

Ecovacs Home Service Robotics Co., Ltd.

RF TEST REPORT

Report Type:

FCC Part 15.247 & ISSED RSS-247 C2PC report

Model:

DLX23

REPORT NUMBER:

230401325SHA-001

ISSUE DATE:

June 6, 2023

DOCUMENT CONTROL NUMBER:

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FCC ID: 2A64B-DLX23

IC: 28593-DLX23

SUMMARY:

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

47CFR Part 15 (2020): 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 (March 2019) Amendment 1: General Requirements for Compliance of Radio Apparatus

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TEST REPORT

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Revision History

Report No.	Version	Description	Issued Date
230200388SHA-001	Rev. 01	Initial issue of report	February 18, 2023
230401325SHA-001	Rev. 01	<p>This report is based on original report 230200388SHA-001 for amendment include the follow changes.</p> <ol style="list-style-type: none"> 1. Added alternative construction with one or two magnet rings; 2. Added alternative photo with different colour; 3. Added photos with different Shielding cover; <p>We test the relevant items and list the worst result in this report.</p>	June 6, 2023

Measurement result summary

TEST ITEM	FCC REFERANCE	IC REFERANCE	RESULT
Minimum 6dB Bandwidth	15.247(a)(2)	RSS-247 Issue 2 Clause 5.2	Refer to report 230200388SHA-001
Maximum conducted output power and e.i.r.p.	15.247(b)(3)	RSS-247 Issue 2 Clause 5.4	Refer to report 230200388SHA-001
Power spectrum density	15.247(e)	RSS-247 Issue 2 Clause 5.2	Refer to report 230200388SHA-001
Emission outside the frequency band	15.247(d)	RSS-247 Issue 2 Clause 5.5	Refer to report 230200388SHA-001
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
Occupied bandwidth	-	RSS-Gen Issue 5 Clause 6.6	Refer to report 230200388SHA-001
Antenna requirement	15.203	-	Refer to report 230200388SHA-001

Notes: 1: NA =Not Applicable

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1 GENERAL INFORMATION

1.1 Description of Equipment Under Test (EUT)

Product name:	Floor Cleaning Robot
Type/Model/PMN/HVIN:	DLX23
Description of EUT:	The EUT is a Floor Cleaning Robot, it supports WIFI functions, there is only one model. we test them and list the worst results in this report.
Rating:	20V DC 2.0A
EUT type:	<input type="checkbox"/> Table top <input checked="" type="checkbox"/> Floor standing
Software Version:	/
Hardware Version:	/
Sample Identification No.:	0230415-26-002
Sample received date:	2023.04.15
Date of test:	2023.04.18-2023.05.11

1.2 Technical Specification

Frequency Band:	2400MHz ~ 2483.5MHz
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)
Channel Separation:	5 MHz
Antenna:	FPC Antenna, 2.90dBi

1.3 Antenna information

Mode	Tx/Rx Function	Beamforming function	CDD function	Directional gain (dBi)
802.11b	1Tx/1Rx	NO	NO	-
802.11g	1Tx/1Rx	NO	NO	-
802.11n(HT20)	1Tx/1Rx	NO	NO	-
802.11n(HT40)	1Tx/1Rx	NO	NO	-

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1.4 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: CN0175
	IC Registration Lab CAB identifier.: CN0014
	VCCI Registration Lab Member No: 3598 (Registration No.: R-14243, G-10845, C-14723, T-12252)
	A2LA Accreditation Lab Certificate Number: 3309.02

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2 TEST SPECIFICATIONS

2.1 Standards or specification

47CFR Part 15 (2020)
 ANSI C63.10 (2013)
 KDB 558074 (v05r02)
 RSS-247 Issue 2 (February 2017)
 RSS-Gen Issue 5 (March 2019) Amendment 1

2.2 Mode of operation during the test

While testing transmitting mode of EUT, the internal modulation and continuously transmission was applied.

Software name	Manufacturer	Version	Supplied by
Putty	-	-	Client

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 and Power setting:

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 rata as the worst case.

