International Journal of Modern Science and Technology *Vol. 1, No. 9, December 2016. Page 324-328.*
http://www.ijmst.co/ ***ISSN: 2456-0235.***

Research Article

Implementation of High performance LEDs using drivers triggered with PWM Technique

T. D. Sudhakar, H. Prasad

Department of Electrical and Electronics Engineering, St. Joseph's College of Engineering, Chennai – 600 119. India.

*Corresponding author's e-mail: t.d.sudhakar@gmail.com

Abstract

Light-emitting diode is a semiconductor technology whose application to general purpose lighting is rapidly growing, with significant room for energy savings. LED devices perform exceptionally well in lab conditions, proving more efficient than incandescent lights by a factor of 10. Now-a-days usage of High Brightness LED to give more Brightness and also with less power consumption is being promoted on a large scale. These LEDs overcome the existing technology like Halogen and HID. For example, the incandescent lamps are producing 12-15 lumens per watt and fluorescent bulbs are producing 40-45 lumens per watt. High Brightness LEDs are found to be efficient in saving energy than incandescent and fluorescent lamps. Another area in which Power LEDs have major potential is the product's lifespan. By implementing suitable driver by means of converter triggered with the help of PWM pulses, one can achieve highly efficient operation of these High Brightness LEDs. This paper discusses such an implementation methodology.

Keywords: Light-emitting diode; High Brightness LEDs; Driver; Converter; Microcontroller.

Introduction

The Department of Energy (DOE) has recognized the necessity to support the development of solid-state lighting with a strong research program. By January of 2008, funded research projects had resulted in 18 solid-state lighting patents [1]. In FY2007 this program had received huge grants in congressional appropriations, and the present value of investment contracts amounts to $74.8 million (Wright, 2008) [2]. According to a comparison of DOE forecasts versus actual progress, the performance of LED solid-state lighting is found to improve much more rapidly than anticipated, and this trend is expected to continue. Analysts attribute the rapid progress in part to strong support provided by the DOE program of innovative U.S. firms, including Philips Lumileds and Cree [3].

Meanwhile, efforts are being made to develop new and competitive standards and rating systems to keep up with the quickly changing market [3]. The much-anticipated ENERGY STAR Solid-State Lighting program, a new labeling system similar to the more general set of standards for energy efficient products, was put into effect on September 30, 2008 (LEDs Magazine, 2008b) [4,5]. The solution leads to a problem whether for a lamp that has to be compatible with an existing socket (Incandescent, CFL and Halogen) or for a new luminaire [3]. In the lamp replacement market LED lamps must conform to the guidelines or existing constraints but at the same time not introducing new issues [6,7].

Existing infrastructure use a variety of dimming circuits and control circuits that provide some bottlenecks for LED based solutions. For the want of efficiency LED drivers use switching solid state inverters to convert between the nature of input voltage and the current for the LED [8,9]. Due to high currents, there is the potential to generate electromagnetic interference (EMI). LED lamps perform efficiently than conventional solutions but the lamp still generates heat. The LEDs need to be manipulated carefully to avoid excessive junction temperatures so the heat sink is typically a significant proportion of the lamp cost. Heat is also the enemy of other components such as electrolytic capacitors that can dry out and cause reliability issues. Power factor –

Received: 13.10.2016; Received after Revision: 10.12.2016; Accepted: 12.12.2016; Published: 13.12.2016

incandescent and halogen lamps are essentially resistive elements but LED lamp drivers can look capacitive so that power factor correction is required [3,10].

Phosphor white lamps use blue LEDs to drive a phosphor that generates white light. The phosphor can be within the LED or remote from it. Conventional phosphors can be used but there are also companies such as Nanoco (UK) developing quantum dot based materials. Optics–LEDs emit over a relatively narrow solid angle compared to existing technologies [4]. Similar issues arise with the design of luminaires although the increased reliability presents new design opportunities [1,2]. Shailesh et al discussed the various testing considerations for LED based lighting solutions [6]. Low cost LED soluations are also being developed thanks to specialized AC- DC converters [7]. Though there are several challenges the industry faces Overall there is considerable scope for innovation in the design of LED based solutions [5].

Proposed work

Power supply unit

All the electronic circuit works only in low voltage, so we need a power supply unit to provide appropriate voltage supply for their proper functioning. This unit consists of transformer, rectifier, filter and regulator. AC voltage of typically 230 rms is connected to a transformer voltage down to the level of desired AC voltage. A diode rectifier is used to provide the full wave rectified DC voltage i.e. initially filtered by a simple capacitor filter too produce a DC voltage. This resultant DC voltage usually has some ripple or AC voltage variation. A regulator can use this DC input to provide DC voltage maintains the same DC value with lesser ripple factor. The diagram for converter circuit is given in figure 1.

