ESP32-LyraTD-DSPG

User Guide

Version 1.0

Espressif Systems

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About This Guide

This document helps you to get started with the ESP32-LyraTD-DSPG development board.

Release Notes

Date	Version	Release notes
2019.07	V1.0	Initial release.

Documentation Change Notification

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1. Overview

ESP32-LyraTD-DSPG is one of Espressif's Audio Development Board based on ESP32 MCU and DBMD5P DSP. It is an Acoustic Echo Cancelation (AEC) solution supporting voice recognition, near-field and far-field voice wake-up. Audio files in the format of WAV, MP3, AAC, FLAC, OPUS and OGG can be decoded and encoded without quality loss. It also supports connection to Amazon's AVS (Alexa Voice Service), Google's Dialogflow and Google's GVA (Google Voice Assistant).

1.1. ESP32-LyraTD-DSPG

ESP32-LyraTD-DSPG is based on ESP32-WROVER-B, a BT/Wi-Fi combo module, and a digital signal processor (DSP) that features a three-microphone array for noise reduction, echo cancelation, beam-forming and detection. ESP32-LyraTD-DSPG is integrated with peripheral devices and consists of two development boards. The sub board mainly consists of the microphone array, function keys and LEDs. The main board is integrated with power management, Wi-Fi and audio modules like DSP, Codec and power amplifier. The two boards can be connected with FPC interface.

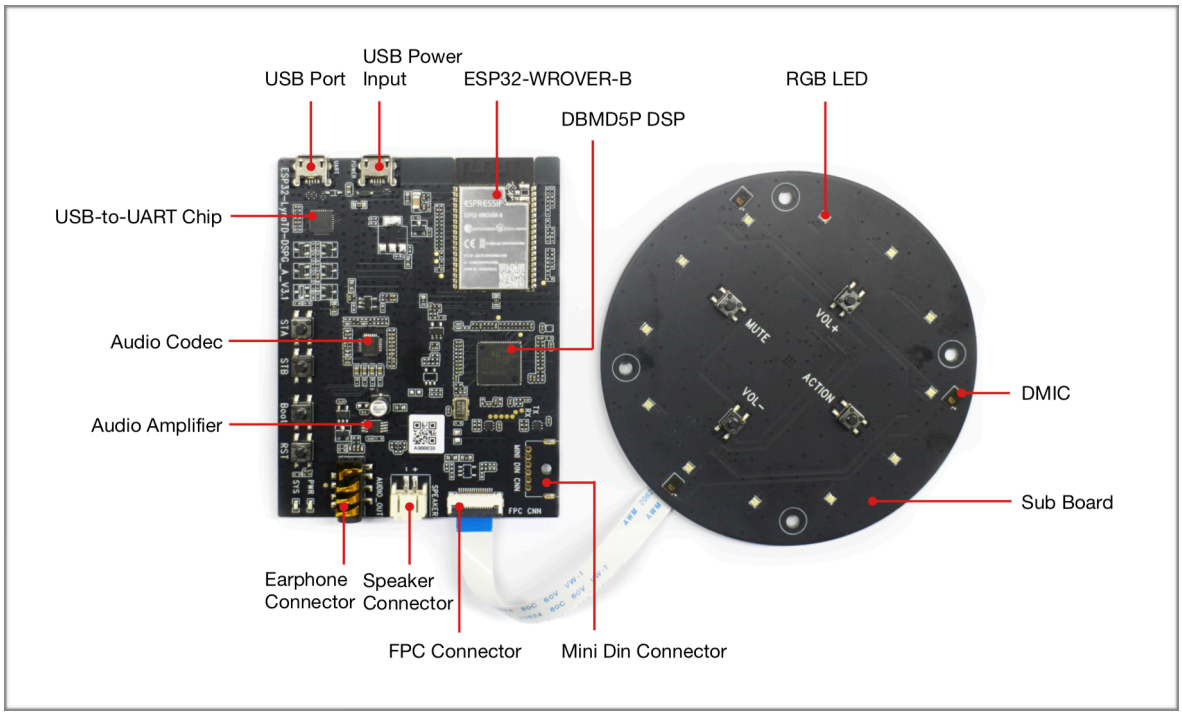


Figure 1-1. ESP32-LyraTD-DSPG Layout

1.2. Hardware Resources

1. USB power input

Provides power supply to the whole system. It is recommended that the system be connected to a power adapter for sufficient current supply.

2. **ESP32-WROVER-B module**

   This is a powerful, general-purpose, Wi-Fi+BT+BLE dual core MCU module, targeting a wide variety of applications ranging from low-power sensor networks to the most demanding tasks, such as voice encoding/decoding, music streaming and runs voice assistant client SDK.

3. **DBMD5P DSP**

   DBMD5P is a dual core, programmable voice processor which supports various functionalities such as voice trigger (VT), voice commands, voice authentication (VA), acoustic echo cancellation (AEC). This audio DSP is used for wake-word detection. It captures audio data from an external array of three digital microphones.

4. **Audio codec**

   E8388 audio codec is used for digital audio conversion to analog audio output.

