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FCC 47 CFR PART 15 SUBPART C
CERTIFICATION TEST REPORT

For

4-gang Wi-Fi Smart Switch

MODEL No.: 4CHR3

FCC ID: 2APN54CHR3

Trade Mark: SONOFF

REPORT NO:ES181127027W

ISSUE DATE: July 18, 2019

Prepared for

Shenzhen Sonoff Technologies Co.,Ltd.
Building 8, Room 1001, Lianhua industrial park, Longyuan Road, Hualian community, Longhua St, Longhua dist, Shenzhen, Guangdong, China.

Prepared by

EMTEK(SHENZHEN) CO., LTD.
Bldg 69, Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China
TEL: 86-755-26954280
FAX: 86-755-26954282

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1 TEST RESULT CERTIFICATION

Applicant:	Shenzhen Sonoff Technologies Co.,Ltd. Building 8, Room 1001, Lianhua industrial park, Longyuan Road, Hualian community, Longhua St, Longhua dist, Shenzhen, Guangdong, China.
Manufacturer:	Shenzhen Sonoff Technologies Co.,Ltd. Building 8, Room 1001, Lianhua industrial park, Longyuan Road, Hualian community, Longhua St, Longhua dist, Shenzhen, Guangdong, China.
Product Description:	4-gang Wi-Fi Smart Switch
Model Number:	4CHR3
Trade Mark:	SONOFF
File Number:	ES181127027W

Measurement Procedure Used:

APPLICABLE STANDARDS	
STANDARD	**TEST RESULT**
FCC 47 CFR Part 2 2018, Subpart J FCC 47 CFR Part 15 2018, Subpart C	PASS

The above equipment was tested by EMTEK(SHENZHEN) CO., LTD. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10 (2013) and the energy emitted by the sample EUT tested as described in this report is in compliance with the requirements of FCC Rules Part 2 2018 and Part 15.247 2018
The test results of this report relate only to the tested sample identified in this report.

Date of Test : November 27, 2018 to July 18, 2019

Prepared by: Yaping Shen/Editor

Reviewer: Sevin Li /Supervisor

EMTEK (SHENZHEN) CO., LTD. TESTING

Approve & Authorized Signer : Lisa Wang/Manager

2 EUT TECHNICAL DESCRIPTION

Characteristics	Description
IEEE 802.11 WLAN Mode Supported	☒802.11b ☒802.11g ☒802.11n(20MHz channel bandwidth)
Data Rate	☒802.11 b:1,2,5.5,11Mbps; ☒802.11 g:6,9,12,18,24,36,48,54Mbps; ☒802.11n(HT20):MCS0-MCS7;
Modulation	DSSS with DBPSK/DQPSK/CCK for 802.11b; OFDM with BPSK/QPSK/16QAM/64QAM for 802.11g/n;
Operating Frequency Range	☒2412-2462MHz for 802.11b/g; ☒2412-2462MHz for 802.11n(HT20);
Number of Channels	☒11 channels for 802.11b/g; ☒11 channels for 802.11n(HT20);
Transmit Power Max	16.39dBm
Antenna Type	PCB antenna
Max Antenna Gain	1 dBi
Smart system	☒SISO for 802.11b/g/n
Power supply:	Input: AC100-240V 16A MAX Output: AC 100-240 10A/Gang 16A Total

3 SUMMARY OF TEST RESULT

FCC PartClause	Test Parameter	Verdict	Remark
15.247(a)(2)	DTS (6dB) Bandwidth	PASS	
15.247(b)(3)	Maximum Peak Conducted Output Power	PASS	
15.247(e)	Maximum Power Spectral Density Level	PASS	
15.247(d)	Unwanted Emission Into Non-Restricted Frequency Bands	PASS	
15.247(d) 15.209	Unwanted Emission Into Restricted Frequency Bands (conducted)	PASS	
15.247(d) 15.209	Radiated Spurious Emission	PASS	
15.207	Conducted EmissionTest	PASS	
15.203	Antenna Application	PASS	
	NOTE1:N/A (Not Applicable) NOTE2:According to FCC OET KDB 558074, the report use radiated measurements in the restricted frequency bands. In addition, the radiated test is also performed to ensure the emissions emanating from the device cabinet also comply with the applicable limits.		

RELATED SUBMITTAL(S) / GRANT(S):

This submittal(s) (test report) is intended for FCC ID: 2APN54CHR3 filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

4 TEST METHODOLOGY

4.1 GENERAL DESCRIPTION OF APPLIED STANDARDS

According to its specifications, the EUT must comply with the requirements of the following standards:
FCC 47 CFR Part 2, Subpart J
FCC 47 CFR Part 15, Subpart C
FCC KDB 558074 D01 DTS Meas Guidance v05r02
FCC KDB 662911 D01 Multiple Transmitter Output v02r01
FCC KDB 662911 D02MIMO With Cross Polarized Antenna V01

4.2 MEASUREMENT EQUIPMENT USED

4.2.1 Conducted Emission Test Equipment

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LASTCAL.	DUE CAL.
Test Receiver	Rohde & Schwarz	ESCI	26115-010-0027	May 18, 2019	May 17, 2020
L.I.S.N.	Rohde & Schwarz	ENV216	101161	May 18, 2019	May 17, 2020
50Ω Coaxial Switch	Anritsu	MP59B	6100175589	May 18, 2019	May 17, 2020

4.2.2 Radiated Emission Test Equipment

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	DUE CAL.
EMI Test Receiver	Rohde & Schwarz	ESU	1302.6005.26	May 18, 2019	May 17, 2020
Pre-Amplifier	HP	8447F	2944A07999	May 18, 2019	May 17, 2020
Bilog Antenna	Schwarzbeck	VULB9163	142	May 18, 2019	May 17, 2020
Loop Antenna	ARA	PLA-1030/B	1029	May 18, 2019	May 17, 2020
Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170399	May 18, 2019	May 17, 2020
Horn Antenna	Schwarzbeck	BBHA 9120	D143	May 18, 2019	May 17, 2020
Cable	Schwarzbeck	AK9513	ACRX1	May 18, 2019	May 17, 2020
Cable	Rosenberger	N/A	FP2RX2	May 18, 2019	May 17, 2020
Cable	Schwarzbeck	AK9513	CRPX1	May 18, 2019	May 17, 2020
Cable	Schwarzbeck	AK9513	CRRX2	May 18, 2019	May 17, 2020

4.2.3 Radio Frequency Test Equipment

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LASTCAL.	DUE CAL.
Spectrum Analyzer	Agilent	E4407B	88156318	May 18, 2019	May 17, 2020
Signal Analyzer	Agilent	N9010A	My53470879	May 18, 2019	May 17, 2020
Power meter	Anritsu	ML2495A	0824006	May 18, 2019	May 17, 2020
Power sensor	Anritsu	MA2411B	0738172	May 18, 2019	May 17, 2020

Remark: *Each piece of equipment is scheduled for calibration once a year.*

4.3 DESCRIPTION OF TEST MODES

The EUT has been tested under its typical operating condition.
The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

The Transmitter was operated in the normal operating mode. The TX frequency was fixed which was for the purpose of the measurements.

Test of channel included the lowest and middle and highest frequency to perform the test, then record on this report.

Those data rates (802.11b: 1 Mbps; 802.11g: 6 Mbps; 802.11n(HT20)) were used for all test.

Pre-defined engineering program for regulatory testing used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

Frequency and Channel list for 802.11 b/g/n(HT20):

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

Test Frequency and Channel for 802.11 b/g/n (HT20):

Lowest Frequency		Middle Frequency		Highest Frequency	
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	6	2437	11	2462

5 FACILITIES AND ACCREDITATIONS

5.1 FACILITIES

All measurement facilities used to collect the measurement data are located at

Bldg 69, Majialong Industry Zone District, Nanshan District, Shenzhen, China
The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.10 and CISPR Publication 22.

5.2 LABORATORY ACCREDITATIONS AND LISTINGS

Site Description

EMC Lab. : Accredited by CNAS, 2016.10.24
The certificate is valid until 2022.10.28
The Laboratory has been assessed and proved to be in compliance with CNAS-CL01: 2006(identical to ISO/IEC17025: 2005)
The Certificate Registration Number is L229

: Accredited by TUV Rheinland Shenzhen, 2016.5.19
The Laboratory has been assessed according to the requirements ISO/IEC 17025.

:
Accredited by FCC, August 06, 2018
The certificate is valid until August 07, 2020
Designation Number: CN1204
Test Firm Registration Number: 882943

: Accredited by Industry Canada, November 09, 2018
The Conformity Assessment Body Identifier is CN0008.

6 TEST SYSTEM UNCERTAINTY

The following measurement uncertainty levels have been estimated for tests performed on the apparatus:

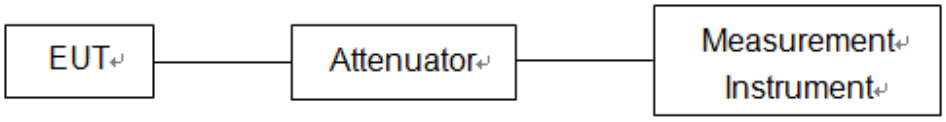
Parameter	Uncertainty
Radio Frequency	±1x10^-5
Maximum Peak Output Power Test	±1.0dB
Conducted Emissions Test	±2.0dB
Radiated Emission Test	±2.0dB
Power Density	±2.0dB
Occupied Bandwidth Test	±1.0dB
Band Edge Test	±3dB
All emission, radiated	±3dB
Antenna Port Emission	±3dB
Temperature	±0.5℃
Humidity	±3%

Measurement Uncertainty for a level of Confidence of 95%

7 SETUP OF EQUIPMENT UNDER TEST

7.1 RADIO FREQUENCY TEST SETUP 1

The WLAN component's antenna ports(s) of the EUT are connected to the measurement instrument per an appropriate attenuator. The EUT is controlled by PC/software to emit the specified signals for the purpose of measurements.



7.2 RADIO FREQUENCY TEST SETUP 2

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4 dB according to the standards: ANSI C63.10. The test distance is 3m.The setup is according to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 and CAN/CSA-CEI/IEC CISPR 22.

Below 30MHz：

The EUT is placed on a turntable 0.8 meters above the ground in the chamber, 3 meter away from the antenna (loop antenna). The Antenna should be positioned with its plane vertical at the specified distance from the EUT androtated about its vertical axis formaximum response at each azimuth about the EUT. The center of the loopshall be 1 m above the ground.For certain applications, the loop antennaplane may also need to be positioned horizontally at the specified distance from the EUT.

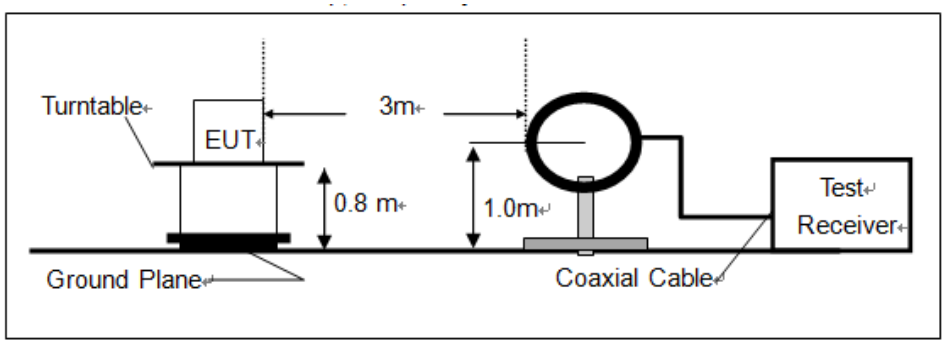
30MHz-1GHz：

The EUT is placed on a turntable 0.8 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).

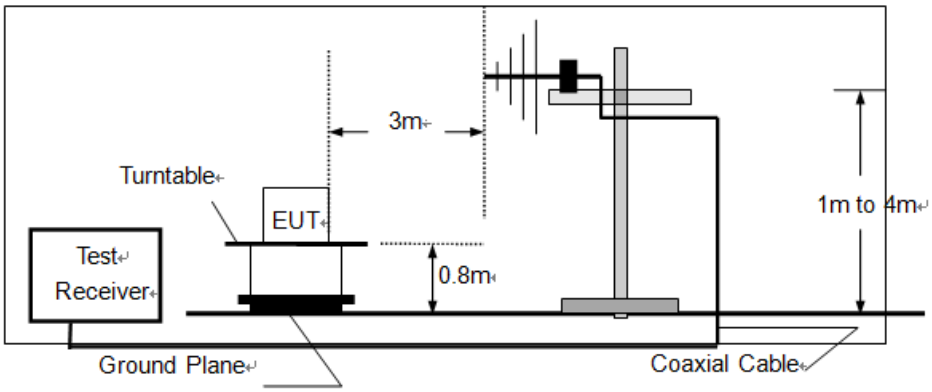
Above 1GHz：

The EUT is placed on a turntable 1.5 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).

