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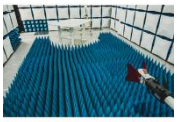

RF EXPOSURE EVALUATION
Maximal Permissible Exposure [MPE]

Applicant Name:
Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:
6/30/2022 - 10/19/2022
Test Site/Location:
Element Materials Technology, Morgan Hill, CA, USA
Test Report Serial No.:
1C2206300045-09.BCG

FCC ID:	**BCGA2825**
IC:	**579C-A2825**
APPLICANT:	**Apple Inc.**

Application Type:	Certification
Model/HVIN:	A2825
EUT Type:	Smart Speaker
FCC Rule Part:	FCC Part 1 (§1.1310) and Part 2 (§2.1091)
ISED Specification:	RSS-102 Issue 5

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in FCC KDB 447498 D01 v06. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RJ Ortanez
Executive Vice President

ACCREDITED
CERT #2041.02

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1.0 RF EXPOSURE EVALUATION – MAXIMUM PERMISSIBLE EXPOSURE (MPE)

1.1 Introduction

This document is prepared to show compliance with the RF Exposure requirements as required in §1.1310 of the FCC Rules and Regulations and RSS-102 of Industry Canada.

The limit for Maximum Permissible Exposure (MPE), specified in FCC §1.1310 is listed in Table 1-1, and specified in RSS-102 is listed in Table 1-2. According to FCC §1.1310 and RSS-102: the criteria listed in the following tables shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b).

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (Minutes)
(A) Limits For Occupational / Control Exposures (f = frequency)				
30-300	61.4	0.163	1.0	6
300-1500	…	…	f/300	6
1500-100,000	…	…	5.0	6
(B) Limits For General Population / Uncontrolled Exposure (f = frequency)				
30-300	27.5	0.073	0.2	30
300-1500	…	…	f/1500	30
1500-100,000	…	…	1.0	30

Table 1-1. FCC Limits for Maximum Permissible Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)	Reference Period (Minutes)
(A) RF Field Strength Limits For Controlled Use Devices (Controlled Environment) (f = frequency)				
20-48	$129.8/ f^{0.25}$	$0.3444/ f^{0.25}$	$44.72/ f^{0.5}$	6
48-100	49.33	0.1309	6.455	6
100-6000	$15.60 f^{0.25}$	$0.04138 f^{0.25}$	$0.6455 f^{0.5}$	6
600-15000	137	0.364	50	6
15000-150000	137	0.364	50	$616000/ f^{1.2}$
150000-300000	$0.354 f^{0.5}$	$9.40 \times 10^{-4} f^{0.5}$	$3.33 \times 10^{-4} f$	$616000/ f^{1.2}$
(B) RF Field Strength Limits For Devices Used by the General Public (Uncontrolled Environment) (f = frequency)				
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	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/ f^{1.2}$

Table 1-2. ISED Limits for Maximum Permissible Exposure (MPE)

1.2 EUT Description

The Equipment Under Test (EUT) is the **Apple Smart Speaker FCC ID: BCGA2825 and IC: 579C-A2825**. The device contains the following capabilities:

802.11b/g/n WLAN, 802.11a/n/ac UNII, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8), UWB, 802.15.4

Test Device Serial No.: *GY9YGK3GVM, LD632YXR23, GP3HTQ664M*

EUT consists of an Apple Smart Speaker containing unlicensed-exempt data communications transmitter modules. The Smart Speaker is powered by an AC Power Source.

1.3 MPE Requirements Overview

Three different categories of transmitters are defined by the FCC KDB 447498 D01. These categories are fixed installation, mobile, and portable and are defined as follows:

- **Fixed Installations:** fixed location means that the device, including its antenna, is physically secured at a permanent location and is not able to be easily moved to another location. Additionally, distance to humans from the antenna is maintained to at least 2 meters.

- **Mobile Devices:** a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. Transmitters designed to be used by consumers or workers that can be easily re-located, such as a wireless modem operating in a laptop computer, are considered mobile devices if they meet the 20 centimeter separation requirement. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR §2.1091.

