

RF Exposure Evaluation Report

APPLICANT : iRobot Corporation
EQUIPMENT : Wichita
BRAND NAME : iRobot
MODEL NAME : AXD-Y1
FCC ID : UFEAXD-Y1
STANDARD : 47 CFR Part 2.1091
FCC KDB 447498 D01 v06

We, Sporton International (Shenzhen) Inc., would like to declare that the device has been evaluated in accordance with 47 CFR Part 2.1091 and FCC KDB 447498 D01 v06, and pass the limit. Without written approval of Sporton International (Shenzhen) Inc., the test report shall not be reproduced except in full.



Approved by: Mark Qu / Manager



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**Revision History**

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA930701-01	Rev. 01	Initial issue of report	Apr. 30, 2019

**1. Administration Data****1.1. Testing Laboratory**

Testing Laboratory	
Test Site	Sporton International (Shenzhen) Inc.
Test Site Location	1/F, 2/F, Bldg 5, Shiling Industrial Zone, Xinwei Village, Xili, Nanshan Shenzhen City Guangdong Province 518055 China TEL: +86-755-8637-9589 FAX: +86-755-8637-9595

Applicant	
Company Name	iRobot Corporation
Address	8 Crosby Drive, Bedford, Massachusetts 01730, United States

Manufacturer	
Company Name	Huizhou BYD Electronic Co.,Ltd.
Address	Xiangshui River,Economic Development Zone,Daya Bay,Huizhou,Guangdong Province,P.R.China

2. Description of Equipment Under Test (EUT)

Product Feature & Specification	
EUT Type	Wichita
Brand Name	iRobot
Model Name	AXD-Y1
FCC ID	UFEAXD-Y1
Wireless Technology and Frequency Range	WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5700 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 ~ 2480 MHz
Mode	WLAN 2.4GHz 802.11b/g/n HT20 WLAN 5GHz 802.11a/n HT20/HT40 WLAN 5GHz 802.11ac VHT20/VHT40/VHT80
HW Version	Wichita B2
SW Version	wichita+2.0.0_rc6+wichita+50
EUT Stage	Production Unit
Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.	

Remark: The antenna provided to the EUT, please refer to the following table.

Antenna No.	Brand	Model	Gain(dBi)	Antenna Type	Frequency range (GHz to GHz)	Cable Length (mm)
1(External)	Laird	EMN2449A2S-16MHF1	3.15	PCB dipole antenna	2.4-2.4835	160
1(External)	Laird	EMN2449A2S-16MHF1	3.38	PCB dipole antenna	5.15-5.25	160
1(External)	Laird	EMN2449A2S-16MHF1	3.38	PCB dipole antenna	5.25-5.35	160
1(External)	Laird	EMN2449A2S-16MHF1	3.51	PCB dipole antenna	5.47-5.725	160
1(External)	Laird	EMN2449A2S-16MHF1	3.23	PCB dipole antenna	5.725-5.85	160
2(External)	Laird	EMN2449A2S-34MHF1	3.15	PCB dipole antenna	2.4-2.4835	340
2(External)	Laird	EMN2449A2S-34MHF1	3.38	PCB dipole antenna	5.15-5.25	340
2(External)	Laird	EMN2449A2S-34MHF1	3.38	PCB dipole antenna	5.25-5.35	340
2(External)	Laird	EMN2449A2S-34MHF1	3.51	PCB dipole antenna	5.47-5.725	340
2(External)	Laird	EMN2449A2S-34MHF1	3.23	PCB dipole antenna	5.725-5.85	340

**3. Maximum RF average output power among production units****SISO Mode:****<WLAN 2.4GHz>**

Mode		Maximum Average Power (dBm)	
		Ant.0	Ant.1
2.4GHz	802.11b	15.50	15.50
	802.11g	16.00	16.50
Bluetooth LE		0	

Note: Bluetooth antenna share with WLAN2.4GHz antenna 0.

<WLAN 5GHz>

Mode		Maximum Average Power (dBm)	
		Ant.0	Ant.1
5.2GHz	802.11a	16.50	16.50
5.3GHz	802.11a	16.00	16.50
5.5GHz	802.11a	16.50	16.50
5.8GHz	802.11a	11.50	11.50

**MIMO Mode:****<WLAN 2.4GHz>**

Mode		Maximum Average Power (dBm)
		Ant.0+1
2.4GHz	802.11n-HT20	17.50

<WLAN 5GHz>

Mode		Maximum Average Power (dBm)
		Ant.0+1
5.2GHz	802.11n-HT20	15.00
	802.11n-HT40	17.50
	802.11ac-VHT20	15.00
	802.11ac-VHT40	17.50
	802.11ac-VHT80	16.00
5.3GHz	802.11n-HT20	17.50
	802.11n-HT40	17.50
	802.11ac-VHT20	17.50
	802.11ac-VHT40	17.50
	802.11ac-VHT80	16.00
5.5GHz	802.11n-HT20	17.50
	802.11n-HT40	17.50
	802.11ac-VHT20	17.50
	802.11ac-VHT40	17.50
	802.11ac-VHT80	16.50
5.8GHz	802.11n-HT20	11.50
	802.11n-HT40	11.50
	802.11ac-VHT20	11.50
	802.11ac-VHT40	11.50
	802.11ac-VHT80	11.50

Note: MIMO power is higher than SISO mode, so only chosen MIMO power to perform RF Exposure analysis.

