

Stereo 101—Stereoscopic Display Technology

A StereoMirror™ monitor consists of two AMLCD displays oriented at a fixed angle through use of a specially designed mounting stand. A passive beamsplitter mirror bisects the angle formed between the two monitors mounted on the stand.

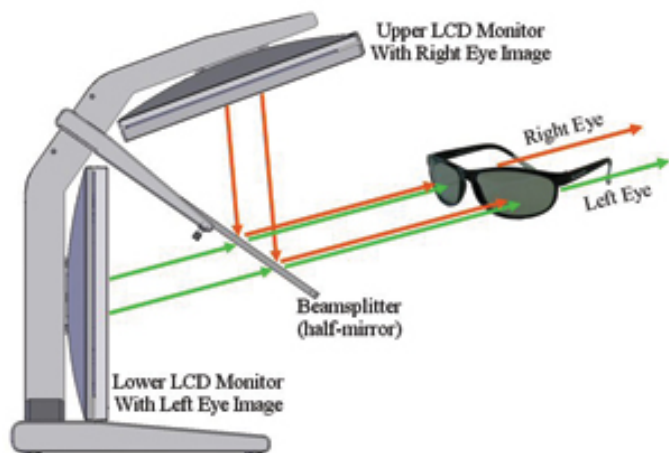
The mirror has the following properties:

- 50% transmission
- 50% reflectance
- Non-birefringent
- Flat spectral response from 400 to 700nm
- Abrasion-resistant hardcoat

An anti-reflective coating is deposited on the side opposite the mirror film to minimize secondary image reflection. There is a fine mechanical adjustment for the mirror angle between the two displays.

The objective of a stereoscopic display is to efficiently present a Left eye image to the Left eye that is isolated from a Right eye image presented to the Right eye. This allows the visual system to merge the two images resulting in the perception of depth, or stereopsis. In the StereoMirror™ design this stereo separation is achieved using the principle of conservation of polarization. Liquid crystal displays operate based on the ability of liquid crystal material to modulate plane-polarized light. The planes of polarization for light emitted from the two AMLCDs in a StereoMirror™ have the same orientation, e.g. 45°, depending on the type of LC cell. The plane of polarization for the image seen in transmission from the lower monitor (Left eye image) is unchanged in passing through the mirror. However, the polarization plane in the light path of the

upper monitor (Right eye image) is effectively rotated 90° upon reflection. When stereo pair images from the two monitors are viewed through crossed-polarizing glasses, the user only sees the Left eye image with the eyepiece having the forty five degree-oriented polarizer and the Right eye image with the eyepiece having the 135° polarizer. Images with orthogonal polarization are extinguished. The result is a single, fused stereoscopic image.



The Left eye and Right eye images are sent to their respective AMLCDs independently and without any special treatment (with the exception of accommodating for the fact that the upper monitor is seen in a mirror ? this will be discussed below). Presenting the stereo pair of images is accomplished using a software application predisposed to accommodate dual monitor stereo viewing. This software is typically written to be compatible with either OpenGL 6 or DirectX 7. It requires no additional modification for use with the StereoMirror™ monitor design. Any software application that uses the OpenGL quad-buffered stereo features is compatible with the StereoMirror™. Quad buffered stereo is a feature of the OpenGL 3D graphics library that allows an application to define two separate Right/Left eye viewpoints instead of the normal single monoscopic viewpoint. The two viewpoints are defined to give the correct parallax separation for the proper stereo effect. Once the two viewpoints have been defined the 3D scene is rendered identically for each of the two viewpoints. Many commercial 3D applications already have stereo viewing modes using the OpenGL stereo features.

Since the upper display in the monitor is seen in reflection there is a need to perform a mirror-flip operation on that data path. This can be accomplished in a number of ways:

- Software processing in the computer CPU
- Firmware manipulation in the graphics card
- An auxiliary signal processing board in the data path to the upper monitor
- Manipulation in the monitor controller board

All of these possibilities have been demonstrated. Manipulation at the graphics card is the preferred option to minimize cost and the possibility of adding a delay between the two video paths. Driving a StereoMirror™ monitor is identical to driving a pair of projection displays used to show stereoscopic images with crossed polarizers in the two separate light paths. An off-the-shelf, dual-output graphics card is employed to drive the two monitors, again with no special preparation with the possible exception of the mirror-flip function.