Shenzhen Global Test Service Co.,Ltd.
1F, Building No. 13A, Zhonghaixin Science and Technology City, No.12,6 Road, Ganli Industrial Park, Buji Street, Longgang District, Shenzhen, Guangdong

FCC PART 15 SUBPART C TEST REPORT

FCC PART 15.407

Report Reference No.....:	**GTSR16060030-5.8WLAN**
FCC ID..... :	**2AIS5-ARKJ01**
Compiled by (position+printed name+signature)..:	File administrators Jimmy Wang
Supervised by (position+printed name+signature)..:	Test Engineer Peter Xiao
Approved by (position+printed name+signature)..:	Manager Sam Wang
Date of issue.....:	Jun. 24, 2016
Test Laboratory Name.....:	**Shenzhen Global Test Service Co.,Ltd.**
Address .....:	1F, Building No. 13A, Zhonghaixin Science and Technology City, No.12,6 Road, Ganli Industrial Park, Buji Street, Longgang District, Shenzhen, Guangdong
Applicant's name.....:	**Beijing Palo Alto Tech Co.,Ltd.**
Address .....:	T3-A-31,Wangjing Soho,Chaoyang District,Beijing,China
Test specification .....:	
Standard .....:	**FCC Part 15.407: UNLICENSED NATIONAL INFORMATION INFRASTRUCTURE DEVICES**
TRF Originator.....:	Shenzhen Global Test Service Co.,Ltd.
Master TRF.....:	Dated 2014-12

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Test item description .....:	CoolGlass
Trade Mark .....:	/
Manufacturer .....:	**Beijing Palo Alto Tech Co.,Ltd.**
Model/Type reference.....:	ARKJ01
Listed Models .....:	/
Operation Frequency.....:	From 5180MHz to 5240MHz/From 5745MHz to 5825MHz
Hardware Version .....:	PD_M200_S3132E_V1.0
Software Version .....:	BP-A-V2.0
Rating .....:	DC 3.80V
Result.....:	**PASS**

TEST REPORT

Test Report No. :	GTSR16060030-5.8WLAN	Jun. 24, 2016 Date of issue

Equipment under Test	:	CoolGlass
Model /Type	:	ARKJ01
Listed Models	:	/
Applicant	:	**Beijing Palo Alto Tech Co.,Ltd.**
Address	:	T3-A-31,Wangjing Soho,Chaoyang District,Beijing,China
Manufacturer	:	**Beijing Palo Alto Tech Co.,Ltd.**
Address	:	T3-A-31,Wangjing Soho,Chaoyang District,Beijing,China

Test Result:	**PASS**

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.

Contents

1. TEST STANDARDS 4

2. SUMMARY 5

2.1. General Remarks 5
2.2. Product Description 5
2.3. Equipment Under Test 5
2.4. Short description of the Equipment under Test (EUT) 5
2.5. EUT operation mode 5
2.6. Block Diagram of Test Setup 6
2.7. Related Submittal(s) / Grant (s) 6
2.8. Modifications 6
2.9. NOTE 6

3. TEST ENVIRONMENT 7

3.1. Address of the test laboratory 7
3.2. Test Facility 7
3.3. Environmental conditions 7
3.4. Summary of Test Results 7
3.5. Test Description 8
3.6. Statement of the measurement uncertainty 9
3.7. Equipments Used during the Test 10

4. TEST CONDITIONS AND RESULTS 11

4.1. AC Power Conducted Emission 11
4.2. Radiated Emission 14
4.3. Duty Cycle 21
4.4. Maximum Average Output Power 24
4.5. Power Spectral Density 26
4.6. 6dB Bandwidth 30
4.7. 26dBc Bandwidth 32
4.8. Band Edge Compliance Radiated 34
4.9. Spurious RF Conducted Emission 37
4.10. Frequency Stability 40
4.11. Antenna Requirement 42

5. TEST SETUP PHOTOS OF THE EUT 43

6. EXTERNAL AND INTERNAL PHOTOS OF THE EUT 45

1. TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 15.407: UNLICENSED NATIONAL INFORMATION INFRASTRUCTURE DEVICES.
ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices
KDB 789033 D02: GUIDELINES FOR COMPLIANCE TESTING OF UNLICENSED NATIONAL INFORAMTION INFRASTRUCTURE (U-NII) DEVICES PART 15, SUBPART E

2 . SUMMARY

2.1. General Remarks

Date of receipt of test sample	:	Jun. 12, 2016
Testing commenced on	:	Jun. 12, 2016
Testing concluded on	:	Jun. 24, 2016

2.2. Product Description

Name of EUT	CoolGlass
Model Number	ARKJ01
Listed Models	/
FCC ID	2AIS5-ARKJ01
Power Supply	Battery DC 3.80V
Supported type:	802.11a/802.11ac/802.11b/802.11g/802.11n HT20
Modulation:	802.11a: OFDM(64QAM, 16QAM, QPSK, BPSK) 802.11ac: OFDM(64QAM, 16QAM, QPSK, BPSK) 802.11b: DSSS(CCK,DQPSK,DBPSK) 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) 802.11n HT20: OFDM (64QAM, 16QAM, QPSK,BPSK)
Operation frequency:	802.11a:5180MHz—5240MHz/5745MHz—5825MHz 802.11ac:5180MHz—5240MHz/5745MHz—5825MHz 802.11b:2412-2462MHz 802.11g:2412-2462MHz 802.11n HT20:2412-2462MHz
Antenna Type	Internal Antenna and maximum antenna gain is 0dBi

2.3. Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	230V / 50 Hz	○	120V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

DC 3.80V

2.4. Short description of the Equipment under Test (EUT)

This is a CoolGlass.

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

2.5. EUT operation mode

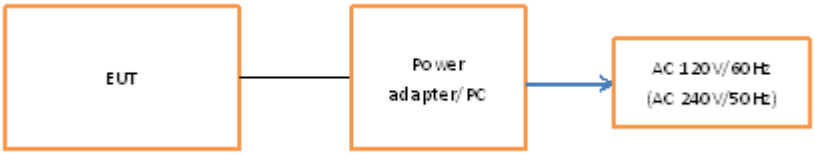
The application provider specific test software to control sample in continuous TX and RX.

IEEE 802.11a/ac:

UNII-1		UNII-1		UNII-1	
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
36	**5180**	38	5190	42	5210
40	**5200**	46	5230		
44	5220				
48	**5240**				

UNII-3		UNII-3		UNII-3	
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
149	**5745**	151	5755	155	5775
153	5765	159	5795		
157	**5785**				
161	5805				
165	**5825**				

2.6. Block Diagram of Test Setup



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

This submittal(s) (test report) is intended for **FCC ID: 2AIS5-ARKJ01** filing to comply with Section 15.407 of the FCC Part 15, Subpart E Rules.

2.8. Modifications

No modifications were implemented to meet testing criteria.

2.9. NOTE

	Test Standards	Reference Report
Bluetooth-BLE	FCC Part 15 Subpart C	GTSR16060030-BLE
WLAN-2.4	FCC Part 15 Subpart C	GTSR16060030-2.4WLAN
WLAN-5.8	FCC Part 15 Subpart E	GTSR16060030-5.8WLAN
RF Exposure	FCC Per 47 CFR 2.1093(d)	GTSR16060030-MPE

3. TEST ENVIRONMENT

3.1. Address of the test laboratory

Test Site 1: Shenzhen Global Test Service Co.,Ltd.
1F, Building No. 13A, Zhonghaixin Science and Technology City, No.12,6 Road, Ganli Industrial Park, Buji Street, Longgang District, Shenzhen, Guangdong

Test Site 2: Shenzhen CTL Testing Technology Co.,Ltd.
1/F.-A, Baisha Technology Park, No.3011, Shahexi Road, Nanshan District, Shenzhen, Guangdong, China

3.2. Test Facility

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

FCC-Registration No.: 964637

Shenzhen Global Test Service 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 964637, Jul 24, 2015.

CNAS-Lab Code: L8169

Shenzhen Global Test Service Co.,Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories. Date of Registration: Dec. 11, 2015. Valid time is until Dec. 10, 2018.

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 970318, December 19, 2013.

3.3. Environmental conditions

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

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	950-1050mbar

3.4. Summary of Test Results

FCC Part § 15.407			
FCC Rules	Description of Test	Results	Test Site
§15.407(a)	Maximum output power	PASS	Site 1
§15.407(a)	Spectrum bandwidth – 26 dB bandwidth	PASS	Site 1
§15.407(e)	Spectrum bandwidth – 6 dB bandwidth	PASS	Site 1
§15.407(b)	Band edge compliance radiated	PASS	Site 2
§15.407(a)	TX spurious emissions conducted	PASS	Site 1
§15.407(a)	TX spurious emissions radiated	PASS	Site 2
§15.205	Emissions at Restricted Band	PASS	Site 2
§15.407(g)	Frequency Stability	PASS	Site 1
§15.207(a)	Conducted Emissions	PASS	Site 1
§15.203	Antenna Requirements	PASS	Site 2

3.5. Test Description

Test Specification clause	Test case	Test Mode	Test Channel	Recorded In Report		Pass	Fail	NA	NP	Remark
§15.203	Antenna gain	802.11a	☒ Lowest ☒ Middle ☒ Highest	802.11a	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.407(a)	Power spectral density	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.407(a)	Spectrum bandwidth – 26 dB bandwidth	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.407(e)	Spectrum bandwidth – 6 dB bandwidth	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.407(a)	Maximum output power	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	☒ ☒ ☒	☐	☐	☐	complies
§15.407(b)	Band edge compliance conducted	802.11a 802.11ac	☒ Lowest ☒ Highest	802.11a 802.11ac	☒ Lowest ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.407(b)	Band edge compliance radiated	802.11a 802.11ac	☒ Lowest ☒ Highest	802.11a 802.11ac	☒ Lowest ☒ Highest	☒	☐	☐	☐	complies
§15.407(a)	TX spurious emissions conducted	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	☒ ☒	☐	☐	☐	complies
§15.407(a)	TX spurious emissions radiated	802.11a 802.11ac	☒ Lowest ☒ Middle ☒ Highest	802.11ac	☒ Lowest ☒ Middle ☒ Highest	☒	☐	☐	☐	complies
§15.407(g)	Frequency Stability	802.11a 802.11ac	☒ Lowest ☒ Highest	802.11ac	☒ Lowest	☒	☐	☐	☐	complies
§15.109	RX spurious emissions radiated	-/-	-/-	-/-	-/-	☒	☐	☐	☐	complies
§15.209(a)	TX spurious Emissions radiated < 30 MHz	802.11a	-/-	802.11a	-/-	☒	☐	☐	☐	complies
§15.107(a) §15.207	Conducted Emissions < 30 MHz	802.11a	-/-	802.11a	-/-	☒	☐	☐	☐	complies

Remark:
1. The measurement uncertainty is not included in the test result.
2. NA = Not Applicable; NP = Not Performed

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate shown in the table below is the worst-case rate with respect to the specific test item. Investigation has been done on all the possible configurations for searching the worst cases. The following table is a list of the test modes shown in this test report.

Test Items	Mode	Data Rate	Channel
Maximum Peak Conducted Output Power Power Spectral Density 6dB Bandwidth 26dB Bandwidth Spurious RF conducted emission Radiated Emission 9kHz~1GHz& Radiated Emission 1GHz~10th Harmonic	11a/ OFDM	1 Mbps	36/40/44
	11ac /OFDM	6 Mbps	149/157/165
Band Edge	11a/ OFDM	1 Mbps	36/40/44
	11ac /OFDM	6 Mbps	149/157/165

3.6. 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 Global Test Service 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 Shenzhen GTS laboratory is reported:

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	30~1000MHz	4.10 dB	(1)
Radiated Emission	1~18GHz	4.32 dB	(1)
Radiated Emission	18-40GHz	5.54 dB	(1)
Conducted Disturbance	0.15~30MHz	3.12 dB	(1)

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

3.7. Equipments Used during the Test

Test Site 1

Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
Spectrum Analyzer	Agilent	N9020A	MY48010425	2016/06/17	2017/06/16
LISN	R&S	ENV216	3560.6550.08	2016/05/28	2017/05/27
LISN	R&S	ESH2-Z5	893606/008	2016/05/27	2017/05/26
EMI Test Receiver	R&S	ESCI	101102	2015/06/26	2016/06/25
EMC Test Software	R&S	ES-K1	N/A	N/A	N/A
RF Cable	H&S	N/A	N/A	2015/06/26	2016/06/25

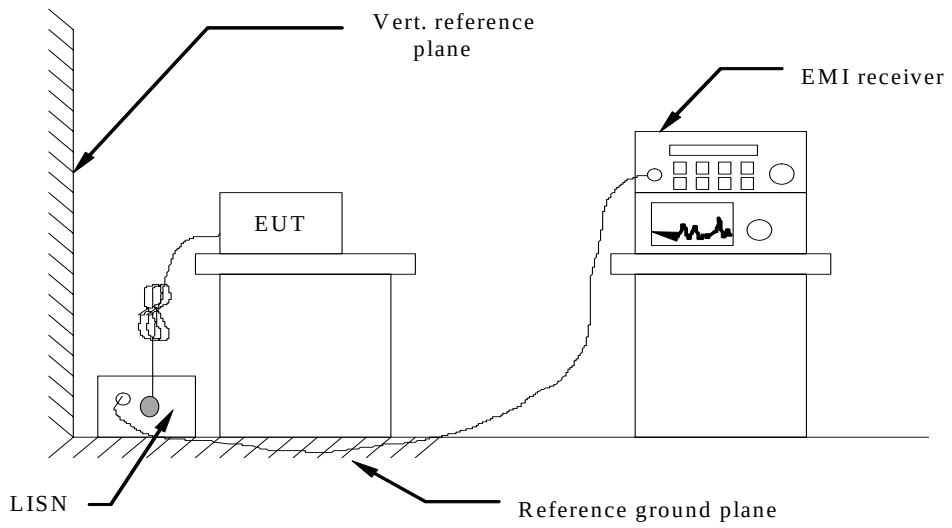
Test Site 2

Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
Bilog Antenna	Sunol Sciences Corp.	JB1	A061713	2016/06/02	2019/06/01
Controller	EM Electronics	Controller EM 1000	N/A	N/A	N/A
Horn Antenna	Sunol Sciences Corp.	DRH-118	A062013	2016/05/19	2019/05/18
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170219	2016/05/19	2019/05/18
Active Loop Antenna	SCHWARZBECK	FMZB1519	1519-037	2016/05/19	2019/05/18
EMC Test Software	R&S	ES-K1	N/A	N/A	N/A
Amplifier	Agilent	8349B	3008A02306	2016/05/19	2017/05/18
Amplifier	Agilent	8447D	2944A10176	2016/05/19	2017/05/18
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
Data acquisition card	Agilent	U2531A	TW53323507	2016/05/20	2017/05/19
Power Sensor	Agilent	U2021XA	MY5365004	2016/05/20	2017/05/19
RF Cable	H&S	RG214	N/A	2016/05/20	2017/05/19
EMI Test Receiver	R&S	ESCI	103710	2016/05/20	2017/05/19
Spectrum Analyzer	Agilent	N9020A	MY49100067	2016/05/20	2017/05/19

4. TEST CONDITIONS AND RESULTS

4.1. AC Power Conducted Emission

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 EUT received DC5V power, the adapter received AC120V/60Hz (AC 240V/50Hz) or DC 5.0V form USB to PC adapter power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5 All support equipments 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.

