

TEST REPORT

Reference No. : WTS15S1136567E
FCC ID : 2AGE6-B3
Applicant : Shenzhen Silver Star Intelligent Technology Co., Ltd.
Address : Dafu Industrial Areas, Guanguang Road, Baoan District, Shenzhen, China
Manufacturer : The same as above.
Address : The same as above.
Product Name : Robot Vacuum Cleaner
Model No. : B3, B4, B5, B6, C1, C2, C3, C4, C5, C6, C7, C8, C11, C15, C16, C18, D1, D2, D3, D4, D5, D6, D7, G1, F1, F2
Standards..... : FCC CFR47 Part 15 Section 15.249: 2014
Date of Receipt sample : Nov. 03, 2015
Date of Test : Nov. 04 - 22, 2015
Date of Issue : Nov. 25, 2015
Test Result..... : Pass

Remarks:

The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

Prepared By:

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2 Test Summary

Test Items	Test Requirement	Result
Conducted Emissions	15.207	N/A
Radiated Emission	15.249(a) 15.209 15.205(a)	PASS
Periodic Operation	15.35(c)	PASS
Outside of Band Emission	15.249 15.205 15.209	PASS
20dB Bandwidth	15:215(c)	PASS
Antenna Requirement	15.203	PASS

3 Contents

	Page
1 COVER PAGE	1
2 TEST SUMMARY	2
3 CONTENTS	3
4 GENERAL INFORMATION	4
4.1 GENERAL DESCRIPTION OF E.U.T.	4
4.2 DETAILS OF E.U.T.	4
4.3 TEST FACILITY	4
5 EQUIPMENT USED DURING TEST	5
5.1 EQUIPMENTS LIST	5
5.2 MEASUREMENT UNCERTAINTY	6
5.3 TEST EQUIPMENT CALIBRATION	6
6 CONDUCTED EMISSION	7
6.1 E.U.T. OPERATION	7
6.2 EUT SETUP	7
6.3 MEASUREMENT DESCRIPTION	7
6.4 TEST RESULT	8
7 RADIATION EMISSION TEST	10
7.1 EUT OPERATION	10
7.2 TEST SETUP	11
7.3 SPECTRUM ANALYZER SETUP	12
7.4 TEST PROCEDURE	13
7.5 TEST RESULT	14
8 PERIODIC OPERATION	15
9 OUTSIDE OF BAND EMISSION	16
9.1 TEST PROCEDURE	16
9.2 TEST RESULT	16
10 20 DB BANDWIDTH MEASUREMENT	17
10.1 TEST PROCEDURE	17
10.2 TEST RESULT	17
11 ANTENNA REQUIREMENT	18
12 PHOTOGRAPHS- MODEL B3 TEST SETUP	19
12.1 RADIATION EMISSION	19
12.2 PHOTOGRAPH – CONDUCTED EMISSION TEST SETUP AT TEST SITE 1#	20
13 PHOTOGRAPHS - CONSTRUCTIONAL DETAILS	21
13.1 MODEL B3- EXTERNAL PHOTOS	21
13.2 MODEL B3- INTERNAL PHOTOS	25

4 General Information

4.1 General Description of E.U.T.

Product Name	: Robot Vacuum Cleaner
Model No.	: B3, B4, B5, B6, C1, C2, C3, C4, C5, C6, C7, C8, C11, C15, C16, C18, D1, D2, D3, D4, D5, D6, D7, G1, F1, F2
Model Differences	: Are same in all respects except the shape cover of control panel.
Type of Modulation	: GFSK
Frequency Range	: 2468MHz
The Lowest Oscillator	: 32.768KHz
Antenna installation	: PCB antenna
Remark	: The test sample model is B3.

4.2 Details of E.U.T.

Technical Data	: DC 24V, 1000mA by adapter AC 100-240V, 50/60Hz, (Model: RHD30W240100) DC 14.8V, 2200mAh by battery
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4.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **IC – Registration No.: 7760A-1**

Waltek Services(Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files. Registration number 7760A-1, Oct 15, 2015.

- **FCC Test Site 1#– Registration No.: 880581**

Waltek Services(Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 880581, April 29, 2014.

- **FCC Test Site 2#– Registration No.: 328995**

Waltek Services(Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 328995, December 3, 2014.

4.3.1 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

Test mode	Lower channel	Middle channel	Upper channel
Transmitting	N/A	2468MHz	N/A

5 Equipment Used during Test

5.1 Equipments List

RF Conducted Testing						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1.	EMC Analyzer (9k~26.5GHz)	Agilent	E7405A	MY4511494 3	Sep.15,2015	Sep.14,2016
2.	Spectrum Analyzer (9k-6GHz)	R&S	FSL6	100959	Sep.15,2015	Sep.14,2016
3.	Humidity Chamber	GF	GTH-225-40- 1P	IAA061213	May 16,2015	May 15,2016
3m Semi-anechoic Chamber for Radiation						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1	Spectrum Analyzer	R&S	FSP	836079/035	May-07-2015	May-06-2016
2	EMI Test Receiver	R&S	ESVB	825471/005	May-07-2015	May-06-2016
3	Pre-amplifier	Agilent	8447F	3113A06717	May-07-2015	May-06-2016
4	Pre-amplifier	Compliance Direction	PAP-0118	24002	May-07-2015	May-06-2016
5	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	9163-333	Apr-20-2015	Apr-19-2016
6	Horn Antenna	ETS	3117	00086197	Apr-20-2015	Apr-19-2016
7	Horn Antenna	ETS	3116B	00088203	Apr-20-2015	Apr-19-2016
8	Loop Antenna	SCHWARZECK	HFRA 5165	9365	Apr-20-2015	Apr-19-2016
Conducted Emissions Test Site 1#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1.	EMI Test Receiver	R&S	ESCI	100947	Sep.15,2015	Sep.14,2016
2.	LISN	R&S	ENV216	101215	Sep.15,2015	Sep.14,2016
3.	Cable	Top	TYPE16(3.5M)	-	Sep.15,2015	Sep.14,2016
Conducted Emissions Test Site 2#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1.	EMI Test Receiver	R&S	ESCI	101155	Sep.15,2015	Sep.14,2016
2.	LISN	SCHWARZBECK	NSLK 8128	8128-289	Sep.15,2015	Sep.14,2016
3.	Limiter	York	MTS-IMP-136	261115-001- 0024	Sep.15,2015	Sep.14,2016
4.	Cable	LARGE	RF300	-	Sep.15,2015	Sep.14,2016

5.2 Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-6}$
RF Power	± 1.0 dB
RF Power Density	± 2.2 dB
Radiated Spurious Emissions test	± 5.03 dB (Bilog antenna 30M~1000MHz)
	± 5.47 dB (Horn antenna 1000M~25000MHz)

5.3 Test Equipment Calibration

All the test equipments used are valid and calibrated by CEPREI Certification Body that address is No.110 Dongguan Zhuang RD. Guangzhou, P.R.China.

6 Conducted Emission

Test Requirement:	FCC CFR 47 Part 15 Section 15.207
Test Method:	ANSI C63.4:2014
Test Result:	PASS
Frequency Range:	150kHz to 30MHz
Class/Severity:	Class B
Limit:	66-56 dB μ V between 0.15MHz & 0.5MHz 56 dB μ V between 0.5MHz & 5MHz 60 dB μ V between 5MHz & 30MHz
Detector:	Peak for pre-scan (9kHz Resolution Bandwidth)

6.1 E.U.T. Operation

Operating Environment :

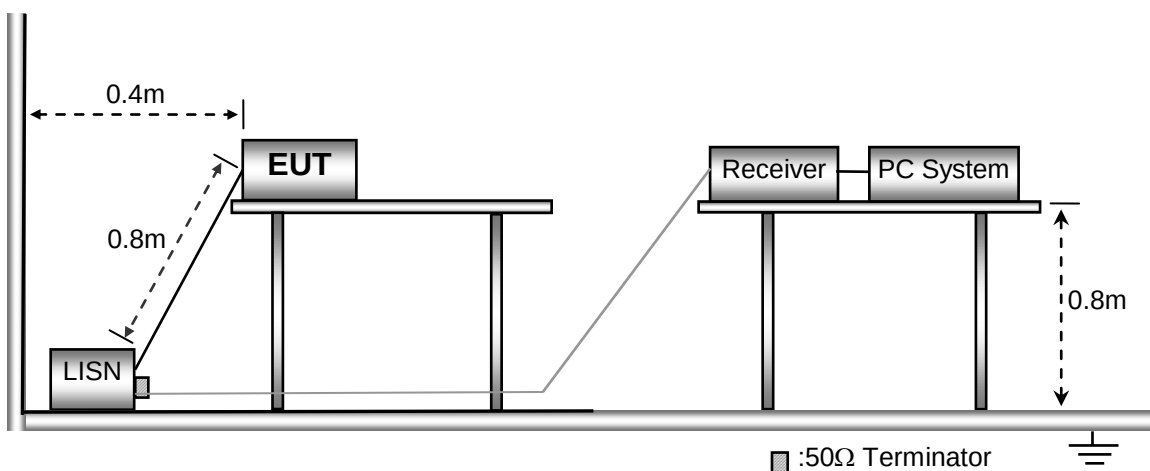
Temperature:	25.5 °C
Humidity:	51 % RH
Atmospheric Pressure:	101.2kPa

EUT Operation :

The test was performed in transmitting mode, the test data were shown in the report.

