LED Devices for Backlight Applications

1. Introduction

In the past, cold cathode fluorescent lamps (CCFL) were generally used as the light source for backlighting in notebook PCs and liquid crystal televisions. However, a transition from CCFL to light-emitting diodes (LED) commenced several years ago based on environmental (mercury-free, low-power-consumption, long life) and functional (thin, lightweight, local dimming) considerations, and LED are now the main light source in use.

LED backlights may be of the direct type, in which LED devices are positioned at the rear of the panel (Fig. 1), or the side type, in which the devices are lined up on the side of the panel (Fig. 2).

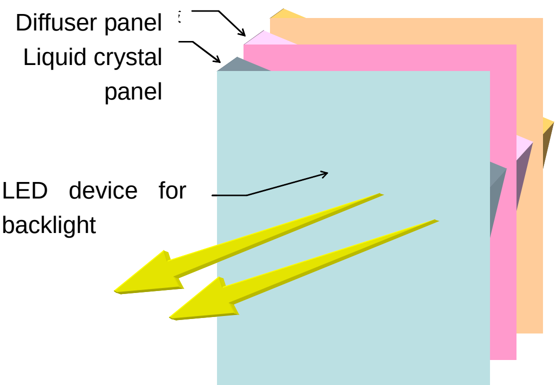


Fig. 1　Direct-type LED backlight

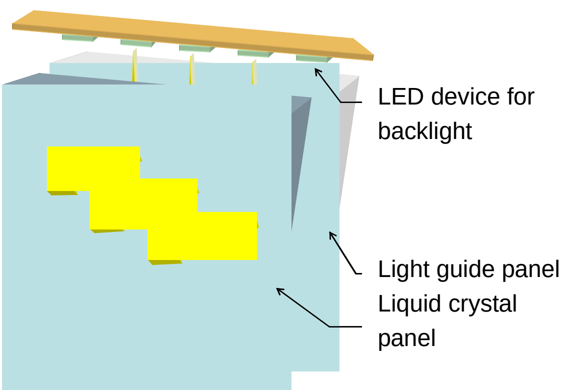


Fig. 2　Side-type LED backlight devices

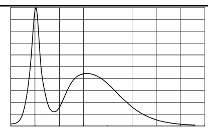
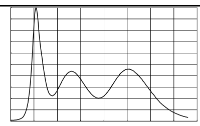
Stanley manufactures LED devices for these backlight applications using ceramic leaded chip carriers (CLCC) and plastic leaded chip carriers (PLCC) as packages.

The major difference between the CLCC and PLCC types is lifespan (50% lumen maintenance). The CLCC type has a lifespan of approximately 60,000 hours, while the PLCC type has a lifespan of 15,000-20,000 hours. We recommend the use of CLCC type LED devices in backlight applications for which longer life is required.

2. CLCC-type LED Devices for Backlight Applications

This chapter will discuss CLCC-type LED devices for backlight applications.

Table 1 shows the four types of LED devices for backlight applications that are composed of ceramic reflectors. Because these devices emit light from the front, they can be used for direct-type LED backlights (Fig. 3), but they can also be used for side-type LED backlights (Fig. 4) if the mounting board is set against the side of the backlight. These LED devices are designed to be small, and the backlight can therefore be made thin in the case of both direct-type and side-type backlights. The CLCC type displays a higher degree of luminosity and higher reliability than the PLCC type to be discussed below, and they are therefore particularly suitable for large (20-inch+) backlight applications.

