Airoha IoT SDK for BT Audio LE Audio Dongle User Guide

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Document revision history

Revision	Date	Description
0.7	30 December 2022	Initial version
0.8	27 March 2023	Updated the document to support AB156x/ AB157x/ AB158x
0.9	28 August 2023	• Added environment chapter • Added I2S-In and Line-In chapter

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1. Introduction

Airoha LE Audio dongle conforms to the SIG LE Audio specification. It works as a CAP initiator and can transmit and receive unicast audio streams and transmit broadcast audio streams.

1.1. Platform Architecture

Airoha LE Audio dongle platform consists of application, middleware and BSP layers as shown in Figure 1. LE Audio profiles and services are implemented in the middleware and the connection logic is implemented in the application dongle_ref_design.

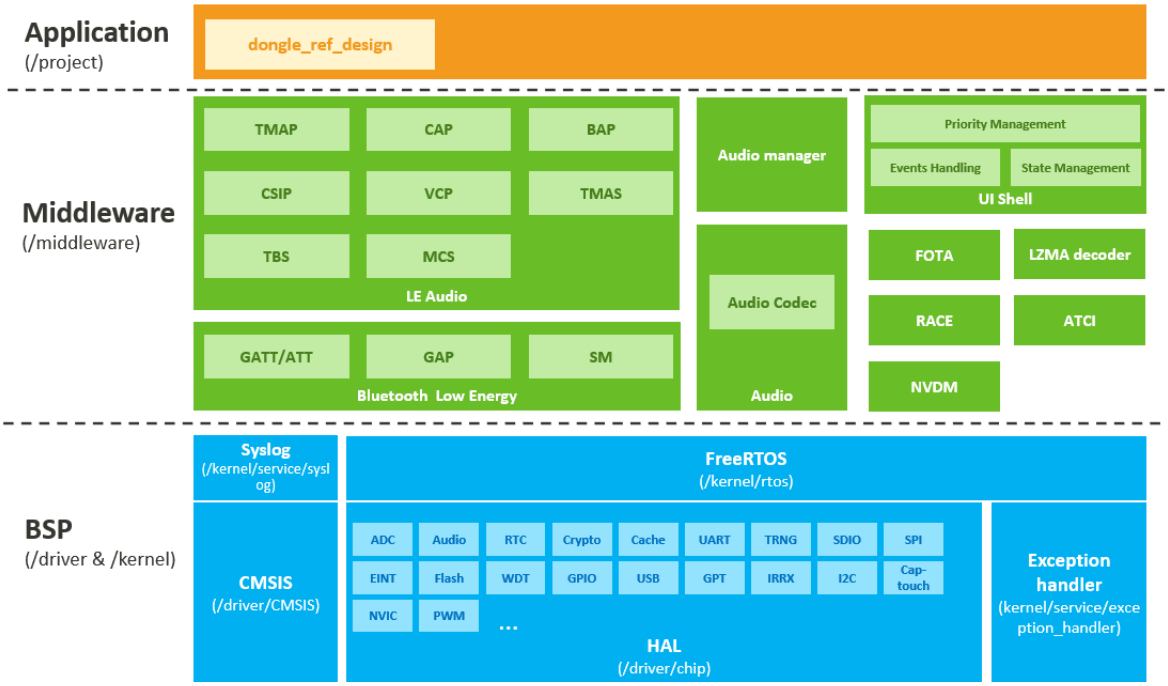

Figure 1. Software architecture

1.2. EVK Settings

Power is usually supplied to the LE Audio dongle via the USB port. Set the two marked jumpers as shown in Figure 2. To power the AB158x EVK via the USB port, you must connect the USB port to a PC. Do not use the adaptor.

