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

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

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

Lighting System Using Flyback Converter Control with Valley Fill Circuit

R.Satheesh [1] , M.Shunmuga Sundar [2] , S.S.Mohamed Haj Masooth [3]

III[rd] Year, Department of Electrical and Electronics Engineering, Francis Xavier Engineering College, Tirunelveli, Tamil Nadu, India

ABSTRACT: The industry and academia has attracted a lot of attention towards the Light-emitting diode (LED) with high brightness because of its high efficiency, ease to drive, environmental friendliness and long lifespan. Single stage structure and two stage structure are the power stages needed to drive LEDs in low power and high power applications. To obtain the feature of both stages in a structure, this paper proposes a new control method with a valley fill circuit. The papers presents a boost integrated flyback converter for LED lighting system with valley fill circuit. Another feature of this paper is that a single switching technique is used to control both the boost power factor correction (PFC) and the flyback converter. The proposed converter has the advantages of high efficiency, high input power factor (PF), long life and luminous efficacy. Simulation of proposed converter is done and results obtained are satisfactory.

KEYWORDS: flyback Converter, Power Factor Correction (PFC), valley fill circuit, light emitting diode (LED).

I. INTRODUCTION

Nowadays, the energy depletion and the environmental problem are serious issue. Especially, LED is widely used by lighting equipment. The conventional incandescent bulb and compact fluorescent lamps (CFL) have low energy efficiency. CFLs contain mercury vapor which causes air pollution. Therefore, LEDs for lighting sources have received great attention in recent years owing to their merits of lightweight, small size, energy saving, high luminous efficiency, long lifetime and environmental friendliness[1].Thus the replacement from conventional lighting fixtures to LED lamp has become trend.

In lighting system, the power stages to drive an LED can be classified into single stage and two stage structures. The single stage is for low power applications and not suitable for high power. Similarly the two stage structure is usually for high power applications and not applicable for low power applications [3]. In two stage topology, the first stage is the ac-dc converter for power factor correction (PFC) and the second stage is dc-dc for regulating output. They provide near unity power factor (PF) and low THD value. Due to more energy stored in the capacitor, provides longer hold up time. There is no invisible flicker problem detected by digital devices. The main problem of the two stage structure is that it requires two independently controlled switches and two control circuits which increase the components. This leads to high cost and low efficiency [4].

The power factor correction (PFC) and the dc-dc converter part are combined in the single stage topology. It is potentially more efficient due to its simplified power stage and control circuit. Also has advantage of low component count and low cost. In single stage structure it is difficult to achieve high power factor (PF) and high efficiency. A flyback converter is a buck boost converter with the inductor split to form a transformer. The flyback converter is used in the lighting application because of its many merits and simplicity.

To handle high efficiency under heavy loads with low ac line and under light loads with high ac line condition, an interleaved method is used [5]. Though it has good efficiency and power factor (PF), the circuit is complex and also needs two switches to control with the increased transformer. To overcome these difficulties the flyback ac-dc converter with valley fill circuit control method is a possible solution.

The topology proposed in this paper is the boost integrated flyback converter along with the valley fill circuit. The interleaved flyback converter is replaced by the valley fill circuit [6]. The valley fill circuit provides low output current ripple and the voltage stress. The proposed method provides high efficiency and high power factor (PF).

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

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

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

II. BLOCK DIAGRAM

Block diagram for the proposed converter is shown in Fig 2.

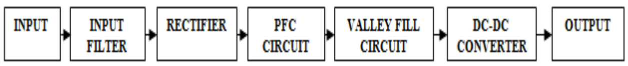


Figure 1**.** Block Diagram of new topology

Input filter is used to eliminate harmonics and ripple at the input side. Rectifier converts the given AC input to the corresponding DC voltage. The rectifier output is given to the Boost PFC and valley fill circuit. DC-DC converter is a normal fly-back converter.

III. PROPOSED CONTROL METHOD

The circuit diagram of the proposed converter is shown in the Fig 2. The proposed circuit consists of ac source Vac, input filter, bridge rectifier; boost inductor, valley fill circuit, and flyback converter.

