



RF Exposure Evaluation Report

APPLICANT : iRobot Corporation
EQUIPMENT : Harpoon
BRAND NAME : iRobot
MODEL NAME : AXE-Y1
FCC ID : UFEAXE-Y1
STANDARD : 47 CFR Part 2.1091

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

Approved by: Mark Qu / Manager



Sporton International (Kunshan) Inc.
No. 1098, Pengxi North Road, Kunshan Economic Development Zone,
Jiangsu Province 215335, China



Table of Contents

1. ADMINISTRATION DATA	4
1.1. Testing Laboratory	4
2. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)	5
3. MAXIMUM RF AVERAGE OUTPUT POWER AMONG PRODUCTION UNITS	6
4. RF EXPOSURE LIMIT INTRODUCTION	7
5. RADIO FREQUENCY RADIATION EXPOSURE EVALUATION	8
5.1. Standalone Power Density Calculation	8



Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA8N1306	Rev. 01	Initial issue of report	Jan. 04, 2019



1. Administration Data

1.1. Testing Laboratory

Testing Laboratory	
Test Site	Sporton International (Kunshan) Inc.
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone, Jiangsu Province 215335, China TEL : 86-512-57900158 FAX : 86-512-57900958

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	Harpoon
Brand Name	iRobot
Model Name	AXE-Y1
FCC ID	UFEAXE-Y1
Wireless Technology and Frequency Range	WLAN2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN5.5GHz Band: 5500 MHz ~ 5700 MHz WLAN5.8GHz 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 Bluetooth LE
Antenna Type	WLAN: PCB Internal Antenna Bluetooth: PCB Internal Antenna
Antenna Gain	WLAN2.4GHz Band: 3.04dBi WLAN 5.2GHz Band: 1.57dBi WLAN 5.3GHz Band: 1.97dBi WLAN5.5GHz Band: 2.96dBi WLAN5.8GHz Band: 1.94dBi Bluetooth: 3.04dBi
HW Version	Harpoon B2
SW Version	lewis+2.0.0_rc13+tridentAPQ8009+0000
EUT Stage	Identical Prototype
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)
1	iRobot	AXE-Y1	3.04	PCB internal antenna	2.4-2.4835
1	iRobot	AXE-Y1	1.57	PCB internal antenna	5.15-5.25
1	iRobot	AXE-Y1	1.97	PCB internal antenna	5.25-5.35
1	iRobot	AXE-Y1	2.96	PCB internal antenna	5.47-5.725
1	iRobot	AXE-Y1	1.94	PCB internal antenna	5.725-5.85

**3. Maximum RF average output power among production units****<WLAN 2.4GHz and Bluetooth>**

Mode		Maximum Average Power (dBm)
2.4GHz	802.11b	15.50
	802.11g	13.00
	802.11n-HT20	12.50
	Bluetooth LE	3.00

<WLAN 5GHz>

Mode		Maximum Average Power (dBm)
5.2GHz	802.11a	16.50
	802.11n-HT20	16.50
	802.11n-HT40	16.50
5.3GHz	802.11a	16.50
	802.11n-HT20	16.50
	802.11n-HT40	16.50
5.5GHz	802.11a	16.50
	802.11n-HT20	16.50
	802.11n-HT40	16.50
5.8GHz	802.11a	12.50
	802.11n-HT20	12.50
	802.11n-HT40	12.50

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)
WLAN2.4GHz 802.11b	2412	3.04	15.50	18.54	0.07	71.45	0.014	1.000
WLAN2.4GHz 802.11g	2412	3.04	13.00	16.04	0.04	40.18	0.008	1.000
WLAN2.4GHz 802.11n-HT20	2412	3.04	12.50	15.54	0.04	35.81	0.007	1.000
Bluetooth	2402	3.04	3.00	6.04	0.00	4.02	0.001	1.000
WLAN5.2GHz 802.11a	5180	1.57	16.50	18.07	0.06	64.12	0.013	1.000
WLAN5.2GHz 802.11n-HT20	5180	1.57	16.50	18.07	0.06	64.12	0.013	1.000
WLAN5.2GHz 802.11n-HT40	5190	1.57	16.50	18.07	0.06	64.12	0.013	1.000
WLAN5.3GHz 802.11a	5260	1.97	16.50	18.47	0.07	70.31	0.014	1.000
WLAN5.3GHz 802.11n-HT20	5260	1.97	16.50	18.47	0.07	70.31	0.014	1.000
WLAN5.3GHz 802.11n-HT40	5270	1.97	16.50	18.47	0.07	70.31	0.014	1.000
WLAN5.5GHz 802.11a	5500	2.96	16.50	19.46	0.09	88.31	0.018	1.000
WLAN5.5GHz 802.11n-HT20	5500	2.96	16.50	19.46	0.09	88.31	0.018	1.000
WLAN5.5GHz 802.11n-HT40	5510	2.96	16.50	19.46	0.09	88.31	0.018	1.000
WLAN5.8GHz 802.11a	5745	1.94	12.50	14.44	0.03	27.80	0.006	1.000
WLAN5.8GHz 802.11n-HT20	5745	1.94	12.50	14.44	0.03	27.80	0.006	1.000
WLAN5.8GHz 802.11n-HT40	5755	1.94	12.50	14.44	0.03	27.80	0.006	1.000

Note:

1. For conservativeness, the lowest frequency of each band is used to determine the MPE limit of that band.
2. WLAN 2.4GHz and Bluetooth share the same antenna, and cannot transmit simultaneously.
3. According to the EUT character, WLAN 5GHz and Bluetooth can't transmit simultaneously.
4. 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.

Conclusion:

According to 47 CFR §2.1091, the RF exposure analysis concludes that the RF Exposure is FCC compliant.