

FCC TEST REPORT

Product Name: Hybrid Full-Touch Handheld Computer

Trade Mark:



Model No.: HF550X

Add. Model No.: N/A

Report Number: 2208151076RFC-3

Test Standards: FCC 47 CFR Part 15 Subpart C

FCC ID: SS4HF550X

Test Result: PASS

Date of Issue: October 26, 2022

Prepared for:

Bluebird Inc.

3F, 115, Irwon-ro, Gangnam-gu, Seoul, Republic of Korea

Prepared by:

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October 26, 2022

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Version

Version No.	Date	Description
V1.0	October 26, 2022	Original



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1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	Bluebird Inc.
Address of Applicant:	3F, 115, Irwon-ro, Gangnam-gu, Seoul, Republic of Korea
Manufacturer:	Bluebird Inc.
Address of Manufacturer:	3F, 115, Irwon-ro, Gangnam-gu, Seoul, Republic of Korea

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	Hybrid Full-Touch Handheld Computer		
Model No.:	HF550X		
Add. Model No.:	N/A		
Trade Mark:			
DUT Stage:	Identical Prototype		
EUT Supports Function: (Provided by the customer)	2.4 GHz ISM Band:	IEEE 802.11b/g/n	
		Bluetooth 5.1	
	5 GHz U-NII Bands:	5 150 MHz to 5 250 MHz	IEEE 802.11a/n/ac
		5 250 MHz to 5 350 MHz	IEEE 802.11a/n/ac
		5 470 MHz to 5 725 MHz	IEEE 802.11a/n/ac
		5 725 MHz to 5 850 MHz	IEEE 802.11a/n/ac
NFC:	13.553 MHz to 13.567 MHz		
Software Version:	R1.00 (Provided by the customer)		
Hardware Version:	0.5 (Provided by the customer)		
Sample Received Date:	August 15, 2022		
Sample Tested Date:	August 19, 2022 to September 21, 2022		
Remark: The above EUT's information was provided by customer. Please refer to the specifications or user's manual for more detailed description.			

1.2.2 Description of Accessories

Adapter	
Model No.:	KSA29B0500200D5
Input:	100-240 V~50/60 Hz 0.5A
Output:	5.0 V $\overline{=}$ 2.0A
AC Cable:	N/A
DC Cable:	N/A

Battery	
Model No.:	BAT-400001
Battery Type:	Lithium-ion Rechargeable Battery
Rated Voltage:	3.85 Vdc
Limited Charge Voltage:	4.4 Vdc
Rated Capacity:	4000 mAh

Cable	
Description:	USB Type-C Plug Cable
Connector:	USB Type-C / USB 3.0 Type A
Cable Type:	Shielded without ferrite
Length:	1 Meter

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1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Band:	2400 MHz to 2483.5 MHz	
Frequency Range:	2412 MHz to 2472 MHz	
Support Standards:	IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40	
Type of Modulation:	IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM (64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT20: OFDM (64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT40: OFDM (64-QAM, 16-QAM, QPSK, BPSK)	
Data Rate:	IEEE 802.11b: Up to 11 Mbps IEEE 802.11g: Up to 54 Mbps IEEE 802.11n-HT20: Up to MCS 15 IEEE 802.11n-HT40: Up to MCS 15	
Number of Channels:	IEEE 802.11b: 13 IEEE 802.11g: 13 IEEE 802.11n-HT20: 13 IEEE 802.11n-HT40: 9	
Channel Separation:	5 MHz	
Antenna Type: (Provided by the customer)	Ant. 0	PIFA Antenna
	Ant. 1	PIFA Antenna
Antenna Gain: (Provided by the customer)	Ant. 0	1.137 dBi
	Ant. 1	0.654 dBi
Maximum Peak Power:	SISO_ Ant. 0	IEEE 802.11b: 21.42 dBm IEEE 802.11g: 23.36 dBm IEEE 802.11n-HT20: 20.14 dBm IEEE 802.11n-HT40: 21.32 dBm
	SISO_ Ant. 1	IEEE 802.11b: 21.17 dBm IEEE 802.11g: 22.15 dBm IEEE 802.11n-HT20: 19.17 dBm IEEE 802.11n-HT40: 20.84 dBm
	MIMO_ Ant. 0+1	IEEE 802.11n-HT20: 22.69 dBm IEEE 802.11n-HT40: 24.07 dBm
Normal Test Voltage:	3.85Vdc and/or 120 Vac	

1.4 OTHER INFORMATION

Operation Frequency Each of Channel	
IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20	$f = 2407 + 5k \text{ MHz}, k = 1, \dots, 13$
IEEE 802.11n-HT40	$f = 2407 + 5k \text{ MHz}, k = 3, \dots, 11$
Note: f is the operating frequency (MHz); k is the operating channel.	

1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

1) Support Equipment

Description	Manufacturer	Model No.	Serial Number	Supplied by
Notebook	DELL	Inspiron 5409	N/A	UnionTrust

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable	SMA	0.3 Meter	UnionTrust

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1.6 TEST LOCATION

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1.7 TEST FACILITY

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

CNAS-Lab Code: L9069

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

A2LA-Lab Certificate No.: 4312.01

Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

ISED Wireless Device Testing Laboratories

CAB identifier: CN0032

FCC Accredited Lab.

Designation Number: CN1194

Test Firm Registration Number: 259480

1.8 DEVIATION FROM STANDARDS

None.

1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

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1.11 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

No.	Item	Measurement Uncertainty
1	Conducted emission 9KHz-150KHz	±3.2 dB
2	Conducted emission 150KHz-30MHz	±2.7 dB
3	Radiated emission 9KHz-30MHz	±4.7 dB
4	Radiated emission 30MHz-1GHz	±4.6 dB
5	Radiated emission 1GHz-18GHz	±4.4 dB
6	Radiated emission 18GHz-26GHz	±4.6 dB

2. TEST SUMMARY

FCC 47 CFR Part 15 Subpart C Test Cases			
Test Item	Test Requirement	Test Method	Result
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (b)	N/A	PASS
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013 Clause 6.2	PASS
Conducted Peak Output Power	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)	ANSI C63.10-2013 Clause 11.9.1.3	PASS
6dB Bandwidth	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)	ANSI C63.10-2013 Clause 11.8.1	PASS
Power Spectral Density	FCC 47 CFR Part 15 Subpart C Section 15.247 (e)	ANSI C63.10-2013 Clause 11.10.2	PASS
Conducted Out of Band Emission	FCC 47 CFR Part 15 Subpart C Section 15.247(d)	ANSI C63.10-2013 Clause 11.11	PASS
Radiated Spurious Emissions	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013 Clause 11.11 & Clause 11.12	PASS
Band Edge Measurements (Radiated)	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013 Clause 11.13	PASS

