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Research paper

Development of Intelligent High Rate LED Driver Module

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Abstract

Background/Objectives: Concerns over need for eco-friendly LED lighting to replace existing lighting source are outweighed by energy efficiency ratio and interest in environmental protection recently. Measures to solve the generated heat which increases proportionally with high powered light are needed. Research and development to solve problem such as LED chip and package module is being vigorously pushed forward because technology of protection against heat has such a big influence on efficiency of LED lighting as well as lifespan.
Methods/Statistical analysis: It is checked status of domestic and foreign technology development and driver module for high efficiency intelligent LED with self-awareness function is developed. Technology of intelligent LED lighting is to be extend. Standardization of control method for illumination sensitivity is performed and sensor controller of intelligent LED lighting is to secure in this study.
Findings: High efficiency intelligent LED driver module with self-awareness is developed and is able to accumulate its technology. Acquisition of LED dimming technology also makes it possible not only to control illumination sensitivity but also to acquire technology of sensor and its control related to LED street lights as well as security lights.
Improvements/Applications: Driver module for high efficiency intelligent LED with self-awareness function is developed. It is expected to find new market and cost saving effect of electric charges by effective management and effect of extension of life span will be expected. The expansion of application industry is expected according to secure new technology.

Keywords: *LED Driver, LED streetlight, AVR, Dimming control system, AUTO DIMMING*

1. Introduction

LED lighting is able to subdivide into indoor lighting, highway lighting, special lighting, stage lighting, and scene lighting[1]. In general, lighting is to be classified into a major lighting and an auxiliary lighting while an auxiliary lighting plays major role, depending on the nature of countries[2,3]. A fluorescent light and a halogen light are classified into a major lighting in Korea, on the other hand, an incandescent lamp and a halogen light are belong to a major lighting in Japan. Downlight which is more commonly used than others recently related to the standard of many lightings is generally used not only a reflector but also a widen directional angle for spreading beam. Its angular spread is normally from 60 degree to 110 degree[4,5]. In general, spotlight used lens is to try to narrow the directional angle and an angular spread is normally from 30 degree to 60 degree. Most conventional lightings with a high response speed are capable of not only modulation in high frequency but also operating regardless of DC or AC[6,7]. A number of LED elements in one package for having a lot of the intensity of radiation luminous is needed because a flux for each LED element is low in case of using LED elements as a lighting. Development of optical technology is a task of how to control an optical characteristic that the intensity of center radiation in LED light is strong enough while the fringe of it is lower due to linear directional beam. Overall development included in a radiant heat of LED chip as well as PCB and lighting apparatus is necessary[8,9]. A study on the mutual relationship of lighting apparatus in consideration of the light distribution curve is needed.

Therefore, high efficiency intelligent LED driver module with self-awareness is developed and is able to accumulate its technology in this study. Acquisition of LED dimming technology also makes it possible not only to control illumination sensitivity but also to acquire technology of sensor and its control related to LED street lights as well as security lights[10].

2. State of Related Technology

2.1. Related Technology Trend in Korea

LED lighting is expected to replace conventional lighting sources based on merits such as effectiveness and long lifespan. t saving effect of electric charges by effective management and effect of extension of life span will be expected.

Luminous efficacy of an existing LED source is 60lm/W which is low standard compared to fluorescent light with 75lm/W while efficiency of LED has surpassed the performance of existing lighting source as high brightness LED of 100lm/w is developed recently. LED lighting is more than times in terms of total efficiency compared to incandescent lamp.

LED lighting is replacing not only incandescent light, fluorescent light, halogen spot lightings but also downlight because the function and characteristics of LED surpass those of existing lightings. LED lighting costs less than fluorescent light in electric charges, replacement cost and initial installment cost in total due to its sharp reduction in price, however, its price is three or four times higher than that of existing lightings. The light source of LED is twenty times more expensive than fluorescent light so the price reduction of LED through ongoing technology development is required to accelerate its supply among existing lighting market.

