TCS3530 EVM

User Guide

True color ambient light sensor with flicker detection

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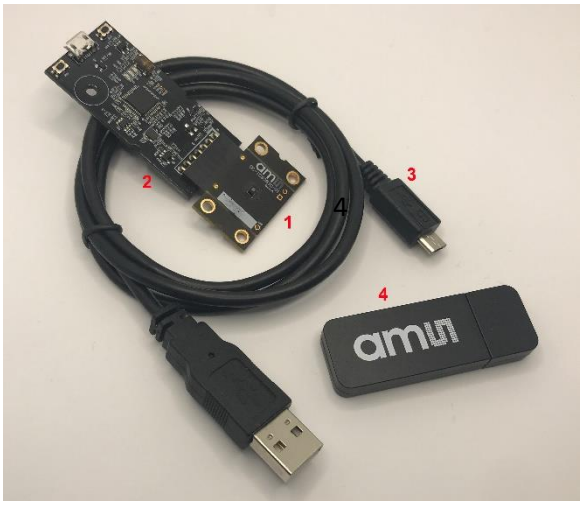
1 Introduction

The TCS3530 evaluation kit comes with everything needed to evaluate the TCS3530. The device features true color XYZ ambient light detection, as well as flicker detection up to 7 kHz, which makes it able to detect flicker from modern LED lighting systems.

1.1 Kit content

Figure 1: Evaluation kit contents



No.	Item	Description
1	TCS3530 EVM Daughter Card	PCB with TCS3530 EVM sensor installed
2	EVM Controller Board	Used to communicate USB to I²C
3	USB Cable (A to Micro-B)	Connects EVM controller to PC
4	Flash Drive	Includes application installer and documents

1.1.1 Ordering information

Ordering code	Description
TCS3530 Eval Kit	Eval Kit for TCS3530

2 Getting started

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

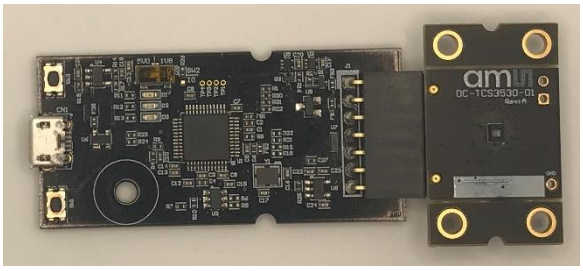
The balance of this document identifies and describes the controls available on the GUI. In combination with the TCS3530 datasheet, the QSG and application notes available on the ams OSRAM website, ams-osram.com, there should be enough information to allow evaluation of the TCS3530 device.

3 Hardware description

The hardware consists of the EVM Controller, the TCS3530 EVM daughter card, and a USB interface cable. The EVM controller board provides power and I²C communication to the daughter card through a seven-pin connector. When the EVM controller is connected to the PC through USB, a green LED on the board lights to indicate the system is getting power. The LED will remain lit until a software application opens the controller. The light will then be switched off so that it will not interfere with any light measurements.

For schematics, layout and BOM information please see the documents included with the install located in the TCS3530 EVM folder (All Programs -> ams-OSRAM -> TCS3530 EVM -> Documents).

