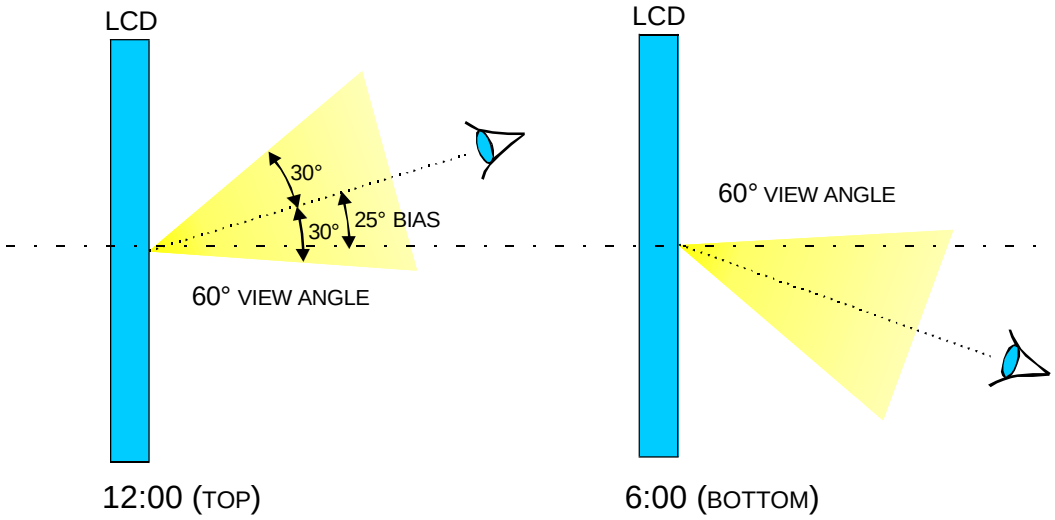
An Explanation of LCD Viewing Angle

General Discussion:

Since LCDs have limited viewing angles, they tend to lose contrast and become hard to read at some viewing angles. Generally the size of the viewing angle is determined by several factors primarily the type of Liquid Crystal fluid and the duty cycle. Because the viewing angle tends to be smaller than most people would like, a bias is designed into the module at the time of manufacturing.
This means the nominal viewing angle is offset from the perpendicular by some amount. Therefore; several LCD versions are offered with this bias set to different angles or positions to accommodate as many applications as possible. The term **Bias angle** is often used erroneously with the term **Viewing angle**.

Definition of Bias angle & Viewing angle:

The **Bias angle** is the angle from the perpendicular from which the display is best viewed. (See **fig 1**)
This angle is determined when the display is designed and can be set at any angle or orientation.
The orientation of the **Bias angle** of a LCD display is often stated with reference to a clock face.
If the offset is above the display, it is referred to as a **12:00** or **Top view.**



VIEWING ANGLE DEFINITIONS (SIDE VIEWS)

Fig 1

The **View angle** is the angle formed on either side of the **Bias angle**, where the contrast of the display is still considered acceptable. Generally, this contrast is specified as 1.4:1. A typical STN character display running at a duty cycle of 1/16 has a viewing angle of ±20 degrees and a bias angle of 25 degrees.
For example, assume the display is a **12:00** (top view) type. When the display is viewed from 25 degrees above the vertical, it will be at its maximum contrast and best look. If the viewer moves their eyes further above the display by an additional 30 degrees, they will see a contrast reduction, but the display will still be readable. Moving the view position any further above the display will reduce the contrast to an unacceptable degree.

Contrast adjustment & its effect on Viewing angle:

Adjusting the contrast voltage, V_L, effects the **Bias angle** to some extent, but not the **View angle**. A top view **12:00** display can be optimized for a bottom view **6:00** viewing position by adjusting the contrast voltage. A **12:00** display set for a **6:00** viewing position will not have as great a contrast as a **6:00** display set for **6:00** viewing position and vice versa.

Generally, displays are optimized for straight-on viewing. Either a **6:00** or a **12:00** module may be used and the contrast voltage can be adjusted slightly to optimize the display for that viewing position. In the above example, the viewing angles of both **6:00** and **12:00** modules actually overlap the perpendicular (*or straight on*) viewing position.

Contrast adjusting:

When the view position is established, the contrast setting can then be determined. This is done during product development on the prototyping units. Generally, a 10Kohm potentiometer is then connected between V_{DD} and V_{SS} in a single supply module, or from V_{DD} to the negative rail in a dual supply module. The wiper of the pot is connected to the V_L input of the module. (See **fig 2**) The LCD is positioned at the nominal viewing position and the pot is adjusted to obtain the desired LCD appearance. The voltage on the V_L pin is now measured and a pair of resistors are chosen to produce this voltage in the production units.

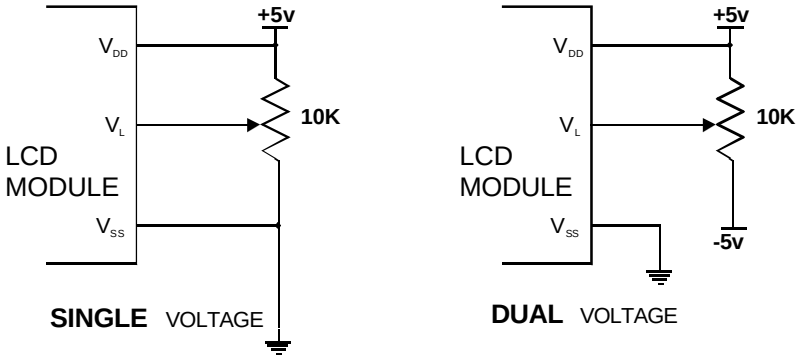


Fig 2

Choosing the correct module for your application:

Most electronic products have a preferred view position. For a device that sits on a desk, such as a calculator, the display is generally viewed from below **6:00** . This is also true for most hand held instruments. For a Liquid Crystal Display mounted in a dashboard of an automobile or airplane, a **12:00** module is suggested.

Conclusion:

Selecting a Liquid Crystal Display with the proper viewing angle is important, but the designer must keep in mind that the contrast setting is also important as both of these parameters work together to determine the appearance of the LCD and the final appearance and appeal of the product.