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FCC RADIO TEST REPORT

Applicant's company	**ASUSTeK COMPUTER INC.**
Applicant Address	4F, No. 150, Li-Te Rd., Peitou, Taipei 112, Taiwan
FCC ID	**MSQ-RTGW00**
Manufacturer's company (1)	**ASKEY TECHNOLOGY (JIANG SU) LTD**
Manufacturer Address	NO1388, Jiao Tong Road, Wujiang Economic Technological Development Area Jiangsu Province 215200 China
Manufacturer's company (2)	**Compal Networking (KunShan) Co., LTD.**
Manufacturer Address	No. 520, Nabbang Rd., Economic & Technical Development Zone Kunshan, Jiangsu Province China

Product Name	Wireless-AC3100 Dual Band Gigabit Router
Brand Name	ASUS
Model No.	RT-AC3100,RT-AC88R,RT-AC88U
Test Rule Part(s)	47 CFR FCC Part 15 Subpart E § 15.407
Test Freq. Range	5150 ~ 5250 MHz / 5725 ~ 5850 MHz
Received Date	Apr. 10, 2015
Final Test Date	Apr. 20, 2016
Submission Type	Class II Change

Statement

Test result included is for the IEEE 802.11n and IEEE 802.11a/ac of the product.

The test result in this report refers exclusively to the presented test model / sample.

Without written approval of SPORTON International Inc., the test report shall not be reproduced except in full.

The measurements and test results shown in this test report were made in accordance with the procedures and found in compliance with the limit given in **ANSI C63.10-2013**, **47 CFR FCC Part 15 Subpart E, KDB789033 D02 v01r02, KDB662911 D01 v02r01, KDB644545 D03 v01, ET Docket No. 13–49; FCC 16–24.**

The test equipment used to perform the test is calibrated and traceable to NML/ROC.

Testing Laboratory
1190

Table of Contents

History of This Test Report

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR531828-04	Rev. 01	Initial issue of report	May 09, 2016

1. VERIFICATION OF COMPLIANCE

Product Name	:	Wireless-AC3100 Dual Band Gigabit Router
Brand Name	:	ASUS
Model No.	:	RT-AC3100,RT-AC88R,RT-AC88U
Applicant	:	ASUSTeK COMPUTER INC.
Test Rule Part(s)	:	47 CFR FCC Part 15 Subpart E § 15.407

Sporton International as requested by the applicant to evaluate the EMC performance of the product sample received on Apr. 10, 2015 would like to declare that the tested sample has been evaluated and found to be in compliance with the tested rule parts. The data recorded as well as the test configuration specified is true and accurate for showing the sample's EMC nature.

Sam Chen

SPORTON INTERNATIONAL INC.

2. SUMMARY OF THE TEST RESULT

Verify below items for SKU A - Rev 5.01 (PCB version)

Applied Standard: 47 CFR FCC Part 15 Subpart E				
Part	**Rule Section**	**Description of Test**	**Result**	**Under Limit**
4.2	15.407(b)	Radiated Emissions	Complies	6.76 dB
4.3	15.407(b)	Band Edge Emissions	Complies	0.48 dB
4.4	15.203	Antenna Requirements	Complies	-

Verify below items for SKU B - Rev 5.20 (PCB version). For the applicant's requirement, the test result for harmonic and bandedge are under 2dB and 1dB respectively.

Applied Standard: 47 CFR FCC Part 15 Subpart E				
Part	**Rule Section**	**Description of Test**	**Result**	**Under Limit**
4.1	15.407(a)	Maximum Conducted Output Power	Complies	2.64 dB
4.2	15.407(b)	Radiated Emissions	Complies	4.34 dB
4.3	15.407(b)	Band Edge Emissions	Complies	1.01 dB
4.4	15.203	Antenna Requirements	Complies	-

3. GENERAL INFORMATION

3.1. Product Details

Items	Description
Product Type	For 2.4GHz Band: WLAN (3TX/3RX, 4TX/4RX) For 5GHz Band: WLAN (3TX/3RX, 4TX/4RX)
Radio Type	Intentional Transceiver
Power Type	From power adapter
Modulation	IEEE 802.11a: OFDM IEEE 802.11n/ac: see the below table
Data Modulation	IEEE 802.11a/n: OFDM (BPSK / QPSK / 16QAM / 64QAM) IEEE 802.11ac: OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM, 1024QAM)
Data Rate (Mbps)	IEEE 802.11a: OFDM (6/9/12/18/24/36/48/54) IEEE 802.11n/ac: see the below table
Frequency Range	5150 ~ 5250 MHz / 5725 ~ 5850 MHz
Channel Number	9 for 20MHz bandwidth ; 4 for 40MHz bandwidth 2 for 80MHz bandwidth
Maximum Conducted Output Power	**<For Non-Beamforming Mode>** Band 1: IEEE 802.11ac MCS0/Nss1 (VHT40): 26.16 dBm **<For Beamforming Mode>** Band 1: IEEE 802.11ac MCS0/Nss1 (VHT80): 23.97 dBm
Carrier Frequencies	Please refer to section 3.4
Antenna	Please refer to section 3.3

Items	Description	
Communication Mode	☒ IP Based (Load Based)	☐ Frame Based
Beamforming Function	☒ With beamforming for 802.11n/ac in 2.4GHz/5GHz	☐ Without beamforming
Operate Condition	☒ Indoor	☐ Outdoor

Antenna and Band width

Antenna	Three (TX)			Four (TX)		
Band width Mode	20 MHz	40 MHz	80 MHz	20 MHz	40 MHz	80 MHz
IEEE 802.11a	V	X	X	V	X	X
IEEE 802.11n	V	V	X	V	V	X
IEEE 802.11ac	V	V	V	V	V	V

IEEE 11n/ac Spec.

Protocol	Number of Transmit Chains (NTX)	Data Rate / MCS
802.11n (HT20)	3, 4	MCS0-23, MCS0-31
802.11n (HT40)	3, 4	MCS0-23, MCS0-31
802.11ac (VHT20)	3, 4	MCS0-11/Nss1-3, MCS0-11/Nss1-4
802.11ac (VHT40)	3, 4	MCS0-11/Nss1-3, MCS0-11/Nss1-4
802.11ac (VHT80)	3, 4	MCS0-11/Nss1-3, MCS0-11/Nss1-4

Note 1: IEEE Std. 802.11n modulation consists of HT20 and HT40 (HT: High Throughput). Then EUT supports HT20 and HT40.

Note 2: IEEE Std. 802.11ac modulation consists of VHT20, VHT40, VHT80 and VHT160 (VHT: Very High Throughput). Then EUT supports VHT20, VHT40 and VHT80.

