FCC TEST REPORT

Test report
On Behalf of
FriendMedia
For
fmStick
Model No.: 3021FS

FCC ID: 2AZ47-3021FS

Prepared for :	**FriendMedia** **6314 Brookside Plaza STE 204, Kansas City, MO 64113, United States**
Prepared By :	**Shenzhen HUAK Testing Technology Co., Ltd.** **1-2/F., Building B2, Junfeng Zhongcheng Zhizao Innovation Park, Heping, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China**

Date of Test:	**May. 11, 2021 ~ May. 20, 2021**
Date of Report:	**May. 20, 2021**
Report Number:	**HK2105101404-2E**

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TEST RESULT CERTIFICATION

Applicant's name.....: FriendMedia

Address .....: 6314 Brookside Plaza STE 204, Kansas City, MO 64113

Manufacture's Name.....: Shenzhen Tomato Technology Co., Ltd

Address .....: Room 1106, Huatong Building, SunGangDong Road, LuoHu District, Shenzhen, Guangdong Province, P.R. 518022, China

Product description

Trade Mark: FriendMedia

Product name.....: fmStick

Model and/or type reference .: 3021FS

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 .....: **May. 11, 2021 ~ May. 20, 2021**

Date of Issue.....: **May. 20, 2021**

Test Result.....: **Pass**

Prepared by: Gary Qian

Project Engineer

Reviewed by: Leo Zhang

Project Supervisor

Approved by: Jason Zhou

Technical Director

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** Modifited History **

Revison	Description	Issued Data	Remark
Revsion 1.0	Initial Test Report Release	May. 20, 2021	Jason Zhou

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1. Test Result Summary

1.1. TEST PROCEDURES AND RESULTS

Requirement	CFR 47 Section	Result
Antenna requirement	§15.203	PASS
AC Power Line Conducted Emission	§15.207	PASS
Maximum Conducted Output Power	§15.407(a)	PASS
6dB Emission Bandwidth	§15.407(e)	N/A
26dB Emission Bandwidth& 99% Occupied Bandwidth	§15.407(a)	PASS
Power Spectral Density	§15.407(a)	PASS
Band edge	§15.407(b)/15.209/15.205	PASS
Radiated Emission	§15.407(b)/15.209/15.205	PASS
Frequency Stability	§15.407(g)	PASS

Note:

1. PASS: Test item meets the requirement.

2. Fail: Test item does not meet the requirement.

3. N/A: Test case does not apply to the test object.

4. The test result judgment is decided by the limit of test standard.

1.2. TEST FACILITY

Test Firm : Shenzhen HUAK Testing Technology Co., Ltd.

Address 1-2/F., Building B2, Junfeng Zhongcheng Zhizao Innovation Park, Heping, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

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1.3. Measurement Uncertainty

The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 %.

No.	Item	MU
1	Conducted Emission	±2.71dB
2	RF power, conducted	±0.37dB
3	Spurious emissions, conducted	±2.2dB
4	All emissions, radiated(<1G)	±3.90dB
5	All emissions, radiated(>1G)	±4.28dB

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2. EUT Description

2.1. GENERAL DESCRIPTION OF EUT

Equipment	fmStick
Model Name	3021FS
Serial No.	N/A
Trade Mark	FriendMedia
Model Difference	N/A
FCC ID	2AZ47-3021FS
Operation Frequency:	IEEE 802.11a/n/ac(HT20) 5.180GHz-5.240GHz IEEE 802.11n/ac(HT40) 5.190GHz-5.230GHz IEEE 802.11ac(HT80) 5.210GHz
Modulation Technology:	IEEE 802.11a/n/ac
Modulation Type	OFDM
Antenna Type	FPCB Antenna
Antenna Gain	3dBi
Power Source	DC 5V from USB
Power Supply:	DC 5V from USB

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2.2. Operation Frequency each of channel

802.11a/802.11n(HT20) 802.11ac(HT20)		802.11n(HT40)/ 802.11ac(HT40)		802.11ac(HT80)	
Channel	Frequency	Channel	Frequency	Channel	Frequency
36	5180	38	5190	42	5210
40	5200	46	5230		
44	5220				
48	5240				

Note:

In section 15.31(m), regards to the operating frequency range over 10 MHz, the Lowest frequency, the middle frequency, and the highest frequency of channel were selected to perform the test, and the selected channel see below:

2.3. Operation of EUT during testing

For 802.11a/n (HT20)/ac(HT20)

Band I (5150 - 5250 MHz)		
Channel Number	Channel	Frequency (MHz)
36	Low	5180
40	Mid	5200
48	High	5240

For 802.11n (HT40)/ ac(HT40)

Band I (5150 - 5250 MHz)		
Channel Number	Channel	Frequency (MHz)
38	Low	5190
46	High	5230

For 802.11ac(HT80)

Band I (5150 - 5250 MHz)	
Channel Number	Frequency (MHz)
42	5210

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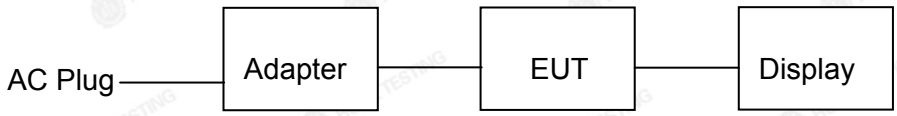
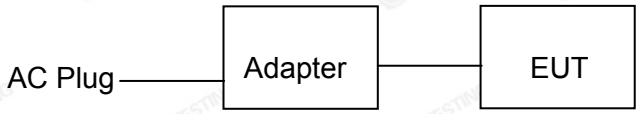
2.4. DESCRIPTION OF TEST SETUP

Operation of EUT during conducted testing and radiation below 1GHz testing:



Operation of EUT during radiation above 1GHz testing:



Adapter information
Model: HW-059200CHQ
Input: 100-240V, 50/60Hz, 0.5A
Output: 5VDC, 2A

Display information
Model: 24PFF3661/T3
Input: AC 120V/60Hz

The sample was placed (0.8m below 1GHz, 1.5m above 1GHz) above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages. The worst case is Z position

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3. Genera Information

3.1. Test environment and mode

Operating Environment:	
Temperature:	25.0 °C
Humidity:	56 % RH
Atmospheric Pressure:	1010 mbar
Test Mode:	
Engineering mode:	Keep the EUT in continuous transmitting by select channel and modulations(The value of duty cycle is 100%)
The sample was placed 0.8m/1.5m for blow/above 1GHz above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages.	

We have verified the construction and function in typical operation. All the test modes were carried out with the EUT in transmitting operation, which was shown in this test report and defined as follows:	
Per-scan all kind of data rate in lowest channel, and found the follow list which it was worst case.	
Mode	Data rate
802.11a	6 Mbps
802.11n(HT20)	MCS0
802.11n(HT40)	MCS0
802.11ac(HT20)/ac(HT40)/ac(HT80)	MCS0
Final Test Mode:	
Operation mode:	Keep the EUT in continuous transmitting with modulation

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3.2. Description of Support Units

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

Equipment	Model No.	Serial No.	FCC ID	Trade Name
/	/	/	/	/

Note:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.

2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

3. For conducted measurements (Output Power, Emission Bandwidth, Power Spectral Density, Spurious Emissions), the antenna of EUT is connected to the test equipment via temporary antenna connector, the antenna connector is soldered on the antenna port of EUT, and the temporary antenna connector is listed in the Test Instruments.

