DragonBoard™ 410c Based on Qualcomm® Snapdragon™ 410E Processor

Stereo Connector and Audio Routing on DragonBoard 410c Application Note

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### Revision history

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1 Introduction

1.1 Purpose

This document provides a description of chipset capabilities. Not all features are available, nor are all features supported in the software.

NOTE: Enabling some features may require additional licensing fees.

This application note provides instructions on how to solder a stereo connector on a J7 connector on the DragonBoard 410c, and provides mixer settings needed to route audio through the stereo connector, instead of HDMI.

1.2 Additional information

For additional information, go to http://www.96boards.org/db410c-getting-started/.
2 Adding a 3.5 mm stereo headset jack

2.1 J7 analog expansion connector

The J7 expansion connector is located near the 96Boards low speed expansion connector on the 410cDragonBoard.
The pinout for J7 is shown below:

![Diagram of J7 pinout](image)

2.2 Standard headset plug connections

A standard 3.5 mm headset plug has the following pinout:

![Standard headset plug](image)

**NOTE:** Some headsets have the common (or ground) and microphone input rings swapped. Ensure you have the correct headset type. If you have the other type, then the connections to the jack (below) must be modified accordingly.
2.3 Soldering a stereo connector J7

The following diagram summarizes the necessary connections between J7 and the 3.5 mm headset connector. Appropriate connectors are available from various suppliers.

See the datasheet of the specific connector you have selected to identify the location of the terminals, as the location of the terminals on the jack varies by manufacturer. Ensure to select a connector with a closed switch that connects to the Tip conductor.

The following diagram summarizes the necessary connections between J7 and the 3.5 mm headset connector.

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**Notes:**
- HPH_REF and AGND should be connected as close to the connector as possible
- ESD protection between GND and HPH_L, HPH_R, HS_DET and MIC_2 signals are recommended (not shown)
- Tip switch is normally closed and opens when a plug is inserted into the jack.
Connect the following six wires, as shown in the figure.

- Headset Jack Tip (furthest from the headset wire) to analog expansion pin 10 (CDC_HPH_L) [Red]
- First ring (closest to the tip) to analog expansion pin 8 (CDC_HPH_R) [Green]
- Second ring to Analog expansion pin 4 (GND) [Green]
- Second ring to Analog Expansion pin 9 (HPH_REF) [Green]
- Third ring (closest to the headset wire) to analog expansion pin 6 (CDC_MIC2_P) [Blue]
- Headset switch (one of the pads on the jack) to analog expansion Pin 11 (CDC_HS_DET) – this one may be optional depending on the system software. [Yellow]

The colour of the wires is not important and are listed only for reference.

### 2.4 Bias signal for the microphone

The Microphone in the headset requires a nominal 1.8 V bias signal. There are four options to provide a bias voltage to the mic. In general, the standard system software uses the option 1. The best solution is to use the internal mic bias in the codec, this requires no changes. The software example in the next section is based on this method.
1. Install the R160 on the DragonBoard 410c. This requires soldering on an extremely tiny resistor.

2. Connect the CDC_MIC_BIAS1 (J7 pin 12) through a 2k resistor to CDC_MIC2_P (J2 pin 6).

3. Turn on the CDC_MIC_BIAS1 and ensure that there is a voltage of 1.8 V on pin 12 (measure between J7 pin 4 and J7 pin 12 while recording) using a volt meter.

There is a 1.8 V supply on the low-speed connector (J8 pin 35, LS_EXP_1V8). This supply may be a little noisy if there is a mezzanine card plugged into the low speed connector.

Use a 2k resistor to connect LS_EXP_1V8 (J8 pin 35) to CDC_MIC2_P (J7 pin 6).

2.5 Amixer commands to test the Audio routing through the stereo connector (Debian)

This information is already available in the ucm config files.

