Shenzhen CTL Testing Technology Co., Ltd.
Tel: +86-755-89486194 Fax: +86-755-26636041

TEST REPORT

FCC PART 15.407

Report Reference No. .....: **CTL1610310501-WF-02**

Compiled by: (position+printed name+signature)	Allen Wang (File administrators)	Allen Wang
Tested by: (position+printed name+signature)	Nice Nong (Test Engineer)	Nice Nong
Approved by: (position+printed name+signature)	Tracy Qi (Manager)	Tracy Qi

Product Name.....:	RELESS RePad R606
Model/Type reference .....:	R606
List Model(s).....:	N/A
Trade Mark.....:	RePad
FCC ID.....:	2AFL3-R606
Applicant's name .....:	**Hummingbird System Inc**
Address of applicant .....:	2140 Peralta Blvd Suite 212D, Fremont, CA 94536
Test Firm .....:	**Shenzhen CTL Testing Technology Co., Ltd.**
Address of Test Firm .....:	Floor 1-A, Baisha Technology Park, No.3011, Shahexi Road, Nanshan District, Shenzhen, China 518055
Test specification.....:	
Standard.....:	**FCC Part 15 Subpart E—Unlicensed National Information Infrastructure Devices**
TRF Originator .....:	Shenzhen CTL Testing Technology Co., Ltd.
Master TRF .....:	Dated 2011-01
Date of Receipt.....:	Nov. 03, 2016
Date of Test Date.....:	Nov. 04, 2016–March 18, 2017
Data of Issue.....:	March 18, 2017
Result.....:	Pass

TEST REPORT

Test Report No. :	CTL1610310501-WF-02	March 18, 2017 Date of issue

Equipment under Test	:	RELESS RePad R606
Model /Type	:	R606
Listed Models	:	N/A
Applicant	:	**Hummingbird System Inc**
Address	:	2140 Peralta Blvd Suite 212D, Fremont, CA 94536
Manufacturer	:	**Five Science and Technology Co.,LTD.**
Address	:	12-13F, Block C2, Nanshan Zhiyuan, No. 1001 Xueyuan Road, Nanshan District, Shenzhen, China

Test result	**Pass ***

* In the configuration tested, the EUT complied with the standards specified page 5.

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

** Modified History **

Revisions	Description	Issued Data	Report No.	Remark
Version 1.0	Initial Test Report Release	2017-03-18	CTL1610310501-WF-02	Tracy Qi

Table of Contents Page

1. SUMMARY

1.1. TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 15 Subpart E—Unlicensed National Information Infrastructure Devices
ANSI C63.10:2013: American National Standard for Testing Unlicensed Wireless Devices
ANSI C63.4: 2014: American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40GHz

Range of 9 kHz to 40GHz

KDB789033 D02: General UNII Test Procedures New Rules v01r02

1.2. Test Description

FCC Requirement		
FCC Part 15.207	AC Power Conducted Emission	PASS
FCC Part 15.407(a)	Emission Bandwidth(26dBm Bandwidth)	$PASS_{Note1}$
FCC Part 15.407(e)	Minimum Emission Bandwidth(6dBm Bandwidth)	$PASS_{Note2}$
FCC Part 15.407(a)	Maximum Conducted Output Power	PASS
FCC Part 15.407(a)	Peak Power Spectral Density	PASS
FCC Part 15.407(g)	Frequency Stability	PASS
FCC Part 15.407(b)	Undesirable emission	PASS
FCC Part 15.407(b)/15.205/15.209	Radiated Emissions	PASS
FCC Part 15.407(h)	Dynamic Frequency Selection	N/A
FCC Part 15.203/15.247(b)	Antenna Requirement	PASS

Note 1: Apply to U-NII 1, U-NII 2A, and U-NII 2C band.
Note 2: Apply to U-NII 3 band only.

1.3. Test Facility

1.3.1 Address of the test laboratory

Shenzhen CTL Testing Technology Co., Ltd.
Floor 1-A, Baisha Technology Park, No. 3011, Shahexi Road, Nanshan, Shenzhen 518055 China

There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents ANSI C63.4 and CISPR 22/EN 55022 requirements.

1.3.2 Laboratory accreditation

The test facility is recognized, certified, or accredited by the following organizations:

IC Registration No.: 9618B

The 3m alternate test site of Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration No.: 9618B.

FCC-Registration No.: 970318

Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration No.: 970318.

1.4. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements“ and is documented in the Shenzhen CTL Testing Technology Co., Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for CTL laboratory is reported:

Test	Measurement Uncertainty	Notes
Transmitter power conducted	±0.57 dB	(1)
Transmitter power Radiated	±2.20 dB	(1)
Conducted spurious emission 9KHz-40 GHz	±2.20 dB	(1)
Occupied Bandwidth	±0.01ppm	(1)
Radiated Emission 30~1000MHz	±4.10dB	(1)
Radiated Emission Above 1GHz	±4.32dB	(1)
Conducted Disturbance0.15~30MHz	±3.20dB	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

2. GENERAL INFORMATION

2.1. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature:	25°C
Relative Humidity:	55 %
Air Pressure:	101 kPa

2.2. General Description of EUT

Product Name:	RELESS RePad R606			
Model:	R606			
Power supply:	DC 3.8V from battery			
5GWLAN				
Supported type:	20MHz system	40MHz system	80MHz system	160MHz system
	802.11ac	802.11ac	N/A	N/A
Operation frequency:	5180MHz-5240MHz 5745MHz-5825MHz	5190MHz-5230MHz 5755MHz-5795MHz	N/A	N/A
Modulation:	OFDM	OFDM	N/A	N/A
Channel number:	9	4	N/A	N/A
Channel separation:	20MHz	40MHz	N/A	N/A
Antenna type/gain:	FPC Antenna: 0 dBi			

Note: For more details, please refer to the user's manual of the EUT.

2.3. Description of Test Modes and Test Frequency

The Applicant provides communication tools software (AMFAN RF Test Tool) to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) and receiving mode for testing.
All test performed at the low, middle and high of operational frequency range of each mode.
Operation Frequency List WLAN on 5G Band:

Operating band	20MHz		40MHz	
	Channel	Frequency (MHz)	Channel	Frequency (MHz)
U-NII 1 (5150MHz-5250MHz)	36	5180	38	5190
	40	5200		
	44	5220	46	5230
	48	5240		
U-NII 3 (5725MHz-5850MHz)	149	5745	151	5755
	153	5765		
	157	5785	159	5795
	161	5805		
	165	5825	--	--

Note:
1. "--"Means no channel(s) available any more.
2. The line display in grey is those Channels/Frequencies select to test is this report for each operation mode.

2.4. Special Accessories

No.	Equipment	Manufacturer	Model No.	Serial No.	Length	shielded/ unshielded	Notes
1	PC	ASUS	X555YA	QCWB335	/	/	DOC
2	Power adapter	ASUS	Y481C	8AW0829002095	1.00m	unshielded	DOC

2.5. Equipments Used during the Test

Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
LISN	R&S	ENV216	3560.6550.12	2016/06/02	2017/06/01
LISN	R&S	ESH2-Z5	860014/010	2016/06/02	2017/06/01
Bilog Antenna	Sunol Sciences Corp.	JB1	A061713	2016/06/02	2017/06/01
EMI Test Receiver	R&S	ESCI	103710	2016/06/02	2017/06/01
Spectrum Analyzer	Agilent	E4407B	MY41440676	2016/05/21	2017/05/20
Spectrum Analyzer	Agilent	N9020A	US46220290	2016/01/17	2017/01/16
Power Meter	Anritsu	ML2487B	110553	2016/06/02	2017/06/01
Power Sensor	Anritsu	MA2411B	100345	2016/05/21	2017/05/20
Controller	EM Electronics	Controller EM 1000	N/A	2016/05/21	2017/05/20
Horn Antenna	Sunol Sciences Corp.	DRH-118	A062013	2016/05/19	2017/05/18
Horn Antenna	SCHWARZBACK	BBHA 9170	BBHA9170184	2016/05/19	2017/05/18
Active Loop Antenna	SCHWARZBECK	FMZB1519	1519-037	2016/05/19	2017/05/18
Amplifier	Agilent	8349B	3008A02306	2016/05/19	2017/05/18
Amplifier	Agilent	8447D	2944A10176	2016/05/19	2017/05/18
Temperature/Humidity Meter	Gangxing	CTH-608	02	2016/05/20	2017/05/19
High-Pass Filter	K&L	9SH10-2700/X12750-O/O	N/A	2016/05/20	2017/05/19
High-Pass Filter	K&L	41H10-1375/U12750-O/O	N/A	2016/05/20	2017/05/19
Coaxial Cables	HUBER+SUHNER	SUCOFLEX 104PEA-10M	10m	2016/06/02	2017/06/01
Coaxial Cables	HUBER+SUHNER	SUCOFLEX 104PEA-3M	3m	2016/06/02	2017/06/01
Coaxial Cables	HUBER+SUHNER	SUCOFLEX 104PEA-3M	3m	2016/06/02	2017/06/01
RF Cable	Megalon	RF-A303	N/A	2016/06/02	2017/06/01
EMC Test Software	Audix	E3	N/A	N/A	N/A
EMC Test Software	R&S	ES-K1	N/A	N/A	N/A

The calibration interval was one year

2.6. Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended to comply with Section 15.407 of the FCC Part 15, Subpart E Rules.

2.7. Modifications

No modifications were implemented to meet testing criteria.

3. TEST CONDITIONS AND RESULTS

3.1. Conducted Emissions Test

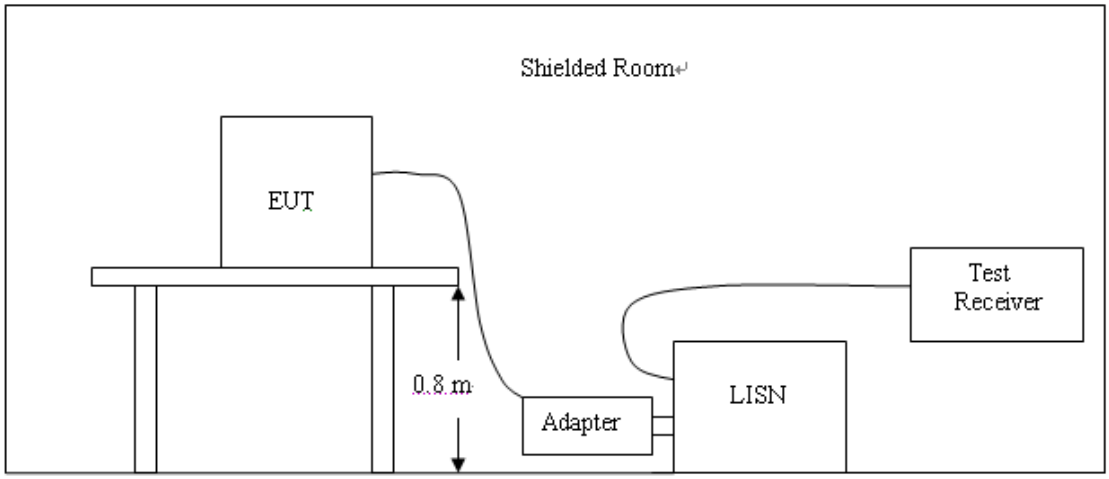
LIMIT

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

* Decreasing linearly with the logarithm of the frequency

TEST CONFIGURATION



TEST PROCEDURE

1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system; a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10:2013.
2. Support equipment, if needed, was placed as per ANSI C63.10:2013.
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10:2013.
4. The adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5. All support equipment received AC power from a second LISN, if any.
6. The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7. Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
8. During the above scans, the emissions were maximized by cable manipulation.

