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 debug and display purposes. The designer may configure the IC via the GUI software for a specific application and evaluate the performance in real time. Although configuration examples will be given, this document is not intended to discuss or address all applications, but rather to provide the user with the necessary configuration, debugging, data logging and header file export knowledge of the GUI software to address their unique application. 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:

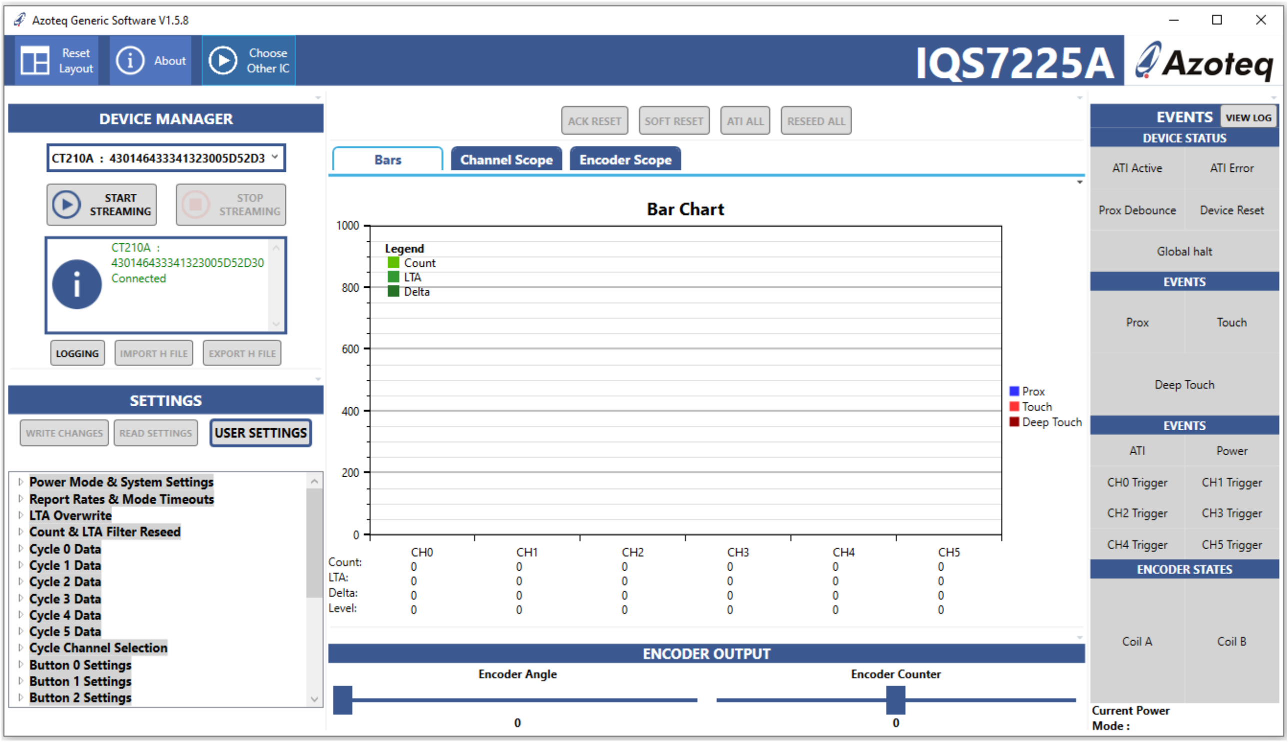

Figure 2.1: Main Window of The Azoteq IQS7225A GUI

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 below picture.

Figure 2.2: Hardware Connection For Streaming And Testing

Connect the application hardware's power supply (VDD), ground (GND), I^2C (SDA and SCL) as well as the data ready interrupt signal (RDY) signal traces to the CT210A USB dongle's pins as shown in the pin-out table numbered and colour coded accordingly to 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

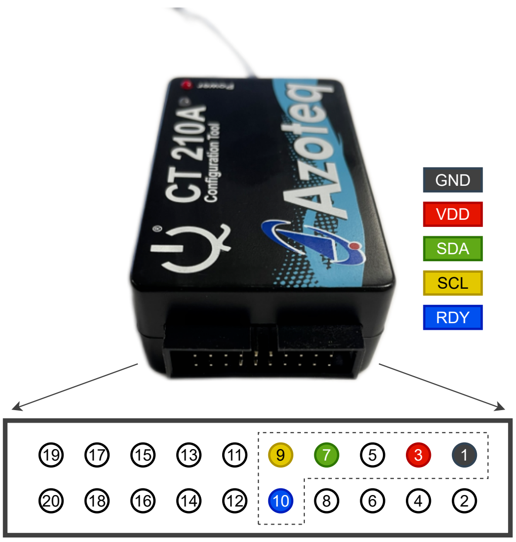

Figure 2.3: CT210A Power, I^2C And RDY Connections

2.3 Step 3: PC Connection Verification

After connecting the CT210A device to the computer via a USB port and micro-USB data cable, the GUI software will automatically install drivers if needed and verify its connection and firmware by displaying the CT210A's device ID and the appropriate 'Device Connected' information message in the configuration tool manager section as indicated in the red block in Figure 2.4.

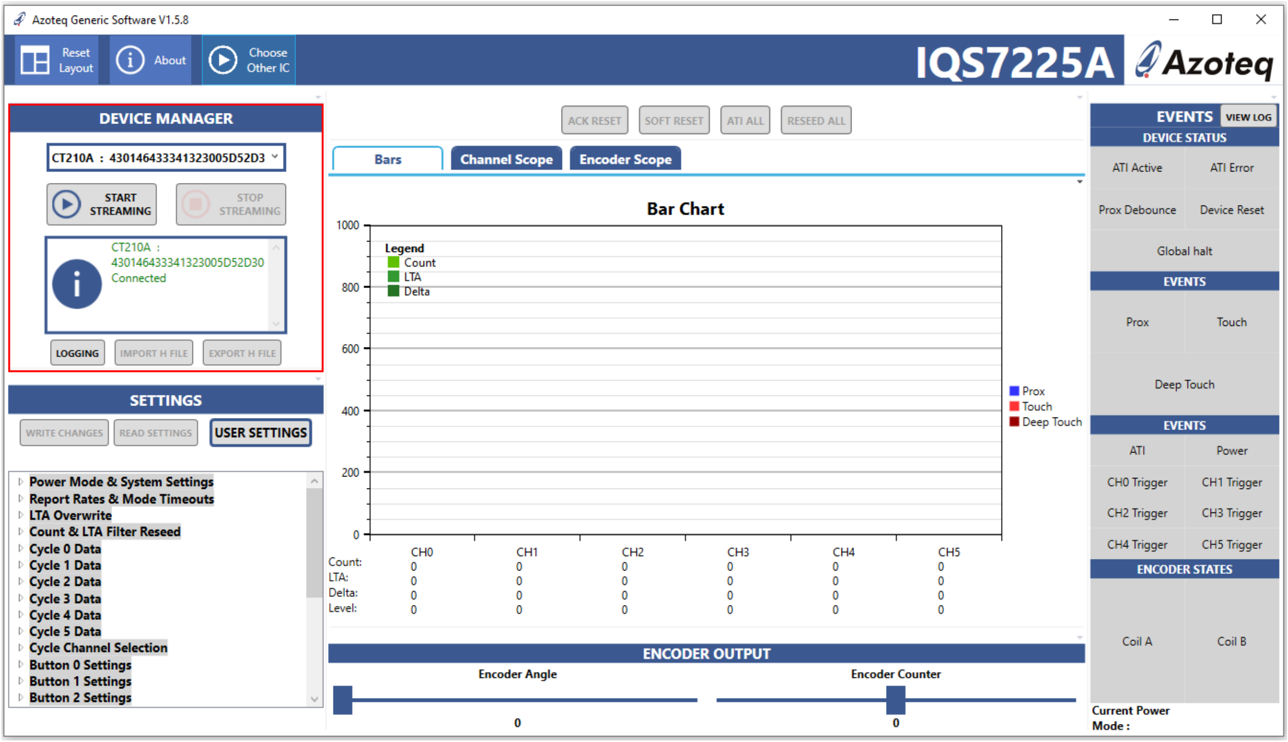

Figure 2.4: CT210A Recognition And Connection

Note: If the connected CT210A device firmware is out of date, an 'Update available' button should automatically appear next to the device enumeration. This button may then be clicked to launch the appropriate CT Firmware upgrade tool to update the firmware as shown in Figure 2.5. For the image displayed in Figure 2.5 the CT210A connected was already up to date with the latest firmware and does not require an update.

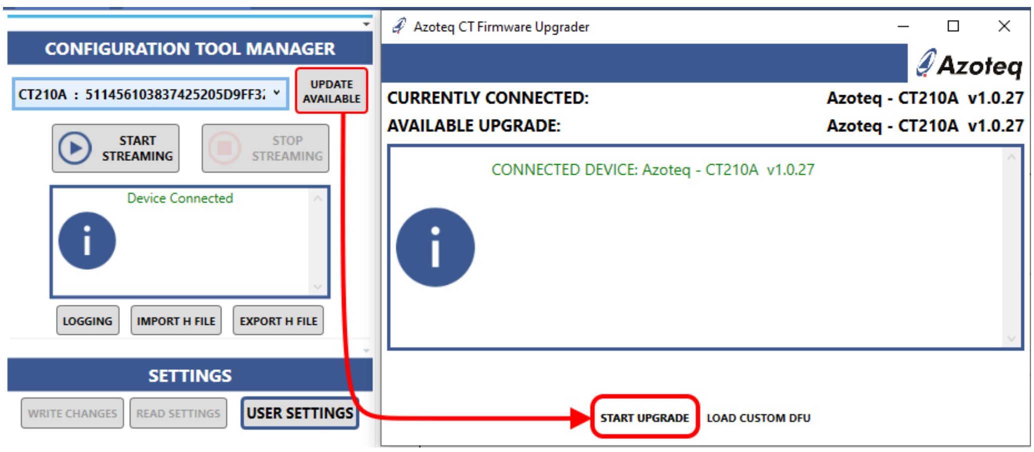

Figure 2.5: CT210A Firmware Upgrade

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

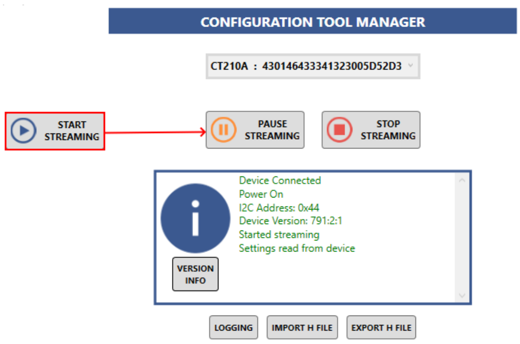

Figure 2.6: Message Dialogue Results From A Successful DUT Connection

If the above messages do not appear, please verify the device connection and the DUT IQS part and version correctness.

2.5 Step 5: Acknowledge Reset

Click on the red text button 'ACK RESET' as shown below. The 'Reset' event flag should clear afterwards and the 'ACK RESET' text should then change colour and remain black for successful reset acknowledgement.

