ISL29023 ALS Performance Enhancement Using IR Compensation

Overview

Performance of an Ambient Light Sensor (ALS) can be severely affected by presence of invisible Infra Red (IR) radiation in the ambient light. This can lead to error in measured light level depending upon the characteristics of the light source. For example measured light level can differ if the light source is an LED or fluorescent light with practically no IR content as compared to an incandescent lamp or sunlight with a significant IR content.

Further, use of an 'inked-cover-glass' to hide the location of the ALS on a device, may significantly attenuates the visible light and only marginally attenuates the IR light resulting in effectively much higher IR to visible light ratio, further increasing error contribution from the IR content.

The ISL29023 permits measurement of ambient light level and measurement of incident infrared via an IR channel. The measured IR content thus can be used to (mathematically) minimize error in the measured light level in the software driver. In essence this compensation results in improved variation in the measured stability of the output lux with different light sources.

IR Compensation Model

In the software driver, the light level (LUX) indicated by the ISL29023 is computed by the linear combination of the visible ALS data and the invisible IR data as:

$$LUX = \ (\propto * k * (ALSData) + \ \beta * \ (IRData))/2^{16}$$

Where $\propto$ and β are coefficients which depend on system design. Constant $\propto$ depends on the visible spectra attenuation properties of the ink & cover glass combination and constant β depends to some extent on the ink/glass type as well as on the invisible IR spectral content of the light source.

ISL29023 provides four different full-scale ranges for ALSData and one range for IRData. Therefore the ALSdata and IRData must be normalized before addition. Constant 'k' provides for the range normalization. 'k' is either 1000, 4000, 16000 or 64000. The IR data is always taken on the 64000 lux range whle ALS data may be taken on any of the four supported ranges.

For a design configuration, constants $\propto$ and β are determined as a part of a calibration procedure during a 'pilot' run. Once determined, the coefficients may be used for the production, i.e. per unit calibration is not required.

Determination of constants $\propto$ and β requires a minimum of two light sources, one without IR content such as a fluorescent or a white LED, other a halogen or an incandescent lamp with high IR content. For fluorescent or LED lighting a color temperature of ~4100 °K is recommended. For halogen or incandescent light source a color temperature of ~3000 °K is recommended.

The light source(s) should be capable of producing ~800 lux ambient light level, preferably be collimated and must illuminate the device uniformly. The light source should be placed directly over the device under test. Light incident at a 'steep' angle may result in improper calibration. Also note that a fluorescent light may take 15 to 30 minutes of warm-up (time) to produce stable illumination.

An external light level meter (Lux Meter) is required to accurately indicate light level (lux) incident on the system.

Constants $\propto$ and β are usually referred as calibration coefficients and need to be stored in a non-volatile memory area of the system for access by the ISL29023 software driver.

Calibration Procedure

The process of calculating $\propto$ and β requires use of a low IR content and a high IR content light source. ALSData and the IRData is read from the ISL29023 registers. ALSData can be measured on any ALS range setting. IRData must be measured on 64000 lux range setting. Measurement sequence is outlined below:

1. Measure Fluorescent/LED light source using Lux Meter (LM1).
2. Set $\propto$ = 1 and β = 0.
3. Measure Fluorescent/LED light source (ALSData) using ISL29023 (VIS1)
4. Set $\propto$ = 0 and β = 1.
5. Measure Fluorescent/LED light source (IRData) using ISL29023 (IR1)
6. Measure Incandescent/Halogen light source using Lux Meter (LM2).
7. Set $\propto$ = 1 and β = 0.
8. Measure Incandescent/Halogen light source (ALSData) using ISL29023 (VIS2).
9. Set $\propto$ = 0 and β = 1.
10. Measure Incandescent/Halogen light source (IRData) using ISL29023 (IR2).

Calculate $\propto$ and β as:

$$\propto = (IR1 * LM2 - IR2 * LM1)/(IR1 * VIS2 - IR2 * VIS1)$$

$$\beta = (LM2 - \propto * VIS2)/IR2$$

Store calibration coefficients $\propto$ and β in non-volatile system memory for access by the ISL29023 software driver.