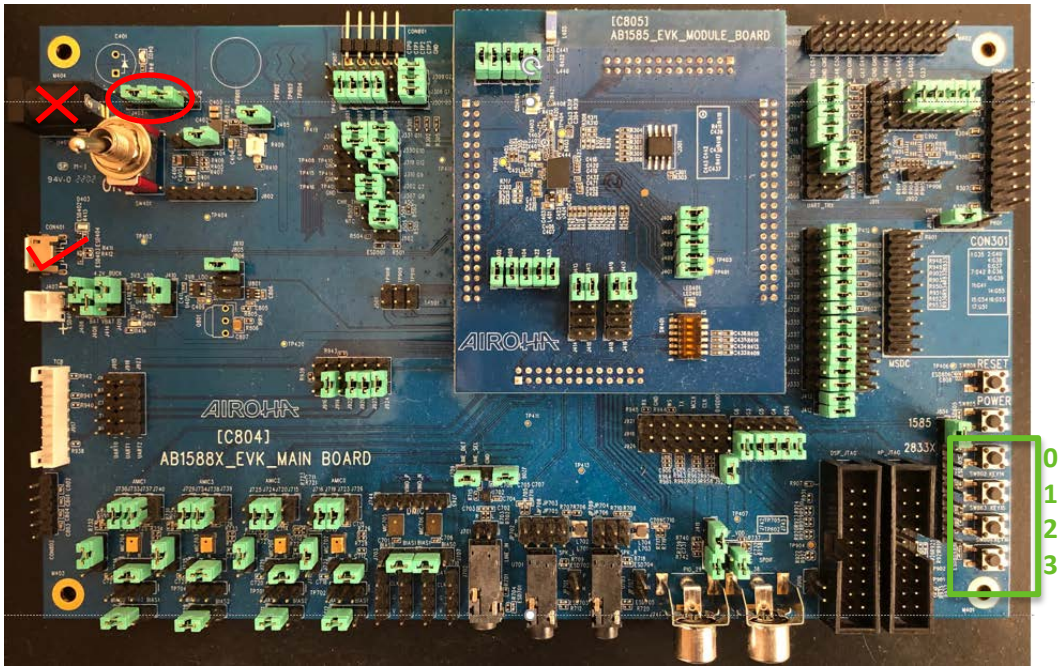

Figure 2. EVK settings

1.3. Environment

1.3.1. Set up build environment

Set up the build environment and run your project with the Airoha IoT SDK, refer to

`mcu/doc/Airoha_IoT_SDK_for_BT_Audio_Get_Started_Guide.pdf`

`mcu/doc/Airoha_IoT_SDK_for_BT_Audio_Build_Environment_Guide.pdf`

1.3.2. Build project command

You can check the build command by "./build.sh list". This command is now for building the LE Audio Dongle project for 1565 dongle as shown in Figure 3.

```
./build.sh ab1565_evk leaudio_dongle
```

Figure 3. Build command

2. Unicast

The LE audio dongle acts as a Unicast Client of Basic Audio Profile (BAP) which scans for advertisements from Unicast Servers and initiates connections to Unicast Servers.

2.1. Feature Options

Set the feature options below to 'y' in the feature makefiles of the DSP project and MCU project to enable the LE audio dongle.

Feature makefile path for DSP project:

- `dsp\project\ab158x\apps\[DSP_project_name]\XT-XCC`

Feature makefile path for MCU project:

- `mcu\project\ab158x\apps\[MCU_project_name]\GCC`

Table 1. LE Audio Dongle Feature Options

Feature option	Note
AIR_LE_AUDIO_ENABLE = y	Set this option to y for both DSP project and MCU project to enable LE Audio.
AIR_LE_AUDIO_DONGLE_ENABLE = y	Set this option to y for both DSP project and MCU project to enable LE Audio dongle features. Dependency: AIR_LE_AUDIO_ENABLE must be enabled when this option is set to y.
AIR_LE_AUDIO_MULTI_DEVICE_ENABLE = y	Set this option to y for MCU project to support the multi-device scenario. Dependency: AIR_LE_AUDIO_DONGLE_ENABLE must be enabled when this option is set to y.

2.2. Connection Setup

2.2.1. BT on

Airoha LE audio dongle turns BT on when USB resumes and turns BT off when USB is suspended. For example, if the dongle is plugged into a notebook via USB, BT turns on at first. After a period of time, if the notebook goes into the sleep mode, BT turns off.

2.2.2. Scan Behavior

The LE audio dongle scans the advertisement of LE audio headset or LE audio earbuds whenever a new connection is allowed.

2.2.2.1. Scan with no Bonded List

The scan behavior depends on whether there is a bonded list. When there is no bonded list, for a headset, the LE Audio dongle scans the advertisement with ASCS UUID to discover headsets supporting LE audio. For earbuds, based on the current design, the LE Audio dongle scans the advertisement with RSI to discover earbuds using the same SIRK. Therefore, the same SIRK should first be set to both the dongle and earbuds.

2.2.2.2. SIRK Configuration

The SIRK is a 128-bit long random number. The method used to generate the SIRK must meet the criteria for random number generation as defined in Volume 2, Part H, Section 2 of Bluetooth Core Specification v5.3.

The SIRK can be set during the manufacture of the dongle. The NVKEY (0x1900) is used for SIRK storage. It can be configured using the Config Tool as shown in Figure 4. For earbuds, different pairs of earbuds must use a different SIRK.

