**Manuals+** — User Manuals Simplified.



# Doodle Labs ACM-DB-3-R2 Industrial Wi-Fi Transceiver User Manual

**Contents**

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## Product Family Overview

Doodle Labs' portfolio of Industrial Wi-Fi transceivers offer the industry's best-in-class performance. These transceivers have high transmit power for long-range communication and has been designed to withstand operation in extremely challenging environments. In addition, these transceivers feature high interference immunity that allows successful operation in today's congested Wi-Fi environments. The transceivers are FCC, CE, and IC certified and have been deployed in numerous demanding applications. Top and bottom views of the ACM-DB-3-R2 transceiver with MMCX connectors.



## Target Applications

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

- Unmanned Vehicles – Drones
- Unmanned Robots
- Industrial IoT applications
- Rugged/Military requirements with extended temperature and vibration resiliency
- Mesh Networking deployments
- Passenger Wi-Fi access aboard airplanes and trains
- Streaming HD Video Surveillance Cameras
- Wireless Infrastructure in harsh operating conditions of the Oil/Gas fields and Mines

## Features

Best-in-class features include:

- Modular FCC, CE and IC certifications to expedite system integration
- Integrated LNA for best-in-class Rx sensitivity to pick up low energy signals from mobile phones
- Up to 30 dBm of RF power to get the largest possible area coverage
- Extended temperature range from -40C to +85C.
- Electrical Stress protection on Antenna ports for outdoor operation
- Long product life cycle to meet the needs of Industrial IoT applications
- High interference immunity for Wi-Fi congested environment
- Hardware "RF Kill" feature to meet the FAA requirement for airborne applications
- High band isolation to support concurrent dual band operation for multi-band routers

Interference immunity performance compared to leading competitors
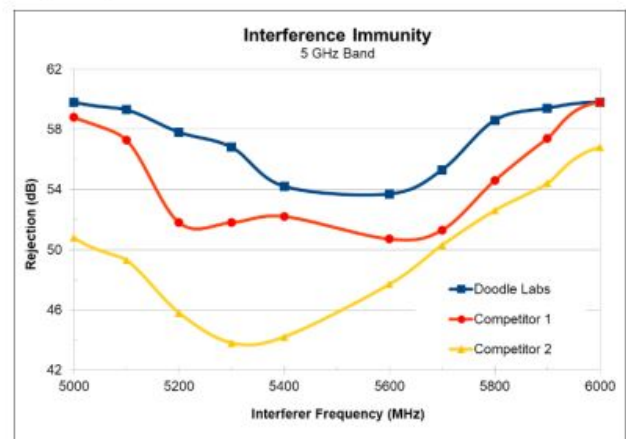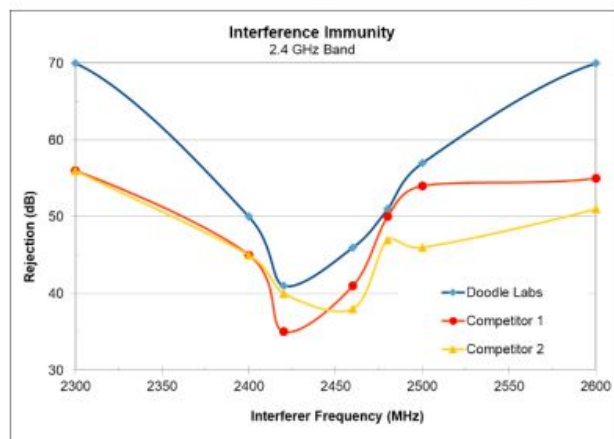


## ACM-DB-3 Specifications

### Technical Specifications

| Ordering Code | ACM-DB-3-R2 with MMCX connectors<br><br>ACM-DB-3-R2 with U.FL connectors |
| --- | --- |
| Radio Configuration | 3×3 MIMO, Dual Band |

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|---|---|
| **Special Features** | – Extended lifespan with planned availability for long time<br><br>– Extreme Reliability, IPC Class 2 standard with Class 3 options<br><br>– Compliant to MIL-STD-202G, Qualified for high shock/vibration environments |
| **Design-In Documentation** | **https://www.doodlelabs.com/technologies/technical-library/** |
| **MAC Chipset** | Qualcomm Atheros: QCA9890-BR4B with Extended Temperature range |
| **Software Support** | Open Source Linux Drivers **ath10k** for 11ac models<br><br>**OpenWRT** (Wireless Router/Linux OS) |
| **Center Frequency Range** | 5.180 GHz ~ 5.825 GHz<br><br>2.412 GHz ~ 2.484 GHz<br><br>This varies by the regulatory domain |
| **Channel Bandwidth\*** | 20, 40 and 80 MHz channels |
| **Radio Modulation/Data Rates (Dynamic Link Adaptation)** | **802.11ac:** MCS0-9 (5.x GHz)<br><br>**802.11a:** 6, 9, 12, 18, 24, 36, 48 and 54 Mbps (5.x GHz)<br><br>**802.11n:** MCS0-23 (5.x and 2.4 GHz)<br><br>**802.11b/g:** 1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48 and 54 Mbps (2.4 GHz) |
| **802.11ac Wave 1 Capabilities** | ·      802.11 dynamic frequency selection (DFS) as an AP and Client<br><br>·      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)<br><br>·      Phy data rates up to 1.3 Gbps (80 MHz channel) |

