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TCS377x EVM

USER'S GUIDE   ams

TCS377x LIGHT-TO-DIGITAL AMBIENT LIGHT / PROXIMITY SENSOR EVALUATION SYSTEM

April 2013

TCS3771 AND TCS3772

The TCS3771 and TCS3772 devices are controlled by the same software. There are only a few differences between the two devices. Throughout this document, the devices will be referred to as TCS377x. The screen images in this document use a TCS3771 device, but where the device controls differ, the appropriate portion of the TCS3772 screen will also be shown.

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). The software will check the system for required component to support the graphical user interface (GUI). The software comes in the kit on a company logo flash drive.

The hardware consists of the Controller EVM v2.1 motherboard, the TCS377x evaluation daughterboard and an A to mini-B USB interface cable.
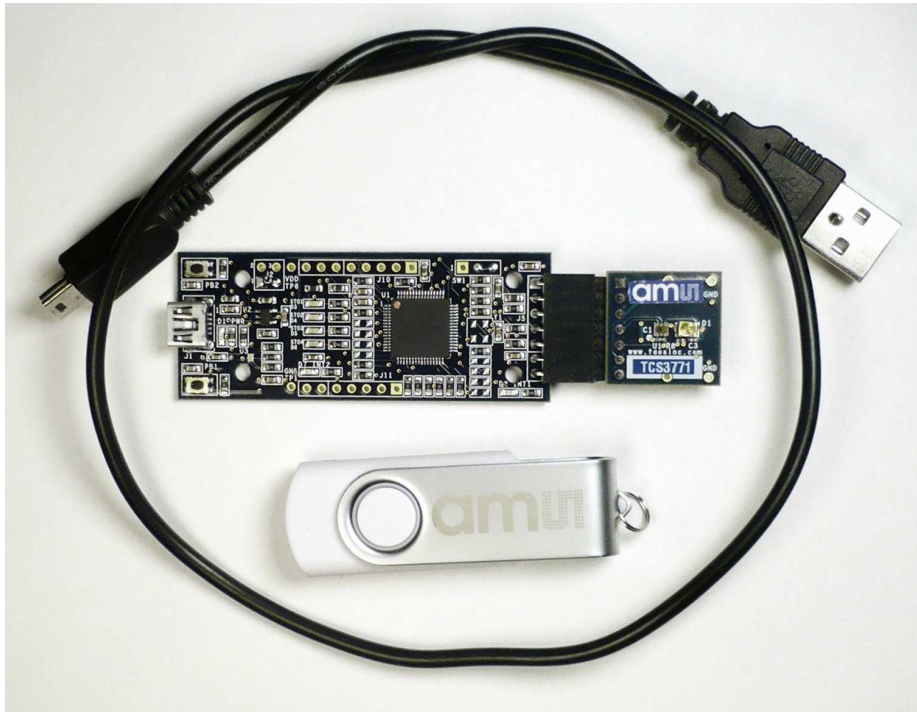

FIGURE 1: TCS3772EVM COMPONENTS

When the USB cable is connected the green LED next to the USB connector should light up indicating that power is being received via the USB interface, and the controller board processor is running. If the green LED does not light up check the USB cable connections, unplug the USB cable and try again. If, after re-trying, the LED does not light, check the PC for USB error messages. See resources section at end of this document for additional assistance. Note, after the "DigitalLightSensor" application program begins executing, it will turn this LED off so that it does not interfere with testing.

ESTABLISHING BASIC FUNCTIONALITY

The software should be started using the desktop icon "DigitalLightSensor" or by double-clicking the "DigitalLightSensor.exe" file from the installation directory. The default installation directory path is:

C:\Program Files\ams\TCS377xEVM   Windows 32 bit operating systems
C:\Program Files (x86)\ams\TCS377xEVM   Windows 64 bit operating systems

where the "x" is replaced with "1" OR "2" depending on the installed device. A different install path may be selected by the user. When started, the following windows will open on the PC. The bottom window is the main user interface "child window" and should be positioned on the screen for easy access. The top window "parent window" is not typically needed and may be placed out of the way.
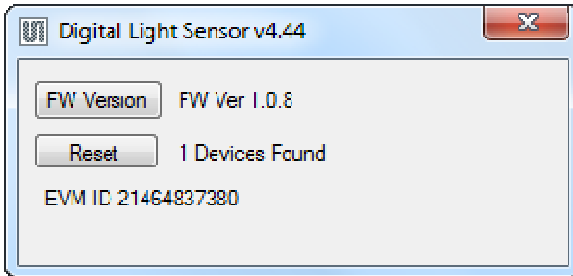
This window is the parent window (PW) to the child window (CW) and may be used to reset the CW.

