# Designing Automatic Gain Control (AGC) With VEML6031X00

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## INTRODUCTION

The VEML6031X00 is an automotive-qualified ambient light sensor based on the AEC-Q100 standard. The sensor is designed with a robust package and the versatile settings required for automotive applications. These versatile settings allow the creation of an algorithm so that the sensor automatically adapts and sets the optimized settings for the given light condition, allowing the sensor to use an optimal resolution regardless of the end application. This paper highlights the importance, challenges, and advantages of such an algorithm, and presents a ready use solution.

## CHALLENGES WHEN DESIGNING WITH AN AMBIENT LIGHT SENSOR

In many applications, especially in automotive, there are two typical challenges that can be expected in the end application.

**Firstly, different glass cover conditions can be expected, ranging from clear to dark.** There is a trend towards hyper-displays in a vehicle's infotainment system, where a black panel is typically used. On the other hand, there are also applications where clear glass is used, such as the rain light tunnel sensor and the rear-view mirror dimming sensor. The sensor settings must be adapted to the glass transmittance in both cases to still allow for a high signal dynamic.

**Secondly, a wide range of lighting conditions can be expected, ranging from 0 klx to 228 klx.** For example, an abrupt light intensity change can happen when a vehicle exits a tunnel that needs to be reacted to. Besides that, the rear-view mirror must be dimmed when there is an abrupt presence of hyper-bright light glare. Therefore, the sensor must be able to adapt the settings according to this extreme change in light conditions.

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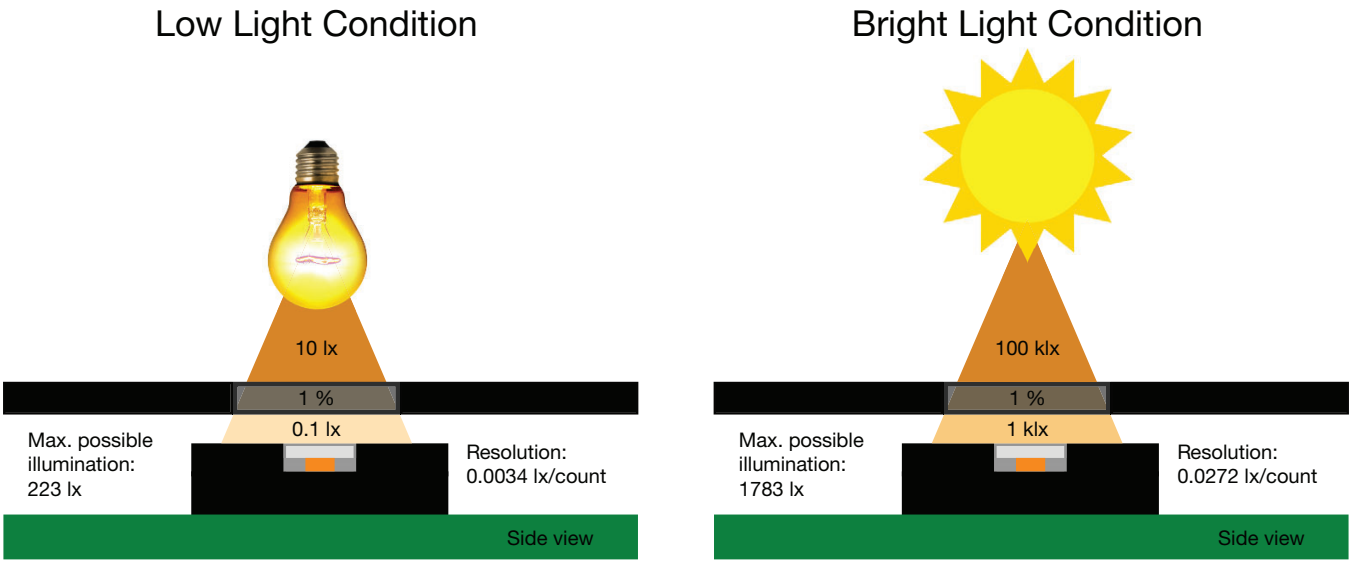
## SOLUTIONS - AUTOMATIC GAIN CONTROL (AGC)

The sensor's settings should be optimized to be sensitive to the change of light in a wide range of light and different glass cover conditions. **Therefore, a possible approach when designing the VEML6031X00 in the end application is by using an algorithm that implements the automatic gain control (AGC) so that the sensor settings are adaptable to the change of light condition seen by the sensor.** This ensures sensor settings with optimized resolution or sensitivity are selected based on the light condition. As a result, the sensor can output an exact lux result with the best possible resolution.