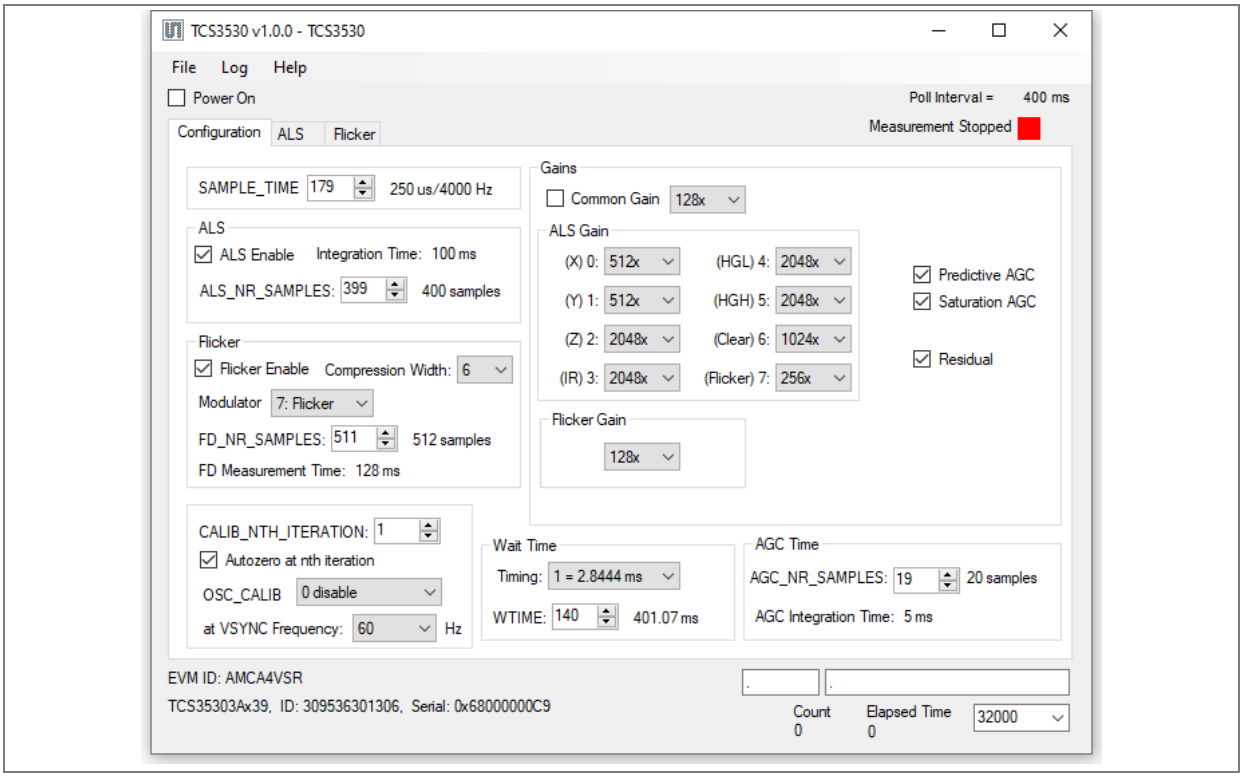
Figure 2: Evaluation kit hardware



4 Software description

The main window (Figure 3) contains the system menus, system level controls, device information and logging status. The configuration tab contains controls to set up both ALS and Flicker detection parameters. The ALS tab displays Color data and has a plot area where raw ALS data can be plotted. The Flicker tab displays information about the Flicker Detection function and has a plot area where raw Flicker data and calculated FFT data can be displayed.

Figure 3: GUI main window



4.1 Connect software to hardware

On startup, the software automatically connects to the hardware. On successful initialization, the software displays a main window, containing controls pertinent to the connected device. If the software detects an error, an error window appears. If “Device not found or is unsupported” appears, verify the correct daughterboard is properly connected to the EVM controller board. If “Cannot connect to EVM board” appears, verify the USB cable is connected. When the EVM controller is connected to the PC through USB, a green LED on the board lights to indicate the system is getting power. The LED will remain lit until an application opens the controller. The light will then be switched off so that it will not interfere with any light measurements.

If the EVM board disconnects from the USB bus while the program is running, it displays an error message and then terminates. Reconnect the EVM board and restart the program.

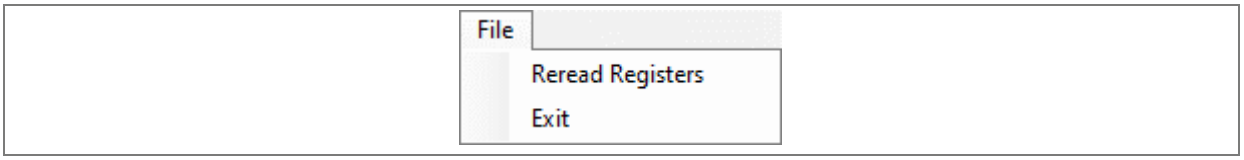
4.2 System menus

At the top of the window there are pull-down menus labeled “File”, “Log”, and “Help”. The **File** menu provides basic application-level control. The **Log** menu controls the logging function, and the **Help** menu provides version and copyright information for the application.

