

# Doodle Labs ACO-DB-2 Wi-Fi Transceiver

Dual Band – 5.x and 2.4 GHz, MIMO, IEEE802.11ac outdoor transceiver

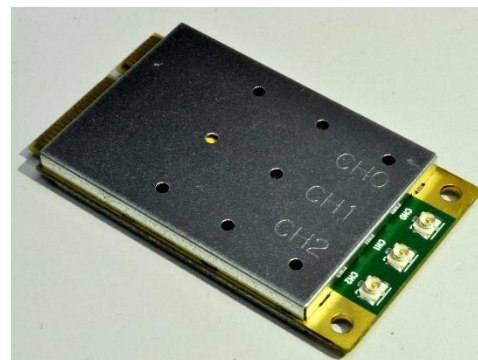
## Product Family Overview

Doodle Labs' portfolio of Outdoor Wi-Fi transceivers offers very reliable wireless performance. These transceivers have high transmit power to achieve long-range communication and withstand operation in outdoor environments. The transceivers are FCC, CE, and IC certified and have been deployed in numerous demanding applications.

## Target Applications

The Doodle Labs Outdoor Wi-Fi transceivers meet the demanding needs of customers across a broad range of industries. Examples include:

- IoT applications
- Access Points for large area coverage
- Fixed wireless PtP links
- Mesh networking deployments
- Streaming HD video surveillance cameras
- Fixed wireless infrastructure for campuses



## Features

Best-in-class features include:

- Modular FCC, CE, and IC certifications to expedite system integration and deployment
- Integrated LNA for high Rx sensitivity to pick up low energy signals from mobile phones
- Up to 27 dBm of RF power to communicate over a large area
- Extended temperature range from -40C to +60C for outdoor operation
- Electrical stress protection on antenna ports for outdoor operation

# ACO-DB-2 Specifications

**Table 1.** Technical Specifications.

|  |   |
|--|---|
| <b>Ordering Code</b>   | ACO-DB-2U with U.FL connectors  |
| <b>Radio Configuration</b>                                   | 2x2 MIMO, Dual Band   |
| <b>MAC Chipset</b>   | Qualcomm Atheros: QCA9890-BR4B with Extended Temperature range  |
| <b>Software Support</b>                                      | Open Source Linux Drivers<br><a href="#">ath10k</a> for 11ac models<br><a href="#">OpenWRT</a> (Wireless Router/Linux OS)   |
| <b>Center Frequency Range</b>                                | 5.180 GHz ~ 5.825 GHz<br>2.412 GHz ~ 2.484 GHz<br>This varies by the regulatory domain  |
| <b>Channel Bandwidth*</b>                                    | 20, 40 and 80 MHz channels  |
| <b>Radio Modulation/Data Rates (Dynamic Link Adaptation)</b> | <a href="#">802.11ac</a> : MCS0-9 (5.x GHz)<br><a href="#">802.11a</a> : 6, 9, 12, 18, 24, 36, 48 and 54 Mbps (5.x GHz)<br><a href="#">802.11n</a> : MCS0-23 (5.x and 2.4 GHz)<br><a href="#">802.11b/g</a> : 1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48 and 54 Mbps (2.4 GHz)   |
| <b>802.11ac Wave 1 Capabilities</b>                          | <ul style="list-style-type: none"> <li>• 802.11 dynamic frequency selection (DFS) as an AP and Client</li> <li>• Packet aggregation: A-MPDU (Tx/Rx), A-MSDU (Tx/Rx), Maximal ratio combining (MRC), Cyclic shift diversity (CSD), Frame aggregation, block ACK, 802.11e compatible bursting, Spatial multiplexing, cyclic-delay diversity (CDD), low-density parity check (LDPC), Space Time Block Code (STBC)</li> <li>• Phy data rates up to 1.3 Gbps (80 MHz channel)</li> </ul> |
| <b>802.11n version 2.0 Capabilities</b>                      | <ul style="list-style-type: none"> <li>• 802.11 dynamic frequency selection (DFS) as an AP and Client</li> <li>• Packet aggregation: A-MPDU (Tx/Rx), A-MSDU (Tx/Rx), Maximal ratio combining (MRC), Cyclic shift diversity (CSD), Frame aggregation, block ACK, 802.11e compatible bursting, Spatial multiplexing, cyclic-delay diversity (CDD), low-density parity check (LDPC), Space Time Block Code (STBC)</li> <li>• Phy data rates up to 450 Mbps (40 MHz channel)</li> </ul> |
| <b>Operating Modes</b>                                       | AP, Client, and Adhoc modes for Access Point, PtP, PtMP, and Mesh networks  |
| <b>MAC Protocol</b>  | TDD with Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)   |

|                                  |   |
|----------------------------------|---|
| <b>Wireless Error Correction</b> | FEC, ARQ  |
| <b>Wireless Data Security</b>    | 128 bit AES, WEP, TKIP and WAPI hardware encryption. Support for IEEE 802.11d, e, h, i, k, r, v, w and time stamp standards |