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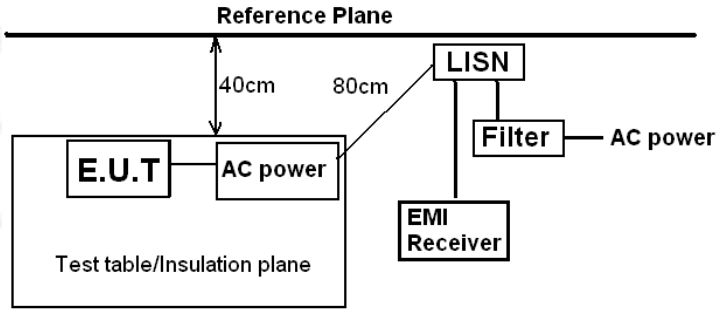
4. Test Results and Measurement Data

4.1. Conducted Emission

4.1.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.207
Test Method:	ANSI C63.10:2013
Frequency Range:	150kHz to 30MHz
Receiver setup:	RBW=9 kHz, VBW=30 kHz, Sweep time=auto
Limits:	Frequency range (MHz) / Limit (dBuV): Quasi-peak / Average 0.15-0.5: 66 to 56* / 56 to 46* 0.5-5: 56 / 46 5-30: 60 / 50
Test Setup:	 *Remark:* *E.U.T: Equipment Under Test* *LISN: Line Impedence Stabilization Network* *Test table height=0.8m*
Test Mode:	Tx Mode
Test Procedure:	1. The E.U.T and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm/50uH coupling impedance for the measuring equipment. 2. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs). 3. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10: 2013 on conducted measurement.
Test Result:	PASS

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4.1.2. Test Instruments

Conducted Emission Shielding Room Test Site (843)					
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Receiver	R&S	ESCI 7	HKE-010	Jun. 18, 2020	Jun. 17, 2021
LISN	R&S	ENV216	HKE-002	Jun. 18, 2020	Jun. 17, 2021
Coax cable (9KHz-30MHz)	Times	381806-002	N/A	Jun. 18, 2020	Jun. 17, 2021
Conducted test software	Tonscend	TS+ Rev 2.5.0.0	HKE-081	N/A	N/A

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

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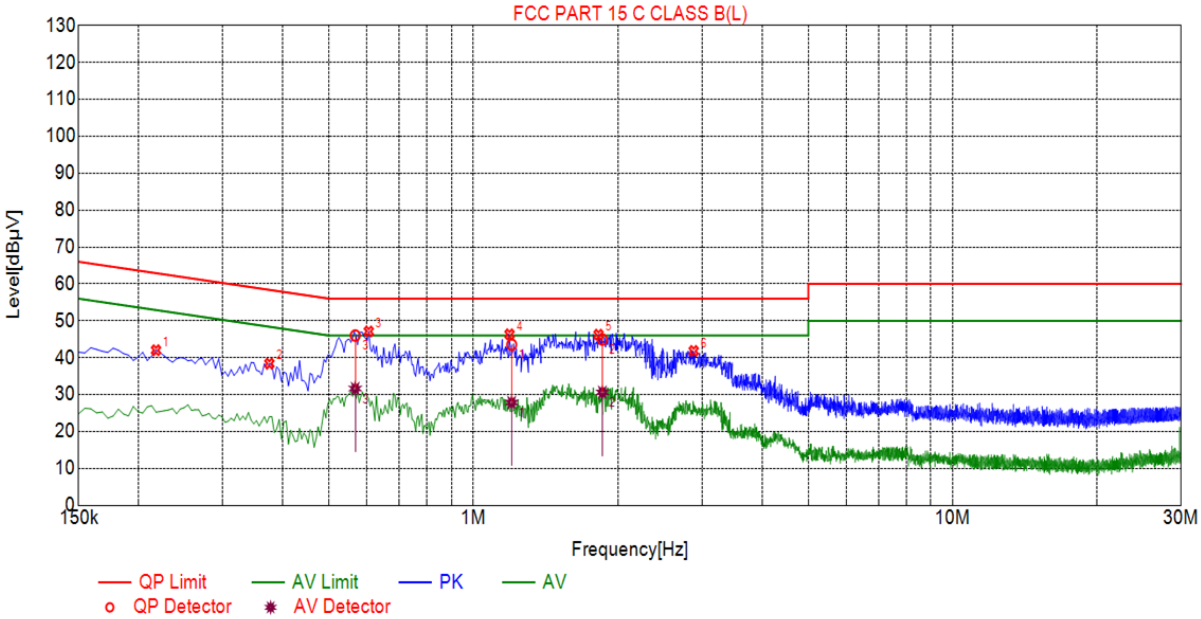
Test data

All the test modes completed for test. only the worst result of (802.11a at 5180MHz) was reported

Conducted Emission on Line Terminal of the power line (150 kHz to 30MHz)



Suspected List								
NO.	Freq. [MHz]	Level [dBμV]	Factor [dB]	Limit [dBμV]	Margin [dB]	Reading [dBμV]	Detector	Type
1	0.2175	42.03	20.05	62.91	20.88	21.98	PK	L
2	0.3750	38.41	20.05	58.39	19.98	18.36	PK	L
3	0.6045	47.11	20.05	56.00	8.89	27.06	PK	L
4	1.1895	46.34	20.09	56.00	9.66	26.25	PK	L
5	1.8240	46.25	20.14	56.00	9.75	26.11	PK	L
6	2.8815	41.83	20.21	56.00	14.17	21.62	PK	L

Final Data List											
NO.	Freq. [MHz]	Correction factor[dB]	QP Value [dBμV]	QP Limit [dBμV]	QP Margin [dB]	QP Reading [dBμV]	AV Value [dBμV]	AV Limit [dBμV]	AV Margin [dB]	AV Reading [dBμV]	Type
1	1.2014	20.09	43.55	56.00	12.45	23.46	27.85	46.00	18.15	7.76	L
2	1.8578	20.14	44.92	56.00	11.08	24.78	30.62	46.00	15.38	10.48	L
3	0.5665	20.05	46.01	56.00	9.99	25.96	31.64	46.00	14.36	11.59	L

Remark: Margin = Limit – Level

Correction factor = Cable lose + LISN insertion loss

Level=Test receiver reading + correction factor

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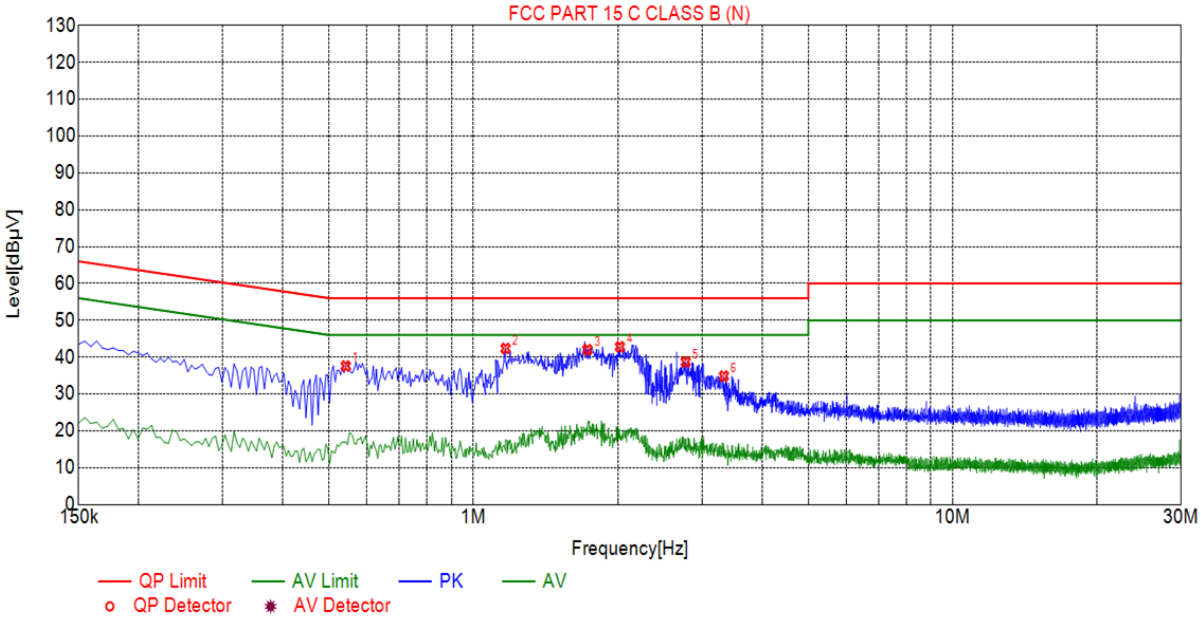
Conducted Emission on Neutral Terminal of the power line (150 kHz to 30MHz)



