IQS7225A GUI Setup Guide

The purpose of this document is to guide the user in configuring the IQS7225A using the GUI PC software

Contents

1 Introduction

The purpose of this document is to describe the graphical user interface (GUI) layout available in the IQS7225A PC Software for device debugging and display purposes. The designer can configure the IC via the GUI software for a specific application and evaluate its performance in real time. Although configuration examples will be provided, this document is not intended to cover all applications. Instead, it aims to equip users with the knowledge needed for configuration, debugging, data logging, and header file export using the GUI software to address their unique applications. Furthermore, the scope of this document is limited to the configuration of the IQS7225A using the appropriate and latest Azoteq IQS7225A GUI PC Software. For guidelines on the hardware and electrode design, please refer to the appropriate application notes. For IC-specific information, operation, and memory map details, please refer to the IQS7225A Datasheet.

2 Getting Started

This section describes the process of initial device set-up prior to application-specific tuning.

2.1 Step 1: GUI Software Installation

Download and install the Azoteq IQS7225A GUI PC Software from the Azoteq website located under: *Design -> Software and Tools* page. Extract the downloaded zip file, follow the installation wizard procedure, and afterwards launch the software executable program. The following window should appear after successful installation and upon software execution:

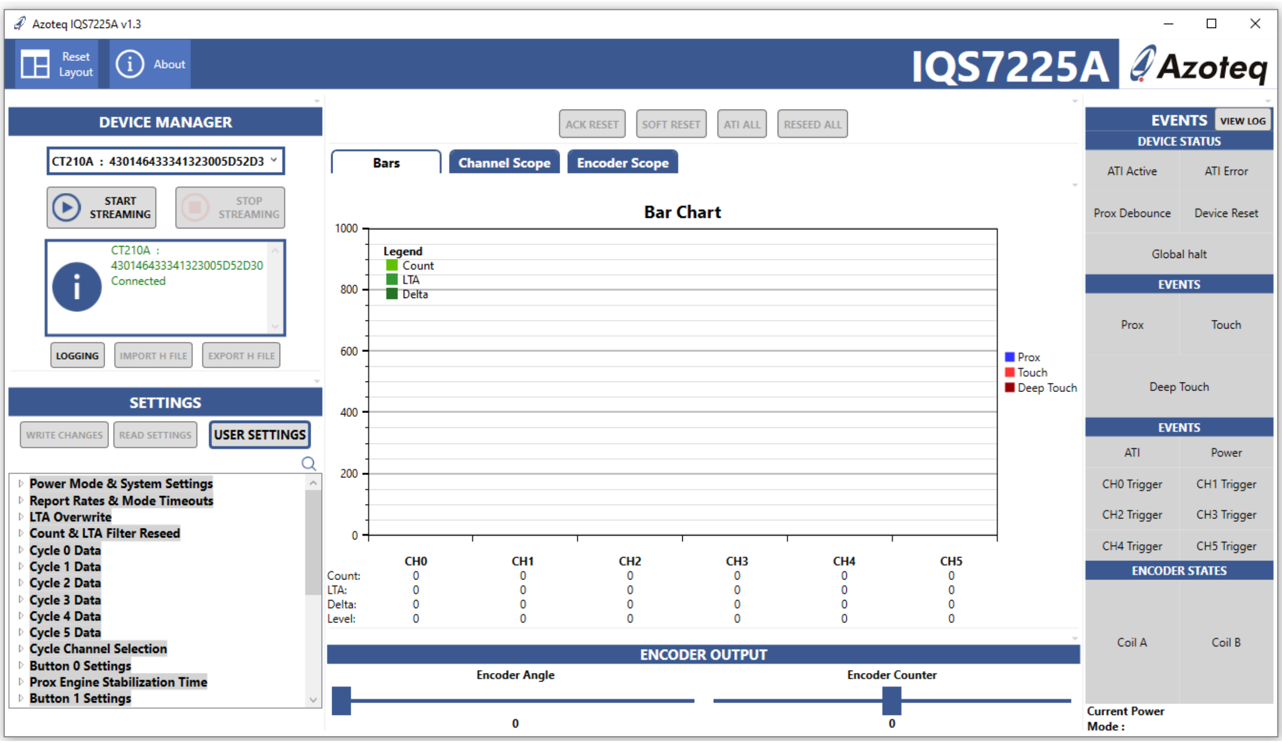

Figure 2.1: Main Window of The Azoteq IQS7225A GUI

2.2 Step 2: Hardware Connections

Connect your PC to the Azoteq configuration debug and display tool CT210A using a standard USB-micro data cable. The device under test (DUT), being either an IQS7225A EV-kit or an application PCBA with the device and required passives mounted on, can be interfaced with a suitable 20-to-10 pin ribbon cable connection (or application-specific connections), as shown in the picture below.

Figure 2.2: Hardware Connection For Streaming And Testing

Connect the power supply (VDD), ground (GND), I^2C (SDA and SCL), and the data-ready interrupt signal (RDY) from the application hardware to the corresponding pins on the CT210A USB dongle, as shown in the numbered and colour-coded pin-out table in Figure 2.3 below.

Table 2.1: CT210A Pin-out

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

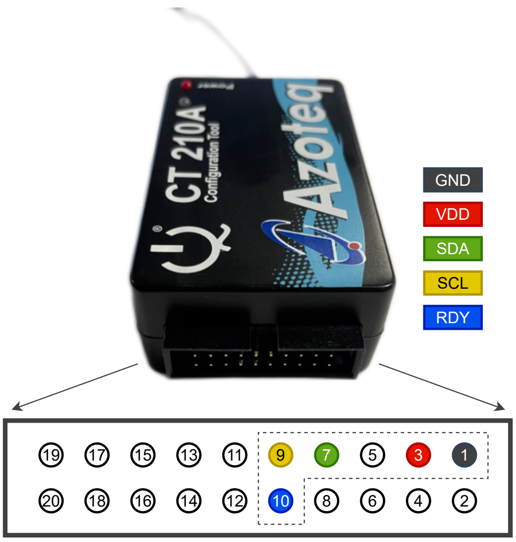

Figure 2.3: CT210A Power, I^2C And RDY Connections

2.3 Step 3: PC Connection Verification

After connecting the CT210A device to the computer using a USB port and micro-USB data cable, the GUI software will automatically install any necessary drivers. It will then verify its connection and firmware, displaying the CT210A's device ID and a 'Device Connected' message in the configuration tool manager section, as shown in the red block in Figure 2.4.

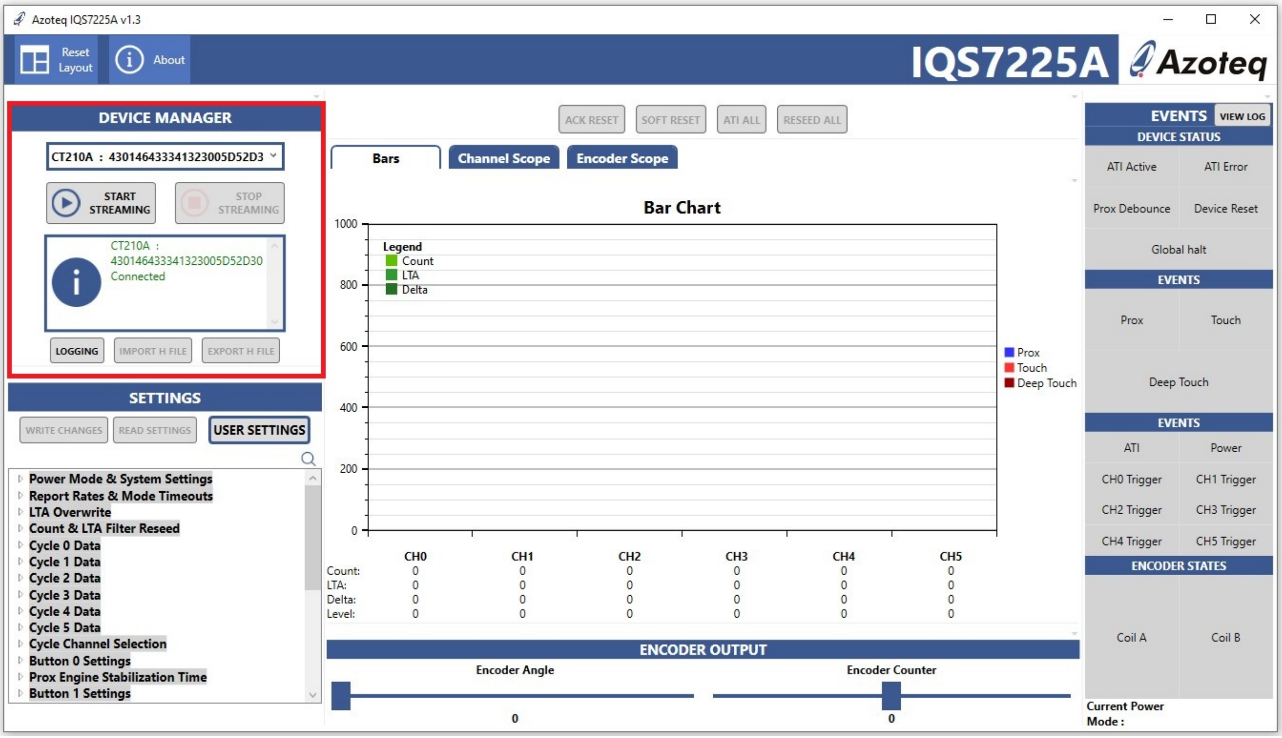

Figure 2.4: CT210A Recognition And Connection

Note - If the connected CT210A device firmware is out of date, an 'Update available' button should automatically appear next to the device enumeration. Click this button to launch the appropriate CT firmware upgrade tool and update the firmware, as shown in Figure 2.5. IN the image displayed in Figure 2.5, the connected CT210A is already up-to-date with the latest firmware and does not require an update.

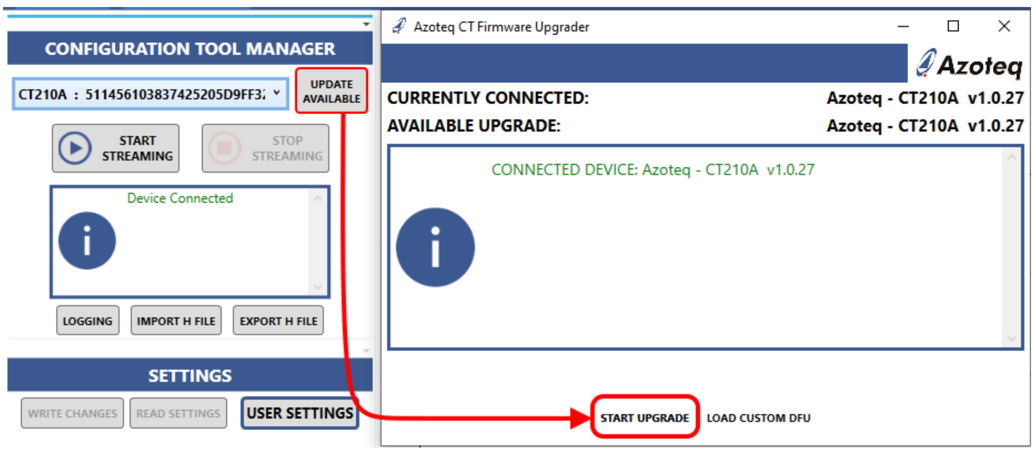

Figure 2.5: CT210A Firmware Upgrade

2.4 Step 4: Initiate DUT Communication (Streaming)

Click on 'START STREAMING' to initialise the serial connection to the DUT. Additional messages will appear and will provide the following information:

- Power status
- I²C address
- Device version information
- Settings and streaming confirmations or errors, as applicable

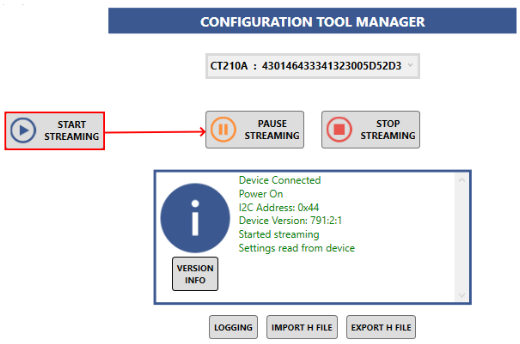

Figure 2.6: Message Dialogue Results From A Successful DUT Connection

If the messages mentioned above fail to appear, please ensure that the device is properly connected and that the DUT IQS part and version accuracy are verified.

2.5 Step 5: Acknowledge Reset

Click on the red text button 'ACK RESET' as shown below. After the 'Reset' event flag clears, the text 'ACK RESET' should change colour to black, indicating successful reset acknowledgement, and should remain so thereafter.