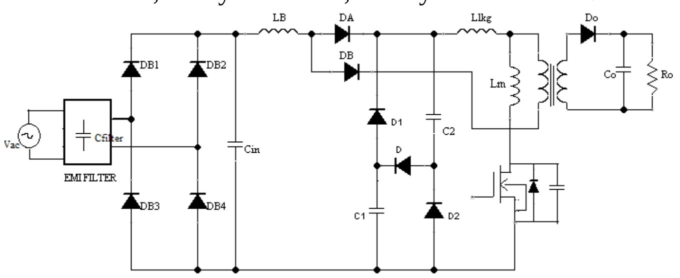


Figure 2. Proposed converter circuit diagram

The valley is circuit is added in between the boost converter and the flyback converter. The valley fill circuit is a collection of electrolytic capacitors and diodes increases the line frequency conduction angle resulting in the improved power factor [7]. The valley fill circuit is composed of three diodes (Dvf1-Dvf3) and two capacitors (Cvf1, Cvf2). These capacitors are charged in series to the valley voltage half the peak line voltage. When the line voltage falls below the capacitor voltage, the diode gets reverse biased and the capacitors are connected in parallel to discharge the voltage

Single MOSFET switch (M1) alone is used to control both the boost PFC and the flyback converter so called as single switching control. Discontinuous conduction mode (DCM) control is used in the boost converter to improve the PFC performance. Similarly flyback converter also operates in the DCM control. Therefore DCM-DCM control scheme is employed. By using DCM operation method the design of the converter is simple. The accumulated energy of the boost inductor is transferred to the valley fill capacitors and then to the flyback converter. The output capacitor is used to deliver the energy to load.

IV. CIRCUIT OPERATION

The proposed converter has five modes of operation. The boost inductor current must be zero level before magnetizing current becomes zero for a proper operation. Operating modes equivalent circuits are shown in Fig 3.

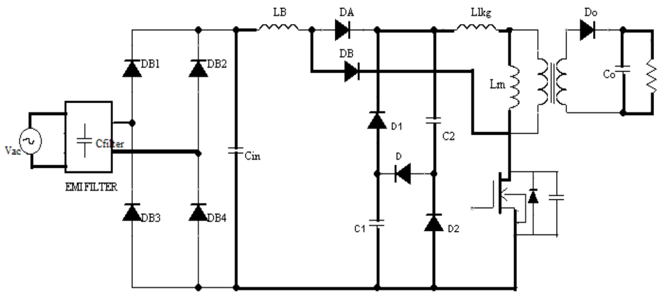
ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

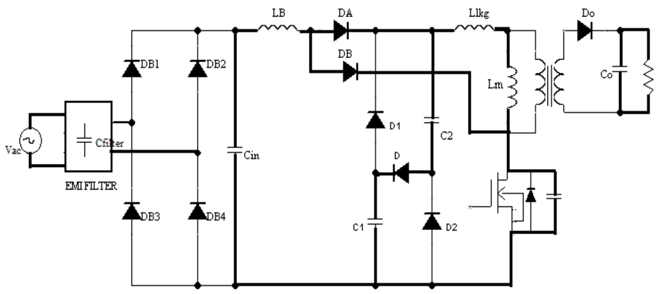
(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

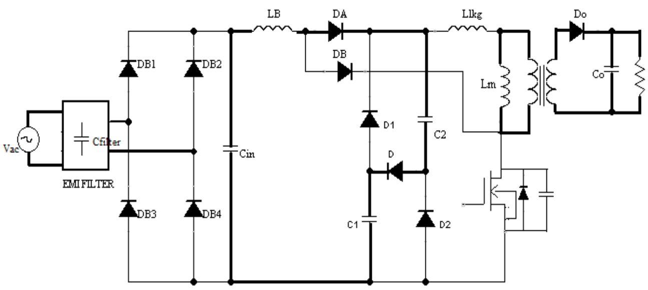
Vol. 9, Issue 3, March 2020



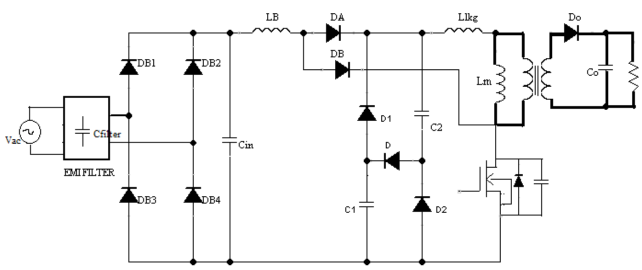
(a)



