

The Outdoor LED Lighting Driven By the ILFC

Diana D Souza¹, Dr Sheryl Grace Colaco²

PG Student, Department of EEE, St. Joseph Engineering College, Mangaluru, Karnataka, India¹

Professor, Department of EEE, St. Joseph Engineering College, Mangaluru, Karnataka, India²

ABSTRACT: The LEDs are widely used in the lighting systems due to its long life span and being eco-friendly. The power rating of the LED varies. Hence an appropriate control method is essential. The DCM based flyback converter is propounded in this paper to obtain high power factor and low THD along with a pulse Frequency Modulation controller which provides high efficiency for the wide range of the output power. This is validated using the MATLAB Simulink and the various parameters are observed.

KEYWORDS: Efficiency, Interleaved Flyback Converter (ILFC), Light Emitting Diode (LED), Power Factor, Total Harmonic Distortion (THD).

I. INTRODUCTION

The Light Emitting Diodes (LEDs) are replacing the existing lighting systems due to its features like being reliability, eco-friendly and lasts for a long duration. The aim of this paper is to present a topology for driving the outdoor LEDs that uses the ac source. In a single stage structure all the power factor correction, output regulation and controlling takes places simultaneously in a single step[1]. Hence no additional control is required which reduces the component counts. The converter can either operates in Discontinuous Conduction Mode (DCM) and Continuous Conduction Mode (CCM). The CCM provides high efficiency whereas the DCM provides the high power factor and low THD[2]. Hence the Pulse Frequency Modulation is employed with DCM to obtain the high efficiency and better power factor and THD.

The flyback converter is similar to the buck-boost converter. It consists of a flyback transformer which is made of the inductor. The windings of this transformer will not conduct simultaneously like the normal transformer. When this transformer operates in DCM, the switch voltage will decrease to zero. The LEDs are driven by the dc supply. Hence the conversion from ac to dc is essential. The ac to dc converter is basically the bridge diode rectifier followed by a capacitor to smoothen the regulated voltage. The rectifier absorbs energy from the ac line and will result in harmonics in the input line current. The power factor should be greater than 0.9 and THD should satisfy the IEC61000-3-2[3]. The PFC reduces the ripple content in the output voltage.

II. PROPOSED SYSTEM

CIRCUIT DESCRIPTION

The flyback converter in the single stage is not capable to handle LEDs application over 60-70W. Hence the interleaving system is the solution to this problem. These will reduce the number of components as well as the stress on the switches. The supply is taken from utility and fed to bridge rectifier. The diodes present in the rectifier will cause the source current to distort. They should meet the standard. Hence this can be eliminated by the appropriate use of a filter before giving to the rectifier. A flyback converter is used for the output regulation. The two identical converters are connected in parallel to form the interleaved system. The propound PFM control technique will lead to achieve high efficiency due to the variation of switching frequency[4]. The turn-on time will vary according to the switching frequency and is given as

$$T_{on} = m \cdot f_{sw} \dots \dots \dots (1)$$

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

where T_{on} is the turn-on time, f_{sw} is the switching frequency and m is a constant. This method will lead to increase in switching frequency and the turn-on time for heavy load at low ac line and decreases the switching frequency and turn-on time for light load at high ac line[5]. Hence the frequency between these lines is expressed in (2)

$$\Delta f_{proposed} = f_{low} \left(\left(\frac{V_{in_high}}{V_{in_low}} \cdot \frac{D_{min}}{D_{max}} \right)^2 - 1 \right) \dots \dots \dots (2)$$

where D_{min} and D_{max} are the duty cycles at full load with high ac and low ac line respectively. Their ratio will be less than unity and hence the proposed method will reduce the switching frequency. The equivalent circuit for the interleaved converter is shown in Figure 1.