Suspected List								
NO.	Freq. [MHz]	Level [dBμV]	Factor [dB]	Limit [dBμV]	Margin [dB]	Reading [dBμV]	Detector	Type
1	0.5415	37.57	20.05	56.00	18.43	22.02	PK	N
2	1.1670	42.36	20.09	56.00	13.64	22.27	PK	N
3	1.7295	42.01	20.13	56.00	13.99	24.29	PK	N
4	2.0220	42.81	20.15	56.00	13.19	23.22	PK	N
5	2.7735	38.68	20.21	56.00	17.32	18.47	PK	N
6	3.3315	34.86	20.24	56.00	21.14	14.62	PK	N

Remark: Margin = Limit – Level

Correction factor = Cable lose + LISN insertion loss

Level=Test receiver reading + correction factor

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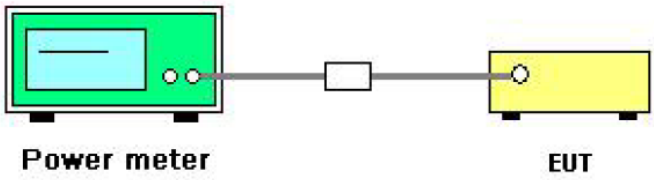
4.2. Maximum Conducted Output Power

4.2.1. Test Specification

Test Requirement:	FCC Part15 E Section 15.407(a)
Test Method:	KDB789033 D02 General UNII Test Procedures New Rules v02.r01 Section E
Limit:	Frequency Band (MHz): Limit 5150-5250: 250mW for client devices
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. The testing follows the Measurement Procedure of KDB789033 D02 General UNII Test Procedures New Rules v02r01 Section E, 3, a 2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement. 3. Set to the maximum power setting and enable the EUT transmit continuously. 5. Measure the conducted output power and record the results in the test report.
Test Result:	PASS
Remark:	Conducted output power= measurement power +10log(1/x) X is duty cycle=1, so 10log(1/1)=0 Conducted output power= measurement power

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4.2.2. Test Instruments

RF Test Room					
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Spectrum analyzer	Agilent	N9020A	HKE-048	Jun. 18, 2020	Jun. 17, 2021
Power meter	Agilent	E4419B	HKE-085	Jun. 18, 2020	Jun. 17, 2021
Power Sensor	Agilent	E9300A	HKE-086	Jun. 18, 2020	Jun. 17, 2021
RF cable	Times	1-40G	HKE-034	Jun. 18, 2020	Jun. 17, 2021
RF automatic control unit	Tonscend	JS0806-2	HKE-060	Jun. 18, 2020	Jun. 17, 2021

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

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Test Data

Configuration Band I (5150 - 5250 MHz)				
Mode	Test channel	Maximum Conducted Output Power (dBm)	FCC Limit (dBm)	Result
11a	CH36	15.49	24	PASS
11a	CH40	14.56	24	PASS
11a	CH48	15.11	24	PASS
11n(HT20)	CH36	15.09	24	PASS
11n(HT20)	CH40	15.32	24	PASS
11n(HT20)	CH48	15.47	24	PASS
11n(HT40)	CH38	16.34	24	PASS
11n(HT40)	CH46	15.24	24	PASS
11ac(HT20)	CH36	14.81	24	PASS
11ac(HT20)	CH40	15.56	24	PASS
11ac(HT20)	CH48	13.92	24	PASS
11ac(HT40)	CH38	13.46	24	PASS
11ac(HT40)	CH46	13.80	24	PASS
11ac(HT80)	CH42	13.66	24	PASS

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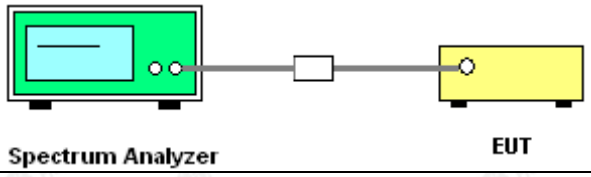
4.3. 6dB Emission Bandwidth

4.3.1. Test Specification

Test Requirement:	FCC CFR47 Part 15 Section 15.407(e)
Test Method:	KDB789033 D02 General UNII Test Procedures New Rules v02r01 Section C
Limit:	>500kHz
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. KDB789033 D02 General UNII Test Procedures New Rules v02r01 Section C 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6dB bandwidth must be greater than 500 kHz. 4. Measure and record the results in the test report.
Test Result:	PASS

4.3.2. Test Instruments

RF Test Room					
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Spectrum analyzer	Agilent	N9020A	HKE-048	Jun. 18, 2020	Jun. 17, 2021
RF cable	Times	1-40G	HKE-034	Jun. 18, 2020	Jun. 17, 2021
RF automatic control unit	Tonscend	JS0806-2	HKE-060	Jun. 18, 2020	Jun. 17, 2021

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

4.3.3Test data

N/A

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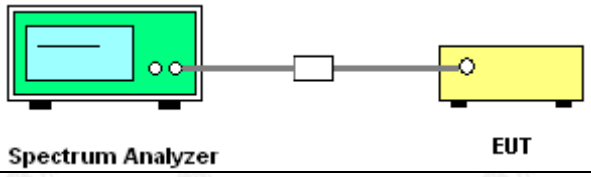
4.4. 26dB Bandwidth and 99% Occupied Bandwidth

4.4.1. Test Specification

Test Requirement:	47 CFR Part 15C Section 15.407
Test Method:	KDB789033 D02 General UNII Test Procedures New Rules v02r01 Section C
Limit:	No restriction limits
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. KDB789033 D02 General UNII Test Procedures New Rules v02r01 Section C 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Make the measurement with the spectrum analyzer's resolution bandwidth RBW = 1% EBW, VBW≥3RBW, In order to make an accurate measurement. 4. Measure and record the results in the test report.
Test Result:	PASS

4.4.2. Test Instruments

RF Test Room					
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Spectrum analyzer	Agilent	N9020A	HKE-048	Jun. 18, 2020	Jun. 17, 2021
RF cable	Times	1-40G	HKE-034	Jun. 18, 2020	Jun. 17, 2021
RF automatic control unit	Tonscend	JS0806-2	HKE-060	Jun. 18, 2020	Jun. 17, 2021

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

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Test data

Band I

Mode	Test channel	Frequency (MHz)	26 dB Bandwidth (MHz)	Verdict
11a	CH36	5180	19.73	PASS
11a	CH40	5200	19.89	PASS
11a	CH48	5240	19.84	PASS
11n(HT20)	CH36	5180	20.83	PASS
11n(HT20)	CH40	5200	20.89	PASS
11n(HT20)	CH48	5240	20.50	PASS
11n(HT40)	CH38	5190	40.41	PASS
11n(HT40)	CH46	5230	40.70	PASS
11ac(HT20)	CH36	5180	20.57	PASS
11ac(HT20)	CH40	5200	20.68	PASS
11ac(HT20)	CH48	5240	20.49	PASS
11ac(HT40)	CH38	5190	41.36	PASS
11ac(HT40)	CH46	5230	41.39	PASS
11ac(HT80)	CH42	5210	82.25	PASS

Test plots as follows:

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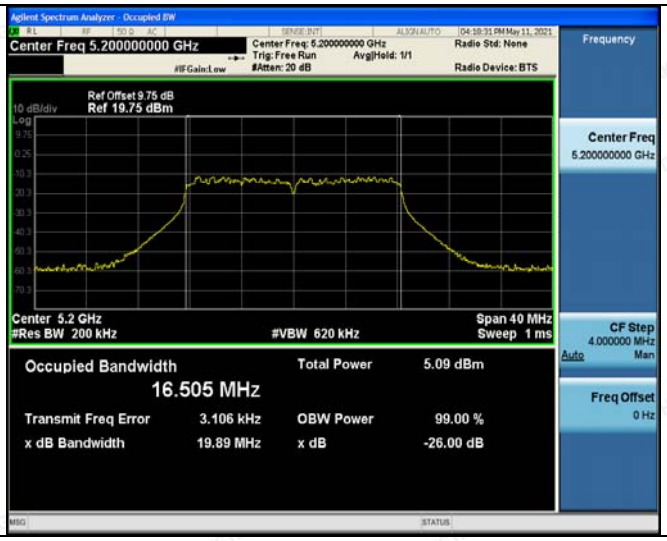
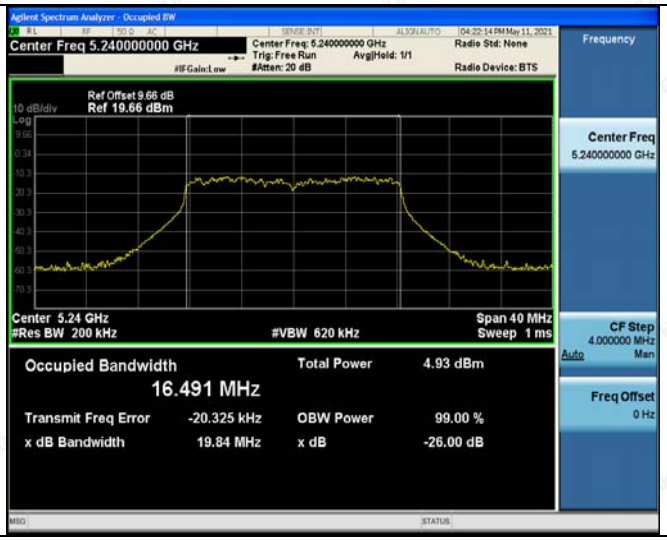
Band I （5150 – 5250 MHz）

802.11a

Low



Mid



High

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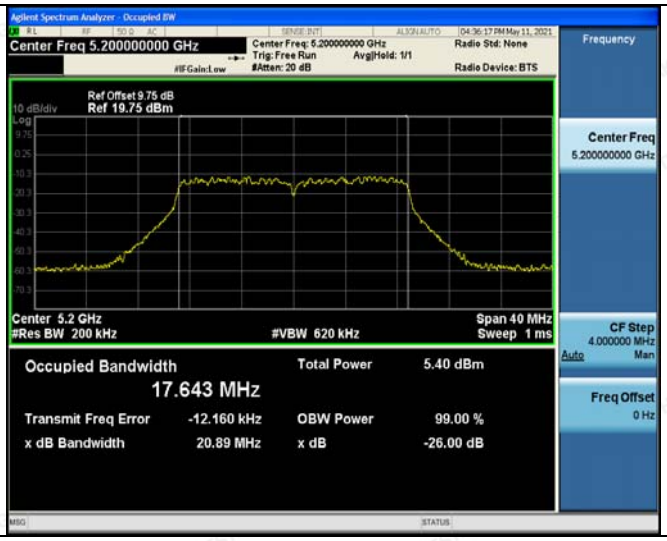
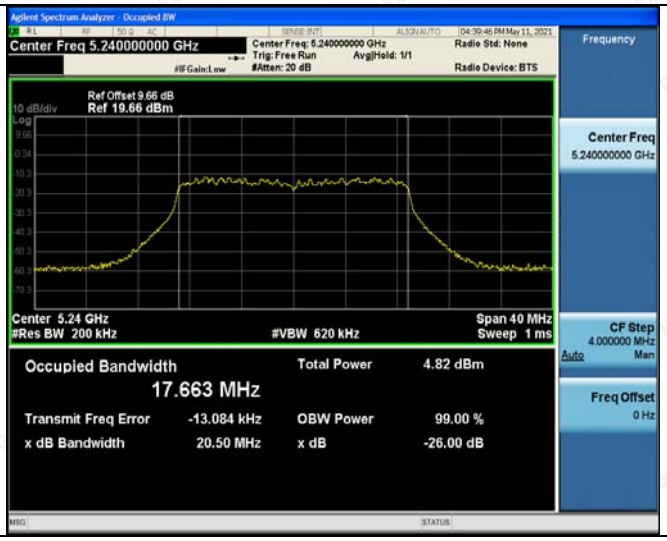
802.11n(HT20)

Low



Mid



High

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802.11n(HT40)

Low

High

802.11ac(HT20)

Low

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Mid

High

802.11ac(HT40)

Low

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High

802.11ac(HT80)

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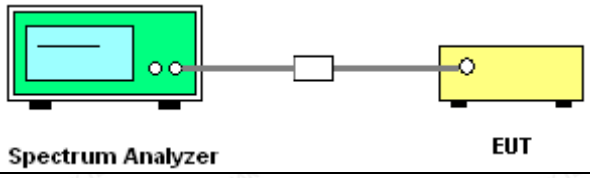
4.5. Power Spectral Density

4.5.1. Test Specification

Test Requirement:	FCC Part15 E Section 15.407 (a)
Test Method:	KDB789033 D02 General UNII Test Procedures New Rules v02r01 Section F
Limit:	≤11.00dBm/MHz for Band I 5150MHz-5250MHz
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. Set the spectrum analyzer or EMI receiver span to view the entire emission bandwidth. 1. Set RBW = 1 MHz, VBW ≥ 3*RBW, Sweep time = Auto, Detector = RMS. 2. Allow the sweeps to continue until the trace stabilizes. 3. Use the peak marker function to determine the maximum amplitude level. 4. The E.I.R.P spectral density used radiated test method. At a test site that has been validated using the procedures of ANSI C63.4 or the latest CISPR 16-1-4 for measurements above 1 GHz, so as to simulate a near free-space environment.
Test Result:	PASS

4.5.2. Test Instruments

RF Test Room					
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Spectrum analyzer	Agilent	N9020A	HKE-048	Jun. 18, 2020	Jun. 17, 2021
RF cable	Times	1-40G	HKE-034	Jun. 18, 2020	Jun. 17, 2021
RF automatic control unit	Tonscend	JS0806-2	HKE-060	Jun. 18, 2020	Jun. 17, 2021

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

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4.5.3. Test data

Configuration Band I (5150 - 5250 MHz)				
Mode	Test channel	Level [dBm/MHz]	Limit (dBm/MHz)	Result
11a	CH36	-7.37	11	PASS
11a	CH40	-6.50	11	PASS
11a	CH48	-5.35	11	PASS
11n(HT20)	CH36	-6.40	11	PASS
11n(HT20)	CH40	-5.98	11	PASS
11n(HT20)	CH48	-7.72	11	PASS
11n(HT40)	CH38	-0.13	11	PASS
11n(HT40)	CH46	-0.85	11	PASS
11ac(HT20)	CH36	0.20	11	PASS
11ac(HT20)	CH40	1.58	11	PASS
11ac(HT20)	CH48	1.51	11	PASS
11ac(HT40)	CH38	1.88	11	PASS
11ac(HT40)	CH46	0.83	11	PASS
11ac(HT80)	CH42	-0.31	11	PASS

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Band I （5150 – 5250 MHz）

802.11a

Low

Mid

High

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802.11n(HT20)

Low

Mid

High

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802.11n(HT40)
 Low
 High

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802.11ac(HT20)
Low
Mid
High

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802.11ac(HT40)

Low

High

802.11ac(HT80)