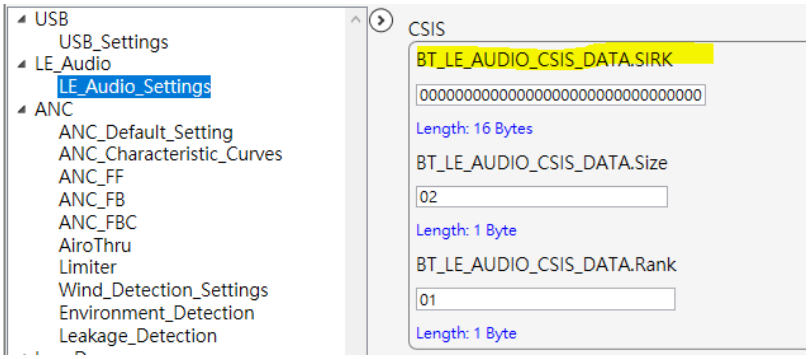

Figure 4. SIRK Configuration

2.2.2.3. Scan with a Bond List

When there is a bonded list, the dongle sets the bond list into the white list and scans for advertisements from only the white list. It only connects to devices on the bond list.

2.3. Connection

The LE audio dongle automatically initiates an LE connection when it discovers a target device.

If there is a microphone USB port enabled, the LE audio dongle enters call mode and creates a bi-directional CIS connection to prepare for a PC call. If there is only speaker USB port enabled, it enters media mode and only unicast CIS is created for PC music.

2.3.1. Headset CIS Connection

Figure 5 shows the headset CIS connection for media mode. Figure 6 shows the Headset CIS connection for call mode.

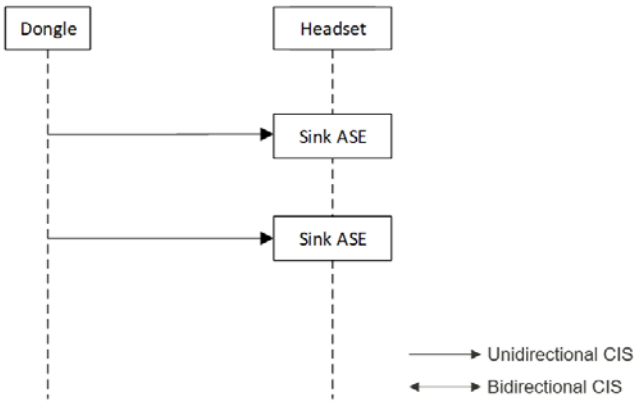

Figure 5. Headset CIS connection for media mode

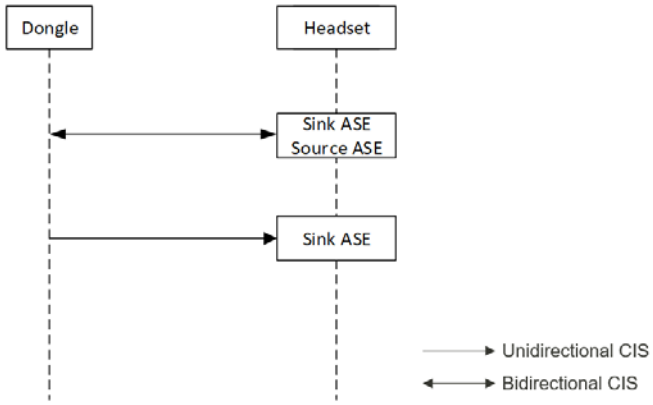

Figure 6. Headset CIS connection for call mode

2.3.2. Earbuds CIS Connection

Figure 7 shows the earbuds CIS connection for media mode. Figure 8 shows the Headset CIS connection for call mode.