AC Power Conducted Emission Limit

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following：

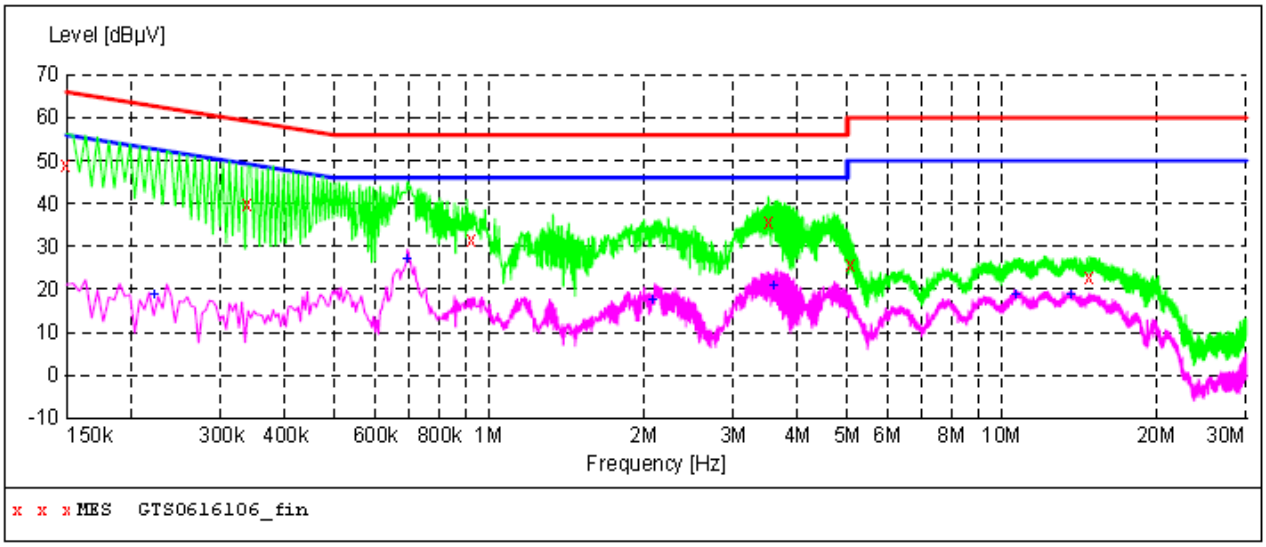
Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50
* Decreases with the logarithm of the frequency.		

TEST RESULTS

Remark:

1. We tested at AC power adapter charging and USB from PC charging mode, also at voltage AC 120V/60Hz and AC 240V/50Hz, recorded worst case.
2. We tested at WLAN Link mode for AC conducted emission

Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	L



MEASUREMENT RESULT: "GTS0616106_fin"

6/16/2016 10:20AM

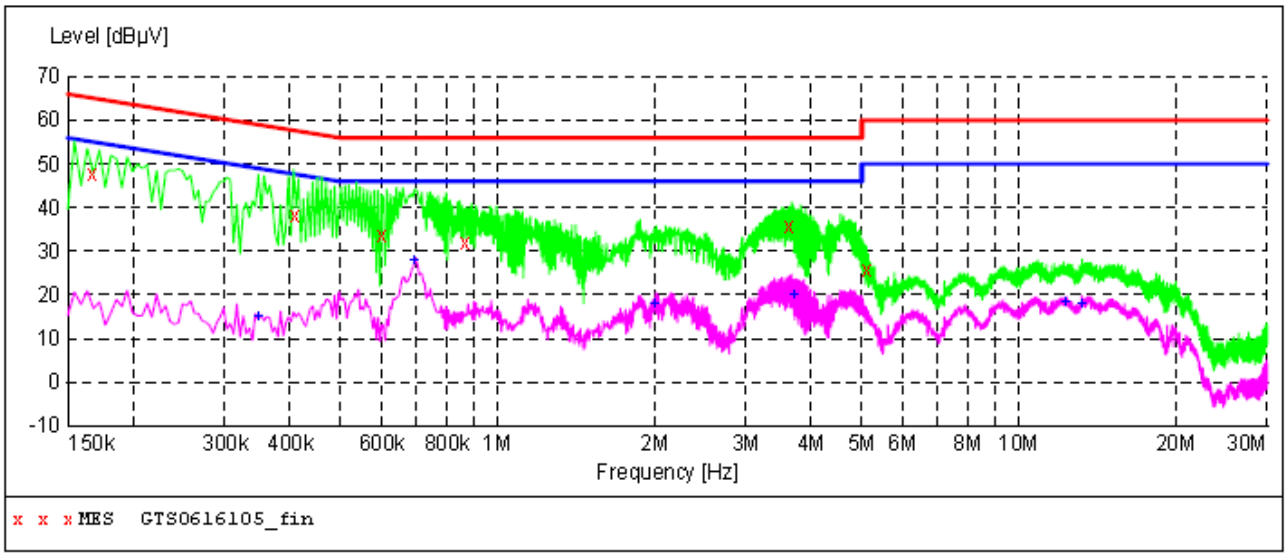
Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.150000	49.10	10.1	66	16.9	QP	L1	GND
0.339000	39.90	9.9	59	19.3	QP	L1	GND
0.924000	31.40	9.6	56	24.6	QP	L1	GND
3.516000	35.60	9.4	56	20.4	QP	L1	GND
5.100000	25.80	9.3	60	34.2	QP	L1	GND
14.856000	22.90	8.2	60	37.1	QP	L1	GND

MEASUREMENT RESULT: "GTS0616106_fin2"

6/16/2016 10:20AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.222000	18.80	10.0	53	33.9	AV	L1	GND
0.690000	27.20	9.7	46	18.8	AV	L1	GND
2.085000	17.50	9.5	46	28.5	AV	L1	GND
3.588000	21.00	9.4	46	25.0	AV	L1	GND
10.608000	18.70	8.8	50	31.3	AV	L1	GND
13.681500	18.70	8.3	50	31.3	AV	L1	GND

Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	N



MEASUREMENT RESULT: "GTS0616105_fin"

6/16/2016 10:17AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.168000	47.60	10.0	65	17.5	QP	N	GND
0.411000	38.10	9.8	58	19.5	QP	N	GND
0.600000	33.80	9.7	56	22.2	QP	N	GND
0.870000	32.00	9.6	56	24.0	QP	N	GND
3.624000	35.90	9.4	56	20.1	QP	N	GND
5.109000	25.70	9.3	60	34.3	QP	N	GND

MEASUREMENT RESULT: "GTS0616105_fin2"

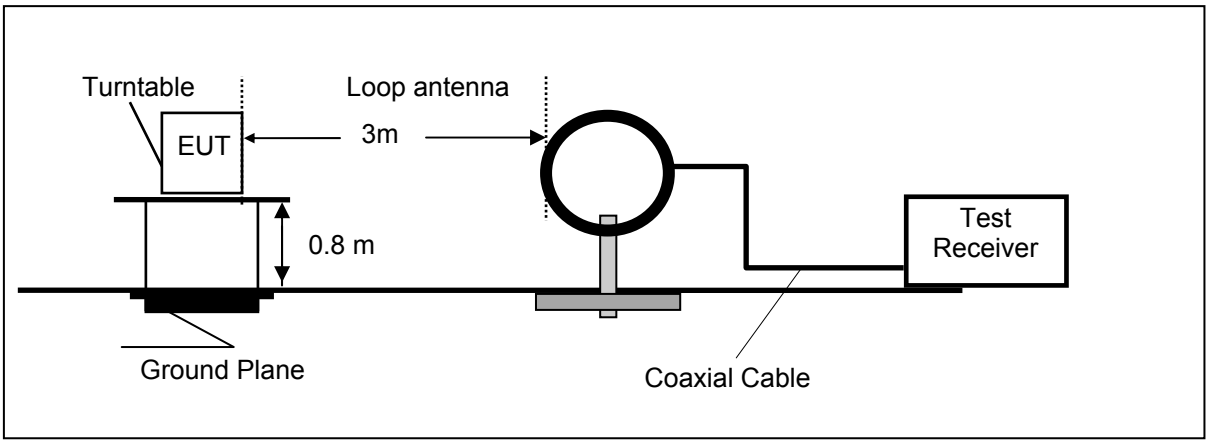
6/16/2016 10:17AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.348000	14.80	9.9	49	34.2	AV	N	GND
0.694500	27.80	9.7	46	18.2	AV	N	GND
1.999500	18.10	9.5	46	27.9	AV	N	GND
3.705000	20.10	9.4	46	25.9	AV	N	GND
12.322500	18.40	8.5	50	31.6	AV	N	GND
13.240500	18.10	8.4	50	31.9	AV	N	GND

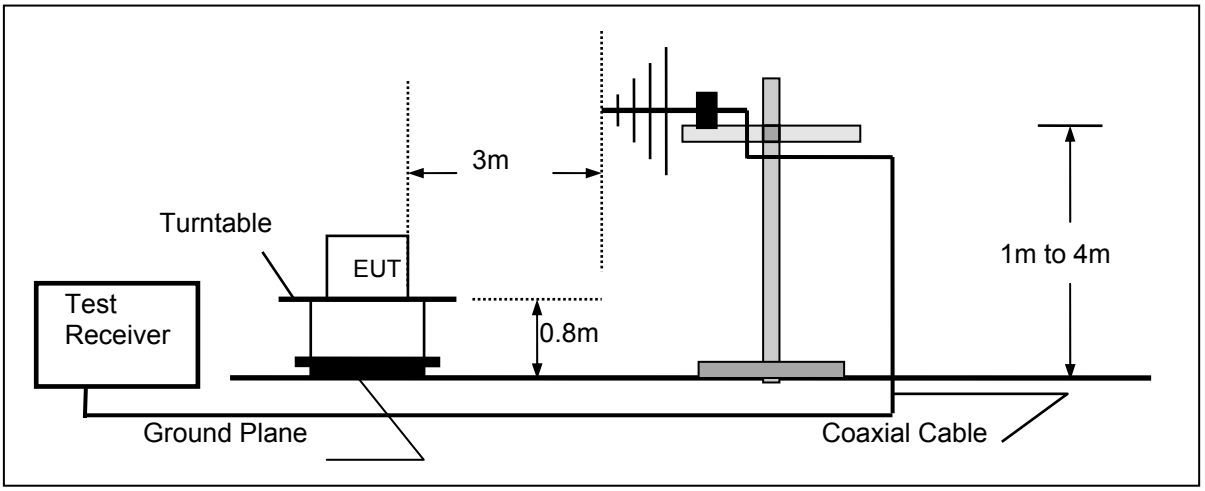
4.2. Radiated Emission

TEST CONFIGURATION

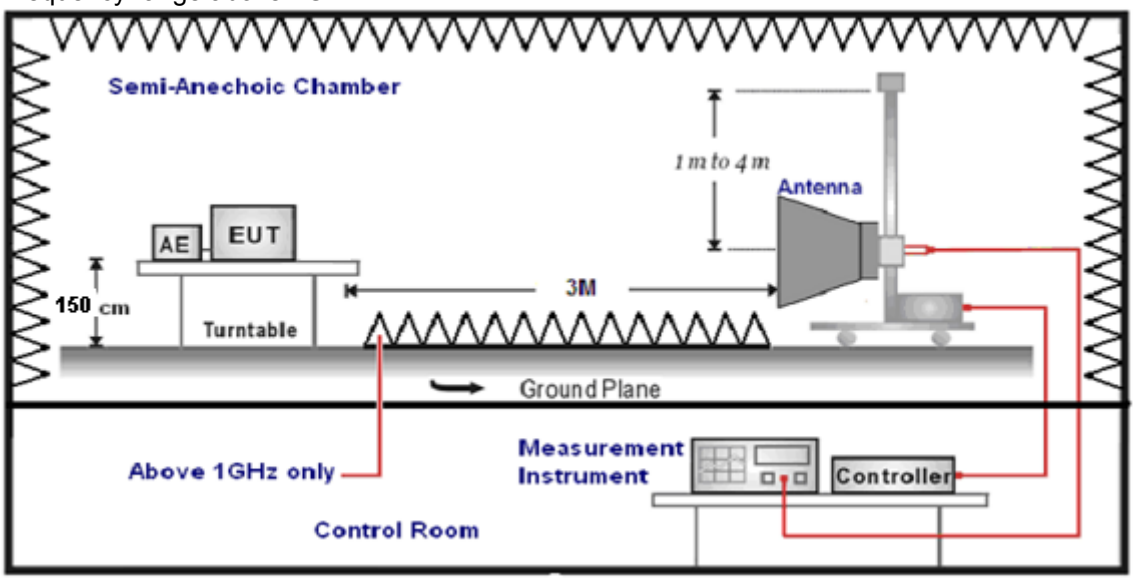
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz



TEST PROCEDURE

1. The EUT was placed on a turn table which is 0.8m above ground plane when testing frequency range 9 KHz –1GHz;the EUT was placed on a turn table which is 1.5m above ground plane when testing frequency range 1GHz – 40GHz.

2. 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.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. The EUT minimum operation frequency was 32.768KHz and maximum operation frequency was 5850MHz.so radiated emission test frequency band from 9KHz to 40GHz.

a) 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	Ultra-Broadband Antenna	3
1GHz-18GHz	Double Ridged Horn Antenna	3
18GHz-40GHz	Horn Anternna	1

b) 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
150KHz-30MHz	RBW=9KHz/VBW=100KHz,Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz,Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

More procudre 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

RADIATION LIMIT

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission out of authorized band shall not exceed the following table at a 3 meters measurement distance.
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)

The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

Frequency (MHz)	Distance (Meters)	Radiated (dBµV/m)	Radiated (µV/m)
0.009-0.49	300	20log(2400/F(KHz))+80	2400/F(KHz)
0.49-1.705	30	20log(24000/F(KHz))+40	24000/F(KHz)
1.705-30	30	20log(30)+40	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 RESULTS

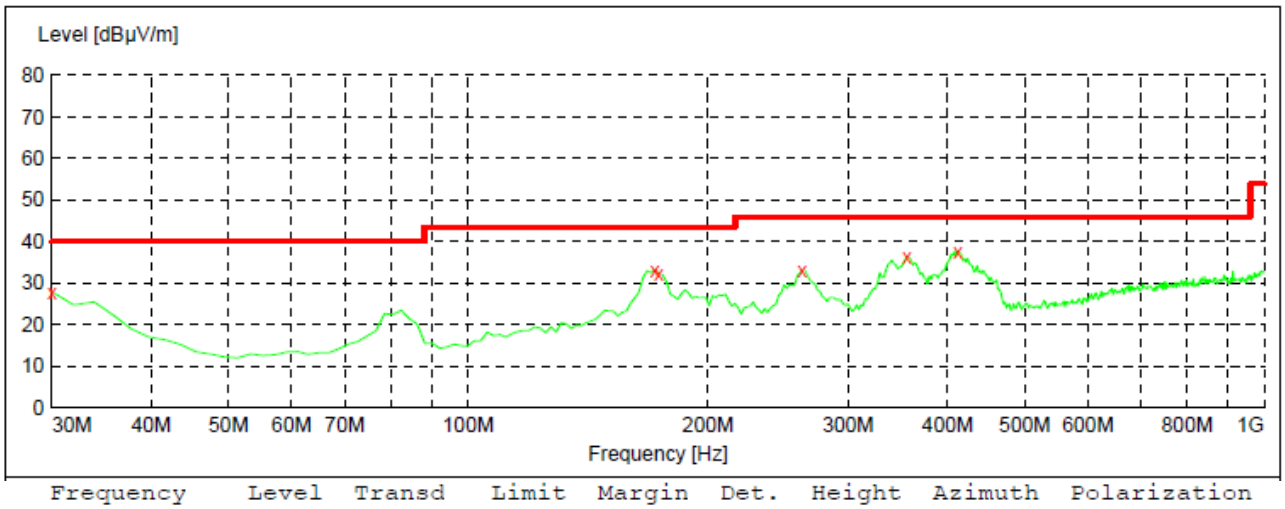
Remark: 1. We tested three positions and recorded worst case.
2. We tested WLAN IEEE 802.11a Link mode for below 1G;
3. Over Limit = Emission level - Limit value
4. "---" states emission level at least lower than limit 20dB, so without recorded any values;
5. The radiated measurement are performed the each channel (low/mid/high), the datum recorded below is the worst case for all test channels.
6. We tested both battery powered and powered by adapter charging mode at three orientate ons, recorded worst case at powered by adapter charging mode.