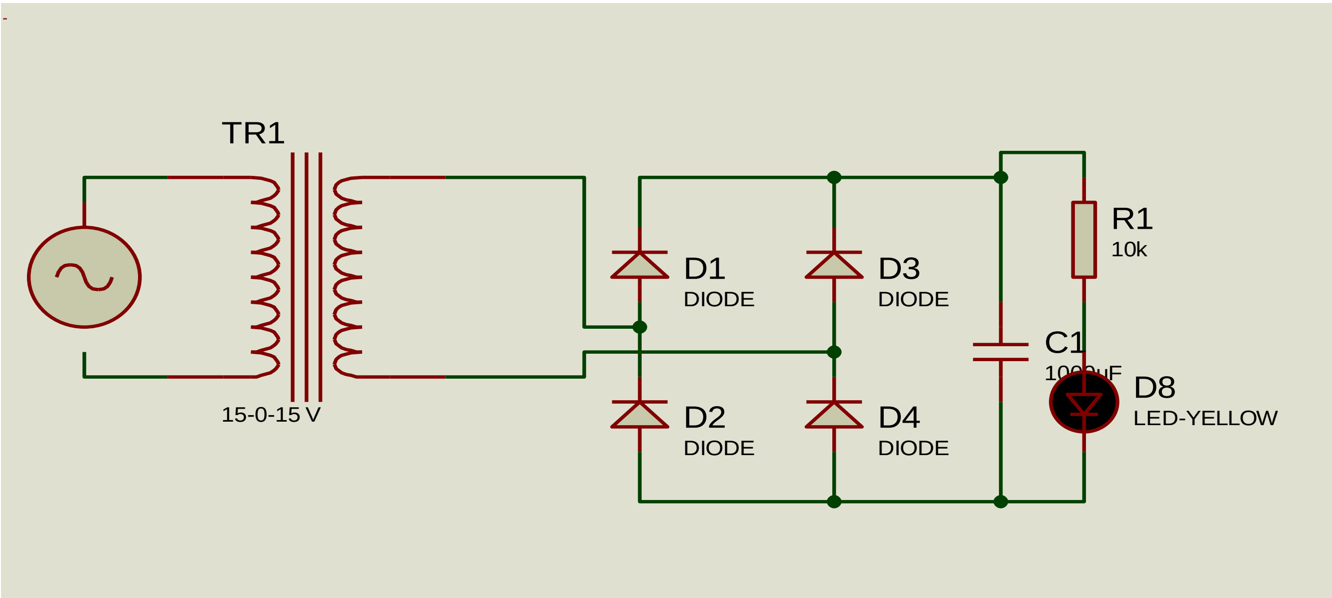

Figure 1. Proposed implementation diagram of the converter

Working

The 230V, 50Hz single phase AC power supply is steeped down using a suitable transformer to get a 12V supply. This AC voltage is converted to DC voltage by using a bridge rectifier. The converted DC voltage is filtered by a capacitor and then given to 7805 voltage regulator to obtain a constant 5V supply. This 5V supply is given to microcontroller for its operation.

Switching logic

The switching frequency for the switches is 30 KHz. We need to trigger the three power switches in the inverter Q_1 respectively for positive half cycle and Q_2 need to be trigger for negative half cycle. The pulse generation method is for open loop control method and for closed loop purpose the temperature which is sensed is feedback to the microcontroller and it is compared with the set temperature and error signal is generated according to positive or negative error the turn on time will increase or decrease depends upon the application. The process continues until the control circuitry is switched off. The simple analogy pulse train is as shown below in figure 2. The Simulation is done using MATLAB/SIUMLINK. The frequency used for carrier signal is 2000 HZ. The PWM pulse generation block set is shown in figure 3.