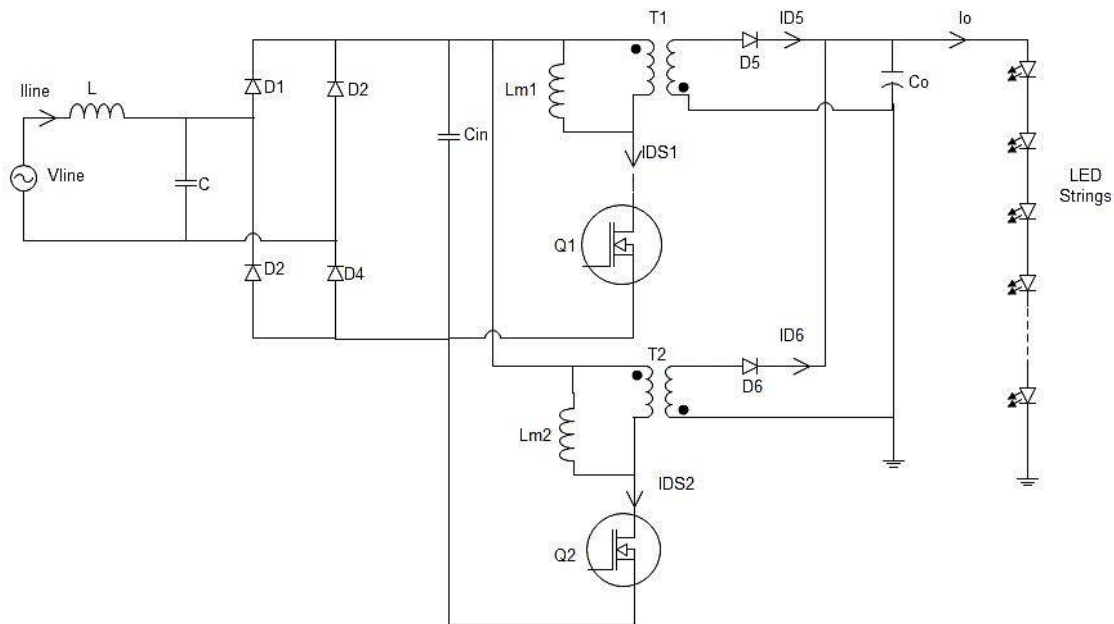


Figure 1: Interleaved flyback converter to drive LED

OPERATION OF THE TOPOLOGY

The interleaved flyback converter operates in the six modes out of which mode 1-3 is similar to mode 4-6 and hence only mode 1-3 is explained. For the ease of the operations of this converter certain assumptions such as the leakage inductance omitted, the magnetizing inductance of both converters alike and both switches 180 degrees out of phase are made. The operation of the circuit in various modes is illustrated in Figure 2 where the (a) represents the operation in mode 1, (b) represents the operation in mode 2, (c) represents the operation in mode 3, (d) represents the operation in mode 4, (e) represents the operation in mode 5 and (f) represents the operation in mode 6. In mode 1, the MOSFET Q1 is ON. The input will be given to the primary side of the transformer T1 and thus energy will be built in the magnetizing inductor Lm1. The diode D5 will be reversed biased and hence the energy stored in the magnetizing inductor Lm2 is transferred to the output. The drain current $IDS1$ of Q1 increases and the diode current $ID6$ decreases. This mode ends when $ID6$ reaches to zero. As this current $ID6$ equals to zero, the mode 2 begins. During this mode, the MOSFET Q1 will remain ON and thus the diodes D1 and D4 to conduct. The magnetizing inductor Lm2 of T2 starts to resonate with the output capacitor CDS2 of Q2. The current flows through D1, D4 and the filter. This mode ends when $IDS1$ reaches zero. When Q1 turns OFF, this mode begins. Hence the diodes D1 and D4 will stop conducting.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

The current flows through CIN. The diode current $ID5$ starts to decrease and the drain current $IDS1$ of Q1 increases. Here both Q1 and Q2 are off. But the internal capacitor $CDS2$ of Q2 will start to charge, thus causing the current $IDS2$ to increase which makes the operation to enter the next mode.

