

IS31SE5117A EvB User Manual

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1. HARDWARE ENVIRONMENT

1.1 Evaluation Board (EvB)

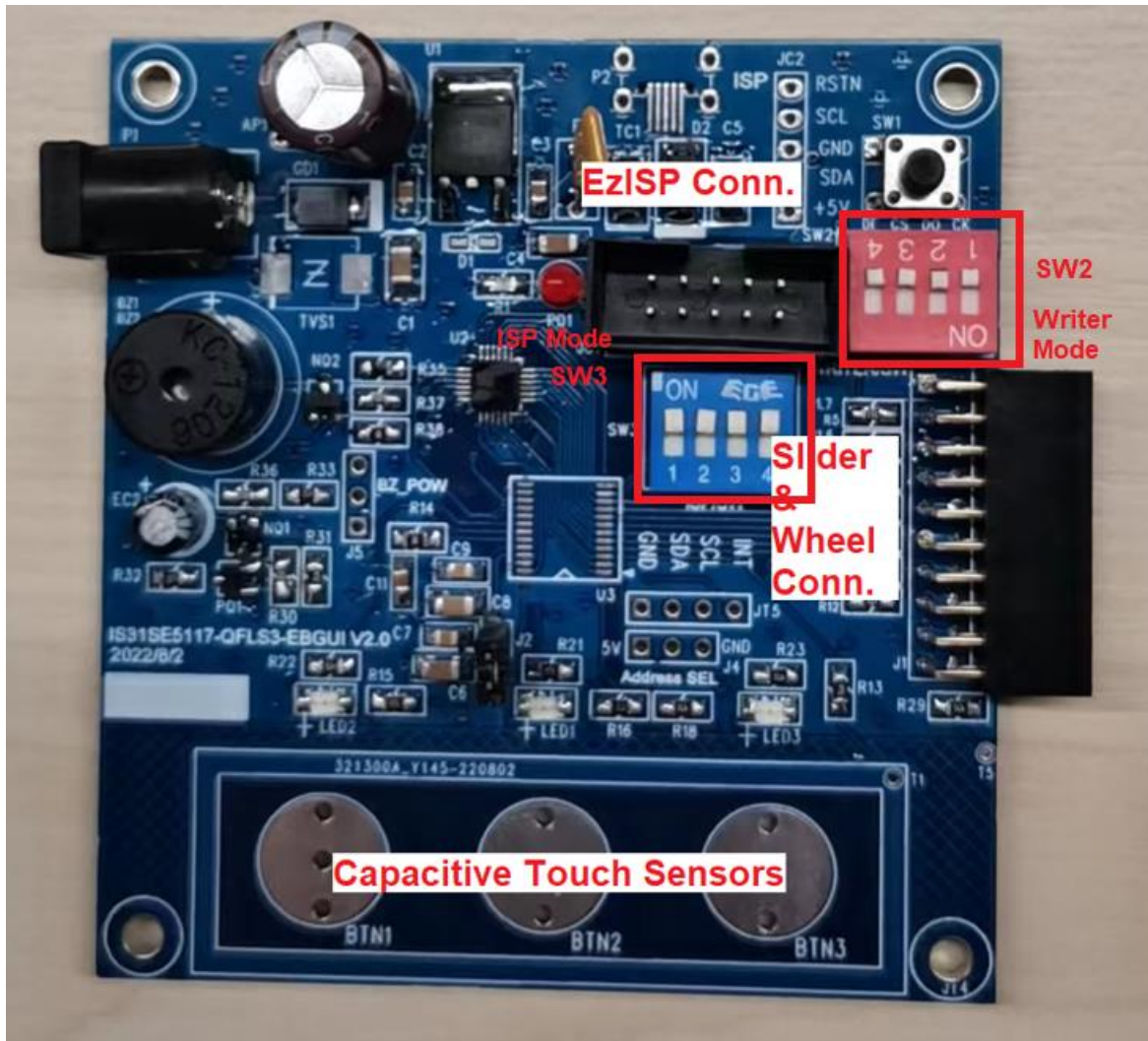


Figure 1-1: Photo of IS31SE5117A Evaluation Board v2.0



Figure 1-2: Photo of Standard 6 Touch Key Board

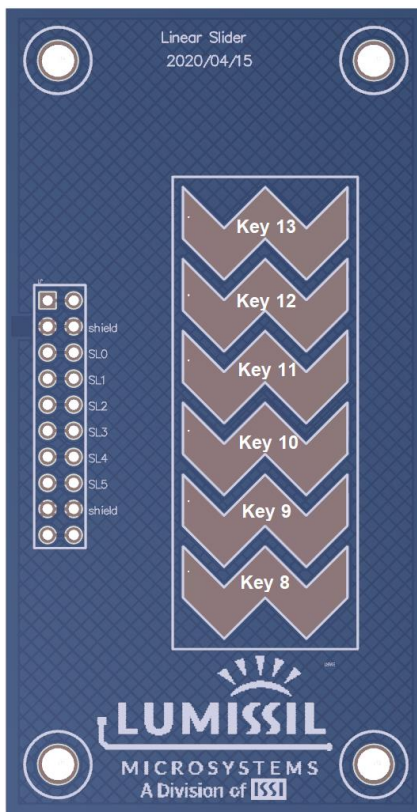


Figure 1-3: Photo of Linear Slider Board

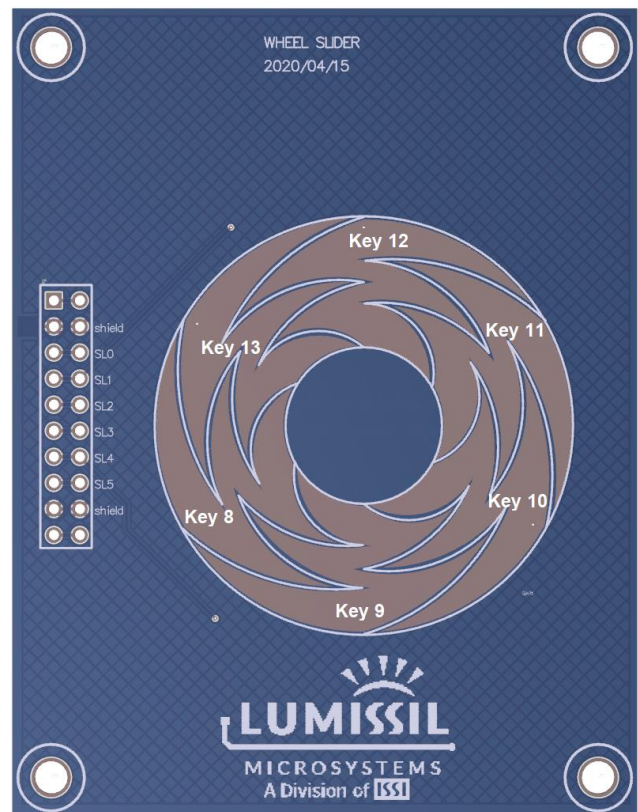


Figure 1-4: Photo of Wheel Slider Board

System Block Diagram:

IS31SE5117A
GUI

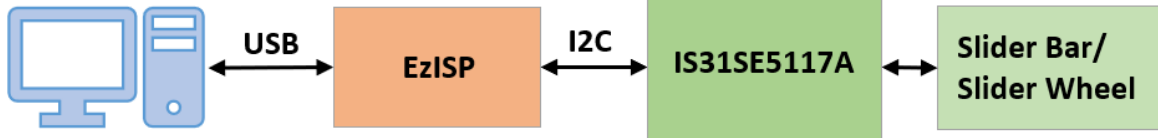


Figure 1-5: IS31SE5117A Evaluation Board Connection Block Diagram

1.2 Schematic of Evaluation Board

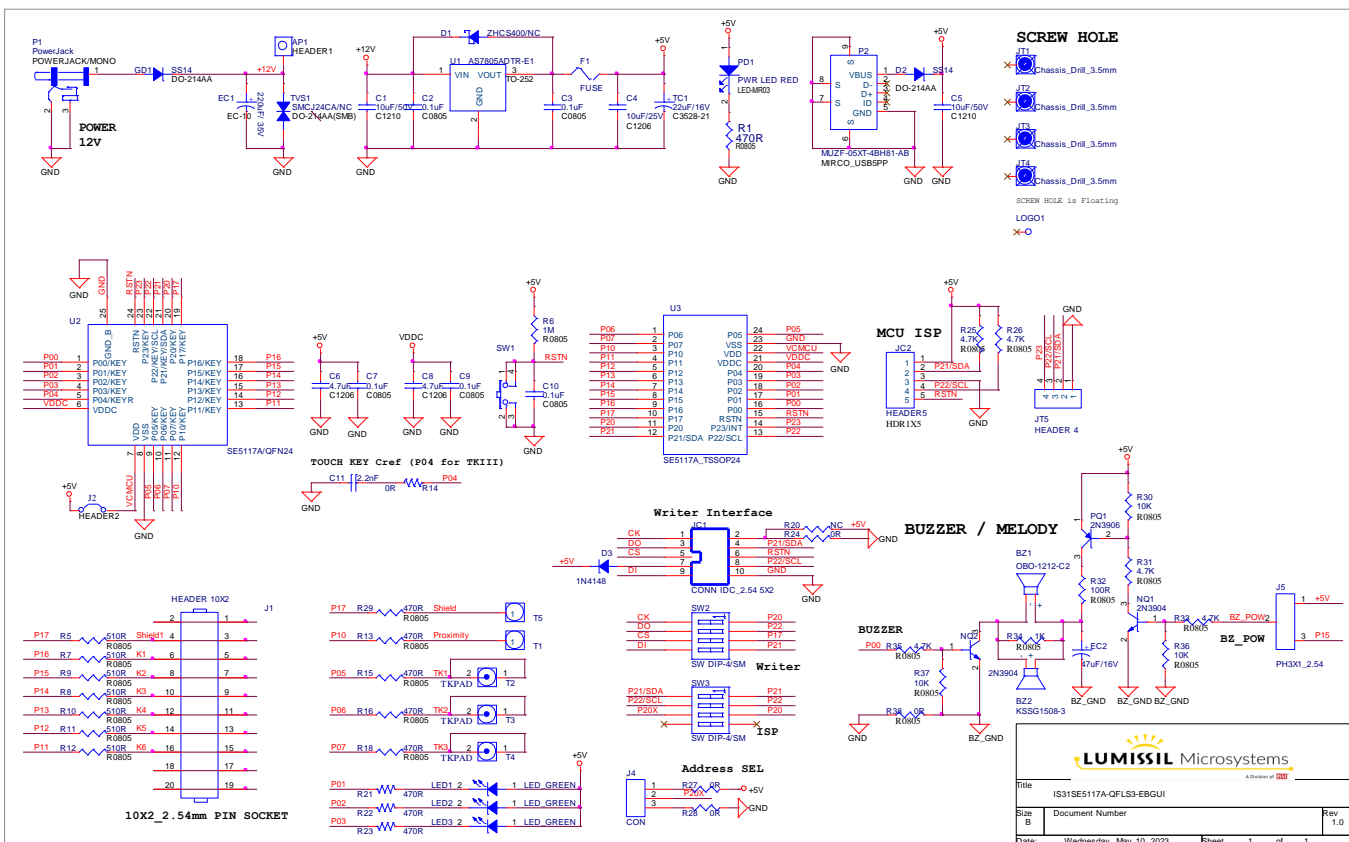


Figure 1-6: Schematic of IS31SE5117A Evaluation Board v1.0

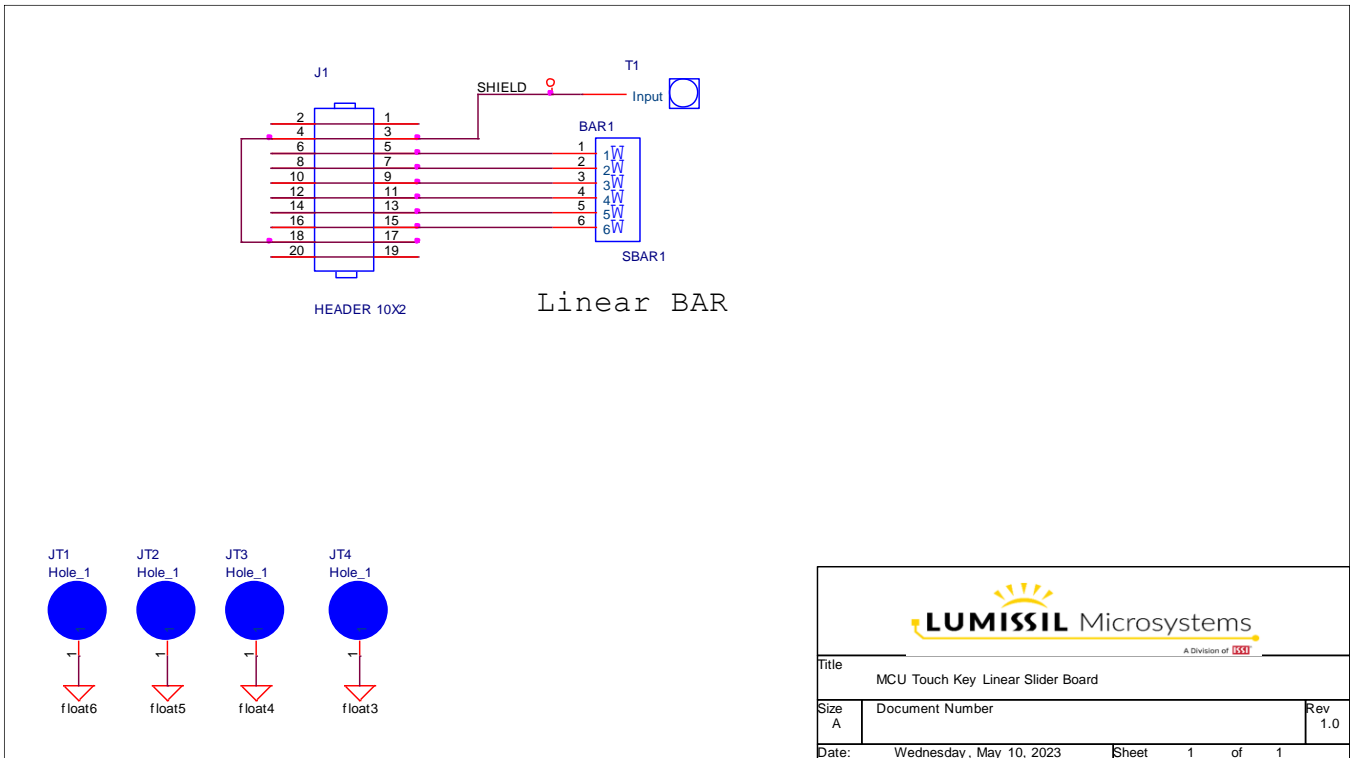


Figure 1-7: Schematic of Slider Board

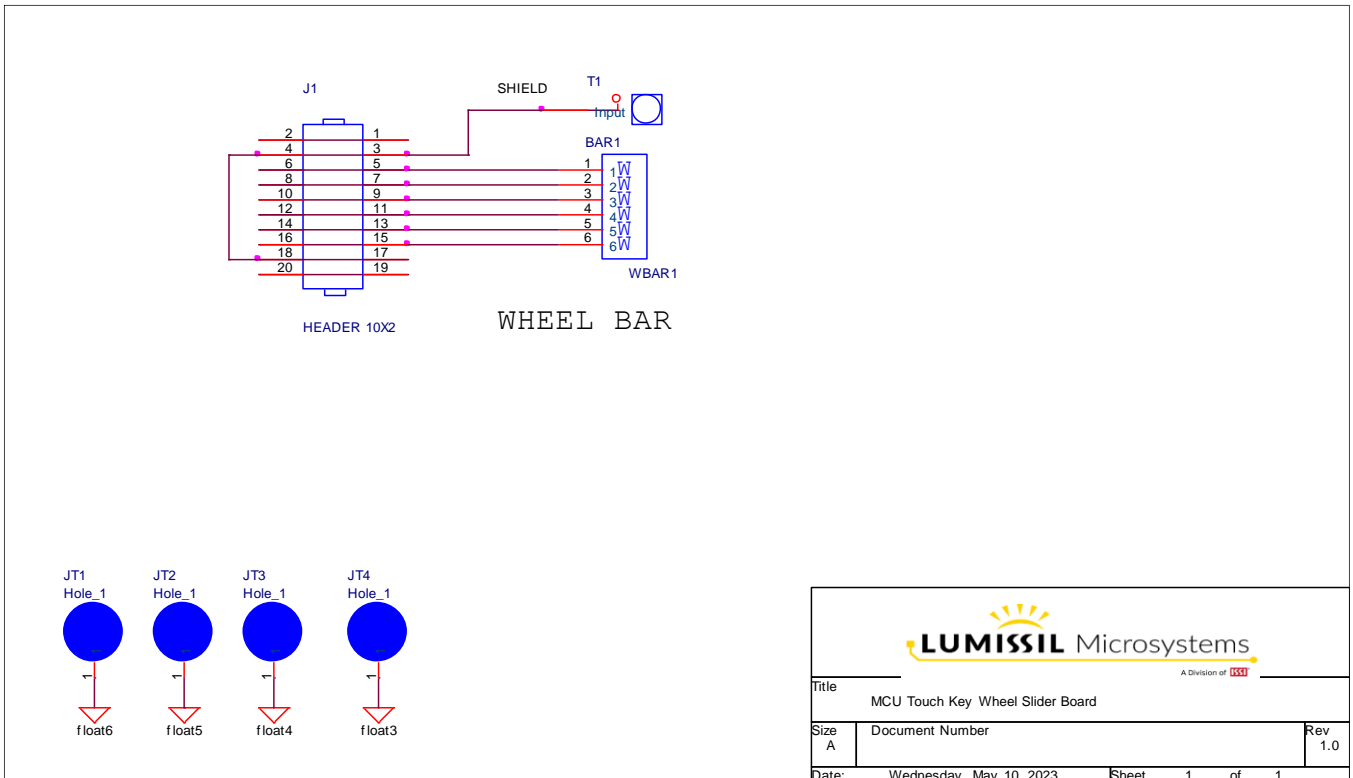


Figure 1-8: Schematic of Wheel Board

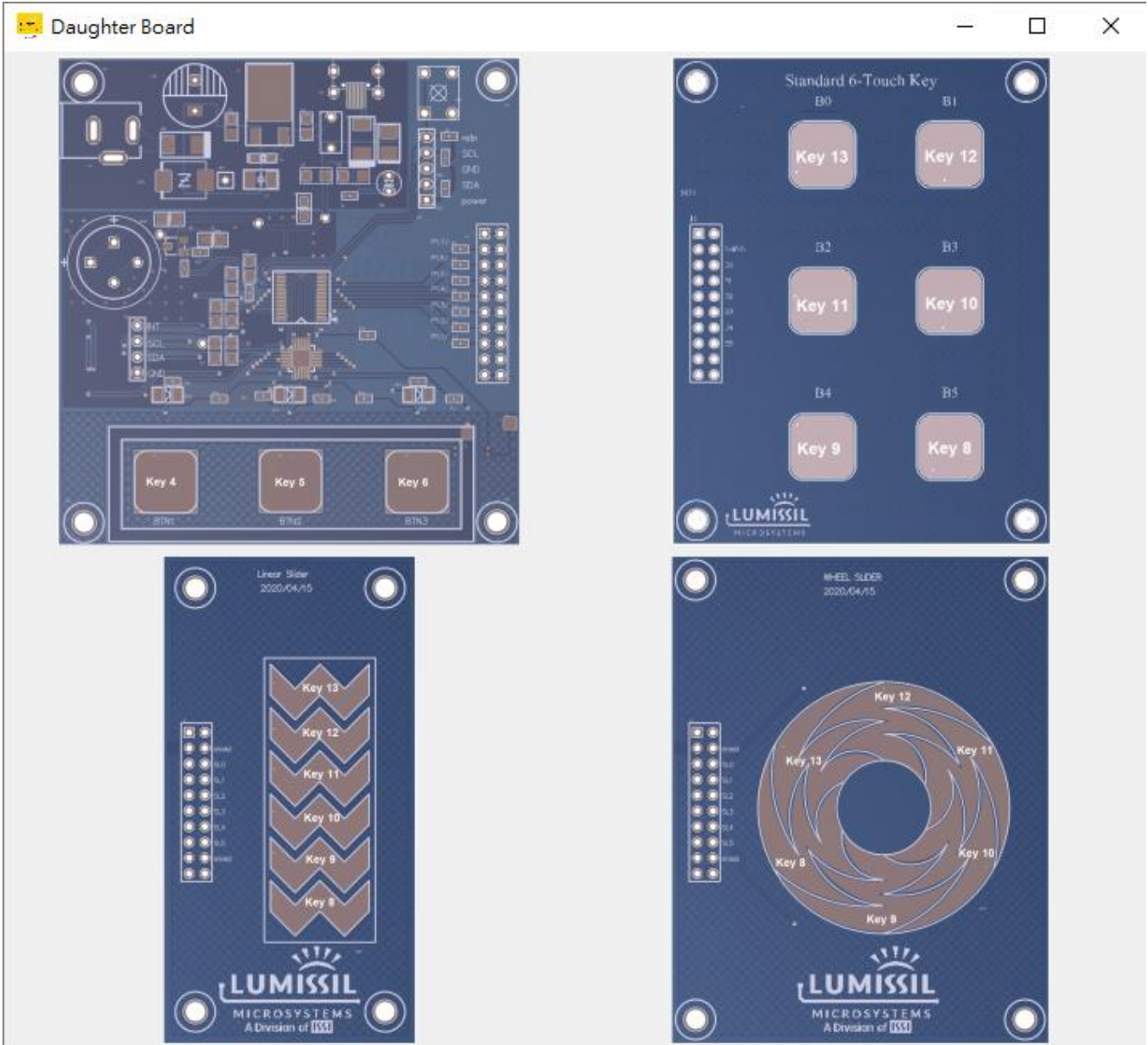


Figure 1-9: Key setting of SE5117A daughter Boards from SW GUI

Note: For IS31SE5117 evaluation board order, above Standard 6 – Touch Key daughter board is not included.

1.3 ORDERING INFORMATION

Table 1: Ordering Information

Part No.	Temperature Range	Package
IS31SE5117A-QFLS3-EBGUI	-40°C ~ +105°C	QFN-24, Lead-free

For pricing, delivery, and ordering information, please contact LUMISSIL's marketing and sales team at <https://www.lumissil.com/company/office-locations> or (408) 969-6600.

2. SOFTWARE SUPPORT

2.1 Software Requirements

Before starting up SE5117A Touch Key GUI software, it is required that the PC be installed with the EzISP USB driver and related files (for example Microsoft Framework and C++ library). Users can unzip file EzISP_V3.3.3.zip and use the setup file for installation. But this installation needs Windows login users with administrator privileges.



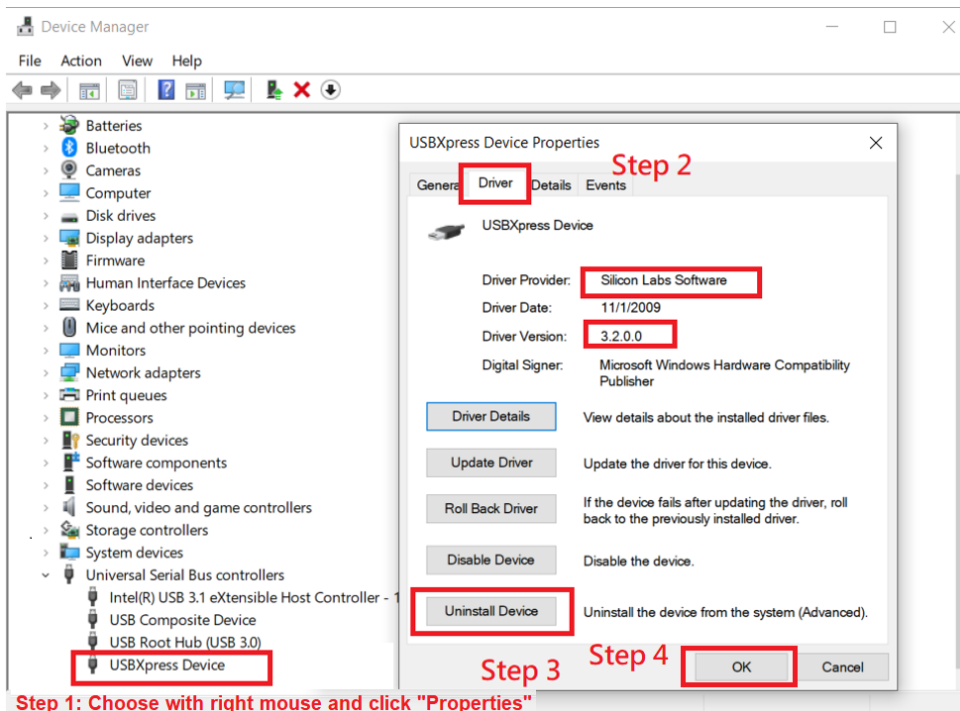
Figure 2-1: Photo of EzISP Board

Windows Software Requirements:

EzISP tool supports Win XP, Vista, Windows 7, Windows 8, Windows 10, and Windows 11. It is required that the Windows-based PC be installed with Microsoft .NET Framework 3.5, Microsoft .NET Framework 4.8, Microsoft Visual C++ 2008, and Silicon Labs' USB driver version 6.7.2.0. After running EzISP setup version 3.3.8 or a later version, Windows will ask the user to install Microsoft .Net Framework or Microsoft Visual C++ 2008 if this PC was not installed with the redistributable packages. Users can follow the pop-up instructions to finish the installation.