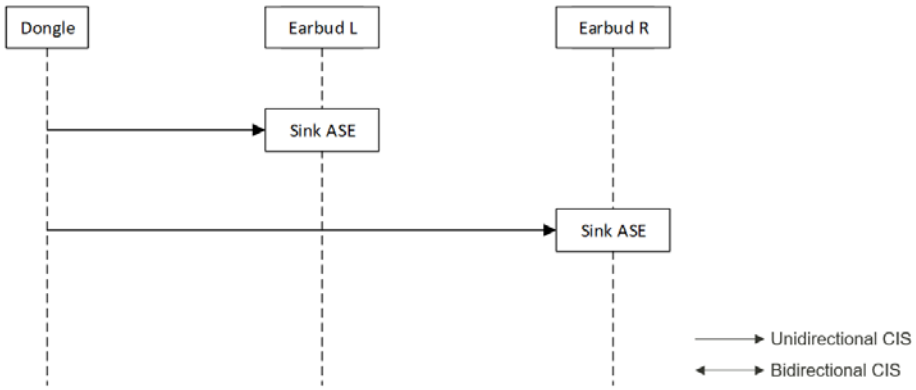

Figure 7. Earbuds CIS connection for media mode

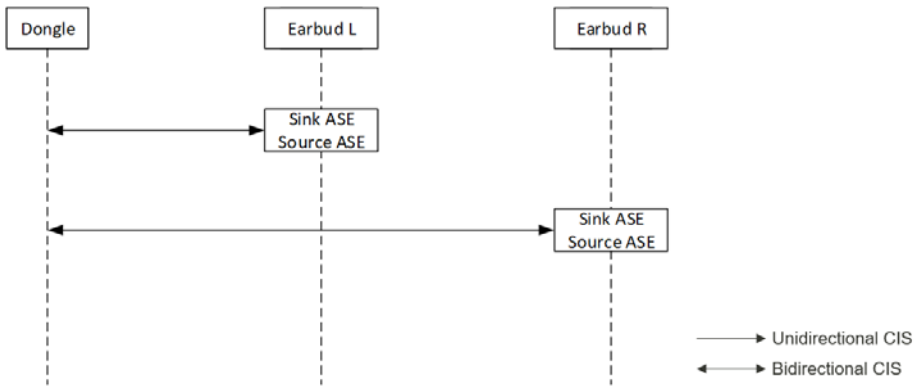

Figure 8. Earbuds CIS connection for call mode

2.4. Volume

This section shows the MMI functions related increasing or decreasing the volume of the speaker and microphone, and how to mute or unmute the microphone.

2.4.1. Changing the volume

You can adjust the sound level of output of Line out and I2S out for a wireless MIC receiver.

Table 2. Speaker Volume

Functionality	Actions	Results	Requirements
Volume up	Press EINT_KEY_0.	NA	In connected, or playing music.
Volume down	Press EINT_KEY_1.	NA	In connected, or playing music.

Because the uplink or downlink with PC is through USB, you can fine-tune the volume on PC.

2.5. Call

Refer to `mcu/doc/AB158x_Series_Earbuds_Reference_Design_User_Guide.pdf` for more information.

2.6. Music

Refer to `mcu/doc/AB158x_Series_Earbuds_Reference_Design_User_Guide.pdf` for more information.

3. Broadcast

Airoha LE audio dongle can transmit broadcast audio streams from USB, Line-in and I2S.

3.1. Feature Options

Refer to 2.1 to enable LE audio dongle first. Set AIR_LE_AUDIO_BIS_ENABLE to y to enable LE Audio broadcast in the feature makefile of MCU project.

Feature makefile path for MCU project:

- `mcu\project\ab158x\apps\[MCU_project_name]\GCC`

Table 3. LE Audio Broadcast Feature Option

Feature option	Note
AIR_LE_AUDIO_BIS_ENABLE = y	Set this option to y to enable LE Audio broadcast. Dependency: AIR_LE_AUDIO_ENABLE must be enabled when this option is set to y.

3.2. Switch Dongle Mode

The LE audio dongle supports both LE Audio unicast mode and LE audio broadcast mode. However, only one mode can be running at a time. Currently, the default mode is unicast mode.

AT+LEAUDIO is used to switch the dongle between unicast mode and broadcast mode.

Table 4. Switch Dongle mode

AT CMD	Description
AT+LEAUDIO=BROADCAST,START	Change to Broadcast mode
AT+LEAUDIO=UNICAST,START	Change to Unicast mode

3.3. Control Broadcast

AT CMD command below is used to enable or disable LE Audio broadcast.

Table 5. Control Broadcast

Functionality	AT CMD	Response
Enable Broadcast	AT+LEAUDIO=BROADCAST,START	Broadcasting…
Disable Broadcast	AT+LEAUDIO=BROADCAST,STOP	Broadcast stopped

3.4. Test the Broadcast

Complete the subsequent procedure to use the broadcast function with LE audio headset or LE audio earbuds:

1) Switch to broadcast mode. Refer to Section 3.2 for more information.

2) Triple-click the power key of Airoha LE audio headset or earbuds to enter the broadcast mode in the headset or earbuds side. For more information, refer to `mcu/doc/AB158x_Series_Earbuds_Reference_Design_User_Guide.pdf`.

3) Play music on PC. The music should be heard in the earbuds or headset side.

4. I2S-In

Airoha LE audio dongle can transmit unicast and broadcast audio streams from the interface I2S. The I2S-in for unicast is only for demo purpose.

4.1. Feature Options

Set the feature options as below in the feature makefiles of the DSP project and MCU project to enable the I2S-In.