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

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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	DELL 5480	-

2.5 Test environment condition:

Test items	Temperature	Humidity
Minimum 6dB Bandwidth	24°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	25°C	51%RH
Power line conducted emission	24°C	52%RH

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2.6 Instrument list

Conducted Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
<input checked="" type="checkbox"/>	Test Receiver	R&S	ESCS 30	EC 2107	2023-07-09
<input checked="" type="checkbox"/>	A.M.N.	R&S	ESH2-Z5	EC 3119	2023-11-09
<input type="checkbox"/>	A.M.N.	R&S	ENV 216	EC 3393	2023-07-09
<input type="checkbox"/>	A.M.N.	R&S	ENV4200	EC 3558	2023-06-09
Radiated Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
<input checked="" type="checkbox"/>	Test Receiver	R&S	ESIB 26	EC 3045	2023-10-19
<input checked="" type="checkbox"/>	Bilog Antenna	TESEQ	CBL 6112D	EC 4206	2023-08-06
<input checked="" type="checkbox"/>	Pre-amplifier	R&S	AFS42-00101800-25-S-42	EC5262	2023-06-09
<input checked="" type="checkbox"/>	Horn antenna	ETS	3117	EC 4792-1	2023-03-27
<input checked="" type="checkbox"/>	Horn antenna	TOYO	HAP18-26W	EC 4792-3	2023-07-08
<input type="checkbox"/>	Active loop antenna	Schwarzbeck	FMZB1519	EC 5345	2023-04-24
RF test					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
<input type="checkbox"/>	PXA Signal Analyzer	Keysight	N9030A	EC 5338	2023-03-14
<input type="checkbox"/>	Power sensor	Agilent	U2021XA	EC 5338-1	2023-03-14
<input type="checkbox"/>	Vector Signal Generator	Agilent	N5182B	EC 5175	2023-03-14
<input type="checkbox"/>	Universal Radio Communication Tester	R&S	CMW500	EC5944	2024-01-20
<input type="checkbox"/>	MXG Analog Signal Generator	Agilent	N5181A	EC 5338-2	2023-03-06
<input type="checkbox"/>	Mobile Test System	Litepoint	lqxel	EC 5176	2024-01-11
<input type="checkbox"/>	Test Receiver	R&S	ESCI 7	EC 4501	2023-12-09
<input type="checkbox"/>	Climate chamber	GWS	MT3065	EC 6021	2023-03-06
<input type="checkbox"/>	Spectrum Analyzer	Keysight	N9030B	EC 6078	2023-06-08
Tet Site					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
<input checked="" type="checkbox"/>	Shielded room	Zhongyu	-	EC 2838	2024-01-24
<input type="checkbox"/>	Shielded room	Zhongyu	-	EC 2839	2024-01-24
<input checked="" type="checkbox"/>	Semi-anechoic	Albatross	-	EC 3048	2023-08-22

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	chamber	project			
<input checked="" type="checkbox"/>	Fully-anechoic chamber	Albatross project	-	EC 3047	2023-08-22
Additional instrument					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
<input checked="" type="checkbox"/>	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3783	2023-03-24
<input type="checkbox"/>	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 5844	2023-03-09
<input checked="" type="checkbox"/>	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3442	2024-01-04
<input checked="" type="checkbox"/>	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 5198	2023-03-09
<input type="checkbox"/>	Pressure meter	YM3	Shanghai Mengde	EC 3320	2023-07-22

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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	± 0.74dB
Radiated Emissions in restricted frequency bands below 1GHz	± 4.90dB
Radiated Emissions in restricted frequency bands above 1GHz	± 5.02dB
Emission outside the frequency band	± 2.89dB
Power line conducted emission	± 3.19dB

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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

The EUT was tested according to Subclause 11.12 of ANSI C63.10.

For Radiated emission below 30MHz:

- a) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meters chamber room. For the floor-standing devices, the EUT was placed on the top of a rotating table 0.1 meters above the ground at 3 meters 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) Both X and Y axes of the antenna are set to make the measurement.
- d) 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.
- e) The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

- 1. 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 above the ground at a 3 meters chamber room. For the floor-standing devices, the EUT was placed on the top of a rotating table 0.1 meters above the ground at 3 meters 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 detector 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.