5. **Audio amplifier**

   This audio power amplifier sends audio signals from the Codec to external speakers for playback.

6. **CP2102N USB-to-UART Chip**

   An upgraded version of the CP2102 chip supports USB-to-UART conversion.

> 📖 ***Note:***
>
> *The IC design of this chip is a little different from CP2102.*

7. **USB Port**

   This is a normal USB communication port between PC and the main board.

8. **Earphone Connector**

   Used for plugging in earphones/headphone. Audio output is via Codec.

9. **Speaker Connector**

   Supports one external speaker output via Power Amplifier.

10. **FPC connector**

    This connection is used for connecting external sub board consisting of microphone array, buttons and LEDs via flex cable.

11. **Mini Din connector**

    This connection can be used for connecting the microphone cable, if there is such a requirement. By default, this connector is not mounted on the main board.

12. **Sub board**

    Sub board consists of LEDs and LED driver along with function keys and Mic array connected via FPC cable.

2. Configuring for AVS

2.1. Software Preparation

1. **Installing Flash Download Tool**

   Linux/macOS/Windows users can use the terminal to flash firmware. For more details, please check *ESP-IDF Programming Guide*.

   Windows users may also use a graphical tool to flash firmware into the board using the *Flash Download Tool*.

2. **Downloading Firmware**

   Please follow the build instructions of the Alexa SDK from the Github page: *https://github.com/espressif/esp-va-sdk*.

   > 📖 ***Note:***
   >
   > *The GitHub repository uses Espressif's wake-word engine (WWE) for processing the 'Alexa' wakeword. This allows easy evaluations. For production use case, please reach out to sales@espressif.com or your DSPG sales representative for obtaining a Amazon certified wake-word engine.*

3. **Debugging Tool**

   Use serial monitor/console that suits your development environment at baud rate of 115200.

4. **App for Provisioning**

   In order to run Alexa you need to provision LyraTD-DSPG with Alexa credentials and network settings (Wi-Fi ssid and passphrase). Please install the android APK from the Play Store here: *https://play.google.com/store/apps/details?id=com.espressif.provbleavs*. iOS support will be available soon.

2.2. Hardware Preparation

- 1 x PC (Linux Operating System is recommended).
- 1 x LyraTD-DSPG.
- 2 x Micro USB cables (one is for the USB power supply).
- 1 x Speaker or 1 x earphone.

2.3. Flashing the Firmware

This document captures the process for flashing the firmware on Windows. Please refer to the *ESP-VA-SDK* repository on Github for setup on other platforms.

2.3.1. Driver Installation

Connect the board to a PC with a Micro-USB cable and install the USB-to-UART driver.

2.3.2. Flashing ESP32

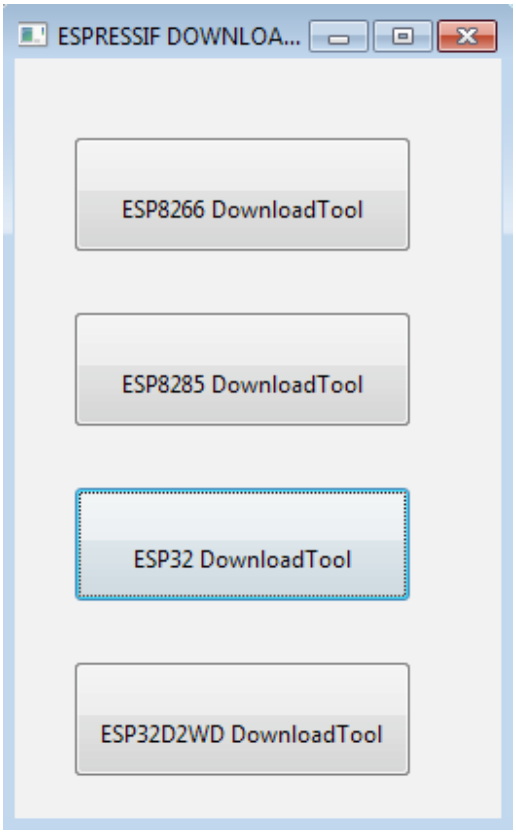


Figure 2-1. Flash Download Tool

- In order to build examples of esp-va-sdk, please follow the instructions mentioned on the *GitHub page.*
- Once you build the Alexa firmware, you will generate three artifacts: ***bootloader.bin***, ***partitions.bin*** and ***alexa.bin***.
- For Flash Download Tool users, follow the instructions given below:
  1. Run Flash Download Tool, and click on "***ESP32 Download Tool***" at the interface. See Figure 2-1 above.
  2. Then you will see the interface shown in Figure 2-2 below.

