Product Document

ams OSRAM

User guide

TCS3400 EVM

TCS3400 Light-To-Digital Sensor Evaluation Kit

**Version 1.0**

Contents

TCS3400

The TCS3400 device provides color and IR (red, green, blue, clear and IR) light sensing. The color sensing provides for improved accuracy lux and color temperature measurements typically used to adjust the backlight intensity and correct the display color gamut. Additionally it can be used for light source type detection as it reports the IR content of the light.

Initial hardware setup

The software should be installed prior to connecting any hardware to the computer. Follow the instructions found in the Quick Start Guide (QSG). This will load the required driver for the USB interface and also the control software and graphical user interface (GUI).

The hardware consists of the EVM Controller v2.1a or v2.1c, the TCS3400 EVM daughterboard and a USB interface cable.
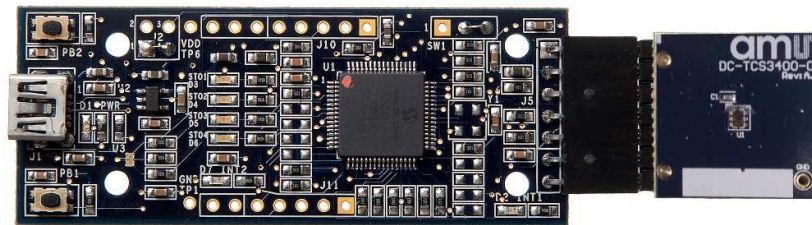
When the USB cable is connected, the green LED should flash indicating that power is being received via the USB interface, and the controller board processor is running. If the green LED does not flash, check the USB cable connections; unplug the USB cable and try again. If the green LED still does not flash, check the PC for USB error messages. See the Resources section at the end of this document for additional assistance.

1 Establishing basic functionality

The software should be started selecting ams->TCS3400 EVM->DigitalLightSensor in the App Programs menu or by double clicking the DigitalLightSensor.exe file from the installation directory. The default installation directory, depending on the operating system you are using, is:

C:\Program Files\ams\TCS3400EVM Windows 32 bit operating systems
C:\Program Files (x86)\ams\TCS3400EVM Windows 64 bit operating systems

A different install path may be selected by the user. When started, two windows will open on the PC. The top window, or Parent Window (PW), is not typically needed and may be placed out of the way. The bottom window, or Child Window (CW), is the main user interface and should be positioned on the screen for easy access.
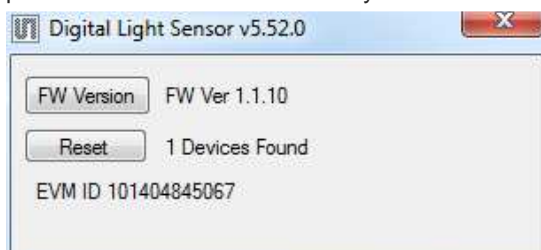
Clicking on the red "X" on the PW will close both windows and terminate the application. Clicking on the red "X" on the CW will close only the CW.

The "Functional" tabs on both the left and right side of the main display (bottom window) will be selected by default. On the right side, numbers should be changing, showing that the ALS functions are operational. By changing the ambient light source or waving your hand over the sensor at <4 inch (100mm) separation you should see the ALS readings change correspondingly.

The balance of this document identifies and describes the controls available on the different tabs of the GUI. In combination with the TCS3400 datasheet, the QSG and application notes available on

the ams website, www.ams.com, there should be enough information to allow evaluation of the TCS3400 device.

2 TCS3400 EVM graphical user interface (GUI)

2.1 Software overview

On initialization the software displays two windows – a smaller "Digital Light Sensor" window and a larger window containing controls pertinent to the device connected.

If "No Devices" appears, verify that the daughterboard is connected to the motherboard properly. If "No_HID" appears, verify the USB cable is connected. A green LED on the motherboard indicates that the USB cable is connected and providing power to the system. The "Reset" button in this window can be pressed, or the software can be restarted, to reinitialize the system.
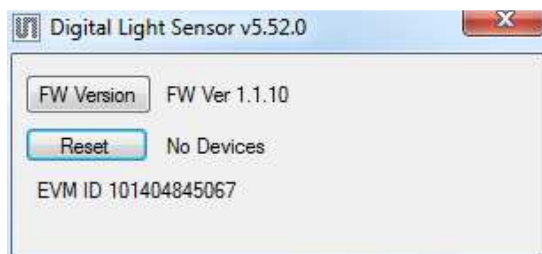
The larger window contains the user interface with control buttons, fields, selection boxes and output values for the device connected. Tabs are used to make control and evaluation of specific device functions easy. For the TCS3400 devices the initial display screen is shown:

This window has inputs organized on the left, and outputs organized on the right. Values for register variables may be set using multiple techniques. The Functional tab is commonly used to quickly evaluate the device with nominal settings. The Input Register tab allows the register settings to be changed, and the Output Register tab allows registers to be viewed. Other tabs provide additional demonstration and test features for evaluation.

