Informational Document

LCD Group

Making the Right Display Choice for Industrial Applications

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In today's competitive marketplace, engineers, developers, and other decision-makers must have a deep and comprehensive understanding of how display specifications impact final products. To choose the right display, it's important to know how an industrial display differs from a non-industrial or consumer display, as well as the benefits realized by these specific features, and how they impact the application.

Liquid Crystal Displays (LCDs), are currently the dominant display technology and also the focus of this whitepaper; however, a large part of the information contained herein is relevant to other emissive and passive display technologies as well. Weighing the pros and cons of the features and specifications outlined in this whitepaper is an essential step in any display selection process. The basic elements that should be considered in evaluating any display include:

- Optics Performance
  - Contrast
  - Color
  - Brightness
  - Response Time
  - Viewing Angle
- Other Performance Factors
  - Durability
  - Backlight Life
  - Vibration Resistance
  - Mounting Locations/Mechanical Structure
- Specifications
- Availability/Life of Product
- Commercial Terms
- Configuration Control
- End-of-Life Scenario
- Serviceability/Replacement Parts
- History

Optics Performance

Optics are always the first item to consider when discussing performance. Optics for a display can be broken down into contrast, color, brightness, response time, and viewing angle.

Contrast

People perceive contrast — the difference between the light and dark pixels — rather than brightness, so this aspect of the optical specification is very critical. In most consumer displays like desktop monitors or small DVD players, a contrast of 200:1 may suffice. In the case of an industrial-grade display where the user may not be at an optimum distance from the display (for instance, a physician looking at the display from an angle) or in ideal lighting conditions (such as factory automation type applications), a higher contrast display is needed. In most industrial applications that use 10.4-, 12.1-, and 15-inch displays, a contrast ratio of 450:1 is ideal.

Color

In some industrial applications, particularly where color information is more critical than text or numbers, it is important to measure the color palette as a percentage of NTSC (National Television Standards Committee) color gamut. In LCD products, the color gamut is influenced heavily by the backlight. CCF (Cold Cathode Fluorescent) backlights are the predominant technology and typically allow between 70 percent and 80 percent of the NTSC color gamut. In certain applications, this range is not sufficient and there is a need to achieve closer to 100 percent of the NTSC color gamut. This full color gamut is typically accomplished by using LED backlights in the LCD product. Seeing an LED display next to a conventional CCF backlit display can help you truly appreciate the difference between the products. Graphic artists, magazine editors, and users of high-end monitors will find the colorimetry enhancement produced by an LED backlight invaluable.

Brightness

Given that most flat panel displays are used in indoor applications, a 15-inch diagonal LCD that is about 250-300 cd/m2 (nits) bright is frequently used; however, this level of brightness isn't adequate in an industrial environment where the ambient light is much greater and competes with the backlight of the LCD. Also, in applications where a touch screen is employed, the touch screens can reduce the light that is emitted from the display, making it look dimmer. In typical medical, industrial, and kiosk applications, a brightness of 450 nits is desired.

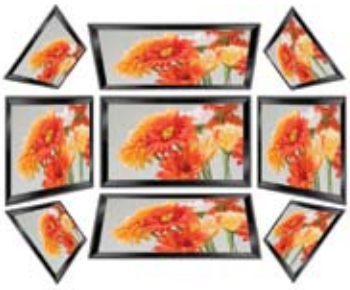
Response Time

Historically, passive-display technologies, including LCDs, have had poor response times compared to emissive display technologies. In consumer displays, whether they are laptop displays or desktop monitors, a response time of less than 30 milliseconds is considered ample; however in industrial, medical, and gaming applications, where the user can perceive the motion in a dynamic content environment, a faster response time in the LCD is desired. Newer technologies like Advanced Super View (ASV) or Multivariate Vertical Alignment (MVA) have reduced this response time to less than ten milliseconds. In the case of TV applications using ASV technology, this figure is a fantastic six milliseconds.

