the hardware output is equal. The required output can be obtained by maximum number of iterations with trial and error method

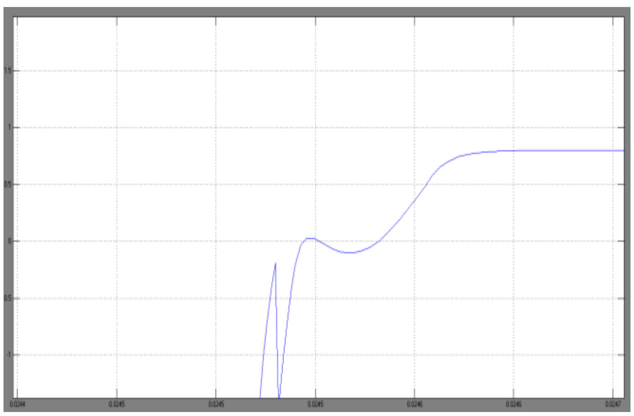

**Fig.10.Voltage Vs Time period**

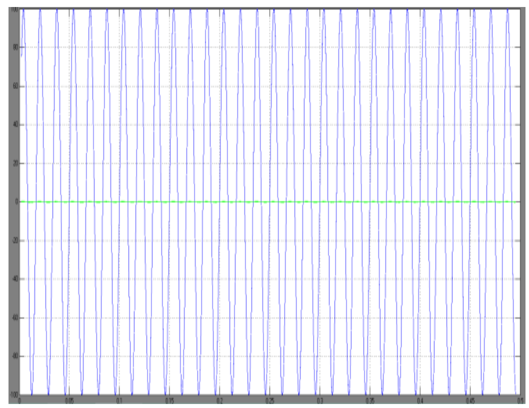

**Fig.11.Voltage Vs Current**

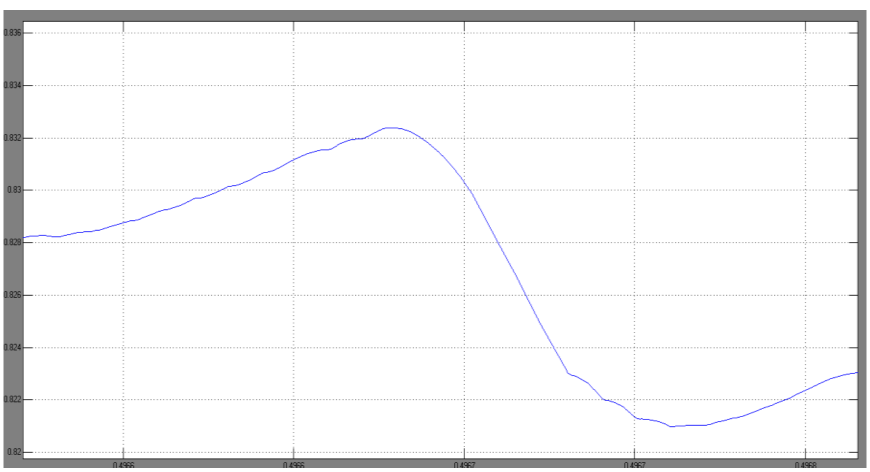

**Fig.12.Power factor waveform**

**Table.1.Comparison table**

| Analysis | Voltage | Current | Power factor |
|---|---|---|---|
| CUK Converter with Bridgeless Rectifier | (step-down) L1-1mH,L2-1mH C1-1µF,C2-1µF Input Voltage-100v Output Voltage-(-50v) | Current-0.2A | 0.75(with PI controller) 0.84(with Neural Network) |

## CONCLUSION

Two new single-phase bridgeless rectifiers with low input current distortion and low conduction losses has been presented and analyzed. By performing the simulation of CUK converter with bridgeless rectifier is that the power factor with pi controller is 0.75 and Neural network is 0.83 .The distortion in Neural network is very less when compared to CUK converter with PI controller.

## REFERENCES

A. F. Souza, and I. Barbi, High power factor rectifier with reduced conduction and commutation losses, in Proc, InternationalTelecommunication Energy Conf., 1999, 1-8.

Al Gabri, A.M. Electr. Eng. Dept, United Arab Emirates Univ, Al Ain, United Arab EmiratesFardoun, A.A. Ismail, E.H Modeling and simulation of bridgeless powerfactor correction modified sepic rectifier with multiplier cell, Published in:Energy Conversion Congress and Exposition (ECCE), 2014 IEEE.

Cosetin, M.R. Bolzan, T.E, Luz, P.C.V, da Silva, M.F,Alonso, J.M. ; do Prado, R.N, Dimmable single-stage sepic-CUK converter for led lighting with reduced storage capacitor, Published in:Industry Applications Society Annual Meeting, 2014 IEEE.

D. S. L. Simonetti, J. Sebastian, and J. Uceda, The DiscontinuousConduction Mode Sepic and CUK Power Factor Preregulators:Analysis and Design,IEEE Trans. Ind. Electron., 44, 1997, 630-637.

G. Moschopoulos, and P. Jain, A Novel Single-Phase Soft-Switched Rectifier With Unity Power Factor and Minimal Component Count,IEEE Trans. Ind. Electron., 51, 2004, 566-576.

Hongbo Ma Sch. of Inf. Sci. & Technol., Southwest Jiaotong Univ., Chengdu, China Wensong Yu; Cong Zheng ; Jih-Sheng Lai ; Quanyuan Feng; Bo-Yuan Chen, A universal input high powerfactorcorrection pre-regulator without electrolytic capacitor for PWM dimming LED lighting application"Energy Conversion Congress and Exposition (ECCE), 2011 IEEE.

R.Sriranjani, A.ShreeBharathi, S.Jayalalitha, Design of CUK converter Powered by PV array, 6(5), 2013, 793-796.

Venturini, W.A. Group of Intell. in Lighting GEDRE, Fed. Univ. of Santa Maria - UFSM, Santa Maria, Brazil Bitencourt, E.A. ; Schlittler, M.E. ; da Silva, M.F. ; do Prado, R.N. Analysis and design methodology of a self-oscillating system based on integrated sepic half bridge for led lighting applications" Published in:Power Electronics Conference (COBEP), 2013 Brazilian.

Y. M. Lai, A PFC Voltage regulator with low input current distortion derived from arectifier less topology, IEEE Trans. Power Electron., 21, 2006, 906-911.