Macintosh: Liquid Crystal Displays (LCDs) Compared (3/95)

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TOPIC ---

This article gives an overview of active- and passive-matrix liquid crystal displays.

DISCUSSION ---

Liquid Crystal Display (LCD) is the display technology used on the screens of Macintosh Portable and PowerBook computers. LCDs are non-emissive (no Extra Low Frequency (ELF) or Very Low Frequency (VLF) emissions); they do not create their own light, but reflect and block light. (The PowerBook series includes a bulb to aid in viewing the screen at different light levels.) LCDs use a reflector, backlight, sidelight, or a combination of a reflector and back/sidelight to send the image to the user. The main difference from a Cathode Ray Tube (CRT) display is that the pixel (the little dots of light that comprise the picture on a computer or TV screen) is not the source of light. A typical LCD consists of a reflector, rear polarizer, back glass, liquid crystal material, front glass, and front polarizer.

The liquid crystal material is a liquid with rod-shaped molecules inside. The rod-shaped molecules can form a twisting helix, or spiral pattern and bend light that enters the display. When a current is applied, the rods straighten out and no longer bend the light. The inside surfaces of the glass are treated and polished to induce the rod-shaped molecules in the liquid crystal material to line up with the polarizers.

The display uses two polarizers to line up the light and reduce glare. If the light is out of phase, it can not pass through the polarizer. By using two polarizers 90 degrees out of phase with each other, the light is blocked. The liquid crystal material bends the light 90 degrees so it will pass through the polarizer. When the LCD has power to it, it does not bend the light, hence it does not pass through the polarizer.

This type of display is called an active matrix, or Thin-Film Transistor (TFT), display. Passive matrix, or Film SuperTwisted Nematic (FSTN), displays are similar to TFT displays, but the liquid crystal molecules in a SuperTwist Display bends or twists light much farther than in a standard TFT display. In fact, the molecules in a SuperTwist display can bend 270 degrees or more to transmit light. One difference you may notice between passive and active matrix

screens is that active matrix has a much wider viewing range than passive matrix. In other words, you can see information displayed on the screen from a wider side angle on an active matrix display than on a passive matrix display.

Passive Matrix

In a passive matrix, or Film SuperTwisted Nematic (FSTN), display a grid of electronic control wires or lines are placed on the front and back glass. A pixel is located at the junction of each row and column control lines. Passive matrix displays use one transistor to address each row and one to address each column of pixels. Pixels are turned on when both row and column lines are energized and off when both control lines are de-energized. This addressing scheme is called multiplexing.

The residual electrical current that travels down each control line can cause crosstalk at unselected pixels. Crosstalk partially darkens pixels and lowers the display's overall contrast. This usually appears on a passive matrix PowerBook display as two dark boxes, parallel to each other on the display.

Active Matrix

The active matrix, or Thin-Film Transistor (TFT) display is the latest technology used in Macintosh PowerBook computers. Rather than using multiplexing (row and column wires on the glass) techniques to address the matrix of crystals, the active matrix LCD includes a transistor fabricated along with each pixel. You can think of the display as one large Integrated Circuit (IC), with the transistors acting as switches to turn on individual pixels. (An IC is a slice or chip of material on which is etched or imprinted a circuit comprised of electronic components and their interconnections.) Because of the transistors, pixels can be turned on and off at a very fast rate. The transistor at each pixel eliminates the crosstalk phenomenon, which lowers contrast on an FSTN display.

The TFT method eliminates the time dependency associated with multiplexed displays by directly addressing each pixel.

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