

High Bright Displays: Get the Picture

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In the old adage, seeing is believing. In today's modern industrial applications, seeing is more than that. It's the essence of control, since the human machine interface (HMI) involves the presentation of visual information. That's why there's such a demand for high bright displays in highly customized industrial computers and in stand alone industrial monitors.

Such displays have a brightness of at least 350 candelas per square meter, or nits, which is required for operation in transportation, medical, military, semiconductor and other areas. For those industrial applications, liquid crystal displays, LCDs, are the best choice. They have the needed brightness, meet viewing angle requirements, come in a variety of sizes and form factors, and offer different mounting options. Their prices are dropping as manufacturing matures and volumes increase. Furthermore, technology advances, such as transfective displays, promise even better performance in a variety of lighting conditions.

However, not all LCDs are the same. In industrial applications, such features as display size, power supply, and location of on-screen display, or OSD, controls have to be considered, along with certifications for operation in harsh environments. This white paper will cover display technologies, indicate which is best for industrial applications, discuss market and technology trends, and finally make recommendations about what to look for in a display.

You Can't Control What You Can't See

What you don't know may not hurt you but what you can't see can. That's particularly true in industrial applications because virtually all information, aside from audible alarms, is presented through a display. Operators need this information so that they can respond appropriately to an out-of-specification warning, a request to select a process recipe, or a demand to enter information. Thus, it's vital that the display be readable under virtually any condition encountered in the normal course of operation.

Because of the nature of the workplace, industrial displays face situations that don't

confront displays intended for office use. Most importantly, industrial applications, unlike offices, often take place in bright light. Military displays, for instance, have to work in partial or full sunlight. A fighter jet doesn't fly only on heavily overcast days. The same is true in transportation, where trucks routinely exit tunnels, which are very dark, into full sunlight – all within the space of a few seconds.

As for medical and semiconductor applications, these don't involve full sunlight, except in the case of emergency, on-the-spot medical care. However, they often do entail operation under bright fluorescent lights, with plenty of glare. Making the circumstances more daunting, it's often not possible to adjust the display angle or location because it is mounted in a piece of equipment. At the same time, the overhead lighting can't be dimmed. Thus displays in medical and semiconductor areas operate under less than ideal viewing conditions.

Besides illumination, a notable point to consider for these applications is the viewing angle. In industrial settings, typically more than one person must see the information on the monitor. It's also common for an operator to read a display while standing to a side. Thus, a wide viewing angle is necessary.

Also, industrial environments can be dusty or wet, full of vibrations that range from the mild to severe, and experience large temperature swings. There's a danger, as well, from more than an occasional soft drink or cup of coffee being spilled. Any industrial display has to be able to withstand dust, vibration, temperature extremes, and a sporadic dousing, although the exact requirements in these categories are dependent on the application.

A final element of industrial settings that sets them apart from the traditional office involves power – specifically the type of voltage. Typical offices offer AC power, which means that displays, which run internally on DC, have an AC-DC power adapter either built in or as an outside brick. In most industrial facilities, however, there's no AC power. Instead everything is DC. So an industrial display must have a DC-DC power option.

Therefore, industrial applications need a display that is bright enough to be seen, has a wide enough viewing angle, can withstand environmental insult, and runs on the power available.

In addition, the display has to be of the appropriate size, form factor, and mounting options.

Otherwise integrating it into a particular setup could be difficult, if not impossible. Lastly, the display needs to meet other criteria such as power consumption, operating and purchasing cost, and operating life, and additional application specific requirements.

Getting the Right Picture

Given these constraints, LCDs are the display technology of choice. Today's computer monitors have luminance's ranging from 50 to 300+ nits, with the lower end populated by devices based on older CRT display technology. In contrast, the brightness of LCDs runs much higher, with the 350 nits needed in industrial situations possible.

LCDs, by their nature, are not emissive – that is pixels don't emit light and require either an outside ambient source for a reflective display or a backlight for a transmissive one. Because of this, LCDs do not natively offer a full 180° viewing angle. However, manufacturers can come close by, for example, orienting the liquid crystals at right angles and not parallel to the backlight or by using optical films on the surface of the LCD. These techniques can yield viewing angles of 150° or better.