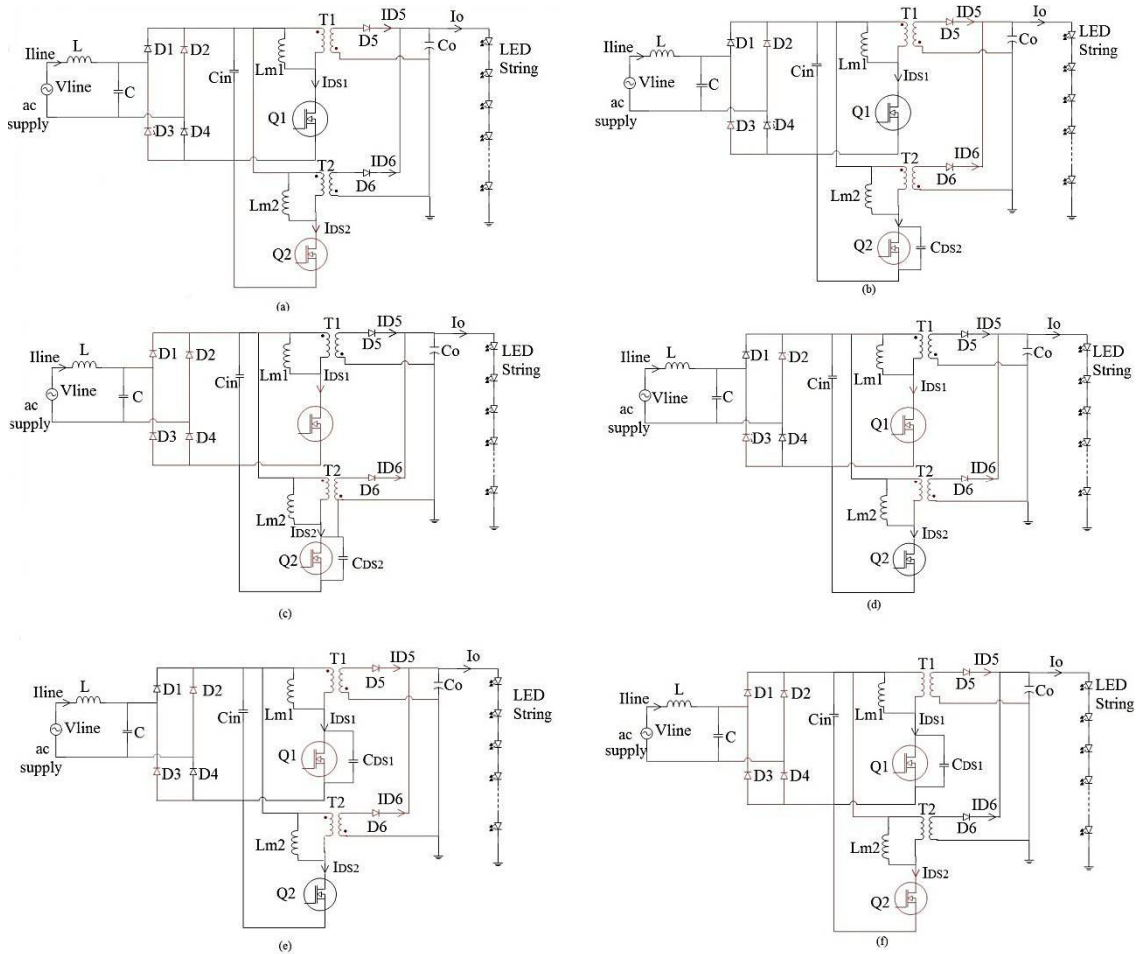


Figure 2: Modes of operation

III. EXPERIMENTAL RESULTS

The operation of this proposed topology is validated and analysed using the MATLAB Simulink. The Simulink model for this topology is shown in the Figure 3. The LEDs units are connected in series and the count will vary based on the requirements.

The MOSFETs are controlled using the Pulse Frequency Modulation technique. The gating pulse for both MOSFETS Q1 and Q2 is shown in Figure 4.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

