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DESIGN OF LED LAMP DRIVER FOR AUTOMOTIVE APPLICATIONS USING FLYBACK CONVERTER

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Abstract

The paper designs and develops an efficient DC-DC converter to drive the LED lamps for head lamps to replace the halogen lamps for automotive application. This is achieved by using Fly back converter implemented in LED driver circuit. By using the Fly back Converter to drive LED lamps in place of halogen lamps improves the lifespan of lamp and illumination can be controlled easily using driver circuits. Also glare can be avoided in head lamp.

Key Words : LED, DC_DC converter, Flyback Converter, Illumination, Halogen Lamps

1.Introduction

Over the past years, we have been using halogen and HID lamps in automobiles. In recent years researches are going on in LED lamps for all our lighting applications. LED lamps consume less power for the same luminance compared to the traditional halogen lamps. Also the luminance of the LED lamps can be varied from minimum to maximum with the help of the drivers. LED has longer lifespan compared to halogen lamps. For these reasons we are going to replace halogen lamps with LED lamps.

The automobile's demand for electrical power has been growing. Although the fuel efficiency of the automobile is primarily determined by vehicle weight, aerodynamic drag and engine efficiency, supplying electrical power impacts fuel efficiency by adding vehicle weight of electronic components and by the power consumed by the alternator.

But, with advancements in light-emitting diode (LED) developments, LED's in automotive applications is expected to increase drastically in the next 10 years. With LED prices

lowered to a tenth of the current price, LED's will be even more competitive compared to conventional light sources.

Unlike traditional automotive light sources, LED's are much more temperature-sensitive and using them in a design requires knowledge of the structure and behaviour overtime, as well as suitable thermal management system like heat sink. The efficient lighting designers can optimize the design to ensure a long lifetime of the LED's. They can more effectively use LED's as a light source thus enabling better growth of overall LED use in the automotive industry.

In this way, their luminous efficiency is quite higher than that of incandescent bulbs in a lighting equivalent incandescent lamp, performing also a series of features that make them quite interesting for their application in automotive lighting. Among those advantages, LEDs perform monochromatic light which makes the use of low efficiency absorbing filters unnecessary, tiny size of the signals, instantaneous light up (especially interesting for brake lights), and a quite high operation life, reaching 50,000 hours for a luminous attenuation of only a 30%, higher than the operation life of the car itself.

There are many converters available to drive the LEDs. In this paper we are using flyback converter to drive LEDs. Flyback concept provides galvanic isolation between load and supply. In future we are likely to use LED lamps in all our lightning applications and this is the stepping stone for that vision.

2. Project description

This system has three switches one is used for ON and OFF operation of headlamp. The other two switches are used for low beam and high beam operation. When supply switch is turned on, flyback converter converts the input voltage into discrete spikes of dc voltage in the output with a certain frequency. This frequency is determined by the gate pulse given to the switch (MOSFET) connected in series with the flyback transformer.

Thus supply is given to the LEDs at certain frequencies. At higher frequencies it provides continuous supply to the load. So far we are using halogen and HID lamps in automotive applications. Since the invention of automobiles, we are using the halogen and HID lamps in automotive applications. But, in this project our aim is to replace LED lamps instead of halogen and HID lamps.

In this project we are replacing the existing halogen and HID lamps with LED lamps. By using a Fly back transformer, we are going to produce an more efficient LED lamps, which give good efficiency to drive the LED lamps in automotive applications.The light intensity of the LED lamps can be controlled easily with the help of the driver. Also, by

using the LED lamps the glare produced by the halogen lamps can be ignored. Also to produce the same amount of luminance, LED uses less power compared to halogen lamps.

2.1. Circuit Diagram

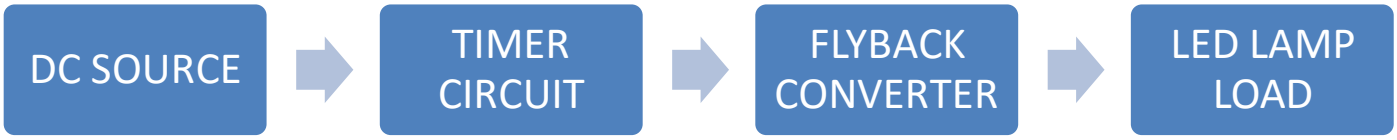

Figure 1.Block diagram

A 6V battery is used here for the power supply for the circuit. The vehicle battery is taken as the DC source. IC 555 timer is used to generate pulsed output which is used to drive the high speed switch (MOSFET). The gate pulse can be varied using timer circuit. The Fly back converter is used to produce high voltage and provides galvanic isolation between source and load. Power LED provides required illumination which is sufficient to use in automobiles.

Fly back converter is connected in parallel with battery and series with high speed switch (MOSFET). When MOSFET is on primary side of the fly back transformer energizes and load is supplied by the output capacitor. When MOSFET is off secondary side of the fly back converter is energized by the primary side and supplies the load as well as charges the output capacitor. By this way continuous supply is given to the load (LED lamps).