Clicking on the red "X" on the PW will close both PW and CW. 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 CW will be selected by default each time the application software is opened. On the right side numbers should be updating showing that the ALS and proximity 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 and proximity readings change respective to the light intensity reaching the sensor.
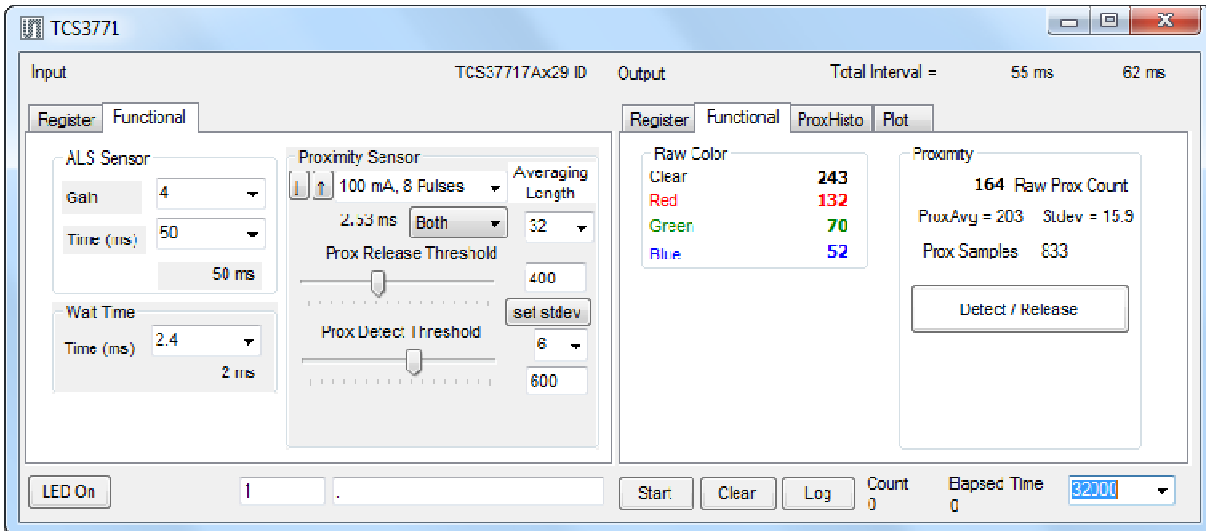
The balance of this document identifies and describes the controls available on the different tabs of the GUI. In combination with the TCS377x datasheet, the quick start guide (QSG) and application notes available on the ams website www.ams.com there should be enough information to allow thorough evaluation of the TCS377x device.

www.ams.com

# TCS377x EVM Graphical User Interface (GUI)

SOFTWARE OVERVIEW

On initialization the software displays two windows – a smaller "Digital Light Sensor" window called the parent window (PW) and a larger window containing controls pertinent to the device connected called the child window (CW). The PW displays the software GUI version and if a controller board is found it will also display the firmware version of the controller board.
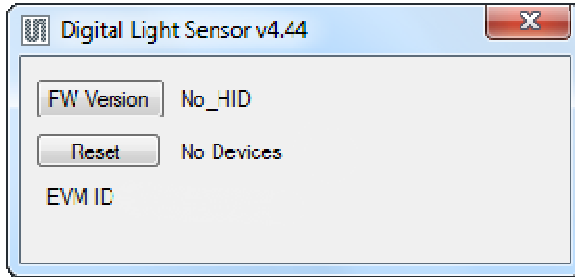
If "No Devices" appears, verify that the daughterboard is connected to the motherboard properly. If "No_HID" appears, verify the USB cable is connected. A green LED on the motherboard indicates that the USB cable is connected and providing power to the system.

The "Reset" button can be pressed or the software can be restarted to reinitialize the system.

