Optimization and Comparison of various Applications of LTC3783

Harish Sharma[1] Manoj Kumar[2]
[1]P.G Scholar [2]Assistant Professor
[1,2]Department of Electronics & Communication Engineering
[1,2]B.R.C.M CET Bahal Haryana

Abstract— This paper presents designing of a low power LED driver circuit, Single Inductor Buck-Boost Application with Analog Dimming and Low Frequency PWM Dimming and PWM LED boost application. The operation principles and design considerations of the studied LED driver and buck-boost application can be analyzed in LT spice software. The current mode PWM (pulse width modulation) controlled boost converter for power LEDs application is introduced. Besides, the current mode PWM controller is used to ensure the system is stable. In all the circuits the input range is 9v to 26v and the output is boosted accordingly. The calculations are based on design specifications.

Key words: LT Spice, PWM, LED Driver Circuit, Buck-Boost

I. INTRODUCTION

Currently, the advancements in the high-power LED are increasingly finding new application in emergency lights, street lights, traffic lights, automobiles, cars, flashlights and general purpose lighting. Because of their superior longevity, low maintenance requirement, improved luminance, there is no mercury inside the devices. Therefore, they perform an extremely longer operating life than other lighting sources. LEDs come in two basic categories which are low power LED and high power LED. Low power LEDs commonly come in 3, 5 and 8 mm sizes. These are fractional wattage devices, typically 0.1 W, operate at low current (~20 mA) and low voltage (3.2 V DC), and produce a small amount of light, perhaps two to four lumens. For high power LEDs, they commonly come in 1-3 W packages. They are driven at much higher current, typically 350, 700 or 1000 mA, and with technology can produce 40-80 lumens per 1-W package. High power LEDs come in many different shapes and sizes [1].LED driver is regulated power supply designed to match the characteristics of an LED or array of LEDs in our application. The LED current can vary substantially over the battery voltage range even in normal operation device, thus affect the brightness and reduce the life of the lighting device. This project presents a method for the system that provides more efficient solution for driving a low power LED driver by control the LED current and to improve the usage of LEDs in good luminosity, efficiency and long life service. The current mode PWM (pulse width modulation) controlled boost converter for power LEDs application is introduced. According to the characteristic of the power LEDs, they are current controlled devices. Typically, the switching converters are used as the driver for power LED. For this project, the boost topology is selected as the power LEDs driver. Besides, the current mode PWM controller is used to ensure the system is stable. The project used LTC 3783 as PWM control IC and connected to driver circuit to drive low power LED [2]. The calculations are based on design specifications. LT Spice software is used for the simulation before the built hardware implementation. The buck-boost is a popular no isolated, inverting power stage topology, sometimes called a step-up/down power stage. Power supply designers choose the buck-boost power stage because the output voltage is inverted from the input voltage, and the output voltage can be either higher or lower than the input voltage. The topology gets its name from producing an output voltage that can be higher (like a boost power stage) or lower (like a buck power stage) in magnitude than the input voltage. The conduction mode of a converter is a function of input voltage, output voltage, output current, and the value of the inductor.

II. DESIGN METHODOLOGY

In this section, the steps to make sure this project was done successfully will be discussed from the beginning until the project was implemented successfully. Firstly, the simulation of LED driver and single inductor buck boost application was done by using LT Spice software. The main purpose of this result is to determine all the power components values in the boost converter power stage design. Secondly, the schematics design by refer some information from books, internet, and paper to represent the circuit of boost converter and led driver into graphic symbols. After designing the schematic circuit, the components that have been selected as per specific requirement to obtain the suitable component value are to be used in the analysis. The figure 1 shows Single Inductor Buck Boost Application with analog dimming. Due to the availability of high side current sensing mode, the LTC3783 is also well-suited to a boost converter in which the load current is returned to V_{in}, hence providing a load voltage (V_{out}– V_{in}) which can be greater or less than the input voltage V_{in}. This configuration allows for complete overlap of input and output voltages, with the disadvantages that only the load current, and not the load voltage, can be tightly regulated. The switch must be rated for a maximum drain to source voltage of MOSFET equal to V_{in}+V_{load}. The design of this circuit resembles that of the boost converter above, and the procedure is much the same, except V_{out} is now (V_{in} + V_{load}), and the duty cycles and voltages must be adjusted.

