

TCS3720 EVM

User Guide

ALS/Color and proximity sensor for behind OLED applications

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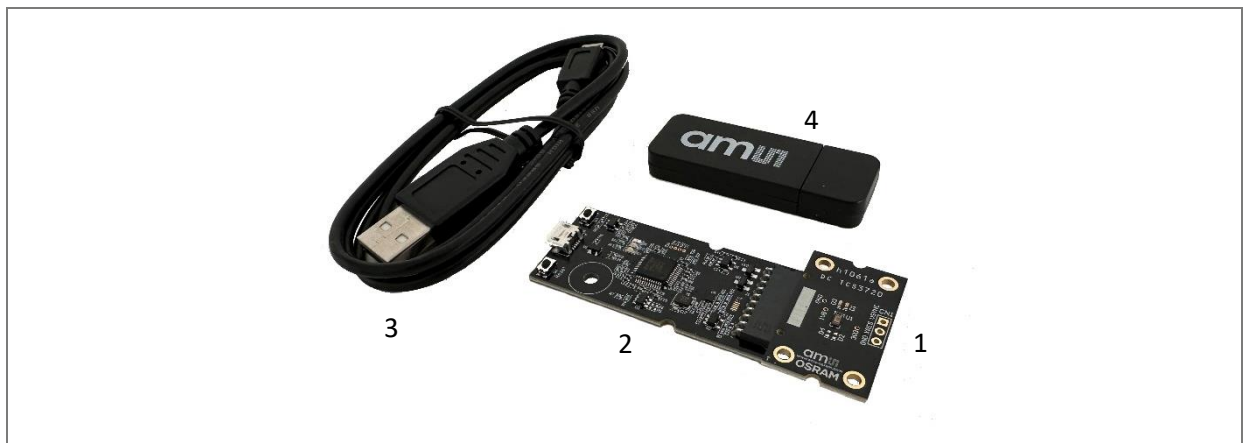
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1 Introduction

The TCS3720 features ambient light, color (RGB) sensing and proximity detection. The device integrates two advanced emitter drivers within a compact 3.34 mm × 1.36 mm × 0.6 mm OLGA package.

1.1 Kit content

Figure 1: Evaluation kit contents



No.	Item	Description
1	TCS3720 daughter card	PCB with TCS3720 sensor installed
2	EVM controller board	Used to communicate USB to I ² C
3	USB cable (A to Micro-B)	Connects EVM controller to PC
4	Flash drive	Include application installer and documents

1.2 Ordering information

Ordering code	Description
TCS3720_EVM_KIT	ALS/Color and proximity sensor for behind OLED applications

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).

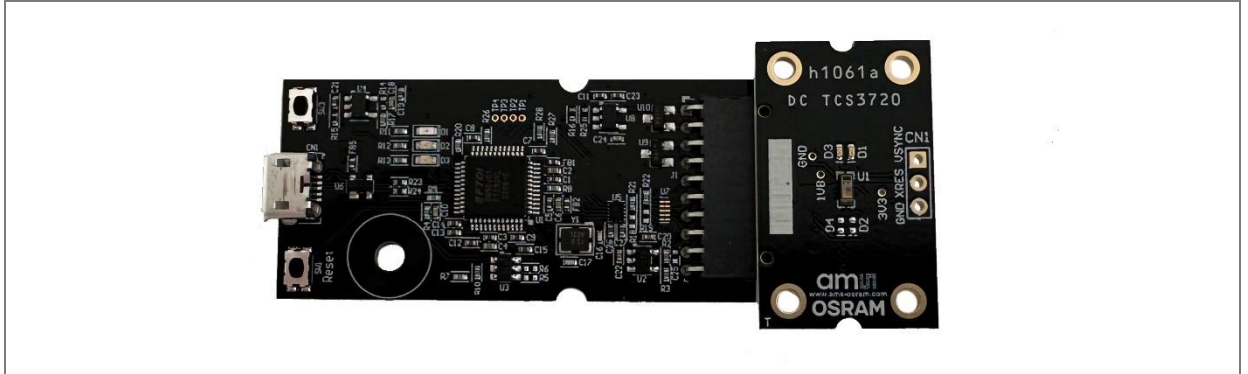
The balance of this document identifies and describes the controls available on the GUI. In combination with the TCS3720 datasheet, the QSG and application notes available on the ams OSRAM website, www.ams-osram.com, there should be enough information to allow evaluation of the TCS3720 device.

3 Hardware description

The hardware consists of the EVM Controller, the TCS3720 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 lights to indicate the system is receiving power. The LED will be turned off when the GUI program is started.

For schematics, layout and BOM information please see the documents located in the TCS3720 EVM folder (All Programs → ams-OSRAM → TCS3720 EVM → Documents).