By default the "Functional" tabs have the focus. The values shown in this document will not exactly match a user's system but the basic window and controls should be identical. This document will identify the usage and operation of these items in detail.

Always visible along the bottom are the following controls:

- LED Off – ON/OFF/ON toggle for the green motherboard LED. This LED is a good power-on indicator but can introduce errors in the optical tests. It is recommended for accurate measurements to turn the LED off.
- A section containing logging controls and sampling status information:

1. Toggles LED on the motherboard.
2. Text entered here is appended to the default file name and stored in the log file. The file name contains the Part Name and address shown in the large "Digital Light Sensor" window, the child window, an underscore "_" and the text entered. The default if nothing is entered is a period (".").
3. Secondary comment box. Text entered here is also appended to the log file name and stored in the log. The default if nothing is entered is a period (".").

   Sample default file name:

   TCS3400_A-B-C_1-2-3_Log.csv

   ———— From DigitalLightSensor.exe
   ———— From User Input

4. The start button tells the program to start logging. The fields entered in #2 and #3 will be used as field names in the output. If you change the values in #2 or #3, the corresponding field names will change in the output beginning at the time of the change. The default log file name will be based on the values in #2 and #3 at the time the log file is written.
5. Clear –The Clear button will flush the previous optical sample readings and reset the elapsed time indicator (see #7).

6. Log – Creates a comma-separated values file containing the log data. The name will be assigned as explained in #3. This will cause the system to write out any data currently in the log buffer.
7. Count of samples in the log buffer. When that number reaches the limit selected in #9, the system will show a file dialog to save the log in a named file.
8. The elapsed time since the beginning of logging data.
9. The number of log samples collected before log entry is written to the log file.

2.1.1 Input side, "Functional" tab

Simple commonly used controls exist for the ALS functionality.

ALS sensor

Gain - The gain control allows the user access to the AGAIN settings in the Control Register (0x8F). The gain amplifies the ADC signal to increase sensitivity. The gain options include 1x, 4x, 16x and 64x and are selected from the list box when the down arrow is depressed

Time (mS) – This list box has numerous preselected values for the integration time of the ALS channels. If a value other than what is shown in the list box is desired it must be entered manually using the Register tab (documented later). Manually entering a value will NOT work in this location. The actual integration time is shown on the line below.

Auto Gain – When this box is checked, the GUI software will automatically adjust the Gain setting based on the output value of the Clear channel. Checking this box will force the Clear photodiode to be selected and disable manual changes to the Gain control. As the value of the Clear channel gets smaller the software will increase the Gain setting. As the Clear channel gets larger the Gain setting will be decreased.

NOTE: The saturation level of the device is partially dependent on the integration time. Digital saturation occurs when the ADC output registers overflow. Digital saturation is reached at 65,536, thus the full-scale output of the TCS3400 is 65,535 (16-bits). If the integration time is set less than 172ms, however, the dynamic range of the device will be limited to the following:

Integration Time > 172ms Saturation = 65,535

Integration Time < 172ms Saturation = ((Integration Time / 2.7) x 1024) – 1

Wait time

When the software initializes, a default wait period of 2.7mS is inserted between the ALS executions. This duration can be adjusted in 2.7mS steps from 0 to 691mS. Note that, if the WEN control bit is not turned on, the device will not insert the wait period.

The WLONG bit, when enabled, causes the displayed wait time to be multiplied by a factor of 12.

IR/Clear

The first data channel can be switched between the Clear and IR photodiodes. This button will toggle between the two modes. The text on the button reflects the photodiode that will be selected when the button is pushed. The TCS3400 device is initialized to the Clear photodiodes, so this button will initially read "IR" since pushing it will switch the device to the IR photodiode. When IR is selected, the button will read "Clear" since pushing it will switch to the Clear Photodiode.