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| **802.11n version 2.0 Capabilities** | ·     802.11 dynamic frequency selection (DFS) as an AP and Client<br><br>·     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)<br><br>·     Phy data rates up to 450 Mbps (40 MHz channel) |
| **Operating Modes** | AP, Client, and Adhoc modes for Access Point, PtP, PtmP, and Mesh networks |
| **MAC Protocol** | TDD with Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) |
| **Wireless Error Correction** | FEC, ARQ |
| **Wireless Data Security** | 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 |
| **FIPS Certification** | ·     Small packet size (96 bytes) in AES encryption at full packet rate.<br><br>·     FIPS 140-2, Level 2 (Temper Evidence Shield), Loop back mode to facilitate FIPS AES certification. |

| Tx/Rx Specification | Radio Modulation | Coding Rate | Tx Power (±2dBm)[2] | Rx Sensitivity (Typ) |
|---|---|---|---|---|
| **5 GHz (20 MHz Channel) – 11ac models** | | | | |
| 802.11a, STBC | BPSK | 1/2 | 27 | -96 |
| 802.11a | 64 QAM | 3/4 | 22 | -81 |
| 802.11ac, 802.11n | BPSK | 1/2 | 27 | -96 |
| 802.11ac, 802.11n | 16 QAM | 3/4 | 25 | -84 |
| 802.11ac, 802.11n | 64 QAM | 5/6 | 22 | -75 |
| 802.11ac | 256 QAM | 3/4 | 20 | -72 |
| **5 GHz (40 MHz Channel) – 11ac models** | | | | |
| 802.11ac, 802.11n | BPSK | 1/2 | 27 | -93 |
| 802.11ac, 802.11n | 16 QAM | 3/4 | 25 | -81 |
| 802.11ac, 802.11n | 64 QAM | 5/6 | 22 | -75 |
| 802.11ac | 256 QAM | 5/6 | 20 | -68 |
| **5 GHz (80 MHz Channel) – 11ac models** | | | | |
| 802.11ac | BPSK | 1/2 | 26 | -87 |
| 802.11ac | 16 QAM | 3/4 | 24 | -78 |
| 802.11ac | 64 QAM | 5/6 | 21 | -72 |
| 802.11ac | 256 QAM | 5/6 | 19 | -65 |

| Tx/Rx Specification | Radio Modulation | Coding Rate | Tx Power (±2dBm)[2] | Rx Sensitivity (Typ) |
|---|---|---|---|---|
| **2.4 GHz (20 MHz Channel) – 11ac models** | | | | |
| 802.11b Single Stream, STBC | 1 Mbps | CCK | 29 | -100 |
| 802.11g | 64 QAM | 3/4 | 24 | -80 |
| 802.11n | BPSK | 1/2 | 29 | -95 |
| 802.11n | 16 QAM | 3/4 | 27 | -83 |
| 802.11n | 64 QAM | 5/6 | 24 | -76 |
| **2.4 GHz (40 MHz Channel) – 11ac models** | | | | |
| 802.11n | BPSK | 1/2 | 29 | -91 |
| 802.11n | 16 QAM | 3/4 | 27 | -80 |
| 802.11n | 64 QAM | 5/6 | 24 | -73 |

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| **Antenna Signal Strength** | -35 to -85 dBm (Recommended), Absolute Maximum=+12 dBm |
| **Interference Immunity** | SAW filters on RF ports for immunity against high power cellular transmissions in the neighboring 2.4 GHz bands. |
| **Antenna port isolation for concurrent operation** | Up to +10 dBm signal strength for 5 GHz signal without degrading 2.4 GHz operation<br><br>Up to +5 dBm signal strength for 2.4 GHz signal without degrading 5.x GHz operation |
| **Integrated Antenna Port Protection** | 10 kV |
| **Receiver LNA Gain** | >10 dB |

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| **Receiver Adjacent Channel Rejection (ACR)** | >18 dB @ 11a, 6 Mbps (Typ) |
| **Receiver Alternate Channel Rejection (ALCR)** | >35 dB @ 11a, 6 Mbps (Typ) |
| **Receive chain Noise Figure** | +6 dB |
| **Transmitter Adjacent Channel Leakage Power Ratio (ACLR)** | 45 dB (Fc ± ChBW) |
| **Transmitter Spurious Emission Suppression** | -40 dBc |
| **RF Power control** | In 0.5 dBm steps. Accuracy of power calibration loop ±2 dBm. Each transceiver individually calibrated and tested. |
| **RF Hardware Disable (RF Kill)** | Pin 20 of miniPCI-E interface. (Required for FAA compliance) |