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3. EQUIPMENT LIST

Radiated Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date	Cal. Due date
☒	3M Chamber & Accessory Equipment	ETS-LINDGREN	3M	Euroshiedpn-CT001270-1317	22-Jan-2021	21-Jan-2024
☒	Receiver	R&S	ESIB26	100114	5-Nov-2021	4-Nov-2022
☒	Loop Antenna	ETS-LINDGREN	6502	00202525	11-Nov-2021	10-Nov-2023
☒	Broadband Antenna	ETS-LINDGREN	3142E	00201566	11-Nov-2021	10-Nov-2023
☒	6dB Attenuator	Talent	RA6A5-N-18	18103001	11-Nov-2021	10-Nov-2023
☒	Preamplifier	HP	8447F	2805A02960	5-Nov-2021	4-Nov-2022
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201874	17-Apr-2022	16-Apr-2024
☒	Pre-amplifier	ETS-LINDGREN	00118385	00201874	6-Nov-2021	5-Nov-2022
☐	Horn Antenna	ETS-LINDGREN	3116C	00200180	17-Apr-2022	16-Apr-2024
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	14-Nov-2020	13-Nov-2022
☒	Pre-amplifier	ETS-LINDGREN	00118384	00202652	17-Nov-2020	16-Nov-2022
☒	Band Reject Filter (2400MHz~2500MHz)	Micro-Tronics	BRM50702	G248	6-Nov-2021	5-Nov-2022
☒	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☒	Test Software	Audix	e3	Software Version: 9.160323		

Conducted Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date	Cal. Due date
☒	Receiver	R&S	ESR7	101181	5-Nov-2021	4-Nov-2022
☒	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	5-Nov-2021	4-Nov-2022
☒	LISN	R&S	ESH2-Z5	860014/024	5-Nov-2021	4-Nov-2022
☐	LISN	ETS-Lindgren	3816/2SH	00201088	5-Nov-2021	4-Nov-2022
☒	Test Software	Audix	e3	Software Version: 9 20151119i		

RF Conducted Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date	Cal. Due date
☒	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	15-Apr-2022	14-Apr-2023
☒	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	5-Nov-2021	4-Nov-2022
☒	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430023	5-Nov-2021	4-Nov-2022

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4. TEST CONFIGURATION

4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

4.1.1 Normal or Extreme Test Conditions

Environment Parameter	Selected Values During Tests		
Test Condition	Ambient		
	Temperature (°C)	Voltage	Relative Humidity (%)
NT/NV	+15 to +35	3.85Vdc and/or 120 Vac	20 to 75
Remark: 1) NV: Normal Voltage; NT: Normal Temperature			

4.1.2 Record of Normal Environment and Test Sample

Test Item	Temp. (°C)	Relative Humidity (%)	Pressure (kPa)	Sample No.	Tested by
AC Power Line Conducted Emission	24.3	42.7	98.95	S20220815342-ZJA08/9	David Zhang
Conducted Peak Output Power	24.5	49	99.9	S20220815342-ZJA09/9	Hank Wu
6dB Bandwidth					
Power Spectral Density					
Conducted Out of Band Emission					
Radiated Spurious Emissions	25.2	50	100.6	S20220815342-ZJA08/9	Andy Lin
Band Edge Measurements (Radiated)					

4.2 TEST CHANNELS

Mode	Tx/Rx Frequency	Test RF Channel Lists				
		Lowest(L)	Middle(M)	Highest(H11)	Highest(H12)	Highest(H13)
IEEE 802.11b	2412 MHz to 2472 MHz	Channel 1	Channel 7	Channel 11	Channel 12	Channel 13
		2412 MHz	2437 MHz	2462 MHz	2467 MHz	2472 MHz
IEEE 802.11g	2412 MHz to 2472 MHz	Channel 1	Channel 7	Channel 11	Channel 12	Channel 13
		2412 MHz	2437 MHz	2462 MHz	2467 MHz	2472 MHz
IEEE 802.11n-HT20	2412 MHz to 2472 MHz	Channel 1	Channel 7	Channel 11	Channel 12	Channel 13
		2412 MHz	2437 MHz	2462 MHz	2467 MHz	2472 MHz
Mode	Tx/Rx Frequency	Test RF Channel Lists				
		Lowest(L)	Middle(M)	Highest(H9)	Highest(H10)	Highest(H11)
IEEE 802.11n-HT40	2422 MHz to 2462 MHz	Channel 3	Channel 7	Channel 9	Channel 10	Channel 11
		2422 MHz	2437 MHz	2452 MHz	2457 MHz	2462 MHz

4.3 EUT TEST STATUS

Mode	Tx/Rx Function	Description
IEEE 802.11b IEEE 802.11g IEEE 802.11n-HT20 IEEE 802.11n-HT40	1Tx/1Rx	1. Keep the EUT in continuously transmitting or receiving with modulation test single.
IEEE 802.11n-HT20 IEEE 802.11n-HT40	2Tx/2Rx	2. Keep the EUT in continuously transmitting or receiving with modulation test single.

Power Setting (Provided by the customer)						
Mode	Channel 1-11		Channel 12		Channel 13	
	Antenna 0	Antenna 1	Antenna 0	Antenna 1	Antenna 0	Antenna 1
IEEE 802.11b	18	18	18	18	18	18
IEEE 802.11g	18	18	18	17	18	16
IEEE 802.11n-HT20	14	14	14	14	14	14
IEEE 802.11n-HT40	14	14	14	14	14	14