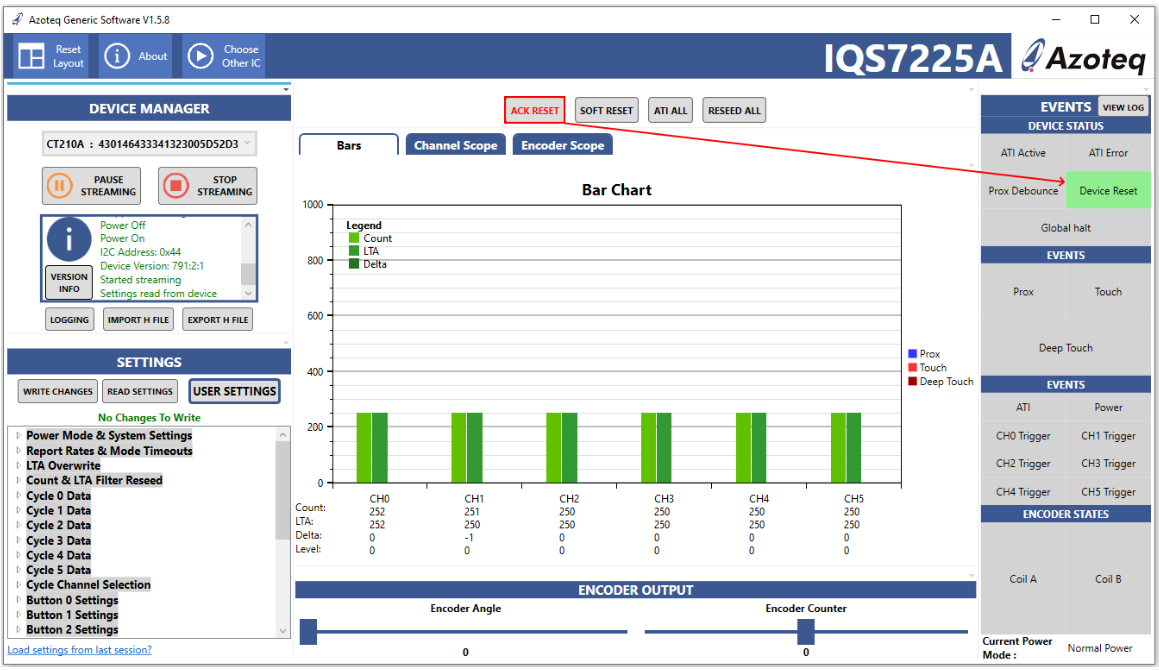

Figure 2.7: Default Device Setup Streaming From DUT After Power-on / Reset

2.6 Step 6: Device Configuration

The device may now be configured further by either loading pre-configured settings (in a *.h* - header file format) or selecting the 'USER SETTINGS' button to open the pop-up window with the settings organised 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) will lead to 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 confirm that the file was imported correctly:

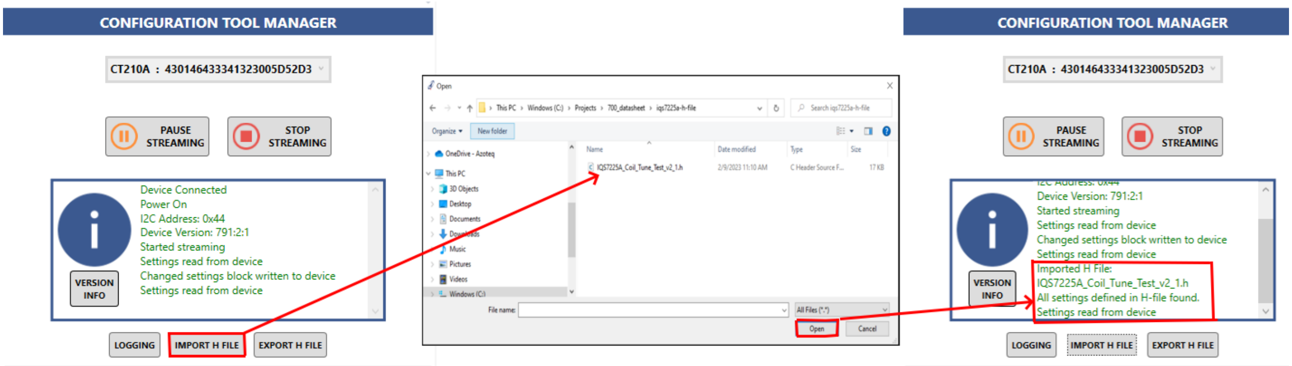

Figure 2.8: Importing A Predefined Configuration

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 "EVKit 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 detail.

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 the DUT has been configured, the new settings may be exported for safe-keeping, sharing or re-use at a later stage or on 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.

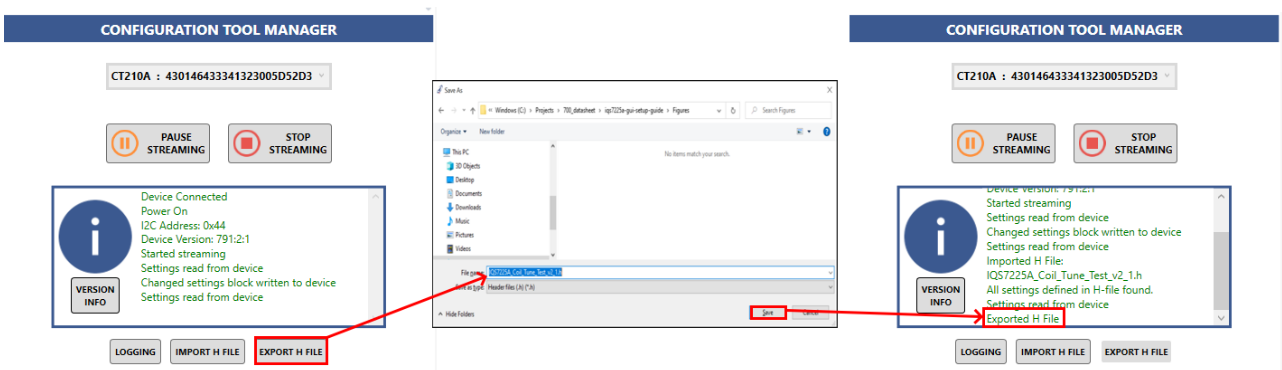

Figure 2.10: Exporting A Defined Configuration

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 that are numbered for later description.

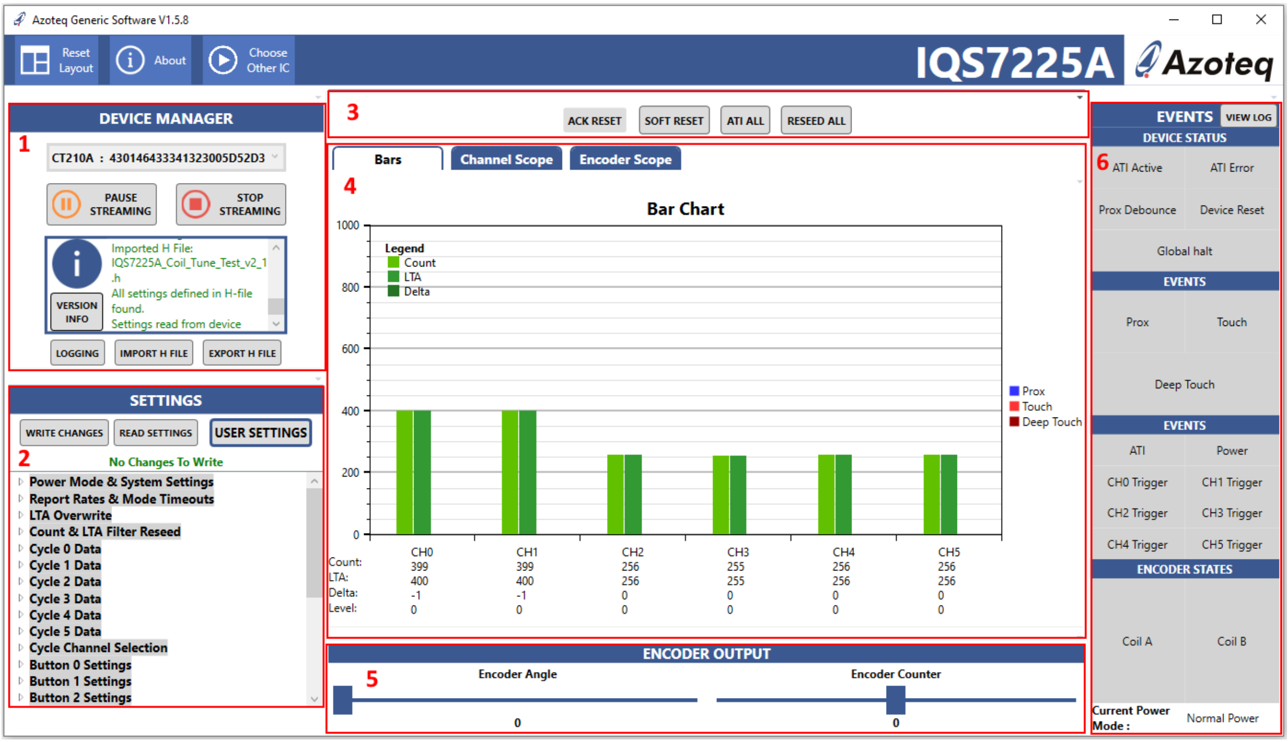

Figure 3.1: Main Window Sections of The Azoteq IQS7225A GUI

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

(1) **Configuration Tool Manager** - Allows for general configuration tool hardware recognition, control and feedback in the GUI. The top drop down box will list the available configuration tool (CT or DS) devices connected to the PC that are available for use. If a valid selection is made, the 'START STREAMING' button may be used to initiate I^2C communication and start a data 'stream' from the DUT. If the stream was initiated successfully, the button will change to 'PAUSE STREAMING' that can temporarily pause the I^2C activity from the configuration tool's side and ignore any DUT RDY signals. The 'STOP STREAMING' button in turn is used to terminate I^2C communication. The text box will provide general information on the I^2C connection, tasks completed, as well as error messages in case of any unsuccessful attempts or lost communications. The logging button may be used to capture/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 settings as the 'USER SETTINGS' window, but it is more a direct representation of the memory map structure. The 'USER SETTINGS' is a more user friendly and logical representation, and it is thus recommended to utilise this as the primary configuration portal. With the exception of some settings described later in this document, the settings tree should not be used without the support of an Azoteq or distributor 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 / reset state (with default device settings populated). The 'SOFT RESET' button will command the DUT to perform a soft reboot. The 'ATI ALL' button will command the DUT to use its automatic tuning implementation (ATI) algorithm for sensor re-calibration (please refer to the IQS7225A datasheet for more information). The 'RESEED' button commands the DUT to seed / set its Long Term Average (LTA) filtered values equal to its current count values. Note: these operations apply globally to all channels or the device as a whole.

(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 decimal representation of the current values are displayed below each channel. 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 signal input from the device's sensors. The 'LTA' is the long term average of the counts and act 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). Adjusting the number of points on the x-axis requires that one presses the 'RESET X AXIS' to apply/update the scope view. For scope navigational control explanations please click on the 'HELP' button.