Feature makefile path for MCU project:

- `mcu\project\$(BOARD)\apps\[MCU_project_name]\GCC`

Feature makefile path for DSP project:

- `dsp\project\$(BOARD)\apps\dsp0_headset_ref_design\XT-XCC`

Table 6. LE Audio Dongle Feature Options for I2S-In

Feature option	Note
LINE_IN_I2S_SLV_IN = I2S_SLV_IN	This option is to choose the type of dongle afe in type. This option is to choose the type of dongle afe in type. NONE: not support afe in. LINE_IN: Only support line in. I2S_MST_IN: Only support i2s master in. I2S_SLV_IN: Only support i2s slave in. LINE_IN_I2S_MST_IN: Support line in and i2s master in, but can't playback at the same time. LINE_IN_I2S_SLV_IN: Support line in and i2s slave in, but can't playback at the same time.
AIR_AUDIO_SILENCE_DETECTION_ENABLE = n	This option is used to enable/disable silence detection feature.

4.2. Config I2S-In

Use Config Tool to config I2S-In.

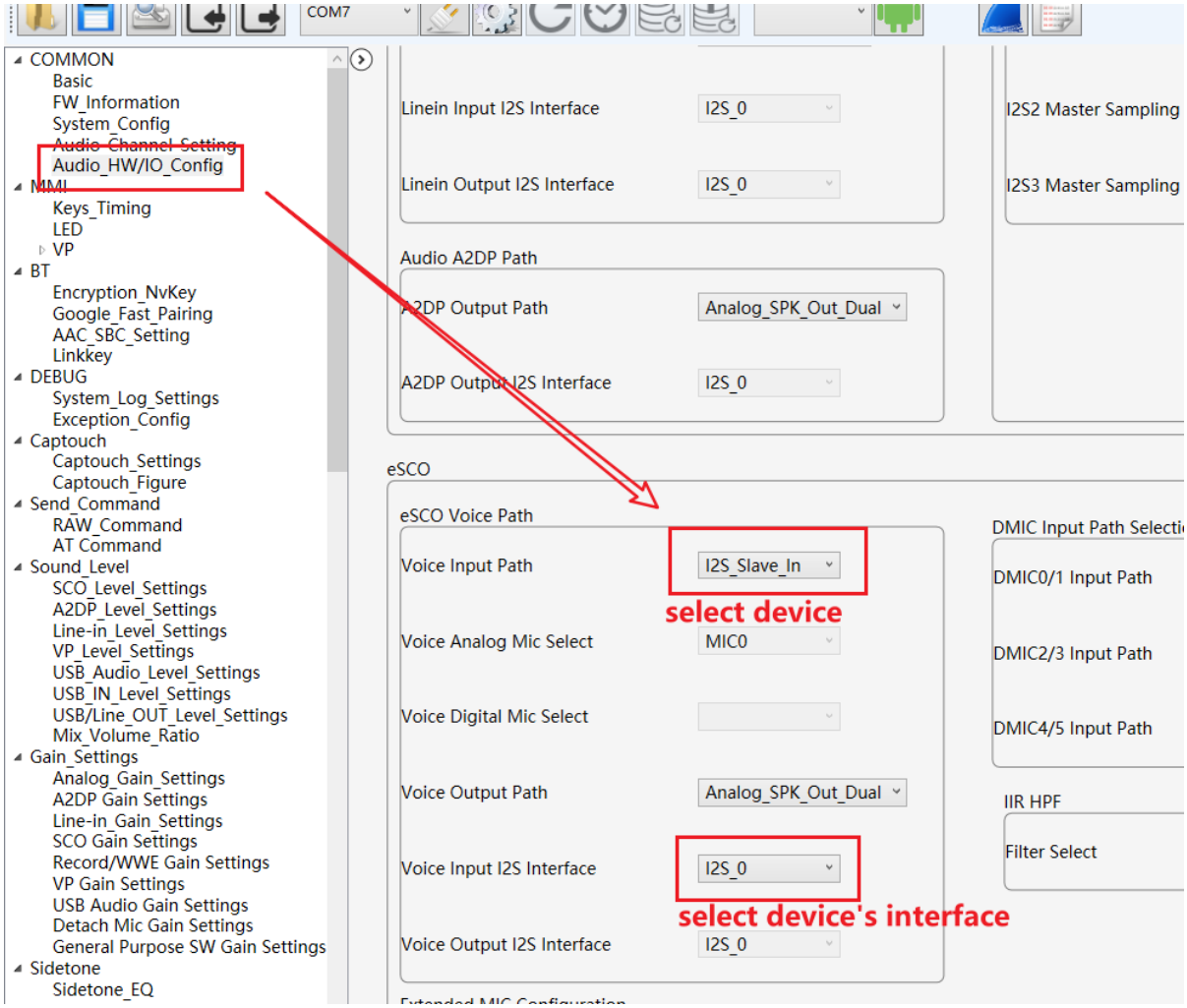

Figure 9. Config Tool to config I2S-In

4.3. I2S-In hardware interface

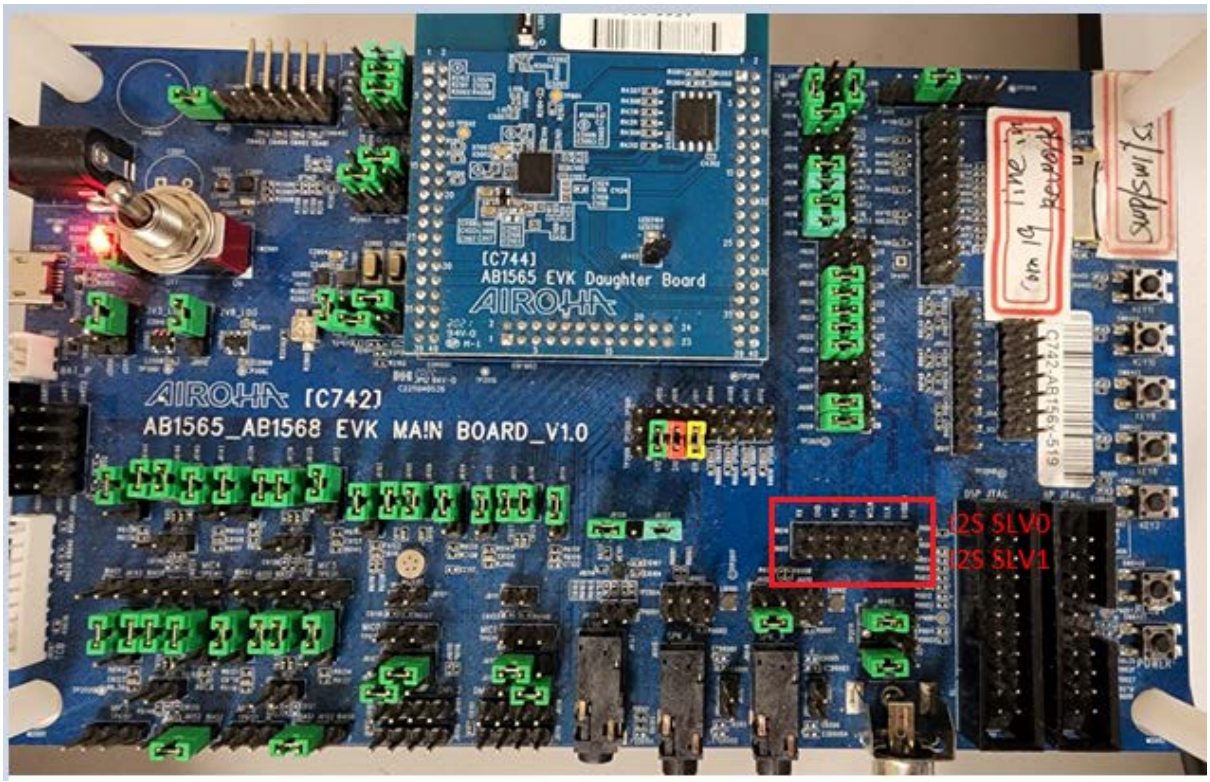

Figure 10. I2S-In hardware interface

4.4. AT Command on dongle

I2S-In Play:

AT+I2S_IN_DET=1,0x2000,1,48000,2,1

I2S-In Stop:

AT+I2S_IN_DET=0

5. Line-In

Airoha LE audio dongle can transmit unicast and broadcast audio streams from the interface Line-In. The Line-in for unicast is only for demo purpose.

5.1. Feature Options

Set the feature options as below in the feature makefiles of the DSP project and MCU project to enable the Line-In.

Feature makefile path for MCU project:

- `mcu\project\ab156x\apps\[MCU_project_name]\GCC`

Feature makefile path for DSP project:

- `dsp/project/$(BOARD)/apps/dsp0_headset_ref_design/XT-XCC/`

Table 7. LE Audio Dongle Feature Options for Line-In

Feature option	Note
LINE_IN_I2S_SLV_IN = LINE_IN	This option is to choose the type of dongle afe in type. NONE: not support afe in. LINE_IN: Only support line in. I2S_MST_IN: Only support i2s master in. I2S_SLV_IN: Only support i2s slave in. LINE_IN_I2S_MST_IN: Support line in and i2s master in, but can't playback at the same time. LINE_IN_I2S_SLV_IN: Support line in and i2s slave in, but can't playback at the same time.
AIR_AUDIO_SILENCE_DETECTION_ENABLE = n	This option is used to enable/disable silence detection feature.

