



AZD123 - IQS721XY TRACKPAD USER GUIDE

User guide for IQS721xy Trackpad series. Description of product configuration using provided supporting tools

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¹Only applicable to IQS7210A.



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1 Introduction

The aim of this document is to give a step-by-step guide on how to configure the IQS721xy device for a custom design application. This guide assumes that the IC is already programmed with generic Azoteq trackpad firmware listed below. For details on programming IQS721xy products, please refer to the Azoteq OTP Programmer guide.

- > [IQS7210A](#)
- > [IQS7211A](#)
- > [IQS7211E](#)

This document will assist in using the IQS721xy in the intended manner to obtain a working solution with ease. A summary of the design process is shown below:

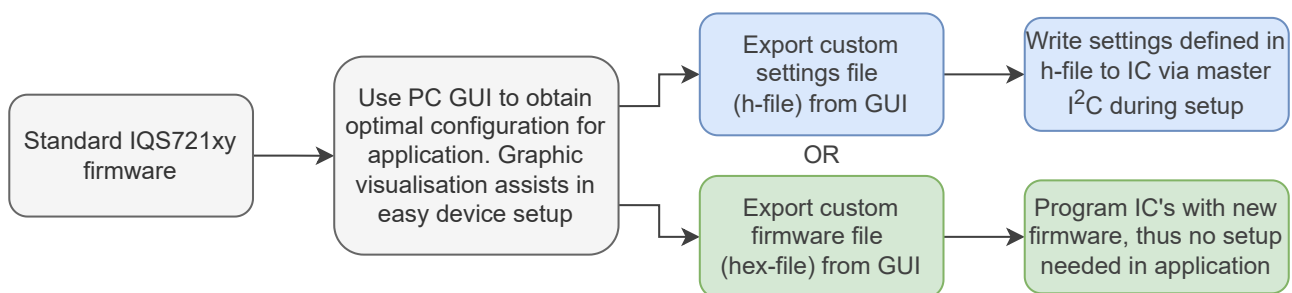


Figure 1.1: Design Process Summary

The result of this process is to obtain a settings or firmware file which includes the parameters specific for the current application. Obtaining a custom firmware file simplifies the master controller firmware with no device setup required at run-time; the device is ready to operate faster after power-up, without any intervention.

Since this is a setup guide, please also refer to the relevant IQS721xy datasheet for specific product details.

Please see the sections listed below for a **summary** of the setup steps.

- > Basic Setup Summary -> [Section 3.5](#)
- > Intermediate Setup Summary -> [Section 4.7](#)
- > Advanced Setup Summary -> [Section 5.9](#)



2 General Setup Guidelines

2.1 Hardware Connections

Connect the application hardware power and I²C lines to the CT210A USB dongle as shown in the table and figure below. Now connect the USB of the CT210A to the PC.

Table 2.1: CT210A Pin-out

IQS721xy Pins	CT210A Pins
GND	Pin 1
VDD	Pin 3
SDA	Pin 7
SCL	Pin 9
RDY	Pin 10

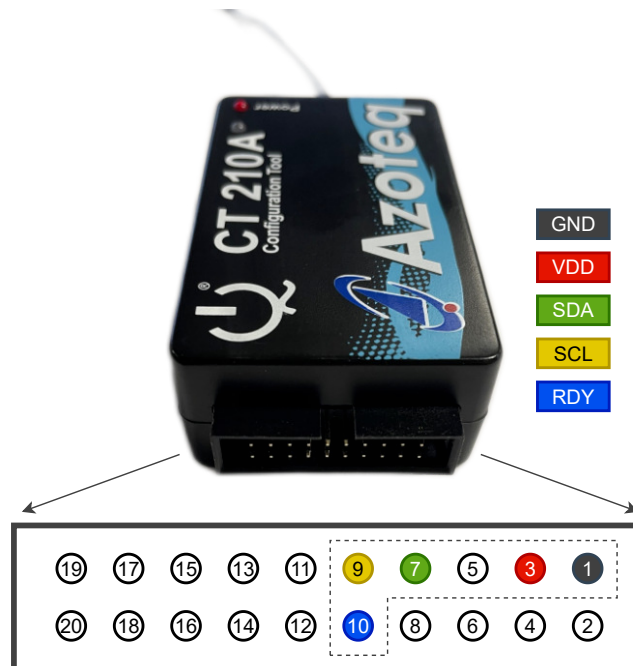


Figure 2.1: CT210A I²C Connections

2.2 IQS721xy GUI Software

The graphical user interface (GUI) is a powerful support/design tool to simplify the process of configuring the IQS721xy device with the parameters required for optimal performance for customer specific hardware.

An introduction on how to use Azoteq's debug and display tool can be seen in this [video](#).

The latest GUI can be obtained from the relevant product page on the [Azoteq website](#).



3 Basic Device Setup

The on-chip parameters need to be configured for the application to operate optimally. Setting up a capacitive sensing device for optimal performance requires several parameters to be tuned correctly. However, to get started, a basic setup is easy to achieve after which the settings can be optimised, and more advanced features can be configured.

3.1 Getting Started

The number of sensors implemented, and their connections, are configured together with an initial configuration from which to start optimising.

The AZP1189A3 EV-kit PCB is the hardware used as example to be configured in this document. The IQS7211A trackpad firmware is compatible with this hardware.

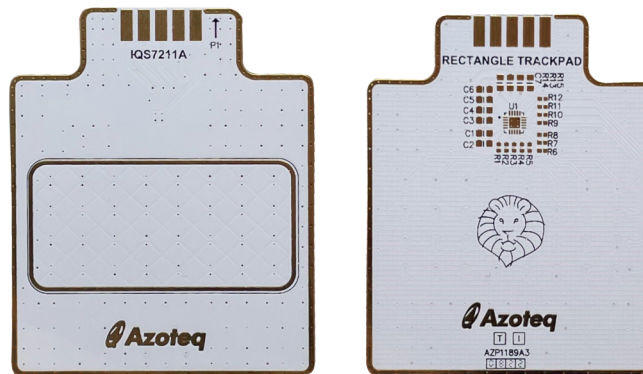


Figure 3.1: AZP1189A3 Trackpad Hardware

Start the device by pressing the 'Start Streaming' button on the main window. Look out for any errors in the top left window, if all is in order, the configuration section should display as follows:

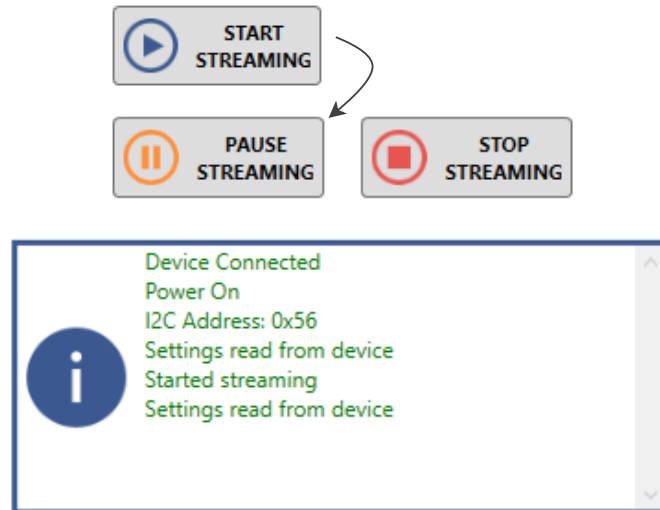


Figure 3.2: Successful Device Connection and Start

If this is not successful, make sure the I²C connections to the device are connected correctly. Also make sure that the CT210A is connected via USB to the PC. If successful, pressing the 'Ack Reset' button will change it from red to black, showing the reset flag was cleared. If it ever becomes red again, the reset flag is set, indicating that an unexpected reset occurred.

The settings are configured from the separate settings window which can be opened from the main window by pressing the 'User Settings' button. Once any setting is modified, it needs to be sent to the device by pressing the 'Write Changes' button. To revert to the settings before the adjustment (if it has not yet been written), the 'Read Settings' button can be pressed.