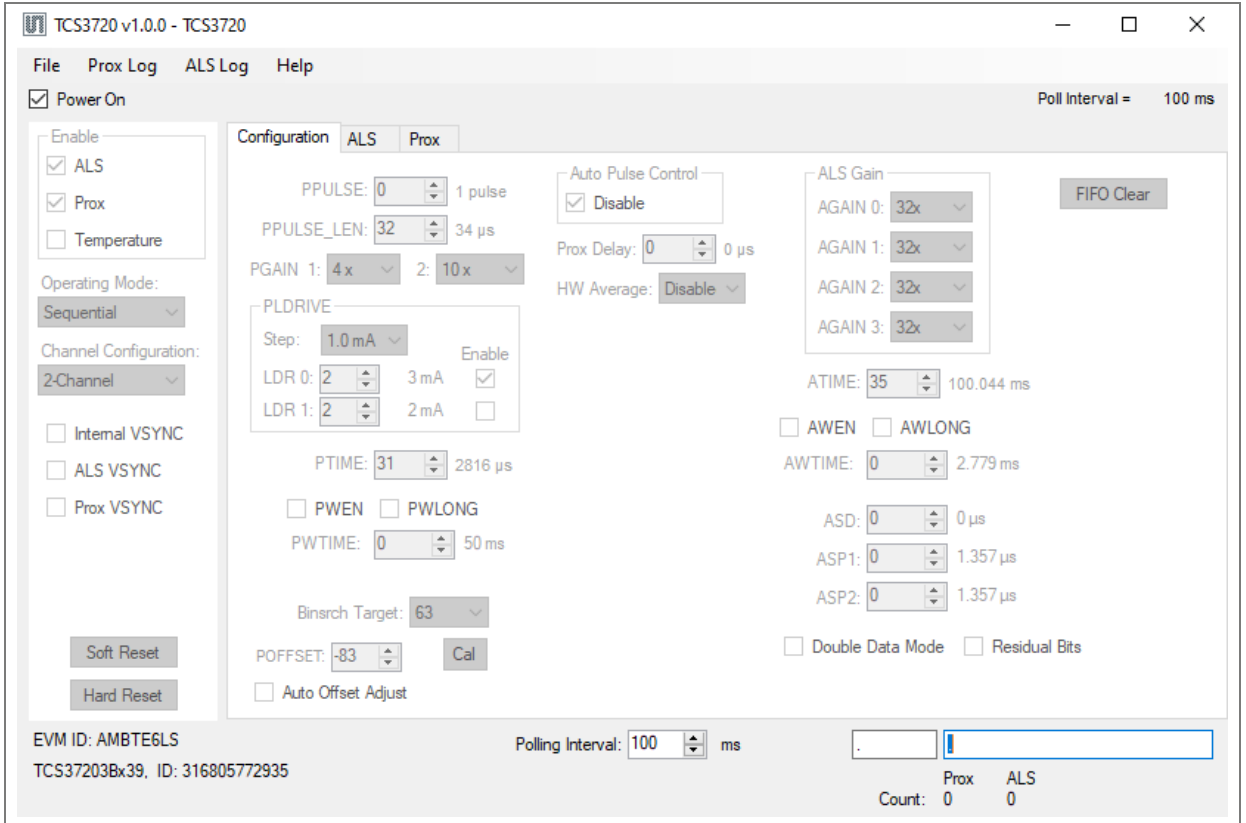
Figure 2: Evaluation kit hardware



4 Software description

The main window (Figure 3) contains the system menus, system level controls, device information and logging status. The box on the left side of the window controls various system-wide parameters and functions. The Configuration tab contains controls to setup both ALS and Proximity detection parameters. Configuration changes are disabled when the device is running (Power On box checked). The ALS tab displays ALS data and contains a plot area in which raw ALS data is drawn. The Prox tab displays proximity data and contains a plot area in which the proximity data is drawn. The application polls the raw proximity data periodically and reads the ALS data from the device FIFO.

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 board is connected to the USB, a green LED lights to indicate the USB cable is connected and providing power to the system. The LED will remain lit until the any software 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.

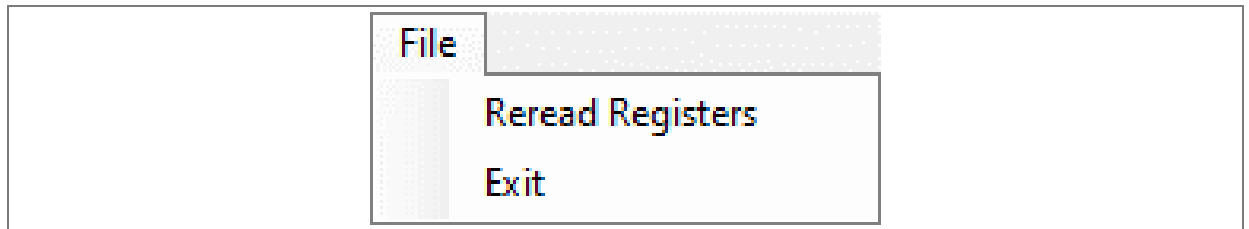
4.2 System menus

At the top of the window there are pull-down menus labeled File, Prox Log, ALS Log, and Help. The **File** menu provides basic application-level control. The **Log** menus control the logging of ALS and Prox data, 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



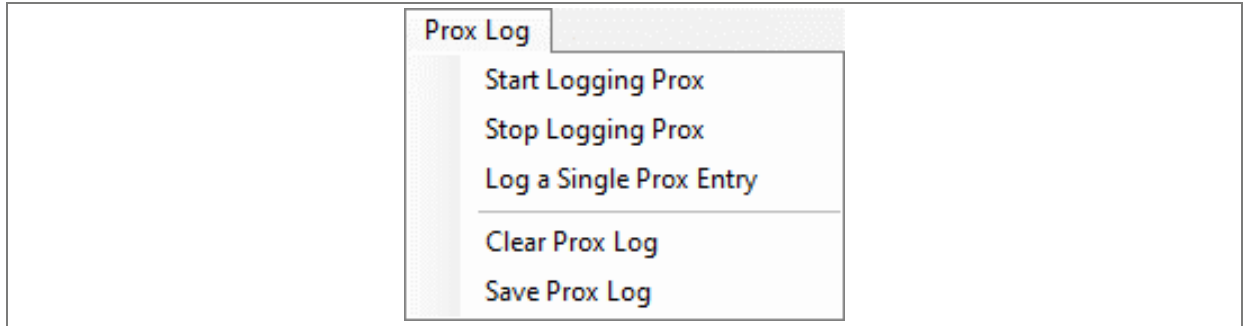
The **Reread Registers** function forces the program to re-read all of the control registers from the device and display them on the screen. This does not read the output data, because the program reads those registers continually while it is running.

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 Prox log menu

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

Figure 5: Prox log menu



Click **Start Logging Prox** 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 Prox** 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 Prox** 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 Prox 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.

