

FCC Test Report

Report No.: RF171110C10

FCC ID: KNYPRW5000AC

Test Model: PCE4552AH

Received Date: Nov. 10, 2017

Test Date: Nov. 21 ~ Nov. 27, 2017

Issued Date: Nov. 30, 2017

Applicant: FreeWave Technologies, Inc.

Address: 5395 Pearl Pkwy Ste 100, Boulder, CO 80301, U.S.A

Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch

Lab Address: No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan (R.O.C.)

Test Location: No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City 33383, TAIWAN (R.O.C.)

**FCC Registration /
Designation Number:** 788550 / TW0003



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Release Control Record

Issue No.	Description	Date Issued
RF171110C10	Original release.	Nov. 30, 2017

1 Certificate of Conformity

Product: Wireless 802.11ac/b/g/n access point

Brand: Freewave

Test Model: PCE4552AH

Sample Status: Engineering sample

Applicant: FreeWave Technologies, Inc.

Test Date: Nov. 21 ~ Nov. 27, 2017

Standards: 47 CFR FCC Part 15, Subpart E (Section 15.407)
ANSI C63.10:2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

Prepared by : Celine Chou , **Date:** Nov. 30, 2017
Celine Chou / Specialist

Approved by : Ken Liu , **Date:** Nov. 30, 2017
Ken Liu / Senior Manager

2 Summary of Test Results

47 CFR FCC Part 15, Subpart E (Section 15.407)			
FCC Clause	Test Item	Result	Remarks
15.407(b)(6)	AC Power Conducted Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -13.63dB at 2.83984MHz.
15.407(b) (1/2/3/4(i/ii)/6)	Radiated Emissions & Band Edge Measurement	Pass	Meet the requirement of limit. Minimum passing margin is -1.6dB at 11590.00MHz.
15.407(a)(1/2/3)	Max Average Transmit Power	Pass	Meet the requirement of limit.
---	Occupied Bandwidth Measurement	-	Reference only.
15.407(a)(1/2/3)	Peak Power Spectral Density	Pass	Meet the requirement of limit.
15.407(e)	6dB bandwidth	Pass	Meet the requirement of limit. (U-NII-3 Band only)
15.407(g)	Frequency Stability	Pass	Meet the requirement of limit.
15.203	Antenna Requirement	Pass	Antenna connector is N-Type. (The device is professionally installed)

*For U-NII-3 band compliance with rule part 15.407(b)(4)(i), the OOB test plots were recorded in Annex A.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (\pm)
Conducted Emissions at mains ports	150kHz ~ 30MHz	2.94 dB
Radiated Emissions up to 1 GHz	30MHz ~ 200MHz	3.86 dB
	200MHz ~ 1000MHz	3.87 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	2.29 dB
	18GHz ~ 40GHz	2.29 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Wireless 802.11ac/b/g/n access point
Brand	Freewave
Test Model	PCE4552AH
Sample Status	Engineering sample
Power Supply Rating	4.2Vdc (DC)
Modulation Type	256QAM, 64QAM, 16QAM, QPSK, BPSK
Modulation Technology	OFDM
Transfer Rate	802.11a: 54/48/36/24/18/12/9/6Mbps 802.11n: up to 450Mbps 802.11ac: up to 1300Mbps
Operating Frequency	5745~5825MHz
Number of Channel	802.11a, 802.11n (HT20), 802.11ac (VHT20): 5 802.11n (HT40), 802.11ac (VHT40): 2 802.11ac (VHT80): 1
Output Power	793.348mW
Antenna Type	Dipole antenna with 7dBi gain
Antenna Connector	N-Type
Accessory Device	N/A
Cable Supplied	N/A

Note: The EUT incorporates a MIMO function. Physically, the EUT provides 3 completed transmitters and 3 receivers.

Modulation Mode	TX Function
802.11a	3TX
802.11n (HT20)	3TX
802.11n (HT40)	3TX
802.11ac (VHT20)	3TX
802.11ac (VHT40)	3TX
802.11ac (VHT80)	3TX

* The modulation and bandwidth are similar for 802.11n mode for 20MHz/40MHz and 802.11ac mode for 20MHz/40MHz, therefore investigated worst case to representative mode in test report. (Final test mode refer section 3.2.1)

3.2 Description of Test Modes

5 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20):

Channel	Frequency	Channel	Frequency
149	5745MHz	161	5805MHz
153	5765MHz	165	5825MHz
157	5785MHz		

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40):

Channel	Frequency	Channel	Frequency
151	5755MHz	159	5795MHz

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency
155	5775MHz

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable to				Description
	RE \geq 1G	RE<1G	PLC	APCM	
-	√	√	√	√	-

Where RE \geq 1G: Radiated Emission above 1GHz & Bandedge Measurement
 RE<1G: Radiated Emission below 1GHz
 PLC: Power Line Conducted Emission
 APCM: Antenna Port Conducted Measurement

Note: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Z-plane**.

Radiated Emission Test (Above 1GHz):

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Technology	Data Rate (Mbps)
-	802.11a	149 to 165	149, 157, 165	OFDM	6.0
-	802.11n (HT20)	149 to 165	149, 157, 165	OFDM	7.2
-	802.11n (HT40)	151 to 159	151, 159	OFDM	15.0
-	802.11ac (VHT80)	155	155	OFDM	97.5

Radiated Emission Test (Below 1GHz):

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Technology	Data Rate (Mbps)
-	802.11a	149 to 165	149	OFDM	6.0

Power Line Conducted Emission Test:

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Technology	Data Rate (Mbps)
-	802.11a	149 to 165	149	OFDM	6.0

Antenna Port Conducted Measurement:

- This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Technology	Data Rate (Mbps)
-	802.11a	149 to 165	149, 157, 165	OFDM	6.0
-	802.11n (HT20)	149 to 165	149, 157, 165	OFDM	7.2
-	802.11n (HT40)	151 to 159	151, 159	OFDM	15.0
-	802.11ac (VHT80)	155	155	OFDM	97.5

Test Condition:

Applicable to	Environmental Conditions	Input Power (System)	Tested by
RE≥1G	23 deg. C, 69% RH	120Vac, 60Hz	Willy Cheng
RE<1G	23 deg. C, 70% RH	120Vac, 60Hz	Willy Cheng
PLC	25 deg. C, 66% RH	120Vac, 60Hz	Willy Cheng
APCM	25 deg. C, 60% RH	120Vac, 60Hz	Chris Lin

3.3 Duty Cycle of Test Signal

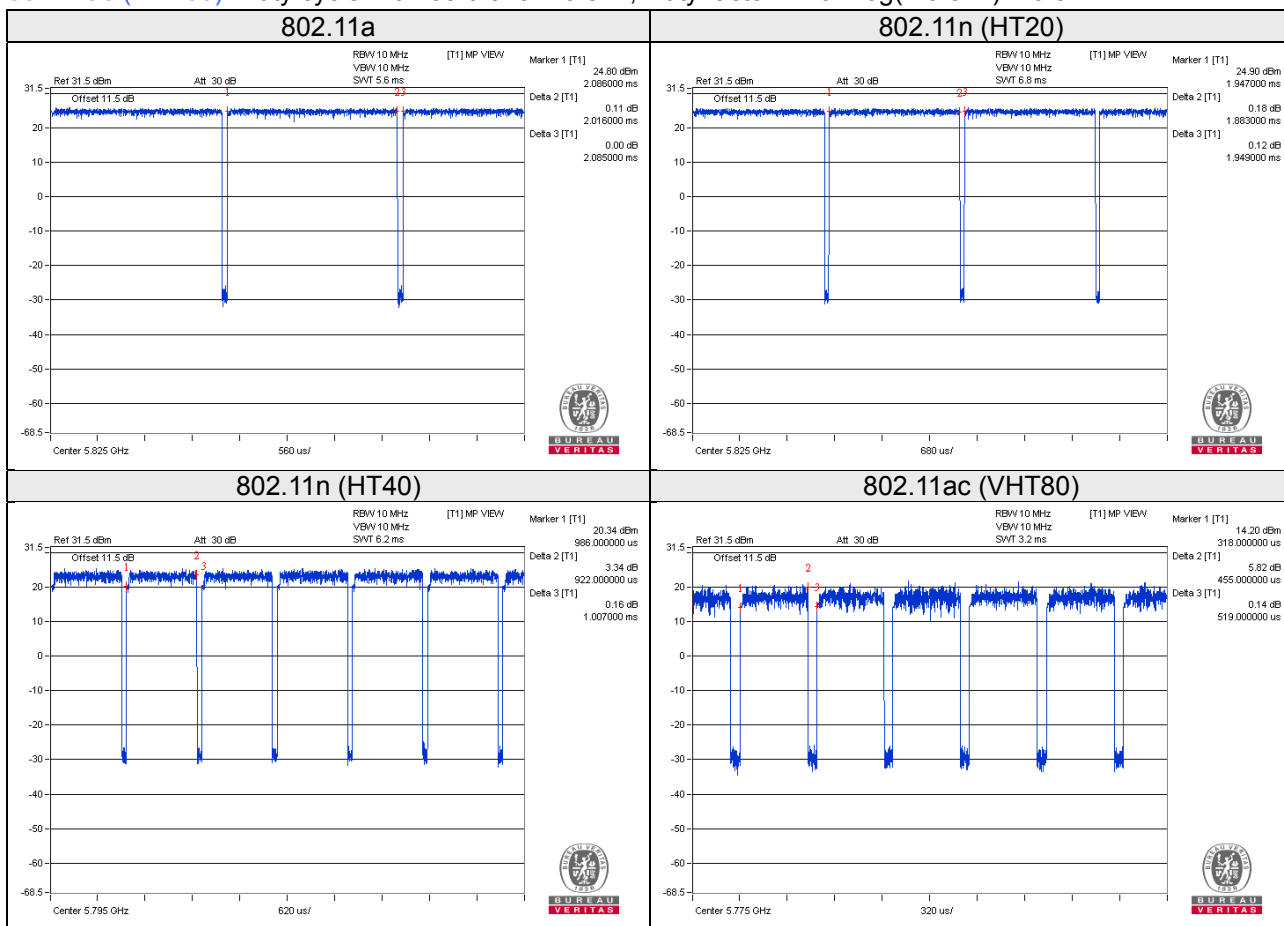
Duty cycle of test signal is < 98%, duty factor is required.

