FCC Test Report (WLAN)

Report No.:	RF170816E07D-1
FCC ID:	PPD-QCNFA344AH
Test Model:	QCNFA344A
Received Date:	Jan. 03, 2018
Test Date:	Jan. 20 to 23, 2018
Issued Date:	Apr. 11, 2018
Applicant:	Qualcomm Atheros, Inc.
Address:	1700 Technology Dr San Jose California 95110 United States
Issued By:	Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory
Lab Address:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan R.O.C.
Test Location:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan R.O.C.
FCC Registration / Designation Number:	723255 / TW2022

Testing Laboratory
2022

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Release Control Record

Issue No.	Description	Date Issued
RF170816E07D-1	Original release.	Apr. 11, 2018

1 Certificate of Conformity

Product:	802.11a/b/g/n/ac + BT 4.1 M.2 2230 Type Card
Brand:	Qualcomm Atheros
Test Model:	QCNFA344A
Sample Status:	R&D SAMPLE
Applicant:	Qualcomm Atheros, Inc.
Test Date:	Jan. 20 to 23, 2018
Standard:	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 EMC characteristics under the conditions specified in this report.

Prepared by : _____ , **Date:** Apr. 11, 2018

Wendy Wu / Specialist

Approved by : _____ , **Date:** Apr. 11, 2018

May Chen / 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) (1/2/3/4(i/ii)/6)	Radiated Emissions & Band Edge Measurement*	Pass	Meet the requirement of limit.
15.407(a)(1/2/3)	Max Average Transmit Power	Pass	Meet the requirement of limit.
15.203	Antenna Requirement	Pass	Antenna connector is IPEX and RSMA not a standard connector.

*For U-NII-3 band compliance with rule part 15.407(b)(4)(i), the OOBE 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) (±)
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	5.10 dB
	6GHz ~ 18GHz	4.85 dB
	18GHz ~ 40GHz	5.24 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT (WLAN)

Product	802.11a/b/g/n/ac + BT 4.1 M.2 2230 Type Card
Brand	Qualcomm Atheros
Test Model	QCNFA344A
Status of EUT	R&D SAMPLE
Power Supply Rating	3.3Vdc form host equipment
Modulation Type	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM 256QAM for OFDM in 11ac mode and VHT (20/40) mode in 2.4GHz
Modulation Technology	DSSS,OFDM
Transfer Rate	802.11b: up to 11Mbps 802.11a/g: up to 54Mbps 802.11n : up to 300Mbps 802.11ac: up to 866.7Mbps
Operating Frequency	**2.4GHz:** 2.412 ~ 2.472GHz **5GHz:** 5.18 ~ 5.24GHz, 5.26 ~ 5.32GHz, 5.50 ~ 5.72GHz, 5.745 ~ 5.825GHz
Number of Channel	**2.4GHz:** 802.11b, 802.11g, 802.11n (HT20): 13 802.11n (HT40): 9 **5GHz:** 802.11a, 802.11n (HT20), 802.11ac (VHT20): 25 802.11n (HT40), 802.11ac (VHT40): 12 802.11ac (VHT80): 6
Output Power	**2.4GHz:** 492.813mW **5GHz:** **5.18 ~ 5.24GHz:** 70.156mW **5.26 ~ 5.32GHz:** 64.548mW **5.50 ~ 5.72GHz:** 70.881mW **5.745 ~ 5.825GH:** 71.633mW
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	NA
Data Cable Supplied	NA

Note:

1. This report is prepared for FCC class II permissive change. The difference compared with the Report No.: RF150107E06B as the following:
   - Upgrade the standard to section 15.407 under new rule.
   - Added new Antenna as following table:

Original

Antenna set 1

Transmitter Circuit	Brand	Model	Ant. Type	2.4GHz Gain with cable loss (dBi)	5GHz Gain with cable loss (dBi)	2.4GHz Cable Loss (dB)	5G Cable Loss (dB)	Connector Type	Cable Length (mm)
Chain (0)	WNC	81-EBJ15.005	PIFA	3.00	Band 1&2: 2.56 Band 3: 4.76 Band 4: 4.76	1.15	Band 1&2: 1.70 Band 3: 1.74 Band 4: 1.79	IPEX	300
Chain (1)	WNC	81-EBJ15.005	PIFA	3.62	Band 1&2: 3.08 Band 3: 3.31 Band 4: 2.42	1.15	Band 1&2: 1.70 Band 3: 1.74 Band 4: 1.79	IPEX	300

Newly

Antenna set 2

Transmitter Circuit	Brand	Model	Ant. Type	2.4GHz Gain with cable loss (dBi)	5GHz Gain with cable loss (dBi)	2.4GHz Cable Loss (dB)	5G Cable Loss (dB)	Ant. Connector Type	Cable Connector Type	Cable Length (mm)
Chain (0)	HONGBO	290-30641	Dipole	1.64	Band 1&2: 2.6 Band 3: 2.22 Band 4: 2.38	0.51	Band 1&2: 0.78 Band 3: 0.61 Band 4: 0.81	RSMA	IPEX to RSMA	210
Chain (1)	HONGBO	290-30641	Dipole	1.64	Band 1&2: 2.6 Band 3: 2.22 Band 4: 2.38	0.51	Band 1&2: 0.78 Band 3: 0.61 Band 4: 0.81	RSMA	IPEX to RSMA	210

Antenna set 3

Transmitter Circuit	Brand	Model	Ant. Type	2.4GHz Gain with cable loss (dBi)	5GHz Gain with cable loss (dBi)	2.4GHz Cable Loss (dB)	5G Cable Loss (dB)	Ant. Connector Type	Cable Connector Type	Cable Length (mm)
Chain (0)	Speed	F.0G.LS-6008-003-00	Dipole	-1.22	Band 1&2: 1.17 Band 3: 1.48 Band 4: 0.38	0.50	Band 1&2: 0.74 Band 3: 0.75 Band 4: 0.76	RSMA	IPEX to RSMA	210
Chain (1)	Speed	F.0G.LS-6008-003-00	Dipole	-1.22	Band 1&2: 1.17 Band 3: 1.48 Band 4: 0.38	0.50	Band 1&2: 0.74 Band 3: 0.75 Band 4: 0.76	RSMA	IPEX to RSMA	210

Note: From the above newly antennas, model: **290-30641** was selected as representative model for the test and its data was recorded in this report.

2. According to above conditions, only OOBE test plots, Conducted power and Radiated Emissions (802.11ac (VHT80) – CH106 to verify Dipole antenna) test item need to be performed. And all data was verified to meet the requirements.
3. There are Bluetooth technology and WLAN technology used for the EUT.