4. RF Exposure Limit Introduction

According to ANSI/IEEE C95.1-1992, the criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in §1.1310.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

The MPE was calculated at 20 cm to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

$$S = \frac{PG}{4\pi R^2}$$

Where:

S = Power Density

P = Output Power at Antenna Terminals

G = Gain of Transmit Antenna (linear gain)

R = Distance from Transmitting Antenna

5. Radio Frequency Radiation Exposure Evaluation

5.1. Standalone Power Density Calculation

Band	Frequency (MHz)	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum EIRP (dBm)	Maximum EIRP (W)	Average EIRP (mW)	Power Density at 20cm (mW/cm ²)	Limit (mW/cm ²)	Power Density / Limit
WLAN2.4GHz 802.11b	2412.0	3.15	15.50	18.650	0.073	73.282	0.0146	1.000	0.0146
WLAN2.4GHz 802.11g	2412.0	3.15	16.50	19.650	0.092	92.257	0.0184	1.000	0.0184
WLAN2.4GHz 802.11n-HT20	2412.0	3.15	17.50	20.650	0.116	116.145	0.023	1.000	0.0231
WLAN5.2GHz 802.11a	5180.0	3.38	16.50	19.880	0.097	97.275	0.0194	1.000	0.0194
WLAN5.2GHz 802.11n-HT20	5180.0	3.38	15.00	18.380	0.069	68.865	0.014	1.000	0.0137
WLAN5.2GHz 802.11n-HT40	5190.0	3.38	17.50	20.880	0.122	122.462	0.0244	1.000	0.0244
WLAN5.2GHz 802.11ac-VHT20	5180.0	3.38	15.00	18.380	0.069	68.865	0.014	1.000	0.0137
WLAN5.2GHz 802.11ac-VHT40	5190.0	3.38	17.50	20.880	0.122	122.462	0.0244	1.000	0.0244
WLAN5.2GHz 802.11ac-VHT80	5210.0	3.38	16.00	19.380	0.087	86.696	0.0173	1.000	0.0173
WLAN5.3GHz 802.11a	5260.0	3.38	16.50	19.880	0.097	97.275	0.0194	1.000	0.0194
WLAN5.3GHz 802.11n-HT20	5260.0	3.38	17.50	20.880	0.122	122.462	0.0244	1.000	0.0244
WLAN5.3GHz 802.11n-HT40	5270.0	3.38	17.50	20.880	0.122	122.462	0.0244	1.000	0.0244
WLAN5.3GHz 802.11ac-VHT20	5260.0	3.38	17.50	20.880	0.122	122.462	0.0244	1.000	0.0244
WLAN5.3GHz 802.11ac-VHT40	5270.0	3.38	17.50	20.880	0.122	122.462	0.0244	1.000	0.0244
WLAN5.3GHz 802.11ac-VHT80	5290.0	3.38	16.00	19.380	0.087	86.696	0.0173	1.000	0.0173
WLAN5.5GHz 802.11a	5500.0	3.51	16.50	20.010	0.100	100.231	0.0200	1.000	0.0200
WLAN5.5GHz 802.11n-HT20	5500.0	3.51	17.50	21.010	0.126	126.183	0.0251	1.000	0.0251
WLAN5.5GHz 802.11n-HT40	5510.0	3.51	17.50	21.010	0.126	126.183	0.0251	1.000	0.0251
WLAN5.5GHz 802.11ac-VHT20	5500.0	3.51	17.50	21.010	0.126	126.183	0.0251	1.000	0.0251
WLAN5.5GHz 802.11ac-VHT40	5510.0	3.51	17.50	21.010	0.126	126.183	0.0251	1.000	0.0251
WLAN5.5GHz 802.11ac-VHT80	5530.0	3.51	16.50	20.010	0.100	100.231	0.0200	1.000	0.0200
WLAN5.8GHz 802.11a	5745.0	3.23	11.50	14.730	0.030	29.717	0.0059	1.000	0.0059
WLAN5.8GHz 802.11n-HT20	5745.0	3.23	11.50	14.730	0.030	29.717	0.0059	1.000	0.0059
WLAN5.8GHz 802.11n-HT40	5755.0	3.23	11.50	14.730	0.030	29.717	0.0059	1.000	0.0059
WLAN5.8GHz 802.11ac-VHT20	5745.0	3.23	11.50	14.730	0.030	29.717	0.0059	1.000	0.0059
WLAN5.8GHz 802.11ac-VHT40	5755.0	3.23	11.50	14.730	0.030	29.717	0.0059	1.000	0.0059
WLAN5.8GHz 802.11ac-VHT80	5775.0	3.23	11.50	14.730	0.030	29.717	0.0059	1.000	0.0059
Bluetooth	2402.0	3.15	0	3.150	0.002	2.065	0.0004	1.000	0.0004

Note:

1. For conservativeness, the lowest frequency of each band is used to determine the MPE limit of that band.
2. Bluetooth antenna share with WLAN2.4GHz antenna 0.
3. EUT will choose either WLAN 2.4GHz or WLAN 5GHz according to the network signal condition; therefore, 2.4GHz WLAN and 5GHz WLAN will not operate simultaneously at any moment.
4. For WLAN MIMO mode, MIMO gain is the same as SISO gain respectively.

5.2. Collocated Power Density Calculation

WLAN2.4GHz Power Density / Limit	Bluetooth Power Density / Limit	Σ (Power Density / Limit) of WLAN2.4GHz+Bluetooth
0.0231	0.0004	0.0235
WLAN5GHz Power Density / Limit	Bluetooth Power Density / Limit	Σ (Power Density / Limit) of WLAN5GHz+Bluetooth
0.0251	0.0004	0.0255

Note:

1. Σ (Power Density / Limit): This is a summation of [(power density for each transmitter/antenna included in the simultaneous transmission)/ (corresponding MPE limit)], for WLAN + Bluetooth.

Conclusion:

According to 47 CFR §2.1091 and FCC KDB 447498 D01 v06, the RF exposure analysis concludes that the RF Exposure is FCC compliant.