As for size and power, LCDs offer important advantages over old fashioned CRTs. They're thinner and lighter, allowing them to be placed in rack mounts, on desk tops, and in wall mounts. Combined with the ability to place OSD controls in front or back, these mounting options provide a great deal of flexibility. Compared to other flat panel display technologies, LCDs consume less power and come in a wider variety of sizes, ranging from six to more than 19 inches.

Finally, LCDs enable some real space savings beyond those that come from being a flat display. The screen that outputs information can also act as an input device, through the combination of an LCD with a touch screen. Such screens can detect pointing fingers or the touch of a pen either through a resistance or capacitance change. For an application where an operator must select from a menu, being able to simply point to a choice can add flexibility to the HMI and increase the power as well as usefulness of the interface. Incorporating a touch screen can, for example, allow the use of soft controls, which can be located and changed as needed on the screen.

Falling Prices, Changing Mix

In addition to these technical advantages and capabilities, LCDs in industrial applications benefit from wider market and technology trends. These include falling prices, with 30 percent annual declines in some market segments. As for technology trends, advances in display construction – such as the advent of transfective displays that are both reflective and transmissive – should allow LCDs to be used in a wider array of settings, ranging from full sunlight to near complete darkness.

Because industrial displays represent a small percentage of the market, it's not possible to get a precise breakout of their price trends. However, the market research firms DisplaySearch and iSupply do gather display statistics in a variety of areas. These figures show that prices are falling and volumes rising, particularly in thin-film transistor (TFT) LCDs that are at the heart of modern full-color monitors.

For example, total TFT LCD shipments increased 29 percent, to better than 77 million units of 10 inch or larger size, from October 2005 to October 2006. At the same time the average selling price fell 16 percent. That decline was actually steeper for most of the year, with stronger seasonal demand and reduced supply slowing price erosion somewhat toward the end of 2006.

Hidden within these numbers are several other trends. For one thing, displays are getting bigger and the average display size is growing. For industrial applications, one reason for this expansion has been the need for more and more real-time data, graphics, charts, and other information to appear in the HMI. Operators can see such information more clearly on a 15 inch display as compared to a 10 or 12 inch display.

According to the research firms, displays in 2006 were 10 percent larger, on average, than those of a year before. At the same time, the display area cost, the cost per square centimeter of the LCD, dropped 30 percent as compared to the year before. The combination of bigger size but less cost per unit area partly explains why the average selling price declined as much as it did.

Prices will continue to fall – for those displays that are in the mainstream. Smaller displays, which today are less than 12 inches and tomorrow may be less than 15 inches, may not benefit

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that much from the overall price decline. Indeed, they could see price stabilization or even a price rise.

Indoors or Out

On the technology front, the capabilities of LCDs are being extended. For one thing, transfective displays are entering the industrial marketplace. One of the oldest LCD technologies used a reflective approach, placing a mirror behind the liquid crystal layer. Ambient light passed through the layer, hit the mirror, and bounced back out. As a result, such displays worked well in bright settings but were extremely hard to read in anything else.

A transmissive display, on the other hand, places a light source such as fluorescent lights or a bank of light emitting diodes, LEDs, behind the liquid crystal layer. This backlight illuminates the liquid crystal regardless of the ambient light and so provides excellent viewing indoors. This technique is widely used in laptops and other portable devices. However, direct sunlight overwhelms the backlight and makes viewing at least difficult and usually impossible.

A transfective display, on the other hand, combines both reflective and transmissive illumination. Such displays have a backlight, topped by a mirror that allows the illumination from the backlight through. A liquid crystal layer covers the mirror. This arrangement enables the display to be viewed under all light conditions. The implementation of such displays in industrial settings promises to overcome difficulties involving viewing in direct sunlight.

Finally, technology improvements on the horizon should fix one of the issues confronting some industrial users. While most industrial applications need a display capable of being viewed in direct sunlight, a few need displays that can handle full night. An example might be a fishing boat, which operates during the day but sometimes runs at night. In the latter case, adjusting the brightness down substantially would be useful. The standard brightness adjustment on most displays will only cut luminance 10 percent or so. New technology should allow brightness to be adjusted to nearly nothing, although such an improvement won't be deployed for some time.

