AC-DC Flyback Converter For Outdoor Led Lighting

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Abstract

An AC-DC flyback converter for outdoor LED lighting is proposed. In the proposed converter is designed to be operated in the discontinuous-conduction mode (DCM) to achieve a high power factor. A DC-DC flyback module is designed to provide input-output electrical isolation. This improves safety. In addition to this, a low-voltage-rating capacitor can be used as the DC-bus. PSIM based simulations are carried out. This paper addresses a novel approach for designing and modeling of the isolated flyback converter. A detailed analysis and simulation are conferred for flyback converter in discontinuous conduction mode (DCM).
Keywords- LED (light emitting diode), interleaved flyback, PFC (power factor correction), THD (Total harmonic distortion), Design, Analysis and result

I. INTRODUCTION

LEDs are widely used in wide range of applications (Street lights, beacon lights, flood lights etc…). These applications require around 10W- 200W power. An interleaved flyback (Fig.2) converter is designed for 170Vac, 50Hz input to get 90V, 81W output.

Fly-back converter is the most commonly used SMPS circuit for low output power applications where the output voltage needs to be isolated from the input main supply. The output power of fly-back type SMPS circuits may vary from few watts to less than 100 watts. The overall circuit topology of this converter is considerably simpler than other SMPS circuits. Input to the circuit is generally unregulated dc voltage obtained by rectifying the utility ac voltage followed by a simple capacitor filter. The circuit can offer single or multiple isolated output voltages and can operate over wide range of input voltage variation. In respect of energy-efficiency, fly-back power supplies are inferior to many other SMPS circuits but it’s simple topology and low cost makes it popular in low output power range.

A. Advantages of Interleaved Flyback Converter

- Reduced transformer and semiconductor peak currents
- Reduced transformer and semiconductor RMS currents
- Reduced input and output capacitor RMS currents
- Reduction of EMI energy due to lower peak currents
- Distribution of heat generating elements

B. Disadvantages of Interleaved Flyback Converter

- Increased component count
- Possible increase in component area
- Control complexity of interleaved drive signals for Dmax greater than 50%

II. PROPOSED SYSTEM

The single phase AC supply is fed to the EMI filter. EMI filter filters out the noises. The output of EMI filter is fed to the rectifier. Rectifier converts it to DC. The rectifier output is then fed to the interleaved flyback converter. The flyback converter is controlled by pulse width modulation. The regulated dc output is then fed to the LED string. Fig. 1 shows the block diagram