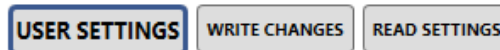


Figure 3.3: Buttons Preview



3.2 Rx and Tx Setup

3.2.1 Total Rxs and TxS

The first step is to select the total number of Rx and Tx sensors implemented in the design. The AZP1189A3 trackpad layout is shown in the figure below, and it can be seen that there are 8 Rxs configured as columns, and 4 TxS configured as rows.

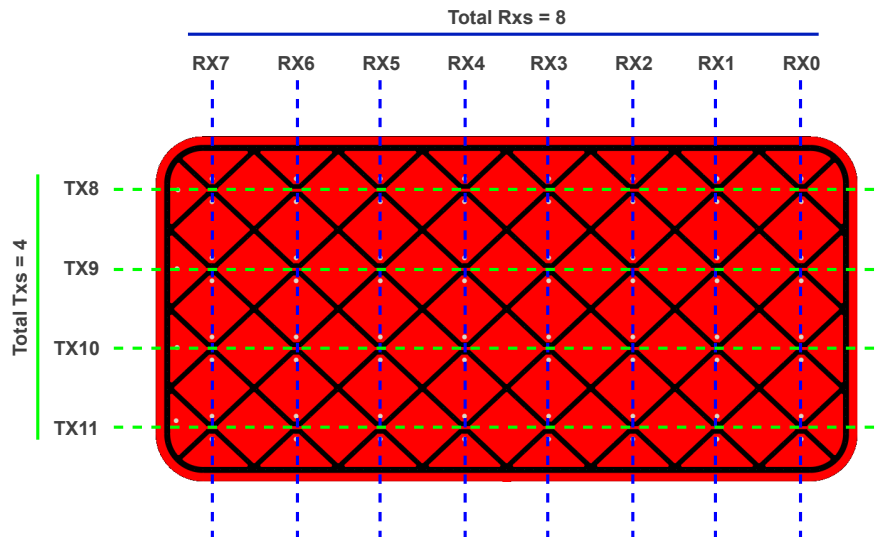


Figure 3.4: AZP1189A3 Trackpad Layout

To set up the Total Rxs and Total TxS parameters, open the 'User Settings' window and click on the 'Trackpad Settings' tab. Here the value for Total Rxs and TxS can be set to 8 and 4 respectively.

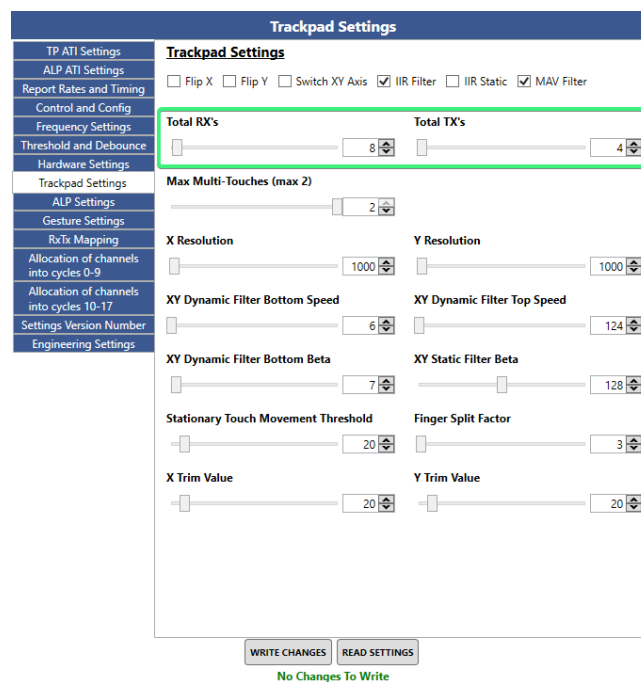


Figure 3.5: Total Rxs and TxS



3.2.2 Rx and Tx Mapping

The Rx and Tx numbers on the AZP1189A3 layout are shown in Figure 3.4 (Rxs being columns, and Txs rows).

The mapping is now configured in the 'RxTx Mapping' tab by modifying the selections. The Rx and Tx mapping is taken from the top-left corner of the trackpad, with the Rxs mapped firstly, followed by the Txs.

The mapping for the AZP1189A3 hardware is configured as shown in the figure below. Rxs are marked in blue and Txs are marked in green. When the Rxs and Txs are correctly set, press 'Write Settings' to send the settings to the IQS721xy. For the remainder of this document, it is assumed that 'Write Settings' is pressed after any parameter is changed.

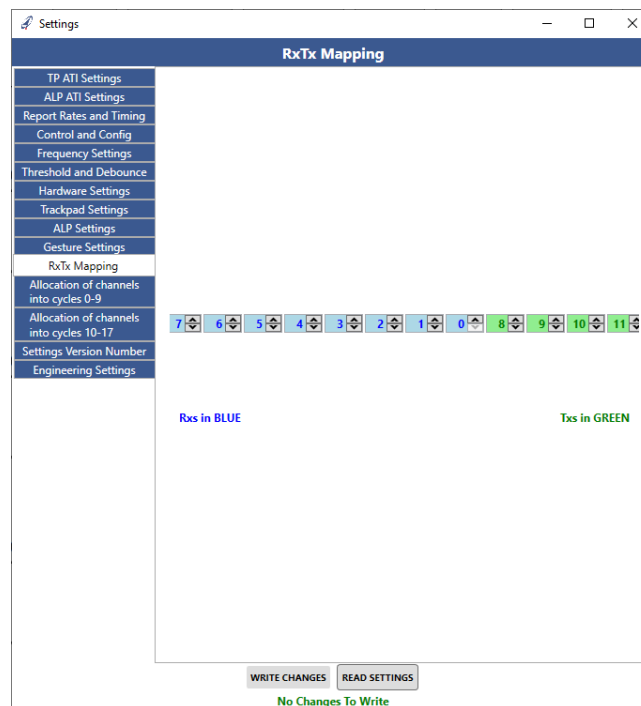


Figure 3.6: Rx/Tx Mapping

3.3 Allocation of Channels into Cycles

These two points are important to remember when doing the trackpad layout:

- > The trackpad channels need to be packed into cycles. Each cycle can simultaneously sense one channel from Prox block A (Rx0-3) and one from Prox block B (Rx4-7). They must be for the same Tx, and the channel numbers are packed into the cycle numbers accordingly. A value of 255 for the channel number indicates no channel is allocated.
- > It is best to design the Rxs as the even numbered sensors, so that optimal cycles/timeslot usage occurs. Similarly, a balanced number of sensors from A and B are optimal. To make routing easier, the sequence of Rx and Tx is not important. If they have been routed out of sequence, this must simply be configured accordingly.

Trackpad channels are numbered from 0 to (Total Rxs * Total Txs) - 1. They are assigned from the top-left corner, first along the Rxs before stepping to the next Tx. The channel number must be known



for allocating channels into sensing cycles (timeslots), and the GUI can assist with this. Hover over one of the channel blocks in the main window to see the channel number and Rx/Tx pair:

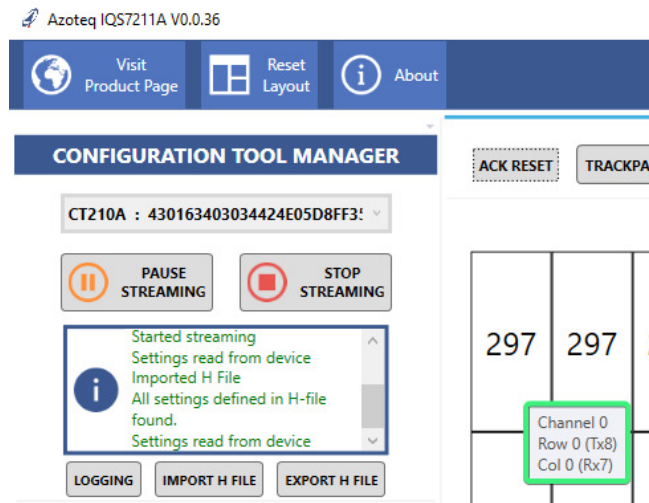


Figure 3.7: Channel Number and Rx/Tx pair

Here is an example of the AZP1189A3 8x4 trackpads' channel numbers:

Table 3.1: Channel Number Assignment

				Rxs							
				7	6	5	4	3	2	1	0
				Columns							
				0	1	2	3	4	5	6	7
Txs	8	Rows	0	0	1	2	3	4	5	6	7
	9		1	8	9	10	11	12	13	14	15
	10		2	16	17	18	19	20	21	22	23
	11		3	24	25	26	27	28	29	30	31

Using Table 3.1 pack the trackpad channels into cycles. The first channel of each cycle must be a channel from Prox block A (Rx0-3) and the second a channel from Prox block B (Rx4-7).



