IQS227/8BEV02 User Guide

IQ Switch® - ProxSense® Series

Table of Contents

1   Introduction

This user guide describes the operation of the IQS227-228BEV02 Evaluation Kit. The EV-Kit consists of ten parts, the main board device, six separate plug-in module boards and three overlays. Additional unprogrammed IC's (3 x IQS227B and 3 x IQS228B) are included. To visualise raw data from the EV-Kit, the main board can be interfaced to any personal computer with USB support, and IQS227 or IQS228 software GUI (Graphical User Interface). The purpose of the IQS227-228BEV02 EV-Kit is to help application and development engineers in evaluating the IQS227B and IQS228B proximity and touch sensor in self-capacitance mode.

2   Standalone/Data Streaming EV-Kit

Figure 2.1 illustrates the evaluation kit main board and a plug-in module board.
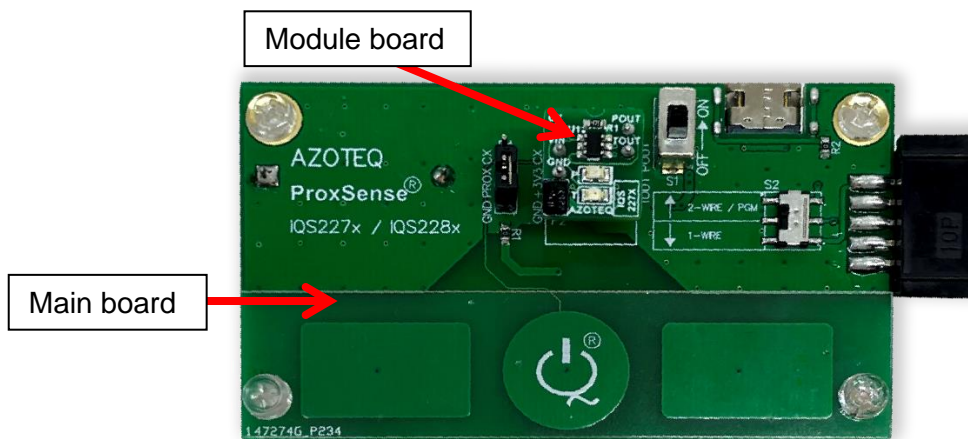

Figure 2.1 IQS227B/228B main board with plugged in IQS228B module board

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IQS227-228BEV02 Evaluation Kit User Guide
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Page **1** of **10**
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Simply plug in the desired module board and turn on the power switch.
Features included in the IQS227-228BEV02:
- Modular design: Connect one of the supplied plug-in modules into the main board, to evaluate and compare proximity and touch performance.
- Reference designs for IQS227B and IQS228B with user proximity and touch detection.
- Used in Data Streaming Mode: EV-Kit requires Micro-USB cable with Azoteq CT210A.

The EV-Kit main board can also draw power from a USB source by means of the USB Type-C connector provided on the main board (optional).

2.1 Overview of module boards

Table 1 gives a summary of the settings burned onto the IC's. The Green, Blue and Black refer to the different coloured module boards and the overlay refers to the thickness of the removable Perspex layers. A 3mm overlay is achievable by stacking three 1mm overlays on top of each other. The Target value is when the IC performs an Antenna Tuning Implementation (ATI) routine and adjusts the Compensation (Comp) and Sensitivity (Sense) multipliers for the Counts value to reach the Target value. The Touch Threshold (TTH) sets the point where a Touch event is triggered. This is calculated as a fraction of the current LTA value. For simplicity, an example of this calculation will be given.

Example:
With a TTH set to 48 and a Long Term Average (LTA) of 512, the equivalent ΔCounts value is calculated as follow:

$$\Delta Counts = LTA \times \frac{TTH}{256} = 512 \times \frac{48}{256} = 96$$

This means that when the Counts value is ΔCounts below the LTA, the Touch event will be triggered.