4.2.1 File menu

The File menu contains the following functions:

Figure 4: File menu



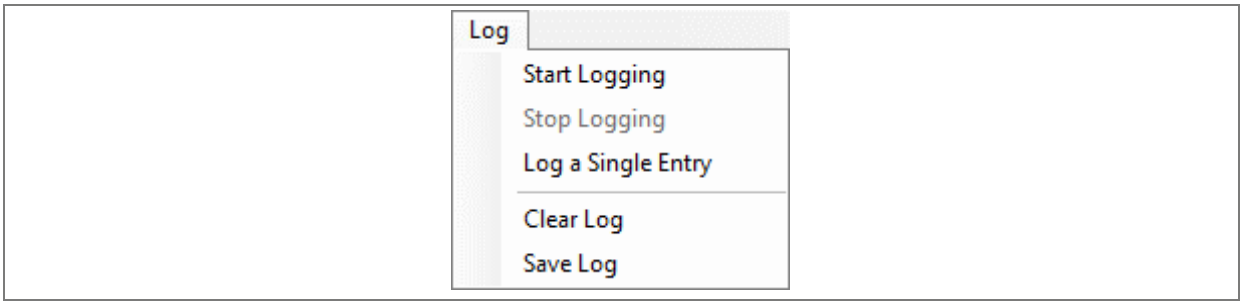
The **Reread Registers** function forces the program to re-read all of the control registers from the device and display them on the screen. This does not read the output data, because the program reads those registers continually while it is running.

Click on the **Exit** command to close the main window and terminate the application. Any unsaved log data is cleared from memory. The application can also be closed by clicking the red “X” in the upper right hand corner.

4.2.2 Log menu

The Log menu controls the logging function and saves the log data to a file. Log data accumulates in memory until discarded or written to a data file.

Figure 5: Log menu



Click **Start Logging** to start the logging function. Each time the program polls the output information from the device, it creates a new log entry showing the raw data values, the values of various control registers, and the values entered by the user into the text fields near the bottom right corner of the window.

Click **Stop Logging** to stop the logging function. Once logging stops, the user may store the data in a file, or continue collecting additional data by clicking **Start Logging** again.

The **Log a Single Entry** command causes logging to start, collect one single entry, and immediately stop again. This function is not available when logging is already running.

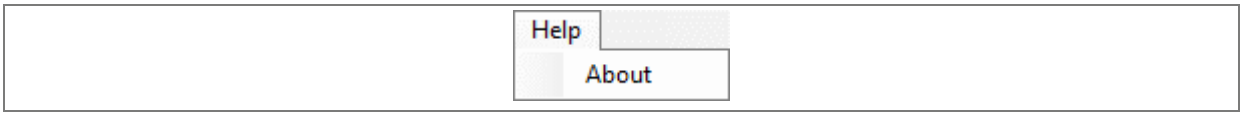
Click **Clear Log** to discard any previously collected data. If there is data in memory, which has not been saved to disk, this function displays a prompt asking to verify it is OK to discard the data. If the log is active when this function executes, the log continues running after the existing data is discarded.

Click **Save Log** to save the collected log data to a csv file. This stops the logging function, if it is active, and displays a file dialog box to specify where to store the logged data. The Log Status and Control Information section below describes the default file name, but you may change the file name if desired.

4.2.3 Help menu

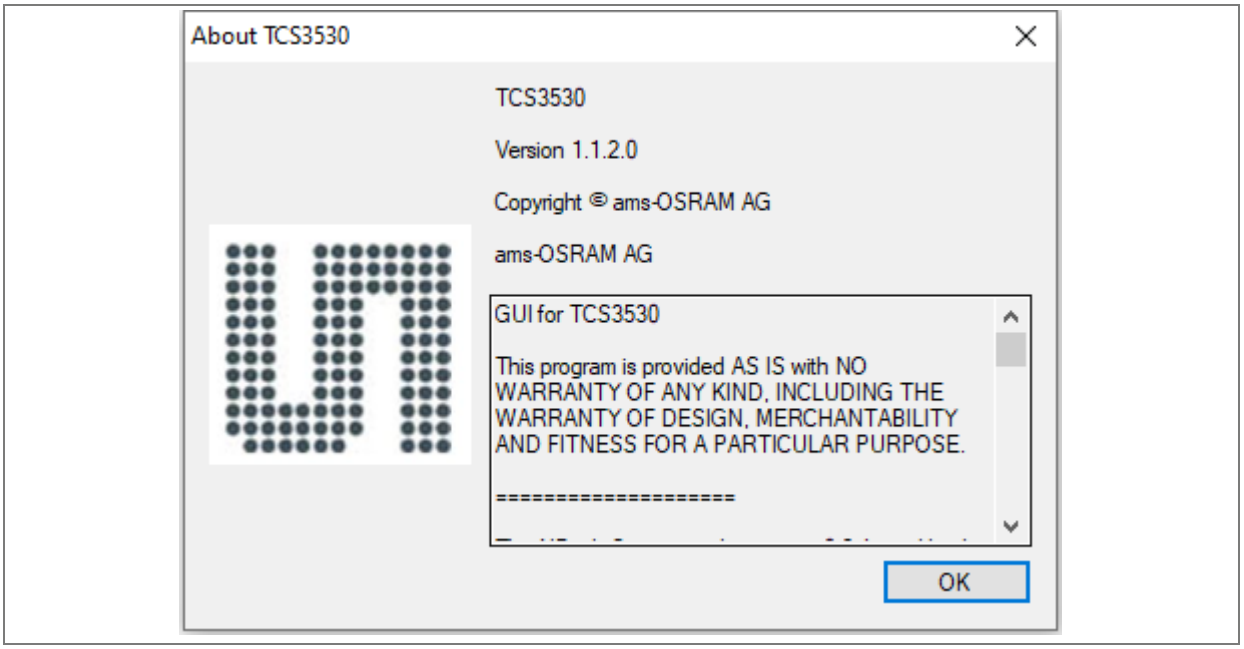
The Help menu contains a single function: About.