2.1.2 Input side, "Register" tab

"Control" Sub Tab

The Register tab provides for direct control of the registers of the device.

The Control sub-tab allows enabling and disabling functionality of the part and also controls the wait time multiplier (WTIME).

- Enable Register (0x80) – Provides the ON/OFF control of the device.
- Check boxes are provided to allow selection of specific functions on the device:
  1. AEN – ALS Enable. Writing a one (1) enables the ALS.
  2. WEN – Wait Enable. Writing a one (1) activates the wait timer.
  3. AIEN – ALS Interrupt Enable. Writing a one (1) enables the ALS interrupt.
  4. PON – Power ON takes the sensor out of idle and enters active mode.
- WTIME (0x83) – Wait time in 2.7mS increments, unless the WLONG bit is set, in which case the wait time is multiplied by 12. The number to the right is the computed WTIME. See the ATIME note in the ALS Sub Tab description.

"ALS" Sub Tab

The ALS tab shows the registers associated with ambient light sensing control. Register values in hex are shown on the left, preselected values are available in list boxes in the middle, and actual values are shown on the right.

- ATIME Register (0x81) controls the ALS integration time. The actual time is:

  (256-ATIME) * 2.7 mS

  Note: The column on the right is the computed value for ATIME and is always correct. Sometimes the value shown in the list box will be one of the preselected values but it has not been selected. If this happens the number will not be the same as the computed number for ATIME on the Control Sub-Tab. The computed value is the one that is correct. This can be fixed by selecting a preselected value from the list box or by cycling the register value UP/DOWN or DOWN/UP. This will set the list box value or clear the value from the list box so the screen is correct.

- Control Register (0x8F) – Controls the ALS gain settings.
  1. AGAIN – Adjusts the ALS input gain. Valid values are 1x, 4x, 16x, and 64x.

"ALS Interrupt" Sub Tab

This tab contains the settings for controlling the generation of ALS interrupts to a control processor.

The AILTH (0x85) and AIHTH (0x87) values are 16 bit thresholds for the upper and lower trigger points. Each is set using two 8-bit registers.

Another control APERS (0x8C) establishes the required persistence, 0 through F, of the interrupt signal.

Also on this screen is a button that will automatically generate the register values to provide threshold settings 25% higher and lower than the currently measured amount of ambient light.

- ALS Interrupt Low Threshold (0x84, 0x85) – Low light threshold for ALS interrupt.
    1. AILTL (0x84) – The lower 8 bits of the 16 bit low threshold value.
    2. AILTH (0x85) – The upper 8 bits of the 16 bit low threshold value.
- ALS Interrupt High Threshold (0x86, 0x87) – High light threshold for ALS interrupt.
    1. AIHTL (0x86) – The lower 8 bits of the 16 bit high threshold value.
    2. AIHTH (0x87) – The upper 8 bits of the 16 bit high threshold value.
- PERS (0x8C) – The APERS field (bits 3:0) controls the number of times the ALS interrupt threshold (AILTH, AIHTH) is exceeded before the interrupt is generated. Setting a zero means an interrupt is generated on every ALS reading. The meaning of the other settings is shown in this table. The table is shown in decimal, however the value set in the GUI window is in hex, 0…F.
- The +/-25% button takes the current ambient light reading and automatically computes new values for the AILTH and AIHTH registers, each with a 25% wider latitude. The values calculated by this button are placed into the threshold registers and displayed (in decimal) immediately above and below the button.

Output side, "Register" tab

The value of internal registers is displayed on this tab. Register values cannot be set here. To set registers use the Register tab on the input side of the screen. The CDATA, GDATA and BDATA and PDATA values are the ADC values for Clear and RGB photodiodes. Each is read via one 8-bit register.
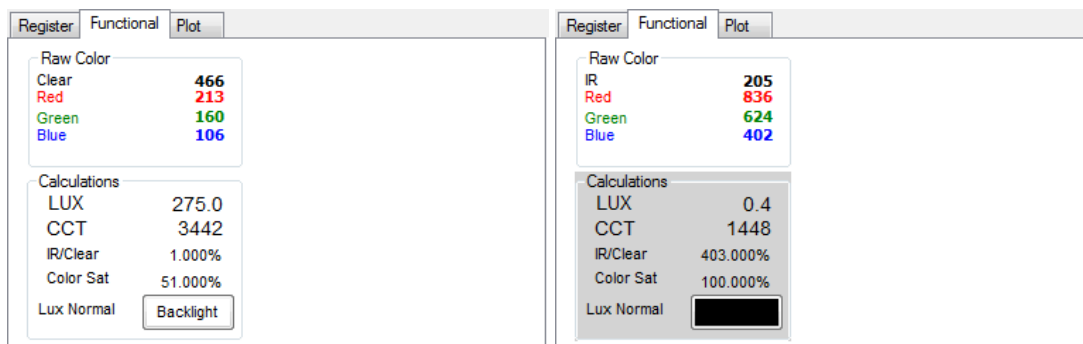

