

FCC TEST REPORT

Test report On Behalf of Shenzhen GMK Technology Co., Ltd For NucBox2 Model No.: KB2

FCC ID: 2AXUD-KB2

Prepared for : Shenzhen GMK Technology Co., Ltd 3/F, #5Bldg, HuaLian Industrial Park, XinShi Community, Dalang St, Longhua Dist, 518109, Shenzhen, China

Prepared By : Shenzhen Tongzhou Testing Co.,Ltd 1th Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China

 Date of Test:
 2021/3/17 ~ 2021/3/22

 Date of Report:
 2021/3/31

 Report Number:
 TZ210302066-E4

The test report apply only to the specific sample(s) tested under stated test conditions It is not permitted to copy extracts of these test result without the written permission of the test laboratory.



TEST RESULT CERTIFICATION

Applicant's name:	Shenzhen GMK Technology Co., Ltd
Address:	3/F, #5Bldg, HuaLian Industrial Park, XinShi Community, Dalang St,
Address	Longhua Dist, 518109, Shenzhen, China
Manufacture's Name:	Shenzhen GMK Technology Co., Ltd
Address:	3/F, #5Bldg, HuaLian Industrial Park, XinShi Community, Dalang St,
Address	Longhua Dist, 518109, Shenzhen, China
Product description	
Trade Mark	GMK, GMKTEC
Product name:	NucBox2
Model and/or type reference :	KB2
Standards:	FCC Rules and Regulations Part 15 Subpart E Section 15.407 ANSI C63.10: 2013

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Date of Test	
Date (s) of performance of tests:	2021/3/17 ~ 2021/3/22
Date of Issue:	2021/3/31
Test Result	Pass

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Testing Engineer

Anna Hu

(Anna Hu)

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Hugo Chen

(Hugo Chen)

Authorized Signatory :

Zhan

(Andy Zhang)



Revision History

Revision	Issue Date	Revisions	Revised By
000	2021/3/31	Initial Issue	Andy Zhang



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1. GENERAL INFORMATION

1.1. Description of Device (EUT)

1	
EUT	: NucBox2
Model Number	: KB2
Model Declaration	: N/A
Test Model	: KB2
Power Supply	: DC 19V by adapter
Hardware version	: IP3_CB1D_MB_V13
Software version	: Windows 10
Sample ID	: TZ210302066–1#
Bluetooth	
Bluetooth Version	: V4.2
Channel Number	. 79 Channels for Bluetooth BR/EDR(DSS) 40 Channels for BLE (DTS)
Modulation Technology	GFSK, π/4-DQPSK, 8-DPSK for Bluetooth BR/EDR (DSS) GFSK for BLE (DTS)
Data Rates	Bluetooth BR/EDR (DSS): 1/2/3Mbps BLE (DTS): 1Mbps
Antenna Type And Gain	Internal Antenna /2.39 dBi(Max.)
WiFi	
WLAN	: Supported IEEE 802.11a/b/g/n
WLAN FCC Operation Frequency	IEEE 802.11b:2412-2462MHz IEEE 802.11g:2412-2462MHz IEEE 802.11n HT20:2412-2462MHz / 5180-5240MHz IEEE 802.11n HT40:5190-5230MHz IEEE 802.11a: 5180-5240MHz IEEE 802.11ac VHT20: 5180-5240MHz IEEE 802.11ac VHT40: 5190-5230MHz IEEE 802.11ac VHT80: 5210MHz
WLAN Channel Number	 11 Channels for 2412-2462MHz(IEEE 802.11b/g/n HT20) 7 Channels for 2422-2452MHz(IEEE 802.11n HT40) : 4 Channels for 5180-5240MHz (IEEE 802.11a/ac VHT20/n HT20) 2 Channels for 5190-5230MHz (IEEE 802.11ac VHT40/n HT40) 1 Channels for 5210MHz (IEEE 802.11ac VHT80)
WLAN Modulation Technology	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK) : IEEE 802.11n: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11a: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ac: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK)
Antenna Type And Gain	Internal Antenna : Wlan2.4G: 2.39 dBi(Max.)
	Wlan5G:1.99 dBi(Max.)

Note1: Antenna position refer to EUT Photos.



1.2 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

 $\Box supplied by the lab <math display="inline">\boxdot$ supplied by the manufacturer

Manufacturer	Description	Model	Serial Number	Certificate
Shenzhen Jihongda Power Co.,Ltd.	Adapter	JHD-AP030U-120200- AS	N/A	N/A

1.3. External I/O Cable

I/O Port Description	Quantity	Cable
USB Port	4	N/A
Earphone Port	1	N/A
HDMI Port	2	N/A
Type-c Port	1	N/A
TF Card Port	1	N/A
LAN	1	N/A

1.4. Description of Test Facility

FCC

Designation Number: CN1275

Test Firm Registration Number: 167722

Shenzhen Tongzhou Testing Co.,Ltd has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

A2LA

Certificate Number: 5463.01

Shenzhen Tongzhou Testing Co.,Ltd has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

IC

ISED#: 22033

CAB identifier: CN0099

Shenzhen Tongzhou Testing Co.,Ltd has been listed by Innovation, Science and Economic Development Canada to perform electromagnetic emission measurement.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010



1.5. Statement of the Measurement Uncertainty

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

1.6. Measurement Uncertainty

Test Item	Frequency Range Uncertainty		Note
	9KHz~30MHz	±3.08dB	(1)
Radiation Uncertainty :	30MHz~1000MHz	±4.42dB	(1)
	1GHz~40GHz	±4.06dB	(1)
Conduction Uncertainty :	150kHz~30MHz	±2.23dB	(1)

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

1.7. Description of Test Modes

The EUT has been tested under operating condition.

Worst-case mode and channel used for 150 kHz-30 MHz power line conducted emissions was the mode and channel with the highest output power that was determined to be IEEE 802.11n HT40 mode (Low Channel).

Worst-case mode and channel used for 9kHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be IEEE 802.11n HT40 mode (Low Channel).

Worst-Case data rates were utilized from preliminary testing of the Chipset, worst-case data rates used during the testing are as follows:

IEEE 802.11a Mode : 6 Mbps, OFDM. IEEE 802.11n HT20 Mode: MCS0, OFDM. IEEE 802.11n HT40 Mode: MCS0, OFDM.