Test Software (Provided by the customer)
Test software name: QRCT4

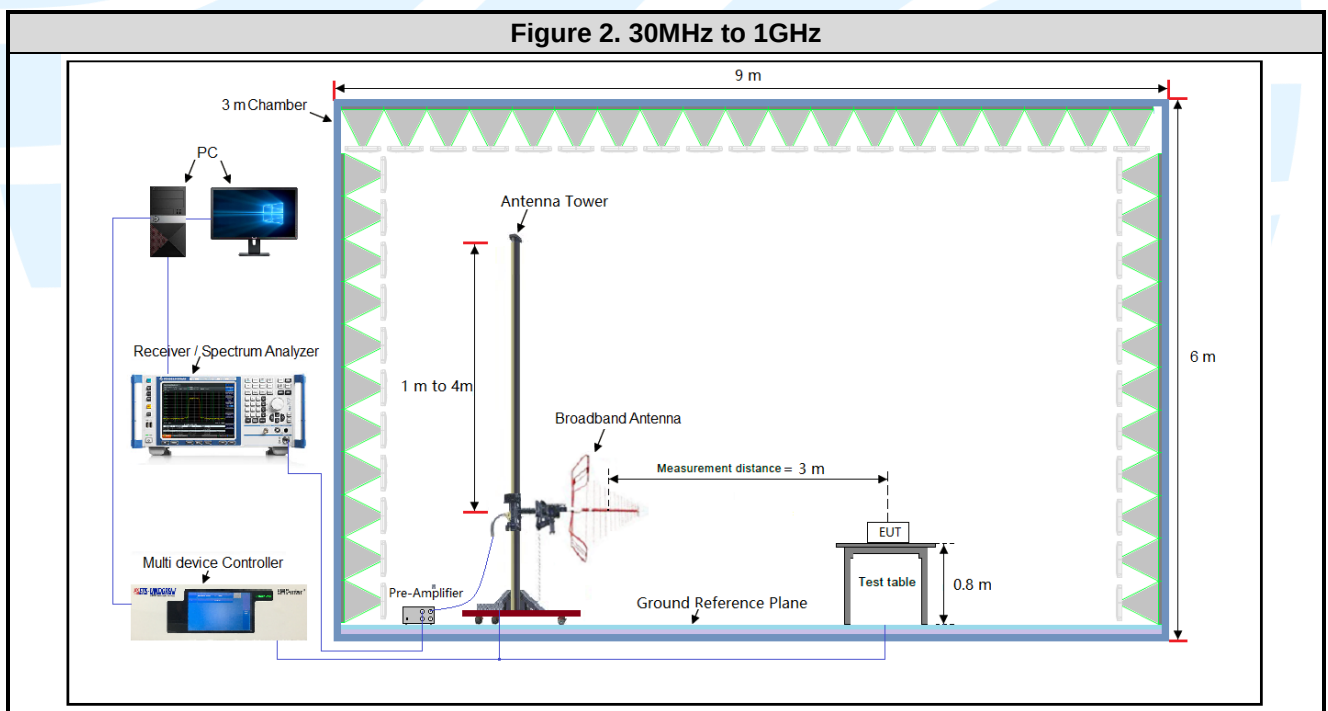
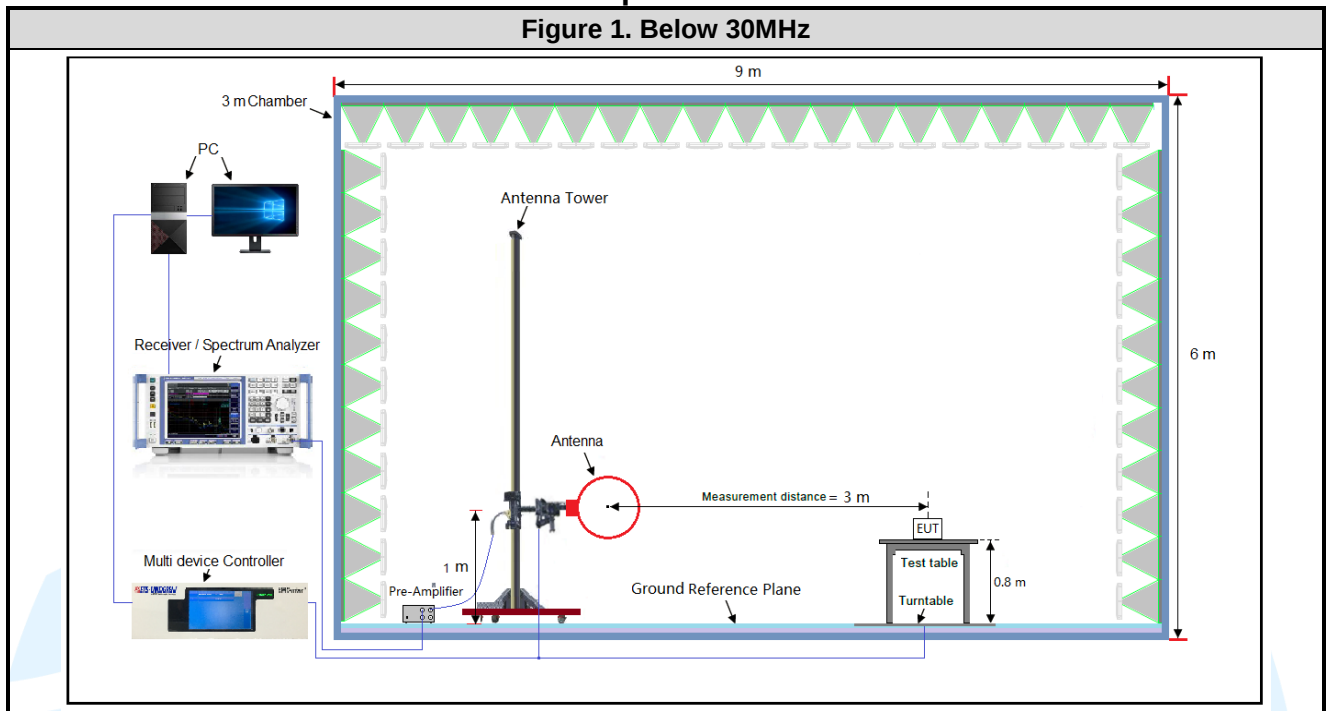
4.4 PRE-SCAN

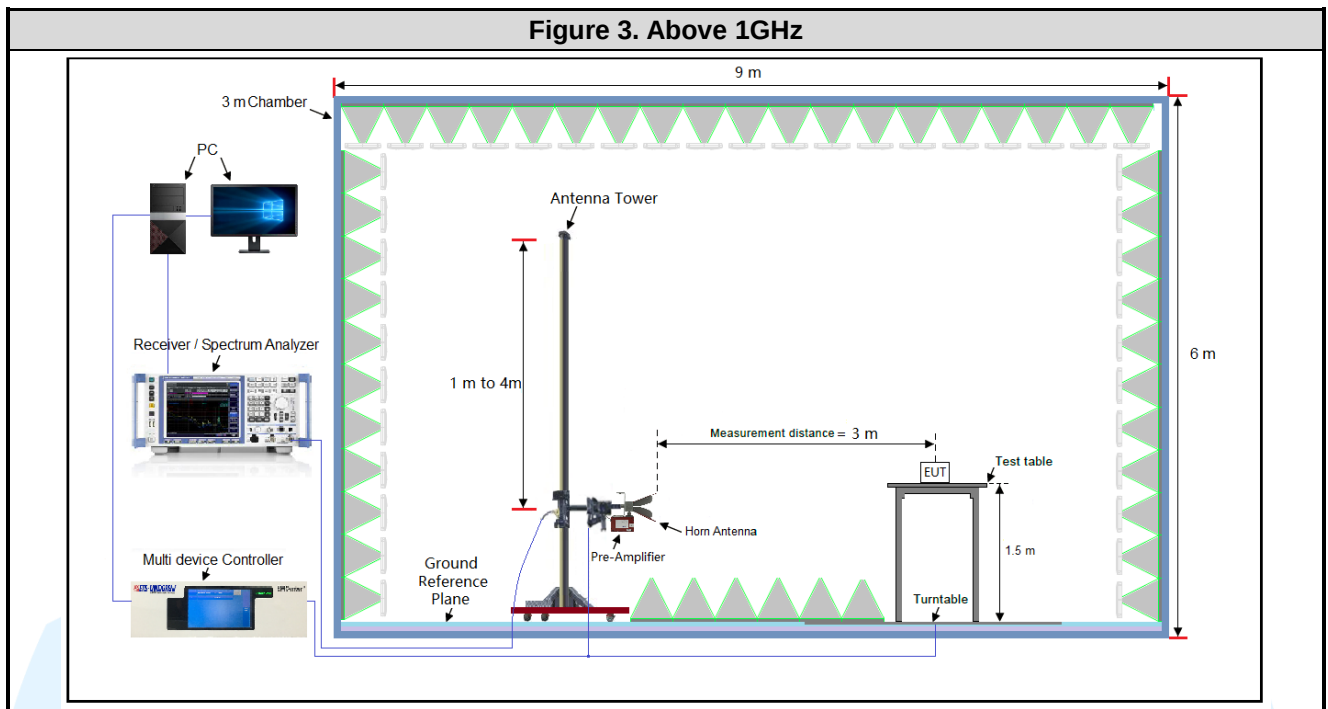
Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and data rate. Following data rate was (were) selected for the final test as listed below

