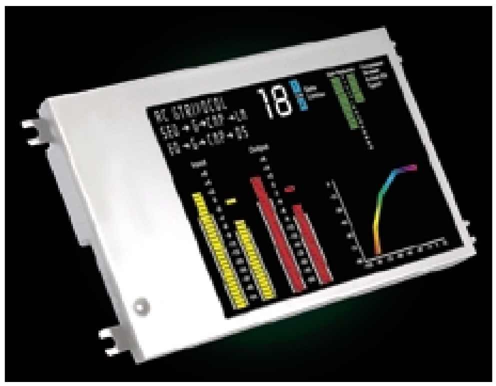
ELECTRONIC
PRODUCTS

Specifying LCDs in wireless/portable apps

Knowledge of the capabilities of the various technologies is key in proper device selection

BY JOHN CRAMER
Optrex America
Plymouth, MI
http://www.optrex.com

Liquid-crystal displays (LCDs) are used in a wide range of products. They appear in telecommunications and Internet devices, test and measurement instruments, handheld data management equipment, in-dash auto displays, office machines, notebook computers, and electronic games. For wireless/portable devices such as cellular telephones and PDAs, LCDs still offer many design advantages over other display technologies (see *box*, "LCD basics").



A 1/8 VGA color STN LCD has a wide viewing angle, suitable for portable monitors, process controllers, and recording studio equipment.

Suiting the application

Most manufacturers offer the engineering and technical support to accommodate unique design needs. For example, suppose a highly uniform background color for a negative-mode display—with no fades or gradations—is critical to a designer's application. A modulated twisted-nematic (MTN-LCD) display is a good solution. The internal side of the glass substrate in this LCD is rough, making the background color appear uniform.

The manufacturer can also configure the LCD module to meet other design needs, such as mounting hole position, shape, and housing color. If a variety of colors are required in the display, reflective color technology may be employed. This technique layers color filters above the inner mirror reflectors, with each filter dedicated to specific display segments, causing those segments to appear in the same color as the filter.

Another method, super-reflective color (SRC), produces varying colors in response to the application of different voltages to individual pixels. Reliable and low cost, SRC LCD modules do not require a color filter.

Portability dictates certain LCD design requirements. A major trend has been the drive toward high content. Early portable devices typically had seven-segment displays capable of imaging digits or crude alphanumeric symbols. Some could also display a few standard icons (single-pixel indicators).

Today's portable devices must display more information. Cell phones and PDAs require advanced graphics displays, capable of multilingual, alphanumeric characters with scalable fonts.

As the trend from segmented, low-information-content displays yields to a push toward high-content displays, LCDs are practical and compact solutions. LCDs also have low power consumption and offer high, consistent contrast—even in sunlight/high-ambient-light conditions.

Integration and miniaturization

As wireless and portable device demand increases, so does the demand for smaller, more-power-efficient parts. Manufacturers are developing ways to dramatically reduce the number of discrete parts required in portable design.

Instead of designing-in many discrete devices, each providing specialized functionality, designers can take advantage of miniaturized components carrying on-board circuitry for more power efficiency and increased functionality. LCDs lend themselves very well to this purpose.

Controller ICs mounted on miniature pc boards are part of LCD modules. In some cases, the ICs are mounted directly on the LCD glass substrate (chip on glass), thereby eliminating the need for a pc board and saving cost and real estate.

Dc/dc converters are now commonly integrated into the LCD module through controller ICs. With batteries serving as the main power source for many portable/wireless devices, input voltage drops as the battery gets used up. This causes backlight flickering or dimming. The dc/dc converter regulates the driving voltage to ensure proper LCD contrast.

The LCD's glass substrate is also subject to miniaturization, with substrates of 0.40 to 0.55 mm now common. To help create the next generation of displays, manufacturers are experimenting with thinner substrates in the 0.3-mm range.

Various operating environments

Size and efficient use of power aren't the only factors the designer of portable-device displays must face. Wireless and portable devices are subjected to a wide range of operating temperatures and varying operating environment conditions. Even if it's small and power smart, an LCD won't meet performance standards without considering its operating environment.

