IS31SE5118A EvB User Manual

Revision: C

Publication: June 28, 2023

1. HARDWARE ENVIRONMENT

1.1 Evaluation Board (EvB)

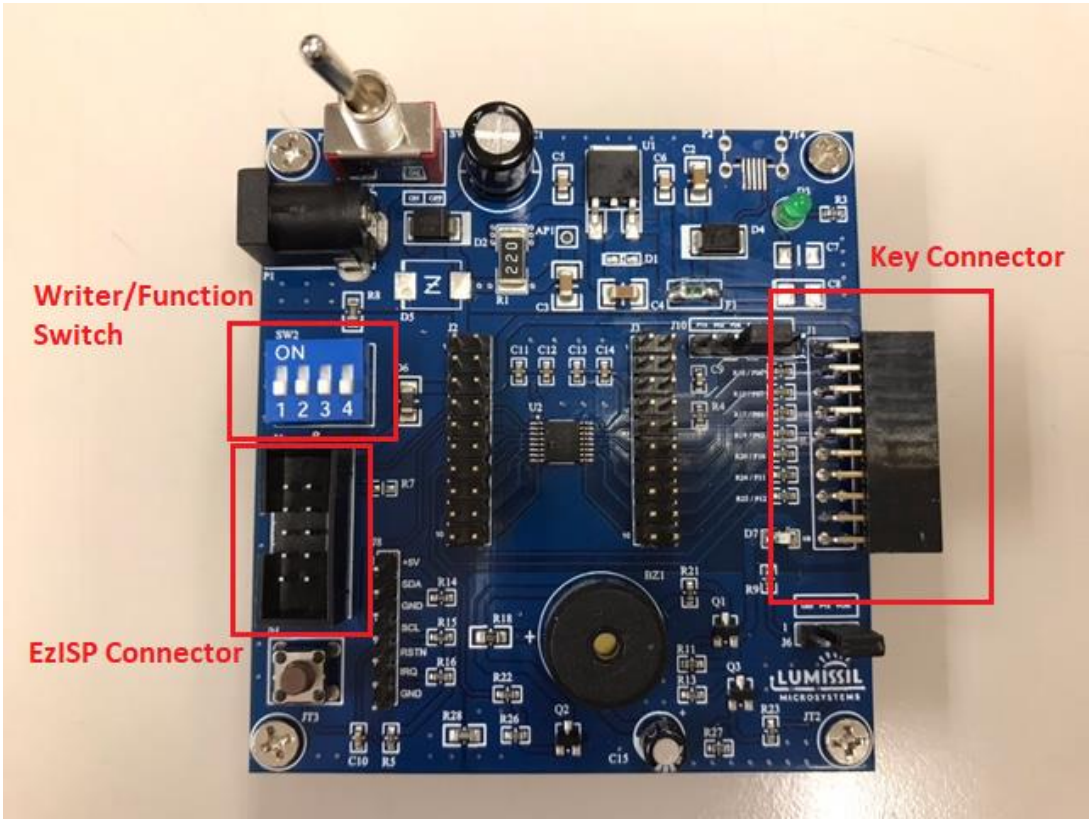


Figure 1-1: Photo of IS31SE5118A Evaluation Board

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

System Block Diagram

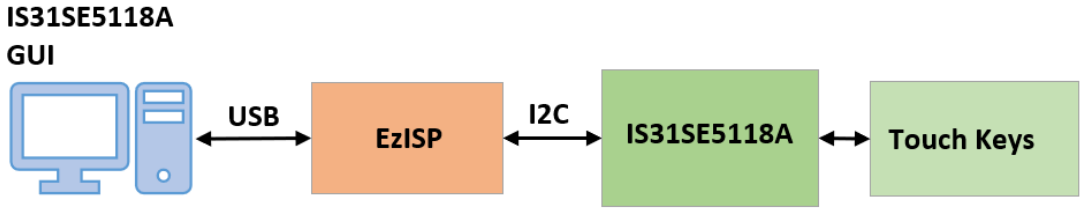


Figure 1-3: IS31SE5118A Evaluation Board Connection Block Diagram

1.2 Schematic of Evaluation Board

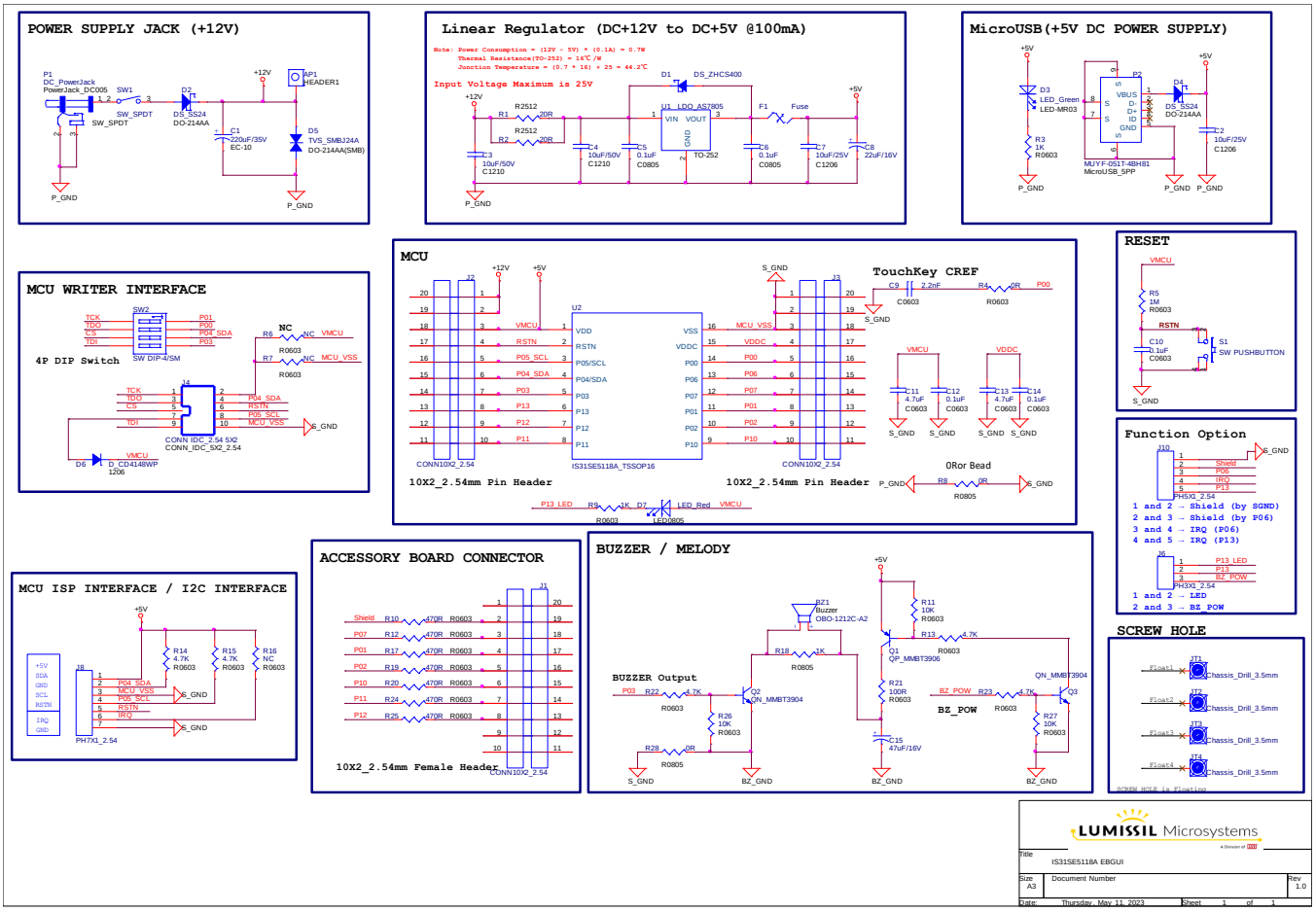


Figure 1-4: Schematic of IS31SE5118A Evaluation Board

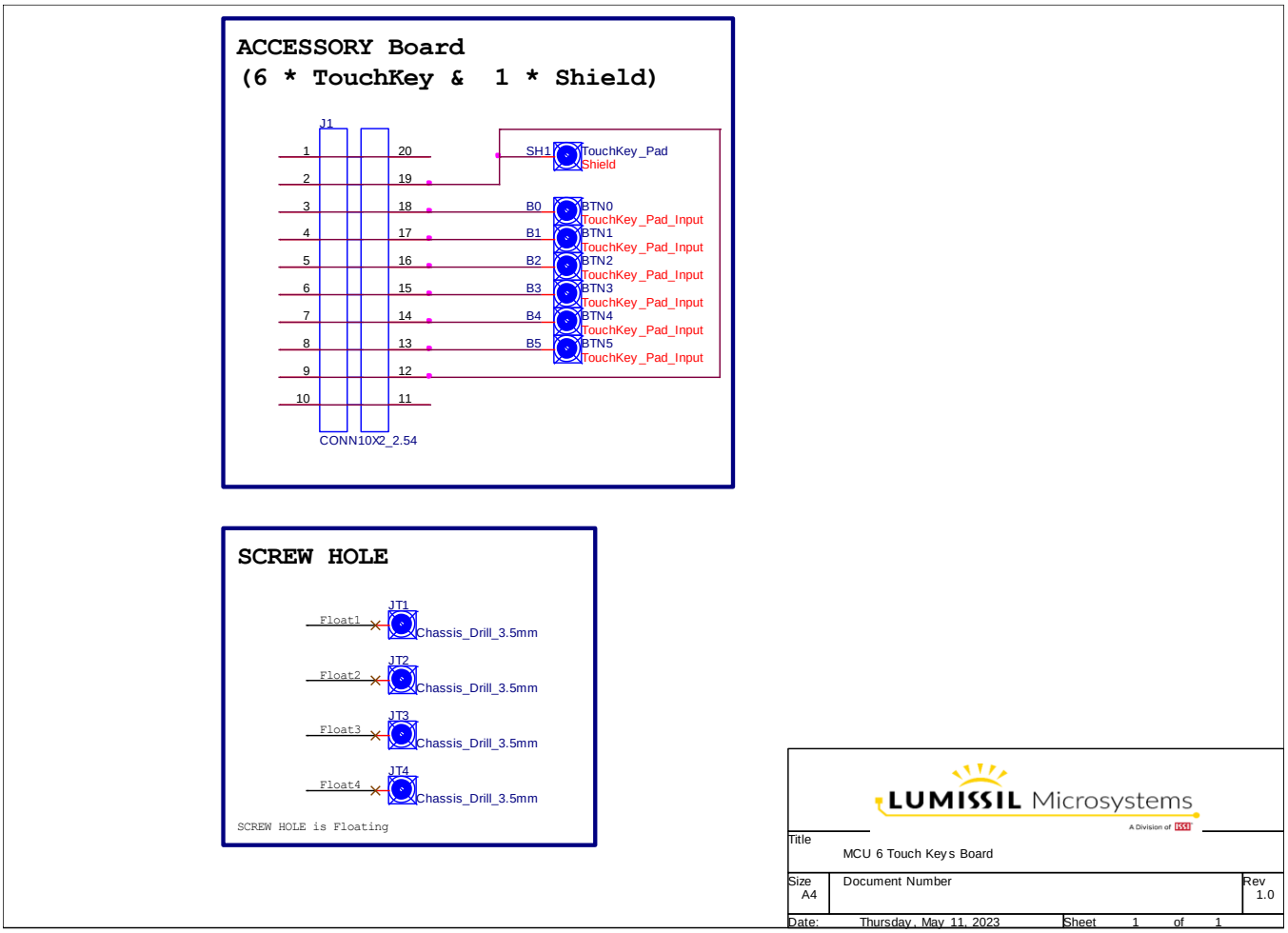


Figure 1-5: Schematic of Standard 6 Touch Key Board

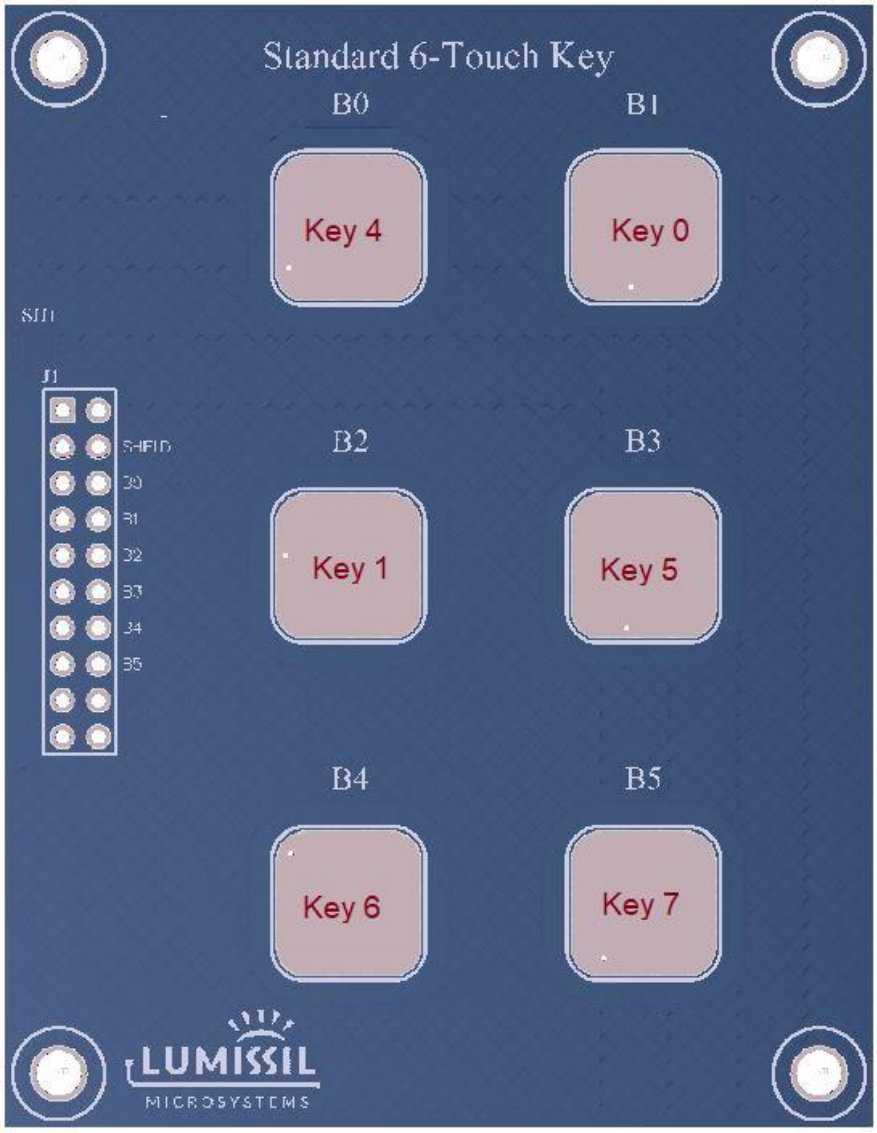


Figure 1-6: Key setting of Standard 6 Touch Key Board

1.3 ORDERING INFORMATION

Table 1: Ordering Information

Part No.	Temperature Range	Package
IS31SE5118A-ZNLS3-EBGUI	-40°C ~ +105°C	TSSOP-16, 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 SE5118A 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.

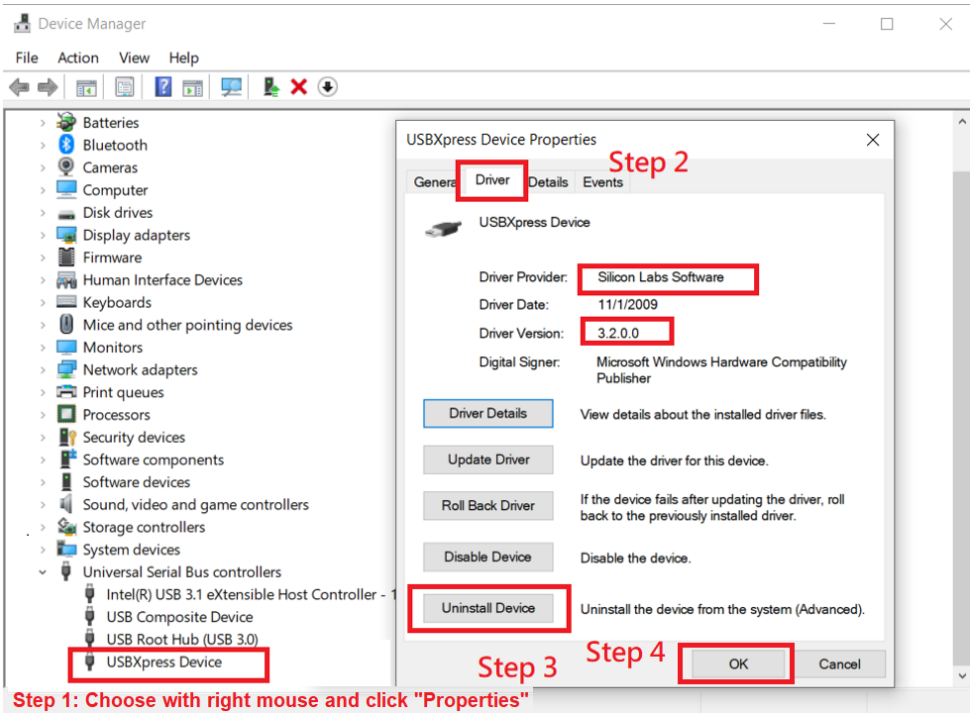
Figure 2-1: Photo of EzISP Board

Windows Software Requirements:

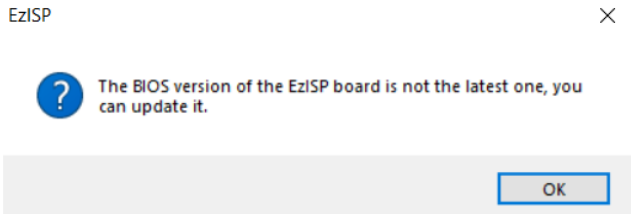
EzISP tool supports Win XP, Vista, Windows 7, Windows 8, Windows 10, and Windows 11. It is required that the Windows-based PC be installed with Microsoft .NET Framework 3.5, Microsoft .NET Framework 4.8, Microsoft Visual C++ 2008, and Silicon Labs' USB driver version 6.7.2.0. After running EzISP setup 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.