6.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.4.

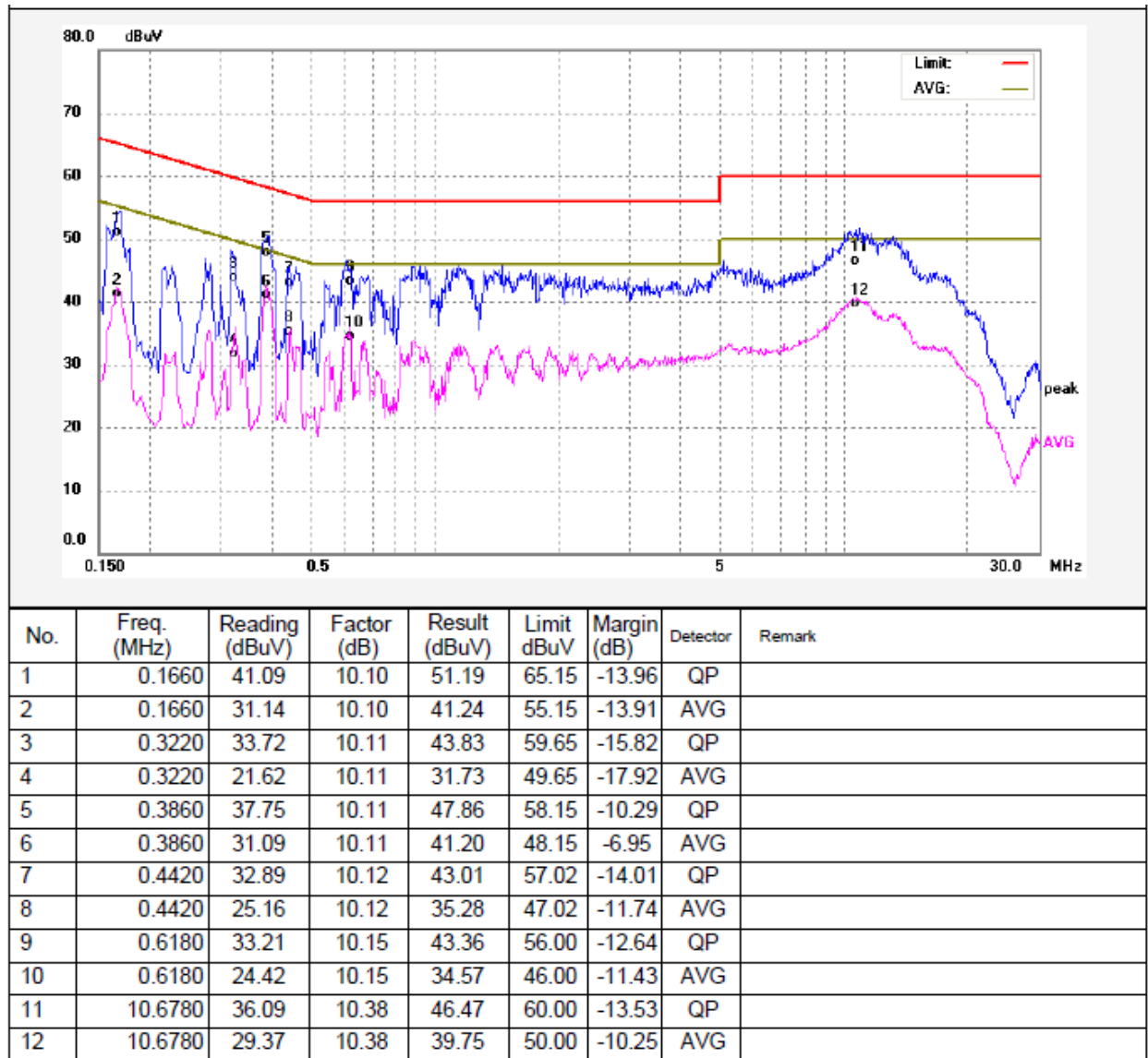


6.3 Measurement Description

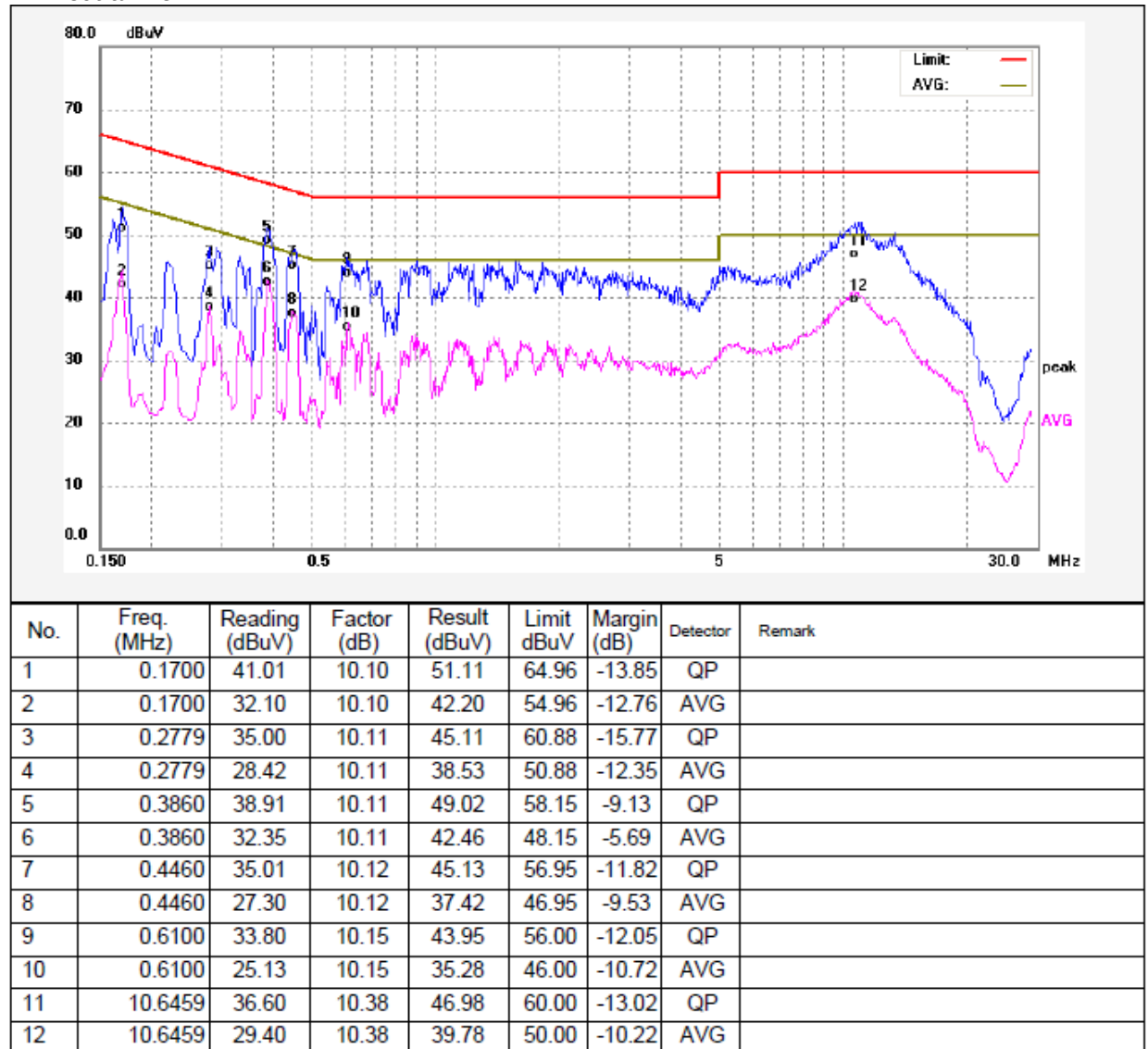
The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