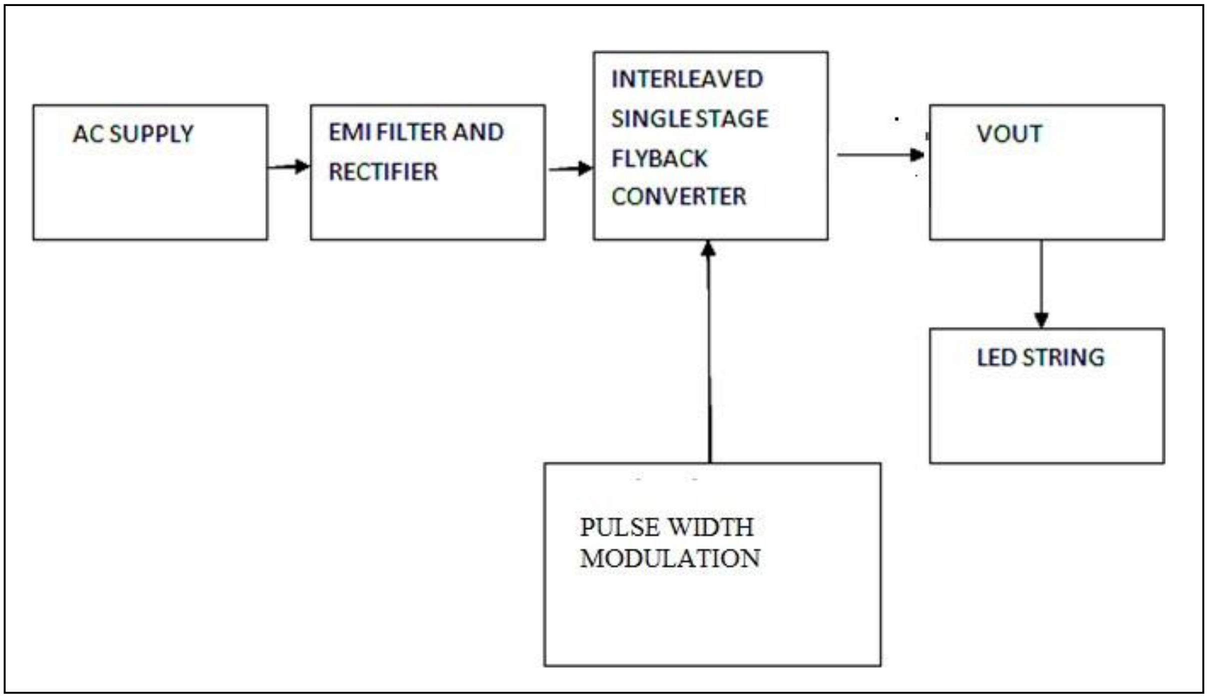

Fig. 1: Block diagram of proposed system

III. PROPOSED CONTROL METHOD

In proposed method discontinuous mode of operation is adopted. This means there will be time delay between turn ON and turning OFF of the switching devices as a result the stress on switching devices will be less and hence efficiency will be more. The sinusoidal pulse width modulation technique is used to control the MOSFET in the flyback converter. In sinusoidal pulse width modulation, triangular wave is the carrier signal and the sine wave is the reference signal. The gating pulses are generated by comparing the reference signal with the carrier wave. This method reduces the power loss in switching device. Fig. 3 shows the PWM signals that are fed to the MOSFET switches Q1 and Q2

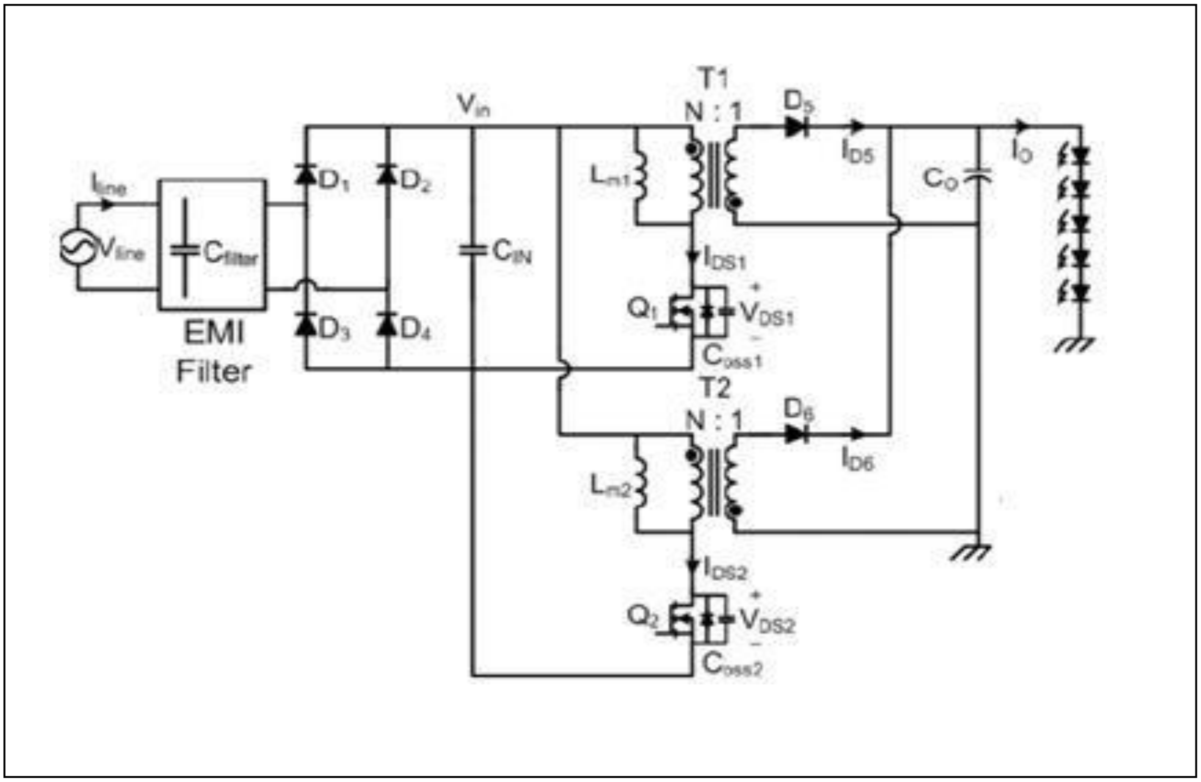

Fig. 2: Interleaved Flyback converter

IV. OPERATING PRINCIPLE

Following assumptions are made for designing an interleaved flyback converter (Fig. 2).

