International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 06 Issue 10
September 2019

High Efficiency RGB AC LED Street Light Color Positioning

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***Abstract**:*

This paper is mainly built a different light color high efficient streetlight system. By the light color difference, according to light color to know where the region of the lighting fixture is. Lighting fixture is composition by the red, green and blue can be adjusted to the three-color brightness, high efficiency AC LED.

Keywords

LED, streetlight, light color, positioning

1. Introduction

LEDs have the characteristic of low power consumption, light weight, and fast response. It has been regarded as the main lighting source for the new generation. Various types of white LEDs such as phosphor powder series and multi-chip LED series are developing rapidly. The brightness of a single LED has increased from few mcd to a few thousand mcd. White LED has been widely used in LCD backlight modules, portable electronic equipment backlight module and other fields. LED table lamp and LED street lighting are becoming more popular. Because the surrounding technology still needs development for structure, packaging, power supply, lighting fixture optics, heat dissipation, etc. Because LED lamps have higher cost and other factors, limit its commoditization. The main factor that affects the overall performance of LED luminaires is: LED components are DC (DC) driven. A semiconductor component with low voltage must provide a suitable DC current for illumination. Therefore, the AC power of the alternating current (AC) is generally reduced its voltage and converted to direct current for LED using. AC to DC converter is bulky and heavy. It not only increases the cost, but also has a considerable amount of power loss. Switching converter circuit has about 15 to 30% power loss. Linear converter circuit is up to about 30 to 50% loss. In terms of R&D concepts and technologies, LED has been developed since the 1950s.

The world's first AC LED bulb is developed by Electronic and Optoelectronic System Research Laboratories, Industrial Technology Research Institute.With the happening of AC LED, it brings broader development space for LED applications.

AC LED does not require a rectifier to convert AC to DC. It not only reduces the size and weight of the LED, but also increased application space and eliminates the cost of converter components. It saves the power consumption of LEDs during converting AC to DC. It improves the luminous efficiency of the overall LED. There are AC LED bulbs that can be used directly with traditional incandescent lamp sockets in the market.

In addition to the high price of AC LEDs, the problem of color rendering makes it difficult to accept in high quality markets. White AC LED bulb is a cold color fluorescent powder white LED composed of blue LED and yellow fluorescent powder in the market. It has low cost and high efficiency. The color rendering is not good enough (Ra~75), it can't meet the IB-level requirement for general daily routine (Ra>80). Warm color fluorescent powder white LEDs using blue LED plus yellow fluorescent powder and red fluorescent powder (or green fluorescent powder and red fluorescent powder), its color rendering is better (Ra~85), it still cannot meet some IA-level (Ra>90) requirements for more stringent color reproduction. To promote LED luminaires, we must continue to improve the performance of LEDs, reduce costs, and increase color rendering. In addition, we can increase the value and competitiveness of LED luminaires by increasing the LED luminaires' the functions.

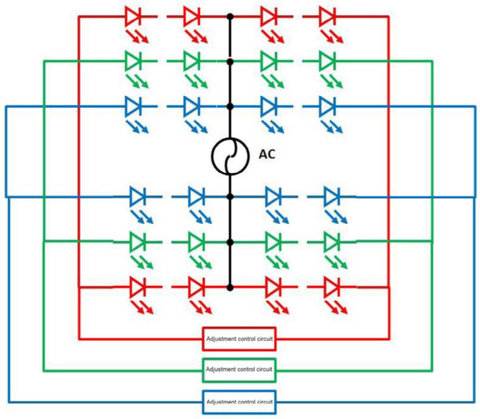


Figure 1. Schematic diagram of a high-efficiency RGB AC LED circuit.

Unlike traditional luminaires, LEDs are not only lightweight and low power consumption, but also have a fast response. In addition to OLEDs, most of light sources have this drawback characteristic. Generally, the light source responds very slowly. Therefore, LED can be used as a signal transmitting component of optical communication. With the signal receiving component of the light detecting diode, it realizes optical communication with short and light equipment and high-speed data transmission. In other words, it is impossible to have a fluorescent fixture with optical communication function. However, it is possible to manufacture LED lamps with optical communication functions.

