Shenzhen Huaxia Testing Technology Co., Ltd

1F., Block A of Tongsheng Technology Building, Huahui Road, Dalang Street, Longhua District, Shenzhen, China

Telephone: +86-755-26648640
Fax: +86-755-26648637
Website: www.cqa-cert.com

Report Template Version: V03
Report Template Revision Date: Mar.1st, 2017

Test Report

Report No. :	CQASZ20200200089E-01
Applicant:	MOKO TECHNOLOGY LIMITED
Address of Applicant:	2F, Building1,No.37 Xiaxintang Xintang village, Fucheng Street, Longhua District， Shenzhen,Guangdong Province, China
Manufacturer:	MOKO TECHNOLOGY LIMITED
Address of Manufacturer:	2F, Building1,No.37 Xiaxintang Xintang village, Fucheng Street, Longhua District， Shenzhen,Guangdong Province, China
Factory:	MOKO TECHNOLOGY LIMITED
Address of Factory:	2F, Building1,No.37 Xiaxintang Xintang village, Fucheng Street, Longhua District， Shenzhen,Guangdong Province, China

Equipment Under Test (EUT):

Product:	Bluetooth Gateway Plug Mini
Model No.:	MK110
Brand Name:	N/A
FCC ID:	2AO94-MK110
Standards:	47 CFR Part 15, Subpart C
Date of Test:	2020-02-17 to 2020-02-28
Date of Issue:	2020-03-02
Test Result :	**PASS***

Tested By： Tom chen. *(Tom chen)*

Reviewed By: Aaron Ma *(Aaron Ma)*

Approved By: *(Jack Ai)*

SHENZHEN HUAXIA TESTING TECHNOLOGY CO.,LTD CQA 华夏准测 APPROVED

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* In the configuration tested, the EUT complied with the standards specified above.

1 Version

Revision History Of Report

Report No.	Version	Description	Issue Date
CQASZ20200200089E-01	Rev.01	Initial report	2020-03-02

2 Test Summary

Test Item	Test Requirement	Test method	Result
Antenna Requirement	47 CFR Part 15, Subpart C Section 15.203/15.247 (c)	ANSI C63.10 2013	PASS
AC Power Line Conducted Emission	47 CFR Part 15, Subpart C Section 15.207	ANSI C63.10 2013	PASS
Conducted Peak & Average Output Power	47 CFR Part 15, Subpart C Section 15.247 (b)(3)	ANSI C63.10 2013	PASS
6dB Occupied Bandwidth	47 CFR Part 15, Subpart C Section 15.247 (a)(2)	ANSI C63.10 2013	PASS
Power Spectral Density	47 CFR Part 15, Subpart C Section 15.247 (e)	ANSI C63.10 2013	PASS
Radiated Spurious Emissions	47 CFR Part 15, Subpart C Section 15.205/15.209	ANSI C63.10 2013	PASS
Restricted bands around fundamental frequency (Radiated Emission)	47 CFR Part 15, Subpart C Section 15.205/15.209	ANSI C63.10 2013	PASS

3 Contents

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4 General Information

4.1 Client Information

Applicant:	MOKO TECHNOLOGY LIMITED
Address of Applicant:	2F, Building1,No.37 Xiaxintang Xintang village, Fucheng Street, Longhua District，Shenzhen,Guangdong Province, China
Manufacturer:	MOKO TECHNOLOGY LIMITED
Address of Manufacturer:	2F, Building1,No.37 Xiaxintang Xintang village, Fucheng Street, Longhua District，Shenzhen,Guangdong Province, China

4.2 General Description of EUT

Product Name:	Bluetooth Gateway Plug Mini
Model No.:	MK110
Trade Mark:	N/A
Type of Modulation:	EEE 802.11b mode: DSSS(CCK,QPSK, BPSK) IEEE 802.11g mode: OFDM (BPSK/QPSK/16QAM/64QAM) IEEE 802.11n HT20 MHz mode: OFDM (BPSK/QPSK/16QAM/64QAM) IEEE 802.11n HT40 MHz mode: OFDM (BPSK/QPSK/16QAM/64QAM) BLE(GFSK)
Channel Spacing:	IEEE 802.11b/g/n(HT20):20MHz IEEE 802.11n(HT40):40MHz BLE:2MHz
Operation Frequency:	IEEE 802.11b;IEEE 802.11g;IEEE 802.11n HT20

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	6	2437	11	2462
2	2417	7	2442		
3	2422	8	2447		
4	2427	9	2452		
5	2432	10	2457		

IEEE 802.11n HT40

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2422	4	2437	7	2452
2	2427	5	2442		
3	2432	6	2447		

BLE

		Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	
		1	2402	2	2404	
		3	2406	4	2408	
		5	2410	6	2412	
		7	2414	8	2416	
		9	2418	10	2420	
		11	2422	12	2424	
		13	2426	14	2428	
		15	2430	16	2432	
		17	2434	18	2436	
		19	2438	20	2440	
		21	2442	22	2444	
		23	2446	24	2448	
		25	2450	26	2452	
		27	2454	28	2456	
		29	2458	30	2460	
		31	2462	32	2464	
		33	2466	34	2468	
		35	2470	36	2472	
		37	2474	38	2476	
		39	2478	40	2480	
Antenna Type:	PCB antenna					
Antenna:	0 dBi gain					
Power Supply:	AC 120V/60Hz					

For 802.11b/g/n (HT20,HT40):

Test mode	Low Channel	Middle Channel	High Channel
IEEE 802.11b;IEEE 802.11g;IEEE 802.11n HT20	2412MHz	2437MHz	2462MHz
IEEE 802.11n HT40	2422MHz	2437MHz	2452MHz

Note:

1. Software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.

2.In radiated measurement,the EUT had been pre-scan on the positioned of each 3 axis(X,Y,Z), the worst case was found when positioned on X-plane.

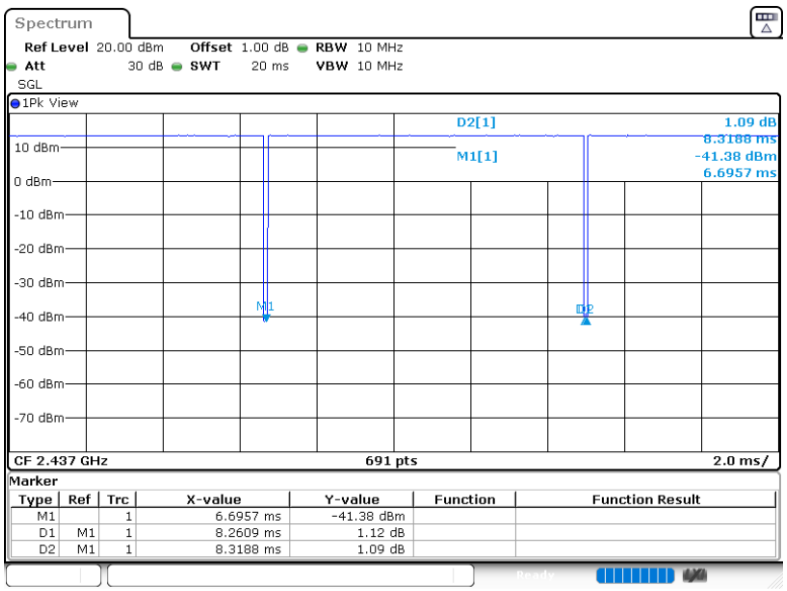
4.3 Duty Cycle

Temperature	25℃	Relative Humidity	55%	Test Voltage	120V/60Hz
Mode	Fre(MHz)	On time(ms)	Total Time(ms)	Duty Cycle	Duty Factor
802.11b	2437	8.26090	8.31880	99.30%	0.00
802.11g	2437	1.37681	1.53623	89.62%	0.48
802.11n HT20	2437	1.28986	1.38406	93.19%	0.31
802.11n HT40	2437	0.64058	0.75942	84.35%	0.74

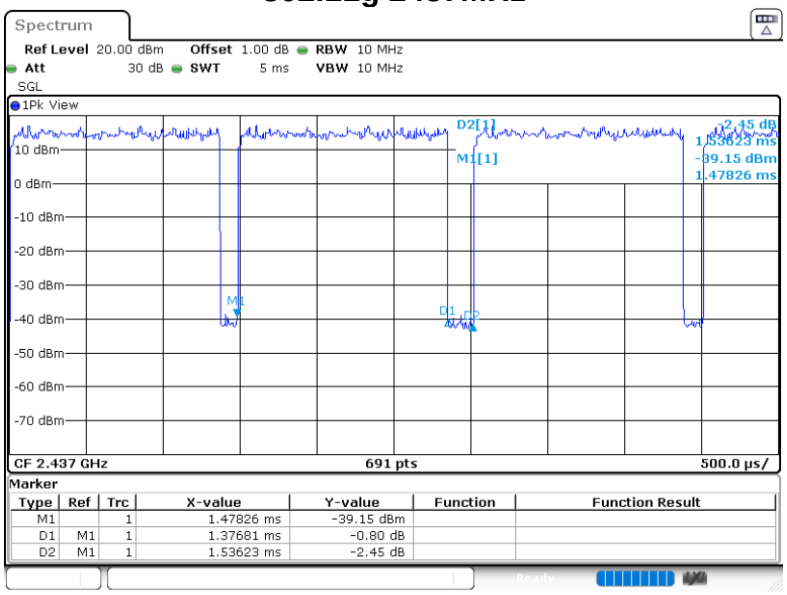
Note:

1. If duty cycle <98 %, the conducted average output power and average power spectral density should be add duty factor.
2. If duty cycle≥98 %,the EUT is consider to be transmitting continuously,the conducted average output power and average power spectral density no need to add duty factor(consider to be zero).
3. The conducted peak output power and peak power spectral density no need to consider duty factor.
4. The on-time time is transmission duration(T).

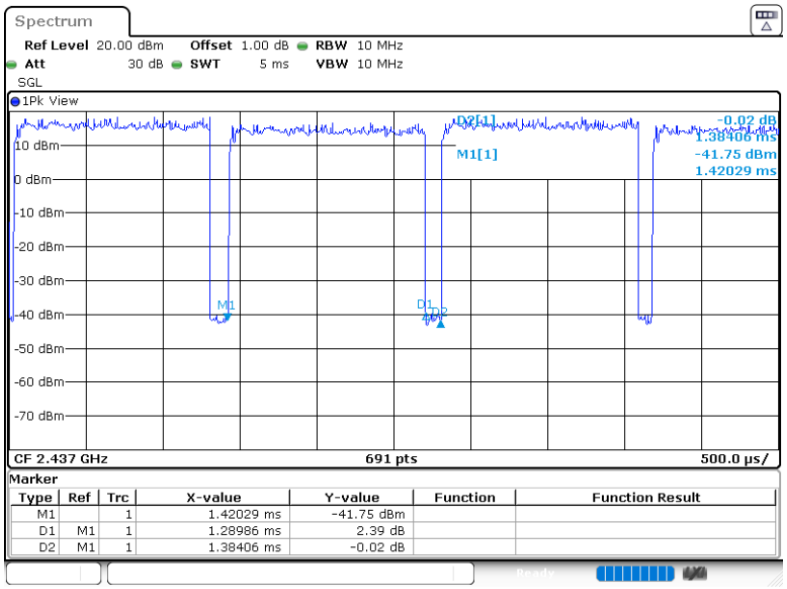
802.11b 2437MHz



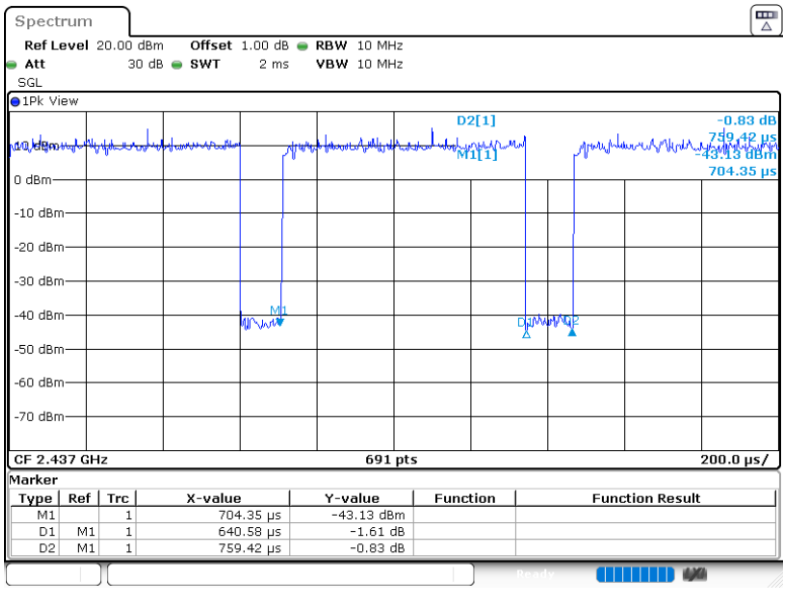
802.11g 2437MHz



802.11n HT20 2437MHz



802.11n HT40 2437MHz



4.4 Description of Support Units

The EUT has been tested with associated equipment below.

Description	Manufacturer	Model No.	Remark	FCC certification
N/A	N/A	N/A	N/A	N/A

4.5 Test Location

All tests were performed at:

Shenzhen Huaxia Testing Technology Co., Ltd.,

1F., Block A of Tongsheng Technology Building, Huahui Road, Dalang Street, Longhua New District, Shenzhen, Guangdong, China

4.6 Test Facility

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

- **CNAS (No. CNAS L5785)**

CNAS has accredited Shenzhen Huaxia Testing Technology Co., Ltd. Shenzhen Branch EMC Lab to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

- **ISED Registration No.: 22984-1**

The 3m Semi-anechoic chamber of Shenzhen Huaxia Testing Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing

- **A2LA (Certificate No. 4742.01)**

Shenzhen Huaxia Testing Technology Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 4742.01.

- **FCC Registration No.: 522263**

Shenzhen Huaxia Testing Technology Co., Ltd., Shenzhen EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration No.:522263

4.7 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 Huaxia Testing Technology 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.