Figure 6: Help menu



The **About** function displays a dialog box (Figure 7) showing the version and copyright information for the application and library. Click the **OK** button to close this window and continue.

Figure 7: About window



4.3 System level controls

Immediately below the top menu bar is the **Power On** checkbox. This controls the PON function of the TCS3530. When this box is checked, the oscillator is on and the device is running measurements according the settings in the Configuration tab. At this time, the Configuration tab is disabled to prevent changing settings while the measurement is ongoing. When this box is unchecked, the device does not collect data. The Configuration tab is then enabled and you can change the controls to setup the parameters for next running.

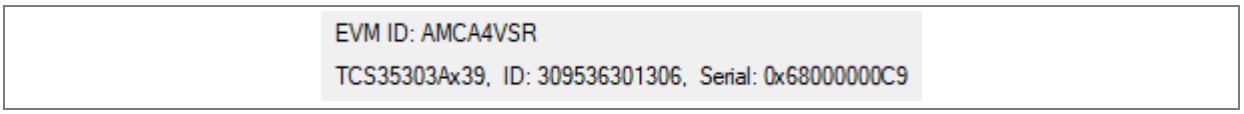
4.4 Auto polling

The application automatically reads the TCS3530 raw ALS and Flicker. The **Poll Interval** at the upper right corner of the form, displays the actual time between screen updates. The time is controlled by the settings of the ALS and Flicker functions and will be affected by the speed and workload of the PC that is running the GUI program.

4.5 Device ID information

The lower left corner of the window displays the unique ID of the EVM Controller board, identifies the device being used and displays the ID and serial number of the TCS3530 device.

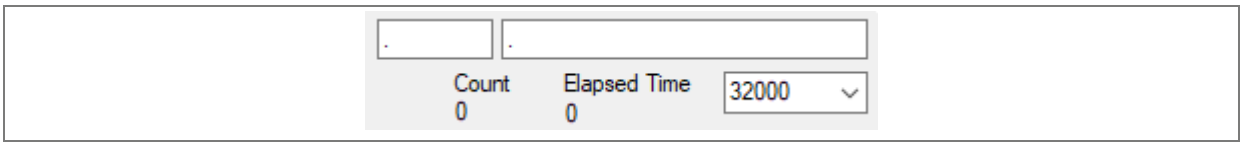
Figure 8: Device ID information



4.6 Log status and control information

The lower right corner of the window contains status information and controls for the logging function:

Figure 9: Logging status



This section contains text boxes that are stored in the log file data and used to build the file name for the log file. If the data in these fields are changed, the new values are stored with any new data logged. The default file name is based on the value in the right-hand textbox, at the time the log file is written. If nothing is entered in the boxes they default to a period (“.”)

Sample default file name:

`TCS3530_1-2-3_Log_HH_MM_SS.csv`

From Application

From User Input

The **Count** value displayed is a count of the number of samples currently in the log buffer.

The **Elapsed Time** value is the total time that has elapsed between the first log sample and the current sample.