For 9 KHz-30MHz

Frequency (MHz)	Corrected Reading (dBuV/m)@3m	FCC Limit (dBuV/m) @3m	Margin (dB)	Detector	Result
0.36	50.24	96.48	46.24	QP	PASS
1.65	44.32	63.25	18.93	QP	PASS
20.51	43.65	69.54	25.89	QP	PASS
25.77	44.21	69.54	25.33	QP	PASS

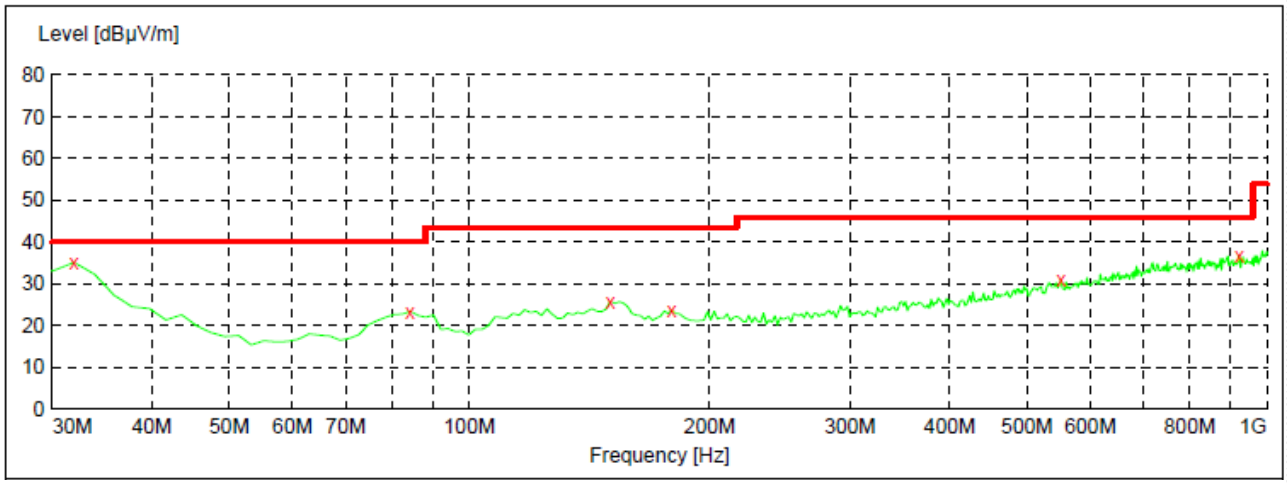
For 30MHz-1GHz

Horizontal



Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
30.000000	27.90	20.8	40.0	12.1	PK	100	58.0	HORIZONTAL
171.620000	33.20	13.1	43.5	10.3	PK	100	114.0	HORIZONTAL
173.560000	32.30	13.0	43.5	11.2	PK	100	157.0	HORIZONTAL
262.800000	33.10	14.8	46.0	12.9	PK	300	203.0	HORIZONTAL
355.920000	36.40	17.0	46.0	9.6	PK	300	228.0	HORIZONTAL
412.180000	37.70	18.4	46.0	8.3	PK	300	285.0	HORIZONTAL

Vertical



Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
31.940000	35.10	19.2	40.0	4.9	PK	100	121.0	VERTICAL
84.320000	23.40	8.8	40.0	16.6	PK	100	155.0	VERTICAL
150.280000	25.80	13.8	43.5	17.7	PK	100	186.0	VERTICAL
179.380000	23.70	13.0	43.5	19.8	PK	300	221.0	VERTICAL
551.860000	30.80	21.0	46.0	15.2	PK	300	269.0	VERTICAL
922.400000	36.80	26.2	46.0	9.2	PK	300	334.0	VERTICAL

For 1GHz to 40GHz

802.11a Mode_Channel 36 _5180 MHz

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	10360	34.19	38.55	33.64	11.24	50.34	74.00	23.66	Peak	Horizontal
1	15540	27.57	36.49	36.53	13.72	41.25	54.00	12.75	AV	Horizontal
2	10360	36.23	38.55	33.64	11.24	52.38	74.00	21.64	Peak	Horizontal
2	15540	28.45	36.49	36.53	13.72	42.13	54.00	11.87	AV	Horizontal

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	10360	34.94	38.55	33.64	11.24	51.09	74.00	22.91	Peak	Vertical
1	15540	27.71	36.49	36.53	13.72	41.39	54.00	12.61	AV	Vertical
2	10360	36.31	38.55	33.64	11.24	52.46	74.00	21.54	Peak	Vertical
2	15540	28.68	36.49	36.53	13.72	42.36	54.00	11.64	AV	Vertical

802.11a Mode_Channel 40 _ 5200 MHz

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	10400	34.14	38.55	33.64	11.36	50.41	74.00	23.59	Peak	Horizontal
1	15600	28.75	36.49	36.53	13.91	42.62	54.00	11.38	AV	Horizontal
2	10400	35.05	38.55	33.64	11.36	51.32	74.00	22.68	Peak	Horizontal
2	15600	28.79	36.49	36.53	13.91	42.66	54.00	11.34	AV	Horizontal

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	10400	35.45	38.55	33.64	11.36	51.72	74.00	22.28	Peak	Vertical
1	15600	28.77	36.49	36.53	13.91	42.64	54.00	11.36	AV	Vertical
2	10400	36.65	38.55	33.64	11.36	52.92	74.00	21.08	Peak	Vertical
2	15600	28.66	36.49	36.53	13.91	42.53	54.00	11.47	AV	Vertical

802.11a Mode_ Channel 48_ 5240 MHz

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	10480	34.91	38.55	33.64	11.41	51.23	74.00	22.77	Peak	Horizontal
1	15720	27.98	36.49	36.53	13.98	41.92	54.00	12.08	AV	Horizontal
2	10480	37.36	38.55	33.64	11.41	53.68	74.00	20.32	Peak	Horizontal
2	15720	27.27	36.49	36.53	13.98	41.21	54.00	12.79	AV	Horizontal

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	10480	35.74	38.55	33.64	11.41	52.06	74.00	21.94	Peak	Vertical
1	15720	24.33	36.49	36.53	13.98	40.33	54.00	13.67	AV	Vertical
2	10480	34.94	38.55	33.64	11.41	51.26	74.00	22.74	Peak	Vertical
2	15720	27.23	36.49	36.53	13.98	41.17	54.00	12.83	AV	Vertical

802.11a Mode_Channel 149_ 5745 MHz

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	11490	36.23	38.46	33.92	11.59	52.36	74.00	21.64	Peak	Horizontal
1	17235	21.33	43.11	37.11	13.94	41.27	54.00	12.73	AV	Horizontal
2	11490	35.59	38.46	33.92	11.59	51.72	74.00	22.28	Peak	Horizontal
2	17235	20.73	43.11	37.11	13.94	40.67	54.00	13.33	AV[J]	Horizontal

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	11490	36.16	38.46	33.92	11.59	52.29	74.00	21.71	Peak	Vertical
1	17235	20.28	43.11	37.11	13.94	40.22	54.00	13.78	AV	Vertical
2	11490	35.31	38.46	33.92	11.59	51.44	74.00	22.56	Peak	Vertical
2	17235	21.87	43.11	37.11	13.94	41.81	54.00	12.19	AV	Vertical

802.11a Mode_Channel 157_5785 MHz

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	11570	35.42	38.46	33.92	11.66	51.62	74.00	22.38	Peak	Horizontal
1	17355	21.37	43.11	37.11	14.02	41.39	54.00	12.61	AV	Horizontal
2	11570	36.59	38.46	33.92	11.66	52.79	74.00	21.21	Peak	Horizontal
2	17355	22.04	43.11	37.11	14.02	42.06	54.00	11.94	AV	Horizontal

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	11570	34.77	38.46	33.92	11.66	50.97	74.00	23.03	Peak	Vertical
1	17355	20.74	43.11	37.11	14.02	40.76	54.00	13.24	AV	Vertical
2	11570	35.09	38.46	33.92	11.66	51.29	74.00	22.71	Peak	Vertical
2	17355	22.94	43.11	37.11	14.02	42.96	54.00	11.04	AV	Vertical

802.11a Mode_Channel 165_5825 MHz

Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	11650	35.58	38.46	33.92	11.71	51.83	74.00	22.17	Peak	Horizontal
1	17475	21.28	43.11	37.11	14.18	41.68	54.00	12.32	AV	Horizontal
2	11650	35.24	38.46	33.92	11.71	51.49	74.00	22.51	Peak	Horizontal
2	17475	21.18	43.11	37.11	14.18	41.36	54.00	12.64	AV	Horizontal

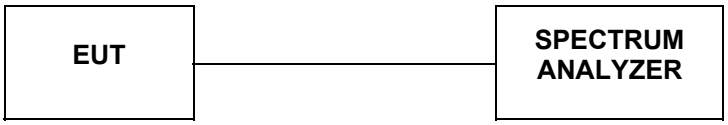
Item (Mark)	Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	11650	36.31	38.55	33.64	11.71	52.93	74.00	21.07	Peak	Vertical
1	17475	29.43	36.49	36.53	14.18	43.57	54.00	10.43	AV	Vertical
2	11650	26.95	38.55	33.64	11.71	51.64	74.00	22.36	Peak	Vertical
2	17475	27.25	36.49	36.53	14.18	41.39	54.00	12.61	AV	Vertical

REMARKS:

1. Result Level = Read Level + Antenna Factor + Cable loss - PRM Factor.
2. The other emission levels were very low against the limit.
3. The average measurement was not performed when the peak measured data under the limit of average detection.
4. Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=10Hz/Sweep time=Auto/Detector=Peak;

4.3. Duty Cycle

TEST CONFIGURATION



TEST PROCEDURE

According to KDB789033 D02 General UNII Test Procedures New Rules v01 B Duty Cycle (x), Transmission Duration (T):

a. A diode detector and an oscilloscope that together have sufficiently short response time to permit accurate measurements of the on and off times of the transmitted signal
b. The zero-span mode on a spectrum analyzer or EMI receiver, if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ EBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zerospan measurement method shall not be used unless both RBW and VBW are > 50/T, where T is defined in section II.B.1.a), and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

TEST RESULTS

For UNII-1 Band

802.11a Test Mode

Channel	Frequency (MHz)	Duty Cycle	Duty factor (dB)
36	5180	0.988	0.052
40	5200	0.986	0.061
48	5240	0.987	0.057

802.11ac Test Mode

Channel	Frequency (MHz)	Duty Cycle	Duty factor (dB)
36	5180	0.986	0.061
40	5200	0.985	0.066
48	5240	0.985	0.066

For UNII-3 Band

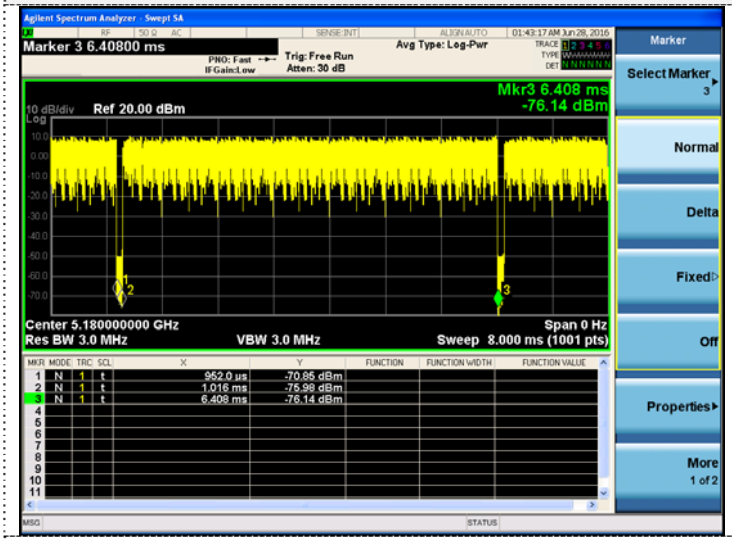
802.11a Test Mode

Channel	Frequency (MHz)	Duty Cycle	Duty factor (dB)
149	5745	0.985	0.066
157	5785	0.982	0.079
165	5825	0.981	0.083

802.11ac Test Mode

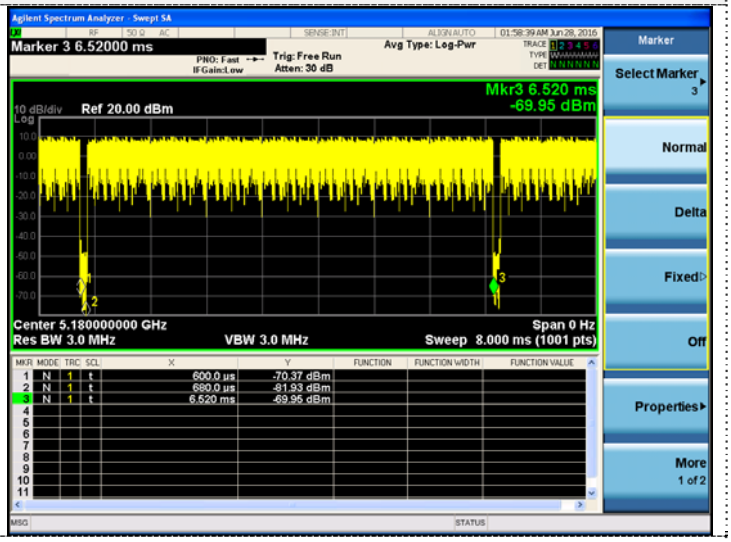
Channel	Frequency (MHz)	Duty Cycle	Duty factor (dB)
149	5745	0.982	0.079
157	5785	0.987	0.057
165	5825	0.986	0.061

