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Development of 120W LED Lighting Equipment for Broadcasting System Using Natural Cooling System

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Abstract
Establishment and focus: LED lighting has significant energy savings compared to conventional lighting such as halogen and fluorescent lamps. And with a long lifetime, maintenance costs are low and failure rates are low. However, LED lighting for broadcast video should be easy to carry while having a higher output than LED lighting devices for general streetlights, advertising or transport equipment. As the output of LED lights increases, heat is generated, which leads to deterioration of LED characteristics and shortened lifespan. Therefore, a separate heat dissipation device is required. Unlike ordinary LED lighting devices for street lights, advertisements or transportation equipment, LED lighting devices for broadcast video cannot be applied with noise radiators.

System: Therefore, the purpose of this paper is to develop a new cooling system without noise and to maximize the functionality of LED elements and control units with heat sources of LED lighting devices for broadcast video. To create a 120W board, six 20W LED boards were arranged in two rows and three columns. In other words, it is possible to select 80W, 200W high-power LED lighting equipment by increasing or decreasing the number of boards by generalizing LED module board size by model. LD module board was decided by considering mass production and SMT production size of chip mounter and considering overall size of product by model.

Keywords**:** LED lighting, broadcast video, 120W board, high-power LED, LED module

1. Introduction

Light emitting diodes (LEDs) emit light when a current flows through a compound such as potassium arsenide, which is a representative semiconductor device that converts electrical energy into light energy[1]. The advantage of LED lighting is that it is small compared to other light sources, does not require filament and valve shape, and it is close to point light source because of small light emitting device. Light emission of a single wavelength, that is, monochromatic light, has a very limited wavelength component such as a red component or a blue component. Compared to the lifespan of 1,000 hours of incandescent bulb, 3,000 hours of halogen bulb and 6,000 hours of fluorescent lamp, LED has a long life of more than 50,000 hours and is excellent in durability and strong light[2]. As such, LEDs have a much longer life than conventional incandescent, halogen and fluorescent lamps and emit light even at low temperatures. Therefore, more than 90% of the energy consumed is emitted by light[3]. Korea has been focusing on the strategic industries to establish the foundation for vitalization of future growth engines with

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high industrial economic value and securing national technology assets. LEDs are included in eight categories along with the digital TV / broadcasting industry, the optical sector and telecommunications. In other countries with technological prowess, the broadcasting video technology among LED lighting devices invests for a long time to directly develop LED devices. The LED lighting device manufacturer has a high technology compared to Korea as it is sometimes applied to its own products by OEM supply. However, in Korea LED devices with high color rendering index are used to express a constant color temperature or to radiate heat. The LED light for broadcast video using the white light LED pack has been increasing efficiency while continuously increasing the input power because the efficiency represents only about 20-30% of the electrical energy. In general, high power(HP) LEDs with outputs ranging from 500mW to 10W in a pack are known to have a heat flux of 70w/cm^2[4,5]. It is known that the temperature increases linearly when the input power rises while the lighting temperature continues to rise unless the HP LED lighting system is equipped with a separate cooling system. As the temperature rises, the luminous flux drops drastically[6]. Therefore, "How do I design a cooling system, a cooling unit?" is inevitable to maintain the efficiency of HP LEDs. The cooling device for maintaining the luminous flux of HP LED for broadcasting video is difficult to apply the water-jacket system, which is being studied a lot recently, and the cooling fan used for various existing electronic devices cannot be used because of the high noise. That is, unlike general lighting, general street lamps, and advertising lights, the cooling fan in the LED lighting device for broadcast video that requires a separate heat dissipation device can not be applied because of noise. Therefore, a method of using a plate heat sink as a natural cooling system has been developed[7-9]. The advantages of LED lighting are its long life compared to the use of conventional lighting, resulting in low failure rates, significant energy savings and low maintenance costs. However, as the output increases, heat is generated in the LED lights, which shortens the lifespan and degrades the LED characteristics[10,11]. Therefore, the lighting equipment for HP LED broadcasting video should use the cooling system without noise in the part with heat source such as the control unit and LED element to maximize the functionality.

2. Materials and Methods

Most of the LED lighting devices in broadcasting video are short-lived due to high power and shortened lamp life and luminous flux. That is, various LED lighting devices have been developed to prevent the long life of more than 50,000 hours, which is the advantage of the LED, and the brightness of the light drops sharply. At present, commercialized systems or devices are mostly cooling systems that employ natural heating by convection and conduction of heat. Products designed to increase the surface area in the form of Fin using various metal materials with high thermal conductivity are commercialized, but there are many cases in which efficiency and economy are inferior. Because most of the heat is generated from the control unit and the LED module, if two parts are integrally fixed in a single case, it may be less effective to prevent heat generation. Therefore, it is planned to prevent heat rise by mutual heat generation after dualizing heat generating site through separation. We devise a way to connect the separated modules effectively to increase the cooling effect by the convection and conduction methods. In order to increase the cooling effect of the LED lighting, the design configuration includes a device design in which the LED PCB and the control PCB are mounted in separate cases, and a device design in which a heat sink is attached. LCD module displaying status is black and white with white LED and black display for easy identification. LCD size adopts wide size 128 * 63 FSTN in consideration of control part size and visibility. In addition, external function parts such as DMX and LCD control for LED lighting operation and status display were reviewed and applied to the design. Before designing the components for networking control, regulation, and operation of LED lighting, a review was made and a display component was