4. The EUT incorporates a 2T2R function.

2.4GHz Band			
MODULATION MODE	**DATA RATE (MCS)**	**TX & RX CONFIGURATION**	
802.11b	1 ~ 11Mbps	2TX	2RX
802.11g	6 ~ 54Mbps	2TX	2RX
802.11n (HT20)	MCS 0~7	2TX	2RX
	MCS 8~15	2TX	2RX
802.11n (HT40)	MCS 0~7	2TX	2RX
	MCS 8~15	2TX	2RX
VHT20	MCS 0~8, Nss=1	2TX	2RX
	MCS 0~8, Nss=2	2TX	2RX
VHT40	MCS 0~9, Nss=1	2TX	2RX
	MCS 0~9, Nss=2	2TX	2RX
5GHz Band			
MODULATION MODE	**DATA RATE (MCS)**	**TX & RX CONFIGURATION**	
802.11a	6 ~ 54Mbps	2TX	2RX
802.11n (HT20)	MCS 0~7	2TX	2RX
	MCS 8~15	2TX	2RX
802.11n (HT40)	MCS 0~7	2TX	2RX
	MCS 8~15	2TX	2RX
802.11ac (VHT20)	MCS 0~8, Nss=1	2TX	2RX
	MCS 0~8, Nss=2	2TX	2RX
802.11ac (VHT40)	MCS 0~9, Nss=1	2TX	2RX
	MCS 0~9, Nss=2	2TX	2RX
802.11ac (VHT80)	MCS 0~9, Nss=1	2TX	2RX
	MCS 0~9, Nss=2	2TX	2RX

Note: 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)

5. The EUT was pre-tested under the following modes:

Test Mode	Data rate
Mode A	400ns GI
Mode B	**800ns GI**

From the above modes, the worst case was found in **Mode B**. Therefore only the test data of the mode was recorded in this report.

6. WLAN/BT coexistence mode:

- 2x2 WLAN + BT:
  - 5GHz 802.11a/an (or 11ac) transmit concurrent with BT.
  - 2.4GHz: timely shared coexistence.

7. The emission (conducted & radiated emission) of the simultaneous operation (WiFi <5GHz> & Bluetooth) have been evaluated and no non-compliance found. The detail combinations of transmitters / frequencies / modes as below table

Mode	Available Channel	Tested Channel	Modulation Technology
5 GHz (802.11a) + Bluetooth (GFSK)	149 to 165	157	OFDM
	0 to 78	39	FHSS

8. The above EUT information was declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

FOR 5180 ~ 5240MHz

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

Channel	Frequency	Channel	Frequency
36	5180 MHz	44	5220 MHz
40	5200 MHz	48	5240 MHz

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

Channel	Frequency	Channel	Frequency
38	5190 MHz	46	5230 MHz

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency
42	5210 MHz

FOR 5260 ~ 5320MHz

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

Channel	Frequency	Channel	Frequency
52	5260 MHz	60	5300 MHz
56	5280 MHz	64	5320 MHz

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

Channel	Frequency	Channel	Frequency
54	5270 MHz	62	5310 MHz

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency
58	5290 MHz

FOR 5500 ~ 5720MHz

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

Channel	Frequency	Channel	Frequency
100	5500 MHz	124	5620 MHz
104	5520 MHz	128	5640 MHz
108	5540 MHz	132	5660 MHz
112	5560 MHz	136	5680 MHz
116	5580 MHz	140	5700 MHz
120	5600 MHz	144	5720 MHz

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

Channel	Frequency	Channel	Frequency
102	5510 MHz	126	5630 MHz
110	5550 MHz	134	5670 MHz
118	5590 MHz	142	5710 MHz

3 channels are provided for 802.11ac (VHT80):

Channel	Frequency	Channel	Frequency
106	5530 MHz	138	5690 MHz
122	5610 MHz		

FOR 5745 ~ 5825MHz:

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

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

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

Channel	Frequency	Channel	Frequency
151	5755 MHz	159	5795 MHz

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency
155	5775 MHz

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable To		Description
	APCM	RE≥1G	
-	√	√	-

Where **APCM:** Antenna Port Conducted Measurement **RE≥1G:** Radiated Emission above 1GHz & Bandedge Measurement

Note: The EUT's antenna (Dipole) had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Y-plane**.

Radiated Emission Test (Above 1GHz):

☒ Following channel(s) was (were) selected for the final test as listed below.

Mode	FREQ. Band (MHz)	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
802.11ac (VHT80)	5180-5240 5260-5320 5500-5720 5745-5825	42 58 106, 122, 138 155	106	OFDM	BPSK	29.3

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.

Mode	FREQ. Band (MHz)	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
802.11a	5180-5240	36 to 48	36, 40, 48	OFDM	BPSK	6
802.11ac (VHT20)		36 to 48	36, 40, 48	OFDM	BPSK	6.5
802.11ac (VHT40)		38 to 46	38, 46	OFDM	BPSK	13.5
802.11ac (VHT80)		42	42	OFDM	BPSK	29.3
802.11a	5260-5320	52 to 64	52, 60, 64	OFDM	BPSK	6
802.11ac (VHT20)		52 to 64	52, 60, 64	OFDM	BPSK	6.5
802.11ac (VHT40)		54 to 62	54, 62	OFDM	BPSK	13.5
802.11ac (VHT80)		58	58	OFDM	BPSK	29.3
802.11a	5500-5720	100 to 144	100, 116, 140, 144	OFDM	BPSK	6
802.11ac (VHT20)		100 to 144	100, 116, 140, 144	OFDM	BPSK	6.5
802.11ac (VHT40)		102 to 142	102, 110, 134, 142	OFDM	BPSK	13.5
802.11ac (VHT80)		106 to 138	106, 122, 138	OFDM	BPSK	29.3
802.11a	5745-5825	149 to 165	149, 157, 165	OFDM	BPSK	6
802.11ac (VHT20)		149 to 165	149, 157, 165	OFDM	BPSK	6.5
802.11ac (VHT40)		151 to 159	151, 159	OFDM	BPSK	13.5
802.11ac (VHT80)		155	155	OFDM	BPSK	29.3

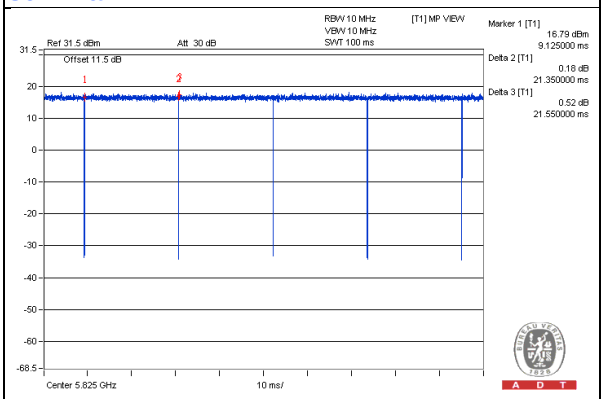
Test Condition:

Applicable To	Environmental Conditions	INPUT POWER (SYSTEM)	TESTED BY
APCM	25deg. C, 60%RH	120Vac, 60Hz	Anderson Chen
RE≥1G	23deg. C, 63%RH	120Vac, 60Hz	Jyunchun Lin