802.11a

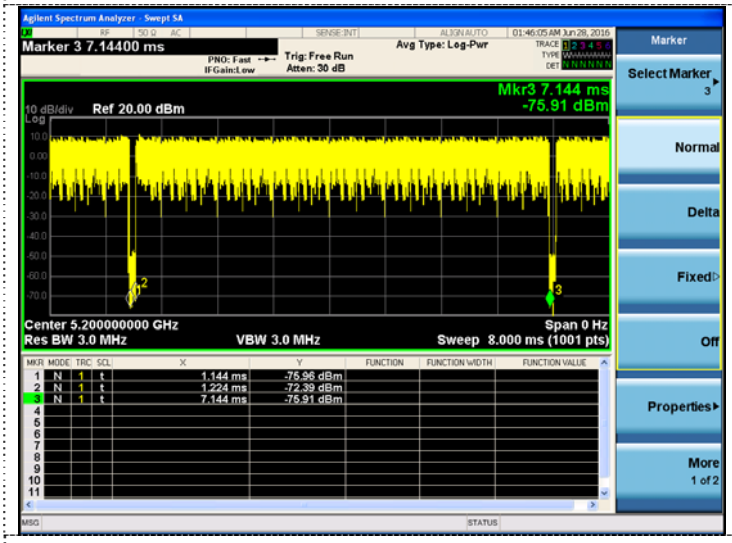


5180 MHz

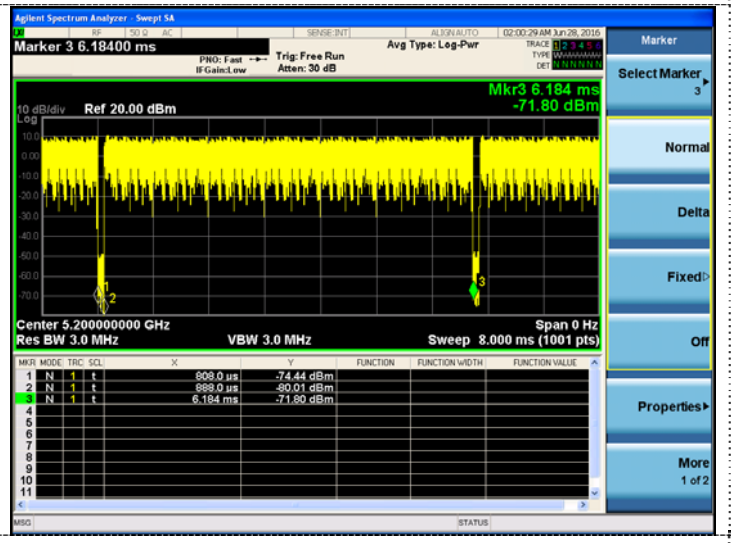
802.11ac



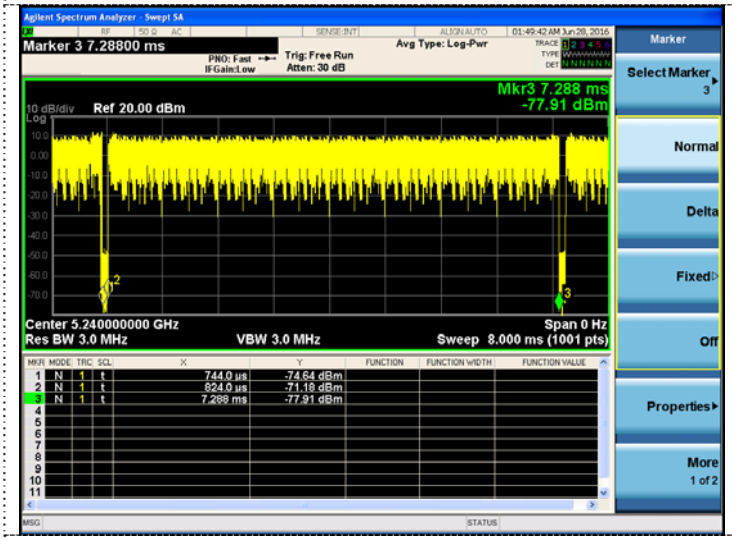
5180 MHz



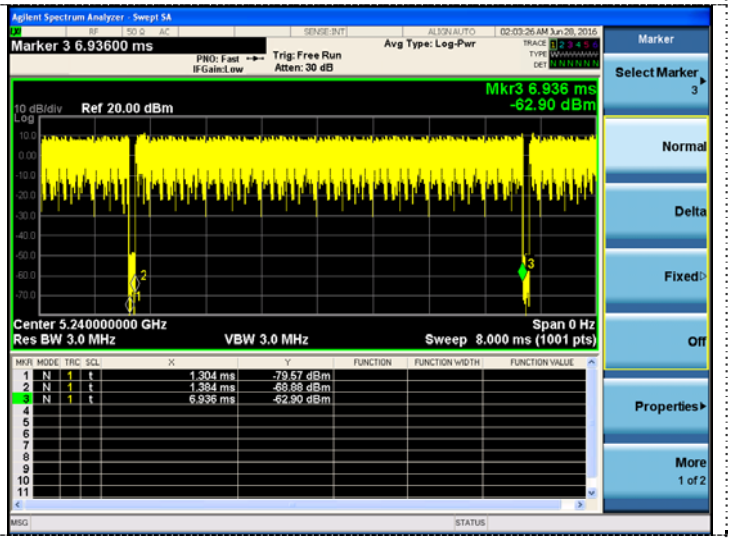
5200 MHz



5200 MHz

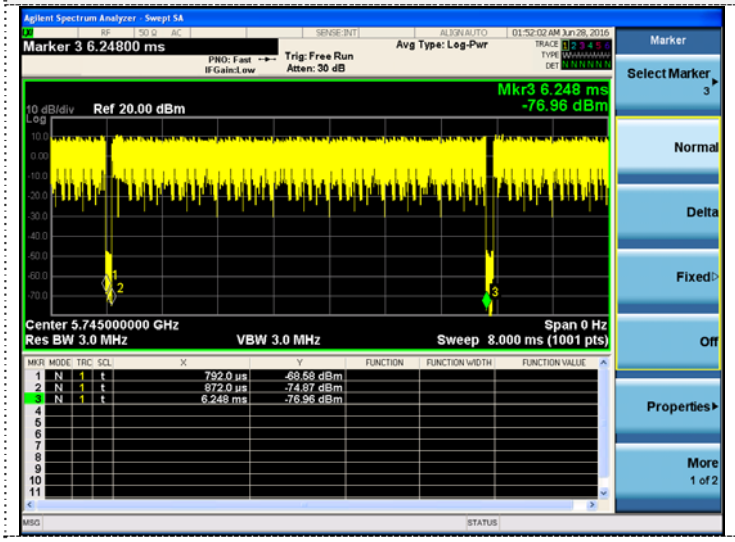


5240 MHz



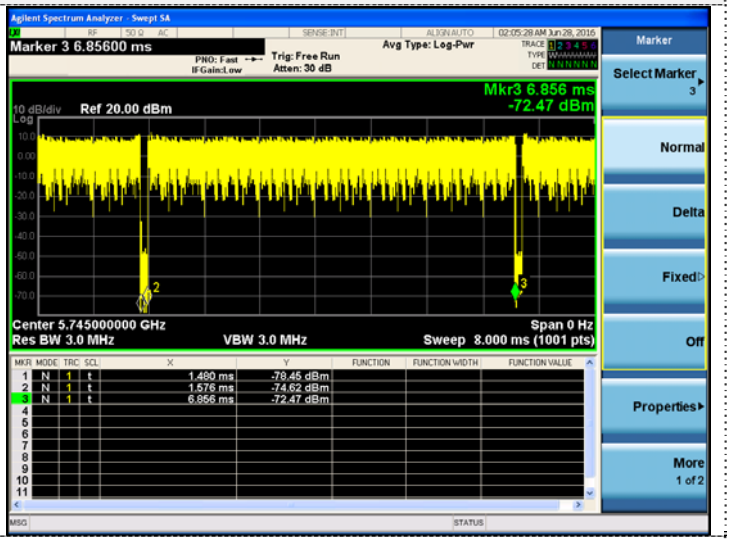
5240 MHz

802.11a

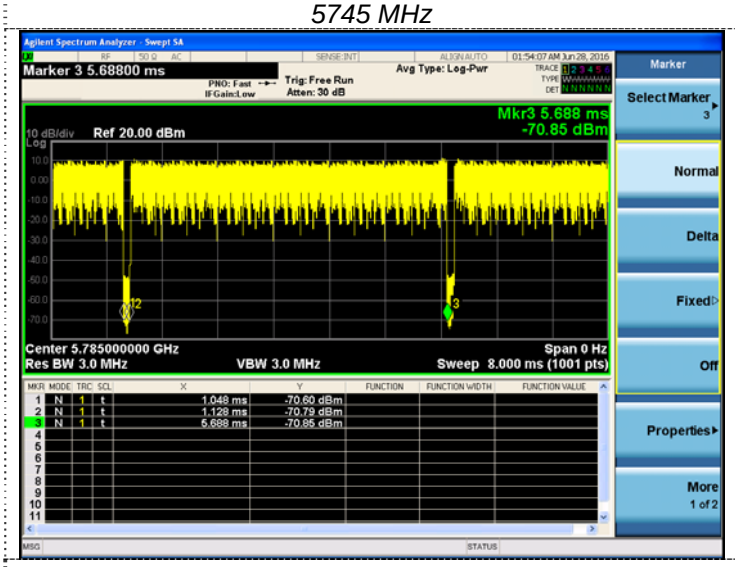


5745 MHz

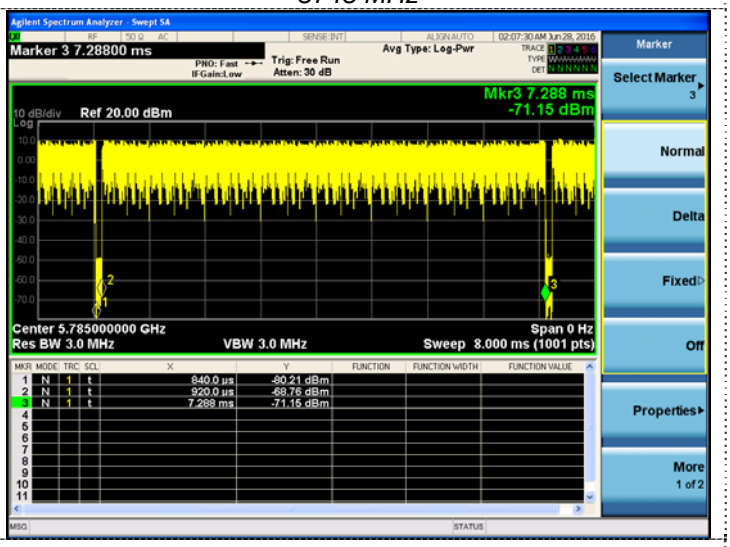
802.11ac



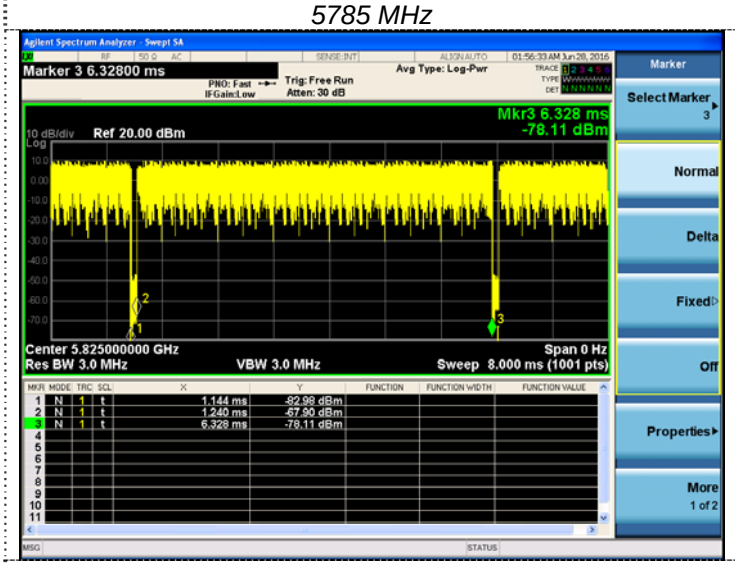
5745 MHz



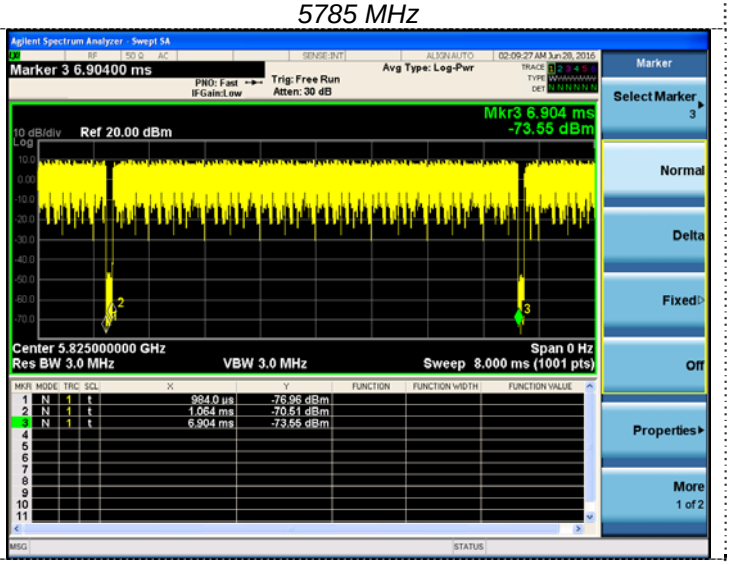
5785 MHz



5785 MHz



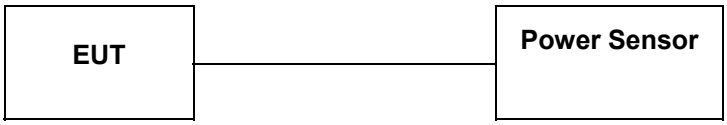
5825 MHz



5825 MHz

4.4. Maximum Average Output Power

TEST CONFIGURATION



TEST PROCEDURE

According to KDB789033 D02 General UNII Test Procedures New Rules v01 Section E3 Measurement using a Power Meter (PM):

a. Measurements may be performed using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied
   1. The EUT is configured to transmit continuously or to transmit with a constant duty cycle
   2. At all times when the EUT is transmitting, it must be transmitting at its maximum power control level.
   3. The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.
b. If the transmitter does not transmit continuously, measure the duty cycle, x, of the transmitter output signal as described in section II.B
c. Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.

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 percent).

LIMIT

According to §15.407(a): The maximum output power should be not exceed follow:

Frequency Range (MHz)	Limit
5150-5250	Fixed:1 Watt (30dBm) Mobile and portable: 250mW (24dBm)
5250-5350	250mW (24dBm)
5470-5725	250mW (24dBm)
5725-5850	1 Watt (30dBm)
Note: The maximum e.i.r.p at anyelevation angle above 30 degrees as measured from the horizon must not exceed 125mW(21dBm)	

TEST RESULTS

For UNII-1 Band

802.11a Test Mode

Channel	Frequency (MHz)	Output Power PK (dBm)	Output Power AV (dBm)	Duty factor (dB)	Output Power AV + Duty factor (dBm)	Limits (dBm)	Verdict
36	5180	9.34	6.01	0.052	6.062	24.00	PASS
40	5200	9.53	6.34	0.061	6.401	24.00	PASS
48	5240	9.25	6.22	0.057	6.277	24.00	PASS

802.11ac Test Mode

Channel	Frequency (MHz)	Output Power PK (dBm)	Output Power AV (dBm)	Duty factor (dB)	Output Power AV+ Duty factor (dBm)	Limits (dBm)	Verdict
36	5180	9.55	6.61	0.061	6.671	24.00	PASS
40	5200	9.04	6.12	0.066	6.186	24.00	PASS
48	5240	9.62	6.54	0.066	6.606	24.00	PASS

For UNII-3 Band

802.11a Test Mode

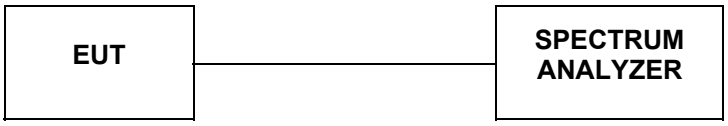
Channel	Frequency (MHz)	Output Power PK (dBm)	Output Power AV (dBm)	Duty factor (dB)	Output Power AV+ Duty factor (dBm)	Limits (dBm)	Verdict
149	5745	9.11	6.35	0.066	6.416	30.00	PASS
157	5785	9.78	6.32	0.079	6.399	30.00	PASS
165	5825	9.66	6.49	0.083	6.573	30.00	PASS

802.11ac Test Mode

Channel	Frequency (MHz)	Output Power PK (dBm)	Output Power AV (dBm)	Duty factor (dB)	Output Power AV+ Duty factor (dBm)	Limits (dBm)	Verdict
149	5745	9.21	6.06	0.079	6.139	30.00	PASS
157	5785	9.69	6.89	0.057	6.947	30.00	PASS
165	5825	9.51	6.47	0.061	6.531	30.00	PASS

4.5. Power Spectral Density

TEST CONFIGURATION



TEST PROCEDURE

According to KDB 789033 D02 General UNII Test Procedures New Rules v01 F: The rules requires "maximum power spectral density" measurements where the intent is to measure the maximum value of the time average of the power spectral density measured during a period of continuous transmission

a. Create an average power spectrum for the EUT operating mode being tested by following the instructions in section II.E.2. for measuring maximum conducted output power using a spectrum analyzer or EMI receiver: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, "Compute power…". (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)
b. Use the peak search function on the instrument to find the peak of the spectrum and record its value.
c. Make the following adjustments to the peak value of the spectrum, if applicable:
   1. If Method SA-2 or SA-2 Alternative was used, add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.
   2.) If Method SA-3 Alternative was used and the linear mode was used in step II.E.2.g)(viii), add 1 dB to the final result to compensate for the difference between linear averaging and power averaging.
d. The result is the Maximum PSD over 1 MHz reference bandwidth.
e. For devices operating in the bands 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.47-5.725 GHz, the above procedures make use of 1 MHz RBW to satisfy directly the 1 MHz reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 GHz, the rules specify a measurement bandwidth of 500 kHz. Many spectrum analyzers do not have 500 kHz RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 MHz, or 500 kHz, "provided that the measured power is integrated over the full reference bandwidth" to show the total power over the specified measurement bandwidth (i.e., 1 MHz, or 500 kHz). If measurements are performed using a reduced resolution bandwidth (< 1 MHz, or < 500 kHz) and integrated over 1 MHz, or 500 KHz bandwidth, the following adjustments to the procedures apply:
   1. Set RBW ≥ 1/T, where T is defined in section II.B.I.a).
   2. Set VBW ≥ 3 RBW.
   3. If measurement bandwidth of Maximum PSD is specified in 500 kHz, add 10log(500kHz/RBW) to the measured result, whereas RBW (< 500 KHz) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
   4. If measurement bandwidth of Maximum PSD is specified in 1 MHz, add 10log(1MHz/RBW) to the measured result, whereas RBW (< 1 MHz) is the reduced resolution bandwidth of spectrum analyzer set during measurement.
   5. Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

   Note: As a practical matter, it is recommended to use reduced RBW of 100 KHz for the sections 5.c) and 5.d) above, since RBW=100 KHz is available on nearly all spectrum analyzers.
f. 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 percent).