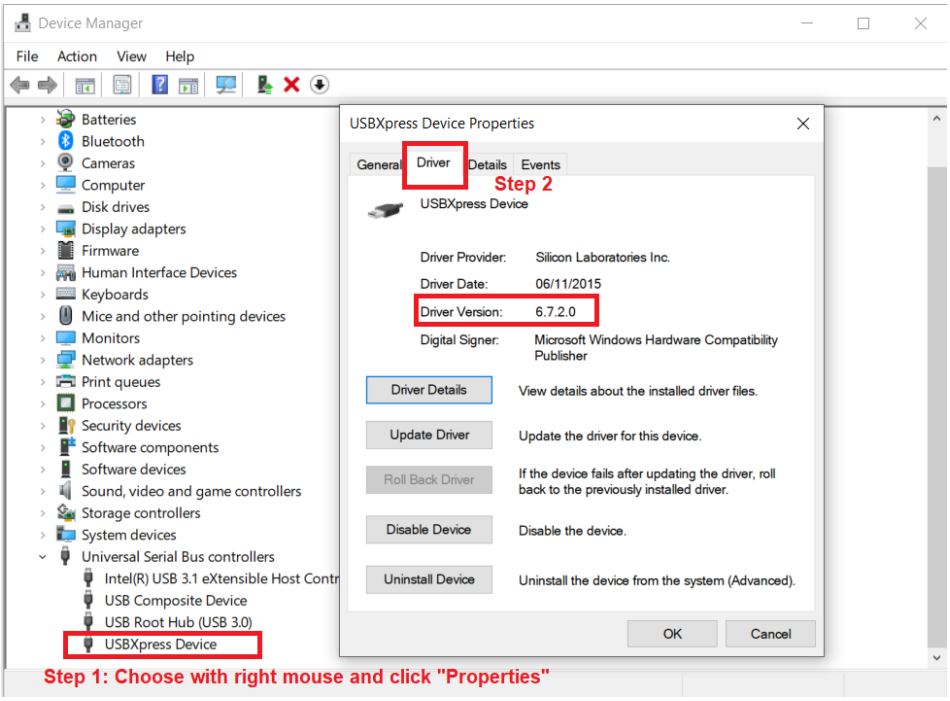
Step 1: For customers who have installed EzISP setup version earlier than 3.3.8 with Silicon Labs' USB driver version 3.2.0.0, USB driver version 3.2.0.0 needs to be uninstalled as the four steps in the below figure before installing the new EzISP setup version 3.3.8.



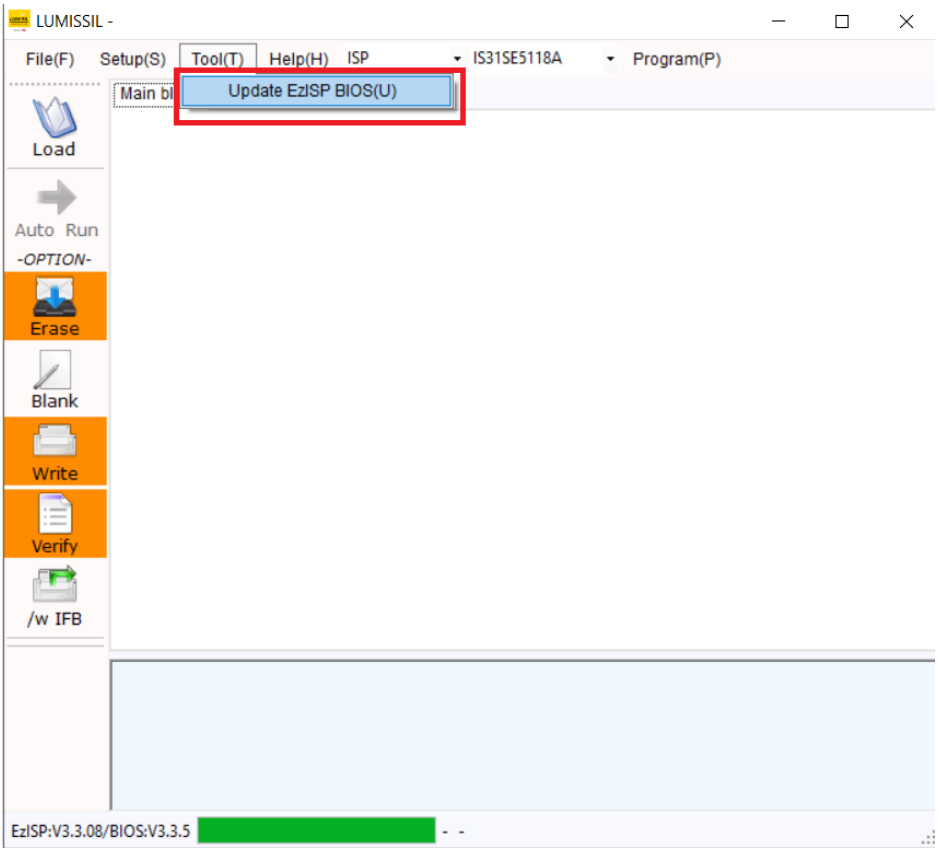
Step 2: Install EzISP setup program. After the installation is done and EzISP is run, users might get below pop-up message and please update with the newer BIOS as Step 3 ~ Step 7.



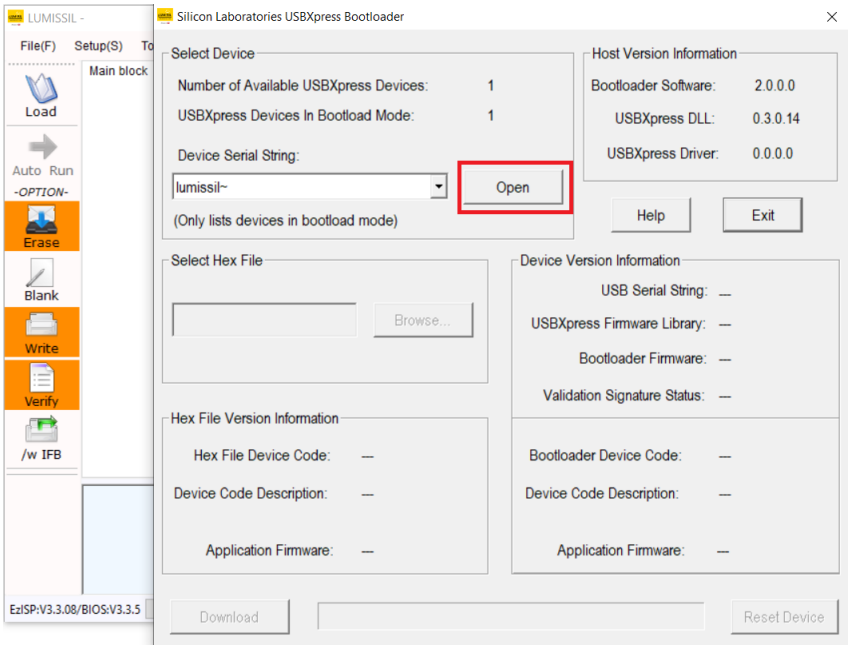
Users can check whether the Silicon Labs' USB driver version 6.7.2.0 is correctly installed or not as the two steps in the below figure.



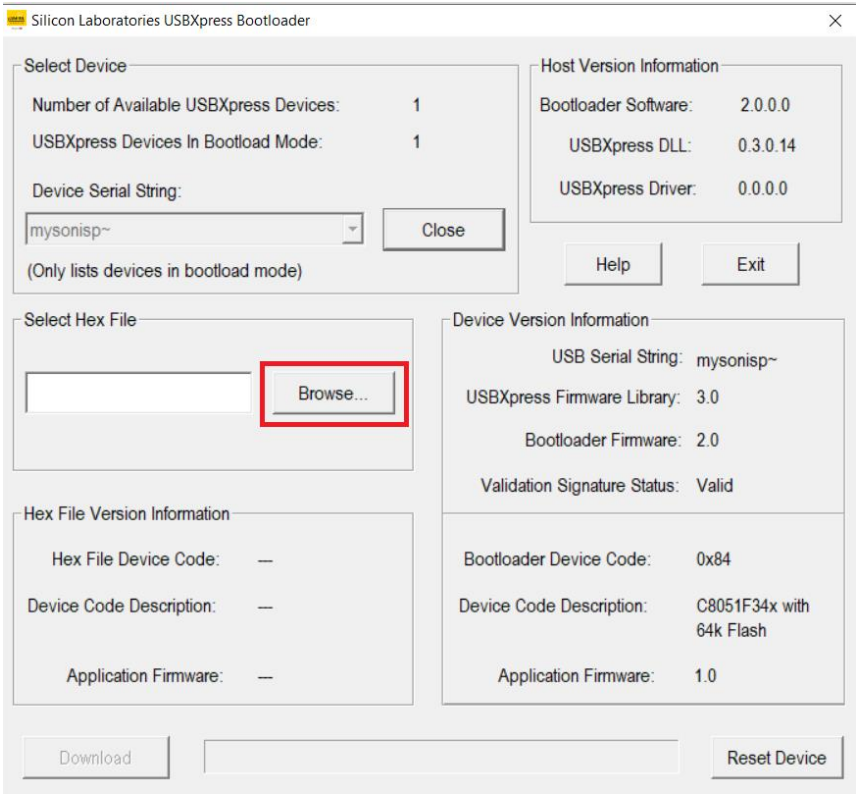
Step 3: Go to "**Tool(T)**" –> "**Update EzISP BIOS(U)**"



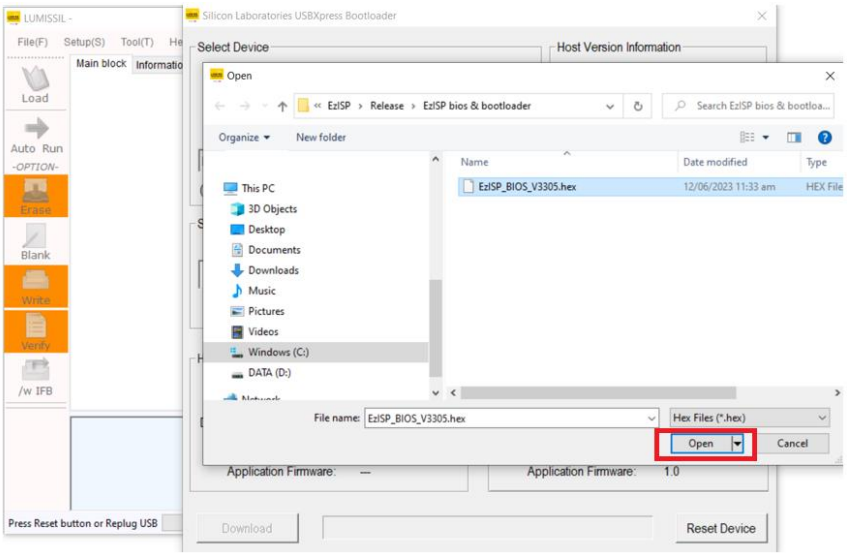
Step 4: Below figure pops out. Click "**Open**" button.



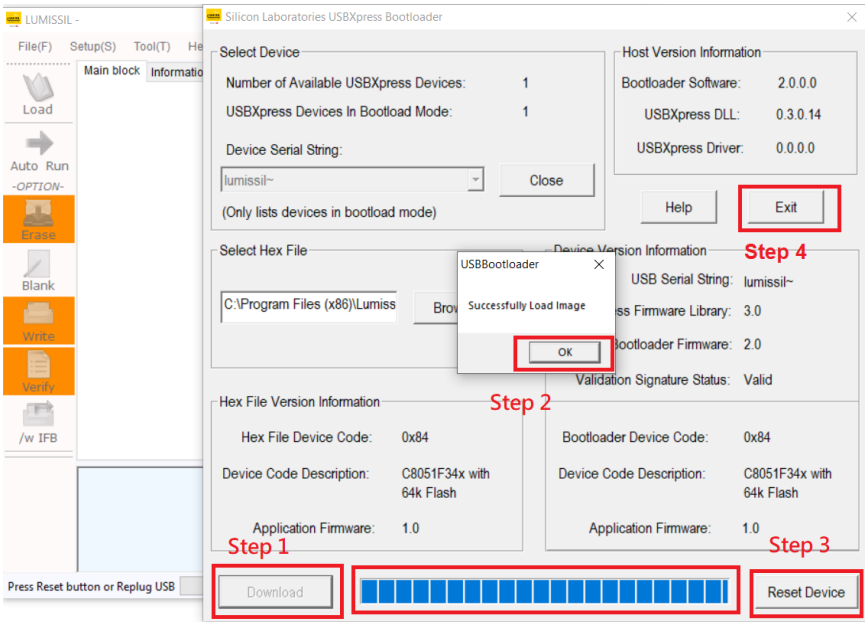
Step 5: Click "**Browse**" button.



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

Three-step setup (Please refer to **Figure 1-3** IS31SE5118A 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 on the EzISP Board to the connector S1 of the IS31SE5118A Evaluation Board.
3. Execute SE5118A Touch Key GUI program (file name: MC10_SE5118A_GUI_rev3.0.exe).

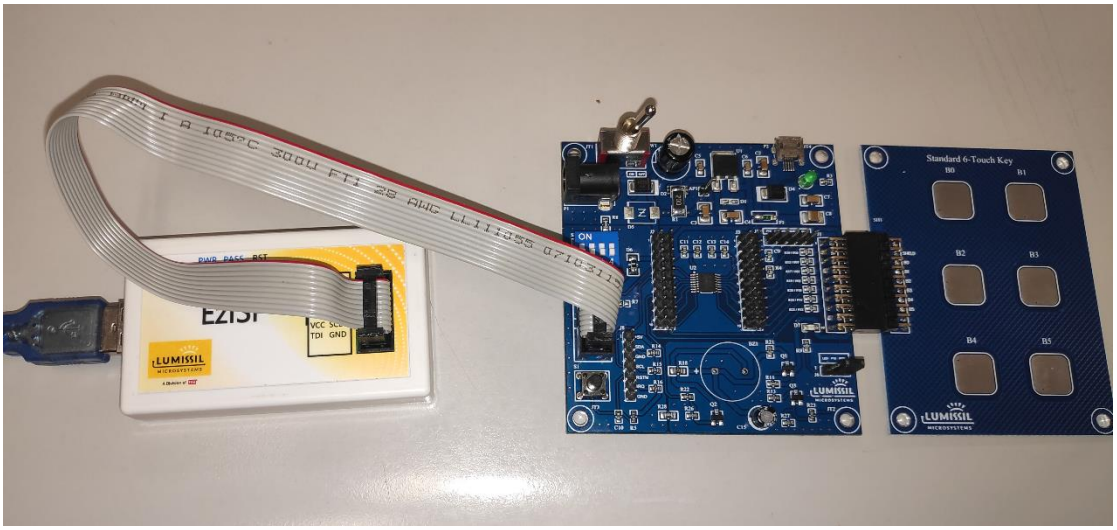


Figure 2-2: Connection of IS31SE5118A Evaluation Board and EzISP Board

Table 2: I2C Slave Address Definition

I2C Slave Address*	Write Command	Read Command
	0x78	0x79

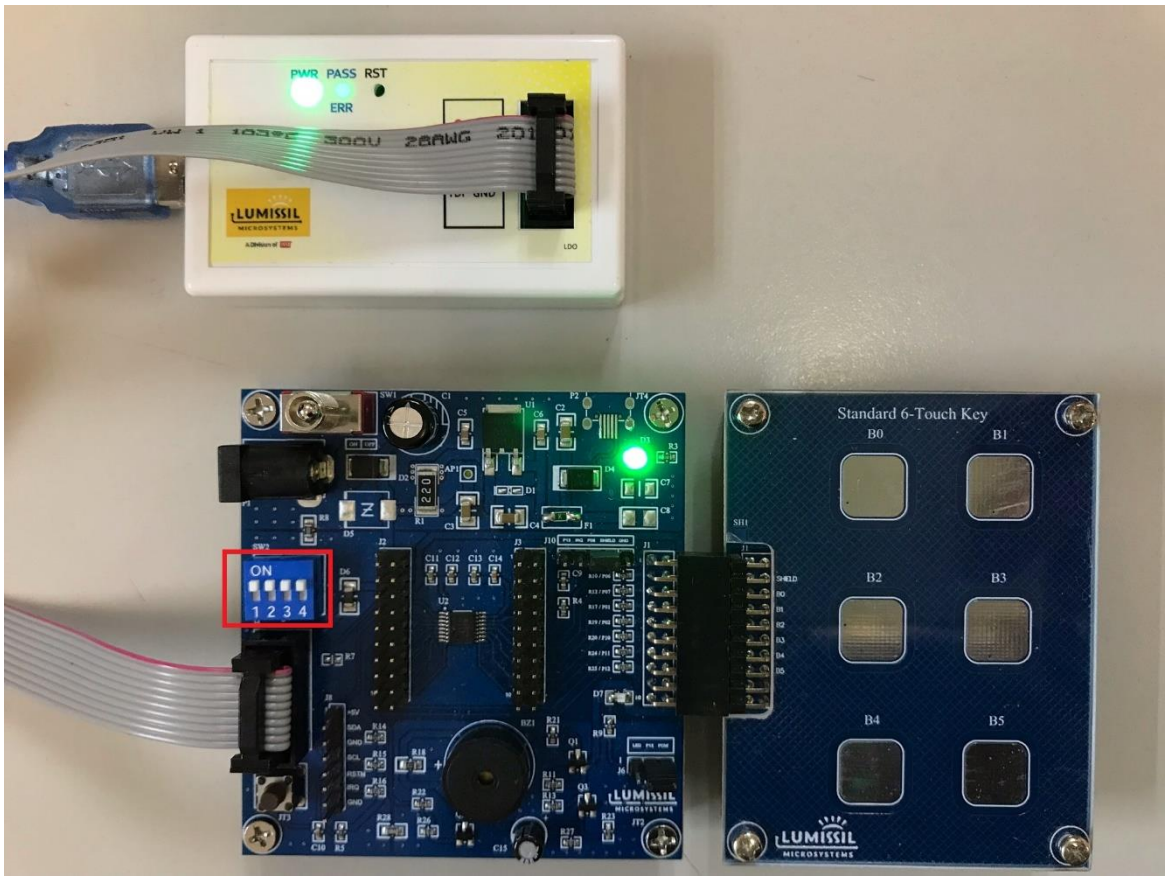
* I2C Slave Address: 7-bit Address + 1 bit(R/W)

2.3 Upgrade Boot Code and Standard Code

This section can help users to upgrade Boot code and Standard code of SE5118A EvB. In case, Boot code or Standard code of SE5118A EvB is ruined, users can follow the below 4 steps to program the code.