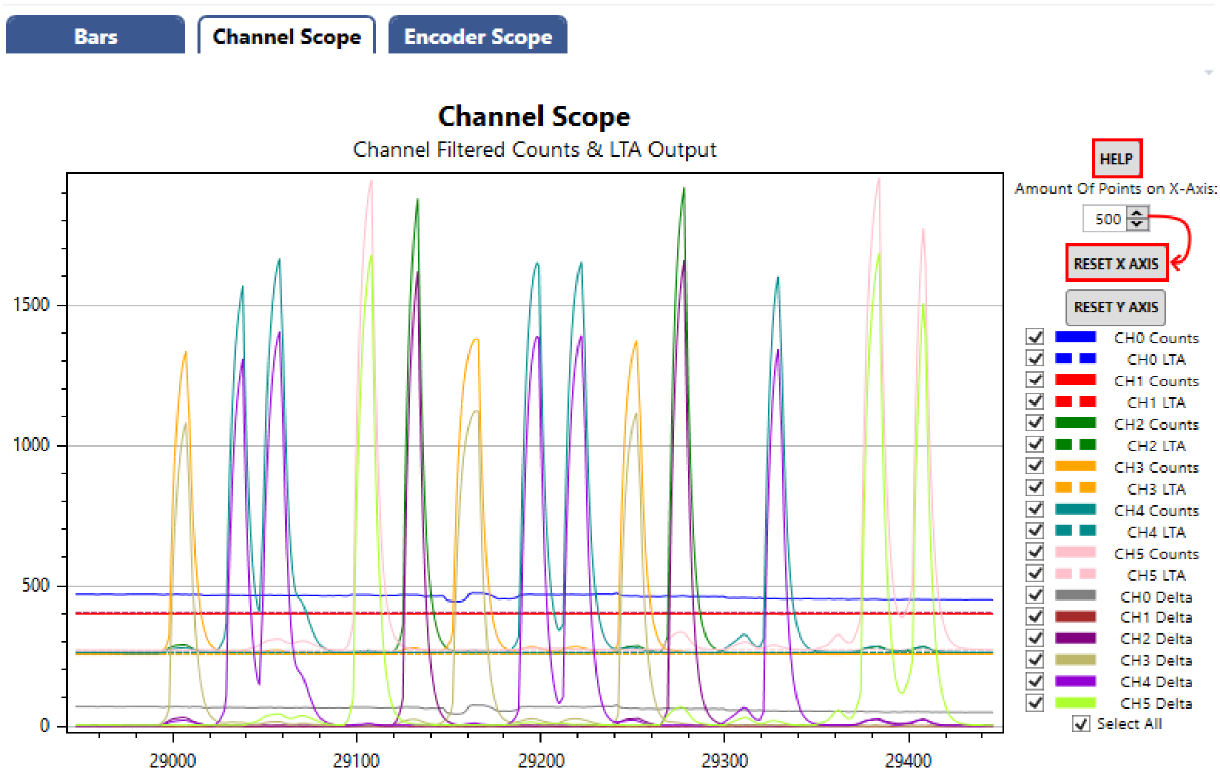

Figure 3.2: Scope View Of The IQS7225A GUI

(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 provides a dashboard overview of various events that are triggered. Individual blocks will 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 different event flags are described below.

- **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. The schematic and electrode layout of the IQS7225A EV-kit is provided in Figure 4.1 and 4.2. The reader should load the predefined configuration settings as discussed in Section 2.6.1.

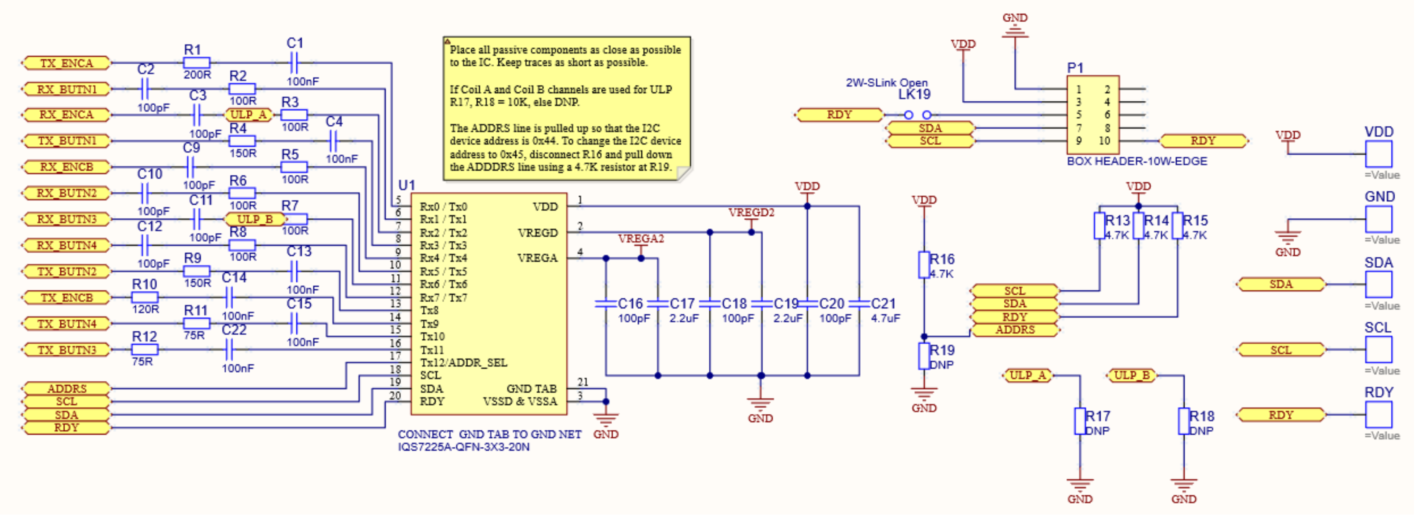

Figure 4.1: IQS7225A EV-kit Schematic Layout: IC With Passives

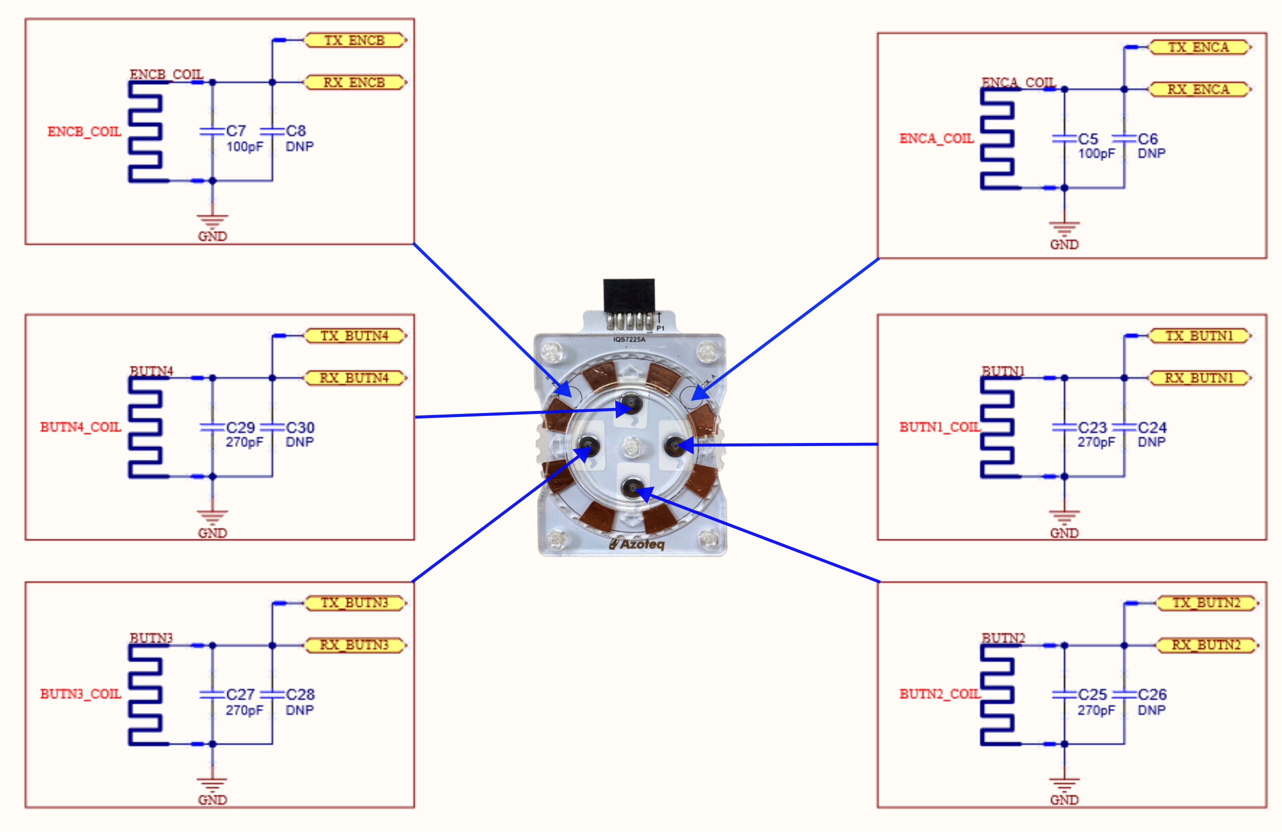

Figure 4.2: IQS7225A EV-kit Hardware Layout: Electrode Connections

4.1.1 Step 1: General Settings

After loading the settings, Figures 4.3 and 4.4 shows the enabled channels used and their Counts and LTA bars visible in the bar chart. Note the relation to the hardware layout.

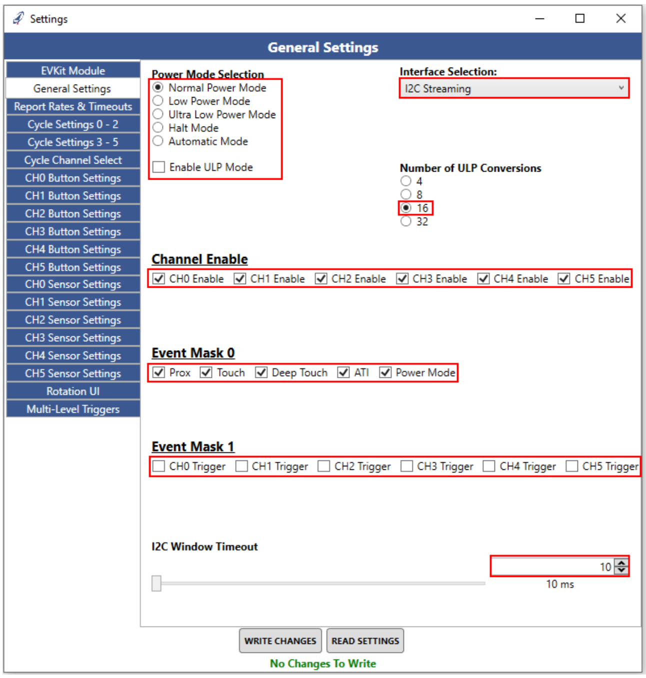

Figure 4.3: Active channels In General Channel Settings Tab

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 mode.
- **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^{2}C window timeout**: Set the required I^{2}C 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 dual ProxFusion sensor engine design on the IQS7225A can operate in parallel but need to be set up for the same sensing technology (or PXS mode) for a 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. The distribution of channels across the two ProxFusion sensor engines is shown in Figure 4.5. Both engines can also be used for sensing at the same time.