A. Assumptions

1) Transformer leakage inductances are negligible.
2) EMI filter is larger than input capacitance.
3) The magnetizing inductances Lm1 and Lm2 are identical.
4) There is 180deg phase shift between the two switches.

There are 6 modes of operation.

1) Mode 1

In mode 1 Q1 is ON and Q2 OFF. Energy is built into the magnetizing inductor Lm1. The energy stored in the inductor Lm2 is transferred to the output through the Diode D6. The diode current ID6 decreases.

2) Mode 2

When diode current ID6 decreases to zero this mode begins. Q1 is ON, the diodes D1 and D4 conduct. The output capacitor Co discharges and the load gets power.

3) Mode 3

When Q1 Is turned OFF, this mode begins. Energy stored in Lm1 is transferred to output Via D5 which is forward biased at that time. This modes ends when ID5 decreases to zero.
Other three modes of operation are same as the first three modes.

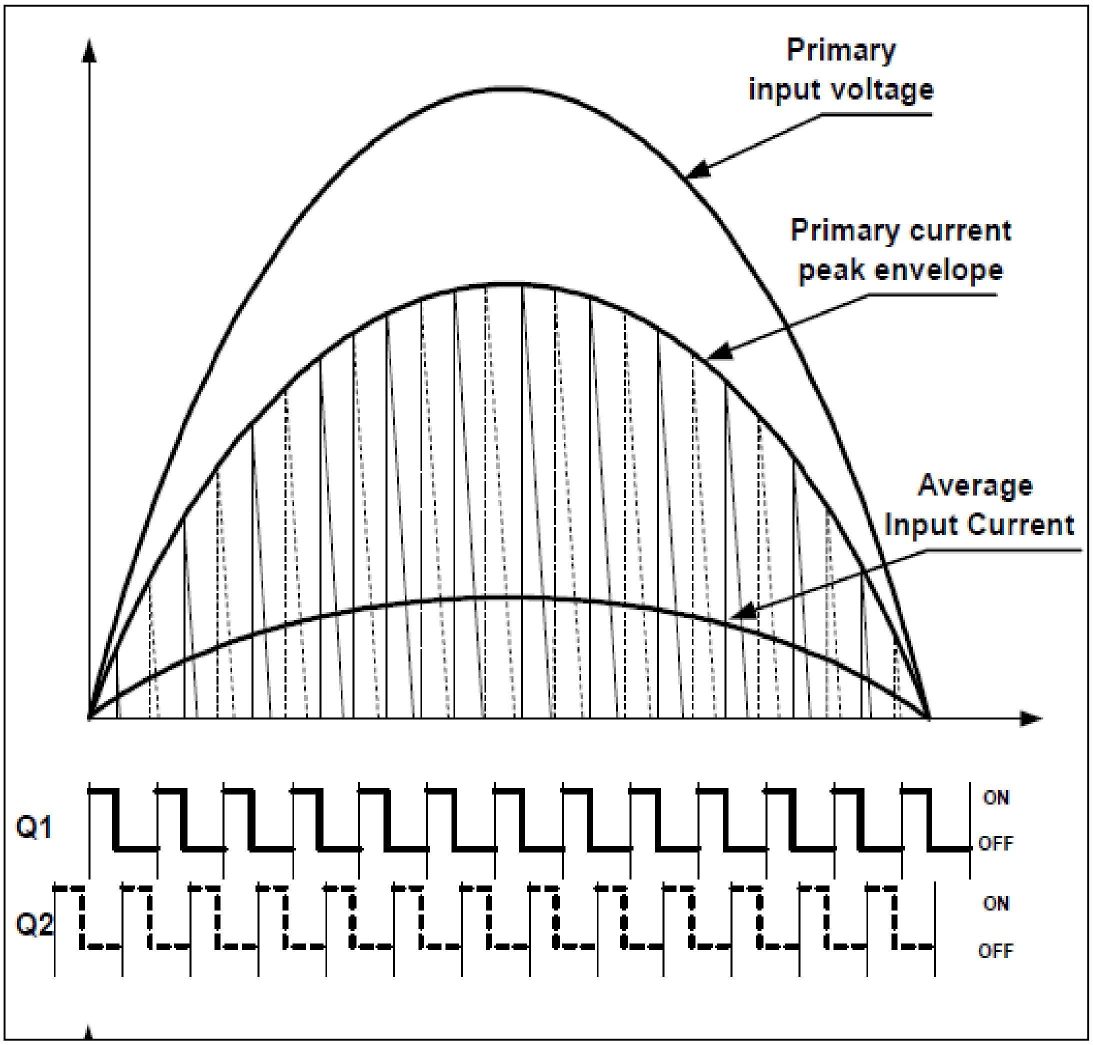

Fig. 3: (A) Input waveforms for interleaved flyback converter, (B) Q1 power switch ON and OFF times, (C) Q2 switch ON and OFF times