Low

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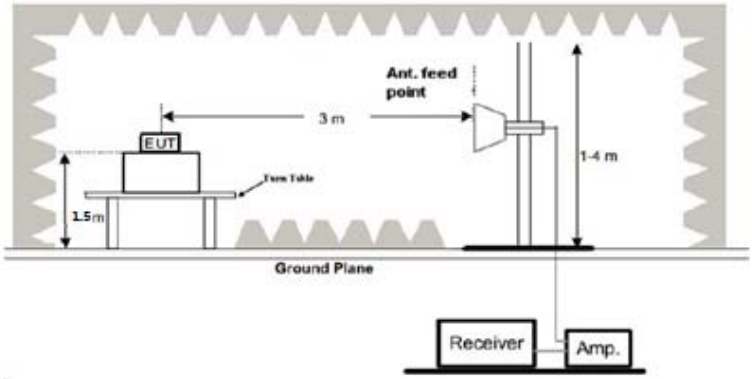
4.6. Band edge

4.6.1. Test Specification

Test Requirement:	FCC CFR47 Part 15E Section 15.407
Test Method:	ANSI C63.10 2013
Limit:	(1) 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. (2) For transmitters operating in the 5.25-5.35 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. (3) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz. (4) For transmitters operating in the 5.725-5.85 GHz band: (i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge. The limit of frequency below 1GHz and which fall in restricted bands should complies 15.209.
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation. 2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

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	3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement. 4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rota table was turned from 0 degrees to 360 degrees to find the maximum reading. 5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. 6. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasipeak or average method as specified and then reported in a data sheet.
Test Result:	PASS

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4.6.2. Test Instruments

Radiated Emission Test Site (966)					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Receiver	R&S	ESRP3	HKE-005	Jun. 18, 2020	Jun. 17, 2021
Spectrum analyzer	Agilent	N9020A	HKE-048	Jun. 18, 2020	Jun. 17, 2021
Preamplifier	EMCI	EMC051845SE	HKE-015	Jun. 18, 2020	Jun. 17, 2021
Preamplifier	Agilent	83051A	HKE-016	Jun. 18, 2020	Jun. 17, 2021
Loop antenna	Schwarzbeck	FMZB 1519 B	HKE-014	Jun. 18, 2020	Jun. 17, 2021
Broadband antenna	Schwarzbeck	VULB 9163	HKE-012	Jun. 18, 2020	Jun. 17, 2021
Horn antenna	Schwarzbeck	9120D	HKE-013	Jun. 18, 2020	Jun. 17, 2021
Antenna Mast	Keleto	CC-A-4M	N/A	N/A	N/A
Position controller	Taiwan MF	MF7802	HKE-011	Jun. 18, 2020	Jun. 17, 2021
Radiated test software	Tonscend	TS+ Rev 2.5.0.0	HKE-082	N/A	N/A
RF cable (9KHz-1GHz)	Times	381806-001	N/A	N/A	N/A
Hf antenna	Schwarzbeck	LB-180400-KF	HKE-031	Jun. 18, 2020	Jun. 17, 2021
RF cable	Tonscend	1-18G	HKE-099	Jun. 18, 2020	Jun. 17, 2021
RF cable	Times	1-40G	HKE-034	Jun. 18, 2020	Jun. 17, 2021

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

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4.6.3. Test Data

Radiated Band Edge Test:
Operation Mode: 802.11a Mode with 5.2G TX CH Low

Horizontal

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
5150	52.66	-2.49	50.17	74	-23.83	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
5150	53.12	-2.49	50.63	74	-23.37	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: TX CH High with 5.2G

Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	51.87	-2.11	49.76	74	-24.24	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	52.24	-2.11	50.13	74	-23.87	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: 802.11n20 Mode with 5.2G TX CH Low

Horizontal

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
5150	54.36	-2.49	51.87	74	-22.13	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
5150	51.17	-2.49	48.68	74	-25.32	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: TX CH High with 5.2G

Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	52.85	-2.11	50.74	74	-23.26	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	52.07	-2.11	49.96	74	-24.04	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: 802.11 n40 Mode with 5.2G TX CH Low

Horizontal

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
5150	52.13	-2.49	49.64	74	-24.36	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
5150	53.65	-2.49	51.16	74	-22.84	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: TX CH High with 5.2G

Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	51.88	-2.11	49.77	74	-24.23	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	53.61	-2.11	51.5	74	-22.5	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: 802.11 ac20 Mode with 5.2G TX CH Low

Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5150	54.75	-2.49	52.26	74	-21.74	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5150	52.34	-2.49	49.85	74	-24.15	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: TX CH High with 5.2G

Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	52.46	-2.11	50.35	74	-23.65	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	51.12	-2.11	49.01	74	-24.99	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: 802.11 ac40 Mode with 5.2G TX CH Low

Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5150	52.74	-2.49	50.25	74	-23.75	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5150	53.05	-2.49	50.56	74	-23.44	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: TX CH High with 5.2G

Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	54.13	-2.11	52.02	74	-21.98	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	52.71	-2.11	50.6	74	-23.4	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: 802.11 ac80 Mode with 5.2G TX CH Low

Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5150	53.49	-2.49	51	74	-23	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5150	52.04	-2.49	49.55	74	-24.45	peak
5150	/	-2.49	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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Operation Mode: TX CH High with 5.2G

Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	53.85	-2.11	51.74	74	-22.26	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
5350	53.14	-2.11	51.03	74	-22.97	peak
5350	/	-2.11	/	54	/	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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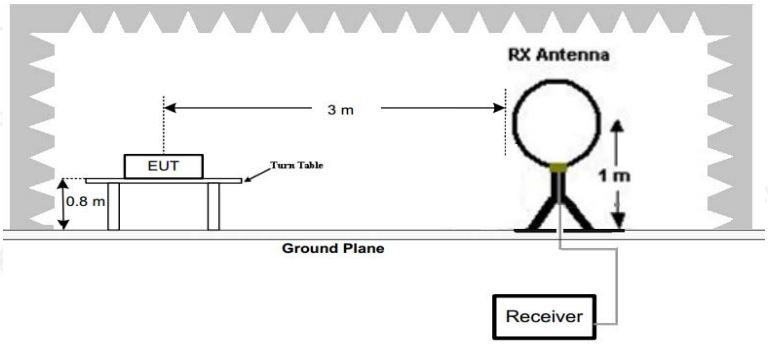
4.7. Spurious Emission

4.7.1.1. Test Specification

<table>
<tr><td>Test Requirement:</td><td>FCC CFR47 Part 15 Section 15.407</td></tr>
<tr><td>Test Method:</td><td>KDB 789033 D02 v02r01</td></tr>
<tr><td>Frequency Range:</td><td>9kHz to 40GHz</td></tr>
<tr><td>Measurement Distance:</td><td>3 m</td></tr>
<tr><td>Antenna Polarization:</td><td>Horizontal & Vertical</td></tr>
<tr><td>Operation mode:</td><td>Transmitting mode with modulation</td></tr>
<tr><td>Receiver Setup:</td><td>
<table>
<tr><td>Frequency</td><td>Detector</td><td>RBW</td><td>VBW</td><td>Remark</td></tr>
<tr><td>9kHz- 150kHz</td><td>Quasi-peak</td><td>200Hz</td><td>1kHz</td><td>Quasi-peak Value</td></tr>
<tr><td>150kHz-30MHz</td><td>Quasi-peak</td><td>9kHz</td><td>30kHz</td><td>Quasi-peak Value</td></tr>
<tr><td>30MHz-1GHz</td><td>Quasi-peak</td><td>120KHz</td><td>300KHz</td><td>Quasi-peak Value</td></tr>
<tr><td rowspan="2">Above 1GHz</td><td>Peak</td><td>1MHz</td><td>3MHz</td><td>Peak Value</td></tr>
<tr><td>Peak</td><td>1MHz</td><td>10Hz</td><td>Average Value</td></tr>
</table>
</td></tr>
<tr><td>Limit:</td><td>(1) 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.
(i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.
The limit of frequency below 1GHz and which fall in restricted b ands should complies 15.209.</td></tr>
<tr><td>Test setup:</td><td>For radiated emissions below 30MHz
 