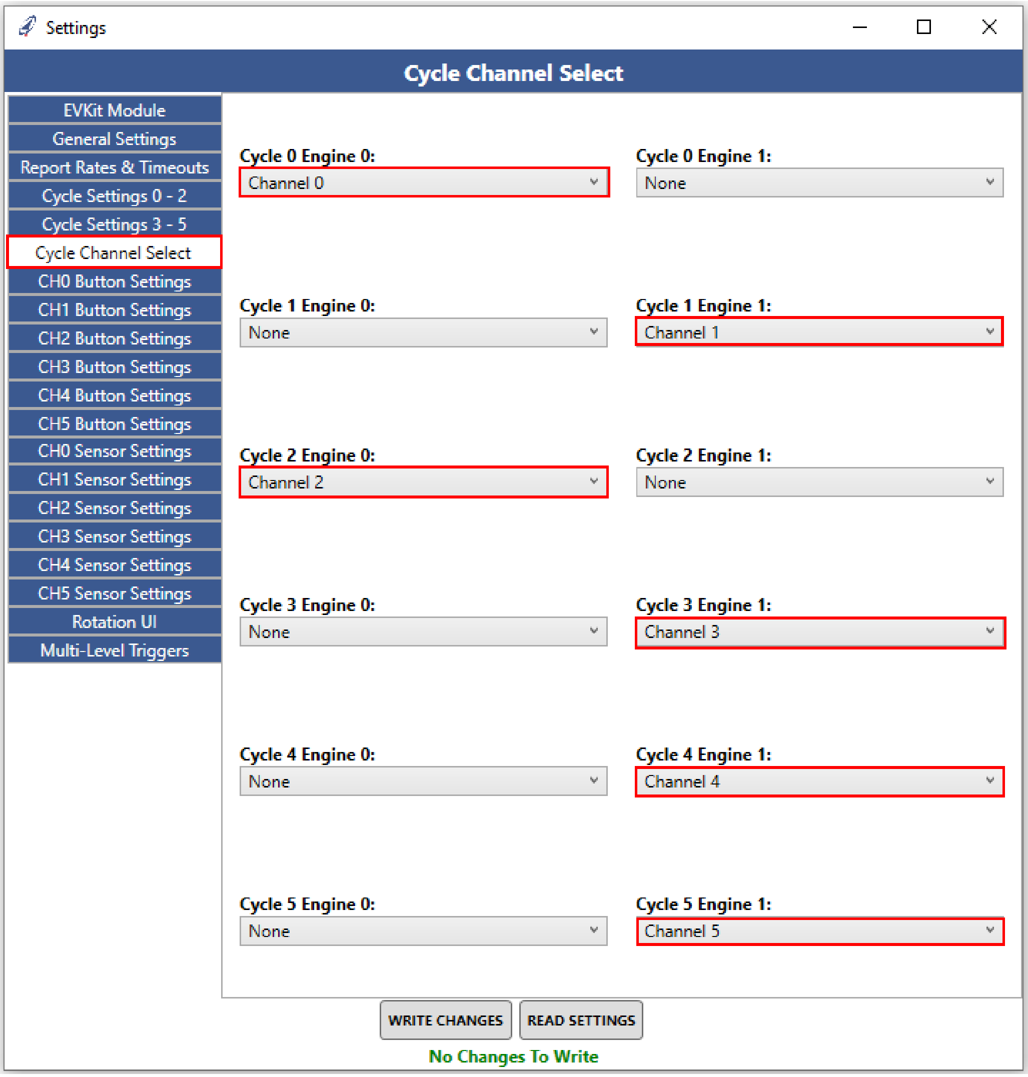

Figure 4.5: Selected Channels for each ProxFusion sensor engine

In this example all cycles are set up in mutual-inductive mode. *Cycle 0* will sense channel 0 and as shown on the EV-kit schematics, the resonant tank connected to the circular coil is driven by Tx0 and measured using Rx2. Tx0 is selected for channel 0 transmitter purpose. The Rx2 selection is made on the channel 0 Sensor Settings tab for receiver purpose. *Cycles* 1, 2, 3, 4, and 5 will perform sensing on channels 1, 2, 3, 4, and 5 respectively. Table 4.1 below provide 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 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.

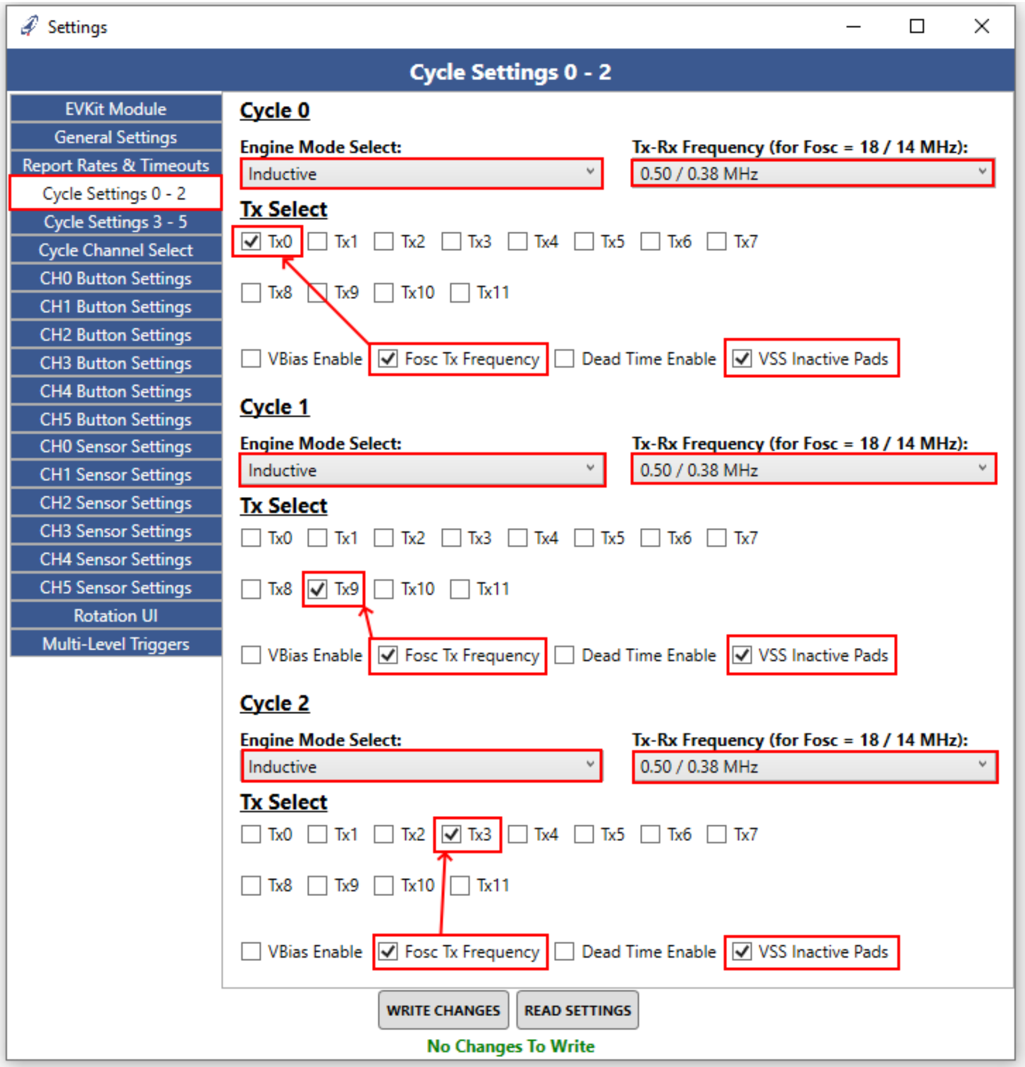

Figure 4.6: All Active Channels In Cycle Settings 0 - 2

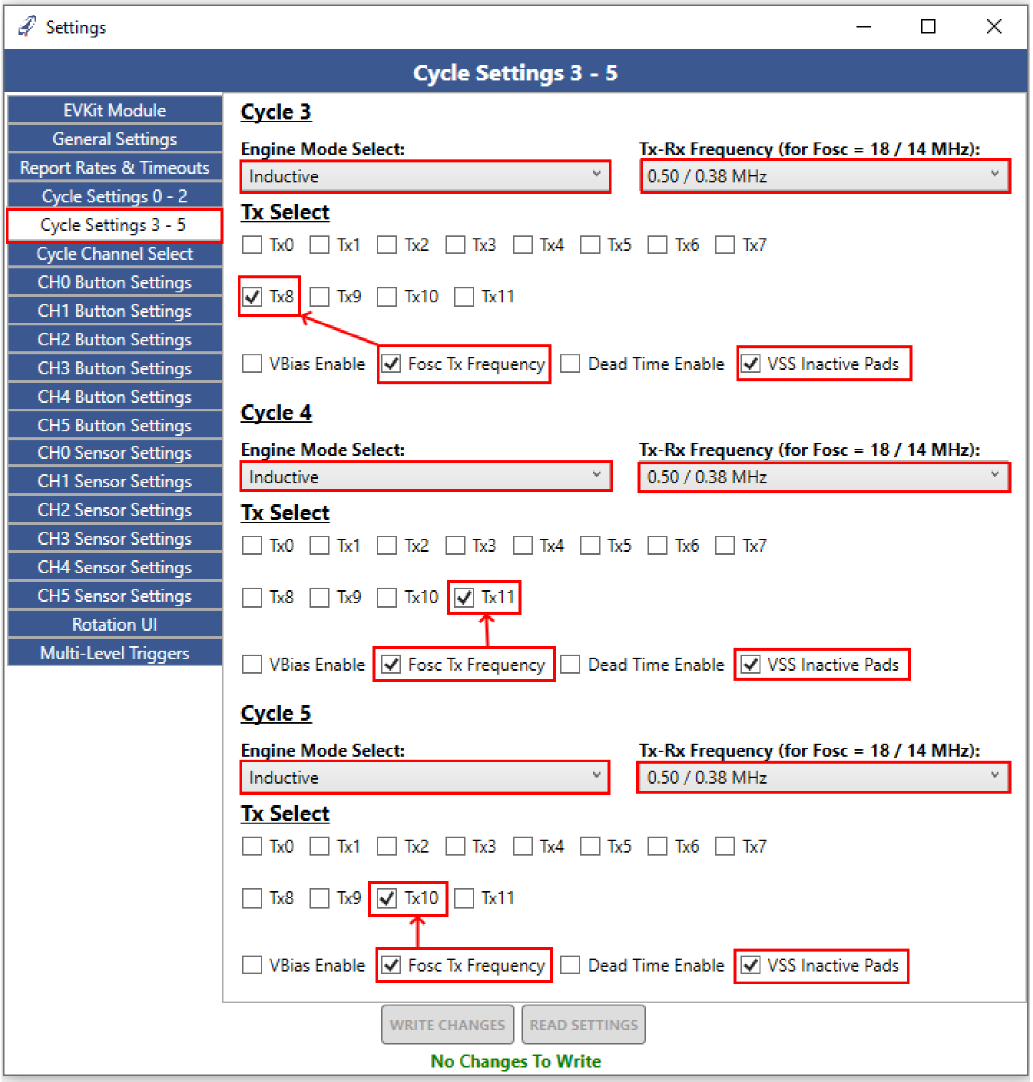

Figure 4.7: All Active Channels In Cycle Settings 3 - 5

4.1.3 Step 3: Channel Setup

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

It is important to select the correct Rx pins for each channel. For example: As seen in Figure 4.3 and on the schematics in Figure 4.2, CH0 uses Tx0 and Rx2. Therefore, under CH0 Settings, Rx2 must be selected as the receiver as shown in Figure 4.8.