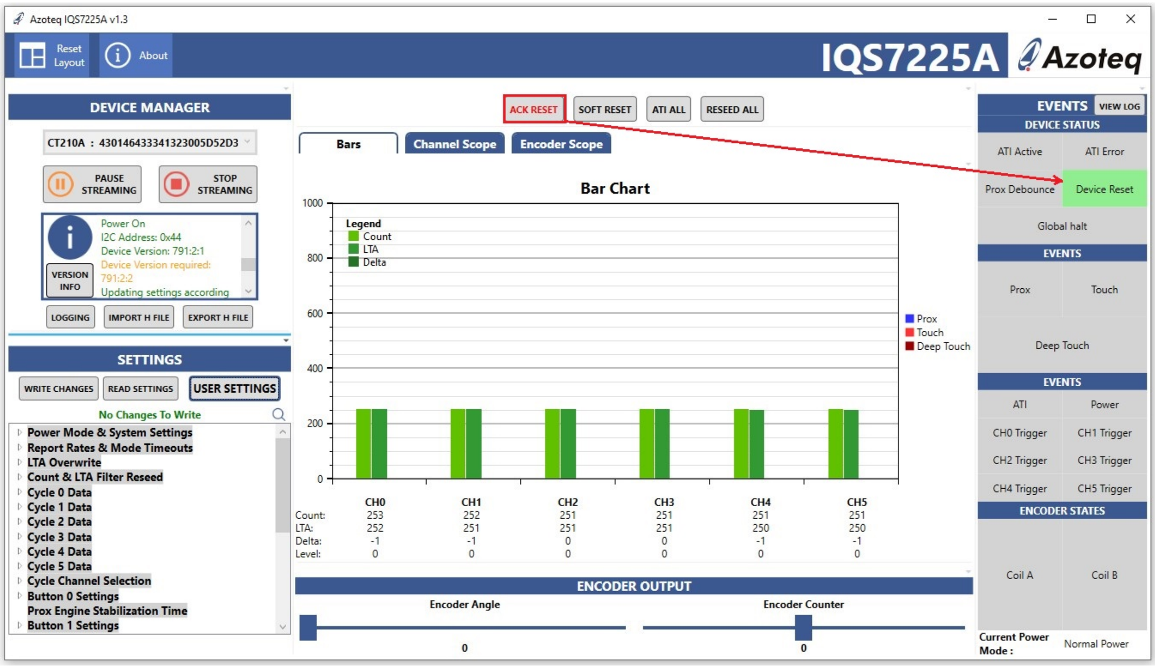

Figure 2.7: Default Device Setup Streaming From DUT After Power-on / Reset

2.6 Step 6: Device Configuration

The device may now be configured further by either loading the pre-configured settings (in a *.h* - header file format) or selecting the 'USER SETTINGS' button to open the pop-up window with settings organized in menu tabs. Refer to Section 4 for more detail.

Note - Only a single instance of the GUI software may run at any given moment, and therefore, only one device can be streamed at a time. Opening multiple instances of the GUI or other Azoteq PC software and tools may cause program and streaming malfunctions.

2.6.1 Configuring Using Pre-Configured H-File

If the device was previously configured and an associated .h-file was exported from the GUI, the file may now be imported into the GUI using the 'IMPORT H FILE' button. Additional information will be provided, to verify that the file was imported correctly:

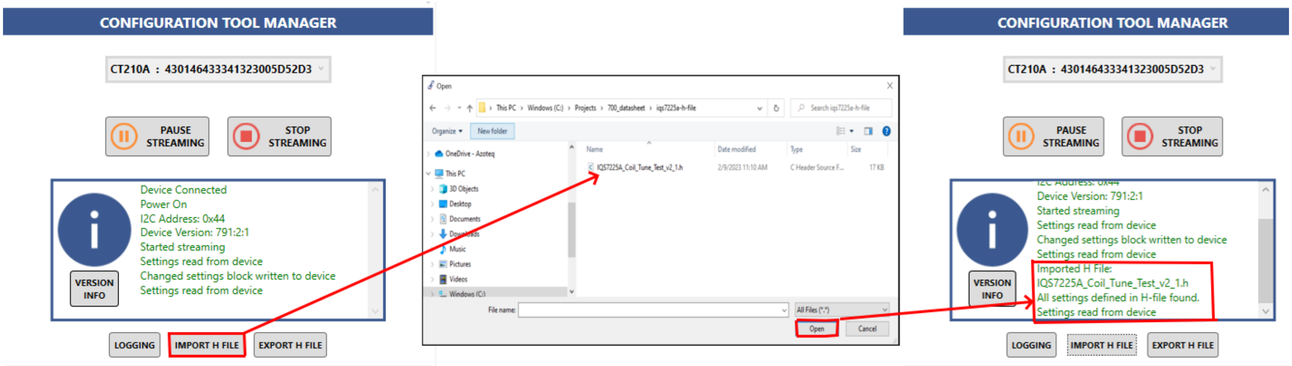

Figure 2.8: Importing A Predefined Configuration

2.6.2 Configuring Using User Settings

As an alternative, when using the standard IQS7225A EV-kit hardware (AZP1277A1), one can simply open the "USER SETTINGS" window, navigate to the first tab named "EV-Kit Module", and click on the image button of the kit to apply the predefined configuration settings for the demo. Refer to Figure 2.9 and Section 4 for the configuration details.

Note - The pop-up user settings window can be used to configure all the IQS7225A device parameters.

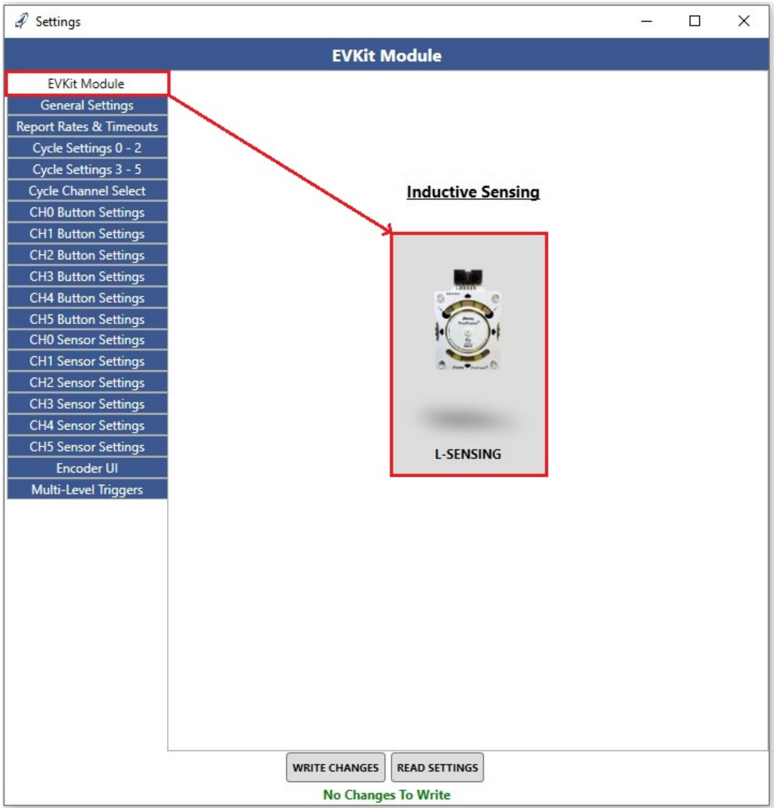

Figure 2.9: Importing The Predefined Demo Configuration

2.7 Step 7: Export Device Configuration

After configuring the DUT, you can export the new settings for safekeeping, sharing, or future use on the same or another device. The settings are exported as a *.h*-header file using the 'EXPORT H FILE' button. Take care to save the new settings file with an appropriate descriptive name and file location, as intended.

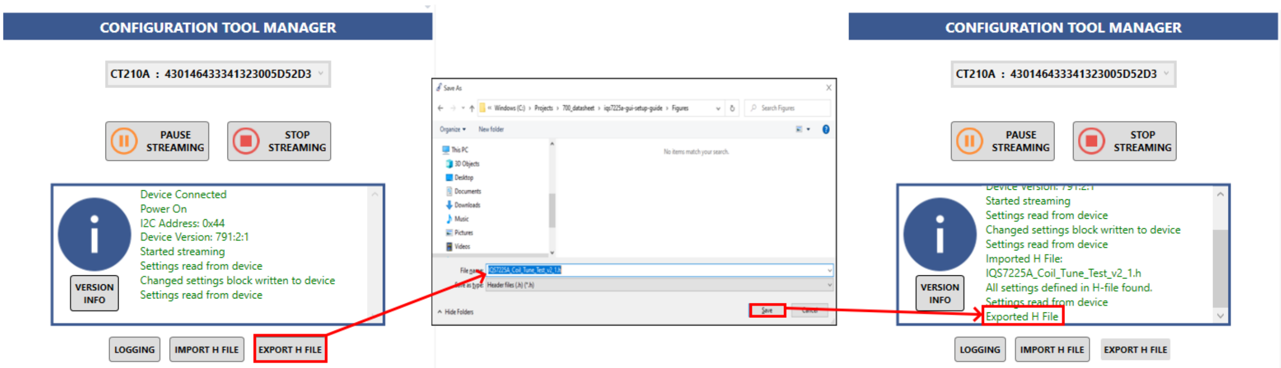

Figure 2.10: Exporting A Defined Configuration

3 GUI Overview

The IQS7225A graphical user interface (GUI) software allows the user to test, configure, and export settings (as *.h*-files) for the IQS7225A IC. Figure 3.1 shows the main window components of the GUI, each numbered for reference in later descriptions.

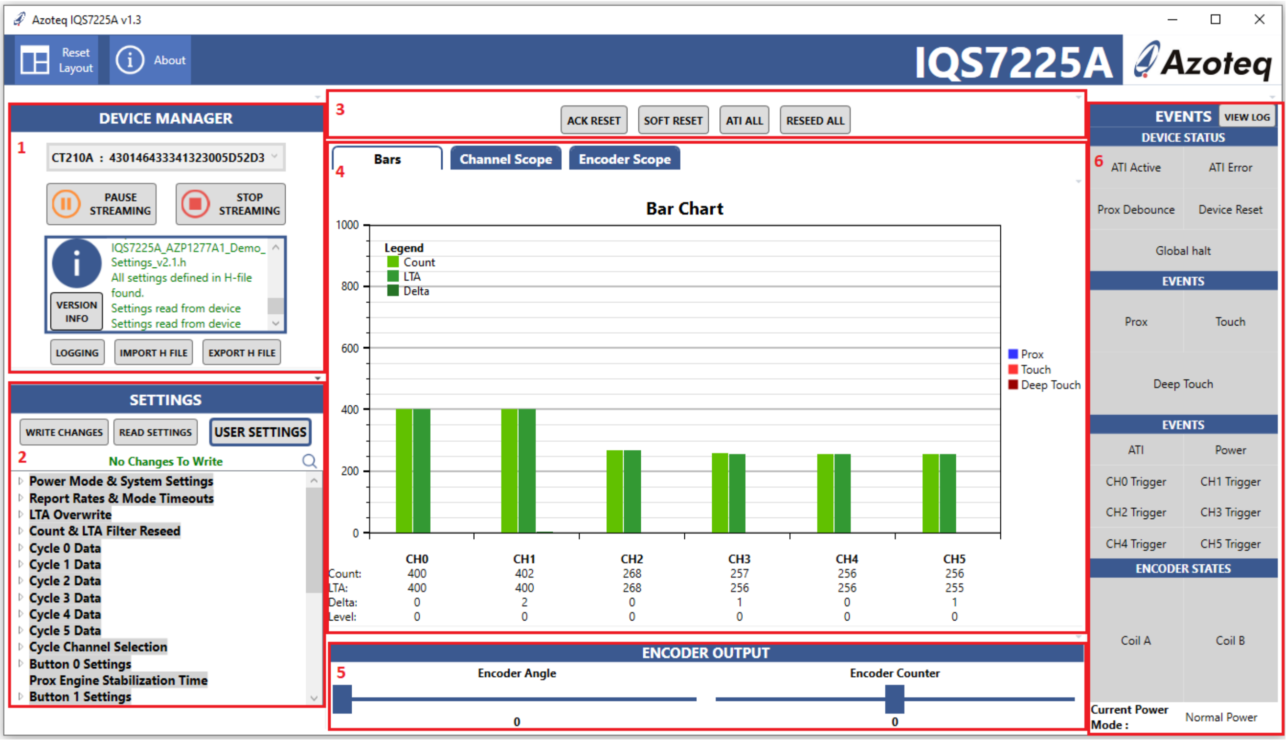

Figure 3.1: Main Window Sections of The Azoteq IQS7225A GUI

The description of each numbered item in Figure 3.1 is provided below.

(1) **Configuration Tool Manager** - Allows for general configuration tool hardware recognition, control, and feedback in the GUI. The top drop-down box will display the available configuration tool (CT or DS) devices connected to the PC. If a valid selection is made, the 'START STREAMING' button may be used to initiate I^{2}C communication and start a data 'stream' from the DUT. If the stream starts successfully, the button will change to 'PAUSE STREAMING', allowing you to temporarily pause I^{2}C activity from the configuration tool and ignore any DUT RDY signals. To end the I^{2}C communication, use the 'STOP STREAMING' BUTTON. The text box provides general information on the I^{2}C connection, completed tasks, and error messages in case of any unsuccessful attempts or lost communications. The logging button may be used to capture or record sensor register data and export the streaming session's data to a *.csv*-file. The 'IMPORT H FILE' button allows the user to load a previously configured settings file (*.h*-file) to the DUT. The 'EXPORT H FILE' button will create, overwrite, and save a new *.h*-file using the current configuration settings present on the DUT.

(2) **Settings Tree** - All available device settings may be found here. The settings tree contains the same options as the 'USER SETTINGS' window but directly represents the memory map structure. The 'USER SETTINGS' interface is more user-friendly and logical, making it the recommened primary configuration portal. Except for some settings described later in this document, the settings tree should only be use with support of an Azoteq or distributor Field Application Engineer (FAE).