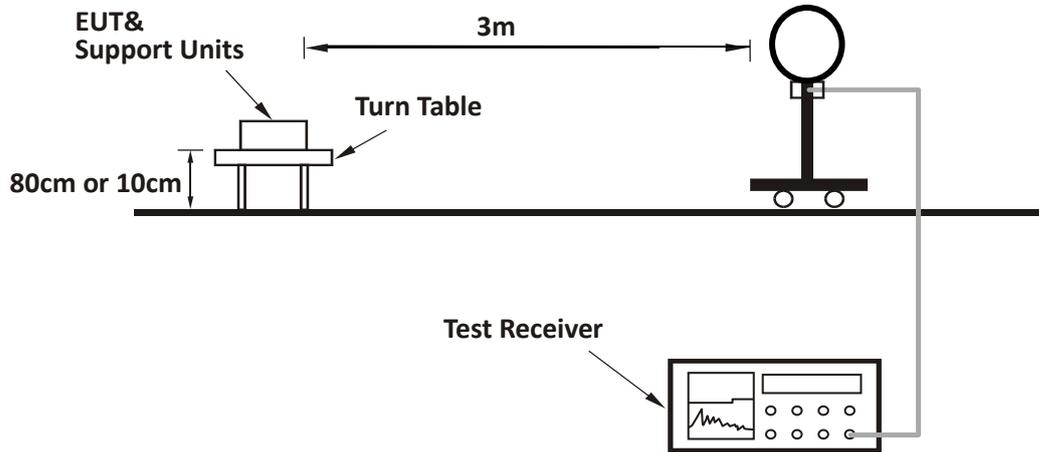
Note:

- 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 $3 \times \text{RBW}$ (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.
- 4. All modes of operation were investigated and the worst-case emissions were reported.

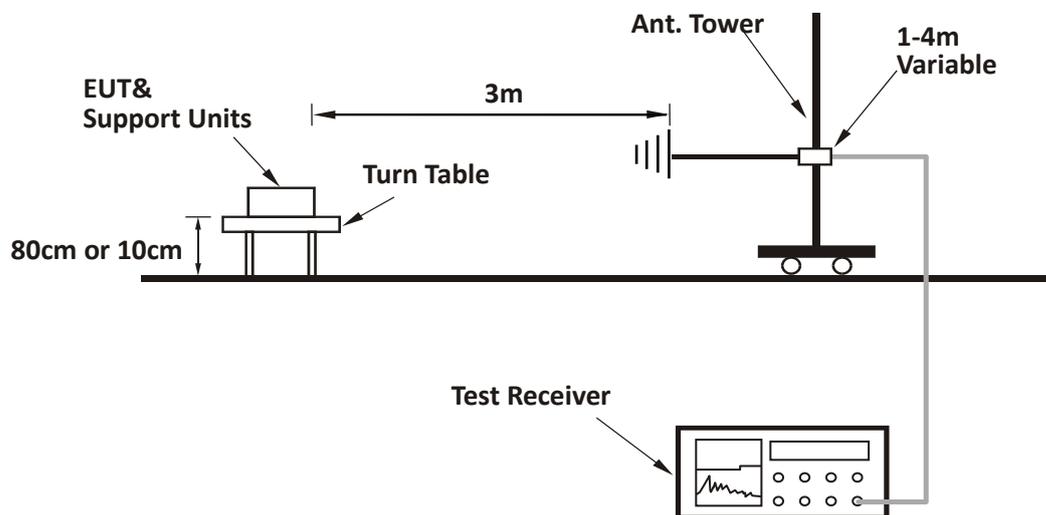
TEST REPORT

3.3 Test Configuration

For Radiated emission below 30MHz:

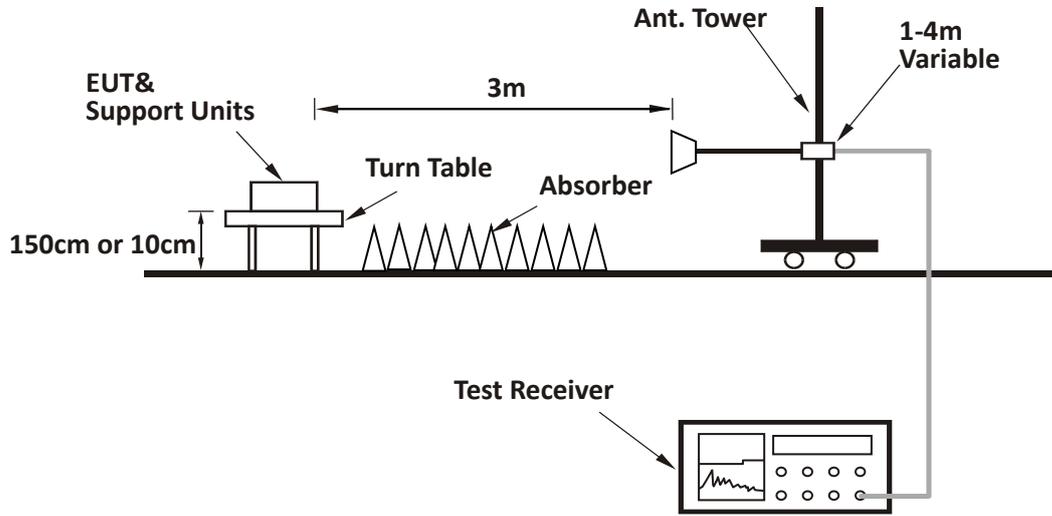


For Radiated emission 30MHz to 1GHz:



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For Radiated emission above 1GHz:

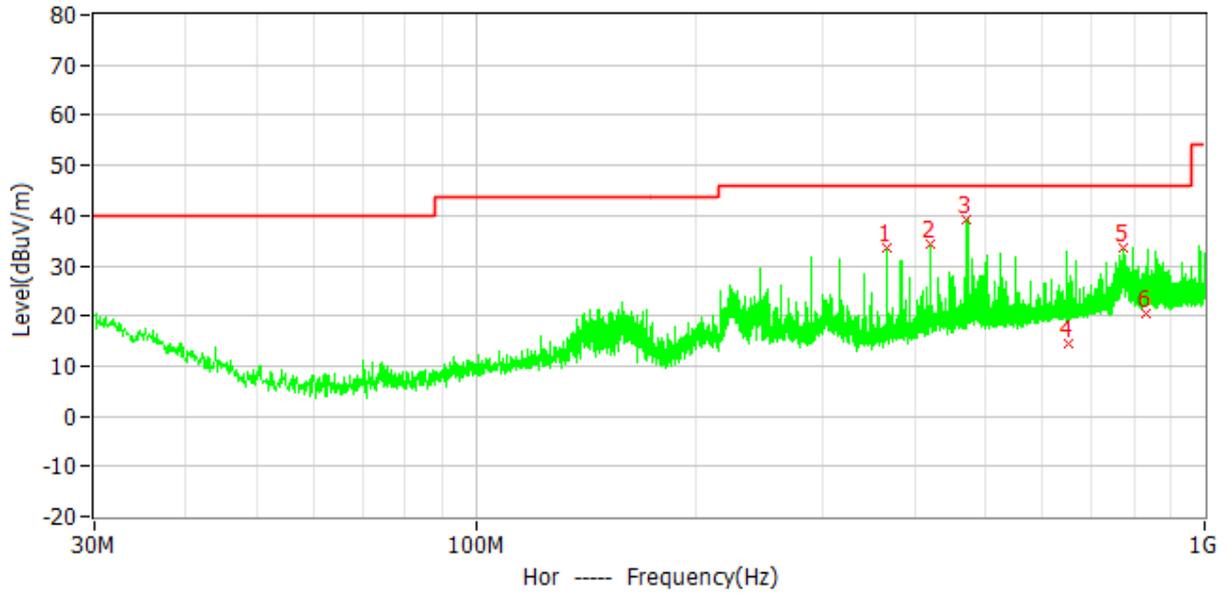


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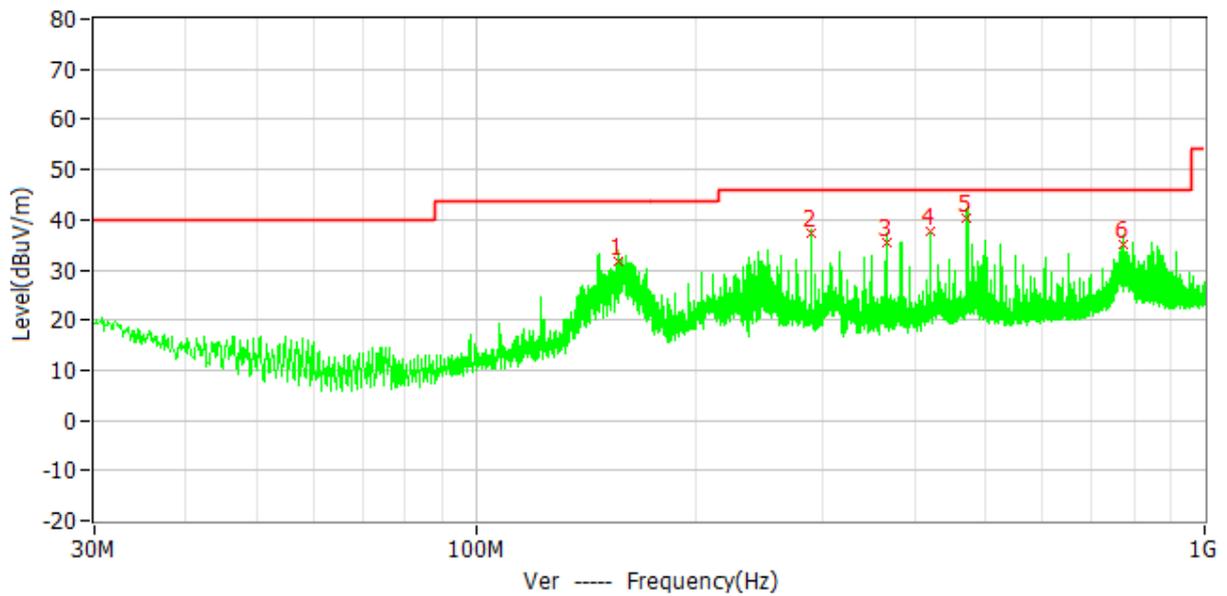
3.4 Test Results of Radiated Emissions

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.

Horizontal



Vertical



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Data:

Antenna	Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
H	367.48	33.50	46.00	12.50	QP
H	419.97	34.30	46.00	11.70	QP
H	472.48	39.00	46.00	7.00	QP
H	651.40	14.40	46.00	31.60	QP
H	774.16	33.60	46.00	12.40	QP
H	828.71	20.30	46.00	25.70	QP
V	156.69	31.50	43.50	12.00	QP
V	288.74	37.30	46.00	8.70	QP
V	367.48	35.40	46.00	10.60	QP
V	419.98	37.70	46.00	8.30	QP
V	472.48	40.30	46.00	5.70	QP
V	774.20	35.20	46.00	10.80	QP

Test result above 1GHz:

The emission was conducted from 1GHz to 25GHz

802.11b

CH	Antenna	Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2390	50.90	74.00	23.10	PK
	V	2390	52.60	74.00	21.40	PK
	H	4824	42.40	74.00	31.60	PK
	V	4824	43.30	74.00	30.70	PK
M	H	4874	42.60	74.00	31.40	PK
	V	4874	43.50	74.00	30.50	PK
H	H	2483.5	51.50	74.00	22.50	PK
	V	2483.5	52.70	74.00	21.30	PK
	H	4924	42.60	74.00	31.40	PK
	V	4924	44.10	74.00	29.90	PK

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802.11g

CH	Antenna	Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	V	2390	58.70	74.00	15.30	PK
	V	2390	45.30	54.00	8.70	AV
	V	4824	44.10	74.00	29.90	PK
M	V	4874	43.80	74.00	30.20	PK
H	V	2483.5	58.50	74.00	15.50	PK
	V	2483.5	44.30	54.00	9.70	AV
	V	4924	44.90	74.00	29.10	PK

802.11n(HT20)

CH	Antenna	Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	V	2390	62.40	74.00	11.60	PK
	V	2390	44.90	54.00	9.10	AV
	V	4824	44.30	74.00	29.70	PK
M	V	4874	43.80	74.00	30.20	PK
H	V	2483.5	59.70	74.00	14.30	PK
	V	2483.5	44.60	54.00	9.40	AV
	V	4924	45.10	74.00	28.90	PK

802.11n(HT40)

CH	Antenna	Frequency (MHz)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	V	2390	64.20	74.00	9.80	PK
	V	2390	46.60	54.00	7.40	AV
	V	4844	44.80	74.00	29.20	PK
M	V	4874	44.90	74.00	29.10	PK
H	V	2483.5	60.70	74.00	13.30	PK
	V	2483.5	45.20	54.00	8.80	AV
	V	4904	45.60	74.00	28.40	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 = $40.00\text{dBuV/m} - 10.20\text{dBuV/m} = 29.80\text{dB}$.