Table 3.2: Channel Number Assignment

	Prox Block A (Rx0-3)	Prox Block B (Rx4-7)
Cycle Number	Channel Number	
0	4	0
1	5	1
2	6	2
3	7	3
4	12	8
5	13	9
6	14	10
7	15	11
8	20	16
9	21	17
10	22	18
11	23	19
12	28	24
13	29	25
14	30	26
15	31	27
16	255	255
17	255	255

Navigate to the 'Allocation of channels into cycles' tabs in the GUI and fill according to Table 3.2.

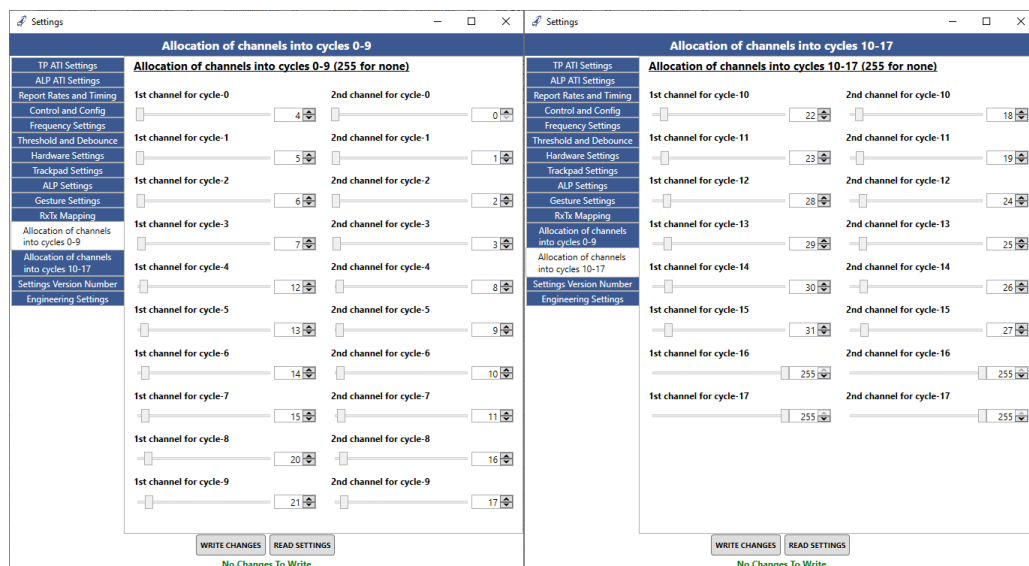


Figure 3.8: Allocation of Channels into Cycles

Now with the trackpad basics configured, press the 'Trackpad Re-ATI' button to reconfigure the trackpad channels.



3.4 Alternate Low-Power Channel (ALP) Rx and Tx Selections

To provide lower power consumption, the trackpad can be configured as a single sensor in Low Power 1 (LP1) and Low Power 2 (LP2), instead of sensing the individual trackpad channels.

This channel needs to detect user interaction to wake the device from LP1/LP2 and to make a transition to the trackpad sensing state (Idle mode). Due to this, it is normally set up using alternating sensors on the trackpad, or a similar configuration providing enough coverage area and wake-up capability on the trackpad. The ALP channel is sensed in a single timeslot.

Mutual- or self-capacitive charging can be configured. Normally the trackpad sensors are used, and therefore, mutual capacitive is used most often. If an additional sensor is designed using an unused Rx it could be possible to configure this as a self-capacitive sensor.

Select some of the Rx and Tx electrodes to form the ALP channel under the 'ALP Settings' tab. It is advised to enable the same number of RxA (Rx0-Rx3) electrodes and RxB (Rx4-7) for the ALP channel. Such as for this example where 2 Rxs from each Prox block were selected. Less electrodes may be selected than in the example below. The electrodes that are active in LP is highlighted in green and blue below.

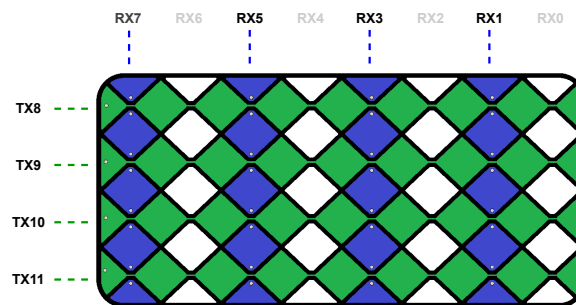


Figure 3.9: ALP Channel Mapping

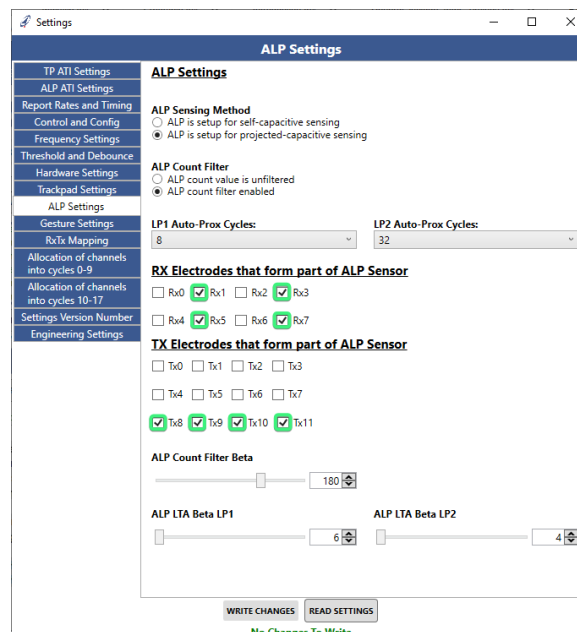


Figure 3.10: ALP Rx and Tx Selections



3.5 Basic Setup Summary

At this point the device is operational. The hardware (layout and sensor design) has been configured on the device. It is advised that settings changed up to this point is now saved to a header file (h-file) so that you don't lose these changes. Click the '*Export H File*' button and click *Save* to save the file. When you stop streaming and disconnect the device you can easily get back to the same save point. To import your settings, click the '*Import H File*' button and select the h-file. See Section [6.1](#) for more details.

1. Connect trackpad hardware to CT210A
2. Connect CT210A to the PC via USB
3. Open Azoteq GUI software
4. Press '*Start Streaming*'
5. Press '*Ack Reset*'
6. Press '*User Settings*'
7. Configure Total Rxs and Total Tx
8. Configure the RxTx Mapping
9. Allocate channels into cycles
10. Press '*Trackpad Re-ATI*'
11. Make the Rx and Tx selections for the ALP channel
12. Proceed to Section [4](#) if you experience any issues or require further assistance



4 Intermediate Device Setup and Debugging

4.1 Rx/Tx Mapping Check

Confirm that the Rx/Tx mapping aligns with the channel display on the main window by touching left, right, top and bottom, and confirming whether the channels mirror the hardware locations (check only touch location, for now ignore the XY position output). If these do not match the finger location on the hardware, then you can reverse the order of the Rx and Tx mapping to correct this. This is mostly a GUI display setup, but it is beneficial that the GUI display and actual hardware location are aligned.

