

FLAT-PANEL DISPLAYS

The term **flat-panel displays** refers to a class of video devices that have reduced volume, weight, and power requirements compared to a CRT. A significant feature of flat-panel displays is that they are thinner than CRTs, and we can hang them on walls or wear them on our wrists.

We can separate flat-panel displays into two categories: **emissive displays** and **nonemissive displays**. The emissive displays (or **emitters**) are devices that display, and light-emitting diodes are examples of emissive displays. Nonemissive displays (or **nonemitters**) use optical effects to convert sunlight or light from some other source into graphics patterns. The most important example of a nonemissive flat-panel display is a liquid-crystal device.

Plasma panels, also called **gas discharge displays**, are constructed by filling the region between two glass plates with a mixture of gases that usually include neon. A series of vertical conducting ribbons is placed on one glass panel, and a set of horizontal ribbons is built into the other glass panel (fig. below). Firing voltages applied to a pair of horizontal and vertical conductors cause the gas at the intersection of the two conductors to break down into a glowing plasma of electrons and ions. Picture definition is stored in a refresh buffer, and the firing voltages are applied to refresh the pixel positions (at the intersections of the conductors) 60 times per second.

Another type of emissive device is the **light-emitting diode (LED)**. A matrix of diodes is arranged to form the pixel positions in the display, and picture definition is stored in refresh buffer. As in scan-line refreshing of a CRT, information is read from the refresh buffer and converted to voltage levels that are applied to the diodes to produce the light patterns in the display.

Liquid-crystal displays (LCDs) are commonly used in systems, such as calculators (fig. below) and portable, laptop computers (fig. below). These nonemissive devices produce a picture by passing polarized light from the surrounding or from an internal light source through a liquid-crystal material that can be aligned to either block or transmit the light.

The term liquid crystal refers to the fact that these compounds have a crystalline arrangement of molecules, yet they flow like a liquid. Flat-panel displays commonly use nematic (threadlike) liquid-crystal compounds that tend to keep the long axes of the rod-shaped molecules aligned. A flat-panel display can then be constructed with a nematic liquid crystal, as demonstrated in fig. below. Two glass plates, each containing a light polarizer at right angles to the other plate, sandwich the liquid-crystal material. Rows of horizontal transparent conductors are built into one glass plate, and columns of vertical conductors are put into the other plate. The intersection of two conductors defines a pixel position. Normally, the molecules are aligned as shown in the "on state" of fig. below. Polarized light passing through the material is twisted so that it will pass through the opposite polarizer. The light is reflected back to the viewer. To turn off the pixel, we apply voltage to the two intersecting conductors to align the molecules so that the light is not twisted. This type of flat-panel device is referred to as a **passive matrix** LCD. Picture definition is stored in a refresh buffer, and the screen is refreshed at the rate of 60 frames per second, as in the emissive devices. Back lighting is also commonly applied using solid-state electronic devices, so that the system is not completely dependent on outside light sources. Colors can be displayed by using different materials or dyes and by placing a triad of color pixels at each screen location. Another method for constructing LCDs is to place a transistor at each pixel location, using thin-film transistor technology.

The transistors are used to control the voltage at pixel locations and to prevent charge from gradually leaking out of the liquid-crystal cells. These devices are called **active-matrix** displays.