**Table 2.** Tx and Rx performance at 5 GHz.

| <b>Tx/Rx Specification</b>                  | <b>Radio Modulation</b> | <b>Coding Rate</b> | <b>Tx Power (<math>\pm 2\text{dBm}</math>)<sup>2</sup></b> | <b>Rx Sensitivity (Typ)</b> |
|---|-------------------------|--------------------|--|-----------------------------|
| <b>5 GHz (20 MHz Channel) – 11ac models</b> |                         |                    |  |                             |
| 802.11a, STBC                               | BPSK                    | 1/2                | 24   | -94                         |
| 802.11a                                     | 64 QAM                  | 3/4                | 19   | -77                         |
| 802.11ac, 802.11n                           | BPSK                    | 1/2                | 24   | -95                         |
| 802.11ac, 802.11n                           | 16 QAM                  | 3/4                | 22   | -82                         |
| 802.11ac, 802.11n                           | 64 QAM                  | 5/6                | 19   | -75                         |
| 802.11ac                                    | 256 QAM                 | 3/4                | 17   | -71                         |
| <b>5 GHz (40 MHz Channel) – 11ac models</b> |                         |                    |  |                             |
| 802.11ac, 802.11n                           | BPSK                    | 1/2                | 24   | -91                         |
| 802.11ac, 802.11n                           | 16 QAM                  | 3/4                | 22   | -79                         |
| 802.11ac, 802.11n                           | 64 QAM                  | 5/6                | 19   | -72                         |
| 802.11ac                                    | 256 QAM                 | 5/6                | 17   | -66                         |
| <b>5 GHz (80 MHz Channel) – 11ac models</b> |                         |                    |  |                             |
| 802.11ac                                    | BPSK                    | 1/2                | 23   | -87                         |

|          |         |     |    |     |
|----------|---------|-----|----|-----|
| 802.11ac | 16 QAM  | 3/4 | 21 | -75 |
| 802.11ac | 64 QAM  | 5/6 | 18 | -69 |
| 802.11ac | 256 QAM | 5/6 | 16 | -62 |

**Table 3.** Tx and Rx performance at 2.4 GHz.

| Tx/Rx Specification                           | Radio Modulation | Coding Rate | Tx Power ( $\pm 2\text{dBm}$ ) <sup>2</sup> | Rx Sensitivity (Typ) |
|---|------------------|-------------|---|----------------------|
| <b>2.4 GHz (20 MHz Channel) – 11ac models</b> |                  |             |   |                      |
| 802.11b<br>Single Stream, STBC                | 1 Mbps           | CCK         | 26  | -96                  |
| 802.11g                                       | 64 QAM           | 3/4         | 21  | -79                  |
| 802.11n                                       | BPSK             | 1/2         | 26  | -93                  |
| 802.11n                                       | 16 QAM           | 3/4         | 24  | -81                  |
| 802.11n                                       | 64 QAM           | 5/6         | 21  | -74                  |
| <b>2.4 GHz (40 MHz Channel) – 11ac models</b> |                  |             |   |                      |
| 802.11n                                       | BPSK             | 1/2         | 26  | -90                  |
| 802.11n                                       | 16 QAM           | 3/4         | 24  | -78                  |
| 802.11n                                       | 64 QAM           | 5/6         | 21  | -71                  |

Note 1: It is advantageous to use the smallest channel bandwidth that can support throughput requirements. Smaller bandwidths provide more channels to choose from and help avoid interference issues.

Note 2: Total Tx power for all streams. Max allowed Tx power depends on the regulatory domain.