LIMIT

According to §15.407(a): The maximum output power should be not exceed follow:

Frequency Range (MHz)	Limit
5150-5250	Other then Mobile and portable:17dBm/MHz Mobile and portable:11dBm/MHz
5250-5350	11dBm/MHz
5470-5725	11dBm/MHz
5725-5850	30dBm/500kHz

TEST RESULTS

For UNII-1 Band

802.11a Test Mode

Channel	Frequency (MHz)	Report PSD (dBm/1MHz)	Duty factor (dB)	RBW factor (dB)	Report PSD+ Duty factor+ RBW factor (dBm/1MHz)	Limits (dBm/1MHz)	Verdict
36	5180	6.728	0.052	0.00	6.780	11	PASS
40	5200	7.014	0.061	0.00	7.075	11	PASS
48	5240	7.868	0.057	0.00	7.925	11	PASS

802.11ac Test Mode

Channel	Frequency (MHz)	Report PSD (dBm/1MHz)	Duty factor (dB)	RBW factor (dB)	Report PSD+ Duty factor+ RBW factor (dBm/1MHz)	Limits (dBm/1MHz)	Verdict
36	5180	6.517	0.061	0.00	6.578	11	PASS
40	5200	7.030	0.066	0.00	7.096	11	PASS
48	5240	7.428	0.066	0.00	7.494	11	PASS

For UNII-3 Band

802.11a Test Mode

Channel	Frequency (MHz)	Report PSD (dBm/100KHz)	Duty factor (dB)	RBW factor (dB)	Report PSD+ Duty factor+ RBW factor (dBm/500kHz)	Limits (dBm/500kHz)	Verdict
149	5745	-6.210	0.066	6.99	0.845	30	PASS
157	5785	-5.786	0.079	6.99	1.125	30	PASS
165	5825	-5.231	0.083	6.99	1.842	30	PASS

802.11ac Test Mode

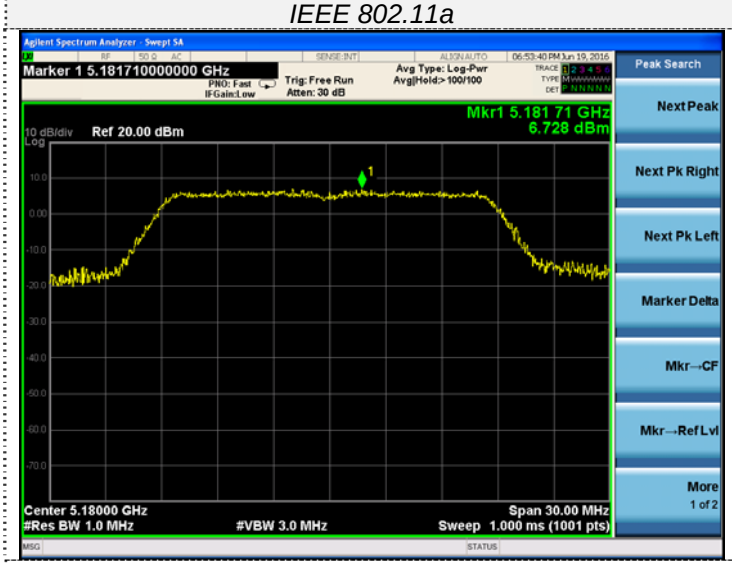
Channel	Frequency (MHz)	Report PSD (dBm/100KHz)	Duty factor (dB)	RBW factor (dB)	Report PSD+ Duty factor+ RBW factor (dBm/500kHz)	Limits (dBm/500kHz)	Verdict
149	5745	-6.301	0.079	6.99	0.768	30	PASS
157	5785	-5.777	0.057	6.99	1.270	30	PASS
165	5825	-5.105	0.061	6.99	1.946	30	PASS

Remark:

1. *Measured output power at difference data rate for each mode and recorded woest case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 6Mbps at IEEE 802.11 a; 6Mbps at IEEE 802.11 ac;*
4. *please refer to following plots;*

