Compliance Testing, LLC
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Test Report

Prepared for: Ubiquiti Networks, Inc

Model: Model: Bullet B-DB-AC
& Bullet AC-IP67

Description: Dual Band Networking Device

Serial Number: N/A

FCC ID: SWX-BDBAC

To

FCC Part 15.407

Date of Issue: January 31, 2018

On the behalf of the applicant:	**Ubiquiti Networks, Inc** **2580 Orchard Parkway** **San Jose, CA 95131**
Attention of:	**Mark Feil** **Ph: (408)942-3085** **E-mail: mark.feil@ubnt.com**

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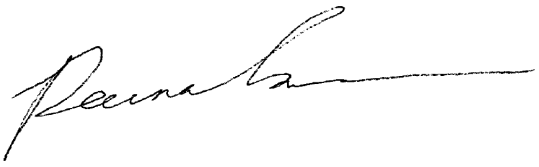

Poona Saber
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	November 8, 2017	Poona Saber	Original Document
2.0	January 30, 2017	Poona Saber	-Added a statement on page 15 for emissions above 18GHz -Updated Annex B to add band edges -Revised page 12 test requirements -updated Annex C based on RTs -Annex A updated
3.0	June 6, 2019	Poona Saber	Added RSS requirements to table on page 9 Added Firmware and Software on page 6 Added Measurement uncertainty table
4.0	August 5, 2019	Poona Saber	Added note of offsets for conducted emissions plot per KDB 789033 on page 13
5.0	August 8, 2019	Poona Saber	Added Bullet AC-IP67 as the extra model with note on page 6

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ILAC / A2LA

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The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to http://www.compliancetesting.com/labscope.html for current scope of accreditation.

Testing Certificate Number: **2152.01**

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IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A

The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a) - Special Accessories

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with C63.10-2013 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

Environmental Conditions		
Temperature (ºC)	**Humidity (%)**	**Pressure (mbar)**
25.4 – 26.6	21.4 – 22.5	976.7 – 980.9

EUT Operation during Tests
EUT is powered by POE (Power over Ethernet) Ethernet cable.

EUT Description
Model: B-DB-AC, Bullet & Bullet AC-IP67
Description: Dual Band Networking Device
Firmware: V8.6
Software: ART
Serial Number: N/A
Additional Information: The Bullet AC (Model: B-DB-AC) is a dual band networking device that is powered over ethernet (passive POE, 24V) and provides an N-type antenna connection. It features dual-band AC mode operation in 5GHz and 2.4GHz bands, and a dedicated 2.4 GHz WiFi management radio for convenient device setup.

For 5 GHz band the radio covers 802.11 a/n/ ac modes with 10,20,30,40,50,60 and 80 MHz bandwidth. It is evaluated that unit would represent worst case operation and highest power number with ac mode and only result of testing is represented for this mode.

Bullet AC-IP67 is electrically identical to B-DB-AC device and it incorporates an outdoor housing which is made of metal instead of plastic

EUT Operation during Tests
Radio testing has been done conducted and radiated with controlling the device for continuous modulation transmission on low, middle and high channels with client's provided commands through telnet.

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Switching mode power supply/ POE	Ubiquiti	GP-A240-050	N/A

Cables:

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Ferrite Y/N
2	Ethernet cable	<3 meters	N	N	N

Modifications: None

EUT Specifications

Equipment Code	NII
Model(s)Tested	802.11 ac-VHT 20,40,80
Model(s) covered	802.11 ac- VHT20 802.11 ac- VHT40 802.11 ac- VHT80
Frequency Range	5725-5850
Bandwidths	10,20,30,40,50,60,80 MHz
Data Rates	MCS0
Modulations	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM

Antenna List

No.	Model	Antenna Type	Peak Gain
1	UniFi Omni	Omni	4
1	AMO-5G13	Omni	13
1	AM-5AC22-45	Sector	22
1	RD-5G34	Dish	34

Note: Omni and Sector Antennas are PTMP and Dish Antenna is PTP

15.203: Antenna Requirement:

	The antenna is permanently attached to the EUT
	The antenna uses a unique coupling
X	The EUT must be professionally installed
	The antenna requirement does not apply