Considerations and Recommendations – Enclosures

Given the current market, the state of technology, and the needs of industrial applications, Advantech has a number of recommendations. The first of these may seem obvious but it bears pointing out. Industrial parts are both more rugged and in demand for far longer than their consumer counterparts. Thus, it's not possible to simply buy a consumer product and drop it into an industrial application.

It's tempting to do so, in part because the price differential between a consumer product and the same-sized industrial display can be many hundreds of dollars. Multiplied by numerous displays, the savings are substantial – but false. Such displays will fail more often and be replaced more frequently. Consumer products also change rapidly, and it may be impossible to get a replacement display long before the rest of the industrial equipment is rendered obsolete.

The resistance of the display to dust, moisture, and vibration is a function of the casing and internal construction. Agencies such as the National Electrical Manufacturers Association (NEMA) in the U. S. and the International Electrotechnical Commission (IEC) in Europe set standards for enclosures. These standards, NEMA4 and IP65 from the IEC, specify that both the equipment and nearby people are protected.

For example, an enclosure meeting the IP65 standard would not allow an external wire to touch anything dangerous, would keep out all dust particles above that of the size of talcum powder, and would not allow a water jet to force fluid into the enclosure in such a way as to cause harmful effects. The NEMA4 specification is similar, although it also extends protection requirements to corrosion.

For both standards, certification that an enclosure, and therefore a display, meets these requirements can be done by a third party. In the case of NEMA, self-certification is also possible. Consequently, LCDs can meet the requirements for dust and water ingress protection, provided that the enclosure itself is properly designed.

Therefore, Advantech's recommendation is that when selecting a display specifically designed and manufactured for an industrial application, it's important to choose one that meets both NEMA4 and IP65 specifications. Likewise, the chosen display must be able to handle the vibration of its setting. Finally, the display must also satisfy any regulations particular to the

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application.

It's also vital to select a display with a long operating life under the conditions common in the application. The combination of lifetime and environmental resistance ensures that the display will last, eliminating the need for field replacement of a failed unit. The resulting operational cost savings can be substantial.

Considerations and Recommendations – Power, Form Factors, and Controls

As for powering a display, Advantech offers a DC-DC power adaptor option, the PWR-246, rated to handle the range of DC voltages typically found in an industrial or manufacturing facility. It will convert 18 to 48 volts DC to the 12 volts needed by a display.

When it comes to form factors, whatever display is selected must be sized correctly and mounted appropriately for the application. The size choice balances the needs of the HMI against the space available. What's ideal may not be a size that's popular. Mounting options present a similar situation, in that one application may need a desktop display while another works best with a wall mounted or rack mounted display. So a wide span of display sizes and a complete catalog of mounting options must be available from the manufacturer, thus ensuring the best possible form factor.

There are also other related characteristics to consider. One is the location of OSD controls. In some cases these must be placed so they're accessible from the front by operators. In others, it's just as imperative that they not be. In the latter case, the button can be placed behind the display itself, so that it can only be reached by technicians authorized to make adjustments.

Finally, the ability to have alternate finishes may be important. For instance, the display bezel may typically be of one substance, such as aluminum. However, another finish, such as stainless steel, would be better for a particular setting because of environmental conditions. Flexibility in the location of OSD controls and the type of finish should be considered before making the final choice of a display.

Conclusion

High bright displays are a vital building block to a successful HMI. Only one display technology – LCDs – offers the combination of brightness, viewing angle, form factors, power, and performance needed for industrial applications. Advances in technology, along with falling prices, promise to make LCDs even better suited for such uses.

However, not all LCDs are the same. In particular, a display intended for industrial setting needs to meet the appropriate environmental ruggedness standards, such as NEMA4 and IP 65, and must be able to function with the voltages present. Beyond that, the display should be of the right size, offer the needed mounting, and have the necessary features, such as finish and OSD location.

If these recommendations are followed, then operators – and others in an industrial application – will indeed get the picture.

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