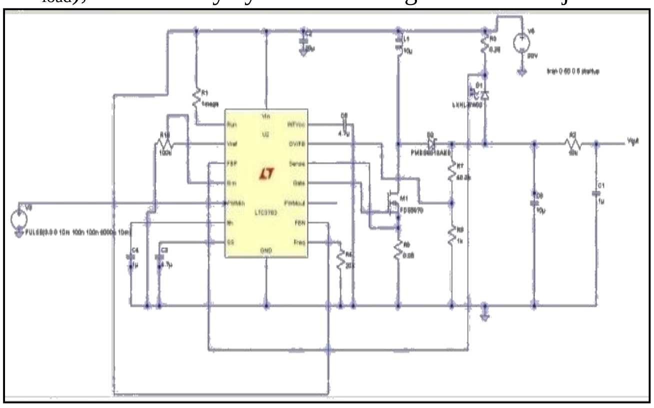


Fig. 1: Single inductor buck boost application with analog dimming.

In the linear regulator, BJT (bipolar junction transistor) will be used with the operation in active region. The load current (collector current) is controlled by the value of the base current. In order to produce a large load current, a Darlington pair BJT is used. However, the power dissipation of the BJT is very big due to high current flow. The BJT may be burnt [3]. Due to the high power loss in the BJT, it is replaced by an alternative current controller, called PWM controller. The main advantage of the PWM controller is that it has better efficiency and can be widely applied to LED driver circuit. PWM controller is a control device which can be used as VMC (voltage mode control) and CMC (current mode control). Figure 2 shows Low Power LED driver circuit.

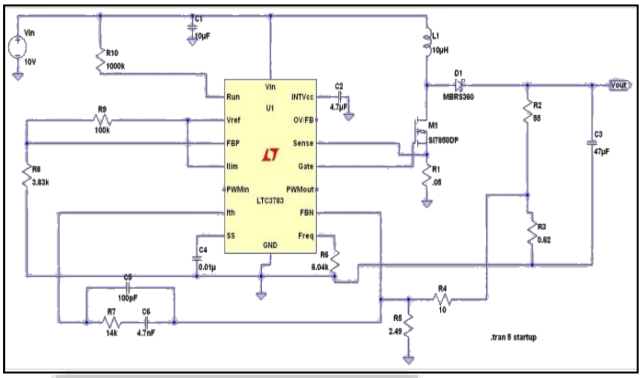


Fig. 2: Low Power Led Driver Circuit

The LTC3783 is a current mode LED driver and boost, flyback and sepic controller that drives both an N-channel power MOSFET and an N-channel load PWM switch [4]. When we use an external load switch, the PWMIN input is not only drives PWMOUT, but also enables controller GATE switching and error amplifier operation, allowing the controller to store load current information while PWMIN is low. This feature (patent pending) provides extremely fast, true PWM load switching with no transient overvoltage or under voltage issues; LED dimming ratios of 3000:1 can be achieved digitally, avoiding the color shift normally associated with LED current dimming. The FBP pin allows analog dimming of load current, further increasing the effective dimming ratio by 100:1 over PWM alone[2].

