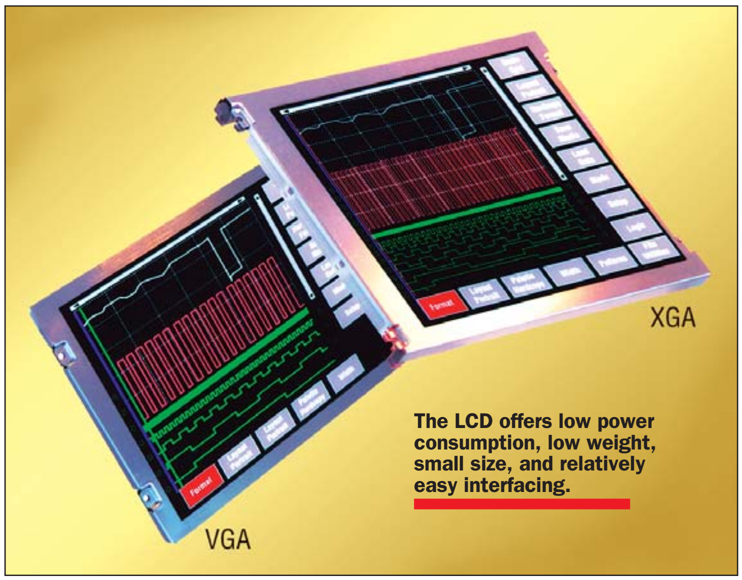
Choosing displays for industrial apps

Engineers need to examine the merits of LCDs and CRTs for the latest generation of non-PC applications



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Displays used in industrial applications range from test and measurement instruments, to industrial automation equipment, to process control monitors. This article will examine the relative merits of each technology, as they apply to the latest generation of non-PC applications.

The CRT

The CRT offers some compelling features—such as fast response time for full-motion video, support for multiple resolutions, wide viewing angles, and broad color reproduction capability—at a relatively inexpensive price. The reliability and durability of the CRT has long been established, and it remains an excellent choice for many situations.

There are, of course, tradeoffs to be considered when looking at a CRT, most especially its daunting size and power consumption. A CRT has excellent viewing-angle properties, since light is being emitted in all directions, but some people are sensitive to screen flicker, especially in their peripheral vision.

Since a CRT is very sensitive to EMI, it is not a good choice in applications that require the viewer to be near a source of a magnetic field. In test and measurement applications, EMI is quite crucial, as the display used must not radiate into the sensitive electronics of the measurement device.

The CRT requires a very high voltage on the anode, from 10,000 to 30,000 V, as well as a relatively high voltage on the electron gun at video frequencies. Voltages from 40 to 80 V are not uncommon, with amplifier bandwidths of over 100 MHz. All of these EMI energy sources must be carefully contained when designing with a CRT.

The LCD

The LCD has been around for more than 30 years, evolving from use in applications such as watch displays to a technology that has enabled the notebook PC to evolve to its present form, where it is challenging the CRT in both the desktop monitor and television markets.

The LCD offers low power consumption, low weight, small size, and relatively easy interfacing (see *figure*). The technology has advanced to the point where LCDs offer advantages such as very high contrast ratios (less than 300:1), very high luminance (less than 300 cd/m^2), excellent color reproduction (less than 70% of NTSC), and remarkable durability (150-g shock).

There are, of course, trade-offs with an LCD. First and foremost is cost, with the acquisition price of a LCD usually about twice that of a CRT. When analyzed over a five-year period, however, the LCD has a lower cost of ownership due to its small size and lower power consumption.

Another tradeoff is viewing angle. The LCD is essentially a light valve. It has either a very bright backlight for emissive mode, an inner mirror for reflective mode, or both for transflective mode. In any case, there is an optical path quite different from a CRT, and various manufacturing techniques and optical films have been created to overcome these limitations.

The LCD does have some advantages over a CRT (especially higher-performance active-matrix TFT-LCDs), since it is a light valve that reacts to the average of the applied video signal, and does not flicker like a CRT. This lower rate of refreshing the screen results in visual anomalies such as some image smearing or “tailing,” but new technologies are being introduced to eliminate these phenomena.

While a CRT can usually withstand a shock of about 30 g, the LCD can withstand shocks of up to 150 g. The LCD does not use magnetic fields in the creation of the image, so it tends not to be sensitive to magnetic fields.

The interface to the LCD is typically 5 V or less, and the liquid-crystal driving voltage is typically 13 V or less. Some LCDs use a cold-cathode fluorescent lamp backlight that operates at 50 to 1,000 V, and some LCDs use LEDs for their backlight, further reducing EMI. In general, because of the lower voltages and lower power found in the LCD, they are better than CRTs for low EMI.

The mean time between failures for an LCD is as much as twice that for a CRT, as well as its operating lifetime to half-luminance. Also, the LCD’s backlight can be replaced at any time, returning it to full luminance without having to replace the entire display.

Image creation

The way that the CRT and LCD represent information to the user is fundamentally different. The CRT consists of a piece of glass coated on the inside with either stripes or dots of phosphor, with a shadow mask, or grill, that guides the electrons to the phosphor.

The phosphor, the shadow mask, and the resolution of the display are not actually linked, and the electron beam can strike all, some, or none of the area of any particular color of phosphor. This allows the CRT to do an excellent job of scaling resolutions dynamically, as the electron beam is turned on and off as needed, without regard for the phosphor screen.

The LCD, however, is made with a finite number of pixels and subpixels. When a color is illuminated, the entire pixel area is illuminated. An XGA display (1,024 x 768 pixels) can only be an XGA display. With additional drive electronics, other resolutions can be displayed, but the image will always look the best at the native XGA resolution.