TEST RESULTS

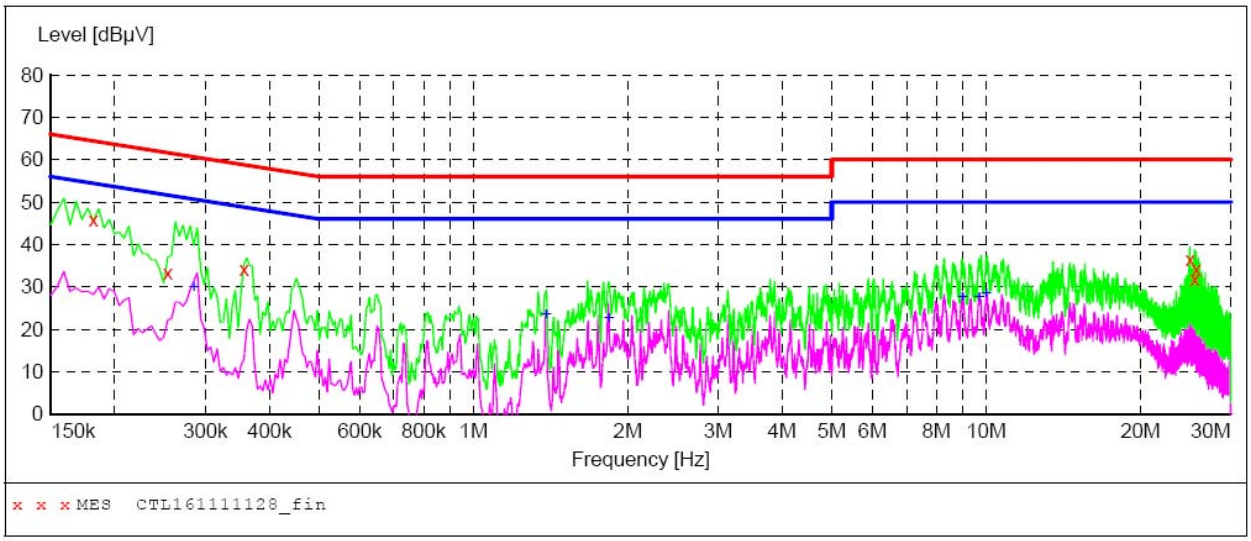
Remark:

1. *We measured both at AC 120V/60Hz and AC 240V/50Hz, recorded worst case at AC 120V/60Hz.*
2. *We measured both at AC power adapter and PC charge modes, recorded worst case at AC power adapter charge mode;*
3. *Measured all modes and recorded worst case at IEEE 802.11ac VHT20 High Channel;*

Test Mode	5GWLAN	Line:	L

SCAN TABLE: "Voltage (9K-30M)FIN"

Short Description: 150K-30M Voltage



MEASUREMENT RESULT: "CTL161111128_fin"

11/11/2016 11:33AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.181501	45.70	10.2	64	18.7	QP	L1	GND
0.253501	33.30	10.2	62	28.3	QP	L1	GND
0.357001	34.10	10.2	59	24.7	QP	L1	GND
24.967501	36.50	11.1	60	23.5	QP	L1	GND
25.507501	31.70	11.1	60	28.3	QP	L1	GND
25.687501	34.20	11.1	60	25.8	QP	L1	GND

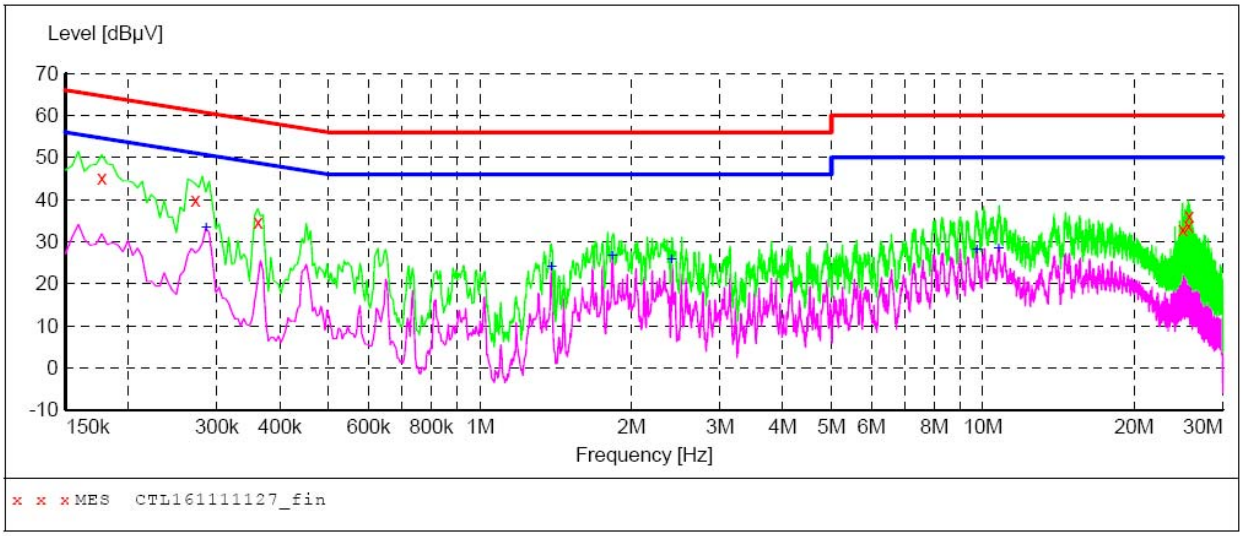
MEASUREMENT RESULT: "CTL161111128_fin2"

11/11/2016 11:33AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.285001	29.70	10.2	51	21.0	AV	L1	GND
1.387501	23.30	10.3	46	22.7	AV	L1	GND
1.837501	22.40	10.3	46	23.6	AV	L1	GND
9.001501	27.50	10.6	50	22.5	AV	L1	GND
9.699001	27.50	10.6	50	22.5	AV	L1	GND
10.009501	28.30	10.6	50	21.7	AV	L1	GND

Test Mode	5GWLAN	Line:	L

SCAN TABLE: "Voltage (9K-30M)FIN"
Short Description: 150K-30M Voltage



MEASUREMENT RESULT: "CTL161111127_fin"

11/11/2016 11:30AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.177001	45.00	10.2	65	19.6	QP	N	GND
0.271501	39.80	10.2	61	21.3	QP	N	GND
0.361501	34.80	10.2	59	23.9	QP	N	GND
24.972001	32.80	11.1	60	27.2	QP	N	GND
25.633501	33.70	11.1	60	26.3	QP	N	GND
25.692001	36.00	11.1	60	24.0	QP	N	GND

MEASUREMENT RESULT: "CTL161111127_fin2"

11/11/2016 11:30AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.285001	33.30	10.2	51	17.4	AV	N	GND
1.387501	24.00	10.3	46	22.0	AV	N	GND
1.833001	26.60	10.3	46	19.4	AV	N	GND
2.404501	25.70	10.4	46	20.3	AV	N	GND
9.721501	27.90	10.6	50	22.1	AV	N	GND
10.747501	28.10	10.6	50	21.9	AV	N	GND

3.2. Radiated Emissions

LIMIT

The maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:
(1) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(3) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(4) For transmitters operating in the 5.725-5.85 GHz band: All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of −17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an e.i.r.p. of −27 dBm/MHz.

Undesirable emission limits

Requirement	Limit(EIRP)	Limit (Field strength at 3m) Note3
15.407(b)(1)	PK:-27(dBm/MHz)	PK:68.2(dBμV/m)
15.407(b)(2)		
15.407(b)(3)		
15.407(b)(4)	PK:-27(dBm/MHz)Note1 PK:-17(dBm/MHz)Note2	PK:68.2(dBμV/m)Note1 PK:78.2(dBμV/m)Note2

Note1: For frequencies beyond 10MHz of band edge.
Note2: For frequencies within10MHz of band edge.
Note3: The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength:

$$E = \frac{1000000\sqrt{30P}}{3}$$ μV/m, where P is the eirp (Watts)

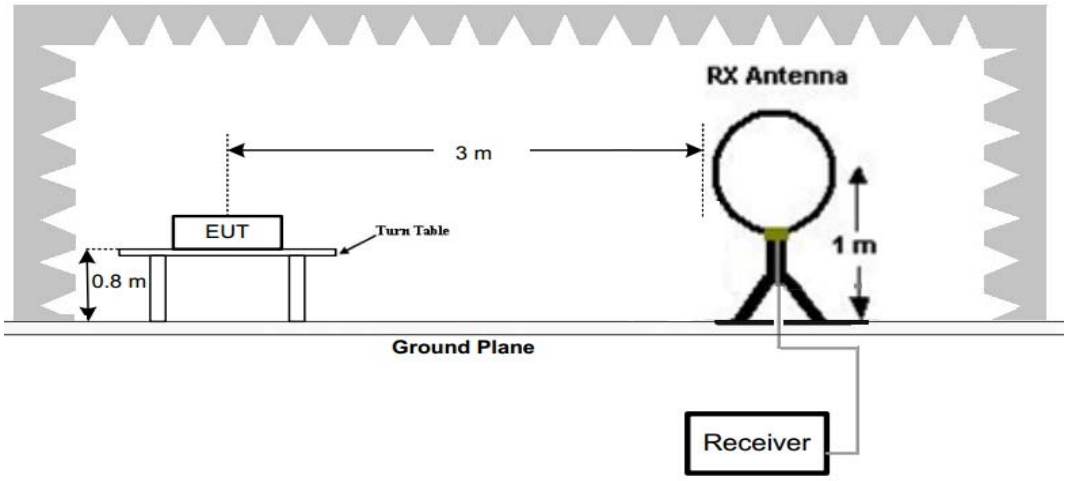
(5) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209
(6)In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a)

Radiated emission limits

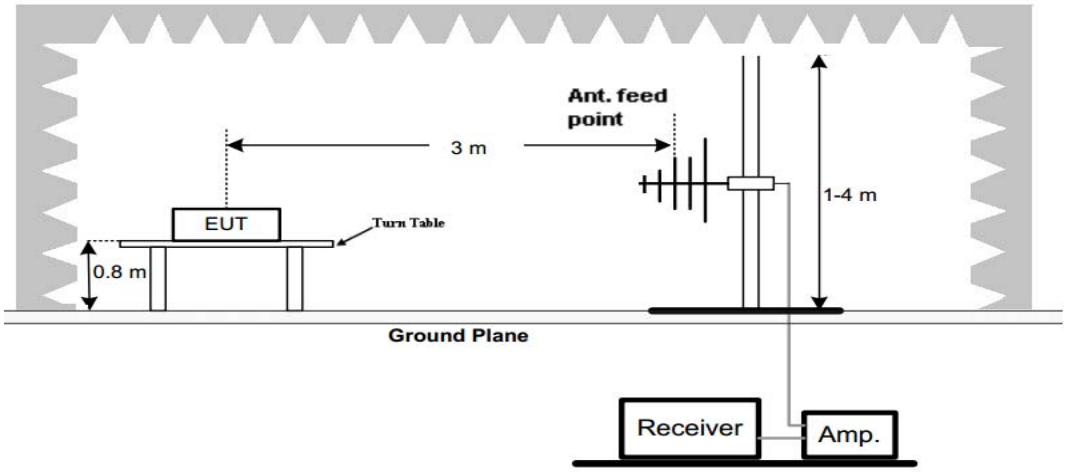
Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
0.009-0.49	3	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)
1.705-30	3	20log(30)+ 40log(30/3)	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