Mode	Worst-case data rates
IEEE 802.11b	1 Mbps
IEEE 802.11g	6 Mbps
IEEE 802.11n-HT20	MCS0
IEEE 802.11n-HT40	MCS0

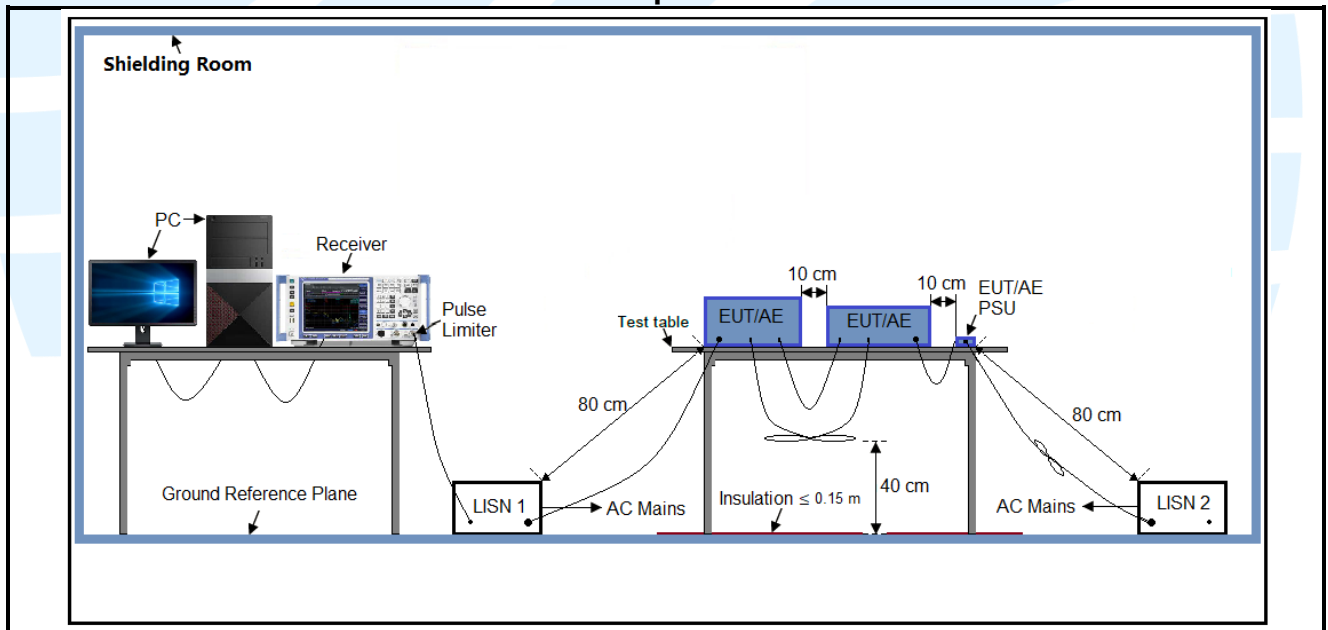
4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

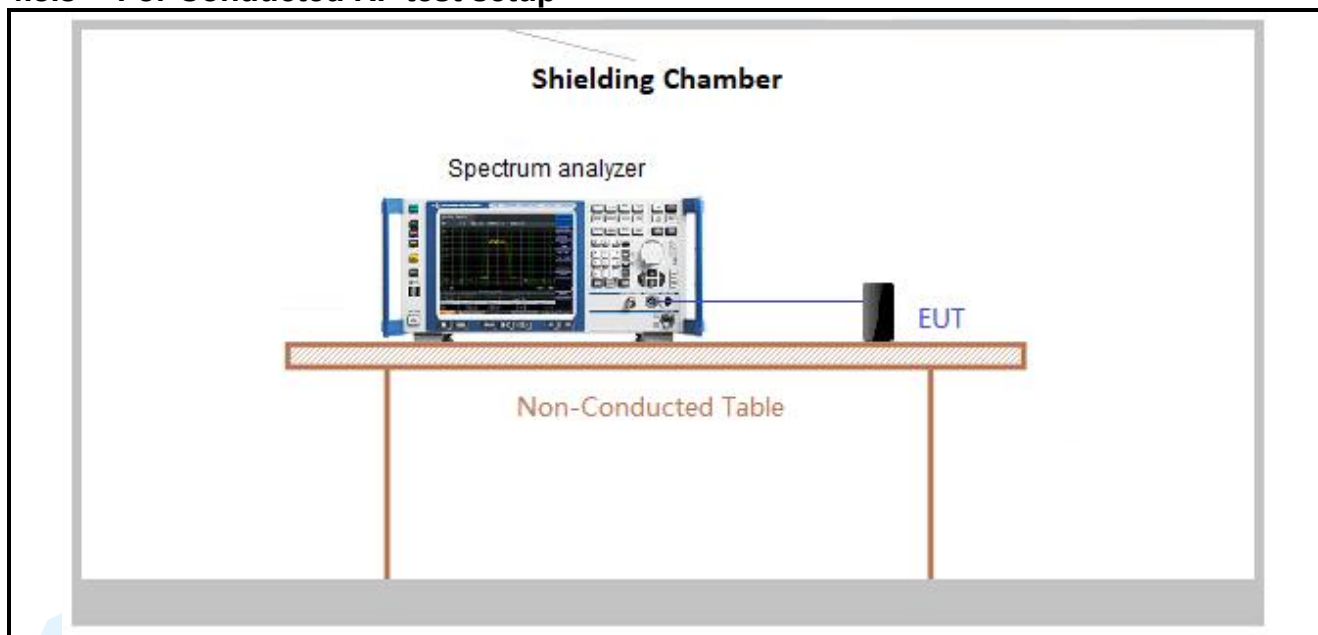




4.5.2 For Conducted Emissions test setup



4.5.3 For Conducted RF test setup



4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. It was powered by 3.85V Battery. Only the worst-case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in orientation.