Viewing Angle

Commercial or consumer displays are typically designed for a single individual who is directly in front of the display. This is rarely the scenario in most industrial applications; for example, a physician or nurse cannot stop in the middle of a procedure to view a display straight on, just to acquire the desired data. For an operator of a large machine, it would be virtually impossible to get directly in front of the display. For the navigator in a boat or airplane, it would be inconvenient to be positioned directly in front of the LCD, especially when there are multiple displays, all at different angles to the user.

Displays should be readable over a wide viewing angle with reasonable contrast, also known as "at-a-glance readability". Consumer displays are often a poor fit for this type of environment, because they use TN technology (Twisted Nematic) and thus have a limited viewing angle. To better fit industrial applications that require wide viewing angles, technologies have been developed (such as ASV or MVA) which allow for viewing angles as wide as 178 degrees.



ASV Viewing Angles

Conventional TN Viewing Angles

Other Performance Factors

Durability

Durability is hard to specify. One way to find out if a particular panel is durable is to ask the manufacturer to provide references of customers that have been using the display for more than five years. Well-designed industrial displays easily survive five years but consumer displays will likely have a shorter lifetime, due to backlight failures or other types of malfunctions.

Backlight Life

CCF lamps are some of the most commonly used backlights for LCDs. In industrial applications, CCF backlights are specified at a minimum of 50K hours to half-life, or the point in which the brightness drops to one-half of the as-new output. In many consumer applications, the design may only require 10K hours of backlight performance before it reaches half of its initial brightness value. Since these applications may not require the display to be on continuously, a 10K-hour-rating CCF backlight might suffice, but not so in most industrial and medical applications. The backlight is usually the weak link in the LCD's life expectancy. There are efforts underway to double the backlight life, but in most industrial applications, a minimum of 50K hours is considered the norm for a CCF backlight.

Vibration Resistance

In applications like handheld devices (Handheld Data Terminal) or portable equipment (Defibrillator), conducting end-product vibration testing ensures that the design will survive the ride in a commercial or emergency response vehicle. In these applications the vibration resistance is important because it allows the designer a certain margin while building the final product. Displays like Sharp's Strong 2 series products boast a vibration resistance of 2G, which allows for more rugged industrial designs.

Mounting Locations/Mechanical Structure

As with any technology, designs fluctuate in the world of flat panel LCD products. In the case of industrial grade panels, this change may happen once in five years or more. The occurrence will be driven by the need to accommodate improved technology or better design. As such, it is important when designing industrial and medical equipment to ensure that there is some level of continuity, including similar mounting holes, connector location, and even some of the same display dimensions. While the display may change in five years, the end product may have a 10-year life cycle. It helps to consider these specifications as well as the company's design philosophy before choosing a display. In contrast, consumer displays may change every six months, making them very difficult to use in applications that require configuration control.

Specifications

Specifications for consumer-grade displays — built for monitors, laptops, or other consumer applications — typically reflect the actual performance envelope of the displays. For industrial-grade displays there is always a de-rating, or buffer, built in for various aspects of the specifications, especially given the demanding environments these displays are required to withstand. Specifications are crucial in the selection of industrial displays, whereas price is much more of a driving factor in the selection of a consumer or commercial grade display.

Availability/Life

It is not unusual for customers in the industrial marketplace, whether they make kiosks or display terminals for an oil rig, to seek a 10-year/life guarantee for a display. Manufacturers such as Sharp offer displays: the 10.4-inch display models (LQ10D368 and LQ10D421) that have lifecycles that met or exceeded 10 years. Most display manufacturers that produce industrial-grade displays build the same products for at least three years and, in reality, offer the products for at least five years.

In stark contrast, consumer-grade displays used in products such as desktop monitors, laptops, and other consumer devices, tend to change inside of a year, sometimes as frequently as six months. These displays, while attractive from a price or form-factor perspective, are like meteorites: they blaze away into oblivion.

But they also have their place. They are great for use in consumer applications where there is not such a strong need for continuity or form-factor compliance.

