



Application Note: AZD070

IQ Switch® - ProxSense® Series

IQS5xx Programming and GUI (data streaming) Guide

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1 Overview

1.1 ProxSense® IQS5xx series – Features

The **IQS5xx** Series ProxSense® devices are fully integrated capacitive touch and proximity sensors with market leading sensitivity and automatic tuning on all the sense electrodes. The device is ready for use in a large range of applications while the I²C compatible interface provides full control to a host. Active low-power options are available with superior proximity sensing range for device wake up.

Main Features

- Proximity, touch and snap on each channel
- Swift report rates¹
- I²C™ (400kHz) compatible communication interface
- ATI: automatic tuning to optimum sensitivity
- Supply Voltage 1.65V to 3.6V
- Active low power operation (<10uA)²
- Event-driven / Continuous data I²C™ operation
- Dedicated proximity channel for superior proximity sensing
- Internal voltage regulator and reference capacitor (minimal external components required)
- On-chip noise detection and suppression

¹ Report rates are dependent on the number of active channels etc. (Please refer to IQS5xx datasheet).

² Current consumption is dependent on device configuration and selected power mode.

1.2 IQS5xx Series Devices

The ProxSense® **IQS5xx** series consist of the **IQS512**, **IQS525**, **IQS572** and **IQS550** devices.

DEVICE	FEATURES
IQS512	Projected Capacitive Sensor with up to 12-channels, X-Y Tracking, Snap (Click).
IQS525	Projected Capacitive Sensor with up to 25-channels, X-Y Tracking, Snap (Click).
IQS572	Projected Capacitive Sensor with up to 72-channels, X-Y Tracking, Snap (Click).
IQS550	Projected Capacitive Sensor with up to 150-channels, X-Y Tracking, Snap (Click).

IQS5xx Datasheets, Application Notes and other ProxSense® information available from:
www.azoteq.com

2 IQS5xx Firmware Programming

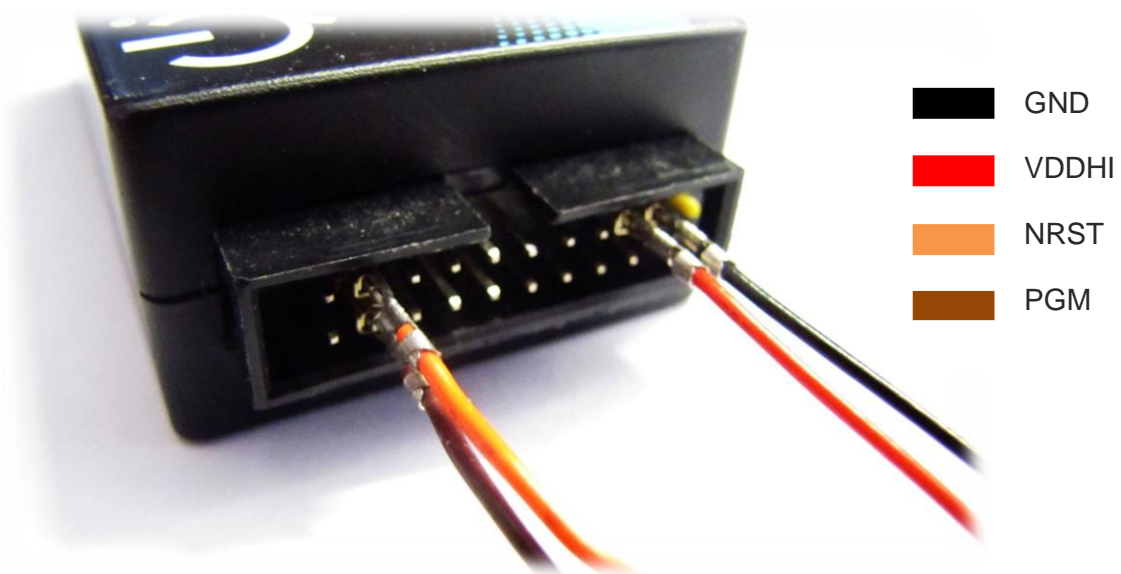
2.1 IQS5xx Firmware Upload:

The following steps are required for programming the **IQS5xx** devices:

- Connect the GND, VDDHI, NRST and PGM pins to the CT210 (or later) USB Dongle.
- Connect the USB dongle to your PC or laptop computer.
- Run the *AZOTEQ FLASH PROGRAMMER* software.
- Load the “*IQS5xx_firmware*”.hex file.
- Click the “Connect to Device” button.
- Click the “Program” button to program the IQS5xx device.