30MHz to 1GHz</td></tr>
</table>

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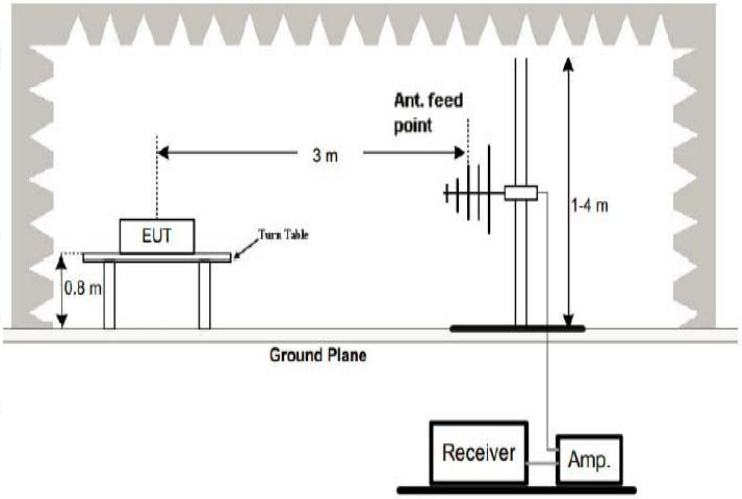
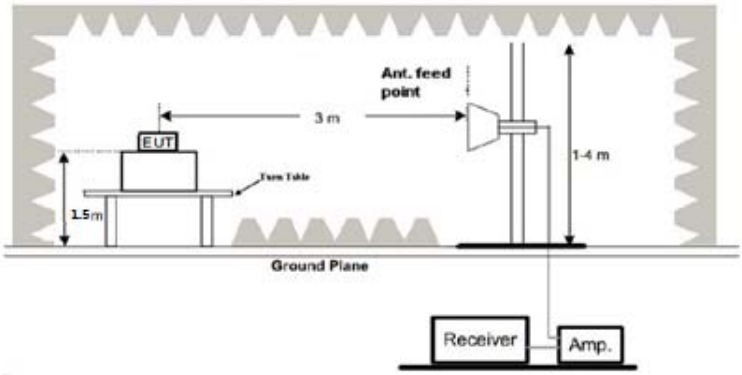
	 Above 1GHz 
Test Procedure:	1. The EUT was placed on the top of a rotating table 0.8 meters above the groundat a 3 meter camber. The table was rotated 360 degrees todetermine the position of the highest radiation. 2. The EUT was set 3 meters away from the interference-receiving antenna, whichwas mounted on the top of a variable-height antenna tower. 3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement. 4. For each suspected emission, the EUT was arranged to its worst case and thenthe antenna was tuned to heights from 1 meter to 4 meters and the rotatablewas turned from 0 degrees to 360 degrees to find the maximum reading. 5. The test-receiver system was set to Peak Detect Function and SpecifiedBandwidth with Maximum Hold Mode. 6. If the emission level of the EUT in peak mode was 10dB lower than the limitspecified, then testing could be stopped and the peak values of the EUT wouldbe reported. Otherwise the emissions that did not have 10dB margin would bere-tested one by one using peak, quasi-peak or average method as specified andthen reported in a data sheet.
Test results:	PASS

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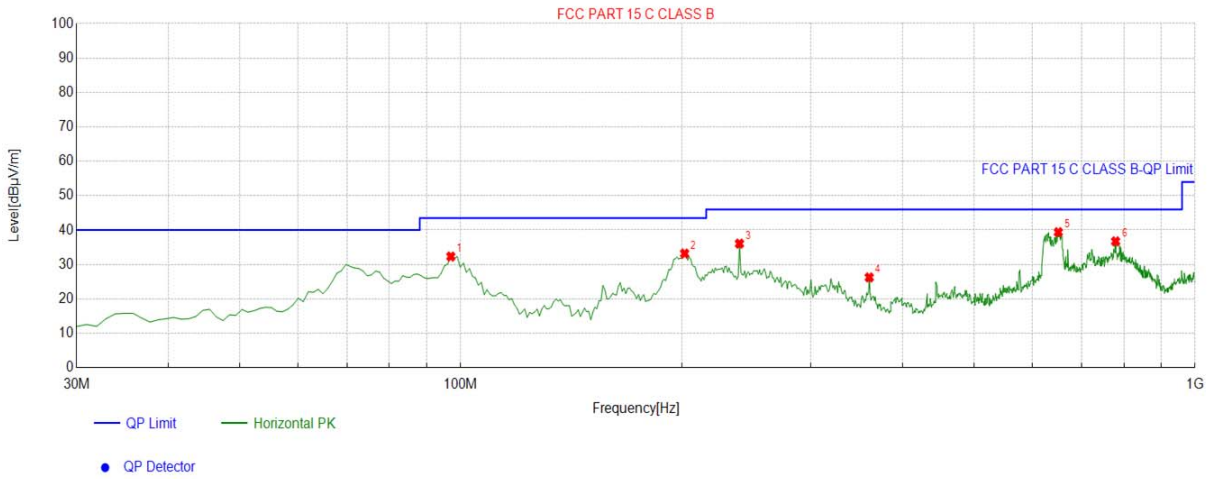
4.7.2. Test Data

All the test modes completed for test. only the worst result of (802.11a at 5180MHz) was reported
Below 1GHz

Horizontal



Suspected List									
NO.	Freq. [MHz]	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	96.9970	-15.90	48.21	32.31	43.50	11.19	100	8	Horizontal
2	201.8619	-15.01	48.18	33.17	43.50	10.33	100	2	Horizontal
3	239.7297	-13.87	49.93	36.06	46.00	9.94	100	324	Horizontal
4	360.1301	-11.34	37.58	26.24	46.00	19.76	100	48	Horizontal
5	651.4214	-5.73	45.12	39.39	46.00	6.61	100	320	Horizontal
6	779.5896	-3.26	39.99	36.73	46.00	9.27	100	64	Horizontal

Remark: Factor = Cable loss + Antenna factor – Preamplifier; Level = Reading + Factor; Margin = Limit – Level;

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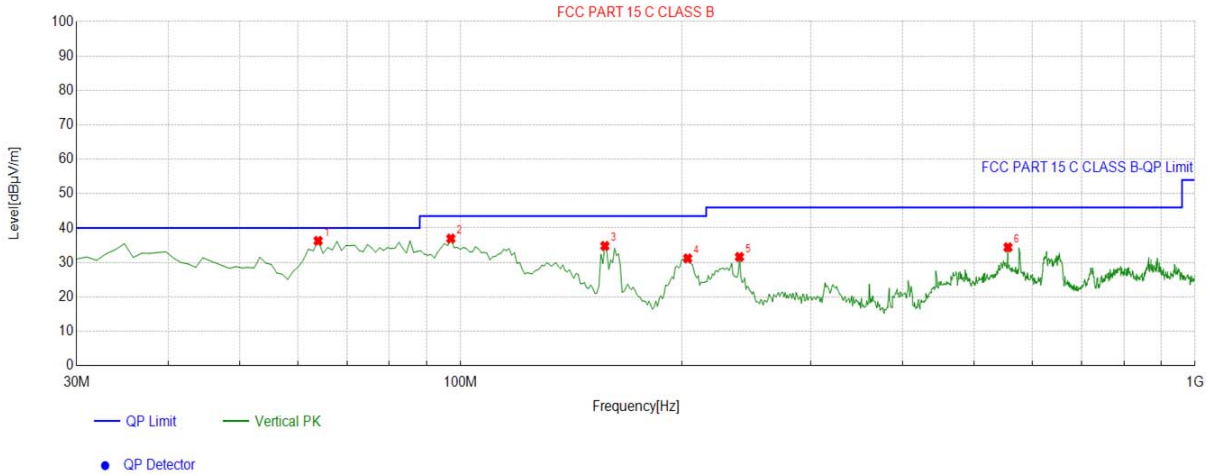
Vertical



