TEST REPORT

Report Number	:	TZ0032260406FRF04
Product Name	:	Wanbo Projector
Model/Type reference	:	Cube 2S, Cube 2, Cube 2 Air, Cube 2 Play, Cube 2 Vibe, Cube 2 beo, Cube 2 Mini, Cube 2 Prime, Cube 2 Pro
FCC ID	:	2A7PI-CUBE2
Prepared for	:	Shenzhen wanbo Technology Co., Ltd. 4th Floor, Building 1, Chuangjian Phase 2, Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China

Prepared By	:	Shenzhen Tongzhou Testing Co.,Ltd. 1st Floor, Building 1, Haomai High-tech Park, Huating Road 387, Dalang Street, Longhua, Shenzhen, China
Standards	:	FCC CFR Title 47 Part 15E, ANSI C63.10-2020 + Cor.1-2023
Date of Test	:	2026-04-23 ~ 2026-05-19
Date of Issue	:	2026-05-20
Prepared by	:	Lena Wen
Reviewed by	:	Allen Lai
Approved by	:	Max Zhang (Authorized Officer)

This publication may be reproduced in whole or in part for non-commercial purposes as long as the Shenzhen Tongzhou Testing Co.,Ltd. is acknowledged as copyright owner and source of the material. Shenzhen Tongzhou Testing Co.,Ltd. takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.
The test report apply only to the specific sample(s) tested under stated test conditions.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

** Report Revise Record **

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	2026-05-20	Valid	Initial release

TABLE OF CONTENTS

1. GENERAL INFORMATION 4
1.1. Client Information 4
1.2. Description of Device (EUT) 4
1.3. Wireless Function Tested in this Report 4
1.4. EUT configuration 5
1.5. Description of Test Facility 5
1.6. Statement of the Measurement Uncertainty 6
1.7. Measurement Uncertainty 6
1.8. Description of Test Modes 6
2. TEST METHODOLOGY 7
2.1. EUT Configuration 7
2.2. EUT Exercise 7
2.3. Test Sample 7
3. SYSTEM TEST CONFIGURATION 8
3.1. Justification 8
3.2. EUT Exercise Software 8
3.3. Special Accessories 8
3.4. Block Diagram/Schematics 8
3.5. Equipment Modifications 8
3.6. Test Setup 8
4. SUMMARY OF TEST RESULTS 9
5. TEST RESULT 10
5.1. On Time and Duty Cycle 10
5.2. Maximum Conducted Output Power Measurement 11
5.3. Power Spectral Density Measurement 13
5.4. 99% Occupied Bandwidth and 26dB Emission Bandwidth Measurement 15
5.5. Radiated Emissions Measurement 16
5.6. Power line conducted emissions 27
5.7. Undesirable Emissions Measurement 30
5.8. Antenna Requirements 37
5.9. Frequency Stability 38
6. LIST OF MEASURING EQUIPMENT 39
7. TEST SETUP PHOTOGRAPHS OF EUT 40
8. EXTERIOR PHOTOGRAPHS OF THE EUT 40
9. INTERIOR PHOTOGRAPHS OF THE EUT 40

1. GENERAL INFORMATION

1.1. Client Information

Applicant	:	Shenzhen wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2, Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China
Manufacturer	:	Shenzhen wanbo Technology Co., Ltd.
Address	:	4th Floor, Building 1, Chuangjian Phase 2, Industrial Park, Yingrenshi Community, Shiyan Street, Baoan District, Shenzhen, China

1.2. Description of Device (EUT)

Product Name	:	Wanbo Projector
Trade Mark	:	wanbo
Model Number	:	Cube 2S, Cube 2, Cube 2 Air, Cube 2 Play, Cube 2 Vibe, Cube 2 beo, Cube 2 Mini, Cube 2 Prime, Cube 2 Pro
Model Declaration	:	All the same except for the model name
Test Model	:	Cube 2S
Power Supply	:	Input: AC 100~240V 50/60Hz 2A (Max)
Hardware version	:	CVTE_9660_S02_WB
Software version	:	V1.0

1.3. Wireless Function Tested in this Report

WiFi		
WLAN	:	Supported IEEE 802.11a/n/ac
WLAN FCC Operation Frequency	:	IEEE 802.11a: 5180-5240MHz IEEE 802.11n HT20/ac VHT20: 5180-5240MHz IEEE 802.11n HT40/ac VHT40: 5190-5230MHz IEEE 802.11ac VHT80: 5210MHz
WLAN Channel Number	:	4 Channels for 5180-5240MHz (IEEE 802.11a/ac VHT20/n HT20) 2 Channels for 5190-5230MHz (IEEE 802.11ac VHT40/n HT40) 1 Channels for 5210MHz (IEEE 802.11ac VHT80)
WLAN Modulation Technology	:	IEEE 802.11n: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11a: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ac: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK)
Antenna Type And Gain	:	Internal antenna, antenna1: 6.85dBi, antenna2: 3.86dBi For power, the MIMO directional gain is 6.85dBi For PSD, the MIMO directional gain is 9.85dBi

Note 1: Antenna position refer to EUT Photos.
Note 2: the above information was supplied by the applicant.

1.4. EUT configuration

The following peripheral devices and interface cables were connected during the measurement:
●supplied by the manufacturer

○supplied by the lab

●	/	Model:	/
		Input:	/
		Output:	/

1.5. Description of Test Facility

FCC

Designation Number: CN1275
Test Firm Registration Number: 167722
Shenzhen Tongzhou Testing Co.,Ltd has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

A2LA

Certificate Number: 5463.01
Shenzhen Tongzhou Testing Co.,Ltd has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

IC

ISED#: 22033
CAB identifier: CN0099
Shenzhen Tongzhou Testing Co.,Ltd has been listed by Innovation, Science and Economic Development Canada to perform electromagnetic emission measurement.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010

1.6. 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 Tongzhou Testing 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.

1.7. Measurement Uncertainty

Test Item		Uncertainty	Note
Radiation Uncertainty(9KHz~30MHz)	:	±3.26dB	(1)
Radiation Uncertainty(30MHz~1000MHz)	:	±3.92dB	(1)
Radiation Uncertainty(1GHz~40GHz)	:	±5.62dB	(1)
Conduction Uncertainty	:	±2.71dB	(1)
Occupied Channel Bandwidth	:	±3.0%	(1)
RF power, conducted	:	±0.16dB	(1)
Power Spectral Density, conducted	:	±1.3dB	(1)
Unwanted Emissions, conducted	:	±1.3dB	(1)
Time	:	±1.0%	(1)
Duty Cycle	:	±3.0%	(1)

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

1.8. Description of Test Modes

The EUT has been tested under operating condition.

This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Worst-case mode and channel used for 150 kHz-30 MHz power line conducted emissions was the mode and channel with the highest output power that was determined to be **802.11n HT20 middle channel**.

Worst-case mode and channel used for 9kHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be **802.11n HT20 middle channel**.

Worst-Case data rates were utilized from preliminary testing of the Chipset, worst-case datarates used during the testing are as follows:

IEEE 802.11a Mode : 6 Mbps, OFDM
IEEE 802.11ac VHT20 Mode: MCS0
IEEE 802.11n HT20 Mode: MCS0
IEEE 802.11ac VHT40 Mode: MCS0
IEEE 802.11n HT40 Mode: MCS0
IEEE 802.11ac VHT80 Mode: MCS0

Antenna & Bandwidth

Antenna	Antenna 1			Antenna 2			Simultaneously
Bandwidth Mode	20MHz	40MHz	80MHz	20MHz	40MHz	80MHz	/
IEEE 802.11a	☑	☐	☐	☑	☐	☐	☐
IEEE 802.11n	☑	☑	☐	☑	☑	☐	☑
IEEE 802.11ac	☑	☑	☑	☑	☑	☑	☑

Note: For the 802.11n/ac modes, each transmit chain uses the same configured power level under both SISO and MIMO operation. SISO operation does not apply any additional power boost or different RF power setting to either antenna chain. Since MIMO operation activates both antenna chains simultaneously and represents the highest aggregate output power condition, the MIMO configuration was selected as the worst case for testing.

2. TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2020 + Cor.1-2023, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen Tongzhou Testing Co.,Ltd

2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2. EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to FCC's request, Test Procedure 789033 D02 General UNII Test Procedures New Rules v02r01 and KDB 662911 are required to be used for this kind of FCC 15.407 UII device.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209 and 15.407 under the FCC Rules Part 15 Subpart E

2.3. Test Sample

Sample ID	Description
TZ0032260406–1#	Engineer sample – continuous transmit
TZ0032260406–2#	Normal sample – Intermittent transmit

3. SYSTEM TEST CONFIGURATION

3.1. Justification

The system was configured for testing in a continuous transmits condition.

