FCC Part 1 Subpart I
FCC Part 2 Subpart J
RSS 102 ISSUE 5

RF EXPOSURE REPORT

FOR

DUAL BAND RADIO MODULE

MODEL NUMBER: AXG-Y1

FCC ID: UFE-AXGY1
IC: 6652A-AXGY1

REPORT NUMBER: R13179001-E6

ISSUE DATE: 2020-09-15

Prepared for
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NVLAP LAB CODE 200246-0

REVISION HISTORY

Ver.	Issue Date	Revisions	Revised By
1	2020-07-24	Initial Issue	Brian T. Kiewra
2	2020-09-01	Revised antenna gain to match OD and test reports. Editorial revisions.	Brian T. Kiewra
3	2020-09-15	Revised antenna gain for External antenna.	Brian T. Kiewra
4	2020-10-23	Removed tolerance note.	Brian T. Kiewra

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: iRobot Corporation
8 Crosby Drive
Bedford, MA 01730, USA

EUT DESCRIPTION: Dual Band Radio Module

MODEL: AXGY1

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC PART 1 SUBPART I & PART 2 SUBPART J	Complies
RSS 102 ISSUE 5	Complies

UL LLC. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.
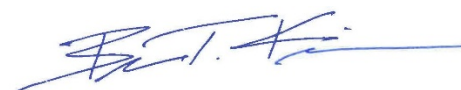
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Approved & Released
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Prepared By:

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2. TEST METHODOLOGY

All calculations were made in accordance with FCC Parts 1.1310, 2.1091, 2.1093, KDB 447498 D01 v06, KDB 447498 D03 V01, IEEE Std C95.1-2005, IEEE Std C95.3-2002, IC Safety Code 6 and RSS 102 Issue 5.

3. REFERENCES

All measurements were made as documented in UL LLC Test Report R13179001-E1, -E2, -E3 for operation in the 2.4 GHz band and 13179001-E4 for operation in the 5GHz band.

Output power is excerpted from the applicable test reports.

Antenna gain data is excerpted from product documentation provided by the applicant.

4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 12 Laboratory Dr., Research Triangle Park, NC 27709, USA and 2800 Perimeter Park Dr., Suite B, Morrisville, NC 27560, USA.

UL LLC (RTP) is accredited by NVLAP, Laboratory Code 200246-0.

5. MAXIMUM PERMISSIBLE EXPOSURE (LIMITS AND EQUATIONS)

5.1. FCC RULES

§1.1310 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 §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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 Exposure				
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
300-1,500			f/300	6
1,500-100,000			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
300-1,500			f/1500	30
1,500-100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Notes:

(1) Occupational/controlled exposure limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when a person is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

(2) General population/uncontrolled exposure limits apply in situations in which the general public may be exposed, or in which persons who are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure

5.2. ISED RULES

For the purpose of this standard, Innovation, Science and Economic Development (ISED) has adopted the SAR and RF field strength limits established in Health Canada's RF exposure guideline, Safety Code 6.

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Dentisty (W/m²)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	-2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142\,f^{0.3417}$	$0.008335\,f^{0.3417}$	$0.02619\,f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\,f^{0.5}$	$4.21 \times 10^{-4}\,f^{0.5}$	$6.67 \times 10^{-5}\,f$	$616000/f^{1.2}$

Note: f is frequency in MHz.

* Based on nerve stimulation (NS).

** Based on specific absorption rate (SAR).

5.3. EQUATIONS

POWER DENSITY

Power density is given by:

S = EIRP / (4 * Pi * D^2)

Where
S = Power density in mW/cm^2
EIRP = Equivalent Isotropic Radiated Power in mW
D = Separation distance in cm

Power density in units of mW/cm^2 is converted to units of W/m^2 by multiplying by 10.

DISTANCE

Distance is given by:

D = SQRT (EIRP / (4 * Pi * S))

Where
D = Separation distance in cm
EIRP = Equivalent Isotropic Radiated Power in mW
S = Power density in mW/cm^2

SOURCE-BASED DUTY CYCLE

Where applicable (for example, multi-slot cell phone applications) a duty cycle factor may be applied.

Source-based time-averaged EIRP = (DC / 100) * EIRP

Where
DC = Duty Cycle in %, as applicable
EIRP = Equivalent Isotropic Radiated Power in W

MIMO AND COLOCATED TRANSMITTERS (IDENTICAL LIMIT FOR ALL TRANSMITTERS)

For multiple chain devices, and colocated transmitters operating simultaneously in frequency bands where the limit is identical, the total power density is calculated using the total EIRP obtained by summing the EIRP (in linear units) of each transmitter.

Total EIRP = (EIRP1) + (EIRP2) + ... + (EIRPn)

where
EIRPx = Source-based time-averaged EIRP of chain x or transmitter x
The total EIRP is then used to calculate the Power Density or the Distance as applicable.

6.   RF EXPOSURE RESULTS

In the table(s) below, Power and Gain are entered in units of dBm and dBi respectively and conversions to linear forms are used for the calculations.

External Antenna

Band	Mode	Separation Distance (cm)	AVG Output Power (dBm)	Ant. Gain (dBi)	Duty Cycle (%)	EIRP (mW)	PD (mW/cm^2)	ISED PD Limit (mW/cm^2)	FCC PD Limit (mW/cm^2)
BLE	GFSK - 500Kbps	4.5	0.53	3.50	100.0	2.53	0.00994	5.350	1.00
BT	GFSK	4.5	11.71	3.50	100.0	33.19	0.13049	5.350	1.00
2.4GHz WLAN	802.11g	4.5	19.07	3.50	100.0	180.72	0.71053	5.370	1.00
5GHz WLAN	802.11a	4.5	16.76	6.37	100.0	205.59	0.80832	9.050	1.00

PCB Antenna

Band	Mode	Separation Distance (cm)	AVG Output Power (dBm)	Ant. Gain (dBi)	Duty Cycle (%)	EIRP (mW)	PD (mW/cm^2)	ISED PD Limit (mW/cm^2)	FCC PD Limit (mW/cm^2)
BLE	GFSK - 125Kbps	4.5	3.82	2.91	100.0	4.71	0.01850	5.350	1.00
BT	GFSK	4.5	13.01	2.91	100.0	39.08	0.15367	5.350	1.00
2.4GHz WLAN	802.11g	4.5	19.69	2.91	100.0	181.97	0.71546	5.370	1.00
5GHz WLAN	802.11a	4.5	18.72	4.31	100.0	200.91	0.78992	9.050	1.00

Notes:

1) The output power in the tables above is the maximum power among various channels, modes, modulations, and data rates within the specific band.

END OF TEST REPORT