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Development of LED Module based on Adjustable AC Line Direct SMPS

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Abstract

In this paper, we perform an AC direct input using PA2200Q driver IC module to improve efficiency of LED. In consideration of durability of LED module and its light module and low cost, This LED light module without using any external capacitors and inductors can be adjust a current waveform automatically in order to accomplish a low noise and high power factor including temperature adaptability. There are also the advantages of not only providing wide range of input voltage (200–260VAC) with 50/60Hz but also improves EMI and power factor as well as decreasing harmonics with sequentially current tracking method.

Keywords: AC Direct Input, Component, High-Efficient LED Module

1. Introduction

LED (Light Emitting Diode) is being highlighted now a days as a replacement for conventional lights also its R&D is performed consistently. Comparing to conventional lights, LED has a lot of advantages over a direction of light, control, dimming, and structure especially saving energy. According to the SSL program conducted by Department of Energy of USA, the technology of LED not only can save total energy consumption of USA less than a quarter but also can provide a good solution of global warming.

LED lights can save more energy than incandescent light bulb to 85% and its durability is above 50 times of light bulb. It is also known as an eco-friendly bulb without any mercury because of a little emission of ultraviolet and infrared rays.

Department of Energy of USA estimates that LED lights can save amounts of 190[Twh] energy until 2030. A converter adapted rectifier circuit converting AC into DC is necessary in order to operate LED light. In order to protect a distortion of current of power during a converting process PFC (Power Factor Correction) circuit is inevitable. PFC is using the two-stage method composed a power factor compensation circuit and power converting circuit. The advantage of two-stage power converting method is control dependently each of them. But there is also disadvantage of low efficiency due to a lot of electrical components.

In this study, to improve the efficiency of LED power control module, PA2200Q driver IC which performs direct input of AC is adapted. Without using any external capacitor and coil for the purpose of a long durability and cost reduction, LED light module is developed[1,2].

2. Relevant Study

2.1 A Lighting Principle of LED

LED is a diode such that light emitted at a p-n junction is proportional to the bias current. Figure 1 shows the principle of a lighting LED. Figure 1(a) shows the state of forward bias which is applied before. Electron holes of p type and electrons of n type of semiconductor make PN junction stable status. After applying forward bias, Figure 1(b) shows the state of PN junction. If a forward bias exceeds Vp, electron holes and electrons will move and

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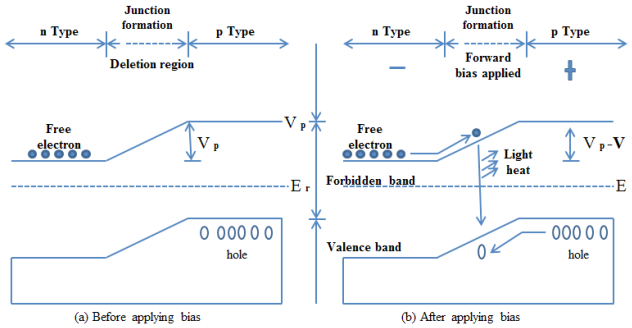

Figure 1. light-emitting principle of LED.

combine at each area. At the moment of a combination of two elements, lights are supposed to illuminate. Light desired wavelength range can be illuminated according to the material characteristic of semiconductor.

2.2 Power Factor Correction

A passive PFC is composed of a filter using inductors and capacitors and Valley fill circuit in order to adjust power factor. There is a strong point of using passive PFC to follow IEC 1000-3-2 Standard for the purpose of providing economical solution. But there is also a weak point of increasing size and weight due to heavy capacity of inductance as well as an the big fluctuation of an out voltage which is proportionally to an input voltage change. Figure 2 shows the kind of passive system.