All readings are extrapolated back to the equivalent three-meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

4.7 DUTY CYCLE

Test Procedure: ANSI C63.10-2013 Clause 11.6.

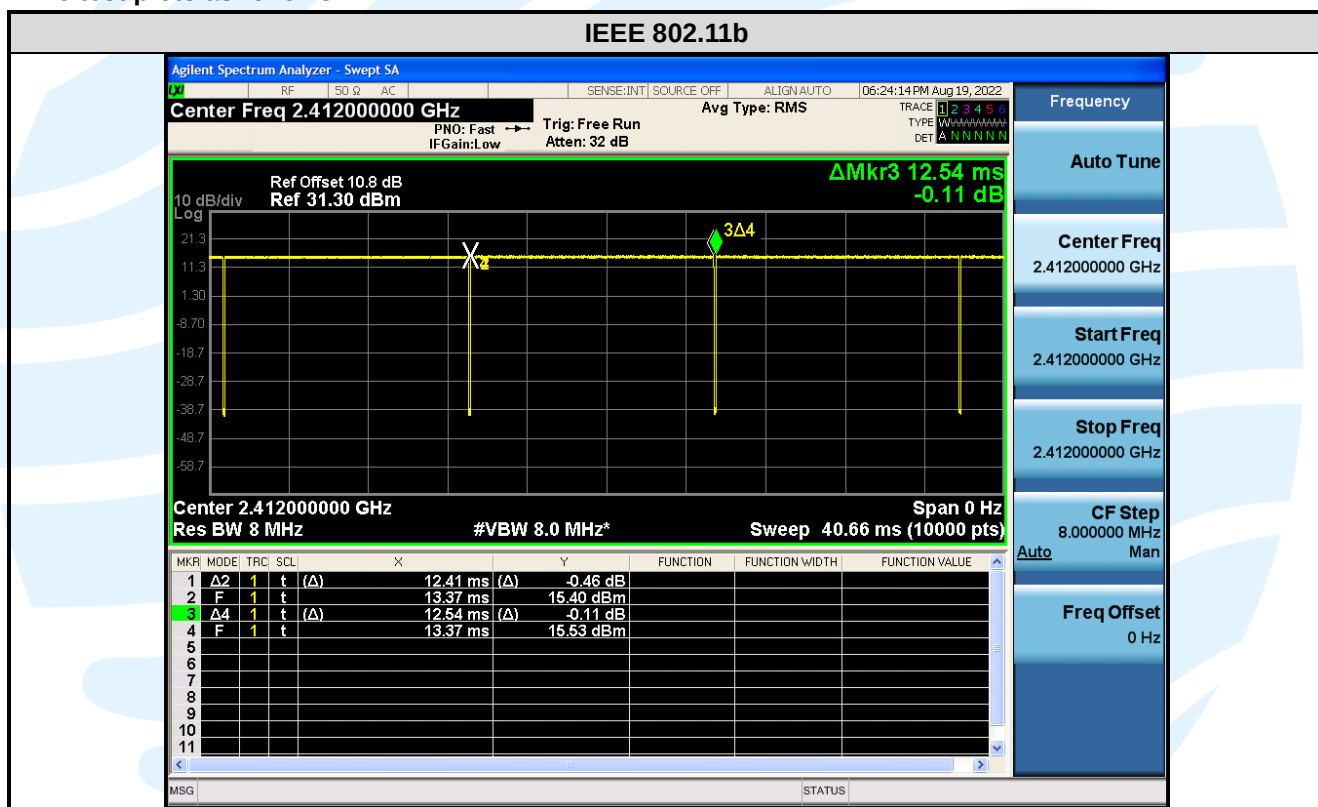
Test Results

Mode	Data Rates	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/T Minimum VBW (kHz)
IEEE 802.11b	1 Mbps	12.41	12.54	0.99	98.96	0.00	0.01
IEEE 802.11g	6 Mbps	2.04	2.10	0.97	97.14	0.13	0.49
IEEE 802.11n-HT20	MCS 0	1.91	1.96	0.97	97.45	0.11	0.52
IEEE 802.11n-HT40	MCS 0	0.940	1.00	0.94	94.00	0.27	1.06

Remark:

- 1) Duty cycle= On Time/ Period;
- 2) Duty Cycle factor = $10 * \log(1/ \text{Duty cycle})$

The test plots as follows



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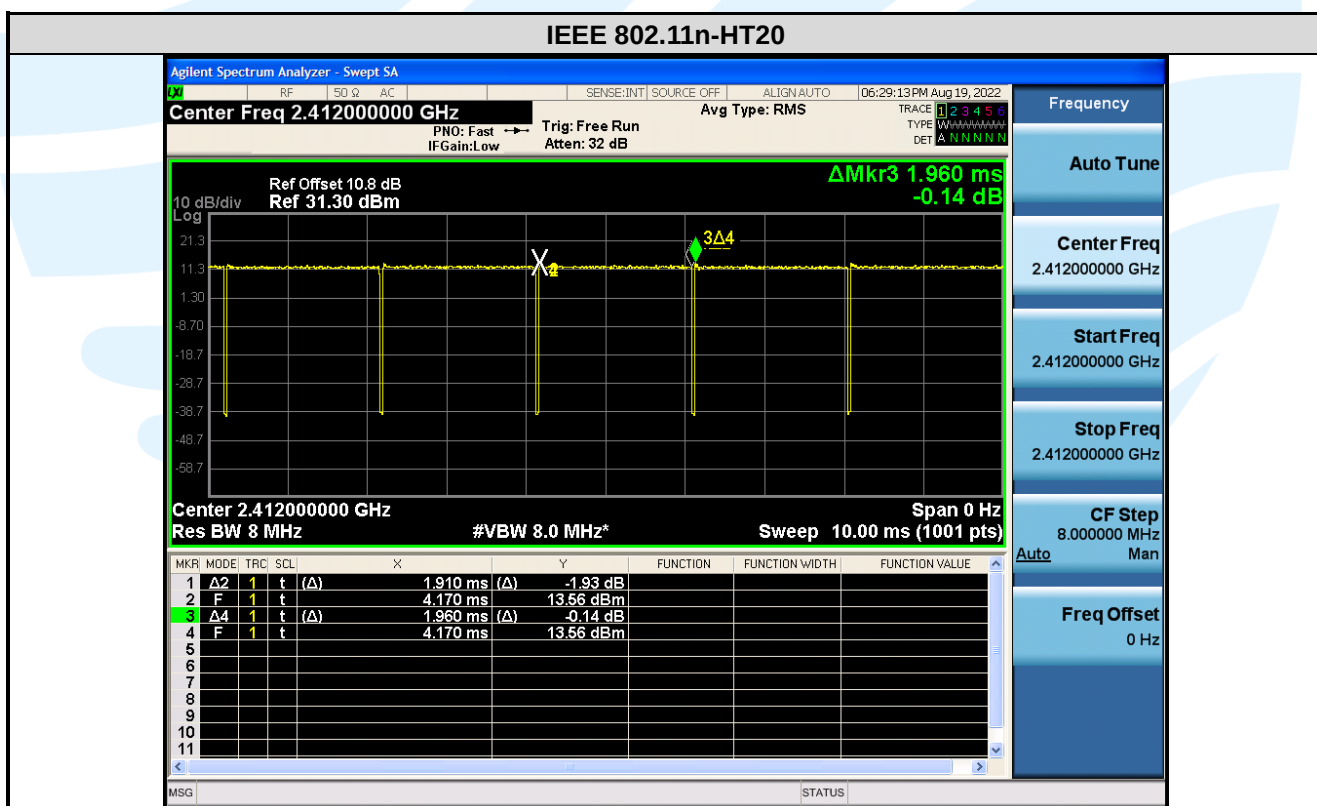
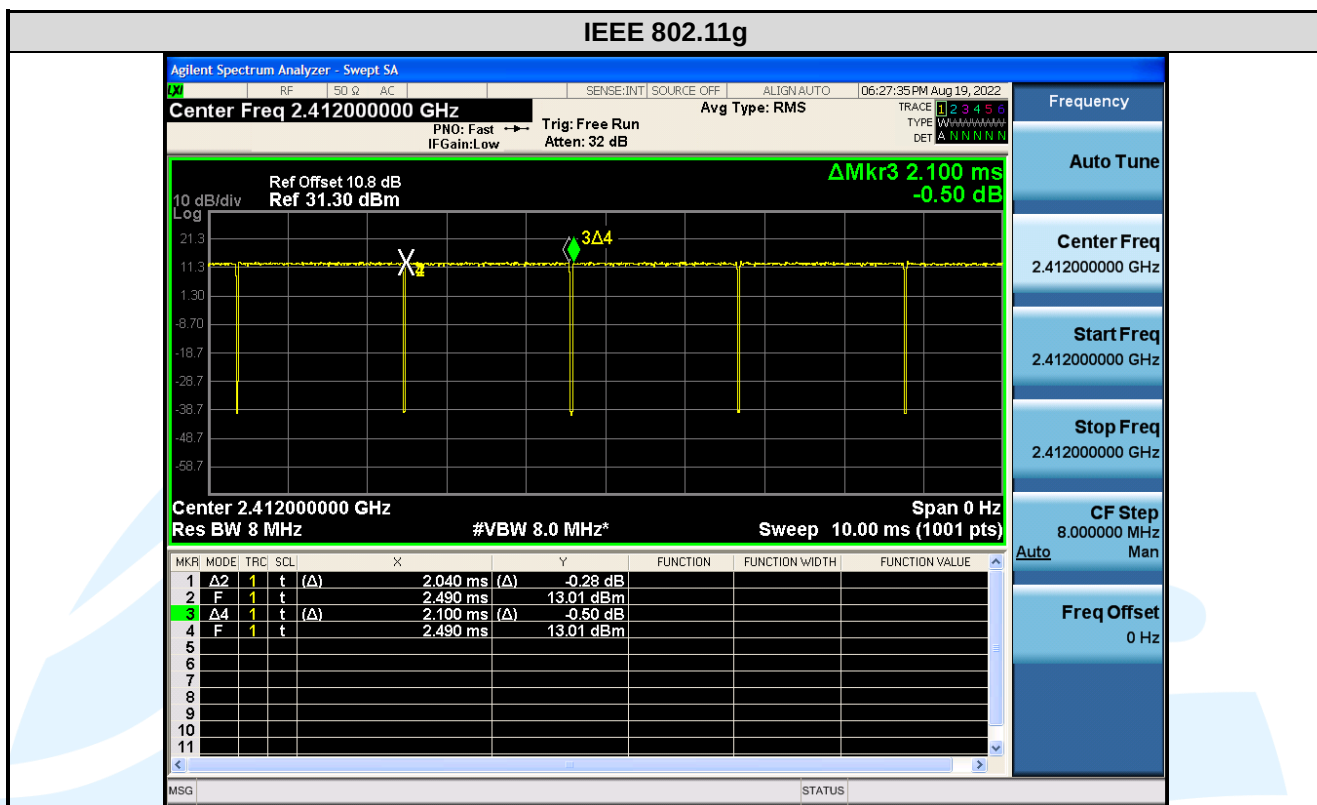
Tel: +86-755-28230888