Hereafter the best measurement capability for CQA laboratory is reported:

No.	Item	Uncertainty	Notes
1	Radiated Emission (Below 1GHz)	±5.12dB	(1)
2	Radiated Emission (Above 1GHz)	±4.60dB	(1)
3	Conducted Disturbance (0.15~30MHz)	±3.34dB	(1)
4	Radio Frequency	3×10^{-8}	(1)
5	Duty cycle	0.6 %.	(1)
6	Occupied Bandwidth	1.1%	(1)
7	RF conducted power	0.86dB	(1)
8	RF power density	0.74	(1)
9	Conducted Spurious emissions	0.86dB	(1)
10	Temperature test	0.8℃	(1)
11	Humidity test	2.0%	(1)
12	Supply voltages	0.5 %.	(1)
13	time	0.6 %.	(1)
14	Frequency Error	5.5 Hz	(1)

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

4.8 Deviation from Standards

None.

4.9 Abnormalities from Standard Conditions

None.

4.10 Other Information Requested by the Customer

None.

4.11 Equipment List

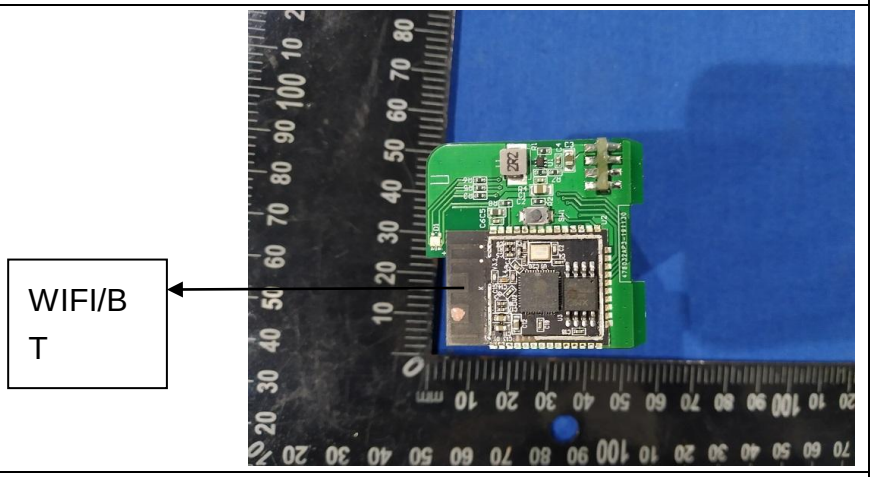
Test Equipment	Manufacturer	Model No.	Instrument No.	Calibration Date	Calibration Due Date
EMI Test Receiver	R&S	ESR7	CQA-005	2019/10/25	2020/10/24
Spectrum analyzer	R&S	FSU26	CQA-038	2019/10/25	2020/10/24
Preamplifier	MITEQ	AFS4-00010300-18-10P-4	CQA-035	2019/10/25	2020/10/24
Preamplifier	MITEQ	AMF-6D-02001800-29-20P	CQA-036	2019/10/21	2020/10/20
Loop antenna	Schwarzbeck	FMZB1516	CQA-087	2019/9/26	2020/9/25
Bilog Antenna	R&S	HL562	CQA-011	2019/9/26	2020/9/25
Horn Antenna	R&S	HF906	CQA-012	2019/9/25	2020/9/24
Horn Antenna	Schwarzbeck	BBHA 9170	CQA-088	2019/9/26	2020/9/25
Coaxial Cable (Above 1GHz)	CQA	N/A	C019	2019/9/26	2020/9/25
Coaxial Cable (Below 1GHz)	CQA	N/A	C020	2019/9/26	2020/9/25
Antenna Connector	CQA	RFC-01	CQA-080	2019/9/26	2020/9/25
RF cable(9KHz~40GHz)	CQA	RF-01	CQA-079	2019/9/26	2020/9/25
Power Sensor	KEYSIGHT	U2021XA	CQA-30	2019/9/26	2020/9/25
N1918A Power Analysis Manager Power Panel	Agilent	N1918A	CQA-074	2019/9/26	2020/9/25
Power divider	MIDWEST	PWD-2533-02-SMA-79	CQA-067	2019/10/23	2020/10/22
EMI Test Receiver	R&S	ESPI3	CQA-013	2019/9/26	2020/9/25
LISN	R&S	ENV216	CQA-003	2019/10/25	2020/10/24
Coaxial cable	CQA	N/A	CQA-C009	2019/10/25	2020/10/24

Note:

The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

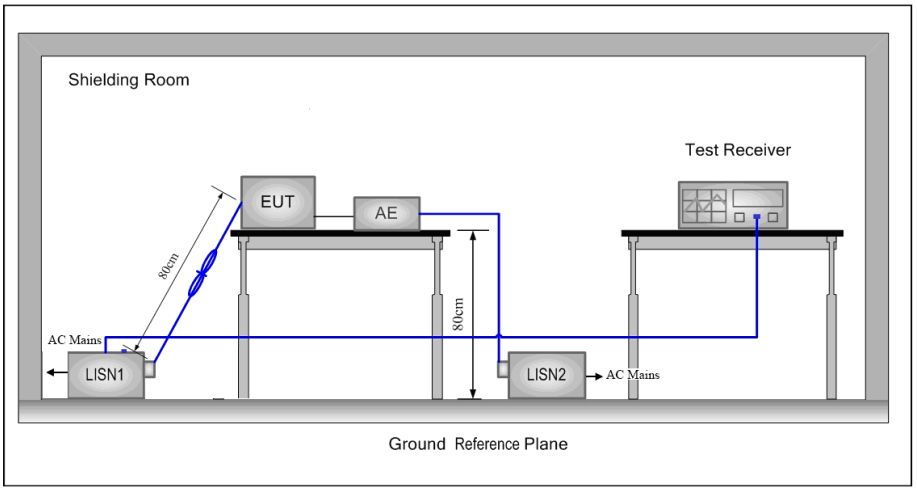
5 Test results and Measurement Data

5.1 Antenna Requirement

Standard requirement:	47 CFR Part 15C Section 15.203 /247(c)
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:	
The antenna is a PCB antenna. Antenna Gain : 0dBi	

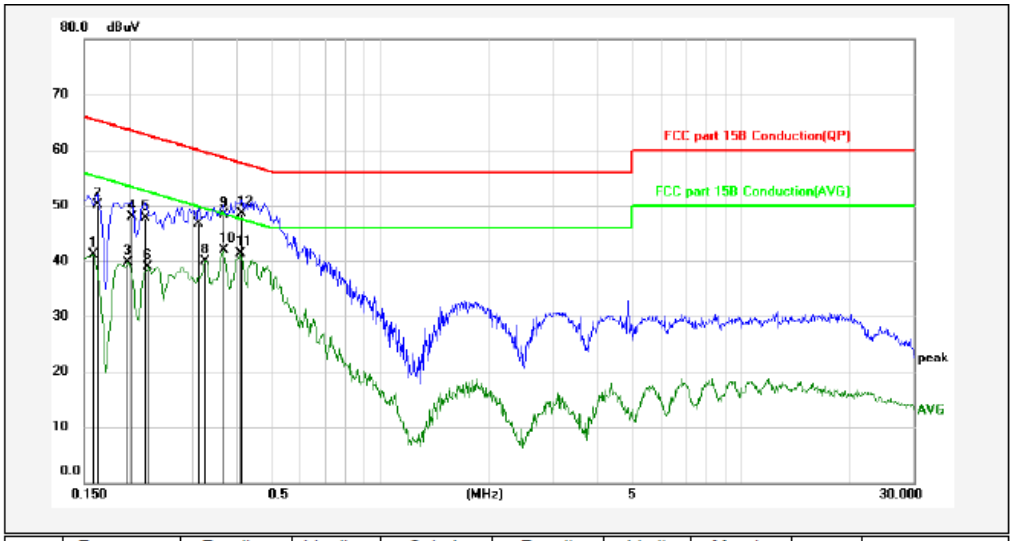
5.2 Conducted Emissions

<table>
<tr><td>Test Requirement:</td><td>47 CFR Part 15C Section 15.207,</td></tr>
<tr><td>Test Method:</td><td>ANSI C63.10: 2013</td></tr>
<tr><td>Test Frequency Range:</td><td>150kHz to 30MHz</td></tr>
<tr><td>Limit:</td><td>
<table>
<tr><th rowspan="2">Frequency range (MHz)</th><th colspan="2">Limit (dBuV)</th></tr>
<tr><th>Quasi-peak</th><th>Average</th></tr>
<tr><td>0.15-0.5</td><td>66 to 56*</td><td>56 to 46*</td></tr>
<tr><td>0.5-5</td><td>56</td><td>46</td></tr>
<tr><td>5-30</td><td>60</td><td>50</td></tr>
</table>
* Decreases with the logarithm of the frequency.
</td></tr>
<tr><td>Test Procedure:</td><td>1) The mains terminal disturbance voltage test was conducted in a shielded room.
2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
5) 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.</td></tr>
</table>

Test Setup:	
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find at lowest channel is the worst case. Only the worst case is recorded in the report.
Test Voltage:	AC120V/60Hz
Test Results:	Pass

Measurement Data

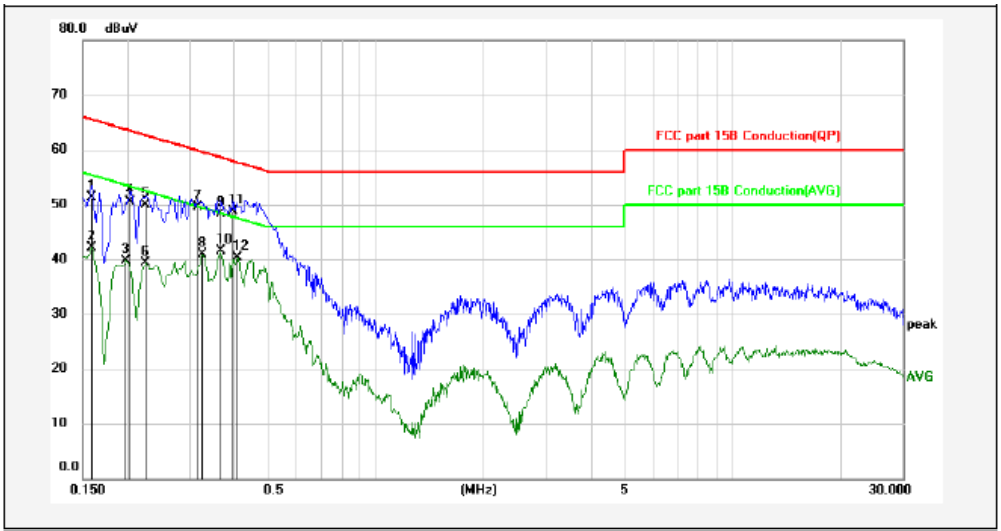
Live Line:



No.	Frequency (MHz)	Reading (dBuV)	Lisn/Isn (dB)	Cab_L (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1590	31.31	9.6	0.22	41.13	55.52	-14.39	AVG	
2	0.1635	40.28	9.6	0.22	50.10	65.28	-15.18	QP	
3	0.1995	29.92	9.6	0.23	39.75	53.63	-13.88	AVG	
4	0.2040	38.17	9.6	0.23	48.00	63.45	-15.45	QP	
5	0.2220	37.87	9.6	0.23	47.70	62.74	-15.04	QP	
6	0.2265	29.11	9.6	0.23	38.94	52.58	-13.64	AVG	
7	0.3120	36.96	9.6	0.24	46.80	59.92	-13.12	QP	
8	0.3255	30.13	9.6	0.24	39.97	49.57	-9.60	AVG	
9	0.3660	38.47	9.59	0.24	48.30	58.59	-10.29	QP	
10	0.3660	31.98	9.59	0.24	41.81	48.59	-6.78	AVG	
11	0.4065	31.52	9.58	0.24	41.34	47.72	-6.38	AVG	
12	0.4110	38.78	9.58	0.24	48.60	57.63	-9.03	QP	

Remarks: 1. Result=Reading+Lisn+Cab_L
2. If the average limit is met when using a quasi-peak detector.
the EUT shall be deemed to meet both limits and measurement
with average detctor is unnecessary.

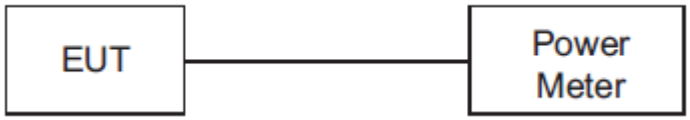
Neutral Line:



No.	Frequency (MHz)	Reading (dBuV)	Lisn/Isn (dB)	Cab_L (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1590	41.48	9.6	0.22	51.30	65.52	-14.22	QP	
2	0.1590	32.27	9.6	0.22	42.09	55.52	-13.43	AVG	
3	0.1995	29.97	9.6	0.23	39.80	53.63	-13.83	AVG	
4	0.2040	40.77	9.6	0.23	50.60	63.45	-12.85	QP	
5	0.2265	40.07	9.6	0.23	49.90	62.58	-12.68	QP	
6	0.2265	29.45	9.6	0.23	39.28	52.58	-13.30	AVG	
7	0.3165	39.76	9.6	0.24	49.60	59.80	-10.20	QP	
8	0.3255	31.04	9.6	0.24	40.88	49.57	-8.69	AVG	
9	0.3660	38.47	9.59	0.24	48.30	58.59	-10.29	QP	
10	0.3660	31.76	9.59	0.24	41.59	48.59	-7.00	AVG	
11	0.3975	38.97	9.59	0.24	48.80	57.91	-9.11	QP	
12	0.4065	30.57	9.58	0.24	40.39	47.72	-7.33	AVG	

Remarks: 1. Result=Reading+Lisn+Cab_L
2. If the average limit is met when using a quasi-peak detector.
the EUT shall be deemed to meet both limits and measurement
with average detctor is unnecessary.