Note 3: Modulation modes consist of below configuration:
HT20/HT40: IEEE 802.11n, VHT20/VHT40/VHT80: IEEE 802.11ac

3.2. Accessories

Power	Brand	Model	Rating
Adapter 1	ASUS	ADP-45BW B	Input: 100-240V ~ 50-60Hz 1.2A Output: 19V, 2.37A
Adapter 2	ASUS	AD883J20	Input: 100-240V ~ 50-60Hz 1.0A Output: 19V, 2.37A
Adapter 3	ASUS	ADP-65DW B	Input: 100-240V ~ 50-60Hz 1.5A Output: 19V, 3.42A
Adapter 4	ASUS	ADP-45BW B	Input: 100-240V ~ 50-60Hz 1.2A Output: 19V, 2.37A
Adapter 5	ASUS	AD883J20	Input: 100-240V ~ 50-60Hz 1.0A Output: 19V, 2.37A
Adapter 6	ASUS	ADP-65DW B	Input: 100-240V ~ 50-60Hz 1.5A Output: 19V, 3.42A
Other			
RJ-45 Cable*1: Non-Shielded, 1.5m			

3.3. Table for Filed Antenna

Set	Brand	P/N	Antenna Type	Connector	Gain (dBi)		Color Ring
					2.4GHz	5GHz	
1	PSA	RFDPA171300SBLB809	Dipole Antenna	Reversed-SMA	2.25	3.37	Red
2	PSA	RFDPA171300SBLB810	Dipole Antenna	Reversed-SMA	2.25	3.37	Black
3	PSA	RFDPA171300SBLB811	Dipole Antenna	Reversed-SMA	2.20	3.36	Black
4	PSA	RFDPA171300SBLB812	Dipole Antenna	Reversed-SMA	2.18	3.19	Black
5	PSA	RFDPA171300SBLB813	Dipole Antenna	Reversed-SMA	2.20	3.36	Red
6	PSA	RFDPA171300SBLB814	Dipole Antenna	Reversed-SMA	2.18	3.19	Red
7	WHA YU	C660-510345-A(SRF2015719)	Dipole Antenna	Reversed-SMA	2.25	3.20	Red
8	WHA YU	C660-510346-A(SRF2015720)	Dipole Antenna	Reversed-SMA	2.25	3.20	Black
9	WHA YU	C660-510364-A(SRF20151386)	Dipole Antenna	Reversed-SMA	1.9	3.3	Black
10	WHA YU	C660-510365-A(SRF20151717)	Dipole Antenna	Reversed-SMA	1.9	3.3	Black

Note: 1. The EUT has ten sets of antenna and there are four antennas for each set.

2. Both antennas above are the same type. Besides, only set 1 antenna was selected to perform the test and written in this report due to the highest gain.

For IEEE 802.11a/b/g/n/ac mode:

For 2.4GHz and 5GHz (3TX/3RX) function:

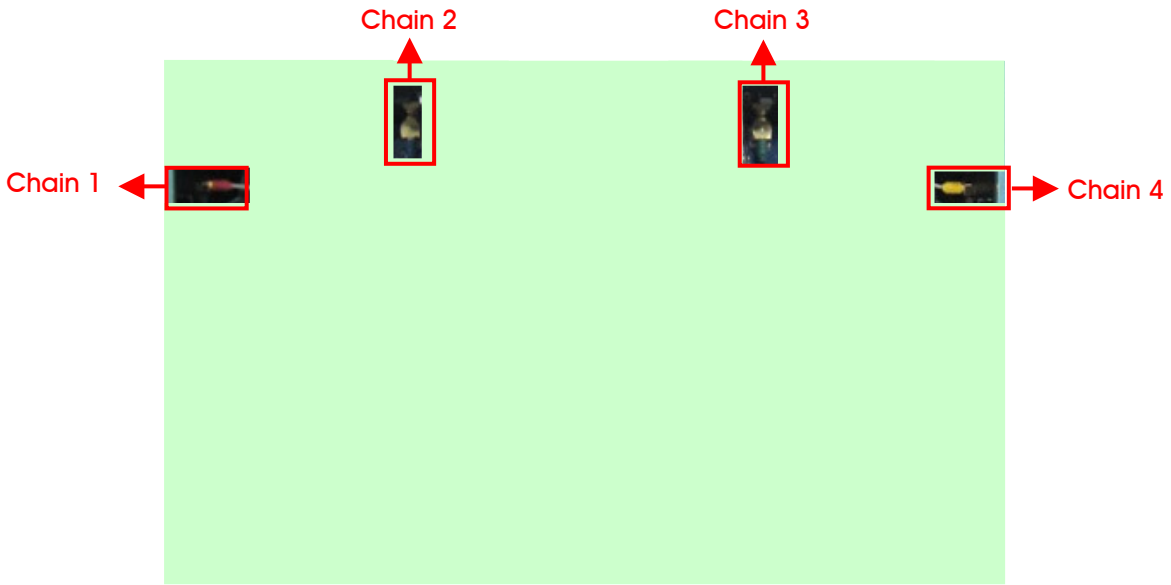
Chain 1, Chain 2 and Chain 3 can be used as transmitting/receiving antenna.

Chain 1, Chain 2 and Chain 3 could transmit/receive simultaneously.

For 2.4GHz and 5GHz (4TX/4RX) function:

Chain 1, Chain 2, Chain 3 and Chain 4 can be used as transmitting/receiving antenna.

Chain 1, Chain 2, Chain 3 and Chain 4 could transmit/receive simultaneously.



3.4. Table for Carrier Frequencies

There are three bandwidth systems.

For 20MHz bandwidth systems, use Channel 36, 40, 44, 48, 149, 153, 157, 161, 165.

For 40MHz bandwidth systems, use Channel 38, 46, 151, 159.

For 80MHz bandwidth systems, use Channel 42, 155.

Frequency Band	Channel No.	Frequency	Channel No.	Frequency
5150~5250 MHz Band 1	36	5180 MHz	44	5220 MHz
	38	5190 MHz	46	5230 MHz
	40	5200 MHz	48	5240 MHz
	42	5210 MHz	-	-
5725~5850 MHz Band 4	149	5745 MHz	157	5785 MHz
	151	5755 MHz	159	5795 MHz
	153	5765 MHz	161	5805 MHz
	155	5775 MHz	165	5825 MHz

3.5. Table for Test Modes

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

Verify below items for SKU A - Rev 5.01 (PCB version)

Test Items	Mode		Data Rate	Channel	Chain
Radiated Emission Above 1GHz	<For Non-Beamforming Mode>				
	11ac VHT40	Band 1&4	MCS0/Nss1	46/159	1+2+3+4
Band Edge Emission	<For Non-Beamforming Mode>				
	11ac VHT40	Band 1&4	MCS0/Nss1	46/159	1+2+3+4

Verify below items for SKU B - Rev 5.20 (PCB version). For the applicant's requirement, the test result for harmonic and bandedge are under 2dB and 1dB respectively.

Test Items	Mode		Data Rate	Channel	Chain
Max. Conducted Output Power	<For Non-Beamforming Mode>				
	11ac VHT40	Band 1	MCS0/Nss1	46	1+2+3+4
	<For Beamforming Mode>				
	11ac VHT80	Band 1	MCS0/Nss1	42	1+2+3+4
Radiated Emission Above 1GHz	<For Non-Beamforming Mode>				
	11ac VHT40	Band 1&4	MCS0/Nss1	46/159	1+2+3+4
	<For Beamforming Mode>				
	11ac VHT80	Band 1	MCS0/Nss1	42	1+2+3+4
Band Edge Emission	<For Non-Beamforming Mode>				
	11ac VHT40	Band 1&4	MCS0/Nss1	46/159	1+2+3+4
	<For Beamforming Mode>				
	11ac VHT80	Band 1	MCS0/Nss1	42	1+2+3+4

Note 1: VHT20/VHT40 covers HT20/HT40, due to same modulation. The power setting for 802.11n HT20 and HT40 are the same or lower than 802.11ac VHT20 and VHT40.

