

# LC823450XGEVK

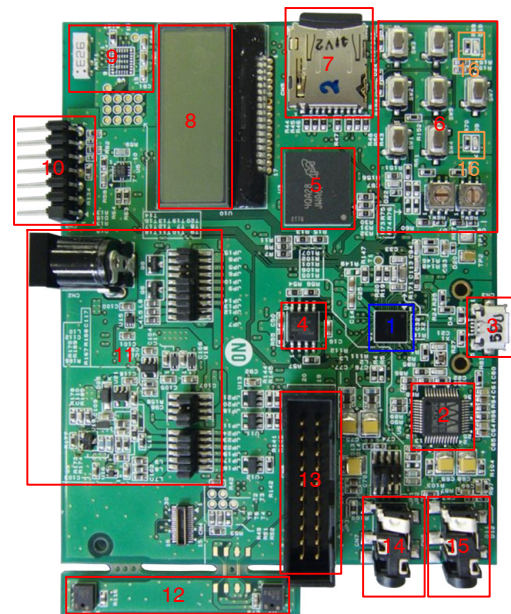
## Low Power & High-Resolution Audio Processing System LSI Evaluation Board User's Manual



ON Semiconductor®

[www.onsemi.com](http://www.onsemi.com)

### EVAL BOARD USER'S MANUAL



- |                 |                         |
|-----------------|-------------------------|
| 1 LC823450      | 9 Bluetooth             |
| 2 Audio CODEC   | 10 UART Connector       |
| 3 USB Connector | 11 Power Supply Control |
| 4 Serial Flash  | 12 Digital Mic          |
| 5 eMMC          | 13 Debugger Connector   |
| 6 Switches      | 14 Headphone            |
| 7 microSD™      | 15 Line Input           |
| 8 LCD           | 16 LEDs                 |

Figure 1. Evaluation Board Picture

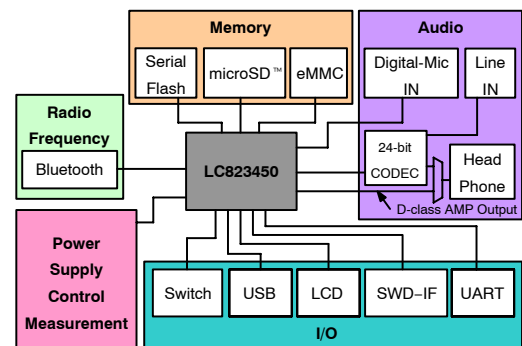


Figure 2. Block Diagram of LC823450XGEVK

### Overview

LC823450XGEVK is an evaluation board for LC823450 Series (called LC823450 hereafter) which is a low power & high-resolution audio processing system LSI for portable sound solution. This user's manual describes the features, design, and operation of the evaluation board.

Intended audience is customers who are building audio application using LC823450.

### Key Features

- File Transfer with Connecting PC by USB
- Standalone Music Playback with Hi-Resolution Audio
- Sound Recording with Noise Cancelling
- Music Streaming from Bluetooth® Connected Device
- Hands Free Talk with Bluetooth Connected Device
- Audio Signal Transfer with Connecting PC by USB (UAC1.0)
- Measurement of Current Consumption with Jumpers

### Circuit Description

Figure 1 shows some main parts on the picture of LC823450XGEVK. The part painted in blue is LC823450, and the parts drawn on the figure are explained in this section. Figure 2 shows the block diagram describing simple connection between LC823450 and other parts on the evaluation board. There are power modules, I/O functions, audio functions, memories, Radio Frequency functions on the board.

#### LC823450:

It is a low power & high-resolution audio processing system LSI which is a target to be evaluated, and it has Cortex®-M3 Dual cores, a LPDSP32, 1,656 kB internal SRAM for system, 256 kB ROM for Cortex-M3, 220 kB ROM for LPDSP32.

Then, it has MP3 hard-wired encoder and decoder, some DSP functions like WMA, AAC, etc made by LPDSP32, D-Class AMP for headphone, SD card I/F, USB2.0 Host and Device, timers, RTC, etc.

LC823450XGEVK implements a WLP package of LC823450 with 24 MHz Xtal.

#### Power Supply Control:

It has a power supply connector for AC adapter and the voltage level is DC 5 V. There are regulators in Power Area on LC823450XGEVK, and all the power sources used in the evaluation board are made by the regulators based on the DC 5 V, and they are delivered to all the power terminals of all the parts in the evaluation board.

# LC823450XGEVK

Power terminals of LC823450 are connected through each jumper post to the power sources, so you can measure the current consumption if you insert an ammeter to each jumper post of the power terminals.

### USB Connector:

It is a connector for USB, and it is used to connect the evaluation board to a PC. If LC823450 is used as USB device, you can work whole of LC823450XGEVK with USB bus power supply as well without the AC adapter connection.

### UART Connector:

The UART connector is a 7-way 2.54 mm pitch connector. It is a connector for UART, and it is used to connect to a PC or an external device. Also, it is used to debug firmware of LC823450 through terminal window on PC. The UART connector pinout is shown in Figure 3 and UART interface pinout table is shown in Table 1.

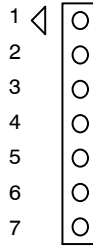


Figure 3. UART Connector Pinout

Table 1. UART INTERFACE PINOUT

Pin	Signal	Pin	Signal
1	NC	2	GND
3	NC	4	VddSD2
5	RXD0	6	TXD0
7	NC		

### Debugger Connector

The Debugger connector is a 20-way 2.54 mm pitch connector called ARM JTAG 20 connector as usual. It can be used in Serial Wire Debug (SWD) mode.

The Debugger connector pinout is shown in Figure 4 and Debugger interface pinout table is shown in Table 2. LC823450 supports Serial Wire Debug Port (SW-DP) among three debugging ports which Cortex-M3 system implements. The Serial Wire Data I/O pin (SWDIO) sends and receives serial data to and from LC823450 during debugging. The Serial Wire Clock pin (SWDCLK) clocks data into and out of LC823450 during debugging. The System Reset pin (nRST) is used to fully reset LC823450. This signal can be initiated by IDE or by SW1 on the board (which is then detected by IDE). nRST is pulled HIGH on the board and pulled strong-LOW to initiate a reset.

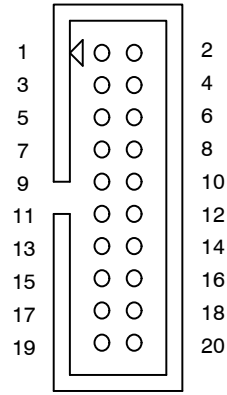


Figure 4. Debugger Connector Pinout

Table 2. DEBUGGER INTERFACE PINOUT

Pin	Signal	Pin	Signal
1	Vdd2	2	Vdd2
3	10 kΩ PU	4	GND
5	NC	6	GND
7	SWDIO	8	GND
9	SWDCLK	10	GND
11	10 kΩ PD	12	GND
13	10 kΩ PU	14	GND
15	nRST	16	GND
17	NC	18	GND
19	10 kΩ PD	20	GND

In addition, there is no debugger connector which is JTAG interface for LPDSP on the evaluation board.