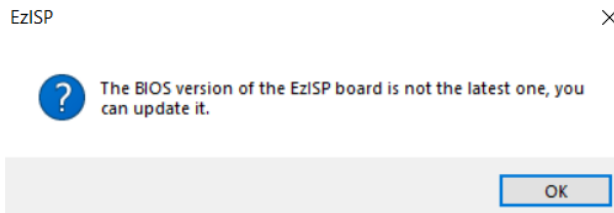
Users might need up to seven steps to finish the EzISP installation and configuration after installation for normal operation.

Step 1: For customers who have installed EzISP setup version earlier than 3.3.8 with Silicon Labs' USB driver version 3.2.0.0, USB driver version 3.2.0.0 needs to be uninstalled as the four steps in the below figure before installing the new EzISP setup version 3.3.8.

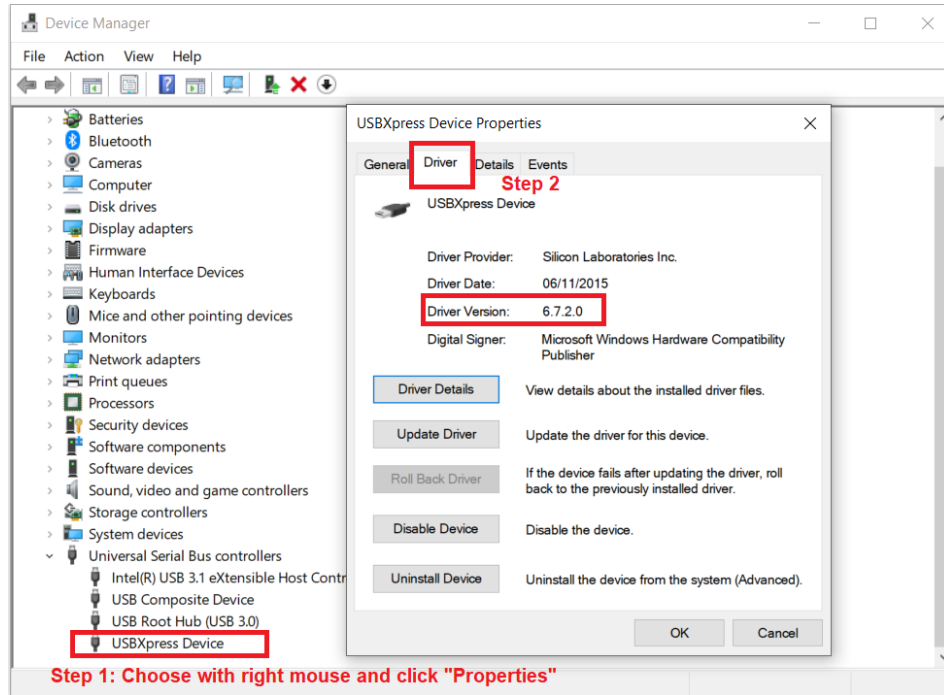


Step 2: Install EzISP setup program. After the installation is done and EzISP is run, users might get

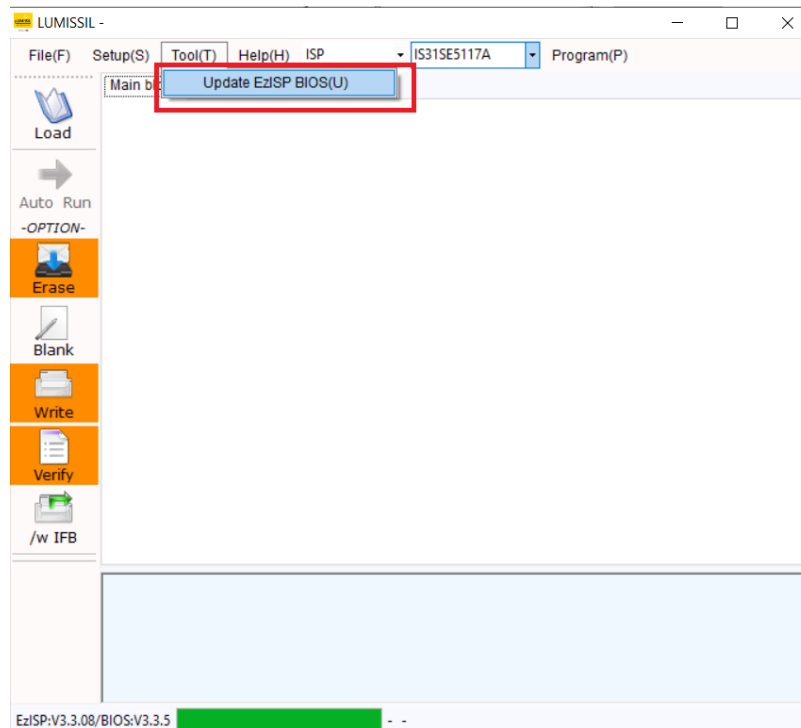
below pop-up message and please update with the newer BIOS as Step 3 ~ Step 7.



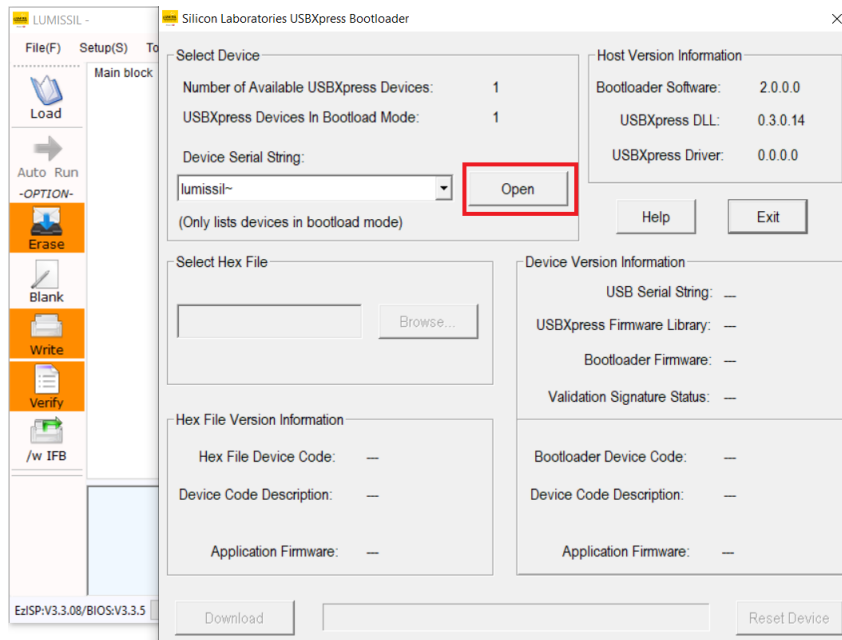
Users can check whether the Silicon Labs' USB driver version 6.7.2.0 is correctly installed or not as the two steps in the below figure.



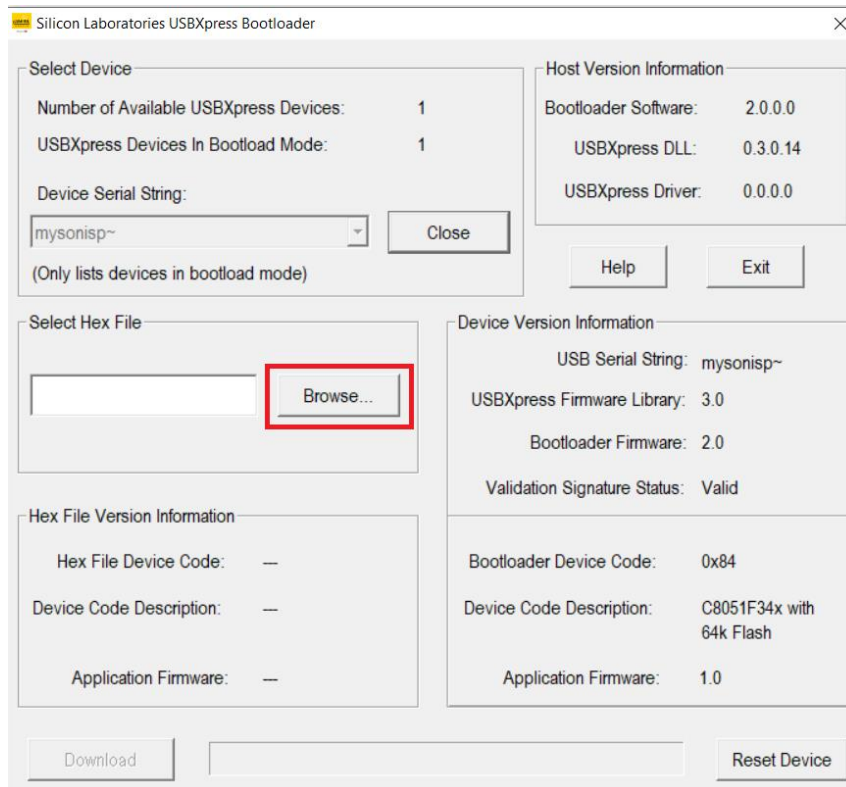
Step 3: Go to "Tool(T)" → "Update EzISP BIOS(U)"



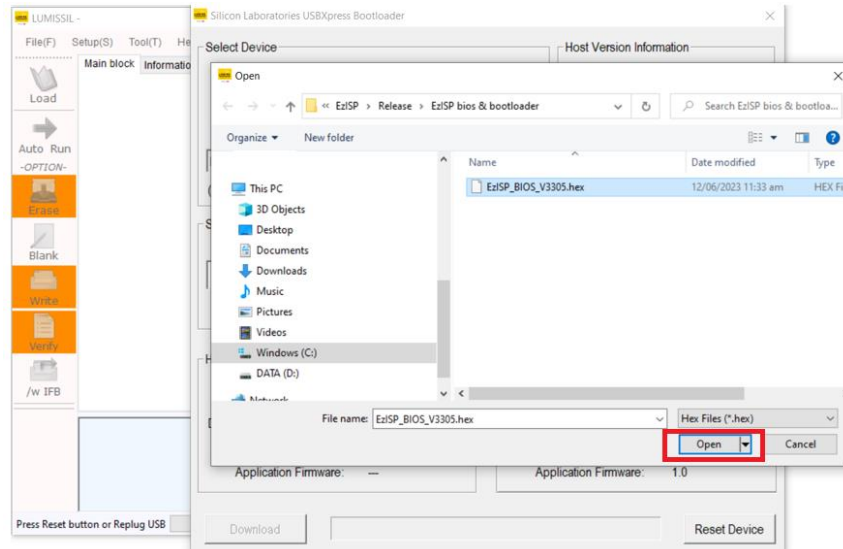
Step 4: Below figure pops out. Click **“Open”** button.



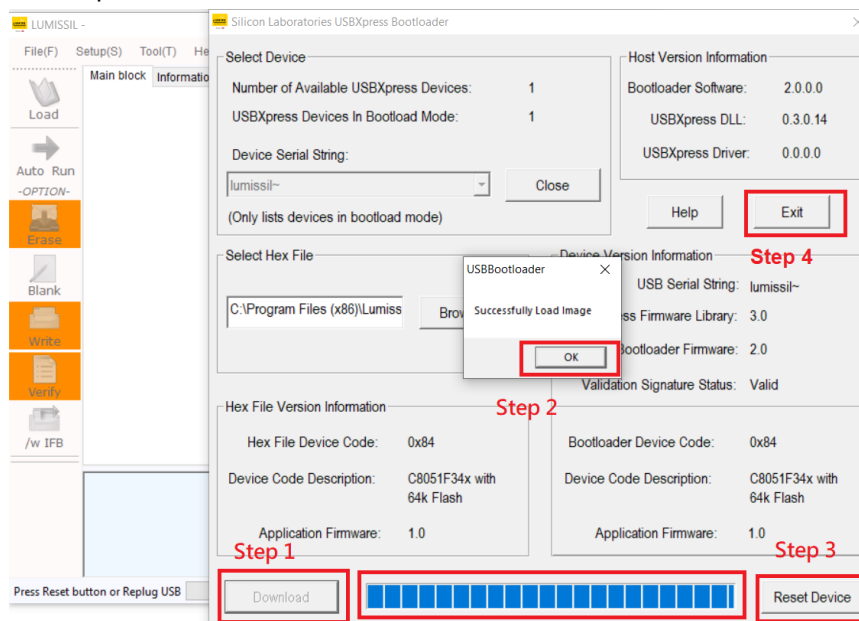
Step 5: Click **“Browse”** button.



Step 6: Below figure pops out. Choose the default pop-out hex file under C:\Program Files (x86)\Lumissil\EzISP\Release\EzISP bios & bootloader and click **“Open”** button.



Step 7: Follow the four steps in the below figure to load Bootloader. Reset the EzISP device to start operation.



2.2 Start up the GUI with EvB

Users need to follow below three steps for the setup (Please refer to **Figure 1-5** IS31SE5117A Evaluation Board Connection Block Diagram.)

1. Connect USB cable between the USB port of the EzISP Board and the USB port of the PC.
2. Connect a 10-pin 2x5 Socket-Socket 2.54mm IDC cable from the connector of the EzISP Board to the JC1 connector of IS31SE5117A EvB board.
3. Execute SE5117A Touch Key GUI program (file name: MC09_SE5117A_GUI_rev3.0.exe).

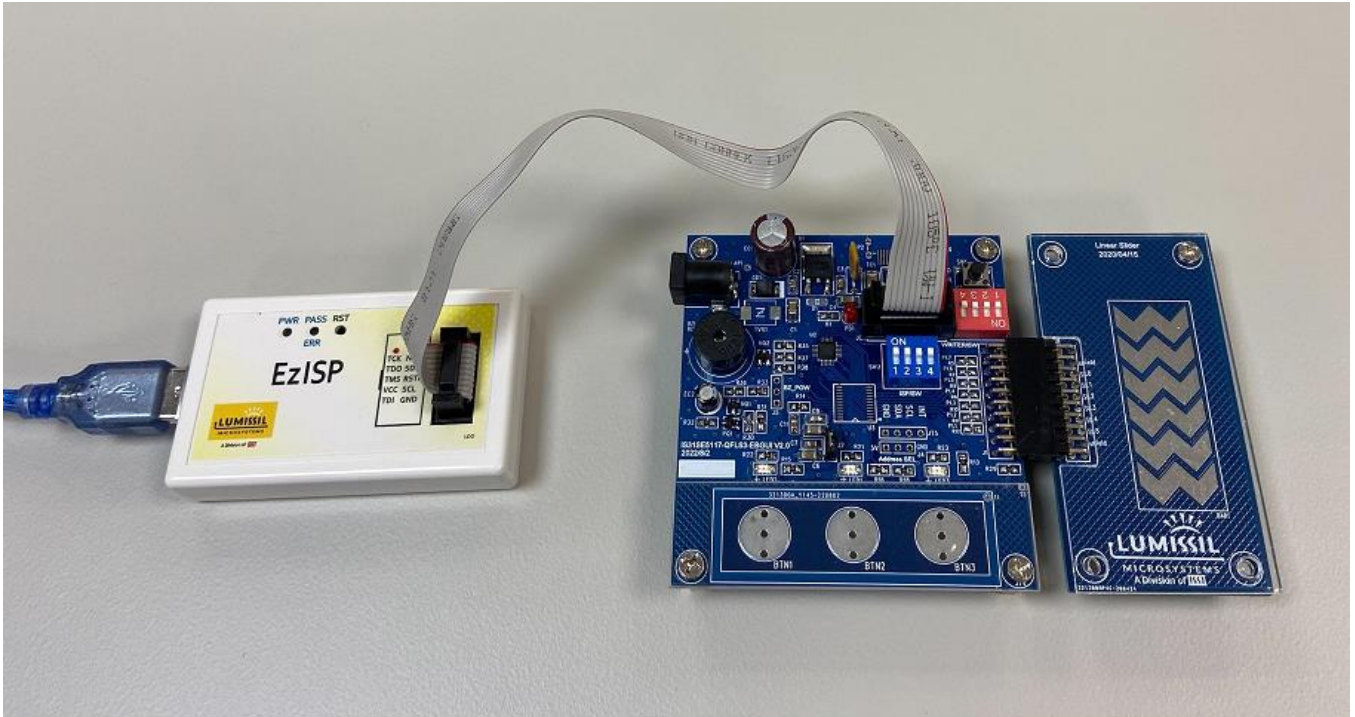


Figure 2-2: Connection of IS31SE5117A Evaluation Board and EzISP Board

Current IS31SE5117A EvB board is set at I2C address 0x78.

Table 2: AD pin selection and I2C slave address definition

I2C Slave Address* / AD Pin Select	Write Command	Read Command
AD = floating	0x78	0x79
AD = GND	0x7A	0x7B
AD = VDD	0x7C	0x7D

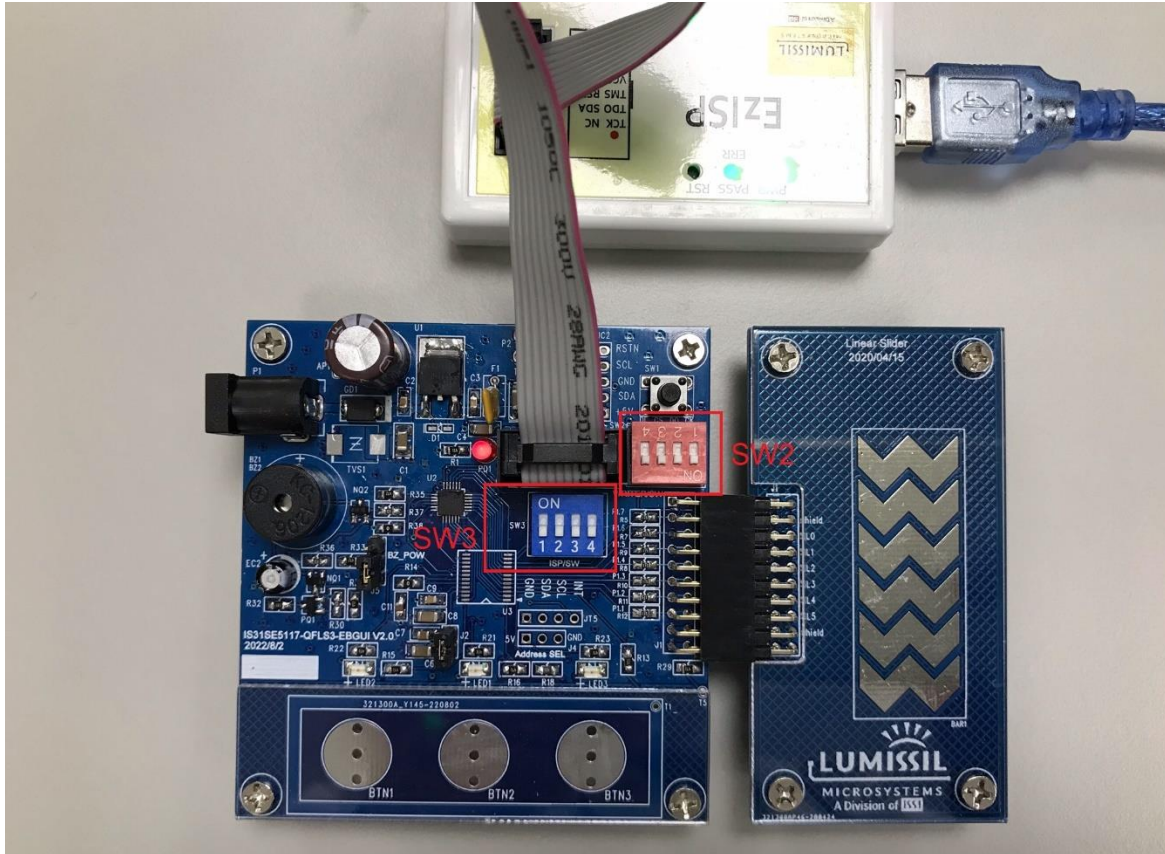
* I2C Slave Address: 7-bit Address + 1 bit(R/W)

2.3 Upgrade Boot Code and Standard Code

This section can help users to upgrade the Boot code and Standard code of SE5117A EvB. In case, Boot code or Standard code of SE5117A EvB is ruined, users can follow the below 4 steps to program code to flash.

Step 1: Turn DIP switch SW2 ON and SW3 OFF

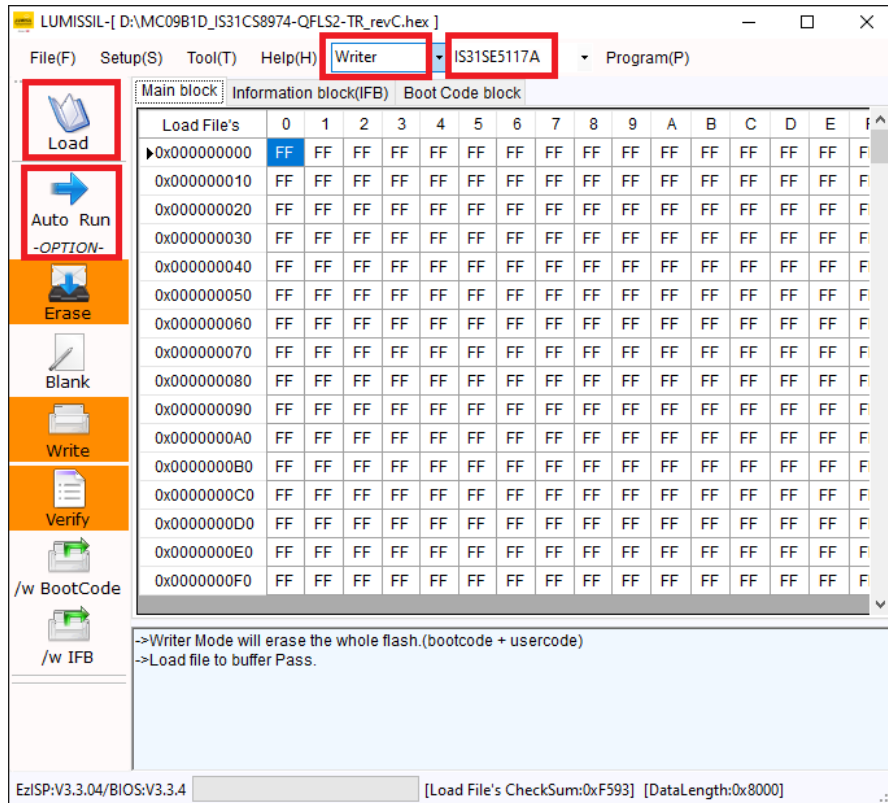
Turn the DIP switch SW2 1/2/3/4 to ON and switch SW3 1/2/3/4 to OFF as the highlighted red in below SE5117A EvB.



Step 2: Program boot code

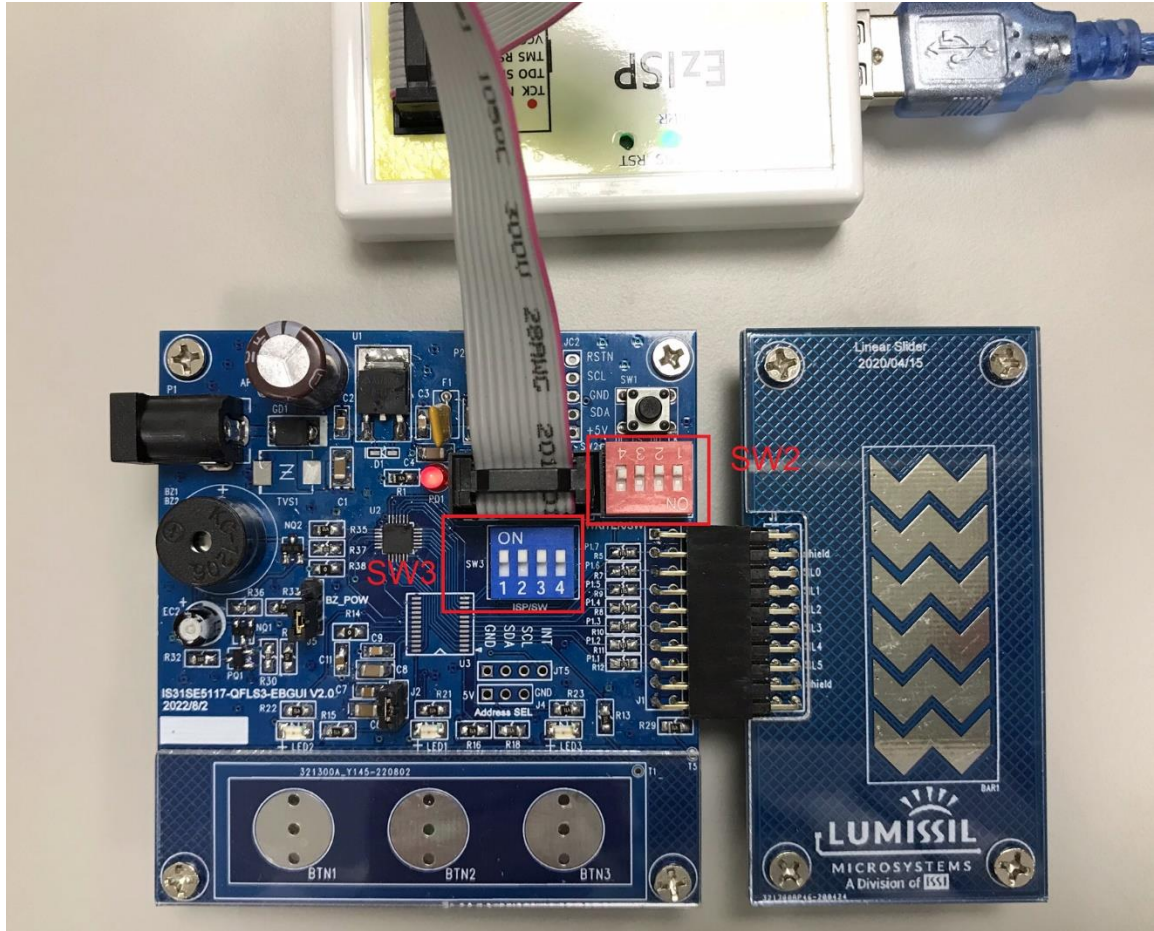
Program boot code "MC09B1D_IS31CS8974-QFLS2-TR_revC.hex" to IS31SE5117A EvB

- Execute the EzISP Tool
- Select "**Writer**" and "**IS31SE5117A**" from the drop-down menu as the highlighted red rectangle in below figure
- Click "**Load**" to load boot code file "MC09B1D_IS31CS8974-QFLS2-TR_revC.hex"
- Click "**Auto Run**"
- Close the EzISP program



Step 3: Turn DIP switch SW2 OFF and SW3 ON

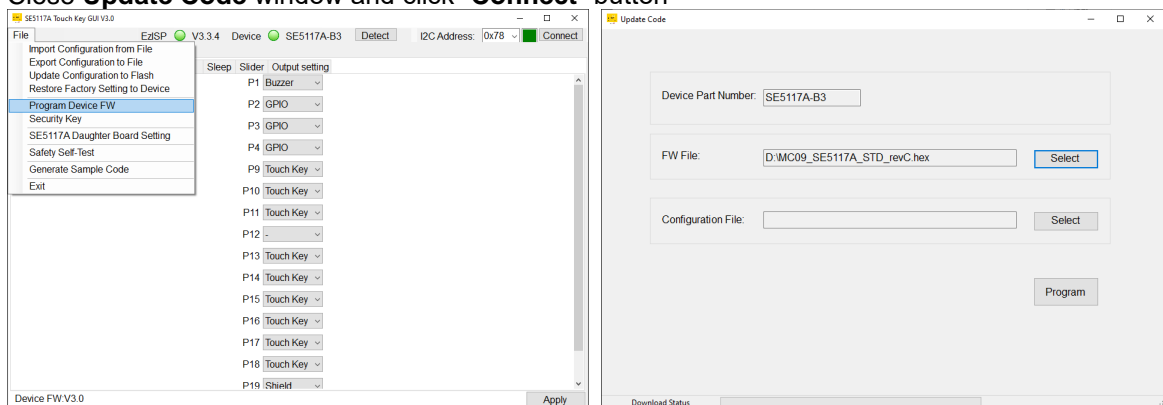
Turn the DIP switch SW2 1/2/3/4 to OFF and SW3 1/2/3/4 to ON as the highlighted red rectangles in below SE5117A EvB.