6.4 Test Result

Live line:



Neutral line:



7 Radiation Emission Test

Test Requirement: FCC Part15 Paragraph 15.249&15.209&15.205

Test Method: ANSI 63.4: 2003

Measurement Distance: 3m

Test Result: PASS

15.249(a)Limit:

Fundamental frequency	Field strength of fundamental		Field strength of harmonics	
	mV/m	dBuV/m	uV/m	dBuV/m
902-928 MHz	50	94	500	54
2400-2483.5 MHz	50	94	500	54
5725-5875 MHz	50	94	500	54
24.0-24.25 GHz	250	108	2500	68

15.209 Limit:

Frequency (MHz)	Field Strength		Field Strength Limit at 3m Measurement Dist	
	uV/m	Distance (m)	uV/m	dBuV/m
0.009 ~ 0.490	2400/F(kHz)	300	10000 * 2400/F(kHz)	$20\log^{(2400/F(kHz))} + 80$
0.490 ~ 1.705	24000/F(kHz)	30	100 * 24000/F(kHz)	$20\log^{(24000/F(kHz))} + 40$
1.705 ~ 30	30	30	100 * 30	$20\log^{(30)} + 40$
30 ~ 88	100	3	100	$20\log^{(100)}$
88 ~ 216	150	3	150	$20\log^{(150)}$
216 ~ 960	200	3	200	$20\log^{(200)}$
Above 960	500	3	500	$20\log^{(500)}$

Note: RF Voltage(dBuV)=20 log₁₀ RF Voltage(uV)

7.1 EUT Operation

Operating Environment :

Temperature: 23.5 °C

Humidity: 51.1 % RH

Atmospheric Pressure: 101.2kPa

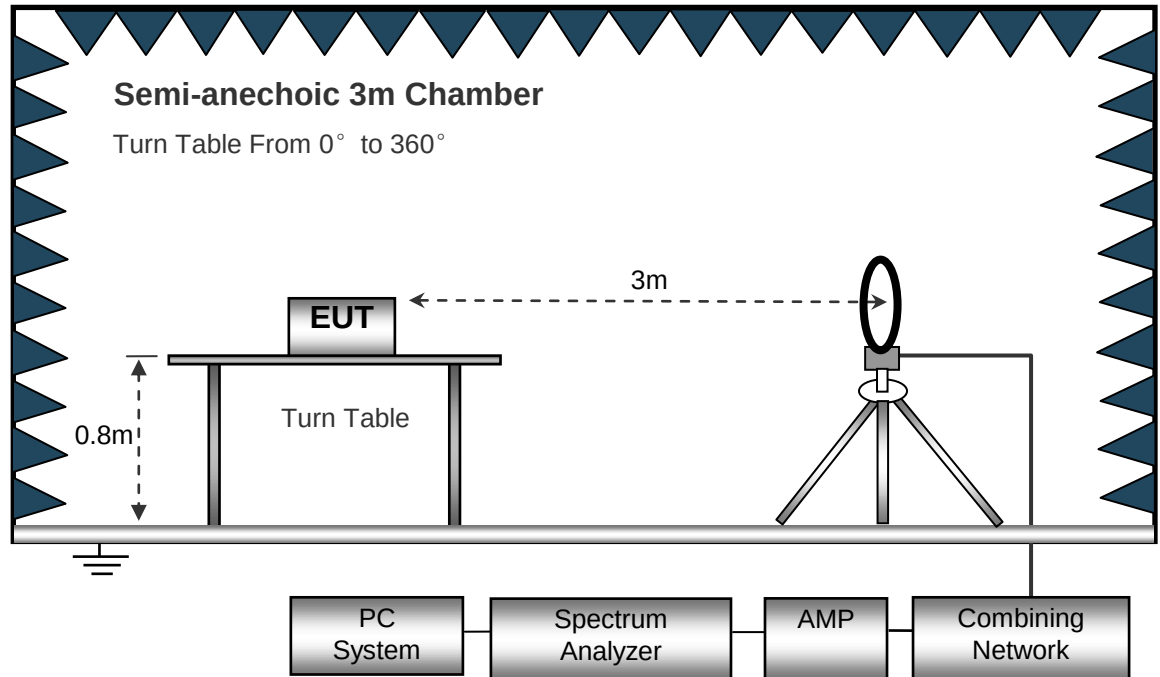
EUT Operation :

The test was performed in transmitting mode, the test data were shown in the report.

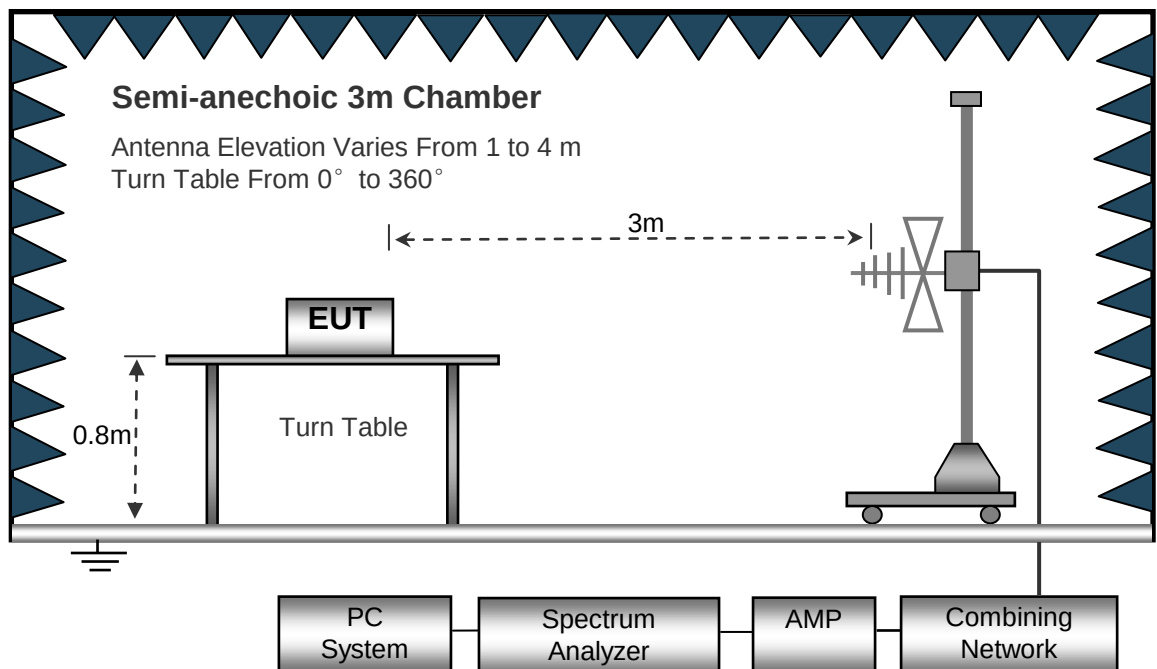
7.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.4: 2003.

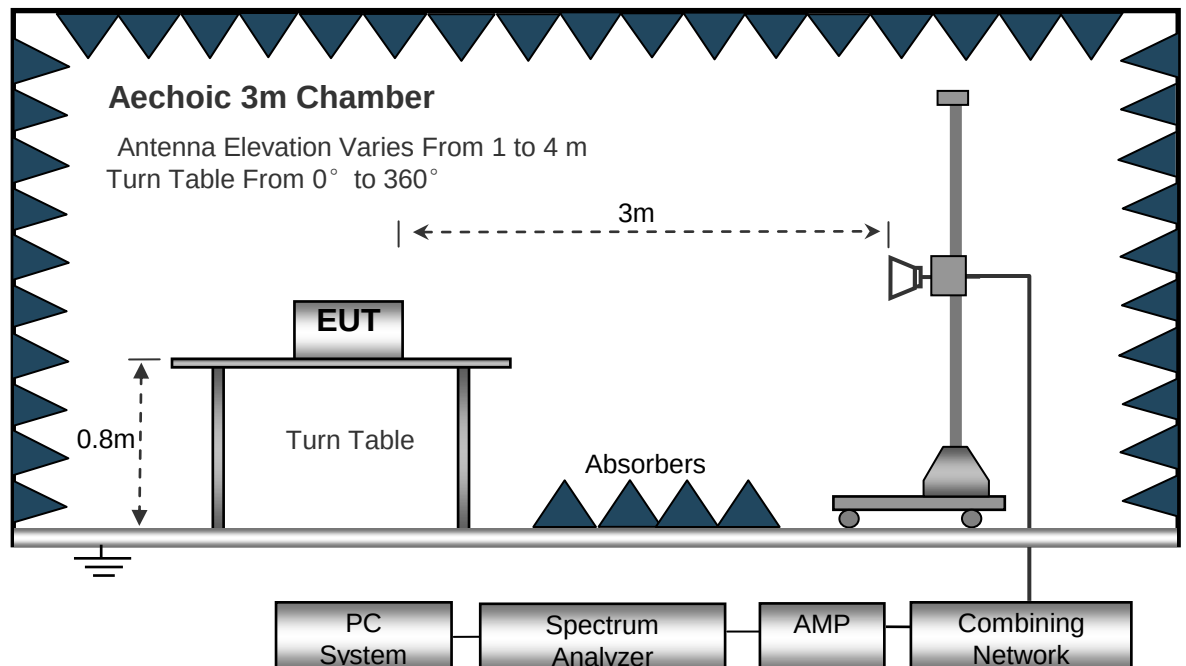
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30MHz to 1GHz.



