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## Application Note FAN9205

### *Display Viewing Angles*

This application note discusses the viewing angle of a display which describes the angle or direction from which the display is the most optimally viewed.

## Display Viewing Angles

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The viewing angle of a display describes the angle or direction from which the display is the most optimally viewed. This is the angle the display will have the highest visual performance. The viewing angle is expressed in degrees from the horizontal and vertical directions from the surface of the screen. The display viewing angle can be described as degrees or as hands on a clock.

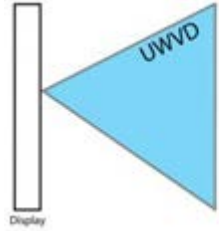


Different LCD technologies can be used to enhance the viewing angle and increase the visual performance of the display. The technologies available for optimizing viewing angle will be reviewed to provide options for each application and display type. This note will characterize display viewing angles and review the visual effects on the display.

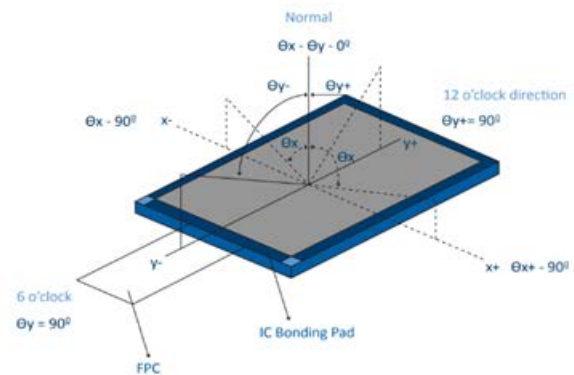
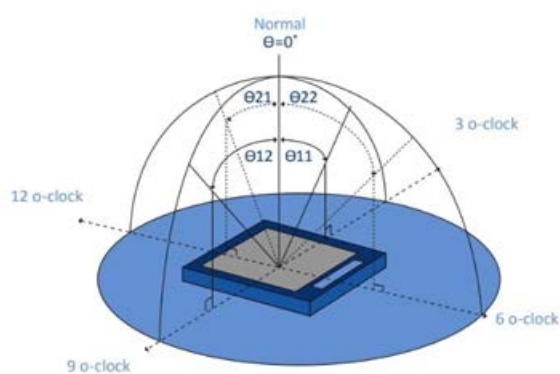
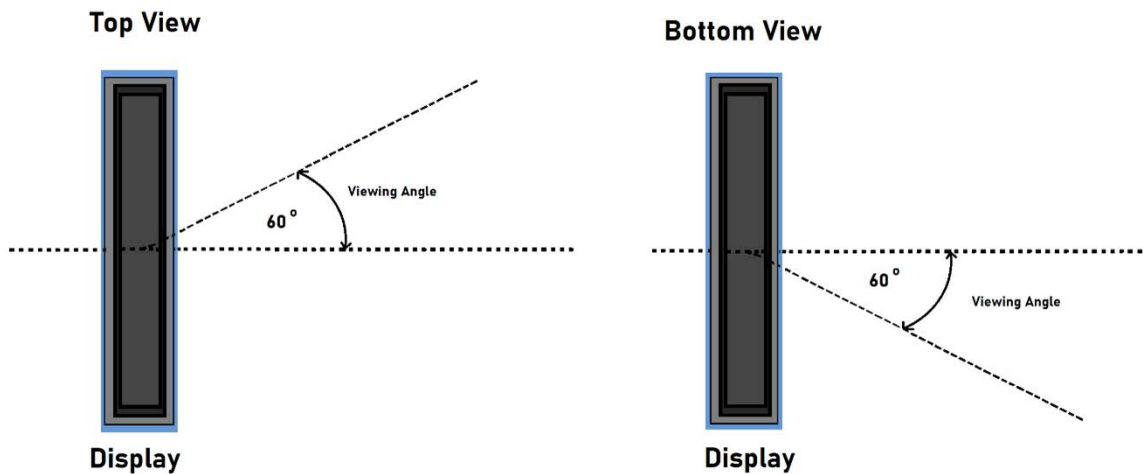
The viewing angle is defined as the maximum angle at which the user can accurately see the display. The viewing angle is measured by the contrast, color gamut, and the brightness of the pixels on the display. Different liquid crystal technologies can enhance these visual attributes.

The viewing angle is specified in relation to the horizontal and vertical axis of the displays surface. These values specify the location at which the user should view the display with the greatest accuracy. These values can be defined in degrees from the display when it is laying flat.

The horizontal and vertical viewing angles are not always the same. The viewing angle from top to bottom and from left to right are uniquely defined. Some displays, especially TFT and UWVD, will have an all or free viewing angle. This means the display is optimally viewed from all directions.



A display that has a top viewing angle is best viewed at an angle above the horizontal axis of the display. The top viewing angle is also called the 12 o'clock viewing angle. The bottom viewing angle is best viewed from below the horizontal axis of the display. This is also called the 6 o'clock viewing angle.



The viewing angle is visually represented by the pixel, dot, or character contrast of the LCD. At the optimal viewing angle, the contrast will be the highest. The contrast is the visual difference between the dark and light, black and white, of the liquid crystal in the display. The contrast is unique to the liquid crystal, material, and backlight of the display.