802.11a: Duty cycle = 2.016/2.085 = 0.967, Duty factor = 10 * log(1/0.967) = 0.15

802.11n (HT20): Duty cycle = 1.883/1.949 = 0.966, Duty factor = 10 * log(1/0.966) = 0.15

802.11n (HT40): Duty cycle = 0.922/1.007 = 0.916, Duty factor = 10 * log(1/0.916) = 0.38

802.11ac (VHT80): Duty cycle = 0.455/0.519 = 0.877, Duty factor = 10 * log(1/0.877) = 0.57



3.4 Description of Support Units

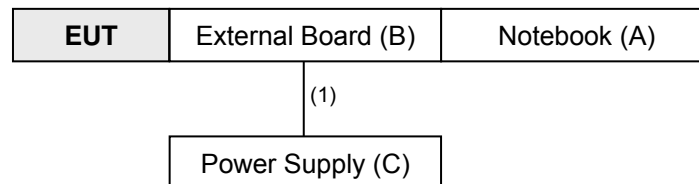
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Notebook	DELL	E5410	1HC2XM1	FCC DoC Approved	-
B.	External Board	NA	NA	NA	NA	Provided by manufacturer
C.	Power Supply	Topward	33010D	807748	NA	-

Note: All power cords of the above support units are non-shielded (1.8m).

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	Power cable	1	1.8	N	0	-

3.4.1 Configuration of System under Test



3.5 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart E (15.407)

KDB 789033 D02 General UNII Test Procedure New Rules v02r01

KDB 662911 D01 Multiple Transmitter Output v02r01

ANSI C63.10:2013

All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table.

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

Limits of unwanted emission out of the restricted bands

Applicable To		Limit	
789033 D02 General UNII Test Procedure New Rules v02r01		Field Strength at 3m	
		PK: 74 (dBµV/m)	AV: 54 (dBµV/m)
Frequency Band	Applicable To	EIRP Limit	Equivalent Field Strength at 3m
5150~5250 MHz	15.407(b)(1)	PK: -27 (dBm/MHz)	PK: 68.2(dBµV/m)
5250~5350 MHz	15.407(b)(2)		
5470~5725 MHz	15.407(b)(3)		
5725~5850 MHz	<input checked="" type="checkbox"/> 15.407(b)(4)(i)	PK: -27 (dBm/MHz) ^{*1} PK: 10 (dBm/MHz) ^{*2} PK: 15.6 (dBm/MHz) ^{*3} PK: 27 (dBm/MHz) ^{*4}	PK: 68.2(dBµV/m) ^{*1} PK: 105.2 (dBµV/m) ^{*2} PK: 110.8(dBµV/m) ^{*3} PK: 122.2 (dBµV/m) ^{*4}
	<input type="checkbox"/> 15.407(b)(4)(ii)	Emission limits in section 15.247(d)	
^{*1} beyond 75 MHz or more above of the band edge.		^{*2} below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above.	
^{*3} below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above.		^{*4} from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.	

Note: The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength:

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

4.1.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Test Receiver ROHDE & SCHWARZ	ESIB7	100187	May 02, 2017	May 01, 2018
Spectrum Analyzer ROHDE & SCHWARZ	FSP40	100040	Aug. 18, 2017	Aug. 17, 2018
BILOG Antenna SCHWARZBECK	VULB9168	9168-171	Dec. 28, 2016	Dec. 27, 2017
HORN Antenna SCHWARZBECK	9120D	209	Dec. 27, 2016	Dec. 26, 2017
HORN Antenna SCHWARZBECK	BBHA 9170	BBHA9170241	Dec. 14, 2016	Dec. 13, 2017
Loop Antenna EMCI	EM-6879	269	Aug. 11, 2017	Aug. 10, 2018
Preamplifier Agilent (Below 1GHz)	8447D	2944A10738	Aug. 21, 2017	Aug. 20, 2018
Preamplifier Agilent (Above 1GHz)	8449B	3008A02465	Apr. 05, 2017	Apr. 04, 2018
RF signal cable HUBER+SUHNER	SUCOFLEX 104	Cable-CH3-03 (223653/4)	Aug. 21, 2017	Aug. 20, 2018
RF signal cable HUBER+SUHNER& EMCI	SUCOFLEX 104&EMC104-SM-SM-8 000	Cable-CH3-03 (309224+170907)	Sep.11, 2017	Sep. 10, 2018
Software BV ADT	ADT_Radiated_ V7.6.15.9.4	NA	NA	NA
Antenna Tower inn-co GmbH	MA 4000	013303	NA	NA
Antenna Tower Controller BV ADT	AT100	AT93021702	NA	NA
Turn Table BV ADT	TT100	TT93021702	NA	NA
Turn Table Controller BV ADT	SC100	SC93021702	NA	NA
26GHz ~ 40GHz Amplifier Agilent	8449B	3008A1960	Aug. 08, 2017	Aug. 07, 2018
High Speed Peak Power Meter	ML2495A	0824012	Aug. 18, 2017	Aug. 17, 2018
Power Sensor	MA2411B	0738171	Aug. 18, 2017	Aug. 17, 2018

- Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
 2. The test was performed in HwaYa Chamber 3.
 3. The horn antenna and preamplifier (model: 8449B) are used only for the measurement of emission frequency above 1GHz if tested.
 4. The FCC Designation Number is TW0003. The number will be varied with the Lab location and scope as attached.
 5. The IC Site Registration No. is IC 7450F-3.

4.1.3 Test Procedures

For Radiated emission below 30MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Both X and Y axes of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

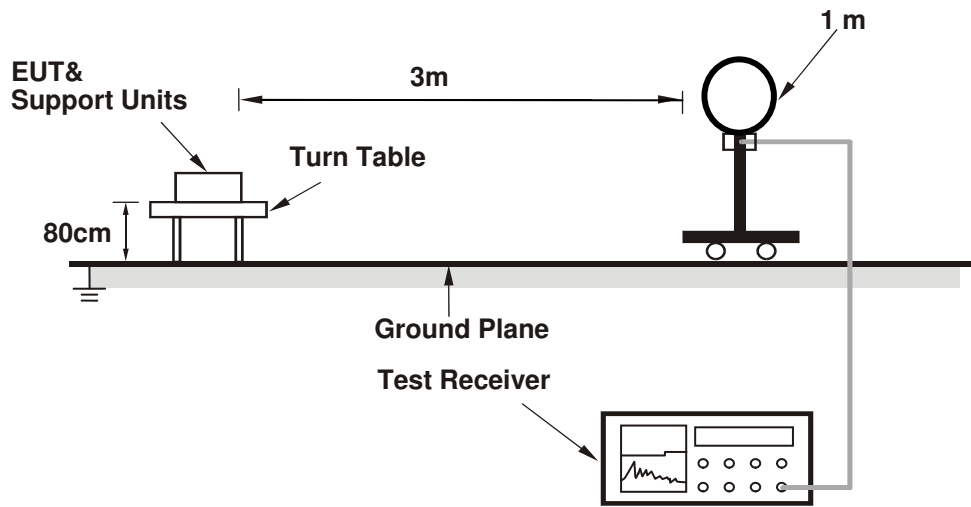
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is $\geq 1/T$ (Duty cycle < 98%) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

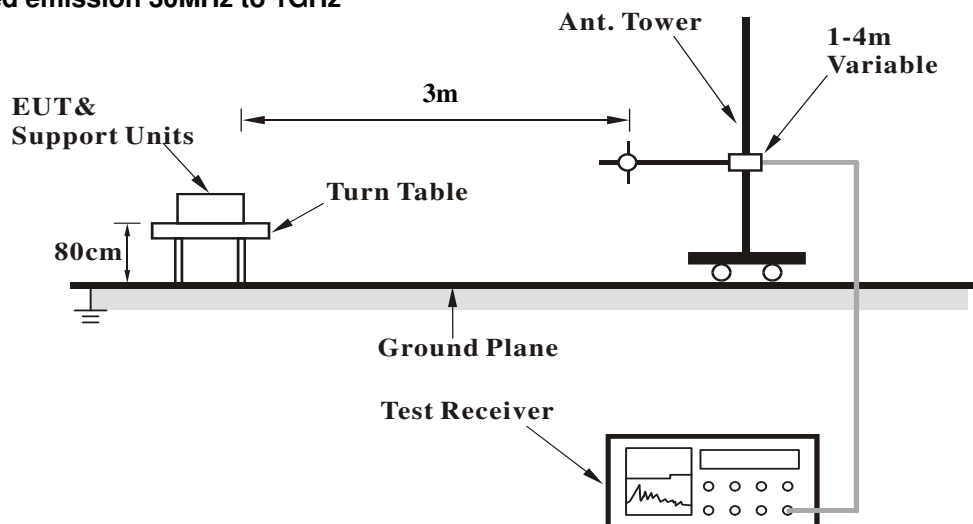
No deviation.

4.1.5 Test Setup

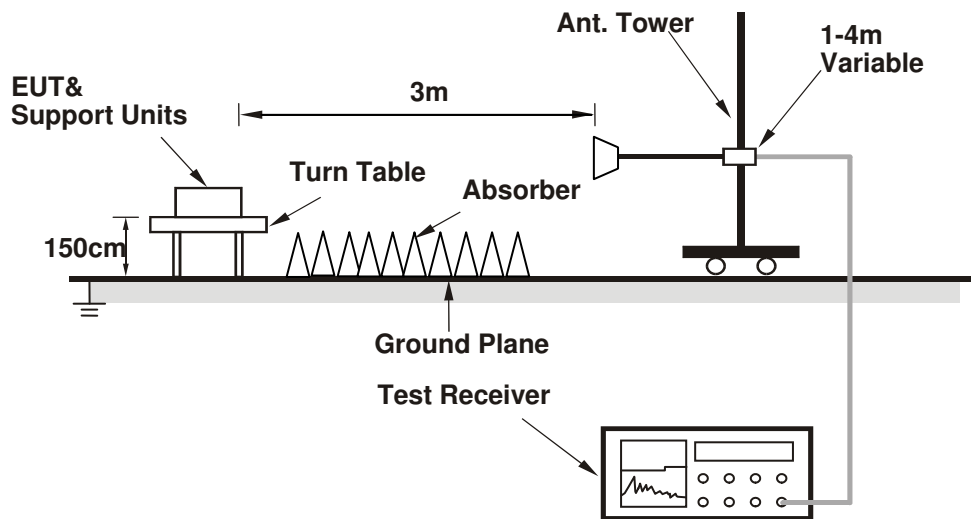
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

- a. Plugged the EUT into notebook via external board and placed them on the testing table.
- b. The notebook system ran a test program (provided by manufacturer) to enable EUT under transmission condition continuously at specific channel frequency.