The test setup for emission measurement above 1 GHz.



7.3 Spectrum Analyzer Setup

Below 30MHz

Sweep SpeedAuto
 IF Bandwidth10kHz
 Video Bandwidth10kHz
 Resolution Bandwidth10kHz

30MHz ~ 1GHz

Sweep SpeedAuto
 DetectorPK
 Resolution Bandwidth100kHz
 Video Bandwidth300kHz

Above 1GHz

Sweep SpeedAuto
 DetectorPK
 Resolution Bandwidth1MHz
 Video Bandwidth3MHz
 DetectorAve.
 Resolution Bandwidth1MHz
 Video Bandwidth10Hz

7.4 Test Procedure

1. The EUT is placed on a turntable, which is 0.8m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are tested under 3-axes(X,Y,Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the X position. So the data shown was the X position only.

7.5 Test Result

Test Frequency :32.768KH ~ 30MHz

The measurements were more than 20 dB below the limit and not reported.

Test Frequency: 30MHz ~ 18GHz

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.231/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)
302.95	39.20	QP	100	1.6	V	-11.40	27.80	40.00	-12.20
2468.00	72.57	PK	342	1.7	H	-13.08	59.49	114.00	-54.51
2468.00	61.74	PK	196	1.5	V	-13.08	48.66	114.00	-65.34
4936.00	71.29	PK	58	1.8	H	0.09	71.38	74.00	-2.62
4936.00	60.61	PK	305	1.1	V	0.09	60.70	74.00	-13.30
7404.00	58.43	PK	330	1.2	H	3.01	61.44	74.00	-12.56
7404.00	56.54	PK	3	1.2	V	3.01	59.55	74.00	-14.45
9872.00	59.61	PK	19	1.0	H	5.39	65.00	74.00	-9.00
9872.00	55.62	PK	224	1.9	V	5.39	61.01	74.00	-12.99

Frequency	PK	Turn table Angle	RX Antenna		Duty cycle Factor	AV	FCC Part 15.231/209/205	
			Height	Polar			Limit	Margin
(MHz)	(dBμV/m)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
2468.00	59.49	342	1.7	H	-31.09	28.40	94.00	-65.60
2468.00	48.66	196	1.5	V	-31.09	17.57	94.00	-76.43
4936.00	71.38	58	1.8	H	-31.09	40.29	54.00	-13.71
4936.00	60.70	305	1.1	V	-31.09	29.61	54.00	-24.39
7404.00	61.44	330	1.2	H	-31.09	30.35	54.00	-23.65
7404.00	59.55	3	1.2	V	-31.09	28.46	54.00	-25.54
9872.00	65.00	19	1.0	H	-31.09	33.91	54.00	-20.09
9872.00	61.01	224	1.9	V	-31.09	29.92	54.00	-24.08

Test Frequency :From 18GHz to 25GHz

The measurements were more than 20 dB below the limit and not reported.

8 Periodic Operation

The duty cycle was determined by the following equation:

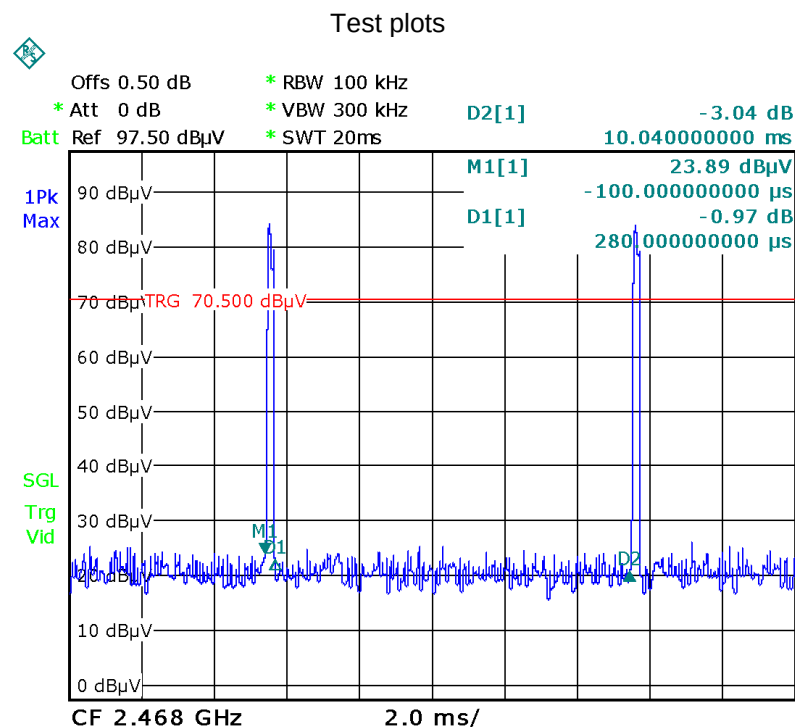
To calculate the actual field intensity, the duty cycle correction factor in decibel is needed for later use and can be obtained from following conversion

Duty Cycle(%)=Total On interval in a complete pulse train/ Length of a complete pulse train * %

Duty Cycle Correction Factor(dB)=20 * Log₁₀(Duty Cycle)

Total transmission time(us)	10040
Length of a complete transmission period(us)	280
Duty Cycle(%)	2.79
Duty Cycle Correction Factor(dB)	-31.09

Refer to the duty cycle plot (as below)



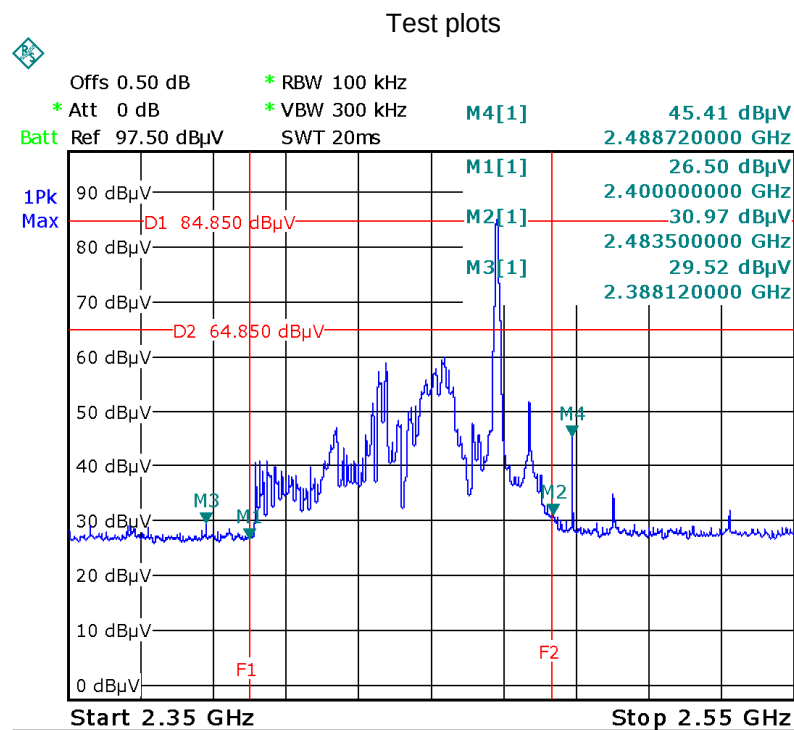
9 Outside of Band Emission

Test Requirement:	15.249(d):Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
Test Method:	ANSI C63.4:2003
Test Mode:	Transmitting

9.1 Test Procedure

Refer to section 7.4 of this test report.