Antenna & Bandwidth

Antenna	Single (Port.1)			Antenna Single (Port.1) Two (Port.1 + Port.2)			rt.2)
Bandwidth Mode	20MHz	40MHz	80MHz	20MHz	40MHz	80MHz	
IEEE 802.11a	V						
IEEE 802.11n	V	N					
IEEE 802.11ac	V	V	\checkmark				



All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen Tongzhou Testing Co.,Ltd

2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2. EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to FCC's request, Test Procedure 789033 D02 General UNII Test Procedures New Rules v02r01 and KDB 662911 are required to be used for this kind of FCC 15.407 UII device.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209 and 15.407 under the FCC Rules Part 15 Subpart E

2.3. General Test Procedures

2.3.1 Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

2.3.2 Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10-2013

2.4. Test Sample

The application provides 1 sample to meet requirement;

Sample ID	Description
TZ210302066–1#	Engineer sample – continuous transmit



3.1. Justification

The system was configured for testing in a continuous transmits condition.

3.2. EUT Exercise Software

The system was configured for testing in a continuous transmits condition and change test channels by software (DRTU) provided by application.

3.3. Special Accessories

Ν	0.	Equipment	Manufacturer	Model No.	Serial No.	Lengt h	shielded/ unshielded	Notes
	1	/	/	/	/	/	/	/

3.4. Block Diagram/Schematics

Please refer to the related document

3.5. Equipment Modifications

Shenzhen Tongzhou Testing Co.,Ltd has not done any modification on the EUT.

3.6. Test Setup

Please refer to the test setup photo.



4. SUMMARY OF TEST RESULTS

	Applied Standard: FCC Part 15 Subpart E							
FCC Rules	Description of Test	Test Sample	Result					
§15.407(a)	Maximum Conducted Output Power	TZ210302066–1#	Compliant					
§15.407(a)	Power Spectral Density	TZ210302066–1#	Compliant					
§15.407(a)	26dB Bandwidth	TZ210302066–1#	Compliant					
§15.407(a)	99% Occupied Bandwidth	TZ210302066–1#	Compliant					
§15.407(b)	Radiated Emissions	TZ210302066–1#	Compliant					
§15.407(b)	Band edge Emissions	TZ210302066–1#	Compliant					
§15.205	Emissions at Restricted Band	TZ210302066–1#	Compliant					
§15.407(g)	Frequency Stability	TZ210302066–1#	Compliant					
§15.207(a)	Line Conducted Emissions	TZ210302066–1#	Compliant					
§15.203	Antenna Requirements	TZ210302066–1#	Compliant					
§2.1093	RF Exposure	N/A	Compliant					



5.1. On Time and Duty Cycle

5.1.1. Standard Applicable

None; for reporting purpose only.

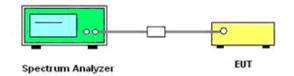
5.1.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of the spectrum analyzer.

5.1.3. Test Procedures

- 1. Set the centre frequency of the spectrum analyzer to the transmitting frequency;
- 2. Set the span=0MHz, RBW=10MHz, VBW=10MHz, Sweep time=5ms;
- 3. Detector = peak;
- 4. Trace mode = Single hold.

5.1.4. Test Setup Layout



5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.1.6. Test result

TestMode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
		5180	1.39	1.46	95.21
11A	Ant1	5200	1.39	1.46	95.21
		5240	1.39	1.46	95.21
		5180	1.30	1.37	94.89
11N20SISO	Ant1	5200	1.31	1.37	95.62
		5240	1.31	1.37	95.62
111100100	A pt1	5190	0.34	0.40	85.00
11N40SISO	Ant1	5230	0.34	0.40	85.00
		5180	0.36	0.43	83.72
11AC20SISO	Ant1	5200	0.36	0.42	85.71
		5240	0.36	0.43	83.72
1140408180	A pt1	5190	0.20	0.26	76.92
11AC40SISO	Ant1	5230	0.20	0.26	76.92
11AC80SISO	Ant1	5210	0.11	0.17	64.71