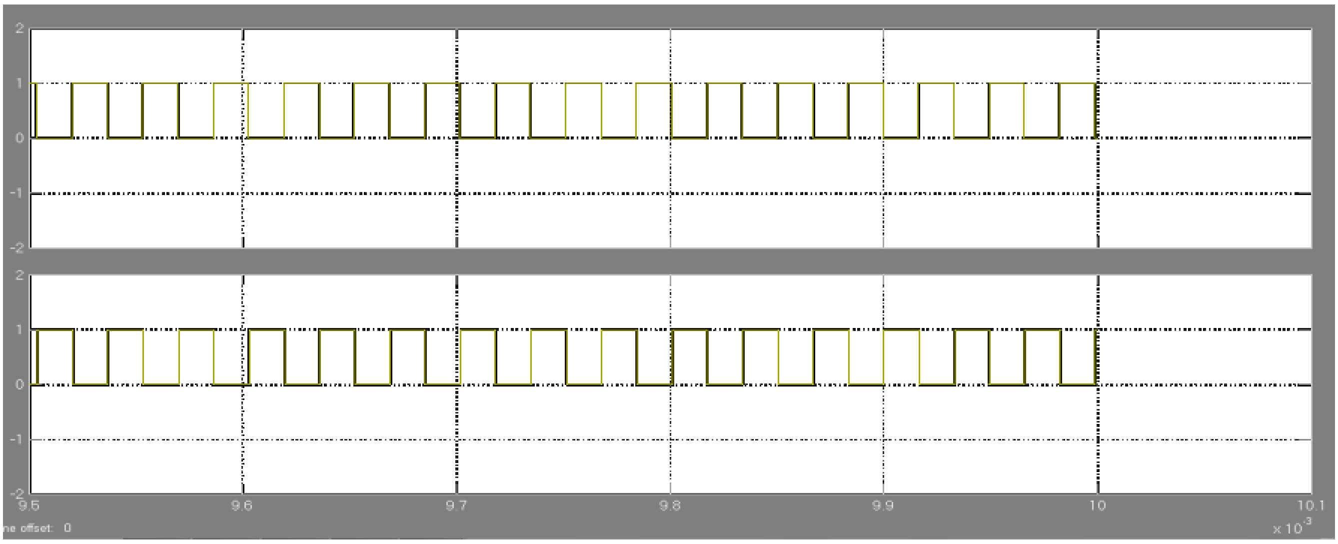

Figure 2. Switching logic waveform

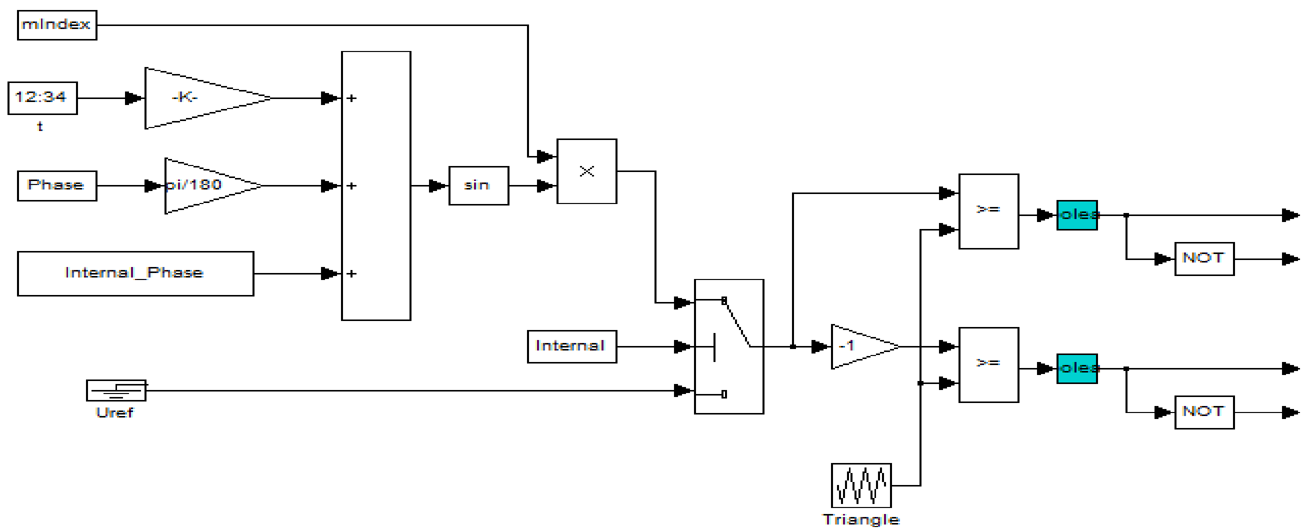

Figure 3. PWM Pulse generation technique

Driver Circuit

The drive circuit usually isolates the control unit and the power unit and ensures the safe operations of the equipment. The 16F877A microcontroller is operated at 5V whereas the converter circuit will be operating at 220V. There is a need of isolation between low voltage side and high voltage in order to avoid heavy inrush current. The heavy inrush current will occur when there is a short circuit in the load side. This will affect the control circuit also. In this project, IR2101 (high and low side driver) is used for the isolation of power circuit and control circuit.

