Journal of Engineering and Applied Sciences 14 (Special Issue 1): 3962-3967, 2019
ISSN: 1816-949X

Developed Self-Aware Intelligent LED Driver Module

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Abstract: Currently, countries around the world are systematically promoting diffusion and diffusion of LEDs in order to save energy and reduce CO_2 emissions. In this study, we have developed a high-efficiency module for self-recognition intelligent LED driver and it contributes to efficient use of LED, reduction of electric energy and extension of LED lifetime which cannot be guaranteed and it can be applied to various LED application products. In this study, the structure of the product is designed to radiate heat without using the heat dissipation structure and the temperature is checked to see if additional heat dissipation is required for the heat dissipation structure. This research is to develop high efficiency self-recognition intelligent LED driver module. The LED driver module to be developed is easy to apply to various LED products because it is composed of simple configuration. At the same time, it is able to control the ON/OFF control and the brightness control by recognizing the situation through the program itself.

Key words: LED, LED drive module, dimming control, various communication interfaces, efficiency, intelligent

INTRODUCTION

Conventional lighting shows only the brightness of light numerically but the lighting that is currently being produced is being planned with a variety of colors and cutting-edge technologies in consideration of human emotional aspects. Therefore, the lighting development should reflect the social trends have a diverse academic knowledge of human emotion and create a lighting environment suitable for the purpose (Jo *et al*., 2014). These LEDs are not only environmentally friendly but mercury-free, compared to conventional light sources: low power, long lifetime, fast response speed but the drawbacks are high power and high heat output. Heat-dissipating technology has a great effect on the efficiency and lifetime of LED lighting, so, LED chip and package module have been actively researched (Chun and Jung, 2011). LED lighting is very energy efficient because electrical energy from semiconductors is directly converted to light energy (Bezdek *et al*., 1984). Only 15% of the electric energy is converted into light and 85% is converted into heat which raises the internal temperature of the LED module, accelerates deterioration of the light quantity and has a problem of drastically lowering the service life (Lau *et al*., 2006). In this study, we have developed a hig-efficiency module for self-recognition intelligent LED driver and it contributes to efficient use of LED, reduction of electric energy and extension of LED lifetime which cannot be guaranteed and it can be applied to various LED application products.

MATERIALS AND METHODS

Design of LED driver module: In this study, LED dimming control can be easily performed using AVR (Alf (Bogen) Vergard (Wollen) Risc) and various application control can be performed using a communication interface. Figure 1 in order to control the dimming of the LED, it is configured to output the proper brightness of the LED security lamp by changing the voltage applied to the LED by PWM (Pulse Width Modulation).

In order to implement the dimming control circuit, we used the micro controller, so that, it can be controlled by a programmatic implementation. Micro controller is used to simplify external design by having flash memory inside. As shown in Fig. 1, supply DC 36 V power->DC 5V

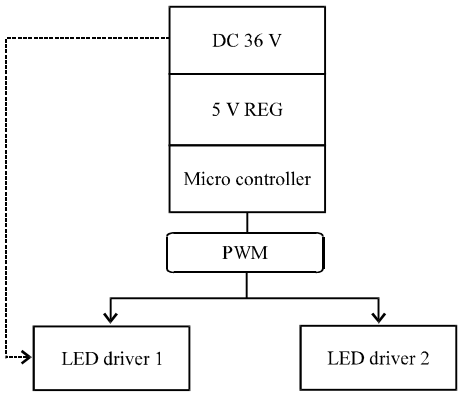

Fig. 1: LED driver PWM control block diagram

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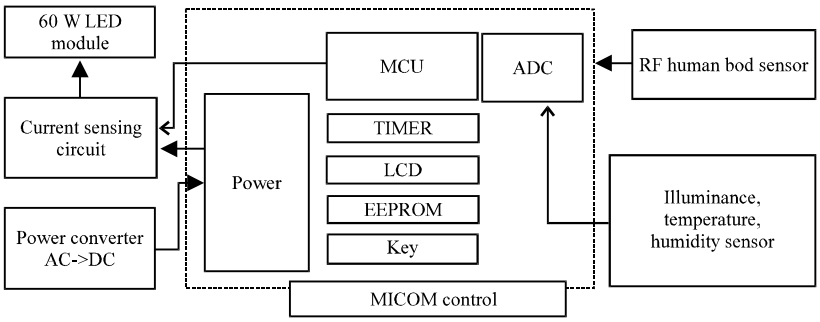