4.1.7 Test Results

Above 1GHz data:

802.11a

CHANNEL	TX Channel 149	DETECTOR	Peak (PK)
FREQUENCY RANGE	1GHz ~ 40GHz	FUNCTION	Average (AV)

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5603.20	56.9 PK	68.2	-11.3	1.73 H	118	52.6	4.3
2	*5745.00	111.9 PK			1.73 H	118	71.5	40.4
3	*5745.00	101.4 AV			1.73 H	118	61.0	40.4
4	#5966.40	57.6 PK	68.2	-10.6	1.73 H	118	52.4	5.2
5	11490.00	63.5 PK	74.0	-10.5	3.06 H	113	45.3	18.2
6	11490.00	50.0 AV	54.0	-4.0	3.06 H	113	31.8	18.2

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5607.20	61.9 PK	68.2	-6.3	1.74 V	297	57.6	4.3
2	*5745.00	126.4 PK			1.74 V	297	86.0	40.4
3	*5745.00	115.9 AV			1.74 V	297	75.5	40.4
4	#5982.40	61.6 PK	68.2	-6.6	1.74 V	297	56.4	5.2
5	11490.00	62.2 PK	74.0	-11.8	2.76 V	3	44.0	18.2
6	11490.00	49.2 AV	54.0	-4.8	2.76 V	3	31.0	18.2

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

CHANNEL	TX Channel 157	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 40GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5632.80	57.2 PK	68.2	-11.0	1.22 H	134	52.9	4.3
2	*5785.00	113.9 PK			1.22 H	134	73.4	40.5
3	*5785.00	103.1 AV			1.22 H	134	62.6	40.5
4	#5927.20	57.9 PK	68.2	-10.3	1.22 H	134	53.0	4.9
5	11570.00	60.3 PK	74.0	-13.7	1.43 H	191	42.0	18.3
6	11570.00	47.0 AV	54.0	-7.0	1.43 H	191	28.7	18.3

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5617.60	66.1 PK	68.2	-2.1	1.81 V	247	61.8	4.3
2	*5785.00	125.8 PK			1.81 V	247	85.3	40.5
3	*5785.00	115.7 AV			1.81 V	247	75.2	40.5
4	#5958.40	65.1 PK	68.2	-3.1	1.81 V	247	60.0	5.1
5	11570.00	65.0 PK	74.0	-9.0	2.36 V	220	46.7	18.3
6	11570.00	50.5 AV	54.0	-3.5	2.36 V	220	32.2	18.3

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

CHANNEL	TX Channel 165	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 40GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5612.00	53.6 PK	68.2	-14.6	1.54 H	110	49.3	4.3
2	*5825.00	110.7 PK			1.54 H	110	70.1	40.6
3	*5825.00	100.6 AV			1.54 H	110	60.0	40.6
4	#5956.80	54.4 PK	68.2	-13.8	1.54 H	110	49.3	5.1
5	11650.00	56.1 PK	74.0	-17.9	1.86 H	309	38.0	18.1
6	11650.00	43.1 AV	54.0	-10.9	1.86 H	309	25.0	18.1

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5628.80	57.1 PK	68.2	-11.1	1.58 V	114	52.8	4.3
2	*5825.00	125.4 PK			1.58 V	114	84.8	40.6
3	*5825.00	115.3 AV			1.58 V	114	74.7	40.6
4	#5933.60	55.4 PK	68.2	-12.8	1.58 V	114	50.4	5.0
5	11650.00	61.4 PK	74.0	-12.6	1.53 V	111	43.3	18.1
6	11650.00	47.9 AV	54.0	-6.1	1.53 V	111	29.8	18.1

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

802.11n (HT20)

CHANNEL	TX Channel 149	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 40GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5605.60	56.0 PK	68.2	-12.2	1.20 H	95	51.7	4.3
2	*5745.00	110.8 PK			1.20 H	95	70.4	40.4
3	*5745.00	100.1 AV			1.20 H	95	59.7	40.4
4	#5983.20	56.8 PK	68.2	-11.4	1.20 H	95	51.6	5.2
5	11490.00	59.5 PK	74.0	-14.5	1.31 H	109	41.3	18.2
6	11490.00	46.4 AV	54.0	-7.6	1.31 H	109	28.2	18.2
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5630.40	58.3 PK	68.2	-9.9	1.85 V	268	54.0	4.3
2	*5745.00	127.0 PK			1.85 V	268	86.6	40.4
3	*5745.00	116.1 AV			1.85 V	268	75.7	40.4
4	#5960.80	55.6 PK	68.2	-12.6	1.85 V	268	50.5	5.1
5	11490.00	62.9 PK	74.0	-11.1	1.87 V	271	44.7	18.2
6	11490.00	49.7 AV	54.0	-4.3	1.87 V	271	31.5	18.2

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

CHANNEL	TX Channel 157	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 40GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5646.40	53.6 PK	68.2	-14.6	1.50 H	111	49.3	4.3
2	*5785.00	111.8 PK			1.50 H	111	71.3	40.5
3	*5785.00	101.3 AV			1.50 H	111	60.8	40.5
4	#5944.00	54.3 PK	68.2	-13.9	1.50 H	111	49.2	5.1
5	11570.00	56.9 PK	74.0	-17.1	1.85 H	312	38.6	18.3
6	11570.00	43.7 AV	54.0	-10.3	1.85 H	312	25.4	18.3

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5618.40	58.2 PK	68.2	-10.0	1.89 V	243	53.9	4.3
2	*5785.00	126.8 PK			1.89 V	243	86.3	40.5
3	*5785.00	116.7 AV			1.89 V	243	76.2	40.5
4	#5964.80	55.3 PK	68.2	-12.9	1.89 V	243	50.1	5.2
5	11570.00	60.3 PK	74.0	-13.7	1.40 V	90	42.0	18.3
6	11570.00	46.7 AV	54.0	-7.3	1.40 V	90	28.4	18.3

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

CHANNEL	TX Channel 165	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 40GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5610.40	55.0 PK	68.2	-13.2	1.74 H	114	50.7	4.3
2	*5825.00	112.7 PK			1.74 H	114	72.1	40.6
3	*5825.00	102.3 AV			1.74 H	114	61.7	40.6
4	#5925.60	54.5 PK	68.2	-13.7	1.74 H	114	49.6	4.9
5	11650.00	56.8 PK	74.0	-17.2	1.88 H	309	38.7	18.1
6	11650.00	43.3 AV	54.0	-10.7	1.88 H	309	25.2	18.1

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5631.20	58.8 PK	68.2	-9.4	1.47 V	62	54.5	4.3
2	*5825.00	125.7 PK			1.47 V	62	85.1	40.6
3	*5825.00	115.3 AV			1.47 V	62	74.7	40.6
4	#5939.20	55.3 PK	68.2	-12.9	1.47 V	62	50.3	5.0
5	11650.00	62.8 PK	74.0	-11.2	1.16 V	55	44.7	18.1
6	11650.00	49.7 AV	54.0	-4.3	1.16 V	55	31.6	18.1

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

802.11n (HT40)

CHANNEL	TX Channel 151	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 40GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5604.00	53.9 PK	68.2	-14.3	1.64 H	115	49.6	4.3
2	#5650.00	51.1 PK	68.2	-17.1	2.11 H	118	46.8	4.3
3	*5755.00	110.5 PK			1.64 H	115	70.1	40.4
4	*5755.00	100.5 AV			1.64 H	115	60.1	40.4
5	#5933.60	55.4 PK	68.2	-12.8	1.64 H	115	50.4	5.0
6	11510.00	56.1 PK	74.0	-17.9	1.57 H	308	37.9	18.2
7	11510.00	43.0 AV	54.0	-11.0	1.57 H	308	24.8	18.2

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5648.80	61.9 PK	68.2	-6.3	1.82 V	267	57.6	4.3
2	#5650.00	64.7 PK	68.2	-3.5	1.39 V	36	60.4	4.3
3	*5755.00	124.0 PK			1.82 V	267	83.6	40.4
4	*5755.00	113.5 AV			1.82 V	267	73.1	40.4
5	#5948.80	55.1 PK	68.2	-13.1	1.82 V	267	50.0	5.1
6	11510.00	57.3 PK	74.0	-16.7	2.11 V	275	39.1	18.2
7	11510.00	44.2 AV	54.0	-9.8	2.11 V	275	26.0	18.2

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

CHANNEL	TX Channel 159	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 40GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5618.40	58.0 PK	68.2	-10.2	1.07 H	96	53.7	4.3
2	#5650.00	57.5 PK	68.2	-10.7	1.19 H	120	53.2	4.3
3	*5795.00	108.1 PK			1.07 H	96	67.6	40.5
4	*5795.00	97.5 AV			1.07 H	96	57.0	40.5
5	#5954.40	57.3 PK	68.2	-10.9	1.07 H	96	52.2	5.1
6	11590.00	61.0 PK	74.0	-13.0	1.45 H	123	42.8	18.2
7	11590.00	47.4 AV	54.0	-6.6	1.45 H	123	29.2	18.2

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5618.40	65.1 PK	68.2	-3.1	1.79 V	85	60.8	4.3
2	#5650.00	65.5 PK	68.2	-2.7	1.85 V	271	61.2	4.3
3	*5795.00	122.9 PK			1.79 V	85	82.4	40.5
4	*5795.00	113.0 AV			1.79 V	85	72.5	40.5
5	#5947.20	59.8 PK	68.2	-8.4	1.79 V	85	54.7	5.1
6	11590.00	65.9 PK	74.0	-8.1	1.87 V	286	47.7	18.2
7	11590.00	52.4 AV	54.0	-1.6	1.87 V	286	34.2	18.2

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

802.11ac (VHT80)

CHANNEL	TX Channel 155	DETECTOR FUNCTION	Peak (PK)
FREQUENCY RANGE	1GHz ~ 40GHz		Average (AV)

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5641.60	54.4 PK	68.2	-13.8	1.98 H	150	50.1	4.3
2	#5650.00	55.4 PK	68.2	-12.8	1.73 H	112	51.1	4.3
3	*5775.00	103.7 PK			1.98 H	150	63.2	40.5
4	*5775.00	92.6 AV			1.98 H	150	52.1	40.5
5	#5925.00	52.4 PK	68.2	-15.8	2.06 H	176	47.5	4.9
6	#5945.60	55.6 PK	68.2	-12.6	1.98 H	150	50.5	5.1
7	11550.00	56.2 PK	74.0	-17.8	2.63 H	331	37.9	18.3
8	11550.00	43.2 AV	54.0	-10.8	2.63 H	331	24.9	18.3

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	#5628.00	61.9 PK	68.2	-6.3	1.64 V	118	57.6	4.3
2	#5650.00	66.5 PK	68.2	-1.7	1.69 V	59	62.2	4.3
3	*5775.00	119.9 PK			1.64 V	118	79.4	40.5
4	*5775.00	106.6 AV			1.64 V	118	66.1	40.5
5	#5925.00	58.2 PK	68.2	-10.0	1.69 V	114	53.3	4.9
6	#5938.40	56.9 PK	68.2	-11.3	1.64 V	118	51.9	5.0
7	11550.00	56.6 PK	74.0	-17.4	1.97 V	300	38.3	18.3
8	11550.00	43.7 AV	54.0	-10.3	1.97 V	300	25.4	18.3

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.
6. " # ": The radiated frequency is out of the restricted band.