2.2. Related Technology Trend in Foreign

Technology-leading companies, such as the major LED leading companies Nichia, Toyota and Gosei, are working in partnership with technology leading companies in German and USA as technology alliances. The products of those manufacturers can be exchanged through the standardization of specification and the companies are actively commercializing the strength of the low power lightings that can replace the incandescent light.LED has been used for various signals and cellular phones but there are some difficulties in supply of LED, not like fluorescent lights or bulbs which can be easily exchange due to absence of the standardization of specification on their products. LED manufacturers has organized the "LED lighting industry council" sponsored by Business and Industry Department. Electricity & electronics and lighting companies, semiconductor chips and material companies are engaged for making the common standard specification that is applied for 100 manufactures. Such standardization has its purpose in leading the establishment of international standard including the standardization in various regulations for LED attachment to lightings, methods of function tests, brightness display, color combination and the lifespan

3. Development of High-efficiency self-cognition intelligent LED driver module

3.1. Main Controller Module

This study presents the method for easy controlling the LED dimming by using AVR and various controlling application by using communicating interface. Converting the voltage driven into LED with PWM(Pulse Width Modulation) is the way to control the LED dimming and output the optimum LED security lighting. To implement the dimming control circuit, micro controller is used to make the programming control possible. Micro controller makes its outer design simpler due to Flash Memory built inside. Figure 1 shows the block diagram of LED driver PWM control. As shown in Figure 1, it has DC 36V power input and supply power that micro controller uses through DC 5V regulator.Micro controller sends two PWM signal and this is for controlling the dimming of the second LED array when the first LED dimming is inefficient.The components of control circuit for LED dimming control are selected with the consideration of the price and reliability for mass production. Micro Controller is most widely used for industrial supply and Atmege 128 manufactured by Atmel cooperation is used as it is more efficient for development and commercialization.

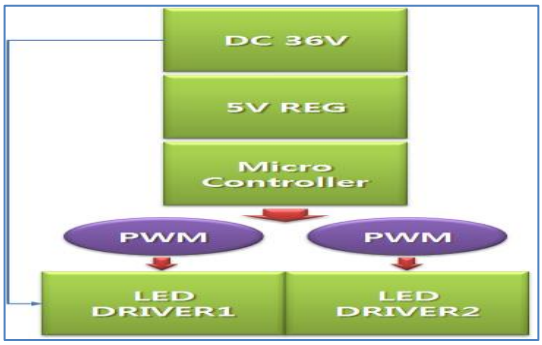

Figure 1: LED Driver PWM Control Block Diagram

Whole system is as shown in figure 2 and it is divided into two major types of function. One is the sensor data receiving part and the other is LED control module part that controls the LED dimming through the sensor data and RTC value.

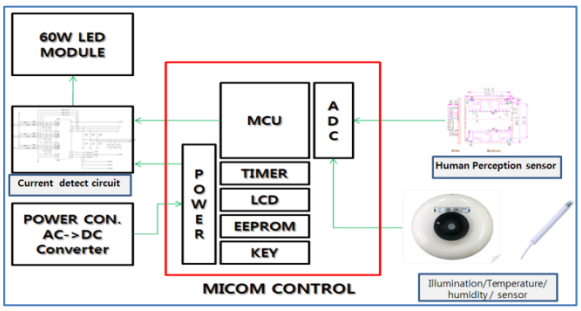

Figure 2: Block diagram of whole system

The device that has less RdsOn and faster switching speed is selected for FET inserted for the dimming of LED module, and it is designed to have structure that gates by the internal 12V power and PWM signal. Whole control command is embedded in the flash memory located inside of micro controller to drive the whole system. The built-in control command inserts the firmware image files with the HEX file formation and it consists of C language. Figure 3 presents the design of control circuit to control dimming of LED security lighting and the circuit drawing is designed by using the PDS tool.