2.2 IQS5xx Connection:

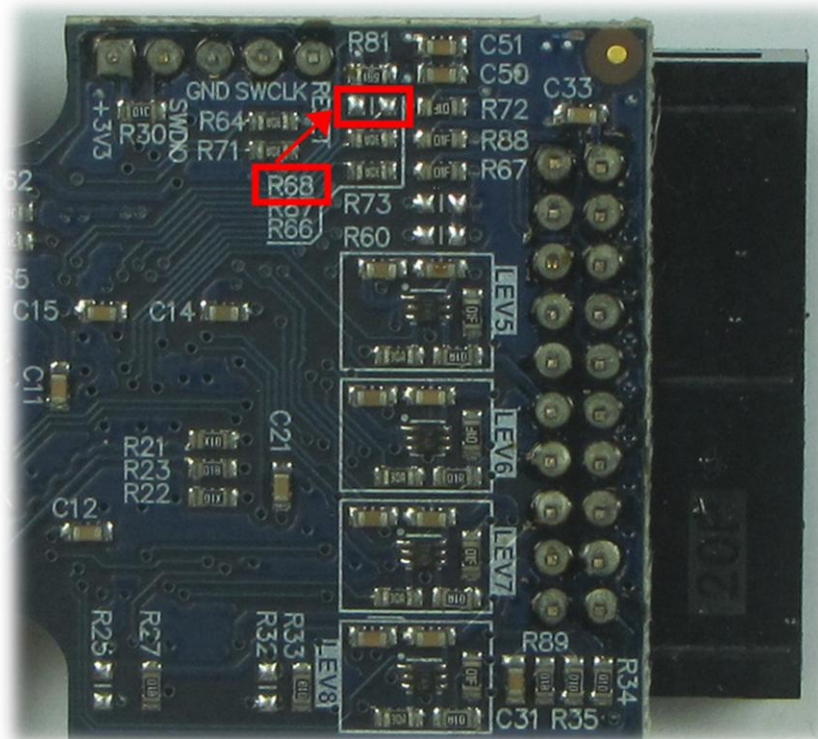
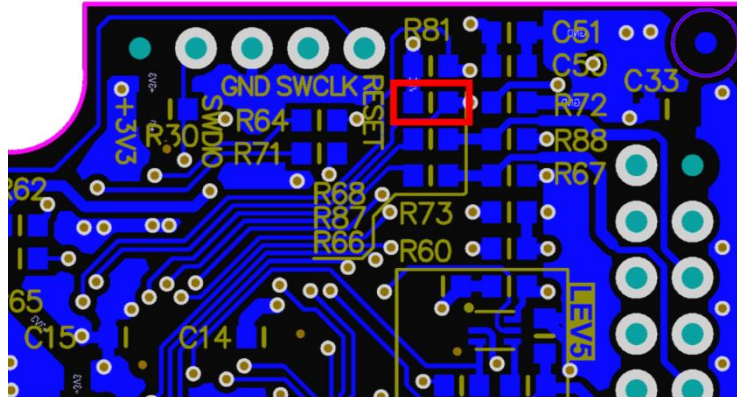
IQS5xx Pins	CT210 – or later (Azoteq Configuration Tool)
GND	CT210 – pin1
VDDHI	CT210 – pin3
NRST	CT210 - pin17
PGM	CT210 - pin18



2.3 NRST pull-up

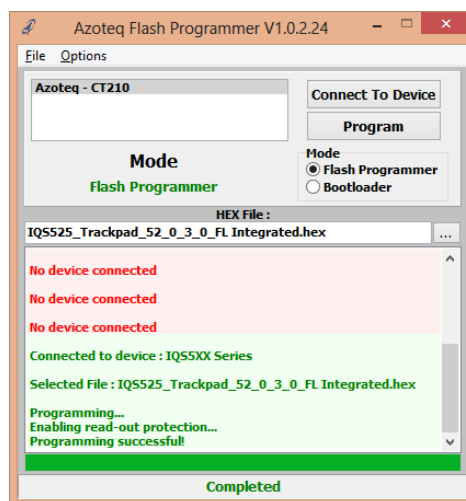
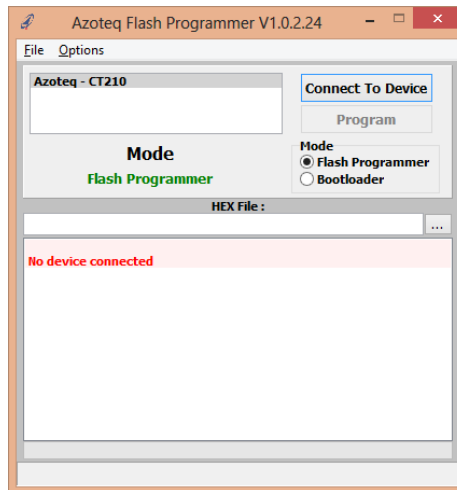
If the application PCB has the suggested 100nF (or similar) capacitor populated on NRST, it might be required to add a 1k pull-up resistor to the programming wires (between NRST and VDDHI). On the latest CT210 programming tools the pull-up is populated, however on some older hardware versions this pull-up is still required.

Alternatively you can populate the actual resistor on the CT210 PCB. You must populate R68 on board AZT231A02 as shown in the pictures below. R68 is populated on the bottom side of the PCB.

