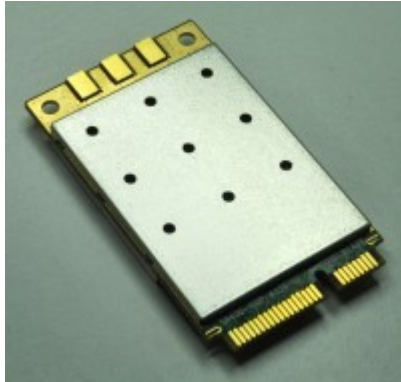# User Manual

ACM-DB-3

Rugged/Military grade 2.4/5 GHz 3x3 MIMO Wi-Fi® Radio Transceivers

Features

- Qualcomm-Atheros QCA9890-BR4B Chipset with Extended Temperature Range
- Up to 1.3 Gbps Throughput with 3x3 MIMO Technology
- Calibrated High Power 2.4 GHz (29 dBm) and 5 GHz operation (27 dBm) for Extended Range
- Supported by OpenWRT and Ath10k Open-Source Driver
- MiniPCIE Interface

Installation and Usage

The ACM-DB-3 has been FCC certified for indoor usage with Superbat 3-dBi rubber-duck antennas (WA2-1321-S02SP1-030 in the 5-GHz bands, and WA2-995-S02SP1-030 antennas in the 2.4GHz band). The ACM-DB-3 mates with a standard PCIE-mini slot and integrates with the Ath10k software driver which is pre-installed in Linux-based systems.

TECHNICAL SPECIFICATIONS	
Model No.	ACM-DB-3 (Rugged/Military Applications, 802.11ac)
MAC Chipset	QCA9890-BR4B with Extended Temperature range for Outdoor and Rugged models)
Software Support	Open Source Linux Driver ath10k OpenWRT (Wireless Router/Linux OS)
Center Frequency Range	5.180 GHz -5.240 Ghz & 5.745 GHz -5.825 Ghz 2.412 GHz ~ 2.484 GHz This varies by the regulatory domain
Channel Bandwidth/(No. of Non-overlapping Channels)*	20/(9), 40/(4) and 80/(2) MHz channels (5.x GHz) 20/(3), and 40/(1) MHz channels (2.4 GHz)
Radio Modulation (Auto Adjust)	BPSK, QPSK, 16 QAM, 64 QAM and 256 QAM (5.x GHz – 11ac models) CCK, BPSK, QPSK, 16 QAM, 64 QAM and 256 QAM (2.4 GHz – 11ac models)
Data Rates Supported	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	●802.11ac Beam Forming ●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)
Operating Modes	AP, STA and Adhoc modes to implement Point to Point, Point to multi Point, 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	Loop back mode to facilitate FIPS AES certification, Small packet size (96 bytes) in AES encryption at full packet rate

Tx/Rx Specification	Data Rate	Radio Modulation	Throughput** Mbps (Cabled Test Setup)	Max Tx Power 3 Antennas	Rx Sensitivity (± 2 dBm) 3 Antennas
5 GHz (20 MHz Channel)					
802.11a, Single Stream, STBC	6 Mbps	BPSK	5.5	23.89	-98
802.11a, Single Stream, STBC	24 Mbps	16 QAM	19	23.89	-89
802.11a, Single Stream, STBC	36 Mbps	16 QAM	25	23.89	-87
802.11a, Single Stream, STBC	48 Mbps	64 QAM	29	23.89	-85
802.11a, Single Stream, STBC	54 Mbps	64 QAM	33	23.89	-83
802.11ac, VHT20, 3 Streams	MCS0	BPSK	18	23.97	-93
802.11ac, VHT20, 3 Streams	MCS2	QPSK	54	23.97	-89
802.11ac, VHT20, 3 Streams	MCS4	16 QAM	106	23.97	-82
802.11ac, VHT20, 3 Streams	MCS7	64 QAM	171	23.97	-74
802.11ac, VHT20, 3 Streams	MCS8	256 QAM	201	23.97	-70
5 GHz (40 MHz Channel)					
802.11ac, VHT40, 3 Streams	MCS0	BPSK	37	23.99	-90
802.11ac, VHT40, 3 Streams	MCS2	QPSK	110	23.99	-82
802.11ac, VHT40, 3 Streams	MCS4	16 QAM	210	23.99	-78
802.11ac, VHT40, 3 Streams	MCS7	64 QAM	331	23.99	-71