Table 1: Settings for the module boards

IC	Module Board	Overlay	Target	TTH	Multiplier Compensation	Multiplier Sensitivity
IQS227B	Green	1mm	512	48	13	2
	Blue	2mm	1024	48	14	2
	Black	3mm	1024	24	Full ATI	
IQS228B	Green	1mm	1024	72	13	2
	Blue	2mm	1200	72	7	2
	Black	3mm	1200	24	Full ATI	

3 Standalone Operation
3.1 Powering on the device
In order to power the device, make sure the main board is set up as follow:
- Connect the IQS227B (green board) plug-in module board.
- Put 1 overlay on the base board.
- Move the slide switch to the ON position.

Always switch OFF the device before making alterations to the main board. This is needed for the Integrated Circuit (IC) to adjust to the main board setup.

There are 3 alterations available:
- The plug-in module board can be exchanged for another board in the EV-Kit.
- The overlays can be added or removed as needed.
- The jumper can be shifted to connect the adjacent pads to the button.

After the device is powered through the ON/OFF slide switch, the device calibrates itself for the main board setup. This normally takes less than a second.

3.2 Jumper placement

The placement of the jumper is very important and should by default connect the GND and PROX pins to add extra ground to the system. This is especially important when operating from a battery as the system does not have a very good ground reference and this will ensure correct operation. The jumper can also be shifted to connect the CX and PROX pins to increase the touch pad's size and reduce the ground in the system. This is advised against when running off batteries as the system's ground reference is too small to ensure correct operation and false Prox events will be triggered when touching the ground pour areas on the board.
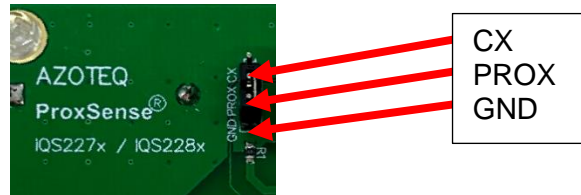
Figure 3.1 Jumper placement

- When the jumper is connected on the PROX and GND pins, the 2 pads on each side of the button are also connected to GND. This takes away some sensitivity, thus smaller detection distance, but also less susceptible to noise that could couple into the system.
- When the jumper is connected on the CX and PROX pins, the 2 pads on each side of the button are also connected to the CX. This increases the sensitivity, thus bigger detection distance, but also more susceptible to noise that could couple into the system.

3.3 Device operation

After power ON, touch the button with a finger and 2 LED's should turn on as in Figure 3.2.
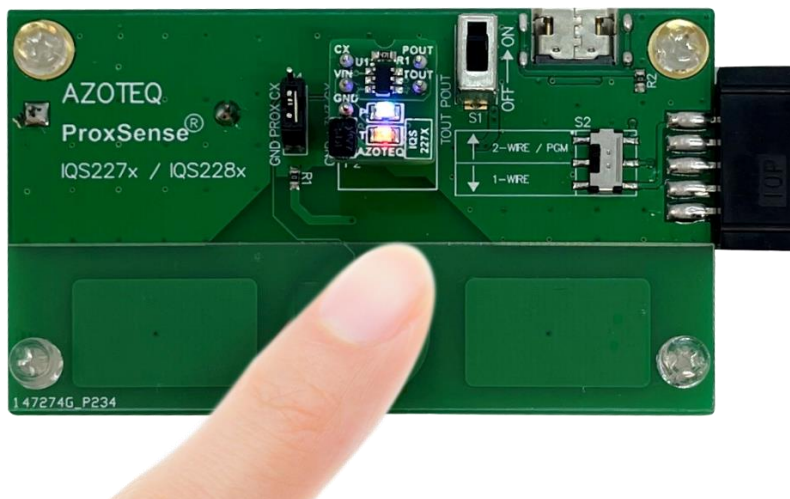
Figure 3.2 Standalone activation

The blue LED indicates a proximity event and the red LED a touch event. Evaluate the different module boards to observe the difference in sensitivity between them.

If the LED's do not turn on when touching the button, release the button or put the device on a table and try again.

4   Data Streaming Operation

The device can also be connected to a computer via the Azoteq CT210A and the data streamed. The difference between the module boards will become clear when visualised on a computer.

