



Achieving Greater Legibility on Displays Utilizing Optical Bonding and Anti- Reflective Surface Treatments

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Abstract

Making TFT displays more readable in direct sunlight or in bright ambient lighting conditions is the goal of many product designers. Displays used in avionics, digital signage, vehicle navigation, outdoor television, and hand carried electronic devices can generally benefit from better readability than is representative of the standard TFT offerings available from their manufacturers. This primer will provide the reader with a general understanding of how optical bonding with anti-reflective surface treatments enhance TFTs for better readability in bright ambient viewing conditions.

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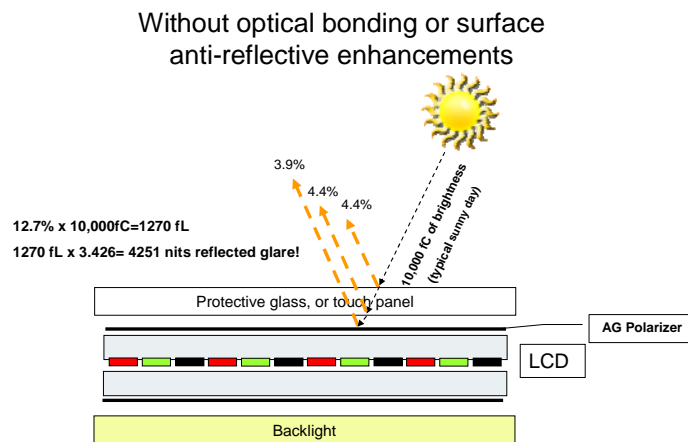
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When a viewer cannot see information presented on a display because of bright ambient lighting conditions, the consequences range from life endangerment to inconvenience. Aviation and driving a speeding police car are activities where slow time to perception could be life threatening. In a brightly lit public space, an advertiser has wasted their advertising budget when a consumer cannot watch a digital ad on an unreadable display.

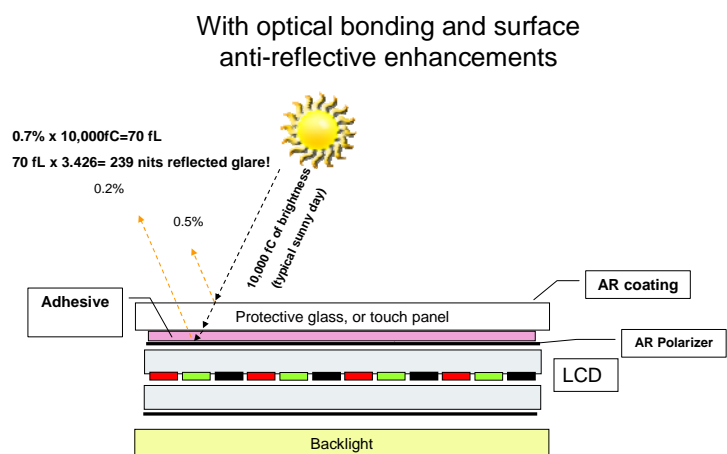
Why optical bonding? Why enhance the front of the display with surface treatments of optical coatings and film lamination? The primary answer is that optical bonding and surface treatments help to increase display legibility in brightly lit environments.

The diagram below depicts the internal and surface reflections which occur when an air gap exists between a display and a cover glass or touch screen, and when coatings are not used to mitigate surface reflections.



The orange lines represent the value of reflections from glass-to-air and air-to-polarizer

Illustration #1



The enhancements are nearly eliminating the glass-to-air, and air-to-polarizer reflections

Illustration #2

As you can see from the illustrations above, eliminating internal and surface reflections are fundamental in increasing readability. By reducing the internal and surface reflections found in air-gap mounting touchscreens and protective glass over a display, we were able to reduce specular reflection luminance from 4251 nits down to 239!

Key Point: Reflected ambient luminescence is brightness that is competing against the luminescence of information you desire to see!

A good rule of thumb in determining information legibility on a color display in ambient light is to have a minimum of 7:1 contrast ratio. In the example in Illustration #1, one would require a display backlight of approximately 26,000 nits to overpower the glare from the screen and reach a 7:1 ratio.

In Illustration #2, the backlight needs to be just ~1650 nits to achieve a 7:1 contrast ratio.

(This is an inexact mathematical representation of contrast ratio, but illustrates outcomes with close proximity. The actual formula for contrast ratio is:

$$\text{Contrast} = (\text{White brightness area} + \text{Total Reflection specular \& diffuse}) / (\text{Black} + \text{Total Reflection specular \& diffuse}).$$



Photo #1

12.1" 1100nit monitor with anti-glare resistive touchscreen mounted with double sided tape. An air-gap exists between the TFT and touchscreen.



Photo #2

12.1" 1100 nit monitor with anti-reflective glass optically bonded to TFT- no air-gap. Anti-resistive coating on surface.

Which display would be faster and/or safer to read while driving quickly? Which display would appeal more to your clients? Your answer is probably Photo #2 - without the air-gap. Optical bonding may be your answer to better legibility.