ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

PFC Cuk Converter for Driving HB-LEDs Power Supply Based on Bridgeless Topology

Radhika R[1], Devisree Sasi[2]

PG Student [PE], Dept. of EEE, Sree Narayana Gurukulam College of Engineering, Kadayiruppu, Kerala, India[1]

Assistant Professor, Dept. of EEE, Sree Narayana Gurukulam College of Engineering, Kadayiruppu, Kerala, India[2]

ABSTRACT: This paper presents a simple and economical method of power factor correction (PFC) for driving High-Brightness LEDs based on bridgeless cuk converter. In recent times HB-LEDs are widely used lighting instruments as it has several advantages like great longevity, multi-coloured and compatible with environment. It works by sampling of input and output voltage and current in the converter. It improves the input power factor and reduces the line current's Total Harmonic Distortion (THD).Nowadays power factor correction (PFC) has become an essential part of new power supply designs. It is a single stage, low cost and high efficiency. In this a technique of producing high power factor for HB-LEDs power supply based on cuk topology is proposed.

KEYWORDS:PFC, HB-LEDs, THD.

I.INTRODUCTION

In recent years use of power switching converter has become usual method of designing a power supply. The main problem of these kind converters is that the current and voltage outputs has irregular pattern. Nowadays manufactures of light fixtures produce the high brightness light emitting diodes (HB-LEDs) with high efficiency output above 100Lumens/Watt. These LED lamps has more advantages such as lower cost, a wide range of colour and high luminance intensity. So among many artificial lighting devices, these are likely to be the best choice for illuminating purposes. The proposed topology makes the power supply to achieve class C regulations of the same requirement. Obtaining a high PFC is possible by some passive and active circuits. Equation(1) , below shows the relation between PF and THD.

$$pf = \frac{Cos\emptyset}{\sqrt{1+THD^2}} \qquad (1)$$

Where $\emptyset$ is the phase angle difference between voltage and current waveform. The figure (1) shows block diagram of DC-DC converter PFC circuit.

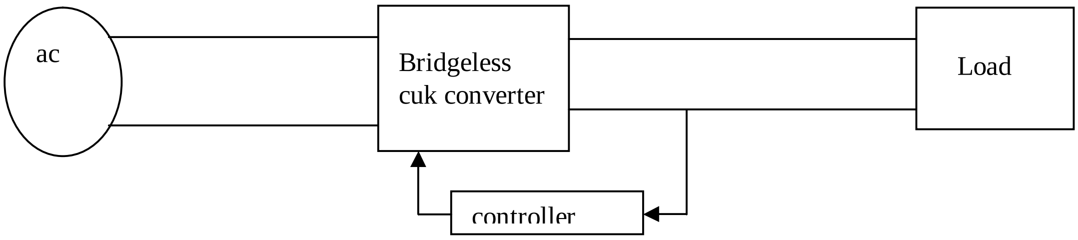


Fig (1)

This circuit is a single stage with an active PFC scheme which in comparison to integrated single stage converter has lower cost, size and THD.

In this we use bridgelesscuk converter. Bridgeless cuk converter reduces the switching losses by reducing the number of power semiconductor switch in the current conduction path. By using the bridgeless topology the input diode bridge is avoided and therefore the conduction losses are reduced which yield a better efficient system. In case of bridgeless buck converterit has the disadvantages like low output voltage, high output ripple. Bridgeless boost converter is applicable only for boost operation and moreover it has high start-up in rush current.

Bridgeless sepic converter has relatively high output voltage ripple due to discontinuous output current. So if these converters are used in a drive system disadvantages of all those converters will decrease the efficiency of whole drive system. The cuk topology based converter offer various advantages than above mentioned topologies such as less electromagnetic interference associated with discontinuous conduction mode (DCM) topology. It has lower input current ripple.

II.SYSTEM MODEL AND WORKING

The bridgeless cuk converter yield the perfect result so that the drive system will be efficient as well as power factor is improved. The proposed converter acts as a AC-DC converter without an input diode bridge; so named as bridgeless topology.

