



FCC RF Test Report

APPLICANT : Hangzhou Tuya Information Technology Co., Ltd
EQUIPMENT : WiFi&Bluetooth Module
MODEL NAME : WBR2D
FCC ID : 2ANDL-WBR2D
STANDARD : FCC Part 15 Subpart E §15.407
CLASSIFICATION : (NII) Unlicensed National Information Infrastructure

The product was received on Oct. 30, 2019 and testing was completed on Jan. 07, 2020. We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.

Jason Jia

Reviewed by: Jason Jia / Supervisor

James Huang

Approved by: James Huang / Manager



Sporton International (Kunshan) Inc.

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People's Republic of China



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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR9O3006D	Rev. 01	Initial issue of report	Mar. 31, 2020

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.403(i)	6dB, 26dB and 99% Occupied Bandwidth	> 500kHz	Pass	-
3.2	15.407(a)	Maximum Conducted Output Power	≤ 30 dBm	Pass	-
3.3	15.407(a)	Power Spectral Density	≤ 30 dBm/500kHz	Pass	-
3.4	15.407(b)	Unwanted Emissions	15.407(b)(4)(i) & 15.209(a)	Pass	Under limit 5.52 dB at 480.080 MHz
3.5	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 12.84 dB at 0.452 MHz
3.6	15.407(c)	Automatically Discontinue Transmission	Discontinue Transmission	Pass	-
3.7	15.203 & 15.407(a)	Antenna Requirement	N/A	Pass	-

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.



1 General Description

1.1 Applicant

Hangzhou Tuya Information Technology Co., Ltd

Room701, Building3, More Center, No.87 GuDun Road, Hangzhou, Zhejiang, China

1.2 Manufacturer

Hangzhou Tuya Information Technology Co., Ltd

Room701, Building3, More Center, No.87 GuDun Road, Hangzhou, Zhejiang, China

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	WiFi&Bluetooth Module
Model Name	WBR2D
FCC ID	2ANDL-WBR2D
EUT supports Radios application	WLAN 2.4GHz 802.11b/g/n HT20/HT40 WLAN 5GHz 802.11a/n HT20/HT40 Bluetooth LE
HW Version	1.0.1
SW Version	2V1

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Channel Frequency Range	5745 MHz ~ 5825 MHz
Maximum Output Power	<5745 MHz ~ 5825 MHz> 802.11a : 14.15 dBm / 0.0260 W 802.11n HT20 : 12.71 dBm / 0.0187 W 802.11n HT40 : 11.98 dBm / 0.0158 W
99% Occupied Bandwidth	802.11a : 18.58 MHz 802.11n HT20 : 18.88 MHz 802.11n HT40 : 36.06 MHz
Type of Modulation	802.11a/n : OFDM (BPSK / QPSK / 16QAM / 64QAM)
Antenna Type / Gain	PCB Antenna with gain 2.60 dBi

1.5 Modification of EUT

No modifications are made to the EUT during all test items.



1.6 Testing Location

Sporton International (Kunshan) Inc. is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Test Firm	Sporton International (Kunshan) Inc.		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	CO01-KS 03CH05-KS TH01-KS	CN1257	314309

1.7 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ 47 CFR Part 15 Subpart E
- ♦ FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

2 Test Configuration of Equipment Under Test

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X plane) were recorded in this report.
- b. AC power line Conducted Emission was tested under maximum output power.

2.1 Carrier Frequency and Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
5745-5825 MHz Band 4 (U-NII-3)	149	5745	157	5785
	151*	5755	159*	5795
	153	5765	161	5805
	-	-	165	5825

Note: The above Frequency and Channel in "*" were 802.11n HT40.

2.2 Test Mode

Final test modes are considering the modulation and worse data rates as below table.

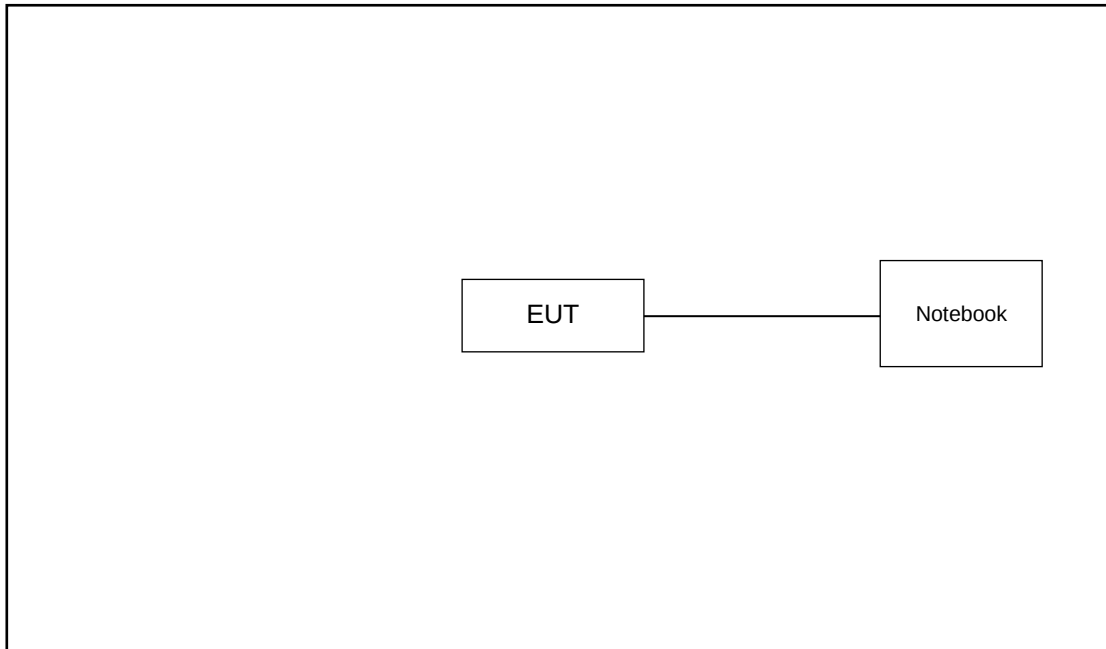
Modulation	Data Rate
802.11a	6 Mbps
802.11n HT20	MCS0
802.11n HT40	MCS0

AC Conducted Emission	Mode 1 : Bluetooth Link + USB Cable(Data link with Notebook) Mode 2 : WLAN Link (5G) + USB Cable(Data link with Notebook)
Remark: The worst case of conducted emission is mode 2; only the test data of it was reported.	

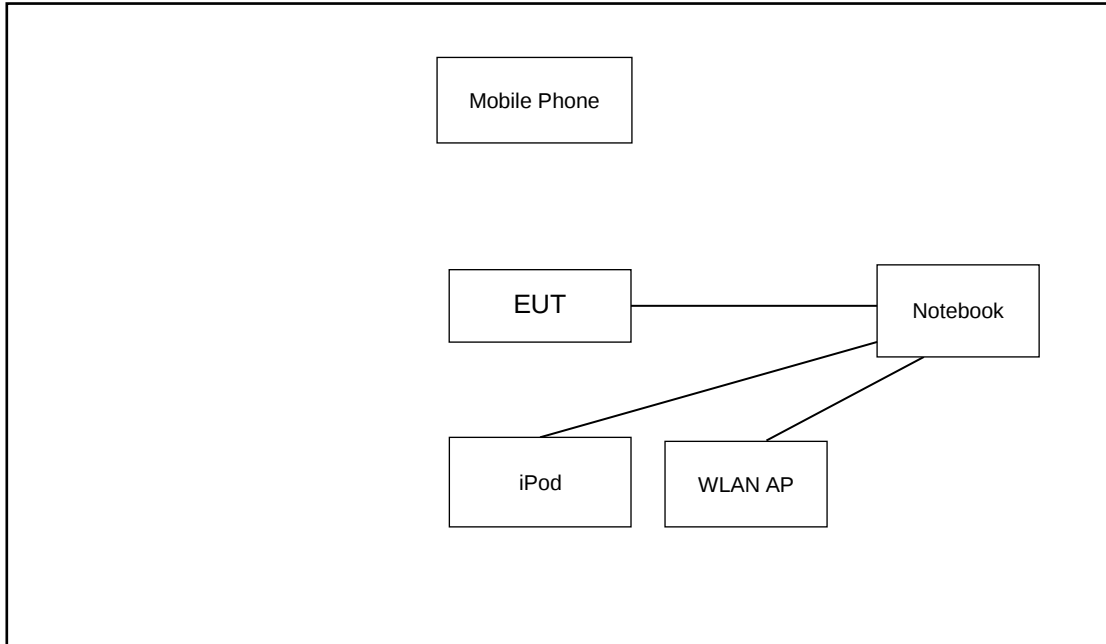
Ch. #		Band IV : 5745-5825 MHz		
		802.11a	802.11n HT20	802.11n HT40
L	Low	149	149	151
M	Middle	157	157	-
H	High	165	165	159