9.2 Test Result



10 20 dB Bandwidth Measurement

Test Requirement:

FCC CFR47 Part 15 Section 15.215(c)

Test Method:

ANSI C63.4:2003

Test Mode:

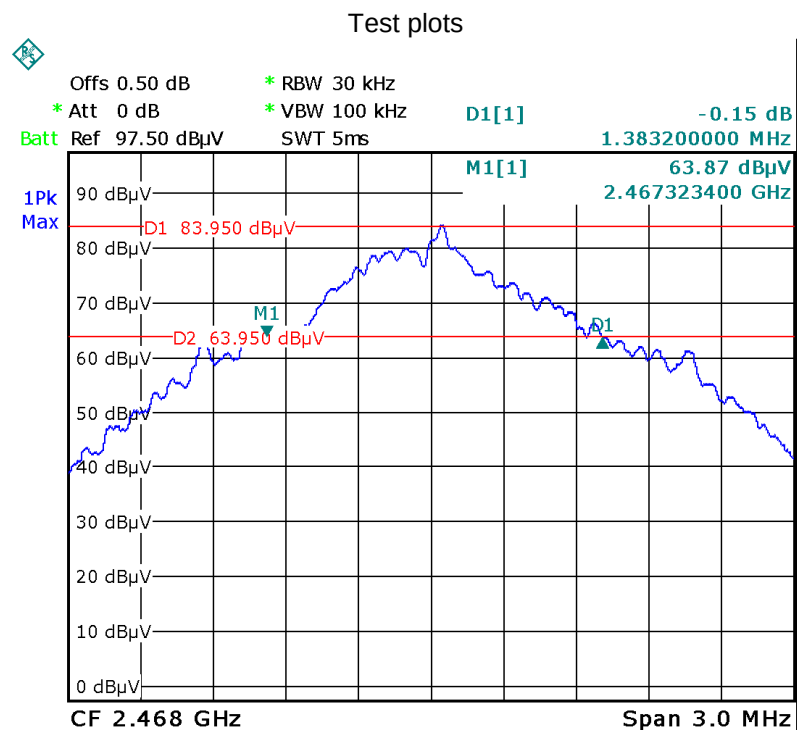
Transmitting

10.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz

10.2 Test Result

Frequency (GHz)	Bandwidth Emission (MHz)	Result
2468	1.383	Pass



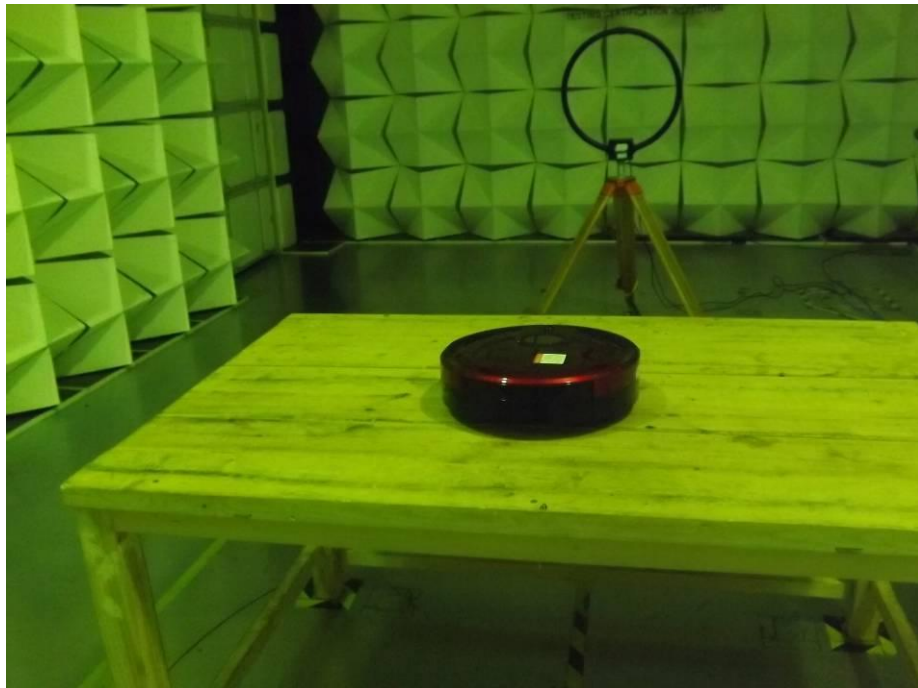
11 Antenna Requirement

According to the FCC Part 15 Paragraph 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. This product has a PCB antenna, fulfil the requirement of this section.

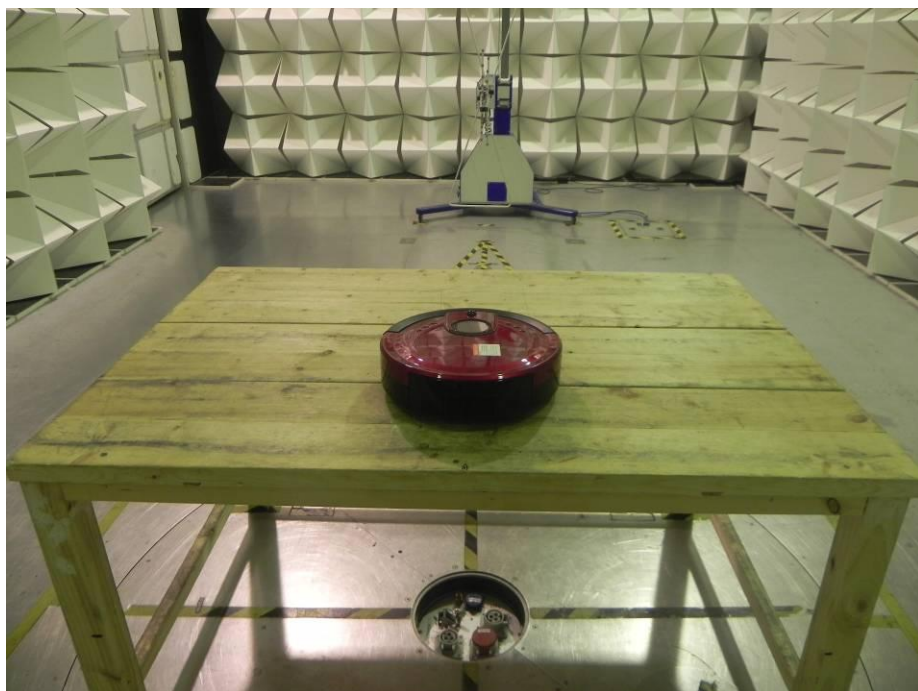
12 Photographs- Model B3 Test Setup

12.1 Radiation Emission

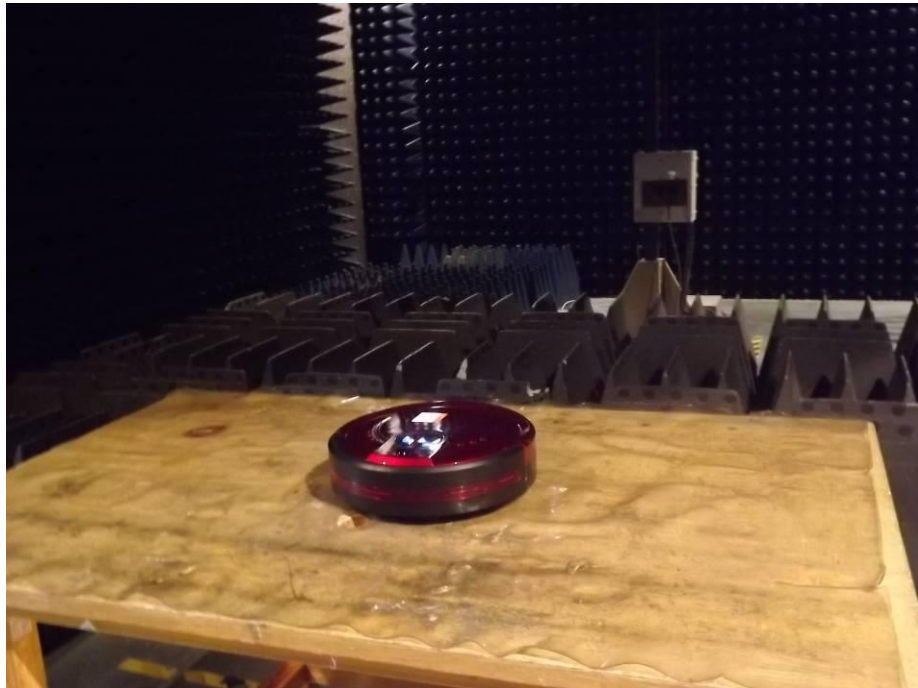
Test frequency below 30MHz at test site 2#