TEST CONFIGURATION

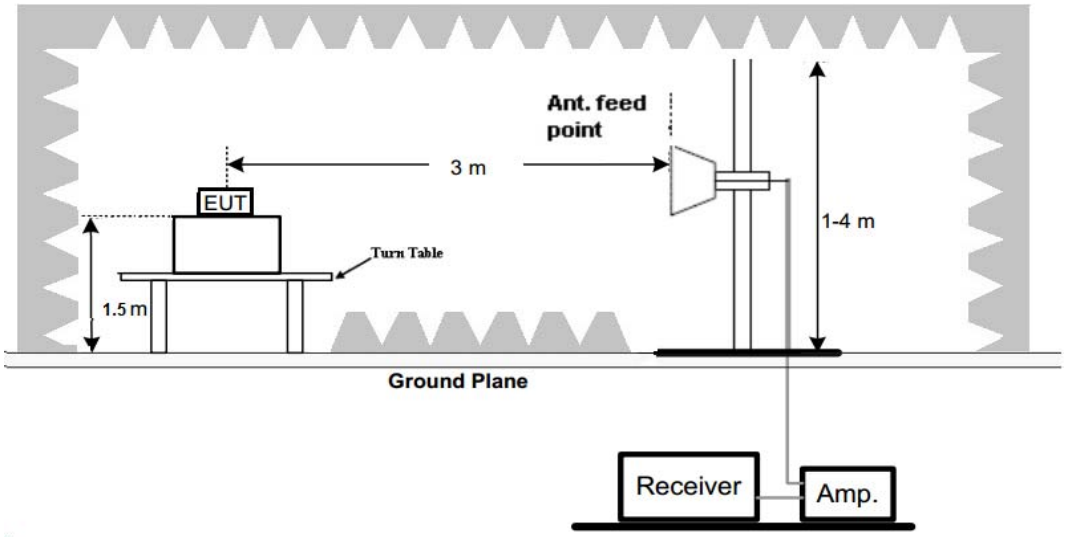
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



(B) Radiated Emission Test Set-Up, Frequency below 1000MHz



(C) Radiated Emission Test Set-Up, Frequency above 1000MHz



TEST PROCEDURE

a. The EUT was placed on a turn table which is 0.8m above ground plane for below 1GHz and 1.50m above ground plane for above 1GHz.
b. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT.
c. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
d. Repeat above procedures until all frequency measurements have been completed.
e. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Bilog Antenna	3
1GHz-18GHz	Horn Antenna	3
18GHz-40GHz	Horn Antenna	1

f. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz,Sweep time=Auto	QP/Average
150KHz-30MHz	RBW=9KHz/VBW=100KHz,Sweep time=Auto	QP/Average
30MHz-1GHz	RBW=120KHz/VBW=1000KHz,Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto	Peak
	Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

More procure as follows;

1) Sequence of testing 9 kHz to 30 MHz

Setup:
--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:
--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna height is 1.0 meter.
--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:
--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).
--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QP detector.
--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

2) Sequence of testing 30 MHz to 1 GHz

Setup:
--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:
--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna is polarized vertical and horizontal.
--- The antenna height changes from 1 to 4 meter.
--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:
--- The final measurement will be performed with minimum the six highest peaks.
--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.
--- The final measurement will be done with QP detector with an EMI receiver.
--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) Sequence of testing 1 GHz to 18 GHz

Setup:
--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:
--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna is polarized vertical and horizontal.
--- The antenna height scan range is 1 meter to 2.5 meter.
--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:
--- The final measurement will be performed with minimum the six highest peaks.
--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.
--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.
--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

4) Sequence of testing above 18 GHz

Setup:
--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 1 meter.
--- The EUT was set into operation.

Premeasurement:
--- The antenna is moved spherical over the EUT in different polarizations of the antenna.
Final measurement:
--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.
--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

For example

Frequency (MHz)	FS (dBµV/m)	RA (dBµV/m)	AF (dB)	CL (dB)	AG (dB)	Transd (dB)
300.00	40	58.1	12.2	1.6	31.90	-18.1

Transd=AF +CL-AG

TEST RESULTS

Remark:
1. *All three channels (lowest/middle/highest) of each mode were measured below 1GHz and recorded worst case at IEEE 802.11ac VHT20 low channel of UNI Band 1.*
2. *All three channels (lowest/middle/highest) of each mode were measured above1GHz and recorded worst case at IEEE 802.11ac VHT20.*
3. *Radiated emission test from 9 KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9 KHz to 30MHz and not recorded in this report.*
4. *"---" means not recorded as emission levels lower than limit.*
5. *Margin= Limit – Level.*

For 9 KHz to 30MHz

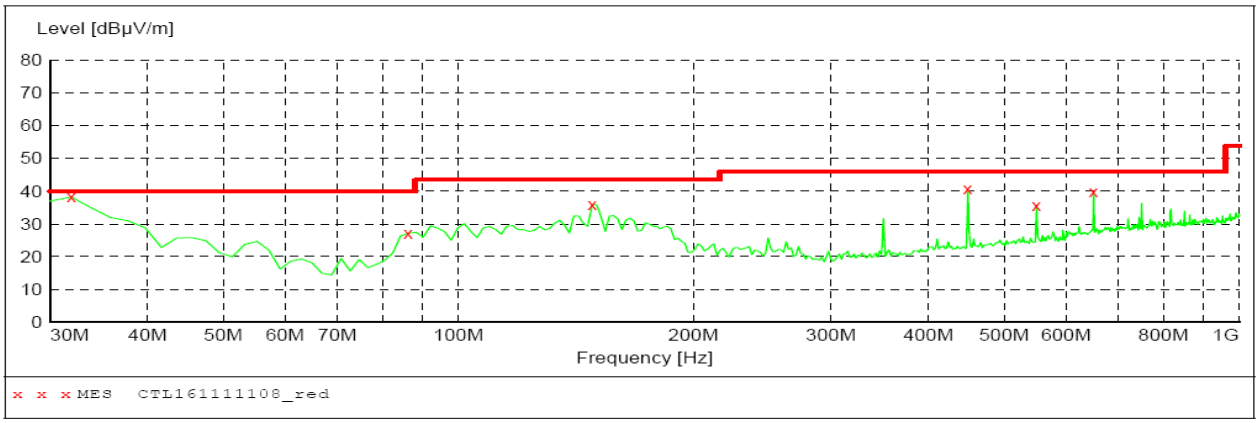
Frequency (MHz)	Corrected Reading (dBµV/m)@3m	FCC Limit (dBµV/m) @3m	Margin (dB)	Detector	Result
---	---	---	---	---	---

For 30MHz-1GHz

Test mode:	5GWLAN Band 1	Polarization:	Horizontal

SWEEP TABLE: "test (30M-1G)"

Short Description:			Field Strength		
Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	300.0 ms	120 kHz	JB1



MEASUREMENT RESULT: "CTL161111108_red"

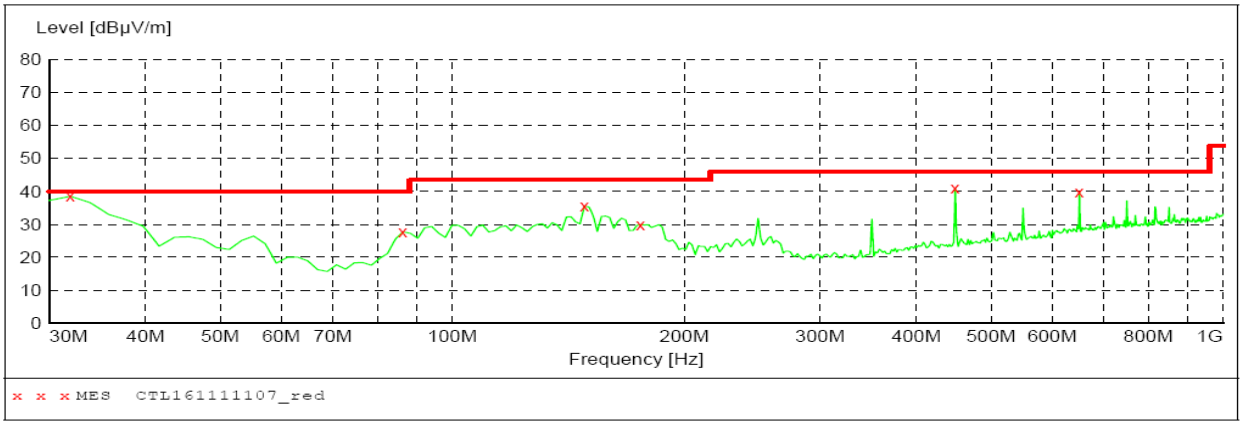
11/11/2016 9:14AM

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
31.940000	38.20	19.2	40.0	1.8	---	0.0	0.00	HORIZONTAL
86.260000	27.10	9.0	40.0	12.9	---	0.0	0.00	HORIZONTAL
148.340000	36.00	13.8	43.5	7.5	---	0.0	0.00	HORIZONTAL
449.040000	40.70	19.1	46.0	5.3	---	0.0	0.00	HORIZONTAL
549.920000	35.60	21.0	46.0	10.4	---	0.0	0.00	HORIZONTAL
650.800000	39.80	22.8	46.0	6.2	---	0.0	0.00	HORIZONTAL

Test mode:	5GWLAN Band 1	Polarization:	Vertical

SWEEP TABLE: "test (30M-1G)"

Short Description:			Field Strength		
Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	300.0 ms	120 kHz	JB1



MEASUREMENT RESULT: "CTL161111107_red"

11/11/2016 9:07AM

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
31.940000	38.50	19.2	40.0	1.5	---	0.0	0.00	VERTICAL
86.260000	27.70	9.0	40.0	12.3	---	0.0	0.00	VERTICAL
148.340000	35.50	13.8	43.5	8.0	---	0.0	0.00	VERTICAL
175.500000	29.90	12.9	43.5	13.6	---	0.0	0.00	VERTICAL
449.040000	40.90	19.1	46.0	5.1	---	0.0	0.00	VERTICAL
650.800000	39.80	22.8	46.0	6.2	---	0.0	0.00	VERTICAL

For 1GHz to 25GHz

Remark:
1. Measured all modes (IEEE 802.11ac VHT20/IEEE 802.11ac VHT40), recorded worst case at IEEE 802.11ac VHT20 mode;

U-NII Band 1 & 802.11ac (HT20) Mode (above 1GHz)