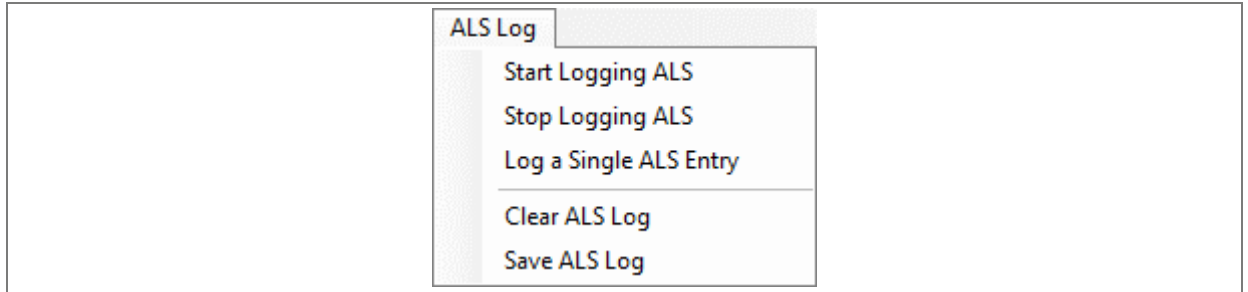
Click **Save Prox Log** to save the collected log data to a csv file. This stops the logging function, if it is active, and displays a file dialog box to specify where to store the logged data. The Log status and control information section below describes the default file name, but you may change the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

4.2.3 ALS log menu

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

Note: ALS data logging is available only when the ASP1/ASP2 feature is disabled (ASP1 is set to 0).

Figure 6: ALS log menu



Click **Start Logging ALS** to start the logging function. Each time the program receives a new set of ALS data 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 ALS** 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 ALS 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 ALS 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 ALS 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.

4.2.4 Help menu

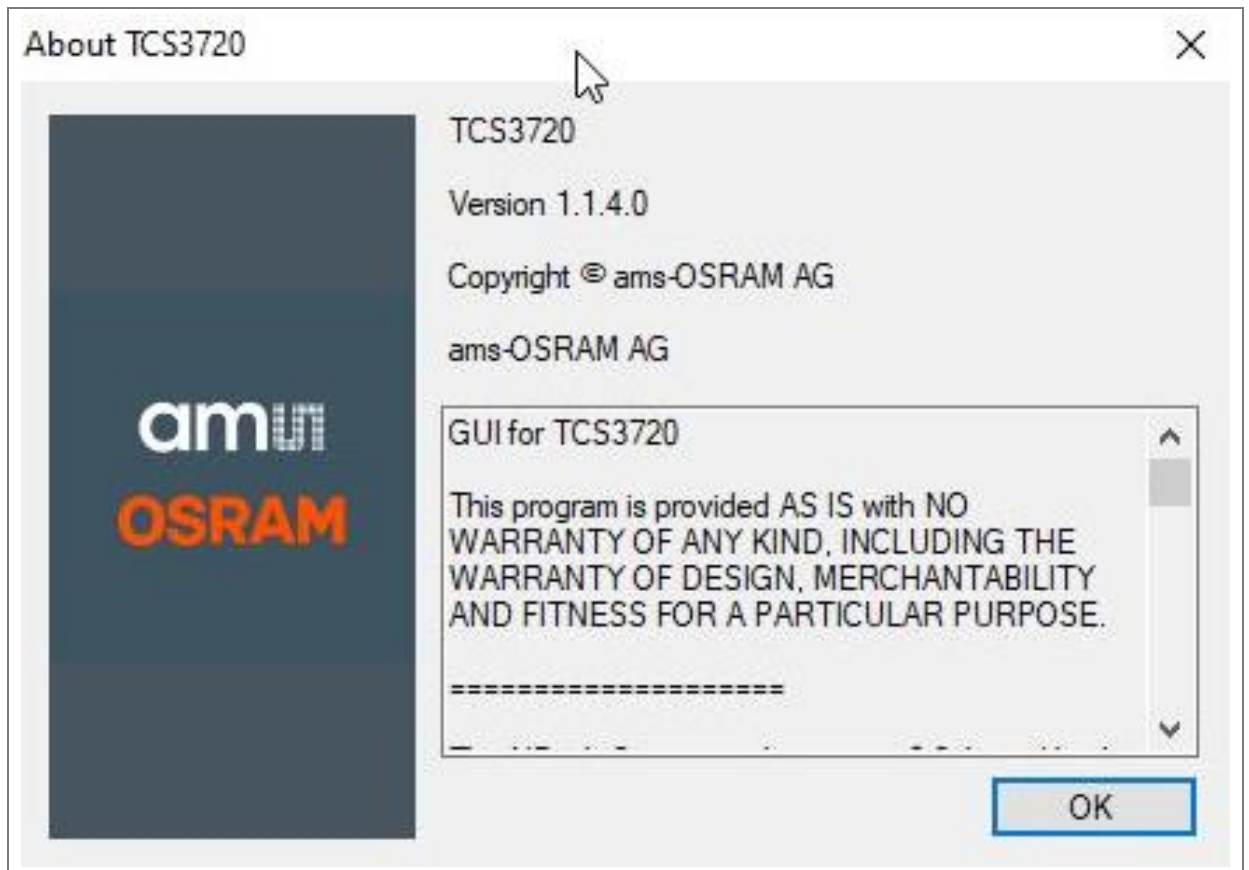
The Help menu contains a single function: About.

Figure 7: Help menu



The **About** function displays a dialog box (Figure 8) showing version and copyright information for the application and library. Click the **OK** button to close this window and continue.

Figure 8: About window



4.3 System level controls

Immediately below the top menu bar there are checkboxes used to control the system level functions of the TCS3720 device.

The **Power On** checkbox controls the PON function of the TCS3720. When this box is checked, the oscillator is on and the device is running measurements according to the settings in the System Level Controls and the Configuration tab. When the device is running, the Configuration tab and System Controls are disabled to prevent changing the settings while the measurement is ongoing. When this box is unchecked, the oscillator is off and the device does

not operate. The Configuration tab and System Controls are then enabled and you can change the controls to setup the parameters for next run.