Test frequency from 30MHz to 1GHz at test site 2#



Test frequency above 1GHz at test site 1#

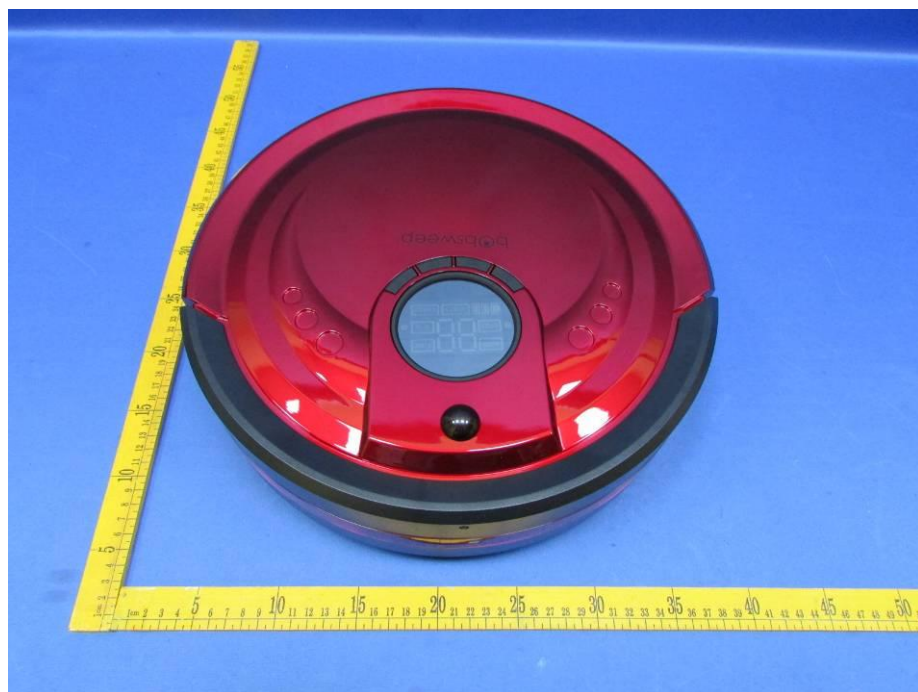


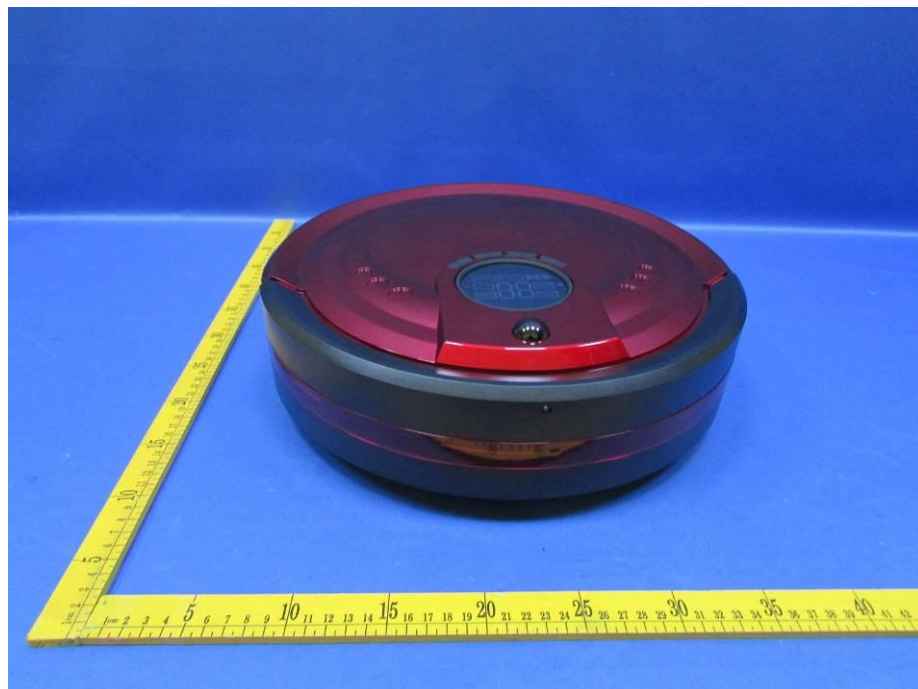
12.2 Photograph – Conducted Emission Test Setup at Test Site 1#