Below 1GHz Worst-Case Data: 802.11a

CHANNEL	TX Channel 149	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	30.00	32.6 QP	40.0	-7.4	1.00 H	135	49.0	-16.4
2	166.00	39.5 QP	43.5	-4.0	1.50 H	157	53.7	-14.2
3	239.88	41.6 QP	46.0	-4.4	1.00 H	79	56.6	-15.0
4	265.16	41.2 QP	46.0	-4.8	1.00 H	109	55.1	-13.9
5	300.16	40.2 QP	46.0	-5.8	1.00 H	159	52.9	-12.7
6	335.15	39.7 QP	46.0	-6.3	1.00 H	156	51.8	-12.1

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M

NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	30.00	36.3 QP	40.0	-3.7	1.00 V	177	52.7	-16.4
2	99.89	33.0 QP	43.5	-10.5	1.00 V	215	51.6	-18.6
3	136.84	37.0 QP	43.5	-6.5	1.00 V	218	51.8	-14.8
4	239.88	37.3 QP	46.0	-8.7	1.00 V	140	52.3	-15.0
5	300.16	42.1 QP	46.0	-3.9	1.00 V	163	54.8	-12.7
6	498.01	42.7 QP	46.0	-3.3	1.00 V	87	52.2	-9.5

Remarks:

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(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.

2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Test Receiver ROHDE & SCHWARZ	ESCS 30	100288	Aug. 17, 2017	Aug. 16, 2018
RF signal cable (with 10dB PAD) Woken	5D-FB	Cable-cond2-01	Sep. 08, 2017	Sep. 07, 2018
LISN ROHDE & SCHWARZ (EUT)	ESH2-Z5	100100	Jan. 17, 2017	Jan. 16, 2018
LISN ROHDE & SCHWARZ (Peripheral)	ESH3-Z5	100312	Aug. 02, 2017	Aug. 01, 2018
Software ADT	BV ADT_Cond_ V7.3.7.3	NA	NA	NA

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.

2. The test was performed in HwaYa Shielded Room 2.

3. The VCCI Site Registration No. is C-2047.

4.2.3 Test Procedures

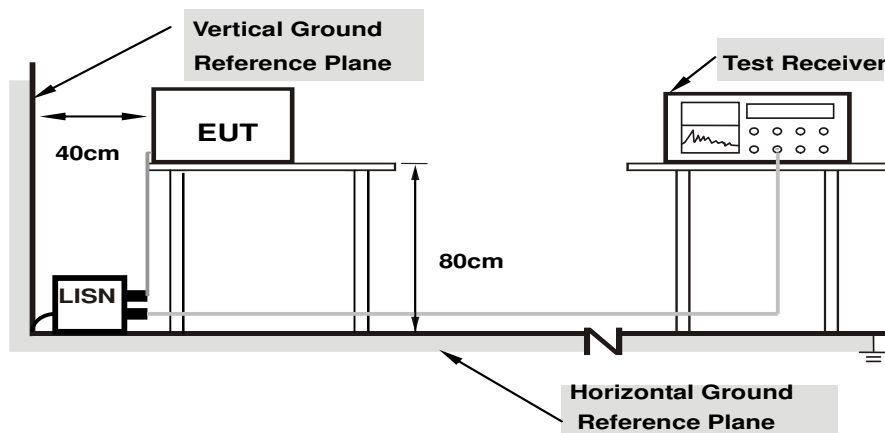
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 Test Setup



Note: 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.6 EUT Operating Conditions

Same as 4.1.6.

4.2.7 Test Results

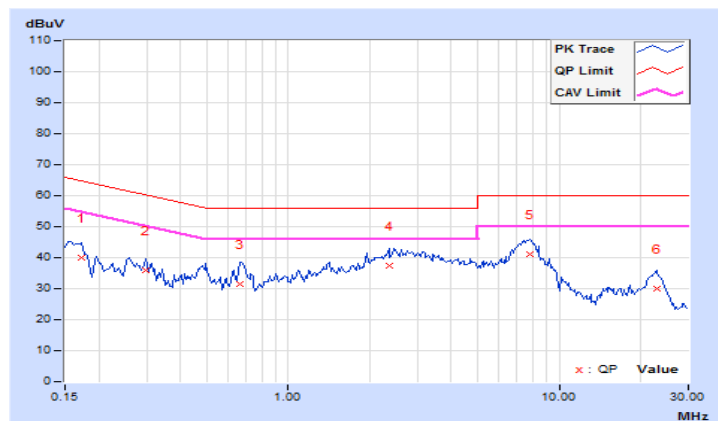
Worst-case data: 802.11a

Phase	Line (L)	Detector Function	Quasi-Peak (QP) / Average (AV)
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No	Freq. [MHz]	Corr. Factor (dB)	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
			1	0.17344	10.40	29.49	17.63	39.89	28.03	64.79
2	0.29844	10.31	25.70	15.63	36.01	25.94	60.29	50.29	-24.28	-24.35
3	0.66563	10.35	21.22	10.30	31.57	20.65	56.00	46.00	-24.43	-25.35
4	2.35156	10.39	26.90	21.83	37.29	32.22	56.00	46.00	-18.71	-13.78
5	7.82031	10.52	30.55	25.00	41.07	35.52	60.00	50.00	-18.93	-14.48
6	22.83203	10.76	19.21	12.38	29.97	23.14	60.00	50.00	-30.03	-26.86

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.

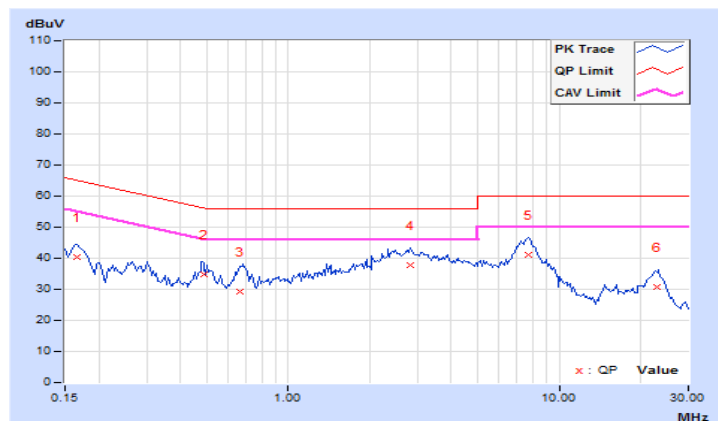


Phase	Neutral (N)	Detector Function	Quasi-Peak (QP) / Average (AV)
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No	Freq. [MHz]	Corr. Factor (dB)	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
			1	0.16562	10.26	30.06	19.11	40.32	29.37	65.18
2	0.48594	10.33	24.30	16.49	34.63	26.82	56.24	46.24	-21.61	-19.42
3	0.66172	10.33	18.76	9.04	29.09	19.37	56.00	46.00	-26.91	-26.63
4	2.83984	10.49	27.15	21.88	37.64	32.37	56.00	46.00	-18.36	-13.63
5	7.75000	10.55	30.62	25.10	41.17	35.65	60.00	50.00	-18.83	-14.35
6	22.86719	10.90	19.74	12.85	30.64	23.75	60.00	50.00	-29.36	-26.25

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.



4.3 Transmit Power Measurement

4.3.1 Limits of Transmit Power Measurement

Operation Band	EUT Category	Limit
U-NII-1	Outdoor Access Point	1 Watt (30 dBm) (Max. e.i.r.p \leq 125mW(21 dBm) at any elevation angle above 30 degrees as measured from the horizon)
	Fixed point-to-point Access Point	1 Watt (30 dBm)
	Indoor Access Point	1 Watt (30 dBm)
	Mobile and Portable client device	250mW (24 dBm)
U-NII-2A		250mW (24 dBm) or 11 dBm+10 log B*
U-NII-2C		250mW (24 dBm) or 11 dBm+10 log B*
U-NII-3	√	1 Watt (30 dBm)

*B is the 26 dB emission bandwidth in megahertz

Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;

Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT} ;

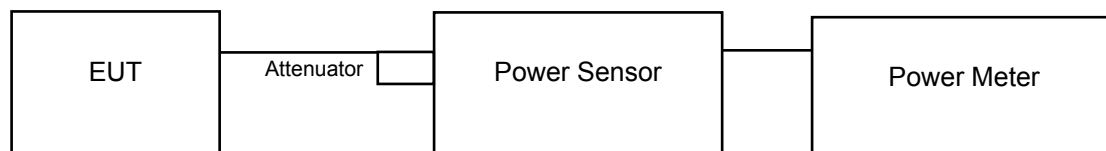
Array Gain = $5 \log(N_{ANT}/N_{SS})$ dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

For power measurements on all other devices: Array Gain = $10 \log(N_{ANT}/N_{SS})$ dB.