The **Enable** box contains checkboxes to enable the ALS, Prox, and Temperature functions. Check a box to enable the function and uncheck it to disable the function. Note that, even though it may be enabled independently, the Temperature function does not operate unless the Prox function is also enabled. If Temperature is enabled but Prox is not, a red error indicator will be displayed beside the Temperature checkbox.

The **Operating Mode** pulldown is used to control the operation of the ALS and Prox functions when both are enabled. In Sequential Mode, ALS and Prox functions are performed serially, one after the other, with no overlap. During Concurrent and Parallel Operation, Prox operations may occur during ALS operations. In Concurrent Mode, the ALS integration will be paused any time a Prox operation is flashing the VCSEL light source. In Parallel Mode, ALS integration will not pause when the VCSEL light source flashes.

The **Channel Configuration** pulldown is used to control how the photodiodes are connected to the ADC channels of the device, and how the device data is collected as a result. In 2-Channel Mode, the Clear and Green photodiodes are connected to channel 0 and the Red and Blue photodiodes are connected to channel 1. In Color mode, the Clear, Red, Green, and Blue are connected to channels 0-3 respectively. The device will produce one ALS value for each active channel during each ALS integration cycle (See ATIME, ASP1, and ASP2 programming below).

The **Internal VSYNC** checkbox enables the VSYNC signal to be generated internally when an external VSYNC signal is not received at the expected time.

Setting the **ALS VSYNC** checkbox allows ALS processing to be synchronized with the VSYNC signal.

Setting the **Prox VSYNC** checkbox allows Prox processing to be synchronized with the VSYNC signal.

Clicking on the **Soft Reset** or **Hard Reset** buttons will perform the soft or hard reset operations as described in the datasheet.

4.4 Auto polling

The application automatically polls the TCS3720 raw Prox data and reads the ALS data from the FIFO, depending on the Enable bits. The **Poll Interval** at the right upper corner of the form displays the actual time between reads of the device. At the bottom center of the screen is a control, **Polling Interval**, which specifies the time to wait between each poll of the hardware. This control may be set from 15 ms to 10000 ms (10 seconds).

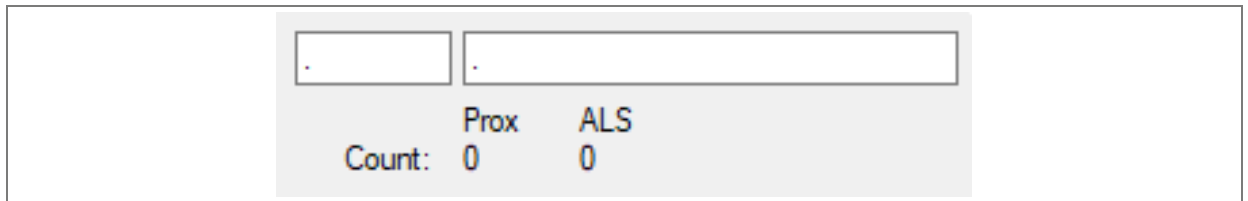
4.5 Device ID information

The lower left corner of the window displays the ID number of the EVM Controller board, identifies the device being used. It also specifies the part number and I2C address of the device and a unique identifier which is stored with any logged data so that you may associate it back to this device.

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:

TCS3720 EVM_1-2-3_Log_HH_MM_SS.csv

■ From Application

■ From User Input

The **Count** values displayed are counts of the number of samples currently in the ALS and Prox log buffers.

4.7 “Configuration” tab

The main portion of the screen contains a tab labeled Configuration.

Figure 10: Configuration tab

The screenshot shows the Configuration tab with two sub-tabs: ALS and Prox. The Prox sub-tab is active. The controls are organized as follows:

- PPULSE:** 0 (1 pulse)
- PPULSE_LEN:** 32 (34 μ s)
- PGAIN 1:** 4x, **PGAIN 2:** 10x
- PLDRIVE:** Step: 1.0 mA, Enable checkbox checked.
- LDR 0:** 2 (3 mA), Enable checkbox checked.
- LDR 1:** 2 (2 mA), Enable checkbox unchecked.
- PTIME:** 31 (2816 μ s)
- PWEN:** unchecked, **PWLONG:** unchecked, **PWTIME:** 0 (50 ms)
- Binsrch Target:** 63
- POFFSET:** -83, Cal button
- Auto Offset Adjust:** unchecked
- Auto Pulse Control:** Disable checkbox checked
- Prox Delay:** 0 (0 μ s)
- HW Average:** Disable dropdown
- ALS Gain:** AGAIN 0: 32x, AGAIN 1: 32x, AGAIN 2: 32x, AGAIN 3: 32x
- FIFO Clear:** button
- ATIME:** 35 (100.044 ms)
- AWEN:** unchecked, **AWLONG:** unchecked, **AWTIME:** 0 (2.779 ms)
- ASD:** 0 (0 μ s), **ASP1:** 0 (1.357 μ s), **ASP2:** 0 (1.357 μ s)
- Double Data Mode:** unchecked, **Residual Bits:** unchecked

4.7.1 Configuration controls

The Configuration Tab contains controls that affect operation of the Prox and ALS functions. The ALS-related tabs are toward the right side of the tab and the Prox-related tabs are on the left.

4.7.1.1 Prox controls

The **PPULSE** control controls the number of pulses that are used for each prox integration. The actual number of pulses is one more than the value of this control and is displayed to the right of the control. The valid settings for this control are from 0 – 63 which corresponds to 1 – 64 pulses.

The **PPULSE_LEN** control sets the length in microseconds of each prox pulse. The length of the actual pulse is two more than the value of this control and is displayed to the right of the control. The valid settings for this control are from 0 – 1023, corresponding to 2 μ s – 1025 μ s.

The **PGAIN1** and **PGAIN2** controls set the value of the Prox Gain stages. The stage 1 gain can be set to 1x, 2x, 4x, 8x, or 16x. The stage 2 gain can be set to 2.5x, 5x, or 10x. The PGAIN2 control includes a setting labeled “Unused”. This value should not be selected and will produce indeterminate results.