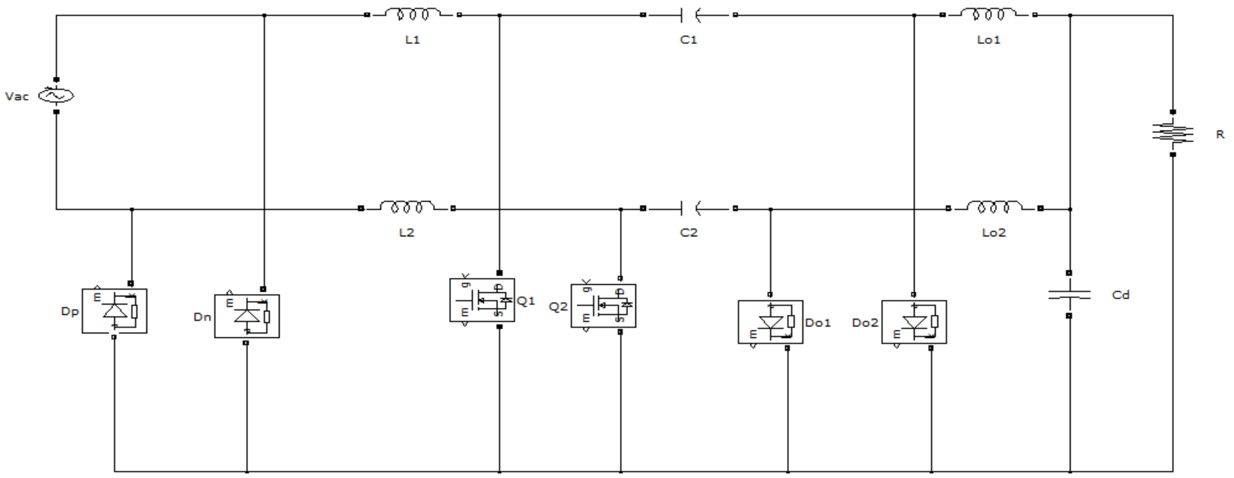


Fig (2)

It has advantages over conventional cuk converter in the case of switching losses. Two DC-DC cuk converters are connected as fig (2) to form bridgeless topology. One of the cuk DC-DC converters will operate for each half line period (T/2) of the input voltage. According to fig (2) there are one or two semiconductor(s) in the current conduction path. Therefore the current conduction losses in the active and passive switches are further reduced and circuit efficiency is improved compared to the cuk converter. Common mode noise problem due to the pulsating output voltage with respect to the ground is a major drawback of almost all the converters. So in order for balancing the circuit there by preventing the common mode noise problem, here output voltage is always connected input ac line through the slow recovery diodes Dp and Dn. Thus the proposed topology does not suffer from the high common mode EMI noise emission problem.

As in the bridgeless converter shown in fig (2) there are two power semiconductor switches Q1,Q2 along with two recovery diodes Dp,Dn. The switches can be driven by the same control with the condition that Q1 will be ON at positive cycle of the input voltage and Q2 vice versa. This can reduce the control circuitry complexity. During positive half cycle of input ac, the first dc-dc cuk converter circuit L1-Q1-C1-Lo1-Do1 will be active through the positive diode Dp. This connects the input ac source to the output. During the negative half cycle the second dc-dc cuk converter circuit L2-Q2-C2-Lo2-Do2, is active through the negative diode Dn which connects the input ac source to the output. The operation is made in discontinuous mode by suitable design of active and passive components like inductors and capacitors.

III.CONVERTER DESIGN

The input voltage is Vac = 12V

Vo = 24V.

P = 11.52W.

Let the switching frequency be 20kHz.

Design equations:

$$D = \frac{\mathrm{Vdc}}{\mathrm{Vdc+Vin}}.$$

Amount of permitted ripple current $\Delta I L_1$ = 30% of I_{in}.

$$I_{in} = \frac{2\mathrm{P}}{\mathrm{Vin}}.$$

$$L_{i1=} L_{i2} = \frac{\mathrm{Vm\ dnom\ Ts}}{0.64}.$$

$$K_{acrit} = \frac{1}{2\{[\frac{\mathrm{Vdcdec}}{\mathrm{Vm}}]+\mathrm{n}\}^2}.$$

$$L_{eq} = \frac{\mathrm{Ro\ Ts\ Ka}}{2}.$$

$$L_{01} = L_{02} = \frac{\mathrm{L}_i\, L_{eq}}{\mathrm{L}_i - \mathrm{L}_{eq}}.$$