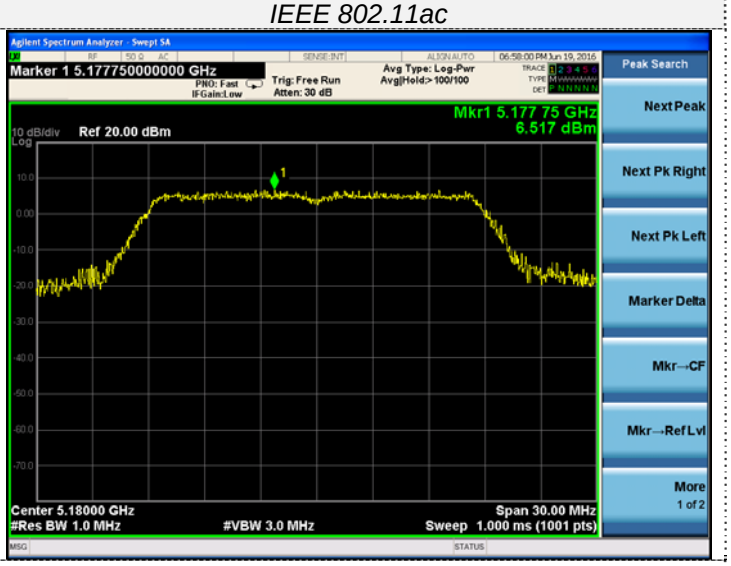
Power Spectral Density

IEEE 802.11a

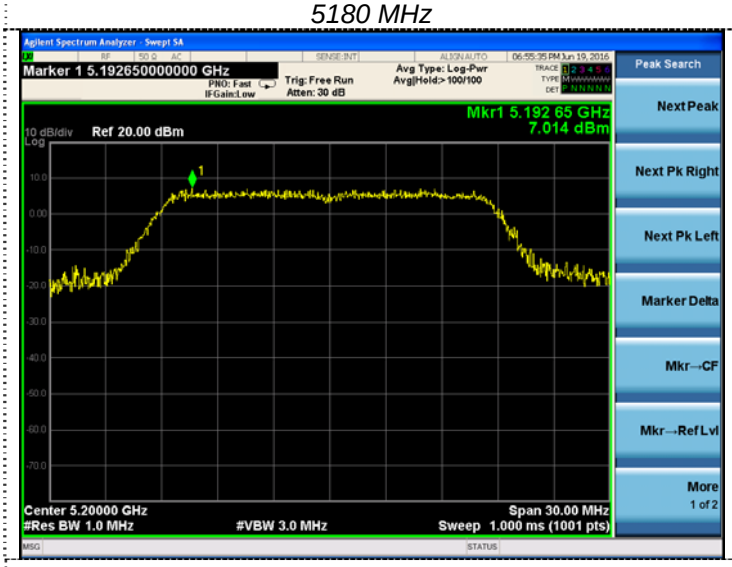


5180 MHz

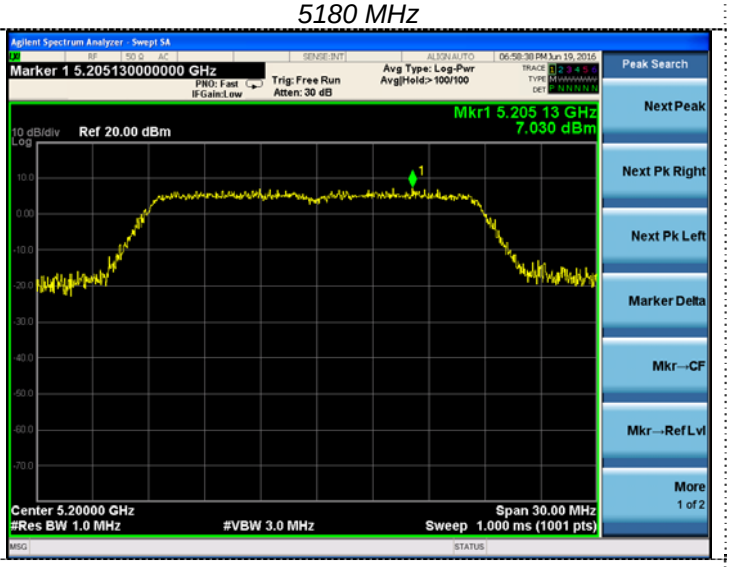
IEEE 802.11ac



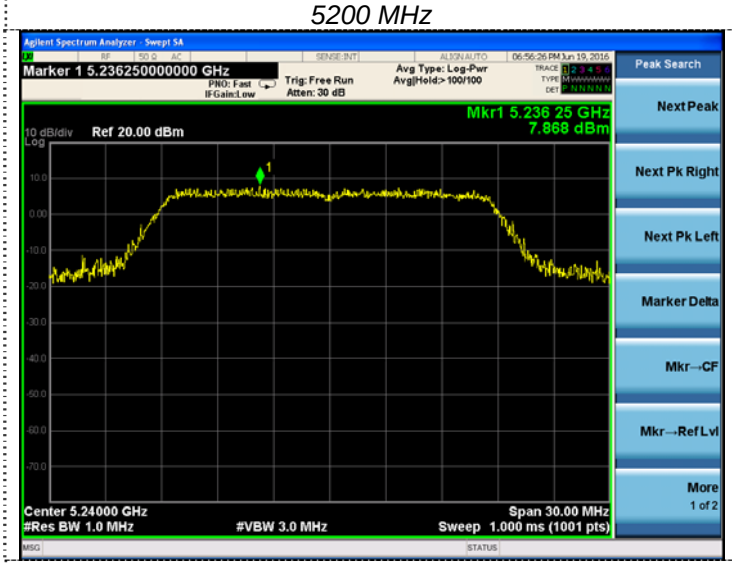
5180 MHz



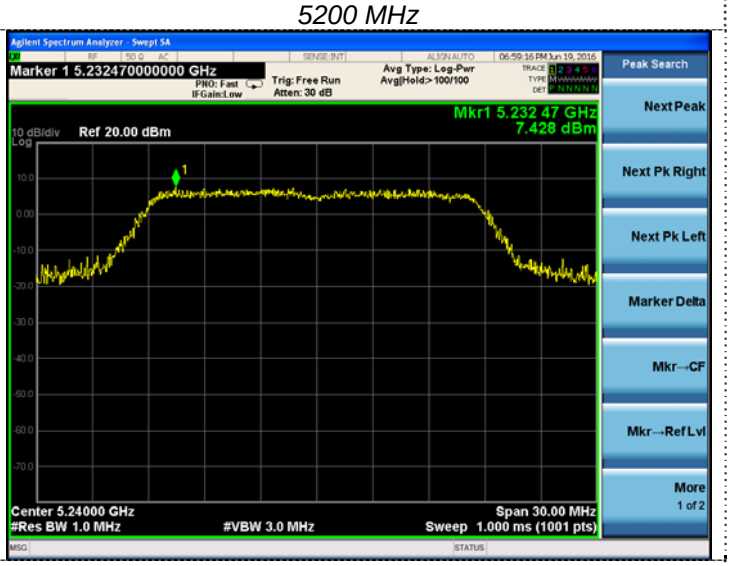
5200 MHz



5200 MHz



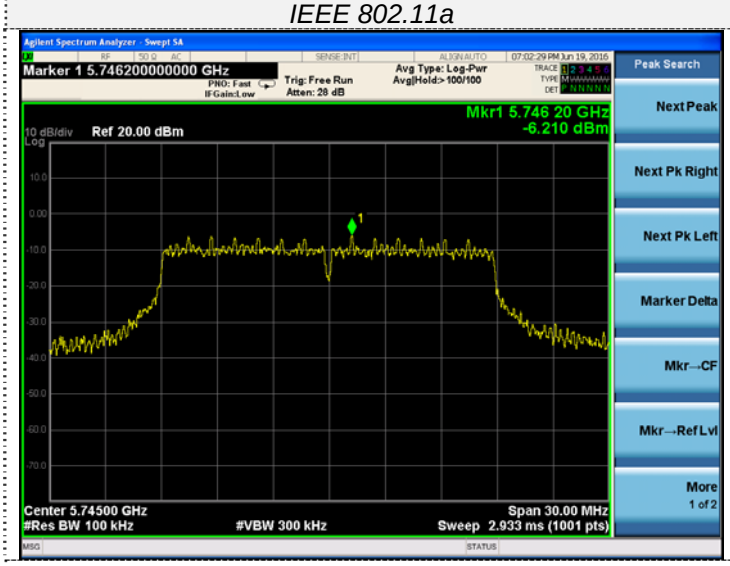
5240 MHz



5240 MHz

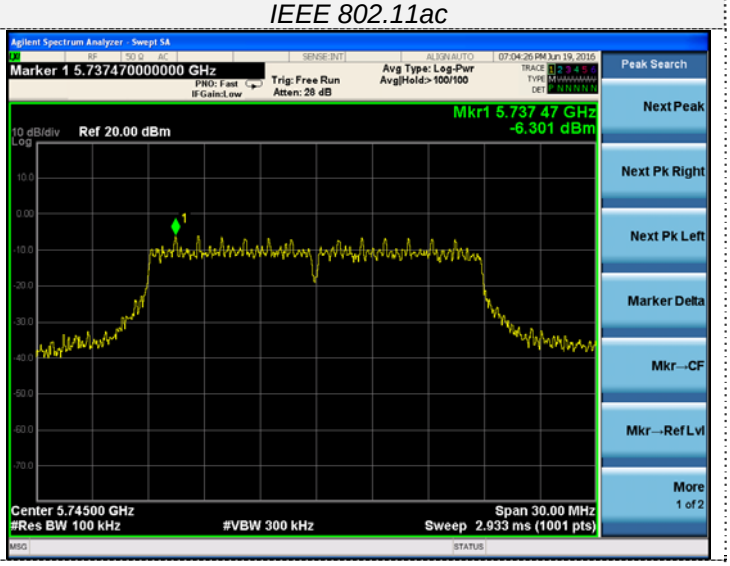
Power Spectral Density

IEEE 802.11a

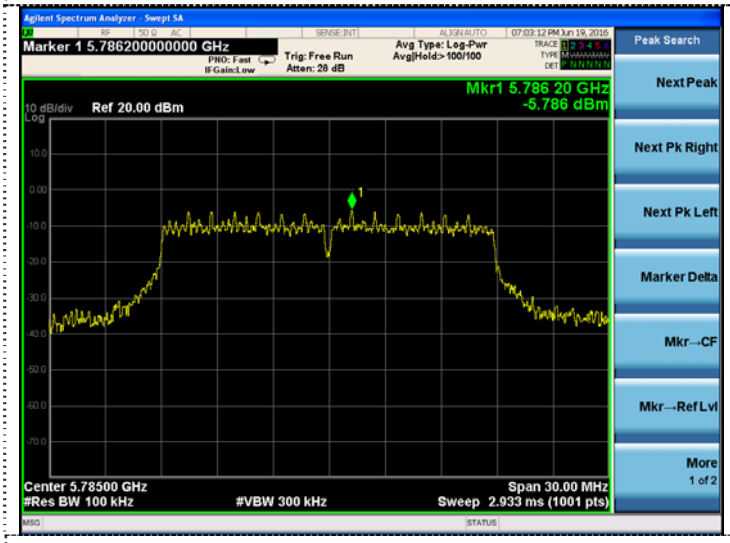


5745 MHz

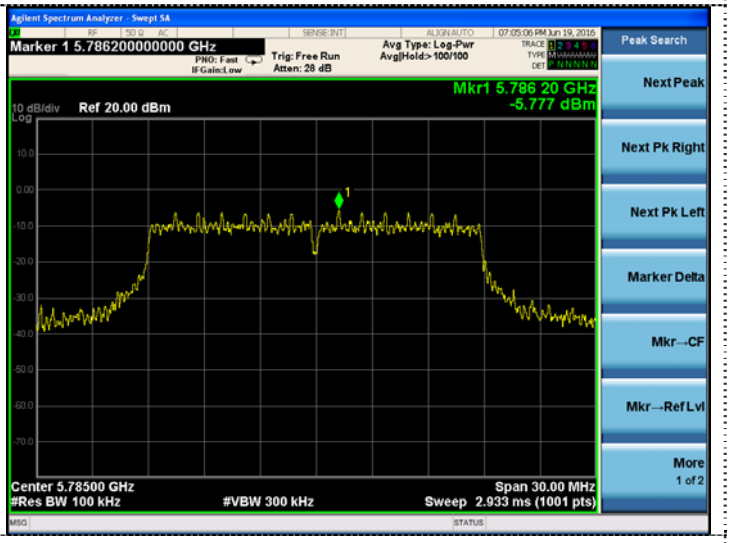
IEEE 802.11ac



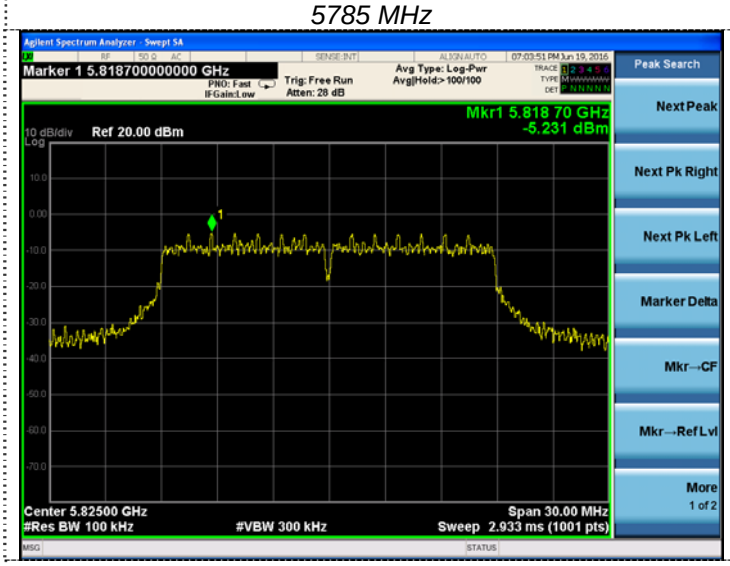
5745 MHz



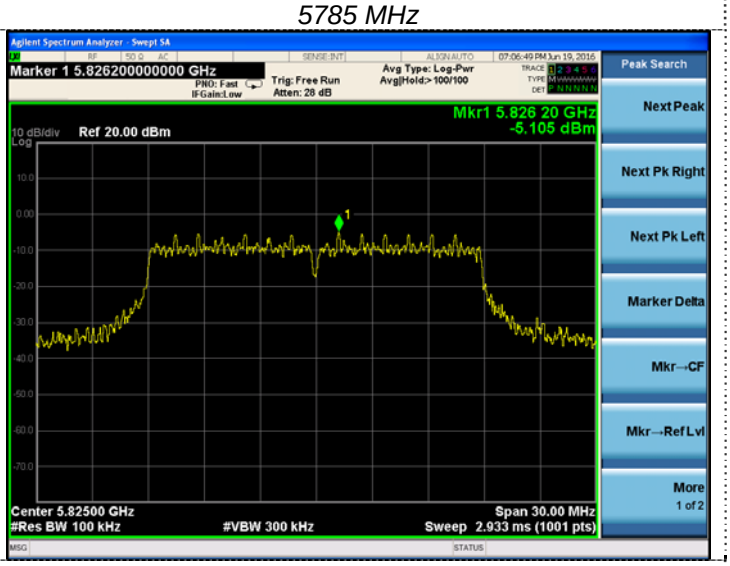
5785 MHz



5785 MHz



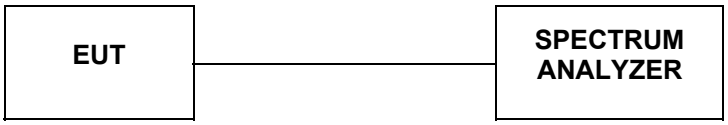
5825 MHz



5825 MHz

4.6. 6dB Bandwidth

TEST CONFIGURATION



TEST PROCEDURE

According to KDB789033 D02 General UNII Test Procedures New Rules v01 for one of the following procedures may be used for section 15.407(e) specifies the minimum 6 dB emission bandwidth of at least 500 KHz for the band 5.715-5.85 GHz. The following procedure shall be used for measuring this bandwidth:

a. Set RBW = 100 kHz.
b. Set the video bandwidth (VBW) ≥ 3 × RBW
c. Detector = Peak.
d. Trace mode = max hold.
e. Sweep = auto couple.
f. Allow the trace to stabilize
g. 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.

Note: The automatic bandwidth measurement capability of a spectrum analyzer or EMI receiver may be employed if it implements the functionality described above.

LIMIT

For Section 15.407(e) specifies the minimum 6 dB emission bandwidth of at least 500 KHz for the band 5.715-5.85 GHz

TEST RESULTS

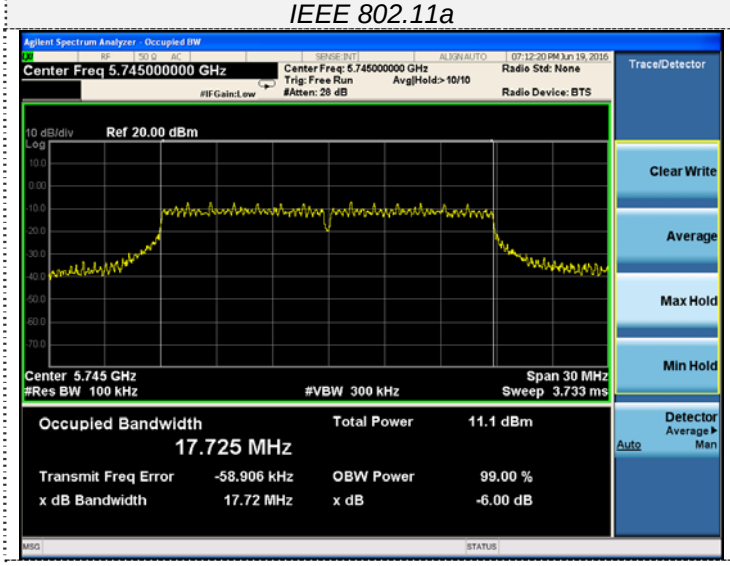
Type	Channel	6dB Bandwidth (MHz)	Limit (MHz)	Result
IEEE 802.11a	149	17.72	≥0.500	Pass
	157	17.71		
	165	17.67		
IEEE 802.11 ac	149	17.51	≥0.500	Pass
	157	17.68		
	165	17.77		

Remark:

1. *Measured output power at difference data rate for each mode and recorded woest case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 6Mbps at IEEE 802.11 a; 6Mbps at IEEE 802.11 ac;*
4. *please refer to following plots;*

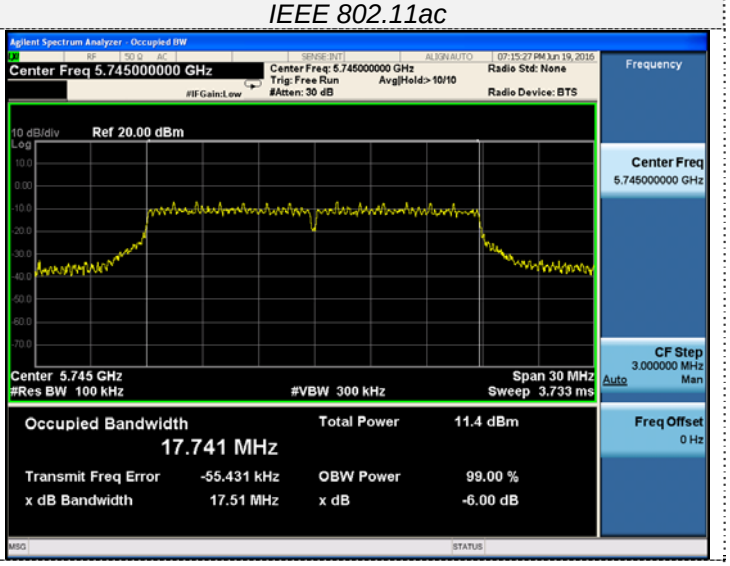
6dB Bandwidth

IEEE 802.11a

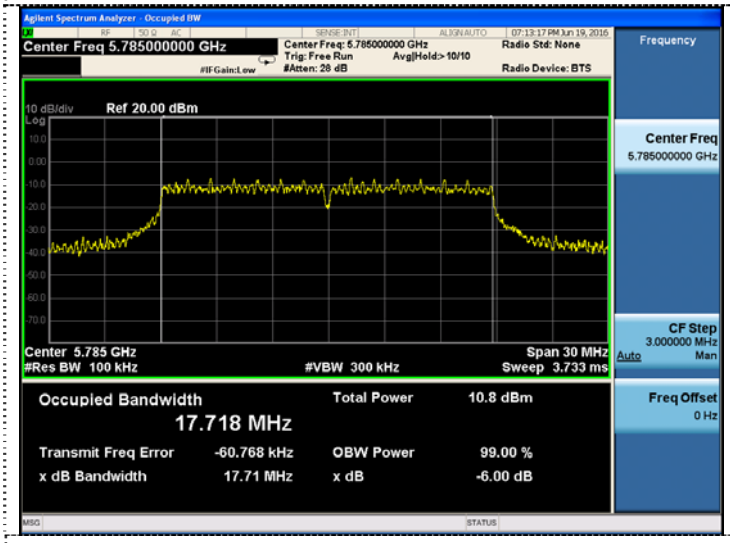


5745 MHz

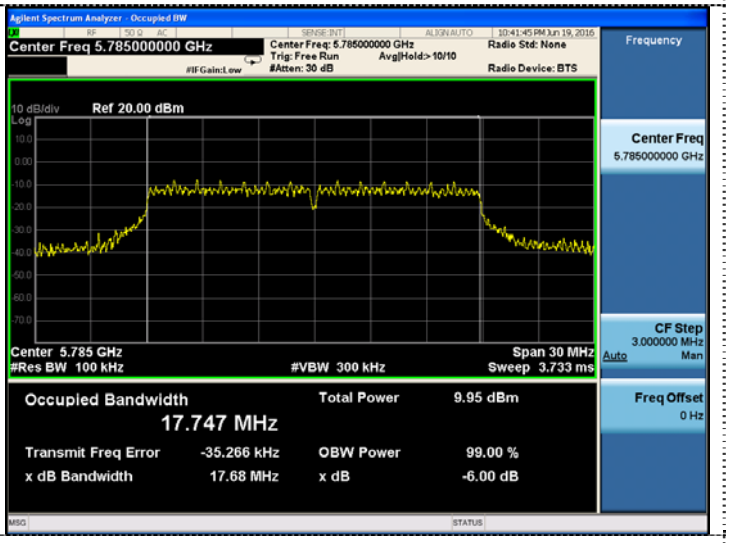
IEEE 802.11ac



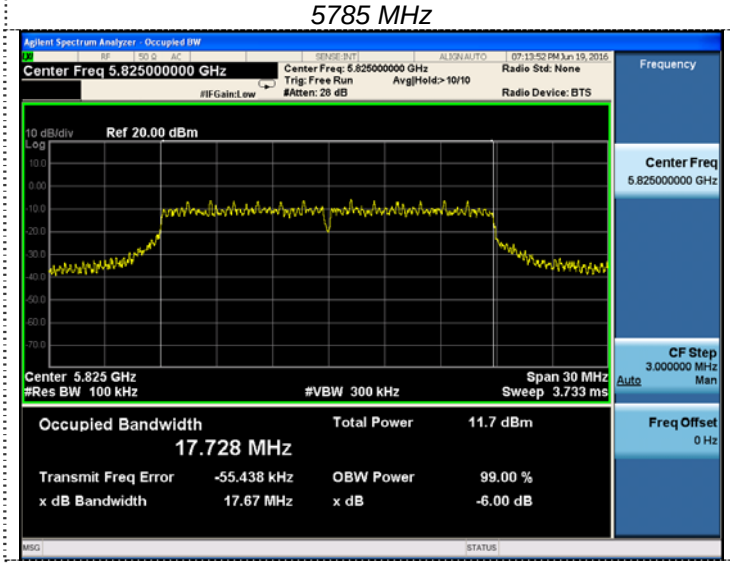
5745 MHz



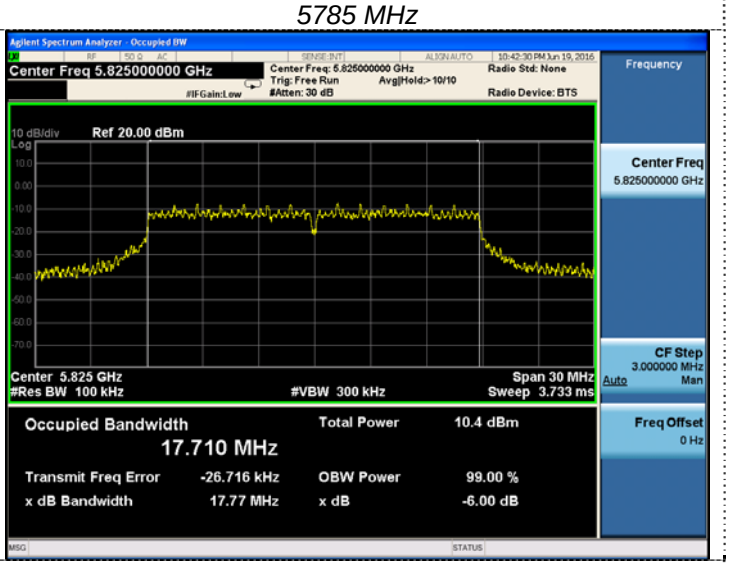
5785 MHz



5785 MHz



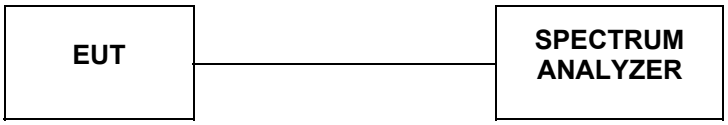
5825 MHz



5825 MHz

4.7. 26dBc Bandwidth

TEST CONFIGURATION



TEST PROCEDURE

According to KDB789033 D02 General UNII Test Procedures New Rules v01 for one of the following procedures may be used for Emission Bandwidth (EBW) measurement:

a. Set RBW = 300 kHz (approximately 1% of the emission bandwidth).
b. Set the video bandwidth (VBW) = 1000 KHz (VBW > RBW)
c. Detector = Peak.
d. Trace mode = max hold.
e. Sweep = auto couple.
f. Allow the trace to stabilize
g. 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%.

Note: The automatic bandwidth measurement capability of a spectrum analyzer or EMI receiver may be employed if it implements the functionality described above.