Note: If you reverse or edit the Rx mapping, you will most likely need to review the cycle allocation also.

4.2 ATI Setup

4.2.1 Trackpad ATI Setup

The ATI parameters are a very important step in the configuration of the IQS721xy device. The channels are configured to give acceptable sensitivity and performance. We will keep the setup basic here, but refer to Azoteq literature for further details regarding ATI technology. While changing trackpad ATI settings it is beneficial to enable *Manual Control* under the 'Control and Config' tab and force the device to stay in *Active* mode. Remember to disable *Manual Control* again afterwards.

These parameters can be set in the 'TP ATI Settings' tab to give acceptable sensitivity and performance. The channel sensitivity can be estimated by:

$$\text{Sensitivity} \propto \frac{\text{ATI Target}}{\text{ATI Base Target}}$$

The *ATI Base Target* can be read from the device and viewed in the channel grid as illustrated below. Click on the 'Counts' radio button under 'Streaming Options' in the main window. Set the *ATI Target* to 0. Remember to press the 'Trackpad Re-ATI' button after changing ATI settings. The *ATI Error* and *Re-ATI Occurred* flags can be seen under *Info Flags* in the bottom right area. The value you see now is the *ATI Base Target*.

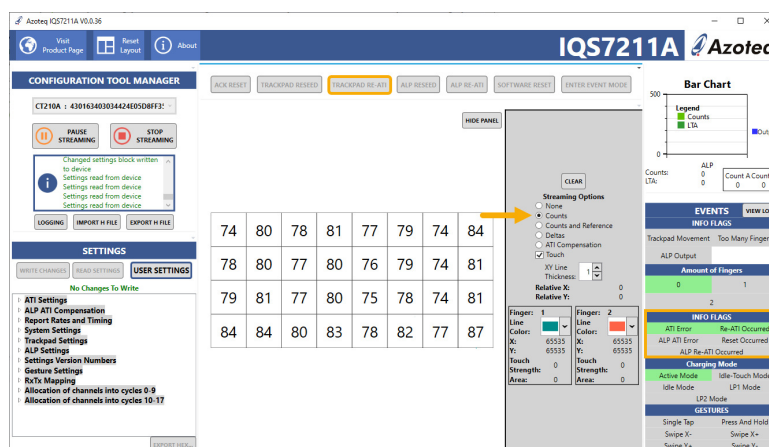


Figure 4.1: Read ATI Base Target Values

The ATI Compensation can be read from the device and viewed in the channel grid as illustrated



below. Change the ATI target back to 300, re-ATI and click on the 'ATI Compensation' radio button under 'Streaming Options' in the main window.

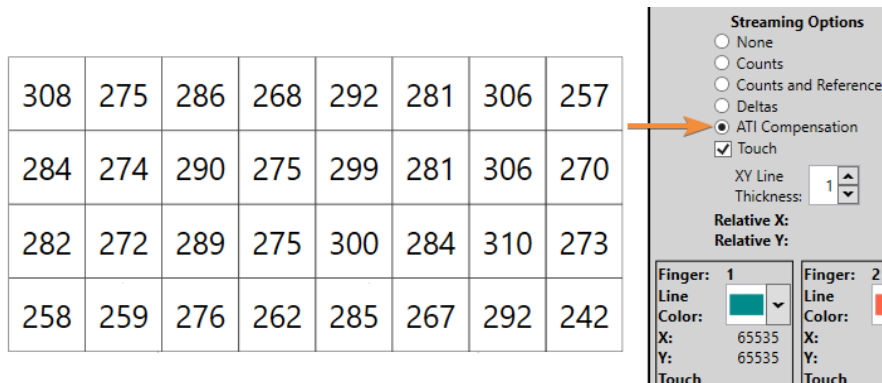


Figure 4.2: Read ATI Compensation Values

- > Increasing the *ATI Target* will increase sensitivity, resulting in larger touch deltas. It is however not recommended to increase larger than 300, since then the report rate is further reduced. Rather adjust the base if more sensitivity is needed.
- > The ATI Compensation can be scaled by means of the *Compensation Divider*. Since the 'size' of compensation is scaled, a small divider value will relate to large compensation, meaning the step size of each compensation unit increase will be larger. For smaller more accurate compensation steps, a larger divider is selected, but the 'range' of compensation is then reduced. Increasing the *Compensation Divider* would increase the ATI Compensation values. Ideally, the ATI Compensation values should not be near the lower or upper limits.
- > The *Coarse Divider / Multiplier* can be used to configure the *base target* value for the trackpad and ALP channels.
 - Increasing the *Coarse Divider* will increase the base target, and therefore decrease ATI Compensation and decrease touch deltas.
 - Increasing the *Coarse Multiplier* will decrease the base target, and therefore increase ATI Compensation and increase touch deltas.
- > Increasing the *Fine Divider* will decrease ATI Compensation and decrease touch deltas.



The table below can be used to assist with selecting ATI parameters.