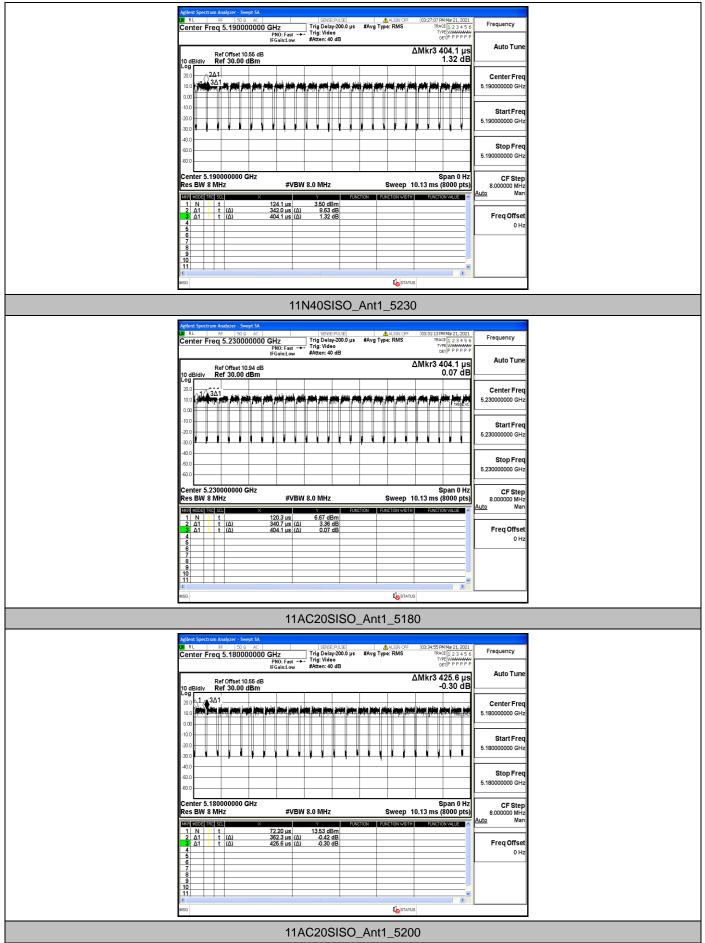


Agilent Spectrum Analyzer - Swept SA	
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10 dBladiv Ref 30.00 dBm 9.35 dB	
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0.00	
	Start Freq
	5.18000000 GHz
-40.0	
-50.0	Stop Freq 5.18000000 GHz
-60.0	
Center 5.180000000 GHz Span 0 Hz Res BW 8 MHz #VBW 8.0 MHz Sweep 10.13 ms (8000 pts)	
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1 N 1 t 1.396 ms 4.57 dBm	
4	Freq Offset 0 Hz
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<u>/</u> 8 9	
<	
11A_Ant1_5200	
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AM4r2 1 457 mg	Auto Tupo
10 dB/div Ref 30.00 dBm -9.76 dB	
	Center Freq
	5.20000000 GHz
-10.0	Start Freq
	5.20000000 GHz
-40.0	Stop Freq
-50.0	5.20000000 GHz
Center 5.200000000 GHz Span 0 Hz Res BW 8 MHz #VBW 8.0 MHz Sweep 10.13 ms (8000 pts)	8.000000 MHz
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1 N 1 t 459.9 μs 14.11 dBm 2 Δ1 t (Δ) 1.393 ms (Δ) - 0.56 dB 3 Δ1 t (Δ) 1.457 ms (Δ) - 9.76 dB	FreqOffset
	0 Hz
9	
K STATUS	
11A_Ant1_5240	
Agilent Spectrum Analyzer - Swept SA	
W RL RF 50.0 AC SENSE-PULSE ▲ALIGN OFF 03:12:14 PM Mar 21, 2021 Center Freq 5 240000000 CHz Tric Delay-200.0 µs #Ayg Type: RMS TRACE [12:3:45:6	Frequency
PN0: Fast +++ IFGain:Low #Atten: 40 dB	
Ref Offset 10.94 dB ΔMkr3 1.457 ms	Auto Tune
10 dB/div Ref 30.00 dBm U.U4 dB	
20.0 Automatication of the second sec	Center Freq
	5.24000000 GHz
-10.0	StartFreq
-20.0	5.240000000 GHz
-50.0	Stop Freq
-60.0	5.240000000 GHz
Center 5.240000000 GHz Span 0 Hz	
Res BW 8 MHz #VBW 8.0 MHz Sweep 10.13 ms (8000 pts)	8.000000 MHz Auto Man
1 N 1 t 74.73 µs 15.82 dBm	
2 Δ1 1 t (Δ) 1.393 ms (Δ) -1.89 dB 3 Δ1 1 t (Δ) 1.457 ms (Δ) 0.04 dB 4	FreqOffset
<u>4</u> <u>5</u> 6	0 Hz
7 8	
9	
11 · · · · · · · · · · · · · · · · · ·	
MSG Los STATUS	
11N20SISO_Ant1_5180	
TIN200100_AII(1_0100	

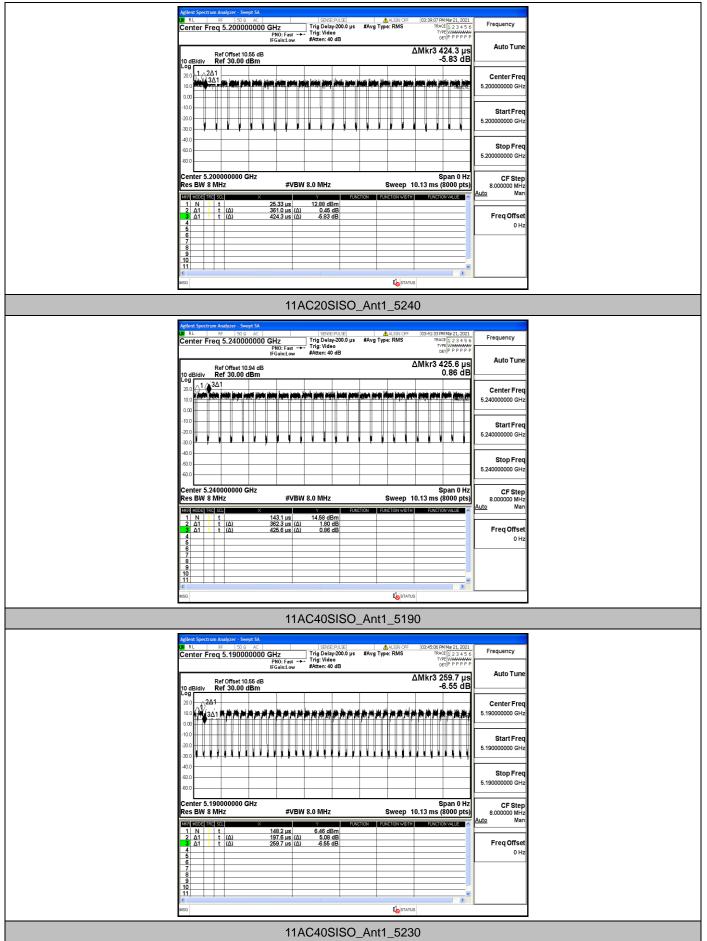


Agilent Spectrum Analyzer - Swept SA ■ RL RF 50 Ω AC SENSE FULSE ▲AUGN OFF 03:16:03 PM Mar 21, 2021	- Frequency
Center Freq 5.180000000 GHz Trig Delay 2000 µs #Avg Type: RMS TracE[12 3 4 3 Trig: Video PNO: Fast Trig: Video Trig: Video Trig: Video IFGainLow #Atten: 40 dB Cerl P P P P I	¥ P
Ref Offset 10.55 dB ΔMkr3 1.368 ms 10 dB/div Ref 30.00 dBm -0.32 dB	Auto Tune
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-50.0 -60.0	5.18000000 GHz
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	Start Freq
	5.20000000 GHz
40.0	Stop Freq 5.20000000 GHz
40.0 Center 5.20000000 GHz Span 0 Hz	
Res BW 8 MHz #VBW 8.0 MHz Sweep 10.13 ms (8000 pts)	
1 N 1 t 595.3 μs 13.31 dBm 2 Δ1 1 t (Δ) 1.306 ms (Δ) -1.77 dB Δ1 1 t (Δ) 1.399 ms (Δ) -0.43 dB	Freq Offset
	0 Hz
7	
MSG STATUS	
11N20SISO_Ant1_5240	
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	Stop Freq
40.0	5.24000000 GHz
Center 5.240000000 GHz Span 0 Hz Res BW 8 MHz #VBW 8.0 MHz Sweep 10.13 ms (8000 pts	
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2 A1 1 t (A) 1.306 ms (A) 0.68 dB 3 A1 1 t (A) 1.369 ms (A) -0.09 dB 4	Freq Offset
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8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	
11N40SISO_Ant1_5190	