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| **Host Interface** | miniPCI-Express 1.2 Standard |
| **Host CPU Board** | Any CPU board with miniPCIe interface |
| **Operating Voltage** | 3.3 Volts from miniPCI-Express connector |
| **Power Consumption** | 5.3W @ Max power, in continuous data transfer mode on all chains<br><br>2.5W @ 20 dBm power (ETSI max), in continuous data transfer mode on all chains<br>0.9W in continuous data receive mode<br><br>250 mW in Sleep mode |

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|---|---|
| **Temperature range** | -40°C to +85°C (shield case) |
| **Humidity (Operating)** | 0% – 95% (Non-condensing) |
| **Dimensions** | 30 x 50 x 4.75 mm, 12 grams. High Res Photos – Mechanical drawings and 3D-CAD files available upon request |
| **MTBF** | 27 years |
| **Regulatory Requirements** | 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. |
| **FCC ID** | 2AG87ACM-DB-3-R2 |
| **CE/ETSI** | 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 |
| **Industry Canada (IC)** | 21411-ACMDB3R2 |
| **RoHS/WEEE Compliance** | Yes. 100% Recyclable/Biodegradable packaging |

## System Integration

**System Integration Block Diagram.**
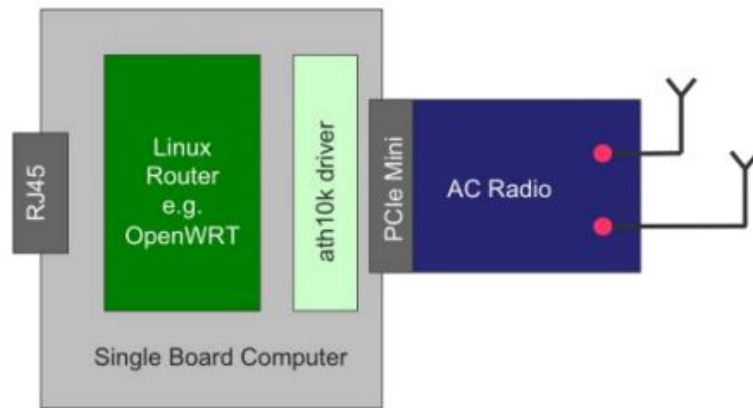
As shown in the block diagram, the modular nature of the MIMO radio transceivers allow for accelerated development of the wireless modem. Any embedded Single Board Computer with standard miniPCI-Express interface is required. The Linux distribution **OpenWRT** has evolved over time and provides advanced features in a wireless router. It is a stable distribution and many OEMs are using OpenWRT as a starting point and 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' Industrial Wi-Fi transceiver portfolio provides configurations optimized 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/**

**Doodle Labs provides extensive design-in documents at:**

**https://www.doodlelabs.com/technologies/technical-library/**

**FCC Statement**
FCC standards: FCC CFR Title 47 Part 15 Subpart C Section 15.247 and FCC CFR Title 47 Part 15 Subpart E Section 15.407: 2016
External Antenna with gain ANT0: 3dBi, ANT1: 3dBi, ANT2: 3dBi
**FCC Regulatory Compliance:**
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- this device may not cause harmful interference, and
- this device must accept any interference received, including interference that may cause undesired operation.
  **Note:** 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.
- Warning: changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
- If power exceeds the limit and the distance(Over 20cm distance in actual use between the device and user) is compliance with the requirement

**RF Exposure Compliance:**
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and any part of your body.

**Notice to OEM integrator**

- If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. The end product shall haves the words "Contains Transmitter Module FCC ID: 2AG87ACM-DB-3-R2".
- The device must be professionally installed.
- The intended use is generally not for the general public. It is generally for industry/commercial use.
- The connector is within the transmitter enclosure and can only be accessed by disassembly of the transmitter that is not normally required. The user has no access to the connector.
- Installation must be controlled. Installation requires special training.
- Any company of the host device which installs this modular with unlimited modular approval should perform the test of radiated & conducted emission and spurious emission, etc. according to FCC part 15C: 15.247 and15.207, 15B Class B and Part 15 Subpart E Section 15.407 requirement, only if the tests result comply with FCC part 15C: 15.247 and15.207, 15B Class B and Part 15 Subpart E Section 15.407 requirement, then the host can be sole legally.
  When the module is installed inside another device, the user manual of the hose contain below
- This device may not cause harmful interference.
-  This device must accept any interference received, including interference that may cause undesired operation

## Documents / Resources



[**Doodle Labs ACM-DB-3-R2 Industrial Wi-Fi Transceiver**](#) [pdf] User Manual
ACM-DB-3-R2, ACMDB3R2, 2AG87ACM-DB-3-R2, 2AG87ACMDB3R2, ACM-DB-3-R2 Industrial Wi-Fi Transceiver, Industrial Wi-Fi Transceiver

## References

- W [**IEEE 802.11a-1999 - Wikipedia**](#)
- W [**IEEE 802.11ac-2013 - Wikipedia**](#)

- <sup>W</sup> **IEEE 802.11g-2003 - Wikipedia**
- <sup>W</sup> **IEEE 802.11n-2009 - Wikipedia**
- **en:users:drivers:ath10k [Linux Wireless]**
- **[OpenWrt Wiki] Welcome to the OpenWrt Project**

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