Therefore, before establishing the "wireless optical communication system", we decided to establish a high-efficiency street lighting system with different color lights. By the difference in the color of the lamps, people without color blindness can know the area according to the light color of the road.

2. Literature Discussion

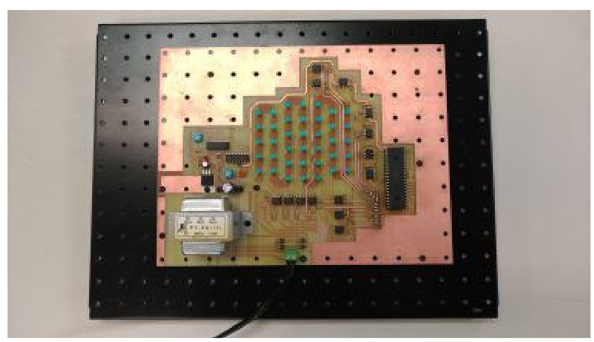
AC-driven AC LED doesn't need to convert the AC to a DC conversion circuit [1-5].. AC LED can not only greatly reduce the size and weight of the LED, but also increase application space and eliminate the cost of converter components. It also saves power consumption when LEDs are switched between DC and AC. Therefore, it is selected as a high-efficiency street lamp system that can adjust different colors of light. To have different color lights, the white ray AC LED should be changed to red, green and blue three-color AC LEDs. We can control the color of light that designed by the red, green and blue three-color AC LEDs. It is easy to recognize different colors using in different places.

3. Research Methods and Purposes

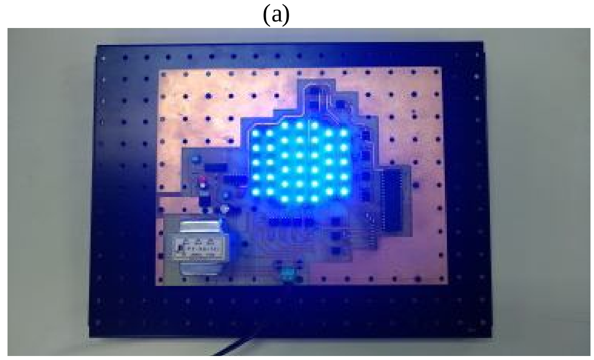
In order to improve the drawbacks of AC LED color rendering due to not excellent, we use red LEDs, green LEDs, and blue LEDs in series to replace the fluorescent white LEDs used in the original AC LEDs. Like the original AC LED, the LEDs connected in series form the structure of the bridge rectifier circuit. From the power supply, the red series LED, the green serial LED, and the blue serial LED are divided into three different bridge circuits. The red, green and blue AC LED circuits are shown in Figure 1. The load connected to the three sets of bridge rectifier circuits in the red LED, the green LED, and the blue LED may be LEDs of corresponding light colors.

In order to adjust the light color of the overall lamp group output effectively, the load portion is connected to an adjustment control circuit.

Owing to the forward voltages of the red, green, and blue LEDs are not the same, therefore, the total number of LEDs on the red LED serial circuit, the green LED serial circuit, and the blue LED serial circuit is different during using the same AC power supply.



(a)



(b)

Figure 2 The picture of the blue AC LED in the RGB AC LED circuit, Figure 2 (a) Turn off blue AC LED, Figure 2 (b) Turn on blue AC LED.

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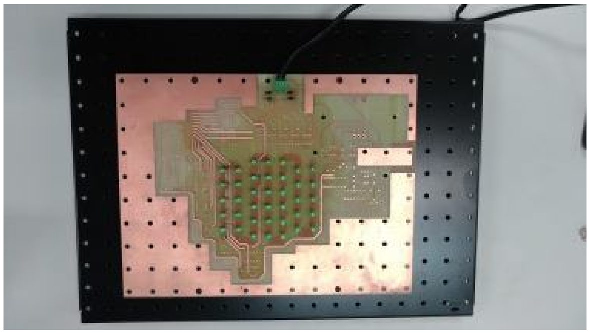
Owing to the brightness of the red, green, and blue LEDs is different, The number of LEDs is also different. We have to choose the specifications and quantity of LEDs, plus the three adjustment control circuits shown in Figure 2. We can make different adjustments to the brightness of the output red, green and blue light to get different light color output. Figure 1 shows a schematic diagram of a high-efficiency RGB AC LED circuit.