Step 1: Turn the DIP switch SW2 ON

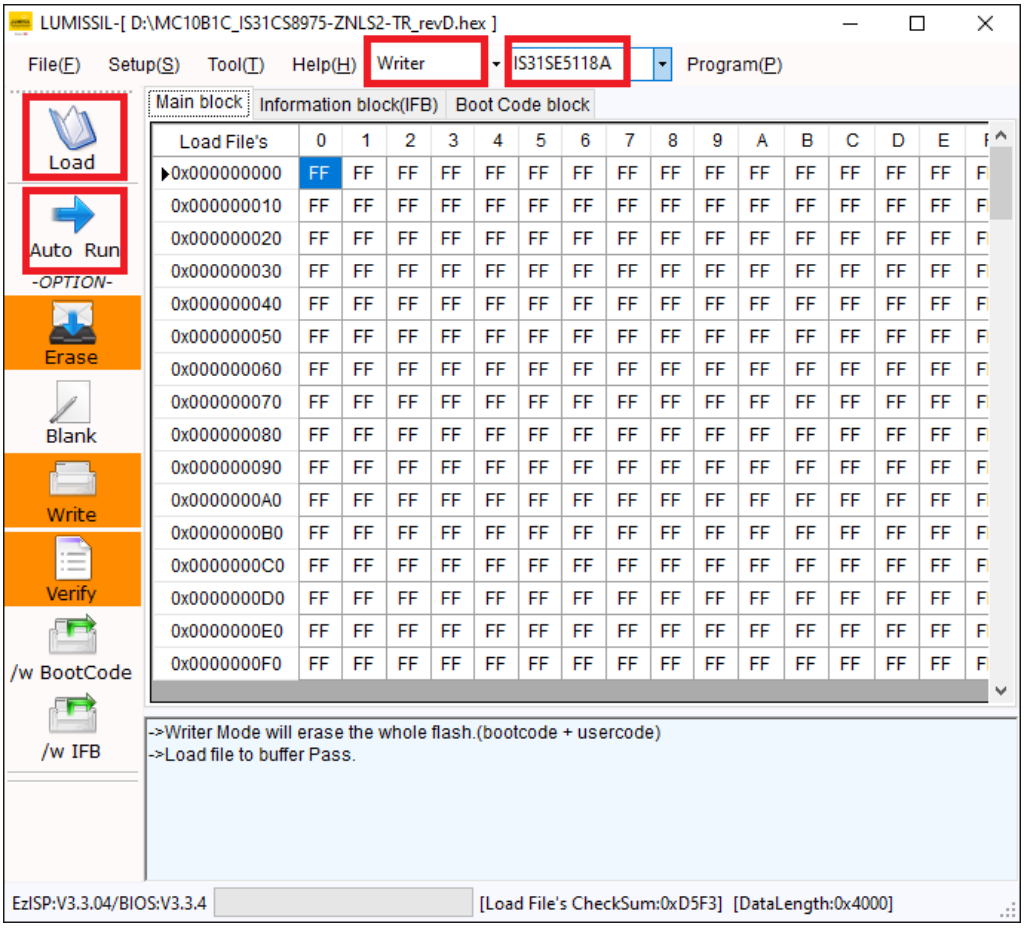
Turn the DIP switch SW2 1/2/3/4 to ON as the highlighted red rectangles in the below SE5118A EvB figure.



Step 2: Program boot code

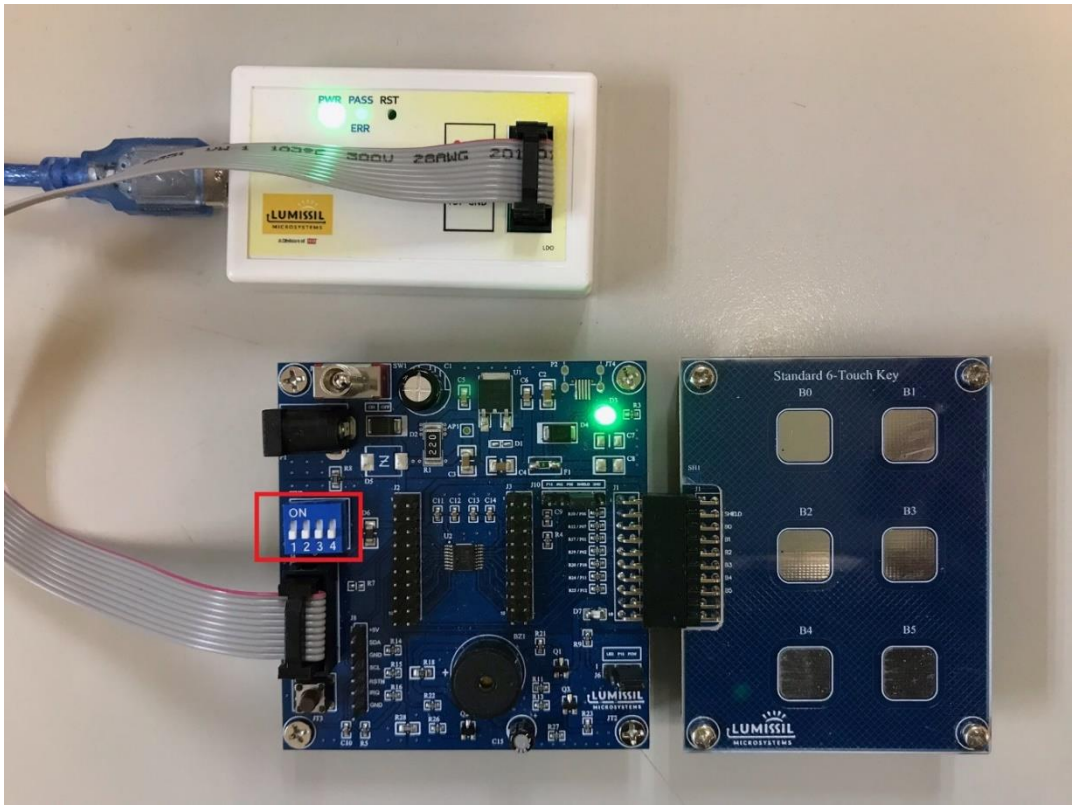
Program boot code " MC10B1C_IS31CS8975-ZNLS2-TR_revD.hex" to IS31SE5118A EvB.

a. Execute the EzISP Tool
b. Select "**Writer**" and "**IS31SE5118A**" from drop-down menu
c. Click "**Load**" to load boot code file "MC10B1C_IS31CS8975-ZNLS2-TR_revD.hex"
d. Click "**Auto Run**"
e. Close the EzISP program



Step3: Turn DIP switch SW2 off

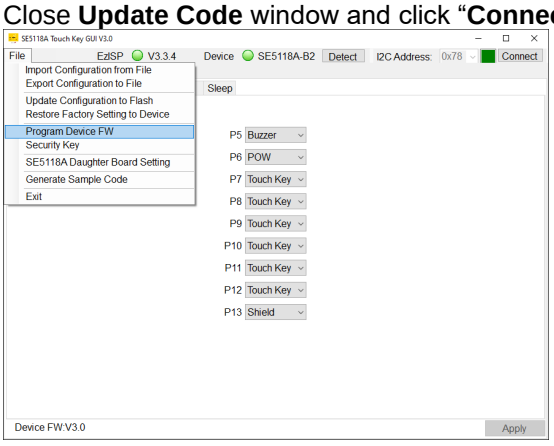
Turn the DIP switch SW2 1/2/3/4 to OFF as the highlighted red rectangles in the below SE5118A EvB figure.

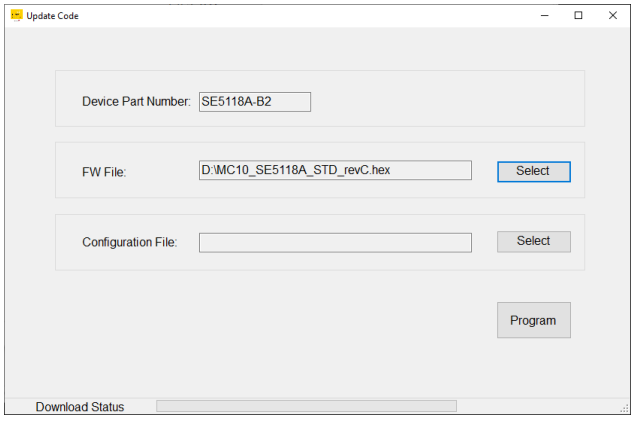


Step 4: Program Device Standard Code/Firmware

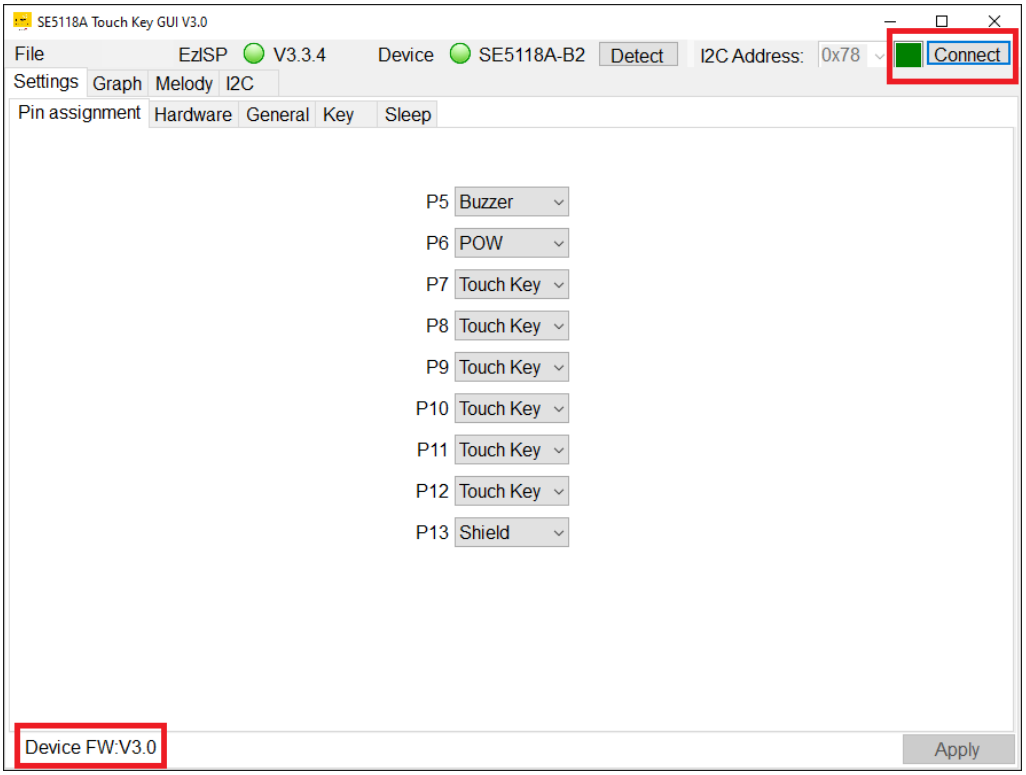
Program Device Firmware into SE5118A EvB

a. Run SE5118A GUI Tool V3.0
b. Click the **Program Device FW** from the **File** drop-down menu
c. Click "**Select**" to open firmware file "MC10_SE5118A_STD_revC.hex", and then click "**Program**"
d. Close **Update Code** window and click "**Connect**" button





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


SE5118A Touch Key GUI V3.0
File
EzISP
V3.3.4
Device
SE5118A-B2
Detect
I2C Address:
0x78
Connect
Settings
Graph
Melody
I2C
Pin assignment
Hardware
General
Key
Sleep
P5 Buzzer
P6 POW
P7 Touch Key
P8 Touch Key
P9 Touch Key
P10 Touch Key
P11 Touch Key
P12 Touch Key
P13 Shield
Device FW:V3.0
Apply

3. SE5118A TOUCH KEY GUI INTERFACE

3.1 Before Use

IS31SE5118A EvB board should have standard code/firmware inside, but users can follow below step 1 to step 3 to program firmware to start evaluation of this board in case there is no standard code firmware inside.

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

Step 2. Click **Select** to open the firmware file 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 IS31SE5118A EvB kit is not connected to the PC before this software is run, "**Connect**" status box will be red after running this software.)

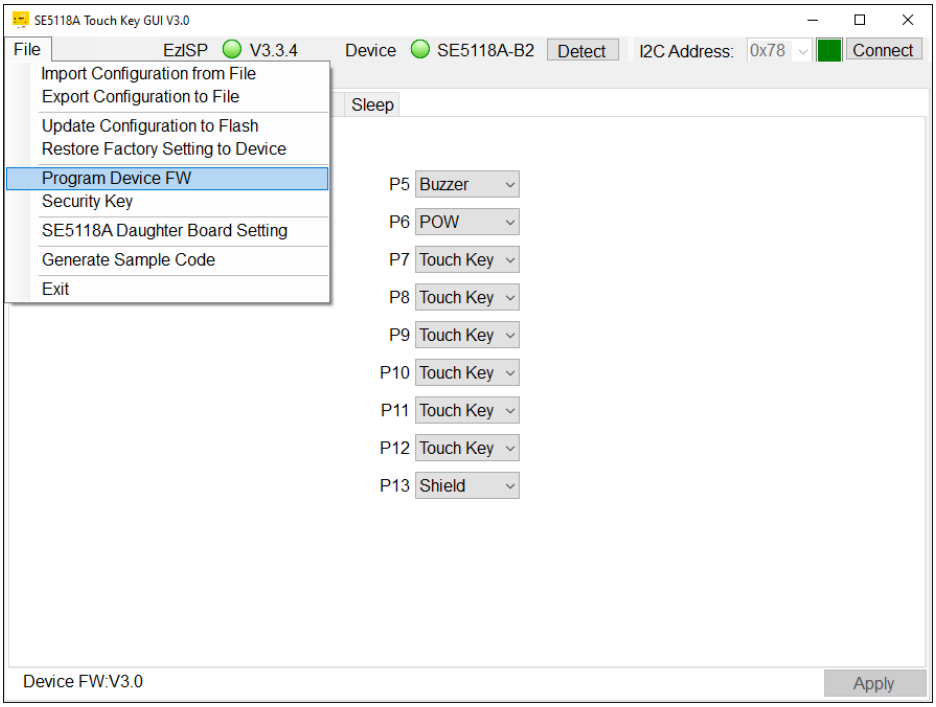


Figure 3-1: Program Device FW Before Use

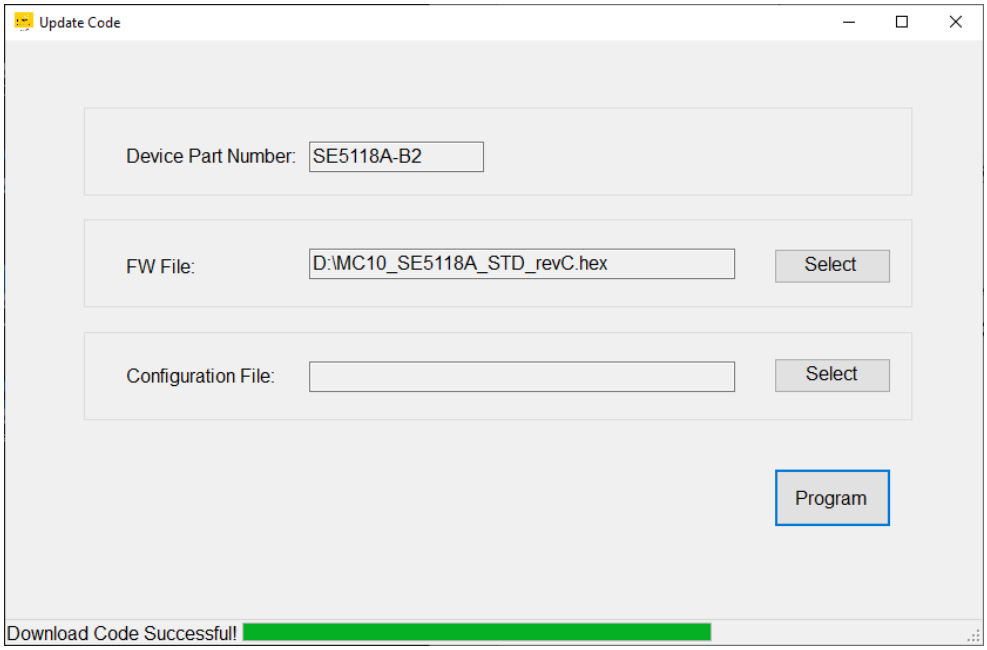


Figure 3-2: Firmware update code

If the GUI looks small, the following method can improve high-DPI support for the GUI.

Users need to find file MC10_SE5118A_GUI_rev3.0.exe, right-click on it and select **Properties**.