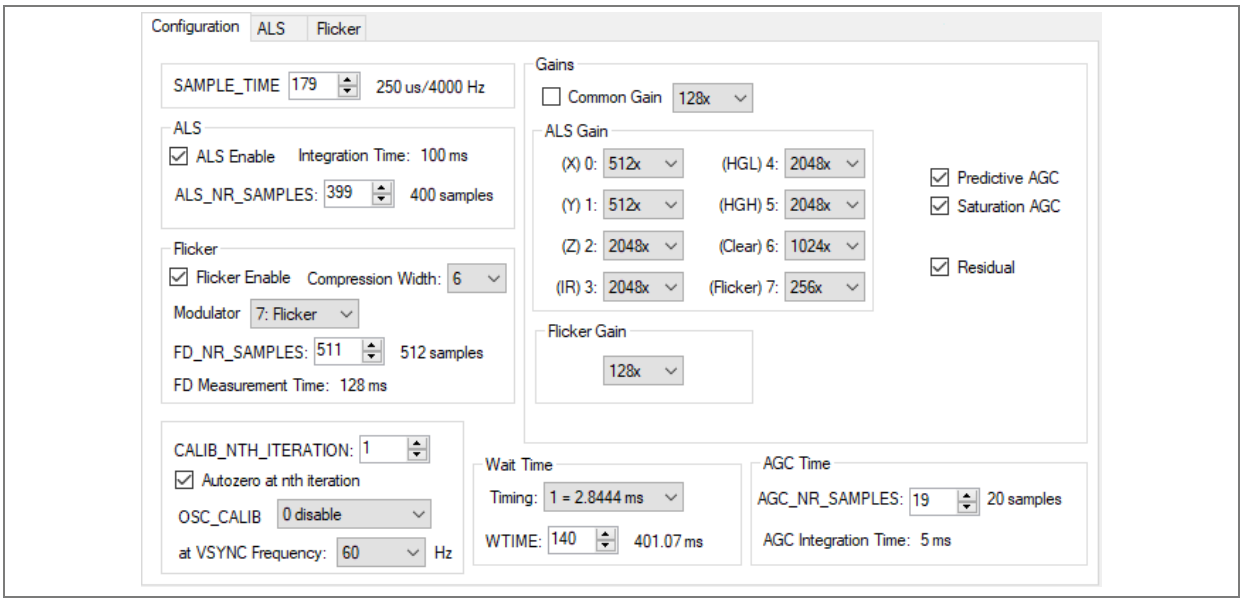
The pulldown control in the lower right corner is used to control the maximum size of the log file. When the number of samples of log data reaches the specified value, the GUI will automatically stop logging and perform a Save Log command, which will display the Save File

dialog box. The stored log data is cleared and can be started again by selecting the Start Logging function.

4.7 "Configuration" tab

The main portion of the screen contains a tab labeled Configuration. The controls on this tab are disabled while data collection is running. To enable this tab, stop data collection by unchecking the Power On checkbox.

Figure 10: Configuration tab



4.7.1 Configuration controls

The Configuration Tab contains controls that affect the operation of the ALS and Flicker functions.

The **SAMPLE_TIME** control adjusts the time for every ALS or Flicker sample. Each sample is (SAMPLE_TIME + 1) × 1.38889 µs. The resulting time and frequency are displayed immediately to the right of this control.

The **ALS** group displays controls for ALS data collection.

- The **ALS Enable** checkbox controls whether ALS data is collected. If this box is checked, the ALS data is collected. If the box is unchecked ALS is not done.
- The number of samples summed together to create each ALS measurement is controlled by the **ALS_NR_SAMPLES** control. The actual number of samples is one more than this control and is shown immediately to the right of the control. After the ALS samples are collected and summed, a single result per channel will be written to the device FIFO.
- The ALS **Integration Time** is calculated using the sample time and number of ALS samples and is displayed in the upper right corner of this box.

The Flicker group displays controls for the Flicker function.

- The **Flicker Enable** checkbox controls whether Flicker Detection is performed. If this box is checked, the Flicker function is performed. If the box is unchecked, Flicker Detection (FD) is not done.
- Because the amount of Flicker data can be quite large, the TCS3530 uses a data compression algorithm to reduce the amount of data that must be transferred. The **Compression Width** control allows changing the basic data width that is used for this compression. When the device is running, the Flicker Tab shows the efficiency of the data compression.
- The **Modulator** pulldown controls which photodiode is used for the Flicker function.
- **FD_NR_SAMPLES** controls the number of samples which are collected for Flicker Detection. Unlike the ALS function, these samples are not added together. Each sample is written to the device FIFO. The actual number of samples is one more than this control and is shown immediately to the right of the control.
- The **FD Measurement Time** is calculated using the sample time and number of FD samples and is displayed at the bottom of this box.