4.1   Setup for data streaming on computer

To stream the data on a computer, the following will be needed besides the IQS227B/228B base board and various module boards:

- CT210A (Available from Azoteq)
- Ribbon cable (Comes with the CT210A)
- Micro USB cable to connect CT210A to a computer
- IQS227 GUI and IQS228 GUI available at www.azoteq.com/proximity-switches-design/capacitance-sensor-software-and-tools
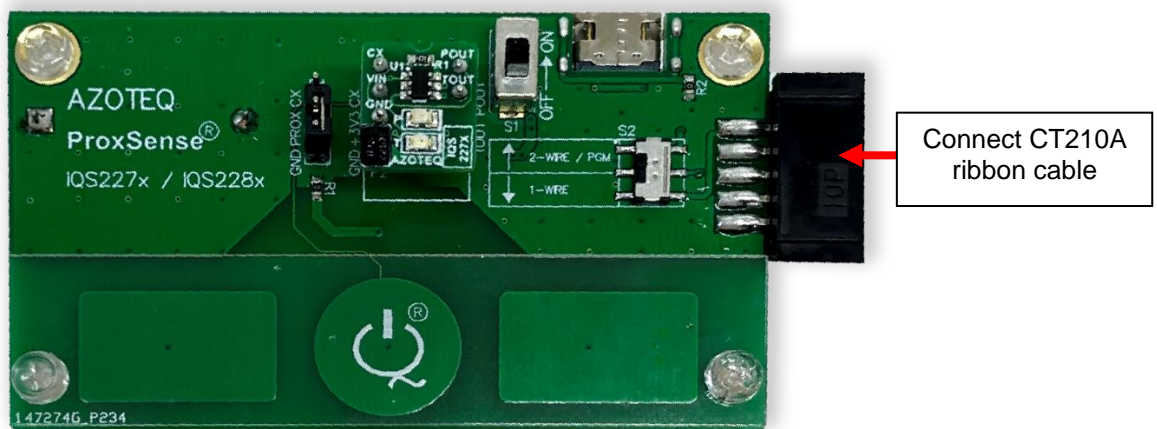
Figure 4.1 Setup for data streaming

Setup the base board connection with a computer by doing the following:

- Connect the CT210A to a computer via a micro USB cable
- Connect the base board to the CT210A
- Insert a module board onto the main board
- Make sure the slide switch is in the OFF position, the board will run on power from the CT210A and not on battery power
- Install the IQS227 and IQS228 GUI on a computer
- Run the application that matches the chosen module board (IQS227/8)

4.2   Using the GUI with the IQS227B IC

When all of this is done correctly, your screen should look like in Figure 4.2. A small popup Hints & Tips window also appears which must be read and closed. The important parts to get started with the GUI are also circled. (We use IQS227 GUI Version 1.0.1.26 in this document and we also encourage customers to use the latest versions available.)
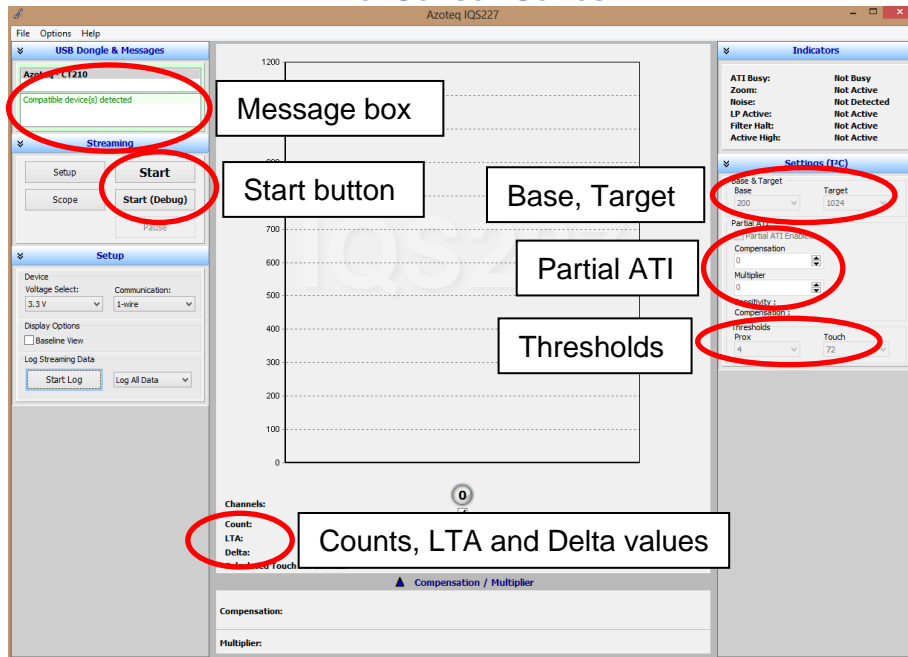
Figure 4.2 IQS227 GUI Start-up Screen