2.5.1 Headset playback:

NOTE: The ‘-c 0’ parameter selects the audio hardware instead of pulse audio.

```
amixer -c 0 cset iface=MIXER,name='RX1 MIX1 INP1' 'RX1'
amixer -c 0 cset iface=MIXER,name='RX2 MIX1 INP1' 'RX2'
amixer -c 0 cset iface=MIXER,name='RDAC2 MUX' 'RX2'
amixer -c 0 cset iface=MIXER,name='HPHL' 1
amixer -c 0 cset iface=MIXER,name='HPHR' 1
amixer -c 0 cset iface=MIXER,name='RX1 Digital Volume' 100
```
amixer -c 0 cset iface=MIXER,name='RX2 Digital Volume' 100
aplay -c 0 -D plughw:0,1 /usr/share/sounds/alsa/Front_Center.wav

2.5.2 Headset Mic Capture:
To capture audio on headset mic use the following commands:

```
amixer -c 0 cset iface=MIXER,name='DEC1 MUX' 'ADC2'
amixer -c 0 cset iface=MIXER,name='ADC2 Volume' 70
amixer -c 0 cset iface=MIXER,name='ADC2 MUX' 'INP2'
arecord -c 0 -D plughw:0,2 -r 16000 -f S16_LE /tmp/f-16000.wav
```

**NOTE:** This uses an internal mic bias so you should not see voltage on CDC_MIC_BIAS1.

Use the Headset playback commands (in the section above) to play back your recorded file (/tmp/f-16000.wav).

To capture audio on a secondary mic connected to CDC_MIC3_IN that has external mic bias taken from CDC_MIC_BIAS1 (install R160)
```
amixer -c 0 cset iface=MIXER,name='DEC1 MUX' 'ADC2'
amixer -c 0 cset iface=MIXER,name='ADC2 Volume' 70
amixer -c 0 cset iface=MIXER,name='ADC2 MUX' 'INP3'
arecord -c 0 -D plughw:0,2 -r 48000 -f S16_LE /tmp/f-48000.wav
```

**NOTE:** While recording on the headset mic there should be voltage on CDC_MIC_BIAS1, otherwise CDC_MIC_BIAS1 is expected to be zero.

2.5.3 Speaker playback:
```
amixer -c 0 cset iface=MIXER,name='RX3 MIX1 INP1' 'RX1'
amixer -c 0 cset iface=MIXER,name='SPK DAC Switch' 1
aplay -c 0 -D plughw:0,1 /usr/share/sounds/alsa/Front_Center.wav
```

2.6 Tinymix commands to test the audio routing through stereo connector (Android)
To play audio through the stereo connector, at the `adb` shell prompt, enter the following commands:
```
adb root
adb remount
adb shell
su
tinymix 'PRI_MI2S_RX Audio Mixer MultiMedia1' 1
tinymix 'RX1 MIX1 INP1' 'RX1'
tinymix 'RX2 MIX1 INP1' 'RX2'
tinymix 'RDAC2 MUX' 'RX2'
tinymix 'HPHL' 'Switch'
tinymix 'HPHR' 'Switch'
tinymix 'MI2S_RX Channels' 'Two'
```
tinyplay /data/test.wav

You should be able to hear playback on the earphone connected to the stereo connector.

Playback using Android Music player would normally play the audio over HDMI, as this is the default setting.

To change the default behavior, edit the file device/qcom/MSM8916_32/mixer_paths_sbc.xml based on the use case and push the file into DragonBoard 410c via adb to /system/etc/.
3 Adding other devices to J7

3.1 Connecting digital microphones to J7

The pins used for the DMIC clock and data, and UART0 are the same. In order to use a DMIC, disable the UART and enable the DMIC in the source code, and then recompile the operating system from source code. Details of how to recompile the operating systems vary from operating system to operating system and are beyond the scope of this document.

![Diagram of DMIC connection to J7 and J8 pins](image)

Notes:
- add a 0.1uF shunt capacitor between Bias and GND if the mic manufacture recommends it.
- ESD protection on LK, Data, and Bias signals are recommended