### Switches:

There are some switches on the evaluation board. The switch of SW1 is used to reset LC823450, and the switches of SW2–SW7 are used to operate audio control, for example, the volume control, playback control, mode control, etc.

On the other hand, there are 2 rotary switches of RSW1 and RSW2 which are used to determine the boot mode of LC823450. RSW1 is connected to BMODE0 on LC823450 and RSW2 is connected to BMODE1 on LC823450 respectively.

LC823450XGEVK can realize two types of boot and update mode by setting BMODE0 and BMODE1. The one is User Area Boot USB mode and the other is SPI Boot SD mode. Therefore, you should set RSW1 and RSW2 to select boot and update mode as shown in Table 3 and Figure 5. In User Area Boot USB mode, the user area of eMMC is used as the boot device and USB is used as the update device. Then, the Initial Program Loader 2 (IPL2) and application program are stored into eMMC, and LC823450 is booted from eMMC. In SPI Boot SD mode, SPI Flash is used as the

# LC823450XGEVK

boot device and SD Card is used as the update device. Then IPL2 and application program are stored into SPI Flash, and LC823450 is booted from SPI Flash. In initial state after LC823450XGEVK shipping, the original IPL2 and application program made by ON Semiconductor is stored into the boot device.

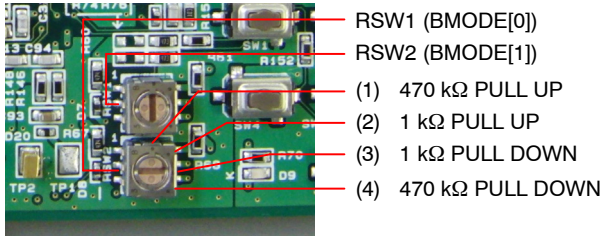


Figure 5. Rotary Switch

Table 3. BOOT MODE SETTING

Mode	RSW2 (BMODE[1])	RSW1 (BMODE[0])
User Area Boot USB	1 kΩ PD (3)	470 kΩ PU (1) 470 kΩ PD (4)
SPI Boot SD	470 kΩ PD (4)	1 kΩ PU (2)

## LEDs:

There are 2 LEDs on the evaluation board as shown in Figure 6. D9 is connected to GPIO00 on LC823450 for general purpose. D10 is connected to GPIO2F on LC823450 for update the boot device. If you want to upload a new IPL2 and application program into the boot device, D10 is used to inform you the timing of erase running or erase completion of the boot device as shown in Table 4.

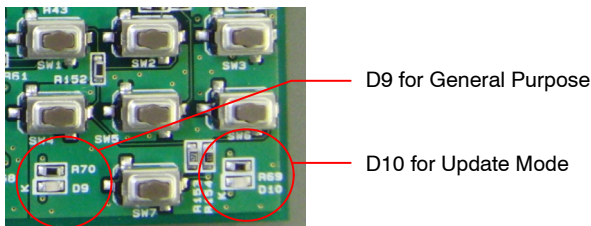


Figure 6. LED D9 and D10

Table 4. LED FOR UPDATE MODE

D10	Message
Turning On	Erase completion of boot device
Blinking	Erase running of boot device

## LCD:

It is a graphic LCD which is the size of vertical 48 dots × horizontal 128 dots, and a character size is 8 × 8 dots. The LCD can display black and white characters of row 6 × column 16, and it is connected to LC823450 with Serial Peripheral Interface.

## eMMC (ch0)/microSD (ch1):

They are used to store files of audio contents which have each audio codec formats, MP3, WAV, WMA, AAC or FLAC. File system is adapted to them, and you can see the files on PC if you connect USB. eMMC is connected to SD Card Interface ch0. microSD is connected to SD Card Interface ch1.

## Audio Codec:

It is an external 24-bit 192 kHz stereo codec and it can deal with High Resolution Audio. It is connected to PCMIF0 on LC823450 and it is output to stereo head phone jack. Then, you can select either this audio codec output or internal D-AMP output on LC823450 as audio output by setting jumper post as shown in Figure 7 and Table 5.

In addition, it corresponds to Line input as well on the evaluation board by option. If you use Line input, you can import audio contents into LC823450 by converting analog to digital in the Audio codec.

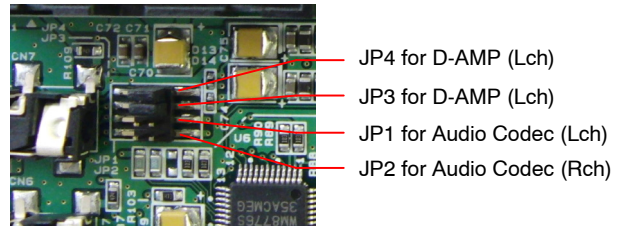


Figure 7. Jumper Post JP1, JP2, JP3 and JP4

Table 5. AUDIO OUTPUT SELECTION

Output	JP1	JP2	JP3	JP4
Audio Codec	ON	ON	OFF	OFF
D-AMP (Default)	OFF	OFF	ON	ON

## Digital MIC:

It is a general MEMS mic, and it is implemented in the small board separated outside to prevent noises from the main board.

Since the signal between data of Digital mic input and data of Audio codec for Line input is common in the evaluation board, so you can use either Digital mic input or Line input by setting 0 Ω resistor as shown in Figure 8 and Table 6. Digital mic is available by default and then you can use Line input function if you change the 0 Ω resistor of R4 to R5.

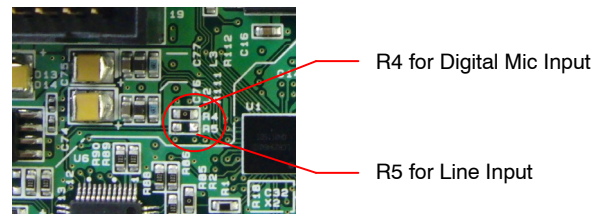


Figure 8. 0 Ω Resistor R4 and R5

# LC823450XGEVK

**Table 6. AUDIO INPUT SECTION**

Function	R4	R5
Digital Mic Input (Default)	0 Ω	Open
Line Input	Open	0 Ω

## Firmware Description

LC823450XGEVK can select boot device either eMMC or SPI Serial FLASH by setting of two rotary switches, RSW1 and RSW2 as shown in Figure 5. Each boot device can realize same functions. LC823450XGEVK can realize various functions by changing boot setting. Table 7 shows the list of functions depending on boot setting. You should select it depending on your desired function.