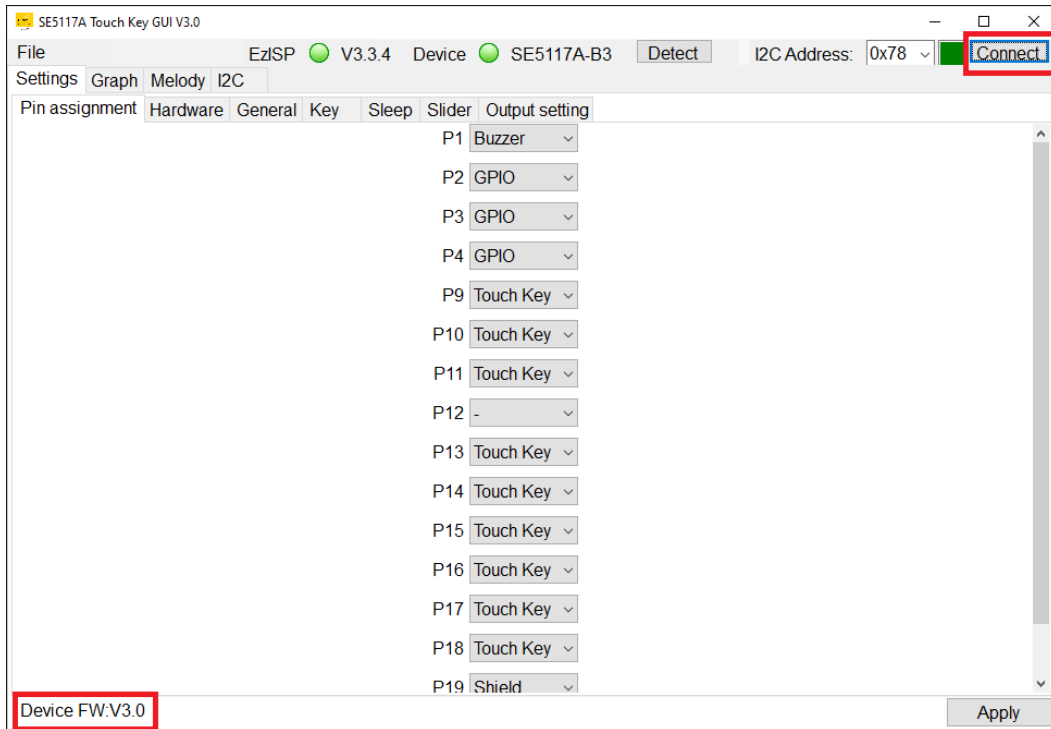
Step 4: Program Firmware

Program Device Firmware into SE5117A EvB

- Run SE5117A GUI Tool V3.0
- Click the **Program Device FW** from the **File** drop-down menu
- Click **"Select"** to open firmware file "MC09_SE5117A_STD_revC.hex" and click **"Program"**
- Close **Update Code** window and click **"Connect"** button



- Connect Status will be displayed as **"Connect"** (with a green box) and this GUI will display the current firmware version after clicking **"Connect"** button.



3. SE5117A TOUCH KEY GUI INTERFACE

3.1 Before Use

IS31SE5117A EvB board should have standard code firmware inside. In case, users can follow below step 1 to step 3 to program firmware to start evaluation of this board.

Step 1. Click the **Program Device FW** from the **File** drop-down menu.

Step 2. Click **Select** to open firmware file, and then click **Program**. If **Configuration File** is not selected, then the default settings will be programmed. Users can click **Export Configuration to File** to save the current configuration and choose the preferred configuration file before performing **Program Device FW**.

Step 3. Close the **Update Code** window and click the **Connect** button if the **Connect** status box is not green. (If IS31SE5117A EvB kit is not connected to the PC before this software is run, the **Connect** status box will be in red after running this software.)

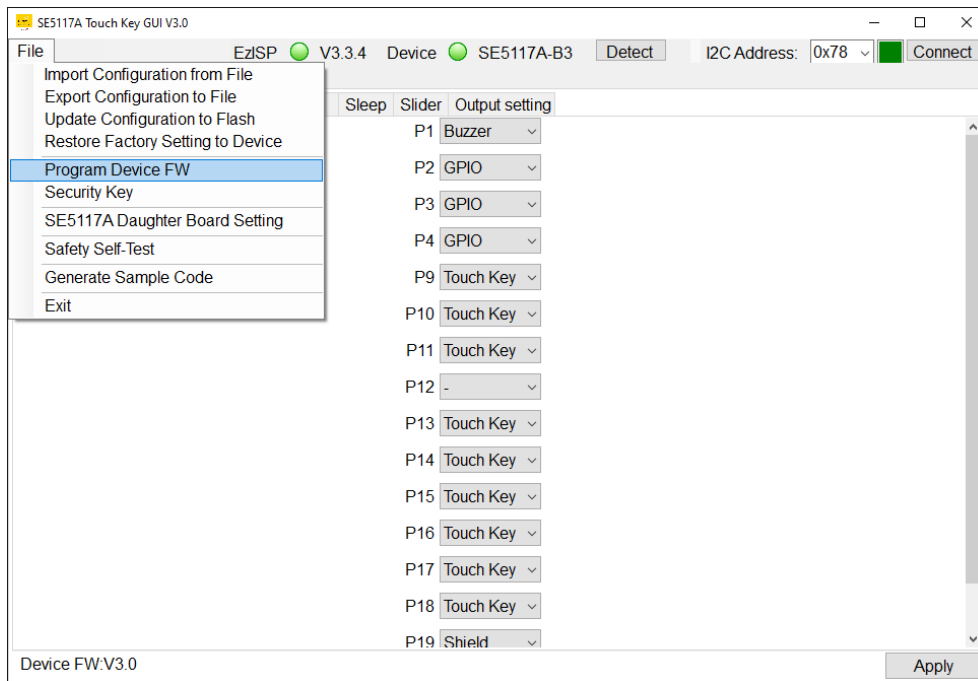


Figure 3-1: Program Device FW Before Use

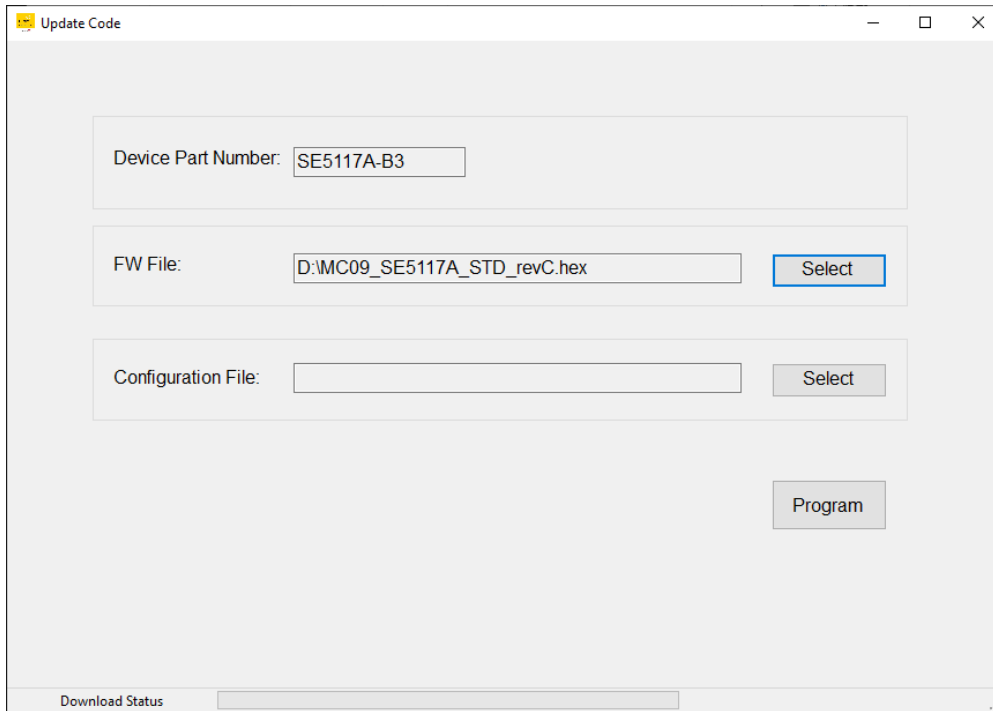


Figure 3-2: Firmware update Code

If the GUI looks small, the following method can improve high-DPI support for the GUI. Users need to find file MC09_SE5117A_GUI_rev3.0.exe, right-click on it and select **Properties**.

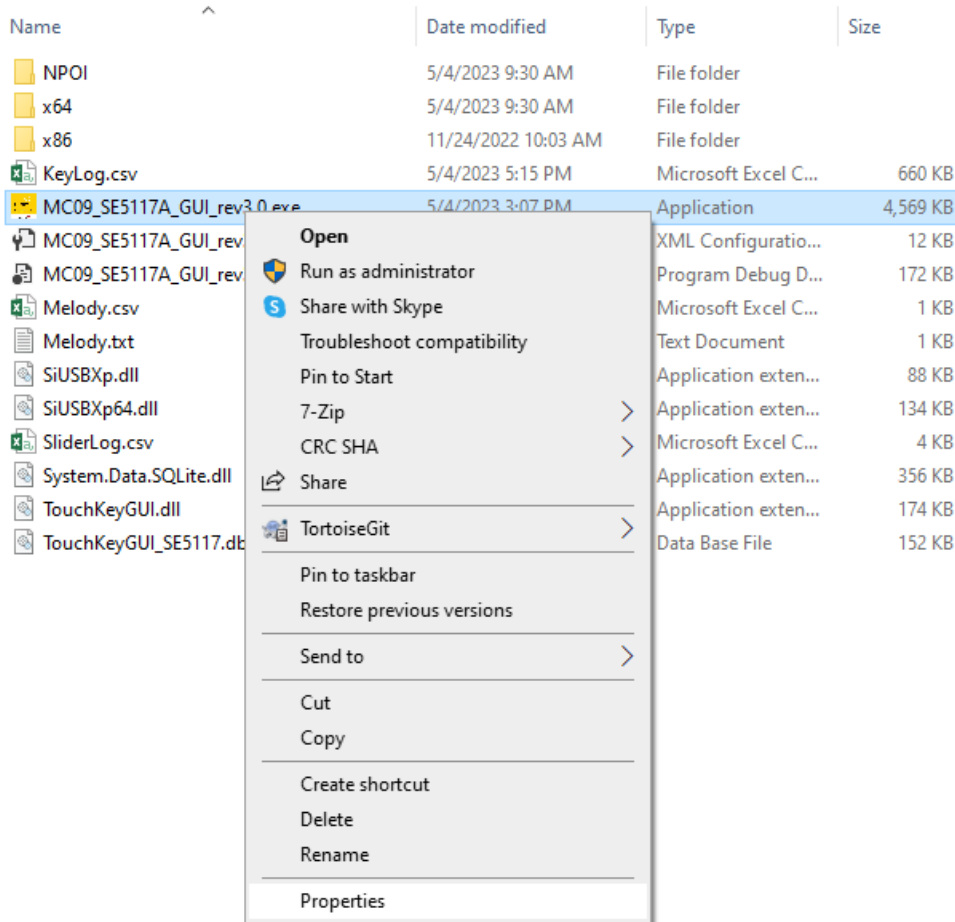


Figure 3-3: Set GUI program Properties

Go to the **Compatibility** tab and click **Change high DPI settings**. Select **Override high DPI scaling behavior**. **Scaling performed by: System or System (Enhanced)** and click **OK**.

Restart the GUI to see if there is an improvement.

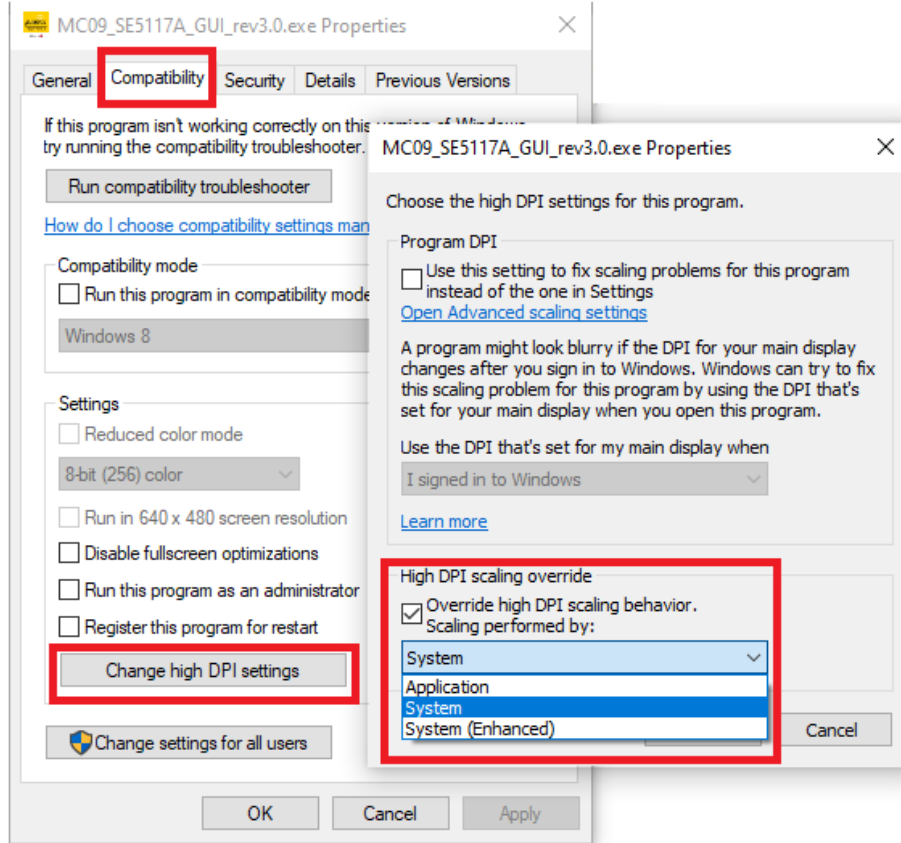


Figure 3-4: Choose High DPI settings

3.2 Connect Status

Before running Touch Key GUI tool, please make sure SW2 switch is all OFF and SW3 is all ON in the IS31SE5117A EvB. Users can refer to [Section 1.1 Evaluation Board](#) to find SW2 and SW3.

The I2C slave address is default at 0x78, as shown in **Figure 3-5: GUI Connect Status Shows Disconnect** with IS31SE5117A EvB connected to PC via EzISP board. Users need to click the **“Connect”** button for normal operation. If the user finds the **“Device”** status in red, please try to re-connect the device. connection with PC USB port and run Touch Key GUI tool again. If the **“Device”** status still shows red, it might be caused by the boot code not being correctly burned. If the **“Connect”** status is still in yellow color after trying to re-connect devices connection with PC USB port and running Touch Key GUI tool again, it might be caused by standard code not being correctly burned.

The **“Connect”** status box might be red and users cannot change any setting if IS31SE5117A EvB and EzISP board are not connected to the PC before the GUI software is run. Users can click the **“Connect”** button and the **“Connect”** status will turn green.

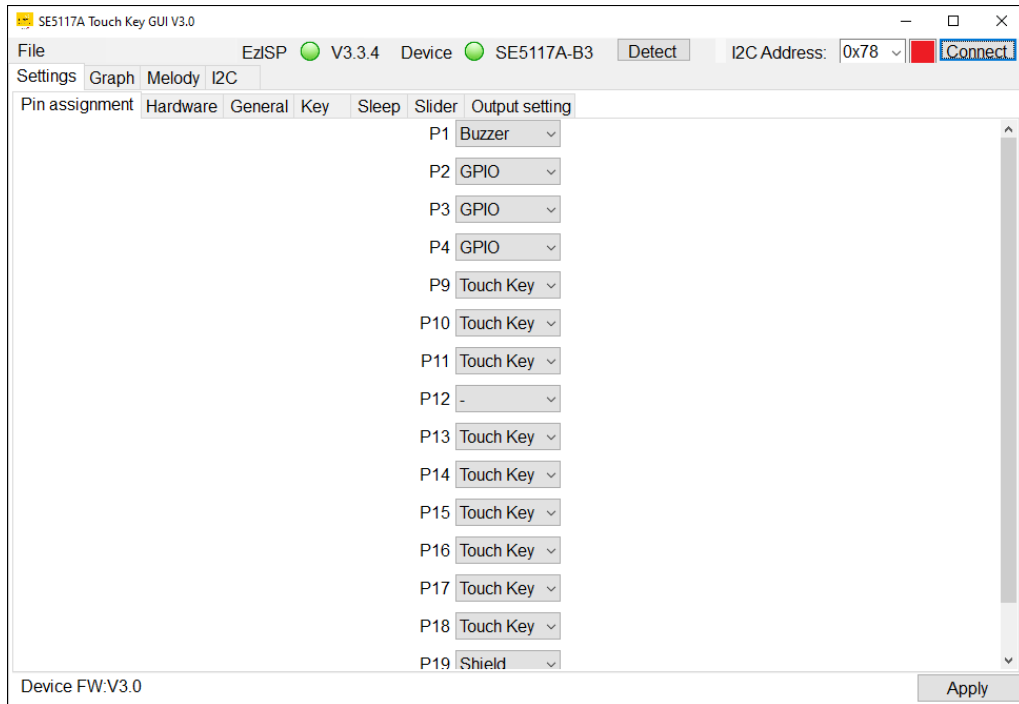


Figure 3-5: Connect Status Shows Disconnect

As shown in **Figure 3-6** below, the “**Connect**” status box is green and GUI displays current firmware version after clicking “**Connect**” button.

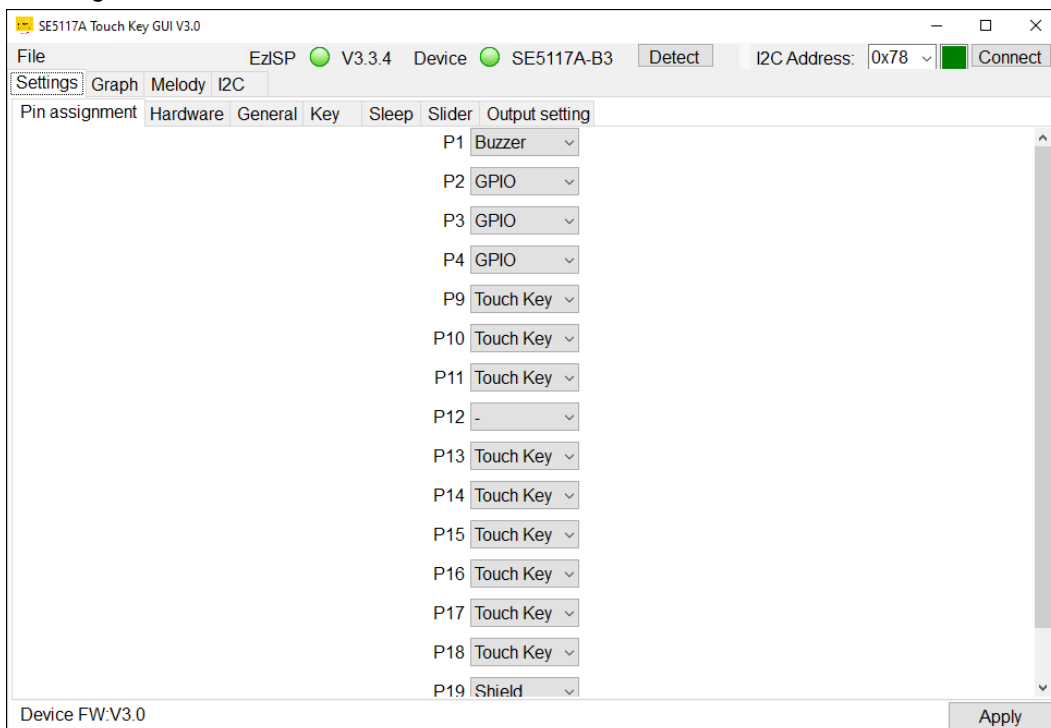


Figure 3-6: Connect Status Shows Connect

3.3 Export/Import Configuration File

As shown in **Figure 3-7** below, **Import Configuration from File** is used to import the configuration setting from the preferred IS31SE5117A GUI settings file into the device. Click **Apply** to apply the parameters to the device.

Export Configuration to File is used to export the configuration of IS31SE5117A and save in a file. By exporting the configuration, we can save the parameters settings in the GUI to a file (The default file name is an excel file “register values” and users can define file name for version control). It also simultaneously creates a BIN file in the same folder and the file can be used for future manufacture.

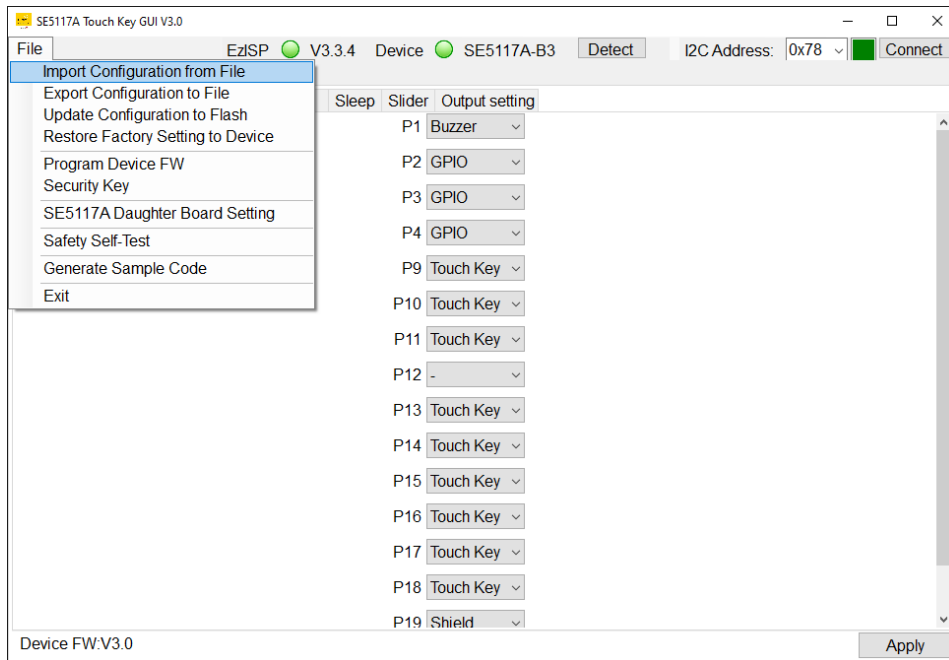


Figure 3-7: Import/Export Options

3.4 Update Configuration to Flash

As shown in **Figure 3-8** below, users can write the parameters settings in the GUI and program into the flash memory of the IS31SE5117A chip. After clicking the **Update Configuration to Flash** from the **File** drop-down menu, writing configuration settings to the flash memory can be completed in about 4 seconds.

The embedded Flash Memory has the capability to hold saved data even when the power is off. When IS31SE5117A is powered on again, the parameters previously written to the flash memory will become the default values.