	B□□W1141JTE	B□□W1151JTE
Exterior		
Dimen-sions	L2.5mm、W1.5mm、H0.7mm	
Light emission character-istic		 High color reproducibility type

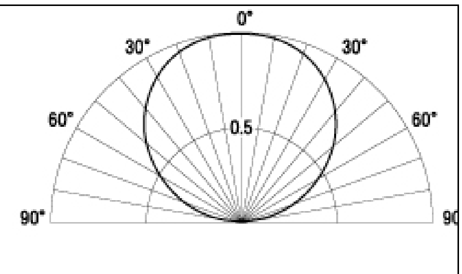
Directional characteristic	 Half value angle 120˚
Standard current	80mA (80mA/1chip)

Table 1 CLCC type LED devices for backlight applications

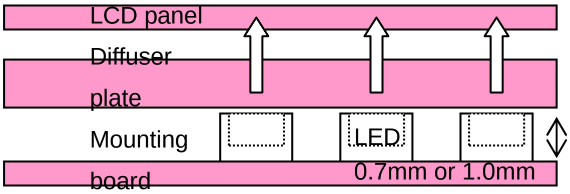


Fig. 3 Cross-section of direct-type LED backlight (CLCC type)

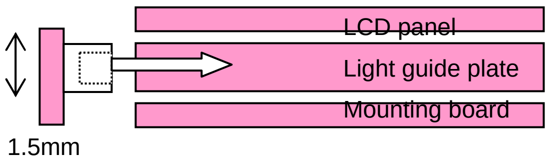


Fig. 4 Cross-section of side-type LED backlight (CLCC type)

2-1. Standards for luminous flux/color

Closely subdivided standards have been set for luminous flux and color in order to ensure uniformity among LED devices (Table 2, Fig. 5).

Rank	min(Lm)	max(Lm)
AZ	8.2	10
B1	10	12
B2	12	15
B3	15	18
B4	18	22
B5	22	27
B6	27	33
B7	33	39
B8	39	47

Table 2 Luminous flux rank specifications for LED devices used in backlight applications

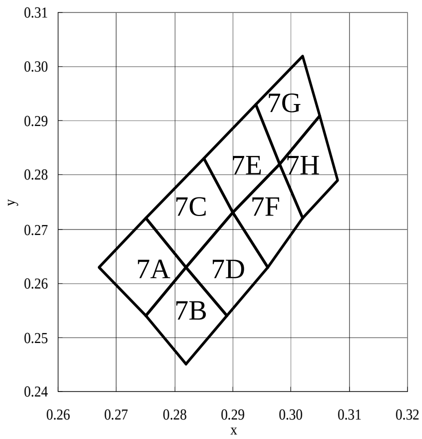


Fig. 5 Color rank standards for LED devices used in backlight applications (CLCC type)

2-2. Measures to prevent sulfurization/color change

A structure in which a silver plating or coating is formed on the surface of the reflector and sealed with silicon resin is frequently used, in particular in white LED devices. This is because silver has a high reflectivity rate for light in the visible domain, and this treatment can therefore be expected to increase the efficiency with which the LED device produces light. However, silver reacts readily with hydrogen sulfide gas and sulfur gas, forming black silver sulfide（H_2S + Ag = Ag_2S, 2Ag + S = Ag_2S）in a process known as sulfurization. In addition, when light is reflected from silver at high temperatures, the silver diffuses in the surrounding area, producing discoloration (light-induced discoloration). In the case of side-type backlights in particular, because the LED devices are positioned facing each other across the light guide plate, they are placed in an environment in which light discoloration can easily occur (Fig. 6). When LED devices used in backlight applications undergo sulfurization or light-induced color change, their light output can decline or color change can occur, resulting in poor image quality on the LCD panel. The progression of sulfurization may also cause the device to stop producing light. An LED device that has undergone sulfurization or light-induced discoloration cannot be returned to its initial state.

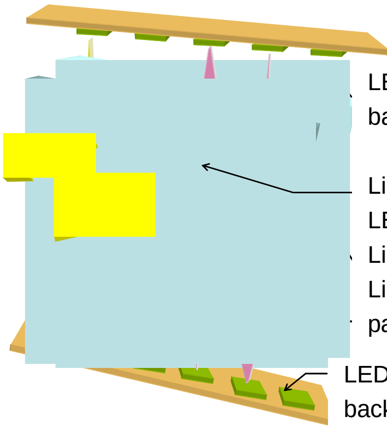


Fig. 6 Side-type LED backlight

In the case of CLCC type LED devices for backlight applications, special compositions are used to prevent sulfurization and light-induced discoloration despite the use of silver. As a result, these devices will display no decline in luminous flux, color, or external appearance even when placed in a H2S:3ppm, Ta:40°C, RH:80% environment for 192 hours (192 hours is equivalent to 20 years in an indoor environment, and two years in a heavy industrial area).