Agilent Spectrum Analyzer - Swept SA			
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Aglient Spectrum Analyzer - Swept SA RL RC SENCE PLACE ALIGN CFF Center Freq 5.210000000 GHz Trig Ulde Trig Ulde Align CFF PR0: Fast Trig Ulde Trig Ulde #Are Type: RMS If GainsLow #Atten: 40 dB #Are 10.55 dB 100 GA301 100 GA301 Gain Gain 100 GA301 100 GA301	(035223 РИ Му 21, 3021 ПРАСЕ [1, 2, 3, 4, 5, 6 туст; Инализирание сеј Р Р Р Р Р АМИКТ 3 ТА, 8, µS - 1, 60 dB	Auto Tune Center Freq 5.21000000 GHz	
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Agtent Spectrum Analyzer - Sweet SA RL SS SS Allow CF Center Freq 5.210000000 GHz IFGaint.ow Tig Delay-200.0 µs Fig Delay-2	1095223094421,2021 Revie [1,2,3,4,5,6 постре Реререр ФМКг3 174,8 µs -1,60 dB	Auto Tune Center Freq 5.21000000 GHz 5.210000000 GHz Stop Freq	
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Addient Spectrum Analyzer - Swept SA. RL RD SD AC ISBNCE PLASE ALIGN CFF Center Freq 5.210000000 GHz Trig Ulde Trig Ulde #Avg Type: RMS PR0: Fault Trig Ulde #Avg Type: RMS If colspan="2">Center Freq 5.210000000 GHz Trig Ulde #Avg Type: RMS If colspan="2">Center Freq 5.210000000 GHz Trig Ulde #Avg Type: RMS If colspan="2">Center Freq 5.210000000 GHz Trig Ulde #Avg Type: RMS If colspan="2">Center Freq 5.210000000 GHz	1095223 РИМи 21, 3021 ПРАСЕ [1:2:3:4:5:6 тесе Силиний исе] Р. Р. Р. Р. Р. Р. АМИКТ 3174.8 µS -1.60 dB -1.60 dB	Auto Tune Center Freq 5.21000000 GHz Start Freq 5.21000000 GHz Stop Freq 5.21000000 GHz CF Step	
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5.2. Maximum Conducted Output Power Measurement

5.2.1. Standard Applicable

(1) For the band 5.15-5.25 GHz.

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

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

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1dB reduction in maximum conducted output power is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

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

5.2.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of the power meter.

5.2.3. Test Procedures

The transmitter output (antenna port) was connected to the power meter.

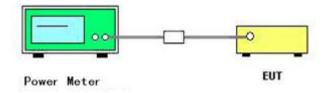
According to KDB 789033 D02 Section 3 (a) Method PM (Measurement using an RF average power meter):

- (i) Measurements may be performed using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.
 - The EUT is configured to transmit continuously or to transmit with a constant duty cycle.
 - At all times when the EUT is transmitting, it must be transmitting at its maximum power control level.
 - The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.
- (ii) If the transmitter does not transmit continuously, measure the duty cycle, x, of the transmitter output signal as described in section II.B.



- (iii) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
- (iv) Adjust the measurement in dBm by adding 10 log (1/x) where x is the duty cycle (e.g., 10 log (1/0.25) if the duty cycle is 25%).

5.2.4. Test Setup Layout



5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.2.6. Test Result of Maximum Conducted Output Power

Tem	perature	22.8 ℃	Humidity	50%	
	Engineer	Anna Hu	Configurations	IEEE 802.11a/n/	′ac
TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verd
		5180	11.97	<=23.98	PAS
11A	Ant1	5200	12.06	<=23.98	PAS
			5240 13.22		PAS
		5180	10.92	<=23.98	PAS
11N20SISO	Ant1	5200	10.96	<=23.98	PAS
		5240	12.20	<=23.98	PAS
11N40SISO	Ant1	5190	11.13	<=23.98	PAS
111403130	Anti	5230	12.17	<=23.98	PAS
		5180	11.00	<=23.98	PAS
11AC20SISO	Ant1	5200	10.84	<=23.98	PAS
		5240	12.28	<=23.98	PAS
11AC40SISO	Ant1	5190	10.96	<=23.98	PAS
1140403130	AIIU	5230	12.00	<=23.98	PAS
11AC80SISO	Ant1	5210	10.83	<=23.98	PAS

Remark:

- 1. Measured output power at difference data rate for each mode and recorded worst case for each mode.
- 2. Test results including cable loss;
- 3. Worst case data at 6Mbps at IEEE 802.11a; MCS0 at IEEE 802.11n HT20, IEEE 802.11n HT40
- 4. Directional Gain =1.49 dBi < 6dBi; no need reduce power limit;
- 5. Report conducted power = Measured conducted average power + Duty Cycle factor;



5.3. Power Spectral Density Measurement

5.3.1. Standard Applicable

For 5150~5250MHz

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

5.3.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of Spectrum Analyzer.

5.3.3. Test Procedures

1. The transmitter was connected directly to a Spectrum Analyzer through a directional couple.

- 2. The power was monitored at the coupler port with a Spectrum Analyzer. The power level was set to the maximum level.
- 3. Set the RBW = 1MHz.
- 4. Set the VBW \geq 3MHz

5. Span=Encompass the entire emissions bandwidth (EBW) of the signal (or, alternatively, the entire 99% occupied bandwidth) of the signal.

6. Number of points in sweep $\ge 2 \times \text{span} / \text{RBW}$. (This ensures that bin-to-bin spacing is $\le \text{RBW}/2$, so that narrowband signals are not lost between frequency bins.)

7. Manually set sweep time $\ge 10 \times$ (number of points in sweep) \times (total on/off period of the transmitted signal).

- 8. Set detector = power averaging (rms).
- 9. Sweep time = auto couple.
- 10. Trace mode = max hold.
- 11. Allow trace to fully stabilize.

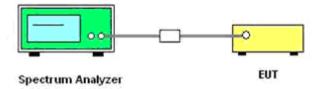
12. Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument's band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively, levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively,

13. Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add 10 log (1/0.25) = 6 dB if the duty cycle is 25%.

14. Use the peak marker function to determine the maximum power level in any 1MHz band segment within the fundamental EBW.



