

Beijing Roborock Technology Co., Ltd.

RF TEST REPORT

Report Type:

FCC Part 15.247 & ISED RSS-247 RF report

Model:

F89ETSM13-W2

REPORT NUMBER:

190802386SHA-001

ISSUE DATE:

November 4, 2019

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Applicant: Beijing Roborock Technology Co., Ltd.
Floor 6, Suite 6016, 6017, 6018, Building C, Kangjian Baosheng Plaza, No.8
Heiquan Road, Haidian District, Beijing, P.R. China

Manufacturer: Beijing Roborock Technology Co., Ltd.
Floor 6, Suite 6016, 6017, 6018, Building C, Kangjian Baosheng Plaza, No.8
Heiquan Road, Haidian District, Beijing, P.R. China

Product Name: WIFI Module

Type/Model: F89ETSM13-W2

FCC ID: 2AN2O-RSW01

IC: 23317-RSW01

SUMMARY:

The equipment complies with the requirements according to the following standard(s) or Specification:

47CFR Part 15 (2017): Radio Frequency Devices (Subpart C)

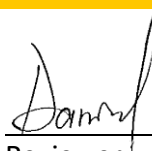
ANSI C63.10 (2013): American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

RSS-247 Issue 2 (February 2017): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS-Gen Issue 5 (April 2018): General Requirements for Compliance of Radio Apparatus

PREPARED BY:

Project Engineer
Wade Zhang

REVIEWED BY:

Reviewer
Daniel Zhao

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TEST REPORT

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Revision History

Report No.	Version	Description	Issued Date
190802386SHA-001	Rev. 01	Initial issue of report	November 4, 2019

Measurement result summary

TEST ITEM	FCC REFERENCE	IC REFERENCE	RESULT
Radiated Emissions in restricted frequency bands	15.247(d), 15.205&15.209	RSS-Gen Issue 5 Clause 8.9&8.10	Pass
Power line conducted emission	15.207(a)	RSS-Gen Issue 5 Clause 8.8	Pass
Antenna requirement	15.203	-	Pass

Notes: 1: NA =Not Applicable

2. Determination of the test conclusion is based on IEC Guide 115 in consideration of measurement uncertainty.

3: Additions, Deviations and Exclusions from Standards: None.

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1 GENERAL INFORMATION

1.1 Description of Equipment Under Test (EUT)

Product name:	WIFI Module
Type/Model:	F89ETSM13-W2
Description of EUT:	The EUT is a WIFI module which support WIFI 2.4GHz technology, and there have only one mode, we tested it and listed the WIFI 2.4GHz band result in this report.
Rating:	DC 3.3V
Software Version:	/
Hardware Version:	/
Sample received date:	September 19, 2019
Date of test:	September 19, 2019 ~ October 25, 2019

1.2 Technical Specification

Frequency Range:	2412MHz ~ 2462MHz
Support Standards:	IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40
Type of Modulation:	IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM (64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT20: OFDM (64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT40: OFDM (64-QAM, 16-QAM, QPSK, BPSK)
Channel Number:	11 Channels for 802.11b, 802.11g and 802.11n(HT20) 7 Channels for 802.11n(HT40)
Data Rate:	IEEE 802.11b: Up to 11 Mbps IEEE 802.11g: Up to 54 Mbps IEEE 802.11n-HT20: Up to MCS7 IEEE 802.11n-HT40: Up to MCS7
Channel Separation:	5 MHz
Antenna:	Internal PCB antenna, 3.7dBi Peak gain

1.3 Description of Test Facility

Name:	Intertek Testing Services Shanghai
Address:	Building 86, No. 1198 Qinzhou Road (North), Shanghai 200233, P.R. China
Telephone:	86 21 61278200
Telefax:	86 21 54262353

The test facility is recognized, certified, or accredited by these organizations:	CNAS Accreditation Lab Registration No. CNAS L0139
	FCC Accredited Lab Designation Number: CN1175
	IC Registration Lab CAB identifier.: CN0051
	VCCI Registration Lab Registration No.: R-14243, G-10845, C-14723, T-12252
	A2LA Accreditation Lab Certificate Number: 3309.02

2 TEST SPECIFICATIONS

2.1 Standards or specification

47CFR Part 15 (2017)

ANSI C63.10 (2013)

RSS-247 Issue 2 (February 2017)

RSS-Gen Issue 5 (April 2018)

KDB 558074 (v05)

2.2 Mode of operation during the test

The EUT will install in a new host device “roborock S5 Max” and the host have different configuration combinations with alternative components, all these configuration combinations were chosen for the pretest radiation emissions, we found and chosen the worst configuration for the final test in this report.

While testing transmitting mode of EUT, the internal modulation and continuously transmission was applied. The lowest, middle and highest channel were tested as representatives.