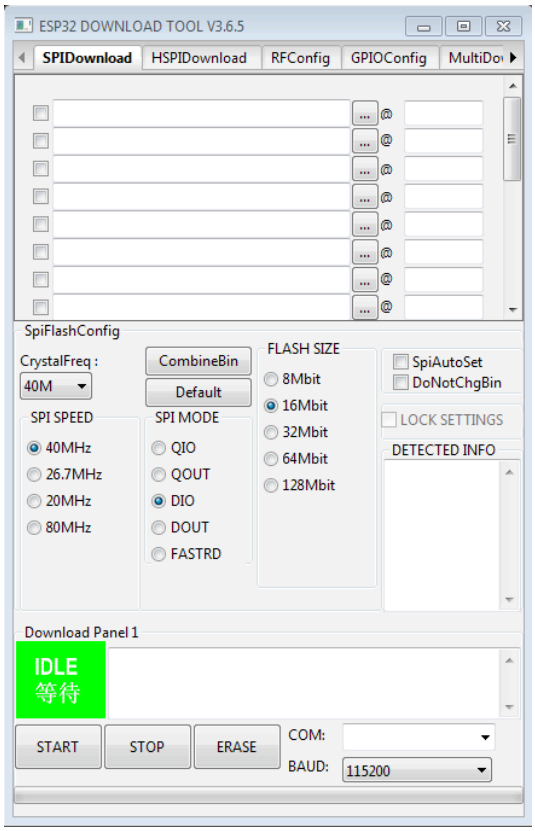


Figure 2-2. ESP32 Download Tool

3. Select the binary files (mentioned in table below) and set appropriate address in the tool as shown in Figure 2-3.

Binary Files	Address	Function
bootloader.bin	0x1000	basic configuration
partitions.bin	0x8000	basic configuration
alexa.bin	0x10000	audio application

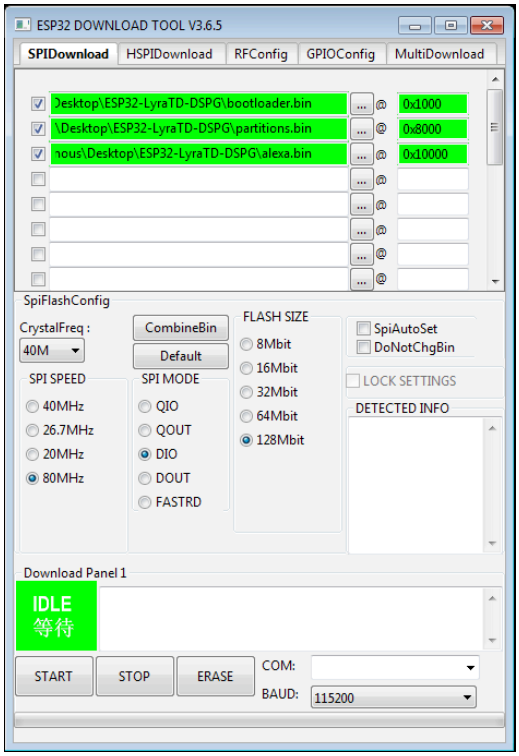


Figure 2-3. Flashing Configuration

4. The SPI Download configuration on the ESP32 Download Tool is shown in Figure 2-3. Select "***80 MHz***" for "***SPI SPEED***"; select "***DIO***" for "***SPI MODE***"; and select "***128 Mbit***" for "***FLASH SIZE***".
5. Select the COM port in line with the one used by the PC; select "***1152000***" as a baud rate.
6. Click the "***Start***" button on the ESP32 Flash Download Tool to start downloading the firmware.
7. Wait for the download to finish. See Figure 2-4.

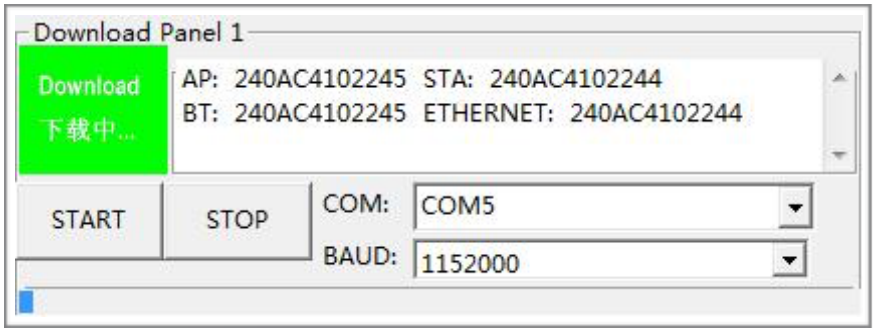


Figure 2-4. Downloading Firmware

> 📖 ***Note:***
>
> *Terminal users can follow the flashing instructions as available on the GitHub page.*

2.4. Network Configuration

2.4.1. Wi-Fi Networking

1. After successfully downloading the firmware, power on the board again by pressing the EN button.
2. To configure the network for the first time:
   - Turn on the bluetooth in your phone. Open Espressif's Alexa programming app and click on Provision New Device. Make sure your phone has internet connectivity.

Figure 2-5. Provision New Device

   - The provisioning happens over BLE (Bluetooth Low Energy). Android mandates applications to have Location permission for accessing BLE. Please provide the permission when the pop-up shows up.
   - You will see the list of available devices that needs to be provisioned, namely ESP-Alexa-WXYZ. Select the device that you wish to provision.