Tested Channel	Frequency (MHz)	Emission Level (dBuV/m)	Detector Mode	ANT Pol	Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre amplifier (dB)	Correction Factor (dB/m)
36 (5180MHz)	5149.50	46.52	PK	H	68.20	21.68	53.78	34.43	7.11	34.28	7.26
	10360.00	50.26	PK	H	68.20	19.94	64.75	39.2	11.45	36.16	14.49
	--	--	--	--	--	--	--	--	--	--	--
40 (5200MHz)	10400.00	49.89	PK	H	68.20	19.94	64.42	39.22	11.48	36.17	14.53
	--	--	--	--	--	--	--	--	--	--	--
48 (5240MHz)	5350.75	47.22	PK	H	68.20	20.98	54.78	34.69	7.23	34.36	7.56
	10480.00	52.38	PK	H	68.20	19.94	68.19	39.22	11.48	34.89	15.81
	--	--	--	--	--	--	--	--	--	--	--

U-NII Band 3 & 802.11ac (HT20) Mode (above 1GHz)

Tested Channel	Frequency (MHz)	Emission Level (dBuV/m)	Detector Mode	ANT Pol	Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre amplifier (dB)	Correction Factor (dB/m)
149 (5745MHz)	5712.85	46.98	PK	H	68.20	21.22	54.71	34.79	7.43	34.49	7.73
	5722.75	49.52	PK	H	78.20	28.68	57.25	34.79	7.43	34.49	7.73
	10950.00	51.23	PK	H	68.20	16.97	68.28	39.53	11.97	34.45	17.05
	--	--	--	--	--	--	--	--	--	--	--
157 (5785MHz)	11570.00	50.89	PK	H	68.20	17.31	69.34	39.71	13.05	34.31	18.45
	--	--	--	--	--	--	--	--	--	--	--
165 (5825MHz)	5850.75	49.56	PK	H	78.20	28.64	55.76	34.81	7.51	36.12	6.20
	5865.50	47.38	PK	H	68.20	20.82	53.59	34.85	7.51	36.15	6.21
	11650.00	51.33	PK	H	68.20	16.87	69.95	39.73	13.19	34.30	18.62
	--	--	--	--	--	--	--	--	--	--	--

Remark:
1. Emission level (dBuV/m) =Raw Value (dBuV) +Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) +Cable Factor (dB)-Pre-amplifier Factor
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.
6. RBW=1MHz VBW=3MHz Peak detector is for Peak value; RBW=1MHz VBW=10Hz Peak detector is for Average value.

3.3. Maximum Conducted Output Power

LIMIT

(1) For the band 5.15-5.25 GHz.
(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1dB reduction in maximum conducted output power is required for each 1 dB of antenna gain in excess of 23 dBi. 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.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(3) 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, both 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 transmitter output (antenna port) was connected to the power meter.
According to KDB 789033 D02 Section 3 (a) Method PM (Measurement using an RF average power meter):
(i) Measurements may be performed using a wideband RF power meter with a thermos couple detector or equivalent if all of the conditions listed below are satisfied.

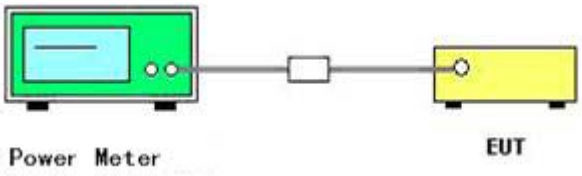
- The EUT is configured to transmit continuously or to transmit with a constant duty cycle.
- At all times when the EUT is transmitting, it must be transmitting at its maximum power control level.
- The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

(ii) If the transmitter does not transmit continuously, measure the duty cycle, x, of the transmitter output signal as described in section II.B.

(iii) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.

(iv) Adjust the measurement in dBm by adding 10 log (1/x) where x is the duty cycle (e.g., 10 log (1/0.25) if the duty cycle is 25%).

TEST CONFIGURATION



TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Measured Output Average Power (dBm)	Duty Cycle factor (dB)	Limits (dBm)	Verdict
IEEE 802.11ac VHT20	36	5180	13.58	0.00	30	PASS
	40	5200	13.26	0.00		
	48	5240	14.98	0.00		
	149	5745	12.54	0.00		
	157	5785	12.89	0.00		
	165	5825	12.63	0.00		
IEEE 802.11ac VHT40	38	5190	12.15	0.00	30	PASS
	46	5230	12.41	0.00		
	151	5755	12.32	0.00		
	159	5795	12.29	0.00		

Remark:
1. Measured output power at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss;
3. Worst case data at 6.5Mbps at IEEE 802.11ac VHT20; 13.5Mbps at IEEE 802.11ac VHT40;

3.4. Power Spectral Density

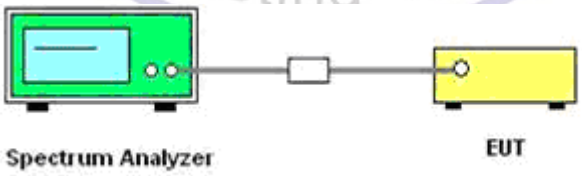
LIMIT

(1) For the band 5.15 - 5.25 GHz.
(i) For an outdoor access point operating in the band 5.15 - 5.25 GHz, the maximum power spectral density shall not exceed 17 dBm in any 1 MHz band.[note1]
(ii) For an indoor access point operating in the band 5.15 - 5.25 GHz, the maximum power spectral density shall not exceed 17 dBm in any 1 MHz band.[note1]
(iii) For fixed point-to-point access points operating in the band 5.15 - 5.25 GHz, transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi.
(iv) For mobile and portable client devices in the 5.15 - 5.25 GHz band, the maximum power spectral density shall not exceed 11 dBm in any 1 MHz band. [note1]
(2) For the 5.25 - 5.35 GHz and 5.47 - 5.725 GHz bands, the peak power spectral density shall not exceed 11 dBm in any 1 MHz band. [note1]
(3) For the band 5.725 - 5.85 GHz, the maximum power spectral density shall not exceed 30 dBm in any 500 kHz band. [note1, note2]
Note1: If transmitting antennas of directional gain greater than 6 dBi are used, the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
Note2: 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.

TEST PROCEDURE

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW = 1MHz for U-NII 1, U-NII 2A, U-NII C band and 510KHz for U-NII 3 band.
3. Set the VBW ≥ 3× RBW.
4. Set the span to encompass the entire EBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum power level.

TEST CONFIGURATION



TEST RESULTS

For UNI Band 1

Test Mode	Channel	Frequency (MHz)	Measured Peak Power Spectral Density (dBm/1MHz)	Duty Cycle factor (dB)	RBW factor (dB)	Limits (dBm/1MHz)	Verdict
IEEE 802.11ac VHT20	36	5180	6.732	0.00	0.00	17	PASS
	40	5200	6.728	0.00	0.00		
	48	5240	7.367	0.00	0.00		
IEEE 802.11ac VHT40	38	5190	4.607	0.00	0.00	17	PASS
	46	5230	4.530	0.00	0.00		

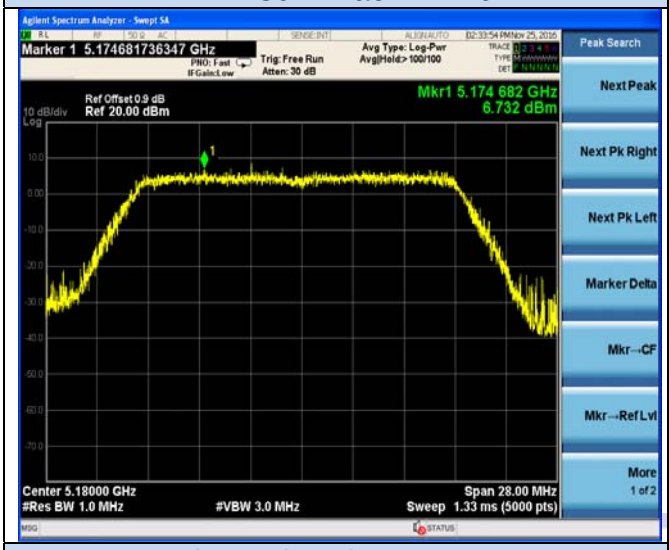
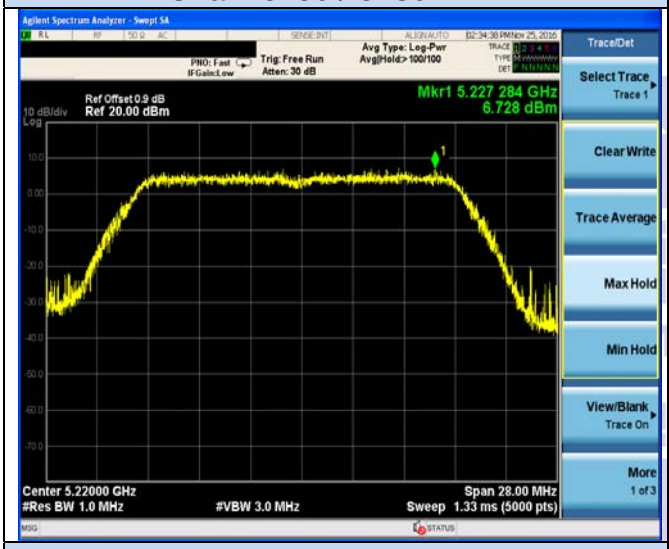
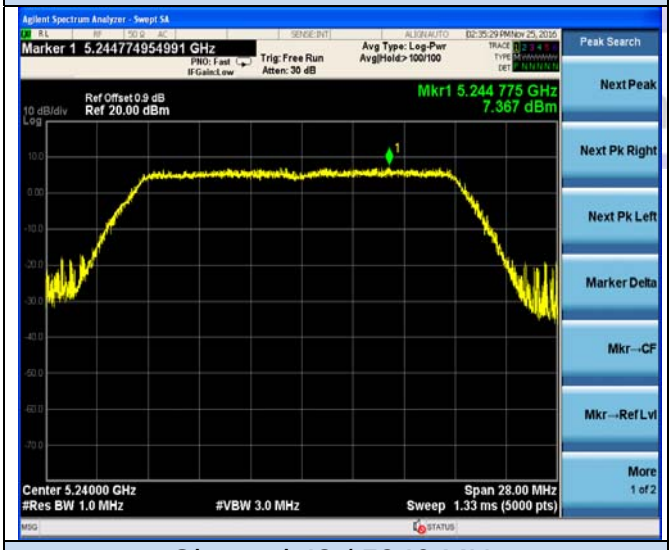
Remark:
1. Measured power spectrum density at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss;
3. Worst case data at 6.5Mbps at IEEE 802.11ac VHT20; 13.5Mbps at IEEE 802.11ac VHT40;
4. Please refer to following plots;

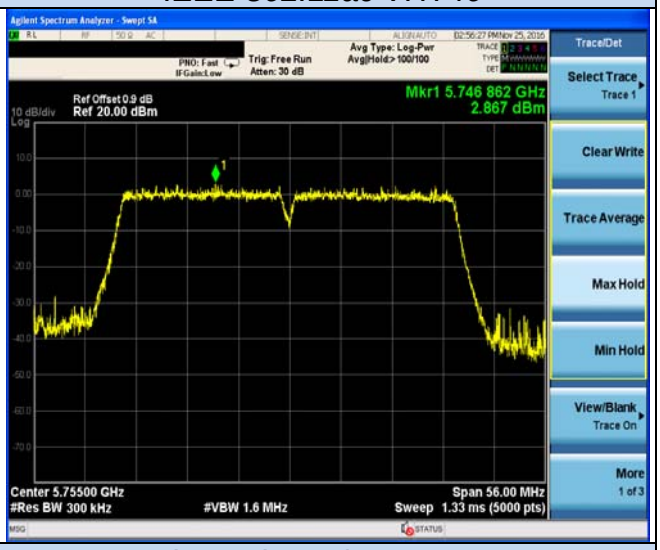
For UNI Band 3

Test Mode	Channel	Frequency (MHz)	Report Peak Power Spectral Density (dBm/500KHz)	Duty Cycle factor (dB)	RBW factor (dB)	Limits (dBm/500KHz)	Verdict
IEEE 802.11ac VHT20	149	5745	7.395	0.00	2.218	30	PASS
	157	5785	8.879	0.00	2.218		
	165	5825	7.497	0.00	2.218		
IEEE 802.11ac VHT40	151	5755	5.085	0.00	2.218	30	PASS
	159	5795	4.906	0.00	2.218		

