2x2 MIMO Prism-WiFi Module Integration Guide (-2H)
Overview

Doodle Labs offers an extensive family of embedded Prism-WiFi™ wireless transceivers to implement best-in-class wireless technology optimized for different applications and in many different frequency bands. These modules have been developed with an innovative and highly configurable Prism™ architecture. Like the Lego blocks, these form factor compatible modules can be quickly factory configured to operate within the 200 MHz to 6 GHz frequency range, MIMO or single stream, various RF power options, Indoor/Extended Temp/Rugged operation etc. This opens up the possibility to introduce models operating in different frequency bands. For more details, please visit our web site. http://www.doodlelabs.com/products/

In this integration guide we hope to provide the necessary information, answers to frequently asked questions and tips for a smooth and quick modem development.

Hardware Integration of the Prism-WiFi Modules

1. Doodle Labs Prism-WiFi radio modules are offered with the IEEE 802.11n (MAC IC QCA9590, ath9k driver).

2. The modular nature of the FES allows for accelerated development of the wireless modem. A large offering of form-factor compatible FES models simplify introduction of modems operating in different frequency bands.

3. The DC power cable and 2x RF cables are included with the samples. For the volume production, these cables can be ordered as a separate accessory item. Please refer to Appendix B1, B2 and C for the cable assembly drawings for these items.

4. Please note that the RF cable to connect the antenna is NOT included due to the wide variety of the antennas on the market. A simple pigtail with MMCX-Male (FES side) to the appropriate antenna connector will be required.

5. The FES modules require 6~40V DC (Pin1=VDD, Pin 5=GND on USB micro)
6. The FES consume about 7~15W of power (depending on the frequency and RF power configuration). Please make sure that the host CPU board can support this power requirement with <100mVpp Voltage ripple. Also ensure that the voltage does not drop during transmission at the highest RF power. You can use a continuous transmission of UDP packets to check this.

7. Each radio and the FES are calibrated together. So care should be used to pair-up the MAC # and the CH# on the label.

8. Because the radio and FES are calibrated together, there is no power offset required. The transceiver will provide the appropriate power as set from the driver.

9. It is recommended to use the radio and the FES together as a pair only. The normal calibrated power from radio is very low, in the range of 5-10 dBm to account for the FES gain. Forcing the radio signal high (above 12 dBm) to feed the FES may damage the input port.

10. Care should be taken to avoid grounding loops between the radio card and the FES. During bench evaluations, this can be avoided by keeping both of them on an Aluminum foil.

11. Proper grounding and ripple free power supply are very important considerations for proper operation of any RF equipment.

12. Because the FES modules generate a fair amount of heat, we recommend to mount them on the modem casing itself for best heat dissipation. The PA is located on the top-right corner (while looking down) of the FES and generates the most heat. The bottom surface of the FES provides maximum heat conduction out of the module.

13. Doodle Labs radio modules should be electrically and mechanically compatible with all the host CPU boards compliant to the miniPCI Express 1.2. The modules have 1.35 mm thickness on the bottom side and 2.4 mm thickness on the top side.

14. Please refer to Appendix A for the miniPCle pin-out of the Doodle Labs radio modules.

15. During initial design/evaluation phase, the Samples Characteristics Report may be a useful reference. It provides the important samples specific radio characteristics. This report is always emailed with the Shipping documents.

16. Please refer to Appendix B and C for mechanical drawings. CAD models are available upon request.

17. The equipment label should have a note “Contains FCC ID: xxxxxxxx”

   Many models have gone through regulatory certifications. This is an ongoing activity so please inquire about the certification status of the model # used in your project. Doodle Labs offers additional certification related services.

Software Integration of the Prism-WiFi Modules
1. Doodle Labs Prism-WiFi modules use the standard Wi-Fi radio modules and hence they work with the standard Open source drivers ath9k (N*-.*-* models).

2. The only required software adjustment is to account for the frequency offset in the GUI. The frequency offset is provided in the characterization report provided with the samples.

3. Because the radio module and the Prism-FES are calibrated together for the best performance, there is no offset required in the RF power setting.

4. OpenWRT is a good open source wireless router. Many of our customers use it as a starting point and further customize it for their needs.

5. We recommend below online resources for documentation and support questions.
   a) iw – Wireless configuration tool - [https://helpmanual.io/help/iw/](https://helpmanual.io/help/iw/)
   c) OpenWRT - [https://openwrt.org/](https://openwrt.org/)

6. Due to many factors involved with software related issues, Doodle Labs is limited in it’s ability to provide significant value add. However, for unique issues, please feel free to ask us for help. We may be able to give you some tips or connect you with some 3rd party software developers that can help you solve the problem.

**Tips – Problems to avoid (based on prior customer issues)**

1. Ensure CONFIG_PCI_MSI setting is disabled in the kernel. Accidental enable will stop sending the beacons.

2. Make sure Pin 20 of the miniPCIe interface is high. Driving it low disables the WLAN interface (RF Kill function required by FAA for airborne applications).

3. Make sure that the power supply voltage at the miniPCIe pins does not drop at full transmit power.

4. Note that the radio module is calibrated to provide only 5-10 dBm of RF power. It is not advisable to use the radio module without the FES.

5. Connecting the FES to high power signal (above ~15 dBm) may permanently damage the RF port of the FES.

6. To achieve long distance operation, adjust the distance setting using iw. The default ACK timeout in ath9k is about 200 meters. To achieve longer range, this parameter should be either set to Auto or desired distance setting.

1. During ground testing, be aware that the antenna height and Fresnel zone may play a significant role in achieving long range.
Appendix A – miniPCIe Pin-out for 802.11n modules
Appendix B – Mechanical Drawing for Radio Module
Appendix C – Mechanical Drawing for FES Module

3D-DLM184-02
Appendix E – Power Cable for FES

### Wiring Configuration

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<tr>
<th>Signal name</th>
<th>AWG</th>
<th>Color</th>
<th>Bare End</th>
<th>Black</th>
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<tbody>
<tr>
<td>VCC</td>
<td>24</td>
<td>Red</td>
<td>Bare End</td>
<td></td>
</tr>
<tr>
<td>Ground</td>
<td>24</td>
<td>Black</td>
<td>Bare End</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
1. Function test: 100% test for open, short, miswire and continuity.
2. Current handling capability: 3V/2A

### Table

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Description</th>
<th>Part Number</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>2C 24 AWG Wire</td>
<td>Bare End</td>
<td>Type B w/ PE Molding</td>
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<tr>
<td>A2</td>
<td>Micro USB Plug</td>
<td>Black &amp; Red Color</td>
<td></td>
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</tbody>
</table>
FCC Statement

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.
-- Increase the separation between the equipment and receiver.
-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-- Consult the dealer or an experienced radio/TV technician for help

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

IC Statement

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

The term “IC: “ before the certification/registration number only signifies that the Industry Canada technical specifications were met. This product meets the applicable Industry Canada technical specifications.

Le présent appareil est conforme aux CNR d'Industrie Canada applicable aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage,
et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.