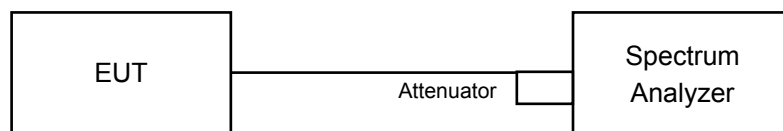
4.3.2 Test Setup

For Power Output

802.11a, 802.11n (HT20), 802.11n (HT40)



802.11ac (VHT80)



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedure

For Average Power Measurement

For 802.11a, 802.11n (HT20), 802.11n (HT40)

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

For 802.11ac (VHT80)

- a. Set span to encompass the entire 26 dB EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.
- b. Set sweep trigger to “free run”.
- c. Set RBW = 1 MHz.
- d. Set VBW \geq 3 MHz.
- e. Number of points in sweep \geq 2 Span / RBW.
- f. Sweep time \leq (number of points in sweep) * T
- g. Using emission bandwidth to determine the frequency span for integration the channel bandwidth.
- h. Detector = RMS.
- i. Trace mode = max hold.
- j. Allow max hold to run for at least 60 seconds, or longer as needed to allow the trace to stabilize.
- k. Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument’s band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the spectrum.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.3.7 Test Result

Power Output:

802.11a

Chan.	Freq. (MHz)	Maximum Conducted Power (dBm)			Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass / Fail
		Chain 0	Chain 1	Chain 2				
149	5745	24.15	23.96	24.54	793.348	28.99	29.00	Pass
157	5785	24.12	23.72	24.56	779.490	28.92	29.00	Pass
165	5825	24.20	23.79	24.59	790.099	28.98	29.00	Pass

Note: Gain = 7dBi > 6dBi, so the power limit shall be reduced to $30-(7-6) = 29.00$ dBm.

802.11n (HT20)

Chan.	Freq. (MHz)	Maximum Conducted Power (dBm)			Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass / Fail
		Chain 0	Chain 1	Chain 2				
149	5745	23.56	23.57	24.35	726.766	28.61	29.00	Pass
157	5785	24.04	23.88	24.39	772.645	28.88	29.00	Pass
165	5825	24.16	23.74	24.35	769.477	28.86	29.00	Pass

Note: Gain = 7dBi > 6dBi, so the power limit shall be reduced to $30-(7-6) = 29.00$ dBm.

802.11n (HT40)

Chan.	Freq. (MHz)	Maximum Conducted Power (dBm)			Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass / Fail
		Chain 0	Chain 1	Chain 2				
151	5755	23.97	24.09	24.41	781.965	28.93	29.00	Pass
159	5795	24.10	23.93	24.51	786.700	28.96	29.00	Pass

Note: Gain = 7dBi > 6dBi, so the power limit shall be reduced to $30-(7-6) = 29.00$ dBm.

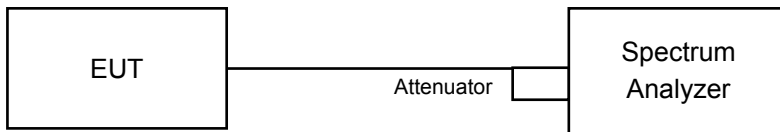
802.11ac (VHT80)

Chan.	Freq. (MHz)	Maximum Conducted Power (dBm)			Total Power (mW)	Total Power (dBm)	Power Limit (dBm)	Pass / Fail
		Chain 0	Chain 1	Chain 2				
155	5775	22.24	21.92	23.63	553.766	27.43	29.00	Pass

Note: Gain = 7dBi > 6dBi, so the power limit shall be reduced to $30-(7-6) = 29.00$ dBm.

4.4 Occupied Bandwidth Measurement

4.4.1 Test Setup



4.4.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.3 Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth and set the detector to sampling. The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5 %of the total mean power of a given emission.

4.4.4 Test Result

802.11a

Chan.	Freq. (MHz)	Occupied Bandwidth (MHz)		
		Chain 0	Chain 1	Chain 2
149	5745	18.60	18.69	18.17
157	5785	26.16	28.44	18.60
165	5825	28.68	28.20	17.88

802.11n (HT20)

Chan.	Freq. (MHz)	Occupied Bandwidth (MHz)		
		Chain 0	Chain 1	Chain 2
149	5745	18.48	18.36	18.24
157	5785	19.44	19.08	18.60
165	5825	29.76	27.60	19.08

802.11n (HT40)

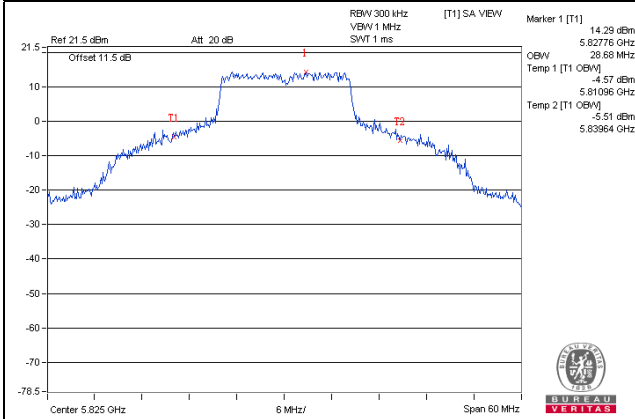
Chan.	Freq. (MHz)	Occupied Bandwidth (MHz)		
		Chain 0	Chain 1	Chain 2
151	5755	37.80	37.44	37.44
159	5795	44.16	42.24	41.64

802.11ac (VHT80)

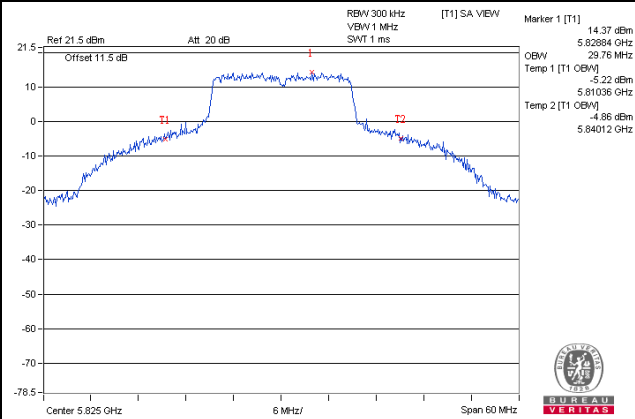
Chan.	Freq. (MHz)	Occupied Bandwidth (MHz)		
		Chain 0	Chain 1	Chain 2
155	5775	75.84	76.08	76.08

Spectrum Plot of Worst Value

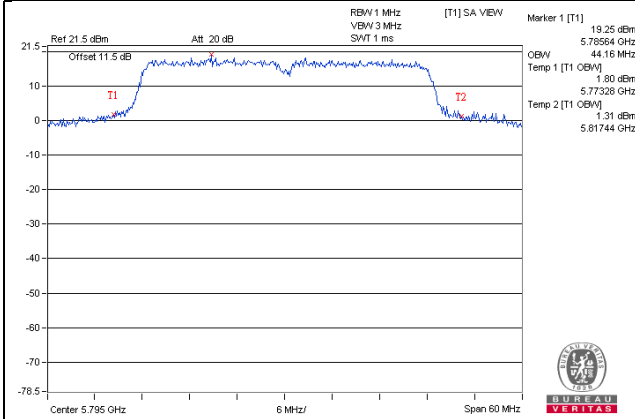
802.11a



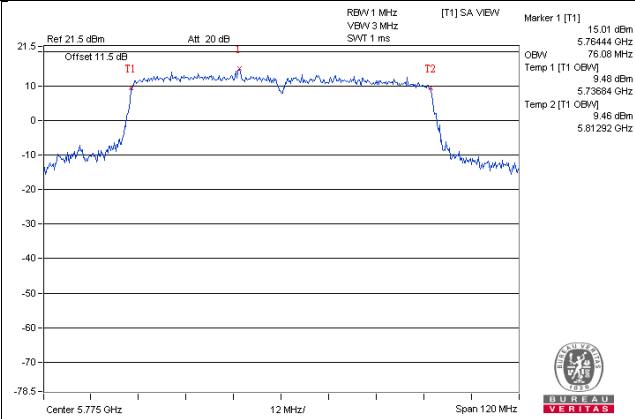
802.11n (HT20)



802.11n (HT40)



802.11ac (VHT80)

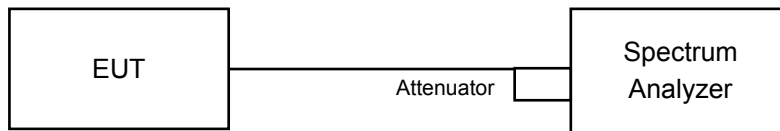


4.5 Peak Power Spectral Density Measurement

4.5.1 Limits of Peak Power Spectral Density Measurement

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	17dBm/ MHz
		Fixed point-to-point Access Point	
		Indoor Access Point	
		Mobile and Portable client device	11dBm/ MHz
U-NII-2A			11dBm/ MHz
U-NII-2C			11dBm/ MHz
U-NII-3	√		30dBm/ 500kHz

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedures

- Set span to encompass the entire emission bandwidth (EBW) of the signal.
- Set RBW = 300 kHz, Set VBW \geq 1 MHz, Detector = RMS
- Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
- Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where $BWCF = 10\log(500 \text{ kHz} / 300 \text{ kHz})$
- Sweep time = auto, trigger set to "free run".
- Trace average at least 100 traces in power averaging mode.
- Record the max value and add $10 \log (1/\text{duty cycle})$

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 EUT Operating Conditions

Same as 4.3.6.

4.5.7 Test Results

802.11a

TX chain	Chan.	Freq. (MHz)	PSD W/O Duty Factor		10 log (N=3) dB	Duty Factor (dB)	Total PSD With Duty Factor (dBm/500kHz)	Limit (dBm/500kHz)	Pass / Fail
			(dBm/300kHz)	(dBm/500kHz)					
0	149	5745	1.96	4.18	4.77	0.15	9.10	24.23	Pass
	157	5785	2.42	4.64	4.77	0.15	9.56	24.23	Pass
	165	5825	1.77	3.99	4.77	0.15	8.91	24.23	Pass
1	149	5745	1.91	4.13	4.77	0.15	9.05	24.23	Pass
	157	5785	2.16	4.38	4.77	0.15	9.30	24.23	Pass
	165	5825	1.79	4.01	4.77	0.15	8.93	24.23	Pass
2	149	5745	2.02	4.24	4.77	0.15	9.16	24.23	Pass
	157	5785	1.20	3.42	4.77	0.15	8.34	24.23	Pass
	165	5825	0.66	2.88	4.77	0.15	7.80	24.23	Pass

Note:

- Method 1 of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
- Directional gain = 7dBi + 10log(3) = 11.77dBi > 6dBi, so the power density limit shall be reduced to 30-(11.77-6) = 24.23dBm.
- Refer to section 3.3 for duty cycle spectrum plot.