Remark:
1. Measured output power at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss;
3. Worst case data at 6.5Mbps at IEEE 802.11ac VHT20; 13.5Mbps at IEEE 802.11ac VHT40;
*4. RBW factor = 10 log (500 kHz/RBW) = 10*log (500 KHz/300KHz) = 2.218 dB;*
5. Report peak power spectral density = Measure peak power spectral density + RBW factor + Duty Cycle factor
6. Please refer to following plots;

Test plot as follows:

Peak Power Spectral Density	
IEEE 802.11ac VHT20	IEEE 802.11ac VHT20
	
Channel 36 / 5180 MHz	Channel 149 / 5745 MHz
	
Channel 40 / 5200 MHz	Channel 157 / 5785 MHz
	
Channel 48 / 5240 MHz	Channel 165 / 5825 MHz

Peak Power Spectral Density	
IEEE 802.11ac VHT40	IEEE 802.11ac VHT40
	
Channel 38 / 5190 MHz	Channel 151 / 5755 MHz
	
Channel 46 / 5230 MHz	Channel 159 / 5795 MHz

3.5. Emission Bandwidth (26dBm Bandwidth)

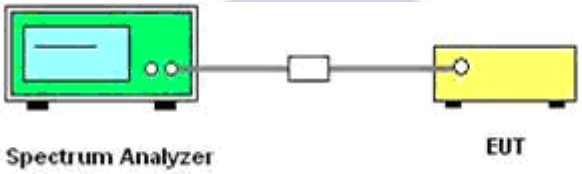
LIMIT

There is no restriction limits for 26dB and 99% occupied bandwidth, report only for reference.

TEST PROCEDURE

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Measure the maximum width of the emission that is 26 dB down from the maximum of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

TEST CONFIGURATION

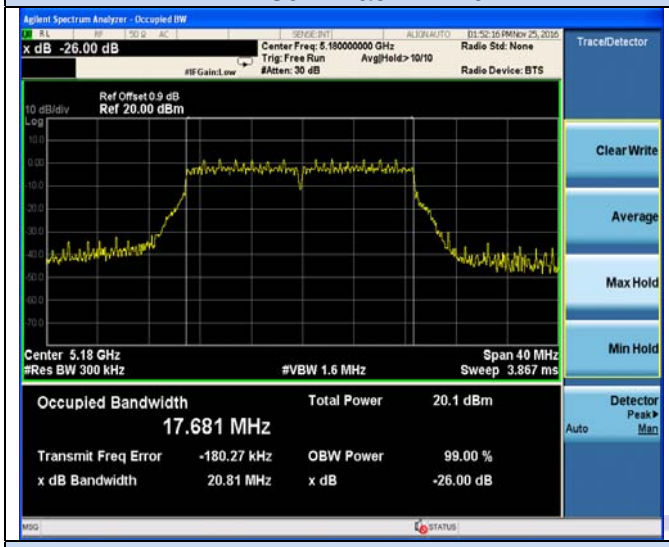
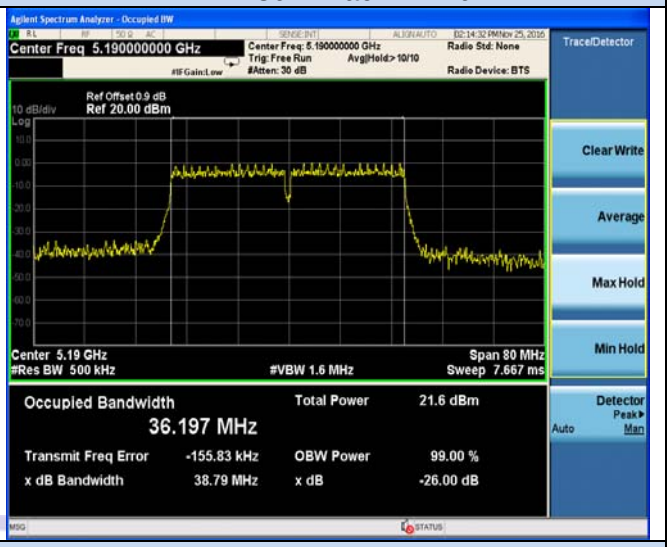
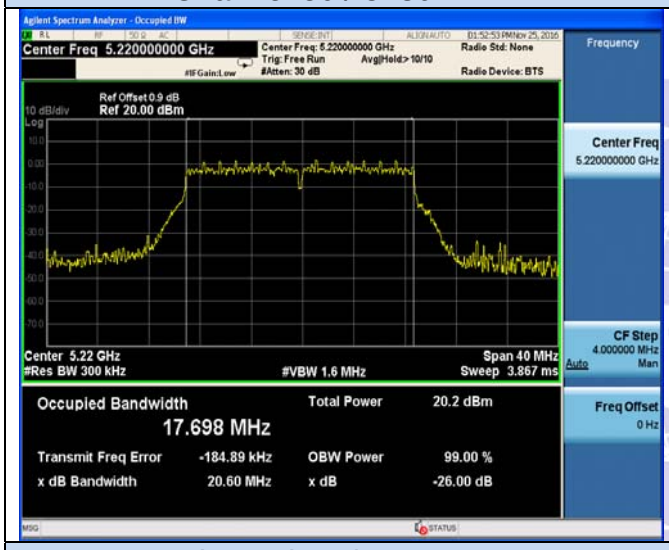
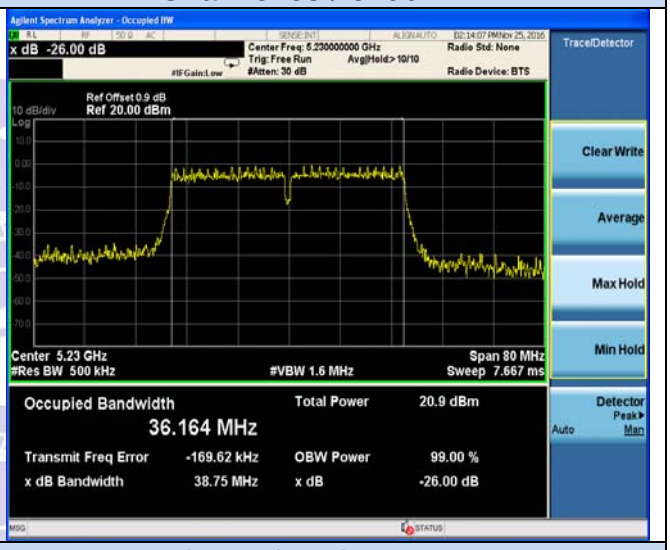
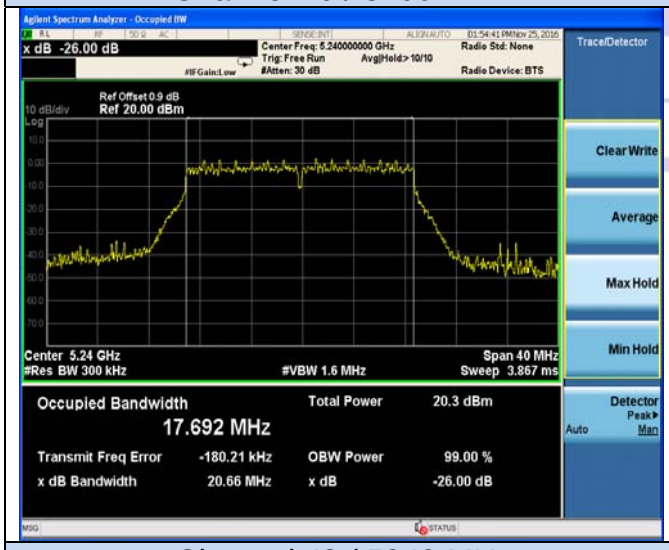


TEST RESULTS

For UNI Band 1

Test Mode	Channel	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)	Limits (MHz)	Verdict
IEEE 802.11ac VHT20	36	5180	20.810	17.681	No Limit	PASS
	40	5200	20.600	17.689		
	48	5240	20.660	17.692		
IEEE 802.11ac VHT40	38	5190	38.790	36.197	No Limit	PASS
	46	5230	38.750	36.164		

Remark:
1. Measured 99% and 26dB emission bandwidth at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss;
3. Worst case data at 6.5Mbps at IEEE 802.11 ac VHT20; 13.5Mbps at IEEE 802.11ac VHT40;
4. Please refer to following plots;