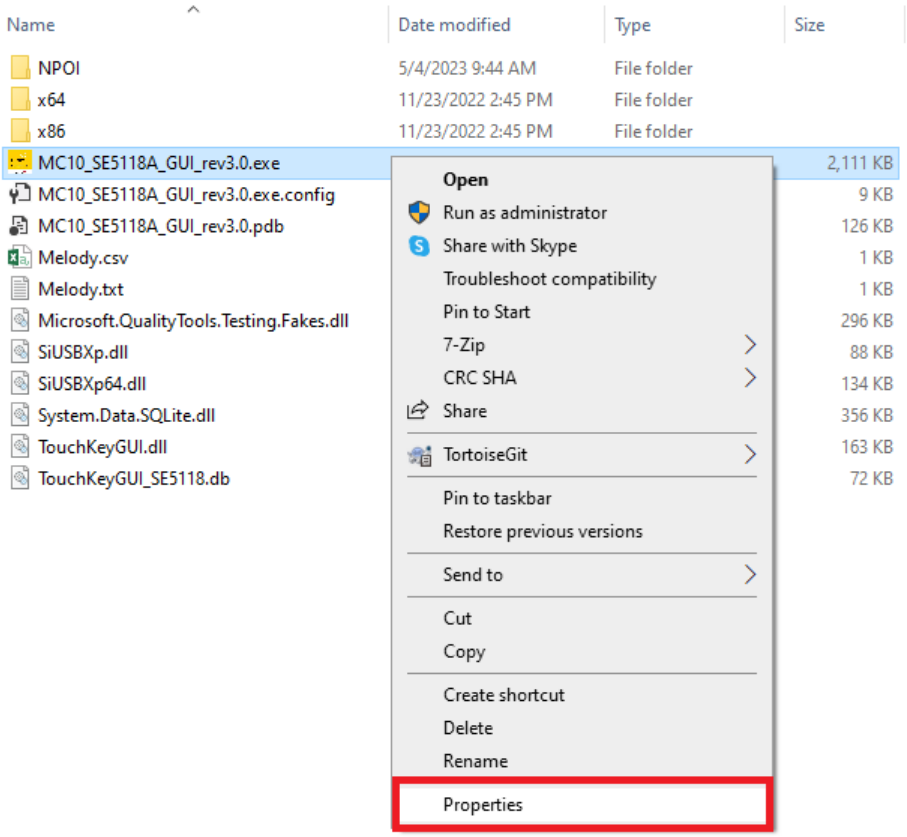


Figure 3-3: Set GUI program Properties

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.

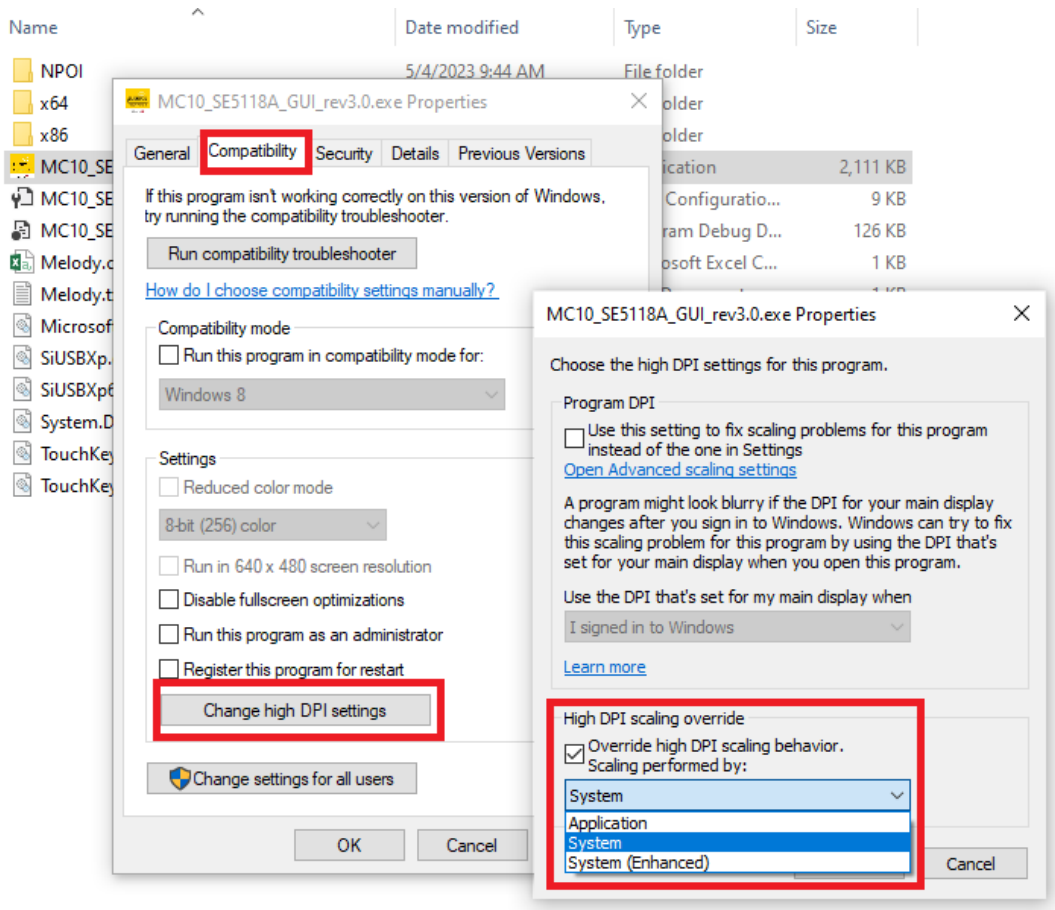


Figure 3-4: Choose High DPI settings

3.2 Connect Status

Before running Touch Key GUI tool, please make sure SW2 switch of the IS31SE5118A EvB is all OFF. Users can refer to Section 1.1 Evaluation Board to find SW2.

The I2C slave address is fixed at 0x78, as shown in **Figure 3-5**: GUI Connect Status Shows Disconnect with IS31SE5118A EvB connected to PC via EzISP board. If the user finds the "**Device"** status in red, please try to re-connect the devices connection with PC USB port, then close and run Touch Key GUI tool again. If the "Device" status still shows red, it might be because the device's boot code is not correctly burned. If the "**Connect"** status is 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 IS31SE5118A EvB and EzISP board are not connected to the PC before running the GUI software. Users can click the "**Connect**" button and the "Connect" status will turn green.

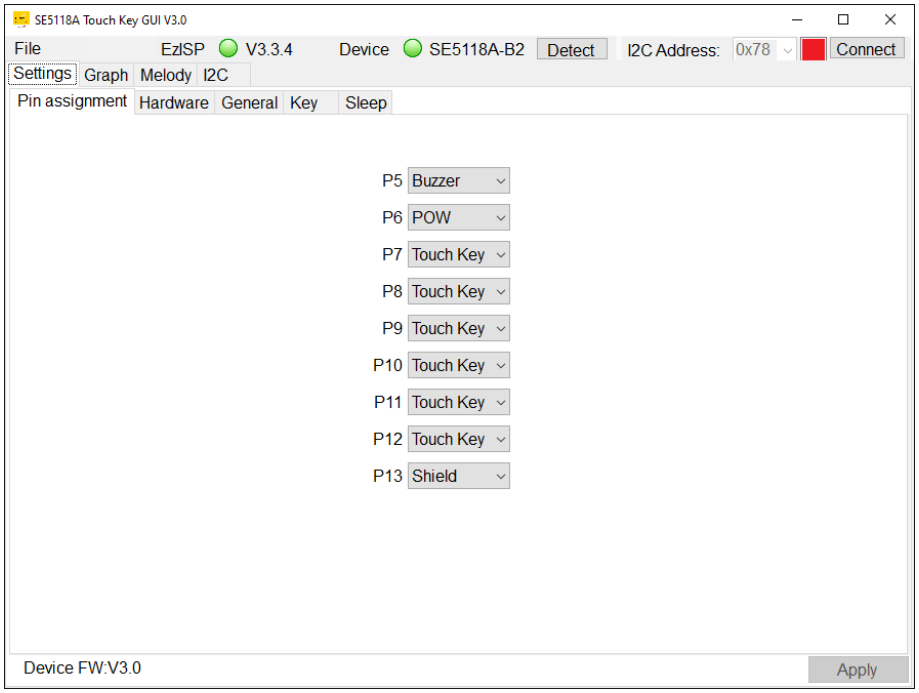


Figure 3-5: GUI Connect Status Shows Disconnect

As shown in **Figure 3.6** below, the "**Connect**" status box will be green and GUI displays current firmware version.

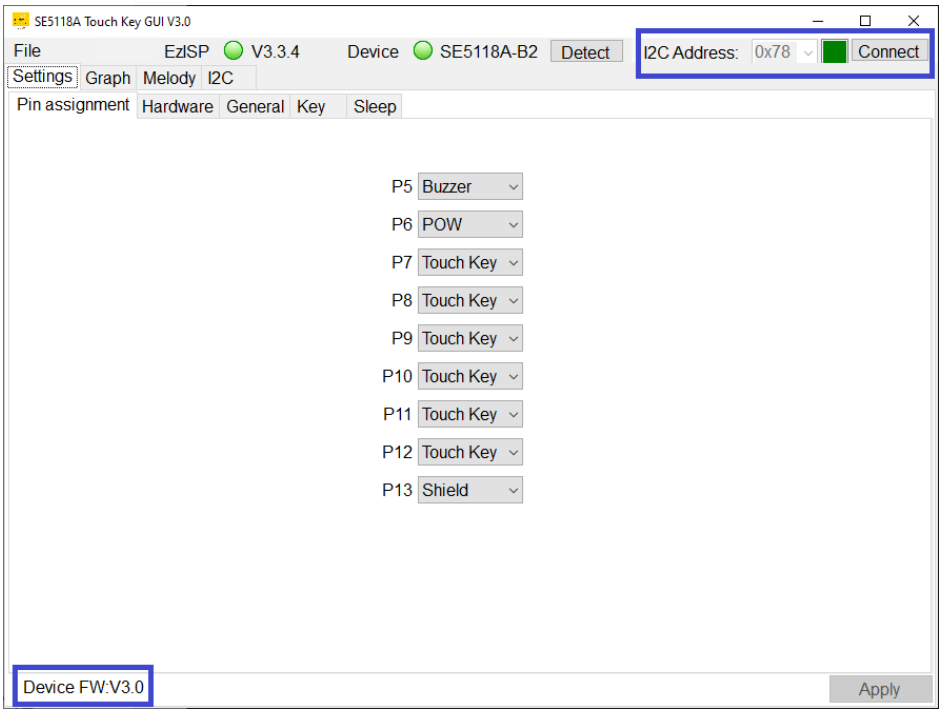


Figure 3.6: GUI Connect Status Shows Connect

3.3 Export/Import Configuration File

As shown in **Figure 3-7** below, **Export Configuration to File** is used to export the configuration of IS31SE5118A 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 manufacture.

Import Configuration from File is used to import the configuration setting from the preferred IS31SE5118A GUI settings file into the device. Click **Apply** to apply the parameters to the device.

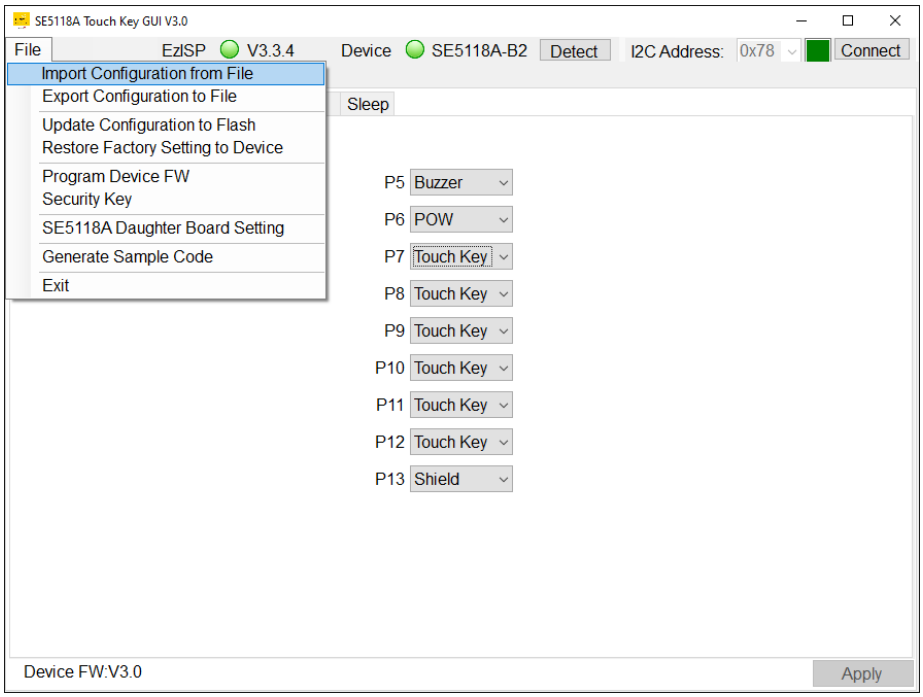


Figure 3-7: GUI Import/Export Options

3.4 Update Configuration to Flash

As shown in **Figure 3-8** below, users can write the parameters settings in the GUI into the flash of the IS31SE5118A chip. After clicking the **Update Configuration to Flash** from the **File** drop-down menu, writing configuration settings to the flash can be completed in about 4 seconds.

The embedded Flash Memory has the capability to hold the saved data even if the power is off. When IS31SE5118A is powered on again, the parameters previously written to the flash will become the default values.

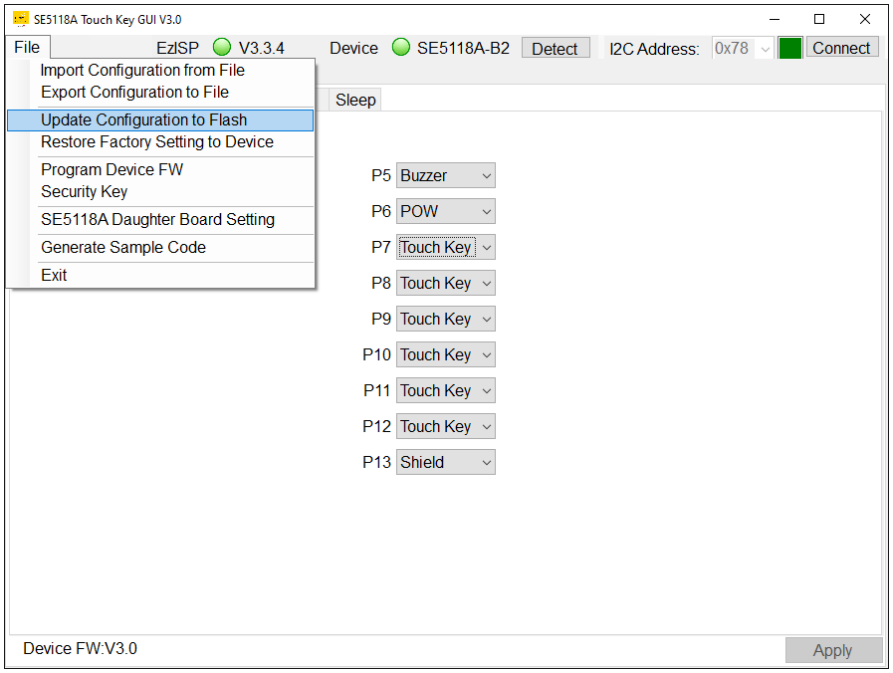


Figure 3-8: GUI Update Configuration to Flash

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 can be completed in about 4 seconds.

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

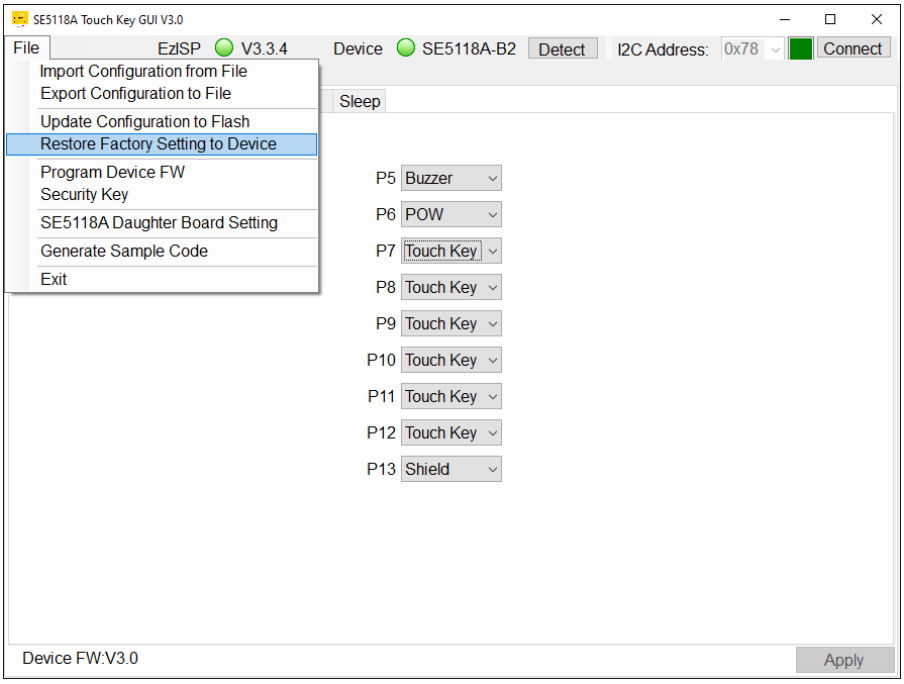


Figure 3-9: Restore Factory Setting to Device

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.

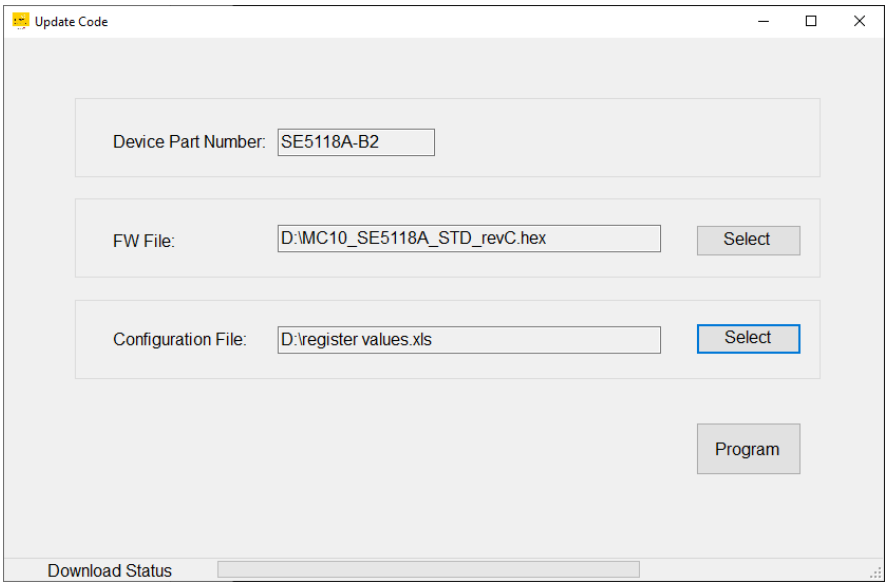


Figure 3-10: Update Code

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.