Test Results Summary

Specification FCC	Specification ISED	Test Name	Pass, Fail, N/A	Comments
§15.203	-	Antenna Requirements	Pass	
§15.207 §15.407(b)(6)	RSS Gen 8.8	Line Conducted Emissions	Pass	
§15.407(a)(3)	RSS 247 6.2.4.1	Conducted Output Power	Pass	
§15.407(a)(3),(5)	RSS 247 6.2.4.1	Power Spectral Density	Pass	
§15.403(i) §15.407(e)	RSS 247 6.2.4.1	6dB Occupied Bandwidth	Pass	
		99% Occupied Bandwidth		
§15.407(b)(4)	RSS 247 6.2.4.2	Undesirable Emissions	Pass	
§15.205 §15.407(b)(4),(5),(6)	RSS Gen 8.10	General Field Strength Limits (Restricted Bands and Radiated Emission limits)	Pass	
§15.407(g)	RSS Gen 8.11	Frequency Stability	Pass	
§15.407(f)	RSS 102	RF Exposure	Pass	

References	Description
CFR47, Part 15, Subpart B	Unintentional Radiators
CFR47, Part 15, Subpart C	Intentional Radiators
CFR47, Part 15, Subpart E	Unlicensed Nation Information Infrastructure Devices (U-NII)
ANSI C63.10-2013	American National standard for testing Unlicensed Wireless Devices
ANSI C63.4-2014	Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz.
ISO/IEC 17025:2005	General requirements for the Competence of Testing and Calibrations Laboratories
KDB 644545 D03	Guidance for IEEE 802 11ac New Rules
KDB 789033 D02	General U-NII Test Procedures New Rules V01
KDB 926956 D01	U-NII Transition Plan

Peak Output Power

Engineer: Poona Saber
Test Date: 10/30/17-11/7/17

Test Requirements

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

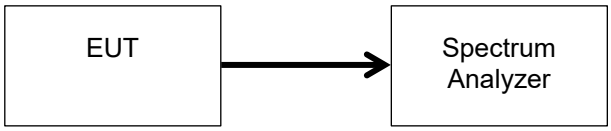
Test Procedure

The RF power was calculated using the spectrum analyzers' band power function per Method SA-1 from KDB 789033 D02 General U-NII Test Procedures New Rules v01. Measurements were made at the low, mid and high channels of the band.

The Spectrum analyzer was set to the following:

a. RBW = 1 MHz
b. VBW ≥ 3 MHz
c. Sweep time = auto
d. Detector = RMS
e. 100 traces in power averaging mode

Test Setup



See Annex A for test results

Transmitter Power Spectral Density

Engineer: Poona Saber

Test Date: 10/30/17-11/7/17

Test Requirements

For the band 5.725-5.85 GHz, the maximum power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in power spectral density.

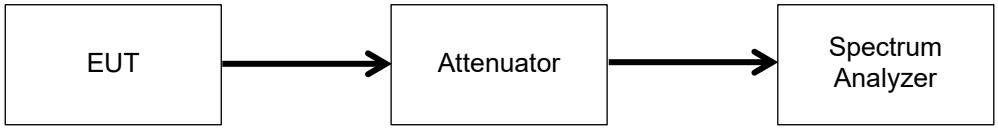
Test Procedure

The Power Spectral Density was measured using the method per SA-1 from KDB 789033 D02 General U-NII Test Procedures New Rules v01. Measurements were made at the low, mid and high channels of the band. The maximum PSD was determine by finding the peak value across the carrier bandwidth.

The Spectrum Analyzer was set to the following:

a. RBW = 500 KHz.
b. VBW ≥ 1500 MHz
c. Span 1.5 * BW
d. Sweep time = auto
e. Detector = RMS
f. 100 traces in power averaging mode

Test Setup



See Annex A for test results

Undesirable Emissions Conducted

Engineer: Poona Saber

Test Date: 10/30/17-11/7/17

Test Requirements

Unwanted Emissions that fall Outside Restricted Bands

For transmitters operating in the 5.725-5.85 GHz band: All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.
Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209.

For Conducted Unwanted Emissions in the Restricted Bands

For conducted measurements above 1000 MHz, EIRP was determined and then the field strength computed by the following:
E[dBµV/m] = EIRP[dBm] - 20 log(d[meters]) + 104.77, where E = field strength and d = 3m
E[dBµV/m] = EIRP[dBm] + 95.2, for d = 3 meters.

For conducted measurements above 1000 MHz, EIRP was determined and then the field strength computed by the following:
E[dBµV/m] = EIRP[dBm] - 20 log(d[meters]) + 104.77, where E = field strength and d = 3m
E[dBµV/m] = EIRP[dBm] + 95.2, for d = 3 meters.

Test Procedure

Per KDB 789033 D02 General U-NII Test Procedures New Rules v01 conducted RF port measurements were made in lieu of radiated. In addition, Cabinet Emissions measurements were performed in a semi-anechoic chamber with the antenna port terminated by a matching load. See additional section for Radiated Emissions.

