

Electric-optical Characteristics of Backlight Unit with LED Light Source in Low Temperature Condition

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LCD (liquid crystal display) industry is needed to goods of high reliability and is interested in products without harmful material. In this experiment, we made the LED backlight unit for Automotive-navigation. And for making this backlight unit we used to eight side emitting type white LEDs with 1W high power of the lumileds company. We could know that this backlight unit releases to 6500 nit in 14 W power consumption and start up voltage time is under the 15ms in the ambient temperature -20 °C.

Keywords : Backlight unit, LED, Low temperature backlight, CCFL (cold cathode fluorescent lamp), LGP (light guide plate)

1. INTRODUCTION

According to the accelerative modern industry, the application fields of many display industries are various gradually. TFT(thin film transistor)-LCD field is continuously processed by means of the large size display from conventional monitor and note PC to TV industry. And TFT-LCD by the application field is applied as the mobile, PDA, and the camera. CNS (car navigation system) is appeared to the most requirements of customers. CNS product is gradually appeared to many needs in convenience of user interface, multimedia player and an intelligent car navigation system. Difference from properties of conventional TFT-LCD is that car navigation system is needed to high reliability in the wide operating temperature range, such as -20 to 50 °C, vibration and an shock. And use of mercury is strictly restricted for driver security in the shut tight structure of car. We have to use backlight unit because liquid crystal display is non-emissive display of active type recently. Therefore CCFL of backlight unit of TFT-LCD is contented in mercury for generation of plasma discharge and starting up. It helps to discharge of CCFL in the normal temperature. But CCFL has defects in the lifetime characteristics of alteration to the liquid in the lower temperature and environmental problem[1,2]. So, guaranteed LED needed to operate in lower temperature, inside shock and vibration by backlight unit source of

solid semiconductor is used for backlight source development of TFT-LCD in this experiment. And optical design is competed by considering to the characteristics of LED light source[3,4].

By using the eight side emitting type LEDs (each LED has 1 W high power), we achieved to the simplicity of mechanical structure and we know that the center brightness of this LED-BLU is 6500 nit by measurement.

2. EXPERIMENTAL AND RESULTS

In order to the development of TFT-LCD used by automobile navigation with needs of high reliability, we made LED BLU by using the side emitting type White LED with 1W high power of the lumileds company in this experiment. Figure 1 is showing to the structure of side emitting type White LED with the consumption power of 1W and emitting characteristics of light.

Before manufacturing of LED Backlight Unit, we measured the light Flux of conventional TFT-LCD used by CCFL. The Result is 203 lumen in 4 W of the consumption power for the measurement of light intensity.

In the base of result, the light Flux of 237 lumen is measured by used to eight side emitting type White LEDs of 1 W with emitting characteristics of 35 lm/W. Side-emitting LEDs are particularly suitable for coupling



Fig. 1. 1 W side-emitter LED diode(Lumileds co., ltd).

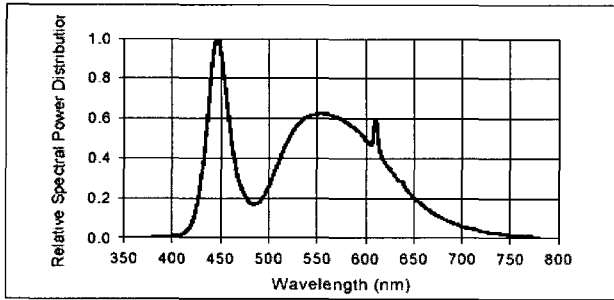


Fig. 2. Spectrum data for 1 W side-emitting type white LED.

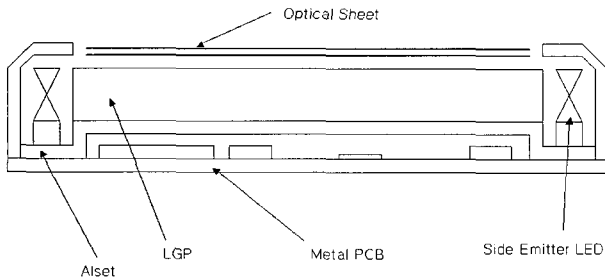


Fig. 3. Structure of the white LED backlight.

the light from the LEDs directly into a light guide[5-8]. Figure 3 is showing to the structure of LED Backlight unit.