(3) **System Commands Section** - The 'ACK RESET' button will issue a reset acknowledgement command to the IC as confirmation of coming from a power-on or reset state (with default device settings populated). The 'SOFT RESET' button commands the DUT to perform a soft reboot. The 'ATI ALL' button commands the DUT to use its automatic tuning implementation (ATI) algorithm for sensor recalibration (please refer to the IQS7225A Datasheet for more information). The 'RESEED' button instructs the DUT to set its Long Term Average (LTA) filtered values to match its current count values.

Note - These operations apply globally to all channels and to the entire device.

(4) **Bar, Channel Scope, and Encoder Scope** - This area will visually display bar graphs of the sensor counts, LTA signals, and delta counts as configured for every channel. The current values for each channel are displayed in a decimal format below their respective channels. The results may be viewed on the bars by selecting the primary 'Bars' tab, or the same data stream can be plotted as lines over time on a secondary scope view by selecting the "Channel Scope" tab. The 'Counts' value represents the filtered input signal from the device's sensors. The 'LTA' is the long-term average of the counts and acts as a slow-adjusting baseline used as a reference to detect any quick deviation in Counts. The channel's Counts and LTA line plots can be selected or deselected for display to make the scope view less cluttered. The encoder angle and encoder counter can also be viewed as a line plot by selecting the "Encoder Scope" tab. To adjust the number of points on the x-axis, press 'RESET X AXIS' to apply or update the scope view. For scope navigational control explanations, please click on the 'HELP' button.

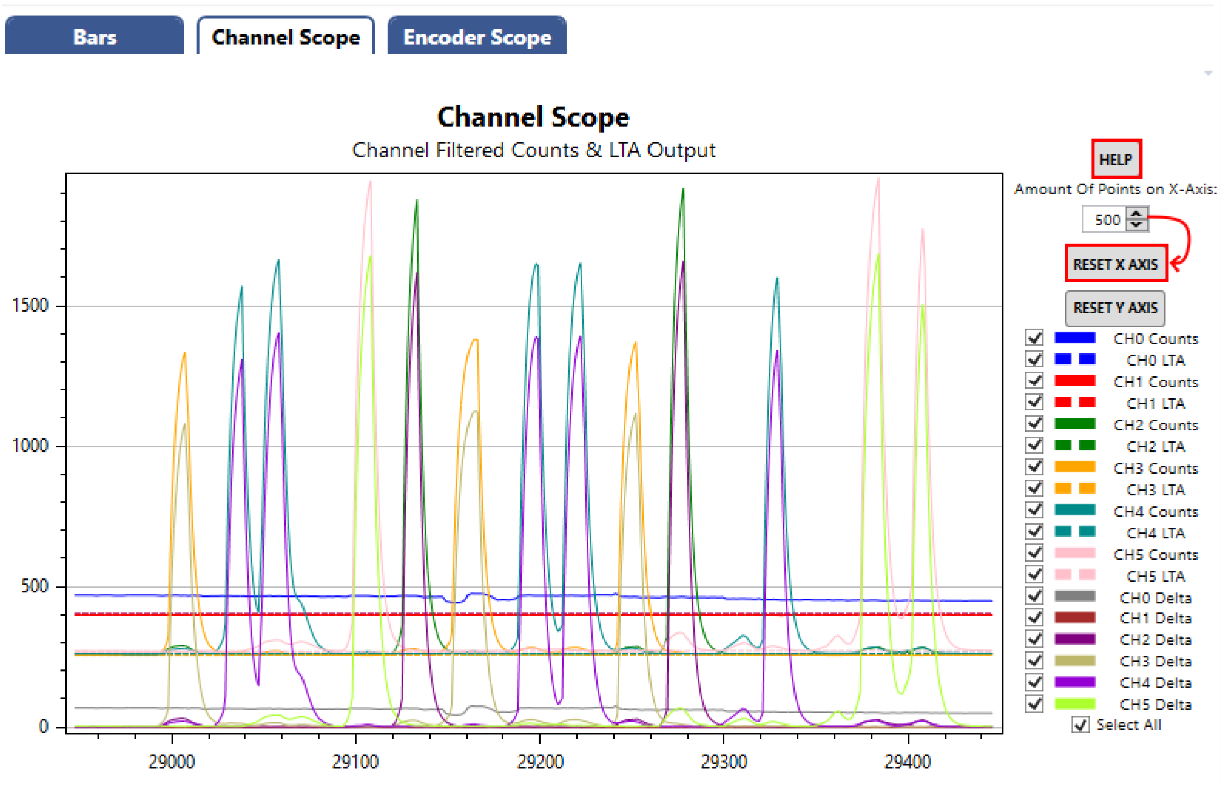

Figure 3.2: Scope View Of The IQS7225A GUI

(5) **Encoder Output** - If the encoder UI is configured for a given channel, then the encoder angle and encoder count of the configured channel will be represented graphically by the two sliding

visual elements together with a decimal value displayed underneath each sliding element. The encoder UI is required to be set up correctly to achieve the desired encoder angle and encoder count.

(6) **Event Flags Section** - This section provides a dashboard overview of various events that are triggered. Individual blocks light up for event occurrences or trigger activation states, and a text log of specific event selections can also be evaluated in the event log (timestamped text) terminal.
The various event flags are described as follows:

- **System flags 0**
  - **ATI active**: Active when ATI routine execution is busy.
  - **ATI error**: Active when the ATI routine encountered an error on any of the channels.
  - **Prox debounce**: Active when a prox debounce occurs.
  - **Device Reset**: Active at power-on or when a reset has occurred (without acknowledgement through 'ACK RESET').
  - **Global halt**: Active when any channels' LTA value is halted by a prox, touch, or deep touch detection (requires global halt to be enabled).
- **System flags 1**
  - **Prox event**: Active when any channel's prox state changes.
  - **Touch event**: Active when any channel's touch state changes.
  - **Deep touch event**: Active when any channel's deep touch state changes.
- **System flag 2**
  - **ATI event**. Active when an ATI execution is initiated or completed.
  - **Power event**. Active when a power mode switch occurred.
  - **CH0 trigger event**. Active when channel 0 trigger event occurred.
  - **CH1 trigger event**. Active when channel 1 trigger event occurred.
  - **CH2 trigger event**. Active when channel 2 trigger event occurred.
  - **CH3 trigger event**. Active when channel 3 trigger event occurred.
  - **CH4 trigger event**. Active when channel 4 trigger event occurred.
  - **CH5 trigger event**. Active when channel 5 trigger event occurred.
- **Encoder status**
  - **Coil A event**. Active when coil A is active.
  - **Coil B event**. Active when coil B is active.
- **Current power mode:**
  - Shows the current power mode state in which the device is currently operating.

4 Application Example

4.1 Mutual-Inductance Setup

This section will use the IQS7225A EV-kit hardware (AZP1277A1) as an example application. Figures 4.1 and 4.2 display the schematic and electrode layout of the IQS7225A EV-kit. The reader should load the predefined configuration settings as discussed in Section 2.6.1.

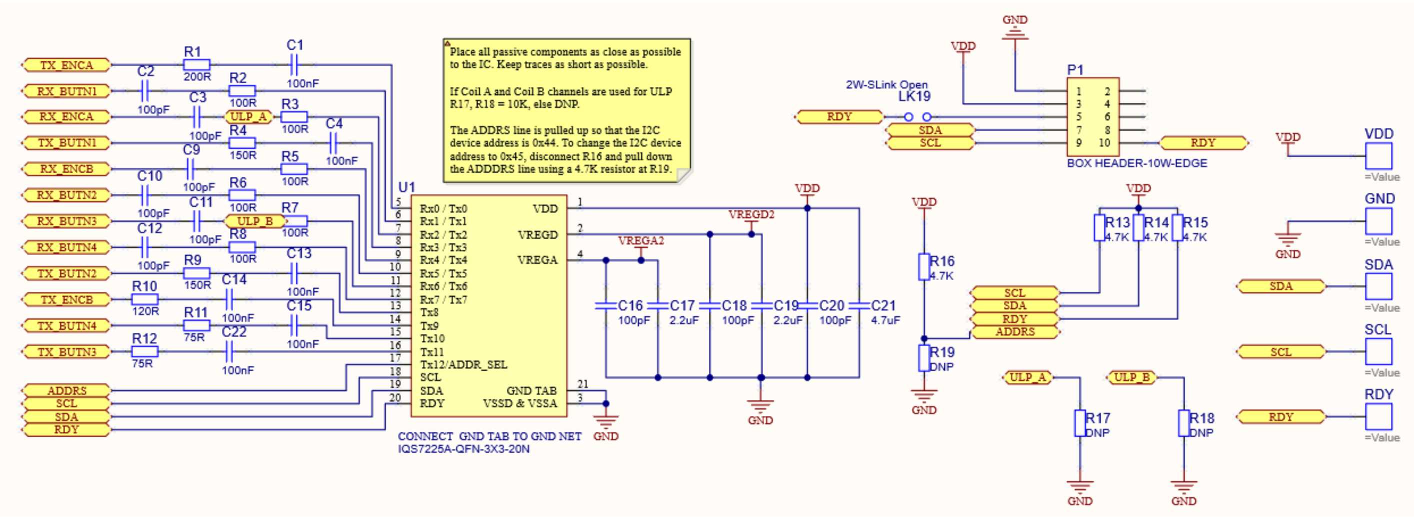

Figure 4.1: IQS7225A EV-kit Schematic Layout: IC With Passives

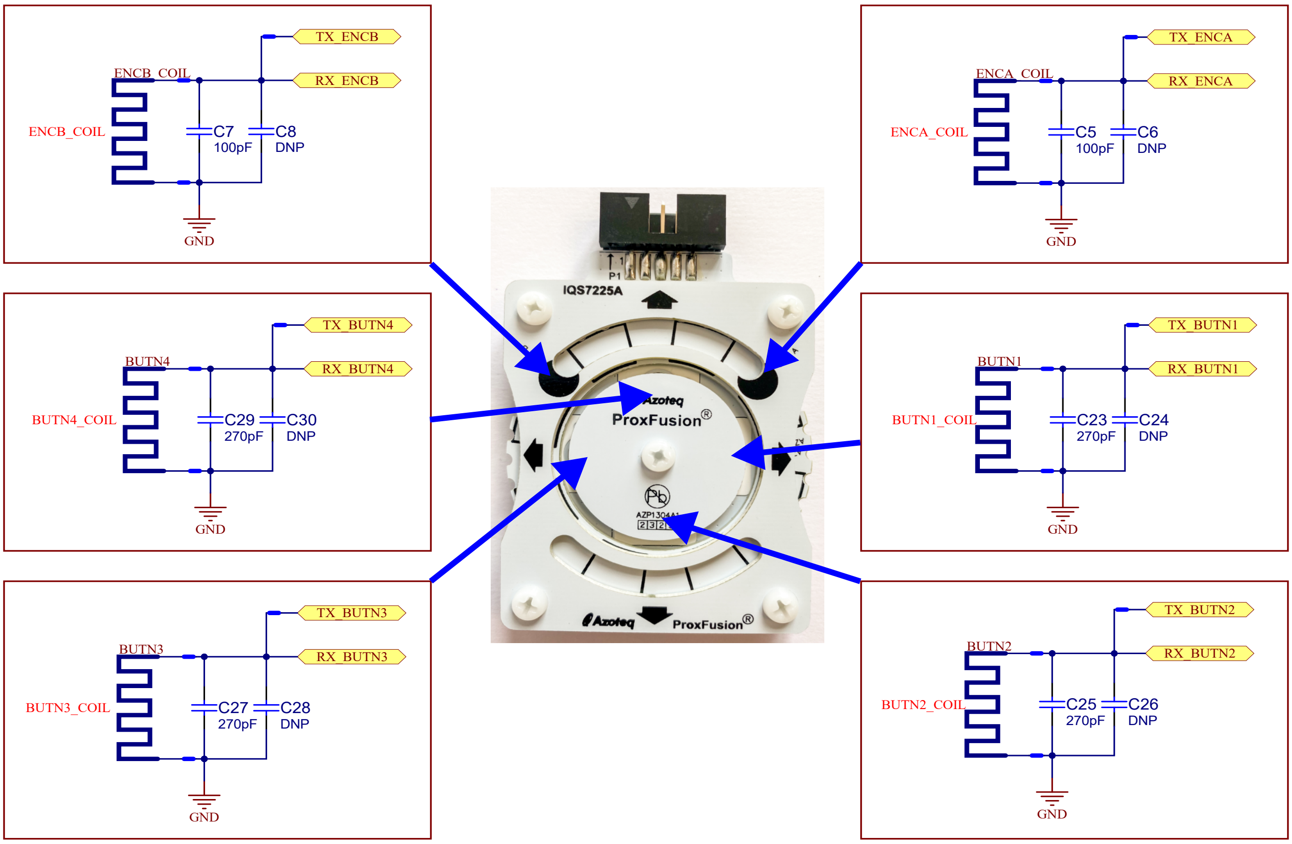

Figure 4.2: IQS7225A EV-kit Hardware Layout: Electrode Connections

4.1.1 Step 1: General Settings

After loading the settings, Figures 4.3 and 4.4 show the enabled channels used and their Counts and LTA bars visible in the bar chart.