5.3.4. Test Setup Layout



5.3.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

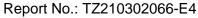
5.3.6. Test Result of Power Spectral Density

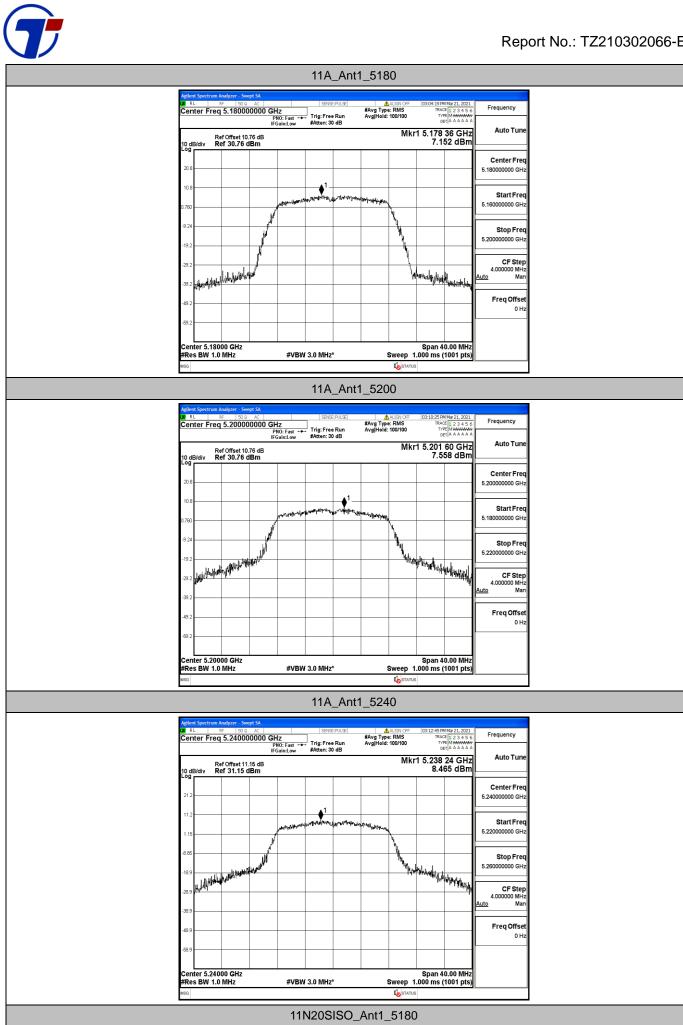
Temperature	22.8 ℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	IEEE 802.11a/n/ac

TestMode	Antenna	Channel	Result [dBm/MHz]	Limit[dBm/MHz]	Verdict
		5180	7.15	<=11	PASS
11A	Ant1	5200	7.56	<=11	PASS
		5240	8.47	<=11	PASS
		5180	5.98	<=11	PASS
11N20SISO	Ant1	5200	6.13	<=11	PASS
		5240	7.51	<=11	PASS
441400100	Anti	5190	5.36	<=11	PASS
11N40SISO	Ant1	5230	5.06	<=11	PASS
		5180	6.96	<=11	PASS
11AC20SISO	Ant1	5200	7.57	<=11	PASS
		5240	7.94	<=11	PASS
4440400100	Anti	5190	4.44	<=11	PASS
11AC40SISO	Ant1	5230	5.55	<=11	PASS
11AC80SISO	Ant1	5210	1.28	<=11	PASS

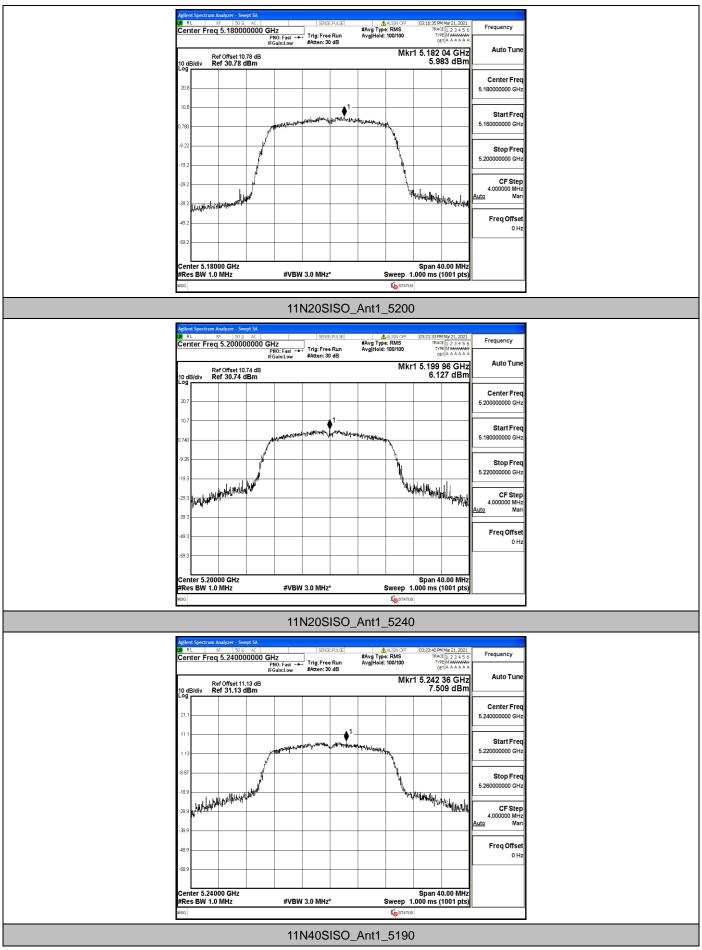
Remark:

- 1. Measured power spectrum density at difference data rate for each mode and recorded worst case for each mode.
- 2. Test results including cable loss;
- 3. Worst case data at 6Mbps at IEEE 802.11a; MCS0 at IEEE 802.11n HT20, IEEE 802.11n HT40
- 4. Directional Gain = 1.49dBi < 6dBi;; no need reduce power spectrum density limit;
- 5. Report conducted PSD = Measured conducted PSD + Duty Cycle factor;
- 6. Please refer to following test plots;