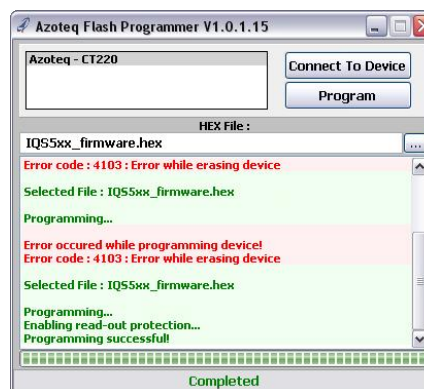
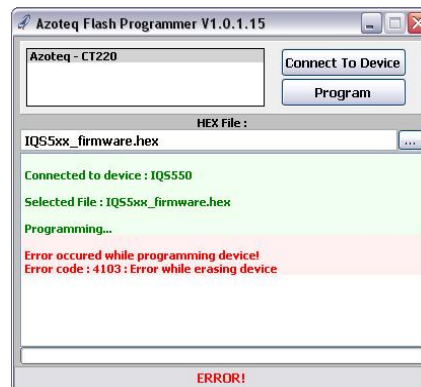


2.4 Troubleshoot:

- Connection error:
 - **No device connected**
 - Please check NRST and PGM line connections.
 - Click “Program” again to program IQS5xx device.
 - Repeat next step if error occurs again.
 - Make sure you have a pull-up resistor modification if you have a large capacitor on NRST, see Section 2.3.
 - If problem persists, please contact ProxSense® support.



- Programming error:
 - **Error Code 4103 - Error while erasing device**
 - Please check NRST and PGM line connections.
 - Click “Program” again to program IQS5xx device.
 - Repeat previous step if error occurs again.
 - If problem persists, please contact ProxSense® support.



3 IQS5xx (I²C) Comms Setup

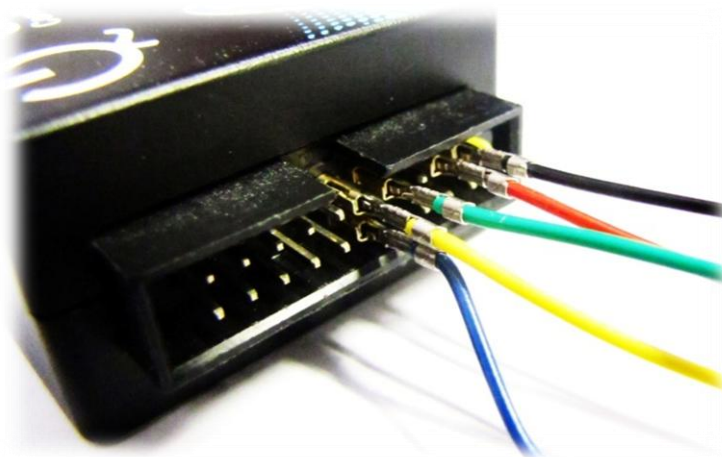
3.1 IQS5xx (I²C) Setup






The following steps are required for I²C data streaming on the **IQS5xx** devices:

- Connect the GND, VDDHI, SDA, SCL and RDY pins to the DS100 or CT210 (or later) USB Dongle.
- Connect the USB dongle to your PC or laptop computer.
- Run the *IQS5xx GUI* software and click “Start”. (See Section 3.4)
- Channel Setup (Select Active Channels)
- Streaming Setup (Select Channel Data)
- Select ATI C value (i.e. configure Base Value)
- Select ATI Target Value.
- Select Proximity and Touch Thresholds.
- Setup *PROX Hardware Settings*
- Setup Timings and Filters
- Save your settings and click “Auto ATI”
- Device is now operational

3.2 IQS5xx Connection:

IQS5xx Pins	DS100/CT210 (Azoteq Data Streamer / Configuration Tool)
GND	CT210 – pin1
VDDHI	CT210 – pin3
SDA	CT210 – pin7
SCL	CT210 – pin9
RDY	CT210 – pin10