The **PLDRIVE** box contains a group of controls which set the drive current for the VCSELs.

- **Step** specifies the step size in milliamps for both of the VCSEL drivers. You may select 0.5 mA, 1.0 mA, 1.5 mA, or 2.0 mA.
- **LDR0** and **LDR1** controls set the drive currents based on the step size. The selected step size is multiplied by (LDRx + 1) to determine the resulting current. The current is displayed to the right of this control. The LDRx controls have a range of 0 – 15, providing a current ranging from 0.5 mA to 32 mA based on the setting of the Step control
- Each of the LDRx controls also has an associated **Enable** checkbox. When this box is checked, the driver is active and will be used during prox measurements. If the box is not checked, the driver will be disabled during prox measurements.

The **PTIME** control sets the rate at which each prox cycle begins when hardware averaging is enabled. The actual time is $(PTIME + 1) \times 88 \mu s$, and is displayed to the right of this control. If PTIME is set to be less than the actual prox time (determined by PPULSE and PPULSE_LEN), the prox time will override this value. The PTIME control can be adjusted from 0 to 255 which provides times ranging from 88 μs to 22.528 ms.

The **PWEN** control enables the insertion of a wait time between normal prox integration cycles.

The **PWTIME** and **PWLONG** controls determine length of the optional prox wait time. If PWLONG is unchecked, the prox wait time is defined as $(PWTIME + 1) \times 2.779 \text{ ms}$. If PWLONG is checked, the wait time is multiplied by 12. PWTIME can be set from 0 to 255, providing a range from 2.779 ms to 711.424 ms. If PWLONG is enabled, this time extends from 33.348 ms to 8.537 sec.

The **Binsrch Target** control selects the target PDATA value that the calibration function will attempt to reach when calibrating the prox response.

The **POFFSET** control sets the offset value which is used to the PDATA value to remove the effects of electrical and system crosstalk. POFFSET is set by the device, during the calibration function, or may be manually set to any value within a range of ± 255 .

Clicking on the **Cal** button will cause the device to perform a calibration. The device will use a binary search method to adjust the POFFSET value so that it produces a PDATA result that is as close as possible to the selected Binsrch Target value.

Checking the **Auto Offset Adjust** checkbox, will cause the device to examine every PDATA value generated. If a PDATA value of 0 is detected, the current POFFSET value will be

reduced by 1. When Auto Offset Adjust is selected, the POFFSET control will be disabled and will be read from the device and displayed each time it polls for the normal Prox data results.

The **Auto Pulse Control** (APC) function can be turned off by checking the **Disable** checkbox. The APC function should normally be disabled in high crosstalk configurations.

The **Prox Delay** control is used along with the Prox VSYNC control to set a time delay between the VSYNC signal and the beginning of the Prox cycle. The delay time is $\text{Prox Delay} \times 1.357 \mu\text{s}$. The value can be set from 0 to 65535 meaning the delay can be up to 88.931 ms.

The **HW Average** control causes the device to average multiple prox integrations for each PDATA output. Using this pull-down menu, you can select to average 2, 4, 8, or 16 values, or disable the hardware averaging function. If enabled, the hardware will use the PTIME value to control how fast the selected number of cycles is collected and will then set PDATA to the average of the collected data.

4.7.1.2 ALS controls

The **ALS GAIN** box contains the controls to set the gain for each of the ALS channels.

AGAIN 0, **AGAIN 1**, **AGAIN 2**, and **AGAIN 3** set the gain values for each of the ALS channels. The gain may be set to any power of two from 1x through 4096x.

The **ATIME** control sets the mail ALS integration time. The actual ALS integration time is $(\text{ATIME} + 1) \times 2.779 \text{ ms}$. If ASP1/ASP2 sampling is not active, each active ALS channel will produce one ALS value per ALS cycle. If ASP1/ASP2 is active, each active channel will produce a value for every alternating ASP1 and ASP2 time within the ATIME time period.

The **AWEN** control enables the insertion of a wait time between normal ALS integration cycles.

The **AWTIME** and **AWLONG** controls determine length of the optional ALS wait time. If AWLONG is unchecked, the ALS wait time is defined as $(\text{AWTIME} + 1) \times 2.779 \text{ ms}$. If AWLONG is checked, the wait time is multiplied by 12. AWTIME can be set from 0 to 255, providing a range from 2.779 ms to 711.424 ms. If AWLONG is enabled, this time extends from 33.348 ms to 8.537 sec.

The **ASD** (ALS Sampling Delay) control is used along with the ALS VSYNC control to set a time delay between the VSYNC signal and the beginning of the ALS cycle. The delay time is $\text{ASD} \times 1.357 \mu\text{s}$. The value can be set from 0 to 65535 meaning the delay can be up to 88.931 ms.

The **ASP1** and **ASP2** settings allow the programmed ATIME period to be broken into multiple alternating ASP1 and ASP2 time periods. If ASP1 is set to 0, ASP2 is disabled and ASP1 will

assume the value of ATIME, meaning only a single ALS sample per channel will be created each ATIME. If ASP1 is non-zero, ASP2 should not be programmed to 0. If only an ASP1 period is required, ASP2 should be programmed to the same value as ASP1. The ASPx controls can be set from 0 to 16383. The ASPx time is calculated as $(ASP_x + 1) \times 1.357 \mu\text{s}$, so the range for each is 1.357 μs to 22.233 ms.

Although the programming of ASP1, ASP2 and ATIME is highly flexible, it is always recommended that ATIME be an integer multiple of $ASP_1 + ASP_2$, that is $ATIME = N \times (ASP_1 + ASP_2)$, where N is a positive integer.

Checking the **Double Data Mode** checkbox causes for each channel to store data into the FIFO as an 8-bit value rather than the normal 16-bit value. In very low-light situations, this allows twice as many samples to be stored in the FIFO, but if the actual data in any channel exceeds 8 bits, this setting will result in the loss of data, and so should be used carefully.

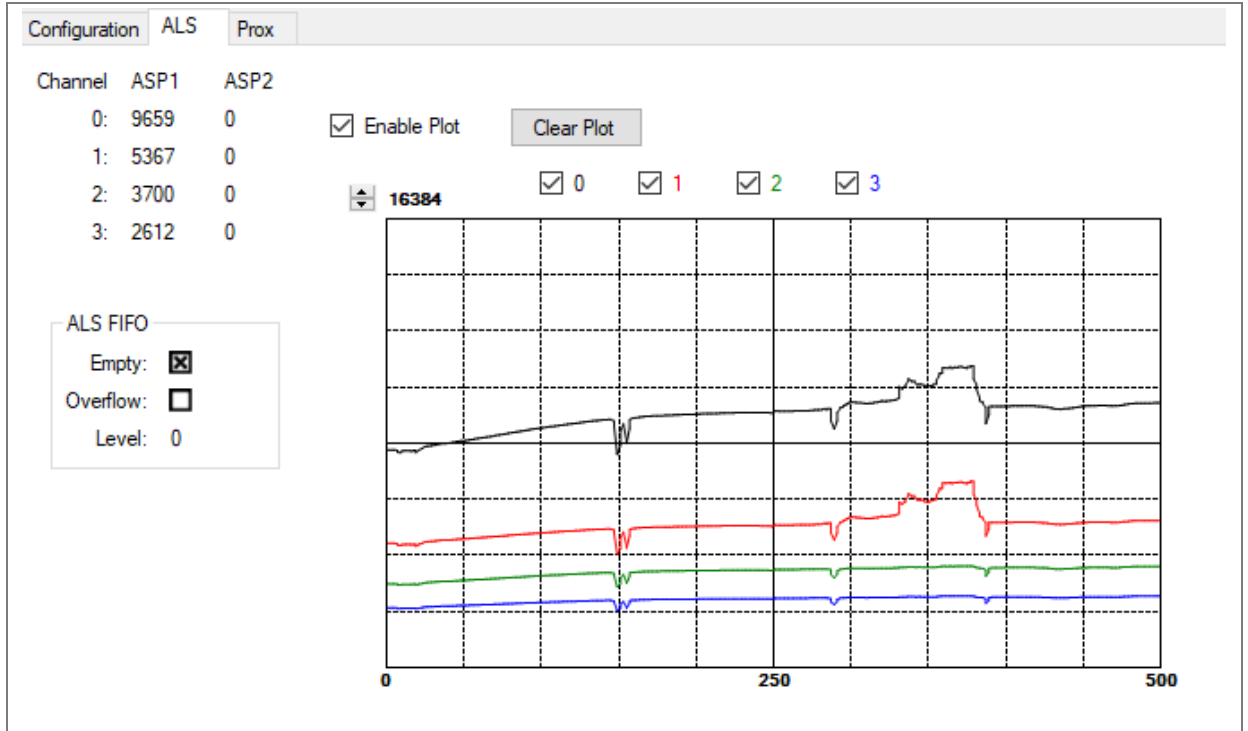
Checking the **Residual Bits** checkbox enables appending additional bits to the ALS data values, to increase their accuracy. See the datasheet for an explanation of the effect that this has on the data format and the interpretation of the ALS channel values.

Clicking on the **FIFO Clear** button will cause any data remaining in the FIFO to be cleared. Under normal operation, the GUI will only start/stop in pre-defined circumstances and use of this button should be unnecessary.

4.8 “ALS” tab

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

Figure 11: ALS tab



4.8.1 ALS output data

The left side of the ALS tab displays the ALS measurement data and a snapshot of the ALS FIFO status. The contents of the ALS data depends on the configuration of the ALS channels and the ASP1 and ASP2 settings.

The ALS data is displayed in four lines, one for each possible active channel. If the device is configured for 2-Channel Mode, then the lines for channels 2 and 3 will be grayed out and will always display 0. If Color Mode is selected, all four lines will be active.

The setting of ASP1 and ASP2 control the display of the data columns. If ASP1/ASP2 operation is not active (ASP1 = 0), all of the data will be displayed in the first column, labeled ASP1, and the ASP2 column will always display 0. If ASP1/ASP2 operation is active (ASP1 > 0) then the data is displayed in both columns.

The ALS data is read from the FIFO until all of the data for the configured ATIME value is read. It is then displayed on the screen. If ASP1/ASP2 operation is not active, there will be a single data point for each. That data will be added to the graph (if enabled) and displayed in the ASP1 and ASP2 columns. If ASP1/ASP2 operation is active, all of the data will be added to the

graph, as appropriate, but *only* the first ASP1 and ASP2 value for each channel will be displayed under the ASP1 and ASP2 columns.