Note 2: The EUT can only be used at Z axis position

Note 3: For the change " Reducing power for Channel 42 Beamforming Mode and Channel 46 Non-beamforming mode. Only SKU B was tested and recorded in this report.

3.6. Table for Testing Locations

Test Site Location					
Address:	No.8, Lane 724, Bo-ai St., Jhubei City, Hsinchu County 302, Taiwan, R.O.C.				
TEL:	886-3-656-9065				
FAX:	886-3-656-9085				
Test Site No.	**Site Category**	**Location**	**FCC Designation No.**	**IC File No.**	**VCCI Reg. No**
03CH01-CB	SAC	Hsin Chu	TW0006	IC 4086D	-
TH01-CB	OVEN Room	Hsin Chu	-	-	-

Open Area Test Site (OATS); Semi Anechoic Chamber (SAC).

3.7. Table for Multiple List

The EUT has three model numbers, which are identical to each other in all aspects except for the following table:

Model No.	LAN Port	Heat sink color
RT-AC88U	8 LAN ports	Silver, Red
RT-AC88R	8 LAN ports	Silver, Red
RT-AC3100	4 LAN ports	Silver, Black

Note 1: From the above models, model: RT-AC88U was selected as representative model for the test and its data was recorded in this report.

Note 2: Red and Black Heat sink each of the three groups, the different just appearance.

3.8. Table for Class II Change

This product is an extension of original one reported under Sporton project number: FR531828-03AA、FR531828-03AB

Below is the table for the change of the product with respect to the original one.

Modifications	Performance Checking
1. Reducing power for Channel 42 Beamforming Mode and Channel 46 Non-beamforming mode. (This is for applicant's requirement that the test result for harmonic and bandedge are under 2dBm and 1dBm respectively.)	1. Max. Conducted Output Power <For Non-Beamforming Mode> VHT40 5230MHz <For Beamforming Mode> VHT80 5210MHz 2. Radiated Emission Above 1GHz <For Non-Beamforming Mode> VHT40 5230MHz <For Beamforming Mode> VHT80 5210MHz 3. Band Edge Emission <For Non-Beamforming Mode> VHT40 5230MHz <For Beamforming Mode> VHT80 5210MHz
2. Updating test rule of 5GHz band 4 to "15.407 (b)(4)(ii) of New Rules (ET Docket No. 13–49; FCC 16–24)" from "Old Rules".	After evaluating, it's not necessary to re-test all test items for 5GHz Band 4 updating to "New Rules" due to the same power as originalfiling.
3. Updating EUT version from Rev 5.01 to "Rev 5.01 (SKU A) and Rev 5.20 (SKU B)". The changes these two SKUs made for this C2PC application are listed as below:	
SKU A - Rev 5.01 (PCB version) 1. Removing 5GHz Low Pass Filter (UA18,UA22,UA27,UA31) by reworking and adding 0ohm (RA35, RA36, RA37, RA38) to connect the gap.	1. Radiated Emission Above 1GHz <For Non-Beamforming Mode> VHT40 5230MHz and 5795MHz 2. Band Edge Emission <For Non-Beamforming Mode> VHT40 5230MHz and 5795MHz
SKU B - Rev 5.20 (PCB version) 1. Removing 5GHz Low Pass Filter (UA18,UA22,UA27,UA31) by designing new layout and connecting the gap by RF trace. 2. Adding electric capacity "0.1pF" at 5GHz PA output (CA27、CA28、CA29、CA30) to improve EVM performance.	1. Max. Conducted Output Power <For Non-Beamforming Mode> VHT40 5230MHz <For Beamforming Mode> VHT80 5210MHz 2. Radiated Emission Above 1GHz <For Non-Beamforming Mode> VHT40 5230MHz and 5795 MHz <For Beamforming Mode> VHT80 5210MHz 3. Band Edge Emission <For Non-Beamforming Mode> VHT40 5230MHz and 5795 MHz <For Beamforming Mode> VHT80 5210MHz

3.9. Table for Supporting Units

For Test Site No: 03CH01-CB <For Non-Beamforming Mode>

Support Unit	Brand	Model	FCC ID
NB	DELL	E4300	DoC

For Test Site No: 03CH01-CB <For Beamforming Mode>

Support Unit	Brand	Model	FCC ID
NB*2	DELL	E4300	DoC
RX Device	Broadcom	Bcm4366	DoC

For Test Site No: TH01-CB

Support Unit	Brand	Model	FCC ID
NB	DELL	E4300	DoC

3.10. Table for Parameters of Test Software Setting

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

Verify below items for SKU B - Rev 5.20 (PCB version). For the applicant's requirement, the test result for harmonic and bandedge are under 2dB and 1dB respectively.

<For Non-Beamforming Mode>

Test Software Version	Mtool 2.0.2.6
Mode	Test Frequency (MHz)
	NCB: 40MHz
802.11ac MCS0/Nss1 VHT40	5230 MHz
	77

<For Beamforming Mode>

Test Software Version	Mtool 2.0.2.6
Mode	Test Frequency (MHz)
	NCB: 80MHz
802.11ac MCS0/Nss1 VHT80	5210 MHz
	69

3.11. EUT Operation during Test

For non-beamforming mode:

The EUT was programmed to be in continuously transmitting mode.

For beamforming mode:

For Conducted Mode:

The EUT was programmed to be in continuously transmitting mode.

For Radiated Mode:

During the test, the following programs under WIN XP were executed.

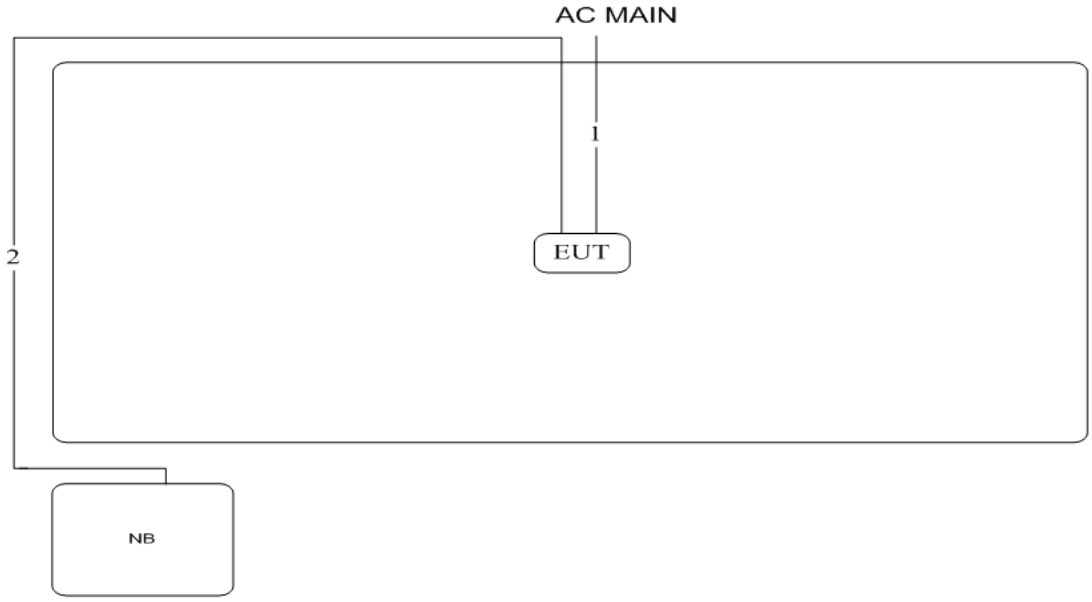
The program was executed as follows:

1. During the test, the EUT operation to normal function.
2. Executed command fixed test channel under DOS.
3. Executed "Lantest.exe " to link with the remote workstation to receive and transmit packet by RX Device and transmit duty cycle no less 98%

3.12. Test Configurations

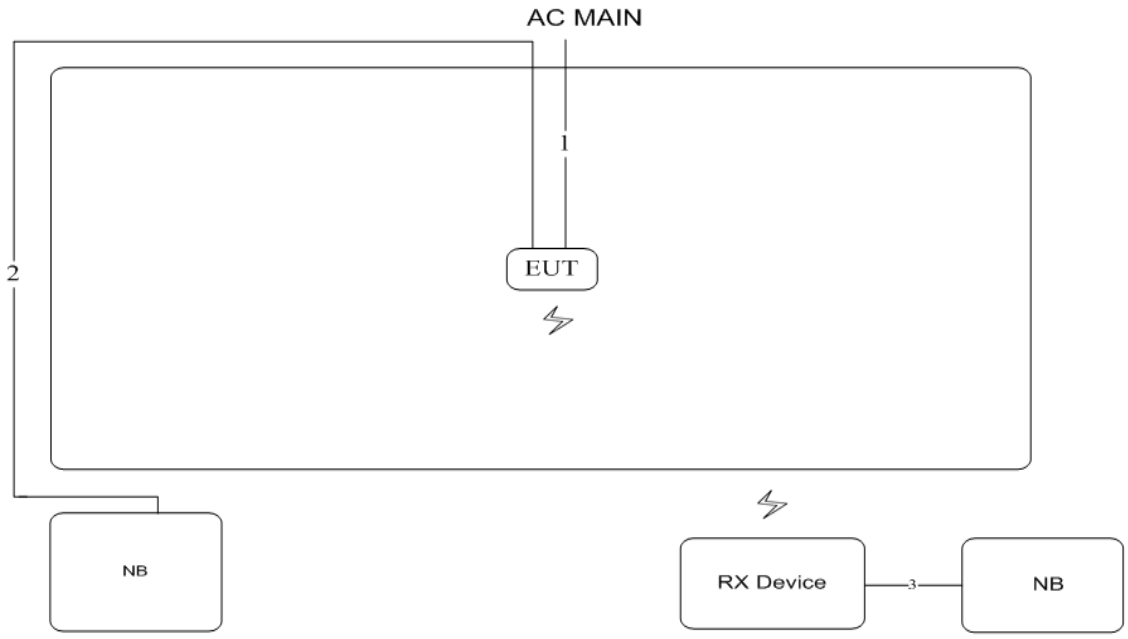
3.12.1. Radiation Emissions Test Configuration

Test Configuration: above 1GHz <For Non-Beamforming Mode>



Item	Connection	Shielded	Length
1	Power Cable	No	2.3m
2	RJ-45 Cable	No	10m

Test Configuration: above 1GHz <For Beamforming Mode>



Item	Connection	Shielded	Length
1	Power Cable	No	2.3m
2	RJ-45 Cable	No	10m
3	RJ-45 Cable	No	1.5m

4. TEST RESULT

4.1. Maximum Conducted Output Power Measurement

4.1.1. Limit

Frequency Band			Limit
☒	5.15~5.25 GHz		
	Operating Mode		
	☐	Outdoor access point	The maximum conducted output power over the frequency band of operation shall not exceed 1 W (30dBm) provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).
	☒	Indoor access point	The maximum conducted output power over the frequency band of operation shall not exceed 1 W (30dBm) provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
	☐	Fixed point-to-point access points	The maximum conducted output power over the frequency band of operation shall not exceed 1 W (30dBm). Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi.
	☐	Client devices	The maximum conducted output power over the frequency band of operation shall not exceed 250 mW (24dBm) provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

☒	5.725~5.85 GHz	The maximum conducted output power over the frequency band of operation shall not exceed 1 W (30dBm). If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power.

4.1.2. Measuring Instruments and Setting

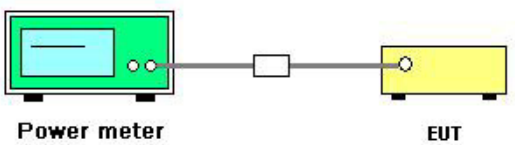
Please refer to section 5 of equipments list in this report. The following table is the setting of the power meter.

Power Meter Parameter	Setting
Detector	AVERAGE

4.1.3. Test Procedures

1. The transmitter output (antenna port) was connected to the power meter.
2. Test was performed in accordance with KDB789033 D02 v01r02 for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - section (E) Maximum conducted output power =>3. Measurement using a Power Meter (PM) =>b) Method PM-G (Measurement using a gated RF average power meter).
3. Multiple antenna systems was performed in accordance with KDB662911 D01 v02r01 Emissions Testing of Transmitters with Multiple Outputs in the Same Band.
4. When measuring maximum conducted output power with multiple antenna systems, add every result of the values by mathematic formula.

4.1.4. Test Setup Layout



4.1.5. Test Deviation

There is no deviation with the original standard.

4.1.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.1.7. Test Result of Maximum Conducted Output Power

Verify below items for SKU B - Rev 5.20 (PCB version). For the applicant's requirement, the test result for harmonic and bandedge are under 2dB and 1dB respectively.

<For Non-Beamforming Mode>

Temperature	20°C	Humidity	60%
Test Engineer	Peter Wu	Test Date	Apr. 01, 2016~Apr. 07, 2016

Mode	Frequency	Conducted Power (dBm)					Max. Limit (dBm)	Result
		Chain 1	Chain 2	Chain 3	Chain 4	Total		
802.11ac MCS0/Nss1 VHT40	5230 MHz	20.02	20.75	19.68	20.02	26.16	30.00	Complies

<For Beamforming Mode>

Temperature	20°C	Humidity	60%
Test Engineer	Peter Wu	Test Date	Apr. 01, 2016~Apr. 07, 2016

Mode	Frequency	Conducted Power (dBm)					Max. Limit (dBm)	Result
		Chain 1	Chain 2	Chain 3	Chain 4	Total		
802.11ac MCS0/Nss1 VHT80	5210 MHz	17.86	18.03	17.98	17.94	23.97	26.61	Complies

Note: $Directional Gain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left\{\sum_{k=1}^{N_{ANT}} g_{j,k}\right\}^2}{N_{ANT}}\right]$ =9.39dBi, so limit= 30-(9.39-6)= 26.61 dBm

4.2. Radiated Emissions Measurement

4.2.1. Limit

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

For transmitters operating in the 5.725-5.85 GHz band: Follow 15.407(b)(4)(ii), the emission limits in § 15.247(d), 30dBc in any 100 kHz bandwidth outside the operating frequency band.