$$C_1 = C_2 = \frac{1}{(\omega_r)^2 \mathrm{L}_i + \mathrm{L}_o}.$$

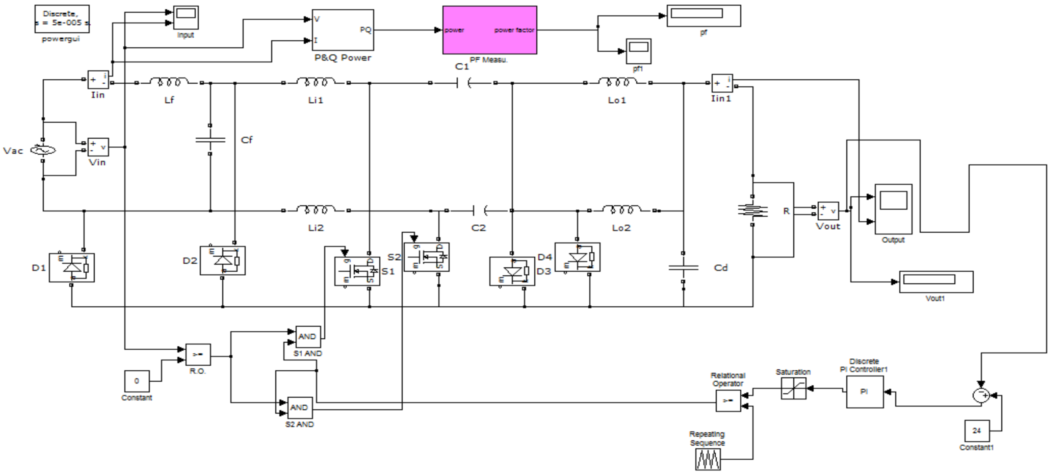
$$C_d = \frac{\mathrm{I}_d}{2\omega_L \Delta Vdc}.$$

$$\mathrm{Cf} = \frac{I_{peak}}{2\omega_l \Delta \mathrm{Vdc}}.$$

$$\mathrm{Lf} = \frac{1}{4\Pi^2 \mathrm{fc}^2\, Cf}.$$

IV.SIMULATION MODEL AND RESULTS

Fig (3) shows the simulation model of bridgeless cuk converter using a PI controller. The input voltage given is 12V.The output obtained is 24V. L_f &C_f are the filter inductor and filter capacitor respectively. L_{i1} and L_{i2} are input inductors. L_{o1} and L_{o2} are output inductors. C_1 and C_2 are the intermediate capacitors.



.

For conventional cuk converter the PF is 0.95 and THD is 12.53%. When the conventional cuk was replaced by bridgeless cuk converter the PF is improved to 0.97 and THD is reduced to 0.31%.

Table head	Cuk converter	Brigdeless cuk converter
PF	0.95	0.97
THD	12.53%	0.31%

Table (1)

The table (1) shows the comparison of PF and THD of conventional cuk converter and bridgeless cuk converter. The fig (4) and fig (5) shows the value of THD for conventional Cuk converter and bridgeless cuk converter respectively. We can clearly note that the THD has been reduced in bridgeless cuk converter.

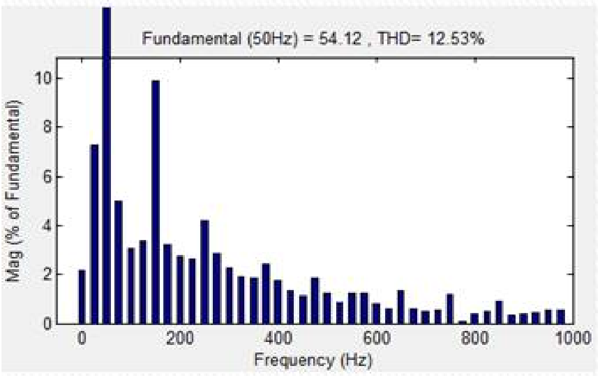
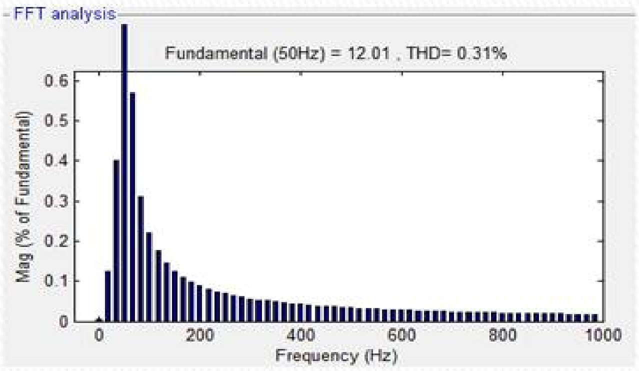


Fig (4)



Fig(5)

The fig (6) is the output waveform of simulation.