For example, “LC8234xx\_17S\_fw\_data\_emmc.bin” is a binary file for eMMC boot and USB update.

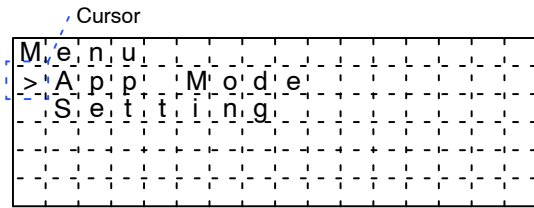
**Table 7. FUNCTIONS OF EACH SOFTWARE**

<b>Portable:</b> <ul style="list-style-type: none"> <li>- Standalone Playback with Hi-Resolution audio</li> <li>- Standalone Recording with Noise Cancelling</li> <li>- USB Audio Streaming Playback with Hi-Resolution audio</li> <li>- USB Audio Streaming Recording with Hi-Resolution audio</li> <li>- USB Mass Storage Class</li> </ul>
<b>BT Headset:</b> <ul style="list-style-type: none"> <li>- A2DP Streaming from BT connected device</li> <li>- Hands free talk with BT connected device</li> <li>- Standalone Playback</li> <li>- USB Mass Storage Class</li> </ul>
<b>BT Earbuds M/S:</b> <ul style="list-style-type: none"> <li>- A2DP Streaming with WS2 from Bluetooth connected device</li> <li>- Standalone Playback with WS2</li> <li>- USB Mass Storage Class</li> </ul>
<b>BT Speakers:</b> <ul style="list-style-type: none"> <li>- A2DP Streaming from Bluetooth connected device</li> <li>- Standalone Playback</li> <li>- USB Mass Storage Class</li> </ul>

## Power ON

LC823450XGEVK can select boot device either eMMC or SPI Serial FLASH. Therefore, you should select boot device by rotary switches before power on as shown in Figure 5.

In order to supply the power for LC823450XGEVK, you should connect it to your PC with a USB cable. When you connect the evaluation board to your PC for the first time, LC823450 will boot up and display the characters of “Menu” on LCD shown in Figure 9. You should push SW5 in order to select App Mode or Setting in Menu moving the cursor by SW2 or SW7.

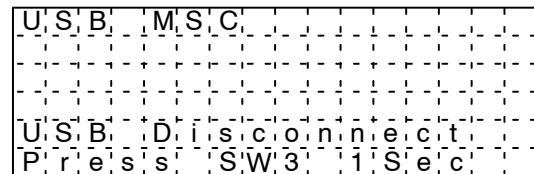


**Figure 9. Display at Menu after the First Power ON**

When you select App Mode in Menu, only USB Mode appears in App Mode Menu. If you select USB Mode in App Mode, LC823450XGEVK is recognized as a removable disk on your PC.

## USB Mass Storage Mode

If you select USB Mode in App Mode, the display of LCD will soon change to Figure 10 and USB connection will start.



**Figure 10. Display at USB Connection**

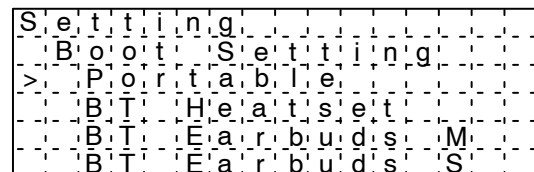
The storage device on LC823450XGEVK, eMMC and SD card (when SD card was inserted in drive) will be recognized as the drive by PC. However, the recognition of another drive may not be possible depending on software. If you want to put the music files to be played back, you need to create the folder named “music” at first, and put the music files into “music” folder. LC823450 can recognize the music files up to 99 in “music” folder.

LC823450 can support the audio file format as follows, MP3, WAV, WMA and AAC. Especially in the case of Hi-Res application, LC823450 can support also FLAC.

If you want to get away from USB MSC mode, you should push SW3 for long time and you will jump back to the previous application mode before USB MSC mode. eMMC/SD Card is released from USB Mass Storage Class and the window of eMMC/SD Card on your PC will be disappeared.

## Boot Setting

When you select Setting in Menu, you can select Boot Setting for the selection of the functions of LC823450XGEVK as shown in Figure 11. You should select it depending on your desired function.



**Figure 11. Display at Boot Setting**

# LC823450XGEVK

Please note that your selection of boot setting will be stored into LC823450XGEVK. Therefore, this selection always will be applied every power ON and reset. If you want to change the boot setting, you should push SW1 while keeping of pushing SW3. Then, Menu display will be appeared again as shown in Figure 9.

## Software Update

In order to change or update the firmware stored in boot device, you should execute the firmware erasing and writing. Please refer to “LC823450XGEVK\_FW\_writing\_Manual.pdf”.

## Portable Mode

Portable mode can realize Standalone Music Playback with Hi-Resolution audio, Sound Recording with Noise Cancelling and Audio Signal Transfer via USB (UAC1.0). Please note that because this mode handles Hi-Resolution audio, it is necessary to use external codec implemented on LC823450XGEVK. Therefore, you should select audio codec output by setting jumper post as shown in Figure 7 and Table 5 in advance.

After you select Portable in Boot Setting, LC823450 will boot up and display the characters of “Player Stop” on LCD shown in Figure 12. This Music Player mode will start as initial state after power on at Portable mode.

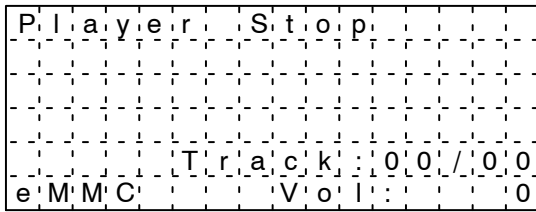


Figure 12. Display at Initial of Portable Mode

When you push SW3 for long time, the display of LCD will soon change to Figure 13. Figure 13 is the menu display to select application or set configuration for Portable mode.

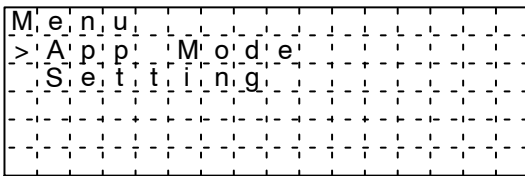
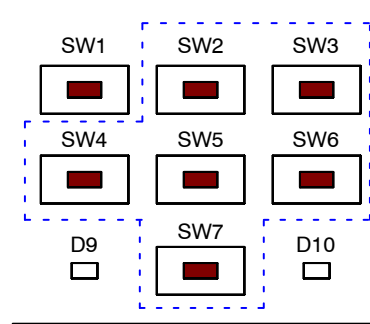


Figure 13. Display at Menu

Figure 14 shows key allocation at Menu.