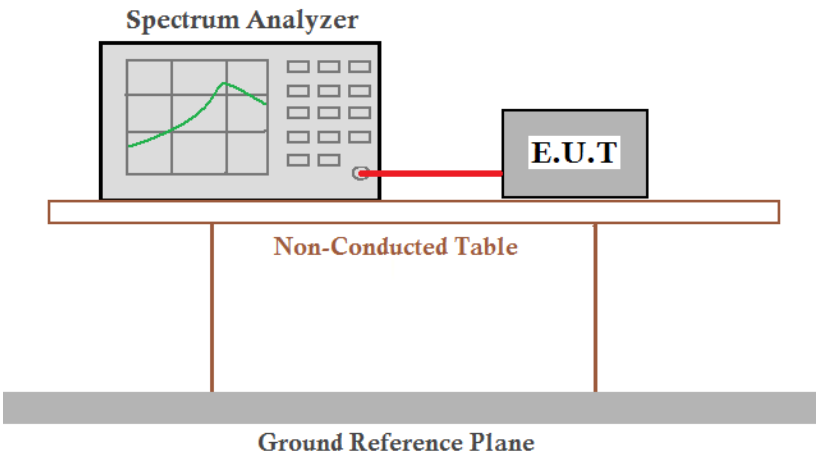
5.3 Conducted Peak Output Power

Test Requirement:	47 CFR Part 15C Section 15.247 (b)(3)
Test Method:	ANSI C63.10: 2013
Test Setup:	 1, Connected the EUT's antenna port to spectrum analyzer device. 2, Follow the test procedure as described in KDB 558074 (1). Set the RBW ≥ DTS bandwidth. (2). Set VBW ≥ 3 x RBW. (3). Set span ≥ 3 x RBW. (4). Sweep time = auto couple. (5). Detector = peak. (6). Trace mode = max hold. (7). Allow trace to fully stabilize. (8). Use peak marker function to determine the peak amplitude level. Note: The cable loss and attenuator loss were offset into measure device as an amplitude offs
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find the 1Mbps of rate is the worst case of 802.11b; 6Mbps of rate is the worst case of 802.11g ; 6.5Mbps of rate is the worst case of 802.11n(HT20/HT40) ; Only the worst case is recorded in the report.
Limit:	30dBm
Test Results:	Pass

Measurement Data

Test Mode	CH	Conducted Power（dBm）	Duty Facror	Result (dBm)	Limit (dBm)
IEEE 802.11 b	CH1	13.72	0	13.72	30
	CH6	13.85	0	13.85	30
	CH11	13.16	0	13.16	30
IEEE 802.11 g	CH1	10.81	0.48	11.29	30
	CH6	10.12	0.48	10.60	30
	CH11	10.46	0.48	10.94	30
IEEE 802.11 n HT20	CH1	9.63	0.31	9.94	30
	CH6	9.83	0.31	10.14	30
	CH11	9.76	0.31	10.07	30
IEEE 802.11 n HT40	CH1	6.71	0.74	7.45	30
	CH4	7.42	0.74	8.16	30
	CH7	7.60	0.74	8.34	30
Conclusion：PASS					

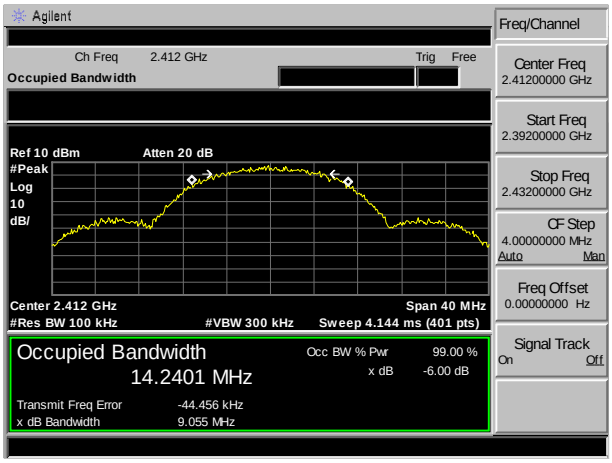
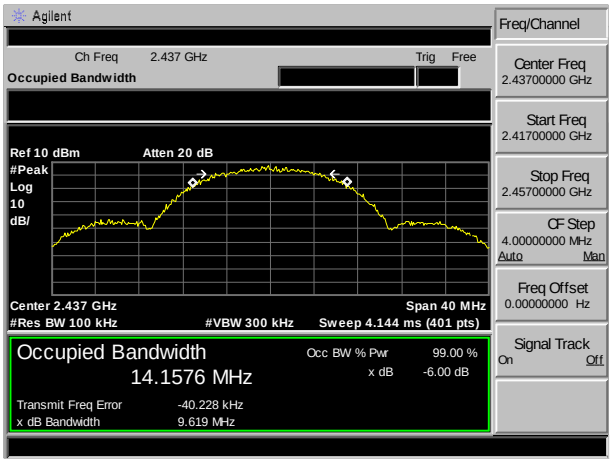
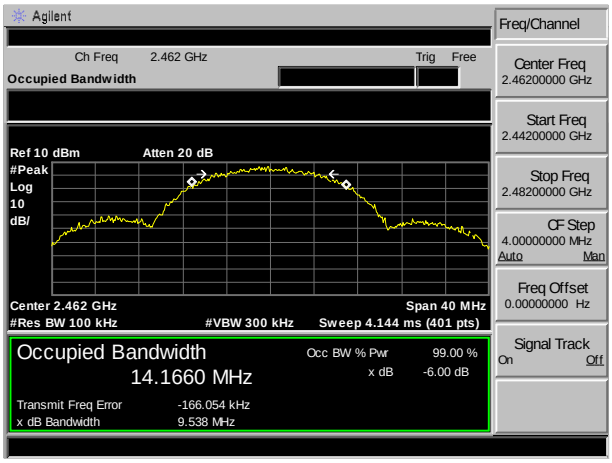
5.4 6dB Occupy Bandwidth

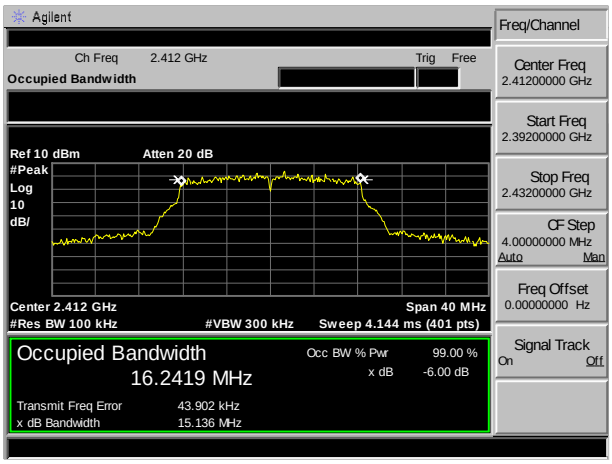
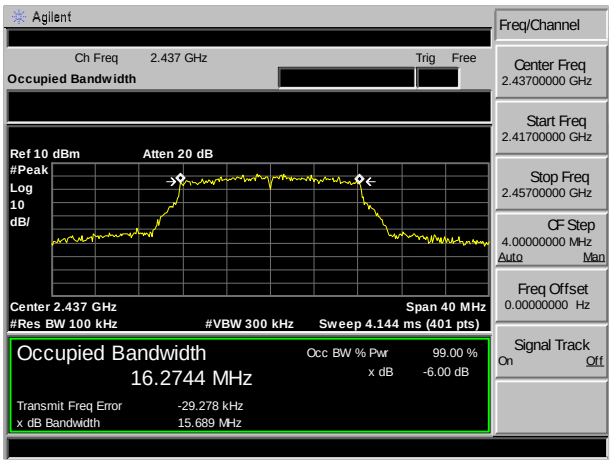
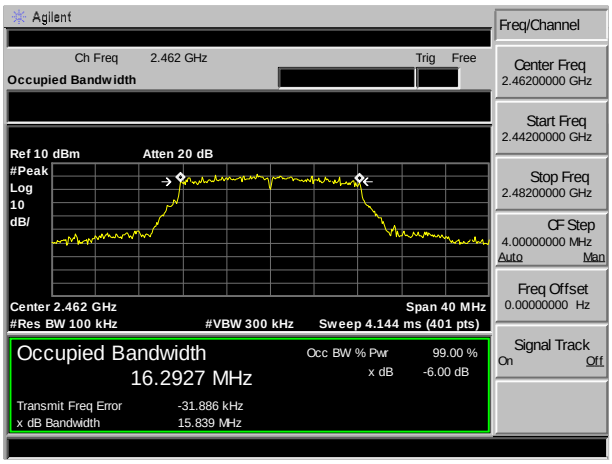
Test Requirement:	47 CFR Part 15C Section 15.247 (a)(2)
Test Method:	ANSI C63.10: 2013
Test Setup:	 1,Connected the EUT's antenna port to spectrum analyzer device. 2, Follow the test procedure as described in KDB 558074 (1). Set resolution bandwidth (RBW) = 100 kHz. (2). Set the video bandwidth (VBW) ≥ 3 x RBW. (3). Detector = Peak. (4). Trace mode = max hold. (5). Sweep = auto couple. (6). Allow the trace to stabilize. (7). Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find the 1Mbps of rate is the worst case of 802.11b; 6Mbps of rate is the worst case of 802.11g ; 6.5Mbps of rate is the worst case of 802.11n(HT20) ,802.11n(HT40)Only the worst case is recorded in the report.
Limit:	≥ 500 kHz
Test Results:	Pass

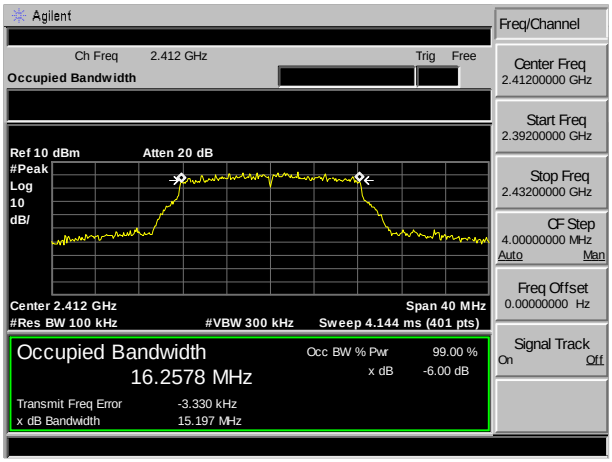
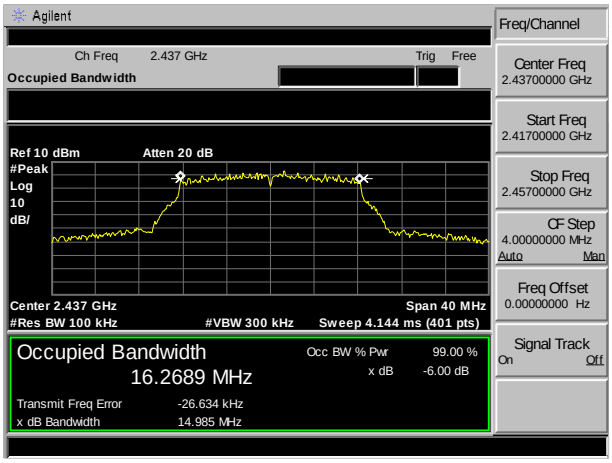
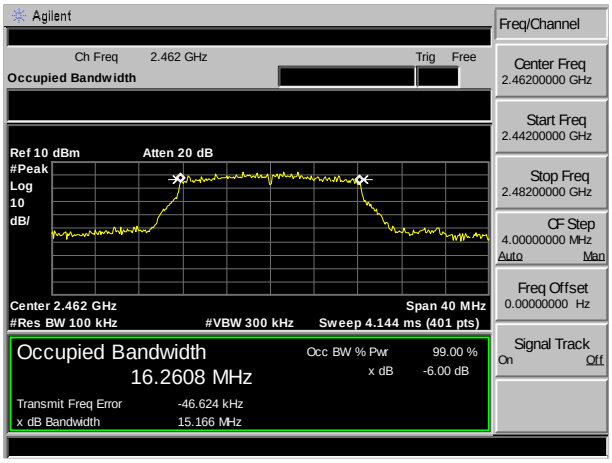
Measurement Data

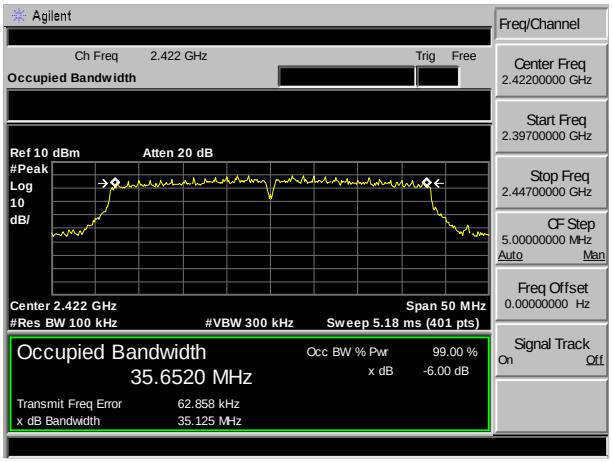
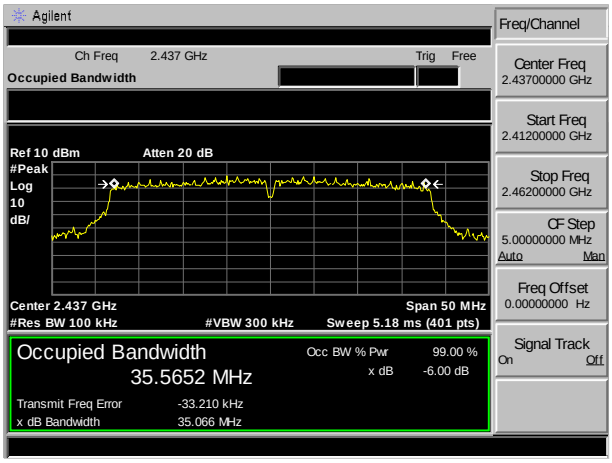
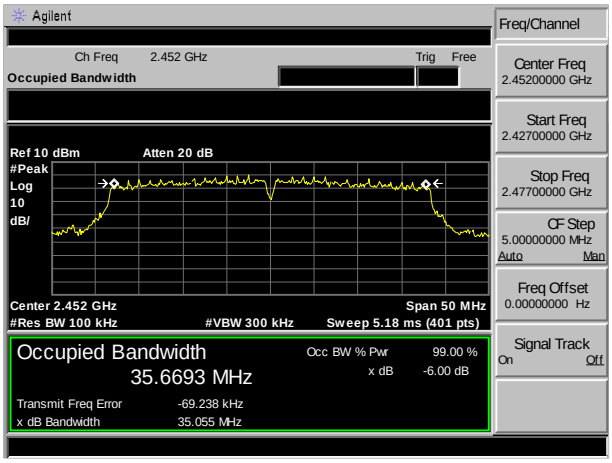
Test Mode	CH	6dB bandwidth（MHz）	20dB bandwidth（MHz）	Limit (KHz)
IEEE 802.11 b	CH1	9.055	16.224	>500
	CH6	9.619	16.209	>500
	CH11	9.538	16.369	>500
IEEE 802.11 g	CH1	15.136	18.437	>500
	CH6	15.689	18.627	>500
	CH11	15.839	18.254	>500
IEEE 802.11 n HT 20	CH1	15.197	18.289	>500
	CH6	14.985	18.306	>500
	CH11	15.166	18.354	>500
IEEE 802.11 n HT 40	CH1	35.125	39.233	>500
	CH4	35.066	39.548	>500
	CH7	35.055	39.572	>500
Conclusion：PASS				