Suspected List									
NO.	Freq. [MHz]	Factor [dB]	Reading [dBμV/m]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	63.9840	-16.16	52.44	36.28	40.00	3.72	100	76	Vertical
2	96.9970	-15.90	52.85	36.95	43.50	6.55	100	128	Vertical
3	157.1972	-18.42	53.22	34.80	43.50	8.70	100	191	Vertical
4	203.8038	-14.96	46.14	31.18	43.50	12.32	100	21	Vertical
5	239.7297	-13.87	45.49	31.62	46.00	14.38	100	13	Vertical
6	556.2663	-6.78	41.18	34.40	46.00	11.60	100	171	Vertical

Remark: Factor = Cable loss + Antenna factor – Preamplifier; Level = Reading + Factor; Margin = Limit – Level;

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Above 1GHz

LOW CH 36 (802.11 a Mode with 5.2G)/5180

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
3647	61.83	-4.59	57.24	74	-16.76	peak
3647	46.85	-4.59	42.26	54	-11.74	AVG
10360	49.25	3.74	52.99	74	-21.01	peak
10360	41.97	3.74	45.71	54	-8.29	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
3647	60.38	-4.59	55.79	74	-18.21	peak
3647	44.88	-4.59	40.29	54	-13.71	AVG
10360	50.9	3.74	54.64	74	-19.36	peak
10360	37.65	3.74	41.39	54	-12.61	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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MID CH40 (802.11 a Mode with 5.2G)/5200
Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
3647	59.26	-4.59	54.67	74	-19.33	peak
3647	44.28	-4.59	39.69	54	-14.31	AVG
10400	52.05	3.74	55.79	74	-18.21	peak
10400	39.18	3.74	42.92	54	-11.08	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
3647	62.02	-4.59	57.43	74	-16.57	peak
3647	44.99	-4.59	40.4	54	-13.6	AVG
10400	52.81	3.74	56.55	74	-17.45	peak
10400	40.05	3.74	43.79	54	-10.21	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

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HIGH CH 48 (802.11a Mode with 5.2G)/5240
Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
3647	59.02	-4.59	54.43	74	-19.57	peak
3647	47.44	-4.59	42.85	54	-11.15	AVG
10480	50.99	3.75	54.74	74	-19.26	peak
10480	40.57	3.75	44.32	54	-9.68	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
3647	58.8	-4.59	54.21	74	-19.79	peak
3647	43.55	-4.59	38.96	54	-15.04	AVG
10480	49.28	3.75	53.03	74	-20.97	peak
10480	36.44	3.75	40.19	54	-13.81	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Remark：
(1) Measuring frequencies from 1 GHz to the 40 GHz。
(2) “F” denotes fundamental frequency; “H” denotes spurious frequency. “E” denotes band edge frequency.
(3) * denotes emission frequency which appearing within the Restricted Bands specified in provision of 15.205, then the general radiated emission limits in 15.209 apply.
(4) The emissions are attenuated more than 20dB below the permissible limits are not recorded in the report.
(5) The IF bandwidth of EMI Test Receiver between 30MHz to 1GHz was 120KHz, 1 MHz for measuring above 1 GHz, below 30MHz was 10KHz.
(6) When the test results of Peak Detected below the limits of Average Detected, the Average Detected is not need completed. For example: Top Channel at Fundamental 73.16dBuV/m(PK Value) <93.98(AV Limit), at harmonic 53.20 dBuV/m(PK Value) <54 dBuV/m(AV Limit), the Average Detected not need to completed.
(7)All modes of operation were investigated and the worst-case of 802.11a are reported.

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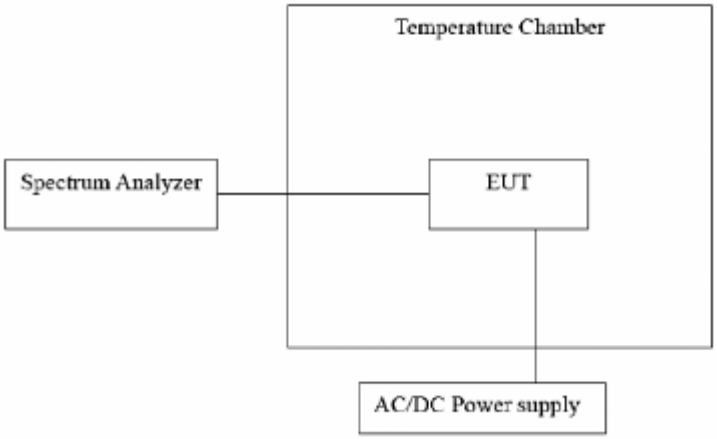
4.8. Frequency Stability Measurement

4.8.1. Test Specification

Test Requirement:	FCC Part15 Section 15.407(g)
Test Method:	ANSI C63.10: 2013
Limit:	The frequency tolerance shall be maintained within the band of operation frequency over a temperature variation of 0 degrees to 35 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C.
Test Setup:	
Test Procedure:	The EUT was placed inside the environmental test chamber and powered by nominal AC/DC voltage. b. Turn the EUT on and couple its output to a spectrum analyzer. c. Turn the EUT off and set the chamber to the highest temperature specified. d. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize. e. Repeat step 2 and 3 with the temperature chamber set to the lowest temperature. f. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.
Test Result:	PASS
Remark:	N/A

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4.8.2. Test Instruments

RF Test Room					
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Spectrum analyzer	Agilent	N9020A	HKE-048	Jun. 18, 2020	Jun. 17, 2021
Temperature and humidity meter	Boyang	HTC-1	HKE-077	Jun. 18, 2020	Jun. 17, 2021
programmable power supply	Agilent	E3646A	HKE-092	Jun. 18, 2020	Jun. 17, 2021

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

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4.8.3.

Test Result as follows:

Mode	Voltage (V)	FHL (5180MHz)	Deviation (KHz)	FHH (5240MHz)	Deviation (KHz)
5.2G Band	4.25V	5180.023	23	5240.013	13
	5.0V	5179.974	-26	5240.007	7
	5.75V	5180.011	11	5240.026	26

Mode	Temperature (℃)	FHL (5180MHz)	Deviation (KHz)	FHH (5240MHz)	Deviation (KHz)
5.2G Band	-30	5180.021	21	5240.027	27
	-20	5180.012	12	5239.985	-15
	-10	5179.987	-13	5239.991	-9
	0	5180.019	19	5239.988	-12
	10	5180.016	16	5240.013	13
	20	5179.984	-16	5240.014	14
	30	5179.997	-3	5239.987	-13
	40	5180.014	14	5239.974	-26
	50	5180.006	6	5240.018	18