Some of the features of IR2101 are (i) Floating channels designed for bootstrap operation, (ii) Gate drive supply of 12 voltage and (iii) Under voltage lockout for both channels. The Schematic of the Driver circuit is given below in figure 4. The overall implementation diagram is given in figure 5 which shows the entire circuit.

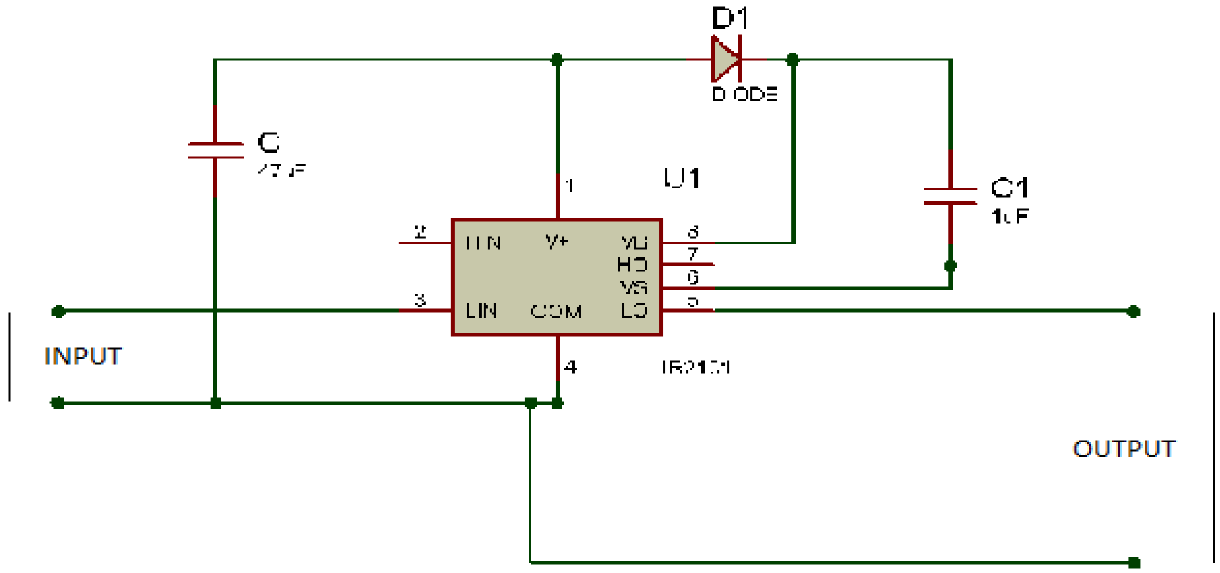

Figure 4. Driver circuit implementation

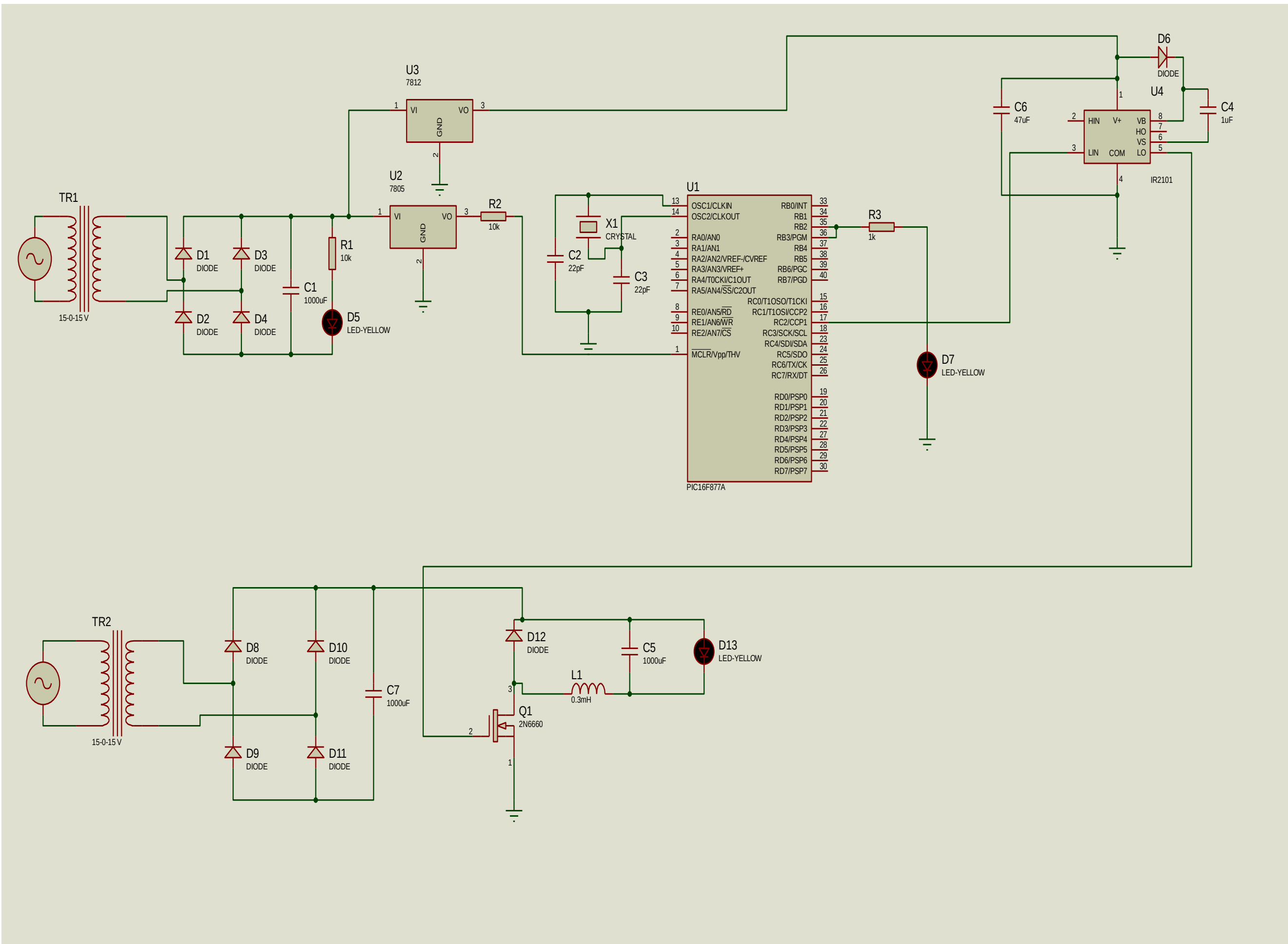

Figure 5. Full implementation diagram

Conclusions

The application explained here is the implementation of High Brightness LED with the help of PWM and a converter. Here, the motto is giving 15 volt supply and getting high brightness with low power consumption. And also for a frequency of 20 KHZ a T_{ON} and T_{OFF} time of 20us and 20us is achieved. Even though this demonstration is intended for many applications especially for automotive applications, the concepts and solutions described herein can be applied to many other industrial and consumer applications that use High brightness LEDs. Here low voltage levels are used for this demonstration. But this same application can be applicable to higher voltages also. And care should be taken with the ratings of devices used.

Conflict of interest

Authors declare there are no conflicts of interest.

References

[1] Qu X, Wong SC, Tse CK. A current balancing scheme with high luminous efficacy for high-power LED lighting. IEEE Transactions on Power Electronics. 2014;29:2649-2654.