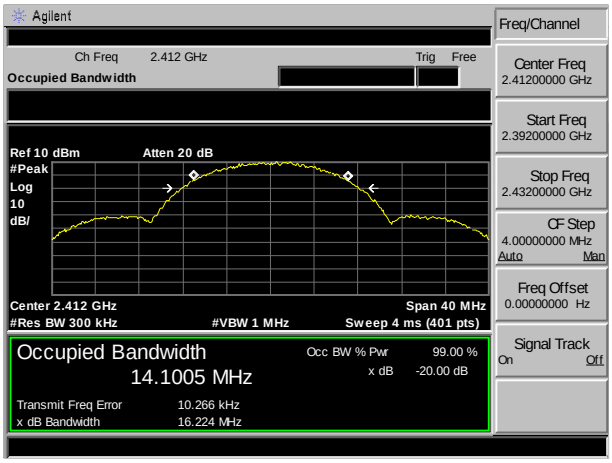
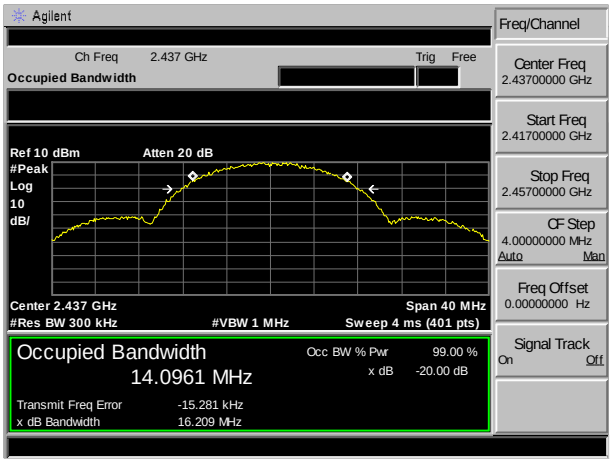
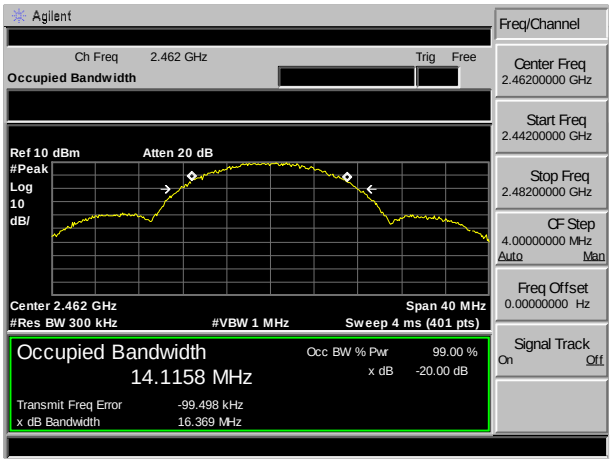
Test plot as follows:

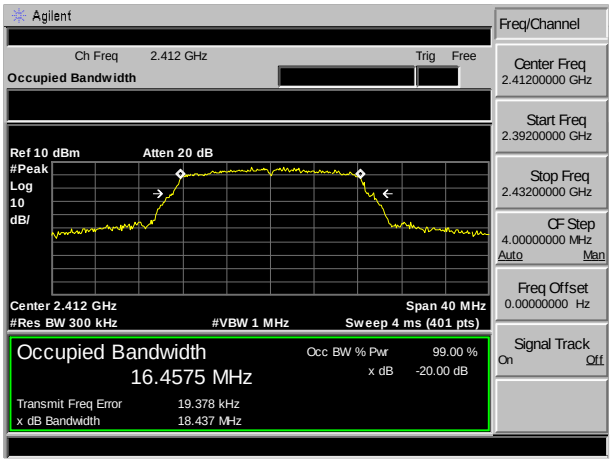
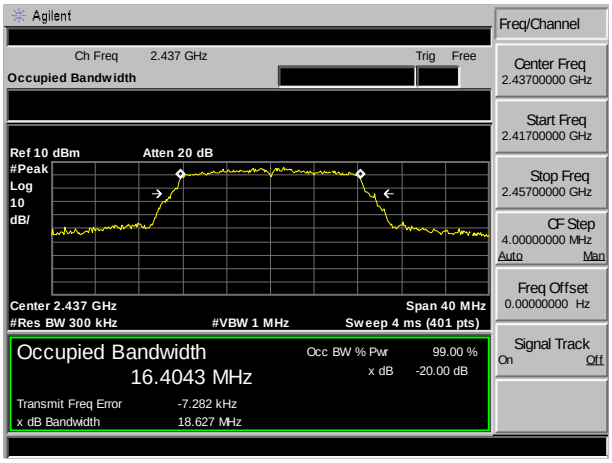
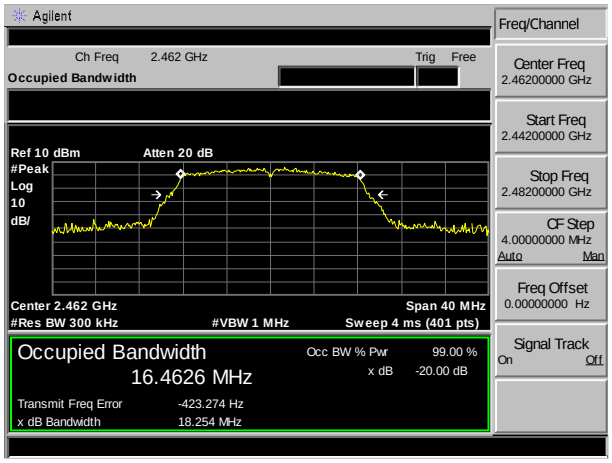
Graphs_6dB Occupy Bandwidth	
IEEE 802.11b 2412MHz	
IEEE 802.11b 2437MHz	
IEEE 802.11b 2462MHz	

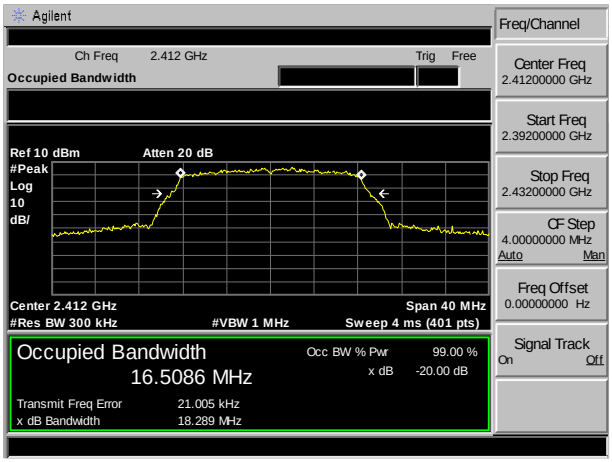
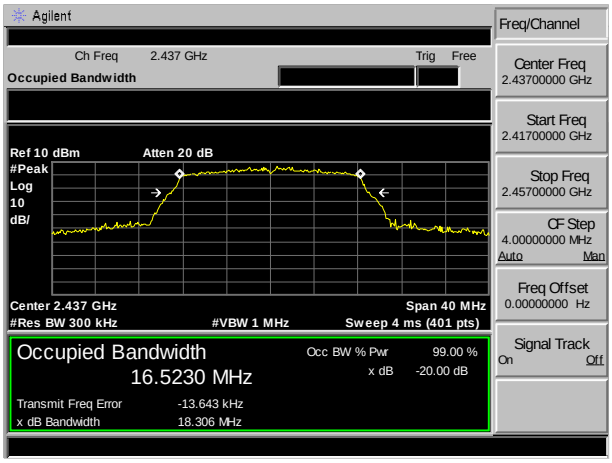
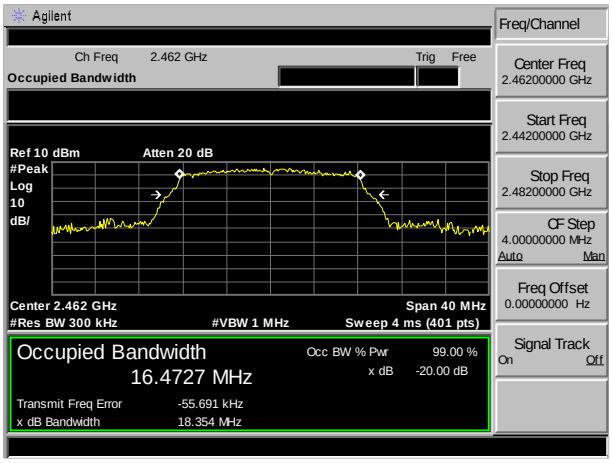
IEEE 802.11g 2412MHz	
IEEE 802.11g 2437MHz	
IEEE 802.11g 2462MHz	

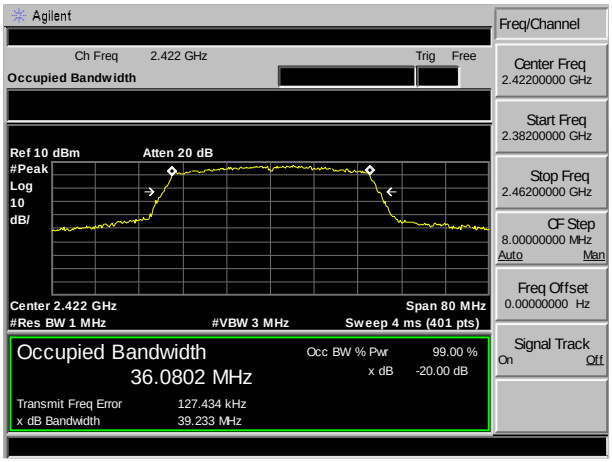
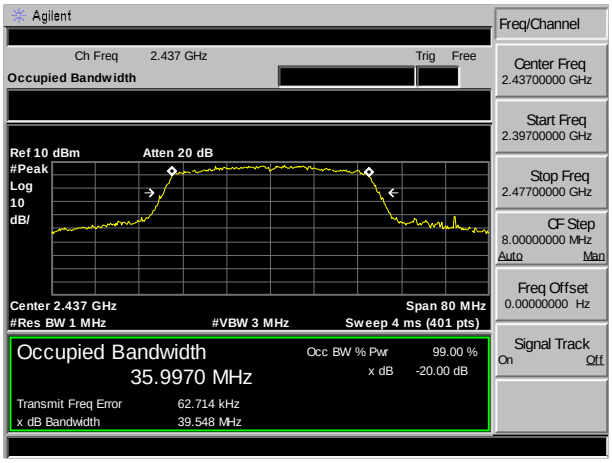
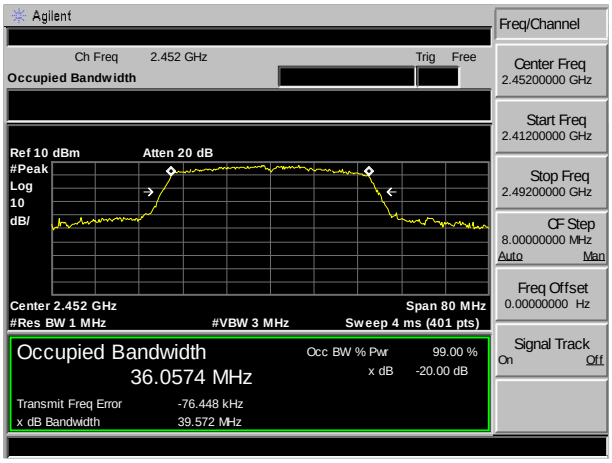
IEEE 802.11n HT20 2412MHz	
IEEE 802.11n HT20 2437MHz	
IEEE 802.11n HT20 2462MHz	

IEEE 802.11n HT40 2422MHz	
IEEE 802.11n HT40 2437MHz	
IEEE 802.11n HT40 2452MHz	

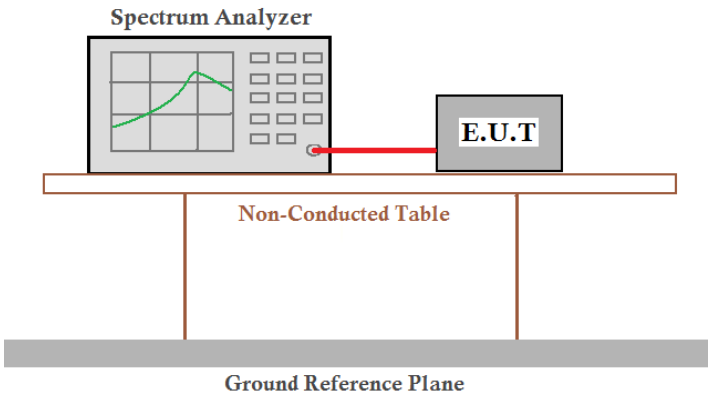
Graphs_20dB Bandwidth	
IEEE 802.11b 2412MHz	
IEEE 802.11b 2437MHz	
IEEE 802.11b 2462MHz	