The following criteria were addressed:

The Spectrum Analyzer was set to the following for emissions > 1000MHz:

a. RBW = 1 MHz
b. VBW ≥ 3 MHz
c. Detector = Peak.
d. Sweep time = auto.
e. Trace mode = max hold.
    1. Note: For emissions where the peak exceeded that of the average 15.209 emission limit the following was performed.
f. RBW = 1 MHz
g. VBW ≤ RBW/100 (i.e., 10 kHz) but not less than 10 Hz.

For emissions < 1000MHz the Spectrum Analyzer settings were as follows:

a. RBW = 100 kHz
b. VBW ≥ 300 kHz
c. Detector = Peak.
d. Sweep time = auto.
e. Trace mode = max hold.

Note: per KDB 789033 and ANSI C63.10 for conducted measurement in lieu of radiated following values have been added as an offset in the measurement plots :

1) For conducted measurements in restricted band the filed strength shall be computed and an additional 4.7 dB shall be added as an upper bound on the field strength that would be observed on a test site with a ground plane for frequencies between 30 MHz and 1000 MHz.

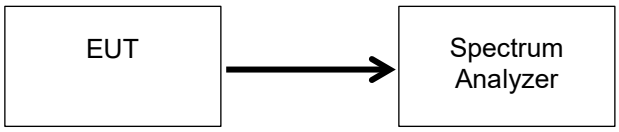
2) A value representative of an upper bound on out-of-band antenna gain (in dBi) shall be added to the measured antenna-port conducted emission power to compute EIRP within the specified measurement bandwidth. (For emissions in the restricted bands, additional calculations are required to convert EIRP to field strength at the specified distance.) The upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands or 2 dBi, whichever is greater.

3) Since the maximum measured antenna gain in all bands is 0 dBi a value of maximum 2 dBi has been added to compare the conducted power measurements to an EIRP limit.

   EIRP= Power (conducted) + Gain

4) When a conducted power measurement is used to compare with Electric field (dBuV/m) limit an offset of –11.8 is added to measurement to compare conducted power (dBm) to electric field limit (dBuV/m) at 3 meters.

Test Setup



Test Results: **See Annex B: Undesirable Emissions Conducted**

Undesirable Emissions Radiated

Engineer: Poona Saber

Test Date: 10/30/17-11/7/17

Test Requirements

The provision of §15.209 were applied. For any emission that falls in the restricted bandwidths of §15.205. Radio port is terminated in 50 Ohms load and emissions out of the EUT case are examined

FCC Part 15 Subpart C Paragraph 15.209(a) Limits

Frequency (MHz)	Frequency (microvolts/meter)	Frequency (meter)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remarks: E field strength (dBµV/m) = 20 log E field strength (uV/m)

Test Procedure

The EUT was setup in accordance with ANSI C63.10. 2013 and tested per KDB 789033. The antenna was replaced with non-radiating matched load. The EUT is placed on non-conductive platform at a height of 0.8 meters above the ground plane of the semi-anechoic chambers. The EUT was rotated 360 degrees and the receive antenna raised and lowered to find the maximum emissions from 30MHz to the 10th harmonic of the fundamental. The EUT was set to the maximum power level allowed and the low, mid, and high channels were investigated for emissions.

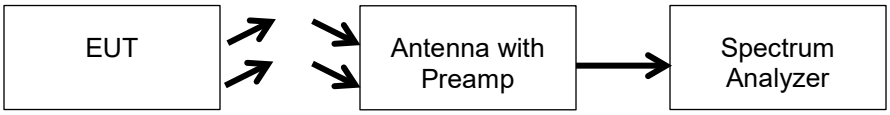
The Spectrum Analyzer was set to the following for emissions > 1000MHz:

a. (RBW = 1 MHz
b. VBW ≥ 3 MHz
c. Detector = Peak.
d. Sweep time = auto.
e. Trace mode = max hold.
    1. Note: For emissions where the peak exceeded that of the average 15.209 emission limit the following was performed.
f. RBW = 1 MHz
g. VBW ≤ RBW/100 (i.e., 10 kHz) but not less than 10Hz