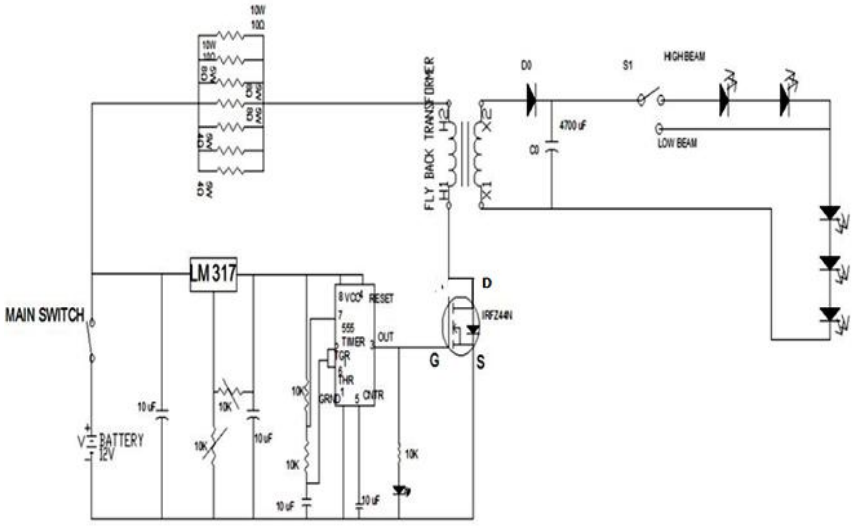

Figure2.Circuit Diagram

2.3. Working of fly back converter

When main switch is turned ON, the battery supply is given to the voltage regulator (LM 317), thus the variable voltage is achieved by the adjust pin of LM 317, thus the variable voltage is given to the 555 timer circuit. 555 timer has a variable resistor, between discharge pin and trigger pin. The Frequency of the 555 timer output signal depends on the resistors R_1,R_2 and Capacitor C.

By varying the resistor R_2, the frequency of the output signal can be varied. This output pulsed signal is connected to the gate pin of the MOSFET(switch). An Indicator LED is connected across the output of the 555 timer and negative terminal of the battery, which is used to indicate the pulsed output signal of the 555 timer. When the gate pulse signal is high, MOSFET get turned ON, which energies the primary side of the Fly back Transformer, as it is connected across the battery through three parallel connected MOSFETs.

During this period (ON State), Load (LED) is supplied by the Capacitor. When the gate pulse is low, MOSFET get turned off. The energy stored in the primary side of the fly back transformer is transferred to the secondary side, which in turns supplies the load and charges the output capacitor C_o.This cycle continues during each ON and OFF states of MOSFET. When switch S1 turned ON to high beam side, all five 5 watt LEDs will be operated as they are connected in series. When switch S_1 turned ON to low beam side, only three 5 watt LEDs will be operated. Thus LEDs can drive in both continuous and discontinuous modes by varying the variable resistor R_2.

The fly back converter is used in both AC/DC and DC/DC conversion with galvanic isolation between the input and any outputs. The fly back converter is a buck-boost converter with the inductor split to form a transformer, so that the voltage ratios are multiplied with an additional advantage of isolation. The schematic of a fly back converter can be seen above. It is equivalent to that of a buck-boost converter with the inductor split to form a transformer. Therefore the operating principle of both converters is very close.

3. High power LEDs

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a PN junction diode, which emits light when activated by electroluminescence effect. Recent development in LEDs allow them to uses in different applications like indoor lighting, outdoor lighting, automotive head lamp and back lights, general lighting etc., But they are designed for high power capacity called high power, high brightness lamps which need careful design in electrical and thermal aspects. In this project high power LEDs with greater than 1watt power capacity is used as head lamps as string. They are arranged in circular fitting and LEDs are arranged in it to make one lamp.

4. Hardware details

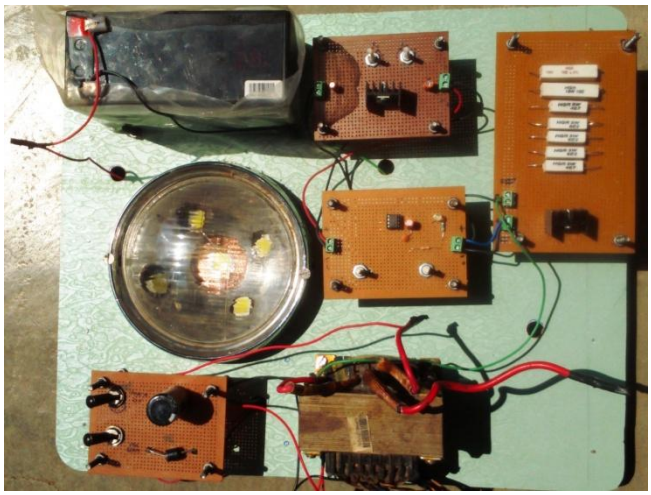

Fig 3. Hardware setup

The battery supply is turned ON , by switching on the main switch of the supply. The 555 timer circuit produce the gate pulses to the MOSFET (switch), which gives the supply to the fly back transformer. The LED lamps are fed by the supply from the Fly back Transformer. A switch S_1 is placed for controlling the High beam and Low beam of Headlight. In the High beam of head light, all the five 5 watt LED's are operated providing the high beam of head light. When the switch S_1 is changed, only three 5 watt LED's are operated thereby providing the Low beam operation. The total luminance of the LED can be varied by the Variable Resistors R_1 and R_2.

By varying the resistor R_2, the frequency of the output signal can be varied. This output pulsed signal is connected to the gate pins of the three MOSFETs, T_1,T_2 and T_3. Thus, the luminance of the head light gets varied.

(i) High beam (ii) Low beam

Fig 4. Light output for high beam and low beam

5. Conclusion

In this paper a low cost LED lamp is designed for automotive application. The results show that this method is feasible for any vehicle due to low power consumption property, no glare problems as in halogen lamps, easy to control illumination of lamp and other design features. But this method still needs further improvement in thermal aspects.

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