IEEE 802.11g 2412MHz	
IEEE 802.11g 2437MHz	
IEEE 802.11g 2462MHz	

IEEE 802.11n HT20 2412MHz	
IEEE 802.11n HT20 2437MHz	
IEEE 802.11n HT20 2462MHz	

IEEE 802.11n HT40 2422MHz	
IEEE 802.11n HT40 2437MHz	
IEEE 802.11n HT40 2452MHz	

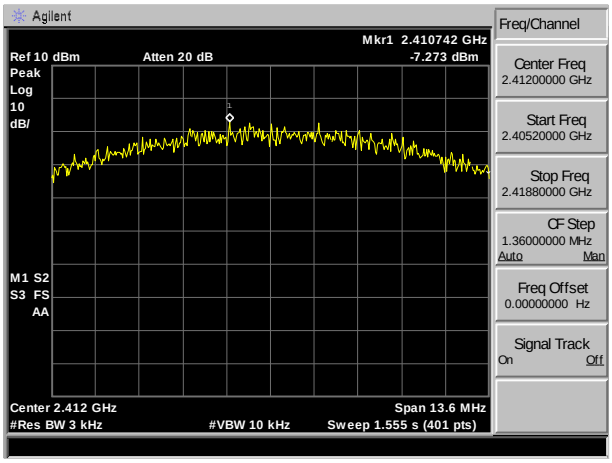
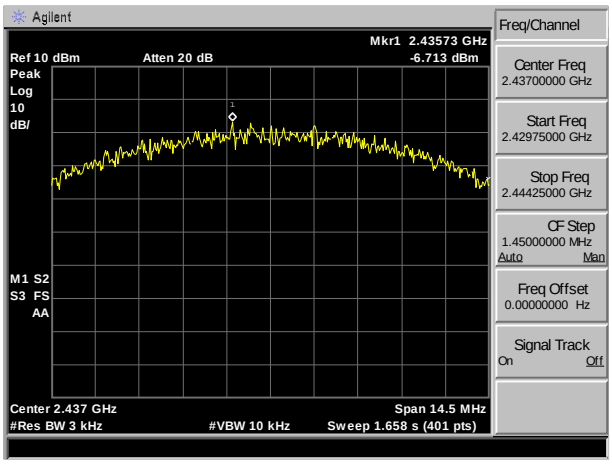
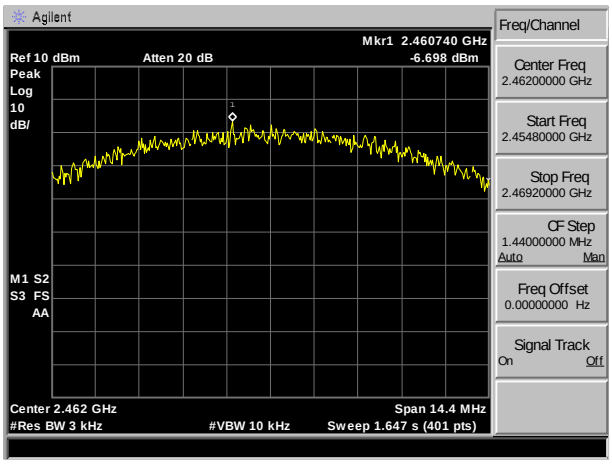
5.5 Power Spectral Density

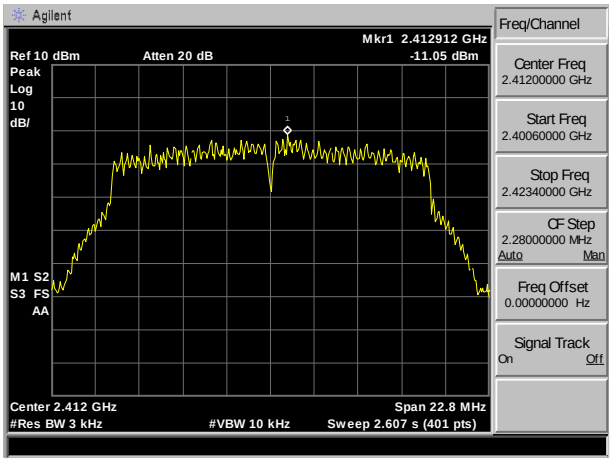
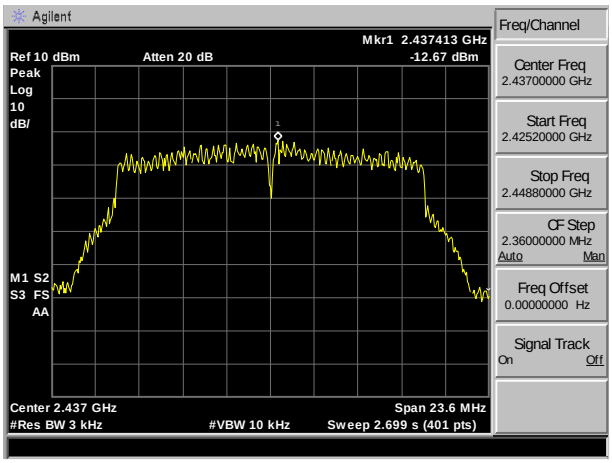
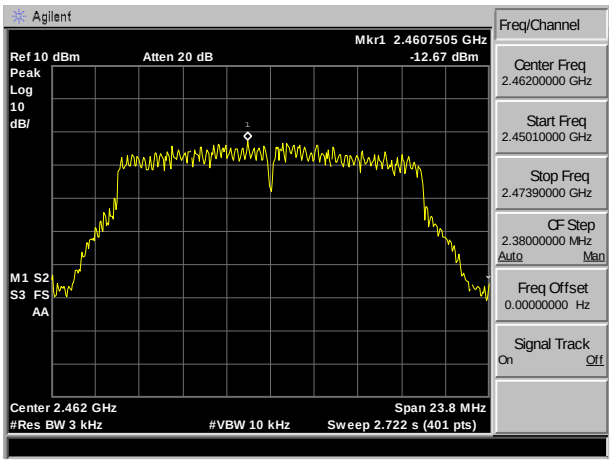
Test Requirement:	47 CFR Part 15C Section 15.247 (e)
Test Method:	ANSI C63.10: 2013
Test Setup:	 1, Connected the EUT's antenna port to spectrum analyzer device. 2, Follow the test procedure as described in KDB 558074 (1). Set analyzer center frequency to DTS channel center frequency. (2). Set the span to 1.5 times the DTS bandwidth. (3). Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz. (4). Set the VBW ≥ 3 RBW. (5). Detector = peak. (6). Sweep time = auto couple. (7). Trace mode = max hold. (8). Allow trace to fully stabilize. (9). Use the peak marker function to determine the maximum amplitude level. (10). If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find the 1Mbps of rate is the worst case of 802.11b; 6Mbps of rate is the worst case of 802.11g ; 6.5Mbps of rate is the worst case of 802.11n(HT20/HT40) ; Only the worst case is recorded in the report.
Limit:	≤8.00dBm/3kHz
Test Results:	Pass

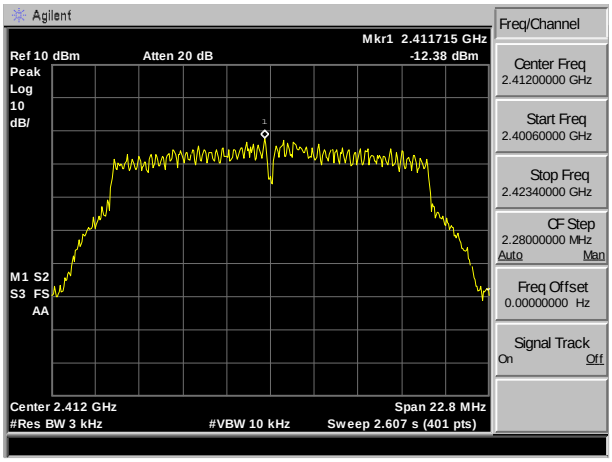
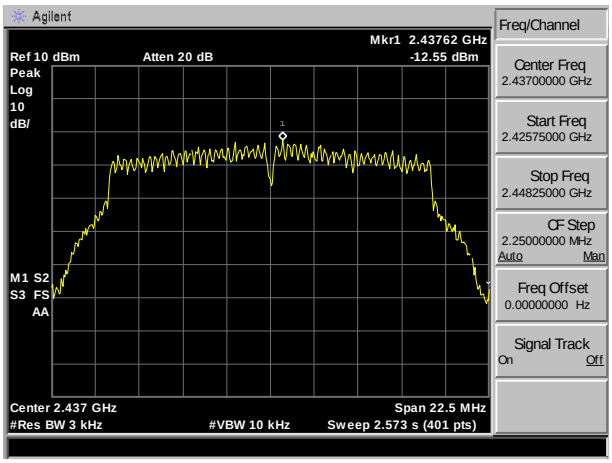
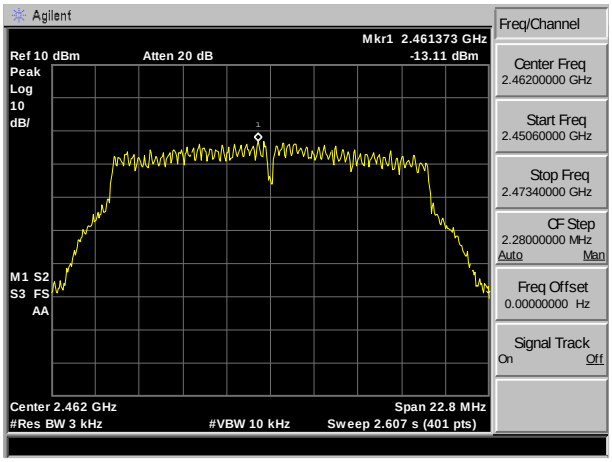
Measurement Data

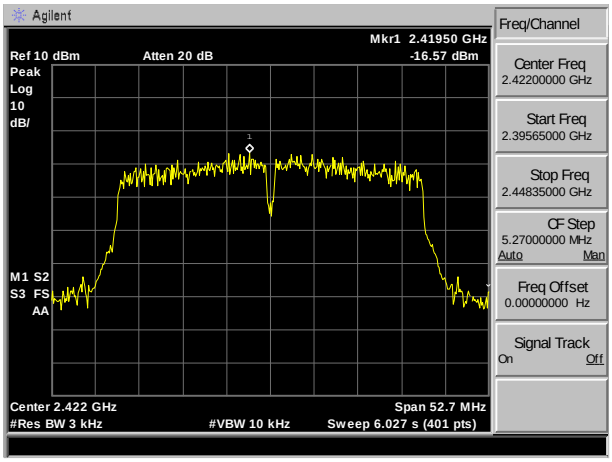
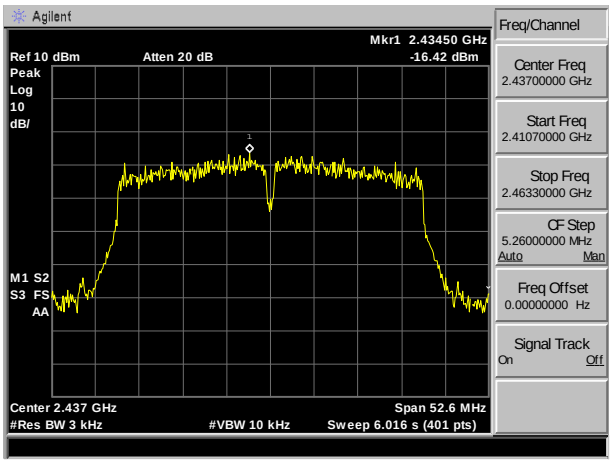
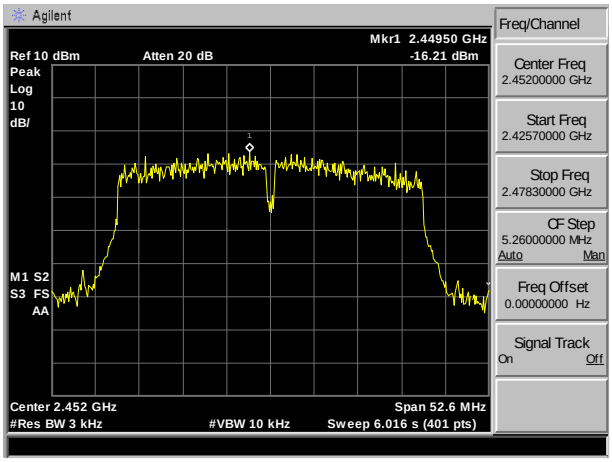
Test Mode	CH	Power density (dBm/3kHz）	Duty Facror	Result (dBm/kHz)	Limit (dBm/3kHz)
IEEE 802.11 b	CH1	-7.273	0	-7.273	8
	CH6	-6.713	0	-6.713	8
	CH11	-6.698	0	-6.698	8
IEEE 802.11 g	CH1	-11.05	0.48	-10.57	8
	CH6	-12.67	0.48	-12.19	8
	CH11	-12.67	0.48	-12.19	8
IEEE 802.11 n HT 20	CH1	-12.38	0.31	-12.07	8
	CH6	-12.55	0.31	-12.24	8
	CH11	-13.11	0.31	-12.80	8
IEEE 802.11 n HT 40	CH1	-16.57	0.74	-15.83	8
	CH6	-16.42	0.74	-15.68	8
	CH11	-16.21	0.74	-15.50	8
Conclusion：PASS					

Test plot as follows:

Graphs	
IEEE 802.11b 2412MHz	
IEEE 802.11b 2437MHz	
IEEE 802.11b 2462MHz	

IEEE 802.11g 2412MHz	
IEEE 802.11g 2437MHz	
IEEE 802.11g 2462MHz	

IEEE 802.11n HT20 2412MHz	
IEEE 802.11n HT20 2437MHz	
IEEE 802.11n HT20 2462MHz	

IEEE 802.11n HT40 2422MHz	
IEEE 802.11n HT40 2437MHz	
IEEE 802.11n HT40 2452MHz	

5.6 Radiated Spurious Emissions

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205
Test Method:	ANSI C63.10 2013
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber)

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Quasi-peak	100 kHz	300kHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

Limit:

Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	100	40.0	Quasi-peak	3
88MHz-216MHz	150	43.5	Quasi-peak	3
216MHz-960MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

Test Setup:	