Frequency Band (MHz)	Mode	Lowest (MHz)	Middle (MHz)	Highest (MHz)
2400-2483.5	802.11b	2412	2437	2462
	802.11g	2412	2437	2462
	802.11n(HT20)	2412	2437	2462
	802.11n(HT40)	2422	2437	2452

Data rate VS Power:

The pre-scan for the conducted power with all rates in each modulation and bands was used, and the worst case was found and used in all test cases. After this pre-scan, we choose the following table of the data rate as the worst case.

Frequency Band (MHz)	Mode	Worst case data rate
2400-2483.5	802.11b	1Mbps
	802.11g	6Mbps
	802.11n(HT20)	MCS0
	802.11n(HT40)	MCS0

The following test mode was chosen for pre-test:

Radiated test mode:

Mode 1: EUT transmitted signal with internal antenna;

Conducted test mode:

Mode 2: EUT transmitted signal from PCBA RF port connected to SPA directly;

We have verified all test modes and choose the worst mode 1 for radiated test and mode 2 for conducted test as representatively to list the results in this report.

2.3 Test software list

Test Items	Software	Manufacturer	Version
Conducted emission	ESxS-K1	R&S	V2.1.0
Radiated emission	ES-K1	R&S	V1.71

2.4 Test peripherals list

Item No.	Name	Band and Model	Description
1	Laptop computer	HP, 6470b	AC 230V 50Hz

Note: The Laptop computer was used for RF setting, not used during the test.

2.5 Test environment condition:

Test items	Temperature	Humidity
Minimum 6dB Bandwidth	23°C	52% RH
Maximum conducted output power and e.i.r.p.		
Power spectrum density		
Emission outside the frequency band		
Occupied bandwidth		
Radiated Emissions in restricted frequency bands	22°C	55% RH
Power line conducted emission	21°C	52% RH

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2.6 Instrument list

Conducted Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☒	Test Receiver	R&S	ESCS 30	EC 2107	2020-07-15
☒	A.M.N.	R&S	ESH2-Z5	EC 3119	2019-11-29
☒	Shielded room	Zhongyu	-	EC 2838	2020-01-13
Radiated Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☒	Test Receiver	R&S	ESIB 26	EC 3045	2020-09-12
☒	Bilog Antenna	TESEQ	CBL 6112D	EC 4206	2019-12-10
☒	Horn antenna	R&S	HF 906	EC 3049	2019-11-16
☒	Horn antenna	ETS	3117	EC 4792-1	2020-02-25
☒	Horn antenna	TOYO	HAP18-26W	EC 4792-3	2020-07-09
☒	Pre-amplifier	R&S	Pre-amp 18	EC5262	2020-06-11
☒	Semi-anechoic chamber	Albatross project	-	EC 3048	2020-07-31
RF test					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☒	PXA Signal Analyzer	Keysight	N9030A	EC 5338	2020-03-04
☒	PXA Signal Analyzer	Keysight	N9030B	EC 6078	2020-06-11
☒	Power sensor	Agilent	U2021XA	EC 5338-1	2020-03-04
☒	Vector Signal Generator	Agilent	N5182B	EC 5175	2020-03-04
☒	MXG Analog Signal Generator	Agilent	N5181A	EC 5338-2	2020-03-04
☒	Test Receiver	R&S	ESCI 7	EC 4501	2020-09-12
Additional instrument					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☒	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3783	2020-03-10
☒	Pressure meter	YM3	Shanghai Mengde	EC 3320	2020-07-01

2.7 Measurement uncertainty

The measurement uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Test item	Measurement uncertainty
Maximum peak output power	$\pm 0.74\text{dB}$
Radiated Emissions in restricted frequency bands below 1GHz	$\pm 4.90\text{dB}$
Radiated Emissions in restricted frequency bands above 1GHz	$\pm 5.02\text{dB}$
Emission outside the frequency band	$\pm 2.89\text{dB}$
Power line conducted emission	$\pm 3.19\text{dB}$

3 Radiated Emissions in restricted frequency bands

Test result: Pass

3.1 Limit

The radiated emissions which fall in the restricted bands, must also comply with the radiated emission limits specified showed as below:

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

3.2 Measurement Procedure

For Radiated emission below 30MHz:

- The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- Both X and Y axes of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