Note - The relation to the hardware layout.

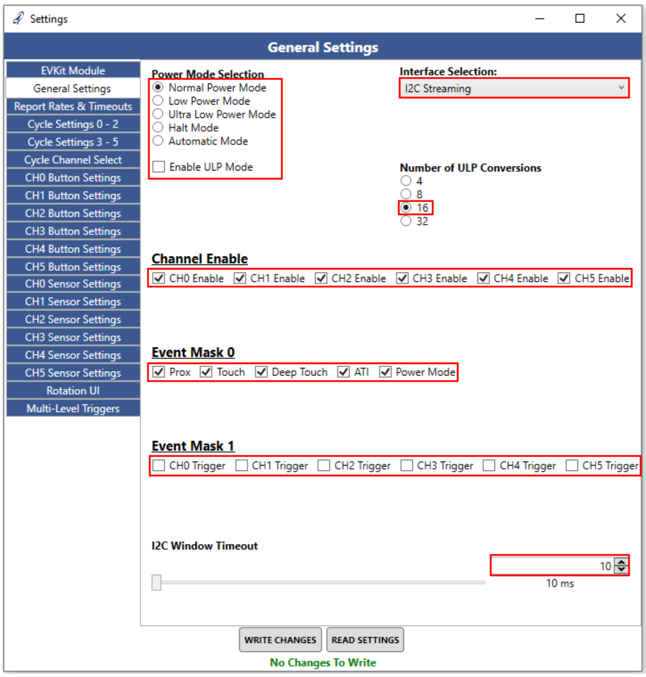

Figure 4.3: Active channels In General Channel Settings Tab

Figure 4.4: Active Channels In The Inductive Coil And Slider Demo

The settings listed in the tab shown in Figure 4.3 can be described as shown below.

- **Power mode selection**: Select between normal, low, ultra-low, halt, and automatic power modes.
- **Enable ULP mode**: Enable or disable ULP mode.
- **Channel enable**: Enable or disable one or more channels.
- **Interface selection**: Select between I^{2}C streaming, I^{2}C events, and I^{2}C stream in touch.
- **Event mask**: Enable or disable proximity, touch, deep touch, ATI, power, and trigger events.

- I^2C **window timeout**: Set the required I^2C window timeout in milliseconds.
- **Number of ULP conversions**: Set the required number of ULP conversions.

4.1.2 Step 2: Cycle Setup

The device uses cycles (or time slots) to perform the sensing on each channel. The IQS7225A is equipped with a dual ProxFusion® sensor engine design that can operate concurrently, necessitating synchronisation in sensing technology (or PXS mode) for each cycle. Channels 0 and 2 (utilising available receiver pins Rx0 - 3) are sensed by the first engine, while channels 1, 3, 4, and 5 (utilising available receiver pins Rx4 - 7) are sensed by the second engine. Figure 4.5 shows the distribution of channels across the two ProxFusion® sensor engines, which can both be used simultaneously for sensing.

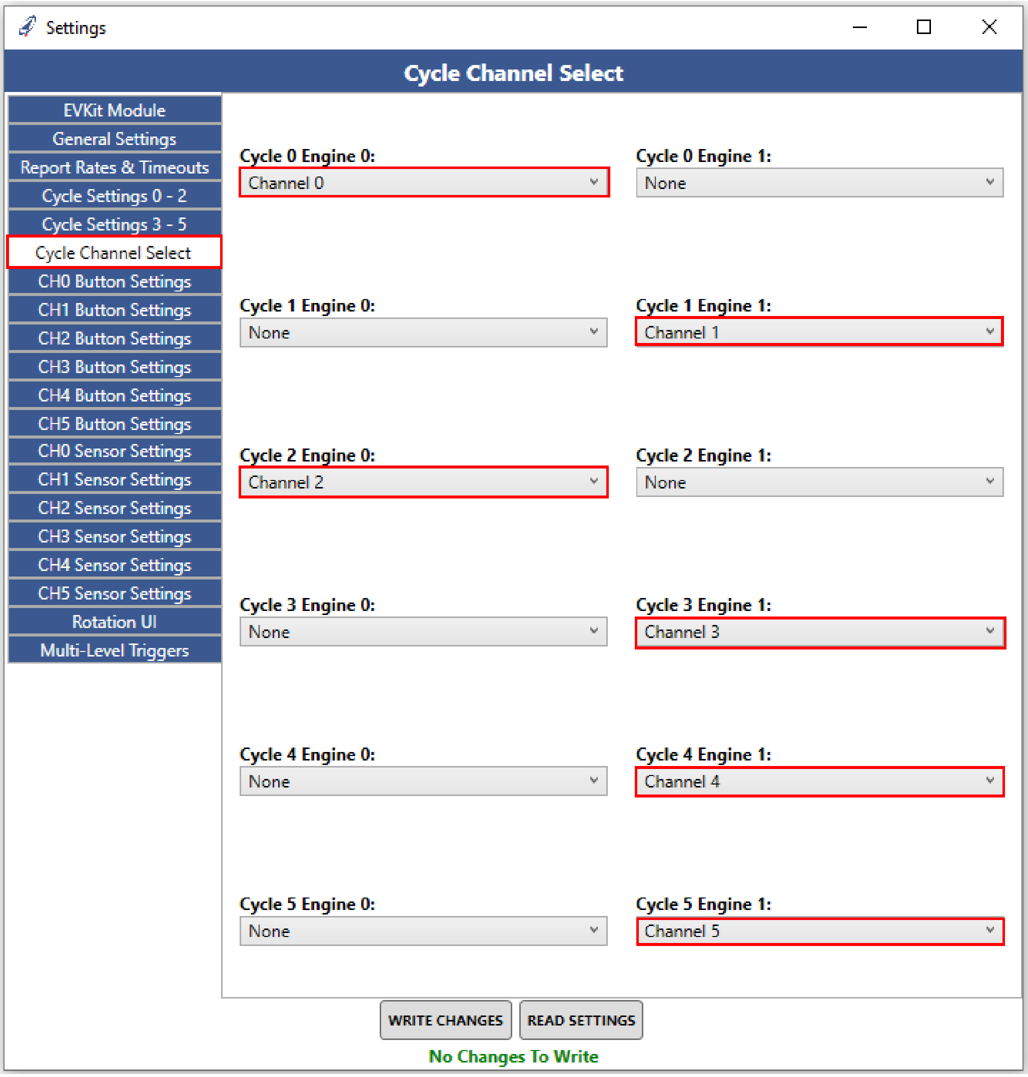

Figure 4.5: Selected Channels for each ProxFusion® sensor engine

In this example, all cycles are configured in mutual-inductive mode. *Cycle 0* will sense channel 0, where the resonant tank connected to the circular coil (as shown in the EV-kit schematics) is driven by Tx0 and measured by Rx2. In the channel 0 Sensor Settings tab, Tx0 is designated as the transmitter and Rx2 as the receiver. *Cycles* 1, 2, 3, 4, and 5 will perform sensing on channels 1, 2, 3, 4, and 5, respectively. Table 4.1 below provides a full summary of the transmitter-receiver pin combinations of the different channels.

Table 4.1: Channel transmitter and receiver pins

Channels	Transmitter	Receiver
CH0	Tx0	Rx2
CH1	Tx9	Rx4
CH2	Tx3	Rx1
CH3	Tx8	Rx5
CH4	Tx11	Rx6
CH5	Tx10	Rx7

As shown in Figures 4.6 and 4.7, all the cycles are configured to drive the selected TX pin at the device's FOSC frequency, while grounding the inactive or unused Rx pins. The cycles are also setup to transmit and receive at the standard 500kHz conversion frequency.

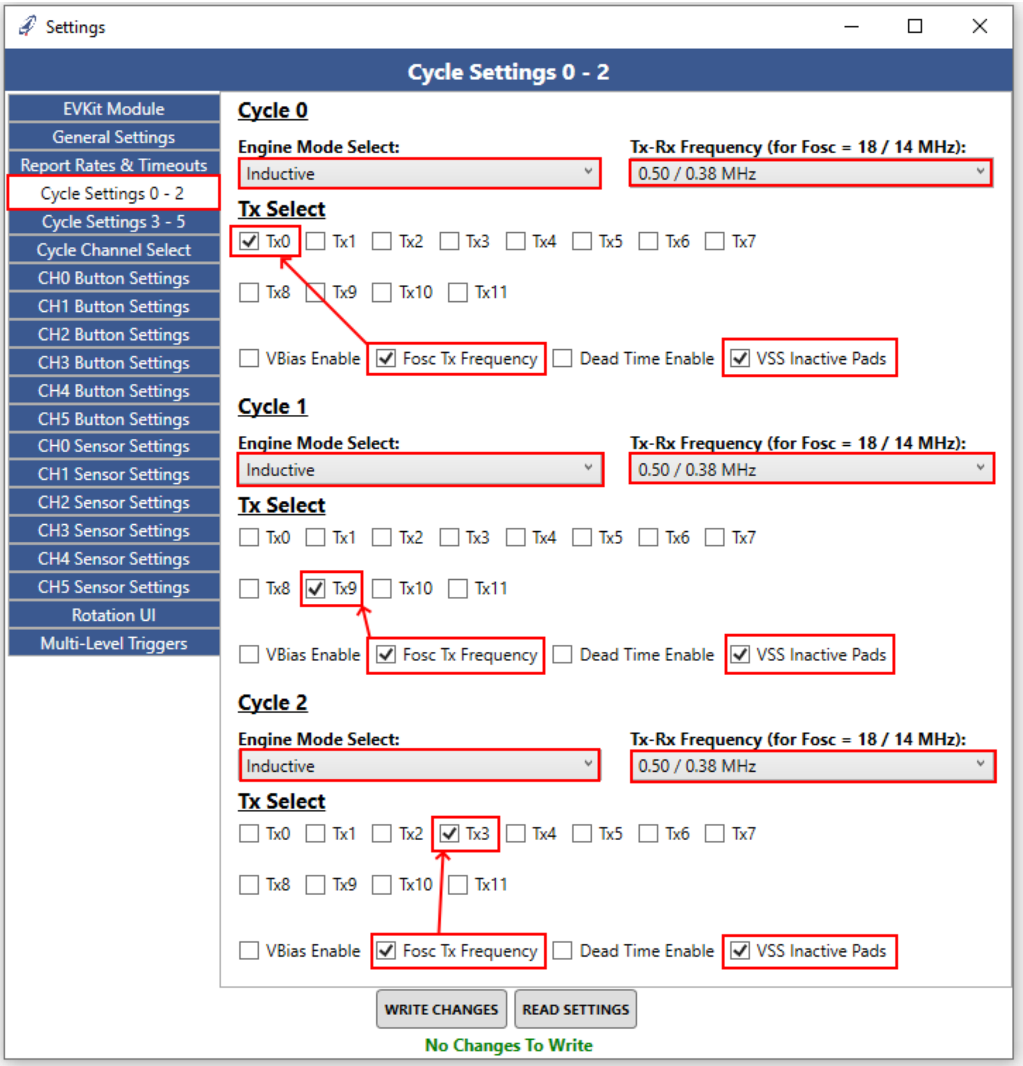

Figure 4.6: All Active Channels In Cycle Settings 0 - 2

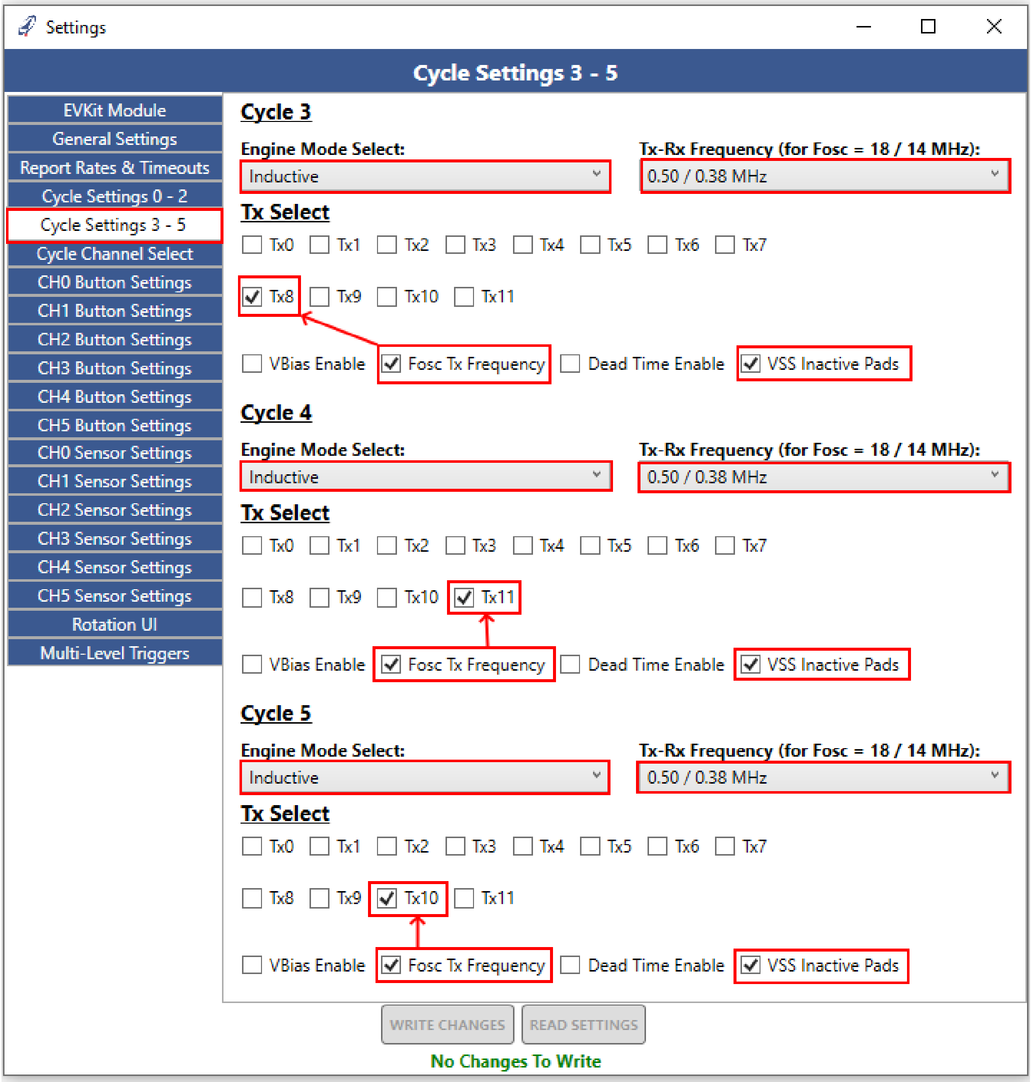

Figure 4.7: All Active Channels In Cycle Settings 3 - 5

4.1.3 Step 3: Channel Setup

Next, set up the applicable channels. This example will focus on Channel 0, though each channel can be configured independently as needed.