99% and 26dB Occupied Bandwidth	
IEEE 802.11ac VHT20	IEEE 802.11ac VHT40
	
Channel 36 / 5180 MHz	Channel 38 / 5190 MHz
	
Channel 40 / 5200 MHz	Channel 46 / 5230 MHz
	
Channel 48 / 5240 MHz	

3.6. Minimum Emission Bandwidth (6dBm Bandwidth)

LIMIT

According to §15.407(e): Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

TEST PROCEDURE

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

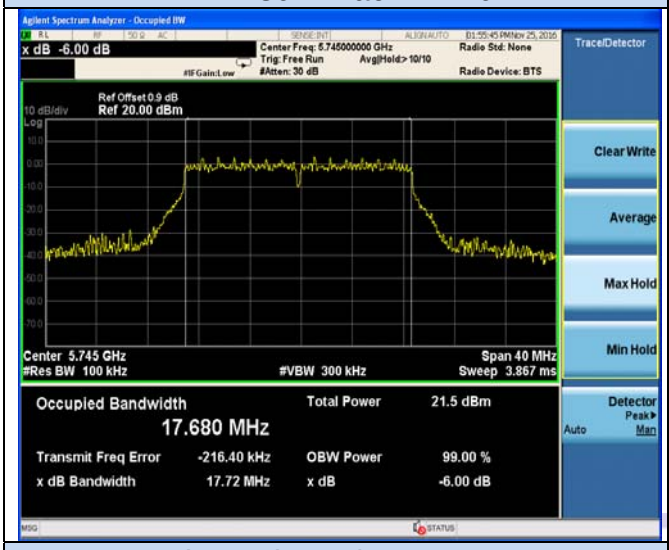
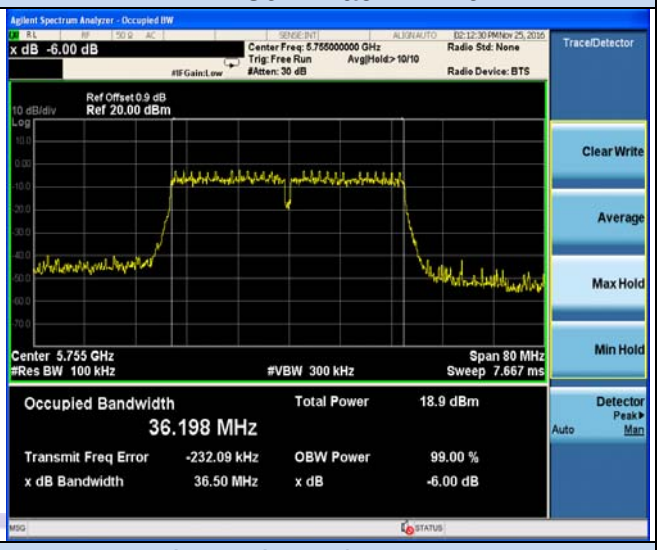
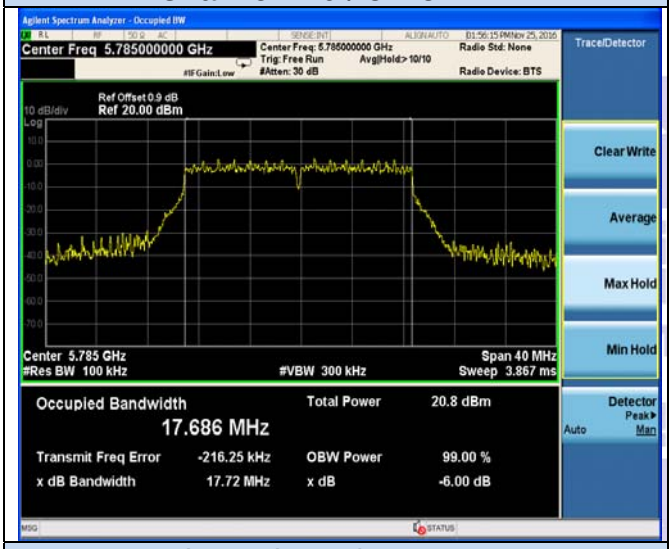
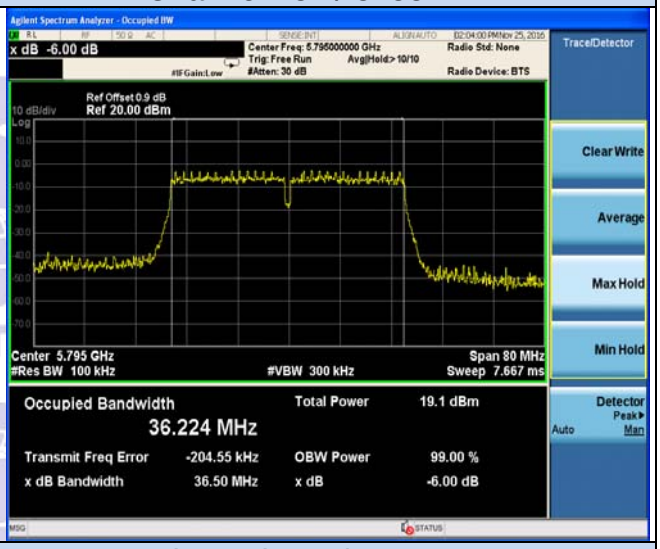
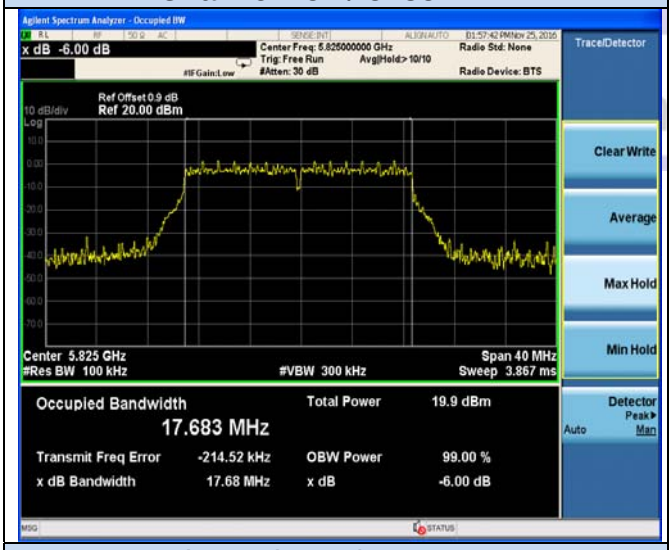
TEST CONFIGURATION

TEST RESULTS

For UNI Band 3

Test Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Limits (MHz)	Verdict
IEEE 802.11ac VHT20	149	5745	17.720	0.500	PASS
	157	5785	17.720		
	165	5825	17.680		
IEEE 802.11ac VHT40	151	5755	36.500	0.500	PASS
	159	5795	36.500		

Remark:
1. Measured 6dB bandwidth at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss;
3. Worst case data at 6.5Mbps at IEEE 802.11ac VHT20; 13.5Mbps at IEEE 802.11ac VHT40;
4. Please refer to following plots;

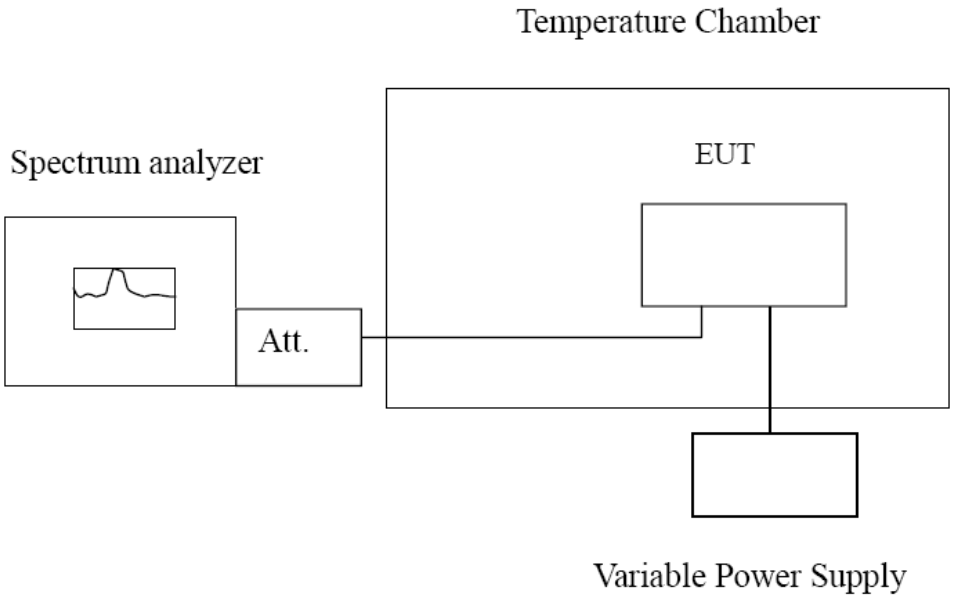
6dB Occupied Bandwidth	
IEEE 802.11ac VHT20	IEEE 802.11ac VHT40
	
Channel 149 / 5745 MHz	Channel 151 / 5755 MHz
	
Channel 157 / 5785 MHz	Channel 159 / 5795 MHz
	
Channel 165 / 5825 MHz	

3.7. Frequency Stability

LIMIT

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 CONFIGURATION



TEST PROCEDURE

Frequency Stability under Temperature Variations:
The equipment under test was connected to an external AC or DC power supply and input rated voltage. RF output was connected to a frequency counter or spectrum analyzer via feed through attenuators. The EUT was placed inside the temperature chamber. Set the spectrum analyzer RBW low enough to obtain the desired frequency resolution and measure EUT 20℃ operating frequency as reference frequency. Turn EUT off and set the chamber temperature to -30℃. After the temperature stabilized for approximately 30 minutes recorded the frequency. Repeat step measure with 10℃ increased per stage until the highest temperature of +50℃ reached.

Frequency Stability under Voltage Variations:
Set chamber temperature to 20℃. Use a variable AC power supply / DC power source to power the EUT and set the voltage to rated voltage. Set the spectrum analyzer RBW low enough to obtain the desired frequency resolution and recorded the frequency.
Reduce the input voltage to specify extreme voltage variation (±15%) and endpoint, record the maximum frequency change.

TEST RESULTS

Remark:
1. Measured all channels and recorded worst case;
2. The extreme voltage is DC 3.40V to DC 4.20V, normal work voltage is DC 3.80V by application;

Reference Frequency: IEEE 802.11ac VHT20 Channel=36 frequency=5180MHz					
Voltage (V)	Temperature (℃)	Frequency error		Limit (ppm)	Result
		Hz	ppm		
3.80	-30	968	0.19	Within the band of operation	Pass
	-20	1025	0.20		
	-10	852	0.16		
	0	914	0.18		
	10	778	0.15		
	20	856	0.17		
	30	1041	0.20		
	40	1125	0.22		
	50	963	0.19		
4.20	25	942	0.18		
3.40	25	985	0.19		

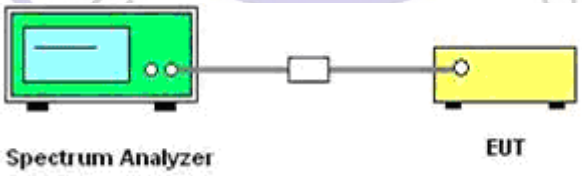
Reference Frequency: IEEE 802.11ac VHT20 Channel=149 frequency=5745MHz					
Voltage (V)	Temperature (℃)	Frequency error		Limit (ppm)	Result
		Hz	ppm		
3.80	-30	1152	0.20	Within the band of operation	Pass
	-20	1152	0.20		
	-10	1186	0.21		
	0	1210	0.21		
	10	1125	0.20		
	20	1196	0.21		
	30	1058	0.18		
	40	1241	0.22		
	50	1356	0.24		
4.20	25	1314	0.23		
3.40	25	1221	0.21		

3.8. Undesirable Emissions Measurement

LIMIT

According to ξ15.407 (b) Undesirable emission limits. Except as shown in paragraph (b) (7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:
(a) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(b) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(c) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(d) For transmitters operating in the 5.725-5.85 GHz band:
(i) 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.
(ii) Devices certified before March 2, 2017 with antenna gain greater than 10 dBi may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease by March 2, 2018. Devices certified before March 2, 2018 with antenna gain of 10 dBi or less may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease before March 2, 2020.
(e) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.
(f) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.
(g) The provisions of §15.205 apply to intentional radiators operating under this section.
(h) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