802.11ac, VHT40, 3 Streams	MCS8	256 QAM	405	23.99	-68
802.11ac, VHT40, 3 Streams	MCS9	256 QAM	429	23.99	-66
5 GHz (80 MHz Channel)					
802.11ac, VHT80, 3 Streams	MCS0	BPSK	76	23.69	-87
802.11ac, VHT80, 3 Streams	MCS2	QPSK	223	23.69	-81
802.11ac, VHT80, 3 Streams	MCS4	16 QAM	404	23.69	-72
802.11ac, VHT80, 3 Streams	MCS7	64 QAM	622	23.69	-66
802.11ac, VHT80, 3 Streams	MCS8	256 QAM	686	23.69	-64
802.11ac, VHT80, 3 Streams	MCS9	256 QAM	789	23.69	-62
2.4 GHz (20 MHz Channel)					
802.11b, Single Stream, STBC	1 Mbps	CCK	0.8	26.43	-100
802.11g, Single Stream, STBC	6 Mbps	BPSK	5.5	26.07	-98
802.11g, Single Stream, STBC	24 Mbps	16 QAM	18	26.07	-90
802.11g, Single Stream, STBC	36 Mbps	16 QAM	24	26.07	-87
802.11g, Single Stream, STBC	48 Mbps	64 QAM	31	26.07	-84
802.11g, Single Stream, STBC	54 Mbps	64 QAM	32	26.07	-82
802.11n, HT20, 3 Streams	MCS16	BPSK	18	26.26	-92
802.11n, HT20, 3 Streams	MCS18	QPSK	54	26.26	-86
802.11n, HT20, 3 Streams	MCS20	16QAM	108	26.26	-79
802.11n, HT20, 3 Streams	MCS22	64 QAM	162	26.26	-75
802.11n, HT20, 3 Streams	MCS23	64QAM	189	26.26	-74
2.4 GHz (40 MHz Channel)					
802.11n, HT40, 3 Streams	MCS16	BPSK	36	25.87	-87
802.11n, HT40, 3 Streams	MCS18	QPSK	108	25.87	-80
802.11n, HT40, 3 Streams	MCS20	16QAM	216	25.87	-74
802.11n, HT40, 3 Streams	MCS22	64 QAM	470	25.87	-70
802.11n, HT40, 3 Streams	MCS23	64QAM	486	25.87	-68

* 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. The system's SNR is higher at smaller Channel Bandwidths and Range is longer.

** Throughput of a wireless link depends on many environmental parameters. Here the bench measurement results are shown to give an indication of the real life performance of Doodle Labs modules. These results are lower than the theoretical values published in most of the literature. They do not include distance related derating.

Antenna Signal Strength	-50 to -90 dBm (Recommended), Absolute Maximum=+12 dBm
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	>12 KV (Human Body Model) for Outdoor and Rugged models (ACO/ACM-DB-3 and NO/NM-DB-3)
Receiver LNA Gain	>12 dB
Receiver Adjacent Channel Rejection (ACR)	>28 dB @6 Mbps, 13 dB @54 Mbps, 3 dB @ VHT80, MCS9
Receiver Next to Adjacent Channel Rejection (ALCR)	>40 dB
Receive chain Noise Figure	+5 dB
Transmitter Adjacent Channel Leakage power Ratio (ACLR)	Min 45 dB (Fc ± ChBW)
Transmitter Spurious Emission	-40 dBc (Minimum)

Suppression	
RF Power control by Driver	In 0.5 dBm steps. Accuracy of power calibration ±2 dBm
RF Hardware Disable	Pin 20 of miniPCI-E interface. (Required for FAA compliance)
Control for External Power Amp	Available as an optional configuration
Spectral Analysis	8 bit resolution spectral FFTs available for software analysis
PHYSICAL, ENVIRONMENTAL AND OTHER SPECIFICATIONS	
Antenna Ports	3 Ports (50 Ohms) with MMCX connectors. Optional configuration with U.FL connectors available on request
Host Interface	miniPCI-Express 1.2 Standard
Host CPU Board	Any CPU board with Industry standard miniPCI-Express interface with minimum 6 mm connector height
Operating Voltage	3.3 Volts from miniPCI-Express connector
Power Consumption	5W @ Max power, in continuous data transfer mode on all 3 chains 3.5W @ 25 dBm power, in continuous data transfer mode on all 3 chains 2.5W @ 20 dBm power (ETSI max), in continuous data transfer mode on all 3 chains 0.9W in continuous data receive mode 250 mW in Sleep mode
Shield case temperature range (Operating)	0°C to +60°C (Enterprise/Indoor "*E-DB-3" models) -40°C to +60°C (Outdoor "*O-DB-3" models) -40°C to +80°C (Rugged "*M-DB-3" models) The System's thermal design should ensure that the transceiver's case temperature is maintained within these specifications.
Humidity (Operating)	0% – 95% (Non-condensing)
Dimensions	30 x 50 x 7 mm, 14 grams (Rugged models). Mechanical drawing and 3D-CAD files available upon request
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	11ac models in AP and Client modes with full DFS – in conformity 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)	Q1 2016
RoHS/WEEE Compliance	Yes. 100% Recyclable/Biodegradable packaging

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

Radiation Exposure Statement:

The modular can be installed or integrated in mobile or fix devices only.
This modular cannot be installed in any portable device, for example, USB dongle like transmitters is forbidden.
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.
This transmitter must not be collocated or operating in conjunction with any other antenna or transmitter.
The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination.
The firmware setting is not accessible by the end user.
The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

If the FCC identification number 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.
This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID:2AG87DLM168N Or Contains FCC ID:2AG87DLM168N" when the module is installed inside another device, the user manual of this device must contain below warning statements;
1. 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.
 (2) This device must accept any interference received, including interference that may cause undesired operation.

2. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product.
The antenna type used is the reverse screw R-SMA antenna and the max antenna gain is 3dBi.
The diagram shows how to connect the modular with its intended antenna .

| Modular | Coaxial Line (50Ω) | Antenna |
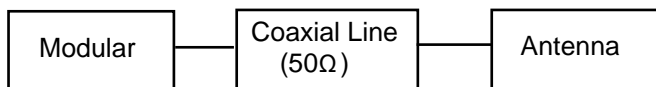
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