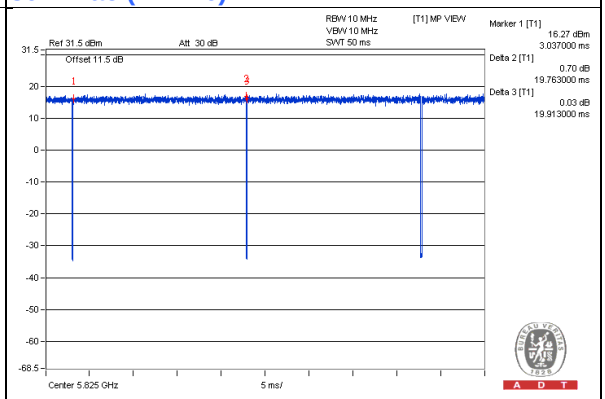
3.3 Duty Cycle of Test Signal

If duty cycle of test signal is ≥ 98 %, duty factor is not required.
If duty cycle of test signal is < 98%, duty factor shall be considered.
802.11a: Duty cycle = 21.35 ms/21.55 ms = 0.991
802.11ac (VHT20): Duty cycle = 19.763 ms/19.913 ms = 0.992
802.11ac (VHT40): Duty cycle = 9.525 ms/9.625 ms = 0.98
802.11ac (VHT80): Duty cycle = 4.43 ms/4.575 ms = 0.968, Duty factor = 10 * log(1/0.968) = 0.14

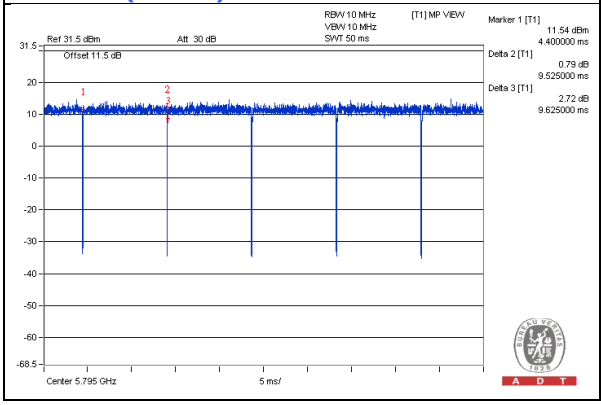
802.11a



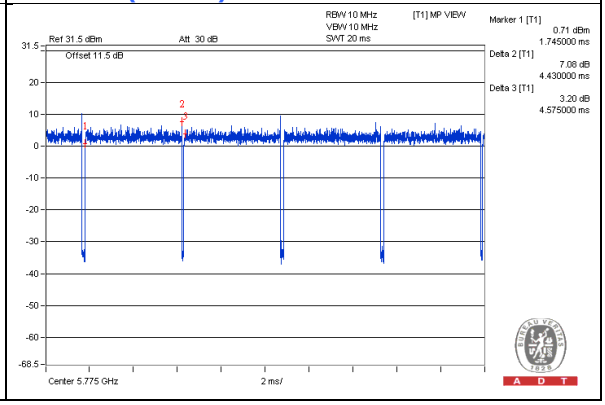
802.11ac (VHT20)



802.11ac (VHT40)



802.11ac (VHT80)



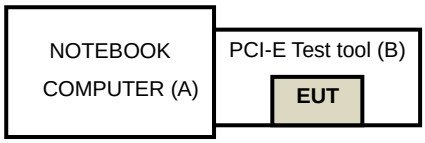
3.4 Description of Support Units

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.

No.	Product	Brand	Model No.	Serial No.	FCC ID	Remark
A	NOTEBOOK COMPUTER	DELL	E5430	HYV4VY1	FCC DoC	Provided by Lab
B	PCI-E Test tool	Qualcomm Atheros	NA	NA	NA	Supplied by Client

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

3.4.1 Configuration of System under Test



3.5 General Description of Applied Standard

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 Transmit Power Measurement

4.1.1 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 ≦ 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)
	√	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,

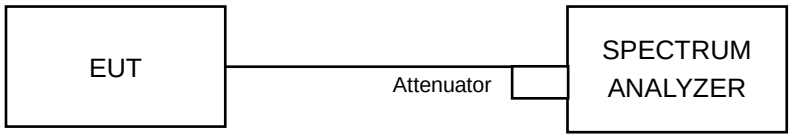
Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};
Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

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

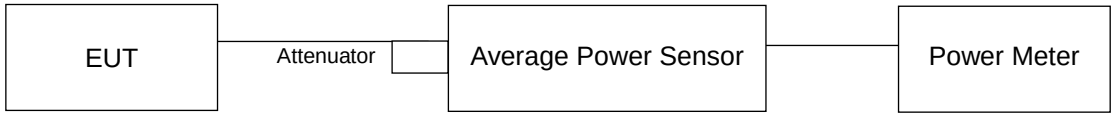
4.1.2 Test Setup

FOR POWER OUTPUT MEASUREMENT

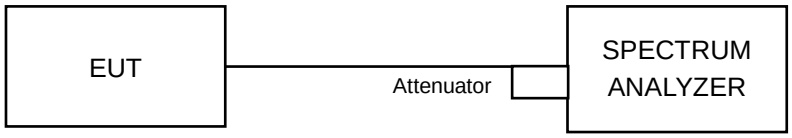
For channel straddling 5725MHz:



For other channels:



FOR 26dB OCCUPIED BANDWIDTH



4.1.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.1.4 Test Procedure

FOR AVERAGE POWER MEASUREMENT

For channel straddling 5725MHz:

Follow FCC KDB 789033 UNII test procedure:

802.11ac (VHT80)

Method SA-2

1. Set span to encompass the emission bandwidth (EBW) of the signal.
2. Set RBW =1MHz.
3. Set the VBW ≥ 3 x RBW.
4. Number of points in sweep ≥ 2 Span / RBW.
5. Sweep time = auto.
6. Detector = RMS.
7. Trace average at least 100 traces in power averaging mode
8. Compute power by integrating the spectrum across the 26 dB EBW of the signal.
9. Duty factor need added to measured value (duty cycle < 98 percent).

Other Modulation mode

Method SA-1

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW =1MHz.
3. Set the VBW ≥ 3 x RBW.
4. Number of points in sweep ≥ 2 Span / RBW.
5. Sweep time = auto.
6. Set trigger to free run (duty cycle ≥ 98 percent) ; Set video trigger (duty cycle < 98 percent)
7. Detector = RMS.
8. Trace average at least 100 traces in power averaging mode
9. Compute power by integrating the spectrum across the 26 dB EBW of the signal.

For other channels:

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 26dB OCCUPIED BANDWIDTH

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Measure the maximum width of the emission that is 26 dB down from the peak 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%.

4.1.5 Deviation from Test Standard

No deviation.

4.1.6 EUT Operating Condition

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

4.1.7 Test Result

802.11a

POWER OUTPUT

Chan.	Chan. Freq. (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
36	5180	13.21	13.95	45.772	16.61	23.91	Pass
40	5200	15.14	15.74	70.156	18.46	23.91	Pass
48	5240	14.93	15.55	67.009	18.26	23.91	Pass
52	5260	14.88	14.84	61.24	17.87	23.91	Pass
60	5300	14.84	14.75	60.333	17.81	23.91	Pass
64	5320	14.03	13.81	49.337	16.93	23.90	Pass
100	5500	13.15	13.81	44.698	16.50	22.23	Pass
116	5580	14.85	15.15	63.283	18.01	22.23	Pass
140	5700	13.67	14.09	48.926	16.90	22.21	Pass
*144 (UNII-2C Band)	5720	9.34	8.98	16.497	12.17	21.02	Pass
*144 (UNII-3 Band)	5720	2.23	1.73	3.16	5.00	28.23	Pass
149	5745	13.18	14.21	47.16	16.74	28.23	Pass
157	5785	15.31	15.76	71.633	18.55	28.23	Pass
165	5825	14.98	15.32	65.518	18.16	28.23	Pass

* Test was performed in accordance with Measurement follow FCC KDB 789033 UNII test procedure Method SA-1 and use spectrum analyzer test.