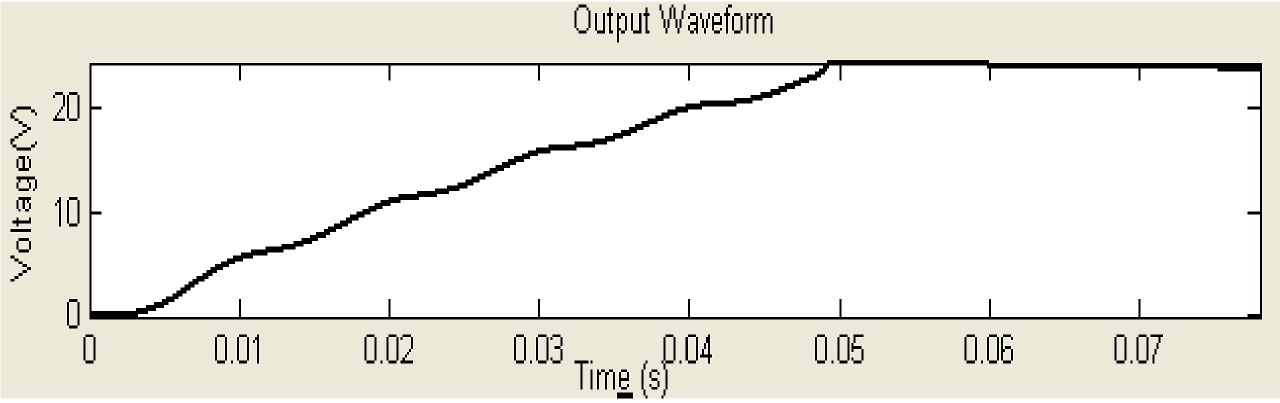


Fig (6)

This is the output of bridgeless cuk converter. The output voltage V_o= 24V.

V.HARDWARE IMPLIMENTATION

The Fig (7) shows the hardware implementation of PFC cuk converter for driving HB-LEDs power supply using bridgeless topology. The diode used is HF04. Mosfet used in hardware implementation is P60N, IC used is DSPIC30F2010.

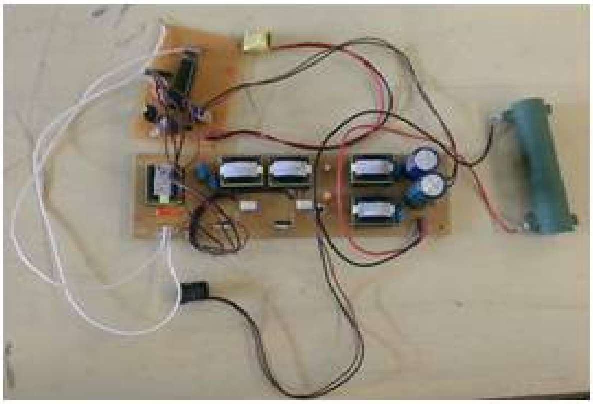


Fig (7)

Fig (8)

Fig (8) shows the output voltage for the proposed system, that is 24V.

VI.CONCLUSION

A new efficient power factor correction circuit for driving HB-LEDs based on cuk topology is simulated and validated. This topology provides high PF, fast output, voltage regulation and reduces THD. Initially two different topologies of power factor correction circuits are evaluated and the best is chosen. Comparison is done using conventional cuk and bridgeless cuk converter. The PF and THD is best while using bridgeless cuk topology.The PF is improved to 0.97 from 0.95 and THD is reduced from 12.32% to 0.31% when conventional cuk converter was replaced by bridgeless cuk topology.

DOI:10.15662/IJAREEIE.2016.0503031

REFERENCES

[1] L. Yarmohammadi, E. Afjei, “A technique for producing High Power Factor for HB-LEDs power supply Based on Boost topology,” the 6th international PEDSTC2015 3-4 February 2015 , Shahid Beheshti University, Theheran, Iran.

[2] Sujith Verma, S. K. Singh and A.G. Rao, “Overview of control techniques for DC-DC converters,” Research journal of Engineering sciences, vol. 2, no. 8, pp. 18-21, 2013.

[3] M. OLeary, “Plug in safeguard AC power line quality,” EDN, pp. 57-66, Mar.18,2004.

[4] Vasist Bist . Bhim Singh., “PFC Cuk converter Fed BLDC motor drive,” IEEE Trans. Power electronics , vol. 30,No.2 Feb. 2015.

[5] Jomy Joy, Amal M.R, “An efficient bridgeless PFC cuk converter based PMBLDCM drive,” International journal of innovative research in electrical, electronics, instrumentation and control engineering, vol. 2, issue. 2, Feb2014.

[6] Sinsha. V, E .Thangam, “Bridgeless cuk converter fed BLDC motor with PFC for Air conditioning system, ”IJERT T , vol. 3, Issue 2, Feb 2014.

[7] Weir B and Cathell F, “LED streetlight demands smart power supply,” Power electronic Technol. , vol. 34, pp. 34–39 Feb.2008.