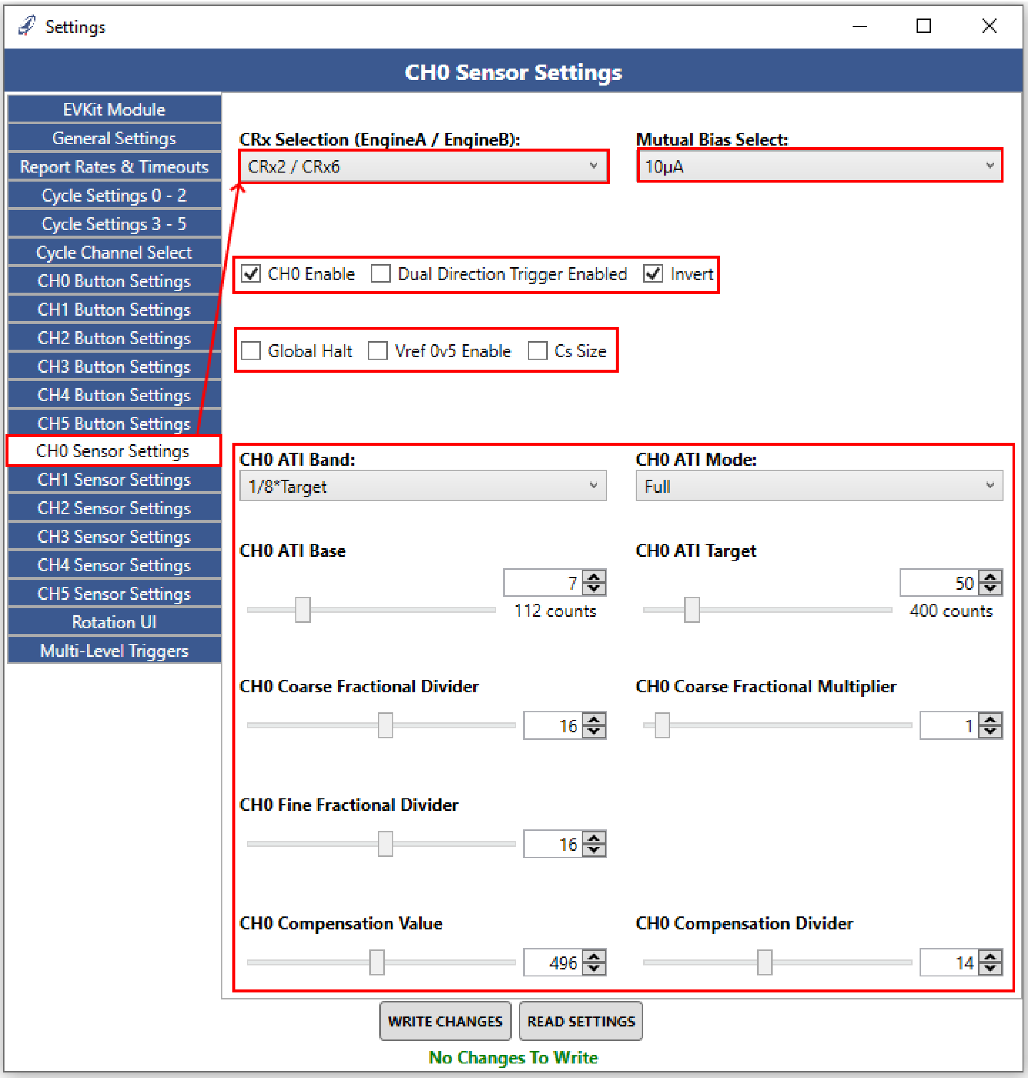

Figure 4.8: Channel Sensor Settings

Other settings listed in the tab shown in Figure 4.8 above are sensor and ATI specific for the channel. Take note of the displayed values and units below each slider as not all settings are directly translated to 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 the recommended use in the majority of designs). These values may vary from one device to another or even change during runtime as needed to keep the sensor's sensitivity optimal and within operational range given external/environmental influences.

4.1.4 Step 4: Button Setup

The button settings that can be configured 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, linearise counts, number of events, and beta filters.

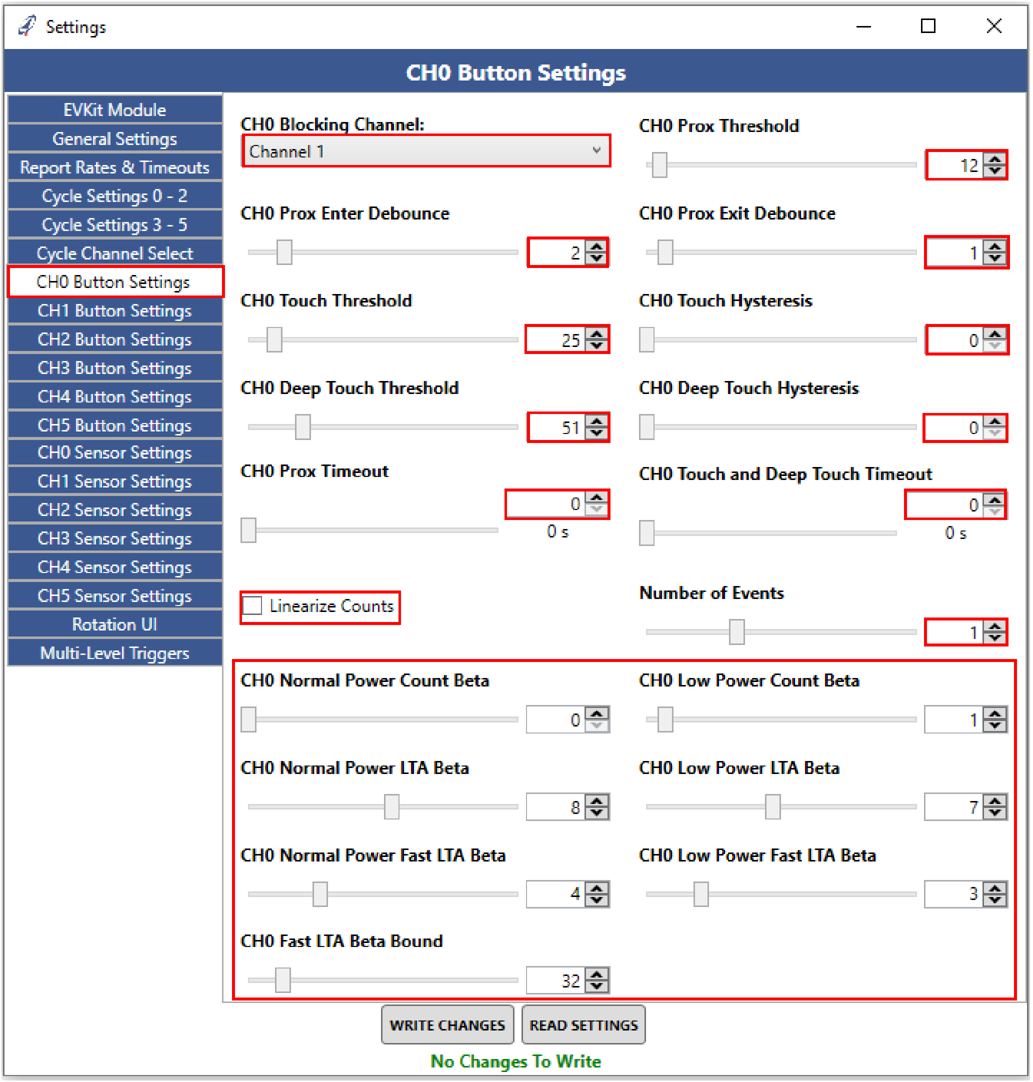

Figure 4.9: Button Settings

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

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

The default beta parameter options have been selected to serve the most common and generic applications. They are intended to filter according to the specific power mode operation to ensure that noise is minimal while still ensuring substantial response without any lagging outputs. The parameters should also adjust LTA amounts to slow varying counts and use the fast LTA beta to follow rapidly for opposing count behavior to normal activations. The defaults are the recommended values and a good starting point.

4.1.5 Step 5: Report Rates And Power Mode Timeout Setup

The settings in Figure 4.10 below are global settings applicable to all the channels and include settings 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 are in steps of a fixed constant or percentage.

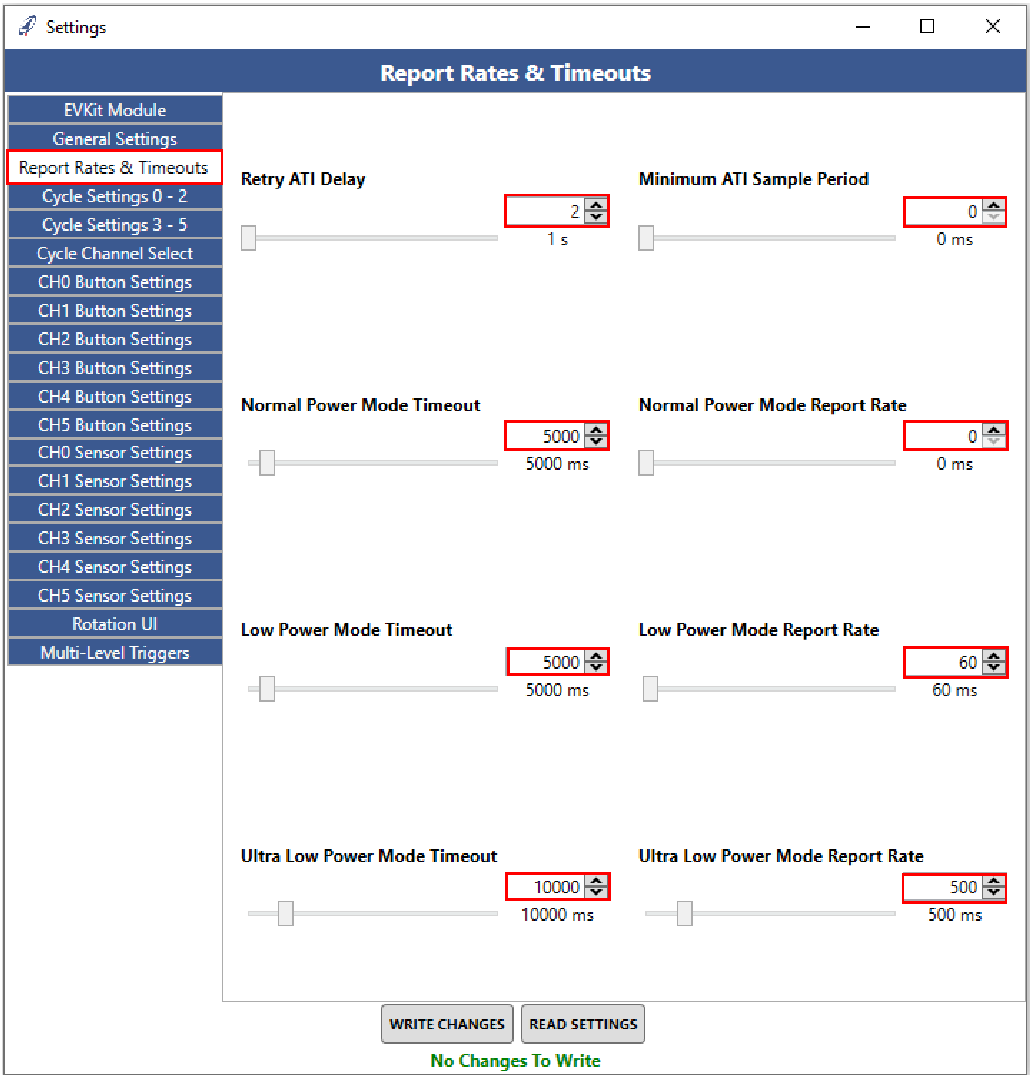

Figure 4.10: Channel Report Rate and Power Mode Timeout Setup

4.1.6 Encoder Setup

The IQS7225A offers the ability to configure 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 "Coil A Channel" and "Coil B Channel" drop down list). When selecting the reference channels, Coil $\bar{A}$ and $\bar{B}$, it is important to note that values less than 5 implies 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.