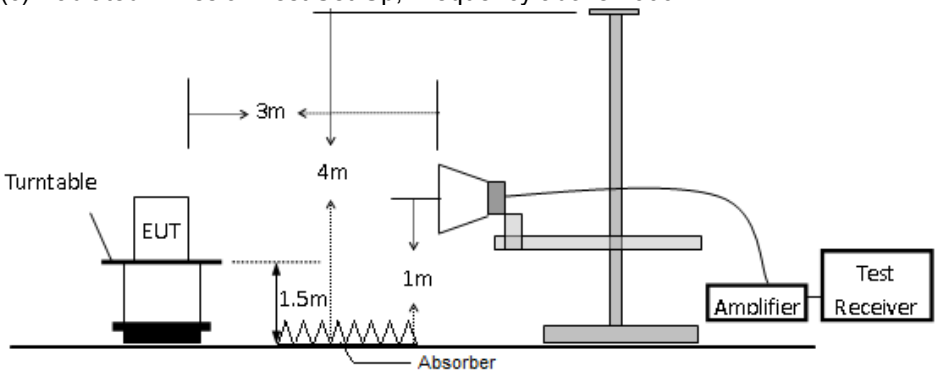
(a) Radiated Emission Test Set-Up, Frequency Below 30MHz



(b)Radiated Emission Test Set-Up, Frequency Below 1000MHz



(c) Radiated Emission Test Set-Up, Frequency above 1000MHz

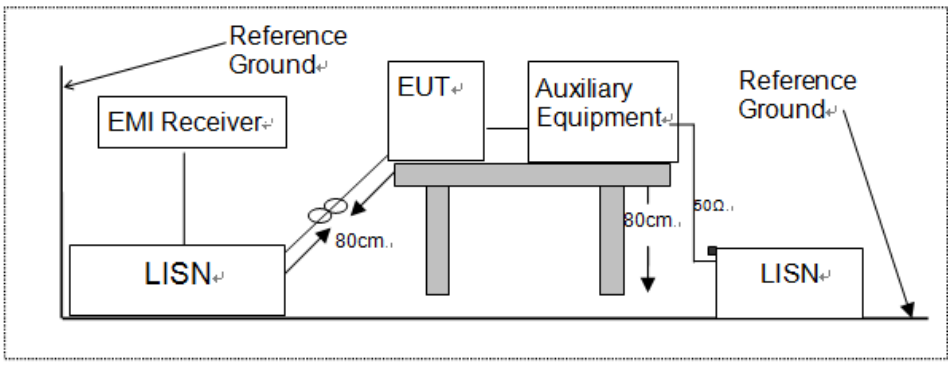


7.3 CONDUCTED EMISSION TEST SETUP

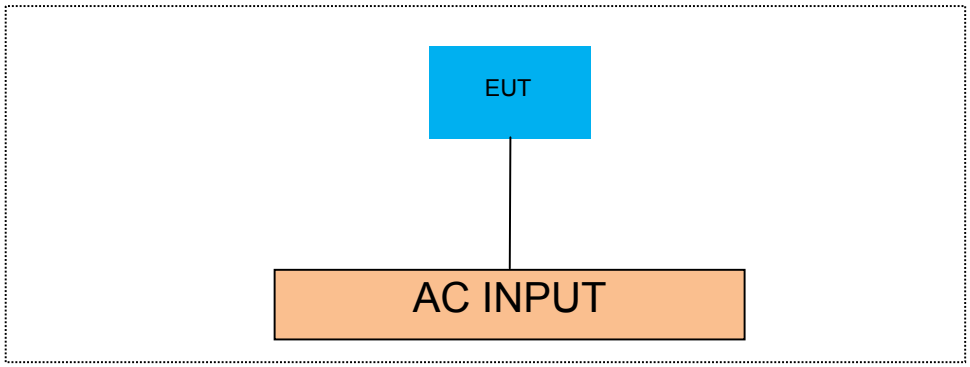
The mains cable of the EUT (maybe per AC/DC Adapter) must be connected to LISN. The LISN shall be placed 0.8 m from the boundary of EUT and bonded to a ground reference plane for LISN mounted on top of the ground reference plane. This distance is between the closest points of the LISN and the EUT. All other units of the EUT and associated equipment shall be at least 0.8m from the LISN.

Ground connections, where required for safety purposes, shall be connected to the reference ground point of the LISN and, where not otherwise provided or specified by the manufacturer, shall be of same length as the mains cable and run parallel to the mains connection at a separation distance of not more than 0.1 m.

According to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-Peak and average detector mode.



7.4 BLOCK DIAGRAM CONFIGURATION OF TEST SYSTEM



7.5 SUPPORT EQUIPMENT

Item	Equipment	Mfr/Brand	Model/Type No.	FCC ID	Series No.	Note
N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

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.*

8 TEST REQUIREMENTS

8.1 DTS(6DB)BANDWIDTH

8.1.1 Applicable Standard

According to FCC Part15.247(a)(2) and KDB558074 DTS 01 Meas. Guidance v05r02

8.1.2 Conformance Limit

The minimum -6 dB bandwidth shall be at least 500 kHz.

8.1.3 Test Configuration

Test according to clause 7.1 radio frequency test setup 1

8.1.4 Test Procedure

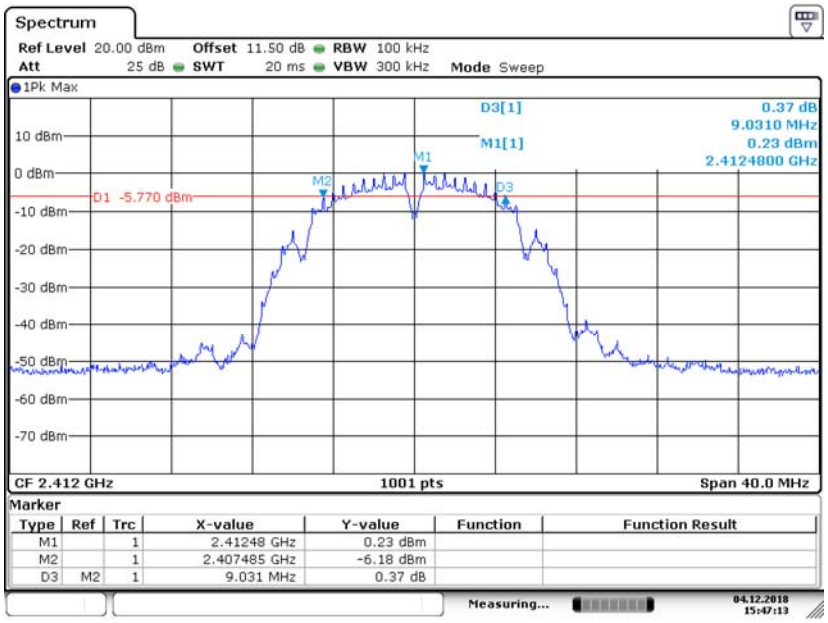
The EUT was operating in IEEE 802.11b/g/n mode and controlled its channel. Printed out the test result from the spectrum by hard copy function.
The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
Set to the maximum power setting and enable the EUT transmit continuously
Set RBW = 100 kHz.
Set the video bandwidth (VBW) =300kHz.
Set Span=2 times OBW
Set Detector = Peak.
Set Trace mode = max hold.
Set Sweep = auto couple.
Allow the trace to stabilize.
Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.
Measure and record the results in the test report.

8.1.5 Test Results

Temperature :	26℃	Test Date :	Dec. 04, 2018
Humidity :	60 %	Test By:	King Kong

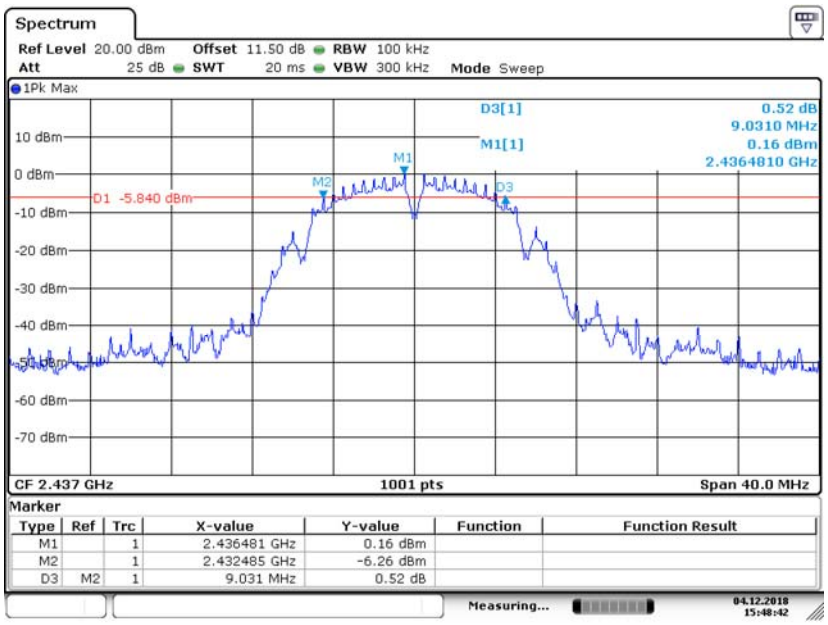
Operation Mode	Channel Number	Channel Frequency (MHz)	Measurement Bandwidth (MHz)	Limit (kHz)	Verdict
802.11b	1	2412	9.031	>500	PASS
	6	2437	9.301	>500	PASS
	11	2462	9.031	>500	PASS
802.11g	1	2412	16.304	>500	PASS
	6	2437	16.304	>500	PASS
	11	2462	16.304	>500	PASS
802.11n (HT20)	1	2412	15.944	>500	PASS
	6	2437	16.304	>500	PASS
	11	2462	16.543	>500	PASS