5.2. Config Line-In

Use Config Tool to config the volume of Line-In.

5.2.1. Adjust software input volume

The general configuration is the maximum.

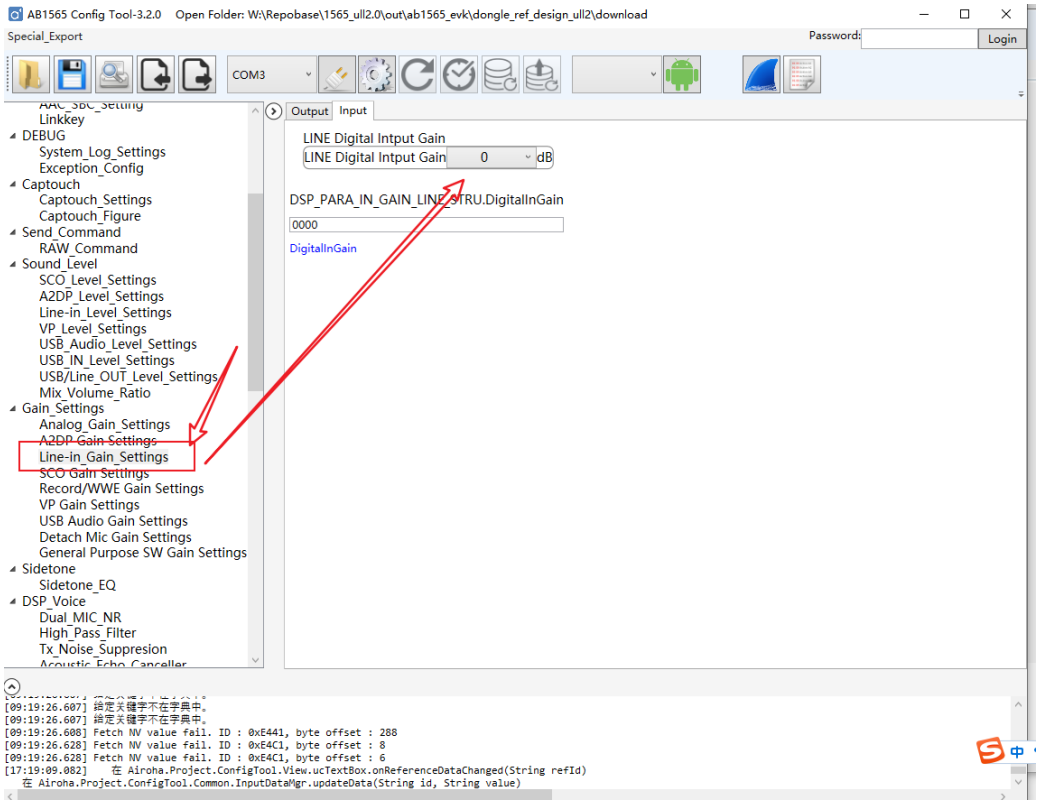

Figure 11. Line-In software volume setting

5.2.2. Adjust hardware input volume

Generally, the minimum configuration is enough. The software may have temporary problems and cannot be configured.