Each four of Manufactured LED-BLU is arranged by light source at top and bottom. And generative emitting light by arranged light source has structure for incidence ray inside to the horizontal setting LGP. We used Prism sheet of 3 M company in order to improve the optical performance. In particular for properties maintenance of LCD with a light weight and small size, this BLU is designed in lower part of reflector generated by mount height of LED. And according to appliance for white LED, external form of LED-BLU is minimized without using each red, green, and blue LED.

The CCFL is mainly used by backlight unit of LCD at the present time. Because the brightness, lifetime and reaching time until the starting up voltage are changed

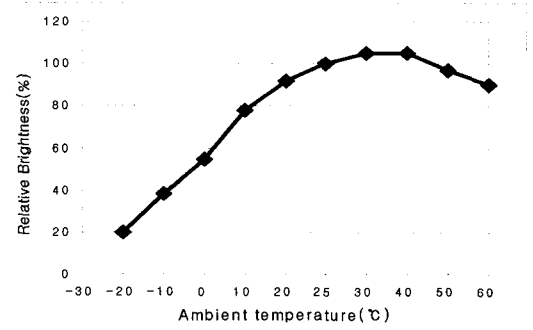


Fig. 4. Relative brightness of CCFL for ambient temperature.

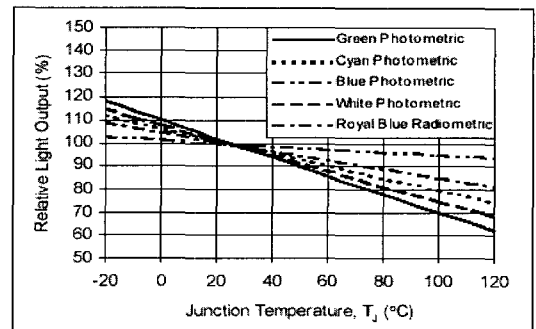


Fig. 5. Relative light output of white LED for ambient temperature.

by variation of the ambient temperature, the application of automobile navigation for needs of high reliability is unsuitable. Because of the problem of the operating characteristics and lifetime at the lower temperature, initial starting up voltage is particularly required to higher voltage value. The CCFL is contained in mercury, argon and neon gases in the vacuum. The very important gas of contents in lamp is mercury. Although the mercury is existed in the lamp, mercury is partly turned to liquid according to decreasing of ambient temperature. Because of this phenomenon, starting discharge voltage for lamp starting up is required high voltage value at lower temperature. And brightness is decreased. Figure 4 is showing to brightness characteristics graph of lamp.

The CCFL is required to High voltage at Initial starting up voltage. But LED backlight unit needs to lower starting up voltage of input voltage 3.42 V. Also because of superior brightness characteristics in lower temperature, LED backlight unit is suitably applied to automobile navigation for needs of high reliability. Figure 5 is showing to brightness characteristics of LED backlight unit according to change the temperature.

We compared normal backlight unit with conventional CCFL (Ne:Ar = 90 %:10 %, 80 torr) with manufactured LED-backlight for this experiment. We measured delay

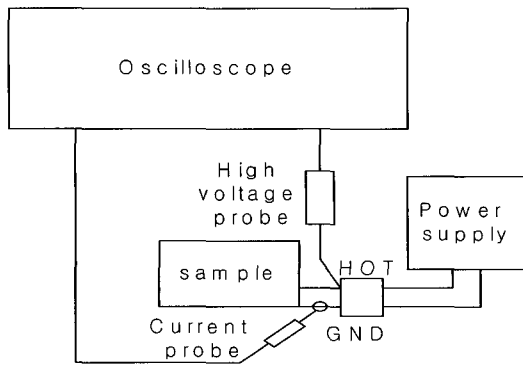


Fig. 6. Equipment of measure to delay time for BLU in the ambient temperature.