802.11n (HT20)

TX chain	Chan.	Freq. (MHz)	PSD W/O Duty Factor		10 log (N=3) dB	Duty Factor (dB)	Total PSD With Duty Factor (dBm/500kHz)	Limit (dBm/500kHz)	Pass / Fail
			(dBm/300kHz)	(dBm/500kHz)					
0	149	5745	1.11	3.33	4.77	0.15	8.25	24.23	Pass
	157	5785	1.88	4.10	4.77	0.15	9.02	24.23	Pass
	165	5825	1.54	3.76	4.77	0.15	8.68	24.23	Pass
1	149	5745	1.25	3.47	4.77	0.15	8.39	24.23	Pass
	157	5785	1.07	3.29	4.77	0.15	8.21	24.23	Pass
	165	5825	1.74	3.96	4.77	0.15	8.88	24.23	Pass
2	149	5745	1.29	3.51	4.77	0.15	8.43	24.23	Pass
	157	5785	0.95	3.17	4.77	0.15	8.09	24.23	Pass
	165	5825	0.65	2.87	4.77	0.15	7.79	24.23	Pass

Note:

- Method 1 of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
- Directional gain = 7dBi + 10log(3) = 11.77dBi > 6dBi, so the power density limit shall be reduced to 30-(11.77-6) = 24.23dBm.
- Refer to section 3.3 for duty cycle spectrum plot.

802.11n (HT40)

TX chain	Chan.	Freq. (MHz)	PSD W/O Duty Factor		10 log (N=3) dB	Duty Factor (dB)	Total PSD With Duty Factor (dBm/500kHz)	Limit (dBm/500kHz)	Pass / Fail
			(dBm/300kHz)	(dBm/500kHz)					
0	151	5755	-1.10	1.12	4.77	0.38	6.27	24.23	Pass
	159	5795	-1.49	0.73	4.77	0.38	5.88	24.23	Pass
1	151	5755	-1.95	0.27	4.77	0.38	5.42	24.23	Pass
	159	5795	-1.22	1.00	4.77	0.38	6.15	24.23	Pass
2	151	5755	-2.21	0.01	4.77	0.38	5.16	24.23	Pass
	159	5795	-1.39	0.83	4.77	0.38	5.98	24.23	Pass

Note:

- Method 1 of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
- Directional gain = $7\text{dBi} + 10\log(3) = 11.77\text{dBi} > 6\text{dBi}$, so the power density limit shall be reduced to $30 - (11.77 - 6) = 24.23\text{dBm}$.
- Refer to section 3.3 for duty cycle spectrum plot.

802.11ac (VHT80)

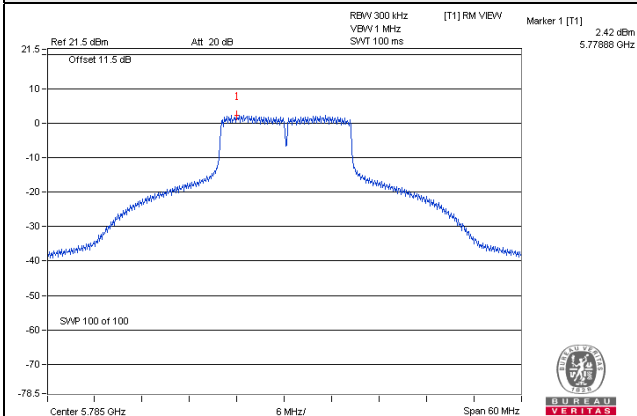
TX chain	Chan.	Freq. (MHz)	PSD W/O Duty Factor		10 log (N=3) dB	Duty Factor (dB)	Total PSD With Duty Factor (dBm/500kHz)	Limit (dBm/500kHz)	Pass / Fail
			(dBm/300kHz)	(dBm/500kHz)					
0	155	5775	-7.10	-4.88	4.77	0.57	0.46	24.23	Pass
1	155	5775	-5.92	-3.70	4.77	0.57	1.64	24.23	Pass
2	155	5775	-6.18	-3.96	4.77	0.57	1.38	24.23	Pass

Note:

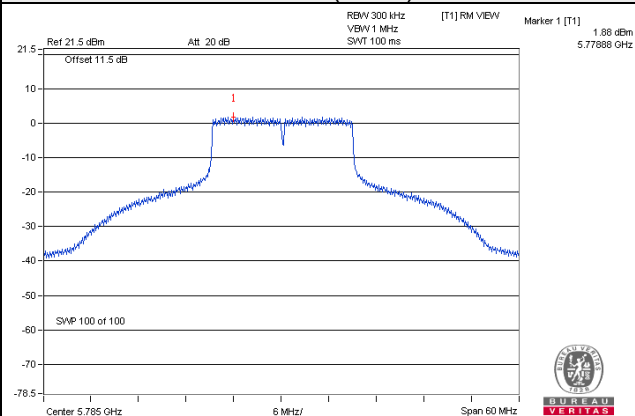
- Method 1 of power density measurement of KDB 662911 is using for calculating total power density. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.
- Directional gain = $7\text{dBi} + 10\log(3) = 11.77\text{dBi} > 6\text{dBi}$, so the power density limit shall be reduced to $30 - (11.77 - 6) = 24.23\text{dBm}$.
- Refer to section 3.3 for duty cycle spectrum plot.

Spectrum Plot of Worst Value

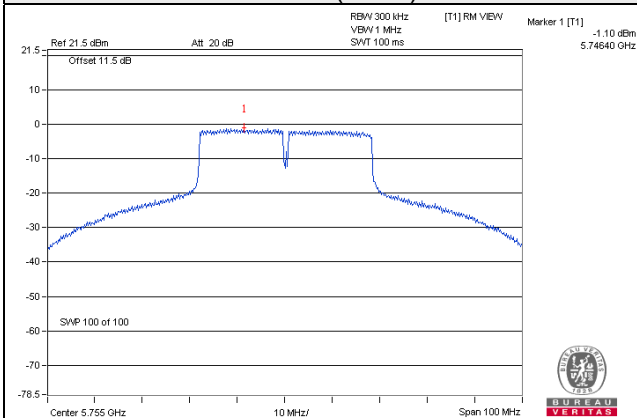
802.11a



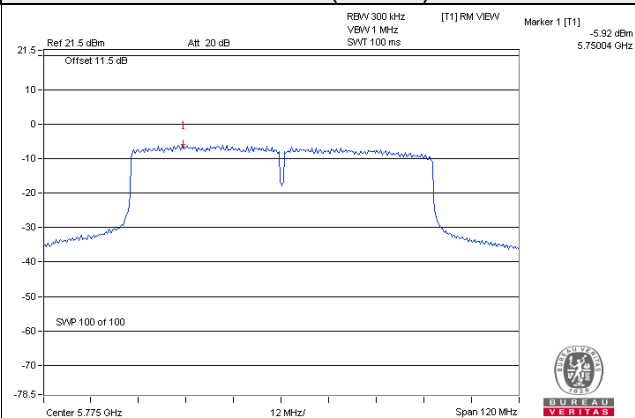
802.11n (HT20)



802.11n (HT40)



802.11ac (VHT80)

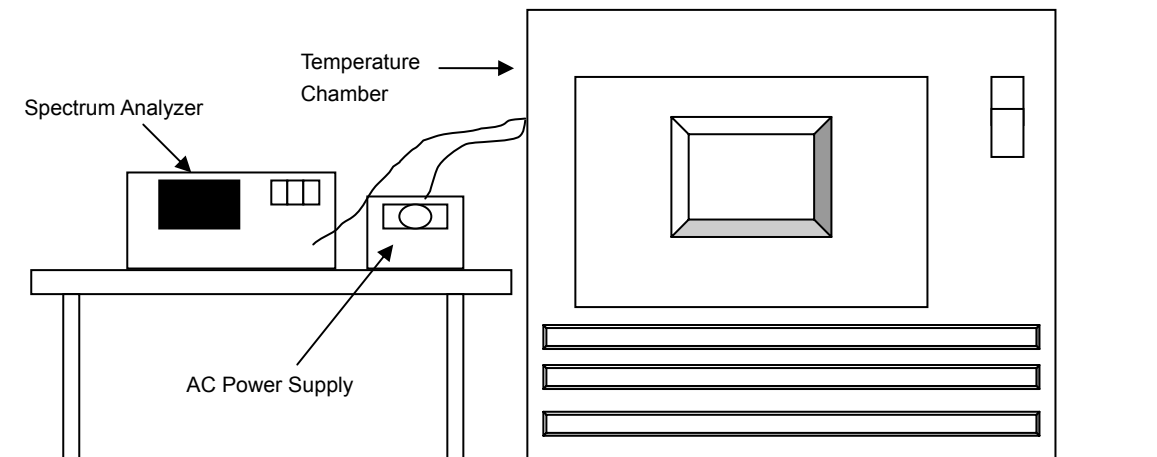


4.6 Frequency Stability

4.6.1 Limits of Frequency Stability Measurement

The frequency of the carrier signal shall be maintained within band of operation

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.6.4 Test Procedure

- The EUT was placed inside the environmental test chamber and powered by nominal AC voltage.
- Turn the EUT on and couple its output to a spectrum analyzer.
- Turn the EUT off and set the chamber to the highest temperature specified.
- Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency after 2, 5, and 10 minutes.
- Repeat step 2 and 3 with the temperature chamber set to the lowest temperature.
- The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.

4.6.5 Deviation from Test Standard

No deviation.

4.6.6 EUT Operating Condition

Set the EUT transmit at un-modulation mode to test frequency stability.