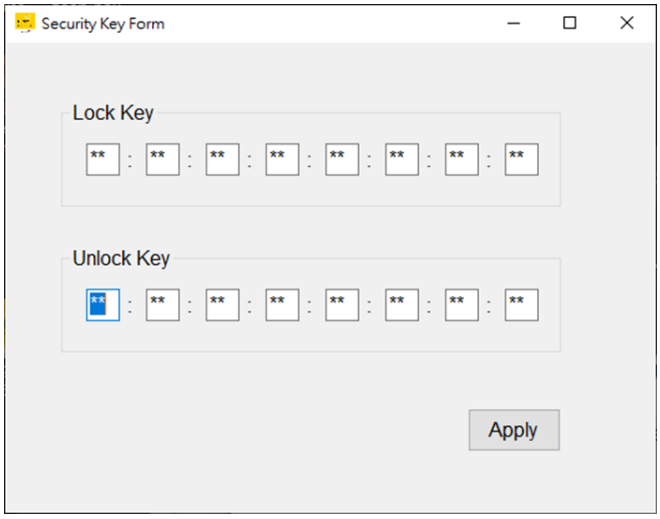


Figure 3-11: Security Key

3.8 Generate Sample Code

As shown in **Figure 3-12** below, "**Generate Sample Code"** is used to create a sample code for configuring SE5118A parameters via I2C bus. Customers can adjust SE5118A Touch Key GUI for the required parameters to meet own application needs. After system level verification, please click "**Apply**" to apply the parameters to the device before "**Generate Sample Code**" is clicked. Clicking "**Generate Sample Code**" will come out a "SE5118A_Sample_code.c" under SE5118A Touch Key GUI tool installation folder.

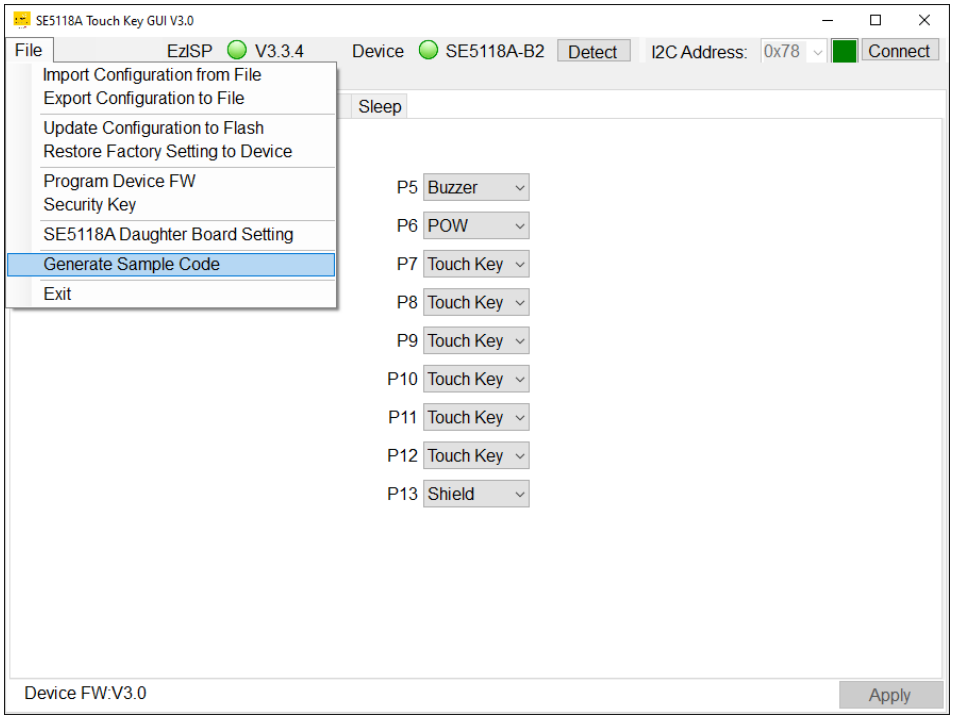


Figure 3-12: Generate Sample Code

3.9 How to Use IS31SE5118A Touch Key GUI

The following steps explain how to use IS31SE5118A 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. MC10_SE5118A_GUI_rev3.0. exe and click **Connect** button to establish connection. Parameters 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 Section 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 users 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.

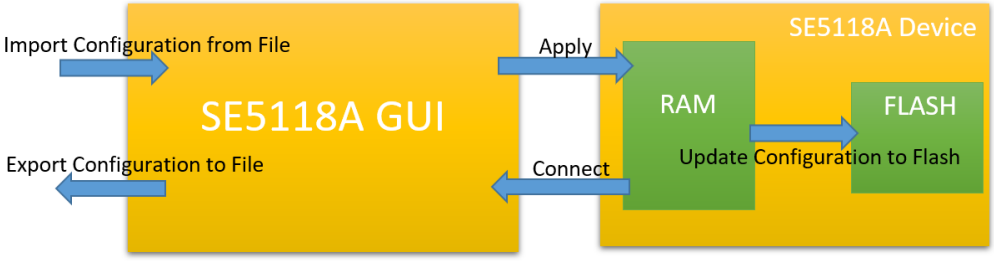


Figure 3-13: Interaction between GUI Configuration and Device

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 assignment from the drop-down menu.

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

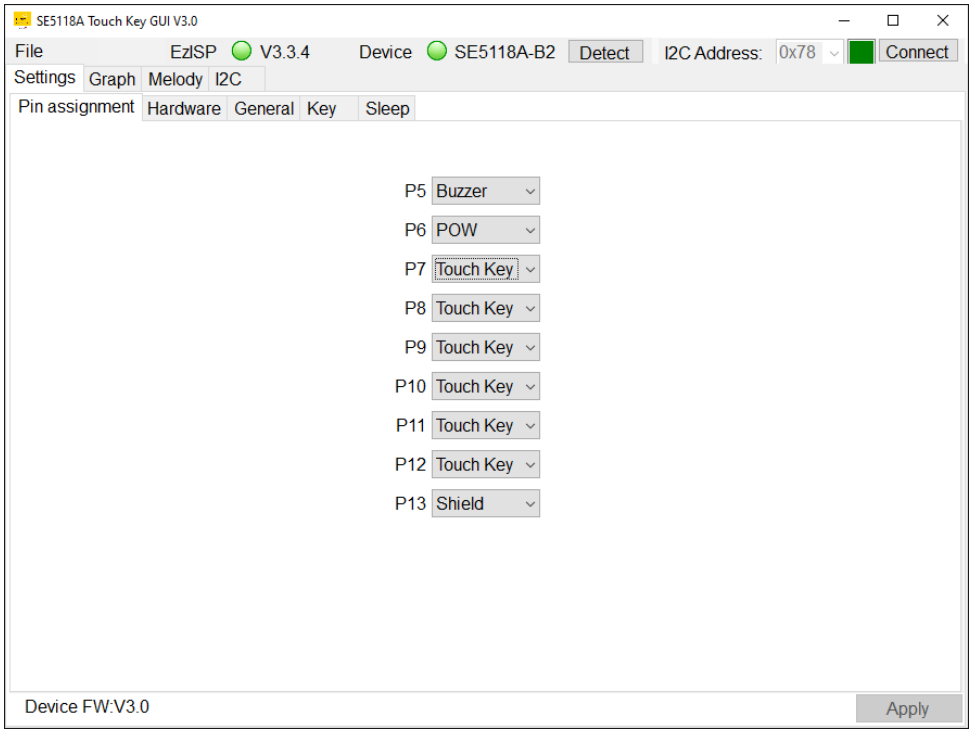


Figure 4-1: Default Pin Assignment

Touch Key : Touch Sense Channel
INT : Interrupt Pin (Active Low)
Shield : Shield Output
Buzzer : Buzzer Output
POW : Melody Power Output

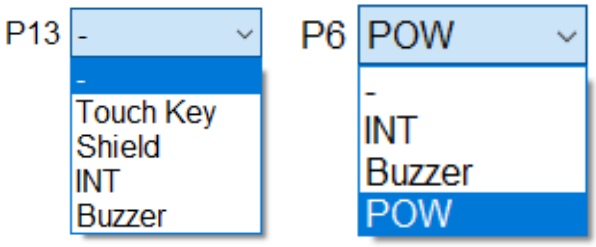


Figure 4-2: Pin Drop-Down Menu

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 should be set for correct touch key detect. All settings will be active by clicking the **Apply** button.

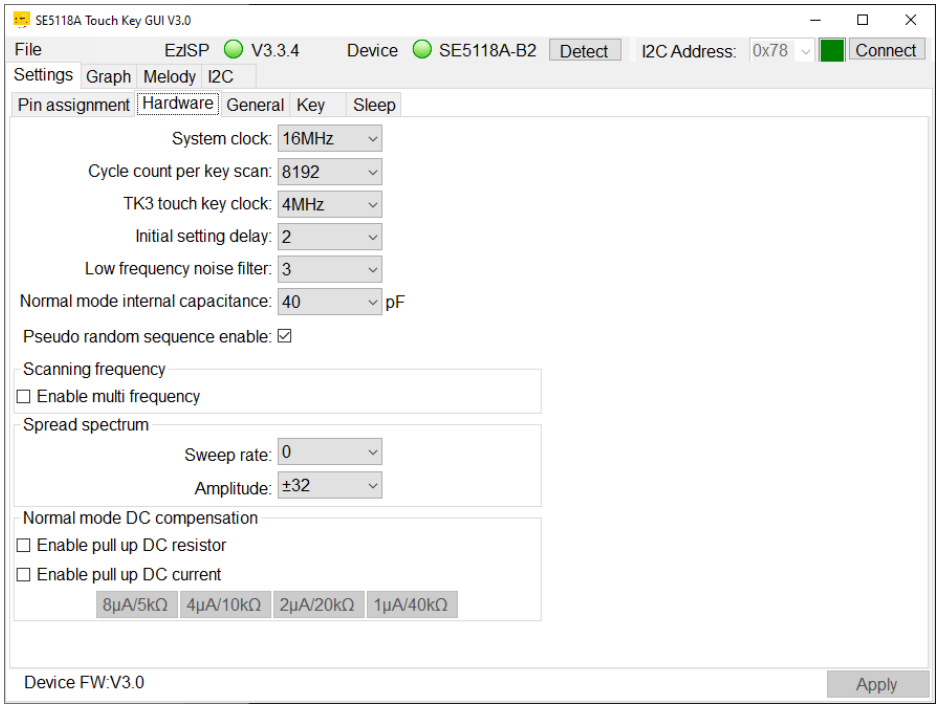


Figure 4-3: Hardware Setting Page

4.2.1 System Clock

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

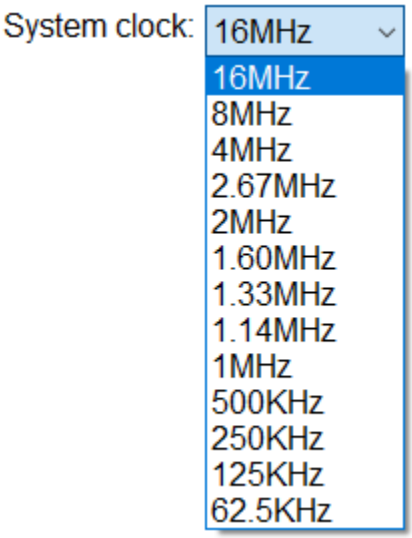


Figure 4-4: System Clock

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

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

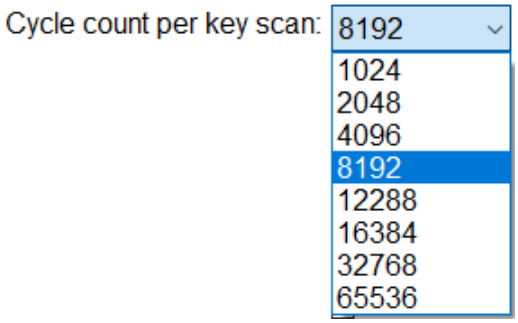


Figure 4-5: Cycle Count Per Key Scan

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

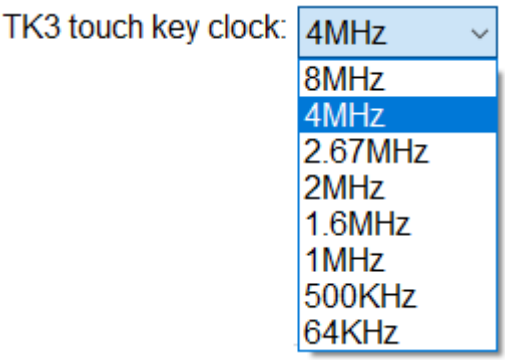


Figure 4-6: TK3 Touch Key Clock

4.2.4 Initial Setting Delay (INI)

Initial setting delay defines the number of TK3 clock (system clock/4) period for initial settling of IS31SE5118A pin Cref (Cref, the integration capacitor of the charge transfer). The delay time is set to (INI + 1) * 4 * TK3 clock time.

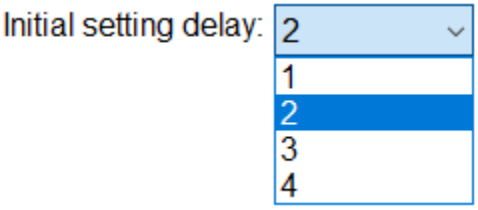


Figure 4-7: Initial Setting Delay

4.2.5 Low Frequency Noise Filter (LFNF)

Regarding low frequency noise rejection, device 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 detect is larger than (LFNF * 8), the scan result is ignored.

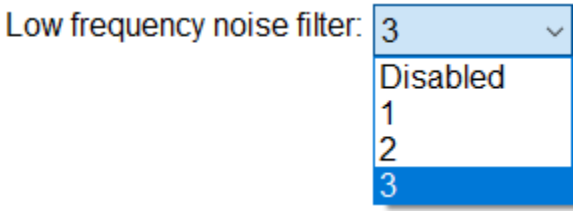


Figure 4-8: Low Frequency Noise Filter

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.

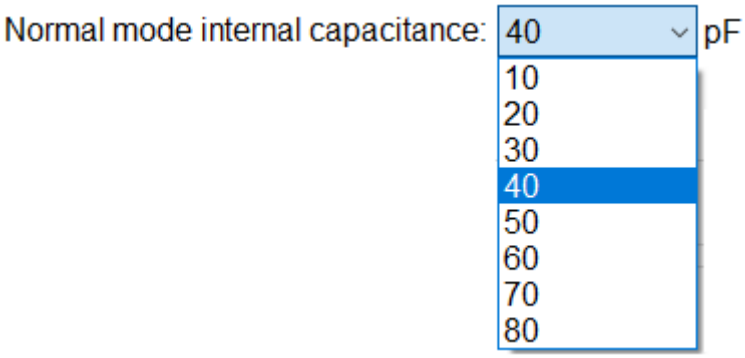


Figure 4-9: Normal Mode Internal Capacitance

4.2.7 Pseudo Random Sequence Enable

IS31SE5118A applies a pseudo-random sequence that randomizes the charge and discharge timing sequences to prevent high frequency noise rejection.

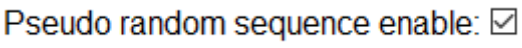


Figure 4-10: Pseudo Random Sequence Enable

4.2.8 Scanning Frequency

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

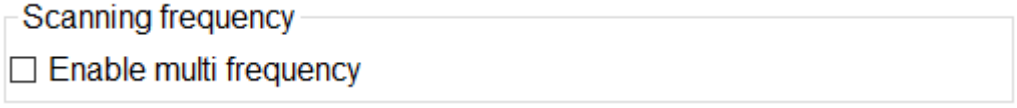


Figure 4-11: Scanning Frequency

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

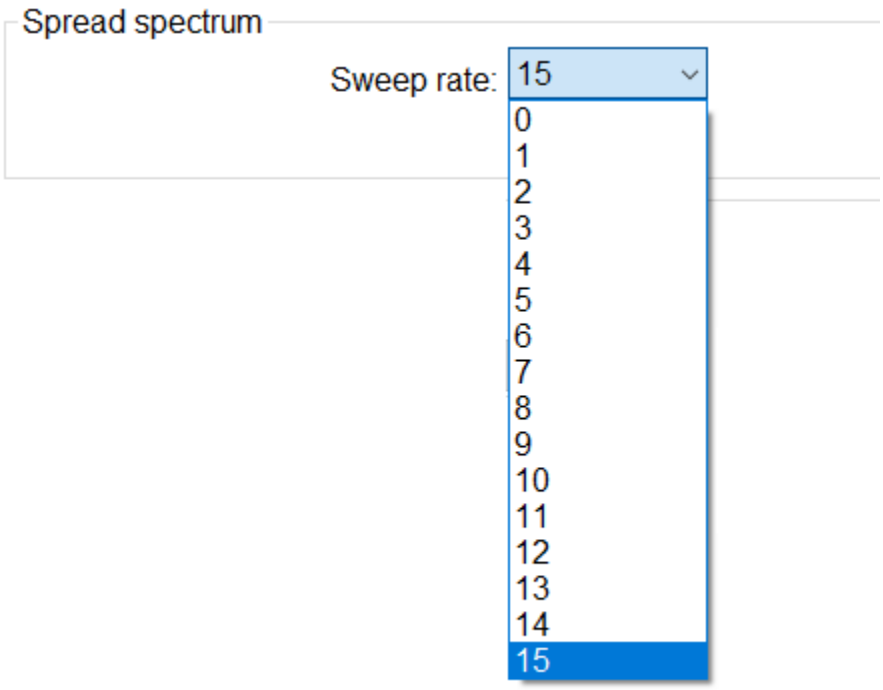


Figure 4-12: Spread Spectrum Sweep Rate

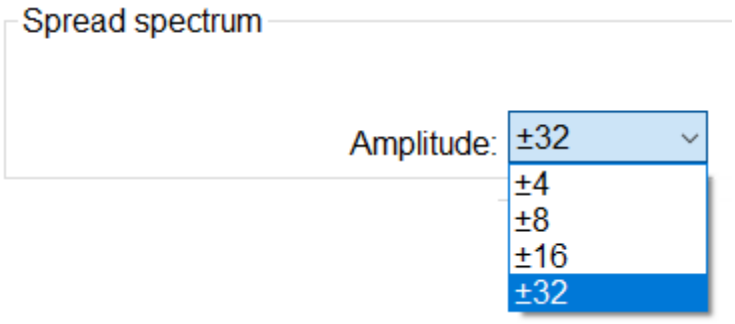


Figure 4-13: Spread Spectrum Amplitude

4.2.10 DC Compensation

The hardware can be configured a constant DC pull-up/pull-down (PUD) on IS31SE5118A pin Cref to allow high capacitance touch-key detection. A DC pull-up/pull-down can compensate 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/5KΩ, 4uA/10KΩ, 2uA/20KΩ, 1uA/40 KΩ or a combination of multiple selections at one time.

