Full Color LCD Backlighting with LEDs

AVAGO TECHNOLOGIES

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Introduction

This application brief will describe the present and future needs for LCD backlighting and compare an LED solution against competing light source technologies. A full color back-lighting scheme with red, green, and blue LEDs is described. It will be shown that the LED solution is technically superior to other light sources that presently have a large portion of the LCD white (full color) backlighting market.

Full Color LCD Backlighting with LEDs

The backlighting of an LCD has become a very popular aesthetic characteristic among all LCD product proliferations. The market demand will not allow for an LCD based product to be competitive without enhanced display visibility in a dark ambient. This backlighting requirement has placed some constraints on some of the major competitive attributes that an LCD without backlighting would have over one with it. These attributes are cost, power dissipation, weight, size, and reliability. Furthermore, most backlighting applications are finding demands to have full color capability. This adds complexity to the overall backlighting solution: lightguide, reflector, and diffuser system that can couple a large bandwidth of wavelengths towards the LCD with high efficiency. When using a white light source (i.e. cold cathode tube lamp, electro-luminescent, etc.), then a special filter system has to be implemented and there has to be at least three LCD pixels (RGB) for every viewer pixel. The filtering adds costs and reduces the efficiency of the lamp's light output. Using three LCD pixels to create one viewer pixel cuts down resolution capability.

In a full color application as described here, using a multiplexed RGB LED solution would be favorable. The multiplexed RGB LED system works as follows: initially, the LCD pixels are configured to show the red information with only the red LED(s) on. Next, the pixels are configured to show the green information with only the green LED(s) on. Finally, the pixels are configured to show the blue information with only the blue LED(s) on. It is just a matter of combining the pulse width modulations of each color to create whatever color is desired. If all three color configurations are cycled at a rate faster than 100 Hz, only the combined color will be observed.

With the LED system, filtering is not required (less cost and increased light transmission) and each LCD pixel can be implemented as a one full color pixel to the viewer (increased resolution). Since LEDs are a semiconductor based technology, their reliability and operating lifetime extend well beyond that of any other light source solution. The efficiency of LEDs (lumens/electrical Watt), depending on the color, is comparable or much better than any other light source per unit volume of the light source material. Transparent Substrate (TS) AlInGaP made by Avago Technologies has been reported to have efficiencies of greater than 40 lm/W (90 lm/A). Also, there has been recent development of blue and green LEDs that can output more than 1.0 cd of light with an input of less than 1.0 electrical Watt. When considering geometrical optics (the light source's reflector and lens packaging), it is not realistic to compare the standard packaging of a common LED to the LCD backlighting specific configurations that have been developed by other technologies. The semiconductor material can be proliferated into whatever package the application would require. It is important to note that competitive blue-green LED technology has just surfaced and will continue to improve. No other light emitting technology has made as many recent advancements as that of the LED. As the LED technology matures, the costs will decrease and the LED solution will be superior to any other regardless of the parameter under consideration.

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