**Table 4.** Additional RF performance information.

|  |  |
|--|--|
| <b>Antenna Signal Strength</b>                                 | -35 to -85 dBm (recommended), Absolute Maximum=+12 dBm   |
| <b>Integrated Antenna Port Protection</b>                      | 10 kV  |
| <b>Receiver LNA Gain</b>                                       | >10 dB   |
| <b>Receiver Adjacent Channel Rejection (ACR)</b>               | >18 dB @ 11a, 6 Mbps (Typ)   |
| <b>Receiver Alternate Channel Rejection (ALCR)</b>             | >35 dB @ 11a, 6 Mbps (Typ)   |
| <b>Receive chain Noise Figure</b>                              | +6 dB  |
| <b>Transmitter Adjacent Channel Leakage Power Ratio (ACLR)</b> | 45 dB ( $F_c \pm ChBW$ )   |
| <b>Transmitter Spurious Emission Suppression</b>               | -40 dBc  |
| <b>RF Power control</b>  | In 0.5 dBm steps. Accuracy of power calibration loop $\pm 2$ dBm. Each transceiver individually calibrated and tested. |

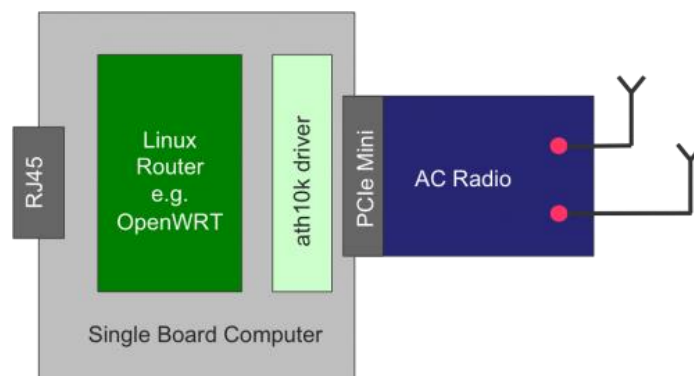
**Table 5.** Physical, Environment, and Other Specifications.

|                          |  |
|--------------------------|--|
| <b>Host Interface</b>    | miniPCI-Express 1.2 Standard   |
| <b>Host CPU Board</b>    | Any CPU board with miniPCIe interface with minimum 6 mm connector height   |
| <b>Operating Voltage</b> | 3.3 Volts from miniPCI-Express connector   |
| <b>Power Consumption</b> | 4W @ Max power, in continuous data transfer mode on all chains<br>2W @ 20 dBm power (ETSI max), in continuous data transfer mode on all chains<br>0.7W in continuous data receive mode<br>250 mW in Sleep mode |

|  |  |
|--|--|
| <b>Shield case temperature range (Operating)</b> | -40°C to +60°C   |
| <b>Humidity (Operating)</b>                      | 0% – 95% (Non-condensing)  |
| <b>Dimensions</b>                                | 30 x 50 x 5.3 mm, 12 grams. Mechanical drawings and 3D-CAD files available upon request  |
| <b>MTBF</b>                                      | 25 years   |
| <b>Regulatory Requirements</b>                   | Designed and verified to meet various regulatory requirements. Formal testing and approval is required based on the integrator’s particular host platform and antenna type. The integrator is also responsible for obtaining all required regulatory approvals in target markets for the finished product. |
| <b>FCC ID</b>                                    | 2AG87DLM168-3  |
| <b>CE/ETSI</b>                                   | Conforms with all the requirements of the European Directive 1999/5/EC – EN 301 893 V1.8.1, EN 300 328 V.1.8.1, EN 301 489-1 V1.9.2, EN 301 489-17 V2.2.1, EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011+ A2:2013  |
| <b>Industry Canada (IC)</b>                      | 21411-DLM1683  |
| <b>RoHS/WEEE Compliance</b>                      | Yes. 100% Recyclable/Biodegradable packaging   |

## System Integration

Figure 3. System Integration Block Diagram.



As shown in the block diagram, the modular nature of the MIMO radio transceivers allows for accelerated development of the wireless modem. An embedded Single Board Computer with standard miniPCI-Express interface is required. The Linux distribution OpenWRT has evolved over time and provides advanced features in a wireless router. It is a stable distribution and many OEMs are using OpenWRT as a starting point and then customize further for their application. The distribution includes the ath10k driver to interface with the MIMO transceivers. Both OpenWRT and open source drivers (ath9k and ath10k) have extensive online documentation available. User group forums also provide responsive technical support.

## Portfolio Index

Doodle Labs' Outdoor Wi-Fi transceiver portfolio provides configurations for a vast variety of project needs. All models are form-factor compatible. For information on other models, please visit - <http://www.doodlelabs.com/products/wi-fi-band-radio-transceivers/>