Optical Sensor Onboard Training: Proximity, UV
Silicon Labs’ optical sensors are uniquely positioned to support embedded proximity applications. The high sensitivity and low noise combined with the ability to gang LED drivers for up to 500mA enables 2 meters range for proximity measurements with lens. This is ideal for applications that want to detect the presence of someone approaching a device. The device can stay in a low power mode and use a slow sample rate proximity measurement to detect presence before powering up to grab the attention of the user. Common applications for proximity includes anything with a backlight display, IoT and consumer control panels, remote controls, a video door bell, or lavatory appliances like touchless faucets and dispensers.
The fact that the target reflect light in wildly varying amounts makes exact distance calculations from the signal impossible.
The two quick measurements to suppress ambient are done very fast (~50 us) to suppress light flicker and other variation.
Incandescent bulbs powered by 60 Hz power flicker at 120 HZ (about 10% modulation depending on filament size). Traditional Fluorescents even more.
The competition: Time of Light sensors consume more power due to the need to time ps of light travel time.
The competition: PIR Is not good at very short distances and needs target motion to work at all
A common issue in applications that must operate in sunlight is that IR interference from sunlight can saturate the proximity sensor therefore not allowing sensitive readings of the reflected LED light.

Some typical applications include electronic entry locks, bicycling computer, video doorbells, automotive gestures, and in-ear heart rate monitoring. Many other indoor applications can benefit when sunlight from a window effects control panels or other proximity applications.

This solution uses proprietary 940nm passband filter applied directly to the photodiode. Natural sunlight energy at 940nm is only 53% of the energy 850nm wavelength due to water molecule absorption. By using a pass band filter we are removing most of the interference and can focused on the reflected 940nm signal, enabling better performance and eliminating IR filtering in the lens/covers.
Light reflection at the Air-Glass or Air to plastic interface is 4% per surface. Some coupling can happen via the PCB but can be controlled by judicious use of copper layers. Not all material that looks “black” to the human eye will block IR. To Block IR in plastic ask for plastic molded with “Carbon Black” (fine carbon/graphite powder). See AN950 for detailed information.
The Si1153 is based on stacked Photodiodes. As a result of the different depth they have different spectral response. The deep diode is the most useful one for proximity measurements.
Si1153 is our latest proximity sensor product which has multiple improvements over Si114x sensors. There’re a total of 3 OPN available for Si1153, two of which come as QFN package and the other one is a LGA module. The LGA module always has the IR filter while the QFN part has both options.

Dark current means leakage current when there is no light. This dark current can change from part to part and change with temperature as well. In Si1153, a reference dark diode is included in the design, it is covered by metal layer so all the current it generates is from leakage so called dark current. Then the hardware will subtract it from the exposed diode, allow it measuring only the needed photos. This will remove the part to part variation and temperature dependency.

Our legacy proximity sensor products include Si114x, Si1120 and Si1102. All of them are not recommended for new designs. Si114x is a lower cost version of Si115x. Si1120 is the only part that offers an analog output.
Recently, we launched the latest Si1153 RevB parts with additional interrupt modes. RevA parts used to be able to trigger interrupts on every sample and whenever the sample is larger than a set threshold. With RevB parts, users can now configure the sensor to trigger interrupts whenever the sample is smaller than a set threshold and whenever the sample enters/exits the set threshold window. This new feature provides more flexibility in customer’s designs and reduces power consumption in certain applications.

RevB parts are backwards compatible with RevA. Existing customer should be able to switch to RevB parts without any software/hardware changes. New proximity sensor customers should also start using Si1153 RevB parts.

OPN are updated to Si1153-AB00-GM, Si1153-AB09-GM and Si1153-AB9X-GM.
Here’s a list of all the Si1153 collaterals. Customers should first read the datasheet and the design guide to have a basic understanding about our sensor and how to use it. If they decide to evaluate our sensors, they can order the 115x-OPT-EXP-EVB kit and play with the demos provided in the GUI.
Here are some FAQs for Si1153 sensors. For more information, please check the KBA on the forum.
Digital UV sensor is mostly used in wearable devices to calculate the UV index. Silicon Labs’ UV sensor is the industrial leader and has won many awards since launched.
Customers often don’t realize that UV Index is not a measure of the UV energy. It’s a weighted curve that combines energy density and the variation is sensitivity of the skin’s to damage at different wavelength.
The UV band is divided into:
    UV-A: near UV
    UV-B: nasty to skin
    UV-C: nasty but so short a wavelength non gets through the atmosphere

NOBODY makes a reasonably priced (> $10,000) system that faithfully follows the “Erythema curve”. It really requires a spectrophotometer.
Si1133 is our 2nd generation (latest) UV sensor. There’s only one OPN for this part.

For Si1133 UV sensor, UVA and UVB are weighted integrated in the chip. The raw ADC result is read from the I2C interface by the host, the UV index can be calculated by a simple equation, where the coefficients are obtained by system calibration, sample C code are provided. Please refer to AN968.

Si1132 is not recommended for new designs. Unlike Si1133 which measures true UV spectrum response, Si1132 uses the ambient light and IR measurement result from direct sunlight to estimate the UV. The performance is not as good as Si1133 and can be affected by other light sources.
The Si1133 UV Sensor

- 2x2 mm clear epoxy package
- Communicates over I2C
- An external diffuser is needed. It is a translucent thin Teflon membrane and solves the following issues:
  - The UV-Index standard demands a cosine law angular response
  - The spectral response characteristics of the undiffused Si1133 varies with the angle of the light.

It is very important that a diffuser is used with the UV sensor
The diffuser is simply thin Teflon tape
It is important that the light from the diffuser illuminate the sensor in a +/- 30 degree cone.
Failure to implement the above will result in very poor performance.
Si1133 collaterals also include datasheet, application note (design guide) and the same GUI/Kit as Si1153.

Optical design is critical for UV applications. It’s strongly recommended that the customer read the application note (AN968) first. Silicon Labs can also help customers review their optical design.
Here are some FAQs for Si1133 sensors.

**Si1133 FAQs**

Does the Si1133 read UVA and UVB?
Si1133 measures UV index, which is a weighted integration of UVA and UVB. It does not measure them separately.

Does the Si1133 output UV Index directly?
The ADC readings need to go through a set of coefficients, and the results will be the UV index. There are two sets of coefficients - one for diffuser designs and one for designs with no diffuser.

Who are the main competitors? What are Silicon Labs advantages?
No digital UV sensor
Si1133 FAQs

Why does Si1133 require a diffuser?
All standard UV instruments have diffusers and require the sensor to be facing straight up vertically regardless of where the sun is. Without a diffuser, the UV sensor will have limited view angle. This is the same for competitors’ product.

Does Si1133 need calibration?
For consumer products that do not require the highest accuracy, the Si1133 does not need calibration if the users follow our guidelines. The user does need to scale the coefficients if their final optical system is different from our reference design.

To achieve the highest accuracy, the user can opt to calibrate their system. Please contact Silicon Labs for further information.

Here are some FAQs for Si1133 sensors.
Salesforce is Silicon Labs’ technical support portal. Any technical issues/questions related to sensor products, either during evaluation or development stage, should be entered as support tickets in Salesforce. We do NOT support customer issues through e-mail.

Alternatively, the customer can try to find answers of their questions on our public forum. Most of the tier4 customer issues should be addressed there. The customer can follow-up others’ posts if they run into similar problems.

Knowledge base articles are written by our technical support team members and posted on the forum. The answer to most of the frequently asked questions can be found there, as well as other important notes when using our sensors.
Si1153/33 EVB and Software Tools
Si1133/5x Optical Sensor Expansion board is the evaluation board for all Si1153 and Si1133 parts available. There are a total of 5 sensors populated on the board with one left for customer’s prototype. In addition, EXT port is provided to allow connection to postage boards using a ribbon cable. The evaluation board supports USB connection to PC as well as a 20pin header connecting to other Silicon Labs’ STK.

Power and I2C source automatically switches between USB or STK interface. USB takes over if both are plugged in.

The application selection switch must have one and only one Application pre-selected on power-up.

The Prox/ALS Application example shown is simplest and lowest cost. No Filter QFN and a nearby LED just below for Prox measurements.

The Gesture/ALS Application example placed the LEDs wide apart and by timing when the hand waving in front is recognized, determines direction of movement.

The UV Application example is shown. It can also to ALS with some loss of sensitivity.

• The UV diffuser shown is not sold by Silabs but we can provide .STEP design files and name of a manufacturer.
The Long range sunlight immune example uses the filtered QFN package version and shows a lens and a filter to get more range.

- The **Lens Assy.** shown is not sold by Silabs but we can provide .STEP design files and name of a manufacturer

The module version of sunlight immune example is shown as well. No extra lens is used.
The UV demo demonstrates the Si1133 sensor on the upper right corner of the EVB. The optical design is a good reference for UV customers.

Silicon Labs does not manufacture the diffuser and holder but can provide design files and suggested supplier for the example in this EVB.

See AN968 and the Users guide for the latest MultiSensor EVB (Rev 3.0)
Si1153 GUI is a windows based software tool that can be used to evaluate sensors on the 115X-OPT-EVB. There’re multiple demos available in the tool that the user can play with. The tool also provides real-time waveform display, C code generation, demo source code and other useful features.

Customers can download the software from our website or in the Simplicity Studio installation package.
Here’s an example of the waveform display of the Long Range Proximity Demo.

X-axis is the sample count and Y-axis is the raw data. Whenever an object approaches the sensor, the sensor’s output will increase.

The raw data of the demo is automatically saved as output.csv file under the installation directory: C:\SiliconLabs\Optical_Sensors\Si115x\executable\launcher
On top of the waveform display, the long range proximity demo also provides an intuitive activity demo that can detect any object within 2m. Once the object is detected, the screen will display “ON” and if there’s no activity for a certain amount of time, the screen will display “OFF”.

- The Long Range Prox/ALS demo also includes an Activity Detection demo.
- When the object is detected by the proximity sensor, it will flash the “Activity Detected” picture and display the computer ON state.
Si115x Control Panel can be used to change the configuration of the sensor and let the user have the capability to play with different settings.

The demo uses a default setting. In order to change settings, the user must stop the demo first and then switch to the Si115x Control Panel.

There’re other useful features available on the control panel: read/save configuration files, view pseudo code...
Silicon Labs also provides example code and API functions for Si1153/33 sensors. Those can be found under the installation directory of the tool.
To help customers develop their embedded projects using Si115x and Si1133 sensors, Silicon Labs provide an example project running on the EFM32PG12 STK. Users can plug in the Si1133/5x Optical Sensor EXP board through the expansion header of the STK and run the demo.

The source code of the project is provided for free. In addition, there’s a nice video showcasing the capability of the example project on Silicon Labs’ official YouTube channel. Make sure you check it out before getting started!
Thank you!

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