Other settings include selecting the number of metal segments, and configuring 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 offers multi-level trigger settings with adjustable number of trigger levels for each channel. Trigger events are activated when there is a transition in the trigger levels on each channel. To setup multi-level triggers on a channel, the channel maximum delta value and the desired number of trigger levels must be selected. The channel output trigger level can be calculated as shown below.

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

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

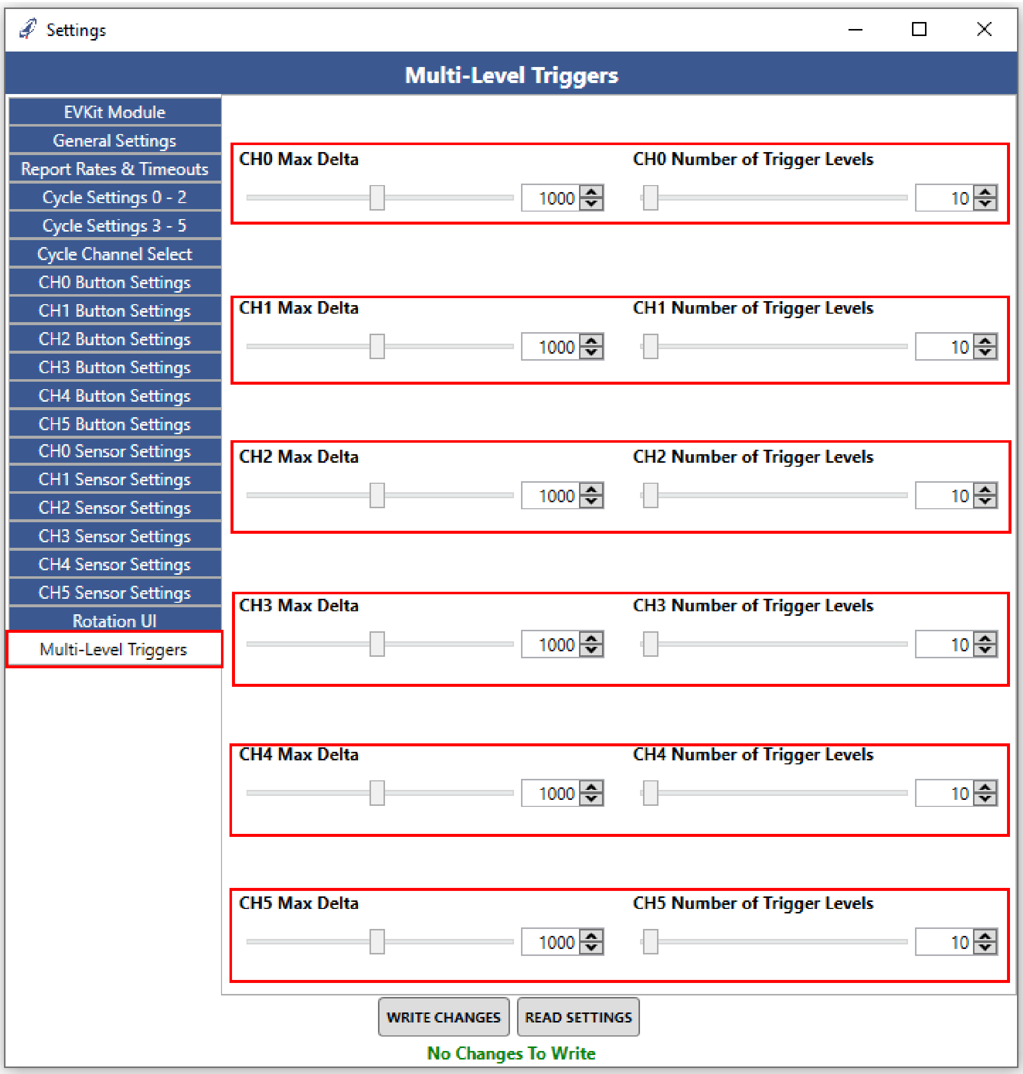

Figure 4.12: Multi-Level Trigger Setup

4.2 Self-Capacitance Setup

Section 4.1 described how to setup 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 requires 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 are shown in Figures 4.13 and 4.14. The allocation of the different channels to the proximity engines are 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.