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determined to indicate the lighting status of the product. In reviewing the jack supplying DC power, the general mono jack has a small allowable current and mechanically weak, which is widely applied to broadcast video products. The connector has a locking feature that prevents the cable from slipping easily due to tension when used outdoors. And since the audio equipment for broadcasting video uses a lot of XLR 3 pins, it is adopted as XLR 4 pins to exclude the case of accidental mounting on the power jack. The power switch adopts a general rocker switch, not a mini type, in consideration of design and allowable current amount. The XLR 3 and 5 pins are used to control the luminaire through digital multiplexer communication. In addition, the XLR 5-pin was adopted to improve noise rejection efficiency and to consider compatibility. The DMX connector is an LED lighting product that consists of the input and output parts of the control signal. IR remote controller is applied as remote controller to easily control light quantity or color temperature when using as stand alone. In the IR remote control, the amount of light, color temperature, and hotkey can be specified for easy conversion to color temperature. AC adapter capacity is more than 125% of the power consumption of LED lights, and KC, CE, and UL certified products that can be used domestically and overseas are adopted. In addition, the control unit and the back panel are separated from each other, and the control unit has a tilting function, thereby adopting a straight hinge as a component to enhance the heat dissipation effect. The problem with large power LEDs is that when the LEDs are placed in close proximity to each other, significant heat can be generated, resulting in damage to the LEDs due to heat generation, which can not satisfy the rated life. The frame design of LED lighting was decided after review through four renderings. The upper and lower frames of the product were extruded to a thickness of 2mm with an aluminum extrusion mold, and cut by size to give a tab. The surface is surface treated with black anodizing with no reflection of light from the product. ‘Figure 1’ shows the upper and lower frame extrusion mold drawings. The left and right frames are extruded 4mm thick with a flat extrusion die. Then cut and tap. Side frames, which are the left and right frames, are mounted in two layers on both sides to ensure robustness when shooting outdoors. In addition, the two-ply shape is different and the left and right sides are different, but when processing by extrusion in one extrusion mold was applied by processing the left and right and two side frames.

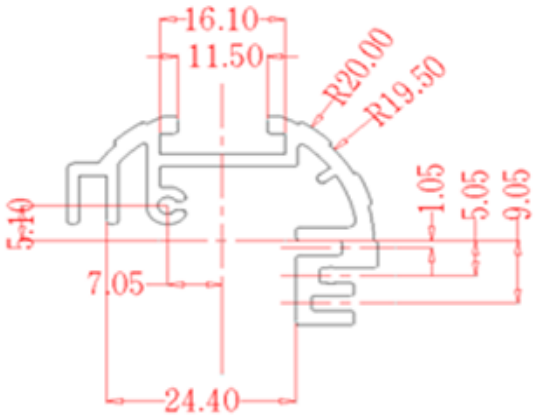

Figure 1. Upper and lower frame extrusion mold drawing

3. Results and Discussion

The surface was surface treated with black anodizing without reflection of light from the product. The side frame is doublely overlapped with the side process hole and is fitted with a

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yoke fixing bolt plate for fixing the yoke. In addition, the upper and lower frames are designed to be mounted and secured with a protective PC panel, a light diffuser, and a half door. The reason for reviewing the frame by extrusion is that the size of the product changes according to the amount of light in the LED panel light. When designing for press mold or plastic injection mold, the investment amount is increased, which increases the cost of the product. Therefore, it is designed to improve the design while reducing the cost. The side frame has a plurality of vents of the same type as the back panel, so that the heat of the heat sink combined with the LED board and the power board can be cooled by convection and conduction, and the handle lever nut plate that fixes the yoke and the product To be fixed. 'Figure 2' shows a processed product with the control unit design.

Figure 2. Control Design and Processed Products

The LED board design increased the density of the light source by setting the distance between LED modules to 15mm, and designed the output per PCB to 20W to make the LED boards common by model. The size of the board was 240mm * 90mm. In order to set the output per PCB to 20W, six 0.22W LEDs were arranged in series and connected in 16 stages in parallel to arrange 96 in each. To check the output 20W per PCB in 'Figure 3', we measured the rated current of the 20W LED board with an input voltage of DC 15V. When calculating the measurement result with the rated current 1.46A, the rated power of one 20W LED board is 21.9W.