For example, temperatures affect the viscosity of the liquid-crystal (LC) fluid suspension. At lower temperatures, the LC thickens and requires more voltage

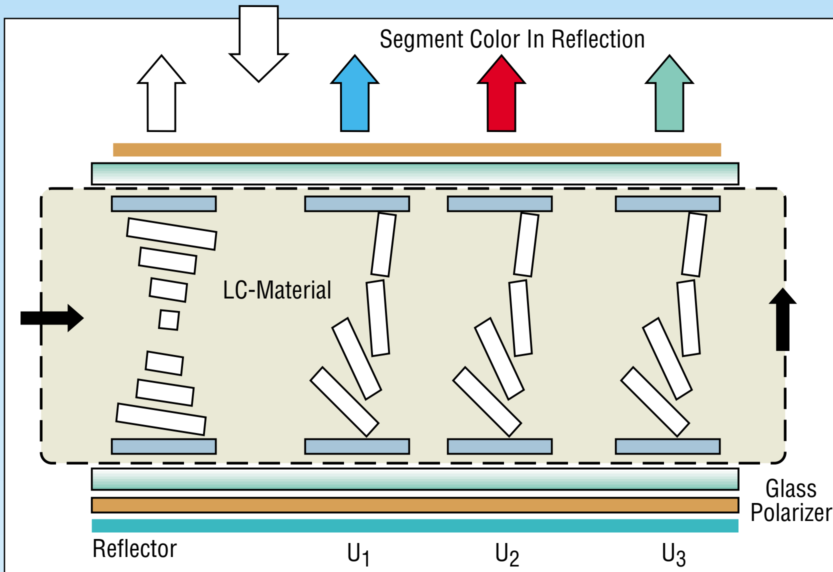
LCD basics

Of the various LCD technologies, twisted nematic (TN) is the lowest cost and most mature, providing high display contrast. However, with a 1/16 maximum duty cycle, TN is limited to displays showing low information content, such as calculators, clocks, and watches.

Supertwisted nematic (STN) is also a low-cost material and mature technology, providing good contrast for medium- to high-information-content displays. Most test equipment, office machines, and other devices with human-machine interfaces employ STN technology.

Film-compensated supertwisted nematic (FSTN) is a more sophisticated LCD technology that offers excellent contrast for medium- to high-information-content monochrome and gray scale displays. For wireless/portable devices where high display content and good resolution are required (such as in cell phones and PDAs), FSTN is a solution offering numerous design options.

By varying the processing of the LCD's layers, manufacturers can produce different iterations of these basic liquid-crystal technologies. Internal color filter layers may be used to modify display color, or a variety of films may be used to affect display contrast and brightness. Other variations are possible—all of which are used to meet specific design requirements for variables such as brightness, color, contrast, viewing-angle magnitude, and power consumption.



Super-reflective color LCD modules are reliable and low cost, and require no color filter.

to activate the crystals. Conversely, at higher temperatures, less voltage is needed to create the display.

On-board temperature control circuitry has been one solution offered by LCD manufacturers. A driver IC with integrated temperature compensation circuitry reduces the total number of components in the device.

LCDs with operating temperatures of –30° to +80°C (or greater) accommodate designers in automotive, aerospace, avionics, and other industries where LCDs must perform in demanding environments. Some manufacturers supply LCDs with an integrated heater to control the LC temperature, ensuring optimum display performance.

Until a few years ago, many cell phones made in the United States used light-emitting diodes (LEDs), which typically washed out under intense ambient light and bright sunlight. The answer has been the development of LCDs with properties that optimize readability under varying ambient light conditions.

Such transflective LCDs exhibit both transmissive and reflective properties, combining backlighting and highly efficient inner-mirror technology. The result is an LCD that uses both illumination methods (backlighting and reflectivity) to match the display to ambient light.

In reflective mode, transflective LCDs achieve 40% reflectivity in monochrome. Reflection and brightness can also be controlled through the use of special films.

Transflective (and reflective) STN-LCDs with inner-mirror technology exhibit a natural change of image against ambient light conditions, resulting in excellent interior matching between the electronic display and mechanical (or printed) displays.

Display contrast, particularly at high temperatures, is enhanced through multiline addressing (MLA), which simultaneously applies activation pulses to several rows in a display frame to ensure fast, flicker-free response across the LCD's operating temperature range.

Efficient use of power

Portable and wireless devices must be power efficient because they often operate from a battery power source. The best way to reduce the power consumption of an LCD is to lower the driving voltage.

MLA has been effective here, decreasing power consumption. Previous display drive schemes sent single-activation pulses to each pixel in a frame. When the last column of pixels had been activated, the pulses were routed back to the top of the grid, and the refreshing process started again one pixel at a time. In contrast, MLA activates several columns of pixels at a time.

The liquid crystals have less time to relax (they retain their energy content) between refreshes so display response time is faster. Reflective LCDs have also been employed as a means to achieve low power consumption.

LCD manufacturers are also integrating booster circuitry with LCD modules instead of using discrete quadruplers and doublers. Real estate is conserved, costs are reduced, and the LCD serves to maximize power efficiency. In some cases, the power-boosting IC on an LCD can raise an input voltage of 1.8 V to as much as 8 or 9 V.

Displays for wireless and portable devices need to light fast and be easily readable and totally reliable. By selecting the proper LCD, designers can ensure these criteria are satisfied in the best way possible.