- The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

TEST REPORT**For Radiated emission above 30MHz:**

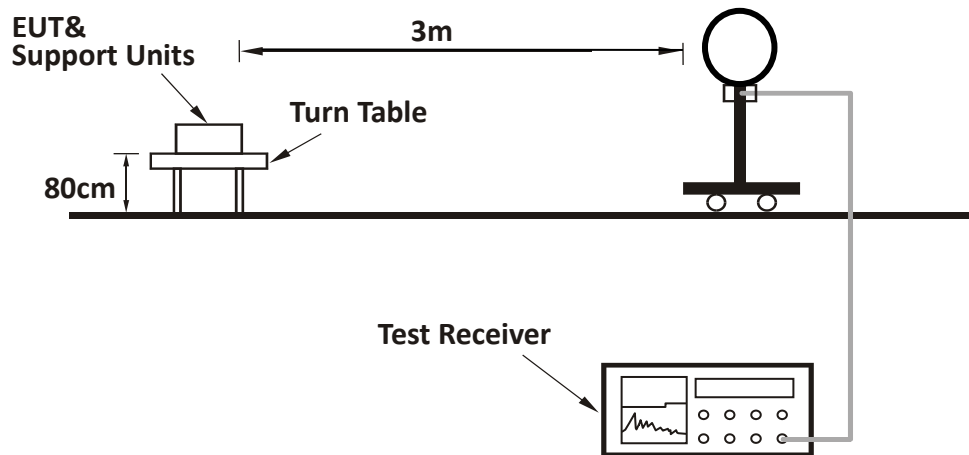
- a) The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c) The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e) The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f) The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

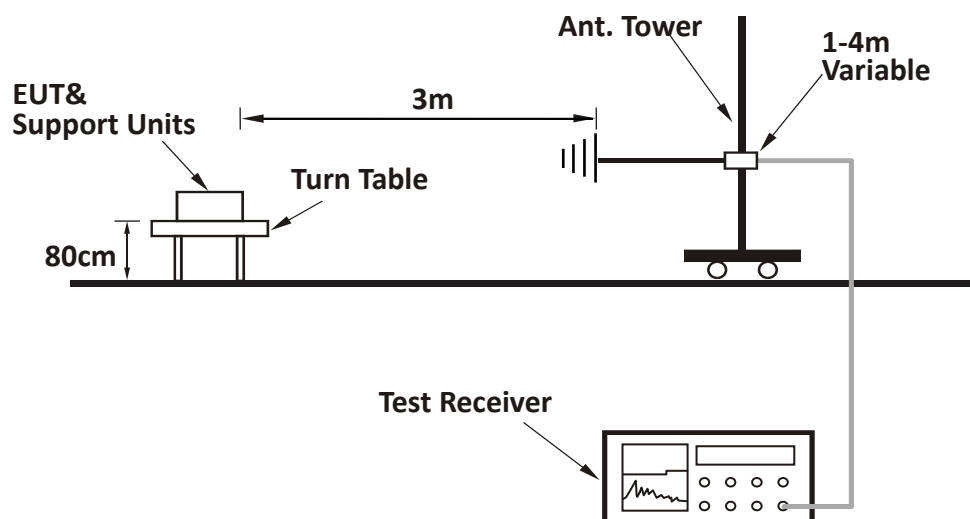
- 1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
- 2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
- 3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is $\geq 1/T$ (Duty cycle < 98%) or 3 x RBW (Duty cycle $\geq$ 98%) for Average detection (AV) at frequency above 1GHz.
- 4. All modes of operation were investigated and the worst-case emissions are reported

3.3 Test Configuration

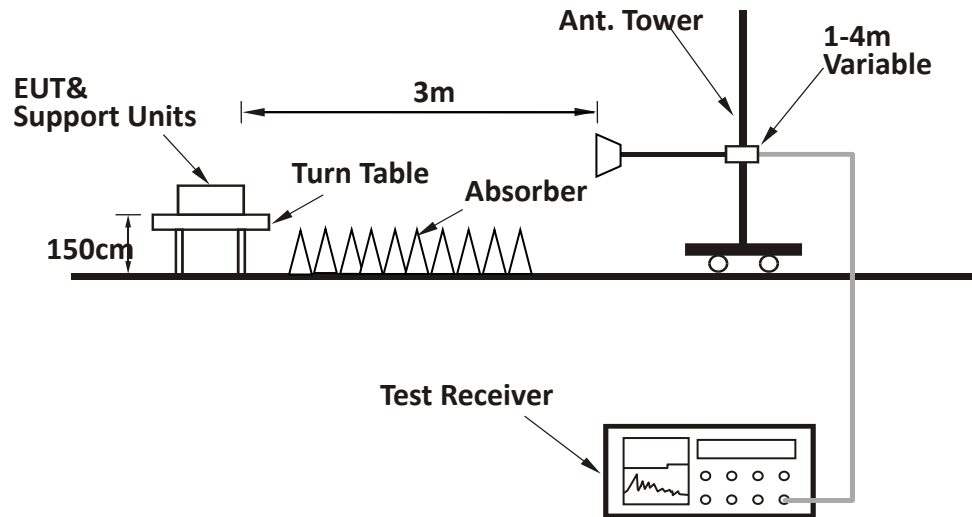
For Radiated emission below 30MHz:



For Radiated emission 30MHz to 1GHz:



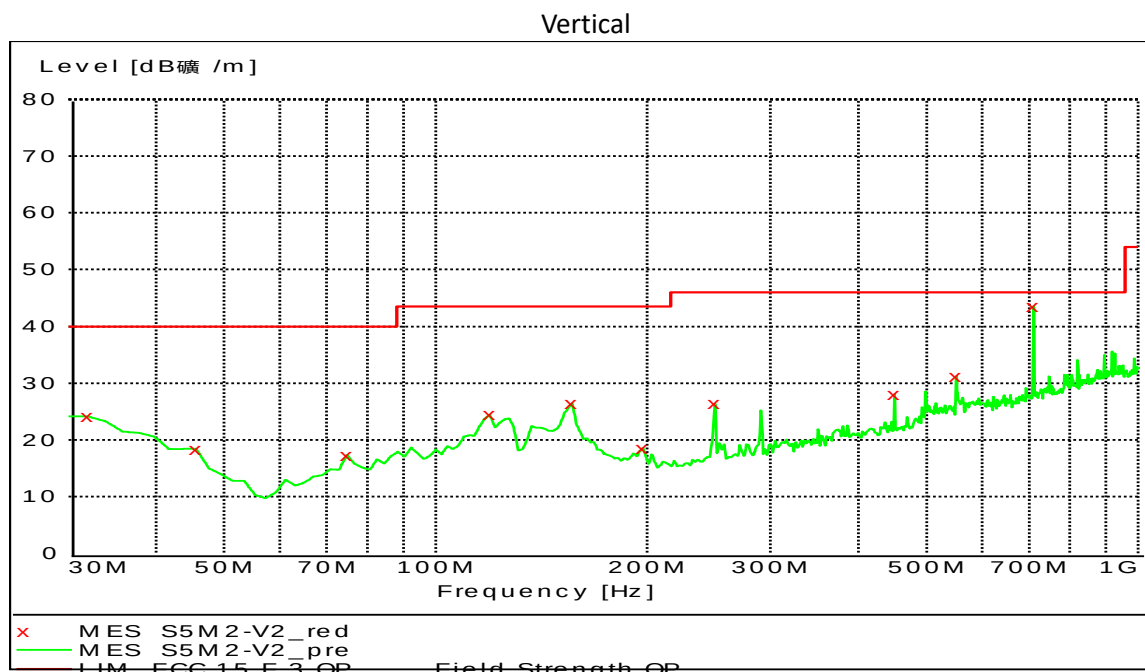
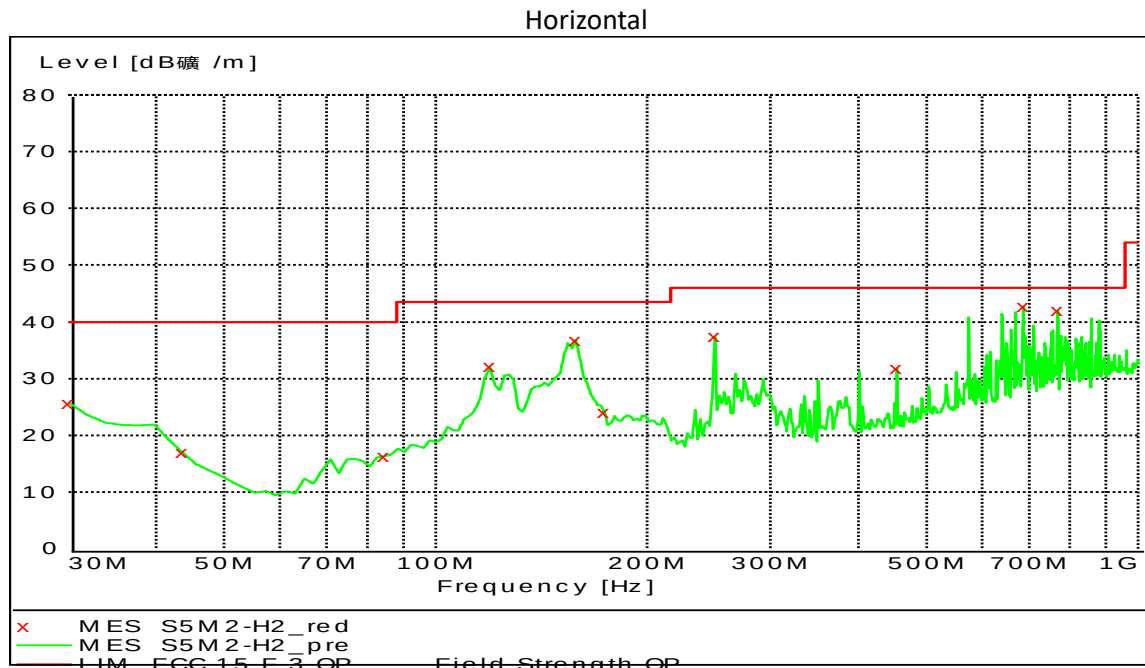
For Radiated emission above 1GHz:



3.4 Test Results of Radiated Emissions

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

The worst waveform from 30MHz to 1000MHz is listed as below:



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Test data below 1GHz

Antenna	Frequency (MHz)	Corrected Reading (dBuV/m)	Correct Factor (dB/m)	Limit (dBuV/m)	Margin (dB)	Detector
H	30.00	25.70	21.30	40.00	14.30	PK
H	43.61	17.00	13.90	40.00	23.00	PK
H	84.43	16.30	10.00	40.00	23.70	PK
H	119.42	32.10	11.90	43.50	11.40	PK
H	158.30	36.80	10.10	43.50	6.70	PK
H	173.85	24.00	10.40	43.50	19.50	PK
H	249.66	37.40	13.10	46.00	8.60	PK
H	453.77	31.80	18.10	46.00	14.20	PK
H	687.03	42.70	22.20	46.00	3.30	PK
H	768.68	42.00	23.10	46.00	4.00	PK
V	31.94	24.10	20.40	40.00	15.90	PK
V	45.55	18.40	12.50	40.00	21.60	PK
V	74.71	17.30	9.50	40.00	22.70	PK
V	119.42	24.50	11.90	43.50	19.00	PK
V	156.35	26.40	10.10	43.50	17.10	PK
V	197.17	18.50	11.20	43.50	25.00	PK
V	249.66	26.40	13.10	46.00	19.60	PK
V	449.88	28.10	18.00	46.00	17.90	PK
V	550.96	31.20	20.00	46.00	14.80	PK
V	710.36	43.50	22.50	46.00	2.50	PK

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Test result above 1GHz:

The emission was conducted from 1GHz to 25GHz

802.11b

CH	Antenna	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
L	H	2390.00	55.24	24.04	-18.76	74.00	31.20	PK
	H	2390.00	48.12	16.92	-5.88	54.00	31.20	AV
	H	4824.00	45.44	42.74	-28.56	74.00	2.70	PK
	V	4824.00	44.63	41.93	-29.37	74.00	2.70	PK
M	H	4874.00	45.66	42.98	-28.34	74.00	2.68	PK
	V	4874.00	46.23	43.55	-27.77	74.00	2.68	PK
H	H	2483.50	53.38	22.19	-20.62	74.00	31.19	PK
	H	2483.50	46.19	15.00	-7.81	54.00	31.19	AV
	H	4924.00	45.55	42.78	-28.45	74.00	2.77	PK
	V	4924.00	45.23	42.46	-28.77	74.00	2.77	PK

802.11g

CH	Antenna	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
L	H	2390.00	57.33	26.13	-16.67	74.00	31.20	PK
	H	2390.00	46.88	15.68	-7.12	54.00	31.20	AV
	H	4824.00	45.56	42.86	-28.44	74.00	2.70	PK
	V	4824.00	46.57	43.87	-27.43	74.00	2.70	PK
M	H	4874.00	46.55	43.87	-27.45	74.00	2.68	PK
	V	4874.00	46.21	43.53	-27.79	74.00	2.68	PK
	H	7311.00	47.24	39.25	-26.76	74.00	7.99	PK
	V	7311.00	47.49	39.50	-26.51	74.00	7.99	PK
H	H	2483.50	55.88	24.69	-18.12	74.00	31.19	PK
	H	2483.50	45.77	14.58	-8.23	54.00	31.19	AV

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	H	4924.00	46.22	43.45	-27.78	74.00	2.77	PK
	V	4924.00	45.61	42.84	-28.39	74.00	2.77	PK

802.11n(HT20)

CH	Antenna	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
L	H	2390.00	58.73	27.53	-15.27	74.00	31.20	PK
	H	2390.00	46.58	15.38	-7.42	54.00	31.20	AV
	H	4824.00	45.33	42.63	-28.67	74.00	2.70	PK
	V	4824.00	45.61	42.91	-28.39	74.00	2.70	PK
M	H	4874.00	46.33	43.66	-27.67	74.00	2.67	PK
	V	4874.00	45.46	42.79	-28.54	74.00	2.67	PK
H	H	2483.50	56.88	25.69	-17.12	74.00	31.19	PK
	H	2483.50	46.61	15.42	-7.39	54.00	31.19	AV
	H	4924.00	46.77	44.01	-27.23	74.00	2.76	PK
	V	4924.00	45.64	42.88	-28.36	74.00	2.76	PK