(b)



(c)



(d)

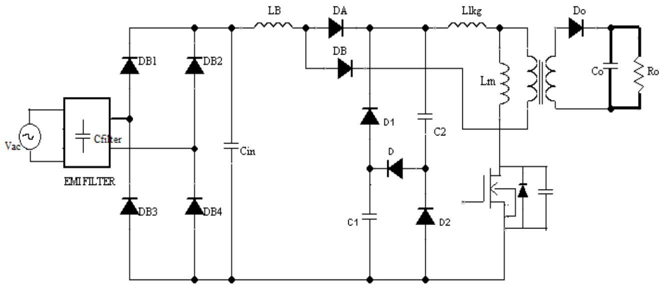
ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020



(e)
Fig. 4. Equivalent Circuits (a) Mode 1. (b) Mode 2.
(c) Mode 3. (d)Mode 4. (e) Mode 5.

Mode I: When the switch M1 is turned on this mode begins. Initially the boost inductor current and the primary current have zero value due to DCM operation. By the input voltage (Vin) the boost inductor current begins to increase. Thus the current flows through the inductor (LB), diode (DB) and the switch. The diode (Dvf2) gets reverse biased when the line voltage falls below the single capacitor voltage. Now the capacitors Cvf1 and cvf2 are connected in parallel to discharge the voltage. As they are connected in parallel they have low frequency voltage ripple. This mode is maintained until the switch is turned off.

Mode II: In this mode the switch is turned off. The leakage inductor (Llkg) energy is delivered to the switch output capacitor. The input inductor current starts to flow through the capacitor Cvf1 and Cvf2 as the diodes DA and Dvf2 are forward biased. This mode ends when the diode DB is reverse biased and also when the leakage current becomes zero. The output capacitor delivers the stored energy to the load.

Mode III: In this mode stored energy is transferred to the secondary side. So the flyback powering operation takes place. The magnetizing current (Lm) begins to decrease. The stored energy in the boost inductor is transferred to valley fill capacitors (C1 and C2) .Thus the boost inductor current also decreases. This mode is maintained until the inductor current reaches zero level.

Mode IV: Expect the transformer and the output diode, the current does not flow through all branches.
This mode ends when the magnetizing current reaches zero level.

Mode V: The output capacitor energy is delivered to the load.
This mode sustains until the switch Ml is turned on.

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

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

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

V. RESULTS AND DISCUSSION

On the basis of obtained design, simulation of converter carried out in DCM operation. Fig 5 . Shows the simulation model of the proposed converter in DCM operation.

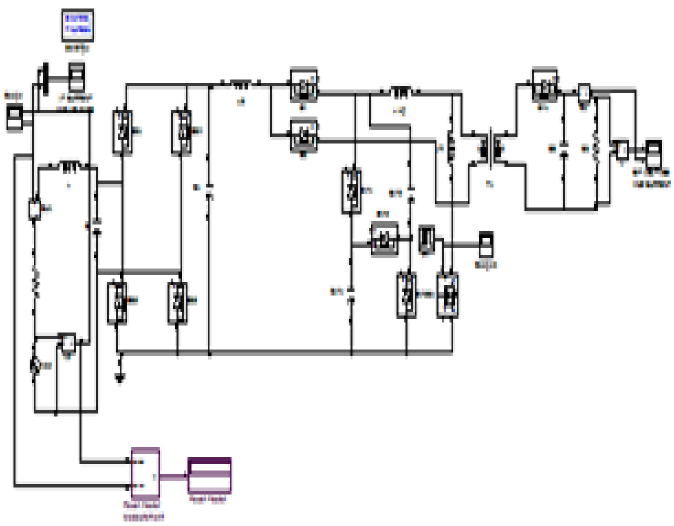


Figure 5 . Simulation diagram

A simulation of the proposed converter is implemented with the specifications shown in Table I. The input filter is used to remove the ripples. Pulse to the switch is given by pulse generator. The voltage and current in phase waveform is shown in fig 6. The output voltage and current are shown in fig 7. 265v is given as input and 90v, 900mA is obtained as the output. Unity power factor is also obtained.

