White Paper

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Eizo Nanao Corporation

LCD Monitors for High-End Graphics: An Overview of the ColorEdge Series

Accurate color reproduction and color management that rivals CRT monitors

Preface

In recent years, the printing and design industries have been increasingly bypassing the conventional color proof based prepress workflow in favor of CTP (Computer To Plate) printing, which offers such benefits as a filmless environment, faster turnaround, lower costs, and reduced production time. However, the success of CTP printing requires that designers and photographers can carry out all color value checks on screen before printing begins. The monitor's ability to produce accurate, consistent display of color will always take priority other considerations such as aesthetics, space efficiency, and energy consumption. CRT monitors retain a dominant position for professionals involved in color critical work despite their obvious drawbacks compared with smaller, thinner LCD monitors. Graphics professionals are eager to switch to flat panel technology, but have been reluctant because there have not been LCD products that satisfy their color reproduction concerns.

ColorEdge CG18

ColorEdge CG21

EIZO has developed its ColorEdge Series of LCD monitors for graphics professionals requiring accurate color reproduction. ColorEdge overcomes problems such as limited color gamut, poor additive color mixture, and inaccurate color gradation display that have prevented LCD monitors from widespread adoption for use in DTP, photography, and soft-proofing for print.

This paper will examine common weaknesses of LCD monitors relating to color reproduction, and how EIZO addresses them with the ColorEdge Series.

Contents:

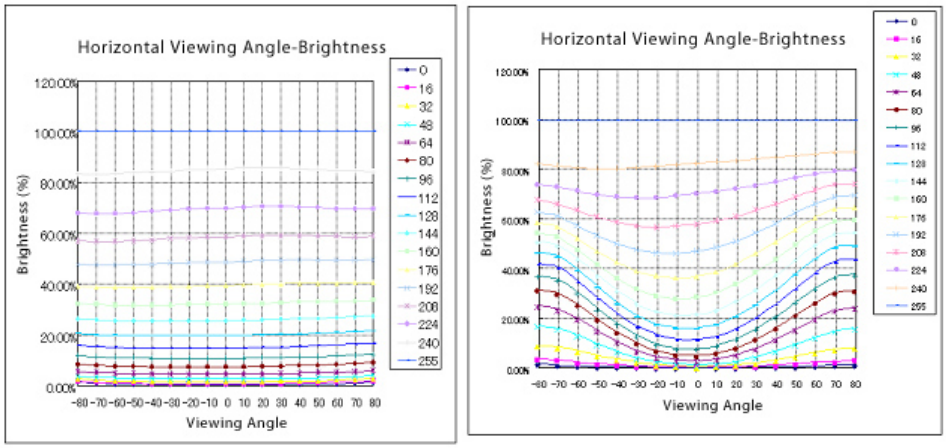
(1) Wide Color Gamut on Par with a High-End CRT Monitor

A limited color gamut (color reproduction range) has typically been cited as one of the biggest drawbacks of LCD monitors. Compared with their CRT counterparts, the colors on LCD monitors usually appear faded and washed out. However, EIZO carefully selects the color filters attached to the LCD panel and the backlight so ColorEdge monitors have a color gamut that is nearly equivalent to a CRT monitor.

Image displayed on ColorEdge (L) and a standard LCD monitor (R).

(2) Minimal Color Shift When Viewed from Off Center

When viewed obliquely, colors on an LCD screen look faded and whitish - a critical flaw that does not effect CRT monitors. Even after several years of advancements in technology, most LCD monitors still exhibit this trait. For ColorEdge, EIZO employs the most advanced IPS (In-Plane Switching) panels available. In addition to having wide viewing angles to minimize changes in contrast, these IPS panels exhibit minimal change in color and color gradations when viewed at an angle.



As the graph on the left shows, ColorEdge exhibits almost no color shift from an angle. (The displacement between each gradation does not change according to viewing angle.) With a standard LCD monitor on the other hand, gradation changes according to viewing angle can be quite severe, causing washout.

(3) True Display of White and Stable Brightness

When doing color-critical work, proper display of white is extremely important. With ColorEdge, the setting for white is possible with each color temperature. For more accurate settings of white, ColorNavigator software (see page 7) is available for calibration.

Compared to a color temperature of 5000K (L), the same image is noticeably bluer at 9300K (R).

Brightness stability is also critical for the proper display of color. All EIZO LCD monitors including ColorEdge contain a patented brightness stabilization function developed in-house. A sensor stabilizes the brightness level within minutes after startup or coming out of power saving mode. It also detects and automatically compensates for brightness fluctuations due to ambient temperature. Other CRT and LCD monitors require a 1-2 hour warm up period to achieve stable brightness, and the brightness level of these monitors is easily affected by changes in

the surrounding temperature.