- ID (0x92) – The ID register provides the value for the part number.
- Status (0x93) – Internal status. Interrupts active (2 bits) and ALS valid bits are here. The contents of the register is decoded as follows:
  1. "ALS OK" or "ALS Not OK" will be displayed based on the AVALID bit (bit 0).
- CDATA (0x94, 0x95): This value is controlled by the Clear/IR button on the Functional Input tab.
  1. CDATAL (0x94) – The lower 8 ADC bits of the Clear or IR photodiode.
  2. CDATAH (0x95) – The upper 8 ADC bits of the Clear or IR photodiode.
- RDATA (0x16, 0x17):
  1. RDATAL (0x16) – The lower 8 ADC bits of the Red photodiode.
  2. RDATAH (0x17) – The upper 8 ADC bits of the Red photodiode.
- GDATA (0x18, 0x19):
  1. GDATAL (0x18) – The lower 8 ADC bits of the Green photodiode.
  2. GDATAH (0x19) – The upper 8 ADC bits of the Green photodiode.
- BDATA (0x1A, 0x1B):
  1. BDATAL (0x1A) – The lower 8 ADC bits of the Blue photodiode.
  2. BDATAH (0x1B) – The upper 8 ADC bits of the Blue photodiode.
- Interrupts
  These buttons clear or set an interrupt.
  1. IForce – forces an Interrupt
  2. CIClear – clears an Interrupt on the Clear Channel
 3. AIClear – clears all Interrupts

2.1.3 Output side, "Functional" tab

Register	Functional	Plot

Raw Color

Clear	**466**
Red	**213**
Green	**160**
Blue	**106**

Calculations

LUX	275.0
CCT	3442
IR/Clear	1.000%
Color Sat	51.000%
Lux Normal	Backlight

Register	Functional	Plot

Raw Color

IR	**205**
Red	**836**
Green	**624**
Blue	**402**

Calculations

LUX	0.4
CCT	1448
IR/Clear	403.000%
Color Sat	100.000%
Lux Normal	

The Color photodiodes raw output values are shown. If the IR channel is selected, the top line of the Raw Color section will be replaced with the IR value as shown in the image on the right. While the IR data is selected, the Calculated fields are all invalid (since the first input channel is not the Clear photodiode), so the Calculations section is shown with a gray background to remind the user that the values are incorrect.

2.1.4 Output side, "PLOT" tab

The Clear and RGB photodiodes can be displayed vs. time on the graph.

Register	Functional	Plot

Clear ▼   RBG ▼

1024

0

0   168   336
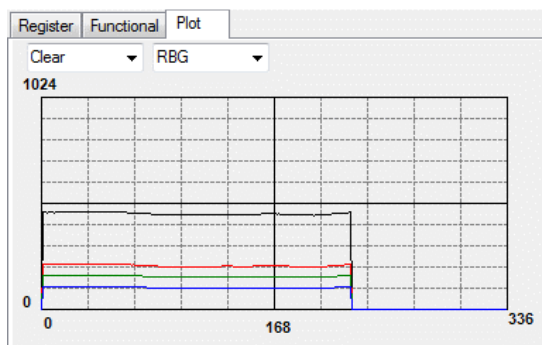
Resources

TCS3400 datasheet

TCS3400 EVM Quick Start Guide (QSG)

Designer's Notebooks

For additional information regarding the TCS3400, please refer to the datasheet. For information regarding the installation of the TCS3400 EVM host application software please refer to the TCS3400 EVM Quick Start Guide.

Designer's Notebooks dealing with various aspects of optical measurement and optical measurement applications are available. All content is available on the ams website www.ams.com.