3.2. EUT Exercise Software

The system was configured for testing in a continuous transmits condition and change test channels by engineer mode (Xshell 7(Build 0076) at power level 10) provided by application.

3.3. Special Accessories

No.	Equipment	Manufacturer	Model No.	Serial No.	Length	shielded/ unshielded	Notes
/	/	/	/	/	/	/	/

3.4. Block Diagram/Schematics

Please refer to the related documentg

3.5. Equipment Modifications

Shenzhen Tongzhou Testing Co.,Ltd has not done any modification on the EUT.

3.6. Test Setup

Please refer to the test setup photo.

4. SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Sample ID	Result
§15.407(a)	Maximum Conducted Output Power	TZ0032260406–1#	Compliant
§15.407(a)	Power Spectral Density	TZ0032260406–1#	Compliant
§15.407(a)	26dB Bandwidth	TZ0032260406–1#	Compliant
/	99% Occupied Bandwidth	TZ0032260406–1#	Note 1
§15.407(b)	Radiated Emissions	TZ0032260406–1#& TZ0032260406–2#	Compliant
§15.407(b)	Band edge Emissions	TZ0032260406–1#	Compliant
§15.205	Emissions at Restricted Band	TZ0032260406–1#	Compliant
§15.407(g)	Frequency Stability	TZ0032260406–1#	Compliant
§15.207(a)	Line Conducted Emissions	TZ0032260406–2#	Compliant
§15.203	Antenna Requirements	N/A	Compliant
Note 1: only for report purpose.			

Remark: The measurement uncertainty is not included in the test result.

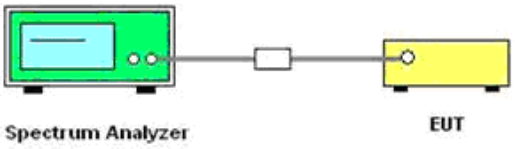
5. TEST RESULT

5.1. On Time and Duty Cycle

5.1.1. Standard Applicable

None. for reporting purpose only.

5.1.2. Block Diagram of Test Setup



5.1.3. Test Procedures

1. Set the centre frequency of the spectrum analyzer to the transmitting frequency.
2. Set the span=0MHz, RBW=8MHz, VBW=8MHz.
3. Detector = peak.
4. Trace mode = Single hold.

5.1.4. Test result

Pass

Remark:

1. Please refer to Appendix F of Appendix Test Data for RLAN(5.2G).

5.2. Maximum Conducted Output Power Measurement

5.2.1. Standard Applicable

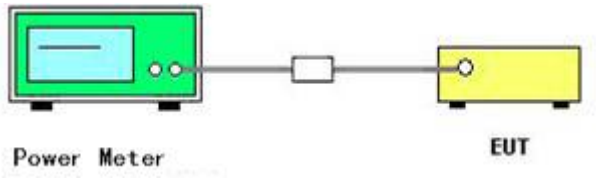
(1) For the band 5.15-5.25 GHz.
(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1dB reduction in maximum conducted output power is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.2.2. Block Diagram of Test Setup



5.2.3. Test Procedures

The transmitter output (antenna port) was connected to the power meter.

According to KDB 789033 D02 Section 3 (a) Method PM (Measurement using an RF average power meter): Measurements may be performed using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.

The EUT is configured to transmit continuously or to transmit with a constant duty cycle.

At all times when the EUT is transmitting, it must be transmitting at its maximum power control level.

The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

If the transmitter does not transmit continuously, measure the duty cycle, x, of the transmitter output signal as described in section II.B.

Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.

Adjust the measurement in dBm by adding 10 log (1/x) where x is the duty cycle (e.g., 10 log (1/0.25) if the duty cycle is 25%).

5.2.4. Test Results

Pass

Remark:

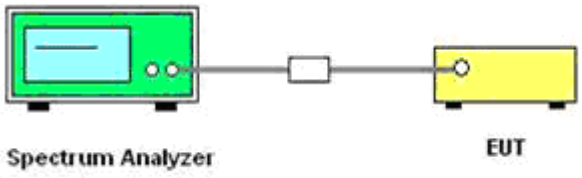
1. Measured output power at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss.
3. Report conducted power = Measured conducted average power + Duty Cycle factor.
4. Please refer to Appendix B of Appendix Test Data for RLAN(5.2G).

5.3. Power Spectral Density Measurement

5.3.1. Standard Applicable

For 5150~5250MHz
(i) For an outdoor access point operating in the band 5.15 - 5.25 GHz, the maximum power spectral density shall not exceed 17 dBm in any 1 MHz band.note1
(ii) For an indoor access point operating in the band 5.15 - 5.25 GHz, the maximum power spectral density shall not exceed 17 dBm in any 1 MHz band.[note1]
(iii) For fixed point-to-point access points operating in the band 5.15 - 5.25 GHz, transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi.
(iv) For mobile and portable client devices in the 5.15 - 5.25 GHz band, the maximum power spectral density shall not exceed 11 dBm in any 1 MHz band. [note1]
Note1: If transmitting antennas of directional gain greater than 6 dBi are used, the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.3.2. Block Diagram of Test Setup



5.3.3. Test Procedures

1. The transmitter was connected directly to a Spectrum Analyzer through a directional couple.
2. The power was monitored at the coupler port with a Spectrum Analyzer. The power level was set to the maximum level.
3. Set the RBW = 1MHz.
4. Set the VBW ≥ 3MHz
5. Span=Encompass the entire emissions bandwidth (EBW) of the signal (or, alternatively, the entire 99% occupied bandwidth) of the signal.
6. Number of points in sweep ≥ 2 × span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
7. Manually set sweep time ≥ 10 × (number of points in sweep) × (total on/off period of the transmitted signal).
8. Set detector = power averaging (rms).
9. Sweep time = auto couple.
10. Trace mode = max hold.
11. Allow trace to fully stabilize.
12. Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument's band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively, levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively,
13. 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 (because the measurement represents an average over both the on and off times of the transmission). For example, add 10 log (1/0.25) = 6 dB if the duty cycle is 25%.
14. Use the peak marker function to determine the maximum power level in any 1MHz band segment within the fundamental EBW.

5.3.4. Test Results

Pass

Remark:
1. Measured power spectrum density at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss.

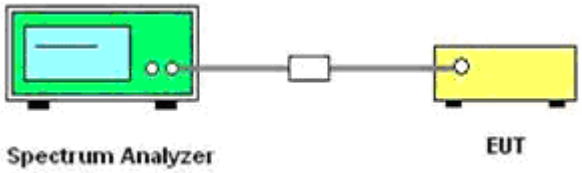
3. Report conducted PSD = Measured conducted PSD + Duty Cycle factor.
4. Please refer to Appendix C of Appendix Test Data for RLAN(5.2G).

5.4. 99% Occupied Bandwidth and 26dB Emission Bandwidth Measurement

5.4.1. Standard Applicable

No restriction limits. But resolution bandwidth within band edge measurement is 1% of the 99% occupied bandwidth.

5.4.2. Block Diagram of Test Setup



5.4.3. Test Procedures

For 26dB Emission Bandwidth
a) Set RBW = approximately 1% of the emission bandwidth.
b) Set the VBW > RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Measure the maximum width of the emission that is 26 dB down from the maximum of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

For 99% Occupied Bandwidth
1. Set center frequency to the nominal EUT channel center frequency.
2. Set span = 1.5 times to 5.0 times the OBW.
3. Set RBW = 1% to 5% of the OBW
4. Set VBW ≥ 3 x RBW
5. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
6. Use the 99% power bandwidth function of the instrument (if available).
7. If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached. that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached. that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

5.4.4. Test Results

Pass

Remark:
1. Measured 99% and 26dB bandwidth at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss.
3. Please refer to Appendix A of Appendix Test Data for RLAN(5.2G).