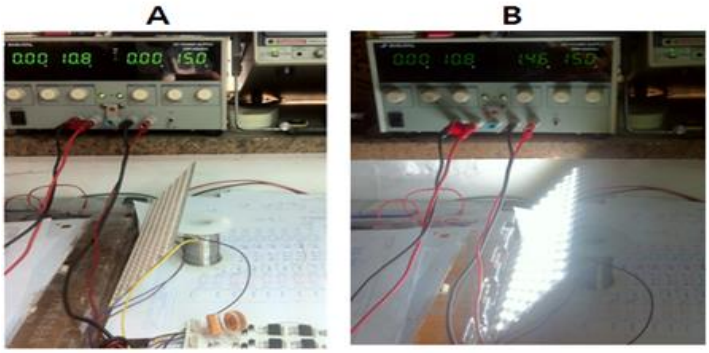

Figure 3. Photo of voltage and current indication of 120W LED board

(A : switch on, B : switch off)

Therefore, 120W products have 20W LED boards arranged in three rows and two columns as shown in 'Figure 4'. In addition, it is designed by direct dialing to control color temperature and light quantity, multiple control by wire through DMX, and product control by IR remote controller alone. A mono LCD module with status display is applied and IR remote control receiver is applied. LED lighting is Bi Color, which allows 3200K-5600K color temperature to be changed.

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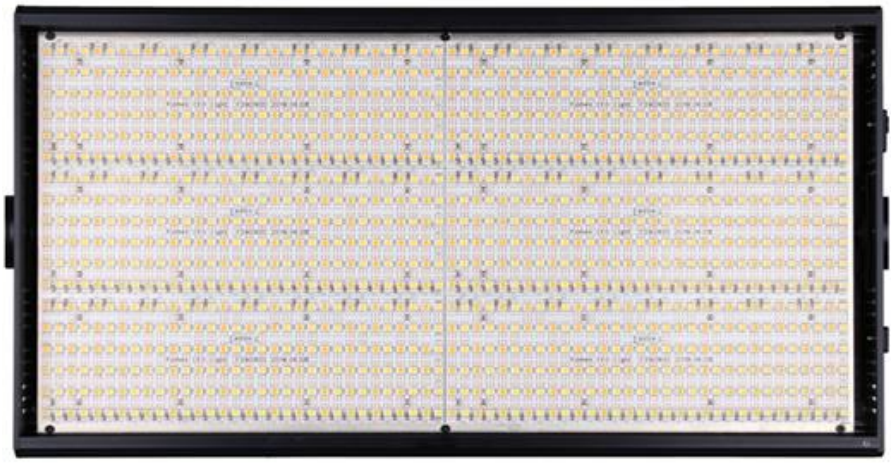

Figure 4. 120W LED board

The MCU is placed in the center of the board, the color temperature control VR and the light intensity control VR are arranged in the left and right centers, and the connector and IR receiver connected to the mono LCD are located above the center. Program installation connector and power connector are on the right side, PWM control connector, push switch control connector and DMX connector are on the left. The control PCB and LED PCB that generate heat are mechanically separated from each other in a separate case to be mounted. Therefore, the effect of heat rising due to the interference of the heat source is maximized to maximize the heat dissipation effect. In addition, a plurality of heat dissipation holes were formed on the lower surface and side surfaces except the front part. That is, as shown in 'Figure 5', through-holes and heat-dissipating holes were formed on the sides and sides of the LED PCB case except for the operation part of the controller PCB case to allow for natural cooling.

Figure 5. LED PCB Case (A has multiple heat sinks on the side and bottom)

4. Conclusion

In this paper, the effect of temperature change was examined in the state where the control unit of the LED panel light, which is a photographic image equipment, and the light source unit, which is the heat generating unit, are separated from each other by the internal angle control function using the hinge. It was shown that the temperature changes in the state in which the heating parts are integrally close to each other and separated by the angle control. The temperature of the control unit is lowered by 6-8°C in the state separated by the tilt function

than in the state in close contact with each other, the heat dissipation effect is caused by the separation of the heat generating unit. The temperature of the LED module part is lower by 1-2°C than when the spaced state is in close contact, and the heat dissipation effect is weak due to the spacing of the heat generating parts. This is because the aluminum 3mm flat plate heat sink is attached to the boards of the LED module to reduce the heat conduction to increase the heat dissipation system. That is, the flat aluminum heat sink should be attached to the board of the LED module to apply the heat dissipation system by conduction so that the efficiency and life of the LED module can be maintained for a long time. The LED lighting market for photographic images is classified as a special lighting market, and is an industrial field with a history and tradition in which the industrial scale is gradually expanding. LED replaces incandescent bulbs and fluorescent lamps, which are existing lights, in automobiles, traffic lights, outdoor and indoor lighting, and fisheries and agriculture, and the replacement rate of light is increasing very much. In addition, the lighting market for photographic images is also entering the activation period of replacing existing lighting with LEDs.

5. Acknowledgment

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