Fig. 2: LED driver PWM control block diagram

regulator->micro controller power supply. The microcontroller will output two PWM signals. The reason for this two signals is that if the efficiency of the first LED array is reduced, two signals are generated to control the dimming of the second LED array. The components used in designing the control circuit to control the LED dimming were selected considering the price and reliability. In addition, to increase the productivity, we applied the most used micro controller for industrial use. Atmel's ATmega128 for the efficiency and commercialization of the proposed R&D (Dong-Wan and Sung-Won, 2006).

A block diagram of the entire system is shown in Fig. 2. First, it can be divided into a sensor data acquisition unit and sensor data and an LED module control unit that dims the LED module through the RTC value. The overall system block diagram of Fig. 2 is briefly described as follows. In case of FET inserted to control dimming of LED module, device with low RDSon and fast switching speed was selected and used. In addition, it is designed to be gated by internal power of 12V and PWM signal. In the internal flash memory of the microcontroller of the control circuit, the control commands for driving the whole system are inputted. The embedded control command inserts the firmware image file configured in C language and is inserted in HEX file format.

RESULTS AND DISCUSSION

Design of communication interface related circuits: In this study, LED is controlled from the outside by using two methods of wire and wireless. It uses USB, RS-232 and Ethernet communication method by wired method and is controlled by ZigBee method by wireless method. In this project, we plan to develop LED security lamps that can be controlled from the outside by programs, smart phones and the web after the project has been embedded in the system. In addition, Fig. 3 the built-in RTC makes it possible to control LED lighting over time. Figure 3 shows the design of the control circuit to control the dimming of the LED security light and the PADS tool was used for the circuit diagram.

Keypad related circuit: The keypad circuit is as shown in Fig. 4. It is used to adjust the RTC setting or to output the value of each sensor. It can set LED dimming control according to illumination value, dimming control setting with time, it is built in the upper part of the main module like the LCD module, so that, it can be selected.

PCB design: Figure 5 shows a Gerber file created by using the CAD tool for the entire main controller. Two main power switches are built in. The sensor input/output port is on the right side and various communication ports are on the bottom. On the left side, it is configured to be a In order to control the LED security bled to be applied through a variety of GPIOs such as a keypad, an LCD and the like and a power circuit is built in the top.

Developed self-aware intelligent LED driver module: In order to develop LED lighting, we need to select LED package. In this project, we designed LED PKG of Taiwan Paragon Company to develop LED lighting module. LEDs vary in their types and performance depending on chip performance and light distribution and electrical and optical characteristics are different depending on the manufacturer. Therefore, it is very important to measure optical and electrical characteristics to select LEDs suitable for color temperature control. In this study, the structure of the product is designed to radiate heat without using the heat dissipation structure and the temperature is checked to see if additional heat dissipation is required for the heat dissipation structure. This research is to develop high efficiency