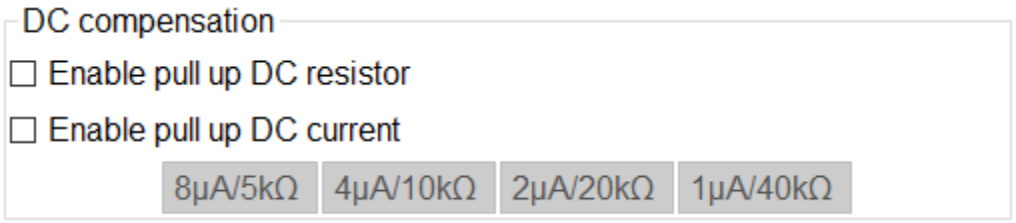


Figure 4-14: DC Compensation

4.2.11 Raw Count Calibration

Step 1. Select **Cycle Count Per Key Scan** (1024 - 65536) as 4.2.2

Step 2. Select larger **Normal Mode Internal Capacitance** (10pF – 80pF) to increase the raw count value.

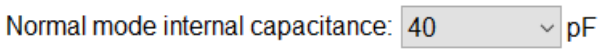
Step 3. Enable **DC Compensation** if needed. But it will increase the raw count.

Step 4. Click **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.



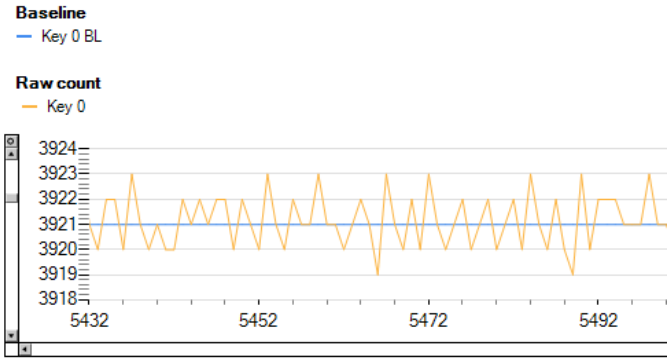


Figure 4-15 : Raw Count Value when Internal Cap = 40pF

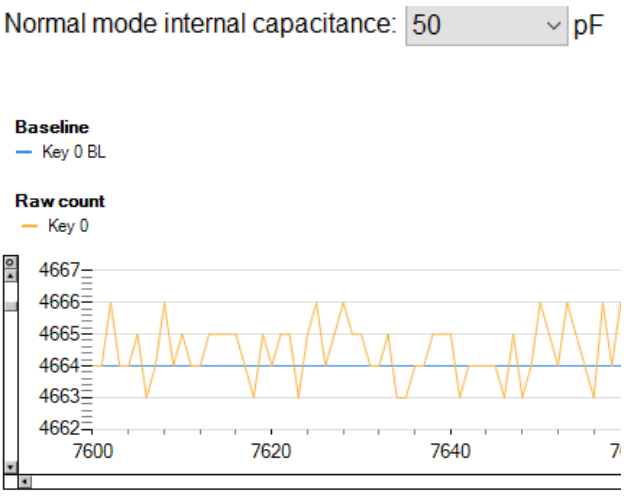


Figure 4-16 : Raw Count Value when Internal Cap = 50pF

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

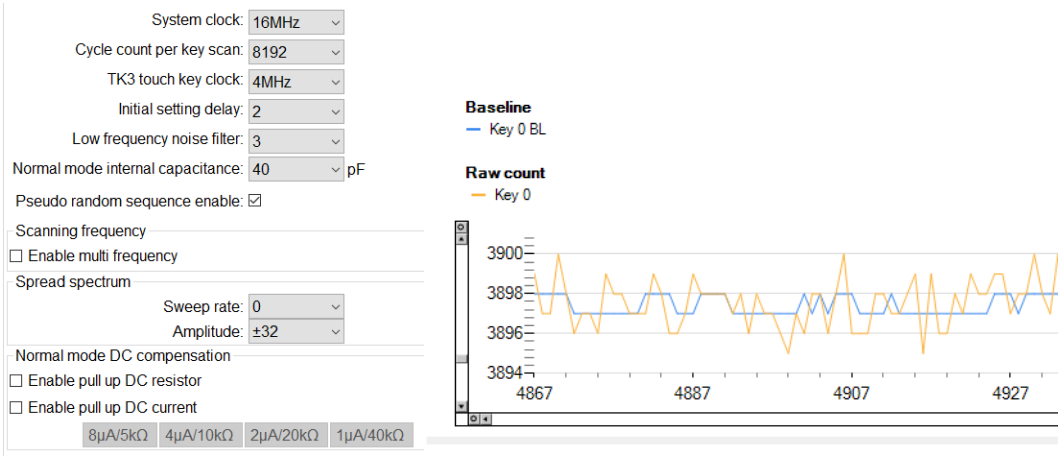


Figure 4-17: Disable DC Compensation

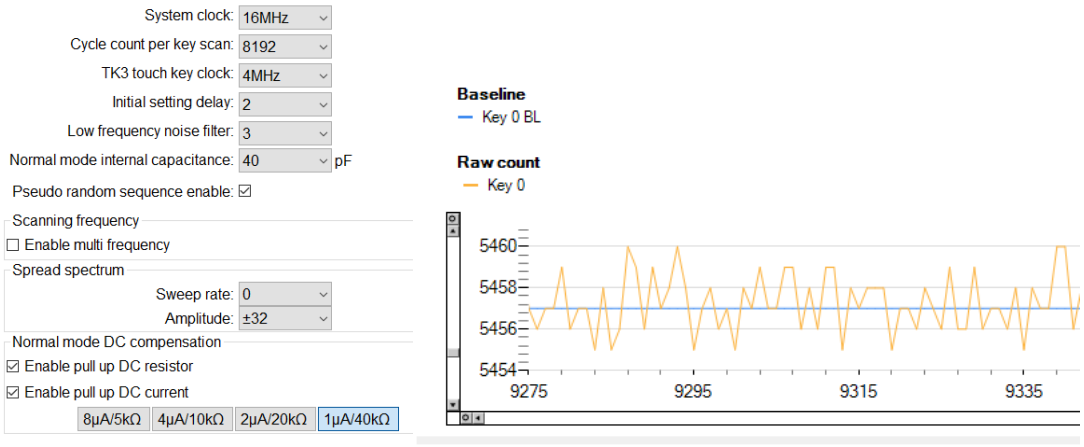


Figure 4-18: Enable DC Current 1uA and Resistor 40KΩ

4.3 General

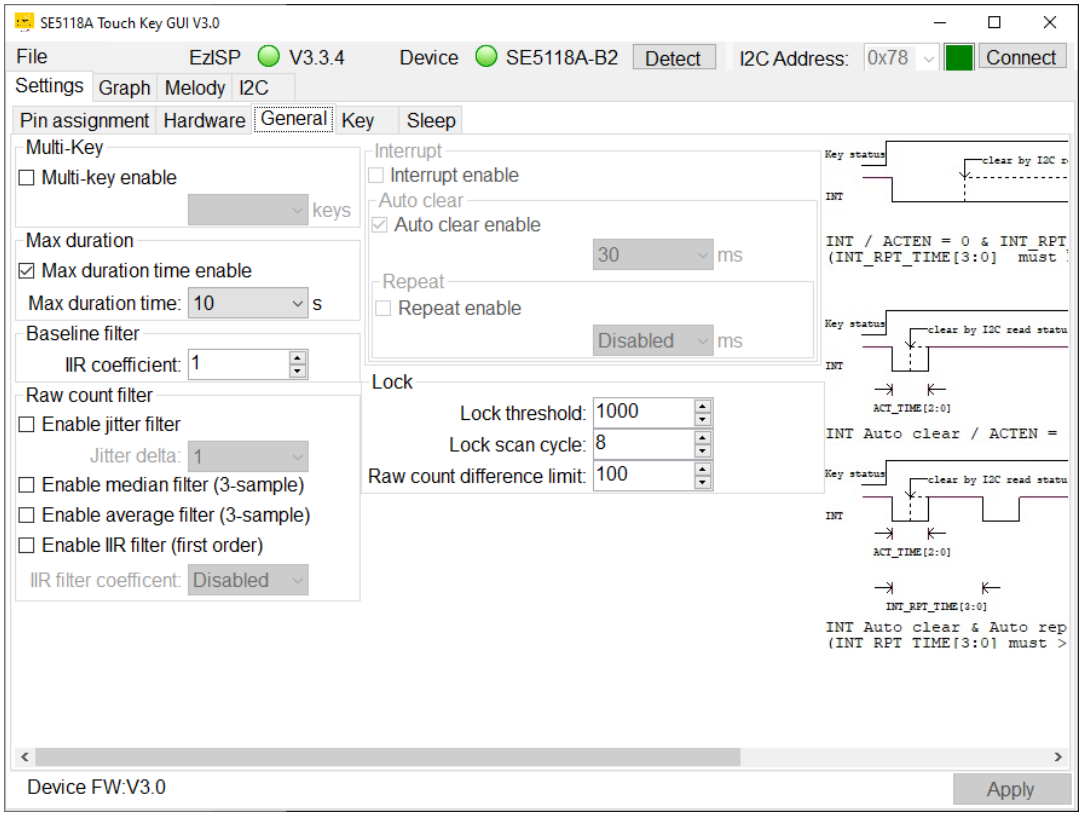


Figure 4-19: General Page

4.3.1 Multi Key

As shown in **Figure 4-** below, **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.

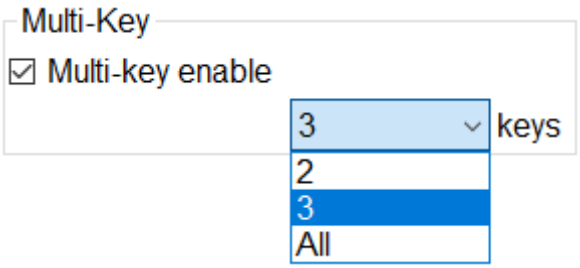


Figure 4-20: Multi-Key

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, 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.

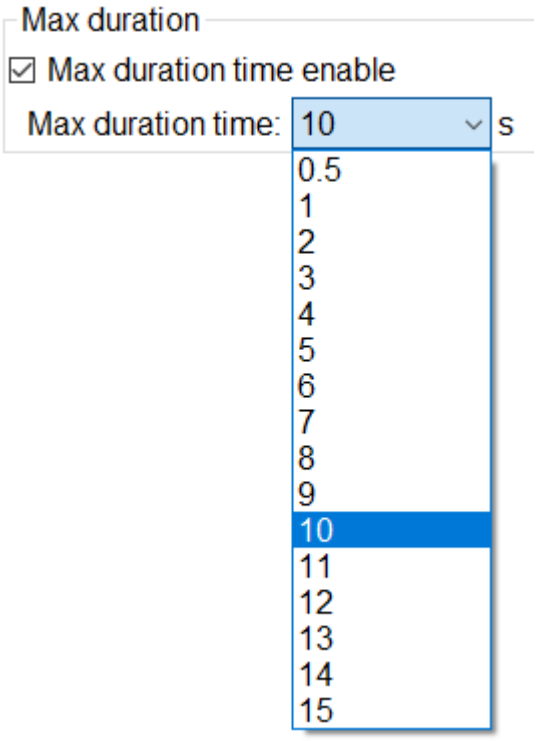


Figure 4-21: Max Duration

4.3.3 Baseline Filter

IIR coefficient

Return the value of coefficient/256 value * the current raw count + (256 - coefficient)/256 * the previous filter value.

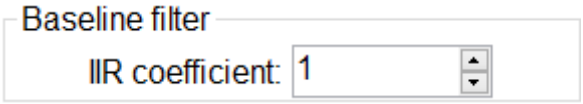


Figure 4-22: Baseline Filter

4.3.4 Raw Count Filter

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

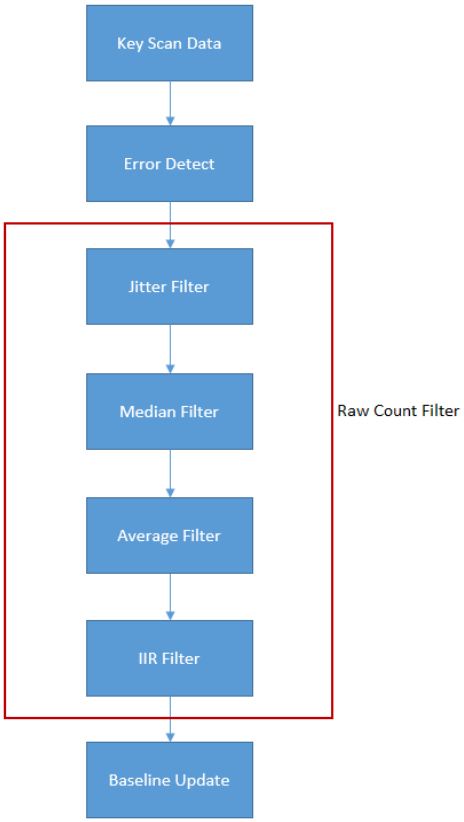


Figure 4-23: Raw Count Filter

Jitter

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

If Input > (previous output + jitter delta), output value is (Input – jitter delta).

If Input < (previous output - jitter delta), output value is (Input + 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 carrying high frequency distortion.

IIR

Return the value of 1/coefficient * the current raw count + (coefficient – 1)/coefficient * 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.

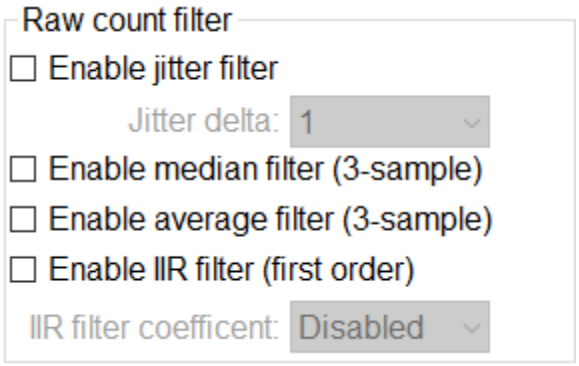


Figure 4-24: Raw Count Filter Settings

4.3.5 Interrupt

Output for interrupt request (IRQ)

Step 1. **Settings ->Pin assignment**, select Pin 6 or Pin 13 as INT.

Step 2. **Settings -> General**, click **Interrupt enable** checkbox. Optional select: **Auto clear enable** /**Repeat enable**

Step 3. **Settings -> Key**, select one or more keys to turn on Interrupt 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.

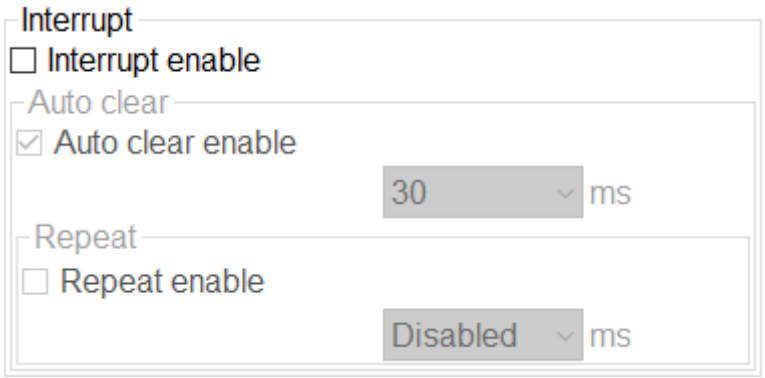


Figure 4-25: Interrupt Menu

Case 1. Click Interrupt Enable

Interrupt output is low if any key touch was detected. Interrupt output is high (by external pull high resistor) if key status register (07h) was read or no key touch was detected.

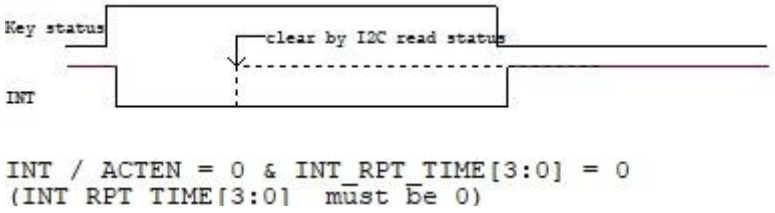


Figure 4-26: INT Output Low by Key ON Status

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, INT pin can be released by reading 07h (Key Status Register). If 07h register is not read within the programmed **Auto clear time** (10ms~200ms), IS31SE5118A will release INT pin after **Auto clear time** is expired.

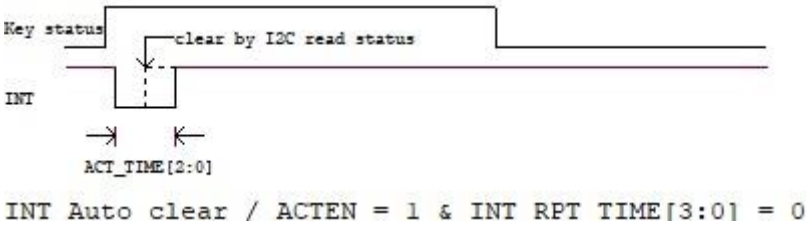


Figure 4-27: Auto Clear INT

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 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.