The Total Power for the straddle channel:

Chan.	Chan. Freq. (MHz)	Average Power (mW)	Average Power (dBm)
*144	5720	19.657	12.94
Note: The total power was calculated through formula and record the value for reference only.			

Note:

5150~5250MHz: Directional gain = 3.08dBi + 10log(2) = 6.09dBi > 6dBi , so the power limit shall be reduced to 24-(6.09-6).

5250~5350MHz: Directional gain = 3.08dBi + 10log(2) = 6.09dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(6.09-6)”.

5470~5725MHz: Directional gain = 4.76dBi + 10log(2) = 7.77dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(7.77-6)”.

5725~5850MHz: Directional gain = 4.76dBi + 10log(2) = 7.77dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(7.77-6)”.

26dB OCCUPIED BANDWIDTH

Channel	Frequency (MHz)	26dBc Bandwidth (MHz)	
		Chain 0	Chain 1
36	5180	20.10	20.24
40	5200	32.22	36.28
48	5240	35.30	34.02
52	5260	21.82	21.21
60	5300	23.54	25.49
64	5320	20.99	19.93
100	5500	20.05	20.41
116	5580	22.26	23.06
140	5700	19.89	19.93
144 (UNII-2C Band)	5720	15.47	15.11

Note: For U-NII-2A, U-NII-2C Band output power limitation is determined based on 26dBc bandwidth

Power Limit = 11dBm + 10logB < U-NII-2A, U-NII-2C >			
Channel Number	Freq.(MHz)	Min. B(MHz)	Determined Conducted Limit (dBm)
52	5260	21.21	24.26 > 24
60	5300	23.54	24.71 > 24
64	5320	19.93	23.99 < 24
100	5500	20.05	24.02 > 24
116	5580	22.26	24.47 > 24
140	5700	19.89	23.98 < 24
144 (UNII-2C Band)	5720	15.11	22.79 < 24

802.11ac (VHT20)

POWER OUTPUT

Chan.	Chan. Freq. (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
36	5180	15.31	13.81	58.007	17.63	23.91	Pass
40	5200	15.21	15.62	69.664	18.43	23.91	Pass
48	5240	15.02	15.14	64.428	18.09	23.91	Pass
52	5260	15.26	14.91	64.548	18.10	23.91	Pass
60	5300	14.76	14.83	60.332	17.81	23.91	Pass
64	5320	14.05	14.13	51.292	17.10	23.91	Pass
100	5500	13.02	13.26	41.229	16.15	22.23	Pass
116	5580	15.50	15.49	70.881	18.51	22.23	Pass
140	5700	13.57	13.65	45.925	16.62	22.23	Pass
*144 (UNII-2C Band)	5720	9.64	9.33	17.774	12.50	21.23	Pass
*144 (UNII-3 Band)	5720	2.84	2.62	3.751	5.74	28.23	Pass
149	5745	12.98	13.88	44.295	16.46	28.23	Pass
157	5785	15.03	15.48	67.16	18.27	28.23	Pass
165	5825	14.96	15.27	64.984	18.13	28.23	Pass

* Test was performed in accordance with Measurement follow FCC KDB 789033 UNII test procedure Method SA-1 and use spectrum analyzer test.

The Total Power for the straddle channel:

Chan.	Chan. Freq. (MHz)	Average Power (mW)	Average Power (dBm)
*144	5720	21.525	13.33
Note: The total power was calculated through formula and record the value for reference only.			

Note:

5150~5250MHz: Directional gain = 3.08dBi + 10log(2) = 6.09dBi > 6dBi , so the power limit shall be reduced to 24-(6.09-6).

5250~5350MHz: Directional gain = 3.08dBi + 10log(2) = 6.09dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(6.09-6)”.

5470~5725MHz: Directional gain = 4.76dBi + 10log(2) = 7.77dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(7.77-6)”.

5725~5850MHz: Directional gain = 4.76dBi + 10log(2) = 7.77dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(7.77-6)”.

26dB OCCUPIED BANDWIDTH

Channel	Frequency (MHz)	26dBc Bandwidth (MHz)	
		Chain 0	Chain 1
36	5180	20.94	20.61
40	5200	34.20	34.68
48	5240	31.13	24.89
52	5260	21.57	21.49
60	5300	24.47	23.91
64	5320	26.81	21.43
100	5500	20.59	21.07
116	5580	24.28	25.22
140	5700	21.21	21.31
144 (UNII-2C Band)	5720	16.05	15.88

Note: For U-NII-2A, U-NII-2C Band output power limitation is determined based on 26dBc bandwidth

Power Limit = 11dBm + 10logB < U-NII-2A, U-NII-2C >			
Channel Number	Freq.(MHz)	Min. B(MHz)	Determined Conducted Limit (dBm)
52	5260	21.49	24.32 > 24
60	5300	23.91	24.78 > 24
64	5320	21.43	24.31 > 24
100	5500	20.59	24.13 > 24
116	5580	24.28	24.85 > 24
140	5700	21.21	24.26 > 24
144 (UNII-2C Band)	5720	15.88	23 < 24

802.11ac (VHT40)

POWER OUTPUT

Chan.	Chan. Freq. (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
38	5190	8.97	9.41	16.619	12.21	23.91	Pass
46	5230	14.41	14.83	58.015	17.64	23.91	Pass
54	5270	14.43	14.33	54.835	17.39	23.91	Pass
62	5310	11.65	11.87	30.004	14.77	23.91	Pass
102	5510	9.00	9.59	17.042	12.32	22.23	Pass
110	5550	14.20	14.23	52.788	17.23	22.23	Pass
134	5670	12.94	13.65	42.853	16.32	22.23	Pass
*142 (UNII-2C Band)	5710	9.22	8.97	16.245	12.11	22.23	Pass
*142 (UNII-3 Band)	5710	-3.69	-3.86	0.8387	-0.76	28.23	Pass
151	5755	8.99	10.46	19.042	12.80	28.23	Pass
159	5795	13.47	13.53	44.775	16.51	28.23	Pass

* Test was performed in accordance with Measurement follow FCC KDB 789033 UNII test procedure Method SA-1 and use spectrum analyzer test.

The Total Power for the straddle channel:

Chan.	Chan. Freq. (MHz)	Average Power (mW)	Average Power (dBm)
*142	5710	17.0837	12.33
Note: The total power was calculated through formula and record the value for reference only.			

Note:

5150~5250MHz: Directional gain = 3.08dBi + 10log(2) = 6.09dBi > 6dBi , so the power limit shall be reduced to 24-(6.09-6).

5250~5350MHz: Directional gain = 3.08dBi + 10log(2) = 6.09dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(6.09-6)”.

5470~5725MHz: Directional gain = 4.76dBi + 10log(2) = 7.77dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(7.77-6)”.