3.1.1 Enabling DMIC under Linux

To enable the use of digital microphones under Linux device tree changes are required. The following patch will disable the UART0 on GPIO_0 and GPIO_1 and enable the DMIC CLK and DATA on the same GPIOs.

```diff
diff --git a/arch/arm64/boot/dts/qcom/apq8016-sbc.dtsi b/arch/arm64/boot/dts/qcom/apq8016-sbc.dtsi
index 5d0d5a3..061f5f3 100644
```
--- a/arch/arm64/boot/dts/qcom/apq8016-sbc.dtsi
+++ b/arch/arm64/boot/dts/qcom/apq8016-sbc.dtsi
@@ -42,7 +42,7 @@

    serial@78af000 {
        label = "LS-UART0";
-       status = "okay";
+       status = "disabled";
        pinctrl-names = "default", "sleep";
        pinctrl-0 = <&blsp1_uart1_default>;
        pinctrl-1 = <&blsp1_uart1_sleep>;
@@ -281,13 +281,17 @@
        reg-names = "mic-iomux", "spkr-iomux";

        status = "okay";
-       pinctrl-0 = <&cdc_pdm_lines_act &ext_sec_tlmm_lines_act &ext_mclk_tlmm_lines_act>;
-       pinctrl-1 = <&cdc_pdm_lines_act &ext_sec_tlmm_lines_act &ext_mclk_tlmm_lines_act>
+       pinctrl-0 = <&cdc_pdm_lines_act &ext_sec_tlmm_lines_act &ext_mclk_tlmm_lines_act &cdc_dmic_lines_act>;
+       pinctrl-1 = <&cdc_pdm_lines_act &ext_sec_tlmm_lines_act &ext_mclk_tlmm_lines_act &cdc_dmic_lines_act>
        pinctrl-names = "default", "sleep";
        qcom,model = "DB410c";
        qcom,audio-routing =
            "AMIC2", "MIC BIAS Internal2",
-           "AMIC3", "MIC BIAS External1";
+           "AMIC3", "MIC BIAS External1",
+           "DMIC1", "MIC BIAS Internal1",
+           "DMIC1", "Digital Mic1";
Adding other devices to J7

```
+ "DMIC2", "MIC BIAS Internal1",
+ "DMIC2", "Digital Mic2"

external-dai-link@0 {
  link-name = "ADV7533"
  cpu { /* QUAT */

@@ -609,4 +613,4 @@

After the changes have been made, the DMIC is available at DEC1 MUX.

root@linaro-alip:~# amixer -c0

Simple mixer control 'DEC1 MUX',0
  Capabilities: enum
  Items: 'ZERO' 'ADC1' 'ADC2' 'ADC3' 'DMIC1' 'DMIC2'
Item0: 'DMIC1'
```
3.2 Connecting an auxiliary analog microphone to J7

![Diagram of microphone connections]

- Analog Mic
  - Bias → To J7 Pin 12 (MIC_BIAS1)
  - Out → To J7 Pin 7 (MIC3_P)
  - GND(s) → To J7 Pin 4 (AGND)
  - To J7 Pin 5 (GND_CFLT)

Notes:
- Add a 0.1μF shunt capacitor between Bias and GND if the mic manufacture recommends it.
- Route GND_CFLT and Out as a differential pair.
- GND_CFLT and AGND should be connected as close to the Mic as possible.
- ESD protection on Bias and Out signals are recommended.

3.3 Connecting a speaker to J7

The 410c chipset supports direct operation of a small speaker. Speakers with 8 Ω to 64 Ω impedance are appropriate, however an external amplifier may be required to achieve higher volumes.

![Diagram of speaker connections]

- To J7 Pin 1 (SPKR_OUT_P)
- To J7 Pin 2 (SPKR_OUT_N)

Note: Mixer commands will need to be modified to use this interface.

3.4 Connecting a FM antenna to J7

The 410c hardware is capable of receiving FM broadcast signals, however this feature is not enabled in current operating system software. Connect a 1 m long 22AWG wire to J7 pin 15 to create a good FM antenna.

3.5 Using the headset cable as a FM antenna

It is also possible to use the ground wire of the headset cable as a FM antenna. This requires a few additional passive components around the 3.5mm headset jack. Details on the components...
and detailed layout rules are beyond the scope of this document. This overview information is included for completeness.

Simplified FM connections

Notes:
- place L and C near the headset jack ground and star route their traces.
- Ferrite Beads and Capacitors must be placed close HPH_L and HPH_R speaker signals to improve FM performance (not shown).
- layout details are critical for operation of this circuit.
- layout details are beyond the scope of this document.

NOTE: The operating system software may not support operation of the FM receiver.
Overview block diagrams of the mixing paths inside the PM8916 and inside the APQ8016 are shown below.
Stere connector and audio routing on DragonBoard 410c application note
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