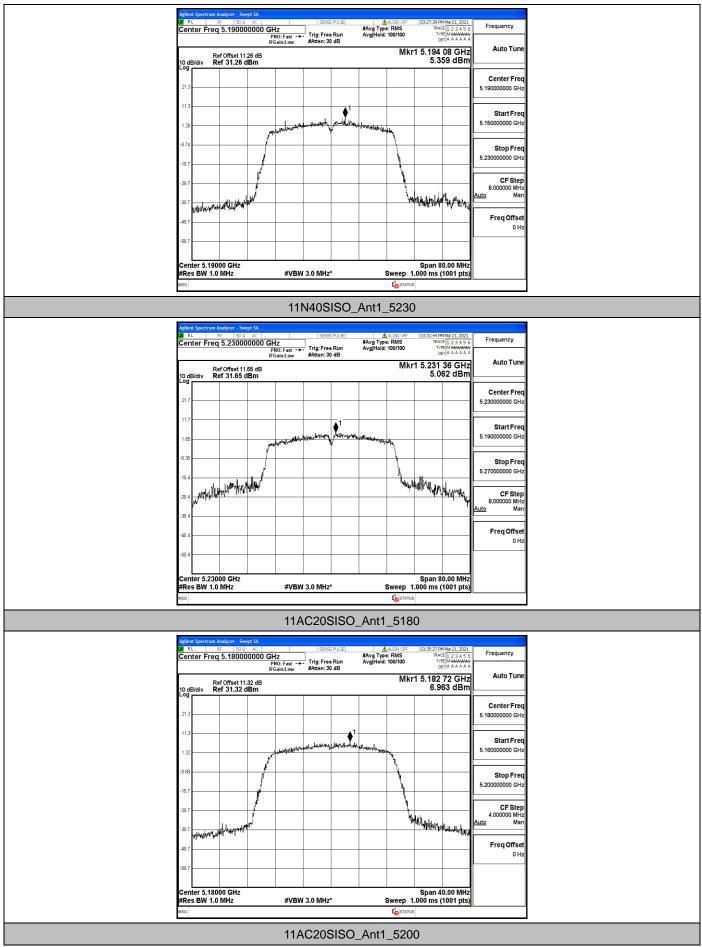




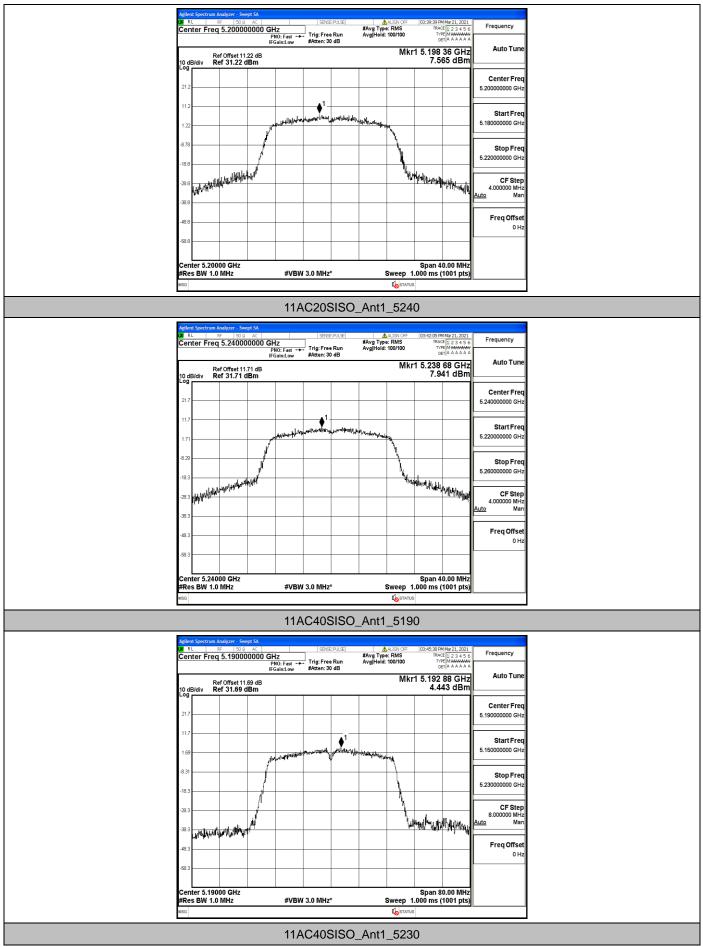




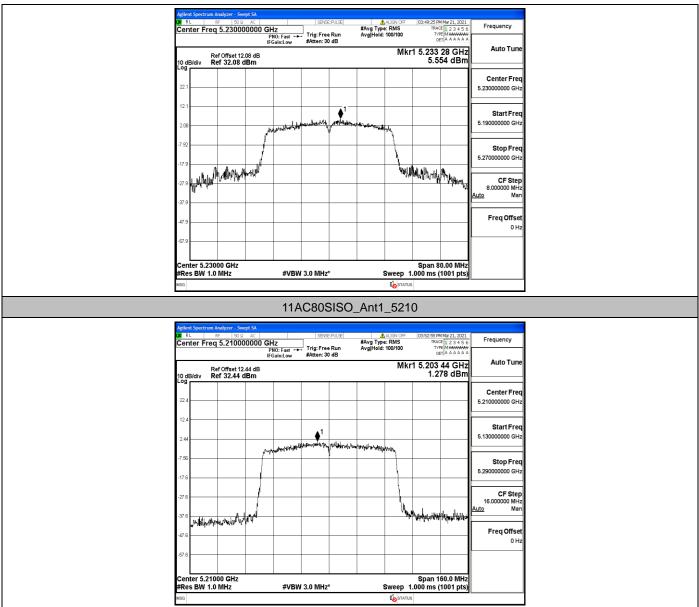














5.4. 99% Occupied Bandwidth and 26dB Emission Bandwidth Measurement

5.4.1. Standard Applicable

No restriction limits. But resolution bandwidth within band edge measurement is 1% of the 99% occupied bandwidth.

5.4.2. Measuring Instruments and Setting

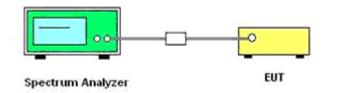
Please refer to section 6 of equipment list in this report. The following table is the setting of the Spectrum Analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span	> 26dB Bandwidth
Detector	Peak
Trace	Max Hold
Sweep Time	100ms
5	

5.4.3. Test Procedures

- 1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
- 2. Set the RBW = approximately 1% of the emission bandwidth.
- 3. Set the VBW \geq 3 * RBW
- 4. Measured the spectrum width with power higher than 26dB below carrier.