TEST CONFIGURATION



TEST PROCEDURE

According to KDB789033 D02 General UNII Test Procedures New Rules v01 Section G: Unwanted Emission Measurement
1. Unwanted Emissions in the Restricted Bands
a) For all measurements, follow the requirements in section II.G.3. “General Requirements for Unwanted Emissions Measurements.”
b) At frequencies below 1000 MHz, use the procedure described in section II.G.4. “Procedure for Unwanted Emissions Measurements below 1000 MHz.”
c) At frequencies above 1000 MHz, measurements performed using the peak and average measurement procedures described in sections II.G.5. and II.G.6, respectively, must satisfy the respective peak and average limits. If all peak measurements satisfy the average limit, then average measurements are not required.
d) For conducted measurements above 1000 MHz, EIRP shall be computed as specified in section II.G.3.b) and then field strength shall be computed as follows (see KDB Publication 412172):

i) E[dBμV/m] = EIRP[dBm] - 20 log (d[meters]) + 104.77, where E = field strength and d = distance at which field strength limit is specified in the rules;
ii) E[dBμV/m] = EIRP[dBm] + 95.2, for d = 3 meters
e) For conducted measurements below 1000 MHz, the field strength shall be computed as specified in d), above, and then an additional 4.7 dB shall be added as an upper bound on the field strength that would be observed on a test range with a ground plane for frequencies between 30 MHz and 1000 MHz, or an additional 6 dB shall be added for frequencies below 30 MHz.
2. Unwanted Emissions that fall Outside of the Restricted Bands
a) For all measurements, follow the requirements in section II.G.3. “General Requirements for Unwanted Emissions Measurements.”
b) At frequencies below 1000 MHz, use the procedure described in section II.G.4. “Procedure for Unwanted Emissions Measurements below 1000 MHz.”
c) At frequencies above 1000 MHz, use the procedure for maximum emissions described in section II.G.5., “Procedure for Unwanted Maximum Unwanted Emissions Measurements Above 1000 MHz.”
d) Section 15.407(b) (1-3) specifies the unwanted emissions limit for the U-NII-1 and 2 bands. As specified, emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz. However, an out-of-band emission that complies with both the average and peak limits of Section 15.209 is not required to satisfy the -27 dBm/MHz dBm/MHz peak emission limit.
i) Section 15.407(b) (4) specifies the unwanted emissions limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b) (4) (i). An alternative to the band emissions mask is specified in Section 15.407(b) (4) (ii). The alternative limits are based on the highest antenna gain specified in the filing. There are also marketing and importation restrictions for the alternative limit.
e) If radiated measurements are performed, field strength is then converted to EIRP as follows:
i) EIRP = ((E×d) ^2) / 30
Where:
- E is the field strength in V/m;
- d is the measurement distance in meters;
- EIRP is the equivalent isotopically radiated power in watts;

ii) Working in dB units, the above equation is equivalent to:
EIRP [dBm] = E [dBμV/m] + 20 log (d [meters]) - 104.77
iii) Or, if d is 3 meters:
EIRP [dBm] = E [dBμV/m] - 95.23
3) Radiated versus Conducted Measurements.
The unwanted emission limits in both the restricted and non-restricted bands are based on radiated measurements; however, as an alternative, antenna-port conducted measurements in conjunction with cabinet emissions tests will be permitted to demonstrate compliance provided that the following steps are performed:
(i) Cabinet emissions measurements. A radiated test shall be performed to ensure that cabinet emissions are below the emission limits. For the cabinet-emission measurements the antenna may be replaced by a termination matching the nominal impedance of the antenna.
(ii) Impedance matching. Conducted tests shall be performed using equipment that matches the nominal impedance of the antenna assembly used with the EUT.
(iii) EIRP calculation. 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] However, for devices that operate in multiple bands using the same transmit antenna, the highest gain of the antenna within the operating band nearest to the out-of-band frequency being measured may be used in lieu of the overall highest gain when measuring emissions at frequencies within 20% of the absolute frequency at the nearest edge of that band, but in no case shall a value less than 2 dBi be selected.
(iv) EIRP adjustments for multiple outputs. For devices with multiple outputs occupying the same or overlapping frequency ranges in the same band (e.g., MIMO or beamforming devices), compute the total EIRP as follows:
- Compute EIRP for each output, as described in (iii), above.
- Follow the procedures specified in KDB Publication 662911 for summing

emissions across the outputs or adjusting emission levels measured on individual outputs by 10 log (N_{ANT}), where N_{ANT} is the number of outputs.

- Add the array gain term specified in KDB Publication 662911 for out-of-band and spurious signals.

(v)Direction of maximum emission.

For all radiated emissions tests, measurements shall correspond to the direction of maximum emission level for each measured emission (see ANSI C63.10 for guidance).

TEST RESULTS

For UNI Band 1

IEEE 802.11ac VHT20							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
5150.000	-35.449	0.000	0.000	61.809	Peak	74.00	PASS
5150.000	-50.009	0.000	0.000	47.249	Average	74.00	PASS
5350.000	-49.353	0.000	0.000	47.905	Peak	74.00	PASS

IEEE 802.11ac VHT40							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
5150.000	-36.815	0.000	0.000	60.443	Peak	74.00	PASS
5150.000	-43.989	0.000	0.000	53.269	Average	54.00	PASS
5350.000	-48.698	-1.500	0.00	48.560	Peak	74.00	PASS

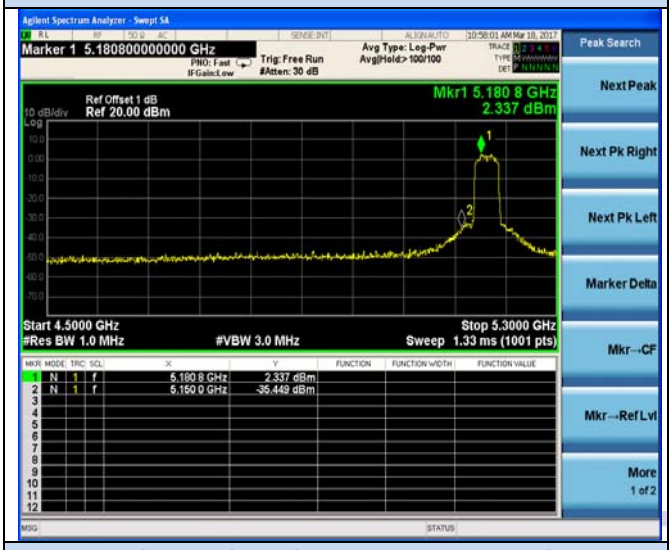
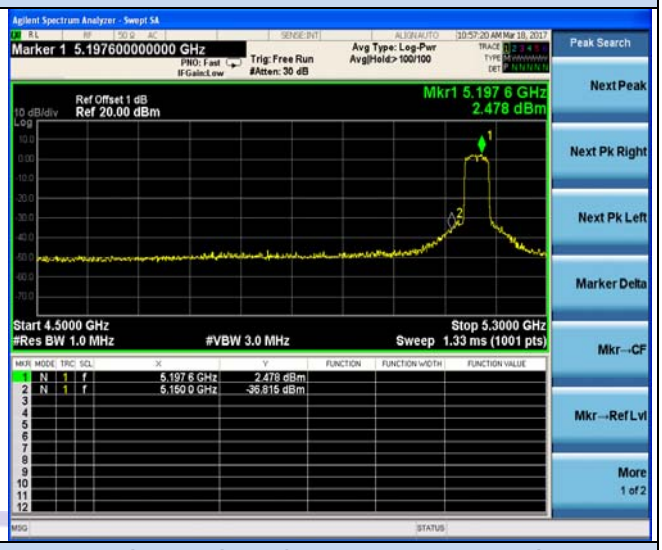
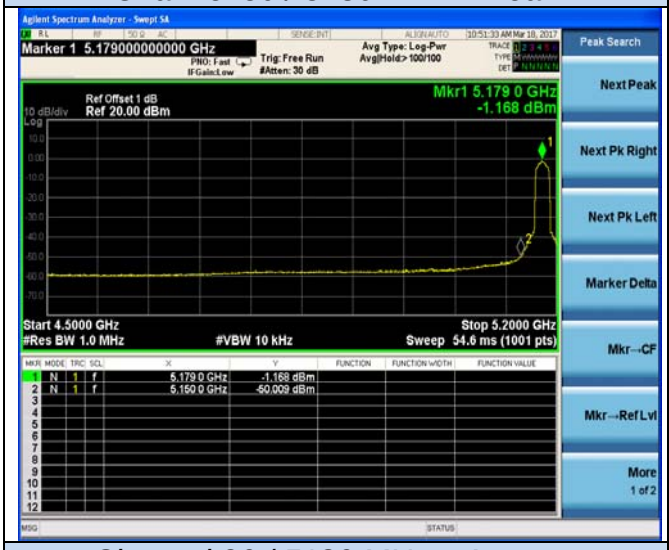
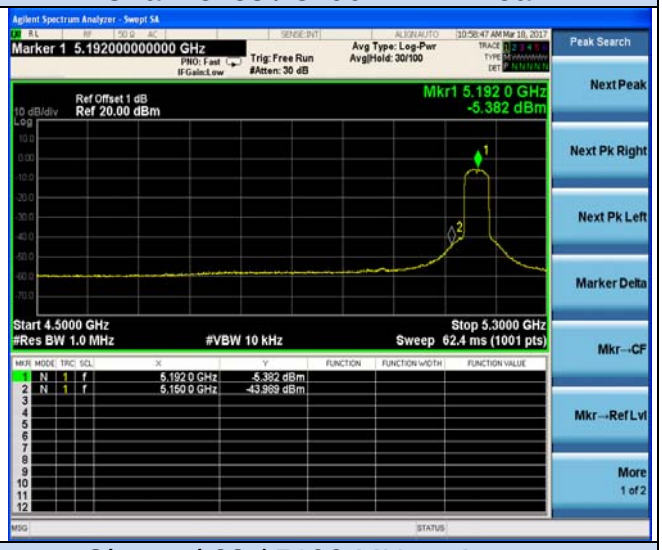
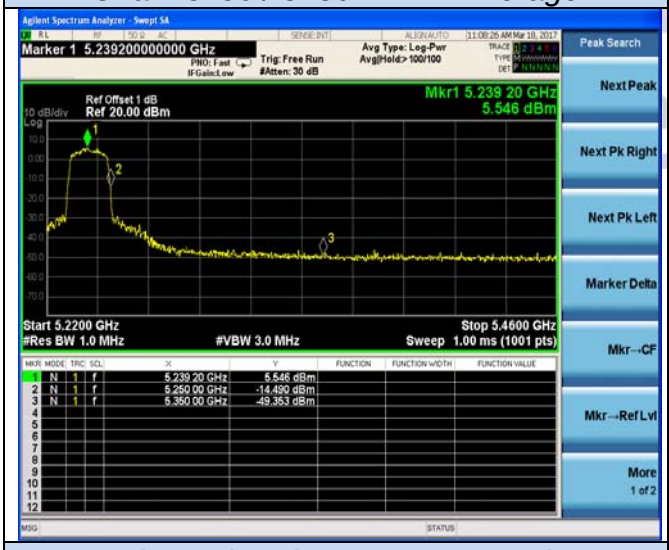
Remark:
1. Measured Undesirable emission at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss;
3. Worst case data at 6.5Mbps at IEEE 802.11ac VHT20; 13.5Mbps at IEEE 802.11ac VHT40;
4. Please refer to following plots;
5. The average measurement was not performed when the peak measured data under the limit of average detection.
6. "---"means that the fundamental frequency not for 15.209 limits requirement.