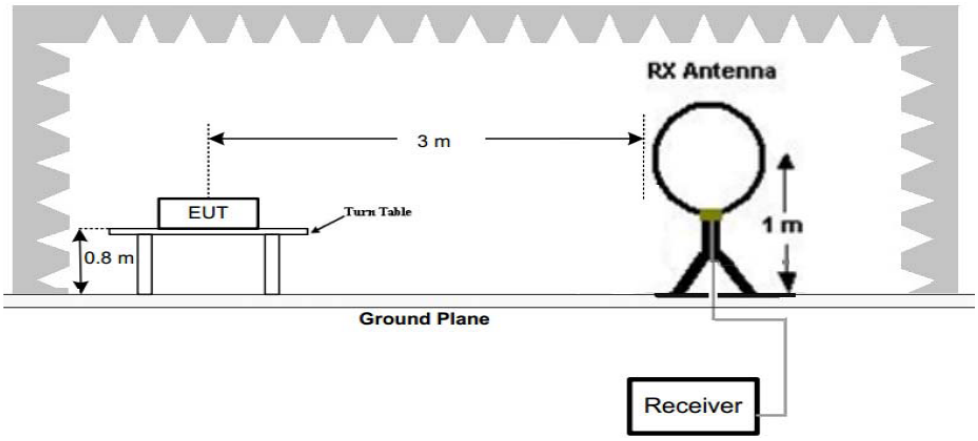


Figure 1. Below 30MHz

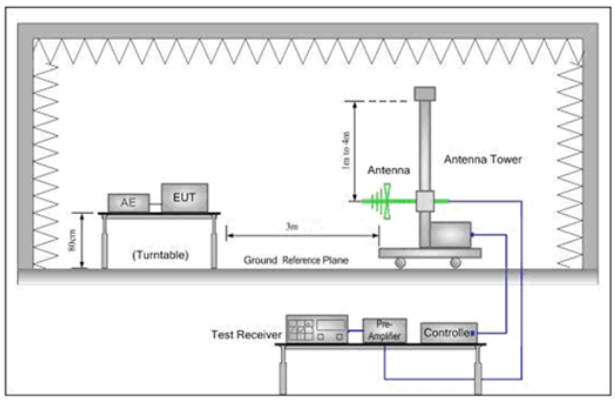


Figure 2. 30MHz to 1GHz

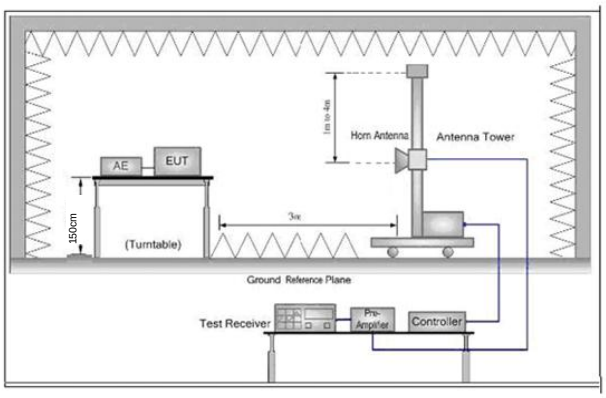


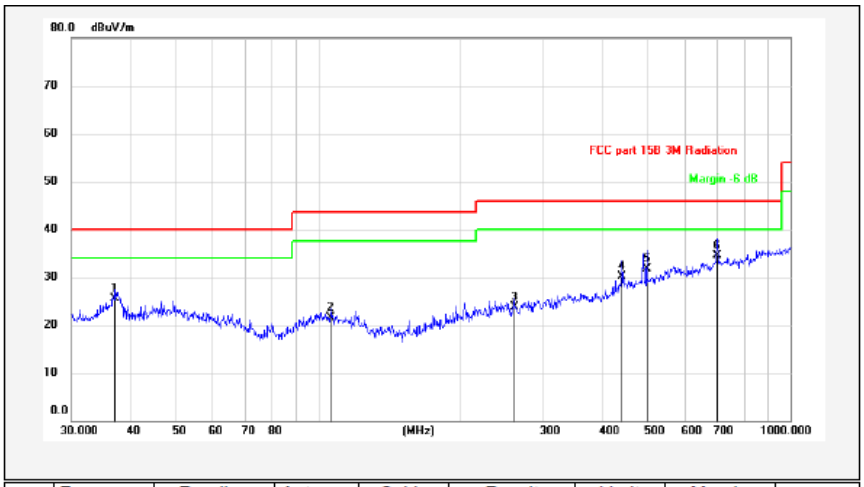
Figure 3. Above 1 GHz

Test Procedure:	a. 1) Below 1G: The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. 2) Above 1G: The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. Note: For the radiated emission test above 1GHz: Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane. b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. c. The 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. d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters(for

	the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. f. 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, quasi-peak or average method as specified and then reported in a data sheet. g. Test the EUT in the lowest channel ,the middle channel ,the Highest channel h. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates. Transmitting mode.
Final Test Mode:	Pretest the EUT at Transmitting mode Through Pre-scan, 802.11b,802.11g M,802.11n(HT20,HT40) find the 1Mbps of rate of 802.11b at lowest channel is the worst case. Only the worst case is recorded in the report.
Test Results:	Pass

5.6.1 Radiated emission below 1GHz

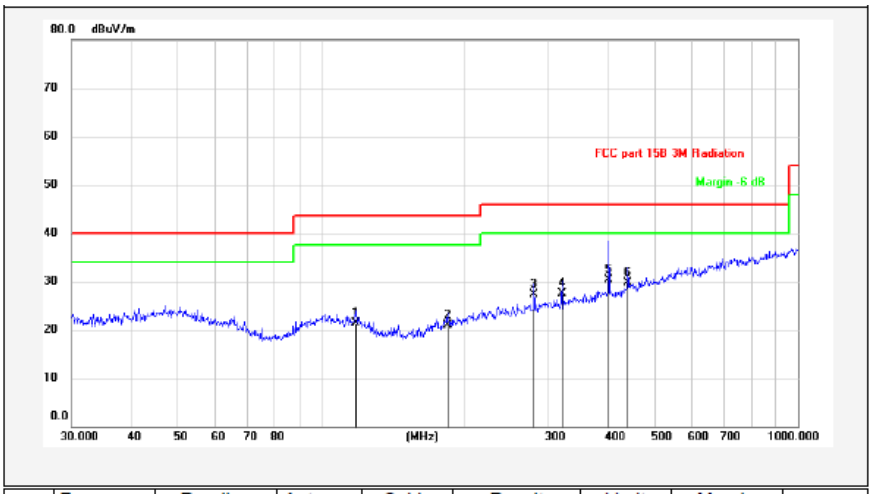
30MHz~1GHz		
Test mode:	Transmitting	Vertical



No.	Frequency (MHz)	Reading (dBuV/m)	Antenna (dB/m)	Cable (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	37.1550	12.18	12.4	0.92	25.50	40.00	-14.50	QP
2	106.3850	7.64	12.33	1.53	21.50	43.50	-22.00	QP
3	260.1444	8.49	13.07	2.24	23.80	46.00	-22.20	QP
4	440.1963	10.94	16.3	2.96	30.20	46.00	-15.80	QP
5	495.9343	11.39	17.12	3.19	31.70	46.00	-14.30	QP
6	699.3046	12.00	18.73	3.87	34.60	46.00	-11.40	QP

Remarks: 1. Result=Reading+Antenna+Cable
2. If Peak Result complies with QP Limit, QP Result is deemed to comply with QP Limit.

Test mode:	Transmitting	Horizontal



No.	Frequency (MHz)	Reading (dBuV/m)	Antenna (dB/m)	Cable (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	118.1860	8.09	11.65	1.56	21.30	43.50	-22.20	QP
2	184.4898	8.74	10.36	1.9	21.00	43.50	-22.50	QP
3	280.0237	11.89	13.1	2.41	27.40	46.00	-18.60	QP
4	319.9370	11.69	13.4	2.51	27.60	46.00	-18.40	QP
5	400.4318	13.09	14.41	2.8	30.30	46.00	-15.70	QP
6	440.1963	10.54	16.3	2.96	29.80	46.00	-16.20	QP

Remarks: 1. Result=Reading+Antenna+Cable
2. If Peak Result complies with QP Limit, QP Result is deemed to comply with QP Limit.

5.6.2 Transmitter emission above 1GHz

Test mode: 802.11b(1Mbps)				Test channel:		Lowest	
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Over (dB)	Detector Type	Ant. Pol. H/V
4824.000	52.31	-4.03	48.28	74	-25.72	peak	H
4824.000	37.72	-4.03	33.69	54	-20.31	AVG	H
7236.000	50.18	1.66	51.84	74	-22.16	peak	H
7236.000	36.64	1.66	38.30	54	-15.70	AVG	H
4824.000	53.40	-4.03	49.37	74	-24.63	peak	V
4824.000	38.53	-4.03	34.50	54	-19.50	AVG	V
7236.000	49.89	1.66	51.55	74	-22.45	peak	V
7236.000	36.45	1.66	38.11	54	-15.89	AVG	V

Test mode: 802.11b(1Mbps)				Test channel:		Middle	
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Over (dB)	Detector Type	Ant. Pol. H/V
4874.000	53.54	-4.26	49.28	74	-24.72	peak	H
4874.000	36.59	-4.26	32.33	54	-21.67	AVG	H
7311.000	51.06	1.18	52.24	74	-21.76	peak	H
7311.000	37.95	1.18	39.13	54	-14.87	AVG	H
4874.000	55.76	-4.26	51.50	74	-22.50	peak	V
4874.000	39.81	-4.26	35.55	54	-18.45	AVG	V
7311.000	50.46	1.18	51.64	74	-22.36	peak	V
7311.000	36.77	1.18	37.95	54	-16.05	AVG	V

Test mode:802.11b(1Mbps)				Test channel:		Highest	
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Over (dB)	Detector Type	Ant. Pol. H/V
4924.000	52.63	-4.12	48.51	74	-25.49	peak	H
4924.000	36.31	-4.12	32.19	54	-21.81	AVG	H
7386.000	49.61	1.46	51.07	74	-22.93	peak	H
7386.000	35.16	1.46	36.62	54	-17.38	AVG	H
4924.000	52.32	-4.12	48.20	74	-25.80	peak	V
4924.000	36.04	-4.12	31.92	54	-22.08	AVG	V
7386.000	48.50	1.46	49.96	74	-24.04	peak	V
7386.000	35.74	1.46	37.20	54	-16.80	AVG	V

Remark:

1) The 1Mbps of rate of ANT 1 802.11b is the worst case.

2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

   Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

3) Scan from 9kHz to 25GHz,The disturbance above 13GHz and below 30MHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

5.7 Restricted bands around fundamental frequency

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205
Test Method:	ANSI C63.10 2013
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber)
Limit:	

Frequency	Limit (dBuV/m @3m)	Remark
30MHz-88MHz	40.0	Quasi-peak Value
88MHz-216MHz	43.5	Quasi-peak Value
216MHz-960MHz	46.0	Quasi-peak Value
960MHz-1GHz	54.0	Quasi-peak Value
Above 1GHz	54.0	Average Value
	74.0	Peak Value

Test Setup:

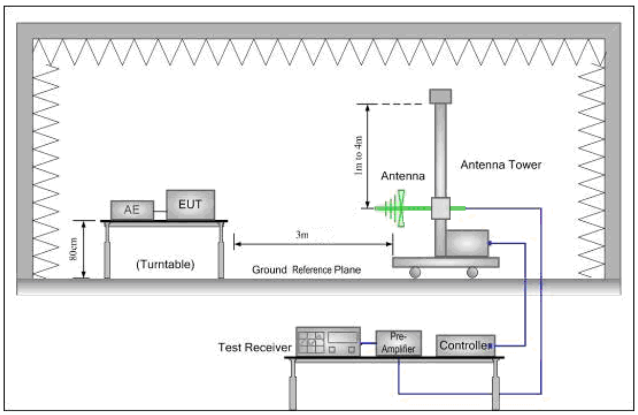


Figure 1. 30MHz to 1GHz

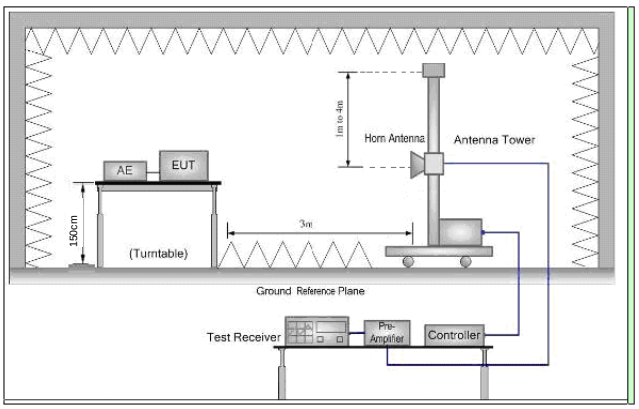


Figure 2. Above 1 GHz

Test Procedure:

a. 1) Below 1G: The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2) Above 1G: The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
Note: For the radiated emission test above 1GHz:

Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

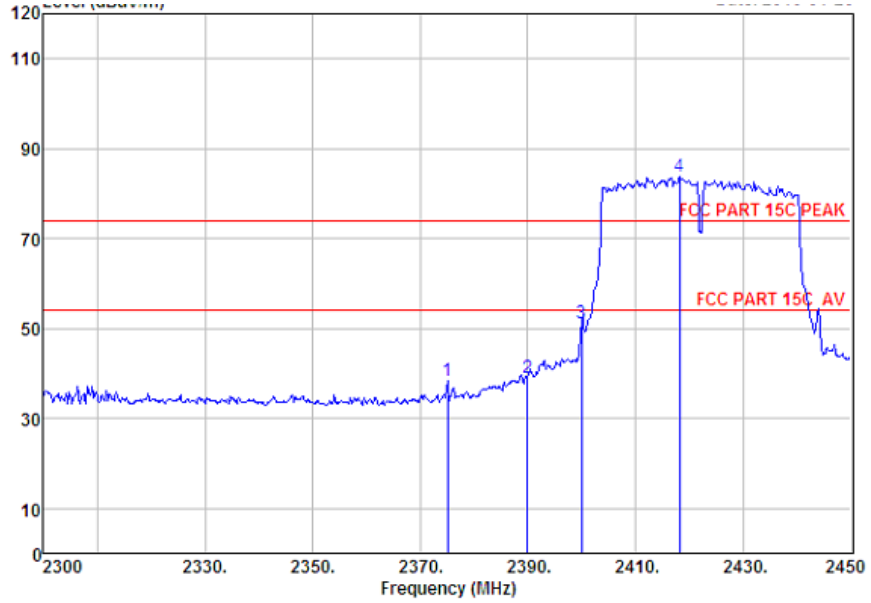
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The 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.

	d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. f. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel g. Test the EUT in the lowest channel , the Highest channel h. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates. Transmitting mode.
Final Test Mode:	Pretest the EUT at Transmitting mode Through Pre-scan, 802.11b,802.11g M,802.11n(HT20,HT40) find the 802.11n HT40 is the worst case. Only the worst case is recorded in the report.
Test Results:	Pass

Test data:

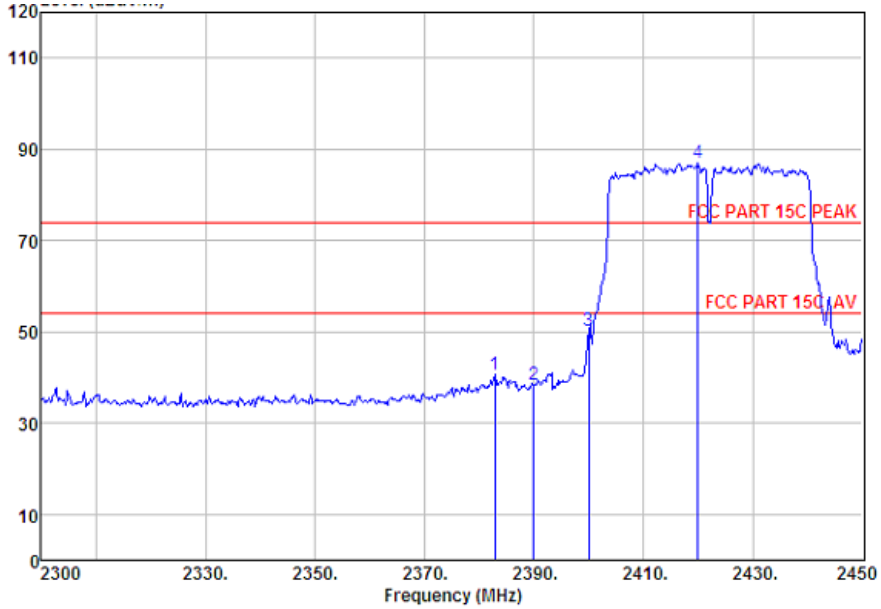
Test mode: 802.11n HT40	Test channel:	Lowest	Polarization	Vertical



	Freq. (MHz)	Ant. Factor (dB/m)	Cable Loss (dB)	Amp Factor (dB)	Reading (dBuV)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Remark
1	2375.00	27.64	6.60	34.59	38.90	38.55	74.00	35.45	Peak
2	2390.00	27.64	6.62	34.62	39.53	39.17	74.00	34.83	Peak
3	2400.00	27.61	6.62	34.64	51.59	51.18	74.00	22.82	Peak
4	2418.20	27.60	6.64	34.74	84.27	83.77	74.00	-9.77	Peak

Remarks: 1. Emission Level= Antenna Factor + Cable Loss - Amp Factor + Reading.
2. The emission levels that are 20dB below the official limit are not reported.