2.3 Connection Diagram of Test System

For Radiation



For Conducted Emission



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Notebook	Lenovo	QDS-BRCM1050I	PRC4	N/A	shielded cable DC O/P 1.8m , Unshielded AC I/P cable 1.8m
2.	WLAN AP	D-link	DIR-655	KA21R655B1	N/A	Unshielded,1.8m
3.	iPod	Apple	A1199	Fcc DoC	Shielded, 1.2m	N/A
4.	Phone	MOTO	XT1952-1	N/A	N/A	N/A

2.5 EUT Operation Test Setup

For WLAN function, the engineering test program was provided and enabled to make EUT continuous transmit/receive.

For AC power line conducted emissions, the EUT was set to connect with the WLAN AP under large package sizes transmission.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example :

The spectrum analyzer offset is derived from RF cable loss.

Offset = RF cable loss.

Following shows an offset computation example with cable loss 5.40dB

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)}. \\ &= 5.40(\text{dB})\end{aligned}$$

3 Test Result

3.1 6dB and 26dB and 99% Occupied Bandwidth Measurement

3.1.1 Description of 6dB and 26dB and 99% Occupied Bandwidth

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

26dB and 99% Occupied bandwidth are reporting only.

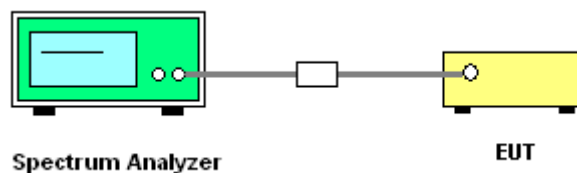
3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.1.3 Test Procedures

1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
Section C) Emission bandwidth for the band 5.725-5.85GHz
2. Set RBW = 100kHz.
3. Set the VBW $\geq 3 \times$ RBW.
4. Detector = Peak.
5. Trace mode = max hold
6. Measure the maximum width of the emission that is 6 dB down from the peak of the emission.
7. Measure and record the results in the test report.

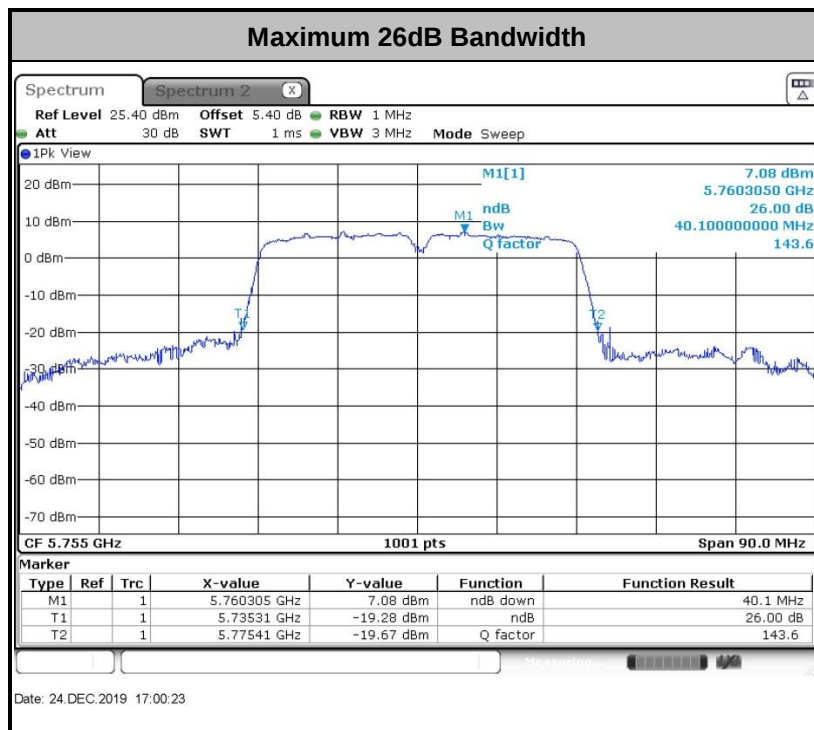
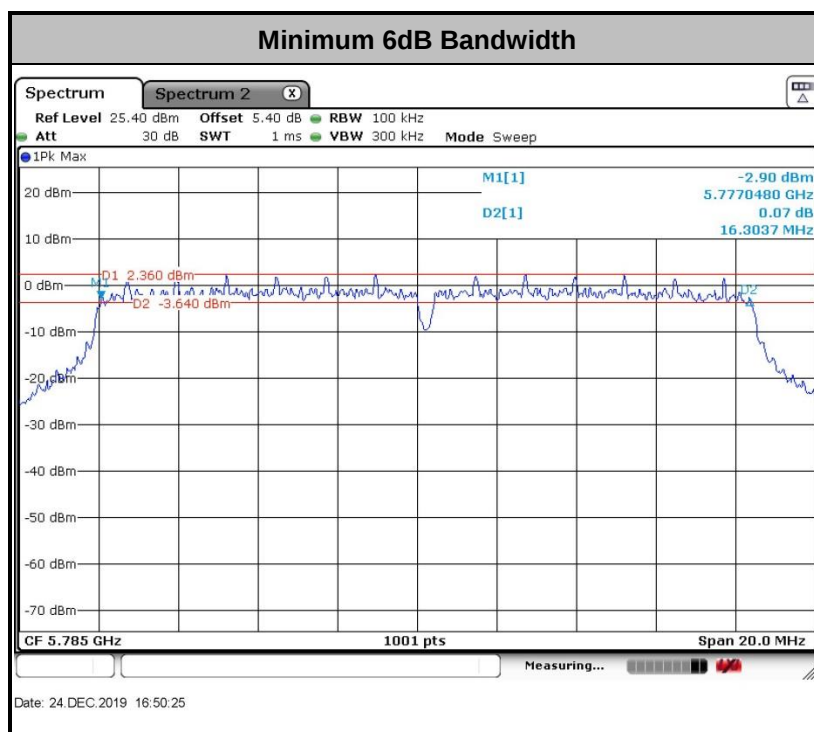
3.1.4 Test Setup

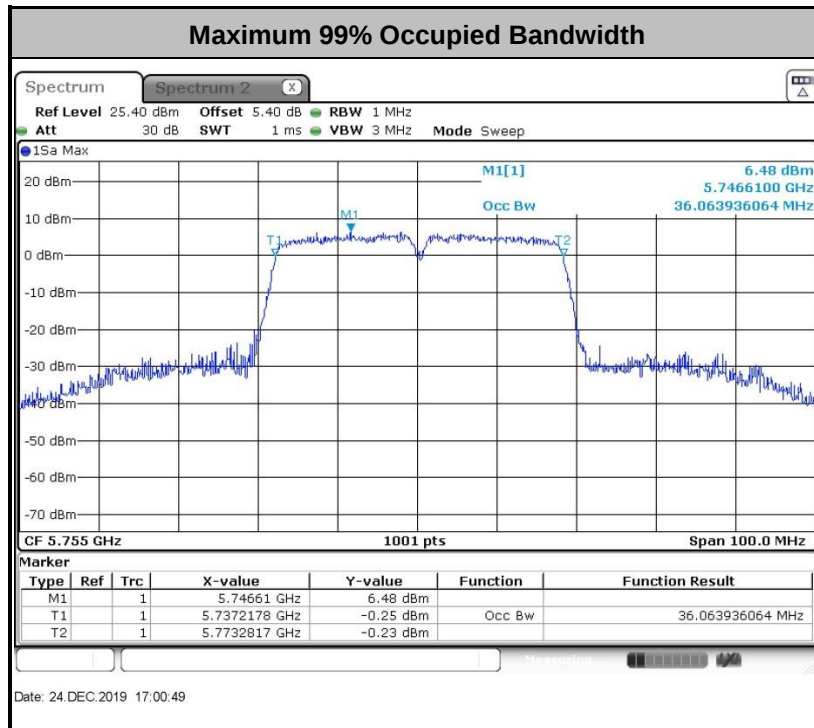




3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.





Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

3.2 Maximum Conducted Output Power Measurement

3.2.1 Limit of Maximum Conducted Output Power

For the band 5.725–5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W.

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.2.3 Test Procedures

The testing follows Method PM of FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.

Method PM (Measurement using an RF average power meter):

1. Measurement is performed using a wideband RF power meter.
2. The EUT is configured to transmit continuously with a consistent duty cycle at its maximum power control level.
3. Measure the average power of the transmitter, and the average power is corrected with duty factor, $10 \log(1/x)$, where x is the duty cycle.

3.2.4 Test Setup



3.2.5 Test Result of Maximum Conducted Output Power

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

For the band 5.725–5.85 GHz, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band.

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.3.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.3.3 Test Procedures

The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
Section F) Maximum power spectral density.

Method SA-2

(trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction).

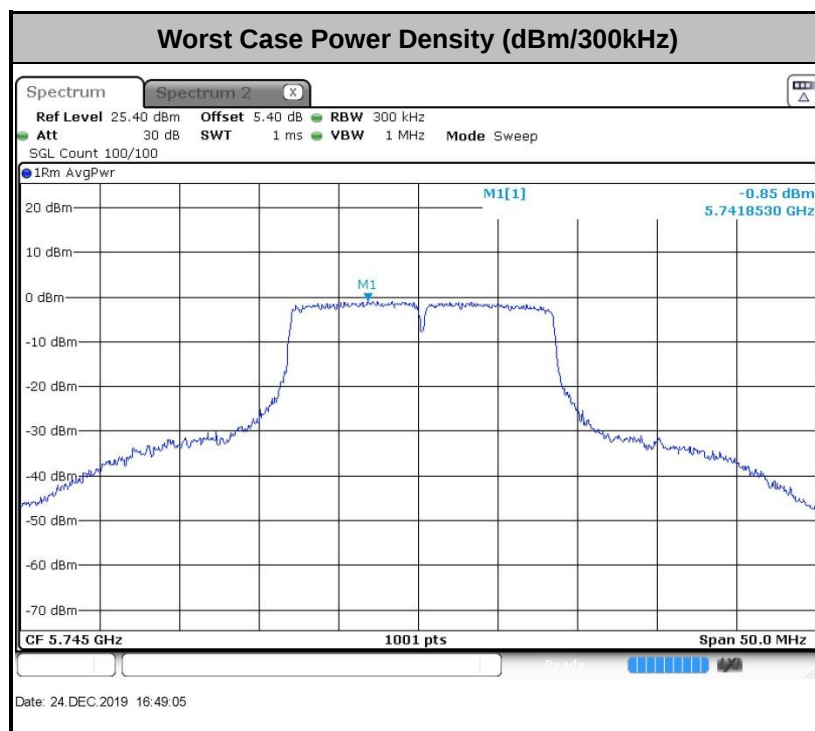
- Measure the duty cycle.
 - Set span to encompass the entire emission bandwidth (EBW) of the signal.
 - Set RBW = 300 kHz.
 - Set VBW $\geq$ 1 MHz.
 - Number of points in sweep $\geq$ 2 Span / RBW.
 - Sweep time = auto.
 - Detector = RMS
 - Trace average at least 100 traces in power averaging mode.
 - Add $10 \log(500\text{kHz}/\text{RBW})$ to the test result.
 - Add $10 \log(1/x)$, where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times. For example, add $10 \log(1/0.25) = 6$ dB if the duty cycle is 25 percent.
1. The RF output of EUT was connected to the spectrum analyzer by a low loss cable.
 2. Each plot has already offset with cable loss, and attenuator loss. Measure the PPSD and record it.

3.3.4 Test Setup



3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.



3.4 Unwanted Emissions Measurement

This section is to measure unwanted emissions through radiated measurement for band edge spurious emissions and out of band emissions measurement.

3.4.1 Limit of Unwanted Emissions

- (1) For transmitters operating in the 5.725-5.85 GHz band:

15.407(b)(4)(i) All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

- (2) Unwanted spurious emissions fallen in restricted bands shall comply with the general field strength limits as below table,

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

EIRP (dBm)	Field Strength at 3m (dBμV/m)
- 27	68.3

Note: The following formula is used to convert the EIRP to field strength.

$$\text{EIRP} = E_{\text{Meas}} + 20\log(d_{\text{Meas}}) - 104.7$$

where

EIRP is the equivalent isotropically radiated power, in dBm

E_{Meas} is the field strength of the emission at the measurement distance, in dBμV/m

d_{Meas} is the measurement distance, in m

3.4.2 Measuring Instruments

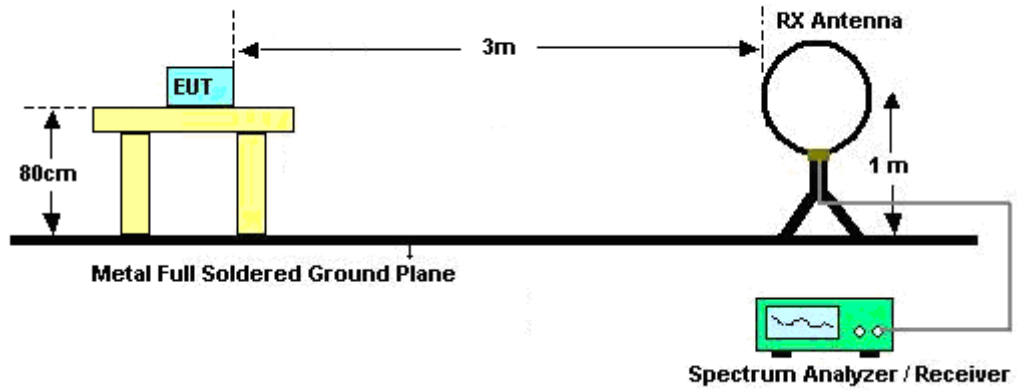
The measuring equipment is listed in the section 4 of this test report.