	GND
	VDDHI
	SDA
	SCL
	RDY

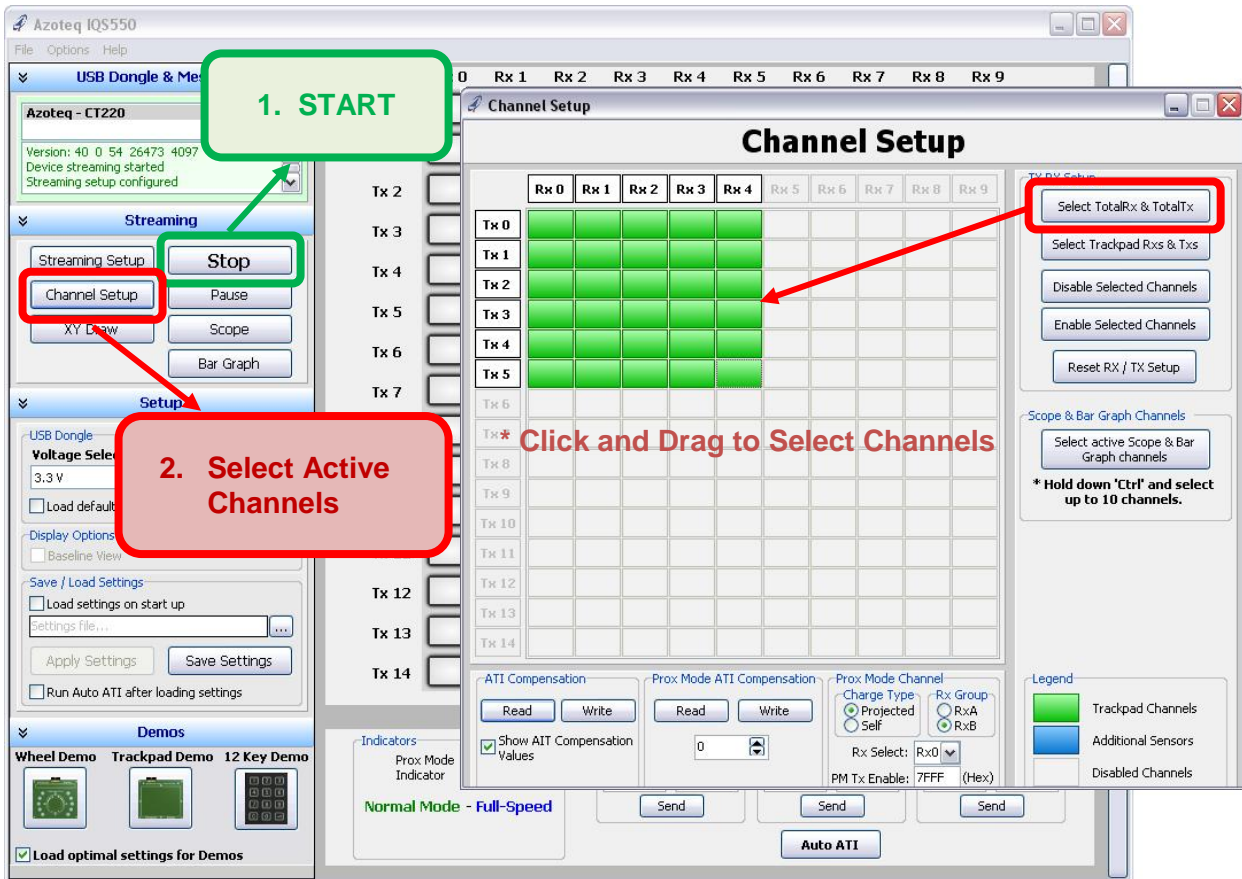


3.3 Troubleshoot:

- Streaming error:
 - **Warning: Unable to start device streaming!**
 - Please check I²C communication line (SDA, SCL and RDY) connections.
 - Check pull-up resistors on I²C lines (typ. 10kΩ).
 - Click “Start” again to start IQS5xx data streaming.
 - If problem persists, please contact ProxSense® support.

4 IQS5xx GUI setup:

4.1 “Start” and “Channel Setup”



- **Normal GUI use:**
 - Click “Start”
 - You can touch the capacitive area after the Start button is clicked.
- **Running a Demo:**
 - Click “Start”
 - Click the picture of the demo used, follow prompts in additional pop-up windows.
- **Setting up Channels**
 - Select Total of Tx’s and Rx’s used for both the Trackpad and Additional sensors (if used).
 - If additional sensors are used outside the Trackpad area, the Trackpad area will also need to be selected. Note that the Trackpad area will remain green, while the Additional sensor channels are changed to a blue colour (see “Legend”).
 - To disable channels, first select the channels to disable then click the “Disable Selected Channels” button.
 - If a Prox channel is needed, it can be setup in the “Prox Mode Channel” text box area. Please refer to the IC specific datasheets to set up the channel(s).



4.2 Channel Data (Streaming Setup)

The screenshot displays the Azoteq IQS550 software interface. The 'Streaming Setup' dialog box is open, showing the following options checked:

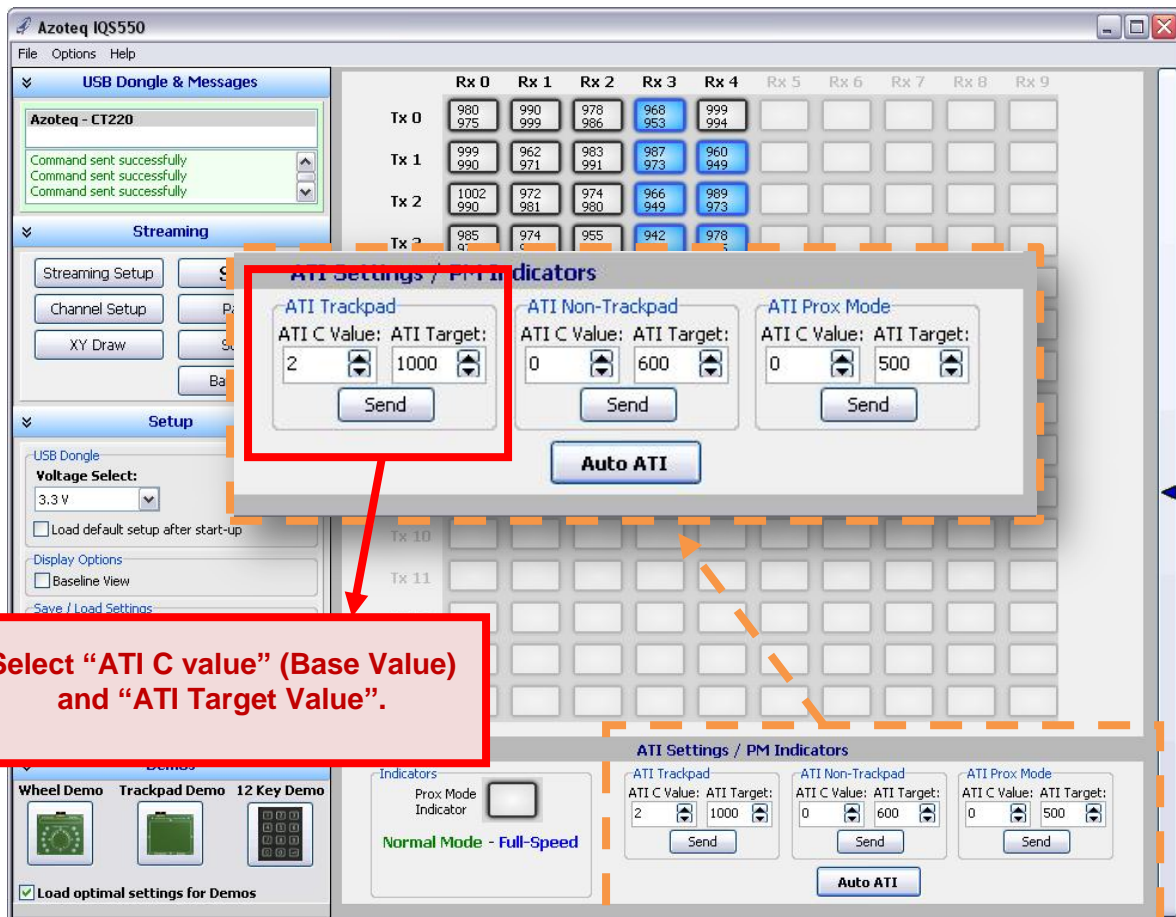
- XY Data
- Prox Status
- Touch Status
- Long Term Averages (LTA)

A green callout box contains the text: "Tick the desired boxes for required channel data." The background interface includes a data grid with Tx and Rx channels, and various control panels for USB Dongle & Messages, Streaming, Setup, and ATi Settings / PM Indicators.

- CS (Count) and LTA (Long-Term Average) values are used for debugging and tuning of the Trackpad sensors.
- Take note that the response rate will be affected so streaming of CS and LTA data should be disabled when not needed.



4.3 “ATI Target” & “ATI C Value” (Base Value)



▪ Tuning the Trackpad for the first time:

- In the ATI Settings panel below the sensor display area, set the “ATI C” and “ATI Target” values to 0 for “ATI Trackpad”, then Click Send and then Auto ATI.
- Now an indication of the amount of parasitic capacitance present in the circuit can be obtained by looking at the CS value (Base Value when: ATI C = 0, ATI Target = 0).
- The sensors of a well designed trackpad will have a uniformly distributed CS count in a range of 10-15% of each other. The higher the base count the more parasitic capacitance there is present in the circuit.
- Select an “ATI C” value to obtain a CS value equal to approximately ¼ of the target value (Typical target for high sensitivity = 900-1000 counts).
- Higher target values induce slower response rates and vice versa (depending of number of active channels etc).
- Adjust the ATI C and Target values to get the desired response rate and sensitivity.

*Note: *The response rate of the IQS5xx devices are influenced by several factors, including number of active channels, amount of streamed data, ATI Target Value, CS filtering and other processing options. Please contact Azoteq for assistance or more information at: ProxSenseSupport@azoteq.com*



4.4 Proximity & Touch Thresholds

The screenshot shows the Azoteq IQS550 GUI with several panels. The 'Thresholds' panel is active, showing 'Touch Threshold (Fraction)' set to 5/2⁷ and 'Trackpad' set to 10. The 'Timing' panel is also visible, showing 'Reseed Time' set to 80 (40s) and 'Power Time' set to 160ms. A red box highlights the 'Touch Threshold (Fraction)' and 'Trackpad' settings, with a red arrow pointing to a text box that says 'Select Required Proximity and Touch Thresholds'. The 'Timing' panel is also highlighted with a dashed orange box.

- Select the required Proximity and Touch Thresholds from the thresholds selection panel (the Settings panel is “activated” by the arrow on the right hand side of the GUI window).
- **Proximity Thresholds** are specified in Counts.
- **Touch Thresholds** are calculated as a fraction of the Long-Term Average (LTA) value, using the equation:

$$Touch\ Threshold = (x/2^y) \times LTA$$

- For this example the Proximity Thresholds will be $P_{TH} = 10$ counts, whereas the Touch Threshold will be $T_{TH} = 5/128 * LTA \approx 40$ counts ($x = 5$; $y = 7$; $LTA \approx 1000$).
- Note there are different touch thresholds for different touch areas, such as Trackpad and Non-Trackpad areas.