In the Message box, "Compatible device(s) detected" should be displayed. If the message "No compatible device(s) connected!" is displayed, there is a connection problem between the computer and the CT210A. Make sure the CT210A is plugged in, the USB cable is a data cable and not only for power delivery or try a different USB port.

Before the device can start streaming data, make sure the base board is setup correctly.
- Move the ON/OFF slide switch to the OFF position
- Move the 2-wire/1-wire slide switch to the 2-wire position
- Make sure the ribbon cable is properly connected, the message "Device did not enter debug mode" will be displayed in the Message box if there is a problem with the ribbon cable connection

Click the **Start (Debug)** button to stream data. All the module boards included are default in standalone mode. The boards can be programmed to Enable Streaming (use the Start button), but then cannot be changed back to Standalone mode. If you click the Start button, you will receive a "Timeout during operation" error in the Message box.

When everything is setup correctly and working in the data streaming mode, the GUI should look similar to Figure 4.3. The Message box now displays "Device streaming started". The LED's on the module board will also turn on, this is not an error. In standalone mode the POUT and TOUT pins of the IC are connected to the 2 LED's. In streaming mode the POUT and TOUT pins are used for the I^2C communications and thus the 2 LED's appear to be constantly on. There will also appear 2 grey bars in the GUI. The left one represents the Counts value (an inverse representation of the measured capacitance) and the right one the LTA value.

Under the Settings (I^2C) menu is some settings that can be changed. For the Green and Blue module boards "Partial ATI Enabled" will be ticked and for the Black board it will not be ticked as default. During ATI, the internal circuitry will try to get the Count value as close as possible to the Target value by adjusting the Compensation and Multiplier fields. The Multiplier field acts as a course adjustment to the Count value and the Compensation field acts as a fine adjustment.
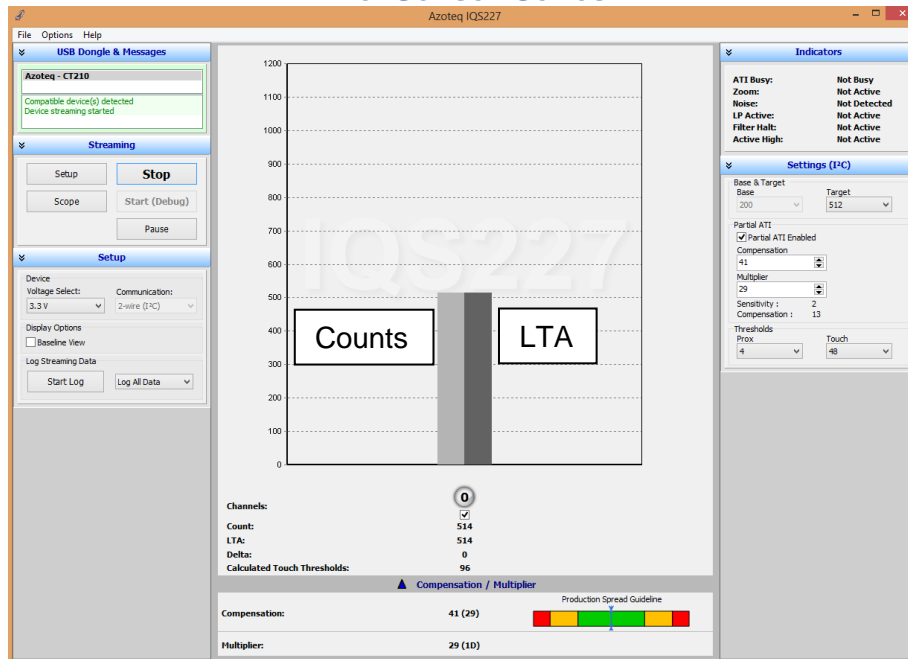
Figure 4.3 Successful Streaming

Start off by choosing suitable Prox and Touch values. The Prox value determines the Delta at which a proximity event is triggered and the Touch value a touch event as described earlier. With "Partial ATI Enabled" ticked, the user has 2 values to pick, namely: Target and Multiplier. Although Compensation can also be adjusted, it is advised not to change this as the IC chooses this value automatically. Every time the Counts value rise to outside a certain level above the LTA, the IC adjusts the Compensation for the Counts to be as close as possible to the Target value.

With "Partial ATI Enabled" not ticked, the Base value option becomes available. By choosing a certain Base value, the IC will automatically pick the Multiplier and Compensation values for the Count value to reach the Target. If a lower Base value is picked, the IC might enter a Touch event and seem like it got stuck. One way to get out of this stuck condition is to wait for the Time-Out timer to complete and re-ATI the IC. The default Time-Out time is 18s.

An important consideration is the "Production Spread Guideline" bar located at the bottom of the window. The IC chooses the Compensation value in order to get as close as possible to the Target value. The Compensation value can range from 0 to 255 and must preferably not be too low or too high. The Multiplier and Compensation values will most likely be application specific, but it is advised to aim for a Compensation value of between 30 and 210.

Another important issue is the Prox and Touch threshold. Ensure that the Prox threshold is always lower than the calculated Touch threshold. This is needed for device stability as the LTA filter only halts when it sees a Prox and then a Touch event. If it sees a Touch event first without the Prox event, the LTA filter halt might not enable and the LTA will follow the Counts.

All the settings should now be setup correctly. When a finger comes close to the button, the device will enter Prox mode. Figure 4.4 shows what a typical Prox event should look like. Note that the Counts and LTA bars have turned blue to indicate a Prox event and the Filter Halt is Active in the Indicators menu.
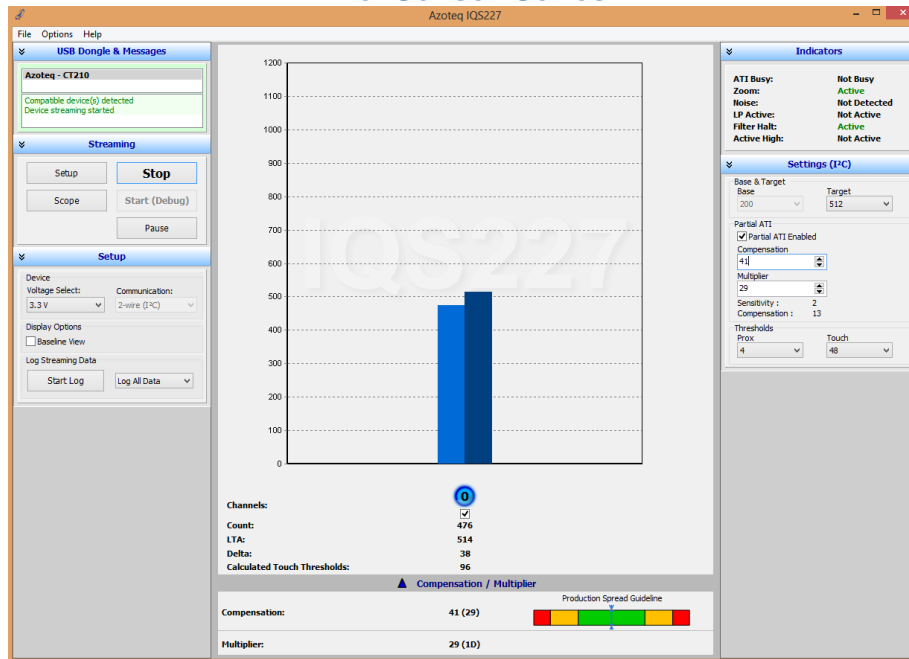
Figure 4.4 IQS227B Proximity Event

When a finger comes closer and touches the button, a Touch event will be triggered. Figure 4.5 shows what a typical Touch event should look like. Note that the Counts and LTA bars have turned red to indicate a Touch event and the Filter Halt is still Active.
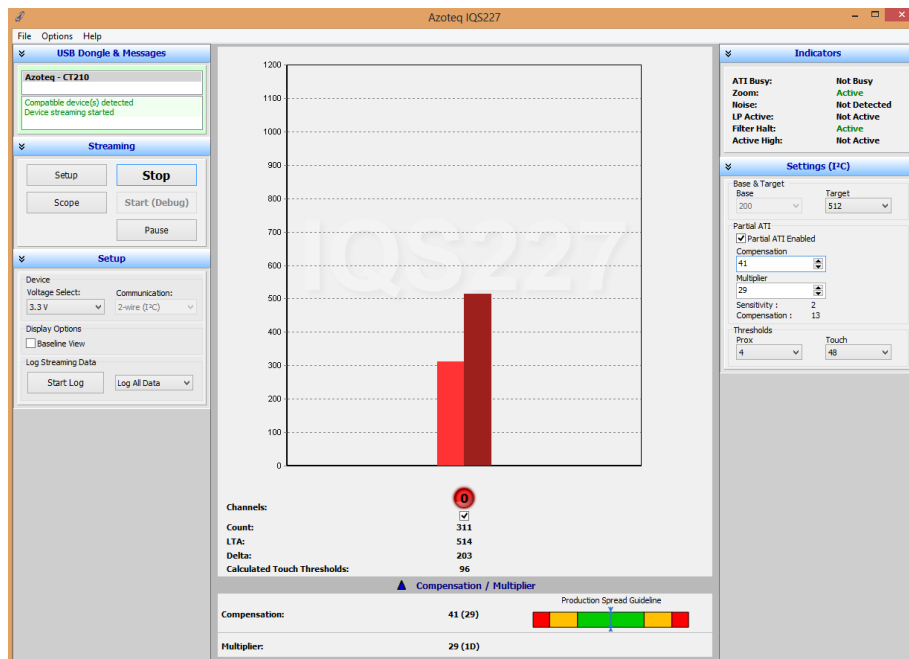

Figure 4.5 IQS227B Touch Event

The various IQS227B module boards can now be evaluated to observe the different obtainable sensitivities for a wide range of applications.

4.3   Using the GUI with the IQS228B IC

The IQS228B IC operates similarly to the IQS227B IC when in Prox mode, but differently when in Touch mode. Place the IQS228B Green module board in the socket and evaluate the board. The

Prox event is very similar to Figure 4.4, but the Touch event is different and shown below in Figure 4.6.
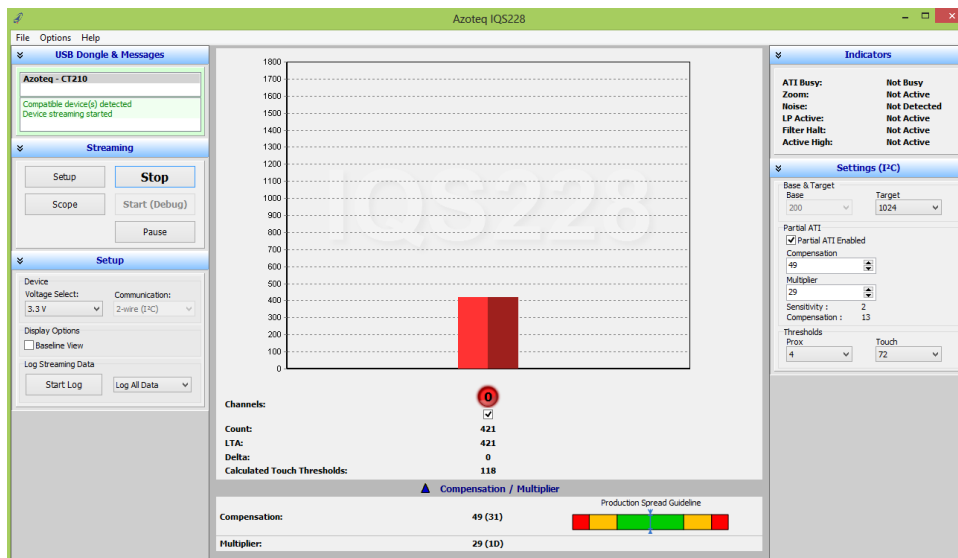
Figure 4.6 IQS228B Touch Event

The IQS228B IC has a DYCAL (Dynamic Calibration) function which works well for long Touch events. When in Prox mode, the Filter Halt is active and the LTA does not follow the Counts. When the device enters Touch mode, the Filter Halt is deactivated and the LTA now follow the Counts. This is needed as during long Touch events the environment can change and the device compensates for these slow varying changes. The device exits the Touch event when the Counts value rise a certain amount above the LTA and is then ready for another touch.

The various settings can also be changed as with the IQS227 GUI. Evaluate the Green, Blue and Black module boards to observe the different sensitivity levels obtainable.

4.4 Configuring the IQS227B and IQS228B
Use the USBProg program, available from the Azoteq website, to burn fuses on the IQS227B IC or IQS228B IC. Consult the IQS227B and IQS228B datasheets for more information available on the Azoteq website.

5 Communications Interface
Communications interface is for debugging only. Please use the CT210A and PC GUI for this purpose.