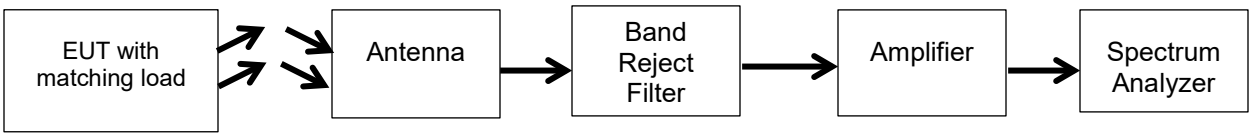
For emissions below 1000MHz the Spectrum Analyzer settings were as follows:

a. RBW = 100 kHz
b. VBW ≥ 300 kHz
c. Detector = Peak.
d. Sweep time = auto.
e. Trace mode = max hold.
    1. Note: A quasi peak detector was used for emissions where the peak exceeded that of the average 15.209 emission limits

Test Setup below 1000MHz



Test Setup above 1000MHz



Test Results: **See Annex C: Undesirable Emission Radiated**

Note: There was no emissions observed beyond noise floor after 18 GHz.

Occupied Bandwidth

Engineer: Poona Saber

Test Date: 10/30/17-11/7/17

Test Requirement

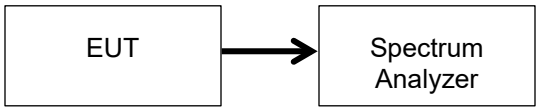
Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz. For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 6 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement

Test Procedure

The Spectrum analyzer was set to the following parameters

a. RBW = 100 kHz.
b. VBW ≥ 300 kHz
c. Detector = Peak.
d. Trace mode = max hold.

Test Setup



Test Results: **See Annex D: Occupied Bandwidth**

Frequency Stability

Engineer: Poona Saber
Test Date: 12/6/2017

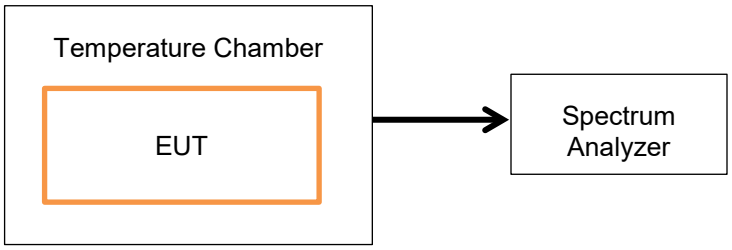
Test Requirement

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

Test Procedure

a. The EUT was placed into a temperature chamber and the temperature ranges were set to the manufacturers' specifications.
b. The RF output of the EUT was connected to a spectrum analyzer
c. The lowest and highest channels of the band were set to transmit
d. The carrier plots were measured to insure that the 6dB band width remained within the band over the prescribed temperature extremes.

Test Setup



Test Results: **See Annex E: Frequency Stability**

A/C Powerline Conducted Emission

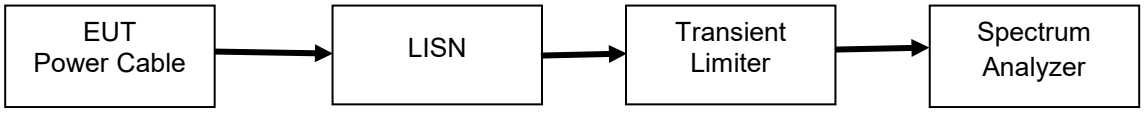
Engineer: Poona Saber

Test Date: 12/12/2017

Test Procedure

The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits.

Test Setup



Test Results: **See Annex F: A/C Powerline Conducted Emission**

Measurement Uncertainty

Test Procedure	Uncertainty
Conducted RF Power	±.75dB
Conducted Emissions (AC Line)	±3.21dB
Radiated Emissions (Signal Line)	±4.5dB
Radiated Spurious Emissions	±4.82
Conducted Spurious Emissions	± 2.49 dB
Occupied Bandwidth	±5%
Power Spectral Density	±1.8dB
DTS Bandwidth	±3%
Frequency	±1Hz
Harmonic Currents	95%
Voltage Flicker	95%
AC Voltage	± 2.3 %
DC Voltage	± 0.12 %
Temperature	± 1.0 deg C
Humidity	± 4.32 %

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Temperature Chamber	Tenney	Tenney II Benchmaster	i00287	NCR	NCR
Preamplifier	HP	8447D	i00055	NCR	NCR
Harmonic Mixer 26.5-40GHz	HP	11970A	i00193	6/4/15	6/4/18
Horn Antenna, Amplified	ARA	DRG-118/A	i00271	6/16/16	6/16/18
Spectrum Analyzer	Agilent	E4407B	i00331	11/21/2017	11/21/2018
Bi-Log Antenna	Teseq	CBL 6111D	i00349	8/3/16	8/3/18
EMI Analyzer	Agilent	E7405A	i00379	2/22/2017	2/22/2018

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT