



# User guide

**TSL2591 EVM**

**TSL2591 Light-To-Digital High Sensitivity Ambient Light Sensor**





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## TSL2591

The TSL2591 is a very-high sensitivity light-to-digital converter that transforms light intensity into a digital signal output capable of direct I2C interface. The device combines one broadband photodiode (visible plus infrared) and one infrared-responding photodiode on a single CMOS integrated circuit. Two integrating ADCs convert the photodiode currents into a digital output that represents the irradiance measured on each channel. This digital output can be input to a microprocessor where illuminance (ambient light level) in lux is derived using an empirical formula to approximate the human eye response. The TSL2591 supports a traditional level style interrupt that remains asserted until the firmware clears it.



## 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 Controller EVM v2.1a or EVM v2.1c, the TSL2591 evaluation daughterboard, a USB interface cable and a USB Memory device with the operating software. When the USB cable is connected the green LED should flash indicating that power is being received via the USB interface, and the Controller processor is running. If the green LED does not flash when it's first plugged in, 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 using the desktop icon or by double clicking the DigitalLightSensor.exe file from the installation directory. The default installation directory, depending on the device and the operating system you are using, is:

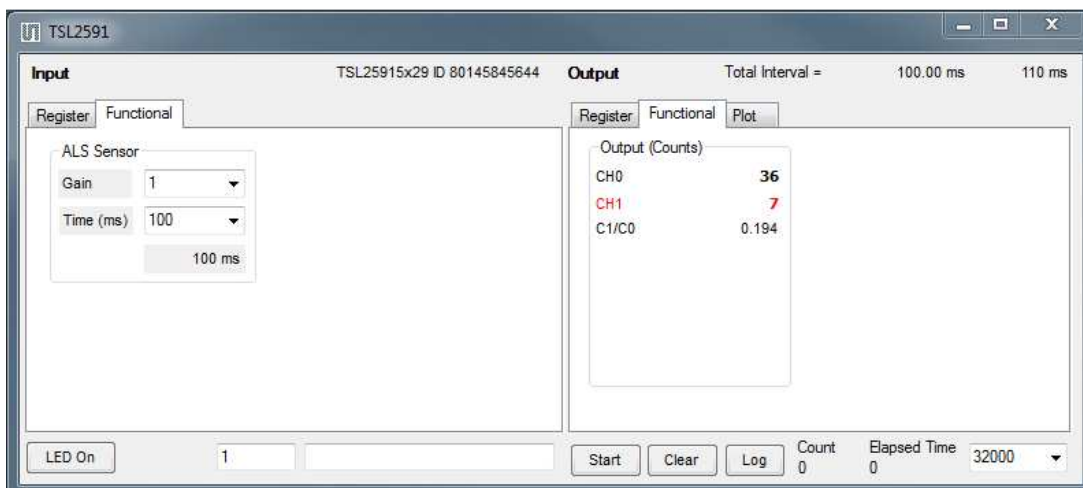
C:\Program Files\ams\TSL2591EVM Windows 32 bit operating systems

C:\Program Files (x86)\ams\TSL2591EVM Windows 64 bit operating systems

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 TSL2591 datasheet, the QSG and application notes available on the **ams** website, [www.ams.com](http://www.ams.com), there should be enough information to allow evaluation of the TSL2591 device.

## 2 TSL2591 EVM graphical user interface (GUI)

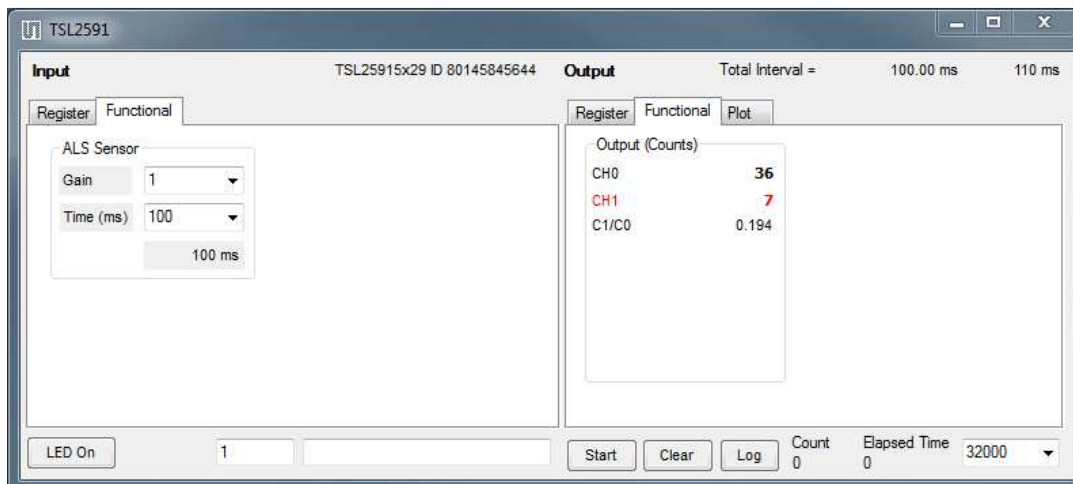
### 2.1 Software overview

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 EVM Controller properly. If “No\_HID” appears, verify the USB cable is connected. A green LED on the EVM Controller indicates that the USB cable is connected and providing power to the system. The “Reset” button 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 identified device connected. Tabs are used to make control and evaluation of specific device functions easy. For the TSL2591 devices the initial display screen is shown:



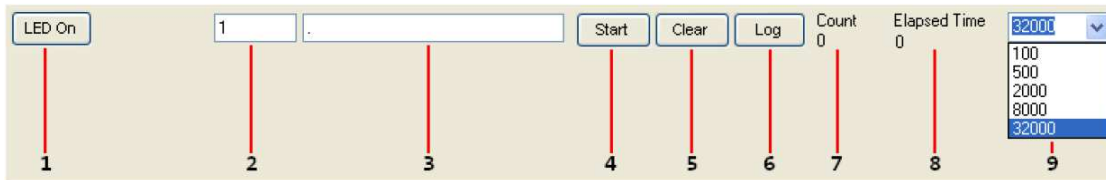


This window has inputs organized on the left, and outputs organized on the right. Values for register variables may be set using multiple techniques. The Functional tab is commonly used to quickly evaluate the device with nominal settings. The Input Register tab allows the register settings to be changed, 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, 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:**

TSL25911Bx39 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

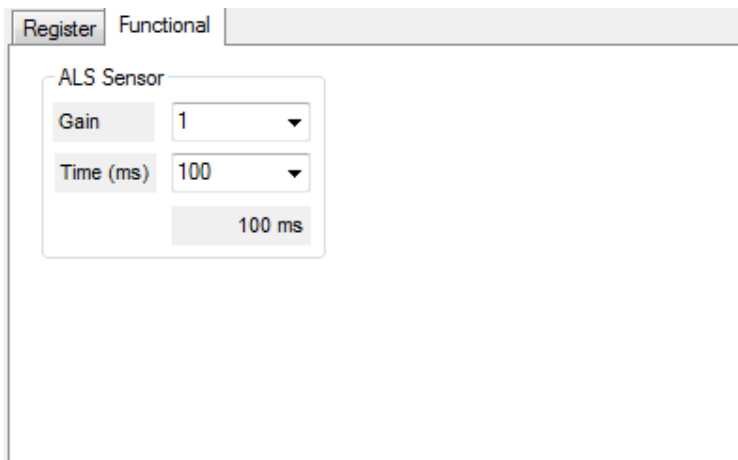


field names will change in the output beginning at the time of the change. The default log file name will be based on the values in #2 and #3 at the time the log file is written.

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 (0x0F). The gain amplifies the ADC signal to increase sensitivity. The gain options include 1x, 8x, 16x and 120x 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 both channels (Ch0 and Ch1). 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.

**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 65,535,



thus the full-scale output of the TSL2591 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

## 2.1.2 Input side, “Register” tab

Additionally, a list box provides options for turning ON all parts (All On) of the device or turning OFF all parts (All Off) of the device simultaneously.

Register Functional

ALS Interrupt

ENABLE (0x00)

UIEN  AIEN  SAI  AEN  PON

CONTROL (0x01) Reset

ATIME (2:0) 0 100 100 ms

AGAIN (5:4) 0 1 1 x

- Enable Register (0x00) – Provides the ON/OFF control of the device.
- Check boxes are provided to allow selection of specific functions on the device:
  1. PON – Power on. Activates internal oscillator. When =0 device is in standby.
  2. AEN – ALS Enable. Writing a one (1) enables the ALS
  3. AIEN – ALS Interrupt Enable. Writing a one (1) enables the ALS interrupt.
  4. SAI – Stop After Interrupt. Writing a one (1) causes the device to power down at the end of the ALS cycle when an interrupt has been generated.
  5. UIEN – Unfiltered ALS Interrupt Enable. Writing a one (1) connects the unfiltered ALS interrupt to the external interrupt pin.

### “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 (0x01) controls the ALS integration time. The actual time is:  
 $(256-ATIME) * 2.72 \text{ mS}$

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 WTIME 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 (0x0F) – Controls the ALS gain settings.
  1. AGAIN – Adjusts the ALS input gain. Valid values are 1x, 8x, 16x, and 120x.

### “ALS Interrupt” Sub Tab

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

The AILT and AIHT values are 16 bit thresholds for the upper and lower trigger points. Each is set using two 8-bit registers. Another control (APERS) establishes the required persistence 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 (0x04, 0x05) – Low light threshold for ALS interrupt.
  1. AILT (0x04) – The lower 8 bits of the 16 bit low threshold value.
  2. AILTH (0x05) – The upper 8 bits of the 16 bit low threshold value.



