White Light Key to High-efficiency LED TV Applications

by William Carrera, Senior Technical LCD Manager, Samsung Semiconductor, Inc.

Backlight technology continues to markedly improve, day after day, making it possible to design LCD panels as thin as a picture frame. Many thought that the use of OLED technology would be the only way to provide ultra-slim TV sets. Now, there are LED LCD TVs with depths as thin as 1.2 inches.

LCD panels are not self-emissive. They must have a backlight with an independent light source whether using CCFL (cold cathode florescent lamp) or LED technology, and these backlights can be installed either using an edge-lit or direct lit approach. Edge-lit backlight units have light sources along each (or most) of its edges and must use a LGP(Light Guide Plate) for brightness uniformity, while direct type of backlight units have the light sources beneath the panel and need an optical cavity and a diffusing plate.

For edge-lit panels, the LGP function provides uniform brightness within a minimum of space. Direct-lit backlighting needs more thickness due to an optical cavity to assure brightness uniformity resulting in LCD TV sets as thick as three inches.

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Edge-lit backlighting in a CCFL environment has not been applied to large LCD TVs mainly because several CCFL tubes cannot provide enough brightness with an LGP due to the large active (viewing) area, compared to a direct-lit CCFL TV set. However, edge-lit LCD technology is quickly catching on, thanks to the use of highly efficient, low-power LEDs.

When all four sides of an LED TV are used for edge-lit backlighting, this provides enough brightness to use a 3mm or 4 mm LGP with 3mm thick LEDs. With this approach, edge-lit backlighting systems with white LEDs can have an LCD panel 10mm thin or even thinner, while direct type LED backlight unit requires 30mm to 40mm.

Besides weight and thickness reductions, there are several other advantages to LEDs as light sources in LCD TV applications. They include better color design efficiency, the absence of mercury, a faster response time for reaching full brightness , and lower power consumption by applying a local dimming algorithm which increases the dynamic contrast ratio substantially. The most powerful advantage, however, is the design efficiency that LED can offer for color reproduction. There can be several combinations of color and light source intensity providing a higher level of power efficiency in notebooks, TVs, and monitors by combining the LED chip with different types of phosphor powder including yellow phosphors, red/green phosphor and green/orange phosphor.

Samsung initially developed an LED TV with an exceptionally high color gamut using RGB LEDs. We then introduced white LED technology that combined a blue LED chip with Red/Green phosphors to improve LED lighting efficiency and increase the TV’s white level brightness

[9]

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by 30 percent, resulting in a 40 percent power reduction compared to RGB LED technology.

After years of research upgrades and extensive testing, we have proven that consumers can get a highly competitive TV display using white LED technology instead of RGB LEDs, while saving considerable money in the process.

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