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4 Power line conducted emission

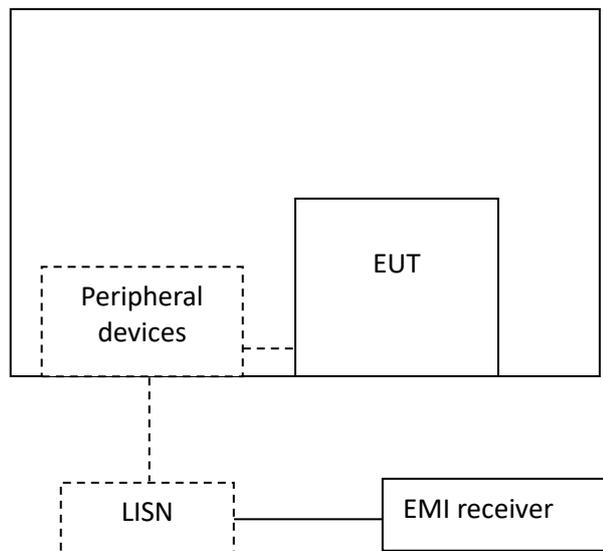
Test result: Pass

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



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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.

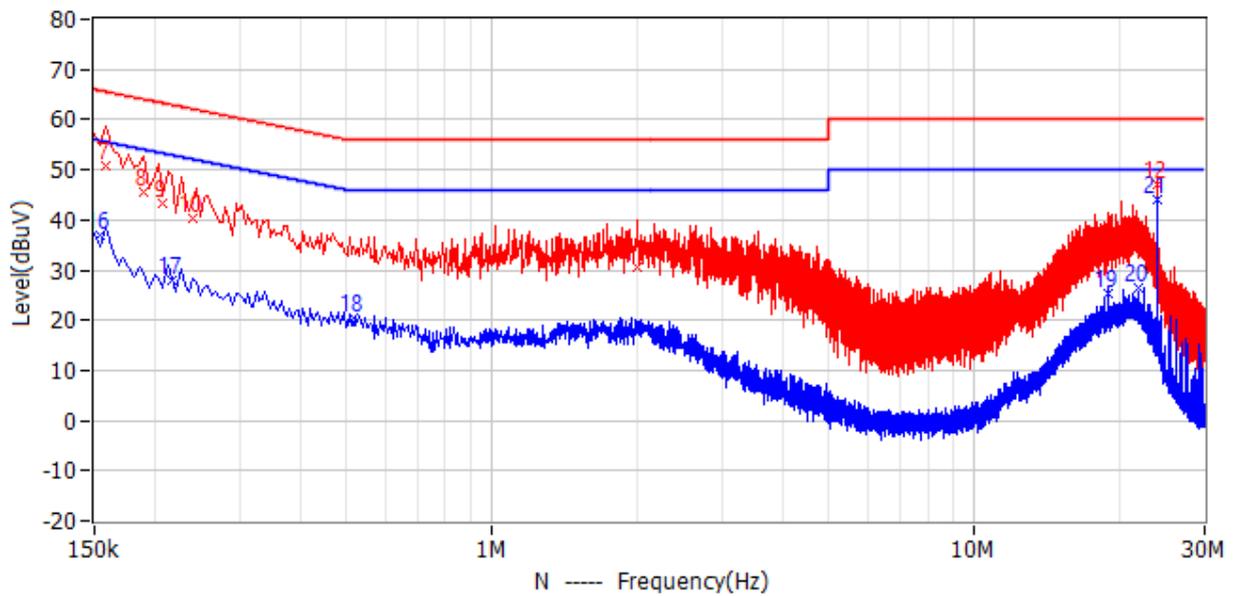
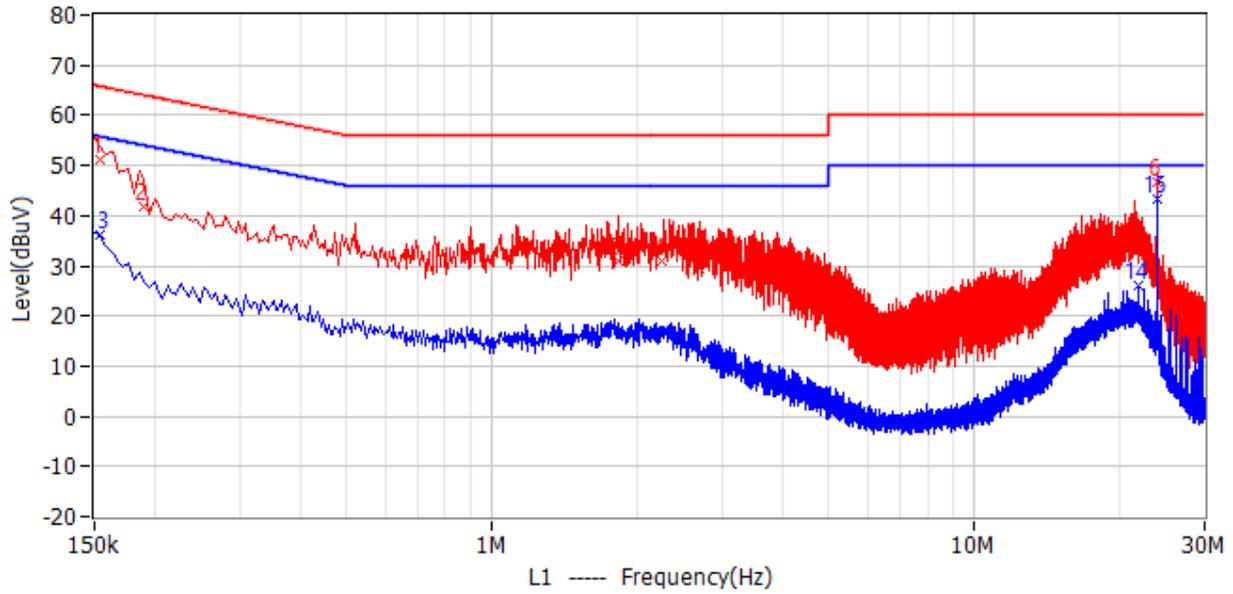
Tabletop devices shall be placed on a platform of nominal size 1 m by 1.5 m, raised 80 cm above the reference ground plane. The vertical conducting plane or wall of an RF-shielded (screened) room shall be located 40 cm to the rear of the EUT. Floor-standing devices shall be placed either directly on 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.