Test Model	DTS (6dB) Bandwidth 802.11b Channel 1: 2412MHz



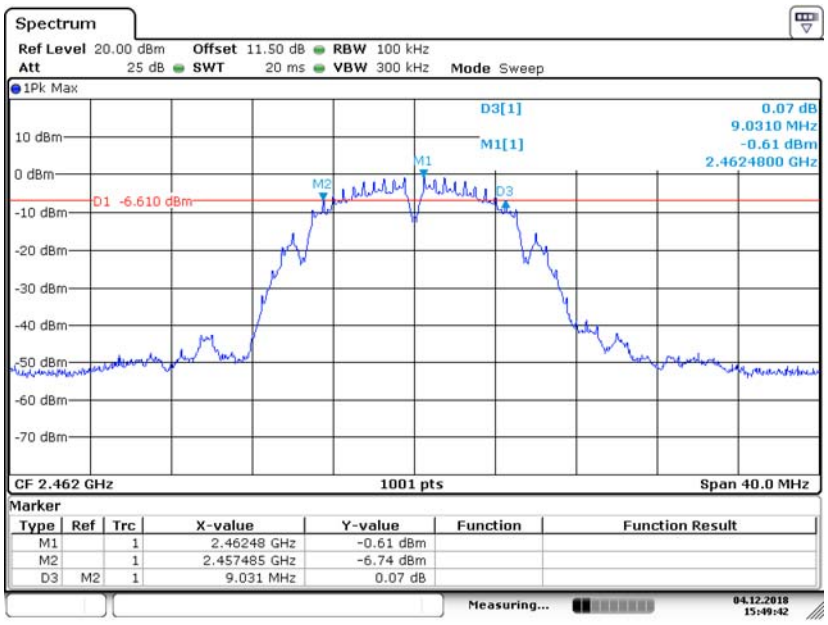
Date: 4.DEC.2018 15:47:13

Test Model	DTS (6dB) Bandwidth 802.11b Channel 6: 2437MHz



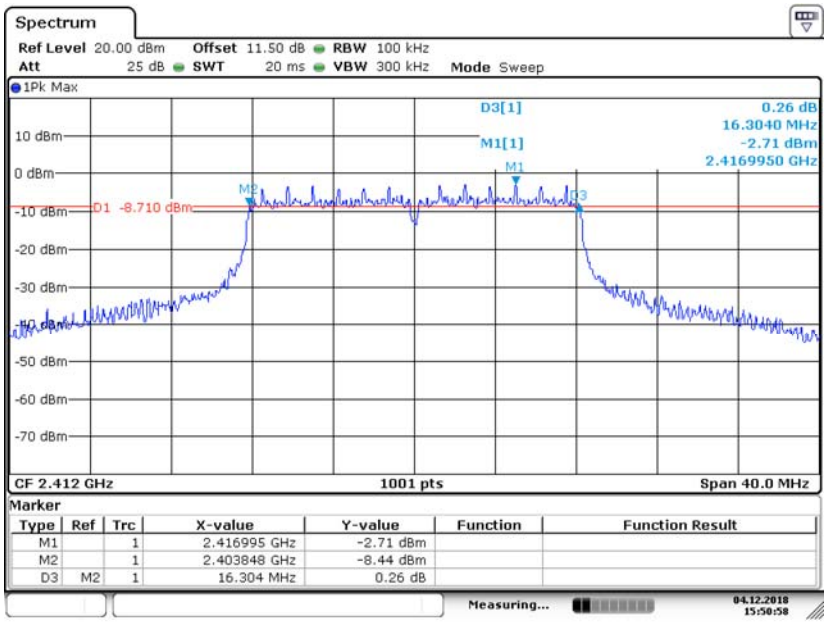
Date: 4.DEC.2018 15:48:42

Test Model	DTS (6dB) Bandwidth 802.11b Channel 11: 2462MHz



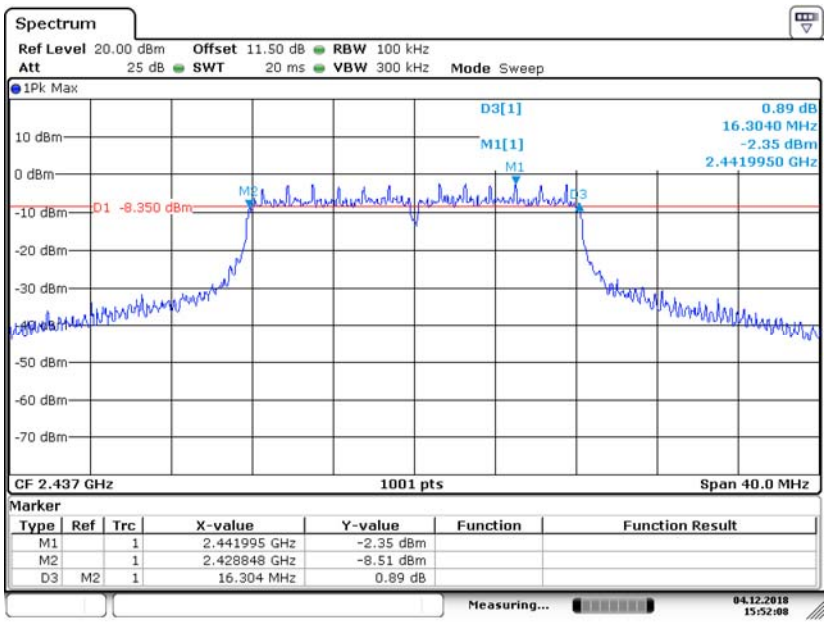
Date: 4.DEC.2018 15:49:41

Test Model	DTS (6dB) Bandwidth 802.11g Channel 1: 2412MHz



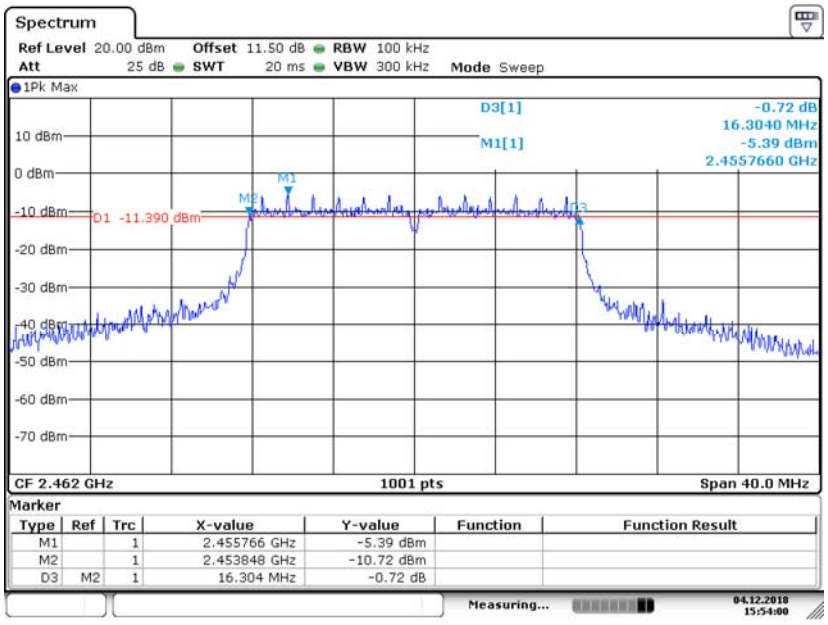
Date: 4.DEC.2018 15:50:57

Test Model	DTS (6dB) Bandwidth 802.11g Channel 6: 2437MHz



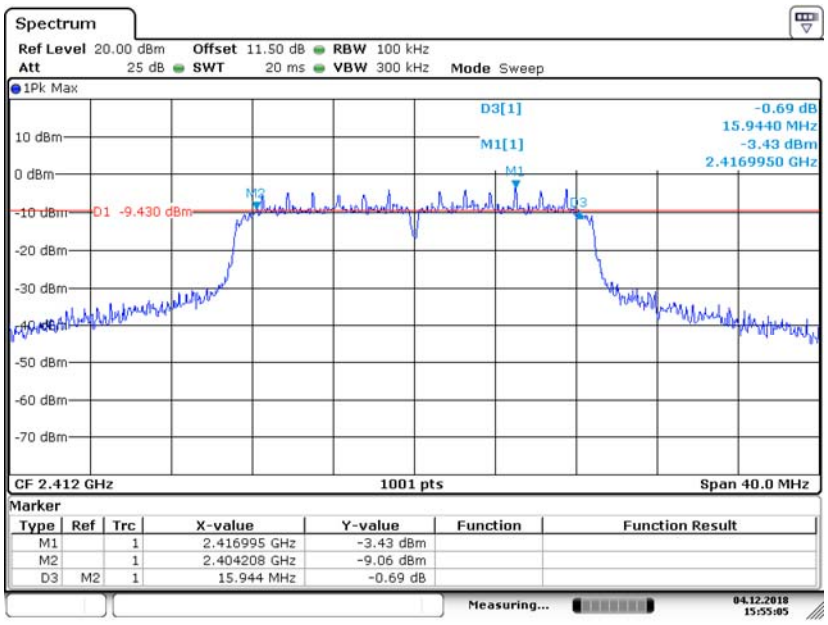
Date: 4.DEC.2018 15:52:07

Test Model	DTS (6dB) Bandwidth 802.11g Channel 11: 2462MHz



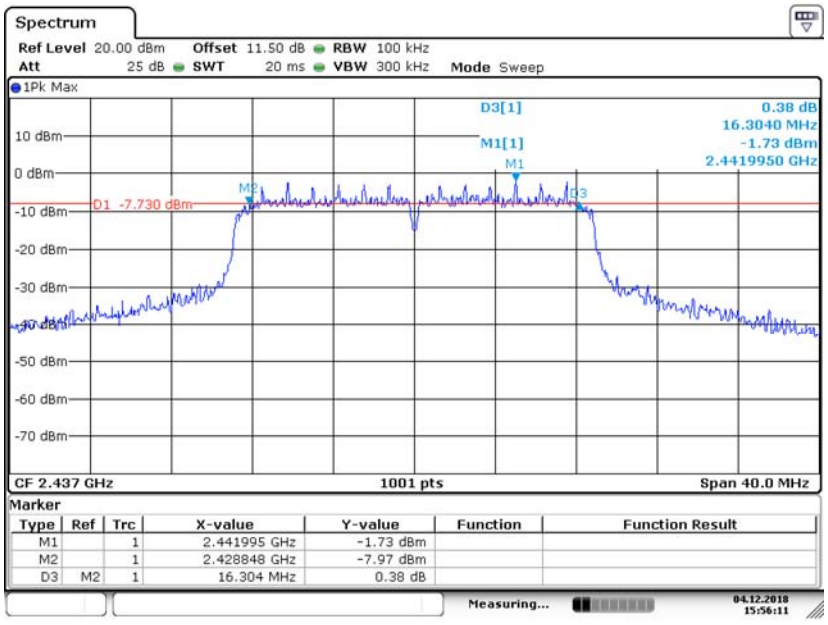
Date: 4.DEC.2018 15:54:00

Test Model	DTS (6dB) Bandwidth 802.11n (HT20) Channel 1: 2412MHz



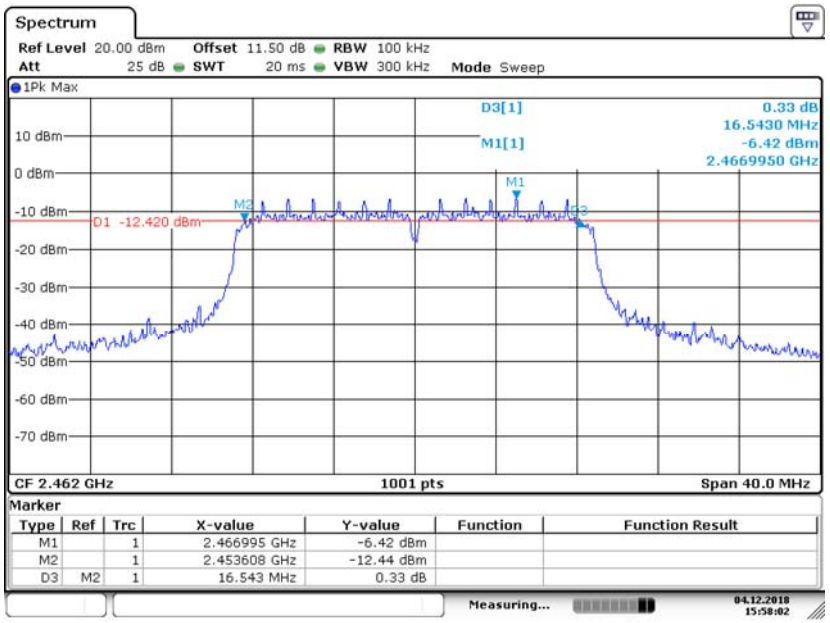
Date: 4.DEC.2018 15:55:05

Test Model	DTS (6dB) Bandwidth 802.11n (HT20) Channel 6: 2437MHz



Date: 4.DEC.2018 15:56:11

Test Model	DTS (6dB) Bandwidth 802.11n (HT20) Channel 11: 2462MHz



Date: 4.DEC.2018 15:58:01

8.2 MAXIMUM PEAK CONDUCTED OUTPUT POWER

8.2.1 Applicable Standard

According to FCC Part15.247(b)(3) and KDB558074 DTS 01 Meas. Guidance v05r02

8.2.2 Conformance Limit

FCC:
The maximum peak conducted output power of the intentional radiator for systems using digital modulation in the 2400 - 2483.5 MHz bands shall not exceed: 1 Watt (30dBm).

8.2.3 Test Configuration

Test according to clause 7.1 radio frequency test setup 1

8.2.4 Test Procedure

- According to FCC Part15.247(b)(3)

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.
The RF output of EUT was connected to the power meter by RF cable and attnuator. The path loss was compensated to the results for each measurement.
Set to the maximum output power setting and enable the EUT transmit continuously.
Measure the conducted output power with cable loss and record the results in the test report.
Measure and record the results in the report.

- According to FCC Part 15.247(b)(4):

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. 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)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
Note: If antenna Gain exceeds 6 dBi, then Output power Limit=30-(Gain- 6)

8.2.5 Test Results

Temperature : 26℃ Test Date : Dec. 04, 2018
Humidity : 60 % Test By: King Kong

Operation Mode	Channel Number	Channel Frequency (MHz)	Measurement Level (dBm)	Limit (dBm)	Verdict
802.11b	1	2412	12.87	30	PASS
	6	2437	12.44	30	PASS
	11	2462	11.52	30	PASS
802.11g	1	2412	15.52	30	PASS
	6	2437	**16.39**	30	PASS
	11	2462	14.06	30	PASS
802.11n (HT20)	1	2412	15.27	30	PASS
	6	2437	15.70	30	PASS
	11	2462	13.41	30	PASS

8.3 MAXIMUM POWER SPECTRAL DENSITY

8.3.1 Applicable Standard

According to FCC Part15.247(e) and KDB558074 DTS 01 Meas. Guidance v05r02

8.3.2 Conformance Limit

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

8.3.3 Test Configuration

Test according to clause 7.1 radio frequency test setup 1

8.3.4 Test Procedure

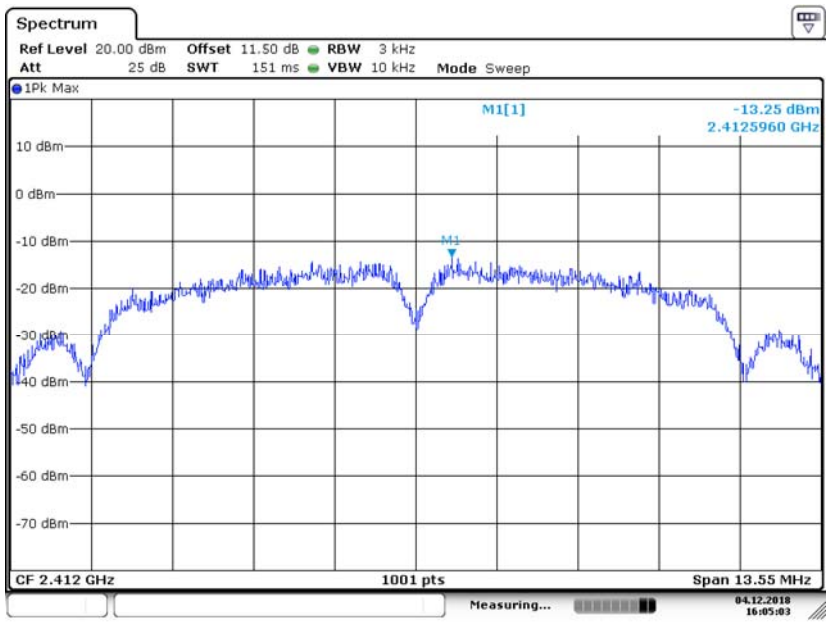
This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance
The transmitter output (antenna port) was connected to the spectrum analyzer
Set analyzer center frequency to DTS channel center frequency.
Set the span to 1.5 times the DTS bandwidth.
Set the RBW to: 3 kHz
Set the VBW to:10 kHz.
Set Detector = peak.
Set Sweep time = auto couple.
Set Trace mode = max hold.
Allow trace to fully stabilize.
Use the peak marker function to determine the maximum amplitude level within the RBW.
Note: If antenna Gain exceeds 6 dBi, then PSD Limit=8-(Gain- 6)

8.3.5 Test Results

Temperature :	26℃	Test Date :	Dec. 04, 2018
Humidity :	60 %	Test By:	King Kong

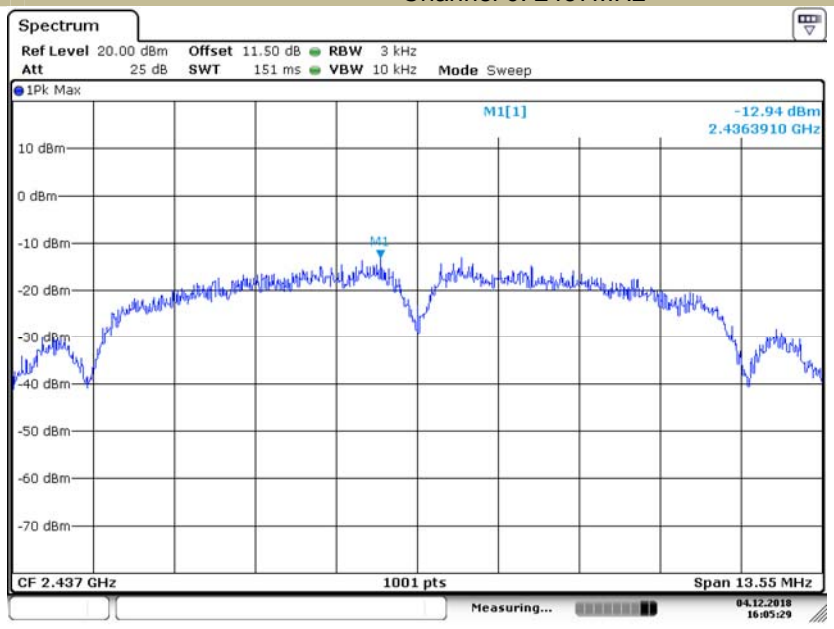
Operation Mode	Channel Number	Channel Frequency (MHz)	Measurement Level (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
802.11b	1	2412	-13.25	8	PASS
	6	2437	-12.94	8	PASS
	11	2462	-13.91	8	PASS
802.11g	1	2412	-18.49	8	PASS
	6	2437	-17.44	8	PASS
	11	2462	-19.46	8	PASS
802.11n (HT20)	1	2412	-18.98	8	PASS
	6	2437	-17.76	8	PASS
	11	2462	-19.97	8	PASS