The CW 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 TCS3771 devices the initial display screen is shown:
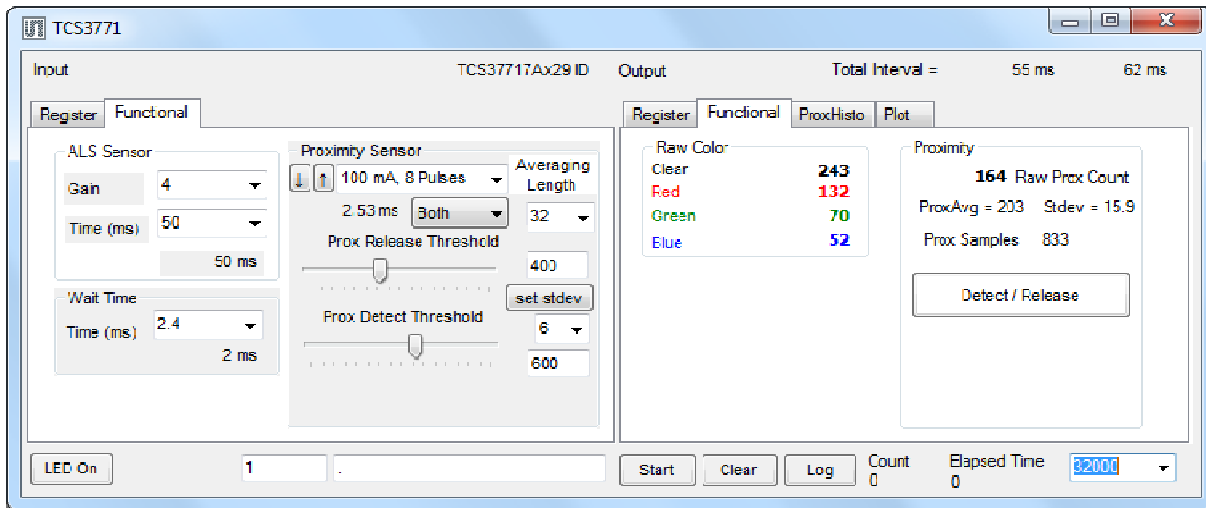
TCS3772 devices will contain an additional tab, "LuxMatrix" on the left side and, on the right side, the "Functional" tab will contain an additional block of Lux-related information:
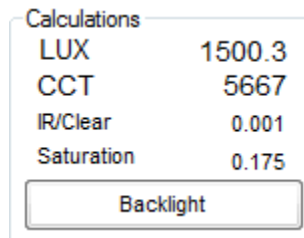
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This window has inputs organized on the left, and outputs organized on the right. Values for register variables may be set using multiple techniques. The Functional tab is commonly used to quickly evaluate the device with nominal settings. The Input 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 users 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 controller board LED. This LED is a good power-on indicator but can introduce errors in the optical tests. However 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 controller board.
2. Text entered here is appended to the default file name. The file name contains the Part Name and address shown in the large "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. . The default if nothing is entered is a period (".").

   Sample:

   TCS37717Bx39_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, but the log file name will not change after logging is started.
5. Clear –The Clear button will flush the previous optical sample readings and reset the elapsed time indicator (see #7).
6. Log – Creates a text log file with 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 to collect before log entry is written to the log file.

INPUT SIDE, "FUNCTIONAL" TAB

Easy to use controls exist for the ALS functionality, the proximity detection functionality, the wait time between samples, and the proximity threshold level. The TCS3772 contains an added tab in the input group, "LuxMatrix." It also, does not have the Diode Selection pull-down in the Proximity Sensor section.
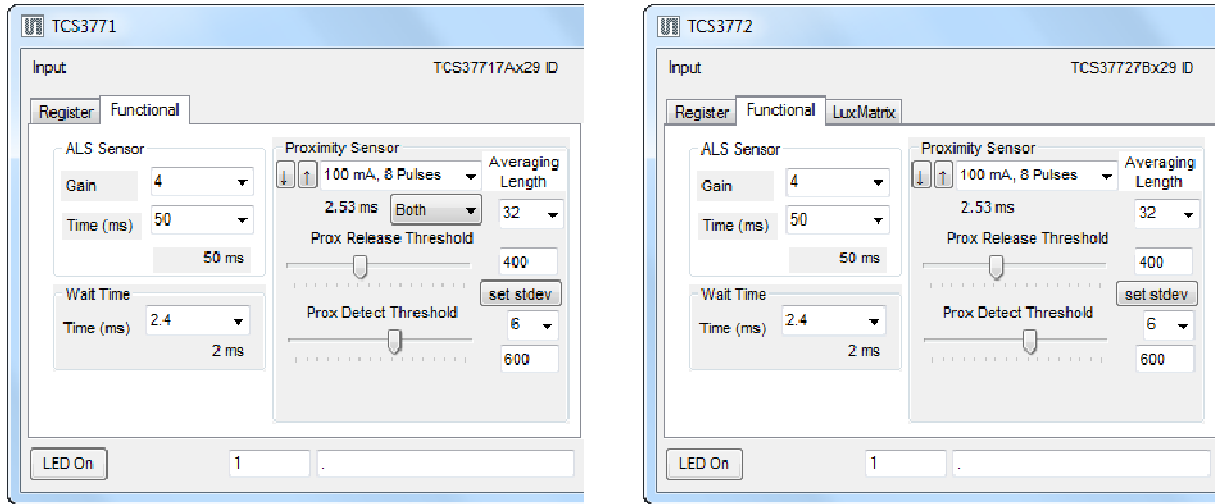
ALS SENSOR