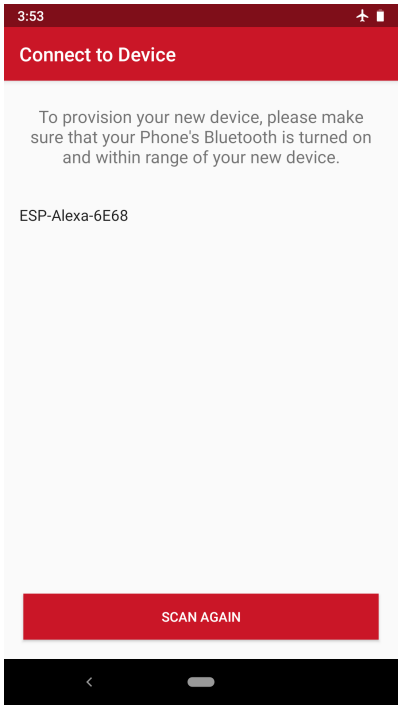


Figure 2-6. List of available devices

- Next step is to login to your amazon account.

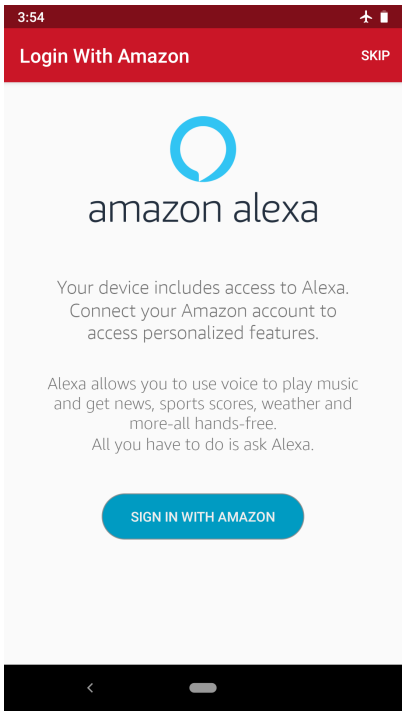


Figure 2-7. Login to your amazon

- After successful login and authorization, you will be shown a list of Wi-Fi networks in the vicinity. Choose the network that you wish the device to connect to. Once selected, enter the passphrase of that Wi-Fi network and click on the provision button.

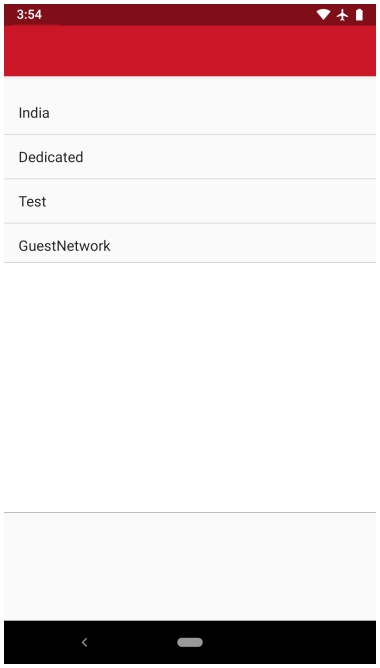


Figure 2-8. Available Wi-Fi networks

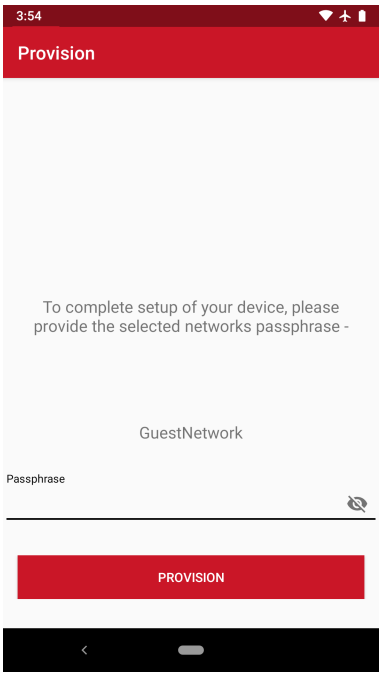


Figure 2-9. Enter your passphrase

- On successfully connecting to the Wi-Fi network, after provisioning, a boot up LED pattern will show up (Same as Echo dot), after which the DSP and Alexa will be initialized, and ready to take voice commands.