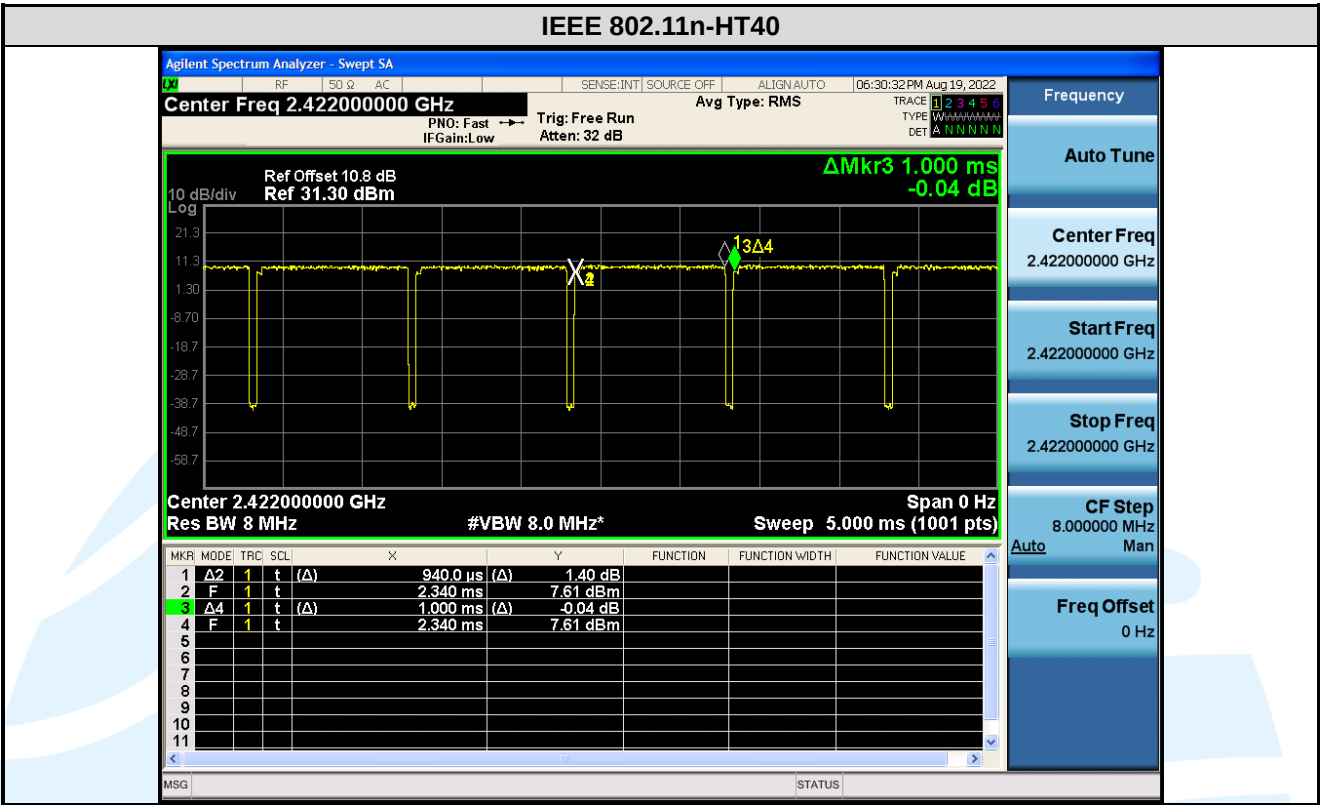
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5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

No.	Identity	Document Title
1	FCC 47 CFR Part 2	Frequency allocations and radio treaty matters; general rules and regulations
2	FCC 47 CFR Part 15	Radio Frequency Devices
3	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
4	KDB 558074 D01 15.247 Meas Guidance v05r02	Guidance for compliance measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum system, and Hybrid system devices operating under Section 15.247 of the FCC rules
5	KDB 662911 D01 Multiple Transmitter Output v02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band

5.2 ANTENNA REQUIREMENT

Standard Requirement
15.203 requirement: 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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 15.247(b) (4) requirement: The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi. EUT Antenna: Both antenna in the interior of the equipment and no consideration of replacement. The transmit signals are correlated with each other and the antenna gain of both chains is completely consistent, the best case directional gain of the antenna is 0.9 dBi (See section 5.3).

5.3 CONDUCTED PEAK OUTPUT POWER

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)

Test Method: ANSI C63.10-2013 Clause 11.9.1.3

Limit: For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.

Test Procedure:

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
2. Measure out each test modes' peak or average output power, record the power level.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results:

Mode	Frequency (MHz)	Max. Peak Power (dBm)				Result
		Ant. 0	Ant. 1	Total	Limit dBm	
IEEE 802.11b	2412	20.67	20.34	N/A	30.00	Pass
	2437	20.81	20.16	N/A	30.00	Pass
	2462	20.53	20.24	N/A	30.00	Pass
	2467	21.18	21.17	N/A	30.00	Pass
	2472	21.42	21.03	N/A	30.00	Pass
IEEE 802.11g	2412	22.25	22.12	N/A	30.00	Pass
	2437	22.13	21.96	N/A	30.00	Pass
	2462	21.91	22.08	N/A	30.00	Pass
	2467	22.83	22.12	N/A	30.00	Pass
	2472	23.36	22.15	N/A	30.00	Pass
IEEE 802.11n-HT20	2412	18.91	18.17	21.57	30.00	Pass
	2437	18.67	18.23	21.47	30.00	Pass
	2462	18.41	18.59	21.51	30.00	Pass
	2467	19.42	18.89	22.17	30.00	Pass
	2472	20.14	19.17	22.69	30.00	Pass
IEEE 802.11n-HT40	2422	20.48	20.33	23.42	30.00	Pass
	2437	20.57	20.27	23.43	30.00	Pass
	2452	20.51	19.88	23.22	30.00	Pass
	2457	21.32	20.56	23.97	30.00	Pass
	2462	21.26	20.84	24.07	30.00	Pass

Mode	Frequency	Max. Avg. Power (dBm)				
	(MHz)	Meas Value Ant. 0	Meas Value Ant. 1	Corr'd Value Ant. 0	Corr'd Value Ant. 1	Total Ant.0+1
IEEE 802.11b	2412	18.31	17.92	18.31	17.92	N/A
	2437	18.48	17.65	18.48	17.65	N/A
	2462	18.25	17.88	18.25	17.88	N/A
	2467	18.88	18.67	18.88	18.67	N/A
	2472	18.95	18.48	18.95	18.48	N/A
IEEE 802.11g	2412	17.78	17.31	17.91	17.44	N/A
	2437	17.89	17.12	18.02	17.25	N/A
	2462	17.64	17.24	17.77	17.37	N/A
	2467	18.22	17.12	18.35	17.25	N/A
	2472	18.38	17.02	18.51	17.15	N/A
IEEE 802.11n-HT20	2412	13.74	13.02	13.85	13.13	16.52
	2437	13.84	13.15	13.95	13.26	16.63
	2462	13.59	13.24	13.70	13.35	16.54
	2467	14.20	13.89	14.31	14.00	17.17
	2472	14.37	13.64	14.48	13.75	17.14
IEEE 802.11n-HT40	2422	14.05	13.51	14.32	13.78	17.07
	2437	14.10	13.41	14.37	13.68	17.05
	2452	14.15	13.48	14.42	13.75	17.11
	2457	14.64	14.11	14.91	14.38	17.66
	2462	14.51	13.87	14.78	14.14	17.48

Remark:

1. Total (Ant 0+1) = $10 \cdot \log[(10^{\text{Ant. 0}/10}) + (10^{\text{Ant. 1}/10})]$

2. Directional gain and the maximum conducted output power limit see table below:

Frequency (MHz)	Antenna Gain (dBi)		Uncorrelated Directional gain (dBi)	Correlated Directional gain (dBi)	Limit	
	Ant .0	Ant .1	Power	PSD	Power (dBm)	PSD (dBm/3kHz)
2400 - 2483.5	1.137	0.654	0.90	3.91	30	8

For CDD transmissions, directional gain is calculated as follows. In all formulas,

N_{ANT} = number of transmit antennas and

N_{SS} = number of spatial streams. (Assume $N_{\text{SS}} = 1$ unless you have specific information to the contrary.)