2-3. When mounting LEDs

When soldering CLCC-type LED devices for backlight use to an aluminum, copper, or other metal mounting board, check in advance the environment that the devices will be used in. If the devices are used in environments in which they are subject to severe thermal shocks, cracks may develop in the solder causing the devices to stop producing light or to detach from the board.

3. PLCC-type LED Devices for Backlight Applications

This chapter will discuss PLCC-type LED devices for backlight applications.

Table 3 shows the four types of PLCC-type LED devices for backlight applications, which use plastic reflectors. Because these products are thin and emit light from the side, they are particularly suited to use in medium-sized (10-inch+) side-type backlight applications (Fig. 7). Because their directional half value angle is 115°, they interfere with peripheral LEDs, making it possible to uniformly illuminate the panel.

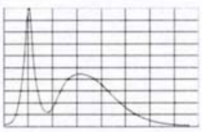
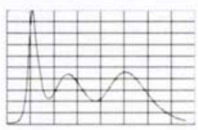
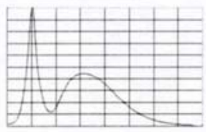
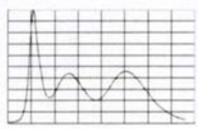
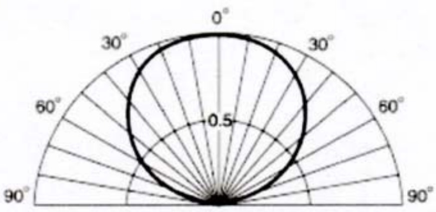
	**W1142LTM	**W1152LTM	**W1145LTM	**W1155LTM
External appearance				
Size	L2.8mm, W1.0mm, H0.8mm		L3.8mm, W1.0mm, H0.6mm	
Light emission character-istic		 High color reproducibility type		 High color reproducibility type
Directional character-istic				
Standard current	20mA (20mA/1chip)			

Table 3 PLCC type LED device for backlight applications

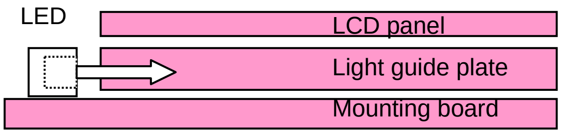


Fig. 7 Cross-section of side-type LED backlight (PLCC type LED)

3-1. Standards for luminous flux/color

Like ceramic-type LEDs, closely subdivided standards for luminous flux and color are set for PLCC-type LED devices for backlight applications (Table 4, Fig. 8).

Rank	min (mcd)	typ (mcd)	max (mcd)
TA	720	755	790
TB	790	830	860
TC	860	900	950
TD	950	975	1000
UA	1000	105	1100
UB	1100	1150	1200
UC	1200	1250	1300
UD	1300	1350	1440
VA	1440	1500	1580
VB	1580	1650	1720
VC	1720	1800	1860
VD	1860	1950	2000
WA	2000	2100	2200
WB	2200	2300	2400
WC	2400	2500	2600
WD	2600	2700	2800

Table 4 Luminous flux rank standards for LEDs for backlight applications (PLCC type)

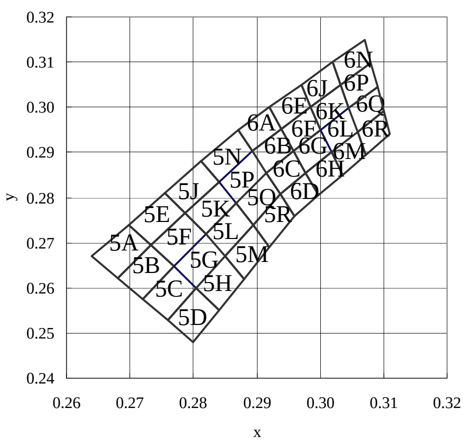


Fig. 8 Color rank standards for LEDs for backlight applications (PLCC type)