- 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, 4x, 16x and 60x 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 all channels (Red, Blue, Green and Clear). 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 dependant 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 TCS377x 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 2.4mS is inserted between the Prox execution and the ALS execution. This duration can be adjusted in 2.4mS steps from 0 to 614mS. A wait multiplier (WLONG=1) may also be used to multiply the wait period by 12x. Using these controls the duration of the wait may be adjusted from none (WEN=0) to 7.37 seconds (WEN=1, WLONG=1, WTIME=0x00).

The Wait Time list box provides a quick mechanism for setting preselected wait periods from 2.4mS to 614mS. The wait period is completely disabled by setting WEN=0 (Enable Register (0x00, bit3).

PROXIMITY SENSOR / PROX THRESHOLD

The control fields to vary the proximity sensor settings are found in this section. Two drop-down controls allow adjustment of the sink current and number of LED pulses. The TCS3771 also allows selection of which photodiodes are used to detect the reflected energy. Two slider controls are provided for selection of proximity release and proximity detection thresholds.

The first list box allows rapid selection of LED sink current and the number of LED pulses. Clicking the down arrow, on the right, brings up a list box with several predefined combinations of current and pulses. Individual settings for the sink current and/or number of pulses can also be made using the device registers as documented later in this manual. The buttons on the left, with arrows pointing upwards and downwards, simply step through the predefined current/pulse choices.

For the TCS3771, the photodiodes receiving the reflected optical energy are chosen in the second line. The list box shows options for Neither, Clear, Red or Both. The TCS3772 does not have this control.
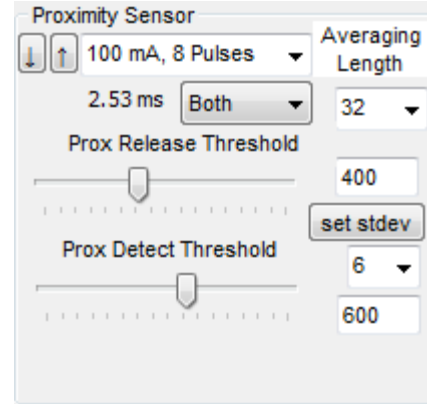
The "Prox Release Threshold" and "Prox Detect Threshold" sliders allow a threshold (with hysteresis) to be selected to determine when a proximity detection occurs. The thresholds can be set to any value from 1 to 1022. The values selected are shown numerically beside the sliders. A separate pull-down menu and a button labeled "set stdev" are provided to quickly set the proximity release and detect thresholds. The software calculates and displays the standard deviation of some number of the most recent proximity readings (determined by the "Averaging Length" pull-down menu. Pressing the "set stdev" button will automatically calculate thresholds which are N standard deviations above and below the average of the most recent readings. The value of N is controlled by the pull-down menu immediately below the "set stdev" button and can be an integer value from 1 through 6.

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 in the part and also controls the wait time multiplier (WLONG).

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.

- 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. PEN – Proximity Enable. Writing a one (1) enables the proximity detection.
    4. WEN – Wait Enable. Writing a one (1) activates the wait timer.
    5. AIEN – ALS Interrupt Enable. Writing a one (1) enables the ALS interrupt.
    6. PIEN - Proximity Interrupt Enable. Writing a one (1) enables the Proximity interrupt.
- WTIME (0x03) – Wait time in 2.4ms 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.
- Config Register (0x0D) – Controls the wait time multiplication factor of x12.
    1. WLONG – Wait Long. When checked (=1) enables the wait multiplier.