4.6.7 Test Results

Frequency Stability Versus Temp.									
Operating Frequency: 5745MHz									
Temp. (°C)	Power Supply (Vac)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Frequency Drift (%)	Measured Frequency (MHz)	Frequency Drift (%)	Measured Frequency (MHz)	Frequency Drift (%)	Measured Frequency (MHz)	Frequency Drift (%)
50	120	5745.0214	0.00037	5745.0194	0.00034	5745.0194	0.00034	5745.0182	0.00032
40	120	5744.9959	-0.00007	5744.9963	-0.00006	5744.9945	-0.00010	5744.9952	-0.00008
30	120	5744.9759	-0.00042	5744.9772	-0.00040	5744.9757	-0.00042	5744.9743	-0.00045
20	120	5745.0077	0.00013	5745.0092	0.00016	5745.0109	0.00019	5745.007	0.00012
10	120	5744.9838	-0.00028	5744.9807	-0.00034	5744.9815	-0.00032	5744.98	-0.00035
0	120	5745.0085	0.00015	5745.0039	0.00007	5745.0081	0.00014	5745.0068	0.00012
-10	120	5745.001	0.00002	5745.0005	0.00001	5745.0008	0.00001	5744.9986	-0.00002
-20	120	5745.006	0.00010	5745.0058	0.00010	5745.0049	0.00009	5745.0029	0.00005
-30	120	5744.9802	-0.00034	5744.9813	-0.00033	5744.9807	-0.00034	5744.978	-0.00038

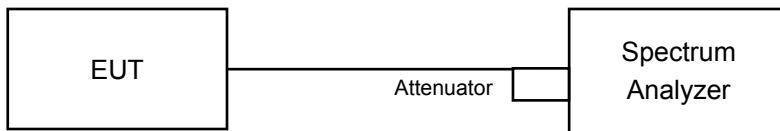
Frequency Stability Versus Voltage									
Operating Frequency: 5745MHz									
Temp. (°C)	Power Supply (Vac)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Frequency Drift (%)	Measured Frequency (MHz)	Frequency Drift (%)	Measured Frequency (MHz)	Frequency Drift (%)	Measured Frequency (MHz)	Frequency Drift (%)
20	138	5745.0084	0.00015	5745.0095	0.00017	5745.0114	0.00020	5745.0064	0.00011
	120	5745.0077	0.00013	5745.0092	0.00016	5745.0109	0.00019	5745.007	0.00012
	102	5745.0083	0.00014	5745.0086	0.00015	5745.0108	0.00019	5745.0075	0.00013

4.7 6dB Bandwidth Measurement

4.7.1 Limits of 6dB Bandwidth Measurement

The minimum of 6dB Bandwidth Measurement is 0.5MHz.

4.7.2 Test Setup



4.7.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.7.4 Test Procedure

Measurement Procedure REF

- Set resolution bandwidth (RBW) = 100kHz
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

4.7.5 Deviation from Test Standard

No deviation.

4.7.6 EUT Operating Condition

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.7.7 Test Results

802.11a

Channel	Frequency (MHz)	6dB Bandwidth (MHz)			Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1	Chain 2		
149	5745	16.38	16.37	16.38	0.5	Pass
157	5785	16.40	16.42	16.43	0.5	Pass
165	5825	16.42	16.42	16.42	0.5	Pass

802.11n (HT20)

Channel	Frequency (MHz)	6dB Bandwidth (MHz)			Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1	Chain 2		
149	5745	17.65	17.63	17.63	0.5	Pass
157	5785	17.65	17.63	17.65	0.5	Pass
165	5825	17.63	17.64	17.65	0.5	Pass

802.11n (HT40)

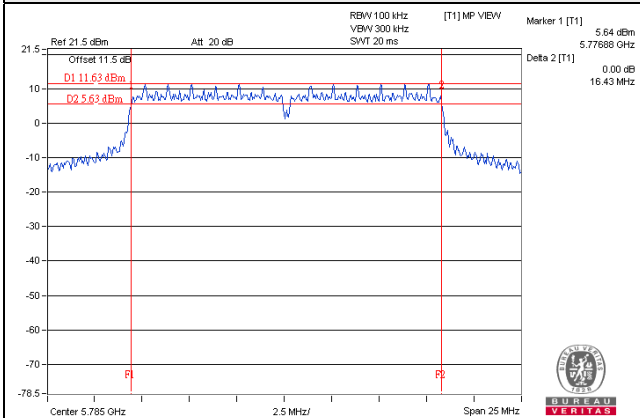
Channel	Frequency (MHz)	6dB Bandwidth (MHz)			Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1	Chain 2		
151	5755	36.41	35.97	36.45	0.5	Pass
159	5795	36.45	36.46	36.44	0.5	Pass

802.11ac (VHT80)

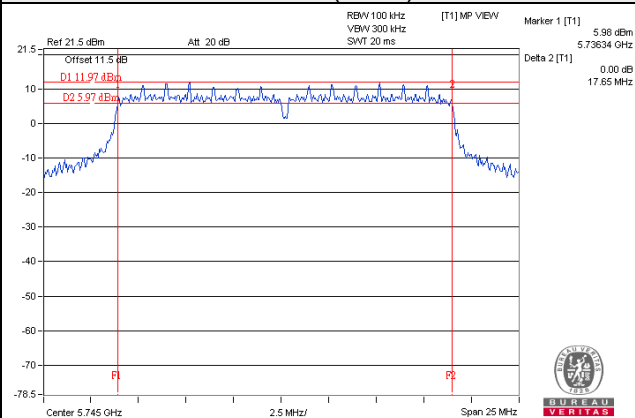
Channel	Frequency (MHz)	6dB Bandwidth (MHz)			Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1	Chain 2		
155	5775	73.31	75.83	75.84	0.5	Pass

Spectrum Plot of Worst Value

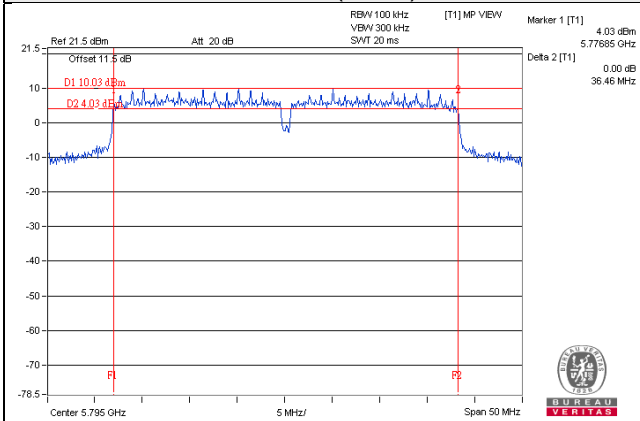
802.11a



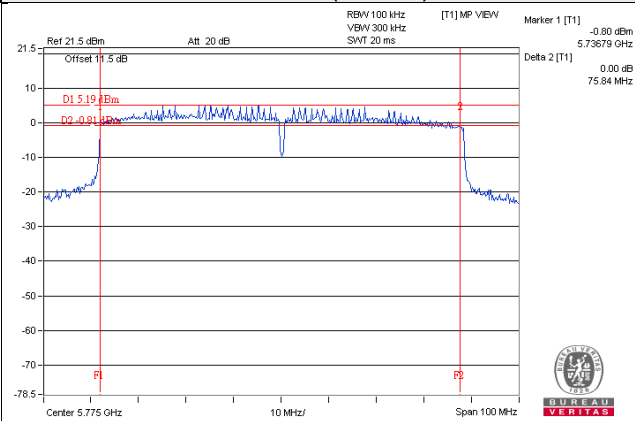
802.11n (HT20)



802.11n (HT40)



802.11ac (VHT80)