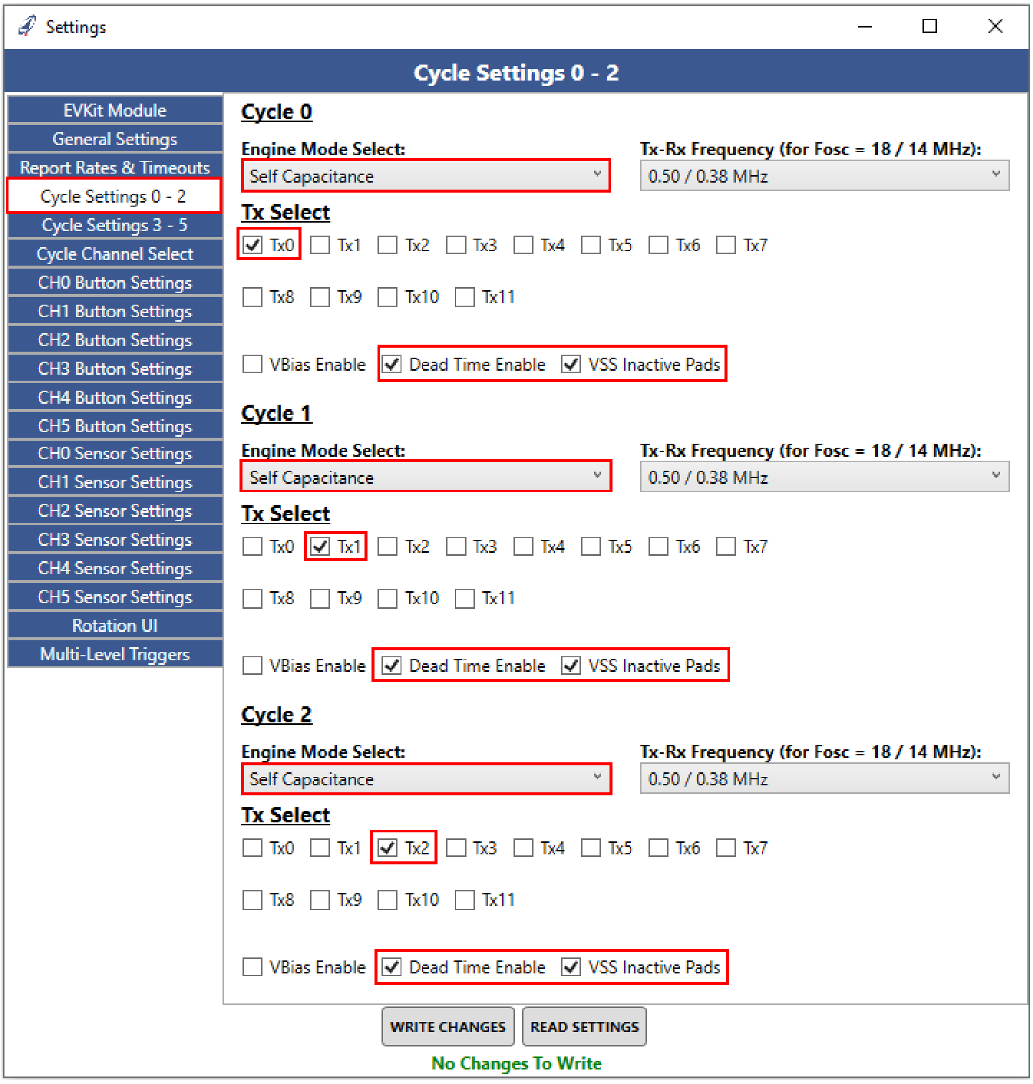

Figure 4.13: All Active Self-Capacitive Channels In Cycle Settings 0 - 2

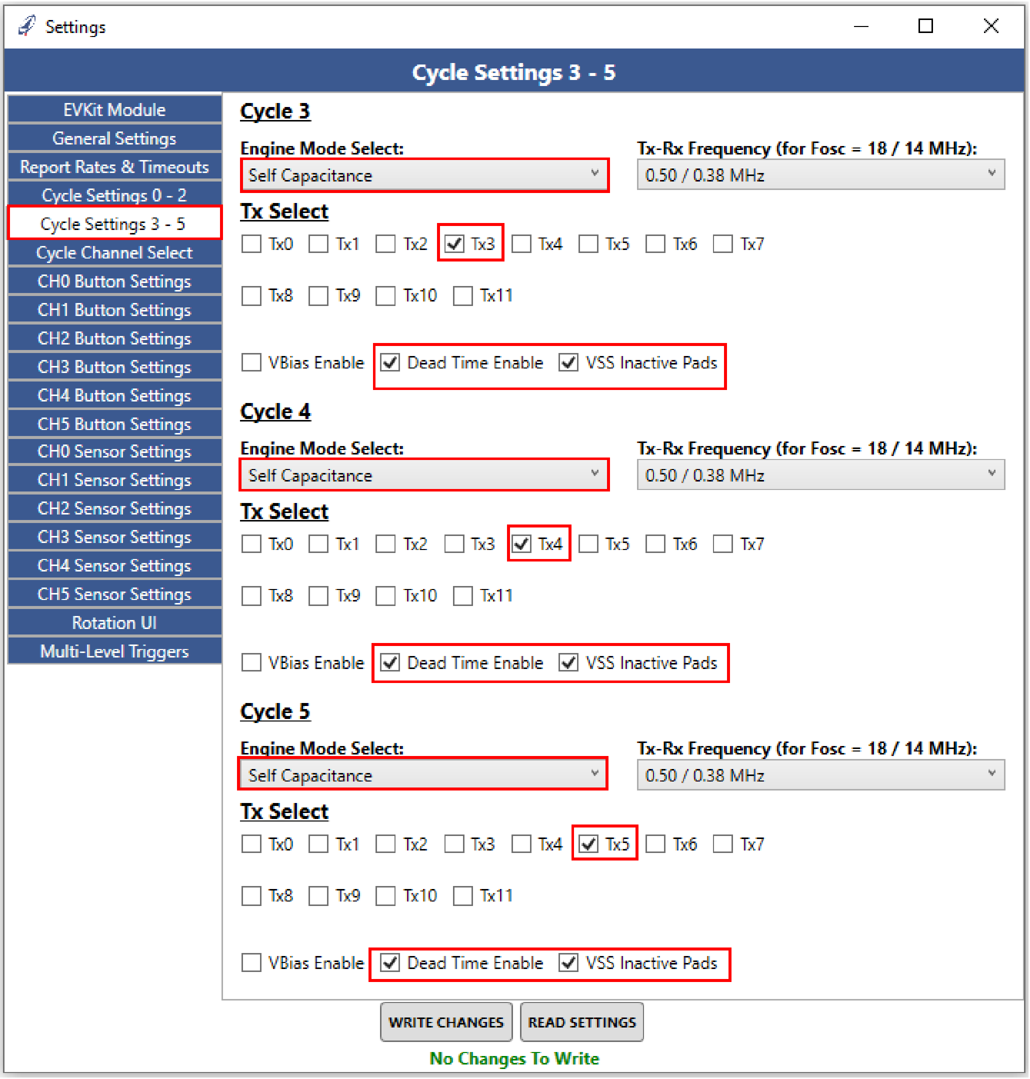

Figure 4.14: All Active Self-Capacitive Channels In Cycle Settings 3 - 5

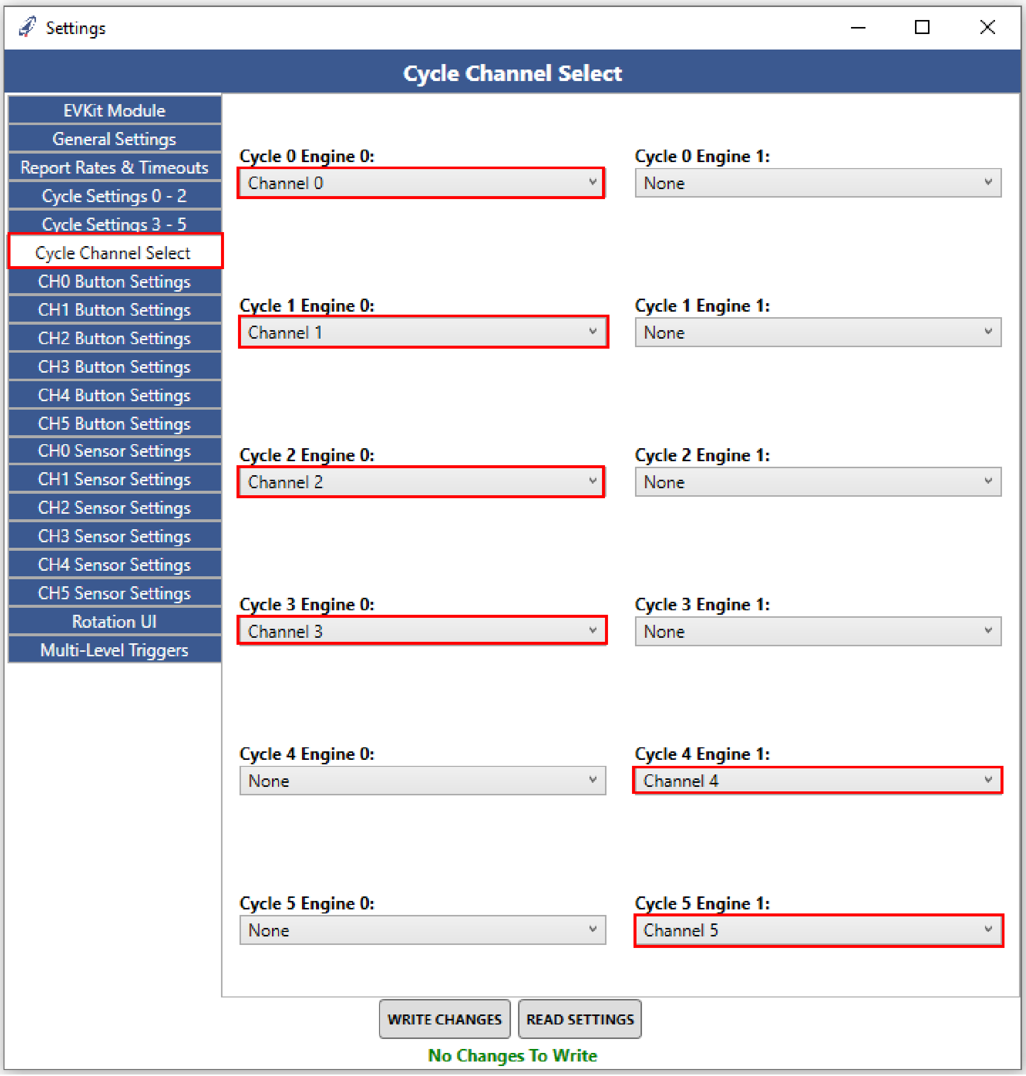

Figure 4.15: Selected Self-Capacitive Channels for Each ProxFusion Sensor Engine

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 an Rx and a Tx. So in this example for CH0 as seen in Figure 4.13, Tx0 must be enabled as well as under CH0 Sensor Settings the Rx0 must be selected as shown in Figure 4.16.

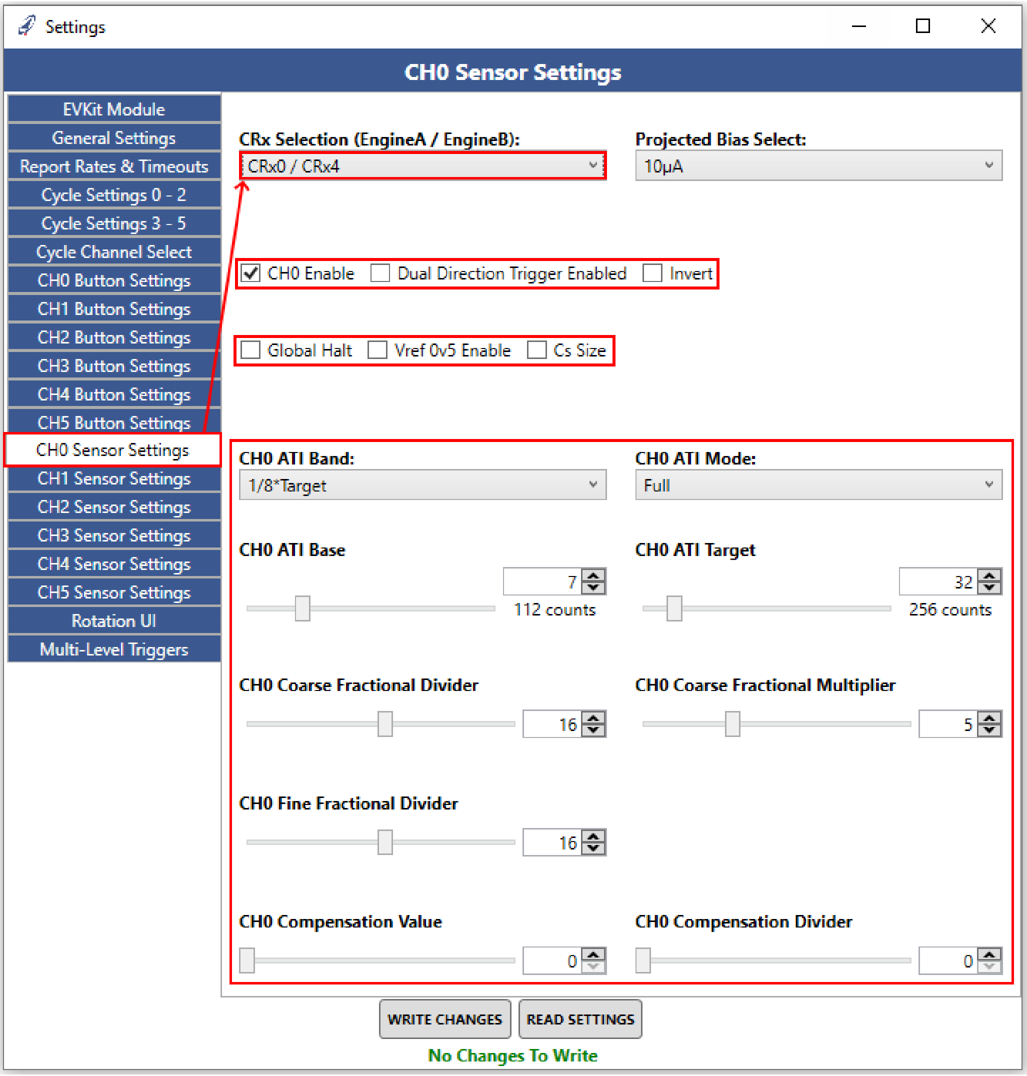

Figure 4.16: Self-Capacitive Channel Sensor Settings

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 setup the EV-kit hardware for inductive sensing and Section 4.2 described an example of a self-capacitive setup. In order to assist the users with a setup for mutual-capacitance sensing, this section was added and provides an example of a mutual-capacitive setup.

The IQS7225A can support mutual-capacitive sensing on all active channels. In this example, the channels are configured for mutual-capacitive sensing and note that mutual-capacitive sensing requires the Tx-Rx combinations are unique for each channel. 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 4.3.

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 are shown in Figure 4.17 and Figure 4.18.