5.5. Radiated Emissions Measurement

5.5.1. Standard Applicable

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
\1\ 0.495-0.505	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	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	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			

\1\ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
\2\ Above 38.6
For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz (68.2dBuV/m at 3m).
In addition, In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (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

5.5.2. Measuring Instruments and Setting

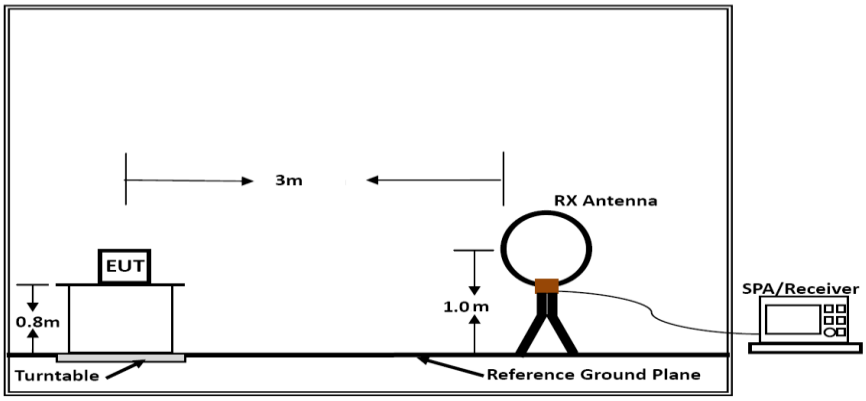
The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 3 MHz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 3 MHz for Average

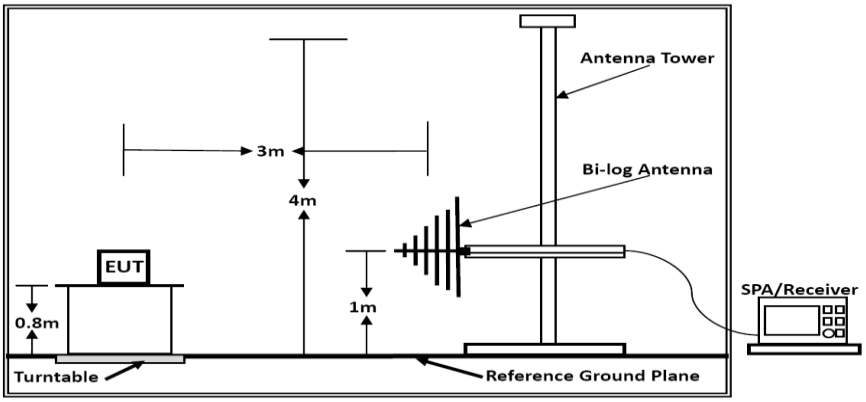
Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB/VB 120kHz/1MHz for QP

5.5.3. Block Diagram of Test Setup

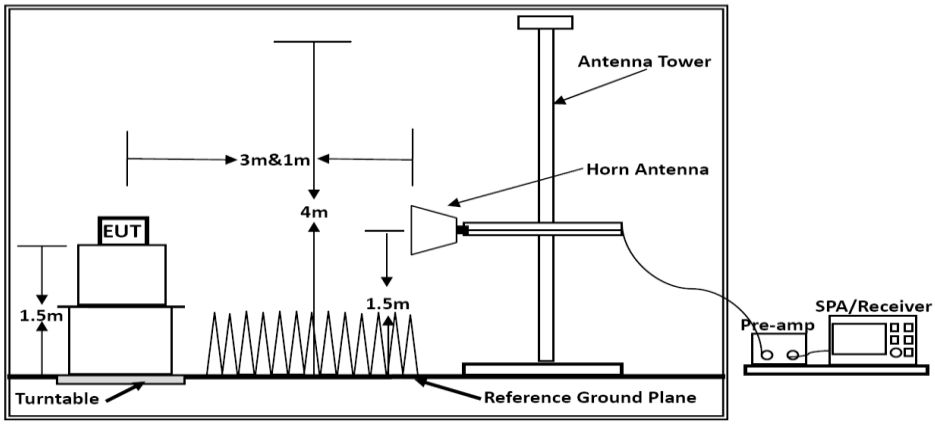
For radiated emissions below 30MHz



Below 30MHz



Below 1GHz



Above 1GHz

Above 18 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m.
Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1m]) (dB).
Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].

5.5.4. Test Procedures

1) Sequence of testing 9 kHz to 30 MHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna height is 1.0 meter.
--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).
--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.
--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

2) Sequence of testing 30 MHz to 1 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna is polarized vertical and horizontal.
--- The antenna height changes from 1 to 3 meter.
--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.
--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.
--- The final measurement will be done with QP detector with an EMI receiver.
--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) Sequence of testing 1 GHz to 40 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 3 meter.
--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.
--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.
--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.
--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meters. This procedure is repeated for both antenna polarizations.
--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.
--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

4) Sequence of testing above 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
--- Auxiliary equipment and cables were positioned to simulate normal operation conditions
--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
--- The measurement distance is 1 meter.
--- The EUT was set into operation.

Premeasurement:

--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

Final measurement:

--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.
--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

5.5.5. Test Results

Pass

Results of Radiated Emissions (9 KHz~30MHz)

Temperature	22.5℃	Humidity	56%
Test Engineer	Tony Luo	Configurations	IEEE 802.11a/n/ac
Test Volgate	AC 120V/60Hz	/	/

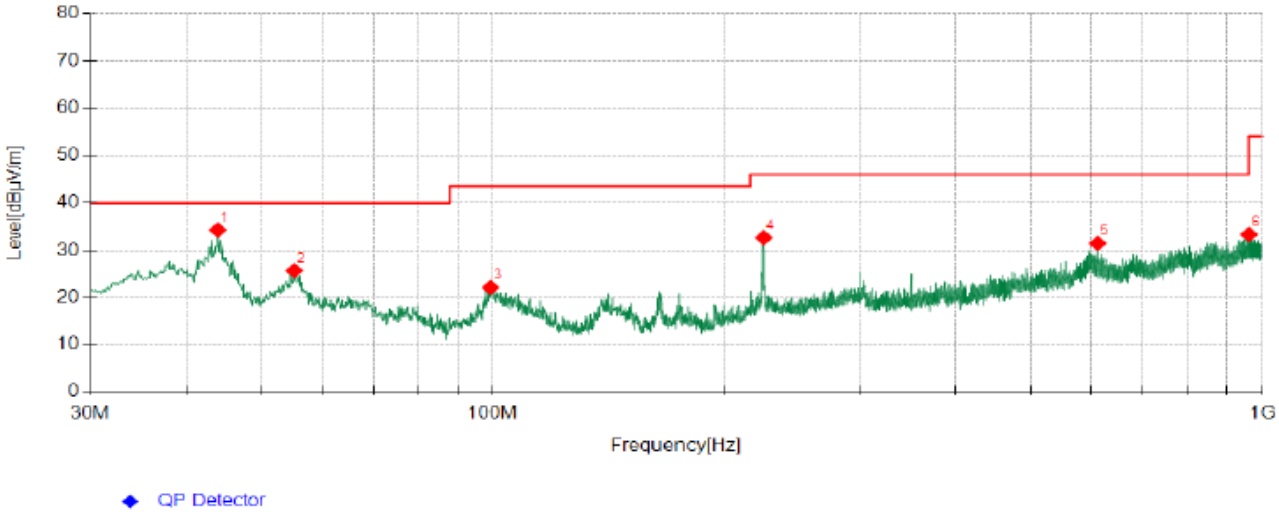
Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Over Limit (dBuV)	Remark
-	-	-	-	See Note

Note:
The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.
Distance extrapolation factor = 40 log (specific distance / test distance) (dB).
Limit line = specific limits (dBuV) + distance extrapolation factor.

Results of Radiated Emissions (30MHz~1GHz)

Temperature	22.5℃	Humidity	56%
Test Engineer	Tony Luo	Configurations	IEEE 802.11a/n/ac
Test Volgate	AC 120V/60Hz	/	/

