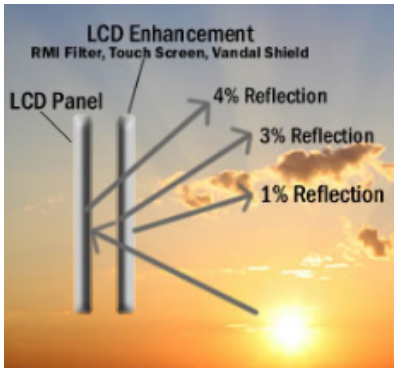
# Industrial Sunlight Readable LCD Monitor Bonding

With this optical stack, controlling reflected light significantly improves the optical performance of an LCD display in any ambient lighting condition. To view an LCD monitor in high ambient light environments and/or direct sunlight one must consider two important factors "luminance" and "illumination". The luminance of an LCD display is its brightness. Brightness is traditionally referred to as a "nit" (Candela per meter/2), a unit of measure, which is the amount of light energy coming out of the display. Illumination is the amount of ambient light shining onto a display. The readability of a display is dependant on the amount of light that is being reflected off the display.

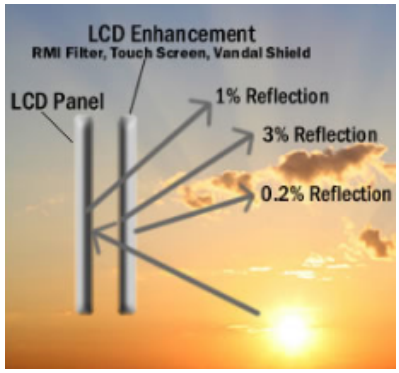
Light has the ability to travel through a variety of transparent materials; such as air, glass, plastic, and even water. The material's ability to transmit light is measured by its indices of refraction. As light transfers from one material to another, such as air to glass, the differences of the index of refraction will cause reflection. In the case of an air-to-glass interface, the reflection will be slightly less than 5% of the ambient light. All surfaces that have an index "mismatch" will reflect cumulatively. In the case of a standard glass or plastic protective overlay window, typically used in front of the delicate LCD, there are three surfaces with an index mismatch which will create a total reflection of nearly 15% of the ambient light. If the total reflection (in nits) is close to the displays brightness, the contrast of the display will be reduced to the point where the display's readability is reduced to unacceptable levels.

The two images below are representative of the reflective loss experienced by an LCD without a optical bonding layer between the LCD enhancement and the display glass of the LCD.

**Reflection with No Optical Bonding**




**Reflection with AR Coating**



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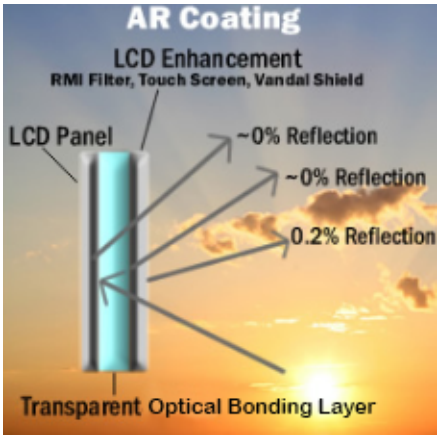
Monitor integrated with the optical bonding process is equipped with a UV protected solid, transparent bond. This procedure permanently bonds the front protective glass overlay or touch screen directly to the frontal face of the display. The optical bonding eliminates reflection from the two internal layers and utilizes an adhesive that matches the index of refraction of the flat panel and the overlay. As well, the outer surface of the protective window is chemically treated with anti-reflecting coatings which matches the front surface of the glass with the index of refraction of air. This combination reduces the total reflection of the display and front cover glass to less than 2% of the ambient light. A reduction of reflection of this level, all but eliminates reflective loss in most ambient lighting conditions. With reductions of this level, displays with 250 to 450 nits of brightness (cd/m2), traditionally not viewable in direct sunlight, will now be readable in very high ambient brightness or indirect lighting conditions. This method also removes all air gaps, therefore reducing the number of internal reflecting surfaces which can lead to significant degradation of the LCD's optical performance.

The Image to the right is representative of the IMPROVED reflective loss experienced when a optical bonding is applied between the face of the LCD and the LCD Enhancement.

**Reflection with Optical Bonding &**




The optical bonding process has many other benefits as well. By providing this durable adhesion between the flat panel and the overlay we greatly improve the displays' ability to resist shock, vibration and moisture. Additionally, with the eliminated air-gap we (1) prevent heat build-up from a "greenhouse" effect, (2) prevent fogging from moisture, and (3) eliminate any contamination from dirt or obtrusive particles.