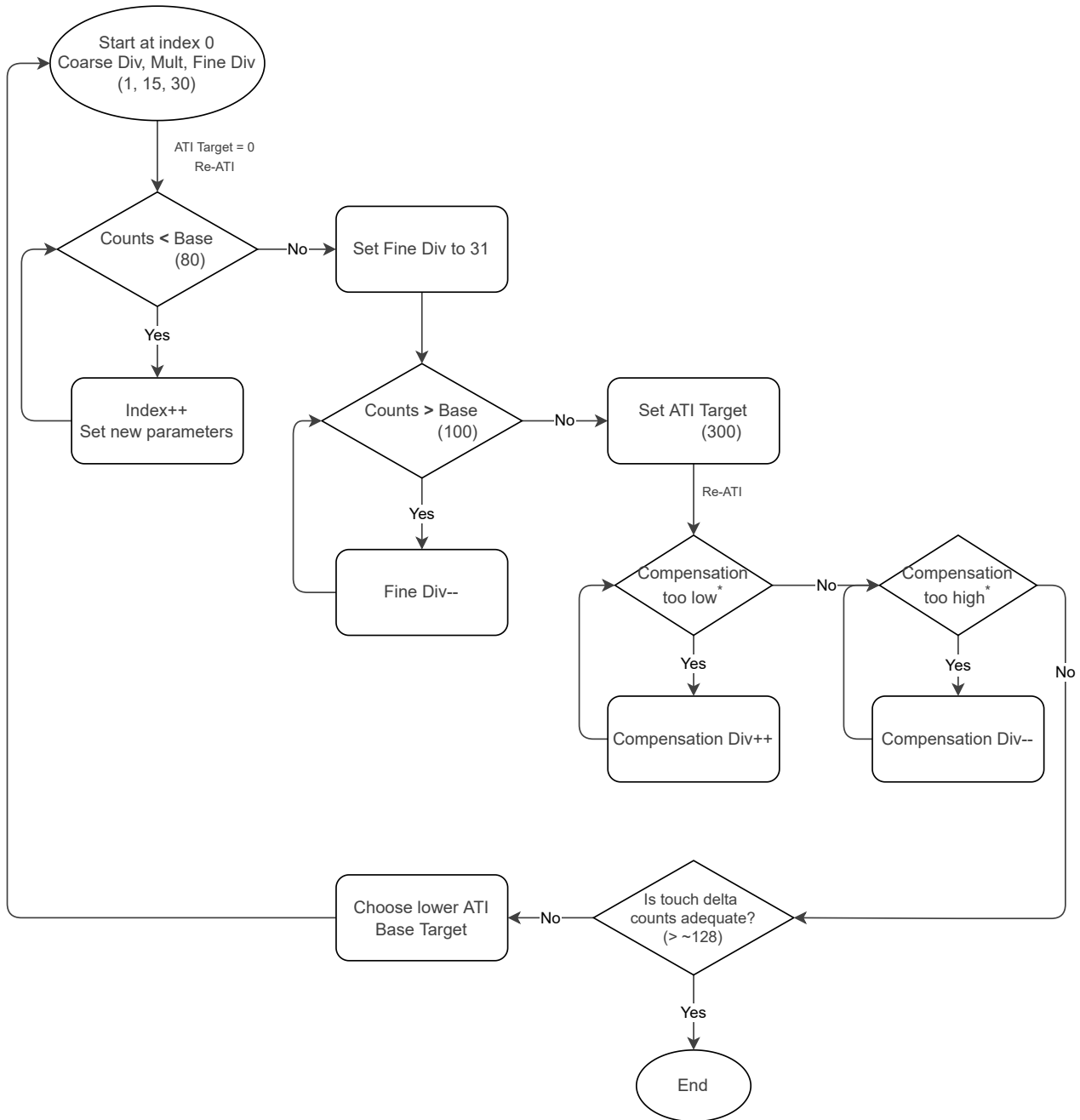
Table 4.1: ATI Parameter Lookup Table

Index	Coarse Divider	Coarse Multiplier	Fine Divider
0	1	15	30
1	1	6	30
2	2	14	30
3	2	4	30
4	2	2	30
5	4	2	30
6	7	2	30
7	14	2	30
8	31	2	30
9	31	1	30

Follow these steps to determine values for the ATI parameters:

1. Enable *Manual Control* under the 'Control and Config' tab and force the device to stay in *Active* mode by selecting it.
2. Start with the values at index 0 as indicated in Table 4.1.
3. Set the *ATI Target* to 0 and press the 'Trackpad Re-ATI' button.
4. Read the ATI Base Target values as illustrated in Figure 4.1.
5. Choose a suitable ATI Base Target. Choose 80 for this example.
6. If the count values you read are **below** the desired ATI Base Target, step to the values at the next index. Continue to step to the next index until the count values are above the desired ATI Base Target.
7. If the count values you read are **above** the desired ATI Base Target, set the *Fine Divider* to 31. Continue to decrease the *Fine Divider* by one until the count values are below the desired ATI Base Target.
8. Set the *ATI Target* to 300 and press the 'Trackpad Re-ATI' button.
9. Read the ATI Compensation values as illustrated in Figure 4.2.
10. The Compensation values should be near the centre of the range (0-1023). If they are too low, then increase the *Compensation Divider*. If they are too high, decrease the *Compensation Divider*. Press the 'Trackpad Re-ATI' button after the *Compensation Divider* is changed to read the new Compensation values.
11. The ATI setup is complete when all the Compensation values read from the channels are near the centre of the range and the touch sensitivity of the channels are acceptable. Typically, adequate touch delta counts on a channel is about 128 counts or more. If the sensitivity is not acceptable, go back to step 5 and choose a lower ATI Base Target.
12. Disable *Manual Control*.

Note: Most of the time it won't be necessary to step past index 0. Meaning, most of the time the *Coarse Divider* will be 1, the *Coarse Multiplier* will be 15 and the *Fine Divider* will be used to reach the ATI Base Target. Do not decrease the *Fine Divider* below 16.



*The aim is achieve Compensation values near the the middle of the 0-1023 range.

Figure 4.3: ATI Setup Flow Diagram

4.2.2 ALP ATI Setup

The ALP ATI setup is done similar to the trackpad ATI setup. It is recommended to enable *Manual Control* under the 'Control and Config' tab and force the device to stay in *LP1* mode while changing ALP ATI settings. It is also recommended to disable *LP1 Auto-Prox Cycles* under the 'ALP Settings' tab, so that all conversions are visible. Remember to disable *Manual Control* again afterwards and enable *LP1 Auto-Prox Cycles*.

The ALP channel counts and LTA can be seen in the top right corner of the main GUI window. The power mode can be seen in the bottom right corner - *LP1* Mode. The two compensation values can



be read in the 'User Settings' pop-up window under the 'ALP ATI Settings' tab.

Press the 'ALP Re-ATI' button after changing ALP ATI settings.

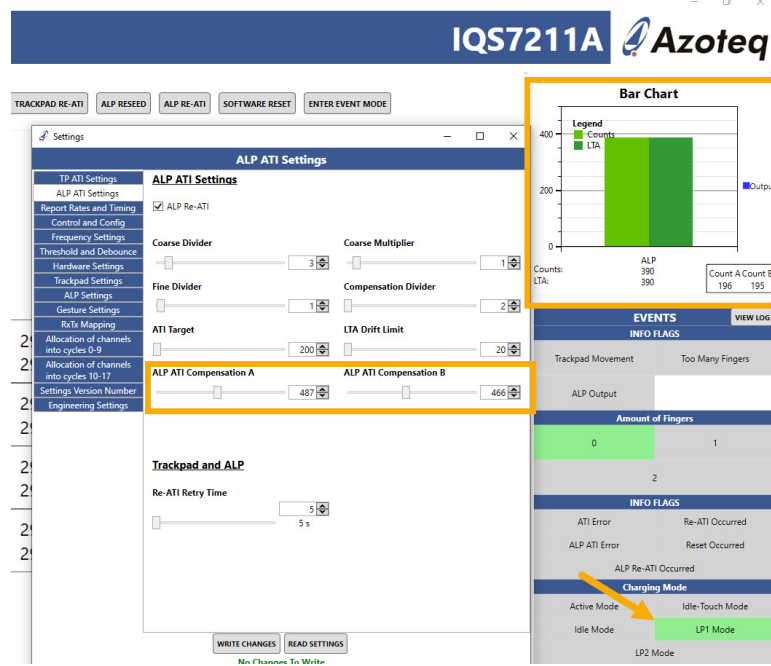


Figure 4.4: ALP ATI Settings



4.2.3 Button ATI Setup²

Full ATI³ is available on the IQS7210A, so the Button ATI setup is less complicated than the trackpad ATI setup. It is recommended to enable *Manual Control* under the 'Control and Config' tab and force the device to stay in *Active* mode while changing Button ATI settings. Remember to disable *Manual Control* again afterwards.

The Button channel counts and LTA can be seen in the top right corner of the main GUI window. The power mode can be seen in the bottom right corner - Active Mode. The compensation value can be read in the 'User Settings' pop-up window under the 'Button ATI Settings' tab.

Set the *Button ATI Target*, and the *Button ATI Base Target*. Press the 'Button Re-ATI' button after changing the ATI settings.

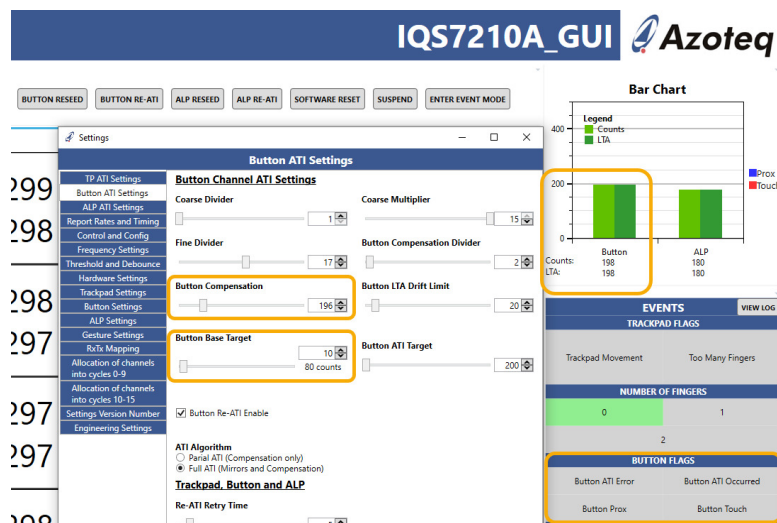


Figure 4.5: Button ATI Settings

²Only applicable to IQS7210A.

³Full ATI is also available on the ALP channel on the IQS7210A.



4.3 Thresholds

4.3.1 Trackpad Threshold Settings

The ATI settings directly affect the channel sensitivity, so after these are modified, the thresholds usually need to be adjusted.