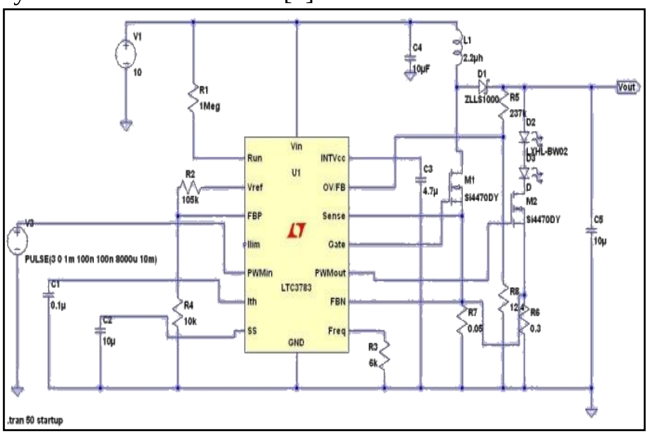
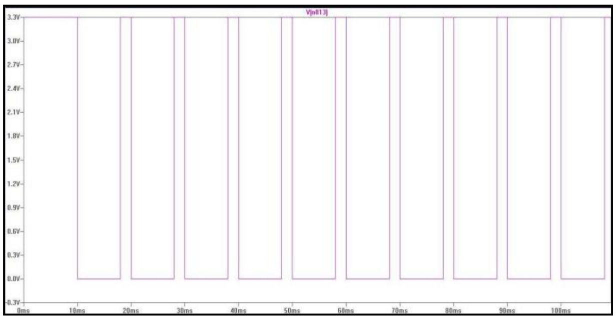


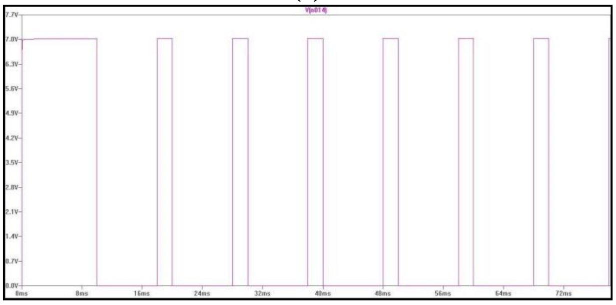
Fig. 3: PWM LED Boost Application

III. RESULT AND DISCUSSION

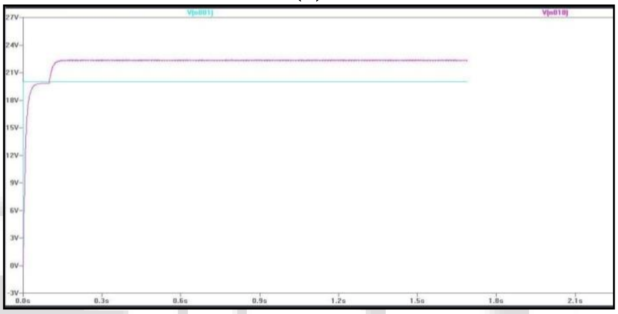
The figure 4 shown below depicts the desired simulation results of single inductor buck-boost application with analog dimming and PWM dimming.



(a)



(b)



(c)

Fig. 4: Simulated results of single inductor buck-boost application with analog dimming and PWM dimming 4(a) PWMIN 4(b) PWMOUT 4(c) Input Output

The figure 5 shown below depicts the desired simulation results of low power LED driver.