802.11n (HT40):

CH	Antenna	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
L	H	2390.00	62.55	31.35	-11.45	74.00	31.20	PK
	H	2390.00	47.52	16.32	-6.48	54.00	31.20	AV
	H	4844.00	45.67	42.99	-28.33	74.00	2.68	PK
	V	4844.00	45.83	43.15	-28.17	74.00	2.68	PK
M	H	4874.00	46.88	44.21	-27.12	74.00	2.67	PK
	V	4874.00	47.21	44.54	-26.79	74.00	2.67	PK
H	H	2483.50	59.69	28.50	-14.31	74.00	31.19	PK
	H	2483.50	46.85	15.66	-7.15	54.00	31.19	AV
	H	4904.00	46.42	43.77	-27.58	74.00	2.65	PK
	V	4904.00	46.13	43.48	-27.87	74.00	2.65	PK

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Remark: 1. Correct Factor = Antenna Factor + Cable Loss (+ Amplifier, for higher than 1GHz), the value was added to Original Receiver Reading by the software automatically.
2. Corrected Reading = Original Receiver Reading + Correct Factor
3. Margin = Limit - Corrected Reading
4. If the PK Corrected Reading is lower than AV limit, the AV test can be elided.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10.00dBuV,
Limit = 40.00dBuV/m.
Then Correct Factor = $30.20 + 2.00 - 32.00 = 0.20\text{dB/m}$;
Corrected Reading = $10\text{dBuV} + 0.20\text{dB/m} = 10.20\text{dBuV/m}$;
Margin = $40.00\text{dBuV/m} - 10.20\text{dBuV/m} = 29.80\text{dB}$.

4 Power line conducted emission

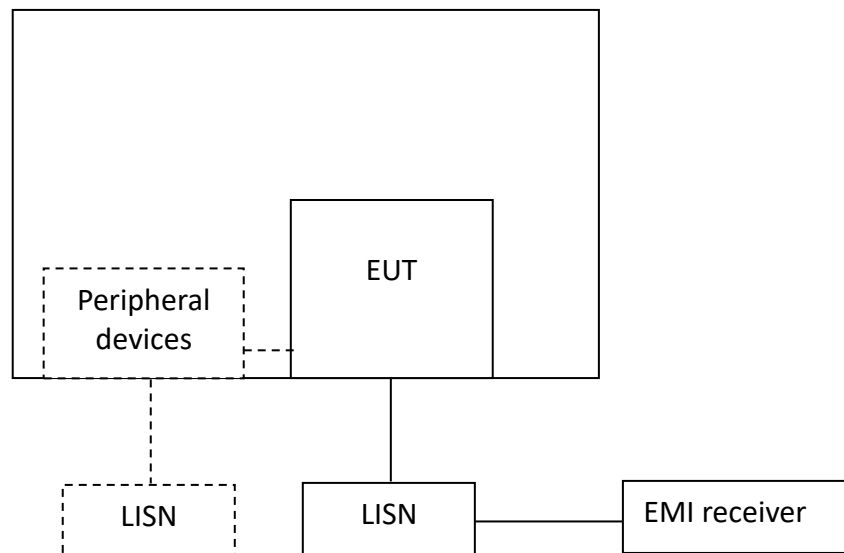
Test result: Pass

4.1 Limit

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	QP	AV
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.