In addition, In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (micorvolts/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

4.2.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of spectrum analyzer and receiver.

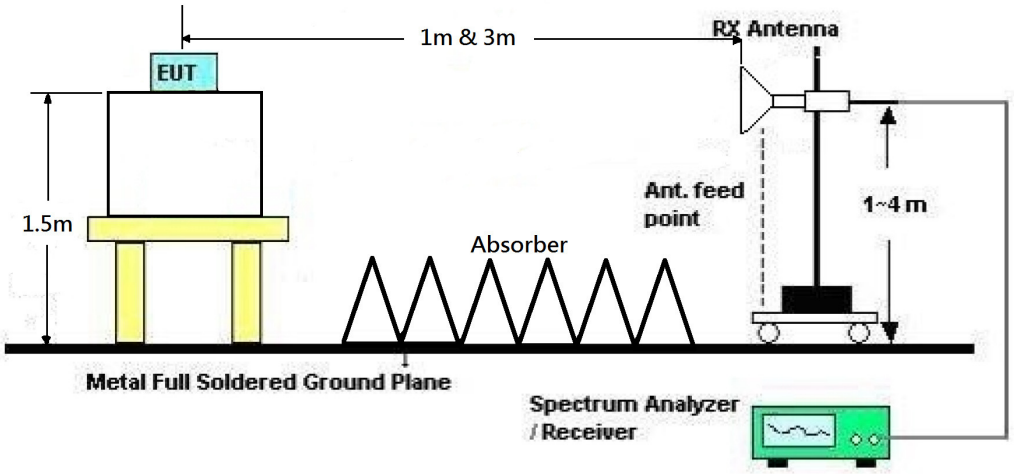
Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	40 GHz
RBW / VBW (Emission in restricted band)	1MHz / 3MHz for Peak, 1MHz / 1/T for Average
RBW / VBW (Emission in non-restricted band)	1MHz / 3MHz for peak

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RBW 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RBW 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RBW 120kHz for QP

4.2.3. Test Procedures

1. Configure the EUT according to ANSI C63.10. The EUT was placed on the top of the turntable 1.5 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 1m & 3m far away from the turntable.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. Set the test-receiver system to Peak or CISPR quasi-peak Detect Function with specified bandwidth under Maximum Hold Mode.
6. For emissions above 1GHz, use 1MHz VBW and 3MHz RBW for peak reading. Then 1MHz RBW and 1/T VBW for average reading in spectrum analyzer.
7. If the emissions level of the EUT in peak mode was 3 dB lower than the average limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
8. For testing above 1GHz, the emissions level of the EUT in peak mode was lower than average limit (that means the emissions level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
9. In case the emission is lower than 30MHz, loop antenna has to be used for measurement and the recorded data should be QP measured by receiver. High – Low scan is not required in this case.

4.2.4. Test Setup Layout



4.2.5. Test Deviation

There is no deviation with the original standard.

4.2.6. EUT Operation during Test

For Non-beamforming mode:

The EUT was programmed to be in continuously transmitting mode.

For beamforming mode:

The EUT was programmed to be in beamforming transmitting mode.

4.2.7. Results for Radiated Emissions (1GHz~40GHz)

Verify below items for SKU A - Rev 5.01 (PCB version)

<For Non-Beamforming Mode>

Temperature	26°C	Humidity	55%
Test Engineer	Gino Huang	Configurations	IEEE 802.11ac MCS0/Nss1 VHT40 CH 46 / Chain 1 + Chain 2 + Chain 3+Chain 4
Test Date	Dec. 07, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Pol/Phase	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	15689.20	60.84	74.00	-13.16	45.77	12.57	38.36	35.86	121	272	HORIZONTAL	Peak
2	15689.76	47.09	54.00	-6.91	32.02	12.57	38.36	35.86	121	272	HORIZONTAL	Average

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Pol/Phase	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	15689.24	60.24	74.00	-13.76	45.17	12.57	38.36	35.86	124	280	VERTICAL	Peak
2	15689.38	47.24	54.00	-6.76	32.17	12.57	38.36	35.86	124	280	VERTICAL	Average

Temperature	26℃	Humidity	55%
Test Engineer	Gino Huang	Configurations	IEEE 802.11ac MCS0/Nss1 VHT40 CH 159 / Chain 1 + Chain 2 + Chain 3+Chain 4
Test Date	Dec. 07, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Pol/Phase	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	11587.84	44.40	54.00	-9.60	30.20	10.99	39.12	35.91	101	179	HORIZONTAL	Average
2	11592.49	57.69	74.00	-16.31	43.49	10.99	39.12	35.91	101	179	HORIZONTAL	Peak

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Pol/Phase	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	11589.33	44.67	54.00	-9.33	30.47	10.99	39.12	35.91	105	145	VERTICAL	Average
2	11591.49	57.70	74.00	-16.30	43.50	10.99	39.12	35.91	105	145	VERTICAL	Peak

Verify below items for SKU B - Rev 5.20 (PCB version). For the applicant's requirement, the test result for harmonic and bandedge are under 2dB and 1dB respectively.

<For Non-Beamforming Mode>

Temperature	26°C	**Humidity**	55%
Test Engineer	Gino Huang	**Configurations**	IEEE 802.11ac MCS0/Nss1 VHT40 CH 46 / Chain 1 + Chain 2 + Chain 3+Chain 4
Test Date	Apr. 20, 2016		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	15690.28	49.24	54.00	-4.76	32.78	13.39	38.28	35.21	167	157	Average	HORIZONTAL
2	15692.47	60.48	74.00	-13.52	44.10	13.39	38.23	35.24	167	157	Peak	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	15683.17	49.38	54.00	-4.62	32.92	13.39	38.28	35.21	225	109	Average	VERTICAL
2	15683.97	60.51	74.00	-13.49	44.05	13.39	38.28	35.21	225	109	Peak	VERTICAL

Temperature	26°C	Humidity	55%
Test Engineer	Gino Huang	Configurations	IEEE 802.11ac MCS0/Nss1 VHT40 CH 159 / Chain 1 + Chain 2 + Chain 3+Chain 4
Test Date	Mar. 03, 2016		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	11590.51	56.86	74.00	-17.14	42.39	10.14	39.16	34.83	102	328	Peak	HORIZONTAL
2	11592.43	42.96	54.00	-11.04	28.49	10.14	39.16	34.83	102	328	Average	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	11590.46	55.74	74.00	-18.26	41.27	10.14	39.16	34.83	100	331	Peak	VERTICAL
2	11590.81	43.10	54.00	-10.90	28.63	10.14	39.16	34.83	100	331	Average	VERTICAL

<For Beamforming Mode>

Temperature	26°C	Humidity	55%
Test Engineer	Gino Huang	Configurations	IEEE 802.11ac MCS0/Nss1 VHT80 CH 42 / Chain 1 + Chain 2 + Chain 3+Chain 4
Test Date	Apr. 20, 2016		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	15627.92	60.77	74.00	-13.23	44.24	13.38	38.34	35.19	130	167	Peak	HORIZONTAL
2	15634.31	49.66	54.00	-4.34	33.13	13.38	38.34	35.19	130	167	Average	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	15626.89	61.24	74.00	-12.76	44.71	13.38	38.34	35.19	167	130	Peak	VERTICAL
2	15631.14	49.64	54.00	-4.36	33.11	13.38	38.34	35.19	167	130	Average	VERTICAL

Note:

The amplitude of spurious emissions that are attenuated by more than 20dB below the permissible value has no need to be reported.

