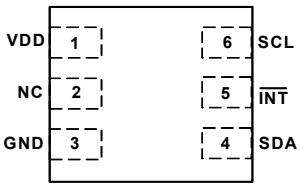
AN1910
Rev 1.00
May 6, 2014

Enhancing RGB Sensitivity and Conversion Time

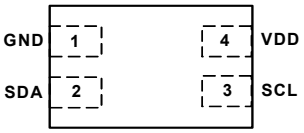
# Introduction

The RGB sensor is a low power, high sensitivity, RED, GREEN, and BLUE color light sensor (RGB) with an $I^2C$ (SMBus compatible) interface. Its state of the-art photodiode array provides an accurate RGB spectral response and excellent light source to light source variation (LS2LS). The sensor is designed to reject IR in light sources allowing the device to operate in environments from sunlight to dark rooms. The integrating ADC rejects 50Hz and 60Hz flicker caused by artificial light sources. Selectable ranges allow the user to optimize sensitivity suitable for the specific application. The sensor has 2 sensitivity ranges such as range 0 from 5.7 mlux to 375 lux and Range 1 from 0.125 lux to 10,000 lux. However, Intersil has options which can expose even higher sensitivity by simple setting in custom registers.

ISL29125
TOP VIEW




ISL29124
TOP VIEW




# Related Literature

ISL29125 datasheet

**TABLE 1. EXPOSE THE CUSTOM REGISTER**

| NAME | REGISTER ADDRESS | | REGISTER BITS | | | | | | | | DEFAULT | ACCESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DEC | HEX | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 | | |
| Device ID | 0 | 0x00 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 7Dh | RO |
| CUSTOM MODE ACCESS | 0 | 0x00 | X | X | X | X | X | X | X | X | N/A | WO |
| REGISTER 0x02 | 2 | 0x02 | See Datasheet for more detail | | | | | | | | 00h | RW |
| STATUS | 8 | 0x08 | TMEN | REVEN | See Datasheet for more detail | | | | | | 04h | RO |
| CUSTOM MODE 1 | 25 | 0x19 | RESERVED | SENS_EN | RESERVED | | | | | | 00h | RW |
| CUSTOM MODE 2 | 26 | 0x1A | RESERVED | | | | | FAST | RESERVED | | 00h | RW |
| CUSTOM MODE 3 | 27 | 0x1B | Gain Setting | | | | | | | | 00h | RW |
| CUSTOM MODE 4 | 28 | 0x1C | RESERVED | | | | | SENSX[1] | SENSX[0] | | 00h | RW |
| CUSTOM MODE 5 | 29 | 0x1D | Gain Setting | | | | | | | | Set by Intersil | RO |

## Register 0x00

Register 0x00 performs two functions. If Reg 0x00 is in READ ONLY mode then it will be a Device ID. When the register is in the WRITE ONLY mode it will open up access to CUSTOM MODE registers.

To access into a CUSTOM MODE, write 89h then C9h into Register 0x00.

To reset all Registers to default and/or all state machine by writing 46h into Reg 0x00.

TABLE 2. DEVICE ID/ CUSTOM ACCESS

| NAME | REGISTER ADDRESS | | REGISTER BITS | REGISTER BITS | | | | | | | DEFAULT | ACCESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DEC | HEX | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 | | |
| Device ID | 0 | 0x00 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 7Dh | RO |
| CUSTOM MODE ACCESS | 0 | 0x00 | X | X | X | X | X | X | X | X | N/A | WO |

## Register 0x02

See datasheet for more detail on how to set IR compensation. Write 00h to Reg 0x02 then Range 0 = 250 lux and range 1 = 6750 lux. Write BFh to Reg 0x02 then Range 0 = 375 lux and Range 1 = 10,000 lux.

## Register 0x08

TABLE 3. STATUS REGISTER (REG0x08)

| NAME | REGISTER ADDRESS | | REGISTER BITS | | | | | | | | DEFAULT | ACCESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DEC | HEX | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 | | |
| STATUS | 8 | 0x08 | TMEN | REVEN | RGBCF[1] | RGBCF[0] | RESERVED | BOUTF | CONVENF | RGBTHF | 0x04 | RO |

## RGBTHF [B0]

This is the status bit of the interrupt. The bit is set to logic high when the interrupt thresholds have been triggered (out of threshold window), and logic low when not yet triggered. Once activated and the interrupt is triggered, the $\overline{INT}$ pin goes low and the interrupt status bit goes high until the status bit is polled through the $I^2C$ read command. Both the $\overline{INT}$ output and the interrupt status bit are automatically cleared at the end of the 8-bit (00h) command register transfer.

TABLE 4. INTERRUPT FLAG

| B0 | OPERATION |
|---|---|
| 0 | Interrupt is cleared or not triggered yet |
| 1 | Interrupt is triggered |

## CONVENF [B1]

This is the status bit of conversion. The bit is set to logic high when the conversion have been completed, and logic low when the conversion is not completed or not converted.