- **Portable Devices:** a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. Portable device requirements are found in Section 2.1093 of the FCC's Rules (47 CFR§2.1093).

The FCC also categorizes the use of the device as based upon the user's awareness and ability to exercise control over his or her exposure. The two categories defined are Occupational/ Controlled Exposure and General Population/Uncontrolled Exposure. These two categories are defined as follows:

- **Occupational/Controlled Exposure:** In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on methods to minimize such exposure risks.

- **General Population/Uncontrolled Exposure:** The general population / uncontrolled exposure limits are applicable to 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 made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices.

The **Apple Smart Speaker FCC ID: BCGA2825 and IC: 579C-A2825** is evaluated to the General Population/Uncontrolled Exposure requirements.

1.4 Procedure

The procedure used to determine the RF power density was based upon a calculation for determining compliance with the MPE requirements.

The power generated by the unlicensed transmitters used in this product were initially calculated using radiated measurement techniques as outlined in the test reports for BCGA2825. Through use of the Friis transmission formula and knowledge of the maximum antenna gain to be used, the power density level is calculated at a distance of 20cm.

All different frequencies per technology have been investigated and only the worst power density ratios have been reported.

Friis Transmission Formula

Friis transmission formula: $P_d = (P_{out}*G) / (4\pi r^2)$

Where,

P_d = Power Density (mW/cm^2)
P_{out} = output power to antenna (mW)
G = gain of antenna in linear scale
π = 3.1416
r = distance between observation point and center of the radiator (cm)

Calculated MPE

The power density limit for General Population/Uncontrolled Exposure at each frequency is determined based on the information in Table 1-1.

	FCC		ISED	
Frequency	2417	MHz	2417	MHz
Limit	1.000	mW/cm^2	5.374	W/m^2
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	24.33	dBm	24.33	dBm
Power (mW), P =	271.019	mW	0.271	W
Tx Ant Gain (dBi), G =	3.0	dBi	3.0	dBi
Power Density (S) at 20cm =	0.10758	mW/cm^2	1.07579	W/m^2
Minimum Distance =	6.55986	cm	0.08949	m

Table 1-3. Calculated MPE for WLAN

	FCC		ISED	
Frequency	2441	MHz	2441	MHz
Limit	1.000	mW/cm^2	5.410	W/m^2
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	16.90	dBm	16.90	dBm
Power (mW), P =	48.978	mW	0.049	W
Tx Ant Gain (dBi), G =	3.0	dBi	3.0	dBi
Power Density (S) at 20cm =	0.01944	mW/cm^2	0.19441	W/m^2
Minimum Distance =	2.78865	cm	0.03791	m

Table 1-4. Calculated MPE for Bluetooth

	FCC		ISED	
Frequency	2478	MHz	2478	MHz
Limit	1.000	mW/cm^2	5.466	W/m^2
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	14.09	dBm	14.09	dBm
Power (mW), P =	25.645	mW	0.026	W
Tx Ant Gain (dBi), G =	3.0	dBi	3.0	dBi
Power Density (S) at 20cm =	0.01018	mW/cm^2	0.10180	W/m^2
Minimum Distance =	2.01788	cm	0.02729	m

Table 1-5. Calculated MPE for Bluetooth HDR

	FCC		ISED	
Frequency	2478	MHz	2478	MHz
Limit	1.000	mW/cm^2	5.466	W/m^2
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	17.00	dBm	17.00	dBm
Power (mW), P =	50.119	mW	0.050	W
Tx Ant Gain (dBi), G =	3.0	dBi	3.0	dBi
Power Density (S) at 20cm =	0.01989	mW/cm^2	0.19894	W/m^2
Minimum Distance =	2.82094	cm	0.03816	m