The group in the lower left corner of the Configuration Tab controls functions relating to the autozero and oscillator functions.

- CALIB_NTH_ITERATON selects the repeat rate of the autozero and AGC functions. If this value is set to 0, the step is never performed. If it is set to 255, it is only performed 1 time after startup. If it is set to any other value, n, the step is performed every nth time
- The checkbox labeled **Autozero at nth iteration** controls whether the autozero function and AGC are performed, or just an AGC is performed.

- The **OSC_CALIB** pulldown controls when/if the oscillator is synchronized with the VSYNC signal. The TCS3530 can internally generate a VSYNC signal if the external VSYNC is not received. This control specifies how often the internal oscillator is synchronized. If this control is set to “disable”, the oscillator is never synched to the VSYNC signal. If “after pon” is selected, the oscillator is synchronized only with the first VSYNC after PON is set to 1. If “always on” is selected, the synchronization occurs for every VSYNC signal.
- The **“at VSYNC Frequency”** control specifies the rate at which an internal VSYNC should be generated (if necessary) and the expected frequency of the VSYNC for synchronization. This control can be set to 60 Hz, 90 Hz, or 120 Hz.

The **Gains** group controls functions related to the gain of the ALS and Flicker data collection.

- The **Common Gain** checkbox and pulldown are not actual register fields. They are provided, by the GUI, to provide an easy way to set all of the gain values at one time. If the Common Gain checkbox is checked, the individual gain pulldown controls will be disabled and all of the individual gain values will be set based on the Common Gain pulldown menu. When the checkbox is unchecked, the Common Gain pulldown menu will be disabled and all of the individual gain controls will be enabled,
- The **ALS Gain** group provides controls to individually set the ALS gain for all 8 channels. If the Common Gain checkbox is checked, these controls will be disabled. While the device is running, each gain pulldown will reflect the most recent gain for the channel. If the AGC functions are enabled, these values will change when the gain values are changed by the hardware. Values for the gain controls includes all powers of 2, ranging from ½ through 4096.
- The **Flicker Gain** Control sets the gain value for the collection of Flicker Data. It also can be controlled via the Common Gain controls and will reflect any changes due to AGC. Values for the gain control includes all powers of 2, ranging from ½ through 4096.
- The **Predictive AGC** checkbox controls whether the predictive AGC function is used. To disable AGC, both the Predictive and Saturation AGC checkboxes must be unchecked.
- The **Saturation AGC** checkbox controls whether the saturation AGC function is used. To disable AGC, both the Predictive and Saturation AGC checkboxes must be unchecked.
- The **Residual** checkbox controls whether the residual values from the ADCs will be collected and added to the raw data values for ALS and Flicker. The residual values provide a higher accuracy to the ALS and Flicker values that can be useful in low-light environments. If the residual function is disabled, the corresponding low-order bits of the ALS and Flicker values will be 0.

The **Wait Time** group, at the bottom center of the tab, controls the time between measurement cycles.

- The **Timing** pulldown menu controls whether the wait time is enabled and the time base used to measure the wait, when enabled. The Timing value is used with the WTIME control to determine the total wait time between measurements. This value can be set to “off”, 2.8444 ms, 45.5110ms, 88.8889 µs, 1.4222 ms, or “vsync”. If “off” is selected, no wait time will be added between measurements. If “vsync” is selected, the device will wait one VSYNC per WTIME step.
- **WTIME** specifies the number of the selected Timing steps to wait between measurements. The actual number of steps is one more than the register value (WTIME = 0 means 1 step). If the Timing control is set to “off”, this control is disabled. The total wait time specified by the Timing and WTIME controls is displayed immediately to the right of this control. Note that if Timing is set to “vsync” this displayed time is not accurate. In this case the wait time is simply WTIME + 1 VSYNC signals.