4.2 Test Configuration



4.3 Measurement Procedure

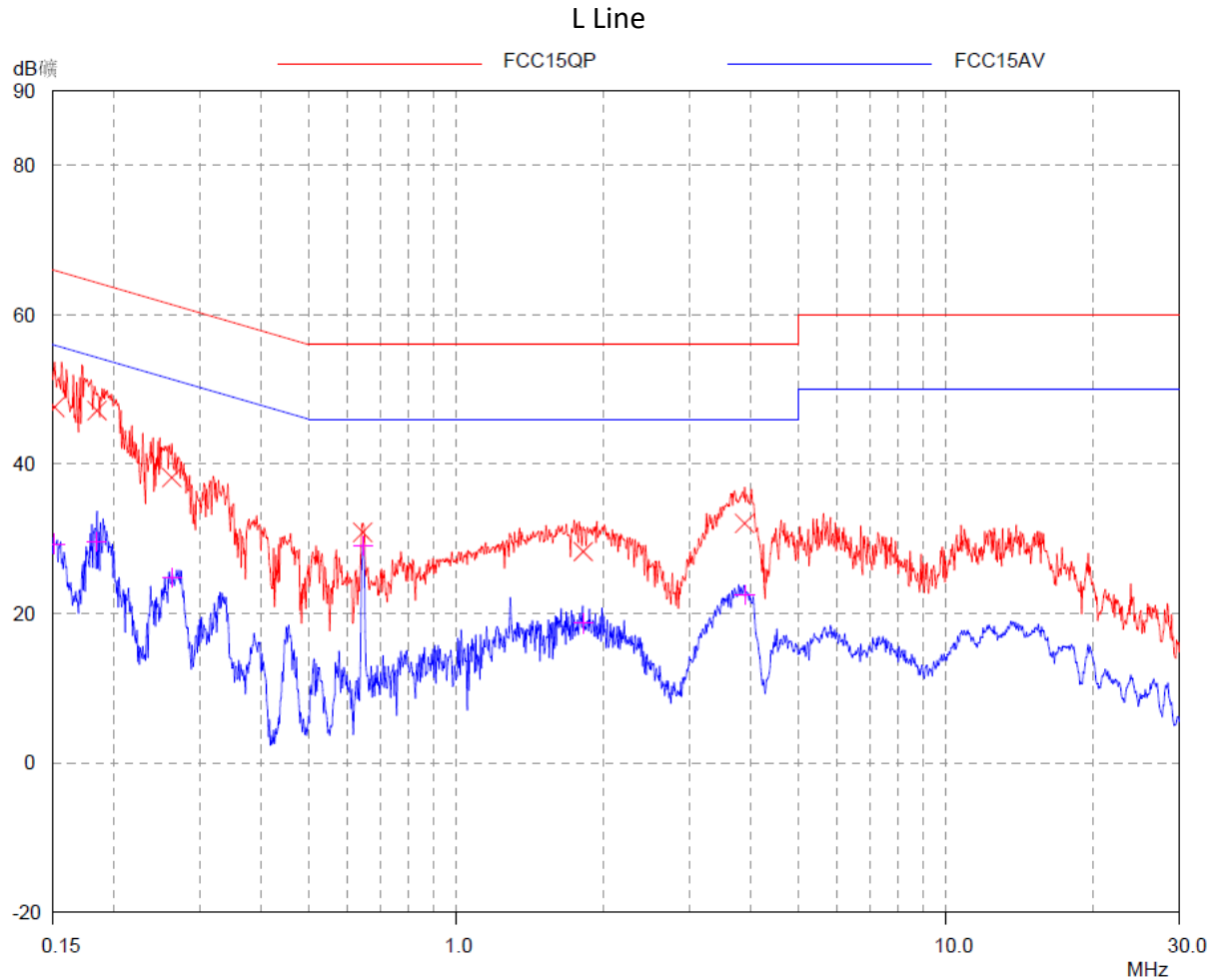
Measured levels of ac power-line conducted emission shall be the emission voltages from the voltage probe, where permitted, or across the 50 Ω LISN port (to which the EUT is connected), where permitted, terminated into a 50 Ω measuring instrument. All emission voltage and current measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord by the use of mating plugs and receptacles on the LISN, if used. Equipment shall be tested with power cords that are normally supplied or recommended by the manufacturer and that have electrical and shielding characteristics that are the same as those cords normally supplied or recommended by the manufacturer. For those measurements using a LISN, the 50 Ω measuring port is terminated by a measuring instrument having 50 Ω input impedance. All other ports are terminated in 50 Ω loads.

Tabletop devices shall be placed on a platform of nominal size 1 m by 1.5 m, raised 80 cm above the reference ground plane. The vertical conducting plane or wall of an RF-shielded (screened) room shall be located 40 cm to the rear of the EUT. Floor-standing devices shall be placed either directly on the reference ground-plane or on insulating material as described in ANSI C63.4. All other surfaces of tabletop or floor-standing EUTs shall be at least 80 cm from any other grounded conducting surface, including the case or cases of one or more LISNs.

The bandwidth of the test receiver is set at 9 kHz.