5.4.4. Test Setup Layout



5.4.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.4.6. Test Result of 99% Occupied Bandwidth and 26dB Emission Bandwidth

Temperature	22.8 ℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	IEEE 802.11a/n/ac



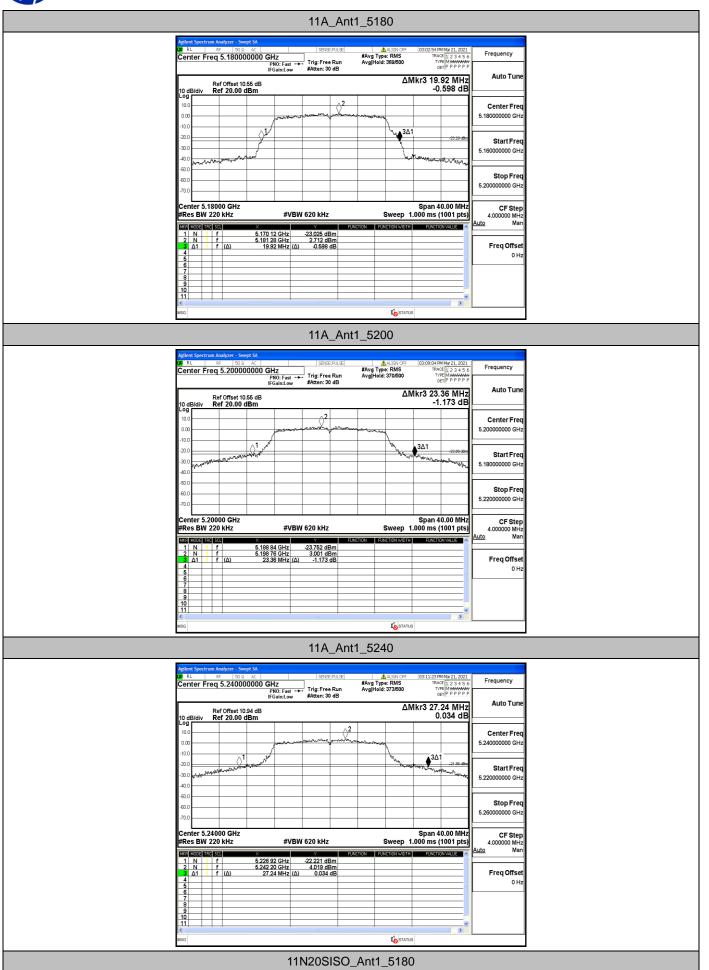
Report No.: TZ210302066-E4

TestMode	Antenna	Channel	26db EBW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
		5180	19.920	5170.120	5190.040		PASS
11A	Ant1	5200	23.360	5188.840	5212.200		PASS
		5240	27.240	5226.920	5254.160		PASS
		5180	20.200	5170.000	5190.200		PASS
11N20SISO	Ant1	5200	20.480	5189.720	5210.200		PASS
		5240	23.040	5228.160	5251.200		PASS
11N40SISO	Ant1	5190	40.240	5170.000	5210.240		PASS
1111403130	Anti	5230	50.800	5205.520	5256.320		PASS
		5180	20.160	5169.960	5190.120		PASS
11AC20SISO	Ant1	5200	20.440	5189.720	5210.160		PASS
		5240	20.880	5229.720	5250.600		PASS
11AC40SISO	Ant1	5190	40.000	5169.920	5209.920		PASS
TAC403130	Anti	5230	60.560	5197.120	5257.680		PASS
11AC80SISO	Ant1	5210	80.800	5169.840	5250.640		PASS

Remark:

- 1. Measured 99% and 26dB bandwidth at difference data rate for each mode and recorded worst case for each mode.
- 2. Test results including cable loss;
- 3. Worst case data at 6Mbps at IEEE 802.11a; MCS0 at IEEE 802.11n HT20, IEEE 802.11n HT40
- 4. Please refer to following test plots;