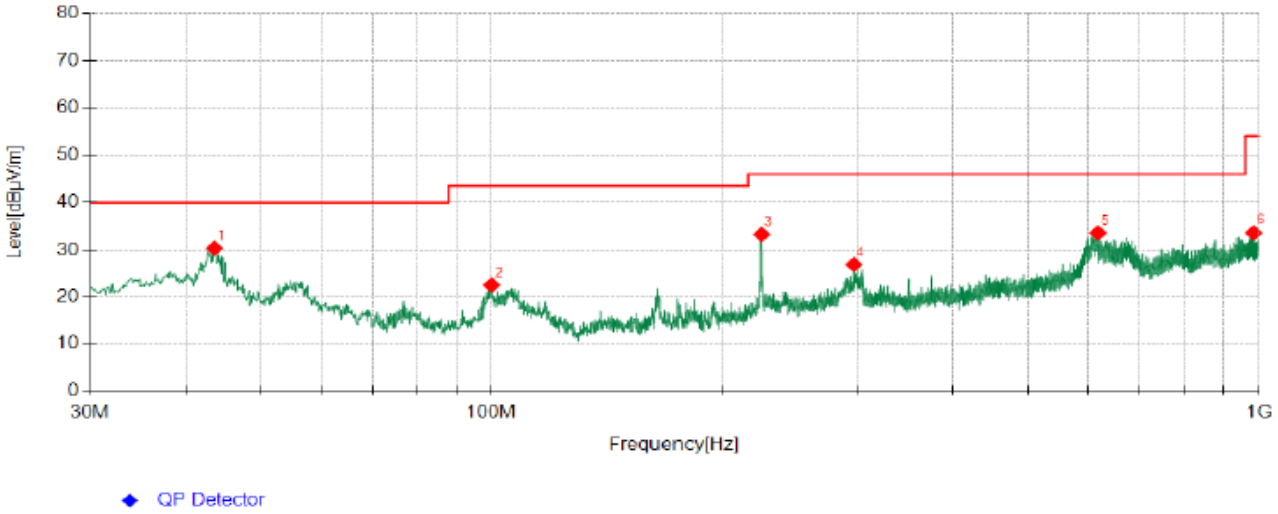
Vertical



Suspected Data List									
NO.	Freq. [MHz]	Reading [dBµV]	Factor [dB]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	43.94	19.22	15.08	34.30	40.00	5.70	100	30	Vertical
2	55.22	11.26	14.46	25.72	40.00	14.28	100	60	Vertical
3	99.35	9.11	13.00	22.11	43.50	21.39	100	290	Vertical
4	224.9	18.71	13.99	32.70	46.00	13.30	100	40	Vertical
5	610.7	8.68	22.84	31.52	46.00	14.48	100	10	Vertical
6	960.4	5.86	27.51	33.37	54.00	20.63	100	270	Vertical

***Note:
1. Level [dBµV/m] = Reading [dBµV] + Factor [dB/m]
2. Margin [dB] = Limit [dBµV/m] - Level [dBµV/m]
3.Pre-scan all modes and recorded the worst case results in this report.

Horizontal



Suspected Data List									
NO.	Freq. [MHz]	Reading [dBμV]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	43.58	15.50	14.86	30.36	40.00	9.64	100	340	Horizontal
2	100.0	9.39	13.11	22.50	43.50	21.00	100	310	Horizontal
3	224.9	19.33	13.99	33.32	46.00	12.68	100	250	Horizontal
4	296.7	10.81	16.06	26.87	46.00	19.13	100	190	Horizontal
5	616.7	10.84	22.78	33.62	46.00	12.38	100	150	Horizontal
6	984.3	6.44	27.20	33.64	54.00	20.36	100	330	Horizontal

***Note:
1. Level [dBμV/m] = Reading [dBμV] + Factor [dB/m]
2. Margin [dB] = Limit [dBμV/m] - Level [dBμV/m]
3.Pre-scan all modes and recorded the worst case results in this report.

Results for Radiated Emissions (1GHz to 40GHz)

Temperature	24℃	Humidity	55.2%
Test Engineer	Tony Luo	Configurations	IEEE 802.11 a/n/ac
Test Volgate	AC 120V/60Hz	/	/

Remark: Measured all modes and recorded worst case.

IEEE 802.11a ANT 1

Channel 36 / 5180 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.54	51.70	33.06	35.04	3.94	53.66	68.20	14.54	Peak	Horizontal
15.54	44.34	33.06	35.04	3.94	46.30	54.00	7.70	Average	Horizontal
15.54	53.42	33.06	35.04	3.94	55.38	68.20	12.82	Peak	Vertical
15.54	42.94	33.06	35.04	3.94	44.90	54.00	9.10	Average	Vertical

Channel 40 / 5200 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.60	56.00	33.16	35.15	3.96	57.97	68.20	10.23	Peak	Horizontal
15.60	42.88	33.16	35.15	3.96	44.85	54.00	9.15	Average	Horizontal
15.60	52.66	33.16	35.15	3.96	54.63	68.20	13.57	Peak	Vertical
15.60	42.08	33.16	35.15	3.96	44.05	54.00	9.95	Average	Vertical

Channel 48 / 5240 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.72	55.16	33.26	35.14	3.98	57.26	68.20	10.94	Peak	Horizontal
15.72	40.75	33.26	35.14	3.98	42.85	54.00	11.15	Average	Horizontal
15.72	52.42	33.26	35.14	3.98	54.52	68.20	13.68	Peak	Vertical
15.72	40.50	33.26	35.14	3.98	42.60	54.00	11.40	Average	Vertical

IEEE 802.11n HT20 MIMO

Channel 36 / 5180 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.54	51.25	33.06	35.04	3.94	53.21	68.20	14.99	Peak	Horizontal
15.54	43.36	33.06	35.04	3.94	45.32	54.00	8.68	Average	Horizontal
15.54	51.48	33.06	35.04	3.94	53.44	68.20	14.76	Peak	Vertical

15.54	44.78	33.06	35.04	3.94	46.74	54.00	7.26	Average	Vertical

Channel 40 / 5200 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.60	52.29	33.16	35.15	3.96	54.26	68.20	13.94	Peak	Horizontal
15.60	44.07	33.16	35.15	3.96	46.04	54.00	7.96	Average	Horizontal
15.60	52.33	33.16	35.15	3.96	54.30	68.20	13.90	Peak	Vertical
15.60	41.22	33.16	35.15	3.96	43.19	54.00	10.81	Average	Vertical

Channel 48 / 5240 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.72	55.49	33.26	35.14	3.98	57.59	68.20	10.61	Peak	Horizontal
15.72	44.32	33.26	35.14	3.98	46.42	54.00	7.58	Average	Horizontal
15.72	51.28	33.26	35.14	3.98	53.38	68.20	14.82	Peak	Vertical
15.72	41.57	33.26	35.14	3.98	43.67	54.00	10.33	Average	Vertical

IEEE 802.11n HT40 MIMO

Channel 38 / 5190 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.57	55.61	33.06	35.04	3.94	57.57	68.20	10.63	Peak	Horizontal
15.57	40.13	33.06	35.04	3.94	42.09	54.00	11.91	Average	Horizontal
15.57	55.39	33.06	35.04	3.94	57.35	68.20	10.85	Peak	Vertical
15.57	42.13	33.06	35.04	3.94	44.09	54.00	9.91	Average	Vertical

Channel 46 / 5230 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.69	55.99	33.16	35.15	3.96	57.96	68.20	10.24	Peak	Horizontal
15.69	41.56	33.16	35.15	3.96	43.53	54.00	10.47	Average	Horizontal
15.69	55.55	33.16	35.15	3.96	57.52	68.20	10.68	Peak	Vertical
15.69	40.97	33.16	35.15	3.96	42.94	54.00	11.06	Average	Vertical

IEEE 802.11ac VHT20 MIMO

Channel 36 / 5180 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.54	51.33	33.06	35.04	3.94	53.29	68.20	14.91	Peak	Horizontal
15.54	44.95	33.06	35.04	3.94	46.91	54.00	7.09	Average	Horizontal
15.54	53.07	33.06	35.04	3.94	55.03	68.20	13.17	Peak	Vertical
15.54	44.58	33.06	35.04	3.94	46.54	54.00	7.46	Average	Vertical

Channel 40 / 5200 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.60	53.02	33.16	35.15	3.96	54.99	68.20	13.21	Peak	Horizontal
15.60	41.91	33.16	35.15	3.96	43.88	54.00	10.12	Average	Horizontal
15.60	55.94	33.16	35.15	3.96	57.91	68.20	10.29	Peak	Vertical
15.60	42.37	33.16	35.15	3.96	44.34	54.00	9.66	Average	Vertical

Channel 48 / 5240 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.72	55.12	33.26	35.14	3.98	57.22	68.20	10.98	Peak	Horizontal
15.72	43.34	33.26	35.14	3.98	45.44	54.00	8.56	Average	Horizontal
15.72	54.90	33.26	35.14	3.98	57.00	68.20	11.20	Peak	Vertical
15.72	43.99	33.26	35.14	3.98	46.09	54.00	7.91	Average	Vertical

IEEE 802.11ac VHT40 MIMO

Channel 38 / 5190 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.57	55.92	33.06	35.04	3.94	57.88	68.20	10.32	Peak	Horizontal
15.57	42.06	33.06	35.04	3.94	44.02	54.00	9.98	Average	Horizontal
15.57	52.16	33.06	35.04	3.94	54.12	68.20	14.08	Peak	Vertical
15.57	44.95	33.06	35.04	3.94	46.91	54.00	7.09	Average	Vertical

Channel 46 / 5230 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.

