Adding U.FL Antenna Connectors to DragonBoard™ 410c and Validating GPS on Android and Linux

Application Note

LM80-P0436-42 Rev. C

January 18, 2018
# Revision history

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<th>Revision</th>
<th>Date</th>
<th>Description</th>
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<td>October 2015</td>
<td>Initial release</td>
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<td>September 2016</td>
<td>Update to ‘E’ part</td>
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<td>C</td>
<td>January 2018</td>
<td>Added Section 3.6</td>
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<td>Updated Table Table 3-2</td>
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1 Introduction

1.1 Purpose

This application note provides instructions on how to add U.FL connectors (for connecting external Wi-Fi or GPS antenna) to the DragonBoard 410c development platform. These instructions are required if the DragonBoard 410c is mounted inside a conductive enclosure. In such a scenario, the on-board Wi-Fi and GPS antenna cannot pick up Wi-Fi or GPS signals from outside the enclosure. Therefore, external Wi-Fi and GPS antennas are required, which are mounted outside the conductive enclosure and connected to the U.FL connectors.

NOTE: These instructions are valid for DragonBoard 410c boards that have shields populated on the processor, power management chip, and memory. Older DragonBoard 410c boards without shields do not function properly for GPS.

1.2 Acronyms, abbreviations, and terms

Table 1-1 provides definitions for the acronyms, abbreviations, and terms used in this document.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>SNR</td>
<td>Signal to Noise Ratio</td>
</tr>
<tr>
<td>U.FL</td>
<td>U.FL is a miniature RF connector for high-frequency signals up to 6 GHz manufactured by Hirose Electric Group and others.</td>
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</tbody>
</table>
2 Wi-Fi U.FL connector

Figure 2-1 DragonBoard 410c schematic showing Wi-Fi antenna circuitry
**2.1 Procedure to connect W-Fi U.FL connector**

To connect the Wi-Fi U.FL connector, perform the following:

1. Solder on J13 (the U.FL connector).
2. Move R96 to R16.

**NOTE:** The resistor is of zero-Ohm. While doing the rework, it is easier to remove R96 and bridge R16 with solder rather than trying to solder on one of the small resistors.
3 GPS U.FL Connector

Figure 3-1 DragonBoard 410c schematic showing GPS antenna circuitry
The options for using an external GPS antenna (with rework instructions) are as follows:

- **Option 1:** Passive GPS antenna - Requires a minimal rework on the board, but provides lower GPS sensitivity.
- **Option 2:** Active GPS antenna - Requires more effort for the rework, but provides better GPS sensitivity.

Active GPS antennas have an active RF gain stage, between 3 dB and 25 dB of gain, which results in better GPS sensitivity. Active antennas are powered by L19 at 5 V. Therefore, a 5 V antenna module must be selected if using an active GPS antenna (such as the Taoglas AP.25E.07.0054A GPS Active Patch Antenna) as shown in Table 3-2.

### 3.1 Option 1: Passive GPS antenna

<table>
<thead>
<tr>
<th>Description</th>
<th>Location (on board)</th>
<th>Vendor</th>
<th>Vendor Part No.</th>
<th>DigiKey Part No.</th>
<th>Mouser Part No.</th>
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<td>U.FL connector, 1.25 mm surface mount, 50 Ohm</td>
<td>J11</td>
<td>Molex</td>
<td>Molex 73412-0110</td>
<td>WM5587CT-ND</td>
<td>538-73412-0110</td>
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<tr>
<td>Passive GPS Antenna</td>
<td>Connect to U.FL connector on J11</td>
<td>Multiple</td>
<td>Adafruit 2460 (Passive GPS Antenna uFL – 9 mm x 9 mm -2 dBi gain)</td>
<td>-</td>
<td>485-2460</td>
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</table>
3.2 Procedure for using a passive GPS antenna

To use a passive GPS antenna, perform the following:

1. Remove R126, which disconnects the on-board GPS antenna.
2. Install the U.FL connector and a zero-ohm resistor in position C216 (a resistor in the position where the schematic shows a capacitor).

NOTE: A solder short is easier to install than a resistor.