- SW2/SW7: Cursor Up/Down
- SW5 or SW6: Execution of Menu
- SW4 (Short): Cancel (Return to Previous Screen)
- SW3 (Long): Return Back to Previous Application Mode

Figure 14. Key Allocation at Menu

## Menu for Application and Setting

If you select App Mode in Menu, you can select the application at Portable mode. Table 8 shows the list in App Mode of Menu. The detail of each application is explained later.

Table 8. LIST OF APP\_MODE MENU AT PORTABLE

Name	Function
USB Mode	USB Mass Storage mode for PC (or USB Audio Class for PC)
Music Player (H)	Hi-Res Standalone Music player mode
Rec Player	Standalone Record player mode

If you select Setting in Menu, you can set the configurations at Portable mode. Table 9 shows the list in Setting of Menu.

Table 9. LIST OF SETTING MENU AT PORTABLE

Name	Function
Sampling Freq	Sampling rate option
Contents Drive	Storage drive option
Rec Noise Cancel	Noise Canceller option for recording
Rec File Setting	Recording file audio format
USB Setting	USB function setting

# LC823450XGEVK

## Sampling Rate Option:

You can select the sampling rate either 44.1 kHz or 48 kHz. 44.1 kHz is in default.

## Storage Drive Option:

You can select the storage drive for standalone playback or standalone recording either eMMC or micro SD card. The default is different depending on the software you select. And, the select of storage device may not be possible depending on software.

## Noise Canceller Option for Recording:

You can select the type of Noise Canceller on standalone recording from 1-mic Noise Canceller, 2-mic Noise Canceller for far talk and 2-mic Noise Canceller for close talk. 1-mic Noise Canceller is in default. Please refer to the application note, "Performance of Noise Canceller of LC823450" for the detail.

## Recording File Audio Format:

You can select the recording file audio format either MP3 or WAV. MP3 is in default.

## USB Setting:

You can select the type of USB function from USB Mass Storage Class or USB Audio Streaming. USB Mass Storage Class is in default.

## USB Audio Streaming Function

If you want to realize USB Audio Streaming mode, you should enter the USB AUDIO mode in Setting Menu in advance. Then, you select USB Mode in App Mode, the display of LCD will soon change to Figure 15.

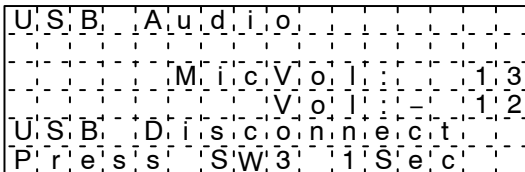
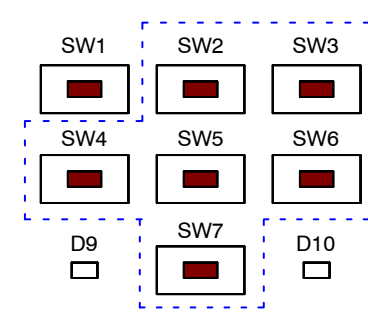


Figure 15. Display at USB AUDIO Connection

After the USB connection with your PC start, you can select LC823450 as the playback device and the recording device in the sound setting on your PC. In the USB Audio Streaming playback mode, you can select the sound quality one of 24-bit 96 kHz, 24-bit 48 kHz or 16-bit 48 kHz in the properties setting in your PC. On the other hand, in the USB Audio Streaming recording mode, you can select the sound quality either 24-bit 48 kHz or 16-bit 48 kHz. In addition, you can use not only the USB Audio Streaming playback and recording at the same time, but also USB Audio

Streaming and the file transfer as USB MSC at the same time.

Figure 16 shows key allocation during USB AUDIO. SW2 is for playback volume up and SW7 is for playback volume down. The volume range is -128 dB up to 42 dB, but the setting of volume level by PC is always given priority. For example, even if you adjusted the volume level to -128 dB on LC823450XGEVK, when you adjust it to 42 dB on your PC, it will be reflected to LC823450XGEVK immediately. SW4 is for Mic volume up and SW6 is for Mic volume down. The Mic volume range is -128 dB up to 42 dB, but the setting of Mic volume level by PC is always given priority as well as playback volume.



- SW2/SW7: Volume Up/Down
- SW4/SW6: Mic Volume Up/Down
- SW3 (Long): Return Back to Playback Stop

Figure 16. Key Allocation at USB Audio

If you want to get away from USB Audio Streaming mode, you should push SW3 for long time and you will jump back to the previous application mode before USB Audio Streaming mode.

## Standalone Music Player Function

When you jump to Music Player Function by power on or by selecting in App Mode, the display will change to Figure 16 for playback. Figure 17 is the same display as Figure 12 after power on.

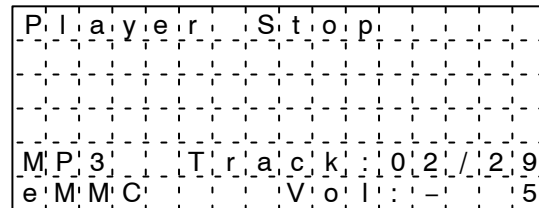
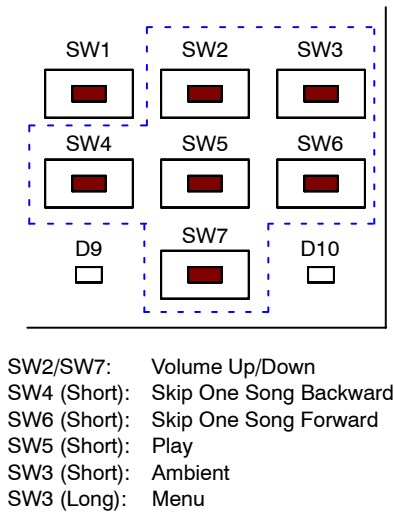


Figure 17. Display at Playback Stop

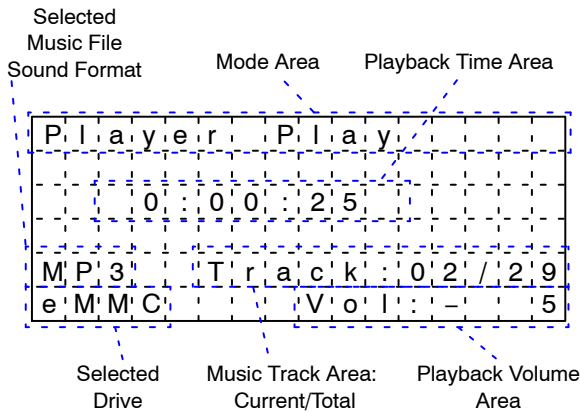
# LC823450XGEVK

Figure 18 shows key allocation at Playback Stop. If you stored music file into eMMC/SD card in advance, you can start to play back music by pushing SW5 at any time.