4.4 Test Results of Power line conducted emission

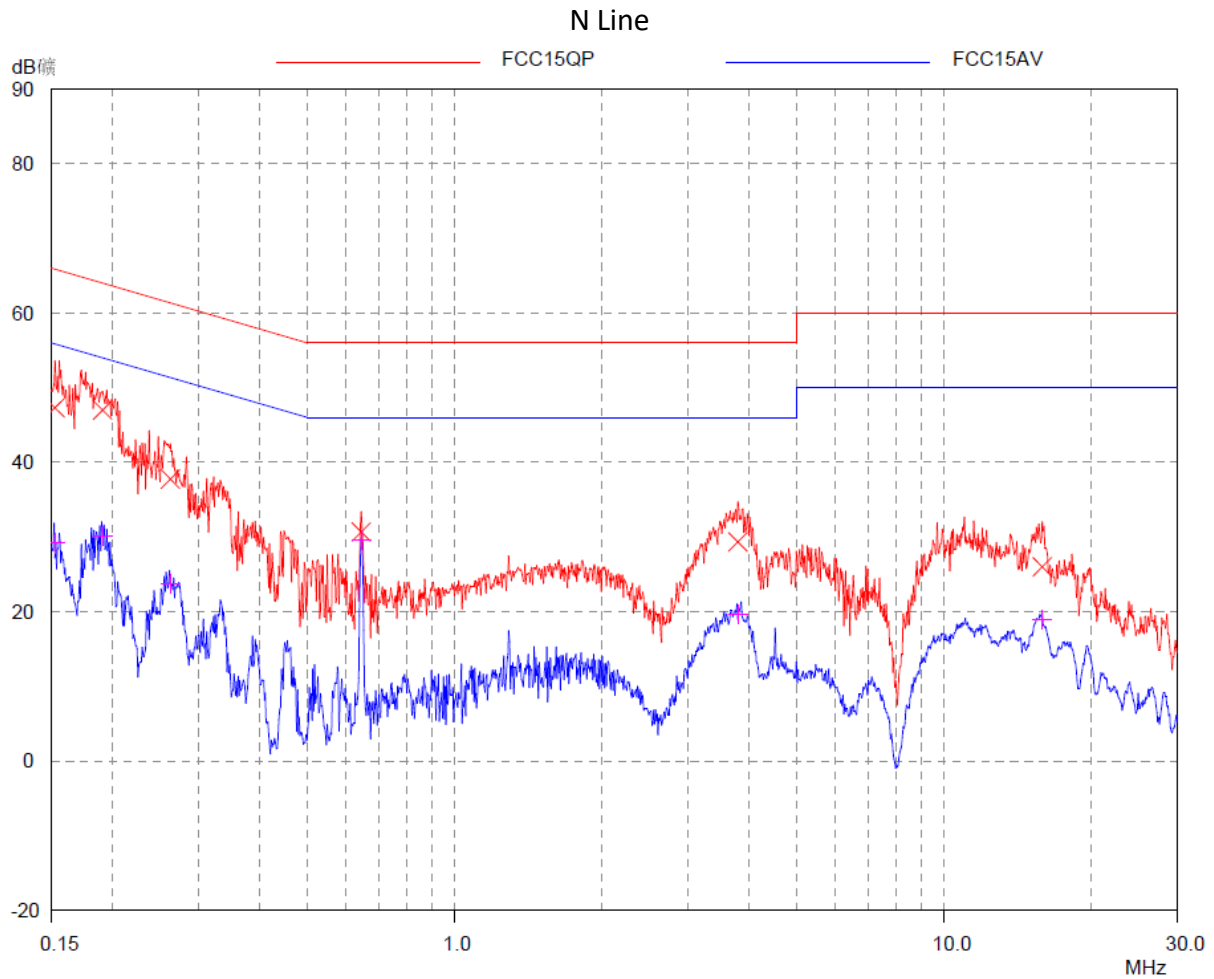
Test Curve:



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(μV)	Limit dB(μV)	Margin (dB)	level dB(μV)	limit dB(μV)	Margin (dB)
0.151	47.63	65.93	18.30	29.31	55.93	26.62
0.185	47.17	64.28	17.11	29.62	54.28	24.66
0.262	38.17	61.36	23.19	24.79	51.36	26.57
0.644	30.85	56.00	25.15	29.08	46.00	16.92
1.818	28.28	56.00	27.72	18.67	46.00	27.33
3.882	32.06	56.00	23.94	22.49	46.00	23.51

Test Curve:



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(μV)	Limit dB(μV)	Margin (dB)	level dB(μV)	limit dB(μV)	Margin (dB)
0.152	47.31	65.87	18.56	29.16	55.87	26.71
0.191	46.99	64.01	17.02	30.13	54.01	23.88
0.262	37.75	61.36	23.61	23.75	51.36	27.61
0.644	30.69	56.00	25.31	29.54	46.00	16.46
3.790	29.34	56.00	26.66	19.61	46.00	26.39
15.888	25.99	60.00	34.01	18.94	50.00	31.06

Remark: 1. Correct Factor = LISN Factor + Cable Loss, the value was added to Original Receiver Reading by the software automatically.

2. Corrected Reading = Original Receiver Reading + Correct Factor

3. Margin = Limit - Corrected Reading

4. If the PK Corrected Reading is lower than AV limit, the AV test can be elided.

5 Antenna requirement

Requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

Result:

EUT uses used a permanently attached PCB antenna to the intentional radiator, so it can comply with the provisions of this section.

***** END *****