Figure 3 shows the types of active PFC. An active PFC is more advantageous in its light weight and circuit size than a passive PFC because of fast switching. Another advantage is able to supply stable out power through a

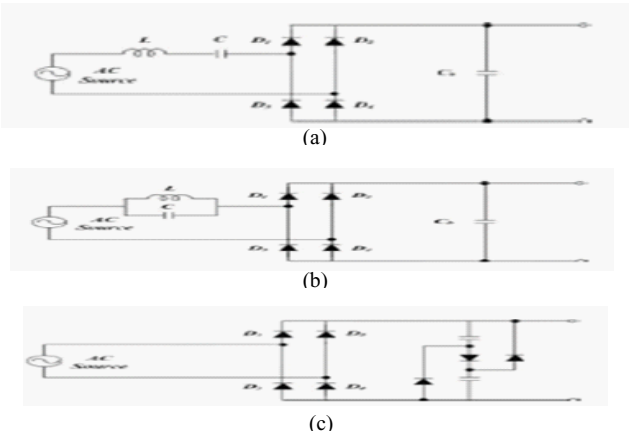

Figure 2. Kind of Passive PFC Circuit, (a) Serial resonance band pass type, (b) Passive resonance band erasable type, (c) Valley fill type.

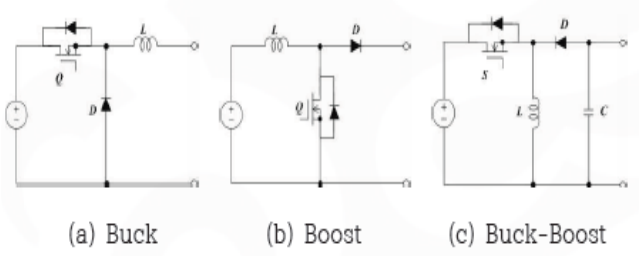

Figure 3. Kind of Active PFC Circuit.

control of input current wave pattern and a control of out voltage. It also makes possible to provide power factor correction above 95%.

3. The Development of LED Power Control Board

3.1 The Requisites of Power Driving Device Design

The power driving device is required to have lamp current for driving voltage to maintain stable LED operation and its span. That is, the power driving device is needed to be designed not beyond the range of allowable current and voltage[3]. Besides, the high power LED for lighting requires to design a constant-current circuit considering radiant heat as a result of constant optical power, and to be high efficient in order to ensure original LED span by high energy-efficiency of the power driving device itself through miniaturization and weight lightening[4]. The power driving device needs to be designed efficiently based on such since the circuit method determines the whole consumption of power and its quality.

3.2 Converter Design by Fly Back Method

As Figure 4 shows the structure of a Fly back circuit of fly back converter can insulate primary voltage from secondary voltage with buck by using a transformer and duty ratio. Also, a fly back converter is competitive in its cost and efficiency in that it can perform PFC function with an existing PFC control IC without additional circuit parts since the operation of a fly back converter's primary is identical to a buck-boost converter. And the output control of a fly back converter through constant current control makes constant-current source driving possible, which can drive constant-current source, and additional circuits for LED dimming control enable Analog Dimming that can control output current value.

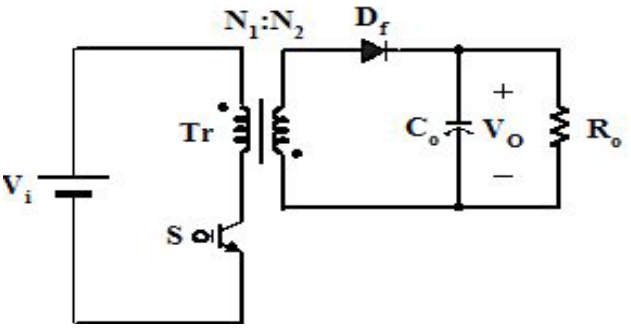

Figure 4. Structure of flyback circuit.

3.3 The Development of LED Module based on SMPS

SMPS (Switching Mode Power Supply) as a more popular power device for LED dimming system is a very durable, small and high-efficient device that transforms AC into DC for lightening devices and sensing gadgets. While it is one of the regulated objects for EMI. Thus for all power supply of the entire lightening devices including LED, we should be careful to replace the existing lightening under Electrical Appliances Safety Control Act, and when a new wiring set is required, make sure of visiting the spot and checking the existing wiring set, for there are many cases existing wiring pipes can't be used for a new wiring. Our high efficient LED power control module is fabricated by using PA2200Q driver IC performing AC direct input. This LED power control module is made to operate without using external capacitors and coil in the LED lighting module to ensure its longer span and cost-cutting effect. This module can control automatically the current wave which enables low noise, high power factor and temperature adaptability, with frequency of 50/60Hz and a wide input voltage range of 200-260 VAC.