**Figure 18. Key Allocation at Playback Stop**

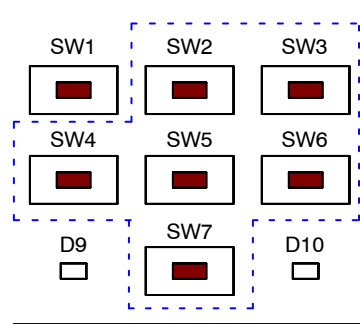
Figure 19 shows display during playback. LC823450XGEVK can display operating mode, playback time, music track information, music file extension (MP3, WAV, WMA, AAC or FLAC), drive (eMMC or uSD) and volume. Music track area shows track information regarding music files stored in “music” folder. Also, mode area will be changed from “Player Stop” to “Player Play” and playback time will be counted up.



**Figure 19. Display during Playback**

Figure 20 shows key allocation during playback. SW2 is for volume up and SW7 is for volume down. The volume range is -128 dB up to 42 dB. SW4 is assigned to two functions, and one is to skip one song backward when pushing it for short time, the other is to rewind with a song played back when pushing it for long time. SW6 is also assigned to two functions, and one is to skip one song

forward when pushing it for short time, the other is to fast-forward with a song played back when pushing it for long time. SW5 is also assigned to two functions too, and one is for pause when pushing it for short time, the other is for stop when pushing it for long time. SW3 is for ambient, and this function picks up sound from the microphone on the board and mixes it with playback sound. SW3 switches on/off as a toggle button.



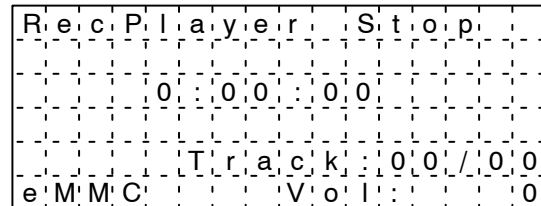
**Figure 20. Key Allocation during Playback**

## Standalone Record Player Function

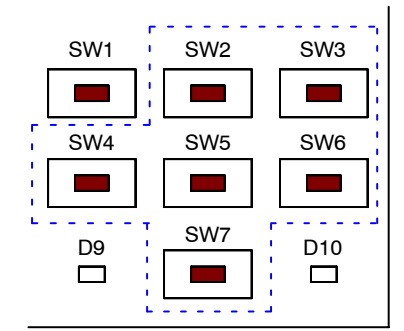
When you jump to Record Player Function by selecting in App Mode, LC823450XGEVK will automatically make “record” folder in the root of eMMC or SD Card to prepare to record sound files, and the display will change to Figure 21 for recording.

Input for recording is only Digital Mic on LC823450XGEVK, and the audio format of recorded sound files can be selected either MP3 or WAV by setting menu. In addition, the audio sampling rate also can be selected either 44.1 kHz or 48 kHz by setting menu.

Then, LC823450XGEVK can record sound files up to 99 files in “record” folder. If the folder is full, you need to delete or move some files in this folder to record new sound files.



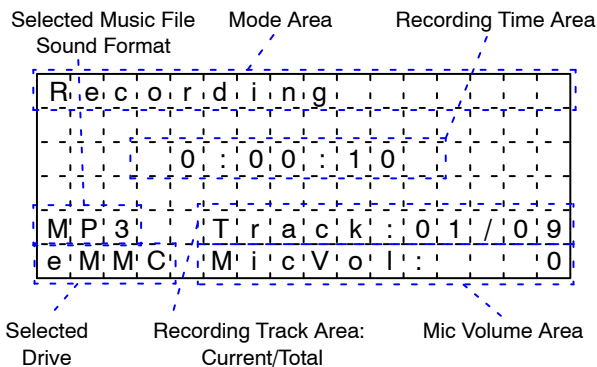
**Figure 21. Display at Recording Stop**



- SW2/SW7: Volume Up/Down
- SW4 (Short): Skip One Sound Backward
- SW6 (Short): Skip One Sound Forward
- SW5 (Short): Play Recorded Sound
- SW5 (Long): Play/Record Stop
- SW3 (Short): Record Start
- SW3 (Long): Menu

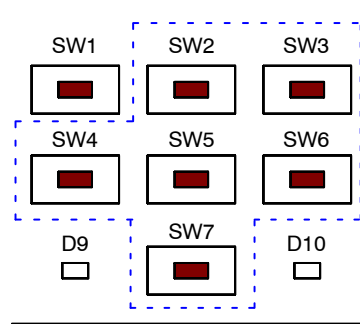
**Figure 22. Key Allocation at Recording Stop**

Figure 22 shows key allocation at Recording Stop. At this time, if you push SW3, you can start to record sound and the display will change to Figure 23. Recording track area shows track information regarding sound files stored in “record” folder. When you start recording to MP3 format, the recorder function will start to encode sound data input from Digital Mic to MP3 data by hard-wired MP3 encoder in LC823450, and it will be stored into “record” folder in eMMC or SD Card as a MP3 sound file until the stop of the recording. When you start recording to WAV format, the recorder function will start to store sound data input from Digital Mic through hard-wired MP3 encoder into “record” folder as a WAV sound file until the stop of the recording. Also, recording time will be counted up. The sound data input from Digital Mic is played back so as to monitor using headphone at the same time of recording. The monitoring function is available to adjust recording volume level by pushing SW2 or SW7 hearing the real sound to be recorded, and the volume level for recording is displayed in Mic volume area and its range is -128 dB up to 42 dB.



**Figure 23. Display during Recording**

Figure 24 shows key allocation during recording. If you push SW5 for short time during recording, you can pause the recording, if you push SW5 for short time again, the recording will restart.



- SW2/SW7: Mic Volume Up/Down
- SW4: Noise Canceller On/Off
- SW5 (Short): Pause
- SW5 (Long): Stop

**Figure 24. Key Allocation during Recording**

SW4 is the switch for Noise Canceller on/off as a toggle button. 1-mic Noise Canceller function enhances voice signal by reducing ambient noise from recording voice. The target noise which can be reduced by this noise canceller is stationary noise like air-conditioner noise. 2-mic Noise Canceller intended for far talk application has little limitation of the microphone setting. It estimates the ambient noise by difference of phase information between two microphones. 2-mic Noise Canceller intended for close talk application estimates ambient noise by difference of signal power between two microphones. It can strongly reduce non-stationary noise by the location difference of two microphones.

If you push SW5 for long time during recording, you can stop the recording and the display will be Figure 21 again which means recording stop. Once stopping recording, the recording process completes and a sound file is generated into “record” folder. Then, Recording track area in the display is also updated.

By the way, in order to see sound files recorded, you need to jump back to menu by pushing SW3 for long time and to enter USB MSC mode. Then, you can see the sound files in “record” folder in eMMC/SD Card by using PC.