This brightness stabilization function is EIZO patented technology (Japan Patent Numbers 3171808 and 3193315; US Patent Number 6188380).

LCD monitor that starts off dark until brightness gradually stabilizes

LCD monitor that starts off extremely bright until brightness gradually stabilizes

ColorEdge - Brightness stabilization soon after startup

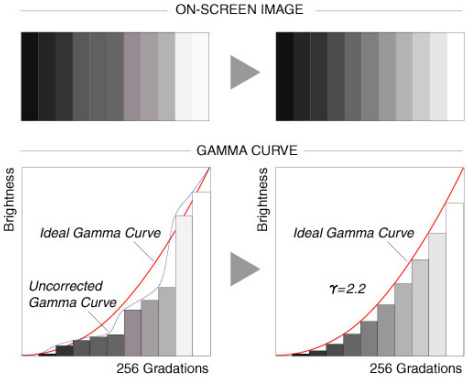
(4) Smooth and Faithful Color Gradations

All LCD panels display grayscales very poorly. This becomes clear by looking at the gradations on a grayscale ramp where there is unevenness between grayscales, and color seepage occurs. However, ColorEdge contains a 10-bit Look-Up Table that individually adjusts the gradation characteristics, producing extremely smooth gradation display, even surpassing that of CRT-based calibration.

Compared with a standard LCD monitor (L), grayscale display with ColorEdge (R) is uniform and smooth.

<ColorEdge10-bit display for RGB>

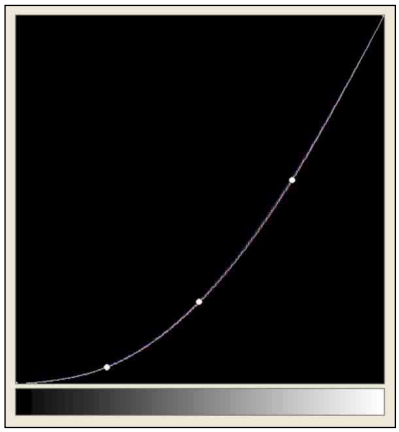
ColorEdge contains a built-in gamma correction function that automatically converts 8-bit data (256 gradations) received from the computer to 10-bit (1021 gradations) and then reassigning this data back to 8-bit with the ideal 256 gradations. The result is far smoother display of gradations than is possible with standard LCD monitors or any other monitors with only 8-bit processing capabilities for calibrating.



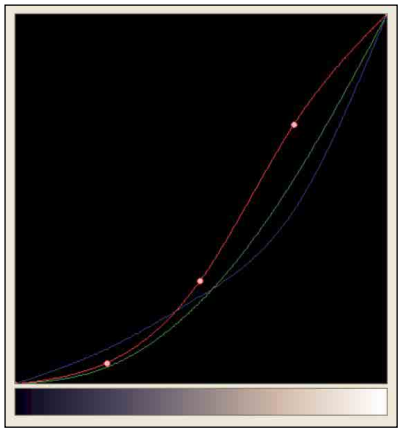
Most monitors cannot adjust the degree to which gradations are changed (gamma). The internal gamma correction function of ColorEdge and can maintain the smoothness of gradations while adjusting the differing gamma levels of operating systems and images. As these photos and illustrations show, gamma value is critical for the correct display of color.

The same image is displayed with gamma values of 2.2 (L) and 1.8 (R). The smaller the gamma value, the brighter the image appears.

Gamma values for RGB are properly aligned.

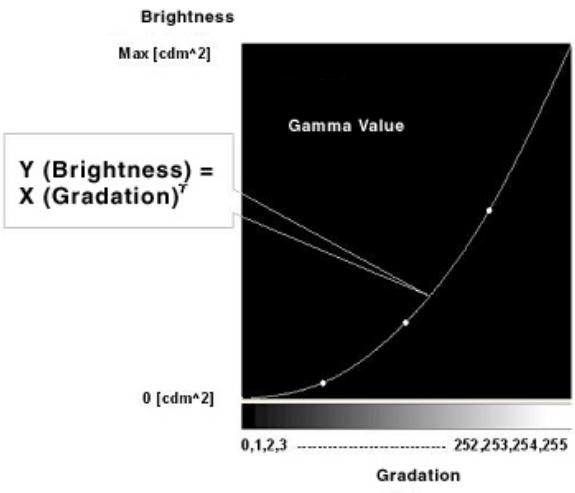


Gamma values for RGB are not aligned. Streaking is visible and colors cannot be reproduced correctly.



