



White Paper

Are Higher Brightness and Contrast Ratio Better?

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EIZO NANA O CORPORATION

1 Preface

In recent years, an increasing number of LCD monitors feature high brightness and contrast ratio. Does this mean that higher brightness and contrast ratio are better? Both brightness and contrast ratio are key specifications and thereby it is crucial to know their meanings and their optimal values. This paper will explain what brightness and contrast ratio are, whether higher brightness and contrast ratio are better, the relationship between brightness / contrast ratio and grayscale characteristics, and the optimal brightness and contrast ratio and advice for monitor selection.

2 Brightness and Contrast Ratio Explained

Brightness refers to the emitted luminous intensity on screen measured in candela per square meter (cd/m^2). The higher the numbers are, the brighter the screen will be. Contrast ratio is the ratio of a screen's whitest white (output level 255) to its blackest black (output level 0). It is expressed in the form of "500:1", and "500" and "1" respectively represent the relative brightness ratio of "white" to "black". It is important to note that the contrast ratio expresses just "ratio" and thereby it is improved simply by increasing the maximum brightness or decreasing the minimum brightness. For example, when the maximum and minimum brightness values are $500 \text{ cd}/\text{m}^2$ and $1 \text{ cd}/\text{m}^2$ respectively, the contrast ratio is 500:1, which is also the case when the maximum and minimum brightness values are $250 \text{ cd}/\text{m}^2$ and $0.5 \text{ cd}/\text{m}^2$ respectively. Which 500:1 contrast ratio is better is a matter of environmental light, use and personal preference.

3 Are Higher Brightness and Contrast Ratio Better?

Higher brightness is not necessarily better. The level of brightness directly affects visibility of, or the easiness to see, images on screen. However, the visibility depends on not only brightness but also an eye-to-monitor distance, observation ability and environmental luminance (ambient light).

High brightness offers the merit of clear visibility of fine detail of the letters and pictures on screen even from a distance in a brightly lit room. However, an eye-to-monitor distance for an LCD monitor for PC display is generally about 50 cm. For viewing a screen from such a close distance, high brightness is not required regardless of the use or the display of moving or still images. If an LCD monitor is set to its maximum brightness for the eye-to-monitor distance of 50 cm, it is too bright and tends to put a strain on the eye. To prevent this, many LCD monitor users normally set their monitor brightness low.

For reference, the required brightnesses for an LCD monitor are $150 \text{ cd}/\text{m}^2$ in TCO^{*1}03 and $35 \text{ cd}/\text{m}^2$ minimum and $100 \text{ cd}/\text{m}^2$ or higher for a brighter environment in ISO^{*2}13406, which defines ergonomic standards for an LCD monitor. In the sRGB standard, a CRT monitor's required brightness is $80 \text{ cd}/\text{m}^2$. (The sRGB standard does not specifically state the required brightness for an LCD monitor.) A high-end 17-inch CRT monitor of a decade ago had a brightness of about 100 to $120 \text{ cd}/\text{m}^2$, which clearly shows that recent LCD monitors have extremely high brightnesses.

The recent trend of high brightness on LCD monitors is greatly influenced by LCD TVs. LCD TVs require high brightness for clear visibility in brightly lit rooms such as a living room and typically have a brightness of

about 500 cd/m².

For LCD monitors for PCs as well as LCD TVs, high brightness is often associated with clear display of moving images. However, the visibility depends not only on brightness but also on eye-to-monitor distance and environmental luminance (ambient light) as stated above. For viewing a monitor at an eye-to-monitor distance of 50 cm under a general fluorescent light at home, a maximum brightness of 250 to 300 cd/m² will be sufficient.

Regarding contrast ratio, higher is generally better. A higher contrast ratio generates sharper and crisper images and usually brings no obvious demerits to an LCD monitor for a PC. Nevertheless, some users may not feel comfortable looking at a high-contrast screen saying that the images are too vivid.



EIZO FlexScan L568, a 17-inch LCD monitor with a contrast ratio of 1000:1, produces vivid colors and a deep black

4 Relationship between Brightness / Contrast Ratio and Grayscale Characteristics

How brightness and contrast ratio affect grayscale tones varies by monitor.

A monitor with a finely adjusted gamma curve will render the correct grayscale tones even if its brightness is changed. On the other hand, if brightness is changed on a monitor with a poorly adjusted gamma curve, some of its grayscale tones will become light purplish or dark bluish.

The value of the contrast ratio itself does not greatly affect grayscale characteristics since 255 grayscale tones are allotted within the range of a given contrast ratio such as 500:1 or 1000:1. However, if contrast ratio or RGB balance setting is changed on a monitor, its grayscale characteristics may also change. Contrast adjustment on a monitor involves the level adjustment of the input signals, and as a result, the number of grayscale tones will slightly decrease and its grayscale characteristics will be affected. This may be a reason why many monitors do not offer a contrast adjustment function. Of course, this does not mean that the grayscale characteristics of contrast-adjustable monitors are necessarily bad. Whether the images reproduced with fewer grayscale tones are acceptable is up to one's intended use and preferences.

