ISL29020 Low Light Sensitivity Measurement

AN1423
Rev 0.00
Aug 28, 2008

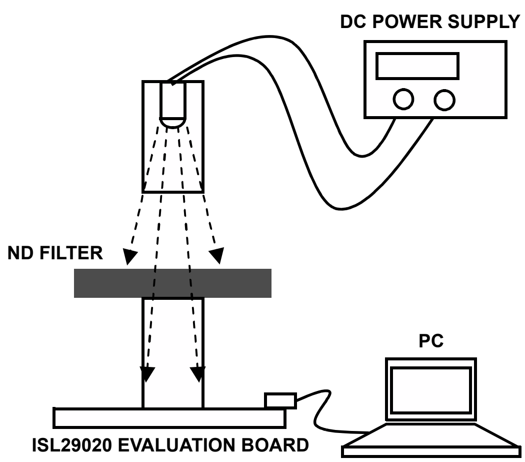

FIGURE 1. LOW LIGHT

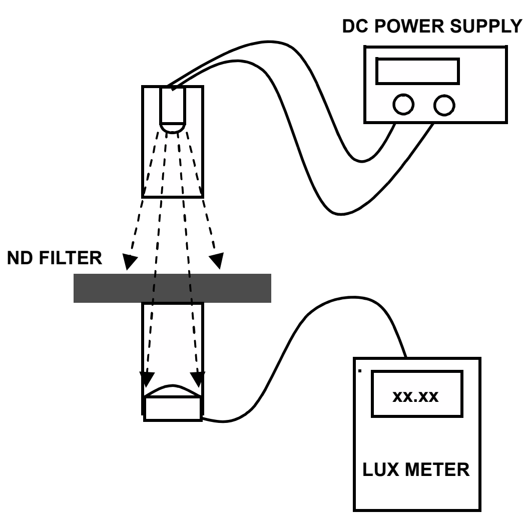

FIGURE 2. ND FILTER CHARACTERIZATION SETUP

The ISL29020 low light measurement is done through 3 steps due to the fact that the sensitivity of lux meter can only measures down to 0.01 lux. The first step is to characterize the neutral density (ND) filter attenuation factor (Figure 2). The second step is to find a light source that is able to create a light intensity from 0.001 lux up to several lux. The third step is to measure the ISL29020 low light sensitivity.

In order to generate a stable low-lux light source, the light source is driven with the proper DC current to ensure the light source operates both stably and with correct spectrum. However, at such a driving current, the output light intensity from the light source is in a range from a couple tenth lux to several hundreds lux. It is too high for low light measurement. In order to generate the low light condition (as low as 0.001 lux), a high power ND filter is used to attenuate light intensity. Its attenuation factor needs to be accurately characterized for correct low light measurement. To characterize the ND filter attenuation factor, several different driving currents from low current to high current are applied to the light source and its corresponding lux readings are measured without the ND filter in the setup. The reason for applying many different driving currents is to ensure the attenuation factor of the ND filter remains the same over frequency. The output spectrum of a light source is usually different with respect to different driving current, especially for incandescent light bulb. Next, apply the same driving currents to the light source and measure its corresponding lux (by the same lux meter) with the ND filter inserted in the setup. In order to get accurate lux meter readings, the light intensity received by the lux meter with the ND filter in the setup has to be high enough for the lux meter to read, usually several tenth lux. With these data points, the averaged ND filter attenuation factor can be obtained.

Since it is a low light measurement, the light source is placed in a black aluminum tube to prevent light scattering. Scattering light reflected from objects back to the lux meter is considered noise in this measurement and can easily affect measurement results. Also, a black light tube is placed between the ND filter and the lux meter to block any possible unwanted light that can affect the measurement. In order to get a wide range of light intensity from 0.001 lux up to several lux, several ND filters are used and characterized in this measurement.

Once the ND filter attenuation factors are obtained, a range of driving currents needs to be defined in order to create light ranging from 0.001 lux up to several lux. The driving currents are calculated based on the ND filter attenuation factors. A matrix of ND filters and driving currents are defined in order to generate 0.001 lux to several lux without a big gap in between 2 adjacent lux readings.

In the last step, ISL29020 is placed at the same position of the lux meter shown in Figure 1 with the same black light tube. By applying the matrix of ND filters and driving currents to the light source, the ISL29020 output count is taken according to each lighting condition. After the measurement is done, the ISl29020 low-light count readings and input light intensity (after the ND filter) can be plotted and its low-light sensitivity is obtained.