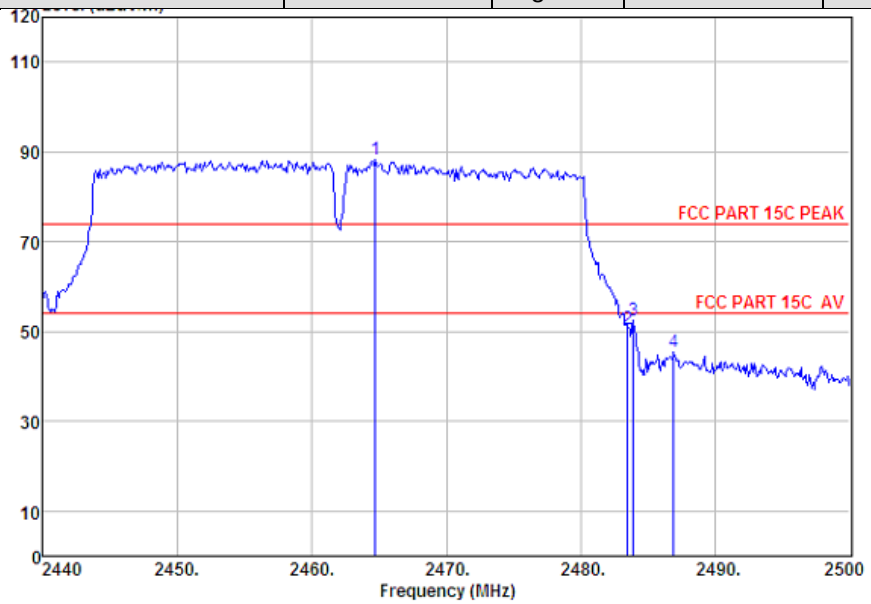
Test mode: 802.11n HT40	Test channel:	Lowest	Polarization	Horizontal



	Freq. (MHz)	Ant. Factor (dB/m)	Cable Loss (dB)	Amp Factor (dB)	Reading (dBuV)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Remark
1	2382.80	27.64	6.60	34.62	41.03	40.65	74.00	33.35	Peak
2	2390.00	27.64	6.62	34.62	38.66	38.30	74.00	35.70	Peak
3	2400.00	27.61	6.62	34.64	50.60	50.19	74.00	23.81	Peak
4	2420.00	27.60	6.66	34.74	87.43	86.95	74.00	-12.95	Peak

Remarks: 1. Emission Level= Antenna Factor + Cable Loss - Amp Factor + Reading.
2. The emission levels that are 20dB below the official limit are not reported.

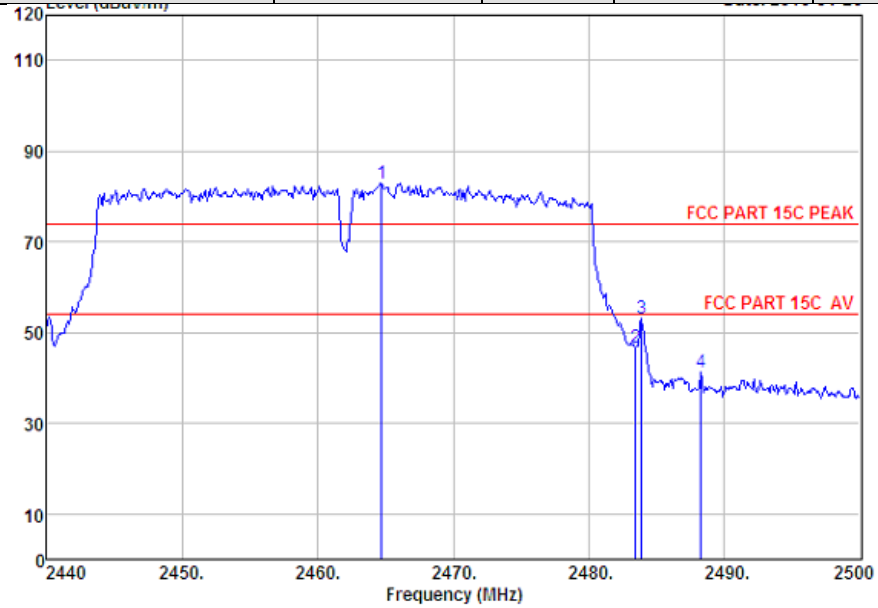
Test mode: 802.11n HT40	Test channel:	Highest	Polarization	Horizontal



	Freq. (MHz)	Ant. Factor (dB/m)	Cable Loss (dB)	Amp Factor (dB)	Reading (dBuV)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Remark
1	2464.72	27.58	6.69	34.98	88.88	88.17	74.00	-14.17	Peak
2	2483.50	27.58	6.71	35.11	51.26	50.44	74.00	23.56	Peak
3	2483.92	27.58	6.71	35.11	53.20	52.38	74.00	21.62	Peak
4	2486.92	27.58	6.71	35.11	46.15	45.33	74.00	28.67	Peak

Remarks: 1. Emission Level= Antenna Factor + Cable Loss - Amp Factor + Reading.
2. The emission levels that are 20dB below the official limit are not reported.

Test mode: 802.11n HT40	Test channel:	Highest	Polarization	Vertical



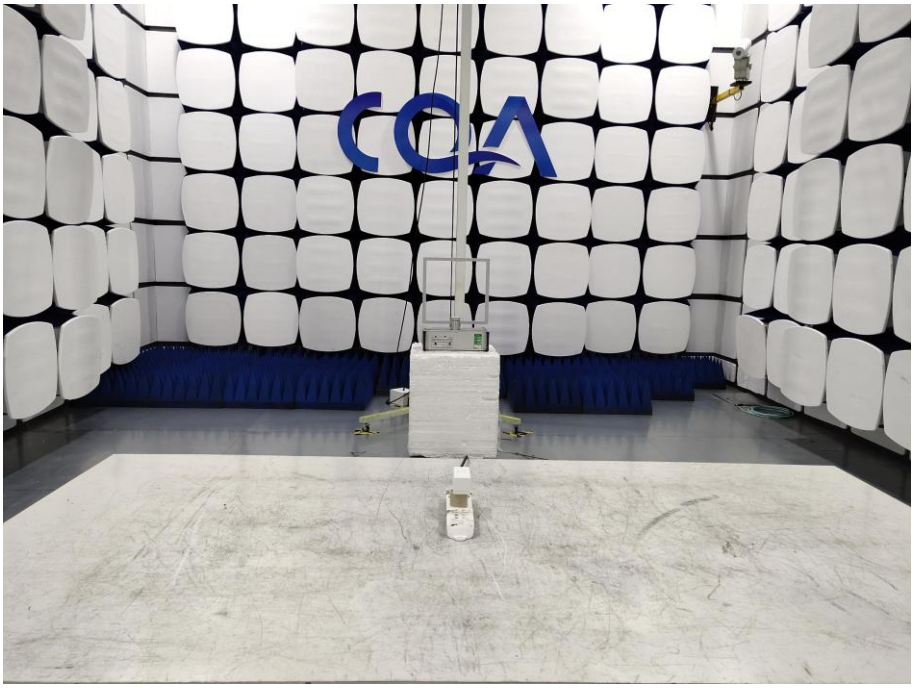
	Freq. (MHz)	Ant. Factor (dB/m)	Cable Loss (dB)	Amp Factor (dB)	Reading (dBuV)	Emission Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Remark
1	2464.72	27.58	6.69	34.98	83.66	82.95	74.00	-8.95	Peak
2	2483.50	27.58	6.71	35.11	47.51	46.69	74.00	27.31	Peak
3	2483.92	27.58	6.71	35.11	53.94	53.12	74.00	20.88	Peak
4	2488.30	27.58	6.73	35.11	42.01	41.21	74.00	32.79	Peak

Remarks: 1. Emission Level= Antenna Factor + Cable Loss - Amp Factor + Reading.
2. The emission levels that are 20dB below the official limit are not reported.

6 Photographs - EUT Test Setup

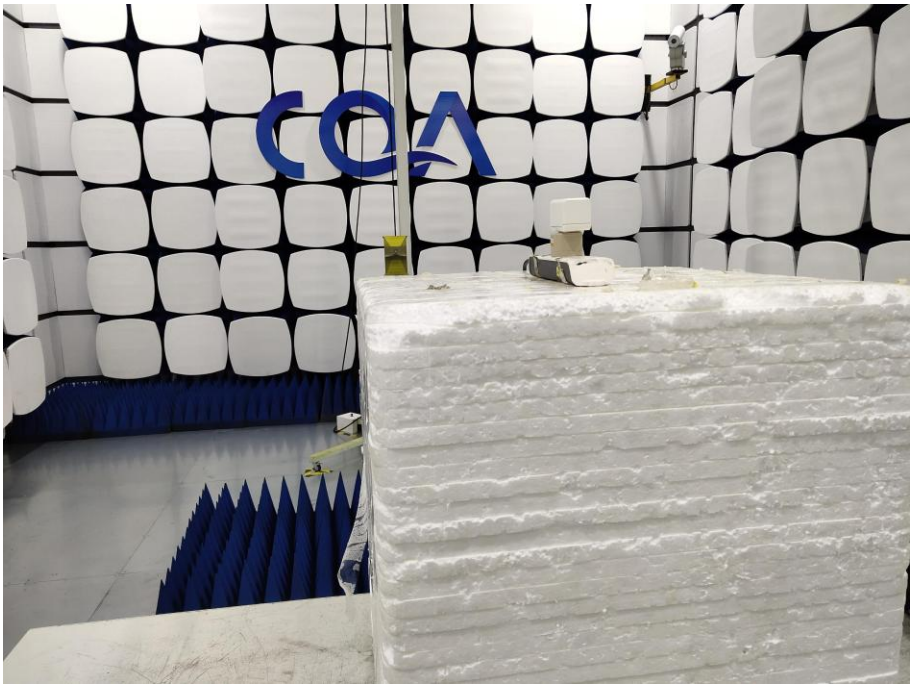
6.1 Radiated Spurious Emission

9KHz~30MHz:



30MHz~1GHz:

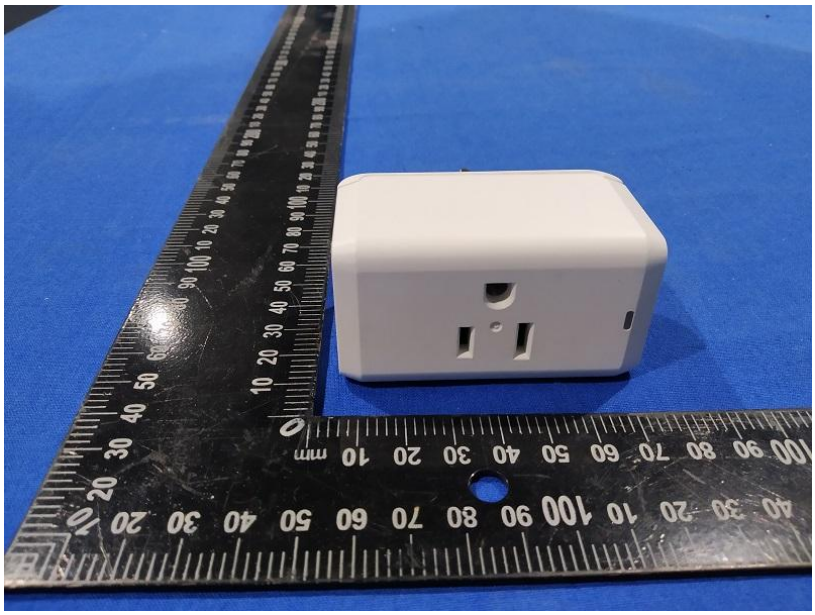
Above 1GHz:

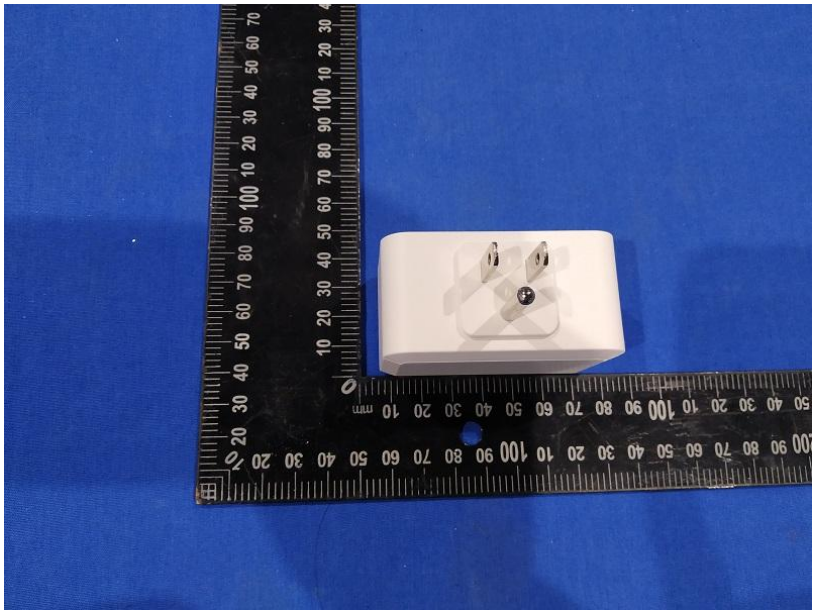


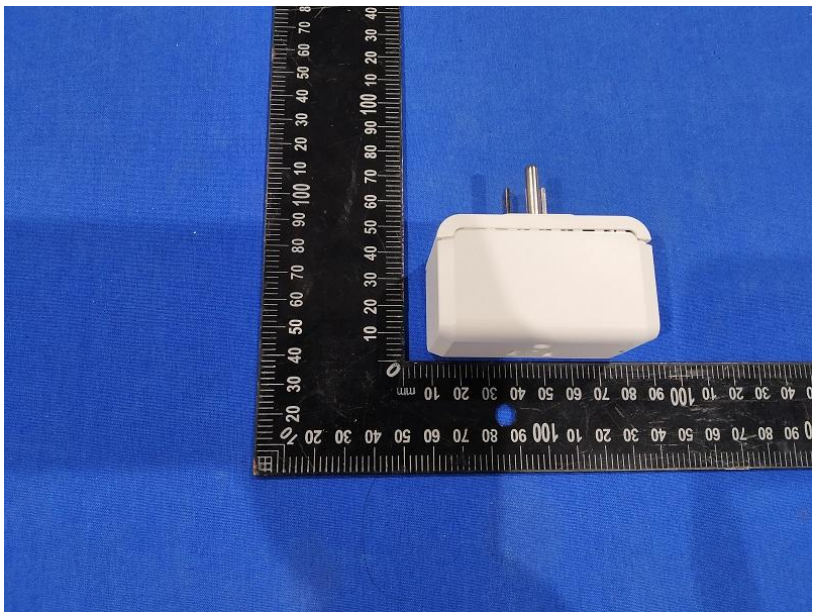
6.2 Conducted Emission

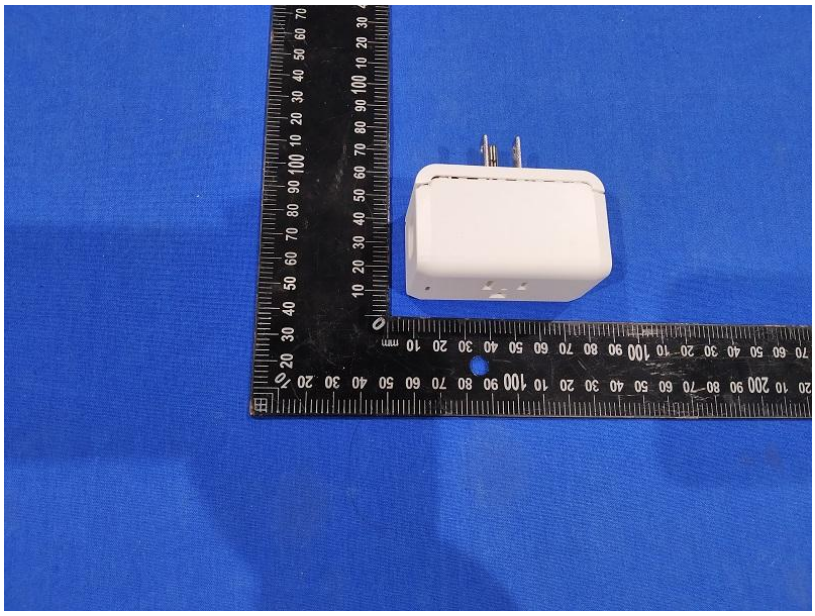
7 Photographs - EUT Constructional Details

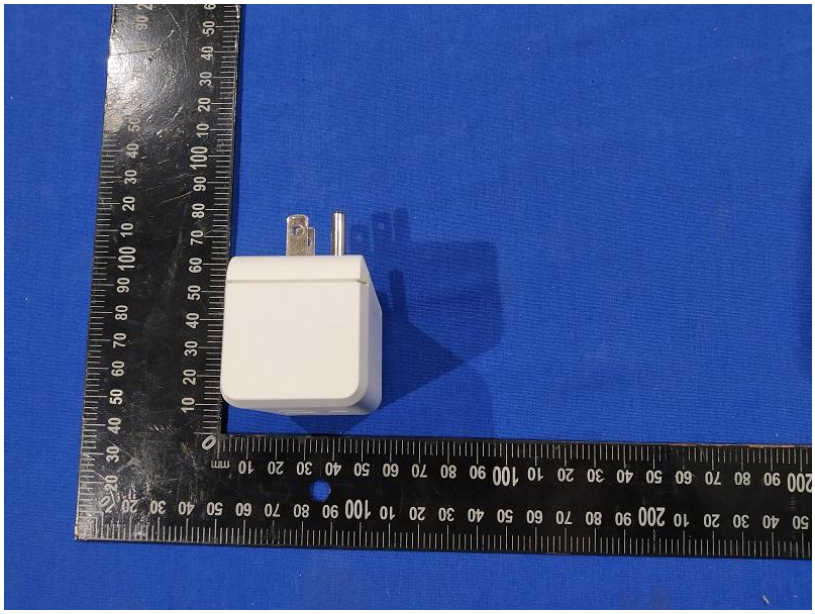
Test model No.: MK110

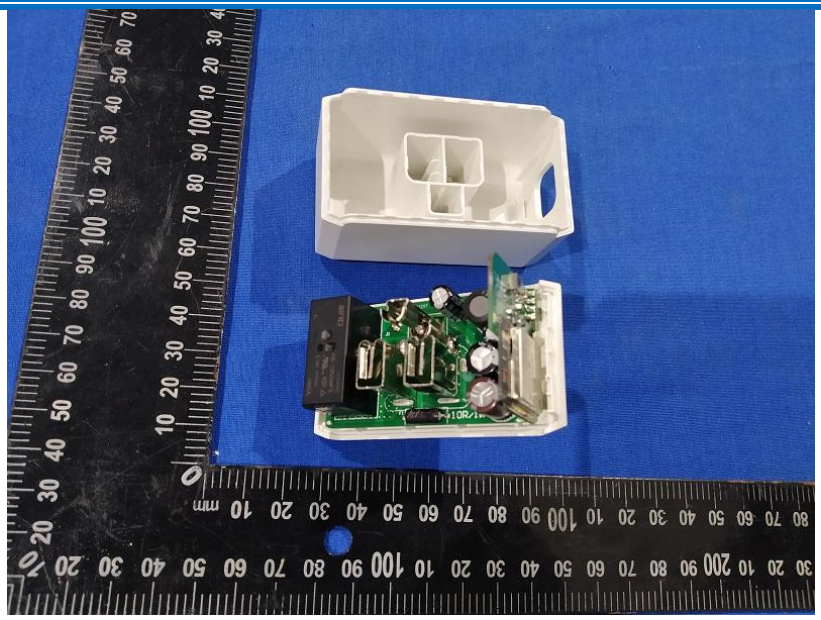


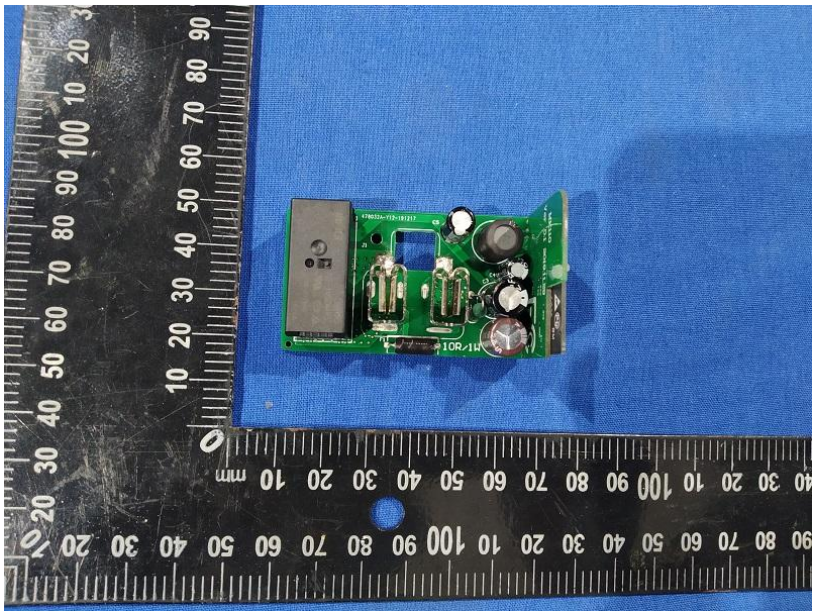


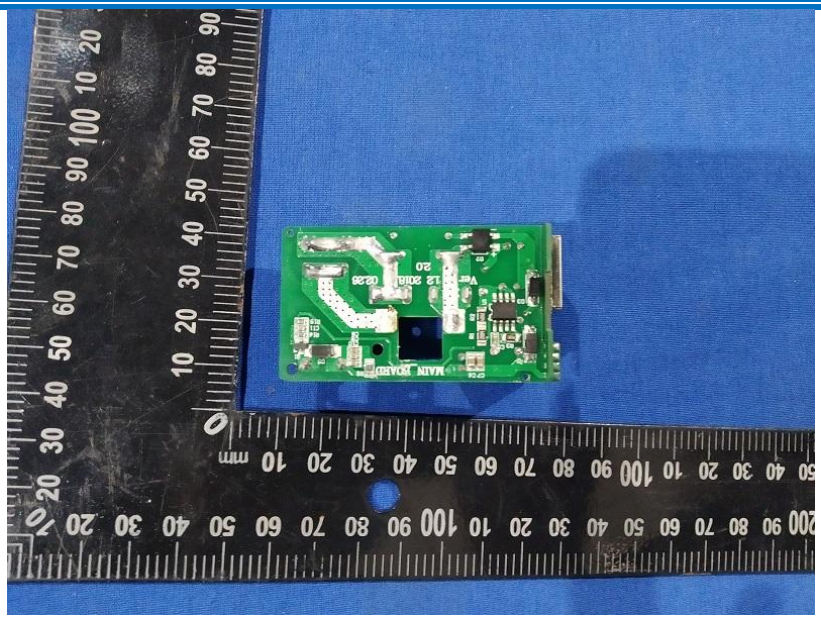


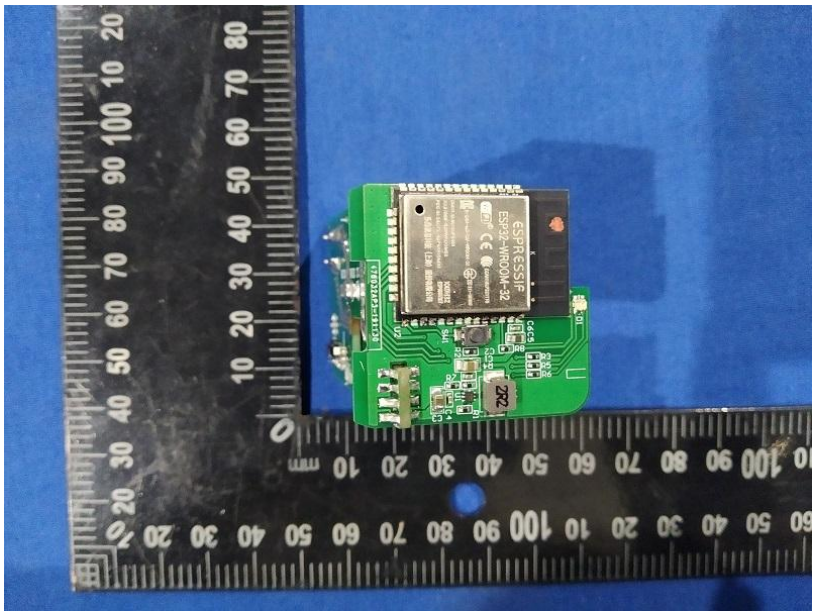


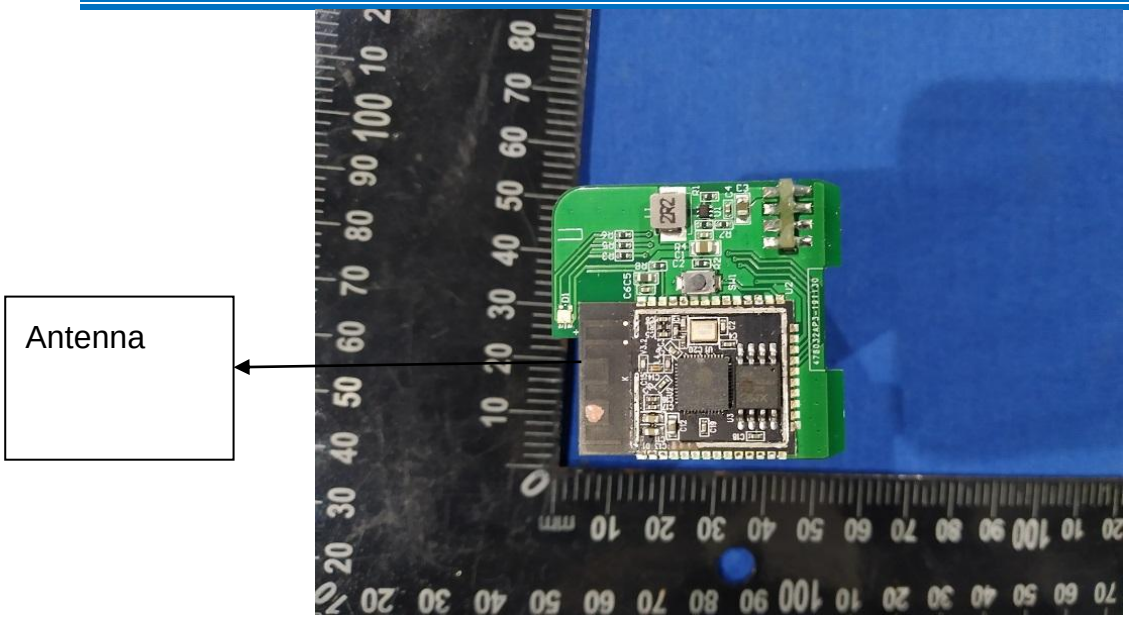









ESPRESSIF
ESP32-WROOM-32



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