4.8.2 FIFO status

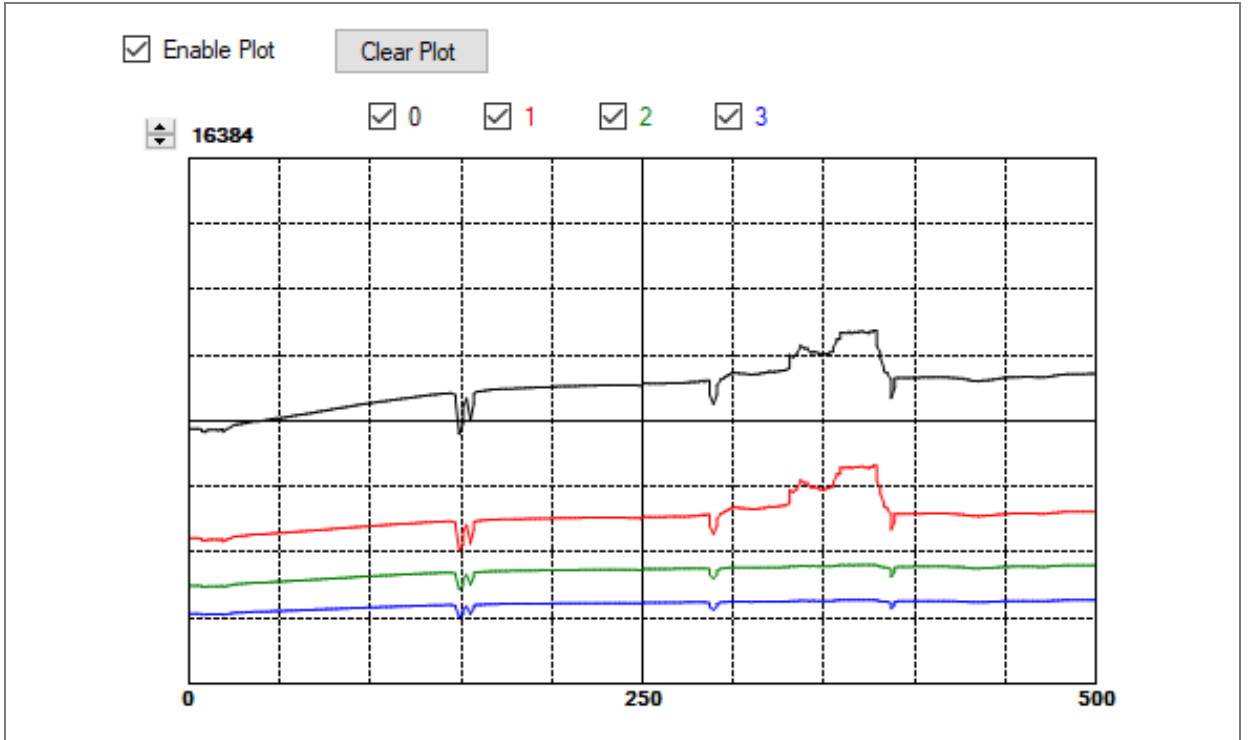
The ALS FIFO box shows a snapshot of the FIFO status each time the program polls the device. The following items are displayed:

- **Empty:** This box will be marked if the FIFO is empty when polled.
- **Overflow:** This box will be marked if an overflow condition has occurred since the last poll.
- **Level:** Shows the number of data sets waiting to be read (Data set size can vary from 2 to 16 bytes, depending on Channel configuration, Double Data Mode, and ASP1/ASP2 settings).

4.8.3 ALS data plot

The remaining portion of the ALS tab is used to display a running plot of the collected ALS values. The last 500 values are collected and plotted on the graph. As additional values are added, the old values will be deleted from the left side of the graph. To start the plotting function, check the **Enable Plot** checkbox and select the **0**, **1**, **2**, and/or **3** checkboxes. If 2-Channel mode is selected only boxes 0 and 1 will be active. The **Clear Plot** button will clear the data from the screen and start a new plot.

Figure 12: ALS data plot



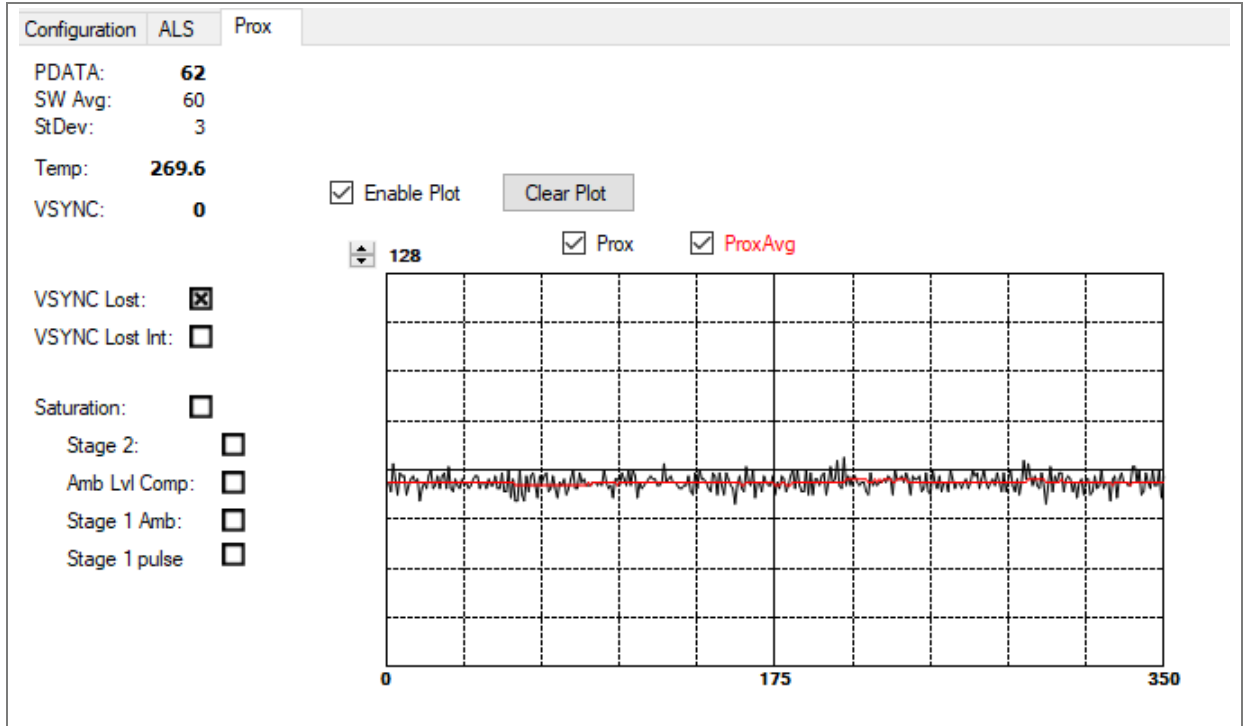
The scale of the Y-axis of the plot can be adjusted by clicking on the small up and down arrows at the top left corner of the plot. The scale can be set to any power of 2 from 64 through 65536.