5725~5850MHz: Directional gain = 4.76dBi + 10log(2) = 7.77dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(7.77-6)”.

26dB OCCUPIED BANDWIDTH

Channel	Frequency (MHz)	26dBc Bandwidth (MHz)	
		Chain 0	Chain 1
38	5190	42.79	41.79
46	5230	57.71	56.06
54	5270	49.48	55.12
62	5310	42.85	42.64
102	5510	43.93	42.02
110	5550	43.18	47.09
134	5670	44.17	42.40
142 (UNII-2C Band)	5710	36.46	38.81

Note: For U-NII-2A, U-NII-2C Band output power limitation is determined based on 26dBc bandwidth

Power Limit = 11dBm + 10logB < U-NII-2A, U-NII-2C >			
Channel Number	Freq.(MHz)	Min. B(MHz)	Determined Conducted Limit (dBm)
54	5270	49.48	27.94 > 24
62	5310	42.64	27.29 > 24
102	5510	42.02	27.23 > 24
110	5550	43.18	27.35 > 24
134	5670	42.40	27.27 > 24
142 (UNII-2C Band)	5710	36.46	26.61 > 24

802.11ac (VHT80)

POWER OUTPUT

Chan.	Chan. Freq. (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
42	5210	7.85	8.57	13.289	11.23	23.91	Pass
58	5290	9.78	9.82	19.1	12.81	23.91	Pass
106	5530	9.58	10.09	19.287	12.85	22.23	Pass
122	5610	13.46	13.75	45.896	16.62	22.23	Pass
*138 (UNII-2C Band)	5690	7.87	7.78	12.519	10.98	22.23	Pass
*138 (UNII-3 Band)	5690	-9.85	-10.33	0.20261	-6.93	28.23	Pass
155	5775	7.22	8.61	12.533	10.98	28.23	Pass

* Test was performed in accordance with Measurement follow FCC KDB 789033 UNII test procedure Method SA-2 and use spectrum analyzer test.

The Total Power for the straddle channel:

Chan.	Chan. Freq. (MHz)	Average Power (mW)	Average Power (dBm)
138	5690	12.72161	11.05
Note: The total power was calculated through formula and record the value for reference only.			

Note:

5150~5250MHz: Directional gain = 3.08dBi + 10log(2) = 6.09dBi > 6dBi , so the power limit shall be reduced to 24-(6.09-6).

5250~5350MHz: Directional gain = 3.08dBi + 10log(2) = 6.09dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(6.09-6)”.

5470~5725MHz: Directional gain = 4.76dBi + 10log(2) = 7.77dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(7.77-6)”.

5725~5850MHz: Directional gain = 4.76dBi + 10log(2) = 7.77dBi > 6dBi , so the power limit shall be reduced to “Determined Conducted Limit-(7.77-6)”.

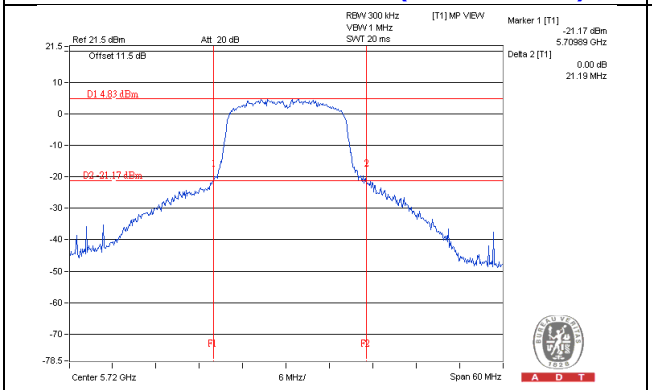
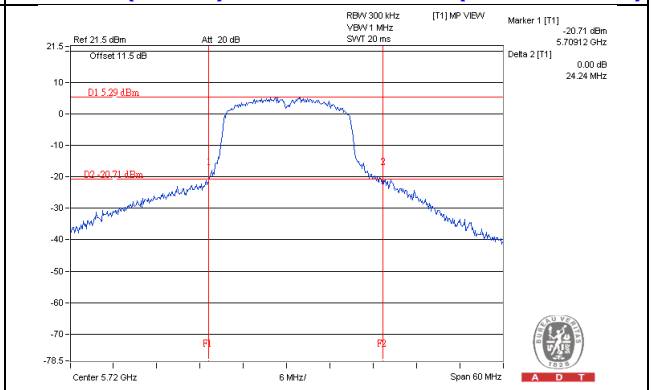
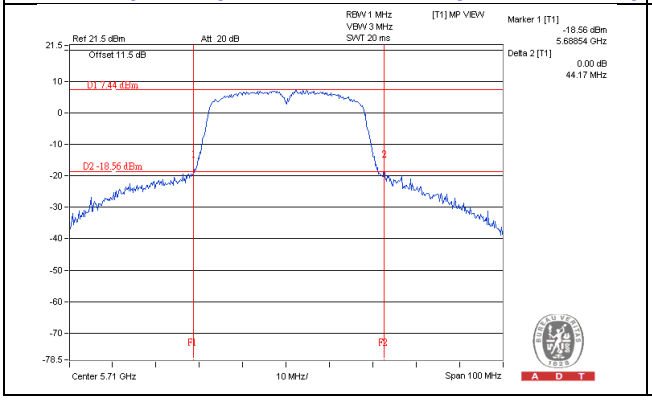
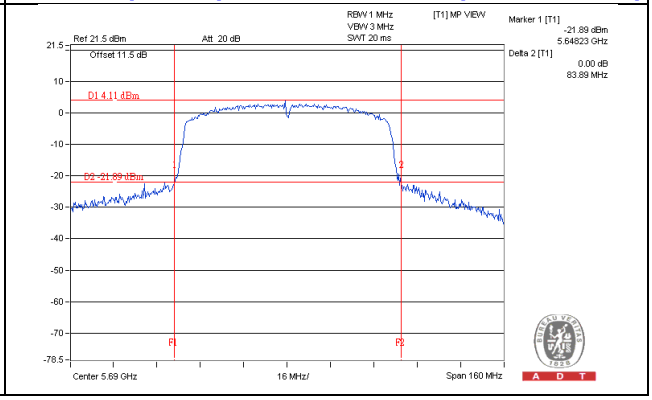
For CH138: Total power (dBm)= Average power <Chain 0 +1>(dBm) + Duty Factor (0.11dB)

26dB OCCUPIED BANDWIDTH

Channel	Frequency (MHz)	26dBc Bandwidth (MHz)	
		Chain 0	Chain 1
42	5210	81.57	83.36
58	5290	83.07	84.06
106	5530	83.72	82.46
122	5610	88.22	91.89
138 (UNII-2C Band)	5690	79.30	76.77

Note: For U-NII-2A, U-NII-2C Band output power limitation is determined based on 26dBc bandwidth

Power Limit = 11dBm + 10logB < U-NII-2A, U-NII-2C >			
Channel Number	Freq.(MHz)	Min. B(MHz)	Determined Conducted Limit (dBm)
58	5290	83.07	30.19 > 24
106	5530	82.46	30.16 > 24
122	5610	88.22	30.45 > 24
138 (UNII-2C Band)	5690	76.77	29.85 > 24