First configure the *Trackpad Touch Set Threshold* in the 'Threshold and Debounce' tab. Change the main window display to *Deltas* under *Streaming Options*. Now with a small finger, press lightly between 4 channels. Try to make the deltas of the 4 channels a similar value by being positioned evenly between the 4 channels, as shown in the figure.

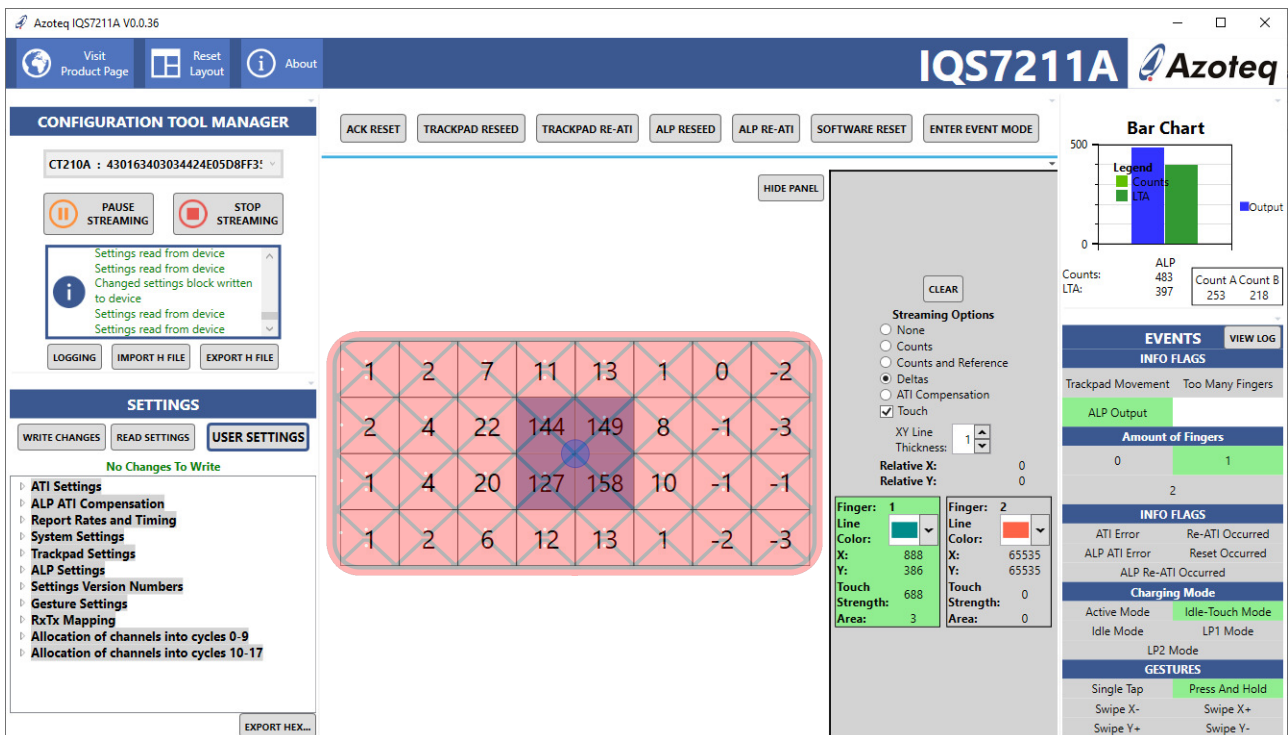


Figure 4.6: GUI Delta View - 4 Channels in Touch

This therefore places the finger furthest away from the four channel centres (their most sensitive areas), giving a good indication of a weak touch that should still be detected. Set both the touch set and clear threshold to the same value, so that a touch (blue display squares) just starts to become detected on these 4 squares. The value you set in the GUI is the *multiplier* value. The touch threshold for a specific channel is calculated as follows:

$$\text{Threshold} = \text{Reference} \times \left(1 + \frac{\text{Multiplier}}{128}\right)$$

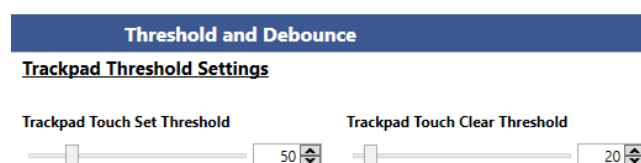


Figure 4.7: Touch Set and Clear Threshold



Assuming a reference count value of 300, the threshold can then be calculated as follows:

$$\text{Touch Set Threshold} = 300 \times \left(1 + \frac{50}{128}\right) = 417 \text{ counts (117 counts delta)}$$

Now add a hysteresis to the touch thresholds by decreasing the touch clear value so that jitter is not seen on touch outputs, because a touch release is now at a more sensitive threshold value compared to the threshold where a touch becomes set. The four channels in the above test should also now all detect constant touch outputs.

$$\text{Touch Clear Threshold} = 300 \times \left(1 + \frac{20}{128}\right) = 346 \text{ counts (46 counts delta)}$$

4.3.2 ALP Threshold Settings

The ALP output is set when the channel's count value deviates from the LTA value by more than the selected threshold - thus a delta setting. This can be used to implement a proximity or touch detection, depending on the threshold used.

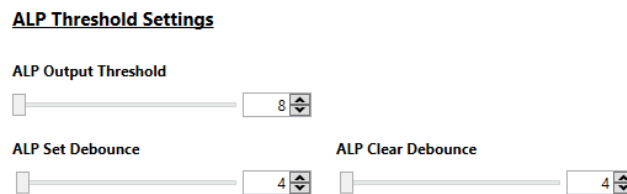


Figure 4.8: ALP Threshold

4.4 XY Output Flip & Switch

By default, the Rx's are columns (thus in the X direction), and Tx's are rows (thus in the Y direction). If this is different, then the axes must be switched in the 'Trackpad Settings' tab. This was not necessary for the AZP1189A3 trackpad.

By default, X positions are calculated from the first column to the last column. Y positions are by default calculated from the first row to the last row. The X and/or Y output can be flipped with *Flip X / Flip Y*, to allow the [0, 0] coordinate to be defined as desired. The X and Y axes can also be switched with *Switch XY Axis* allowing X to be the Tx's, and Y to be along the Rx's.

Note: The channel numbers are still assigned the same way, first along the Rx's, then to the next Tx, it is not affected by this setting. For simplicity, it is still recommend to allocate the channels into cycles before switching the X and Y positions.

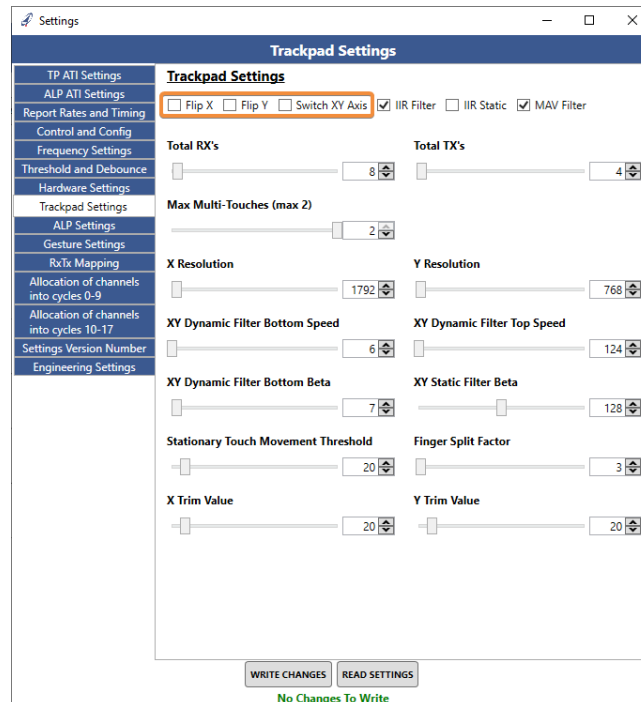


Figure 4.9: XY Output Flip & Switch

4.5 X and Y Resolution

The output resolution for the X and Y coordinates are configurable in the 'Trackpad Settings' tab. The on-chip algorithms use 256 points between each row and column. For the AZP1189A3 hardware the maximum resolution can be configured as 1792x768 (8x4 channels). You will see that the channel display in the main window of the GUI will also change when the resolution is changed.