15.69	53.75	33.16	35.15	3.96	55.72	68.20	12.48	Peak	Horizontal
15.69	40.53	33.16	35.15	3.96	42.50	54.00	11.50	Average	Horizontal
15.69	51.33	33.16	35.15	3.96	53.30	68.20	14.90	Peak	Vertical
15.69	42.75	33.16	35.15	3.96	44.72	54.00	9.28	Average	Vertical

IEEE 802.11ac VHT80 MIMO

Channel 42 / 5210 MHz

Freq. GHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
15.63	52.20	33.06	35.04	3.94	54.16	68.20	14.04	Peak	Horizontal
15.63	40.05	33.06	35.04	3.94	42.01	54.00	11.99	Average	Horizontal
15.63	51.55	33.06	35.04	3.94	53.51	68.20	14.69	Peak	Vertical
15.63	44.88	33.06	35.04	3.94	46.84	54.00	7.16	Average	Vertical

Notes:
1. Measuring frequencies from 9 KHz ~40 GHz, No emission found between lowest internal used/generated frequencies to 30MHz.
2. Radiated emissions measured in frequency range from 9 KHz ~40GHz were made with an instrument using Peak detector mode.
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.
4. Level= Reading + Ant. Fac - Pre. Fac. + Cab. Loss. Margin = Limit - Level

5.6. Power line conducted emissions

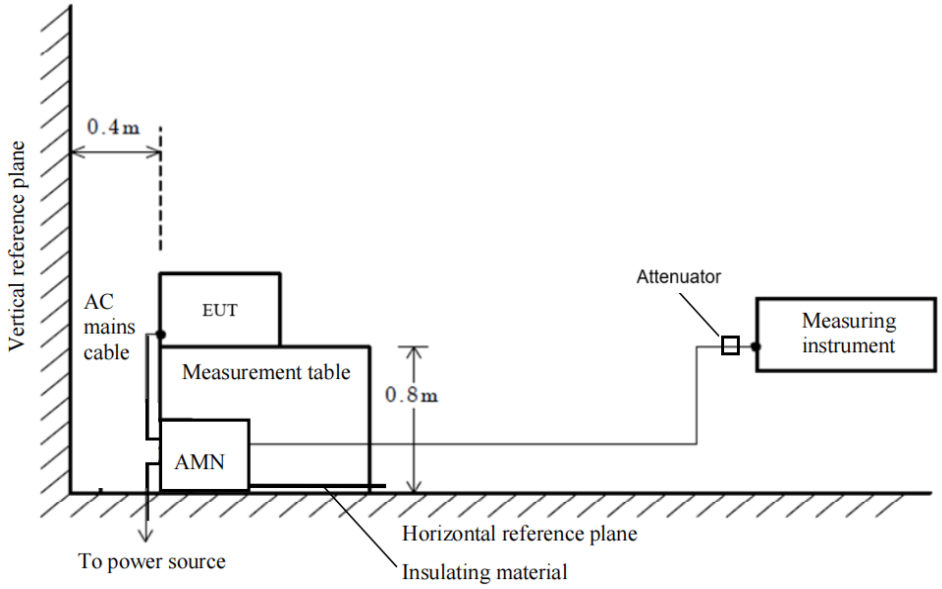
5.6.1. Standard Applicable

According to §15.207 (a): For an intentional radiator which 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 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

* Decreasing linearly with the logarithm of the frequency

5.6.2. Block Diagram of Test Setup



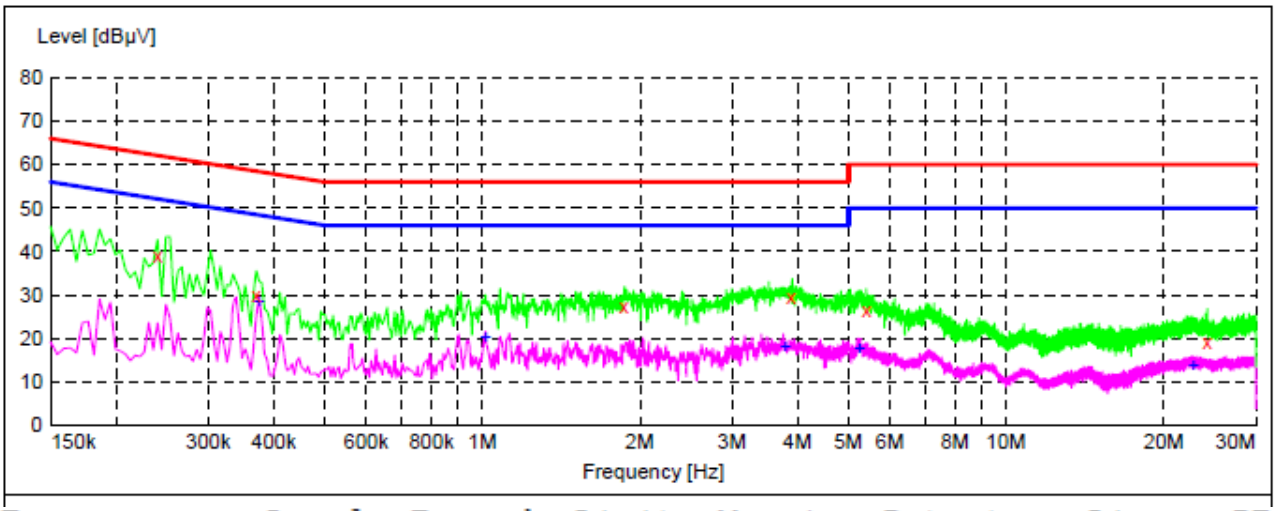
Note: the distance between LISN and Vertical reference plane is 40 cm and the distance between LISN and EUT is 80 cm.

5.6.3. Test Results

PASS.

Temperature	24.3℃	Humidity	55.4%
Test Engineer	Tony Luo	Configurations	802.11a/n/ac
Test Volgate	AC 120V/60Hz	/	/

Neutral Line

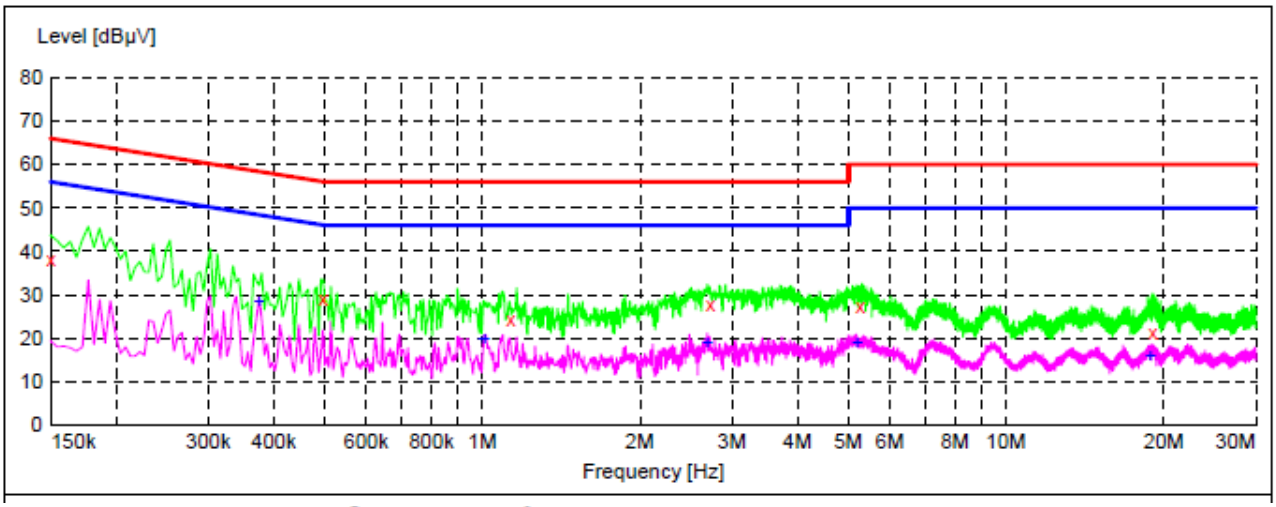


Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.240000	39.20	9.6	62	22.9	QP	N	GND
0.370500	30.00	9.7	59	28.5	QP	N	GND
1.860000	27.20	9.7	56	28.8	QP	N	GND
3.880500	29.40	9.7	56	26.6	QP	N	GND
5.410500	26.30	9.7	60	33.7	QP	N	GND
24.193500	19.10	9.8	60	40.9	QP	N	GND

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.375000	28.70	9.7	48	19.7	AV	N	GND
1.014000	20.40	9.7	46	25.6	AV	N	GND
3.790500	18.40	9.7	46	27.6	AV	N	GND
5.244000	17.70	9.7	50	32.3	AV	N	GND
22.771500	14.10	9.8	50	35.9	AV	N	GND

Note:
1. Margin(dB)= Limit(dBµV) - Level(dBµV)
2. If QP Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 9 kHz (150 kHz—30 MHz), Step size: 4 kHz, Scan time: auto.
4. Pre-scan all modes and recorded the worst case results in this report.