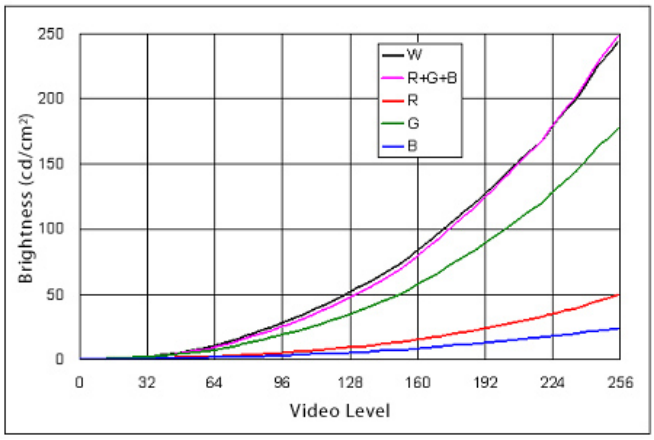
<What is Gamma Value?>

Gamma value is the coefficient of a gradation and brightness expressed in a formula. The gamma power of X is shown in the illustration to the right. The horizontal axis is the gradation value, and the vertical axis the brightness value. Gamma value indicates the relationship between gradation and brightness – the higher the gradation, the greater the brightness.

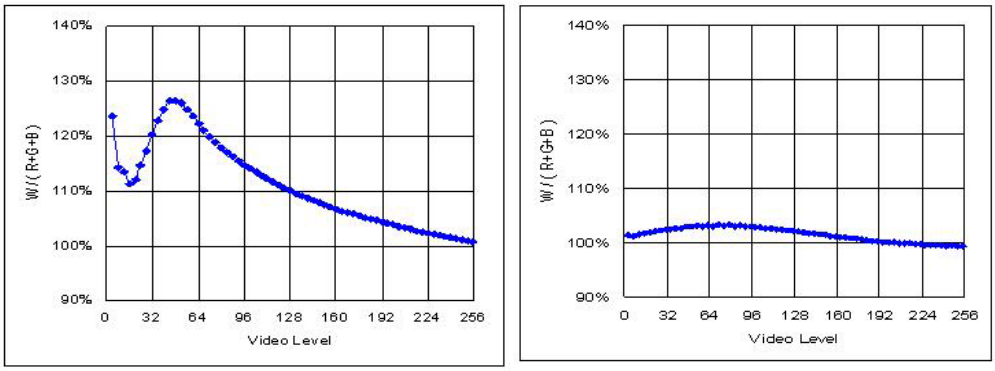


(5) **Accurate Additive Color Mixture**

Monitors produce color through additive color mixture in which the three primary colors – red, green, and blue – combine to form white. The diagram on the right shows the difference between white as directly measured by the black line, and R,G,B as measured individually and combined (R+G+B) in the pink line. On most LCD monitors, these curves deviate greatly, but ColorEdge has nearly the same capabilities as CRT monitors. The color reproduction capabilities of ColorEdge are such that it can accurately produce even delicate colors.



The graphs below show the additive color mixture of ColorEdge and standard LCD monitors. The horizontal axis is gradations, and the vertical axis (W/ R+G+B) shows the comparison between White and R+G+B in the graph above. Standard LCD monitors reproduce low gradations poorly, causing their additive color mixture to be highly inaccurate. A monitor with an inaccurate additive color mixture requires compromise when making an ICC profile. A typical ICC profile carries only information for white, each RGB, and the gamma values for each RGB. However, when the additive color mixture is inaccurate, the ICC profile is nothing more an approximate Look-Up Table made up of numerous color patches.



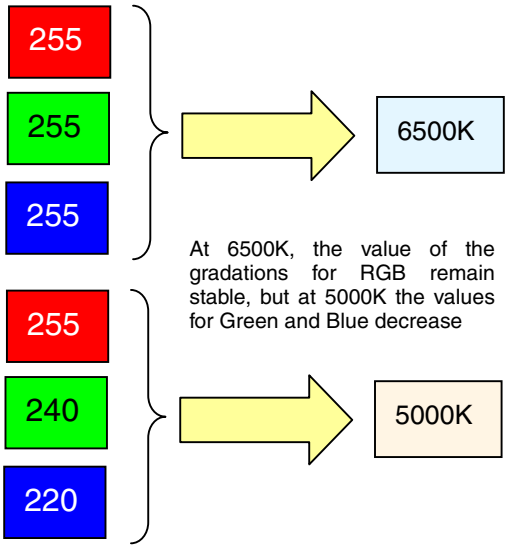
Compared with a standard monitor (L), the additive color mixture of ColorEdge (R) has very few fluctuations.

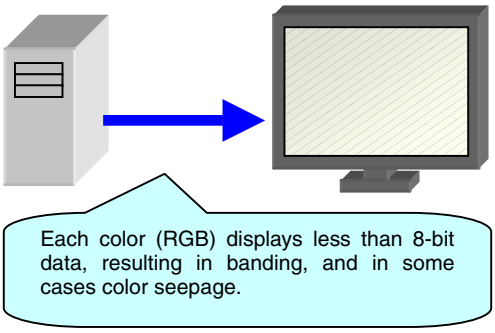
(6) **Highly Precise Hardware Calibration**

There are two types of calibration – hardware and software. We will take a brief look at the two before concluding with an explanation of calibration of ColorEdge.