4.6 X & Y Trim

Due to boundary conditions at the edges of the trackpad, it is unlikely that the X and Y extreme values will be achievable (0 and X/Y Resolution). To be able to achieve this, the edges can be trimmed with configurable amount (*X Trim* / *Y Trim*) on-chip. For example, say *X Trim* is set to 0, and a finger on the left of the trackpad gives a minimum X output of 18, and a maximum of 1773 for a finger to the far right (for X resolution set to 1792). Then an *X Trim* = 20 could be used to trim away the 'dead' area, and the full 0 to 1792 range will be achievable.



4.7 Intermediate Setup Summary

The ATI parameters have been adjusted to allow for adequate sensing of user interaction. Thresholds have been set so that inputs are reliably detected, and accurate XY outputs are obtained.

The power modes of the device have not been changed, and at this point the power modes will cause the device to automatically make a transition from the Idle state to the LP1 state, and then further to the LP2 state. The report rates of the different states are also standard values for this configuration, and provide sufficient low power consumption. Currently only the ALP channel is sensed in LP1/LP2.

At this point gesture outputs should also be visible, unless if the hardware is very different from standard designs. In that case the gesture parameters would need to be optimised.

1. Check Rx/Tx Mapping
2. Configure the ATI Setup
3. Set the appropriate touch set/clear thresholds
4. Confirm correct XY coordinate output
5. Set the X and Y resolution
6. Check whether it is necessary to set X and Y trim values
7. Proceed to Section [5](#) if you require further assistance



5 Advanced Device Setup

5.1 Frequency Settings

The main oscillator frequency can be selected to be either 14MHz or 18MHz. If the 18MHz option is considered note that the minimum supply voltage is 2.2V.

The conversion frequency is also configurable. Too high conversion frequency values will result in non-ideal charge transfer.

Table 5.1: Conversion Frequency Example

Main Oscillator Frequency	Requested Conversion Frequency ⁴	Fraction Value	Up/Pass Length	Actual Conversion Frequency
14MHz	125kHz	127	54	128kHz
	250kHz	127	26	258kHz
	350kHz	127	18	362kHz
	500kHz	127	12	515kHz
	1MHz	127	5	1.04MHz
18MHz	125kHz	127	70	127kHz
	250kHz	127	34	254kHz
	500kHz	127	16	513kHz
	750kHz	127	10	772kHz
	1MHz	127	7	1.03MHz

5.2 Mode Configuration

5.2.1 Report Rates

Remember to disable *Manual Control* under the 'Control and Config' tab since the ATI setup is complete. The device will now transition to lower power modes with slower report rates to reduce current consumption. The report rates are configurable and the extent to which it can be adjusted, is determined by the application.

The mode settings are configured under the 'Report Rates and Timing' tab, as highlighted in the picture below.

⁴Higher conversion frequencies are available, please contact Azoteq for support.

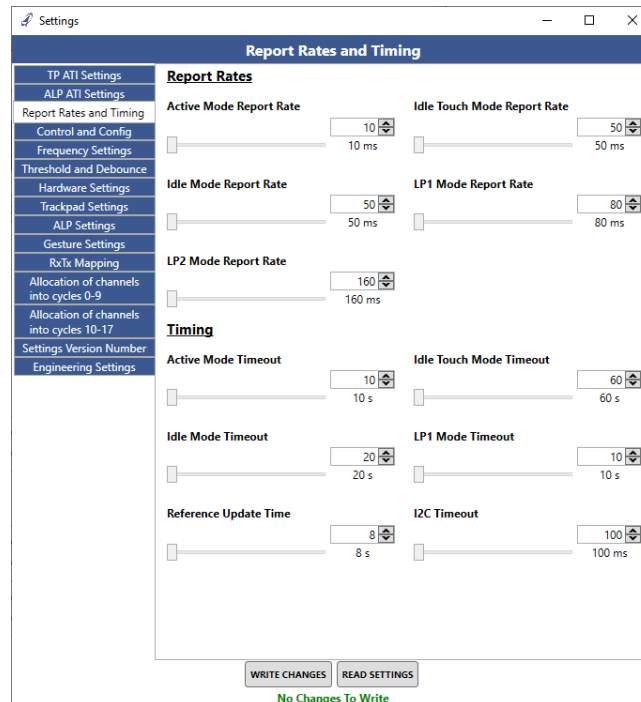


Figure 5.1: Report Rates and Timing

The report rate settings are normally driven by the power consumption budget of the design. A slow report rate will reduce the average consumption because the IQS721xy will have longer periods of low power sleep added to obtain the selected report rate. The reaction speed required on the trackpad must be considered when selecting the Active mode report rate, and the wake-up capability from low power must be considered when setting the LP1 and LP2 report rates.

For the AZP1189A3 hardware, fast response is needed from the trackpad, so a 10ms report rate is selected for *Active* mode. The *Idle* mode saves power when the finger is lifted, but must still give quick response when a gesture is performed, so 50ms is chosen. $LP1 = 80ms$ and $LP2 = 160ms$ was selected for this example. When a long stationary touch is detected, the system enters *Idle-Touch* mode, and its report rate is set to 50ms.

Remember that streaming large amounts of I²C data in the GUI can cause the report rate to not be achieved, or increases the current consumption, so data streamed must be kept to a minimum when doing such evaluations. Set the *Streaming Options* to stream out minimal data by clicking the 'None' radio button and unticking the 'Touch' checkbox.

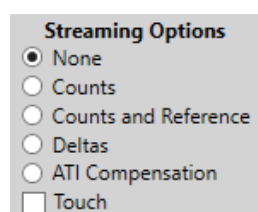


Figure 5.2: Minimal Streaming Options



5.2.2 Mode Timings

The timings responsible for transitions between the modes can be configured. The *Active Mode* timeout selects how long a stationary finger must be sensed before stepping to *Idle-Touch* mode.

The *Idle-Touch* timeout sets how long a stationary finger in *Idle-Touch* will be allowed before it is seen as a 'stuck' condition, and a reseed is triggered. Often this is disabled and handled by the host, in this case, set this value to '0', meaning 'disabled'.

The *Idle* timeout sets how long the system stays in *Idle* mode before stepping to the next power state (*LP1*). The *LP1* timeout determines the length of time spent in *LP1* before stepping to *LP2*. If *LP2* is configured as a very low power (and thus slow response) state, the *LP1* timeout is usually set quite long, so that this is only entered when the user has stopped using the device for a long time, and then extreme low power is entered.

The default values have been kept for the AZP1189A3 example.

5.3 Stationary Touch Setup

For applications where the user could rest his/her finger on the trackpad for long periods of time, it is beneficial for power consumption to utilise the *Idle-Touch* mode. From the system mode state diagram in the datasheet, it is clear that the system will remain in the *Active* mode during a touch if consistent finger movement is detected. However, if the finger becomes stationary for the length of time configured, then the mode will change to *Idle-Touch*. The number of pixels that the finger needs to move before it is classified as 'movement' can be configured in the '*Trackpad Settings*' tab, by changing the *Stationary Touch Movement Threshold*.

If movement is detected on the IQS721xy it is visible in a status flag which is displayed on the main window.

5.4 Gesture Settings

Please refer to the [datasheet](#) of the relevant device to configure the *Gesture* settings for optimal performance.

5.5 Hardware Settings

Not recommended to configure, unless under guidance of Azoteq support.