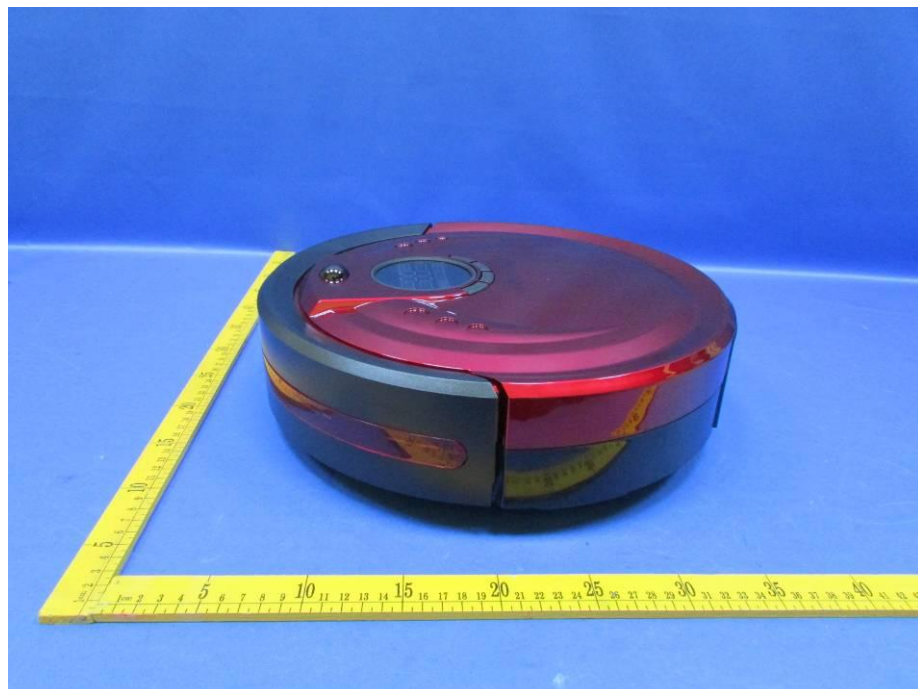


13 Photographs - Constructional Details

13.1 Model B3- External Photos

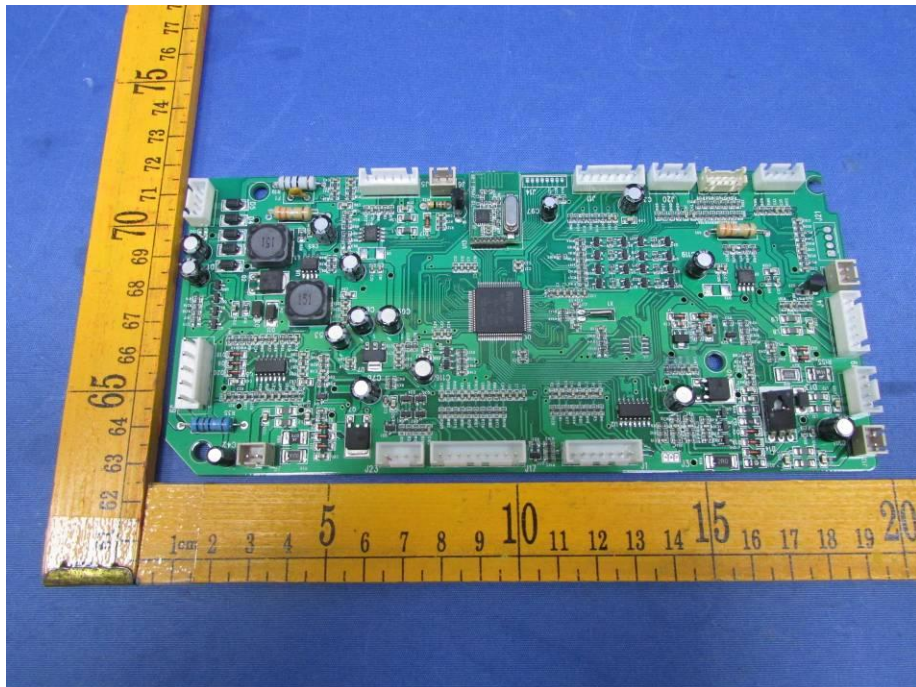
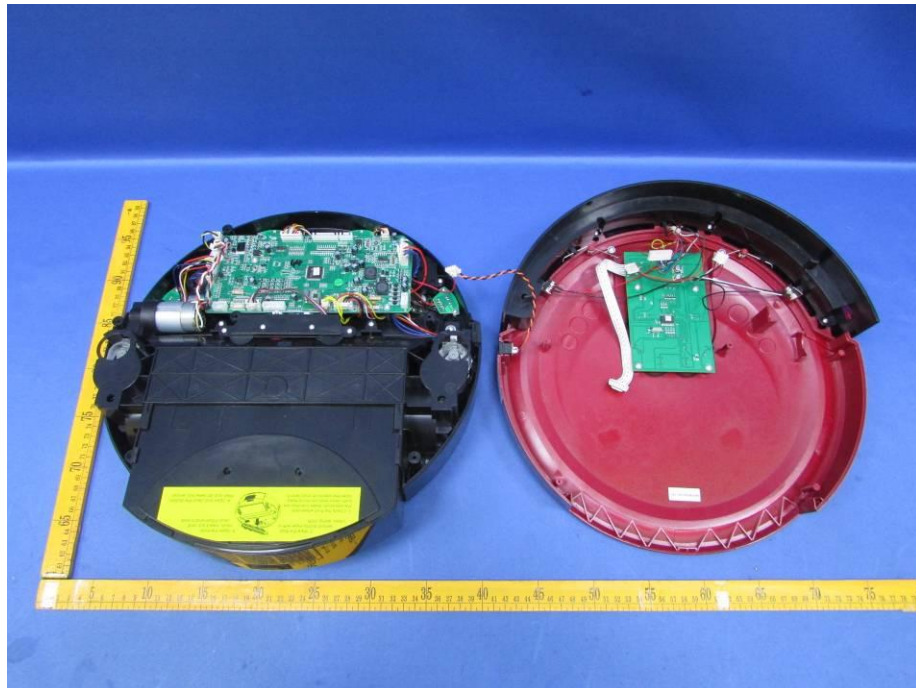


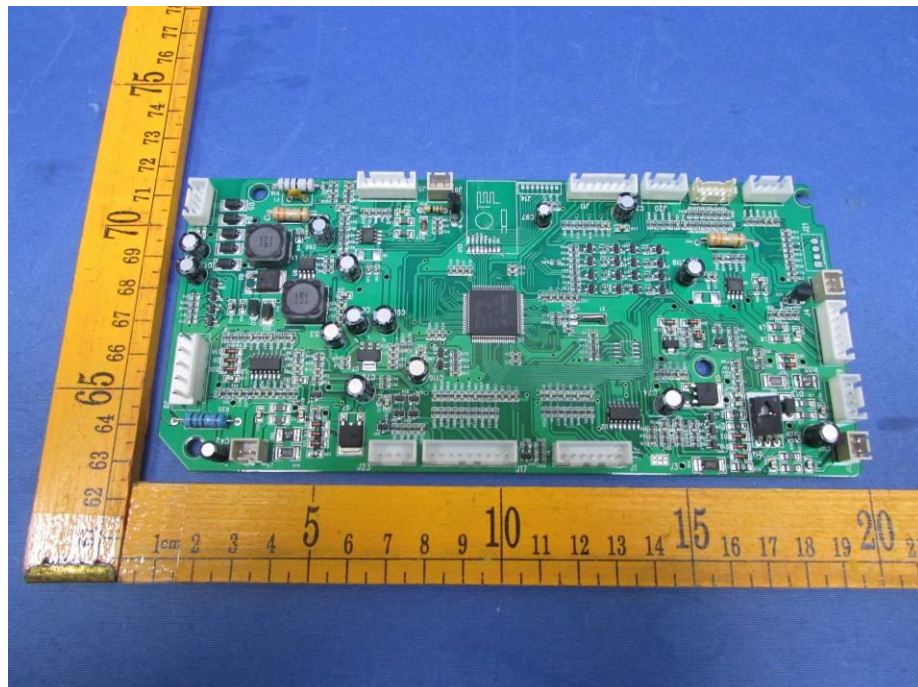
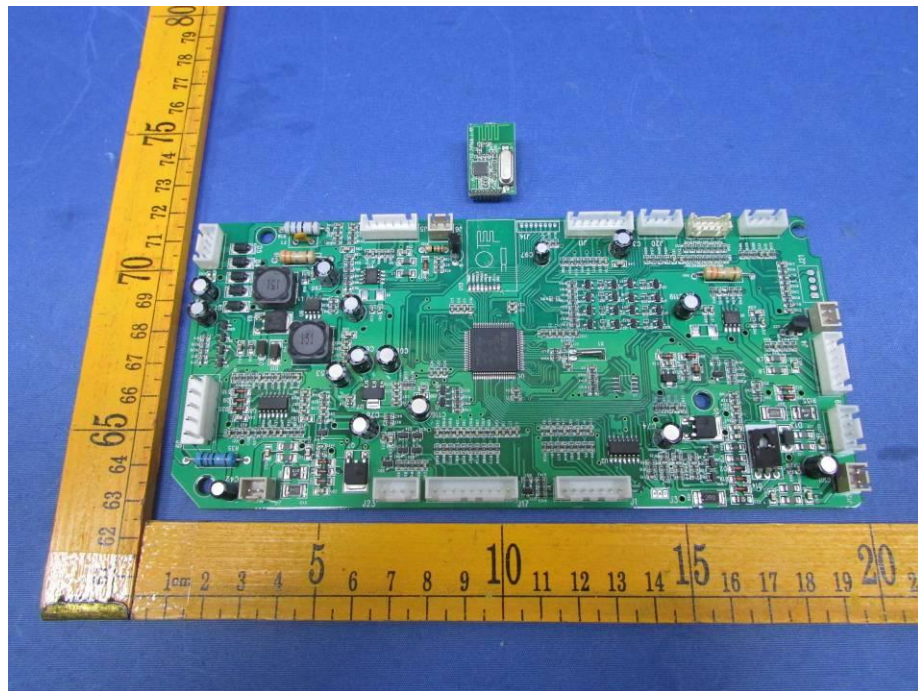