5 Optimal Brightness and Contrast Ratio and Advice For Monitor Selection

When selecting a monitor, the maximum brightness of 250 to 300 cd/m² or higher is the reference value. For a 19-inch or larger LCD monitor to be viewed from a distance, higher brightness is recommended.

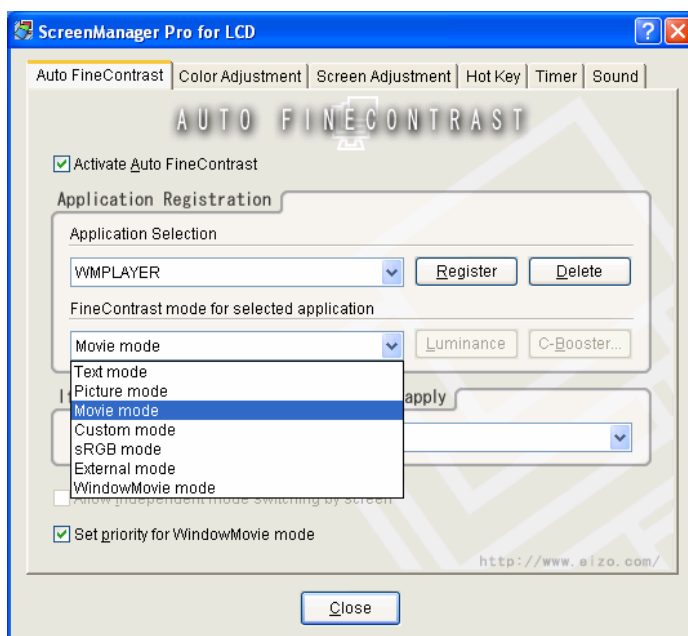
The contrast ratio of LCD monitors will continue to increase. High contrast ratio is usually not a disadvantage for an LCD monitor, and accordingly it is recommended to select a monitor with as high a contrast ratio as possible.

Brightness and contrast ratio of an LCD monitor mainly depend on a backlight and its layout, driving system (TN, VA and IPS), RGB color filter and polarized filter. Structurally, a higher contrast ratio is achievable with VA, TN and IPS in descending order.

Selecting a monitor with a wide brightness adjustment range is advised. When viewing a screen for long hours such as for office work, lower brightness is easier on the eye, but it should be noted that some monitors do not darken much even if brightness is set to the minimum on the OSD*⁴.

In addition, it is suggested to change brightness according to the use. Higher brightness will be suitable for watching movies and still images, and lower brightness will be better suited for Internet browsing and business applications. Many of the recently released LCD monitors incorporate modes such as “Text”, “Picture” and “Movie”, which allow users to optimize the display setting including brightness and color tone at the push of a button.

Most of EIZO’s products incorporate the “Auto Fine Contrast” function which automatically switches modes with the use of the bundled software. This function enables user to assign Fine Contrast modes for any application that has been installed in the computer in advance so that when the application is activated, the screen automatically changes to the assigned mode.



The “Auto Fine Contrast” tab available in the “ScreenManager Pro for LCD” software bundled with most of EIZO’s LCD monitors

When an application is activated while the ScreenManager Pro for LCD is running, the application is indicated in the “Application Selection” pull-down menu options on the window. By assigning a Fine Contrast mode for each application in advance, the monitor automatically switches to the assigned Fine Contrast mode when the applications are activated.

- *1 TCO: TCO are the initials (in Swedish) for the Swedish Confederation of Professional Employees. This international standard requires office equipment to meet stricter standards in the areas of safety, ergonomics, electromagnetic field emission, energy conservation, and ecology (toxic substance and recycling). The TCO-label is also a well-known mark of environmental performance of an LCD monitor. TCO'03 is the latest version of the standard that regulates environment, ergonomics and safety.
- *2 ISO: (International Organization for Standardization) ISO is a worldwide federation of national standard bodies established in 1947. The mission of ISO is to promote the development of standardization in the fields of scientific and technological activity. ISO 13406 is the standard concerning ergonomic requirements for the image quality of flat panel displays.
- *3 sRGB: (standard RGB) sRGB is a world color space standard established by the International Electrotechnical Commission (IEC) to define the accurate communication of color information between input and output devices such as scanners, printers, digital cameras and browsers.
- *4 OSD: An on-screen display (OSD) is an on-screen control panel on a computer monitor that allows users to display and adjust settings of the monitor.

Reference:

Toshiaki Hayashi, "Are Higher Brightness and Contrast Ratio Better?" *IT media +D / EIZO channel*
<<http://plusd.itmedia.co.jp/pcupdate/articles/0507/08/news001.html>> (2005/07/07)

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