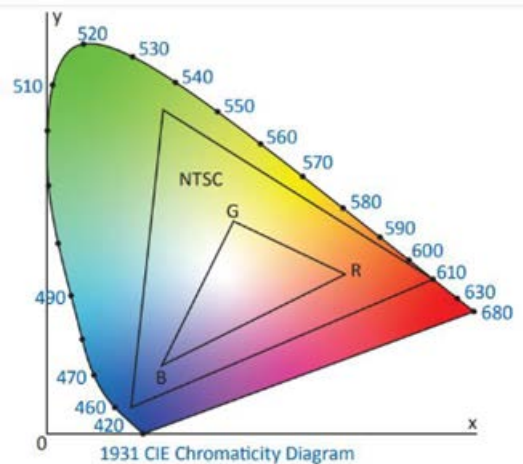


Fig. 1931 CIE chromacity diagram

$$\text{Color gamut: } S = \frac{\text{Area of RGB triangle}}{\text{Area of NTSC triangle}} \times 100\%$$

The maximum angle at which the display can be viewed from is defined by contrast ratio, color gamut and color chromaticity. These values are specified for each display and can be found in the Focus LCDs display datasheet.

For TFT displays, the color chromaticity filter and color gamut are measured at the specified viewing angle. The color gamut is the range of color that can be seen by the human eye. The color chromaticity filter is the intensity of each of the red, green, and blue values of each pixel. These color values are maximized at the indicated viewing angle.

## Viewing Angle Technologies

A variety of display technologies are available that can promote the field of view and contrast of the display. The technologies are differentiated by the type of fluid used and how the light is reflected through it. The technologies available that have a wide viewing angle are reviewed below.

## IPS

In Plane Switching is a display technology that is known for its wide viewing angles, higher contrast, and vivid colors. IPS displays have been used to solve some of the limiting optical characteristics of twisted nematic (TN) liquid crystal displays. IPS displays are a great option for increasing the viewing angle of the display.

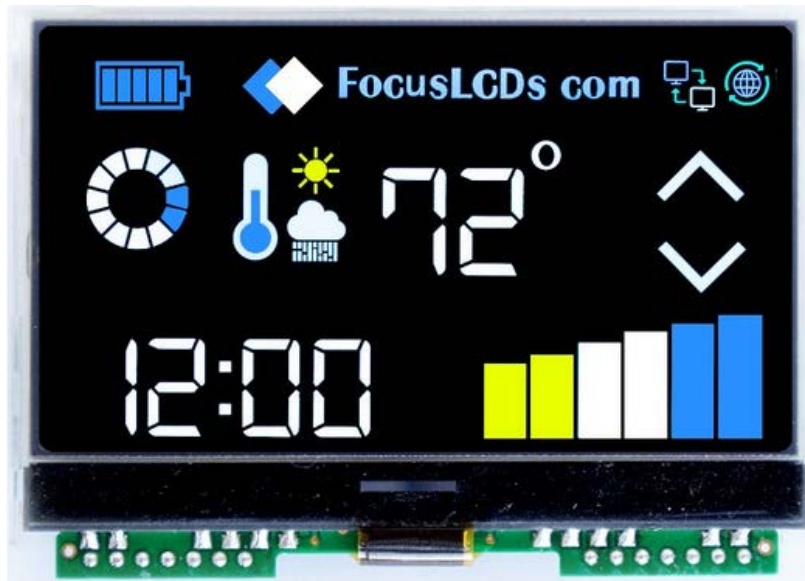


IPS displays align the liquid crystals in a parallel configuration which allows the light to travel through the material at a wider range. IPS displays will have an ultra-wide viewing angle and great color performance. IPS displays are a good option for TFT display types because they benefit from the wide range of vivid colors.

## UWVD

Ultra-Wide Viewing Displays technology is used to improve the viewing angle, brightness, and contrast of standard liquid crystal displays. UWVD technology provides an option for increasing the viewing angle and brightness of the display.

UWVD technology has improved contrast and brightness compared to standard liquid crystal displays. These displays are easy to view from a wide viewing angle which is attributed to the sharp contrast of the pixels. The UWVD technology creates bright segments and dark backgrounds.



The UWVD displays are a great technology choice for segment, graphic and character displays. The increased contrast and definition is good for applications at a distance and if wide viewing angles are needed.

## VA

Vertical Alignment displays are attributed by the alignment of the liquid crystal which allows light to pass through the display vertically. The vertical alignment (VA) liquid crystal displays are known for having deep blacks and high contrast pixels.

The VA display has liquid crystal that aligns perpendicularly which increases the transmission of the light through the display. The light transmission, brightness, and contrast are the key features of the vertical alignment displays.



The excellent contrast of the VA displays creates a wider viewing angle for the display. VA displays have a wider range between dark and light pixels and are typically operated in the normally black transmissive mode.

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Reference: (1) [https://en.wikipedia.org/wiki/Gamma\\_correction](https://en.wikipedia.org/wiki/Gamma_correction)