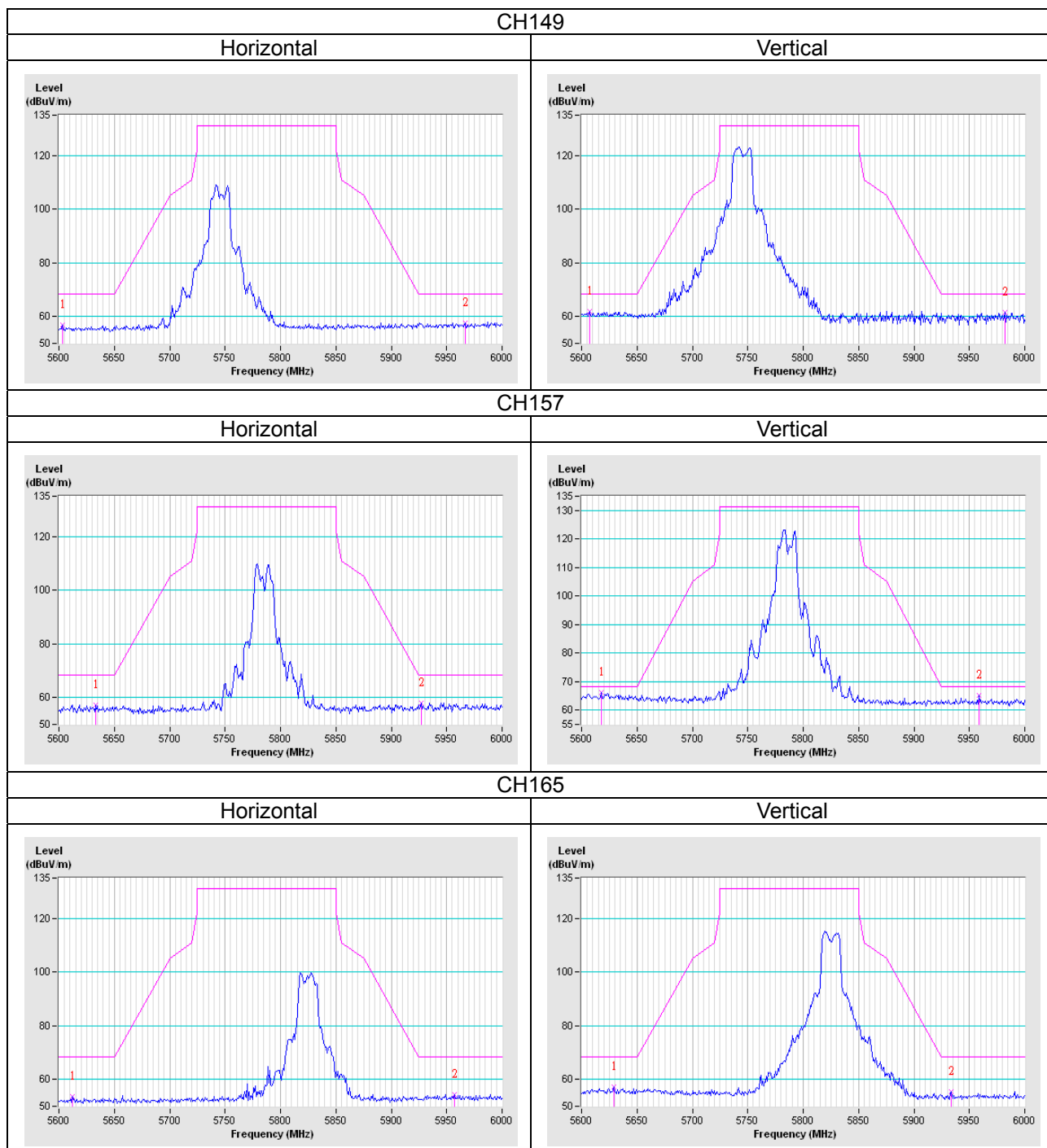


5 Pictures of Test Arrangements

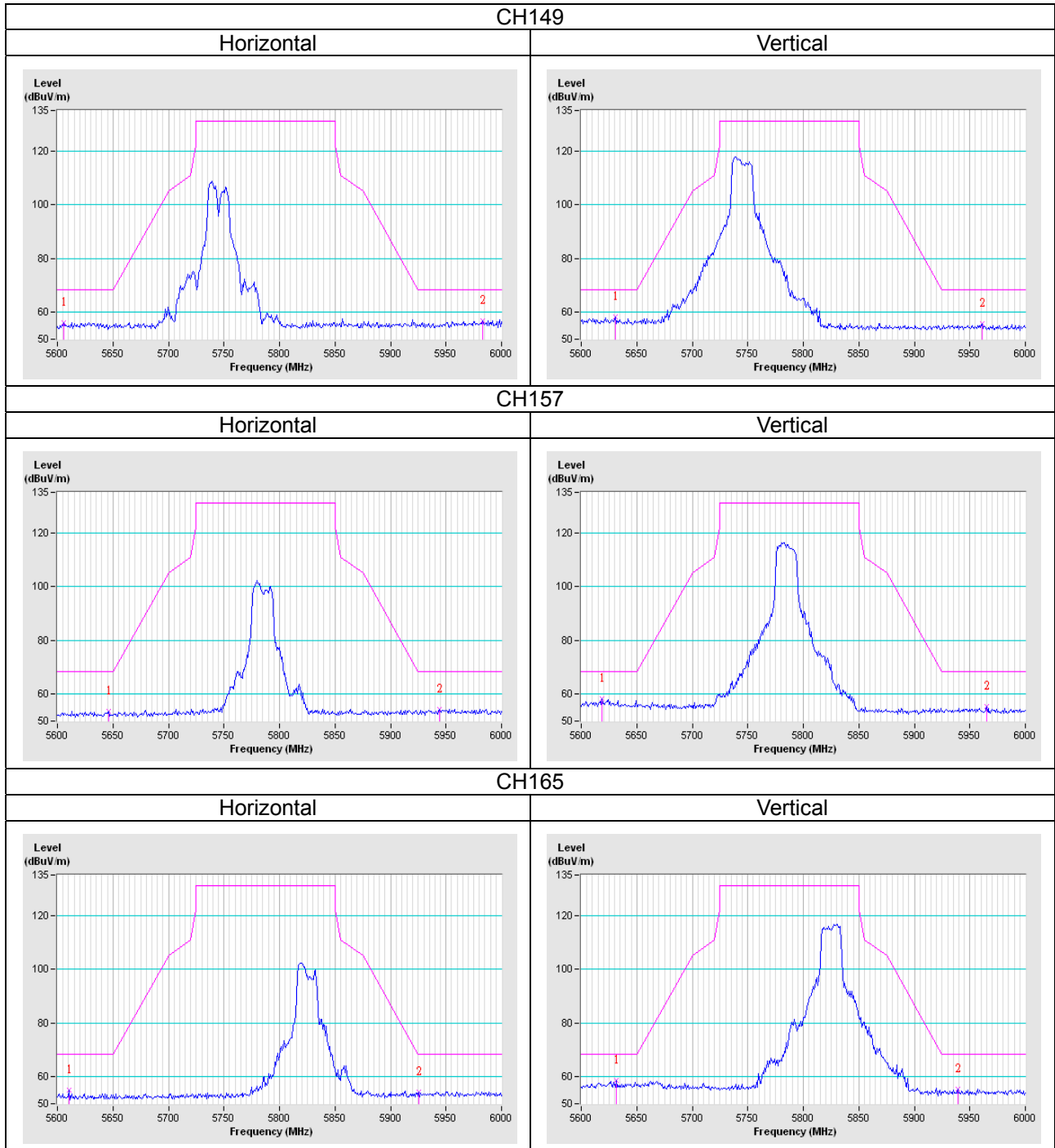
Please refer to the attached file (Test Setup Photo).

Annex A- Radiated Out of Band Emission (OOBE) Measurement (For U-NII-3 band)

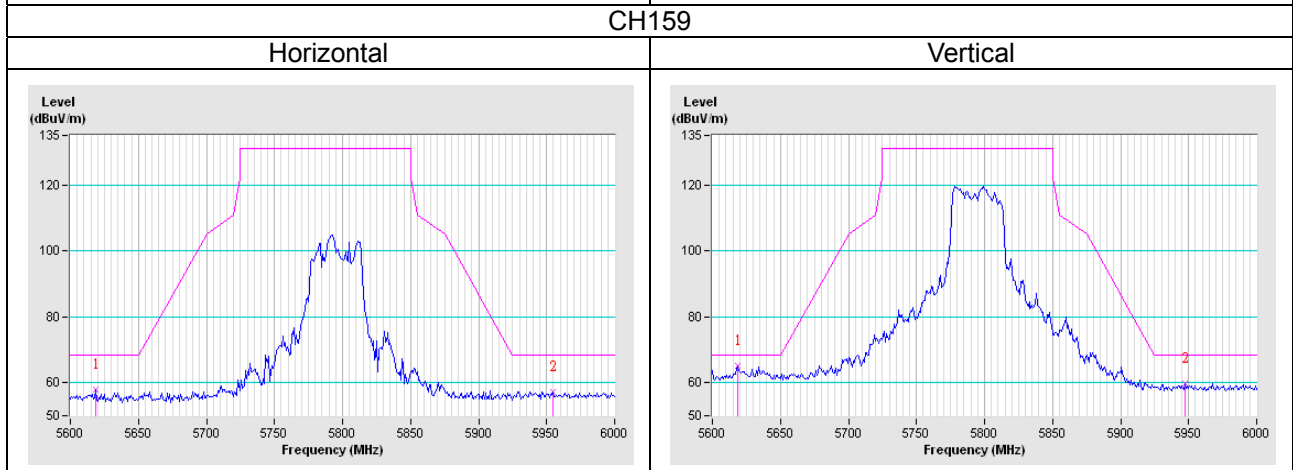
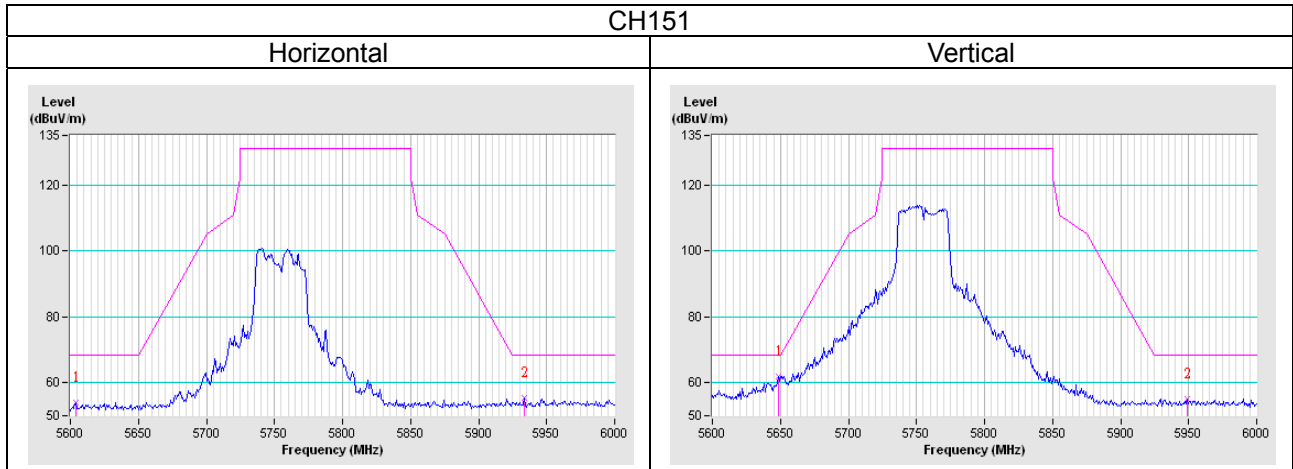
802.11a



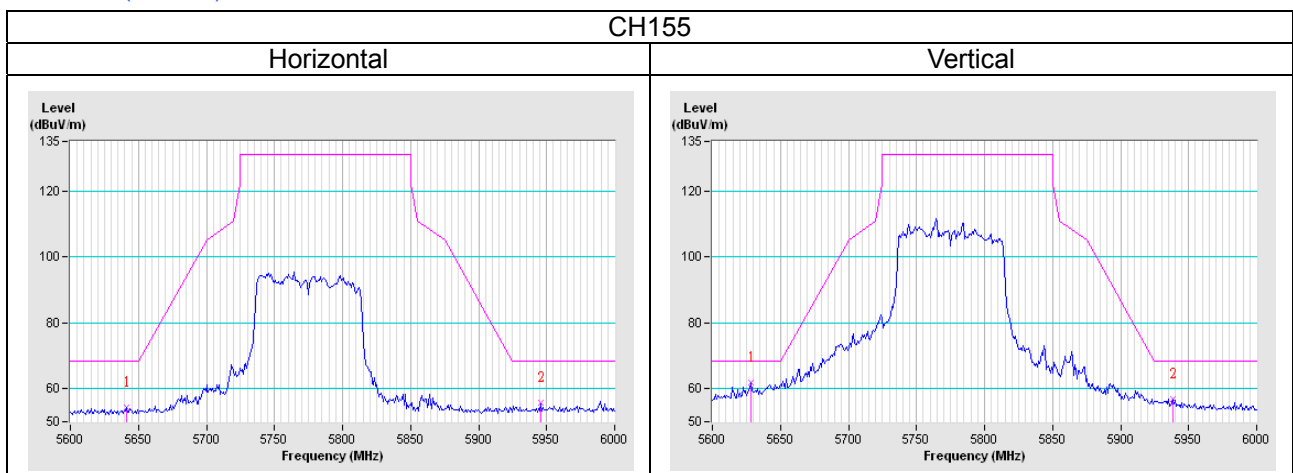
802.11n (HT20)



802.11n (HT40)



802.11ac (VHT80)



Appendix – Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Linko EMC/RF Lab

Tel: 886-2-26052180

Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab

Tel: 886-3-6668565

Fax: 886-3-6668323

Hwa Ya EMC/RF/Safety

Tel: 886-3-3183232

Fax: 886-3-3270892

Email: service.adt@tw.bureauveritas.com

Web Site: www.bureauveritas-adt.com

The address and road map of all our labs can be found in our web site also.

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