Test Model	Power Spectral Density 802.11b Channel 1: 2412MHz



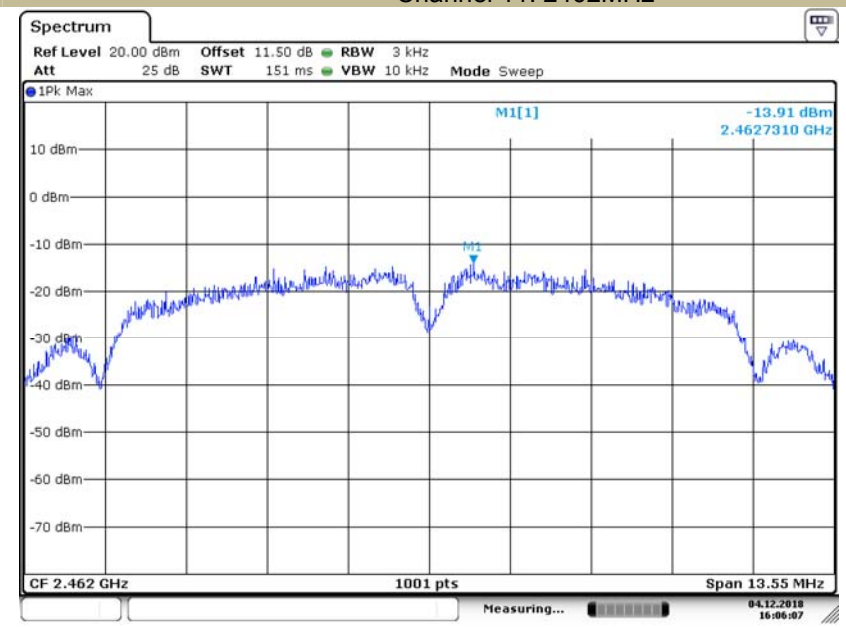
Date: 4.DEC.2018 16:05:02

Test Model	Power Spectral Density 802.11b Channel 6: 2437MHz



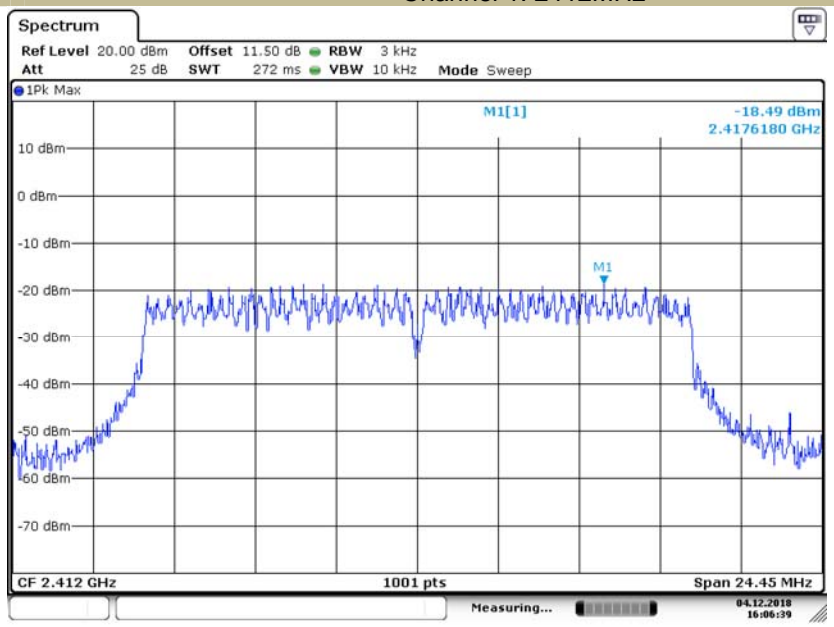
Date: 4.DEC.2018 16:05:29

Test Model	Power Spectral Density 802.11b Channel 11: 2462MHz



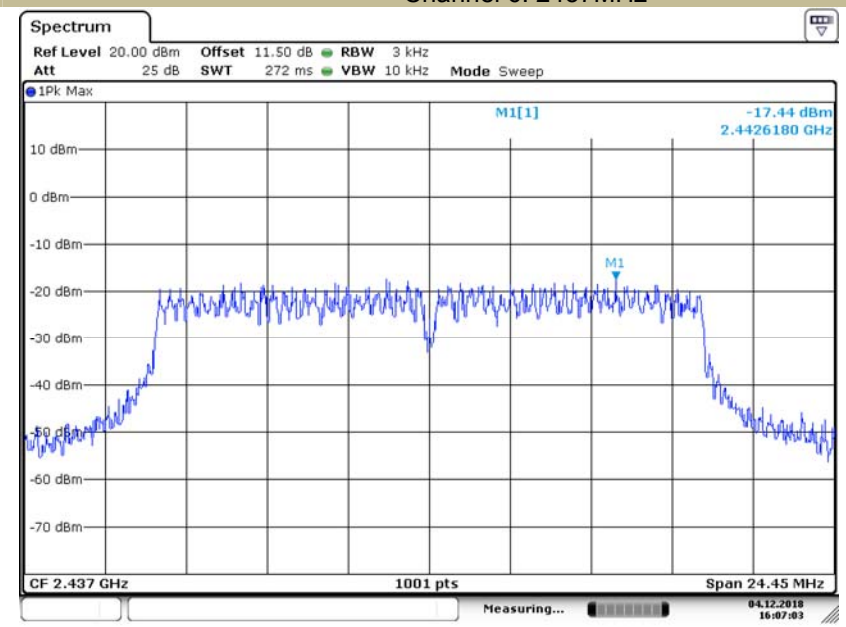
Date: 4.DEC.2018 16:06:06

Test Model	Power Spectral Density 802.11g Channel 1: 2412MHz



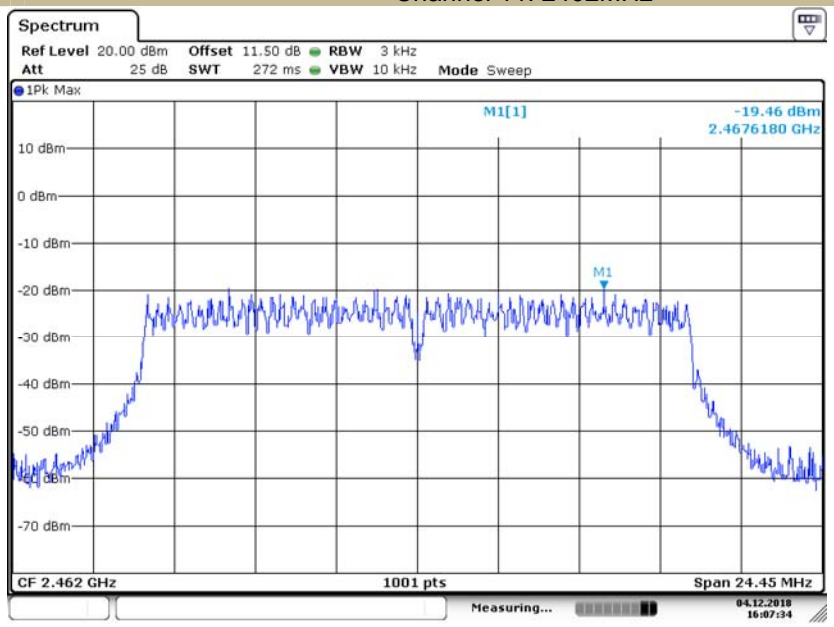
Date: 4.DEC.2018 16:06:39

Test Model	Power Spectral Density 802.11g Channel 6: 2437MHz



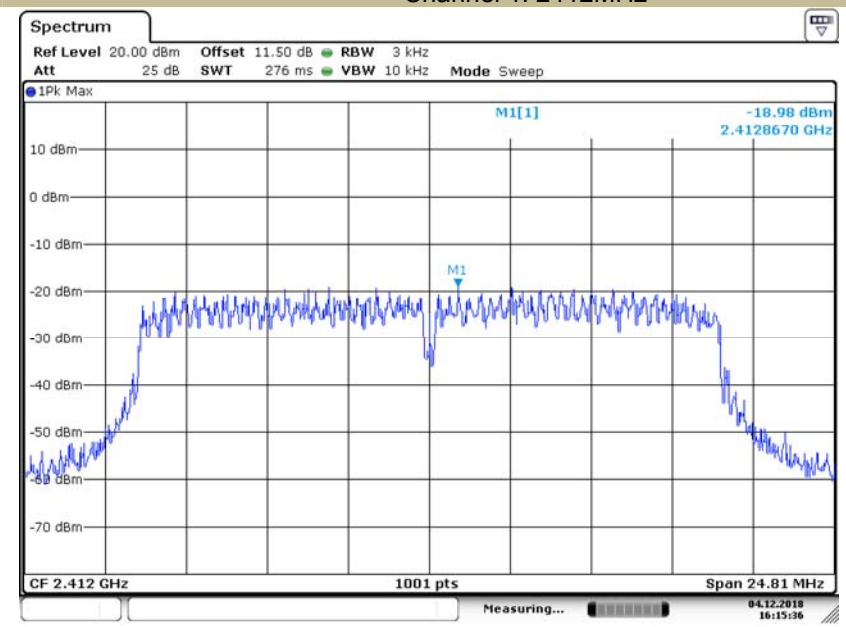
Date: 4.DEC.2018 16:07:02

Test Model	Power Spectral Density 802.11g Channel 11: 2462MHz



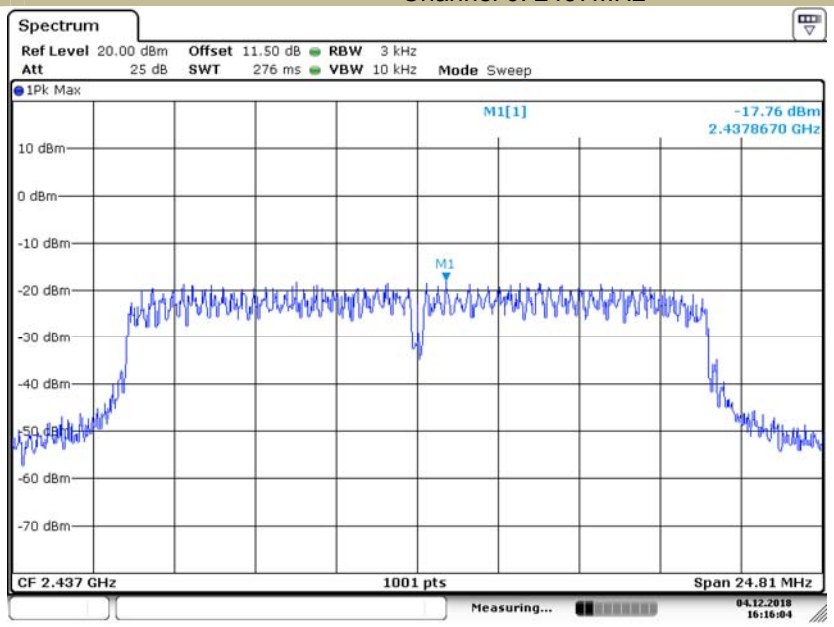
Date: 4.DEC.2018 16:07:33

Test Model	Power Spectral Density 802.11n (HT20) Channel 1: 2412MHz



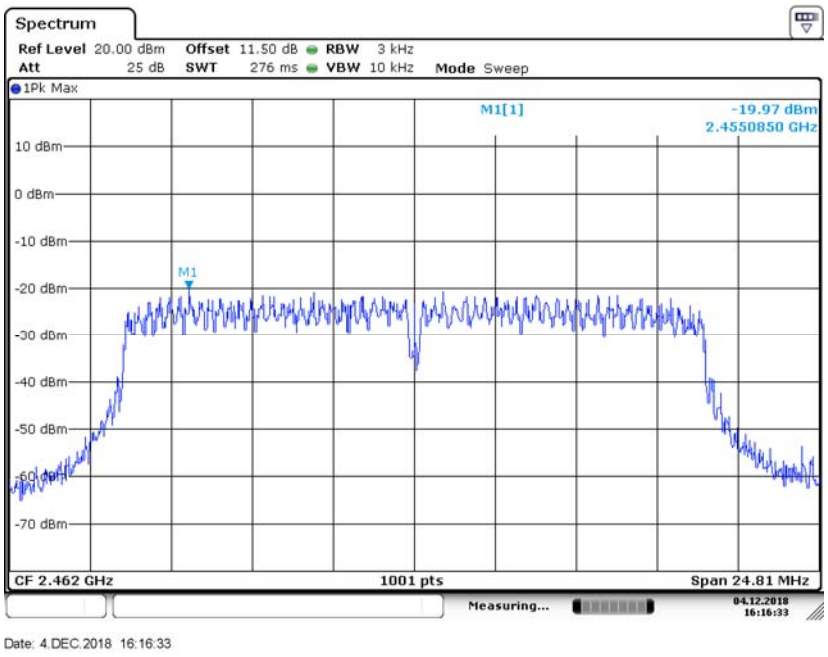
Date: 4.DEC.2018 16:15:36

Test Model	Power Spectral Density 802.11n (HT20) Channel 6: 2437MHz



Date: 4.DEC.2018 16:16:04

Test Model	Power Spectral Density 802.11n (HT20) Channel 11: 2462MHz



8.4 UNWANTED EMISSIONS IN NON-RESTRICTED FREQUENCY BANDS

8.4.1 Applicable Standard

According to FCC Part15.247(d) and KDB558074 DTS 01 Meas. Guidance v05r02

8.4.2 Conformance Limit

According to FCC Part 15.247(d):
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

8.4.3 Test Configuration

Test according to clause 7.1 radio frequency test setup 1

8.4.4 Test Procedure

The transmitter output (antenna port) was connected to the spectrum analyzer

- **Reference level measurement**

Establish a reference level by using the following procedure:
Set instrument center frequency to DTS channel center frequency.
Set the span to ≥ 1.5 times the DTS bandwidth.
Set the RBW = 100 kHz.
Set the VBW ≥ 3 x RBW.
Set Detector = peak.
Set Sweep time = auto couple.
Set Trace mode = max hold.
Allow trace to fully stabilize.
Use the peak marker function to determine the maximum PSD level.
Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

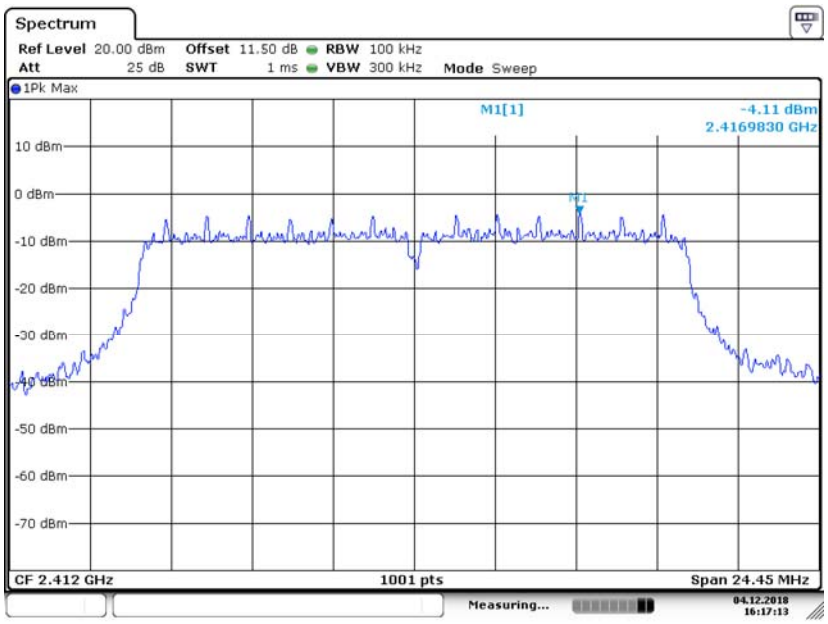
- **Emission level measurement**

Set the center frequency and span to encompass frequency range to be measured.
Set the RBW = 100 kHz.
Set the VBW =300 kHz.
Set Detector = peak
Sweep time = auto couple.
Trace mode = max hold.
Allow trace to fully stabilize.
Use the peak marker function to determine the maximum amplitude level.
Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements . Report the three highest emissions relative to the limit.

