ADAPTIVE
Adaptive Micro Systems LLC

Billions and Trillions of Colors: A Visible Difference?

The facts behind color delivery

Like every other product in the marketplace, LED displays are subject to enthusiastic claims of the "latest and greatest" technology. Armed with impressive statistics that purport to revolutionize the industry, manufacturers deliver their latest product offerings with an underlying warning: "This is the Next Big Thing—don't get left behind!"

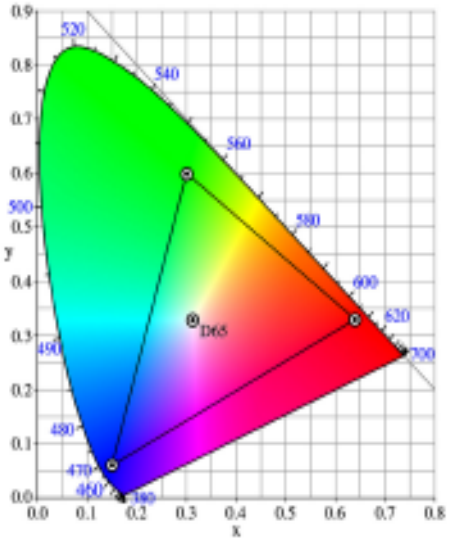
One of the latest trends in the LED display business is the promised delivery of billions—and even trillions—of colors. Sounds amazing doesn't it? It certainly does, but upon closer examination, this actually turns out to be a case of delivery exceeding need.

The Science of Color

On most LED signs manufactured today, the signal input is 24 bits of data per pixel (which breaks down to eight bits for each red, green, and blue LED in the pixel), resulting in 16.7 million colors. The majority of computer monitors—and even HDTVs—offer the same number of colors, yet by most estimations the human eye can only actually process around 10 million colors.

Since LEDs are assembled from man-made materials, we have only limited control over the outcome of the substances that makes up the semiconductors. Although at first glance, two green LEDs might seem indistinguishable from each other, the specific wavelength of the color they emit does actually differ when measured precisely. When grouped into a larger pixel array, the visual result is a blotchy or "quilted" pattern, unless the assembly method and controls of the display manufacturer account for this.

Building signs that disregard LED color variation is a lesson Adaptive learned many years ago. However, many of the LED sign manufacturers that have cropped up in recent years haven't make this discovery



The C.I.E. 1931 Chromaticity Diagram

Named for the the International Commission on Illumination (or, in French, Commission internationale de l'éclairage)—the international authority on light, illumination, color, and color spaces—this diagram portrays the way that the human eye perceives and interprets the wavelengths of light that become "color".

In this illustration, a triangle has been imposed on the diagram, representing the output of red, green, and blue LED bulbs. As the actual color of the bulbs inevitably varies from lot to lot, Adaptive's engineers use this diagram to determine the proper combination of output from all the bulbs in the 3-LED pixel to produce a consistent color result.

For example, if a red LED emits a wavelength that would show up to the right of the spot on this diagram, the output of the blue and green can be adjusted to compensate. These subtle shifts, virtually unnoticeable to the eye, are repeated throughout the board, allowing Adaptive's boards to accurately render specific color with a minimum of "blotchiness" or uneven tone.

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yet, leading to a plethora of cheaply priced products that, unfortunately, fail to meet the expectations of the buyer. To counteract this phenomenon of LED color variations, Adaptive uses a proprietary grading scheme based on the CIE Chromaticity Diagram (see inset) to tune the LEDs to a specific color, which serves as a basis from which the other colors can be adjusted accordingly.

Furthermore, Adaptive takes into account the anatomy of the human eye, and incorporates another scheme called gamma correction to assure that the nonlinear nature of display circuitry is appropriately adjusted so that color detail is not missing for the user.

Making these adjustments, however, will essentially use up some of the colors that the system delivers. So even though a display might start with 4.3 trillion colors, you'll end up with far fewer after color correction and gamma correction—although the resulting color delivery will still far exceed that of even an HDTV.

Can There Be Too Much Color?

Here's the real kicker: most of the images used on LED displays come from standard video devices and formats such as DVIs, digital cameras, GIFs, bitmaps, JPEGs, and standard content managers — all of which are limited to 16.7 million colors. The claim of billions and trillions of colors suddenly becomes irrelevant since the color is throttled by the media by which it is delivered, and only proves that the manufacturer used a bigger processor than necessary to effect what turns out to be a non-factor in image quality.

The truth is that until the video industry jumps to the next level of color processing (such as some developing HDTV formats, which may offer 10 to 12 bits per color), it makes no sense to pay for more than is actually useable.

In conclusion, the deciding factor in color projection and fidelity lies with the quality—and not the quantity—of colors. An LED sign that delivers trillions of colors won't guarantee proper color representation if the product is not graded correctly at the LED level. When considering an LED display, the buyer should know that when it comes to delivering maximum impact, Adaptive's focus on color correctness and contrast ratio simply trumps billions or trillions of colors.

It is also crucial to note that Adaptive pays just as much attention to quality construction techniques, customer support, reliability, and power conservation, resulting in the best overall value-to-cost ratio in the industry. It's this commitment to overall excellence and long-term value that makes our products truly stand out from the crowd.

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