2.5. Interactive Function

2.5.1. Voice Recognition

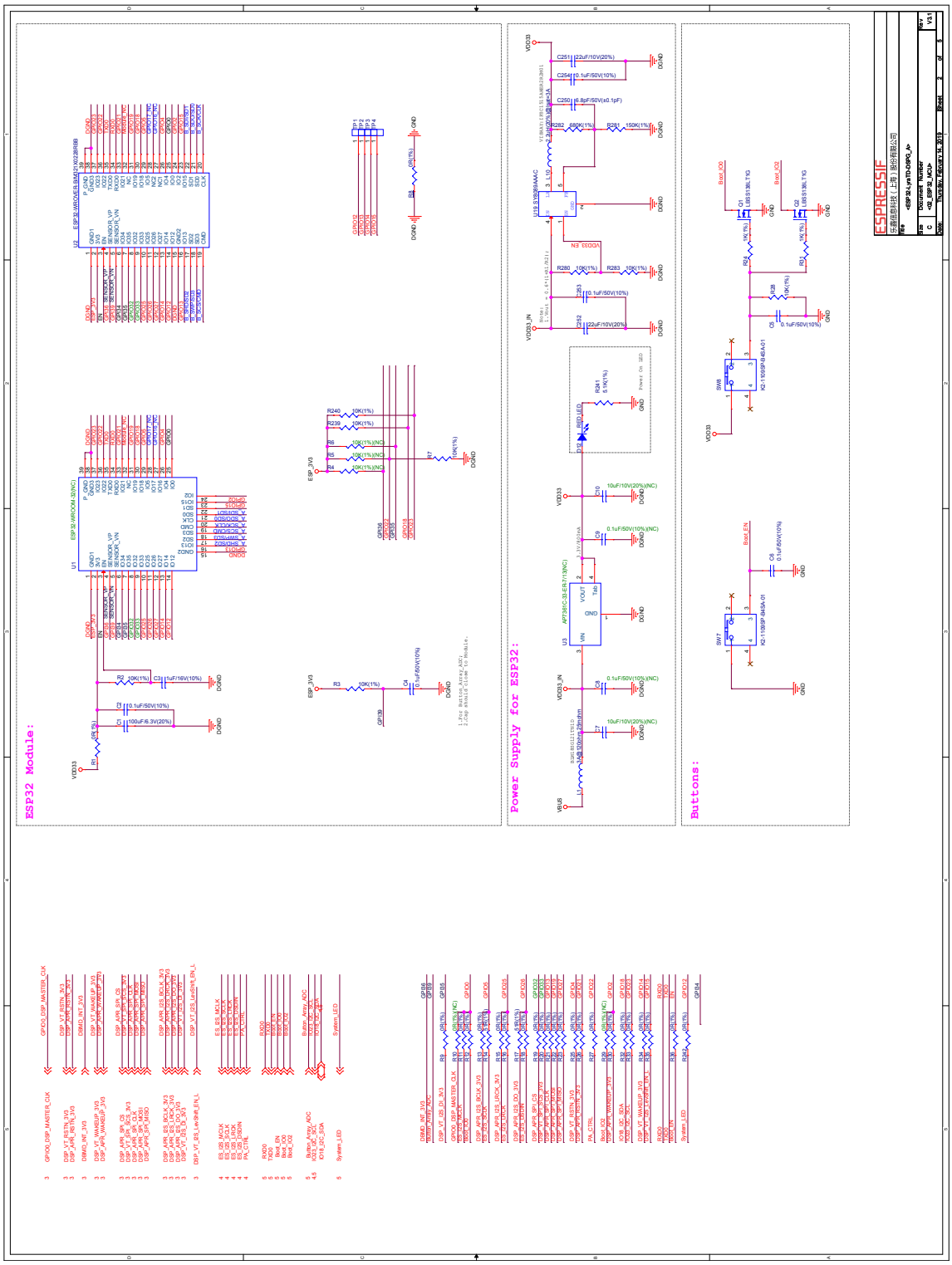
- Once all initialization are done, the device is ready. You can use either use "Action" button on the board (Tap-To-Talk) or say "Alexa" to start a conversation. For Tap-to-Talk, press and release the button and speak.
- You can now ask any command like:
  - Tell me a joke.
  - How is the weather?
  - Will it rain today?
  - Sing a song.
  - Play TuneIn radio.
  - Set volume level to 7.