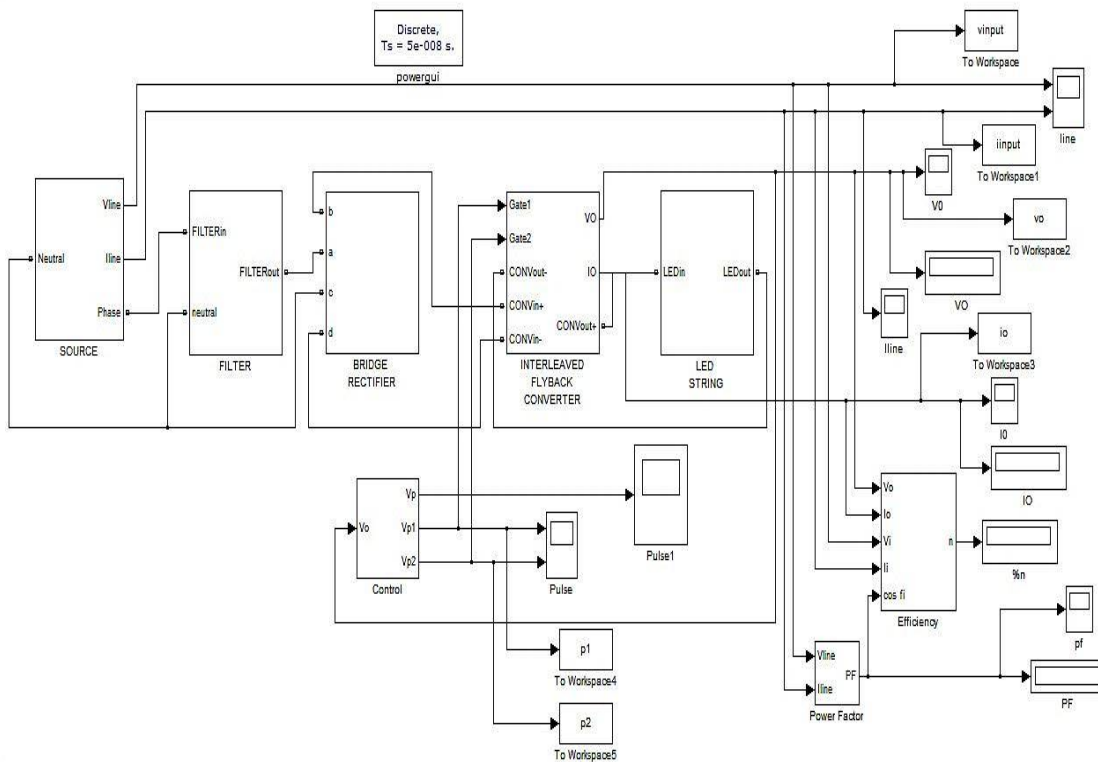


Figure 3: Simulink Model

For a particular time period, the gating pulse of one MOSFET will be 180 degrees out of phase with the other MOSFET. This is done by using equation (1) by taking a constant value m .

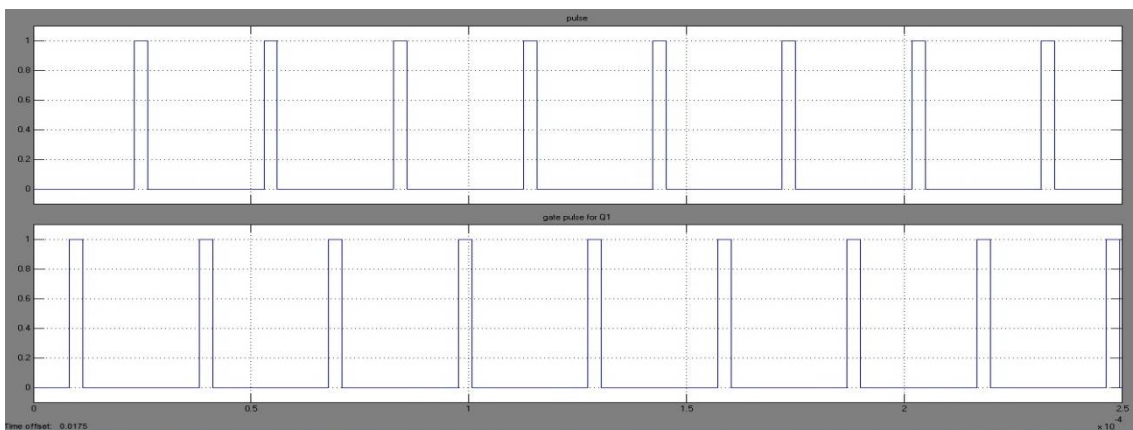


Figure 4: Gating pulse for MOSFETs

The ac line voltage (V_i) and the line current (I_i) are observed and the power factor for this topology is determined. This obtained waveform for this is shown in Figure 5.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