Software Calibration

The gamma adjustment function of an operating system and a typical calibration package are examples of software calibration. The target color is achieved by decreasing the graphics board's output of either all or a combination of white point, gradations adjustment, and brightness. Let us take the adjustment of white point as an example. If the values for RGB are 255, 255, and 255 as in the illustration to the right, and the color temperature is lowered, the gradations for green and blue will decrease. Likewise, if gamma or brightness is adjusted, the gradations will decrease. If the resulting image is displayed in grayscale, color seepage and banding will be visible.

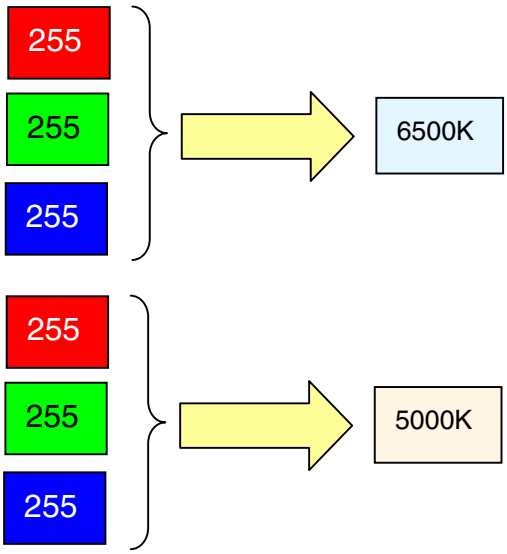


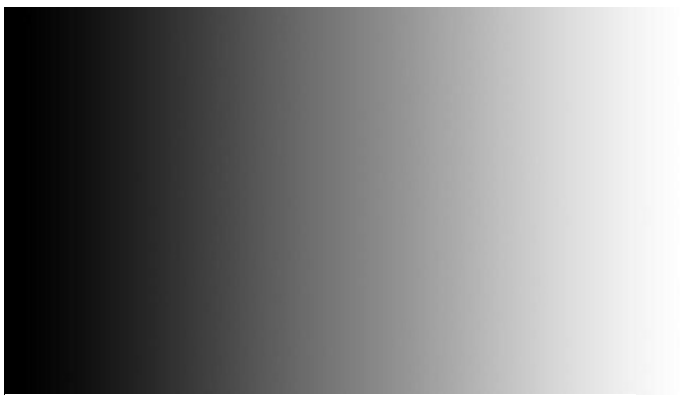


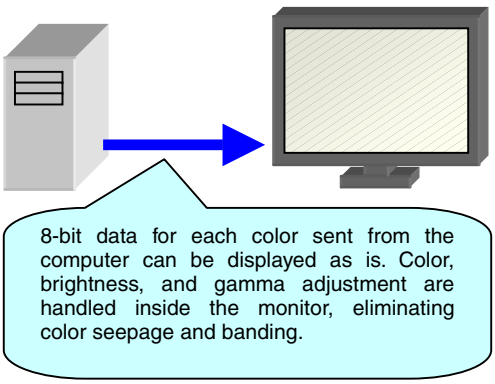
With software calibration, color seepage and banding are visible in a grayscale ramp.

Hardware Calibration

With hardware calibration, the target color is reproduced not by reducing the graphics board output for all or some combination of white point, gradation, and brightness, but by changing the output within the hardware, in other words the monitor. For example, if the values for RGB are 255, 255, 255 and the color temperature is lowered, color adjustment is performed within the monitor so the values of R and G remain at 255. Likewise, with gamma or brightness adjustment, there is no loss of gradations from 0 to 255 because the monitor's 10-bit Look-Up Table ensures the most appropriate 256 gradations are always displayed. As a result, if an image is viewed in grayscale, color seepage and banding are virtually undetectable.







Because there is no decrease in the number of displayable gradations with ColorEdge's hardware calibration, there is no color seepage or banding in the grayscale ramp.

EIZO Original ColorNavigator Software

Hardware calibration of ColorEdge monitors is performed with EIZO's proprietary ColorNavigator software and a GretagMacbeth Eye-One measuring device. In calibrating white point, gamma, and brightness, there is no loss of gradations as all adjustment of color is performed on the monitor. ColorNavigator directly accesses the monitor's 10-bit Look-Up Table for each color and conducts very delicate color adjustments for images with no banding or posturization. This 256-gradation display produces a result noticeably different from monitors that rely on software calibration for a E difference of less than 0.5

Calibration with ColorNavigator produces colors with a ΔE difference of less than 0.5.