When you want to play back sound files recorded, you should push SW5 at recording stop in Figure 21 after selecting a target sound file by operating SW4 or SW6 to skip sound files, then you can play back the target sound file in “record” folder.



**BT Headset Mode**

BT Headset mode can play music streaming and call with Hands Free Talk with Bluetooth connected device.

After you select BT Headset in Boot Setting, LC823450 will start to boot up and display the characters of “BT Headset” on LCD shown in Figure 25.

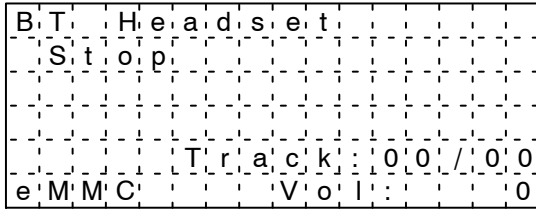


Figure 25. Display at BT Headset

**Standalone Music Playback Function**

The key allocation at BT Headset Playback Stop and during Playback are same with the one at Portable mode. If you stored music file into eMMC/SD card in advance, you can start to play back music by pushing SW5 at any time. The operation is same as at Portable mode. However, because internal code & D-AMP are used for audio playback at the BT Headset mode, Hi-Resolution audio can't be played back. Even if some audio contents with Hi-Resolution audio are stored in eMMC/SD card, those are not recognized as music file by LC823450.

**A2DP Streaming Playback Function**

In order to play A2DP streaming, you should connect LC823450XGEVK to your Bluetooth device by Bluetooth connection. You can connect under each application mode except menu mode including USB MSC mode.

1. Turn on the Bluetooth function of your device, and select “BtMdSampleHeadset1” to pair.
2. When you paired LC823450XGEVK with your Bluetooth device, LC823450XGEVK and your device connected by Bluetooth each other.
3. You can play A2DP streaming from your Bluetooth device. During the A2DP streaming, the characters of “A2dpPlay” will be displayed on LCD shown in Figure 26.

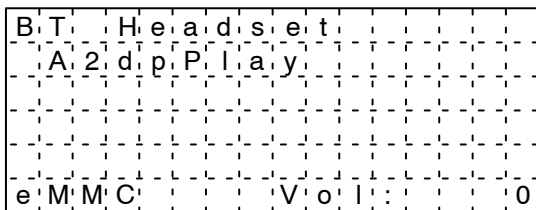
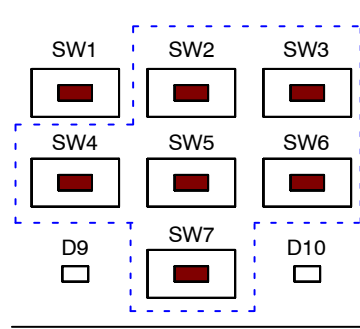


Figure 26. Display during BT Headset A2DP Streaming

Figure 27 shows key allocation at BT Headset A2DP streaming. SW2 is for volume up and SW7 is for volume down. The volume range is -128 dB up to 42 dB, but the volume level is also depend on your device. SW3 is for ambient, and this function picks up sound from the microphone on the board and mixes it with streaming sound. SW3 switches on/off as a toggle button.

If you want to get away from A2DP streaming mode, you should disconnect Bluetooth connection by your Bluetooth device. You will return to the previous application mode before A2DP streaming.



- SW2/SW7: Volume Up/Down
- SW4 (Short): Skip One Song Backward
- SW6 (Short): Skip One Song Forward
- SW5 (Short): Play
- SW5 (Long): Pause
- SW3 (Short): Ambient

Figure 27. Key Allocation at BT Headset A2DP Streaming

**Hands Free Call Function**

If you call or answer the phone call, LC823450 changes to Hands Free Call mode automatically, and the display will be changed as shown in Figure 28. The music playback just before phone call will be paused during the call, and it will be resumed after the call.

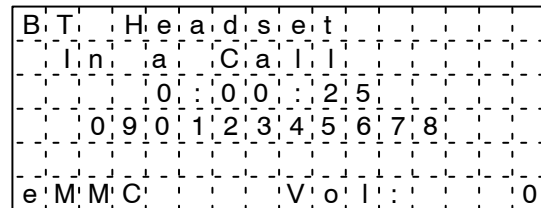


Figure 28. Display at Hands Free Talk

Figure 29 shows key allocation during Hands Free Call. SW2 is for volume up and SW7 is for volume down. The volume range is -128 dB up to 42 dB, but the volume level is also depend on your device. SW5 is for Answer or Hang up.

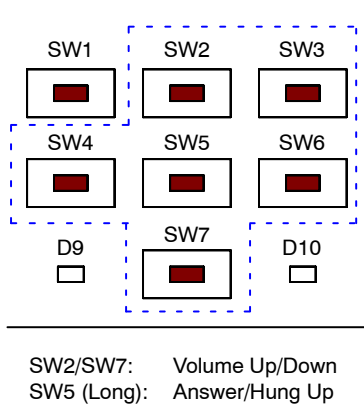


Figure 29. Key Allocation at Hands Free Talk

**BT Earbuds Mode**

BT Earbuds mode can play music with Wireless Synchronized Stereo (WS2). WS2 connects two earbud of left and right channel by wireless using Bluetooth. Please note that LC823450XGEVK for left channel should be selected “BT Earbuds M” and LC823450XGEVK for right channel should be selected “BT Earbuds S” in Boot setting respectively. (“M” means Master side, “S” means Slave side) After you select BT Earbuds in Boot Setting, LC823450 will start to boot up and display the characters of “BT Earbuds M” on LCD shown in Figure 30 (in the case of Master side).

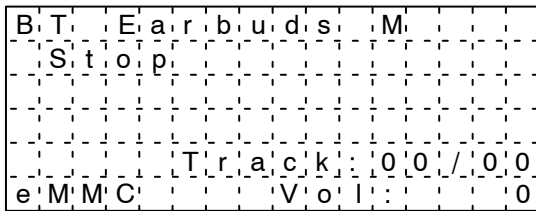


Figure 30. Display at BT Earbuds Stop (Master Side)

**Standalone Music Playback Function with WS2**

The key allocations at BT Earbuds Playback Stop and during Playback are same with the one at Portable mode. If you stored music file into eMMC/SD card on both LC823450XGEVK in advance, you can start to play back music with WS2 by pushing SW5 on the LC823450XGEVK assigned as “Earbuds M” at any time. Please note that all operations in BT Earbuds mode are executed on the Master side LC823450XGEVK assigned as “Earbuds M”, and same as at Portable mode. However, because internal code & D-AMP are used for audio playback at the BT Earbuds mode, Hi-Resolution audio can’t be played back. Even if some audio contents with Hi-Resolution audio are stored in eMMC/SD card, those are not recognized as music file by LC823450.