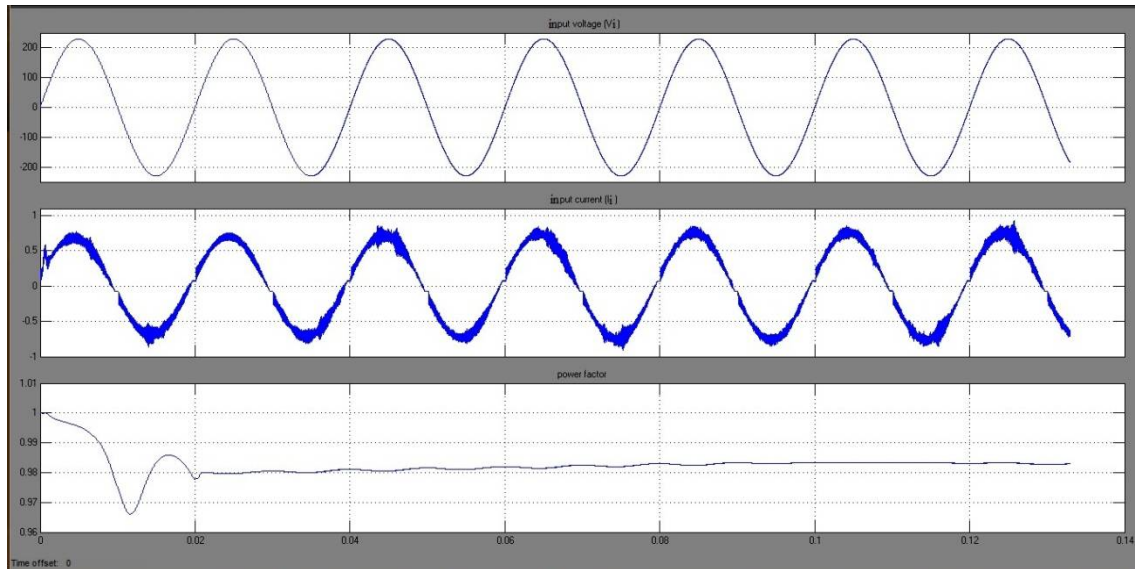


Figure 5: Signal representing waveforms of source along with power factor

The output voltage (V_0) and output current (I_0) for 30 LEDs connected in series is observed in MATLAB Simulink. This is illustrated by the waveform shown in Figure 6.

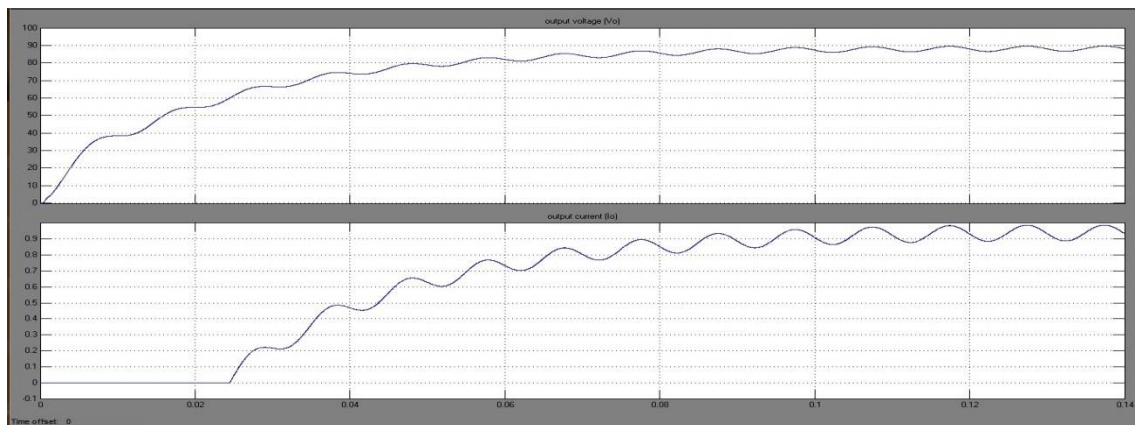


Figure 6: Output waveforms

The diodes present in the rectifier will distort the source ac current. This will lead to inject the THD about 100%. But using the proposed topology the THD present in the line current can be reduced and this is observed using the FFT analysis in the MATLAB Simulink. This is illustrated in the Figure 7.