Spectrum Plot of Worst Value	
802.11a / Chain 1 – CH144 (UNII-2C Band)	**802.11ac (VHT20) / Chain 1 - CH144 (UNII-2C Band)**
	
802.11ac (VHT40) / Chain 0 - CH142(UNII-2C Band)	**802.11ac (VHT80) / Chain 1 - CH138 (UNII-2C Band)**
	

NOTE:

For CH144 (UNII-2C Band) = 5725MHz - Marker 1
For CH142 (UNII-2C Band) = 5725MHz - Marker 1
For CH138 (UNII-2C Band) = 5725MHz - Marker 1

5 Pictures of Test Arrangements

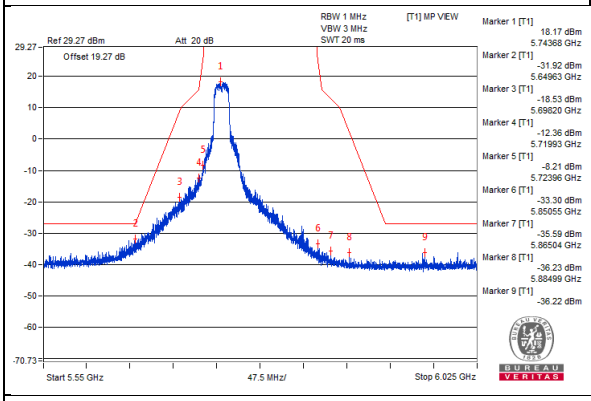
Please refer to the attached file (Test Setup Photo).

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

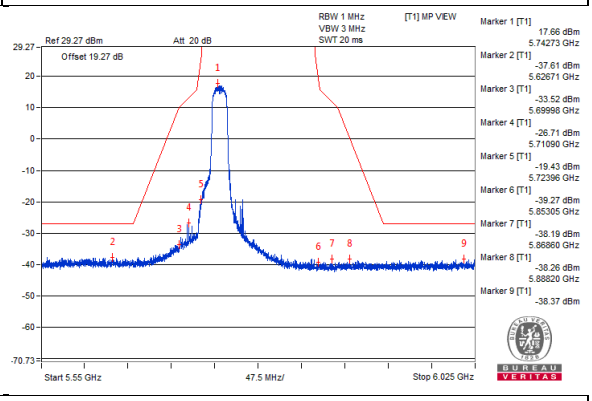
802.11a

CH149

Chain 0

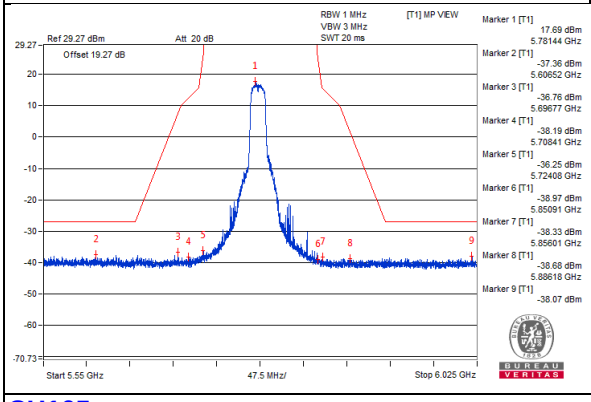


Chain 1

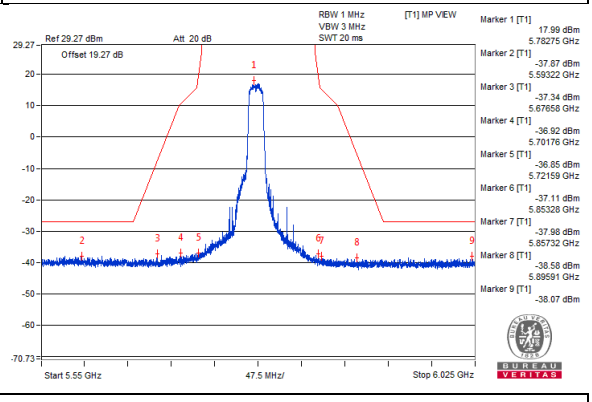


CH157

Chain 0

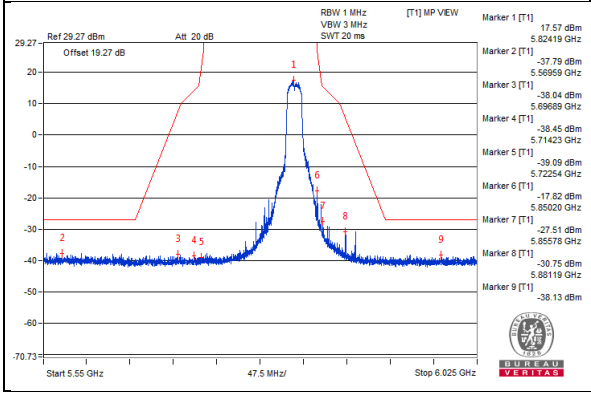


Chain 1

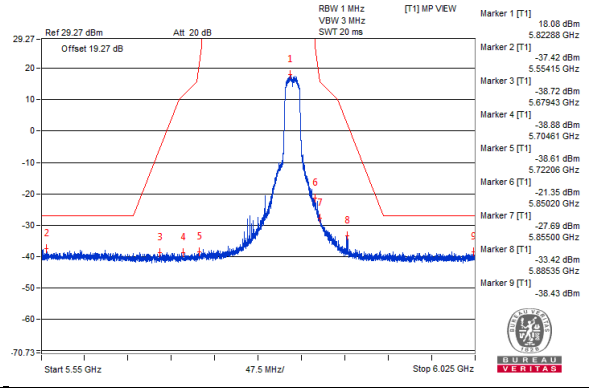


CH165

Chain 0



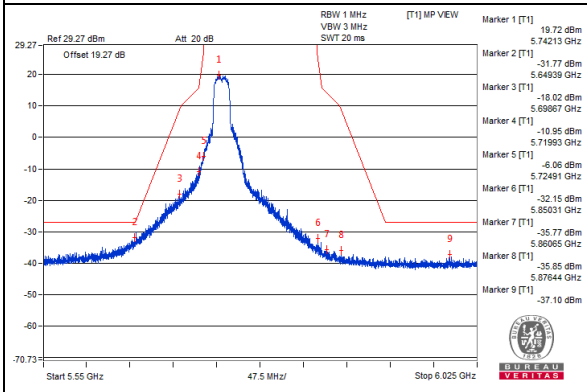
Chain 1



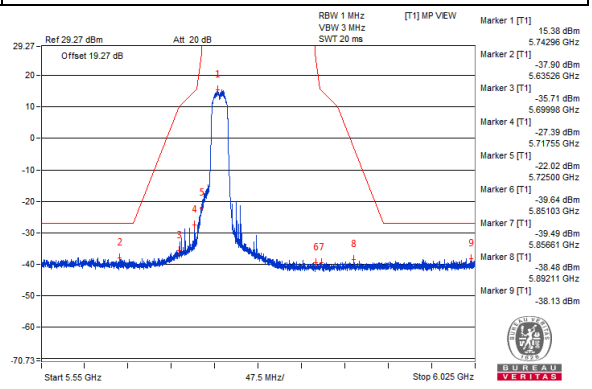
802.11ac (VHT20)