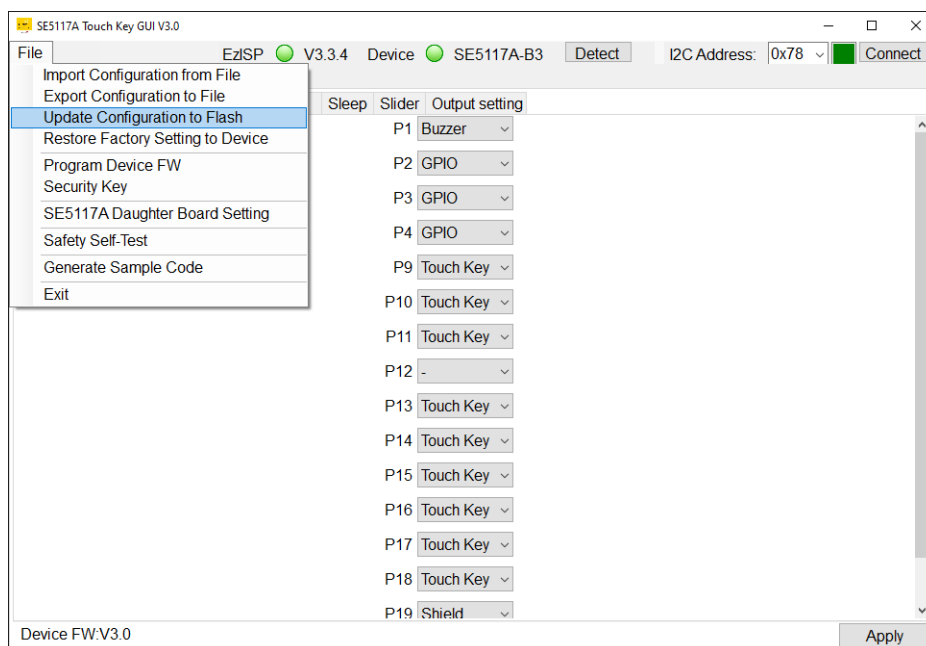


Figure 3-8: Update Configuration to Flash

3.5 Restore Factory Setting to Device

As shown in **Figure 3-9** below, after clicking the **Restore Factory Setting to Device** from the **File** drop-down menu, writing factory default parameters to the flash memory can be completed in about 4 seconds.

Need to click “**Connect**” button to refresh parameters in the GUI.

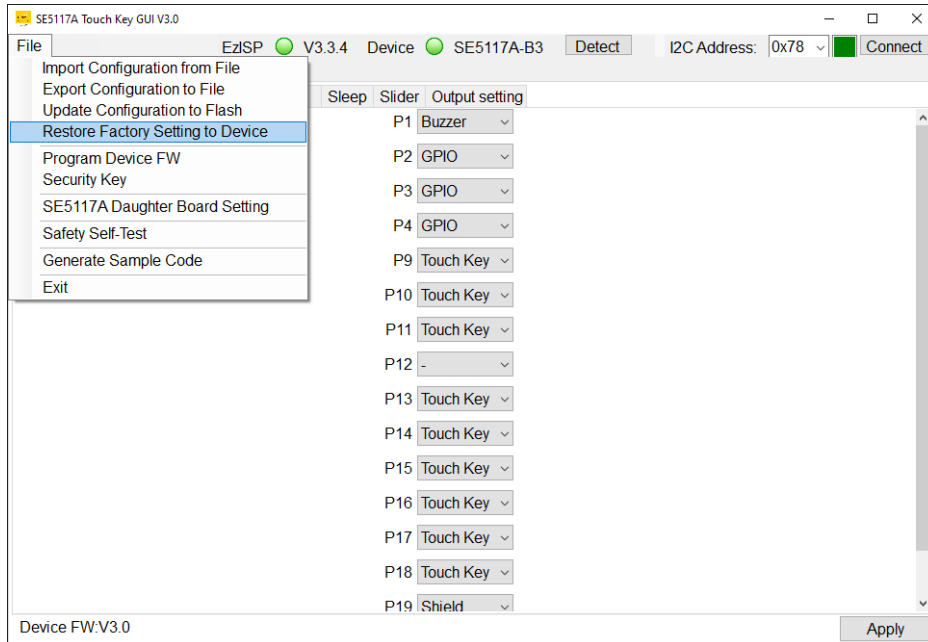


Figure 3-9: Restore Factory Setting to Device

3.6 Program Device Firmware

After clicking the **Program Device FW** from the **File** drop-down menu, a pop-up window will appear as shown in **Figure 3-10** below. Click **Select** to open firmware file and configuration file. Configuration will be restored to the factory settings if configuration file is not selected. Click **Program** to update firmware code.

Need to click **Connect** button to reconnect device after programming device firmware.

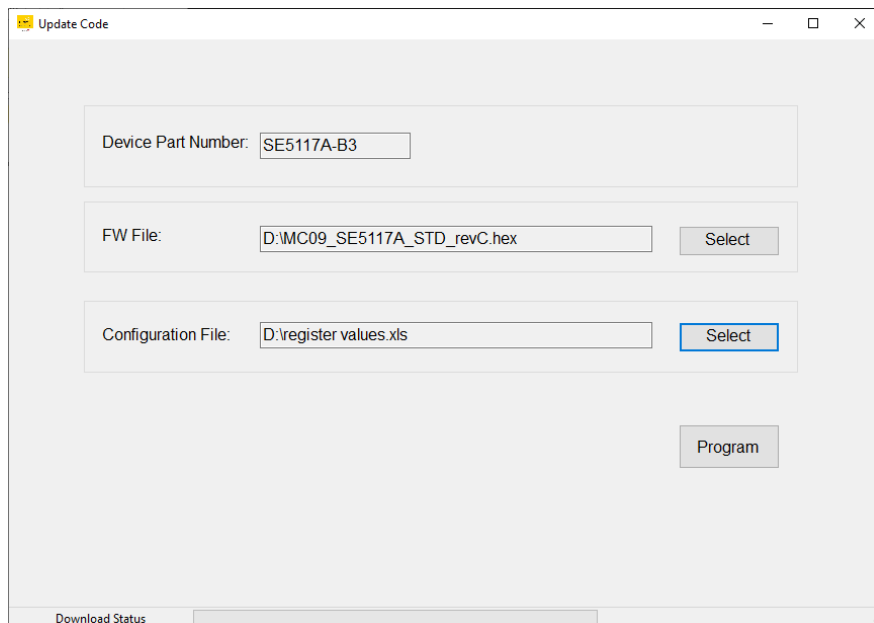


Figure 3-10: Update Code

3.7 Security Key

After clicking the **Security Key** from the **File** drop-down menu, a pop-up window will appear as shown in **Figure 3-11** below.

There are 8-bytes **Lock/Unlock Key** and the default setting is 0xFFFFFFFFFFFFFFFF.

Lock Key will be updated with the programmed device firmware.

The security key is used to protect user's defined device parameters. Invalid security key inhibits reading the chip information, but programming a new FW is allowed, i.e., users can reset the security key by programming a new FW.

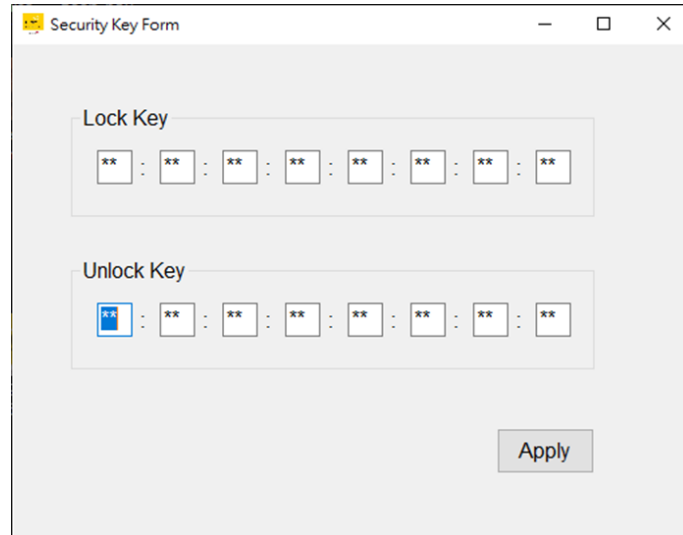


Figure 3-11: Security Key

3.8 Generate Sample Code

As shown in **Figure 3-12** below, "**Generate Sample Code**" is used to create a sample code for configuring SE5117A via I2C bus. Customers can adjust SE5117A Touch Key GUI for the required parameters to meet their own application needs. After system level verification, please click **Apply** to apply the parameters to the device before "**Generate Sample Code**" is clicked.

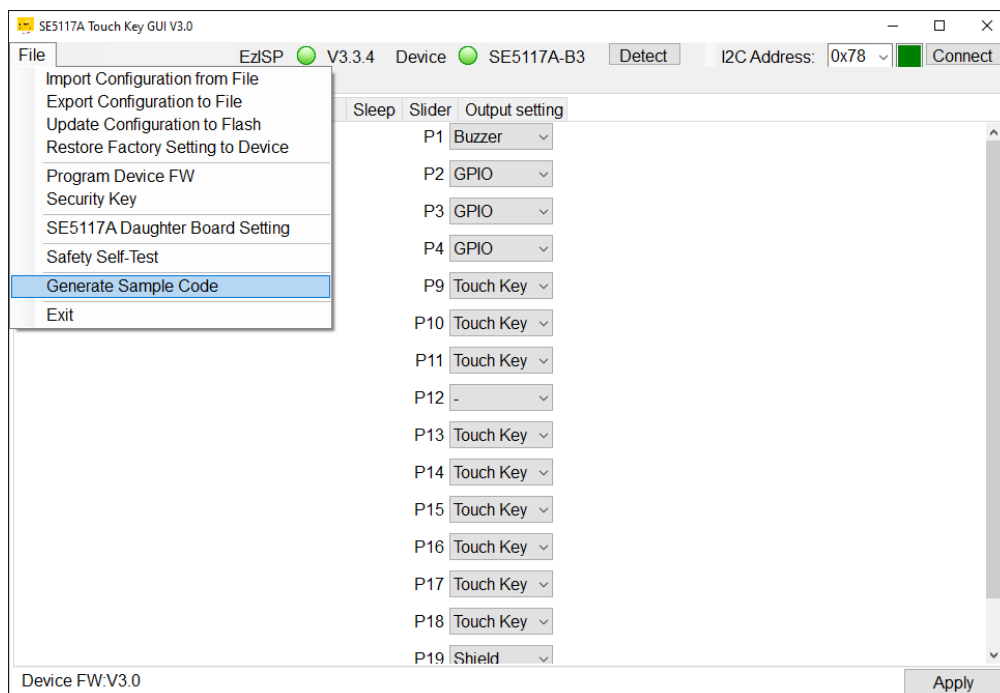


Figure 3-12: Generate Sample Code

3.9 How to Use IS31SE5117A Touch Key GUI

The following steps explain how to use IS31SE5117A Touch Key GUI. **We recommend using a round copper bar instead of a human finger for the touch key parameters testing and setting.**

Step 1. Run MC09_SE5117A_GUI_rev3.0.exe and click **Connect** button to establish connection.

Parameters in the GUI will be uploaded from the device.

Step 2. Click **Import Configuration from File** from **File** menu and click **Apply** to apply the parameters to the device (optional).

Step 3. Follow Chapter 4. SETTINGS to configure setting of pins, hardware, key parameters and so on.

Step 4. Click **Apply** to apply the parameters to device and check the result by **Graph** or other methods.

Step 5. Click **Update Configuration to Flash** from **File** menu if you want to use these parameters as the device default settings or click **Export Configuration to File** from **File** Menu to save the current GUI parameters.

“**Export Configuration to File**” also creates a BIN file in addition to saving a user-defined excel file in the same folder for future manufacture.

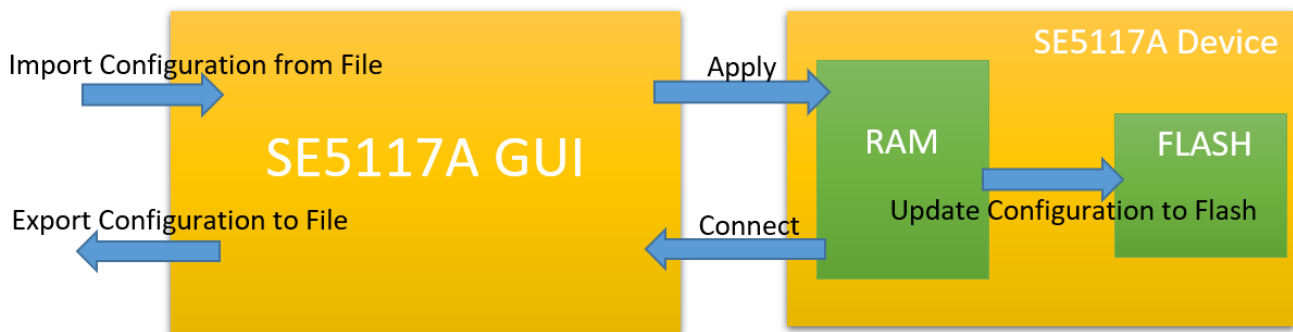


Figure 3-13: Interaction between GUI Configuration and Device

4. SETTINGS

4.1 Pin Assignment

As shown in **Figure 4-1** below, after clicking **Connect** button, the “**Connect**” status box is green and the EvB board has been successfully connected. Users can choose different pin assignments from the drop-down menu.

Users must click the “**Apply**” button located at the right bottom corner of the figure below to submit selected settings.

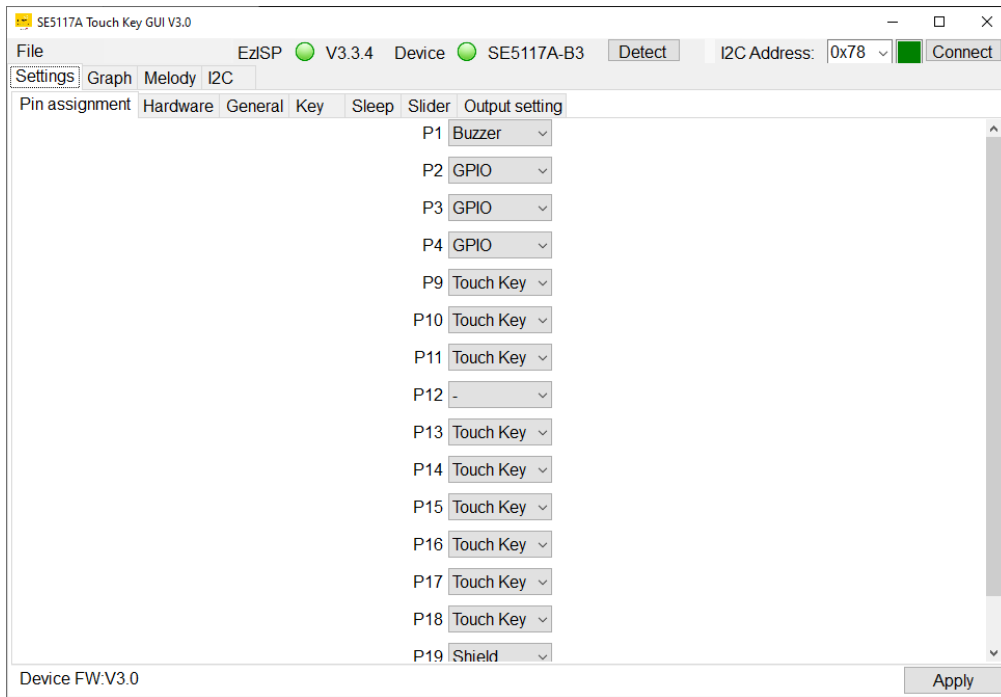


Figure 4-1: Default Pin Assignment

- Touch Key** : Touch Sense Channel
- Shield** : Shield Output
- Buzzer** : Buzzer Output
- POW** : Melody Power Output
- GPIO** : General Purpose Input/Output

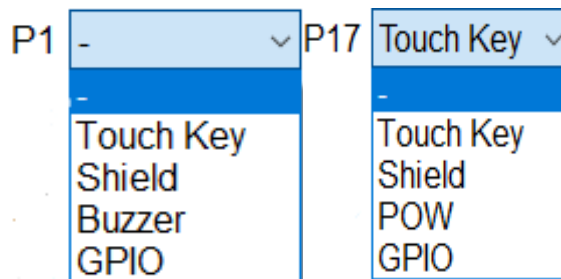


Figure 4-2: Pin Drop-Down Menu

4.2 Hardware Setting

As shown in **Figure 4-3** below, TK3 stands for Touch Key technology generation III for Lumissil. TK3 uses dual-slope technology to detect key touch via charging and discharging among an internal charge capacitor, an external reference capacitor, and the Touch Key capacitor. Several parameters for the TK3 can be set to improve touch key detection. All settings will be applied by clicking the **Apply** button.

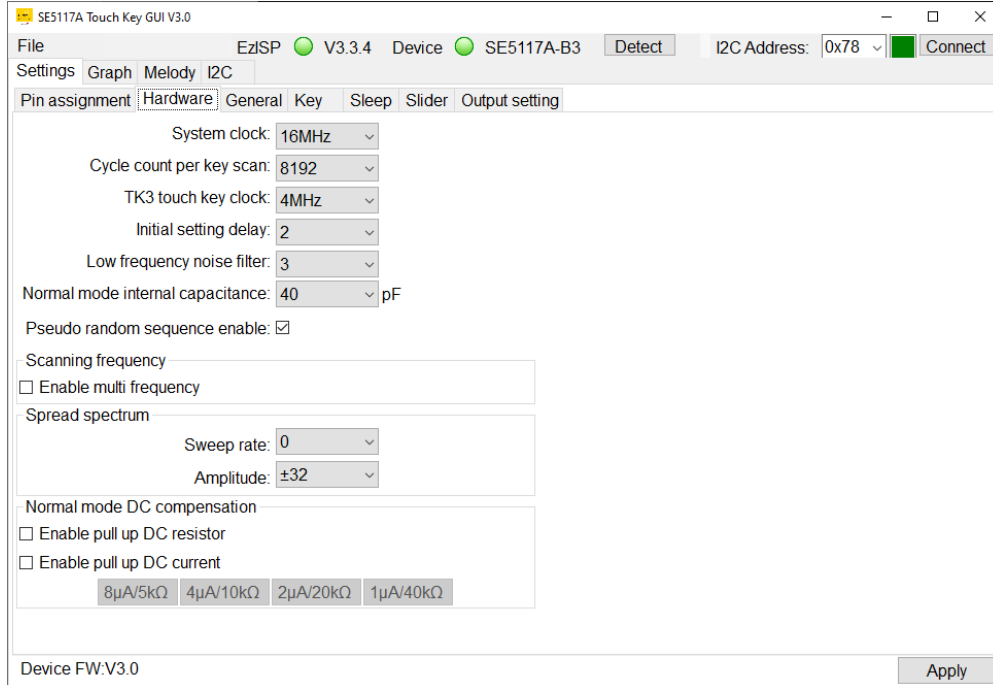


Figure 4-3: Hardware Setting Page

4.2.1 System Clock

Select **System clock** to change device's clock and the default setting is 16MHz. The lower system clock may cause I2C communication error.

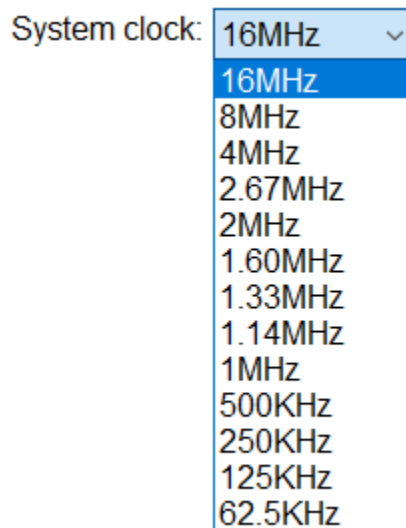


Figure 4-4: System Clock

4.2.2 Cycle Count Per Key Scan

For example: Cycle Count = 8192, total keys = 5, TK3 touch key clock = 4MHz

One scan cycle = $(1/4M) * 8192 * 5 = 10.24ms$

The higher cycle count per key scan will increase key's resolution for detect, but it will have a longer scan time. The default setting is 8192. Choosing different cycle count setting, users might need to modify the key detect parameters like finger threshold to have correct key detect.

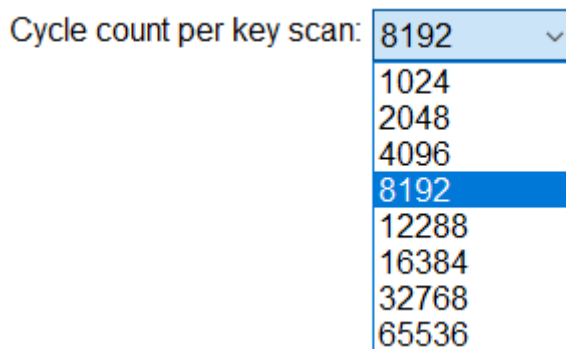


Figure 4-5: Cycle Count Per Key Scan

4.2.3 TK3 Touch Key Clock

Select **TK3 touch key clock** to change touch key clock and the default setting is system clock/4 = 16MHz/4 = 4MHz

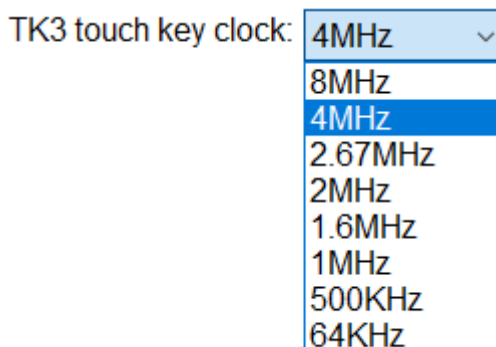


Figure 4-6: TK3 Touch Key Clock

4.2.4 Initial Setting Delay (INI)

Initial setting delay defines the number of TK3 clock (system clock/4) period for initial settling of IS31SE5117A pin Cref (Cref, the integration capacitor of the charge transfer). The delay time is set to $(INI + 1) * 4 * \text{TK3 clock time}$.

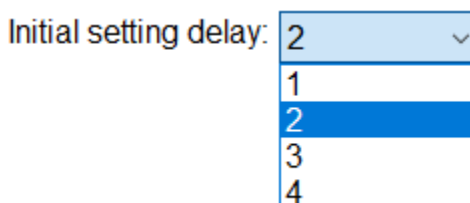


Figure 4-7: Initial Setting Delay

4.2.5 Low Frequency Noise Filter (LFNF)

Regarding low frequency noise rejection, users can use this setting to reject a continuous high or low comparator output that exceeds the setting duration. If the scan count with noise injection detection is larger than $(\text{LFNF} * 8)$, the scan result is ignored.

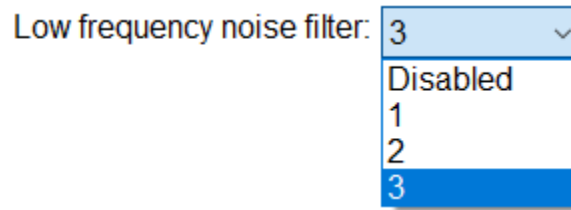


Figure 4-8: Low Frequency Noise Filter

4.2.6 Normal Mode Internal Capacitance

It is suggested to set the charge capacitance value at around twice the capacitance value of touch pad and we can evaluate the setting value by checking the raw count without touching keys.

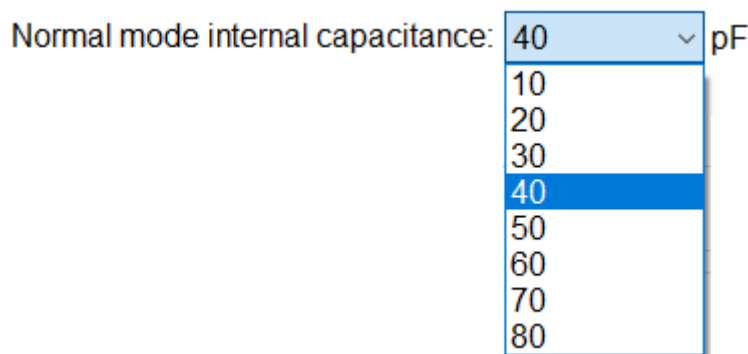


Figure 4-9: Normal Mode Internal Capacitance

4.2.7 Pseudo Random Sequence Enable

IS31SE5117A applies a pseudo-random sequence that randomizes the charge and discharge timing sequences to prevent high frequency noise rejection.

Pseudo random sequence enable:

Figure 4-10: Pseudo Random Sequence Enable

4.2.8 Scanning Frequency

Scan one key at three different frequencies to prevent noise, however it will increase scan time.

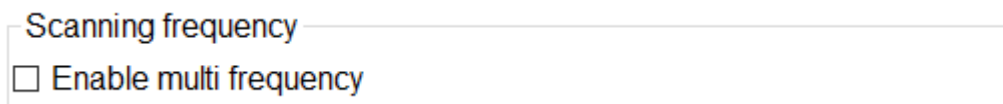


Figure 4-11: Scanning Frequency

4.2.9 Spread Spectrum

The spread is achieved by varying the output to the oscillator circuit, thus effectively changing the oscillation frequency.

When SS (Spread Spectrum) is enabled, the frequency of IOSC varies according to time and setting, and therefore the accuracy of IOSC frequency cannot be guaranteed.

As Spread Spectrum suggests, the total EMI energy is not reduced, but the energy is spread over a wider frequency. It is recommended that SS usage should be carefully evaluated and the setting of spread amplitude and the sweep rate/frequency should be chosen carefully for reducing the

EMI effect.

Sweep rate

Define the spread spectrum sweep rate and the spread spectrum function is disabled when **Sweep rate** = 0.