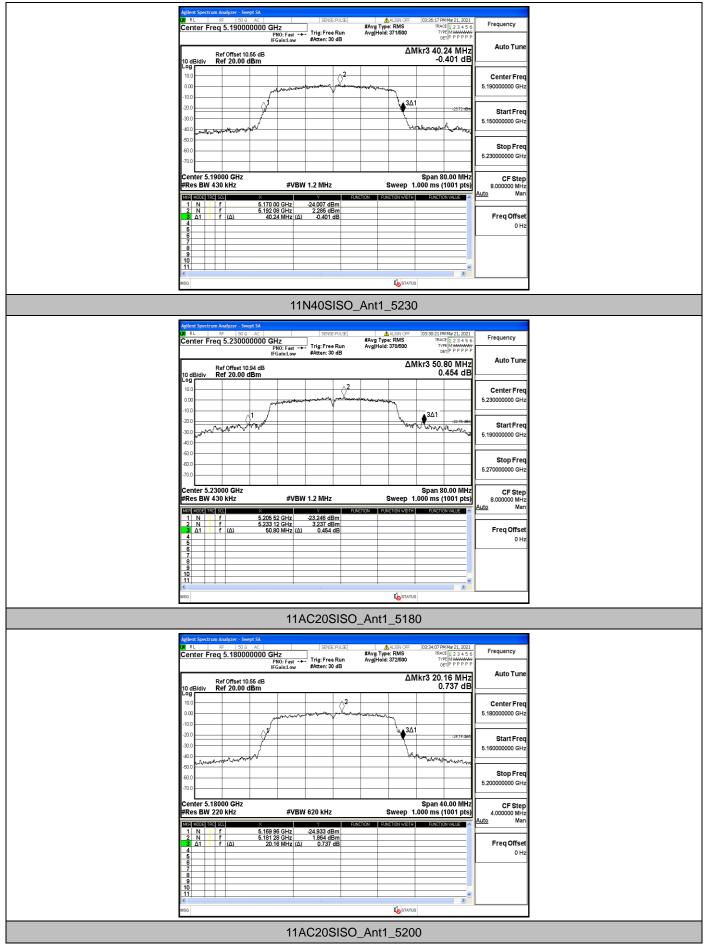


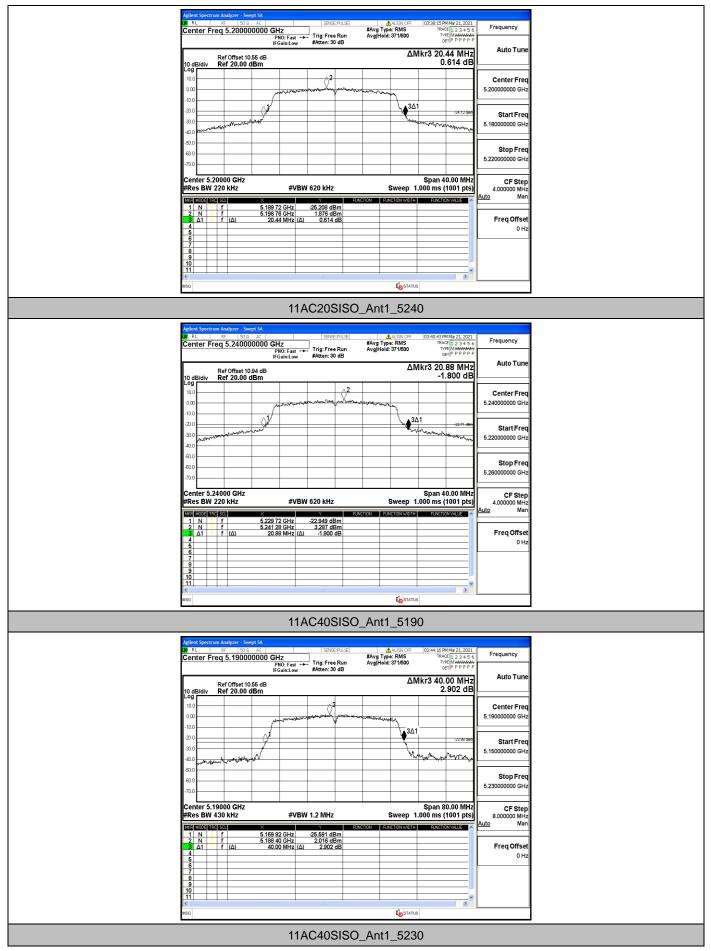














Agilent Spectrum Analyzer - Swept SA						
KIRL RF 50 Q AC		SENSE:PULSE	ALIGN OFF #Avg Type: RMS	03:48:04 PM Mar 21, 2021	Frequency	
Center Freq 5.2300000	PNO: Fast +++ Tr	g: Free Run	Avg Hold: 371/500	TRACE 1 2 3 4 5 6 TYPE MWWWWW		
1	PNO: Fast +++ Tr IFGain:Low #A	tten: 30 dB		DETPPPPP		
				11-2 00 50 MUL	Auto Tune	
Ref Offset 10.94 d	в		ΔN	1kr3 60.56 MHz		
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5.5. Radiated Emissions Measurement

5.5.1. Standard Applicable

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
\1\ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293.	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(\2\)
13.36-13.41			

\1\ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
 \2\ Above 38.6

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 (68.2dBuV/m at 3m).

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	Field Strength	Measurement Distance		
(MHz)	(microvolts/meter)	(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		

5.5.2. Measuring Instruments and Setting

Please refer to section 6 of equipment 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	10 th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB/VB 120kHz/1MHz for QP



5.5.3. Test Procedures

1) Sequence of testing 9 kHz to 30 MHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 1.5 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.



2) Sequence of testing 30 MHz to 1 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

- --- The antenna is polarized vertical and horizontal.
- --- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (\pm 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.



3) Sequence of testing 1 GHz to 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position $(\pm 45^\circ)$ and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.



4) Sequence of testing above 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

Premeasurement:

--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

Final measurement:

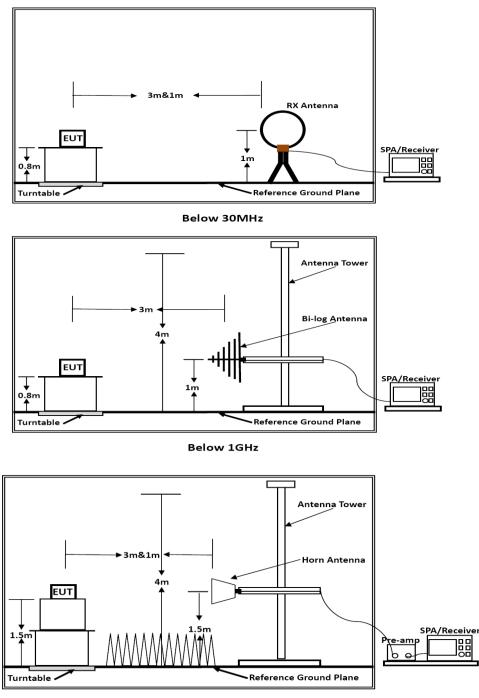
--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.



5.5.4. Test Setup Layout

For radiated emissions below 30MHz



Above 1GHz

Above 10 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m.

Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1.5m]) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].



5.5.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.5.6. Results of Radiated Emissions (9 KHz~30MHz)

Temperature	24.5 ℃	Humidity	56.2%
Test Engineer	Anna Hu	Configurations	IEEE 802.11a/n/ac

Freq.	Level	Over Limit	Over Limit	Remark
(MHz)	(dBuV)	(dB)	(dBuV)	
-	-	-	-	See Note

Note:

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

Distance extrapolation factor = 40 log (specific distance / test distance) (dB);

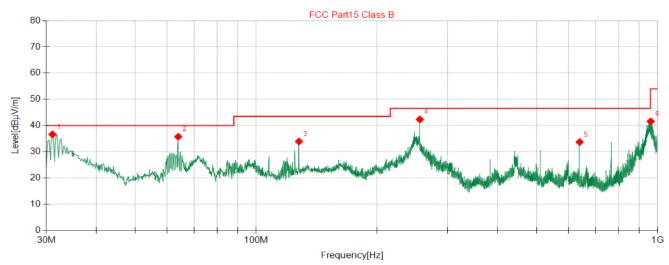
Limit line = specific limits (dBuV) + distance extrapolation factor.

5.5.7. Results of Radiated Emissions (30MHz~1GHz)

Temperature	24.5 ℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	IEEE 802.11a, 5180MHz

Test result for IEEE 802.11a, 5180MHz





QP Detector

Suspected Data List							
NO	Freq.	Level	Limit	Margin	Height	Angle	Polarity
NO.	[MHz]	[dBµV/m]	[dBµV/m]	[dB]	[cm]	[°]	
1	31.091	36.63	40.00	3.37	100	68	Vertical
2	63.950	35.73	40.00	4.27	100	352	Vertical
3	127.84	33.91	43.50	9.59	100	95	Vertical
4	255.76	42.33	46.50	4.17	100	358	Vertical
5	639.64	33.70	46.50	12.80	100	19	Vertical
6	961.56	41.58	54.00	12.42	100	33	Vertical