CH149

Chain 0

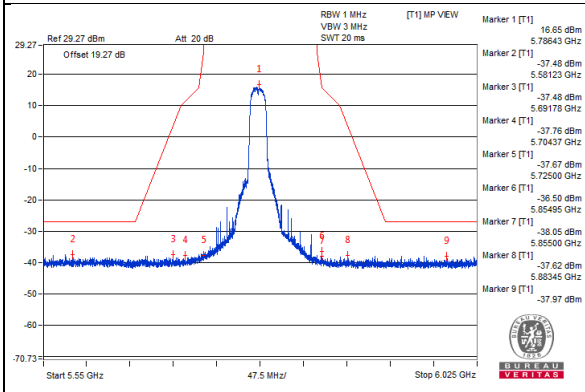


Chain 1

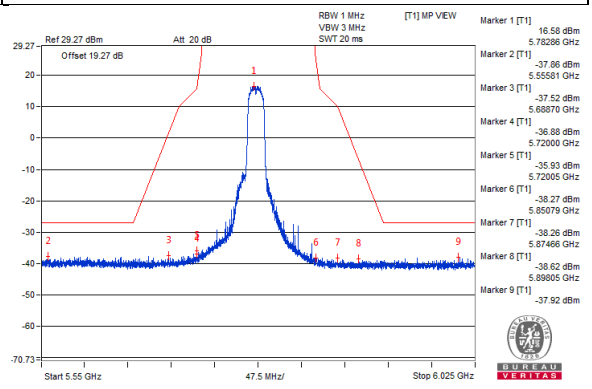


CH157

Chain 0

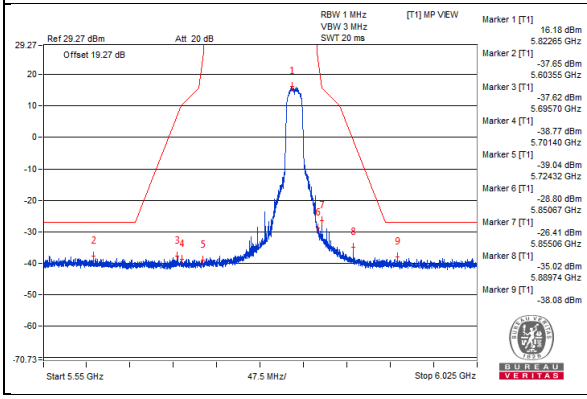


Chain 1

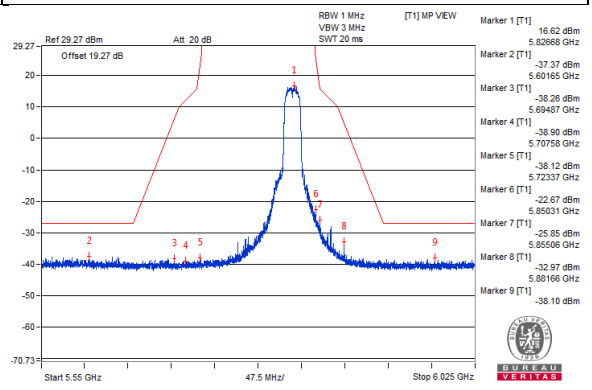


CH165

Chain 0



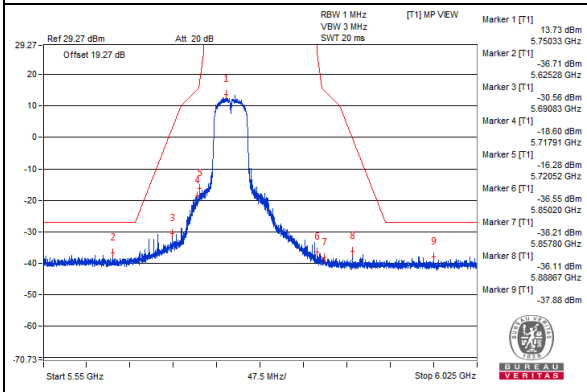
Chain 1



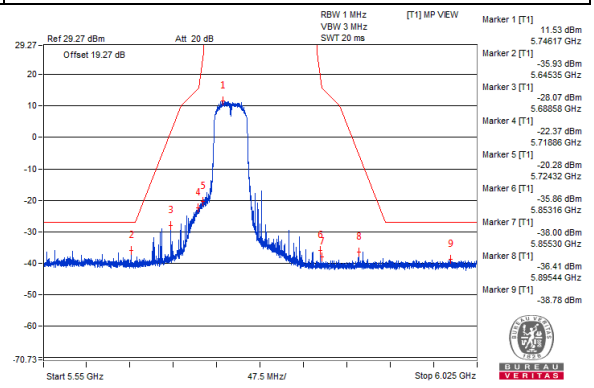
802.11ac (VHT40)

CH151

Chain 0

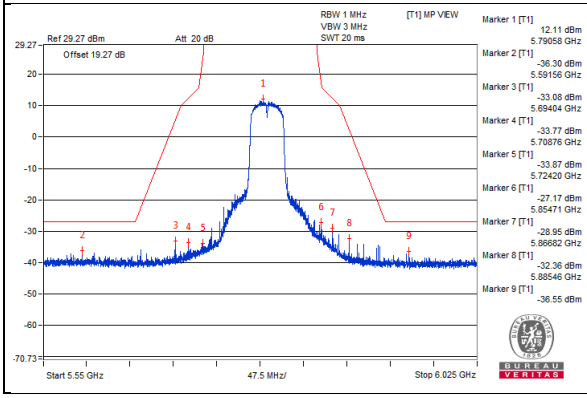


Chain 1

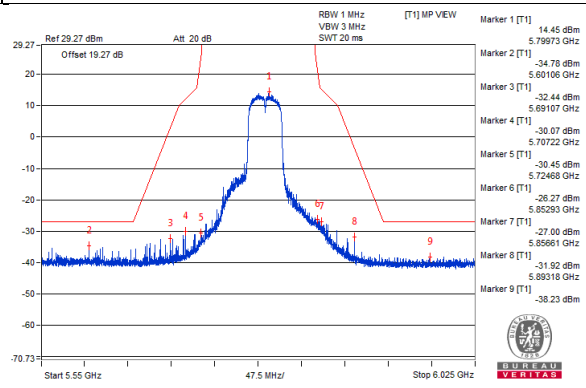


CH159

Chain 0



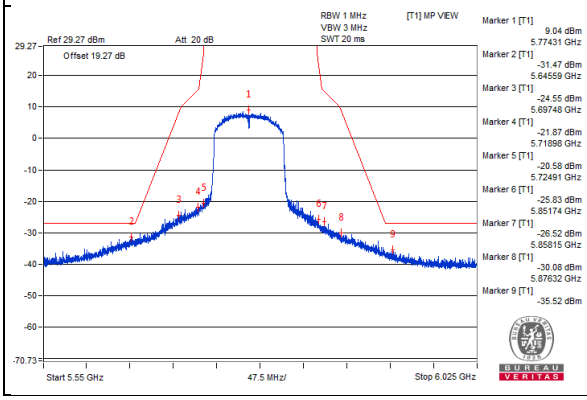
Chain 1



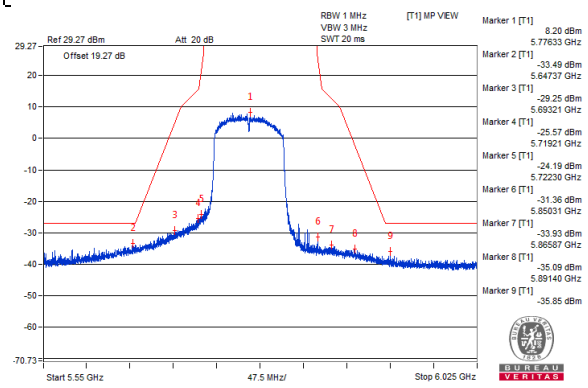
802.11ac (VHT80)