Live Line



Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.150000	38.20	9.6	66	27.8	QP	L1	GND
0.496500	29.10	9.6	56	27.0	QP	L1	GND
1.135500	24.30	9.7	56	31.7	QP	L1	GND
2.724000	27.90	9.7	56	28.1	QP	L1	GND
5.266500	27.40	9.7	60	32.6	QP	L1	GND
19.077000	21.40	9.8	60	38.6	QP	L1	GND

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.375000	28.50	9.7	48	19.9	AV	L1	GND
1.009500	20.20	9.7	46	25.8	AV	L1	GND
2.692500	19.00	9.7	46	27.0	AV	L1	GND
5.199000	19.10	9.7	50	30.9	AV	L1	GND
18.811500	16.00	9.8	50	34.0	AV	L1	GND

Note:
1. Margin(dB)= Limit(dBµV) - Level(dBµV)
2. If QP Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 9 kHz (150 kHz—30 MHz), Step size: 4 kHz, Scan time: auto.
4. Pre-scan all modes and recorded the worst case results in this report.

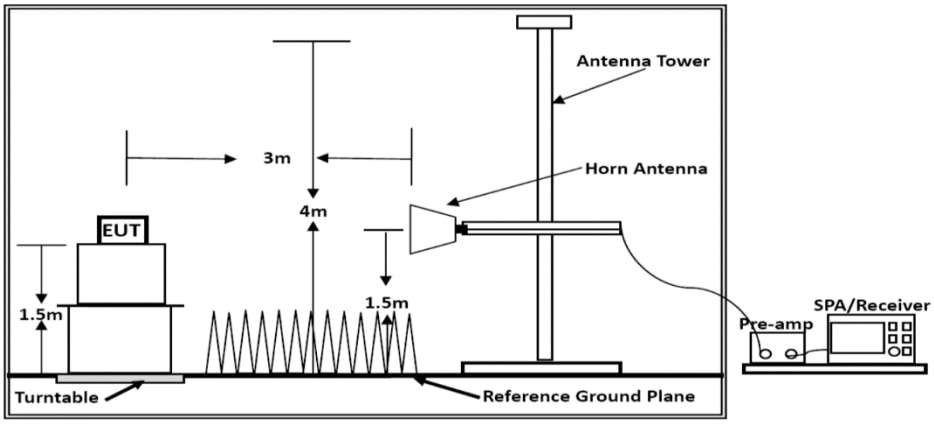
5.7. Undesirable Emissions Measurement

5.7.1. Limit

According to ξ15.407 (b) Undesirable emission limits. Except as shown in paragraph (b) (7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:
(a) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(b) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(c) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(d) For transmitters operating in the 5.725-5.85 GHz band:
(i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.
(ii) Devices certified before March 2, 2017 with antenna gain greater than 10 dBi may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease by March 2, 2018. Devices certified before March 2, 2018 with antenna gain of 10 dBi or less may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease before March 2, 2020.
(e) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.
(f) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.
(g) The provisions of §15.205 apply to intentional radiators operating under this section.
(h) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

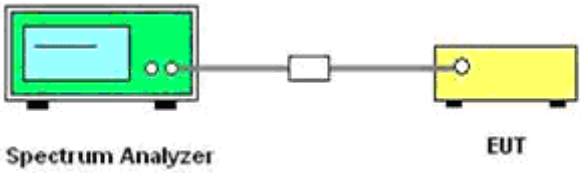
5.7.2. Block Diagram of Test Setup

☒**For Radiated**



Above 1GHz

☐**For Conducted**



5.7.3. Test Procedure

☒**Radiated Method:**

1. The EUT was placed on a turn table which is 1.5m above ground plane.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0° to 360° to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed..
5. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto	Peak
	Average Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto	Average

☐**Conducted Method:**

According to KDB789033 D02 General UNII Test Procedures New Rules v02r01 Section G: Unwanted Emission Measurement

1. Unwanted Emissions in the Restricted Bands

a) For all measurements, follow the requirements in section II.G.3. “General Requirements for Unwanted Emissions Measurements.”
b) At frequencies below 1000 MHz, use the procedure described in section II.G.4. “Procedure for Unwanted

Emissions Measurements below 1000 MHz."
c) At frequencies above 1000 MHz, measurements performed using the peak and average measurement procedures described in sections II.G.5. and II.G.6, respectively, must satisfy the respective peak and average limits. If all peak measurements satisfy the average limit, then average measurements are not required.
d) For conducted measurements above 1000 MHz, EIRP shall be computed as specified in section II.G.3.b) and then field strength shall be computed as follows (see KDB Publication 412172):
i) E[dBμV/m] = EIRP[dBm] - 20 log (d[meters]) + 104.77, where E = field strength and d = distance at which field strength limit is specified in the rules.
ii) E[dBμV/m] = EIRP[dBm] + 95.2, for d = 3 meters
e) For conducted measurements below 1000 MHz, the field strength shall be computed as specified in d), above, and then an additional 4.7 dB shall be added as an upper bound on the field strength that would be observed on a test range with a ground plane for frequencies between 30 MHz and 1000 MHz, or an additional 6 dB shall be added for frequencies below 30 MHz.

2. Unwanted Emissions that fall Outside of the Restricted Bands
a) For all measurements, follow the requirements in section II.G.3. "General Requirements for Unwanted Emissions Measurements."
b) At frequencies below 1000 MHz, use the procedure described in section II.G.4. "Procedure for Unwanted Emissions Measurements below 1000 MHz."
c) At frequencies above 1000 MHz, use the procedure for maximum emissions described in section II.G.5., "Procedure for Unwanted Maximum Unwanted Emissions Measurements Above 1000 MHz."
d) Section 15.407(b) (1-3) specifies the unwanted emissions limit for the U-NII-1 and 2 bands. As specified, emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz. However, an out-of-band emission that complies with both the average and peak limits of Section 15.209 is not required to satisfy the -27 dBm/MHz dBm/MHz peak emission limit.
i) Section 15.407(b) (4) specifies the unwanted emissions limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b) (4) (i). An alternative to the band emissions mask is specified in Section 15.407(b) (4) (ii). The alternative limits are based on the highest antenna gain specified in the filing. There are also marketing and importation restrictions for the alternative limit.
e) If radiated measurements are performed, field strength is then converted to EIRP as follows:
i) EIRP = ((E×d) ^2) / 30
Where:
- E is the field strength in V/m.
- d is the measurement distance in meters.
- EIRP is the equivalent isotopically radiated power in watts.

ii) Working in dB units, the above equation is equivalent to:
EIRP [dBm] = E [dBμV/m] + 20 log (d [meters]) - 104.77
iii) Or, if d is 3 meters:
EIRP [dBm] = E [dBμV/m] - 95.23

3. Radiated versus Conducted Measurements.
The unwanted emission limits in both the restricted and non-restricted bands are based on radiated measurements. however, as an alternative, antenna-port conducted measurements in conjunction with cabinet emissions tests will be permitted to demonstrate compliance provided that the following steps are performed:

(i) Cabinet emissions measurements. A radiated test shall be performed to ensure that cabinet emissions are below the emission limits. For the cabinet-emission measurements the antenna may be replaced by a termination matching the nominal impedance of the antenna.

(ii) Impedance matching. Conducted tests shall be performed using equipment that matches the nominal impedance of the antenna assembly used with the EUT.

(iii) EIRP calculation. A value representative of an upper bound on out-of-band antenna gain (in dBi) shall be added to the measured antenna-port conducted emission power to compute EIRP within the specified measurement bandwidth. (For emissions in the restricted bands, additional calculations are required to convert EIRP to field strength at the specified distance.) The upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands or 2 dBi, whichever is greater.[3] However, for devices that operate in multiple bands using the same transmit antenna, the highest gain of the antenna within the operating band nearest to the out-of-band frequency being measured may be used in lieu of the overall highest gain when measuring emissions at

frequencies within 20% of the absolute frequency at the nearest edge of that band, but in no case shall a value less than 2 dBi be selected.