6 Reference Designs

Figure 6.1 and Figure 6.2 shows reference designs for the main board and the module boards.
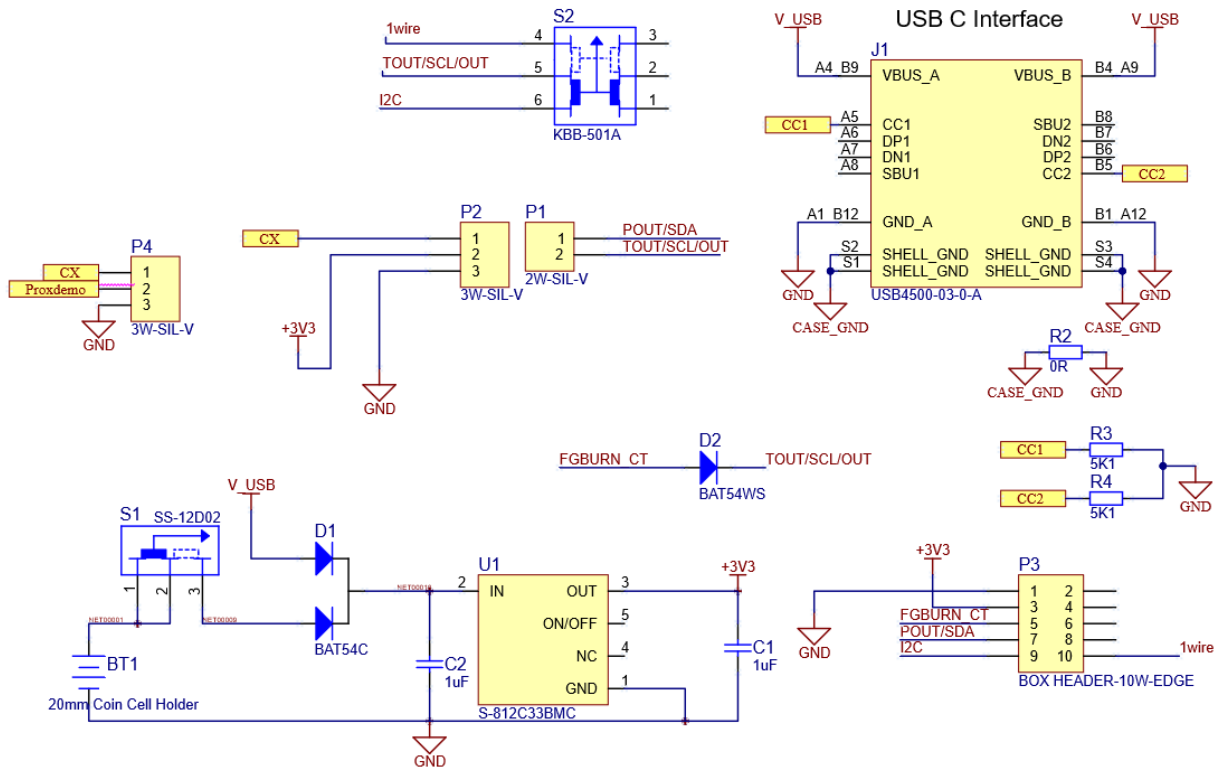
Figure 6.1 IQS227-228BEV02 Main board design
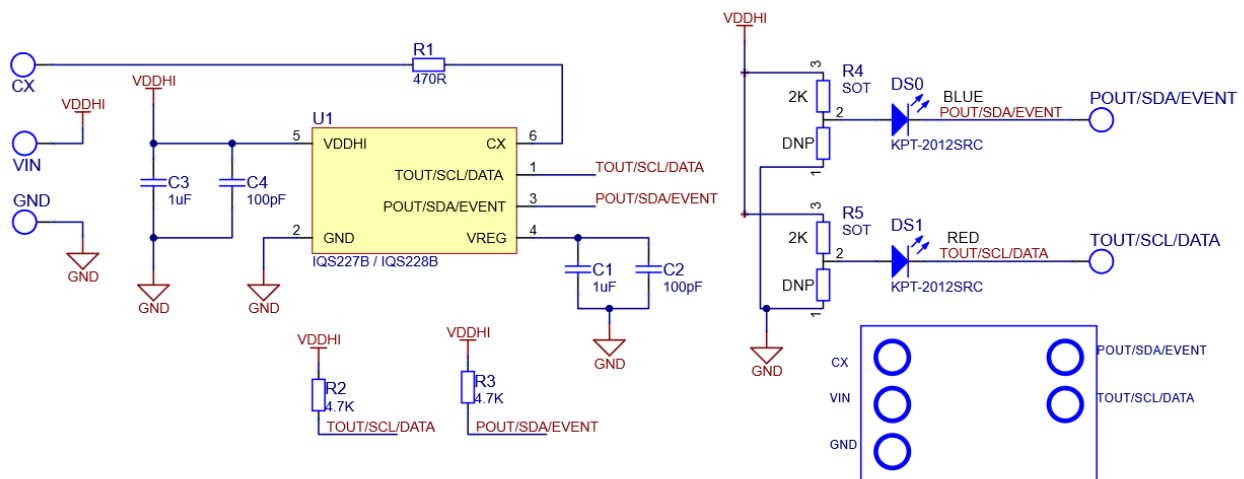
Figure 6.2 IQS227-228BEV02 Module board design

Appendix A   Contact Information

	USA	Asia	South Africa
Physical Address	11940 Jollyville Suite 120-S Austin TX 78750 USA	Room 501A, Block A, T-Share International Centre, Taoyuan Road, Nanshan District, Shenzhen, Guangdong, PRC	1 Bergsig Avenue Paarl 7646 South Africa
Postal Address	11940 Jollyville Suite 120-S Austin TX 78750 USA	Room 501A, Block A, T-Share International Centre, Taoyuan Road, Nanshan District, Shenzhen, Guangdong, PRC	PO Box 3534 Paarl 7620 South Africa
Tel	+1 512 538 1995	+86 755 8303 5294 ext 808	+27 21 863 0033
Email	info@azoteq.com	info@azoteq.com	info@azoteq.com

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