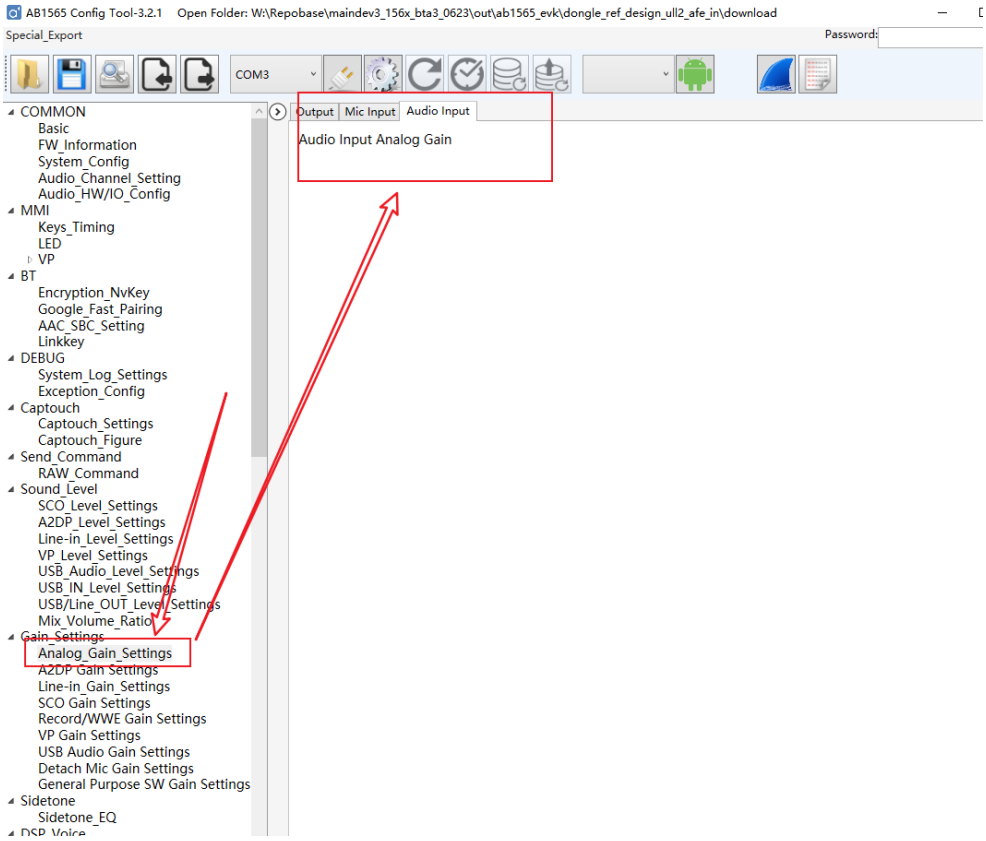

Figure 12. Line-In hardware volume setting

5.3. Line-In hardware interface

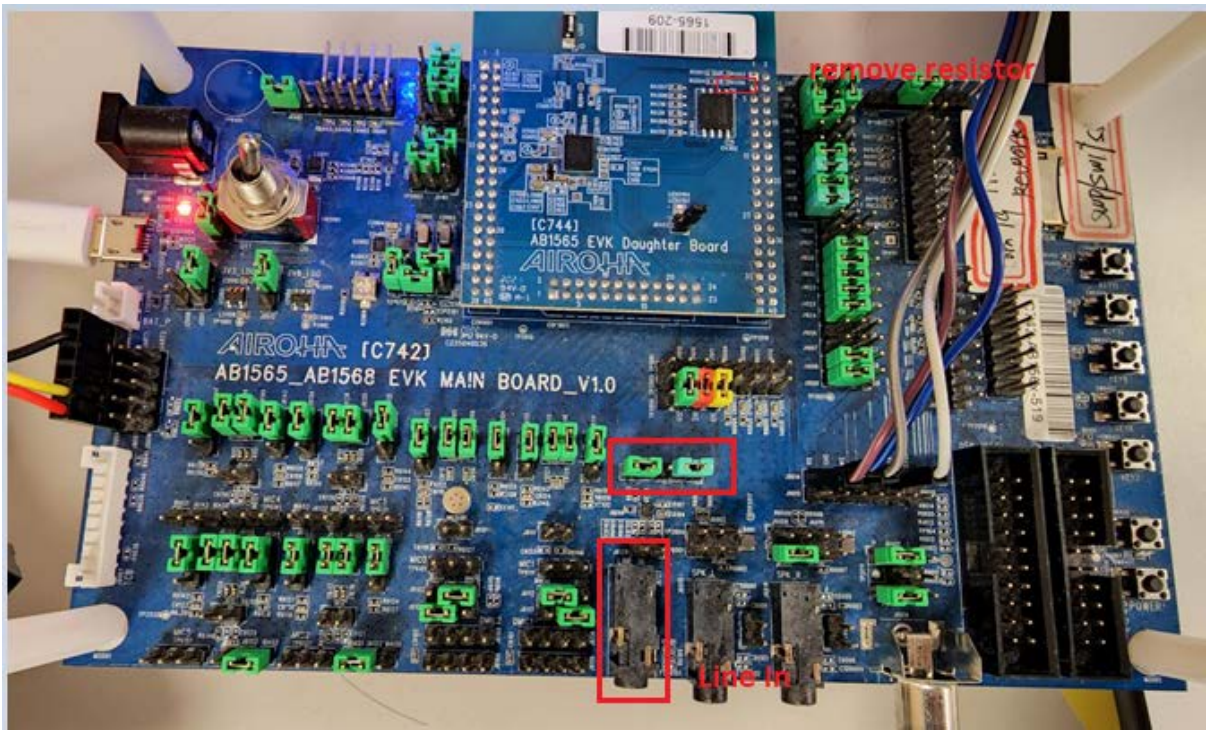

Figure 13. Line-In hardware interface

5.4. AT Command on dongle

If you do not remove the resistor, you can use the AT command to manually trigger the Line-In.

Line-In Play:

AT+LINE_IN_DET=1

Line-In Stop:

AT+LINE_IN_DET=0