LIMIT

No Limits for 26dBc Bandwith

TEST RESULTS

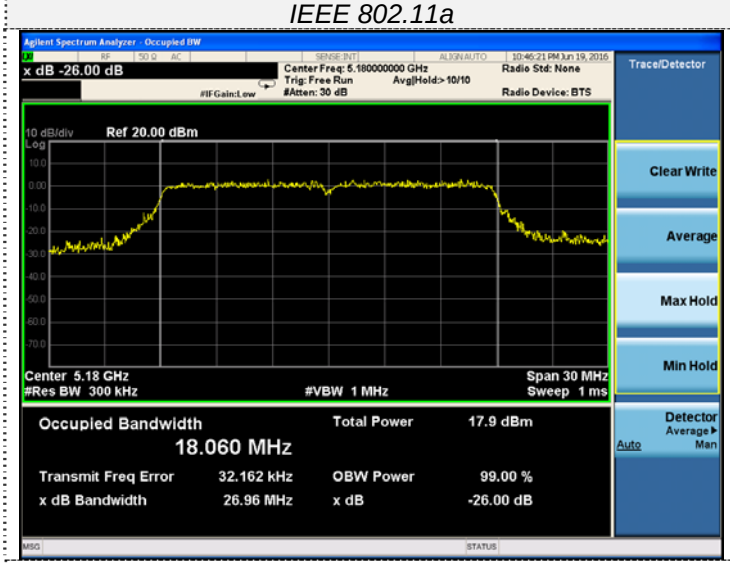
Type	Channel	26dB Bandwidth (MHz)	Limit (KHz)	Result
IEEE 802.11a	36	26.96	---	Pass
	40	27.24		
	48	29.22		
IEEE 802.11ac	36	25.82	---	Pass
	40	27.04		
	48	29.83		

Remark:

1. *Measured output power at difference data rate for each mode and recorded woest case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 6Mbps at IEEE 802.11 a; 6Mbps at IEEE 802.11 ac;*
4. *please refer to following plots;*

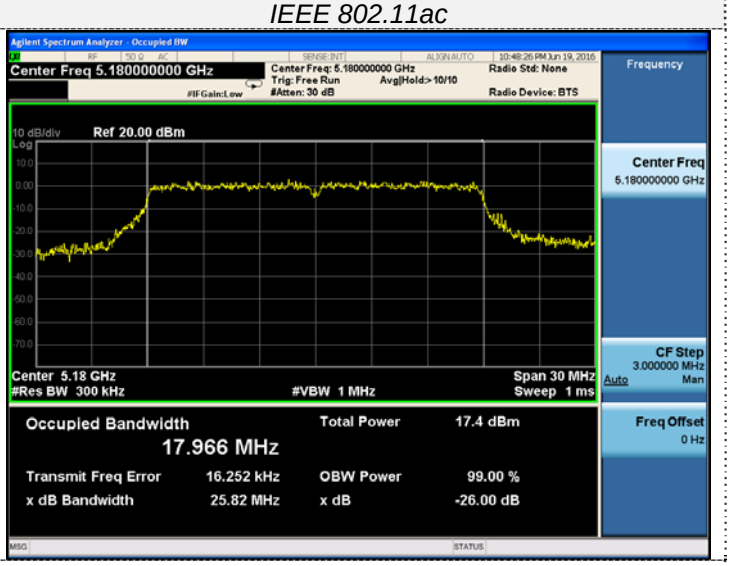
26dBc Bandwidth

IEEE 802.11a

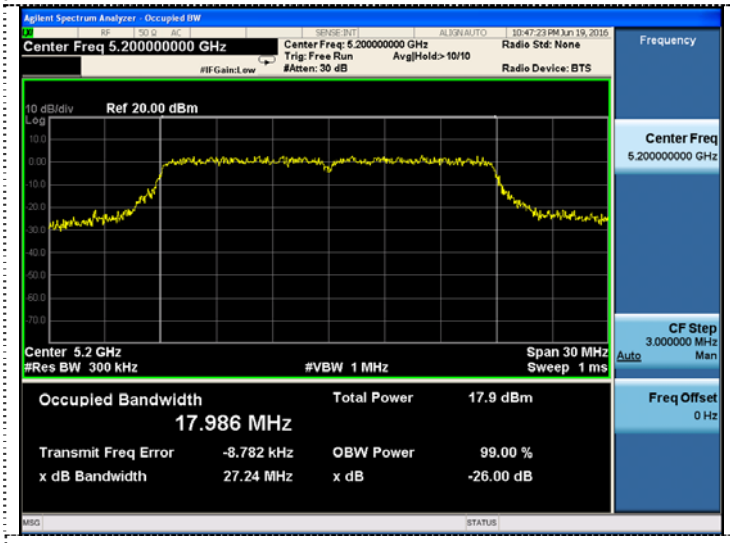


5180 MHz

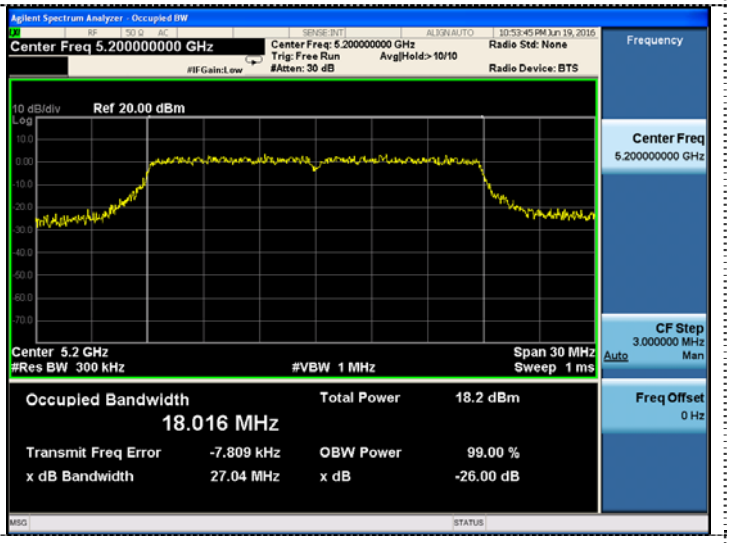
IEEE 802.11ac



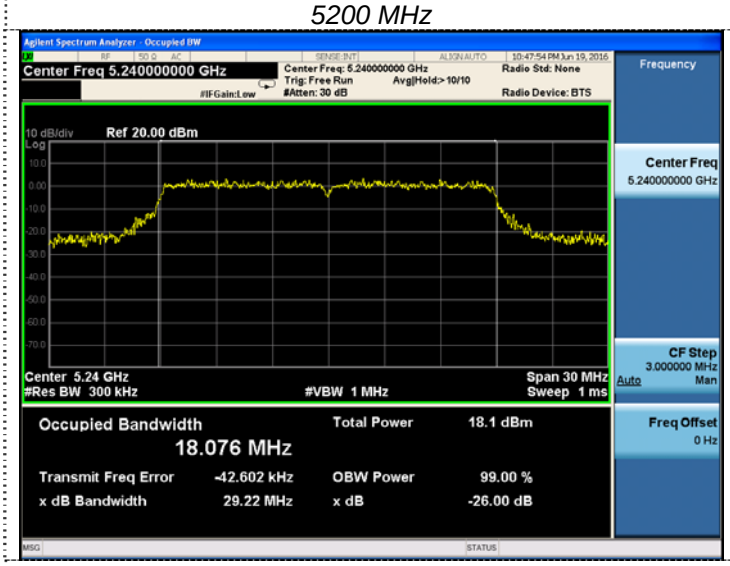
5180 MHz



5200 MHz



5200 MHz

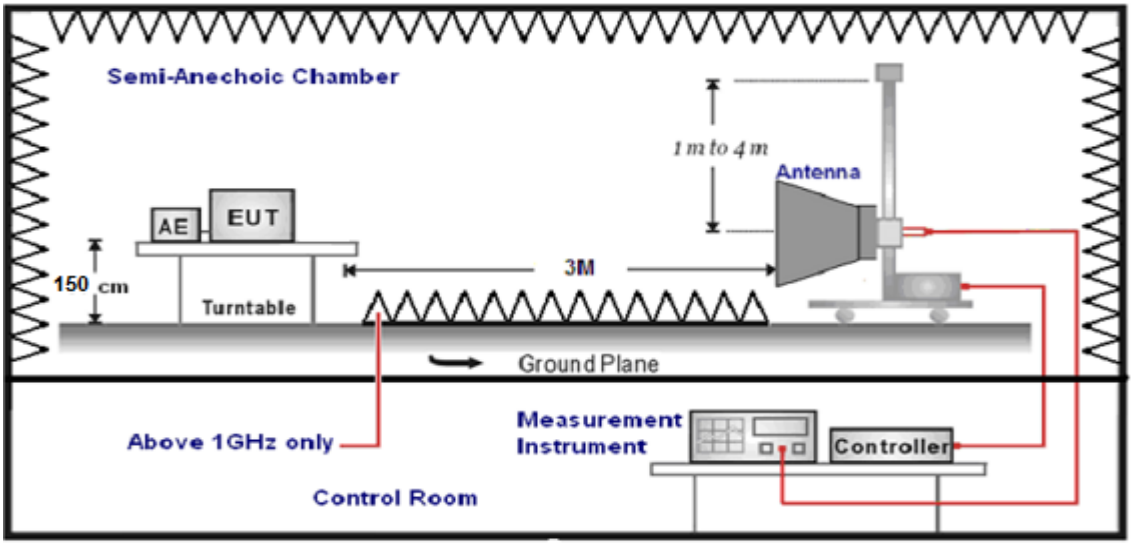


5240 MHz

5240 MHz

4.8. Band Edge Compliance Radiated

TEST CONFIGURATION



LIMIT

20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

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

According to §15.407 (b): 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

Frequency (MHz)	EIRP Limit (dBm)	Equivalent Field Strength at 3m (dBμV/m)
5150-5250	-27	68.3
5250-5350	-27	68.3
5470-5725	-27	68.3
5725-5850	-27 (beyond 10MHz of the bandedge)	68.3
	-17 (within 10 MHz of band edge)	78.3

TEST PROCEDURE

1. The EUT was placed on a turn table which is 1.5m above 1GHz.
2. 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.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed..
5. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
1GHz-18GHz	Double Ridged Horn Antenna	3

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

Test Frequency range	Test Receiver/Spectrum Setting	Detector
1GHz-18GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz,	Peak

	Sweep time=Auto	

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	

TEST RESULTS

For UNII-1 Band

Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor (dB)	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
5150.00	36.46	35.58	29.04	8.28	51.26	68.30	17.04	Peak	Horizontal
5150.00	26.53	35.58	29.04	8.28	41.35	54.00	12.65	AV	Horizontal
5174.60	73.76	35.55	29.04	8.28	88.55	---	---	Peak	Horizontal
5175.00	76.43	35.55	29.04	8.28	91.22	---	---	AV	Horizontal
5150.00	37.49	35.58	29.04	8.28	52.31	68.30	15.99	Peak	Vertical
5150.00	26.24	35.58	29.04	8.28	41.06	54.00	12.94	AV	Vertical
5177.90	73.92	35.55	29.04	8.28	88.77	---	---	Peak	Vertical
5177.55	74.46	35.55	29.04	8.28	89.25	---	---	AV	Vertical
5237.46	63.55	35.51	29.05	8.32	78.33	---	---	Peak	Horizontal
5238.65	67.84	35.51	29.05	8.32	82.62	---	---	AV	Horizontal
5350.00	34.90	35.42	29.06	8.39	49.65	68.30	18.65	Peak	Horizontal
5350.00	25.62	35.42	29.06	8.39	40.37	54.00	13.63	AV	Horizontal
5243.26	74.13	35.51	29.05	8.32	88.91	---	---	Peak	Vertical
5242.30	67.88	35.51	29.05	8.32	82.66	---	---	AV	Vertical
5350.00	36.47	35.42	29.06	8.39	51.22	68.30	17.08	Peak	Vertical
5350.00	27.49	35.42	29.06	8.39	42.24	54.00	11.76	AV	Vertical

For UNII-3 Band

Freq (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor (dB)	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
5725.00	37.18	35.69	29.13	8.65	52.39	78.30	25.91	Peak	Horizontal
5725.00	27.67	35.69	29.13	8.65	42.88	68.30	25.42	AV	Horizontal
5740.12	72.12	35.69	29.14	8.69	87.36	---	---	Peak	Horizontal
5743.35	66.04	35.69	29.14	8.69	81.28	---	---	AV	Horizontal
5725.00	35.86	35.69	29.13	8.65	51.07	78.30	27.23	Peak	Vertical
5725.00	27.48	35.69	29.13	8.65	42.69	68.30	25.61	AV	Vertical
5737.95	64.10	35.69	29.14	8.69	79.34	---	---	Peak	Vertical
5751.50	68.03	35.69	29.14	8.69	83.27	---	---	AV	Vertical
5826.92	73.48	35.82	29.16	8.77	88.91	---	---	Peak	Horizontal
5828.41	74.91	35.82	29.16	8.77	90.34	---	---	AV	Horizontal
5850.00	36.10	35.85	29.16	8.77	51.56	78.30	26.74	Peak	Horizontal
5850.00	29.18	35.85	29.16	8.77	44.64	68.30	23.66	AV	Horizontal
5820.43	65.90	35.82	29.16	8.77	81.33	---	---	Peak	Vertical
5819.09	71.52	35.82	29.16	8.77	86.95	---	---	AV[1]	Vertical
5850.00	36.86	35.85	29.16	8.77	52.32	78.30	25.98	Peak	Vertical
5850.00	28.82	35.85	29.16	8.77	44.28	68.30	24.02	AV[1]	Vertical

Remark:
1. Result Level = Read Level + Antenna Factor + Cable loss - PRM Factor.
2. The other emission levels were very low against the limit.
3. The average measurement was not performed when the peak measured data under the limit of average detection.
4. Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=10Hz/Sweep time=Auto/Detector=Peak;

4.9. Spurious RF Conducted Emission

LIMITS

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:

(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.

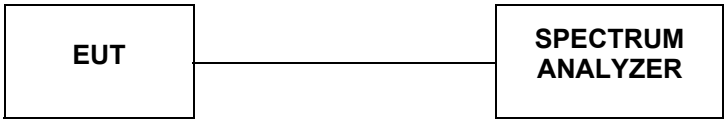
(2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(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.

(5) 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.

TEST CONFIGURATION



TEST PROCEDURE

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.

TEST RESULTS

For UNII-1 Band

Test Mode	Channel	Frequency (MHz)	Spurious RF Condcuted Emission (dBm)	Limits (dBm)	Verdict
IEEE 802.11 a	149	5180	<-27 dBm/MHz	−27 dBm/MHz	PASS
	165	5240	<-27 dBm/MHz	−27 dBm/MHz	
IEEE 802.11 ac	149	5180	<-27 dBm/MHz	−27 dBm/MHz	PASS
	165	5240	<-27 dBm/MHz	−27 dBm/MHz	

For UNII-3 Band

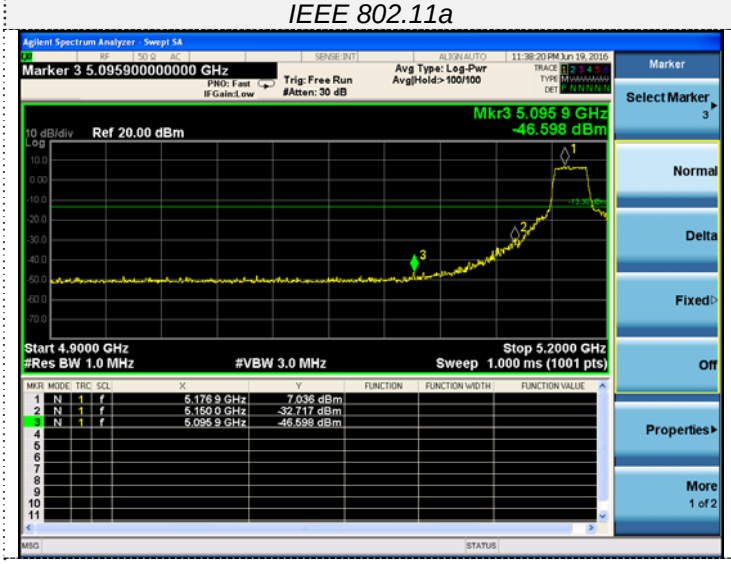
Test Mode	Channel	Frequency (MHz)	Spurious RF Condcuted Emission (dBm)	Limits (dBm)	Verdict
IEEE 802.11 a	36	5745	<-27 dBm/MHz	−27 dBm/MHz	PASS
	48	5825	<-27 dBm/MHz	−27 dBm/MHz	
IEEE 802.11 ac	36	5745	<-27 dBm/MHz	−27 dBm/MHz	PASS
	48	5825	<-27 dBm/MHz	−27 dBm/MHz	

Remark:

1. *Measured output power at difference data rate for each mode and recorded woest case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 6Mbps at IEEE 802.11 a; 6Mbps at IEEE 802.11 ac;*
4. *please refer to following plots;*