**A2DP Streaming Playback Function with WS2**

In order to play A2DP streaming with WS2 by using two LC823450XGEVKs, you should connect

LC823450XGEVK assigned as “Earbuds M” to your Bluetooth device by Bluetooth connection. You can connect under each application mode except menu mode including USB MSC mode.

1. Turn on the Bluetooth function of your device, and select “BtMdSampleEarbuds M1” to pair.
2. When you paired LC823450XGEVK with your Bluetooth device, LC823450XGEVK assigned as “Earbuds M” and your device are connected by Bluetooth each other. And simultaneously both of LC823450XGEVKs also are connected by Bluetooth each other.
3. You can play A2DP streaming from your Bluetooth device. During the A2DP streaming, the characters of “A2dpPlay” will be displayed on LCD shown in Figure 31.

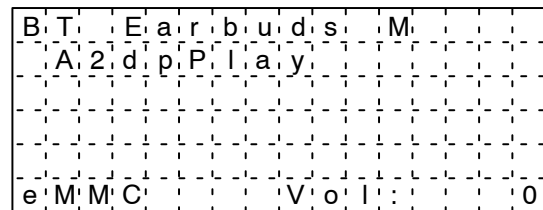


Figure 31. Display during BT Earbuds A2DP Streaming

Figure 32 shows key allocation at BT Earbuds A2DP Streaming. SW2 is for volume up and SW7 is for volume down. SW3 is for ambient,.

If you want to get away from A2DP streaming mode, you should disconnect Bluetooth connection by your Bluetooth device. You will return to the previous application mode before A2DP streaming.

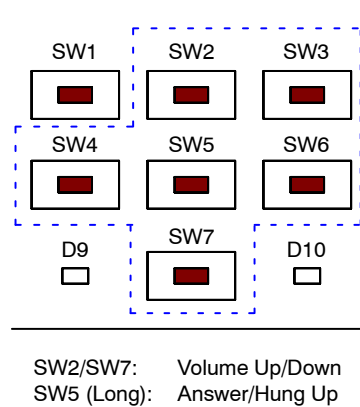


Figure 32. Key Allocation at BT Earbuds A2DP Streaming

**BT Speaker Mode**

BT Speaker mode can play music streaming via Bluetooth.

After you select BT Speaker in Boot Setting, LC823450 will start to boot up and display the characters of “BT Speaker” on LCD shown in Figure 33.

# LC823450XGEVK

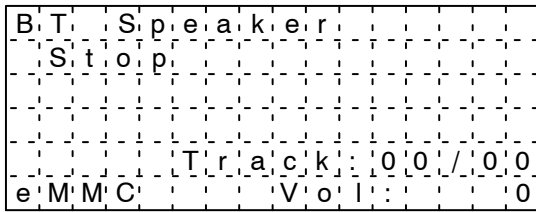


Figure 33. Display at BT Speaker Stop

## Standalone Music Playback Function

The key allocation at BT Speaker Playback Stop and during Playback are same with the one at Portable mode. If you stored music file into eMMC/SD card in advance, you can start to play back music by pushing SW5 at any time. All operation is same as at Portable mode. However, because internal code & D-AMP are used for audio playback at the BT Speaker mode, Hi-Resolution audio can't be played back. Even if some audio contents with Hi-Resolution audio are stored in eMMC/SD card, those are not recognized as music file by LC823450.

## A2DP Streaming Playback Function

In order to play A2DP streaming, you should connect LC823450XGEVK to your Bluetooth device by Bluetooth connection. You can connect under each application mode except menu mode including USB MSC mode.

1. Turn on the Bluetooth function of your device, and select "BtMdSampleSpeaker1" to pair.
2. When you paired LC823450XGEVK with your Bluetooth device, LC823450XGEVK and your device connected by Bluetooth each other.
3. You can play A2DP streaming from your Bluetooth device. During the A2DP streaming, the characters of "A2dpPlay" will be displayed on LCD shown in Figure 34.

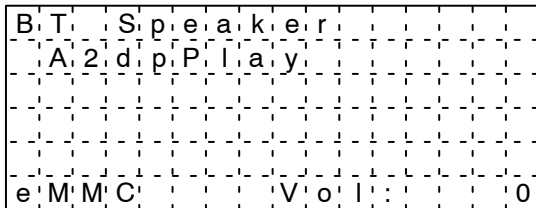


Figure 34. Display during BT Speaker A2DP Streaming

The key allocation at BT Speaker A2DP Streaming is same with the one at BT Headset mode.

If you want to get away from A2DP streaming mode, you should disconnect Bluetooth connection by your Bluetooth device. You will return to the previous application mode before A2DP streaming.

## Debugging Tool for LC823450

If you want to debug for Cortex-M3 Dual cores including in LC823450, you can use the following four debugging tools supporting multi-core debugging via Serial Wire Debug Port (SW-DP) on LC823450XGEVK. You can also use other proper debugging tools but we cannot fully support those tools which we don't have.

### J-Link Base:

It is a USB powered JTAG debug probe supporting ARM core as shown in Figure 35, made by SEGGER Microcontroller in Germany (<https://www.segger.com>).

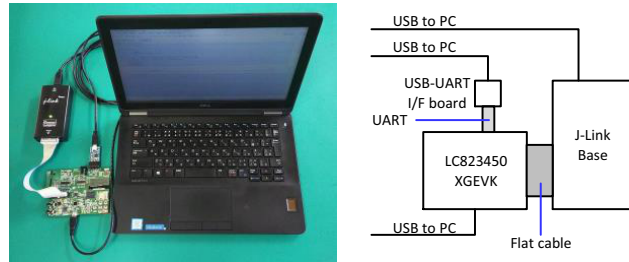


Figure 35. SEGGER J-Link Base

### ARM-USB-TINY-H:

It is an OpenOCD compatible JTAG/SWD interface made by Olimex in Bulgaria as shown in Figure 36. (<https://www.olimex.com/>)



Figure 36. Olimex ARM-USB-TINY-H

### Advice LUNA II:

It is a JTAG emulator that can support multi-core debugging as shown in Figure 37, made by Yokogawa Digital Computer Corporation in Japan. (<http://www2.yokogawa-digital.com/en/>)

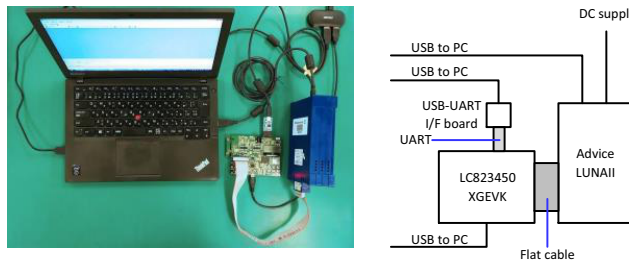


Figure 37. Yokogawa Advice LUNA II

# LC823450XGEVK

## μTrace 32:

It is a new all-in-one debug and trace solution as shown in Figure 38, made by Lauterbach in Germany. (<http://www.lauterbach.com/frames.html?home.html>)

