Sunlight Readable Technology
in the Trimble Yuma Rugged Tablet Computer

Computer displays aren't valuable if you can't read them, and bright sunlight can easily make most screens nearly unusable. In order to avoid errors, diminished productivity, physical danger and eye strain, highly visible displays are essential for users of rugged mobile devices.

There are two conventional approaches to optimizing viewability—increasing the level of screen brightness and decreasing reflectivity (typically with anti-reflective screen coatings). A key issue with increasing screen brightness is that a brighter fluorescent backlight consumes dramatically more power, cutting battery life in portable devices. Anti-reflective coatings tend to be expensive; they can add to the cost of a touchscreen by as much as a factor of three to four. Both methods are significantly limited in their ability to improve display appearance in bright sunlight on their own.

The Yuma rugged tablet computer combines proprietary technologies for both screen brightness and anti-reflectivity to overcome these limitations. Its Sunlight Readable Technology enables display viewability that is more than six times better than competing solutions, while still maintaining the battery life required in a mobile device.

Super-Bright LED Backlights Save Power in Portable Devices

The core means of increasing outdoor viewability is to increase the contrast between the information being displayed and the sunlight being reflected by the screen. One simple "brute force" method is to increase the display brightness in an effort to compete with the sun.

Typical displays are generally in the range of 250 to 1,000 NITs (the unit used for brightness, one candela per m2, is typically referred to as a NIT). Because of the power limitations mentioned above, it is difficult for manufacturers to go beyond these levels. To compensate for this power drain, default power schemes often automatically dim the display when it is on battery power, which is precisely when users need maximum display brightness.

The Yuma computer display backlight design is based on light-emitting diode (LED) sources to replace the cold cathode fluorescent lamps (CCFLs) that are commonly used. The less diffused light from an LED enables a power-efficient, bright display operating at 650NITs, without sacrificing battery life or resorting to undesirable power-management schemes.

LEDS OVERCOME FLUORESCENT LIMITATIONS

Replacing fluorescent backlight sources with LEDs enables brighter, more efficient, and more reliable displays:

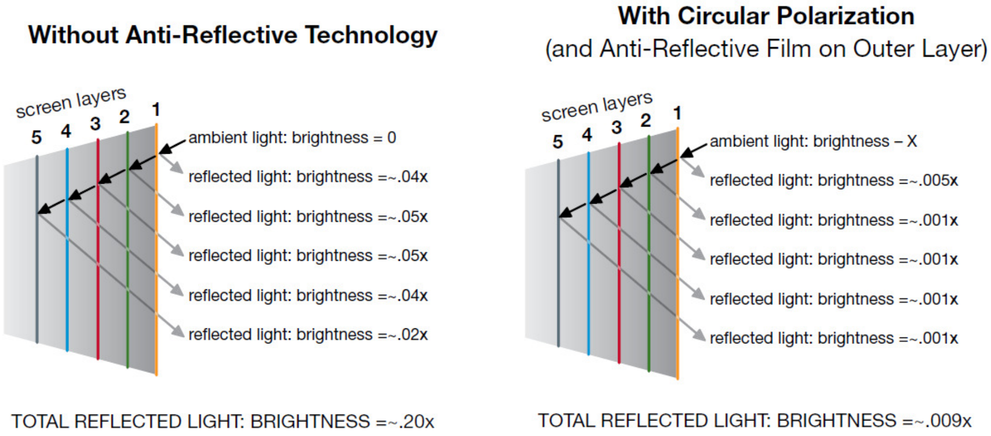
- **Energy Efficient:** LED display backlights can save significantly on power and heat, relative to CCFLs.
- **Mercury-Free:** Unlike CCFLs, LEDs contain no mercury, enabling regulatory compliance.
- **Durable:** The solid-state construction of LEDs tends to be more durable than glass-enveloped CCFLs.
- **Consistent:** LEDs have a superior profile to CCFLs in terms of deteriorating in brightness over time.

Active Anti-Reflective Process is Superior to Coatings Alone

While the super-bright backlight technology is very valuable, it is only one part of the solution. Direct sunlight is typically in the range of approximately 10,000 to 100,000 Lux, significantly higher than displays. Touchscreen displays typically have five layers, and each untreated touchscreen layer reflects approximately four percent of the sunlight. Those reflections can easily overwhelm the brightest backlights alone, making antireflective technology vitally important to solving the issue of daylight usage.

The Sunlight Readable Technology of the Yuma computer uses an active anti-reflective process based on circular polarization to block reflected light, dramatically increasing viewability, even under the harshest daylight conditions. The net effect of this technique in reducing the amount of light reflected back from a display is shown in Figure 1 .

Figure 1. The reduction of reflected light enabled by circular polarization



On the left-hand side of Figure 1, approximately four percent of the light incident on each surface is reflected back (depending on the layer’s composition), with an additive effect that results in as much as 20 percent of the ambient light being reflected back to the user. On the right, circular polarization blocks almost all reflection from the display layers behind the outermost layer. Combined with an anti-reflective coating on the outermost layer (saving considerable cost compared to putting coatings on all layers), this technology can potentially limit the total reflectivity to as little as 0.9%.

THE MECHANISM OF CIRCULAR POLARIZATION

The process of blocking reflections using circular polarization consists of the following steps, as depicted in the figure below:

1. Unpolarized light passes through a linear polarizer and becomes linear-polarized (along the horizontal axis in the image).
2. The polarized light passes through a quarter-wave retardation film, which delays its phase, making it right-circular polarized.
3. When the right-circular polarized light reflects off a surface, it changes orientation, becoming left-circular polarized.
4. When the left-circular polarized light passes back through the retardation film, it becomes linear-polarized again, but now along the opposite of its original axis (shown as vertical in the image).
5. Because the light is polarized on the opposite axis, it is blocked from passing back through the linear polarizer.