Amplitude

Setting to adjust the range of spread spectrum frequency. Be careful to select the setting of Sweep rate and Amplitude to reduce EMI.

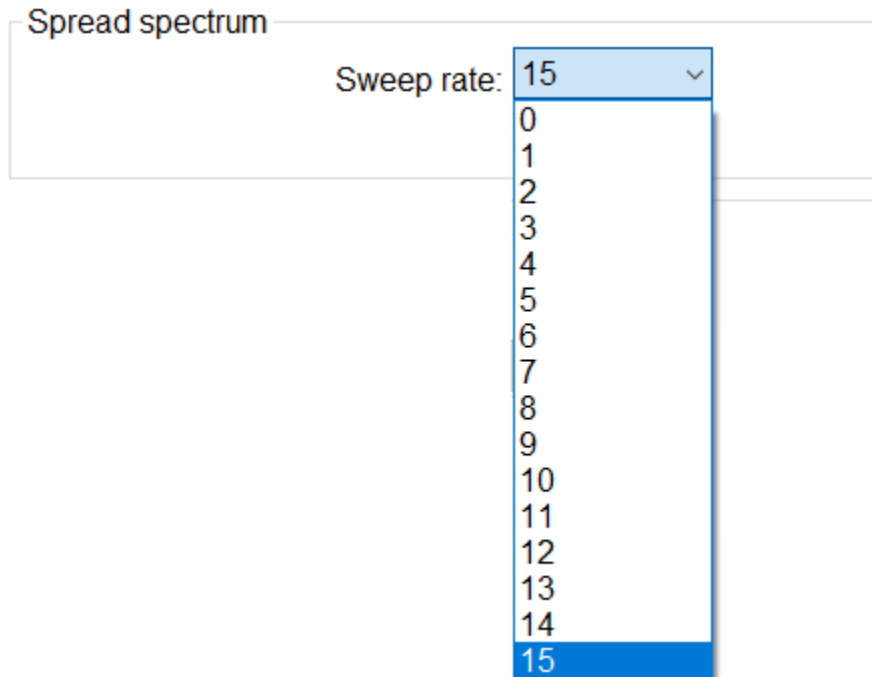


Figure 4-12: Spread Spectrum Sweep Rate

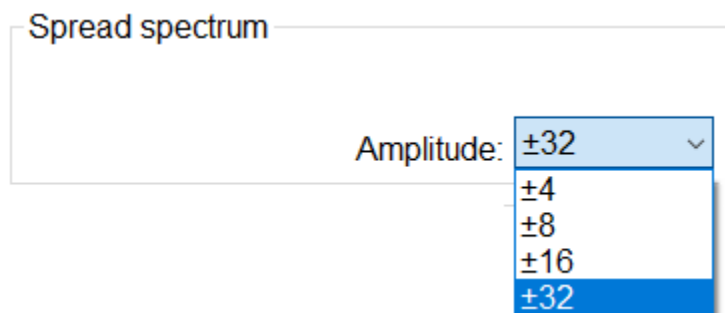


Figure 4-13: Spread Spectrum Amplitude

4.2.10 DC Compensation

The hardware can be configured a constant DC pull-up/pull-down (PUD) on IS31SE5117A pin Cref to allow high capacitance touch-key detection. A DC pull-up/pull-down can compensate for the equivalent resistance caused by a high capacitance key. Connecting a switching current source or a resistor can thus maintain touch key detection sensitivity.

For DC current, PUD can enable 8uA/4uA/2uA/1uA current source. For Resistor, PUD can enable 5K/10K/20K/40K resistor. Users can choose any of the settings 8uA/5 K Ω , 4uA/10 K Ω , 2uA/20 K Ω , 1uA/40 K Ω or a combination of multiple selections at one time.

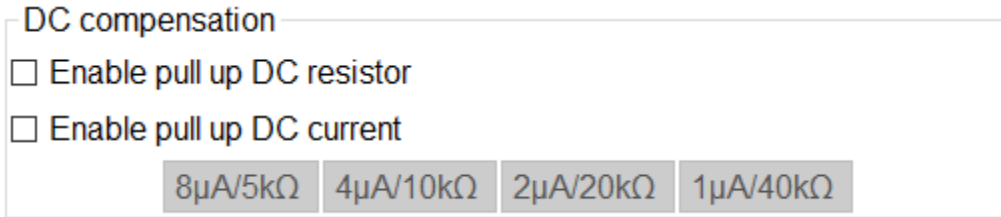


Figure 4-14: DC Compensation

4.2.11 Raw Count Calibration

- Step 1. Select **Cycle Count Per Key Scan** (1024 - 65536) as 4.2.1
- Step 2. Select larger **Normal Mode Internal Capacitance** (10pF – 80pF) to increase the raw count value.
- Step 3. Enable **DC Compensation** if needed. But it will increase the raw count.
- Step 4. Click the **“Apply”** button located at the right bottom corner of the GUI to submit the setting.
- Step 5. Check current raw count/baseline from **GRAPH**.
- Step 6. It is good to have Raw count and Baseline count closer to 1/2 of **“Cycle count per key scan”** count. If not, go to step 2.

Example 1: Set Cycle count per key scan = 8192 and compare raw counts for different internal capacitance settings.

Normal mode internal capacitance: 40 pF

Figure 4-15: Normal mode internal capacitor

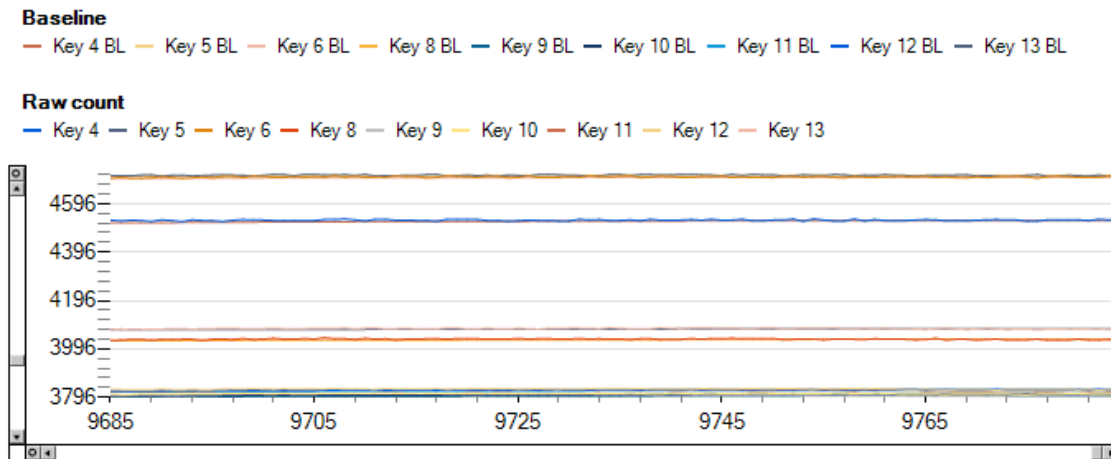


Figure 4-16: Raw Count Value when Internal Cap = 40pF

Normal mode internal capacitance: 50 pF

Figure 4-17: Normal mode Internal Cap = 50pF

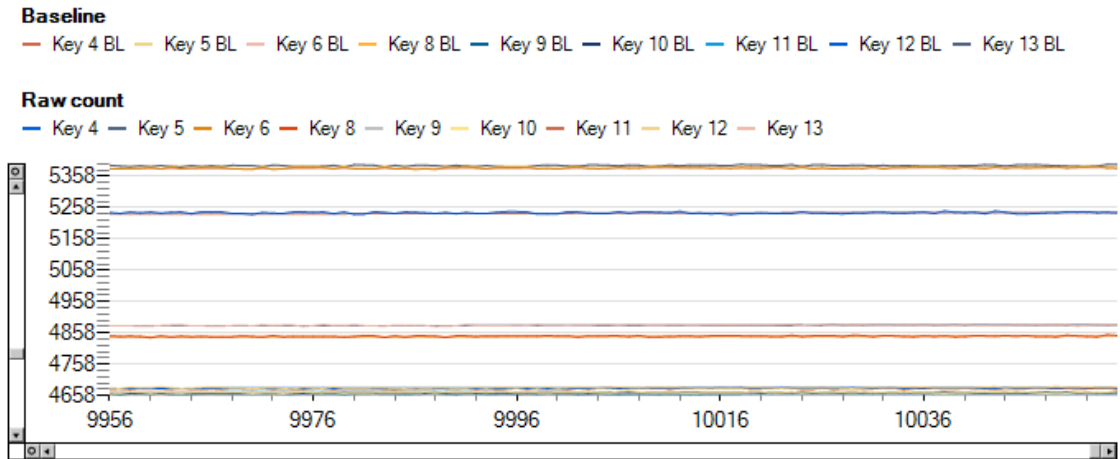


Figure 4-18: Raw Count Value when Internal Cap = 50pF

Example 2: Set **Cycle count per key scan** = 8192 and compare baseline and raw counts for different settings of DC compensation.

Cycle count per key scan: 8192 ▾

Oscillator division: 1 ▾

Initial setting delay: 2 ▾

Low frequency noise filter: 3 ▾

Normal mode internal capacitance: 50 ▾ pF

Pseudo random sequence enable:

Scanning frequency

Enable multi frequency

Spread spectrum

Sweep rate: 0 ▾

Amplitude: ±32 ▾

Normal mode DC compensation

Enable pull up DC resistor

Enable pull up DC current

8μA/5kΩ 4μA/10kΩ 2μA/20kΩ 1μA/40kΩ

Figure 4-19: Raw Count Value when Internal Cap = 50pF

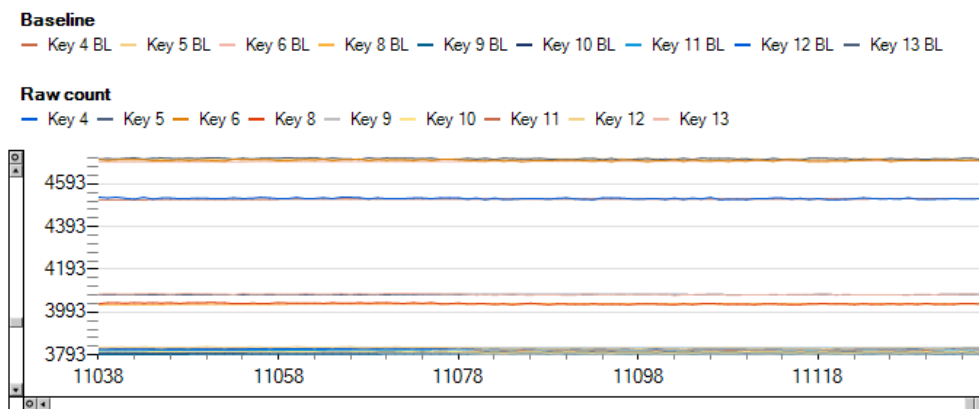


Figure 4-20: Disable DC Compensation

Cycle count per key scan: 8192
 Oscillator division: 1
 Initial setting delay: 2
 Low frequency noise filter: 3
 Normal mode internal capacitance: 40 pF
 Pseudo random sequence enable:

Scanning frequency
 Enable multi frequency

Spread spectrum
 Sweep rate: 0
 Amplitude: ±32

Normal mode DC compensation
 Enable pull up DC resistor
 Enable pull up DC current

Figure 4-21: DC Current and Resistor setting

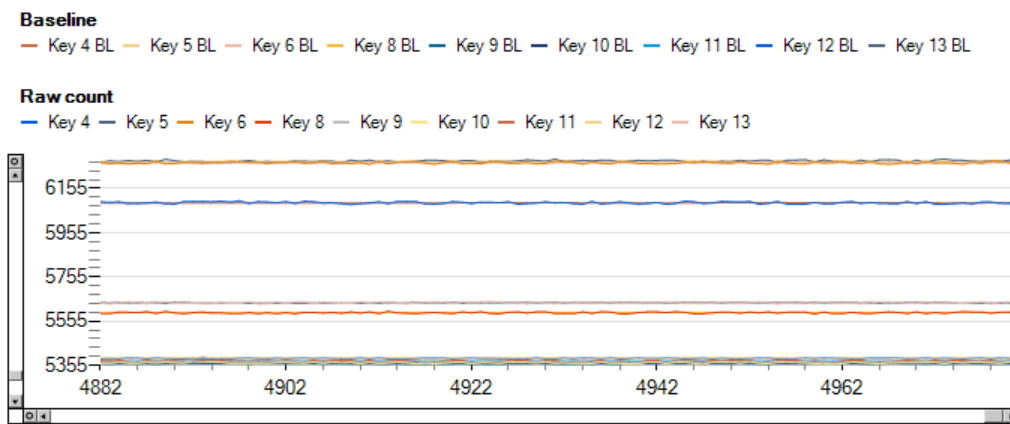


Figure 4-22: Enable DC Current 1uA and Resistor 40KΩ

4.3 General

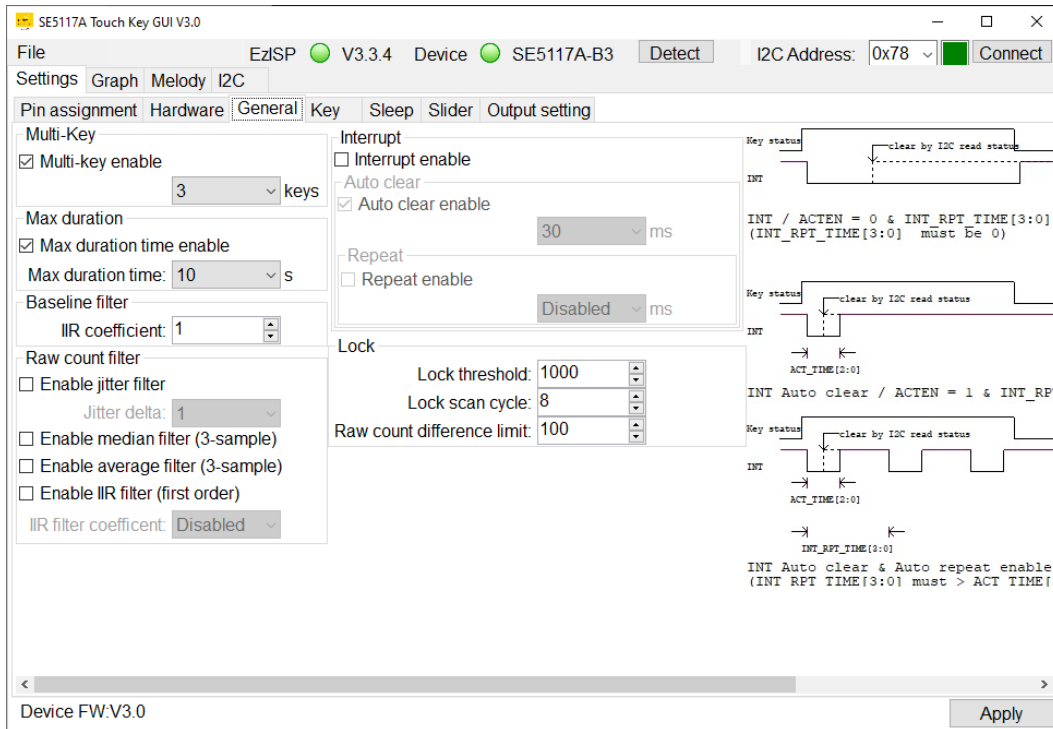


Figure 4-23: General Page

4.3.1 Multi Key

As shown in below **Figure 4-24**, **Multi-key enable** is to enable multi-key function. When **Multi-key enable** is not checked, only one key is detectable. **Multi-key enable** selection can be set to TWO KEYS, THREE KEYS or All KEYS. In some applications, such as a password lock, the number of keys pressed can be set via this setting. The **Multi-key enable** should be unchecked by default to prevent error on password lock.

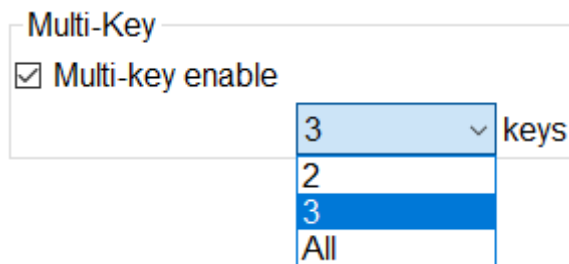


Figure 4-24: Multi-Key

4.3.2 Maximum Duration

Max duration time enable is the maximum pressing duration time setting in seconds. When the pressing time is longer than the maximum duration time, the device will be forced to do calibration automatically on the pressed key.

This function is mainly used to recover a touch key mis-triggered by the environmental factor. For example, a water droplet falls on a touch button and causes a trigger status. That key will stay triggered until a reset occurs and hence not usable. However, if the maximum duration time is set, the mis-triggered key will be turned off since a forced calibration of the baseline will occur after the maximum duration time is expired. Once the forced calibration is done, the touch key with the water droplet can be used again.

Max duration

Max duration time enable

Max duration time: 10 s

- 0.5
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15

Figure 4-25: Max Duration

4.3.3 Baseline Filter

IIR coefficient

Return the value of $\text{coefficient}/256 * \text{the current raw count} + (256 - \text{coefficient})/256 * \text{the previous filter value}$.

Baseline filter

IIR coefficient: 1

Figure 4-26: Baseline Filter

4.3.4 Raw Count Filter

There are four types of filters for raw count. One or more filters can be selected and adopted following the sequences **Jitter filter** → **Median filter** → **Average filter** → **IIR filter**.

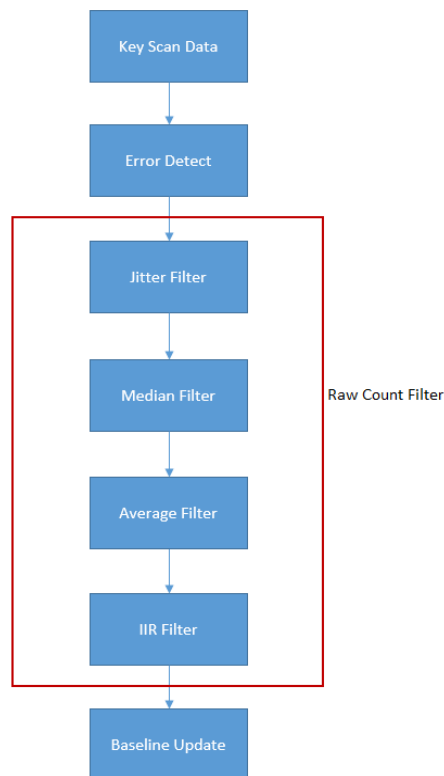


Figure 4-27: Raw Count Filter

Jitter

This filter is to remove centroid noise for slider or touch key buttons.

If $\text{Input} > (\text{previous output} + \text{jitter delta})$, output value is $(\text{Input} - \text{jitter delta})$.

If $\text{Input} < (\text{previous output} - \text{jitter delta})$, output value is $(\text{Input} + \text{jitter delta})$.

Otherwise, output value is the previous filter value.

Median

Return the middle value after sorting the last three raw counts.

This is a nonlinear filter. The median is computed using a two-step process. First, the buffer values are sorted from the smallest to the largest; and the middle value is selected from the ordered list. The buffer is scanned for the median with each update of the buffer.

Average

Return the average value of the last three raw counts.

It is used in the case where is necessary to smooth data that carries high frequency distortion.

IIR

Return the value of $1/\text{coefficient} * \text{the current raw count} + (\text{coefficient} - 1)/\text{coefficient} * \text{the previous filter value}$.

The IIR filter (Infinite Impulse Response filter) is a recursive filter because the output from the filter is computed by using the current and previous outputs.

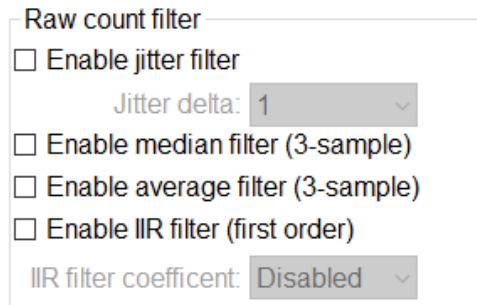


Figure 4-28: Raw Count Filter Settings

4.3.5 Interrupt

Interrupt is the output for interrupt request (IRQ) and interrupt pin has been fixed at Pin 23 INTB.

From **Settings -> General**, click **Interrupt enable** checkbox. Optional select: **Auto clear enable /Repeat enable**

All changes will be active by clicking the **Apply** button.

Reading key status register through I2C from the host has the high priority to clear INT.

Interrupt enable is a global interrupt setting. If it is disabled, interrupt of all keys will be turned off even though some key is pressed.

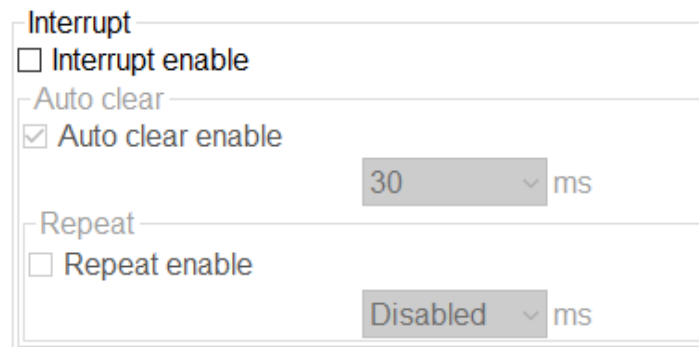


Figure 4-29: Interrupt Menu

Case 1. Click Interrupt Enable

Interrupt output is low if any key touch is detected. Interrupt output is high (by external pull high resistor) if key status registers (07h and 08h) are read or no key touch is detected.

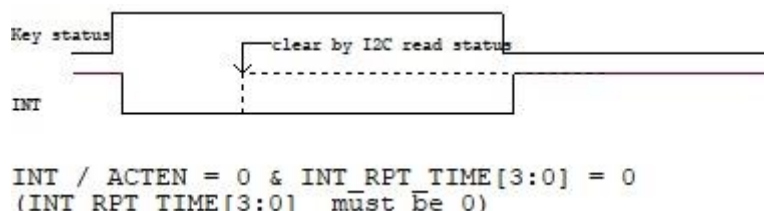


Figure 4-30: INT Output Low by Key ON Status

Case 2. Click Interrupt Enable and Auto Clear Enable

Auto clear enable is to enable auto clear interrupt function. Check to enable.

Auto clear time is to set auto clear interrupt time interval in milliseconds.

When **Auto clear enable** is enabled and 07h & 08h registers are not read within the programmed **Auto clear time** (10ms~200ms), IS31SE5117A will release INT pin after **Auto clear time** is expired. INT pin can also be released by reading registers 07h and 08h (Key Status Register).

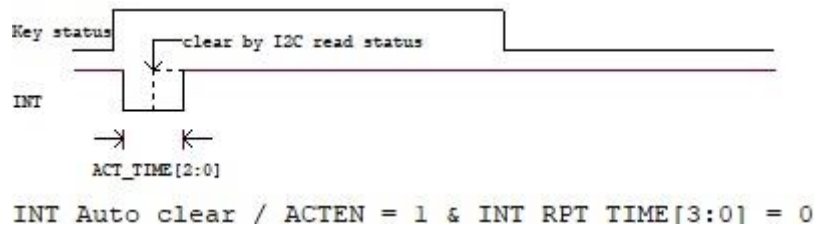


Figure 4-31: Auto Clear INT

Case 3. Click Interrupt Enable, Auto Clear Enable and Repeat Enable

Repeat Enable is used to set interrupt auto-repeat time. Click drop down menu to choose a different time and the unit is millisecond. If there is a key keeping pressed, the second interrupt will be generated after the repeat time is expired.

If Multi Key function is enabled, INT signal will be immediately low when there is a 2nd key touch detection even the repeat INT process as the below figure is on-going.

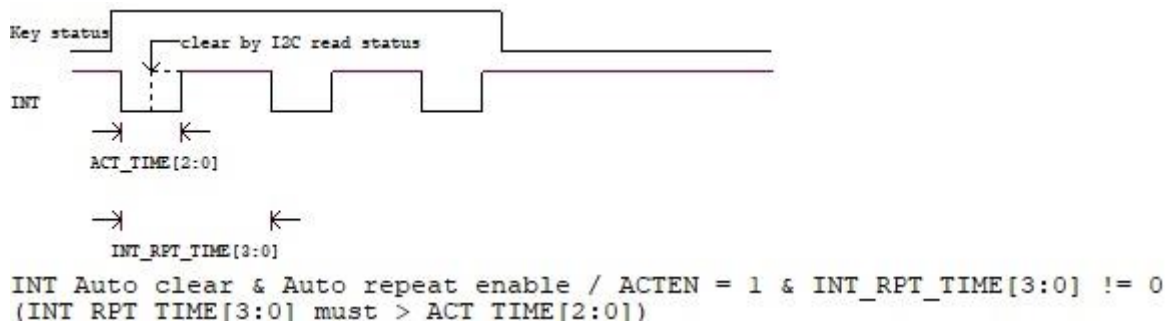


Figure 4-32: Repeat INT

4.3.6 Lock

Lock threshold

Ignore touch key scan if the count difference between baseline count and raw count exceeds the lock threshold.

Lock scan cycle

When Lock threshold is reached, ignore key scanning for the following “**Lock scan cycle**” setting time to prevent noise interference.

Raw count difference limit

Ignore the key scan data if the difference between previous raw count and current raw count exceeds the limit setting.