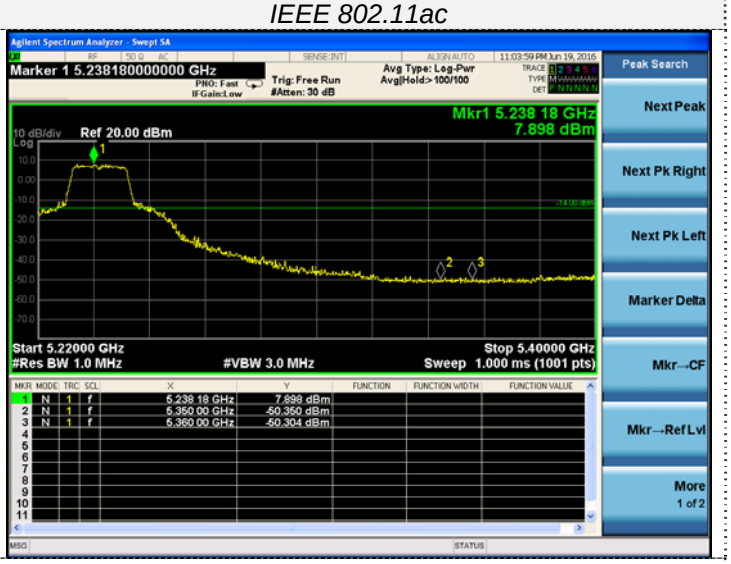
Spurious RF Condcuted Emission

IEEE 802.11a

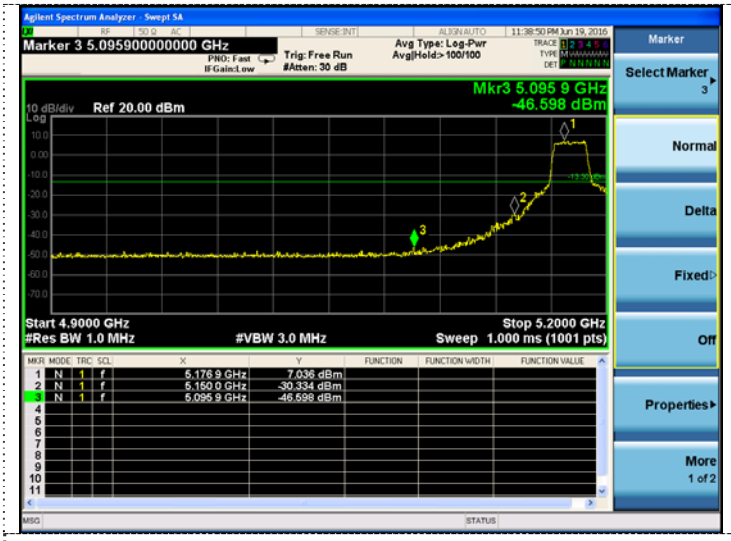


5180 MHz

IEEE 802.11ac



5180 MHz

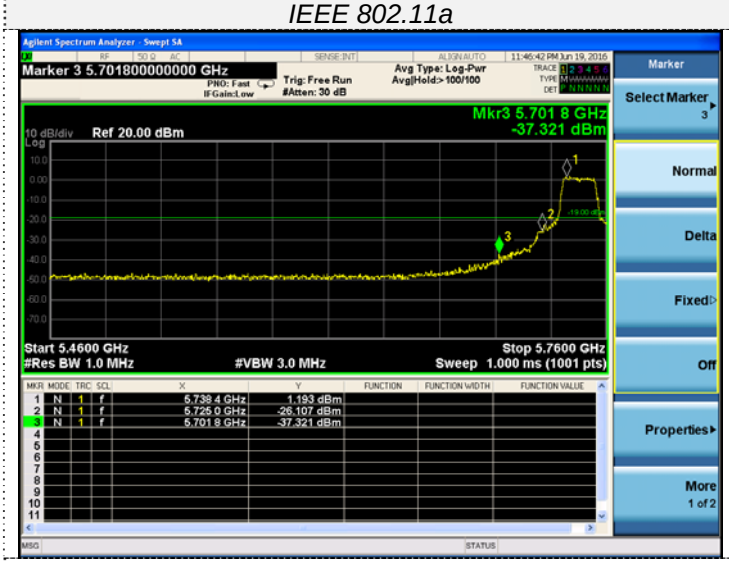


5240 MHz

5240 MHz

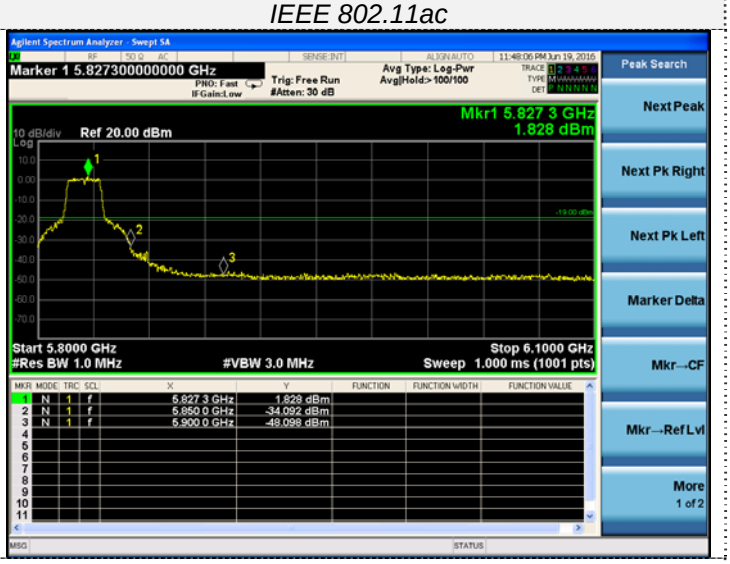
Spurious RF Condcuted Emission

IEEE 802.11a

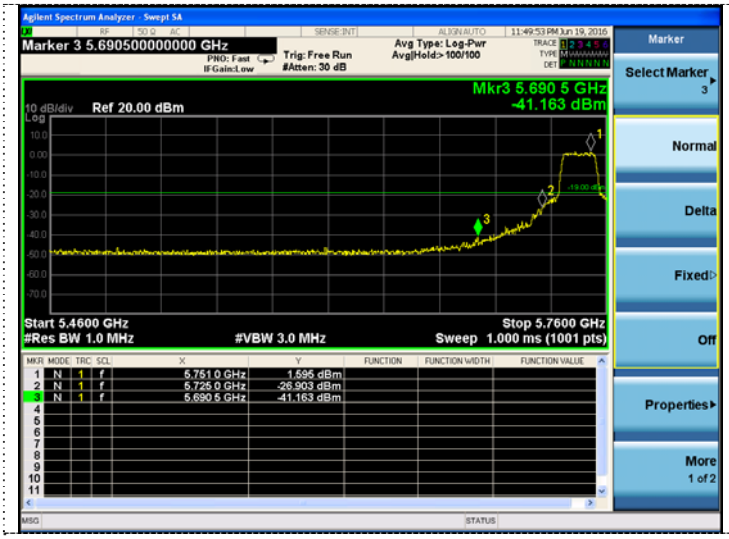


5745 MHz

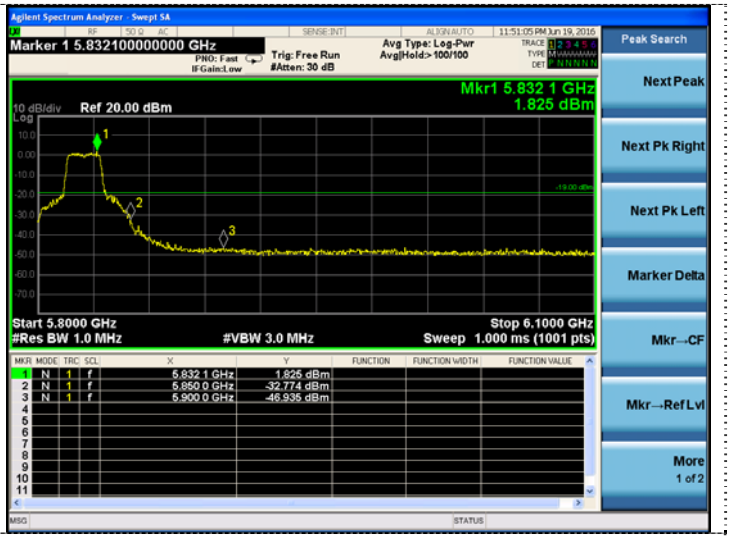
IEEE 802.11ac



5745 MHz



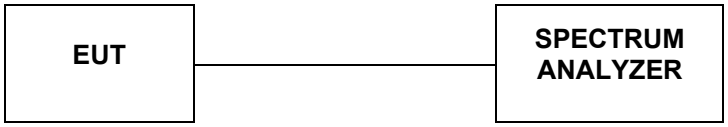
5825 MHz



5825 MHz

4.10. Frequency Stability

TEST CONFIGURATION



TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port
b. Spectrum setting as follows:
   RBW=10KHz
   VBW=30KHz
   Span= Entire absence of modulation emissionsbandwidth
   Sweep Time= Auto
   Attenuation= Auto
c. The test extreme voltage is to change the primary supply voltage from 85 to 115 percent of the nominal value.

LIMIT

Frequency Range (MHz)	Limit
5150-5250	Specifiedin the user's manual
5250-5350	
5470-5725	
5725-5850	

TEST RESULTS

For UNII-1 Band

Voltage. Frequency Stability

Voltage (V)	Measurement Frequency (MHz)
4.2	5180.0000
3.8	5180.0000
3.4	5180.0000
Maximum Deviation (MHz)	0.0000
Maximum Deviation (ppm)	0.0000

Temperature. Frequency Stability

Temperature (℃)	Measurement Frequency (MHz)
-10	5180.0000
5	5180.0000
15	5180.0000
25	5180.0000
35	5180.0000
45	5180.0000
55	5180.0000
Maximum Deviation (MHz)	0.0000
Maximum Deviation (ppm)	0.0000

For UNII-3 Band

Voltage. Frequency Stability

Voltage (V)	Measurement Frequency (MHz)
4.2	5745.0000
3.8	5745.0000
3.4	5745.0000
Maximum Deviation (MHz)	0.0000
Maximum Deviation (ppm)	0.0000

Temperature. Frequency Stability

Temperature (℃)	Measurement Frequency (MHz)
-10	5745.0000
5	5745.0000
15	5745.0000
25	5745.0000
35	5745.0000
45	5745.0000
55	5745.0000
Maximum Deviation (MHz)	0.0000
Maximum Deviation (ppm)	0.0000

4.11. 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.

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.

Refer to statement below for compliance.

The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

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.For normal WLAN devices, the IEEE 802.11a mode is used.

Measurement parameters

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

Limits

Antenna Gain	6 dBi

Results

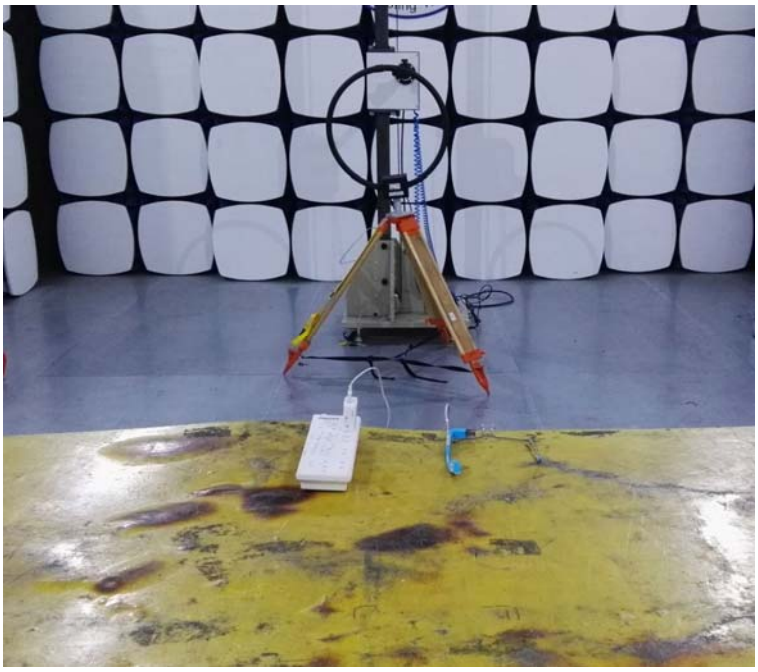
For UNII-1 Band

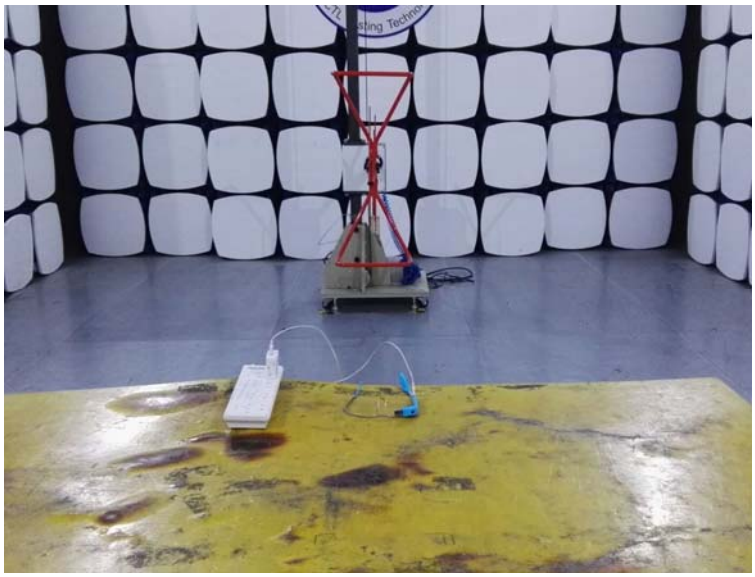
T_{nom}	V_{nom}	Lowest Channel 5180 MHz	Middle Channel 5200 MHz	Highest Channel 5240 MHz
Conducted power [dBm] Measured with IEEE 802.11a		5.16	5.19	5.11
Radiated power [dBm] Measured with IEEE 802.11a		4.09	4.98	4.23
Gain [dBi] Calculated		-1.07	-0.21	-0.88
Measurement uncertainty		± 0.6 dB (cond.) / ± 2.56 dB (rad.)		

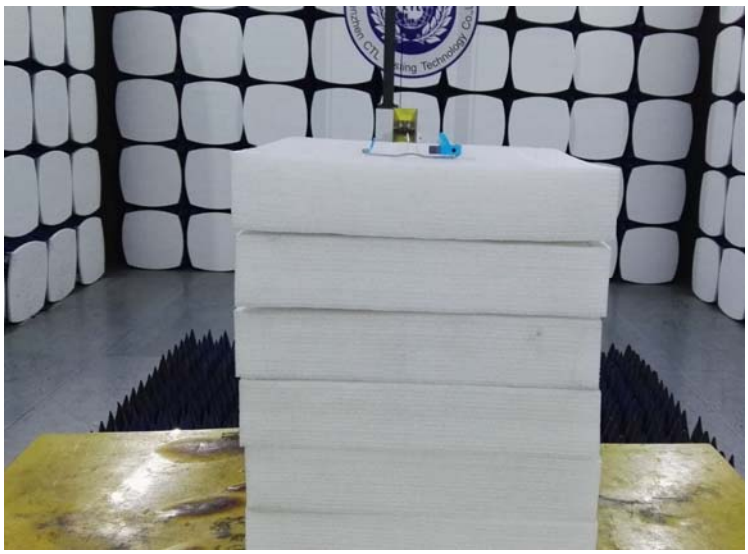
For UNII-3 Band

T_{nom}	V_{nom}	Lowest Channel 5745 MHz	Middle Channel 5785 MHz	Highest Channel 5825 MHz
Conducted power [dBm] Measured with IEEE 802.11a		5.06	5.42	5.38
Radiated power [dBm] Measured with IEEE 802.11a		3.51	4.26	3.41
Gain [dBi] Calculated		-1.55	-1.16	-1.97
Measurement uncertainty		± 0.6 dB (cond.) / ±4.32 dB (rad.)		

5. Test Setup Photos of the EUT







6. External and Internal Photos of the EUT

Reference to the test report No. GTSR16060030-BLE

.....End of Report.....