8.4.5 Test Results

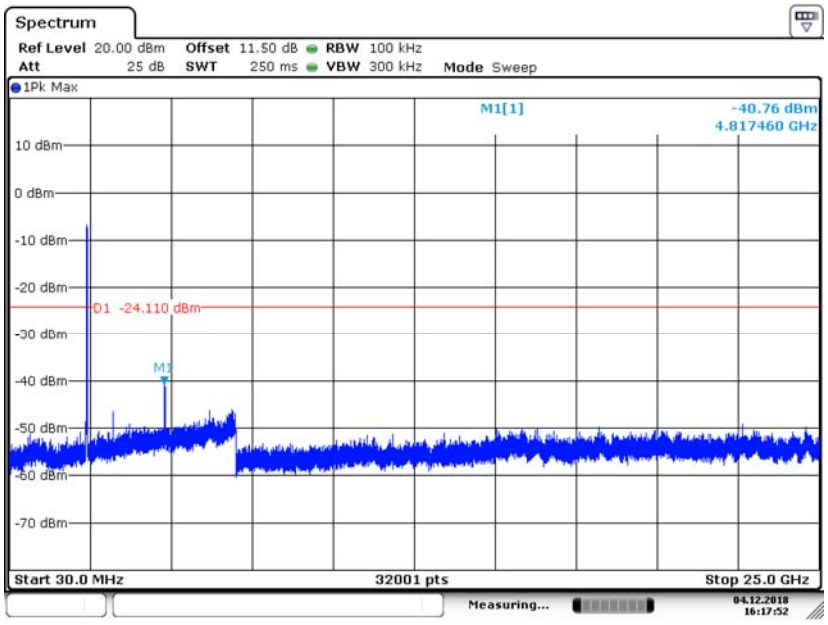
All modes 2.4G 802.11b/g/n have been tested, and the worst result 802.11g recorded was report as below:

Test Model	PSD(Power Spectral Density) RBW=100kHz ☐802.11b ☒802.11g ☐802.11n(HT20) ☐802.11n(HT40) ☒Channel 1: 2412MHz ☐Channel 3: 2422MHz



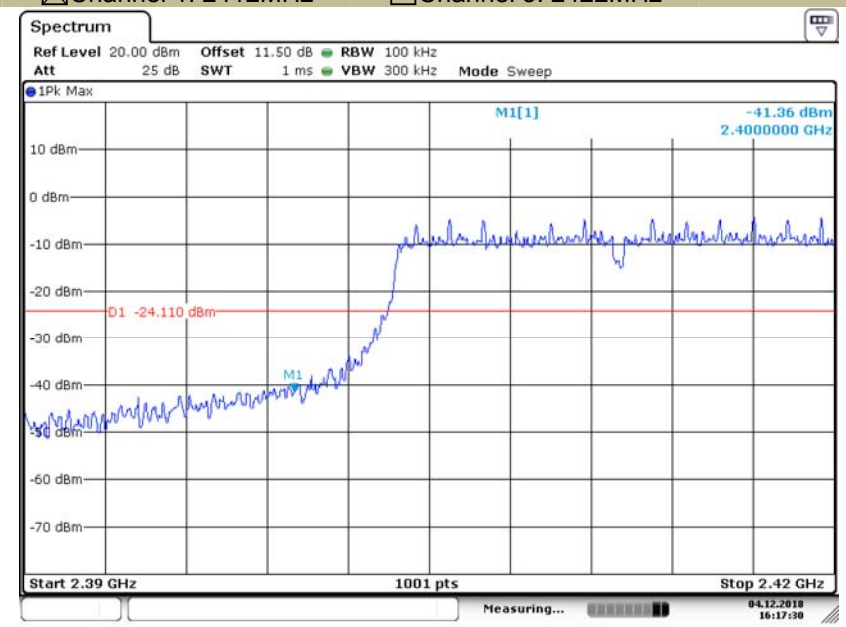
Date: 4.DEC.2018 16:17:12

Test Model	Unwanted Emissions in non-restricted frequency bands ☐802.11b ☒802.11g ☐802.11n(HT20) ☐802.11n(HT40) ☒Channel 1: 2412MHz ☐Channel 3: 2422MHz



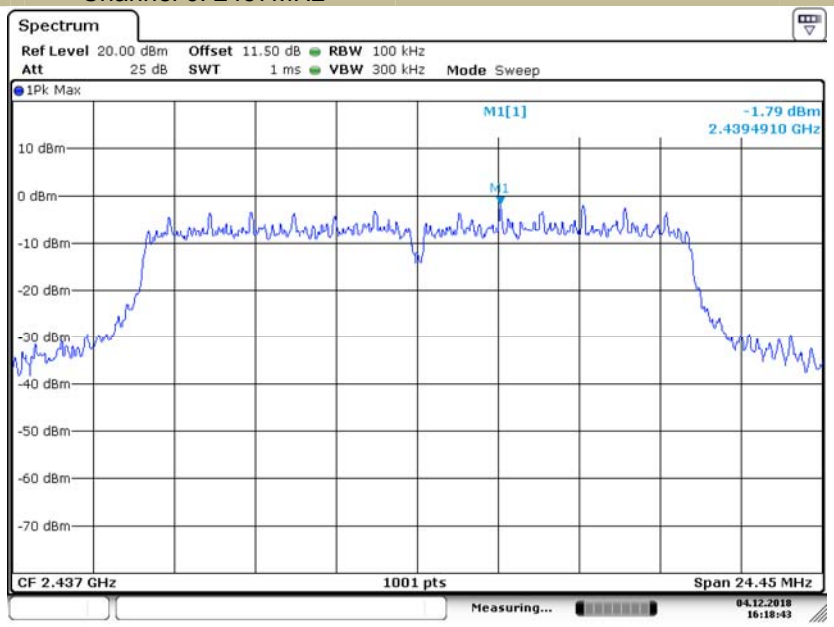
Date: 4.DEC.2018 16:17:51

Test Model	Band edge ☐802.11b ☒802.11g ☐802.11n(HT20) ☐802.11n(HT40) ☒Channel 1: 2412MHz ☐Channel 3: 2422MHz



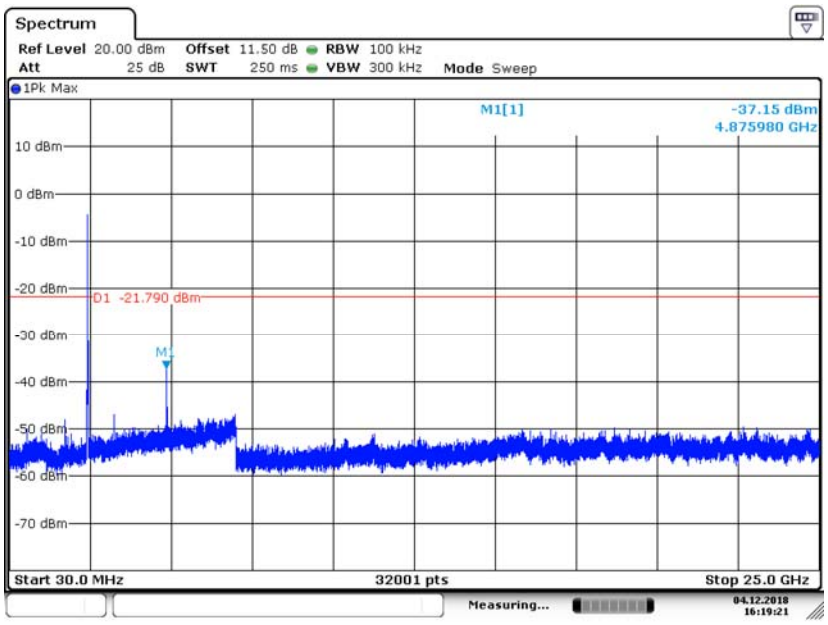
Date: 4.DEC.2018 16:17:30

Test Model	PSD(Power Spectral Density) RBW=100kHz ☐802.11b ☒802.11g ☐802.11n(HT20) ☐802.11n(HT40) Channel 6: 2437MHz



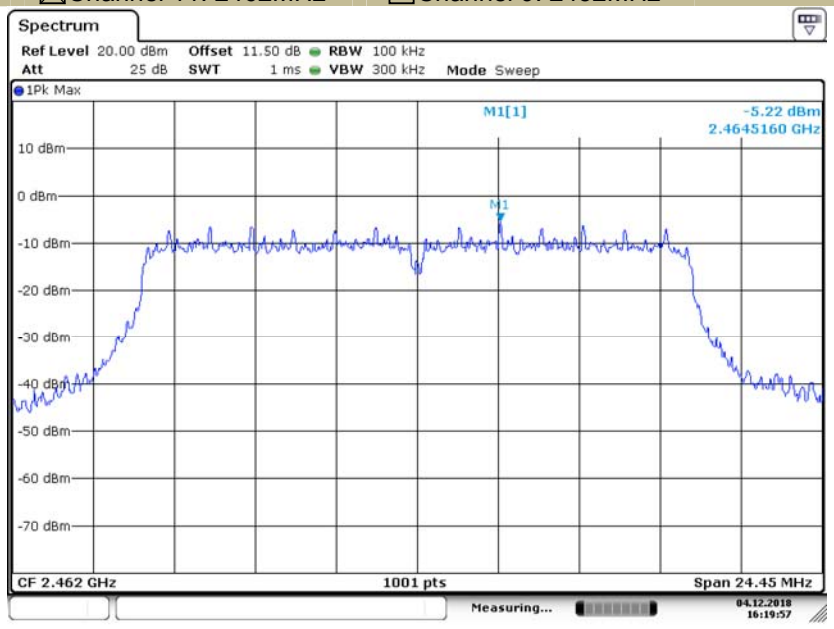
Date: 4.DEC.2018 16:18:43

Test Model	Unwanted Emissions In Non-Restricted Frequency Bands ☐802.11b ☒802.11g ☐802.11n(HT20) ☐802.11n(HT40) Channel 6: 2437MHz



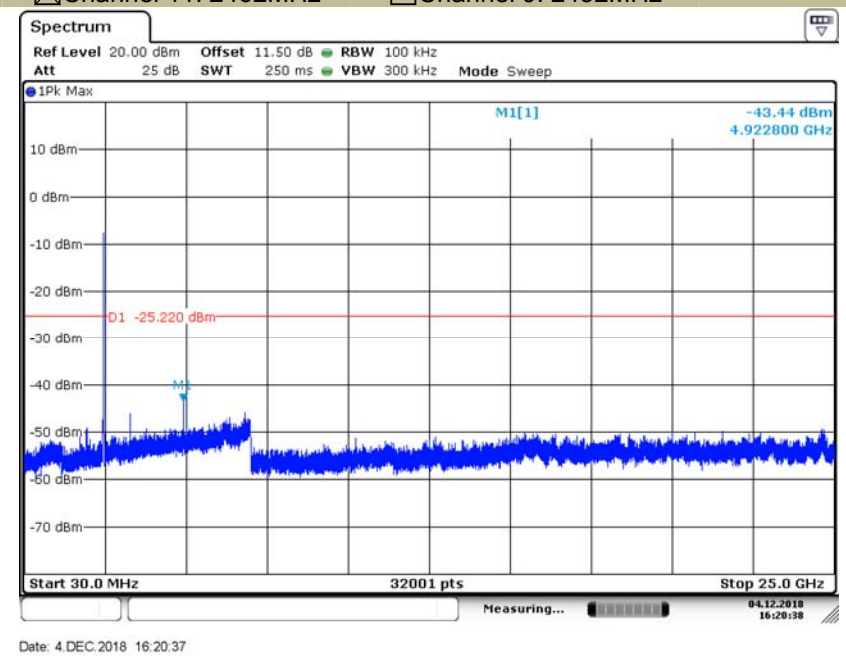
Date: 4.DEC.2018 16:19:20

Test Model	PSD(Power Spectral Density) RBW=100kHz ☐802.11b ☒802.11g ☐802.11n(HT20) ☐802.11n(HT40) ☒Channel 11: 2462MHz ☐Channel 9: 2452MHz



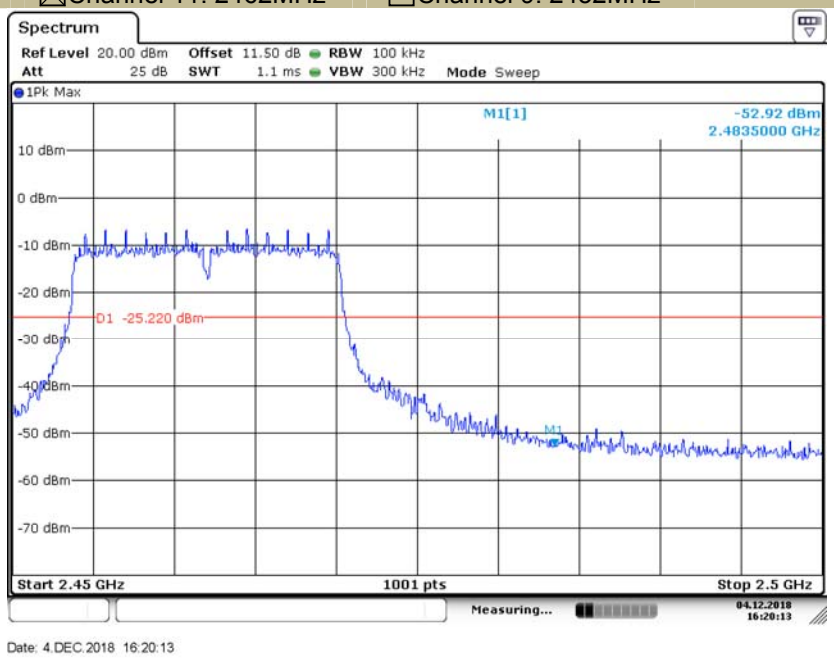
Date: 4.DEC.2018 16:19:57

Test Model	Unwanted Emissions In Non-Restricted Frequency Bands ☐802.11b ☒802.11g ☐802.11n(HT20) ☐802.11n(HT40) ☒Channel 11: 2462MHz ☐Channel 9: 2452MHz



Date: 4.DEC.2018 16:20:37

Test Model	Band edge ☐802.11b ☒802.11g ☐802.11n(HT20) ☐802.11n(HT40) ☒Channel 11: 2462MHz ☐Channel 9: 2452MHz



Date: 4.DEC.2018 16:20:13

8.5 RADIATED SPURIOUS EMISSION

8.5.1 Applicable Standard

According to FCC Part 15.247(d) and 15.209 and KDB558074 DTS 01 Meas. Guidance v05r02

8.5.2 Conformance Limit

According to FCC Part 15.247(d): radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
According to FCC Part15.205, Restricted bands

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(2)
13.36-13.41			

According to FCC Part15.205,the level of any transmitter spurious emission in Restricted bands shall not exceed the level of the emission specified in the following table

Restricted Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance
0.009-0.490	2400/F(KHz)	20 log (uV/m)	300
0.490-1.705	2400/F(KHz)	20 log (uV/m)	30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

8.5.3 Test Configuration

Test according to clause 7.2 radio frequency test setup 2

8.5.4 Test Procedure

This test is required for any spurious emission that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:
The EUT was placed on a turn table which is 0.8m above ground plane.
Maximum procedure was performed on the highest emissions to ensure EUT compliance.
Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz(1GHz to 25GHz), 100 kHz for f < 1 GHz(30MHz to 1GHz), 200Hz for f<150KHz(9KHz to 150KHz), 9KHz for f<30MHz(150KHz to 30KHz)
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Follow the guidelines in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT,

measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc. A pre-amp and a high pass filter are required for this test, in order to provide the measuring system with sufficient sensitivity. Allow the trace to stabilize. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, which must comply with the limit specified in Section 15.35(b). Submit this data.
Now set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a “duty cycle correction factor”, derived from 20log(dwell time/100 ms), in an effort to demonstrate compliance with the 15.209 limit. Submit this data.
Repeat above procedures until all frequency measured was complete.