CH155

Chain 0



Chain 1



6 Appendix A – Radiated Emission Measurement

6.1.1 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

<table>
<tr><td colspan="2">Applicable To</td><td colspan="2">Limit</td></tr>
<tr><td colspan="2" rowspan="2">789033 D02 General UNII Test Procedure New Rules v02r01</td><td colspan="2">Field Strength at 3m</td></tr>
<tr><td>PK:74 (dBµV/m)</td><td>AV:54 (dBµV/m)</td></tr>
<tr><td colspan="2">Applicable To</td><td>Eirp Limit</td><td>Equivalent Field Strength at 3m</td></tr>
<tr><td>5150~5250 MHz</td><td>RSS-247 6.2.1.2</td><td rowspan="3">PK:-27 (dBm/MHz)</td><td rowspan="3">PK:68.2(dBµV/m)</td></tr>
<tr><td>5250~5350 MHz</td><td>RSS-247 6.2.2.2</td></tr>
<tr><td>5470~5725 MHz</td><td>RSS-247 6.2.3.2</td></tr>
<tr><td>5725~5850 MHz</td><td>RSS-247 6.2.4.2</td><td>PK:-27 (dBm/MHz) *d
PK:10 (dBm/MHz) *c
PK:15.6 (dBm/MHz) *b
PK:27 (dBm/MHz) *a</td><td>PK: 68.2(dBµV/m) *d
PK:105.2 (dBµV/m) *c
PK: 110.8(dBµV/m) *b
PK:122.2 (dBµV/m) *a</td></tr>
<tr><td colspan="4">a. 27 dBm/MHz at frequencies from the band edges decreasing linearly to 15.6 dBm/MHz at 5 MHz above or below the band edges;
b. 15.6 dBm/MHz at 5 MHz above or below the band edges decreasing linearly to 10 dBm/MHz at 25 MHz above or below the band edges;
c. 10 dBm/MHz at 25 MHz above or below the band edges decreasing linearly to -27 dBm/MHz at 75 MHz above or below the band edges; and
d. -27 dBm/MHz at frequencies more than 75 MHz above or below the band edges.</td></tr>
</table>

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

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

6.1.1 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver Keysight	N9038A	MY54450088	July 08, 2017	July 07, 2018
Horn_Antenna SCHWARZBECK	BBHA 9120D	9120D-783	Dec. 12, 2017	Dec. 11, 2018
Pre-Amplifier EMCI	EMC12630SE	980385	Feb. 02, 2017	Feb. 01, 2018
RF Cable	EMC104-SM-SM-1200 EMC104-SM-SM-2000 EMC104-SM-SM-5000	160923 150318 150321	Feb. 02, 2017 Mar. 29, 2017 Mar. 29, 2017	Feb. 01, 2018 Mar. 28, 2018 Mar. 28, 2018
Pre-Amplifier EMCI	EMC184045SE	980387	Feb. 02, 2017	Feb. 01, 2018
Horn_Antenna SCHWARZBECK	BBHA 9170	BBHA9170608	Dec. 14, 2017	Dec. 13, 2018
RF Cable	SUCOFLEX 102	36432/2 36433/2	Jan. 11, 2018	Jan. 10, 2019
Software	ADT_Radiated_V8.7.08	NA	NA	NA
Antenna Tower & Turn Table Max-Full	MF-7802	MF780208410	NA	NA
Boresight Antenna Fixture	FBA-01	FBA-SIP02	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 966 Chamber No. 4.
3. The CANADA Site Registration No. is 20331-2
4. Tested Date: Jan. 20, 2018

6.1.1 Test Procedures

a. The EUT was placed on the top of a rotating table 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 peak and average detects 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.

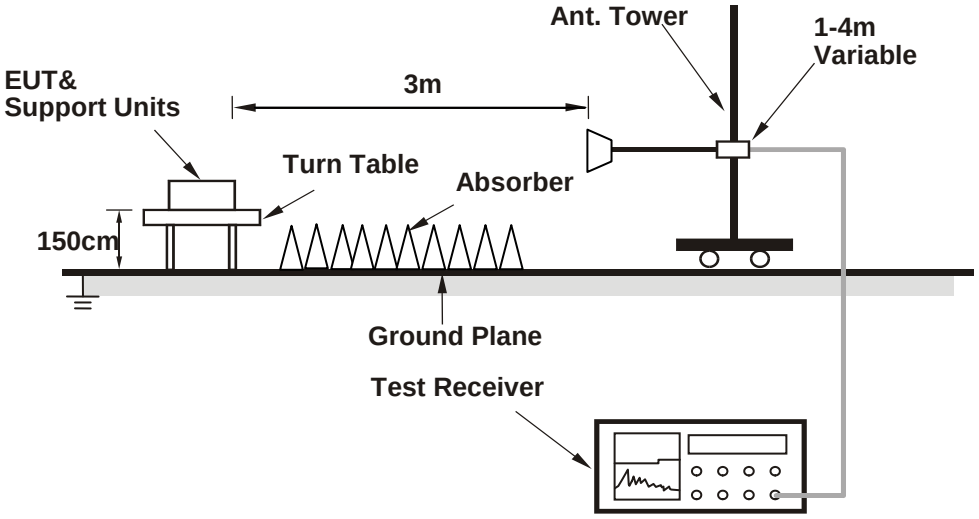
Note:

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

6.1.2 Deviation from Test Standard

No deviation.

6.1.3 Test Setup



6.1.4 EUT Operating Conditions

1. Connect the EUT with the support unit A (Notebook Computer) which is placed on a testing table.
2. The communication partner run test program “QCART Version: 3.0.33.0” to enable EUT under transmission/receiving condition continuously at specific channel frequency.

6.1.1 Test Results

This result was tested by radiated measurement to verify Dipole antenna.

802.11ac (VHT80)

CHANNEL	TX Channel 106	**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	#5469.87	60.6 PK	74.0	-13.4	1.00 H	223	56.3	4.3
2	#5469.87	48.6 AV	54.0	-5.4	1.00 H	223	44.3	4.3
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	#5469.87	65.6 PK	74.0	-8.4	1.83 V	210	61.3	4.3
2	#5469.87	52.8 AV	54.0	-1.2	1.83 V	210	48.5	4.3

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. " # ": The radiated frequency is out of the restricted band.

Appendix B – 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 according to ISO/IEC 17025.

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

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

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