This measurement was repeated several times in order to find where the ISL29020 light count reaches 1 stably (because 1 count is the lowest output that ISL29020 can measure). In lower lighting conditions, the ISL29020 will always have an output count equal to 1.

The sensitivity of the ISL29020 is determined by the external resistor. In this measurement there are four external resistors used to check for low-light sensitivity. The resistors are 0.5MΩ, 1.0MΩ, 1.5MΩ, and 2.0MΩ. Their corresponding low light sensitivity are plotted in Figure 3. With higher gain settings, the ISL29020 is more sensitive to the input light. The lowest detectable input light is measured (with an external 2MΩ resistor) to be 0.003 lux while its corresponding count equals 1. All curves in Figure 3 are bending down at very low light condition because the incandescent light output spectrum changes with respect to the driving current (or its temperature). Since the ISL29020 is designed to simulate the human eyes response, this nonlinear optical spectral response is expected.

Green LED is also used in this measurement to characterize the ISL29020 low light sensitivity with respect to its peak sensitivity. The green LED used in this measurement outputs spectrum is centered at 543nm, which is very close to the peak sensitivity (~550nm) of both the ISL29020 and human eye. Figure 4 shows the low light sensitivity with respect to external resistor values while using a green LED as the light source.

The same procedure previously mentioned is used to characterize the ND filter attenuation factors at 543nm and to characterize the ISL29020 low light sensitivity. In order not to shift the green LED output optical spectrum and to ensure that the green LED is operating stably, the driving current needs to be higher than the LED threshold current. Once the driving current is above the threshold current, the LED lights up and its minimum output intensity is fixed. In Figure 4, the ISL29020 shows straight sensitivity curves compared to incandescent light bulbs because LEDs don't change output spectrum with respect to driving current.

When using the ISL29020 ambient light sensor for very low-light detection, the light sensor readings may need to be calibrated because most of the light sources change output spectrum with temperature. Also, human eyes have peak spectral sensitivity at a shorter wavelength (~ 450nm) in low light conditions, but a light sensor doesn't. Since the ISL29020 is simulating human eye sensitivity, light sensor readings can be very different than human eye response in the low light condition. Without proper calibration, this difference could affect the ambient light detection result.

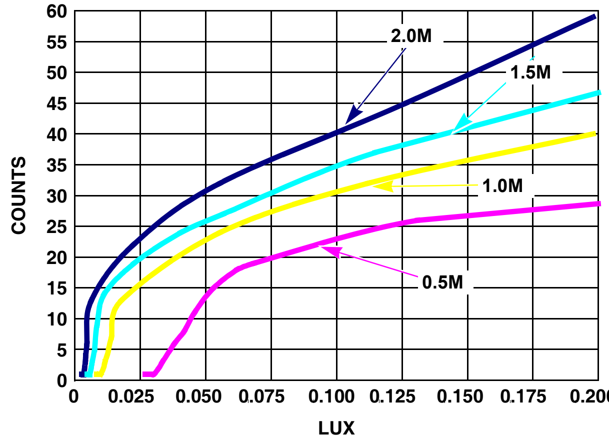

FIGURE 3. ISL29020 INCANDESCENT LIGHT LOW LIGHT

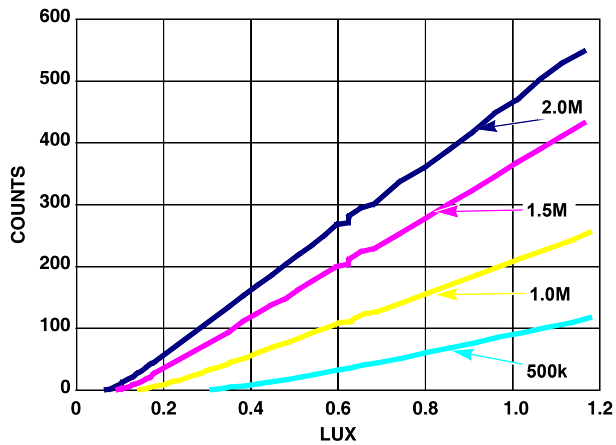

FIGURE 4. ISL29020 543nm LOW LIGHT SENSITIVITY vs EXTERNAL RESISTOR

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(Rev.4.0-1 November 2017)

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