Emission level (dBuV/m) = 20 log Emission level (uV/m).

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

4.3. Band Edge Emissions Measurement

4.3.1. Limit

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

For transmitters operating in the 5.725-5.85 GHz band: Follow 15.407(b)(4)(ii), the emission limits in § 15.247(d), 30dBc in any 100 kHz bandwidth outside the operating frequency band.

In addition, In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (micorvolts/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

4.3.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	100 MHz
RBW / VBW (Emission in restricted band)	1MHz / 3MHz for Peak, 1MHz / 1/T for Average
RBW / VBW (Emission in non-restricted band)	1MHz / 3MHz for Peak
RBW / VBW (30dBc in any 100 kHz bandwidth emission)	100 kHz / 300 kHz for Peak

4.3.3. Test Procedures

For Radiated band edges Measurement:

The test procedure is the same as section 4.2.3.

For Radiated Emissions in non-restricted frequency bands Measurement:

Test was performed in accordance with Clause 11.11 of ANSI C63.10-2013 and/or in Section 11.0 of KDB Publication 558074.

4.3.4. Test Setup Layout

For Radiated band edges Measurement:

This test setup layout is the same as that shown in section 4.2.4.

For Radiated Emissions in non-restricted frequency bands Measurement:

This test setup layout is the same as that shown in section 4.2.4.

4.3.5. Test Deviation

There is no deviation with the original standard.

4.3.6. EUT Operation during Test

For Non-beamforming mode:

The EUT was programmed to be in continuously transmitting mode.

For beamforming mode:

The EUT was programmed to be in beamforming transmitting mode.

4.3.7. Test Result of Band Edge and Fundamental Emissions

Verify below items for SKU A - Rev 5.01 (PCB version)

<For Non-Beamforming Mode>

Temperature	26°C	Humidity	55%
Test Engineer	Gino Huang	Configurations	IEEE 802.11ac MCS0/Nss1 VHT40 CH 46 / Chain 1 + Chain 2 + Chain 3+ Chain 4
Test Date	Dec. 07, 2015		

Channel 46

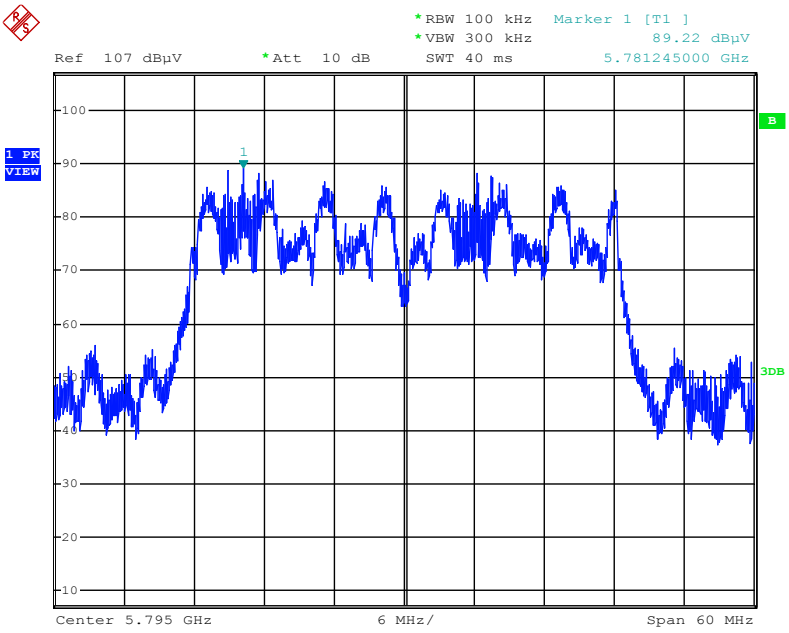
	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Pol/Phase	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	5146.00	53.52	54.00	-0.48	49.61	7.24	33.17	36.50	253	22	VERTICAL	Average
2	5150.00	63.99	74.00	-10.01	60.08	7.24	33.17	36.50	253	22	VERTICAL	Peak
3	5215.60	119.96			115.84	7.33	33.28	36.49	253	22	VERTICAL	Peak
4	5236.00	110.22			106.00	7.36	33.34	36.48	253	22	VERTICAL	Average
5	5376.40	64.23	74.00	-9.77	59.62	7.49	33.58	36.46	253	22	VERTICAL	Peak
6	5401.60	52.66	54.00	-1.34	47.94	7.53	33.64	36.45	253	22	VERTICAL	Average

Item 3, 4 are the fundamental frequency at 5230 MHz.