TABLE 5. CONVERSION FLAG

| B1 | OPERATION |
|---|---|
| 0 | Still convert or cleared |
| 1 | Conversion completed |

## BOUTF [B2]

Bit2 on register address 0x08 is a status bit for the brownout condition (BOUT). The default value of this bit is HIGH, BOUT = 1, during the initial power-up. This indicates the device may possibly have gone through a brownout condition. Therefore, the status bit should be reset to LOW, BOUT = 0, by an $I^2C$ write command during the initial configuration of the device. The default register value is 0x04 at power-on.

TABLE 6. BROWNOUT FLAG

| B2 | OPERATION |
|---|---|
| 0 | No Brownout |
| 1 | Power-down or Brownout occurred |

## RGBCF [B5:B4]

B[5:4] are flag bits to display7.

TABLE 7. CONVERSION FLAG

| B5:4 | RGB UNDER CONVERSION |
|---|---|
| 00 | No Operation |
| 01 | GREEN |
| 10 | RED |
| 11 | BLUE |

## REVEN [B6]

REVEN is Bit 6 of the status register. The bit is asserted to logic 1 when writing 89h to reg 0x00. By default this bit is logic low.

TABLE 8.

| B6 | OPERATION |
|---|---|
| 0 | Logic low or not writing 89h to Reg 0x00 |
| 1 | Writing 89h to Reg 0x00 |

## TMEN[B7]

TMEN is Bit 7 of the status bit of Custom Mode condition. The bit is asserted to logic 1 when writing C9h to reg 0x00 and REVEN is at logic 1. By default it is at logic low.

TABLE 9.

| B7 | OPERATION |
|---|---|
| 0 | Logic low or not writing C9h to Reg 0x00 and REVEN = 0 |
| 1 | Writing C9h to reg 0x00 and REVEN = 1 |

B7 and B6 are indicated whether the RGB sensor is in the custom mode or not.

## Register 0x19

SENS_EN is Bit 6 of CUSTOM MODE 1. In order to enable the CUSTOM MODE 4, SENS_EN should be asserted to a logic high. By default, it is a logic low or not enable CUSTOM MODE 4.

TABLE 10.

| B6 | OPERATION |
|---|---|
| 0 | Not Enable |
| 1 | Access to CUSTOM MODE 4 |

TABLE 11. CUSTOM MODE 1 (REG 0x19)

| NAME | REGISTER ADDRESS | | REGISTER BITS | | | | | | | | DEFAULT | ACCESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DEC | HEX | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 | | |
| CUSTOM MODE 1 | 25 | 0x19 | RESERVED | SENS_EN | RESERVED | | | | | | 00h | RW |

## Register 0x1A

TABLE 12. CUSTOM MODE 2 (REG 0x1A)

| NAME | REGISTER ADDRESS | | REGISTER BITS | | | | | | | | DEFAULT | ACCESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DEC | HEX | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 | | |
| CUSTOM MODE 2 | 26 | 0x1A | RESERVED | | | | | FAST | RESERVED | | 00h | RW |

## FAST [2]

Bit 2 in Reg 0x1A is asserted to a logic high then ADC clock frequency is 4x faster than normal mode. By default FAST bit is set to low for normal mode.

TABLE 13.

| B2 | OPERATION |
|---|---|
| 0 | Normal conversion time |
| 1 | 4x faster than normal conversion time |

## Register 0x1B and 0x1D

TABLE 14. CUSTOM MODES 3 AND 5 (REG 0x1B AND REG 0x1D)

| NAME | REGISTER ADDRESS | | REGISTER BITS | | | | | | | | DEFAULT | ACCESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DEC | HEX | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 | | |
| CUSTOM MODE 3 | 27 | 0x1B | GAIN SETTING | | | | | | | | 00h | RW |
| CUSTOM MODE 5 | 29 | 0x1D | GAIN SETTING | | | | | | | | Set by Intersil | RO |

Both CUSTOM MODE 3 and CUSTOM MODE 5 are set by Intersil in order to have a better part-to-part variation performance.

## Register 0x1C

TABLE 15. CUSTOM MODE 4 (REG 0x1C)

| NAME | REGISTER ADDRESS | | REGISTER BITS | | | | | | | | DEFAULT | ACCESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DEC | HEX | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 | | |
| TEST MODE 4 | 28 | 0x1C | RESERVED | | | | | | SENX[1] | SENX[0] | 00h | RW |

## SENX[1:0]

The full-scale range can be extended to be a high sensitivity at Bit[1:0] of reg0x1C. The range determines the ADC resolution (12 bits, and 16 bits). Each selectable range at SENX has a maximum allowable lux value. More information will be discussed in the following section.