Commercial Terms

Because industrial-grade displays are designed to last longer and have enduring specs, manufacturers are able to offer more relaxed commercial terms. Whether sold directly or through distribution channels, terms may include smaller lot quantities, forward-looking prices, possible acceptance of blanket orders that stretch out over a year, better warranty terms, formal failure analysis, engineering change notices, and the like. Although these may not be of any value to someone that is building a widget for a short-term project, there are important factors to OEMs that build products to last for many years. In the case of customers that are not able to forecast market requirements to the extent necessary to use commercial or consumer-grade displays, the industrial-grade displays will offer them the supply stability needed to be successful.

Configuration Control

The definition of configuration control is that the display product is maintained in a Form/Fit/Function (FFF) compatible mode over a certain period. This basically allows the display manufacturer the flexibility to change subcomponents to keep up with technology or market needs. Also, it allows the user to transition to the newer display products with minimal design changes. Product changes are inevitable; it is a question of how soon and how much impact the changes will have on the customer in terms of time and resources. It is helpful to focus on managing the change to minimize the impact when it comes to configuration control.

Industrial displays are designed to allow for changes; the manufacturers strive to keep the changes minimal, and when they have to change they not only have a well-established and accepted Engineering/Product Change Notification (ECN/PCN) plan but the information is conveyed to the customer in sufficient time to allow the customer to accommodate the changes without seriously impacting their business. It is typical for PCNs to be dispatched three months before the changes are implemented. These changes are then documented and, as appropriate, new samples are available for customers to test before they receive the new production parts.

In the case of consumer displays, demand for configuration control is rare and not usually requested by the markets served. Most of the consumer-grade displays are sold on a short-term basis and are usually subject to change without notice.

End-of-Life Scenario

When a consumer display is selected for End-of-Life (EOL), it is typically because the primary user of the display has gone away or transitioned to a different product. It is not uncommon for this to happen in less than a year with many consumer-type products. In contrast, for many industrial applications (such as gaming, kiosk, and medical) it may take 12-18 months lead-time from the time a display is selected to the time the product actually goes into mass production. As you can imagine, the risk of using a consumer display in such instances can be catastrophic. Yet, some customers get lucky in that they pick a display from a consumer application that has indeed survived a long time and they can take advantage of the available volumes and the corresponding lower price points.

Industrial-grade displays typically have a longer lifecycle of three to five years. When products are selected for EOL, a notice will be distributed to the customer outlining the reason such as discontinuation of a subcomponent, significant change in technology, or market demand. This is followed by a Last-Time-Buy (LTB) opportunity within 30-180 days and a Last-Time-Delivery of three to six months beyond that. This kind of predictable EOL process allows OEMs to plan for a smooth transition to another display product with minimal disruption to their business.

Serviceability/Replacement Parts

If there is a failure in the consumer-grade display, whether it is during assembly or in the field, the display is typically scrapped. The manufacturer rarely intends for the display to be repaired in the field or reworked in the factory. This is acceptable in many applications where the cost of sending out a technician to repair the product is more expensive than disposing of the display. But in industrial markets, the OEM is expected to stand behind the product in terms of serviceability and be able to repair the end product over a period of a few years. Whether it is to replace the backlight, inverter, or to refurbish the display, this is part of the service business with many OEM customers.

Disassembled LCD Panel with Backlight

Manufacturers that offer industrial-grade displays typically design their products such that the backlights are replaceable, and the display assembly can be disassembled easily to get to the subcomponents. They also offer spares, which typically consist of backlights, inverters, and other subcomponents. The concept of spares in a commercial display environment is rare.

History

When selecting a display for a new or unfamiliar application, ask the manufacturer to provide references that have used their displays for ten years or more. Ideally the reference would be someone in your own industry that has used a certain type of display and can share their experiences with you. Especially if you're on a short deadline to select a display, this may be an effective shortcut to finding a display or a manufacturer that matches your needs.

Conclusion

Commercial displays are an excellent option when performance and price requirements dictate; however, in some applications, it is preferable to pay a premium to design using an industrial-grade display. The time you spend up front selecting a display will pay off in the long run.

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