5.6 ATI and Re-ATI Conditions

5.6.1 Re-ATI deltas

The delta that the reference values are allowed to drift away from the ATI Target, before a Re-ATI is automatically performed, can be adjusted with this parameter. This value should be selected so that a reasonable deviation needs to be seen on the counts before a Re-ATI is triggered. This allows the sensors to recalibrate (re-ATI) if drift - such as temperature drift - causes changes. The recalibration keeps the sensor working consistently.

5.6.2 Min count

The minimum count parameter also monitors for incorrect sensor behaviour. In this case, since a mutual capacitive sensor counts increase with user interaction, a decrease in count values on the



trackpad is against expectation. This parameter is a delta value below the reference. If 14 consecutive negative deltas are sensed below the min value delta, a Re-ATI is triggered.

Some sensors exhibit a sensor saturation effect under certain conditions. This saturation causes a reverse effect on the count values, and care must be taken to select a threshold below this decrease. The design must be optimised to reduce this effect as far as possible. For example, when a thin overlay is used GND islands in the diamonds of the trackpad pattern are recommended.

The main scenario addressed by this parameter is when an ATI is configured while a user is touching / interacting with the trackpad. Because the user is touching the trackpad, the count values are higher than normal. Therefore, to reach the ATI Target value, less ATI Compensation will be configured on the affected channels. If the touch is later removed, the count values will decrease, and their sensitivity will also be greatly reduced compared to other correctly configured channels. To recover from this, the decline in count values on channels will be detected after the finger removal, and a Re-ATI will trigger and correct the previous incorrect configuration. The threshold must thus be selected so that this scenario is correctly recovered from.

5.7 Max Multi-Touches

Set the total multi-touches that are required for the design (max 2) in the '*Trackpad Settings*' tab. Remember if more than the configured value is sensed, all outputs are cleared until the total is less than or equal to that configured. The '*Too Many Fingers*' flag will also be set. If post-processing will reject unwanted points, set this value higher so that XY outputs are still provided to the master device for post-processing.

5.8 Event Mode and Communication

Normally the master device is only interested in communication with the IQS721xy if certain events have taken place. At other times communication is thus not necessary. When the complete setup is done, enable *Event Mode* by clicking the '*Enter Event Mode*' button or tick the *Event Mode* box under the '*Control and Config*' tab.

The different events that should cause I²C communication to occur can be selected in the '*Control and Config*' tab. *Trackpad Touch Event* will typically only be selected if individual touch buttons are implemented, since they trigger an event when the touch status of a channel changes. *ALP Event* could be used to trigger some backlighting or other device wake-up actions since user interaction has been detected.

Typically, *Trackpad Events* are enabled since this causes communication when the system is in *Active* mode, i.e. when there is tracking and movement on the trackpad. *Gesture Events* are also a common option, triggering communication when a gesture is present.

For the AZP1189A3 hardware, only gestures and tracking events are required for the master device to obtain all useful information.

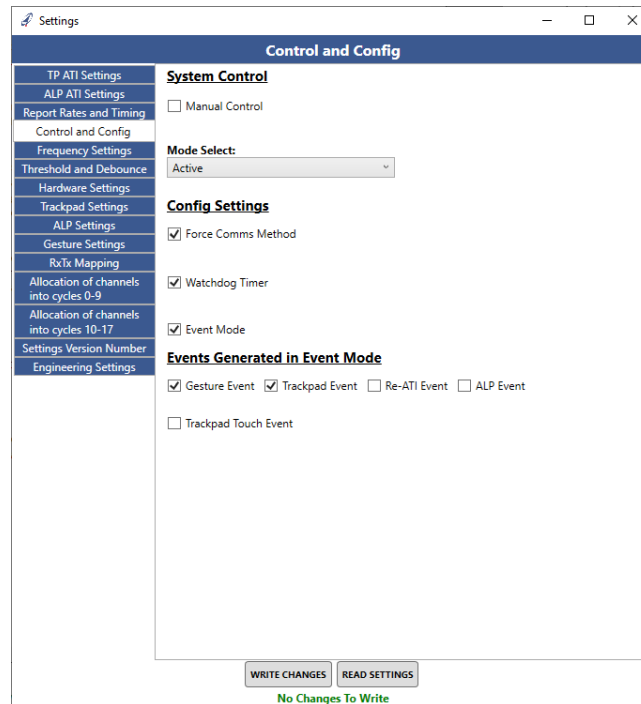


Figure 5.3: Event Mode Setup

Refer to the [datasheet](#) for more detail on I²C communication.



5.9 Advanced Setup Summary

Not many applications will require the user to configure the settings discussed in this section. Be sure to read the relevant [datasheet](#) before configuring these parameters.

1. Operating frequency setup
2. Mode configuration
3. Stationary touch setup
4. Gesture setup
5. Hardware settings
6. ATI and re-ATI conditions
7. Max multi-touches
8. Event mode and communication setup



6 Export Settings

The *Minor Version Number* and *Major Version Number* parameters are available under the 'Settings Version Number' tab. These parameters are available so that the designer can label and identify the user selected default start-up settings. This allows the master to verify that the device firmware has the required configuration.

6.1 Export/Import Settings H-file

Once the device is correctly set up, the parameters can be used to create a new settings h-file. The GUI can export such an h-file, which can be used by the master MCU to write these settings during initial setup. This h-file can also be imported by the GUI software, which then writes the settings included in the file to the device under test. Click the 'Export H File' button and click *Save* to save the file. Similarly, click the 'Import H File' button and select the h-file you want to import.

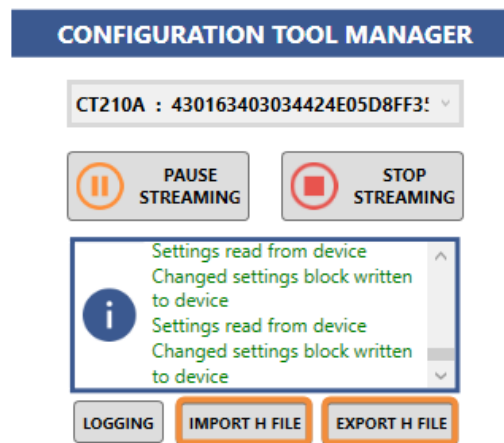


Figure 6.1: Export or Import H-file with GUI Software

6.2 Export Hex file

Alternatively, when the device is correctly set up, the parameters can be used to create a new application hex-file. The GUI can export such a hex-file, and this can be programmed onto the device. With this custom firmware programmed; the device setup is correct after power-up without any interaction required from the master. The parameters are thus determined using the GUI software, which is an easy design environment to obtain these settings.

In the bottom left corner of the main window, press the 'Export Hex...' button. This will navigate the user to a file manager window where the new HEX file can be saved. Note that the GUI will use the latest firmware file available (packaged with GUI) and insert the settings into the HEX of the device at that moment. For this reason, it is important to ensure that you have the latest GUI software. After saving this file, you can use the Azoteq OTP Programmer software to program the OTP (one time programmable) memory of the next devices.

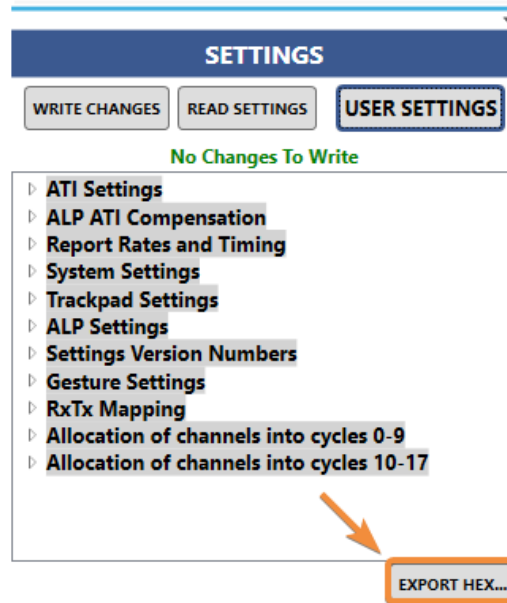


Figure 6.2: Export or Import H-file with GUI Software



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