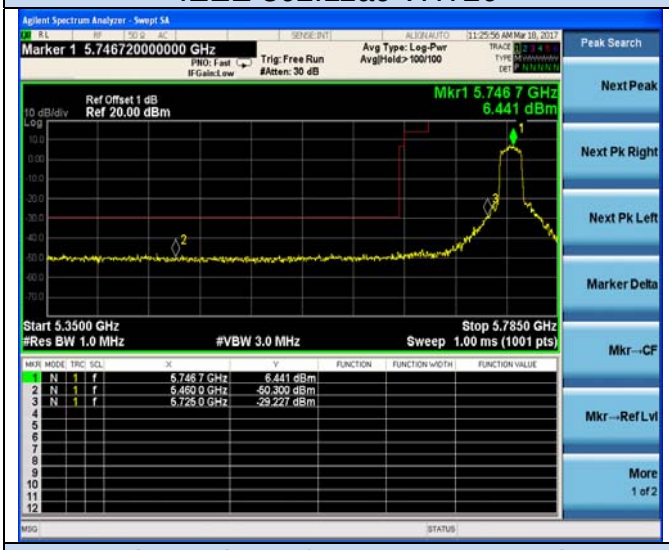
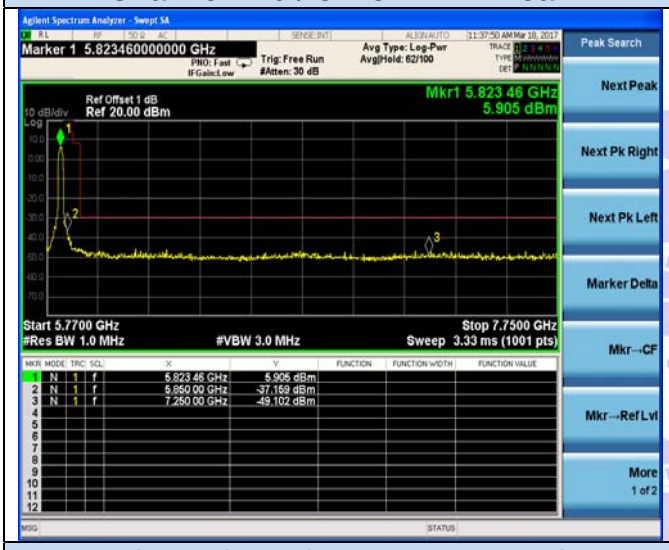
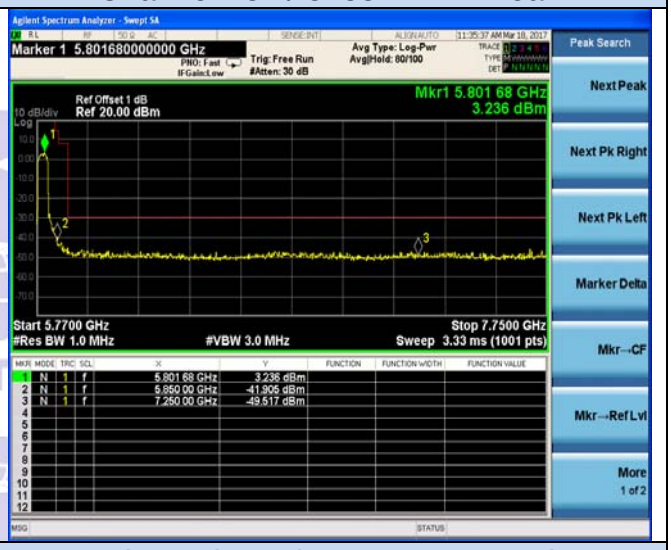
For UNI Band 3

IEEE 802.11ac VHT20						
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm/1MHz)	Detector	Limit (dBm/1MHz)	Verdict
5650.000	---	0.000	---	Peak	-27.000	PASS
5700.000	---	0.000	---	Peak	10.000	PASS
5720.000	---	0.000	---	Peak	15.600	PASS
5725.000	-29.227	0.000	-27.227	Peak	27.000	PASS
5850.000	-37.159	0.000	-35.159	Peak	27.000	PASS
5855.000	---	0.000		Peak	15.600	PASS
5875.000	---	0.000		Peak	10.000	PASS
5925.000	---	0.000		Peak	-27.000	PASS

IEEE 802.11ac VHT40						
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm/1MHz)	Detector	Limit (dBm/1MHz)	Verdict
5650.000	---	0.000	---	Peak	-27.000	PASS
5700.000	---	0.000	---	Peak	-17.000	PASS
5720.000	---	0.000	---	Peak	15.600	PASS
5725.000	-33.123	0.000	-31.123	Peak	27.000	PASS
5850.000	-41.905	0.000	-39.905	Peak	27.000	PASS
5855.000	---	0.000		Peak	15.600	PASS
5875.000	---	0.000		Peak	-37.000	PASS
5925.000	---	0.000		Peak	-27.000	PASS

Remark:
1. Measured undesirable emission at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss;
3. Worst case data at 6.5Mbps at IEEE 802.11ac VHT20; 13.5Mbps at IEEE 802.11ac VHT40;
4. Please refer to following plots;
5. The average measurement was not performed when the peak measured data under the limit of average detection.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. Emission limit reduce antenna gain;
8. --- means lower than emission limit at least 20dB;

Band-edge Measurements for Radiated Emissions	
IEEE 802.11ac VHT20	*IEEE 802.11ac VHT40*
	
Channel 36 / 5180 MHz – Peak	*Channel 38 / 5190 MHz – Peak*
	
Channel 36 / 5180 MHz – Average	*Channel 38 / 5190 MHz – Average*
	
Channel 48 / 5240 MHz – Peak	*Channel 46 / 5230 MHz – Peak*

Undesirable Emissions	
IEEE 802.11ac VHT20	*IEEE 802.11ac VHT40*
	
Channel 149 / 5745 MHz – Peak	*Channel 151 / 5755 MHz – Peak*
	
Channel 165 / 5825 MHz – Peak	*Channel 159 / 5795 MHz – Peak*

3.9. Antenna Requirement

Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited
And according to FCC 47 CFR Section 15.407 (a), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

Antenna Connected Construction

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

The directional gains of antenna used for transmitting is 0 dBi, and the antenna is an internal antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.
The WLAN and Bluetooth share same antenna.

Measurement

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.
Conducted power refers ANSI C63.10:2013 Output power test procedure for U-NII devices.
Radiated power refers to ANSI C63.10:2013 Radiated emissions tests.

Measurement parameters

Measurement parameter	
Detector:	Peak
Sweep Time:	Auto
Resolution bandwidth:	1MHz
Video bandwidth:	3MHz
Trace-Mode:	Max hold

Note: The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.

LIMITS

FCC	ISED
Antenna Gain	
6 dBi	

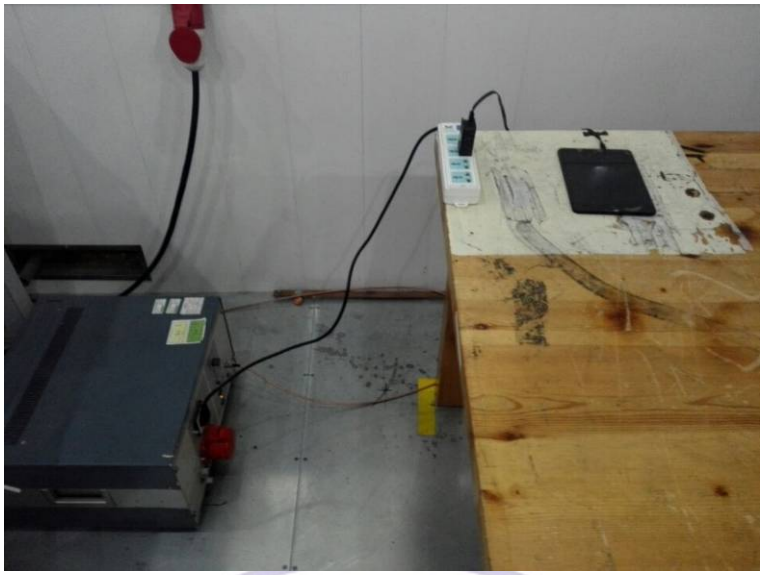
TEST RESULTS:

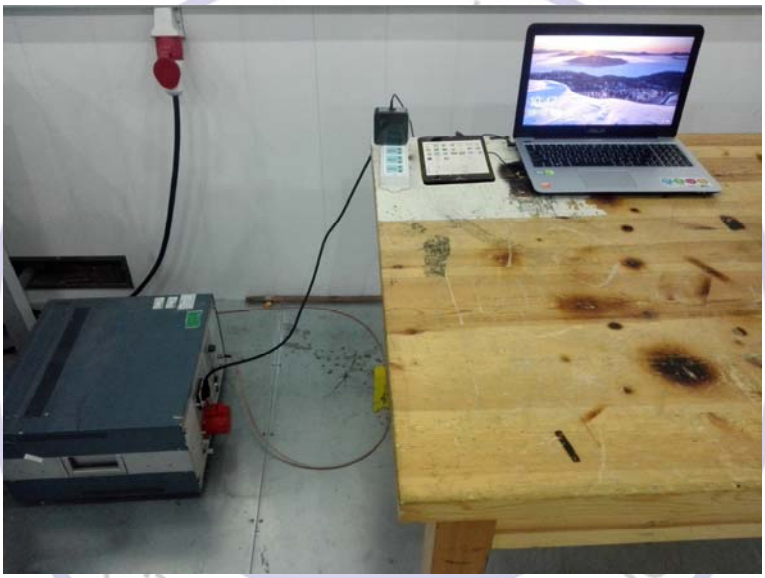
PASS

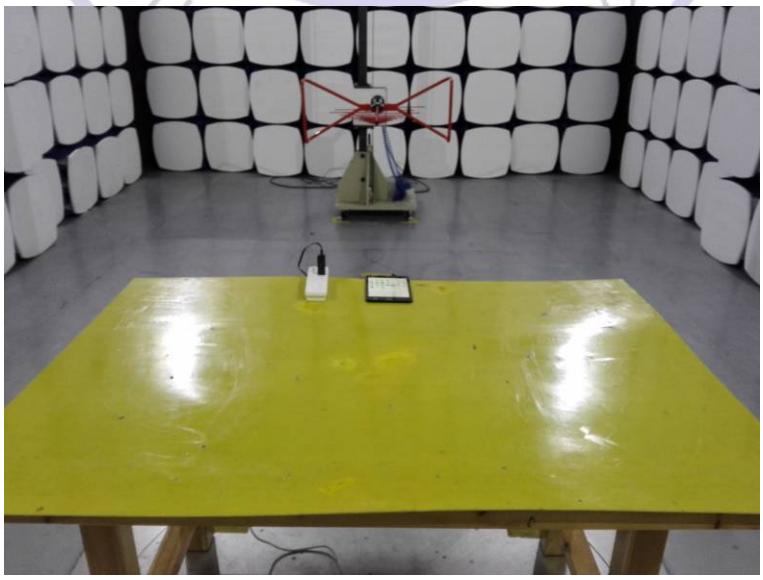
T_{nom}	V_{nom}	lowest channel 5180 MHz	middle channel 5200 MHz	highest channel 5240 MHz
Conducted power [dBm] Measured with OFDM modulation		4.782	4.478	5.661
Radiated power [dBm] Measured with OFDM modulation		1.254	0.922	2.049
Gain [dBi] Calculated		-3.528	-3.556	-3.612
Measurement uncertainty			0.57 dB (cond.) / 2.20 dB (rad.)	

T_{nom}	V_{nom}	lowest channel 5745 MHz	middle channel 5785 MHz	highest channel 5825 MHz
Conducted power [dBm] Measured with OFDM modulation		5.998	5.976	5.642
Radiated power [dBm] Measured with OFDM modulation		2.274	2.223	1.876
Gain [dBi] Calculated		-3.724	-3.753	-3.766
Measurement uncertainty			0.57 dB (cond.) / 2.20 dB (rad.)	

4. Test Setup Photos of the EUT







5. Photos of the EUT

Reference to the test report No. CTL1610310501-WF-01

********** End of Report **********