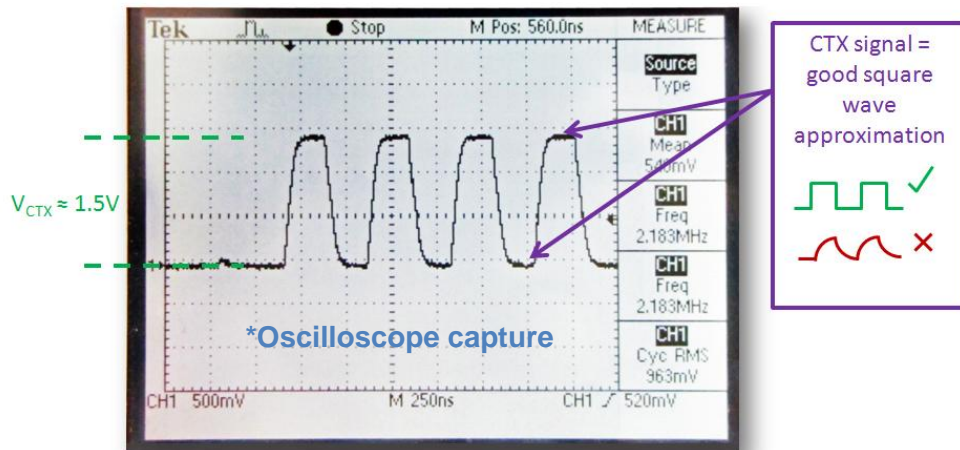
4.5 PROX Hardware Settings

The screenshot shows the Azoteq IQS550 software interface. A 'Prox Hardware Settings' dialog box is open, highlighting several configuration options:

- Increment Up/Pass
- Analogue Dead-time
- CRx Coupling (CxVss)
- Prox Module LowPower
- Noise Detect Enable
- SYNC Enable
- Sync Edge Select
 - Falling Edge
 - Rising Edge
- Pass Length: 011
- UpLength: 100
- Vtrip: 0101
- Opamp Bias: 5.0 uA
- Stabilise Time: 1.7ms
- Prox Clock: 16MHz

The background interface shows a grid of transmit (Tx) and receive (Rx) signal levels, a 'Thresholds' section for touch and proximity settings, and a 'Timing' section for reseed and sleep times. A status indicator at the bottom shows 'Normal Mode - Full-Speed'.

- PROX Hardware Settings may be adjusted to obtain the required Transmit (TX) signal, so as to acquire sufficient charge transfer.



- Please note that changing these settings is not advised without sufficient knowledge of the device's sensing mechanisms. Please contact Azoteq at ProxSenseSupport@azoteq.com



4.6 Timings, Filters & Debounce

The screenshot displays the Azoteq IQS550 software interface. The central panel shows a grid of Tx (Tx 0 to Tx 14) and Rx (Rx 0 to Rx 3) values. The right-hand side contains several configuration panels: 'Thresholds', 'Timing', 'Position Tracking & Filters', and 'Other'. The 'Timing' panel is highlighted with a red box and contains the following settings: Reseed Time: 80 = 40s, I²C Timeout: 100 ms, Mode Timer: 8 = 4s, Low Power Time: 160ms, and Sleep Time: 5ms. The 'Position Tracking & Filters' panel is also highlighted with a red box and contains: Touch Filter (Dynamic Filter selected), Damping Value (Touch XY: 128 /256, Hover XY: 38 /256), Touch Point Filtering (checked), Hover Point Filtering (checked), ProxMode Count Filter (checked), and NormalMode Count Filter (checked). The 'Other' panel is highlighted with a red box and contains: Control (Event Mode Comms, Snap/Click Enable, Sleep Enable), Charging Mode (Normal Mode selected), and Debounce settings (Proximity: Set 4, Clear 4; Touch: Set 1, Clear 1; Click: Set 1, Clear 1). The 'Other' panel also includes a 'Prox Hardware Settings' section with options for Low Power Mode and PM Reverse.

- Timing values may be set according to the requirements of the application.
- Typical filtering of the CS count data is performed by the “NormalMode Count Filter” and “NM Count” filter value.
- Debouncing of Proximity and Touch events are configured by the number of “Set” and “Clear” samples.
- Please refer to device specific datasheets for more information on these settings.



4.7 Save Settings & “Auto ATI”

The screenshot shows the Azoteq IQS550 software interface. The left sidebar contains several sections: 'USB Dongle & Messages', 'Streaming', 'Setup', and 'Demos'. The 'Setup' section is highlighted with a red box, and a red arrow points from the 'Save Settings' button to a red box labeled '1. Save Settings'. The 'Demos' section has 'Load optimal settings for Demos' checked. The main area displays a grid of Tx and Rx channels with numerical values. A red box labeled '2. Click “Auto ATI”' has a red arrow pointing to the 'Auto ATI' button in the 'ATI Settings / PM Indicators' section at the bottom right.