8.5.5 Test Results

■ Spurious Emission below 30MHz(9KHz to 30MHz)

Temperature:	24℃	Test Date:	June 30, 2019
Humidity:	53 %	Test By:	King Kong
Test mode:	TX Mode		

Freq. (MHz)	Ant.Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
		PK	AV	PK	AV	PK	AV
--	--	--	--	--	--	--	--

Note: the amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.
Distance extrapolation factor =40log(Specific distance/ test distance)(dB);
Limit line=Specific limits(dBuV) + distance extrapolation factor

■ Spurious Emission Above 1GHz(1GHz to 25GHz)
All modes 2.4G 802.11b/g/n and two antenna have been tested, and the worst result 802.11b with ant0 recorded was report as below:

Temperature :	26℃	Test Date :	June 30, 2019
Humidity :	60 %	Test By:	King Kong
Test mode:	802.11b	Frequency:	Channel 1: 2412MHz

Freq.	Ant.Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
(MHz)	H/V	PK	AV	PK	AV	PK	AV
2186.3	V	49.19	36.43	74.00	54.00	-24.81	-17.57
12056.5	V	56.94	42.58	74.00	54.00	-17.06	-11.42
18462.1	V	58.71	43.98	74.00	54.00	-15.29	-10.02
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
2243.25	H	48.86	36.49	74.00	54.00	-25.14	-17.51
9241.3	H	55.74	42.05	74.00	54.00	-18.26	-11.95
18502.05	H	60.54	43.78	74.00	54.00	-13.46	-10.22

Temperature :	26℃	Test Date :	June 30, 2019
Humidity :	60 %	Test By:	King Kong
Test mode:	802.11b	Frequency:	Channel 6: 2437MHz

Freq.	Ant.Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
(MHz)	H/V	PK	AV	PK	AV	PK	AV
2232.2	V	48.92	35.99	74.00	54.00	-25.08	-18.01
10779.8	V	57.74	42.82	74.00	54.00	-16.26	-11.18
18487.6	V	59.16	43.69	74.00	54.00	-14.84	-10.31
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
2238.15	H	49.07	35.88	74.00	54.00	-24.93	-18.12
9736.85	H	56.37	42.05	74.00	54.00	-17.63	-11.95
18473.15	H	60.19	43.83	74.00	54.00	-13.81	-10.17

Temperature :	26℃	Test Date :	June 30, 2019
Humidity :	60 %	Test By:	King Kong
Test mode:	802.11b	Frequency:	Channel 11: 2462MHz

Freq.	Ant.Pol.	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
(MHz)	H/V	PK	AV	PK	AV	PK	AV
2197.35	V	48.62	45.67	74.00	54.00	-25.38	-8.33
10785.75	V	57.53	41.95	74.00	54.00	-16.47	-12.05
18445.1	V	60.04	43.94	74.00	54.00	-13.96	-10.06
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
2218.6	H	48.67	36.58	74.00	54.00	-25.33	-17.42
10772.15	H	57.34	42.66	74.00	54.00	-16.66	-11.34
18469.75	H	59.59	44.02	74.00	54.00	-14.41	-9.98

Note: (1) All Readings are Peak Value (VBW=3MHz) and Average Value (VBW=10Hz).
(2) Emission Level= Reading Level+Probe Factor +Cable Loss.
(3) Data of measurement within this frequency range shown " -- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

■ Spurious Emission in Restricted Band 2310-2390MHz and 2483.5-2500MHz
All modes 2.4G 802.11b/g/n have been tested, and the worst result 802.11n recorded was report as below:

Temperature :	26℃	Test Date :	June 17, 2019
Humidity :	60 %	Test By:	King Kong
Test mode:	802.11n	Frequency:	Channel 1: 2412MHz

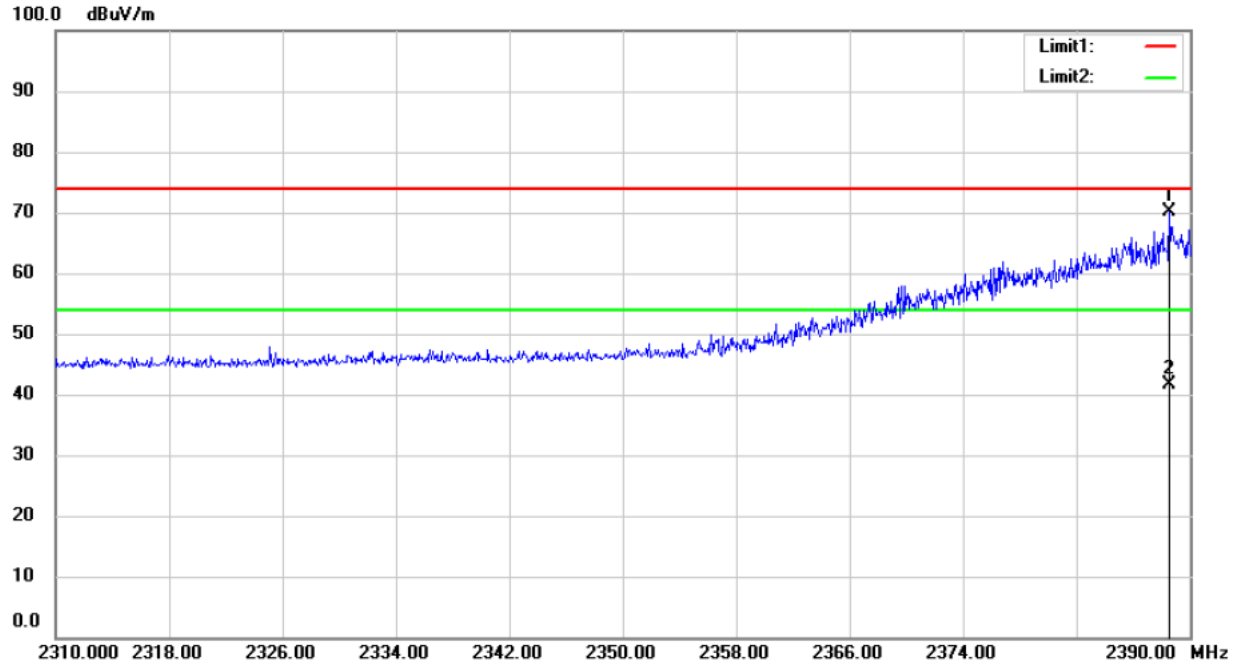
Frequency (MHz)	Polarity	PK(dBuV/m) (VBW=3MHz)	Limit 3m (dBuV/m)	Margin (dB)	AV(dBuV/m) (VBW=10Hz)	Limit 3m (dBuV/m)	Margin (dB)
2388.564	H	64.55	74.00	-9.45	39.52	54.00	-14.48
2389.116	V	70.16	74.00	-3.84	41.68	54.00	-12.32

Temperature :	26℃	Test Date :	June 17, 2019
Humidity :	60 %	Test By:	King Kong
Test mode:	802.11n	Frequency:	Channel 11: 2462MHz

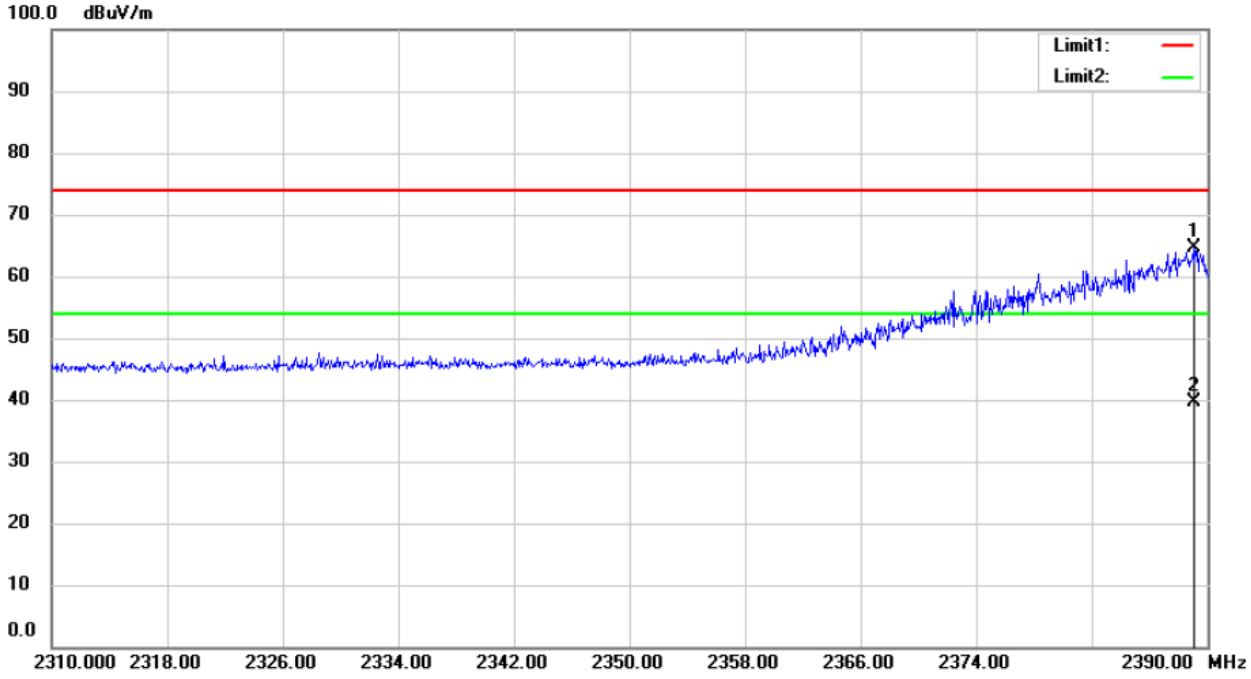
Frequency (MHz)	Polarity	PK(dBuV/m) (VBW=3MHz)	Limit 3m (dBuV/m)	Margin (dB)	AV(dBuV/m) (VBW=10Hz)	Limit 3m (dBuV/m)	Margin (dB)
2483.817	H	66.99	74.00	-7.01	40.14	54.00	-13.86
2484.865	V	68.14	74.00	-5.86	40.61	54.00	-13.39

Note: (1) All Readings are Peak Value (VBW=3MHz) and Average Value (VBW=10Hz).
(2) Emission Level= Reading Level+Probe Factor +Cable Loss.
(3) Data of measurement within this frequency range shown " -- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

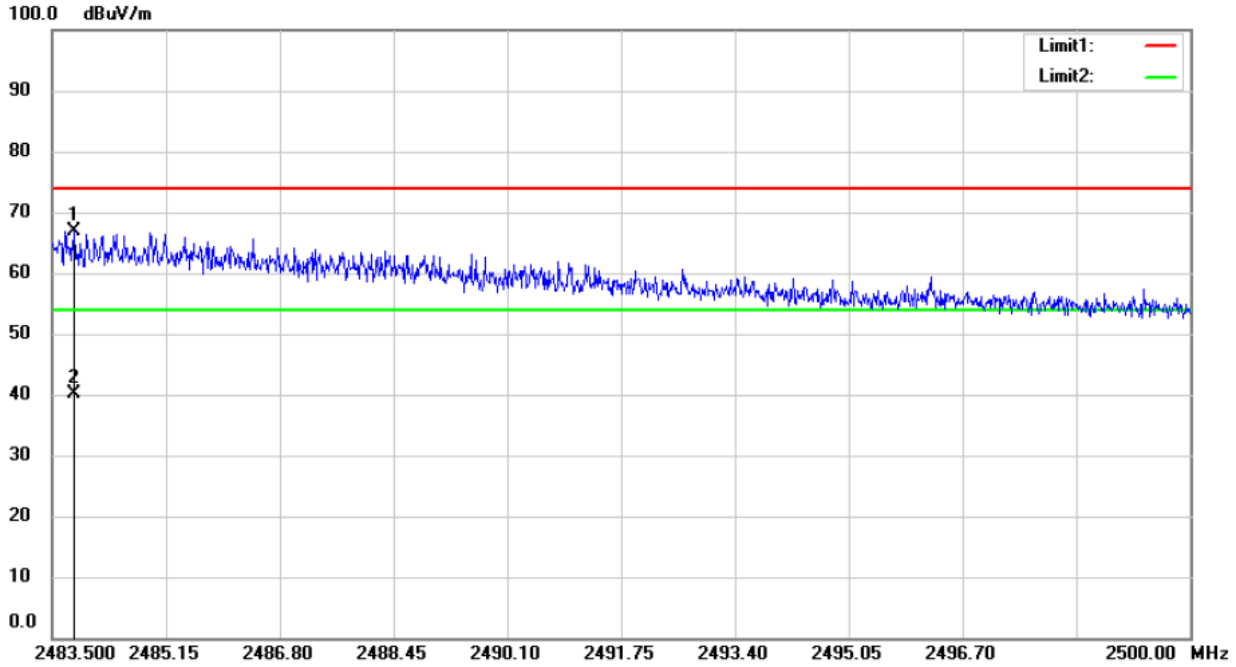
Test Model	Spurious Emission in Restricted Band 2310-2390MHz ☐802.11b ☐802.11g ☒802.11n(HT20) ☐802.11n(HT40) ☒Channel 1: 2412MHz ☐Channel 3: 2422MHz Polarity: H VBW=3MHz Test By: King Kong