[2] Arias M, Diaz MF, Cadierno JER, Lamar DG, Sebastian J. Digital implementation of the feed forward loop of the asymmetrical half-bridge converter for LED lighting applications. IEEE Journal of Emerging and Selected Topics in Power Electronics. 2015;3:642-653.
[3] Gereffi G, Lowe M et. al. LED Lighting. Centre on Globalization Governance and Competitiveness. 2008.
[4] Narendran N. Improved Performance white LED. Fifth International Conference on Solid State Lightning. Bellingham:2005
[5] Adragna C, Ferrazza F, Gritti G. The Seven Challenges of LED Lighting. PCIM Europe International Exhibition and Conference for Power Electronics, Intelligent Motion, Renewable Energy and Energy Management. 2016.
[6] Shailesh KR, Kini SG, Kurian CP. Summary of LED down light testing and its implications. 10th IEEE International Conference on Intelligent Systems and Control. 2016.
[7] Nigsch S, Marquart J, Schenk K. Low cost high density AC-DC converter for LED Lighting Applications. PCIM Europe International Exhibition and Conference for Power Electronics, Intelligent Motion, Renewable Energy and Energy Management. 2016.
[8] Xu R, Li Y, Zhong L, Liu J. Research of an Efficient LED Lighting Driver Based on Boost-Buck Converter. Circuits and Systems. 2014;5:153-159.
[9] Jiang Y, Zhang D, Yu M. A novel integrated circuit driver for LED Lighting. Circuits and Systems. 2014;5:161-169.
[10] Jettanasen C, Pothisarn C. Analytical study of harmonics issued from LED lamp driver. Proceedings of the International Multi Conference of Engineers and Computer Scientists. Hong Kong:2014.

****