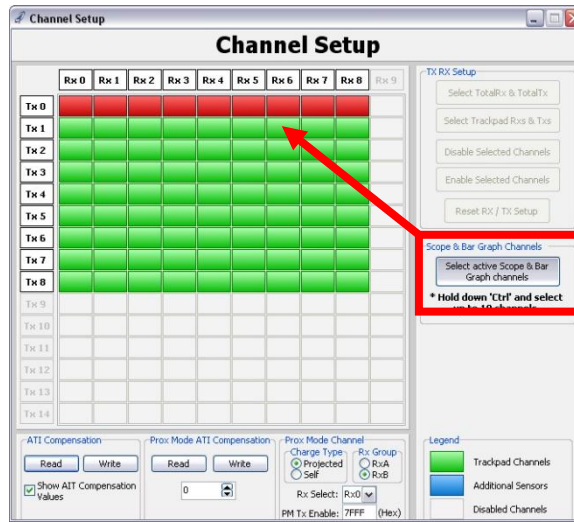
	Rx 0	Rx 1	Rx 2	Rx 3	Rx 4	Rx 5	Rx 6	Rx 7	Rx 8	Rx 9
Tx 0	980 975	990 999	978 986	968 953	999 994					
Tx 1	999 990	962 971	983 991	987 973	960 949					
Tx 2	1002 990	972 981	974 980	966 949	989 973					
Tx 3	985 979	974 983	955 960	942 924	978 965					
Tx 4	988 980	990 995	992 997	990 972	984 966					
Tx 5	970 959	975 978	970 970	976 956	965 946					
Tx 6										
Tx 7										
Tx 8										
Tx 9										
Tx 10										
Tx 11										
Tx 12										
Tx 13										
Tx 14										

- The configured settings can be saved as a “.ini” file, which can be loaded on start-up.
- Click the “Auto ATI” button to redo the ATI (Antenna Tuning Implementation) algorithm.
- The device should now be fully set-up and ready for use.