It is important to select the correct Rx pins for each channel. For instance, as depicted in Figures 4.3 and 4.2, Channel 0 (CH0) uses Tx0 and Rx2. Therefore, under CH0 Settings, Rx2 should be selected as the receiver, as shown in Figure 4.8.

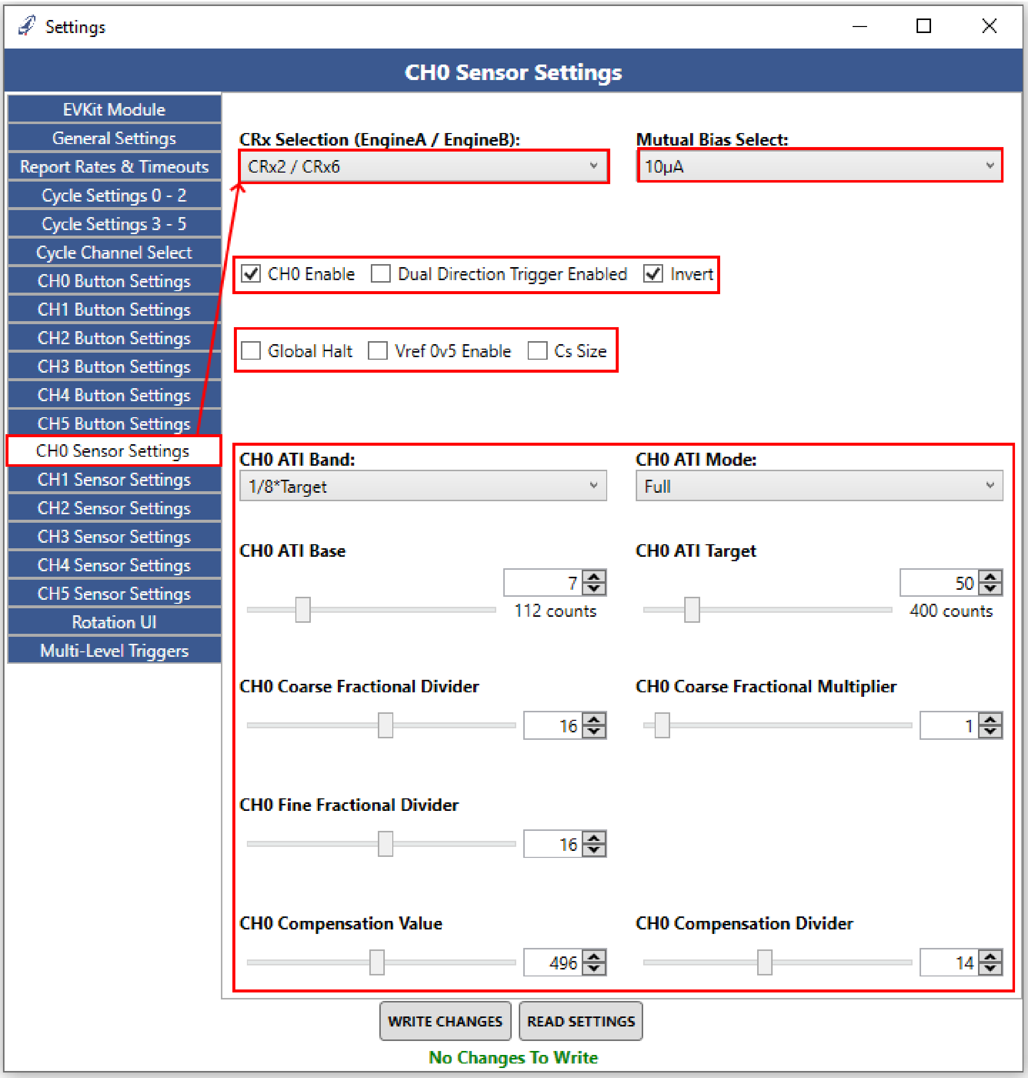

Figure 4.8: Channel Sensor Settings

Other settings listed in the tab shown in Figure 4.8 above are sensor- and ATI-specific for the channel. Take note of the values and units displayed below each slider, as some settings are not directly translated into decimal units. Some sliding setting controls are in steps of a constant factor, percentage, or calculated from the *ATI target*.

Multiplier, divider, and compensation options are automatically selected and updated by the ATI algorithm, when set to *Full ATI*, which is recommended for most designs. These values may vary between devices and can even change during runtime to maintain optimal sensor sensitivity within the operational range, accounting for external and environmental influences.

4.1.4 Step 4: Button Setup

The configurable button settings as shown in Figure 4.9 below include blocking channel, proximity threshold, proximity enter and exit debounce, touch threshold and hysteresis, deep touch threshold and hysteresis, proximity event timeout, touch event timeout, deep touch event timeout, linearize counts, number of events, and beta filters.

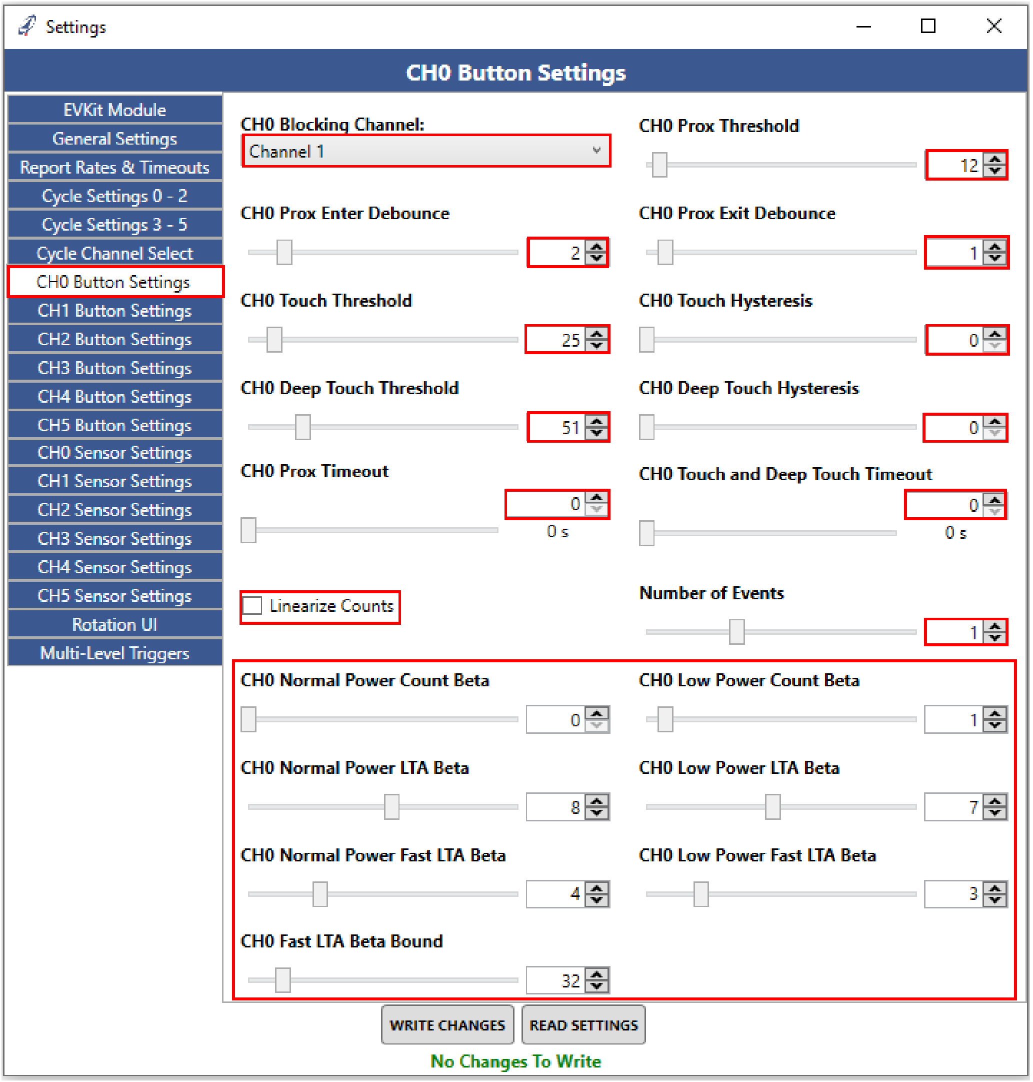

Figure 4.9: Button Settings

All the buttons have the same settings, except for the blocking channel settings, which apply only to Channel 0 and Channel 1 (the Rotation UI Channels). Again, take note of the displayed values and units below each slider, as not all settings are shown in decimal units. Some settings are presented in fixed steps or percentages. The threshold can be calculated as illustrated below.

$$\text{Button touch threshold} = \frac{\text{threshold decimal setting}}{256} \times \text{LTA} \tag{1}$$

The default beta parameter options have been selected to accommodate the most common and generic applications. They are intended to filter according to specific power mode operations, thereby ensuring minimal noise while maintaining substantial response without lagging outputs. The parameters should also be adjusted to modify LTA amounts for slowly varying counts and to utilise the fast LTA beta for rapidly responding to count behaviour contrary to normal activations. These defaults are the recommended values and serve as a good starting point.

4.1.5 Step 5: Report Rates And Power Mode Timeout Setup

The settings depicted in Figure 4.10 are global settings applicable to all channels, encompassing parameters such as ATI re-try delay, minimum ATI sampling period, power mode timeout, and power mode report rate. Take note of the displayed values and units below each slider, as not all settings are directly translated to decimal units. Some settings are presented in steps of a fixed constant or as percentages.

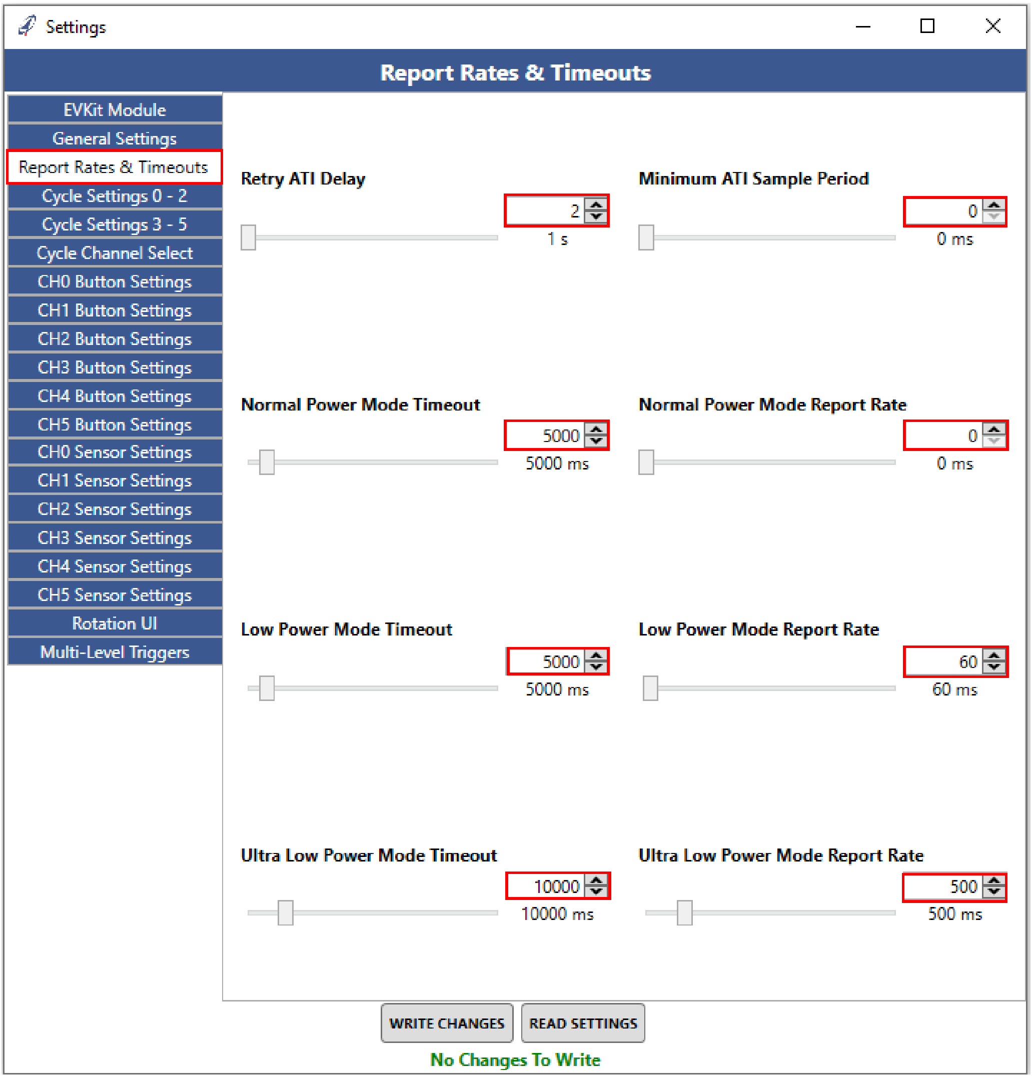

Figure 4.10: Channel Report Rate and Power Mode Timeout Setup

4.1.6 Encoder Setup

The IQS7225A allows for the configuration of two inductive coils to provide additional encoder outputs, such as:

(a) Encoder angle
(b) Encoder count

In this example, Channel 0 is connected to Coil A, and Channel 1 is connected to Coil B. Channels can be selected from the "Coil A Channel" and "Coil B Channel" drop-down lists. When selecting the reference channels, Coil $\bar{A}$ and $\bar{B}$, it should be noted that values less than 5 indicate that the reference channel LTA will be used as the encoder channel LTA. For values greater than 5, the encoder channel LTA is calculated as 8 times the selected value.

Additional settings include the selection of the number of metal segments and the configuration of the enter and exit thresholds of Coil A and Coil B.

Figure 4.11: Encoder Settings

4.1.7 Multi-Level Trigger Setup

The IQS7225A provides multi-level trigger settings, allowing an adjustable number of trigger levels to be set for each channel. Trigger events are activated when there is a transition in the trigger levels of each channel. To configure multi-level triggers on a channel, both the maximum delta value and the desired number of trigger levels must be selected. The calculation for the channel output trigger level can be determined as illustrated below.

$$\text{Channel output trigger level} = \frac{\text{Max delta}}{\text{number of trigger levels}} \quad (2)$$

In this example, the channels are configured using the default maximum delta values of 1000 and 10 trigger levels, as shown in Figure 4.12.

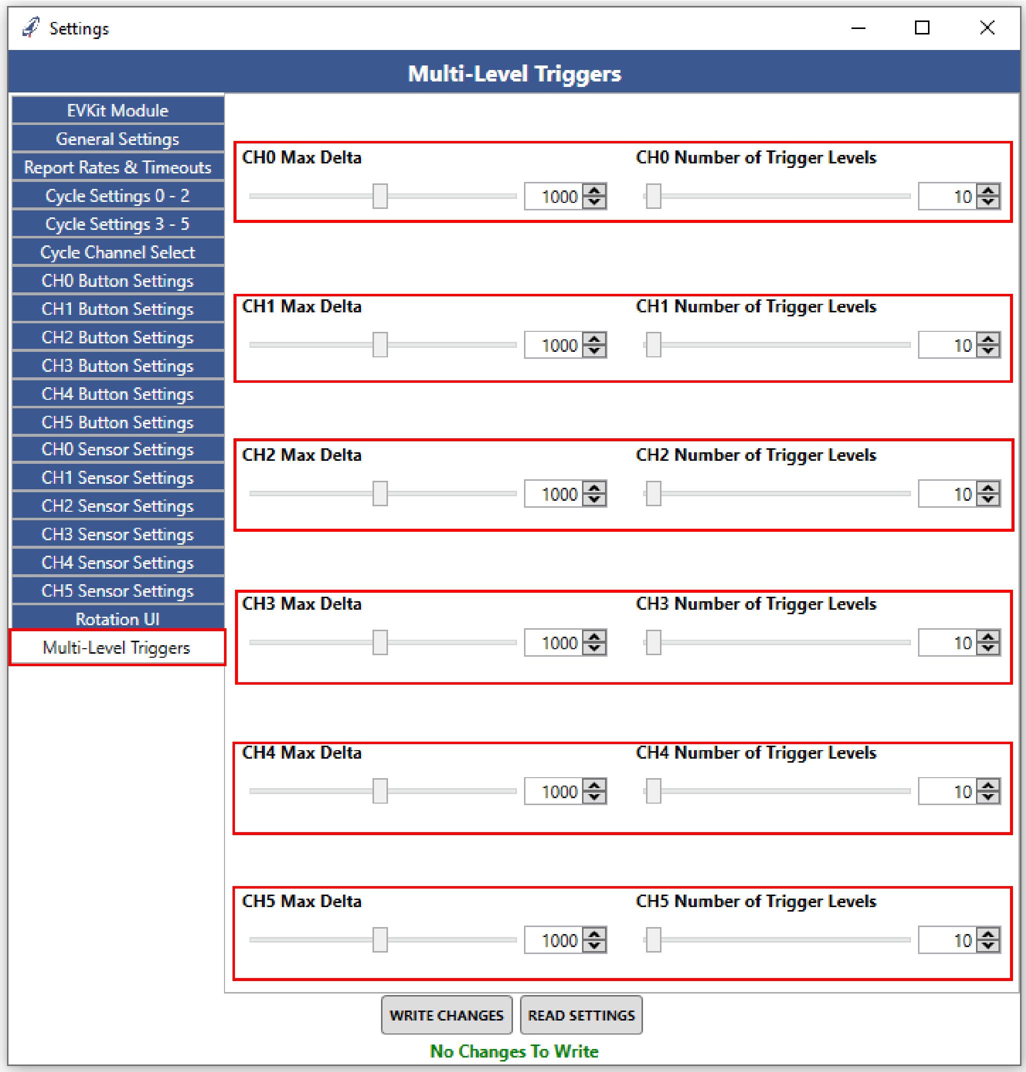

Figure 4.12: Multi-Level Trigger Setup

4.2 Self-Capacitance Setup

Section 4.1 describes how to set up the EV-kit hardware for inductive sensing. In order to assist the users with a setup for self-capacitance sensing, this section was added and provides an example of a self-capacitive setup. The IQS7225A supports self-capacitive sensing on all active channels. In this example, the channels are configured for self-capacitive sensing, and note that self-capacitive channels require both the Tx and Rx pins to be the same.

The IQS7225A device uses Rx0 - Rx3 for ProxFusion® Engine A and Rx4 - Rx7 for ProxFusion® Engine B. The Tx-Rx combinations for the different channels are shown in Table 4.2.

Table 4.2: Channel transmitter and receiver pins

Channels[1]	Transmitter	Receiver
CH0	Tx0	Rx0
CH1	Tx1	Rx1
CH2	Tx2	Rx2
CH3	Tx3	Rx3
CH4	Tx4	Rx4
CH5	Tx5	Rx5

4.2.1 Cycle Setup

In this example, each channel is linked to a different cycle, and the pin numbers are selected to match the channel number just for consistency. The self-capacitive cycle setup of all the channels is shown in Figures 4.13 and 4.14. The allocation of the different channels to the proximity engines is shown in Figure 4.15.

[1] Please note that for self capacitive sensing, TxZ and RxZ are physically the same pin/electrode on the IC.

