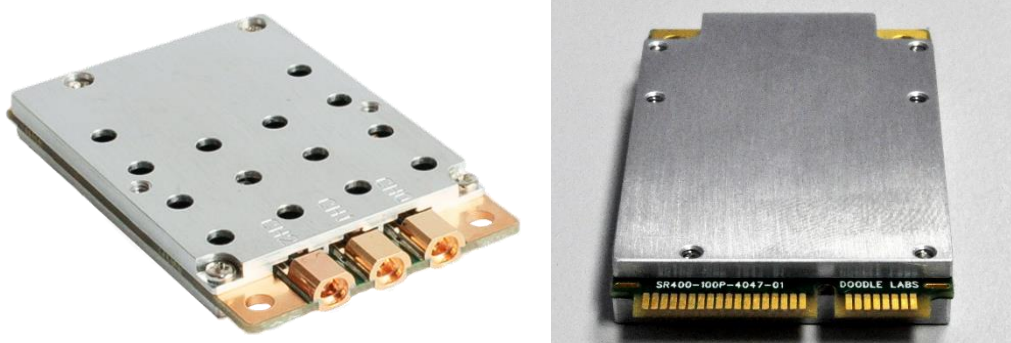# Doodle Labs ACM-DB-3 Industrial Wi-Fi Transceiver
Dual Band – 5.x and 2.4 GHz, 3x3 MIMO, IEEE802.11ac transceiver

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 to achieve long range and offer the rugged construction to withstand operation in the extended temperature range. In addition, our 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.

Figure 1. Top and bottom views of the ACM-DB-3M 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:
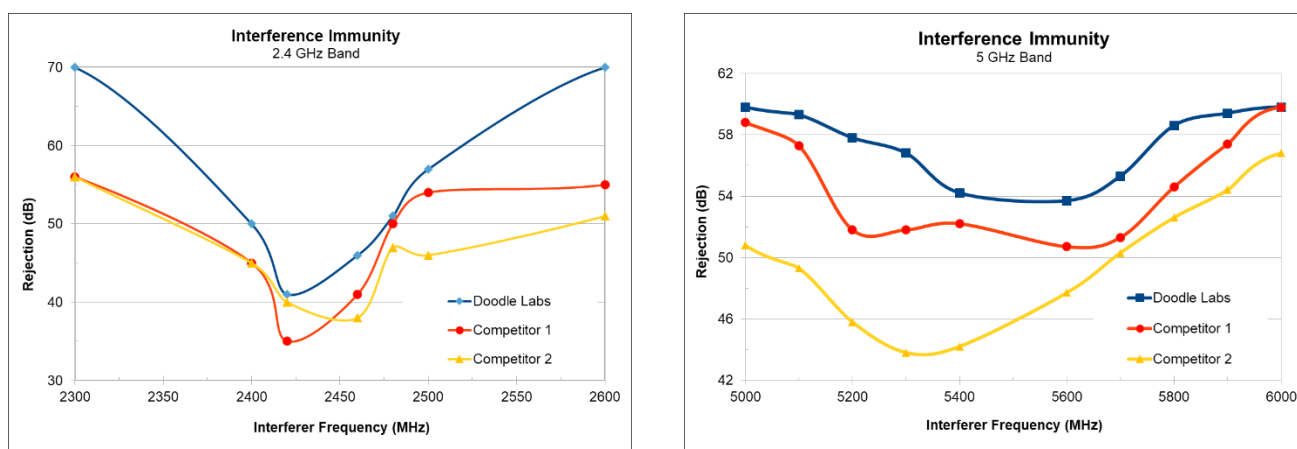
- Unmanned Vehicles – Drones
- Unmanned Robots
- Industrial IoT applications
- Rugged/Military requirements with extended temperature and vibration resiliency
- Mesh Networking deployments
- Passenger Wi-Fi access aboard airplanes and trains
- Streaming HD Video Surveillance Cameras
- Wireless Infrastructure in harsh operating conditions of the Oil/Gas fields and Mines

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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

Figure 2. Interference immunity performance compared to leading competitors.

ACM-DB-3 Specifications

Table 1. Technical Specifications.

Ordering Code	ACM-DB-3M with MMCX connectors ACM-DB-3U with U.FL connectors
Radio Configuration	3x3 MIMO, Dual Band
Special Features	– Extended lifespan with planned availability for long time – Extreme Reliability, IPC Class 2 standard with Class 3 options – Compliant to MIL-STD-202G, Qualified for high shock/vibration environments
MAC Chipset	Qualcomm Atheros: QCA9890-BR4B with Extended Temperature range

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Software Support	Open Source Linux Drivers ath10k for 11ac models OpenWRT (Wireless Router/Linux OS)
Center Frequency Range	5.180 GHz ~ 5.825 GHz 2.412 GHz ~ 2.484 GHz 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) 802.11a: 6, 9, 12, 18, 24, 36, 48 and 54 Mbps (5.x GHz) 802.11n: MCS0-23 (5.x and 2.4 GHz) 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 • 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) • Phy data rates up to 1.3 Gbps (80 MHz channel)
802.11n version 2.0 Capabilities	• 802.11 dynamic frequency selection (DFS) as an AP and Client • 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) • 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. • FIPS 140-2, Level 2 (Temper Evidence Shield), Loop back mode to facilitate FIPS AES certification.

Table 2. Tx and Rx performance at 5 GHz.

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

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Table 3. Tx and Rx performance at 2.4 GHz.

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

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

Note 2: Total Tx power for all streams. Max allowed Tx power depends on the regulatory domain. De-rating of -1 dBm for U.FL connector.

Table 4. Additional RF performance information.

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 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
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)
Control for External Power Amp	DC biased signal over RF ports
Spectral Analysis	8 bit resolution spectral FFTs available for software analysis

Table 5. Physical, Environment, and Other Specifications.

Host Interface	miniPCI-Express 1.2 Standard
Host CPU Board	Any CPU board with miniPCIe interface with minimum 6 mm connector height
Operating Voltage	3.3 Volts from miniPCI-Express connector
Power Consumption	5.3W @ Max power, in continuous data transfer mode on all chains 2.5W @ 20 dBm power (ETSI max), in continuous data transfer mode on all chains 0.9W in continuous data receive mode 250 mW in Sleep mode
Shield case temperature range (Operating)	-40°C to +85°C
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	2AG87DLM168N
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-DLM1683
RoHS/WEEE Compliance	Yes. 100% Recyclable/Biodegradable packaging

System Integration

Figure 3. System Integration Block Diagram.
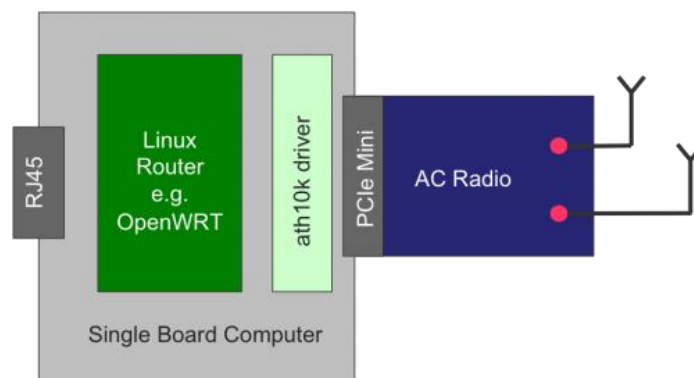
As shown in the block diagram, the modular nature of the MIMO radio transceivers allow for accelerated development of the wireless modem. Any embedded Single Board Computer with standard miniPCI-Express interface is required. The Linux distribution OpenWRT has evolved over time and provides advanced 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/

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