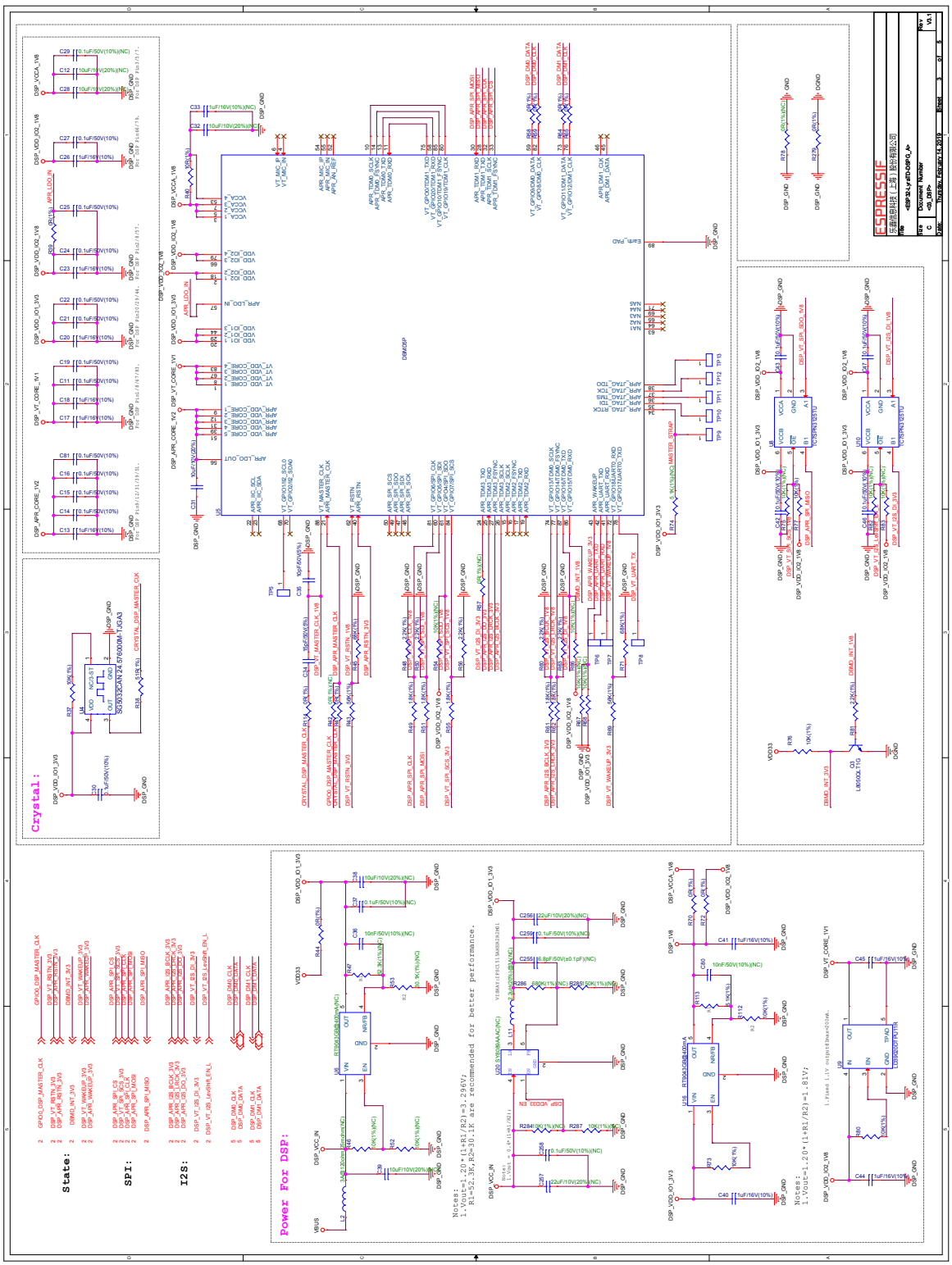
2.5.2. Buttons

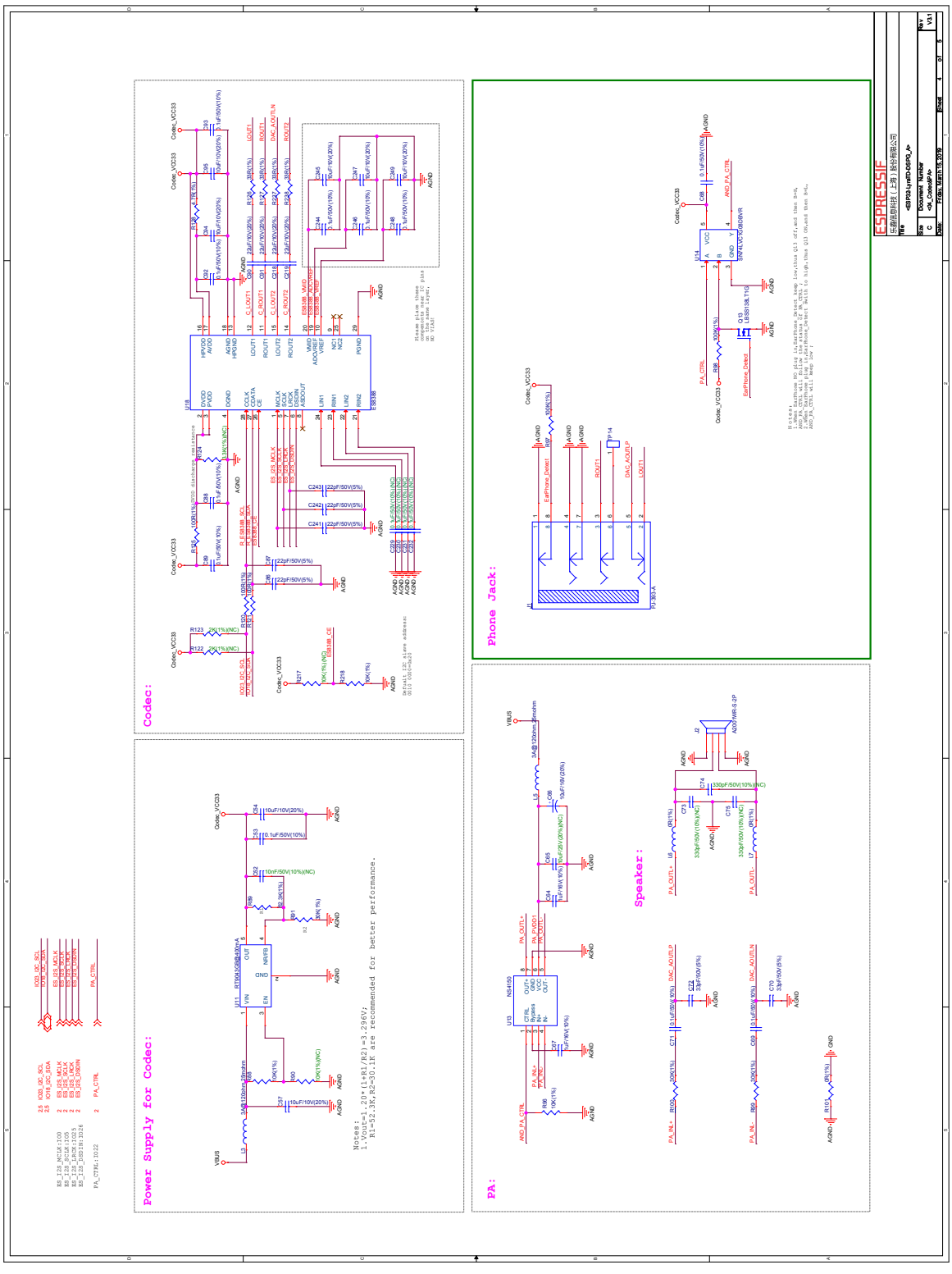
- The “Action” button can be used as tap-to-talk. The same button can also be used to disable an Alarm/Timer.
- The “Vol+” and “Vol-” buttons can be used to adjust the volume of the sound. Press them repeatedly until you reach the desired sound volume.
- The "Mute" button can be used to mute/unmute the device.
- To reset to factory settings, press Vol+ and Vol- button together for about 10 seconds until you see LED blink pattern.