3.4.3 Test Procedures

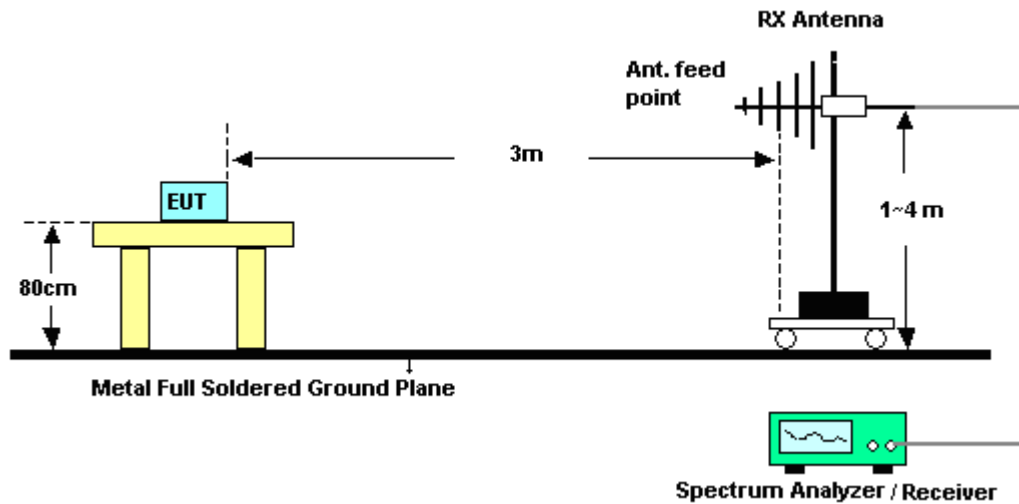
1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
Section G) Unwanted emissions measurement.
 - (1) Procedure for Unwanted Emissions Measurements Below 1000MHz
 - RBW = 120 kHz
 - VBW = 300 kHz
 - Detector = Peak
 - Trace mode = max hold
 - (2) Procedure for Peak Unwanted Emissions Measurements Above 1000 MHz
 - RBW = 1 MHz
 - VBW $\geq$ 3 MHz
 - Detector = Peak
 - Sweep time = auto
 - Trace mode = max hold
 - (3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz
 - RBW = 1 MHz
 - VBW = 10 Hz, when duty cycle is no less than 98 percent.
 - VBW $\geq$ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
2. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
3. The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
4. The antenna is a broadband antenna and its height is adjusted between one meter and four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
5. For each suspected emission, the EUT was arranged to its worst case and then adjust the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

3.4.4 Test Setup

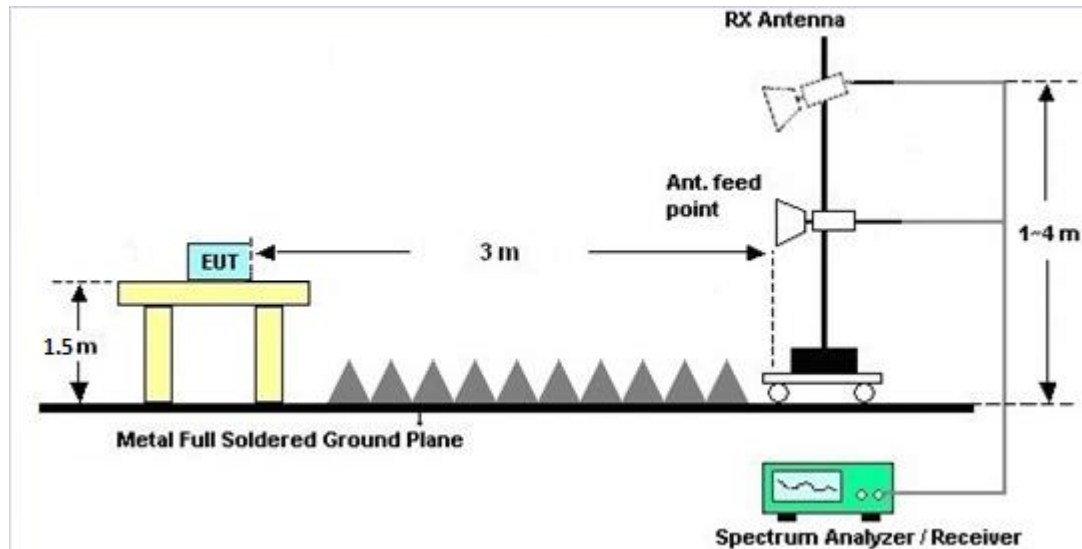
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.4.5 Test Results of Radiated Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.4.6 Test Result of Radiated Band Edges

Please refer to Appendix C.

3.4.7 Duty Cycle

Please refer to Appendix D.

3.4.8 Test Result of Unwanted Radiated Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix C.

3.5 AC Conducted Emission Measurement

3.5.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

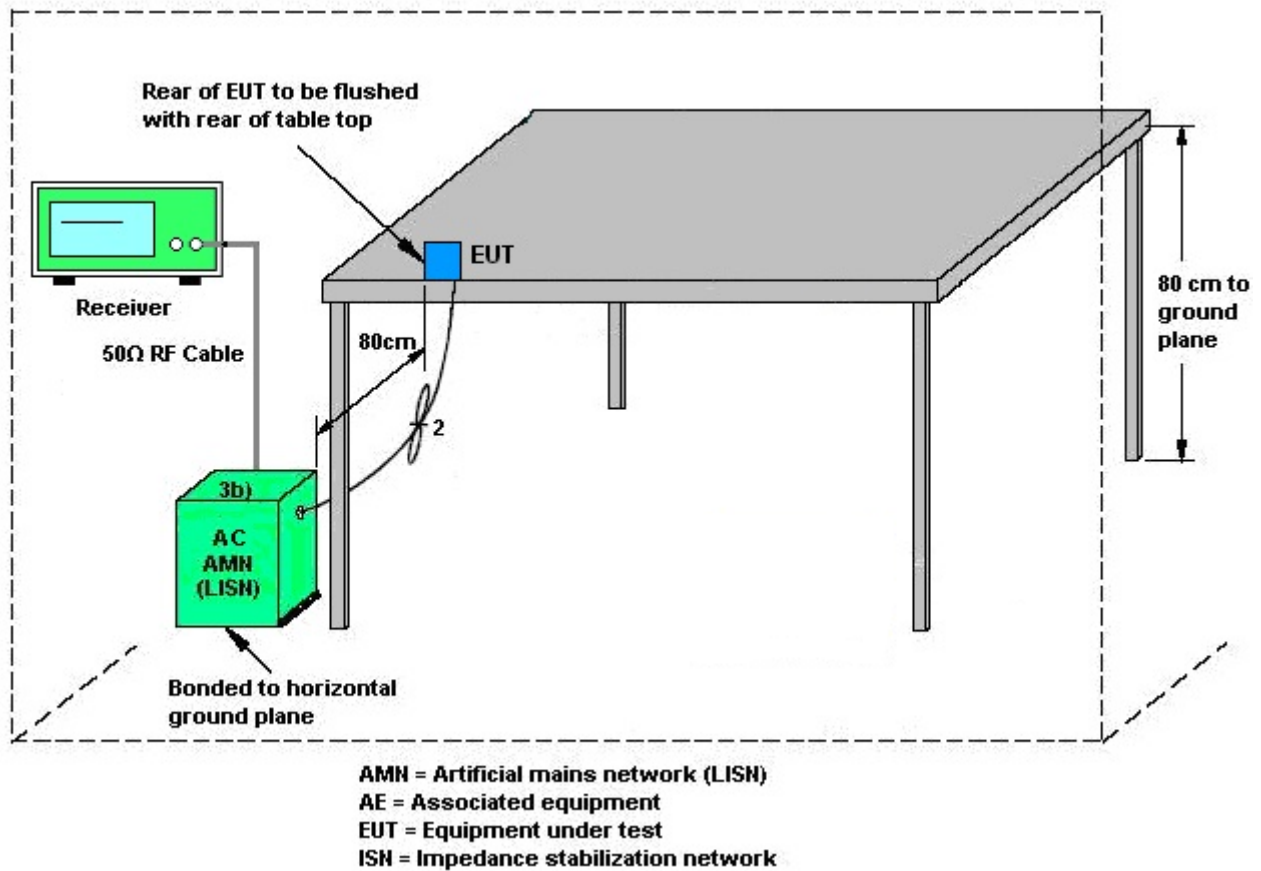
3.5.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.5.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth with Maximum Hold Mode.

3.5.4 Test Setup



3.5.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.6 Automatically Discontinue Transmission

3.6.1 Limit of Automatically Discontinue Transmission

The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signaling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization to describe how this requirement is met.