This LED power control module designed its circuit as Figure 5 to control a valved LED module at 220VAC

Also, the artwork of the power control module was designed as follows

Table 1. Development Goals

evaluation ittm	unit	local level	goals
power factor (10W~30W)	%	over 0.9	over 0.95
THD (10W~30W)	%	below 30	below 25
module size	Cm*Cm	–	6*6

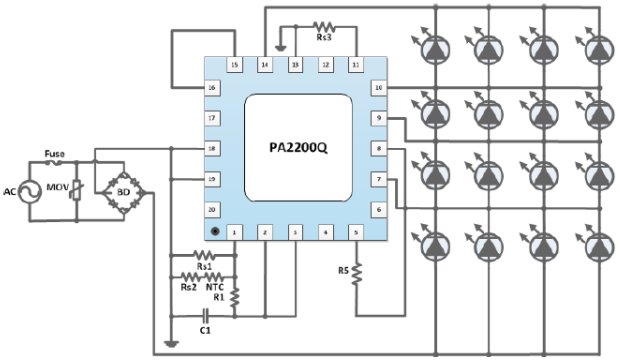

Figure 5. Design of LED power control module.

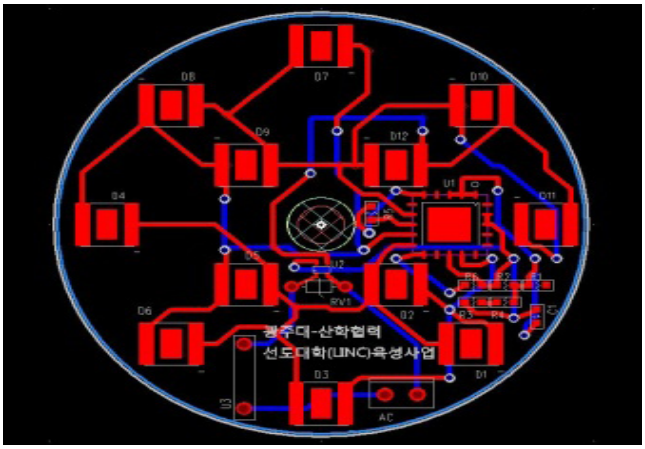

Figure 6. Artwork of led power control module.

4. Prototype Performance Test

Fabrication of an embeded device for the connection board monitoring We measured power factor by analyzing both loaded and unloaded electrical characteristic of an LED converter and the result as Figure 7.

The results of each performance test of LED modules based on Adjustable AC line direct SMPS as follows.

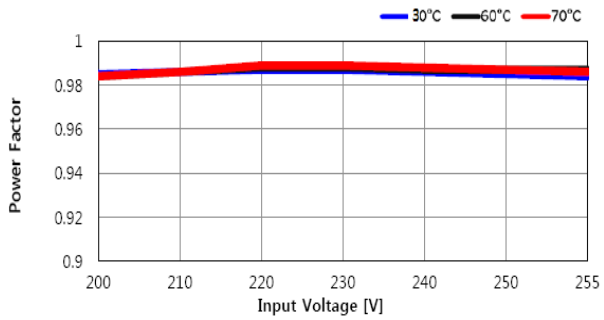

Figure 7. Test graph of power factor.

Table 2. Test result

Parameter	Symbol	min	typ	max	unit
AC input volt	Vac	200	220	260	Vrms
Output Power	Cop	4		20	W
Operating Freq	fo		50/60		Hz
Power Factor	PF	0.95			
Power Efficiency	Pe			90	%
Athd	Athd			25%	%

5. Result

PFC uses two-staged method consisting of power factor correction and a power converter. The two-staged power converter has a good quality that power factor correction and output voltage control operate independently. But the two-staged power converter has a shortcoming of its large bulk, much weight, complicated system structure and low efficiency as a result of a number of circuit elements. To improve this problem in this study we fabricated our high-efficient LED power control module by using PA2200Q driver IC performing AC direct input. Our LED power control module was fabricated to ensure its longer span and cost-cutting effect without using external capacitors and coil in the LED lighting module.

6. Acknowledgment

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