(iv) EIRP adjustments for multiple outputs. For devices with multiple outputs occupying the same or overlapping frequency ranges in the same band (e.g., MIMO or beamforming devices), compute the total EIRP as follows:

- Compute EIRP for each output, as described in (iii), above.
- Follow the procedures specified in KDB Publication 662911 for summing emissions across the outputs or adjusting emission levels measured on individual outputs by 10 log (N_{ANT}), where N_{ANT} is the number of outputs.
- Add the array gain term specified in KDB Publication 662911 for out-of-band and spurious signals.

(v) Direction of maximum emission.
For all radiated emissions tests, measurements shall correspond to the direction of maximum emission level for each measured emission (see ANSI C63.10 for guidance).

5.7.4. Test Results

Temperature	24.3℃	Humidity	55.4%
Test Engineer	Tony Luo	Configurations	802.11a/n/ac
Test Volgate	AC 120V/60Hz	/	/

Mode	Channel	Freq. MHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Psol.
IEEE 802.11a ANT 1	Low	4500	54.14	29.19	30.13	10.65	63.85	68.2	4.35	Peak	Horizontal
		4500	38.61	29.19	30.13	10.65	48.32	54	5.68	AV[1]	Horizontal
		4500	52.7	29.19	30.13	10.65	62.41	68.2	5.79	Peak	Vertical
		4500	38.93	29.19	30.13	10.65	48.64	54	5.36	AV[1]	Vertical
		5150	53.22	29.15	29.63	10.95	63.69	68.2	4.51	Peak	Horizontal
		5150	26.84	29.15	29.63	10.95	37.31	54	16.69	AV[1]	Horizontal
		5150	54.03	29.15	29.63	10.95	64.5	68.2	3.7	Peak	Vertical
		5150	26.12	29.15	29.63	10.95	36.59	54	17.41	AV[1]	Vertical
	High	5350	54.79	29.19	30.13	10.65	64.5	68.2	3.7	Peak	Horizontal
		5350	40.61	29.19	30.13	10.65	50.32	54	3.68	AV[1]	Horizontal
		5350	54.51	29.19	30.13	10.65	64.22	68.2	3.98	Peak	Vertical
		5350	39.92	29.19	30.13	10.65	49.63	54	4.37	AV[1]	Vertical
		5460	52.36	29.15	29.63	10.95	62.83	68.2	5.37	Peak	Horizontal
		5460	28.92	29.15	29.63	10.95	39.39	54	14.61	AV[1]	Horizontal
		5460	52.26	29.15	29.63	10.95	62.73	68.2	5.47	Peak	Vertical
		5460	26.28	29.15	29.63	10.95	36.75	54	17.25	AV[1]	Vertical

Mode	Channel	Freq. MHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
IEEE 802.11n	Low	4500	55.08	29.19	30.13	10.65	64.79	68.2	3.41	Peak	Horizontal
		4500	39.18	29.19	30.13	10.65	48.89	54	5.11	AV[1]	Horizontal

HT20 MIMO		4500	55.28	29.19	30.13	10.65	64.99	68.2	3.21	Peak	Vertical
		4500	36.62	29.19	30.13	10.65	46.33	54	7.67	AV[1]	Vertical
		5150	50.77	29.15	29.63	10.95	61.24	68.2	6.96	Peak	Horizontal
		5150	30.1	29.15	29.63	10.95	40.57	54	13.43	AV[1]	Horizontal
		5150	50.35	29.15	29.63	10.95	60.82	68.2	7.38	Peak	Vertical
		5150	29.36	29.15	29.63	10.95	39.83	54	14.17	AV[1]	Vertical
	High	5350	55.67	29.19	30.13	10.65	65.38	68.2	2.82	Peak	Horizontal
		5350	36.85	29.19	30.13	10.65	46.56	54	7.44	AV[1]	Horizontal
		5350	55.42	29.19	30.13	10.65	65.13	68.2	3.07	Peak	Vertical
		5350	40.15	29.19	30.13	10.65	49.86	54	4.14	AV[1]	Vertical
		5460	54.77	29.15	29.63	10.95	65.24	68.2	2.96	Peak	Horizontal
		5460	29.39	29.15	29.63	10.95	39.86	54	14.14	AV[1]	Horizontal
		5460	50.91	29.15	29.63	10.95	61.38	68.2	6.82	Peak	Vertical
		5460	31.23	29.15	29.63	10.95	41.7	54	12.3	AV[1]	Vertical

Mode	Channel	Freq. MHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
IEEE 802.11n HT40 MIMO	Low	4500	53.25	29.19	30.13	10.65	62.96	68.2	5.24	Peak	Horizontal
		4500	38.35	29.19	30.13	10.65	48.06	54	5.94	AV[1]	Horizontal
		4500	53.57	29.19	30.13	10.65	63.28	68.2	4.92	Peak	Vertical
		4500	38.83	29.19	30.13	10.65	48.54	54	5.46	AV[1]	Vertical
		5150	52.52	29.15	29.63	10.95	62.99	68.2	5.21	Peak	Horizontal
		5150	30.75	29.15	29.63	10.95	41.22	54	12.78	AV[1]	Horizontal
		5150	51.2	29.15	29.63	10.95	61.67	68.2	6.53	Peak	Vertical
		5150	25.02	29.15	29.63	10.95	35.49	54	18.51	AV[1]	Vertical
	High	5350	55.97	29.19	30.13	10.65	65.68	68.2	2.52	Peak	Horizontal
		5350	39.49	29.19	30.13	10.65	49.2	54	4.8	AV[1]	Horizontal
		5350	56.02	29.19	30.13	10.65	65.73	68.2	2.47	Peak	Vertical
		5350	38.25	29.19	30.13	10.65	47.96	54	6.04	AV[1]	Vertical
		5460	55.32	29.15	29.63	10.95	65.79	68.2	2.41	Peak	Horizontal
		5460	30.78	29.15	29.63	10.95	41.25	54	12.75	AV[1]	Horizontal
		5460	53.8	29.15	29.63	10.95	64.27	68.2	3.93	Peak	Vertical
		5460	27.99	29.15	29.63	10.95	38.46	54	15.54	AV[1]	Vertical

Mode	Channel	Freq. MHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
IEEE 802.11ac VHT20	Low	4500	55.18	29.19	30.13	10.65	64.89	68.2	3.31	Peak	Horizontal
		4500	36.87	29.19	30.13	10.65	46.58	54	7.42	AV[1]	Horizontal
		4500	54.78	29.19	30.13	10.65	64.49	68.2	3.71	Peak	Vertical

MIMO		4500	39.41	29.19	30.13	10.65	49.12	54	4.88	AV[1]	Vertical
		5150	53.88	29.15	29.63	10.95	64.35	68.2	3.85	Peak	Horizontal
		5150	27.02	29.15	29.63	10.95	37.49	54	16.51	AV[1]	Horizontal
		5150	51.6	29.15	29.63	10.95	62.07	68.2	6.13	Peak	Vertical
		5150	30.49	29.15	29.63	10.95	40.96	54	13.04	AV[1]	Vertical
	High	5350	53.58	29.19	30.13	10.65	63.29	68.2	4.91	Peak	Horizontal
		5350	38.07	29.19	30.13	10.65	47.78	54	6.22	AV[1]	Horizontal
		5350	55.62	29.19	30.13	10.65	65.33	68.2	2.87	Peak	Vertical
		5350	40.78	29.19	30.13	10.65	50.49	54	3.51	AV[1]	Vertical
		5460	54.46	29.15	29.63	10.95	64.93	68.2	3.27	Peak	Horizontal
		5460	26.97	29.15	29.63	10.95	37.44	54	16.56	AV[1]	Horizontal
		5460	51.41	29.15	29.63	10.95	61.88	68.2	6.32	Peak	Vertical
		5460	27.87	29.15	29.63	10.95	38.34	54	15.66	AV[1]	Vertical