Table 1-6. Calculated MPE for Bluetooth LE

	FCC		ISED	
Frequency	5580	MHz	5580	MHz
Limit	1.000	mW/cm^2	9.519	W/m^2
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	16.49	dBm	16.49	dBm
Power (mW), P =	44.566	mW	0.045	W
Tx Ant Gain (dBi), G =	4.3	dBi	4.3	dBi
Power Density (S) at 20cm =	0.02386	mW/cm^2	0.23863	W/m^2
Minimum Distance =	3.08955	cm	0.03167	m

Table 1-7. Calculated MPE for UNII

	FCC		ISED	
Frequency	8257.7	MHz	8257.7	MHz
Limit	1.000	mW/cm^2	10.000	W/m^2
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	-3.89	dBm	-3.89	dBm
Power (mW), P =	0.408	mW	0.0004	W
Tx Ant Gain (dBi), G =	2.2	dBi	2.2	dBi
Power Density (S) at 20cm =	0.00013	mW/cm^2	0.00135	W/m^2
Minimum Distance =	0.23222	cm	0.00232	m

Table 1-8. Calculated MPE for UWB Antenna 0

	FCC		ISED	
Frequency	8257	MHz	8257	MHz
Limit	1.000	mW/cm^2	10.000	W/m^2
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	-3.76	dBm	-3.76	dBm
Power (mW), P =	0.421	mW	0.0004	W
Tx Ant Gain (dBi), G =	2.9	dBi	2.9	dBi
Power Density (S) at 20cm =	0.00016	mW/cm^2	0.00163	W/m^2
Minimum Distance =	0.25550	cm	0.00256	m

Table 1-9. Calculated MPE for UWB Antenna 1

	FCC		ISED	
Frequency	2440.0	MHz	2440.0	MHz
Limit	1.000	mW/cm^2	5.409	W/m^2
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	17.45	dBm	17.45	dBm
Power (mW), P =	55.590	mW	0.056	W
Tx Ant Gain (dBi), G =	0.6	dBi	0.6	dBi
Power Density (S) at 20cm =	0.01270	mW/cm^2	0.12698	W/m^2
Minimum Distance =	2.25369	cm	0.03064	m

Table 1-10. Calculated MPE for 802.15.4

1.5 Summary of Results

	Power Density (mW/cm^2)	Limit (mW/cm^2)	Percent MPE Used (%)
Transmitter #1 WLAN	0.10758	1.00000	10.75794
Transmitter #2 Bluetooth	0.01944	1.00000	1.94415
Transmitter #3 Bluetooth HDR	0.01018	1.00000	1.01796
Transmitter #4 Bluetooth LE	0.01989	1.00000	1.98943
Transmitter #5 UNII	0.02386	1.00000	2.38632
Transmitter #6 UWB Antenna 0	0.00013	1.00000	0.01348
Transmitter #7 UWB Antenna 1	0.00016	1.00000	0.01632
Transmitter #8 802.15.4	0.01270	1.00000	1.26978
Total			19.39538

Table 1-13. FCC Cumulative Results for Multiple Transmitters

	Power Density (W/m^2)	Limit (W/m^2)	Percent MPE Used (%)
Transmitter #1 WLAN	1.07579	5.37362	20.01992
Transmitter #2 Bluetooth	0.19441	5.41003	3.59360
Transmitter #3 Bluetooth HDR	0.10180	5.46593	1.86236
Transmitter #4 Bluetooth LE	0.19894	5.46593	3.63969
Transmitter #5 UNII	0.23863	9.51887	2.50694
Transmitter #6 UWB Antenna 0	0.00135	10.00000	0.01348
Transmitter #7 UWB Antenna 1	0.00163	10.00000	0.01632
Transmitter #8 802.15.4	0.12698	5.40851	2.34775
Total			34.00007

Table 1-14. ISED Cumulative Results for Multiple Transmitters

2.0 CONCLUSION

The device meets the mobile RF exposure limit at a 20cm separation distance as specified in §2.1091 of the FCC Rules and Regulations and Health Canada Safety Code 6. An appropriate RF exposure compliance statement will be placed in the user's manual.