

# Automatic control of Display backlight using an Ambient Light Sensor with Human-eye response



When you think of displays, what do you think of? Traditionally interpreted as a part of televisions and computers, display technology is now everywhere—from thermostats, handheld terminals, automotive infotainment systems, automotive clusters, to electronic point of sale machines (EPOS) and more. People like the display to be lit comfortably so it is easy to see and not strain the eyes. In many of these applications, ambient light sensors (ALS) are used to set the display brightness based on the surrounding light conditions. Depending on the environment a product is designed to be used in, the problems present in designing an ambient light sensor into these products are trying to match human eye response, reaching the correct IR rejection due to conditions under dark glass, and maintaining long battery life. Texas Instruments provides not only the [OPT3001](#) to solve these problems, but also the [OPT3001-Q1](#) that is an automotive qualified device to be used in infotainment systems.

A problem with display backlights in portable electronics is the need to provide a clear picture in all ambient light conditions while simultaneously optimizing the power consumption to preserve battery life. The same problem occurs with display backlights in stationary applications, such as thermostats, but the environmental conditions are varied. Stationary applications must provide a clear picture in a variety of light conditions, like florescent light, incandescent light, or no light at all. Ambient light sensors from TI are being designed into products such as these to provide information to the display about the ambient light level surrounding the display. This light level can then be used to automatically adjust the display brightness via the backlight, providing just the right brightness level for clear viewing, preserving power and avoiding end user frustration that the display is too bright or too dim.

Figure 1 shows a typical block diagram for a display application.

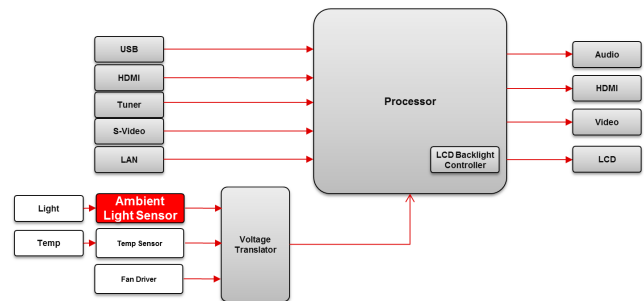
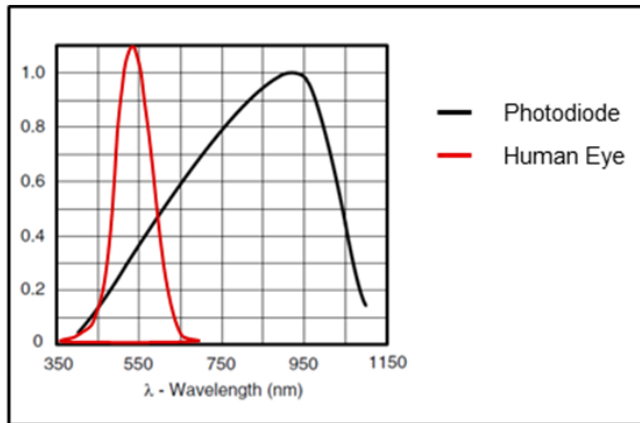


Figure 1. Display Block Diagram

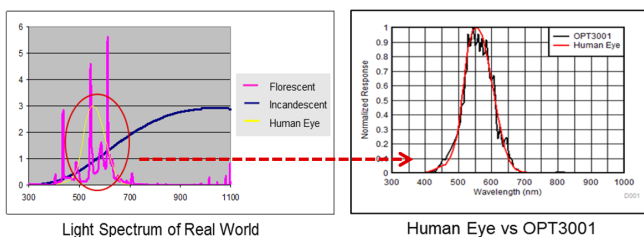
The end goal behind using ALS in any display application is to be able to measure what a human sees, so the display can be adjusted accordingly. Just as the human eye adjusts under different light sources, display brightness needs to change from one light source to another. If these different light sources are not accounted for it could result in user discomfort as well as a non-optimum display power.