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4.4 Test Results of Power line conducted emission

Test Voltage: AC 120V, 60Hz



Total Quality. Assured.

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Data:

No.	Frequency	Limit dBuV	Level dBuV	Delta dB	Reading dBuV	Factor dB	Detector	Phase
1	154.500kHz	65.8	51.2	-14.6	45.0	6.2	QP	L1
2	190.500kHz	64.0	41.9	-22.1	35.7	6.2	QP	L1
3	1.829MHz	56.0	31.0	-25.0	24.8	6.2	QP	L1
4	2.256MHz	56.0	31.0	-25.0	24.8	6.2	QP	L1
5	2.697MHz	56.0	29.6	-26.4	23.4	6.2	QP	L1
6	24.005MHz	60.0	46.7	-13.3	40.3	6.4	QP	L1
7	159.000kHz	65.5	50.8	-14.7	44.5	6.3	QP	N
8	190.500kHz	64.0	45.5	-18.6	39.3	6.2	QP	N
9	208.500kHz	63.3	43.3	-20.0	37.0	6.3	QP	N
10	240.000kHz	62.1	40.2	-21.9	34.0	6.2	QP	N
11	2.009MHz	56.0	30.4	-25.6	24.1	6.3	QP	N
12	24.005MHz	60.0	47.2	-12.8	40.7	6.5	QP	N
13	154.500kHz	55.8	36.2	-19.5	30.0	6.2	CAV	L1
14	21.903MHz	50.0	26.0	-24.0	19.6	6.4	CAV	L1
15	24.005MHz	50.0	43.4	-6.6	37.0	6.4	CAV	L1
16	154.500kHz	55.8	36.8	-18.9	30.5	6.3	CAV	N
17	217.500kHz	52.9	27.9	-25.0	21.6	6.3	CAV	N
18	514.500kHz	46.0	20.6	-25.4	14.3	6.3	CAV	N
19	18.902MHz	50.0	25.3	-24.7	18.8	6.5	CAV	N
20	21.903MHz	50.0	26.3	-23.7	19.8	6.5	CAV	N
21	24.005MHz	50.0	43.9	-6.1	37.4	6.5	CAV	N

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

2. Level = Original Receiver Reading + Correct Factor

3. Delta = Level - Limit

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

***** END *****