TABLE 16.

| B1:0 | HIGH SENSITIVITY RANGES |
|---|---|
| 00 | 1X |
| 01 | 1.5X |
| 10 | 2X |
| 11 | 2.5X |

# Application Information

In order to expose high sensitivity ranges and speed up its conversion time, the sensor needs to be in the custom mode, instructed in the following steps:

1. Write 89h to Reg 0x00
2. Write C9h to Reg 0x00 to enter CUSTOM mode. If user want to check flag status at bit [7] and bit [6] of Reg0x08 should be asserted to logic. If they are asserted logic 1 then the sensor is in the CUSTOM mode.
3. Read reg 0x1D then store that value in a temp variable (software GUI/driver).
4. Write 40h to Reg 0x19 to enable high sensitivity ranges (Reg 0x1C/ CUSTOM MODE 4).
5. Write temp variable at step 2 to reg 0x1B.
6. Table 17 explains multiple higher sensitivity options the sensor can be:
7. Table 18 explains how the sensor can be sped up in the conversion time for 16-bit and 12-bit ADC.
8. To get out of CUSTOM MODE without resetting the device, write any hex values other than 89h and C9 to Reg 0x00. OR
9. To get out of CUSTOM MODE and reset the device, write 46h to Reg 0x00. This will reset all registers to their default states.

TABLE 17. SENSITIVITY RANGES

| Register 0x02 | Write 00h to Register 0x02 | | Write BFh to Register 0x02 | |
|---|---|---|---|---|
| | Range 0 = 250 lux, Range 1 = 6750 lux | | Range 0 = 375 lux, Range 1 = 10,000 lux | |
| Register 0x1C [1:0] | SENX[1:0] | High Sensitivity Range (Lux) | SENX[1:0] | High Sensitivity Range (Lux) |
| RANGE 0 | 00 | 250 | 00 | 375 |
| | 01 | 165 | 01 | 250 |
| | 10 | 125 | 10 | 187.5 |
| | 11 | 100 | 11 | 150 |
| RANGE 1 | 00 | 6750 | 00 | 10,000 |
| | 01 | 6750 | 01 | 10,000 |
| | 10 | 6750 | 10 | 10,000 |
| | 11 | 6750 | 11 | 10,000 |

TABLE 18. SPEED-UP CONVERSION TIME

| Reg0x01 [4] (Bit) | 16-bit ADC (Bit[4] = 0) | | 12-bit ADC (Bit[4] = 1) | |
|---|---|---|---|---|
| Reg0x1A [2] (FAST bit) | FAST= 0 | FAST = 1 | FAST =0 | FAST = 1 |
| Conversion time (ms) | 100 | 25 | 6.25 | 1.56 |
| Number of Clocks | 65536 | | 4096 | |
| ADC clock Period (µs) | 1.52 | 0.38 | 1.52 | 0.38 |

# Block Diagram for High Sensitivity Control Logic

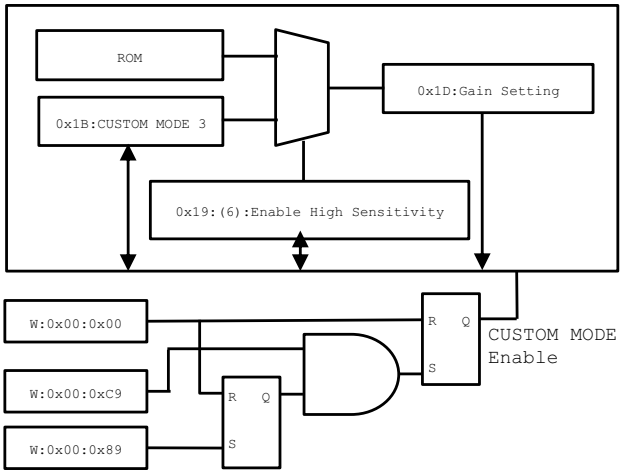



FIGURE 1. HIGH SENSITIVITY CONTROL LOGIC DIAGRAM

| Initialization (1 time only) | |
|---|---|
| Set CUSTOM Mode Enable | W:0x00:0x89<br>W:0x00:0xC9 |
| Read Value | R:0x1D → MEM |
| Enable High Sensitivity | W:0x19:0x40 |
| Write Value | W:0x1B:MEM |
| Exit CUSTOM Mode | W:0x00:0x00 |
| **Run Time** | |
| Set CUSTOM Mode Enable | W:0x00:0x89<br>W:0x00:0xC9 |
| Set High Sensitivity | W:0x1C:0x03*ON |
| Exit CUSTOM Mode | W:0x00:0x00 |

FIGURE 2. INITIALIZATION AND RUNNING TIME

# Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: “Standard” and “High Quality”. The intended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below.

   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user’s manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user’s manuals, application notes, “General Notes for Handling and Using Semiconductor Devices” in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note 1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note 2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

RENESAS

## SALES OFFICES

Renesas Electronics Corporation

http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.


**Renesas Electronics America Inc.**
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

**Renesas Electronics Canada Limited**
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

**Renesas Electronics Europe Limited**
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

**Renesas Electronics Europe GmbH**
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

**Renesas Electronics (China) Co., Ltd.**
Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

**Renesas Electronics (Shanghai) Co., Ltd.**
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

**Renesas Electronics Hong Kong Limited**
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

**Renesas Electronics Taiwan Co., Ltd.**
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

**Renesas Electronics Singapore Pte. Ltd.**
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

**Renesas Electronics Malaysia Sdn.Bhd.**
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

**Renesas Electronics India Pvt. Ltd.**
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700, Fax: +91-80-67208777

**Renesas Electronics Korea Co., Ltd.**
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338




Colophon 7.0