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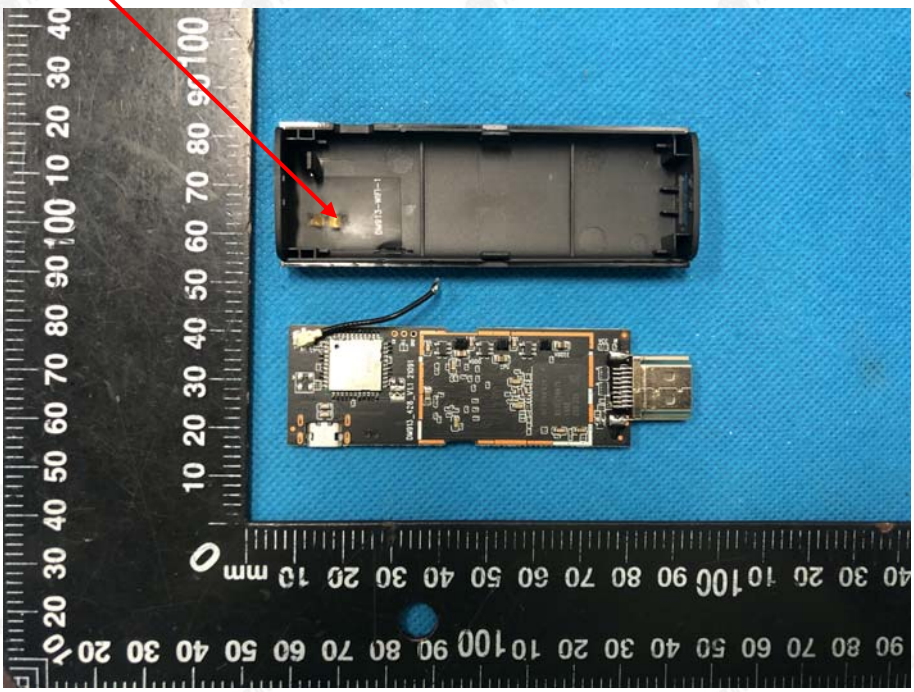
4.9. ANTENNA REQUIREMENT

Standard Applicable
For intentional device, according to FCC 47 CFR Section 15.203, 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.

Refer to statement below for compliance.
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.

Antenna Connected Construction
The antenna used in this product is a FPCB Antenna, need professional installation, not easy to remove. It conforms to the standard requirements. The directional gains of antenna used for transmitting is 3dBi.

WIFI ANTENNA



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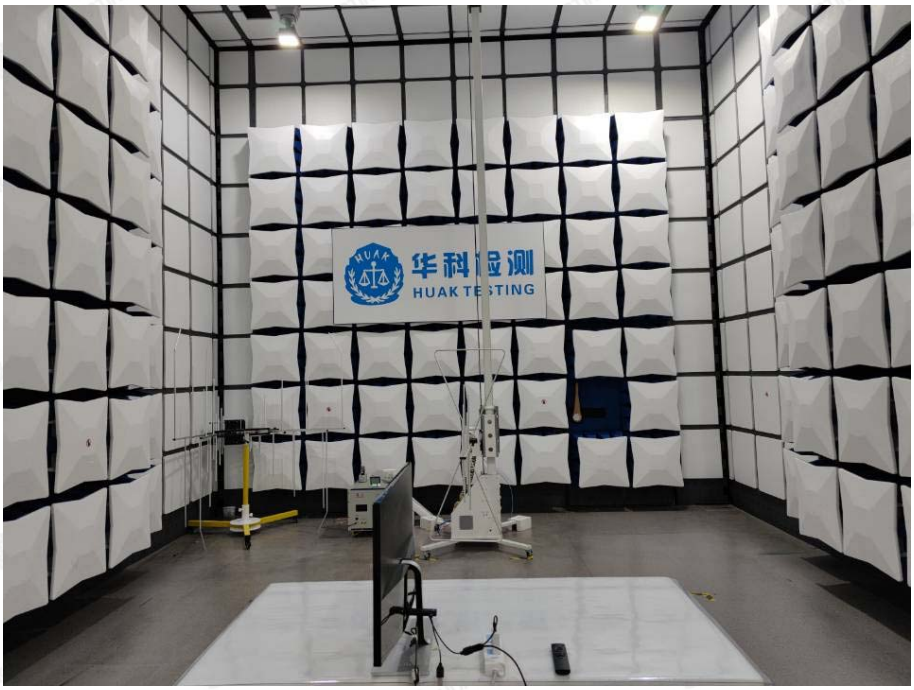
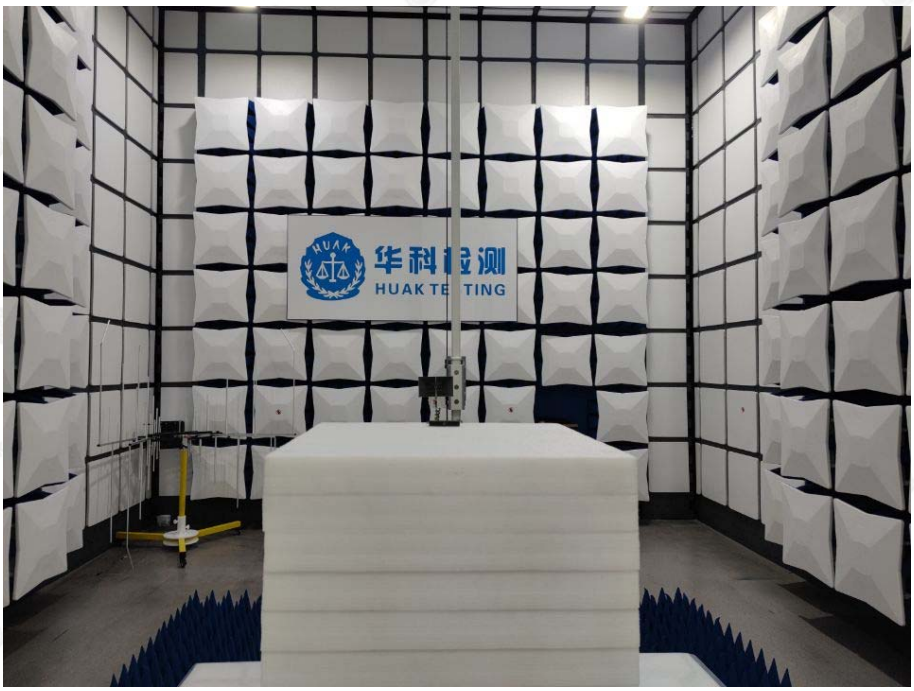
4.10. Photographs of Test Setup

Radiated Emission





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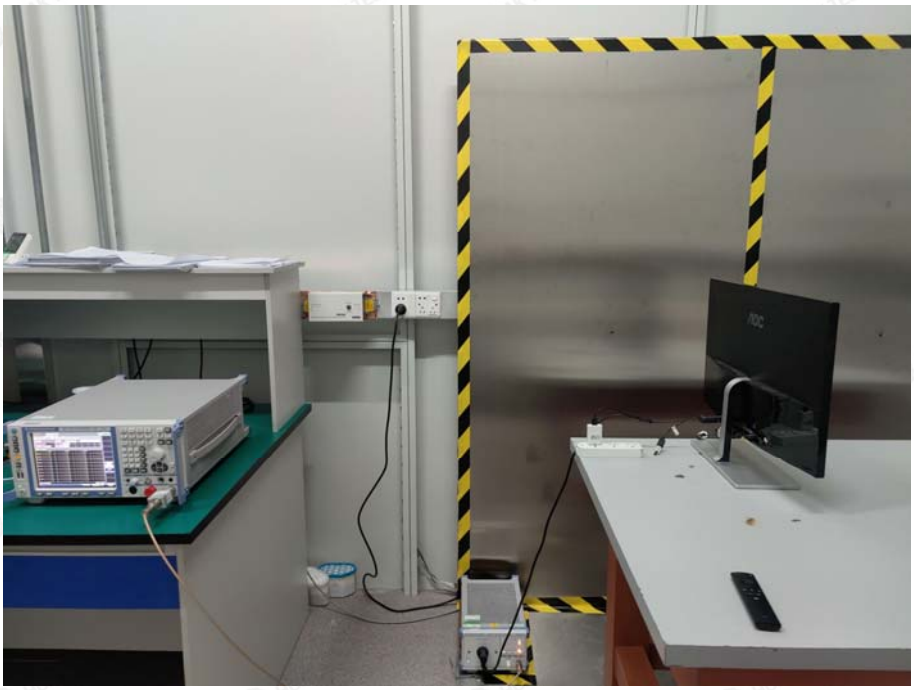
Conducted Emission



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5. PHOTOS OF THE EUT

Reference to the report: ANNEX A of external photos and ANNEX B of internal photos

---------End of test report---------

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