3.6.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.6.3 Test Result of Automatically Discontinue Transmission

While the EUT is not transmitting any information, the EUT can automatically discontinue transmission and become standby mode for power saving. The EUT can detect the controlling signal of ACK message transmitting from remote device and verify whether it shall resend or discontinue transmission.



3.7 Antenna Requirements

3.7.1 Standard Applicable

If transmitting antenna directional gain is greater than 6 dBi, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.



4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV40	101040	10Hz~40GHz	Aug. 06, 2019	Dec. 24, 2019	Aug. 05, 2020	Conducted (TH01-KS)
Pulse Power Sensor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 14, 2019	Dec. 24, 2019	Jan. 13, 2020	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 14, 2019	Dec. 24, 2019	Jan. 13, 2020	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY57290151	3Hz~8.5GHz; Max 30dBm	Jul..18.2019	Dec. 21, 2019	Jul..17.2020	Radiation (03CH05-KS)
EXA Spectrum Analyzer	Keysight	N9010A	MY55150244	10Hz~44G, MAX 30dB	Apr.16, 2019	Dec. 21, 2019	Apr. 15, 2020	Radiation (03CH05-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Nov. 10, 2019	Dec. 21, 2019	Nov. 9, 2020	Radiation (03CH05-KS)
Bilog Antenna	TeseQ	CBL6111D	49922	30MHz~1GHz	May. 30, 2019	Dec. 21, 2019	May. 29, 2020	Radiation (03CH05-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	75959	1GHz~18GHz	Jan. 27, 2019	Dec. 21, 2019	Jan. 26, 2020	Radiation (03CH05-KS)
SHF-EHF Horn	Com-power	AH-840	101070	18GHz~40GHz	Jan. 05, 2019	Dec. 21, 2019	Jan.04, 2020	Radiation (03CH05-KS)
Amplifier	SONOMA	310N	187289	9KHz~1GHz	Aug..06.2019	Dec. 21, 2019	Aug.05.2020	Radiation (03CH05-KS)
Amplifier	MITEQ	TTA1840-35-HG	2014749	18~40GHz	Jan. 14, 2019	Dec. 21, 2019	Jan.13, 2020	Radiation (03CH05-KS)
high gain Amplifier	MITEQ	AMF-7D-0010 1800-30-10P	2025788	1Ghz~18Ghz	Aug.17.2019	Dec. 21, 2019	Aug.16,2020	Radiation (03CH05-KS)
Amplifier	Keysight	83017A	MY53270316	500MHz~26.5GHz	Oct.18.2019	Dec. 21, 2019	Oct.17.2020	Radiation (03CH05-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	Dec. 21, 2019	NCR	Radiation (03CH05-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Dec. 21, 2019	NCR	Radiation (03CH05-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Dec. 21, 2019	NCR	Radiation (03CH05-KS)
EMI Receiver	R&S	ESCI7	100768	9kHz~7GHz;	Apr. 16, 2019	Jan. 07, 2020	Apr. 15, 2020	Conduction (CO01-KS)
AC LISN	MessTec	AN3016	060103	9kHz~30MHz	Oct. 11, 2019	Jan. 07, 2020	Oct. 10, 2020	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060103	9kHz~30MHz	Oct. 18, 2019	Jan. 07, 2020	Oct. 17, 2020	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP000000811	AC 0V~300V, 45Hz~1000Hz	Oct. 11, 2019	Jan. 07, 2020	Oct. 10, 2020	Conduction (CO01-KS)

NCR: No Calibration Required

5 Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Emission Measurement (150kHz ~ 30MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	2.9dB
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Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.0dB
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.0dB
---	-------

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.0dB
---	-------



Appendix A. Conducted Test Results

Report Number : FR9O3006D

Test Engineer:	Aly Cao	Temperature:	21~25	°C
Test Date:	2019/12/24	Relative Humidity:	51~54	%

TEST RESULTS DATA
6dB and 26dB EBW and 99% OBW

Band IV									
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)	6 dB Bandwidth (MHz)	6dB Bandwidth min. Limit (MHz)	Pass/Fail
11a	6M bps	1	149	5745	18.58	31.419	16.3237	0.5	Pass
11a	6Mbps	1	157	5785	18.13	24.176	16.3037	0.5	Pass
11a	6Mbps	1	165	5825	17.98	23.277	16.3237	0.5	Pass
HT20	MCS 0	1	149	5745	18.88	24.176	17.2627	0.5	Pass
HT20	MCS 0	1	157	5785	18.78	24.326	17.5425	0.5	Pass
HT20	MCS 0	1	165	5825	18.78	23.876	17.3027	0.5	Pass
HT40	MCS 0	1	151	5755	36.06	40.1	35.3247	0.5	Pass
HT40	MCS 0	1	159	5795	35.96	39.74	35.1249	0.5	Pass

TEST RESULTS DATA
Average Power Table

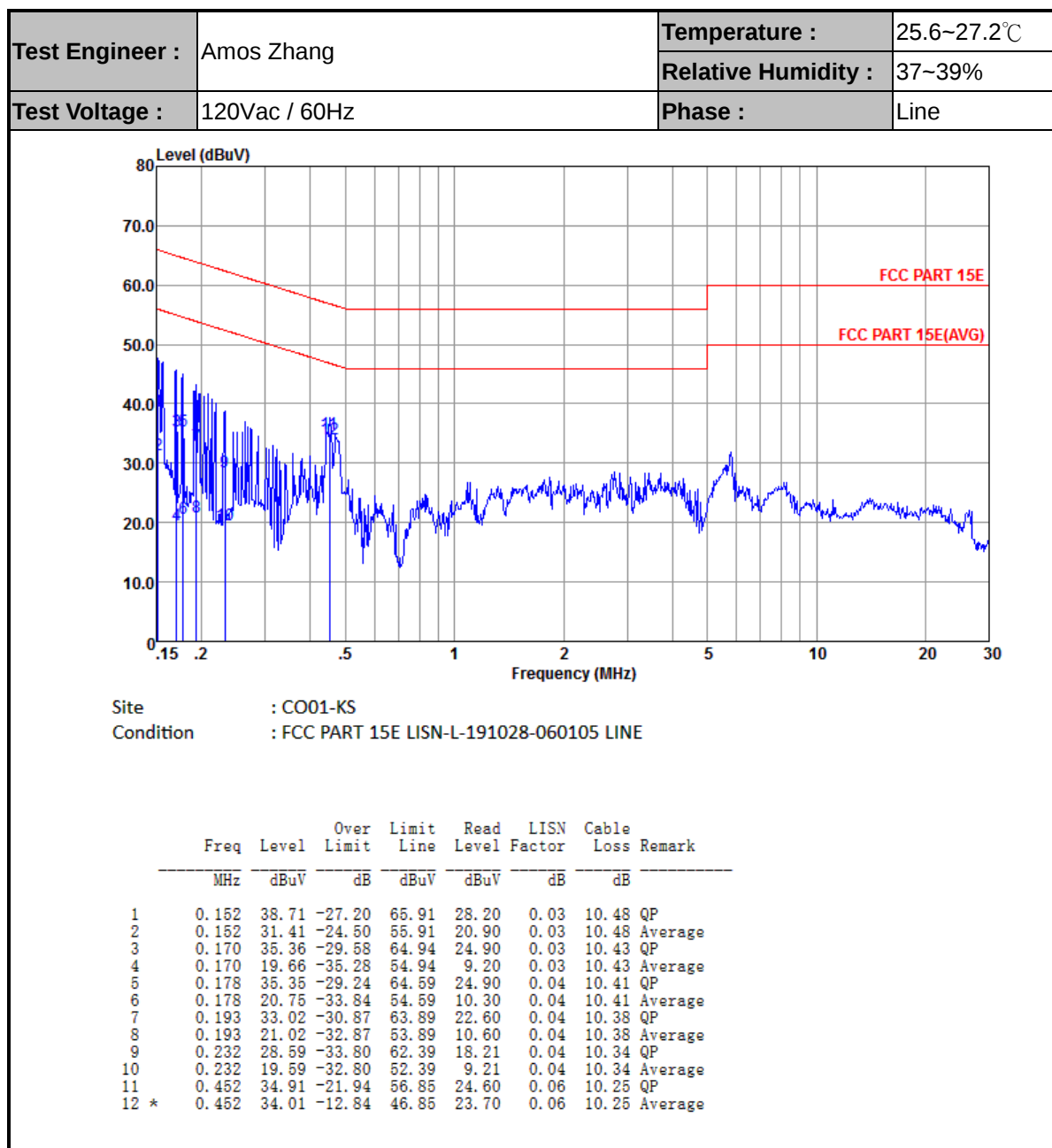
Band IV										
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)	FCC Conducted Power Limit (dBm)	DG (dBi)		Pass/Fail
11a	6M bps	1	149	5745	0.27	14.15	30.00	2.60		Pass
11a	6Mbps	1	157	5785	0.27	13.25	30.00	2.60		Pass
11a	6Mbps	1	165	5825	0.27	12.56	30.00	2.60		Pass
HT20	MCS 0	1	149	5745	0.29	12.71	30.00	2.60		Pass
HT20	MCS 0	1	157	5785	0.29	11.88	30.00	2.60		Pass
HT20	MCS 0	1	165	5825	0.29	11.38	30.00	2.60		Pass
HT40	MCS 0	1	151	5755	0.56	11.98	30.00	2.60		Pass
HT40	MCS 0	1	159	5795	0.56	10.75	30.00	2.60		Pass