The data for each channel will be displayed in a different color, but if ASP1/ASP2 operation is active, the lines for the ASP1 and ASP2 data will be the same color.

4.9 “Prox” tab

The main portion of the screen contains a tab labeled Prox. The controls in this tab are divided into two sections, each performing a separate function.

Figure 13: Prox tab



4.9.1 Prox output data

The left side of the Prox Tab displays output and status data. This data is polled from the device at the user-specified interval. The actual polling interval is shown in the upper right-hand corner of the screen.

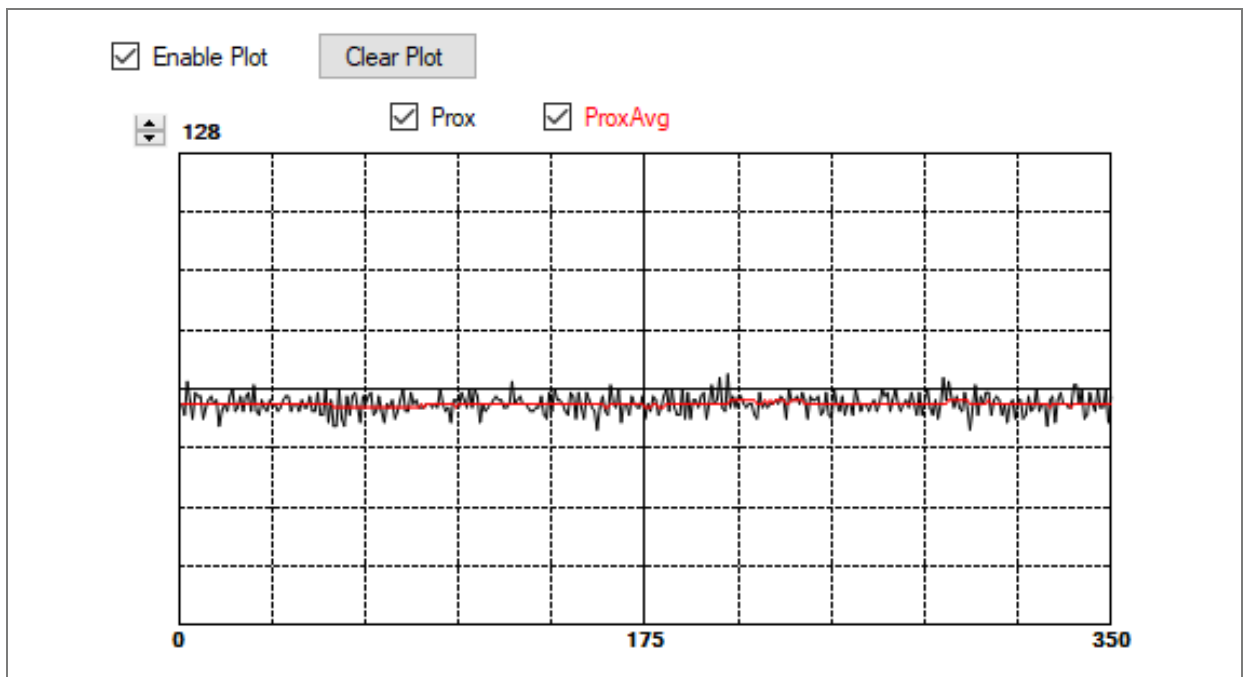
1. **PDATA** displays the latest polled Proximity channel count. Note that the TCS3720 EVM can be configured to run much faster than this program can run, so this field will not display every PDATA value from the device.
2. **SW Avg** is an average of the most recent 32 values polled from the device.
3. **StDev** is the standard deviation of the last 32 values polled from the device.
4. **Temp** is the current temperature reading from the device. This value is only valid if *both* prox and Temperature are enabled.
5. **VSYNC** indicates the most recent VSYNC period detected. This value is only valid if a VSYNC signal is present.

6. **VSYNC Lost** will be marked when the device detects a missing VSYNC signal
7. **VSYNC LOST Int** will be marked when the VSYNC LOST Interrupt is active.
8. **Saturation** is marked to indicate that some saturation condition has occurred in the prox processing. The **Stage 2, Amb Lvl Comp, Stage 1 Amb,** and **Stage 1 Pulse** indicators provide further information regarding the saturation condition. See the Datasheet for an explanation of the meaning of each of these status bits.

4.9.2 Prox data plot

The remaining portion of the Prox tab is used to display a running plot of the collected PDATA values. The last 350 values are collected and plotted on the graph. As additional values are added, the old values will be deleted from the left side of the graph. To start the plotting function, check the Enable Plot checkbox.

Figure 14: Prox data plot



The scale of the Y-axis of the plot can be adjusted by clicking on the small up and down arrows at the top left corner of the plot. The scale can be set to any power of 2 from 16 to 16384.

The **Prox** and **ProxAvg** checkboxes control which data is displayed on the plot.

Click the Clear Plot button to discard the current data and continue plotting the new data. Note if the Clear Plot button is clicked while the plot is disabled, the data is discarded, but the actual plot will not be updated until the plot function is re-enabled.

5 Resources

For additional information regarding the TCS3720 EVM, please refer to the datasheet. For information regarding the installation of the TCS3720 EVM host application software please refer to the TCS3720 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 www.ams-osram.com.



For further information, please refer to the following documents:

- TCS3720 Datasheet
 - TCS3720 QG001011 EVM Quick Start Guide (QSG)
 - TCS3720 UG001018 User's Guide (this document)
 - TCS3720 EVM Schematic Layout
-

6 Revision information

Definitions

Draft / Preliminary:

The draft / preliminary status of a document indicates that the content is still under internal review and subject to change without notice. ams-OSRAM AG does not give any warranties as to the accuracy or completeness of information included in a draft / preliminary version of a document and shall have no liability for the consequences of use of such information.

Changes from previous released version to current revision v3-00	Page
Update images to include new EVM board design	3, 4
Updated Ordering code	4
Update image of About Box	10

- 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.

7 Legal information

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