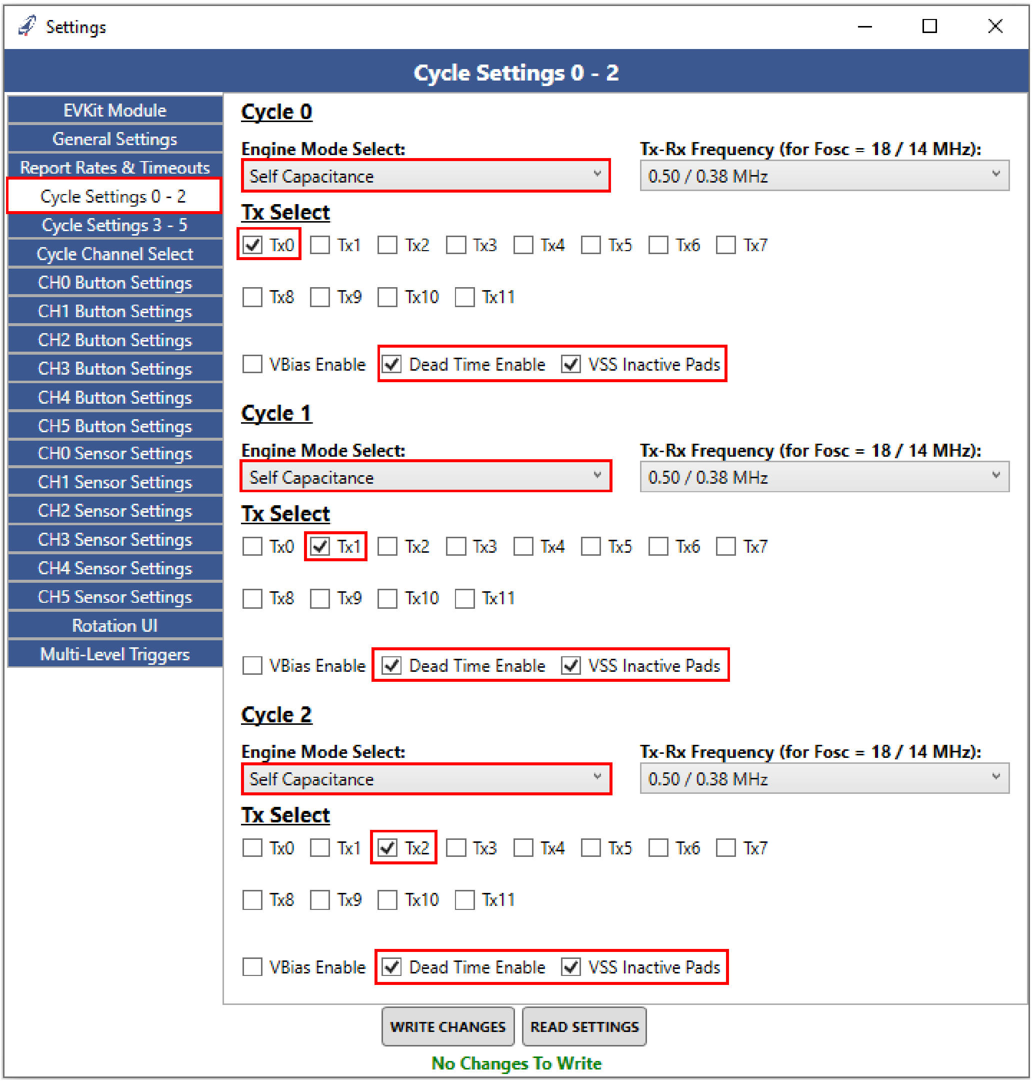

Figure 4.13: All Active Self-Capacitive Channels In Cycle Settings 0 - 2

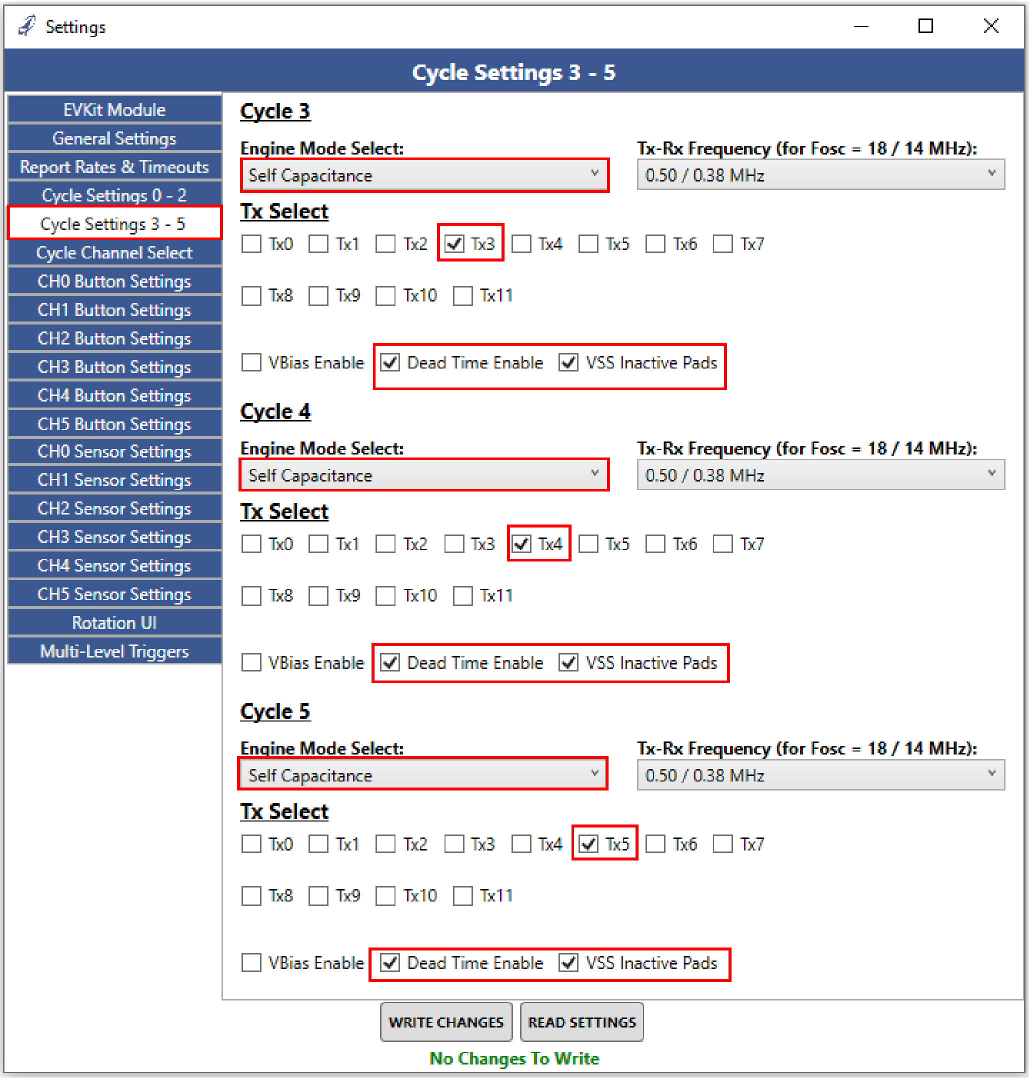

Figure 4.14: All Active Self-Capacitive Channels In Cycle Settings 3 - 5

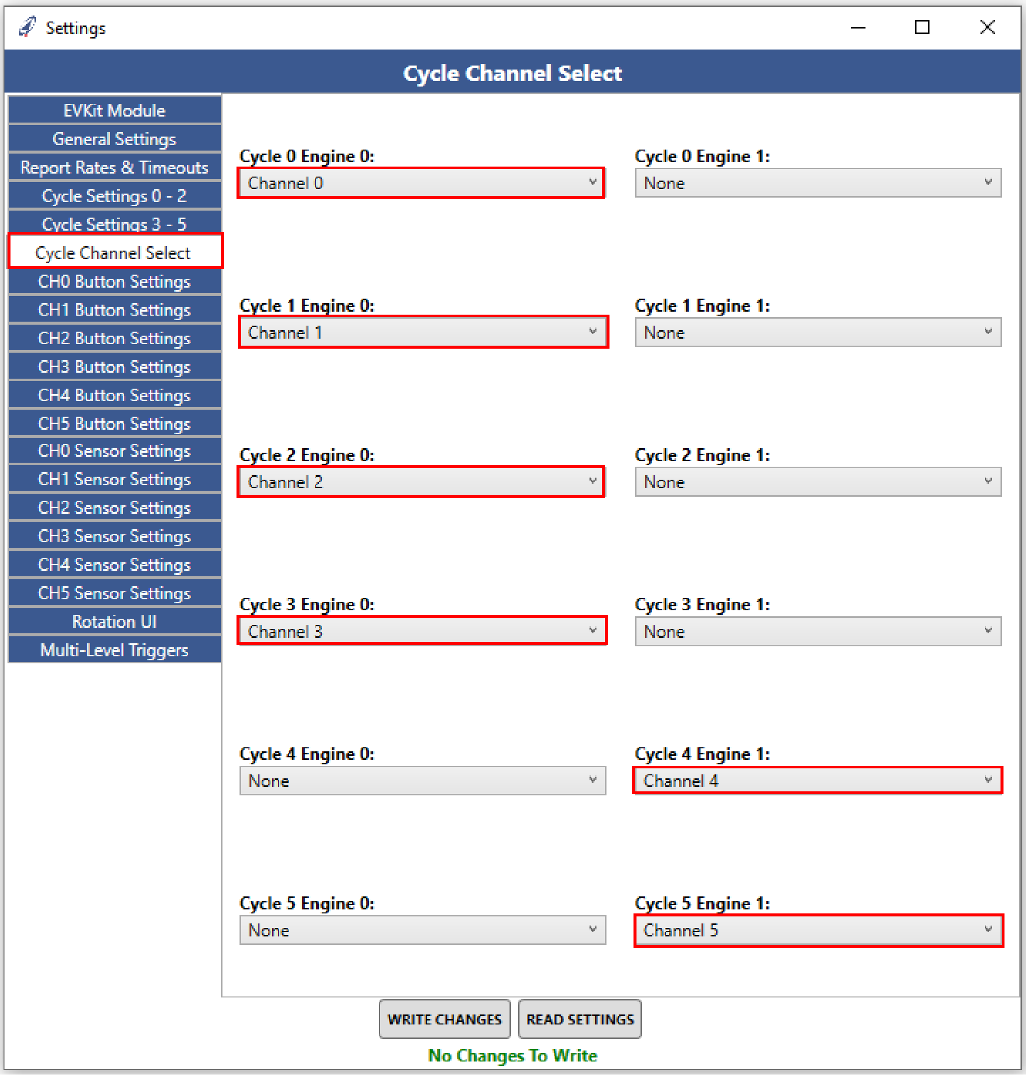

Figure 4.15: Selected Self-Capacitive Channels for Each ProxFusion® Sensor Engine

4.2.2 Channel Setup

Next, the applicable channels need to be set up. For this, only Channel 0 will be shown in this example. Nonetheless, each channel can be configured independently as needed.

When configuring a channel in self-capacitive mode, you need to enable that electrode as a Rx and a Tx. So in this example for CH0, as seen in Figure 4.13, Tx0 must be enabled, and under CH0 Sensor Settings, Rx0 must be selected, as shown in Figure 4.16.

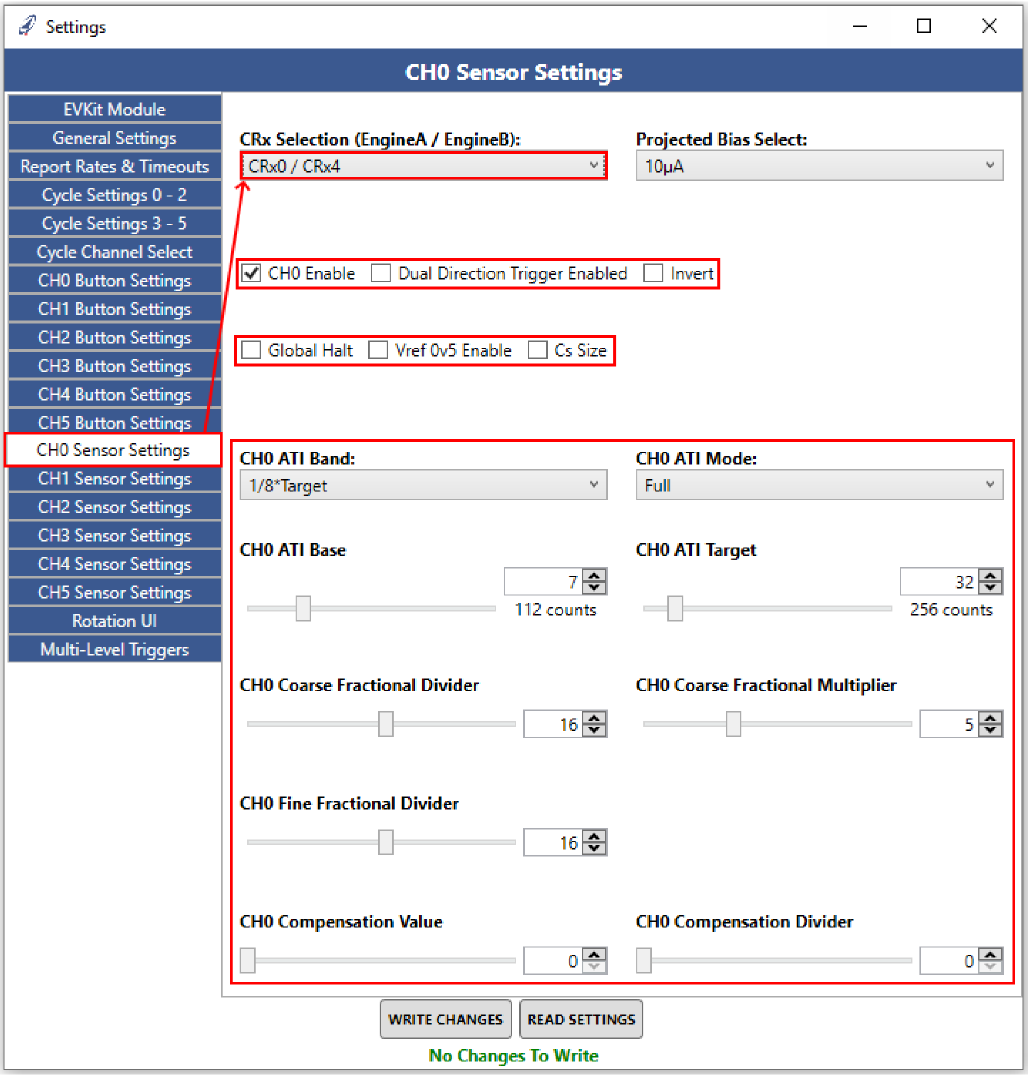

Figure 4.16: Self-Capacitive Channel Sensor Settings

Note - In addition to the settings described in Section 4.2, other settings that are needed for self-capacitance sensing are already described in Section 4.1, such as the general settings shown in Figure 4.3, the button settings shown in Figure 4.9, the report rate and power mode timeout settings shown in Figure 4.10, and optionally, the multi-level trigger settings shown in Figure 4.12.

4.3 Mutual-Capacitance Setup

Section 4.1 described how to set up of the EV-kit hardware for inductive sensing, and Section 4.2 provided an example of a self-capacitive setup. To assist users with configuring mutual-capacitance sensing, this section has been added to illustrate a mutual-capacitive setup.

The IQS7225A supports mutual-capacitive sensing on all active channels. In this example, the channels are configured for mutual-capacitive sensing, noting that each channel requires unique Tx-Rx combinations. The IQS7225A device utilises Rx0 - Rx3 for ProxFusion® Engine A and Rx4 - Rx7 for ProxFusion® Engine B. Table 4.3 shows the Tx-Rx combinations for the different channels.

Table 4.3: Channel transmitter and receiver pins

Channels	Transmitter	Receiver
CH0	Tx0	Rx1
CH1	Tx2	Rx3
CH2	Tx8	Rx4
CH3	Tx9	Rx5
CH4	Tx10	Rx6
CH5	Tx11	Rx7

4.3.1 Cycle Setup

In this example, each channel is linked to a different cycle. The mutual-capacitive cycle setup of all the channels is shown in Figures 4.17 and 4.18.