4. LEDs for Backlight Applications with High Color Reproducibility

Color reproducibility refers to the degree to which an image on the display medium reproduces the color of the actual object. There are two different emission spectrum types for LED devices for backlight applications, and we recommend the use of high color reproduction types when a high level of color reproduction is required. LEDs with high color reproduction are available in both the CLCC and PLCC types.

Most white LED devices produce white light by means of a combination of blue light from blue LED elements and yellow light produced by a fluorescent material excited by the light from the blue LED elements. However, standard LCD screens are made up of red, green, and blue filters, and when these white LED devices are employed, it is necessary to split the yellow light into green and red. Because of this, the image appearing on the LCD screen differs in color from the actual object, naturally resulting in a decline in color reproducibility. The reason for this phenomenon is as follows: Because the red component of the yellow light is minimal, it is necessary to use a filter composition that emphasizes red; the green light split from the yellow light therefore appears on the liquid crystal screen with more of a yellow tinge than the actual object displays (Fig. 9).

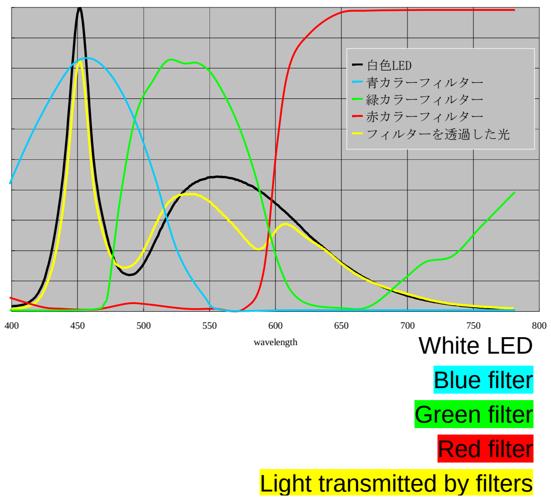
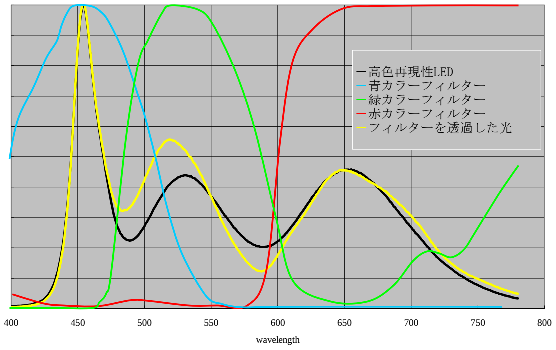


Fig. 9 Light emission spectrum and transmission spectrum for standard white LED device

By contrast, high color reproducibility-type LED devices for backlight applications combine green and red fluorescent materials which match the wavelength characteristics of the color filters (Fig. 10). In order to increase color reproducibility, it is important to match the wavelengths of the color filters and the white LED devices. Because Stanley has prepared variations of blue LED elements and green and red fluorescent materials, we are able to reproduce the optimum red, green, and blue for our customers' needs.



High color reproducibility LED
Blue filter
Green filter
Red filter
Light transmitted by filters

Fig. 10 Light emission spectrum and transmission spectrum for high color reproducibility-type LED device

The ranges of color reproduction achieved when using standard white LED devices and high color reproducibility LED devices, as demonstrated by simulations, are shown in Fig. 11 and 12.