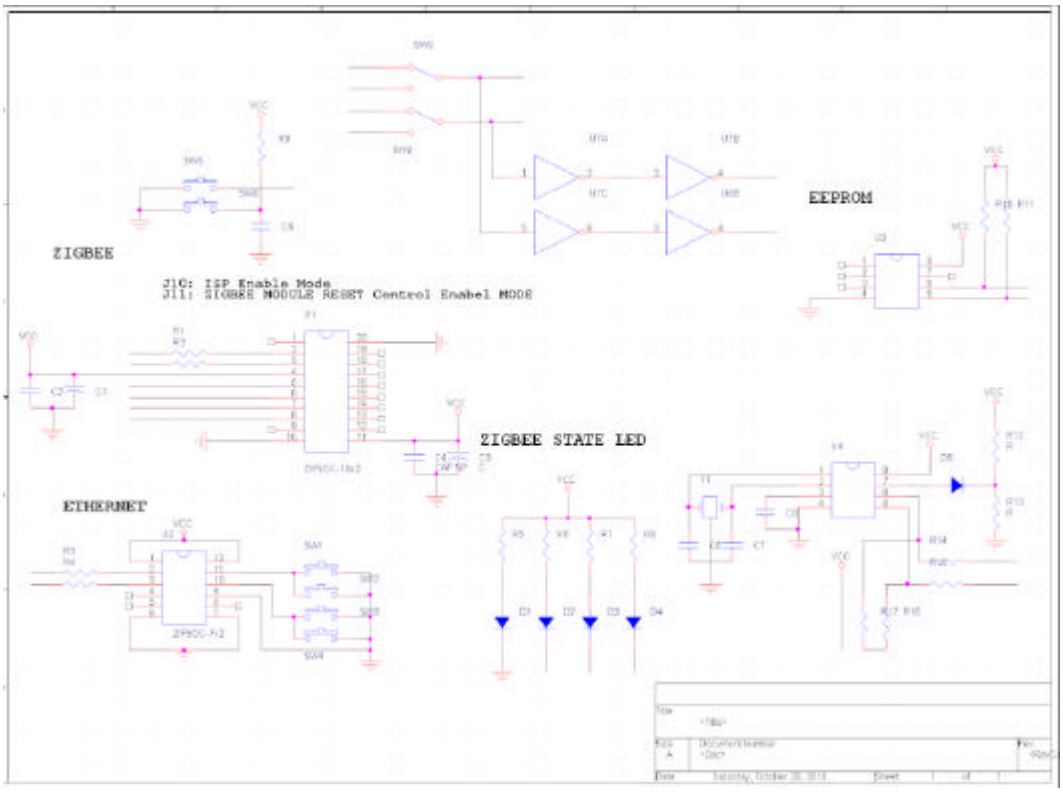

Fig. 3: Communication interface and RTC, memory related circuit

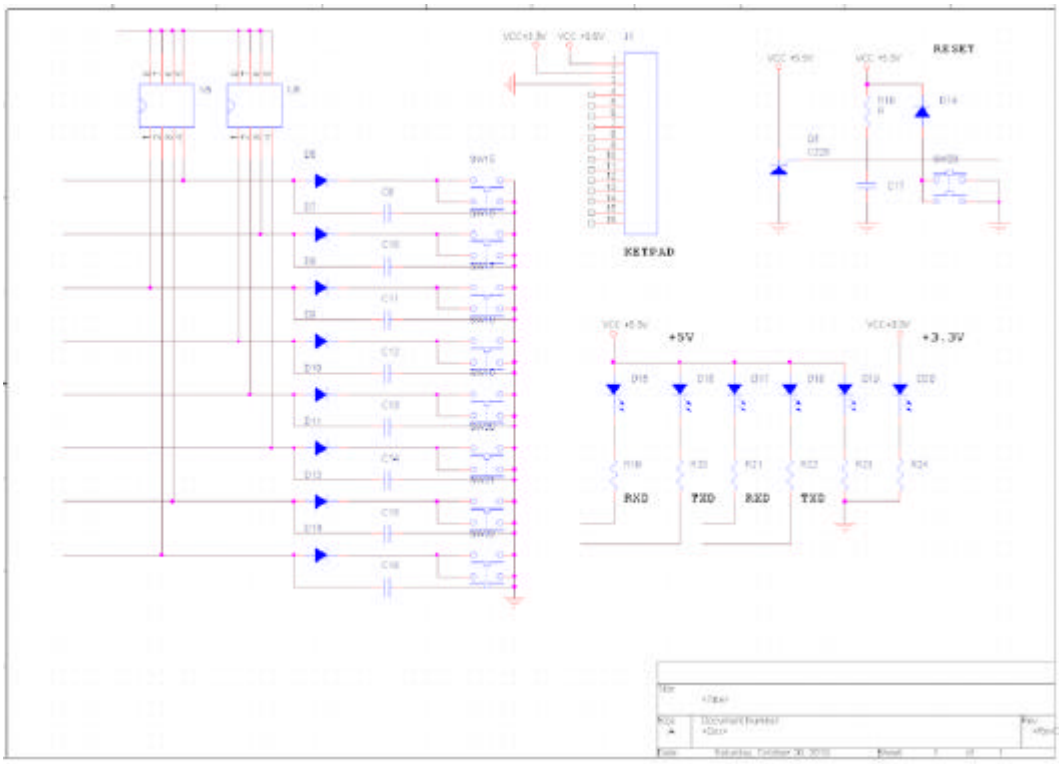

Fig. 4: Keypad control circuit

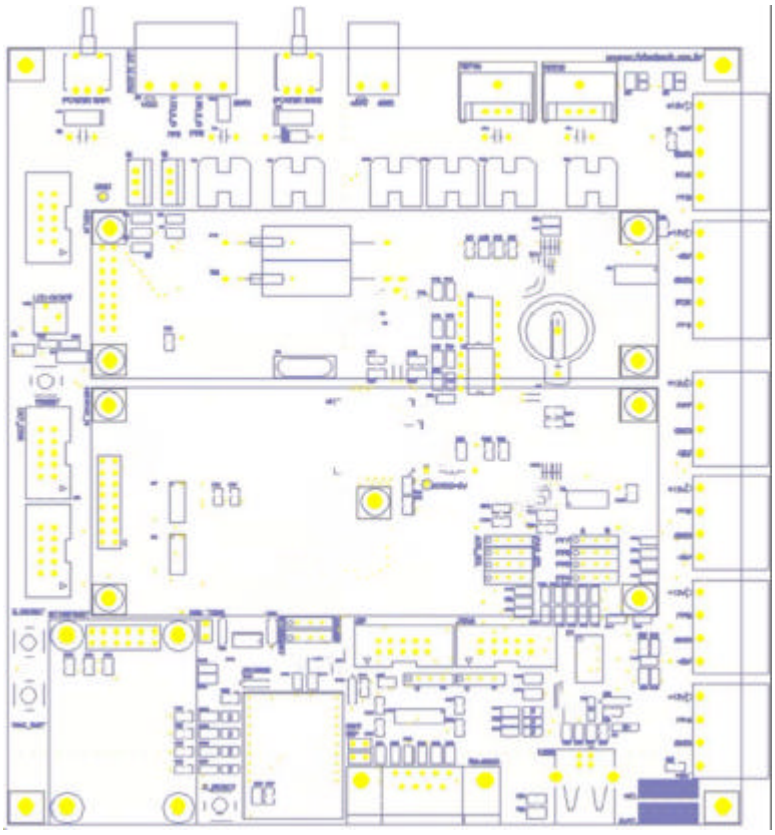

Fig. 5: Main controller PCB silk drawing

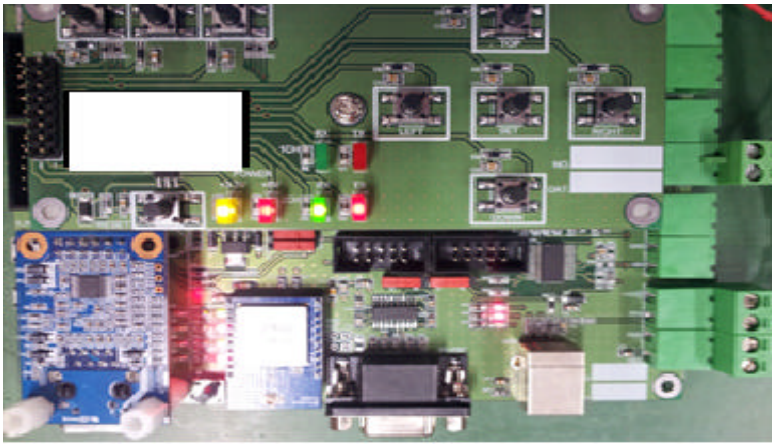

Fig. 6: Various communication interfaces (USB, RS-232, ZigBee, Ethernet)

self-recognition intelligent LED driver module. The LED driver module to be developed is easy to apply to various LED products because it is composed of simple configuration. At the same time, it is able to control the ON/OFF control and the brightness control by recognizing the situation through the program itself.