Lock

Lock threshold:	1000	▲ ▼
Lock scan cycle:	8	▲ ▼
Raw count difference limit:	100	▲ ▼

Figure 4-33: Lock

4.4 Key

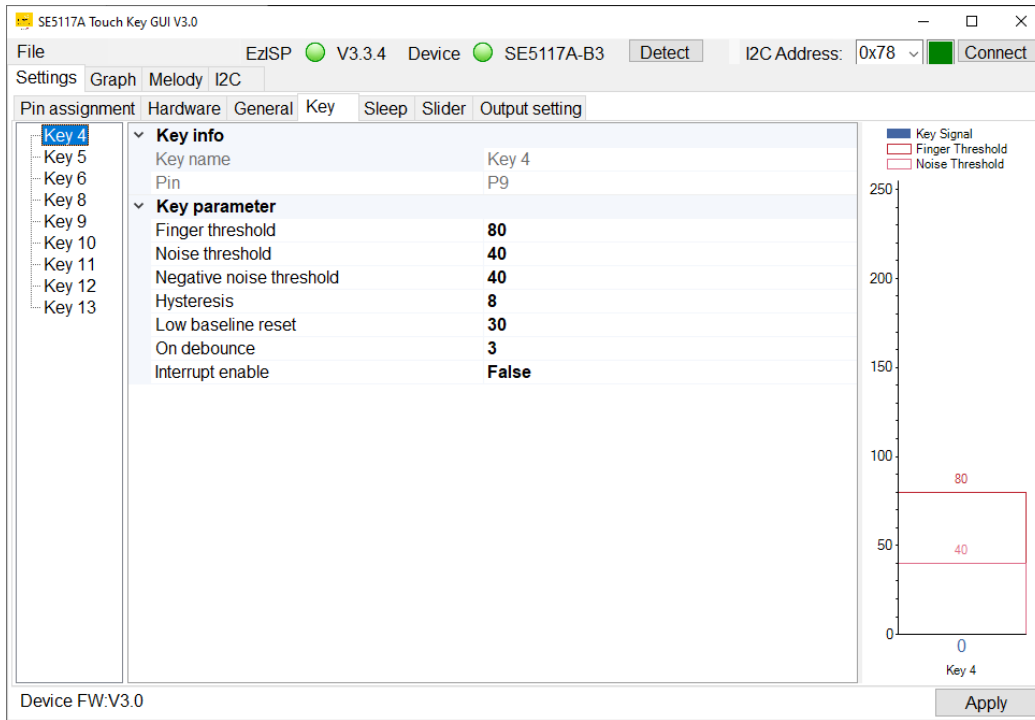


Figure 4-34: Key Page

4.4.1 Key Info

It includes key name and pin number.

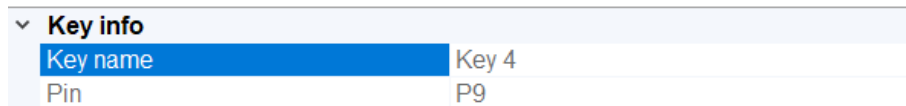


Figure 4-35: Key Info

4.4.2 Key Parameter

Finger threshold

It is used with hysteresis to determine the key status.

Noise threshold

Baseline is updated if the difference count of baseline count and raw count is below the noise threshold.

Negative noise threshold

It is used with the low baseline reset count to reset baseline count to the current raw count. Please refer to the description of **Low baseline reset**.

Hysteresis

Touch key is triggered when its signal is bigger than the finger threshold plus hysteresis value and is released when its signal is smaller than the finger threshold minus the hysteresis value.

Low baseline reset

Low baseline reset count of each key. A reset count increases by one if the absolute $|raw\ count - baseline| > absolute\ |negative\ noise\ threshold|$. Once the reset count exceeds the low baseline reset register value, the baseline is reset to the current raw count. The reset count will be reset to 0 if the absolute $|raw\ count - baseline| \leq absolute\ |negative\ noise\ threshold|$.

On debounce

When one key's on debounce count is reached, this key is triggered.

Interrupt enable

The Interrupt enable determines whether a key is detected and causes the interrupt pin to be asserted.

Key parameter	
Finger threshold	80
Noise threshold	40
Negative noise threshold	40
Hysteresis	9
Low baseline reset	30
On debounce	3
Interrupt enable	False

Figure 4-36: Key Parameter

4.4.3 Key Signal Bar Chart

It shows individual key signals. The corresponding value will be displayed in the box when pressing KEYS on EvB. The key number X turns red if its signal value is over finger threshold plus hysteresis and it means this key is triggered. The maximum value is 254. GUI will keep at 254 if the input value is over 254.

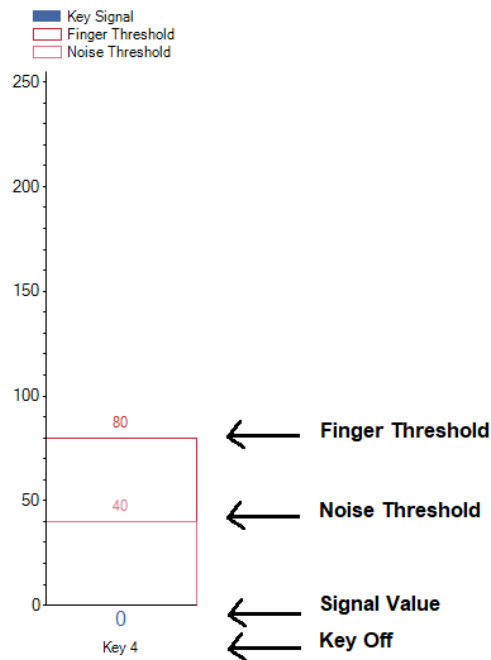


Figure 4-37: Key Signal Bar Chart

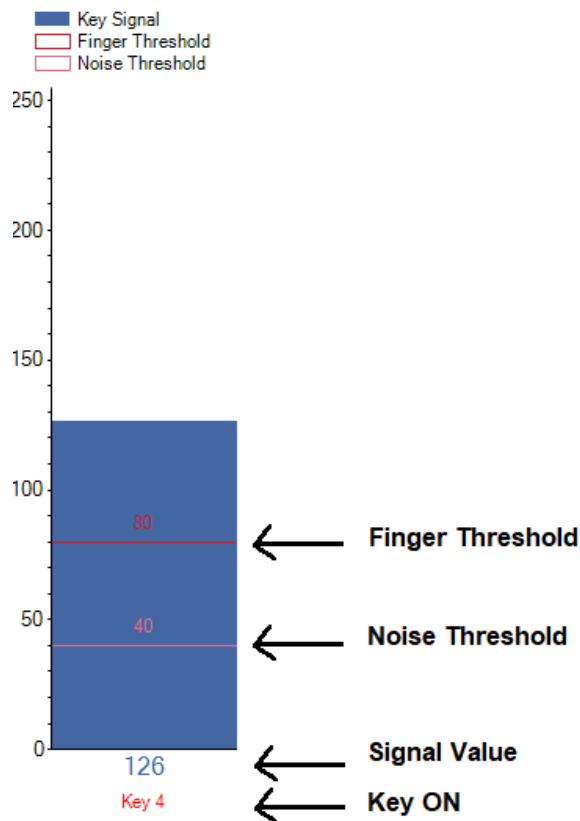


Figure 4-38: Signal Bar Char with Finger Touch

4.5 Sleep

IS31SE5117A integrates auto sleep function, and the entering-sleep time can be configured. Device will enter sleep mode when there is no touch key detected. It will be woken up by the key touch. For applications that require low power consumption, this device can be set to sleep mode automatically.

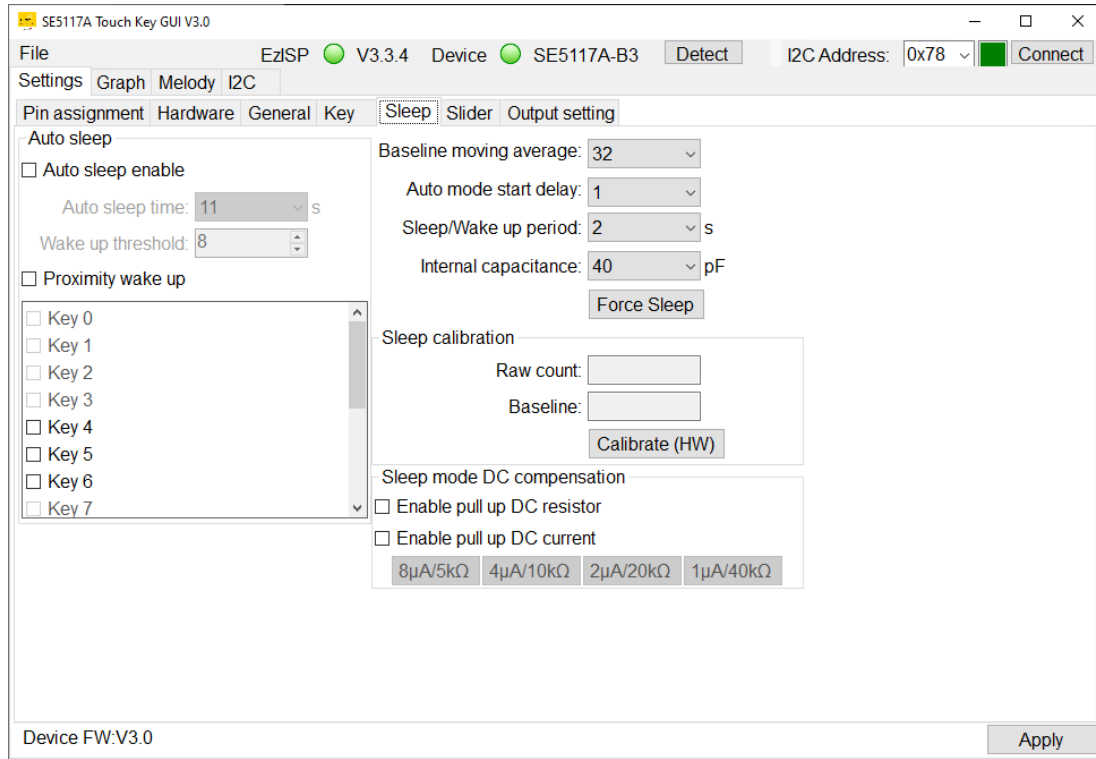


Figure 4-39: Sleep Page

4.5.1 Auto Sleep

IS31SE5117A can only be woken up by the key that has been previously set as a touch key and the wake-up function is enabled to return to normal mode.

Enable the corresponding key and the device will be woken up as the key value arrives at the **Wake-up threshold**.

Wake-up threshold is to set the key threshold of waking up from sleep mode. Input setting in the box and press enter, tab key, or move the cursor to another location will save the setting.

Proximity wake-up

Apply non-contact detection to wake up the device.

Disable: Approaching device won't wake up device and device behavior will follow settings in **Auto sleep enable**.

Device wakes up -> scans key once -> goes to sleep again if no key is detected.

Enable: Approaching device will wake up the device. Device wakes up -> generates INT signal (optional) -> goes to sleep after **Auto sleep time** is expired if no key is detected.

Generate the INT signal for wake-up event if **Interrupt enable** option is checked in General Tab.

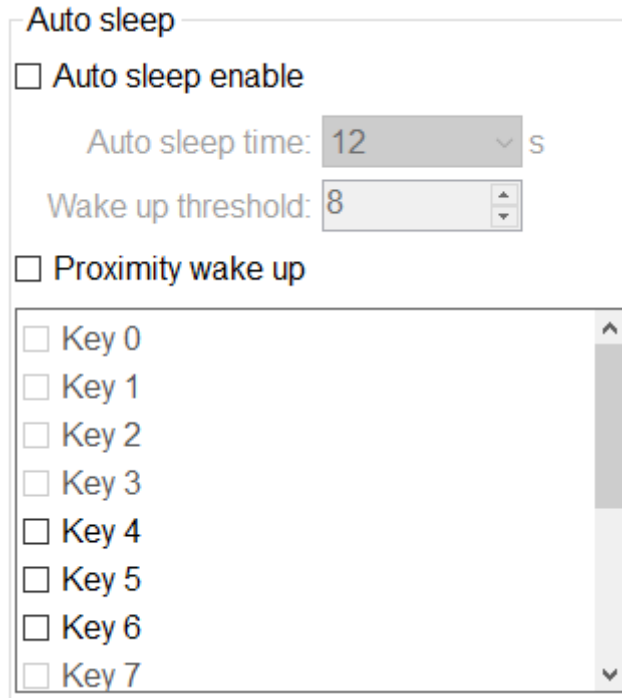


Figure 4-40: Auto Sleep Setting

The “**Connect**” status box is yellow whenever device enters sleep mode.

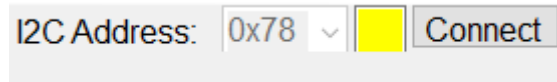


Figure 4-41: I2C Address

The GUI cannot operate in sleep mode. Device needs to return to normal mode by pressing the selected wake-up key or “**Connect**” button.

Exit Sleep Mode

- Step 1. Press the selected wake-up key and the “**Connect**” status box will be green.
- Step 2. Hold the key pressed if needed and it will keep the device in normal mode.
- Step 3. Disable sleep mode by unchecking **Auto Sleep enable** box and clicking **Apply**.

4.5.2 Baseline Moving Average

Device will enter sleep mode if baseline exceeds the setting Baseline moving average.

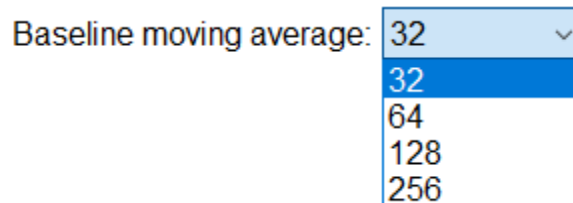


Figure 4-42: Baseline Moving Average

4.5.3 Auto Mode Start Delay (ASTDLY)

ASTDLY inserts an inter-sequence idle time of $(ASTDLY+1) * 256 * TK3$ clock time at each sequence start. This delay allows the stabilization time from normal mode to sleep mode.

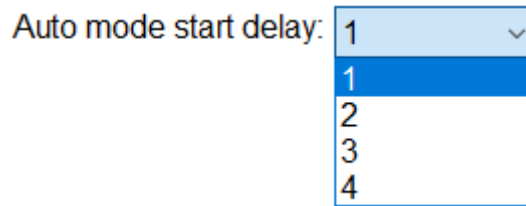


Figure 4-43: Auto Mode Start Delay

4.5.4 Sleep/Wake Up Period

Set “**Sleep/wake up period**” and the touch key baseline will be dynamically adjusted after the setting time is expired. The default setting is 2 seconds.

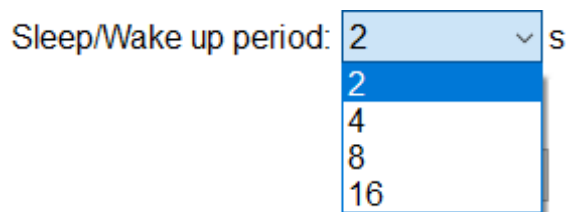


Figure 4-44: Sleep/Wake Up Period

4.5.5 Internal Capacitance

This setting is to select internal charging capacitance value.

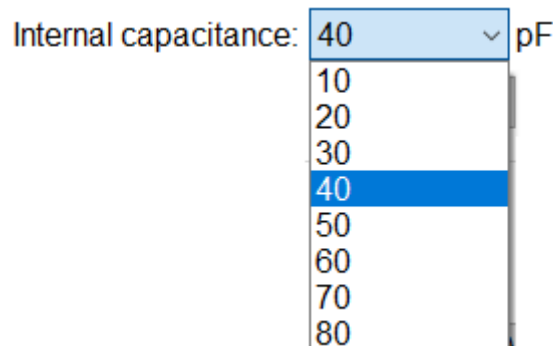
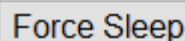


Figure 4-45: Internal Capacitance

4.5.6 Force Sleep

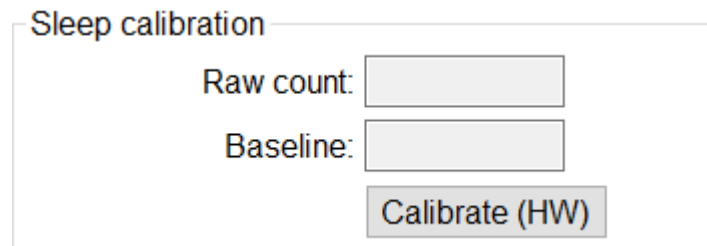
When IS31SE5117A EvB is in normal mode, the “**Connect**” button box in GUI will turn green. After clicking **Force Sleep**, IS31SE5117A EvB will enter sleep mode and the “**Connect**” status box is yellow. Touch the assigned wake-up key or click “**Connect**” button, device will return to normal state.



Force Sleep

Figure 4-46: Force Sleep

4.5.7 Sleep Calibration



The screenshot shows a window titled "Sleep calibration". Inside the window, there are two input fields: "Raw count:" and "Baseline:". Below these fields is a button labeled "Calibrate (HW)".

Figure 4-47: Sleep Calibration

Sleep Calibration Method – Use calibration result to set up Wake-up threshold.

- Step 1. Select available Key 0~Key 14 for wakeup. Suggest choosing one Key or raising internal capacitor setting value, otherwise there might not come out raw count and baseline value when you click **Calibrate (HW)** button.
- Step 2. Select related settings like internal capacitance, DC compensation, ..., etc. Users must click **Apply** button located at GUI's right bottom corner to submit setting.
- Step 3. Click **Calibrate (HW)** button to get raw count and baseline data and click button again to stop calibration. Need to stop calibration before going to the next step.
- Step 4. It is good to have raw count and baseline count closer to 1/2 of "Cycle count per key scan". If not, go to step 2.
- Step 5. Record the raw count without finger touch and with finger touch and set the **Wake-up threshold** by the difference value of both counts.

Example:

Make sure the device is connected (with a green "**Connect**" status box). If not, click the **Connect** button.

- Step 1. Select wake-up key = Key 4.
- Step 2. Select internal capacitance = 40pF.
- Step 3. Click **Apply**.
- Step 4. Click **Calibrate (HW)**, raw count = 3771.
- Step 5. Click **Calibrate (HW)** again to stop calibration.
- Step 6. Record the raw count without finger touch and with finger touch and set the **Wake-up threshold** by the difference value of both counts.

Case 1: Sleep calibration raw count = 3771 without finger touch when Internal capacitance = 40pF

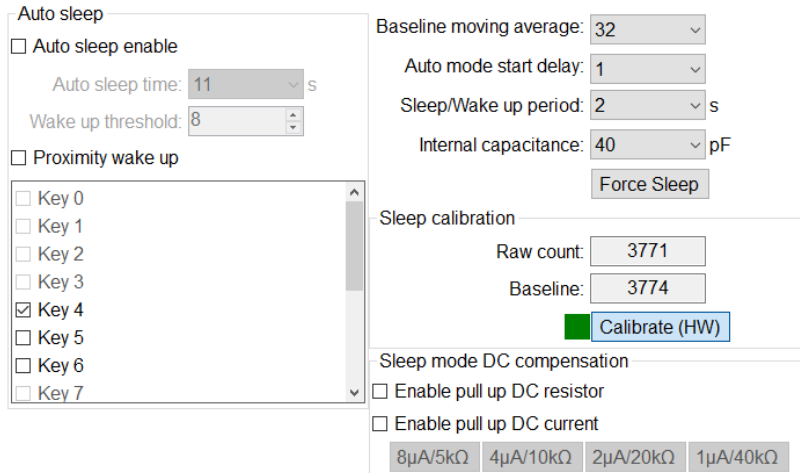


Figure 4-48: Sleep Calibration case 1

Case 2: Sleep calibration raw count = 5206 without finger touch when Internal capacitance = 60pF

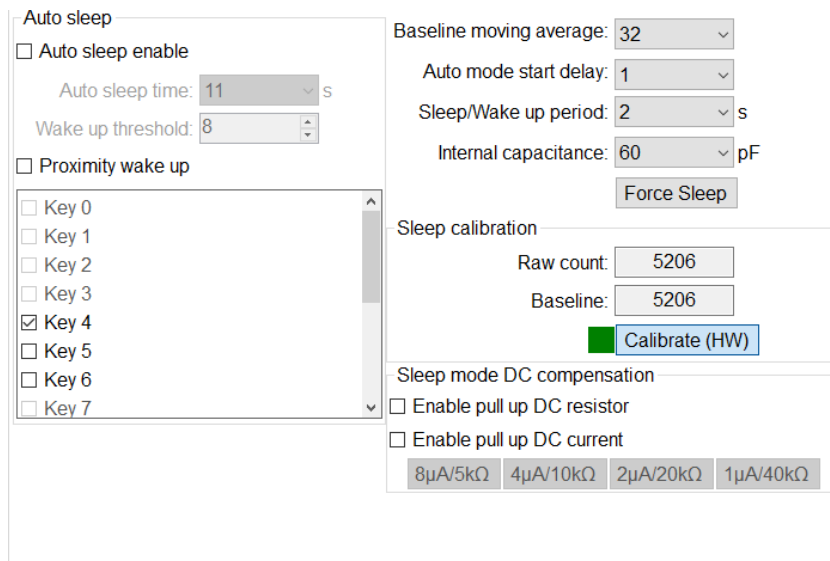


Figure 4-49: Sleep Calibration case 2

Case 3: Sleep calibration raw count = 5111 with finger touch when Internal capacitance = 60pF

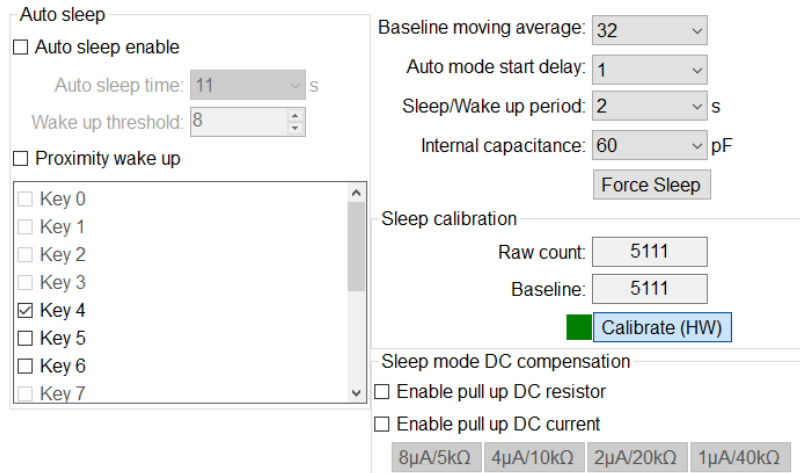


Figure 4-50: Sleep Calibration case 3

4.5.8 DC Compensation

DC compensation in sleep mode is the same as in the normal mode. But DC compensation in the sleep mode will be performed based on total effects of all the keys you selected.

The hardware is to configure a constant DC pull-up/pull-down (PUD) on IS31SE5117A pin Cref to allow high capacitance touch-key detection. A DC pull-up/pull-down can compensate for the equivalent resistance which is caused by a high capacitance key. Connecting a switching current source or resistor can thus maintain sensitivity of touch key detection.

For DC current, PUD can enable 8uA/4uA/2uA/1uA current source with Cref pin connecting with 5KΩ/10KΩ/20KΩ/40KΩ resistor respectively.

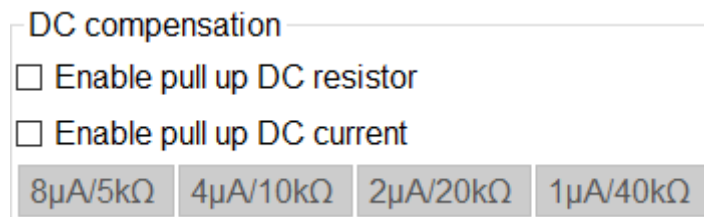


Figure 4-51: DC Compensation

Example:

Make sure the device is connected (with a green **“Connect”** status box). If not, click the **Connect** button.

Step 1. Select wake-up key = Key 4, Key5, Key6.

Step 2. Select internal capacitance = 40pF.

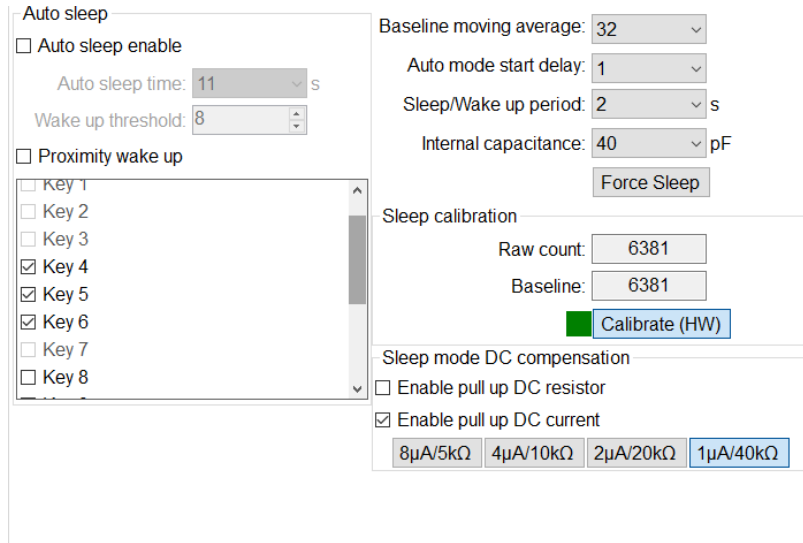
Step 3. Enable pull up DC current by selecting the checkbox and click **1uA/40kΩ**.

Step 4. Click **Apply**.

Step 5. Click **Calibrate (HW)**, raw count = 6381.

Step 6. Click **Calibrate (HW)** again to stop calibration.