"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.
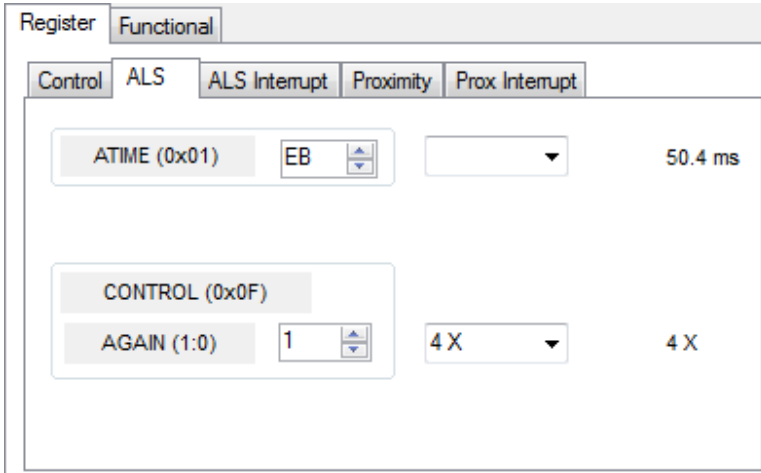
Note: The column on the right is the computed value for ATIME and is always correct. Sometimes the value shown in the list box will be one of the preselected values but it has not been selected. If this happens the number will not be the same as the computed number for WTIME on the Control Sub-Tab. The 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.
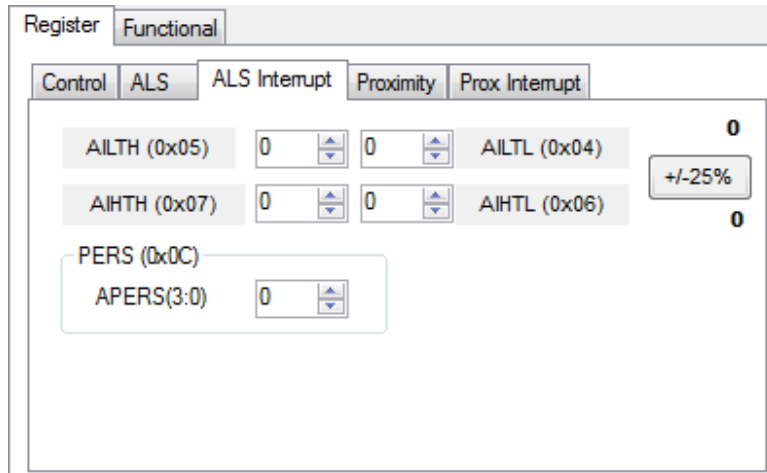
"ALS Interrupt" Sub Tab

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 control 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. AILTL (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.
  1. AIHTL (0x06) – The lower 8 bits of the 16 bit high threshold value.
  2. AIHTH (0x07) – The upper 8 bits of the 16 bit high threshold value.

- PERS (0x0C) – The APERS field (bits 3:0) allows the number of times the ALS interrupt threshold (AILT, AIHT) is exceeded before the interrupt is generated to be controlled. Setting a zero means an interrupt is generated on every ALS reading.
- 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.

"Proximity" Sub Tab

The Proximity tab shows editable registers associated with proximity sensing control.

Register values in hex are shown on the left, the middle section contains preset controls for quick configurations, and the column on the right displays the actual values in use.

The TCS3772 does not have controls for PDIODE.

Note: Values entered via the registers and list boxes for PDRIVE and PDIODE do not automatically update each other, so the values displayed may not match. The computed values on the right are always correct and show the values currently in use.
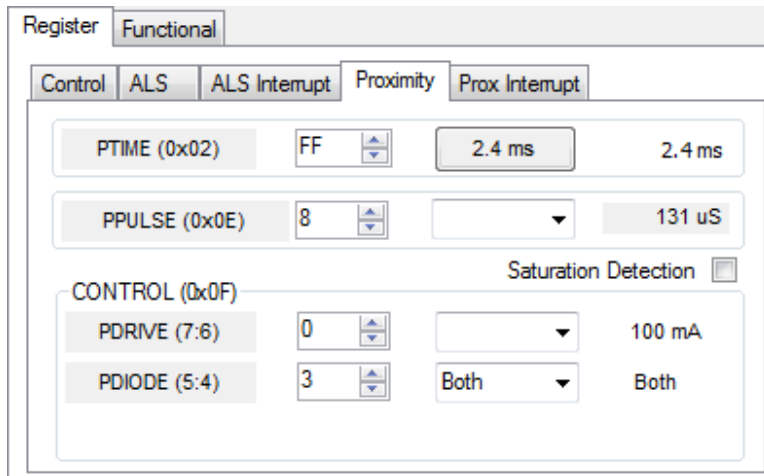

- PTIME (0x02) – Sets the integration time of the proximity ADC in 2.4mS increments.
- PPULSE (0x0E) - Allows the user to select the number of LED pulses for proximity detection. The pulses have a frequency of 125kHz and a 50% duty cycle.
- PDRIVE – sets the sink current through the IR LED.
- PDIODE – (TCS3771 only) choses the active photodiode(s) for proximity sensing.