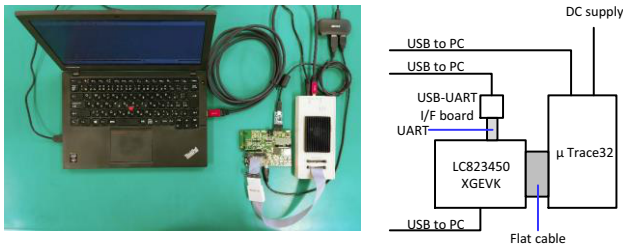


Figure 38. Lauterbach μTrace 32

If you don't have any debugging tool in your hand, then it is possible to debug using UART. We also provide USB-UART conversion sub-board included in LC823450XGEVK evaluation kit, you can use Console using UART by the connection with CN9 terminal as shown in Figure 39.

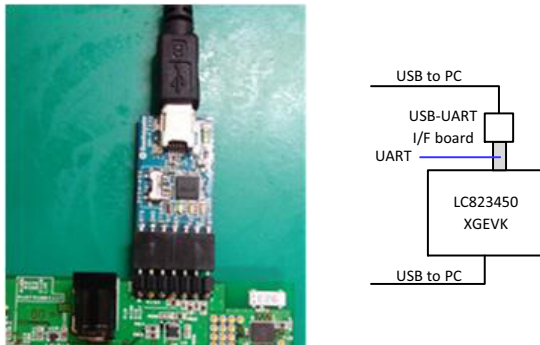


Figure 39. Debugging Using UART

The port driver is installed automatically when you connect it to your PC. If the install does not start, you can download the driver from the following URL (<http://www.ftdichip.com/Drivers/VCP.htm>).

Please install the terminal soft to your PC and run it. Set the serial port parameters to 115,200 bps (baud rate), 8 data bits, none parity and one stop bit as shown in Figure 40. You can confirm the command when you input “app help” on the console window after starting the terminal soft. However, these UART commands were added for internal work by each our software engineer. Therefore, there are several commands not to work at present in that. The list of representative UART commands is shown in Appendix A as an example. Please note that we do not guarantee it about the operation at all.

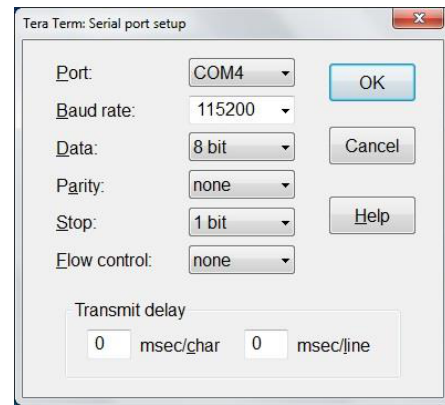


Figure 40. Serial Port Parameter

## Measurement of Current Consumption with Jumpers

Power terminals of LC823450 are connected through each jumper post to the power sources, so you can measure the current consumption if you insert an ammeter to each jumper post of the power terminals.

Figure 41 and Table 10 shows the relation of power terminal, voltage level and jumper post.

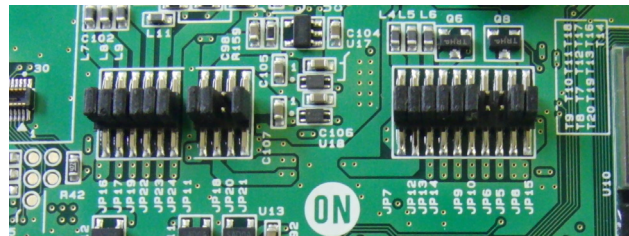


Figure 41. Jumper Post of Power Terminals

Table 10. MEASUREMENT POINTS OF CURRENT CONSUMPTION

Terminal Name	Voltage (V)	Jumper
Vdd1	1.0*	JP22
AVddUSBPHY1	1.0*	JP23
VddRTC	1.0	JP24
VddXT1	1.1	JP16
AVddPLL1	1.1	JP17
AVddPLL2	1.1	JP19
AVddDAMPL	1.5	JP21
AVddDAMPR	1.5	JP21
Vdd2	3.3	JP8
VddSD0	1.8	JP18
VddSD1	3.3*	JP11
VddSD2	3.3	JP9
VddQSPI	3.3	JP10
AVddADC	3.3	JP12
AVddUSBPHY2	3.3	JP13


\*Default settings.

APPENDIX A

Table 11. UART COMMANDS

Command	Function	1 <sup>st</sup> Argument	2 <sup>nd</sup> Argument
rew	Move to the next content		
ff	Move to the previous content		
vol_up	Increase the playback volume		
vol_down	Decrease the playback volume		
nvol_up	Increase the notification volume		
nvol_down	Decrease the notification volume		
vol	To specify the playback volume	Value of volume	
nvol	To specify the notification volume	Value of volume	
mvol	To specify the mic volume	Value of volume	
lvol	To specify the master volume	Value of volume	
dsp_on	To enable the specified DSP function	Value of T_AUDMD_DSPMODE	
dsp_off	To disable the specified DSP function	Value of T_AUDMD_DSPMODE	
ambient_on	To enable the ambient mode		
ambient_off	To disable the ambient mode		
notice1	To play the 0th notice		
notice2	To play the 1st notice		
notice3	To play the 2nd notice		
notice_stop	To stop and close the playing notice		
notice_pause	To pause the playing notice		
notice_restart	To resume the pausing notice		
TestClk	To change the function clock	Frequency(Hz)	
playtime	ON / OFF of playback time display	On or Off	
outfreq	To change the output frequency	mp or a2dp or hfp	8000 or 16000 or 44100 or 48000
execute	To change the operation mode of AudioMiddle	On or Off	
resume_clear	To clear the playback position for resume		
reboot	To reset the LSI by WDT		

Arm, the Arm logo, and Cortex are registered trademarks of Arm Limited (or its subsidiaries) in the EU and/or elsewhere. Bluetooth is a registered trademark of Bluetooth SIG. microSD is a trademark of SD–3C, LLC in the United States, other countries or both. All other brand names and product names appearing in this document are registered trademarks or trademarks of their respective holders.

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

**PUBLICATION ORDERING INFORMATION**

**LITERATURE FULFILLMENT:**  
 Literature Distribution Center for ON Semiconductor  
 19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
 USA/Canada  
**Europe, Middle East and Africa Technical Support:**  
 Phone: 421 33 790 2910  
**Japan Customer Focus Center**  
 Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>  
 For additional information, please contact your local Sales Representative