For Radiated Emissions in non-restricted frequency bands Measurement

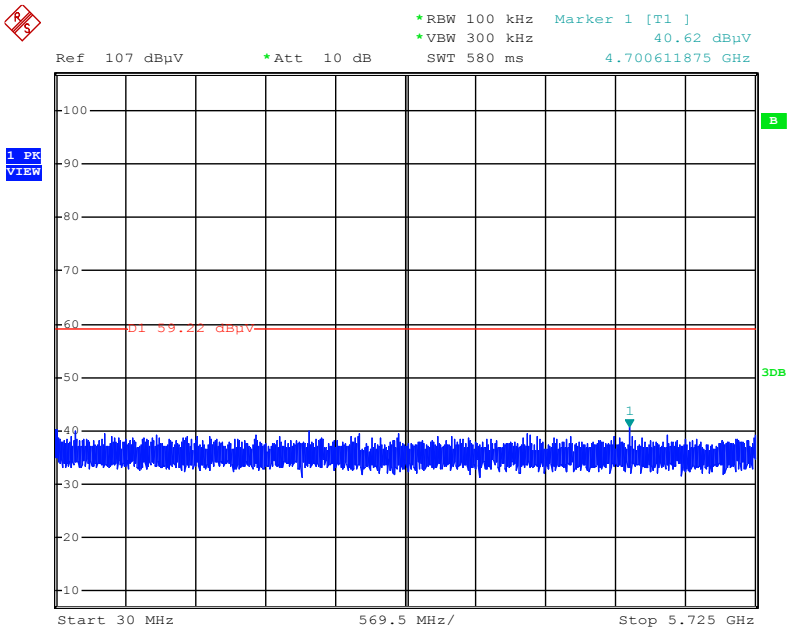
<For Non-Beamforming Mode>

Plot on Configuration IEEE 802.11ac MCS0/Nss1 VHT40 / Reference Level



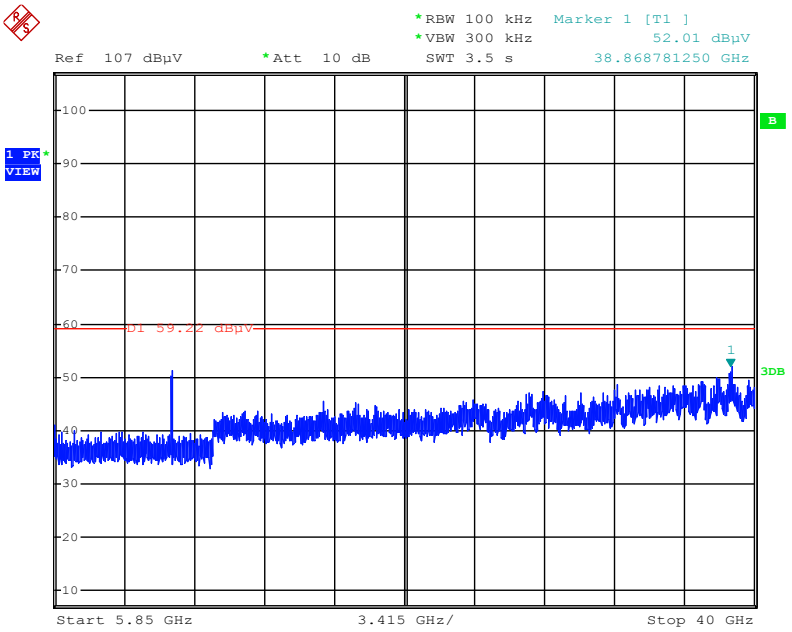
Date: 7.DEC.2015 23:59:37

Plot on Configuration IEEE 802.11ac MCS0/Nss1 VHT40 / CH 159 / 30MHz~5725MHz (down 30dBc)



Date: 8.DEC.2015 00:00:33

Plot on Configuration IEEE 802.11ac MCS0/Nss1 VHT40 / CH 159 / 5850MHz~40000MHz (down 30dBc)



Date: 8.DEC.2015 00:01:42

Verify below items for SKU B - Rev 5.20 (PCB version). For the applicant's requirement, the test result for harmonic and bandedge are under 2dB and 1dB respectively.

<For Non-Beamforming Mode>

Temperature	26°C	**Humidity**	55%
Test Engineer	Gino Huang	**Configurations**	IEEE 802.11ac MCS0/Nss1 VHT40 CH 46/ Chain 1 + Chain 2 + Chain 3+ Chain 4
Test Date	Apr. 20, 2016		

Channel 46

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	5140.40	52.35	54.00	-1.65	44.94	7.48	34.84	34.91	288	20	Average	VERTICAL
2	5141.60	63.01	74.00	-10.99	55.60	7.48	34.84	34.91	288	20	Peak	VERTICAL
3	5215.60	105.83			98.34	7.49	34.91	34.91	288	20	Average	VERTICAL
4	5240.80	114.34			106.81	7.50	34.94	34.91	288	20	Peak	VERTICAL
5	5354.80	62.73	74.00	-11.27	55.02	7.56	35.06	34.91	288	20	Peak	VERTICAL
6	5376.30	52.90	54.00	-1.10	45.17	7.57	35.08	34.92	288	20	Average	VERTICAL

Item 3, 4 are the fundamental frequency at 5230MHz.

<For Beamforming Mode>

Temperature	26°C	Humidity	55%
Test Engineer	Gino Huang	Configurations	IEEE 802.11ac MCS0/Nss1 VHT80 CH 42/ Chain 1 + Chain 2 + Chain 3+ Chain 4
Test Date	Apr. 20, 2016		

Channel 42

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	5144.00	52.99	54.00	-1.01	45.57	7.48	34.85	34.91	271	8	Average	VERTICAL
2	5144.00	65.89	74.00	-8.11	58.47	7.48	34.85	34.91	271	8	Peak	VERTICAL
3	5236.00	104.15			96.62	7.50	34.94	34.91	271	8	Average	VERTICAL
4	5236.00	115.15			107.62	7.50	34.94	34.91	271	8	Peak	VERTICAL
5	5394.00	50.54	54.00	-3.46	42.79	7.58	35.09	34.92	271	8	Average	VERTICAL
6	5394.00	61.54	74.00	-12.46	53.79	7.58	35.09	34.92	271	8	Peak	VERTICAL

Item 3, 4 are the fundamental frequency at 5210 MHz.

Note:

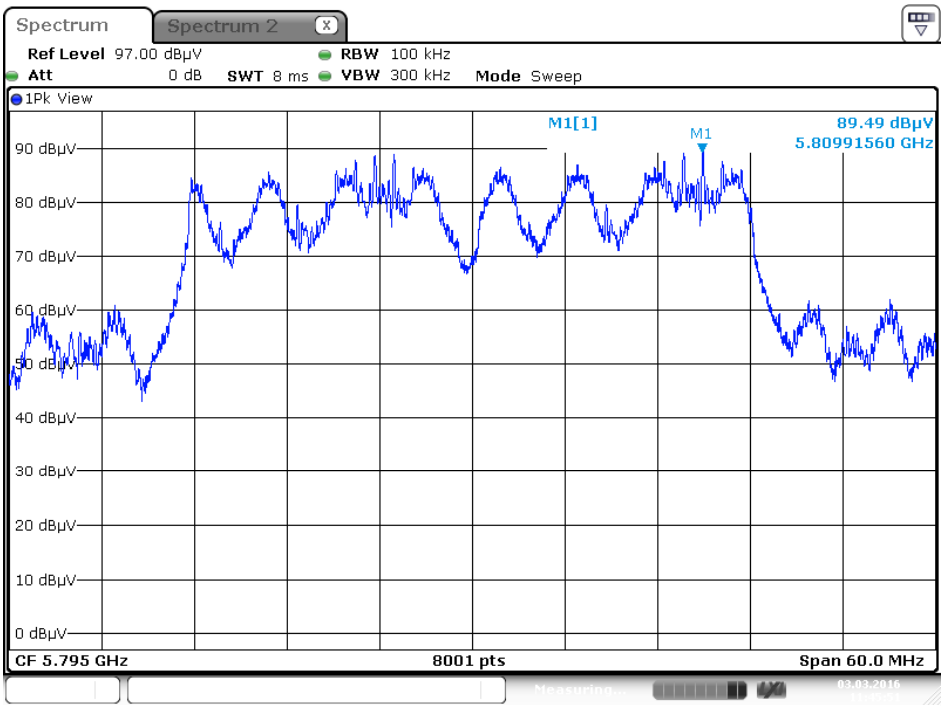
Emission level (dBuV/m) = 20 log Emission level (uV/m)