Mode	Channel	Freq. MHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
IEEE 802.11ac VHT40 MIMO	Low	4500	55.29	29.19	30.13	10.65	65	68.2	3.2	Peak	Horizontal
		4500	40.48	29.19	30.13	10.65	50.19	54	3.81	AV[1]	Horizontal
		4500	54.85	29.19	30.13	10.65	64.56	68.2	3.64	Peak	Vertical
		4500	39.89	29.19	30.13	10.65	49.6	54	4.4	AV[1]	Vertical
		5150	51.72	29.15	29.63	10.95	62.19	68.2	6.01	Peak	Horizontal
		5150	29.17	29.15	29.63	10.95	39.64	54	14.36	AV[1]	Horizontal
		5150	51.81	29.15	29.63	10.95	62.28	68.2	5.92	Peak	Vertical
		5150	30.73	29.15	29.63	10.95	41.2	54	12.8	AV[1]	Vertical
	High	5350	55.45	29.19	30.13	10.65	65.16	68.2	3.04	Peak	Horizontal
		5350	36.51	29.19	30.13	10.65	46.22	54	7.78	AV[1]	Horizontal
		5350	54.42	29.19	30.13	10.65	64.13	68.2	4.07	Peak	Vertical
		5350	38.85	29.19	30.13	10.65	48.56	54	5.44	AV[1]	Vertical
		5460	54.68	29.15	29.63	10.95	65.15	68.2	3.05	Peak	Horizontal
		5460	27.93	29.15	29.63	10.95	38.4	54	15.6	AV[1]	Horizontal
		5460	50.24	29.15	29.63	10.95	60.71	68.2	7.49	Peak	Vertical
		5460	28.74	29.15	29.63	10.95	39.21	54	14.79	AV[1]	Vertical

Mode	Channel	Freq. MHz	Reading dBμV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Level dBμV/m	Limit dBμV/m	Margin dB	Remark	Pol.
IEEE 802.11ac VHT80	Low	4500	55.17	29.19	30.13	10.65	64.88	68.2	3.32	Peak	Horizontal
		4500	37.25	29.19	30.13	10.65	46.96	54	7.04	AV[1]	Horizontal
		4500	53	29.19	30.13	10.65	62.71	68.2	5.49	Peak	Vertical

MIMO		4500	36.4	29.19	30.13	10.65	46.11	54	7.89	AV[1]	Vertical
		5150	52.41	29.15	29.63	10.95	62.88	68.2	5.32	Peak	Horizontal
		5150	30.39	29.15	29.63	10.95	40.86	54	13.14	AV[1]	Horizontal
		5150	51.58	29.15	29.63	10.95	62.05	68.2	6.15	Peak	Vertical
		5150	25.71	29.15	29.63	10.95	36.18	54	17.82	AV[1]	Vertical
	High	5350	54.76	29.19	30.13	10.65	64.47	68.2	3.73	Peak	Horizontal
		5350	36.67	29.19	30.13	10.65	46.38	54	7.62	AV[1]	Horizontal
		5350	55.55	29.19	30.13	10.65	65.26	68.2	2.94	Peak	Vertical
		5350	39.45	29.19	30.13	10.65	49.16	54	4.84	AV[1]	Vertical
		5460	53.52	29.15	29.63	10.95	63.99	68.2	4.21	Peak	Horizontal
		5460	29.66	29.15	29.63	10.95	40.13	54	13.87	AV[1]	Horizontal
		5460	49.42	29.15	29.63	10.95	59.89	68.2	8.31	Peak	Vertical
		5460	27.85	29.15	29.63	10.95	38.32	54	15.68	AV[1]	Vertical

Remark:

1. Measured Undesirable emission at difference data rate for each mode and recorded worst case for each mode.
2. Level = Read Level + Antenna Factor – PRM + Cable Loss
3. Margin =Limit - Level

5.8. Antenna Requirements

5.8.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. 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
And according to FCC 47 CFR Section 15.407 (a), 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.

5.8.2. Antenna Connector Construction

The directional gains of antenna refer to section 1.3, and the antenna is an internal antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

5.8.3. Results

Compliance

5.9. Frequency Stability

5.9.1. Standard Applicable

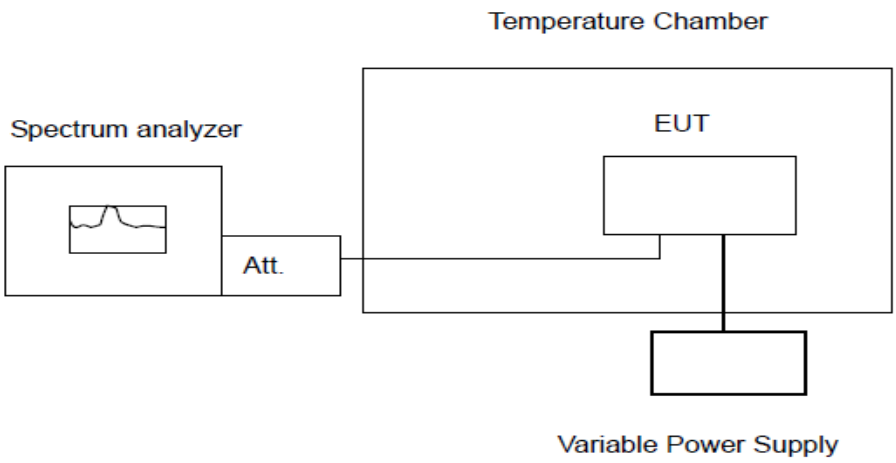
According to FCC §15.407(g) “Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user manual.”
According to FCC §2.1055(a) “The frequency stability shall be measured with variation of ambient temperature as follows:”

(1) From −30° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

(2) From −20° to + 50° centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radio beacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.

(3) From 0° to + 50° centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

5.9.2. Block Diagram of Test Setup



5.9.3. Test Procedure

The equipment under test was connected to an external AC or DC power supply and input rated voltage. RF output was connected to a frequency counter or spectrum anzlyer via feed through attenators. The EUT was placed inside the temperature chamber. Set the spectrum analyzer RBW low engouh to obtain the desired frequency resoluation and measure EUT 20 degree operating frequency as reference frequency. Turn EUT off and set the chamber temperature to -30 degree. After the temperature stabilized for approximately 30 minutes recorded the frequency. Repeat step measure with 10 degree increased per stage until the highest temperature of +50 degree reached.

5.9.4. Test Results

Pass

Remark:
1. Measured all conditions and recorded worst case.
2. Please refer to Appendix E of Appendix Test Data for RLAN(5.2G).

6. LIST OF MEASURING EQUIPMENT

Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2026-01-11	2027-01-10
2	Power Sensor	Agilent	U2021XA	MY5365004	2026-01-11	2027-01-10
3	Power Meter	Agilent	U2531A	TW53323507	2026-01-11	2027-01-10
4	Loop Antenna	schwarzbeck	FMZB1519B	00023	2025-10-18	2028-10-17
5	Wideband Antenna	schwarzbeck	VULB 9163	958	2025-10-18	2028-10-17
6	Horn Antenna	schwarzbeck	BBHA 9120D	01989	2025-10-18	2028-10-17
7	EMI Test Receiver	R&S	ESCI	100849/003	2026-01-11	2027-01-10
8	Controller	MF	MF7802	N/A	N/A	N/A
9	Amplifier	schwarzbeck	BBV 9743	209	2026-01-11	2027-01-10
10	Amplifier	Tonscend	TSAMP-0518SE	--	2026-01-11	2027-01-10
11	RF Cable(below 1GHz)	HUBER+SUHNER	RG214	N/A	2026-01-11	2027-01-10
12	RF Cable(above 1GHz)	HUBER+SUHNER	RG214	N/A	2026-01-11	2027-01-10
13	Artificial Mains	ROHDE & SCHWARZ	ENV 216	101333-IP	2026-01-11	2027-01-10
14	EMI Test Software	ROHDE & SCHWARZ	ESK1	V1.71	N/A	N/A
15	Amplifier	Chengyi	EMC184045SE	980508	2026-01-11	2027-01-10
16	Horn Antenna	A-INFO	LB-180400-KF	J211020657	2025-10-18	2028-10-17
17	Spectrum Analyzer	R&S	FSV40	101321	2026-01-11	2027-01-10
18	Fixed Attenuator	Mini circuits	BW-S6-2W263A+	N/A	2026-01-11	2027-01-10
19	Climate Chamber	KRUOMR	KRM-1000	KRM16072901	2026-01-11	2027-01-10
20	AC POWER SOURCE	KRUOMR	KAP-31030	N/A	2026-01-11	2027-01-10

Test software used:

Item	Test Software	Manufacturer	Name	Version
1	EMI Test Software	ROHDE & SCHWARZ	ESK1	V1.71
2	RE test software	Tonscend	JS32-RE	V5.0.0.0
3	Test Software	Tonscend	JS1120-3	V3.2.22

7. TEST SETUP PHOTOGRAPHS OF EUT

Please refer to separated files for Test Setup Photos of the EUT.

8. EXTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for External Photos of the EUT.

9. INTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for Internal Photos of the EUT.

----------THE END OF REPORT----------