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Application Note 1682

Author: Tamara Schmitz

What are the Advantages of Packaging a Proximity Sensor with an Ambient Light Sensor?

Consumer devices like cell phones are using more and more sensors to save power and enhance our interaction with them. Some of the latest devices have more than 10 sensors. It is a natural question for cell phone manufacturers to ask if any of these sensors can be co-packaged to save power, space and cost. There are many good reasons for co-packaging a Proximity Sensor with an Ambient Light Sensor. After clarifying their roles, their operations and some simple differences, these reasons will be discussed.

An ambient light sensor acts like an eye for a system that measures the surrounding light. If the device is indoors, it is the light in a room. If the device is outside, it could be bright from sunlight or less in the shade. The measurement of this amount of light is made by a light emitting diode (LED) and quantified to enable a system to adjust its own display. If the surrounding light is bright, the backlight of the display is run at full power. If the area is darker, the backlight is reduced, saving power. Incidentally, this is also pleasing to the user. Have you ever tried looking directly into a bright light in a dark room? Eyes can tire quite quickly for this overstimulation, so the dimming function provided by the ambient light sensor is a welcome addition. The challenge is that silicon diodes naturally react to a wide spectrum of wavelengths. An ambient light sensor must be designed to mimic the human eye. This filtering is one of the quality measurements of the sensor, especially since the majority of light sources have energy in the infrared wavelengths (think about which light sources also give off heat). To demonstrate this filtering, see the plot in Figure 1. The ISL29028A from Intersil provides the best match of filtering in its ambient light sensor compared to the response of the human eye.

A proximity sensor measures an infrared signal. Instead of the signal coming from the surrounding area, the proximity sensor drives an external infrared LED. The signal from this LED is directed out above the proximity sensor. If something enters the path of the infrared emission, some will be reflected back toward the sensor. There is another LED within the proximity sensor ready to pick up this reflected light. This allows a system to react to someone or something coming close. A great example of this is on many cell phones. The user doesn't want their cheek to be "pressing buttons" or hanging up on a call while they have the phone up to their ear. It would be convenient if the phone could turn off the touch screen whenever the phone is brought up to a user's ear. This is exactly what the proximity sensor allows the phone to do.

These two separate systems are now being offered in one package. Are semiconductor companies overexcited by their drive to integrate more features and systems, or are there real advantages in co-packaging the proximity sensor with the ambient light sensor?

While it is true that they are two separate systems, they are both optical systems utilizing a sensing LED. They collect information from the outside world, quantify it and provide it to the system. Currently, the system predominantly uses the information to adjust the backlight of the display. The information could just as easily be used to control more system features in the future.

Of course, it is convenient to save space, to share supplies, and to combine power supply bypassing. The size of the solution is a critical parameter in many systems, especially portable ones. The co-packaging of the proximity sensor and ambient light sensor is an enabling step in the development of more compact, yet feature enhanced, cell phones.

The next reason is slightly more subtle: Location. Both the proximity sensor and ambient light sensor need access to the outside world for proper function, so their placement within a system is strongly related to their sensitivity and their correct operation. In some cases where an ambient light sensor is packaged alone, it has been placed deeper within a system-behind a speaker screen or further down a printed circuit board from a nearby external access point. This practice has pushed ambient light sensors to be more and more sensitive to this indirect light. Light intensity is measured in lux. While sunlight exceeds 100,000 lux, these ambient light sensors can detect 0.001 lux! That's a tiny fraction of a candle's light. For a practical array of the lux levels of various light sources, see Table 1.

A final and compelling reason to house the proximity sensor and ambient light sensor in the same package is that it enables quick and undisturbed communication between the two. Remember in the beginning during the explanation of the operation of the ambient light sensor that we explained how its sensor must mimic the human eye? The human eye does not see infrared light, so the ambient light sensor is specifically designed to remove as much energy in the infrared wavelengths as possible. Remember also that the proximity sensor operates precisely within the infrared spectrum. Whenever the proximity sensor is attempting the make a measurement, it is simultaneously sending out infrared light in the hope of bouncing off of a nearby object. This infrared energy could easily swamp the ambient light sensor's input and cause false positive measurements (where the ambient light sensor measures more light energy than is actually in the surrounding area). It is for this reason that it is vital to coordinate the operation of the ambient light sensor with the proximity sensor. While this could be accomplished with a microcontroller, it is easier and a much smaller footprint to have this coordination within a single package. That one package houses both the ambient light sensor and the proximity sensor.

Locating the ambient light sensor and proximity sensor in the same package provides a number of advantages. They both enable power savings through the dimming or shutdown of the backlight and interface with the same system blocks. Co-packaging saves space and reduces complexity. Both sensors need access to the outside of the system and would likely be located in similar places. And since interference from the proximity sensor system can disturb the ambient light sensor, coordination between these two features is paramount. It is for all of these reasons that there is a huge advantage in co-packaging the proximity sensor and ambient light sensor.

TABLE 1. TABLE OF LUX VALUES

Direct Sunlight	100,000 to 130,000 Lux
Full Daylight	10,000 to 20,000 Lux
Cloudy Day	1,000 Lux
Office Lights	300-500 Lux
Candlelight/dark 10-15 Lux	10-15 Lux

NOTE: “Lux” - Measure of light density within the visible spectrum.

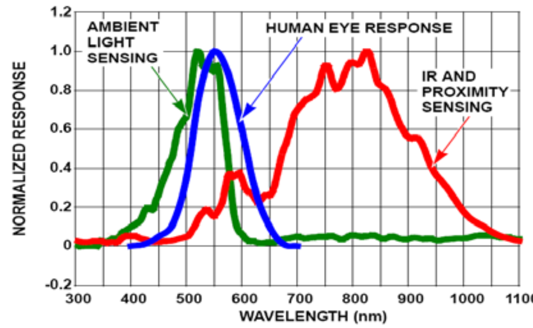

FIGURE 1. HUMAN EYE RESPONSE, AMBIENT LIGHT SENSOR SPECTRUM AND PROXIMITY SENSING SPECTRUM OF THE ISL29028A