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level

For Radiated Emissions in non-restricted frequency bands Measurement

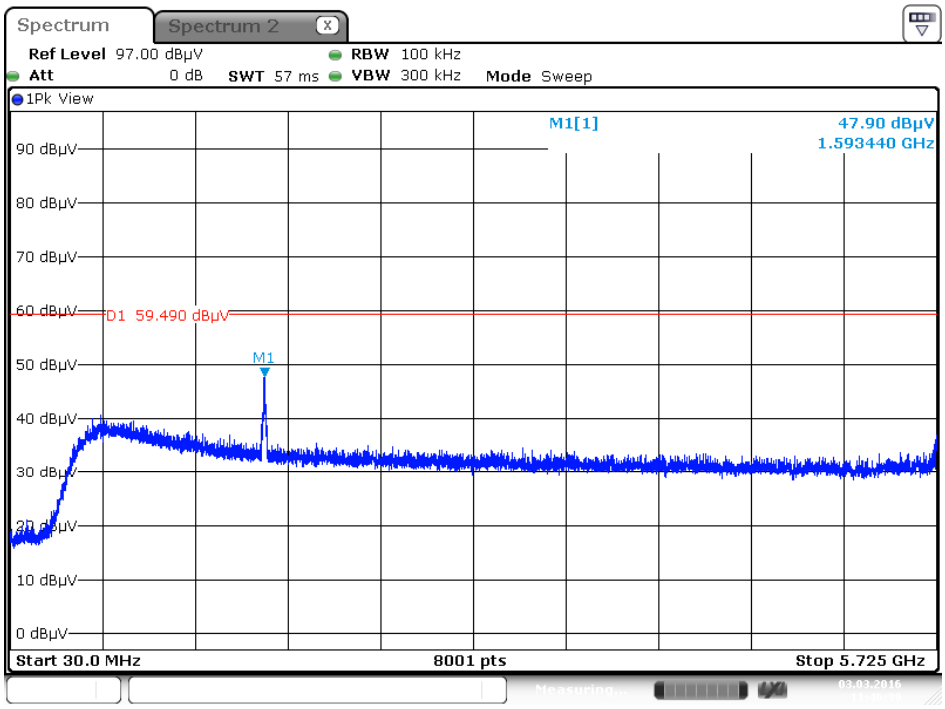
<For Non-Beamforming Mode>

Plot on Configuration IEEE 802.11ac MCS0/Nss1 VHT40 / Reference Level



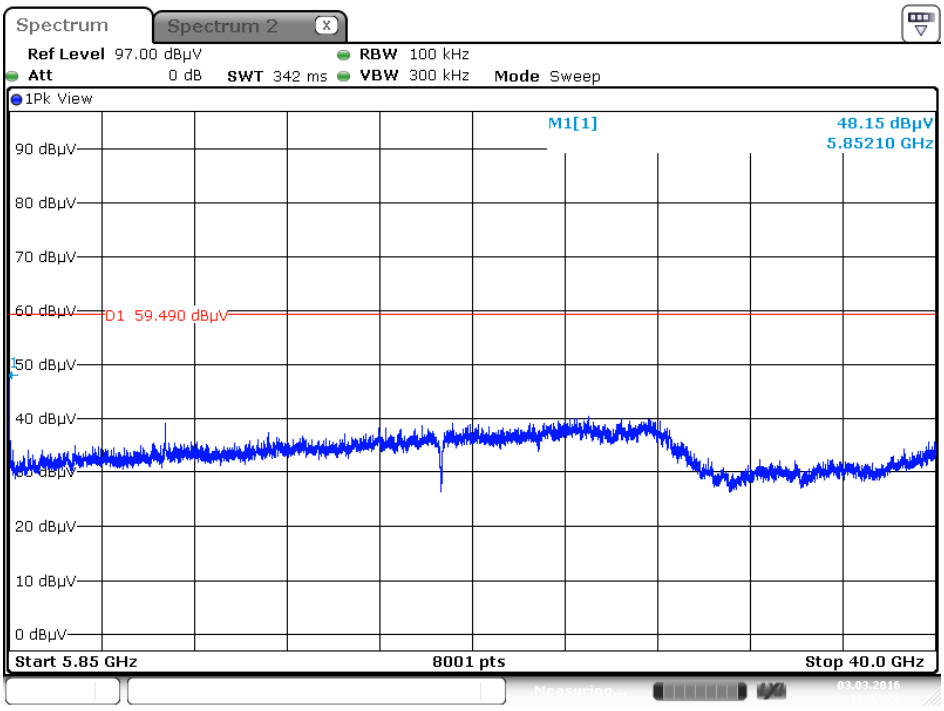
Date: 3.MAR.2016 11:45:52

Plot on Configuration IEEE 802.11ac MCS0/Nss1 VHT40 / CH 159 / 30MHz~5725MHz (down 30dBc)



Date: 3.MAR.2016 11:46:39

Plot on Configuration IEEE 802.11ac MCS0/Nss1 VHT40 / CH 159 / 5850MHz~40000MHz (down 30dBc)



Date: 3.MAR.2016 11:47:23

4.4. Antenna Requirements

4.4.1. Limit

Except for special regulations, the Low-power Radio-frequency Devices must not be equipped with any jacket for installing an antenna with extension cable. An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

4.4.2. Antenna Connector Construction

Please refer to section 3.3 in this test report; antenna connector complied with the requirements.

5. LIST OF MEASURING EQUIPMENTS

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Remark
Horn Antenna	EMCO	3115	00075790	750MHz ~ 18GHz	Oct. 22, 2015	Radiation (03CH01-CB)
Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170252	15GHz ~ 40GHz	Jul. 21, 2015	Radiation (03CH01-CB)
Pre-Amplifier	Agilent	8449B	3008A02310	1GHz ~ 26.5GHz	Jan. 12, 2015	Radiation (03CH01-CB)
Pre-Amplifier	Agilent	8449B	3008A02310	1GHz ~ 26.5GHz	Jan. 18, 2016	Radiation (03CH01-CB)
Pre-Amplifier	WM	TF-130N-R1	923365	26GHz ~ 40GHz	Nov. 13, 2015	Radiation (03CH01-CB)
Spectrum Analyzer	R&S	FSP40	100056	9kHz ~ 40GHz	Oct. 27, 2015	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-16	N/A	1 GHz ~ 18 GHz	Nov. 02, 2015	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-17	N/A	1 GHz ~ 18 GHz	Nov. 02, 2015	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-40G-1	N/A	18GHz ~ 40 GHz	Nov. 02, 2015	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-40G-2	N/A	18GHz ~ 40 GHz	Nov. 02, 2015	Radiation (03CH01-CB)
Test Software	Audix	E3	6.2009-I0-7	N/A	N/A	Radiation (03CH01-CB)
Spectrum analyzer	R&S	FSV40	100979	9kHz~40GHz	Dec. 09, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-6	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-7	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-8	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-9	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-10	1 GHz – 26.5 GHz	Nov. 02, 2015	Conducted (TH01-CB)
Power Sensor	Agilent	U2021XA	MY53410001	50MHz~18GHz	Nov. 02, 2015	Conducted (TH01-CB)

Note: Calibration Interval of instruments listed above is one year.

6. MEASUREMENT UNCERTAINTY

Test Items	Uncertainty	Remark
Radiated Emission (1GHz ~ 18GHz)	3.7 dB	Confidence levels of 95%
Radiated Emission (18GHz ~ 40GHz)	3.5 dB	Confidence levels of 95%
Conducted Emission	1.7 dB	Confidence levels of 95%