3.3 Option 2: active GPS Antenna

Table 3-2 Components required for GPS U.FL connector for use with active GPS antenna

<table>
<thead>
<tr>
<th>Description</th>
<th>Location (on board)</th>
<th>Vendor</th>
<th>Vendor Part No.</th>
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<tr>
<td>U.FL connector, 1.25 mm surface mount, 50 Ohm</td>
<td>J11</td>
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<td>Molex 73412-0110</td>
<td>WM5587CT-ND</td>
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<td>Fixed Inductor, 100nH, 200 mA, 1.5 Ohm, 0402 package</td>
<td>L19</td>
<td>Taiyo Yunden</td>
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<td>587-1531-1-ND</td>
<td>963-HK1005R10J-T</td>
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<td>22 pf, 25 V, COG/NPO, 0201 package</td>
<td>C216</td>
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<td>1.0 uF, 6.3 V, X5R, 20%, 0201 package</td>
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<td>VENKEL CORP C0201X5R6R3-105MNP</td>
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<tr>
<td>Active GPS Antenna (5 V antenna module)</td>
<td>Connect to U.FL connector on J11</td>
<td>Multiple</td>
<td>Taoglas AP.25E.07.0054A</td>
<td>931-1141-ND</td>
<td>960-AP25E070054A</td>
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</table>

### 3.4 Procedure for using an active GPS antenna

To use an active GPS antenna, perform the following:

1. Remove R126, which disconnects the on-board GPS antenna.
2. Install the U.FL connector AND components C216, C217, L19.

**Note:** Many active GPS antennae require more than 1.8V to operate the gain-stage inside the antenna, it may be necessary to stand L19 on its end and use a jumper wire to a higher voltage supply (example 5V) to get the best performance from the selected antenna.
Adding U.FL Antenna Connectors to DragonBoard™ 410c and Validating GPS on Android and Linux Application Note

GPS U.FL Connector

Figure 3-3 U.FL connector rework completed for use with active GPS antenna

Figure 3-4 Active GPS antenna connected to U.FL connector
3.5 Validate GPS on Android

To validate GPS on Android, perform the following:

1. Flash the Android images.
2. Boot the DragonBoard 410c.
3. Ensure that the adb is enumerated on Device Manager.
4. Install the GPS Test application.
5. Run the following commands to install GPS Test apk:
   ```
   adb devices
   adb root
   adb remount
   adb install "GPS Test APK"
   ```
6. Go to Settings and change the following options:
   - Location – ON
   - Location mode – High Accuracy or Device only
7. Open the GPS Test application from Application menu.
   Depending on the outdoor location, antenna position, and weather conditions, the application finds the multiple Space vehicles (SVs) within the reasonable time frame.
   After finding multiple SVs with signal strength average of 35, a 2D/3D fix is achieved.
8. Figure 3-5 shows the 3D Fix (3D-Latitude, Longitude, and Altitude).

NOTE: The time to get First Fix varies on Signal-to-noise ratio (SNR) values and the state of the GPS engine, which runs on the device. Normally, in good-signal condition, maximum accuracy can reach up to 10 feet (3 meters).
Figure 3-5 3D fix

Figure 3-5 shows 21 in-view satellites (number of satellites that are tracking) and 12 in-use satellites (number of satellites that are used to track).

9. Click Satellite View (right side, top corner box in Figure 3-5) to list all the satellites being used and tracked. If it is 3D, then position is obtained (3D – Longitude, Latitude, Altitude). In Figure 3-6, First Fix Time is 3 seconds.

Figure 3-6 Satellite view
10. Click on the World Map (right side, second box from the top in Figure 3-6) to show the Longitude and Latitude of the device in WGS84 coordinate system, as shown in Figure 3-7.

![Figure 3-7 Longitude and latitude of the device](image)

11. Click Speed (on the right side, third box from the top in Figure 3-7) to show the speed at which the device is moving (in miles per hour) and the Altitude of the device (in feet). Here, the device is in a constant position. So, the speed is 0 mph, as shown in Figure 3-8.

![Figure 3-8 Speed](image)
12. Click **Time** (on the right side, fourth box from the top in Figure 3-8) to see the time in UTC format, as shown in Figure 3-9.

![Figure 3-9 Time](image)

### 3.6 Validate GPS on Linux

The GPS software stack runs on the DSP subsystem. The communication between the main CPU and the DSP is done with a specific IPC driver called QRTR. For more information, see `/net/qrtr/` in the kernel source tree. The GPS packages are not installed automatically in the default images. To start the GPS software, some additional packages must be installed. After these packages are installed, the DSP is started automatically (at boot). Any gpsd client can be started and is able to retrieve GPS data.

**NOTE:** The sensitivity of the onboard antenna is low. Therefore, getting a FIX takes several minutes. Refer to the dedicated application note to install an external antenna for better GPS performance.

To get started with GPS, perform the following:

1. Install the following packages:
   ```bash
   sudo apt-get install gpsd-clients gnss-gpsd
   ```
   The package gnss-gpsd brings all the needed dependencies to use the onboard GPS.

2. Use any gpsd client, such as gpsmon or xgps.
EXHIBIT 1

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