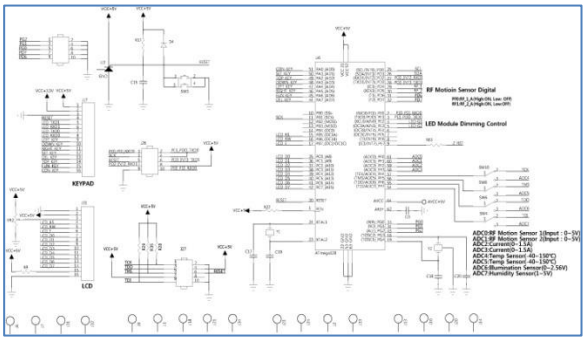

Figure 3: Control circuit of micro controller

3.2. Main Controller Power Circuit

The power source needed for the main controller is DC 12V, DC 5V, DC 3.3V and it uses three regulator ICs to outputs three power sources at DC 36V input power source. DC 12V or DC 5V power source is gated and DC 5V of main controller IC power source is used as well. Zigbee wireless communication module and Ethernet module are driven by DC 3.3V. Figure 4 shows the power circuit.

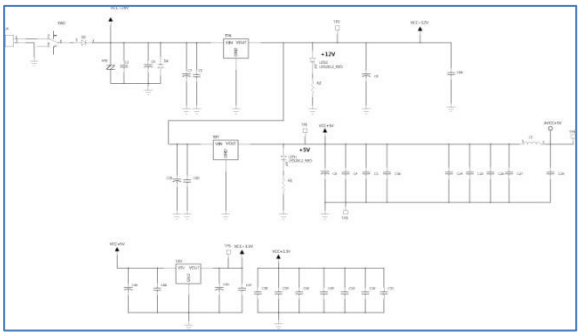

Figure 4:.Power circuit drawing

3.3. Sensor I/O Circuit

The sensors used to control dimming the LED security light can be classified RF human body detecting sensor, intensity, temperature and current. As shown in figure 5, the plat type is used for RF human body detecting sensor and the test type board that can recognize the human within 20m is used. It is able to control the distance and sensing so as to the operator in security lighting manipulate it easily. Various application through human

body sensing is possible because RF sensor detects the minute of movement in human and thing. Transmit receive module of X-band Doppler sensor to detect motion is composed of DR generator, passive diode mixer, and patch antenna for providing most reliable solution to detect movement. It is easy to use component of desired application field due to output voltage with digital.

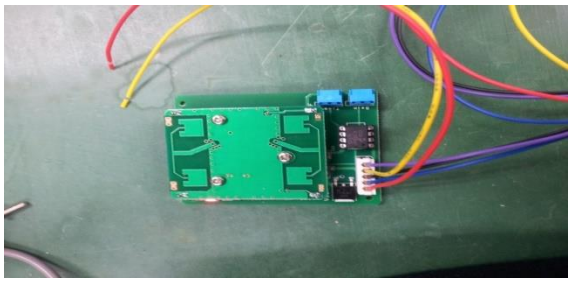

Figure 5: RF sensor detecting motion of human body and thing

It is easy and convenient for installing and utilizing by drilling inside. NTC type that can measure the temperature from 40 to 100 Celsius is used for the temperature sensor. One point inserted in LED module checks the temperature of module and one point built outside checks the exterior temperature to examine the condition of actual temperature of LED and inform the result to operator.

3.4. Related Circuit of Communication Circuit

Wired method is used USB, RS-22, and Ethernet communication way to externally control security light and the wireless communication method Zigbee is also composed to be able to control it as well. This study presents the built-in component system and will further develop the LED security light control able external by program, smart phone and web after this study competed. By building the RTC inside of the circuit, controlling the time of LED light is available.

Figure 6 shows the communication interface & RTC and the memory related circuit.