Owing to the forward voltages of the red, green, and blue LEDs are not the same, therefore, the total number of LEDs on the red LED serial circuit, the green LED serial circuit, and the blue LED serial circuit is different during using the same AC power supply. If using a 110 V mains electricity, assume that the red LED has a forward voltage drop of 2 V, the green LED has a forward voltage drop of 2.5 V, and the blue LED has a forward voltage drop of 3 V. Then, each red LED of the series circuit needs about 55, the green LED needs about 45, and the blue LED needs about 37, the circuit shown in Figure 2. Each bridge circuit requires about 110 red LEDs, about 90 green LEDs, and about 74 blue LEDs. 110 V is the rms voltage value, and its peak value is about 156 V, also it is the instantaneous voltage value. Based on experience, the number of LEDs required is multiplied by the forward voltage equal to the rms voltage value to work properly. If the number of LEDs is too small, it will burn out. If the number is too large, it will not be critically biased and will not be bright. If the forward voltage of the selected LED is large, the number of serial connections required is reduced, and if the forward voltage of the selected LED is small, the number of serial connections required is increased. The above is just an approximate value, the actual number is determined by the LED characteristics.

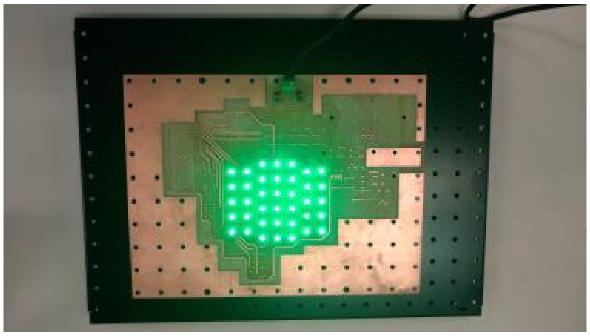
Owing to the brightness of the red, green, and blue LEDs is different, The number of LEDs is also different. We have to choose the specifications and quantity of LEDs, plus the three adjustment control circuits shown in Figure 1. We can make different adjustments to the brightness of the output red, green and blue light to get different light color output. We can make different adjustments to the brightness of the output red, green and blue light to get different light color output. For example, the brightness of the red LED string, the green LED string, and the blue LED string is adjusted to 1:4.5907:0.0601 to obtain a uniform white light output with high color rendering. It is possible to change the different brightness ratios to get different situational light colors. In addition, the regulation control circuit can have the functions of current limiting and protection circuits to make the AC LED lamps using safer.

4. Design

The AC LED luminaire is composed of red, green and blue AC illuminating diode circuits as shown in Figure 1.



(a)



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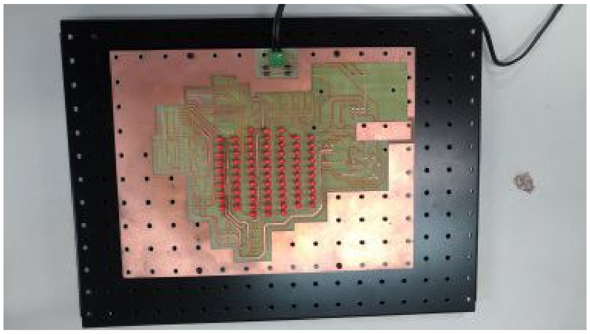
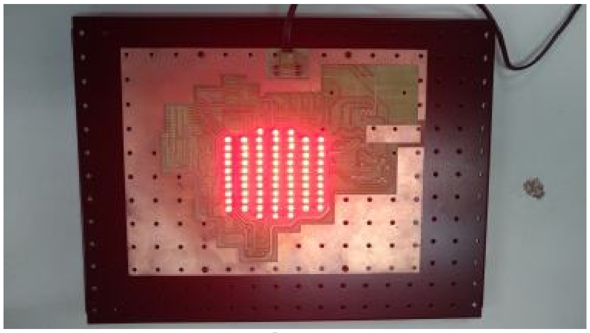


(c)



(d)

Figure 3 The physical photo of the green AC LED and the red AC LED in the RGB AC LED circuit. Figure 3 (a) shows the green light LED off. Figure 3 (b) shows the green light LED on. Figure 3 (c) shows the red light LED off. Figure 3 (d) shows the red light LED on.