Case 4: Sleep calibration raw count = 6381 without finger touch when Internal cap = 40pF, DC current = 1uA



Auto sleep

Auto sleep enable

Auto sleep time: 11 s

Wake up threshold: 8

Proximity wake up

- Key 1
- Key 2
- Key 3
- Key 4
- Key 5
- Key 6
- Key 7
- Key 8

Baseline moving average: 32

Auto mode start delay: 1

Sleep/Wake up period: 2 s

Internal capacitance: 40 pF

Force Sleep

Sleep calibration

Raw count: 6381

Baseline: 6381

Calibrate (HW)

Sleep mode DC compensation

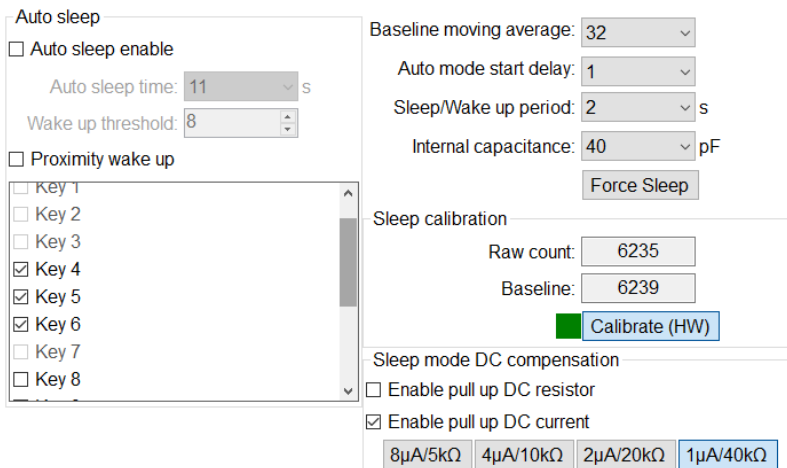
Enable pull up DC resistor

Enable pull up DC current

8μA/5kΩ 4μA/10kΩ 2μA/20kΩ 1μA/40kΩ

Figure 4-52: Sleep Calibration case 4

Case 5: Sleep calibration raw count = 6235 with finger touch when Internal cap = 40pF, DC current = 1uA



Auto sleep

Auto sleep enable

Auto sleep time: 11 s

Wake up threshold: 8

Proximity wake up

- Key 1
- Key 2
- Key 3
- Key 4
- Key 5
- Key 6
- Key 7
- Key 8

Baseline moving average: 32

Auto mode start delay: 1

Sleep/Wake up period: 2 s

Internal capacitance: 40 pF

Force Sleep

Sleep calibration

Raw count: 6235

Baseline: 6239

Calibrate (HW)

Sleep mode DC compensation

Enable pull up DC resistor

Enable pull up DC current

8μA/5kΩ 4μA/10kΩ 2μA/20kΩ 1μA/40kΩ

Figure 4-53: Sleep Calibration case 5

4.6 Slider

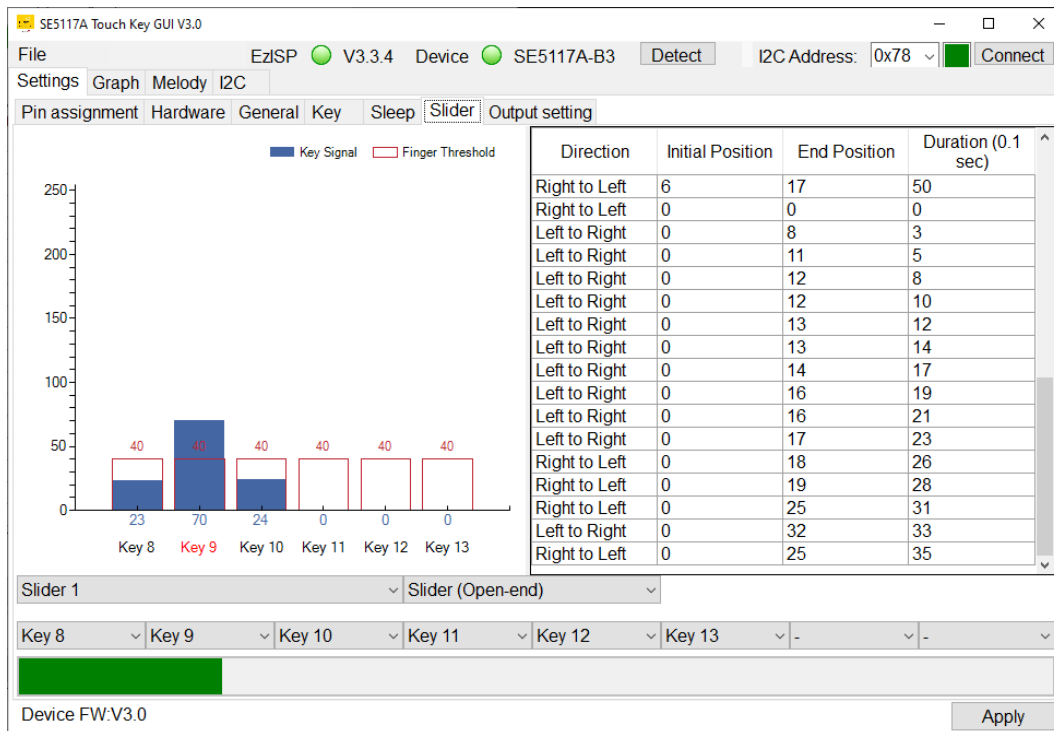


Figure 4-54: Slider Page

Users can switch the order of the selected keys based on needs.

IS31SE5117A EvB can support linear slider and wheel slider as below figures.

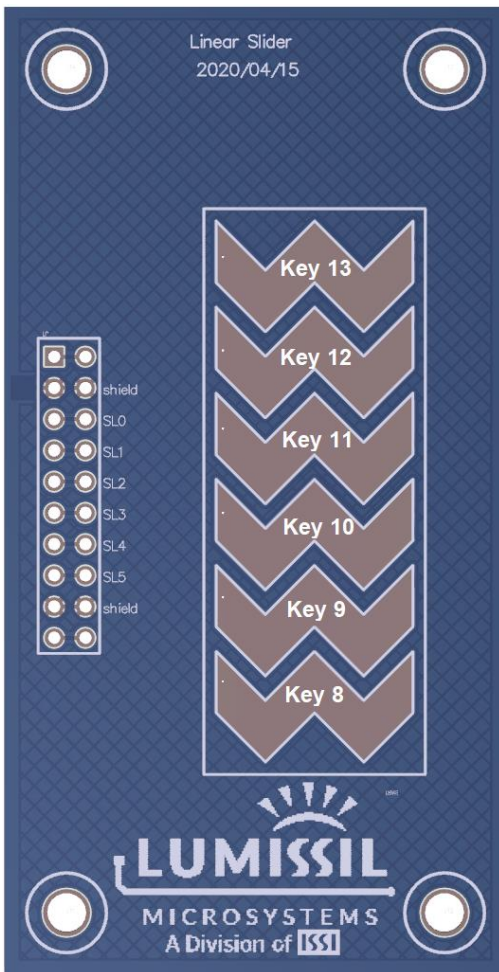


Figure 4-55: Open end Linear Slider

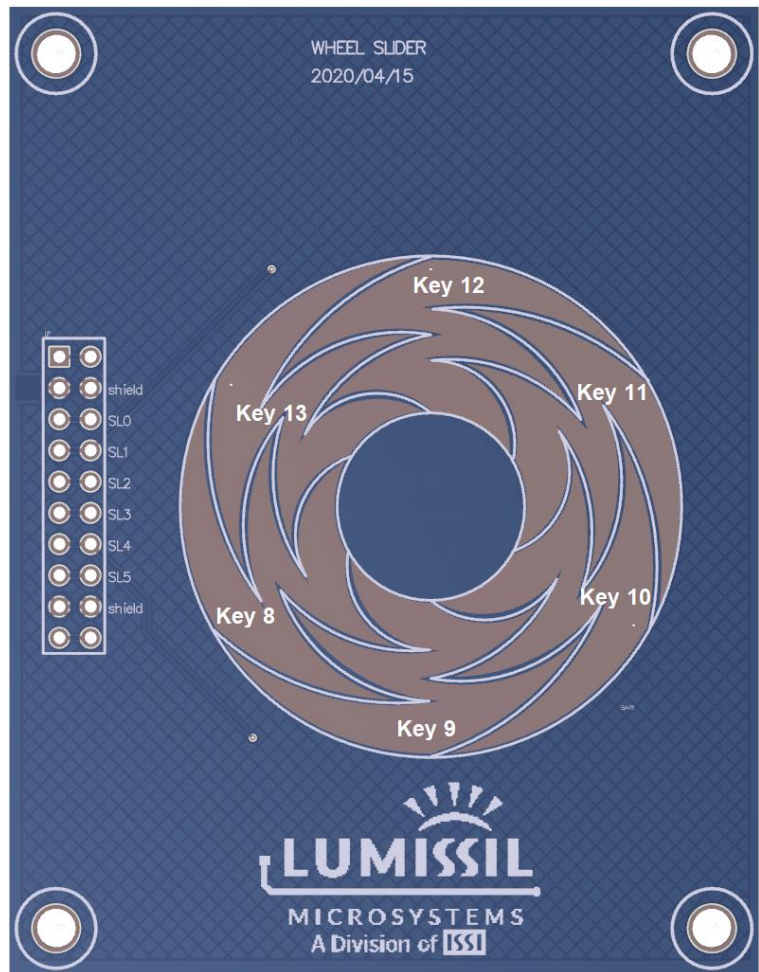


Figure 4-56: Closed end Wheel Slider

Users might need to modify key finger threshold to pass calibration. Key finger threshold can be modified as below figure. Remember to click **Apply** to make the setting valid.

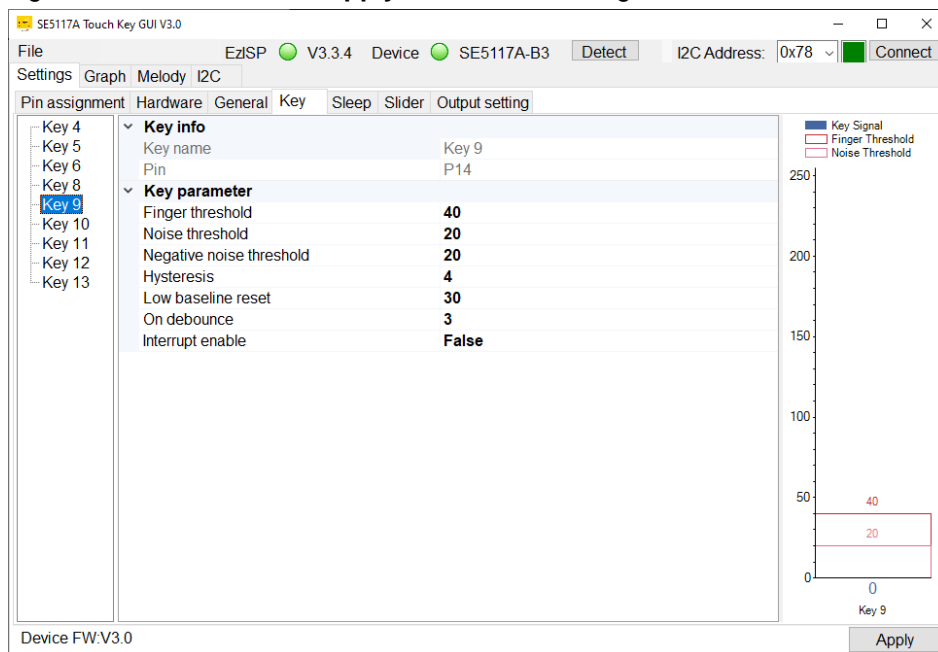


Figure 4-57: Key Setting Page

4.7 Output setting

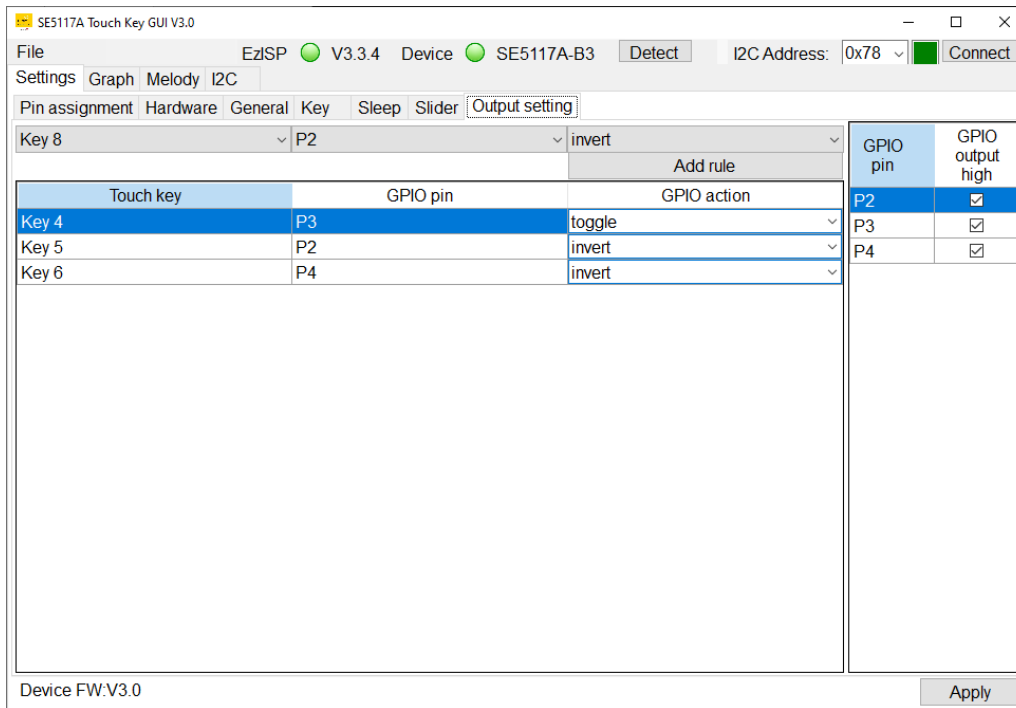


Figure 4-58: Output Setting Page

4.7.1 Add GPIO rule

Users can click “**Add rule**” and select Key x, Px and invert/toggle settings to add more Key setting as below figure highlighted in red. Key x is the key number in IS31SE5117A EvB or daughter boards. Px is the pin number of SE5117A IC part. Remember to click **Apply** to save the setting.

In case users need to remove some **Add rule** like for Key 9, select the whole Key 9 row in blue color as below figure and press “**delete**” key of the keyboard.

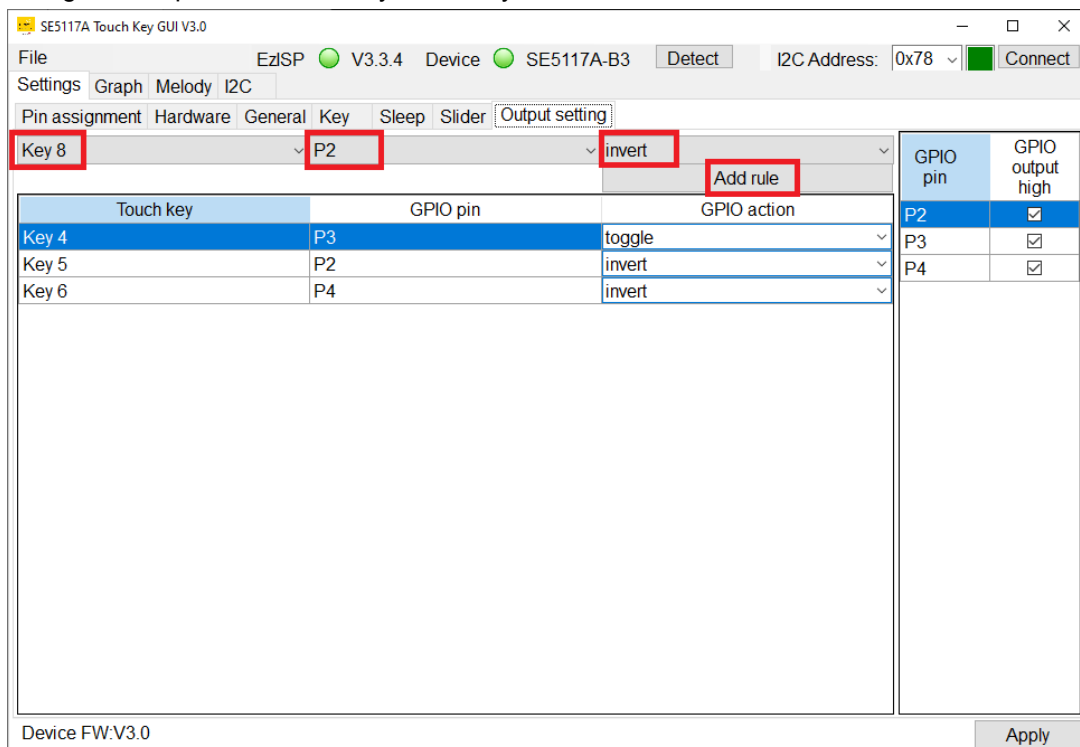


Figure 4-59: Add and remove rule for Output setting

4.7.2 GPIO setting

When Key 4 is set "toggle", the LED 2 on the top of Key 4 will turn on and keep on until Key 4 is triggered again. Then the LED 2 will turn off. When Key 4 is set "invert", the LED 2 will turn on and then off when Key 4 is triggered. LED 1~3 can be configured for different Keys based on the setting rule. Please refer below figure.



Figure 4-60: Key 4~6 and LED 1~3

When "GPIO output high" is enabled, the default GPIO output is HIGH and the corresponding LED will be OFF. If "GPIO output high" is disabled, the GPIO output is LOW and the corresponding LED will be ON.

GPIO pin	GPIO output high
P2	<input checked="" type="checkbox"/>
P3	<input checked="" type="checkbox"/>
P4	<input checked="" type="checkbox"/>

Figure 4-61: GPIO output high setting

5. GRAPH

As shown in **Figure 5-1** below, Line Chart is the KEY value curves to show the current value of KEY8~KEY13. The historical value of KEYS will be checked by pulling the scroll bar. Users can uncheck the key enable box at the higher right corner of Line chart content to remove the unwanted key information.

Reset baseline: Click this button and baseline will be replaced by raw count.

I2C sync: If the option is enabled, baseline and raw count will be synchronized.

GUI polling period: Default is 50ms. It can be increased or decreased by 10ms per click.

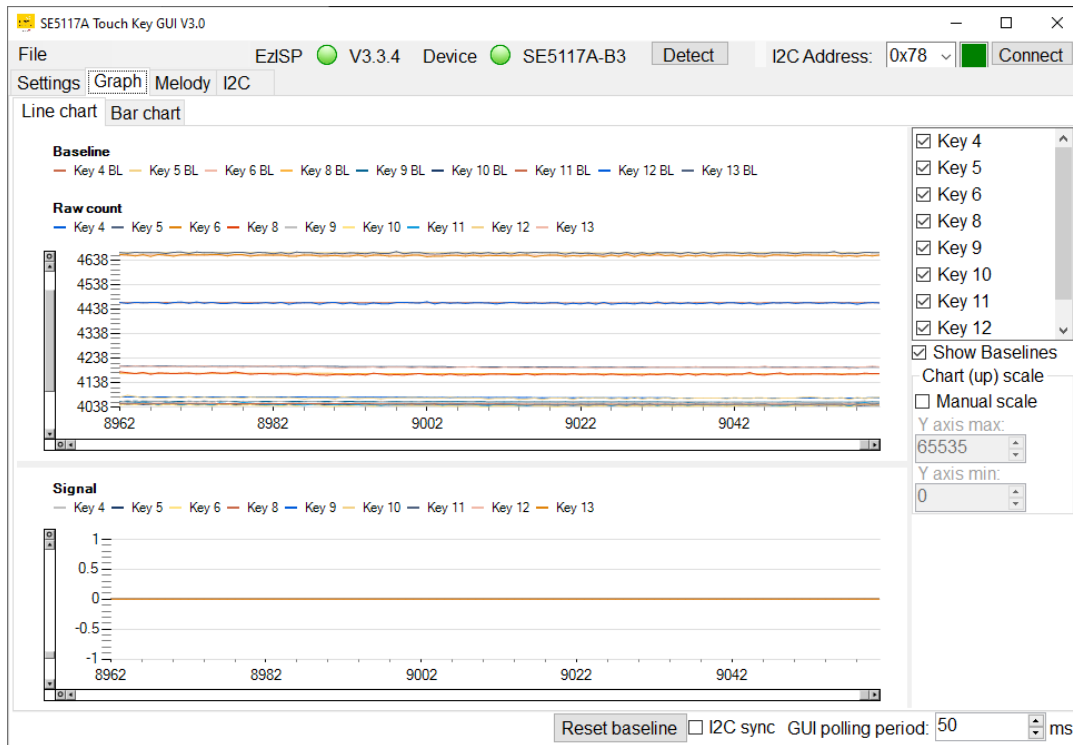


Figure 5-1: Graph Line Chart

As shown in **Figure 5-2** below, Bar Chart is to show the current signal value of KEY8~KEY13. Red color on Key 8 means the device has detected a finger touch on Key 8.

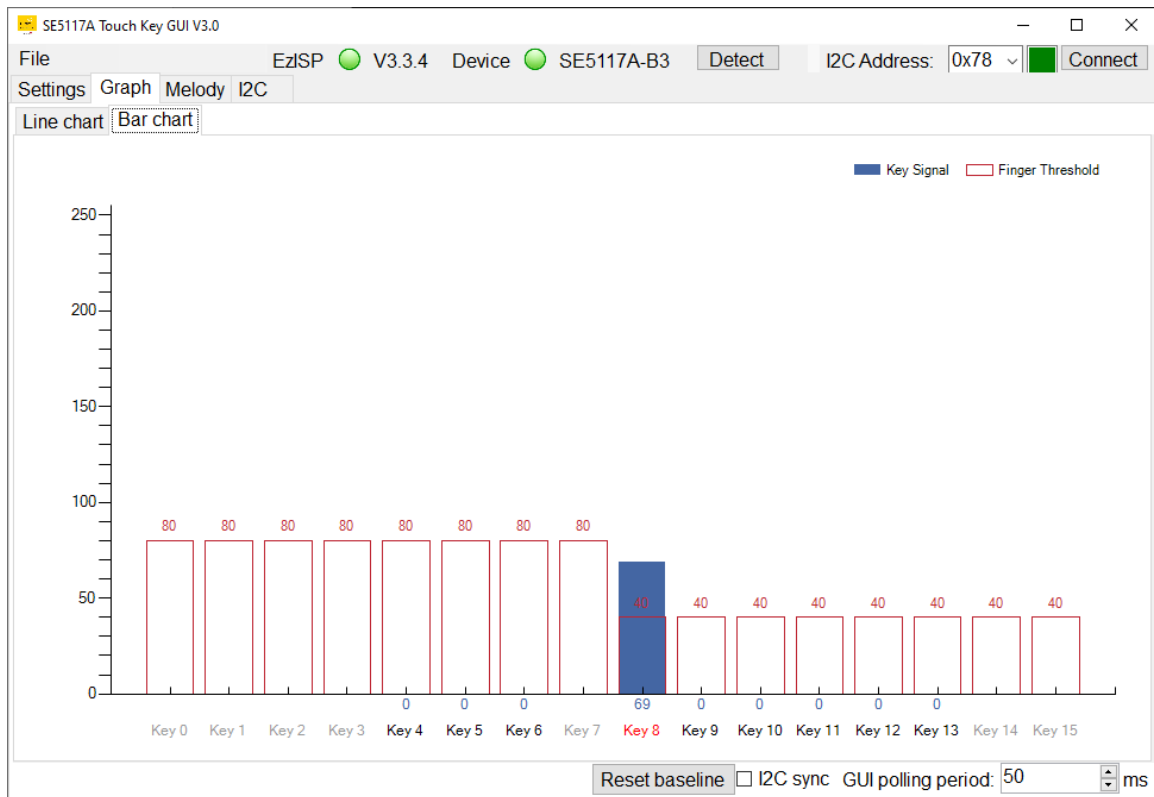


Figure 5-2: Graph Bar Chart

6. MELODY

As shown in **Figure 6-1** below, the built-in melody function has 10 FIFOs, and the host controller can send the melody data up to 10 notes.