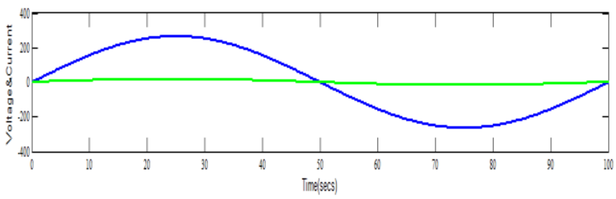


Fig 6 . Voltage and current in phase

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

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

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

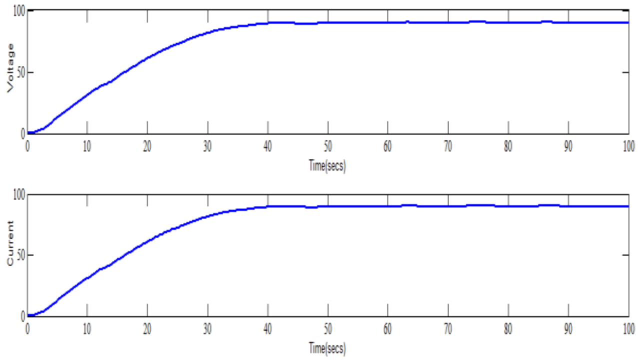


Fig 7. Output voltage and current

TABLE I

CIRCUIT SPECIFICATIONS FOR PROPOSED CONVERTER

Input Voltage	265vac
Output Voltage	90vdc
Output Current,	900mA
Transformer primary to secondary turn ratio N_1/N_2	96:48
Magnetizing inductance	800µH
Leakage inductance	3µH
Switching Frequency(fsw)	70KHZ

VIII. CONCLUSION

This paper presents a boost integrated flyback converter with valley fill circuit. The circuit here is designed with single switch which reduces the voltage stress. The structure is simple with minimum components, so cost effective and provides unity power factor. Thus high efficiency is obtained which in turn increases the life span of LED lamp. It is used for both indoor and outdoor LED lamp lighting applications.

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

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

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 9, Issue 3, March 2020

REFERENCES

[1] Y.-C. Chuang,Y.-L.Ke, H.-S. Chuang, andC.-C. He, "Single-stage powerfactor- correction circuit with flyback converter to drive LEDs for lighting applications," in *Proc. IEEE Ind. Appl. Soc. Annu. Meeting*, 2010, pp. 1–9.

[2] Y. Hu, L. Huber, and M. M. Jovanovic, "Single-stage, universal-input AC/DC LED driver with current-controlled variable PFC boost inductor," *IEEE Trans. Power Electron.*, vol. 27, no. 3, pp. 1579–1588, Mar. 2012.

[3] R. Redl and L. Balogh, "Design considerations for single-stage isolated power-factor-corrected power supplies with fast regulation of the output voltage," in *Proc. IEEE Appl. Power Electron. Conf.*, 1995, vol. 1, pp. 454– 458.

[4] Y. Hu, L. Huber, and M. M. Jovanovic, "Single-stage, universal-input AC/DC LED driver with current-controlled variable PFC boost inductor," *IEEE Trans. Power Electron.*, vol. 27, no. 3, pp. 1579–1588, Mar. 2012.

[5] SangCheol Moon, Gwan-Bon Koo, and Gun-Woo Moon, "A New Control Method of Interleaved Single-Stage Flyback AC–DC Converter for Outdoor LED Lighting Systems" *IEEE Trans. Power Electron., Vol. 28, No. 8, August 2013.*

[6] S.Y.R. Hui, S.N. Li, XH. Tao, W. Chen, and W.M. Ng, "A Novel Passive Off-line Light-Emitting Diode (LED) Driver with Long Lifetime," in Proc. IEEE APEC, 2010, pp. 594-600.