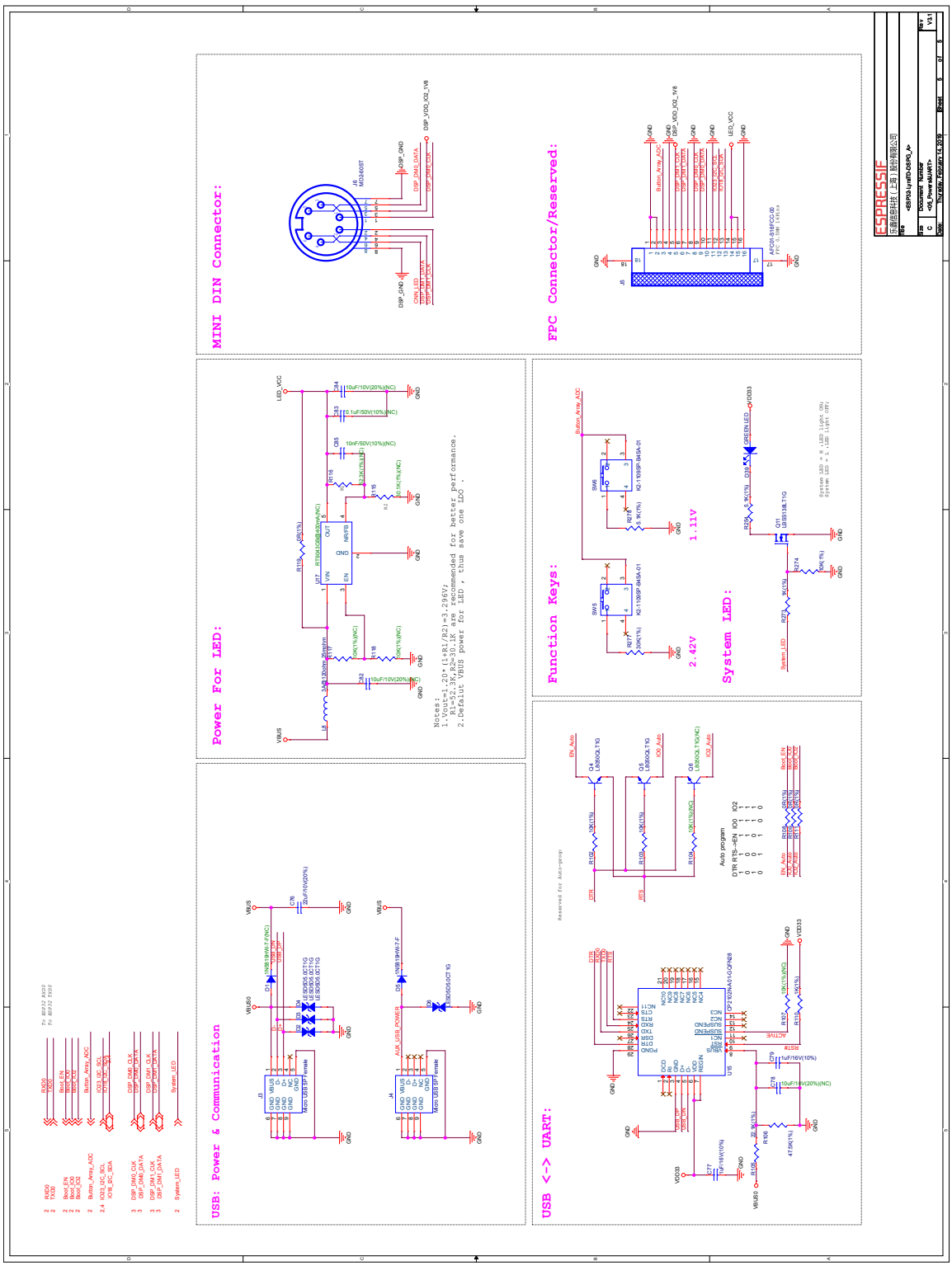
A. Appendix - Schematics

A.1. Main Board (A)

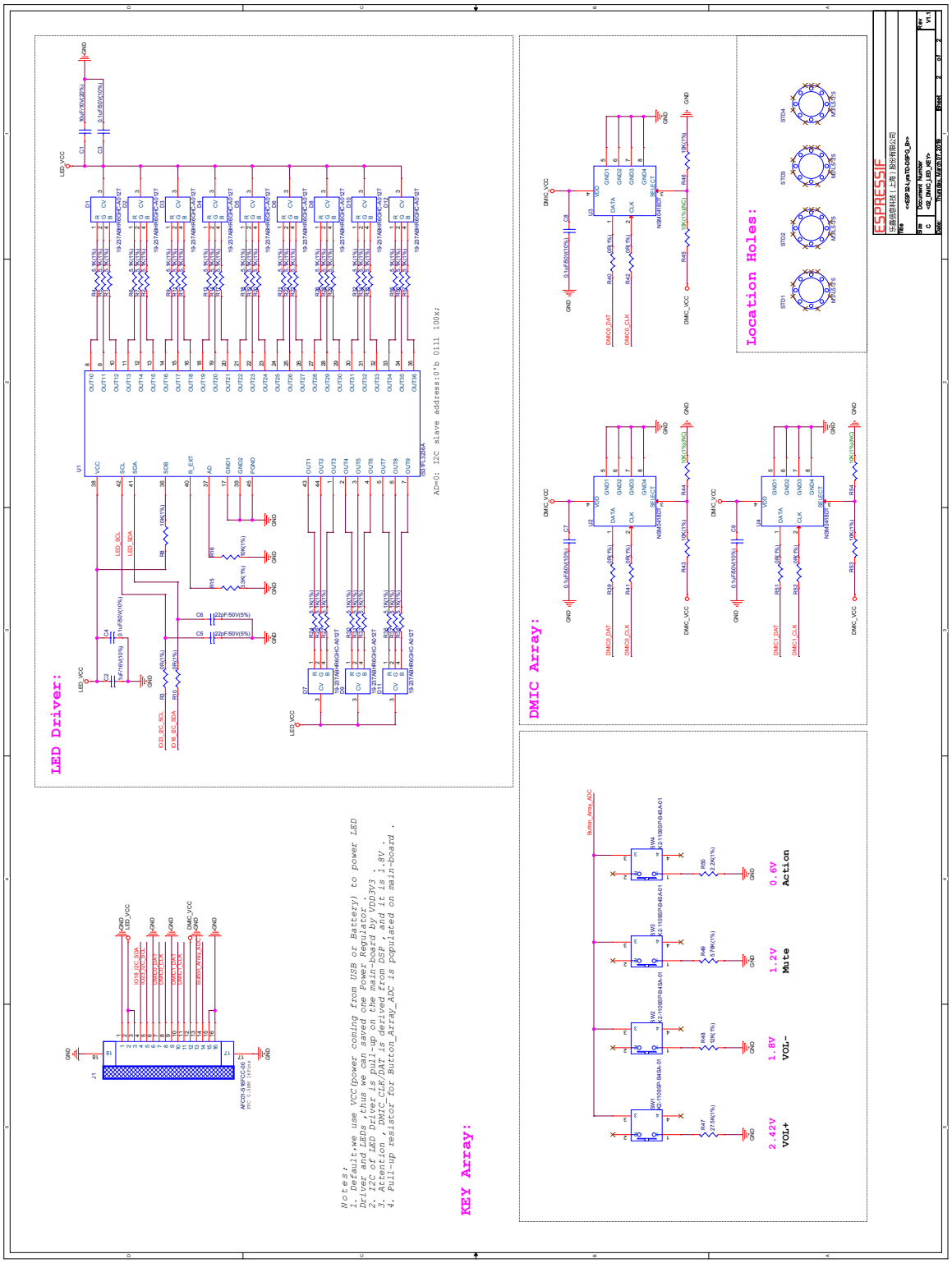





Codec:
Power Supply for Codec:
Phone Jack:
PA:
Speaker:
ESPRESSIF


MINI DIN Connector:
FPC Connector/Reserved:
Power For LED:
Function Keys:
System LED:
USB: Power & Communication
USB <-> UART:
ESPRESSIF

A.2. Sub Board (B)



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