If all antennas have the same gain, G_{ANT} , Directional gain = G_{ANT} + Array Gain, where Array Gain is as follows.

For power spectral density (PSD) measurements on all devices,

Array Gain = $10 \log(N_{\text{ANT}}/N_{\text{SS}})$ dB.

For power measurements on IEEE 802.11 devices, 1,2

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

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

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

For Uncorrelated transmissions, directional gain is calculated as follows. In all formulas:

Directional gain = $10 \log[(10^{G_1/20} + 10^{G_2/20} + \dots + 10^{G_N/20})^2 / N_{\text{ANT}}]$ dBi [Note the "20"s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

5.46 DB BANDWIDTH

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)

Test Method: ANSI C63.10-2013 Clause 11.8.1

Limit: For direct sequence systems, the minimum 6dB bandwidth shall be at least 500kHz

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

Use the following spectrum analyzer settings:

a) Set RBW = 100 kHz.

b) Set the video bandwidth (VBW) $\geq 3 \times$ RBW.

c) Detector = Peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

f) Allow the trace to stabilize.

g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

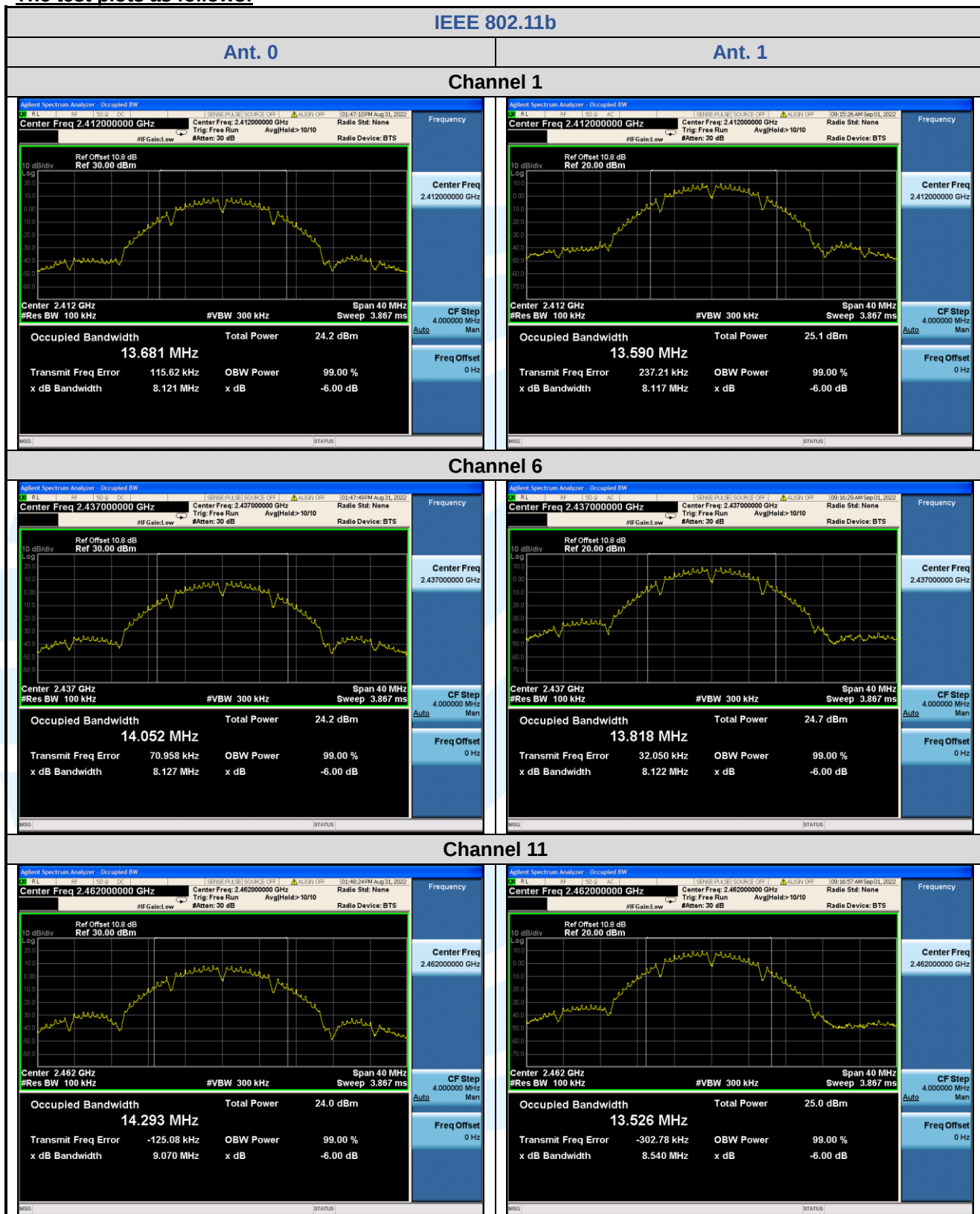
Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results:

Mode	Channel/ Frequency (MHz)	6 dB Bandwidth (MHz)		6 dB Bandwidth Limit	Result
		Ant. 0	Ant. 1		
IEEE 802.11b	1(2412)	8.121	8.117	> 500 kHz	Pass
	6(2437)	8.127	8.122	> 500 kHz	Pass
	11(2462)	9.070	8.540	> 500 kHz	Pass
	12(2467)	9.099	8.125	> 500 kHz	Pass
	13(2472)	8.112	8.131	> 500 kHz	Pass
IEEE 802.11g	1(2412)	15.17	15.17	> 500 kHz	Pass
	6(2437)	15.38	15.68	> 500 kHz	Pass
	11(2462)	15.95	15.76	> 500 kHz	Pass
	12(2467)	15.84	16.34	> 500 kHz	Pass
	13(2472)	15.15	15.49	> 500 kHz	Pass
IEEE 802.11n-HT20	1(2412)	15.17	15.17	> 500 kHz	Pass
	6(2437)	16.02	16.57	> 500 kHz	Pass
	11(2462)	16.40	16.38	> 500 kHz	Pass
	12(2467)	16.32	16.98	> 500 kHz	Pass
	13(2472)	15.15	16.05	> 500 kHz	Pass
IEEE 802.11n-HT40	3(2422)	35.21	35.18	> 500 kHz	Pass
	6(2437)	35.80	36.38	> 500 kHz	Pass
	9(2452)	35.15	35.14	> 500 kHz	Pass
	10(2457)	35.40	35.14	> 500 kHz	Pass
	11(2462)	35.78	35.24	> 500 kHz	Pass

The test plots as follows:



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