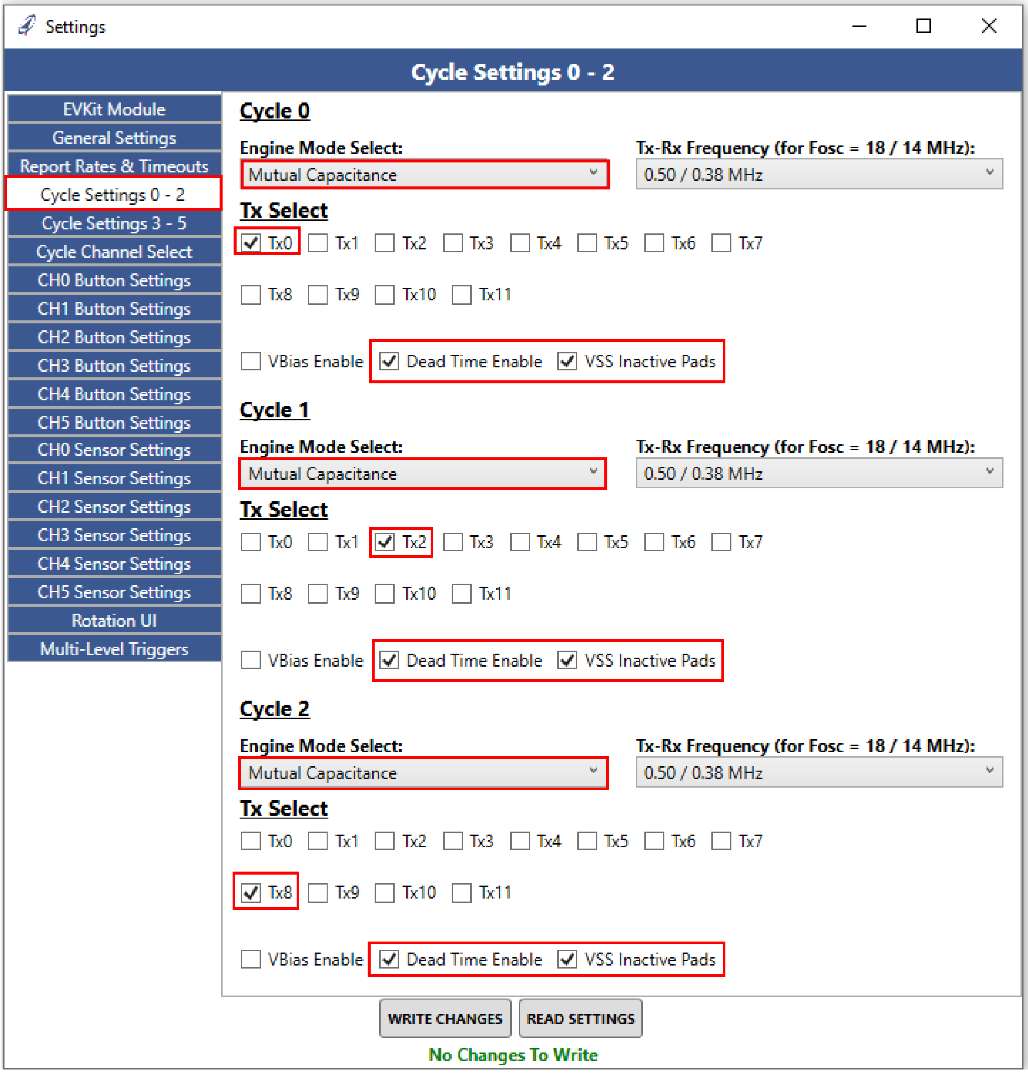

Figure 4.17: All Active Mutual-Capacitive Channels In Cycle Settings 0 - 2

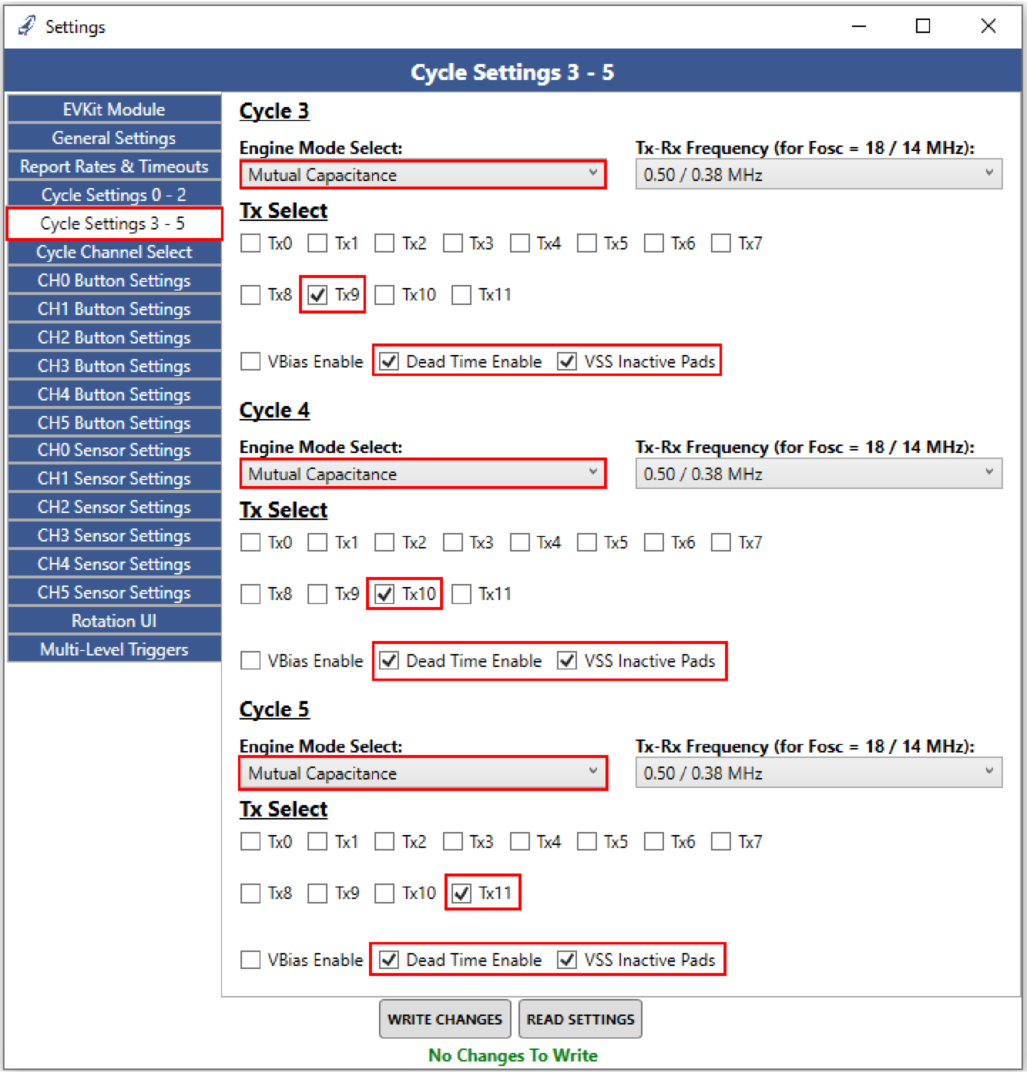

Figure 4.18: All Active Mutual-Capacitive Channels In Cycle Settings 3 - 5

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

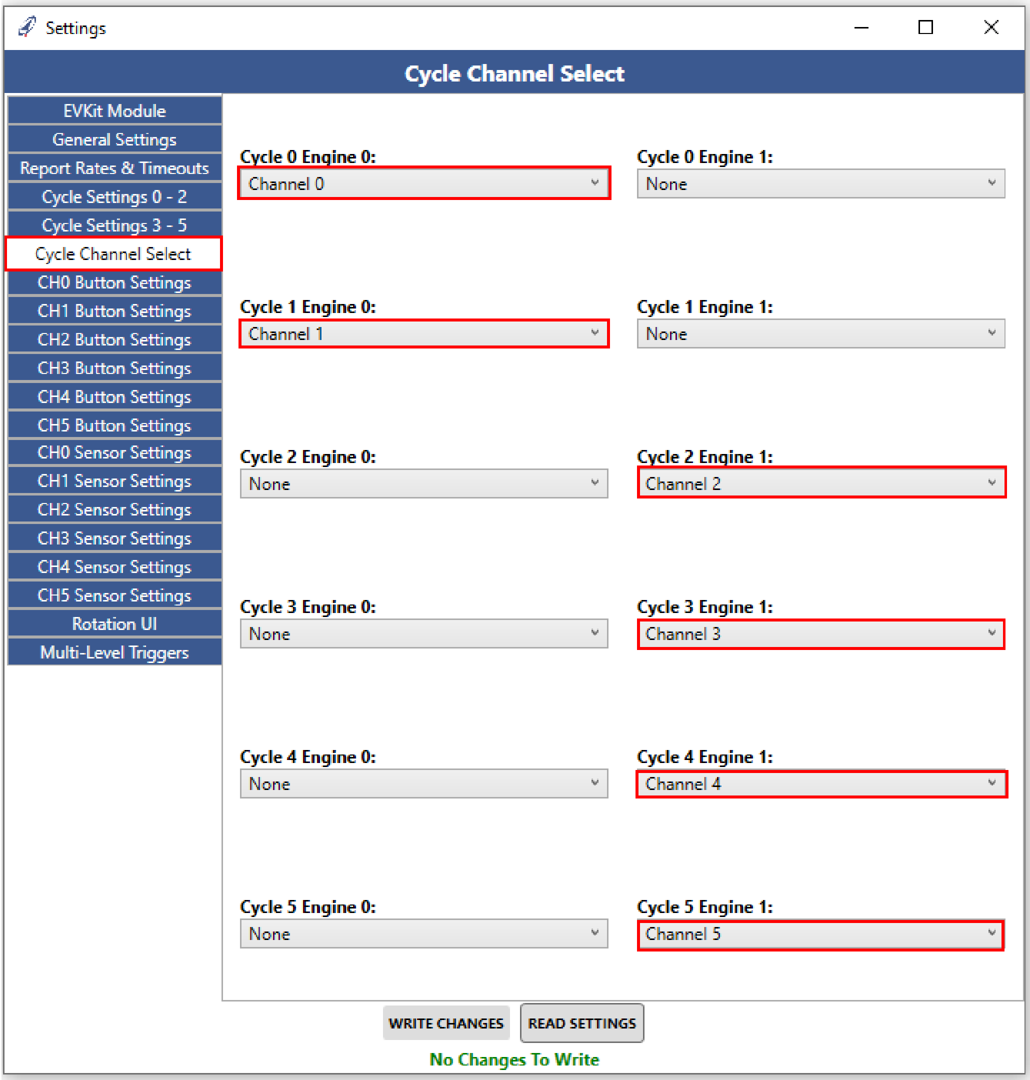

Figure 4.19: Selected Mutual-Capacitive Channels for Each ProxFusion Sensor Engine

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 such 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 CH0 Settings as shown in Figure 4.20.

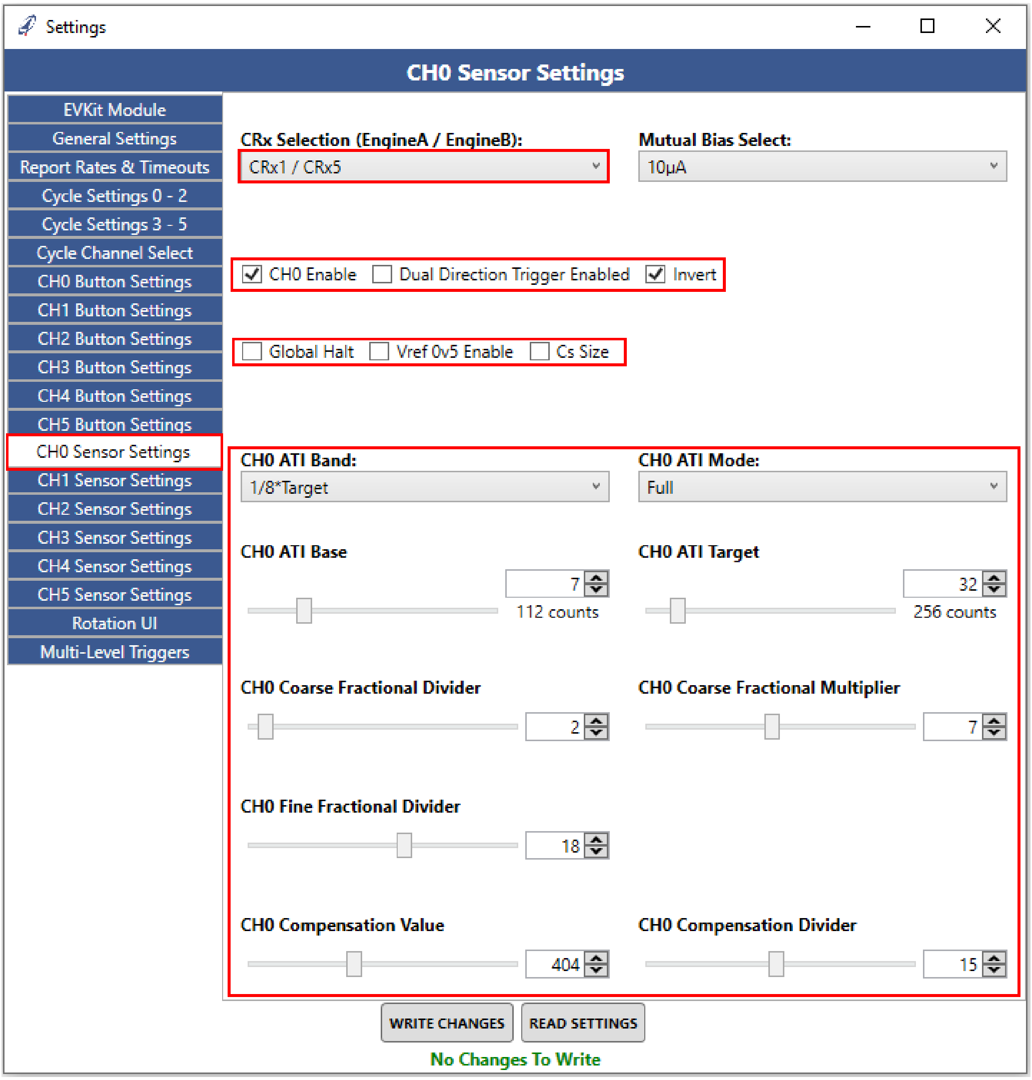

Figure 4.20: Mutual-Capacitive Channel Sensor Settings

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 and explains 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
v1.0	2023/0x/xx	Initial document released

Contact Information

	USA	Asia	South Africa
Physical Address	11940 Jollyville Suite 120-S Austin TX 78759 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 78759 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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