TEST RESULTS DATA
Power Spectral Density

Band IV										
Mod.	Data Rate	N _{TX}	CH.	Freq. (MHz)	Duty Factor (dB)	10log (500kHz /RBW) Factor (dB)	Average Power Density (dBm/500kHz)	Average PSD Limit (dBm/500kHz)	DG (dBi)	Pass/Fail
11a	6M bps	1	149	5745	0.27	2.22	1.64	30.00	2.60	Pass
11a	6Mbps	1	157	5785	0.27	2.22	0.72	30.00	2.60	Pass
11a	6Mbps	1	165	5825	0.27	2.22	0.00	30.00	2.60	Pass
HT20	MCS 0	1	149	5745	0.29	2.22	-0.72	30.00	2.60	Pass
HT20	MCS 0	1	157	5785	0.29	2.22	-1.43	30.00	2.60	Pass
HT20	MCS 0	1	165	5825	0.29	2.22	-1.64	30.00	2.60	Pass
HT40	MCS 0	1	151	5755	0.56	2.22	-4.49	30.00	2.60	Pass
HT40	MCS 0	1	159	5795	0.56	2.22	-5.56	30.00	2.60	Pass

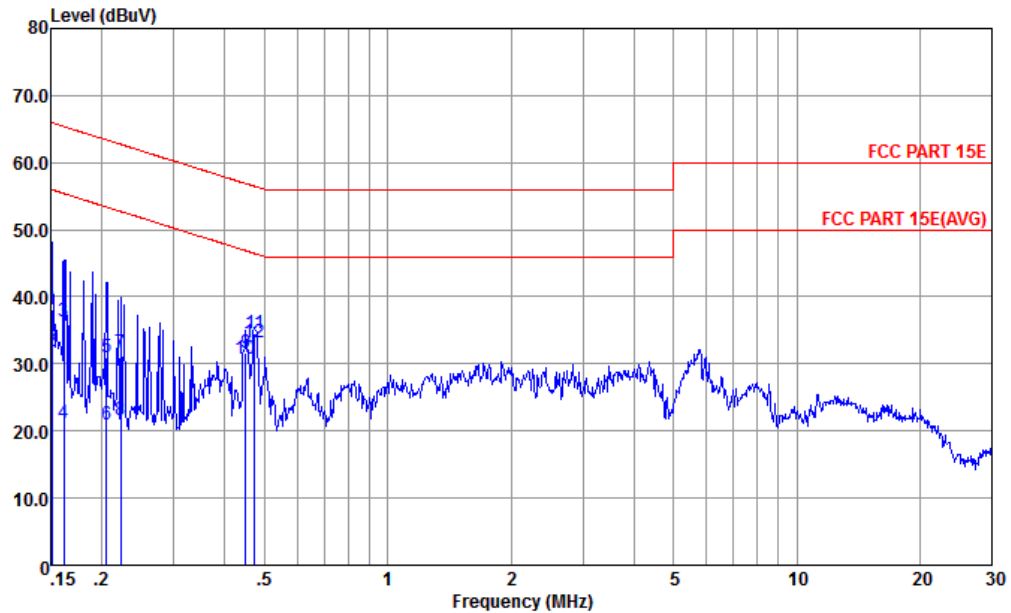


Appendix B. AC Conducted Emission Test Results





Test Engineer :	Amos Zhang	Temperature :	25.6~27.2℃
		Relative Humidity :	37~39%
Test Voltage :	120Vac / 60Hz	Phase :	Neutral



Site : CO01-KS
Condition : FCC PART 15E LISN-N-191028-060105 NEUTRAL

	Freq	Level	Over	Limit	Read	LISN	Cable	Remark
	MHz	dBuV	Limit	Line	Level	Factor	Loss	
			dB	dBuV	dBuV	dB	dB	
1	0.151	38.16	-27.80	65.96	27.60	0.08	10.48	QP
2	0.151	31.86	-24.10	55.96	21.30	0.08	10.48	Average
3	0.162	36.43	-28.95	65.38	25.90	0.08	10.45	QP
4	0.162	21.13	-34.25	55.38	10.60	0.08	10.45	Average
5	0.205	31.04	-32.36	63.40	20.60	0.08	10.36	QP
6	0.205	21.04	-32.36	53.40	10.60	0.08	10.36	Average
7	0.222	31.63	-31.11	62.74	21.20	0.08	10.35	QP
8	0.222	21.63	-31.11	52.74	11.20	0.08	10.35	Average
9	0.449	31.65	-25.24	56.89	21.30	0.10	10.25	QP
10	0.449	30.65	-16.24	46.89	20.30	0.10	10.25	Average
11	0.474	34.44	-22.01	56.45	24.10	0.10	10.24	QP
12 *	0.474	33.24	-13.21	46.45	22.90	0.10	10.24	Average

Note:

1. Level(dBμV) = Read Level(dBμV) + LISN Factor(dB) + Cable Loss(dB)
2. Over Limit(dB) = Level(dBμV) – Limit Line(dBμV)



Appendix C. Radiated Spurious Emission

Band 4 - 5725~5850MHz

WIFI 802.11a (Band Edge @ 3m)

WIFI Ant.	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11a CH 149 5745MHz		5626.8	54.88	-13.42	68.3	42.96	34.68	8.55	31.31	108	144	P	H
		5663.2	53.99	-24.11	78.1	42.15	34.72	8.58	31.46	108	144	P	H
		5714	56.68	-52.54	109.22	45.08	34.76	8.61	31.77	108	144	P	H
		5724.8	62.89	-58.95	121.84	51.42	34.78	8.61	31.92	108	144	P	H
		5746	104.44	-	-	93.08	34.79	8.64	32.07	108	144	P	H
		5746	96.81	-	-	85.45	34.79	8.64	32.07	108	144	A	H
		5626.8	53.94	-14.36	68.3	42.02	34.68	8.55	31.31	400	101	P	V
		5654.4	52.34	-19.23	71.57	40.38	34.72	8.55	31.31	400	101	P	V
		5702.8	52.07	-54.02	106.09	40.47	34.76	8.61	31.77	400	101	P	V
		5724.8	56.14	-65.7	121.84	44.67	34.78	8.61	31.92	400	101	P	V
		5740	100.92	-	-	89.56	34.79	8.64	32.07	400	101	P	V
		5740	93.16	-	-	81.8	34.79	8.64	32.07	400	101	A	V



WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11a CH 165 5825MHz		5850.4	59.61	-61.78	121.39	48.85	34.88	8.72	32.84	100	111	P	H
		5874.8	53.73	-51.63	105.36	43.03	34.91	8.77	32.98	100	111	P	H
		5875.2	53.73	-51.42	105.15	43.03	34.91	8.77	32.98	100	111	P	H
		5944.4	52.58	-15.72	68.3	41.69	34.94	8.88	32.93	100	111	P	H
		5830	103.19	-	-	92.28	34.87	8.72	32.68	100	111	P	H
		5830	95.54	-	-	84.63	34.87	8.72	32.68	100	111	A	H
		5850	53.08	-69.22	122.3	42.32	34.88	8.72	32.84	393	37	P	V
		5862	52.13	-56.81	108.94	41.45	34.9	8.77	32.99	393	37	P	V
		5888.4	51.2	-44.15	95.35	40.49	34.92	8.77	32.98	393	37	P	V
		5973.2	51.71	-16.59	68.3	40.72	34.96	8.93	32.9	393	37	P	V
		5824	100.85	-	-	89.94	34.87	8.72	32.68	393	37	P	V
		5824	92.39	-	-	81.48	34.87	8.72	32.68	393	37	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Band 4 5725~5850MHz

WIFI 802.11a (Harmonic @ 3m)

WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11a CH 149 5745MHz		11490	48.09	-25.91	74	62.43	37.69	12.74	64.77	100	360	P	H
		11490	45.09	-28.91	74	59.43	37.69	12.74	64.77	100	360	P	V
802.11a CH 157 5785MHz		11570	48.75	-25.25	74	62.59	37.84	12.79	64.47	100	360	P	H
		11570	48	-26	74	61.84	37.84	12.79	64.47	100	360	P	V
802.11a CH 165 5825MHz		11650	50.38	-23.62	74	63.71	37.98	12.85	64.16	100	360	P	H
		11650	41.91	-12.09	54	55.24	37.98	12.85	64.16	100	75	A	H
		11650	48.41	-25.59	74	61.74	37.98	12.85	64.16	100	360	P	V
		11650	41.64	-12.36	54	54.97	37.98	12.85	64.16	100	92	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Band 4 5725~5850MHz

WIFI 802.11n HT20 (Band Edge @ 3m)

WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11n HT20 CH 149 5745MHz		5631.6	53.53	-14.77	68.3	41.61	34.68	8.55	31.31	100	144	P	H
		5650.4	54	-14.6	68.6	42.04	34.72	8.55	31.31	100	144	P	H
		5700.4	54.25	-51.16	105.41	42.66	34.75	8.61	31.77	100	144	P	H
		5724.8	62.39	-59.45	121.84	50.92	34.78	8.61	31.92	100	144	P	H
		5746	102.97	-	-	91.61	34.79	8.64	32.07	100	144	P	H
		5746	94.93	-	-	83.57	34.79	8.64	32.07	100	144	A	H
		5631.6	52.53	-15.77	68.3	40.61	34.68	8.55	31.31	386	38	P	V
		5664.8	51.55	-27.74	79.29	39.71	34.72	8.58	31.46	386	38	P	V
		5702	52.6	-53.26	105.86	41	34.76	8.61	31.77	386	38	P	V
		5723.2	54.02	-64.18	118.2	42.55	34.78	8.61	31.92	386	38	P	V
		5752	97.21	-	-	85.83	34.81	8.64	32.07	386	38	P	V
		5752	90.33	-	-	78.95	34.81	8.64	32.07	386	38	A	V



WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11n HT20 CH 165 5825MHz		5852.4	54.76	-62.07	116.83	44	34.88	8.72	32.84	100	110	P	H
		5855.2	52.17	-58.67	110.84	41.54	34.9	8.72	32.99	100	110	P	H
		5877.2	52.56	-51.11	103.67	41.86	34.91	8.77	32.98	100	110	P	H
		5941.2	52.47	-15.83	68.3	41.58	34.94	8.88	32.93	100	110	P	H
		5830	102.05	-	-	91.14	34.87	8.72	32.68	100	110	P	H
		5830	94.38	-	-	83.47	34.87	8.72	32.68	100	110	A	H
		5851.6	51.43	-67.22	118.65	40.67	34.88	8.72	32.84	389	89	P	V
		5860.8	51.26	-58.01	109.27	40.58	34.9	8.77	32.99	389	89	P	V
		5898.4	52.28	-35.67	87.95	41.5	34.92	8.82	32.96	389	89	P	V
		5953.6	51.69	-16.61	68.3	40.79	34.94	8.88	32.92	389	89	P	V
		5824	97.89	-	-	86.98	34.87	8.72	32.68	389	89	P	V
		5824	90.54	-	-	79.63	34.87	8.72	32.68	389	89	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Band 4 5725~5850MHz

WIFI 802.11n HT20 (Harmonic @ 3m)

WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11n HT20		11490	46.9	-27.1	74	61.24	37.69	12.74	64.77	100	360	P	H
CH 149 5745MHz		11490	43.65	-30.35	74	57.99	37.69	12.74	64.77	100	360	P	V
802.11n HT20		11570	46.58	-27.42	74	60.42	37.84	12.79	64.47	100	360	P	H
CH 157 5785MHz		11570	47.25	-26.75	74	61.09	37.84	12.79	64.47	100	360	P	V
802.11n HT20		11650	46.48	-27.52	74	59.81	37.98	12.85	64.16	100	348	P	H
CH 165		11650	38.95	-15.05	54	52.28	37.98	12.85	64.16	100	348	A	H
5825MHz		11650	47.43	-26.57	74	60.76	37.98	12.85	64.16	100	360	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Band 4 5725~5850MHz

WIFI 802.11n HT40 (Band Edge @ 3m)

WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11n HT40 CH 151 5755MHz		5620.8	54.28	-14.02	68.3	42.39	34.68	8.52	31.31	100	144	P	H
		5658.4	53.38	-21.16	74.54	41.57	34.72	8.55	31.46	100	144	P	H
		5718.8	54.89	-55.67	110.56	43.42	34.78	8.61	31.92	100	144	P	H
		5722.8	55.99	-61.29	117.28	44.52	34.78	8.61	31.92	100	144	P	H
		5758	99	-	-	87.78	34.81	8.64	32.23	100	144	P	H
		5758	91.21	-	-	79.99	34.81	8.64	32.23	100	144	A	H
		5853.6	49.92	-64.17	114.09	39.29	34.9	8.72	32.99	100	144	P	H
		5866.8	52.41	-55.18	107.59	41.73	34.9	8.77	32.99	100	144	P	H
		5885.6	51.74	-45.69	97.43	41.04	34.91	8.77	32.98	100	144	P	H
		5940.4	51.51	-16.79	68.3	40.62	34.94	8.88	32.93	100	144	P	H
		5633.2	52.61	-15.69	68.3	40.67	34.7	8.55	31.31	100	261	P	V
		5665.6	52.16	-27.72	79.88	40.32	34.72	8.58	31.46	100	261	P	V
		5719.6	52.78	-58.01	110.79	41.31	34.78	8.61	31.92	100	261	P	V
		5723.6	52.47	-66.64	119.11	41	34.78	8.61	31.92	100	261	P	V
		5758	93.41	-	-	82.19	34.81	8.64	32.23	100	261	P	V
		5758	85.62	-	-	74.4	34.81	8.64	32.23	100	261	A	V
		5850	50.51	-71.79	122.3	39.75	34.88	8.72	32.84	100	261	P	V
		5861.6	52.02	-57.03	109.05	41.34	34.9	8.77	32.99	100	261	P	V
		5895.2	52.87	-37.44	90.31	42.09	34.92	8.82	32.96	100	261	P	V
		5946	51.42	-16.88	68.3	40.53	34.94	8.88	32.93	100	261	P	V



WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11n HT40 CH 159 5795MHz		5637.6	52.43	-15.87	68.3	40.49	34.7	8.55	31.31	100	147	P	H
		5670.8	53.55	-30.18	83.73	41.7	34.73	8.58	31.46	100	147	P	H
		5714.8	53.6	-55.85	109.45	42	34.76	8.61	31.77	100	147	P	H
		5720	53.24	-57.66	110.9	41.77	34.78	8.61	31.92	100	147	P	H
		5806	97.72	-	-	86.73	34.85	8.67	32.53	100	147	P	H
		5806	90.24	-	-	79.25	34.85	8.67	32.53	100	147	A	H
		5851.6	50.92	-67.73	118.65	40.16	34.88	8.72	32.84	100	147	P	H
		5862	51.67	-57.27	108.94	40.99	34.9	8.77	32.99	100	147	P	H
		5894	52.26	-38.94	91.2	41.53	34.92	8.77	32.96	100	147	P	H
		5926.4	52.05	-16.25	68.3	41.25	34.93	8.82	32.95	100	147	P	H
		5608	52.28	-16.02	68.3	40.41	34.66	8.52	31.31	100	263	P	V
		5664	51.91	-26.78	78.69	40.07	34.72	8.58	31.46	100	263	P	V
		5704.8	51.14	-55.51	106.65	39.54	34.76	8.61	31.77	100	263	P	V
		5721.6	50.78	-63.77	114.55	39.31	34.78	8.61	31.92	100	263	P	V
		5788	92.33	-	-	81.2	34.84	8.67	32.38	100	263	P	V
		5788	84.97	-	-	73.84	34.84	8.67	32.38	100	263	A	V
		5850.4	50.53	-70.86	121.39	39.77	34.88	8.72	32.84	100	263	P	V
		5860	51.64	-57.86	109.5	40.96	34.9	8.77	32.99	100	263	P	V
		5875.6	51.77	-53.08	104.85	41.07	34.91	8.77	32.98	100	263	P	V
		5964.4	51.41	-16.89	68.3	40.5	34.95	8.88	32.92	100	263	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Band 4 5725~5850MHz

WIFI 802.11n HT40 (Harmonic @ 3m)

WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11n HT40		11510	43.36	-30.64	74	57.69	37.7	12.74	64.77	100	360	P	H
CH 151 5755MHz		11510	42.14	-31.86	74	56.47	37.7	12.74	64.77	100	360	P	V
802.11n HT40		11590	44.83	-29.17	74	58.53	37.87	12.82	64.39	100	360	P	H
CH 159 5795MHz		11590	47.18	-26.82	74	60.88	37.87	12.82	64.39	100	360	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Band 4 5725~5850MHz

Emission below 1GHz

5GHz WIFI 802.11a (LF @ 3m)

WIFI Ant.	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamplifier Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
5GHz 802.11a LF		41.64	24.52	-15.48	40	38	19.06	0.56	33.1	-	-	P	H
		191.99	31.69	-11.81	43.5	46.7	16.49	1.42	32.92	-	-	P	H
		216.24	35.99	-10.01	46	50	17.35	1.51	32.87	-	-	P	H
		320.03	39.03	-6.97	46	49.26	20.64	1.87	32.74	-	-	P	H
		384.05	38.9	-7.1	46	47.1	22.19	2.07	32.46	-	-	P	H
		480.08	40.48	-5.52	46	46.54	24.02	2.3	32.38	100	0	P	H
		45.52	24.72	-15.28	40	41.08	16.15	0.59	33.1	-	-	P	V
		144.46	21.81	-21.69	43.5	36.63	16.97	1.22	33.01	-	-	P	V
		455.83	30.3	-15.7	46	37.69	22.6	2.24	32.23	-	-	P	V
		480.08	34.03	-11.97	46	41.07	23.04	2.3	32.38	100	0	P	V
		504.33	30.1	-15.9	46	36.82	23.45	2.36	32.53	-	-	P	V
		576.11	28.82	-17.18	46	34.82	24.31	2.54	32.85	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

**Note symbol**

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is over limit line.
P/A	P eak or A verage
H/V	H orizontal or V ertical



A calculation example for radiated spurious emission is shown as below:

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
2		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
CH 01													
2412MHz		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Level(dBμV/m) =

Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

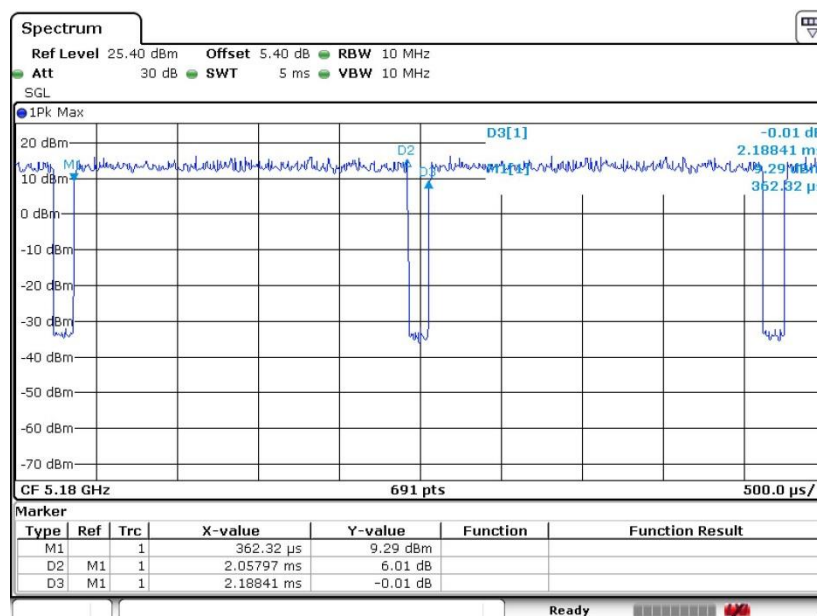
= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is “PASS”.

Appendix D. Duty Cycle Plots

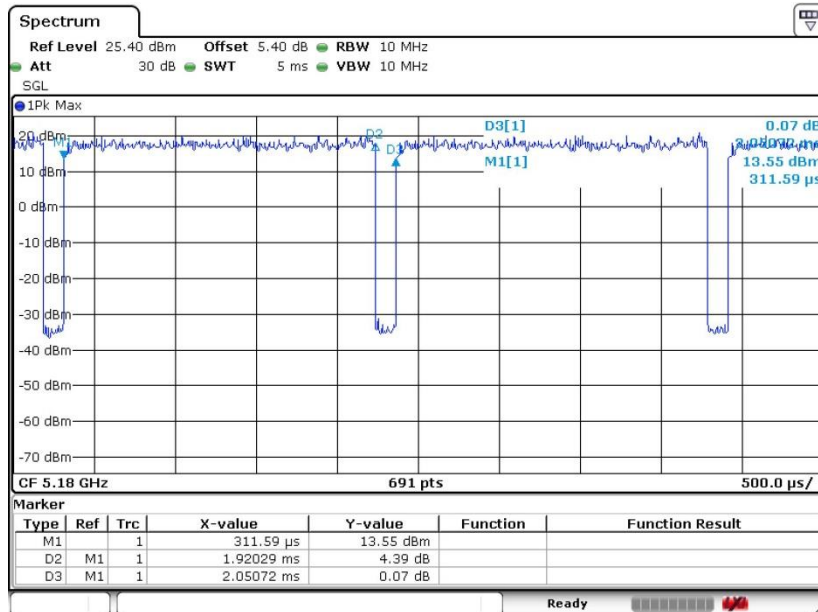
Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
802.11a	94.04	2.058	0.486	0.51KHz
802.11n HT20	93.64	1.920	0.521	0.56KHz
802.11n HT40	87.84	0.942	1.062	1.1KHz

802.11a





802.11n HT20



802.11n HT40