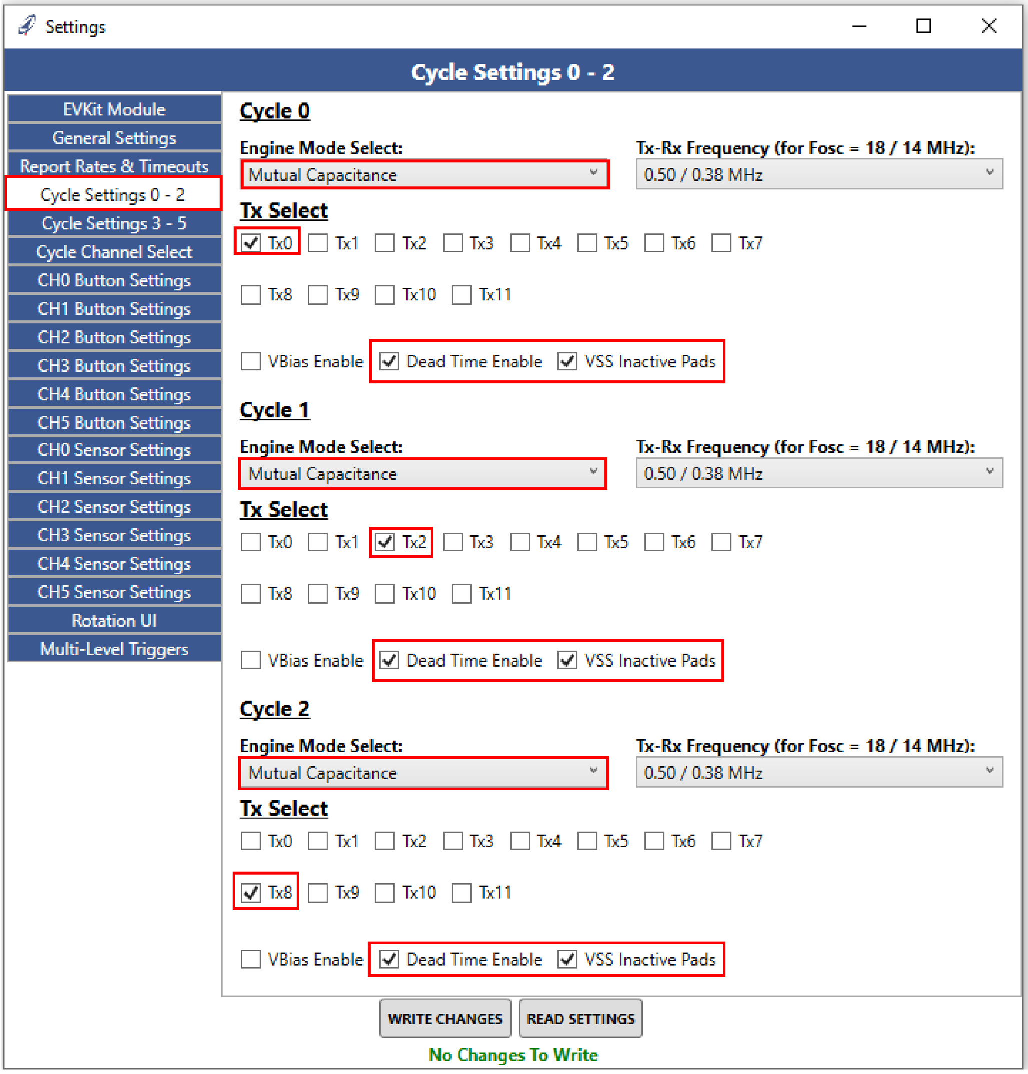

Figure 4.17: All Active Mutual-Capacitive Channels In Cycle Settings 0 - 2

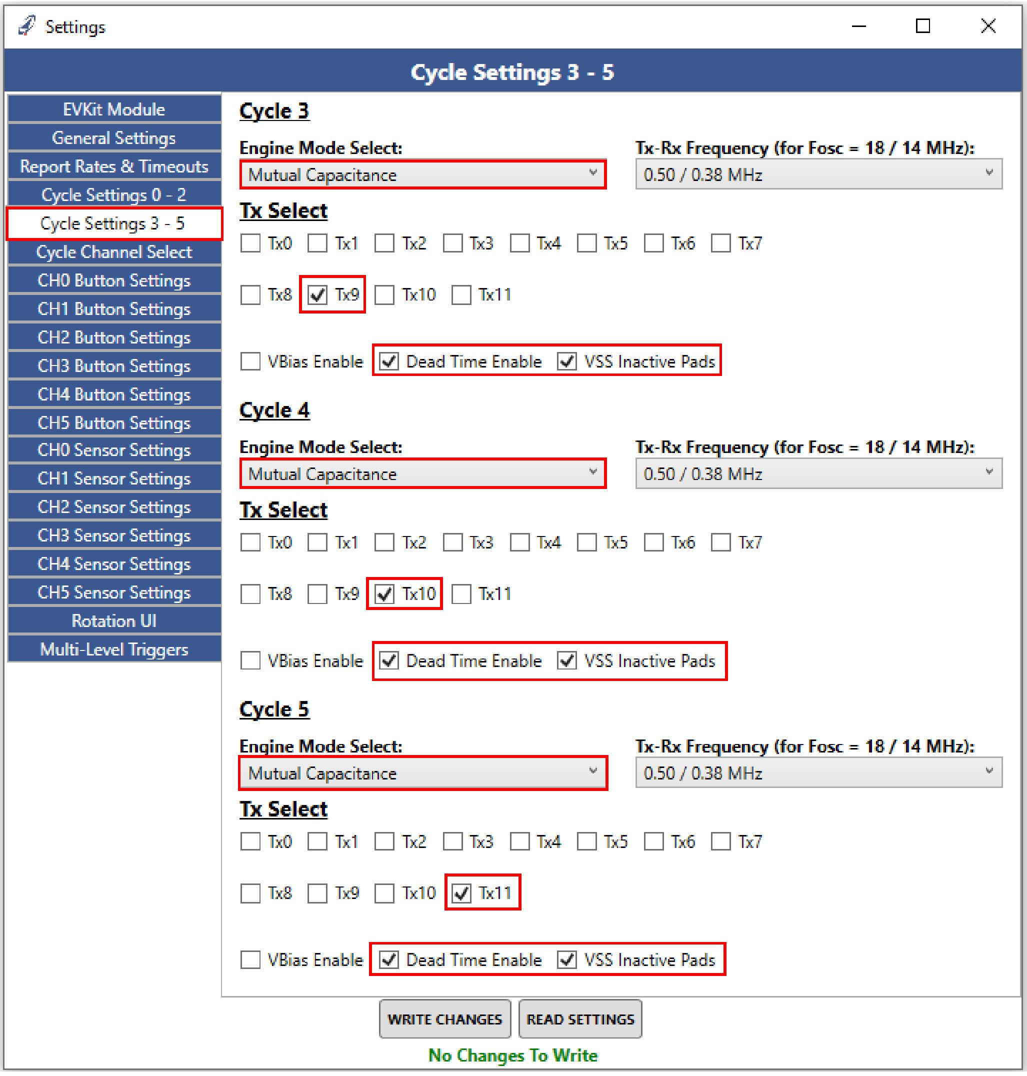

Figure 4.18: All Active Mutual-Capacitive Channels In Cycle Settings 3 - 5

The allocation of the different channels to the proximity engines is shown in Figure 4.19.

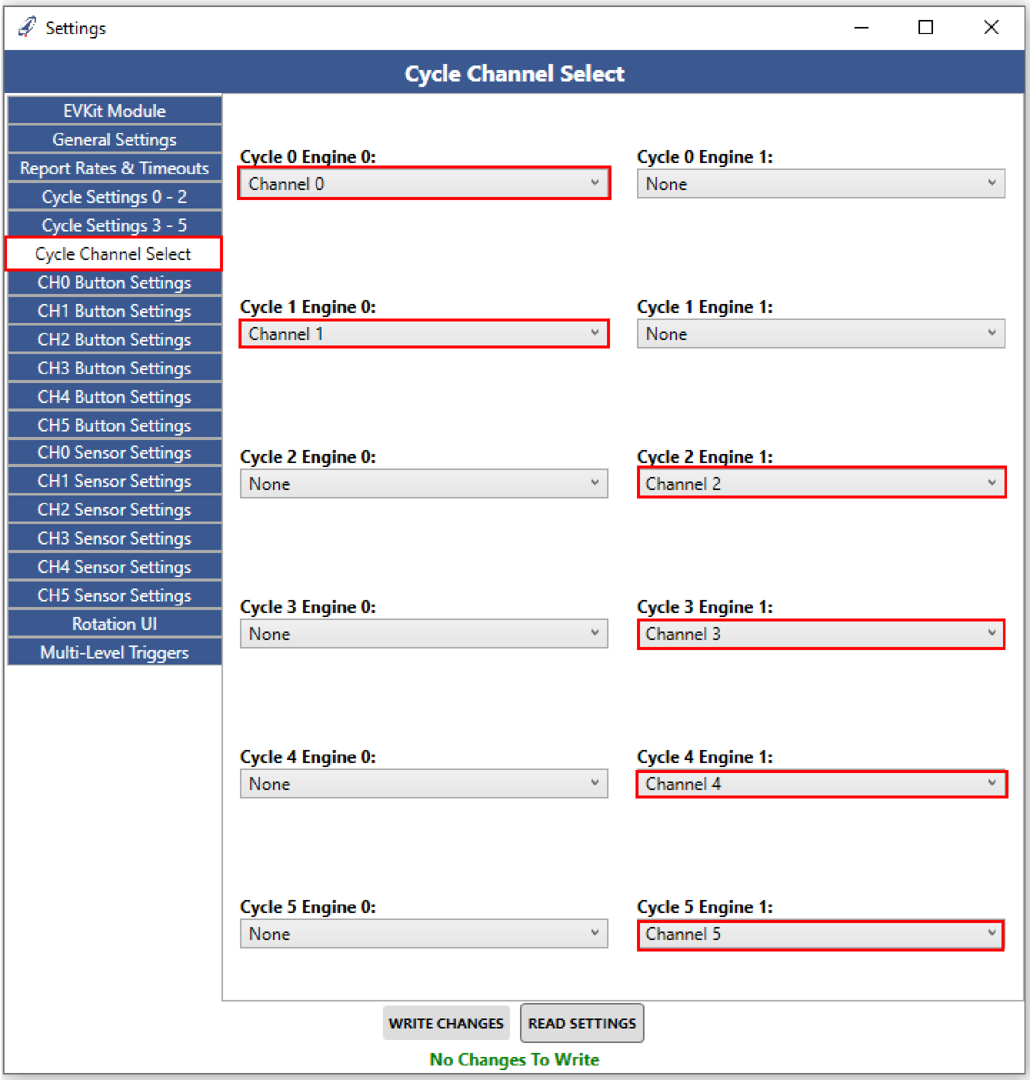

Figure 4.19: Selected Mutual-Capacitive Channels for Each ProxFusion® Sensor Engine

4.3.2 Channel Setup

Next, the applicable channels need to be set up. For this, only Channel 0 will be shown in this example. Nonetheless, each channel can be configured independently as needed.

It is important to select the correct Rx pins for each channel so that the Tx-Rx pairs are unique for each channel. Channel 0 uses Tx0, as seen in Figure 4.17, and Rx1 can be selected as the receiver under the CH0 Settings, as shown in Figure 4.20.

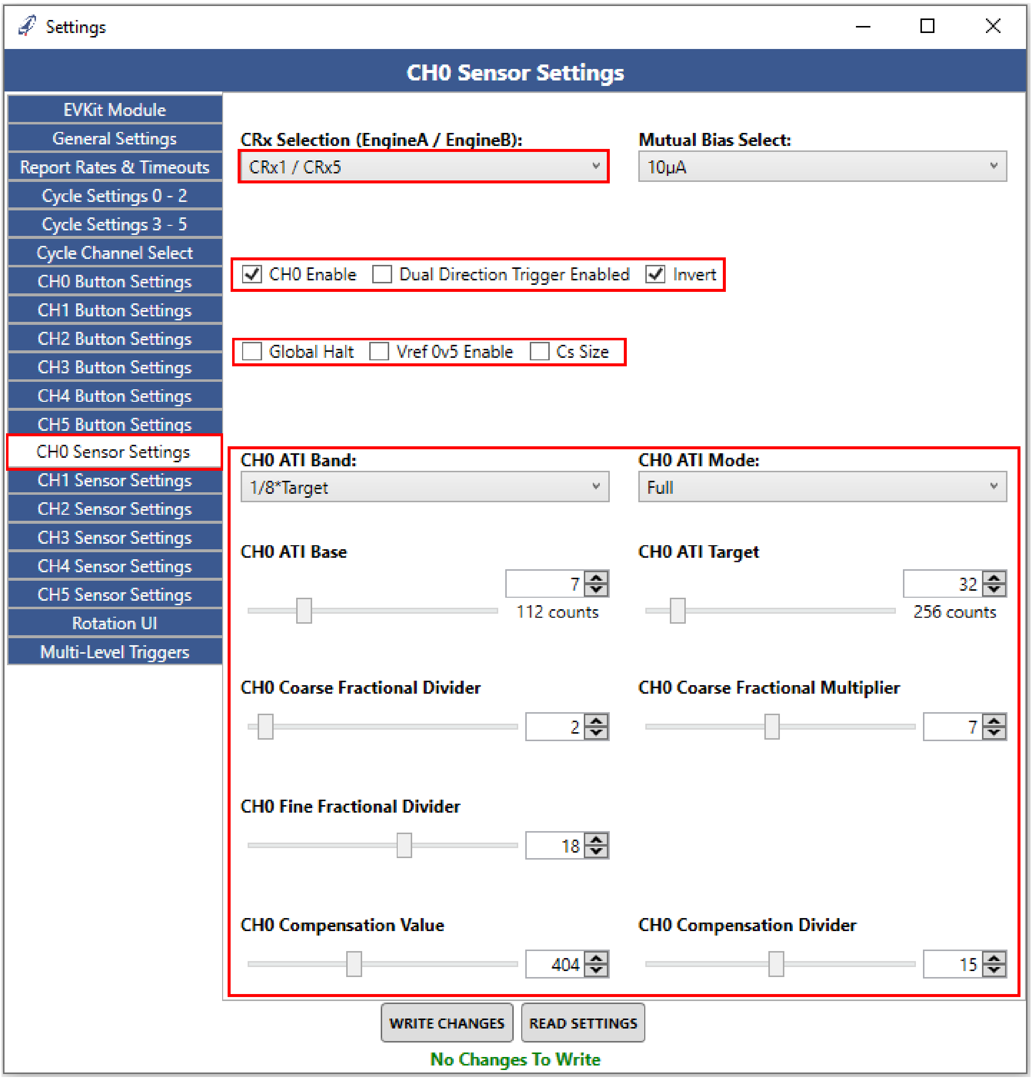

Figure 4.20: Mutual-Capacitive Channel Sensor Settings

Note - In addition to the settings described in Section 4.3, other settings that are needed for mutual-capacitance sensing are already described in Section 4.1, such as the general settings shown in Figure 4.3, the button settings shown in Figure 4.9, the report rate and power mode timeout settings shown in Figure 4.10, and optionally, the multi-level trigger settings shown in Figure 4.12.

5 Conclusion

This document explains the layout, operation, and related settings of the IQS7225A's GUI PC software. This document uses the IQS7225A EV-kit hardware as an example to explain how to configure the device using its GUI and how to export the resulting settings as a C/C++ header file for use in an application.

6 Revision History

Release	Date	Comments
v0.1	February 2023	Initial document released
v1.0	March 2023	Improved EV-Kit graphics
v1.1	June 2024	Azoteq generic GUI images replaced with IQS7225A GUI images

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