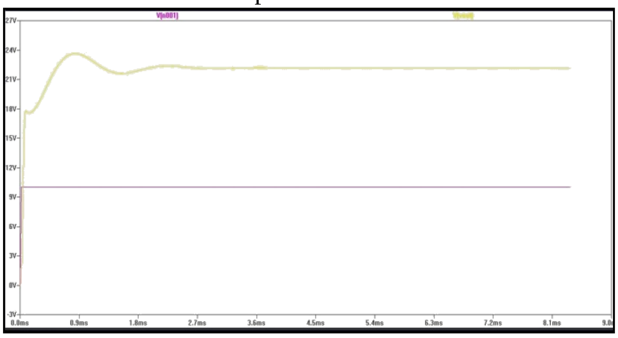
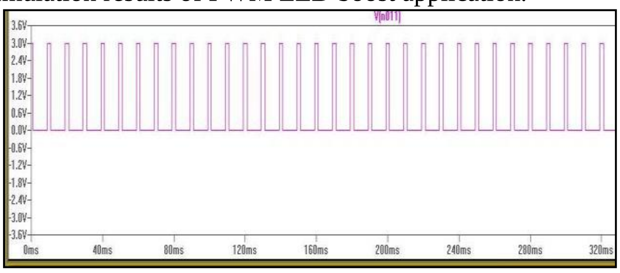
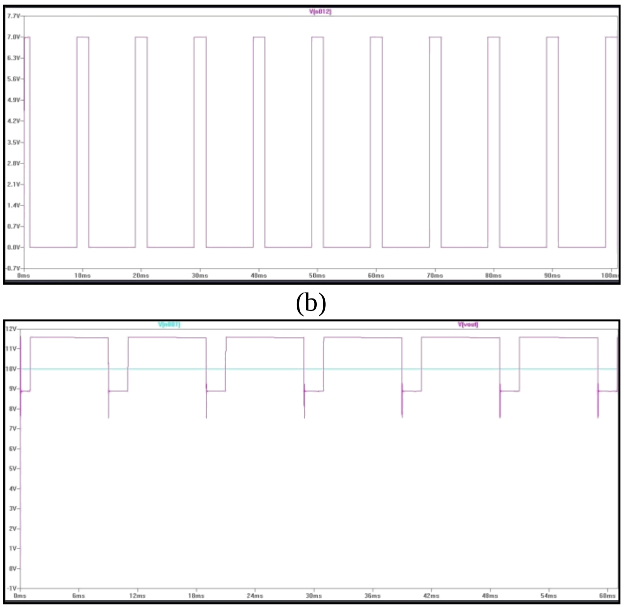


Fig. 5: Simulated results of input-output for low power LED driver

The figure 6 shown below depicts the desired simulation results of PWM LED boost application.



(a)



(b)

(c)

Fig. 6: simulated results of PWM LED boost application 6(a) PWMIN 4(b) PWMOUT 4(c) Input Output

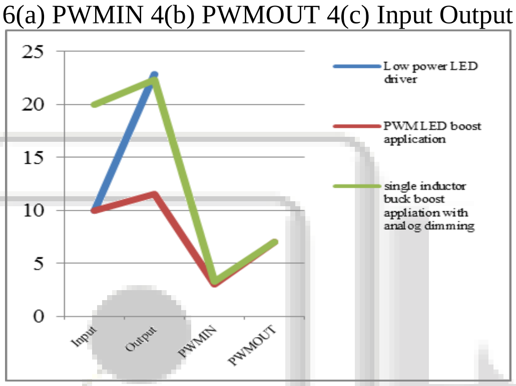


Fig. 7: shows the comparison of results of three configurations i.e. single inductor buck boost application with analog dimming and PWM dimming, low power LED driver and PWM LED boost applications respectively.

The table 1 below shows the comparison of results of three configurations i.e. single inductor buck boost application with analog dimming and PWM dimming, low power LED driver and PWM LED boost applications respectively.

Parameters	Single inductor buck boost analog dimming with PWM dimming	Low power LED driver	PWM LED boost application
PWMIN	3.3V	--	3V
PWMOUT	7V	--	7V
INPUT	20V	10V	10V
OUTPUT	22.32V	22.88V	11.56V

Table 1: Comparison of simulated results of three configurations

IV. CONCLUSION

It is observed from simulated results that in single inductor buck boost application with analog dimming and low frequency PWM dimming the input which is given is firstly bucked up to 100ms after that input is boosted and PWM output is achieved. In low power LED driver circuit the output is more than double of input. Lastly in PWM LED boost application output exceeds input by 1.56V and PWM output is obtained respectively. Thus significant objective have been achieved.

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