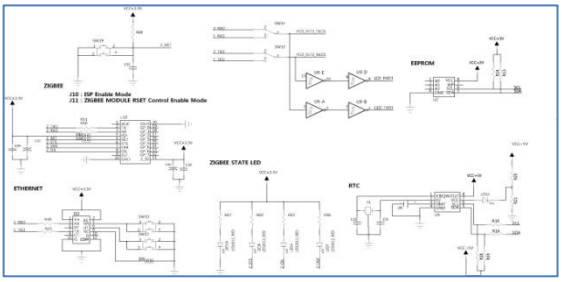

Figure 6:. Communication interface and RTC, memory related circuit

3.5 Key Pad Related Circuit

The key pad circuit is as shown in figure 7. It is for controlling the output value of sensor and RTC setting. This key pad circuit for options to set LED diming control setting based on intensity of illumination and time or to output the status information. They are built in the upper part with LCD modules.

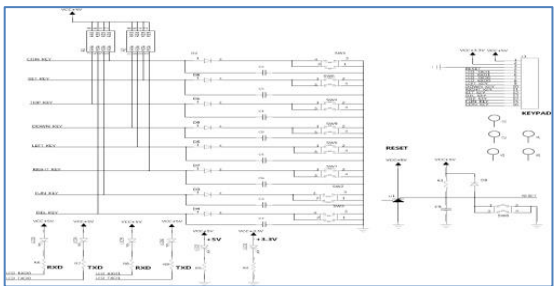

Figure 7:. Keypad control circuit

3.6. Manufacturing PCB

Manufactured gerber file using the whole main controller CAD tool is shown in Figure 8. PCB is built in two layers at both sides. It is equipped with two main power switches inside and sensor I/O port is built-in on the right side and the various communicating ports are embedded in the lower part. It consists of key pad on the left side, LCD and other kinds of GPIO applicable and power circuit is built in its upper part.

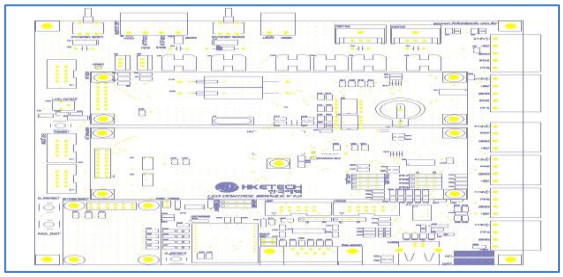

Figure 8:.Main controller PCB gerber filer

Figure 9 shows the whole main controller completed by inserting components into PCB and actually operated LCD which can be observed in the figure. In Figure 10, the first output value is supposed to present the name of the company and the time. The value of temperature, current, intensity of illumination, RF sensing are to be shown in LCD in case of pressing Config key. On pressing the related keys, values are to be set or to be saved setting value.

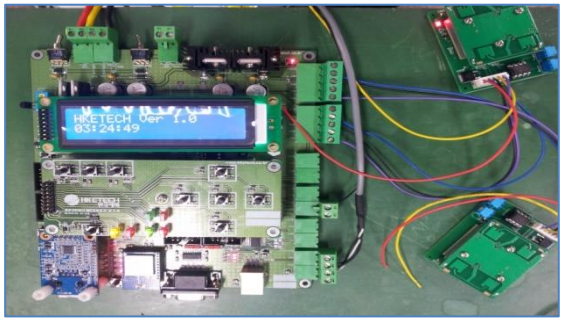

Figure 9:. Main control board of LED security light

Figure 10: Initial output screen of LCD(Display present time)

4. Conclusion

High efficiency intelligent LED driver module with self-awareness which is adapted the optical technology to control an optical characteristic that the intensity of center radiation in LED light is strong enough while the fringe of it is lower due to linear directional beam is developed and is able to accumulate its technology through the development in this study. Acquisition of LED dimming technology also makes it possible not only to control illumination sensitivity but also to acquire technology of sensor and its control related to LED street lights as well as security lights.

Through this research, we have developed a highly efficient

intelligent LED driver module, It is expected that LG Display will expand its intelligent LED lighting technology and lead standardization of lighting sensitivity control method. It also has an intelligent LED

Acknowledgment

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