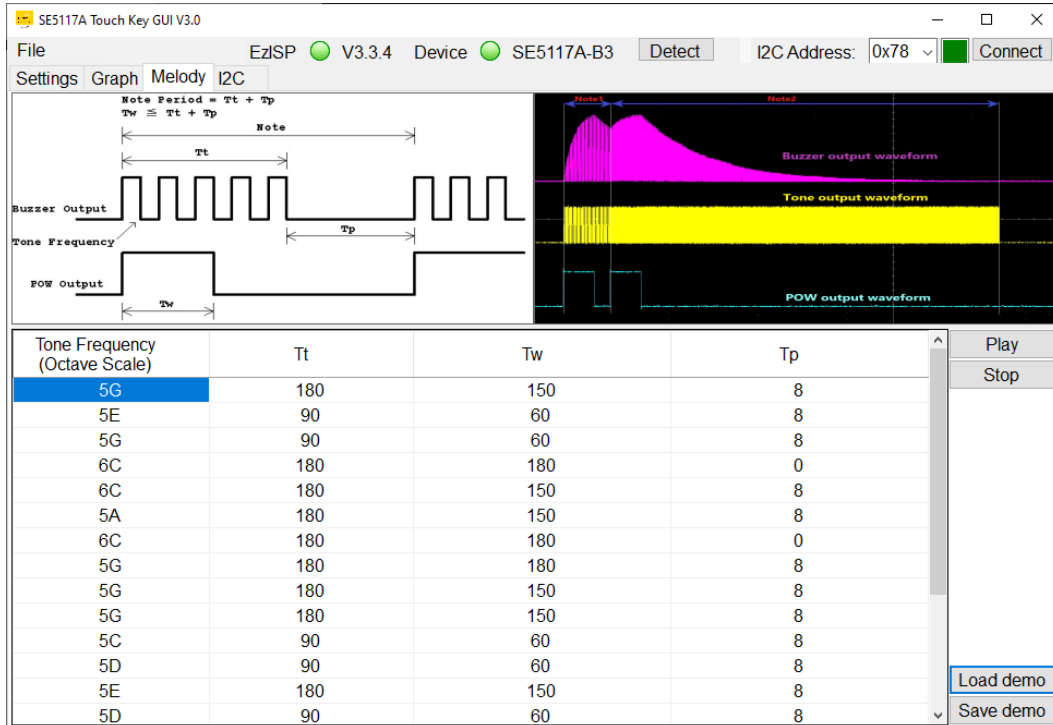


Figure 6-1: Melody Page of GUI

Support scale from 3A to 8G#

Frequencies for equal-tempered scale, A4 = 440 Hz "Middle C" is C4												
	3	freq	divisor	freq error	4	freq	divisor	freq error	5	freq	divisor	freq error
C					3	261.6	1911	0.01%	15	523.3	956	-0.05%
C#					4	277.2	1804	-0.01%	16	554.4	902	-0.01%
D					5	293.7	1703	-0.02%	17	587.3	851	0.04%
D#					6	311.1	1607	0.00%	18	622.3	804	-0.06%
E					7	329.6	1517	-0.01%	19	659.3	758	0.06%
F					8	349.2	1432	-0.02%	20	698.5	716	-0.02%
F#					9	370.0	1351	0.03%	21	740.0	676	-0.05%
G					10	392.0	1276	-0.04%	22	784.0	638	-0.04%
G#					11	415.3	1204	-0.01%	23	830.6	602	-0.01%
A	0	220.0	2273	-0.01%	12	440.0	1136	0.03%	24	880.0	568	0.03%
A#	1	233.1	2145	0.01%	13	466.2	1073	-0.04%	25	932.3	536	0.05%
B	2	246.9	2025	-0.01%	14	493.9	1012	0.04%	26	987.8	506	0.04%

	6	freq	divisor	freq error	7	freq	divisor	freq error	8	freq	divisor	freq error
C	27	1046.5	478	-0.05%	39	2093.0	239	-0.05%	51	4186.0	119	0.37%
C#	28	1108.7	451	-0.01%	40	2217.5	225	0.21%	52	4434.9	113	-0.23%
D	29	1174.7	426	-0.08%	41	2349.3	213	-0.08%	53	4698.6	106	0.39%
D#	30	1244.5	402	-0.06%	42	2489.0	201	-0.06%	54	4978.0	100	0.44%
E	31	1318.5	379	0.06%	43	2637.0	190	-0.21%	55	5274.0	95	-0.21%
F	32	1396.9	358	-0.02%	44	2793.8	179	-0.02%	56	5587.7	89	0.54%
F#	33	1480.0	338	-0.05%	45	2960.0	169	-0.05%	57	5919.9	84	0.55%
G	34	1568.0	319	-0.04%	46	3136.0	159	0.28%	58	6271.9	80	-0.35%
G#	35	1661.2	301	-0.01%	47	3322.4	150	0.33%	59	6644.9	75	0.33%
A	36	1760.0	284	0.03%	48	3520.0	142	0.03%				
A#	37	1864.7	268	0.05%	49	3729.3	134	0.05%				
B	38	1975.5	253	0.04%	50	3951.1	127	-0.36%				

I2C command format (Each note is composed of 4-byte data and the incomplete note will be ignored.)

0x78, 0xF0, (scale_id, Tt, Tw, Tp), (scale_id, Tt, Tw, Tp),

0x78, 0xF0, 0xFF Stop the melody play and clear the FIFO

0x78, 0xF0 Set the register no. to 0xF0

0x79 Read FIFO remaining length

Scale ID 0 is 3A, 1 is 3A#, 2 is 3B

The range of Tt, Tw and Tp is from 0 to 255 and each value increase refers to a 4 ms increase.

7. I2C COMMUNICATION

In the blue highlighted rectangular box for “**Command list**” in **Figure 7-1**, users can issue I2C commands to the EvB. On the GUI right-hand side, choose to **Send**, **Clear**, **Save** and **Load**. I2C command set can be composed of several bytes. These bytes can be separated by space or comma. I2C command set can be terminated by a line wrap.

As shown in the red highlighted rectangular box on the right bottom, you can choose to save or clear the data log after the I2C command is issued. The data Log content is under the “**Command list**” box. The green highlighted rectangular box on the right middle indicates the delay time setting between each command and the delay setting range is 10ms~1000ms.

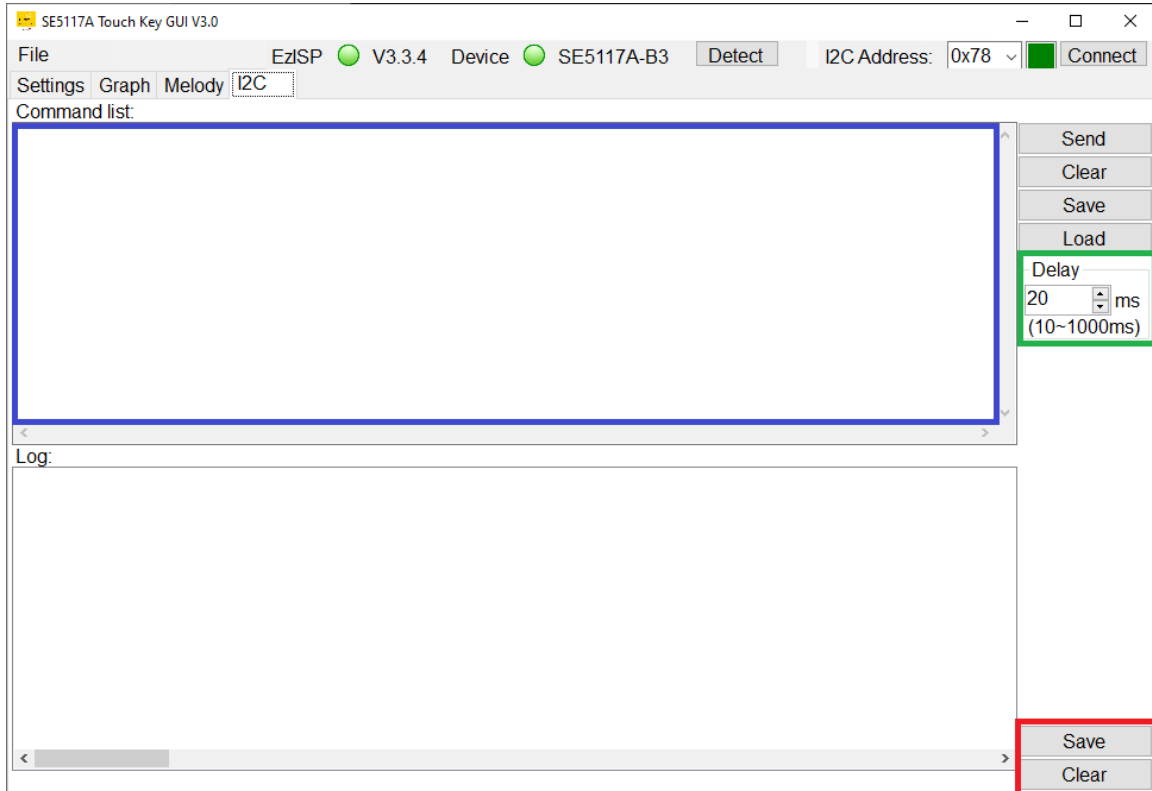


Figure 7-1: I2C Communication Page of GUI

7.1 I2C Communication Example (Touch Key)

Command list:

78 06 0A 3C	Write data 0x0A to register no. 06
	Write data 0x3C to register no. 07
78 06	Write register no. 06
79	Read data from register no. 06
78 07	Write register no. 07
79	Read data from register no. 07

Log list:

22:16:45:170	>>	78 06 0A 3C	Write data 0x0A to register no. 06
			Write data 0x3C to register no. 07
22:16:45:197	>>	78 06	Write register no. 06
22:16:45:218	<<	0A	Read data from register address 06
22:16:45:238	>>	78 07	Write register no. 07
22:16:45:238	<<	3C	Read data from register address 07

Note:

All the expressed number will be treated as hex, i.e., 0x16 is 22 in decimal.

Only one byte data can be read at one command.

8. Safety Self-Test

Lumissil built a set of library functions to support IEC60730-1 Class B Self-Test Library (STL) which is for MCU self-test according to the requirements of IEC60730-1 Standard Annex H and the hardware resources of MCU itself. Through the MCU self-test, the reliability and security of the system operation can increase.

Lumissil provides a sample code containing Self-Test Library to help software developers better understand STL and accelerate the development of products that require IEC60730-1 certification. Developers can refer to the usage of STL and integrate it into their own projects.

SE5117A Touch Key GUI 3.0 provides SE5117A Safety Self-Test items for function verification in addition to Touch Key function support. For detailed Safety Self-Test application, please refer to Lumissil's IEC60730-1 ClassB STL Application Note for 8 bit MCU.pdf.

8.1 Safety Self-Test

Click the **Safety Self-Test** from the **File** drop-down menu as below Figure 8-1.

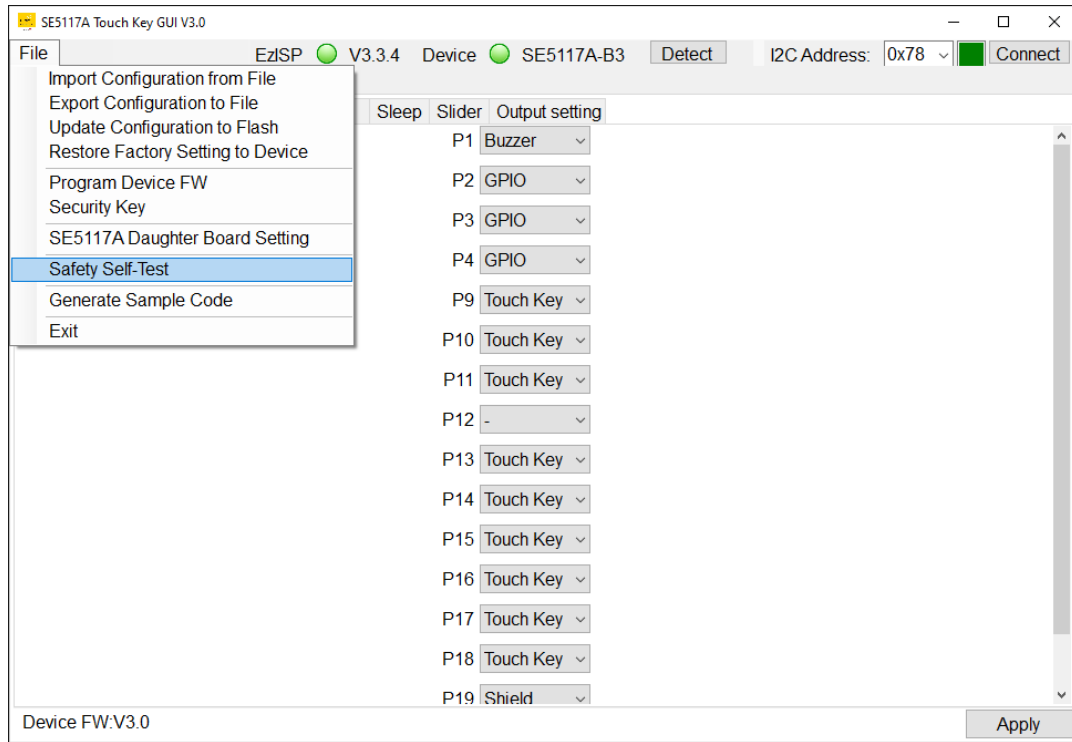


Figure 8-1: Safety Self-Test

Below **Safety Self-Test** window will pop out and the above SE5117A Touch Key GUI “**Connect**” status will turn yellow color. **User needs to click “Connect” button again. The connect status will turn green color and Safety Self-Test can be performed.**

When the user chooses any test item, the bottom box of the Safety Self-Test window will provide detailed information for the selected test item. For example, a CPU test item is selected and there is CPU register test information in the message box at the bottom. And CPU test will start.

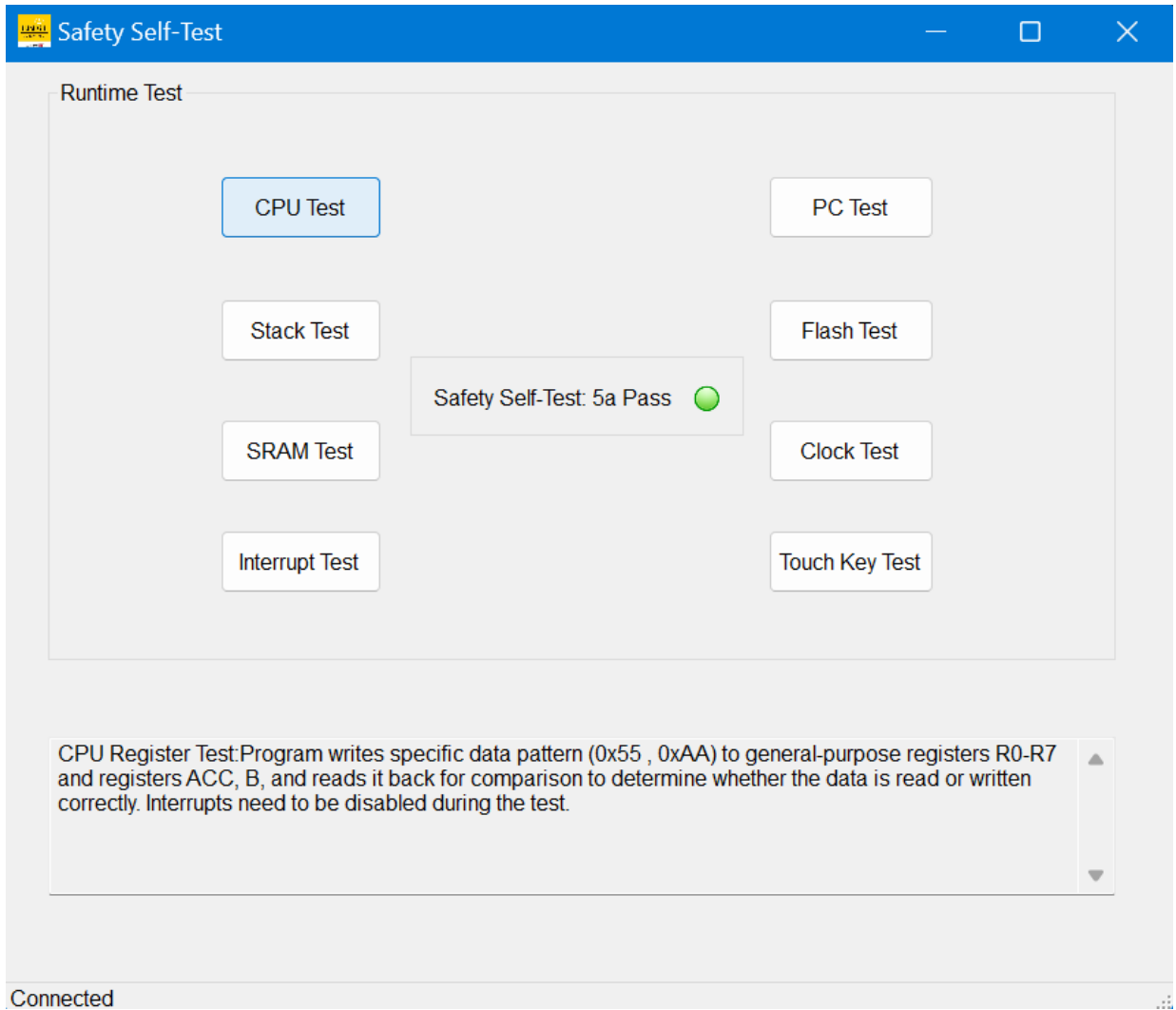


Figure 8-2: Safety Self-Test options

If the selected test item passed, then user would see “**Safety Safe-Test :5a Pass**” with green color status as above figure. If the test fails, “**Safety Safe-Test :1 Fail**” status will come with red color.

For the default setting, the Flash test and SRAM test will test the whole memory space at one time, and it will take a long time. If the user wants to reduce the testing time, the memory space can be split into continuous segments, and perform testing based on the inquiry.

8.2 Safety Self-Test

Below is Safety Self-Test Command and Address table for your reference.

Address	Name	Definition of Parameters		R/W	Default Value
0x9C	Self-Test command	CPU	0x01	R/W	0x00
		PC	0x02		
		Stack	0x03		
		Flash*	0x04		
		SRAM*	0x05		
		Clock	0x06		
		Interrupt	0x07		

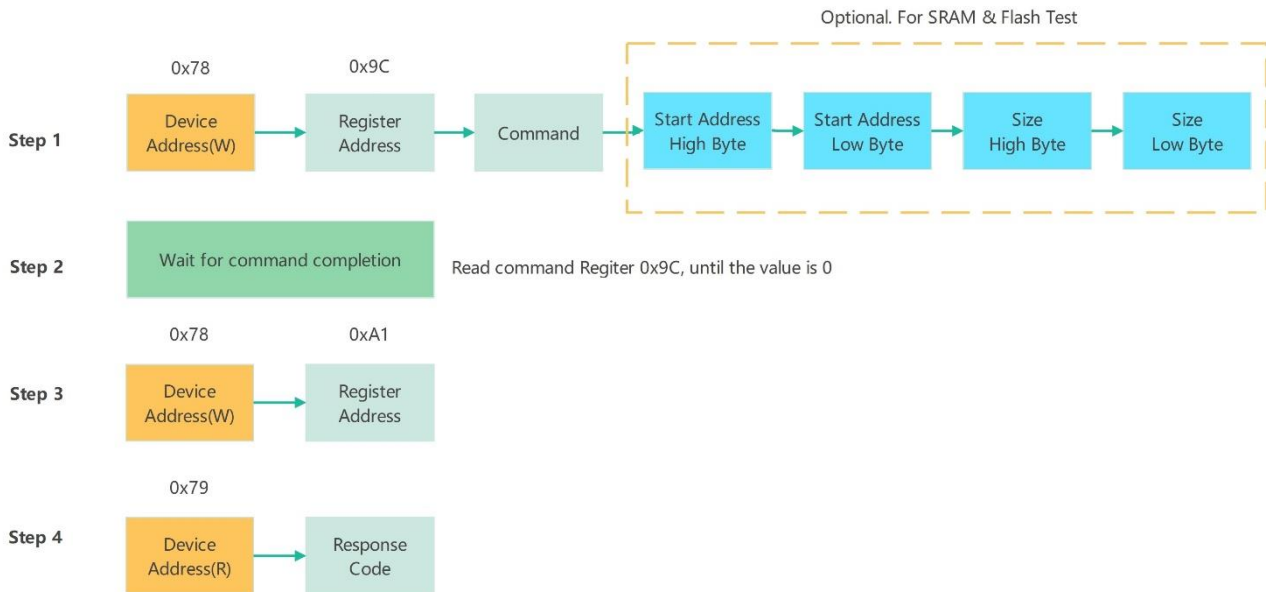
		Touch Key	0x08		
0x9D	Start address of Flash and SRAM	Start address high byte	/	W	
0x9E		Start address low byte			
0x9F	Test size of Flash and SRAM	Test size high byte			
0xA0		Test size low byte			
0xA1	Self-Test result	Pass	0x5A	R	
		Fail	0x01		

* Start address and test size of Flash and SRAM are defined at addresses 0x9D - 0xA0.

Safety Self-Test Command & Address Table

Type	Min. Start Address	Max. End Address	Max. Size
SRAM	0x0008	0x7BF	0x7B8
FLASH	0x0000	0x6FF7	0x6FF8

Below are 4 steps to place a self-test command and get the test result.



User can refer to following sample code for Flash Self-Test.

Flash test example

```
=====
Device address : 0x78
Start address  : 0x0000
Size          : 0x6FF8
```

I2C command sequence

```
-----
// switch to page 0
0x78, 0x06, 0x00

// write command, start address high byte, start address low byte,
// test size high byte and test size low byte.
0x78, 0x9C, 0x04, 0x00, 0x00, 0x6F, 0xF8

// Wait command completion, repeat read the value of register 0x9C, until the value is zero.
// set address of command (0x9C)
0x78, 0x9C
// Read result
0x79

// check if the value is 0, if not, repeat to read 0x9C.
// if the value is 0, continue to the next step.

// set address of result (0xA1)
0x78, 0xA1
```

```
// Read the result  
0x79
```

```
// check the result  
// if the result value is 0x5a, test passed.  
// if the result value is 0x01, test failed.
```

9. DEBUG TARGET BOARD VIA GUI SOFTWARE

9.1 Connection Block Diagram

As shown in **Figure 9-1** below, the EzISP board can be connected to the customer's target board to configure touch keys through the GUI interface.

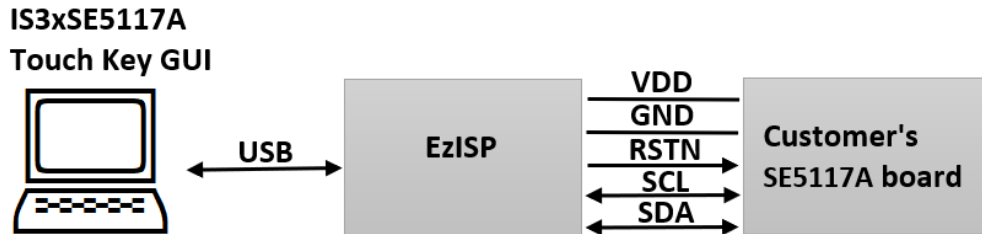


Figure 9-1: Block diagram of EzISP Board connection with the customer's target board

As shown in **Figure 9-2** below, the EzISP Board only needs five pins to connect to the customer's target board. The five pins are VCC, GND, RSTN, SCL, and SDA.



Figure 9-2: Pin configuration on EzISP board

9.2 Customer Target Board Configuration by GUI

Users can run SE5117A Touch Key GUI software on their own target board to adjust the parameters of the touch keys without having to develop code for the MCU at the beginning of evaluation. This tool can also shorten development time.

REVISIONS

Revision	Detailed Information	Date
A	First Formal Release	2020.09.20
B	Second Release with minor update	2020.10.25
C	Remove GUI 1.0 introduction and update with SE5117 Touch Key GUI 2.0 Add more descriptions for functions and registers	2021.12.20
D	<ol style="list-style-type: none"> Update Figure 1-1 Photo of IS31SE5117 Evaluation Board with v2.0 Update Figure 1-6 Schematics of IS31SE5117 Evaluation Board v2.0 Add Windows System Requirements at Section 2.1 Software Requirements for how to do EZISP software installation and requirements Remove Figure 2-2 Back view of IS31SE5117 EVB Update Figure 2-3 as Figure 2-2 Connection of IS31SE5117 Evaluation and EzISP board and the descriptions of step 2 of three-step setup of EzISP and IS31SE5117 EvB board at Section 2.1 Start up the GUI with EvB Add RSTN pin along with VDD, GND, SDC and SDL pins for EzISP board connecting with SE5117 board to run SE5117 Touch Key GUI tool. This description is at Section 8.1 Connection Block Diagram Fix some typos and reword content for clear descriptions Add EzISP support for Windows 11 in addition to Win XP, Vista, and Win 7 to Win 10 support Change file name from "IS31SE5117 Eval Board User's Manual" to "IS3xSE5117 Eval Board User's Manual" Add multiple key support for all Keys 	2022.12.30
E	<ol style="list-style-type: none"> Update to support SE5117A Touch Key GUI 3.0 Update Figure 1-1: Photo of IS31SE5117A Evaluation Board v2.0 to add indications for SW2 Writer Mode and SW3 ISP Mode Add more descriptions for "Detect" and "Connect" statuses handling in Section 3.2 Connect Status Change export/import Configuration File format from csv to excel. Please refer to 3.3 Export/Import Configuration File Add Section 3.8 Generate Sample Code Add 4.2.1 System Clock Add 4.2.3 TK3 Touch Key Clock Add information about system clock and duration per touch key scan in Section 4.2.2 Cycle Count Per Key Scan Add information about how spread spectrum affects IOSC frequency accuracy and EMI in Section 4.2.9 Spread Spectrum Add more information about Jitter, Media, Average, and IIR filters in Section 4.3.4 Raw Count Filter Add INT description for Multi-Key enable for Case 3. Click Interrupt Enable, Auto Clear Enable and Repeat Enable in Section 4.3.5 Interrupt For firmware 3.0, register 7 and register 8 need to be read to acquire key status, and interrupt will be clear after register 8 is read. Please refer to Case 1. Click Interrupt Enable of Section 4.3.5 Interrupt. For firmware 2.0, register 6 and register 7 need to be read to acquire key status and interrupt will be clear after register 7 is read Remove Slider calibration in Section 4.6 Slider and Figure 4.56: Slider Calibration Add Chapter 8 Safety Self-Test Change file name from "IS3xSE5117 Eval Board User's Manual" to "IS31SE5117A Eval Board User's Manual_E with Safety Self-Test" Add SE5117A EVB order information "IS31SE5117A-QFLS3-EBGUI" for new firmware 3.0 support 	2023.06.28

	17. Update <u>2.1 Software Requirements</u> to support Silabs USB driver version 6.7.2.0 and detailed EzISP setup steps and configuration after setup installation. Besides, update Windows software requirement of Microsoft .NET Framework 4.6.2 as Microsoft .NET Framework version 4.8	
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