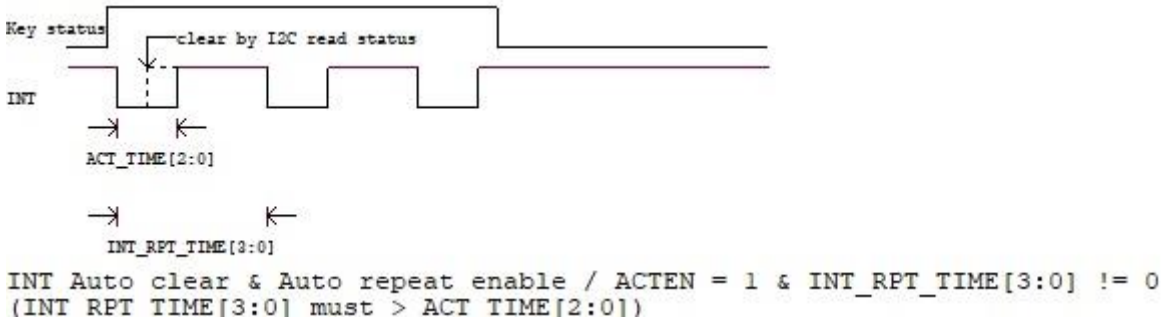


Figure 4-28: Repeat INT

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 the effect of 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 for noise immunity.

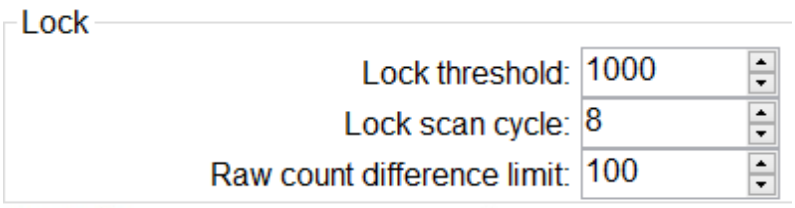


Figure 4-29: Lock

4.4 Key

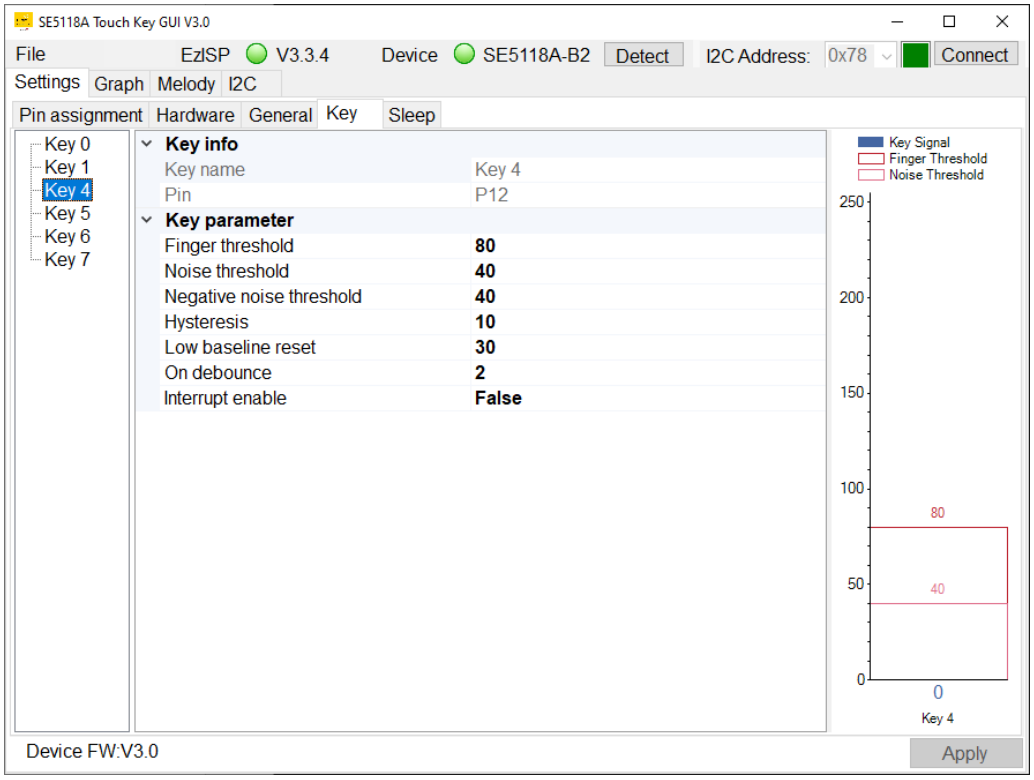


Figure 4-30: Key Page

4.4.1 Key Info

It includes key name and pin number.

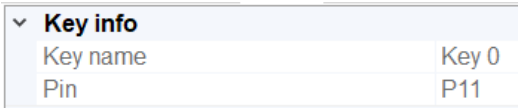


Figure 4-31: Key Info

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| <= absolute |negative noise threshold|.

On debounce

When one key's on debounce count is reached, this key is definitely 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	10
Low baseline reset	30
On debounce	2
Interrupt enable	False

Figure 4-32: Key Parameter

4.4.3 Key Signal Bar Chart

It shows individual key signal. The corresponding value will be displayed in the box when pressing KEYs (KEY0~KEY7) 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.

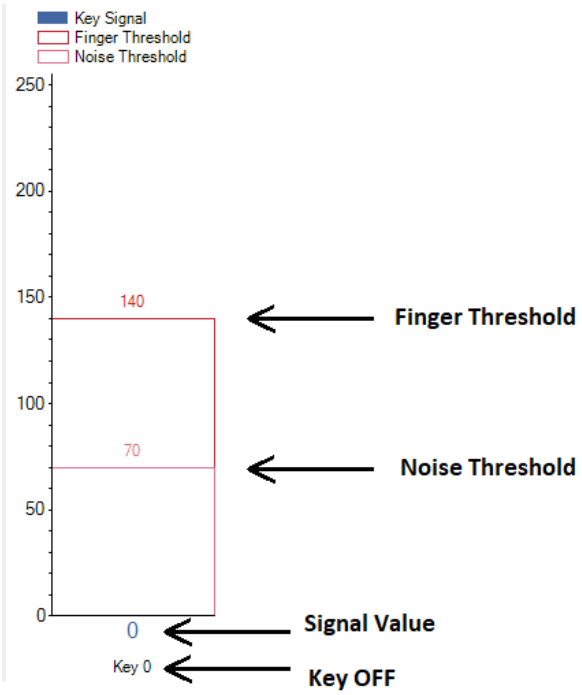


Figure 4-33: Key Signal Bar Chart

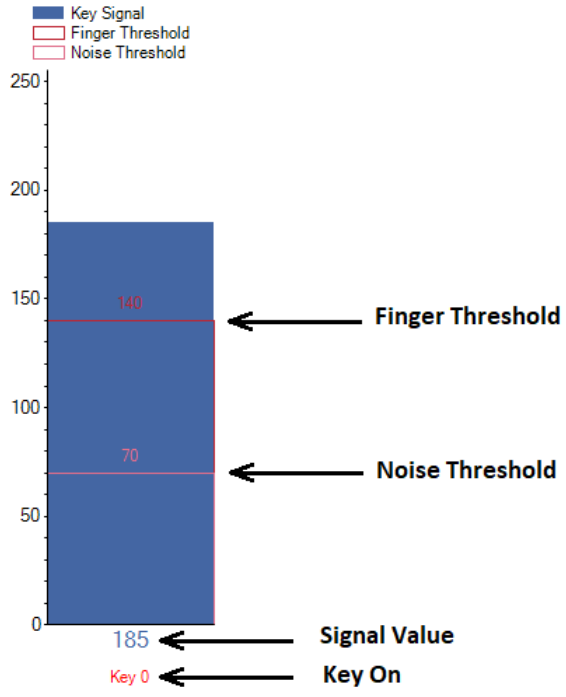


Figure 4-34: Signal Bar Char with Finger Touch

4.5 Sleep

IS31SE5118A integrates auto sleep function and the entering-sleep time can be configured. Device will enter into 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.

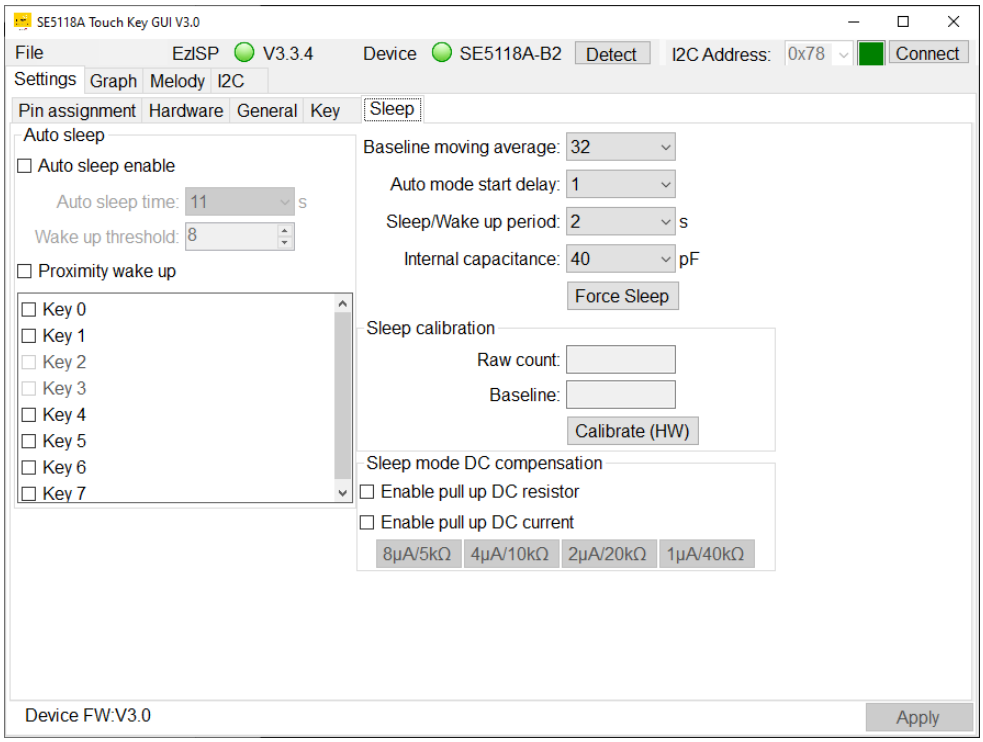


Figure 4-35: Sleep Page

4.5.1 Auto Sleep

IS31SE5118A 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 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 **Pin assignment** selects INT pin and **Interrupt enable** option is checked in General Tab.

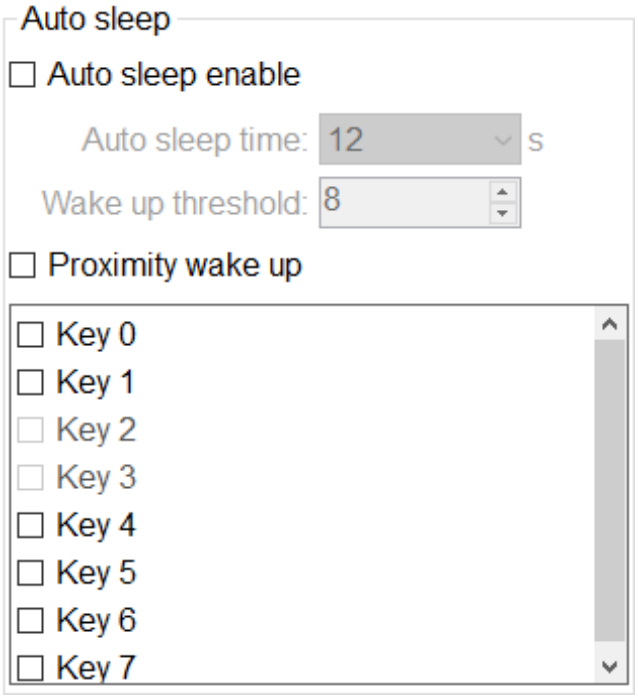


Figure 4-36: Auto Sleep

The "**Connect**" status box will be displayed in yellow color whenever device enters into sleep mode.

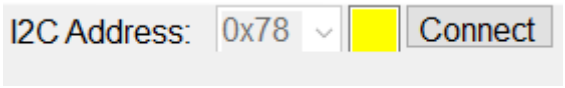


Figure 4-37: I2C Address

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 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.

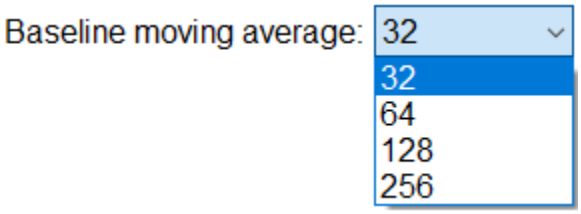


Figure 4-38: Baseline Moving Average

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.

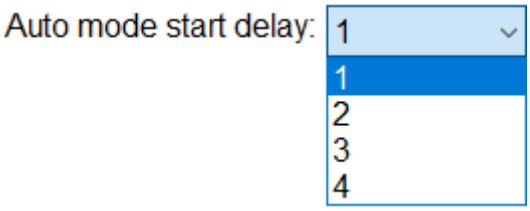


Figure 4-39: Auto Mode Start Delay

4.5.4 Internal Capacitance

This setting is to select internal charging capacitance value.

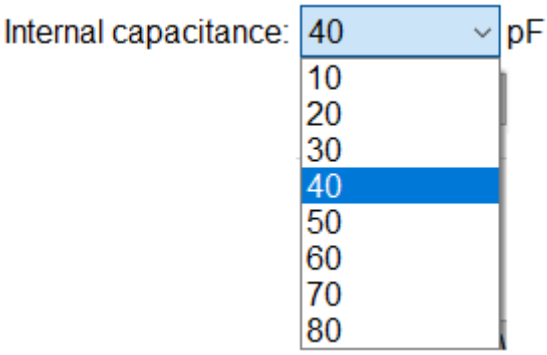


Figure 4-40: Internal Capacitance

4.5.5 Sleep/Wake Up Period

Set "Sleep/wake up period" and the touch key baseline will be dynamically adjusted after the setting time is expired. Default setting is 2 seconds.

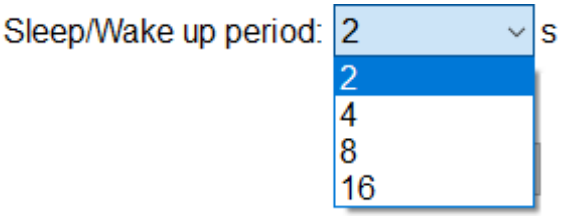


Figure 4-41: Sleep/Wake Up Period

4.5.6 Force Sleep

When IS31SE5118A EvB is in normal mode, the "**Connect**" button in GUI will turn green. After clicking the **Force Sleep**, IS31SE5118A EvB will enter sleep mode and the "**Connect**" status box turns yellow. Click "**Connect**" button, device will return to normal state.

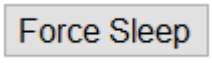


Figure 4-42: Force Sleep

4.5.7 Sleep Calibration

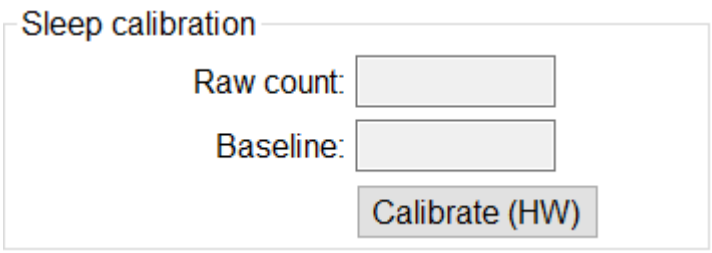


Figure 4-43: Sleep Calibration

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

Step 1. Select available Key 0~Key 7 for wakeup. Suggest choosing one Key or raise internal capacitor setting value, otherwise there might not come out raw count and baseline value when users 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 **Connect** button.

Step 1. Select wake-up key = Key 0.

Step 2. Select internal capacitance = 40pF.

Step 3. Click **Apply**.

Step 4. Click **Calibrate (HW)**, raw count = 2457.