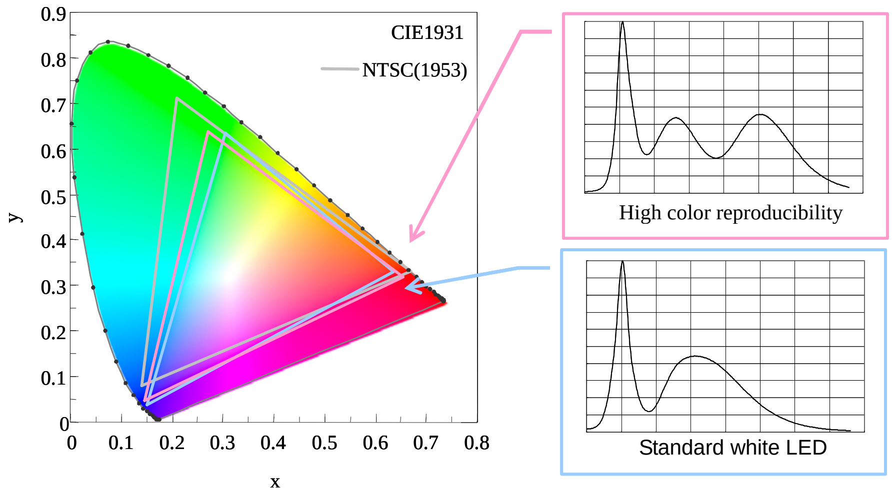


Fig. 11 Color reproducibility of white LED device for backlight applications (xy coordinates)

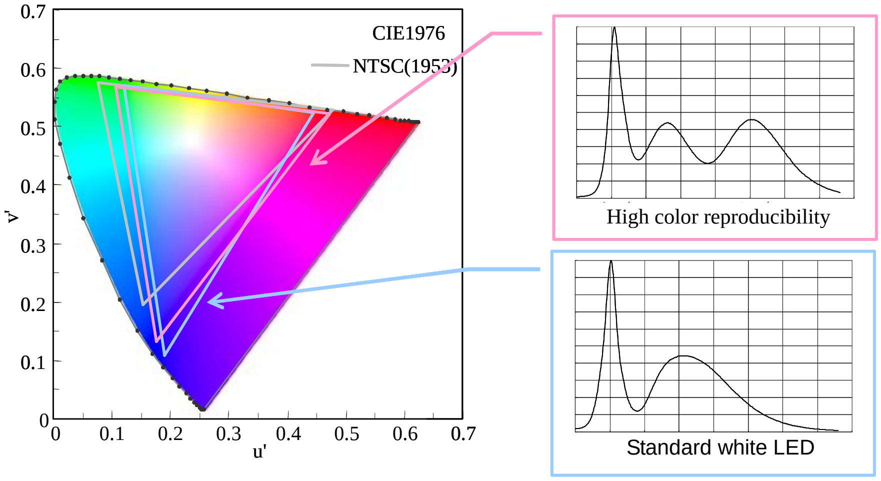


Fig. 12 Color reproducibility of white LED device for backlight applications (u'v' coordinates)

For color reproducibility, u'v' coordinates correct the wavelength intervals of the xy coordinates, enabling more accurate evaluation of the color differences.

5. When Designing Backlights

In order to increase the light-receiving efficiency of the light guide plate, we recommend selecting LED devices that are smaller than the light-receiving section of the light guide plate. In addition, because the light-receiving efficiency also changes with the distance between the light guide plate and the LED devices, management of variations when mounting the LED devices is also important.

Dispersion resulting from the surface treatment applied to the light guide plate or the materials used in it may result in differences in color between the light-receiving side and the anti-light-receiving side. We recommend that users take sufficient care in matching the LED devices to the light guide plate.

The light output of LED devices is affected by temperature. In particular when a number of the devices are used close together, a temperature gradient is produced within the mounting area, and this may cause irregularity in light output. In addition, LED devices generate heat as they produce light, and their temperature therefore tends to increase during operation. Swelling of the light guide plate or mounting board and a change in the relative positioning of the light guide plate and the devices can therefore be envisaged. During the design process, consideration should be given to the temperature distribution and temperature increase of the LED devices, and the use of heat-dissipating materials or a temperature controller should be examined.