V. DESIGN

Table 1: Design requirement

	Symbols	Values
minimum input voltage	Vimin	170Vac
maximum input voltage	Vimax	270Vac
maximum output voltage	Vomax	90
maximum output current	Iomax	0.9A
window utilization	Ku	0.29
switching frequency	Fs	25KHz
converter efficiency	n	90%
maximum duty ratio	Dmax	0.5
Dwell time duty ratio	Dw	0.1
regulation	α	1.0 %
operating flux density	Bm	0.25
Diode voltage	Vd	1.0

VI. SIMULATION

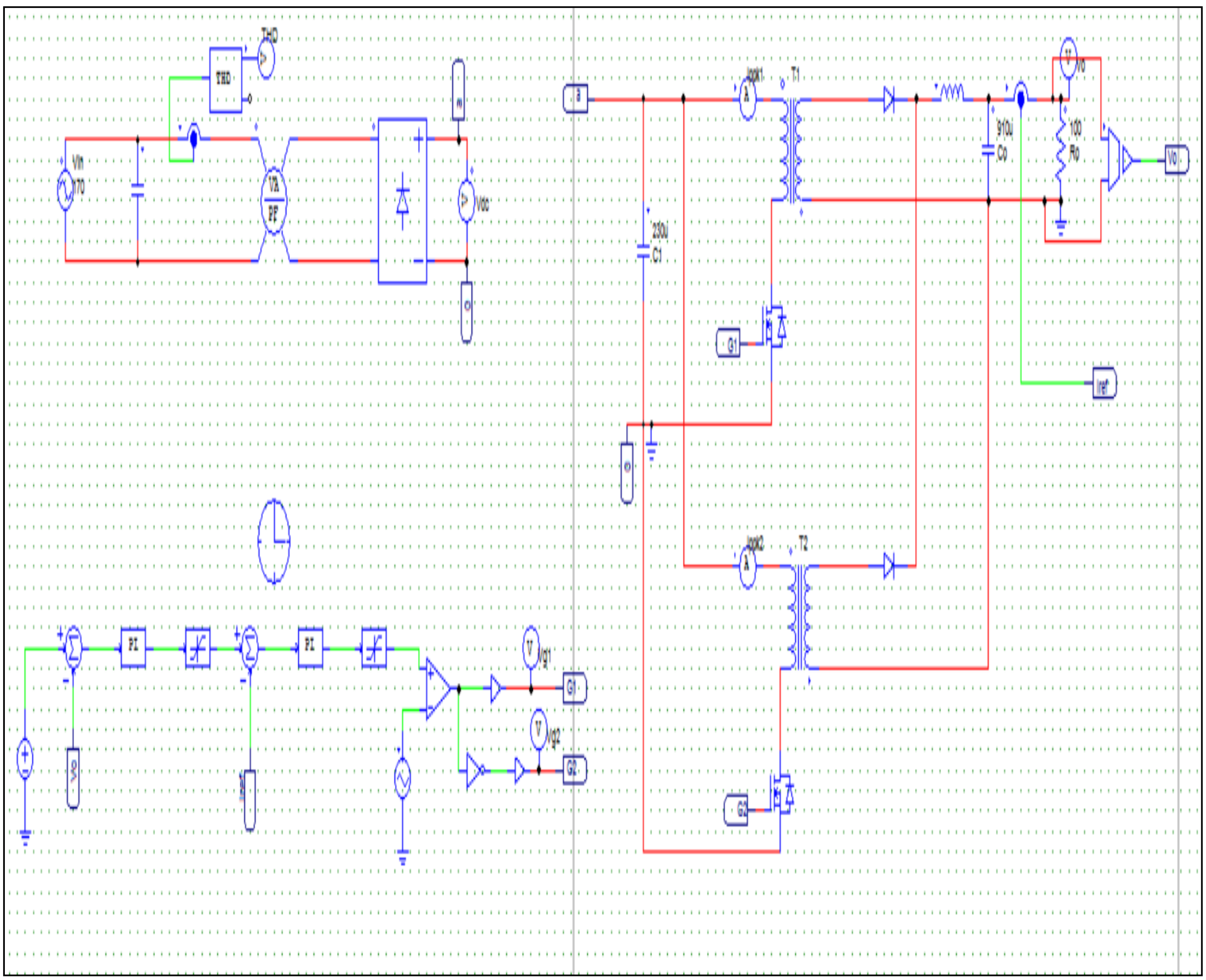

Fig. 4: Psim model of AC-DC flyback converter

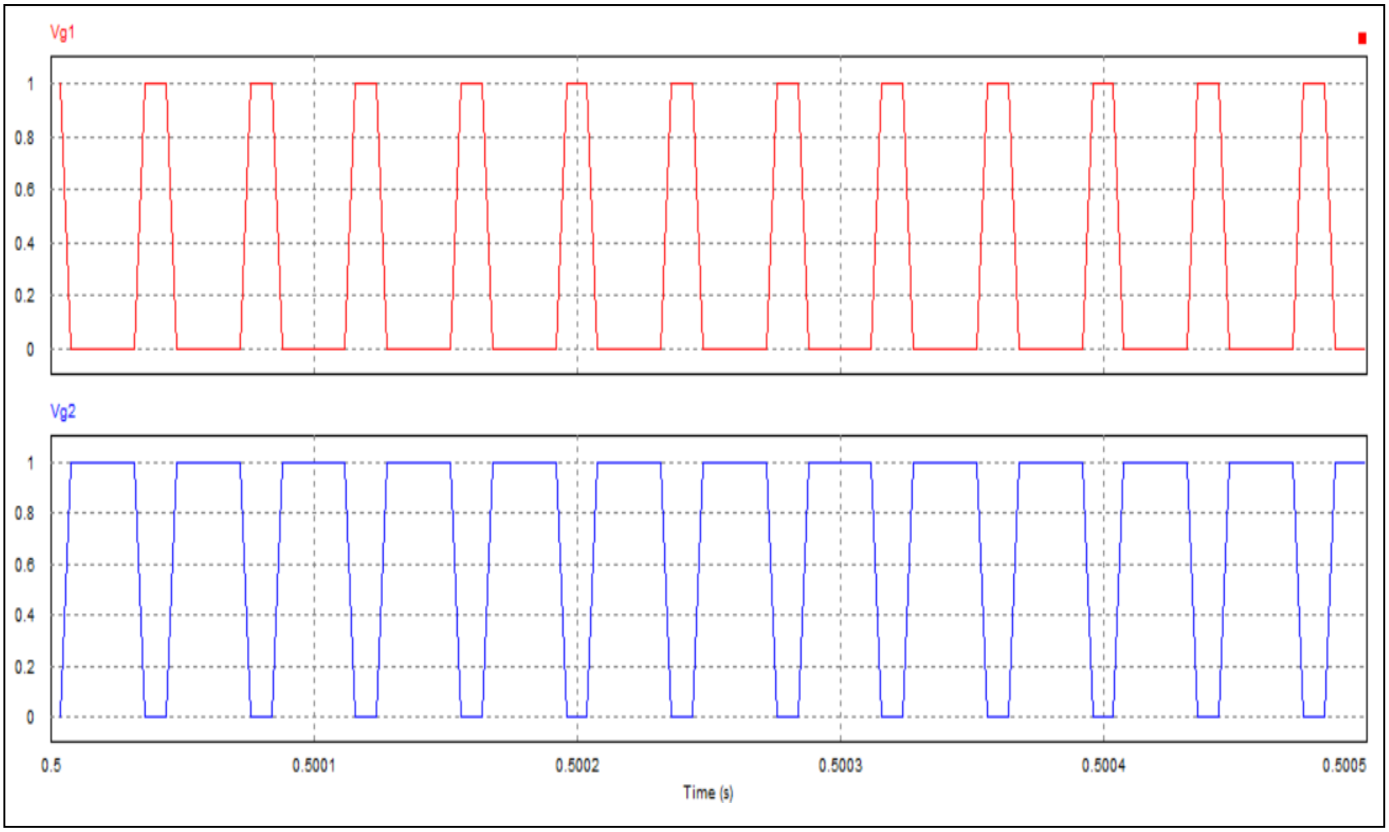

Fig. 5: PWM signals fed to MOSFET switches

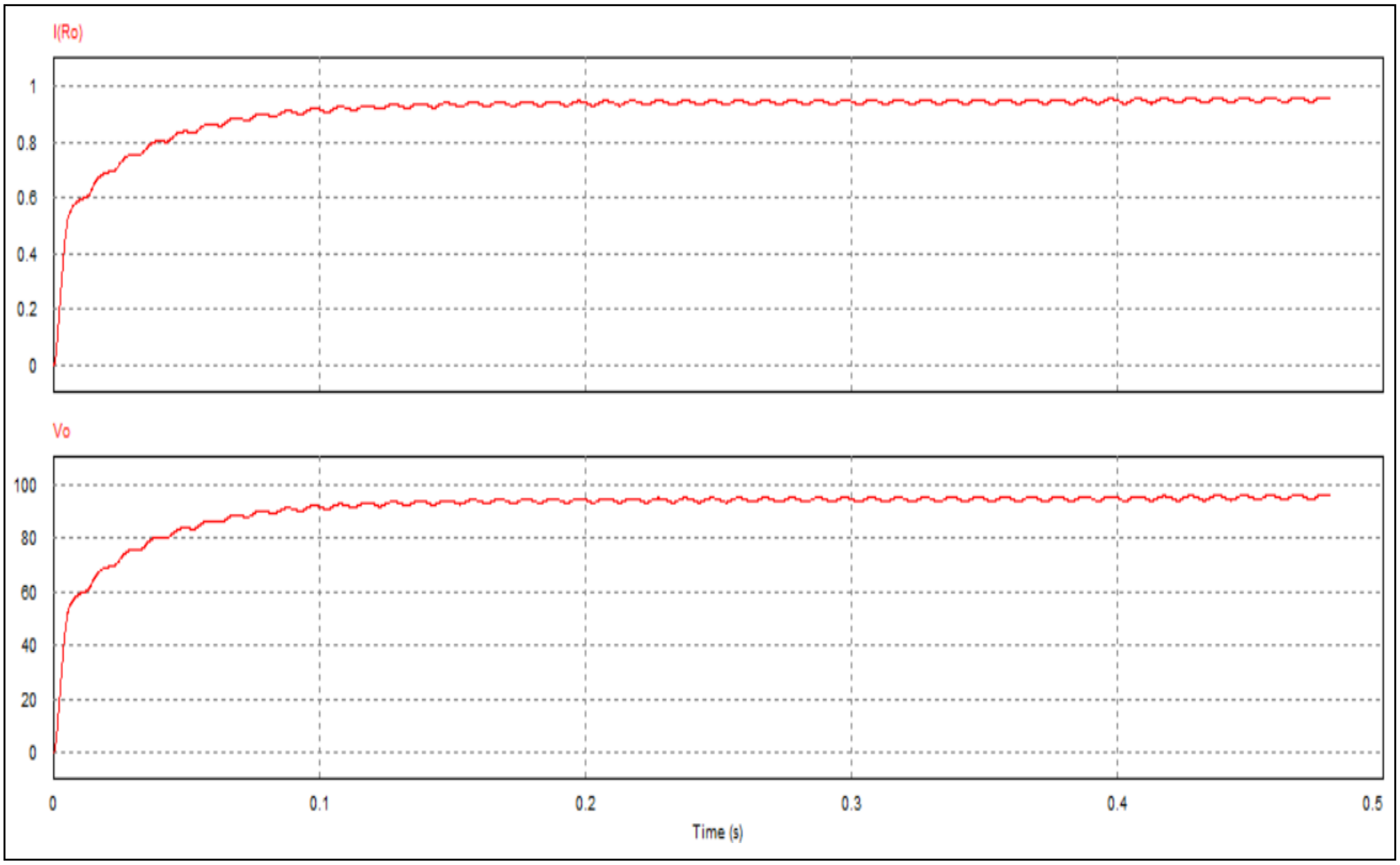

Fig. 6: Output current and Voltages

Table 2: Simulation parameters

Parameters	*Values*
Vin	*170-270Vac*
Vo	*90Vdc*
Io	*0.9A*
Cin	*230µF*
Co	*910 µF*
Magnetisin inductance Lm1=Lm2	*510mH*
Output resistance	*100Ω*
THD	*2%*
PF	*0.62*

VII. CONCLUSION

An LED driver is presented. This proposed converter provides regulated output with very low ripple content. In closed loop we get 2% THD and 0.62 power factor. Hence an interleaved single-stage flyback ac-dc converter operating in the DCM mode is an appropriate choice for wide output range LED applications.

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