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 = 2457 without finger touch when Internal capacitance = 40pF

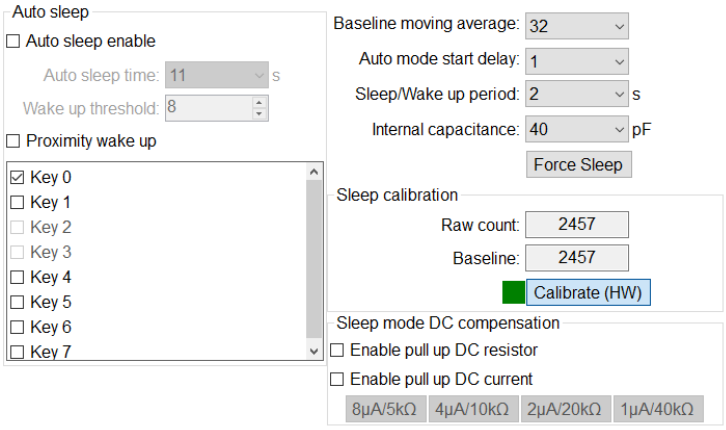


Figure 4-44: Sleep Calibration case 1

Case 2: Sleep calibration raw count = 4300 without finger touch when Internal capacitance = 60pF

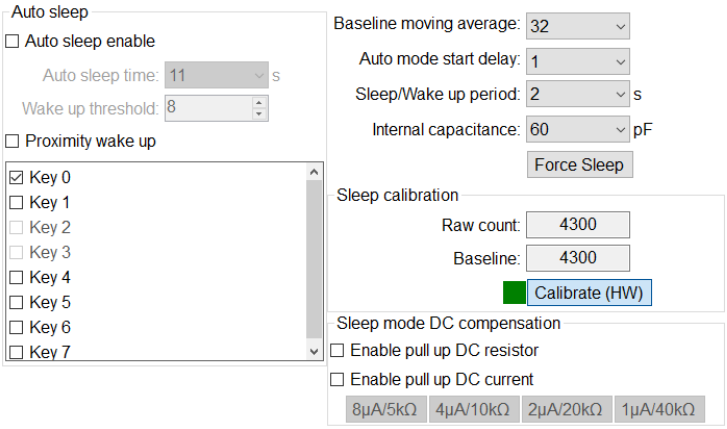


Figure 4-45: Sleep Calibration case 2

Case 3: Sleep calibration raw count = 4202 with finger touch when Internal capacitance = 60pF

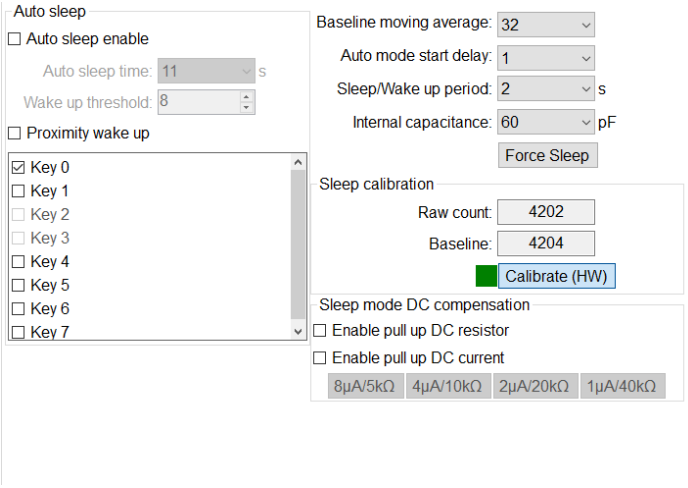


Figure 4-46: Sleep Calibration case 3

4.5.8 DC Compensation

DC compensation in the 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 users selected.

The hardware is to configure a constant DC pull-up/pull-down (PUD) on pin Cref to allow high capacitance touch-key detection. A DC pull-up/pull-down can compensate 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 5K**Ω**/10K**Ω**/20K**Ω**/40K**Ω** resistor respectively.

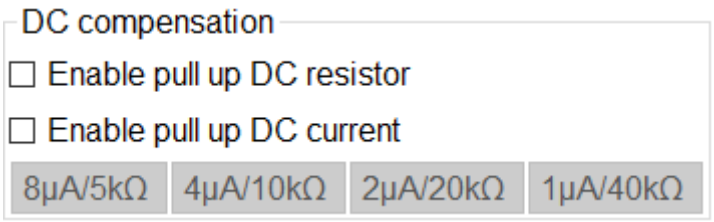


Figure 4-47: DC Compensation

Example:

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

Step 1. Select wake-up key from available Key 0~Key 7.

Step 2. Select internal capacitance = 40pF.

Step 3. Enable pull up DC current by selecting the checkbox and click **2uA/20kΩ**.

Step 4. Click **Apply**.

Step 5. Click **Calibrate (HW)**, raw count = 4068.

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

Case 4: Sleep calibration raw count = 4068 without finger touch when Internal cap = 40pF, DC current = 2uA

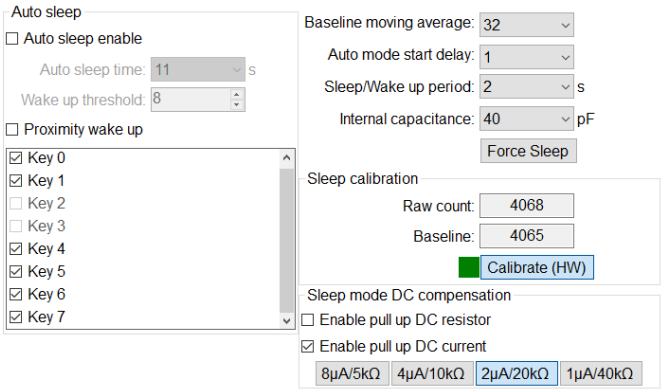


Figure 4-48: Sleep Calibration case 4

Case 5: Sleep calibration raw count = 3930 with finger touch when Internal cap = 40pF, DC current = 2uA

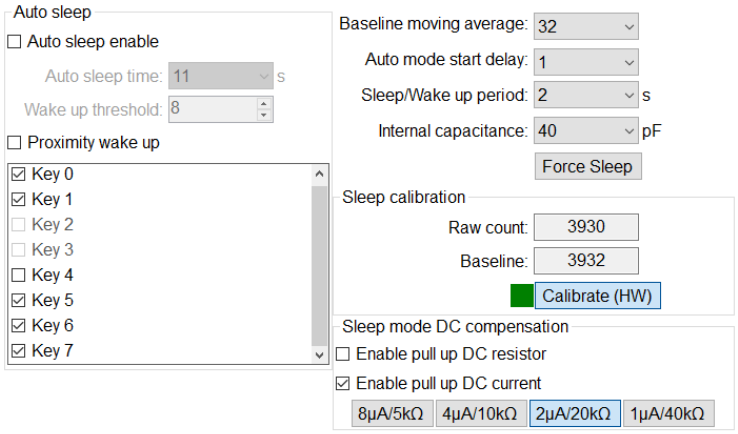


Figure 4-49: Sleep Calibration case 5

5. GRAPH

As shown in **Figure 5-1** below, Line Chart is the KEY value curves to show the current value of KEY0~KEY7. 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 for 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 KEY0~KEY7. Red color on Key 5 means the device has detected a finger touch on Key 5.

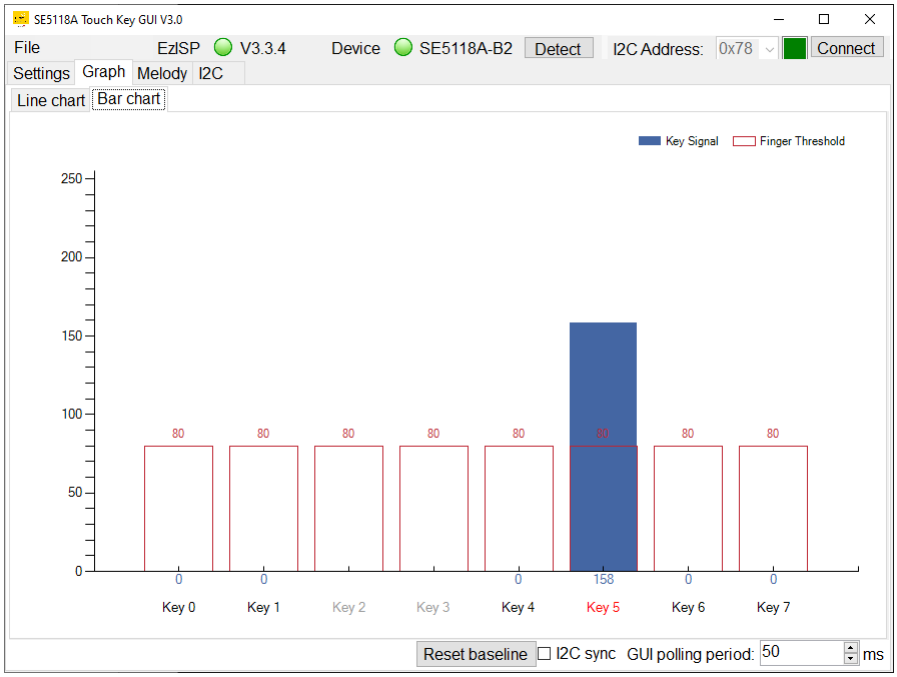


Figure 5-2: Graph Bar Chart

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.

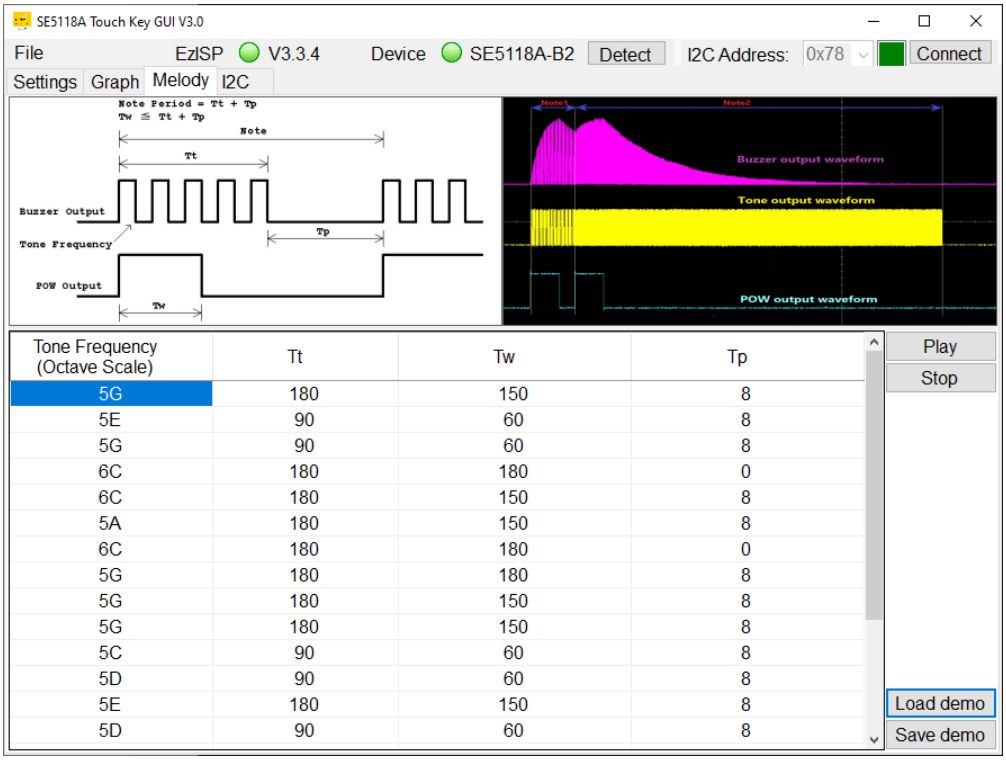


Figure 6-1: Melody Page of GUI

Support scale from 3A to 8G#

Frequencies for equal-tempered scale, A**4** = 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 4 ms increase.

7. I2C COMMUNICATION

In the blue rectangular box for "**Command list**" in **Figure 7-1: I2C Communication Page of GUI**, users can issue I2C commands to the EvB. On the GUI right-hand, 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, users 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

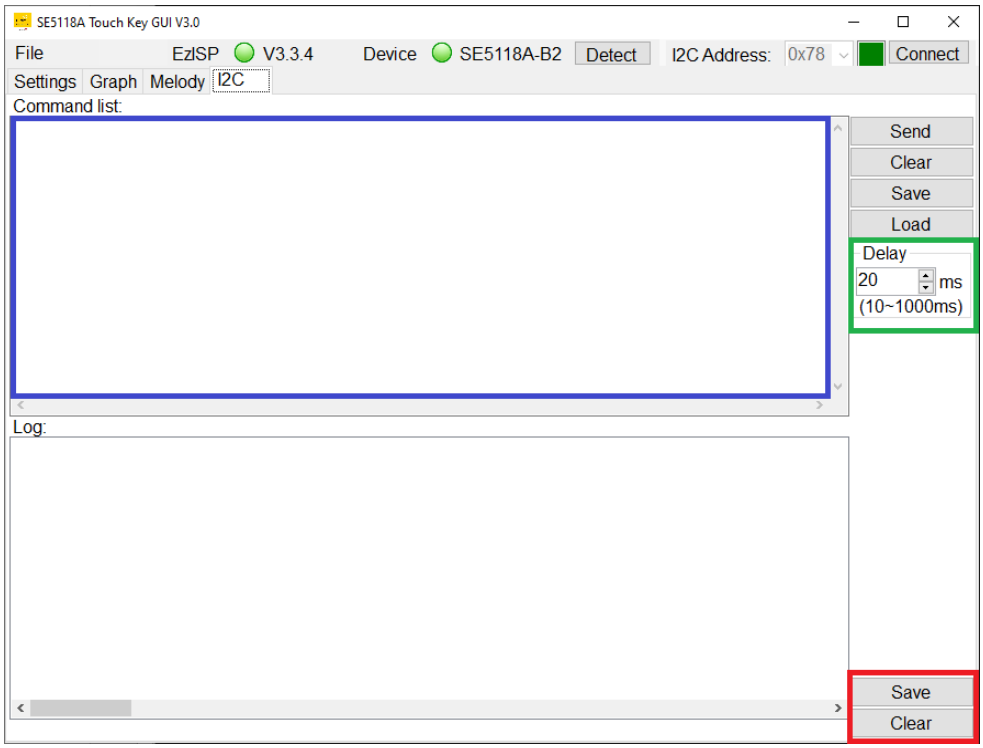


Figure 7-1: I2C Communication Page of GUI

7.1 I2C Communication Example (Touch Key)

Command list:

Command	Description
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:

Time	Direction	Command/Data	Description
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. DEBUG TARGET BOARD VIA GUI SOFTWARE

8.1 Connection Block Diagram

As shown in Figure 8-1 below, the EzISP board can be connected to the customer's target board to configure touch keys through the GUI interface.

Figure 8-1: Block diagram of EzISP Board connection to the customer's target board

As shown in Figure 8 2 below, the EzISP Board needs five pins to connect to the customer's target board. The five pins are VCC, GND, RSTN, SCL, and SDA.

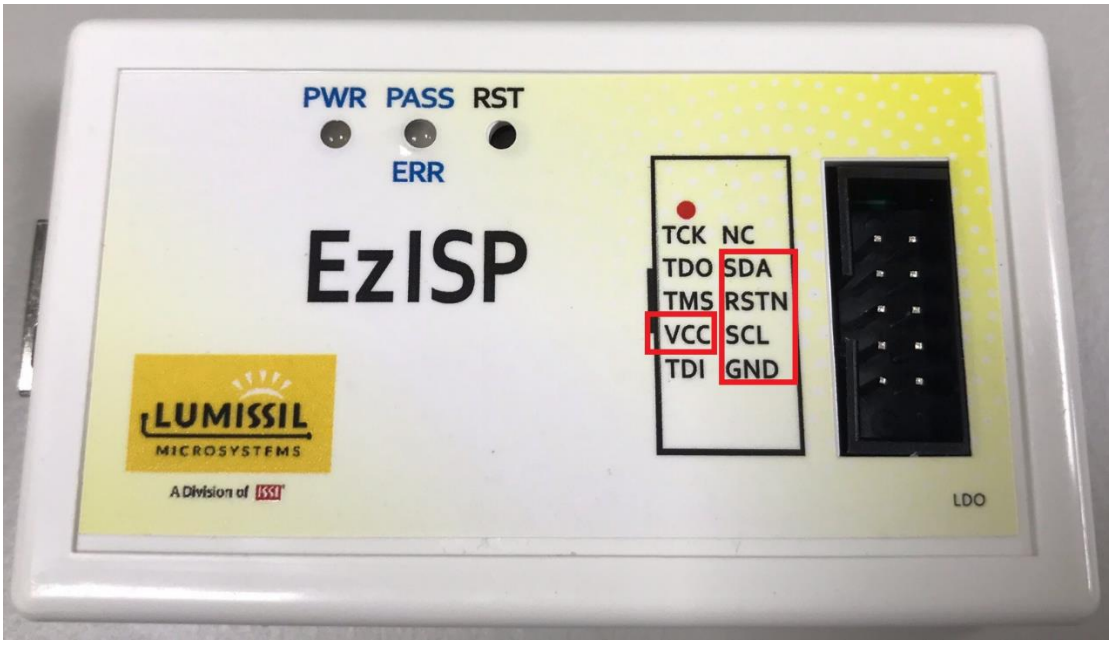


Figure 8-2: Pin configuration on EzISP board

8.2 Customer Target Board Configuration by GUI

Users can run SE5118A Touch Key GUI software for own target boards 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 the development time.

REVISIONS

Revision	Detailed Information	Date
0A	Initial Release	2020.10.20
A	Formal Release Update SE5118 GUI v2.1	2021.12.30
B	1. Add Windows System Requirements at Section 2.1 Software Requirements for how to do EZISP software installation and requirements 2. Add RSTN pin along with VCC, GND, SDC and SDL pins for EzISP board connecting with SE5118 board to run SE5118 Touch Key GUI tool. This description is at Section 8.1 Connection Block Diagram 3. Fix some typos and reword content for clear descriptions 4. Add EzISP support for Windows 11 in addition to Win XP, Vista, and Win 7 to Win 10 support 5. Add Section 2.3 Upgrade Boot Code and Standard Code 6. Change file name from "IS31SE5118 Eval Board User's Manual" to "IS31SE5118 Eval Board User's Manual	2022.12.29
C	1. Update to support SE5118A Touch Key GUI 3.0 2. Add more descriptions for "Detect" and "Connect" statuses handling in Section 3.2 Connect Status 3. Change export/import Configuration File format from csv to excel. Please refer to 3.3 Export/Import Configuration File 4. Add Section 3.8 Generate Sample Code 5. Add 4.2.1 System Clock 6. Add 4.2.3 TK3 Touch Key Clock 7. Add information about system clock and duration per touch key scan in Section 4.2.2 Cycle Count Per Key Scan 8. Add information about how spread spectrum affects IOSC frequency accuracy and EMI in Section 4.2.9 Spread Spectrum 9. Add more information about Jitter, Media, Average, and IIR filters in Section 4.3.4 Raw Count Filter 10. Update Section 4.3.1 Multi Key 11. 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 12. With firmware 3.0, reading register 7 can acquire key status and clear interrupt. Please refer to Case 1. Click Interrupt Enable of Section 4.3.5 Interrupt. For firmware 2.0, reading register 6 can acquire key status and clear interrupt 13. Change file name from "IS3xSE5118 Eval Board User's Manual" to "IS31SE5118A Eval Board User's Manual_C" 14. Add SE5118A EVB order information "IS31SE5118A-ZNLS3-EBGUI" for new firmware 3.0 support 15. Update 2.1 Software Requirements 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	2023.06.28