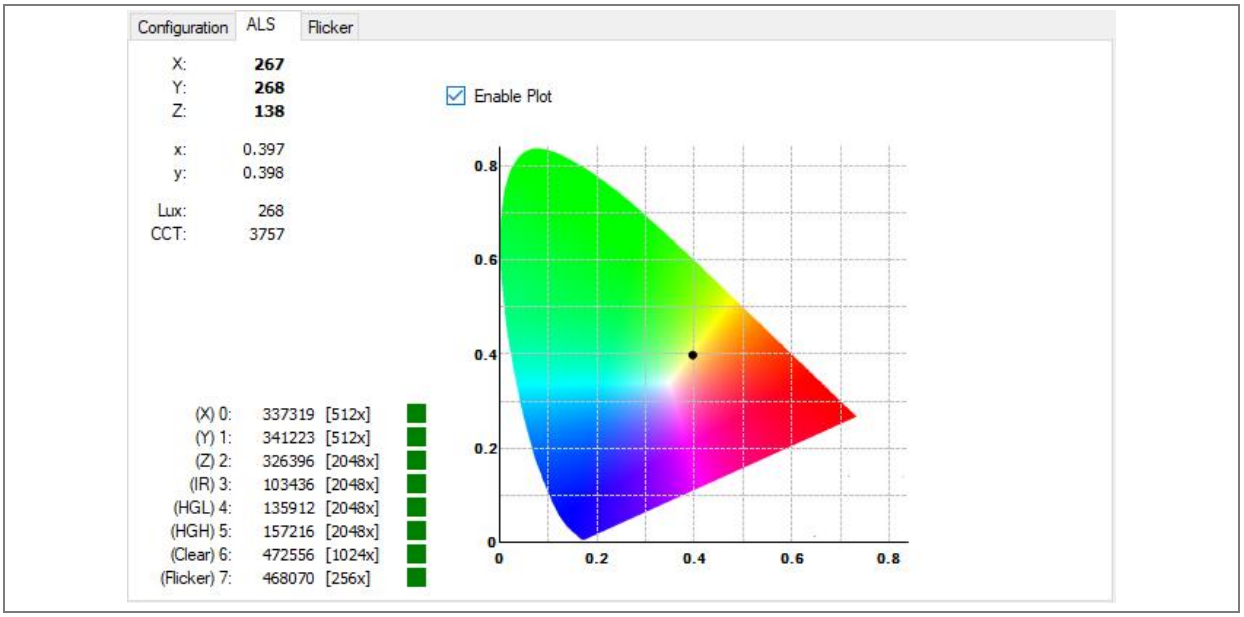
The **AGC Time** group, in the lower right corner of the tab, controls the number of AGC samples.

- The **AGC_NR_SAMPLES** control specifies the number of samples for every AGC measurement. The actual number of samples is one more than AGC_NR_SAMPLES and is displayed immediately to the right of this control.
- The **AGC Integration Time** is calculated using the sample time and number of AGC samples and is displayed at the bottom of this box.

4.8 “ALS” tab

The main portion of the screen contains a tab labeled ALS. It displays ALS measurement data.

Figure 11: ALS tab



4.8.1 Color data

The ALS color data is displayed on the top left side of the tab. The data is displayed using the CIE XYZ color space and the CIE xy color space. The Lux and CCT are also displayed.

4.8.2 Raw ALS status

At the bottom left of the tab there are four columns for each of the eight data channels.

- The first column lists the channel number and describes the associated frequency band. The TCS3530 datasheet lists the specific characteristics of each channel.
- The second column shows the raw count value for the channel. This data is not calibrated, and has not been adjusted based on gain.
- The third column shows the gain value that was used to collect the data for that channel.