The photodiodes (PDs) in most light sensors are not as responsive as the human eye due to the wide spectrum of wavelengths the PD measures. The human eye naturally has high IR rejection and the [OPT3001](#) matches the response of the human eye and includes significant infrared rejection. The IR light that is captured during a sunset for example is interpreted as “high ambient” by a regular photodiode, which leads to increased display brightness. The [OPT3001](#) will interpret the light source and provide optimal display brightness. See [Figure 2](#) for the typical behavior.



**Figure 2. Typical Photodiode Response**

The **OPT3001** response matches human eye response. It detects the ambient light precisely and enables optimum control of backlight, which leads to extended battery and display life as well as an improved user experience. Daylight is around 100k lux, outdoor shadow is around 10k, and night is around 50 lux (200x less than shadow). To get the same performance in each scenario, the backlight LED current can be reduced by 200x during night. See [Figure 3](#) for **OPT3001** Response data.



**Figure 3. OPT3001 Response**

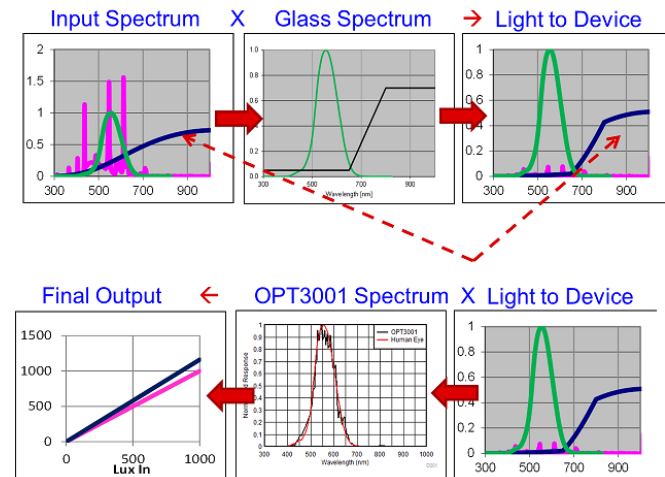
To help achieve the reaction of the human eye the **OPT3001** also has an auto-gain setting feature that adjusts automatically based on input light level. No additional adjustments are needed, unlike those required when using a discrete solution. The device always stays in optimal range with good resolution and tight accuracy between ranges. The relative accuracy between gain ranges is 0.2%. This allows for optimum display under all light levels.

Another problem that can occur with backlight display is that light measurement changes under different light inputs. Dark glass, for example, transmits IR. Sources like incandescent light have high IR that reaches the sensor due to glass transmissivity. If a photodiode were to be used, there is a higher risk for inaccuracy

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due to the wideband of the photodiode. The **OPT3001** has a very high IR rejection and discards most of the IR light reaching the actual sensor, measuring only what is in the visible region. See [Figure 4](#) for graphical data. The Input Spectrum is the same graph seen in [Figure 3](#) of the different light sources. Green Curve: Human Eye, Pink Curve: Florescent, Blue Curve: Incandescent, Black Curve glass response.



**Figure 4. IR Rejection**

The strong IR rejection also aids in maintaining high accuracy when the design calls for mounting the sensor under dark glass for aesthetic purposes. The **OPT3001** is designed for systems that create light-based experiences for humans, and is an ideal replacement for photodiodes, photoresistors, or other ambient light sensors with less human eye matching and IR rejection.

The **OPT3001** and **OPT3001-Q1** devices are sensors that measure the intensity of visible light and are suitable for display applications. The spectral response of the sensor tightly matches the response of the human eye, includes significant infrared rejection. The **OPT3001** maintains performance regardless of light source or application.

## 1 Related Documentation/Learn More

- **OPT3001 Product Folder:**  
<http://www.ti.com/product/OPT3001>
- **OPT3001-Q1 Product Folder:**  
<http://www.ti.com/product/OPT3001-Q1>
- **OPT3001EVM:**  
<http://www.ti.com/tool/opt3001evm>

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