"Prox Interrupt" Sub Tab

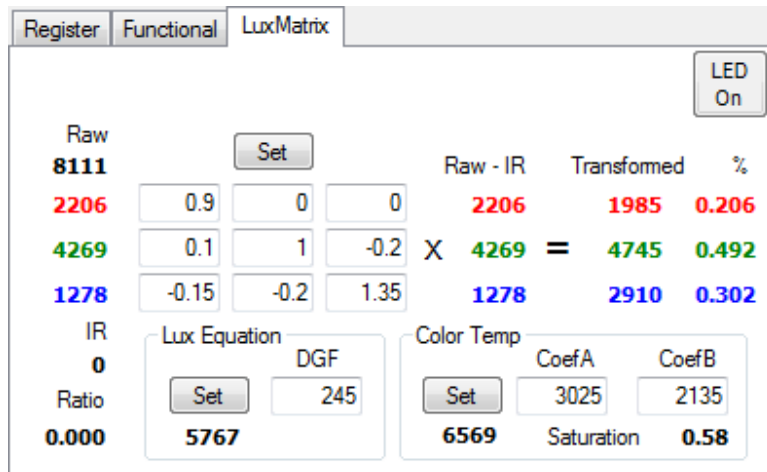This tab contains the settings for controlling the generation of Prox interrupts to a control processor.
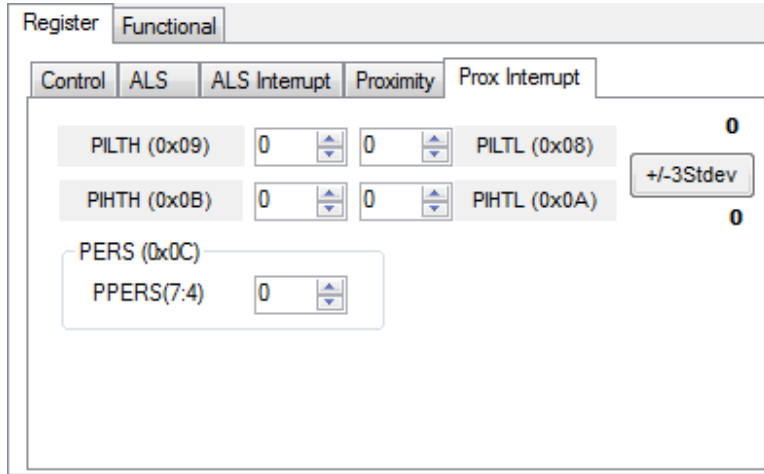
The PILT and PIHT values are 16 bit thresholds for the upper and lower trigger points. Each is set using two 8-bit registers. Another control (PPERS) establishes the required persistence of the interrupt signal.

Also on this screen is a control that will automatically generate the register values to provide threshold settings 25% higher and lower than the Proximity Data Register value.

- Proximity Interrupt Low Threshold (0x04, 0x05) – Low threshold for proximity interrupt.
    1. PILTL (0x08) – The lower 8 bits of the 16 bit low threshold value.
    2. PILTH (0x09) – The upper 8 bits of the 16 bit low threshold value.
- Proximity Interrupt High Threshold (0x06, 0x07) – High threshold for proximity interrupt.
    1. PIHTL (0x0A) – The lower 8 bits of the 16 bit high threshold value.
    2. PIHTH (0x0B) – The upper 8 bits of the 16 bit high threshold value.
- PERS (0x0C) – The PPERS field (bits 7:4) allows the number of times the Prox interrupt threshold (PILT, PIHT) is exceeded before the interrupt is generated to be controlled. Setting a zero means an interrupt is generated on every proximity reading.
- The +/-25% button takes the current Proximity Data Register value and automatically computes new values for the PILT and PIHT registers, each with a 25% wider latitude.