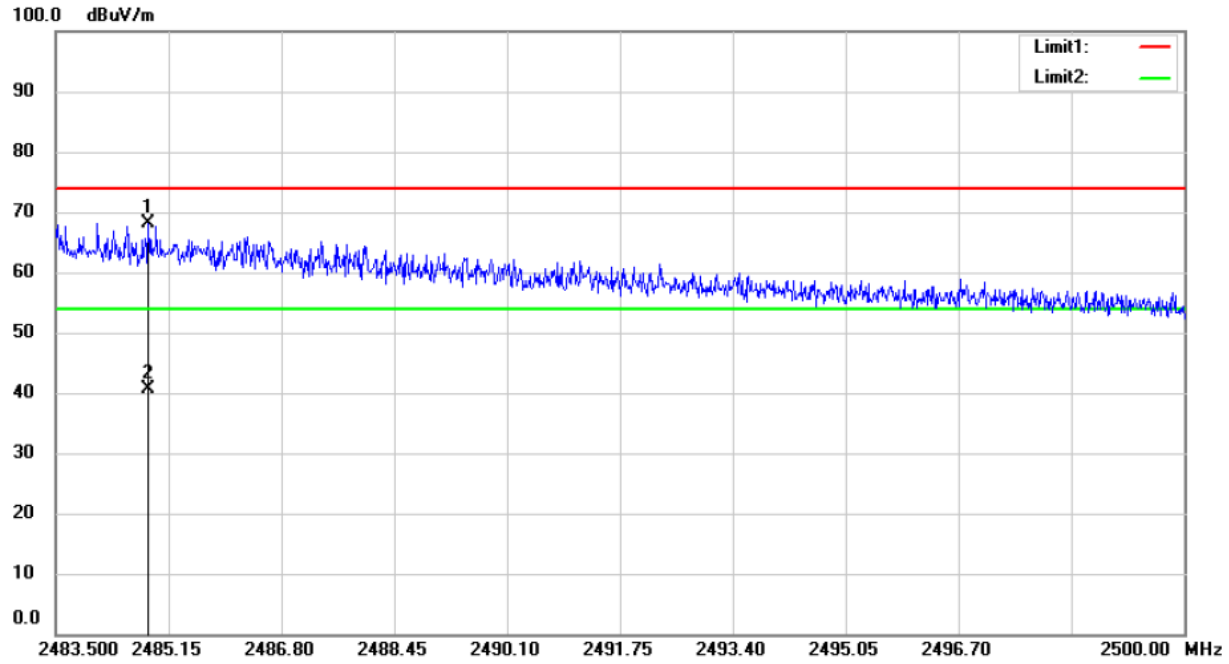
Test Model	Spurious Emission in Restricted Band 2310-2390MHz ☐802.11b ☐802.11g ☒802.11n(HT20) ☐802.11n(HT40) ☒Channel 1: 2412MHz ☐Channel 3: 2422MHz Polarity:V VBW=3MHz Test By: King Kong



Test Model	Spurious Emission in Restricted Band 2483.5-2500MHz ☐802.11b ☐802.11g ☒802.11n(HT20) ☐802.11n(HT40) ☒Channel 11: 2462MHz ☐Channel 9: 2452MHz Polarity: H VBW=3MHz Test By: King Kong

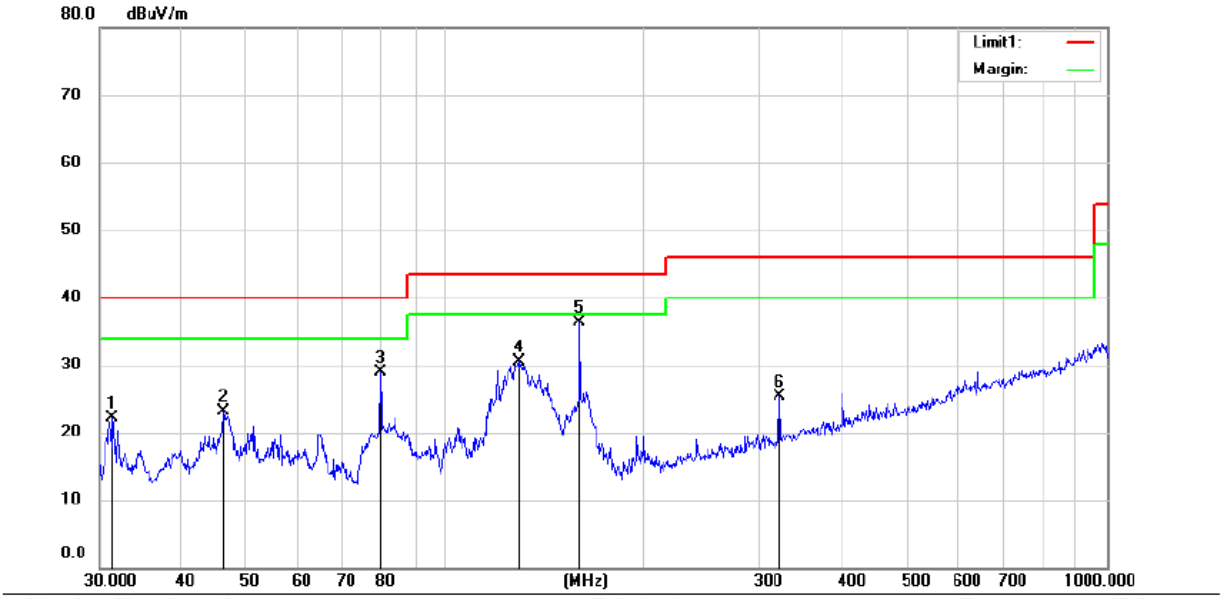


Test Model	Spurious Emission in Restricted Band2483.5-2500MHz ☐802.11b ☐802.11g ☒802.11n(HT20) ☐802.11n(HT40) ☒Channel 11: 2462MHz ☐Channel 9: 2452MHz Polarity: V VBW=3MHz Test By: King Kong



■ Spurious Emission below 1GHz (30MHz to 1GHz)

All modes 2.4G 802.11b/g/n have been tested, and the worst result recorded was report as below:



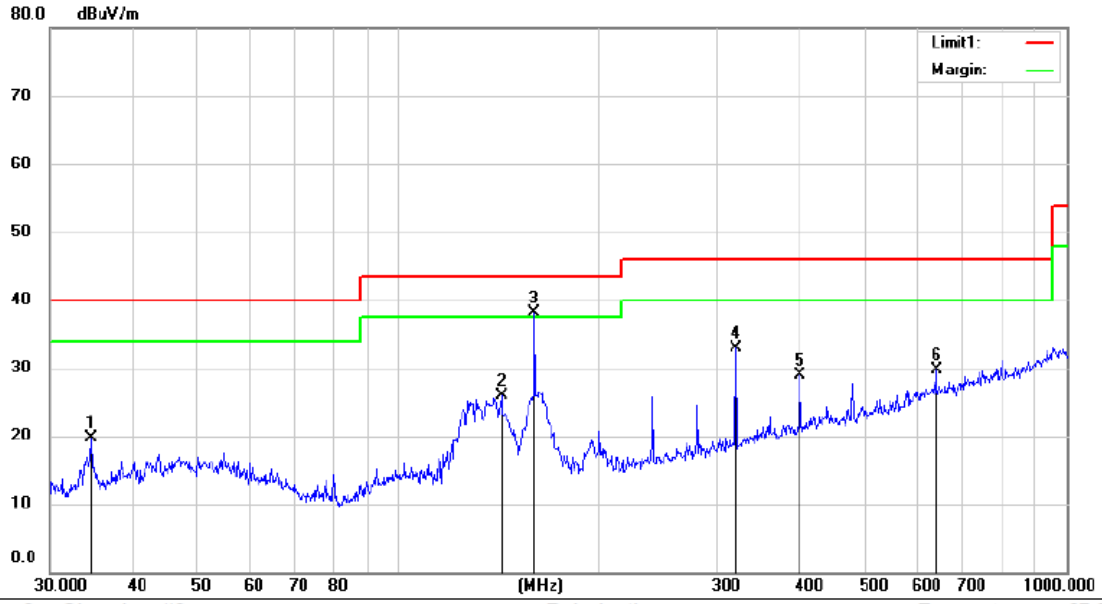
Site 3m Chamber #3 Polarization: *Vertical* Temperature: 27 C

Limit: (RE)FCC PART 15C Power: AC 120V/60Hz Humidity: 43 %

Mode:11B-2412

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		31.4405	36.24	-14.15	22.09	40.00	-17.91	QP			
2		46.2591	34.44	-11.28	23.16	40.00	-16.84	QP			
3		80.0104	45.73	-16.87	28.86	40.00	-11.14	QP			
4		129.1276	45.92	-15.32	30.60	43.50	-12.90	QP			
5	*	159.9947	50.95	-14.72	36.23	43.50	-7.27	QP			
6		320.0772	33.19	-7.93	25.26	46.00	-20.74	QP			



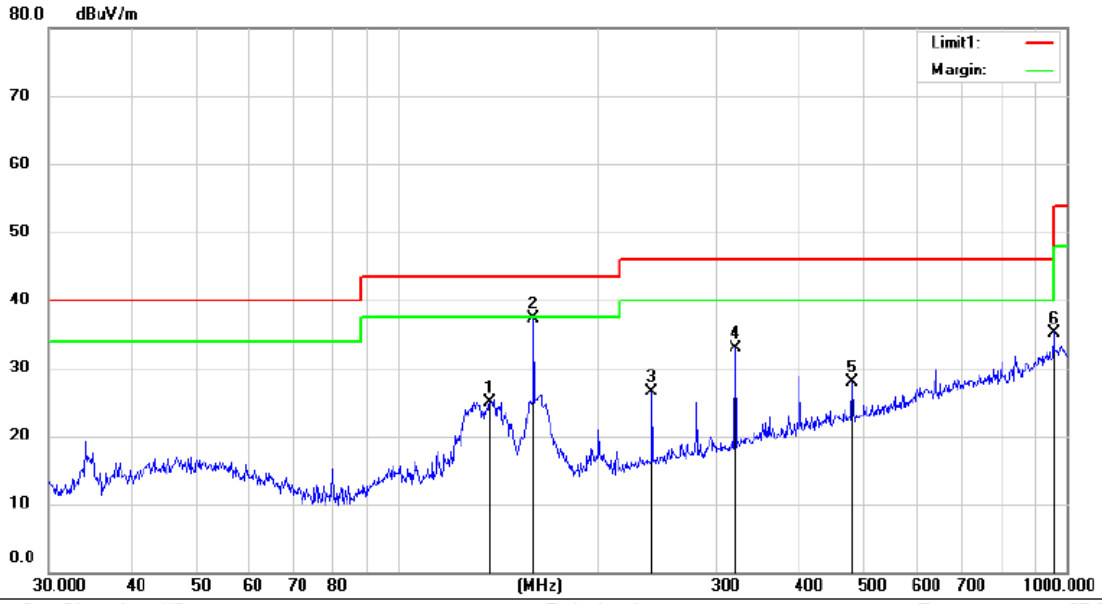
Site 3m Chamber #3 Polarization: *Horizontal* Temperature: 27 C

Limit: (RE)FCC PART 15C Power: AC 120V/60Hz Humidity: 43 %

Mode:11B-2412

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		34.6385	32.84	-13.21	19.63	40.00	-20.37	QP			
2		142.3868	41.50	-15.61	25.89	43.50	-17.61	QP			
3	*	160.0648	52.87	-14.72	38.15	43.50	-5.35	QP			
4		320.0772	40.86	-7.93	32.93	46.00	-13.07	QP			
5		400.0810	34.92	-6.02	28.90	46.00	-17.10	QP			
6		640.0497	31.43	-1.76	29.67	46.00	-16.33	QP			



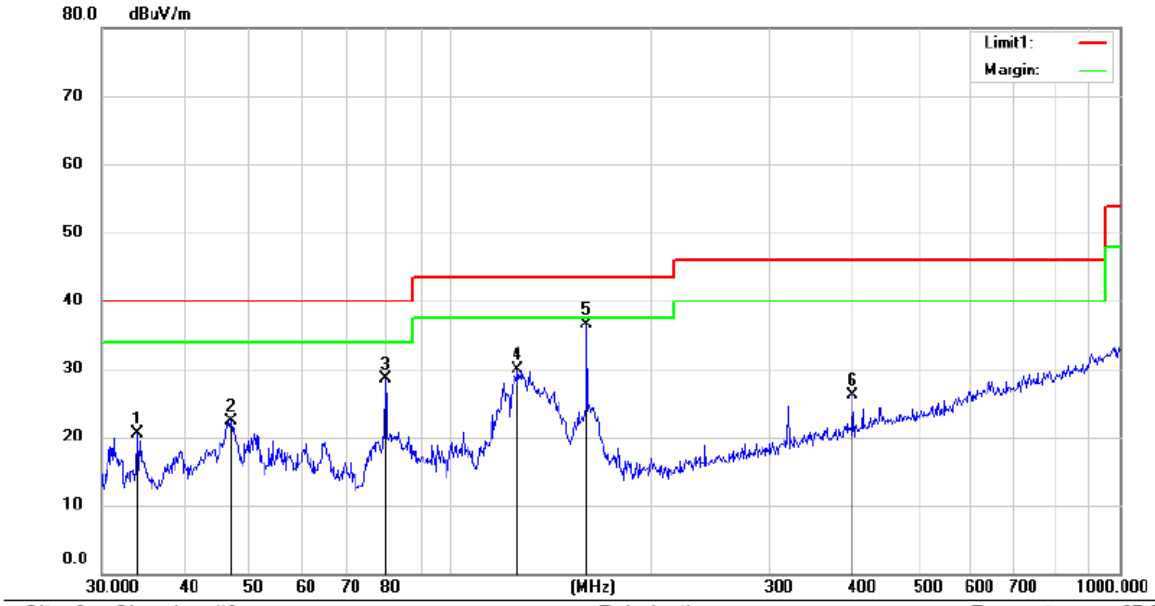
Site 3m Chamber #3 Polarization: *Horizontal* Temperature: 27 C

Limit: (RE)FCC PART 15C Power: AC 120V/60Hz Humidity: 43 %

Mode: 11B-2437

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		137.7820	40.58	-15.61	24.97	43.50	-18.53	QP			
2	*	160.0648	52.10	-14.72	37.38	43.50	-6.12	QP			
3		239.9873	36.68	-10.16	26.52	46.00	-19.48	QP			
4		320.0772	40.78	-7.93	32.85	46.00	-13.15	QP			
5		480.1065	32.94	-5.03	27.91	46.00	-18.09	QP			
6		960.0560	32.00	3.20	35.20	54.00	-18.80	QP			