Table 1. Condition of light source in the normal BLU and LED-BLU.

CCFL		White LED	
Dimension(L* ϕ)	243 \pm 1.0*22 \pm 0.05	Dimension(L*H)	14.5 \pm 0.3*6.09
Starting up Voltage (Vrms, 25 $^{\circ}$ C)	1100	Forward Voltage (V)	3.4
Hg Amount (mg)	Typical 20	Forward Current (mA)	350
Electrode Material	Nikel	Optical efficiency (lm/W)	35
Electrode Length	6mm (cup type)	Radiation type	side emitting
Pressure Ratio(Ne:Ar)	90 : 10	White color generate type	phosphor convert

time of the starting up voltage according to the changing temperature with two backlight units. The normal BLU was operated by the Royer type inverter (HIU 741, Harison Co., Ltd) in condition that voltage 1100 Vrms.

The result of measurement occurred that no discharge phenomenon is 13 EA in 16 EA. Figure 6 is showing to a scheme of experimental setting for operating voltage measurement of backlight unit.

Table 1 is showing condition of light source in the normal BLU and LED-BLU.

Figure 7 is showing to the starting up voltage time of normal backlight unit used to CCFL and LED backlight unit in the normal temperature.

And, Figure 8 is showing to the starting up voltage time of normal backlight unit used to CCFL and LED backlight unit in the ambient temperature -20° C.

3. CONCLUSION

Normal backlight unit with CCFL used to conventional backlight source of LCD occurs to the reliability problems at the lower temperature. To solve this problem, we release to the LED backlight unit. The LED backlight unit with eight side emitting type white

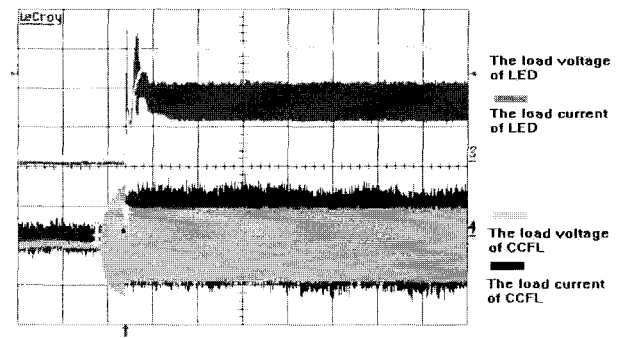


Fig. 7. Delay time of normal BLU and LED-BLU in the normal temperature(25 $^{\circ}$ C).

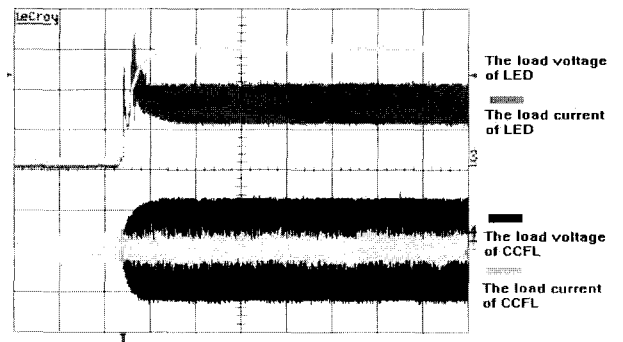


Fig. 8. Delay time of normal BLU and LED-BLU in the low temperature(-20° C).

LED of 1W appears to reach characteristics to the center brightness 6500 nit at total consumption power 13.3 W. As a result of this experiment result, we know that the reaching time to the starting up voltage value in backlight unit which used LED light source in the ambient temperature -20° C is under 15 ms. And we confirmed that LED backlight source is solution for the starting up voltage characteristic improvement of CCFL with no discharge phenomenon in the lower temperature according to the result.

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