INPUT SIDE, "LuxMatrix" TAB

The "LuxMatrix" tab on the Input Side is present only for the TCS3772. It is used when developing custom Lux and color temperature equations. Refer to Designer's Notebook number 28 (DN28), "Developing a Custom Lux Equation," for information regarding the use of this tab.

OUTPUT SIDE, "REGISTER" TAB

The values of internal registers are displayed on this tab. Register values cannot be set here. To set registers use the Register tab on the input side of the screen.

Controls are provided for clearing the Proximity interrupt (PINT) and the ALS interrupt (AINT). The current interrupt status is also shown.

The CDATA, RDATA, GDATA, and BDATA are the ADC values from the Clear, Red, Green and Blue channel photodiodes. PDATA values are the proximity detection value. Each is read via two 8-bit registers.

- Status (0x13) – Internal status. Interrupts active (2 bits) and ALS valid bits are here.
- ID (0x12) – The ID register provides the value for the part number.
- CDATA (0x14, 0x15):
  1. CDATA (0x14) – The lower 8 ADC bits of the Clear photodiode.
  2. CDATAH (0x15) – The upper 8 ADC bits of the Clear photodiode.
- RDATA (0x16, 0x17):
  1. IRDATA (0x16) – The lower 8 ADC bits of the Red photodiode.
  2. IRDATAH (0x17) – The upper 8 ADC bits of the Red photodiode.
- GDATA (0x18, 0x19):
  1. IRDATA (0x18) – The lower 8 ADC bits of the Green photodiode.
  2. IRDATAH (0x19) – The upper 8 ADC bits of the Green photodiode.
- BDATA (0x1A, 0x1B):
  1. IRDATA (0x1A) – The lower 8 ADC bits of the Blue photodiode.
  2. IRDATAH (0x1B) – The upper 8 ADC bits of the Blue photodiode.
- PDATA (0x1C, 0x1D):
  1. PDATA (0x1C) – The lower 8 bits of the proximity value.
  2. PDATAH (0x1D) – The upper 8 bits of the proximity value.

OUTPUT SIDE, "FUNCTIONAL" TAB
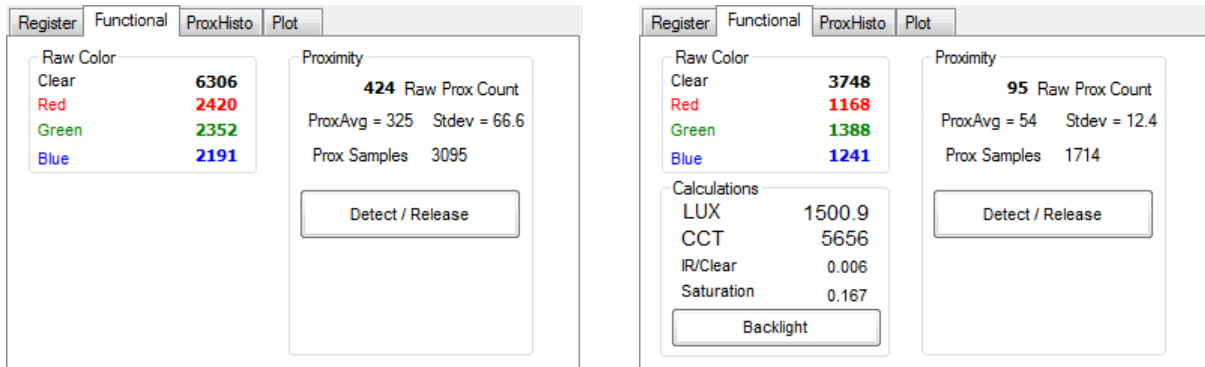
The Output Side "Functional" Tabs for the TCS3771 and the TCS3772 tabs are shown above, on the left and right sides, respectively.

The Raw Color box displays the output register values of the Clear, Red, Green and Blue photodiodes.

The Prox indication shows the current reading (Raw Count), the rolling average, and the standard deviation of the prox readings. The average and standard deviation are computed over the number of samples specified on the INPUT/Functional tab.

The Detect/Release box is a visual indicator of proximity detection. When the prox threshold is exceeded the box will turn red.

The Calculations box is present only on the TCS3772. It displays the calculated lux and color temperature values. The coefficients for calculating these values are shown, and can be changed, on the Input Side LuxMatrix tab. This box also displays the ratio of detected IR to Clear light and a saturation indicator. This saturation value should normally be small. As it approaches 0.75 or higher, it indicates that the color detectors are becoming saturated.