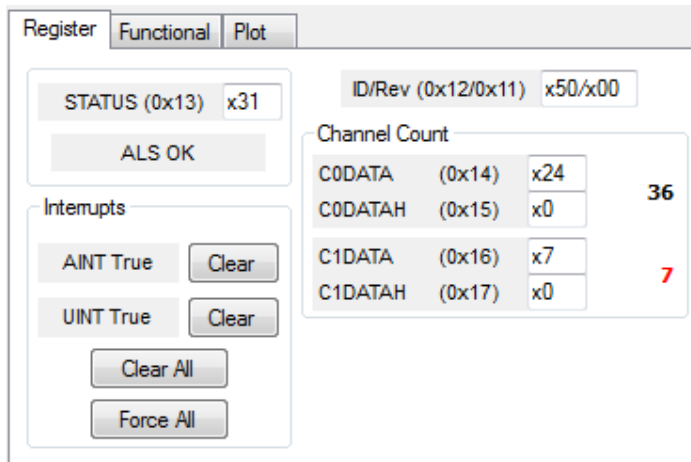
- ALS Interrupt High Threshold (0x06, 0x07) – High light threshold for ALS interrupt.
  - AIHTL (0x06) – The lower 8 bits of the 16 bit high threshold value.
  - AIHTH (0x07) – The upper 8 bits of the 16 bit high threshold value.
- PERS (0x0C) – The APERS field (bits 3:0) controls the number of times the ALS interrupt threshold (AILT, AIHT) 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.

| APERS Value                         | 0     | 1 | 2 | 3 | 4 | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 |
|-------------------------------------|-------|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|
| Consecutive Out of Range ADC Values | Every | 1 | 2 | 3 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |

- The +/-25% button takes the current ambient light reading and automatically computes new values for the AILT and AIHT registers, each with a 25% wider latitude.

### 2.1.3 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. Buttons are provided for clearing the ALS interrupt (AINT) and the Unfiltered (UINT) interrupt. The current interrupt status is also shown. The C0DATA and C1DATA values are the ADC values for the Ch 0 and Ch 1. Each is read via two 8-bit registers.



- ID (0x12) – The ID register provides the value for the part number.



- Status (0x13) – 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.
  2. Interrupts
    - a. “AINT True” or “AINT False” and “UINT True” or “UINT False” is displayed to indicate whether the ALS interrupt bit is set. Clicking on this Clear button will clear the ALS interrupt. Note that if the proper conditions exist, the interrupt will be raised again immediately.
    - b. Clicking on the Clear buttons will clear the ALS interrupts and Force will force an interrupt. Note that if the proper conditions exist, interrupt(s) will be raised again immediately.
- C0DATA (0x14, 0x15):
  1. C0DATA (0x14) – The lower 8 ADC bits of the Ch 0 photodiode.
  2. C0DATAH (0x15) – The upper 8 ADC bits of the Ch 0 photodiode.
  3. The full 16-bit value is displayed, in black, next to the C0DATA fields.
- C1DATA (0x16, 0x17):
  1. C1DATA (0x16) – The lower 8 ADC bits of the Ch 1 photodiode.
  2. C1DATAH (0x17) – The upper 8 ADC bits of the Ch 1 photodiode.
  3. The full 16-bit value is displayed, in red, next to the C1DATA fields.

#### 2.1.4 Output side, “Functional” tab

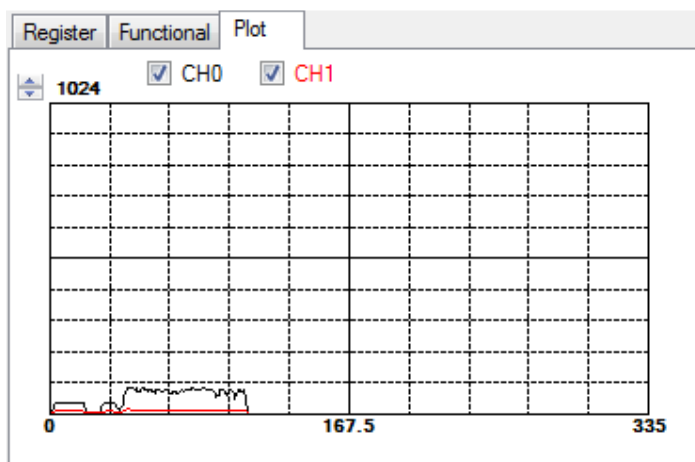
The Ch 0 and Ch 1 photodiodes output values are shown, and their ratio is shown below.

| Register        | Functional | Plot  |
|-----------------|------------|-------|
| Output (Counts) |            |       |
| CH0             |            | 36    |
| CH1             |            | 7     |
| C1/C0           |            | 0.194 |



## 2.1.5 Output side, “PLOT” tab

The two photodiodes can be displayed vs. time on the graph.



### Resources

TSL2591 datasheet

Quick Start Guide (QSG)

Designer's Notebooks

For additional information regarding the TSL2591, please refer to the respective datasheet. For information regarding the installation of the TSL2591 EVM host application please refer to the 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](http://www.ams.com)