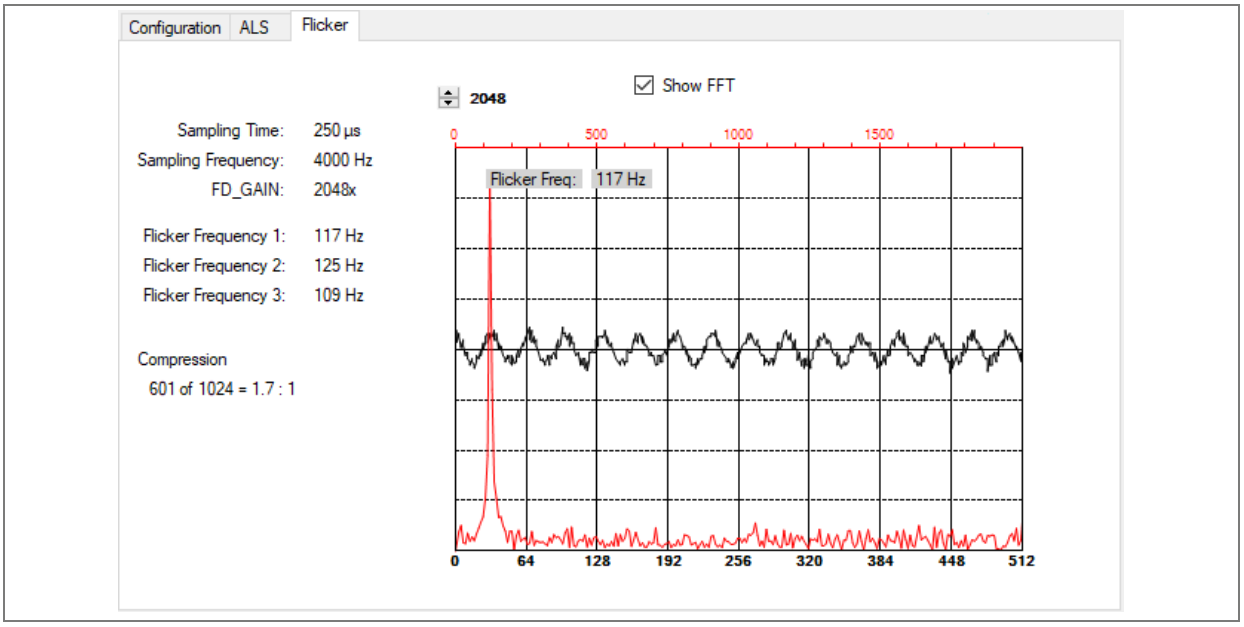
- The fourth column indicates the saturation status for the channel. If the box is green, the channel was not saturated during the data collection. If any saturation was detected in a channel during data collection, the box will be red.

The graph on the ALS Tab is a CIE 1932 color space chromaticity diagram. If the **Enable Plot** box is checked, a single point, at the calculated (x, y) values will be plotted. This point will move as the x and y values change.

4.9 Flicker tab

The main portion of the screen contains a tab labeled Flicker. This tab displays a graph of up to 512 points of the raw Flicker data. As a demonstration, it also calculates an FFT and displays lists the frequency bins with the highest power. It can also display a representation of the calculated FFT data.

Figure 12: Flicker tab



4.9.1 Flicker configuration information

At the top left of the screen, Flicker settings from the Configuration Tab are displayed. These include the total **Sampling Time**, the **Sampling Frequency** and the **FD_GAIN** value that was used to collect the data.

4.9.2 Flicker frequencies

Below the configuration information, the Frequencies of the largest 3 bins from the FFT are displayed. The FFT is always calculated using 512 input points. If FD_NR_SAMPLES is set to more than 512 samples, only the first 512 will be used. If FD_NR_SAMPLES is less than 512 samples, the data will be padded with zeros to create 512 points, but doing so will cause the output of the FFT to be inaccurate.

4.9.3 Flicker data plot

Checking the **Show FFT** checkbox will display the FFT output data. The red labels at the top of the graph are only present when Show FFT is checked, and indicate the frequency of the FFT points. The FFT data does not show any Y-Axis values since, by the nature of the FFT calculations, the scale may be different for every FFT and the relative magnitudes of the data points is what is pertinent for peak detection.

The black labels at the bottom of the graph are always present and simply represent the number of points displayed. The Y-Axis scale of the raw data can be controlled using the small up/down arrows immediately above the left edge of the graph. The range of the axis can be set to any power of two from 16 through 65536, and is displayed immediately to the right of the arrows.

4.9.4 Data compression status

At the bottom of the data on the left side of the tab, the program displays information to show the reduction of FIFO data due to data compression. This information includes the number of bytes that are actually received from the FIFO, the number of bytes that would be required for uncompressed data and a ratio of the uncompressed size to the compressed size.

In the example shown in Figure 12, the FD_NR_SAMPLES is set to 512 samples. Since each sample is 16 bits, this would normally require 1024 bytes. Because of data compression, only 601 bytes were actually placed into the FIFO. This resulted in a 1.7 : 1 compression ratio.

5 Resources

For additional information regarding the TCS3530, please refer to the datasheet. For information regarding the installation of the TCS3530 EVM host application software please refer to the TCS3530 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 OSRAM website ams-osram.com.

Referring documents:

- TCS3530 Datasheet
- TCS3530 EVM Quick Start Guide, QG001020 (QSG)
- TCS3530 EVM User's Guide (this document)
- TCS3530 EVM Schematic Layout

6 Revision information

Definitions

Draft / Preliminary:
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Changes from previous released version to current revision v3-00	Page
Document contents transferred to latest ams OSRAM template	
Document security class is updated to “PUBLIC” in the footer	

- Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
- Correction of typographical errors is not explicitly mentioned.

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