The red, green and blue LED power control switches of the control circuit turn the red, green and blue LED on and off respectively. White light is composed of appropriate proportions of red, green and blue light. Of course, it is also possible to adjust the light output to different hues according to requirements. The LED power control switches control LED on and off. The microcontroller obtains the control signal and the data to be transmitted, and converts it into a signal that actually controls the red, green, and blue AC LEDs. LED power control switch controls to drive red, green and blue LEDs to properly response for specific time. It sends red, green, and blue light communication signals and red, green, and blue light for illumination.

Therefore, three kinds of optical signals of red light, green light and blue light are sent out at the same time. In a other word, three different wavelengths of optical signals appear in the same area at the same time.

The reference time point is the cycle timing of the AC mains detected by the zero-crossing detection circuit. It is sent to the microcontroller as a trigger time reference point.

Figure 2 shows the picture of the blue AC LED in the RGB AC LED circuit. Fig. 2(a) shows the LED off, and Fig. 2(b) shows the LED on.

The microcontroller used in the control circuit is PIC18F877. Its power is supplied by a 5V power supply circuit. In the physical photo of the blue-ray AC LED in Figure 2, the forty-foot IC on the right of the picture is PIC18F877. At the bottom left of the photo are transformers and other circuits, which are 5V power supply circuits. This power supply circuit does not supply LED power. Photo upper left circuit is zero cross point detection circuit. In order to save production costs, our green AC LED and red AC LED do not have a control circuit. Figure 3 shows the physical photo of the green AC LED and the red AC LED in the RGB AC LED circuit. Figure 3 (a) shows the green light LED off. Figure 3 (b) shows the green light LED on. Figure 3 (c) shows the red light LED off. Figure 3 (d) shows the red light LED on. So at the photo in Figure 3, there is no microcontroller and other circuits in Figure 2. The LED is directly connected to the 110V AC mains.

5. Results and Discussion

We have established a high-efficiency AC LED street lighting system that can adjust the brightness of the output of red, green and blue. By means of the difference in the color of the lamps, people can distinguish the orientation according to the color of the road.

In the actual test, the uncorrected illuminometer (mobile app program) can establish a range change with the same illumination and 30% difference. As long as the rules are properly set, the difference in light color can be recognized with the naked eye. As long as the light color circuit is added, the positioning of the movable device can be completed in Figure 4. In Figure 4, the mobile device 1 only receives the signal transmitter A signal, which can be judged near the signal transmitter A. The mobile device 3 only receives the signal transmitter B signal, which can be judged near the signal transmitter B. The mobile device 2 receives the signal transmitter A and the signal transmitter B signal, and can be judged in the middle of the signal transmitter A and the signal transmitter B. We can achieve a cheap and simple approximate positioning system.

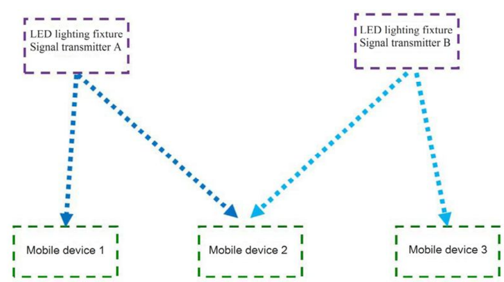


Figure 4. Schematic diagram of establishing a simple positioning system with wireless optical communication

6. Conclusion

Before establishing the "wireless optical communication system", we will establish a high-efficiency AC LED street light system that can adjust the brightness of the output of red, green and blue. By the difference of the color of the lamps, people can know the area according to the light color of the road. Finally, we finish the high-efficiency RGB AC LED road light color positioning.

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