## AGC USE CASE 1 - DARK GLASS IN THE INFOTAINMENT SYSTEM WITH A LOW LIGHT CONDITION

The vehicle's infotainment system often uses a black panel glass with a typical 1 % transmittance. This stack-up requires high resolution settings to detect small changes in light conditions. **An AGC algorithm solves the challenges above by changing the settings automatically to increase the sensitivity or resolution during the low light condition. Additionally, AGC adjusts the settings automatically to increase the maximum possible illumination detection while not sacrificing the resolution during the bright light condition.**




The main applications that require AGC in low light conditions are:

- Human-machine interfaces (HMI) in the infotainment system
- Heads-up displays (HUD)

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## AGC USE CASE 2 - TWO EXTREME LIGHT CONDITIONS


Extreme changes in light conditions can happen, especially for applications with a sensor underneath a clear glass with 90 % transmittance. For example, low light conditions lesser than or equal to 10 lx can abruptly change to direct sunlight with illuminance up to 100 klx, such as at the end of a tunnel. Besides that, there is a possibility of double sun, where the illuminance of direct sunlight could be doubled. This is due to reflected sunlight rays from many buildings within a city, which increases the maximum possible illuminance up to 200 klx. Therefore, the sensor has to be able to detect both low light (≤ 10 lx) and double sun (200 klx) conditions. **The AGC algorithm can automatically adapt the settings to increase the sensitivity or resolution during the low light condition and abruptly change the settings to increase the maximum possible illumination detection during the double sun condition.**

The main applications that require AGC in two extreme light conditions are:

- Rear-view mirror dimming
- Rain light tunnel (RLT) sensors

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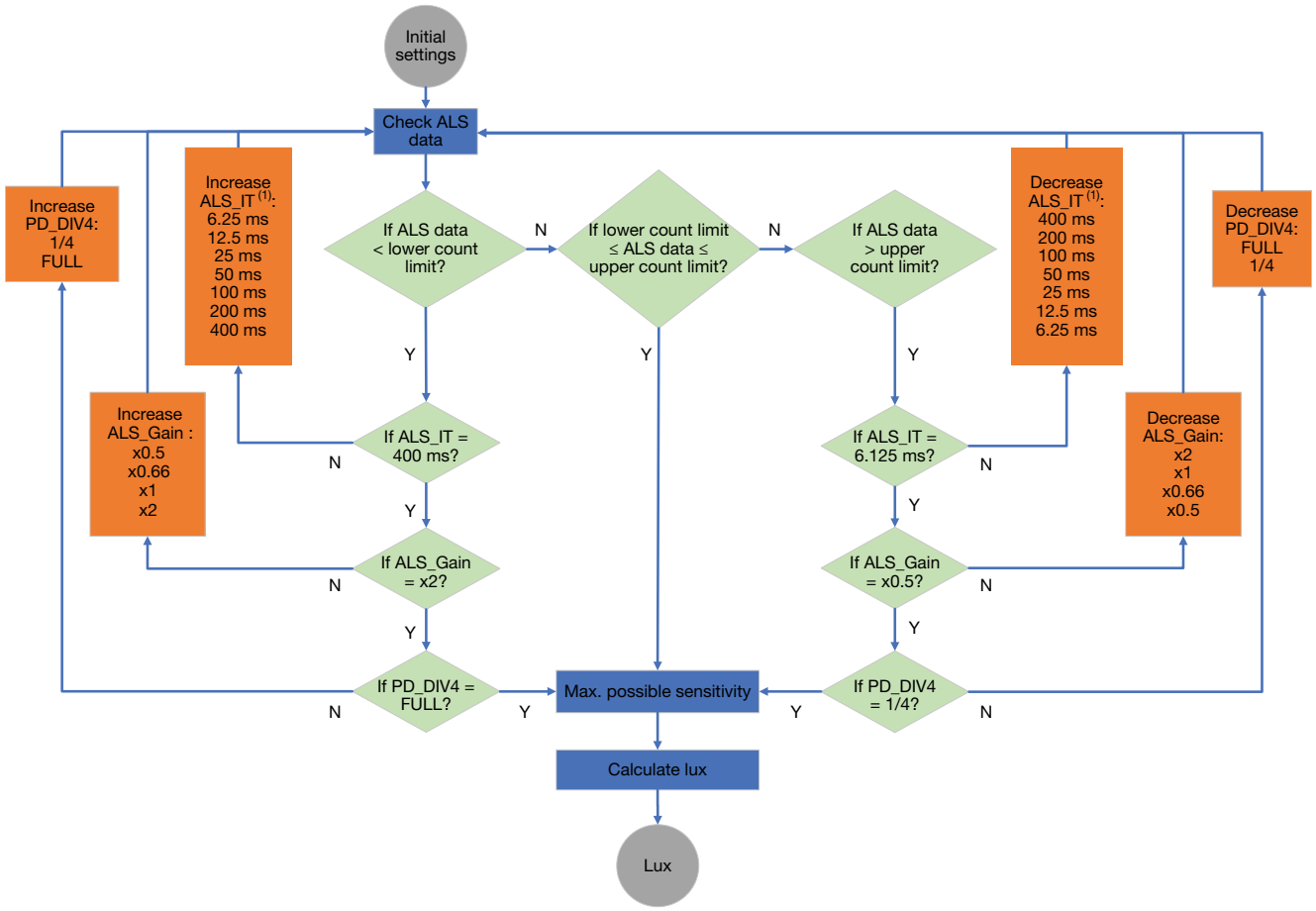
## SUMMARY OF THE AGC SOFTWARE IMPLEMENTATION

The software implementation of the AGC can be summarized by the flow chart below:




**Note**

(1) The integration time of 3.125 ms should not be used in the AGC algorithmn because the data is no longer 16 bit

The sensor's settings will be changed based on the ALS data counts to ensure the sensor has the highest possible sensitivity for the given light condition. The target is to change the settings so that the count range is optimized within the lower and upper limits. A typical range would be between 25 000 counts and 55 000 counts. Using the AGC, the sensor will continuously check the ALS data and change the settings according to the condition. The example code with the AGC algorithm can be downloaded here: www.vishay.com/doc?80318.