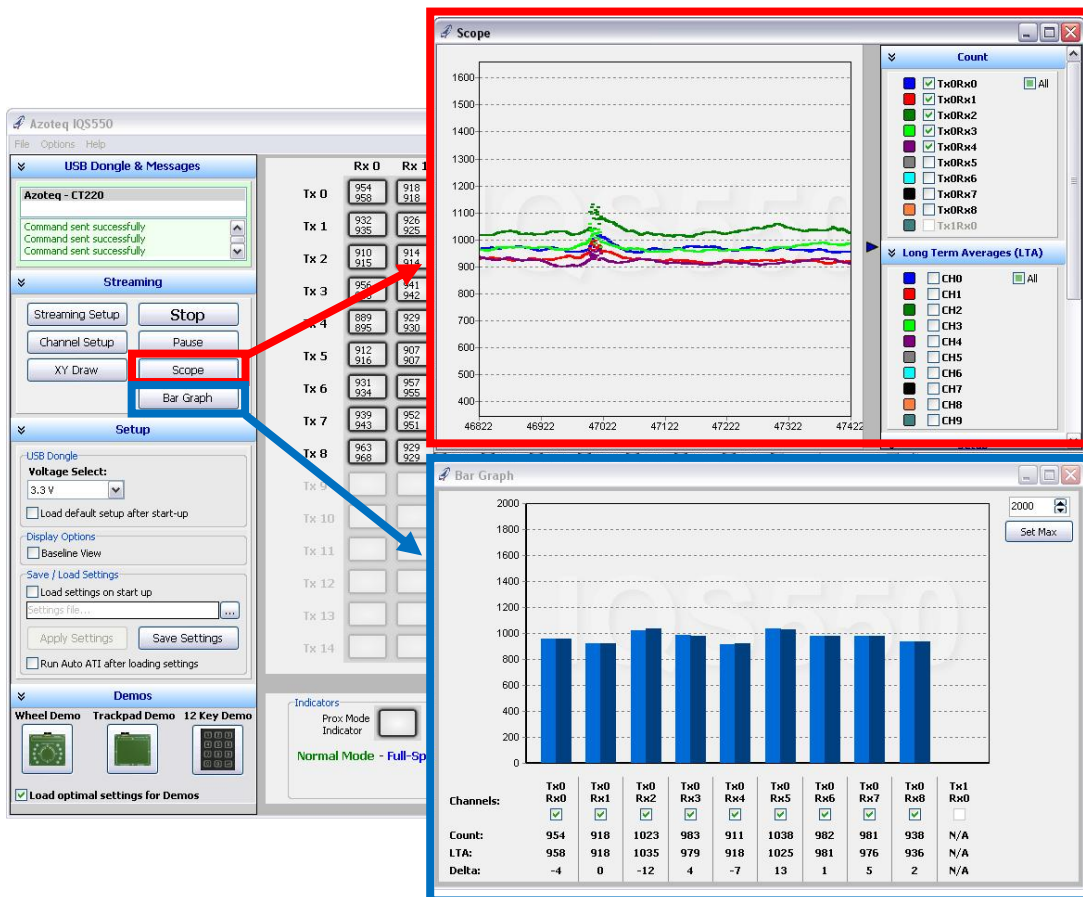


5 IQS5xx GUI Features

5.1 Bar Graph and Scope View

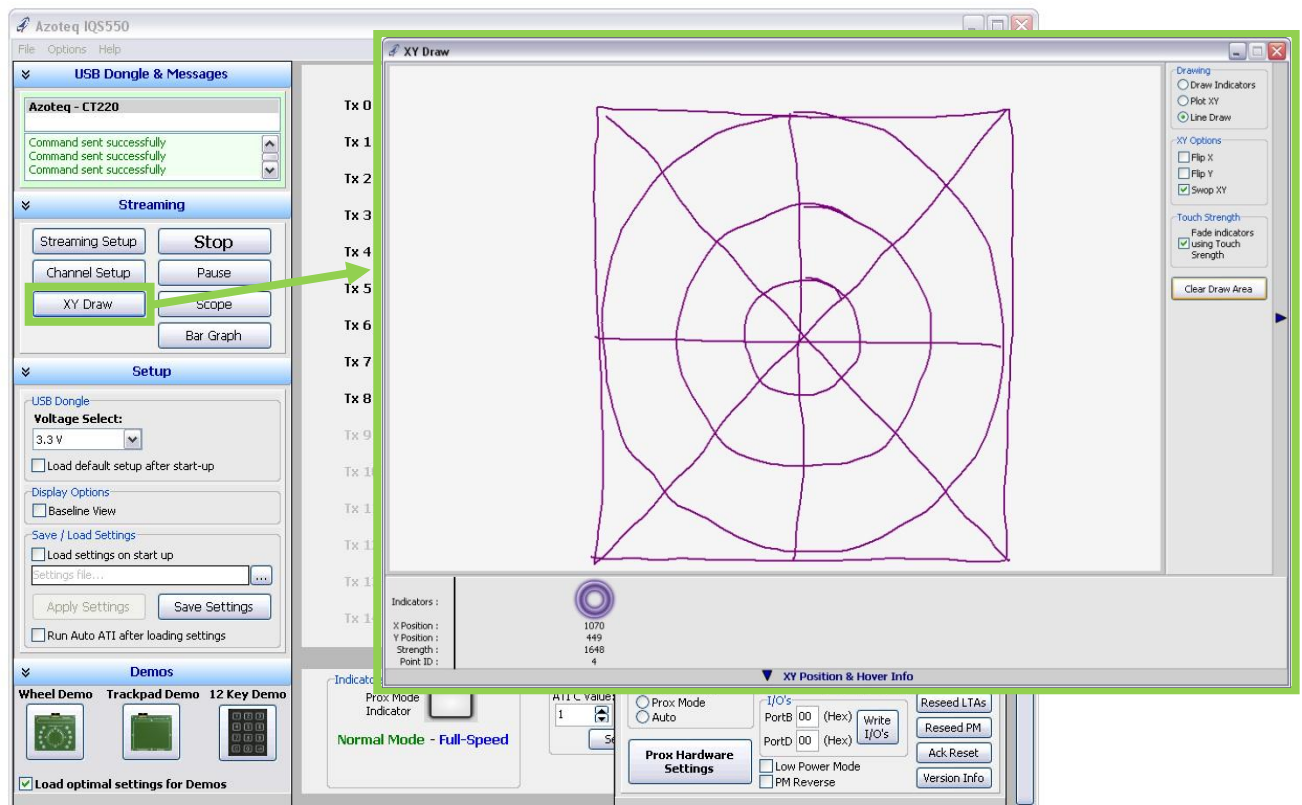


- In the Channel Setup Window, click “Select active Scope & Bar Graph channels”.
- Hold “ctrl” key and click the desired channels to be viewed.



- Click the “Bar Graph” or “Scope” buttons to view channel data in the respective formats.

5.2 XY Draw



- Click the “XY Draw” button to enable the XY Draw window.
- Select the appropriate “Drawing” and “XY Options” in the panel on the right.
- Multi-touch/-draw functionality allowed on most **IQS5xx** devices.



For more information on ProxSense® IQS5xx Series devices, please contact Azoteq or your local distributor of Azoteq ProxSense® devices.

The following patents relate to the device or usage of the device: US 6,249,089 B1, US 6,621,225 B2, US 6,650,066 B2, US 6,952,084 B2, US 6,984,900 B1, US 7,084,526 B2, US 7,084,531 B2, US 7,119,459 B2, US 7,265,494 B2, US 7,291,940 B2, US 7,329,970 B2, US 7,336,037 B2, US 7,443,101 B2, US 7,466,040 B2, US 7,498,749 B2, US 7,528,508 B2, US 7,755,219 B2, US 7,772,781, US 7,781,980 B2, US 7,915,765 B2, EP 1 120 018 B1, EP 1 206 168 B1, EP 1 308 913 B1, EP 1 530 178 B1, ZL 99 8 14357.X, AUS 761094

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