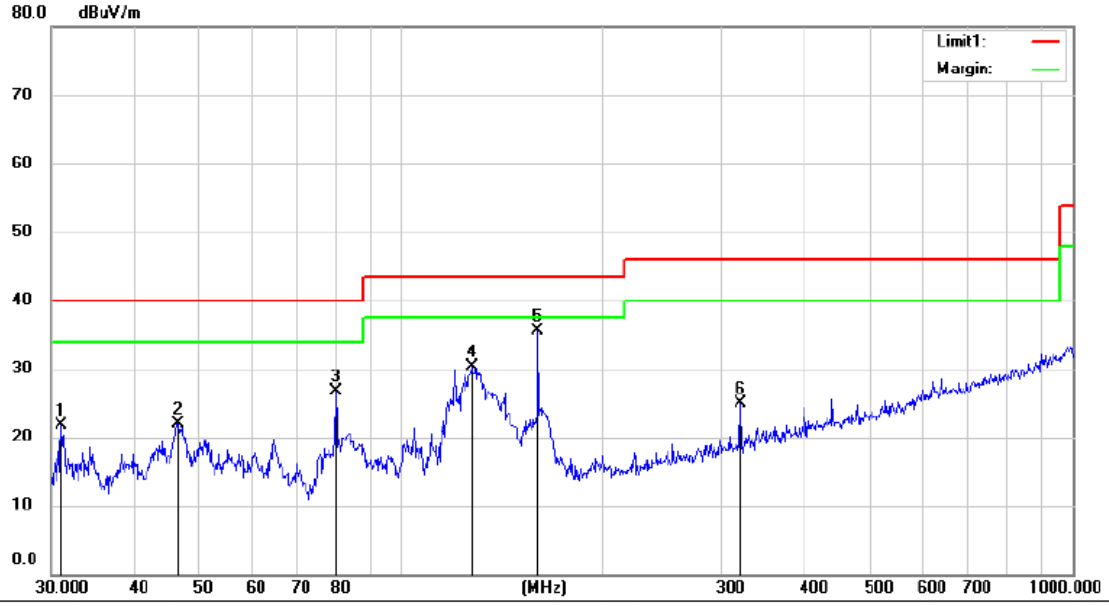
Site 3m Chamber #3 Polarization: *Vertical* Temperature: 27 C

Limit: (RE)FCC PART 15C Power: AC 120V/60Hz Humidity: 43 %

Mode:11B-2437

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		33.9918	33.51	-13.05	20.46	40.00	-19.54	QP			
2		46.8714	33.48	-11.24	22.24	40.00	-17.76	QP			
3		80.0104	45.37	-16.87	28.50	40.00	-11.50	QP			
4		126.2180	44.95	-15.08	29.87	43.50	-13.63	QP			
5	*	159.9947	51.18	-14.72	36.46	43.50	-7.04	QP			
6		400.0810	32.20	-6.02	26.18	46.00	-19.82	QP			



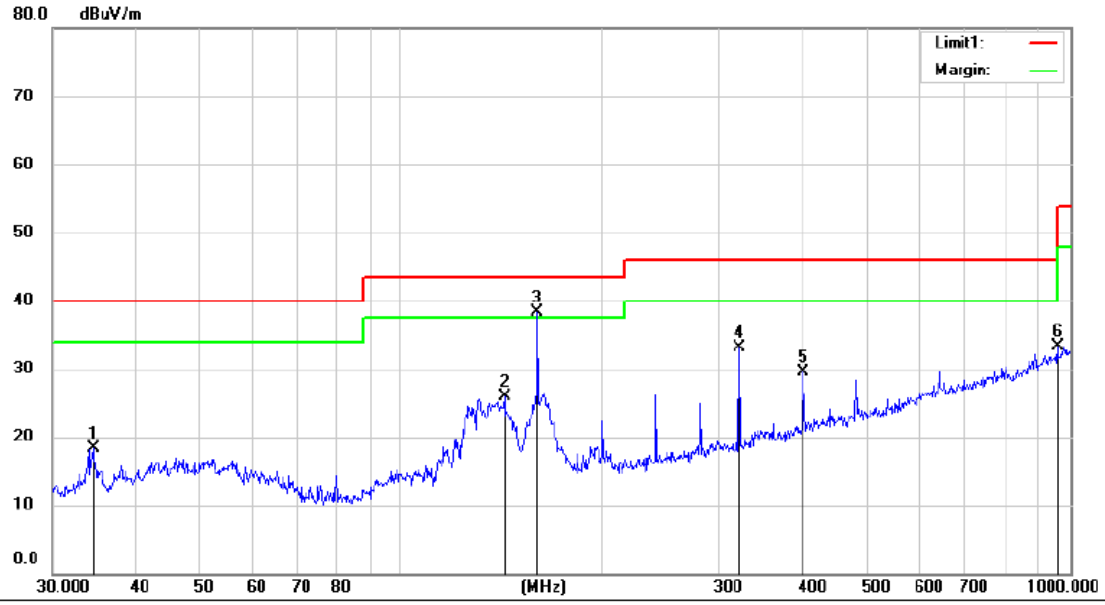
Site 3m Chamber #3 Polarization: *Vertical* Temperature: 27 C

Limit: (RE)FCC PART 15C Power: AC 120V/60Hz Humidity: 43 %

Mode: 11B-2462

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		31.0842	35.91	-14.15	21.76	40.00	-18.24	QP			
2		46.5642	33.13	-11.26	21.87	40.00	-18.13	QP			
3		79.9753	43.59	-16.87	26.72	40.00	-13.28	QP			
4		127.2734	45.50	-15.17	30.33	43.50	-13.17	QP			
5	*	159.9946	50.28	-14.72	35.56	43.50	-7.94	QP			
6		320.0772	32.80	-7.93	24.87	46.00	-21.13	QP			



Site 3m Chamber #3 Polarization: *Horizontal* Temperature: 27 C

Limit: (RE)FCC PART 15C Power: AC 120V/60Hz Humidity: 43 %

Mode:11B-2462

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		34.5778	31.54	-13.19	18.35	40.00	-21.65	QP			
2		142.3868	41.59	-15.61	25.98	43.50	-17.52	QP			
3	*	160.0648	53.03	-14.72	38.31	43.50	-5.19	QP			
4		320.0772	41.07	-7.93	33.14	46.00	-12.86	QP			
5		400.0810	35.57	-6.02	29.55	46.00	-16.45	QP			
6		960.0560	30.18	3.20	33.38	54.00	-20.62	QP			

8.6 CONDUCTED EMISSIONS TEST

8.6.1 Applicable Standard

According to FCC Part 15.207(a)

8.6.2 Conformance Limit

Conducted Emission Limit		
Frequency(MHz)	Quasi-peak	Average
0.15-0.5	66-56	56-46
0.5-5.0	56	46
5.0-30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

8.6.3 Test Configuration

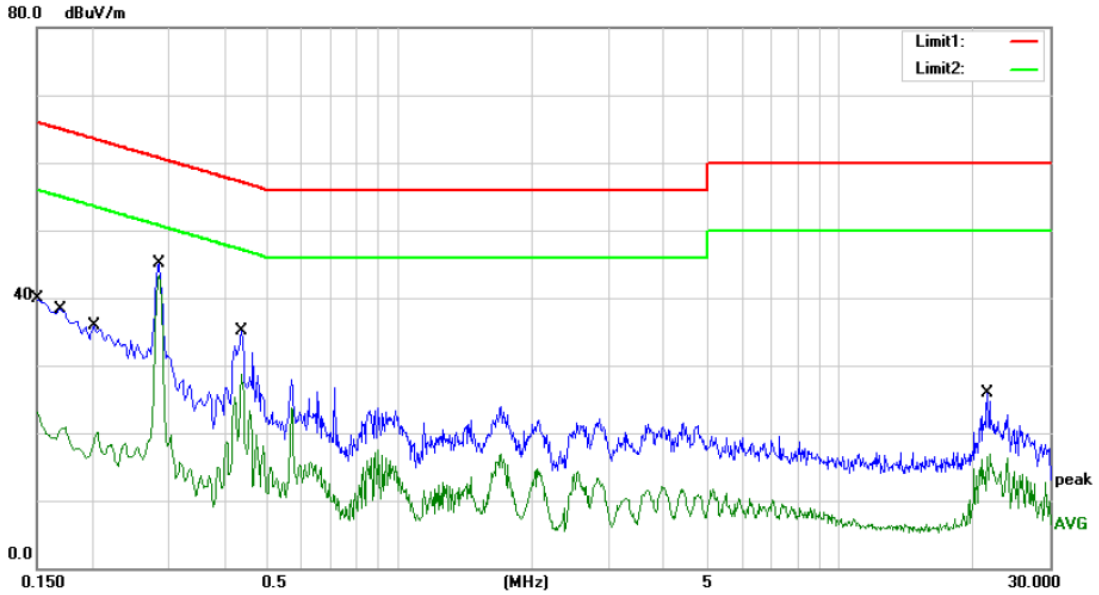
Test according to clause 7.3conducted emission test setup

8.6.4 Test Procedure

The EUT was placed on a table which is 0.8m above ground plane.
Maximum procedure was performed on the highest emissions to ensure EUT compliance.
Repeat above procedures until all frequency measured were complete.

8.6.5 Test Results

Pass



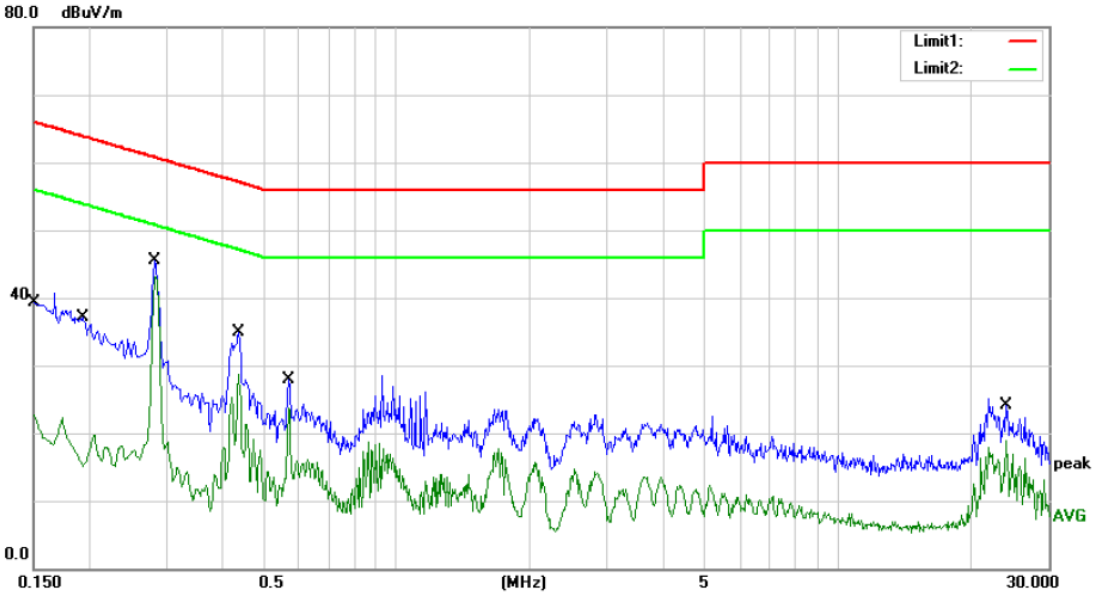
Site Conduction #2 Phase: *L1* Temperature: 23.7

Limit: (CE)FCC PART 15 C Power: AC 120V/60Hz Humidity: 41 %

Mode: WIFI ON

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV/m	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		0.1500	29.96	9.89	39.85	66.00	-26.15	QP	
2		0.1500	13.70	9.89	23.59	56.00	-32.41	AVG	
3		0.1712	28.22	9.90	38.12	64.90	-26.78	QP	
4		0.1712	10.93	9.90	20.83	54.90	-34.07	AVG	
5		0.2030	25.72	9.90	35.62	63.49	-27.87	QP	
6		0.2030	10.27	9.90	20.17	53.49	-33.32	AVG	
7		0.2860	35.20	9.91	45.11	60.64	-15.53	QP	
8	*	0.2860	33.33	9.91	43.24	50.64	-7.40	AVG	
9		0.4380	25.14	9.92	35.06	57.10	-22.04	QP	
10		0.4380	18.88	9.92	28.80	47.10	-18.30	AVG	
11		21.6660	15.73	10.15	25.88	60.00	-34.12	QP	
12		21.6660	6.81	10.15	16.96	50.00	-33.04	AVG	



Site Conduction #2 Phase: N Temperature: 23.7

Limit: (CE)FCC PART 15 C Power: AC 120V/60Hz Humidity: 41 %

Mode: WIFI ON

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV/m	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1		0.1500	29.47	9.89	39.36	66.00	-26.64	QP	
2		0.1500	13.36	9.89	23.25	56.00	-32.75	AVG	
3		0.1945	26.92	9.90	36.82	63.84	-27.02	QP	
4		0.1945	9.84	9.90	19.74	53.84	-34.10	AVG	
5		0.2820	35.57	9.91	45.48	60.76	-15.28	QP	
6	*	0.2820	33.25	9.91	43.16	50.76	-7.60	AVG	
7		0.4380	24.96	9.92	34.88	57.10	-22.22	QP	
8		0.4380	18.87	9.92	28.79	47.10	-18.31	AVG	
9		0.5700	18.04	9.92	27.96	56.00	-28.04	QP	
10		0.5700	13.71	9.92	23.63	46.00	-22.37	AVG	
11		24.0300	13.78	10.24	24.02	60.00	-35.98	QP	
12		24.0300	8.72	10.24	18.96	50.00	-31.04	AVG	

8.7 ANTENNA APPLICATION

8.7.1 Antenna Requirement

Standard	Requirement
FCC CRF Part15.203	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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217,§15.219, or §15.221. Further, this requirement does not apply to intentionalradiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

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. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

8.7.2 Result

PASS.

The EUT has 1 antenna: a PCB Antenna for WIFI, the gain is 1 dBi;

Note: ☒ Antenna use a permanently attached antenna which is not replaceable.
☐ Not using a standard antenna jack or electrical connector for antenna replacement
☐ The antenna has to be professionally installed (please provide method of installation)

which in accordance to section 15.203, please refer to the internal photos.