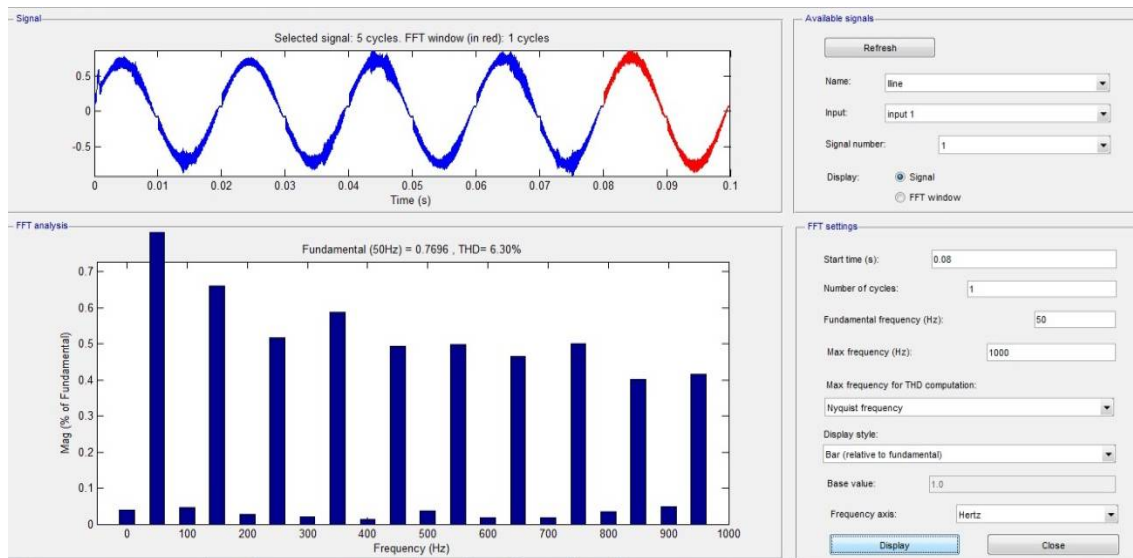


Figure 7: FFT analysis to determine THD

The analysis and the proper validation of this proposed topology which is observed using MATLAB Simulink can be summarised using the Table 1.

Table 1: Observed results

Specifications	Values
Input Voltage	230V ac
Turns Ratio	29:14
Switches	N type MOSFET
Output Voltage	87.32V
Output Current	0.9105
Output Power	80W
Power Factor	0.9833
Efficiency	86.92%
THD	6.30%

IV. CONCLUSION

The outdoor lighting using the LED driver is proposed in this paper. This proposed converter will give the output which is having minimum ripples. Also this proposed topology has higher efficiency, lower THD and best power factor. Using the pulse frequency modulation technique, this proposed conveyer can be used for wide range of output.

REFERENCES

- [1] Yongqiang Zheng and Gerry Moschopoulos, "Design considerations for a new ac-dc single stage flyback converter", Applied Power Electronics Conference and Exposition, pp. 400-406, 2006.
- [2] S. Howimanporm and C. Bunlaksananusorn, "Performance comparison of Continuous Conduction Mode (CCM) and Discontinuous Mode (DCM) flyback converters", The Fifth International Conference on Power Electronics and Drive Systems, 1434-1438, 2003.
- [3] "Electromagnetic Compatibility (EMC)", Part 3, International Standards IEC6100-3-2-2001.
- [4] K. I. Hwu and C.F. Chuang, "Development of interleaved control for the PFC flyback converter", TENCON- IEEE Region 10 Conference, pp.1-4, 2007.
- [5] T. Anuradha and V. Senthil Kumar, "Design and analysis of high efficiency soft switched interleaved flyback converter", International Conference on Power, Energy and Control, pp.325-328, 2013.