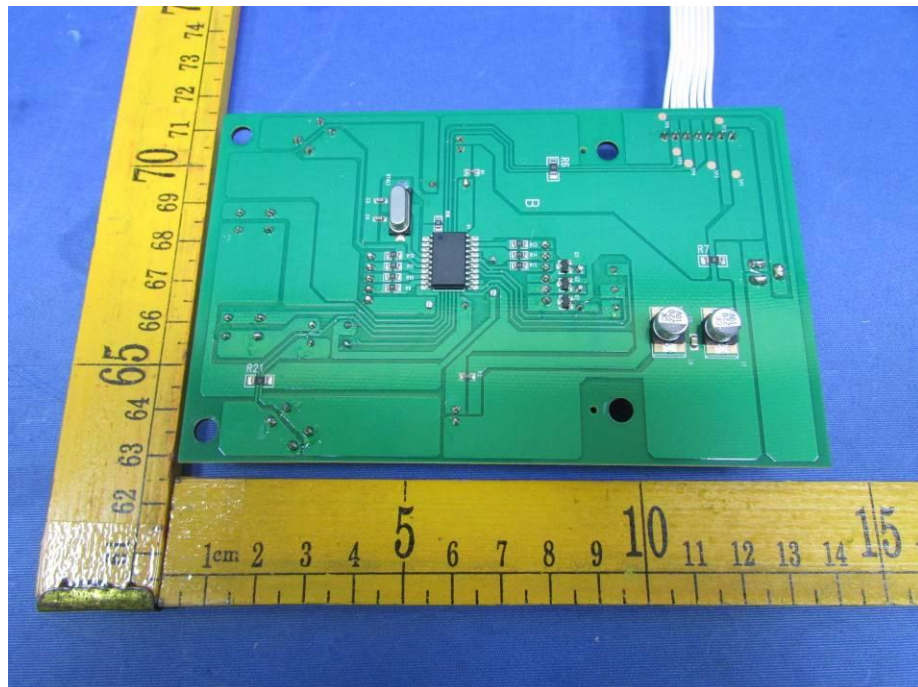
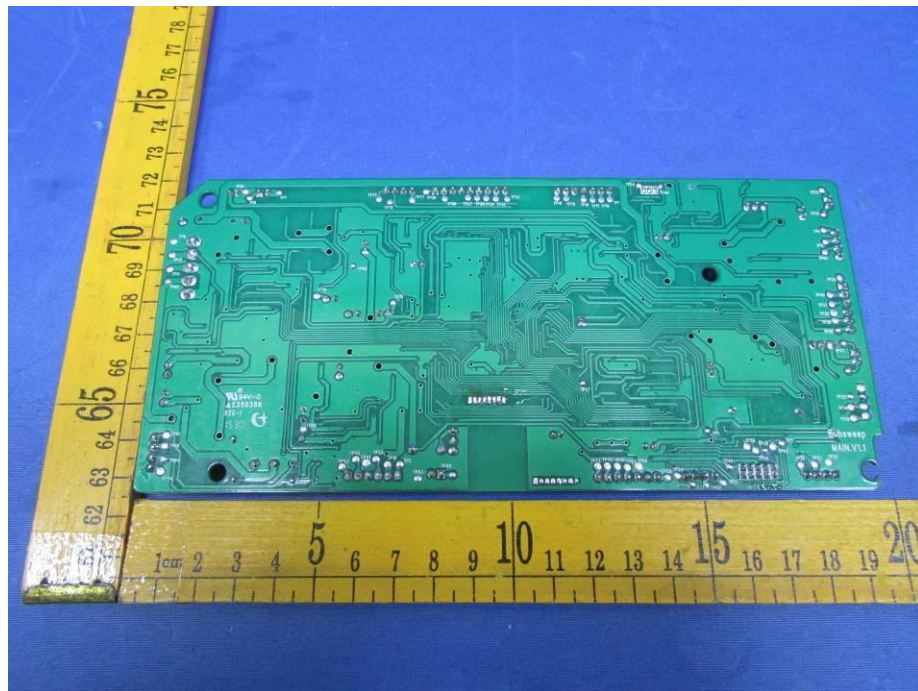


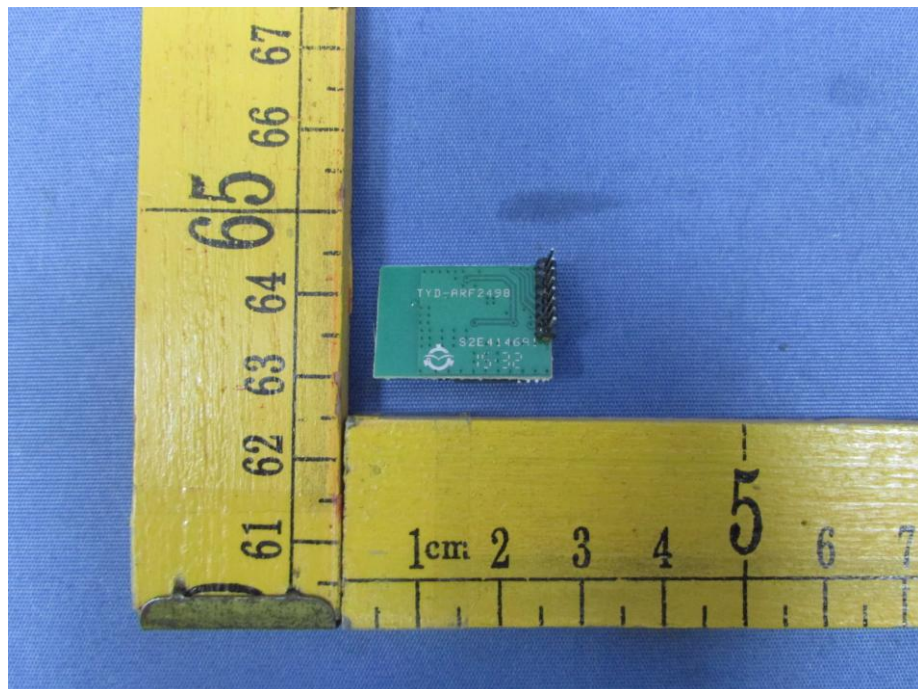
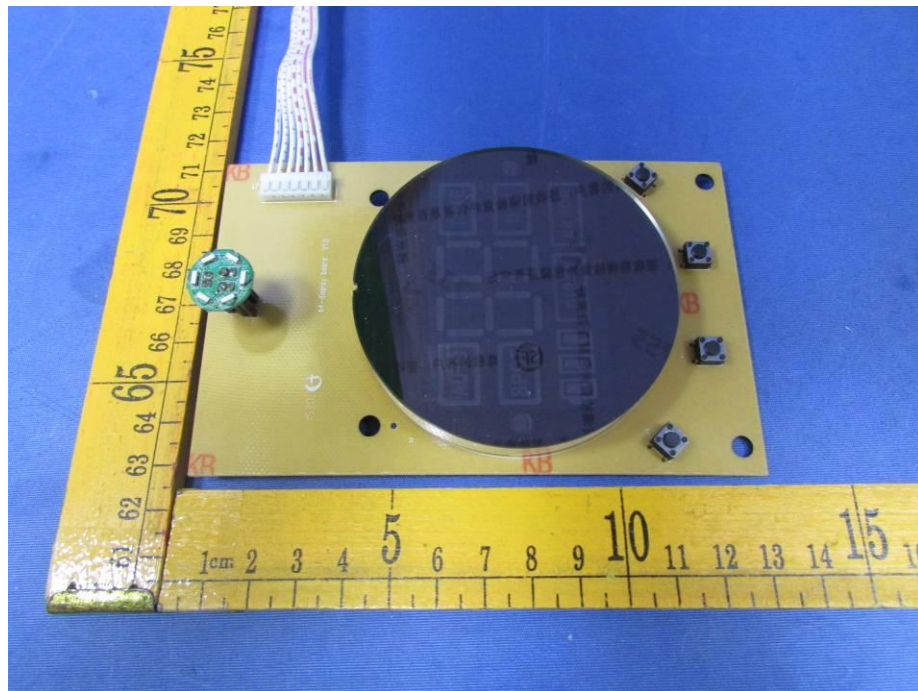


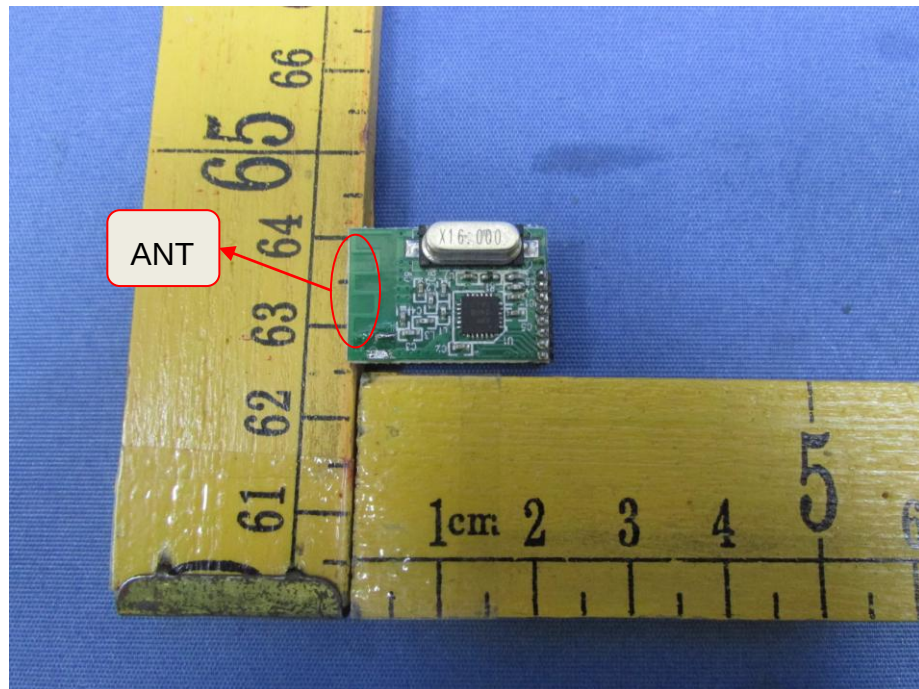
13.2 Model B3- Internal Photos













=====End of Report=====