OUTPUT SIDE, "PROXHISTO" TAB
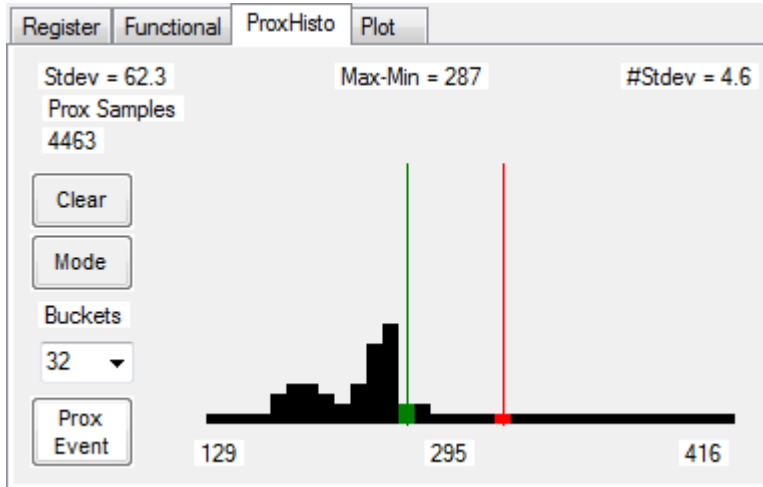
This tab contains a histogram of the recent prox evaluations. It is displayed as a rolling histogram spanning the number of readings in the Test tab of the input. Changing the "Averaging Length" control on the Input Side Functional tab will change the number of samples used for these calculations.

Stdev – standard deviation of the displayed data

Max-Min – difference between the maximum reading and the minimum reading

The range of the horizontal axis is based on the PTIME register value, but is not displayed. The numbers below the axis show the minimum value and the maximum value, and the mean of the samples. The red vertical line shows the proximity detection threshold and the green line shows the release threshold as set by the sliders on the functional input tab of the GUI.

The Clear button will discard the accumulated samples and restart a new running average. The Mode button toggles the graph so that all of the samples remain drawn on the screen, rather than only the number of samples selected. This function operates similarly to the Max-Hold function on an oscilliscope.

The Buckets pull-down menu controls the number of vertical bars displayed on the graph. Specifying a higher number will cause more bars to be displayed.

The Prox Event control will turn red when the prox average exceeds the Prox Detect Threshold set on the Input Side Function tab, and will remain red until the average goes below the Prox Release Threshold specified.

OUTPUT SIDE, "PLOT" TAB

The four photodiodes and the proximity reading can be displayed vs. time on the graph.
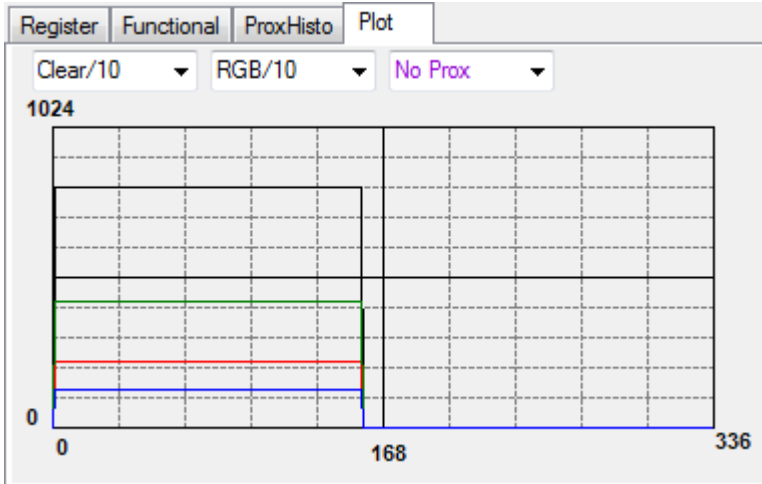
This sample graph shows all the color outputs for a static system. The X-axis plots 337 points then rolls over back to 1 on the graph. The Y-axis is set to range 0 to 1024; this range cannot be adjusted. However Multipliers (selected from the list boxes) may be used to scale the display accordingly.

RESOURCES

TCS377x datasheet (included with EVM media)
Quick Start Guide (QSG included with EVM media)
Application Notes (available from website)

For additional information regarding the TCS377x, please refer to the datasheet. For information regarding the installation of the TCS377x EVM host application please refer to the Quick Start Guide.

Application notes dealing with various aspects of optical measurement and optical measurement applications are available.

All content is available on the ams website www.ams.com