PCB design: We use the wired USB, RS-232 and Ethernet communication method to control the LED from the outside and ZigBee method for wireless control. In this study, we embed all in the system. In addition, built-in RTC enables control of LED lighting over time. Figure 6 is an interface module designed to enable various

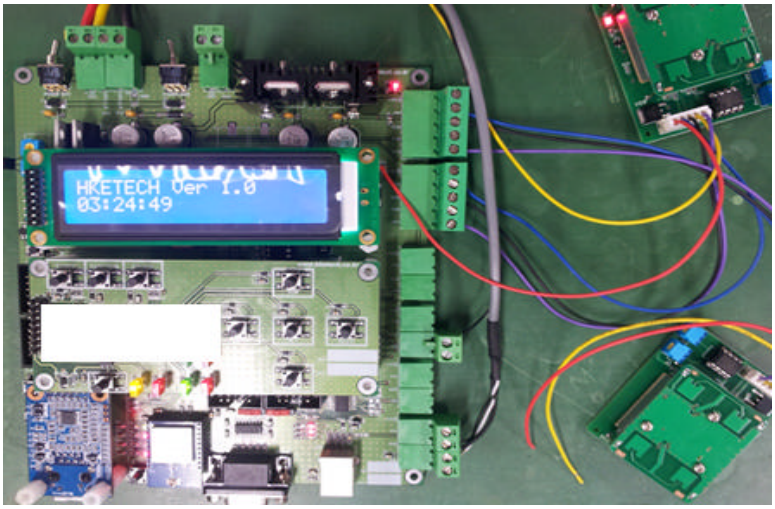

Fig. 7: LED main control module

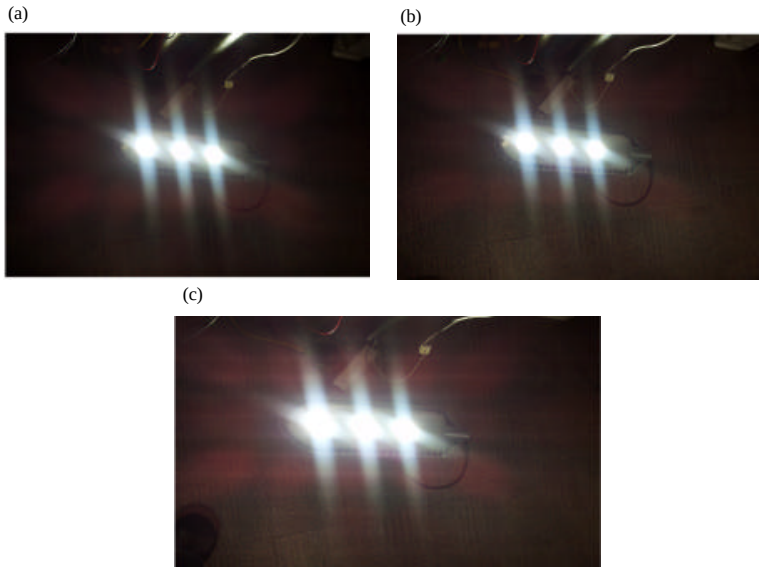

Fig. 8: Step by step LED security brightness adjustment (30, 60 and 100%): a) LED brightness adjustment (1st step: 30%); b) LED brightness adjustment (2ST step:60%) and c) LED brightness adjustment (3ST Step:100%)

communications. Figure 7 shows a photo of the entire main controller completed by inserting parts into the manufactured PCB and the actual driven LCD can be visually confirmed. The initial LCD output value is configured to output the company name and time. When the config key is pressed, the LCD displays the temperature value, current value, illuminance value and RF detection value. By pressing the relevant key, the setting can be made or the setting value can be saved.

LED dimming control: The method for LED dimming control is classified into a time-based method, a method based on illumination value and a method based on RF detection and each control method can be selectively set. The control according to the illuminance value is 100% output in the case of dark brightness and 30 and 60% in the case of slightly dark such as cloudy day or sunset. Figure 8 shows a photograph of the LED module when the dimming control is performed step by step.

CONCLUSION

Conventional lighting shows only the brightness of light numerically but the lighting that is currently being

produced is being planned with a variety of colors and cutting-edge technologies in consideration of human emotional aspects. In this study, we have developed a high-efficiency module for self-recognition intelligent LED driver and it contributes to efficient use of LED, reduction of electric energy and extension of LED lifetime which cannot be guaranteed and it can be applied to various LED application products.

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